t-SNE-Balanced-AFF-Review

November 22, 2018

1 t-SNE Visualization on Amazon Food Review Dataset

1.1 Import Required Modules

```
In [1]: import os # for file management
        import shutil # for file management
        from pathlib import Path # for file management
        import sqlite3
        import pandas as pd
        import numpy as np
        import csv
        from tqdm import tqdm
        import matplotlib.pyplot as plt
        import seaborn as sns
        import time # for time measurement
        import imageio # for GIF creation

        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

        from sklearn.preprocessing import StandardScaler # for Column Standardization - DO WE NEED THIS?
        from sklearn.manifold import TSNE # for t-SNE
```

```
In [2]: ## Configure Matplotlib for nice image in PDF
        from IPython.display import set_matplotlib_formats
        set_matplotlib_formats('pdf', 'png')
        plt.rcParams['savefig.dpi'] = 75
        plt.rcParams['figure.figsize'] = 10,6
        plt.rcParams['axes.labelsize'] = 18
        plt.rcParams['axes.titlesize'] = 20
        plt.rcParams['font.size'] = 10
        plt.rcParams['lines.linewidth'] = 2.0
        plt.rcParams['lines.markersize'] = 8
```

```
In [3]: # All the outputs generated by this notebook will be placed in separate folder
        output_dir = 'Output'
        if not os.path.exists(output_dir):
            os.makedirs(output_dir)
```

1.2 Load Data

```
In [4]: # Loading all the reviews from the database
        # cleaned.sqlite already has reviews of 1,2,4,5 ratings only (also changed to +ive/-ive)
        con = sqlite3.connect('./cleaned.sqlite')

        df = pd.read_sql_query("""SELECT * from Reviews""", con)
        df.head()
```

```
Out[4]:     index      Id   ProductId          UserId                  ProfileName  \
        0  138706  150524  0006641040   ACITT7DI6IDDL              shari zychinski
        1  138688  150506  0006641040  A2IW4PEEKO2R0U                        Tracy
        2  138689  150507  0006641040  A1S4A3IQ2MU7V4         sally sue "sally sue"
        3  138690  150508  0006641040     AZGXZ2UUK6X  Catherine Hallberg "(Kate)"
        4  138691  150509  0006641040  A3CMRKGE0P909G                       Teresa

           HelpfulnessNumerator  HelpfulnessDenominator  Score        Time  \
        0                     0                       0      1   939340800
        1                     1                       1      1  1194739200
        2                     1                       1      1  1191456000
        3                     1                       1      1  1076025600
        4                     3                       4      1  1018396800

                                            Summary  \
        0                 EVERY book is educational
        1  Love the book, miss the hard cover version
```

```
2               chicken soup with rice months
3      a good swingy rhythm for reading aloud
4             A great way to learn the months

                                                Text  \
0  this witty little book makes my son laugh at l...
1  I grew up reading these Sendak books, and watc...
2  This is a fun way for children to learn their ...
3  This is a great little book to read aloud- it ...
4  This is a book of poetry about the months of t...

                                         CleanedText
0  b'witti littl book make son laugh loud recit c...
1  b'grew read sendak book watch realli rosi movi...
2  b'fun way children learn month year learn poem...
3  b'great littl book read nice rhythm well good ...
4  b'book poetri month year goe month cute littl ...
```

```
In [5]: df.describe()
```

```
Out[5]:                 index             Id  HelpfulnessNumerator  \
count  364106.000000  364106.000000         364106.000000
mean   261221.056821  282777.564772              1.738411
std    152361.122483  164601.735167              6.716471
min         0.000000       1.000000              0.000000
25%    129625.250000  140699.250000              0.000000
50%    257307.500000  278947.500000              0.000000
75%    396338.750000  428557.750000              2.000000
max    525813.000000  568454.000000            866.000000

       HelpfulnessDenominator          Score          Time
count           364106.000000  364106.000000  3.641060e+05
mean                 2.186231       0.843164  1.296157e+09
std                  7.339767       0.363647  4.859821e+07
min                  0.000000       0.000000  9.393408e+08
25%                  0.000000       1.000000  1.270858e+09
50%                  1.000000       1.000000  1.311379e+09
75%                  2.000000       1.000000  1.332893e+09
max                878.000000       1.000000  1.351210e+09
```

```
In [6]: df.dtypes
```

```
Out[6]: index                      int64
        Id                         int64
