

# Classifying Emotions in Tweets - MSADS 509 - Applied Text Mining

University of San Diego, M.S. Applied Data Science

Christopher Robinson, Jose Luis Estrada, Leonid Shpaner

## GitHub Repository

[https://github.com/lshpaner/twitter\\_emotions](https://github.com/lshpaner/twitter_emotions)

This notebook implements a text mining sentiment analysis project

First we fetch the data from google drive

```
[1]: %matplotlib inline
import warnings
warnings.simplefilter(action='ignore', category=FutureWarning)
from matplotlib import pyplot as plt
import numpy as np
import pandas as pd
from sklearn import preprocessing
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.decomposition import NMF, TruncatedSVD, LatentDirichletAllocation
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import classification_report, roc_auc_score, roc_curve
from sklearn.pipeline import Pipeline
from sklearn.cluster import KMeans
import string
from string import punctuation
import nltk
import re
import subprocess
from wordcloud import WordCloud
from collections import Counter, defaultdict
nltk.download('punkt')
from nltk.corpus import stopwords
stop = stopwords.words("english")
```

```
[nltk_data] Downloading package punkt to
```

```
[nltk_data] C:\Users\Chris\AppData\Roaming\nltk_data...
```

```
[nltk_data] Package punkt is already up-to-date!
```

```
[2]: pd.set_option('display.max_rows', None)
```

## Read data

```
[3]: #Pulling data from Google Drive from Stanford Engineering Computer Science
↳Department's website
def download_gdrive(id, print_stout=True):
    coomand = 'gdown https://drive.google.com/uc?id={}'.format(id)
    returned_value = subprocess.run(coomand, shell=True, stdout=subprocess.PIPE,
↳stderr=subprocess.STDOUT)
    if print_stout: print(returned_value.stdout.decode("utf-8"))
    else: print("Download Complete")
```

```
train_data = download_gdrive("10rDg15zAvUdVgSoVngHfwJnf8I1tdpZi", print_stout=True)
test_data = download_gdrive("10qeDcgwdJC76Nv5cCj6WsUYjD6846fEL", print_stout=True)
```

Downloading...

From: <https://drive.google.com/uc?id=10rDg15zAvUdVgSoVngHfwJnf8I1tdpZi>

To: C:\Users\Chris\Desktop\ADS509\Project\train\_data.csv

100%|#####| 239M/239M [00:15<00:00, 15.1MB/s]

Downloading...

From: <https://drive.google.com/uc?id=10qeDcgwdJC76Nv5cCj6WsUYjD6846fEL>

To: C:\Users\Chris\Desktop\ADS509\Project\test\_data.csv

100%|#####| 74.3k/74.3k [00:00<00:00, 3.92MB/s]

```
[4]: #Read train and test sets
columns = ['polarity', 'tweetid', 'date', 'query_name', 'user', 'text']
dftrain = pd.read_csv('train_data.csv',
                      header = None,
                      encoding = 'ISO-8859-1')
dftest = pd.read_csv('test_data.csv',
                     header = None,
                     encoding = 'ISO-8859-1')
dftrain.columns = columns
dftest.columns = columns
```

```
[5]: #Sample 1M entries from the training set
dftrain = dftrain.sample(1000000)
```

## Text pre-processing

```
[6]: #Remove punctuation on texts to just analyze text
def remove_punctuations(text):
    for punctuation in string.punctuation:
        text = text.replace(punctuation, '')
    return text

#Replace url and username's links to tokens URL and USERNAME
class PrePreprocess(object):
    user_pat = '(?<=^|(?<=[^a-zA-Z0-9-_\.]))@([A-Za-z]+[A-Za-z0-9]+)'
    http_pat = '(https?:\/\/(?:www\.|(!www))[\^s\.] +\.[\^s]{2,}|www\.[\^s]+\.
↳[\^s]{2,})'
    repeat_pat, repeat_repl = "(.)\\1\\1+", '\\1\\1'
    def __init__(self):
        pass

    def transform(self, X):
        is_pd_series = isinstance(X, pd.core.frame.Series)
        if not is_pd_series:
            pp_text = pd.Series(X)
        else:
            pp_text = X
        pp_text = pp_text.str.replace(pat = self.user_pat, repl = 'USERNAME')
```

```

pp_text = pp_text.str.replace(pat = self.http_pat, repl = 'URL')
pp_text.str.replace(pat = self.repeat_pat, repl = self.repeat_repl)
return pp_text

def fit(self, X, y=None):
    return self

