[1]. Reading Data

Taken help from https://github.com/krpiyush5/Amazon-Fine-Food-Review/blob/master/10%20Amazon%20Fine%20Food%20Reviews%20Analysis_Clustering.ipynb for v of code i was able to understand also https://github.com/Manish-12/Clustering-Techniques-on-Amaz reviews/blob/master/DBSCAN.ipynb

Let me copy code from my previous assignment where we are doing preprocessing steps like deduplic decontraction of words,lemmatization etc.

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

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.m
```

```
cd drive/My\ Drive
```

```
[Errno 2] No such file or directory: 'drive/My Drive'
/content/drive/My Drive
```

```
%matplotlib inline
import warnings
warnings.filterwarnings("ignore")
import nltk
nltk.download('stopwords')
```

```
import sqlite3
import pandas as pd
import numpy as np
import nltk
import string
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.feature_extraction.text import TfidfTransformer
from sklearn.feature_extraction.text import TfidfVectorizer

from sklearn.feature_extraction.text import CountVectorizer
from sklearn.metrics import confusion_matrix
from sklearn import metrics
from sklearn.metrics import roc_curve, auc
from nltk.stem.porter import PorterStemmer
from nltk.stem import PorterStemmer
from nltk.stem.snowball import SnowballStemmer
```

```
import re
# Tutorial about Python regular expressions: https://pymotw.com/2/re/
import string
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer
from nltk.stem.wordnet import WordNetLemmatizer

from gensim.models import Word2Vec
from gensim.models import KeyedVectors
import pickle
from sklearn.model_selection import cross_val_score
from sklearn.metrics import accuracy_score
from sklearn.metrics import roc_auc_score

from tqdm import tqdm
import os
```

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

```
#con = sqlite3.connect(r"D:\AppliedAI\AAIC_Course_handouts\11_Amazon Fine Food Reviews\ama
con = sqlite3.connect(r"database.sqlite")
data = pd.read_sql_query(""" SELECT * FROM Reviews WHERE Score != 3""",con)
#data = pd.read_csv(""" SELECT * FROM Reviews WHERE Score != 3""",con)

# Change Score with 1 n 2 as -ve and 4 n 5 as +ve

def chng_to_0_or_1 (Score):
    if Score ==4 or Score ==5:
        return 1
    elif Score ==1 or Score ==2:
        return 0
    else:# Thus in case by some mistake any data is their with rating 6 or 7 etc due to sc
        pass
currentScore = data["Score"]
new_Score = currentScore.map(chng_to_0_or_1)
data["Score"] = new_Score
print ("Number of data points available")
print (data.shape)#Gives original number of data points available


#2 Data Cleaning a.) Getting rid of duplicates and b.) if helpnessdenominator < helpfulnes


data = data.drop_duplicates(subset = ["UserId","ProfileName","HelpfulnessNumerator","Helpf
print ("Number of data points after removing duplicates")
print (data.shape)#Gives data points are deduplication

# Reference: Copied from above cell  final=final[final.HelpfulnessNumerator<=final.Helpful
data=data[data.HelpfulnessNumerator<=data.HelpfulnessDenominator]
```

```
print ("Number of data points after removing where HelpfulnessNumerator is more than Helpf
print (data.shape)

#3 Preprocessing begins

#Convert to lower case,convert shortcut words to proper words, remove Special Character

#i) Convert to lower case:
data["Text"] =  (data["Text"].str.lower())
data["Summary"] =  (data["Summary"].str.lower())

#ii) Convert Shortcuts words to proper words
#List of Words are:https://en.wikipedia.org/wiki/Wikipedia:List_of_English_contractions
#Reference:https://stackoverflow.com/questions/39602824/pandas-replace-string-with-another
data['Text'] = data['Text'].replace({"ain't":"am not","amn't":"am not","aren't":"are not",
"can't":"cannot","cause":"because","could've":"could have","couldn't":"could not","couldn'
"daren't":"dare not","daresn't":"dare not","dasn't":"dare not","didn't":"did not","doesn't
"don't":"do not","e'er":"ever","everyone's":"everyone is","finna":"fixing to","gimme":"giv
"gonna":"going to","gon't":"go not","gotta":"got to","hadn't":"had not","hasn't":"has not'
"he'd":"he had","he'll":"he shall","he's":"he has","he've":"he have","how'd":"how did","ho
"how're":"how are","how's":"how has","I'd":"I had","I'll":"I shall","I'm":"I am","I'm'a":'
"I'm'o":"I am going to","I've":"I have","isn't":"is not","it'd":"it would","it'll":"it sha
"let's":"let us","mayn't":"may not","may've":"may have","mightn't":"might not","might've":
"mustn't":"must not","mustn't've":"must not have","must've":"must have","needn't":"need no
"o'clock":"of the clock","o'er":"","ol'":"old","oughtn't":"ought not","shalln't":"shall no
"she'd":"she had","she'll":"she shall","she's":"she is","should've":"should have","shouldn
"shouldn't've":"should not have","somebody's":"somebody has","someone's":"someone has","so
"that'll":"that will","that're":"that are","that's":"that is","that'd":"that would","there
"there'll":"there shall","there're":"there are","there's":"there is","these're":"hese are'
"they'll":"they will","they're":"they are","they've":"they have","this's":"","those're":"t
"twas":"it was","wasn't":"was not","we'd":"we had","we'd've":"we would have","we'll":"we w
"we've":"we have","weren't":"were not","what'd":"what did","what'll":"what will","what're'
"what've":"what have","when's":"when is","where'd":"where did","where're":"where are","whe
"which's":"which has","who'd":"who would","who'd've":"who would have","who'll":"who shall'
"who's":"who has","who've":"who have","why'd":"why did","why're":"why are","why's":"why ha
"would've":"would have","wouldn't":"would not","y'all":"you all","you'd":"you had","you'll
"you've":"you have"})
##############Lets do the same for summary Text#####################################
data['Summary'] = data['Summary'].replace({"ain't":"am not","amn't":"am not","aren't":"are
"can't":"cannot","cause":"because","could've":"could have","couldn't":"could not","couldn'
"daren't":"dare not","daresn't":"dare not","dasn't":"dare not","didn't":"did not","doesn't
"don't":"do not","e'er":"ever","everyone's":"everyone is","finna":"fixing to","gimme":"giv
"gonna":"going to","gon't":"go not","gotta":"got to","hadn't":"had not","hasn't":"has not'
"he'd":"he had","he'll":"he shall","he's":"he has","he've":"he have","how'd":"how did","ho
"how're":"how are","how's":"how has","I'd":"I had","I'll":"I shall","I'm":"I am","I'm'a":'
"I'm'o":"I am going to","I've":"I have","isn't":"is not","it'd":"it would","it'll":"it sha
"let's":"let us","mayn't":"may not","may've":"may have","mightn't":"might not","might've":
"mustn't":"must not","mustn't've":"must not have","must've":"must have","needn't":"need no
"o'clock":"of the clock","o'er":"","ol'":"old","oughtn't":"ought not","shalln't":"shall no
"she'd":"she had","she'll":"she shall","she's":"she is","should've":"should have","shouldn
"shouldn't've":"should not have","somebody's":"somebody has","someone's":"someone has","so
"that'll":"that will","that're":"that are","that's":"that is","that'd":"that would","there
```

```
"there'll":"there shall","there're":"there are","there's":"there is","these're":"hese are'
"they'll":"they will","they're":"they are","they've":"they have","this's":"","those're":"t
"twas":"it was","wasn't":"was not","we'd":"we had","we'd've":"we would have","we'll":"we v
"we've":"we have","weren't":"were not","what'd":"what did","what'll":"what will","what're'
"what've":"what have","when's":"when is","where'd":"where did","where're":"where are","whe
"which's":"which has","who'd":"who would","who'd've":"who would have","who'll":"who shall'
"who's":"who has","who've":"who have","why'd":"why did","why're":"why are","why's":"why ha
"would've":"would have","wouldn't":"would not","y'all":"you all","you'd":"you had","you'll
"you've":"you have"})
##############################################################################################
# iii) Remove Special Characters except alpahbets and numbers
#The reason i dont want to remove number people might write got five eggs as 5 eggs or vic
#that information which could be useful
#Ref:https://stackoverflow.com/questions/33257344/how-to-remove-special-characers-from-a-c
data["Text"]=data["Text"].map(lambda x: re.sub(r'[^a-zA-Z_0-9 -]', '', x))
data["Summary_copy"]=data["Summary"].map(lambda x: re.sub(r'[^a-zA-Z_0-9 -]', '', x))

#The Summary are usually so small if we remove few stopwords the meaning itself would be c
# So let us see what all stopwords we have
#Ref:::::::::https://stackoverflow.com/questions/5511708/adding-words-to-nltk-stoplist
#https://chrisalbon.com/machine_learning/preprocessing_text/remove_stop_words/

stopwords = nltk.corpus.stopwords.words('english')
newStopWords = ['would','could','br','<br>','<','>']
notstopwords = ['not','no','nor']
stopwords.extend(newStopWords)
stopwords = [word for word in stopwords if word not in notstopwords]

#  iv) For now let us just go with flow will use default stopwords as creating our own stc
#Rather will use n-gram stratergy to get rid of problem of stopwords removal changing the
#Ref:https://stackoverflow.com/questions/43184364/python-remove-stop-words-from-pandas-dat
data["New_Text"]= data['Text'].apply(lambda x: [item for item in str.split(x) if item not
data["Summary"]= data['Summary_copy'].apply(lambda x: [item for item in str.split(x) if it

#Ref:https://stackoverflow.com/questions/37347725/converting-a-panda-df-list-into-a-string
#we are creating new column New_summary so in case in future we need summary it is intact
data["New_Text"]=data["New_Text"].apply(' '.join)
data["Summary"]=data["Summary"].apply(' '.join)

# v) Now lets do Stemming
#https://stackoverflow.com/questions/48617589/beginner-stemming-in-pandas-produces-letters
english_stemmer=SnowballStemmer('english', ignore_stopwords=True)
data["New_Text"] = data["New_Text"].apply(english_stemmer.stem)
data["Summary"] = data["Summary"].apply(english_stemmer.stem)
data["New_Text"] = data["New_Text"].astype(str)
data["Summary"] = data["Summary"].astype(str)

#vi) stemming without removing stop words
english_stemmer=SnowballStemmer('english', ignore_stopwords=True)
#https://stackoverflow.com/questions/34724246/attributeerror-float-object-has-no-attribute
data["Text_with_stop"]=data["Text"].astype(str)
```

```
data["Summary"]=data["Summary"].astype(str)
data["Text_with_stop"]=data["Text_with_stop"].str.lower().map(english_stemmer.stem)
data["Summary"]=data["Summary"].str.lower().map(english_stemmer.stem)
data["Text_with_stop"]=data["Text_with_stop"].apply(''.join)
data["Summary"]=data["Summary"].apply(''.join)
data["Text_with_stop"] = data["Text_with_stop"].astype(str)
data["Summary"] = data["Summary"].astype(str)
print(data["Score"].value_counts())
print ("Thus we see there are 85% and 15% positive and negative reviews,thus a unbalanced
dataset we first copy negative dataset 6 times than we sample with same number of times as
# Let include another feature which is the length of the text
data_neg = data[data["Score"] == 0]
data_pos = data[data["Score"] == 1]
data = pd.concat([data_pos,data_neg])
#https://stackoverflow.com/questions/46429033/how-do-i-count-the-total-number-of-words-in-
data["Text_length"]= (data["New_Text"].str.count(' ') + 1)
data["Summary_length"]= (data["Summary"].str.count(' ') + 1)
data["Time_formatted"]= pd.to_datetime(data["Time"])
data.sort_values(by=['Time_formatted'], inplace=True)
```

