In [359…

```
# !pip install vaderSentiment
# !pip install -U textblob
# !pip install swifter
!pip install gensim==3.8.3
```

```
Requirement already satisfied: gensim==3.8.3 in /Users/my_love/opt/anaconda3/li
b/python3.8/site-packages (3.8.3)
Requirement already satisfied: smart-open>=1.8.1 in /Users/my_love/opt/anaconda
3/lib/python3.8/site-packages (from gensim==3.8.3) (5.0.0)
Requirement already satisfied: scipy>=0.18.1 in /Users/my_love/opt/anaconda3/li
b/python3.8/site-packages (from gensim==3.8.3) (1.5.2)
Requirement already satisfied: numpy>=1.11.3 in /Users/my_love/opt/anaconda3/li
b/python3.8/site-packages (from gensim==3.8.3) (1.19.2)
Requirement already satisfied: six>=1.5.0 in /Users/my_love/opt/anaconda3/lib/py
thon3.8/site-packages (from gensim==3.8.3) (1.15.0)
```

In [360…

```
from nltk.corpus import stopwords
import matplotlib.pyplot as plt
from textblob import TextBlob
import seaborn as sns
from tqdm import tqdm
from time import time
import pandas as pd
import numpy as np
import regex as re
import unicodedata
import swifter
import gc
import json

import nltk
sns.set_style('white')

from vaderSentiment.vaderSentiment import SentimentIntensityAnalyzer
from sklearn.feature_extraction.text import TfidfVectorizer
from gensim.models.phrases import Phrases, Phraser
from nltk.tokenize import TweetTokenizer
from gensim.models import Word2Vec
from sklearn.cluster import KMeans

from sklearn.metrics import accuracy_score, confusion_matrix, precision_score, r
```

In [361…

```
df = pd.read_csv('../data/tweets_01-08-2021.csv')
df
```

Out[361…

	id	text	isRetweet	isDeleted	device	favorites	retv
0	98454970654916608	Republicans and Democrats have both created ou...	f	f	TweetDeck	49	
1	1234653427789070336	I was thrilled to be back in the Great city of...	f	f	Twitter for iPhone	73748	1

	id	text	isRetweet	isDeleted	device	favorites	retv
2	1218010753434820614	RT @CBS_Herridge: READ: Letter to surveillance...	t	f	Twitter for iPhone	0	
3	1304875170860015617	The Unsolicited Mail In Ballot Scam is a major...	f	f	Twitter for iPhone	80527	2
4	1218159531554897920	RT @MZHemingway: Very friendly telling of even...	t	f	Twitter for iPhone	0	
...	...	...	...	...	...	...	...
56566	1319485303363571714	RT @RandPaul: I don't know why @JoeBiden think...	t	f	Twitter for iPhone	0	2
56567	1319484210101379072	RT @EliseStefanik: President @realDonaldTrump ...	t	f	Twitter for iPhone	0	
56568	1319444420861829121	RT @TeamTrump: LIVE: Presidential Debate #Deba...	t	f	Twitter for iPhone	0	
56569	1319384118849949702	Just signed an order to support the workers of...	f	f	Twitter for iPhone	176289	3
56570	1319345719829008387	Suburban women want Safety & Security. Joe...	f	f	Twitter for iPhone	95169	1

56571 rows × 9 columns

Sentiment Analysis

Pre-processing the data

Source: https://link-springer-com.ezproxy.cul.columbia.edu/content/pdf/10.1007%2F978-3-319-09339-0.pdf (page 617)

In [362…

```
# Add additional feature 'retweeted'
tweets = df['text'].to_list()
values = []

for tweet in tweets:
    if tweet.startswith('RT'):
        value = True
    else:
        value = False

    values.append(value)
```

```
df['retweeted'] = values
```

In [363…

```
# Step 1: Denoising – Remove Username, Hashtags, Links, Change to lowercase
def denoise(tweets):

    clean_tweets = []

    for tweet in tweets:
        result = unicodedata.normalize('NFKD', tweet)
        result = re.sub("@(\w{1,15})", " ", result) # mentions
        result = re.sub("#(\w{1,15})", " ", result) # hashtags
        result = re.sub("https?://([^\s]+)", ' ', result) # links
        result = re.sub("RT", ' ', result) # RT :

        result = re.sub(" &amp", ' ', result) # &amp
        result = re.sub("[\n\r\t\0]", ' ', result) # new line, tabs, etc

        result = re.sub(r"\'t", "not", result)
        result = re.sub(r"\'re", " are", result)
        result = re.sub(r"\'s", " is", result)
        result = re.sub(r"\'d", " would", result)
        result = re.sub(r"\'ll", " will", result)
        result = re.sub(r"\'ve", " have", result)
        result = re.sub(r"\'m", " am", result)

        result = re.sub(r'\b\w\b', ' ', result) # sigle letter
        result = re.sub('[!,.-;:\+\-\()?""\[\]{}]', ' ', result) # punct

        result = re.sub('\s{2,}', ' ', result) # 2+ whitespaces

        result = result.strip()

        clean_tweets.append(result)

    return clean_tweets
```

In [364…

```
# Step 2: Normalizing contractions
# source: https://towardsdatascience.com/text-normalization-7ecc8e084e31

def normalize_contractions(tweets):
    contraction_list = json.loads(open('../data/english_contractions.json', 'r')
    clean_tweets = []

    for tweet in tweets:
        clean_tweets.append(_normalize_contractions_text(tweet, contraction_list

    return clean_tweets

def _normalize_contractions_text(text, contractions):
    """
    This function normalizes english contractions.
    """
    new_token_list = []
    token_list = text.split()

    for word_pos in range(len(token_list)):
        word = token_list[word_pos]
```

```
        first_upper = False
        if word[0].isupper():
            first_upper = True
        if word.lower() in contractions:
            replacement = contractions[word.lower()]
            if first_upper:
                replacement = replacement[0].upper()+replacement[1:]
            replacement_tokens = replacement.split()
            if len(replacement_tokens)>1:
                new_token_list.append(replacement_tokens[0])
                new_token_list.append(replacement_tokens[1])
            else:
                new_token_list.append(replacement_tokens[0])
        else:
            new_token_list.append(word)

    tweet = " ".join(new_token_list).strip(" ").lower()

    return tweet
```

In [365…

```
def remove_stop_words(tweets):
    stopwords_english = stopwords.words('english')

    to_be_removed = ["haven't", "against", "not", "weren't", "won't", 'no']

    for word in to_be_removed:
        stopwords_english.remove(word)

    stopwords_english.append('pm')
    stopwords_english.append('am')

    clean_tweets = []

    # instantiate the tokenizer class
    tokenizer = TweetTokenizer(preserve_case=False,
                               strip_handles=True,
                               reduce_len=True)

    for tweet in tweets:

        # tokenize the tweets
        tweet_tokens = tokenizer.tokenize(tweet)

        tweet_clean = ''

        for word in tweet_tokens: # Go through every word in your tokens list
            if word not in stopwords_english:
                tweet_clean = tweet_clean + ' ' + word

        clean_tweets.append(tweet_clean.strip())

    return clean_tweets
```

In [366…

```
def deEmojify(tweets):
    clean_tweets = []

    for tweet in tweets:
        regrex_pattern = re.compile(pattern = "["
```

```
            u"\U0001F600-\U0001F64F"  # emoticons
            u"\U0001F300-\U0001F5FF"  # symbols & pictographs
            u"\U0001F680-\U0001F6FF"  # transport & map symbols
            u"\U0001F1E0-\U0001F1FF"  # flags (iOS)
                               "]+", flags = re.UNICODE)

        clean_tweets.append(regrex_pattern.sub(r'', tweet))

    return clean_tweets
```

In [367…

```
def normalization_pipeline(tweets):

    tweets = denoise(tweets)
    tweets = deEmojify(tweets)
    tweets = normalize_contractions(tweets)
    tweets = remove_stop_words(tweets)

    return tweets
```

In [368…

```
# load tweets
tweets = df['text'].to_list()

clean_tweets = normalization_pipeline(tweets)
```

In [369…

```
df['sentiment_text'] = clean_tweets
```

In [370…

```
#remove tweets that are empty
df = df[df['sentiment_text'] != '']
```

Sentiment Analysis

Part 1: Vader & TextBlob

In [371…

```
def sentiment_scores(tweet):

    # Create a SentimentIntensityAnalyzer object.
    sid_obj = SentimentIntensityAnalyzer()

    sentiment_score = sid_obj.polarity_scores(tweet)['compound']
    blob_dict = TextBlob(tweet).sentiment

    sentiment_vader.append(sentiment_score)
    polarity.append(blob_dict.polarity)
    subjectivity.append(blob_dict.subjectivity)
```

In [372…

```
# compute scores
tweets_clean = df['sentiment_text']

polarity = []
subjectivity = []
sentiment_vader = []
```

```
for tweet in tweets_clean:
    sentiment_scores(tweet)

df['subjectivity_score'] = subjectivity
df['TextBlob_sa'] = polarity
df['Vader_sa'] = sentiment_vader
```

```
<ipython-input-372-aad1d5f1801e>:11: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stab
le/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['subjectivity_score'] = subjectivity
<ipython-input-372-aad1d5f1801e>:12: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stab
le/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['TextBlob_sa'] = polarity
<ipython-input-372-aad1d5f1801e>:13: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stab
le/user_guide/indexing.html#returning-a-view-versus-a-copy
  df['Vader_sa'] = sentiment_vader
```