```

## Descriptive statistics

```

[7]: #Descriptive statistics with function that analyzes number of tokens
def descriptive_stats(tokens, top_num_tokens = 5, verbose=True) :
    """
        Given a list of tokens, print number of tokens, number of unique tokens,
        number of characters, lexical diversity
        (https://en.wikipedia.org/wiki/Lexical\_diversity),
        and num_tokens most common tokens. Return a list with the number of
        tokens, number of unique tokens, lexical diversity, and number of
        characters.
    """

    # Fill in the correct values here.
    num_tokens = len(tokens)
    num_unique_tokens = len(set(tokens))
    lexical_diversity = num_unique_tokens/num_tokens
    num_characters = len("".join(tokens))

    if verbose :
        print(f"There are {num_tokens} tokens in the data.")
        print(f"There are {num_unique_tokens} unique tokens in the data.")
        print(f"There are {num_characters} characters in the data.")
        print(f"The lexical diversity is {lexical_diversity:.3f} in the data.")

        # print the five most common tokens
        index = pd.Index(tokens)
        index.value_counts()
        df = pd.DataFrame(index.value_counts())
        top5 = df.head(top_num_tokens)
        print(top5.index.tolist())

    return([num_tokens, num_unique_tokens,
            lexical_diversity,
            num_characters])

def count_words(df, column='tokens', preprocess=None, min_freq=1):

    # process tokens and update counter
    def update(doc):

```

```

        tokens = doc if preprocess is None else preprocess(doc)
        counter.update(tokens)

# create counter and run through all data
counter = Counter()
df[column].map(update)

# transform counter into data frame
freq_df = pd.DataFrame.from_dict(counter, orient='index', columns=['freq'])
freq_df = freq_df.query('freq >= @min_freq')
freq_df.index.name = 'token'

return freq_df#.sort_values('freq', ascending=False)

def display_topics(model, features, no_top_words=5):
    for topic, words in enumerate(model.components_):
        total = words.sum()
        largest = words.argsort()[::-1] # invert sort order
        print("\nTopic %02d" % topic)
        for i in range(0, no_top_words):
            print(" %s (%2.2f)" % (features[largest[i]],
                abs(words[largest[i]]*100.0/total)))

def wordcloud(word_freq, title=None, max_words=200, stopwords=None):

    wc = WordCloud(width=800, height=400,
                    background_color= "black", colormap="Paired",
                    max_font_size=150, max_words=max_words)

    # convert data frame into dict
    if type(word_freq) == pd.Series:
        counter = Counter(word_freq.fillna(0).to_dict())
    else:
        counter = word_freq

    wc.generate_from_frequencies(counter)

    plt.title(title)

    plt.imshow(wc, interpolation='bilinear')
    plt.axis("off")

def wordcloud_clusters(model, vectors, features, no_top_words=5):
    for cluster in np.unique(model.labels_):
        size = {}
        words = vectors[model.labels_ == cluster].sum(axis=0).A[0]
        largest = words.argsort()[::-1] # invert sort order
        for i in range(0, no_top_words):

```

```

        size[features[largest[i]]] = abs(words[largest[i]])
    wc = WordCloud(background_color="white", max_words=100,
                    width=960, height=540)
    wc.generate_from_frequencies(size)
    plt.figure(figsize=(12,12))
    plt.imshow(wc, interpolation='bilinear')
    plt.axis("off")

```

```

[8]: # Remove Stopwords
dftrain['text'] = dftrain['text'].apply(lambda x: ' '.join([word for word \
    in x.split() if word not in (stop)]))

p = PrePreprocess()
#PRE-Process step
dftrain['tokens'] = p.transform(dftrain['text'])
dftrain['tokens'] = dftrain['tokens'].apply(remove_punctuations)
##word_tokenize
dftrain['tokens'] = dftrain.apply(lambda row: nltk.word_tokenize(row['tokens']),
    axis=1)

print("DESCRIPTIVE STATS ON Tokens: ")
all = []
#on 100k data
#for li in dftrain['text'].sample(100).iteritems(): all += li[1]
#on all data
for li in dftrain['tokens'].iteritems(): all += li[1]

descriptive_stats(all, verbose=True)
print("\n")

print("DESCRIPTIVE STATS ON SENTIMENT POLARITY:")
dftrain['polarity'].describe()

```

DESCRIPTIVE STATS ON Tokens:

