

TwitterHateSpeechNLP

December 30, 2021

```
[1]: import pandas as pd
import numpy as np
import re
```

```
[2]: data = pd.read_csv('TwitterHate.csv')
```

```
[3]: data.head()
```

```
[3]:
```

	id	label	tweet
0	1	0	@user when a father is dysfunctional and is s...
1	2	0	@user @user thanks for #lyft credit i can't us...
2	3	0	bihday your majesty
3	4	0	#model i love u take with u all the time in ...
4	5	0	factsguide: society now #motivation

```
[4]: tweets = data['tweet']
tweets
```

```
[4]: 0      @user when a father is dysfunctional and is s...
1      @user @user thanks for #lyft credit i can't us...
2      bihday your majesty
3      #model i love u take with u all the time in ...
4      factsguide: society now #motivation

...
31957  ate @user isz that youuu?ð ð ð ð ð ð...
31958  to see nina turner on the airwaves trying to...
31959  listening to sad songs on a monday morning otw...
31960  @user #sikh #temple vandalised in in #calgary,...
31961  thank you @user for you follow
Name: tweet, Length: 31962, dtype: object
```

0.0.1 Data Cleaning and Analysis

Normalize the casing.

Using regular expressions, remove user handles. These begin with '@'.

Using regular expressions, remove URLs.

Using TweetTokenizer from NLTK, tokenize the tweets into individual terms.

Remove stop words.

Remove redundant terms like 'amp', 'rt', etc.

Remove '#' symbols from the tweet while retaining the term.

```
[5]: import nltk
nltk.download('stopwords')
nltk.download('wordnet')

from nltk.corpus import stopwords
from nltk import TweetTokenizer
from nltk.stem import WordNetLemmatizer
from nltk.stem import PorterStemmer
from wordcloud import WordCloud
import matplotlib.pyplot as plt
```

```
[nltk_data] Downloading package stopwords to
[nltk_data] /home/labsuser/nltk_data...
[nltk_data] Package stopwords is already up-to-date!
[nltk_data] Downloading package wordnet to /home/labsuser/nltk_data...
[nltk_data] Package wordnet is already up-to-date!
```

```
[6]: def print_tweets(ts, count):
    for i in range(count):
        print(ts[i])
```

```
[7]: tweets = [tweet.lower().strip() for tweet in tweets]
print_tweets(tweets, 5)
```

```
@user when a father is dysfunctional and is so selfish he drags his kids into
his dysfunction. #run
@user @user thanks for #lyft credit i can't use cause they don't offer
wheelchair vans in pdx. #disappointed #getthanked
bihday your majesty
#model i love u take with u all the time in urð ±!!!
ð ð ð ð ð |ð |ð |
factsguide: society now #motivation
```

```
[8]: tweets_clean = [re.sub('@([a-z]+[a-z0-9-_]+)', '', tweet).strip() for tweet in
    ↪ tweets]
print_tweets(tweets_clean, 5)
```

```
when a father is dysfunctional and is so selfish he drags his kids into his
dysfunction. #run
thanks for #lyft credit i can't use cause they don't offer wheelchair vans in
pdx. #disappointed #getthanked
bihday your majesty
```

```
#model i love u take with u all the time in urð ±!!!
ð ð ð ð ð |ð |ð |
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```

```
[9]: url_re = 'www\.([a-zA-Z]|[0-9]|[$-_@.&+]|[*\(\),])+([a-z0-9])'
tweets_clean = [re.sub(url_re, '', tweet).strip() for tweet in tweets]

for tweet in tweets_clean:
    if re.search(url_re, tweet):
        print(tweet)
```

```
[10]: tknizr = TweetTokenizer( strip_handles=True, reduce_len=True)
```

```
[11]: tweets_tokenized = [tknizr.tokenize(tweet) for tweet in tweets_clean]
print_tweets(tweets_tokenized, 5)
```

```
['when', 'a', 'father', 'is', 'dysfunctional', 'and', 'is', 'so', 'selfish',
'he', 'drags', 'his', 'kids', 'into', 'his', 'dysfunction', '.', '#run']
['thanks', 'for', '#lyft', 'credit', 'i', "can't", 'use', 'cause', 'they',
"don't", 'offer', 'wheelchair', 'vans', 'in', 'pdx', '.', '#disappointed',
'#getthanked']
['bihday', 'your', 'majesty']
['#model', 'i', 'love', 'u', 'take', 'with', 'u', 'all', 'the', 'time', 'in',
'urð', '\x9f', '\x93', '±', '!', '!', '!', 'ð', '\x9f', '\x98', '\x99', 'ð',
'\x9f', '\x98', '\x8e', 'ð', '\x9f', '\x91', '\x84', 'ð', '\x9f', '\x91', 'ð',
'\x9f', '\x92', '!', 'ð', '\x9f', '\x92', '!', 'ð', '\x9f', '\x92', '!']
['factsguide', ':', 'society', 'now', '#motivation']
```

```
[12]: !pip install unicode
```

Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: unicode in /usr/local/lib/python3.7/site-packages (1.1.1)

WARNING: You are using pip version 20.3.3; however, version 21.3.1 is available.

You should consider upgrading via the '/usr/local/bin/python3.7 -m pip install --upgrade pip' command.