Plotting the results

In [373…

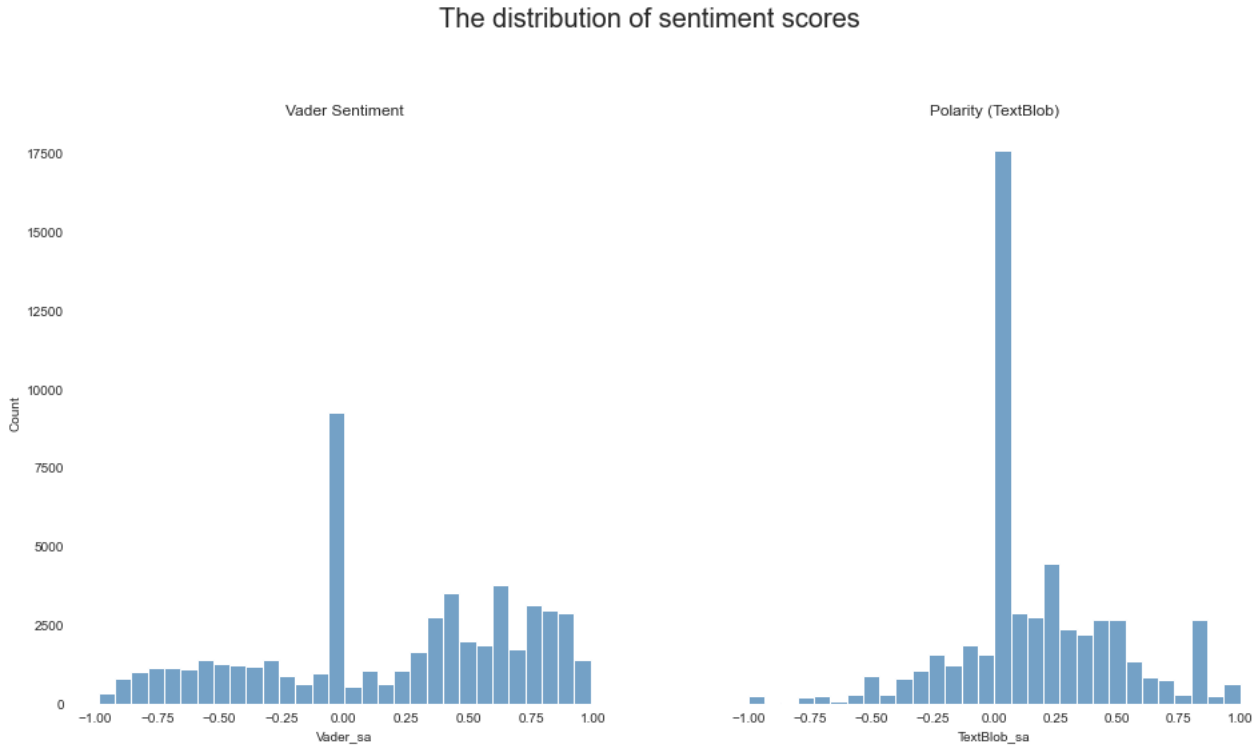
```
def get_rid_of_spine(axes):
    for ax in axes:
        for spine in ax.spines.values():
            spine.set_visible(False)
```

In [374…

```
# Plotting polarity vs sentiment
fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(16,8), sharey=True)
g1 = sns.histplot(x=df['Vader_sa'], color="steelblue", ax=ax1, bins = 30)
g2 = sns.histplot(x=df['TextBlob_sa'], color="steelblue", ax=ax2, bins = 30)

ax1.set_title("Vader Sentiment")
ax2.set_title("Polarity (TextBlob)")

get_rid_of_spine([ax1, ax2])
plt.suptitle("The distribution of sentiment scores", y = 1.03, fontsize=20)
```