There are 8676094 tokens in the data.  
 There are 419665 unique tokens in the data.  
 There are 43095701 characters in the data.  
 The lexical diversity is 0.048 in the data.  
 ['USERNAME', 'I', 'Im', 'get', 'day']

DESCRIPTIVE STATS ON SENTIMENT POLARITY:

```

[8]: count    1000000.00000
     mean         1.99784
     std         2.00000
     min         0.00000
     25%         0.00000
     50%         0.00000
     75%         4.00000
     max         4.00000
     Name: polarity, dtype: float64

```

```
[9]: dftrain.head(10)
```

```
[9]:      polarity  tweetid      date query_name \
341044         0  2014963399  Wed Jun 03 03:15:55 PDT 2009  NO_QUERY
741824         0  2266376131  Sun Jun 21 08:24:00 PDT 2009  NO_QUERY
963790         4  1827470235  Sun May 17 10:46:42 PDT 2009  NO_QUERY
1494963        4  2069827015  Sun Jun 07 16:35:58 PDT 2009  NO_QUERY
951563         4  1824267900  Sun May 17 00:40:30 PDT 2009  NO_QUERY
1065129        4  1964871845  Fri May 29 14:56:51 PDT 2009  NO_QUERY
988099         4  1834729207  Mon May 18 04:00:31 PDT 2009  NO_QUERY
1024864        4  1883348972  Fri May 22 08:24:37 PDT 2009  NO_QUERY
449326         0  2069224343  Sun Jun 07 15:29:18 PDT 2009  NO_QUERY
1218083        4  1989797737  Mon Jun 01 02:50:43 PDT 2009  NO_QUERY

      user      text \
341044  chillysella  @nadirairdiana nad,jadi nonton pcd? dont watch...
741824  iamAlexMcKerrow  Actually I grasp Trigonometry 3d all, gonna re...
963790      flarrossa      @lisesilveira hey bitch
1494963    iRelvs2lv      @hazyeyez u def dye sounds hot haha
951563    stevemanch      @trunty_me_jazzo may ?? Never know
1065129    Adele_x      @rhea123 lol yep good old days
988099    FieFieSoMajor      @Coodieranks morning boo
1024864    xbeckaxockx  finished sophomore year highschool today. I wi...
449326    barneygale      BNP seat. #eu09
1218083    TwittingNala      one exam go!!! semester least

      tokens
341044  [USERNAME, nadjadi, nonton, pcd, dont, watch, ...
741824  [Actually, I, grasp, Trigonometry, 3d, all, go...
963790      [USERNAME, hey, bitch]
1494963      [USERNAME, u, def, dye, sounds, hot, haha]
951563      [USERNAMEmejazzo, may, Never, know]
1065129      [USERNAME, lol, yep, good, old, days]
988099      [USERNAME, morning, boo]
1024864  [finished, sophomore, year, highschool, today,...
449326      [BNP, seat, eu09]
1218083      [one, exam, go, semester, least]
```

```
[10]: #Identify positive and negative tweets based on polarity
      #Count frequency of tokens used in each dataset
cv = CountVectorizer()
cv.fit(dftrain.text)
neg_doc_matrix = cv.transform(dftrain[dftrain.polarity == 0].text)
pos_doc_matrix = cv.transform(dftrain[dftrain.polarity == 4].text)
neg_tf = np.sum(neg_doc_matrix,axis=0)
pos_tf = np.sum(pos_doc_matrix,axis=0)
neg = np.squeeze(np.asarray(neg_tf))
pos = np.squeeze(np.asarray(pos_tf))
term_freq_df = pd.DataFrame([neg,pos],
                             columns=cv.get_feature_names()
                             ).transpose()
```

```
term_freq_df.columns = ['negative', 'positive']
term_freq_df['total'] = term_freq_df['negative'] + term_freq_df['positive']
term_freq_df.sort_values(by='total',
                        ascending=False
                        ).iloc[:10]
```

```
[10]:
```

