Data Wrangling on Amazon Fine Food Review dataset

Import Required Modules

In [13]:

```
import os # for file handling
import sqlite3 # for database handling
from pathlib import Path # for file management
import pandas as pd # for handling data as frames
import numpy as np # for matrix processing
import csv # for CSV file handling
#from tqdm import tqdm_notebook
from tqdm import tqdm # for tracking the execution progress
import re # for regular expression over sentences for pre-processing
from nltk.corpus import stopwords # for stopwords removal
import string  # for punctuation mark list

from sklearn.feature_extraction.text import CountVectorizer # for Bag Of Words
from sklearn.feature_extraction.text import TfidfVectorizer # for text to vector creation
from gensim.models import Word2Vec # For Word2Vec
#from sklearn.preprocessing import StandardScaler # for Column Standardization
from sklearn.preprocessing import MinMaxScaler # for Row Standardization

from sklearn.decomposition import TruncatedSVD # for reducing Bow/TFIDF dimension

import scipy.sparse # for storing sparse matrix
```

```python
import pickle # for storing review polarities

import nltk # for pre-processing text data
nltk.download('stopwords')

from prettytable import PrettyTable # for pretty table
from matplotlib import pyplot as plt # for pie char
```

```
[nltk_data] Downloading package stopwords to C:\Users\yuvaraja
[nltk_data]     manikandan\AppData\Roaming\nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
```

In [2]:

```python
# All the outputs generated by this notebook will be placed in a separa
te folder
output_dir = 'Output'
if not os.path.exists(output_dir):
    os.mkdir(output_dir)

def getOutputFileNamePath(file_name):
    return str(Path.cwd() / output_dir / file_name)

def saveListToFile(file_name, my_list):
    '''
    Helper function to save the given list into a file
    Each item is considered as a string and stored in a separate line
    '''
    with open(getOutputFileNamePath(file_name), 'w') as f:
        for item in my_list:
            f.write("%s\n" % item)

def storeSet(w_set, file_name):
    with open(getOutputFileNamePath(file_name), 'w', encoding="utf-8")
as csv_file:
        for w in w_set:
            csv_file.write(str(w))
            csv_file.write('\n')


# https://stats.stackexchange.com/questions/340933/truncatedsvd-always-
```

```
reduces-dataset-to-1d
def GetRandomizedSVD(**kwargs):
    '''
    Common function wtih fixed SVD configuration for TruncatedSVD
    '''
    return TruncatedSVD(algorithm='randomized',
                        random_state=42,
                        **kwargs)

def GetOptimalDimension(X,req_variance=0.95):
    '''
    Function to get dimension on SVD having 95% variance
    Input:
        X: Numpy Array of the data
        req_variance - Require varianced (default 0.95)
    Output:
        Max dimensions after SVD that is needed to have the requested v
ariance
    '''

    max_svd_components = X.get_shape()[1] - 1
    print('GetOptimalDimension -> Actual: ', X.get_shape()[1], ' Select
ed: ', max_svd_components)
    svd = GetRandomizedSVD(n_components=max_svd_components)
    svd.fit(X)
    cumsum = np.cumsum(svd.explained_variance_ratio_)
    max_svd_components = np.argmax(cumsum >= req_variance) + 1
    print('GetOptimalDimension -> Final SVD Component Size: ', max_svd_
components)
    #print('Cum Var: ', cumsum)

    return max_svd_components

    '''
    print('Final SVD Component Size: ', max_svd_components, 'Cum Var:
 ', cumsum)

    svd = get_svd(n_components=max_svd_components)
    return svd.fit_transform(X)
    '''
```

Load Data

In [3]:

```
# Using sqlite read data from the database
#con = sqlite3.connect('/content/drive/My Drive/Colab Notebooks/AFF-Rev
iew/database.sqlite')
db_path = Path.cwd() / 'database.sqlite'
con = sqlite3.connect(str(db_path))

# Get reviews which do not have score as 3
filtered_data = pd.read_sql_query(""" SELECT * FROM Reviews WHERE Score
 != 3 """, con)
filtered_data.head()
```

Out[3]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	Helpfulnes
0	1	B001E4KFG0	A3SGXH7AUHU8GW	delmartian	1	1
1	2	B00813GRG4	A1D87F6ZCVE5NK	dll pa	0	0

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	Helpfulnes
2	3	B000LQOCH0	ABXLMWJIXXAIN	Natalia Corres "Natalia Corres"	1	1
3	4	B000UA0QIQ	A395BORC6FGVXV	Karl	3	3
4	5	B006K2ZZ7K	A1UQRSCLF8GW1T	Michael D. Bigham "M. Wassir"	0	0

Insights about Data (Highlevel Statistics)

Let me try to understand the dataset that is given to me (Basically 'Understanding the Data')

In [4]:

```
filtered_data.describe()
```

Out[4]:

	Id	HelpfulnessNumerator	HelpfulnessDenominator	Score	
count	525814.000000	525814.000000	525814.000000	525814.000000	5

	Id	HelpfulnessNumerator	HelpfulnessDenominator	Score	
mean	284599.060038	1.747293	2.209544	4.279148	1
std	163984.038077	7.575819	8.195329	1.316725	4
min	1.000000	0.000000	0.000000	1.000000	9
25%	142730.250000	0.000000	0.000000	4.000000	1
50%	284989.500000	0.000000	1.000000	5.000000	1
75%	426446.750000	2.000000	2.000000	5.000000	1
max	568454.000000	866.000000	878.000000	5.000000	1

Features/ Labels

In [5]:

```
print(filtered_data.columns)
print(filtered_data.dtypes)
```

```
Index(['Id', 'ProductId', 'UserId', 'ProfileName', 'HelpfulnessNumerato
r',
       'HelpfulnessDenominator', 'Score', 'Time', 'Summary', 'Text'],
      dtype='object')
Id                         int64
ProductId                 object
UserId                    object
ProfileName               object
HelpfulnessNumerator       int64
HelpfulnessDenominator     int64
Score                      int64
Time                       int64
Summary                   object
Text                      object
dtype: object
```

Observation

- Totally 10 features given
- No labels given
- From Kaggle below information I have obtained about teach feature
  - https://www.kaggle.com/snap/amazon-fine-food-reviews
- Id
  - Row Id
- ProductId
  - Unique identifier for the product
- UserId
  - Unqiue identifier for the user
- ProfileName
  - Profile name of the user
- HelpfulnessNumerator
  - Number of users who found the review helpful
- HelpfulnessDenominator
  - Number of users who indicated whether they found the review helpful
- Score
  - Rating between 1 and 5
- Time
  - Timestamp for the review
- Summary
  - Brief summary of the review
- Text
  - Text of the review

Data Cleaning

Since it is a text corpus, before feature creation, data neet to be cleaned.

I have executed this stage in two steps

1. First analyse the give data for abnormality

2. Execute the cleaning process based on previous step observations

Analysis

Features Analysis

In [6]:

```
# Id
u = filtered_data.Id.value_counts()
u.unique()
```

Out[6]:

```
array([1], dtype=int64)
```

In [7]:

```
# ProductId
len(filtered_data.ProductId.unique())
```

Out[7]:

```
72005
```

In [8]:

```
# UserId
len(filtered_data.UserId.unique())
```

Out[8]:

```
243414
```

In [9]:

```
# HelpfulnessNumerator
print(filtered_data.HelpfulnessNumerator.min(),
      filtered_data.HelpfulnessNumerator.max(),
      len(filtered_data.HelpfulnessNumerator.unique()))
```

```
0 866 222
```

In [10]:

```
# HelpfulnessDenominator
print(filtered_data.HelpfulnessDenominator.min(),
      filtered_data.HelpfulnessDenominator.max(),
      len(filtered_data.HelpfulnessDenominator.unique()))

# As per feature details, Denominator should be greater than Numerator
# Lets check whether the data follows that description
filtered_data[(filtered_data.HelpfulnessDenominator < filtered_data.Hel
pfulnessNumerator)]
```

```
0 878 227
```

Out[10]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	Hel
41159	44737	B001EQ55RW	A2V0I904FH7ABY	Ram	3	2
59301	64422	B000MIDROQ	A161DK06JJMCYF	J. E. Stephens "Jeanne"	3	1

In [11]:

```
# Score
print(filtered_data.Score.unique())
print(filtered_data.Score.value_counts())
```

```
[5 1 4 2]
5    363122
4     80655
1     52268
2     29769
Name: Score, dtype: int64
```

In [12]:

```
# Time
print(len(filtered_data.Time.unique()))
```

```
#filtered_data['Time'].value_counts()

# Check whether any entry with same time for more than one product
# which is practically not possible
userid_group = filtered_data.groupby('UserId')
#g = userid_group.groups
#g.values()

fil_val = userid_group.filter(lambda x:len(x)>1).sort_values('Time')
fil_val.to_csv(getOutputFileNamePath('user_id_grouped.csv'))
fil_val.head()
```

```
3157
```

Out[12]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	H
346055	374359	B00004CI84	A344SMIA5JECGM	Vincent P. Ross	1	2
417859	451878	B00004CXX9	A344SMIA5JECGM	Vincent P. Ross	1	2
212472	230285	B00004RYGX	A344SMIA5JECGM	Vincent P. Ross	1	2
346116	374422	B00004CI84	A1048CYU0OV4O8	Judy L. Eans	2	2

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	H
417927	451949	B00004CXX9	A1048CYU0OV4O8	Judy L. Eans	2	2

Invalid Review check / Analysis - on Summary

In [13]:

```
def getEntriesHavingWords(df, col_to_search, regex_list):
    '''
    Function to search for given list of regex expressions over the requested column
    '''
    indices = []
    counts = []
    for regex_val in regex_list:
        l = df[df[col_to_search].str.contains(regex_val,regex=True)].index.tolist()
        counts.append(len(l))
        indices = indices + l
    return indices, counts
```

In [14]:

```
text_list = ['Tim Burton', r'\b[bB]ook\b', r'\b[fF]ilm\b']
suspicious_indices, counts = getEntriesHavingWords(filtered_data,
                                                   'Summary',
                                                   text_list)

for i in range(len(counts)):
    print("No. of entries having '{0}' is {1}".format(text_list[i], counts[i]))

print('Total suspicious entries : ', len(suspicious_indices))
```

```
save_data = filtered_data.iloc[suspicious_indices]
save_data.to_csv(getOutputFileNamePath('non_related_review_entries.csv'
))
save_data.head()
```

```
No. of entries having 'Tim Burton' is 36
No. of entries having '\b[bB]ook\b' is 58
No. of entries having '\b[fF]ilm\b' is 17
Total suspicious entries :  111
```

Out[14]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator
212391	230200	B00004RYGX	A2H1WNB30JNAWU	Jack D. Lowry	0
212417	230228	B00004RYGX	ASJ54MITON1NO	Dr. Feelgood "Dr. Feelgood"	0
212423	230234	B00004RYGX	A1FMJJKSVQDDQ	Eric S. Kim	0

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator
212439	230250	B00004RYGX	A1TW9ZGRDQQZ2Y	Monkdude	0
212444	230255	B00004RYGX	A1JZV9MCT6KOX4	C. Eallonardo "Kali's Copilot"	0

Invalid Entry check / analysis - on review text

Since checking this process takes long time, after this check, I have disabled this code to avoid huge delay in pre-processing

In [52]:
```
def getUniqueWords(df, col_name):
    words = [w for index,row in df[col_name].items() for w in row.split
()]
    return list(set(words))
```

In [53]:
```
%%time
summary_words = getUniqueWords(filtered_data, 'Summary')
```

```
Wall time: 479 ms
```

In [54]:
```
%%time
text_words = getUniqueWords(filtered_data, 'Text')
```

```
Wall time: 9.43 s
```

In [55]:
```
print('Total unique words in Summary: ', len(summary_words))
print('Total unique words in Review Text: ', len(text_words))
```

```
Total unique words in Summary:  98264
Total unique words in Review Text:  553862
```

In [56]:
```
storeSet(summary_words, 'summary_words.csv')
storeSet(text_words, 'text_words.csv')
```

In [57]:
```
invalidChars = set(string.punctuation.replace("_", ""))

def containsAny(word, char_list):
    '''
    If any of the character in char_list found in 'word' will return True
    Otherwise returns False
    '''
    for c in char_list:
        if c in word:
            return True
    return False

def containsAll(word, char_list):
    '''
    If all of the characters in char_list found in 'word' will return True
    Otherwise returns False
    '''
    for c in char_list:
        if c not in word:
            return True
    return False
```

In [69]:
```
def getWordsHavingSpecialChar(df, col_name):
    '''
    Function to get list of words having special characters in the requested column
    '''
    words = []
    count  = 0
    for row in tqdm(df[col_name],ascii=True):
        w_c_l = []
        for w in row.split():
            if containsAny(w, invalidChars):
                words.append(w)
    return words
```

In [70]:

```
%%time
summary_invalid_words = getWordsHavingSpecialChar(filtered_data, 'Summa
ry')
```

```
100%|###################################################################
####| 525814/525814 [00:03<00:00, 140180.76it/s]
```

```
Wall time: 3.76 s
```

In [71]:

```
%%time
text_invalid_words = getWordsHavingSpecialChar(filtered_data, 'Text')
```

```
100%|###################################################################
######| 525814/525814 [00:54<00:00, 9734.75it/s]
```

```
Wall time: 54 s
```

In [72]:

```
print('Total unique (invalid) words in Summary: ', len(summary_invalid_
words))
print('Total unique (invalid) words in Review Text: ', len(text_invalid
_words))
```

```
Total unique (invalid) words in Summary:  345554
Total unique (invalid) words in Review Text:  6728685
```

In [73]:

```
storeSet(summary_invalid_words, 'summary_invalid_words.csv')
storeSet(text_invalid_words, 'text_invalid_words.csv')
```

Observation Summary

- Id
    - No Id repeation
- ProductId
    - 72005 Products
- UserId
    - 243414 Users
- HelpfulnessNumerator
    - value ranges from 0 to 808
    - 222 unique entries
- HelpfulnessDenominator
    - value ranges from 0 to 878
    - 227 unique entries
    - **2 invalid entries found**
        - Denominator is greater than Numerator
- Score
    - Scores range from 1 to 5 only
    - No invalid entries found
    - **No equal amount of data points for each score**
        - We have an **IMBALANCED** dataset
- Entries with book/Book words found in text reviews
- Entries with film/Film words found in text reviews
- There are duplicates

Cleaning

Actual cleaning process I am doing here

Convert Score to Positive/Negative review

In [74]:

```
def ScoreToReviewType(score):
    if score < 3:
        return 0
    return 1

filtered_data.Score = filtered_data.Score.map(ScoreToReviewType)
print(filtered_data.Score.unique())
```

```
[1 0]
```

Drop Duplicates

In [75]:

```
# Sort the data based on ProductID in ascending order so that we can ke
ep only one kind of product review
sorted_data = filtered_data.sort_values('Time',axis=0, ascending=True,
inplace=False, na_position='last')
```

In [76]:

```
# keep first entry, drop remaining duplicate entries
final_data = sorted_data.drop_duplicates(subset={'UserId','Time'},keep=
'first',inplace=False)
print(final_data.shape)
```

```
(328732, 10)
```

In [77]:

```
# Cross-checking for NaN removal
final_data.isnull().sum().sum()
```

Out[77]:

```
0
```

Remove Invalid Helpfull Score entries

In [78]:

```
# Drop data having invalid helpful score entries
# that is removing entries which has denominator greater than numerato
r, which is practically impossible
final_data = final_data[final_data.HelpfulnessNumerator <= final_data.H
elpfulnessDenominator]
print(final_data.shape)
```

```
(328731, 10)
```

Remove Invalid Summary Entries

- Remove actual film reviews
- Tim Burton (found by filtering film words and looking into data)

In [79]:

```python
# Remove reviews unrelated to foods

text_list = ['Tim Burton', r'\b[bB]ook\b', r'\b[fF]ilm\b']
suspicious_indices, counts = getEntriesHavingWords(final_data,
                                                   'Summary',
                                                   text_list)

final_data = final_data.drop(suspicious_indices)
print(final_data.shape)
```

```
(328674, 10)
```

Remove Invalid Text (Review) Entries

In [80]:

```python
# Remove film reviews found in Review Text
final_data = final_data[~final_data.Text.str.contains('Tim Burton')]
print(final_data.shape)
```

```
(328622, 10)
```

In [81]:

```python
def removeHtmlTags(sentence):
    '''
    function to remove HTML tags in the given sentence
    '''
    reg_exp = re.compile('<.*?>', )
    cleaned_text = re.sub(reg_exp, ' ', sentence)
    return cleaned_text

def removePunctuations(sentence):
    '''
    function to remove punctuations in the given sentence
    '''
    cleaned_sentence = re.sub(r'[?|!|\'|"|#]',r'',sentence)
    cleaned_sentence = re.sub(r'[.|,|)|(|\|/]',r' ',cleaned_sentence)
    return cleaned_sentence

# s = 'Hi I am <pr> test </pr> testing'
# removeHtmlTags(s).split()
```

In [82]:

```
stop_words = set(stopwords.words('english')) # get stop words for Engli
sh
#print(stop)
snow_stem = nltk.stem.SnowballStemmer('english') # get Stemmer for Engl
ish
#print(snow)
```

In [83]:

```
# Creating final dataset set using/following steps

# 1. Removing HTML tags that are found in my above analysis
# 2. Removing punctuations, which has no meaning as a word
# 3. Stemming words based on English vocabulary set from NLTK
# 4. Creating a seperate list for both positive and negative cases, hav
ing only those words

all_positive_words = []
all_negative_words = []
final_review_texts = []
df_index = 0 # for tracking the observations

for sent in tqdm(final_data['Text'].values,ascii=True):
    #print('{0} ==> '.format(df_index), sent)
    sent = removeHtmlTags(sent) # remove HTML tags first
    #print('{0} ==> '.format(df_index), sent)

    filtered_words = []
    for w in sent.split():
        #print(removePunctuations(w))
        for cleaned_word in removePunctuations(w).split():
            if ((cleaned_word.isalpha()) & (len(cleaned_word) > 2)):
                cleaned_word = cleaned_word.lower()
                #print(cleaned_word)
                if (cleaned_word not in stop_words):
                    s = (snow_stem.stem(cleaned_word)).encode('utf8')
                    filtered_words.append(s)
                    if ((final_data['Score'].values)[df_index] == 1):
                        all_positive_words.append(s)
                    else:
                        all_negative_words.append(s)
                else:
                    continue
            else:
                continue

    filtered_sent = b" ".join(filtered_words)
    #print(filtered_words, filtered_sent)
    final_review_texts.append(filtered_sent)

    df_index += 1
    #if df_index > 10:
        #break
```

```
100%|######################################################################
#######| 328622/328622 [06:31<00:00, 840.06it/s]
```

Store cleaned data

In [84]:
```
len(final_review_texts)
```

Out[84]:
```
328622
```

In [85]:
```
# add cleaned text as a seperate column (feature) into our final data d
ataframe
# It will easy me in handling the cleaned data
```

```
final_data['CleanedText'] = final_review_texts
final_data.head()
```

Out[85]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	H
138683	150501	0006641040	AJ46FKXOVC7NR	Nicholas A Mesiano	2	2
417839	451856	B00004CXX9	AIUWLEQ1ADEG5	Elizabeth Medina	0	0
417838	451855	B00004CXX9	AJH6LUC1UT1ON	The Phantom of the Opera	0	0
417927	451949	B00004CXX9	A1048CYU0OV4O8	Judy L. Eans	2	2

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	He
417847	451864	B00004CXX9	A1B2IZU1JLZA6	Wes	19	23

In [86]:

```
# Sort data based on Time
sorted_data = final_data.sort_values('Time',axis=0, ascending=True, inp
lace=False, na_position='last')
```

In [87]:

```
print(len(sorted_data))
sorted_data.head()
```

```
328622
```

Out[87]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	He
138683	150501	0006641040	AJ46FKXOVC7NR	Nicholas A Mesiano	2	2
417839	451856	B00004CXX9	AIUWLEQ1ADEG5	Elizabeth Medina	0	0

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	He
417838	451855	B00004CXX9	AJH6LUC1UT1ON	The Phantom of the Opera	0	0
417927	451949	B00004CXX9	A1048CYU0OV4O8	Judy L. Eans	2	2
417847	451864	B00004CXX9	A1B2IZU1JLZA6	Wes	19	23

In [88]:

```
# store final data into new database
conn = sqlite3.connect(getOutputFileNamePath('cleaned.sqlite'))
c = conn.cursor()
conn.text_factory = str
sorted_data.to_sql('Reviews', conn, schema=None, if_exists='replace',
                   index=True, index_label=None, dtype=None)
conn.close()
```

In [89]:

```
# Store review polarities in a seperate file
with open(getOutputFileNamePath('positive_words.pkl'), 'wb') as f:
    pickle.dump(all_positive_words, f)
```

```
with open(getOutputFileNamePath('negative_words.pkl'), 'wb') as f:
    pickle.dump(all_negative_words, f)
```

In [90]:

```
def getUniqueWords_2(df, col_name):
    words = [w for index,row in df[col_name].items() for w in row.decod
e('utf-8').split()]
    return list(set(words))
```

In [91]:

```
%%time

# How many unique words do we have in cleaned text?
text_words_cleaned = getUniqueWords_2(sorted_data, 'CleanedText')
print('Total unique words in Cleaned Text: ', len(text_words_cleaned))
storeSet(text_words_cleaned, 'cleanded_text_words.csv')
```

```
Total unique words in Cleaned Text:  68864
Wall time: 3.06 s
```

In [92]:

```
storeSet(text_words_cleaned, 'cleanded_text_words.csv')
```

In [98]:

```
def getWordsHavingSpecialChar_2(df, col_name):
    '''
    Function to get list of words having special characters in the requ
ested column
    '''
    words = []
    count  = 0
    for row in tqdm(df[col_name],ascii=True):
        for w in row.decode('utf-8').split():
            if containsAny(w, invalidChars):
                words.append(w)
    return words
```

In [99]:

```
%%time

# Do we have any invalid words still in cleaned text?
text_invalid_words_cleanded = getWordsHavingSpecialChar_2(sorted_data,
'CleanedText')
print('Total unique (invalid) words in Cleaned Text: ', len(text_invali
d_words_cleanded))
storeSet(text_invalid_words_cleanded, 'cleanded_invalid_text_words.csv'
)
```

```
100%|#################################################################
#####| 328622/328622 [00:17<00:00, 18492.56it/s]
```

```
Total unique (invalid) words in Cleaned Text:  0
Wall time: 17.8 s
```

Data Set Preparation (splitting)

- We have approximately 328K reviews sorted according to its entry timestamp
- Due to memory limitation, I will be taking first 100K Reviews for Study
- Selected dataset will be splitted into:
    - First 60% as Training Data set
    - Next 20% as Cross Validation Data set
    - Remaining 20% as Test Data Set

In [3]:

```
total_entries = 150 * 1000 # 150K

n_train_entries = int(total_entries * 0.60)
n_cv_entries = int(total_entries * 0.20)
n_test_entries = int(total_entries * 0.20)

print('Train {0}, CV {1}, Test {2}, Total {3}'.format(n_train_entries,
n_cv_entries, n_test_entries, total_entries))
```

```
Train 90000, CV 30000, Test 30000, Total 150000
```

In [4]:

```
con = sqlite3.connect(getOutputFileNamePath('cleaned.sqlite'))
df = pd.read_sql_query("""SELECT * from Reviews""", con)
df.head()
con.close()
```

In [5]:

```python
# Creating Total DataSet
total_dataset = df.iloc[:total_entries]
#total_dataset = df.sample(n=total_entries,random_state=42)
print(total_dataset.shape)
total_dataset.head()
```

```
(150000, 12)
```

Out[5]:

	index	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator
0	138683	150501	0006641040	AJ46FKXOVC7NR	Nicholas A Mesiano	2
1	417839	451856	B00004CXX9	AIUWLEQ1ADEG5	Elizabeth Medina	0
2	417838	451855	B00004CXX9	AJH6LUC1UT1ON	The Phantom of the Opera	0

	index	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator
3	417927	451949	B00004CXX9	A1048CYU0OV4O8	Judy L. Eans	2
4	417847	451864	B00004CXX9	A1B2IZU1JLZA6	Wes	19

In [6]:

```
# Sort dataset based on Time
total_dataset = total_dataset.sort_values('Time',axis=0, ascending=True
, inplace=False, na_position='last')
total_dataset.head()
```

Out[6]:

	index	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator
0	138683	150501	0006641040	AJ46FKXOVC7NR	Nicholas A Mesiano	2

	index	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator
1	417839	451856	B00004CXX9	AIUWLEQ1ADEG5	Elizabeth Medina	0
2	417838	451855	B00004CXX9	AJH6LUC1UT1ON	The Phantom of the Opera	0
3	417927	451949	B00004CXX9	A1048CYU0OV4O8	Judy L. Eans	2
4	417847	451864	B00004CXX9	A1B2IZU1JLZA6	Wes	19

In [7]:

```
# Creating Training Dataset
train_dataset = total_dataset.iloc[:n_train_entries]
print(train_dataset.shape)
train_dataset.head()
```

```
(90000, 12)
```

Out[7]:

	index	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator
0	138683	150501	0006641040	AJ46FKXOVC7NR	Nicholas A Mesiano	2
1	417839	451856	B00004CXX9	AIUWLEQ1ADEG5	Elizabeth Medina	0
2	417838	451855	B00004CXX9	AJH6LUC1UT1ON	The Phantom of the Opera	0
3	417927	451949	B00004CXX9	A1048CYU0OV4O8	Judy L. Eans	2
4	417847	451864	B00004CXX9	A1B2IZU1JLZA6	Wes	19

In [8]:

```
# Creating Cross Validation Dataset
cv_dataset = total_dataset.iloc[n_train_entries:(n_train_entries+n_cv_e
ntries)]
print(cv_dataset.shape)
cv_dataset.head()
```

```
(30000, 12)
```

Out[8]:

	index	Id	ProductId	UserId	ProfileName	HelpfulnessNume
89923	272268	295091	B002GPG6BE	AVT5YM077UHFE	Vicki R. Boggs	1
89918	378488	409246	B003750AGE	AQS57P332FTEG	Van Gogh	0
90073	337369	365031	B001AC67DQ	A1270OOH9URZW4	KDragon	1
90074	406009	439058	B000NY31EA	A3OQ3LTW5OTHP1	Peg B.	3

	index	Id	ProductId	UserId	ProfileName	HelpfulnessNume
90075	224408	243340	B00305L330	A2B117UIX7AJOA	L. Meaux	0

In [9]:

```python
# Creating Test Dataset
test_dataset = total_dataset.iloc[(n_train_entries+n_cv_entries):]
print(test_dataset.shape)
test_dataset.head()
```

```
(30000, 12)
```

Out[9]:

	index	Id	ProductId	UserId	ProfileName	HelpfulnessI
120084	249105	270074	B000LRIFU4	A34RLIHYRNS32O	Eileen	1
120073	394347	426432	B000I62E82	A2X4F1HB3GUKWU	Red Writer	0

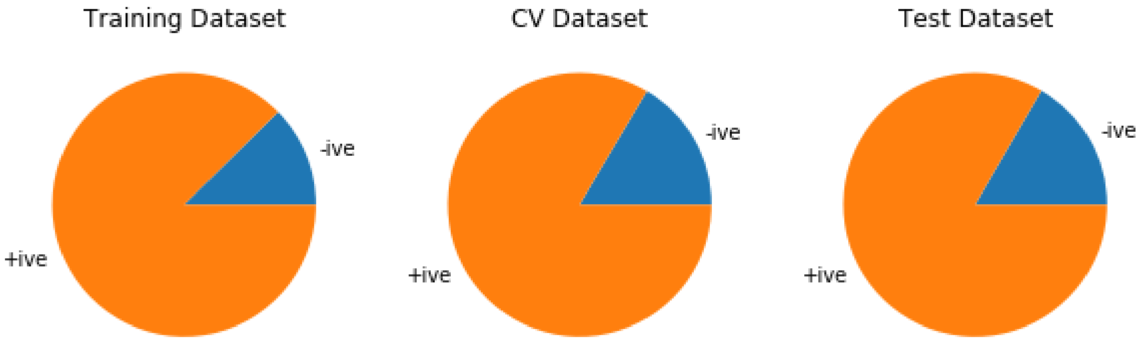
	index	Id	ProductId	UserId	ProfileName	Helpfulness
120004	329113	356190	B0018RYBZ4	A2I3Q8D73940OC	MichiganMommy	0
119900	438189	473861	B000FPDYR6	A2N9HNTRR1ZDZG	SV "TeaRific"	0
120002	417520	451524	B001M0503E	A16D04BXWBATFS	Jack Jericho	0

In [15]:

```
# What is balance of review polarity in our dataset(s)?
class_ratio = PrettyTable()
class_ratio.field_names = ["DataSet", "Total", "Postivie Reviews", "Neg
ative Reviews", "Ratio"]
plt.figure(figsize=(10,10))

pos_rev_count = train_dataset[train_dataset.Score == 1].Score.value_cou
nts().tolist()[0]
neg_rev_count = train_dataset[train_dataset.Score == 0].Score.value_cou
nts().tolist()[0]
ratio = '{0} : {1}'.format(round(pos_rev_count/len(train_dataset),3),ro
und(neg_rev_count/len(train_dataset),3))
class_ratio.add_row(['Train', len(train_dataset), pos_rev_count, neg_re
v_count, ratio])
plt.subplot(1,3,1)
plt.pie([neg_rev_count, pos_rev_count], labels=['-ive', '+ive']);
plt.title('Training Dataset');

pos_rev_count = cv_dataset[cv_dataset.Score == 1].Score.value_counts().
tolist()[0]
neg_rev_count = cv_dataset[cv_dataset.Score == 0].Score.value_counts().
tolist()[0]
ratio = '{0} : {1}'.format(round(pos_rev_count/len(cv_dataset),3),round
(neg_rev_count/len(cv_dataset),3))
class_ratio.add_row(['CV', len(cv_dataset), pos_rev_count, neg_rev_coun
t, ratio])
plt.subplot(1,3,2)
plt.pie([neg_rev_count, pos_rev_count], labels=['-ive', '+ive']);
plt.title('CV Dataset');

pos_rev_count = test_dataset[test_dataset.Score == 1].Score.value_count
s().tolist()[0]
neg_rev_count = test_dataset[test_dataset.Score == 0].Score.value_count
s().tolist()[0]
ratio = '{0} : {1}'.format(round(pos_rev_count/len(test_dataset),3),rou
nd(neg_rev_count/len(test_dataset),3))
class_ratio.add_row(['Test', len(test_dataset), pos_rev_count, neg_rev_
count, ratio])
plt.subplot(1,3,3)
plt.pie([neg_rev_count, pos_rev_count], labels=['-ive', '+ive']);
plt.title('Test Dataset');

print(class_ratio)
```

```
+---------+-------+------------------+------------------+--------------
-+
| DataSet | Total | Postivie Reviews | Negative Reviews |     Ratio
|
+---------+-------+------------------+------------------+--------------
-+
|  Train  | 90000 |      78845       |      11155       | 0.876 : 0.124
|
|    CV   | 30000 |      25062       |       4938       | 0.835 : 0.165
```

```
|
|   Test  | 30000 |      25020       |       4980       | 0.834 : 0.166
|
+---------+-------+------------------+------------------+--------------
-+
```



Bag of Words Sparse Matrix

- Create BoW Vectorizer Model with:
    - min word frequency of 30
    - considering both uni-gram and bi-gram words
    - of maximum 3000 features
- Fit Training Data to the BoW Model
- For each dataset (Training, Cross-Validataion and Test)
    - Transform DataSet using the trained model
    - Store the Transformed data
    - Row Normalize the Training Data
    - Store the Row Normalized data in a separate file

In [170]:
```
def genBowDataSets():
    '''
    Generates BoW Vectors for Training, CV and Test datasets
    '''
    ##################################
    # Vectorizing  Training Dataset #
    #################################
    print('Generating Training Dataset')
    data_array = train_dataset['CleanedText']
    label_array = train_dataset['Score']
    file_prefix = 'Train'

    label_file_name = getOutputFileNamePath('{0}_bow_label'.format(file
_prefix))
    vec_file_name = getOutputFileNamePath('{0}_bow'.format(file_prefix
))
    vec_svd_file_name = getOutputFileNamePath('{0}_bow_svd'.format(file
_prefix))
    ved_std_file_name = getOutputFileNamePath('{0}_bow_std'.format(file
_prefix))

    # Store Label as a separate file
    scipy.sparse.save_npz(label_file_name, scipy.sparse.csr_matrix(labe
l_array))

    # Train the Model
    bow_model = CountVectorizer(min_df=30, max_features=2500, ngram_ran
ge=(1,2))
    bow_vectorizer = bow_model.fit(data_array)

    bow_vector = bow_vectorizer.transform(data_array)
    print('Shape of BoW Vectorizer: ', bow_vector.get_shape())
    print('Total no.of unique words: ', bow_vector.get_shape()[1])
    scipy.sparse.save_npz(vec_file_name, scipy.sparse.csr_matrix(bow_ve
ctor))

    # Reduce dimensionality using TruncatedSVD
    max_svd_components = GetOptimalDimension(bow_vector)
    svd_model = GetRandomizedSVD(n_components=max_svd_components)
    svd_model = svd_model.fit(bow_vector)
    svd_data = svd_model.transform(bow_vector)
    scipy.sparse.save_npz(vec_svd_file_name, scipy.sparse.csr_matrix(sv
d_data))
```

```
    # Row-Normalize the Data
    scaler_model = MinMaxScaler()
    scaler_data = bow_vector.todense().astype(np.float64).T
    scaler_model = scaler_model.fit(scaler_data)
    scaler_data = scaler_model.transform(scaler_data)
    scaler_data = scaler_data.T
    print('Shape of Scaled data', scaler_data.shape)
    scipy.sparse.save_npz(ved_std_file_name, scipy.sparse.csr_matrix(sc
aler_data))

    ##########################
    # Vectorizing CV Dataset #
    ##########################
    print('\nGenerating CV Dataset')
    data_array = cv_dataset['CleanedText']
    label_array = cv_dataset['Score']
    file_prefix = 'CV'

    label_file_name = getOutputFileNamePath('{0}_bow_label'.format(file
_prefix))
    vec_file_name = getOutputFileNamePath('{0}_bow'.format(file_prefix
))
    vec_svd_file_name = getOutputFileNamePath('{0}_bow_svd'.format(file
_prefix))
    ved_std_file_name = getOutputFileNamePath('{0}_bow_std'.format(file
_prefix))

    # Store Label as a separate file
    scipy.sparse.save_npz(label_file_name, scipy.sparse.csr_matrix(labe
l_array))

    # Transform the Dataset using fitted model
    bow_vector = bow_vectorizer.transform(data_array)
    print('Shape of BoW Vectorizer: ', bow_vector.get_shape())
    print('Total no.of unique words: ', bow_vector.get_shape()[1])
    scipy.sparse.save_npz(vec_file_name, scipy.sparse.csr_matrix(bow_ve
ctor))

    # Reduce dimensionality using TruncatedSVD
    svd_data = svd_model.transform(bow_vector)
    scipy.sparse.save_npz(vec_svd_file_name, scipy.sparse.csr_matrix(sv
d_data))

    # Row-Normalize the Data
    scaler_model = MinMaxScaler()
    scaler_data = bow_vector.todense().astype(np.float64).T
    scaler_model = scaler_model.fit(scaler_data)
    scaler_data = scaler_model.transform(scaler_data)
    scaler_data = scaler_data.T
    print('Shape of Scaled data', scaler_data.shape)
    scipy.sparse.save_npz(ved_std_file_name, scipy.sparse.csr_matrix(sc
aler_data))


    ############################
    # Vectorizing Test Dataset #
    ############################
    print('\nGenerating Test Dataset')
    data_array = test_dataset['CleanedText']
    label_array = test_dataset['Score']
    file_prefix = 'Test'

    label_file_name = getOutputFileNamePath('{0}_bow_label'.format(file
_prefix))
    vec_file_name = getOutputFileNamePath('{0}_bow'.format(file_prefix
))
    vec_svd_file_name = getOutputFileNamePath('{0}_bow_svd'.format(file
_prefix))
    ved_std_file_name = getOutputFileNamePath('{0}_bow_std'.format(file
_prefix))

    # Store Label as a separate file
    scipy.sparse.save_npz(label_file_name, scipy.sparse.csr_matrix(labe
l_array))

    # Transform the Dataset using fitted model
    bow_vector = bow_vectorizer.transform(data_array)
    print('Shape of BoW Vectorizer: ', bow_vector.get_shape())
    print('Total no.of unique words: ', bow_vector.get_shape()[1])
    scipy.sparse.save_npz(vec_file_name, scipy.sparse.csr_matrix(bow_ve
ctor))

    # Reduce dimensionality using TruncatedSVD
    svd_data = svd_model.transform(bow_vector)
    scipy.sparse.save_npz(vec_svd_file_name, scipy.sparse.csr_matrix(sv
d_data))

    # Row-Normalize the Data
    scaler_model = MinMaxScaler()
    scaler_data = bow_vector.todense().astype(np.float64).T
    scaler_model = scaler_model.fit(scaler_data)
    scaler_data = scaler_model.transform(scaler_data)
    scaler_data = scaler_data.T
    print('Shape of Scaled data', scaler_data.shape)
    scipy.sparse.save_npz(ved_std_file_name, scipy.sparse.csr_matrix(sc
aler_data))
```

In [171]:

```
%%time

genBowDataSets()
```

```
Generating Training Dataset
Shape of BoW Vectorizer:  (90000, 2500)
Total no.of unique words:  2500
GetOptimalDimension -> Actual:  2500  Selected:  2499
GetOptimalDimension -> Final SVD Component Size:  1537
Shape of Scaled data (90000, 2500)

Generating CV Dataset
Shape of BoW Vectorizer:  (30000, 2500)
Total no.of unique words:  2500
Shape of Scaled data (30000, 2500)

Generating Test Dataset
Shape of BoW Vectorizer:  (30000, 2500)
Total no.of unique words:  2500
```

```
Shape of Scaled data (30000, 2500)
Wall time: 6min 7s
```

TF-IDF Sparse Matrix

In [179]:

```
def genTfIdfDataSets():
    '''
    Generates TF-IDF Vectors for Training, CV and Test datasets
    '''
    #################################
    # Vectorizing  Training Dataset #
    #################################
    print('Generating Training Dataset')
    data_array = train_dataset['CleanedText']
    label_array = train_dataset['Score']
    file_prefix = 'Train'

    label_file_name = getOutputFileNamePath('{0}_tfidf_label'.format(fi
le_prefix))
    vec_file_name = getOutputFileNamePath('{0}_tfidf'.format(file_prefi
x))
    vec_svd_file_name = getOutputFileNamePath('{0}_tfid_svd'.format(fil
e_prefix))
    ved_std_file_name = getOutputFileNamePath('{0}_tfidf_std'.format(fi
le_prefix))

    # Store Label as a separate file
    scipy.sparse.save_npz(label_file_name, scipy.sparse.csr_matrix(labe
l_array))

    # Train the Model
    tfidf_model = TfidfVectorizer(min_df=30, max_features=2000, ngram_r
ange=(1,2))
    tfidf_vectorizer = tfidf_model.fit(data_array)

    tfidf_vector = tfidf_vectorizer.transform(data_array)
    print('Shape of TfIDF Vectorizer: ', tfidf_vector.get_shape())
    print('Total no.of unique words: ', tfidf_vector.get_shape()[1])
    scipy.sparse.save_npz(vec_file_name, scipy.sparse.csr_matrix(tfidf_
vector))


    # Reduce dimensionality using TruncatedSVD
    max_svd_components = GetOptimalDimension(tfidf_vector)
    svd_model = GetRandomizedSVD(n_components=max_svd_components)
    svd_model = svd_model.fit(tfidf_vector)
    svd_data = svd_model.transform(tfidf_vector)
    scipy.sparse.save_npz(vec_svd_file_name, scipy.sparse.csr_matrix(sv
d_data))

    # Row-Normalize the Data
    scaler_model = MinMaxScaler()
    scaler_data = tfidf_vector.todense().astype(np.float64).T
    scaler_model = scaler_model.fit(scaler_data)
    scaler_data = scaler_model.transform(scaler_data)
    scaler_data = scaler_data.T
    print('Shape of Scaled data', scaler_data.shape)
    scipy.sparse.save_npz(ved_std_file_name, scipy.sparse.csr_matrix(sc
aler_data))

    ##########################
    # Vectorizing CV Dataset #
    ##########################
    print('\nGenerating CV Dataset')
    data_array = cv_dataset['CleanedText']
    label_array = cv_dataset['Score']
    file_prefix = 'CV'

    label_file_name = getOutputFileNamePath('{0}_tfidf_label'.format(fi
le_prefix))
    vec_file_name = getOutputFileNamePath('{0}_tfidf'.format(file_prefi
x))
    vec_svd_file_name = getOutputFileNamePath('{0}_tfid_svd'.format(fil
e_prefix))
    ved_std_file_name = getOutputFileNamePath('{0}_tfidf_std'.format(fi
le_prefix))
```

```
    # Store Label as a separate file
    scipy.sparse.save_npz(label_file_name, scipy.sparse.csr_matrix(labe
l_array))

    # Transform the Dataset using fitted model
    tfidf_vector = tfidf_vectorizer.transform(data_array)
    print('Shape of TfIDF Vectorizer: ', tfidf_vector.get_shape())
    print('Total no.of unique words: ', tfidf_vector.get_shape()[1])
    scipy.sparse.save_npz(vec_file_name, scipy.sparse.csr_matrix(tfidf_
vector))

    # Reduce dimensionality using TruncatedSVD
    svd_data = svd_model.transform(tfidf_vector)
    scipy.sparse.save_npz(vec_svd_file_name, scipy.sparse.csr_matrix(sv
d_data))

    # Row-Normalize the Data
    scaler_model = MinMaxScaler()
    scaler_data = tfidf_vector.todense().astype(np.float64).T
    scaler_model = scaler_model.fit(scaler_data)
    scaler_data = scaler_model.transform(scaler_data)
    scaler_data = scaler_data.T
    print('Shape of Scaled data', scaler_data.shape)
    scipy.sparse.save_npz(ved_std_file_name, scipy.sparse.csr_matrix(sc
aler_data))

    ############################
    # Vectorizing Test Dataset #
    ############################
    print('\nGenerating Test Dataset')
    data_array = test_dataset['CleanedText']
    label_array = test_dataset['Score']
    file_prefix = 'Test'

    label_file_name = getOutputFileNamePath('{0}_tfidf_label'.format(fi
le_prefix))
    vec_file_name = getOutputFileNamePath('{0}_tfidf'.format(file_prefi
x))
```

```
    vec_svd_file_name = getOutputFileNamePath('{0}_tfid_svd'.format(fil
e_prefix))
    ved_std_file_name = getOutputFileNamePath('{0}_tfidf_std'.format(fi
le_prefix))

    # Store Label as a separate file
    scipy.sparse.save_npz(label_file_name, scipy.sparse.csr_matrix(labe
l_array))

    # Transform the Dataset using fitted model
    tfidf_vector = tfidf_vectorizer.transform(data_array)
    print('Shape of BoW Vectorizer: ', tfidf_vector.get_shape())
    print('Total no.of unique words: ', tfidf_vector.get_shape()[1])
    scipy.sparse.save_npz(vec_file_name, scipy.sparse.csr_matrix(tfidf_
vector))

    # Reduce dimensionality using TruncatedSVD
    svd_data = svd_model.transform(tfidf_vector)
    scipy.sparse.save_npz(vec_svd_file_name, scipy.sparse.csr_matrix(sv
d_data))

    # Row-Normalize the Data
    scaler_model = MinMaxScaler()
    scaler_data = tfidf_vector.todense().astype(np.float64).T
    scaler_model = scaler_model.fit(scaler_data)
    scaler_data = scaler_model.transform(scaler_data)
    scaler_data = scaler_data.T
    print('Shape of Scaled data', scaler_data.shape)
    scipy.sparse.save_npz(ved_std_file_name, scipy.sparse.csr_matrix(sc
aler_data))
```

In [180]:
```
%%time

genTfIdfDataSets()
```

```
Generating Training Dataset
Shape of TfIDF Vectorizer:  (90000, 2000)
Total no.of unique words:  2000
GetOptimalDimension -> Actual:  2000  Selected:  1999
GetOptimalDimension -> Final SVD Component Size:  1606
Shape of Scaled data (90000, 2000)

Generating CV Dataset
Shape of TfIDF Vectorizer:  (30000, 2000)
Total no.of unique words:  2000
Shape of Scaled data (30000, 2000)

Generating Test Dataset
Shape of BoW Vectorizer:  (30000, 2000)
Total no.of unique words:  2000
Shape of Scaled data (30000, 2000)
Wall time: 5min 22s
```

Avg Word2Vec

Max Dimension for Word2Vec = 50 (some arbitraty value, no calculation made on selecting this value)

In [181]:

```
def getListOfSentences(data_array):
    '''
    returns list having each sentence as an entry
    '''
    list_of_sent = []
    for sent in data_array:
        list_of_sent.append(sent.decode("utf-8").split())
    return list_of_sent
```

In [182]:

```
def getAvgW2VReviewVectors(w2v_model,data_array):
    '''
    returns the w2v for all the reviews that exist in data_array using
 w2v_vocab
    Input:
        w2v_model - Model which need to be used for vectorization
        data_array - Reviews that need to be vectorized
    Output:
        List having W2V Vectorized data for data_array
    '''
    list_of_sent = getListOfSentences(data_array)
    w2v_words = list(w2v_model.wv.vocab)
    #saveListToFile(file_prefix + '_avg_w2v_w2v_words',w2v_words)
    #print("number of words that occured minimum 5 times : ",len(w2v_words))
    #print("sample words ", w2v_words[0:50])

    # Computing average w2v for each review in selected training dataset
    review_vectors = []
    for sent in tqdm(list_of_sent, ascii=True):
        sent_vec = np.zeros(w2v_d) # array to hold the vectors. Initially assuming no vectors in this review
        no_of_words_in_review = 0 # number of words with valid vector in this review

        # count all the words (that are in w2v model) and take average
        for word in sent:
            if word in w2v_words:
                vec = w2v_model.wv[word]
                sent_vec += vec
                no_of_words_in_review += 1
        if no_of_words_in_review != 0:
            sent_vec /= no_of_words_in_review
        review_vectors.append(sent_vec)

    return review_vectors
```

In [183]:

```
# Required dimension
w2v_d = 50
```

In [184]:

```
def getAvgW2VDataSet():
    '''
    Generates Average Word2Vec Vector for Training, CV and Test datasets
    '''
    #################################
    # Vectorizing  Training Dataset #
    #################################
    print('Generating Training Dataset')
    data_array = train_dataset['CleanedText']
    label_array = train_dataset['Score']
    file_prefix = 'Train'

    label_file_name = getOutputFileNamePath('{0}_avg_w2v_label'.format(
file_prefix))
    vec_file_name = getOutputFileNamePath('{0}_avg_w2v'.format(file_pre
fix))
    ved_std_file_name = getOutputFileNamePath('{0}_avg_w2v_std'.format(
file_prefix))

    # Store Label as a separate file
    scipy.sparse.save_npz(label_file_name, scipy.sparse.csr_matrix(labe
l_array.T))

    # Create Training DataSet List array for creating own W2V
    train_list_of_sent = getListOfSentences(data_array.values)

    # Considering words that are occured atleast 5 times in the corpus
    w2v_model = Word2Vec(train_list_of_sent, min_count=5, size=w2v_d, w
orkers=16)

    # Computing average w2v for each review in selected training datase
t
    review_vectors = getAvgW2VReviewVectors(w2v_model, data_array)
    np.save(vec_file_name, review_vectors)
    #print(len(review_vectors))
    #print(len(review_vectors[0]))

    # Row-Normalize the Data
    scaler_model = MinMaxScaler()
    scaler_data = np.array(review_vectors).astype(np.float64).T
    scaler_model = scaler_model.fit(scaler_data)
    scaler_data = scaler_model.transform(scaler_data)
    scaler_data = scaler_data.T
    print('Shape of Scaled data', scaler_data.shape)
    scipy.sparse.save_npz(ved_std_file_name, scipy.sparse.csr_matrix(sc
aler_data))

    ##########################
    # Vectorizing CV Dataset #
    ##########################
    print('\nGenerating CV Dataset')
    data_array = cv_dataset['CleanedText']
    label_array = cv_dataset['Score']
    file_prefix = 'CV'

    label_file_name = getOutputFileNamePath('{0}_avg_w2v_label'.format(
file_prefix))
    vec_file_name = getOutputFileNamePath('{0}_avg_w2v'.format(file_pre
fix))
    ved_std_file_name = getOutputFileNamePath('{0}_avg_w2v_std'.format(
file_prefix))

    # Store Label as a separate file
    scipy.sparse.save_npz(label_file_name, scipy.sparse.csr_matrix(labe
l_array.T))

    # Computing average w2v for each review in selected training datase
t
    review_vectors = getAvgW2VReviewVectors(w2v_model, data_array)
    np.save(vec_file_name, review_vectors)
    #print(len(review_vectors))
    #print(len(review_vectors[0]))

    # Row-Normalize the Data
    scaler_model = MinMaxScaler()
    scaler_data = np.array(review_vectors).astype(np.float64).T
    scaler_model = scaler_model.fit(scaler_data)
    scaler_data = scaler_model.transform(scaler_data)
    scaler_data = scaler_data.T
    print('Shape of Scaled data', scaler_data.shape)
    scipy.sparse.save_npz(ved_std_file_name, scipy.sparse.csr_matrix(sc
aler_data))
```

```
    ############################
    # Vectorizing Test Dataset #
    ############################
    print('\nGenerating Test Dataset')
    data_array = test_dataset['CleanedText']
    label_array = test_dataset['Score']
    file_prefix = 'Test'

    label_file_name = getOutputFileNamePath('{0}_avg_w2v_label'.format(
file_prefix))
    vec_file_name = getOutputFileNamePath('{0}_avg_w2v'.format(file_pre
fix))
    ved_std_file_name = getOutputFileNamePath('{0}_avg_w2v_std'.format(
file_prefix))

    # Store Label as a separate file
    scipy.sparse.save_npz(label_file_name, scipy.sparse.csr_matrix(labe
l_array.T))

    # Computing average w2v for each review in selected training datase
t
    review_vectors = getAvgW2VReviewVectors(w2v_model, data_array)
    np.save(vec_file_name, review_vectors)
    #print(len(review_vectors))
    #print(len(review_vectors[0]))

    # Row-Normalize the Data
    scaler_model = MinMaxScaler()
    scaler_data = np.array(review_vectors).astype(np.float64).T
    scaler_model = scaler_model.fit(scaler_data)
    scaler_data = scaler_model.transform(scaler_data)
    scaler_data = scaler_data.T
    print('Shape of Scaled data', scaler_data.shape)
    scipy.sparse.save_npz(ved_std_file_name, scipy.sparse.csr_matrix(sc
aler_data))
    return
```

In [185]:

```
%%time
```

```
getAvgW2VDataSet()
```

```
Generating Training Dataset
```

```
100%|#################################################################
########| 90000/90000 [01:20<00:00, 1111.54it/s]
```

```
Shape of Scaled data (90000, 50)

Generating CV Dataset
```

```
100%|#################################################################
#########| 30000/30000 [00:30<00:00, 986.79it/s]
```

```
Shape of Scaled data (30000, 50)

Generating Test Dataset
```

```
100%|#################################################################
#########| 30000/30000 [00:33<00:00, 902.41it/s]
```

```
Shape of Scaled data (30000, 50)
Wall time: 2min 39s
```

TF-IDF Weighted Word2Vec

Max Dimension for Word2Vec = 50 (some arbitraty value, no calculation made on selecting this value)

In [186]:

```
def getTFIDFWW2VReviewVectors(w2v_model,tf_idf_dict,data_array):
    '''
    returns the w2v for all the reviews that exist in data_array using
 w2v_vocab
    Input:
        w2v_model - Model which need to be used for vectorization
        tf_idf_dict - Dictionary having the vocabularies
        data_array - Reviews that need to be vectorized
    Output:
        List having W2V Vectorized data for data_array
    '''
```

```python
    list_of_sent = getListOfSentences(data_array)
    w2v_words = list(w2v_model.wv.vocab)

    review_vectors = []
    for sent in tqdm(list_of_sent, ascii=True):
        sent_vec = np.zeros(w2v_d) # array to hold the vectors
        no_of_words_in_review = 0 # number of words with valid vector in this review

        # count all the words (that are in w2v model) and take average
        for word in sent:
            if word in w2v_words:
                vec = w2v_model.wv[word]
                # calculate tf-idf weighted w2v value for this word
                tf_idf = tf_idf_dict[word] * (sent.count(word)/len(sent))

                sent_vec += (vec * tf_idf)
                no_of_words_in_review += 1
        if no_of_words_in_review != 0:
            sent_vec /= no_of_words_in_review
        review_vectors.append(sent_vec)

    return review_vectors
```

In [187]:

```python
def getTfIdfWeightedW2VDataset():
    '''
    Generates Average Word2Vec Vector for Training, CV and Test datasets
    '''
    #################################
    # Vectorizing  Training Dataset #
    #################################
    print('Generating Training Dataset')
    data_array = train_dataset['CleanedText']
    label_array = train_dataset['Score']
    file_prefix = 'Train'

    label_file_name = getOutputFileNamePath('{0}_tfidf_w_w2v_label'.format(file_prefix))
    vec_file_name = getOutputFileNamePath('{0}_tfidf_w_w2v'.format(file_prefix))
    ved_std_file_name = getOutputFileNamePath('{0}_tfidf_w_w2v_std'.format(file_prefix))

    # Store Label as a separate file
    scipy.sparse.save_npz(label_file_name, scipy.sparse.csr_matrix(label_array.T))

    # Create List array for creating own W2V
    train_list_of_sent = getListOfSentences(data_array.values)

    # Create tf-idf vector matrix
    tf_idf_model = TfidfVectorizer(ngram_range=(1,2))
    tf_idf_matrix = tf_idf_model.fit_transform(data_array.values)

    # Create dictionary having words (features) as keys, its tf-idf values as values
    tf_idf_dict = dict(zip(tf_idf_model.get_feature_names(), list(tf_idf_model.idf_)))
    len(tf_idf_dict)

    tf_idf_feat = tf_idf_model.get_feature_names()

    # Considering words that are occured atleast 5 times in the corpus
    w2v_model = Word2Vec(train_list_of_sent, min_count=5, size=w2v_d, workers=16)

    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])

    # Computing tf-idf weighted w2v for each review in selected training dataset
    review_vectors = getTFIDFWW2VReviewVectors(w2v_model, tf_idf_dict, data_array)
    np.save(vec_file_name, review_vectors)
    #print(len(review_vectors))
    #print(len(review_vectors[0]))

    # Row-Normalize the Data
    scaler_model = MinMaxScaler()
    scaler_data = np.array(review_vectors).astype(np.float64).T
    scaler_model = scaler_model.fit(scaler_data)
    scaler_data = scaler_model.transform(scaler_data)
    scaler_data = scaler_data.T
    print('Shape of Scaled data', scaler_data.shape)
    scipy.sparse.save_npz(ved_std_file_name, scipy.sparse.csr_matrix(sc
aler_data))

    ##########################
    # Vectorizing CV Dataset #
    ##########################
    print('\nGenerating CV Dataset')
    data_array = cv_dataset['CleanedText']
    label_array = cv_dataset['Score']
    file_prefix = 'CV'

    label_file_name = getOutputFileNamePath('{0}_tfidf_w_w2v_label'.for
mat(file_prefix))
    vec_file_name = getOutputFileNamePath('{0}_tfidf_w_w2v'.format(file
_prefix))
    ved_std_file_name = getOutputFileNamePath('{0}_tfidf_w_w2v_std'.for
mat(file_prefix))

    # Store Label as a separate file
    scipy.sparse.save_npz(label_file_name, scipy.sparse.csr_matrix(labe
l_array.T))

    # Computing tf-idf weighted w2v for each review in selected trainin
g dataset
    review_vectors = getTFIDFWW2VReviewVectors(w2v_model, tf_idf_dict,
data_array)
    np.save(vec_file_name, review_vectors)

    # Row-Normalize the Data
    scaler_model = MinMaxScaler()
    scaler_data = np.array(review_vectors).astype(np.float64).T
    scaler_model = scaler_model.fit(scaler_data)
    scaler_data = scaler_model.transform(scaler_data)
    scaler_data = scaler_data.T
    print('Shape of Scaled data', scaler_data.shape)
    scipy.sparse.save_npz(ved_std_file_name, scipy.sparse.csr_matrix(sc
aler_data))

    ############################
    # Vectorizing Test Dataset #
    ############################
    print('\nGenerating Test Dataset')
    data_array = test_dataset['CleanedText']
    label_array = test_dataset['Score']
    file_prefix = 'Test'

    label_file_name = getOutputFileNamePath('{0}_tfidf_w_w2v_label'.for
mat(file_prefix))
    vec_file_name = getOutputFileNamePath('{0}_tfidf_w_w2v'.format(file
_prefix))
    ved_std_file_name = getOutputFileNamePath('{0}_tfidf_w_w2v_std'.for
mat(file_prefix))

    # Store Label as a separate file
    scipy.sparse.save_npz(label_file_name, scipy.sparse.csr_matrix(labe
l_array.T))

    # Computing tf-idf weighted w2v for each review in selected trainin
g dataset
    review_vectors = getTFIDFWW2VReviewVectors(w2v_model, tf_idf_dict,
data_array)
    np.save(vec_file_name, review_vectors)

    # Row-Normalize the Data
    scaler_model = MinMaxScaler()
    scaler_data = np.array(review_vectors).astype(np.float64).T
    scaler_model = scaler_model.fit(scaler_data)
    scaler_data = scaler_model.transform(scaler_data)
    scaler_data = scaler_data.T
    print('Shape of Scaled data', scaler_data.shape)
    scipy.sparse.save_npz(ved_std_file_name, scipy.sparse.csr_matrix(sc
aler_data))

    return
```

In [188]:

```
%%time

getTfIdfWeightedW2VDataset()
```

```
Generating Training Dataset
```

```
100%|##################################################################
#########| 90000/90000 [02:17<00:00, 652.28it/s]
```

```
Shape of Scaled data (90000, 50)

Generating CV Dataset
```

```
100%|##################################################################
#########| 30000/30000 [00:51<00:00, 578.07it/s]
```

```
Shape of Scaled data (30000, 50)

Generating Test Dataset
```

```
100%|##################################################################
#########| 30000/30000 [01:08<00:00, 437.25it/s]
```

```
Shape of Scaled data (30000, 50)
Wall time: 4min 49s
```