        ProductId                 object
        UserId                    object
        ProfileName               object
        HelpfulnessNumerator       int64
        HelpfulnessDenominator     int64
        Score                      int64
        Time                       int64
        Summary                   object
        Text                      object
        CleanedText               object
        dtype: object
```

```
In [7]: # Split data
        # positive review score, negative review score and review text as seperate dataframes
        df_text = df['CleanedText']
        print(df_text.shape)
        df_text.head()
```

```
(364106,)
```

```
Out[7]: 0    b'witti littl book make son laugh loud recit c...
        1    b'grew read sendak book watch realli rosi movi...
        2    b'fun way children learn month year learn poem...
        3    b'great littl book read nice rhythm well good ...
        4    b'book poetri month year goe month cute littl ...
        Name: CleanedText, dtype: object
```

```
In [8]: # Procedure of t-SNE generation is same for all types of vector analysis
        # So creating a common function to generate t-SNE visualization
        # using passed values

        def genTSNEGif(std_data, ndp, p, itr_list, file_prefix, closePlt=False):
```

```
    '''
    Fuction which genrate t-SNE visualtion for each itr_list using given ndp and p
    Generates a GIF and stores it under '{img_name}.gif'
    Where:
        std_data - Column Standardized Data
        ndp - Number of Data Points to consider in std_data
        p - Perplexity
        itr_list - List of iterations, each iteration will be a frame in GIF
        file_prefix - Prefix to the name of GIF image
        closePlt - If you do not want to display the generated image in Notebook
    '''
    image_name = '{0}_tsne_ndp_{1}_p_{2}.gif'.format(file_prefix,ndp,p)
    print('No.Of Data Points - {0}, Perplexity - {1}, Iterations - {2}, ImageName - {3}'.format(
            ndp, p, itr_list, image_name))

    # list to hold the frames
    frames = []
    p_data = std_data
    p_labels = final_reviews_scores[0:ndp]

    #print('t-SNE Data Points {0} and its Labels {1}'.format(p_data.shape, p_labels.shape))
    for itr_val in itr_list:
        img_title = '{0}-ndp={1} p={2} itr={3}'.format(file_prefix, ndp, p, itr_val)

        time_start = time.time()

        model = TSNE(n_components=2,random_state=0,perplexity=p,n_iter=itr_val) # ,verbose=2
        tsne_data = model.fit_transform(p_data)
        time_elapsed = time.time() - time_start
        print('{0} ==> t-SNE done! Time elapsed: {1} seconds'.format(img_title, time.time() - time_start))

        tsne_data = np.vstack((tsne_data.T,p_labels)).T
        #print(tsne_data.shape)
        #tsne_data[:4]
        tsne_df = pd.DataFrame(tsne_data,columns=['Dim_1','Dim_2','Score'])
        #tsne_df.head()
        g = sns.FacetGrid(tsne_df,hue='Score',height=10).map(plt.scatter, 'Dim_1', 'Dim_2').add_legend();
        g.fig.suptitle(img_title);
        g.fig.canvas.draw();
        image = np.frombuffer(g.fig.canvas.tostring_rgb(), dtype='uint8')
        image = image.reshape(g.fig.canvas.get_width_height()[::-1] + (3,))
        frames.append(image)

        if (closePlt == True):
            plt.close()

    kwargs_write = {'fps':1.0, 'quantizer':'nq'}
    imageio.mimsave(Path.cwd() / output_dir / image_name, frames, fps=1)

    return
```

1.3 Training Data for Visualization - 2K Points

```
In [9]: # we can't process all 364K revies, selecting a subset of it
        total_data_set_size = 2000

        # Create a Balanced dataset having both +ive and -ive reviews
        df_positive_reviews = df[df.Score == 1].sample(int(total_data_set_size/2))
        df_negative_reviews = df[df.Score == 0].sample(int(total_data_set_size/2))

        final_reviews = pd.concat([df_positive_reviews, df_negative_reviews])
        final_reviews_scores = final_reviews['Score']

        print('Shape of Training Data {0}'.format(final_reviews.shape))
        print('Shape of Training Label {0}'.format(final_reviews_scores.shape))
```

```
Shape of Training Data (2000, 12)
Shape of Training Label (2000,)
```

```
In [10]: final_reviews.head()
```

```
Out[10]:          index      Id   ProductId          UserId  \
         160283  202154  219052  B001CRAWCQ  A15C0QFMZ6JTE1
         350384   44522   48450  B006H34CUS  A1C935N5QX5S4S
         32515   178397  193447  B000BBDZ82  A3CZNNTEY657TE
         60680    17311   18879  B000F4H5FY  A2434W0L2ZL5X1
```

```
43145   381893  412923  B000E4C2LW  A3TXD09392M8NJ

                               ProfileName  HelpfulnessNumerator  \
160283                    Ivana Pandurovic                     1
350384                      Jamie Radcliff                     1
32515           C. Gardner "SgtCheeseNOLS"                     1
60680                                Brian                     0
43145   Beth Mitchum "Ultravioletlove.com"                     1

        HelpfulnessDenominator  Score        Time  \
160283                       2      1  1303344000
350384                       0      1  1346716800
32515                        1      1  1325462400
60680                        0      1  1291507200
43145                        1      1  1275350400

                            Summary  \
160283           LOVE Illy cafecito
350384                  Not too bad
32515                      LOVE IT!
60680     Pretty good! Great Price!
43145   Good Stuff at a Great Price

                                                      Text  \
160283  i am european, addicted not only to coffee but...
350384  I received a sample of this from Influenster a...
32515   I first tried this tea at my day spa I go to f...
60680   I am aware that tea bags do not give the same ...
43145   I know what you're thinking.  Corn flakes are ...

                                               CleanedText
160283  b'european addict coffe good coffe illi best c...
350384  b'receiv sampl influenst pretti excit tri inte...
32515   b'first tri tea day spa massag delici tea comp...
60680   b'awar tea bag give flavour looseleaf stuff st...
43145   b'know your think corn flake corn flake right ...
```

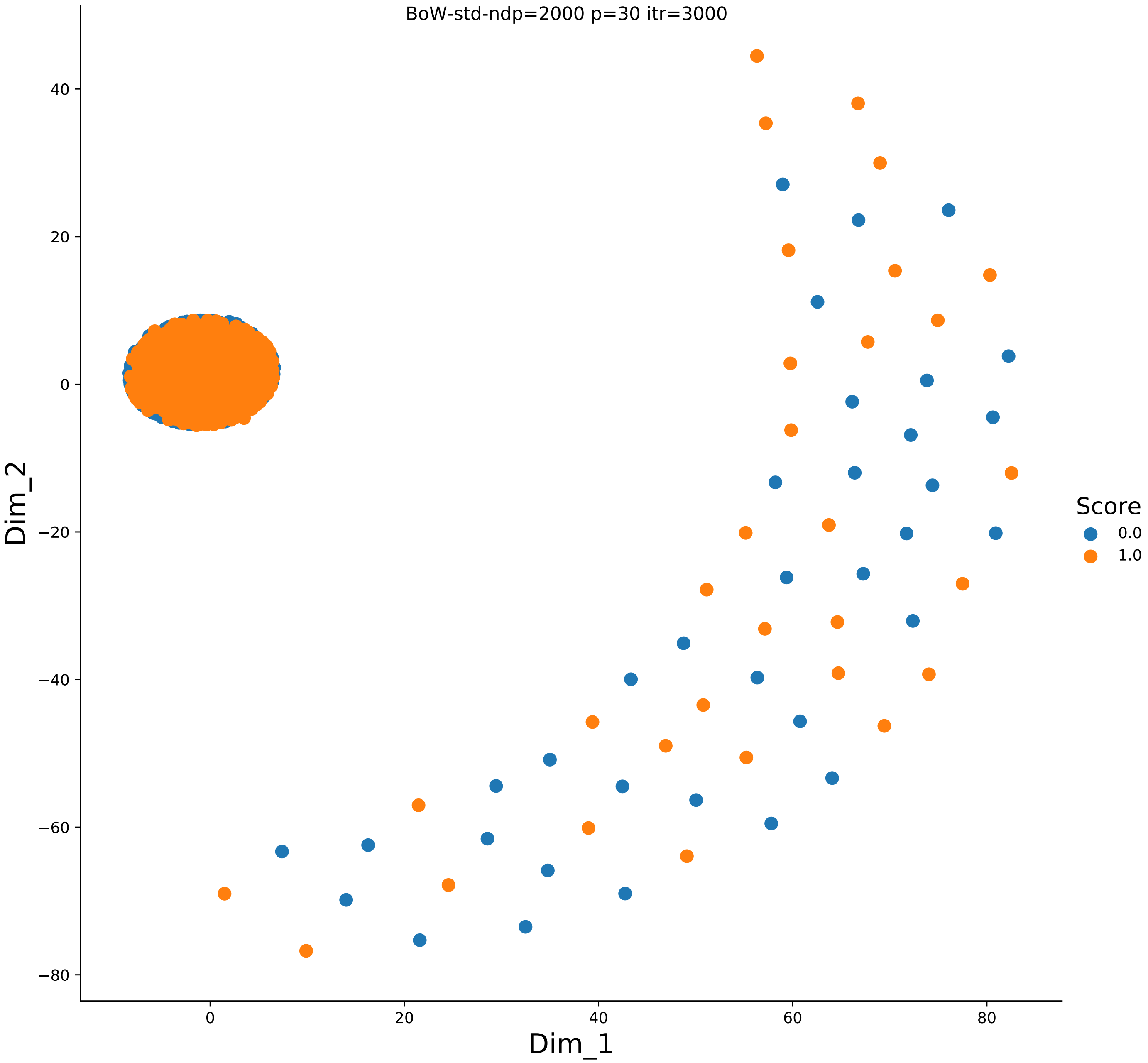
2 Bag of Words (BoW)

```
In [11]: # Create Vectors
         count_vect = CountVectorizer(ngram_range=(1,2)) # create an instance
         final_counts = count_vect.fit_transform(final_reviews['CleanedText'].values)
         print('Shape of BoW Vectorizer: ', final_counts.get_shape())
         print('Total no.of unique words: ', final_counts.get_shape()[1])

         # Standardize the Data
         standardized_data = StandardScaler().fit_transform(final_counts.toarray().astype(np.float64)) #, with_mean=False
         print('Shape of Standardized data', standardized_data.shape)
```

```
Shape of BoW Vectorizer:  (2000, 66148)
Total no.of unique words:  66148
Shape of Standardized data (2000, 66148)
```

```
In [12]: # Generating t-SNE for BoW
         genTSNEGif(standardized_data, len(standardized_data), 30, range(3000,3001,1000), 'BoW-std')

         # For various iterations I use below looping
         #dense_mat = final_counts.toarray().astype(np.float64)
         #for p in range(10, 101, 10):
         #    genTSNEGif(dense_mat, len(dense_mat), p, range(1000,5001,1000), 'BoW',closePlt=True)
```

```
No.Of Data Points - 2000, Perplexity - 30, Iterations - range(3000, 3001, 1000), ImageName - BoW-std_tsne_ndp_2000_p_30.gif
BoW-std-ndp=2000 p=30 itr=3000 ==> t-SNE done! Time elapsed: 598.4183218479156 seconds
```