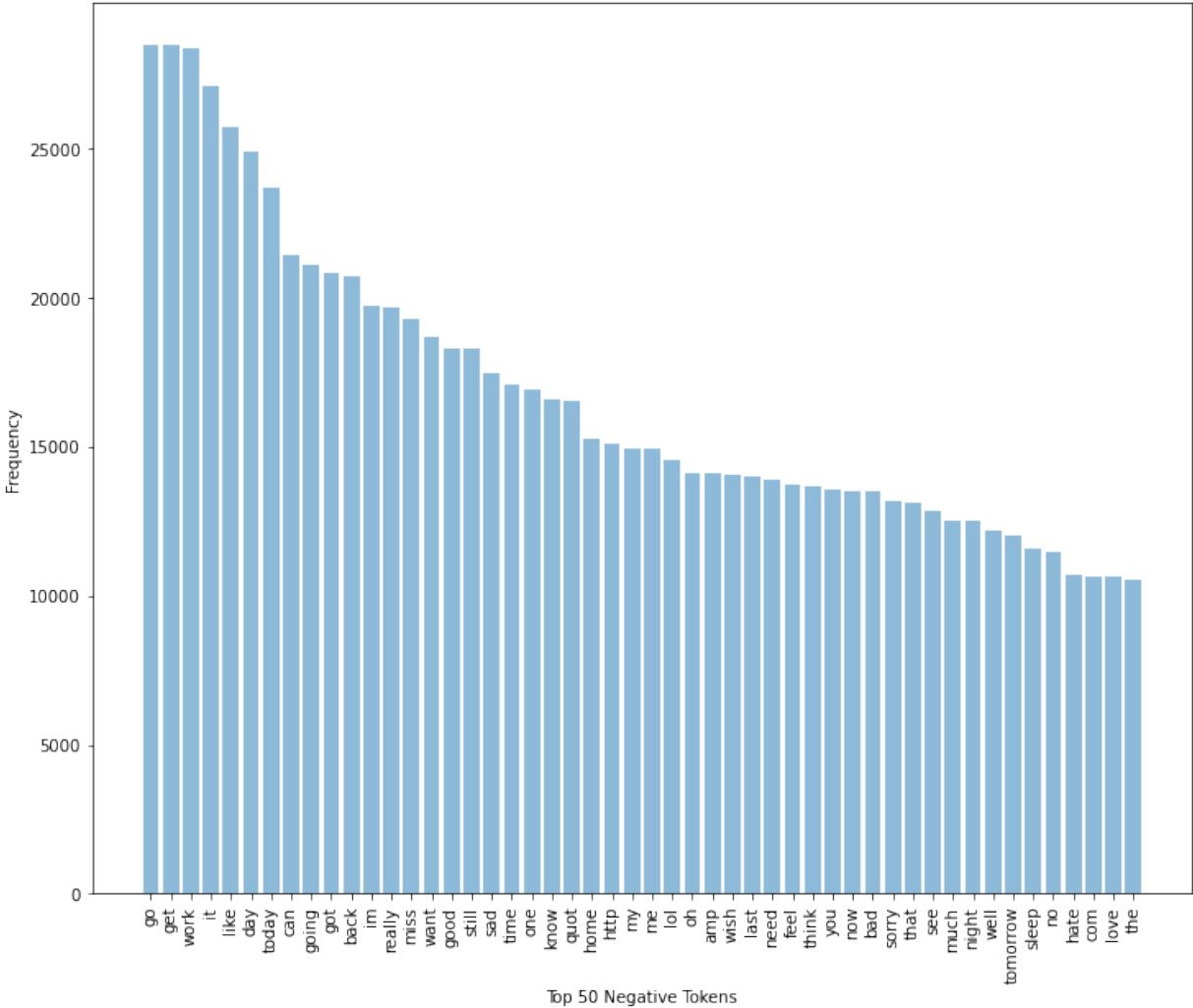
	negative	positive	total
good	18298	38797	57095
it	27122	29015	56137
day	24909	29535	54444
get	28494	22823	51317
like	25747	23259	49006
go	28515	17590	46105
quot	16560	28667	45227
http	15131	29439	44570
today	23685	18600	42285
you	13567	28319	41886

```
[11]: #Show top 50 negative tokens in tweets
y_pos = np.arange(50)
plt.figure(figsize=(12,10))
plt.bar(y_pos,
        term_freq_df.sort_values(by='negative',ascending=False)
                                ['negative'][:50],
        align='center',
        alpha=0.5)

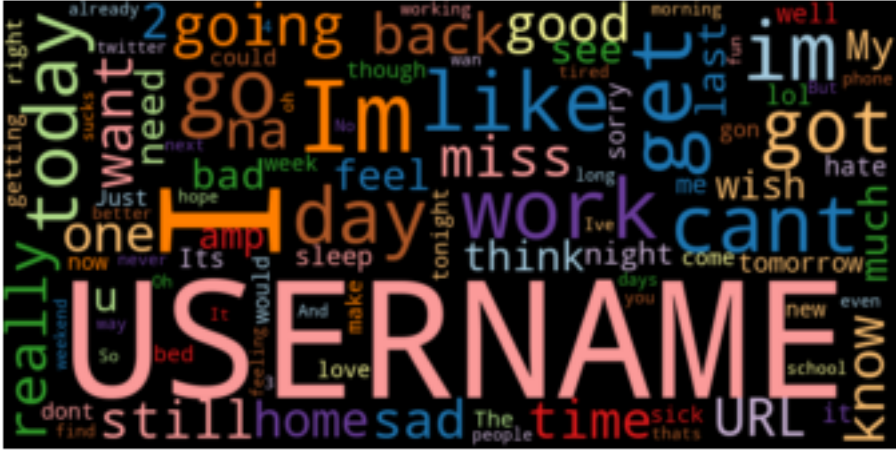
plt.xticks(y_pos,
           term_freq_df.sort_values(by='negative',ascending=False)
                                ['negative']
                                [:50].index,
           rotation='vertical')

plt.ylabel('Frequency')
plt.title('Top 50 tokens in Negative Tweets')
plt.xlabel('Top 50 Negative Tokens')
plt.show()
```