```
[13]: import unicode

tweets_filtered = []
for tweet in tweets_tokenized:
    filter_wd = []
    for wd in tweet:
        if wd != '\d*':
            filter_wd.append(unicode.unidecode(wd))
```

```
tweets_filtered.append(filter_wd)
```

```
[14]: print(set(stopwords.words('english')))
```

```
{'but', 'each', 'nor', 'about', 'yourselves', 'their', 'with', 'above', 'most',  
'here', 'those', 'own', 'ain', 'after', 'they', 'we', 'couldn't', 'you'll',  
'it', 'hadn't', 'doesn't', 'does', 'on', 'shouldn', 'hasn't', 'hasn', 'if',  
'or', 'wasn't', 're', 'weren't', 'why', 'didn', 'down', 'to', 'now', 'couldn',  
'ours', 'themselves', 'no', 'y', 'you'd', 'mustn't', 'my', 'a', 'and', 'an',  
'shouldn't', 'me', 'do', 'haven't', 'you've', 'over', 'same', 'aren', 'hadn',  
'them', 'into', 'from', 'needn't', 'ourselves', 'shan', 'once', 'more',  
'before', 'wasn', 'o', 'this', 'you're', 'should', 'should've', 'these',  
'through', 'that'll', 'mightn', 'needn', 'aren't', 'herself', 'won't', 'some',  
'll', 'yourself', 'be', 'been', 'wouldn', 'for', 'doesn', 'then', 'not', 'has',  
'her', 'doing', 'who', 'too', 'so', 'isn', 'having', 'him', 'such', 'again',  
'other', 'only', 's', 'his', 'our', 'had', 'ma', 'all', 'will', 'didn't',  
'your', 'where', 'theirs', 'which', 'being', 'how', 'it's', 've', 'yours',  
'are', 'just', 'am', 'as', 'while', 'weren', 'by', 'were', 'itself', 't', 'did',  
'below', 'the', 'its', 'out', 'haven', 'isn't', 'she', 'was', 'when', 'until',  
'that', 'can', 'what', 'myself', 'don', 'm', 'off', 'whom', 'during', 'up',  
'you', 'under', 'she's', 'he', 'mightn't', 'don't', 'there', 'at', 'because',  
'against', 'mustn', 'won', 'shan't', 'have', 'than', 'very', 'further', 'i',  
'between', 'd', 'of', 'hers', 'himself', 'few', 'both', 'is', 'any', 'wouldn't',  
'in'}
```

```
[15]: stop_words = stopwords.words('english')
```

```
[16]: tweets_filter_sw = []  
for tweet in tweets_filtered:  
    filter_wd = []  
    for wd in tweet:  
        if wd not in stop_words:  
            filter_wd.append(wd)  
  
    tweets_filter_sw.append(filter_wd)  
  
print_tweets(tweets_filter_sw, 5)
```

```
['father', 'dysfunctional', 'selfish', 'drags', 'kids', 'dysfunction', '.',  
 '#run']  
['thanks', '#lyft', 'credit', 'can't', 'use', 'cause', 'offer', 'wheelchair',  
 'vans', 'pdx', '.', '#disappointed', '#getthanked']  
['bihday', 'majesty']  
['#model', 'love', 'u', 'take', 'u', 'time', 'urd', '', '', '+-', '!', '!', '!',  
 '', '', '', '', '', '', '', '', '', '', '|', '', '|', '|', '|',  
 '|']
```

```
['factsguide', ':', 'society', '#motivation']
```

```
[17]: tweets_filtered = []
      for tweet in tweets_filter_sw:
          filter_wd = []
          for wd in tweet:
              if len(wd) > 1:
                  filter_wd.append(wd)

          tweets_filtered.append(filter_wd)

      print_tweets(tweets_filtered, 5)
```

```
['father', 'dysfunctional', 'selfish', 'drags', 'kids', 'dysfunction', '#run']
['thanks', '#lyft', 'credit', "can't", 'use', 'cause', 'offer', 'wheelchair',
'vans', 'pdx', '#disappointed', '#getthanked']
['bihday', 'majesty']
['#model', 'love', 'take', 'time', 'urd', '+-']
['factsguide', 'society', '#motivation']
```