Out[374…

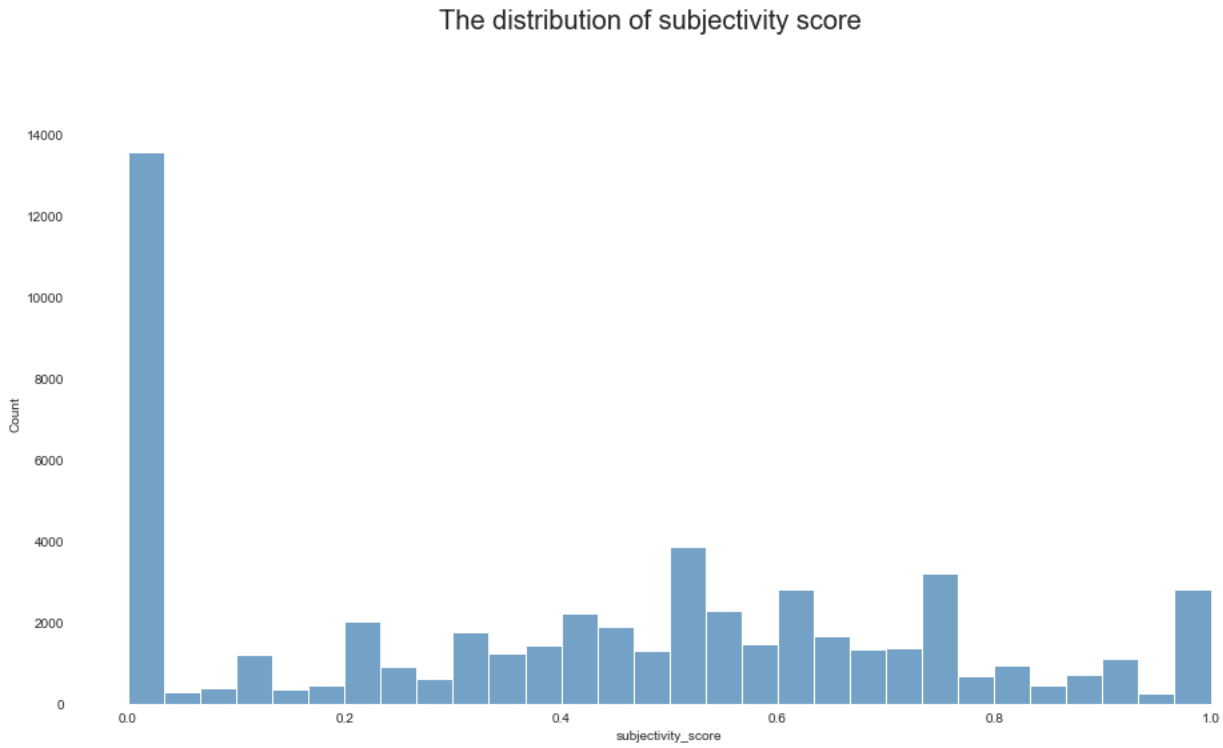
```
Text(0.5, 1.03, 'The distribution of sentiment scores')
```



In [375…

```
# Plotting objectivity
# subjectivity_score = 0: very objective
# subjectivity_score = 1: very subjective
fig, ax = plt.subplots(figsize=(16,8))
g1 = sns.histplot(x=df['subjectivity_score'], color="steelblue", bins = 30)
get_rid_of_spine([ax])
plt.suptitle("The distribution of subjectivity score", y = 1.03, fontsize=20)
```

Out[375… Text(0.5, 1.03, 'The distribution of subjectivity score')



In [376…

```
df.to_csv(r'../output/sentiment_analysis_clean.csv', index = False)
```

Part 2: Word-2-vec and KMeans

Source: https://towardsdatascience.com/unsupervised-sentiment-analysis-a38bf1906483

In [377…

```
# loading clean dataset
df_tweets = pd.read_csv('../output/sentiment_analysis_clean.csv')
df_tweets.head()
```

Out[377…

	id	text	isRetweet	isDeleted	device	favorites	retweets
0	98454970654916608	Republicans and Democrats have both created ou...	f	f	TweetDeck	49	255
1	1234653427789070336	I was thrilled to be back in the Great city of...	f	f	Twitter for iPhone	73748	17404
2	1218010753434820614	RT @CBS_Herridge: READ: Letter to surveillance...	t	f	Twitter for iPhone	0	7396
3	1304875170860015617	The Unsolicited Mail In Ballot Scam is a major...	f	f	Twitter for iPhone	80527	23502
4	1218159531554897920	RT @MZHemingway: Very friendly telling of even...	t	f	Twitter for iPhone	0	9081

In [378…

```
# Removing empty sentiment_text
df_tweets = df_tweets[-df_tweets.sentiment_text.isna()]

# Tokenizing sentiment_text for compatibility with gensim package
df_tweets.sentiment_text = df_tweets.sentiment_text.swifter.apply(lambda x: x.sp

df_tweets.sentiment_text.head()
```

Out[378…

```
0    [republicans, democrats, created, economic, pr...
1    [thrilled, back, great, city, charlotte, north...
2    [read, letter, surveillance, court, obtained, ...
3    [unsolicited, mail, ballot, scam, major, threa...
4    [friendly, telling, events, comey, apparent, l...
Name: sentiment_text, dtype: object
```

In [379…

```
corpus = [tweet for tweet in df_tweets.sentiment_text]
phrases = Phrases(corpus, min_count=10)
bigram = Phraser(phrases)
sentences = bigram[corpus]
```

In [380…
```
# Example of sentence with bigram token
sentences[1]
```

Out[380…
```
['thrilled_back',
 'great',
 'city',
 'charlotte',
 'north_carolina',
 'thousands',
 'hardworking_american',
 'patriots',
 'love',
 'country',
 'cherish',
 'values',
 'respect',
 'laws',
 'always',
 'put',
 'america',
 'first',
 'thank',
 'wonderful',
 'evening']
```

In [ ]:
```
w2v_model = Word2Vec(min_count=1,
                     window=7,
                     size=300,
                     sample=1e-5,
                     alpha=0.03,
                     min_alpha=0.0007,
                     negative=10,
                     workers=-1)

start = time()

w2v_model.build_vocab(sentences,
                      progress_per=50000)

print('Time to build vocab: {} mins'.format(round((time() - start) / 60, 2)))
```