### Top 50 tokens in Negative Tweets



```
[12]: neg_word_freq = count_words(dftrain[dftrain["polarity"] == 0])
      wordcloud(neg_word_freq['freq'], max_words=100,
                stopwords=neg_word_freq.head(50).index)
```

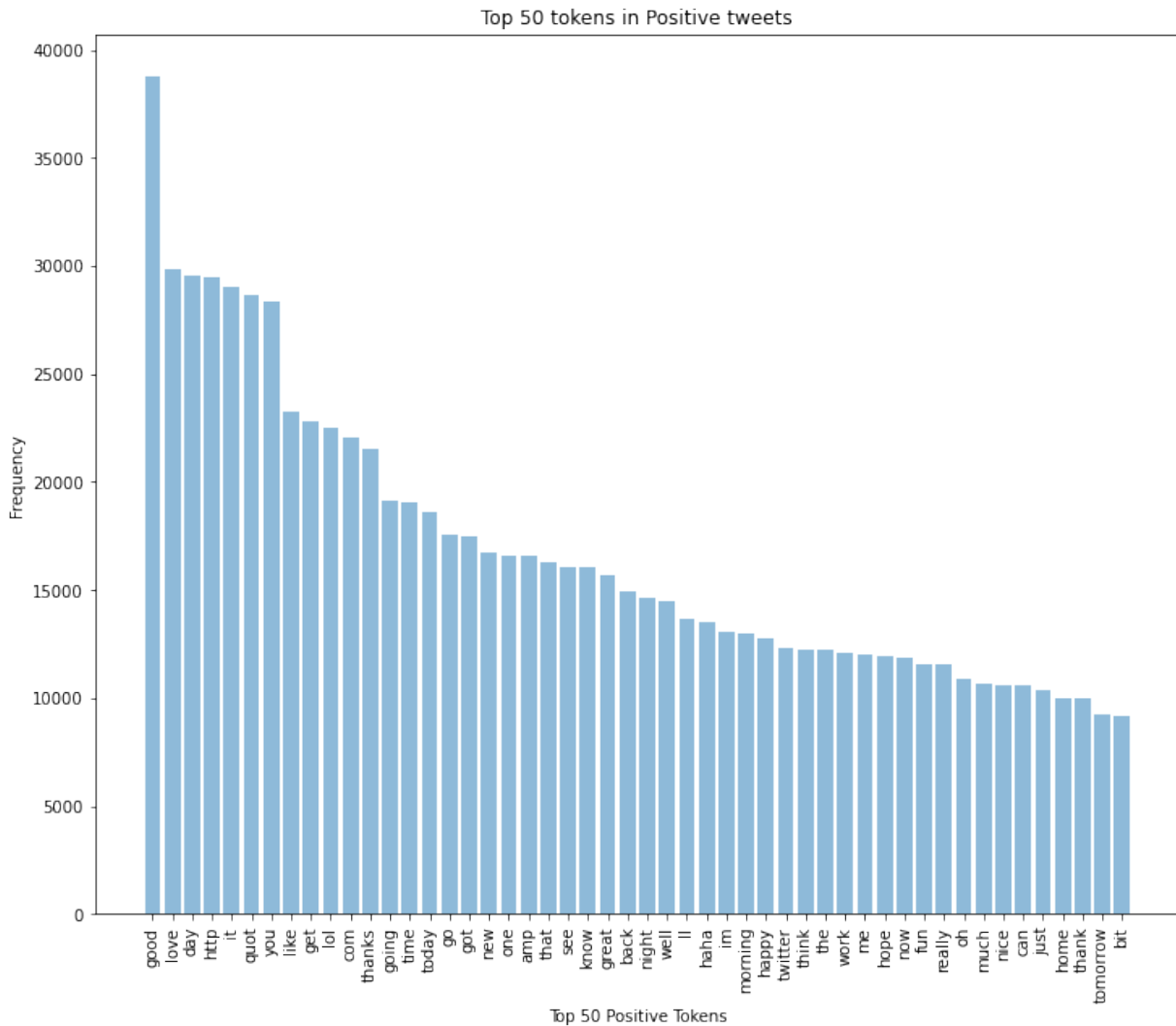




```
[13]: #Show top 50 positive tokens in tweets
y_pos = np.arange(50)
plt.figure(figsize=(12,10))
plt.bar(y_pos,
        term_freq_df.sort_values(by='positive',ascending=False)
                                ['positive'][:50],
        align='center',
        alpha=0.5)

plt.xticks(y_pos,
            term_freq_df.sort_values(by='positive',ascending=False)
                                ['positive']
                                [:50].index,
            rotation='vertical')

plt.ylabel('Frequency')
plt.xlabel('Top 50 Positive Tokens')
plt.title('Top 50 tokens in Positive tweets')
plt.show()
```





```

        self.tags = dangerous_tags ##LR
def predict(self, text):
    out = self.model.predict_proba(text)
    print(out)
    score = 0
    if out[0][0] > 0.60: score = -1
    elif out[0][1] > 0.60: score = 1

    tok = self.model.named_steps['cvect'].transform([text])
    word_list = self.model.named_steps['cvect'].get_feature_names_out()
    count_list = tok.toarray().sum(axis=0)
    o = dict(zip(word_list, count_list)) #this is the features used to predict!

