

```
In [1]: 1 #import necessary libraries
2
3 import pandas as pd
4 import numpy as np
5 import string
6 import re
7 from matplotlib import pyplot as plt
8 import seaborn as sns
9 import nltk
10 from nltk.corpus import stopwords
11 from nltk import FreqDist, word_tokenize
12 from nltk.tokenize import TweetTokenizer
13 from nltk.stem import WordNetLemmatizer
14 from wordcloud import WordCloud, STOPWORDS
15 import re,string
16 import unicode
17 import html
18
19
20 from nltk.collocations import *
21 bigram_measures = nltk.collocations.BigramAssocMeasures()
22 trigram_measures = nltk.collocations.TrigramAssocMeasures()
23 fourgram_measures = nltk.collocations.QuadgramAssocMeasures()
```

Overview

Process twitter text data to gain insights on a brand and associated products. Create a machine learning sentiment classifier in order to predict sentiment in never before seen tweets. Create word frequency distributions, wordclouds, bigrams, and quadgrams to easily assess actionable insight to address concerns for the brand and its product line.

Business Problem

A growing business with an established social media presence wants to explore options for generating actionable insights from twitter text data. They already plan to host a party to reveal their newest product. They are thinking of asking the crowd to participate in giving some feedback on how a collection of tweets about their brand makes them feel in order to win prizes and boost their social media traffic for the event.

Apple decided to host an event in 2011 in Austin during a [SXSW \(https://www.sxsw.com/\)](https://www.sxsw.com/) event in order to crowd source some labeled twitter data involving their company and their competitor, Google.

Using this data, sourced from [CrowdFlower \(\)](#), as well as some data from an additional [Apple Twitter Sentiment Dataset \(\)](#) also made available from CrowdFlower but cleaned and processed and made available on [kaggle \(\)](#) by author Chanran Kim, a machine learning classifier will be created in order to predict for sentiment contained within a tweet and show how it could be used in tandem with some NLP techniques to extract actionable insights from cluttered tweet data in a manageable way.

Function Definition

```

In [2]: 1 #force lowercase of text series
2 def lower_case_text(text_series):
3     text_series = text_series.apply(lambda x: str.lower(x))
4     return text_series
5
6
7 #strip text of any hyperlinks
8 def strip_links(text):
9     link_regex = re.compile('((https?):(\\|\\/|) (\\|\\|\\|))+(\\|w\\|d:#@%\\|/;$ (
10     links = re.findall(link_regex, text)
11     for link in links:
12         text = text.replace(link[0], ' ', ' ')
13     return text
14
15 #strip text of '@' and '#' entities
16 def strip_all_entities(text):
17     entity_prefixes = ['@', '#']
18     for separator in string.punctuation:
19         if separator not in entity_prefixes:
20             text = text.replace(separator, ' ')
21     words = []
22     for word in text.split():
23         word = word.strip()
24         if word:
25             if word[0] not in entity_prefixes:
26                 words.append(word)
27     return ' '.join(words)
28
29
30 #tokenize text and remove stopwords
31 def process_text(text):
32     tokenizer = TweetTokenizer()
33
34     stopwords_list = stopwords.words('english') + list(string.punctuat
35     stopwords_list += ['"', "'", '...', '`']
36     my_stop = ["#sxsw",
37               "sxsw",
38               "sxswi",
39               "#sxswi's",
40               "#sxswi",
41               "southbysouthwest",
42               "rt",
43               "tweet",
44               "tweet's",
45               "twitter",
46               "austin",
47               "#austin",
48               "link",
49               "1/2",
50               "southby",
51               "south",
52               "texas",
53               "@mention",
54               "i",
55               "i",
56               "½i",

```

```

57         "¿",
58         "½",
59         "link",
60         "via",
61         "mention",
62         "quot",
63         "amp",
64         "austin",
65         "march"
66     ]
67
68
69     brand_stop = ["apple",
70                  "@apple",
71                  "@apple",
72                  "apple",
73                  "#apple",
74                  "google",
75                  "downtown"
76                ]
77
78     stopwords_list += my_stop
79     stopwords_list += brand_stop
80
81     tokens = tokenizer.tokenize(text)
82     stopwords_removed = [token for token in tokens if token not in stopwords_list]
83     return stopwords_removed
84
85
86     #concat processed text data
87     def concat_text(processed_text):
88         text_concat = []
89         for text in processed_text:
90             text_concat += text
91         return text_concat
92
93
94     #use regex to find Brand/company
95     #mentioned in tweet
96     def fill_brand_values(df):
97
98         apple_regex_pattern = r'/ipad\s*\d?\s*app|(?i)ipads?\s*\d?|(?i)iph
99         google_regex_patter = r'/(?i)android\s*app|(?i)androids?|(?i)googl
100
101
102         df.loc[df['tweet'].str.contains(apple_regex_pattern), 'brand_or_pro
103         df.loc[df['tweet'].str.contains(google_regex_patter), 'brand_or_pro
104
105         df.rename({'brand_or_product': 'brand'}, axis=1, inplace=True)
106
107         df['brand'].replace({'Other Google product or service': 'Google',
108                             'iPad or iPhone App': 'Apple',
109                             'Other Apple product or service': 'App
110                             'Android App': 'Google',
111                             'Android': 'Google'
112                             },
113                             inplace=True