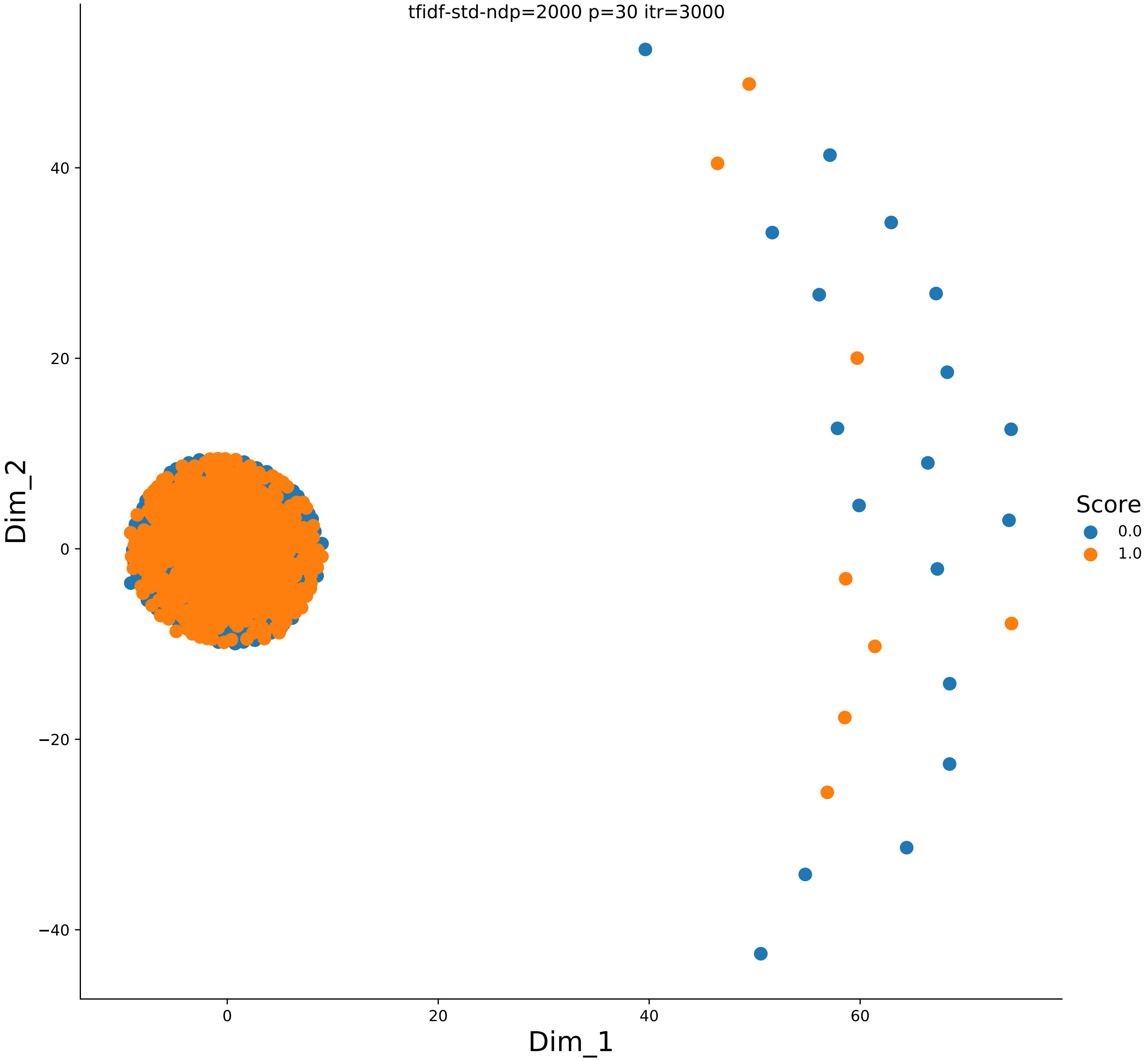
3 TFIDF

```
In [13]: # Create Vectors

         tf_idf_vec = TfidfVectorizer(ngram_range=(1,2))
         final_counts = tf_idf_vec.fit_transform(final_reviews['CleanedText'].values)

         #.fit_transform(final_reviews['CleanedText'].values)
         print('Shape of BoW Vectorizer: ', final_counts.get_shape())
         print('Total no.of unique words: ', final_counts.get_shape()[1])

         # Standardize the Data
         standardized_data = StandardScaler().fit_transform(final_counts.toarray().astype(np.float64)) #, with_mean=False
         print('Shape of Standardized data', standardized_data.shape)
```

```
Shape of BoW Vectorizer:  (2000, 66148)
Total no.of unique words:  66148
Shape of Standardized data (2000, 66148)
```

```
In [14]: genTSNEGif(standardized_data, len(standardized_data), 30, range(3000,3001,1000), 'tfidf-std')

         # For finding optimal perplexity and iteration, I execute below loop
         #dense_mat = final_counts.toarray().astype(np.float64)
         #for p in range(10, 61, 10):
         #    genTSNEGif(dense_mat, len(dense_mat), p, range(1000,6001,1000), 'tfidf',closePlt=True)
```

```
No.Of Data Points - 2000, Perplexity - 30, Iterations - range(3000, 3001, 1000), ImageName - tfidf-std_tsne_ndp_2000_p_30.gif
tfidf-std-ndp=2000 p=30 itr=3000 ==> t-SNE done! Time elapsed: 599.3038096427917 seconds
```