    flag = False
    print(text)
    for char in text.split( ):
        if char in self.tags: flag = True

    return (score, flag)

dangerous_tags = {"kill", "killed", "shoot", "attack", "hurt", "gun", "guns", \
    "weapon", "die", "bleed", "suicide", "shooting", "rifle", "choke", \
    "punch", "massacre", "shooting", "pain", "revenge", "bomb", \
    "destroy", "Stick", "Knife", "Blade", "Club", "Ax", "Sword", \
    "Spear", "Halberd", "Pike", "Lance", "Revolver", "Rifle", \
    "Shotgun", "Semi Automatic Gun", "Fully Automatic Gun", \
    "Machine Gun", "Crossbow", "Flamethrower", "Grenade", \
    "Nerve Gas", "Mustard Gas", "Tear Gas", "Pepper Spray", "AR15", "AR-15"}

model = FinalModel(sentiment_model=sentiment_lr, dangerous_tags=dangerous_tags)

```

### Test model with designed examples

```

[17]: text = "Hello big beautiful world"
print(text)
pred = model.predict(text)
print("Sentiment score: {} \t is it dangerous: {}".format(pred, \
    True if pred[0]==-1 and pred[1]==True else False))
print("\n")

text = "I hate this stupid world!!"
print(text)
pred = model.predict(text)
print("Sentiment score: {} \t is it dangerous: {}".format(pred, \
    True if pred[0]==-1 and pred[1]==True else False))
print("\n")

text = "I will hurt you tomorrow"
print(text)

```

```

pred = model.predict(text)
print("Sentiment score: {} \t is it dangerous: {}".format(pred, \
    True if pred[0]==-1 and pred[1]==True else False))
print("\n")

text = "That movie killed me! It was great"
print(text)
pred = model.predict(text)
print("Sentiment score: {} \t is it dangerous: {}".format(pred, \
    True if pred[0]==-1 and pred[1]==True else False))
print("\n")

text = "Im going to punch the stupid teacher tomorrow!"
print(text)
pred = model.predict(text)
print("Sentiment score: {} \t is it dangerous: {}".format(pred, \
    True if pred[0]==-1 and pred[1]==True else False))
print("\n")

text = "I like fruit punch" #testing bad spelling
print(text)
pred = model.predict(text)
print("Sentiment score: {} \t is it dangerous: {}".format(pred, \
    True if pred[0]==-1 and pred[1]==True else False))
print("\n")

text = "i enjoy to kill zombies on my playstation!" #testing bad spelling
print(text)
pred = model.predict(text)
print("Sentiment score: {} \t is it dangerous: {}".format(pred, \
    True if pred[0]==-1 and pred[1]==True else False))
print("\n")

text = "Just got out of shooting practice" #testing bad spelling
print(text)
pred = model.predict(text)
print("Sentiment score: {} \t is it dangerous: {}".format(pred, \
    True if pred[0]==-1 and pred[1]==True else False))
print("\n")

text = "Im bringing my AR15 to hurt everyone" #testing bad spelling
print(text)
pred = model.predict(text)
print("Sentiment score: {} \t is it dangerous: {}".format(pred, \
    True if pred[0]==-1 and pred[1]==True else False))
print("\n")

text = "I like shooting my AR-15 after school" #testing bad spelling
print(text)
pred = model.predict(text)
print("Sentiment score: {} \t is it dangerous: {}".format(pred, \

```

```

    True if pred[0]==-1 and pred[1]==True else False))
print("\n")

text = "I am going to shoot you" #testing bad spelling
print(text)
pred = model.predict(text)
print("Sentiment score: {} \t is it dangerous: {}".format(pred, \
    True if pred[0]==-1 and pred[1]==True else False))
print("\n")

text = "I was going shooting tommorow but I hurn my hand." #testing bad spelling
print(text)
pred = model.predict(text)
print("Sentiment score: {} \t is it dangerous: {}".format(pred, \
    True if pred[0]==-1 and pred[1]==True else False))
print("\n")

```

```

Hello big beautiful world
[[0.06974756 0.93025244]]
Hello big beautiful world
Sentiment score: (1, False)      is it dangerous: False

```

```

I hate this stupid world!!
[[0.91563958 0.08436042]]
I hate this stupid world!!
Sentiment score: (-1, False)    is it dangerous: False

```

```

I will hurt you tomorrow
[[0.68821564 0.31178436]]
I will hurt you tomorrow
Sentiment score: (-1, True)     is it dangerous: True

```

```

That movie killed me! It was great
[[0.53942551 0.46057449]]
That movie killed me! It was great
Sentiment score: (0, True)      is it dangerous: False

```

```

Im going to punch the stupid teacher tomorrow!
[[0.72408045 0.27591955]]
Im going to punch the stupid teacher tomorrow!
Sentiment score: (-1, True)     is it dangerous: True

```

```

I like fruit punch
[[0.43423355 0.56576645]]
I like fruit punch
Sentiment score: (0, True)      is it dangerous: False

```

```
i enjoy to kill zombies on my playstation!
[[0.35594534 0.64405466]]
i enjoy to kill zombies on my playstation!
Sentiment score: (1, True)          is it dangerous: False
```

```
Just got out of shooting practice
[[0.30373027 0.69626973]]
Just got out of shooting practice
Sentiment score: (1, True)          is it dangerous: False
```

```
Im bringing my AR15 to hurt everyone
[[0.82390043 0.17609957]]
Im bringing my AR15 to hurt everyone
Sentiment score: (-1, True)         is it dangerous: True
```

```
I like shooting my AR-15 after school
[[0.4934614 0.5065386]]
I like shooting my AR-15 after school
Sentiment score: (0, True)          is it dangerous: False
```

```
I am going to shoot you
[[0.37671528 0.62328472]]
I am going to shoot you
Sentiment score: (1, True)          is it dangerous: False
```

```
I was going shooting tommorow but I hurn my hand.
[[0.74574716 0.25425284]]
I was going shooting tommorow but I hurn my hand.
Sentiment score: (-1, True)         is it dangerous: True
```

## Topic Modelling

```
[18]: # Taking a sample from the train data for the topic modelling
      Topic_Data = dftrain.sample(10000)
```

```
[19]: # TF-IDF vectorization
      from sklearn.feature_extraction.text import TfidfVectorizer, CountVectorizer

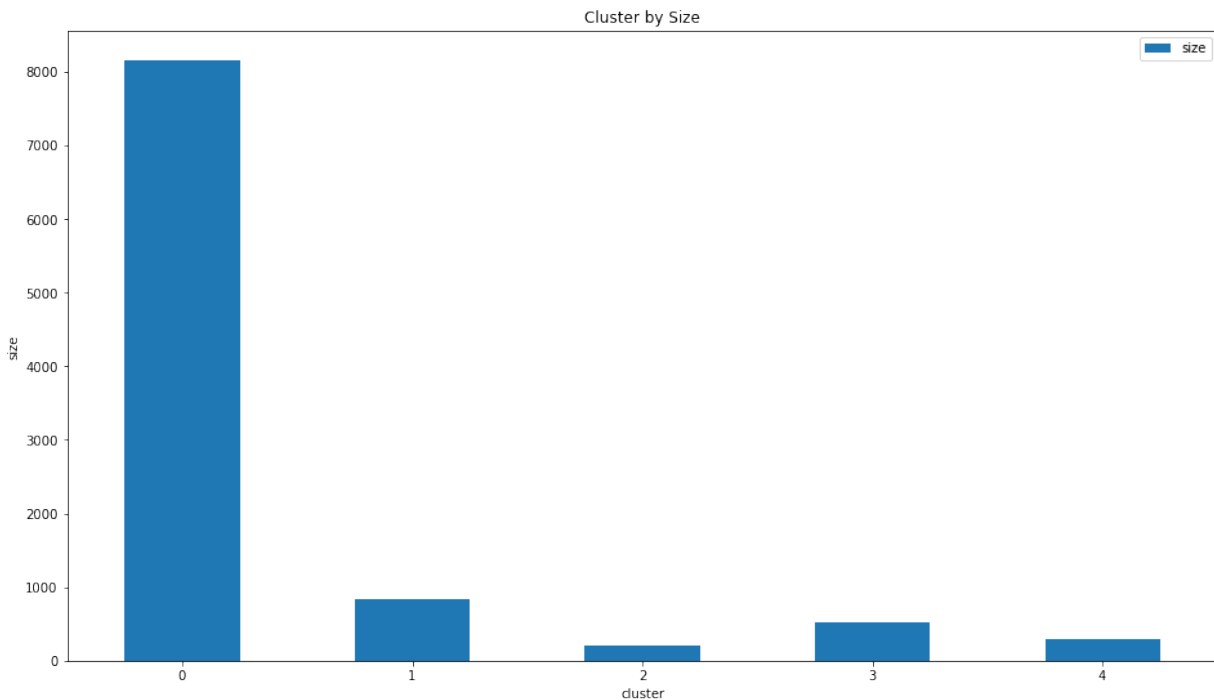
      tfidf_text_vectorizer = TfidfVectorizer(stop_words=stop, min_df=5, max_df=0.7)
      tfidf_text_vectors = tfidf_text_vectorizer.fit_transform(Topic_Data['text'])
      tfidf_text_vectors.shape
```

```
[19]: (10000, 2050)
```

```
[20]: k_means_text = KMeans(n_clusters=5, random_state=42)
model = k_means_text.fit(tfidf_text_vectors)

np.unique(model.labels_, return_counts=True)

sizes = []
for i in range(5):
    sizes.append({"cluster": i, "size": np.sum(model.labels_==i)})
pd.DataFrame(sizes).set_index("cluster").plot.bar(figsize=(16,9))
plt.xticks(rotation=0)
plt.title('Cluster by Size')
plt.ylabel('size')
plt.show()
```



```
[21]: wordcloud_clusters(model, tfidf_text_vectors,
                        tfidf_text_vectorizer.get_feature_names())
```

loveday  
gethttpgo

work  
got  
back  
stilltime



http watching

quot

1o1 day

good day  
night

Luck

morning

lol dont  
get  
know let

[22]: *# Fitting an LSA Model*

```
svd_text_model = TruncatedSVD(n_components = 5, random_state=42)
W_svd_text_matrix = svd_text_model.fit_transform(tfidf_text_vectors)
H_svd_text_matrix = svd_text_model.components_

# call display_topics
display_topics(svd_text_model, tfidf_text_vectorizer.get_feature_names())
```

Topic 00

good (1.57)  
day (1.35)  
http (1.32)  
com (1.11)  
work (1.06)

Topic 01

http (21.98)  
com (19.50)  
twitpic (14.05)  
ly (4.34)  
bit (4.10)

Topic 02

thanks (212.44)  
quot (39.01)  
love (25.33)  
know (11.41)

much (10.75)

Topic 03

quot (30.24)

love (2.77)

back (2.72)

like (2.57)

lol (2.55)

Topic 04

quot (16.66)

good (15.91)

morning (8.83)

day (3.94)

luck (1.28)