In [382…
```
start = time()

w2v_model.train(sentences, total_examples=w2v_model.corpus_count, epochs=200, re

print('Time to train the model: {} mins'.format(round((time() - start) / 60, 2))

w2v_model.init_sims(replace=True)
```

```
Time to train the model: 1.61 mins
<ipython-input-382-9b3f9f8c7e0a>:7: DeprecationWarning: Call to deprecated `init
_sims` (Gensim 4.0.0 implemented internal optimizations that make calls to init_
sims() unnecessary. init_sims() is now obsoleted and will be completely removed
in future versions. See https://github.com/RaRe-Technologies/gensim/wiki/Migrati
ng-from-Gensim-3.x-to-4).
  w2v_model.init_sims(replace=True)
```

In [383…

```
w2v_model.save("../output/word2vec.model")

word_vectors = Word2Vec.load("../output/word2vec.model").wv
```

In [384…

```
# build Kmeans model
model = KMeans(n_clusters=2, max_iter=1000, random_state=True, n_init=50).fit(X=
word_vectors.similar_by_vector(model.cluster_centers_[0], topn=50, restrict_voca
```

Out[384…
```
[('hanna', 0.2546403706073761),
 ('reactor', 0.2425016611814499),
 ('jones', 0.229448601603508),
 ('chickens', 0.2241600900888443),
 ('eliminates', 0.21723613142967224),
 ('taj', 0.2135332226753235),
 ('donate', 0.21283449232578278),
 ('calenders', 0.20683975517749786),
 ('bought', 0.20530638098716736),
 ('ensue', 0.20398637652397156),
 ('proceedings', 0.19942763447761536),
 ('cumming', 0.19820238649845123),
 ('vaccines', 0.19622787833213806),
 ('chester', 0.19548356533050537),
 ('overflowing', 0.19547200202941895),
 ('locale', 0.19536355137825012),
 ('yt', 0.19525468349456787),
 ('begs', 0.1929004192352295),
 ('explicit', 0.19289487600326538),
 ('challenger', 0.1925903856754303),
 ('omaha', 0.19106560945510864),
 ("america'executive", 0.19088676571846008),
 ('defiance', 0.1892756223678589),
 ('dismantles', 0.18781165778636932),
 ('fig', 0.18645288050174713),
 ('create', 0.18580549955368042),
 ('se', 0.18480007350444794),
 ('diligently', 0.18452215194702148),
 ('retainer', 0.18416795134544373),
 ('vulnerabilities', 0.18341287970542908),
 ('vocabulary', 0.18300214409828186),
 ('seattle', 0.18205475807189941),
 ('valid', 0.18139460682868958),
 ('degenerates', 0.18015271425247192),
 ('ungratefulness', 0.17942260205745697),
 ('harmful', 0.1793481707572937),
 ('australians', 0.1781979501247406),
 ('beard', 0.1778695285320282),
 ('lashed', 0.17739585041999817),
 ('picasso', 0.1767440140247345),
 ('hbcu', 0.1767164021730423),
 ('stadium', 0.1766815036535263),
 ('parkland', 0.17590627074241638),
 ('bankrupting', 0.17567592859268188),
 ('precautions', 0.17534536123275757),
 ('i', 0.17530637979507446),
 ('rejection', 0.17524150013923645),
 ('granting', 0.17355895042419434),
 ('lindsay', 0.17346470057964325),
 ('joe_scarborough', 0.17333108186721802)]
```

In [413…

```
positive_cluster_index = 1
positive_cluster_center = model.cluster_centers_[positive_cluster_index]
negative_cluster_center = model.cluster_centers_[1-positive_cluster_index]
```

```
words = pd.DataFrame(word_vectors.vocab.keys)
words.columns = ['words']
words['vectors'] = words.words.apply(lambda x: word_vectors[f'{x}'])
words['cluster'] = words.vectors.apply(lambda x: model.predict([np.array(x)]))
words.cluster = words.cluster.apply(lambda x: x[0])

words['cluster_value'] = [1 if i==positive_cluster_index else -1 for i in words.
words['closeness_score'] = words.apply(lambda x: 1/(model.transform([x.vectors])
words['sentiment_coeff'] = words.closeness_score * words.cluster_value

words.head(20)
```

```
---------------------------------------------------------------------------
AttributeError                            Traceback (most recent call last)
<ipython-input-413-feca139475f1> in <module>
      3 negative_cluster_center = model.cluster_centers_[1-positive_cluster_inde
x]
      4
----> 5 words = pd.DataFrame(word_vectors.vocab.keys)
      6 words.columns = ['words']
      7 words['vectors'] = words.words.apply(lambda x: word_vectors[f'{x}'])

~/opt/anaconda3/lib/python3.8/site-packages/gensim/models/keyedvectors.py in voc
ab(self)
    643             embeddings closest to a given word embedding.
    644         exponent : float, optional
--> 645             Take the word embedding similarities larger than `threshold`
to the power of `exponent`.
    646         nonzero_limit : int, optional
    647             The maximum number of non-zero elements outside the diagonal
in a single column of the

AttributeError: The vocab attribute was removed from KeyedVector in Gensim 4.0.
0.
Use KeyedVector's .key_to_index dict, .index_to_key list, and methods .get_vecat
tr(key, attr) and .set_vecattr(key, attr, new_val) instead.
See https://github.com/RaRe-Technologies/gensim/wiki/Migrating-from-Gensim-3.x-t
o-4
```

