Assignment 2 - TSNE Amazon Fine Food Reviews

November 28, 2018

1 Amazon Fine Food Reviews

Context

This dataset consists of reviews of fine foods from amazon. The data span a period of more than

Dataset Description

```
The dataset is included with 2 formats - Reviews.csv and database.sqlite(which contains Reviews
   Overall Description:
       Data includes:
         - Reviews from Oct 1999 - Oct 2012
         - 568,454 reviews
         - 256,059 users
         - 74,258 products
         - 260 users with > 50 reviews

    High level Description: Attributes Information
        - 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 h
        - Score - Rating between 1 and 5
        - Time - Timestamp for the review
        - Summary - Brief summary of the review
        - Text - Text of the review
```

Objective

The main objective is - Given a review, determine whether that review is Positive or Negative.
The review can be classified as positive if the Rating/Score is more than 3 and similarly, negat
Note - This is a very approximate and proxy method of determining the polarity of the reviews as

1.1 Importing the libraries

```
In [1]: %matplotlib inline
        import warnings
        warnings.filterwarnings('ignore')

        import numpy as np
        import pandas as pd
        import seaborn as sns
        from matplotlib import pyplot as plt
        from tqdm import tqdm
        import string
        import sqlite3
        import nltk
        import re
        import time
        from nltk.corpus import stopwords

        from sklearn.preprocessing import StandardScaler
        from sklearn.manifold import TSNE
        from sklearn.feature_extraction.text import CountVectorizer
        from sklearn.feature_extraction.text import TfidfVectorizer

        from gensim.models import Word2Vec
```

1.2 Loading the data

```
In [2]: # Create a connection
        conn = sqlite3.connect('../../../../Datasets/amazon-reviews-dataset/database.sqlite')

        # Read from the sqlite3 database using the connection and save it in dataframe using pan
        # Note - We will only fetch those reviews where the score is not equal to 3 (Assumption
        data_df = pd.read_sql_query('SELECT * FROM REVIEWS WHERE SCORE != 3', conn)

        # Printing out the shape of the dataframe
        df_shape_tup = data_df.shape
        print("Number of Reviews - {} and Features/Attributes - {}".format(df_shape_tup[0],df_sh
```

```
Number of Reviews - 525814 and Features/Attributes - 10
```

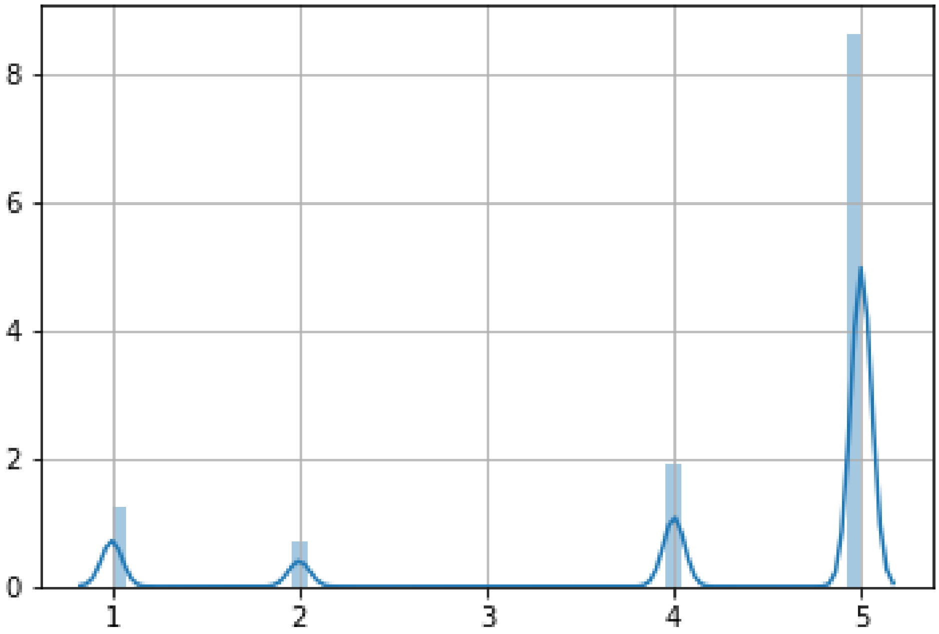
```
In [3]: # Printing out the first 2 rows of data_db dataframe
        data_df.head(2)
```

```
Out[3]:    Id                         ...
        0   1                         ...                              I have bought several of the V
        1   2                         ...                              Product arrived labeled as Jum

        [2 rows x 10 columns]
```

```
In [4]: # Printing out the higher level statistics of the dataset
        data_df.describe()
```

```
Out[4]:                   Id      ...               Time
        count  525814.000000      ...       5.258140e+05
        mean   284599.060038      ...       1.295943e+09
        std    163984.038077      ...       4.828129e+07
        min         1.000000      ...       9.393408e+08
        25%    142730.250000      ...       1.270598e+09
        50%    284989.500000      ...       1.310861e+09
        75%    426446.750000      ...       1.332634e+09
        max    568454.000000      ...       1.351210e+09

        [8 rows x 5 columns]
```

```
In [3]: plt.close()
        sns.distplot(data_df['Score'].values)
        plt.grid()
        plt.show()
```



```
In [5]: # Printing out the higher level information of each feature
        print(data_df.info())
        print("\nThe Unique values in the class attribute column are : {}".format(data_df['Score
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 525814 entries, 0 to 525813
```

```
Data columns (total 10 columns):
Id                        525814 non-null int64
ProductId                 525814 non-null object
UserId                    525814 non-null object
ProfileName               525814 non-null object
HelpfulnessNumerator      525814 non-null int64
HelpfulnessDenominator    525814 non-null int64
Score                     525814 non-null int64
Time                      525814 non-null int64
Summary                   525814 non-null object
Text                      525814 non-null object
dtypes: int64(5), object(5)
memory usage: 40.1+ MB
None

The Unique values in the class attribute column are : [5 1 4 2]
```

Observation: 1. The dataset contains 525814 rows with 10 attributes/features. 2. The dataset doesnot contain any null/NA values in features. 3. For our analysis, the score is used for classification whether the review 'Text' is positive or negative. Since the column/attribute/feature is Numeric. It must be converted to categorical datatype by using some if else logic. 4. The Score can be mapped as Positive if the value is greater than 3 and Negative if the value is less than 3.

1.3 Data Preprocessing, Data DeDuplication, Stemming, Removing Stopwords

```
In [6]: # Data Preprocessing
        # 1. Score mapping - The Score which is classification attribute needs to be mapped to P
        #                    for better classfication visually.

        def score_mapping(score):
            if score > 3:
                return "Positive"
            else:
                return "Negative"


        data_df['Score'] = data_df['Score'].map(score_mapping)
        print(data_df['Score'].value_counts())
        print("\n" + str(data_df['Score'].value_counts(normalize=True)))
        print("\n" + str(data_df.isnull().any()))
```

```
Positive    443777
Negative     82037
Name: Score, dtype: int64

Positive    0.843981
Negative    0.156019
```

```
Name: Score, dtype: float64

Id                        False
ProductId                 False
UserId                    False
ProfileName               False
HelpfulnessNumerator      False
HelpfulnessDenominator    False
Score                     False
Time                      False
Summary                   False
Text                      False
dtype: bool
```

