Data Cleaning and Exploration

Data Cleaning

Data Cleaning

In [1]:
```
# load libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import re

# nltk packages
import nltk
nltk.download('stopwords', quiet=True)
from nltk.tokenize import TweetTokenizer
from nltk.corpus import stopwords
from nltk.collocations import *
from nltk import FreqDist, word_tokenize

# WordCloud
from wordcloud import WordCloud

# TextBlob
from textblob import TextBlob
```

In [2]:
```
# load dataset
df = pd.read_csv('./data/tweet_product_company.csv', encoding="ISO-8859-1")
df.head()
```

Out[2]:

	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

In [3]:
```
# info of df
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 9093 entries, 0 to 9092
Data columns (total 3 columns):
 #   Column                                              Non-Null Count  Dtype 
---  ------                                              --------------  ----- 
 0   tweet_text                                          9092 non-null   object
 1   emotion_in_tweet_is_directed_at                     3291 non-null   object
 2   is_there_an_emotion_directed_at_a_brand_or_product  9093 non-null   object
dtypes: object(3)
memory usage: 213.2+ KB
```

The dataframe contains 3 columns: tweet_text, emotion_in_tweet_is_directed_at, and is_there_an_emotion_directed_at_a-brand_or_product. I'm definitely going to change the column names to something more concise. There are nulls in the second column and there is one null in the tweet_text column. I'll deal with these soon.

Changing column names

In [4]:
```
# creating new column names
new_names = ['tweet_text', 'directed_at', 'sentiment']

# replacing column names
df.columns = new_names
df.columns
```

Out[4]:
```
Index(['tweet_text', 'directed_at', 'sentiment'], dtype='object')
```

Value Counts

In [5]:
```
df.directed_at.value_counts()
```

Out[5]:
```
iPad                               946
Apple                              661
iPad or iPhone App                 470
Google                             430
iPhone                             297
Other Google product or service    293
Android App                         81
Android                             78
Other Apple product or service      35
Name: directed_at, dtype: int64
```

In [6]:
```
df.isnull().sum()
```

Out[6]:
```
tweet_text        1
directed_at    5802
sentiment         0
dtype: int64
```

Majority of the rows in 'directed_at' are null. Besides null the most are directed at iPad and Apple

In [7]:
```
# value counts for sentiment
df.sentiment.value_counts()
```

Out[7]:
```
No emotion toward brand or product    5389
Positive emotion                      2978
Negative emotion                       570
I can't tell                           156
Name: sentiment, dtype: int64
```

In [8]:
```
# value counts for sentiment
df.sentiment.value_counts(normalize=True)
```

Out[8]:
```
No emotion toward brand or product    0.592654
Positive emotion                      0.327505
Negative emotion                      0.062686
I can't tell                          0.017156
Name: sentiment, dtype: float64
```

Majority of the tweets are neutral followed by positive sentiment. There is a very small amount of negative tweets which can be a problem once I create my classification model. 'I can't tell' values are interesting I'll look into those tweets further and possibly use TextBlob to add a sentiment to them.

Null Values

In [9]:
```
df.isnull().sum()
```

Out[9]:
```
tweet_text        1
directed_at    5802
sentiment         0
dtype: int64
```

In [10]:
```
# null value for tweet
df.loc[df['tweet_text'].isnull()]
```

Out[10]:

	tweet_text	directed_at	sentiment
6	NaN	NaN	No emotion toward brand or product

I'll drop this row because there is only one.

In [11]:
```
# drop null value from tweet_text
df.dropna(subset=['tweet_text'], inplace=True)
```

In [12]:
```
# fill null with 'Unknown' for directed_at
df.directed_at.fillna(value='Unknown', inplace=True)
```

In [13]:
```
df.isnull().sum()
```

Out[13]:
```
tweet_text     0
directed_at    0
sentiment      0
dtype: int64
```

Checking for Duplicate Values

In [14]:
```
# duplicate rows
df.duplicated().sum()
```

Out[14]:
```
22
```

In [15]:
```
# inspecting duplicate rows
df.loc[df.duplicated(keep=False)]
```

Out[15]:

	tweet_text	directed_at	sentiment
7	#SXSW is just starting, #CTIA is around the co...	Android	Positive emotion
9	Counting down the days to #sxsw plus strong Ca...	Apple	Positive emotion
17	I just noticed DST is coming this weekend. How...	iPhone	Negative emotion
20	Need to buy an iPad2 while I'm in Austin at #s...	iPad	Positive emotion
21	Oh. My. God. The #SXSW app for iPad is pure, u...	iPad or iPhone App	Positive emotion
24	Really enjoying the changes in Gowalla 3.0 for...	Android App	Positive emotion
466	Before It Even Begins, Apple Wins #SXSW {link}	Apple	Positive emotion
468	Before It Even Begins, Apple Wins #SXSW {link}	Apple	Positive emotion
774	Google to Launch Major New Social Network Call...	Unknown	No emotion toward brand or product
776	Google to Launch Major New Social Network Call...	Unknown	No emotion toward brand or product
2230	Marissa Mayer: Google Will Connect the Digital...	Unknown	No emotion toward brand or product

In [16]:
```
df.iloc[6297]['tweet_text']
```

Out[16]:
```
'RT @mention Marissa Mayer: Google Will Connect the Digital &amp;amp; Physical Worlds Through Mobile - {link} #sxsw'
```

In [17]:
```
# print out the tweets to see them
for tweet in df.loc[df.duplicated(keep=False)]['tweet_text']:
    print(tweet)
```

```
#SXSW is just starting, #CTIA is around the corner and #googleio is only a hop skip and a jump from there, g
ood time to be an #android fan
Counting down the days to #sxsw plus strong Canadian dollar means stock up on Apple gear
I just noticed DST is coming this weekend. How many iPhone users will be an hour late at SXSW come Sunday mo
rning? #SXSW #iPhone
Need to buy an iPad2 while I'm in Austin at #sxsw. Not sure if I'll need to Q up at an Austin Apple store?
Oh. My. God. The #SXSW app for iPad is pure, unadulterated awesome. It's easier to browse events on iPad tha
n on the website!!!
Really enjoying the changes in Gowalla 3.0 for Android! Looking forward to seeing what else they &amp;amp; Fours
quare have up their sleeves at #SXSW
Before It Even Begins, Apple Wins #SXSW {link}
Before It Even Begins, Apple Wins #SXSW {link}
Google to Launch Major New Social Network Called Circles, Possibly Today {link} #sxsw
Google to Launch Major New Social Network Called Circles, Possibly Today {link} #sxsw
Marissa Mayer: Google Will Connect the Digital &amp;amp; Physical Worlds Through Mobile - {link} #sxsw
Marissa Mayer: Google Will Connect the Digital &amp;amp; Physical Worlds Through Mobile - {link} #sxsw
Counting down the days to #sxsw plus strong Canadian dollar means stock up on Apple gear
Really enjoying the changes in Gowalla 3.0 for Android! Looking forward to seeing what else they &amp;amp; Fours
quare have up their sleeves at #SXSW
```

In [18]:
```
# drop duplicates
df.drop_duplicates(inplace=True)
```

Mapping Columns

In [19]:
```
df.head()
```

Out[19]:

	tweet_text	directed_at	sentiment
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

In [20]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 9070 entries, 0 to 9092
Data columns (total 3 columns):
 #   Column       Non-Null Count  Dtype 
---  ------       --------------  ----- 
 0   tweet_text   9070 non-null   object
 1   directed_at  9070 non-null   object
 2   sentiment    9070 non-null   object
dtypes: object(3)
memory usage: 283.4+ KB
```

In [21]:
```
df.directed_at.value_counts()
```

Out[21]:
```
Unknown                            5788
iPad                                945
Apple                               659
iPad or iPhone App                  469
Google                              428
iPhone                              296
Other Google product or service     293
Android App                          80
Android                              77
Other Apple product or service       35
Name: directed_at, dtype: int64
```

In [22]:
```
# add a new column 'company' based on directed_at
company_dict = {
    'Unknown': "Unknown",
    'iPad': "Apple",
    'Apple': "Apple",
    'iPad or iPhone App': "Apple",
    'Google': "Google",
    'iPhone': "Apple",
    'Other Google product or service': "Google",
    'Android App': "Google",
    'Android': "Google",
    'Other Apple product or service': "Apple"
}

# create 'company' column
df['company'] = df['directed_at'].map(company_dict)
```

In [23]:
```
df.head()
```

Out[23]:

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

In [24]:
```
df.company.value_counts(normalize=True)
```

Out[24]:
```
Unknown    0.638148
Apple      0.265050
Google     0.096803
Name: company, dtype: float64
```

Mapping sentiment column

In [25]:
```
df.sentiment.value_counts(normalize=True)
```

Out[25]:
```
No emotion toward brand or product    0.592613
Positive emotion                      0.327453
Negative emotion                      0.062734
I can't tell                          0.017200
Name: sentiment, dtype: float64
```

In [26]:
```
# creating sentiment dictionary
sentiment_dict = {
    'No emotion toward brand or product': "neutral",
    'Positive emotion': "positive",
    'Negative emotion': 'negative',
    "I can't tell": 'unknown'
}

# creating 'target' column
df['target'] = df['sentiment'].map(sentiment_dict)
```

In [27]:
```
df.head()
```

Out[27]:

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

In [28]:
```
df.target.value_counts(normalize=True)
```

Out[28]:
```
neutral     0.592613
positive    0.327453
negative    0.062734
unknown     0.017200
Name: target, dtype: float64
```

Create new column with cleaned tweet

The tweets contain hashtags and mentions and I want to remove them so I can do EDA. The mentions won't play much significance in frequency distributions and the #swsw won't have much significance because every tweet contains it. For these reasons I am going to get rid of the hashtags and mentions in each tweet.

In [29]:
```
# function to preprocess tweets
def clean_hash_mentions(tweet):
    # pattern to remove hashtags and mentions
    hashtag_mention_pattern = '([@#][\w_-]+)'

    # remove hashtags and mentions
    tweet_clean = re.sub(hashtag_mention_pattern, '', tweet)

    # lower case
    tweet_clean = tweet_clean.lower()

    # tokenize tweet
    pattern = "([a-zA-Z0-9]+(?:'[a-z]+)?)"
    tweet_clean = nltk.regexp_tokenize(tweet_clean, pattern)

    # join tweet back together
    tweet_clean = ' '.join(tweet_clean)

    return tweet_clean
```

In [30]:
```
# create new column clean_tweet
df['clean_tweet'] = df['tweet_text'].map(clean_hash_mentions)
```

In [31]:
```
df.head()
```

Out[31]:

	tweet_text	directed_at	sentiment	company	target	clean_tweet
0	.@wesley83 I have a 3G iPhone. After 3 hrs twe...	iPhone	Negative emotion	Apple	negative	i have a 3g iphone after 3 hrs tweeting at it ...
1	@jessedee Know about @fludapp ? Awesome iPad/i...	iPad or iPhone App	Positive emotion	Apple	positive	know about awesome ipad iphone app that you'll...
2	@swonderlin Can not wait for #iPad 2 also. The...	iPad	Positive emotion	Apple	positive	can not wait for 2 also they should sale them ...
3	@sxsw I hope this year's festival isn't as cra...	iPad or iPhone App	Negative emotion	Apple	negative	i hope this year's festival isn't as crashy as...
4	@sxtxstate great stuff on Fri #SXSW: Marissa M...	Google	Positive emotion	Google	positive	great stuff on fri marissa mayer google tim o'...

Create new column with hashtags from tweets

In [32]:
```
# capture all the hashtags in the tweet
def hashtags(tweet):
    # pattern to remove hashtags and mentions
    hashtag_pattern = '([#][\w_-]+)'

    # remove hashtags and mentions
    tweet_clean = re.findall(hashtag_pattern, tweet)

    # join tweet back together
    tweet_clean = ' '.join(tweet_clean)

    # lower case
    tweet_clean = tweet_clean.lower()

    return tweet_clean
```

In [33]:
```
# creating hashtags column
df['hashtags'] = df['tweet_text'].map(hashtags)
```

In [34]:
```
df.head()
```

Out[34]:

	tweet_text	directed_at	sentiment	company	target	clean_tweet	hashtags
0	.@wesley83 I have a 3G iPhone. After 3 hrs twe...	iPhone	Negative emotion	Apple	negative	i have a 3g iphone after 3 hrs tweeting at it ...	#rise_austin #sxsw
1	@jessedee Know about @fludapp ? Awesome iPad/i...	iPad or iPhone App	Positive emotion	Apple	positive	know about awesome ipad iphone app that you'll...	#sxsw
2	@swonderlin Can not wait for #iPad 2 also. The...	iPad	Positive emotion	Apple	positive	can not wait for 2 also they should sale them ...	#ipad #sxsw
3	@sxsw I hope this year's festival isn't as cra...	iPad or iPhone App	Negative emotion	Apple	negative	i hope this year's festival isn't as crashy as...	#sxsw
4	@sxtxstate great stuff on Fri #SXSW: Marissa M...	Google	Positive emotion	Google	positive	great stuff on fri marissa mayer google tim o'...	#sxsw

Create new column with mentions from tweets

In [35]:
```
# capture all the mentions in the tweet
def mentions(tweet):
    # pattern to remove hashtags and mentions
    mention_pattern = '([@][\w_-]+)'

    # remove hashtags and mentions
    tweet_clean = re.findall(mention_pattern, tweet)

    # join tweet back together
    tweet_clean = ' '.join(tweet_clean)

    # lower case
    tweet_clean = tweet_clean.lower()

    return tweet_clean
```

In [36]:
```
# creating mentions column
df['mentions'] = df['tweet_text'].map(mentions)
```

In [37]:
```
df.head()
```

Out[37]:

	tweet_text	directed_at	sentiment	company	target	clean_tweet	hashtags	mentions
0	.@wesley83 I have a 3G iPhone. After 3 hrs twe...	iPhone	Negative emotion	Apple	negative	i have a 3g iphone after 3 hrs tweeting at it ...	#rise_austin #sxsw	@wesley83
1	@jessedee Know about @fludapp ? Awesome iPad/i...	iPad or iPhone App	Positive emotion	Apple	positive	know about awesome ipad iphone app that you'll...	#sxsw	@jessedee @fludapp
2	@swonderlin Can not wait for #iPad 2 also. The...	iPad	Positive emotion	Apple	positive	can not wait for 2 also they should sale them ...	#ipad #sxsw	@swonderlin
3	@sxsw I hope this year's festival isn't as cra...	iPad or iPhone App	Negative emotion	Apple	negative	i hope this year's festival isn't as crashy as...	#sxsw	@sxsw
4	@sxtxstate great stuff on Fri #SXSW: Marissa M...	Google	Positive emotion	Google	positive	great stuff on fri marissa mayer google tim o'...	#sxsw	@sxtxstate

Looking for duplicates again

I removed hashtags and mentions from the tweets. I want to look at the clean_tweets columns to see if there are duplicates because it is possible there are now duplicates of these tweets. The tweets may share the same content and have a differecnt mention in them. So essentially the tweets are the same so I may want to remove the duplicates.

In [38]:
```
df['clean_tweet'].duplicated().sum()
```

Out[38]:
```
394
```

There are 389 duplicate clean tweets. Let's take a look at them.

In [39]:
```
# looking at duplicate clean_tweet column
df.loc[df['clean_tweet'].duplicated(keep=False)].sort_values('clean_tweet')
```

Out[39]:

	tweet_text	directed_at	sentiment	company	target	clean_tweet	hashtags	mentions
7346	#sxsw #japan #sendai #prayforjapan #beforetwit...	Unknown	No emotion toward brand or product	Unknown	neutral		#sxsw #japan #sendai #prayforjapan #beforetwit...	
1561	@mention @mention $ #tweethouse #ipad #sxsw #d...	Unknown	No emotion toward brand or product	Unknown	neutral		#tweethouse #ipad #sxsw #dotco	@mention @mention
4953	40% of google maps use is mobile #sxsw	Unknown	No emotion toward brand or product	Unknown	neutral	40 of google maps use is mobile	#sxsw	
4954	40% of Google maps use is mobile #sxsw	Unknown	No emotion toward brand or product	Unknown	neutral	40 of google maps use is mobile	#sxsw	
2252	Apple grabbed the tablet mindshare at #sxsw bu...	Apple	Positive emotion	Apple	positive	apple grabbed the tablet mindshare at but rim ...	#sxsw #foodspotting #mnbuzz	
...	...	...	...	...	...	...	...	...
3811	Win free ipad 2 from webdoc.com #sxsw RT	Unknown	No emotion toward brand or product	Unknown	neutral	win free ipad 2 from webdoc com rt	#sxsw	
3810	Win free IPad 2 from webdoc.com #sxsw RT	Unknown	No emotion toward brand or product	Unknown	neutral	win free ipad 2 from webdoc com rt	#sxsw	
3809	win free iPad 2 from webdoc.com #sxsw RT	Unknown	No emotion toward brand or product	Unknown	neutral	win free ipad 2 from webdoc com rt	#sxsw	
4199	Yes! Gowalla wins best Andoid app at the Team ...	Android App	Positive emotion	Google	positive	yes gowalla wins best andoid app at the team a...	#sxsw	
1341	ÛÏ@mention Yes! Gowalla wins best Andoid app ...	Android App	Positive emotion	Google	positive	yes gowalla wins best andoid app at the team a...	#sxsw	@mention

659 rows × 8 columns

I can see the duplicated tweets but now there is a bigger problem.

There are duplicated tweets that each have a different sentiment/target. That does not make sense how the same tweet can have multiple sentiments. I'm going to drop all the duplicates that have multiple sentiments and keep only of the duplicate rows that only have 1 sentiment to them.

For the duplicates with multiple sentiments, I can't keep at least one of them because I don't know which of the sentiments is correct. For this reason, I have to treat these values as invalid and get rid of them all.

In [40]:
```
# looking at duplicate clean_tweet column
df.loc[df['clean_tweet'].duplicated(keep=False)].sort_values('clean_tweet')
```

Out[40]:

	tweet_text	directed_at	sentiment	company	target	clean_tweet	hashtags	mentions
7346	#sxsw #japan #sendai #prayforjapan #beforetwit...	Unknown	No emotion toward brand or product	Unknown	neutral		#sxsw #japan #sendai #prayforjapan #beforetwit...	
1561	@mention @mention $ #tweethouse #ipad #sxsw #d...	Unknown	No emotion toward brand or product	Unknown	neutral		#tweethouse #ipad #sxsw #dotco	@mention @mention
4953	40% of google maps use is mobile #sxsw	Unknown	No emotion toward brand or product	Unknown	neutral	40 of google maps use is mobile	#sxsw	
4954	40% of Google maps use is mobile #sxsw	Unknown	No emotion toward brand or product	Unknown	neutral	40 of google maps use is mobile	#sxsw	
2252	Apple grabbed the tablet mindshare at #sxsw bu...	Apple	Positive emotion	Apple	positive	apple grabbed the tablet mindshare at but rim ...	#sxsw #foodspotting #mnbuzz	
...	...	...	...	...	...	...	...	...
3811	Win free ipad 2 from webdoc.com #sxsw RT	Unknown	No emotion toward brand or product	Unknown	neutral	win free ipad 2 from webdoc com rt	#sxsw	
3810	Win free IPad 2 from webdoc.com #sxsw RT	Unknown	No emotion toward brand or product	Unknown	neutral	win free ipad 2 from webdoc com rt	#sxsw	
3809	win free iPad 2 from webdoc.com #sxsw RT	Unknown	No emotion toward brand or product	Unknown	neutral	win free ipad 2 from webdoc com rt	#sxsw	
4199	Yes! Gowalla wins best Andoid app at the Team ...	Android App	Positive emotion	Google	positive	yes gowalla wins best andoid app at the team a...	#sxsw	
1341	ÛÏ@mention Yes! Gowalla wins best Andoid app ...	Android App	Positive emotion	Google	positive	yes gowalla wins best andoid app at the team a...	#sxsw	@mention

659 rows × 8 columns

In [41]:
```
# group by clean_tweets and target and count the occurence
# here I can see the tweets with more than one target
df.loc[df['clean_tweet'].duplicated(keep=False)].sort_values('clean_tweet')\
.groupby(['clean_tweet', 'target']).count().reset_index()
```

Out[41]:

	clean_tweet	target	tweet_text	directed_at	sentiment	company	hashtags	mentions
0		neutral	2	2	2	2	2	2
1	40 of google maps use is mobile	neutral	2	2	2	2	2	2
2	apple grabbed the tablet mindshare at but rim ...	neutral	1	1	1	1	1	1
3	apple grabbed the tablet mindshare at but rim ...	positive	1	1	1	1	1	1
4	apple has two austin stores but until this wee...	neutral	1	1	1	1	1	1
...	...	...	...	...	...	...	...	...
329	will google reveal a new social network called...	neutral	2	2	2	2	2	2
330	will google reveal a new social network called...	neutral	2	2	2	2	2	2
331	win free ipad 2 from webdoc com rt	neutral	4	4	4	4	4	4
332	win free ipad 2 from webdoc com rt	positive	2	2	2	2	2	2
333	yes gowalla wins best andoid app at the team a...	positive	2	2	2	2	2	2

334 rows × 8 columns

In [42]:
```
# group again by clean_tweet and count the sentiment
# anything more than 1 indicates more than 1 sentiment
df.loc[df['clean_tweet'].duplicated(keep=False)].sort_values('clean_tweet')\
.groupby(['clean_tweet', 'target']).count().reset_index().groupby('clean_tweet')\
.count().reset_index()

# print value counts
print(df.loc[df['clean_tweet'].duplicated(keep=False)].sort_values('clean_tweet')\
.groupby(['clean_tweet', 'target']).count().reset_index().groupby('clean_tweet')\
.count().reset_index().target.value_counts())
```

```
1    196
2     69
Name: target, dtype: int64
```

There are 64 tweets that are duplicated and have different sentiments. Now I have to get a list of those tweets.

In [43]:
```
# saving above table as a dataframe
dup_tweets = df.loc[df['clean_tweet'].duplicated(keep=False)].sort_values('clean_tweet')\
.groupby(['clean_tweet', 'target']).count().reset_index().groupby('clean_tweet')\
.count().reset_index()

tweets_to_drop = list(dup_tweets.loc[dup_tweets['target'] > 1]['clean_tweet'])
```

In [44]:
```
# filter out tweets_to_drop from df
df = df.loc[~df['clean_tweet'].isin(tweets_to_drop)]
```

Now I have to drop any remaining duplicated from the clean_tweet column. These tweets should be duplicates and have only one sentiment.

In [45]:
```
df.clean_tweet.duplicated().sum()
```

Out[45]:
```
225
```

In [46]:
```
# drop remaining duplicate values from df
df.drop_duplicates(subset=['clean_tweet'], inplace=True)
```

In [47]:
```
df.head()
```

Out[47]:

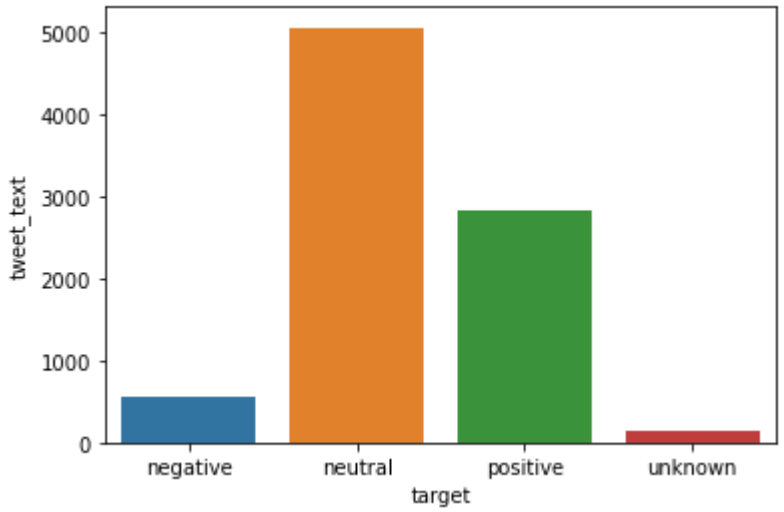
	tweet_text	directed_at	sentiment	company	target	clean_tweet	hashtags	mentions
0	.@wesley83 I have a 3G iPhone. After 3 hrs twe...	iPhone	Negative emotion	Apple	negative	i have a 3g iphone after 3 hrs tweeting at it ...	#rise_austin #sxsw	@wesley83
1	@jessedee Know about @fludapp ? Awesome iPad/i...	iPad or iPhone App	Positive emotion	Apple	positive	know about awesome ipad iphone app that you'll...	#sxsw	@jessedee @fludapp
2	@swonderlin Can not wait for #iPad 2 also. The...	iPad	Positive emotion	Apple	positive	can not wait for 2 also they should sale them ...	#ipad #sxsw	@swonderlin
3	@sxsw I hope this year's festival isn't as cra...	iPad or iPhone App	Negative emotion	Apple	negative	i hope this year's festival isn't as crashy as...	#sxsw	@sxsw
4	@sxtxstate great stuff on Fri #SXSW: Marissa M...	Google	Positive emotion	Google	positive	great stuff on fri marissa mayer google tim o'...	#sxsw	@sxtxstate

Exploratory Data Analysis

Distribution of Tweets

In [48]:
```
# bar plot showing the number of targets
sns.barplot(data=df.groupby(['target']).count()['tweet_text'].reset_index(),
            x='target',
            y='tweet_text')
```

Out[48]:
```
<AxesSubplot:xlabel='target', ylabel='tweet_text'>
```



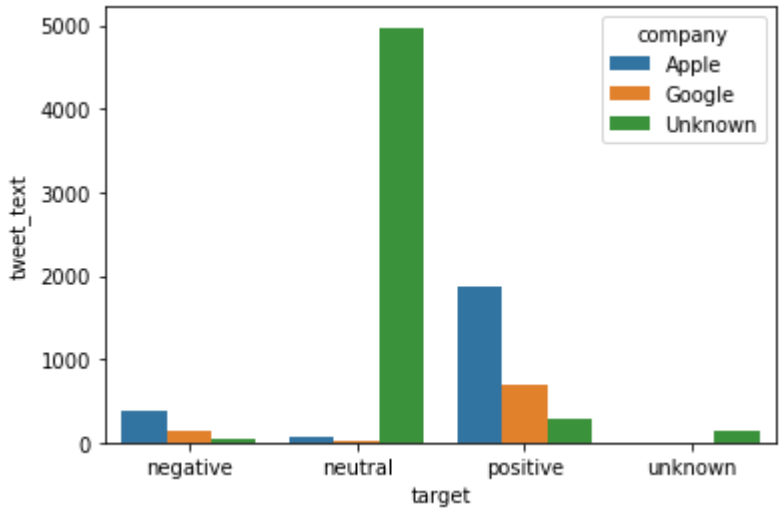
In [49]:
```
df.groupby(['target', 'company']).count()['tweet_text'].reset_index()
```

Out[49]:

	target	company	tweet_text
0	negative	Apple	378
1	negative	Google	128
2	negative	Unknown	49
3	neutral	Apple	63
4	neutral	Google	23
5	neutral	Unknown	4974
6	positive	Apple	1866
7	positive	Google	683
8	positive	Unknown	292
9	unknown	Apple	7
10	unknown	Google	2
11	unknown	Unknown	142

In [50]:
```
sns.barplot(data=df.groupby(['target', 'company']).count()['tweet_text'].reset_index(),
            x='target',
            y='tweet_text',
            hue='company')
```

Out[50]:
```
<AxesSubplot:xlabel='target', ylabel='tweet_text'>
```



Unknown sentiment makes up only a small amount of the total tweets and of those tweets the vast majority have an unknown direction. I will drop these values.

In [51]:
```
# filter target column
filter_s = df['target'] != 'unknown'

# filter dataframe
df = df.loc[filter_s]
```

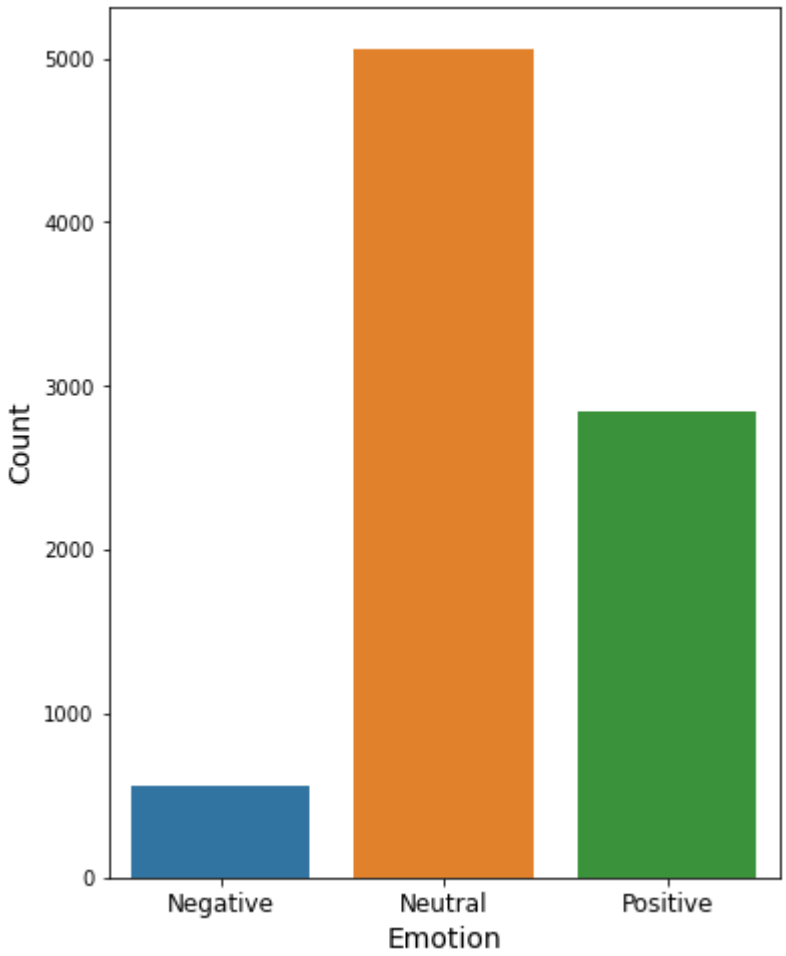
In [52]:
```
df.head()
```

Out[52]:

	tweet_text	directed_at	sentiment	company	target	clean_tweet	hashtags	mentions
0	.@wesley83 I have a 3G iPhone. After 3 hrs twe...	iPhone	Negative emotion	Apple	negative	i have a 3g iphone after 3 hrs tweeting at it ...	#rise_austin #sxsw	@wesley83
1	@jessedee Know about @fludapp ? Awesome iPad/i...	iPad or iPhone App	Positive emotion	Apple	positive	know about awesome ipad iphone app that you'll...	#sxsw	@jessedee @fludapp
2	@swonderlin Can not wait for #iPad 2 also. The...	iPad	Positive emotion	Apple	positive	can not wait for 2 also they should sale them ...	#ipad #sxsw	@swonderlin
3	@sxsw I hope this year's festival isn't as cra...	iPad or iPhone App	Negative emotion	Apple	negative	i hope this year's festival isn't as crashy as...	#sxsw	@sxsw
4	@sxtxstate great stuff on Fri #SXSW: Marissa M...	Google	Positive emotion	Google	positive	great stuff on fri marissa mayer google tim o'...	#sxsw	@sxtxstate

In [99]:

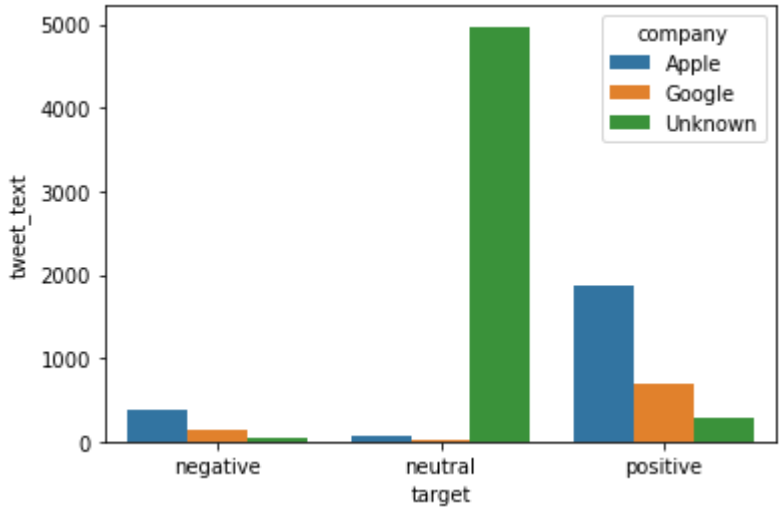
```
# set up fig and ax
fig, ax = plt.subplots(figsize=(6,8))

# bar plot to show number of tweets by target
sns.barplot(data=df.groupby(['target']).count()['tweet_text'].reset_index(),
            x='target',
            y='tweet_text',
            ax=ax)

# labels
ax.set_ylabel('Count', fontsize=14)
ax.set_xlabel('Emotion', fontsize=14)
ax.set_xticklabels(['Negative','Neutral','Positive'],
                   fontsize=12);
```



Here is the distribution of the classes. Neutral has the most occurences by far followed by positive and negative.

In [54]:
```
# bar plot to show number of tweets by target and company
sns.barplot(data=df.groupby(['target', 'company']).count()['tweet_text'].reset_index(),
            x='target',
            y='tweet_text',
            hue='company')
```

Out[54]: <AxesSubplot:xlabel='target', ylabel='tweet_text'>



Unknown has the most neutral tweets by far. Apple has the most positive and negative tweets written about them. I'm curious as to what people are talking about in those tweets.

In [55]:
```
df.groupby(['directed_at', 'target']).count()['tweet_text'].reset_index()
```

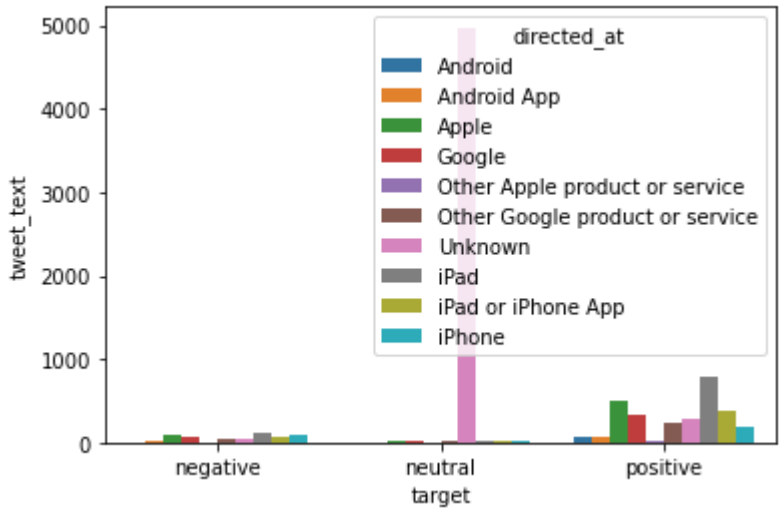
Out[55]:

	directed_at	target	tweet_text
0	Android	negative	7
1	Android	neutral	1
2	Android	positive	66
3	Android App	negative	8
4	Android App	neutral	1
5	Android App	positive	66
6	Apple	negative	94
7	Apple	neutral	20
8	Apple	positive	500
9	Google	negative	66
10	Google	neutral	13
11	Google	positive	327
12	Other Apple product or service	negative	2
13	Other Apple product or service	neutral	1
14	Other Apple product or service	positive	31
15	Other Google product or service	negative	47
16	Other Google product or service	neutral	8
17	Other Google product or service	positive	224
18	Unknown	negative	49
19	Unknown	neutral	4974
20	Unknown	positive	292
21	iPad	negative	120
22	iPad	neutral	23
23	iPad	positive	778
24	iPad or iPhone App	negative	61

	directed_at	target	tweet_text
25	iPad or iPhone App	neutral	10
26	iPad or iPhone App	positive	375
27	iPhone	negative	101
28	iPhone	neutral	9
29	iPhone	positive	182

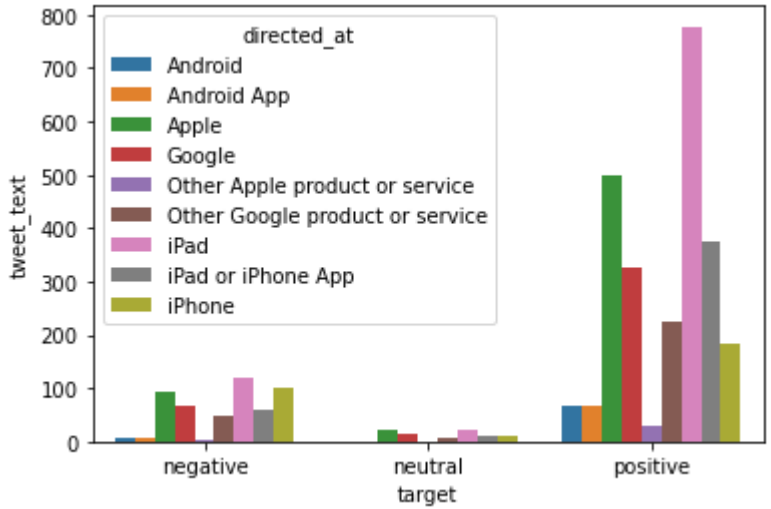
In [56]:
```
# bar plot to show number of tweets by target and company
sns.barplot(data=df.groupby(['target', 'directed_at']).count()['tweet_text'].reset_index(),
            x='target',
            y='tweet_text',
            hue='directed_at')
```

Out[56]:
```
<AxesSubplot:xlabel='target', ylabel='tweet_text'>
```



This graph is hard to read due to the Unknowns. I'll filter these out to create a new graph.

In [57]:
```
# create variable for the table
data_table = df.groupby(['directed_at', 'target']).count()['tweet_text'].reset_index()

# filter out unknown values
data_table.loc[data_table['directed_at'] != 'Unknown']

# bar plot to show number of tweets by target and company
sns.barplot(data=data_table.loc[data_table['directed_at'] != 'Unknown'],
            x='target',
            y='tweet_text',
            hue='directed_at');
```



- Most of the positive tweets are about the iPad and Apple followed by iPad or iPhone App and Google.
- Most of the negative tweets about about iPad and iPhone followed by Apple and Google.

Frequency Distributions

I'll create frequency distributions to see which words and phrases are most associated with each of the classes. I'll also take a look at which words and phrases are associated with the companies and their sentiments.

Helper Functions

These helper function will help with creating frequency distributions, normalized distribution functions, and n grams

In [58]:
```
# function to convert series to clean tokenized list
def clean_tokenize(series):
    # convert rows of tweets to one string
    allwords = ' '.join(series)

    # tokenize allwords
    allwords = allwords.split(' ')

    # remove stop words
    stopwords_list = stopwords.words('english')

    # add to stop words
    stopwords_list += ['link', 'rt']

    allwords_stopped = [word for word in allwords if word not in stopwords_list]

    return allwords_stopped

# create a frequency distribution and output n most common
def n_most_common(token_list, n=None):
    freq_dist = FreqDist(token_list)

    if n == None:
        return freq_dist
    else:
        return freq_dist.most_common(n)

# normalized distribution function
def norm_dist(freq_dist):
    # normalized distribution function
    total_word_count = sum(freq_dist.values())
    top_50_words = freq_dist.most_common(50)

    # prints headers for the output
    print(f'{"Word":10} Normalized Frequency')

    # for loop to print normalized distribution function
    for word in top_50_words:
        normalized_distribution = word[1] / total_word_count
        print(f"{word[0]:10} {normalized_distribution:^20.4}")

# bigram function
```

```python
def bigram(token_list, pmi=False, apply_filter=5):
    # bigram measures
    bigram_measures = nltk.collocations.BigramAssocMeasures

    if pmi:
        # mutual information score (pmi)
        pmi_finder = BigramCollocationFinder.from_words(token_list)
        pmi_finder.apply_freq_filter(apply_filter)
        pmi_scored = pmi_finder.score_ngrams(bigram_measures.pmi)

        return pmi_scored
    else:
        # creating bigrams
        finder = BigramCollocationFinder.from_words(token_list)
        scored = finder.score_ngrams(bigram_measures.raw_freq)

        return scored

# trigram function
def trigram(token_list, pmi=False, apply_filter=5):
    # trigram measures
    trigram_measures = nltk.collocations.TrigramAssocMeasures

    if pmi:
        # mutual information score (pmi)
        pmi_finder = TrigramCollocationFinder.from_words(token_list)
        pmi_finder.apply_freq_filter(apply_filter)
        pmi_scored = pmi_finder.score_ngrams(trigram_measures.pmi)

        return pmi_scored
    else:
        # creating trigrams
        finder = TrigramCollocationFinder.from_words(token_list)
        scored = finder.score_ngrams(trigram_measures.raw_freq)

        return scored
```

Frequency Distributions Based on Sentiment

Positive Tweets

In [59]:
```
# positive filter
pos_filter = df['target'] == 'positive'

# positive tweets
positive_tweets = df.loc[pos_filter]
```

In [60]:
```
positive_tweets.head()
```

Out[60]:

	tweet_text	directed_at	sentiment	company	target	clean_tweet	hashtags	mentions
1	@jessedee Know about @fludapp ? Awesome iPad/i...	iPad or iPhone App	Positive emotion	Apple	positive	know about awesome ipad iphone app that you'll...	#sxsw	@jessedee @fludapp
2	@swonderlin Can not wait for #iPad 2 also. The...	iPad	Positive emotion	Apple	positive	can not wait for 2 also they should sale them ...	#ipad #sxsw	@swonderlin
4	@sxtxstate great stuff on Fri #SXSW: Marissa M...	Google	Positive emotion	Google	positive	great stuff on fri marissa mayer google tim o'...	#sxsw	@sxtxstate
7	#SXSW is just starting, #CTIA is around the co...	Android	Positive emotion	Google	positive	is just starting is around the corner and is o...	#sxsw #ctia #googleio #android	
8	Beautifully smart and simple idea RT @madebyma...	iPad or iPhone App	Positive emotion	Apple	positive	beautifully smart and simple idea rt wrote abo...	#hollergram #sxsw	@madebymany @thenextweb

In [61]:
```
# create string of all the clean tweets
positive_tweets_token = clean_tokenize(positive_tweets['clean_tweet'])
```

In [62]:
```
# create frequency distribution of positive tweets
pos_freq_dist = n_most_common(positive_tweets_token)

# 50 most common words
pos_freq_dist.most_common(50)
```

Out[62]:
```
[('ipad', 897),
 ('apple', 677),
 ('google', 580),
 ('store', 524),
 ('iphone', 454),
 ('2', 453),
 ('quot', 430),
 ('app', 364),
 ('new', 324),
 ('austin', 236),
 ('pop', 207),
 ('amp', 199),
 ('android', 158),
 ('get', 155),
 ('launch', 142),
 ('great', 135),
 ('line', 132),
 ('sxsw', 131),
 ('party', 131),
```

In [63]:
```
# normalized distribution function positive tweets
norm_dist(pos_freq_dist) # 50 most common words
```

```
Word       Normalized Frequency
ipad              0.03287
apple             0.02481
google            0.02125
store              0.0192
iphone            0.01664
2                  0.0166
quot              0.01576
app               0.01334
new               0.01187
austin           0.008648
pop              0.007585
amp              0.007292
android          0.005789
get               0.00568
launch           0.005203
great            0.004947
line             0.004837
sxsw               0.0048
```

In [64]:
```
# most common bigrams
bigram(positive_tweets_token)
```

Out[64]:
```
[(('ipad', '2'), 0.013227804037961232),
 (('apple', 'store'), 0.006962002125242754),
 (('pop', 'store'), 0.0046901909054266975),
 (('iphone', 'app'), 0.0037008537613132534),
 (('google', 'maps'), 0.0027481587336484555),
 (('social', 'network'), 0.0026382323843025172),
 (('apple', 'pop'), 0.002381737569161995),
 (('ipad', 'app'), 0.002381737569161995),
 (('new', 'social'), 0.002381737569161995),
 (('temporary', 'store'), 0.0023450954527133487),
 (('downtown', 'austin'), 0.0023084533362647025),
 (('store', 'downtown'), 0.0023084533362647025),
 (('apple', 'opening'), 0.0021985269869187643),
 (('google', 'launch'), 0.0019420321717782418),
 (('new', 'ipad'), 0.0018687479388809498),
 (('marissa', 'mayer'), 0.0017954637059836576),
 (('2', 'launch'), 0.0017221794730863656),
 (('store', 'austin'), 0.0017221794730863656),
 (('called', 'circles'), 0.0016855373566377193),
```

In [65]:
```
# most common bigrams with pmi
bigram(positive_tweets_token, pmi=True)
```

Out[65]:
```
[(('ice', 'cream'), 12.414209543642368),
 (('etch', 'sketch'), 12.151175137808572),
 (('league', 'extraordinary'), 12.151175137808572),
 (('lustre', 'pearl'), 12.151175137808572),
 (('exhibit', 'hall'), 11.928782716472124),
 (('awesomely', 'rad'), 11.566212637087418),
 (('haha', 'awesomely'), 11.566212637087418),
 (('south', 'southwest'), 11.566212637087418),
 (('mark', 'belinsky'), 11.543492560587332),
 (('maggie', "mae's"), 11.27670601989243),
 (('city', 'end'), 11.058065733417092),
 (('150', 'million'), 10.98125013636626),
 (('macbook', 'pro'), 10.928782716472124),
 (('fam', 'showing'), 10.736137638529728),
 (('physical', 'worlds'), 10.736137638529728),
 (('holler', 'gram'), 10.648674797279389),
 (('includes', 'uberguide'), 10.648674797279389),
 (('64gig', 'wifi'), 10.566212637087418),
 (('choice', 'awards'), 10.566212637087418),
```

In [66]:
```
# most common trigrams
trigram(positive_tweets_token, pmi=False)
```

Out[66]:
```
[(('new', 'social', 'network'), 0.0022718112198160567),
 (('store', 'downtown', 'austin'), 0.002088600637572826),
 (('apple', 'pop', 'store'), 0.0018321058224323038),
 (('ipad', '2', 'launch'), 0.0017221794730863656),
 (('network', 'called', 'circles'), 0.0016488952401890733),
 (('social', 'network', 'called'), 0.0016488952401890733),
 (('launch', 'major', 'new'), 0.001575611007291781),
 (('major', 'new', 'social'), 0.001575611007291781),
 (('google', 'launch', 'major'), 0.0014290425414971969),
 (('opening', 'temporary', 'store'), 0.0013191161921512586),
 (('temporary', 'store', 'downtown'), 0.0011725477263566744),
 (('apple', 'opening', 'temporary'), 0.001135905609908028 4),
 (('circles', 'possibly', 'today'), 0.001135905609908028 4),
 (('called', 'circles', 'possibly'), 0.0010992634934593821),
 (('quot', 'apple', 'comes'), 0.0010259792605620901),
 (('begins', 'apple', 'wins'), 0.0009526950276647979),
 (('even', 'begins', 'apple'), 0.0009526950276647979),
 (("one's", 'ever', 'heard'), 0.0009526950276647979),
 (('pop', 'store', 'austin'), 0.0009526950276647979),
```

In [67]:
```
# most common trigrams with pmi
trigram(positive_tweets_token, pmi=True)
```

Out[67]:
```
[(('haha', 'awesomely', 'rad'), 23.132425274174835),
 (('mark', 'belinsky', 'panel'), 21.070176833488112),
 (('http', 'bit', 'ly'), 20.395459680008628),
 (('includes', 'uberguide', 'sponsored'), 20.192167357866726),
 (('schools', 'marketing', 'experts'), 20.17271499520055),
 (('brain', 'search', 'x'), 20.0799578542807),
 (('left', 'brain', 'search'), 18.964480636860763),
 (('choice', 'awards', 'thanks'), 18.946754467964386),
 (('technology', "one's", 'ever'), 18.856300868900593),
 (('w', 'fam', 'showing'), 18.814063794307664),
 (('150', 'million', 'mobile'), 18.664276438436424),
 (("one's", 'ever', 'heard'), 18.640572177845158),
 (('live', 'video', 'streaming'), 18.628179808186836),
 (('route', 'around', 'traffic'), 18.049028027748818),
 (('shop', 'core', 'action'), 18.003269484624536),
 (('android', 'choice', 'awards'), 17.998569527440043),
 (('wins', 'best', 'andoid'), 17.78402496792628),
 (('web', 'site', 'coming'), 17.763967315585028),
 (('cool', 'technology', "one's"), 17.579969640453342),
```

Negative Tweets

In [68]:
```
# negative filter
neg_filter = df['target'] == 'negative'

# negative tweets
negative_tweets = df.loc[neg_filter]
```

In [69]:
```
negative_tweets.head()
```

Out[69]:

	tweet_text	directed_at	sentiment	company	target	clean_tweet	hashtags	mentions
0	.@wesley83 I have a 3G iPhone. After 3 hrs twe...	iPhone	Negative emotion	Apple	negative	i have a 3g iphone after 3 hrs tweeting at it ...	#rise_austin #sxsw	@wesley83
3	@sxsw I hope this year's festival isn't as cra...	iPad or iPhone App	Negative emotion	Apple	negative	i hope this year's festival isn't as crashy as...	#sxsw	@sxsw
17	I just noticed DST is coming this weekend. How...	iPhone	Negative emotion	Apple	negative	i just noticed dst is coming this weekend how ...	#sxsw #iphone	
64	Again? RT @mention Line at the Apple store is ...	Unknown	Negative emotion	Unknown	negative	again rt line at the apple store is insane	#sxsw	@mention
67	attending @mention iPad design headaches #sxsw...	iPad	Negative emotion	Apple	negative	attending ipad design headaches link	#sxsw	@mention

In [70]:
```
# create string of all the clean tweets
negative_tweets_token = clean_tokenize(negative_tweets['clean_tweet'])
```

In [71]:
```
negative_tweets_token
```

Out[71]:
```
['3g',
 'iphone',
 '3',
 'hrs',
 'tweeting',
 'dead',
 'need',
 'upgrade',
 'plugin',
 'stations',
 'hope',
 "year's",
 'festival',
 'crashy',
 "year's",
 'iphone',
 'app',
 'noticed',
 'dst',
```

In [72]:
```
# create frequency distribution of negative tweets
neg_freq_dist = n_most_common(negative_tweets_token)

# 50 most common words
neg_freq_dist.most_common(50)
```

Out[72]:
```
[('ipad', 163),
 ('quot', 163),
 ('iphone', 141),
 ('google', 132),
 ('apple', 100),
 ('2', 62),
 ('app', 59),
 ('store', 46),
 ('new', 42),
 ('like', 38),
 ('design', 29),
 ('people', 29),
 ('social', 27),
 ('apps', 25),
 ('austin', 25),
 ('get', 24),
 ('circles', 23),
 ('amp', 22),
 ('one', 22),
```

In [73]:
```
# normalized distribution function negative tweets
norm_dist(neg_freq_dist) # 50 most common words
```

```
Word       Normalized Frequency
ipad             0.02924
quot             0.02924
iphone           0.02529
google           0.02368
apple            0.01794
2                0.01112
app              0.01058
store            0.008251
new              0.007534
like             0.006816
design           0.005202
people           0.005202
social           0.004843
apps             0.004484
austin           0.004484
get              0.004305
circles          0.004126
amp              0.003946
```

In [74]:
```
# most common bigrams
bigram(negative_tweets_token)
```

Out[74]:
```
[(('ipad', '2'), 0.008071748878923767),
 (('apple', 'store'), 0.004304932735426009),
 (('ipad', 'design'), 0.0034080717488789236),
 (('iphone', 'app'), 0.0034080717488789236),
 (('design', 'headaches'), 0.0030493273542600897),
 (('new', 'social'), 0.0026905829596412557),
 (('quot', 'quot'), 0.0026905829596412557),
 (('social', 'network'), 0.0025112107623318385),
 (('company', 'america'), 0.0023318385650224214),
 (('fascist', 'company'), 0.0021524663677130046),
 (('major', 'new'), 0.0021524663677130046),
 (('google', 'launch'), 0.0019730941704035874),
 (('launch', 'major'), 0.0017937219730941704),
 (('network', 'called'), 0.0017937219730941704),
 (('quot', 'apple'), 0.0017937219730941704),
 (('called', 'circles'), 0.0016143497757847534),
 (('fades', 'fast'), 0.0016143497757847534),
 (('fast', 'among'), 0.0016143497757847534),
 (('google', 'circles'), 0.0016143497757847534),
```

In [75]:
```
# most common bigrams with pmi
bigram(negative_tweets_token, pmi=True)
```

Out[75]:
```
[(('kara', 'swisher'), 9.44475608969503),
 (('marissa', 'mayer'), 9.122827994807668),
 (('among', 'digital'), 9.082186010310323),
 (('digital', 'delegates'), 9.082186010310323),
 (('fast', 'among'), 8.859793588973872),
 (('way', 'caring'), 8.744316371553937),
 (('fades', 'fast'), 8.707790495528823),
 (('caring', 'much'), 8.53786549408651),
 (('much', 'business'), 8.53786549408651),
 (('classiest', 'fascist'), 8.467476166195112),
 (('company', 'america'), 8.43095029017),
 (('fascist', 'company'), 8.415008746300977),
 (('network', 'called'), 8.274831088252718),
 (('elegant', 'fascist'), 8.151974340467183),
 (('lost', 'way'), 8.0662444664413),
 (('possibly', 'today'), 7.859793588973875),
 (('social', 'network'), 7.5903329139806495),
 (('design', 'headaches'), 7.586775094567457),
 (('launch', 'major'), 7.567011839746028),
```

In [76]:
```
# most common trigrams
trigram(negative_tweets_token, pmi=False)
```

Out[76]:
```
[(('ipad', 'design', 'headaches'), 0.0028699551569506725),
 (('major', 'new', 'social'), 0.0021524663677130046),
 (('new', 'social', 'network'), 0.0021524663677130046),
 (('fascist', 'company', 'america'), 0.0019730941704035874),
 (('launch', 'major', 'new'), 0.0017937219730941704),
 (('social', 'network', 'called'), 0.0017937219730941704),
 (('fades', 'fast', 'among'), 0.0016143497757847534),
 (('google', 'launch', 'major'), 0.0016143497757847534),
 (('network', 'called', 'circles'), 0.0016143497757847534),
 (('classiest', 'fascist', 'company'), 0.0014349775784753362),
 (('company', 'america', 'quot'), 0.0014349775784753362),
 (('among', 'digital', 'delegates'), 0.0012556053811659193),
 (('fast', 'among', 'digital'), 0.0012556053811659193),
 (('ipad', 'news', 'apps'), 0.0012556053811659193),
 (('apps', 'fades', 'fast'), 0.0010762331838565023),
 (('called', 'circles', 'possibly'), 0.0010762331838565023),
 (('circles', 'possibly', 'today'), 0.0010762331838565023),
 (('news', 'apps', 'fades'), 0.0010762331838565023),
 (('pop', 'apple', 'store'), 0.0010762331838565023),
```

In [77]:
```
# most common trigrams
trigram(negative_tweets_token, pmi=True)
```

Out[77]:
```
[(('caring', 'much', 'business'), 18.66069348889418),
 (('among', 'digital', 'delegates'), 18.357017098563038),
 (('lost', 'way', 'caring'), 18.18907246124897),
 (('fades', 'fast', 'among'), 17.98262158378154),
 (('fast', 'among', 'digital'), 17.941979599284196),
 (('way', 'caring', 'much'), 17.282181865640446),
 (('classiest', 'fascist', 'company'), 17.10487733383254),
 (('fascist', 'company', 'america'), 16.82734335830363),
 (('called', 'circles', 'possibly'), 16.365950223333048),
 (('network', 'called', 'circles'), 16.044022128445683),
 (('social', 'network', 'called'), 15.964699675784274),
 (('apps', 'fades', 'fast'), 15.923727894727975),
 (('circles', 'possibly', 'today'), 15.558595301275444),
 (('news', 'apps', 'fades'), 15.42122755419879),
 (('launch', 'major', 'new'), 14.619450506662293),
 (('major', 'new', 'social'), 14.51991483311138),
 (('new', 'social', 'network'), 14.420379159560467),
 (('apple', 'elegant', 'fascist'), 13.952874240387487),
 (('quot', 'classiest', 'fascist'), 13.148466602380223),
 (('company', 'america', 'quot'), 12.82653850749286),
 (('google', 'launch', 'major'), 12.815370716637554),
 (('novelty', 'ipad', 'news'), 12.605324277353692),
 (('ipad', 'design', 'headaches'), 12.59534018878107),
 (('ipad', 'news', 'apps'), 11.61681991619152),
 (('pop', 'apple', 'store'), 11.21959369302914),
 (('quot', 'apple', 'elegant'), 10.411501008214014),
 (('apple', 'quot', 'classiest'), 10.048930928829307),
 (('quot', 'ipad', 'design'), 7.656002970687695)]
```

Neutral Tweets

In [78]:
```
# neutral filter
neutral_filter = df['target'] == 'neutral'

# neutral tweets
neutral_tweets = df.loc[neutral_filter]
```

In [79]:
```
neutral_tweets.head()
```

Out[79]:

	tweet_text	directed_at	sentiment	company	target	clean_tweet	hashtags	mentions
5	@teachntech00 New iPad Apps For #SpeechTherapy...	Unknown	No emotion toward brand or product	Unknown	neutral	new ipad apps for and communication are showca...	#speechtherapy #sxsw #iear #edchat #asd	@teachntech00
16	Holler Gram for iPad on the iTunes App Store -...	Unknown	No emotion toward brand or product	Unknown	neutral	holler gram for ipad on the itunes app store h...	#sxsw	@marc_is_ken
32	Attn: All #SXSW frineds, @mention Register fo...	Unknown	No emotion toward brand or product	Unknown	neutral	attn all frineds register for and see cobra ir...	#sxsw #gdgtlive	@mention
33	Anyone at #sxsw want to sell their old iPad?	Unknown	No emotion toward brand or product	Unknown	neutral	anyone at want to sell their old ipad	#sxsw	
34	Anyone at #SXSW who bought the new iPad want ...	Unknown	No emotion toward brand or product	Unknown	neutral	anyone at who bought the new ipad want to sell...	#sxsw	

In [80]:
```
# create string of all the clean tweets
neutral_tweets_token = clean_tokenize(neutral_tweets['clean_tweet'])
```

In [81]:
```
neutral_tweets_token
```

Out[81]:
```
['new',
 'ipad',
 'apps',
 'communication',
 'showcased',
 'conference',
 'http',
 'ht',
 'ly',
 '49n4m',
 'holler',
 'gram',
 'ipad',
 'itunes',
 'app',
 'store',
 'http',
 'co',
 'kfn3f5q',
```

In [82]:
```
# create frequency distribution of neutral tweets
neutral_freq_dist = n_most_common(neutral_tweets_token)

# 50 most common words
neutral_freq_dist.most_common(50)
```

Out[82]:
```
[('google', 1227),
 ('ipad', 1055),
 ('quot', 967),
 ('apple', 920),
 ('store', 804),
 ('iphone', 653),
 ('amp', 568),
 ('new', 557),
 ('2', 530),
 ('austin', 507),
 ('social', 378),
 ('launch', 347),
 ('today', 340),
 ('pop', 333),
 ('circles', 331),
 ('app', 322),
 ('sxsw', 311),
 ('android', 264),
 ('network', 258),
```

In [83]:
```
# normalized distribution function neutral tweets
norm_dist(neutral_freq_dist) # 50 most common words
```

```
Word       Normalized Frequency
google           0.02642
ipad             0.02271
quot             0.02082
apple            0.01981
store            0.01731
iphone           0.01406
amp              0.01223
new              0.01199
2                0.01141
austin           0.01092
social           0.008138
launch           0.007471
today            0.00732
pop              0.007169
circles          0.007126
app              0.006933
sxsw             0.006696
android          0.005684
```

In [84]:
```
# most common bigrams
bigram(neutral_tweets_token)
```

Out[84]:
```
[(('ipad', '2'), 0.008396667169031369),
 (('apple', 'store'), 0.006803453398497212),
 (('social', 'network'), 0.005382478954507288),
 (('new', 'social'), 0.004736581479966413),
 (('pop', 'store'), 0.003939974594699335),
 (('network', 'called'), 0.003423256615066635),
 (('google', 'launch'), 0.003143367709432256),
 (('called', 'circles'), 0.0030572480461601393),
 (('major', 'new'), 0.0030141882145240813),
 (('launch', 'major'), 0.0029065386354339352),
 (('apple', 'opening'), 0.0023467608241651773),
 (('possibly', 'today'), 0.0023467608241651773),
 (('store', 'austin'), 0.002260641160893061),
 (('google', 'circles'), 0.0022175813292570025),
 (('temporary', 'store'), 0.0022175813292570025),
 (('circles', 'possibly'), 0.0021314616659848 86),
 (('downtown', 'austin'), 0.0019376924236226237),
 (('marissa', 'mayer'), 0.0019376924236226237),
 (('store', 'downtown'), 0.0017869830128964196),
```

In [85]:
```
# most common bigrams with pmi
bigram(neutral_tweets_token, pmi=True)
```

Out[85]:
```
[(('cameron', 'sinclair'), 13.181369700970887),
 (('charlie', 'sheen'), 13.181369700970887),
 (('holler', 'gram'), 13.181369700970887),
 (('sheen', 'goddesses'), 13.181369700970887),
 (('jc', 'penney'), 12.91833529513709),
 (('knitted', 'staircase'), 12.91833529513709),
 (('98', 'accuracy'), 12.695942873800643),
 (('acoustic', 'solo'), 12.695942873800643),
 (('barton', 'hollow'), 12.695942873800643),
 (('entered', 'automatically'), 12.695942873800643),
 (('poked', 'liked'), 12.695942873800643),
 (('themed', 'costume'), 12.695942873800643),
 (('tim', "o'reilly"), 12.503297795858249),
 (('staircase', 'attendance'), 12.503297795858245),
 (('til', 'midnight'), 12.503297795858245),
 (('charles', 'chen'), 12.333372794415936),
 (('ice', 'cream'), 12.333372794415936),
 (('lustre', 'pearl'), 12.333372794415933),
 (('galaxy', 'ii'), 12.280905374521797),
```

In [86]:
```
# most common trigrams
trigram(neutral_tweets_token, pmi=False)
```

Out[86]:
```
[(('new', 'social', 'network'), 0.0043059831636058305),
 (('social', 'network', 'called'), 0.003401726699248606),
 (('major', 'new', 'social'), 0.002992658298706052),
 (('network', 'called', 'circles'), 0.002992658298706052),
 (('launch', 'major', 'new'), 0.0029065386354339352),
 (('google', 'launch', 'major'), 0.0024113505716192 65),
 (('circles', 'possibly', 'today'), 0.0021314616659848 86),
 (('called', 'circles', 'possibly'), 0.0020884018343488276),
 (('apple', 'pop', 'store'), 0.0015501539388980989),
 (('store', 'downtown', 'austin'), 0.0015501539388980989),
 (('ipad', '2', 'launch'), 0.0013779146123538658),
 (('pop', 'apple', 'store'), 0.0012272052016276617),
 (('apple', 'opening', 'temporary'), 0.0012056752858096325),
 (('opening', 'temporary', 'store'), 0.001141085538355545),
 (('pop', 'store', 'austin'), 0.0011195556225375158),
 (('temporary', 'store', 'downtown'), 0.0009257863801752535),
 (('opening', 'pop', 'store'), 0.0008611966327211661),
 (('austin', 'ipad', '2'), 0.0008396667169031369),
 (('59', '59p', '03'), 0.0008181368010851078),
```

In [87]:
```
# most common trigrams
trigram(neutral_tweets_token, pmi=True)
```

Out[87]:
```
[(('charlie', 'sheen', 'goddesses'), 26.36273940194177),
 (('knitted', 'staircase', 'attendance'), 25.42163309099534),
 (('tomo', '7pm', 'hosted'), 24.251708089553027),
 (('geek', 'charlie', 'sheen'), 24.099704996107977),
 (('therapy', 'communication', 'showcased'), 23.907059918165583),
 (('80s', 'themed', 'costume'), 23.80692324688013),
 (('speech', 'therapy', 'communication'), 23.68466749682913),
 (('everything', 'except', '64gig'), 23.597204655578793),
 (('except', '64gig', 'wifi'), 23.597204655578793),
 (('sign', 'entered', 'automatically'), 23.555384479884168),
 (('steps', 'bulletproof', 'ux'), 23.44435316749542),
 (('access', 'acoustic', 'solo'), 23.19924066965889),
 (('register', 'exclusive', 'passes'), 23.17009432399938),
 (('communication', 'showcased', 'conference'), 23.099704996107974),
 (('interrupt', 'regularly', 'scheduled'), 23.099704996107974),
 (('donating', 'japanese', 'red'), 22.903307783304477),
 (('japanese', 'red', 'cross'), 22.903307783304477),
 (('bulletproof', 'ux', 'strategy'), 22.851777482664396),
 (('league', 'extraordinary', 'hackers'), 22.71708897452151),
```

Hashtag Frequency Distributions

In [88]:
```
# token list for hashtags
hashtag_tokens = clean_tokenize(df['hashtags'])

# create frequency distribution
hashtag_freq_dist = n_most_common(hashtag_tokens)

# top 50 most common hashtags
hashtag_freq_dist.most_common(50)
```

Out[88]:
```
[('#sxsw', 8471),
 ('#apple', 363),
 ('#google', 289),
 ('#sxswi', 287),
 ('#ipad2', 272),
 ('#ipad', 252),
 ('#iphone', 236),
 ('#android', 121),
 ('#austin', 106),
 ('#circles', 74),
 ('#gsdm', 62),
 ('#tech', 54),
 ('#tapworthy', 52),
 ('#ubersocial', 51),
 ('#infektd', 48),
 ('#japan', 46),
 ('#fb', 46),
 ('#qagb', 45),
 ('#winning', 42),
```

In [89]:
```
# Normalized Distribution Function
norm_dist(hashtag_freq_dist)
```

```
Word       Normalized Frequency
#sxsw              0.5815
#apple            0.02492
#google           0.01984
#sxswi             0.0197
#ipad2            0.01867
#ipad               0.0173
#iphone             0.0162
#android          0.008306
#austin           0.007277
#circles           0.00508
#gsdm             0.004256
#tech             0.003707
#tapworthy         0.00357
#ubersocial       0.003501
#infektd          0.003295
#japan            0.003158
#fb               0.003158
#qagb             0.003089
```

Saving DataFrame to CSV

Saving the final dataframe so I can use it for modeling.

In [90]:
```
# save dataframe to csv
df.to_csv('./data/tweets_clean.csv')
```