# Assignment - 2 (t-SNE visualization of Amazon reviews with polarity based color-coding)

August 19, 2018

OBJECTIVE : Given a review, determine whether the review is positive (Rating of 4 or 5) or negative (rating of 1 or 2).

```
In [1]: # Importing libraries
        %matplotlib inline
        import warnings
        warnings.filterwarnings("ignore")
```

```
In [3]: import sqlite3
        import pandas as pd
        import numpy as np
        import nltk
        import string
        import matplotlib.pyplot as plt
        import seaborn as sns
        from sklearn.feature_extraction.text import TfidfTransformer
        from sklearn.feature_extraction.text import TfidfVectorizer

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

        import re

        import string
        from nltk.corpus import stopwords
        from nltk.stem import PorterStemmer
        from nltk.stem.wordnet import WordNetLemmatizer

        from gensim.models import Word2Vec
        from gensim.models import KeyedVectors
        import pickle
        import warnings
        warnings.filterwarnings("ignore")
```

# 1 (1) . Loading Data

```
In [4]: # using the SQLite Table to read data.
        con1 = sqlite3.connect('database.sqlite')
```

```
In [5]: # Eliminating neutral reviews i.e. those reviews with Score = 3
        filtered_data = pd.read_sql_query(" SELECT * FROM Reviews WHERE Score != 3 ", con1)
```

```
In [6]: # Give reviews with Score>3 a positive rating, and reviews with a score<3 a negative r
        def polarity(x):
            if x < 3:
                return 'negative'
            return 'positive'

        # Applying polarity function on Score column of filtered_data
        filtered_data['Score'] = filtered_data['Score'].map(polarity)
```

```
In [7]: print(filtered_data.shape)
        filtered_data.head()
```

```
(525814, 10)
```

```
Out[7]:    Id   ProductId          UserId                      ProfileName  \
        0   1  B001E4KFG0  A3SGXH7AUHU8GW                       delmartian
        1   2  B00813GRG4  A1D87F6ZCVE5NK                           dll pa
        2   3  B000LQOCH0   ABXLMWJIXXAIN  Natalia Corres "Natalia Corres"
        3   4  B000UA0QIQ  A395BORC6FGVXV                             Karl
        4   5  B006K2ZZ7K  A1UQRSCLF8GW1T    Michael D. Bigham "M. Wassir"

           HelpfulnessNumerator  HelpfulnessDenominator     Score        Time  \
        0                     1                       1  positive  1303862400
        1                     0                       0  negative  1346976000
        2                     1                       1  positive  1219017600
        3                     3                       3  negative  1307923200
        4                     0                       0  positive  1350777600

                         Summary                                               Text
        0  Good Quality Dog Food  I have bought several of the Vitality canned d...
        1      Not as Advertised  Product arrived labeled as Jumbo Salted Peanut...
        2  "Delight" says it all  This is a confection that has been around a fe...
        3         Cough Medicine  If you are looking for the secret ingredient i...
        4            Great taffy  Great taffy at a great price.  There was a wid...
```

# 2 Data Cleaning: Deduplication

```
In [8]: #Sorting data according to ProductId in ascending order
        sorted_data=filtered_data.sort_values('ProductId', axis=0, ascending=True, inplace=Fals
```

In [9]:
```
#Deduplication of entries
final=sorted_data.drop_duplicates(subset={"UserId","ProfileName","Time","Text"}, keep=
final.shape
```

Out[9]: (364173, 10)

In [10]:
```
#Checking to see how much % of data still remains
((final.shape[0]*1.0)/(filtered_data.shape[0]*1.0)*100)
```

Out[10]: 69.25890143662969

In [11]:
```
# Removing rows where HelpfulnessNumerator is greater than HelpfulnessDenominator
final = final[final.HelpfulnessNumerator <= final.HelpfulnessDenominator]
```

In [12]:
```
print(final.shape)
```

```
(364171, 10)
```

In [13]:
```
final[30:50]
```

Out[13]:
```
            Id   ProductId          UserId  \
138683  150501  0006641040   AJ46FKXOVC7NR
138676  150493  0006641040   AMX0PJKV4PPNJ
138682  150500  0006641040  A1IJKK6Q1GTEAY
138681  150499  0006641040  A3E7R866M94L0C
476617  515426  141278509X   AB1A5EGHHVA9M
22621    24751  2734888454  A1C298ITT645B6
22620    24750  2734888454  A13ISQV0U9GZIC
284375  308077  2841233731  A3QD68O22M2XHQ
157850  171161  7310172001   AFXMWPNS1BLU4
157849  171160  7310172001   A74C7IARQEM1R
157833  171144  7310172001  A1V5MY8V9AWUQB
157832  171143  7310172001  A2SW060IW01VPX
157837  171148  7310172001  A3TFTWTG2CC1GA
157831  171142  7310172001  A2ZO1AYFVQYG44
157830  171141  7310172001   AZ40270J4JBZN
157829  171140  7310172001   ADXXVGRCGQQUO
157828  171139  7310172001  A13MS1JQG2ADOJ
157827  171138  7310172001  A13LAE0YTXA11B
157848  171159  7310172001  A16GY2RCF410DT
157834  171145  7310172001  A1L8DNQYY69L2Z

                                            ProfileName  \
138683                               Nicholas A Mesiano
138676                         E. R. Bird "Ramseelbird"
138682                                       A Customer
138681                           L. Barker "simienwolf"
476617                                          CHelmic
```

| | |
|---|---|
| 22621 | Hugh G. Pritchard |
| 22620 | Sandikaye |
| 284375 | LABRNTH |
| 157850 | H. Sandler |
| 157849 | stucker |
| 157833 | Cheryl Sapper "champagne girl" |
| 157832 | Sam |
| 157837 | J. Umphress |
| 157831 | Cindy Rellie "Rellie" |
| 157830 | Zhinka Chunmee "gamer from way back in the 70's" |
| 157829 | Richard Pearlstein |
| 157828 | C. Perrone |
| 157827 | Dita Vyslouzilova "dita" |
| 157848 | LB |
| 157834 | R. Flores |

| | HelpfulnessNumerator | HelpfulnessDenominator | Score | Time \ |
|---|---|---|---|---|
| 138683 | 2 | 2 | positive | 940809600 |
| 138676 | 71 | 72 | positive | 1096416000 |
| 138682 | 2 | 2 | positive | 1009324800 |
| 138681 | 2 | 2 | positive | 1065830400 |
| 476617 | 1 | 1 | positive | 1332547200 |
| 22621 | 0 | 0 | positive | 1195948800 |
| 22620 | 1 | 1 | negative | 1192060800 |
| 284375 | 0 | 0 | positive | 1345852800 |
| 157850 | 0 | 0 | positive | 1229385600 |
| 157849 | 0 | 0 | positive | 1230076800 |
| 157833 | 0 | 0 | positive | 1244764800 |
| 157832 | 0 | 0 | positive | 1252022400 |
| 157837 | 0 | 0 | positive | 1240272000 |
| 157831 | 0 | 0 | positive | 1254960000 |
| 157830 | 0 | 0 | positive | 1264291200 |
| 157829 | 0 | 0 | positive | 1264377600 |
| 157828 | 0 | 0 | positive | 1265760000 |
| 157827 | 0 | 0 | positive | 1269216000 |
| 157848 | 0 | 0 | positive | 1231718400 |
| 157834 | 0 | 0 | positive | 1243728000 |

| | Summary \ |
|---|---|
| 138683 | This whole series is great way to spend time w... |
| 138676 | Read it once. Read it twice. Reading Chicken S... |
| 138682 | It Was a favorite! |
| 138681 | Can't explain why |
| 476617 | The best drink mix |
| 22621 | Dog Lover Delites |
| 22620 | made in china |
| 284375 | Great recipe book for my babycook |
| 157850 | Excellent treats |

```
157849                                       Sophie's Treats
157833                                THE BEST healthy dog treat!
157832                           My Alaskan Malamute Loves Them!!
157837                                         Best treat ever!
157831       my 12 year old maltese has always loved these
157830                          Dogs, Cats, Ferrets all love this
157829                                                5 snouts!
157828                                       Best dog treat ever
157827                                  Great for puppy training
157848                                                   Great!
157834                                          Terrific Treats

                                                           Text
138683  I can remember seeing the show when it aired o...
138676  These days, when a person says, "chicken soup"...
138682  This was a favorite book of mine when I was a ...
138681  This book has been a favorite of mine since I ...
476617  This product by Archer Farms is the best drink...
22621   Our dogs just love them.  I saw them in a pet ...
22620   My dogs loves this chicken but its a product f...
284375  This book is easy to read and the ingredients ...
157850  I have been feeding my greyhounds these treats...
157849  This is one product that my welsh terrier can ...
157833  This is the ONLY dog treat that my Lhasa Apso ...
157832  These liver treas are phenomenal. When i recei...
157837  This was the only treat my dog liked during ob...
157831  No waste , even if she is having a  day when s...
157830  I wanted a treat that was accepted and well li...
157829  My Westie loves these things!  She loves anyth...
157828  This is the only dog treat that my terrier wil...
157827  New puppy loves this, only treat he will pay a...
157848  My dog loves these treats!  We started using t...
157834  This is a great treat which all three of my do...
```

OBSERVATION :- Here books with ProductId - 0006641040 and 2841233731 are also there so we have to remove all these rows with these ProductIds from the data

```
In [14]: final = final[final['ProductId'] != '2841233731']
```

```
In [15]: final = final[final['ProductId'] != '0006641040']
```

```
In [16]: final.shape
```

```
Out[16]: (364136, 10)
```

# 3 Text Preprocessing: Stemming, stop-word removal and Lemmatization.

```
In [17]: #set of stopwords in English
         from nltk.corpus import stopwords
```

```
        stop = set(stopwords.words('english'))

In [18]: words_to_keep = set(('not'))
         stop -= words_to_keep

In [19]: #initialising the snowball stemmer
         sno = nltk.stem.SnowballStemmer('english')

In [20]:  #function to clean the word of any html-tags
         def cleanhtml(sentence):
             cleanr = re.compile('<.*?>')
             cleantext = re.sub(cleanr, ' ', sentence)
             return cleantext

In [21]: #function to clean the word of any punctuation or special characters
         def cleanpunc(sentence):
             cleaned = re.sub(r'[?|!|\'|"|#]',r'',sentence)
             cleaned = re.sub(r'[.|,|)|(|\|/]',r' ',cleaned)
             return  cleaned

In [22]: #Code for removing HTML tags , punctuations . Code for removing stopwords . Code for 
         # also greater than 2 . Code for stemmimg and also to convert them to lowercase lette
         i=0
         str1=' '
         final_string=[]
         all_positive_words=[] # store words from +ve reviews here
         all_negative_words=[] # store words from -ve reviews here.
         s=''
         for sent in final['Text'].values:
             filtered_sentence=[]
             #print(sent);
             sent=cleanhtml(sent) # remove HTMl tags
             for w in sent.split():
                 for cleaned_words in cleanpunc(w).split():
                     if((cleaned_words.isalpha()) & (len(cleaned_words)>2)):
                         if(cleaned_words.lower() not in stop):
                             s=(sno.stem(cleaned_words.lower())).encode('utf8')
                             filtered_sentence.append(s)
                             if (final['Score'].values)[i] == 'positive':
                                 all_positive_words.append(s) #list of all words used to descr
                             if(final['Score'].values)[i] == 'negative':
                                 all_negative_words.append(s) #list of all words used to descr
                         else:
                             continue
                     else:
                         continue

             str1 = b" ".join(filtered_sentence) #final string of cleaned words
```

```
        final_string.append(str1)
        i+=1
```

In [23]:
```
#adding a column of CleanedText which displays the data after pre-processing of the r
final['CleanedText']=final_string
final['CleanedText']=final['CleanedText'].str.decode("utf-8")
#below the processed review can be seen in the CleanedText Column
print('Shape of final',final.shape)
final.head()
```

```
Shape of final (364136, 11)
```

Out[23]:
```
            Id   ProductId          UserId        ProfileName  \
476617  515426  141278509X   AB1A5EGHHVA9M            CHelmic
22621    24751  2734888454  A1C298ITT645B6  Hugh G. Pritchard
22620    24750  2734888454  A13ISQV0U9GZIC           Sandikaye
157850  171161  7310172001   AFXMWPNS1BLU4         H. Sandler
157849  171160  7310172001   A74C7IARQEM1R            stucker

        HelpfulnessNumerator  HelpfulnessDenominator     Score        Time  \
476617                     1                       1  positive  1332547200
22621                      0                       0  positive  1195948800
22620                      1                       1  negative  1192060800
157850                     0                       0  positive  1229385600
157849                     0                       0  positive  1230076800

                  Summary                                               Text  \
476617  The best drink mix  This product by Archer Farms is the best drink...
22621    Dog Lover Delites  Our dogs just love them.  I saw them in a pet ...
22620        made in china  My dogs loves this chicken but its a product f...
157850    Excellent treats  I have been feeding my greyhounds these treats...
157849     Sophie's Treats  This is one product that my welsh terrier can ...

                                              CleanedText
476617  product archer farm best drink mix ever mix fl...
22621   dog love saw pet store tag attach regard made ...
22620   dog love chicken product china wont buy anymor...
157850  feed greyhound treat year hound littl finicki ...
157849  one product welsh terrier eat sophi food alerg...
```

# 4 (1). Bag of Words (BoW)

In [27]:
```
# Using only 4K (4000) rows for further analysis as my RAM is only 8 GB
my_final = final[0:4000]
```

In [29]:
```
my_final.shape
```

Out[29]: (4000, 11)

In [34]:
```
my_final['Score'].value_counts()
```

Out[34]:
```
positive    3327
negative     673
Name: Score, dtype: int64
```

In [35]:
```
my_final['CleanedText'].values.shape
```

Out[35]: (4000,)

In [65]:
```
#BoW
count_vect = CountVectorizer(min_df=10) #in scikit-learn
final_counts = count_vect.fit_transform(my_final['CleanedText'].values)
print("the type of count vectorizer ",type(final_counts))
print("the shape of out text BOW vectorizer ",final_counts.get_shape())
print("the number of unique words ", final_counts.get_shape()[1])
```

```
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text BOW vectorizer  (4000, 2010)
the number of unique words  2010
```

In [66]:
```
# Change sparse matrix to dense matrix
final_counts  = final_counts.toarray()
```

In [67]:
```
final_counts.shape
```

Out[67]: (4000, 2010)

In [40]:
```
import warnings
warnings.filterwarnings('ignore')
# Data-preprocessing: Standardizing the data

from sklearn.preprocessing import StandardScaler
standardized_data = StandardScaler().fit_transform(final_counts)
print(standardized_data.shape)
```

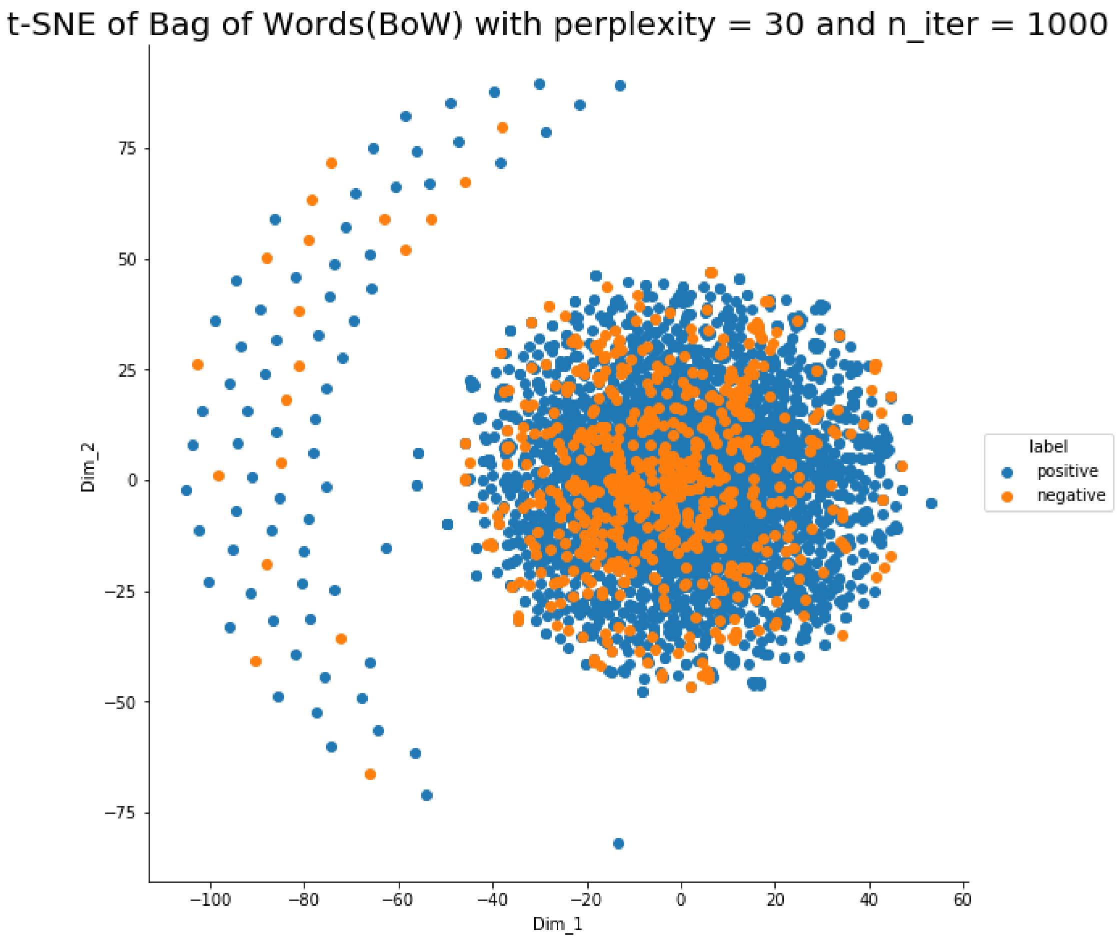
```
(4000, 2010)
```

# 5 t-SNE of Bag Of Words

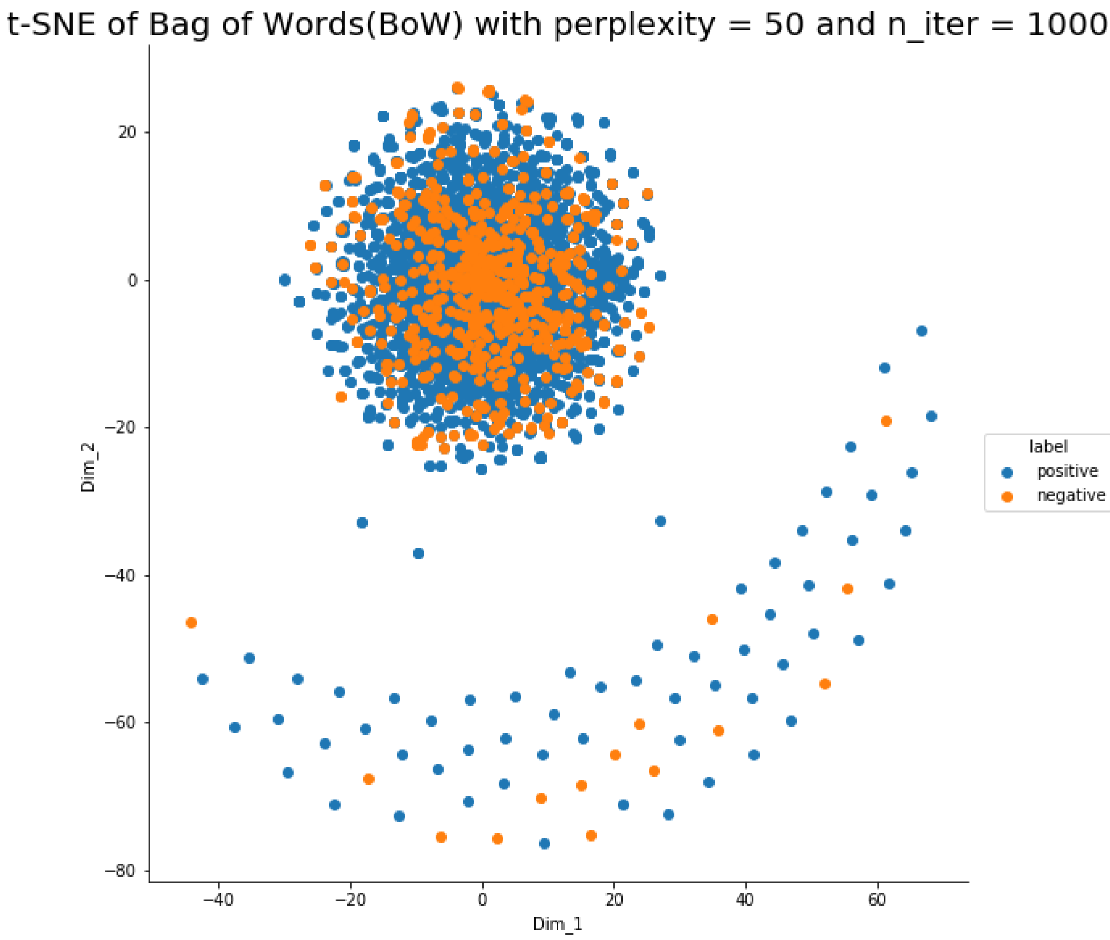
In [41]:
```
my_final['Score'].shape
```

Out[41]: (4000,)

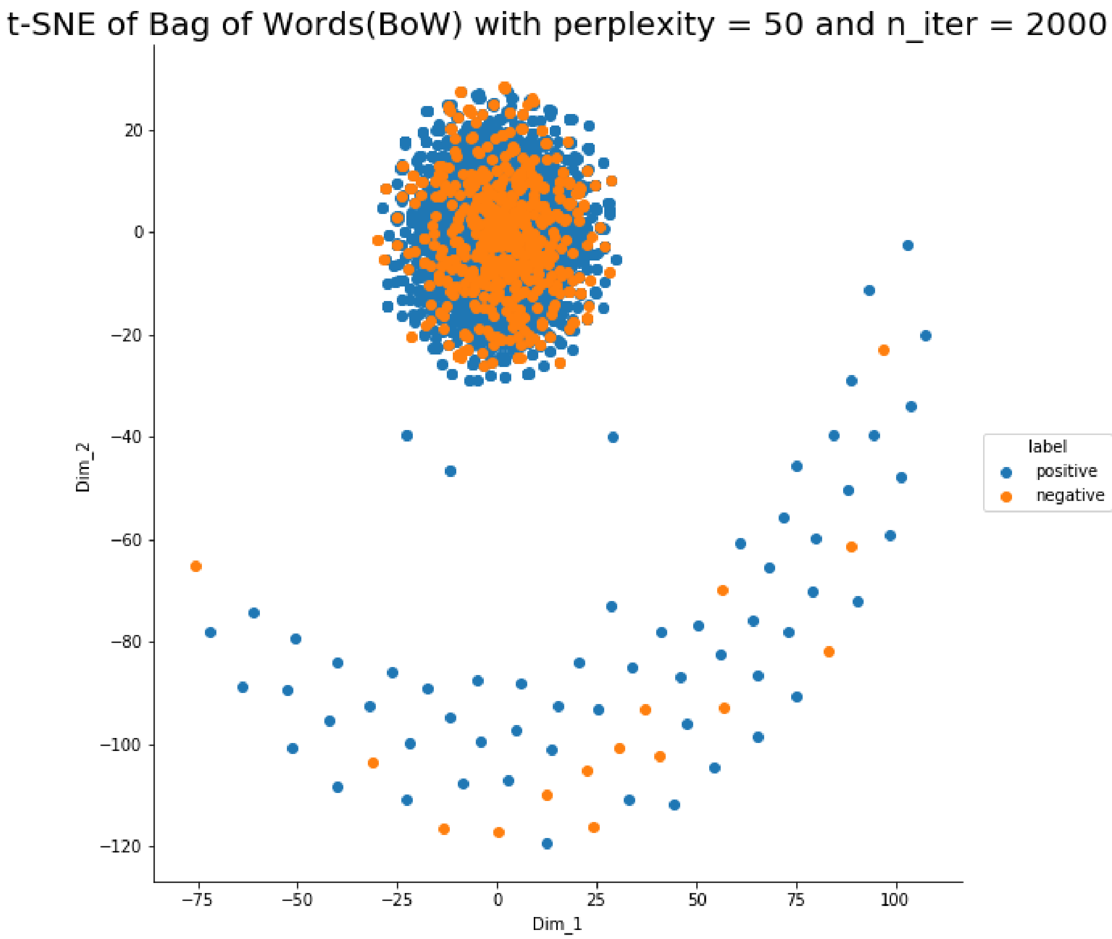
In [42]:
```
# TSNE

from sklearn.manifold import TSNE


model = TSNE(n_components=2, random_state=0)
# configuring the parameteres
# the number of components = 2
# default perplexity = 30
# default learning rate = 200
# default Maximum number of iterations for the optimization = 1000

tsne_data = model.fit_transform(standardized_data)


# creating a new data frame which help us in ploting the result data
tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

# Ploting the result of tsne
sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_leg
plt.title('t-SNE of Bag of Words(BoW) with perplexity = 30 and n_iter = 1000',size=20)
plt.show()
```



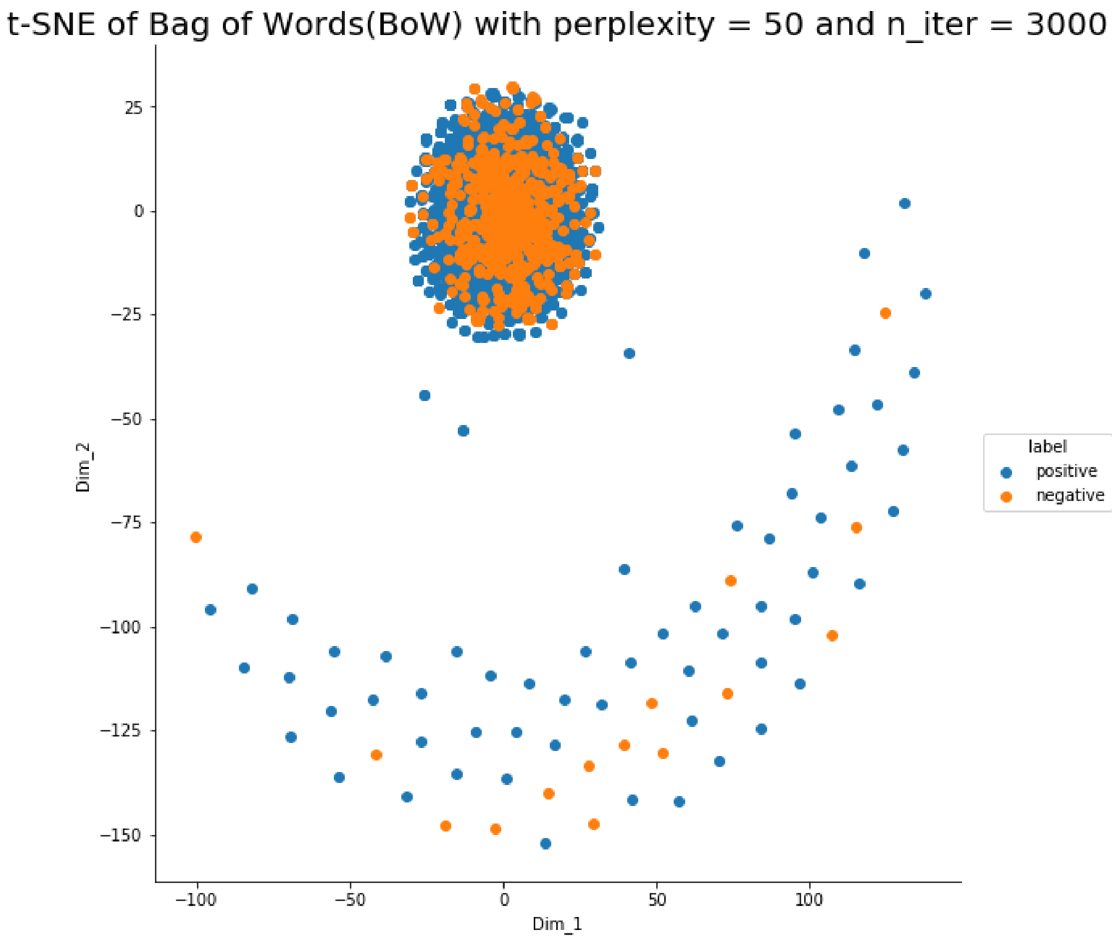

```
In [43]: # t-SNE with perplexity = 50 and n_iter = 1000
         model = TSNE(n_components=2, random_state=0, perplexity=50,  n_iter=1000)

         tsne_data = model.fit_transform(standardized_data)


         # creating a new data frame which help us in ploting the result data
         tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
         tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

         # Ploting the result of tsne
         sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_leg
         plt.title('t-SNE of Bag of Words(BoW) with perplexity = 50 and n_iter = 1000',size=20)
         plt.show()
```



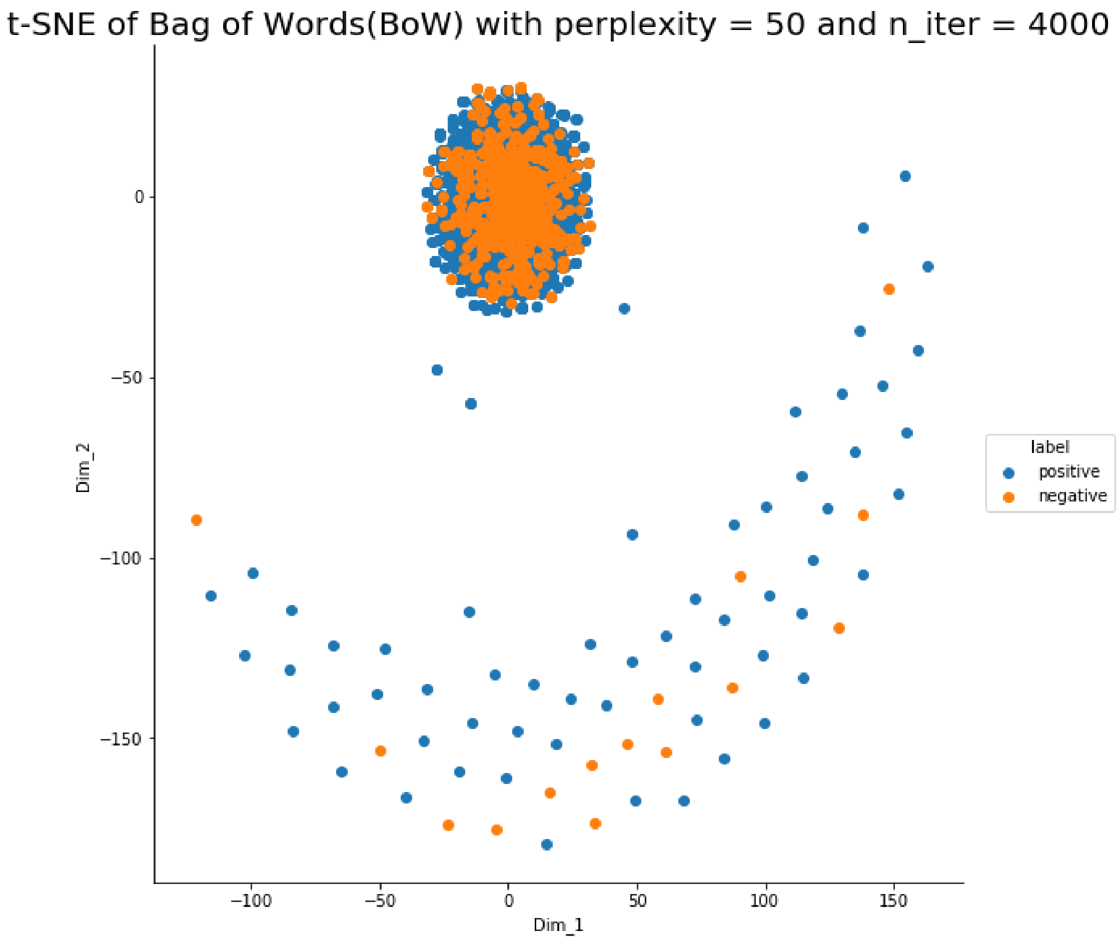

In [44]:
```
# t-SNE with perplexity = 50 and n_iter = 2000
model = TSNE(n_components=2, random_state=0, perplexity=50,  n_iter=2000)

tsne_data = model.fit_transform(standardized_data)


# creating a new data frame which help us in ploting the result data
tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

# Ploting the result of tsne
sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_leg
plt.title('t-SNE of Bag of Words(BoW) with perplexity = 50 and n_iter = 2000',size=20)
plt.show()
```



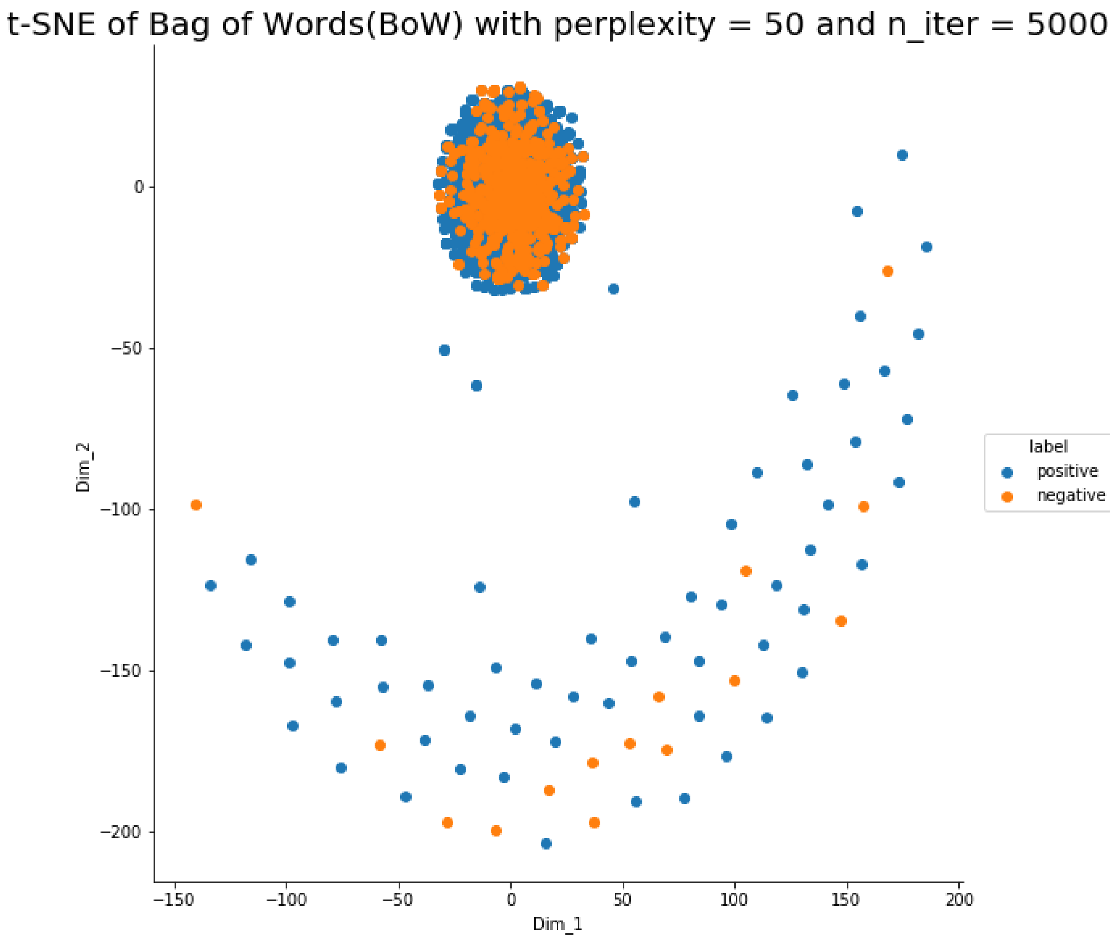

```
In [45]: # t-SNE with perplexity = 50 and n_iter = 3000
         model = TSNE(n_components=2, random_state=0, perplexity=50,  n_iter=3000)

         tsne_data = model.fit_transform(standardized_data)


         # creating a new data frame which help us in ploting the result data
         tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
         tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

         # Ploting the result of tsne
         sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_leg
         plt.title('t-SNE of Bag of Words(BoW) with perplexity = 50 and n_iter = 3000',size=20)
         plt.show()
```



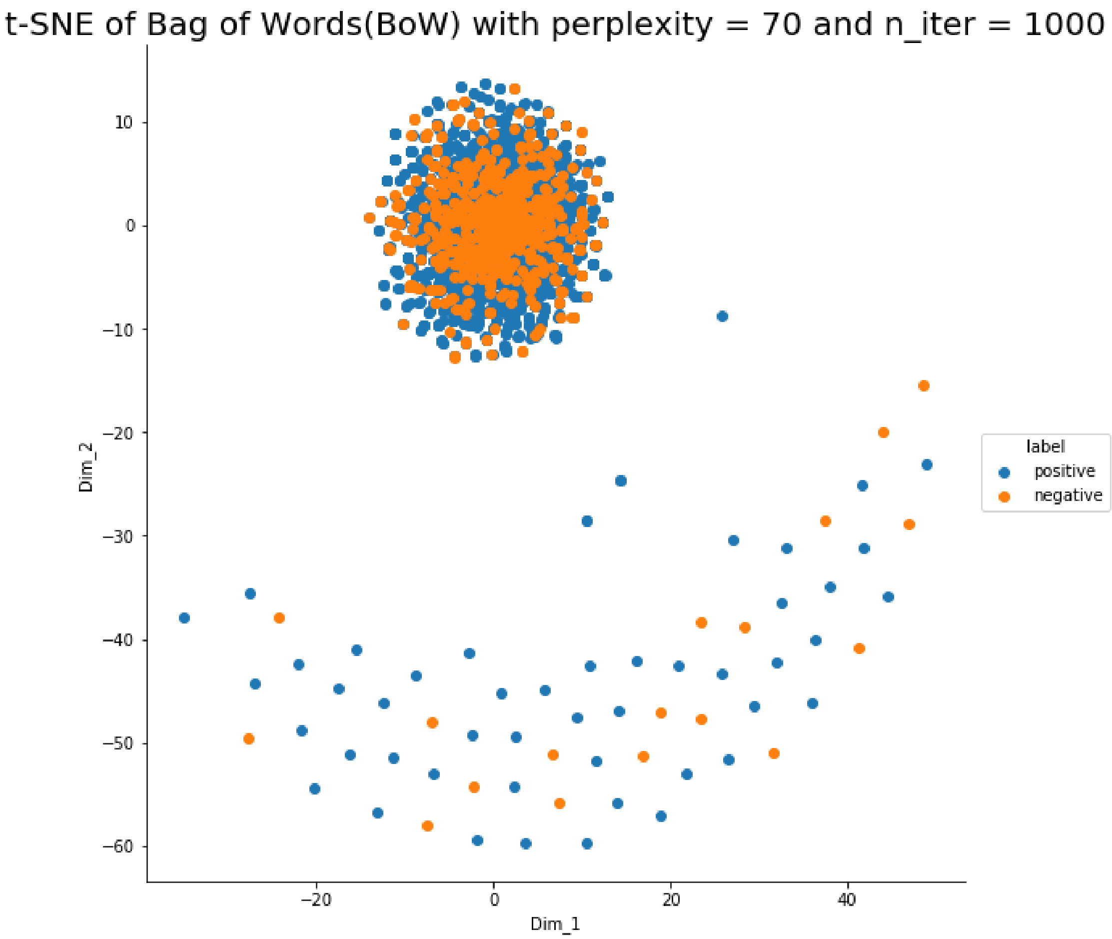

```
In [46]: # t-SNE with perplexity = 50 and n_iter = 4000
         model = TSNE(n_components=2, random_state=0, perplexity=50,  n_iter=4000)

         tsne_data = model.fit_transform(standardized_data)


         # creating a new data frame which help us in ploting the result data
         tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
         tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

         # Ploting the result of tsne
         sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_leg
         plt.title('t-SNE of Bag of Words(BoW) with perplexity = 50 and n_iter = 4000',size=20)
         plt.show()
```



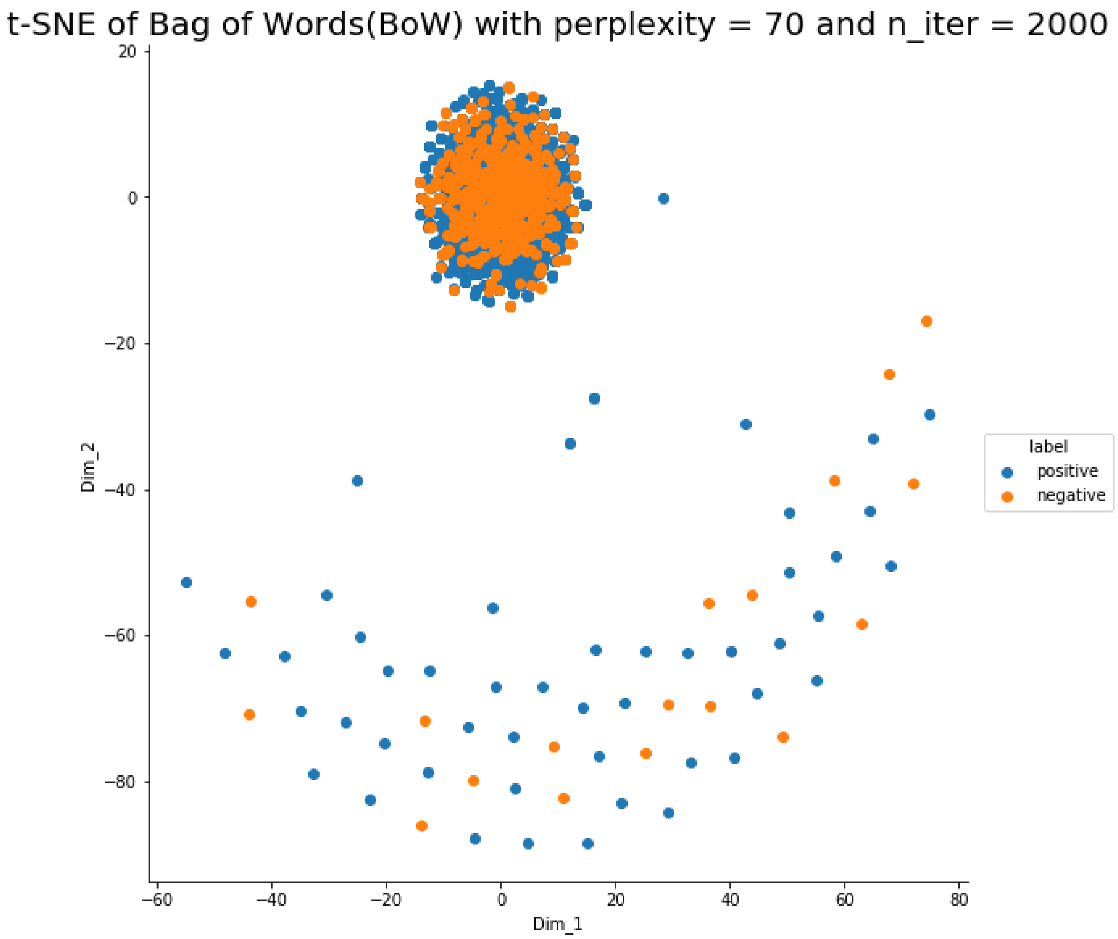

In [47]:
```
# t-SNE with perplexity = 50 and n_iter = 5000
model = TSNE(n_components=2, random_state=0, perplexity=50,  n_iter=5000)

tsne_data = model.fit_transform(standardized_data)


# creating a new data frame which help us in ploting the result data
tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

# Ploting the result of tsne
sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_leg
plt.title('t-SNE of Bag of Words(BoW) with perplexity = 50 and n_iter = 5000',size=20)
plt.show()
```



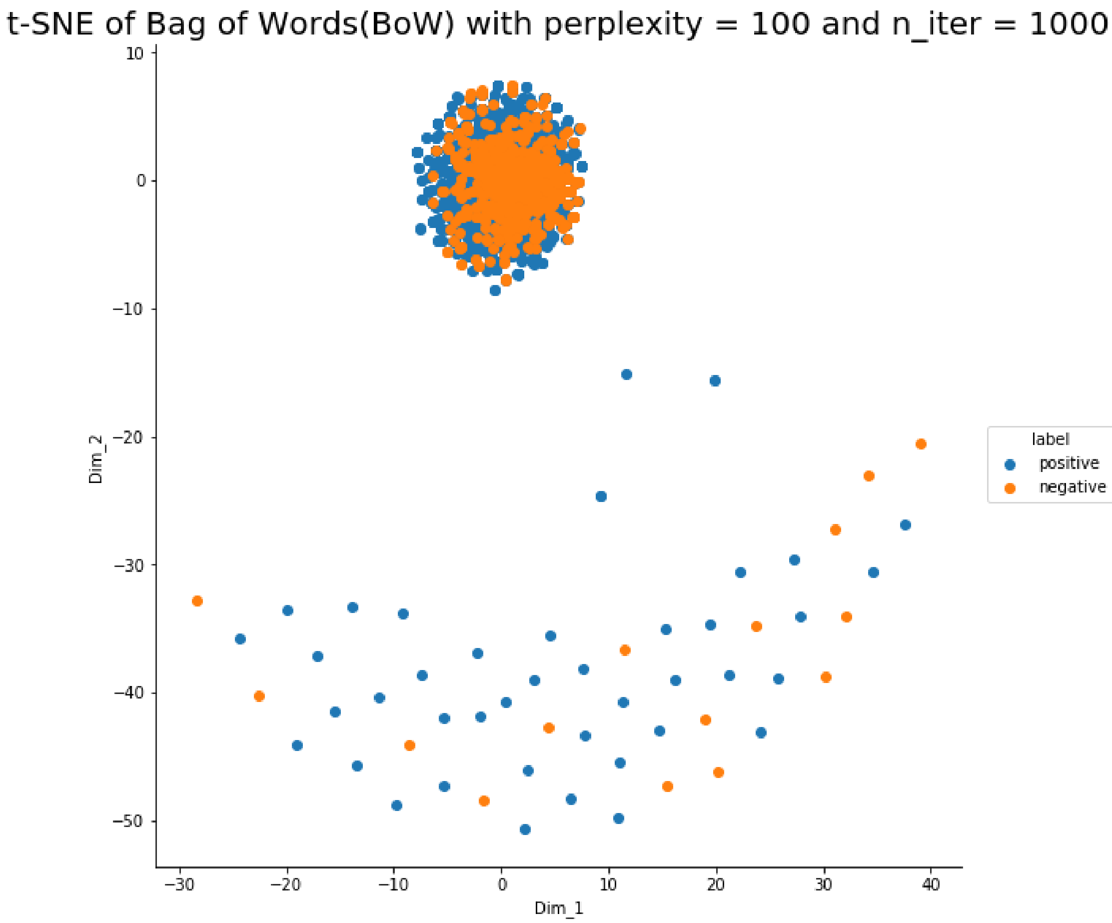

```
In [48]: # t-SNE with perplexity = 70 and n_iter = 1000
         model = TSNE(n_components=2, random_state=0, perplexity=70,  n_iter=1000)

         tsne_data = model.fit_transform(standardized_data)


         # creating a new data frame which help us in ploting the result data
         tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
         tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

         # Ploting the result of tsne
         sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_leg
         plt.title('t-SNE of Bag of Words(BoW) with perplexity = 70 and n_iter = 1000',size=20)
         plt.show()
```



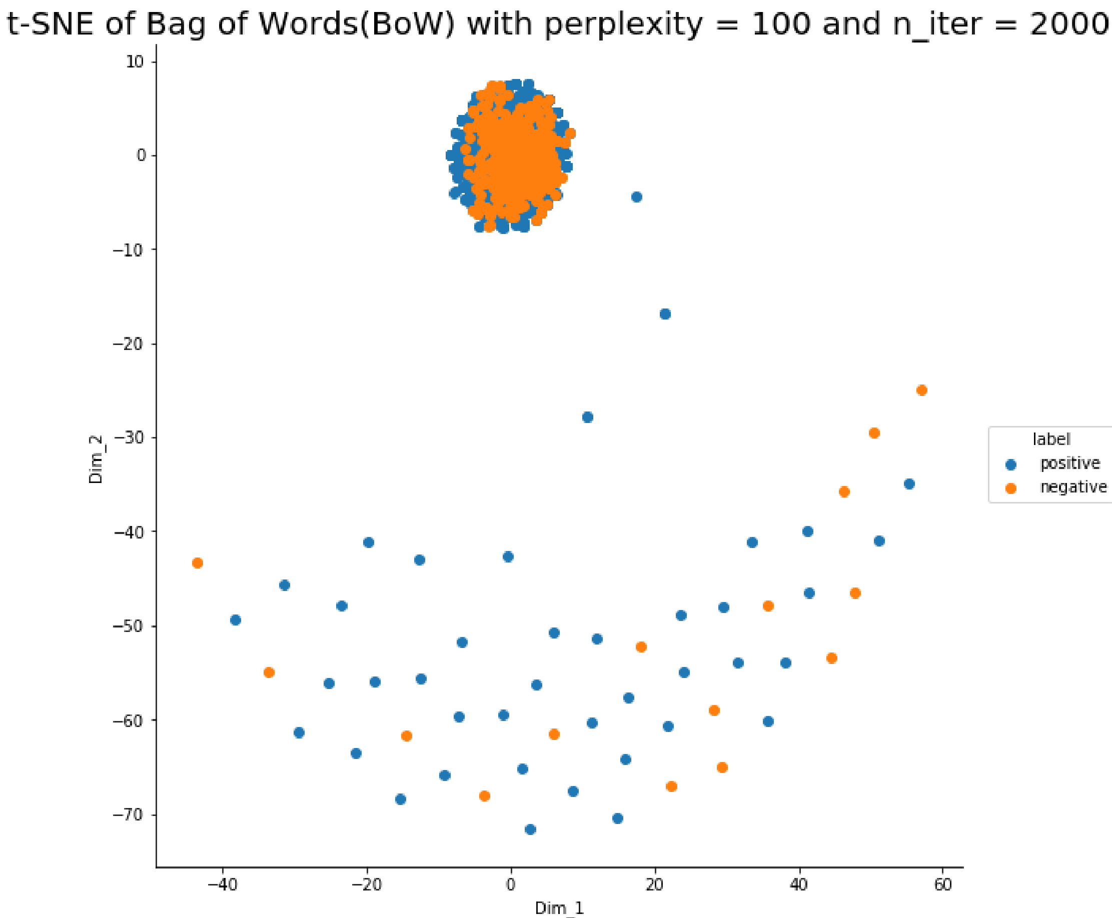

```
In [49]: # t-SNE with perplexity = 70 and n_iter = 2000
         model = TSNE(n_components=2, random_state=0, perplexity=70,  n_iter=2000)

         tsne_data = model.fit_transform(standardized_data)


         # creating a new data frame which help us in ploting the result data
         tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
         tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

         # Ploting the result of tsne
         sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_leg
         plt.title('t-SNE of Bag of Words(BoW) with perplexity = 70 and n_iter = 2000',size=20)
         plt.show()
```




```
In [50]: # t-SNE with perplexity = 100 and n_iter = 1000
         model = TSNE(n_components=2, random_state=0, perplexity=100,  n_iter=1000)

         tsne_data = model.fit_transform(standardized_data)


         # creating a new data frame which help us in ploting the result data
         tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
         tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

         # Ploting the result of tsne
         sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_leg
         plt.title('t-SNE of Bag of Words(BoW) with perplexity = 100 and n_iter = 1000',size=20
         plt.show()
```




```
In [51]: # t-SNE with perplexity = 100 and n_iter = 2000
         model = TSNE(n_components=2, random_state=0, perplexity=100,  n_iter=2000)

         tsne_data = model.fit_transform(standardized_data)


         # creating a new data frame which help us in ploting the result data
         tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
         tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

         # Ploting the result of tsne
         sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_leg
         plt.title('t-SNE of Bag of Words(BoW) with perplexity = 100 and n_iter = 2000',size=2(
         plt.show()
```




OBSERVATIONS :- After drawing and observing t-SNE plots for different values of perplexity and n_iter . It is good to draw t-SNE plots for further techniques using following hyper-parameters :

(1). perplexity = 50

(2). n_iter = 3000

OBSERVATION FOR ABOVE PLOTS : From above plots it is clear that they are overlapping almost 90%-95% and it is very difficult to draw a line to classify the polarity of the reviews .

# 6 Bi-Grams

```
In [63]: #Bi-Gram
         count_vect = CountVectorizer(ngram_range=(1,2),min_df=5 ) #in scikit-learn
         final_bigram_counts = count_vect.fit_transform(my_final['CleanedText'].values)
         print("the type of count vectorizer ",type(final_bigram_counts))
         print("the shape of out text BOW vectorizer ",final_bigram_counts.get_shape())
         print("the number of unique words including both unigrams and bigrams ", final_bigram_
```

```
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text BOW vectorizer  (4000, 6369)
```

```
the number of unique words including both unigrams and bigrams  6369
```

```
In [69]: # Change sparse matrix to dense matrix
         final_bigram_counts  = final_bigram_counts.toarray()
```

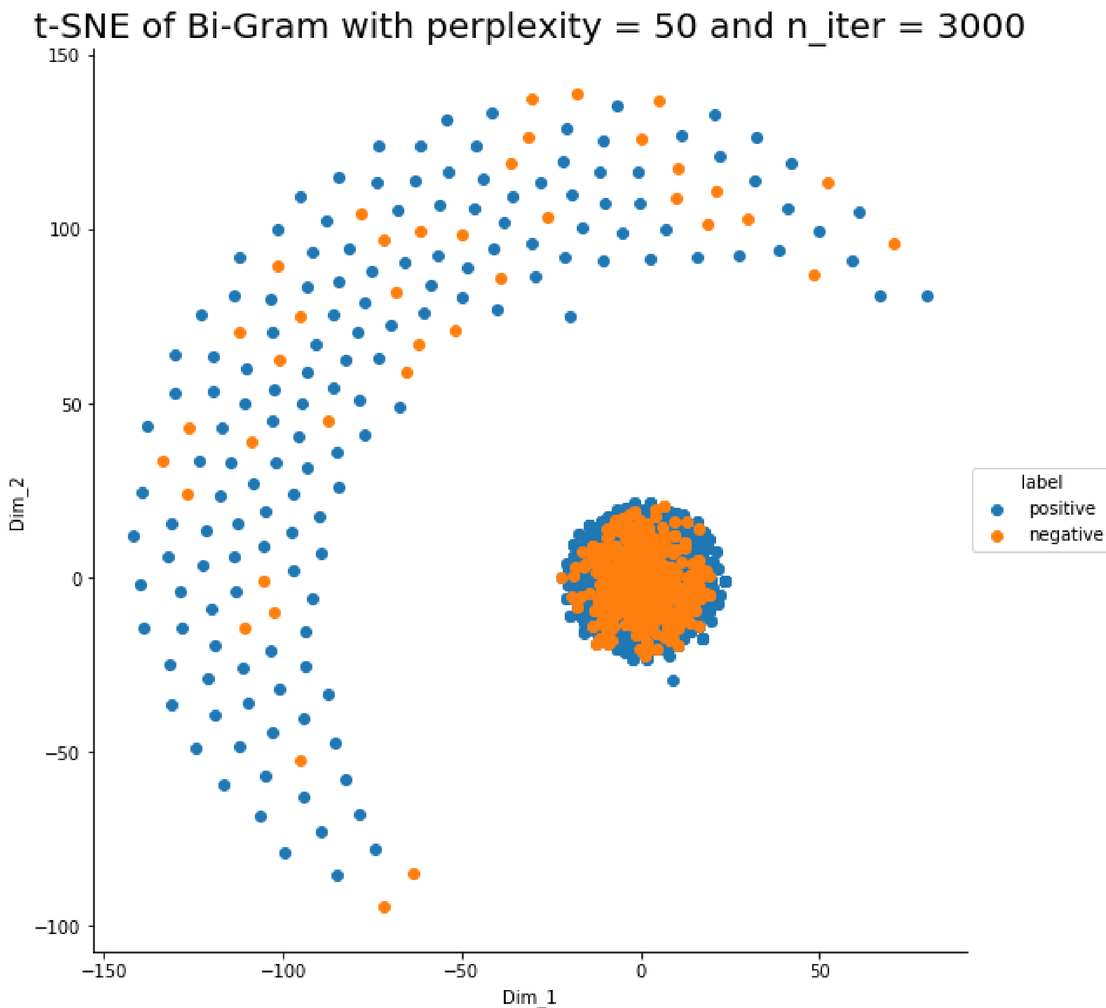
```
In [70]: final_bigram_counts.shape
```

```
Out[70]: (4000, 6369)
```

```
In [71]: import warnings
         warnings.filterwarnings('ignore')
         # Data-preprocessing: Standardizing the data

         from sklearn.preprocessing import StandardScaler
         standardized_data = StandardScaler().fit_transform(final_bigram_counts)
         print(standardized_data.shape)
```

```
(4000, 6369)
```

```
In [72]: # TSNE

         from sklearn.manifold import TSNE

         # t-SNE with perplexity = 50 and n_iter = 3000
         model = TSNE(n_components=2, random_state=0, perplexity=50,  n_iter=3000)

         tsne_data = model.fit_transform(standardized_data)


         # creating a new data frame which help us in ploting the result data
         tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
         tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

         # Ploting the result of tsne
         sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_leg
         plt.title('t-SNE of Bi-Gram with perplexity = 50 and n_iter = 3000',size=20)
         plt.show()
```




OBSERVATION FOR ABOVE PLOT : From above plot it is clear that they are overlapping almost 90%-95% and it is very difficult to draw a line to classify the polarity of the reviews .

## 7 (2). TF-IDF

```
In [86]: tf_idf_vect = TfidfVectorizer(ngram_range=(1,2),min_df=5)
         final_tf_idf = tf_idf_vect.fit_transform(my_final['CleanedText'].values)
         print("the type of count vectorizer ",type(final_tf_idf))
         print("the shape of out text TFIDF vectorizer ",final_tf_idf.get_shape())
         print("the number of unique words including both unigrams and bigrams ", final_tf_idf
```

```
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text TFIDF vectorizer  (4000, 6369)
the number of unique words including both unigrams and bigrams  6369
```

In [87]:
```
features = tf_idf_vect.get_feature_names()
print("some sample features(unique words in the corpus)",features[1000:1010])
```

```
some sample features(unique words in the corpus) ['coffe use', 'colada', 'cold', 'cold water',
```

In [88]:
```
# Change sparse matrix to dense matrix
final_tf_idf  = final_tf_idf.toarray()
```

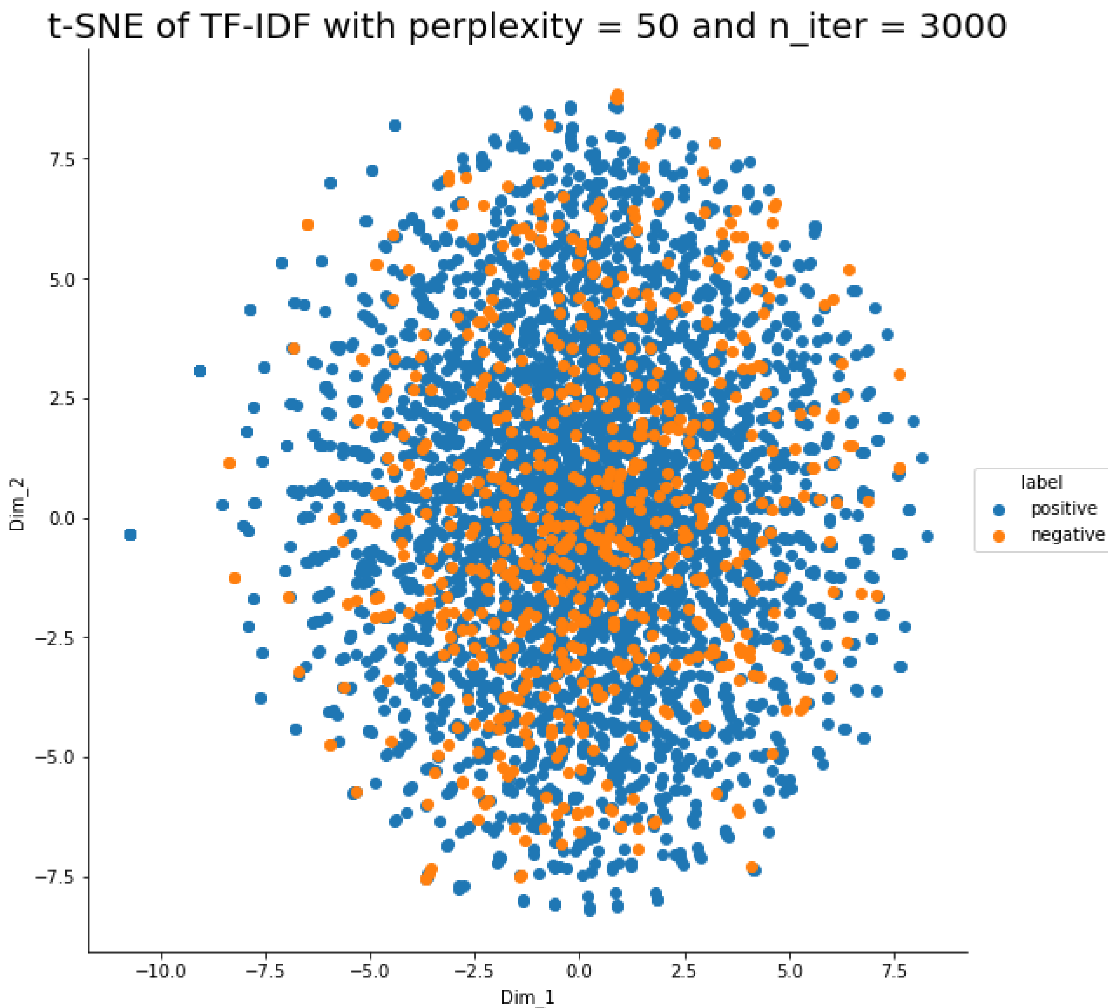
In [89]:
```
final_tf_idf.shape
```

Out[89]:
```
(4000, 6369)
```

In [90]:
```
import warnings
warnings.filterwarnings('ignore')
# Data-preprocessing: Standardizing the data

from sklearn.preprocessing import StandardScaler
standardized_data = StandardScaler().fit_transform(final_tf_idf)
print(standardized_data.shape)
```

```
(4000, 6369)
```

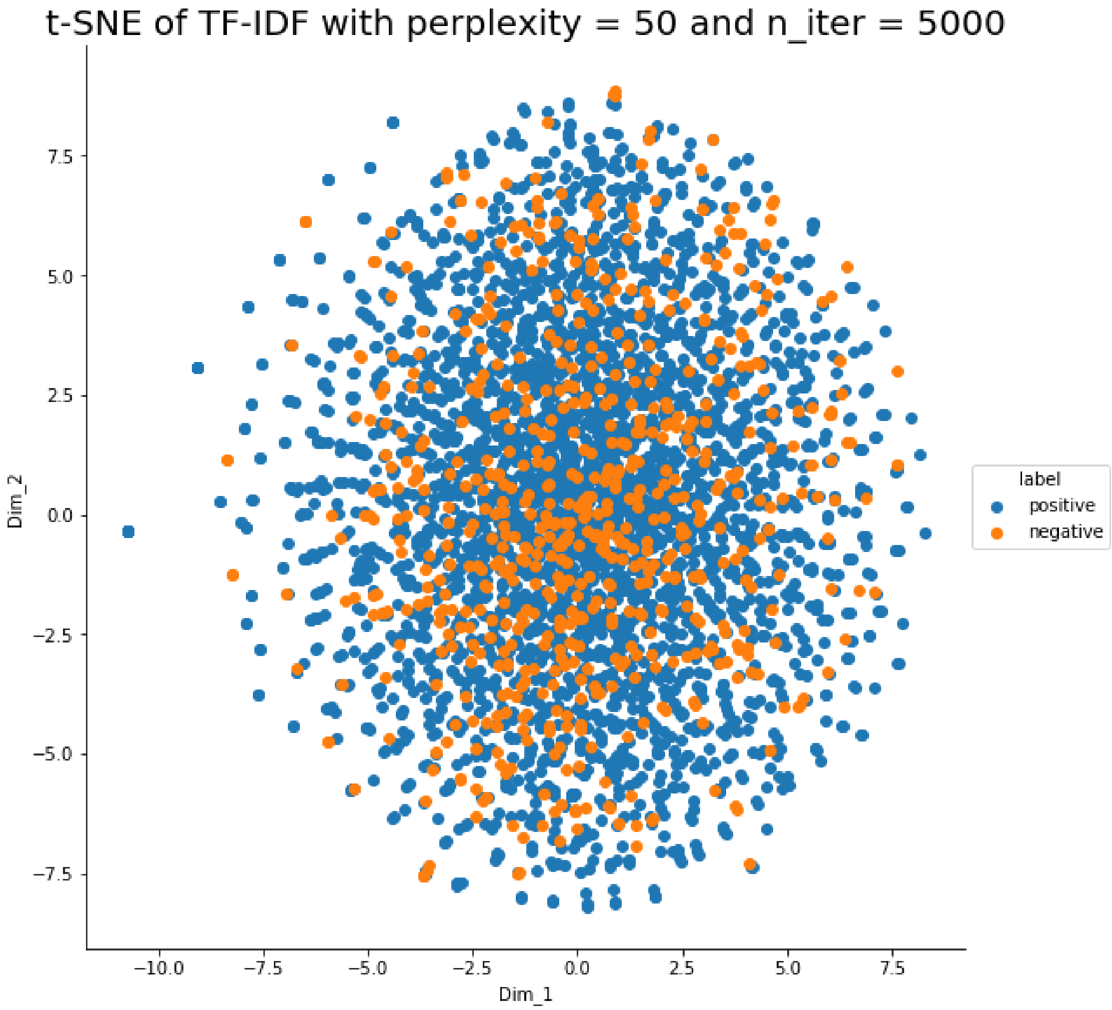
In [80]:
```
# TSNE

from sklearn.manifold import TSNE

# t-SNE with perplexity = 50 and n_iter = 3000
model = TSNE(n_components=2, random_state=0, perplexity=50,  n_iter=3000)

tsne_data = model.fit_transform(standardized_data)


# creating a new data frame which help us in ploting the result data
tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

# Ploting the result of tsne
sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_le
plt.title('t-SNE of TF-IDF with perplexity = 50 and n_iter = 3000',size=20)
plt.show()
```




OBSERVATION FOR ABOVE PLOT : From above plot it is clear that they are overlapping almost 85%-90% and it is very difficult to draw a line to classify the polarity of the reviews .

```
In [91]: # TSNE

         from sklearn.manifold import TSNE

         # t-SNE with perplexity = 50 and n_iter = 5000
         model = TSNE(n_components=2, random_state=0, perplexity=50,  n_iter=5000)

         tsne_data = model.fit_transform(standardized_data)


         # creating a new data frame which help us in ploting the result data
         tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
         tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))
```

```
# Ploting the result of tsne
sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_leg
plt.title('t-SNE of TF-IDF with perplexity = 50 and n_iter = 5000',size=20)
plt.show()
```




OBSERVATION FOR ABOVE PLOT : From above plot it is clear that they are overlapping almost 85%-90% and it is very difficult to draw a line to classify the polarity of the reviews .

# 8 Word2Vec

```
In [93]: # Train your own Word2Vec model using your own text corpus
         list_of_sent=[]
         for sent in my_final['CleanedText'].values:
             list_of_sent.append(sent.split())

In [94]: print(final['CleanedText'].values[0])
```

```
print("****************************************************************")
print(list_of_sent[0])
```

```
product archer farm best drink mix ever mix flavor packet water bottl contain natur sweetner s
*****************************************************************
['product', 'archer', 'farm', 'best', 'drink', 'mix', 'ever', 'mix', 'flavor', 'packet', 'wate
```

```
In [95]: # min_count = 5 considers only words that occured atleast 5 times
         w2v_model=Word2Vec(list_of_sent,min_count=5,size=50, workers=4)
```

```
In [98]: w2v_words = list(w2v_model.wv.vocab)
         print("number of words that occured minimum 5 times ",len(w2v_words))
```

```
number of words that occured minimum 5 times  3253
```

# 9 (3). Avg Word2Vec

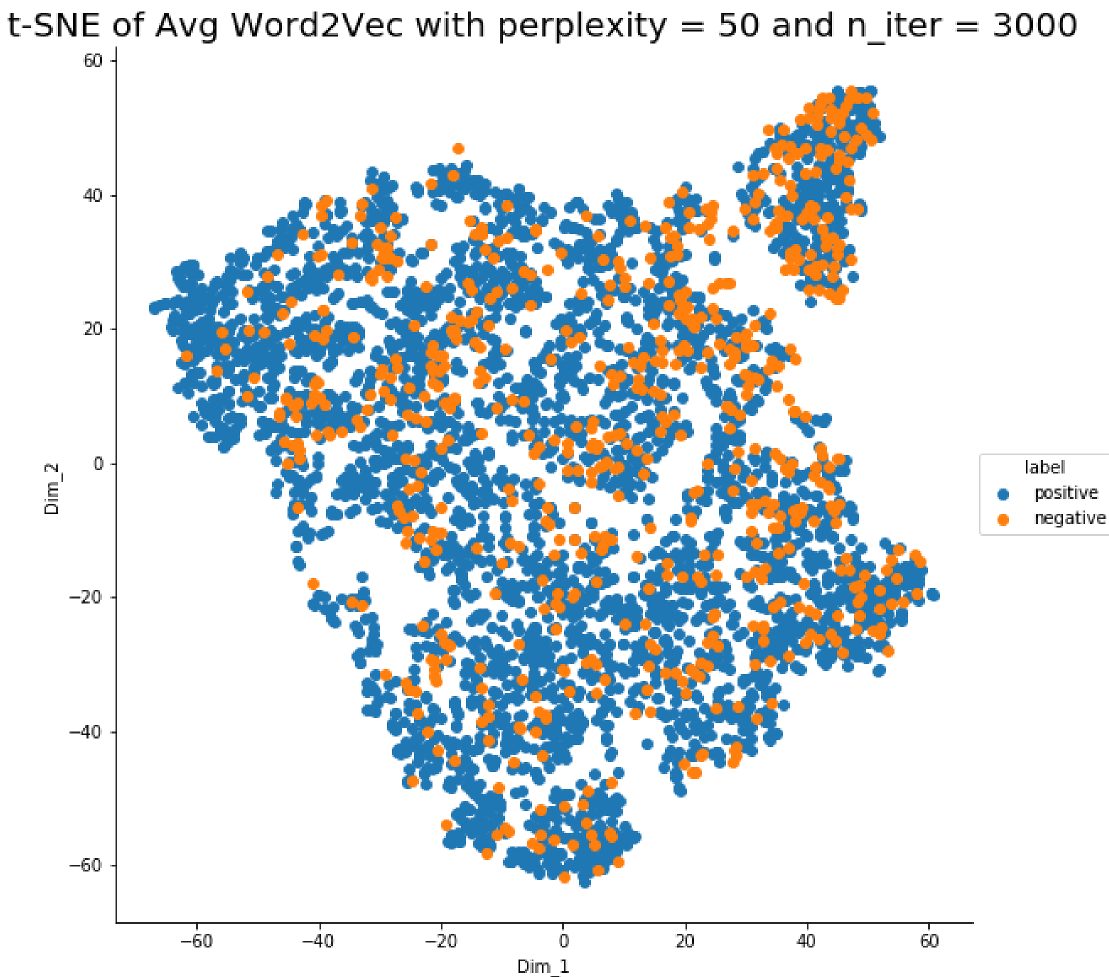
```
In [99]: # average Word2Vec
         # compute average word2vec for each review.
         sent_vectors = []; # the avg-w2v for each sentence/review is stored in this list
         for sent in list_of_sent: # for each review/sentence
             sent_vec = np.zeros(50) # as word vectors are of zero 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(len(sent_vectors))
         print(len(sent_vectors[0]))
```

```
4000
50
```

```
In [101]: import warnings
          warnings.filterwarnings('ignore')
          # Data-preprocessing: Standardizing the data

          from sklearn.preprocessing import StandardScaler
          standardized_data = StandardScaler().fit_transform(sent_vectors)
          print(standardized_data.shape)
```

```
(4000, 50)
```

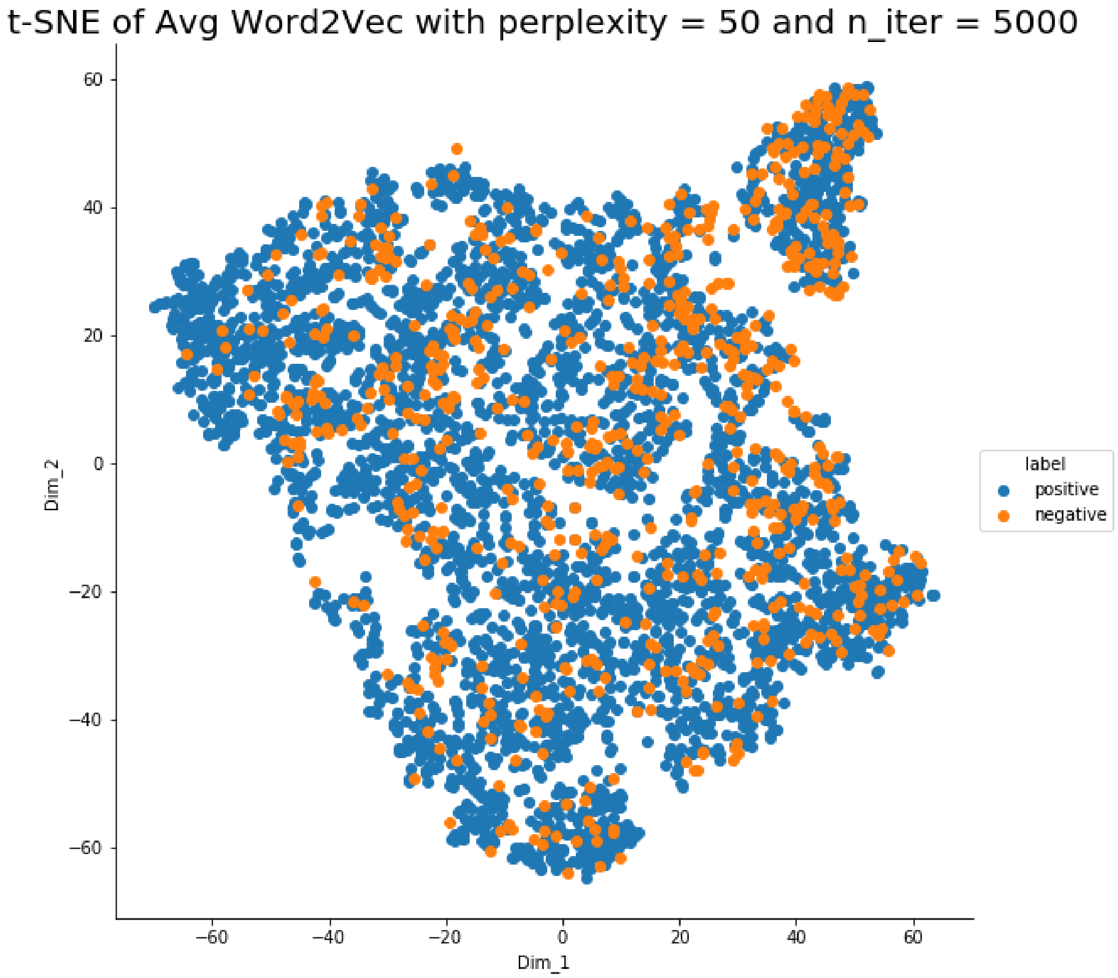
```
In [102]: # TSNE

          from sklearn.manifold import TSNE

          # t-SNE with perplexity = 50 and n_iter = 3000
          model = TSNE(n_components=2, random_state=0, perplexity=50,  n_iter=3000)

          tsne_data = model.fit_transform(standardized_data)


          # creating a new data frame which help us in ploting the result data
          tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
          tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

          # Ploting the result of tsne
          sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_le
          plt.title('t-SNE of Avg Word2Vec with perplexity = 50 and n_iter = 3000',size=20)
          plt.show()
```




OBSERVATION FOR ABOVE PLOT : From above plot it is clear that they are overlapping almost 80%-85% and it is very difficult to draw a line to classify the polarity of the reviews . But it is better than above plots .

In [103]:
```
# TSNE

from sklearn.manifold import TSNE

# t-SNE with perplexity = 50 and n_iter = 5000
model = TSNE(n_components=2, random_state=0, perplexity=50,  n_iter=5000)

tsne_data = model.fit_transform(standardized_data)


# creating a new data frame which help us in ploting the result data
tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))
```

```
# Ploting the result of tsne
sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_le
plt.title('t-SNE of Avg Word2Vec with perplexity = 50 and n_iter = 5000',size=20)
plt.show()
```




OBSERVATION FOR ABOVE PLOT : From above plot it is clear that they are overlapping almost 80%-85% and it is very difficult to draw a line to classify the polarity of the reviews . But it is better than above plots .

## 10 (4). TFIDF-Word2Vec

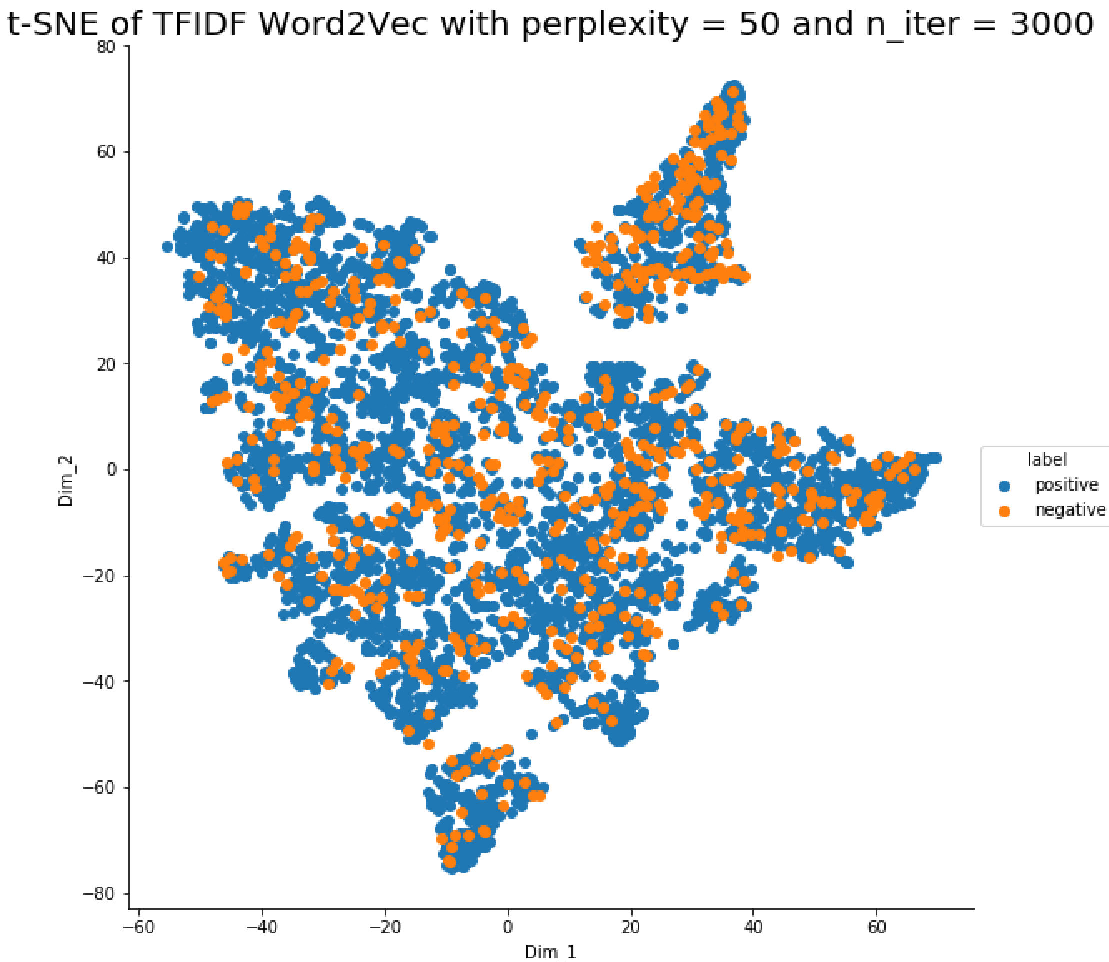
In [104]:
```
tf_idf_vect = TfidfVectorizer()
final_tf_idf = tf_idf_vect.fit_transform(my_final['CleanedText'].values)
```

In [105]:
```
final_tf_idf.shape
```

Out[105]:
```
(4000, 9454)
```

```
In [106]: # TF-IDF weighted Word2Vec
          tfidf_feat = tf_idf_vect.get_feature_names() # tfidf words/col-names
          # final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfid

In [107]: tfidf_sent_vectors = []; # the tfidf-w2v for each sentence/review is stored in this
          row=0;
          for sent in list_of_sent: # for each review/sentence
              sent_vec = np.zeros(50) # as word vectors are of zero length
              weight_sum =0; # num of words with a valid vector in the sentence/review
              for word in sent: # for each word in a review/sentence
                  if word in w2v_words:
                      vec = w2v_model.wv[word]
                      # obtain the tf_idfidf of a word in a sentence/review
                      tf_idf = final_tf_idf[row, tfidf_feat.index(word)]
                      sent_vec += (vec * tf_idf)
                      weight_sum += tf_idf
              if weight_sum != 0:
                  sent_vec /= weight_sum
              tfidf_sent_vectors.append(sent_vec)
              row += 1

In [108]: import warnings
          warnings.filterwarnings('ignore')
          # Data-preprocessing: Standardizing the data

          from sklearn.preprocessing import StandardScaler
          standardized_data = StandardScaler().fit_transform(tfidf_sent_vectors)
          print(standardized_data.shape)

(4000, 50)


In [109]: # TSNE

          from sklearn.manifold import TSNE

          # t-SNE with perplexity = 50 and n_iter = 3000
          model = TSNE(n_components=2, random_state=0, perplexity=50,  n_iter=3000)

          tsne_data = model.fit_transform(standardized_data)


          # creating a new data frame which help us in ploting the result data
          tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
          tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

          # Ploting the result of tsne
          sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_le
```

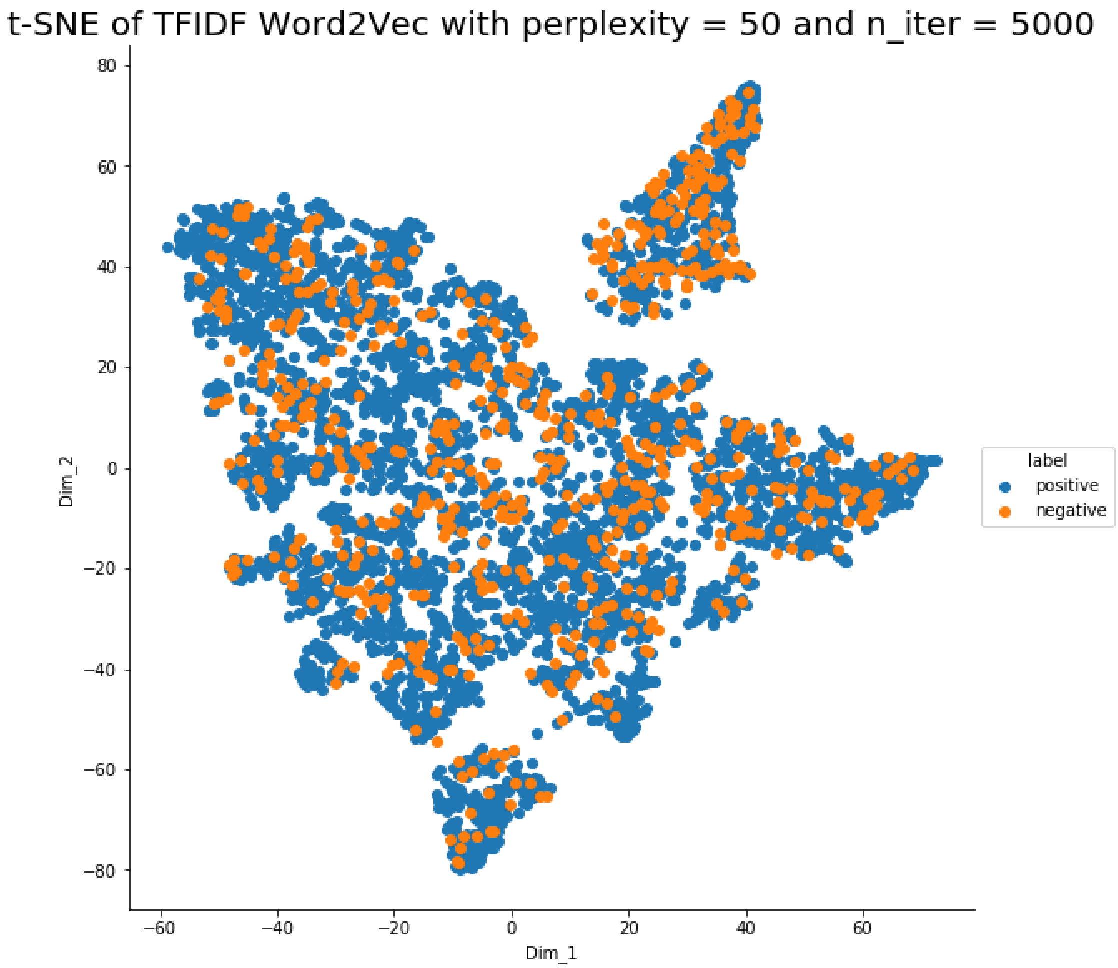
```
plt.title('t-SNE of TFIDF Word2Vec with perplexity = 50 and n_iter = 3000',size=20)
plt.show()
```




OBSERVATION FOR ABOVE PLOT : From above plot it is clear that they are overlapping almost 70%-80% and it is very difficult to draw a line to classify the polarity of the reviews . But it is better than above plots .

In [110]:
```
# TSNE

from sklearn.manifold import TSNE

# t-SNE with perplexity = 50 and n_iter = 5000
model = TSNE(n_components=2, random_state=0, perplexity=50,  n_iter=5000)

tsne_data = model.fit_transform(standardized_data)


# creating a new data frame which help us in ploting the result data
```

```
tsne_data = np.vstack((tsne_data.T, my_final['Score'])).T
tsne_df = pd.DataFrame(data=tsne_data, columns=("Dim_1", "Dim_2", "label"))

# Ploting the result of tsne
sns.FacetGrid(tsne_df, hue="label", size=8).map(plt.scatter, 'Dim_1', 'Dim_2').add_le
plt.title('t-SNE of TFIDF Word2Vec with perplexity = 50 and n_iter = 5000',size=20)
plt.show()
```




OBSERVATION FOR ABOVE PLOT : From above plot it is clear that they are overlapping almost 70%-80% and it is very difficult to draw a line to classify the polarity of the reviews . But it is much better than above plots .