```
Number of data points available
(525814, 10)
Number of data points after removing duplicates
(366392, 10)
Number of data points after removing where HelpfulnessNumerator is more than Helpfulr
(366390, 10)
1    308679
0     57711
Name: Score, dtype: int64
Thus we see there are 85% and 15% positive and negative reviews,thus a unbalanced dat
```

Now in actual scenario of Clustering we should not be having ground truth or yi's . So we should drop
algorithm like K means etc is able to give results.

Let us keep "data" frame intact so incase something gets corrupted we can resuse it. We will create a r
named "newdata"

```
#newdata=data.drop(columns=['Score'])
newdata = data
```

Let us just last 50k (Latest) reviews as per the assignment for K means we need to use 50K reviews fo
agglomerative and DBSCAN

```
newdata_50K = data.tail(50000)
newdata_50K.sort_values(by=['Time_formatted'], inplace=True)

newdata_5K = data.tail(5000)
newdata_5K.sort_values(by=['Time_formatted'], inplace=True)


X_no_stop_50k_reviews = newdata_50K['New_Text'].values
```

```
X_no_stop_50k_reviews = newdata_50K['New_Text'].values

X_no_stop_5k_reviews = newdata_5K['New_Text'].values
```

[4] Featurization

[4.1] BAG OF WORDS

```
%time
from sklearn.feature_extraction.text import CountVectorizer
import math

bow_vect_50K = CountVectorizer(min_df = 7,max_features=9000)
bow_X_no_stop_50k_reviews = bow_vect_50K.fit_transform(X_no_stop_50k_reviews)
#bow_X_summary_50k = bow_vect.fit_transform(X_summary_50k)
#bow_X_no_stop_5k_reviews = bow_vect.fit_transform(X_no_stop_5k_reviews)
#bow_X_summary_5k = bow_vect.fit_transform(X_summary_5k)
```

```
CPU times: user 3 µs, sys: 0 ns, total: 3 µs
Wall time: 7.63 µs
```

```
features = bow_vect_50K.get_feature_names()
print (len(features))
```

```
9000
```

```
print("the shape of out text BOW vectorizer using 50K reviews",bow_X_no_stop_50k_reviews.g
#print("the shape of out summary BOW vectorizer using 50K reviews ",bow_X_summary_50k.get_
#print("the shape of out text BOW vectorizer using 5K reviews",bow_X_no_stop_5k_reviews.ge
#print("the shape of out summary BOW vectorizer using 5K reviews",bow_X_summary_5k.get_sha
```

```
the shape of out text BOW vectorizer using 50K reviews (50000, 9000)
```

```
#BoW
"""
count_vect = CountVectorizer() #in scikit-learn
count_vect.fit(preprocessed_reviews)
print("some feature names ", count_vect.get_feature_names()[:10])
print('='*50)

final_counts = count_vect.transform(preprocessed_reviews)
print("the type of count vectorizer ",type(final_counts))
print("the shape of out text BOW vectorizer ",final_counts.get_shape())
print("the number of unique words ", final_counts.get_shape()[1])
"""
```

```
'\ncount_vect = CountVectorizer() #in scikit-learn\ncount_vect.fit(preprocessed_revie
```

Let us also standarize the data to be on safer side

```
from sklearn.preprocessing import StandardScaler
import warnings
warnings.filterwarnings('ignore')

bow_X_no_stop_50k_reviews_std =StandardScaler(with_mean=False,with_std=False).fit_transfor
#bow_X_summary_50k_std =StandardScaler(with_mean=False,with_std=False).fit_transform(bow_X
#bow_X_no_stop_5k_reviews_std =StandardScaler(with_mean=False,with_std=False).fit_transfor
#bow_X_summary_5k_std =StandardScaler(with_mean=False,with_std=False).fit_transform(bow_X_

print("the shape of out text BOW vectorizer using 50K reviews after standarization",bow_X_
#print("the shape of out summary BOW vectorizer using 50K reviews after standarization",bo
#print("the shape of out text BOW vectorizer using 5K reviews after standarization",bow_X_
#print("the shape of out summary BOW vectorizer using 5K reviews after standarization",bov
```

```
the shape of out text BOW vectorizer using 50K reviews after standarization (50000, 9
```

[4.2] Bi-Grams and n-Grams.

```
#bi-gram, tri-gram and n-gram

#removing stop words like "not" should be avoided before building n-grams
# count_vect = CountVectorizer(ngram_range=(1,2))
# please do read the CountVectorizer documentation http://scikit-learn.org/stable/modules/

# you can choose these numebrs min_df=10, max_features=5000, of your choice
'''
count_vect = CountVectorizer(ngram_range=(1,2), min_df=10, max_features=5000)
final_bigram_counts = count_vect.fit_transform(preprocessed_reviews)
print("the type of count vectorizer ",type(final_bigram_counts))
print("the shape of out text BOW vectorizer ",final_bigram_counts.get_shape())
print("the number of unique words including both unigrams and bigrams ", final_bigram_cour
'''
```

```
'\ncount_vect = CountVectorizer(ngram_range=(1,2), min_df=10, max_features=5000)\nfir
```

```
bow_vect_bigram = CountVectorizer(ngram_range = (1,2),min_df = 7,max_features=9000)
bow_X_no_stop_50k_reviews_bigram = bow_vect_bigram.fit_transform(X_no_stop_50k_reviews)
#bow_X_summary_50k_bigram = bow_vect_bigram.fit_transform(X_summary_50k)
#bow_X_no_stop_5k_reviews_bigram = bow_vect_bigram.fit_transform(X_no_stop_5k_reviews)
```

```
#bow_X_summary_5k_bigram = bow_vect_bigram.fit_transform(X_summary_5k)


bow_X_no_stop_50k_reviews_bigram_std =StandardScaler(with_mean=False,with_std=False).fit_t
#bow_X_summary_50k_bigram_std =StandardScaler(with_mean=False,with_std=False).fit_transfor
#bow_X_no_stop_5k_reviews_bigram_std =StandardScaler(with_mean=False,with_std=False).fit_t
#bow_X_summary_5k_bigram_std =StandardScaler(with_mean=False,with_std=False).fit_transform


print("the shape of out text BOW vectorizer with bigram using 50K reviews after standariza
#print("the shape of out summary BOW vectorizer with bigram using 50K reviews after standa
#print("the shape of out text BOW vectorizer with bigram using 5K reviews after standariza
#print("the shape of out summary BOW vectorizer with bigram using 5K reviews after standar
```

```
the shape of out text BOW vectorizer with bigram using 50K reviews after standarizati
```

[4.3] TF-IDF

```
tf_idf_vect = TfidfVectorizer(ngram_range=(1,2), min_df=10,max_features=9000)
tfidf_X_no_stop_50k_reviews=tf_idf_vect.fit_transform(X_no_stop_50k_reviews)
#tfidf_X_summary_50k=tf_idf_vect.fit_transform(X_summary_50k)
#tfidf_X_no_stop_5k_reviews=tf_idf_vect.fit_transform(X_no_stop_5k_reviews)
#tfidf_X_summary_5k=tf_idf_vect.fit_transform(X_summary_5k)

tfidf_X_no_stop_50k_reviews_std =StandardScaler(with_mean=False,with_std=False).fit_transf
#tfidf_X_summary_50k_std =StandardScaler(with_mean=False,with_std=False).fit_transform(tfi
#tfidf_X_no_stop_5k_reviews_std =StandardScaler(with_mean=False,with_std=False).fit_transf
#tfidf_X_summary_5k_std =StandardScaler(with_mean=False,with_std=False).fit_transform(tfic
"""
print("some sample features(unique words in the corpus)",tf_idf_vect.get_feature_names()[0
print('='*50)

final_tf_idf = tf_idf_vect.transform(preprocessed_reviews)
print("the type of count vectorizer ",type(final_tf_idf))
print("the shape of out text TFIDF vectorizer ",final_tf_idf.get_shape())
print("the number of unique words including both unigrams and bigrams ", final_tf_idf.get_
"""
```

```
'\nprint("some sample features(unique words in the corpus)",tf_idf_vect.get_feature_r
```

```
print("the shape of out text TFIDF vectorizer with bigram using 50K reviews after standari
#print("the shape of out summary TFIDF vectorizer with bigram using 50K summary after star
#print("the shape of out text TFIDF vectorizer with bigram using 5K reviews after standari
#print("the shape of out summary TFIDF vectorizer with bigram using 5K summary after stand
```

```
the shape of out text TFIDF vectorizer with bigram using 50K reviews after standariza
```

[4.4] Word2Vec

```
lst_50k_reviews=[]
#lst_5k_reviews=[]
lst_of_lst_50k_review = []
#lst_of_lst_5k_review = []

for sentance in tqdm(X_no_stop_50k_reviews):
    lst_50k_reviews.append(sentance.strip())
for sentance in tqdm(lst_50k_reviews):
    lst_of_lst_50k_review.append(sentance.split())

#for sent in tqdm(X_no_stop_5k_reviews):
#    lst_5k_reviews.append(sent.strip())
#for sent in tqdm(lst_5k_reviews):
#    lst_of_lst_5k_review.append(sent.split())


w2v_model_self_taught_50K=Word2Vec(lst_of_lst_50k_review,min_count=1,size=50, workers=4)
w2v_words_50K = list(w2v_model_self_taught_50K.wv.vocab)

#w2v_model_self_taught_5K=Word2Vec(lst_of_lst_5k_review,min_count=1,size=50, workers=4)
#w2v_words_5K = list(w2v_model_self_taught_5K.wv.vocab)
```

```
100%|██████████| 50000/50000 [00:00<00:00, 904619.39it/s]
100%|██████████| 50000/50000 [00:00<00:00, 68187.09it/s]
```

```
print (len(w2v_words_50K))
```

```
69537
```

```
"""
# Using Google News Word2Vectors

# in this project we are using a pretrained model by google
# its 3.3G file, once you load this into your memory
# it occupies ~9Gb, so please do this step only if you have >12G of ram
# we will provide a pickle file wich contains a dict ,
# and it contains all our courpus words as keys and  model[word] as values
# To use this code-snippet, download "GoogleNews-vectors-negative300.bin"
# from https://drive.google.com/file/d/0B7XkCwpI5KDYNlNUTTlSS21pQmM/edit
# it's 1.9GB in size.


# http://kavita-ganesan.com/gensim-word2vec-tutorial-starter-code/#.W17SRFAzZPY
# you can comment this whole cell
# or change these varible according to your need
```

```
is_your_ram_gt_16g=False
want_to_use_google_w2v = False
want_to_train_w2v = True

if want_to_train_w2v:
    # min_count = 5 considers only words that occured atleast 5 times
    w2v_model=Word2Vec(list_of_sentance,min_count=5,size=50, workers=4)
    print(w2v_model.wv.most_similar('great'))
    print('='*50)
    print(w2v_model.wv.most_similar('worst'))

elif want_to_use_google_w2v and is_your_ram_gt_16g:
    if os.path.isfile('GoogleNews-vectors-negative300.bin'):
        w2v_model=KeyedVectors.load_word2vec_format('GoogleNews-vectors-negative300.bin',
        print(w2v_model.wv.most_similar('great'))
        print(w2v_model.wv.most_similar('worst'))
    else:
        print("you don't have gogole's word2vec file, keep want_to_train_w2v = True, to tr

"""
```

```
'\n# Using Google News Word2Vectors\n\n# in this project we are using a pretrained mc
```

```
"""
w2v_words = list(w2v_model.wv.vocab)
print("number of words that occured minimum 5 times ",len(w2v_words))
print("sample words ", w2v_words[0:50])
"""
```

```
'\nw2v_words = list(w2v_model.wv.vocab)\nprint("number of words that occured minimum
```

[4.4.1] Converting text into vectors using Avg W2V, TFIDF-W2V

[4.4.1.1] Avg W2v

```
sent_vectors_50K = []
for sent1 in tqdm(lst_of_lst_50k_review): # for each review/sentence
    sent_vec1 = np.zeros(50)
    cnt_words1 = 0
    for word1 in sent1:
        if word1 in w2v_words_50K:
            vec1 = w2v_model_self_taught_50K.wv[word1]
            sent_vec1 += vec1
            cnt_words1 += 1
    if cnt_words1 != 0:
        sent_vec1 /= cnt_words1
```

```
    sent_vectors_50K.append(sent_vec1)
```

```
100%|██████████| 50000/50000 [02:23<00:00, 349.12it/s]
```

```
print (len(sent_vectors_50K))
```

```
50000
```

```
"""
sent_vectors_5K = []
for sent2 in tqdm(lst_of_lst_5k_review): # for each review/sentence
    sent_vec2 = np.zeros(50)
    cnt_words2 = 0
    for word2 in sent2:
        if word2 in w2v_words_5K:
            vec2 = w2v_model_self_taught_5K.wv[word2]
            sent_vec2 += vec2
            cnt_words2 += 1
    if cnt_words2 != 0:
        sent_vec2 /= cnt_words2
    sent_vectors_5K.append(sent_vec2)
"""
```

```
'\nsent_vectors_5K = []\nfor sent2 in tqdm(lst_of_lst_5k_review): # for each review/s
```

```
#print (len(sent_vectors_5K))
```

```
from sklearn.preprocessing import StandardScaler
import warnings
warnings.filterwarnings('ignore')

sent_vectors_50K_std =StandardScaler(with_mean=False,with_std=False).fit_transform(sent_ve
#sent_vectors_5K_std = StandardScaler(with_mean=False,with_std=False).fit_transform(sent_v
```

```
"""# average Word2Vec
# compute average word2vec for each review.
sent_vectors = []; # the avg-w2v for each sentence/review is stored in this list
for sent in tqdm(list_of_sentance): # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length 50, you might need to cha
    cnt_words =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    sent_vectors.append(sent_vec)
```

```
print(len(sent_vectors))
print(len(sent_vectors[0]))
"""
```

```
"# average Word2Vec\n# compute average word2vec for each review.\nsent_vectors = [];
```

[4.4.1.2] TFIDF weighted W2v

```
"""
# S = ["abc def pqr", "def def def abc", "pqr pqr def"]
model = TfidfVectorizer()
tf_idf_matrix = model.fit_transform(preprocessed_reviews)
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(model.get_feature_names(), list(model.idf_)))
"""
```

```
'\n# S = ["abc def pqr", "def def def abc", "pqr pqr def"]\nmodel = TfidfVectorizer()
```

```
"""
# TF-IDF weighted Word2Vec
tfidf_feat = model.get_feature_names() # tfidf words/col-names
# final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf

tfidf_sent_vectors = []; # the tfidf-w2v for each sentence/review is stored in this list
row=0;
for sent in tqdm(list_of_sentance): # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words and word in tfidf_feat:
            vec = w2v_model.wv[word]
#             tf_idf = tf_idf_matrix[row, tfidf_feat.index(word)]
            # to reduce the computation we are
            # dictionary[word] = idf value of word in whole courpus
            # sent.count(word) = tf valeus of word in this review
            tf_idf = dictionary[word]*(sent.count(word)/len(sent))
            sent_vec += (vec * tf_idf)
            weight_sum += tf_idf
    if weight_sum != 0:
        sent_vec /= weight_sum
    tfidf_sent_vectors.append(sent_vec)
    row += 1
    """
```

```
'\n# TF-IDF weighted Word2Vec\ntfidf_feat = model.get_feature_names() # tfidf words/c
```

```
model = TfidfVectorizer()
model.fit(X_no_stop_50k_reviews)
dictionary = dict(zip(model.get_feature_names(), list(model.idf_)))

tfidf_feat = model.get_feature_names() # tfidf words/col-names

tfidf_w2v_sent_vectors_50k = []; # the tfidf-w2v for each sentence/review is stored in thi
row=0;
for sent4 in tqdm(lst_of_lst_50k_review): # for each review/sentence
    sent_vec4 = np.zeros(50) # as word vectors are of zero length
    weight_sum4 =0; # num of words with a valid vector in the sentence/review
    for word4 in sent4: # for each word in a review/sentence
        if word4 in w2v_words_50K and word4 in tfidf_feat:
            vec4 = w2v_model_self_taught_50K.wv[word4]
            tf_idf_50k = dictionary[word4]*(sent4.count(word4)/len(sent4))
            sent_vec4 += (vec4 * tf_idf_50k)
            weight_sum4 += tf_idf_50k
    if weight_sum4 != 0:
        sent_vec4 /= weight_sum4
    tfidf_w2v_sent_vectors_50k.append(sent_vec4)
    row += 1
```

```
100%|██████████| 50000/50000 [31:40<00:00, 26.30it/s]
```

```
from sklearn.preprocessing import StandardScaler
import warnings
warnings.filterwarnings('ignore')

tfidf_w2v_sent_vectors_50k_std =StandardScaler(with_mean=False,with_std=False).fit_transfo



"""
model2 = TfidfVectorizer()
model2.fit(X_no_stop_5k_reviews)
dictionary = dict(zip(model2.get_feature_names(), list(model.idf_)))

tfidf_feat2 = model2.get_feature_names() # tfidf words/col-names

tfidf_w2v_sent_vectors_5k = []; # the tfidf-w2v for each sentence/review is stored in this
row=0;
for sent5 in tqdm(lst_of_lst_5k_review): # for each review/sentence
    sent_vec5 = np.zeros(50) # as word vectors are of zero length
    weight_sum5 =0; # num of words with a valid vector in the sentence/review
    for word5 in sent5: # for each word in a review/sentence
        if word5 in w2v_words_5K and word5 in tfidf_feat2:
            vec5 = w2v_model_self_taught_5K.wv[word5]
            tf_idf_5k = dictionary[word5]*(sent5.count(word5)/len(sent5))
            sent_vec5 += (vec5 * tf_idf_5k)
            weight_sum5 += tf_idf_5k
    if weight_sum5 != 0:
        sent_vec5 /= weight_sum5
```

```
    tfidf_w2v_sent_vectors_5k.append(sent_vec5)
    row += 1
"""


"""
from sklearn.preprocessing import StandardScaler
import warnings
warnings.filterwarnings('ignore')

tfidf_w2v_sent_vectors_5k_std =StandardScaler(with_mean=False,with_std=False).fit_transfor
"""
```

[5] Assignment 10: K-Means, Agglomerative & DBSCAN Cluster

1. **Apply K-means Clustering on these feature sets:**
   - SET 1:Review text, preprocessed one converted into vectors using (BOW)
   - SET 2:Review text, preprocessed one converted into vectors using (TFIDF)
   - SET 3:Review text, preprocessed one converted into vectors using (AVG W2v)
   - SET 4:Review text, preprocessed one converted into vectors using (TFIDF W2v)
   - Find the best 'k' using the elbow-knee method (plot k vs inertia_)
   - Once after you find the k clusters, plot the word cloud per each cluster so that at a single g

2. **Apply Agglomerative Clustering on these feature sets:**
   - SET 3:Review text, preprocessed one converted into vectors using (AVG W2v)
   - SET 4:Review text, preprocessed one converted into vectors using (TFIDF W2v)
   - Apply agglomerative algorithm and try a different number of clusters like 2,5 etc.
   - Same as that of K-means, plot word clouds for each cluster and summarize in your own w
   - You can take around 5000 reviews or so(as this is very computationally expensive one)

3. **Apply DBSCAN Clustering on these feature sets:**
   - SET 3:Review text, preprocessed one converted into vectors using (AVG W2v)
   - SET 4:Review text, preprocessed one converted into vectors using (TFIDF W2v)
   - Find the best 'Eps' using the elbow-knee method.
   - Same as before, plot word clouds for each cluster and summarize in your own words what
   - You can take around 5000 reviews for this as well.

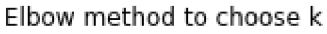
[5.1] K-Means Clustering

[5.1.1] Applying K-Means Clustering on BOW, SET 1

```
from sklearn.cluster import KMeans
inertia_bow_kmeans = []
n_clusters = [2,3,5,7,8,9,10,11,12,13,14,15]

for n in tqdm(n_clusters):
    Kmean_bow_50k_txt = KMeans(n_clusters=n, init='k-means++')
    Kmean_bow_50k_txt.fit(bow_X_no_stop_50k_reviews_std)
    inertia_bow_kmeans.append(Kmean_bow_50k_txt.inertia_)
```

```
  0%|          | 0/12 [00:00<?, ?it/s]
  8%|▊         | 1/12 [04:53<53:52, 293.88s/it]
 17%|█▋        | 2/12 [09:34<48:20, 290.03s/it]
 25%|██▌       | 3/12 [22:35<1:05:33, 437.08s/it]
 33%|███▎      | 4/12 [33:58<1:08:07, 510.95s/it]
 42%|████▏     | 5/12 [44:00<1:02:47, 538.26s/it]
 50%|█████     | 6/12 [1:00:50<1:07:58, 679.75s/it]
 58%|█████▊    | 7/12 [1:15:09<1:01:07, 733.50s/it]
 67%|██████▋   | 8/12 [1:28:16<49:58, 749.59s/it]
 75%|███████▌  | 9/12 [1:40:46<37:29, 749.89s/it]
 83%|████████▎ | 10/12 [1:56:32<26:57, 808.68s/it]
 92%|█████████▏| 11/12 [2:08:56<13:09, 789.07s/it]
100%|██████████| 12/12 [2:21:10<00:00, 772.80s/it]
```

```
plt.plot(n_clusters, inertia_bow_kmeans, "-o")
plt.title("Elbow method to choose k")
plt.xlabel("K")
plt.ylabel("Loss")
plt.minorticks_on()
plt.legend(['Clusters', 'Inertia'], loc='upper right')
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```



So we see sharp fall in loss till n_clusters = 7 , then afterthat it is very much small fall.