4 Word2Vec

I am creating vectors having 50 dimensions. Just a random value, not inherent calculation I made on this size decision.

```
In [15]: # Create List arry for creating own W2V
         list_of_sent = []
         for sent in final_reviews['CleanedText'].values:
             list_of_sent.append(sent.decode("utf-8").split())
```

```
        print(final_reviews.CleanedText.values[0])
        print(len(list_of_sent), list_of_sent[0])
```

```
b'european addict coffe good coffe illi best cant start day without illi espresso doubl one'
2000 ['european', 'addict', 'coffe', 'good', 'coffe', 'illi', 'best', 'cant', 'start', 'day', 'without', 'illi', 'espresso', 'doubl', 'one']
```

```
In [16]: # Required dimension
        w2v_d = 50

        # Considering words that are occured atleast 5 times in the corpus
        w2v_model = Word2Vec(list_of_sent, min_count=5, size=w2v_d, workers=4)

        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])
```

```
number of words that occured minimum 5 times :  2017
sample words  ['addict', 'coffe', 'good', 'illi', 'best', 'cant', 'start', 'day', 'without', 'espresso', 'doubl', 'one', 'receiv', 'sampl', '
```

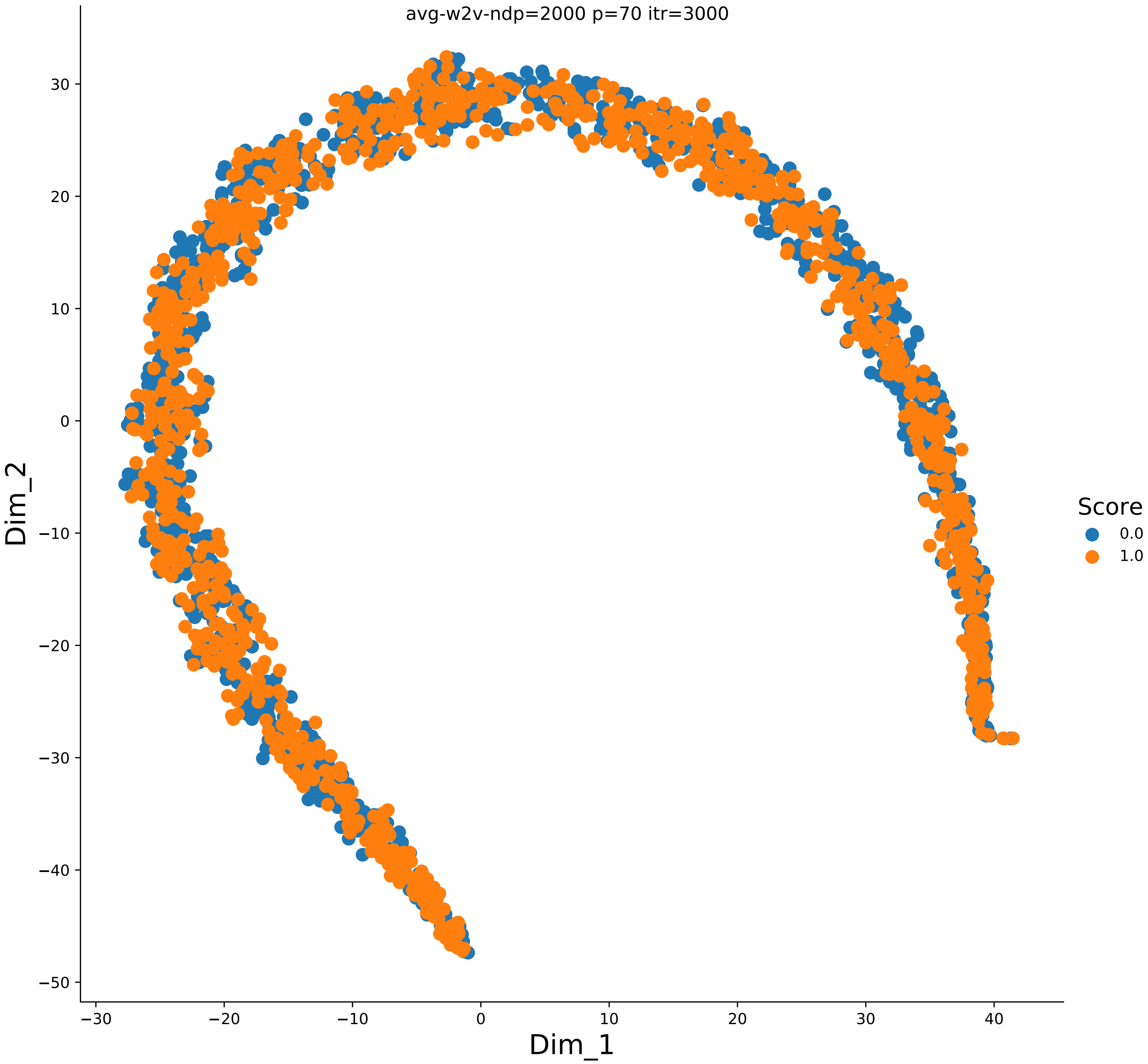
4.1 Avg-W2V

```
In [17]: # 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)

        print(len(review_vectors))
        print(len(review_vectors[0]))
```

```
100%|##########| 2000/2000 [00:02<00:00, 733.21it/s]

2000
50
```

```
In [18]: # t-SNE using Average Word2Vec

        genTSNEGif(review_vectors, len(review_vectors), 70, range(3000,3001,1000), 'avg-w2v')

        # for finding perplexity and iteration, I use below loop
        #for p in range(10, 101, 10):
        #    genTSNEGif(review_vectors, len(review_vectors), p, range(1000,5001,1000), 'avg-w2v',closePlt=True)
```

```
No.Of Data Points - 2000, Perplexity - 70, Iterations - range(3000, 3001, 1000), ImageName - avg-w2v_tsne_ndp_2000_p_70.gif
avg-w2v-ndp=2000 p=70 itr=3000 ==> t-SNE done! Time elapsed: 56.379451274871826 seconds
```



4.2 TFIDF Weighted W2V

Computing tfidf weighted w2v over the selected training dataset

```
In [19]: # Create tf-idf vector matrix
         tf_idf_model = TfidfVectorizer(ngram_range=(1,2))
         tf_idf_matrix = tf_idf_model.fit_transform(final_reviews['CleanedText'].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)
```

```
Out[19]: 66148
```

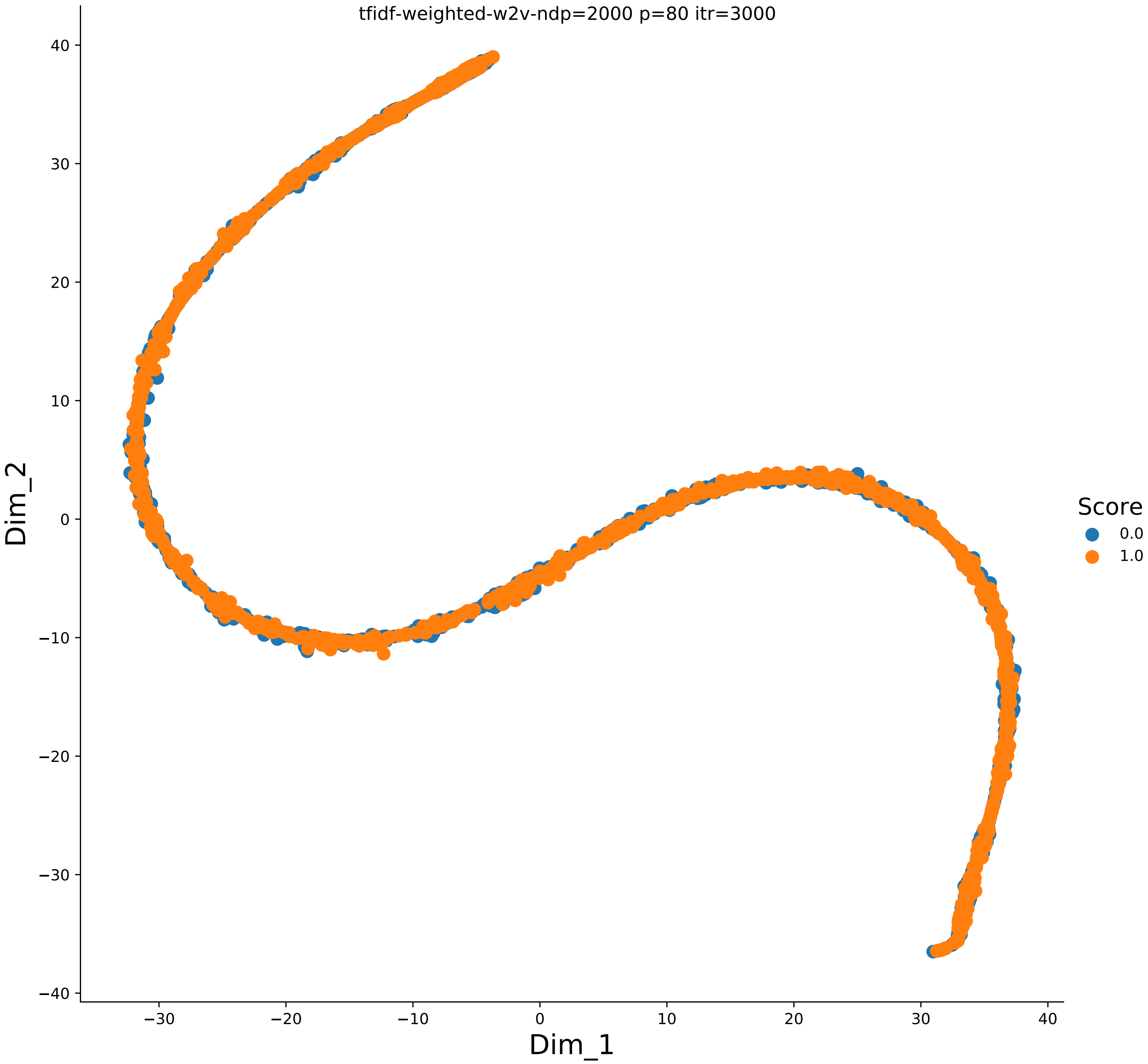
```
In [20]: tf_idf_feat = tf_idf_model.get_feature_names()

         # Computing tf-idf weighted 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
             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)

        print(len(review_vectors))
        print(len(review_vectors[0]))
```

```
100%|##########| 2000/2000 [00:03<00:00, 563.31it/s]

2000
50
```

```
In [21]: # t-SNE using tf-idf weighted s2v

         genTSNEGif(review_vectors, len(review_vectors), 80, range(3000,3001,1000), 'tfidf-weighted-w2v')

         #for p in range(10, 101, 10):
         #    genTSNEGif(review_vectors, len(review_vectors), p, range(1000,5001,1000), 'tfidf-weighted-w2v',closePlt=True)
```

```
No.Of Data Points - 2000, Perplexity - 80, Iterations - range(3000, 3001, 1000), ImageName - tfidf-weighted-w2v_tsne_ndp_2000_p_80.gif
tfidf-weighted-w2v-ndp=2000 p=80 itr=3000 ==> t-SNE done! Time elapsed: 52.13369131088257 seconds
```



5 t-SNE Observation

Due to memory limitation, only 2000 reviews out of 364K reviews of Amazon Fine Food Review has been taken
Created a Balanced dataset having 1000 positive and negative reviews respectively.
Generated t-SNE 2-D visualization from the vectors created with 1) Bag of Words, 2) TF-IDF, 3) Average Word 2 Vec and 4) TF-IDF Weighter Word2Vec.
I have generated my own Word2Vec from those 2K reviews having dimensionve of 50

- Both BoW and TF-IDF generated a small circled image, having both Positive and Negative reviews overlapped in same place
  - There are some outliers kind of observation as well seen
- In Avg-W2V, U-Shaped curve is seen. But still here as well both postivie and negative reviews overlap each other
- In TFIDF Weighter W2V, kind of sign wave observed, but still both positive and negative reviews overlap occured.

In conclusion, no clustering seen from t-SNE. So we can't have a linearly seperable classification function to classify that whether a review is positive or not.