```
import pandas as pd
import numpy as np
from sklearn.datasets import load_iris
from sklearn.model_selection import train_test_split
from sklearn.naive_bayes import MultinomialNB
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.metrics import accuracy_score, classification_report
import matplotlib.pyplot as plt
from wordcloud import WordCloud,STOPWORDS
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize
import nltk
import string
import re
from tqdm.contrib.concurrent import process_map
nltk.download('stopwords')
from bs4 import BeautifulSoup
# import spacy
from nltk.stem import WordNetLemmatizer
nltk.download('wordnet')
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Unzipping corpora/stopwords.zip.
[nltk_data] Downloading package wordnet to /root/nltk_data...
True
```

```
# mounting google drive to get the sqlite file
from google.colab import drive
drive_path = drive.mount('/content/drive/')
```

```
Mounted at /content/drive/
```

```
# storing the file path in a variable
file_path = "/content/drive/MyDrive/foods.txt"

# Reading the content of the files using readlines
# readlines reads each line in a iteration
# Storing all the data in the variable file_data
with open(file_path, 'r', encoding='latin-1') as file:
    file_data = file.readlines()
```

```
# Creating an empty lists of each column of the our dataframe
productIds, userIds, profileNames, helpfulness, scores, times, summaries, texts = ([] for _ in range(8))

# Going through each line of the data and appending them into different columns (separating the data column wise)
for line in file_data:
    if line.startswith('product/productId:'):
        productIds.append(line.split(': ')[1].strip())
    elif line.startswith('review/userId:'):
        userIds.append(line.split(': ')[1].strip())
    elif line.startswith('review/profileName:'):
        profileNames.append(line.split(': ')[1].strip())
    elif line.startswith('review/helpfulness:'):
        helpfulness.append(line.split(': ')[1].strip())
    elif line.startswith('review/score:'):
        scores.append(line.split(': ')[1].strip())
    elif line.startswith('review/time:'):
        times.append(line.split(': ')[1].strip())
    elif line.startswith('review/summary:'):
        summaries.append(line.split(': ')[1].strip())
    elif line.startswith('review/text:'):
        texts.append(line.split(': ')[1].strip())

# checking if the data split correctly into different columns
print("Sameple data of productIds: ", productIds[:5])
print("Sameple data of userIds: ", userIds[:5])
print("Sameple data of profileNames: ", profileNames[:5])
print("Sameple data of helpfulness: ", helpfulness[:5])
print("Sameple data of scores: ", scores[:5])
print("Sameple data of times: ", times[:5])
print("Sameple data of summaries: ", summaries[:5])
print("Sameple data of texts: ", texts[:2])
```

```
Sameple data of productIds:  ['B001E4KFG0', 'B00813GRG4', 'B000LQOCH0', 'B000UA0QIQ', 'B006K2ZZ7K']
Sameple data of userIds:  ['A3SGXH7AUHU8GW', 'A1D87F6ZCVE5NK', 'ABXLMWJIXXAIN', 'A395BORC6FGVXV', 'A1UQRSCLF8GW1T']
Sameple data of profileNames:  ['delmartian', 'dll pa', 'Natalia Corres "Natalia Corres"', 'Karl', 'Michael D. Bigham "M. Wassir"']
Sameple data of helpfulness:  ['1/1', '0/0', '1/1', '3/3', '0/0']
Sameple data of scores:  ['5.0', '1.0', '4.0', '2.0', '5.0']
Sameple data of times:  ['1303862400', '1346976000', '1219017600', '1307923200', '1350777600']
```

```
Sameple data of summaries:  ['Good Quality Dog Food', 'Not as Advertised', '"Delight" says it all', 'Cough Medicine', 'Great taffy'
Sameple data of texts:  ['I have bought several of the Vitality canned dog food products and have found them all to be of good quali
```

```
# Creating a data frame with the above column data
foods_df = pd.DataFrame({
    'product/productId': productIds,
    'review/userId': userIds,
    'review/profileName': profileNames,
    'review/helpfulness': helpfulness,
    'review/score': scores,
    'review/time': times,
    'review/summary': summaries,
    'review/text': texts
})
foods_df.head()
```

	product/productId	review/userId	review/profileName	review/helpfulness	rev
0	B001E4KFG0	A3SGXH7AUHU8GW	delmartian	1/1	
1	B00813GRG4	A1D87F6ZCVE5NK	dll pa	0/0	
2	B000LQOCH0	ABXLMWJIXXAIN	Natalia Corres "Natalia Corres"	1/1	

```
# converting all the data into lower case
foods_df['review/text'] = foods_df['review/text'].str.lower()
foods_df['review/summary'] = foods_df['review/summary'].str.lower()
foods_df['review/profileName'] = foods_df['review/profileName'].str.lower()
```

```
# checking if there is nan data
print(foods_df[foods_df == 'nan'].count())
```

```
product/productId      0
review/userId          0
review/profileName    34
review/helpfulness     0
review/score           0
review/time            0
review/summary         2
review/text            0
dtype: int64
```

```
# checking if there is none data
print(foods_df[foods_df == 'none'].count())
```

```
product/productId      0
review/userId          0
review/profileName    20
review/helpfulness     0
review/score           0
review/time            0
review/summary         2
review/text            0
dtype: int64
```

```
# the data which is nan
foods_df[foods_df['review/profileName'] == 'nan']
```

	product/productId	review/userId	review/profileName	review/helpfulne
25509	B000LKZB4Y	A36BVYD0NT7Z0F	nan	
29042	B000MPRP4C	A1DJV0XTCCSZ8F	nan	
38874	B000AYDGZ2	A36BVYD0NT7Z0F	nan	
49800	B000CRHQN0	A2LYFY32LXQDON	nan	
67077	B0006348H2	A2P0P67Y55SNOX	nan	
106550	B001EQ5DG0	A1P500QXEG3IUZ	nan	
110490	B00438XVGU	AOISTMMFDR9LU	nan	
113995	B000EYRHL2	AUQ465FVJ8ID8	nan	
137613	B000CQE3HS	AGT3BYX5P9SLH	nan	
163191	B000CQID1A	AGT3BYX5P9SLH	nan	
215456	B0014X5O1C	A1DJV0XTCCSZ8F	nan	
220566	B0034EDLS2	AOZHN8BHN0Y1O	nan	
235366	B0034EDMCW	AOZHN8BHN0Y1O	nan	
237199	B000EDM772	A29D3R6BWL2I88	nan	
291337	B004WJTMUE	A2XUKU2YKB9FHH	nan	
292867	B001E5DXH2	A20B063XORM0EG	nan	
301147	B003Z6ZG7K	AOISTMMFDR9LU	nan	

301147	B003Z6ZGZK	AOISTMMFDR9LU	nan	
306751	B000RI1W8E	AGT3BYX5P9SLH	nan	
320131	B003Z6W32E	AOISTMMFDR9LU	nan	
327104	B001EQ54QE	A3BJM4BT38KVOQ	nan	
373765	B004WTHCO2	A59FXNKPGM2I4	nan	
383570	B00451WLYI	AOISTMMFDR9LU	nan	
425852	B0034EDMLI	AOZHN8BHN0Y1O	nan	
431598	B000W5P0KI	A36BVYD0NT7Z0F	nan	13
433664	B001LQCOIS	A59FXNKPGM2I4	nan	
440825	B008LFAS08	AC0E8TXIYABB5	nan	
443966	B0034EDM2W	AOZHN8BHN0Y1O	nan	
483361	B0006Z7NOK	AGUUTD07ZXD0U	nan	
490412	B000CQE3IC	AGT3BYX5P9SLH	nan	
493563	B0028GWGY2	A2JOYB7DQTT0W6	nan	

```
foods_df[(foods_df['review/summary'] == 'nan') | (foods_df['review/summary'] == 'none') | (foods_df['review/summary'] == '1') | (foods_c
```

	product/productId	review/userId	review/profileName	review/helpfuln
33958	B00412W76S	A3TJPSWY2HE4BS	s. layton "homeschool blogger"	
40548	B00020HHRW	A3TJPSWY2HE4BS	s. layton "homeschool blogger"	
101106	B0014B0HWK	A3TJPSWY2HE4BS	s. layton "homeschool blogger"	
102979	B000FVDWU4	A3TJPSWY2HE4BS	s. layton "homeschool blogger"	
117515	B0016B7Z32	A3TJPSWY2HE4BS	s. layton "homeschool blogger"	
119242	B000E1DSTK	A2OEAC7J61WO8W	hollis mccollum	
144396	B001TNXSZG	A3JYBMJJWX5ABL	rbeccaboopsie	
155712	B0009VO58S	A3TJPSWY2HE4BS	s. layton "homeschool blogger"	
178290	B00073IVAQ	A3TJPSWY2HE4BS	s. layton "homeschool blogger"	
198474	B000FVBYCW	A3TJPSWY2HE4BS	s. layton "homeschool blogger"	
212691	B00020HHAO	A3TJPSWY2HE4BS	s. layton "homeschool blogger"	
223957	B004H6MV28	A11OJJ3SJK5P5C	nancy m. clement caron	
237565	B000ELGPAO	A15AMT9T9A1309	film-friend	
293906	B00020HHM2	A3TJPSWY2HE4BS	s. layton "homeschool blogger"	
299495	B00142BX68	A3TJPSWY2HE4BS	s. layton "homeschool blogger"	
300961	B000VJYTZM	A3TJPSWY2HE4BS	s. layton "homeschool blogger"	

333556	B00188S3PM	A3TJPSWY2HE4BS	s. layton "homeschool blogger"
352043	B000M0F58U	A3TJPSWY2HE4BS	s. layton "homeschool blogger"
357215	B0006I5M2M	A3TJPSWY2HE4BS	s. layton "homeschool blogger"
357814	B001GCTTRQ	A3TJPSWY2HE4BS	s. layton "homeschool blogger"
360782	B00020HHHC	A3TJPSWY2HE4BS	s. layton "homeschool blogger"
379473	B007RLRCLK	A3TJPSWY2HE4BS	s. layton "homeschool blogger"
380558	B00014DXCC	A3TJPSWY2HE4BS	s. layton "homeschool blogger"
381313	B00020HHK4	A3TJPSWY2HE4BS	s. layton "homeschool blogger"
386283	B00073JVFU	A3TJPSWY2HE4BS	blogger"

We can see a lot of data missing in the summaries column but there is an associated text column present. But, if we see the data carefully we observe that there is a lot of duplicate data.

```
# we replaced all the profile names that were nan with anonymous
foods_df['review/profileName'] = foods_df['review/profileName'].replace('nan', 'anonymous')
print(foods_df[foods_df['review/profileName'] == 'nan'].count())
```

```
product/productId     0
review/userId         0
review/profileName    0
review/helpfulness    0
review/score          0
review/time           0
review/summary        0
review/text           0
dtype: int64
```

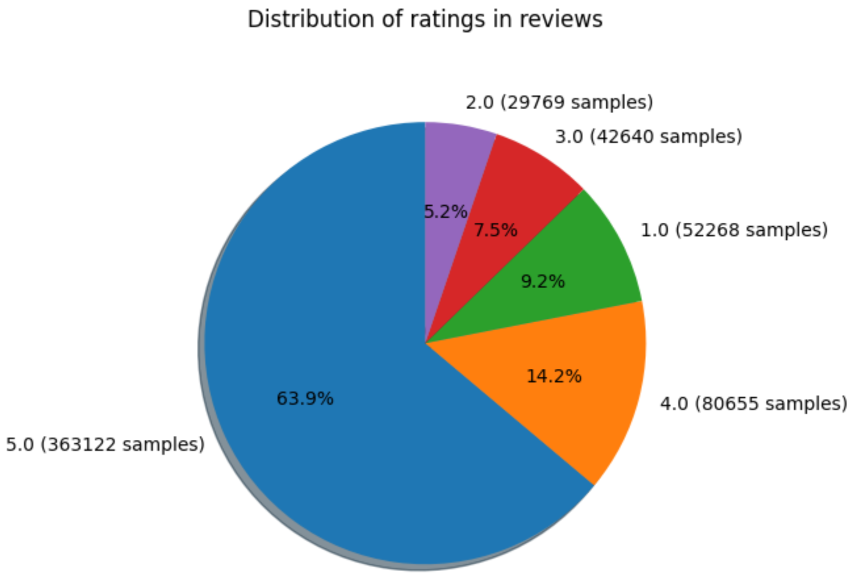
```
# we replaced all the summarires that were nan with anonymous
foods_df['review/summary'] = foods_df['review/summary'].replace('nan', 'no summary')
print(foods_df[foods_df['review/summary'] == 'nan'].count())
```

```
product/productId     0
review/userId         0
review/profileName    0
review/helpfulness    0
review/score          0
review/time           0
review/summary        0
review/text           0
dtype: int64
```

We can plot to see how many of our reviews are postive(>3), negative(<3) and neutral(=3)

```
labels = [f'{k} ({foods_df["review/score"].value_counts()[k]} samples)' for k in foods_df['review/score'].value_counts().keys()]
sizes = dict(foods_df['review/score'].value_counts()).values()

fig1, ax1 = plt.subplots()
ax1.pie(sizes, labels=labels, autopct='%1.1f%%',
        shadow=True, startangle=90)
# Equal aspect ratio ensures that pie is drawn as a circle.
ax1.axis('equal')
ax1.set_title("Distribution of ratings in reviews",pad=40)
plt.show();
```



We can see a lot of positive reviews and a very little neutral reviews

1. positive reviews: 78% (approximately)
2. Negative reviews: 14% (approximately)
3. Neutral reviews: 8% (approximately)

```
# foods_df.dropna(inplace=True)
# foods_df = foods_df.drop_duplicates()
# foods_df
```

Now since we want to classify if a data is positive or negative we have to decide which scores are positive and negative. considerations:

1. score = 4, 5 as positive
2. score = 1, 2 as negative
3. score = 3 as neutral So, we can remove the data with score = 3 to make the data even cleaner

```
# converting score into float
foods_df['review/score'] = foods_df['review/score'].astype(float)
```

```
foods_df = foods_df[foods_df['review/score'] != 3]
foods_df
```

	product/productId	review/userId	review/profileName	review/helpfulness
0	B001E4KFG0	A3SGXH7AUHU8GW	delmartian	1/1
1	B00813GRG4	A1D87F6ZCVE5NK	dll pa	0/0
2	B000LQOCH0	ABXLMWJIXXAIN	natalia corres "natalia corres"	1/1
3	B000UA0QIQ	A395BORC6FGVXV	karl	3/3
4	B006K2ZZ7K	A1UQRSCLF8GW1T	michael d. bigham "m. wassir"	0/0
...	...	...	...	..
568449	B001EO7N10	A28KG5XORO54AY	lettie d. carter	0/0

```
# Assigning review type based on score
foods_df.loc[foods_df["review/score"] > 3, 'review/type'] = 'Positive'
foods_df.loc[foods_df["review/score"] < 3, 'review/type'] = 'Negative'
foods_df
```

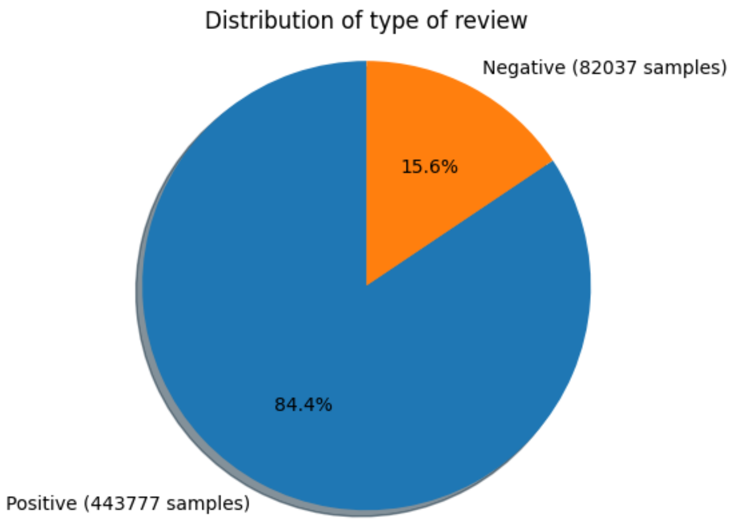
```
<ipython-input-17-207736703d4f>:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable
  foods_df.loc[foods_df["review/score"] > 3, 'review/type'] = 'Positive'
```

	product/productId	review/userId	review/profileName	review/helpful
0	B001E4KFG0	A3SGXH7AUHU8GW	delmartian	

```
# counting the total positive and negative reviews
labels = [f'{k} ({foods_df["review/type"].value_counts()[k]} samples)' for k in foods_df['review/type'].value_counts().keys()]
sizes = dict(foods_df['review/type'].value_counts()).values()

fig1, ax1 = plt.subplots()
ax1.pie(sizes, labels=labels, autopct='%1.1f%%',
        shadow=True, startangle=90)
# Equal aspect ratio ensures that pie is drawn as a circle.
ax1.axis('equal')
ax1.set_title("Distribution of type of review")
plt.show();
```



We can see that most of the reviews are positive. The postive reviews comprise almost 85% of the total data we have.

We can use word cloud to understand the frequently used words depending on the type of review

```
positive_review = foods_df[foods_df["review/type"] == "Positive"]
text = " ".join(review for review in positive_review['review/summary'] + positive_review['review/text'])
print ("There are {} words in the combination of all review.".format(len(text)))

# Create stopword list:
default_stopwords=set(stopwords.words('english'))

# Generate a word cloud image
wordcloud = WordCloud(stopwords=default_stopwords, background_color="white", width=1200, height=600).generate(text)

# Display the generated image:
plt.figure()
plt.title('Positive reviews wordcloud')
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```

```
There are 185505236 words in the combination of all review.
```

The words like like, delicious, great, good, best have appeared very frequently. We can also see that there are lot of words that are not helpful for our classification. It has a lot of html tag related data that can be seen in the above word cloud. We can also infer that the number 1 has also very frequently occured in our data which has to be cleaned.

```
negative_review = foods_df[foods_df["review/type"] == "Negative"]
text = " ".join(review for review in negative_review['review/summary'] + negative_review['review/text'])
print ("There are {} words in the combination of all review.".format(len(text)))

# Create stopword list:
default_stopwords=set(stopwords.words('english'))

# Generate a word cloud image
wordcloud = WordCloud(stopwords=default_stopwords, background_color="white", width=1200, height=600).generate(text)

# Display the generated image:
plt.figure()
plt.title('Negative reviews wordcloud')
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```

```
There are 38844364 words in the combination of all review.
```

Words like bad, don't like can be seen Similar to the postive review wordcloud we can observe the dominance of the html tag data that has to be cleaned.

We have to check if there was redundant data, the data that might have been duplicated. There are rows of data that have the same information.

```
# duplicate rows
mask_duplicated_reviews = foods_df.duplicated(subset=["review/userId","product/productId","review/time"], keep='first')
count_duplicated_reviews = mask_duplicated_reviews.value_counts()

sum_reviews = count_duplicated_reviews.sum()
perc_duplicated_reviews = (count_duplicated_reviews/sum_reviews) * 100
print(sum_reviews)
print(perc_duplicated_reviews)
```

```
525814
False    99.299182
True      0.700818
dtype: float64
```

```
# removing duplicate rows in a data frame
duplicate = foods_df[mask_duplicated_reviews]
duplicate.sort_values(by = ['review/profileName'])
```

	product/productId	review/userId	review/profileName	review/helpfulness
359571	B007M832YY	A3A1OA237FOZFK	#1 amazon fan	0/0
359572	B007M832YY	A3A1OA237FOZFK	#1 amazon fan	0/0
30985	B007M83302	A3A1OA237FOZFK	#1 amazon fan	0/0
30984	B007M83302	A3A1OA237FOZFK	#1 amazon fan	0/0
547610	B006HYLW32	A3A1OA237FOZFK	#1 amazon fan	0/0
...	...	...	...	...
247331	B000EOXQS0	A1JLE30SBP6J3A	zefran	0/0
445314	B000ODH4BG	A1JLE30SBP6J3A	zefran	0/0
445315	B000ODH4BG	A1JLE30SBP6J3A	zefran	0/0
445313	B000ODH4BG	A1JLE30SBP6J3A	zefran	0/0

```
# delete the duplicate rows
foods_df = foods_df[~mask_duplicated_reviews]
foods_df
```

	product/productId	review/userId	review/profileName	review/helpfuln
0	B001E4KFG0	A3SGXH7AUHU8GW	delmartian	
1	B00813GRG4	A1D87F6ZCVE5NK	dll pa	
2	B000LQOCH0	ABXLMWJIXXAIN	natalia corres "natalia corres"	
3	B000UA0QIQ	A395BORC6FGVXV	karl	

```
# duplicate
mask_duplicated_reviews = foods_df.duplicated(subset=["review/userId","product/productId","review/summary"], keep='first')
count_duplicated_reviews = mask_duplicated_reviews.value_counts()

sum_reviews = count_duplicated_reviews.sum()
perc_duplicated_reviews = (count_duplicated_reviews/sum_reviews) * 100
print(sum_reviews)
print(perc_duplicated_reviews)

# removing duplicate rows in a data frame
duplicate = foods_df[mask_duplicated_reviews]
duplicate.sort_values(by = ['review/profileName'])
```

```
522129
False    99.950395
True      0.049605
dtype: float64
```

	product/productId	review/userId	review/profileName	review/helpfuln
435906	B000LKXQCS	AWM1KZ2MDOVWJ	a. winters "be good humans."	

```
# delete the duplicate rows
foods_df = foods_df[~mask_duplicated_reviews]
foods_df
```

	product/productId	review/userId	review/profileName	review/helpfuln
0	B001E4KFG0	A3SGXH7AUHU8GW	delmartian	
1	B00813GRG4	A1D87F6ZCVE5NK	dll pa	
2	B000LQOCH0	ABXLMWJIXXAIN	natalia corres "natalia corres"	
3	B000UA0QIQ	A395BORC6FGVXV	karl	
4	B006K2ZZ7K	A1UQRSCLF8GW1T	michael d. bigham "m. wassir"	
...	...	...	...	
568449	B001EO7N10	A28KG5XORO54AY	lettie d. carter	
568450	B003S1WTCU	A3I8AFVPEE8KI5	r. sawyer	
568451	B004I613EE	A121AA1GQV751Z	pksd "pk_007"	
568452	B004I613EE	A3IBEVCTXKNOH	kathy a. welch "katwel"	
568453	B001LR2CU2	A3LGQPJCZVL9UC	srfell17	

521870 rows × 9 columns

```
# duplicate
mask_duplicated_reviews = foods_df.duplicated(subset=["review/userId","product/productId","review/text"], keep='first')
count_duplicated_reviews = mask_duplicated_reviews.value_counts()

sum_reviews = count_duplicated_reviews.sum()
perc_duplicated_reviews = (count_duplicated_reviews/sum_reviews) * 100
print(sum_reviews)
print(perc_duplicated_reviews)

# removing duplicate rows in a data frame
duplicate = foods_df[mask_duplicated_reviews]
duplicate.sort_values(by = ['review/profileName'])
```

```
521870
False    99.990994
True      0.009006
dtype: float64
```

	product/productId	review/userId	review/profileName	review/helpfuln
488254	B0013A0QXC	A3K5C7JVGRD7EM	b. van gelder "senseo"	
464614	B000UBD88A	A3K5C7JVGRD7EM	b. van gelder "senseo"	
126174	B000XQ5HDQ	A21Z8B8XSZ4R17	eric r. dierks	
463539	B000GW67KY	A21Z8B8XSZ4R17	eric r. dierks	
302871	B000GW0UGG	A21Z8B8XSZ4R17	eric r. dierks	
10884	B0034KP00S	A1TMAVN4CEM8U8	gunner	
562165	B004HOSGWE	A1TMAVN4CEM8U8	gunner	
225034	B001LNTY70	A1TMAVN4CEM8U8	gunner	
229970	B000ZSX4GE	A1TMAVN4CEM8U8	gunner	
307041	B004HOOZEW	A1TMAVN4CEM8U8	gunner	
307043	B004HOOZEW	A1TMAVN4CEM8U8	gunner	
351106	B0034KN29O	A1TMAVN4CEM8U8	gunner	
221975	B0049Z9ANU	A1TMAVN4CEM8U8	gunner	
370161	B000ZSZ5S4	A1TMAVN4CEM8U8	gunner	
370163	B000ZSZ5S4	A1TMAVN4CEM8U8	gunner	

491262	B008114GDW	A1TMAVN4CEM8U8	gunner
513329	B004HOLD60	A1TMAVN4CEM8U8	gunner
513331	B004HOLD60	A1TMAVN4CEM8U8	gunner
562163	B004HOSGWE	A1TMAVN4CEM8U8	gunner
347897	B000ZT15EQ	A1TMAVN4CEM8U8	gunner
195161	B0049Z5OSK	A1TMAVN4CEM8U8	gunner
225032	B001LNTY70	A1TMAVN4CEM8U8	gunner
134893	B004HOQE64	A1TMAVN4CEM8U8	gunner
43719	B0049ZCF9G	A1TMAVN4CEM8U8	gunner
43464	B001EQ4P2I	A1TMAVN4CEM8U8	gunner
43462	B001EQ4P2I	A1TMAVN4CEM8U8	gunner
158908	B001TH4C2A	A1TMAVN4CEM8U8	gunner
78166	B004MC0CNW	A1TMAVN4CEM8U8	gunner
81453	B001EQ4RBM	A1TMAVN4CEM8U8	gunner
81455	B001EQ4RBM	A1TMAVN4CEM8U8	gunner

96132	B004HOLD4W	A1TMAVN4CEM8U8	gunner
96134	B004HOLD4W	A1TMAVN4CEM8U8	gunner

As we observed in the word cloud there is a lot of data with the html tags. So, using beautiful soup we are deleting the data that includes words like br, .com

```
# Function to remove HTML tags from a string
def remove_html_tags(text):
    soup = BeautifulSoup(text, 'html.parser')
    return soup.get_text()
     # Replace <br> tags with spaces
    for br in soup.find_all('br'):
        br.replace_with(' ')

    return soup.get_text()

foods_df['review/text'] = foods_df['review/text'].apply(remove_html_tags)
foods_df['review/summary'] = foods_df['review/summary'].apply(remove_html_tags)
foods_df
```

```
<ipython-input-27-2164b4b2f235>:3: MarkupResemblesLocatorWarning: The input looks
  soup = BeautifulSoup(text, 'html.parser')
<ipython-input-27-2164b4b2f235>:11: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable
  foods_df['review/text'] = foods_df['review/text'].apply(remove_html_tags)
<ipython-input-27-2164b4b2f235>:3: MarkupResemblesLocatorWarning: The input looks
  soup = BeautifulSoup(text, 'html.parser')
<ipython-input-27-2164b4b2f235>:12: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
```

There are a lot of times when humans express emotions with a lot of charaters where not necessary like soooo gooodd. We are trying to eliminate those characters by deleting the characters which have the same repeated character for more than 3 times.

product/productId review/userId review/profileName review/helpful

```
# removing words with repeated alphabets
def remove_words_with_repeated_characters(sentence):
    pattern = re.compile("\\s*\\b(?=\\w*(\\w)\\1{2,})\\w*\\b")
    clean_text  = re.sub(pattern,' ',sentence)
    return (clean_text)


# apply the function:
foods_df['review/summary'] = foods_df['review/summary'].apply(remove_words_with_repeated_characters)
foods_df['review/text'] = foods_df['review/text'].apply(remove_words_with_repeated_characters)
foods_df.head()
```

```
<ipython-input-28-0c3f8c00e636>:9: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
  foods_df['review/summary'] = foods_df['review/summary'].apply(remove_words_with_rep
<ipython-input-28-0c3f8c00e636>:10: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
  foods_df['review/text'] = foods_df['review/text'].apply(remove_words_with_repeated_
```

	product/productId	review/userId	review/profileName	review/helpfulness	rev
0	B001E4KFG0	A3SGXH7AUHU8GW	delmartian	1/1	
1	B00813GRG4	A1D87F6ZCVE5NK	dll pa	0/0	
2	B000LQOCH0	ABXLMWJIXXAIN	natalia corres "natalia corres"	1/1	
3	B000UA0QIQ	A395BORC6FGVXV	karl	3/3	
4	B006K2ZZ7K	A1UQRSCLF8GW1T	michael d. bigham "m. wassir"	0/0	

521870 rows × 9 columns

We observed in our word cloud that the numebr 1 was repeated a lot of times. There might be a lot of numerical data in the text columns like that which are noise for us. So, we are cleaning numerical data.

```
# removing digits
def remove_digits(text):
    pattern = r'[^a-zA-z.,!?/:;\"\'\s]'
    return re.sub(pattern, '', text)

# apply the function:
foods_df['review/summary'] = foods_df['review/summary'].apply(remove_digits)
foods_df['review/text'] = foods_df['review/text'].apply(remove_digits)
foods_df.head()
```

```
<ipython-input-29-d1eabc9a2ba0>:7: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-
  foods_df['review/summary'] = foods_df['review/summary'].apply(remove_digits)
<ipython-input-29-d1eabc9a2ba0>:8: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-
  foods_df['review/text'] = foods_df['review/text'].apply(remove_digits)
```

	product/productId	review/userId	review/profileName	review/helpfulness	review/score	review/time	review/summary	review/
0	B001E4KFG0	A3SGXH7AUHU8GW	delmartian	1/1	5.0	1303862400	good quality dog food	i have bc several c vi cannei
1	B00813GRG4	A1D87F6ZCVE5NK	dll pa	0/0	1.0	1346976000	not as advertised	prc ar labele jumbo s pear
2	B000LQOCH0	ABXLMWJIXXAIN	natalia corres "natalia corres"	1/1	4.0	1219017600	"delight" says it all	this confe tha been ar a
3	B000UA0QIQ	A395BORC6FGVXV	karl	3/3	2.0	1307923200	cough medicine	if you lookin the s ingredie
4	B006K2ZZ7K	A1UQRSCLF8GW1T	michael d. bigham "m. wassir"	0/0	5.0	1350777600	great taffy	great ta a great p there w v

While classifying data having punctutaions and special charcters just increases the amount of data but not useful data.

```
# create function for punctuation and special characters removal:
def remove_special_chars_punctuations(sentence):
    # match a single character not present in the set (basically anything other than a-z and A-Z)
    pattern = re.compile("[^a-zA-Z]+")
    clean_text  = re.sub(pattern,' ',sentence).strip()
    return clean_text

# apply the function:
foods_df['review/summary'] = foods_df['review/summary'].apply(remove_special_chars_punctuations)
foods_df['review/text'] = foods_df['review/text'].apply(remove_special_chars_punctuations)
foods_df.head()
```

```
<ipython-input-30-24e128c81ff2>:9: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
  foods_df['review/summary'] = foods_df['review/summary'].apply(remove_special_chars_
<ipython-input-30-24e128c81ff2>:10: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
```

STOP words are a major thing than can be eliminated while cleaning text data. Stop words are a set of commomly used word in a language. These words include 'a', 'the', 'is', 'are' etc. These words usually have a very little almost no importance in our classification. Eliminating these words will give us only the useful words in a big sentence which will help us better classify.

```
# cleaning the stop words
stop_words = set(stopwords.words('english'))
foods_df['review/text'] = foods_df['review/text'].apply(lambda x: ' '.join([word for word in x.split() if word not in (stop_words)]))
foods_df['review/summary'] = foods_df['review/summary'].apply(lambda x: ' '.join([word for word in x.split() if word not in (stop_words)
foods_df
```

```
<ipython-input-31-bf2535701b8d>:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable
  foods_df['review/text'] = foods_df['review/text'].apply(lambda x: ' '.join([word
<ipython-input-31-bf2535701b8d>:4: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable
  foods_df['review/summary'] = foods_df['review/summary'].apply(lambda x: ' '.join
         product/productId      review/userId  review/profileName  review/helpfuln
```

We are plotting the word cloud after cleaning the data to see how well we were able to clean the data.

```
positive_review = foods_df[foods_df["review/type"] == "Positive"]
text = " ".join(review for review in positive_review['review/text'] + ' ' + positive_review['review/summary'])
print ("There are {} words in the combination of all review.".format(len(text)))

# Create stopword list:
default_stopwords=set(stopwords.words('english'))

# Generate a word cloud image
wordcloud = WordCloud(width=800, height=400, background_color='white').generate(text)

# Display the generated image:
plt.figure()
plt.title('Positive reviews wordcloud')
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```

```
There are 111719718 words in the combination of all review.
```

After cleaning the data and removing the unnecessary data we can see that our word cloud has words that are relavent to the positive feedback. We can see that the html data and numerical data that was present in the plot before is eliminated.

```
negative_review = foods_df[foods_df["review/type"] == "Negative"]
text = " ".join(review for review in negative_review['review/text'] + ' ' + negative_review['review/summary'])
print ("There are {} words in the combination of all review.".format(len(text)))

# Create stopword list:
default_stopwords=set(stopwords.words('english'))

# Generate a word cloud image
wordcloud = WordCloud(background_color="white", width=1200, height=600).generate(text)

# Display the generated image:
plt.figure()
plt.title('Negative reviews wordcloud')
plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```

```
There are 22594232 words in the combination of all review.
```

Negative reviews wordcloud


```
# downloading the needed resources
# Download necessary resources
nltk.download('punkt')
nltk.download('wordnet')

# lemmatizing the data
def lemmatize_text(text):
    lemmatizer = WordNetLemmatizer()
    tokens = word_tokenize(text)
    lemmatized_tokens = [lemmatizer.lemmatize(token) for token in tokens]
    return ' '.join(lemmatized_tokens)

foods_df['lemmatized_text'] = foods_df['review/text'].apply(lemmatize_text)
foods_df['lemmatized_summary'] = foods_df['review/summary'].apply(lemmatize_text)

# after lemmatizing
foods_df.head(10)
```

```
[nltk_data] Downloading package punkt to /root/nltk_data...
[nltk_data]   Unzipping tokenizers/punkt.zip.
[nltk_data] Downloading package wordnet to /root/nltk_data...
[nltk_data]   Package wordnet is already up-to-date!
<ipython-input-34-0314e85d9ffa>:13: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable
  foods_df['lemmatized_text'] = foods_df['review/text'].apply(lemmatize_text)
<ipython-input-34-0314e85d9ffa>:14: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable
```

```
# making a new column
foods_df['clean_combined_text'] = foods_df['lemmatized_summary'] + ' ' + foods_df['lemmatized_text']
foods_df.head()
```

```
<ipython-input-35-10ad7eefa6ad>:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/us
  foods_df['clean_combined_text'] = foods_df['lemmatized_summary'] + ' ' + foods_df['
```

	product/productId	review/userId	review/profileName	review/helpfulness	rev
0	B001E4KFG0	A3SGXH7AUHU8GW	delmartian	1/1	
1	B00813GRG4	A1D87F6ZCVE5NK	dll pa	0/0	
2	B000LQOCH0	ABXLMWJIXXAIN	natalia corres "natalia corres"	1/1	
3	B000UA0QIQ	A395BORC6FGVXV	karl	3/3	
4	B006K2ZZ7K	A1UQRSCLF8GW1T	michael d. bigham "m. wassir"	0/0	

```
# Splitting the data into train and test data
X_train, X_test, y_train, y_test = train_test_split(foods_df['clean_combined_text'], foods_df['review/score'], test_size=0.2, random_st
```

```
# Vectorizing the text
# Bags of words
vectorizer = CountVectorizer()

X_train_text = vectorizer.fit_transform(X_train)
X_test_text = vectorizer.transform(X_test)
```

Naive Bayes classifier

```
# creating a naive bayes classifier
classifier = MultinomialNB(force_alpha=True)

# fit the data to the classifier
classifier.fit(X_train_text, y_train)
```

```
MultinomialNB
MultinomialNB(force_alpha=True)
```

```
# Evaluating the model
y_prediction = classifier.predict(X_test_text)

# accuracy
accuracy = accuracy_score(y_test, y_prediction)
print("Accuracy", accuracy)
```

Logistic regression

```
from sklearn.linear_model import LogisticRegression

classifier = LogisticRegression(max_iter=1000, random_state=42)
classifier.fit(X_train_text, y_train)

y_pred = classifier.predict(X_test_text)

accuracy = accuracy_score(y_test, y_pred)
print(f'Accuracy: {accuracy}')
# print(classification_report(y_test, y_pred))
```

```
Accuracy: 0.8196294096230862
/usr/local/lib/python3.10/dist-packages/sklearn/linear_model/_logistic.py:458: ConvergenceWarning: lbfgs failed to converge (status=
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
```

To classify the score using reviews we have to first clean the data to ensure that we give our classifier clean data to make sure we build a good model.

After reading the data into a pandas Data Frame we are cleaning the data. These are the ways the data has been cleaned.

1. We made all the data into lower case to ensure that data is read similarly.
2. We removed duplicate rows of data to ensure there is no redundant data.
3. HTML tags data is being as deleted as the given data has been scraped from a website and contains a lot of html tag data.
4. There was a lot of data where one character has been repeated more than once to express emotions those type of data has been cleaned.
5. Removed punctuations and special cravings to eliminate excess data that has no importance for our classification.
6. Removed digits from textual data.
7. STOP words take up a lot of space that is not required. English words that are used to make sentences gramatically correct. These words are not needed for our classification.

Before and after cleaning the data a word cloud is plotted to see the freqency of the words in our data. We can see the clear distinction of the data difference between the wordclouds that are plotted.

Naive Bayes and logistic regression have been used to classify the data. We can see that logistic regression predicted the data more accurately than naive bayes.

Accuracy of Naive Bayes: 77.13%

Accuracy of logistic regression: 81.96%