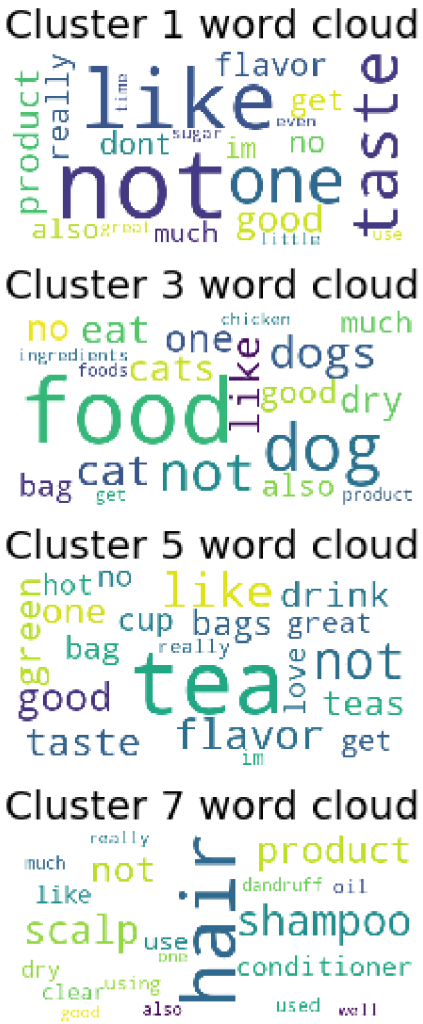
So best n_cluster value is 7

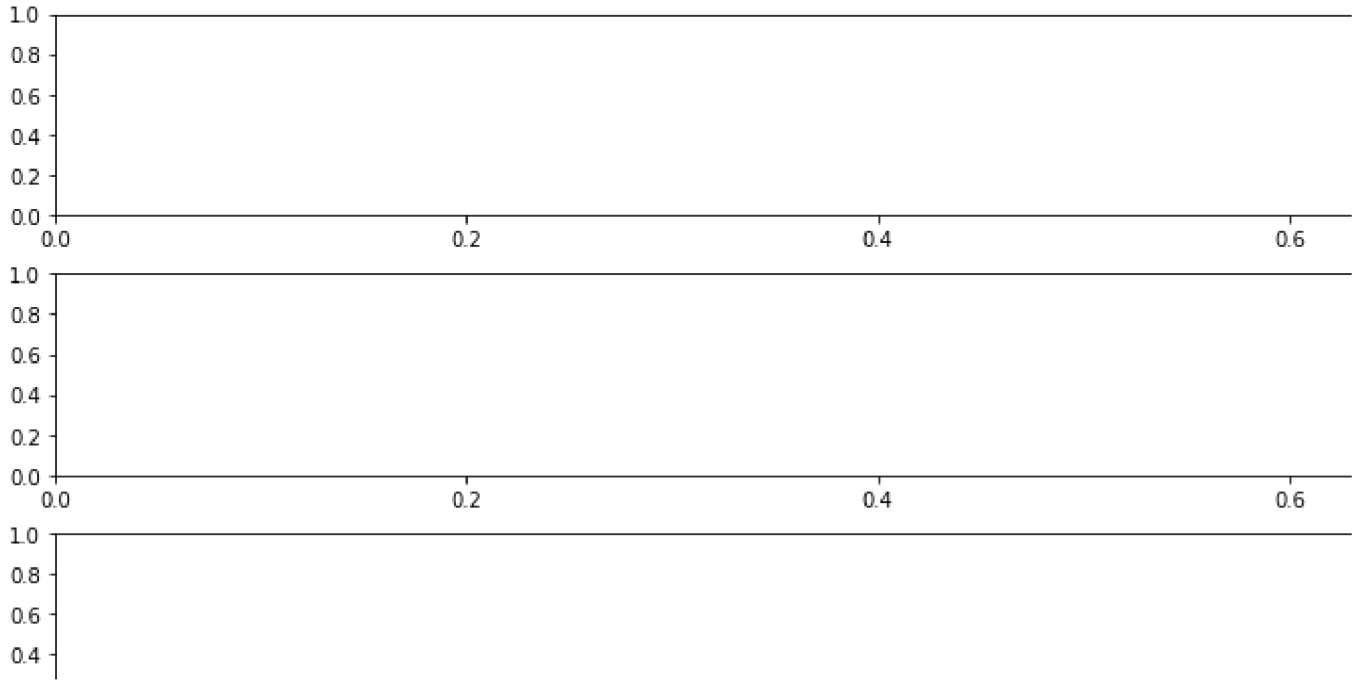
[5.1.2] Wordclouds of clusters obtained after applying k-means on BOW SET 1

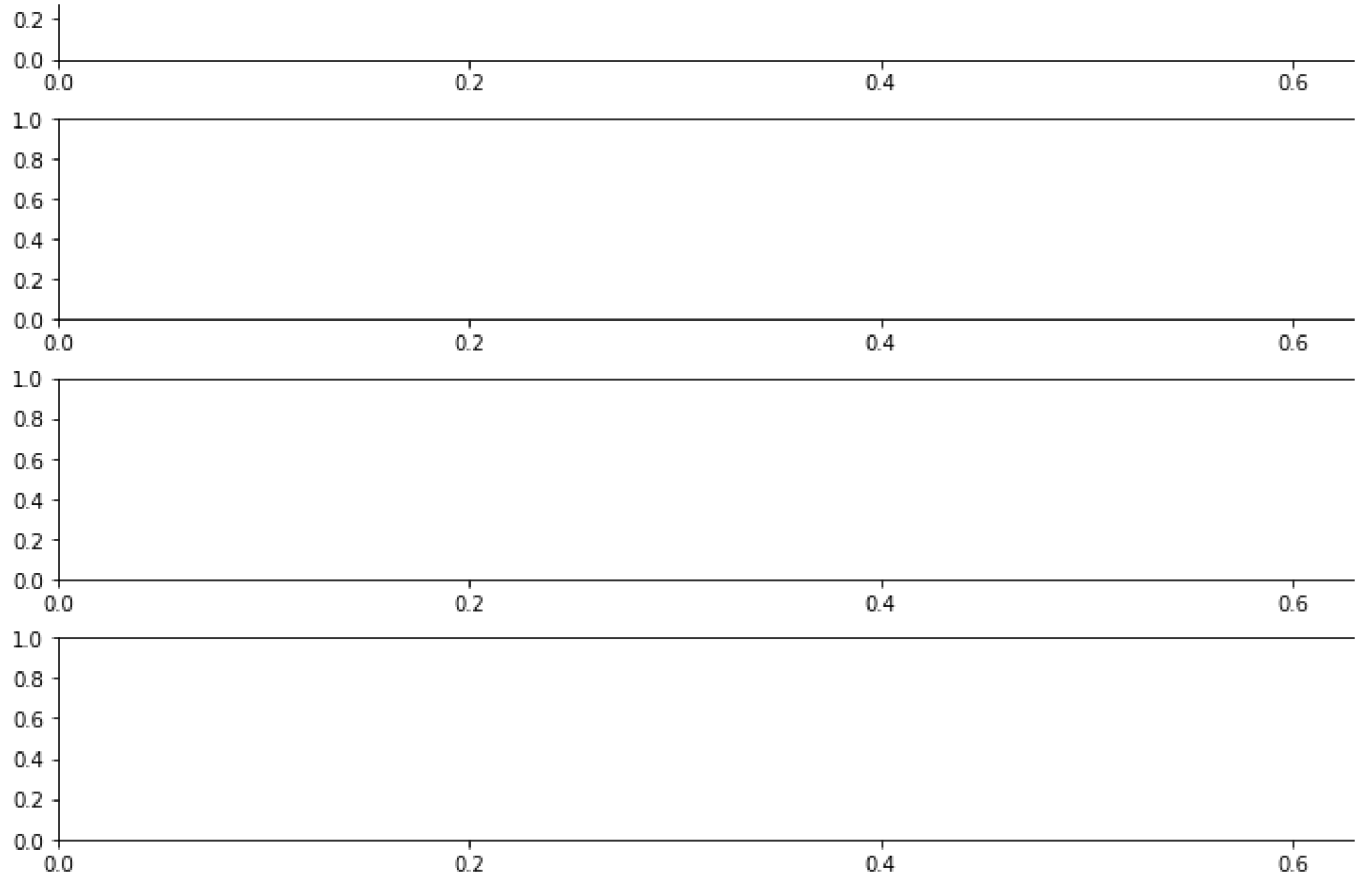
```
best_Kmean_bow_50k_txt = KMeans(n_clusters=7, init='k-means++')
best_Kmean_bow_50k_txt.fit(bow_X_no_stop_50k_reviews_std)
```

```
KMeans(algorithm='auto', copy_x=True, init='k-means++', max_iter=300,
       n_clusters=7, n_init=10, n_jobs=None, precompute_distances='auto',
       random_state=None, tol=0.0001, verbose=0)
```

```
#Plot each cluster features in a cloud
def plot_cluster_cloud(features, coef):
    coef_df = pd.DataFrame(coef, columns = features)
    #print(len(coef_df))
    # Create a figure and set of 15 subplots because our k range is in between
    fig, axes = plt.subplots(10, 2, figsize = (30, 20))
    fig.suptitle("Top 20 words for each cluster ", fontsize = 20)
    cent = range(len(coef_df))
    for ax, i in zip(axes.flat, cent):
        wordcloud = WordCloud(background_color = "white").generate_from_frequencies(coef_c
        ax.imshow(wordcloud)
        ax.set_title("Cluster {} word cloud".format(i+1), fontsize = 20)
        ax.axis("off")
    plt.tight_layout()
    fig.subplots_adjust(top = 0.90)
    plt.show()


from wordcloud import WordCloud

features = bow_vect_50K.get_feature_names()
coef = best_Kmean_bow_50k_txt.cluster_centers_
plot_cluster_cloud(features, coef)
```


Cluster 1 word cloud
like
not
one
taste
flavor
get
product
really
time
dont
sugar
even
im
no
good
also
great
much
little
use
Cluster 3 word cloud
food
dog
cat
not
dogs
eat
no
one
like
cats
good
dry
much
chicken
ingredients
foods
also
bag
get
product
Cluster 5 word cloud
tea
like
drink
not
cup
bags
great
one
green
hot
no
bag
really
love
good
teas
taste
flavor
get
im
Cluster 7 word cloud
hair
product
not
shampoo
scalp
conditioner
really
much
like
dandruff
oil
use
dry
clear
using
also
used
well
good


1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6

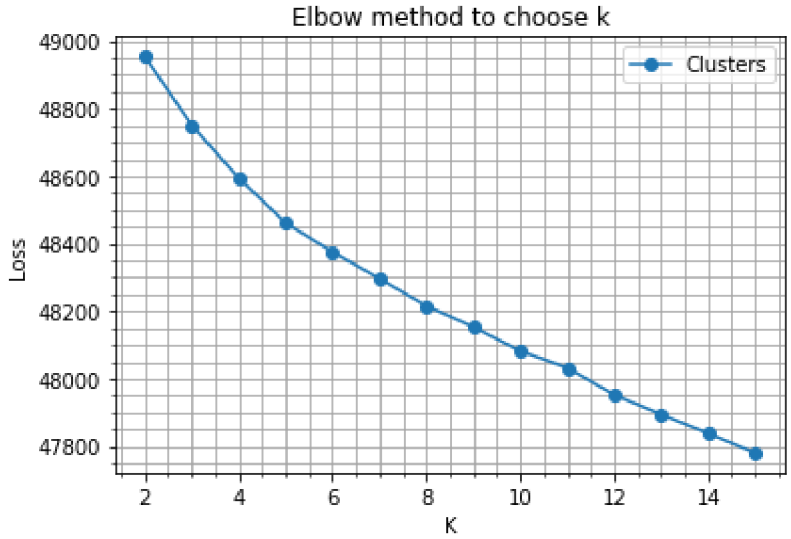


[5.1.3] Applying K-Means Clustering on TFIDF, SET 2

```
from sklearn.feature_extraction.text import CountVectorizer, TfidfVectorizer

tf_idf_vect = TfidfVectorizer(ngram_range=(1,2), min_df=10,max_features=9000)
tfidf_X_no_stop_50k_reviews=tf_idf_vect.fit_transform(X_no_stop_50k_reviews)
tfidf_X_no_stop_50k_reviews_std =StandardScaler(with_mean=False,with_std=False).fit_transf


from sklearn.cluster import KMeans
inertia_tfidf_kmeans = []
n_clusters = [2,3,4,5,6,7,8,9,10,11,12,13,14,15]

for n in tqdm(n_clusters):
    Kmean_tfidf_50k_txt = KMeans(n_clusters=n, init='k-means++')
    Kmean_tfidf_50k_txt.fit(tfidf_X_no_stop_50k_reviews_std)
    inertia_tfidf_kmeans.append(Kmean_tfidf_50k_txt.inertia_)

plt.plot(n_clusters, inertia_tfidf_kmeans, "-o")
plt.title("Elbow method to choose k")
plt.xlabel("K")
plt.ylabel("Loss")
plt.minorticks_on()
plt.legend(['Clusters', 'Inertia'], loc='upper right')
plt.grid(b=True, which='both', color='0.65', linestyle='-')
```

```
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```

```
100%|██████████| 14/14 [3:07:22<00:00, 897.16s/it]
```



[5.1.4] Wordclouds of clusters obtained after applying k-means on TFIDF SET 2

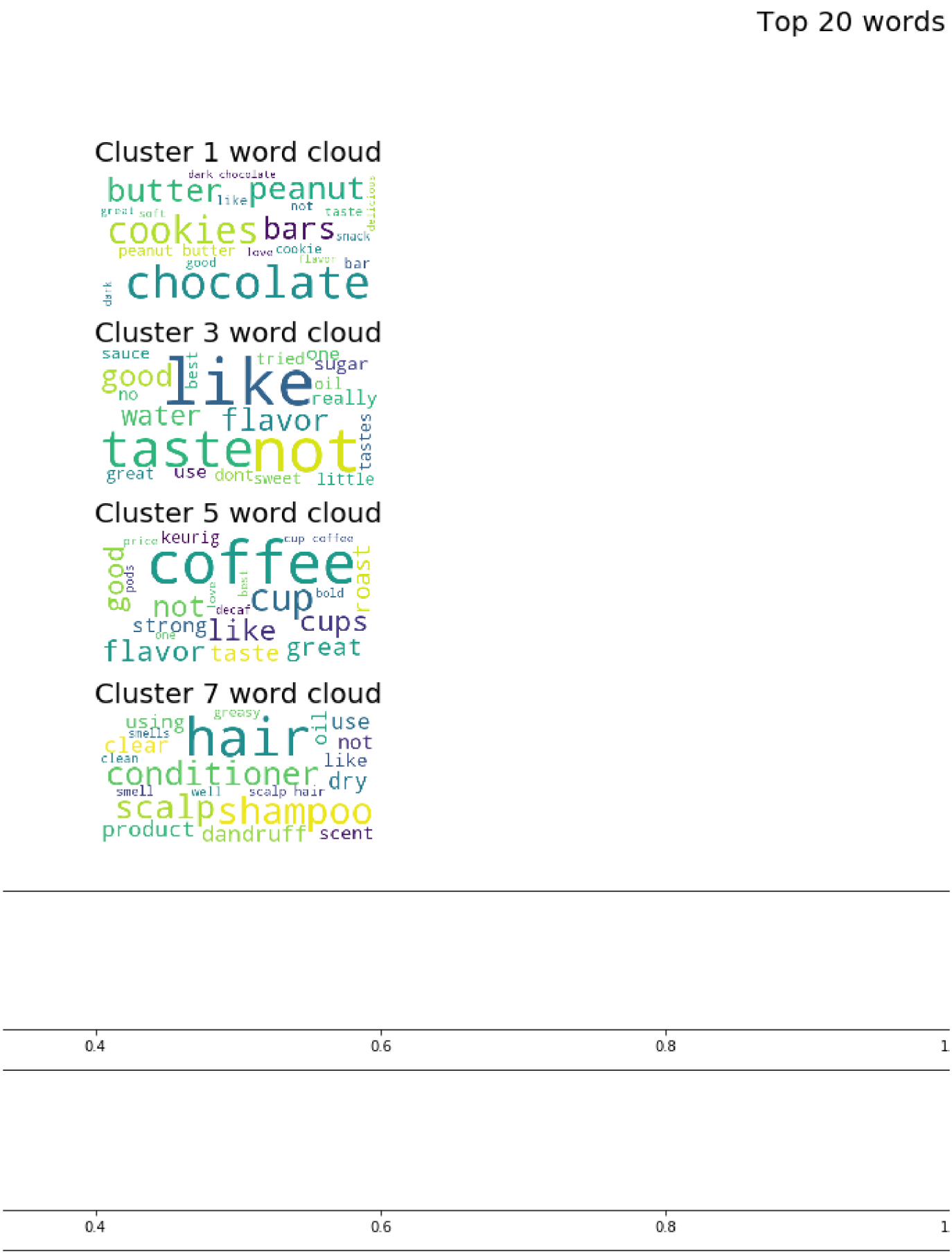
```
best_Kmean_tfidf_50k_txt = KMeans(n_clusters=7, init='k-means++')
best_Kmean_tfidf_50k_txt.fit(tfidf_X_no_stop_50k_reviews_std)
```

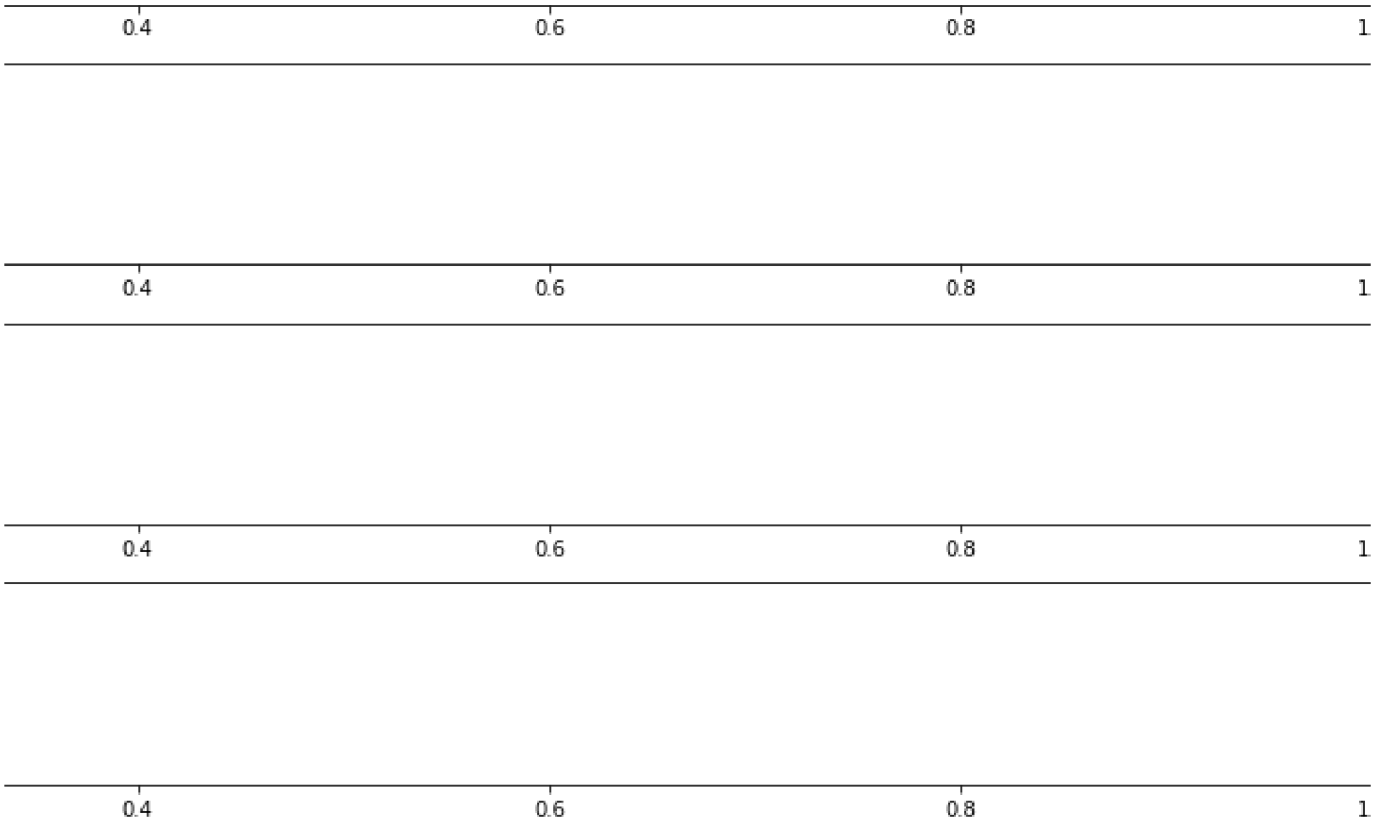
```
KMeans(algorithm='auto', copy_x=True, init='k-means++', max_iter=300,
       n_clusters=7, n_init=10, n_jobs=None, precompute_distances='auto',
       random_state=None, tol=0.0001, verbose=0)
```

```
#Plot each cluster features in a cloud
def plot_cluster_cloud(features, coef):
    coef_df = pd.DataFrame(coef, columns = features)
    #print(len(coef_df))
    # Create a figure and set of 15 subplots because our k range is in between
    fig, axes = plt.subplots(10, 2, figsize = (30, 20))
    fig.suptitle("Top 20 words for each cluster ", fontsize = 20)
    cent = range(len(coef_df))
    for ax, i in zip(axes.flat, cent):
        wordcloud = WordCloud(background_color = "white").generate_from_frequencies(coef_c
        ax.imshow(wordcloud)
        ax.set_title("Cluster {} word cloud".format(i+1), fontsize = 20)
        ax.axis("off")
    plt.tight_layout()
    fig.subplots_adjust(top = 0.90)
    plt.show()
```

```
from wordcloud import WordCloud

features_50K_tfidf = tf_idf_vect.get_feature_names()
coef_50k_tfidf = best_Kmean_tfidf_50k_txt.cluster_centers_
```

```
plot_cluster_cloud(features_50K_tfidf, coef_50k_tfidf)
```

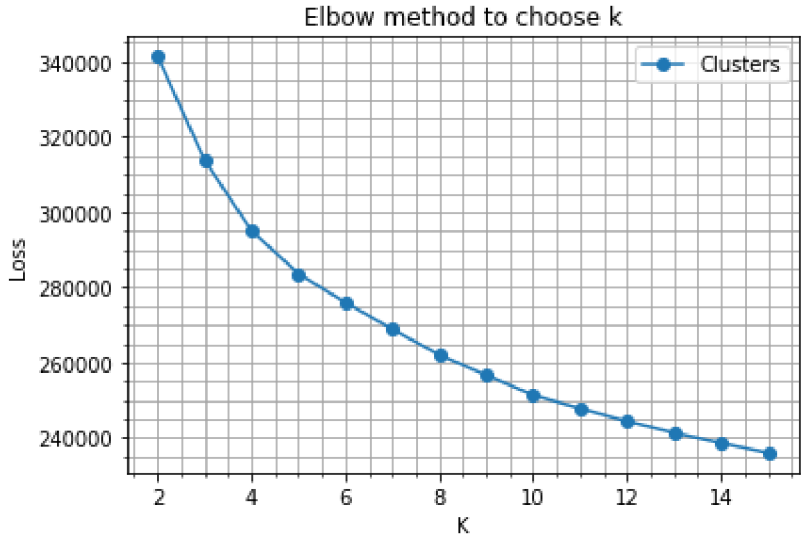

Top 20 words
Cluster 1 word cloud
dark chocolate
butter
peanut
like
not
taste
delicious
great
soft
cookies
bars
snack
peanut butter
love
cookie
flavor
bar
good
dark
chocolate
Cluster 3 word cloud
sauce
tried
one
sugar
good
best
like
no
oil
really
water
flavor
taste
not
tastes
great
use
dont
sweet
little
Cluster 5 word cloud
price
keurig
cup coffee
coffee
good
pods
love
best
roast
not
decaf
bold
cup
strong
like
cups
one
flavor
taste
great
Cluster 7 word cloud
greasy
using
hair
oil
use
smells
clear
not
clean
like
conditioner
dry
smell
well
scalp hair
scalp
shampoo
product
dandruff
scent
0.4
0.6
0.8
1.
0.4
0.6
0.8
1.



[5.1.5] Applying K-Means Clustering on AVG W2V, SET 3

```
# Please write all the code with proper documentation


from sklearn.cluster import KMeans

inertia_avgw2v_kmeans = []
n_clusters = [2,3,4,5,6,7,8,9,10,11,12,13,14,15]

for n in tqdm(n_clusters):
    Kmean_avgw2v_50k_txt = KMeans(n_clusters=n, init='k-means++')
    Kmean_avgw2v_50k_txt.fit(sent_vectors_50K_std)
    inertia_avgw2v_kmeans.append(Kmean_avgw2v_50k_txt.inertia_)

plt.plot(n_clusters, inertia_avgw2v_kmeans, "-o")
plt.title("Elbow method to choose k")
plt.xlabel("K")
plt.ylabel("Loss")
plt.minorticks_on()
plt.legend(['Clusters', 'Inertia'], loc='upper right')
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```

```
100%|██████████| 14/14 [01:53<00:00, 12.49s/it]
```



[5.1.6] Wordclouds of clusters obtained after applying k-means on AVG W2V SET

```
best_Kmean_avgw2v_50k_txt = KMeans(n_clusters=8, init='k-means++')
best_Kmean_avgw2v_50k_txt.fit(sent_vectors_50K_std)
```

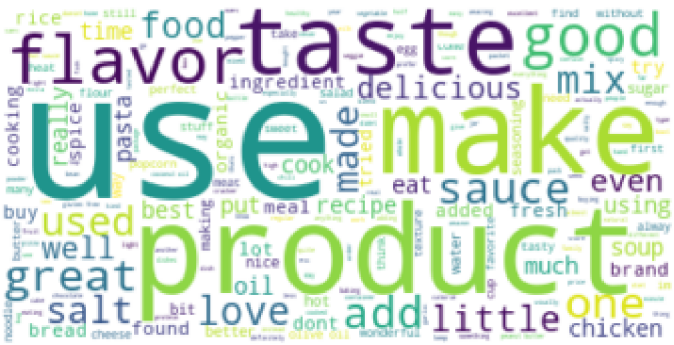
```
KMeans(algorithm='auto', copy_x=True, init='k-means++', max_iter=300,
       n_clusters=8, n_init=10, n_jobs=None, precompute_distances='auto',
       random_state=None, tol=0.0001, verbose=0)
```

```
cluster1,cluster2,cluster3,cluster4,cluster5,cluster6,cluster7,cluster8=[],[],[],[],[],[],
for i in range(best_Kmean_avgw2v_50k_txt.labels_.shape[0]):
    if best_Kmean_avgw2v_50k_txt.labels_[i] == 0:
        cluster1.append(X_no_stop_50k_reviews[i])
    elif best_Kmean_avgw2v_50k_txt.labels_[i] == 1:
        cluster2.append(X_no_stop_50k_reviews[i])
    elif best_Kmean_avgw2v_50k_txt.labels_[i] == 2:
        cluster3.append(X_no_stop_50k_reviews[i])
    elif best_Kmean_avgw2v_50k_txt.labels_[i] == 3:
        cluster4.append(X_no_stop_50k_reviews[i])
    elif best_Kmean_avgw2v_50k_txt.labels_[i] == 4:
        cluster5.append(X_no_stop_50k_reviews[i])
    elif best_Kmean_avgw2v_50k_txt.labels_[i] == 5:
        cluster6.append(X_no_stop_50k_reviews[i])
    elif best_Kmean_avgw2v_50k_txt.labels_[i] == 6:
        cluster7.append(X_no_stop_50k_reviews[i])
    else:
        cluster8.append(X_no_stop_50k_reviews[i])
```

```
#for cluster 1
data=''
```

```
for i in cluster1:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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


```
#for cluster 2
data=''
for i in cluster2:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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



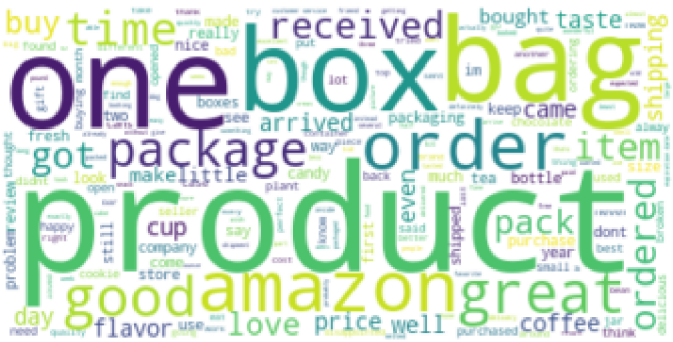

```
#for cluster 3
data=''
for i in cluster3:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)
```

```
wordcloud = WordCloud(background_color="white").generate(data)

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


```
#for cluster 4
data=''
for i in cluster4:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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

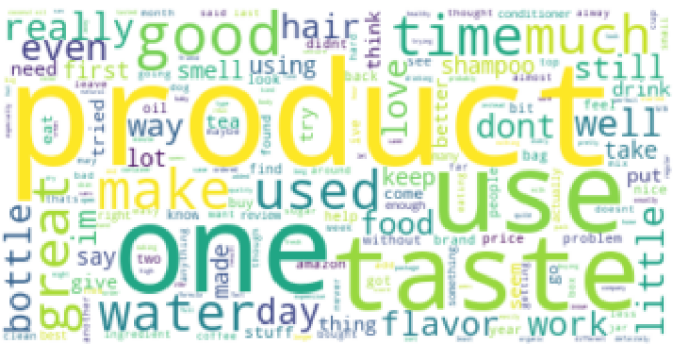

```
#for cluster 5
data=''
for i in cluster5:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

# Display the generated image:
plt.imshow(wordcloud, interpolation='bilinear')
```

```
plt.axis("off")
plt.show()
```




```
#for cluster 6
data=''
for i in cluster6:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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


```
#for cluster 7
data=''
for i in cluster7:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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



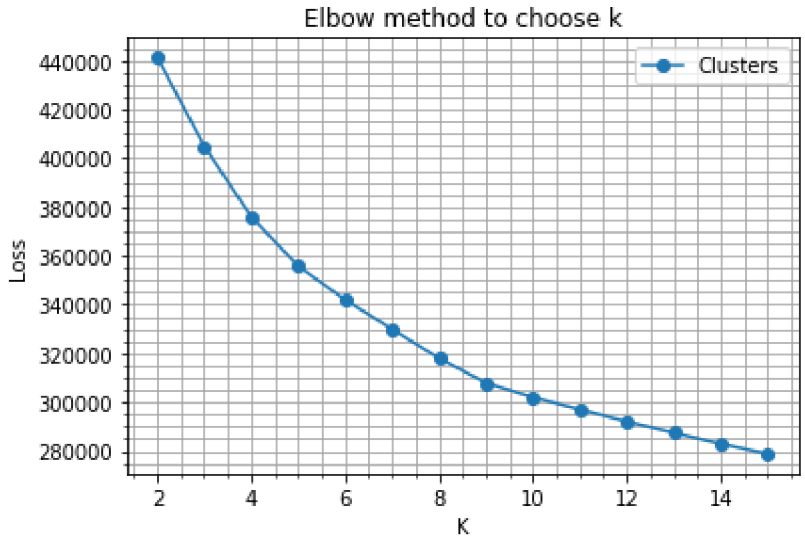

```
#for cluster 8
data=''
for i in cluster8:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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

[5.1.7] Applying K-Means Clustering on TFIDF W2V, SET 4

```
from sklearn.cluster import KMeans

inertia_tfidfw2v_kmeans = []
n_clusters = [2,3,4,5,6,7,8,9,10,11,12,13,14,15]

for n in tqdm(n_clusters):
    Kmean_tfidfw2v_50k_txt = KMeans(n_clusters=n, init='k-means++')
    Kmean_tfidfw2v_50k_txt.fit(tfidf_w2v_sent_vectors_50k_std)
    inertia_tfidfw2v_kmeans.append(Kmean_tfidfw2v_50k_txt.inertia_)

plt.plot(n_clusters, inertia_tfidfw2v_kmeans, "-o")
plt.title("Elbow method to choose k")
plt.xlabel("K")
```

```
plt.ylabel("Loss")
plt.minorticks_on()
plt.legend(['Clusters', 'Inertia'], loc='upper right')
plt.grid(b=True, which='both', color='0.65', linestyle='-')
plt.show()
```

```
100%|██████████| 14/14 [01:36<00:00, 11.76s/it]
```



[5.1.8] Wordclouds of clusters obtained after applying k-means on TFIDF W2V SE

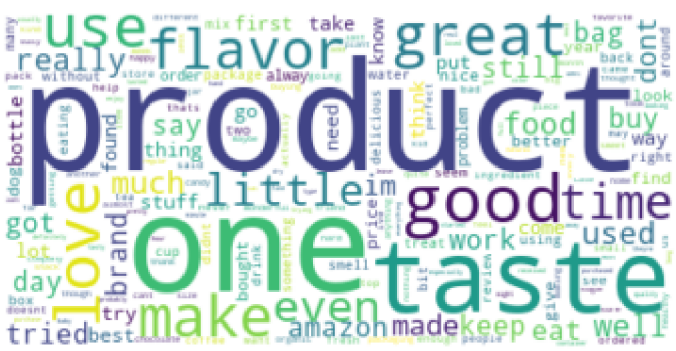
```
best_Kmean_tfidfw2v_50k_txt = KMeans(n_clusters=9, init='k-means++')
best_Kmean_tfidfw2v_50k_txt.fit(tfidf_w2v_sent_vectors_50k_std)
```

```
KMeans(algorithm='auto', copy_x=True, init='k-means++', max_iter=300,
       n_clusters=9, n_init=10, n_jobs=None, precompute_distances='auto',
       random_state=None, tol=0.0001, verbose=0)
```

```
cluster1,cluster2,cluster3,cluster4,cluster5,cluster6,cluster7,cluster8,cluster9=[],[],[],
for i in range(best_Kmean_tfidfw2v_50k_txt.labels_.shape[0]):
    if best_Kmean_tfidfw2v_50k_txt.labels_[i] == 0:
        cluster1.append(X_no_stop_50k_reviews[i])
    elif best_Kmean_tfidfw2v_50k_txt.labels_[i] == 1:
        cluster2.append(X_no_stop_50k_reviews[i])
    elif best_Kmean_tfidfw2v_50k_txt.labels_[i] == 2:
        cluster3.append(X_no_stop_50k_reviews[i])
    elif best_Kmean_tfidfw2v_50k_txt.labels_[i] == 3:
        cluster4.append(X_no_stop_50k_reviews[i])
    elif best_Kmean_tfidfw2v_50k_txt.labels_[i] == 4:
        cluster5.append(X_no_stop_50k_reviews[i])
    elif best_Kmean_tfidfw2v_50k_txt.labels_[i] == 5:
        cluster6.append(X_no_stop_50k_reviews[i])
    elif best_Kmean_tfidfw2v_50k_txt.labels_[i] == 6:
        cluster7.append(X_no_stop_50k_reviews[i])
    elif best_Kmean_tfidfw2v_50k_txt.labels_[i] == 7:
```

```
            cluster8.append(X_no_stop_50k_reviews[i])
        else:
            cluster9.append(X_no_stop_50k_reviews[i])
```

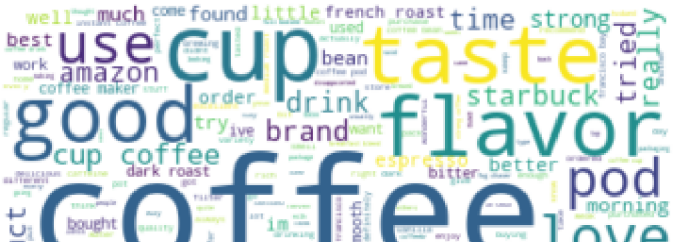
```
#for cluster 1
data=''
for i in cluster1:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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



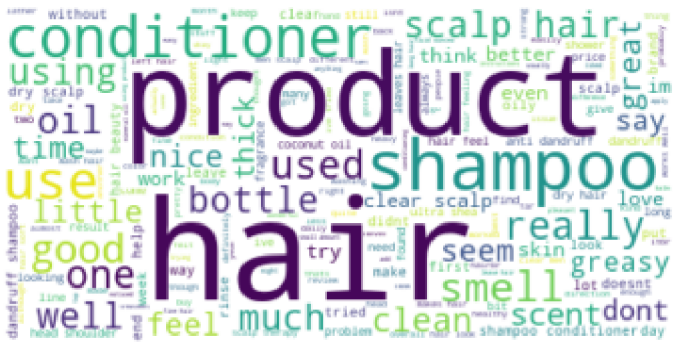

```
#for cluster 2
data=''
for i in cluster2:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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


```
#for cluster 3
data=''
for i in cluster3:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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


```
#for cluster 4
data=''
for i in cluster4:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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

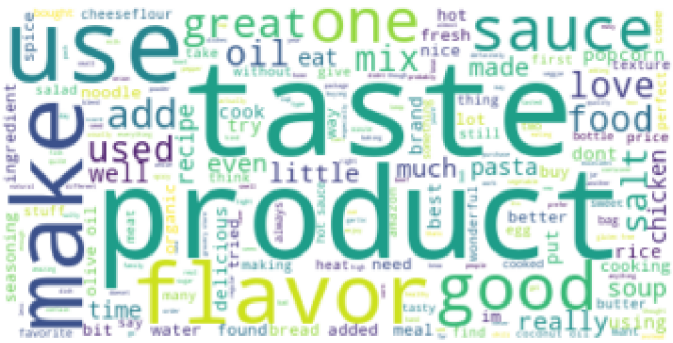



```
#for cluster 5
data=''
for i in cluster5:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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




```
#for cluster 6
data=''
for i in cluster6:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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


```
#for cluster 7
data=''
for i in cluster7:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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




```
#for cluster 8
data=''
for i in cluster8:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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


```
#for cluster 9
data=''
for i in cluster9:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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

[5.2] Agglomerative Clustering

```
lst_5k_reviews=[]
lst_of_lst_5k_review = []

for sent in tqdm(X_no_stop_5k_reviews):
    lst_5k_reviews.append(sent.strip())
for sent in tqdm(lst_5k_reviews):
    lst_of_lst_5k_review.append(sent.split())

w2v_model_self_taught_5K=Word2Vec(lst_of_lst_5k_review,min_count=1,size=50, workers=4)
w2v_words_5K = list(w2v_model_self_taught_5K.wv.vocab)
```

```
100%|██████████| 5000/5000 [00:00<00:00, 642096.69it/s]
```

```
sent_vectors_5K = []
for sent6 in tqdm(lst_of_lst_5k_review): # for each review/sentence
    sent_vec6 = np.zeros(50)
    cnt_words6 = 0
    for word6 in sent6:
        if word6 in w2v_words_5K:
            vec6 = w2v_model_self_taught_5K.wv[word6]
            sent_vec6 += vec6
            cnt_words6 += 1
    if cnt_words6 != 0:
        sent_vec6 /= cnt_words6
    sent_vectors_5K.append(sent_vec6)
```

```
100%|██████████| 5000/5000 [00:06<00:00, 767.02it/s]
```

```
from sklearn.preprocessing import StandardScaler
import warnings
warnings.filterwarnings('ignore')

sent_vectors_5K_std = StandardScaler(with_mean=False,with_std=False).fit_transform(sent_ve



model_5k = TfidfVectorizer()
model_5k.fit(X_no_stop_5k_reviews)
dictionary_5k = dict(zip(model_5k.get_feature_names(), list(model_5k.idf_)))

tfidf_feat_5k = model_5k.get_feature_names() # tfidf words/col-names

tfidf_w2v_sent_vectors_5k = []; # the tfidf-w2v for each sentence/review is stored in this
row=0;
for sent7 in tqdm(lst_of_lst_5k_review): # for each review/sentence
    sent_vec7 = np.zeros(50) # as word vectors are of zero length
    weight_sum7 =0; # num of words with a valid vector in the sentence/review
    for word7 in sent7: # for each word in a review/sentence
        if word7 in w2v_words_5K and word7 in tfidf_feat_5k:
            vec7 = w2v_model_self_taught_5K.wv[word7]
            tf_idf_5k = dictionary_5k[word7]*(sent7.count(word7)/len(sent7))
            sent_vec7 += (vec7 * tf_idf_5k)
            weight_sum7 += tf_idf_5k
    if weight_sum7 != 0:
        sent_vec7 /= weight_sum7
    tfidf_w2v_sent_vectors_5k.append(sent_vec7)
    row += 1
```

```
100%|██████████| 5000/5000 [00:40<00:00, 122.35it/s]
```

```
from sklearn.preprocessing import StandardScaler
import warnings
warnings.filterwarnings('ignore')
```

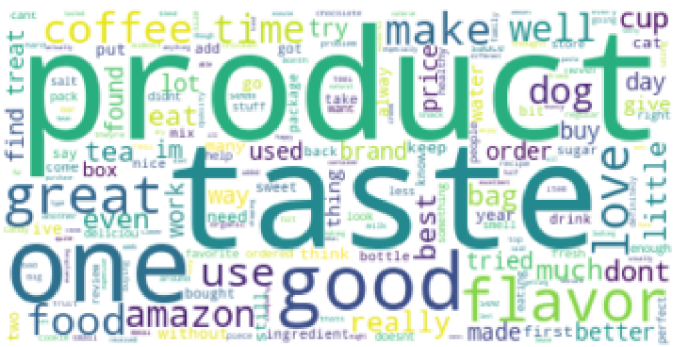
```
tfidf_w2v_sent_vectors_5k_std =StandardScaler(with_mean=False,with_std=False).fit_transfor
```

[5.2.1] Applying Agglomerative Clustering on AVG W2V, SET 3

```
from sklearn.cluster import AgglomerativeClustering

aggclus_avgw2v_5k_txt_cluster2=AgglomerativeClustering(n_clusters=2).fit(sent_vectors_5K_s
aggclus_avgw2v_5k_txt_cluster5=AgglomerativeClustering(n_clusters=5).fit(sent_vectors_5K_s
```

For k =2 clusters

```
cluster1,cluster2=[],[]
for i in range(aggclus_avgw2v_5k_txt_cluster2.labels_.shape[0]):
    if aggclus_avgw2v_5k_txt_cluster2.labels_[i] == 0:
        cluster1.append(X_no_stop_5k_reviews[i])
    else:
        cluster2.append(X_no_stop_5k_reviews[i])


#for cluster 1
data=''
for i in cluster1:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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




```
#for cluster 2
data=''
for i in cluster2:
    data+=str(i)
from wordcloud import WordCloud
```

```
wordcloud = WordCloud(background_color="white").generate(data)

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

For K =5

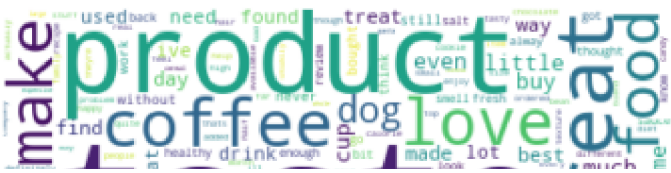
```
cluster1,cluster2,cluster3,cluster4,cluster5=[],[],[],[],[]
for i in range(aggclus_avgw2v_5k_txt_cluster5.labels_.shape[0]):
    if aggclus_avgw2v_5k_txt_cluster5.labels_[i] == 0:
        cluster1.append(X_no_stop_5k_reviews[i])
    elif aggclus_avgw2v_5k_txt_cluster5.labels_[i] == 1:
        cluster2.append(X_no_stop_5k_reviews[i])
    elif aggclus_avgw2v_5k_txt_cluster5.labels_[i] == 2:
        cluster3.append(X_no_stop_5k_reviews[i])
    elif aggclus_avgw2v_5k_txt_cluster5.labels_[i] == 3:
        cluster4.append(X_no_stop_5k_reviews[i])
    else:
        cluster5.append(X_no_stop_5k_reviews[i])
```

[5.2.2] Wordclouds of clusters obtained after applying Agglomerative Clustering

```
data=''
for i in cluster1:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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


```
data=''
for i in cluster2:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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

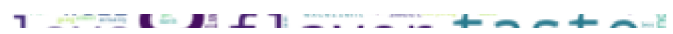

```
data=''
for i in cluster3:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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




```
data=''
for i in cluster4:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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


```
data=''
for i in cluster5:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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

[5.2.3] Applying Agglomerative Clustering on TFIDF W2V, SET 4



```
model_5k = TfidfVectorizer()
model_5k.fit(X_no_stop_5k_reviews)
dictionary_5k = dict(zip(model_5k.get_feature_names(), list(model_5k.idf_)))

tfidf_feat_5k = model_5k.get_feature_names() # tfidf words/col-names

tfidf_w2v_sent_vectors_5k = []; # the tfidf-w2v for each sentence/review is stored in this
row=0;
for sent7 in tqdm(lst_of_lst_5k_review): # for each review/sentence
    sent_vec7 = np.zeros(50) # as word vectors are of zero length
    weight_sum7 =0; # num of words with a valid vector in the sentence/review
    for word7 in sent7: # for each word in a review/sentence
        if word7 in w2v_words_5K and word7 in tfidf_feat_5k:
            vec7 = w2v_model_self_taught_5K.wv[word7]
            tf_idf_5k = dictionary_5k[word7]*(sent7.count(word7)/len(sent7))
            sent_vec7 += (vec7 * tf_idf_5k)
            weight_sum7 += tf_idf_5k
    if weight_sum7 != 0:
        sent_vec7 /= weight_sum7
    tfidf_w2v_sent_vectors_5k.append(sent_vec7)
    row += 1
```

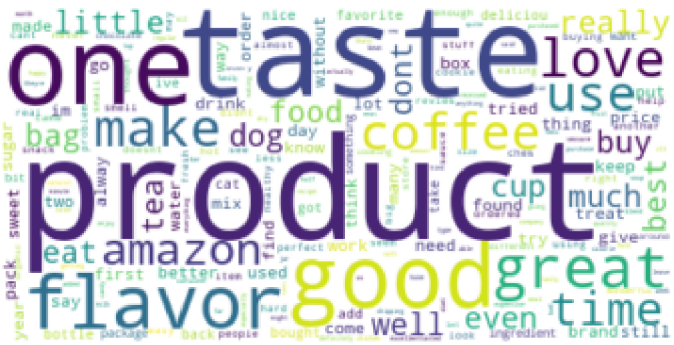
```
100%|██████████| 5000/5000 [00:33<00:00, 151.40it/s]
```

```
from sklearn.preprocessing import StandardScaler
import warnings
warnings.filterwarnings('ignore')

tfidf_w2v_sent_vectors_5k_std =StandardScaler(with_mean=False,with_std=False).fit_transfor



from sklearn.cluster import AgglomerativeClustering

aggclus_tfidf_5k_txt_cluster2=AgglomerativeClustering(n_clusters=2).fit(tfidf_w2v_sent_vec
aggclus_tfidf_5k_txt_cluster5=AgglomerativeClustering(n_clusters=5).fit(tfidf_w2v_sent_vec
```

For k =2 clusters

```
cluster1,cluster2=[],[]
for i in range(aggclus_tfidf_5k_txt_cluster2.labels_.shape[0]):
    if aggclus_tfidf_5k_txt_cluster2.labels_[i] == 0:
```

```
            cluster1.append(X_no_stop_5k_reviews[i])
        else:
            cluster2.append(X_no_stop_5k_reviews[i])


data=''
for i in cluster1:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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




```
data=''
for i in cluster2:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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

For K =5

```
cluster1,cluster2,cluster3,cluster4,cluster5=[],[],[],[],[]
for i in range(aggclus_tfidf_5k_txt_cluster5.labels_.shape[0]):
    if aggclus_tfidf_5k_txt_cluster5.labels_[i] == 0:
        cluster1.append(X_no_stop_5k_reviews[i])
    elif aggclus_tfidf_5k_txt_cluster5.labels_[i] == 1:
        cluster2.append(X_no_stop_5k_reviews[i])
    elif aggclus_tfidf_5k_txt_cluster5.labels_[i] == 2:
        cluster3.append(X_no_stop_5k_reviews[i])
    elif aggclus_tfidf_5k_txt_cluster5.labels_[i] == 3:
        cluster4.append(X_no_stop_5k_reviews[i])
    else:
        cluster5.append(X_no_stop_5k_reviews[i])
```

```
data=''
for i in cluster1:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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

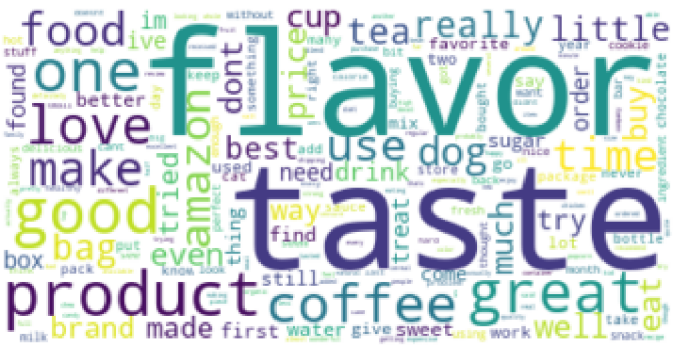

```
data=''
for i in cluster2:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)
```

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


```
data=''
for i in cluster3:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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


```
data=''
for i in cluster4:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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


```
data=''
for i in cluster5:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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



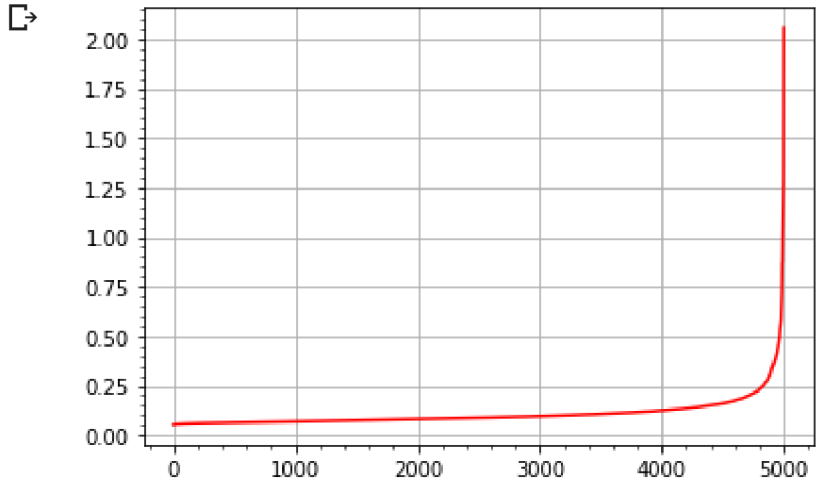
[5.2.4] Wordclouds of clusters obtained after applying Agglomerative Clustering

[5.3] DBSCAN Clustering

[5.3.1] Applying DBSCAN on AVG W2V, SET 3

```
from sklearn.cluster import DBSCAN
from sklearn.neighbors import NearestNeighbors
min_point = 100
knn = NearestNeighbors(n_neighbors = min_point)
```

```
knn = NearestNeighbors(n_neighbors = min_point)
knn.fit(sent_vectors_5K_std)
dist , index = knn.kneighbors(sent_vectors_5K_std)


sort = sorted(dist[:,min_point-1])
plt.plot(list(range(1,len(sent_vectors_5K_std)+1)),sort,'r-')
plt.minorticks_on()
plt.grid()
plt.show()
```




```
dbscan_avgw2v_5k_txt = DBSCAN(eps = .25 , min_samples = 100)
dbscan_avgw2v_5k_txt.fit(sent_vectors_5K_std)

print('No of clusters: ',len(set(dbscan_avgw2v_5k_txt.labels_)))
```

```
No of clusters:  2
```

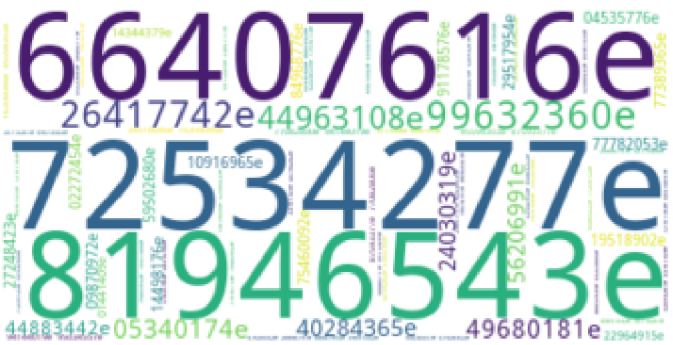
```
print((dbscan_avgw2v_5k_txt.labels_).shape)
```

```
(5000,)
```

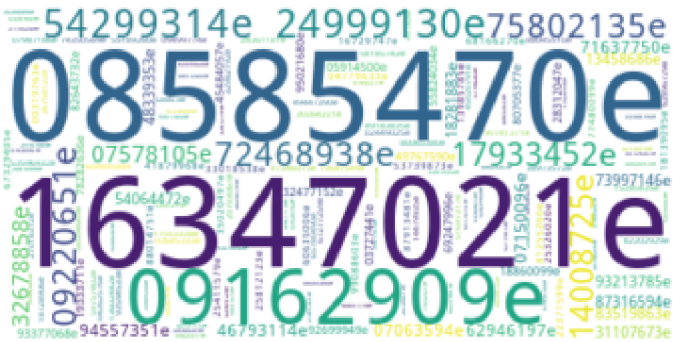
[5.3.2] Wordclouds of clusters obtained after applying DBSCAN on AVG W2V SET

```
cluster1,cluster2=[],[]

for i in range(dbscan_avgw2v_5k_txt.labels_.shape[0]):
    if dbscan_avgw2v_5k_txt.labels_[i] == 0:
        cluster1.append(sent_vectors_5K_std[i])
    else:
        cluster2.append(sent_vectors_5K_std[i])



data=''
for i in cluster1:
```

```
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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




```
data=''
for i in cluster2:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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



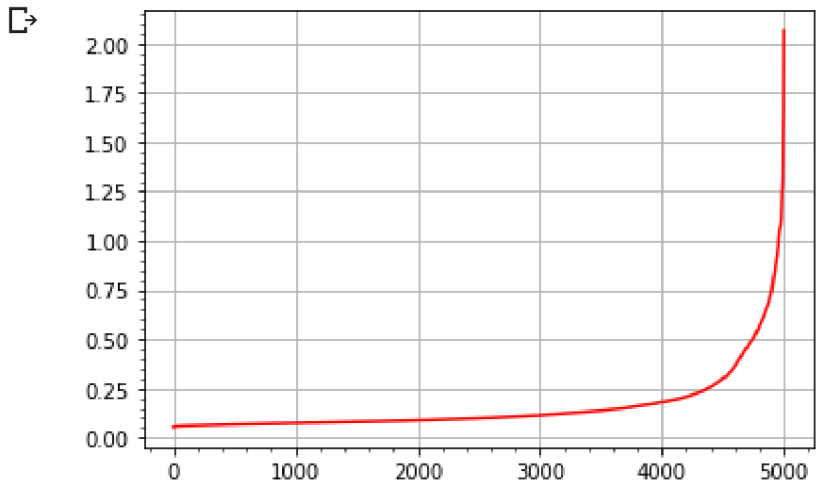
[5.3.3] Applying DBSCAN on TFIDF W2V, SET 4

Now MINPTS should be more than d+1 and around range of 2*d. SO here MINPts=100

https://scikit-learn.org/stable/modules/generated/sklearn.cluster.DBSCAN.html

https://github.com/Manish-12/Clustering-Techniques-on-Amazon-fine-food-reviews/blob/master/DBS

```
from sklearn.cluster import DBSCAN
from sklearn.neighbors import NearestNeighbors
min_point = 100
knn = NearestNeighbors(n_neighbors = min_point)
knn.fit(sent_vectors_5K_std)
dist , index = knn.kneighbors(tfidf_w2v_sent_vectors_5k_std)


sort = sorted(dist[:,min_point-1])
plt.plot(list(range(1,len(tfidf_w2v_sent_vectors_5k_std)+1)),sort,'r-')
plt.minorticks_on()
plt.grid()
plt.show()
```



Seems .25 is the best EPS

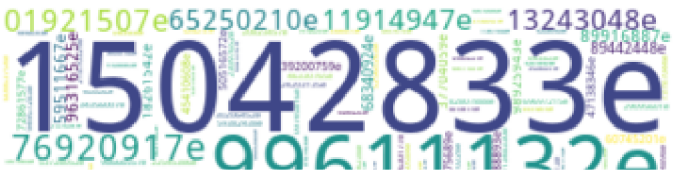
```
dbscan_tfidfw2v_5k_txt = DBSCAN(eps = .25 , min_samples = 100)
dbscan_tfidfw2v_5k_txt.fit(tfidf_w2v_sent_vectors_5k_std)

print('No of clusters: ',len(set(dbscan_tfidfw2v_5k_txt.labels_)))
```

```
No of clusters:  2
```

[5.3.4] Wordclouds of clusters obtained after applying DBSCAN on TFIDF W2V SE

```
cluster1,cluster2=[],[]

for i in range(dbscan_tfidfw2v_5k_txt.labels_.shape[0]):
    if dbscan_tfidfw2v_5k_txt.labels_[i] == 0:
        cluster1.append(tfidf_w2v_sent_vectors_5k_std[i])
    else:
        cluster2.append(tfidf_w2v_sent_vectors_5k_std[i])



data=''
for i in cluster1:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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


```
data=''
for i in cluster2:
    data+=str(i)
from wordcloud import WordCloud
wordcloud = WordCloud(background_color="white").generate(data)

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



[6] Conclusions

```
# Please compare all your models using Prettytable library.
# You can have 3 tables, one each for kmeans, agllomerative and dbscan

print ("Pretty Table for K-Means")
from prettytable import PrettyTable
x = PrettyTable()
x.field_names = ["Vectorizer","Best k"]
x.add_row(['BOW','7'])
x.add_row(['TFIDF','7'])
x.add_row(['AVG W2vec','8'])
x.add_row(['TFIDF W2vec','9'])
print(x)
```

```
Pretty Table for K-Means
+--------------+--------+
|  Vectorizer | Best k |
+--------------+--------+
|     BOW     |   7    |
|    TFIDF    |   7    |
|  AVG W2vec  |   8    |
| TFIDF W2vec |   9    |
+--------------+--------+
```

K Means seems to have work well. If we give lesser number of clusters it still custers well and if we giv granular information

```
print ("Pretty Table for DBSCAN")
from prettytable import PrettyTable
x = PrettyTable()
x.field_names = ["Vectorizer","EPS"]
x.add_row(['AVG W2vec','.25'])
x.add_row(['TFIDF W2vec','.25'])
print(x)
```