2 - EDA with Text

December 1, 2021

Table of Contents

[1]:
```
#from google.colab import drive
#drive.mount('/content/drive')
```

0.0.1 Load the data into a dataframe

[2]:
```
!pip install contractions
!pip install pyspellchecker

import pandas as pd
import numpy
import matplotlib
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
matplotlib.rcParams['figure.figsize'] = (10.0, 6.0)

from sklearn.feature_extraction.text import CountVectorizer
import contractions
from collections import Counter
#from pyspellchecker import SpellChecker
import string
import re
from textblob import TextBlob

import nltk
nltk.download('punkt')
nltk.download('averaged_perceptron_tagger')
from nltk.tokenize import word_tokenize
from nltk.tokenize import sent_tokenize
```

```
Requirement already satisfied: contractions in
/opt/anaconda3/lib/python3.8/site-packages (0.0.58)
```

```
Requirement already satisfied: textsearch>=0.0.21 in
/opt/anaconda3/lib/python3.8/site-packages (from contractions) (0.0.21)
Requirement already satisfied: pyahocorasick in
/opt/anaconda3/lib/python3.8/site-packages (from
textsearch>=0.0.21->contractions) (1.4.2)
Requirement already satisfied: anyascii in /opt/anaconda3/lib/python3.8/site-
packages (from textsearch>=0.0.21->contractions) (0.3.0)
Requirement already satisfied: pyspellchecker in
/opt/anaconda3/lib/python3.8/site-packages (0.6.2)
```

```
[nltk_data] Downloading package punkt to /Users/jimcody/nltk_data…
[nltk_data]   Package punkt is already up-to-date!
[nltk_data] Downloading package averaged_perceptron_tagger to
[nltk_data]     /Users/jimcody/nltk_data…
[nltk_data]   Package averaged_perceptron_tagger is already up-to-
[nltk_data]       date!
```

[3]:
```
latuda = pd.read_csv('https://raw.githubusercontent.com/jimcody2014/nlp_cdc/
↪main/data/latuda.csv')
latuda.head()
```

[3]:

	drugName	condition	review	rating	date	usefulCount
0	Latuda	Bipolar Disorde	"I have had great experience so far with Latud…	8	20-Feb-12	39
1	Latuda	Bipolar Disorde	"I've taken a lot of medications. I was prescr…	3	28-Oct-16	25
2	Latuda	Bipolar Disorde	"I was deeply suicidal for 15 years with repet…	9	25-Dec-15	33
3	Latuda	Bipolar Disorde	"I have been taking Latuda 80 mg for 8 months …	3	23-Apr-13	34
4	Latuda	Schizophrenia	"We've heard of the Latuda 20-40 mg restlessne…	9	5-Feb-16	15

0.1 Pre-processing

[4]:
```
def clean_text_round1(text):
    text = text.lower()
    text = re.sub('\[.*?\]', '', text)
    text = re.sub('[%s]' % re.escape(string.punctuation), '', text)
```

```
    text = re.sub('\w*\d\w*', '', text)
    text = re.sub('[‘’""…]', '', text)
    text = re.sub('\n', '', text)
    return text
```

[5]:
```
round1 = lambda x: clean_text_round1(x)

# Let's take a look at the updated text
latuda.review = pd.DataFrame(latuda.review.apply(round1))
latuda.head()
```

[5]:
```
  drugName        condition  \
0   Latuda  Bipolar Disorde
1   Latuda  Bipolar Disorde
2   Latuda  Bipolar Disorde
3   Latuda  Bipolar Disorde
4   Latuda    Schizophrenia

                                              review  rating       date  \
0  i have had great experience so far with latuda…       8  20-Feb-12
1  ive taken a lot of medications i was prescribe…       3  28-Oct-16
2  i was deeply suicidal for  years with repetiti…       9  25-Dec-15
3  i have been taking latuda  mg for  months and …       3  23-Apr-13
4  weve heard of the latuda  mg restlessnesssense…       9   5-Feb-16

   usefulCount
0           39
1           25
2           33
3           34
4           15
```

[6]:
```
# Add a column 'target' based on the rating column
latuda['target'] = latuda['rating'].apply(lambda x: 'Good' if x >= 6 else 'Bad')
```

1 This is new!

1.0.1 Determine sentiment polarity

[7]:
```
# New column for sentiment polarity. Two new columns for lengths of the review␣
 ↪and word count.
latuda['polarity'] = latuda['review'].map(lambda text: TextBlob(text).sentiment.
 ↪polarity)
latuda['review_len'] = latuda['review'].astype(str).apply(len)
latuda['word_count'] = latuda['review'].apply(lambda x: len(str(x).split()))
latuda.head()
```

[7]:
```
   drugName        condition  \
0   Latuda  Bipolar Disorde
1   Latuda  Bipolar Disorde
2   Latuda  Bipolar Disorde
3   Latuda  Bipolar Disorde
4   Latuda    Schizophrenia

                                              review  rating       date  \
0  i have had great experience so far with latuda…       8  20-Feb-12
1  ive taken a lot of medications i was prescribe…       3  28-Oct-16
2  i was deeply suicidal for  years with repetiti…       9  25-Dec-15
3  i have been taking latuda  mg for  months and …       3  23-Apr-13
4  weve heard of the latuda  mg restlessnesssense…       9   5-Feb-16

   usefulCount target  polarity  review_len  word_count
0           39   Good  0.170000         564         109
1           25    Bad  0.377222         298          61
2           33   Good -0.040427         719         137
3           34    Bad  0.185119         672         123
4           15   Good  0.175000         428          72
```

[8]:
```
print('5 random reviews with the highest positive sentiment polarity: \n')
polarity_max = latuda.polarity.max()
polarity_mean = latuda.polarity.mean()
polarity_median = latuda.polarity.median()
polarity_mode = latuda.polarity.mode()
polarity_min = latuda.polarity.min()

print(polarity_max)
print(polarity_mean)
print(polarity_median)
print(polarity_mode)
print(polarity_min)
```

```
5 random reviews with the highest positive sentiment polarity:

0.8
0.06861209701462832
0.08500000000000002
0    0.0
dtype: float64
-0.9
```

[9]:
```
print(latuda.loc[latuda.polarity == 0.8])
```

```
    drugName        condition  \
131   Latuda  Bipolar Disorde
```

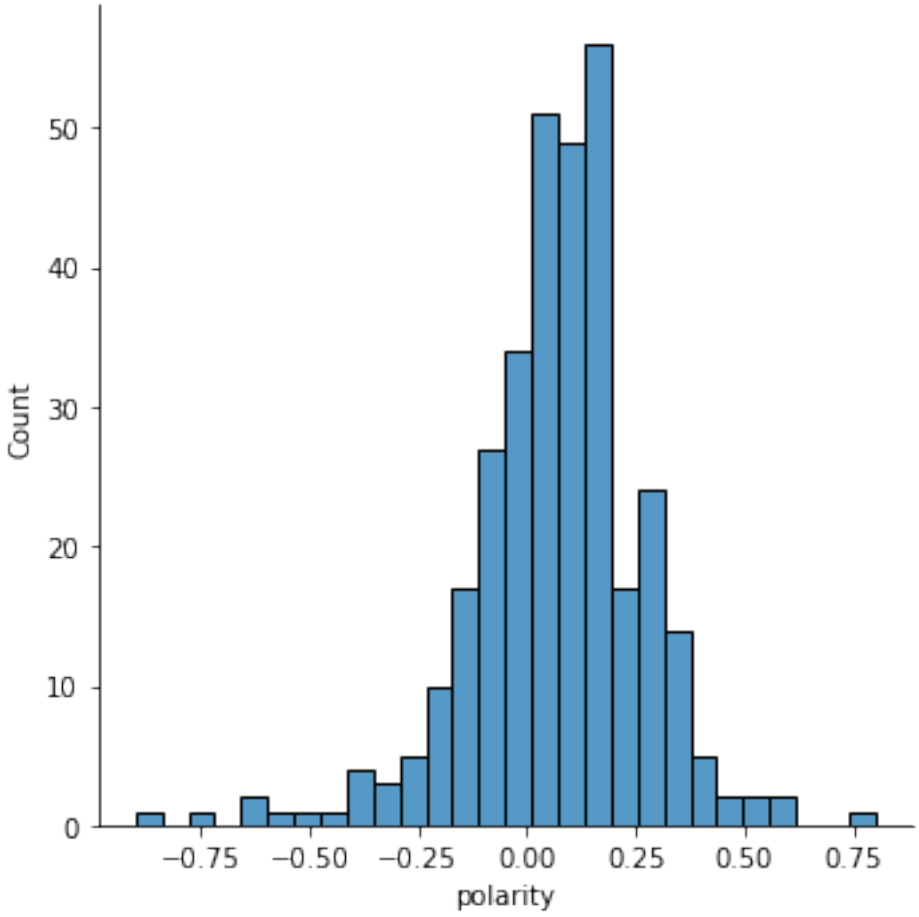
```
                                                  review  rating       date  \
131  i had been on latuda for two months  great med…       1  29-Nov-11

     usefulCount target  polarity  review_len  word_count
131           38    Bad       0.8          87          16
```

1.0.2 Distribution of review polarity scores

[10]:
```
sns.displot(data=latuda,x='polarity')
```

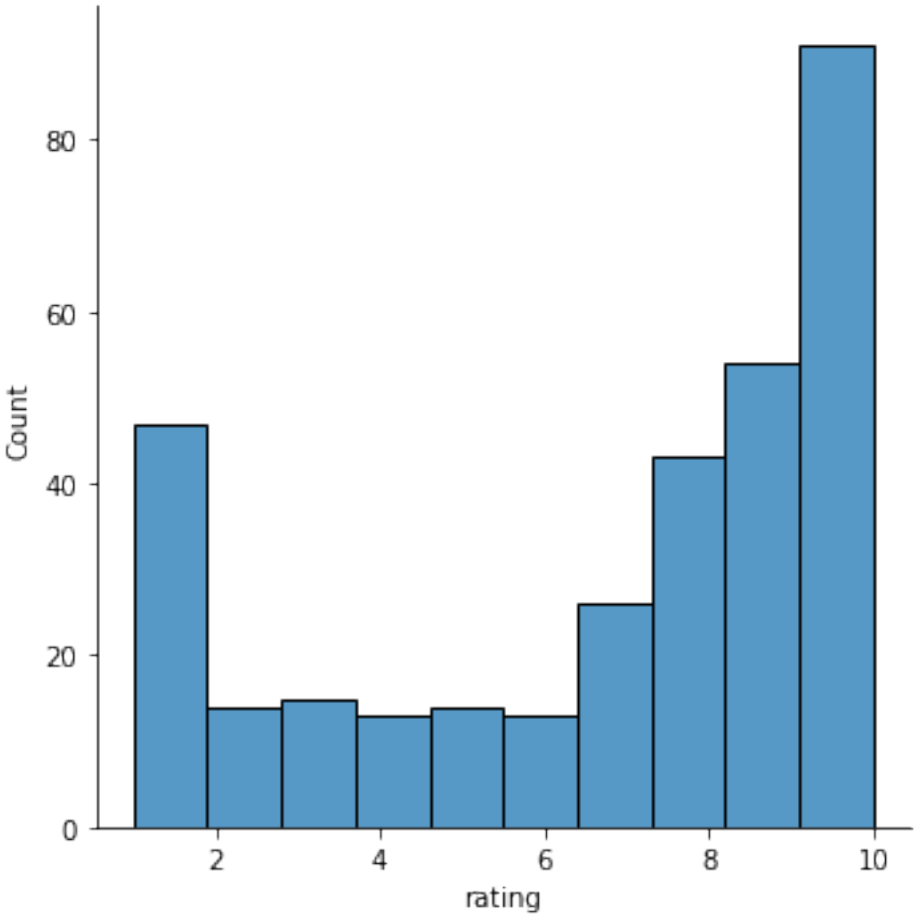
[10]:
```
<seaborn.axisgrid.FacetGrid at 0x7f8021d160a0>
```



1.0.3 Distribution of Ratings

[11]:
```
sns.displot(data=latuda,x='rating')
```

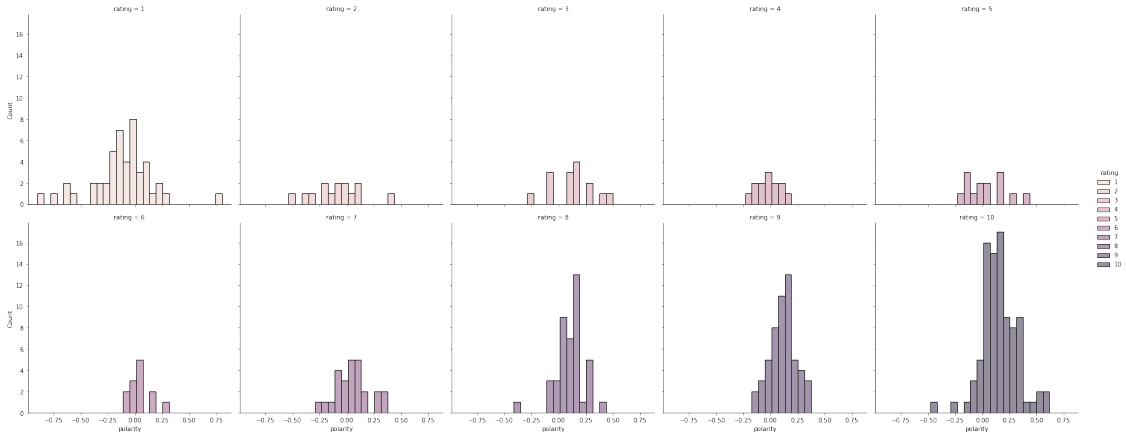
[11]:
```
<seaborn.axisgrid.FacetGrid at 0x7f8021cb8970>
```



1.0.4 Distribution of polarity by rating

[12]:
```
sns.displot(data=latuda, x="polarity", hue="rating", col="rating", col_wrap =5,␣
↪kind = 'hist')
```

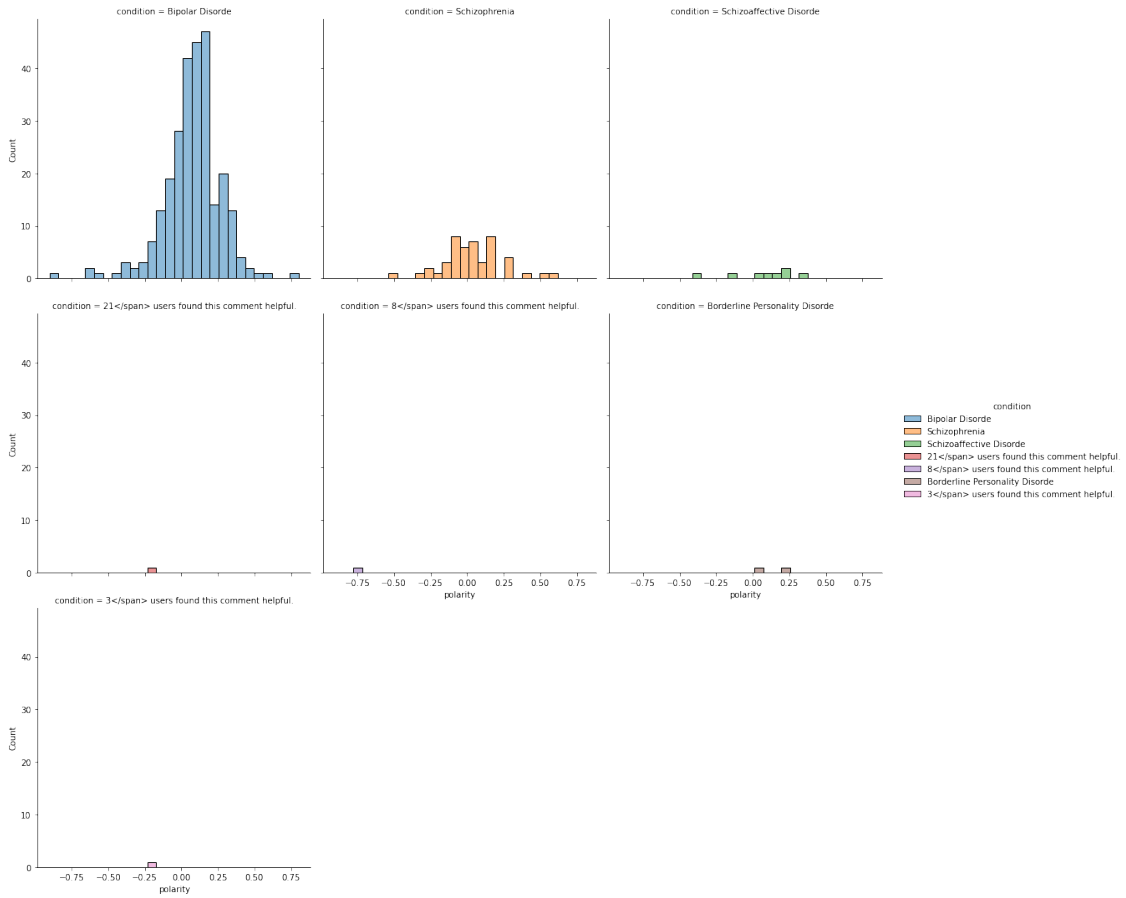
[12]:
```
<seaborn.axisgrid.FacetGrid at 0x7f8022085eb0>
```



1.0.5 Distribution of polarity by condition

[13]:
```
sns.displot(data=latuda, x="polarity", hue="condition", col="condition",␣
↪col_wrap =3, kind = 'hist')
```

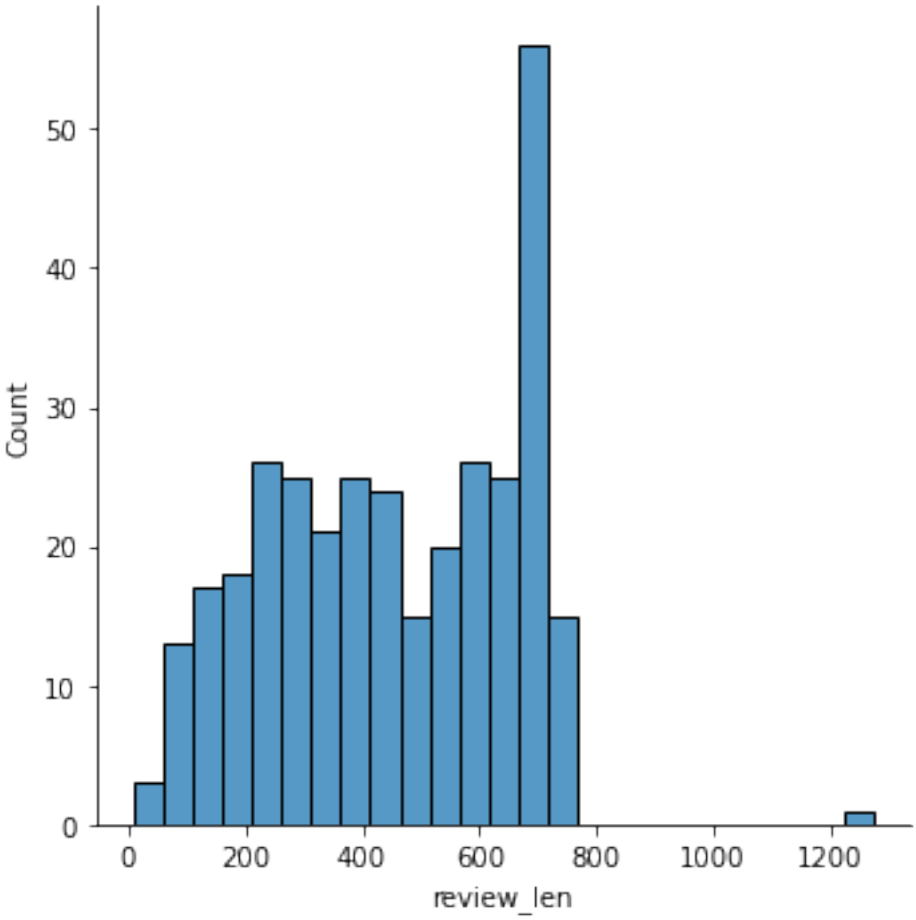
[13]: <seaborn.axisgrid.FacetGrid at 0x7f800399de80>



1.0.6 Distribution by review length

[14]:
```
sns.displot(data=latuda,x='review_len', bins = 25)
```

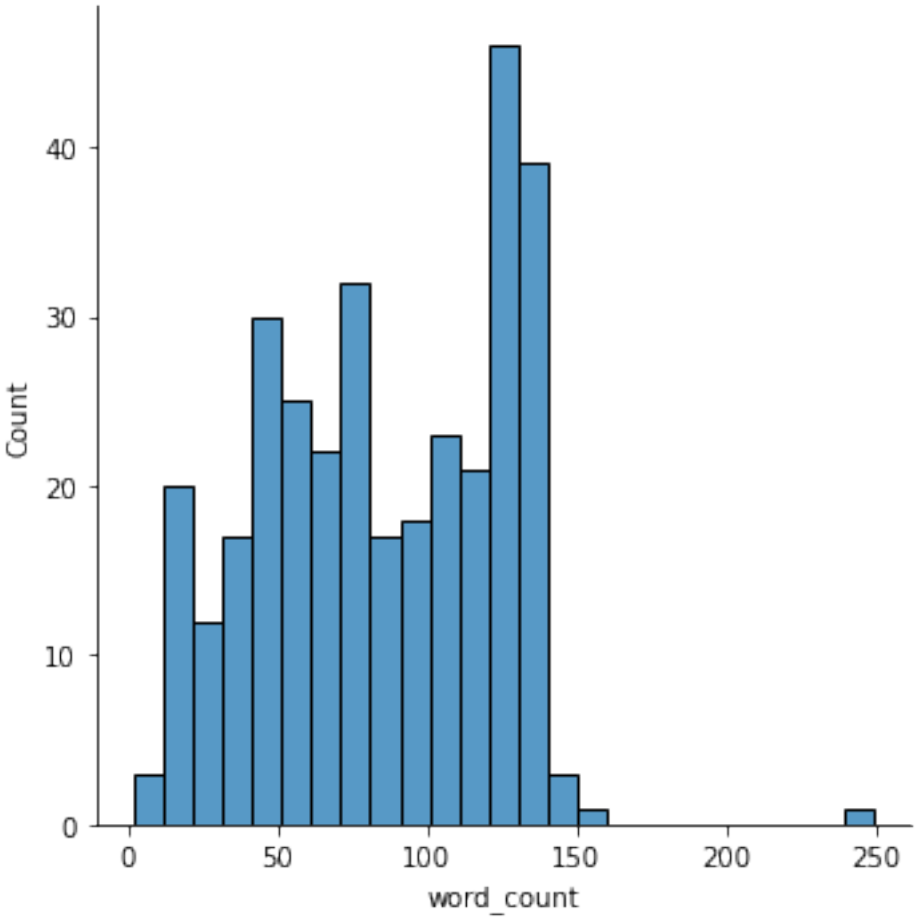
[14]:
```
<seaborn.axisgrid.FacetGrid at 0x7f8003cdbd90>
```



1.0.7 Distribution by word count

[15]:
```
sns.displot(data=latuda,x='word_count', bins = 25)
```

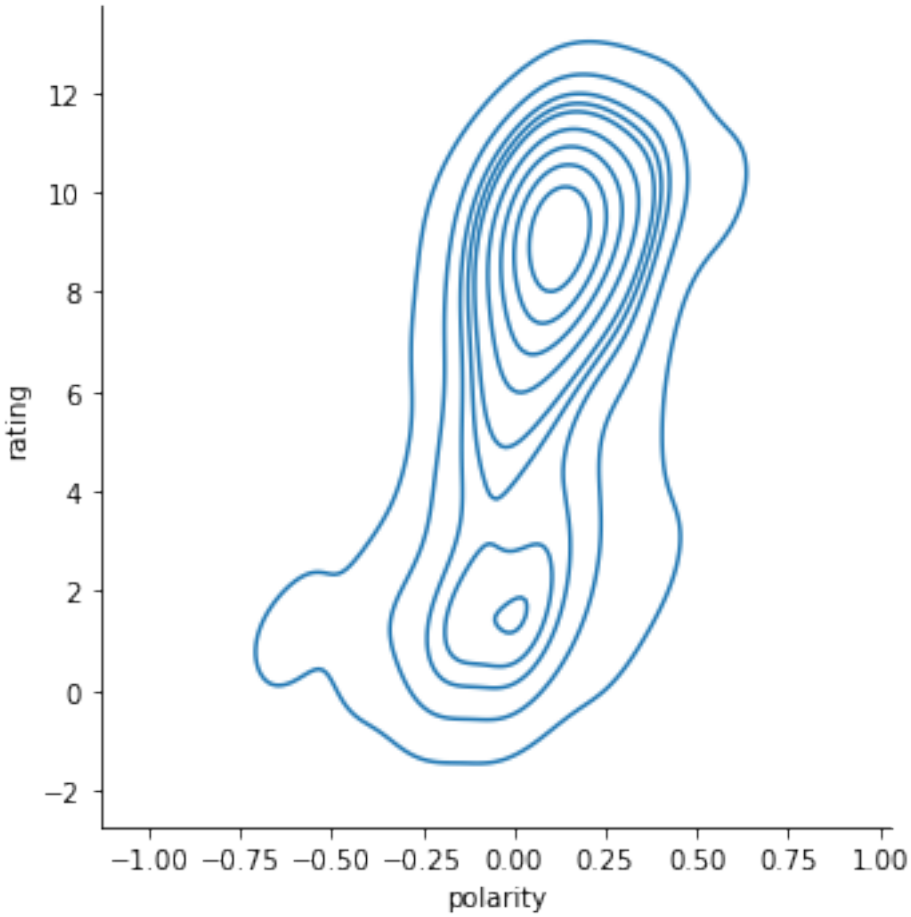
[15]:
```
<seaborn.axisgrid.FacetGrid at 0x7f8005019b80>
```



1.0.8 Density plots

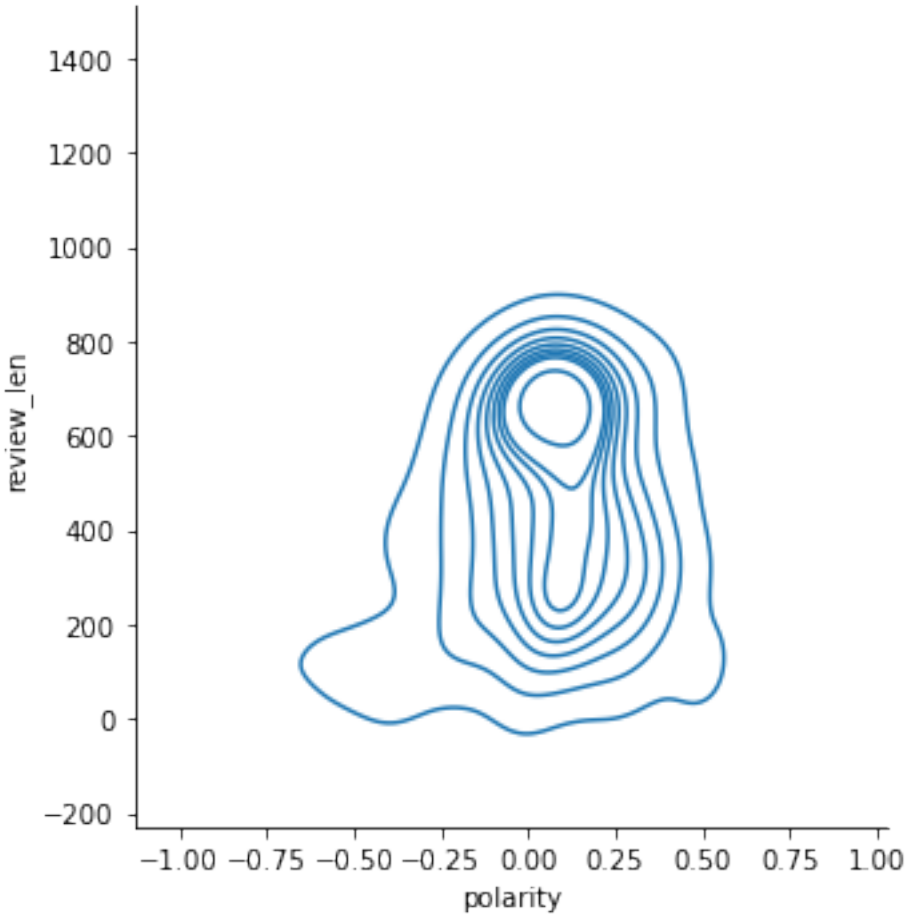
[16]:
```
sns.displot(data=latuda, x="polarity", y='rating', kind ='kde')
```

[16]:
```
<seaborn.axisgrid.FacetGrid at 0x7f8003a904f0>
```



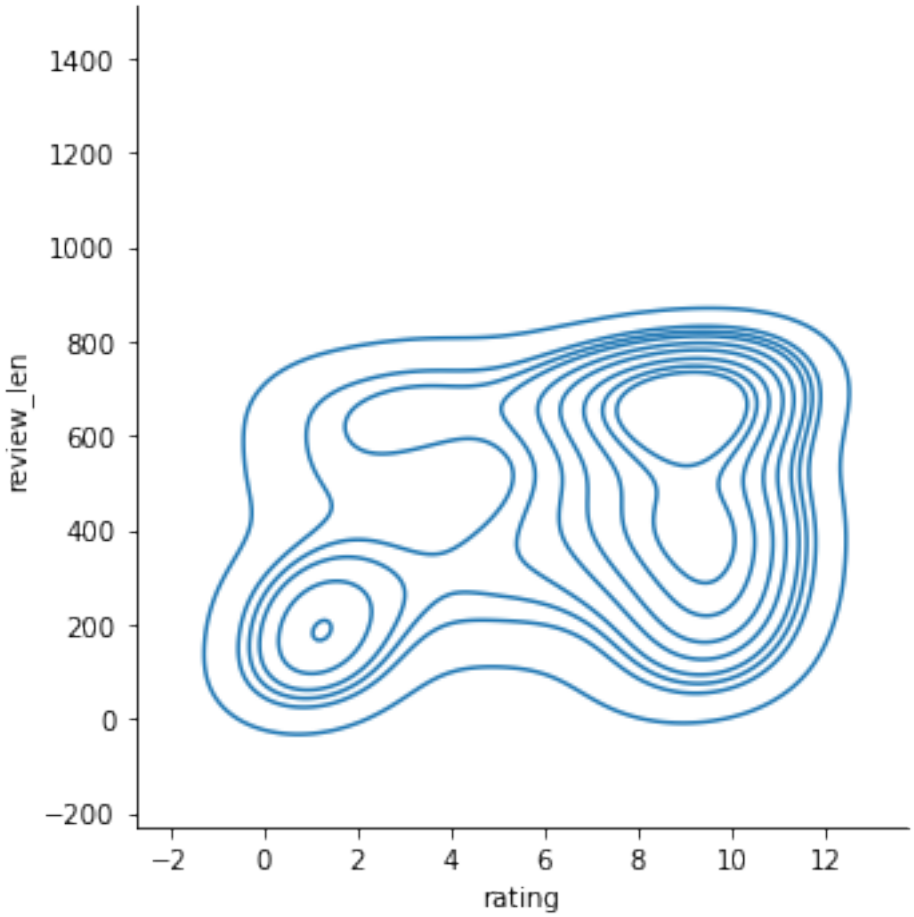
[17]:
```
sns.displot(data=latuda, x="polarity", y='review_len', kind ='kde')
```

[17]: <seaborn.axisgrid.FacetGrid at 0x7f8004fded90>



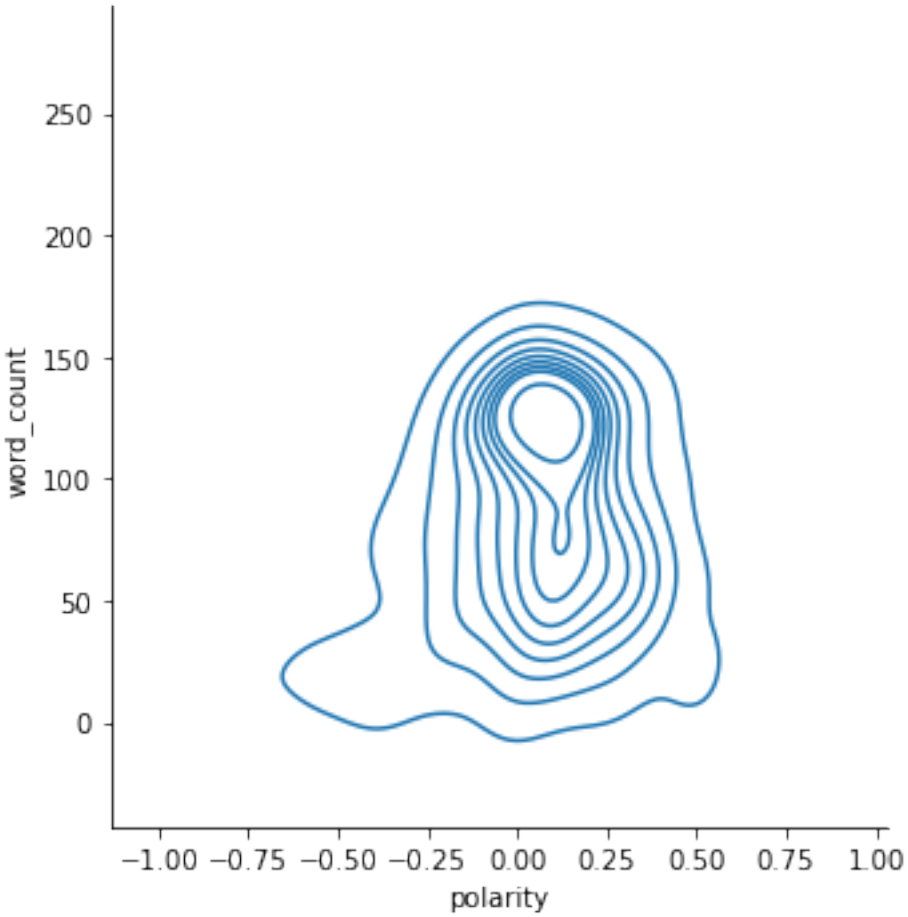
[18]:
```
sns.displot(data=latuda, x="rating", y='review_len', kind ='kde')
```

[18]: <seaborn.axisgrid.FacetGrid at 0x7f800622e2b0>



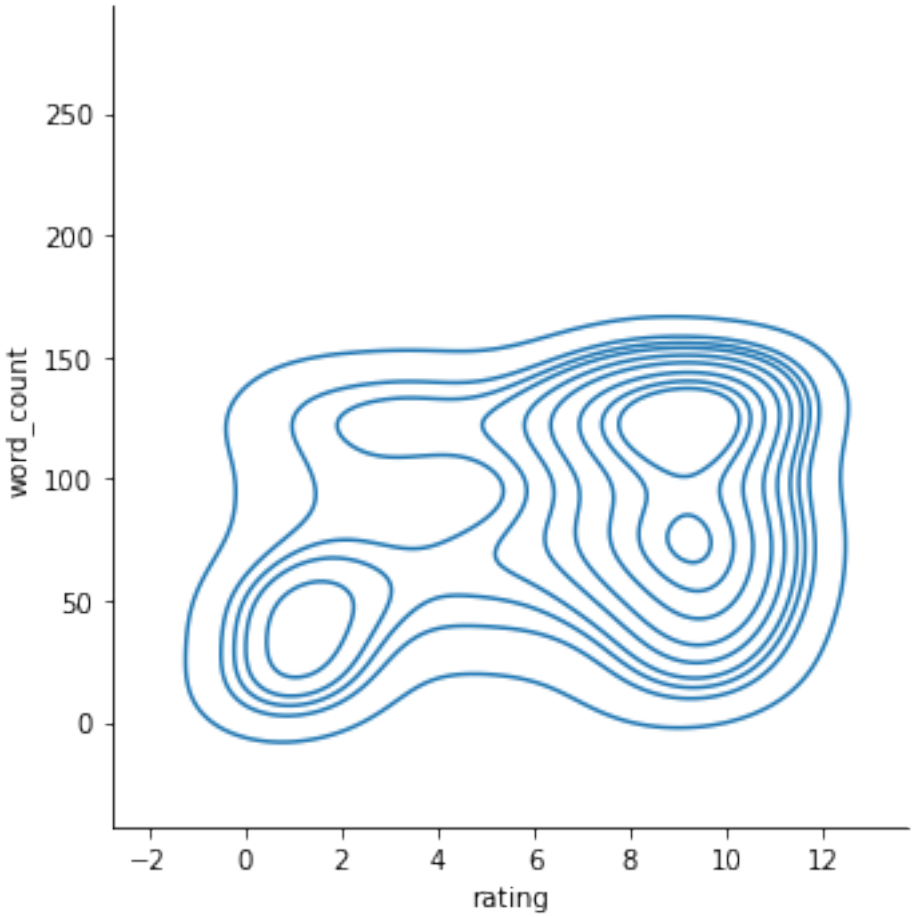
[19]:
```
sns.displot(data=latuda, x="polarity", y='word_count', kind ='kde')
```

[19]: <seaborn.axisgrid.FacetGrid at 0x7f80062e9d00>



[20]:
```
sns.displot(data=latuda, x="rating", y='word_count', kind ='kde')
```

[20]:
```
<seaborn.axisgrid.FacetGrid at 0x7f80069d05e0>
```



2 Vectorization

Vectorization - turn a list of words into an array of numbers (aka - document matrix) (See bag of words example below)

- Bag of Words:
  - A dictionary of unique words contained in the text, and then finds the count of each word within the text.
  - Does not preserve the order of the words.
- TD-IDF (term frequency-inverse document frequency):
  - Similar to BOW, except the value in each column for each row is scaled by the number of terms in the document and the relative rarity of the word.
  - Term frequency equals the number of times a word appears in a document divided by the total number of words in the document.
  - Inverse document frequency calculates the weight of rare words in all documents in the corpus, with rare words having a high IDF score, and words that are present in all documents in a corpus having IDF close to zero.
  - Allows words that have a. lot of meaning to carry more weight, even if they appear

rarely in the document.

- Word2Vec:
  - A neural network approach.
  - Calculates the cosine similarity between two words, and plots words in space so that similar words are grouped together

2.0.1 Bag of Words

[39]:
```
phrase = ['coronavirus is a highly infectious disease',
   'coronavirus affects older people the most',
   'older people are at high risk due to this disease']
cv = CountVectorizer()        # Count Vectorizer automatically tokenizes and␣
 ↪counts words
x = cv.fit_transform(phrase)  # creates the bag of words
# x is the bag of words
```

Short article on fit_transform & transform

https://towardsdatascience.com/what-and-why-behind-fit-transform-vs-transform-in-scikit-learn-78f915cf96fe

[22]:
```
x = x.toarray()
x

# Three phrases results in an array with 3 lists
# The sorted vacabulary let's us know which column is associated with each word.
# For example, column 4 is the word coronavirus.  Pharases 1 & 2 contain the␣
 ↪word coronavirus.
```

[22]:
```
array([[0, 0, 0, 1, 1, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0],
       [1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 1, 0, 0],
       [0, 1, 1, 0, 1, 1, 1, 0, 0, 0, 0, 1, 1, 1, 0, 1, 1]])
```

[23]:
```
sorted(cv.vocabulary_.keys())
```

[23]:
```
['affects',
 'are',
 'at',
 'coronavirus',
 'disease',
 'due',
 'high',
 'highly',
 'infectious',
 'is',
 'most',
 'older',
 'people',
 'risk',
```

```
 'the',
 'this',
 'to']
```

[24]:
```
cv = CountVectorizer(ngram_range=(2,2))
y = cv.fit_transform(phrase)
y = y.toarray()
y
```

[24]:
```
array([[0, 0, 0, 0, 1, 0, 0, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0],
       [1, 0, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0],
       [0, 1, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 1, 0, 1, 1]])
```

[25]:
```
sorted(cv.vocabulary_.keys())
```

[25]:
```
['affects older',
 'are at',
 'at high',
 'coronavirus affects',
 'coronavirus is',
 'due to',
 'high risk',
 'highly infectious',
 'infectious disease',
 'is highly',
 'older people',
 'people are',
 'people the',
 'risk due',
 'the most',
 'this disease',
 'to this']
```

2.1 N-grams

2.1.1 Top unigrams before removing stop words

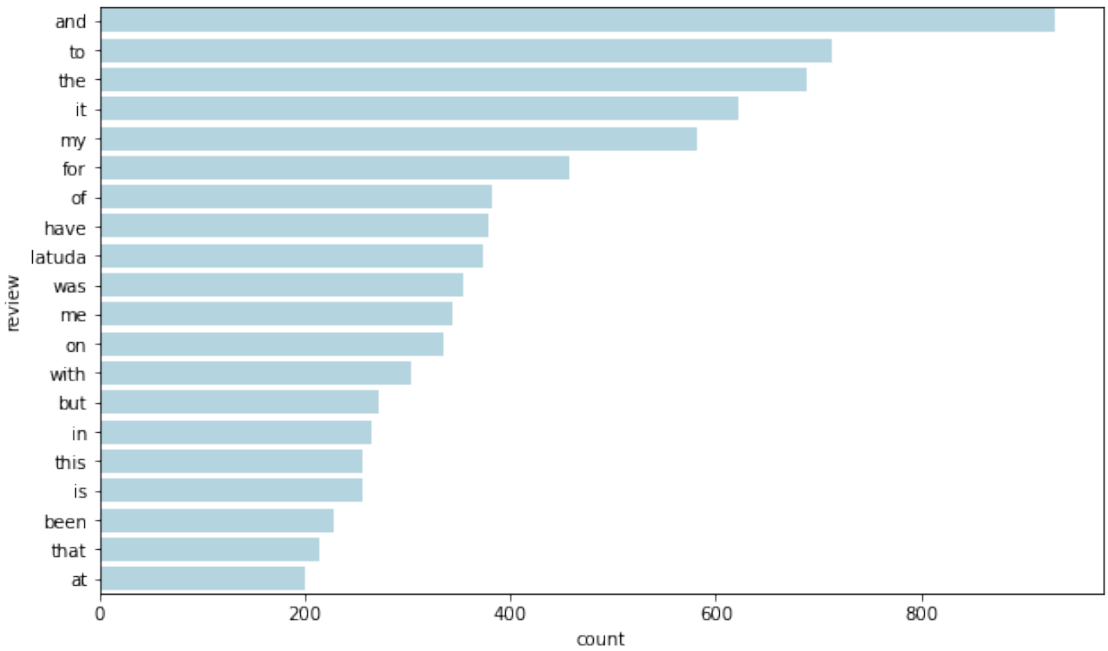
[26]:
```
def get_top_n_words(corpus, n=None):
    vec = CountVectorizer().fit(corpus)
    bag_of_words = vec.transform(corpus)
    sum_words = bag_of_words.sum(axis=0)
    words_freq = [(word, sum_words[0, idx]) for word, idx in vec.vocabulary_.
 ↪items()]
    words_freq =sorted(words_freq, key = lambda x: x[1], reverse=True)
    return words_freq[:n]
common_words = get_top_n_words(latuda['review'], 20)
for word, freq in common_words:
    print(word, freq)
```

```
df1 = pd.DataFrame(common_words, columns = ['review' , 'count'])
```

```
and 931
to 713
the 689
it 622
my 582
for 458
of 382
have 379
latuda 373
was 354
me 343
on 335
with 303
but 272
in 264
this 256
is 256
been 227
that 214
at 199
```

[27]:
```
sns.barplot(x="count", y="review", data=df1, color = 'lightblue')
```

[27]: <AxesSubplot:xlabel='count', ylabel='review'>

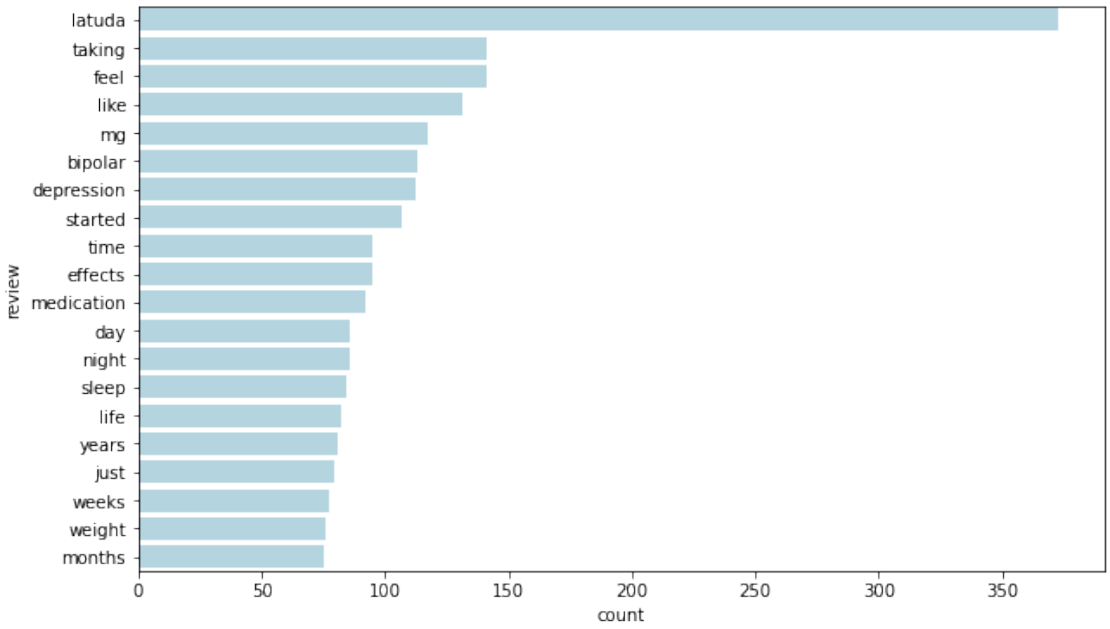


2.1.2 Top unigrams after removing stop words

[28]:
```
def get_top_n_words(corpus, n=None):
    vec = CountVectorizer(stop_words = 'english').fit(corpus)
    bag_of_words = vec.transform(corpus)
    sum_words = bag_of_words.sum(axis=0)
    words_freq = [(word, sum_words[0, idx]) for word, idx in vec.vocabulary_.
 ↪items()]
    words_freq =sorted(words_freq, key = lambda x: x[1], reverse=True)
    return words_freq[:n]
common_words = get_top_n_words(latuda['review'], 20)
#for word, freq in common_words:
#    print(word, freq)
df2 = pd.DataFrame(common_words, columns = ['review' , 'count'])
```

[29]:
```
sns.barplot(x="count", y="review", data=df2, color = 'lightblue')
```

[29]:
```
<AxesSubplot:xlabel='count', ylabel='review'>
```



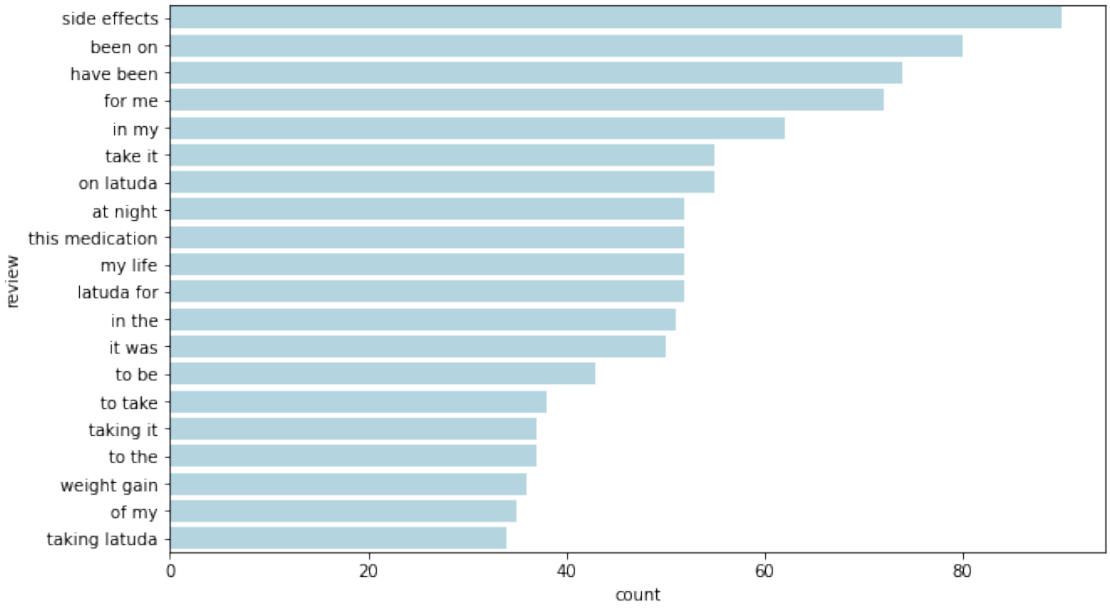
2.1.3 Top bigrams before removing stop words

[30]:
```
def get_top_n_bigram(corpus, n=None):
    vec = CountVectorizer(ngram_range=(2, 2)).fit(corpus)
    bag_of_words = vec.transform(corpus)
    sum_words = bag_of_words.sum(axis=0)
```

```
    words_freq = [(word, sum_words[0, idx]) for word, idx in vec.vocabulary_.
 ↪items()]
    words_freq =sorted(words_freq, key = lambda x: x[1], reverse=True)
    return words_freq[:n]
common_words = get_top_n_bigram(latuda['review'], 20)
#for word, freq in common_words:
#    print(word, freq)
df3 = pd.DataFrame(common_words, columns = ['review' , 'count'])
```

[31]:
```
sns.barplot(x="count", y="review", data=df3, color = 'lightblue')
```

[31]: <AxesSubplot:xlabel='count', ylabel='review'>



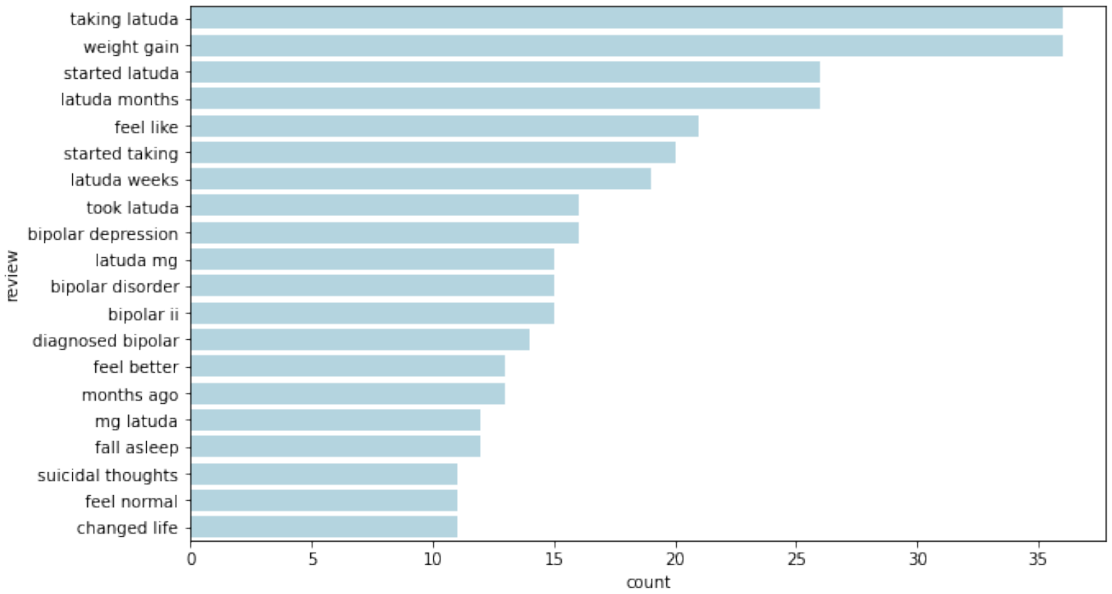
2.1.4 Top bigrams after removing stop words

[32]:
```
def get_top_n_bigram(corpus, n=None):
    vec = CountVectorizer(ngram_range=(2, 2), stop_words='english').fit(corpus)
    bag_of_words = vec.transform(corpus)
    sum_words = bag_of_words.sum(axis=0)
    words_freq = [(word, sum_words[0, idx]) for word, idx in vec.vocabulary_.
 ↪items()]
    words_freq =sorted(words_freq, key = lambda x: x[1], reverse=True)
    return words_freq[:n]
common_words = get_top_n_bigram(latuda['review'], 20)
#for word, freq in common_words:
#    print(word, freq)
```

```
df4 = pd.DataFrame(common_words, columns = ['review' , 'count'])
```

[33]:
```
sns.barplot(x="count", y="review", data=df4, color = 'lightblue')
```

[33]: <AxesSubplot:xlabel='count', ylabel='review'>

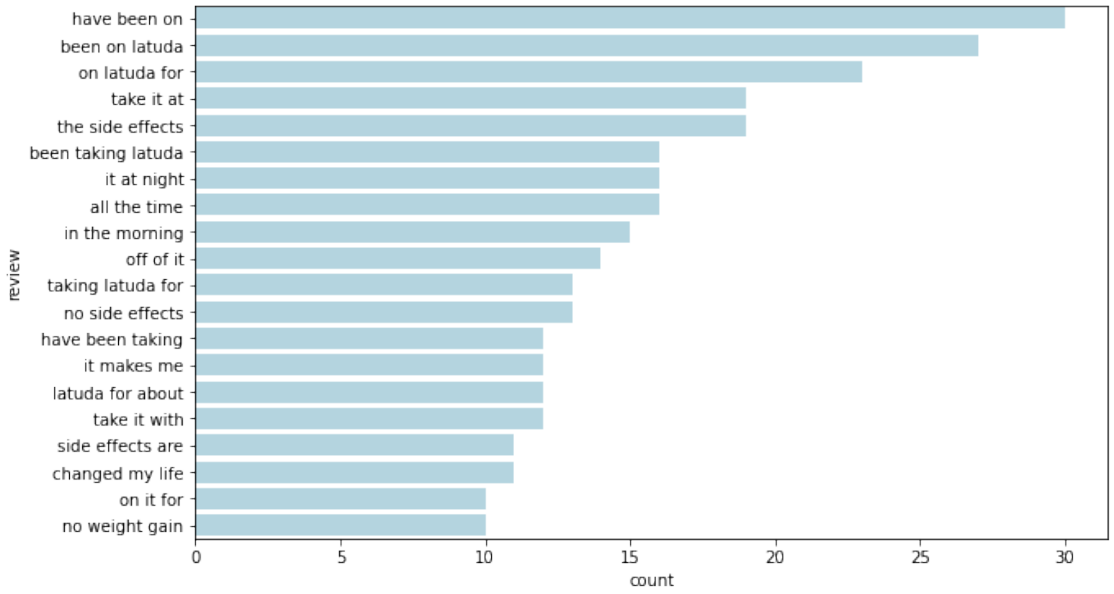


2.1.5 Top trigrams before removing stop words

[34]:
```
def get_top_n_trigram(corpus, n=None):
    vec = CountVectorizer(ngram_range=(3, 3)).fit(corpus)
    bag_of_words = vec.transform(corpus)
    sum_words = bag_of_words.sum(axis=0)
    words_freq = [(word, sum_words[0, idx]) for word, idx in vec.vocabulary_.
 ↪items()]
    words_freq =sorted(words_freq, key = lambda x: x[1], reverse=True)
    return words_freq[:n]
common_words = get_top_n_trigram(latuda['review'], 20)
#for word, freq in common_words:
#    print(word, freq)
df5 = pd.DataFrame(common_words, columns = ['review' , 'count'])
```

[35]:
```
sns.barplot(x="count", y="review", data=df5, color = 'lightblue')
```

[35]: <AxesSubplot:xlabel='count', ylabel='review'>

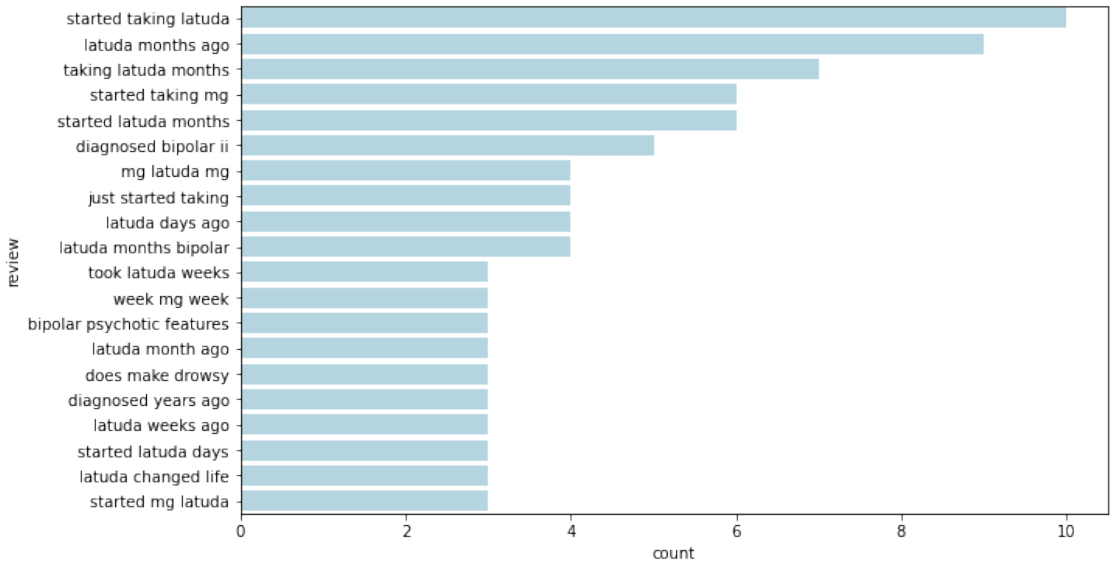


2.1.6 Top trigrams after removing stop words

[36]:
```
def get_top_n_trigram(corpus, n=None):
    vec = CountVectorizer(ngram_range=(3, 3), stop_words='english').fit(corpus)
    bag_of_words = vec.transform(corpus)
    sum_words = bag_of_words.sum(axis=0)
    words_freq = [(word, sum_words[0, idx]) for word, idx in vec.vocabulary_.
 ↪items()]
    words_freq =sorted(words_freq, key = lambda x: x[1], reverse=True)
    return words_freq[:n]
common_words = get_top_n_trigram(latuda['review'], 20)
#for word, freq in common_words:
#    print(word, freq)
df6 = pd.DataFrame(common_words, columns = ['review' , 'count'])
```

[37]:
```
sns.barplot(x="count", y="review", data=df6, color = 'lightblue')
```

[37]:
```
<AxesSubplot:xlabel='count', ylabel='review'>
```



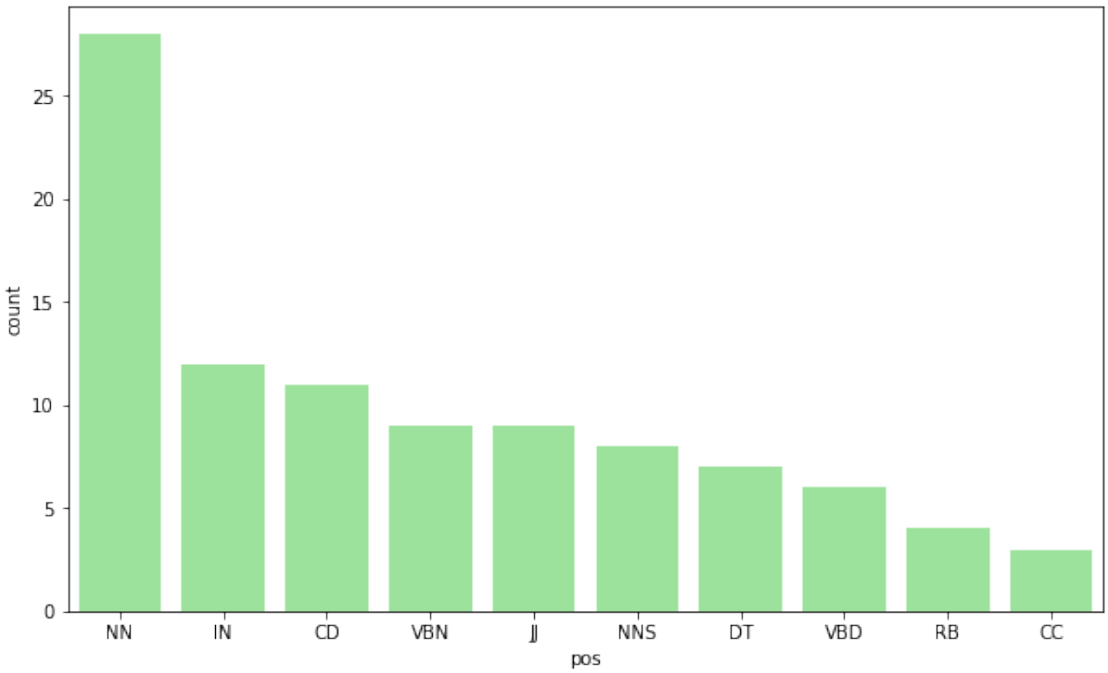
2.1.7 Top 10 Parts of Speech

- Useful because the same word with a different part of speech can have two completely different meanings
- POS tagging should be done straight after tokenization and before any words are removed so that sentence structure is preserved and it is more obvious what part of speech the word belongs to

[40]:
```
blob = TextBlob(str(latuda['review']))
pos_latuda = pd.DataFrame(blob.tags, columns = ['word' , 'pos'])
sns.countplot(x="pos", data=pos_latuda, color = 'lightgreen', order =␣
↪pos_latuda['pos'].value_counts()[:10].index)

# nltk: nltk.pos_tag(blob)
```

[40]:
```
<AxesSubplot:xlabel='pos', ylabel='count'>
```


25
20
15
10
5
0
count
NN
IN
CD
VBN
JJ
NNS
DT
VBD
RB
CC
pos

[ ]:

[ ]: