CMPE 257 - PROJECT PROPOSAL

Sentiment Analysis on Product Reviews

Dataset:
https://data.world/datafiniti/amazon-and-best-buy-electronics

GitHub Repository:
https://github.com/Tejasree-Goli/CMPE-257-Project.git

Google Colab [.ipynb]:
https://colab.research.google.com/drive/17iAiIujSmmJuZwQQZOBg-jefQna6B18g?usp=sharing

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Project Title: Sentiment Analysis on Product Reviews

Dataset Source: **https://data.world/datafiniti/amazon-and-best-buy-electronics**

The above data set is taken from Data World [primary source: Datafiniti's Product Database]. The dataset contains around 7200 online reviews posted on e-commerce websites like Amazon, BestBuy and Walmart for various brand products. The data set reviews about 50 electronic products that contain 27 different attributes including reviews title, reviews text, reviews username, reviews rating, product name, manufacturer, brand, image URLs etc.

Problem Statement:

The world is drastically shifting towards the era of online shopping and social media. People find it extremely feasible and less time-consuming to shop online by just sitting and shopping for anything and everything they need from the comfort of their homes. This leads to minimal customer-manufacturer interaction and for this reason, it raises a concern for the suppliers to figure out their product performance and analyze feedback. A manufacturer requires constant feedback on how their products are doing in the market and the level of customer satisfaction that they are delivering.

Therefore, to address this, we have a need for text and sentiment analysis of consumer feedback and product reviews that are purchased by consumers on online platforms. This approach will help in categorizing data based on certain attributes which will make it easier to analyze and observe the trends/reviews of products.

Project Idea:

1. **Objective:** To determine whether a review on a given product is positive or negative by analyzing the text in user reviews on various products and performing a binary classification of each product's reviews.

2. **Approach:** We will be implementing our model on supervised learning methods using word embeddings to predict or classify different sentiments. We plan on experimenting and exploring the data using KNN, SVMs, Random Forest Classifier or different BERT architectures.

   a. **Data Cleaning and Preprocessing:** The raw data is cleaned by removing the rows which have null values for the columns: reviews.rating, reviews.title and reviews.text columns. The duplicate records in the dataset have been dropped. Stopwords have been removed using the Natural Language Toolkit (NLTK) module.

b. **Initial Findings:** Post data visualization, we observed the frequently used words by consumers in the reviews, the frequency of the ratings, the average rating of various brands and the correlation between variables in the data. The reviews are mostly positive, even on the brand/manufacturer level. Moreover, the text reviews are significantly higher for positive ratings and most of the products are recommended by the users which shows an incline towards higher positive ratings in the data.

c. **Challenges:** There is an imbalance in the dataset with a majority of positive ratings. Also, for the negative ratings, the review texts are minimal.

CMPE_257_project_proposal

November 2, 2022

1 Sentiment Analysis on Product Reviews.

Mounting drive for the colab notebook

[1]:
```python
#Mounting the drive for the colab notebook
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call
drive.mount("/content/drive", force_remount=True).
```

Importing the required libraries

[2]:
```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import plotly.tools as tls
import plotly.offline as py
import plotly.graph_objs as go
import warnings

# NLP modules
import nltk
import re
import string
from nltk.corpus import stopwords
from stop_words import get_stop_words
from nltk.stem.porter import PorterStemmer
from textblob import TextBlob , Word
from nltk.stem import WordNetLemmatizer
from nltk.tokenize import word_tokenize

# Wordcloud Modules
from wordcloud import WordCloud , STOPWORDS
```

[3]:
```python
color = sns.color_palette()
warnings.filterwarnings('ignore')
py.init_notebook_mode(connected=True)
```

```python
nltk.download("stopwords")
nltk.download("all")
```

```
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[nltk_data]    | Downloading package senseval to /root/nltk_data…
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[nltk_data]  Done downloading collection all
```

```
[3]: True
```

1.1 Understanding data

Load/Read the dataset

```
[4]: reviews_df=pd.read_csv('/content/drive/MyDrive/amazon_dataset/product.csv')
     reviews_df.head(5)
```

```
[4]:                      id       asins      brand  \
     0  AVpf3txeLJeJML43FN82  B0168YIWSI  Microsoft
     1  AVpf3txeLJeJML43FN82  B0168YIWSI  Microsoft
     2  AVpf3txeLJeJML43FN82  B0168YIWSI  Microsoft
     3  AVpf3txeLJeJML43FN82  B0168YIWSI  Microsoft
     4  AVpf3txeLJeJML43FN82  B0168YIWSI  Microsoft

                                               categories colors  \
     0  Electronics,Computers,Computer Accessories,Key…  Black
     1  Electronics,Computers,Computer Accessories,Key…  Black
     2  Electronics,Computers,Computer Accessories,Key…  Black
     3  Electronics,Computers,Computer Accessories,Key…  Black
     4  Electronics,Computers,Computer Accessories,Key…  Black

                   dateAdded           dateUpdated                   dimension  \
     0  2015-11-13T12:28:09Z  2018-01-29T02:15:13Z  11.6 in x 8.5 in x 0.19 in
     1  2015-11-13T12:28:09Z  2018-01-29T02:15:13Z  11.6 in x 8.5 in x 0.19 in
     2  2015-11-13T12:28:09Z  2018-01-29T02:15:13Z  11.6 in x 8.5 in x 0.19 in
     3  2015-11-13T12:28:09Z  2018-01-29T02:15:13Z  11.6 in x 8.5 in x 0.19 in
     4  2015-11-13T12:28:09Z  2018-01-29T02:15:13Z  11.6 in x 8.5 in x 0.19 in

                 ean                                        imageURLs  …  \
     0  8.900000e+11  https://i5.walmartimages.com/asr/2a41f6f0-844e…  …
     1  8.900000e+11  https://i5.walmartimages.com/asr/2a41f6f0-844e…  …
     2  8.900000e+11  https://i5.walmartimages.com/asr/2a41f6f0-844e…  …
     3  8.900000e+11  https://i5.walmartimages.com/asr/2a41f6f0-844e…  …
     4  8.900000e+11  https://i5.walmartimages.com/asr/2a41f6f0-844e…  …

       reviews.doRecommend reviews.numHelpful reviews.rating  \
     0                True                0.0            5.0
     1                True                0.0            4.0
     2                True                0.0            4.0
     3                True                0.0            5.0
     4                True                0.0            5.0

                                      reviews.sourceURLs  \
     0  http://reviews.bestbuy.com/3545/4562009/review…
     1  http://reviews.bestbuy.com/3545/4562009/review…
     2  http://reviews.bestbuy.com/3545/4562009/review…
     3  http://reviews.bestbuy.com/3545/4562009/review…
     4  http://reviews.bestbuy.com/3545/4562009/review…

                                            reviews.text  \
     0  This keyboard is very easy to type on, but the…
     1  It's thin and light. I can type pretty easily …
     2  I love the new design the keys are spaced well…
     3  Attached easily and firmly. Has a nice feel. A…
```

```
4  Our original keyboard was okay, but did not ha…

                 reviews.title reviews.username  \
0  Love the fingerprint reader             JNH1
1                         Nice             Appa
2                          New             Kman
3                 Nice keyboard        UpstateNY
4              Nice improvement        Glickster

                                          sourceURLs           upc      weight
0  https://www.walmart.com/ip/Microsoft-Surface-P…  8.900000e+11  1.1 pounds
1  https://www.walmart.com/ip/Microsoft-Surface-P…  8.900000e+11  1.1 pounds
2  https://www.walmart.com/ip/Microsoft-Surface-P…  8.900000e+11  1.1 pounds
3  https://www.walmart.com/ip/Microsoft-Surface-P…  8.900000e+11  1.1 pounds
4  https://www.walmart.com/ip/Microsoft-Surface-P…  8.900000e+11  1.1 pounds

[5 rows x 27 columns]
```

Shape of the dataframe

[5]:
```
reviews_df.shape
```

[5]:
```
(7299, 27)
```

There are 27 columns and a total of 7299 rows in this dataset.

[6]:
```
#Columns/attributes and their datatypes
reviews_df.dtypes
```

[6]:
```
id                        object
asins                     object
brand                     object
categories                object
colors                    object
dateAdded                 object
dateUpdated               object
dimension                 object
ean                      float64
imageURLs                 object
keys                      object
manufacturer              object
manufacturerNumber        object
name                      object
primaryCategories         object
reviews.date              object
reviews.dateSeen          object
reviews.doRecommend       object
reviews.numHelpful       float64
reviews.rating         float64
reviews.sourceURLs      object
reviews.text            object
reviews.title           object
reviews.username        object
sourceURLs              object
upc                    float64
weight                  object
dtype: object
```

The columns reflect on different attributes that are useful in understanding the reviews on products. We mainly look at the brand manufacturers, recommendations, ratings, and user reviews for different products sold on Amazon, Ebay, etc.

1.2 Data Cleaning and preprocessing

[7]:

```
reviews_df.isnull().sum()
```

[7]:

```
id                        0
asins                     0
brand                     0
categories                0
colors                 2019
dateAdded                 0
dateUpdated               0
dimension              1209
ean                    4348
imageURLs                 0
keys                      0
manufacturer           2667
manufacturerNumber        0
name                      0
primaryCategories         0
reviews.date             61
reviews.dateSeen          0
reviews.doRecommend    1391
reviews.numHelpful     1486
reviews.rating          164
reviews.sourceURLs        0
reviews.text              5
reviews.title             4
reviews.username          0
sourceURLs                0
upc                       0
weight                    0
dtype: int64
```

We look at the null values in the data to drop them. The fields that are most used for sentiment classification in the data are user review in text and the rating of the product. All the null values are dropped.

```
[8]: reviews_df = reviews_df.dropna(subset=['reviews.text']) #dropping null reviews
     reviews_df = reviews_df.dropna(subset=['reviews.rating']) #dropping null ratings
```

```
[9]: reviews_df.shape
```

```
[9]: (7130, 27)
```

Then we get rid of the duplicate values in the text. We match the text of the review, rating, username and the date when the review was posted to identify the duplicate values and drop them.

```
[10]: reviews_df.duplicated(subset=['reviews.text', 'reviews.username', 'reviews.
        ↪rating', 'reviews.date']).sum()
```

```
[10]: 14
```

```
[11]: reviews_df=reviews_df.drop_duplicates(subset=['reviews.text', 'reviews.
        ↪username', 'reviews.rating', 'reviews.date'])
```

```
[12]: reviews_df.shape
```

```
[12]: (7116, 27)
```

After dropping null values and duplicate entries, there are now 7116 rows in the data.

We then convert our reviews to all lowercase text and remove the unnecessary string literals from the text for proper preprocessing. This is done to avoid having different representations of the same word in the vector space. We remove the stopwords in order to remove the low level information from our text and give more focus to the important information.

```
[13]: reviews_df["reviews.text"] = (
          reviews_df["reviews.text"]
          .str.lower()
          .str.replace("[^\w\s]", "")
          .str.replace("\d+", "")
          .str.replace("\n", " ")
          .replace("\r", "")
          .str.replace("[^a-zA-Z0-9\s]", "")
      )
```

```
[14]: def word_cleaner(data):
          words = [re.sub("[^a-zA-Z]", " ", i) for i in data]
          words = [i.lower() for j in words for i in j.split()] # Split all the␣
        ↪sentences into words
          words = [i for i in words if not i in set(stopwords.words("english"))] #␣
        ↪Split all the sentences into words
```

```
    return words
```

We identify the most common used words in the text to analyze them in product reviews and plot the frequency of these words. The words such as “great” and “remote” are used frequently in the reviews.

[15]:

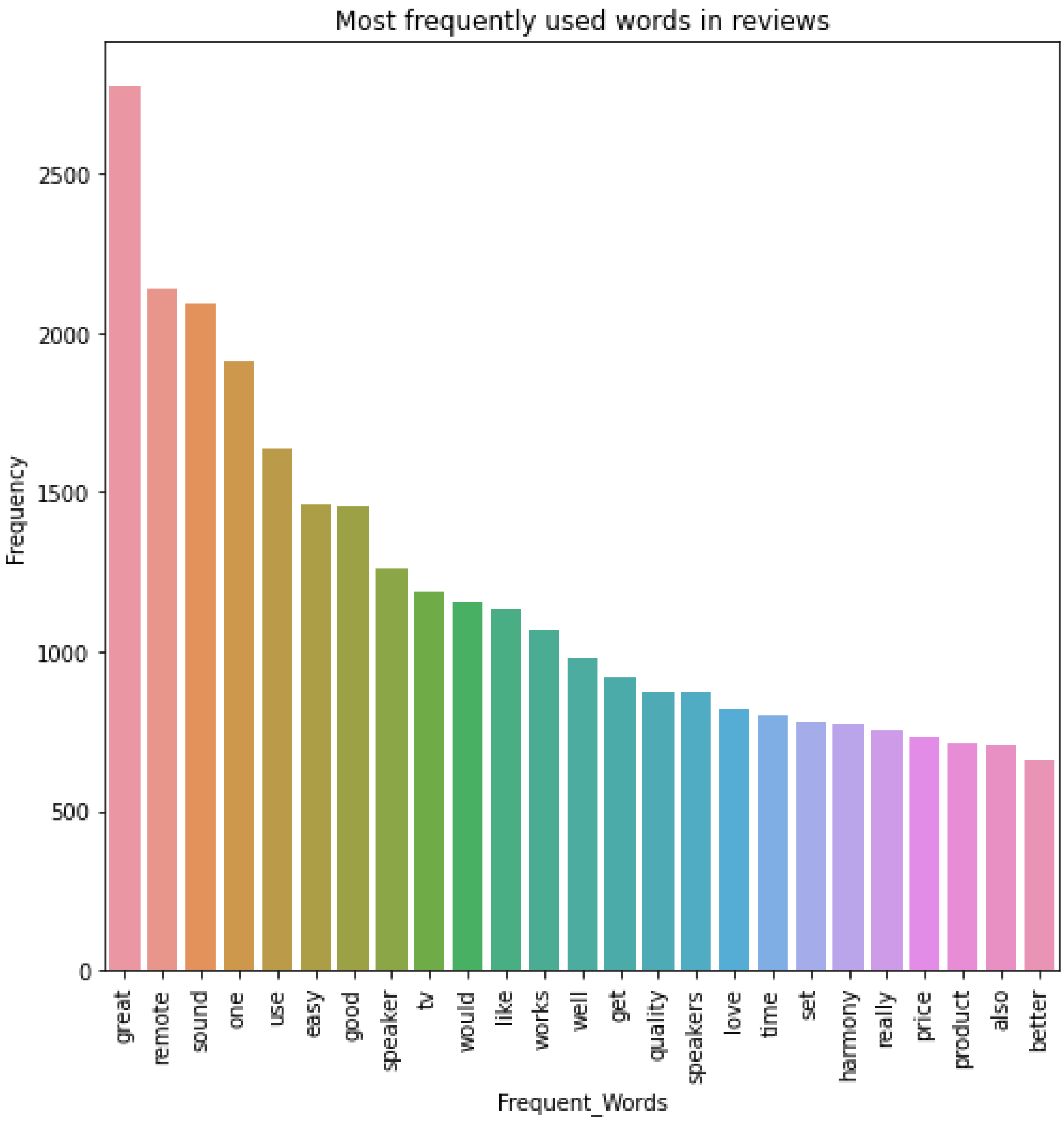
```
word_frequency = pd.DataFrame(
    nltk.FreqDist(word_cleaner(reviews_df["reviews.text"])).most_common(25),
    columns=["Frequent_Words", "Frequency"],
)
```

[16]:

```
plt.figure(figsize=(8, 8))
plt.xticks(rotation=90)
plt.title("Most frequently used words in reviews")
sns.barplot(x="Frequent_Words", y="Frequency", data=word_frequency)
```

[16]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f3359c75c90>
```



```
[17]: lemmatizer_output = WordNetLemmatizer()

      reviews_df["reviews.text"] = reviews_df["reviews.text"].apply(
          lambda x: word_tokenize(x.lower())
      )
      reviews_df["reviews.text"] = reviews_df["reviews.text"].apply(
          lambda x: [word for word in x if word not in STOPWORDS]
      )
      reviews_df["reviews.text"] = reviews_df["reviews.text"].apply(
          lambda x: [lemmatizer_output.lemmatize(word) for word in x]
      )
```

```
reviews_df["reviews.text"] = reviews_df["reviews.text"].apply(lambda x: " ".
 ↪join(x))
```

[18]:

```
reviews_df['reviews.text'].head(10)
```

[18]:

```
0    keyboard easy type fingerprint reader best fea…
1                        thin light type pretty easily
2    love new design key spaced well mi type finger…
3    attached easily firmly nice feel must surface pro
4    original keyboard okay laptop feel bit floppy …
5    purchased replace original surface pro keyboar…
6      find comfortable type rarely use fingerprint id
7    good keyboard addition surface pro platform de…
8    tough getting work surface pro worked bug love…
9    now quickly hassle free log surface finger pri…
Name: reviews.text, dtype: object
```

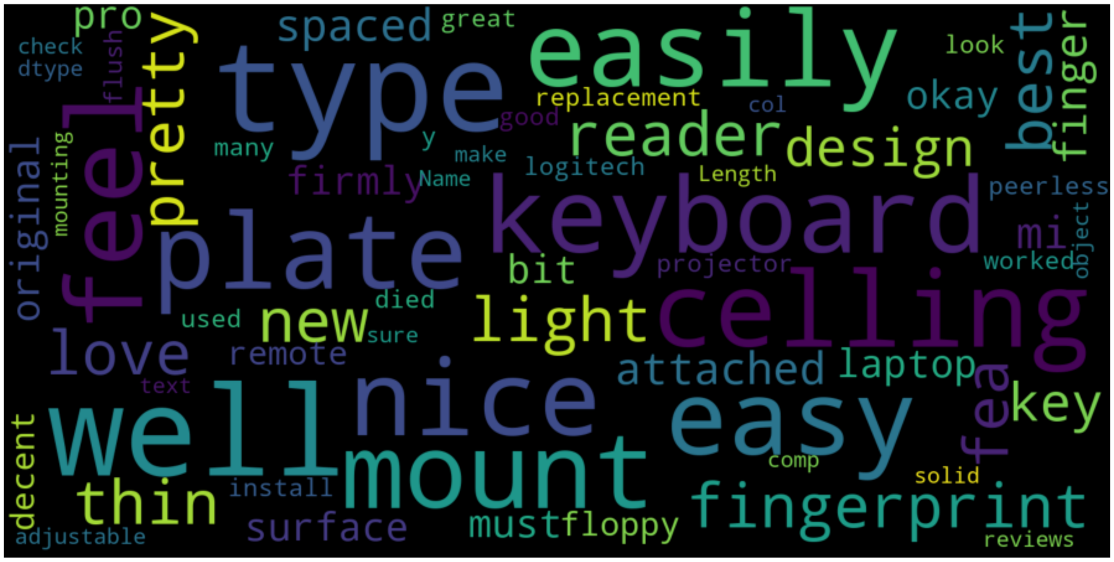
1.3 Visualization

A word cloud can be considered as a snapshot of the text. It is useful in understanding the text at a glance.

[19]:

```
from wordcloud import WordCloud, STOPWORDS

stopwords = set(STOPWORDS)


def show_wordcloud(data, title=None):
    wordcloud = WordCloud(
        background_color="black",
        stopwords=stopwords,
        max_words=250,
        max_font_size=45,
        scale=4,
        random_state=1,
    ).generate(str(data))

    fig = plt.figure(1, figsize=(16, 16))
    plt.axis("off")
    if title:
        fig.suptitle(title, fontsize=21)
        fig.subplots_adjust(top=2.1)

    plt.imshow(wordcloud)
    plt.show()
```

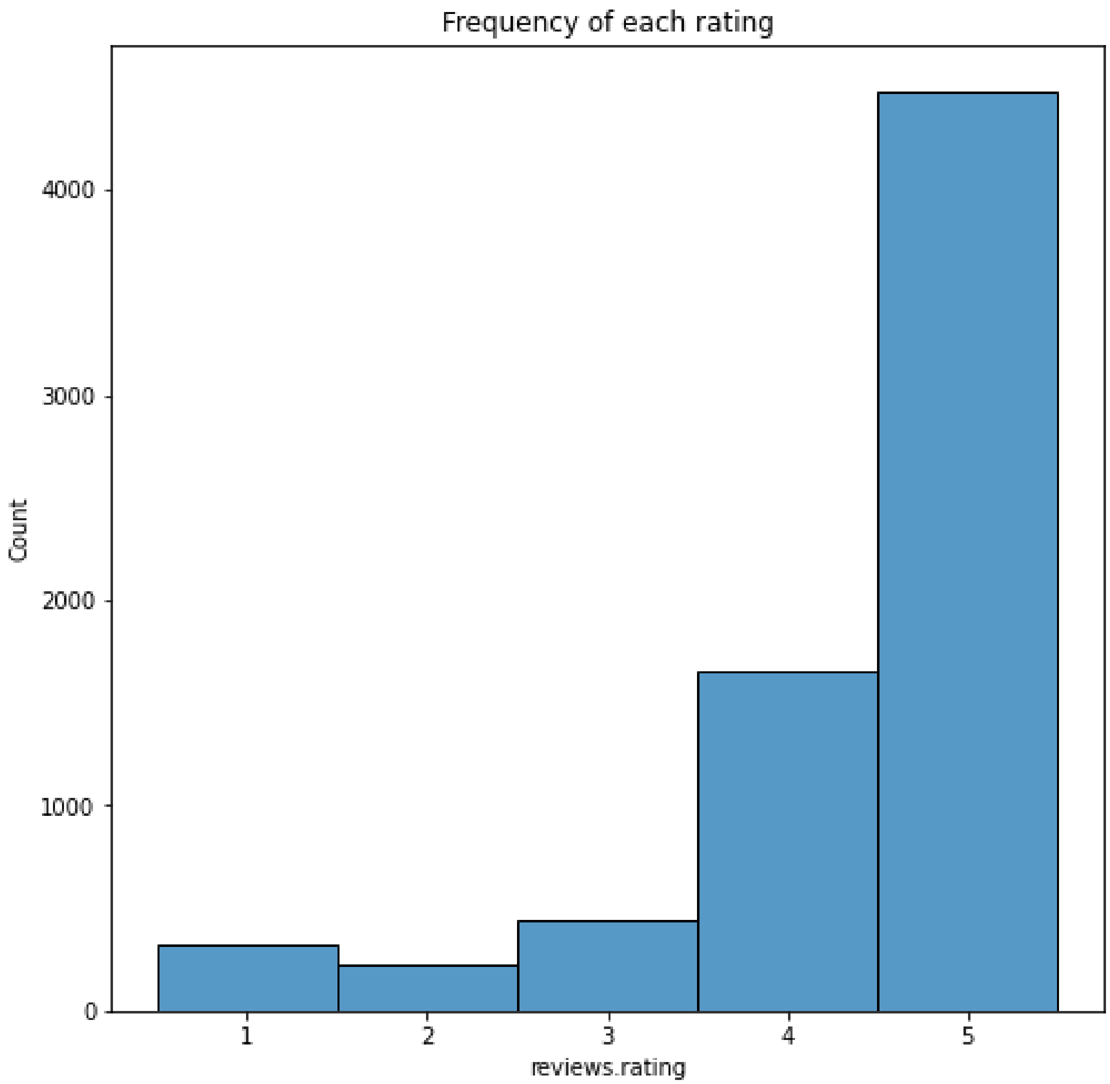
```
show_wordcloud(reviews_df["reviews.text"])
```



Plotting the frequency of ratings from 0 stars to 5 stars.

[20]:
```
plt.figure(figsize=(8,8))
sns.histplot(data=reviews_df, x=reviews_df['reviews.rating'], discrete="True").
 ↪set(title = "Frequency of each rating")
```

[20]:
```
[Text(0.5, 1.0, 'Frequency of each rating')]
```



The distribution here is mostly positive (4 and 5 stars) and implies that the customers are happy with the products they purchase.

We also look at the reviews of each brand. When predicting the sentiment labels for customer satisfaction, this could be useful to understand the customer satisfaction for a particular brand.

```
[21]: #review by brand
      reviews_df.groupby(reviews_df['brand']).mean()['reviews.rating']
```

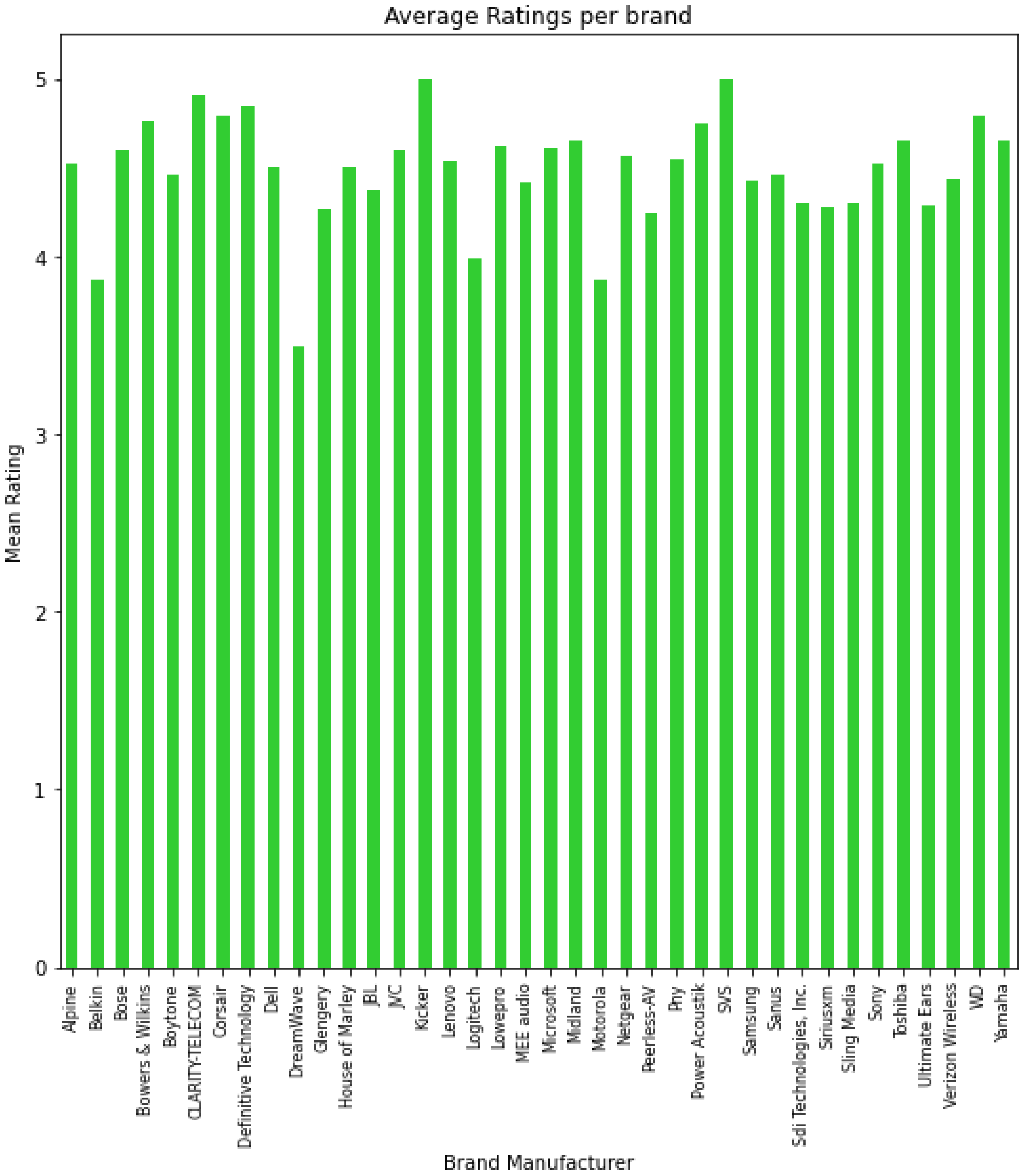
```
[21]: brand
      Alpine                    4.526923
      Belkin                    3.875000
      Bose                      4.600000
      Bowers & Wilkins          4.766355
```

```
Boytone                     4.459459
CLARITY-TELECOM             4.909091
Corsair                     4.798246
Definitive Technology       4.851852
Dell                        4.500000
DreamWave                   3.500000
Glengery                    4.263158
House of Marley             4.500000
JBL                         4.370044
JVC                         4.604478
Kicker                      5.000000
Lenovo                      4.535714
Logitech                    3.992908
Lowepro                     4.625954
MEE audio                   4.412903
Microsoft                   4.606061
Midland                     4.659091
Motorola                    3.868421
Netgear                     4.570470
Peerless-AV                 4.250000
Pny                         4.549738
Power Acoustik              4.750000
SVS                         5.000000
Samsung                     4.423445
Sanus                       4.456790
Sdi Technologies, Inc.      4.298701
Siriusxm                    4.277778
Sling Media                 4.301170
Sony                        4.522705
Toshiba                     4.652174
Ultimate Ears               4.290000
Verizon Wireless            4.435714
WD                          4.796296
Yamaha                      4.657143
Name: reviews.rating, dtype: float64
```

[22]:

```
reviews_df = reviews_df.replace(np.nan, 0)
reviews_dfm = reviews_df.groupby(reviews_df["brand"]).mean()["reviews.rating"]
plt.title("Average Ratings per brand")
plt.xticks(fontsize=8)
reviews_dfm.plot(
    kind="bar",
    ylabel="Mean Rating",
    xlabel="Brand Manufacturer",
    figsize=(9, 9),
    color="limegreen",
)
```

```
[22]: <matplotlib.axes._subplots.AxesSubplot at 0x7f3357e36450>
```

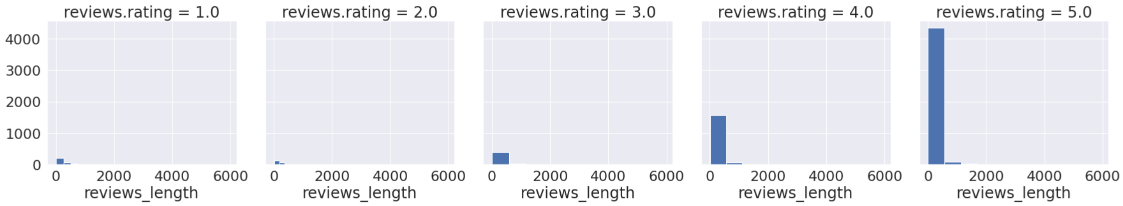


To understand the data, we plot the graphs for length of text in reviews. The users tend to give little or no written review for low ratings. For high ratings, the average review length is about 60 to 80.

```
[23]: reviews_df["reviews_length"] = reviews_df["reviews.text"].apply(len)
      sns.set(font_scale=2.0)
```

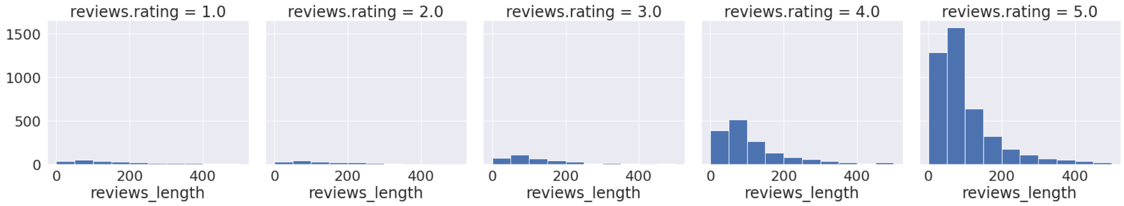
```
graph = sns.FacetGrid(reviews_df, col="reviews.rating", size=5)
graph.map(plt.hist, "reviews_length")
```

```
[23]: <seaborn.axisgrid.FacetGrid at 0x7f3357f23890>
```



```
[24]: graph = sns.FacetGrid(reviews_df,col='reviews.rating',size=5)
      graph.map(plt.hist,'reviews_length', range=[0, 500])
```

```
[24]: <seaborn.axisgrid.FacetGrid at 0x7f3357936890>
```

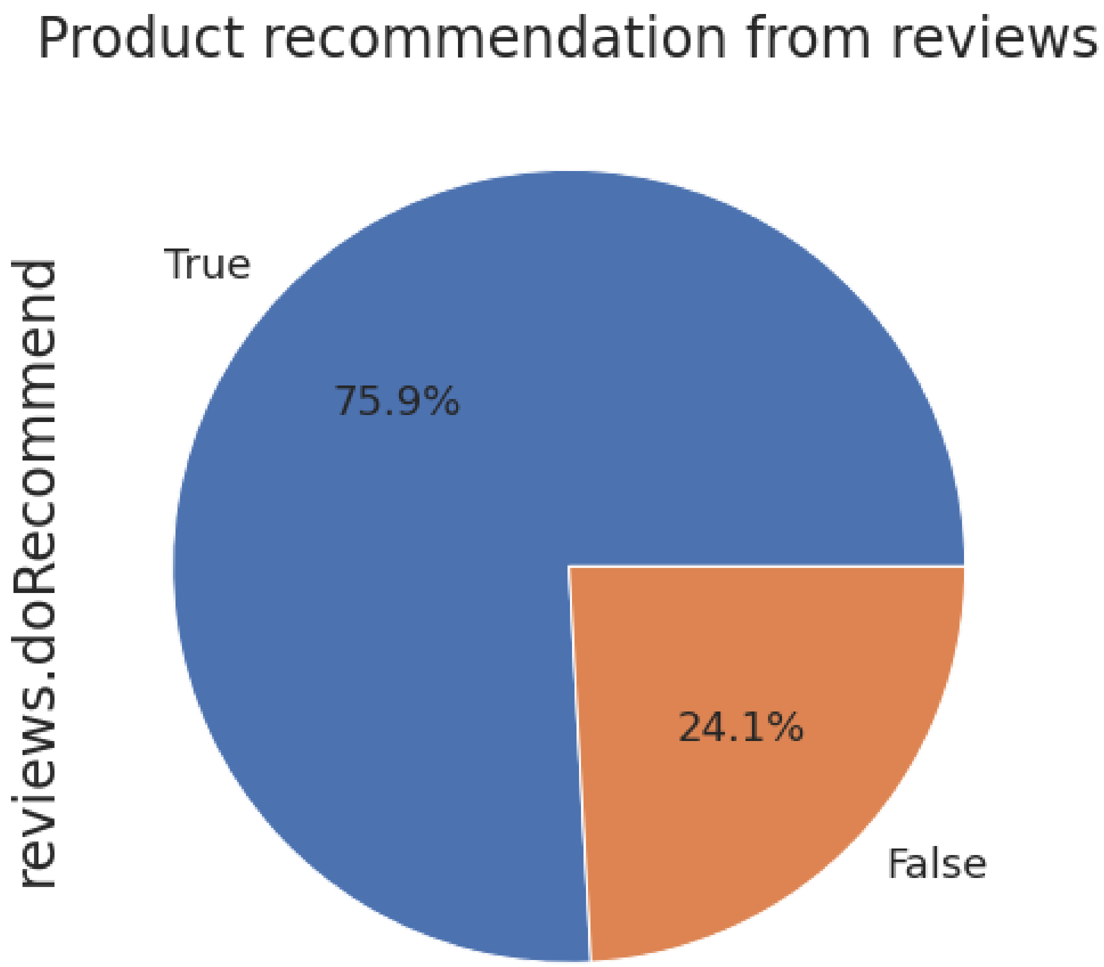


Product recommendation by the users or the e-commerce sites such as Amazon and Ebay also gives information about the customer satisfaction. From the pie plot that is shown below, the recommendations are fairly positive.

```
[25]: reviews_df['reviews.doRecommend'].fillna("N/A",inplace=True)
```

```
[26]: plt.figure(figsize = (8,8))
      plt.title("Product recommendation from reviews")
      reviews_df["reviews.doRecommend"].value_counts().plot.pie(autopct="%1.
       ↪1f%%",textprops={'fontsize': 18})
```

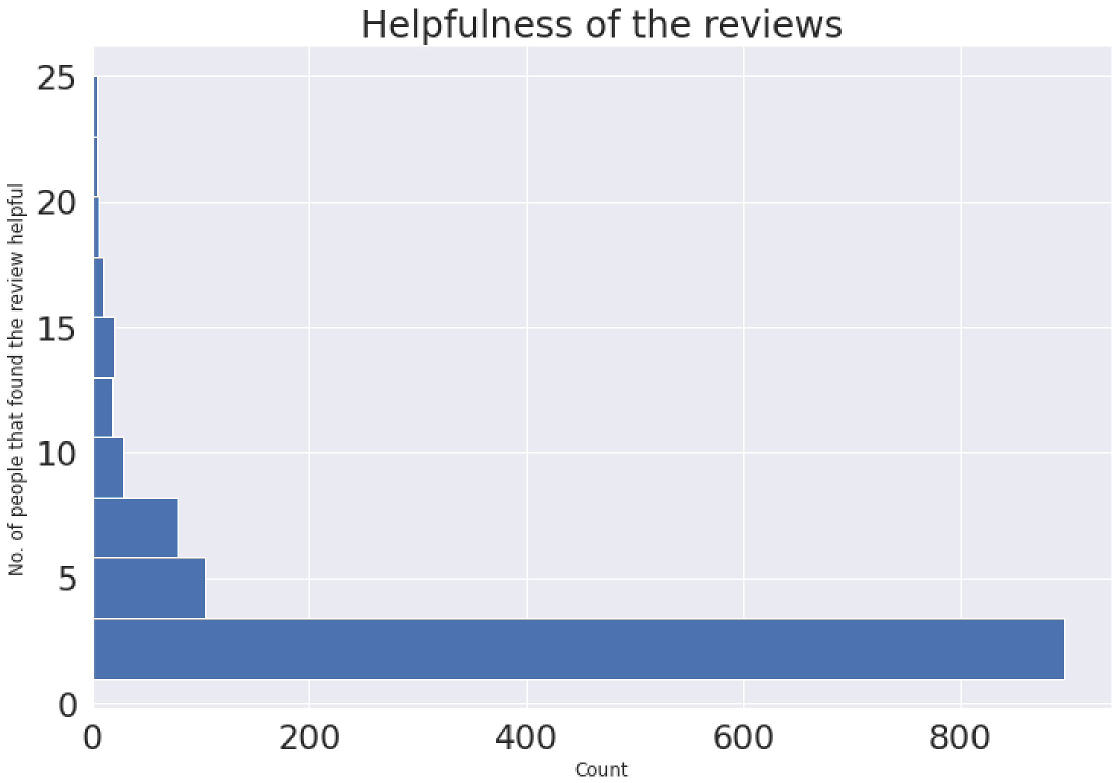
```
[26]: <matplotlib.axes._subplots.AxesSubplot at 0x7f33579a6050>
```



Plotting the count of reviews that are found useful to others when shopping online.

```
[27]: plt.figure(figsize=(12,8))
      plt.hist(reviews_df['reviews.numHelpful'],range=[1, 25],␣
       ↪orientation='horizontal')
      plt.title("Helpfulness of the reviews")
      plt.xlabel("Count", fontsize=12)
      plt.ylabel("No. of people that found the review helpful", fontsize=12)
```

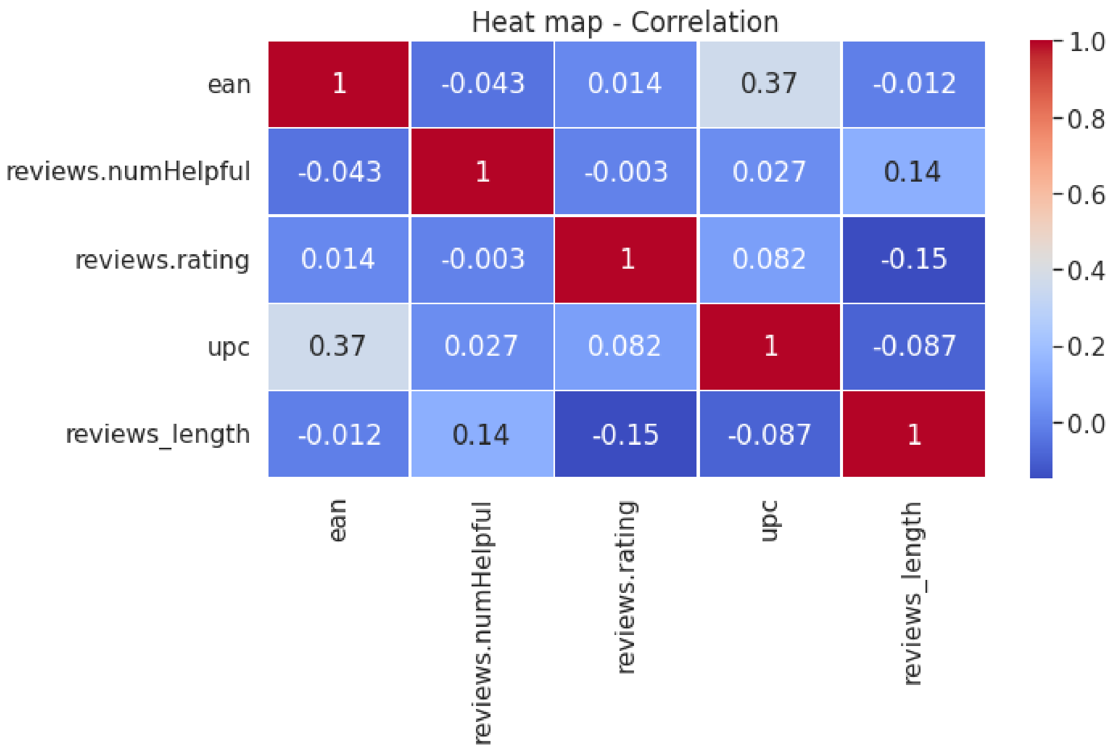
```
[27]: Text(0, 0.5, 'No. of people that found the review helpful')
```



Correlation measures the strength of the relationship between different variables in the data. When a value of one variable changes, it effects the other variable in a certain way.

```
[28]: sns.set(font_scale=1.4)
      plt.figure(figsize = (10,5))
      plt.title("Heat map - Correlation")
      sns.heatmap(reviews_df.corr(),cmap='coolwarm',annot=True,linewidths=.5)
```

```
[28]: <matplotlib.axes._subplots.AxesSubplot at 0x7f3357984690>
```


Heat map - Correlation
ean
reviews.numHelpful
reviews.rating
upc
reviews_length
1
-0.043
0.014
0.37
-0.012
-0.043
1
-0.003
0.027
0.14
0.014
-0.003
1
0.082
-0.15
0.37
0.027
0.082
1
-0.087
-0.012
0.14
-0.15
-0.087
1
ean
reviews.numHelpful
reviews.rating
upc
reviews_length
1.0
0.8
0.6
0.4
0.2
0.0

[ ]: