07 Amazon Fine Food Reviews Analysis_Support Vector Machines

June 14, 2019

1 Amazon Fine Food Reviews Analysis

Data Source: https://www.kaggle.com/snap/amazon-fine-food-reviews

EDA: https://nycdatascience.com/blog/student-works/amazon-fine-foods-visualization/

The Amazon Fine Food Reviews dataset consists of reviews of fine foods from Amazon.

Number of reviews: 568,454 Number of users: 256,059 Number of products: 74,258 Timespan: Oct 1999 - Oct 2012 Number of Attributes/Columns in data: 10

Attribute Information:

1. Id
2. ProductId - unique identifier for the product
3. UserId - unqiue identifier for the user
4. ProfileName
5. HelpfulnessNumerator - number of users who found the review helpful
6. HelpfulnessDenominator - number of users who indicated whether they found the review helpful or not
7. Score - rating between 1 and 5
8. Time - timestamp for the review
9. Summary - brief summary of the review
10. Text - text of the review

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

[Q] How to determine if a review is positive or negative? [Ans] We could use Score/Rating. A rating of 4 or 5 can be cosnidered as a positive review. A rating of 1 or 2 can be considered as negative one. A review of rating 3 is considered nuetral and such reviews are ignored from our analysis. This is an approximate and proxy way of determining the polarity (positivity/negativity) of a review.

2 [1]. Reading Data

2.1 [1.1] Loading the data

The dataset is available in two forms 1. .csv file 2. SQLite Database

In order to load the data, We have used the SQLITE dataset as it is easier to query the data and visualise the data efficiently.

Here 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 is above 3, then the recommendation wil be set to "positive". Otherwise, it will be set to "negative".

```
In [119]: %matplotlib inline
          import warnings
          warnings.filterwarnings("ignore")


          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
          # Tutorial about Python regular expressions: https://pymotw.com/2/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

          from tqdm import tqdm
          import os

          # importing Cross validation libs
          from sklearn.model_selection import train_test_split
          from sklearn.model_selection import cross_val_score
          from sklearn import model_selection

          # Python script for confusion matrix creation.
          from sklearn.metrics import confusion_matrix
          from sklearn.metrics import accuracy_score
          from sklearn.metrics import classification_report
```

```
# roc curve and auc
from sklearn.datasets import make_classification
from sklearn.metrics import roc_curve
from sklearn.metrics import roc_auc_score
from matplotlib import pyplot
from sklearn.metrics import roc_curve, auc
from sklearn.model_selection import GridSearchCV

import seaborn as sns

from sklearn.model_selection import TimeSeriesSplit
from sklearn.model_selection import RandomizedSearchCV
import numpy as np
from sklearn.metrics import f1_score,recall_score,precision_score

from sklearn.linear_model import SGDClassifier
from sklearn.calibration import CalibratedClassifierCV
from sklearn.svm import SVC
from sklearn_pandas import DataFrameMapper
from joblib import dump, load
```

In [120]:

```
# using SQLite Table to read data.
con = sqlite3.connect(r'/home/pranay/ML datasource/amazon-fine-food-reviews/database

# filtering only positive and negative reviews i.e.
# not taking into consideration those reviews with Score=3
# SELECT * FROM Reviews WHERE Score != 3 LIMIT 500000, will give top 500000 data poi
# you can change the number to any other number based on your computing power

# filtered_data = pd.read_sql_query(""" SELECT * FROM Reviews WHERE Score != 3 LIMIT
# for tsne assignment you can take 5k data points

filtered_data = pd.read_sql_query(""" SELECT * FROM Reviews WHERE Score != 3 LIMIT 4

# Give reviews with Score>3 a positive rating(1), and reviews with a score<3 a negat
def partition(x):
    if x < 3:
        return 0
    return 1

#changing reviews with score less than 3 to be positive and vice-versa
actualScore = filtered_data['Score']
positiveNegative = actualScore.map(partition)
filtered_data['Score'] = positiveNegative
print("Number of data points in our data", filtered_data.shape)
filtered_data.head(3)
```

```
Number of data points in our data (40000, 10)
```

```
Out[120]:    Id   ProductId          UserId                      ProfileName  \
          0   1  B001E4KFG0  A3SGXH7AUHU8GW                       delmartian
          1   2  B00813GRG4  A1D87F6ZCVE5NK                           dll pa
          2   3  B000LQOCH0   ABXLMWJIXXAIN  Natalia Corres "Natalia Corres"

             HelpfulnessNumerator  HelpfulnessDenominator  Score        Time  \
          0                     1                       1      1  1303862400
          1                     0                       0      0  1346976000
          2                     1                       1      1  1219017600

                           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...
```

```
In [121]: display = pd.read_sql_query("""
          SELECT UserId, ProductId, ProfileName, Time, Score, Text, COUNT(*)
          FROM Reviews
          GROUP BY UserId
          HAVING COUNT(*)>1
          """, con)
```

```
In [122]: print(display.shape)
          display.head()
```

```
(80668, 7)
```

```
Out[122]:                UserId   ProductId             ProfileName        Time  Score  \
          0  #oc-R115TNMSPFT9I7  B005ZBZLT4                 Breyton  1331510400      2
          1  #oc-R11D9D7SHXIJB9  B005HG9ESG  Louis E. Emory "hoppy"  1342396800      5
          2  #oc-R11DNU2NBKQ23Z  B005ZBZLT4        Kim Cieszykowski  1348531200      1
          3  #oc-R11O5J5ZVQE25C  B005HG9ESG           Penguin Chick  1346889600      5
          4  #oc-R12KPBODL2B5ZD  B007OSBEV0   Christopher P. Presta  1348617600      1

                                                          Text  COUNT(*)
          0  Overall its just OK when considering the price...         2
          1  My wife has recurring extreme muscle spasms, u...         3
          2  This coffee is horrible and unfortunately not ...         2
          3  This will be the bottle that you grab from the...         3
          4  I didnt like this coffee. Instead of telling y...         2
```

```
In [123]: display[display['UserId']=='AZY10LLTJ71NX']
```

```
Out[123]:               UserId   ProductId                       ProfileName        Time  \
          80638  AZY10LLTJ71NX  B001ATMQK2  undertheshrine "undertheshrine"  1296691200

                 Score                                               Text  COUNT(*)
          80638      5  I bought this 6 pack because for the price tha...         5
```

```
In [124]: display['COUNT(*)'].sum()

Out[124]: 393063
```

3 [2] Exploratory Data Analysis

3.1 [2.1] Data Cleaning: Deduplication

It is observed (as shown in the table below) that the reviews data had many duplicate entries. Hence it was necessary to remove duplicates in order to get unbiased results for the analysis of the data. Following is an example:

```
In [125]: display= pd.read_sql_query("""
          SELECT *
          FROM Reviews
          WHERE Score != 3 AND UserId="AR5J8UI46CURR"
          ORDER BY ProductID
          """, con)
          display.head()

Out[125]:        Id   ProductId         UserId      ProfileName  HelpfulnessNumerator  \
          0   78445  B000HDL1RQ  AR5J8UI46CURR  Geetha Krishnan                     2
          1  138317  B000HDOPYC  AR5J8UI46CURR  Geetha Krishnan                     2
          2  138277  B000HDOPYM  AR5J8UI46CURR  Geetha Krishnan                     2
          3   73791  B000HDOPZG  AR5J8UI46CURR  Geetha Krishnan                     2
          4  155049  B000PAQ75C  AR5J8UI46CURR  Geetha Krishnan                     2

             HelpfulnessDenominator  Score        Time  \
          0                       2      5  1199577600
          1                       2      5  1199577600
          2                       2      5  1199577600
          3                       2      5  1199577600
          4                       2      5  1199577600

                                       Summary  \
          0  LOACKER QUADRATINI VANILLA WAFERS
          1  LOACKER QUADRATINI VANILLA WAFERS
          2  LOACKER QUADRATINI VANILLA WAFERS
          3  LOACKER QUADRATINI VANILLA WAFERS
          4  LOACKER QUADRATINI VANILLA WAFERS

                                                          Text
          0  DELICIOUS WAFERS. I FIND THAT EUROPEAN WAFERS ...
          1  DELICIOUS WAFERS. I FIND THAT EUROPEAN WAFERS ...
          2  DELICIOUS WAFERS. I FIND THAT EUROPEAN WAFERS ...
          3  DELICIOUS WAFERS. I FIND THAT EUROPEAN WAFERS ...
          4  DELICIOUS WAFERS. I FIND THAT EUROPEAN WAFERS ...
```

As it can be seen above that same user has multiple reviews with same values for HelpfulnessNumerator, HelpfulnessDenominator, Score, Time, Summary and Text and on doing analysis it was found that ProductId=B000HDOPZG was Loacker Quadratini Vanilla Wafer Cookies, 8.82-Ounce Packages (Pack of 8) ProductId=B000HDL1RQ was Loacker Quadratini Lemon Wafer Cookies, 8.82-Ounce Packages (Pack of 8) and so on

It was inferred after analysis that reviews with same parameters other than ProductId belonged to the same product just having different flavour or quantity. Hence in order to reduce redundancy it was decided to eliminate the rows having same parameters.

