Web_Analytics_Project

September 9, 2021

[ ]:
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# Internal vs. External Company Reputation
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Outline of Project

- First steps
  - Input company variable
  - Format for Glassdoor URL
  - Already set for Tweepy
- Using Tweepy and For loop from previous assignments for tweets and Glassdoor review
  - Pulling from Bonus lecture
  - Homework 2+3
- Cleaning data set + Print word cloud
  - split() function
  - Normalization (stemming and lemmatization)
  - Remove stop words (remove_noise function)
  - Categorize text (3 different classifiers)
  - Top 30 positive and negative words using Word Cloud
- 2 models (mix and match with different classifiers)
- Print confusion matrix, sensitivity, specificity, accuracy, and model with best accuracy

Resources (CITE in code and at the end too) * https://www.kaggle.com/adepvenugopal/sentiment-analysis-of-glassdoor-review

- https://www.kaggle.com/sid321axn/natural-language-processing-sentiment-analysis https://vu-d.gitbook.io/journey/data-analytics/glassdoor-scrape

- https://www.digitalocean.com/community/tutorials/how-to-perform-sentiment-analysis-in-python-3-using-the-natural-language-toolkit-nltk

- https://scikit-learn.org/stable/modules/generated/sklearn.feature_extraction.text.CountVectorizer.html

- https://realpython.com/beautiful-soup-web-scraper-python/

- https://www.kaggle.com/sid321axn/natural-language-processing-sentiment-analysis

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# Tweepy allows us to access the twitter API in python
import tweepy as tw

# Pandas will allow us to extract tweets/users and load the data into dataframe
import pandas as pd
```

```
# JSON will allow us to work with JSON files
import json

# json_normalize() will allows us to normalize semi-structured JSON data into a␣
↪flat table
from pandas.io.json import json_normalize

# Variables that contain the credentials to access Twitter API
# Use your own key and tokens instead
consumer_key    = "rMgBcDkAEiDKJHnIjkh8nwnLa"
consumer_secret = "y7jA77Bmr4rWUAdC5yImzlYBGtTVagTSwWqVciTOKan6aQWlb5"
access_key      = "1326566976672641025-TbwphBECIGOu3FSZy3xbs1P7tHosI1"
access_secret   = "x0pVhadxslvbOfE6qxFVBSKRLlpxXJQ3A8lqeUXQug9P1"

# Setup access to API
auth = tw.OAuthHandler(consumer_key, consumer_secret)
auth.set_access_token(access_key, access_secret)

# create the API object
api = tw.API(auth)
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# Twitter: External Reputation

# Begin code from https://www.earthdatascience.org/courses/
↪use-data-open-source-python/intro-to-apis/twitter-data-in-python/

# Define the search term and the date_since date as variables
# Ignoring all retweets by adding -filter:retweets
company = input('Please enter a company: ')

# Filtering out retweets
company_twitter = company + '-filter:retweets'

# pulling from 2016
date_since = "2018-11-16"

# Searching for tweets with the keyword as the company
tweets = tw.Cursor(api.search,
                       q=company_twitter,
                       lang="en",
                       since=date_since).items(140)

# Starting with an empty list to make a for loop
company_tweets = []
```

```
# Adding only the text of tweet to the list
for tweet in tweets:
    curr_tweet = tweet.text
    company_tweets.append(curr_tweet)

# End code from https://www.earthdatascience.org/courses/
↪use-data-open-source-python/intro-to-apis/twitter-data-in-python/

#company_tweets
```

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# Indeed: Internal reputation

# Import the necessary libraries
import requests
import re
import bs4
from bs4 import BeautifulSoup
import pandas as pd
import time

# Create an empty list to add our data to
internal_review_data = []

# Using company variable from previous chunk

# Format the company name so that it works in the URL for our web parser
if ' ' in company:
    company = company.replace(' ', '-')

webpage = "https://www.indeed.com/cmp/"+company+"/reviews?fcountry=ALL"
k = 20
PageNum = 7

# Creating a for loop to scape movie data from number of pages provided
for i in range(1, PageNum + 1):

    # First page is different from the rest, so I made an if statement to give␣
↪it a custom url
    if i == 1:
        current_page = webpage

    # All other pages have this layout for the url
    else:
        current_page = webpage + '&start='+ str(k)
        k +=20

    #conducting a request of the stated URL above:
```

```
    page = requests.get(current_page)
    html = page.content
    #specifying a desired format of "page" using the html parser - this allows␣
↪python to read the various components of the page, rather than treating it␣
↪as one long string.
    soup = BeautifulSoup(html.decode('ascii', 'ignore'), 'lxml')
    reviews = soup.findAll('div', {'class':re.compile('cmp-Review-container')})

    for review in reviews:
        review_header, review_text, review_pros, review_cons, review_rating =␣
↪'NA', 'NA', 'NA', 'NA', 'NA'

    # Find the text for the header
        head = review.find('a', {'href':re.compile('/cmp/'+company+'/reviews/
↪')})
        if head:
            review_header = head.text.strip()

      # Find the text for the main review text
        txt = review.find('div', {'class':re.compile('cmp-Review-text')})
        if txt:
            review_text = txt.text.strip()

      # Find the text from the pros/cons sections
        pros = review.find('div', {'class':re.
↪compile('cmp-ReviewProsCons-prosText')})
        if pros:
            review_pros = pros.text.strip()

        cons = review.find('div', {'class':re.
↪compile('cmp-ReviewProsCons-consText')})
        if cons:
            review_cons = cons.text.strip()

      # Find the number (out of 5) given as the rating
        rating = review.find('button', {'class':re.
↪compile('cmp-ReviewRating-text')})
        if rating:
          review_rating = rating.text.strip()

        combined = review_text + review_pros + review_cons + review_rating
       # Add all of our data to the empty list we created earlier
        internal_review_data.append([review_header, review_text, review_pros,␣
↪review_cons, review_rating])
```

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# Import the necessary libraries
import pandas as pd
import numpy as np
import matplotlib as plt
import seaborn as sns

# Format our data into a Pandas data frame
internal_company_review_df = pd.DataFrame(internal_review_data, columns =␣
↪['Header', 'Review Text', 'Pros', 'Cons', 'Rating'])

# Create an empty list to append whether a review was positive (1) or not (0)␣
↪and add to our Pandas data frame
internal_positive_review = []

for i in range(len(internal_company_review_df)):
  # Criteria for positivity is a review rating > than 3.0 as this is considered␣
↪"neutral"
    if internal_company_review_df['Rating'][i] > '3.0':
        internal_positive_review.append(1)
    else:
        internal_positive_review.append(0)

# Add the built up list to our Pandas data frame
internal_company_review_df['Positive'] = internal_positive_review
#print(internal_company_review_df)
```

```
                            Header  … Positive
0                 It's a fun place  …        1
1       Google is getting political  …        0
2                              Idkk  …        0
3       Very Beautiful place to work  …        1
4                            Google  …        1
..                             …   …       …
100  Productive and Fun work place  …        1
101             Good place to work  …        1
102     Very supportive environment  …        1
103            Great peace of mind  …        1
104                              1  …        1

[105 rows x 6 columns]
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```
from nltk.corpus import stopwords
import nltk
nltk.download('stopwords')

# Clean the stop word and return clean data
def clean_the_stop_word(info):
```

```
  stop_words = stopwords.words('english')
  # print(stop_words)
  # except the stop word
  clean_word = [word for word in info if word not in stop_words]
  return clean_word
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data…
[nltk_data]   Unzipping corpora/stopwords.zip.
```

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```
# count the sentiment score by word
from textblob import TextBlob

# the score is between -1 and 1
# [0, 1] means positive
# [-1, 0] meas negative
def get_score(word):
  blob = TextBlob(word)
  # print(blob.sentiment[0])
  return blob.sentiment[0]
```

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0.5
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```
import nltk


nltk.download('punkt')
# cut down the text by nltk
def cut_down_text_to_words(text):
  # convert text list to a string
  text_string = " ".join(text)
  # cut down the words
  words = nltk.word_tokenize(text_string)
  return words
```

```
[nltk_data] Downloading package punkt to /root/nltk_data…
[nltk_data]   Unzipping tokenizers/punkt.zip.
```

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from numpy import *

# convert text to words
```

```python
def convert_text_to_one_dimensional(text):
  word_list = []
  # flatten the list
  word_list = array(text)
  # convert multi-dimensional data to one-dimensional data
  word_list = word_list.flatten()
  # convert to list
  word_list = list(word_list)
  return word_list
```

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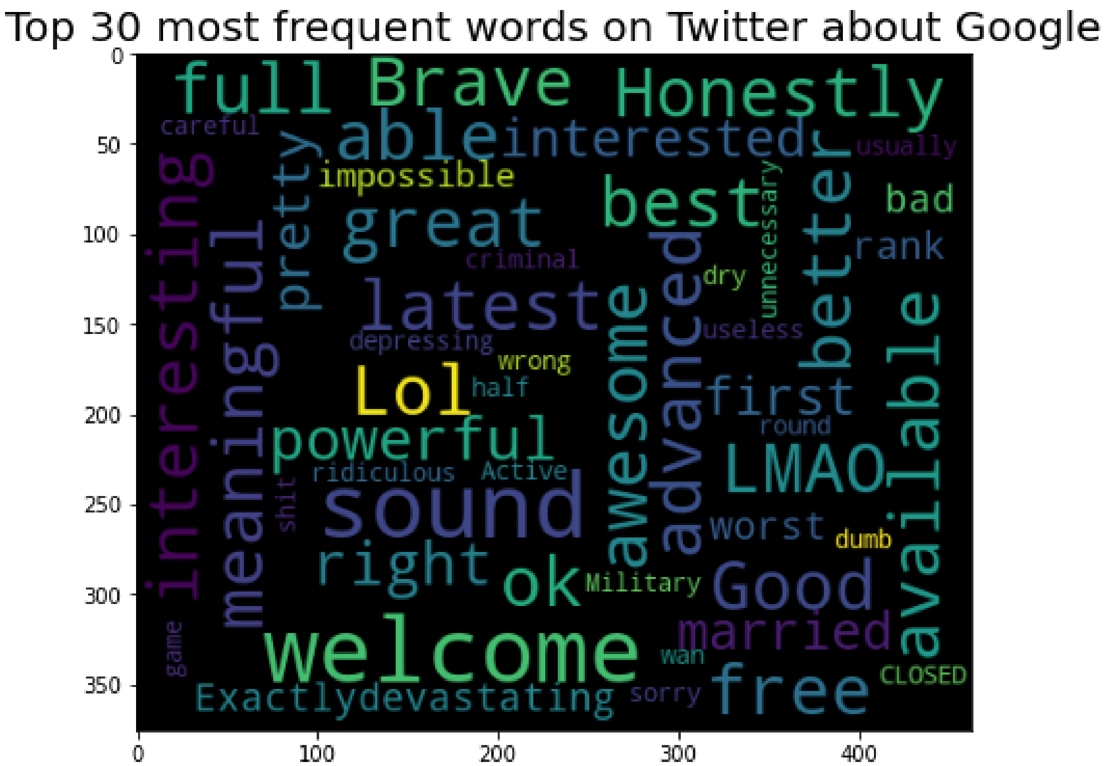
```python
# Plot the word cloud
from wordcloud import wordcloud
import matplotlib.pyplot as plt
import collections

def plot_word_cloud(all_word, name):

  # clean the data
  all_word = clean_the_stop_word(all_word)

  # init a dict
  dict_table_pos = collections.defaultdict(float)
  dict_table_neg = collections.defaultdict(float)

  # loop t#he postive word
  for w in all_word:
    # count the score
    score = get_score(w)
    # if score > 0 is postive word
    if score > 0:
      dict_table_pos[w] = score
    # if socre < 0 is negative word
    if score < 0:
      dict_table_neg[w] = score


  # sort the postive result table
  dict_table_pos = sorted(dict_table_pos.items(), key=lambda x: x[1],␣
↪reverse=True)

  # sort the negative result table
  dict_table_neg = sorted(dict_table_neg.items(), key=lambda x: x[1],␣
↪reverse=False)

  # get top 30 positive words
```

```python
pos_list = []

# if the number is bigger than 30
if len(dict_table_pos) >= 30:
  # copy value to post_list
  for k,v in dict_table_pos[:30]:
    pos_list.append(k)
else:
  for k,v in dict_table_pos:
    pos_list.append(k)

# get top 30 negative words
neg_list = []

if len(dict_table_neg) >= 30:
  for k, v in dict_table_neg[:30]:
    neg_list.append(k)
else:
  for k, v in dict_table_neg:
    neg_list.append(k)

# convert list to string gap by blank
# print(pos_list)
# print(neg_list)
pos_list = " ".join(pos_list)
neg_list = " ".join(neg_list)

# combine positive and negative list
result = pos_list + neg_list

# print the cloud
# confit the base info
wc = wordcloud.WordCloud(
    # backgroud_color='black',
    width=1000,
    height=600,
    max_font_size=50,
    min_font_size=10,
    mask=plt.imread('https://pic1.zhimg.com/
↪v2-b76b4152e6bfe6e6f15d46e4f7f1b83c_r.jpg'),
    max_words=60
)
# generate the img
wc.generate(result)
# edit parameters of the word cloud image
plt.figure(figsize=(8,6))
```

```
    plt.title("Top 30 most frequent words on "+name+" about "+company, fontsize=20)
    # input wc to plt
    plt.imshow(wc)
    # show the result
    plt.show()
```

```
[ ]: # Show Top 30 positive and negative words using Word Cloud

     # convert text to one dimensioanl
     text_data = convert_text_to_one_dimensional(internal_review_data)
     tweet_data = convert_text_to_one_dimensional(company_tweets)
     # cut down the text to word
     words = cut_down_text_to_words(text_data)
     tweets = cut_down_text_to_words(tweet_data)
     # exe word cloud
     plot_word_cloud(words, "Indeed")
     plot_word_cloud(tweets, "Twitter")
```

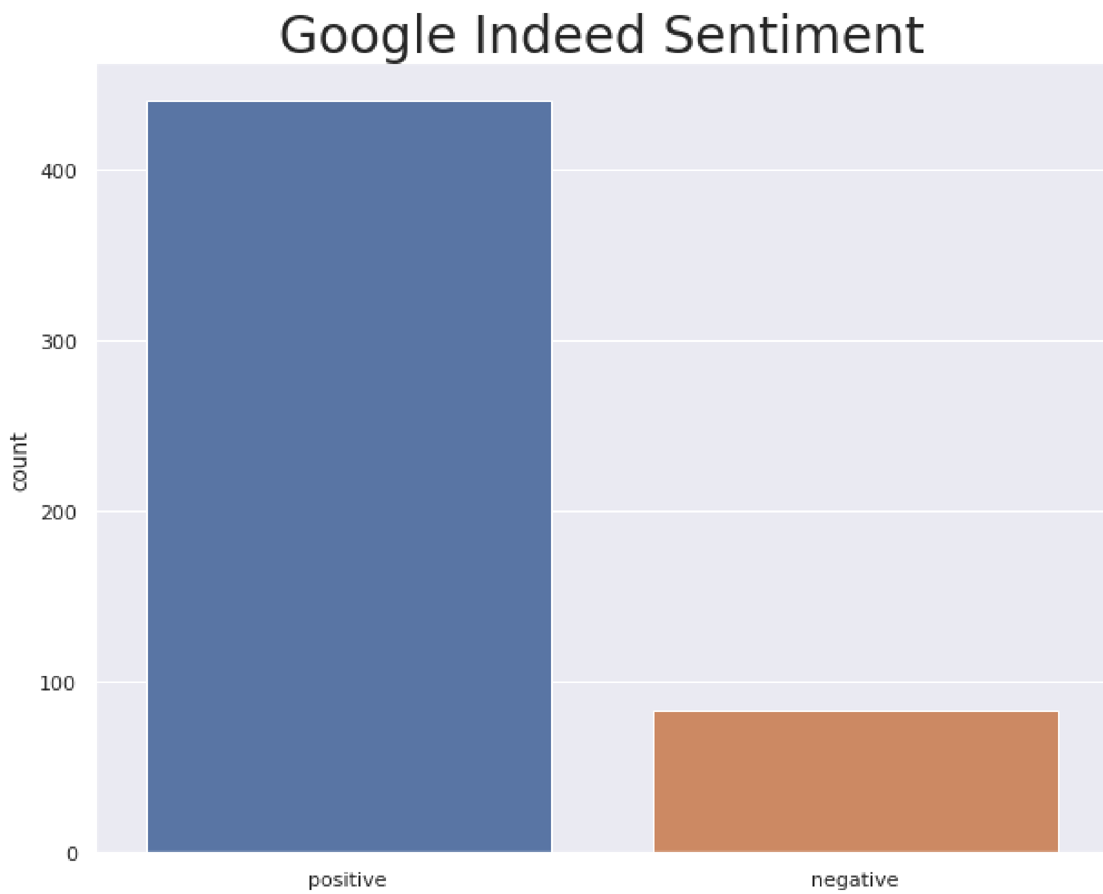
```
/usr/local/lib/python3.6/dist-packages/wordcloud/wordcloud.py:721: UserWarning:
mask image should be unsigned byte between 0 and 255. Got a float array
  warnings.warn("mask image should be unsigned byte between 0"
```

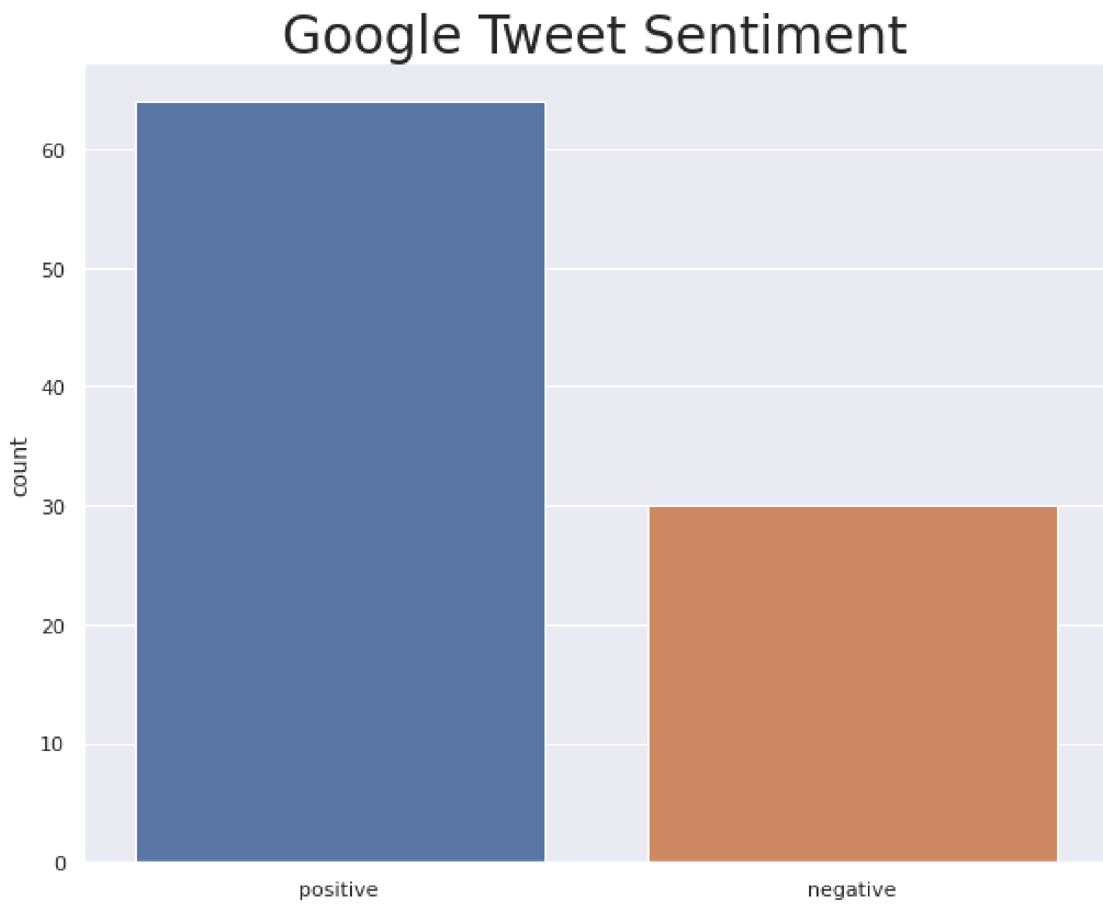


[ ]:
```python
# Using our sentiment score function, apply it to our Indeed and Twitter data to create a sentiment visualization

# Create empty lists to append our sentiment scores and number of 'positive' or 'negative' words
tweet_sentiment = []
indeed_sentiment = []
sentiment_results_t = []
sentiment_results_i = []

# Get our sentiment score for each word in our Indeed data
for i in range(len(words)):
  indeed_sentiment.append(get_score(words[i]))
# Get our sentiment score for each word in our Twitter data
for i in range(len(tweets)):
  tweet_sentiment.append(get_score(tweets[i]))

# Create a list with the number of positive/negative sentiments for both sets of data
for score in indeed_sentiment:
  if score > 0:
    sentiment_results_i.append('positive')
```

```
  elif score < 0:
    sentiment_results_i.append('negative')

for score in tweet_sentiment:
  if score > 0:
    sentiment_results_t.append('positive')
  elif score < 0:
    sentiment_results_t.append('negative')

import seaborn as sns

# Plot the sentiment scores
plt.figure(figsize=(10, 8))
sns.set(style="darkgrid")
sns.countplot(x=sentiment_results_i, order=['positive', 'negative']).
 ↪set_title(company+' Indeed Sentiment', fontsize=28)

plt.figure(figsize=(10, 8))
sns.set(style="darkgrid")
sns.countplot(x=sentiment_results_t, order=['positive', 'negative']).
 ↪set_title(company+' Tweet Sentiment', fontsize=28)
```

[ ]:
```
Text(0.5, 1.0, 'Google Tweet Sentiment')
```


Google Indeed Sentiment
400
300
count
200
100
0
positive
negative



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```
# Calculating positivity score
positivity_score_i = sentiment_results_i.count('positive')/sentiment_results_i.
 ↪count('negative')
positivity_score_t = sentiment_results_t.count('positive')/sentiment_results_t.
 ↪count('negative')

# Printing scores for users and explaining their purpose
print("The positivity score of "+company+"'s sentiment on Indeed is␣
 ↪"+str(round(positivity_score_i, 2)))
print("i.e. there are "+str(round(positivity_score_i, 2))+" more positive␣
 ↪sentiments than negative ones")


print("\nThe positivity score of "+company+"'s sentiment on Twitter is␣
 ↪"+str(round(positivity_score_t, 2)))
print("i.e. there are "+str(round(positivity_score_t, 2))+" more positive␣
 ↪sentiments than negative ones")
```

```
The positivity score of Google's sentiment on Indeed is 5.3
```

i.e. there are 5.3 more positive sentiments than negative ones

The positivity score of Google's sentiment on Twitter is 2.13
i.e. there are 2.13 more positive sentiments than negative ones

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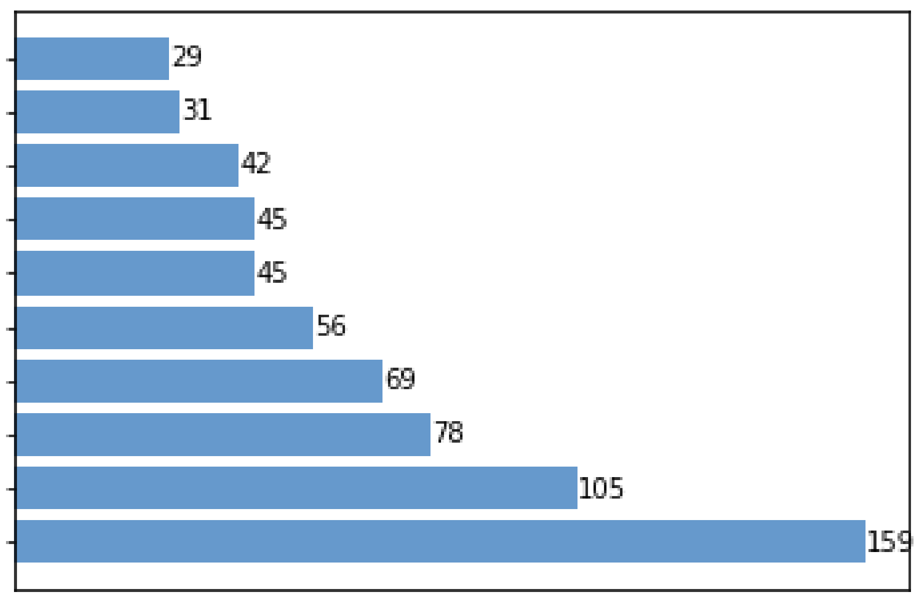
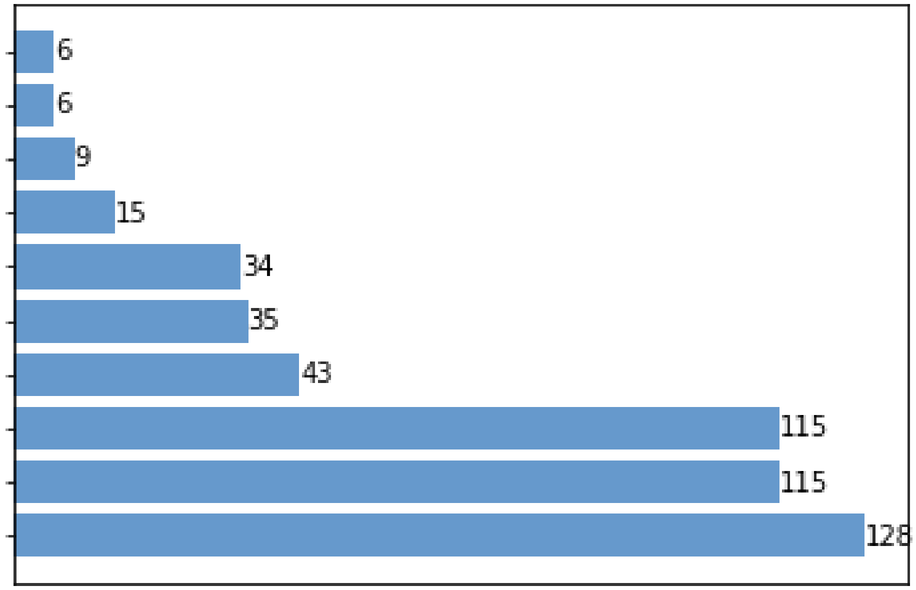
```
# Import the necessary libraries
import matplotlib
import matplotlib.pyplot as plt
from collections import Counter
from nltk.tokenize import RegexpTokenizer


# plot histogram by words
def plot_histogram_by_words(words, name):

  # clean the data
  words = clean_the_stop_word(words)

  # except punctuation
  tokenizer = RegexpTokenizer(r'\w+')
  words = tokenizer.tokenize(" ".join(words))

  # count word
  wd = Counter(words)
  # get top 10 frequent word
  top_data = wd.most_common(10)

  # create two list to save data
  y_val = []
  x_val = []

  # init a subplot
  figure, axes = plt.subplots()

  # loop the top data
  for y, x in top_data:
    # add y col value
    y_val.append(y)
    # add x col value
    x_val.append(x)

  # add y_val, x_val to barh
  b = axes.barh(y_val, x_val, color='#6699CC')

  # add label to axes
  for tmp in b:
    # get the width
```

```
    width = tmp.get_width()
    # add text, set the layout
    axes.text(width, tmp.get_y() + tmp.get_height()/2, "%d" % int(width),␣
↪ha="left", va="center")

  # set y_val lable
  axes.set_yticklabels(y_val)

  # set y_val color to while
  [b.set_color(a) for (a, b) in zip(['white']*len(y_val), axes.yaxis.
↪get_ticklabels()) ]

  # drop out the axis x lable
  plt.xticks(())

  # print(top_data)
  plt.title('top 10 words by ' + name, fontsize='20', loc='center',␣
↪color='white')

  # show the plot
  plt.show()


plot_histogram_by_words(words, 'Indeed')
plot_histogram_by_words(tweets, 'Twitter')
```



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```
[ ]: # Naive Bayes Indeed model

     # Import the necessary libraries
     from sklearn.feature_extraction.text import TfidfVectorizer
     from sklearn.model_selection import train_test_split
     from sklearn.feature_extraction.text import CountVectorizer
     import pandas as pd
     from sklearn.naive_bayes import MultinomialNB
     from sklearn.model_selection import cross_val_score
     from sklearn.model_selection import cross_val_predict
     from sklearn.pipeline import make_pipeline
     import nltk
     from nltk.corpus import stopwords
     # nltk.download('stopwords')

     def word_cut(text):
       return " ".join(nltk.word_tokenize(text))

     # Build MultinomialNB model to categorize text
     # def categorize_text(internal_company_review_df):

       # get the review text column
     x_text = internal_company_review_df[['Review Text']]
```

```
  # user apply function to cut down the sentence
x_text['cutted_comment'] = x_text['Review Text'].apply(word_cut)

  # get the lable from internal_company_review_df
y_text = internal_company_review_df['Positive']

  # print(x_text)

  # print(y_text)

  # split the data to train data and test data
x_train, x_test, y_train, y_test = train_test_split(x_text, y_text,␣
 ↪random_state=1)

  # convert word to vector
vect = CountVectorizer(stop_words=frozenset(stopwords.words("english")))
  # Converts a segmented training set statement with the vectorization tool
term_matrix = pd.DataFrame(vect.fit_transform(x_train.cutted_comment).
 ↪toarray(), columns=vect.get_feature_names())

  # create Multinomial naive bayes model
nb = MultinomialNB()

  # combine vect and nb
pipe = make_pipeline(vect, nb)
accuracy = cross_val_score(pipe, x_train.cutted_comment, y_train, cv=5,␣
 ↪scoring='accuracy').mean()
accuracy_indeed = str(round(accuracy, 3))
#res = categorize_text(internal_company_review_df)
```

```
/usr/local/lib/python3.6/dist-packages/ipykernel_launcher.py:26:
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
```

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```
# ouput the accuracy by Multinomial naive bayes model

print("The Multinomial naive bayes model: accuracy of our classifier for Indeed␣
 ↪data is " + str(accuracy_indeed))

# Printing confusion matrix
from sklearn.metrics import confusion_matrix
```

```
# Applying model to test set
y_pred = cross_val_predict(pipe, x_test.cutted_comment, y_test, cv=5)

# Using confusion matrix function
cm = confusion_matrix(y_test, y_pred)
print(cm)

# Determining whether model has greater sensitivity, specificity, or neither
if cm[0][1] > cm[1][0]:
    print('This model has more false positives and therefore has high␣
 ↪sensitivity.')
elif cm[1][0] > cm[0][1]:
    print('This model has more false negatives and therefore has high␣
 ↪specificity.')
else:
    print('This model does not have high specificity nor high sensitivity.')
```

```
The Multinomial naive bayes model: accuracy of our classifier for Indeed data is
0.821
[[ 0  3]
 [ 0 24]]
This model has more false positives and therefore has high sensitivity.
```

```
/usr/local/lib/python3.6/dist-packages/sklearn/model_selection/_split.py:667:
UserWarning: The least populated class in y has only 3 members, which is less
than n_splits=5.
  % (min_groups, self.n_splits)), UserWarning)
```

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```
# Logistic Regression for Indeed data

# Import models and evaluation functions
from sklearn import linear_model
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import BernoulliNB
from sklearn import metrics
#from sklearn import cross_validation
#from sklearn.model_selection import cross_validate
from sklearn.model_selection import cross_val_score

# Import vectorizers to turn text into numeric
from sklearn.feature_extraction.text import CountVectorizer

# First, we want to go from text to numeric data
# Separate out the X and Y data
X_text = internal_company_review_df['Review Text']
```

```
Y = internal_company_review_df['Positive']

# Create a vectorizer that will track text as binary features
count_vectorizer = CountVectorizer()

# Let the vectorizer learn what tokens exist in the text data
count_vectorizer.fit(X_text)

# Turn these tokens into a numeric matrix
X = count_vectorizer.transform(X_text)

# Create a model
logistic_regression = LogisticRegression()

# Splitting into training and test set
x_train, x_test, y_train, y_test = train_test_split(X, Y, random_state=1)

# Use this model and our data to get 5-fold cross validation AUCs
aucs = cross_val_score(logistic_regression, x_train, y_train,␣
 ↪scoring="accuracy", cv=5)
```

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```
# Print out the average AUC rounded to three decimal points
print("Accuracy of our Logistic Regression classifier for the Indeed data is "␣
 ↪+ str(round(np.mean(aucs), 3)))

# Applying model to test set
y_pred = cross_val_predict(logistic_regression, x_test, y_test, cv=5)

# Using confusion matrix function
cm = confusion_matrix(y_test, y_pred)
print(cm)

# Determining whether model has greater sensitivity, specificity, or neither
if cm[0][1] > cm[1][0]:
    print('This model has more false positives and therefore has high␣
 ↪sensitivity.')
elif cm[1][0] > cm[0][1]:
    print('This model has more false negatives and therefore has high␣
 ↪specificity.')
else:
    print('This model does not have high specificity nor high sensitivity.')
```

```
Accuracy of our Logistic Regression classifier for the Indeed data is 0.822
[[ 0  3]
 [ 0 24]]
This model has more false positives and therefore has high sensitivity.
```

```
/usr/local/lib/python3.6/dist-packages/sklearn/model_selection/_split.py:667:
```

```
UserWarning: The least populated class in y has only 3 members, which is less
than n_splits=5.
  % (min_groups, self.n_splits)), UserWarning)
```

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```
# Naive Bayes Twitter model

from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import CountVectorizer
import pandas as pd
from sklearn.naive_bayes import MultinomialNB
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import cross_val_predict
from sklearn.pipeline import make_pipeline
import nltk
from nltk.corpus import stopwords
# nltk.download('stopwords')

def word_cut(text):
  return " ".join(nltk.word_tokenize(text))

# Build MultinomialNB model to categorize text
# def categorize_text(internal_company_review_df):

  # get the review text column
x_text = company_tweets

positive = []
# Begin code from https://www.freecodecamp.org/news/
 ↪how-to-build-a-twitter-sentiments-analyzer-in-python-using-textblob-948e1e8aae14/
 ↪
for tweet in x_text:
    analysis = TextBlob(tweet)

    if analysis.sentiment[0]>0:
        positive.append(1)
    elif analysis.sentiment[0]<0:
        positive.append(0)
    else:
        positive.append(1)
# End code from https://www.freecodecamp.org/news/
 ↪how-to-build-a-twitter-sentiments-analyzer-in-python-using-textblob-948e1e8aae14/
 ↪

d = {'Tweet':company_tweets,'Positive':positive}
```

```
twitter_data = pd.DataFrame(d)

  # get the review text column
x_text = twitter_data[['Tweet']]

  # user apply function to cut down the sentence
x_text['cutted_comment'] = x_text['Tweet'].apply(word_cut)

  # get the lable from internal_company_review_df
y_text = twitter_data['Positive']

  # print(x_text)

  # print(y_text)

  # split the data to train data and test data
x_train, x_test, y_train, y_test = train_test_split(x_text, y_text,␣
 ↪random_state=1)

  # convert word to vector
vect = CountVectorizer(stop_words=frozenset(stopwords.words("english")))
  # Converts a segmented training set statement with the vectorization tool
term_matrix = pd.DataFrame(vect.fit_transform(x_train.cutted_comment).
 ↪toarray(), columns=vect.get_feature_names())

  # create Multinomial naive bayes model
nb = MultinomialNB()

  # combine vect and nb
pipe = make_pipeline(vect, nb)
accuracy = cross_val_score(pipe, x_train.cutted_comment, y_train, cv=5,␣
 ↪scoring='accuracy').mean()
accuracy_indeed = str(round(accuracy, 3))
```

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```
# output the accuracy by Multinomial naive bayes model

print("The Multinomial naive bayes model: accuracy of our classifier for␣
 ↪Twitter data is " + str(accuracy_indeed))

# Printing confusion matrix
from sklearn.metrics import confusion_matrix

# Applying model to test set
y_pred = cross_val_predict(pipe, x_test.cutted_comment, y_test, cv=5)

# Using confusion matrix function
cm = confusion_matrix(y_test, y_pred)
```

```
print(cm)

# Determining whether model has greater sensitivity, specificity, or neither
if cm[0][1] > cm[1][0]:
    print('This model has more false positives and therefore has high␣
 ↪sensitivity.')
elif cm[1][0] > cm[0][1]:
    print('This model has more false negatives and therefore has high␣
 ↪specificity.')
else:
    print('This model does not have high specificity nor high sensitivity.')
```

```
The Multinomial naive bayes model: accuracy of our classifier for Twitter data
is 0.876
[[ 2  4]
 [ 0 29]]
This model has more false positives and therefore has high sensitivity.
```

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```
# Logistic Regression for Twitter data

# Import models and evaluation functions
from sklearn import linear_model
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import BernoulliNB
from sklearn import metrics
#from sklearn import cross_validation
#from sklearn.model_selection import cross_validate
from sklearn.model_selection import cross_val_score

# Import vectorizers to turn text into numeric
from sklearn.feature_extraction.text import CountVectorizer

# First, we want to go from text to numeric data
# Separate out the X and Y data
X_text = twitter_data['Tweet']
Y = twitter_data['Positive']

# Create a vectorizer that will track text as binary features
count_vectorizer = CountVectorizer()

# Let the vectorizer learn what tokens exist in the text data
count_vectorizer.fit(X_text)

# Turn these tokens into a numeric matrix
X = count_vectorizer.transform(X_text)
```

```
# Create a model
logistic_regression = LogisticRegression()

# Splitting into training and test set
x_train, x_test, y_train, y_test = train_test_split(X, Y, random_state=1)

# Use this model and our data to get 5-fold cross validation AUCs
aucs = cross_val_score(logistic_regression, x_train, y_train,␣
 ↪scoring="accuracy", cv=5)
```

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```
# Print out the average AUC rounded to three decimal points
print("Accuracy of our Logistic Regression classifier for the Twitter data is "␣
 ↪+ str(round(np.mean(aucs), 3)))

# Applying model to test set
y_pred = cross_val_predict(logistic_regression, x_test, y_test, cv=5)

# Using confusion matrix function
cm = confusion_matrix(y_test, y_pred)
print(cm)

# Determining whether model has greater sensitivity, specificity, or neither
if cm[0][1] > cm[1][0]:
    print('This model has more false positives and therefore has high␣
 ↪sensitivity.')
elif cm[1][0] > cm[0][1]:
    print('This model has more false negatives and therefore has high␣
 ↪specificity.')
else:
    print('This model does not have high specificity nor high sensitivity.')
```

```
Accuracy of our Logistic Regression classifier for the Twitter data is 0.876
[[ 2  4]
 [ 0 29]]
This model has more false positives and therefore has high sensitivity.
```

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```
```