PERFORMING KNN ON AMAZON FINE FOOD REVIEWS

August 3, 2018

1 KNN On Amazon Fine Food Reviews:

```
In [ ]: => Predictions:

        The purpose of this analysis is to make up a prediction model where we will
        be able to predict whether a recommendation is positive or negative. In this
        analysis, we will not focus on the Score, but only the positive/negative
        sentiment of the recommendation.To do so, we will work on Amazon's
        recommendation dataset, we will build a Term-doc incidence matrix
        using term frequency and inverse document frequency ponderation.

        When the data is ready, we will load it into predicitve algorithms,
        mainly naïve Bayesianand regression.In the end, we hope to find a
        "best" model for predicting there commendation's sentiment.

        => Loading the data:

        In order to load the data, we will use the SQLITE dataset where
        we will only fetch the Score and the recommendation summary.

        2.As we only want to get the global sentiment of the recommendations
        (positive or negative),we will purposefully ignore all Scores equal to

        3. If the score id above 3, then the
        recommendation wil be set to "postive". Otherwise, it will be set to "negative".

        The data will be split into an training set and a test set with a
        test set ratio of 0.2
```

```
In [ ]: => Attribute information:

        1.Id
        2.Product id
        3.User id
        4.Profile name
        5.Helpful numerator
        6.helpful denominator
```

```
7.Reviews=Positive (4 or 5) and Negative (1 or 2)
8.Time
9.Summary
10.Text
Objective:

1. Applied K-Nearest Neighbour on Different Featurization of Data viz.
   BOW, tfidf, Avg-Word2Vec(using Word2Vec model pretrained on Google
   News) and tf-idf-Word2Vec.
2. Used both brute & kd-tree implementation of KNN
3.Perform train and test split using time bassed slicing.
4.perform 10 fold cross validation to find optimal "k" in knn
5.Perform test acccuracy on
  A.BOW
  B.Tfidf
  C.Avg word2vec
  D.Tfidf W2v
```

```
In [51]: %matplotlib inline
         import warnings
         warnings.filterwarnings("ignore")
         import re
         import pandas as pd
         import numpy as np
         import nltk
         import string
         import matplotlib.pyplot as plt
         from time import time
         import random
         import gensim
         import seaborn as sns
         from sklearn.feature_extraction.text import TfidfTransformer
         from sklearn.feature_extraction.text import TfidfVectorizer
         from sklearn.feature_extraction.text import CountVectorizer
         from sklearn.metrics import confusion_matrix
         from sklearn import metrics
         from sklearn.metrics import roc_curve, auc
         from nltk.stem.porter import PorterStemmer
         from sklearn.cross_validation import train_test_split
         from sklearn.neighbors import KNeighborsClassifier
         from sklearn.metrics import accuracy_score
         from sklearn.cross_validation import cross_val_score
         from collections import Counter
         from sklearn.metrics import accuracy_score
         from sklearn import cross_validation


         # Using the  table to read data
```

```
        df=pd.read_csv('Reviews.csv')
        df.head()

Out[51]:    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      5  1303862400
        1                     0                       0      1  1346976000
        2                     1                       1      4  1219017600
        3                     3                       3      2  1307923200
        4                     0                       0      5  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...

In [52]: filtered_data=pd.read_csv('Reviews.csv')
         filtered_data.head()

Out[52]:    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      5  1303862400
        1                     0                       0      1  1346976000
        2                     1                       1      4  1219017600
        3                     3                       3      2  1307923200
        4                     0                       0      5  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...
```

```
In [53]: def partition(x):
             if x<3:
                 return 'negative'
             return 'positive'
```

```
In [54]: actualScore=filtered_data['Score']
         positiveNegative=actualScore.map(partition)
         filtered_data['Score']=positiveNegative
         filtered_data.shape
         filtered_data.head()
```

```
Out[54]:    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...
```

```
In [55]: df.duplicated()
         df.head()
```

```
Out[55]:    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      5  1303862400
         1                     0                       0      1  1346976000
         2                     1                       1      4  1219017600
         3                     3                       3      2  1307923200
         4                      0                       0      5  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...
```

```
In [56]: sorted_data=filtered_data.sort_values('ProductId', axis=0, ascending=True,)
```

```
In [57]: final=sorted_data.drop_duplicates(subset={'UserId','ProfileName','Time','Text'}
                                          ,keep='first',inplace=False)
         final.shape
```

```
Out[57]: (393933, 10)
```

```
In [58]: (final["Id"].size*1.0)/(filtered_data['Id'].size*1.0)*100
```

```
Out[58]: 69.29901100176971
```

```
In [59]: display=pd.read_csv('Reviews.csv')
         display

         final=final[final.HelpfulnessNumerator<=final.HelpfulnessDenominator]
```

```
In [60]: print(final.shape)
```

```
(393931, 10)
```

```
In [61]: final['Score'].value_counts()
```

```
Out[61]: positive    336824
         negative     57107
         Name: Score, dtype: int64
```

```
In [62]: i=0;
         for sent in final['Text'].values:
             if (len(re.findall('<.*?>', sent))):
                 print(i)
                 print(sent)
                 break;
             i += 1;
```

```
0
In June<br />I saw a charming group<br />of roses all begin<br />to droop<br />I pepped them u
In [63]: import nltk
         from nltk.corpus import stopwords
         nltk.download('stopwords')
         stopwords = stopwords.words('english')
         import re
         import string
         from nltk.corpus import stopwords
         from nltk.stem import PorterStemmer
         from nltk.stem.wordnet import WordNetLemmatizer
         stop = set(stopwords.words('english')) #set of stopwords
         sno = nltk.stem.SnowballStemmer('english') #initialising the snowball stemmer
         def cleanhtml(sentence): #function to clean the word of any html-tags
             cleanr = re.compile('<.*?>')
             cleantext = re.sub(cleanr, ' ', sentence)
             return cleantext
         def cleanpunc(sentence): #function to clean the word of any punctuation or special_ch
             cleaned = re.sub(r'[?|!|\'|"|#]',r'',sentence)
             cleaned = re.sub(r'[.|,|)|(|\|/]',r' ',cleaned)
             return cleaned
         print(stop)
         print('************************************')
         print(sno.stem('tasty'))
```

```
[nltk_data] Downloading package stopwords to
[nltk_data]     C:\Users\Saurabh\AppData\Roaming\nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
{'you', "you'll", 'what', 'each', 'and', 'but', "it's", 'shan', 'being', 'very', 'between', 'ha
************************************
tasti
```

```
In [64]: 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 us
                             if(final['Score'].values)[i] == 'negative':
                                 all_negative_words.append(s) #list of all words used to descr
                         else:
                             continue
                     else:
                         continue
             #print(filtered_sentence)
             str1 = b" ".join(filtered_sentence) #final string of cleaned words
             #print("***********************************************************************")

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

```
In [65]: final['CleanedText']=final_string
```

2 Taking Sample Data

```
In [66]: n_samples = 25000
         df_sample = df.sample(n_samples)

         ###Sorting as we want according to time series

         df_sample.sort_values('Time',inplace=True)
         df_sample.head(10)
```

```
Out[66]:             Id   ProductId          UserId         ProfileName  \
         451902  451903  B00004CXX9  A2DEE7F9XKP3ZR              jerome
         230333  230334  B00004RYGX  A1GB1Q193DNFGR    Bruce Lee Pullen
         451922  451923  B00004CXX9   ANIMV3SPDD8SH    Guy De Federicis
         374333  374334  B00004CI84  A2HIZRVOKXKZ52       KAY N. FOWLER
         374418  374419  B00004CI84   ADIDQRLLR4KBQ    "paradise_found"
         374330  374331  B00004CI84  A1OP3SQP78M1PP         James Gowen
         230255  230256  B00004RYGX   AAI57M3OXP5NK           "gibraud"
         451937  451938  B00004CXX9  A1CAA94EOP0J2S      Travis J Smith
         219437  219438  B00005IX97  A24IUOMVERXVEG  Rick "rick_street"
         326756  326757  B000A28TJ2  A2RSOEBCK1K70S          G. Preston

                 HelpfulnessNumerator  HelpfulnessDenominator  Score         Time  \
         451902                     0                       1      5    959990400
         230333                     5                       5      5    970531200
         451922                     1                      12      2    992217600
         374333                     0                       0      5   1012780800
         374418                     2                       2      5   1015545600
         374330                     0                       0      5   1015718400
         230255                     0                       0      5   1025654400
         451937                     4                       4      5   1036022400
         219437                    11                      11      5   1036108800
```

```
326756                    19                      21      5  1036627200

                                             Summary  \
451902                                      Research
230333  Fabulous Comedic Fanasy Directed by a Master
451922             CASPER IS THE GHOST WITH THE MOST
374333         Beetlejuice - Great Fun for Everyone!
374418   Because My Middle Name is &quot;Weird&quot;
374330             A movie to "literally die for!!!"
230255                              Love This Movie!
451937                                  Great Comedy
219437                    Great Easy cup of Espresso
326756                               Boxed Evolution

                                                      Text
451902  I'm getting crazy.<p>Is it really impossible t...
230333  Beetlejuice is an awe-inspiring wonderfully am...
451922  Michael Keaton brings no distinguishing charac...
374333  When vacationing Adam and Barbara Maitland mee...
374418  Set in a small New England town, Tim Burton's ...
374330  Beetlejuice is not a movie that you can't watc...
230255  This movie is a very odd movie but I love it b...
451937  Beetlejuice is the story of ghosts (Alec Baldw...
219437  I've purchased both the Espressione Espresso (...
326756  Long live Camper Van Beethoven!! This is a ble...
```

```
In [67]: new_final_counts=final[:25000]
         print(new_final_counts.shape)
```

```
(25000, 11)
```

3 An Introduction to Bag Of Words =>

```
In [ ]: We convert text to a numerical representation called a feature vector.
        A feature vector can be as simple as a list of numbers.

        The bag-of-words model is one of the feature extraction algorithms for text.
```

4 Classification Of Bag Of Words Using Knn (Brute Force)

```
In [ ]: from sklearn.model_selection import train_test_split

        from sklearn import preprocessing
        X_train, X_test, y_train, y_test = train_test_split(new_final_counts
        ['CleanedText'].values,new_final_counts['Score'].values ,test_size=0.30,
                                                           shuffle=False)
```

```
In [ ]: #Text -> Uni gram Vectors

        uni_gram = CountVectorizer()
        X_train = uni_gram.fit_transform(X_train)

        #Normalize Data

        X_train = preprocessing.normalize(X_train)
        print("Train Data Size: ",X_train.shape)
        X_test = uni_gram.transform(X_test)

        #Normalize Data

        X_test = preprocessing.normalize(X_test)
        print("Test Data Size: ",X_test.shape)
```

```
In [ ]: from sklearn.model_selection import TimeSeriesSplit

        tscv = TimeSeriesSplit(n_splits=10)
        for train, cv in tscv.split(X_train):

            # print("%s %s" % (train, cv))
            print(X_train[train].shape, X_train[cv].shape)
```

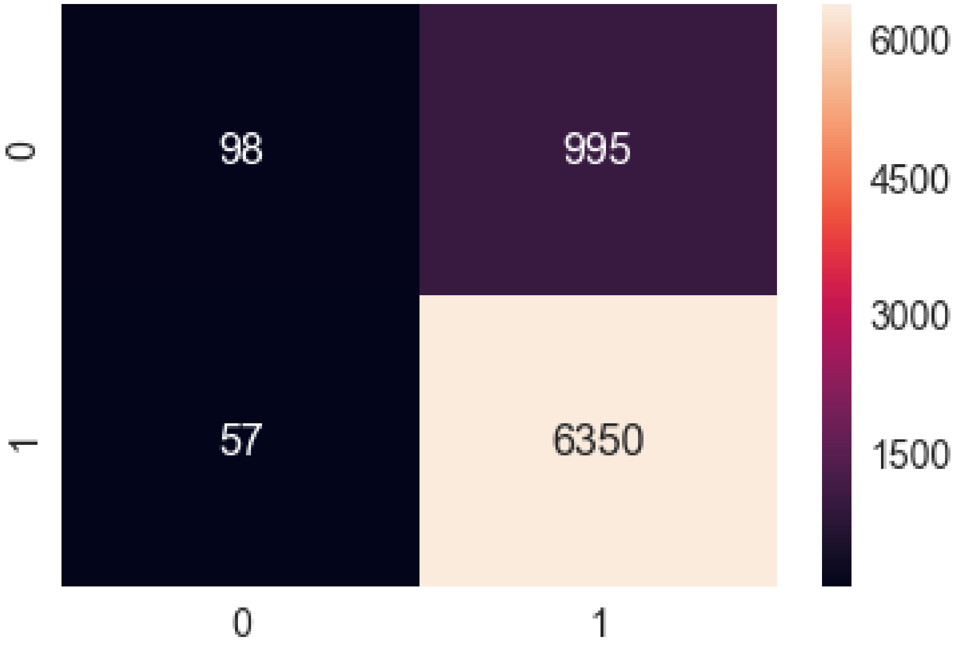
```
In [ ]: %time
        from sklearn.model_selection import GridSearchCV
        from sklearn.neighbors import KNeighborsClassifier

        knn = KNeighborsClassifier(algorithm='brute')

        # neigh = np.arange(1,100,2)

        param_grid = {'n_neighbors':np.arange(1,100,2)} #params we need to try on classifier
        tscv = TimeSeriesSplit(n_splits=10) #For time based splitting

        gsv = GridSearchCV(knn,param_grid,cv=tscv,verbose=1)
        gsv.fit(X_train,y_train)

        print("Best HyperParameter: ",gsv.best_params_)
        print("Best Accuracy: %.2f%%"%(gsv.best_score_*100))
```

```
In [69]: #Testing Accuracy on Test data

         %time

         from sklearn.neighbors import KNeighborsClassifier
         from sklearn.metrics import confusion_matrix
```

```
        knn = KNeighborsClassifier(n_neighbors=11)
        knn.fit(X_train,y_train)
        y_pred = knn.predict(X_test)

        print("Accuracy on test set: %0.3f%%"%(accuracy_score(y_test, y_pred)*100))
        print("Confusion Matrix of test set:\n [ [TN FP]\n [FN TP] ]\n")

        df_cm = pd.DataFrame(confusion_matrix(y_test, y_pred), range(2),range(2))
        sns.set(font_scale=1.4)#for label size
        sns.heatmap(df_cm, annot=True,annot_kws={"size": 16}, fmt='g')
```

```
Wall time: 0 ns
Accuracy on test set: 85.973%
Confusion Matrix of test set:
 [ [TN FP]
 [FN TP] ]
```

```
Out[69]: <matplotlib.axes._subplots.AxesSubplot at 0x205ff6be2b0>
```



5 Observation

```
In [ ]: 1.Here we observe that while using 25k points the heat map of confusion
        matrix is very clear and a/c to this we see that the model is perfect
```

```
 because the TN and TP are having high values.

2.The accuracy on text data using brute force algorithm is 85.973%
 which shows that model is perfect.
```

6 An introduction to TF-IDF =>

```
In [ ]: TF-IDF stands for Term FrequenctInverse Data Frequency.

        Term Frequency (tf): gives us the frequency of the word in each document in the corpus
        It is the ratio of number of times the word appears in a document compared to the
        total number of words in that document.It increases as the number of occurrences
        of that word within the document increases. Each document has its own tf.

        Inverse Data Frequency (idf)=>

        Used to calculate the weight of rare words across all documents in the corpus.
        The words that occur rarely in the corpus have a high IDF score. It is given by
        the equation below.
```

7 Classification of TF-IDF using Knn Algorithm (Brute Force)

```
In [81]: %%time
          from sklearn.feature_extraction.text import TfidfVectorizer
          from sklearn.model_selection import train_test_split
          from sklearn import preprocessing

          #Breaking into Train and test
          X_train, X_test, y_train1, y_test = train_test_split(new_final_counts
          ['CleanedText'].values,new_final_counts['Score'].values ,test
          _size=0.30,shuffle=False)

          tfidf = TfidfVectorizer(ngram_range=(1,2)) #Using bi-grams
          X_train_tfidf=tfidf.fit_transform(X_train)



          #Normalize Data
          X_traintfidf_counts = preprocessing.normalize(X_train_tfidf)
          print("Train Data Size: ",X_traintfidf_counts.shape)
          X_test = tfidf.transform(X_test)
          #Normalize Data
          X_test = preprocessing.normalize(X_test)
          print("Test Data Size: ",X_test.shape)
```

```
Train Data Size:  (17500, 379637)
Test Data Size:  (7500, 379637)
```

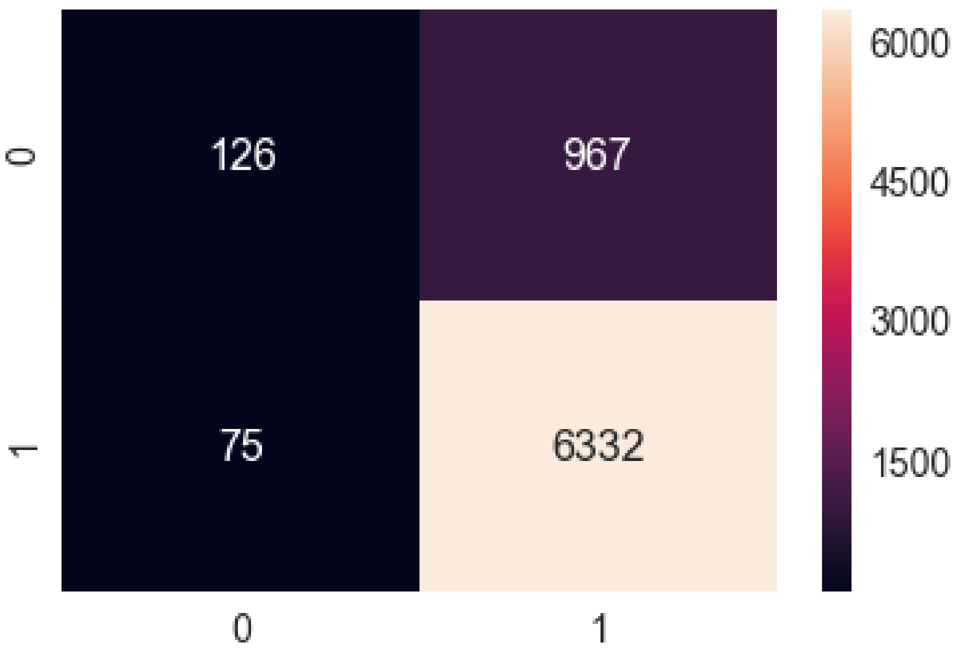
```
Wall time: 3.55 s
```

```
In [ ]: %time

        from sklearn.model_selection import GridSearchCV
        from sklearn.neighbors import KNeighborsClassifier
        knn = KNeighborsClassifier(algorithm='brute')

        # neigh = np.arange(1,100,2)

        param_grid = {'n_neighbors':np.arange(1,100,2)} #params we need to try on classifier
        tscv = TimeSeriesSplit(n_splits=10) #For time based splitting

        gsv = GridSearchCV(knn,param_grid,cv=tscv,verbose=1)
        gsv.fit(X_train,y_train)

        print("Best HyperParameter: ",gsv.best_params_)
        print("Best Accuracy: %.2f%%"%(gsv.best_score_*100))
```

```
In [70]: #Testing Accuracy on Test data

         from sklearn.neighbors import KNeighborsClassifier
         knn = KNeighborsClassifier(n_neighbors=9)
         knn.fit(X_train,y_train)
         y_pred = knn.predict(X_test)

         print("Accuracy on test set: %0.3f%%"%(accuracy_score(y_test, y_pred)*100))
         print("Confusion Matrix of test set:\n [ [TN FP]\n [FN TP] ]\n")

         df_cm = pd.DataFrame(confusion_matrix(y_test, y_pred), range(2),range(2))
         sns.set(font_scale=1.4)#for label size
         sns.heatmap(df_cm, annot=True,annot_kws={"size": 16}, fmt='g')
```

```
Accuracy on test set: 86.107%
Confusion Matrix of test set:
 [ [TN FP]
 [FN TP] ]
```

```
Out[70]: <matplotlib.axes._subplots.AxesSubplot at 0x205864517f0>
```



8 Observation=>

```
In [ ]: 1.Here we observe that while using 25k points the heat map of confusion
          matrix is very clear and a/c to this we see that the model is perfect
          because the TN and TP are having high values.

        2.The accuracy on text data using brute force algorithm is 86.107% which
          shows that model is perfect.
```

9 Word2vec =>

```
In [ ]: word2vec is an algorithm for constructing vector representations of words, also known
        as word embeddings. The vector for each word is a semantic description of how that
        word is used in context, so two words that are used similarly in text will get
        similar vector represenations.Once you map words into vector space, you can then
        use vector math to find words that have similar semantics.
```

10 Using Google News Word2Vectors

```
In [ ]: Gensim

        Gensim is a robust open-source vector space modeling and topic modeling
        toolkit implemented in Python. It uses NumPy,SciPy and optionally
        Cython for performance. Gensim is specifically designed to handle
```

```
         large text collections, using datastreaming and efficient incremental
         algorithms, which differentiates it from most other scientific software
         packages thatonly target batch and in-memory processing.
```

```
In [ ]: %time

         import re
         from gensim.models import Word2Vec
         from gensim.models import KeyedVectors
         import pickle

         model = KeyedVectors.load_word2vec_format('GoogleNews-vectors-negative300.bin',
                                                   binary=True)
```

```
In [83]: # Train your own Word2Vec model using your own text corpus
         import gensim
         i=0
         list_of_sent=[]
         for sent in final['Text'].values:
             filtered_sentence=[]
             sent=cleanhtml(sent)
             for w in sent.split():
                 for cleaned_words in cleanpunc(w).split():
                     if(cleaned_words.isalpha()):
                         filtered_sentence.append(cleaned_words.lower())
                     else:
                         continue
             list_of_sent.append(filtered_sentence)
```

```
In [84]: w2v_model=gensim.models.Word2Vec(list_of_sent,min_count=5,size=50, workers=4)
```

```
In [85]: w2v_vocub = model.wv.vocab
         len(w2v_vocub)

Out[85]: 3000000
```

11 Avg Word2Vec Using Brute Force Algorithm

```
In [ ]: 1.One of the most naive but good ways to convert a sentence into a vector.
        2.Convert all the words to vectors and then just take the avg of the
        vectors the resulting vector represent the sentence.
```

```
In [86]: # 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
        try:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
        except:
            pass
    sent_vec /= cnt_words
    sent_vectors.append(sent_vec)
print(len(sent_vectors))
```

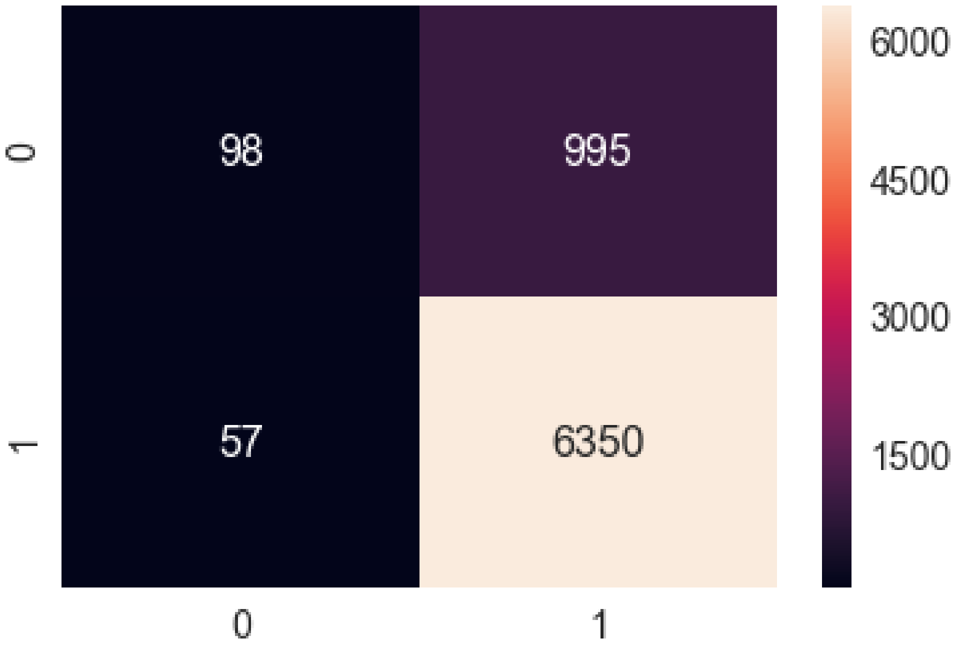
```
393931
```

```
In [ ]: %time
        from sklearn.model_selection import GridSearchCV
        from sklearn.neighbors import KNeighborsClassifier

        knn = KNeighborsClassifier(algorithm='brute')

        # neigh = np.arange(1,100,2)

        param_grid = {'n_neighbors':np.arange(1,100,2)} #params we need to try on classifier
        tscv = TimeSeriesSplit(n_splits=10) #For time based splitting

        gsv = GridSearchCV(knn,param_grid,cv=tscv,verbose=1)
        gsv.fit(X_train,y_train)

        print("Best HyperParameter: ",gsv.best_params_)
        print("Best Accuracy: %.2f%%"%(gsv.best_score_*100))
```

```
In [71]: #Testing Accuracy on Test data

         from sklearn.neighbors import KNeighborsClassifier
         knn = KNeighborsClassifier(n_neighbors=11)
         knn.fit(X_train,y_train)

         y_pred = knn.predict(X_test)

         print("Accuracy on test set: %0.3f%%"%(accuracy_score(y_test, y_pred)*100))
         print("Confusion Matrix of test set:\n [ [TN FP]\n [FN TP] ]\n")

         df_cm = pd.DataFrame(confusion_matrix(y_test, y_pred), range(2),range(2))
         sns.set(font_scale=1.4)#for label size
         sns.heatmap(df_cm, annot=True,annot_kws={"size": 16}, fmt='g')
```

```
Accuracy on test set: 85.973%
Confusion Matrix of test set:
 [ [TN FP]
 [FN TP] ]
```

```
Out[71]: <matplotlib.axes._subplots.AxesSubplot at 0x20581de7d68>
```



12 Observation

```
In [ ]: 1.Here we observe that while using 25k points the heat map of confusion
          matrix is very clear and a/c to this we see that the model is perfect
          because the TN and TP are having high values.

        2.The accuracy on text data using brute force algorithm is 85.973% which
          shows that model is perfect.
```

13 Tf-idf W2Vec Using Brute Force Algorithm

```
In [ ]: 1.Another way to covert sentence into vectors
        2.Take weighted sum of the vectors divided by the sum of all the tfidf's
        i.e. (tfidf(word) x w2v(word))/sum(tfidf's)
```

```
In [87]: # TF-IDF weighted Word2Vec
         tfidf_feat = tfidf.get_feature_names() # tfidf words/col-names
         # final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf
```

```
        tfidf_sent_vectors = []; # the tfidf-w2v for each sentence/review is stored in this l
        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
                try:
                    vec = w2v_model.wv[word]
                    # obtain the tf_idfidf of a word in a sentence/review
                    tfidf = final_tf_idf[row, tfidf_feat.index(word)]
                    sent_vec += (vec * tf_idf)
                    weight_sum += tf_idf
                except:
                    pass
            sent_vec /= weight_sum
            tfidf_sent_vectors.append(sent_vec)
            row += 1
```

```
In [88]: new_tfidf_sent_vectors=tfidf_sent_vectors[:25000]
         new_final=final[:25000]
```

```
In [90]: #Not shuffling the data as we want it on time basis
         X_train, X_test, y_train, y_test = train_test_split(new_tfidf_sent
         _vectors,new_final['Score'].values,test_size=0.3,shuffle=False)
```

```
In [91]: from sklearn.model_selection import TimeSeriesSplit
         tscv=TimeSeriesSplit(n_splits=10)
```

```
In [93]: from sklearn.model_selection import TimeSeriesSplit
         tscv=TimeSeriesSplit(n_splits=10)
```

```
In [95]: X_train=np.isnan(X_train)
         np.where(np.isnan(X_train))
         np.nan_to_num(X_train)
         X_test=np.isnan(X_test)
         np.where(np.isnan(X_test))
         np.nan_to_num(X_test)
```

```
Out[95]: array([[ True,  True,  True, ...,  True,  True,  True],
                [ True,  True,  True, ...,  True,  True,  True],
                [ True,  True,  True, ...,  True,  True,  True],
                ...,
                [ True,  True,  True, ...,  True,  True,  True],
                [ True,  True,  True, ...,  True,  True,  True],
                [ True,  True,  True, ...,  True,  True,  True]])
```

```
In [96]: %time
```

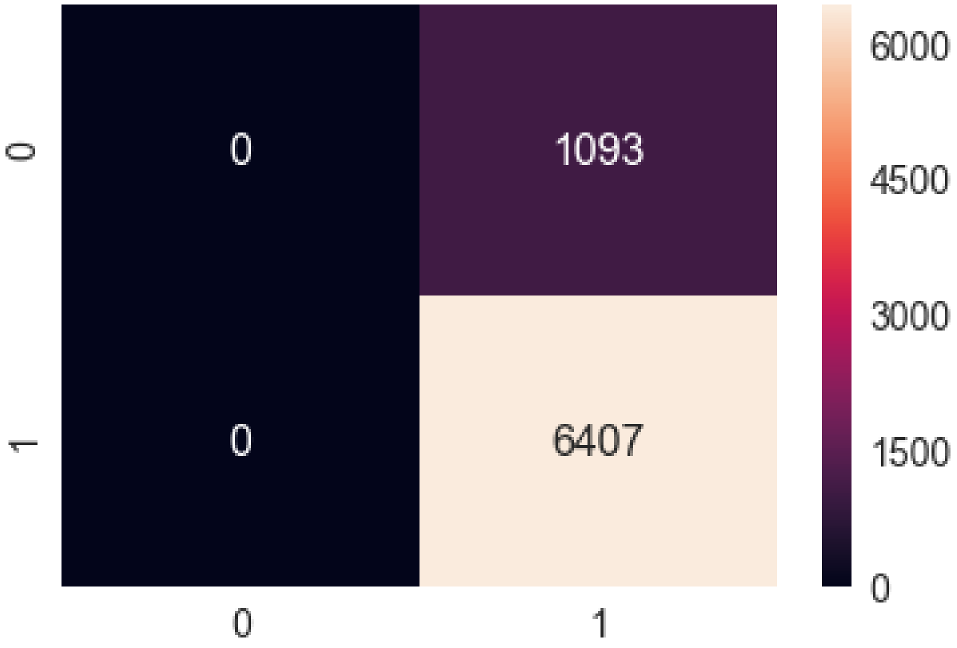
```
from sklearn.model_selection import GridSearchCV
from sklearn.neighbors import KNeighborsClassifier
from sklearn.model_selection import TimeSeriesSplit

knn = KNeighborsClassifier(algorithm='brute')

# neigh = np.arange(1,100,2)

param_grid = {'n_neighbors':np.arange(1,40,2)} #params we need to try on classifier
tscv = TimeSeriesSplit(n_splits=10) #For time based splitting

gsv = GridSearchCV(knn,param_grid,cv=tscv,verbose=1)
gsv.fit(X_train,y_train)
print("Best HyperParameter: ",gsv.best_params_)
print("Best Accuracy: %.2f%%"%(gsv.best_score_*100))
```

```
Wall time: 0 ns
Fitting 10 folds for each of 20 candidates, totalling 200 fits
Best HyperParameter:  {'n_neighbors': 1}
Best Accuracy: 85.67%


[Parallel(n_jobs=1)]: Done 200 out of 200 | elapsed:  8.0min finished
```

```
In [97]: #Testing Accuracy on Test data

         from sklearn.neighbors import KNeighborsClassifier
         knn = KNeighborsClassifier(n_neighbors=9)
         knn.fit(X_train,y_train)
         y_pred = knn.predict(X_test)

         print("Accuracy on test set: %0.3f%%"%(accuracy_score(y_test, y_pred)*100))
         print("Confusion Matrix of test set:\n [ [TN FP]\n [FN TP] ]\n")

         df_cm = pd.DataFrame(confusion_matrix(y_test, y_pred), range(2),range(2))
         sns.set(font_scale=1.4)#for label size
         sns.heatmap(df_cm, annot=True,annot_kws={"size": 16}, fmt='g')
```

```
Accuracy on test set: 85.427%
Confusion Matrix of test set:
 [ [TN FP]
 [FN TP] ]
```

```
Out[97]: <matplotlib.axes._subplots.AxesSubplot at 0x205fdd9c860>
```



14 Conclusions

```
In [ ]: Here is the test accuracies of Feature Vectors

        Bow          = 85.973%
        TF-IDF       = 86.107%
        Avg word2vec = 85.973%
        TF-IDF W2V   = 85.427%
```

```
In [ ]: Note: As I have taken only 25k points(due to huge training time) the accuracy
               will not be the representive of the real accuracy

        1. Best Accuracy of 85.107% is achieved by TF-IDF Featurization

        2. The kd-tree and brute implementation of KNN gives relatively similar results.
           But in this I'am not using kdtree because when I pass the sparse matrix to knn
           with kdtree algo, it can't process it, so it will internally stop using kdtree
           and uses brute force only

        3. KNN is a very slow Algorithm compared to others takes a lot of time to train
           good for this dataset
```