The method used for the same was that we first sort the data according to ProductId and then just keep the first similar product review and delelte the others. for eg. in the above just the review for ProductId=B000HDL1RQ remains. This method ensures that there is only one representative for each product and deduplication without sorting would lead to possibility of different representatives still existing for the same product.

```
In [126]: #Sorting data according to ProductId in ascending order
          sorted_data=filtered_data.sort_values('ProductId', axis=0, ascending=True, inplace=Fa
```

```
In [127]: #Deduplication of entries
          final=sorted_data.drop_duplicates(subset={"UserId","ProfileName","Time","Text"}, keep
          final.shape
```

```
Out[127]: (37415, 10)
```

```
In [128]: #Checking to see how much % of data still remains
          (final['Id'].size*1.0)/(filtered_data['Id'].size*1.0)*100
```

```
Out[128]: 93.5375
```

Observation:- It was also seen that in two rows given below the value of HelpfulnessNumerator is greater than HelpfulnessDenominator which is not practically possible hence these two rows too are removed from calcualtions

```
In [129]: display= pd.read_sql_query("""
          SELECT *
          FROM Reviews
          WHERE Score != 3 AND Id=44737 OR Id=64422
          ORDER BY ProductID
          """, con)

          display.head()
```

```
Out[129]:       Id   ProductId          UserId               ProfileName  \
          0  64422  B000MIDROQ  A161DK06JJMCYF  J. E. Stephens "Jeanne"
          1  44737  B001EQ55RW  A2V0I904FH7ABY                       Ram

             HelpfulnessNumerator  HelpfulnessDenominator  Score        Time  \
          0                     3                       1      5  1224892800
          1                     3                       2      4  1212883200
```

```
                                      Summary  \
0             Bought This for My Son at College
1  Pure cocoa taste with crunchy almonds inside

                                               Text
0  My son loves spaghetti so I didn't hesitate or...
1  It was almost a 'love at first bite' - the per...
```

```
In [130]: final=final[final.HelpfulnessNumerator<=final.HelpfulnessDenominator]
```

```
In [131]: #Before starting the next phase of preprocessing lets see the number of entries left
          print(final.shape)

          #How many positive and negative reviews are present in our dataset?
          final['Score'].value_counts()
```

```
(37415, 10)
```

```
Out[131]: 1    31324
          0     6091
          Name: Score, dtype: int64
```

4 [3] Preprocessing

4.1 [3.1]. Preprocessing Review Text

Now that we have finished deduplication our data requires some preprocessing before we go on further with analysis and making the prediction model.

Hence in the Preprocessing phase we do the following in the order below:-

1. Begin by removing the html tags
2. Remove any punctuations or limited set of special characters like , or . or # etc.
3. Check if the word is made up of english letters and is not alpha-numeric
4. Check to see if the length of the word is greater than 2 (as it was researched that there is no adjective in 2-letters)
5. Convert the word to lowercase
6. Remove Stopwords
7. Finally Snowball Stemming the word (it was obsereved to be better than Porter Stemming)

After which we collect the words used to describe positive and negative reviews

```
In [132]: # printing some random reviews
          sent_0 = final['Text'].values[0]
          print(sent_0)
          print("="*50)

          sent_1000 = final['Text'].values[1000]
          print(sent_1000)
```

```
        print("="*50)

        sent_1500 = final['Text'].values[1500]
        print(sent_1500)
        print("="*50)

        sent_4900 = final['Text'].values[4900]
        print(sent_4900)
        print("="*50)
```

```
Our dogs just love them.  I saw them in a pet store and a tag was attached regarding them being
==================================================
It's Branston pickle, what is there to say. If you've never tried it you most likely wont like
==================================================
First Impression: The friendly folks over at "Exclusively Dog" heard about my website and sent
==================================================
It is hard to find candy that is overly sweet. My wife and Granddaughter both love Pink Grapefi
==================================================
```

```
In [133]: # remove urls from text python: https://stackoverflow.com/a/40823105/4084039
          sent_0 = re.sub(r"http\S+", "", sent_0)
          sent_1000 = re.sub(r"http\S+", "", sent_1000)
          sent_150 = re.sub(r"http\S+", "", sent_1500)
          sent_4900 = re.sub(r"http\S+", "", sent_4900)

          print(sent_0)
```

```
Our dogs just love them.  I saw them in a pet store and a tag was attached regarding them being
```

```
In [134]: # https://stackoverflow.com/questions/16206380/python-beautifulsoup-how-to-remove-al
          from bs4 import BeautifulSoup

          soup = BeautifulSoup(sent_0, 'lxml')
          text = soup.get_text()
          print(text)
          print("="*50)

          soup = BeautifulSoup(sent_1000, 'lxml')
          text = soup.get_text()
          print(text)
          print("="*50)

          soup = BeautifulSoup(sent_1500, 'lxml')
          text = soup.get_text()
          print(text)
          print("="*50)
```

```
         soup = BeautifulSoup(sent_4900, 'lxml')
         text = soup.get_text()
         print(text)
```

```
Our dogs just love them.  I saw them in a pet store and a tag was attached regarding them being
==================================================
It's Branston pickle, what is there to say. If you've never tried it you most likely wont like
==================================================
First Impression: The friendly folks over at "Exclusively Dog" heard about my website and sent
==================================================
It is hard to find candy that is overly sweet. My wife and Granddaughter both love Pink Grapef
```

```
In [135]: # https://stackoverflow.com/a/47091490/4084039
          import re

          def decontracted(phrase):
              # specific
              phrase = re.sub(r"won't", "will not", phrase)
              phrase = re.sub(r"can\'t", "can not", phrase)

              # general
              phrase = re.sub(r"n\'t", " not", phrase)
              phrase = re.sub(r"\'re", " are", phrase)
              phrase = re.sub(r"\'s", " is", phrase)
              phrase = re.sub(r"\'d", " would", phrase)
              phrase = re.sub(r"\'ll", " will", phrase)
              phrase = re.sub(r"\'t", " not", phrase)
              phrase = re.sub(r"\'ve", " have", phrase)
              phrase = re.sub(r"\'m", " am", phrase)
              return phrase
```

```
In [136]: sent_1500 = decontracted(sent_1500)
          print(sent_1500)
          print("="*50)
```

```
First Impression: The friendly folks over at "Exclusively Dog" heard about my website and sent
==================================================
```

```
In [137]: #remove words with numbers python: https://stackoverflow.com/a/18082370/4084039
          sent_0 = re.sub("\S*\d\S*", "", sent_0).strip()
          print(sent_0)
```

```
Our dogs just love them.  I saw them in a pet store and a tag was attached regarding them being
```

```
In [138]: #remove spacial character: https://stackoverflow.com/a/5843547/4084039
          sent_1500 = re.sub('[^A-Za-z0-9]+', ' ', sent_1500)
          print(sent_1500)
```

```
First Impression The friendly folks over at Exclusively Dog heard about my website and sent me
```

```
In [139]: # https://gist.github.com/sebleier/554280
          # we are removing the words from the stop words list: 'no', 'nor', 'not'
          # <br /><br /> ==> after the above steps, we are getting "br br"
          # we are including them into stop words list
          # instead of <br /> if we have <br/> these tags would have revmoved in the 1st step

          stopwords= set(['br', 'the', 'i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselv
                      "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him
                      'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself',
                      'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', '
                      'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has',
                      'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'a
                      'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'throug
                      'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off',
                      'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'a
                      'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'to
                      's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've",
                      've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn'
                      "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'mi
                      "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't",
                      'won', "won't", 'wouldn', "wouldn't"])
```

```
In [140]: #filtered out whole reviews

          from bs4 import BeautifulSoup
          # Combining all the above stundents
          from tqdm import tqdm
          # tqdm is for printing the status bar
          word_counter = []
          def filterised_text(text):
              preprocessed_text = []
              for sentance in tqdm(text):
                  sentance = re.sub(r"http\S+", "", sentance)
                  sentance = BeautifulSoup(sentance, 'lxml').get_text()
                  sentance = decontracted(sentance)
                  sentance = re.sub("\S*\d\S*", "", sentance).strip()
                  sentance = re.sub('[^A-Za-z]+', ' ', sentance)
                  # https://gist.github.com/sebleier/554280
                  sentance = ' '.join(e.lower() for e in sentance.split() if e.lower() not in s
                  count = len(sentance.split())
                  word_counter.append(count)
                  preprocessed_text.append(sentance.strip())
              return preprocessed_text
```

```
In [141]: preprocessed_reviews = filterised_text(final['Text'].values)
```

```
         final['preprocessed_reviews']  = preprocessed_reviews
         preprocessed_reviews[1822]

100%|| 37415/37415 [00:11<00:00, 3149.19it/s]


Out[141]: 'wasabi lovers want not like cheap version peanut little bit green horse radish flav

In [142]: final['numbers_of_words']  = word_counter
          word_counter[1822]

Out[142]: 18
```