In [386…

```
words[['words', 'sentiment_coeff']].to_csv('../output/sentiment_dictionary.csv',
```

In [387…

```
df_tweets.sentiment_text = df_tweets.sentiment_text.swifter.apply(lambda x: ' '.

cut_labels = [-1, 0, 1]
cut_bins = [-1, -0.00000001, 0.00000001, 1]
df_tweets['VADER'] = pd.cut(df_tweets.Vader_sa, bins=cut_bins, labels=cut_labels
df_tweets['TextBlob'] = pd.cut(df_tweets.TextBlob_sa, bins=cut_bins, labels=cut_

df_tweets['VADER'].value_counts()
```

Out[387…

```
1     31055
-1    14920
0      8699
Name: VADER, dtype: int64
```

In [388…

```
df_tweets.head()
```

Out[388…

	id	text	isRetweet	isDeleted	device	favorites	retweets
0	98454970654916608	Republicans and Democrats have both created ou...	f	f	TweetDeck	49	255
1	1234653427789070336	I was thrilled to be back in the Great city of...	f	f	Twitter for iPhone	73748	17404
2	1218010753434820614	RT @CBS_Herridge: READ: Letter to surveillance...	t	f	Twitter for iPhone	0	7396
3	1304875170860015617	The Unsolicited Mail In Ballot Scam is a major...	f	f	Twitter for iPhone	80527	23502
4	1218159531554897920	RT @MZHemingway: Very friendly telling of even...	t	f	Twitter for iPhone	0	9081

In [389…

```
df_tweets[['sentiment_text', 'VADER', 'TextBlob']].to_csv('../output/cleaned_dat
```

In [390…

```
final_file = pd.read_csv('../output/cleaned_dataset.csv')
sentiment_map = pd.read_csv('../output/sentiment_dictionary.csv')
sentiment_dict = dict(zip(sentiment_map.words.values, sentiment_map.sentiment_co
file_weighting = final_file.copy()
```

In [391…

```
tfidf = TfidfVectorizer(tokenizer=lambda y: y.split(), norm=None)
tfidf.fit(file_weighting.sentiment_text)
features = pd.Series(tfidf.get_feature_names())
transformed = tfidf.transform(file_weighting.sentiment_text)
```

```
/Users/my_love/opt/anaconda3/lib/python3.8/site-packages/sklearn/feature_extract
ion/text.py:489: UserWarning: The parameter 'token_pattern' will not be used sin
ce 'tokenizer' is not None'
  warnings.warn("The parameter 'token_pattern' will not be used"
```

In [392…

```
def create_tfidf_dictionary(x, transformed_file, features):
    '''
    create dictionary for each input sentence x, where each word has assigned it

    inspired  by function from this wonderful article:
    https://medium.com/analytics-vidhya/automated-keyword-extraction-from-articl

    x - row of dataframe, containing sentences, and their indexes,
    transformed_file - all sentences transformed with TfidfVectorizer
    features - names of all words in corpus used in TfidfVectorizer

    '''
    vector_coo = transformed_file[x.name].tocoo()
```

```
    vector_coo.col = features.iloc[vector_coo.col].values
    dict_from_coo = dict(zip(vector_coo.col, vector_coo.data))
    return dict_from_coo

def replace_tfidf_words(x, transformed_file, features):
    '''
    replacing each word with it's calculated tfidf dictionary with scores of eac
    x - row of dataframe, containing sentences, and their indexes,
    transformed_file - all sentences transformed with TfidfVectorizer
    features - names of all words in corpus used in TfidfVectorizer
    '''
    dictionary = create_tfidf_dictionary(x, transformed_file, features)
    return list(map(lambda y:dictionary[f'{y}'], x.sentiment_text.split()))
```

In [393…

```
%%time
replaced_tfidf_scores = file_weighting.apply(lambda x: replace_tfidf_words(x, tr
#this step takes around 3-4 minutes minutes to calculate
```

```
CPU times: user 12.6 s, sys: 53.3 ms, total: 12.6 s
Wall time: 12.7 s
```

In [394…

```
def replace_sentiment_words(word, sentiment_dict):
    '''
    replacing each word with its associated sentiment score from sentiment dict
    '''
    try:
        out = sentiment_dict[word]
    except KeyError:
        out = 0
    return out
```

In [395…

```
replaced_closeness_scores = file_weighting.sentiment_text.apply(lambda x: list(m
```

In [396…

```
replacement_df = pd.DataFrame(data=[replaced_closeness_scores, replaced_tfidf_sc
replacement_df.columns = ['sentiment_coeff', 'tfidf_scores', 'sentence', 'sentim
replacement_df['sentiment_rate'] = replacement_df.apply(lambda x: np.array(x.loc
replacement_df['prediction'] = (replacement_df.sentiment_rate>0).astype('int8')
replacement_df['sentiment'] = [1 if i==1 else -1 for i in replacement_df.sentime
replacement_df['prediction'].replace(0,-1, inplace=True)
```

In [397…

```
replacement_df.head()
```

Out[397…

	sentiment_coeff	tfidf_scores	sentence	sentiment	sentiment_rate	predictic
0	[-1.0032081886722843, 0.9992893224842098, -1.0...	[5.489166917397826, 4.58797328880549, 7.284189...	republicans democrats created economic problems	-1	-8.320141	
1	[-1.000372480604695, 0.9989952176917658, -1.00...	[9.075948501488753, 3.1859305707174603, 6.2960...	thrilled_back great city charlotte north_carol...	1	-33.690149	

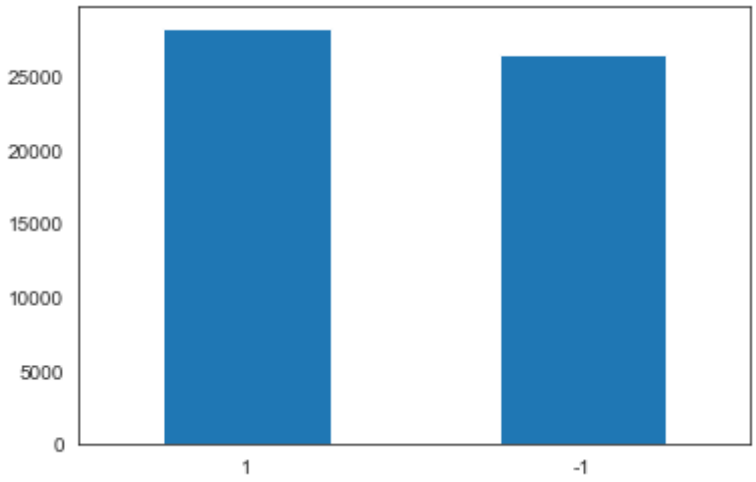
	sentiment_coeff	tfidf_scores	sentence	sentiment	sentiment_rate	predictic
2	[0.9998935654160628, 1.0037705941866502, -1.00...	[6.166158657735486, 7.565356423691285, 8.38280...	read letter surveillance court obtained cbs ne...	-1	16.693269	
3	[1.0017545222232345, -1.0002839633854088, 1.00...	[9.511266572746598, 8.913429571990978, 7.00388...	unsolicited mail_ballot scam major threat demo...	-1	-15.410082	
4	[1.0010711474717309, -0.9999162068042134, 0.99...	[8.61332497954064, 7.632495726528913, 7.689654...	friendly telling events comey apparent leaking...	1	-0.688301	

In [398…
```
replacement_df.prediction.value_counts()
```

Out[398…
```
 1    28272
-1    26402
Name: prediction, dtype: int64
```

In [399…
```
replacement_df.prediction.value_counts().plot(kind='bar', rot=0)
```

Out[399…
```
<AxesSubplot:>
```



In [400…
```
df_merged = pd.concat([df_tweets, replacement_df], axis=1)
df_merged.rename(columns={"prediction": "W2V-kNN"}, inplace=True)
df_merged.columns
```

Out[400…
```
Index(['id', 'text', 'isRetweet', 'isDeleted', 'device', 'favorites',
       'retweets', 'date', 'isFlagged', 'retweeted', 'sentiment_text',
       'subjectivity_score', 'TextBlob_sa', 'Vader_sa', 'VADER', 'TextBlob',
       'sentiment_coeff', 'tfidf_scores', 'sentence', 'sentiment',
       'sentiment_rate', 'W2V-kNN'],
      dtype='object')
```

In [401…
```
df_final = df_merged.iloc[:,[0,1,10,11,14,15,-1]]
```

```
df_final.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 54674 entries, 0 to 54673
Data columns (total 7 columns):
 #   Column              Non-Null Count  Dtype   
---  ------              --------------  -----   
 0   id                  54674 non-null  int64   
 1   text                54674 non-null  object  
 2   sentiment_text      54674 non-null  object  
 3   subjectivity_score  54674 non-null  float64 
 4   VADER               54674 non-null  category
 5   TextBlob            54422 non-null  category
 6   W2V-kNN             54674 non-null  int8    
dtypes: category(2), float64(1), int64(1), int8(1), object(2)
memory usage: 4.7+ MB
```

