Product Recommendation System

Goals: Suggest top five products for the investment bracket, with detailed report sentiment analysis on those products reviews.

```
#import the drive
from google.colab import drive
drive.mount('/content/drive')
```

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

Step1: Importing Required packages and loading required dataset

```
import pandas as pd

import numpy as np

from sklearn.neighbors import NearestNeighbors

from sklearn.linear_model import LogisticRegression

from sklearn.metrics import accuracy_score, mean_squared_error

from sklearn.feature_selection import SelectKBest

from sklearn.feature_extraction.text import TfidfTransformer, TfidfVectorizer

import re

from wordcloud import WordCloud, STOPWORDS, ImageColorGenerator

from sklearn.model_selection import train_test_split

from sklearn import neighbors

import matplotlib.pyplot as plt

import matplotlib_inline
```

I have used 5-core Home and Kitchen reviews dataset. It is subset of the data in which all users and items have at least 5 reviews

```
from google.colab import drive
drive.mount('/content/drive')
```

```
import json

path = '/content/drive/MyDrive/Capstone Project/Home_and_Kitchen_5.json'

prod = []

with open(path, 'r') as f:
    for line in f:
        prod.append(json.loads(line))
```

I would like to see the top five rows of dataset.

```
sys = pd.DataFrame(prod)
```

```
#partial top 5 views
sys.head()
```

	reviewerID	asin	reviewerName	helpful	reviewText	overall	summary	unixReviewTime	reviewTime
0	APYOBQE6M18AA	0615391206	Martin Schwartz	[0, 0]	My daughter wanted this book and the price on ...	5.0	Best Price	1382140800	10 19, 2013
1	A1JVQTAGHYOL7F	0615391206	Michelle Dinh	[0, 0]	I bought this zoku quick pop for my daughterr ...	5.0	zoku	1403049600	06 18, 2014
2	A3UPYGJKZ0XTU4	0615391206	mirasreviews	[26, 27]	There is no shortage of pop recipes available ...	4.0	Excels at Sweet Dessert Pops, but Falls Short ...	1367712000	05 5, 2013
3	A2MHCTX43MIMDZ	0615391206	M. Johnson "Tea Lover"	[14, 18]	This book is a must have if you get a Zoku (wh...	5.0	Creative Combos	1312416000	08 4, 2011
4	[illegible]	[illegible]	[illegible]	[illegible]	This cookbook is great. I	[illegible]	A must own if you own	[illegible]	[illegible]

Data Dict

The above dataset has 9 variables. Those are

reviewerID: ID of the reviewer

asin: ID of the product

reviewerName: Name of the reviewer

helpful: helpfulness rating of the reviewer, e.g: 2/3

reviewText: text of the review

overall: rating of the product

summary: summary of the review

unixReviewTime: time of the review (unix time)

reviewTime: time of the review (raw)

```
#checking the shape of dataset
sys.shape
```

```
(551682, 9)
```

From the above we can say that the dataset has 551682 rows and 9 columns of information.

Step2: Preparing data for KNN modeling

```
sys.helpful.values.tolist()
```

Show hidden output

```
# Make new two columns out of 'helpful' column
sys[['helpfulfirst', 'helpfulsecond']] = pd.DataFrame(sys.helpful.values.tolist(), index=sys.index)
```

```
#checking the shape
sys.shape
```

```
(551682, 10)
```

I take the prodcuts with more than 100 product reviews for further analysis and modeling.

```
reviews_count = sys.groupby('asin').count().reset_index()
```

```
#checking the partial top view
reviews_count.head().T
```

	0	1	2	3	4
asin	0615391206	0689027818	0912696591	1223070743	1567120709
reviewerID	11	5	93	8	16
reviewerName	11	5	93	8	16
reviewText	11	5	93	8	16
overall	11	5	93	8	16
summary	11	5	93	8	16
unixReviewTime	11	5	93	8	16
reviewTime	11	5	93	8	16
helpfulfirst	11	5	93	8	16
helpfulsecond	11	5	93	8	16