Observation: 1. As per the analysis on class attribute "Score", we find that the dataset is quite imbalanced with 84% values as positive and 16% values as negative. 2. Also there are no null values in any of the columns/attributes/features.

```
In [7]: # Data Preprocessing
        # 2. Helpfulness Numerator must be less than or equal to Helpfulness Denominator
        previous_n = data_df.shape[0]
        data_df = data_df[data_df['HelpfulnessNumerator'] <= data_df["HelpfulnessDenominator"]]
        print("After Data processing Step 2: Shape - " + str(data_df.shape))
        print("{} reviews removed".format(previous_n-data_df.shape[0]))
```

```
After Data processing Step 2: Shape - (525812, 10)
2 reviews removed
```

```
In [8]: # Data Preprocessing
        # 3. Removing duplicate entries
        previous_n = data_df.shape[0]
        data_df.sort_values(by='ProductId', axis=0, ascending=True, inplace=True, kind='quicksor
        data_df.drop_duplicates(subset={"UserId","ProfileName","Time","Text"}, keep='first', inp
        print("After Data processing Step 2: Shape - " + str(data_df.shape))
        print("{} reviews removed".format(previous_n-data_df.shape[0]))
```

```
After Data processing Step 2: Shape - (364171, 10)
161641 reviews removed
```

```
In [9]: # Data Preprocessing
        # 4. Removing HTML tags,punctuations,stopwords and stemming
        def CleanHTML(sentence):
            cleanedText = re.sub('<.*?>', '', sentence)
            return cleanedText

        def CleanPunc(sentence):
```

```
        cleanedText = re.sub(r'[?|!|@|#|^|&|*|_|-|"|\'|:|;|+]', r'', sentence)
        cleanedText = re.sub(r'[.|,|)|(|\|/]', r' ', cleanedText)
        return cleanedText

    def cleanText(input):
        stop = set(stopwords.words('english')) #set of stopwords
        sno = nltk.stem.SnowballStemmer('english') #initialising the snowball stemmer
        cleanedText_df = pd.DataFrame()
        final_str = []
        str = ''
        for sentence in tqdm(input.values):
            filtered_sentence = []
            for words in CleanHTML(sentence).split():
                for cleanedText in CleanPunc(words).split():
                    if(len(cleanedText) > 2 & cleanedText.isalpha()):
                        if(cleanedText.lower() not in stop):
                            s = (sno.stem(cleanedText.lower())).encode('UTF-8')
                            filtered_sentence.append(s)
            str = b' '.join(filtered_sentence)
            final_str.append(str)
        cleanedText_df['CleanedText'] = final_str
        cleanedText_df['CleanedText'] = cleanedText_df['CleanedText'].str.decode('UTF-8')
        return cleanedText_df['CleanedText'].values


    scores_df = data_df['Score'].values
    final_df = pd.DataFrame(data_df['Text'], columns=['Text'])
    final_df['Score'] = scores_df

    del data_df
    del scores_df
    final_df = final_df.sample(n=15000, random_state=0)
    final_df['CleanedText'] = cleanText(final_df['Text'])

    final_df.shape
```

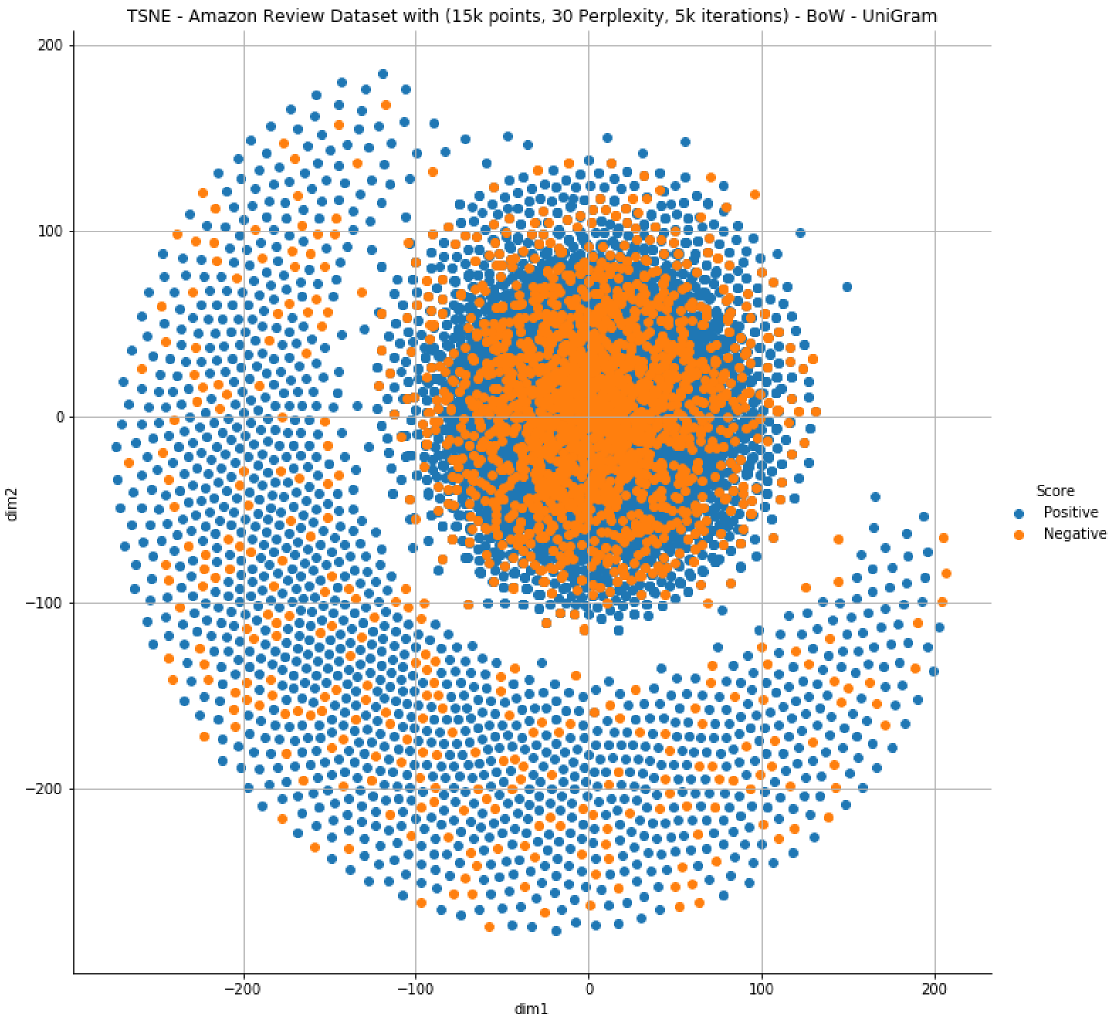
```
100%|| 15000/15000 [00:13<00:00, 1142.28it/s]
```

```
Out[9]: (15000, 3)
```

```
In [10]: # BOW
         def bowUniGramMethod(df):
             print("Starting BOW methods with shape : " + str(df.shape))
             # BOW Uni-Gram
             scores_df = df['Score']
             start_time = time.time()
             print('Starting BoW UniGram')
```

```
    final_text = CountVectorizer().fit_transform(df['CleanedText'].values)
    print("The Shape of BoW Model Uni-Gram : " + str(final_text.shape))

    print('Converting the csr_matrix to ndarray')
    final_text = final_text.toarray().astype(float)
    print('Standardizing the data')
    final_text = StandardScaler().fit_transform(final_text)
    print('Starting the TSNE Model')
    tsne_data = TSNE(perplexity=30, n_iter=5000, n_components=2, random_state=0).fit_tr
    final_df = pd.DataFrame(tsne_data, columns=['dim1', 'dim2'])
    final_df['Score'] = scores_df.values
    print('TSNE Model completed for Bow-UniGram in ' + str(time.time() - start_time))

    plt.close()
    sns.FacetGrid(data=final_df, hue='Score', height=10).map(plt.scatter, "dim1", "dim2
    plt.title('TSNE - Amazon Review Dataset with (15k points, 30 Perplexity, 5k iterati
    plt.grid()
    plt.show()


bowUniGramMethod(final_df)
```

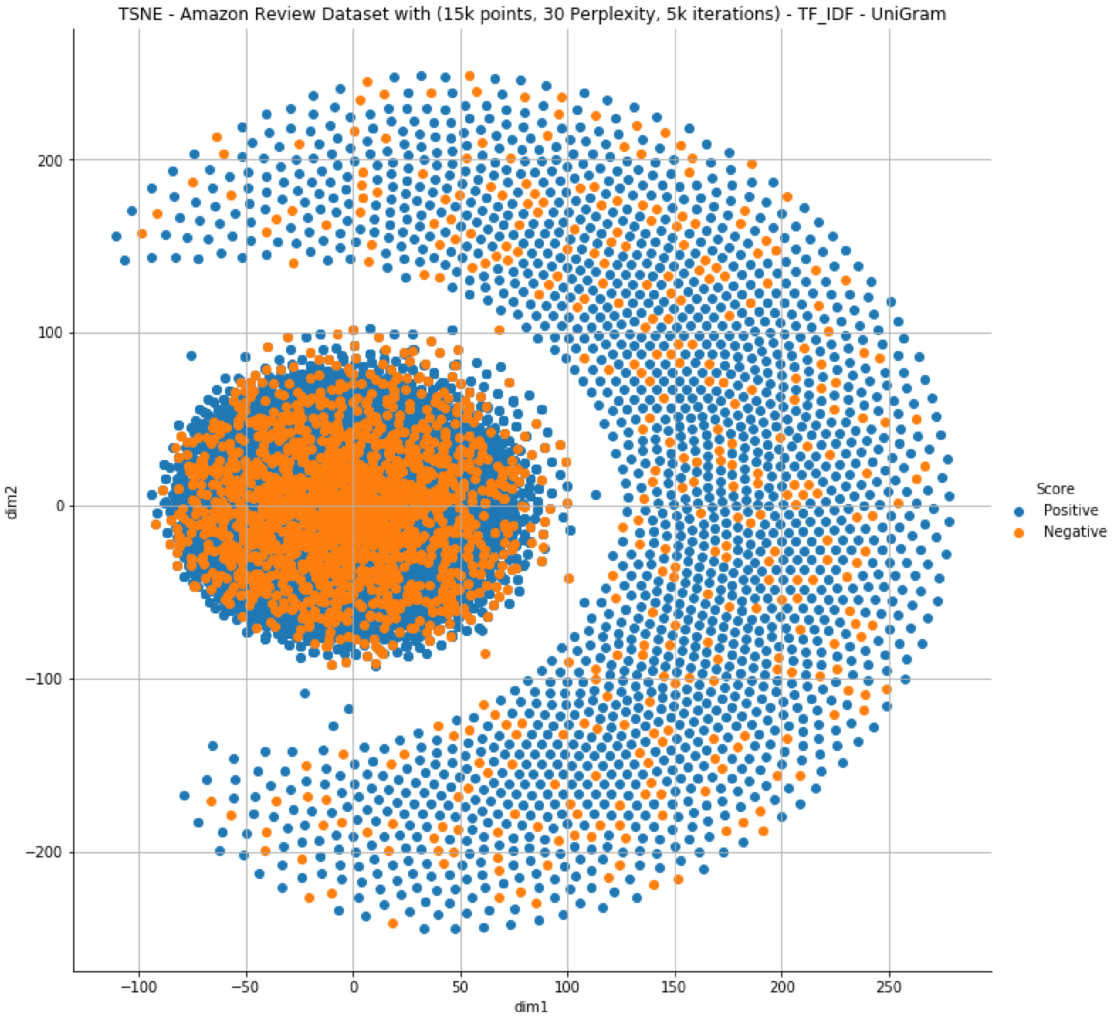
```
Starting BOW methods with shape : (15000, 3)
Starting BoW UniGram
The Shape of BoW Model Uni-Gram : (15000, 19849)
Converting the csr_matrix to ndarray
Standardizing the data
Starting the TSNE Model
TSNE Model completed for Bow-UniGram in 10120.856751441956
```



```
In [11]: # TF-IDF
         def tfidfUniGramMethod(df):
             print("Starting TF_IDF methods with shape : " + str(df.shape))
             global dictionary
             # TF_IDF Uni-Gram
             scores_df = df['Score']
             start_time = time.time()
             print('Starting TF_IDF UniGram')
             model = TfidfVectorizer()
             final_text = model.fit_transform(df['CleanedText'].values)
             print("The Shape of TF_IDF Model Uni-Gram : " + str(final_text.shape))
             dictionary = dict(zip(model.get_feature_names(), list(model.idf_)))

             print('Converting the csr_matrix to ndarray')
             final_text = final_text.toarray().astype(float)
             print('Standardizing the data')
```

```
    final_text = StandardScaler().fit_transform(final_text)
    print('Starting the TSNE Model')
    tsne_data = TSNE(perplexity=30, n_iter=5000, n_components=2, random_state=0).fit_tr
    final_df = pd.DataFrame(tsne_data, columns=['dim1', 'dim2'])
    final_df['Score'] = scores_df.values
    print('TSNE Model completed for TF_IDF-UniGram in '+ str(time.time() - start_time))

    plt.close()
    sns.FacetGrid(data=final_df, hue='Score', height=10).map(plt.scatter, "dim1", "dim2
    plt.title('TSNE - Amazon Review Dataset with (15k points, 30 Perplexity, 5k iterati
    plt.grid()
    plt.show()


tfidfUniGramMethod(final_df)
```

```
Starting TF_IDF methods with shape : (15000, 3)
Starting TF_IDF UniGram
The Shape of TF_IDF Model Uni-Gram : (15000, 19849)
Converting the csr_matrix to ndarray
Standardizing the data
Starting the TSNE Model
TSNE Model completed for TF_IDF-UniGram in 10463.602090597153
```



```
In [12]: def returnListOfSentences(df):
             list_of_sentences = []
             for sent in df.values:
                 list_of_sentences.append(sent.split())
             return list_of_sentences

         start_time = time.time()
         sentList = returnListOfSentences(final_df['CleanedText'])
         print("Starting W2V Model..")
         w2v_model = Word2Vec(sentList, size=100, min_count=4, workers=8)
         w2v_words = list(w2v_model.wv.vocab)
         print("Number of words that occured minimum 4 times ",len(w2v_words))
         #print("sample words ", w2v_words[0:50])
         print('W2V Model completed for in '+ str(time.time() - start_time))
```

```
Starting W2V Model..
Number of words that occured minimum 4 times  6824
```

```
W2V Model completed for in 4.378483533859253
```

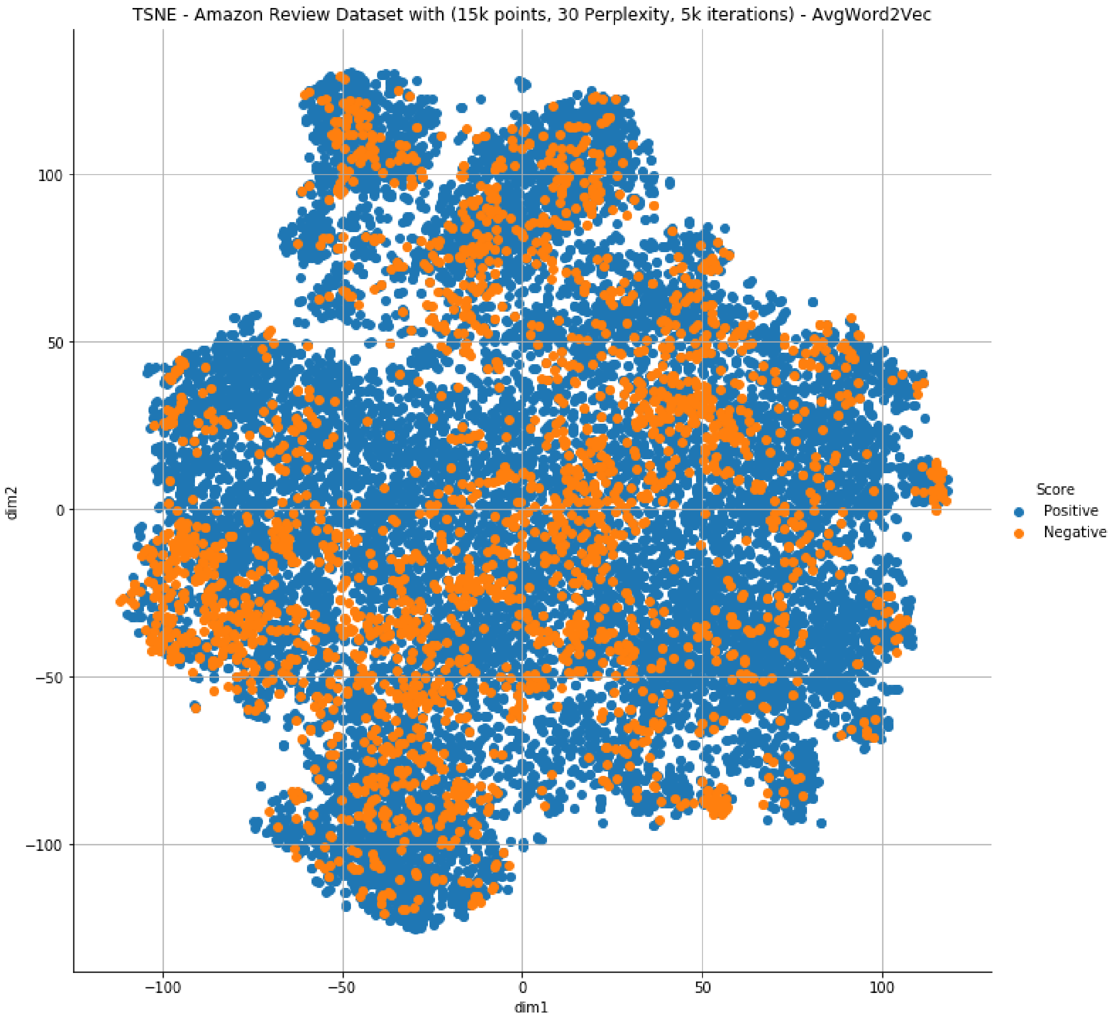
```
In [13]: def avgW2VcomputeModel(list_of_sent):
             # average Word2Vec
             # compute average word2vec for each review.
             start_time = time.time()
             sent_vectors = []; # the avg-w2v for each sentence/review is stored in this list
             for sent in tqdm(list_of_sent): # for each review/sentence
                 sent_vec = np.zeros(100) # as word vectors are of zero length
                 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('AvgW2V Model completed for in '+ str(time.time() - start_time))
             return sent_vectors


         print("Computing AvgWord2Vec Model..")
         sentVectors = avgW2VcomputeModel(sentList)
```

```
  1%|          | 142/15000 [00:00<00:10, 1404.58it/s]

Computing AvgWord2Vec Model..


100%|| 15000/15000 [00:22<00:00, 654.65it/s]

AvgW2V Model completed for in 22.920954942703247
```

```
In [14]: def plotTSNEModelForAvgW2V(sentVect, score_df):
             start_time = time.time()
             print("Converting to ndarray")
             arrayVec = np.array(sentVect, dtype=np.float64)
             print("Standardizing Array")
             standardizedVec = StandardScaler().fit_transform(arrayVec)
             print("Starting TSNE Model..")
             tsne_data = TSNE(perplexity=30, n_iter=5000, n_components=2, random_state=0).fit_tr
             final_df = pd.DataFrame(tsne_data, columns=['dim1', 'dim2'])
             final_df['Score'] = score_df.values
```

```
        print('TSNE Model completed for AvgW2V in '+ str(time.time() - start_time))

        plt.close()
        sns.FacetGrid(data=final_df, hue='Score', height=10).map(plt.scatter, "dim1", "dim2
        plt.title('TSNE - Amazon Review Dataset with (15k points, 30 Perplexity, 5k iterati
        plt.grid()
        plt.show()


    plotTSNEModelForAvgW2V(sentVectors, final_df['Score'])
```

```
Converting to ndarray
Standardizing Array
Starting TSNE Model..
TSNE Model completed for AvgW2V in 2007.5378654003143
```



```
In [15]: def tfidfW2VComputeModel(list_of_sent):
             # TF_IDF Word2Vec
             # compute TF_IDF word2vec for each review.
             start_time = time.time()

             tfidf_sent_vectors = []; # the tf-idf-w2v for each sentence/review is stored in thi
             for sent in tqdm(list_of_sent): # for each review/sentence
                 sent_vec = np.zeros(100) # 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:
                         if word in dictionary:
                             vec = w2v_model.wv[word]
                             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)
             print('TF_IDFW2V Model completed for in '+ str(time.time() - start_time))
             return tfidf_sent_vectors

         print("Computing TF_IDFW2V Model..")
         sentVectors = tfidfW2VComputeModel(sentList)
```

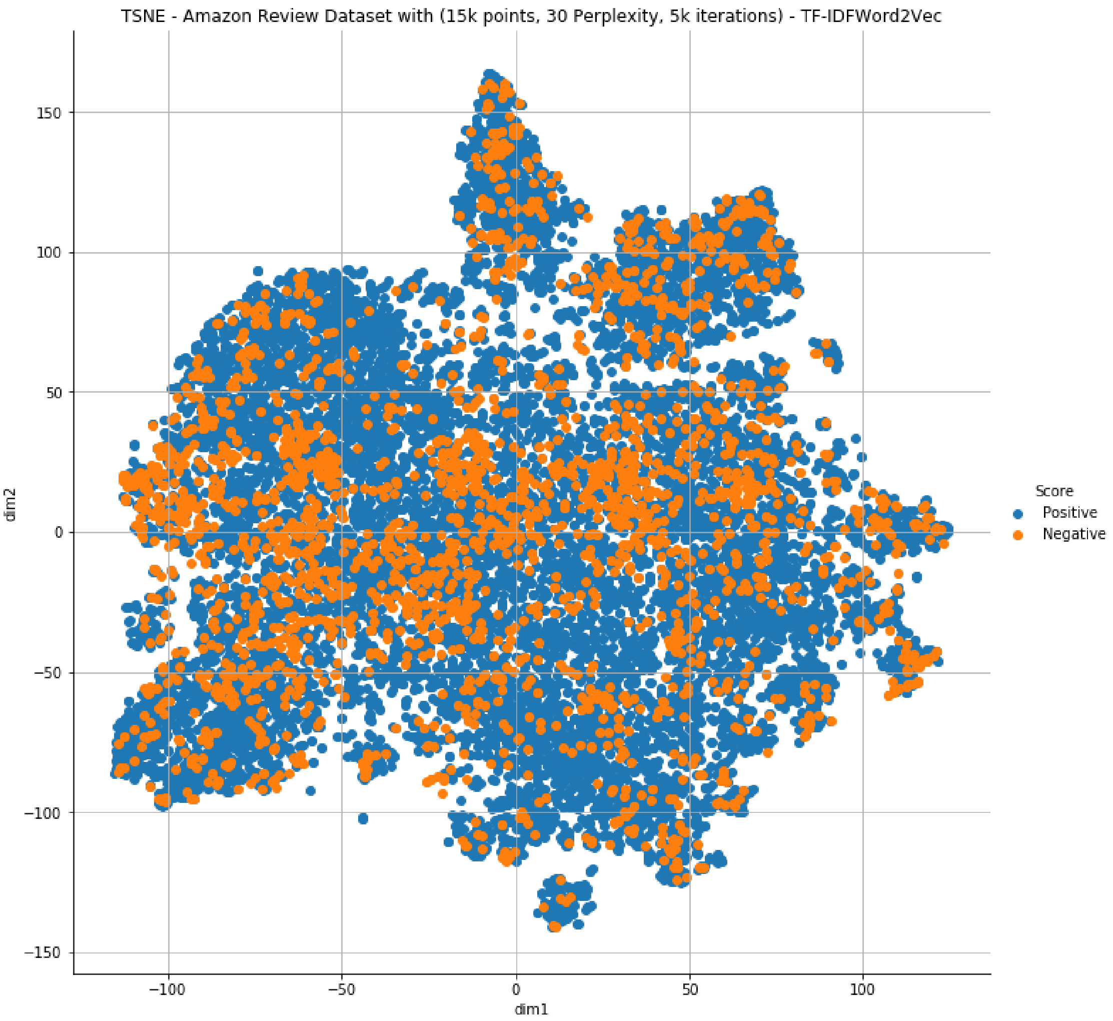
```
  1%|          | 107/15000 [00:00<00:14, 1049.89it/s]

Computing TF_IDFW2V Model..


100%|| 15000/15000 [00:36<00:00, 415.22it/s]

TF_IDFW2V Model completed for in 36.130290031433105
```

```
In [16]: def plotTSNEModelForTFIDFW2V(sentVect, score_df):
             start_time = time.time()
             print("Converting to ndarray")
             arrayVec = np.array(sentVect, dtype=np.float64)
             print("Standardizing Array")
             standardizedVec = StandardScaler().fit_transform(arrayVec)
             print("Starting TSNE Model..")
             tsne_data = TSNE(perplexity=30, n_iter=5000, n_components=2, random_state=0).fit_tr
             final_df = pd.DataFrame(tsne_data, columns=['dim1', 'dim2'])
             final_df['Score'] = score_df.values
             print('TSNE Model completed for TF-IDFW2V in '+ str(time.time() - start_time))
```

```
    plt.close()
    sns.FacetGrid(data=final_df, hue='Score', height=10).map(plt.scatter, "dim1", "dim2
    plt.title('TSNE - Amazon Review Dataset with (15k points, 30 Perplexity, 5k iterati
    plt.grid()
    plt.show()
```

```
plotTSNEModelForTFIDFW2V(sentVectors, final_df['Score'])
```

```
Converting to ndarray
Standardizing Array
Starting TSNE Model..
TSNE Model completed for TF-IDFW2V in 2054.895176887512
```



1.4 Conclusion / Final thoughts -

1. Each of the plots above for BOW, TFIDF, BowAvgw2V and TFIDFW2v methods are highly overlapped.
2. None of the plots gives a well seperation between both positive/negative reviews.
3. We need to explore more using advance algorithms for better understanding or better differentiation for the classification.