In [5]:

```
#importing the required Packages
import pandas as pd
from textblob import TextBlob
import re
import matplotlib.pyplot as plt
import seaborn
import itertools
import string
import nltk
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize
from wordcloud import WordCloud
from wordcloud import  STOPWORDS
from sklearn import ensemble
from sklearn import tree
from sklearn import metrics
from sklearn.feature_extraction.text import CountVectorizer, TfidfTransformer
from sklearn.naive_bayes import MultinomialNB
from sklearn.svm import SVC, LinearSVC
from sklearn.metrics import classification_report, accuracy_score, confusion_matrix
from sklearn.pipeline import Pipeline
from sklearn.cross_validation import cross_val_score, train_test_split
from sklearn.tree import DecisionTreeClassifier
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier, AdaBoostClassifier
from sklearn.naive_bayes import BernoulliNB
from sklearn.preprocessing import Binarizer, StandardScaler
from sklearn.neighbors import KNeighborsClassifier
from sklearn.feature_extraction.text import TfidfVectorizer
from nltk.sentiment.util import mark_negation
from matplotlib import pylab
pylab.rcParams['figure.figsize'] = (15, 9)

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

In [6]:

```
################## Defining the required Defined Functions

#%% Functions
def clean_tweet(tweet):
        '''
        Utility function to clean tweet text by removing links, special characters
        using simple regex statements.
        '''
        return ' '.join(re.sub("(@[A-Za-z0-9]+)|([^0-9A-Za-z \t])|(\w+:\/\/\S+)", " ", str(tweet)).
split())

def get_tweet_sentiment(tweet):
        '''
        Utility function to classify sentiment of passed tweet
        using textblob's sentiment method
        '''
        # create TextBlob object of passed tweet text
        analysis = TextBlob(clean_tweet(tweet))
        # set sentiment
        if analysis.sentiment.polarity > 0:
            return 'positive'
        elif analysis.sentiment.polarity == 0:
            return 'neutral'
        else:
            return 'negative'

def tweet_clean(df):
    temp_df = df.copy()
    # Remove hyperlinks
    temp_df.loc[:, "Text"] = temp_df.loc[:, "Text"].replace('https?:\/\/.*\/\w*', '', regex=True)
    # Remove citations
    temp_df.loc[:, "Text"] = temp_df.loc[:, "Text"].replace('\@\w*', '', regex=True)
    # Remove tickers
    temp_df.loc[:, "Text"] = temp_df.loc[:, "Text"].replace('\$\w*', '', regex=True)
    # Remove punctuation
    temp_df.loc[:, "Text"] = temp_df.loc[:, "Text"].replace('[' + string.punctuation + ']+', '', re
gex=True)
    # Remove quotes
    temp_df.loc[:, "Text"] = temp_df.loc[:, "Text"].replace('\&*[amp]*\;|gt+', '', regex=True)
    # Remove RT
    temp_df.loc[:, "Text"] = temp_df.loc[:, "Text"].replace('RT', '', regex=True)
    # Remove linebreak, tab, return
    temp_df.loc[:, "Text"] = temp_df.loc[:, "Text"].replace('[\n\t\r]+', ' ', regex=True)
    # Remove via with blank
    temp_df.loc[:, "Text"] = temp_df.loc[:, "Text"].replace('via+\s', '', regex=True)
    # Remove multiple whitespace
    temp_df.loc[:, "Text"] = temp_df.loc[:, "Text"].replace('\s+\s+', ' ', regex=True)
    # Remove multiple whitespace
    temp_df.loc[:, "Text"] = temp_df.loc[:, "Text"].replace('\s+\s+', ' ', regex=True)
    # Remove HashTags
    temp_df.loc[:, "Text"] = temp_df.loc[:, "Text"].replace('\#+[\w_]+[\w\'_\-]*[\w_]+', ' ', regex
=True)
    # Remove Smileys
    temp_df.loc[:, "Text"] = temp_df.loc[:, "Text"].replace('[:=]+(|o|O| )+[D\)\]]+[\(\[]+[pP]+[doO
/\\]+[\(\[]+(\^_\^|)', ' ', regex=True)
    # Remove empty rows
    temp_df = temp_df.dropna()
    return temp_df

def regularExpression(textToFilter):
    filteredTweet = []
    retweetPattern = 'RT|@RT'
    urlPattern = 'https://[a-zA-Z0-9+&@#/%?=~_|!:,.;]*'

    for textLine in textToFilter:
        tweet = re.sub(retweetPattern,'',textLine)
        tweet = re.sub(urlPattern,'',tweet)
        filteredTweet.append(tweet)
    return filteredTweet

def nltkTokenizer(textToTokenize):
    filteredSentence = []
    usersPattern = re.compile('@[a-zA-Z0-9]*',re.UNICODE)
    hashtagPattern = re.compile('#[a-zA-Z0-9]*',re.UNICODE)
    stop_words = stopwords.words('english')

    for textLine in textToTokenize:
        words = re.sub(usersPattern,'',textLine)
        words = re.sub(hashtagPattern,'',words)
        words = word_tokenize(words)
        for w in words:
            if w not in stop_words and w not in '@' and w not in '#':
                filteredSentence.append(w)
    return filteredSentence

def tweet_to_words(raw_tweet):
    tweet = ''.join(c for c in raw_tweet if c not in string.punctuation)
    tweet = re.sub('((www\S+)|(http\S+))', 'urlsite', tweet)
    tweet = re.sub(r'\d+', 'contnum', tweet)
    tweet = re.sub(' +',' ', tweet)
    words = tweet.lower().split()
    stops = set(stopwords.words("english"))

    meaningful_words = [w for w in words if not w in stops]
    return( " ".join( meaningful_words ))

def users(tweet):
    user = []
    usersPattern = re.compile('@[a-zA-Z0-9]*',re.UNICODE)

    for t in tweet:
        u = re.findall(usersPattern,t)
        user.append(u)
    return user

def split_into_tokens(Text):
    return TextBlob(Text).words

def split_into_lemmas(Text):
    Text = Text.lower()
    words = TextBlob(Text).words
    # for each word, take its "base form" = lemma
    return [word.lemma for word in words]
```

In [7]:

```
file_path = "C:\\Users\\91953\\Desktop\\Analytic Labs\\Thesis and Course\\Dublin Business School\\
Subham\\Thesis\\Data\\All_Tweets.csv"
```

In [8]:

```
tweets = pd.read_csv(file_path)

print(tweets.shape[0])

tweet = tweets["Text"]

cleaed_Tweet = clean_tweet(tweet)

Polarity = []
for tweet in tweets['Text']:
    Polarity.append(get_tweet_sentiment(tweet))

tweet = tweets['Text']
data_sent = {'Text': tweet, 'Polarity': Polarity}
tweet_data = pd.DataFrame(data=data_sent)

print("=========================================================================")
print("Printing the Head of the Tweets: ========================================")
print(tweet_data.head())
print("=========================================================================")
```

```
12000
=========================================================================
Printing the Head of the Tweets: ========================================
                                               Text  Polarity
0  89% of the cases reported today are asymptomat...  positive
1  89% of the cases reported today are asymptomat...  positive
2  @BarbaraGirouard @JamesE2020 @FriendsOScience ...   neutral
3  89% of today's record high Covid-19 cases in K...  positive
4  89% of the cases reported today are asymptomat...  positive
=========================================================================
```

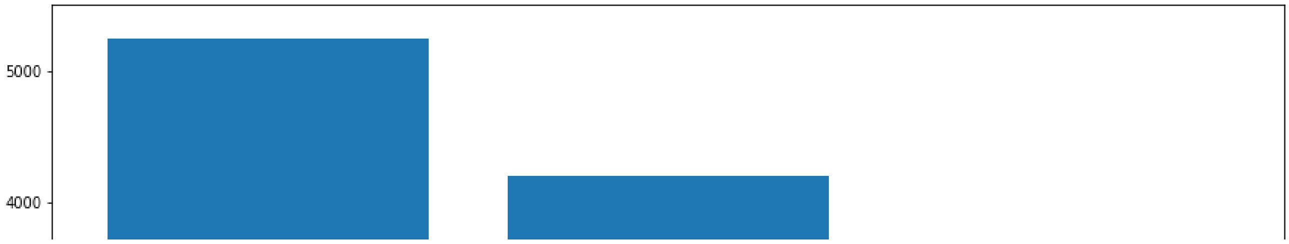
In [10]:

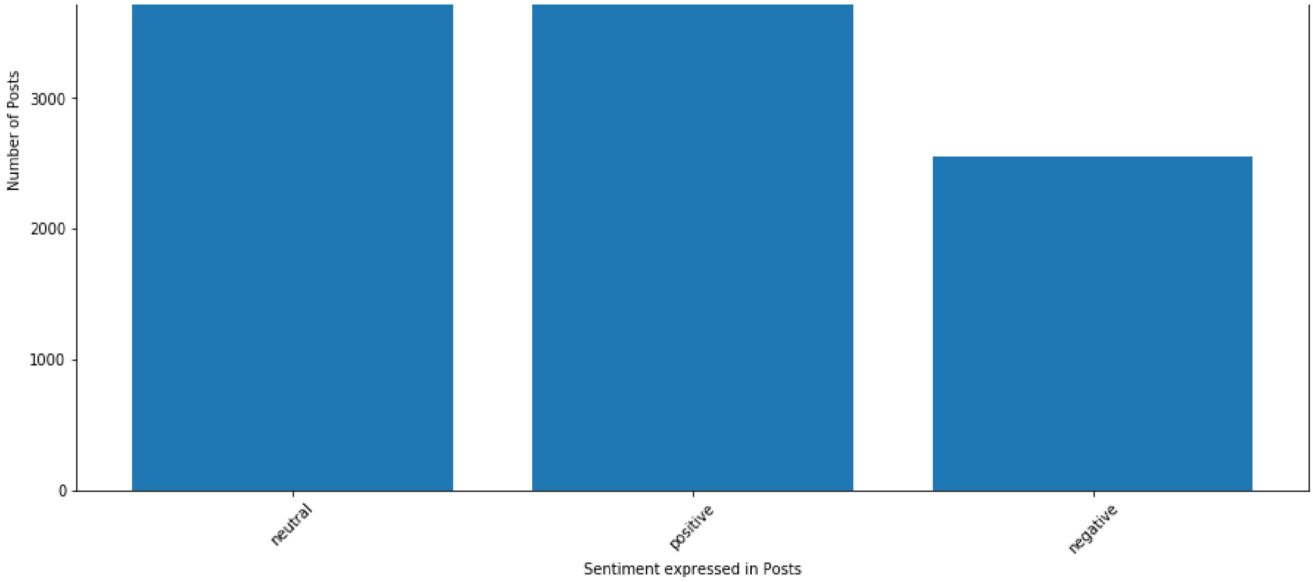
```
print("Ploting the TextBlob Sentiments: ========================================")
Index = [1,2,3]
print(tweet_data.Polarity.value_counts())
plt.bar(Index,tweet_data.Polarity.value_counts())
plt.xticks(Index,['neutral','positive', 'negative'],rotation=45)
plt.ylabel('Number of Posts')
plt.xlabel('Sentiment expressed in Posts')
```

```
Ploting the TextBlob Sentiments: ========================================
neutral     5247
positive    4198
negative    2555
Name: Polarity, dtype: int64
```

Out[10]:

```
Text(0.5,0,'Sentiment expressed in Posts')
```





In [11]:

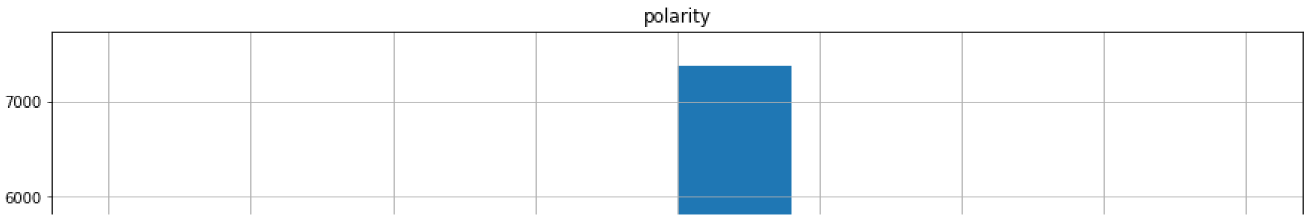
```
polar = pd.DataFrame()
n = int(len(tweet))
sen = []
for i in range(n):
    blob = TextBlob(str(tweet[i]))
    k = blob.sentiment.polarity
    sen.append(k)

polar['polarity'] = sen
print("Printing the Polar Data Head: ===========================================")
print(polar.head())
```

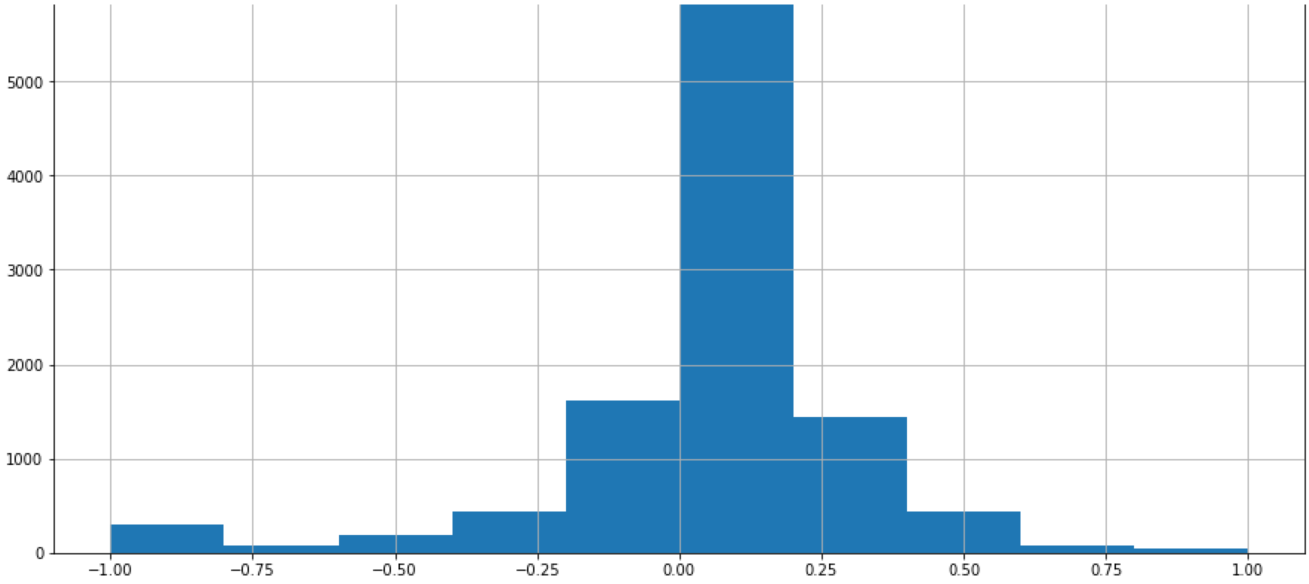
```
Printing the Polar Data Head: ===========================================
   polarity
0  0.219444
1  0.219444
2  0.000000
3  0.086010
4  0.219444
```

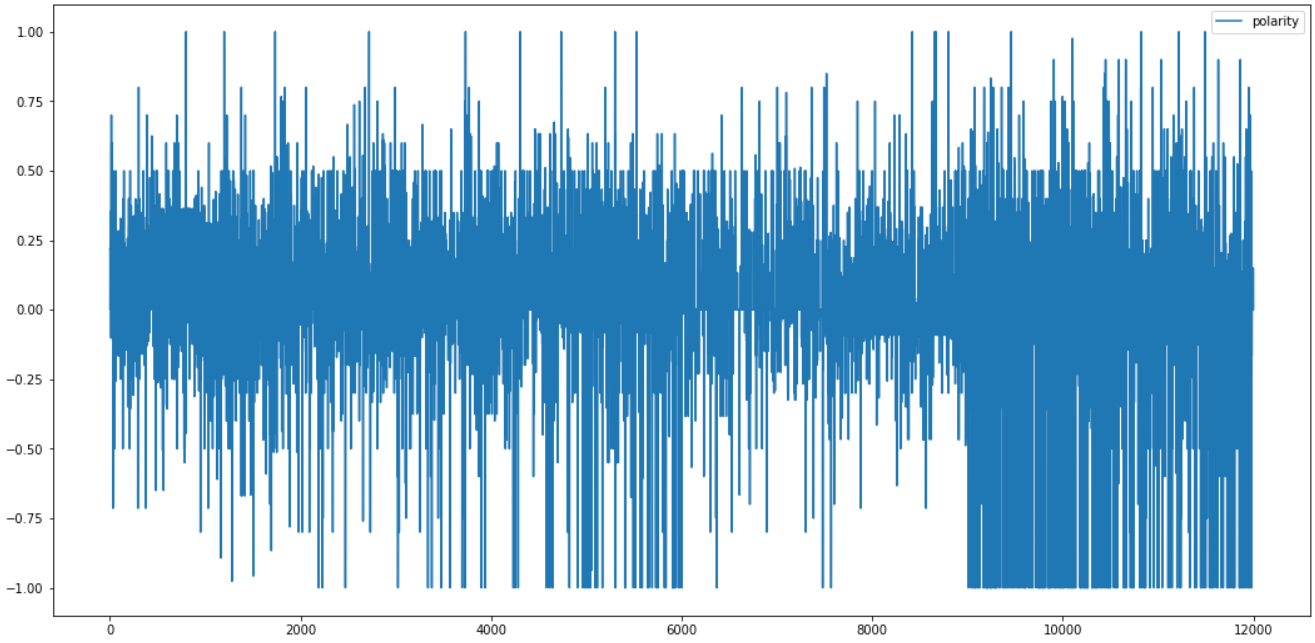
In [12]:

```
polar.hist()
polar.plot.line(y='polarity',figsize=(18,9))

tweet_data.groupby('Polarity').describe()

tweet_data['length'] = tweet_data['Text'].map(lambda text: len(text))
print("Printing the head of Tweets Data Newly Formed: ==========================")
print(tweet_data.head())
print("=========================================================================")
```

```
Printing the head of Tweets Data Newly Formed: ==========================
                                                Text  Polarity  length
0  89% of the cases reported today are asymptomat...  positive     162
1  89% of the cases reported today are asymptomat...  positive     162
2  @BarbaraGirouard @JamesE2020 @FriendsOScience ...   neutral     589
3  89% of today's record high Covid-19 cases in K...  positive     297
4  89% of the cases reported today are asymptomat...  positive     162
=========================================================================
```



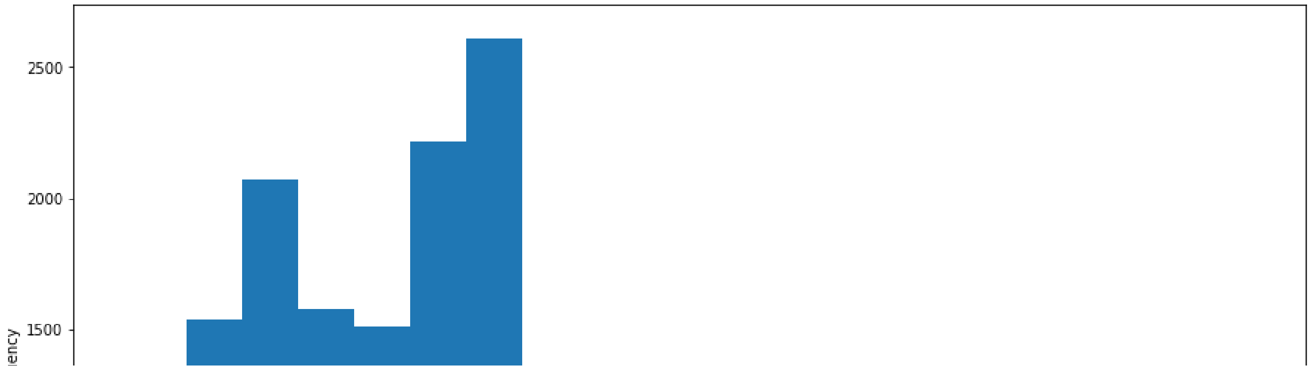


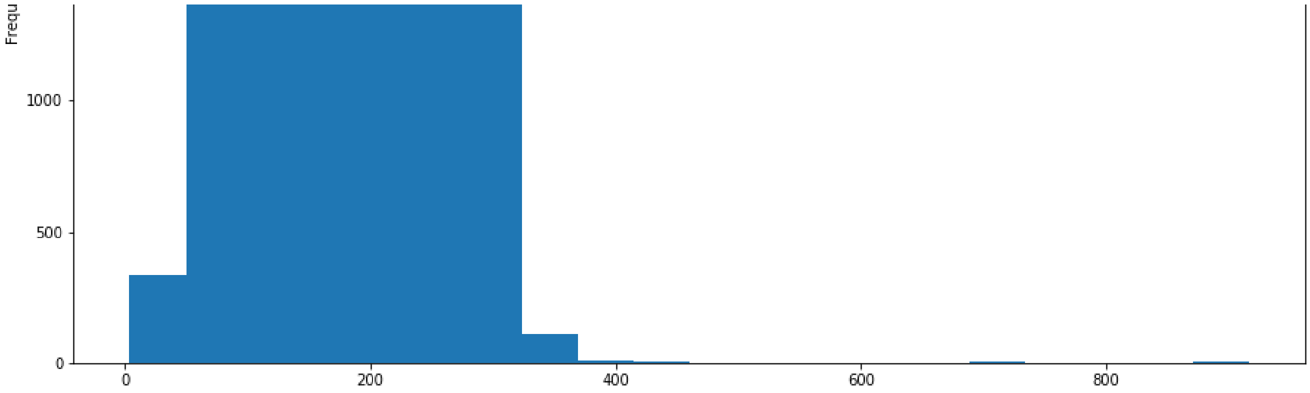


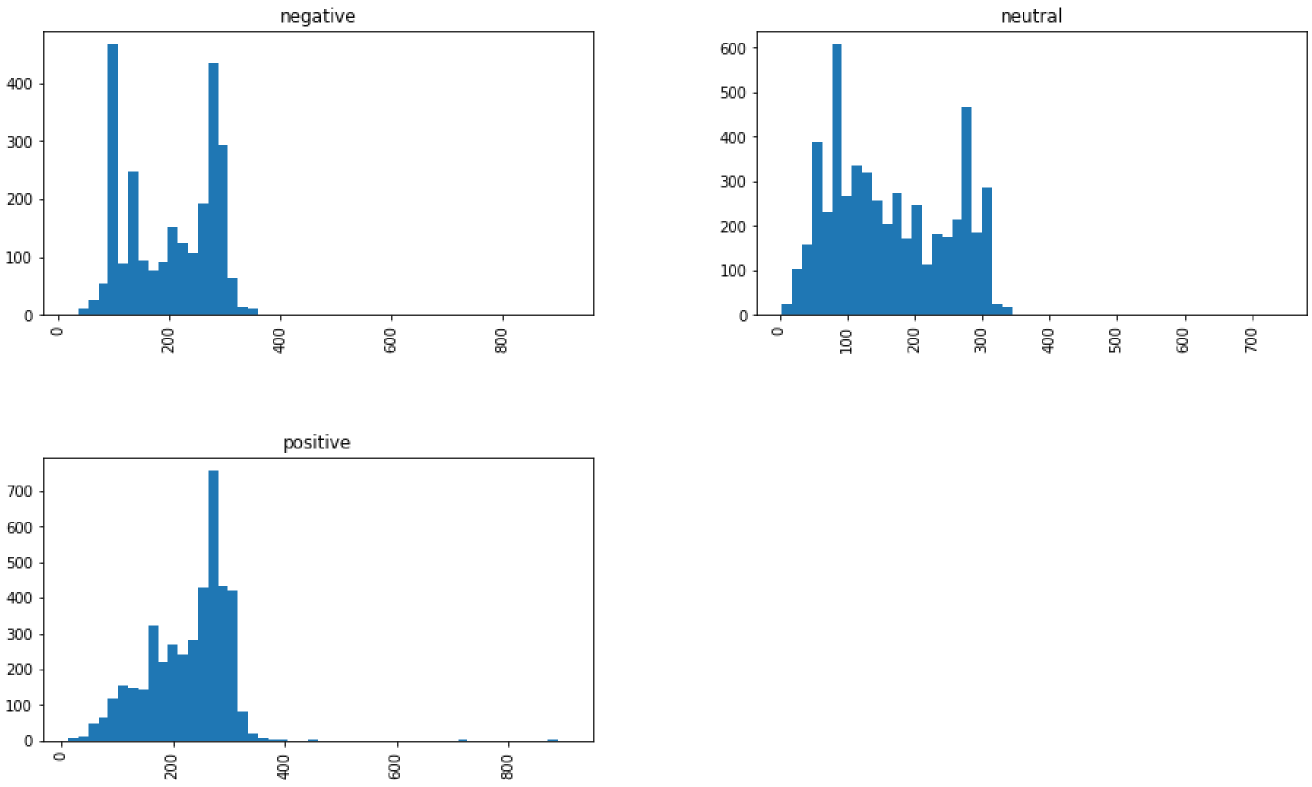
In [13]:

```
print("Histogram Plot of the Frequency: =======================================")
tweet_data.length.plot(bins=20, kind='hist')

tweet_data.hist(column='length', by='Polarity', bins=50)
print("Printing the Shape of the Tweets: ======================================")
print(tweet_data.shape)
```

```
Histogram Plot of the Frequency: =======================================
Printing the Shape of the Tweets: ======================================
(12000, 3)
```







In [14]:

```
tweets_texts = tweet_data["Text"].tolist()
stop_words=stopwords.words('english')
english_vocab = set(w.lower() for w in nltk.corpus.words.words())

# Get all the hashhtag words that has "#"
hashtags = ""
for line in tweets:
    words = line.split()
    for w in words:
        if w.startswith("#"):
            hashtags += w + " "

# Get all the hashtags in a list
hashtags_list = re.findall(r"#(\w+)", hashtags)

print("Ploting the Hashtag WordCloud: =========================================")
try:
    # Set the figure-size
    plt.figure(figsize= (20,10))
    wordcloud = WordCloud(
                          stopwords=STOPWORDS,
                          background_color='white',
                          width=3000,
                          height=2000
                         ).generate(str(hashtags_list))

    plt.figure(1,figsize=(20, 20))
    plt.imshow(wordcloud)
    plt.axis('off')
    plt.savefig('./twitter_wordcloud.png', dpi=300)
    plt.show()
except:
    print("No HashTags Found!! Please Verify the length")

print(len(hashtags_list))
print("========================================================================")
```

```
Ploting the Hashtag WordCloud: =========================================
No HashTags Found!! Please Verify the length
0
========================================================================


<Figure size 1440x720 with 0 Axes>
```

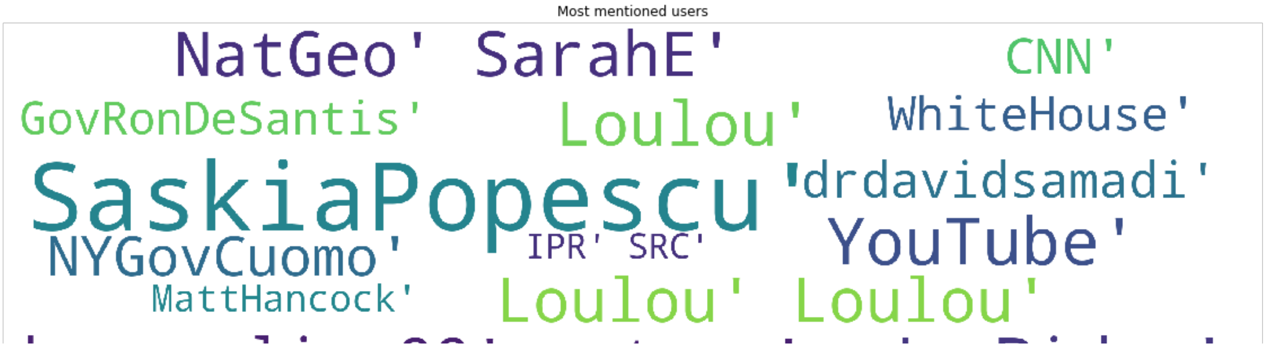
In [15]:

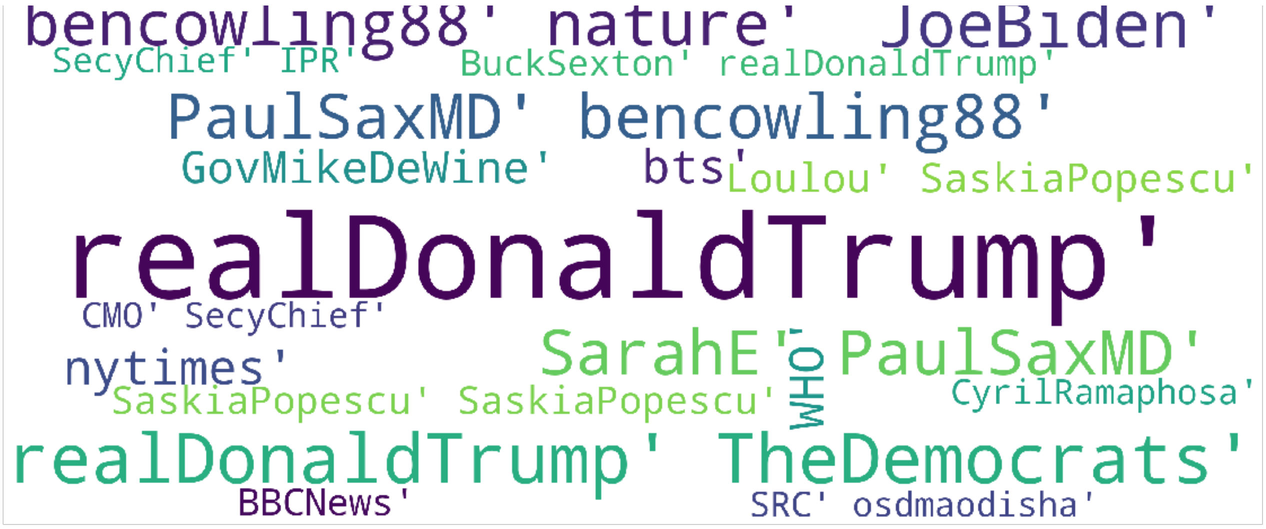
```
#%%
# Text contains 'RT' for every retweet and url refrences
# We want to remover 'RT' and URL

filteredTweet = regularExpression(tweet_data.Text)
filteredSentence = nltkTokenizer(filteredTweet)


hashtagList = list(itertools.chain.from_iterable(hashtags_list))
hashtagCount = {}

for h in hashtagList:
    if h in hashtagCount:
        hashtagCount[h] +=1
    else:
        hashtagCount[h] = 1

# Extracting hastags that occurs more than 1000 times

hashtagCount = { k : v for k,v in hashtagCount.items() if v >10}
name = [k for k in hashtagCount if k ]
value = [v for v in hashtagCount.values()]
```

In [16]:

```
print("Extracting the User words used in the Tweets: ==========================")
user = users(filteredTweet)

str1 = ' '.join(str(e) for e in user)

plt.figure(figsize= (20,20))

wordcloud = WordCloud(width= 3000,height=
2000,background_color='white',max_words=30).generate(str1)
plt.imshow(wordcloud)
plt.title('Most mentioned users')
plt.axis("off")
plt.show()
print("========================================================================")
```

```
Extracting the User words used in the Tweets: ==========================
```



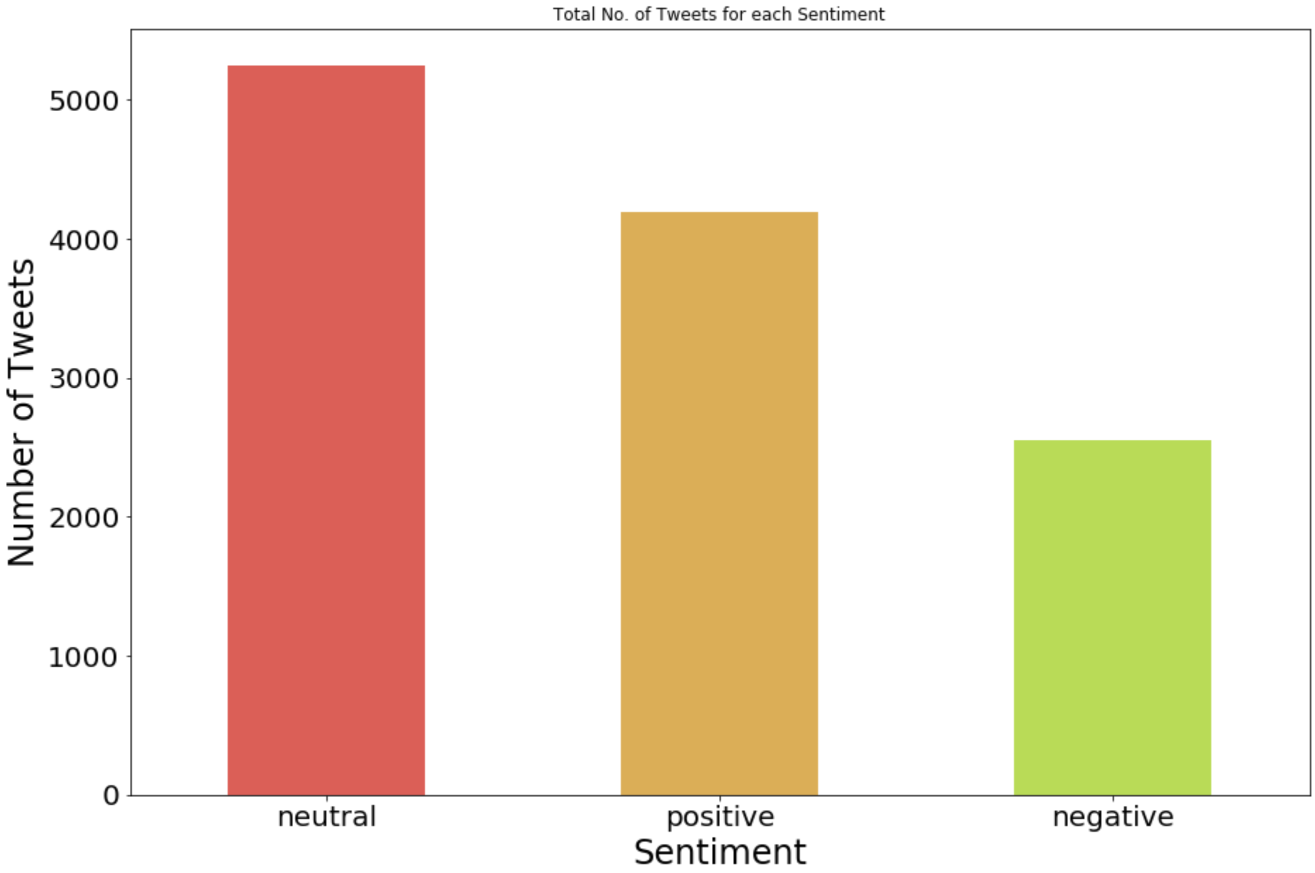


```
==========================================================================
```

In [17]:

```
print("Ploting the Polarity Numbers Extracted from the TextBlob: ==============")
tweet_data.Polarity.value_counts()

colors=seaborn.color_palette("hls", 10)
pd.Series(tweet_data["Polarity"]).value_counts().plot(kind = "bar",
                        color=colors,figsize=(15,10),fontsize=20,rot = 0, title = "Total No. of Twe
ts for each Sentiment")
plt.xlabel('Sentiment', fontsize=24)
plt.ylabel('Number of Tweets', fontsize=24)

colors=seaborn.color_palette("husl", 10)
```

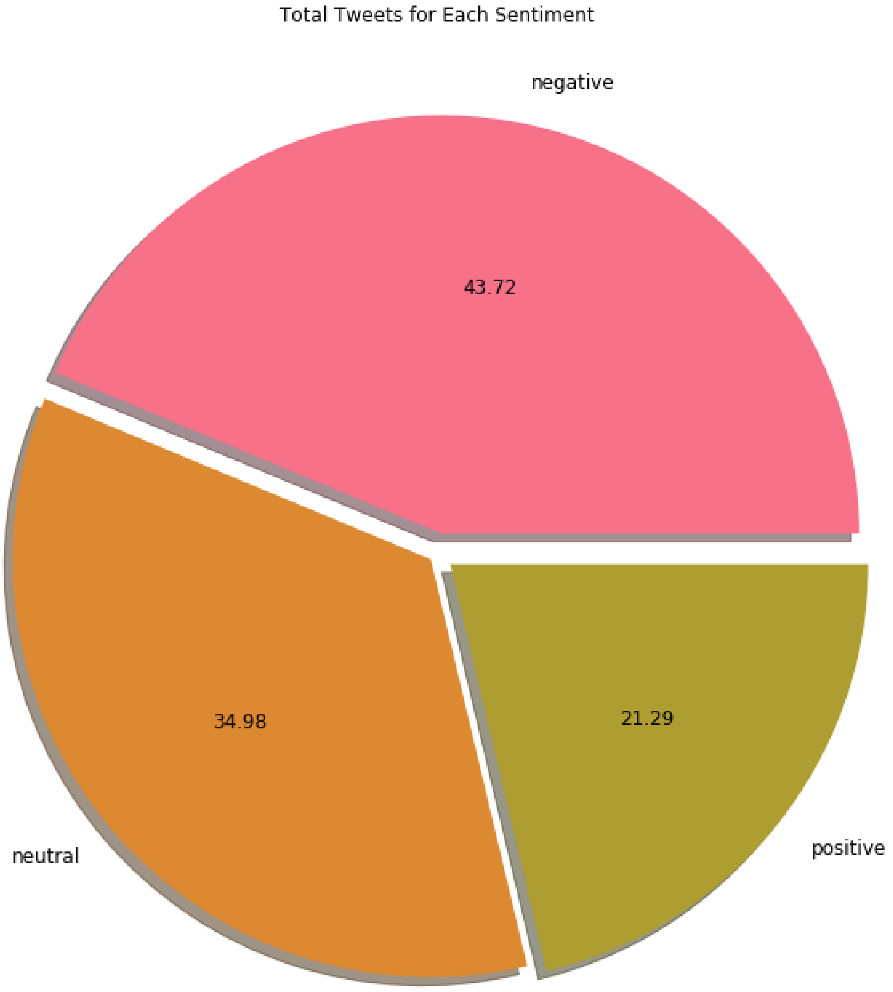
```
Ploting the Polarity Numbers Extracted from the TextBlob: ==============
```



In [18]:

In [18]:

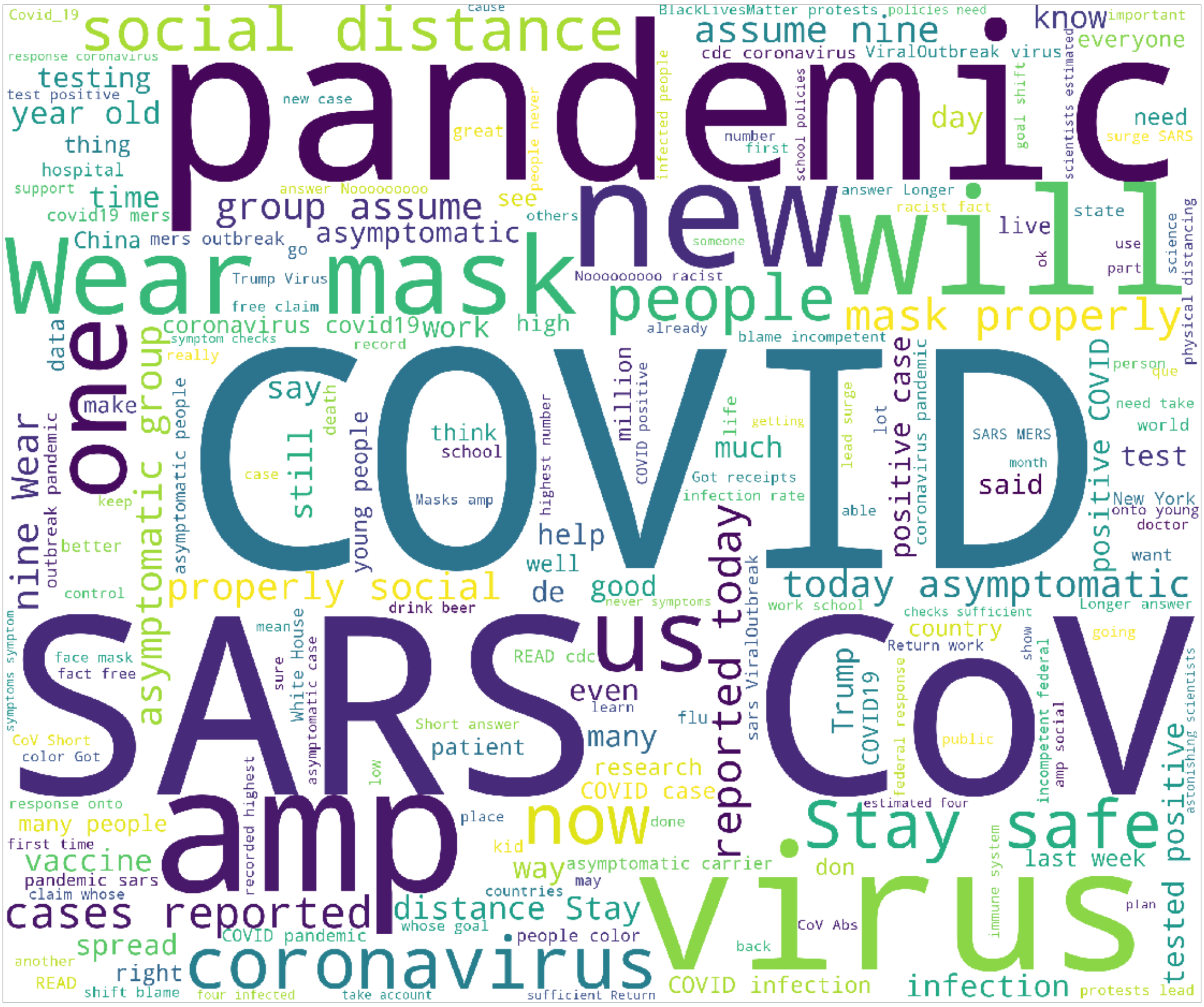
```
pd.Series(tweet_data["Polarity"]).value_counts().plot(kind="pie",colors=colors,
    labels=["negative", "neutral", "positive"],explode=[0.05,0.02,0.04],
    shadow=True,autopct='%.2f', fontsize=12,figsize=(12,12),title = "Total Tweets for Each Sentiment")

df=tweet_data[tweet_data['Polarity']=='negative']
words = ' '.join(df['Text'])
cleaned_word = " ".join([word for word in words.split()
                            if 'http' not in word
                                and not word.startswith('@')
                                and word != 'RT'])

wordcloud = WordCloud(stopwords=STOPWORDS,
                      background_color='white',
                      width=3000,
                      height=2500
                     ).generate(cleaned_word)

plt.figure(1,figsize=(20, 20))
plt.imshow(wordcloud)
plt.axis('off')
plt.savefig('./negative_tweet_wordcloud.png', dpi=300)
plt.show()
```



In [19]:

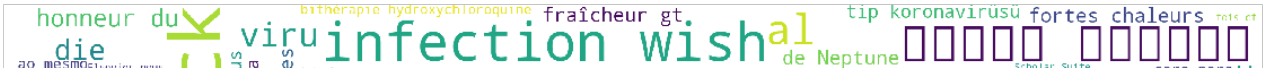
```
df=tweet_data[tweet_data['Polarity']=='positive']
words = ' '.join(df['Text'])
cleaned_word = " ".join([word for word in words.split()
                            if 'http' not in word
                                and not word.startswith('@')
                                and word != 'RT'])
```

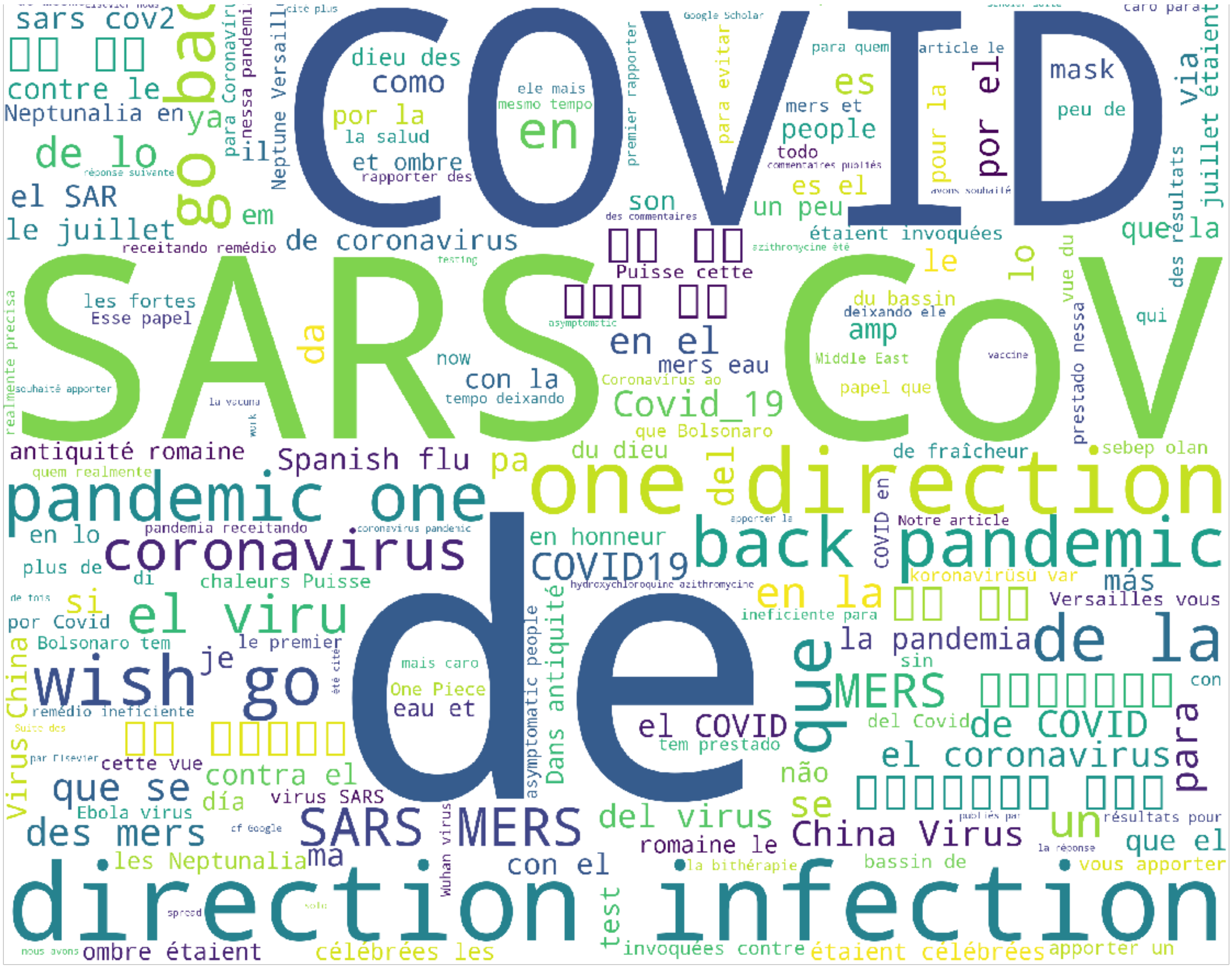
```
wordcloud = WordCloud(stopwords=STOPWORDS,
                      background_color='white',
                      width=3000,
                      height=2500
                     ).generate(cleaned_word)

plt.figure(1,figsize=(20, 20))
plt.imshow(wordcloud)
plt.axis('off')
plt.savefig('./positive_tweet_wordcloud.png', dpi=300)
plt.show()
```



In [20]:

```
df=tweet_data[tweet_data['Polarity']=='neutral']
words = ' '.join(df['Text'])
cleaned_word = " ".join([word for word in words.split()
                            if 'http' not in word
                                and not word.startswith('@')
                                and word != 'RT'])
wordcloud = WordCloud(stopwords=STOPWORDS,
                      background_color='white',
                      width=3000,
                      height=2500
                     ).generate(cleaned_word)
plt.figure(1,figsize=(20, 20))
plt.imshow(wordcloud)
plt.axis('off')
plt.show()
print("==========================================================================")
```

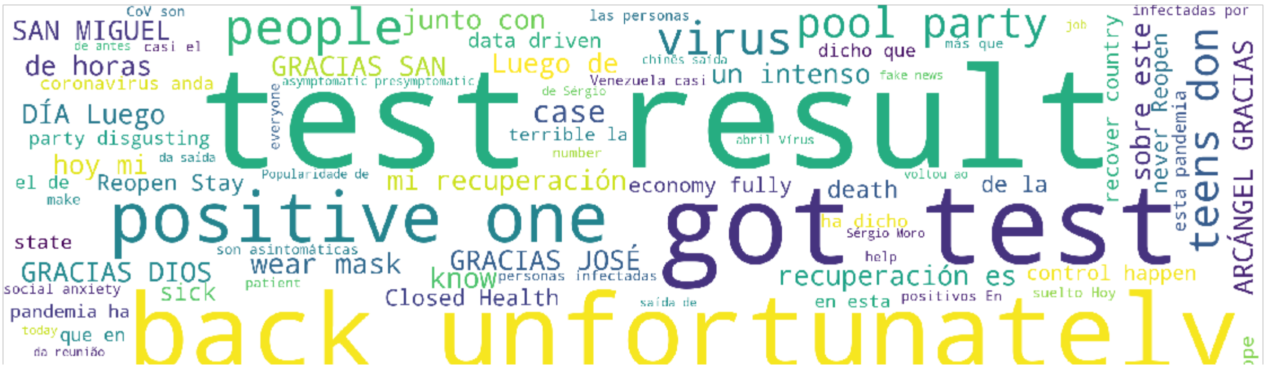


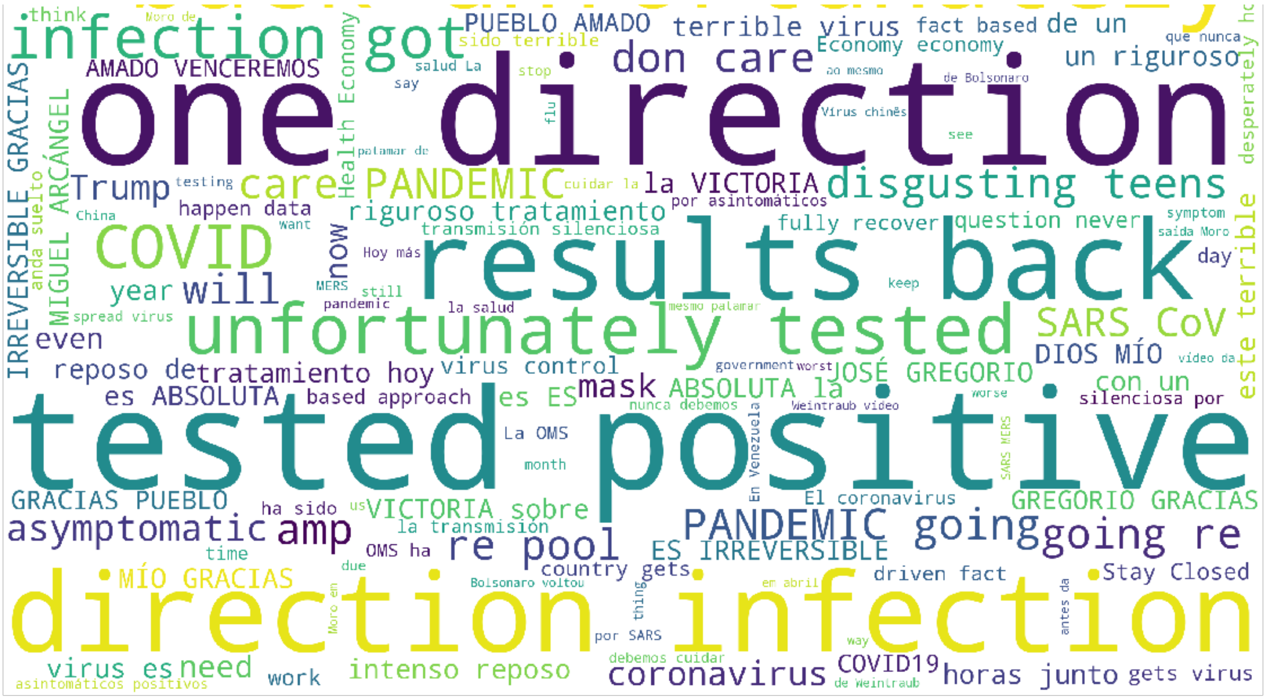


```
==========================================================================
```

In [21]:

```
df=tweet_data[tweet_data['Polarity']=='negative']
words = ' '.join(df['Text'])
cleaned_word = " ".join([word for word in words.split()
                            if 'http' not in word
                                and not word.startswith('@')
                                and word != 'RT'])

wordcloud = WordCloud(stopwords=STOPWORDS,
                      background_color='white',
                      width=3000,
                      height=2500
                     ).generate(cleaned_word)

plt.figure(1,figsize=(20, 20))
plt.imshow(wordcloud)
plt.axis('off')
plt.savefig('./negative_tweet_wordcloud.png', dpi=300)
plt.show()
```





In [22]:

```
print("=========================================================================")
print("Starting the Machine Learning Analysis: =================================")
print("=========================================================================")

tweet_data['clean_tweet']=tweet_data['Text'].apply(lambda x: tweet_to_words(x))
train,test = train_test_split(tweet_data,test_size=0.33,random_state=0)

train_clean_tweet=[]
for tweet in train['clean_tweet']:
    train_clean_tweet.append(tweet)
test_clean_tweet=[]
for tweet in test['clean_tweet']:
    test_clean_tweet.append(tweet)
print("Using the COUNTVECTORIZER: ==============================================")
v = CountVectorizer(analyzer = "word")
train_features= v.fit_transform(train_clean_tweet)
test_features=v.transform(test_clean_tweet)


Classifiers = [
    LogisticRegression(C=0.001,multi_class='multinomial',max_iter=10,solver='sag', tol=1e-1),

    RandomForestClassifier(n_estimators=200, bootstrap=True, class_weight=None, criterion='gini',
            max_depth=50, max_features='auto', max_leaf_nodes=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_jobs= -1,
            oob_score=False, random_state=10),

    AdaBoostClassifier(n_estimators=100, random_state=10),

    BernoulliNB(),

    MultinomialNB(alpha=1.0, class_prior=None, fit_prior=True),

    KNeighborsClassifier(algorithm='auto', metric='minkowski',
           metric_params=None, n_neighbors=2, p=2,
           weights='uniform'),

    tree.DecisionTreeClassifier(),

    ensemble.ExtraTreesClassifier(n_estimators=100,
                                  max_features= 50,
                                  criterion= 'entropy'),

    ensemble.GradientBoostingClassifier(criterion='friedman_mse', init=None,
             learning_rate=0.001,n_estimators=50,presort='auto', random_state=None, verbose = 0)]
```

```python
dense_features=train_features.toarray()
dense_test= test_features.toarray()
Accuracy=[]
Model=[]
print("Entering into the Classifiers: =========================================")
for classifier in Classifiers:
    try:
        fit = classifier.fit(train_features,train['Polarity'])
        pred = fit.predict(test_features)
    except Exception:
        fit = classifier.fit(dense_features,train['Polarity'])
        pred = fit.predict(dense_test)
    accuracy = accuracy_score(pred,test['Polarity'])
    print("====================================================================")
    print("********************************************************************")
    print('Accuracy of '+classifier.__class__.__name__+'is '+str(accuracy))
    print("********************************************************************")
    print("====================================================================")
    Accuracy.append(accuracy)
    print("Classification report for classifier %s:\n%s\n"
      % (classifier, metrics.classification_report(test['Polarity'], pred)))
    cm = metrics.confusion_matrix(test['Polarity'], pred)
    print("--------------------------------------------------------------------")
    print("Confusion matrix:\n%s" % cm)
    print("--------------------------------------------------------------------")
    Model.append(classifier.__class__.__name__)
    print("********************************************************************")
    print("====================================================================")
```

```
========================================================================
Starting the Machine Learning Analysis: ================================
========================================================================
Using the COUNTVECTORIZER: =============================================
Entering into the Classifiers: =========================================
====================================================================
********************************************************************
Accuracy of LogisticRegressionis 0.7080808080808081
********************************************************************
====================================================================
Classification report for classifier LogisticRegression(C=0.001, class_weight=None, dual=False, fi
t_intercept=True,
          intercept_scaling=1, max_iter=10, multi_class='multinomial',
          n_jobs=1, penalty='l2', random_state=None, solver='sag', tol=0.1,
          verbose=0, warm_start=False):
             precision    recall  f1-score   support

   negative       0.90      0.29      0.44       857
    neutral       0.86      0.76      0.81      1757
   positive       0.57      0.90      0.70      1346

avg / total       0.77      0.71      0.69      3960


--------------------------------------------------------------------
Confusion matrix:
[[ 251   98  508]
 [   6 1341  410]
 [  21  113 1212]]
--------------------------------------------------------------------
********************************************************************
====================================================================
====================================================================
********************************************************************
Accuracy of RandomForestClassifieris 0.8113636363636364
********************************************************************
====================================================================
Classification report for classifier RandomForestClassifier(bootstrap=True, class_weight=None,
criterion='gini',
            max_depth=50, max_features='auto', max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, n_estimators=200, n_jobs=-1,
            oob_score=False, random_state=10, verbose=0, warm_start=False):
             precision    recall  f1-score   support
   negative       1.00      0.47      0.64       857
    neutral       0.81      0.95      0.87      1757
   positive       0.76      0.85      0.80      1346

avg / total       0.83      0.81      0.80      3960


--------------------------------------------------------------------
Confusion matrix:
[[ 405  189  263]
 [   0 1665   92]
 [   1  202 1143]]
--------------------------------------------------------------------
********************************************************************
====================================================================
====================================================================
********************************************************************
Accuracy of AdaBoostClassifieris 0.8037878787878788
********************************************************************
====================================================================
Classification report for classifier AdaBoostClassifier(algorithm='SAMME.R', base_estimator=None,
          learning_rate=1.0, n_estimators=100, random_state=10):
             precision    recall  f1-score   support

   negative       0.81      0.63      0.71       857
    neutral       0.78      0.96      0.86      1757
   positive       0.85      0.71      0.77      1346

avg / total       0.81      0.80      0.80      3960


--------------------------------------------------------------------
Confusion matrix:
[[ 544  184  129]
 [  25 1690   42]
 [ 100  297  949]]
--------------------------------------------------------------------
********************************************************************
====================================================================
====================================================================
********************************************************************
Accuracy of BernoulliNBis 0.7863636363636364
********************************************************************
====================================================================
Classification report for classifier BernoulliNB(alpha=1.0, binarize=0.0, class_prior=None,
fit_prior=True):
             precision    recall  f1-score   support

   negative       0.96      0.50      0.65       857
    neutral       0.93      0.81      0.87      1757
   positive       0.64      0.94      0.76      1346

avg / total       0.84      0.79      0.78      3960


--------------------------------------------------------------------
Confusion matrix:
[[ 425   40  392]
 [   5 1428  324]
 [  13   72 1261]]
--------------------------------------------------------------------
********************************************************************
====================================================================
====================================================================
********************************************************************
Accuracy of MultinomialNBis 0.7638888888888888
********************************************************************
====================================================================
Classification report for classifier MultinomialNB(alpha=1.0, class_prior=None, fit_prior=True):
             precision    recall  f1-score   support

   negative       0.84      0.59      0.70       857
    neutral       0.94      0.72      0.82      1757
   positive       0.62      0.93      0.74      1346

avg / total       0.81      0.76      0.77      3960
```

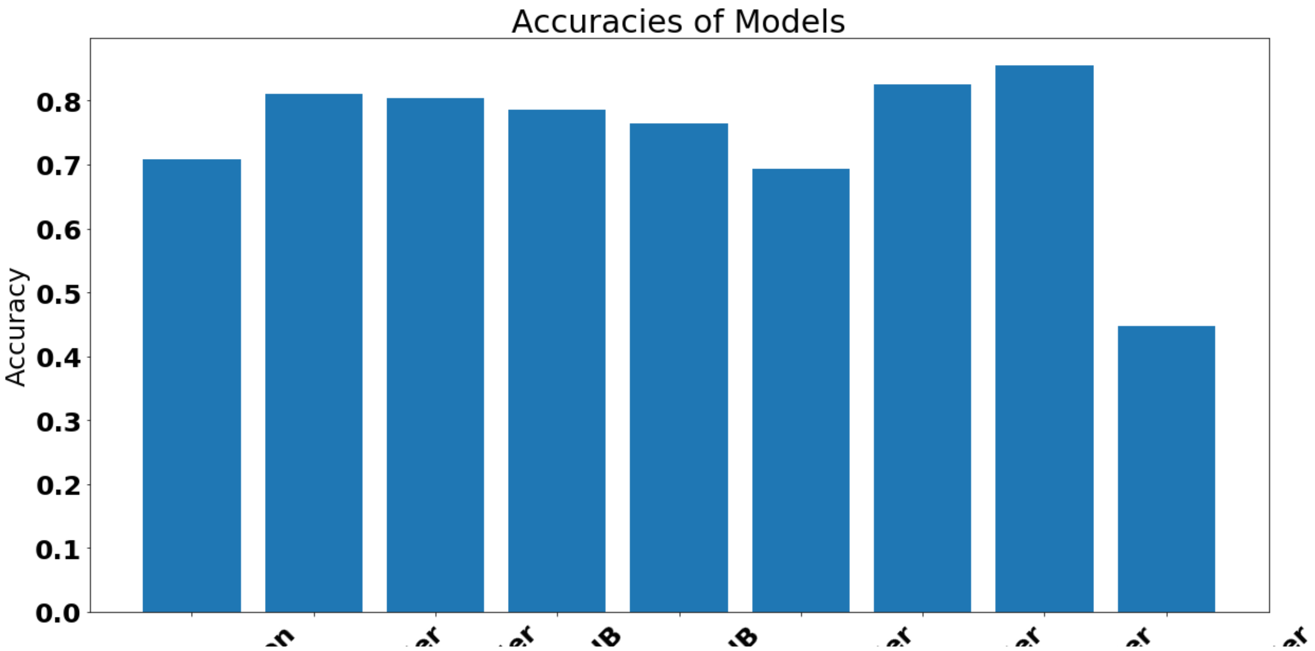
```
--------------------------------------------------------------------
Confusion matrix:
[[ 508   21  328]
 [  53 1268  436]
 [  43   54 1249]]
--------------------------------------------------------------------
********************************************************************
====================================================================
====================================================================
********************************************************************
Accuracy of KNeighborsClassifieris 0.6941919191919191
********************************************************************
====================================================================
Classification report for classifier KNeighborsClassifier(algorithm='auto', leaf_size=30,
metric='minkowski',
           metric_params=None, n_jobs=1, n_neighbors=2, p=2,
           weights='uniform'):
             precision    recall  f1-score   support

   negative       0.94      0.55      0.70       857
    neutral       0.60      0.99      0.75      1757
   positive       0.97      0.39      0.56      1346

avg / total       0.80      0.69      0.67      3960


--------------------------------------------------------------------
Confusion matrix:
[[ 474  370   13]
 [   9 1745    3]
 [  22  794  530]]
--------------------------------------------------------------------
********************************************************************
====================================================================
====================================================================
********************************************************************
Accuracy of DecisionTreeClassifieris 0.825
********************************************************************
====================================================================
Classification report for classifier DecisionTreeClassifier(class_weight=None, criterion='gini', m
ax_depth=None,
            max_features=None, max_leaf_nodes=None,
            min_impurity_decrease=0.0, min_impurity_split=None,
            min_samples_leaf=1, min_samples_split=2,
            min_weight_fraction_leaf=0.0, presort=False, random_state=None,
            splitter='best'):
             precision    recall  f1-score   support

   negative       0.81      0.67      0.73       857
    neutral       0.86      0.91      0.88      1757
   positive       0.79      0.81      0.80      1346

avg / total       0.82      0.82      0.82      3960


--------------------------------------------------------------------
Confusion matrix:
[[ 574  106  177]
 [  39 1600  118]
 [  97  156 1093]]
--------------------------------------------------------------------
********************************************************************
====================================================================
====================================================================
********************************************************************
Accuracy of ExtraTreesClassifieris 0.8550505050505051
********************************************************************
====================================================================
Classification report for classifier ExtraTreesClassifier(bootstrap=False, class_weight=None,
criterion='entropy',
           max_depth=None, max_features=50, max_leaf_nodes=None,
           min_impurity_decrease=0.0, min_impurity_split=None,
           min_samples_leaf=1, min_samples_split=2,
           min_weight_fraction_leaf=0.0, n_estimators=100, n_jobs=1,
           oob_score=False, random_state=None, verbose=0, warm_start=False):
             precision    recall  f1-score   support
   negative       0.96      0.61      0.74       857
    neutral       0.87      0.96      0.91      1757
   positive       0.80      0.88      0.84      1346

avg / total       0.86      0.86      0.85      3960


--------------------------------------------------------------------
Confusion matrix:
[[ 521  112  224]
 [   3 1680   74]
 [  18  143 1185]]
--------------------------------------------------------------------
********************************************************************
====================================================================
====================================================================
********************************************************************
Accuracy of GradientBoostingClassifieris 0.44772727272727275
********************************************************************
====================================================================
Classification report for classifier GradientBoostingClassifier(criterion='friedman_mse',
init=None,
              learning_rate=0.001, loss='deviance', max_depth=3,
              max_features=None, max_leaf_nodes=None,
              min_impurity_decrease=0.0, min_impurity_split=None,
              min_samples_leaf=1, min_samples_split=2,
              min_weight_fraction_leaf=0.0, n_estimators=50,
              presort='auto', random_state=None, subsample=1.0, verbose=0,
              warm_start=False):
             precision    recall  f1-score   support

   negative       0.00      0.00      0.00       857
    neutral       0.45      1.00      0.62      1757
   positive       1.00      0.01      0.02      1346

avg / total       0.54      0.45      0.28      3960


--------------------------------------------------------------------
Confusion matrix:
[[   0  857    0]
 [   0 1757    0]
 [   0 1330   16]]
--------------------------------------------------------------------
********************************************************************
====================================================================
```

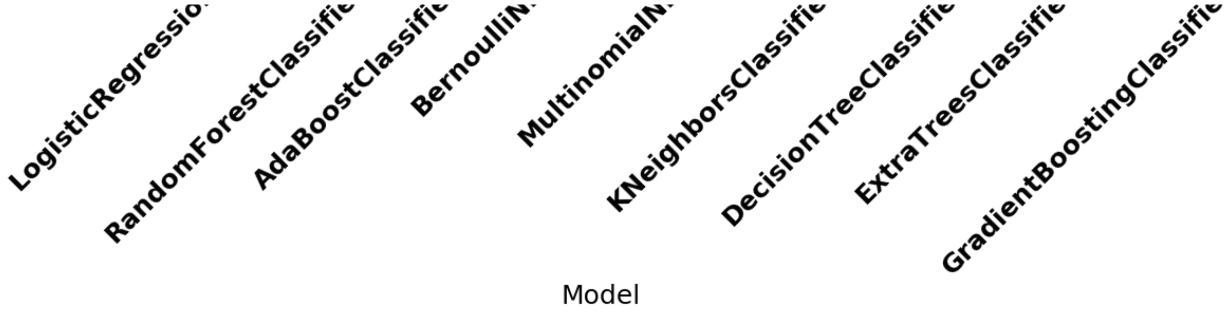
In [23]:

```
print("Ploting the Model Performances: ========================================")
Index = [1,2,3,4,5,6,7,8,9]
plt.figure(1,figsize=(20, 10))
font = {'weight' : 'bold',
        'size'   : 25}

plt.rc('font', **font)

plt.bar(Index,Accuracy)
plt.xticks(Index, Model,rotation=45)
plt.ylabel('Accuracy')
plt.xlabel('Model')
plt.title('Accuracies of Models')

print("Using the CountVectorizer on the Original Data: ========================")
tweets = tweet_data['Text']
cv = CountVectorizer(ngram_range=(1,2), min_df=3, max_df=.95, stop_words='english')
bow = cv.fit_transform(tweets)

# use below if you need a data frame
bow_df = pd.DataFrame(bow.toarray(), index=tweets.index, columns=cv.get_feature_names())

X, Y = bow, (tweet_data['Polarity']).ravel()

binarize = Binarizer()
X = binarize.fit_transform(X)
```

```
X_train, X_test, y_train, y_test = \
    train_test_split(X, Y,test_size=0.3)

model = MultinomialNB()
model.fit(X_train, y_train)

preds = model.predict(X_test)

accuracy = accuracy_score(preds, y_test)
print("=========================================================================")
print("*************************************************************************")
print('Accuracy is ' + str(accuracy))
print("-------------------------------------------------------------------------")
print("Classification report for classifier %s:\n%s\n"
      % (classifier, metrics.classification_report(y_test, preds)))
cm = metrics.confusion_matrix(y_test, preds)
print("-------------------------------------------------------------------------")
print("Confusion matrix:\n%s" % cm)
print("=========================================================================")
```

```
Ploting the Model Performances: ========================================
Using the CountVectorizer on the Original Data: ========================
========================================================================
************************************************************************
Accuracy is 0.8058333333333333
------------------------------------------------------------------------
Classification report for classifier GradientBoostingClassifier(criterion='friedman_mse',
init=None,
              learning_rate=0.001, loss='deviance', max_depth=3,
              max_features=None, max_leaf_nodes=None,
              min_impurity_decrease=0.0, min_impurity_split=None,
              min_samples_leaf=1, min_samples_split=2,
              min_weight_fraction_leaf=0.0, n_estimators=50,
              presort='auto', random_state=None, subsample=1.0, verbose=0,
              warm_start=False):
             precision    recall  f1-score   support

   negative       0.78      0.66      0.72       749
    neutral       0.96      0.78      0.86      1575
   positive       0.70      0.92      0.79      1276

avg / total       0.83      0.81      0.81      3600


------------------------------------------------------------------------
Confusion matrix:
[[ 498   15  236]
 [  71 1229  275]
 [  70   32 1174]]
========================================================================
```





In [24]:

```
X, Y = bow, (tweet_data['Polarity']).ravel()
ss = StandardScaler()
X = X.toarray()
X = ss.fit_transform(X)

X_train, X_test, y_train, y_test = \
    train_test_split(X, Y,test_size=0.3)

model = SVC()
model.fit(X_train, y_train)

preds = model.predict(X_test)

accuracy = accuracy_score(preds, y_test)
print("************************************************************************")
print('Accuracy is '+str(accuracy))
print("------------------------------------------------------------------------")
print("Classification report for classifier %s:\n%s\n"
      % (classifier, metrics.classification_report(y_test, preds)))
cm = metrics.confusion_matrix(y_test, preds)
print("------------------------------------------------------------------------")
print("Confusion matrix:\n%s" % cm)
print("========================================================================")

models = [('mNB' , MultinomialNB()),
          ('bNB' , BernoulliNB()),
          ('svc' , SVC())]

print('{0}\t{1:<1}\t{2:<4}\t{3:<4}'.format("ACCURACY", "MEAN", "MIN", "MAX"))
```

```
************************************************************************
Accuracy is 0.8063888888888889
------------------------------------------------------------------------
Classification report for classifier GradientBoostingClassifier(criterion='friedman_mse',
init=None,
              learning_rate=0.001, loss='deviance', max_depth=3,
              max_features=None, max_leaf_nodes=None,
              min_impurity_decrease=0.0, min_impurity_split=None,
              min_samples_leaf=1, min_samples_split=2,
              min_weight_fraction_leaf=0.0, n_estimators=50,
              presort='auto', random_state=None, subsample=1.0, verbose=0,
              warm_start=False):
             precision    recall  f1-score   support

   negative       1.00      0.56      0.71       772
    neutral       0.79      0.93      0.85      1580
   positive       0.77      0.81      0.79      1248

avg / total       0.83      0.81      0.80      3600


------------------------------------------------------------------------
Confusion matrix:
[[ 429  149  194]
 [   0 1466  114]
 [   2  238 1008]]
========================================================================
ACCURACY MEAN MIN  MAX
```

In [25]:

```
for name, model in models:
    X, Y = bow, (tweet_data['Polarity']).ravel()

    if name == 'bNB':
        binarize = Binarizer()
        X = binarize.fit_transform(X)
    elif name == 'svc':
        ss = StandardScaler()
        X = X.toarray()
        X = ss.fit_transform(X)

    cv = cross_val_score(model, X, Y, cv=5, scoring='accuracy')

    print('{0}\t{1:<3}\t{2:<4}\t{3:<4}'.format(name, round(cv.mean(), 4), round(cv.min(), 4), round
(cv.max(), 4)))
```

```
mNB 0.648 0.5427 0.7421
bNB 0.6791 0.5932 0.7621
svc 0.662 0.5685 0.7591
```

In [26]:

```
tweet_data.Text.head()

tweet_data.Text.apply(split_into_tokens)

bow_transformer = CountVectorizer(analyzer=split_into_lemmas).fit(tweet_data['Text'])
print("Printing the COuntVectorizer BOW: ========================================")
print(len(bow_transformer.vocabulary_))
print("=========================================================================")

tweet1 = tweet_data['Text'][0]
print(tweet1)

bow1 = bow_transformer.transform([tweet1])
print(bow1)
print(bow1.shape)

print("=========================================================================")
```

```
Printing the COuntVectorizer BOW: ========================================
40237
=========================================================================
89% of the cases reported today are asymptomatic.
If you are in a group of 10, assume nine of you have it!
Wear your mask properly and social distance.
Stay safe!
  (0, 253)	1
  (0, 1350)	1
  (0, 1436)	1
  (0, 2612)	1
  (0, 3070)	2
  (0, 3328)	1
  (0, 3354)	1
  (0, 5576)	1
  (0, 9496)	1
  (0, 13429)	1
  (0, 13827)	1
  (0, 14668)	1
  (0, 14938)	1
  (0, 15813)	1
  (0, 18644)	1
  (0, 20736)	1
  (0, 21318)	3
  (0, 23971)	1
  (0, 25399)	1
  (0, 26283)	1
  (0, 27755)	1
  (0, 28247)	1
  (0, 34047)	1
  (0, 34390)	1
  (0, 36612)	1
  (0, 37224)	2
  (0, 37233)	1
```

```
(1, 40237)
========================================================================
```

In [27]:

```
tweets_bow = bow_transformer.transform(tweet_data['Text'])
print('sparse matrix shape:', tweets_bow.shape)
print('number of non-zeros:', tweets_bow.nnz)
print('sparsity: %.2f%%' % (100.0 * tweets_bow.nnz / (tweets_bow.shape[0] * tweets_bow.shape[1])))
print("========================================================================")

tfidf_transformer = TfidfTransformer().fit(tweets_bow)
tfidf1 = tfidf_transformer.transform(bow1)
print("Printing the TF-IDF Vectors: ===========================================")
print(tfidf1)
print("========================================================================")
print("TF-IDF Shape ===========================================================")
print(tfidf1.shape)
print("========================================================================")
tweets_tfidf = tfidf_transformer.transform(tweets_bow)
```

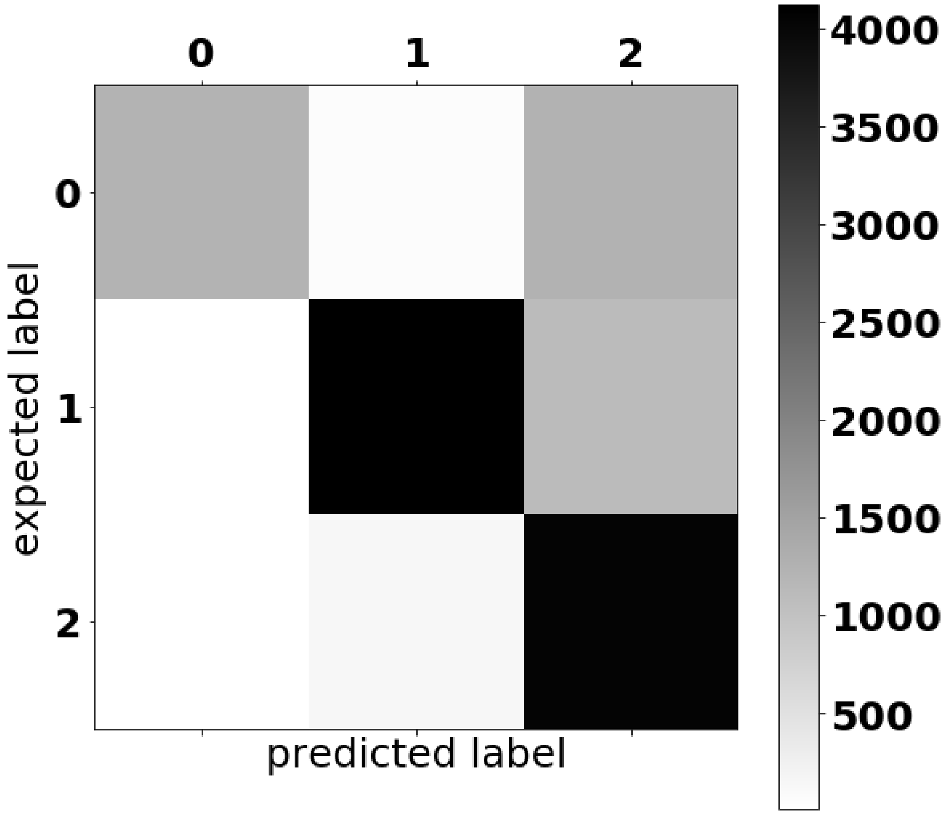
```
sparse matrix shape: (12000, 40237)
number of non-zeros: 321873
sparsity: 0.07%
========================================================================
Printing the TF-IDF Vectors: ===========================================
  (0, 37233)	0.17023825244130142
  (0, 37224)	0.269388204804755
  (0, 36612)	0.19868285680668113
  (0, 34390)	0.193090325525985
  (0, 34047)	0.07384332794172017
  (0, 28247)	0.20350308280208593
  (0, 27755)	0.20734193860214528
  (0, 26283)	0.21374339216488197
  (0, 25399)	0.21042163368618824
  (0, 23971)	0.23233463848108252
  (0, 21318)	0.2821371783638204
  (0, 20736)	0.23630146679872074
  (0, 18644)	0.1607742858578646
  (0, 15813)	0.11887685296562249
  (0, 14938)	0.10133959242272426
  (0, 14668)	0.15218409503709066
  (0, 13827)	0.12138630362976884
  (0, 13429)	0.2253684863238835
  (0, 9496)	0.2272844955816938
  (0, 5576)	0.15705174877315234
  (0, 3354)	0.13231740875470657
  (0, 3328)	0.23735418075323655
  (0, 3070)	0.24490418752774623
  (0, 2612)	0.09158969922734571
  (0, 1436)	0.0821434755239757
  (0, 1350)	0.21354060124203336
  (0, 253)	0.20647724944119555
========================================================================
TF-IDF Shape ===========================================================
(1, 40237)
========================================================================
```

In [28]:

```
print("************************************************************************")
print("Running Multinomial NB on TF-IDF")
print("************************************************************************")
polarity_detector = MultinomialNB().fit(tweets_tfidf, tweet_data['Polarity'])

print('predicted:', polarity_detector.predict(tfidf1[0]))
print('expected:', tweet_data.Polarity[0])

all_predictions = polarity_detector.predict(tweets_tfidf)
print(all_predictions)

print('accuracy', accuracy_score(tweet_data['Polarity'], all_predictions))
print('confusion matrix\n', confusion_matrix(tweet_data['Polarity'], all_predictions))
print('(row=expected, col=predicted)')
```

```
plt.figure(figsize=(10,10))
plt.matshow(confusion_matrix(tweet_data['Polarity'], all_predictions), cmap=plt.cm.binary,
interpolation='nearest')
plt.colorbar()
plt.ylabel('expected label')
plt.xlabel('predicted label')

print(classification_report(tweet_data['Polarity'], all_predictions))
print("========================================================================")
```

```
************************************************************************
Running Multinomial NB on TF-IDF
************************************************************************
predicted: ['positive']
expected: positive
['positive' 'positive' 'positive' ... 'positive' 'positive' 'neutral']
accuracy 0.7835833333333333
confusion matrix
 [[1233   70 1252]
 [  10 4122 1115]
 [  11  139 4048]]
(row=expected, col=predicted)
             precision    recall  f1-score   support

   negative       0.98      0.48      0.65      2555
    neutral       0.95      0.79      0.86      5247
   positive       0.63      0.96      0.76      4198

avg / total       0.85      0.78      0.78     12000

========================================================================


<Figure size 720x720 with 0 Axes>
```



In [29]:

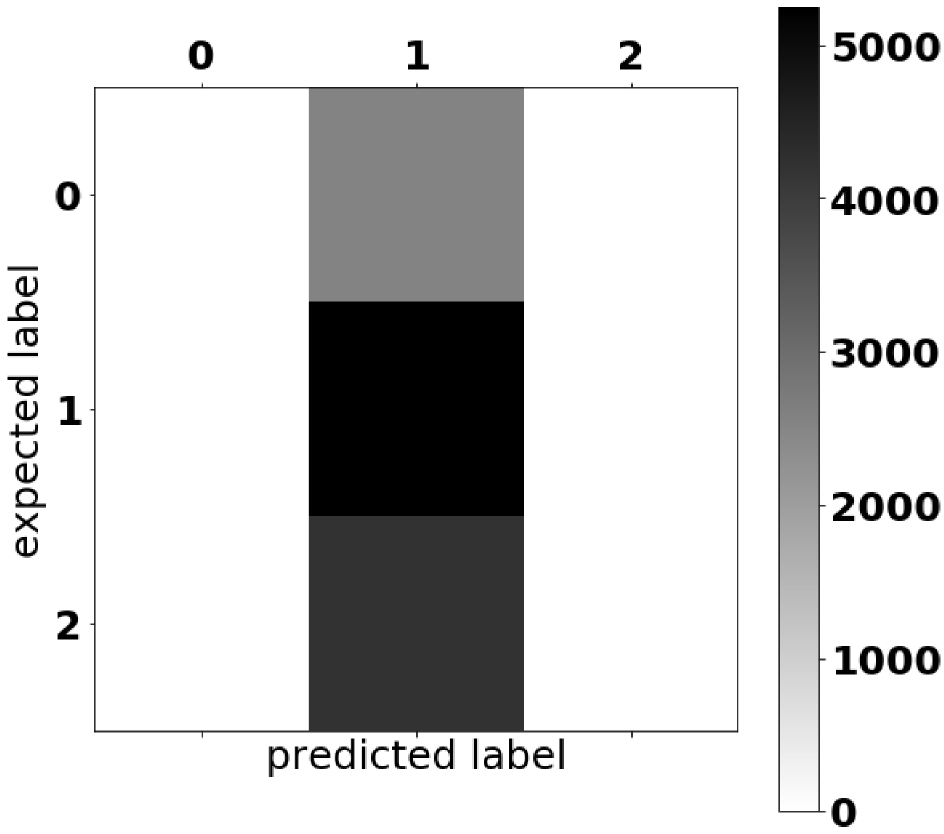
```
print("************************************************************************")
print("Running Support Vector Machines on TF-IDF")
print("************************************************************************")
polarity_detector = SVC().fit(tweets_tfidf, tweet_data['Polarity'])
print('predicted:', polarity_detector.predict(tfidf1[0]))
print('expected:', tweet_data.Polarity[0])
```

```
all_predictions = polarity_detector.predict(tweets_tfidf)
print(all_predictions)

print('accuracy', accuracy_score(tweet_data['Polarity'], all_predictions))
print('confusion matrix\n', confusion_matrix(tweet_data['Polarity'], all_predictions))
print('(row=expected, col=predicted)')

plt.matshow(confusion_matrix(tweet_data['Polarity'], all_predictions), cmap=plt.cm.binary,
interpolation='nearest')
plt.colorbar()
plt.ylabel('expected label')
plt.xlabel('predicted label')
```

```
************************************************************************
Running Support Vector Machines on TF-IDF
************************************************************************
predicted: ['neutral']
expected: positive
['neutral' 'neutral' 'neutral' ... 'neutral' 'neutral' 'neutral']
accuracy 0.43725
confusion matrix
 [[   0 2555    0]
 [   0 5247    0]
 [   0 4198    0]]
(row=expected, col=predicted)
```

Out[29]:

```
Text(0.5,0,'predicted label')
```



In [30]:

```
print("========================================================================")
print("Comparison Run: ========================================================")

X_train, X_test, y_train, y_test = \
    train_test_split(tweet_data['Text'], tweet_data['Polarity'], test_size=0.2)

vectorizer = TfidfVectorizer(min_df=5, max_df = 0.8, sublinear_tf=True, use_idf=True,stop_words='en
glish')
train_corpus_tf_idf = vectorizer.fit_transform(X_train)
```

```
test_corpus_tf_idf = vectorizer.transform(X_test)

svm_model = LinearSVC()
nb_model = MultinomialNB()

svm_model.fit(train_corpus_tf_idf,y_train)
nb_model.fit(train_corpus_tf_idf,y_train)

svm_result = svm_model.predict(test_corpus_tf_idf)
nb_result = nb_model.predict(test_corpus_tf_idf)
```

```
========================================================================
Comparison Run: ========================================================
```

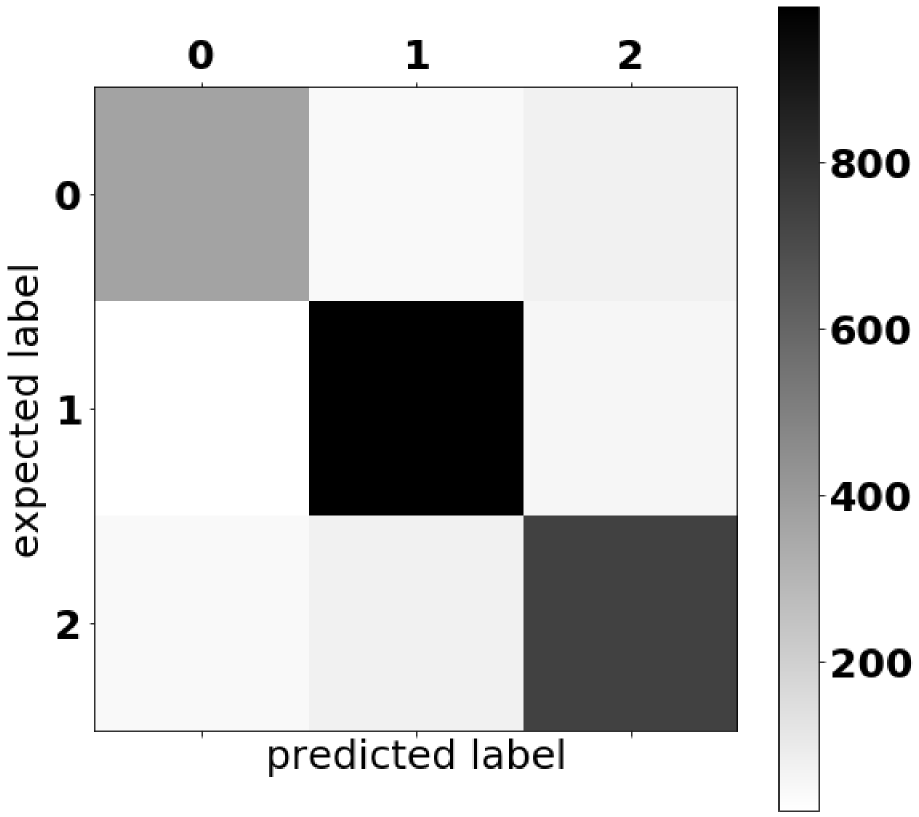
In [31]:

```
print('accuracy', accuracy_score(y_test, svm_result))
print('confusion matrix\n', confusion_matrix(y_test, svm_result))
print('(row=expected, col=predicted)')
plt.matshow(confusion_matrix(y_test, svm_result), cmap=plt.cm.binary, interpolation='nearest')
plt.colorbar()
plt.ylabel('expected label')
plt.xlabel('predicted label')
```

```
accuracy 0.87
confusion matrix
 [[366  43  73]
 [ 20 986  55]
 [ 46  75 736]]
(row=expected, col=predicted)
```

Out[31]:

```
Text(0.5,0,'predicted label')
```



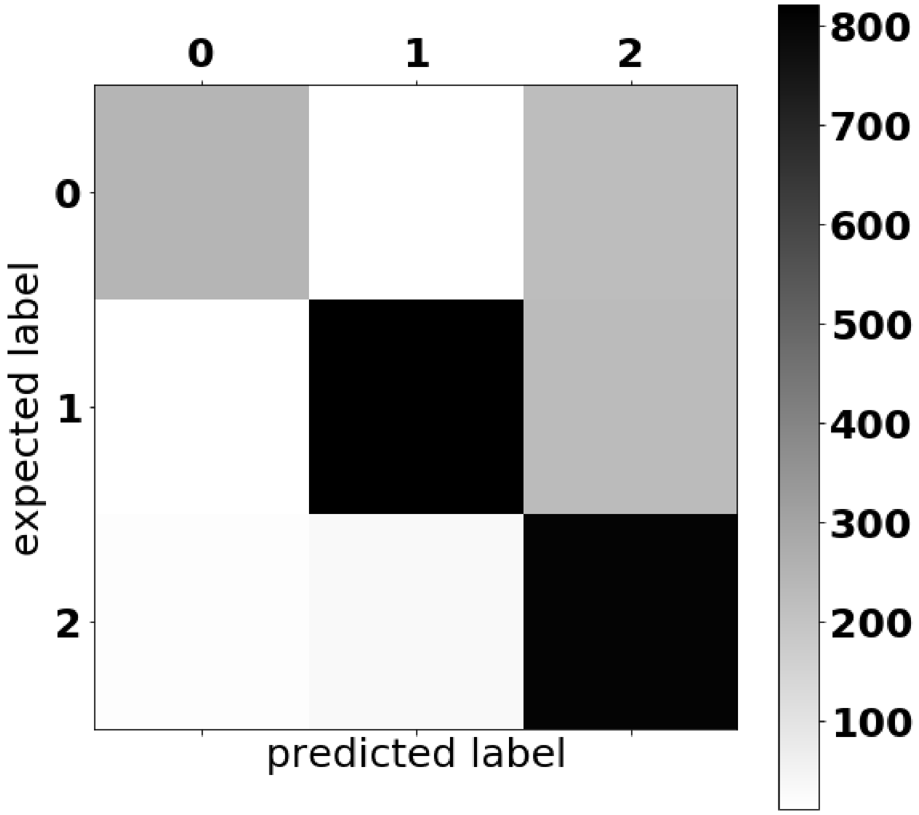
In [32]:

```
print('accuracy', accuracy_score(y_test, nb_result))
print('confusion matrix\n', confusion_matrix(y_test, nb_result))
print('(row=expected, col=predicted)')
plt.matshow(confusion_matrix(y_test, nb_result), cmap=plt.cm.binary, interpolation='nearest')
plt.colorbar()
plt.ylabel('expected label')
plt.xlabel('predicted label')
```

```
accuracy 0.7804166666666666
confusion matrix
 [[246  14 222]
 [ 11 821 229]
 [ 18  33 806]]
(row=expected, col=predicted)
```

Out[32]:

```
Text(0.5,0,'predicted label')
```



In [33]:

```
clf = Pipeline([
    ('vectorizer', CountVectorizer(analyzer="word",
                                   tokenizer=word_tokenize,         # ! Comment line to include ma
_negation and uncomment next line
                                   #tokenizer=lambda text: mark_negation(word_tokenize(text)),
                                   preprocessor=lambda text: text.replace("<br />", " "),
                                   max_features=10000) ),
    ('classifier', LinearSVC())
])

clf.fit(X_train, y_train)
clf.score(X_test, y_test)


clf = Pipeline([
    ('vectorizer', CountVectorizer(analyzer="word",
                                   #tokenizer=word_tokenize,         # ! Comment line to include ma
k_negation and uncomment next line
                                   tokenizer=lambda text: mark_negation(word_tokenize(text)),
                                   preprocessor=lambda text: text.replace("<br />", " "),
                                   max_features=10000) ),
    ('classifier', LinearSVC())
])

clf.fit(X_train, y_train)
t = clf.score(X_test, y_test)
print("Analysis for the Linear SVC using CountVectorizer: ", t)
```

```
Analysis for the Linear SVC using CountVectorizer:  0.8508333333333333
```

In [34]:

```
print("========================================================================")
print("Running the N-Grams on the Tweets: ")
print("========================================================================")
bigram_clf = Pipeline([
    ('vectorizer', CountVectorizer(analyzer="word",
                                   ngram_range=(2, 2),
                                   tokenizer=word_tokenize,
                                   # tokenizer=lambda text: mark_negation(word_tokenize(text)),
                                   preprocessor=lambda text: text.replace("<br />", " "),)),
    ('classifier', LinearSVC())
])

bigram_clf.fit(X_train, y_train)
t = bigram_clf.score(X_test, y_test)
print("Bi Gram Analysis Results with Ngram 2,2: ", t)
print("------------------------------------------------------------------------")
unigram_bigram_clf = Pipeline([
    ('vectorizer', CountVectorizer(analyzer="word",
                                   ngram_range=(1, 2),
                                   tokenizer=word_tokenize,
                                   # tokenizer=lambda text: mark_negation(word_tokenize(text)),
                                   preprocessor=lambda text: text.replace("<br />", " "),)),
    ('classifier', LinearSVC())
])

unigram_bigram_clf.fit(X_train, y_train)
t = unigram_bigram_clf.score(X_test, y_test)
print("UNigram Bigram Analysis with ngram 1,2: ", t)
print("------------------------------------------------------------------------")
unigram_bigram_clf = Pipeline([
    ('vectorizer', CountVectorizer(analyzer="word",
                                   ngram_range=(1, 2),
                                   #tokenizer=word_tokenize,
                                   tokenizer=lambda text: mark_negation(word_tokenize(text)),
                                   preprocessor=lambda text: text.replace("<br />", " "),)),
    ('classifier', LinearSVC())
])

unigram_bigram_clf.fit(X_train, y_train)
t = unigram_bigram_clf.score(X_test, y_test)
print("UNigram Bigram Analysis with ngram 1,2 and Tokennization: ", t)
print("------------------------------------------------------------------------")
print("END of the Analysis")
print("------------------------------------------------------------------------")
print("========================================================================")
```

```
========================================================================
Running the N-Grams on the Tweets:
========================================================================
Bi Gram Analysis Results with Ngram 2,2:  0.80875
------------------------------------------------------------------------
UNigram Bigram Analysis with ngram 1,2:  0.85
------------------------------------------------------------------------
UNigram Bigram Analysis with ngram 1,2 and Tokennization:  0.84875
------------------------------------------------------------------------
END of the Analysis
------------------------------------------------------------------------
========================================================================
```