In [402…

```
df_final.dropna(how='any', inplace=True)
df_final.VADER = df_final.VADER.astype(int)
df_final.TextBlob = df_final.TextBlob.cat.codes - 1
df_final['W2V-kNN'] = df_final['W2V-kNN'].astype(int)
```

```
<ipython-input-402-bdbf950dc954>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stab
le/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_final.dropna(how='any', inplace=True)
/Users/my_love/opt/anaconda3/lib/python3.8/site-packages/pandas/core/generic.py:
5168: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stab
le/user_guide/indexing.html#returning-a-view-versus-a-copy
  self[name] = value
<ipython-input-402-bdbf950dc954>:4: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stab
le/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_final['W2V-kNN'] = df_final['W2V-kNN'].astype(int)
```

In [403…

```
df_final['Final'] = (df_final.VADER + df_final.TextBlob + df_final['W2V-kNN'])/3
```

```
<ipython-input-403-62f24c0e67c7>:1: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stab
le/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_final['Final'] = (df_final.VADER + df_final.TextBlob + df_final['W2V-kN
N'])/3
```

In [404…

```
cut_labels = [-1, 0, 1]
cut_bins = [-100, -0.00001, 0.00001, 100]
df_final['Final'] = pd.cut(df_final['Final'], bins=cut_bins, labels=cut_labels)
```

```
<ipython-input-404-03855659e3aa>:3: SettingWithCopyWarning:
```

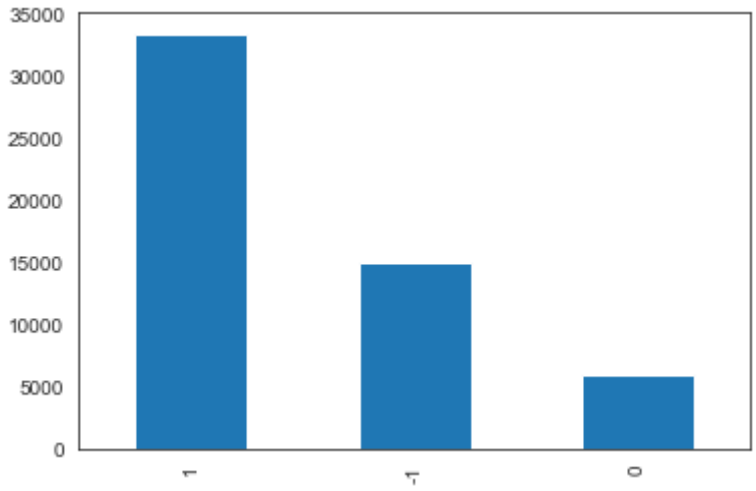
```
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  df_final['Final'] = pd.cut(df_final['Final'], bins=cut_bins, labels=cut_labels)
```

In [405…]
```
df_final['Final'].value_counts()
```

Out[405…]
```
1     33397
-1    15045
0      5980
Name: Final, dtype: int64
```

In [406…]
```
df_final['Final'].value_counts().plot(kind='bar')
```

Out[406…]
```
<AxesSubplot:>
```



In [407…]
```
df_final.to_csv('../output/sentiment_labels.csv')
```

In [408…]
```
df_final = pd.read_csv('../output/sentiment_labels.csv', index_col=None).iloc[:,
df_final.head()
```

Out[408…]

	id	text	sentiment_text	subjectivity_score	VADER	TextBlob
0	98454970654916608	Republicans and Democrats have both created ou...	republicans democrats created economic problems	0.200000	-1	1
1	1234653427789070336	I was thrilled to be back in the Great city of...	thrilled_back great city charlotte north_carol...	0.483333	1	1
2	1218010753434820614	RT @CBS_Herridge: READ: Letter to surveillance...	read letter surveillance court obtained cbs ne...	0.100000	0	1

	id	text	sentiment_text	subjectivity_score	VADER	TextBlob
3	1304875170860015617	The Unsolicited Mail In Ballot Scam is a major...	unsolicited mail_ballot scam major threat demo...	0.454762	-1	1
4	1218159531554897920	RT @MZHemingway: Very friendly telling of even...	friendly telling events comey apparent leaking...	0.425000	1	1

In [409…
```
df_final['VADER'].value_counts()
```

Out[409…
```
 1    31041
-1    14684
 0     8697
Name: VADER, dtype: int64
```

In [410…
```
df_final['TextBlob'].value_counts()
```

Out[410…
```
 1    28536
 0    15852
-1    10034
Name: TextBlob, dtype: int64
```

In [411…
```
df_final['W2V-kNN'].value_counts()
```

Out[411…
```
 1    28148
-1    26274
Name: W2V-kNN, dtype: int64
```

In [412…
```
df_final['Final'].value_counts()
```

Out[412…
```
 1    33397
-1    15045
 0     5980
Name: Final, dtype: int64
```

In [ ]:
```

```