```
[18]: hashtags = []
      for tweet in tweets_filtered:
          filter_wd = []
          for wd in tweet:
              if wd.startswith('#'):
                  filter_wd.append(wd[1:])

          if len(filter_wd) == 0:
              filter_wd.append('No #')
          hashtags.append(filter_wd)

      print_tweets(hashtags, 5)
```

```
['run']
['lyft', 'disappointed', 'getthanked']
['No #']
['model']
['motivation']
```

```
[19]: wnlem = WordNetLemmatizer()

      tweets_lem = []
      for tweet in tweets_filtered:
          filter_wd = []
          for wd in tweet:
              filter_wd.append(wnlem.lemmatize(wd))

          tweets_lem.append(filter_wd)
```

```
print_tweets(tweets_lem, 5)
```

```
['father', 'dysfunctional', 'selfish', 'drag', 'kid', 'dysfunction', '#run']  
['thanks', '#lyft', 'credit', "can't", 'use', 'cause', 'offer', 'wheelchair',  
'van', 'pdx', '#disappointed', '#getthanked']  
['bihday', 'majesty']  
['#model', 'love', 'take', 'time', 'urd', '+-']  
['factsguide', 'society', '#motivation']
```

```
[20]: pstem = PorterStemmer()  
  
tweets_stem = []  
for tweet in tweets_lem:  
    filter_wd = []  
    for wd in tweet:  
        filter_wd.append(pstem.stem(wd))  
  
    tweets_stem.append(filter_wd)  
  
print_tweets(tweets_stem, 5)
```

```
['father', 'dysfunct', 'selfish', 'drag', 'kid', 'dysfunct', '#run']  
['thank', '#lyft', 'credit', "can't", 'use', 'caus', 'offer', 'wheelchair',  
'van', 'pdx', '#disappoint', '#getthank']  
['bihday', 'majesti']  
['#model', 'love', 'take', 'time', 'urd', '+-']  
['factsguid', 'societi', '#motiv']
```

```
[21]: tweet_corpus = []  
for tweet in tweets_stem:  
    tweet_corpus.append(' '.join(tweet))  
  
print_tweets(tweet_corpus, 5)
```

```
father dysfunct selfish drag kid dysfunct #run  
thank #lyft credit can't use caus offer wheelchair van pdx #disappoint #getthank  
bihday majesti  
#model love take time urd +-  
factsguid societi #motiv
```

```
[22]: from collections import Counter  
  
#10 most common words  
  
all_words = []  
for tweet in tweets_stem:
```

```
Top ten most common words :
[('...', 2810), ('day', 2491), ('happi', 1720), ('#love', 1621), ('love',
1548), ('$?', 1311), ('get', 1246), ('go', 1230), ('time', 1203), ('thank',
1039)]
```

```
[24]: words_cloud = WordCloud().generate(all_words_non_hate)
      print('Word Cloud: Non hate words')
      plt.figure(figsize= (12,8))
      plt.imshow(words_cloud, interpolation = 'bilinear', cmap='viridis')
      plt.axis('off')
```

[24]: (-0.5, 399.5, 199.5, -0.5)




```
[29]: logReg = LogisticRegression(random_state=99)

logReg.fit(x_train_vect, y_train)
```

```
[29]: LogisticRegression(random_state=99)
```

```
[30]: lr_pred_train = logReg.predict(x_train_vect)
lr_pred_test = logReg.predict(x_test_vect)
```

```
[31]: print('Test set')
print('Accuracy score: ', accuracy_score(y_test, lr_pred_test))
print('Recall Score: ', recall_score(y_test, lr_pred_test))
print('F1 score: ', f1_score(y_test, lr_pred_test))
print('Confusion Matrix : \n', confusion_matrix(y_test, lr_pred_test))
```

```
Test set
Accuracy score: 0.9524455104807592
Recall Score: 0.3302325581395349
F1 score: 0.48299319727891155
Confusion Matrix :
[[8920  24]
 [ 432 213]]
```

```
[32]: logReg = LogisticRegression(class_weight='balanced', random_state=99)

logReg.fit(x_train_vect, y_train)

lr_pred_train = logReg.predict(x_train_vect)
lr_pred_test = logReg.predict(x_test_vect)
```

```
[33]: print('Test set')
print('Accuracy score: ', accuracy_score(y_test, lr_pred_test))
print('Recall Score: ', recall_score(y_test, lr_pred_test))
print('F1 score: ', f1_score(y_test, lr_pred_test))
print('Confusion Matrix : \n', confusion_matrix(y_test, lr_pred_test))
```

```
Test set
Accuracy score: 0.9296068411721764
Recall Score: 0.7891472868217054
F1 score: 0.6012994683992912
Confusion Matrix :
[[8405  539]
 [ 136 509]]
```

0.0.3 Regularization and Hyperparameter tuning