4.2 [3.2] Preprocessing Review Summary

```
In [143]: preprocessed_summary = filterised_text(final['Summary'].values)
          final['preprocessed_summary']  = preprocessed_summary
          preprocessed_summary[1822]

100%|| 37415/37415 [00:07<00:00, 5053.69it/s]


Out[143]: 'perfect'

In [144]: X = final['preprocessed_reviews']
          y = final['Score']

          # split the data set into train and test
          X_train, x_test, y_train, y_test = model_selection.train_test_split(X, y, test_size=

          print(X_train.shape, x_test.shape, y_train.shape, y_test.shape)

(26190,) (11225,) (26190,) (11225,)


In [145]: avg_w2v_trained_model_100000 = '/home/pranay/ML trained models/W2V/avg_w2v_trained_m
          avg_w2v_test_model_100000 = '/home/pranay/ML trained models/W2V/avg_w2v_test_model_1

          w2v_tf_idf_trained_model_100000 = '/home/pranay/ML trained models/W2V_TFIDF/w2v_tf_i
          w2v_tf_idf_test_model_100000 = '/home/pranay/ML trained models/W2V_TFIDF/w2v_tf_idf_

In [146]: # Common Methods

          alpha_values = (1e-4, 1e-3,1e-2,0.05,1e-1,0.5, 1e0,1e1,1e2,1e3)
          gamma_values = [0.0001, 0.001, 0.01, 0.1, 0.5, 1]

          def finding_best_alpha(X_tr,y_tr,which_method,whichAlgo, penalty):

              if whichAlgo == 'SGDClassifier' :
                  # instantiate a SGDClassifier
```

```
        if penalty == 'l1':
            clf = SGDClassifier(loss='hinge', class_weight='balanced',n_jobs=-1, pena
        else:
            clf = SGDClassifier(loss='hinge', class_weight='balanced',n_jobs=-1, pena
        param_grid=dict(alpha=alpha_values)
    else:
        # instantiate a SVC
        clf = SVC(kernel='rbf', class_weight='balanced')
        param_grid=dict(gamma=gamma_values, C=gamma_values)

    #For time based splitting
    tscv = TimeSeriesSplit(n_splits=10)

    if which_method == 'gridsearch':

        # instantiate the grid for training data
        trained = GridSearchCV(clf, param_grid, cv=tscv, scoring='roc_auc',n_jobs =-
    else:
        # instantiate the grid for training data
        trained = RandomizedSearchCV(clf, param_grid, cv=tscv, scoring='roc_auc',n_jo

    # fit with traing data
    trained.fit(X_tr, y_tr)

    return trained


# plot a graph which show difference between validation error and training error
def plotAccuracyGraph(training_grid):
    alpha_range = [i for i in alpha_values]
    accuracy = [i for i in training_grid.cv_results_['mean_train_score']]
    accuracy_test = [i for i in training_grid.cv_results_['mean_test_score']]
    plt.semilogx(alpha_range, accuracy,'r',label='train_accuracy')
    plt.semilogx(alpha_range, accuracy_test,'b',label='validation_accuracy')
    plt.title('Accuracy plot')
    plt.xlabel('Alpha')
    plt.ylabel('Accuracy')
    plt.grid('on')
    plt.legend()
    plt.show()

# https://www.geeksforgeeks.org/confusion-matrix-machine-learning/
def plotConfusionMatrix(y_test,pred):
    # calculate confusion matrix
    cm =  confusion_matrix(y_test,pred)
    class_label = ['negative', 'positive']
    df_conf_matrix = pd.DataFrame(cm, index=class_label, columns=class_label)
    # heatmap --> Plot rectangular data as a color-encoded matrix.
    sns.heatmap(df_conf_matrix, annot=True, fmt='d')
    # give title to graph
    plt.title("Confusion Matrix")
    # mention axis label
    plt.xlabel("Predicted")
    plt.ylabel("Actual")
    # show the plot
    plt.show()


# https://machinelearningmastery.com/roc-curves-and-precision-recall-curves-for-clas
# plot AUC curve
def plotAUC_ROC(nb_optimal,X_train, y_train, X_test, y_test):
    # predict probabilities
    test_probs = nb_optimal.predict_proba(X_test)
    train_probs = nb_optimal.predict_proba(X_train)

    # keep probabilities for the positive outcome only
    test_probs = test_probs[:, 1]
    train_probs = train_probs[:, 1]

    # calculate AUC
    test_auc = roc_auc_score(y_test, test_probs)
    train_auc = roc_auc_score(y_train, train_probs)

    # calculate roc curve
    train_fpr, train_tpr, thresholds = roc_curve(y_train, train_probs)
    test_fpr, test_tpr, thresholds2 = roc_curve(y_test, test_probs)

    # plot no skill
    pyplot.plot([0, 1], [0, 1], linestyle='--')

    # plot the roc curve for the model
    pyplot.plot(train_fpr, train_tpr, 'r',marker='.', label="train AUC ="+str(train_a
    pyplot.plot(test_fpr, test_tpr, 'b',marker='.',label="test AUC ="+str(test_auc))

    pyplot.legend()
    pyplot.xlabel("K: hyperparameter")
    pyplot.ylabel("AUC")
    pyplot.title("ERROR PLOTS")
    # show the plot
    pyplot.show()

    return train_auc, test_auc

class color:
   PURPLE = '\033[95m'
   CYAN = '\033[96m'
```

```
               DARKCYAN = '\033[36m'
               BLUE = '\033[94m'
               GREEN = '\033[92m'
               YELLOW = '\033[93m'
               RED = '\033[91m'
               BOLD = '\033[1m'
               UNDERLINE = '\033[4m'
               END = '\033[0m'
```

5 [4] Featurization

5.1 [4.1] BAG OF WORDS

```
In [147]: ##BoW

          count_vect = CountVectorizer(ngram_range=(1,2), min_df=10, max_features = 500) #in s

          # train data
          X_train_bow = count_vect.fit_transform(X_train)

          # test data
          x_test_bow = count_vect.transform(x_test)


          print('X_train_bow',X_train_bow.shape)
          print('==='*10)
          print('x_test_bow',x_test_bow.shape)
```

```
X_train_bow (26190, 500)
==============================
x_test_bow (11225, 500)
```

5.1.1 Hyper parameter tuning using GridSearch

```
In [148]: bow_hyperparam = '/home/pranay/Amazon Assignments/SVM RBF/bow_hyperparam_tune'
          exists = os.path.isfile(bow_hyperparam)

          if exists:
              print('yes exists')
              bow_train = load(bow_hyperparam)
          else:
              print('not exists')
              bow_train =finding_best_alpha (X_train_bow,y_train, 'gridsearch','RBF','l2')
              dump(bow_train,bow_hyperparam)

          # view the complete results (list of named tuples)
          print("=======Training========")
          print (bow_train.best_score_)
          print (bow_train.best_params_)
          print (bow_train.best_estimator_)
```

```
yes exists
=======Training========
0.8943955313168906
{'C': 1, 'gamma': 0.01}
SVC(C=1, cache_size=200, class_weight='balanced', coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=0.01, kernel='rbf',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
```

```
In [149]: gamma_val = bow_train.best_params_.get("gamma", "")
          C_val = bow_train.best_params_.get("C", "")
          print('\n'+color.RED+'Optimal best gamma is : '+color.END+color.BOLD+str(gamma_val)+c
          print('\n'+color.RED+'Optimal best C value is : '+color.END+color.BOLD+str(C_val)+col
```

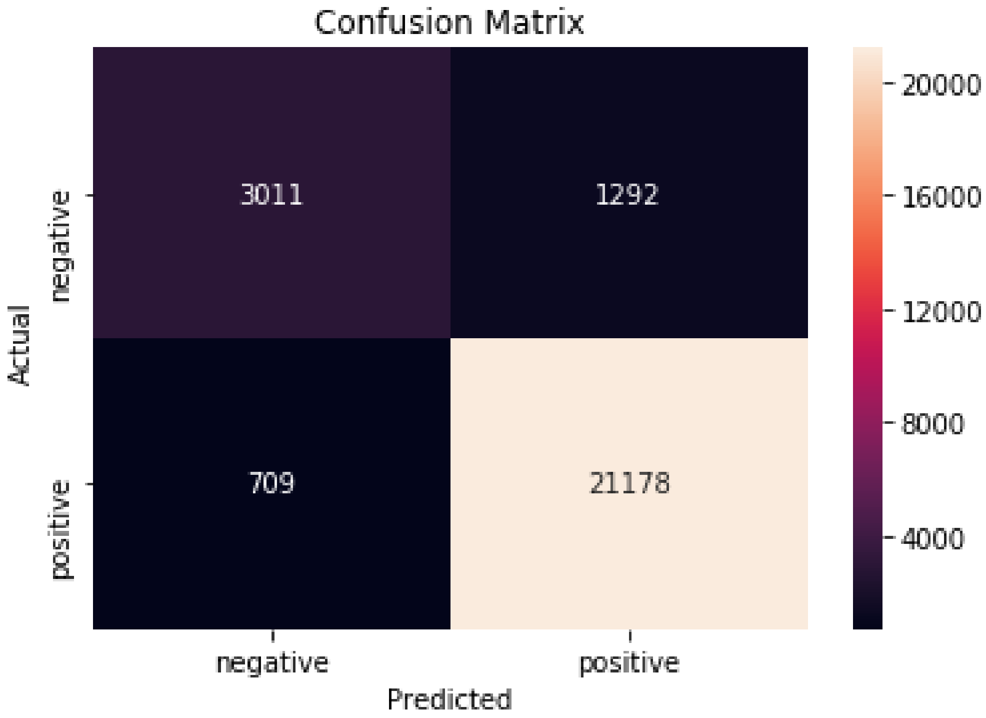
```
Optimal best gamma is : 0.01

Optimal best C value is : 1
```

5.2 RBF SVM on BoW

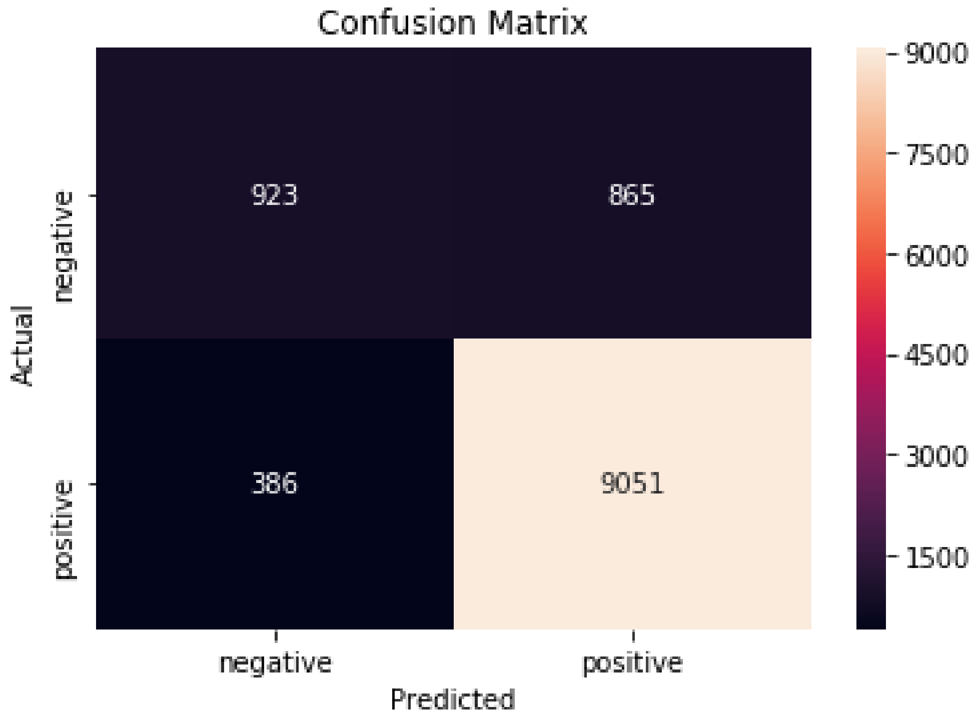
```
In [150]: optimal_model = SVC(C=C_val, cache_size=200, class_weight='balanced', coef0=0.0,
            decision_function_shape='ovr', degree=3, gamma=gamma_val,
            kernel='rbf', max_iter=-1, probability=False, random_state=None,
            shrinking=True, tol=0.001, verbose=False)

          # https://www.kaggle.com/mpearmain/calibrated-sgdclassifier

          model_calib = CalibratedClassifierCV(base_estimator=optimal_model, cv=5, method='iso

          # fitting the model
          model_calib.fit(X_train_bow, y_train)

          # predict the response
          test_pred = model_calib.predict(x_test_bow)
          train_pred = model_calib.predict(X_train_bow)

          # plot confusion matrix

          print('\n'+color.BOLD +'Confusion Matrix for Train data'+color.END)
          plotConfusionMatrix(y_train,train_pred)

          print('\n'+color.BOLD +'Confusion Matrix for Test data'+color.END)
```

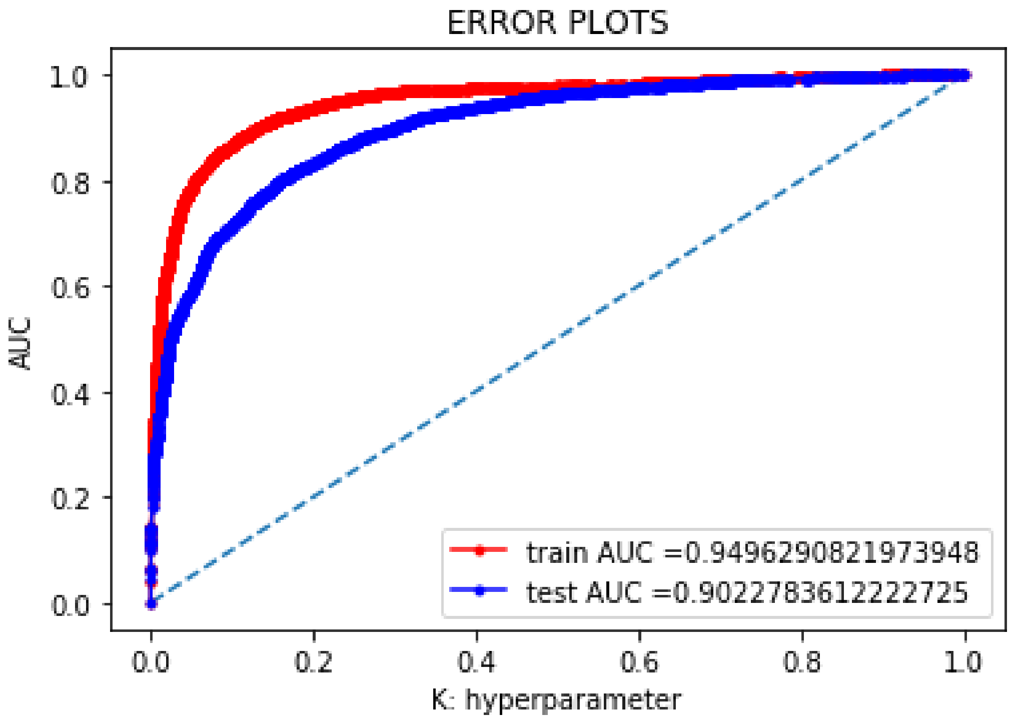
```
plotConfusionMatrix(y_test,test_pred)

# plot AUC
train_auc,test_auc = plotAUC_ROC(model_calib,X_train_bow, y_train,x_test_bow, y_test
print('\n'+color.RED+'AUC (Train): '+color.END+color.BOLD+str(train_auc)+color.END)
print('\n'+color.RED+'AUC (Test): '+color.END+color.BOLD+str(test_auc)+color.END)

# f1 score
score = f1_score(y_test,test_pred)
print('\n'+color.RED+'F1 SCORE (Train) : '+color.END+color.BOLD+str(f1_score(y_train
print('\n'+color.RED+'F1 SCORE (Test) : '+color.END+color.BOLD+str(score)+color.END)

# recall
recall = metrics.recall_score(y_test, test_pred)
print('\n'+color.RED+'RECALL (Train): '+color.END+color.BOLD+str(metrics.recall_score
print('\n'+color.RED+'RECALL (Test): '+color.END+color.BOLD+str(recall)+color.END)

# precision
precision = metrics.precision_score(y_test, test_pred)
print('\n'+color.RED+'PRECISION  (Train) : '+color.END+color.BOLD+str(metrics.precisi
print('\n'+color.RED+'PRECISION  (Test) : '+color.END+color.BOLD+str(precision)+colo
```

```
Confusion Matrix for Train data
```



```
Confusion Matrix for Test data
```





```
AUC (Train): 0.9496290821973948

AUC (Test): 0.9022783612222725

F1 SCORE (Train) : 0.9548887436030391

F1 SCORE (Test) : 0.9353588590916138

RECALL (Train): 0.9676063416640015

RECALL (Test): 0.9590971707110311

PRECISION  (Train) : 0.9425011125945706

PRECISION  (Test) : 0.912767244856797
```

5.3 [4.3] TF-IDF

```
In [151]: X = final['preprocessed_reviews']
          y = final['Score']

          # split the data set into train and test
          X_train, x_test, y_train, y_test = model_selection.train_test_split(X, y, test_size=

          print(X_train.shape, x_test.shape, y_train.shape, y_test.shape)

          tf_idf_vect = TfidfVectorizer(ngram_range=(1,3), min_df=10,  max_features = 500) #in

          # train data
          X_train_tfidf = tf_idf_vect.fit_transform(X_train)

          # test data
          x_test_tfidf = tf_idf_vect.transform(x_test)

          print('X_train_tfidf', X_train_tfidf.shape)
          print('==='*10)
          print('x_test_tfidf', x_test_tfidf.shape)
```

```
(26190,) (11225,) (26190,) (11225,)
X_train_tfidf (26190, 500)
==============================
x_test_tfidf (11225, 500)
```

5.3.1 Hyper parameter tunign using GridSearch

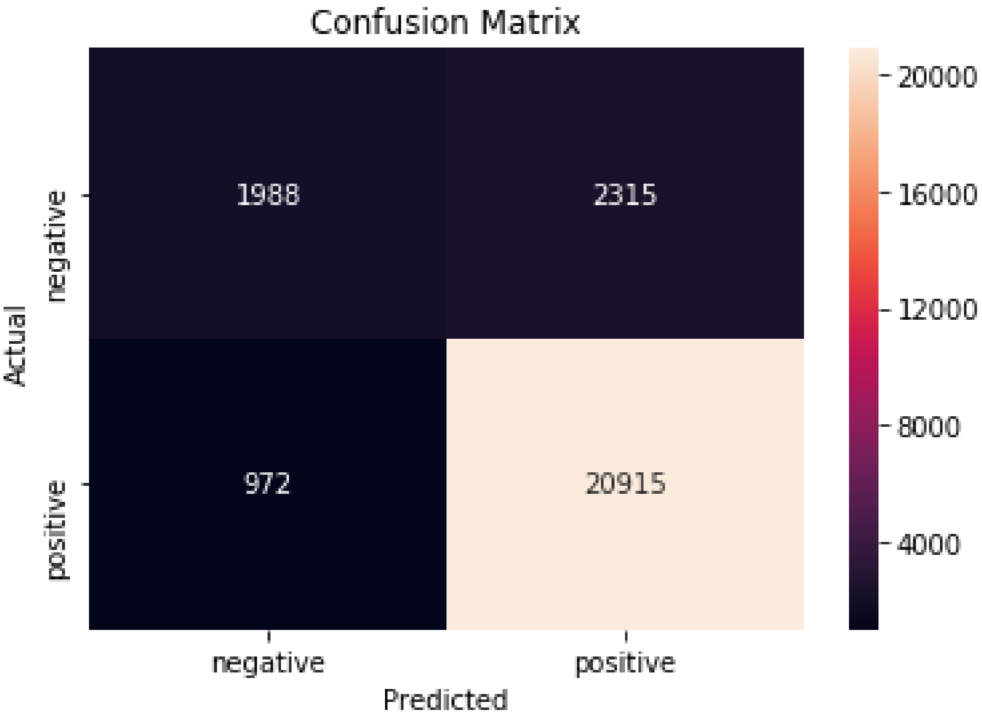
```
In [177]: tfidf_hyperparam_path = '/home/pranay/Amazon Assignments/SVM RBF/tfidf_hyperparam_tu
          exists = os.path.isfile(tfidf_hyperparam_path)

          if exists:
              print('yes exists')
              tfidf_train = load(tfidf_hyperparam_path)
          else:
              print('not exists')
              tfidf_train = finding_best_alpha (X_train_tfidf,y_train, 'gridsearch','RBF','l2'
              dump(tfidf_train,tfidf_hyperparam_path)


          # view the complete results (list of named tuples)
          print("=======Training========")
          print (tfidf_train.best_score_)
          print (tfidf_train.best_params_)
          print (tfidf_train.best_estimator_)

          gamma_val = tfidf_train.best_params_.get("gamma", "")
          C_val = tfidf_train.best_params_.get("C", "")
          print('\n'+color.RED+'Optimal best gamma is : '+color.END+color.BOLD+str(gamma_val)+c
          print('\n'+color.RED+'Optimal best C value is : '+color.END+color.BOLD+str(C_val)+col
```

```
yes exists
=======Training========
0.9021741347522226
{'C': 1, 'gamma': 1}
SVC(C=1, cache_size=200, class_weight='balanced', coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=1, kernel='rbf',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)

Optimal best gamma is : 1

Optimal best C value is : 1
```

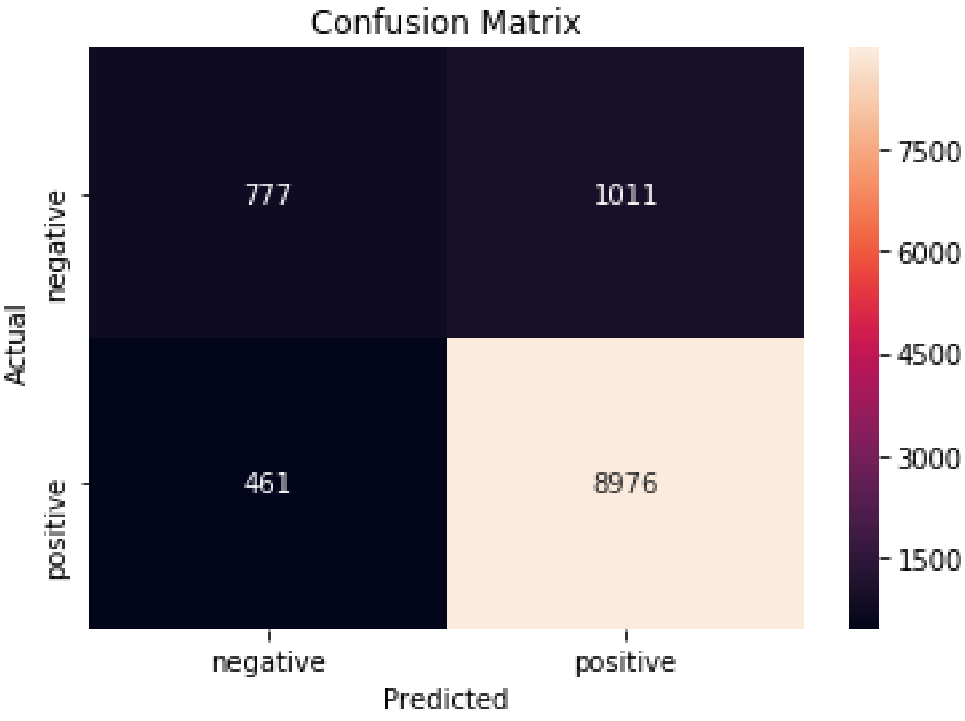
5.4 Apply RBF SVM on TFIDF

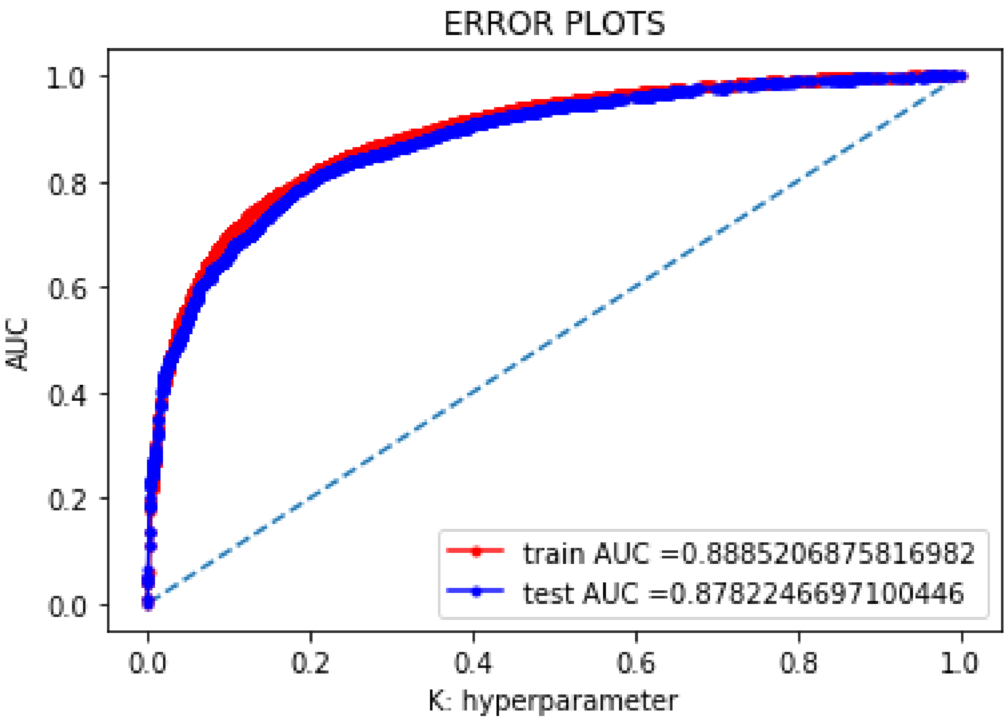
```
In [153]: optimal_model = SVC(C=0.5, cache_size=200, class_weight='balanced', coef0=0.0,
            decision_function_shape='ovr', degree=3, gamma=gamma_val,
            kernel='rbf', max_iter=-1, probability=False, random_state=None,
            shrinking=True, tol=0.001, verbose=False)

          # https://www.kaggle.com/mpearmain/calibrated-sgdclassifier

          model_calib = CalibratedClassifierCV(base_estimator=optimal_model, cv=5, method='iso
          # fitting the model
          model_calib.fit(X_train_tfidf,y_train)

          # predict the response
          test_pred = model_calib.predict(x_test_tfidf)
          train_pred = model_calib.predict(X_train_tfidf)

          # plot confusion matrix

          print('\n'+color.BOLD +'Confusion Matrix for Train data'+color.END)
          plotConfusionMatrix(y_train,train_pred)

          print('\n'+color.BOLD +'Confusion Matrix for Test data'+color.END)
          plotConfusionMatrix(y_test,test_pred)

          # plot AUC
          train_auc,test_auc = plotAUC_ROC(model_calib,X_train_tfidf, y_train,x_test_tfidf, y_
          print('\n'+color.RED+'AUC (Train): '+color.END+color.BOLD+str(train_auc)+color.END)
          print('\n'+color.RED+'AUC (Test): '+color.END+color.BOLD+str(test_auc)+color.END)

          # f1 score
          score = f1_score(y_test,test_pred)
          print('\n'+color.RED+'F1 SCORE (Train) : '+color.END+color.BOLD+str(f1_score(y_train
          print('\n'+color.RED+'F1 SCORE (Test) : '+color.END+color.BOLD+str(score)+color.END)

          # recall
          recall = metrics.recall_score(y_test, test_pred)
          print('\n'+color.RED+'RECALL (Train): '+color.END+color.BOLD+str(metrics.recall_score
          print('\n'+color.RED+'RECALL (Test): '+color.END+color.BOLD+str(recall)+color.END)

          # precision
          precision = metrics.precision_score(y_test, test_pred)
          print('\n'+color.RED+'PRECISION  (Train) : '+color.END+color.BOLD+str(metrics.precisi
          print('\n'+color.RED+'PRECISION  (Test) : '+color.END+color.BOLD+str(precision)+colo
```

```
Optimal best gamma is : 0.01

Optimal best C value is : 1

Confusion Matrix for Train data
```



Confusion Matrix for Test data





```
AUC (Train): 0.8885206875816982

AUC (Test): 0.8782246697100446

F1 SCORE (Train) : 0.9271449786111665

F1 SCORE (Test) : 0.9242174629324547

RECALL (Train): 0.9555900763010006

RECALL (Test): 0.9511497297870086

PRECISION  (Train) : 0.9003443822643133

PRECISION  (Test) : 0.8987683989185942
```

5.5 [4.4] Word2Vec

```
In [154]: X = final['preprocessed_reviews']
          y = final['Score']
          # split the data set into train and test
          X_train, x_test, y_train, y_test = model_selection.train_test_split(X, y, test_size=

          print(X_train.shape, x_test.shape, y_train.shape, y_test.shape)

(26190,) (11225,) (26190,) (11225,)
```

```
In [155]: # Train your own Word2Vec model using your own text corpus

          # Train data
          list_of_sentance=[]
          for sentance in X_train:
              list_of_sentance.append(sentance.split())

          # Test data
          list_of_test_sentence = []
          for sentance in x_test:
              list_of_test_sentence.append(sentance.split())
```

```
In [156]: # Using Google News Word2Vectors

          # in this project we are using a pretrained model by google
          # its 3.3G file, once you load this into your memory
          # it occupies ~9Gb, so please do this step only if you have >12G of ram
          # we will provide a pickle file wich contains a dict ,
          # and it contains all our courpus words as keys and  model[word] as values
          # To use this code-snippet, download "GoogleNews-vectors-negative300.bin"
          # from https://drive.google.com/file/d/0B7XkCwpI5KDYNlNUTTlSS21pQmM/edit
          # it's 1.9GB in size.


          # http://kavita-ganesan.com/gensim-word2vec-tutorial-starter-code/#.W17SRFAzZPY
          # you can comment this whole cell
          # or change these varible according to your need

          is_your_ram_gt_16g=False
          want_to_use_google_w2v = False
          want_to_train_w2v = True

          if want_to_train_w2v:
              # min_count = 5 considers only words that occured atleast 5 times
              # train data
              w2v_model_tr=Word2Vec(list_of_sentance,min_count=5,size=50, workers=4)
              # train model on test data
              w2v_model_test = Word2Vec(list_of_test_sentence,min_count=5,size=50, workers=4)
              print(w2v_model_tr.wv.most_similar('great'))
              print('='*50)
              print(w2v_model_tr.wv.most_similar('worst'))

          elif want_to_use_google_w2v and is_your_ram_gt_16g:
              if os.path.isfile('GoogleNews-vectors-negative300.bin'):
                  w2v_model=KeyedVectors.load_word2vec_format('GoogleNews-vectors-negative300.l
                  print(w2v_model.wv.most_similar('great'))
                  print(w2v_model.wv.most_similar('worst'))
              else:
                  print("you don't have gogole's word2vec file, keep want_to_train_w2v = True,
```

```
[('awesome', 0.8309053182601929), ('fantastic', 0.8299707174301147), ('amazing', 0.80377042293
==================================================
[('greatest', 0.7583379745483398), ('best', 0.7561699151992798), ('ive', 0.7102117538452148),
```

```
In [157]: # train data operation
          w2v_train_words = list(w2v_model_tr.wv.vocab)
          print("number of words that occured minimum 5 times ",len(w2v_train_words))
          print("sample words ", w2v_train_words[0:50])
```

```
number of words that occured minimum 5 times  9799
sample words  ['cats', 'really', 'seem', 'like', 'food', 'look', 'people', 'tuna', 'shrimp', 'v
```

```
In [158]: # test data operation
          w2v_test_words = list(w2v_model_test.wv.vocab)
          print("number of words that occured minimum 5 times ",len(w2v_test_words))
          print("sample words ", w2v_test_words[0:50])
```

```
number of words that occured minimum 5 times  6345
sample words  ['texture', 'flavor', 'popcorn', 'unlike', 'really', 'delicious', 'find', 'best'
```

```
In [159]: # average Word2Vec

          # train data operation
          exists = os.path.isfile(avg_w2v_trained_model_100000)
          exists = False
          if exists:
              print("yes exist")
              final_w2v_train = load(avg_w2v_trained_model_100000)
          else:
              print("not exist")
              # compute average word2vec for each review.
              final_w2v_train = []; # the avg-w2v for each sentence/review is stored in this l
              for sent in tqdm(list_of_sentance): # for each review/sentence
                  sent_vec = np.zeros(50) # as word vectors are of zero length 50, you might n
                  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_train_words:
                        vec = w2v_model_tr.wv[word]
                        sent_vec += vec
                        cnt_words += 1
                if cnt_words != 0:
                    sent_vec /= cnt_words
                final_w2v_train.append(sent_vec)
            print(len(final_w2v_train))
            print(len(final_w2v_train[0]))
        #     dump(final_w2v_train,avg_w2v_trained_model_100000)


        # test data operation
        exists = os.path.isfile(avg_w2v_test_model_100000)
        exists = False

        if exists:
            print("yes exist")
            final_w2v_test = load(avg_w2v_test_model_100000)
        else:
            print("not exist")
            final_w2v_test = []; # the avg-w2v for each sentence/review is stored in this li
            for sent in tqdm(list_of_test_sentence): # for each review/sentence
                sent_vec = np.zeros(50) # as word vectors are of zero length 50, you might n
                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_test_words:
                        vec = w2v_model_test.wv[word]
                        sent_vec += vec
                        cnt_words += 1
                if cnt_words != 0:
                    sent_vec /= cnt_words
                final_w2v_test.append(sent_vec)
            print(len(final_w2v_test))
            print(len(final_w2v_test[0]))
        #     dump(final_w2v_test,avg_w2v_test_model_100000)
```

```
not exist


100%|| 26190/26190 [00:42<00:00, 617.43it/s]
  2%|         | 222/11225 [00:00<00:09, 1123.37it/s]

26190
50
not exist
```

```
100%|| 11225/11225 [00:14<00:00, 748.57it/s]

11225
50
```

5.5.1 Hyper parameter tunig using GridSearch

```
In [160]: w2v_hyperparam_path = '/home/pranay/Amazon Assignments/SVM RBF/w2v_hyperparam_tune'
          exists = os.path.isfile(w2v_hyperparam_path)

          if exists:
              print('yes exists')
              w2v_train= load(w2v_hyperparam_path)
          else:
              w2v_train = finding_best_alpha (final_w2v_train,y_train, 'gridsearch','RBF','l2'
              dump(w2v_train,w2v_hyperparam_path)


          # view the complete results (list of named tuples)
          print("=======Training========")
          print (w2v_train.best_score_)
          print (w2v_train.best_params_)
          print (w2v_train.best_estimator_)
```

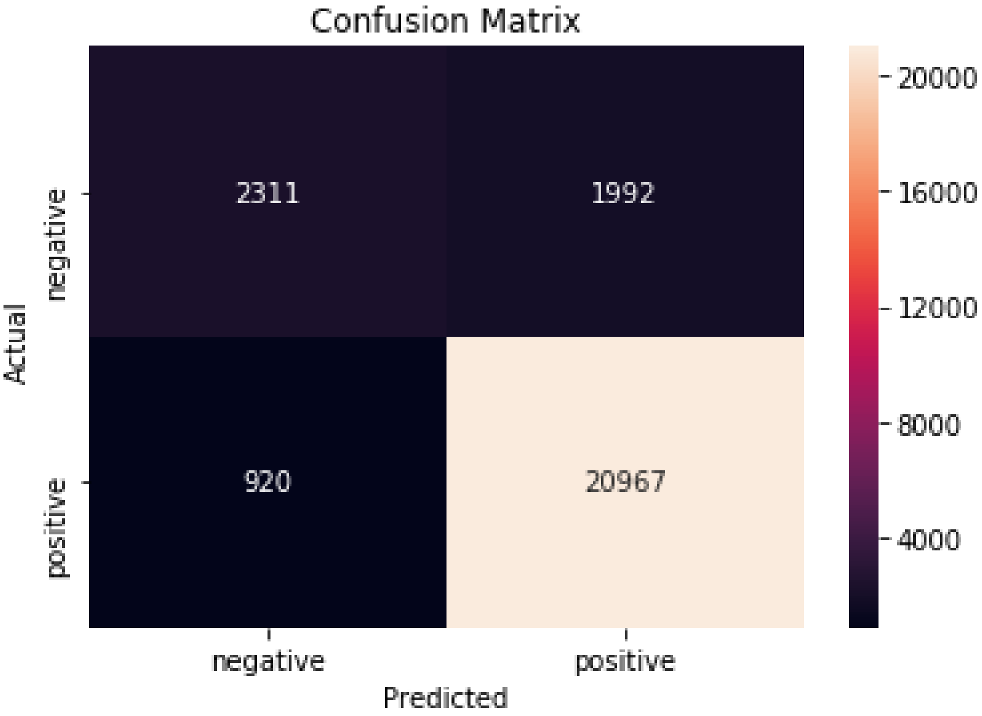
```
yes exists
=======Training========
0.8967242712122014
{'C': 1, 'gamma': 0.1}
SVC(C=1, cache_size=200, class_weight='balanced', coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=0.1, kernel='rbf',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
```

5.6 Apply RBF SVM on W2V

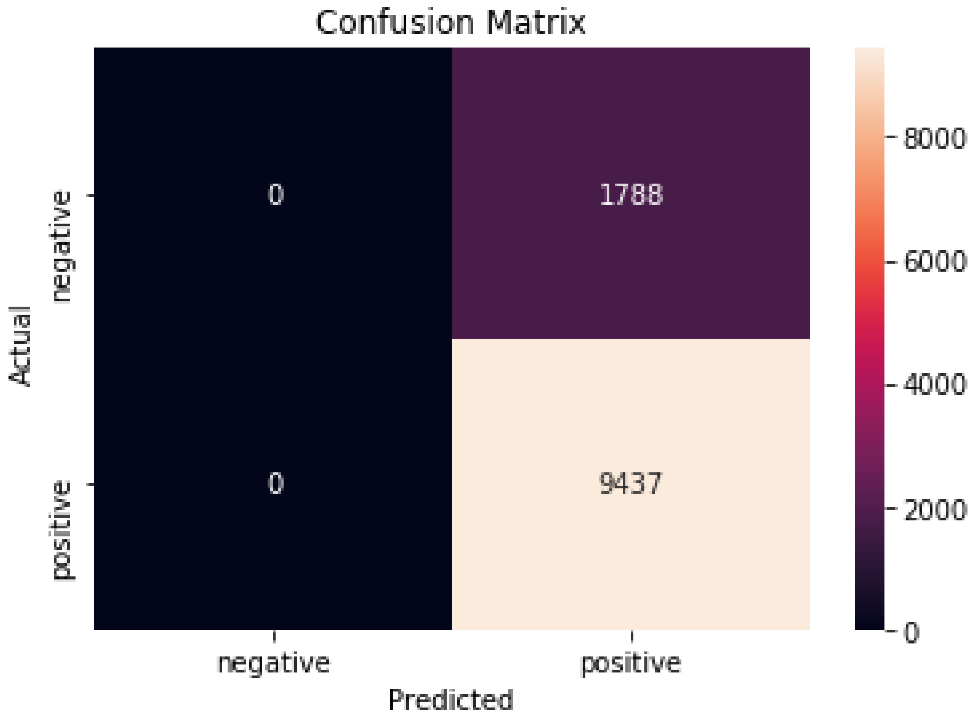
```
In [161]: gamma_val = w2v_train.best_params_.get("gamma", "")
          C_val = w2v_train.best_params_.get("C", "")

          print('\n'+color.RED+'Optimal best gamma is : '+color.END+color.BOLD+str(gamma_val)+
          print('\n'+color.RED+'Optimal best C value is : '+color.END+color.BOLD+str(C_val)+co
```

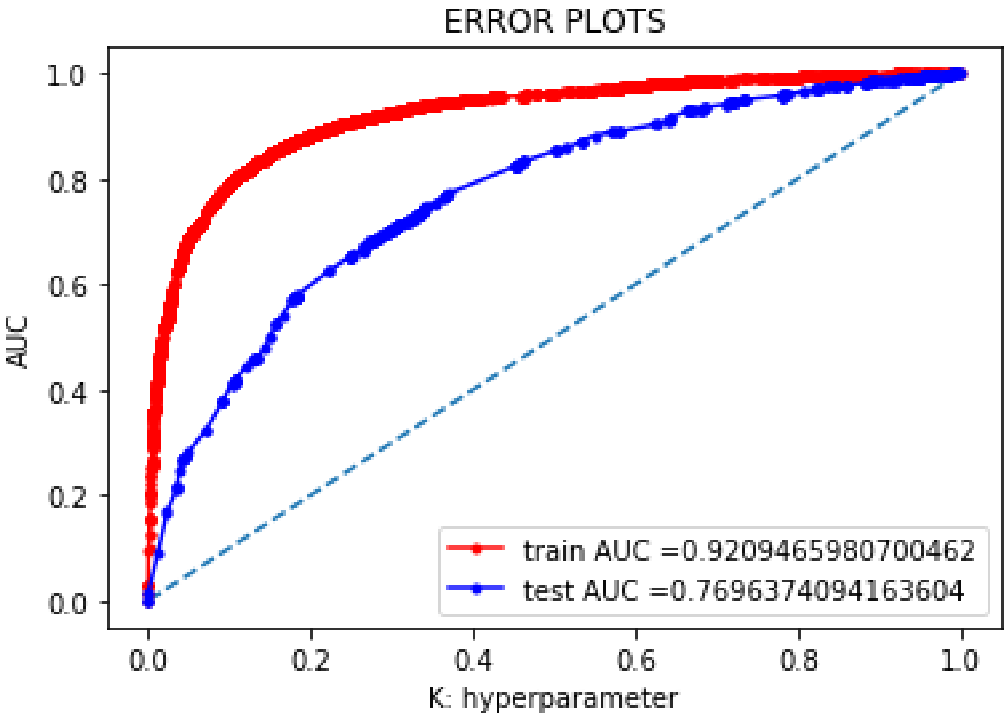
```
Optimal best gamma is : 0.1
Optimal best C value is : 1
```

In [162]:
```
optimal_model = SVC(C=C_val, cache_size=200, class_weight='balanced', coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=gamma_val,
  kernel='rbf', max_iter=-1, probability=False, random_state=None,
  shrinking=True, tol=0.001, verbose=False)

# https://www.kaggle.com/mpearmain/calibrated-sgdclassifier

model_calib = CalibratedClassifierCV(base_estimator=optimal_model, cv=5, method='iso

# fitting the model
model_calib.fit(final_w2v_train,y_train)

# predict the response
test_pred = model_calib.predict(final_w2v_test)
train_pred = model_calib.predict(final_w2v_train)

# plot confusion matrix

print('\n'+color.BOLD +'Confusion Matrix for Train data'+color.END)
plotConfusionMatrix(y_train,train_pred)

print('\n'+color.BOLD +'Confusion Matrix for Test data'+color.END)
plotConfusionMatrix(y_test,test_pred)

# plot AUC
train_auc,test_auc = plotAUC_ROC(model_calib,final_w2v_train, y_train,final_w2v_test
print('\n'+color.RED+'AUC (Train): '+color.END+color.BOLD+str(train_auc)+color.END)
print('\n'+color.RED+'AUC (Test): '+color.END+color.BOLD+str(test_auc)+color.END)

# f1 score
score = f1_score(y_test,test_pred)
print('\n'+color.RED+'F1 SCORE (Train) : '+color.END+color.BOLD+str(f1_score(y_train
print('\n'+color.RED+'F1 SCORE (Test) : '+color.END+color.BOLD+str(score)+color.END)

# recall
recall = metrics.recall_score(y_test, test_pred)
print('\n'+color.RED+'RECALL (Train): '+color.END+color.BOLD+str(metrics.recall_score
print('\n'+color.RED+'RECALL (Test): '+color.END+color.BOLD+str(recall)+color.END)

# precision
precision = metrics.precision_score(y_test, test_pred)
print('\n'+color.RED+'PRECISION  (Train) : '+color.END+color.BOLD+str(metrics.precisi
print('\n'+color.RED+'PRECISION  (Test) : '+color.END+color.BOLD+str(precision)+colo
Confusion Matrix for Train data
```



```
Confusion Matrix for Test data
```


Confusion Matrix
Actual
negative
positive
Predicted
negative
positive
0
1788
0
9437
8000
6000
4000
2000
0


ERROR PLOTS
AUC
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
K: hyperparameter
train AUC =0.9209465980700462
test AUC =0.7696374094163604

```
AUC (Train): 0.9209465980700462

AUC (Test): 0.7696374094163604

F1 SCORE (Train) : 0.9350666726129421

F1 SCORE (Test) : 0.9134643306553092

RECALL (Train): 0.9579659158404532

RECALL (Test): 1.0

PRECISION  (Train) : 0.9132366392264472

PRECISION  (Test) : 0.8407126948775056
```

5.7 [4.4.1] Converting text into vectors using Avg W2V, TFIDF-W2V

In [163]:
```
X = final['preprocessed_reviews']
y = final['Score']

# split the data set into train and test
X_train, x_test, y_train, y_test = model_selection.train_test_split(X, y, test_size=

print(X_train.shape, x_test.shape, y_train.shape, y_test.shape)
```

```
(26190,) (11225,) (26190,) (11225,)
```

[4.4.1.2] TFIDF weighted W2v

In [164]:
```
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(tf_idf_vect.get_feature_names(), list(tf_idf_vect.idf_)))

# TF-IDF weighted Word2Vec

# Train data operation

# store model to hard disk if exist then load model directly from memory
exists = os.path.isfile(w2v_tf_idf_trained_model_100000)
exists = False
if exists:
    print("yes exist")
    final_tfidf_w2v_tr = load(w2v_tf_idf_trained_model_100000)
else:
    print("not exist")
    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 =

    final_tfidf_w2v_tr = []; # the tfidf-w2v for each sentence/review is stored in th
    row=0;
    for sent in tqdm(list_of_sentance): # 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_train_words and word in tfidf_feat:
                vec = w2v_model_tr.wv[word]
    #             tf_idf = tf_idf_matrix[row, tfidf_feat.index(word)]
                # to reduce the computation we are
                # dictionary[word] = idf value of word in whole courpus
                # sent.count(word) = tf valeus of word in this review
                tf_idf = dictionary[word]*(sent.count(word)/len(sent))
                sent_vec += (vec * tf_idf)
                weight_sum += tf_idf
        if weight_sum != 0:
            sent_vec /= weight_sum
        final_tfidf_w2v_tr.append(sent_vec)
        row += 1
#     dump(final_tfidf_w2v_tr,w2v_tf_idf_trained_model_100000)


# Test data operation ============

# store model to hard disk if exist then load model directly from memory
exists = os.path.isfile(w2v_tf_idf_test_model_100000)
exists = False
if exists:
    print("yes exist")
    final_tfidf_w2v_test = load(w2v_tf_idf_test_model_100000)

else:
    print("not exist")
    # final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val =
    final_tfidf_w2v_test = []; # the tfidf-w2v for each sentence/review is stored in
    row=0;
    for sent in tqdm(list_of_test_sentence): # 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_test_words and word in tfidf_feat:
                vec = w2v_model_test.wv[word]
    #             tf_idf = tf_idf_matrix[row, tfidf_feat.index(word)]
                # to reduce the computation we are
                # dictionary[word] = idf value of word in whole courpus
```

```
                    # sent.count(word) = tf valeus of word in this review
                    tf_idf = dictionary[word]*(sent.count(word)/len(sent))
                    sent_vec += (vec * tf_idf)
                    weight_sum += tf_idf
            if weight_sum != 0:
                sent_vec /= weight_sum
            final_tfidf_w2v_test.append(sent_vec)
            row += 1
#     dump(final_tfidf_w2v_test,w2v_tf_idf_test_model_100000)
```

```
not exist


100%|| 26190/26190 [00:44<00:00, 586.49it/s]
  3%|         | 357/11225 [00:00<00:16, 675.77it/s]

not exist


100%|| 11225/11225 [00:16<00:00, 697.80it/s]
```

5.7.1 Hyper paramter tuning using Gridsearch

```
In [165]: w2v_tfidf_hyperparam_path = '/home/pranay/Amazon Assignments/SVM RBF/w2v_tfidf_hyper

          exists = os.path.isfile(w2v_tfidf_hyperparam_path)

          if exists:
              print('yes exists')
              w2v_tfidf_train = load(w2v_tfidf_hyperparam_path)
          else:
              print('not exists')
              w2v_tfidf_train = finding_best_alpha (final_tfidf_w2v_tr,y_train, 'gridsearch','
              dump(w2v_tfidf_train,w2v_tfidf_hyperparam_path)


          # view the complete results (list of named tuples)
          print("=======Training========")
          print (w2v_tfidf_train.best_score_)
          print (w2v_tfidf_train.best_params_)
          print (w2v_tfidf_train.best_estimator_)
```

```
yes exists
=======Training========
0.8498412444277511
{'C': 0.5, 'gamma': 0.1}
SVC(C=0.5, cache_size=200, class_weight='balanced', coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=0.1, kernel='rbf',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
```

5.8 RBF SVM TFIDF weighted W2V

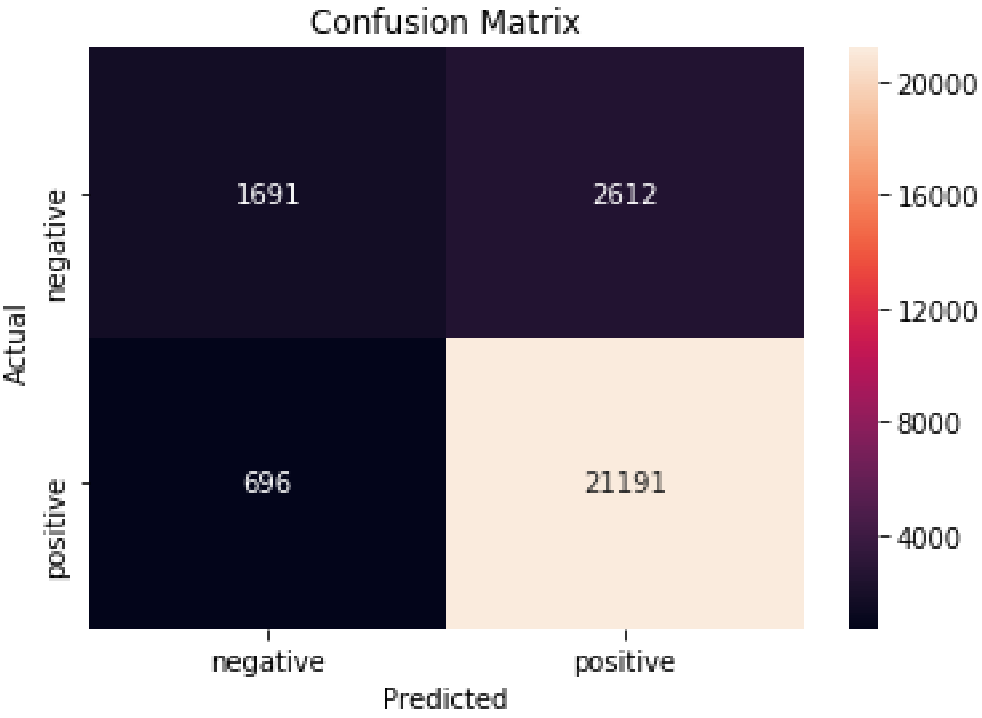
```
In [166]: gamma_val = w2v_tfidf_train.best_params_.get("gamma", "")
          C_val = w2v_tfidf_train.best_params_.get("C", "")
          print('\n'+color.RED+'Optimal best gamma is : '+color.END+color.BOLD+str(gamma_val)+c
          print('\n'+color.RED+'Optimal best C value is : '+color.END+color.BOLD+str(C_val)+col
```

```

Optimal best gamma is : 0.1

Optimal best C value is : 0.5
```

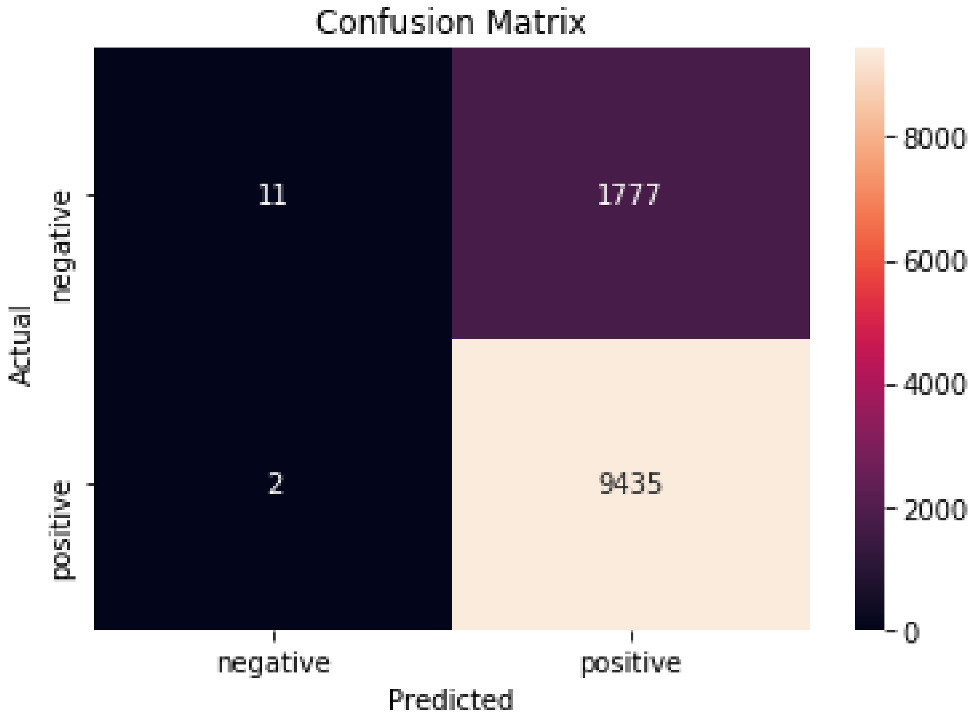
```
In [167]: optimal_model = SVC(C=C_val, cache_size=200, class_weight='balanced', coef0=0.0,
            decision_function_shape='ovr', degree=3, gamma=gamma_val,
            kernel='rbf', max_iter=-1, probability=False, random_state=None,
            shrinking=True, tol=0.001, verbose=False)

          # https://www.kaggle.com/mpearmain/calibrated-sgdclassifier

          model_calib = CalibratedClassifierCV(base_estimator=optimal_model, cv=5, method='iso

          # fitting the model
          model_calib.fit(final_tfidf_w2v_tr,y_train)

          # predict the response
          test_pred = model_calib.predict(final_tfidf_w2v_test)
          train_pred = model_calib.predict(final_tfidf_w2v_tr)

          # plot confusion matrix

          print('\n'+color.BOLD +'Confusion Matrix for Train data'+color.END)
          plotConfusionMatrix(y_train,train_pred)

          print('\n'+color.BOLD +'Confusion Matrix for Test data'+color.END)
          plotConfusionMatrix(y_test,test_pred)

          # plot AUC
          train_auc,test_auc = plotAUC_ROC(model_calib,final_tfidf_w2v_tr, y_train,final_tfidf_
          print('\n'+color.RED+'AUC (Train): '+color.END+color.BOLD+str(train_auc)+color.END)
          print('\n'+color.RED+'AUC (Test): '+color.END+color.BOLD+str(test_auc)+color.END)

          # f1 score
```

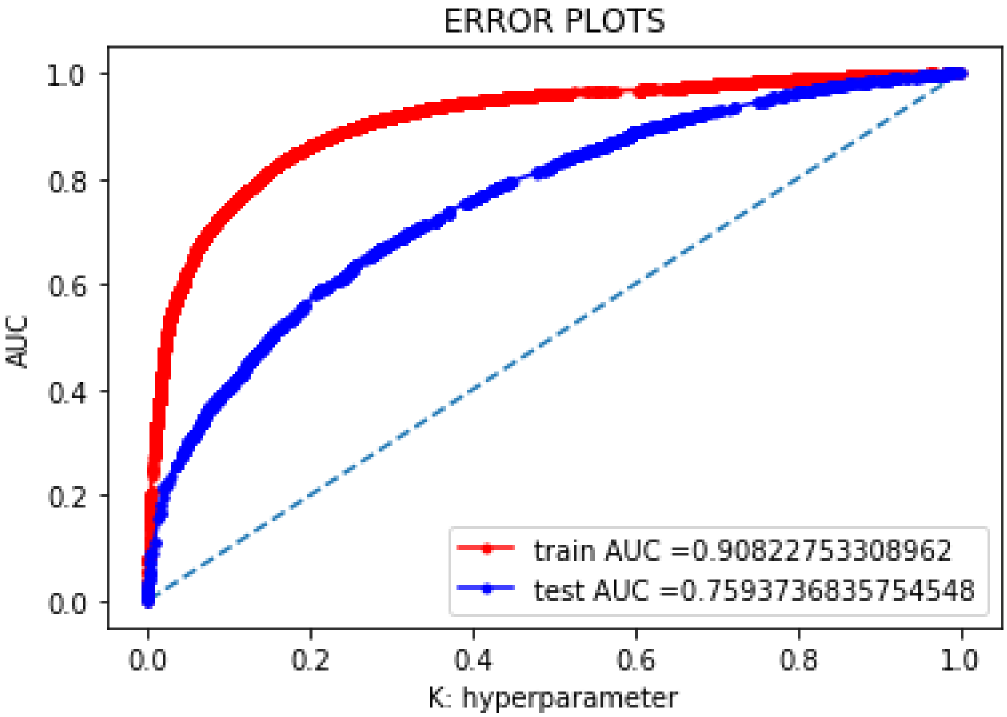
```
score = f1_score(y_test,test_pred)
print('\n'+color.RED+'F1 SCORE (Train) : '+color.END+color.BOLD+str(f1_score(y_train
print('\n'+color.RED+'F1 SCORE (Test) : '+color.END+color.BOLD+str(score)+color.END)

# recall
recall = metrics.recall_score(y_test, test_pred)
print('\n'+color.RED+'RECALL (Train): '+color.END+color.BOLD+str(metrics.recall_scor
print('\n'+color.RED+'RECALL (Test): '+color.END+color.BOLD+str(recall)+color.END)

# precision
precision = metrics.precision_score(y_test, test_pred)
print('\n'+color.RED+'PRECISION  (Train) : '+color.END+color.BOLD+str(metrics.precisi
print('\n'+color.RED+'PRECISION  (Test) : '+color.END+color.BOLD+str(precision)+colo
```

```
Confusion Matrix for Train data
```



```
Confusion Matrix for Test data
```


Confusion Matrix
Actual
negative
positive
Predicted
negative
positive
11
1777
2
9435
8000
6000
4000
2000
0


ERROR PLOTS
AUC
K: hyperparameter
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
train AUC =0.90822753308962
test AUC =0.7593736835754548

```
AUC (Train): 0.90822753308962

AUC (Test): 0.7593736835754548

F1 SCORE (Train) : 0.9275990369884001

F1 SCORE (Test) : 0.9138457068138892

RECALL (Train): 0.9682003015488646

RECALL (Test): 0.999788068242026

PRECISION  (Train) : 0.8902659328656052

PRECISION  (Test) : 0.8415090973956475
```

6 [6] Conclusions

```
In [183]: import pandas as pd
          from prettytable import PrettyTable

          print(color.BOLD+'\t\t\t\t RBF SVM  '+color.END)
          print('\n')

          print(color.BOLD+'For BOW and TFIDF, We have considered 40k points'+color.END)


          x = PrettyTable()
          x.field_names =  ['Metric','BOW','TFIDF', 'W2V', 'TFIDF-W2V']

          x.add_row(["C Value ", 1,0.5,1,0.5])
          x.add_row(["gamma Value ", 0.01,1,0.1,0.1])


          x.add_row(["AUC Train ", 0.9496,0.88852,0.9209,0.9082])
          x.add_row(["AUC Test ", 0.90227,0.87822,0.7696,0.75937])

          x.add_row(["F1 SCORE Train ", 0.95488,0.92714,0.935066,0.92759])
          x.add_row(["F1 SCORE Test ", 0.93535,0.92421,0.913464,0.9138])

          x.add_row(["RECALL Train ",0.9676,0.9555,0.95796,0.9682])
          x.add_row(["RECALL Test ", 0.959097,0.95114,1.0,0.9997])

          x.add_row(["PRECISION Train ", 0.94250,0.900344,0.9132,0.8902])
          x.add_row(["PRECISION Test ",0.91276,0.89876,0.84071,0.84150])
```

```
    print('\n')
    print(x)
```

```
                                 RBF SVM


For BOW and TFIDF, We have considered 40k points


+------------------+----------+----------+----------+-----------+
|      Metric      |   BOW    |  TFIDF   |   W2V    | TFIDF-W2V |
+------------------+----------+----------+----------+-----------+
|     C Value      |    1     |   0.5    |    1     |    0.5    |
|   gamma Value    |   0.01   |    1     |   0.1    |    0.1    |
|    AUC Train     |  0.9496  | 0.88852  |  0.9209  |   0.9082  |
|    AUC Test      | 0.90227  | 0.87822  |  0.7696  |  0.75937  |
| F1 SCORE Train   | 0.95488  | 0.92714  | 0.935066 |  0.92759  |
|  F1 SCORE Test   | 0.93535  | 0.92421  | 0.913464 |   0.9138  |
|  RECALL Train    |  0.9676  |  0.9555  | 0.95796  |   0.9682  |
|   RECALL Test    | 0.959097 | 0.95114  |   1.0    |   0.9997  |
| PRECISION Train  |  0.9425  | 0.900344 |  0.9132  |   0.8902  |
| PRECISION Test   | 0.91276  | 0.89876  | 0.84071  |   0.8415  |
+------------------+----------+----------+----------+-----------+
```

In [ ]: