```
# IMPORTING ALL THE NECESSARY LIBRARIES

import matplotlib.pyplot as plt
import seaborn as sns
import pandas as pd
import string
import nltk
nltk.download('wordnet')
nltk.download('stopwords')
nltk.download('stopwords')
nltk.download('punkt')
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer, WordNetLemmatizer
import re
from wordcloud import WordCloud
from collections import Counter
from nltk.util import ngrams
from nltk.tokenize import word_tokenize
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.feature_extraction.text import ENGLISH_STOP_WORDS
import scipy.stats as stats
```

```
[nltk_data] Downloading package wordnet to /root/nltk_data...
[nltk_data]   Package wordnet is already up-to-date!
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Package punkt is already up-to-date!
```

```
# FIRST GLIMPSE OF THE DATA
df = pd.read_csv('McDonald_s_Reviews.csv', encoding="ISO-8859-1")
df.head()
```

```
   reviewer_id  store_name              category  \
0            1  McDonald's  Fast food restaurant
1            2  McDonald's  Fast food restaurant
2            3  McDonald's  Fast food restaurant
3            4  McDonald's  Fast food restaurant
4            5  McDonald's  Fast food restaurant

                                       store_address  latitude 
longitude  \
0  13749 US-183 Hwy, Austin, TX 78750, United States  30.460718 -
97.792874
1  13749 US-183 Hwy, Austin, TX 78750, United States  30.460718 -
97.792874
2  13749 US-183 Hwy, Austin, TX 78750, United States  30.460718 -
97.792874
```

```
3  13749 US-183 Hwy, Austin, TX 78750, United States  30.460718 -
97.792874
4  13749 US-183 Hwy, Austin, TX 78750, United States  30.460718 -
97.792874

  rating_count   review_time  \
0        1,240  3 months ago
1        1,240    5 days ago
2        1,240    5 days ago
3        1,240   a month ago
4        1,240  2 months ago

                                              review   rating
0  Why does it look like someone spit on my food?...   1 star
1  It'd McDonalds. It is what it is as far as the...  4 stars
2  Made a mobile order got to the speaker and che...   1 star
3  My mc. Crispy chicken sandwich was ï¿½ï¿½ï¿½ï¿...  5 stars
4  I repeat my order 3 times in the drive thru, a...   1 star
```

```
# PERFORMING INITIAL INSPECTION
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 33396 entries, 0 to 33395
Data columns (total 10 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   reviewer_id    33396 non-null  int64
 1   store_name     33396 non-null  object
 2   category       33396 non-null  object
 3   store_address  33396 non-null  object
 4   latitude       32736 non-null  float64
 5   longitude      32736 non-null  float64
 6   rating_count   33396 non-null  object
 7   review_time    33396 non-null  object
 8   review         33396 non-null  object
 9   rating         33396 non-null  object
dtypes: float64(2), int64(1), object(7)
memory usage: 2.5+ MB
```

```
# RATING COLUMN IS OF TYPE OBJECT. CONVERTING THAT TO NUMBERS
df['rating'].unique()
```

```
array(['1 star', '4 stars', '5 stars', '2 stars', '3 stars'],
dtype=object)
```

```
df['rating'] = df['rating'].apply(lambda x: int(x[0]))

df.head()
```

```
   reviewer_id  store_name              category  \
0            1  McDonald's  Fast food restaurant
1            2  McDonald's  Fast food restaurant
2            3  McDonald's  Fast food restaurant
3            4  McDonald's  Fast food restaurant
4            5  McDonald's  Fast food restaurant

                                       store_address  latitude 
longitude  \
0  13749 US-183 Hwy, Austin, TX 78750, United States  30.460718 -
97.792874
1  13749 US-183 Hwy, Austin, TX 78750, United States  30.460718 -
97.792874
2  13749 US-183 Hwy, Austin, TX 78750, United States  30.460718 -
97.792874
3  13749 US-183 Hwy, Austin, TX 78750, United States  30.460718 -
97.792874
4  13749 US-183 Hwy, Austin, TX 78750, United States  30.460718 -
97.792874

  rating_count   review_time  \
0        1,240  3 months ago
1        1,240    5 days ago
2        1,240    5 days ago
3        1,240   a month ago
4        1,240  2 months ago

                                              review  rating
0  Why does it look like someone spit on my food?...       1
1  It'd McDonalds. It is what it is as far as the...       4
2  Made a mobile order got to the speaker and che...       1
3  My mc. Crispy chicken sandwich was ï¿½ï¿½ï¿½ï¿...       5
4  I repeat my order 3 times in the drive thru, a...       1
```

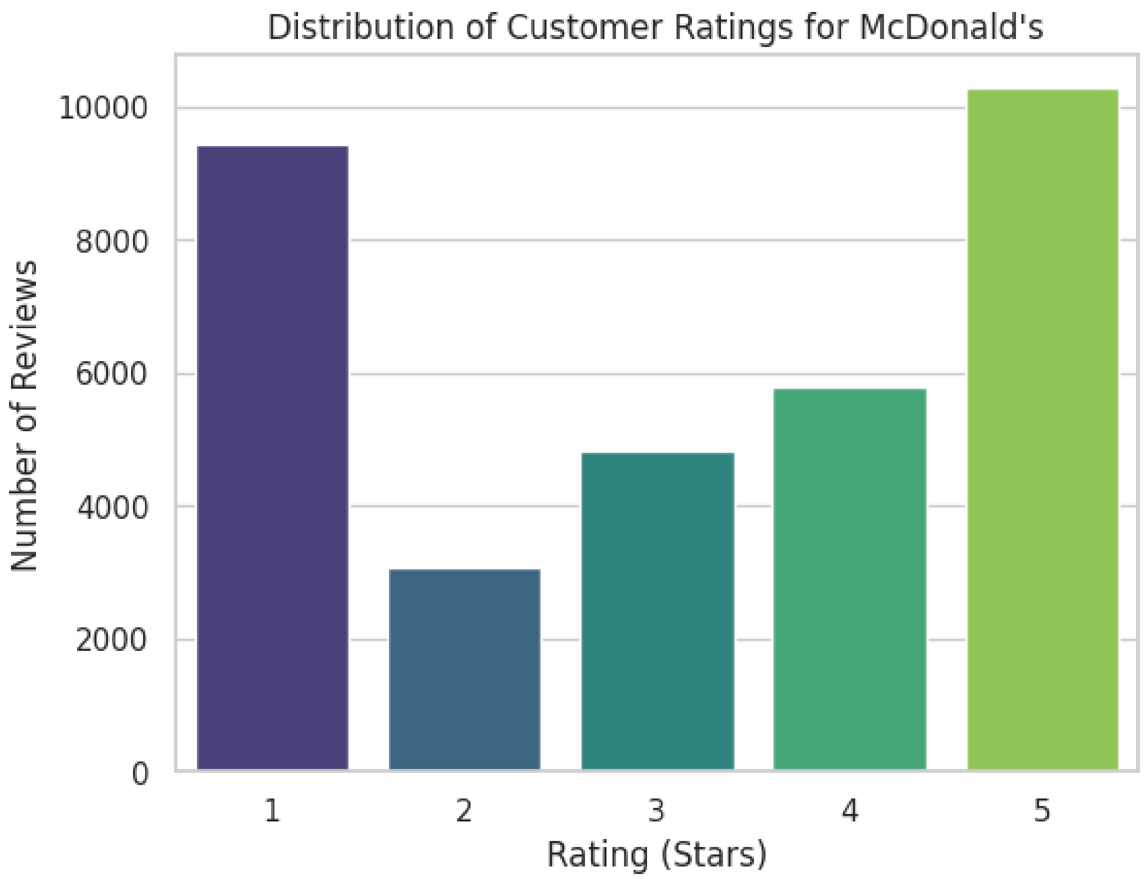
```
# ANALYSING FOR THE LENGTH OF THE DATAFRAME
print('Number of unique values in each columns')
for column in list(df.columns):
    print(f'{column} : {df[column].nunique()}')
```

```
Number of unique values in each columns
reviewer_id : 33396
store_name : 2
category : 1
store_address : 40
latitude  : 39
longitude : 39
rating_count : 51
review_time : 39
review : 22285
rating : 5
```

```
# DROPPING THE UNNECESSARY COLUMNS
df.drop(columns =
['reviewer_id','store_name','category','store_address','latitude
','longitude','review_time','rating_count'], axis = 1, inplace = True)

df.head()
```

```
                                              review  rating
0  Why does it look like someone spit on my food?...       1
1  It'd McDonalds. It is what it is as far as the...       4
2  Made a mobile order got to the speaker and che...       1
3  My mc. Crispy chicken sandwich was ï¿½ï¿½ï¿½ï¿...       5
4  I repeat my order 3 times in the drive thru, a...       1
```

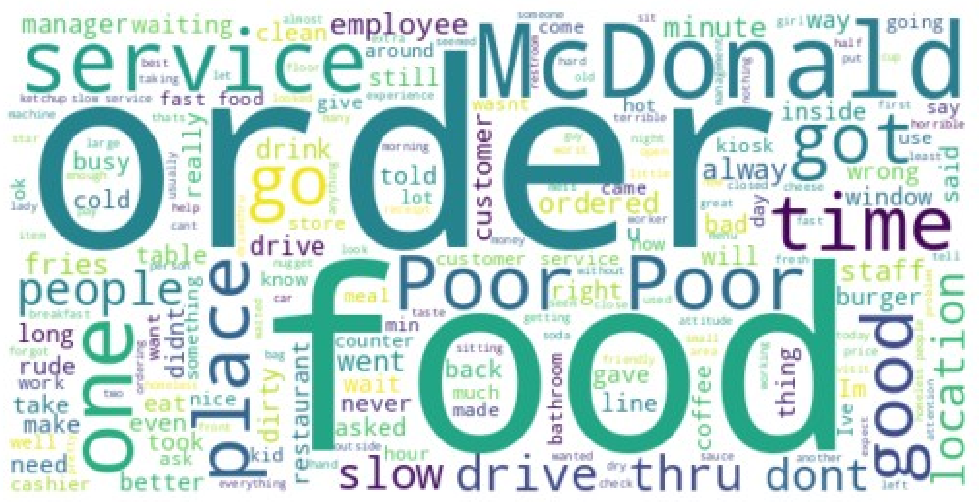
```
# DATA CLEANING

def cleanText(text):

    # REMOVING PUNCTUATIONS
    text = text.translate(str.maketrans('', '', string.punctuation))

    # REMOVING NON ALPHA-NUMERIC CHARACTERS
    text = re.sub(r'[^a-zA-Z0-9\s]', '', text)

    # CONVERTING TEXT TO LOWER CASE
    text = text.lower()

    # TOKENIZING THE TEXT
    words = text.split()

    # PERFORMING LEMMATIZATION
    lemma = WordNetLemmatizer()
    words = [lemma.lemmatize(word) for word in words]

    # STEMMING
    stemmer = PorterStemmer()
    words = [stemmer.stem(word) for word in words]

    # REMOVING STOPWORDS
    stopWords = set(stopwords.words('english'))
    words = [word for word in words if word not in stopWords]

    return " ".join(words)

# CREATING A COLUMN AND ADDING BACK
df['cleanReview'] = df['review'].apply(cleanText)

# DATA CLEANING

def cleanText(text):
    # REMOVING NON ALPHA-NUMERIC CHARACTERS
    text = re.sub(r'[^a-zA-Z0-9\s]', '', text)
    return text

# CREATING A COLUMN AND ADDING BACK
df['reviewForBERT'] = df['review'].apply(cleanText)

df.head()

                                              review  rating  \
0  Why does it look like someone spit on my food?...       1
1  It'd McDonalds. It is what it is as far as the...       4
2  Made a mobile order got to the speaker and che...       1
3  My mc. Crispy chicken sandwich was ï¿½ï¿½ï¿½ï¿...       5
4  I repeat my order 3 times in the drive thru, a...       1

                                         cleanReview  \
0  whi doe look like someon spit food normal tran...
1  itd mcdonald far food atmospher go staff doe m...
2  made mobil order got speaker check line wa mov...
3  mc crispi chicken sandwich wa custom servic wa...
4  repeat order 3 time drive thru still manag mes...

                                       reviewForBERT
0  Why does it look like someone spit on my food\...
1  Itd McDonalds It is what it is as far as the f...
2  Made a mobile order got to the speaker and che...
3  My mc Crispy chicken sandwich was  customer se...
4  I repeat my order 3 times in the drive thru an...

# VIISUALIZING TO GET TO KNOW THE DATA MORE
sns.set(style="whitegrid")
sns.countplot(x='rating', data=df, palette="viridis")
plt.title('Distribution of Customer Ratings for McDonald\'s')
plt.xlabel('Rating (Stars)')
plt.ylabel('Number of Reviews')
plt.show()
```



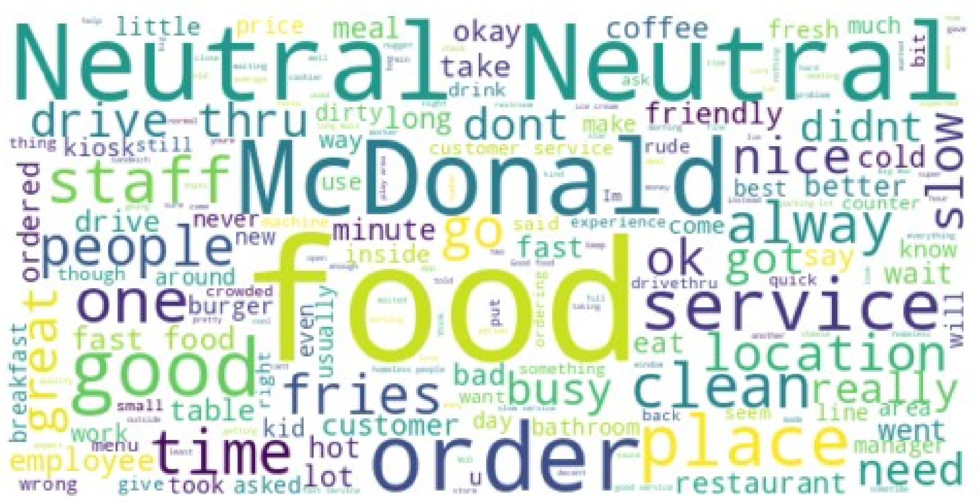
```python
# FUNCTION TO CREATE WORD CLOUD
def createWordCloud(text):
    wordcloud = WordCloud(width=600, height=300, 
background_color='white').generate(text)
    plt.imshow(wordcloud, interpolation='bilinear')
    plt.axis('off')
    plt.show()

textForWordCloud = ' '.join(review for review in df['reviewForBERT'])
createWordCloud(textForWordCloud)
```

```
for i in range(1, 6):
    textForWordCloud = ' '
    for index, row in df.iterrows():
        if row['rating'] == i:
            textForWordCloud += row['reviewForBERT'] + ' '
    createWordCloud(textForWordCloud)
    print(f'WORDCLOUD FOR RATING{i}')
```

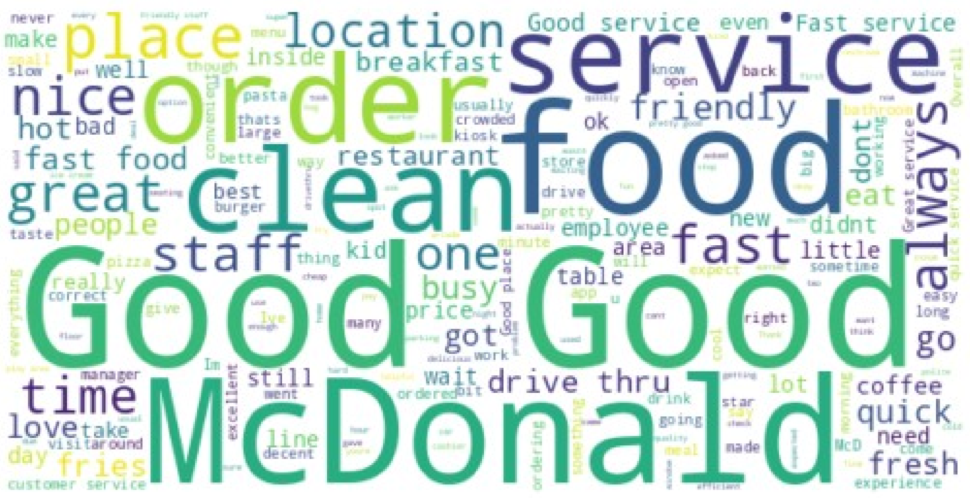
```
WORDCLOUD FOR RATING1
```



```
WORDCLOUD FOR RATING2
```

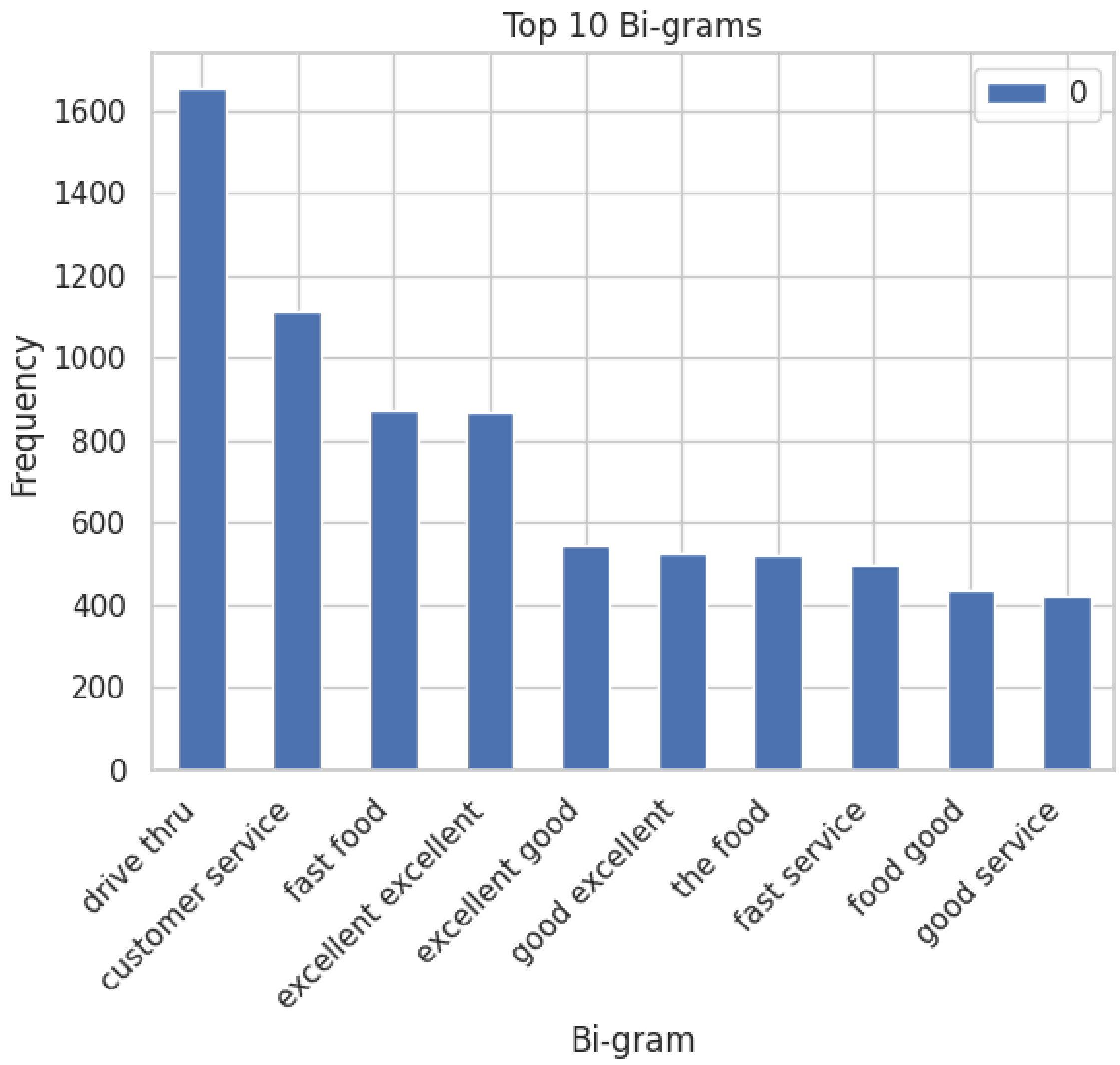


```
WORDCLOUD FOR RATING3
```



```
WORDCLOUD FOR RATING4
```

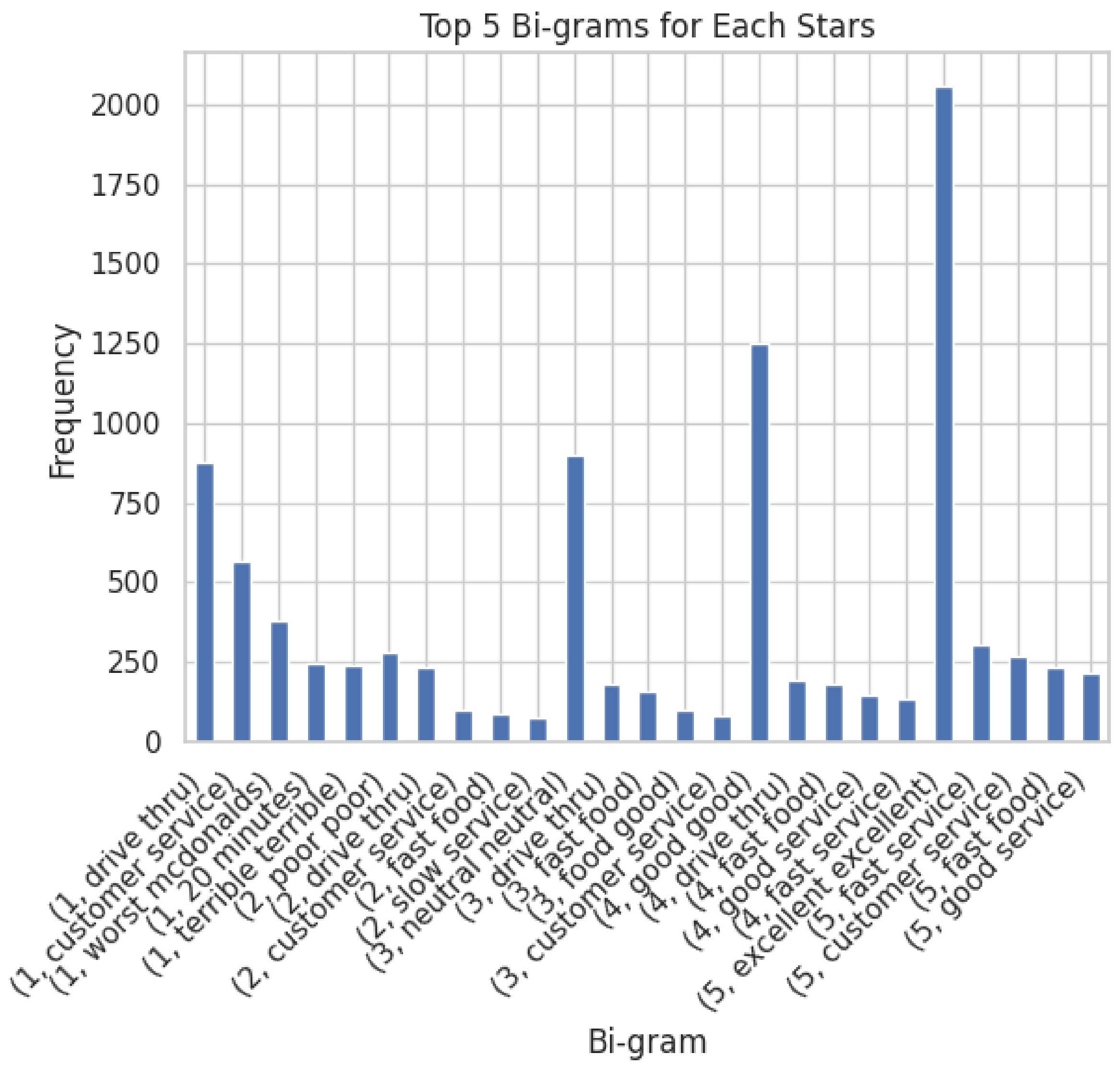
```
WORDCLOUD FOR RATING5

df.to_csv('topicModelling.csv', index = False)

textForNGram = ""
stopWords = set(stopwords.words('english'))
for _,row in df.iterrows():
  for word in row['reviewForBERT'].split():
    if word not in stopWords:
      textForNGram += word + ' '

# BI-GRAM ANALYSIS
vectorizer = CountVectorizer(ngram_range=(2, 2))
ngrams = vectorizer.fit_transform([textForNGram])
ngramsFreq = pd.DataFrame(ngrams.sum(axis=0),
columns=vectorizer.get_feature_names_out()).T.sort_values(0,
ascending=False)
top_10_bigrams = ngramsFreq.head(10)

# Plotting the top 10 trigrams
top_10_bigrams.plot(kind='bar')
plt.title('Top 10 Bi-grams')
plt.xlabel('Bi-gram')
plt.xticks(rotation=45, ha='right')
plt.ylabel('Frequency')
plt.show()
```



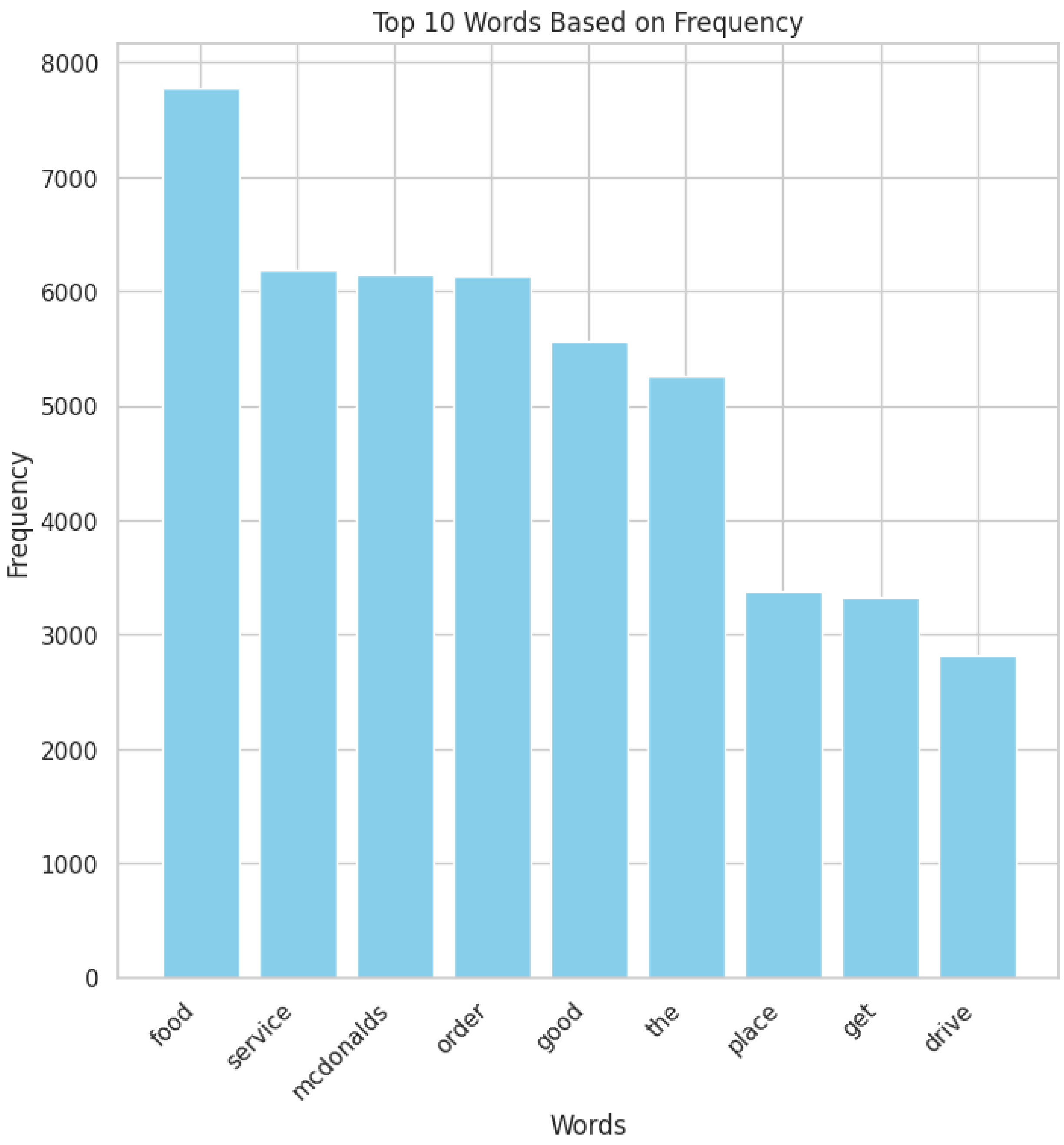
```
# Function to remove stop words and get top bigrams
def get_top_bigrams(texts):
    text_for_ngram = ""
    stop_words = set(stopwords.words('english'))
```

```python
    # Remove stop words for each review
    for review in texts:
        for word in review.split():
            if word.lower() not in stop_words:
                text_for_ngram += word + ' '

    # Get top bigrams
    vectorizer = CountVectorizer(ngram_range=(2, 2))
    ngrams = vectorizer.fit_transform([text_for_ngram])
    ngrams_freq = pd.DataFrame(ngrams.sum(axis=0),
columns=vectorizer.get_feature_names_out()).T.sort_values(0,
ascending=False)
    top_10_bigrams = ngrams_freq.head(5)

    return top_10_bigrams

# Apply the function to each star rating group
grouped = df.groupby('rating')['reviewForBERT'].apply(lambda x:
get_top_bigrams(x))

# Plotting the top 5 bigrams for each group
for star_rating, top_bigrams in grouped.iteritems():
    top_bigrams.plot(kind='bar')
    plt.title(f'Top 5 Bi-grams for Each Stars')
    plt.xlabel('Bi-gram')
    plt.xticks(rotation=45, ha='right')
    plt.ylabel('Frequency')
    plt.show()
```

```
<ipython-input-102-6e0a4d738252>:24: FutureWarning: iteritems is
deprecated and will be removed in a future version. Use .items
instead.
  for star_rating, top_bigrams in grouped.iteritems():
```



```python
def getTopWords(text, topN):
    words = re.findall(r'\b\w+\b', text.lower())
    wordCounts = Counter(words)
    topWords = wordCounts.most_common(topN)
    return topWords

topWords = getTopWords(textForNGram,10)

words, frequencies = zip(*topWords)
words, frequencies = words[1:], frequencies[1:]

# Plot the top words
plt.figure(figsize=(8, 8))
plt.bar(words, frequencies, color='skyblue')
plt.title('Top 10 Words Based on Frequency')
plt.xlabel('Words')
plt.ylabel('Frequency')
plt.xticks(rotation=45, ha='right')
plt.show()
```



```
!pip install vaderSentiment

Collecting vaderSentiment
  Downloading vaderSentiment-3.3.2-py2.py3-none-any.whl (125 kB)
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 0.0/126.0 kB ? eta -:--:--
```

```
━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ ━━━━━━━━━━ 92.2/126.0 kB 2.5 MB/s eta
0:00:01 ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━ 126.0/126.0 kB 2.7
MB/s eta 0:00:00
ent already satisfied: requests in /usr/local/lib/python3.10/dist-
packages (from vaderSentiment) (2.31.0)
Requirement already satisfied: charset-normalizer<4,>=2 in
/usr/local/lib/python3.10/dist-packages (from requests-
>vaderSentiment) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in
/usr/local/lib/python3.10/dist-packages (from requests-
>vaderSentiment) (3.6)
Requirement already satisfied: urllib3<3,>=1.21.1 in
/usr/local/lib/python3.10/dist-packages (from requests-
>vaderSentiment) (2.0.7)
Requirement already satisfied: certifi>=2017.4.17 in
/usr/local/lib/python3.10/dist-packages (from requests-
>vaderSentiment) (2023.11.17)
Installing collected packages: vaderSentiment
Successfully installed vaderSentiment-3.3.2
```

```
from vaderSentiment.vaderSentiment import SentimentIntensityAnalyzer
def sentiment_scores(sentence):

    sid_obj = SentimentIntensityAnalyzer()
    sentiment_dict = sid_obj.polarity_scores(sentence)
    return sentiment_dict['compound']

df['vaderSentiment'] = df['cleanReview'].apply(sentiment_scores)

# Display the updated dataframe
df.head()
```

```
                                              review  rating  \
0  Why does it look like someone spit on my food?...       1
1  It'd McDonalds. It is what it is as far as the...       4
2  Made a mobile order got to the speaker and che...       1
3  My mc. Crispy chicken sandwich was ï¿½ï¿½ï¿½ï¿...       5
4  I repeat my order 3 times in the drive thru, a...       1

                                         cleanReview  \
0  whi doe look like someon spit food normal tran...
1  itd mcdonald far food atmospher go staff doe m...
2  made mobil order got speaker check line wa mov...
3  mc crispi chicken sandwich wa custom servic wa...
4  repeat order 3 time drive thru still manag mes...

                                       reviewForBERT  vaderSentiment
0  Why does it look like someone spit on my food\...          0.5541
1  Itd McDonalds It is what it is as far as the f...          0.7003
```

```
2  Made a mobile order got to the speaker and che...          -0.2500
3  My mc Crispy chicken sandwich was  customer se...           0.0000
4  I repeat my order 3 times in the drive thru an...          -0.7184
```

```
def textClassification(text):
  if text >= 0.05:
    return('positive')
  if text <= -0.05:
    return('negative')
  return('neutral')
```

```
df['vaderSentimentClassification'] =
df['vaderSentiment'].apply(textClassification)
```

```
df[['rating','cleanReview',
'vaderSentiment','vaderSentimentClassification']].to_csv('delete.csv',
index = False)
```

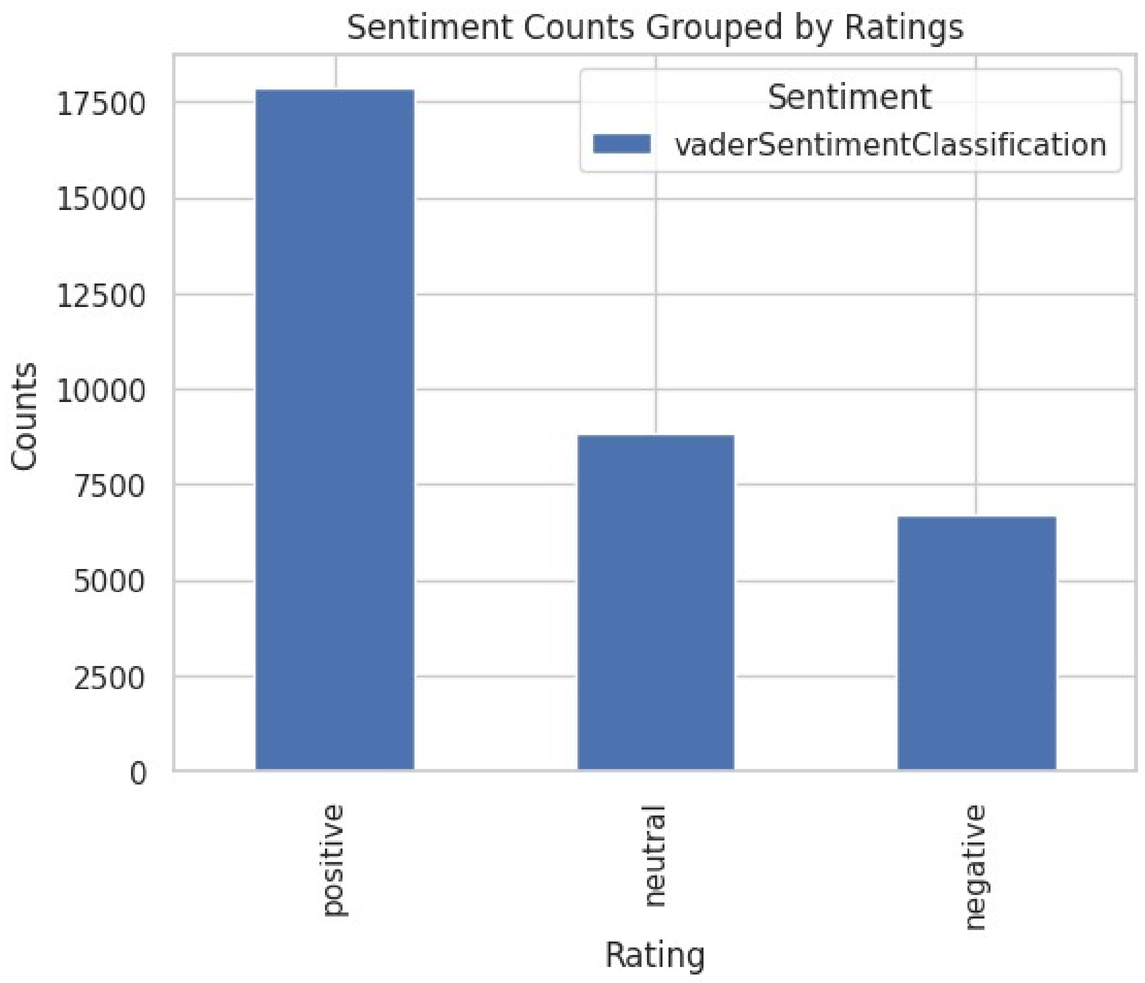
```
df.vaderSentimentClassification.value_counts()
```

```
positive    17856
neutral      8849
negative     6691
Name: vaderSentimentClassification, dtype: int64
```

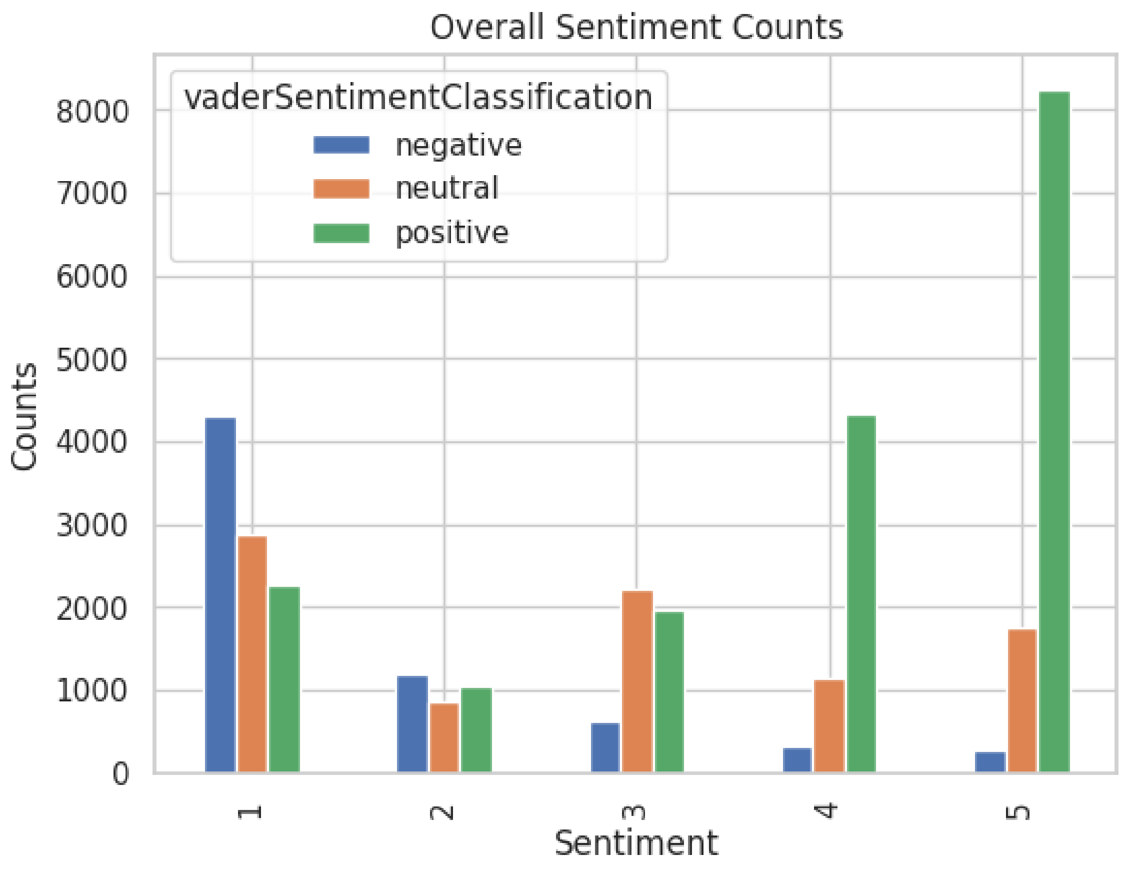
```
df['vaderSentiment'].iloc[2] <= -0.05
```

```
True
```

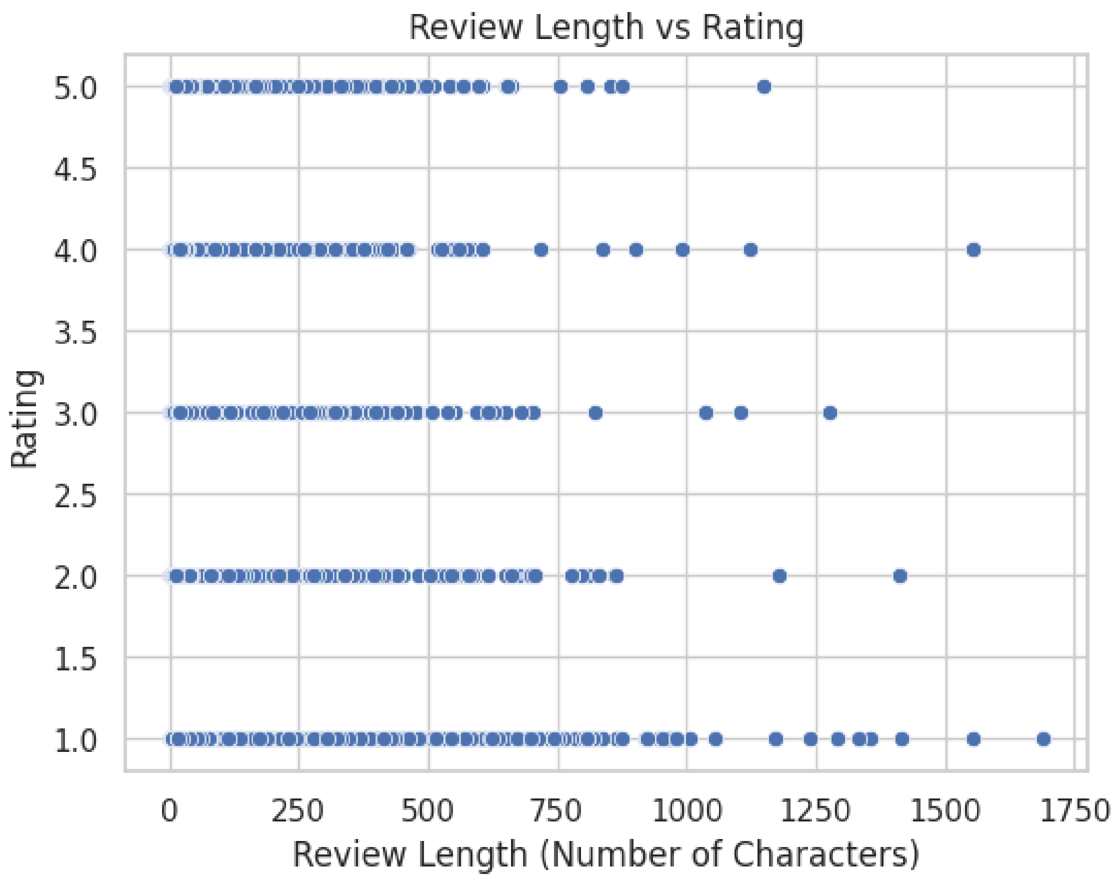
```
sentimentCounts.plot(kind='bar', stacked=True, ax=plt.gca())
plt.title('Sentiment Counts Grouped by Ratings')
plt.xlabel('Rating')
plt.ylabel('Counts')
plt.legend(title='Sentiment')
plt.show()
```



```
sentimentCounts = df['vaderSentimentClassification'].value_counts()
groupedSentiments = df.groupby(['rating',
'vaderSentimentClassification']).size().unstack().fillna(0)

groupedSentiments.plot(kind='bar')
plt.title('Overall Sentiment Counts')
plt.xlabel('Sentiment')
plt.ylabel('Counts')
plt.show()
```



```
df['review_length'] = df['cleanReview'].apply(lambda x: len(str(x)))
sns.scatterplot(x='review_length', y='rating', data=df)
plt.title('Review Length vs Rating')
plt.xlabel('Review Length (Number of Characters)')
plt.ylabel('Rating')
plt.show()
```



```
temp = pd.read_csv('senimentsBertAllThree.csv')

temp.head()

   Unnamed: 0                                      0
0           0  [0.9752794  0.02260427 0.00211631]
1           1  [0.00268567 0.02331932 0.97399503]
2           2  [0.7752055  0.21287917 0.01191532]
3           3  [0.00576835 0.09304767 0.90118396]
4           4  [0.92126226 0.07193809 0.00679967]

temp.drop(columns = ['Unnamed: 0'], axis = 1, inplace = True)

temp.head()

                                      0
0  [0.9752794  0.02260427 0.00211631]
1  [0.00268567 0.02331932 0.97399503]
2  [0.7752055  0.21287917 0.01191532]
3  [0.00576835 0.09304767 0.90118396]
4  [0.92126226 0.07193809 0.00679967]

temp.rename(columns={'0':'all'}, inplace = True)
```

```
def convertToList(dataStr):
  if type(dataStr) == str:
    numberStr = dataStr.strip("[]")
    return [float(num) for num in numberStr.split()]

res = []
res.append(temp['all'].apply(convertToList))

val1, val2, val3 =[],[],[]
for i in range(len(res[0])):
    if res[0][i]:
        val1.append(res[0][i][0])
        val2.append(res[0][i][1])
        val3.append(res[0][i][2])

# DROPPING 7 ROWS FOR WHICH WE WERE UNABLE TO GET BERT SENTIMENTS
list(temp.loc[pd.isna(temp["all"]), :].index)
```

```
[17316, 23021, 23156, 23689, 27955, 28090, 28803]
```

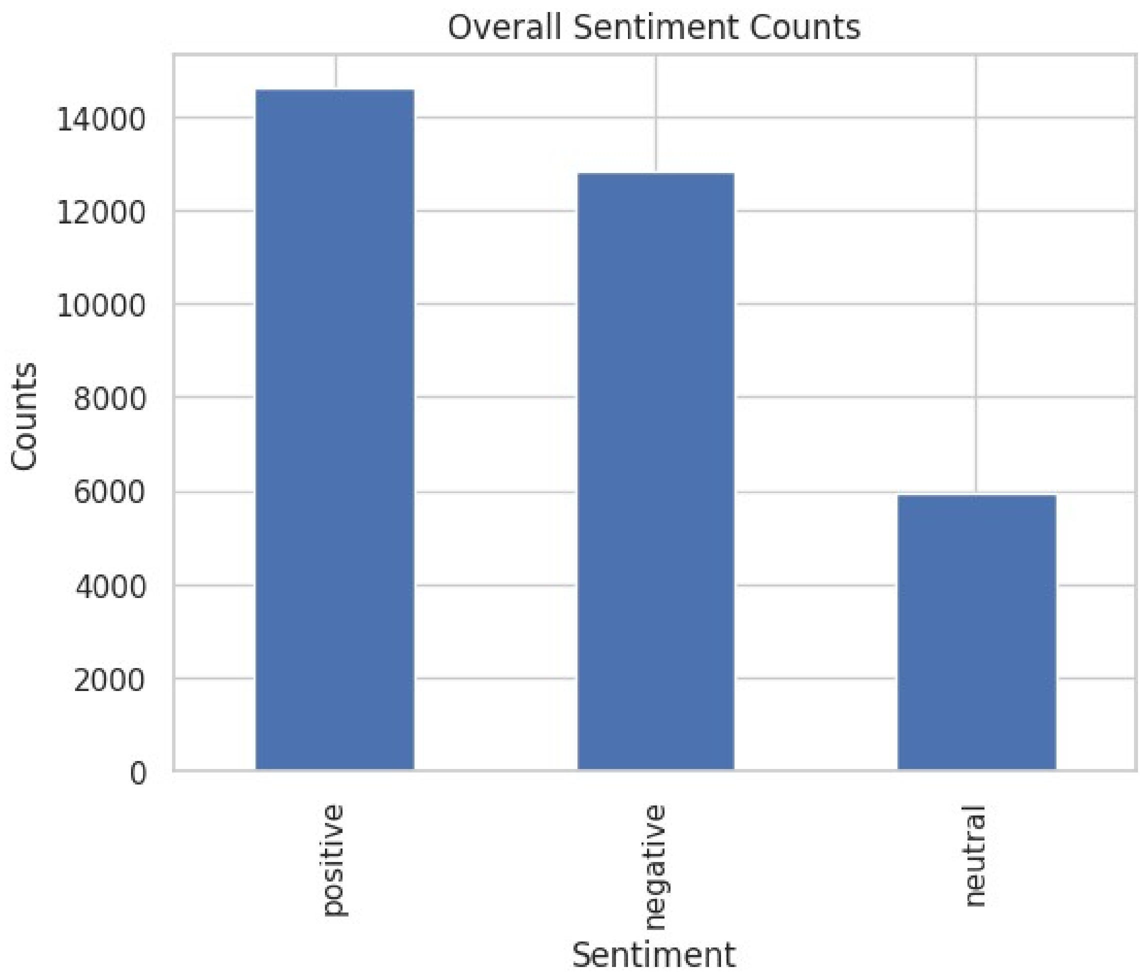
```
dfForBERT = df.drop(list(temp.loc[pd.isna(temp["all"]), :].index))

len(dfForBERT)
```

```
33389
```

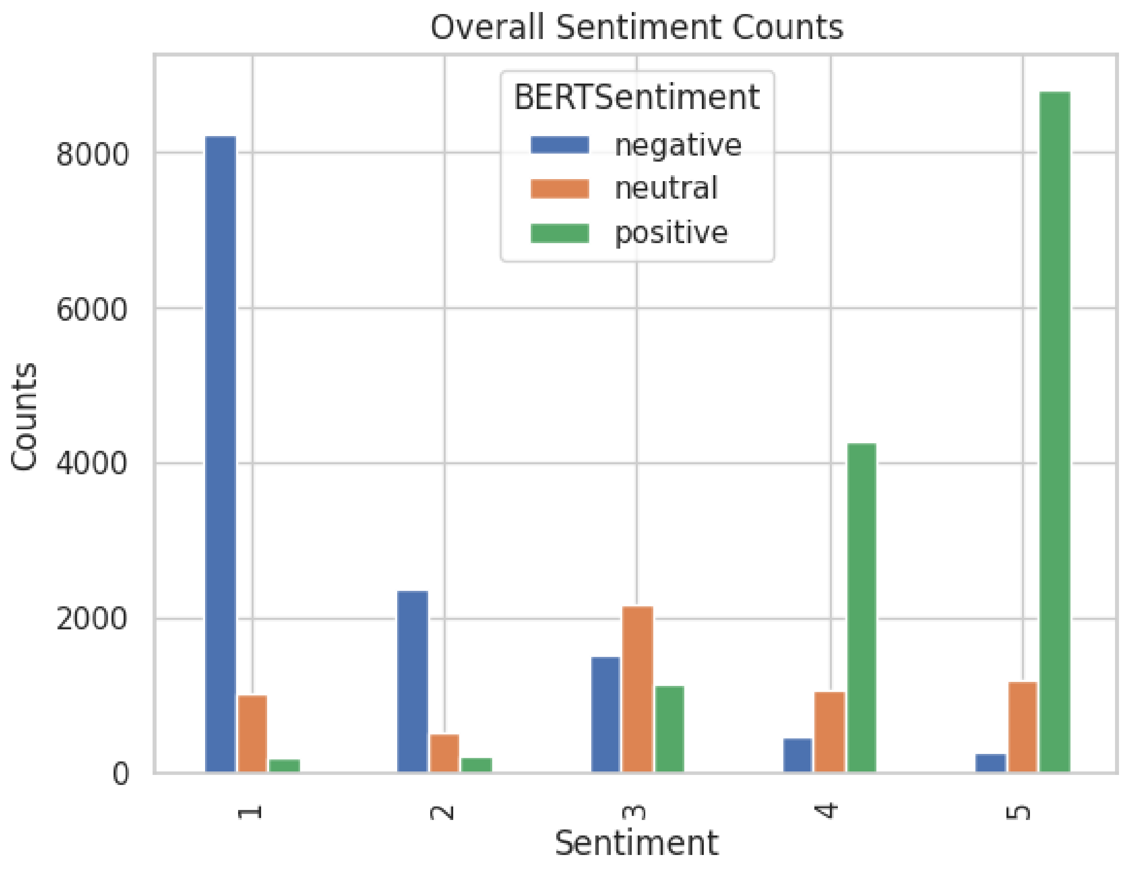
```
dfForBERT['negativeSentiment'] = val1
dfForBERT['neutralSentiment'] = val2
dfForBERT['positiveSentiment'] = val3

def determineSentiment(row):
    if row['negativeSentiment'] > max(row['neutralSentiment'],
row['positiveSentiment']):
        return 'negative'
    elif row['positiveSentiment'] > max(row['neutralSentiment'],
row['negativeSentiment']):
        return 'positive'
    else:
        return 'neutral'

dfForBERT['BERTSentiment'] = dfForBERT.apply(determineSentiment,
axis=1)

# Display the updated DataFrame
dfForBERT.head()
```

```
                                              review  rating  \
0  Why does it look like someone spit on my food?...       1
1  It'd McDonalds. It is what it is as far as the...       4
2  Made a mobile order got to the speaker and che...       1
3  My mc. Crispy chicken sandwich was ï¿½ï¿½ï¿½ï¿...       5
4  I repeat my order 3 times in the drive thru, a...       1
```

```
                                         cleanReview  \
0  whi doe look like someon spit food normal tran...
1  itd mcdonald far food atmospher go staff doe m...
2  made mobil order got speaker check line wa mov...
3  mc crispi chicken sandwich wa custom servic wa...
4  repeat order 3 time drive thru still manag mes...

                                       reviewForBERT
vaderSentiment  \
0  Why does it look like someone spit on my food\...          0.5541

1  Itd McDonalds It is what it is as far as the f...          0.7003

2  Made a mobile order got to the speaker and che...         -0.2500

3  My mc Crispy chicken sandwich was  customer se...          0.0000

4  I repeat my order 3 times in the drive thru an...         -0.7184


  vaderSentimentClassification  review_length  negativeSentiment  \
0                     positive            154           0.975279
1                     positive            128           0.002686
2                     negative            193           0.775205
3                      neutral             54           0.005768
4                     negative            188           0.921262

   neutralSentiment  positiveSentiment BERTSentiment
0          0.022604           0.002116      negative
1          0.023319           0.973995      positive
2          0.212879           0.011915      negative
3          0.093048           0.901184      positive
4          0.071938           0.006800      negative

sentimentCounts = dfForBERT['BERTSentiment'].value_counts()
groupedSentiments = dfForBERT.groupby(['rating',
'BERTSentiment']).size().unstack().fillna(0)

sentimentCounts.plot(kind='bar')
plt.title('Overall Sentiment Counts')
plt.xlabel('Sentiment')
plt.ylabel('Counts')
plt.show()
```



```
groupedSentiments.plot(kind='bar',ax=plt.gca())
plt.title('Overall Sentiment Counts')
plt.xlabel('Sentiment')
plt.ylabel('Counts')
plt.show()
```



```
dfForBERT['vaderSentimentClassification'].value_counts()

positive    17850
neutral      8849
negative     6690
Name: vaderSentimentClassification, dtype: int64

dfForBERT['BERTSentiment'].value_counts()

positive    14605
negative    12839
neutral      5945
Name: BERTSentiment, dtype: int64

dfForBERT[dfForBERT['rating'] == 1]['BERTSentiment'].value_counts()

negative    8243
neutral     1005
positive     180
Name: BERTSentiment, dtype: int64

mismatched_data = dfForBERT[dfForBERT['vaderSentimentClassification']
!= dfForBERT['BERTSentiment']]
mismatched_data = mismatched_data[mismatched_data['rating']==1]
```

```
# Selecting 5 to 10 samples from the mismatched data
sampled_mismatched_data = mismatched_data.sample(n=10, random_state=1)

sampled_mismatched_data[['rating', 'reviewForBERT',
'vaderSentimentClassification', 'BERTSentiment']]
```

```
       rating                                      reviewForBERT  \
241         1  Not open 24 hours Only the drivethru Dining ro...
7761        1  As we walk in a girl behind the counter identi...
10687       1  I cant seriously believe this place is still i...
15287       1  I love McDonalds but in this one I have had th...
10863       1  Always out of nearly everything regardless of ...
25349       1  Newly removed  You would think this place woul...
32273       1  I went today to get food and they said two tim...
24740       1  This location is NOT open 24 hours Please adju...
8029        1  Terrible customer service and no juice for the...
21823       1            Its breakfast sandwiches are human meat

      vaderSentimentClassification BERTSentiment
241                        neutral      negative
7761                      positive      negative
10687                     positive      negative
15287                      neutral      negative
10863                     positive      negative
25349                     positive      negative
32273                     positive      negative
24740                      neutral      negative
8029                       neutral      negative
21823                      neutral      negative
```

NULL HYPOTHESIS: The average of negative sentiment scores with 1-star rating is equal to average of negative sentiment scores of 2-star rating and above.

ALTERNATE HYPOTHESIS: The average of negative sentiment scores with 1-star rating is greater than the average of negative sentiment scores of 2-star rating and above.

```
groupedOneStar = dfForBERT[dfForBERT['rating'] == 1]
['negativeSentiment']
groupedAboveOneStar = dfForBERT[dfForBERT['rating'] != 1]
['negativeSentiment']

statistic, p_value = stats.mannwhitneyu(groupedOneStar,
groupedAboveOneStar, alternative='greater')
```

```
print("Mann-Whitney U Statistic:", statistic)
print("P-value:", p_value)
alpha = 0.05
if p_value < alpha:
    print("Reject the null hypothesis")
    print("Accept alternate hypothesis \"The average of negative
sentiment scores with 1-star rating is greater than the average of
negative sentiment scores of 2-star rating and above.\"")
else:
    print("Fail to reject the null hypothesis. The average of negative
sentiment scores with 1-star rating is equal to average of negative
sentiment scores of 2-star rating and above.")
```

```
Mann-Whitney U Statistic: 206162428.5
P-value: 0.0
Reject the null hypothesis
Accept alternate hypothesis "The average of negative sentiment scores
with 1-star rating is greater than the average of negative sentiment
scores of 2-star rating and above."
```

NULL HYPOTHESIS: The average of negative sentiment scores with 1-star rating is equal to average of negative sentiment scores of 2-star rating.

ALTERNATE HYPOTHESIS: The average of negative sentiment scores with 1-star rating is greater than the average of negative sentiment scores of 2-star rating.

```
groupedOneStar = dfForBERT[dfForBERT['rating'] == 1]
['negativeSentiment']
groupedATwoStar = dfForBERT[dfForBERT['rating'] == 2]
['negativeSentiment']

statistic, p_value = stats.mannwhitneyu(groupedOneStar,
groupedATwoStar, alternative='greater')

print("Mann-Whitney U Statistic:", statistic)
print("P-value:", p_value)

# Decide whether to reject the null hypothesis
alpha = 0.05  # Set your significance level
if p_value < alpha:
    print("Reject the null hypothesis")
    print("Accept alternate hypothesis \"The average of negative
sentiment scores with 1-star rating is greater than the average of
negative sentiment scores of 2-star rating.\"")
else:
    print("Fail to reject the null hypothesis. The average of negative
sentiment scores with 1-star rating is equal to average of negative
sentiment scores of 2-star rating.")
```

```
Mann-Whitney U Statistic: 19446270.5
P-value: 3.987120594260143e-175
Reject the null hypothesis
Accept alternate hypothesis "The average of negative sentiment scores
with 1-star rating is greater than the average of negative sentiment
scores of 2-star rating."
```