Next steps: Generate code with `reviews_count` View recommended plots New interactive sheet

```
# merge the column of sys and reviews_count
sys_merged = pd.merge(sys, reviews_count, on = 'asin', how = 'right')
```

```
#renaming the columns
sys_merged.rename(columns={'reviewerID_y':'reviews_count','overall_x':'overall_review','summary_x':'summary_review'},inplace=True)
```

```
#merge the final columns
sys_final = sys_merged[['asin', 'summary_review', 'overall_review', 'reviews_count']]
```

```
#The code will sort the reviews by the number of reviews, and then return a list of all reviews with the highest count.
sys_merged=sys_merged.sort_values(by=['reviews_count'],ascending=False)
```

```
# selecting products with more than 50 reviews
sys_count = sys_merged[sys_merged.reviews_count > 50]
```

```
# The code will generate a DataFrame with the mean rating for each asin
sys_review_mean = sys_count.groupby('asin')['overall_review'].mean().reset_index()
```

```
sys_count.head()
```

	reviewerID_x	asin	reviewerName_x	reviewText_x	overall_review	summary_review	unixReviewTime_x	reviewTime_x	helpfulfirst_
42042	A1KB2Z9BE3BSI	B00006JSUA	Adam	I got this for the hype of searing steaks and ...	5.0	Great for someone new to cast iron	1390435200	01 23, 2014	
43074	A3ROWXDK7R0WKS	B00006JSUA	Will H	I use this skillet for cooking bacon and most ...	5.0	Best $10 ever spent	1402099200	06 7, 2014	
43073	AOGU17DLH0A4M	B00006JSUA	will	Handy smaller cast iron pan for the oven...Gre...	5.0	Add This Pan To Your Cooking Tool....	1383696000	11 6, 2013	
43072	AN1N8AMFA3K34	B00006JSUA	wifemeetslife	I have purchased several Lodge Products. This ...	5.0	The Busiest Pan in my Kitchen	1345766400	08 24, 2012	
43099	A9E9CW0ZEI160	B00006JSUA	Zorazen	I use this skillet every week. I expect I'll c...	5.0	Everything I could ask for.	1382486400	10 23, 2013	

```
#The code attempts to create a DataFrame of all the reviews for each product.
sys_summary_review = pd.DataFrame(sys_count.groupby('asin')['summary_review'].apply(list).reset_index())
```

```
#merge the reviews
sys_model = pd.merge(sys_summary_review, sys_review_mean, on = 'asin', how = 'inner')
```

```
sys_model_data = sys_model[['asin', 'summary_review', 'overall_review']]
```

```
#checking the partial view
sys_model_data.head(5)
```

```
         asin                                      summary_review  overall_review
0  0912696591  [simple book but tons of info, Nice Book, Need...        4.548387
1  B00000JGRP  [Great Little Tool!, Not made to the same stan...        3.948052
2  B00000JGRT  [milk-based products OK, but doesn't work for ...        4.473934
3  B00002N5Z9        [Fits perfect, and energy efficient., Ability ...        4.176471
4  B00002N602  [Couldn't live without this, Save Gas and Elec...        4.563107
```

Next steps: Generate code with `sys_model_data` | View recommended plots | New interactive sheet

Text processing for modeling:

```
#define a text process as text as input parameter
def text_process(text):
  text = text.lower()
  text = re.sub('[^a-z]+', ' ', text).strip()
  return text
```

The code will create a new column in the dataframe called clean_summary_review that is a string of all the text in df_model_data['summary_review'] with any single word or sentence replaced by an underscore.

```
sys_model_data['clean_summary_review'] = sys_model_data['summary_review'].apply(' '.join).apply(lambda x: text_process(x)).copy(deep=True)
```

```
#checking the partial view
sys_model_data['clean_summary_review'].head(5)
```

```
                             clean_summary_review
0  simple book but tons of info nice book needed ...
1     great little tool not made to the same standar...
2  milk based products ok but doesn t work for so...
3       fits perfect and energy efficient ability to m...
4     couldn t live without this save gas and electr...

dtype: object
```

```
#The code will drop all duplicates of the overall category.
sys_model_data.drop_duplicates(['overall_review'],keep = 'last', inplace=True)
```

```
#The code simply resets the index of the dataframe.
sys_model_data = sys_model_data.reset_index()
```

TFIDF model feature extraction from clean_summary_review column:

```
#TfidfVectorizer
tfidf = TfidfVectorizer(stop_words='english', ngram_range=(1,2), max_features = 500)
#The code will create a new dataframe with the tfidf values for each review.
X = tfidf.fit_transform(sys_model_data['clean_summary_review'])
```

Splitting X into train and test datasets.

```
#The code creates a DataFrame with the data that is stored in X_reviews.
X_reviews = pd.DataFrame(X.toarray(), columns = tfidf.get_feature_names_out()).astype(int)
```

```
X_reviews.head()
```

	absolutely	accurate	actually	addition	advertised	affordable	air	alternative	amazing	amazon	appliance	attractive	away	awesome	bad	b
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

5 rows × 500 columns

```
#The code will create a list of reviews and then convert it into an array.
X_reviews_array= np.array(X_reviews)
```

```
split_percent = 0.8

#The code is used to calculate the percentage of reviews that are positive and negative.
split_size = np.floor(split_percent * X_reviews_array.shape[0]).astype(int)
```

```
print(split_size)
```

```
1255
```

```
#split the dataset
X_train = X_reviews_array[:split_size]

X_test = X_reviews_array[split_size:]
```

Predictive Modeling: Let's use KNerighborsClassifier to classify: Predicting overall review based on product reviews:

Let's define the target variable for predictive modeling

The code starts by creating a list of the overall data.This is done with sys_model_data['overall'].Then, it creates two variables: X_train and y_train.These are lists of all the training data for this model.The first variable, X_train, has shape[0] equal to 10 because there are 10 rows in that list.The second variable, y_test, has shape[0]: 9 because there are 9 columns in that list.Next, it creates an array called xy which contains all the features from both arrays (X and Y).

```
y_train = sys_model_data['overall_review'][:X_train.shape[0]].astype(int)

y_test = sys_model_data['overall_review'][X_train.shape[0]:].astype(int)
```

```
knnclassifier = neighbors.KNeighborsClassifier(n_neighbors=5, weights='distance')

#The code creates a model that predicts the probability of an event occurring.
knnclassifier.fit(X_train, y_train)
#predict the results
knnclassifier_predictions= knnclassifier.predict(X_test)
```

```
# the accucary score and mean squared error
print('Accuracy score: ', accuracy_score(y_test, knnclassifier_predictions))

print('Mean squared error: ', mean_squared_error(y_test, knnclassifier_predictions))
```

```
Accuracy score:  0.8949044585987261
Mean squared error:  0.10509554140127389
```

Word Clouding for each review group:

```
#he code will create a list of all the reviews for each overall rating.
review_text_for_overall = sys_model_data.groupby('overall_review')['summary_review'].apply(list).reset_index()
```

```
#print top 5 view
review_text_for_overall
```

	overall_review	summary_review
0	2.839286	[[You get what you pay for, It works okay., Di...
1	2.942029	[[High maintenance, but makes great coffee, Mi...
2	2.988095	[[Frayed after 1 wash, Purchasing linens witho...
3	3.016667	[[Really efficient little grinder, Best coffee...
4	3.030612	[[Works...By Trial And Error, Nice for breakfa...
...	...	...
1564	4.934426	[[I love these, Love these, Keep Your Wine Dif...
1565	4.952381	[[Found it!, Trimumph of Design, Works great!,...
1566	4.972603	[[Love it! The best!, Love that BMI is include...
1567	4.983051	[[creative & easy to use, Love these labels!!!...
1568	4.984375	[[Amazing small fan with lots of functions, Co...

1569 rows × 2 columns

Next steps: Generate code with `review_text_for_overall` View recommended plots New interactive sheet

The code starts by creating a list of review text objects. It then creates an empty string and appends the summary to it, which is done with the .join() method. The code then uses the text_process function to process each word in this string, which is done with the lambda x: text_process(x) function. The code takes the text of the review and converts it into a list of words, which are then joined together.

```
review_text_for_overall['clean_summary'] = review_text_for_overall['summary_review'].apply(
    lambda review_list: ' '.join([str(item) for item in review_list])
).apply(lambda x: text_process(x))
```

```
review_text_for_overall
```

	overall_review	summary_review	clean_summary
0	2.839286	[[You get what you pay for, It works okay., Di...	you get what you pay for it works okay disappo...
1	2.942029	[[High maintenance, but makes great coffee, Mi...	high maintenance but makes great coffee mixed ...
2	2.988095	[[Frayed after 1 wash, Purchasing linens witho...	frayed after wash purchasing linens without to...
3	3.016667	[[Really efficient little grinder, Best coffee...	really efficient little grinder best coffee gr...
4	3.030612	[[Works...By Trial And Error, Nice for breakfa...	works by trial and error nice for breakfast ok...
...	...	...	...
1564	4.934426	[[I love these, Love these, Keep Your Wine Dif...	i love these love these keep your wine differe...
1565	4.952381	[[Found it!, Trimumph of Design, Works great!,...	found it trimumph of design works great stunni...
1566	4.972603	[[Love it! The best!, Love that BMI is include...	love it the best love that bmi is included gre...
1567	4.983051	[[creative & easy to use, Love these labels!!!...	creative easy to use love these labels amazing...
1568	4.984375	[[Amazing small fan with lots of functions, Co...	amazing small fan with lots of functions compa...

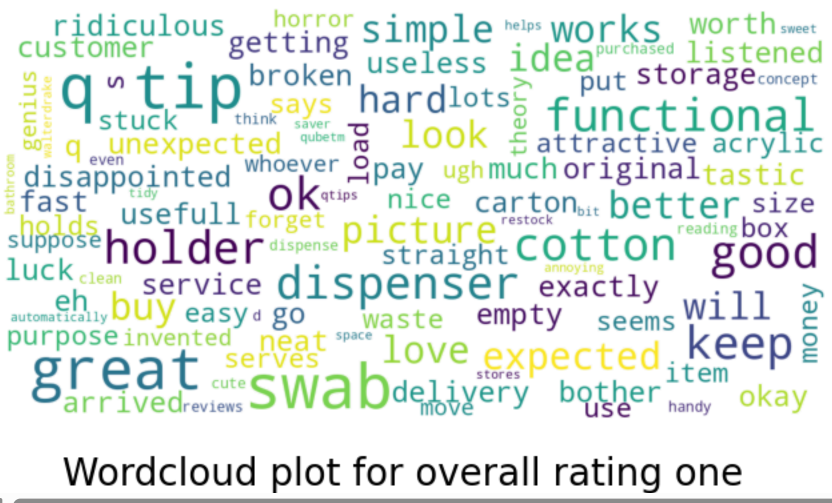
1569 rows × 3 columns

Next steps: Generate code with `review_text_for_overall` View recommended plots New interactive sheet

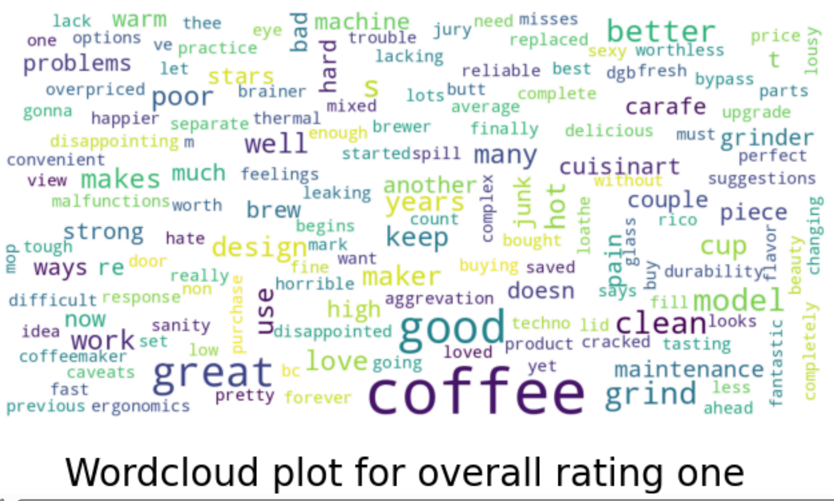
Write a function to draw wordcloud for each overall rating group:

```
#set the stop words
stop_words = set(STOPWORDS)


def wordcloud_plot(txt_dat, title=None):
    wordcloud = WordCloud(background_color='white', stopwords=stop_words, max_words=300, max_font_size=30,scale=3, random_state=1).generate(str(txt_da



    fig = plt.figure(figsize=(8, 8))
    plt.axis('off')
    if title:
        fig.suptitle(title, fontsize=20)
        fig.subplots_adjust(top=2.3)


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

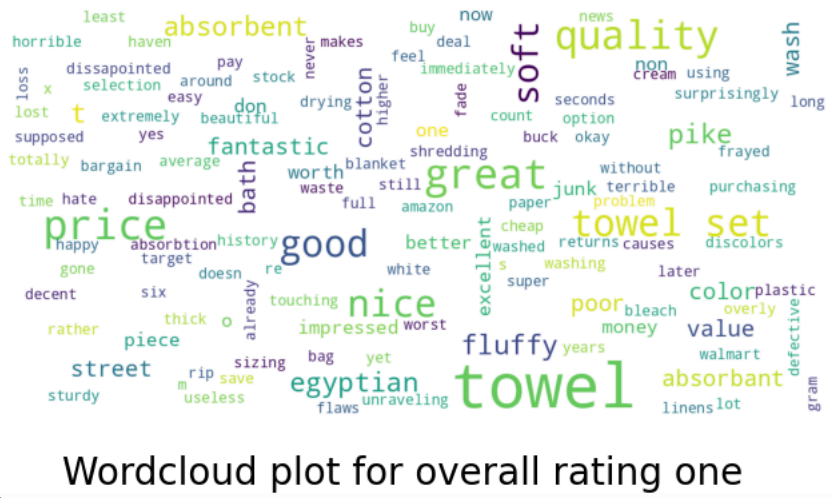
```
#the graph of one rating
wordcloud_plot(review_text_for_overall['clean_summary'][0], title = 'Wordcloud plot for overall rating one')
```



```
#the graph of two rating


wordcloud_plot(review_text_for_overall['clean_summary'][1], title = 'Wordcloud plot for overall rating one')
```



```
#the graph of three rating

wordcloud_plot(review_text_for_overall['clean_summary'][2], title = 'Wordcloud plot for overall rating one')
```



```
#plot the graph of four rating

wordcloud_plot(review_text_for_overall['clean_summary'][3], title = 'Wordcloud plot for overall rating one')
```

Wordcloud plot for overall rating one

```
#the graph of five rating

wordcloud_plot(review_text_for_overall['clean_summary'][4], title = 'Wordcloud plot for overall rating one')
```

Wordcloud plot for overall rating one

Applying KNN model to find out five nearest prodcuts:

To find the 5 nearest neighbors, I am going to use NearestNeighbors algorithm.

```
#The code is used to calculate the nearest neighbors of a given point in a dataset.
#with n=5 and algorithm ball_tree and fit the model
nearest_neighbors = NearestNeighbors(n_neighbors=5, algorithm='ball_tree').fit(X_train)
```

```
#The code will find the index of the nearest neighbor to X_train.
dist, indices = nearest_neighbors.kneighbors(X_train)
```

We have predicted the 5 products based on ratings by using KNN

```
for i in range(X_test.shape[0]):
    try:
        # Get the nearest neighbors for the i-th test product
        test_neighbors = nearest_neighbors.kneighbors([X_test[i]])
        related_product_indices = indices[i]  # assuming 'indices' is already from kneighbors()

        # Extract top 5 nearest neighbor indices
        first_nearest_product = related_product_indices[0]
        second_nearest_product = related_product_indices[1]
        third_nearest_product = related_product_indices[2]
        fourth_nearest_product = related_product_indices[3]
        fifth_nearest_product = related_product_indices[4]

        if i < 4:
            # Print the original product's review info
            print('Based on product reviews of', sys_model_data['asin'][X_train.shape[0] + i],
                  'the average rating is', sys_model_data['overall_review'][X_train.shape[0] + i])

            # Print recommended products
            print('The 1st recommended product is', sys_model_data['asin'][first_nearest_product],
                  'the average rating is', sys_model_data['overall_review'][first_nearest_product])
        print('The 2nd recommended product is', sys_model_data['asin'][second_nearest_product],
              'the average rating is', sys_model_data['overall_review'][second_nearest_product])
        print('The 3rd recommended product is', sys_model_data['asin'][third_nearest_product],
              'the average rating is', sys_model_data['overall_review'][third_nearest_product])
        print('The 4th recommended product is', sys_model_data['asin'][fourth_nearest_product],
              'the average rating is', sys_model_data['overall_review'][fourth_nearest_product])
        print('The 5th recommended product is', sys_model_data['asin'][fifth_nearest_product],
              'the average rating is', sys_model_data['overall_review'][fifth_nearest_product])
        print('---------------------------------------------------------------------------------------------')

    except Exception as e:
        print(f"Error processing index {i}: {e}")
```

```
Based on product reviews of B005SI8YZC the average rating is 3.8656716417910446
The 1st recommended product is 0912696591 the average rating is 4.548387096774194
The 2nd recommended product is B00002N8CX the average rating is 4.28476821192053
The 3rd recommended product is B00002N602 the average rating is 4.563106796116505
The 4th recommended product is B00000JGRP the average rating is 3.948051948051948
The 5th recommended product is B00004OCO6 the average rating is 4.43956043956044
-------------------------------------------------------------------------------------------
Based on product reviews of B005SPEV66 the average rating is 4.322033898305085
The 1st recommended product is 0912696591 the average rating is 4.548387096774194
The 2nd recommended product is B00002N8CX the average rating is 4.28476821192053
The 3rd recommended product is B00002N602 the average rating is 4.563106796116505
The 4th recommended product is B00000JGRP the average rating is 3.948051948051948
The 5th recommended product is B00004OCO6 the average rating is 4.43956043956044
-------------------------------------------------------------------------------------------
Based on product reviews of B005TOVVSC the average rating is 4.516666666666667
The 1st recommended product is 0912696591 the average rating is 4.548387096774194
The 2nd recommended product is B00002N8CX the average rating is 4.28476821192053
The 3rd recommended product is B00002N602 the average rating is 4.563106796116505
The 4th recommended product is B00000JGRP the average rating is 3.948051948051948
The 5th recommended product is B00004OCO6 the average rating is 4.43956043956044
-------------------------------------------------------------------------------------------
Based on product reviews of B005TOVZSS the average rating is 4.706666666666667
The 1st recommended product is 0912696591 the average rating is 4.548387096774194
The 2nd recommended product is B00002N8CX the average rating is 4.28476821192053
The 3rd recommended product is B00002N602 the average rating is 4.563106796116505
The 4th recommended product is B00000JGRP the average rating is 3.948051948051948
The 5th recommended product is B00004OCO6 the average rating is 4.43956043956044
-------------------------------------------------------------------------------------------
```