```

```

114         )
115     return df
116
117 #tokenize series
118 def series_to_tokens(processed_series):
119     tokenizer = TweetTokenizer()
120     string = " ".join(processed_series)
121     tokens = tokenizer.tokenize(string)
122     return tokens
123
124 #master cleaning function
125 def Master_Pre_Vectorization(text_series):
126     text_series = lower_case_text(text_series)
127     text_series = text_series.apply(strip_links).apply(strip_all_entit
128     text_series = text_series.apply(unidecode.unidecode).apply(html.un
129     text_series = text_series.apply(process_text)
130     lemmatizer = WordNetLemmatizer()
131     text_series = text_series.apply(lambda x: [lemmatizer.lemmatize(wo
132     return text_series.str.join(' ').copy()
133

```

The dataset was made available by [CrowdFlower \(https://data.world/crowdflower/brands-and-product-emotions\)](https://data.world/crowdflower/brands-and-product-emotions).

Participants evaluated tweets about multiple brands and products. The 2011 [SXSW \(https://www.sxsw.com/\)](https://www.sxsw.com/) crowd was asked if the tweet expressed positive, negative, or no emotion towards a brand and/or product. If some emotion was expressed they were also asked to say which brand or product was the target of that emotion. The dataset was made available by [CrowdFlower \(https://data.world/crowdflower/brands-and-product-emotions\)](https://data.world/crowdflower/brands-and-product-emotions).

It contains over 9000 tweets labeled in the manner expressed above.

```
In [3]: 1 #import data from CrowdFlower
2 df1 = pd.read_csv('data/judge_1377884607_tweet_product_company.csv',
3                  encoding='latin-1')
4
5 display(df1.head())
6 display(df1.info())
7
8 #rename column names for ease of use
9 #and understanding
10 df1.columns = ['tweet', 'brand_or_product', 'emotion']
```

| | tweet_text | emotion in tweet is directed at | is there an emotion directed at a brand or product |
|---|---|---------------------------------|--|
| 0 | .@wesley83 I have a 3G iPhone. After 3 hrs twe... | iPhone | Negative emotion |
| 1 | @jessedee Know about @fludapp ? Awesome iPad/i... | iPad or iPhone App | Positive emotion |
| 2 | @swonderlin Can not wait for #iPad 2 also. The... | iPad | Positive emotion |
| 3 | @sxsw I hope this year's festival isn't as cra... | iPad or iPhone App | Negative emotion |
| 4 | @sxtxstate great stuff on Fri #SXSW: Marissa M... | Google | Positive emotion |

```
<class 'pandas.core.frame.DataFrame'>
```

```
RangeIndex: 8721 entries, 0 to 8720
```

```
Data columns (total 3 columns):
```

| # | Column | Non-Null Count |
|---|--|----------------|
| 0 | tweet_text | 8720 non-null |
| 1 | emotion_in_tweet_is_directed_at | 3169 non-null |
| 2 | is_there_an_emotion_directed_at_a_brand_or_product | 8721 non-null |

```

Dtype
----
0    object
1    object
2    object
dtypes: object(3)
memory usage: 204.5+ KB

```

```
None
```

```
In [4]: 1 display(df1.isna().sum())
2
3 #inspect single NAN tweet
4 #drop after inspection
5 display(df1[df1['tweet'].isna()])
6 df1 = df1[df1['tweet'].isna() == False]
7 df1.isna().sum()
8 # replace all null values for brand
9 #with 'unknown'
10 df1['brand_or_product'].fillna('unknown', inplace=True)
11 display(df1.isna().sum())
```

```
tweet          1
brand_or_product  5552
emotion        0
dtype: int64
```

| | tweet | brand_or_product | emotion |
|---|-------|------------------|------------------------------------|
| 6 | NaN | NaN | No emotion toward brand or product |

```
tweet          0
brand_or_product  0
emotion        0
dtype: int64
```

```
In [5]: 1 display(df1['emotion'].value_counts())
2
3 #remap emotions
4 #to create binary target
5 emotion_remapper = {'No emotion toward brand or product': 'neutral',
6                     'Positive emotion': 'positive',
7                     'Negative emotion': 'negative',
8                     "I can't tell": 'unknown'}
9
10 df1['emotion'] = df1['emotion'].map(emotion_remapper)
11
12 display(df1['emotion'].value_counts())
13
14 df1 = df1[(df1['emotion'] != 'unknown') & (df1['emotion'] != 'neutral')]
15
16 df1['emotion'].value_counts()
```

```
No emotion toward brand or product    5155
Positive emotion                      2869
Negative emotion                      545
I can't tell                          151
Name: emotion, dtype: int64
```

```
neutral      5155
positive     2869
negative      545
unknown       151
Name: emotion, dtype: int64
```

```
Out[5]: positive      2869
negative      545
Name: emotion, dtype: int64
```

Looking at the normalized value counts below and the bar chart below, we can see that there is a pretty severe class imbalance, biased towards positive tweets. As apple will likely be interested in addressing problems highlighted in negative tweets, this imbalance will play an important role in deciding how to model the data.

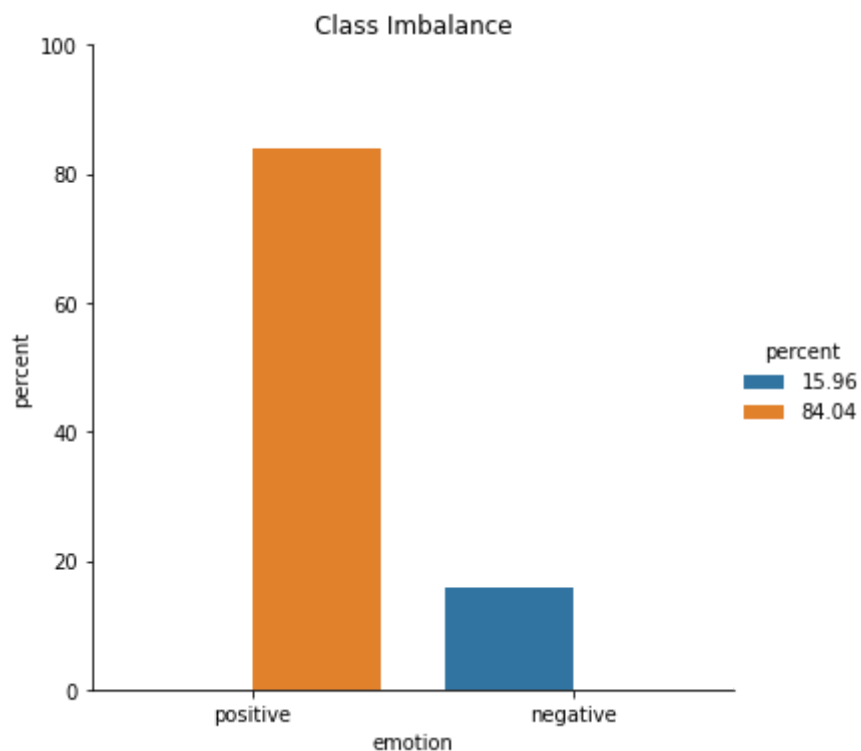
Luckily, there was more data readily available to import from kaggle that was originally sourced from CrowdFlower as well.

[Another Apple Twitter Sentiment Dataset \(https://data.world/crowdfLOWER/apple-twitter-sentiment\)](https://data.world/crowdfLOWER/apple-twitter-sentiment) was made available from CrowdFlower.

[The same dataset but cleaned and processed \(https://datasetsearch.research.google.com/search?query=twitter%20sentiment%20apple&docid=L2cvMTFqOWJiNTVyNg%3D%3D\)](https://datasetsearch.research.google.com/search?query=twitter%20sentiment%20apple&docid=L2cvMTFqOWJiNTVyNg%3D%3D) was made available on kaggle by author Chanran Kim.

I decided to extract the negative tweets from this dataset to add to my current data to help to somewhat correct the imbalance in the data.


```
In [6]: 1 #create plot in order to
2 #visualize class imbalance
3
4
5 df_plot = df1['emotion'].value_counts(normalize=True)
6 df_plot = round(df_plot.mul(100), 2)
7 df_plot = df_plot.rename('percent').reset_index()
8
9
10 df_plot = df1['emotion'].value_counts(normalize=True)
11 df_plot = round(df_plot.mul(100), 2)
12 df_plot = df_plot.rename('percent').reset_index()
13
14 g = sns.catplot(x='index',
15                 y='percent',
16                 hue='percent',
17                 kind='bar',
18
19                 data=df_plot)
20 g.ax.set_ylim(0,100)
21 g.ax.set_title('Class Imbalance')
22 g.ax.set_xlabel('emotion');
```



```
In [7]: 1 # create numerical target
2 target_mapper = {'negative': 1,
3                 'positive': 0
4                 }
5 df1['target'] = df1['emotion'].replace(target_mapper)
6 df1['target'].value_counts()
7
8 #I chose positive tweets to have a value of 1
9 #as it is the more interesting emotion
10 #to gain actionable insight from
```

```
Out[7]: 0    2869
1       545
Name: target, dtype: int64
```

```
In [8]: 1 #import data from cleaned dataset provided on kaggle.com
2 #original data sourced from CrowdFlower
3 df_extra = pd.read_csv('data/apple-twitter-sentiment-texts.csv')
4 display(df_extra.head())
5 df_extra.isna().sum()
```

| | text | sentiment |
|---|---|-----------|
| 0 | Wow. Yall needa step it up @Apple RT @heynyla:... | -1 |
| 1 | What Happened To Apple Inc? http://t.co/FJEX... | 0 |
| 2 | Thank u @apple I can now compile all of the pi... | 1 |
| 3 | The oddly uplifting story of the Apple co-foun... | 0 |
| 4 | @apple can i exchange my iphone for a differen... | 0 |

```
Out[8]: text      0
sentiment    0
dtype: int64
```

```
In [9]: 1 #keep only negative sentiment tweets
2 df_extra = df_extra[df_extra['sentiment'] == -1]
3 display(df_extra.sentiment.value_counts())
4 #create emotion column
5 df_extra['emotion'] = df_extra['sentiment'].replace({-1: 'negative'})
6 display(df_extra['emotion'].value_counts())
7 #create target column
8 df_extra['target'] = df_extra['emotion'].replace({'negative': 1})
9 df_extra['target'].value_counts()
```

```
-1    686
Name: sentiment, dtype: int64

negative    686
Name: emotion, dtype: int64
```

```
Out[9]: 1    686
Name: target, dtype: int64
```

```
In [10]: 1 #prepare new data add to DataFrame
2 df_extra.reset_index(drop=True, inplace=True)
3 df_extra.drop(columns=['sentiment'], axis=1, inplace=True)
4 df_extra.columns = ['tweet', 'emotion', 'target']
5 display(df_extra.head())
6 display(df1.head())
7
8 #join new data
9 df = pd.concat([df1, df_extra])
10 df['brand_or_product'].fillna('unknown', inplace=True)
11
12 df['brand_or_product'].value_counts()
```

| | tweet | emotion | target |
|---|---|----------|--------|
| 0 | Wow. Yall needa step it up @Apple RT @heynyla:... | negative | 1 |
| 1 | RT @JPDesloges: Apple Acted Unfairly In Suppre... | negative | 1 |
| 2 | Apple Inc. Deleted Songs From Rival Services F... | negative | 1 |
| 3 | Happy Monday! My camera on my fancy @Apple #iP... | negative | 1 |
| 4 | Facebook CEO Mark Zuckerberg criticizes Apple ... | negative | 1 |

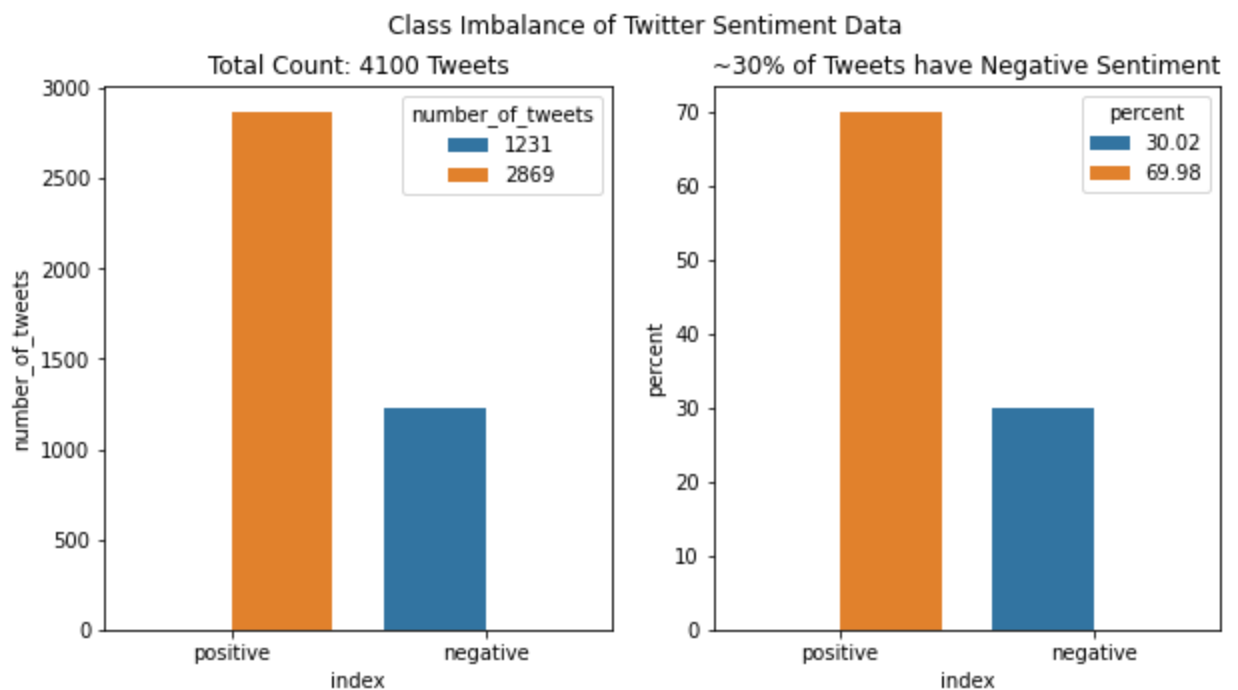
| | tweet | brand_or_product | emotion | target |
|---|---|--------------------|----------|--------|
| 0 | .@wesley83 I have a 3G iPhone. After 3 hrs twe... | iPhone | negative | 1 |
| 1 | @jessedee Know about @fludapp ? Awesome iPad/i... | iPad or iPhone App | positive | 0 |
| 2 | @swonderlin Can not wait for #iPad 2 also. The... | iPad | positive | 0 |
| 3 | @sxsw I hope this year's festival isn't as cra... | iPad or iPhone App | negative | 1 |
| 4 | @sxtxstate great stuff on Fri #SXSW: Marissa M... | Google | positive | 0 |

```
Out[10]: unknown          1027
         iPad             884
         Apple            618
         iPad or iPhone App 441
         Google           397
         iPhone           278
         Other Google product or service 272
         Android App       77
         Android           73
         Other Apple product or service 33
         Name: brand_or_product, dtype: int64
```

```

In [11]: 1 df_plot2 = df['emotion'].value_counts(normalize=True)
2 df_plot2 = round(df_plot2.mul(100), 2)
3 df_plot2 = df_plot2.rename('percent').reset_index()
4 df_plot3 = df['emotion'].value_counts()
5 df_plot3 = df_plot3.rename('number_of_tweets').reset_index()
6
7
8 fig, (ax1, ax2) = plt.subplots(ncols = 2, figsize=(10, 5))
9
10 sns.barplot(x='index',
11             y='number_of_tweets',
12             hue='number_of_tweets',
13             ax=ax1,
14             data=df_plot3
15             )
16
17 sns.barplot(x='index',
18             y='percent',
19             hue='percent',
20             ax=ax2,
21             data=df_plot2
22             )
23
24 fig.suptitle('Class Imbalance of Twitter Sentiment Data')
25 ax1.set_title('Total Count: 4100 Tweets')
26 ax2.set_title('~30% of Tweets have Negative Sentiment')
27
28 plt.savefig('images/Class_Imbalance_Image.jpg')
29 plt.show();
30 # g2.ax.set_ylim(0,100)
31 # g2.ax.set_title('Class Imbalance')
32 # g2.ax.set_xlabel('emotion');

```



```
In [12]: 1 #export for modeling
        2 # df.to_csv('data/clean_df.csv')
```

Data Exploration By Brand

```
In [13]: 1 df_brands = df.copy()
        2 fill_brand_values(df_brands)
        3 df_brands['brand'].value_counts()
```

```
Out[13]: Apple      3100
        Google      876
        unknown    124
        Name: brand, dtype: int64
```

```
In [14]: 1 print('Apple Positive vs Negative Tweet Counts')
        2 display(df_brands[df_brands['brand'] == 'Apple']['emotion'].value_count
        3 display(df_brands[df_brands['brand'] == 'Apple']['emotion'].value_count
        4 print('-----')
        5 print('Google Positive vs Negative Tweet Counts')
        6 display(df_brands[df_brands['brand'] == 'Google']['emotion'].value_coun
        7 df_brands[df_brands['brand'] == 'Google']['emotion'].value_counts(norma
```

Apple Positive vs Negative Tweet Counts

```
positive    0.654194
negative    0.345806
Name: emotion, dtype: float64
```

```
positive    2028
negative    1072
Name: emotion, dtype: int64
```

Google Positive vs Negative Tweet Counts

```
positive    740
negative    136
Name: emotion, dtype: int64
```

```
Out[14]: positive    0.844749
        negative    0.155251
        Name: emotion, dtype: float64
```

```
In [15]: 1 neg_apple_df = df_brands[(df_brands['brand'] == 'Apple') & (df_brands['  
2 pos_apple_df = df_brands[(df_brands['brand'] == 'Apple') & (df_brands['  
3 neg_google_df = df_brands[(df_brands['brand'] == 'Google') & (df_brands  
4 pos_google_df = df_brands[(df_brands['brand'] == 'Google') & (df_brands  
5  
6  
7 processed_pos_apple = Master_Pre_Vectorization(pos_apple_df['tweet'])  
8 processed_neg_apple = Master_Pre_Vectorization(neg_apple_df['tweet'])  
9 processed_pos_google = Master_Pre_Vectorization(pos_google_df['tweet'])  
10 processed_neg_google = Master_Pre_Vectorization(neg_google_df['tweet'])  
11  
12 pos_apple_tokens = series_to_tokens(processed_pos_apple)  
13 neg_apple_tokens = series_to_tokens(processed_neg_apple)  
14 pos_google_tokens = series_to_tokens(processed_pos_google)  
15 neg_google_tokens = series_to_tokens(processed_neg_google)
```

```
In [16]: 1 pos_apple_freqdist = FreqDist(pos_apple_tokens)  
2 neg_apple_freqdist = FreqDist(neg_apple_tokens)  
3 pos_google_freqdist = FreqDist(pos_google_tokens)  
4 neg_google_freqdist = FreqDist(neg_google_tokens)  
5  
6 display(pos_apple_freqdist.most_common(50))  
7 display(neg_apple_freqdist.most_common(50))  
8 display(neg_google_freqdist.most_common(50))  
9 display(pos_google_freqdist.most_common(50))
```

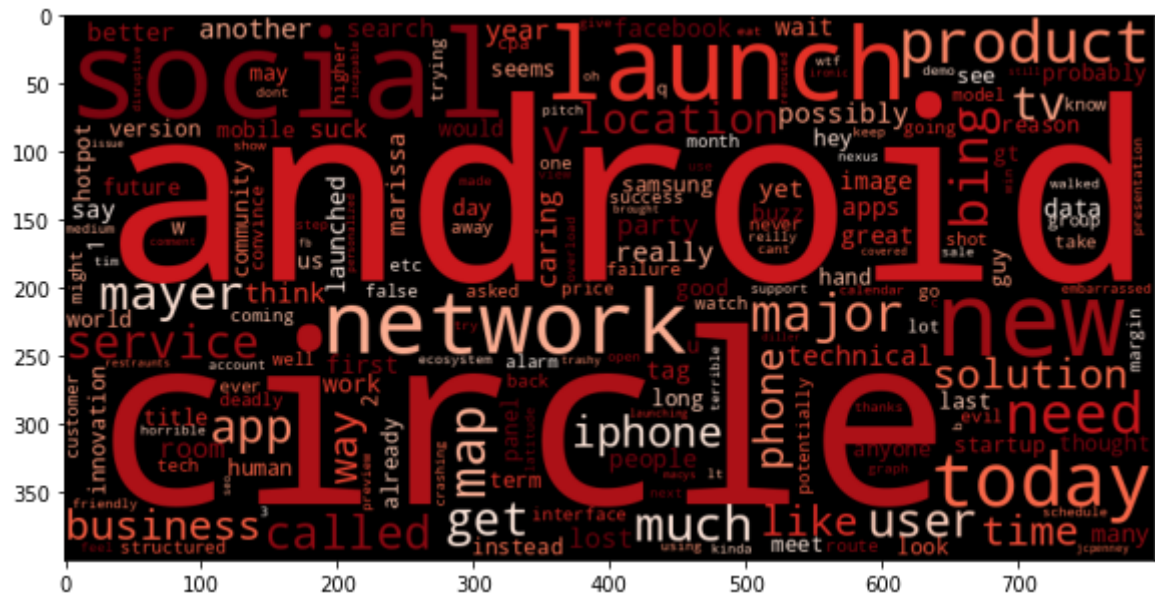
```
1 wordcloud = WordCloud(background_color='black',
2                       colormap='Greens',
3                       width=800,
4                       height=400)
5
6 wordcloud.fit_words(pos_apple_freqdist)
7 wordcloud.to_file('images/pos_apple_cloud.jpg')
8
9 plt.figure(figsize=(10,5))
10 plt.imshow(wordcloud);
```



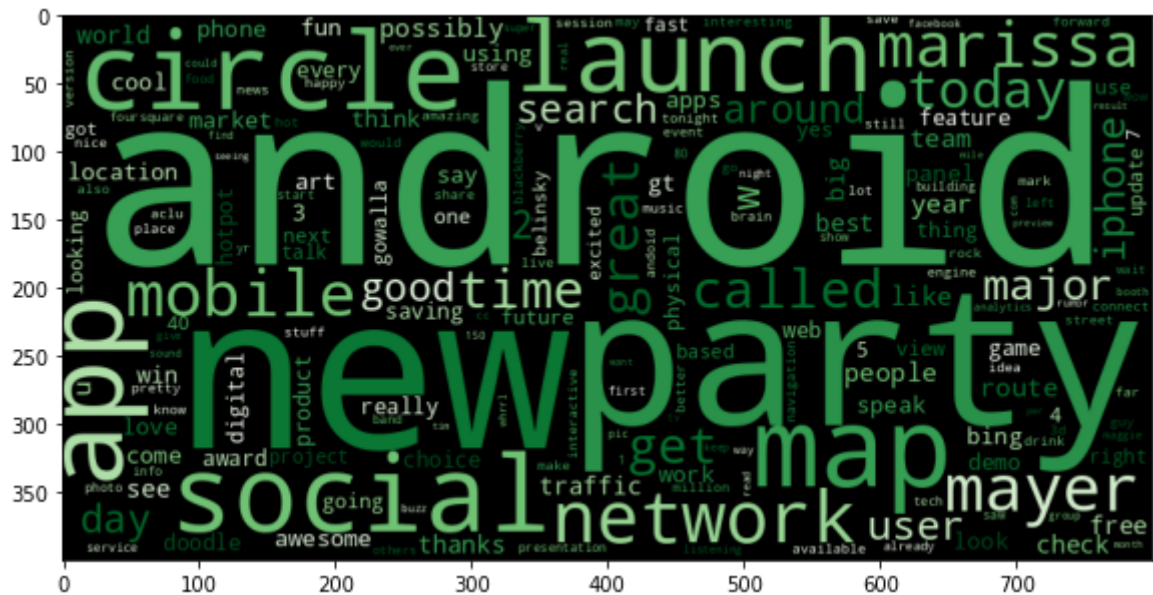
```
1 wordcloud = WordCloud(background_color='black',
2                       colormap='Reds',
3                       width=800,
4                       height=400)
5
6 wordcloud.fit_words(neg_apple_freqdist)
7 wordcloud.to_file('images/neg_apple_cloud.jpg')
8
9 plt.figure(figsize=(10,5))
10 plt.imshow(wordcloud);
```




```
1 wordcloud = WordCloud(background_color='black',
2                        colormap='Reds',
3                        width=800,
4                        height=400)
5
6 wordcloud.fit_words(neg_google_freqdist)
7 wordcloud.to_file('images/neg_google_cloud.jpg')
8
9 plt.figure(figsize=(10,5))
10 plt.imshow(wordcloud);
```



```
In [20]: 1 wordcloud = WordCloud(background_color='black',
2                       colormap='Greens',
3                       width=800,
4                       height=400)
5
6 wordcloud.fit_words(pos_google_freqdist)
7 wordcloud.to_file('images/pos_google_cloud.jpg')
8
9 plt.figure(figsize=(10,5))
10 plt.imshow(wordcloud);
```



```
In [21]: 1 bigram_measures = nltk.collocations.BigramAssocMeasures()  
2 apple_neg_finder = BigramCollocationFinder.from_words(neg_apple_tokens)  
3 apple_neg_scored = apple_neg_finder.score_ngrams(bigram_measures.raw_fr  
4 display(apple_neg_scored[:50])  
5  
6  
7 neg_apple_pmi_finder = BigramCollocationFinder.from_words(neg_apple_tok  
8 neg_apple_pmi_finder.apply_freq_filter(5)  
9 neg_apple_pmi_scored = neg_apple_pmi_finder.score_ngrams(bigram_measure  
10 display(neg_apple_pmi_scored)
```

```
In [22]: 1 neg_apple_pmi_finder = BigramCollocationFinder.from_words(neg_apple_tok
2 neg_apple_pmi_finder.apply_freq_filter(5)
3 neg_apple_pmi_scored = neg_apple_pmi_finder.score_ngrams(bigram_measure
4 display(neg_apple_pmi_scored)
```

```
[(('barry', 'diller'), 10.511917335582625),
 (('kara', 'swisher'), 10.096879836303781),
 (('fast', 'among'), 9.77495174141642),
 (('among', 'digital'), 9.611453009133538),
 (('digital', 'delegate'), 9.611453009133538),
 (('fade', 'fast'), 9.260378568586662),
 (('steve', 'job'), 9.203795040220296),
 (('classiest', 'fascist'), 9.119599912803864),
 (('heard', 'weekend'), 9.037986147250212),
 (('elegant', 'fascist'), 8.804098087075934),
 (('company', 'america'), 8.802966117586013),
 (('fascist', 'company'), 8.787024573716995),
 (('macbook', 'pro'), 8.718368213050052),
 (('power', 'cord'), 8.663920429027673),
 (('weekend', 'gave'), 8.552559320079972),
 (('money', 'relief'), 8.380672802304375),
 (('design', 'headache'), 8.289524914246178),
 (('thing', 'heard'), 8.131095551641694),
 (('best', 'thing'), 7.993592027891758),
 (('customer', 'service'), 7.981402618883845),
 (('io', '8'), 7.708384124477428),
 (('relief', 'need'), 7.542290984626144),
 (('news', 'apps'), 7.139363167625296),
 (('piece', 'shit'), 6.777207715356786),
 (('pop', 'store'), 6.4794958578902495),
 (('shit', 'together'), 6.362170216077944),
 (('battery', 'life'), 6.154365330964541),
 (('please', 'stop'), 6.152021390496241),
 (('every', 'time'), 6.033870038777982),
 (('phone', 'died'), 5.951202381108146),
 (('look', 'like'), 5.498827336142181),
 (('5', 'charger'), 5.382634318637658),
 (('2', 'money'), 5.097584449280371),
 (('ipad', '2'), 5.020997500801553),
 (('get', 'ur'), 5.004122695383927),
 (('ipad', 'design'), 4.88202108765274),
 (('iphone', '6'), 4.84206593727496),
 (('gave', 'ipad'), 4.712096086210428),
 (('app', 'store'), 4.540896402554393),
 (('fix', 'shit'), 4.362170216077944),
 (('get', 'shit'), 4.246692998658007),
 (('ipad', 'news'), 4.19752291338067),
 (('fuck', 'u'), 4.039790644096961),
 (('iphone', 'user'), 4.020064239252951),
 (('iphone', 'app'), 3.5960379567468514),
 (('iphone', '5'), 3.5752793965800542),
 (('iphone', 'battery'), 3.484513932656874),
 (('ipad', '1'), 3.3495260068257195),
 (('phone', 'charger'), 3.1553430978883714),
 (('new', 'iphone'), 2.9087031303052466),
 (('need', 'ipad'), 2.7722170786479996),
 (('new', 'ipad'), 2.682949740550912),
```

```
(('hate', 'ipad'), 2.5934515897118082),
(('iphone', 'charger'), 2.54613305092054),
(('ipad', 'app'), 1.7328546463772252)]
```

In [23]:

```
1 neg_apple_pmi_finder = TrigramCollocationFinder.from_words(neg_apple_to
2 neg_apple_pmi_finder.apply_freq_filter(4)
3 neg_apple_pmi_scored = neg_apple_pmi_finder.score_ngrams(trigram_measur
4 display(neg_apple_pmi_scored)
```

```
[('heat', 'million', 'sun'), 21.286869076999047),
(('button', 'heat', 'million'), 20.412399959082904),
(('among', 'digital', 'delegate'), 19.900977923379717),
(('fade', 'fast', 'among'), 19.549903482832836),
(('fast', 'among', 'digital'), 19.386404750549957),
(('heard', 'weekend', 'gave'), 18.32751106149639),
(('classiest', 'fascist', 'company'), 18.129016907857306),
(('back', 'button', 'heat'), 17.876347058842697),
(('fascist', 'company', 'america'), 17.851482932328395),
(('best', 'thing', 'heard'), 17.76854376930818),
(('thing', 'heard', 'weekend'), 17.49100979377927),
(('apps', 'fade', 'fast'), 16.69192248770527),
(('news', 'apps', 'fade'), 16.106959986984112),
(('money', 'relief', 'need'), 15.922963786930515),
(('2', 'money', 'relief'), 15.001819207641754),
(('weekend', 'gave', 'ipad'), 14.072010328348005),
(('novelty', 'ipad', 'news'), 13.902085326905693),
(('ipad', 'design', 'headache'), 13.715866518122727),
(('relief', 'need', 'ipad'), 12.869096914951779),
(('get', 'shit', 'together'), 12.758610334240633),
(('ipad', 'news', 'apps'), 12.436421754556882),
(('ipad', 'back', 'button'), 12.298918230806947),
(('gave', 'ipad', '2'), 11.33324249154781),
(('ipad', '2', 'money'), 10.617035457548404),
(('iphone', 'battery', 'life'), 10.536999649602205),
(('hate', 'ipad', 'back'), 10.510422336000659),
(('ipad', '2', 'take'), 9.681165794968123),
(('need', 'ipad', '2'), 9.393363483985379)]
```

```
In [24]: 1 neg_apple_pmi_finder = QuadgramCollocationFinder.from_words(neg_apple_t
2 neg_apple_pmi_finder.apply_freq_filter(3)
3 neg_apple_pmi_scored = neg_apple_pmi_finder.score_ngrams(fourgram_measu
4 display(neg_apple_pmi_scored)
```

```
[('minor', 'improvement', 'worth', 'unless'), 33.79878641258167),
 ('forward', 'delicious', 'mobile', '4g'), 32.06182081841546),
 ('button', 'heat', 'million', 'sun'), 30.92431729466553),
 ('fast', 'among', 'digital', 'delegate'), 29.67592966479613),
 ('truly', 'displeased', 'customer', 'service'), 29.590199790770253),
 ('displeased', 'customer', 'service', 'given'), 29.268271695882888),
 ('fade', 'fast', 'among', 'digital'), 29.161356491966373),
 ('2', 'minor', 'improvement', 'worth'), 28.90801548233643),
 ('back', 'button', 'heat', 'million'), 28.651298800259113),
 ('recently', 'deleted', 'photo', 'album'), 28.342272277326664),
 ('news', 'fade', 'fast', 'among'), 27.517500302191657),
 ('novelty', 'news', 'fade', 'fast'), 27.517500302191657),
 ('best', 'thing', 'heard', 'weekend'), 27.12845801144575),
 ('classiest', 'fascist', 'company', 'america'), 27.126361070610177),
 ('company', 'america', 'kara', 'swisher'), 27.073893650716037),
 ('apps', 'fade', 'fast', 'among'), 26.98144740195145),
 ('thing', 'heard', 'weekend', 'gave'), 26.78053470802545),
 ('delicious', 'mobile', '4g', 'iphone'), 26.669503395636703),
 ('elegant', 'fascist', 'company', 'america'), 26.266538728658436),
 ('dying', 'charger', 'ur', 'stuff'), 26.25446589635786),
 ('news', 'apps', 'fade', 'fast'), 25.88191172840053),
 ('app', 'store', 'includes', 'uberguide'), 25.6902619558035),
 ('take', 'photo', 'look', 'weird'), 25.48691198235823),
 ('4g', 'iphone', 'user', 'struggle'), 25.40646898980291),
 ('iphone', 'user', 'struggle', 'anything'), 24.40646898980291),
 ('fuck', 'recently', 'deleted', 'photo'), 24.372645926370186),
 ('mobile', '4g', 'iphone', 'user'), 24.08454089491555),
 ('heard', 'weekend', 'gave', 'ipad'), 23.846962069764423),
 ('official', 'people', 'using', 'ipad'), 23.69640239318904),
 ('ipad', '2', 'minor', 'improvement'), 23.652514749188043),
 ('ipad', 'back', 'button', 'heat'), 23.39579806711073),
 ('cashmore', 'ipad', '2', 'minor'), 23.2374772499092),
 ('peter', 'cashmore', 'ipad', '2'), 23.2374772499092),
 ('2', 'best', 'thing', 'heard'), 22.97465267536672),
 ('charger', 'ur', 'stuff', 'suck'), 22.751965555828676),
 ('2', 'money', 'relief', 'need'), 22.544110192267905),
 ('phone', 'dying', 'charger', 'ur'), 22.371822846996018),
 ('novelty', 'ipad', 'news', 'apps'), 22.140984168081904),
 ('hey', 'phone', 'dying', 'charger'), 22.00925276761131),
 ('new', 'app', 'store', 'includes'), 21.631368266749934),
 ('ipad', 'news', 'apps', 'fade'), 21.626410995252144),
 ('2', 'take', 'photo', 'look'), 21.59614105211299),
 ('money', 'relief', 'need', 'ipad'), 21.220022373862104),
 ('weekend', 'gave', 'ipad', '2'), 20.693156733685388),
 ('ipad', '2', 'money', 'relief'), 20.521270215909794),
 ('phone', 'charger', 'terrible', 'fix'), 20.272287173445104),
 ('hate', 'ipad', 'back', 'button'), 20.147870553667143),
 ('gave', 'ipad', '2', 'money'), 19.906560371794583),
 ('using', 'ipad', '2', 'take'), 19.555653209935453),
 ('relief', 'need', 'ipad', '2'), 19.490243320289167),
 ('people', 'using', 'ipad', '2'), 18.8056314629438),
 ('ipad', '2', 'best', 'thing'), 18.719151942218332),
```

```
(( 'ipad', '2', 'take', 'photo'), 18.662568413851965),  
(( 'need', 'ipad', '2', 'best'), 17.80841928031542)]
```

Some observations from exploring the data:

- Multiple complaints about issues with iphone 6 and its new touch id feature. Some googling unveiled an issue in which iphone 6 touch id button / home button would malfunction and heat up to high temperatures.
- many complaints about phone chargers
- high negative sentiment for iphone batteries
- Some users displeased with issues with apple news app
- apple ipad 2 described as a design headache
- Complaints about customer service
- public image described as fascist

Recommend to focus on improving battery life and quality. Improve phone accessories for charging and protecting battery. (apple did improve a lot on this since 2011 when many of the tweets were collected)

Address technical issues with iphone 6 and apple news app crashing.

Launch public relations campaign and give back to community to boost public image.

Reassess training protocols for customer facing employees and ensure customer service is a cornerstone of Apple culture.

Proof of Concept

Actionable insight can be gained with enough social media data. A reasonable amount of labeled data can be budgeted for a growing business in order to train a machine learning sentiment classifier on that data and deploy it in order to gain more insights into consumer sentiment on your brand or products.

This is the end of this notebook. Please feel free to continue on to the modeling notebook to see how a classifier could be trained and tuned.

Feel free to reach out with corrections or questions. Thank you.

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