```
[34]: param_dict={'penalty': ['l1', 'l2'], 'solver': ['liblinear', 'newton-cg',  
→ 'sag'], 'C':[100, 10, 1.0, 0.1, 0.01]}
```

```
[35]: logReg = LogisticRegression(class_weight='balanced', random_state=99)
```

```
[36]: skf = StratifiedKFold(n_splits=4, shuffle=True, random_state=99)
```

```
[37]: grid_search = GridSearchCV(logReg, param_dict, cv=skf, scoring='recall',  
→ verbose=1)
```

```
[38]: grid_search.fit(x_train_vect, y_train)
```

Fitting 4 folds for each of 30 candidates, totalling 120 fits

```
/usr/local/lib/python3.7/site-  
packages/sklearn/model_selection/_validation.py:619: FitFailedWarning: Estimator  
fit failed. The score on this train-test partition for these parameters will be  
set to nan. Details:
```

```
Traceback (most recent call last):
```

```
File "/usr/local/lib/python3.7/site-  
packages/sklearn/model_selection/_validation.py", line 598, in _fit_and_score  
    estimator.fit(X_train, y_train, **fit_params)
```

```
File "/usr/local/lib/python3.7/site-  
packages/sklearn/linear_model/_logistic.py", line 1306, in fit  
    solver = _check_solver(self.solver, self.penalty, self.dual)
```

```
File "/usr/local/lib/python3.7/site-  
packages/sklearn/linear_model/_logistic.py", line 444, in _check_solver  
    "got %s penalty." % (solver, penalty))
```

```
ValueError: Solver newton-cg supports only 'l2' or 'none' penalties, got l1  
penalty.
```

```
FitFailedWarning)
```

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```

```

FitFailedWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/_sag.py:329:
ConvergenceWarning: The max_iter was reached which means the coef_ did not
converge
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Traceback (most recent call last):
  File "/usr/local/lib/python3.7/site-
packages/sklearn/model_selection/_validation.py", line 598, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/usr/local/lib/python3.7/site-
packages/sklearn/linear_model/_logistic.py", line 1306, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "/usr/local/lib/python3.7/site-
packages/sklearn/linear_model/_logistic.py", line 444, in _check_solver
    "got %s penalty." % (solver, penalty))
ValueError: Solver newton-cg supports only 'l2' or 'none' penalties, got l1
penalty.

```

```

FitFailedWarning)
/usr/local/lib/python3.7/site-
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```

```
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    "got %s penalty." % (solver, penalty))
ValueError: Solver sag supports only 'l2' or 'none' penalties, got l1 penalty.

FitFailedWarning)
/usr/local/lib/python3.7/site-packages/sklearn/model_selection/_search.py:925:
UserWarning: One or more of the test scores are non-finite: [0.67125157
nan          nan 0.69442982 0.69442982 0.69379856
0.70506109      nan          nan 0.73824091 0.73824091 0.74575971

```

```

0.74513784      nan      nan 0.78020677 0.78020677 0.78020677
0.61490602      nan      nan 0.77707237 0.77707237 0.77707237
0.07138315      nan      nan 0.74013628 0.73825815 0.73825815]
category=UserWarning

```

```

[38]: GridSearchCV(cv=StratifiedKFold(n_splits=4, random_state=99, shuffle=True),
                  estimator=LogisticRegression(class_weight='balanced',
                                                random_state=99),
                  param_grid={'C': [100, 10, 1.0, 0.1, 0.01],
                              'penalty': ['l1', 'l2'],
                              'solver': ['liblinear', 'newton-cg', 'sag']},
                  scoring='recall', verbose=1)

```

```

[39]: grid_search.best_estimator_

```

```

[39]: LogisticRegression(class_weight='balanced', random_state=99, solver='liblinear')

```

```

[40]: grid_search.best_score_

```

```

[40]: 0.7802067669172932

```

```

[41]: grid_search.best_params_

```

```

[41]: {'C': 1.0, 'penalty': 'l2', 'solver': 'liblinear'}

```

```

[42]: gs_y_pred = grid_search.best_estimator_.predict(x_test_vect)

```

```

[43]: print('Test set')
      print('Accuracy score: ', accuracy_score(y_test, gs_y_pred))
      print('Recall Score: ', recall_score(y_test, gs_y_pred))
      print('F1 score: ', f1_score(y_test, gs_y_pred))
      print('Confusion Matrix : \n', confusion_matrix(y_test, gs_y_pred))

```

```

Test set
Accuracy score:  0.92950255501095
Recall Score:   0.7891472868217054
F1 score:       0.6009445100354192
Confusion Matrix :
[[8404  540]
 [ 136  509]]

```