KNN

May 23, 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 [194]:
```
%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
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score
from sklearn.utils import class_weight

# 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 , AUC curve
# 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
# kFold
from sklearn.model_selection import KFold

from sklearn.model_selection import GridSearchCV

import seaborn as sns

from sklearn.model_selection import TimeSeriesSplit
from sklearn.model_selection import RandomizedSearchCV
from sklearn.metrics import classification_report
# https://scikit-learn.org/stable/modules/generated/sklearn.model_selection.train_te
# https://scikit-learn.org/stable/modules/generated/sklearn.model_selection.KFold.ht
# https://scikit-learn.org/stable/modules/generated/sklearn.metrics.roc_curve.html
from sklearn.metrics import f1_score,recall_score,precision_score

import os
from joblib import dump, load
```

In [195]:
```
# 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 1

# 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 (100000, 10)
```

Out[195]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDenominator	Score	Time	Summary	Text
0	1	B001E4KFG0	A3SGXH7AUHU8GW	delmartian	1	1	1	1303862400	Good Quality Dog Food	I have bought several of the Vitality canned d...
1	2	B00813GRG4	A1D87F6ZCVE5NK	dll pa	0	0	0	1346976000	Not as Advertised	Product arrived labeled as Jumbo Salted Peanut...
2	3	B000LQOCH0	ABXLMWJIXXAIN	Natalia Corres "Natalia Corres"	1	1	1	1219017600	"Delight" says it all	This is a confection that has been around a fe...

In [196]:
```
display = pd.read_sql_query("""
SELECT UserId, ProductId, ProfileName, Time, Score, Text, COUNT(*)
FROM Reviews
GROUP BY UserId
HAVING COUNT(*)>1
""", con)
```

In [197]:
```
print(display.shape)
display.head()
```

```
(80668, 7)
```

Out[197]:

	UserId	ProductId	ProfileName	Time	Score	Text	COUNT(*)
0	#oc-R115TNMSPFT9I7	B005ZBZLT4	Breyton	1331510400	2	Overall its just OK when considering the price...	2
1	#oc-R11D9D7SHXIJB9	B005HG9ESG	Louis E. Emory "hoppy"	1342396800	5	My wife has recurring extreme muscle spasms, u...	3
2	#oc-R11DNU2NBKQ23Z	B005ZBZLT4	Kim Cieszykowski	1348531200	1	This coffee is horrible and unfortunately not ...	2
3	#oc-R11O5J5ZVQE25C	B005HG9ESG	Penguin Chick	1346889600	5	This will be the bottle that you grab from the...	3
4	#oc-R12KPBODL2B5ZD	B007OSBEV0	Christopher P. Presta	1348617600	1	I didnt like this coffee. Instead of telling y...	2

```
In [198]: display[display['UserId']=='AZY10LLTJ71NX']
```

```
Out[198]:              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 [199]: display['COUNT(*)'].sum()
```

```
Out[199]: 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 [200]: display= pd.read_sql_query("""
          SELECT *
          FROM Reviews
          WHERE Score != 3 AND UserId="AR5J8UI46CURR"
          ORDER BY ProductID
          """, con)
          display.head()
```

```
Out[200]:        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 [201]: #Sorting data according to ProductId in ascending order
          sorted_data=filtered_data.sort_values('ProductId', axis=0, ascending=True, inplace=Fa

In [202]: #Deduplication of entries
          final=sorted_data.drop_duplicates(subset={"UserId","ProfileName","Time","Text"}, keep
          final.shape

Out[202]: (87775, 10)

In [203]: #Checking to see how much % of data still remains
          (final['Id'].size*1.0)/(filtered_data['Id'].size*1.0)*100

Out[203]: 87.775
```

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

          display.head()
```

```
Out[204]:       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 [205]: final=final[final.HelpfulnessNumerator<=final.HelpfulnessDenominator]
```

```
In [206]: #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()
```

```
(87773, 10)


Out[206]: 1    73592
          0    14181
          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 [207]:
```
# 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)
```

```
My dogs loves this chicken but its a product from China, so we wont be buying it anymore.  Its
==================================================
The Candy Blocks were a nice visual for the Lego Birthday party but the candy has little taste
==================================================
was way to hot for my blood, took a bite and did a jig  lol
==================================================
My dog LOVES these treats. They tend to have a very strong fish oil smell. So if you are afrai
==================================================
```

In [208]:
```
# 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)
```

```
My dogs loves this chicken but its a product from China, so we wont be buying it anymore.  Its
```

In [209]:
```
# 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)
```

```
My dogs loves this chicken but its a product from China, so we wont be buying it anymore.  Its
==================================================
The Candy Blocks were a nice visual for the Lego Birthday party but the candy has little taste
==================================================
was way to hot for my blood, took a bite and did a jig  lol
==================================================
My dog LOVES these treats. They tend to have a very strong fish oil smell. So if you are afraic
```

In [210]:
```
# 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 [211]:
```
sent_1500 = decontracted(sent_1500)
print(sent_1500)
print("="*50)
```

```
was way to hot for my blood, took a bite and did a jig  lol
==================================================
```

In [212]:
```
#remove words with numbers python: https://stackoverflow.com/a/18082370/4084039
sent_0 = re.sub("\S*\d\S*", "", sent_0).strip()
print(sent_0)
```

```
My dogs loves this chicken but its a product from China, so we wont be buying it anymore.  Its
```

In [213]:
```
#remove spacial character: https://stackoverflow.com/a/5843547/4084039
sent_1500 = re.sub('[^A-Za-z0-9]+', ' ', sent_1500)
print(sent_1500)
```

```
was way to hot for my blood took a bite and did a jig lol
```

In [214]:
```
# 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', 'oursel
            "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't
            "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 [215]:
```
#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 = []
    loop_size = 1
    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
                preprocessed_text.append(sentance.strip())
                count = len(sentance.strip().split())
                word_counter.append(count)
            return preprocessed_text
```

```
In [216]: preprocessed_reviews = filterised_text(final['Text'].values)
          final['preprocessed_reviews']  = preprocessed_reviews
          preprocessed_reviews[1]
```

```
100%|| 87773/87773 [00:27<00:00, 3175.59it/s]
```

```
Out[216]: 'dogs love saw pet store tag attached regarding made china satisfied safe'
```

```
In [217]: final['numbers_of_words']  = word_counter
          len(word_counter)
```

```
Out[217]: 87773
```

[3.2] Preprocessing Review Summary

```
In [218]: preprocessed_summary = filterised_text(final['Summary'].values)
          final['preprocessed_summary']  = preprocessed_summary
          preprocessed_summary[1822]
```

```
100%|| 87773/87773 [00:16<00:00, 5196.53it/s]
```

```
Out[218]: 'pop corn'
```

```
In [219]: bow_trained_model_25000 ='/home/pranay/ML trained models/BoW/bow_trained_model_25000
          bow_test_model_25000 ='/home/pranay/ML trained models/BoW/bow_test_model_25000'
          bow_trained_model_20000 ='/home/pranay/ML trained models/BoW/bow_trained_model_20000
          bow_trained_model_100000 ='/home/pranay/ML trained models/BoW/bow_trained_model_10000
          bow_test_model_100000 ='/home/pranay/ML trained models/BoW/bow_test_model_100000'
          bow_trained_count_vect ='/home/pranay/ML trained models/BoW/bow_trained_count_vect'

          tf_idf_trained_model_25000 = '/home/pranay/ML trained models/TFIDF/tf_idf_trained_mod
          tf_idf_test_model_25000 = '/home/pranay/ML trained models/TFIDF/tf_idf_test_model_250
          tf_idf_trained_model_20000 = '/home/pranay/ML trained models/TFIDF/tf_idf_trained_mod
          tf_idf_trained_model_100000 = '/home/pranay/ML trained models/TFIDF/tf_idf_trained_mo
          tf_idf_test_model_100000 = '/home/pranay/ML trained models/TFIDF/tf_idf_test_model_10
          trained_tf_idf_vect_20000 = '/home/pranay/ML trained models/TFIDF/tf_idf_vect_20000'
          tfidf_vectorizer ='/home/pranay/ML trained models/BoW/tfidf_vectorizer'

          w2v_trained_model_20000 = '/home/pranay/ML trained models/W2V/w2v_trained_model_20000
          avg_w2v_trained_model_25000 = '/home/pranay/ML trained models/W2V/avg_w2v_trained_mod
```

```
avg_w2v_test_model_25000 = '/home/pranay/ML trained models/W2V/avg_w2v_test_model_250
avg_w2v_trained_model_20000 = '/home/pranay/ML trained models/W2V/avg_w2v_trained_mod
avg_w2v_trained_model_100000 = '/home/pranay/ML trained models/W2V/avg_w2v_trained_mo
avg_w2v_test_model_100000 = '/home/pranay/ML trained models/W2V/avg_w2v_test_model_10


w2v_tf_idf_trained_model_25000 = '/home/pranay/ML trained models/W2V_TFIDF/w2v_tf_idf
w2v_tf_idf_test_model_25000 = '/home/pranay/ML trained models/W2V_TFIDF/w2v_tf_idf_te
w2v_tf_idf_trained_model_20000 = '/home/pranay/ML trained models/W2V_TFIDF/w2v_tf_idf
w2v_tf_idf_trained_model_100000 = '/home/pranay/ML trained models/W2V_TFIDF/w2v_tf_id
w2v_tf_idf_test_model_100000 = '/home/pranay/ML trained models/W2V_TFIDF/w2v_tf_idf_t
w2v_tf_idf_model_20000 = '/home/pranay/ML trained modelsW2V_TFIDF/w2v_tf_idf_model_20

knn_trained_bow = '/home/pranay/Amazon Assignments/KNN/BOW/bow_optimal'
knn_trained_tfidf = '/home/pranay/Amazon Assignments/KNN/TFIDF/tfidf_optimal'
knn_trained_w2v = '/home/pranay/Amazon Assignments/KNN/W2V/w2v_optimal'
knn_trained_w2v_tfidf = '/home/pranay/Amazon Assignments/KNN/W2V TFIDF/w2v_tfidf_opti
```

4.1.1 Splitting data

In [220]:
```
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=0

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

```
(61441,) (26332,) (61441,) (26332,)
```

5 [4] Featurization

5.1 [4.1] BAG OF WORDS

In [221]:
```
#BoW

# Train Vectorizor
# store model to hard disk if exist then load model directly from memory
exists = os.path.isfile(bow_trained_model_100000)

if exists:
    print("yes exist")
    final_bow_count_vect = load(bow_trained_model_100000)
    bow_count_vect = load(bow_trained_count_vect)
    print("the type of count vectorizer ",type(final_bow_count_vect))
    print("the shape of out text BOW vectorizer ",final_bow_count_vect.get_shape())
    print("the number of unique words ", final_bow_count_vect.get_shape()[1])
```

```
        else:
            print("not exist")
            bow_count_vect = CountVectorizer() #in scikit-learn
            bow_count_vect.fit(X_train)
            print("some feature names ", bow_count_vect.get_feature_names()[:10])
            print('='*50)
            final_bow_count_vect = bow_count_vect.fit_transform(X_train)
            print("the type of count vectorizer ",type(final_bow_count_vect))
            print("the shape of out text BOW vectorizer ",final_bow_count_vect.get_shape())
            print("the number of unique words ", final_bow_count_vect.get_shape()[1])
            dump(final_bow_count_vect, bow_trained_model_100000)
            dump(bow_count_vect, bow_trained_count_vect)


        # Test Vectorizor
        exists = os.path.isfile(bow_test_model_100000)

        if exists:
            final_bow_test = load(bow_test_model_100000)
        else:
            final_bow_test = bow_count_vect.transform(x_test)
            dump(final_bow_test,bow_test_model_100000 )
            final_bow_test.shape
```

```
yes exist
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text BOW vectorizer  (61441, 46446)
the number of unique words  46446
```

5.2 [4.2] TF-IDF

```
In [222]: # Train Vectorizor
          # store model to hard disk if exist then load model directly from memory
          exists = os.path.isfile(tf_idf_trained_model_100000)

          if exists:
              print("yes exist")
              final_tf_idf = load(tf_idf_trained_model_100000)
              tf_idf_vect = load(tfidf_vectorizer)
              print("the type of count vectorizer ",type(final_tf_idf))
              print("the shape of out text TFIDF vectorizer ",final_tf_idf.get_shape())
              print("the number of unique words including both unigrams and bigrams ", final_t

          else:
              print("not exist")
              tf_idf_vect = TfidfVectorizer(ngram_range=(1,2), min_df=10)
              tf_idf_vect.fit(X_train)
```

```
        print("some sample features(unique words in the corpus)",tf_idf_vect.get_feature
        print('='*50)

        final_tf_idf = tf_idf_vect.transform(X_train)
        print("the type of count vectorizer ",type(final_tf_idf))
        print("the shape of out text TFIDF vectorizer ",final_tf_idf.get_shape())
        print("the number of unique words including both unigrams and bigrams ", final_t
        dump(final_tf_idf, tf_idf_trained_model_100000)
        dump(tf_idf_vect, tfidf_vectorizer)


    # # Test Vectorizor

    exists = os.path.isfile(tf_idf_test_model_100000)

    if exists:
        print("yes exist")
        final_tfidf_test = load(tf_idf_test_model_100000)
    else:
        print("not exist")
        final_tfidf_test = tf_idf_vect.transform(x_test)
        dump(final_tfidf_test,tf_idf_test_model_100000 )
        final_tfidf_test.shape
```

```
yes exist
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text TFIDF vectorizer  (61441, 36487)
the number of unique words including both unigrams and bigrams  36487
yes exist
```

5.3 [4.4] Word2Vec

In [223]:
```
# 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 [224]:
```
# 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.
        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,
```

```
[('fantastic', 0.8559020757675171), ('good', 0.8421187996864319), ('awesome', 0.811998426914215
==================================================
[('greatest', 0.8042837381362915), ('best', 0.7369340658187866), ('nastiest', 0.687537312507629
```

```
In [225]: # 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  14910
sample words  ['aroma', 'flavor', 'seem', 'fine', 'weak', 'value', 'used', 'entire', 'bottle',
```

```
In [226]: # 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  9806
sample words  ['used', 'use', 'cheaper', 'grocery', 'store', 'brands', 'two', 'cats', 'got', 's
```

5.4 [4.4.1] Converting text into vectors using Avg W2V, TFIDF-W2V

[4.4.1.1] Avg W2v

```
In [227]: # average Word2Vec

          # train data operation
          exists = os.path.isfile(avg_w2v_trained_model_100000)


          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)

          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)
```

```
yes exist
yes exist
```

[4.4.1.2] TFIDF weighted W2v

```
In [228]: # 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_)))
```

```
In [229]: # 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)

          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 t
              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)

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)
```

```
yes exist
yes exist
```

6 [5] Assignment 3: KNN

In [230]:
```
# Common Methods

    # define the range, through which we are going to find K-hyperparameter
    k_range = list(range(7, 67,6))

    def finding_best_k(X_tr,y_tr ,algoName):

        # instantiate learning model
        knn = KNeighborsClassifier(algorithm = algoName)

        param_grid = dict(n_neighbors=k_range)

        #For time based splitting
        tscv = TimeSeriesSplit(n_splits=12)

        # instantiate the training grid search model
        train_grid = GridSearchCV(knn, param_grid, cv=tscv, scoring='roc_auc',n_jobs =-1

        # fit the training data to train model
        train_grid.fit(X_tr, y_tr)

        return train_grid

    def train_with_optimal_k(kvalue, algoName):

        # instantiate learning model
        knn = KNeighborsClassifier(n_neighbors=kvalue , algorithm = algoName)
        return knn


    def plotAccuracyGraph(training_grid):
        neig = [i for i in k_range]
        accuracy = [(i)*100 for i in training_grid.cv_results_['mean_train_score']]
        accuracy_test = [(i)*100 for i in training_grid.cv_results_['mean_test_score']]
        plt.plot(neig, accuracy,'r',label='train_accuracy')
        plt.plot(neig, 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):
    conf_matrix =  confusion_matrix(y_test,pred)
    class_label = ['negative', 'positive']
    df_conf_matrix = pd.DataFrame(
        conf_matrix, index=class_label, columns=class_label)
    sns.heatmap(df_conf_matrix, annot=True, fmt='d')
    plt.title("Confusion Matrix")
    plt.xlabel("Predicted")
    plt.ylabel("Actual")
    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'
```

6.0.1 Note : For Brute force algorithm, we have trained model on '100k' points

6.1 [5.1] Applying KNN brute force

6.1.1 [5.1.1] Applying KNN brute force on BOW using GridSearchCV

```
In [231]: # instantiate learning model
          knn = KNeighborsClassifier(algorithm = 'brute')
```

```
In [232]: # define the range, through which we are going to find K-hyperparameter
          k_range = list(range(7, 67,6))

          param_grid = dict(n_neighbors=k_range)
          print(param_grid)
```

```
{'n_neighbors': [7, 13, 19, 25, 31, 37, 43, 49, 55, 61]}
```

```
In [233]: print(final_bow_count_vect.shape)
          print(final_bow_test.shape)
```

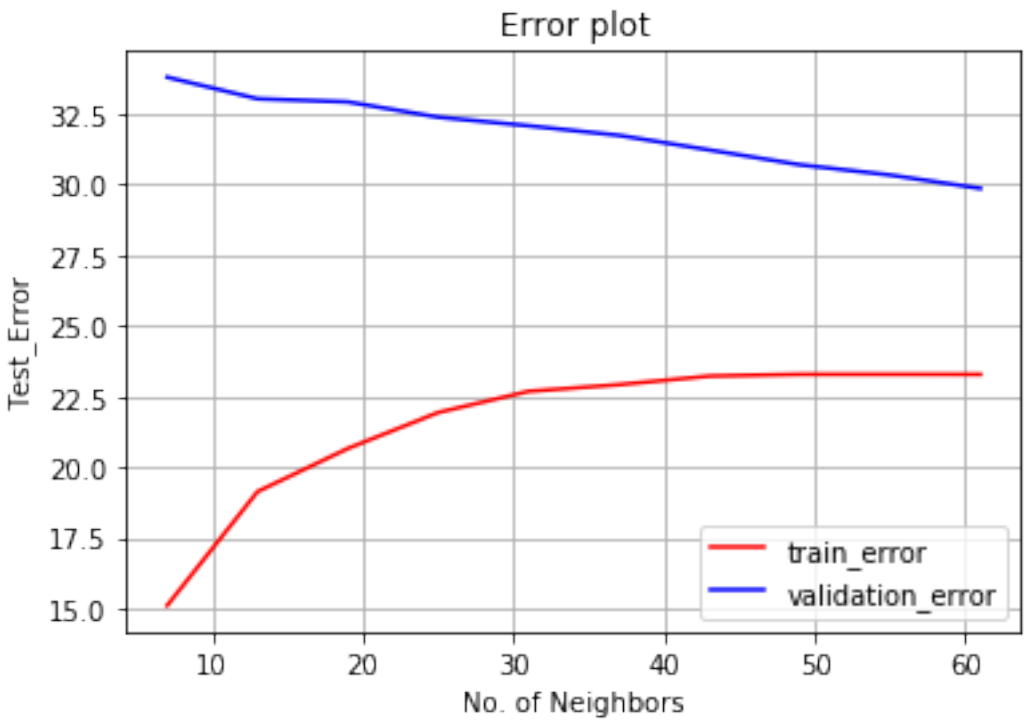
```
(61441, 46446)
(26332, 46446)
```

```
In [234]: bow_brute_train = '/home/pranay/Amazon Assignments/KNN/BOW/bow_brute_train'

          exists = os.path.isfile(bow_brute_train)
          if exists:
              print("yes exist")
              bow_train = load(bow_brute_train)
          else:
              #For time based splitting
              tscv = TimeSeriesSplit(n_splits=10)

              # instantiate the grid
```

```
            bow_train = GridSearchCV(knn, param_grid, cv=tscv, scoring='roc_auc',n_jobs =-1 )

            # fit the grid with training data
            bow_train.fit(final_bow_count_vect, y_train)

            dump(bow_train,bow_brute_train)

        # 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 exist
=======Training========
0.7013419068399666
{'n_neighbors': 61}
KNeighborsClassifier(algorithm='brute', leaf_size=30, metric='minkowski',
           metric_params=None, n_jobs=None, n_neighbors=61, p=2,
           weights='uniform')
```

```
In [235]: neig = [i for i in k_range]
          error = [(1-i)*100 for i in bow_train.cv_results_['mean_train_score']]
          error_test = [(1-i)*100 for i in bow_train.cv_results_['mean_test_score']]
          plt.plot(neig, error,'r',label='train_error')
          plt.plot(neig, error_test,'b',label='validation_error')
          plt.title('Error plot')
          plt.xlabel('No. of Neighbors')
          plt.ylabel('Test_Error')
          plt.grid('on')
          plt.legend()
          plt.show()
```



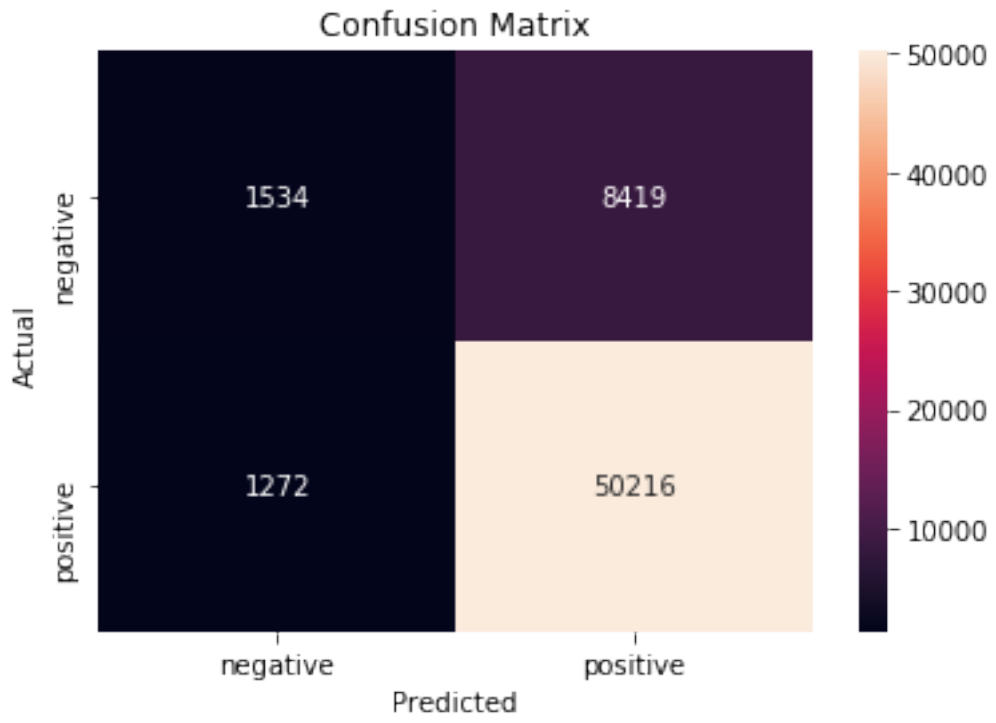
In [236]:
```
# ============================== KNN with k = optimal_k ============================
```

```
exists = os.path.isfile(knn_trained_bow)
if exists:
    print("yes exist")
    knn_optimal = load(knn_trained_bow)
    bow_pred = knn_optimal.predict(final_bow_test)
    bow_train_pred = knn_optimal.predict(final_bow_count_vect)
else:
    print("not exist")
    # instantiate learning model k = optimal_k
    knn_optimal = KNeighborsClassifier(n_neighbors=optimal_k , algorithm = 'brute')

    # fitting the model
    knn_optimal.fit(final_bow_count_vect, y_train)

    # predict the response
    bow_pred = knn_optimal.predict(final_bow_test)
    bow_train_pred = knn_optimal.predict(final_bow_count_vect)
    dump(knn_optimal,knn_trained_bow)
```

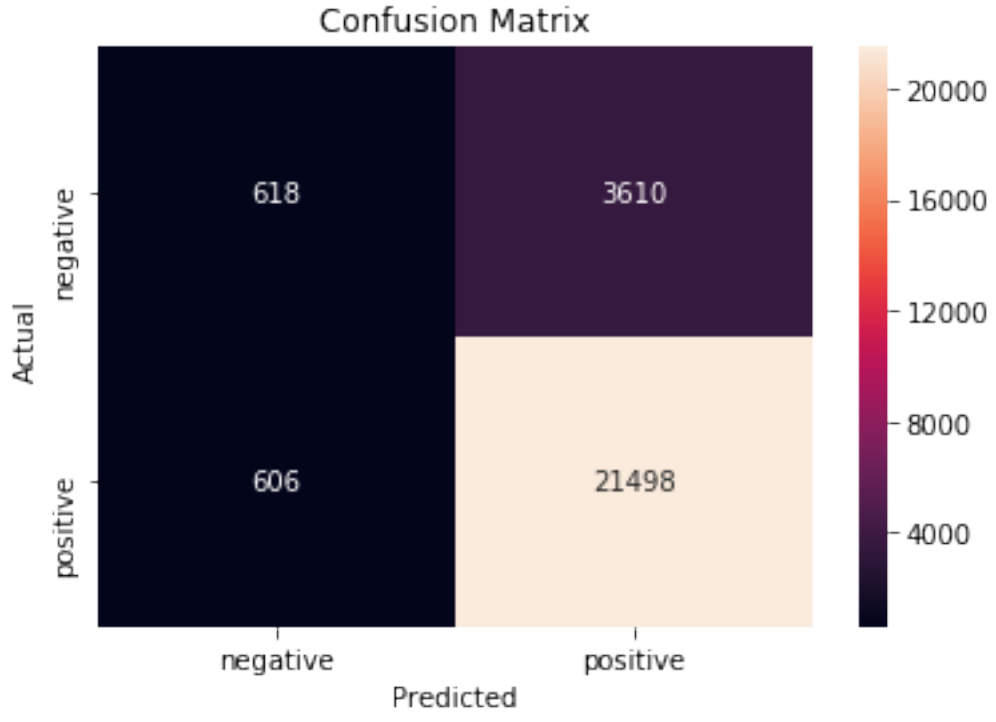
```
yes exist
```

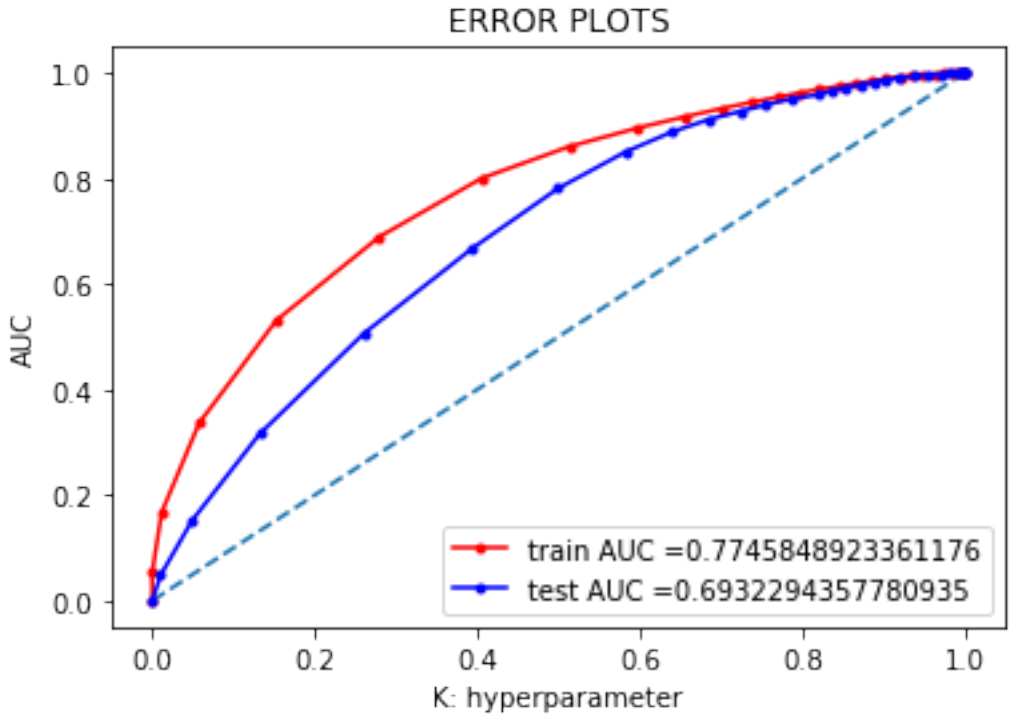
In [237]:
```
# plot confusion matrix

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

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

# plot AUC
train_auc, test_auc = plotAUC_ROC(knn_optimal,final_bow_count_vect, y_train ,final_bo
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,bow_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, bow_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, bow_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





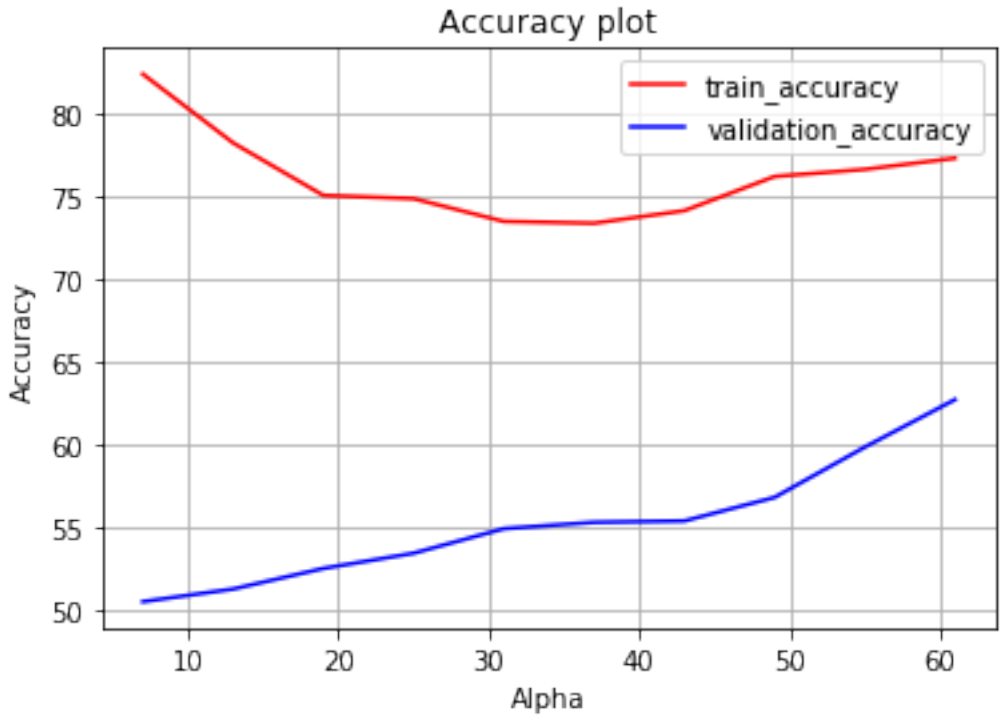

```
AUC (Train): 0.7745848923361176

AUC (Test): 0.6932294357780935

F1 SCORE (Train) : 0.9119984017870927

F1 SCORE (Test) : 0.910700669321359

RECALL (Train): 0.9752952144188938

RECALL (Test): 0.9725841476655809

PRECISION  (Train) : 0.8564168158949433

PRECISION  (Test) : 0.8562211247411183
```

6.1.2 [5.1.2] Applying KNN brute force on TFIDF, using GridSearchCV

```
In [238]: path_tfidf_train = '/home/pranay/Amazon Assignments/KNN/TFIDF/tfidf_brute_train'
```

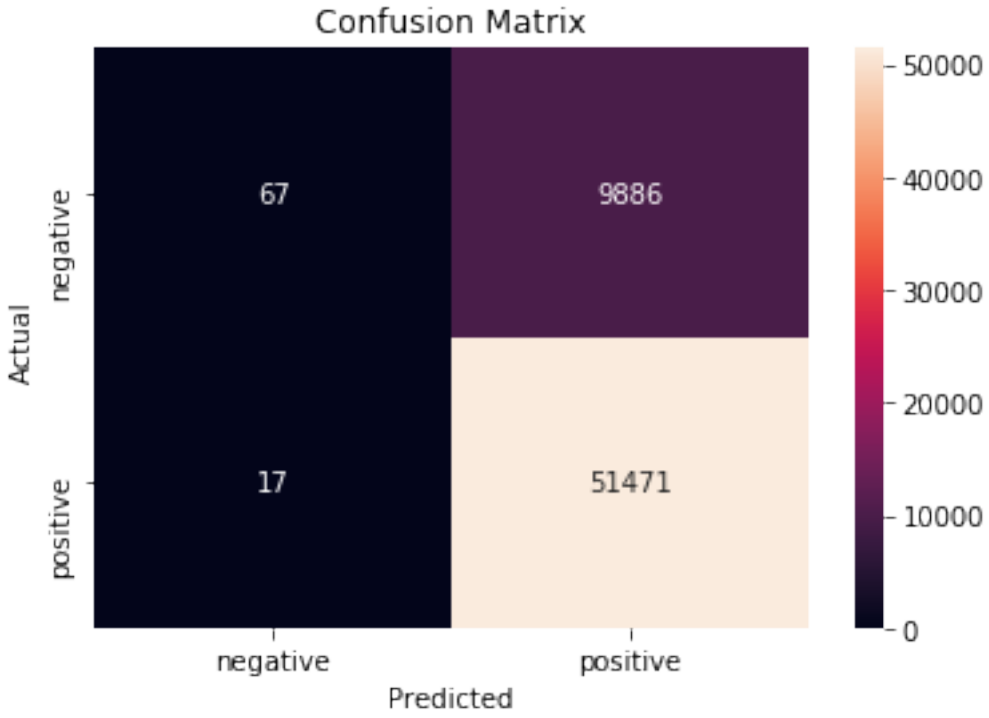
```
exists = os.path.isfile(path_tfidf_train)
if exists:
    tfidf_train = load(path_tfidf_train)
else:
    print("not exist")
    tfidf_train = finding_best_k(final_tf_idf,y_train, 'brute')
    dump(tfidf_train,path_tfidf_train)

# 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_)

plotAccuracyGraph(tfidf_train)
```

```
=======Training========
0.6270425413945637
{'n_neighbors': 61}
KNeighborsClassifier(algorithm='brute', leaf_size=30, metric='minkowski',
           metric_params=None, n_jobs=None, n_neighbors=61, p=2,
           weights='uniform')
```

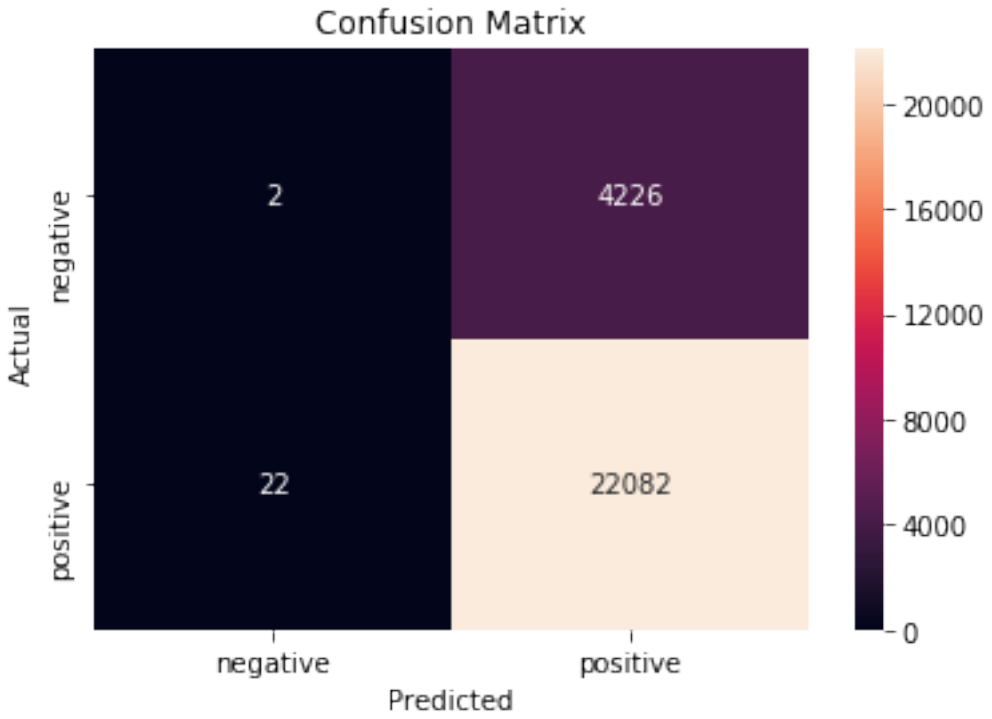


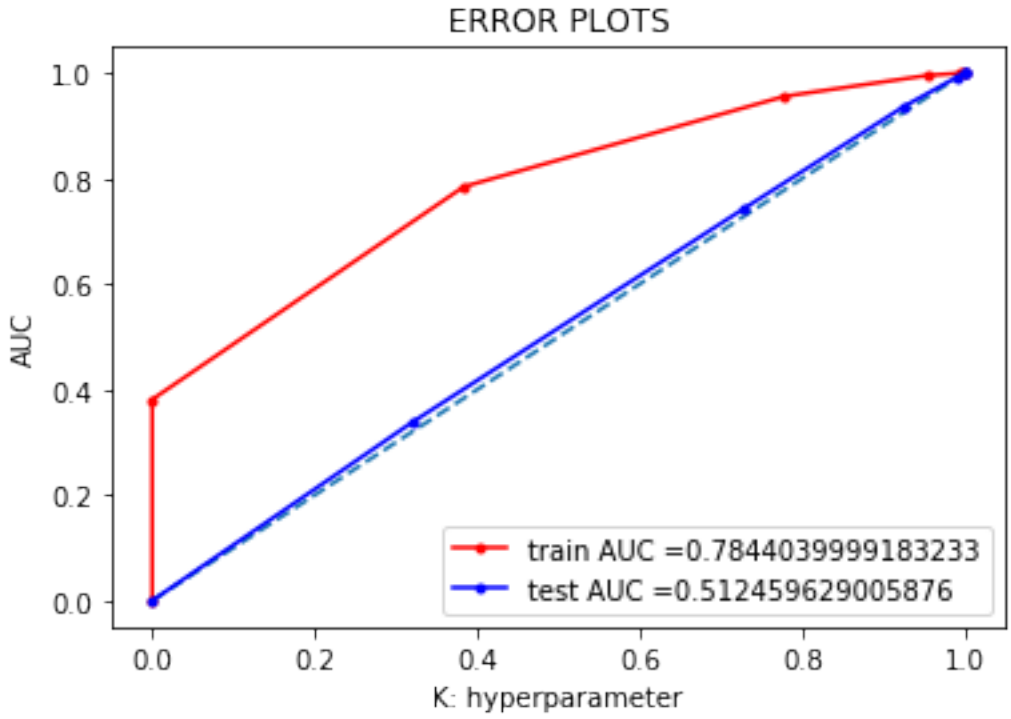
In [239]:
```
path_tfidf_optimal = '/home/pranay/Amazon Assignments/KNN/TFIDF/tfidf_brute_optimal'

exists = os.path.isfile(path_tfidf_optimal)

if exists:
    knn_optimal = load(path_tfidf_optimal)
    # predict the response
    tfidf_pred = knn_optimal.predict(final_tfidf_test)
    tfidf_train_pred = knn_optimal.predict(final_tf_idf)
else:
    knn_optimal= train_with_optimal_k(9,'brute') # it will return trained model with

    # fitting the model
    knn_optimal.fit(final_tf_idf, y_train)

    # predict the response
    tfidf_pred = knn_optimal.predict(final_tfidf_test)
    tfidf_train_pred = knn_optimal.predict(final_tf_idf)
    dump(knn_optimal, path_tfidf_optimal)


# plot confusion matrix

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

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

# plot AUC
train_auc,test_auc = plotAUC_ROC(knn_optimal,final_tf_idf, y_train,final_tfidf_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,tfidf_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, tfidf_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, tfidf_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
2
4226
22
22082
negative
positive
Actual
negative
positive
Predicted
20000
16000
12000
8000
4000
0

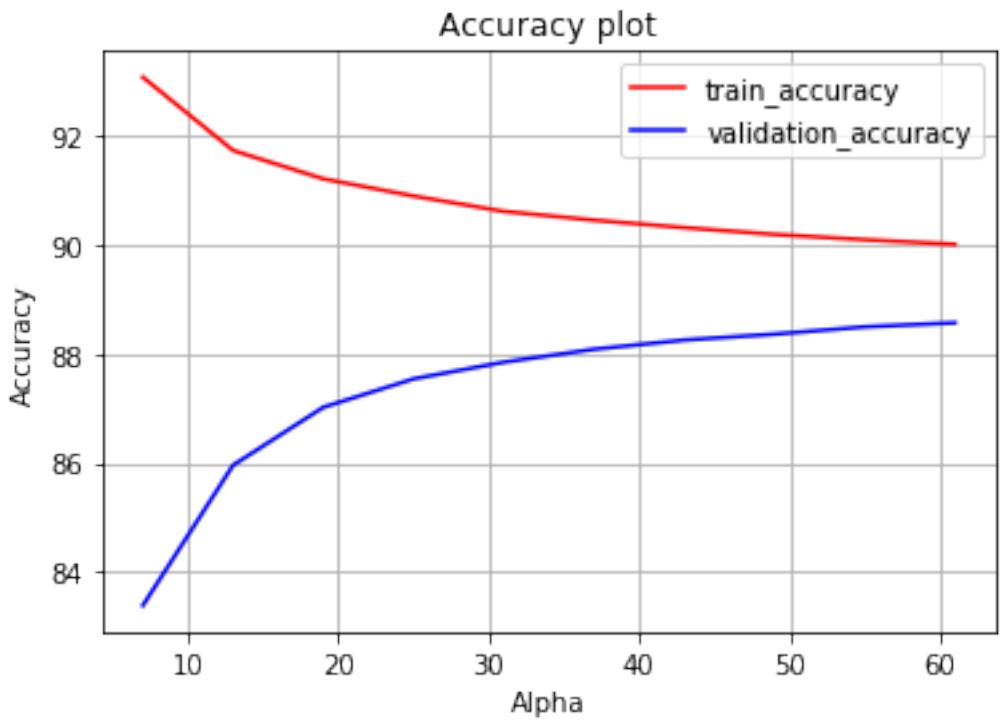

ERROR PLOTS
AUC
K: hyperparameter
train AUC =0.7844039999183233
test AUC =0.512459629005876
0.0
0.2
0.4
0.6
0.8
1.0

```
AUC (Train): 0.7844039999183233

AUC (Test): 0.512459629005876

F1 SCORE (Train) : 0.9122424564668351

F1 SCORE (Test) : 0.9122531603734612

RECALL (Train): 0.9996698259788689

RECALL (Test): 0.9990047050307637

PRECISION  (Train) : 0.8388773897028864

PRECISION  (Test) : 0.8393644518777558
```

6.1.3 [5.1.3] Applying KNN brute force on AVG W2V, using GridSearchCV

```
In [240]: path_w2v_train = '/home/pranay/Amazon Assignments/KNN/W2V/w2v_brute_train'

          exists = os.path.isfile(path_w2v_train)
          if exists:
              w2v_train = load(path_w2v_train)

          else:
              print("not exist")
              w2v_train = finding_best_k(final_w2v_train,y_train,'brute')
              dump(w2v_train,path_w2v_train)

          # 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_)

          plotAccuracyGraph(w2v_train)
```

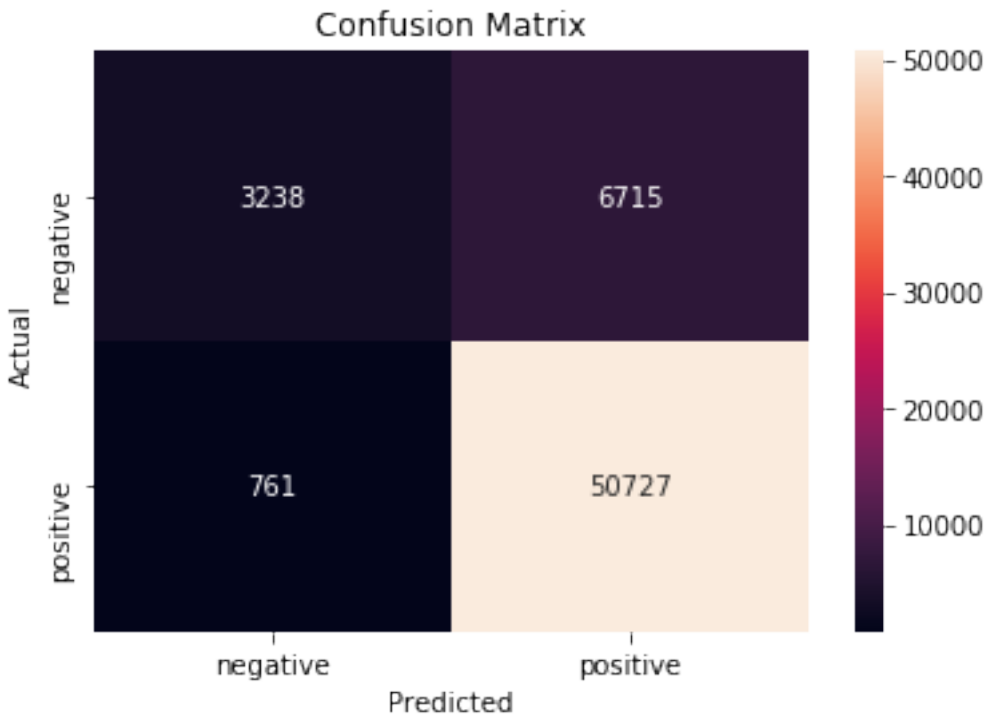
```
=======Training========
0.8857065392653695
{'n_neighbors': 61}
KNeighborsClassifier(algorithm='brute', leaf_size=30, metric='minkowski',
           metric_params=None, n_jobs=None, n_neighbors=61, p=2,
           weights='uniform')
```



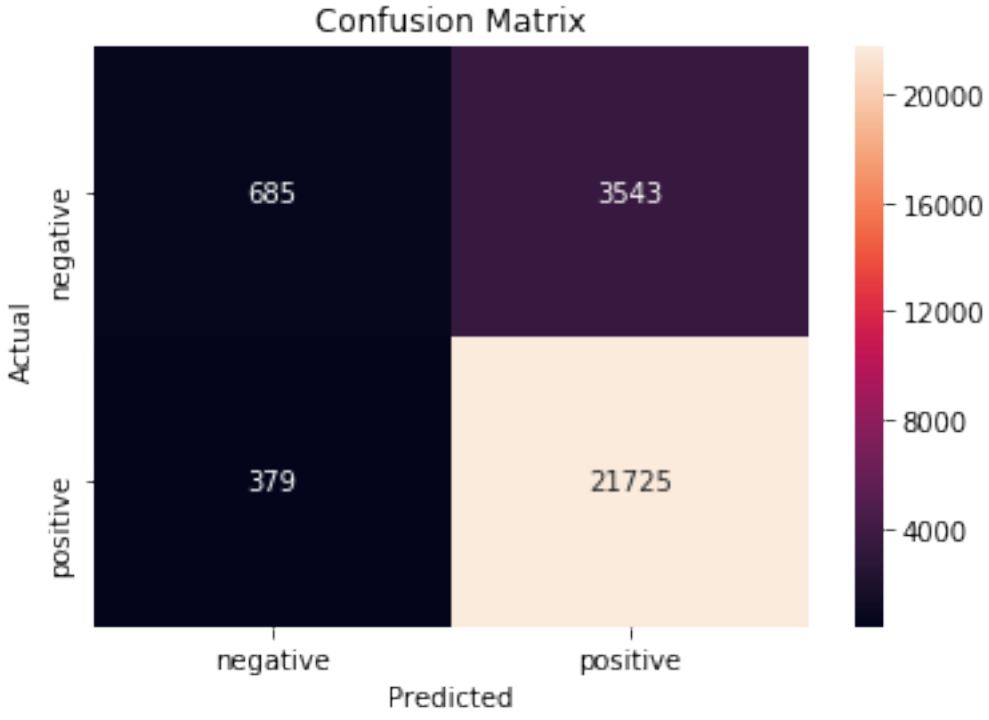
In [241]:
```
path_w2v_optimal = '/home/pranay/Amazon Assignments/KNN/W2V/w2v_brute_optimal'

# best_k_value = w2v_train.best_params_.get('n_neighbors')

exists = os.path.isfile(path_w2v_optimal)

if exists:
    print("yes exist")
    knn_optimal = load(path_w2v_optimal)
    # predict the response
    test_pred = knn_optimal.predict(final_w2v_test)
    train_pred = knn_optimal.predict(final_w2v_train)

else:
    print("not exist")
    knn_optimal= train_with_optimal_k(40,'brute') # it will return trained model wit

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

    # predict the response
    test_pred = knn_optimal.predict(final_w2v_test)
    train_pred = knn_optimal.predict(final_w2v_train)
    dump(knn_optimal, path_w2v_optimal)
```

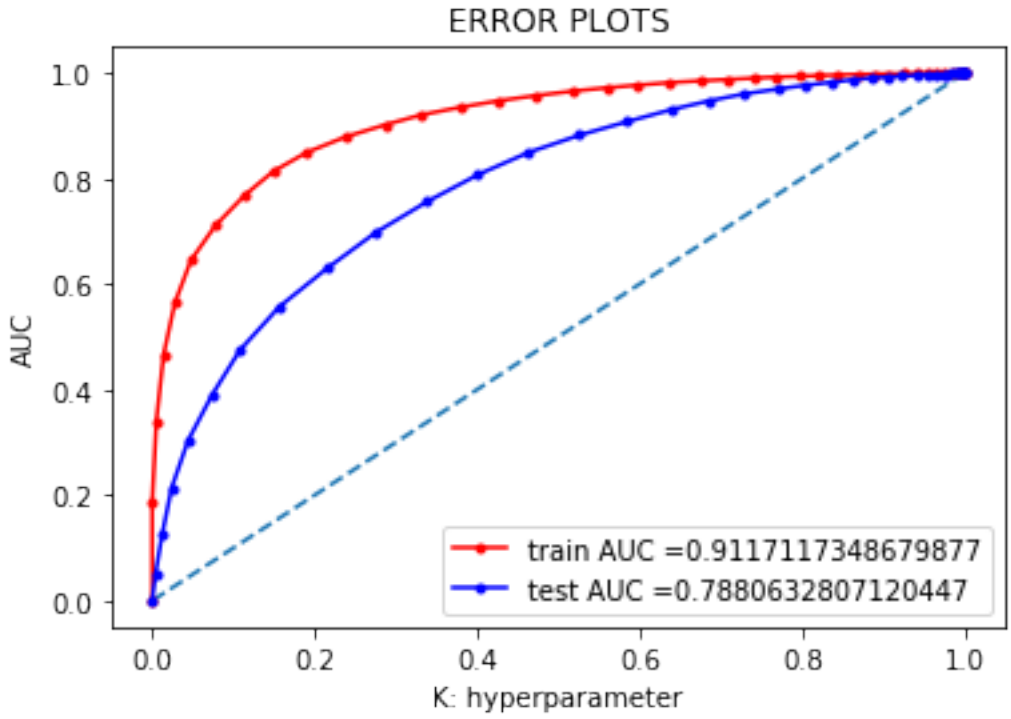
```
        # plot confusion matrix

        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(knn_optimal,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
```

```
yes exist

Confusion Matrix for Train data
```



Confusion Matrix for Test data





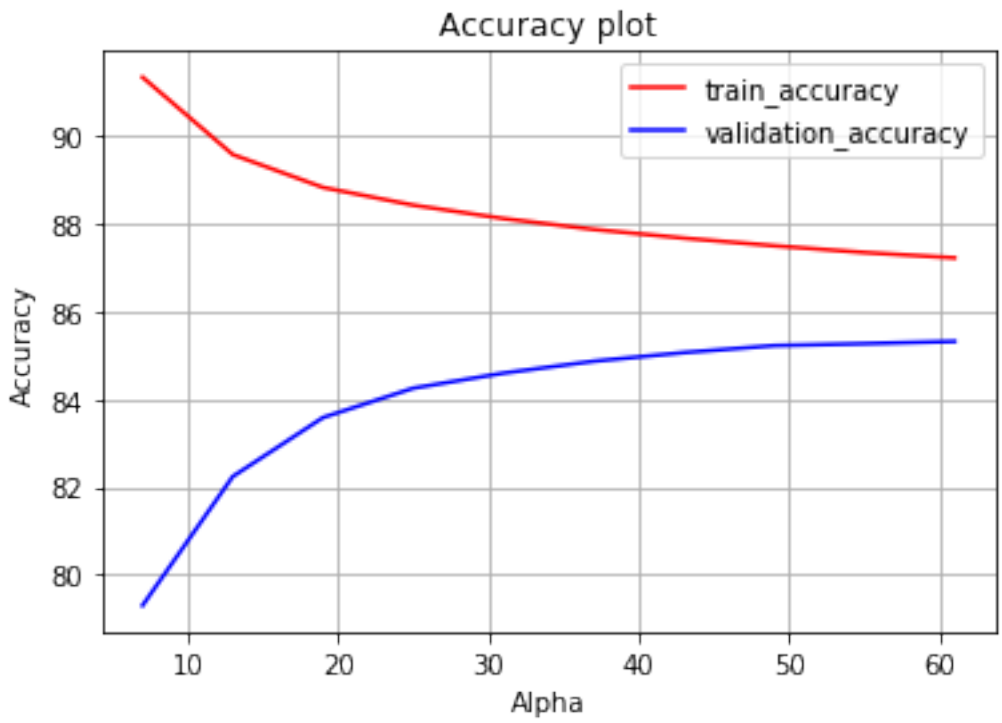

```
AUC (Train): 0.9117117348679877

AUC (Test): 0.7880632807120447

F1 SCORE (Train) : 0.931368768934178

F1 SCORE (Test) : 0.9172084775816939

RECALL (Train): 0.9852198570540709

RECALL (Test): 0.9828537821208831

PRECISION  (Train) : 0.8830994742522893

PRECISION  (Test) : 0.8597831249010607
```

6.1.4 [5.1.4] Applying KNN brute force on TFIDF W2V, using GridSearchCV

```
In [242]: path_w2v_tfidf_train = '/home/pranay/Amazon Assignments/KNN/W2V TFIDF/w2v_tfidf_brute
```

```
exists = os.path.isfile(path_w2v_tfidf_train)
if exists:
    print("yes exist")
    w2v_tfidf_train = load(path_w2v_tfidf_train)

else:
    print("not exist")
    w2v_tfidf_train = finding_best_k(final_tfidf_w2v_tr,y_train,'brute')
    dump(w2v_tfidf_train,path_w2v_tfidf_train )

# 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_)

plotAccuracyGraph(w2v_tfidf_train)
```

```
yes exist
=======Training========
0.8531849168462964
{'n_neighbors': 61}
KNeighborsClassifier(algorithm='brute', leaf_size=30, metric='minkowski',
           metric_params=None, n_jobs=None, n_neighbors=61, p=2,
           weights='uniform')
```

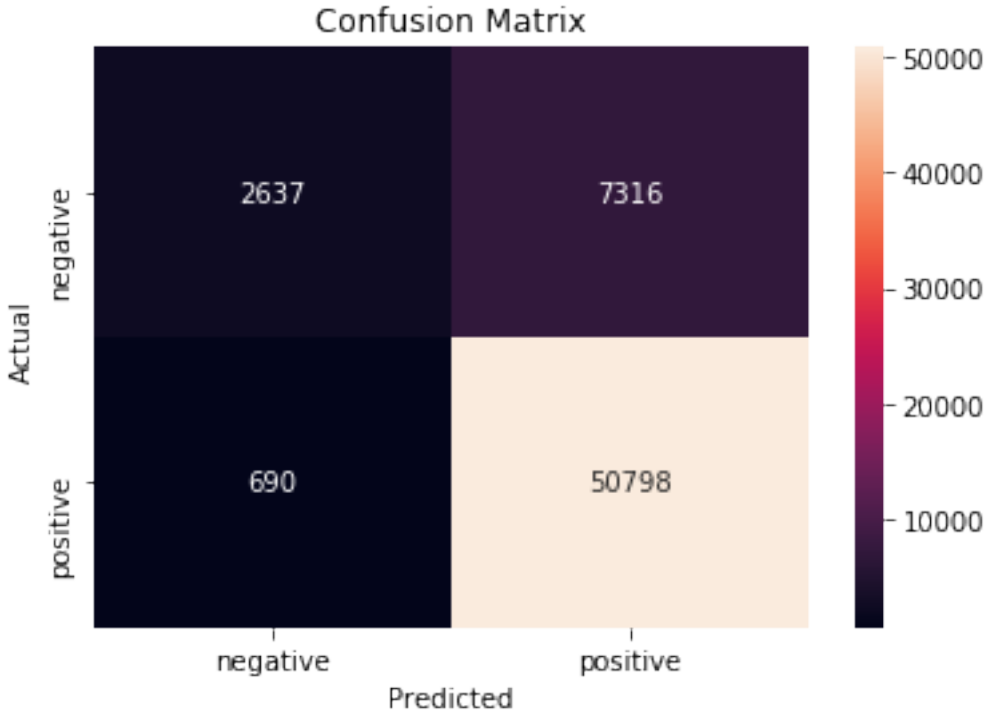


In [243]:
```
path_w2v_tfidf_optimal = '/home/pranay/Amazon Assignments/KNN/W2V TFIDF/w2v_tfidf_bru

# best_k_value = w2v_tfidf_train.best_params_.get('n_neighbors')

exists = os.path.isfile(path_w2v_tfidf_optimal)
if exists:
    print("yes exist")
    knn_optimal = load(path_w2v_tfidf_optimal)
    # predict the response
    test_pred = knn_optimal.predict(final_tfidf_w2v_test)
    train_pred = knn_optimal.predict(final_tfidf_w2v_tr)

else:
    print("not exist")
    knn_optimal= train_with_optimal_k(40,'brute') # it will return trained model wit

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

    # predict the response
    test_pred = knn_optimal.predict(final_tfidf_w2v_test)
    train_pred = knn_optimal.predict(final_tfidf_w2v_tr)
    dump(knn_optimal,path_w2v_tfidf_optimal)

# 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(knn_optimal,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_score
```

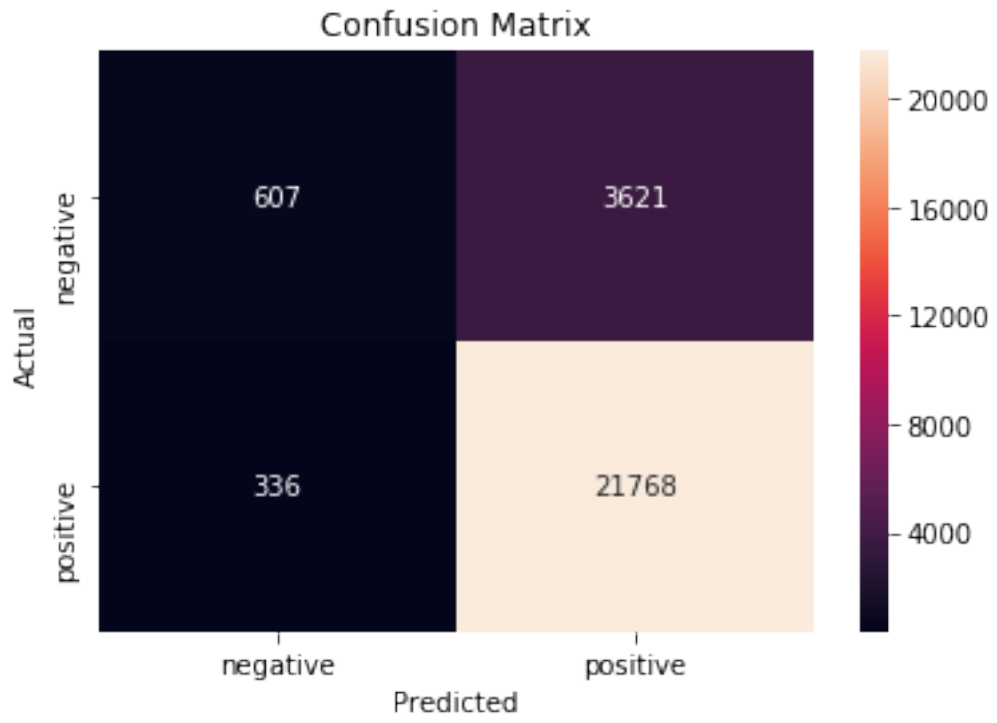
```
        print('\n'+color.RED+'RECALL (Test): '+color.END+color.BOLD+str(recall)+color.END)

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

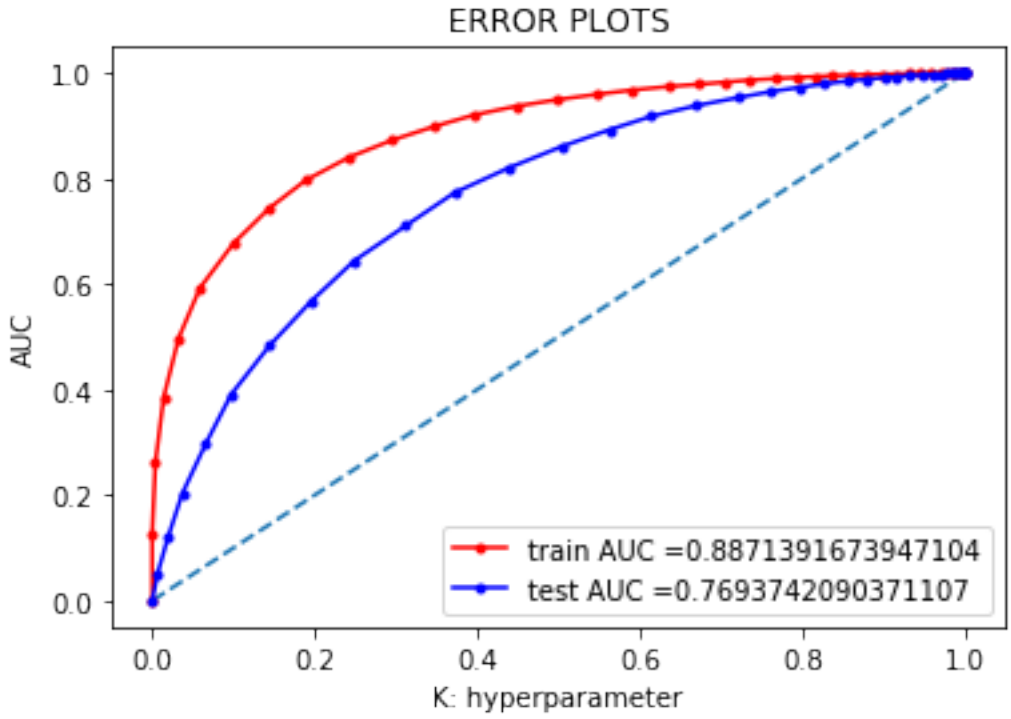
```
yes exist
```

Confusion Matrix for Train data



Confusion Matrix for Test data


Confusion Matrix
607
3621
336
21768
negative
positive
Actual
negative
positive
Predicted
20000
16000
12000
8000
4000


ERROR PLOTS
AUC
K: hyperparameter
train AUC =0.8871391673947104
test AUC =0.7693742090371107
0.0
0.2
0.4
0.6
0.8
1.0

```
AUC (Train): 0.8871391673947104

AUC (Test): 0.7693742090371107

F1 SCORE (Train) : 0.9269538877027791

F1 SCORE (Test) : 0.9166824584675637

RECALL (Train): 0.9865988191423244

RECALL (Test): 0.9847991313789359

PRECISION  (Train) : 0.8741095088963072

PRECISION  (Test) : 0.8573791799598252
```

6.2 [5.2] Applying KNN kd-tree

6.2.1 Note : For KD-Tree algorithm, we have trained model on '33k' points and top 5000 feautes only

```
In [244]: X = final['preprocessed_reviews'][:33000]
          y = final['Score'][:33000]

          # 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)
```

```
(26400,) (6600,) (26400,) (6600,)
```

6.2.2 [5.2.1] Applying KNN kd-tree on BOW, using GridSearchCV

```
In [245]: bow_trained_count_vect2='/home/pranay/ML trained models/BoW/bow_trained_count_vect2'

          #BoW

          # Train Vectorizor
          # store model to hard disk if exist then load model directly from memory
          exists = os.path.isfile(bow_trained_model_25000)

          if exists:
              print("yes exist")
              final_bow_count_vect = load(bow_trained_model_25000)
              bow_count_vect = load(bow_trained_count_vect)
              print("the type of count vectorizer ",type(final_bow_count_vect))
```

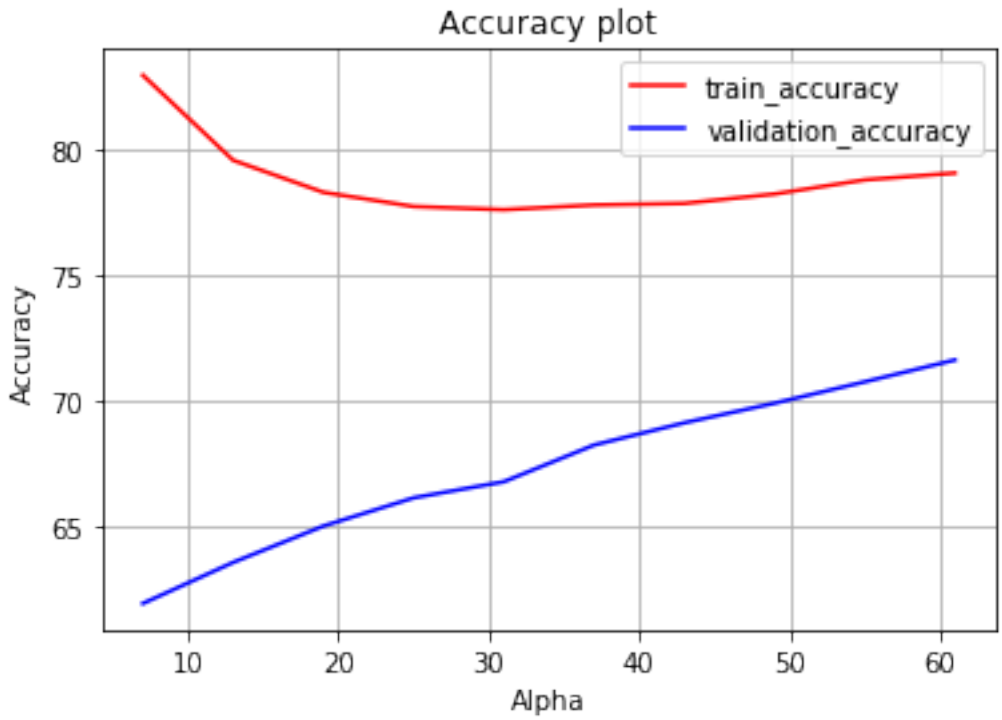
```
        print("the shape of out text BOW vectorizer ",final_bow_count_vect.get_shape())
        print("the number of unique words ", final_bow_count_vect.get_shape()[1])
    else:
        print("not exist")
        bow_count_vect = CountVectorizer(min_df=10, max_features=5000) #in scikit-learn
        bow_count_vect.fit(X_train)
        print("some feature names ", bow_count_vect.get_feature_names()[:10])
        print('='*50)
        final_bow_count_vect = bow_count_vect.fit_transform(X_train)
        print("the type of count vectorizer ",type(final_bow_count_vect))
        print("the shape of out text BOW vectorizer ",final_bow_count_vect.get_shape())
        print("the number of unique words ", final_bow_count_vect.get_shape()[1])
        dump(final_bow_count_vect, bow_trained_model_25000)
        dump(bow_count_vect, bow_trained_count_vect2)


    # Test Vectorizor
    exists = os.path.isfile(bow_test_model_25000)

    if exists:
        final_bow_test = load(bow_test_model_25000)
    else:
        final_bow_test = bow_count_vect.transform(x_test)
        dump(final_bow_test,bow_test_model_25000 )
        final_bow_test.shape
```

```
yes exist
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text BOW vectorizer  (26400, 5000)
the number of unique words  5000
```

```
In [246]: bow_kdtree_train = '/home/pranay/Amazon Assignments/KNN/BOW/bow_kdtree_train'

    exists = os.path.isfile(bow_kdtree_train)
    if exists:
        bow_train = load(bow_kdtree_train)

    else:
        print("not exist")
        bow_train = finding_best_k(final_bow_count_vect,y_train, 'kd_tree')
        dump(bow_train, bow_kdtree_train)

    # 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_)
```

```
plotAccuracyGraph(bow_train)
```

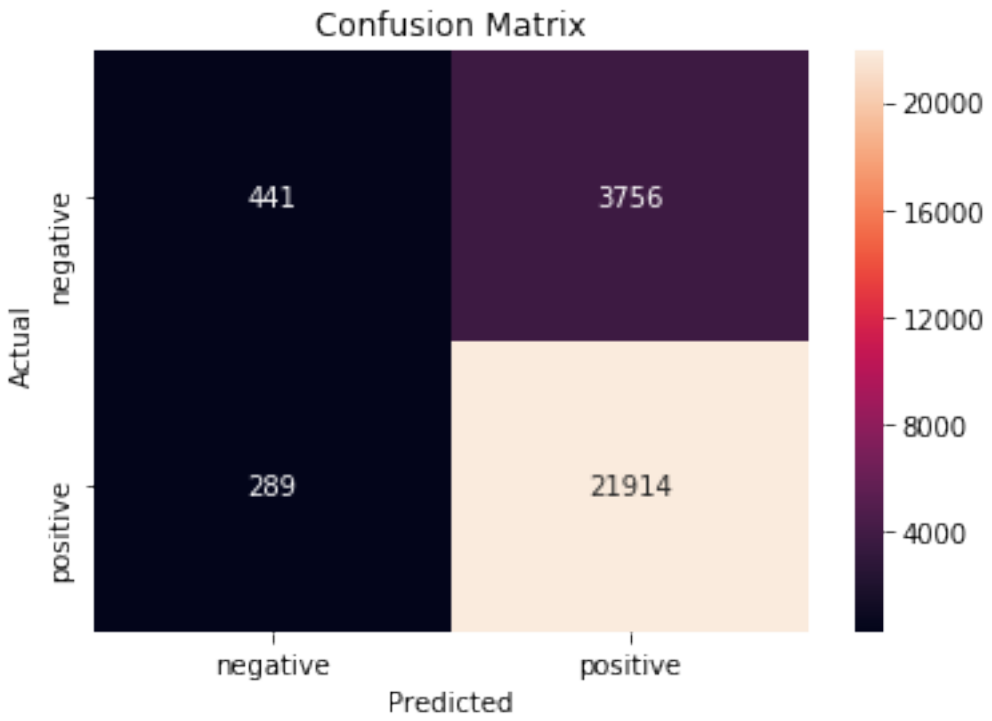
```
=======Training========
0.7165645157303911
{'n_neighbors': 61}
KNeighborsClassifier(algorithm='kd_tree', leaf_size=30, metric='minkowski',
           metric_params=None, n_jobs=None, n_neighbors=61, p=2,
           weights='uniform')
```



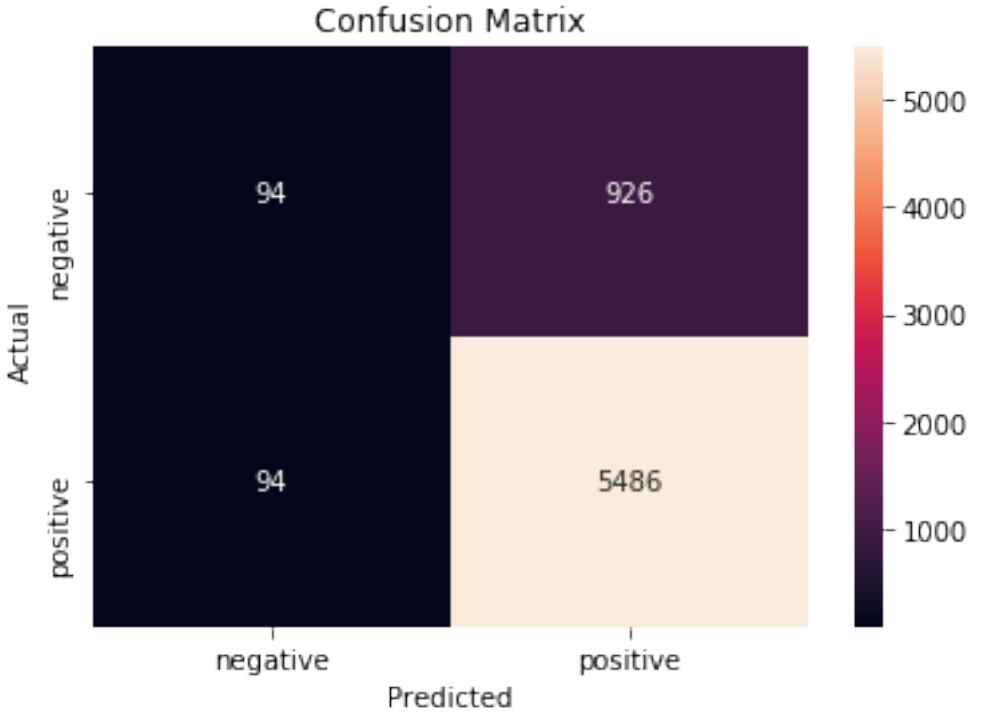
In [247]:
```
path_bow_kdtree_optimal = '/home/pranay/Amazon Assignments/KNN/BOW/bow_kdtree_optimal

exists = os.path.isfile(path_bow_kdtree_optimal)
if exists:
    print("yes exist")
    knn_optimal = load(path_bow_kdtree_optimal)
    # predict the response
    bow_pred = knn_optimal.predict(final_bow_test)
    bow_train_pred = knn_optimal.predict(final_bow_count_vect)

else:
    print("not exist")
    knn_optimal= train_with_optimal_k(best_k_value,'kd_tree') # it will return train
```

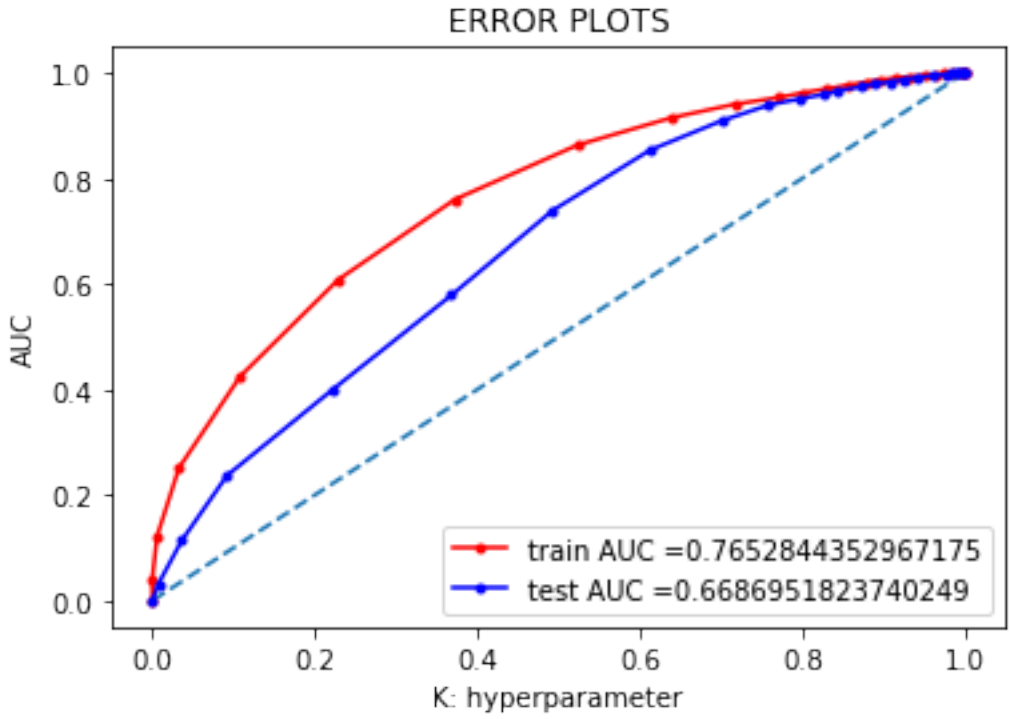
```
            # fitting the model
            knn_optimal.fit(final_bow_count_vect,y_train)

            # predict the response
            bow_pred = knn_optimal.predict(final_bow_test)
            bow_train_pred = knn_optimal.predict(final_bow_count_vect)
            dump(knn_optimal,path_bow_kdtree_optimal)

        # plot confusion matrix

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

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

        # plot AUC
        train_auc, test_auc = plotAUC_ROC(knn_optimal,final_bow_count_vect, y_train ,final_bo
        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,bow_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, bow_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, bow_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
```

```
yes exist

Confusion Matrix for Train data
```



Confusion Matrix for Test data






```
AUC (Train): 0.7652844352967175

AUC (Test): 0.6686951823740249

F1 SCORE (Train) : 0.9155056085893928

F1 SCORE (Test) : 0.9149432955303536

RECALL (Train): 0.9869837409359096

RECALL (Test): 0.9831541218637992

PRECISION  (Train) : 0.8536813400857032

PRECISION  (Test) : 0.8555832813474735
```

6.2.3 [5.2.2] Applying KNN kd-tree on TFIDF, using GridSearchCV

```
In [248]: # Train Vectorizor
          # store model to hard disk if exist then load model directly from memory
```

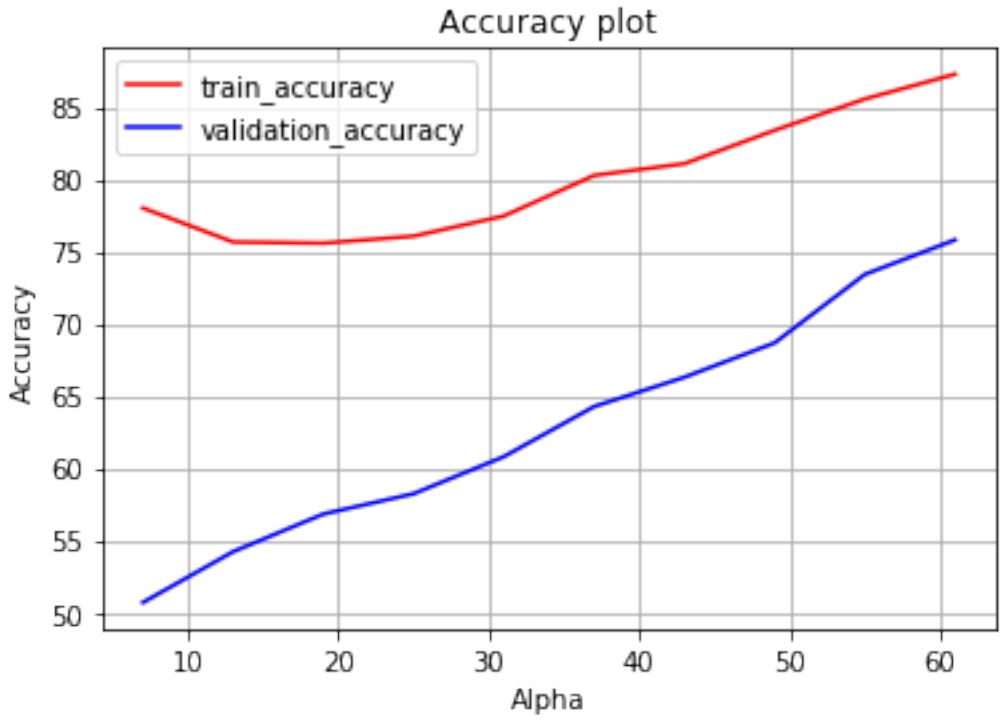
```
        exists = os.path.isfile(tf_idf_trained_model_25000)
        if exists:
            print("yes exist")
            final_tf_idf = load(tf_idf_trained_model_25000)
            tf_idf_vect = load(tfidf_vectorizer)
            print("the type of count vectorizer ",type(final_tf_idf))
            print("the shape of out text TFIDF vectorizer ",final_tf_idf.get_shape())
            print("the number of unique words including both unigrams and bigrams ", final_t

        else:
            print("not exist")
            tf_idf_vect = TfidfVectorizer(ngram_range=(1,2), min_df=10,max_features=5000)
            tf_idf_vect.fit(X_train)
            print("some sample features(unique words in the corpus)",tf_idf_vect.get_feature_
            print('='*50)

            final_tf_idf = tf_idf_vect.transform(X_train)
            print("the type of count vectorizer ",type(final_tf_idf))
            print("the shape of out text TFIDF vectorizer ",final_tf_idf.get_shape())
            print("the number of unique words including both unigrams and bigrams ", final_t
            dump(final_tf_idf, tf_idf_trained_model_25000)
            dump(tf_idf_vect, tfidf_vectorizer)


        # Test Vectorizor

        exists = os.path.isfile(tf_idf_test_model_25000)

        if exists:
            print("yes exist")
            final_tfidf_test = load(tf_idf_test_model_25000)
        else:
            print("not exist")
            final_tfidf_test = tf_idf_vect.transform(x_test)
            dump(final_tfidf_test,tf_idf_test_model_25000 )
            final_tfidf_test.shape
```

```
yes exist
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text TFIDF vectorizer  (26400, 5000)
the number of unique words including both unigrams and bigrams  5000
yes exist
```

```
In [249]: path_tfidf_train = '/home/pranay/Amazon Assignments/KNN/TFIDF/tfidf_kdtree_train'

          exists = os.path.isfile(path_tfidf_train)
          if exists:
```

```
            tfidf_train = load(path_tfidf_train)
        else:
            print("not exist")
            tfidf_train = finding_best_k(final_tf_idf,y_train, 'kd_tree')
            dump(tfidf_train,path_tfidf_train)

        # 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_)

        plotAccuracyGraph(tfidf_train)
```

```
=======Training========
0.757998306854127
{'n_neighbors': 61}
KNeighborsClassifier(algorithm='kd_tree', leaf_size=30, metric='minkowski',
           metric_params=None, n_jobs=None, n_neighbors=61, p=2,
           weights='uniform')
```



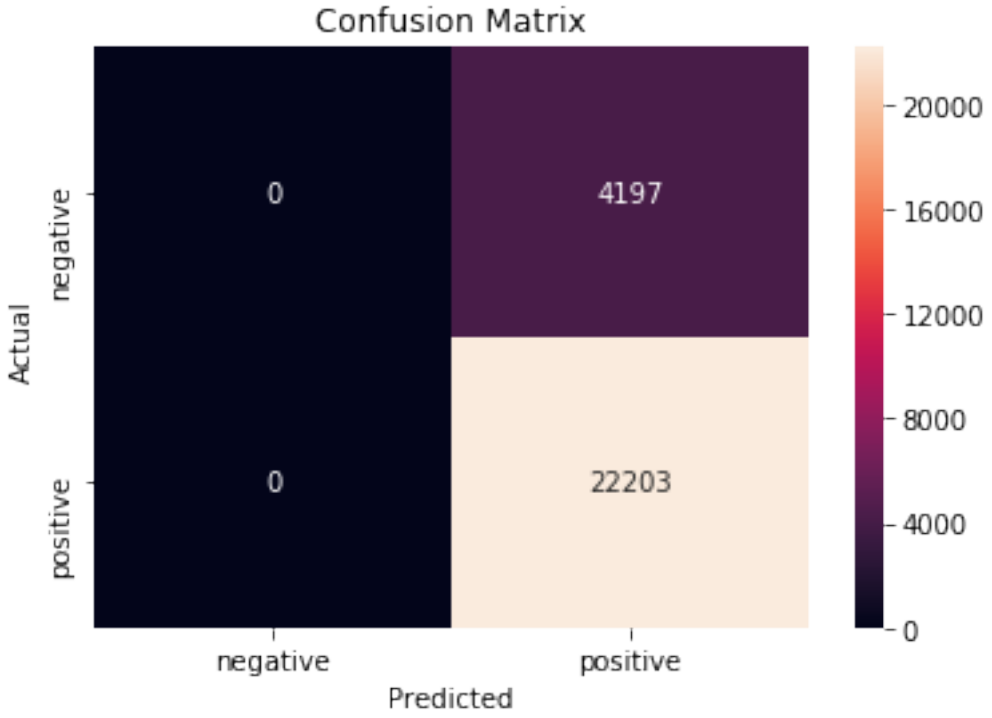
In [250]: final_tf_idf.shape, y_train.shape,final_tfidf_test.shape,y_test.shape

Out[250]: ((26400, 5000), (26400,), (6600, 5000), (6600,))

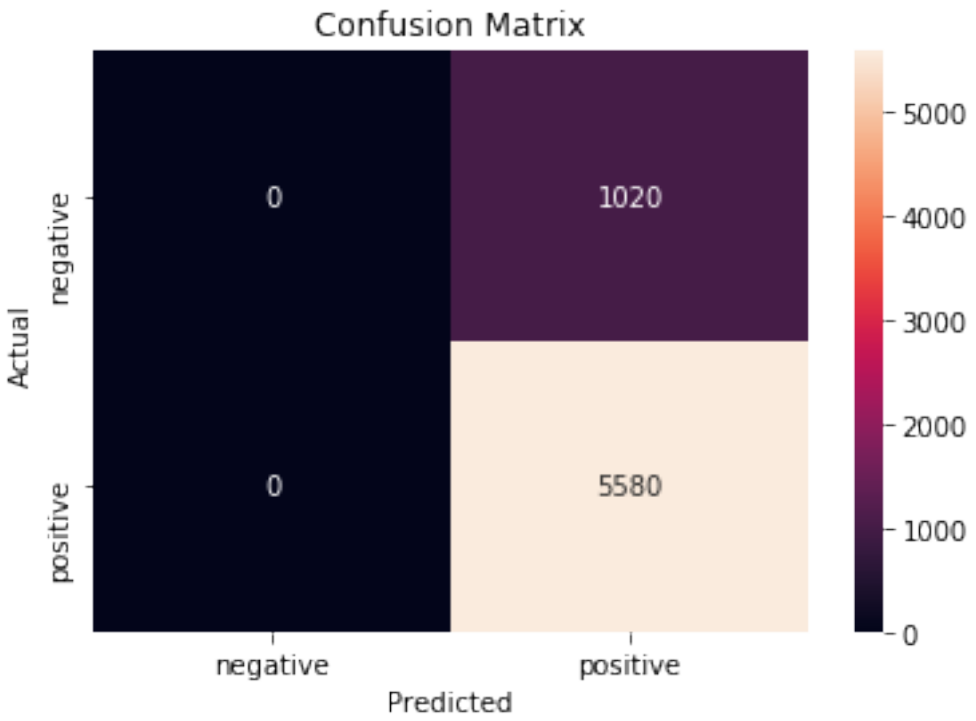
In [251]:
```
path_tfidf_kdtree_optimal = '/home/pranay/Amazon Assignments/KNN/TFIDF/tfidf_kdtree_

exists = os.path.isfile(path_tfidf_kdtree_optimal)

if exists:
    knn_optimal = load(path_tfidf_kdtree_optimal)

else:
    knn_optimal= train_with_optimal_k(35,'kd_tree') # it will return trained model w

    # fitting the model
    knn_optimal.fit(final_tf_idf, y_train)

    dump(knn_optimal, path_tfidf_kdtree_optimal)

# # instantiate learning model k = optimal_k
# knn_optimal = KNeighborsClassifier(n_neighbors=15 , algorithm = 'kd_tree')


# # fitting the model
# knn_optimal.fit(final_tf_idf, y_train)

# predict the response
tfidf_pred = knn_optimal.predict(final_tfidf_test)
tfidf_train_pred = knn_optimal.predict(final_tf_idf)

# dump(knn_optimal, path_tfidf_kdtree_optimal)

# plot confusion matrix

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

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

# plot AUC
train_auc,test_auc = plotAUC_ROC(knn_optimal,final_tf_idf, y_train,final_tfidf_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,tfidf_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, tfidf_pred)
```

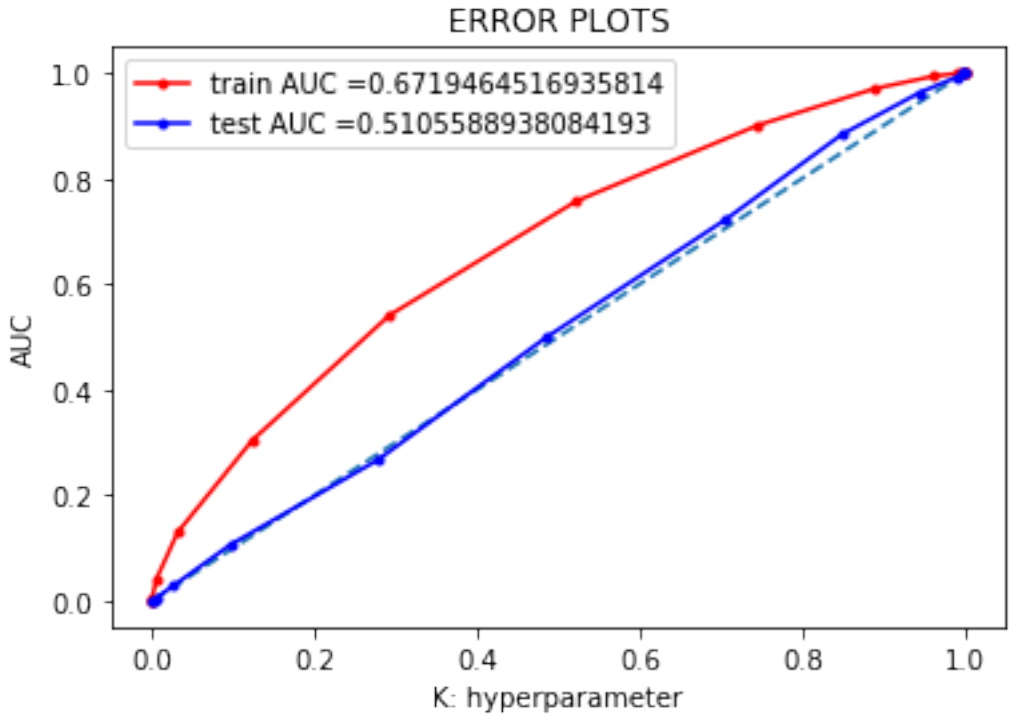
```
print('\n'+color.RED+'RECALL (Train): '+color.END+color.BOLD+str(metrics.recall_score
print('\n'+color.RED+'RECALL (Test): '+color.END+color.BOLD+str(recall)+color.END)

# precision
precision = metrics.precision_score(y_test, tfidf_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
0
1020
0
5580
negative
positive
Actual
negative
positive
Predicted
5000
4000
3000
2000
1000
0


ERROR PLOTS
train AUC =0.6719464516935814
test AUC =0.5105588938084193
AUC
K: hyperparameter
0.0
0.2
0.4
0.6
0.8
1.0

```
AUC (Train): 0.6719464516935814

AUC (Test): 0.5105588938084193

F1 SCORE (Train) : 0.913647305721869

F1 SCORE (Test) : 0.916256157635468

RECALL (Train): 1.0

RECALL (Test): 1.0

PRECISION  (Train) : 0.8410227272727273

PRECISION  (Test) : 0.8454545454545455
```

6.2.4 [5.2.3] Applying KNN kd-tree on AVG W2V, using GridSearchCV

In [252]:
```
# 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())

        # 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)


        # 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])

        # 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])
```

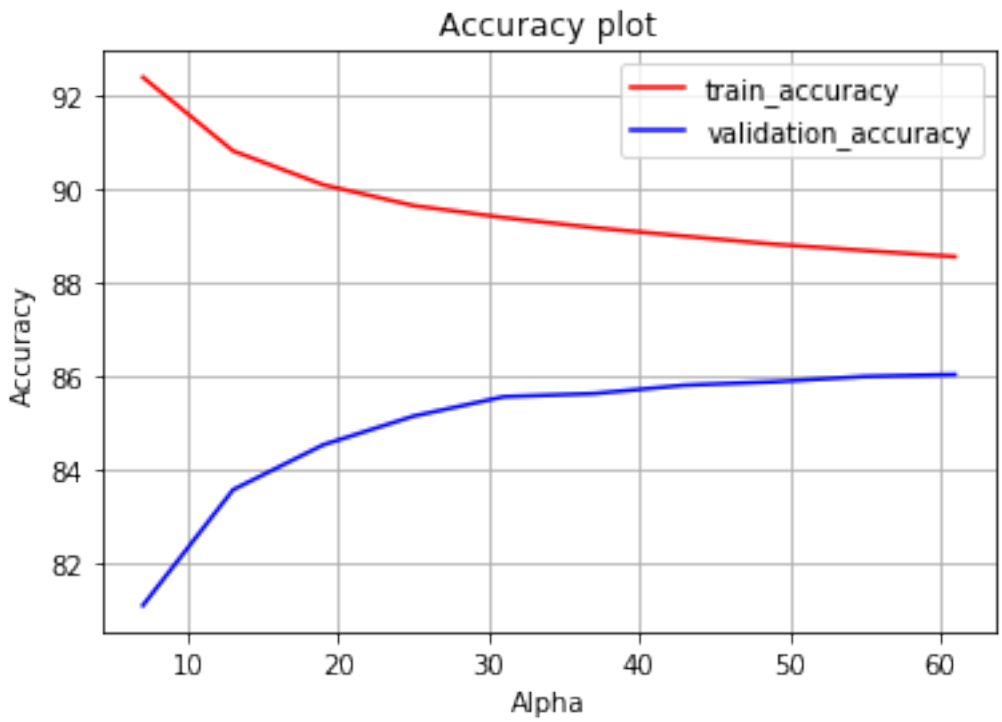
```
# average Word2Vec

# train data operation
exists = os.path.isfile(avg_w2v_trained_model_25000)

if exists:
    print("yes exist")
    final_w2v_train = load(avg_w2v_trained_model_25000)
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_25000)


# test data operation
exists = os.path.isfile(avg_w2v_test_model_25000)

if exists:
    print("yes exist")
    final_w2v_test = load(avg_w2v_test_model_25000)
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_25000)
```

```
number of words that occured minimum 5 times  9823
sample words  ['cereal', 'rice', 'awesome', 'daughter', 'loves', 'good', 'buy', 'target', 'way
number of words that occured minimum 5 times  4834
sample words  ['haribo', 'makes', 'wide', 'range', 'candies', 'including', 'world', 'class', 'g
yes exist
yes exist
```

In [253]:
```
path_w2v_kdtree_train = '/home/pranay/Amazon Assignments/KNN/W2V/w2v_kdtree_train'

exists = os.path.isfile(path_w2v_kdtree_train)
if exists:
    w2v_train = load(path_w2v_kdtree_train)

else:
    print("not exist")
    w2v_train = finding_best_k(final_w2v_train,y_train, 'kd_tree')
    dump(w2v_train,path_w2v_kdtree_train)

# 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_)

plotAccuracyGraph(w2v_train)
```

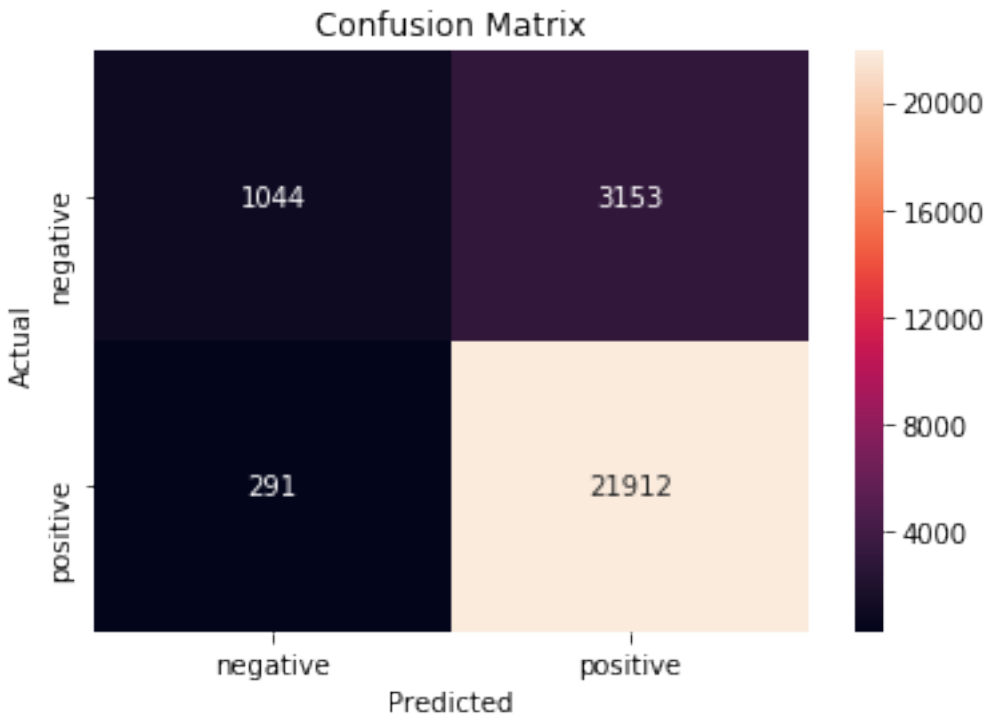
```
=======Training========
0.8602306953513348
{'n_neighbors': 61}
KNeighborsClassifier(algorithm='kd_tree', leaf_size=30, metric='minkowski',
           metric_params=None, n_jobs=None, n_neighbors=61, p=2,
           weights='uniform')
```



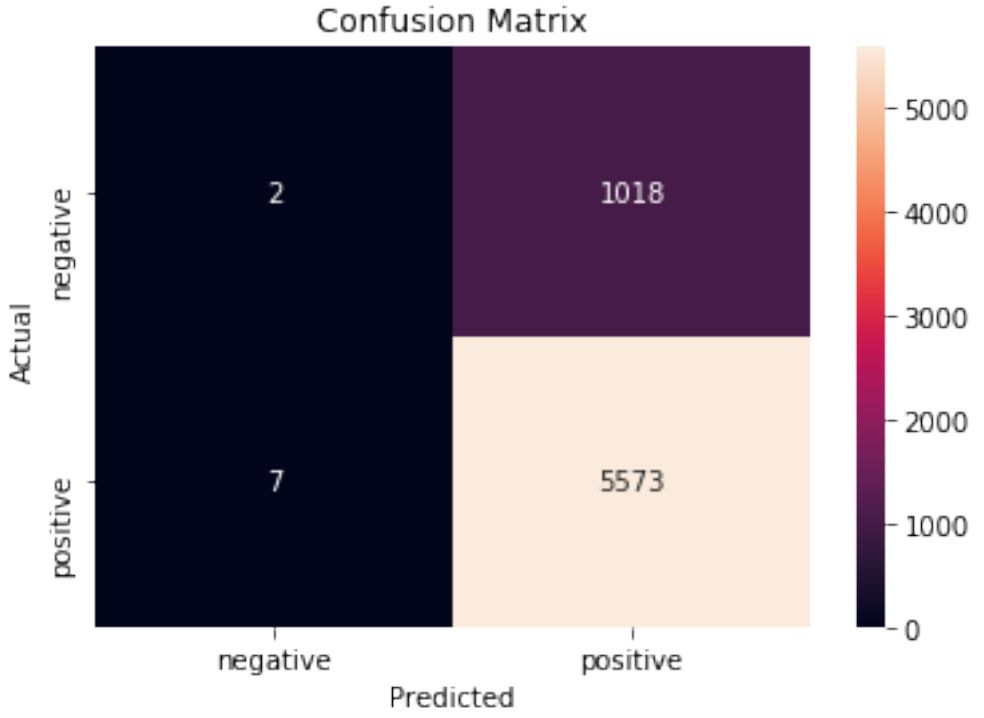
In [254]:
```
path_w2v_kdtree_optimal = '/home/pranay/Amazon Assignments/KNN/W2V/w2v_kdtree_optimal

exists = os.path.isfile(path_w2v_kdtree_optimal)
if exists:
    print("yes exist")
    knn_optimal = load(path_w2v_kdtree_optimal)

else:
    print("not exist")

    knn_optimal= train_with_optimal_k(45,'kd_tree') # it will return trained model w

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

# knn_optimal = KNeighborsClassifier(n_neighbors=30 , algorithm = 'kd_tree')

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

# predict the response
test_pred = knn_optimal.predict(final_w2v_test)
train_pred = knn_optimal.predict(final_w2v_train)
# dump(knn_optimal, path_w2v_kdtree_optimal)
```

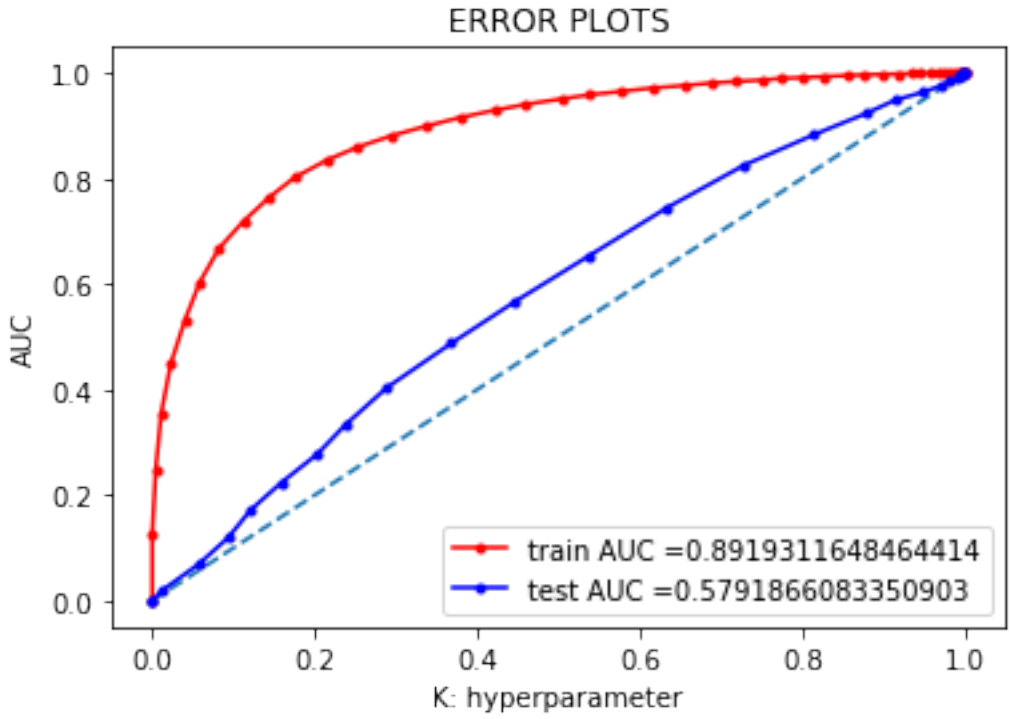
```
        # plot confusion matrix

        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(knn_optimal,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
```

```
not exist

Confusion Matrix for Train data
```




```
Confusion Matrix for Test data
```






```
AUC (Train): 0.8919311648464414

AUC (Test): 0.5791866083350903

F1 SCORE (Train) : 0.9271388677329272

F1 SCORE (Test) : 0.9157834196039766

RECALL (Train): 0.986893663018511

RECALL (Test): 0.9987455197132616

PRECISION  (Train) : 0.8742070616397367

PRECISION  (Test) : 0.8455469579729935
```

6.2.5 [5.2.4] Applying KNN kd-tree on TFIDF W2V, using GridSearchCV

```
In [255]: # 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_25000)

if exists:
    print("yes exist")
    final_tfidf_w2v_tr = load(w2v_tf_idf_trained_model_25000)
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 t
    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_25000)


# 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_25000)

if exists:
    print("yes exist")
    final_tfidf_w2v_test = load(w2v_tf_idf_test_model_25000)

else:
    print("not exist")
```

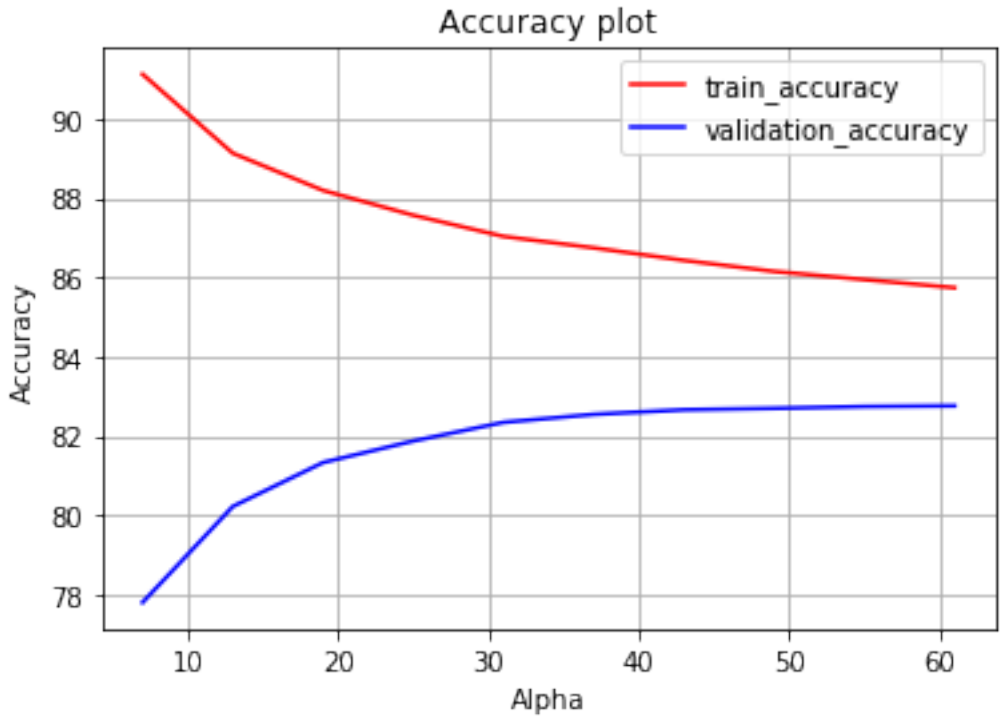
```
    # final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val =
    final_tfidf_w2v_test = []; # the tfidf-w2v for each sentence/review is stored in
    row=0;
    for sent in tqdm(list_of_test_sentence): # for each review/sentence
        sent_vec = np.zeros(50) # as word vectors 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_25000)
```

```
yes exist
yes exist
```

In [256]:
```
path_w2v_tfidf_kdtree_train = '/home/pranay/Amazon Assignments/KNN/W2V TFIDF/w2v_tfi

exists = os.path.isfile(path_w2v_tfidf_kdtree_train)
if exists:
    print("yes exist")
    w2v_tfidf_train = load(path_w2v_tfidf_kdtree_train)
else:
    print("not exist")
    w2v_tfidf_train = finding_best_k(final_tfidf_w2v_tr,y_train, 'kd_tree')
    dump(w2v_tfidf_train,path_w2v_tfidf_kdtree_train )

# 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_)

plotAccuracyGraph(w2v_tfidf_train)
```

```
yes exist
=======Training========
```

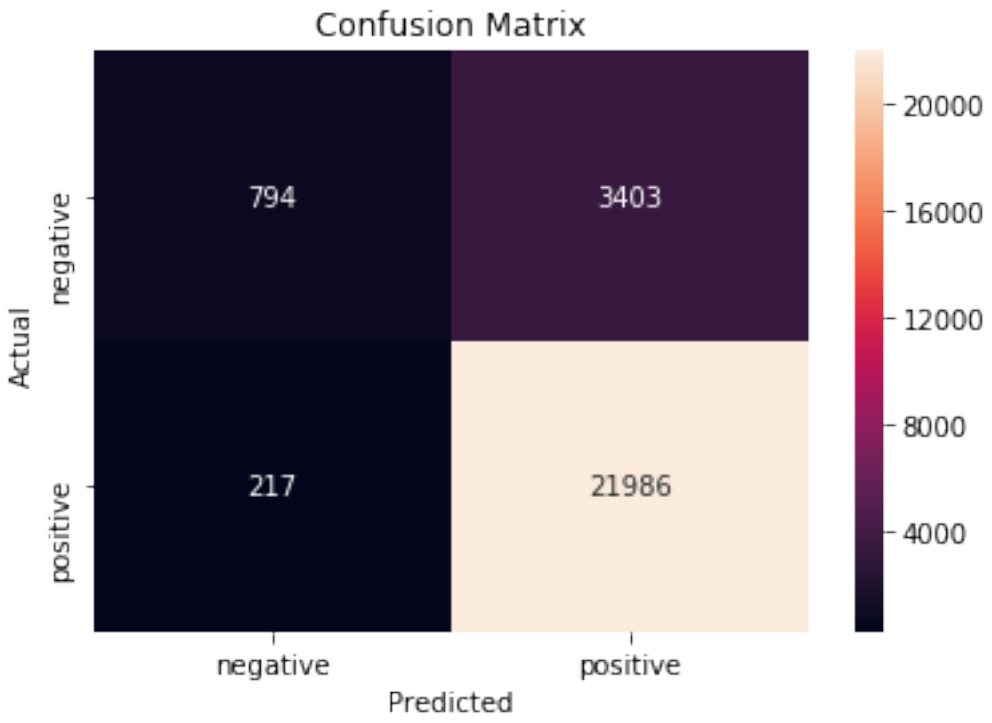
```
0.8276248326019916
{'n_neighbors': 61}
KNeighborsClassifier(algorithm='kd_tree', leaf_size=30, metric='minkowski',
           metric_params=None, n_jobs=None, n_neighbors=61, p=2,
           weights='uniform')
```



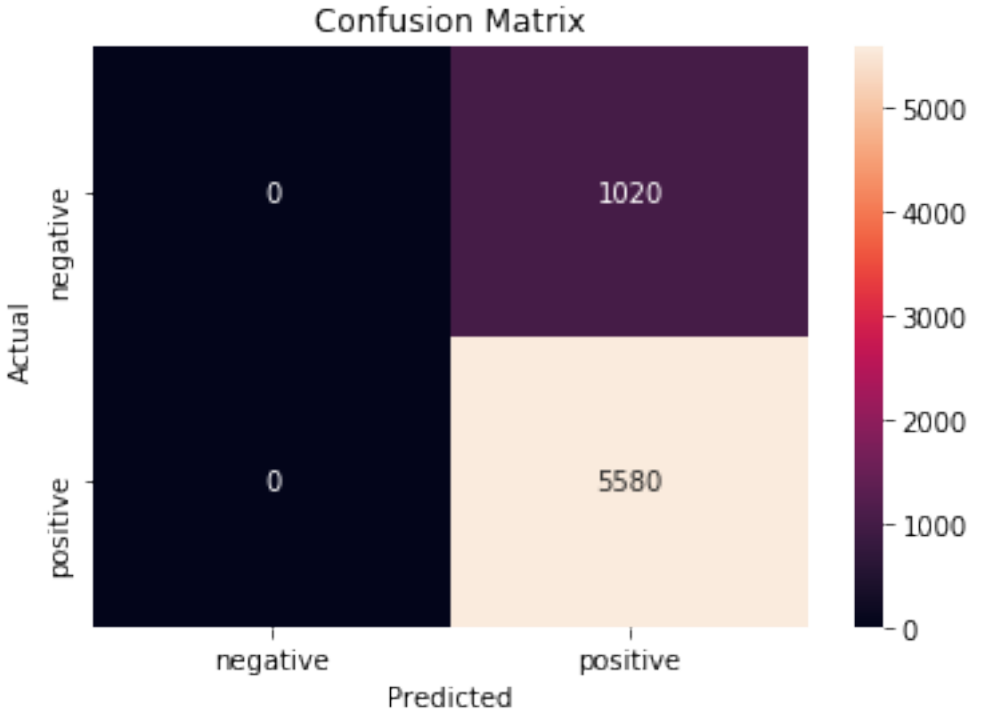

```
In [257]: path_w2v_tfidf_kdtree_optimal = '/home/pranay/Amazon Assignments/KNN/W2V TFIDF/w2v_t

          exists = os.path.isfile(path_w2v_tfidf_kdtree_optimal)
          if exists:
              print("yes exist")
              knn_optimal = load(path_w2v_tfidf_kdtree_optimal)

          else:
              print("not exist")

              knn_optimal= train_with_optimal_k(43,'kd_tree') # it will return trained model w

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

              # predict the response
              dump(knn_optimal,path_w2v_tfidf_kdtree_optimal)
```

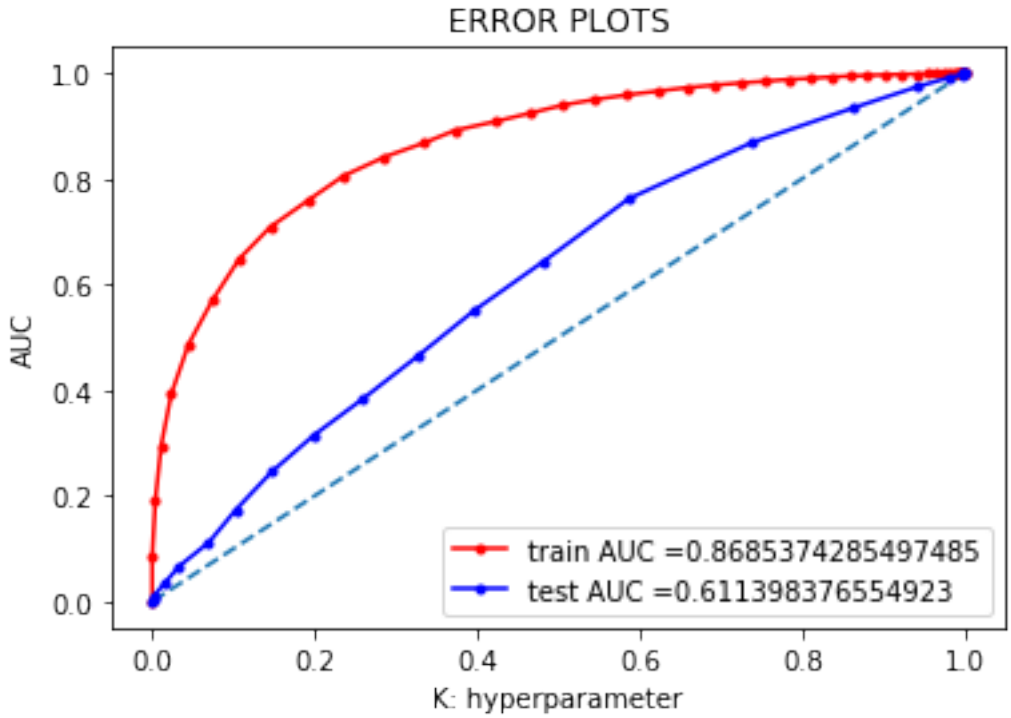
```
        # knn_optimal = KNeighborsClassifier(n_neighbors=49 , algorithm = 'kd_tree')

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

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

        # dump(knn_optimal,path_w2v_tfidf_kdtree_optimal)

        # 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(knn_optimal,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_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
```

```
yes exist

Confusion Matrix for Train data
```



Confusion Matrix for Test data





AUC (Train): 0.8685374285497485

AUC (Test): 0.611398376554923

F1 SCORE (Train) : 0.9239367961001849

F1 SCORE (Test) : 0.916256157635468

RECALL (Train): 0.9902265459622573

RECALL (Test): 1.0

PRECISION (Train) : 0.865965575642995

PRECISION (Test) : 0.8454545454545455

7 [6] Conclusions

In [260]:
```
import pandas as pd
print(color.BOLD+'KNN Brute Force, trained on 100k Points')
dataframe = pd.DataFrame(
{
    "Model": ['BOW','TF-IDF','Avg W2V','AVG W2V-TFIDF'],
    "K value": [30,30,35,37],
    "AUC": [0.6932,0.5124,0.7830,0.7693],
    "F1- Score ": [0.9104,0.9122,0.9172,0.9166],
    "Recall ": [0.9725,0.999,0.98285,0.98647],
    "Precision ": [0.8562,0.8393,0.85978,0.8573],
}

)
dataframe
```

KNN Brute Force, trained on 100k Points

Out[260]:

	Model	K value	AUC	F1- Score	Recall	Precision
0	BOW	30	0.6932	0.9104	0.97250	0.85620
1	TF-IDF	30	0.5124	0.9122	0.99900	0.83930
2	Avg W2V	35	0.7830	0.9172	0.98285	0.85978
3	AVG W2V-TFIDF	37	0.7693	0.9166	0.98647	0.85730

In [261]:
```
print(color.BOLD+'KNN KD-Tree, trained on 33k Points')
dataframe = pd.DataFrame(
{
    "Model": ['BOW','TF-IDF','Avg W2V','AVG W2V-TFIDF'],
    "K value": [30,35,45,43],
    "AUC": [0.6686,0.5105,0.5791,0.6113],
    "F1- Score ": [0.9149,0.9162,0.9157,0.91625],
    "Recall ": [0.9831,1.0,0.9987,1.0],
    "Precision ": [0.8558,0.84545,0.8455,0.84548],
}
)
dataframe
```

KNN KD-Tree, trained on 33k Points

Out[261]:

	Model	K value	AUC	F1- Score	Recall	Precision
0	BOW	30	0.6686	0.91490	0.9831	0.85580
1	TF-IDF	35	0.5105	0.91620	1.0000	0.84545
2	Avg W2V	45	0.5791	0.91570	0.9987	0.84550
3	AVG W2V-TFIDF	43	0.6113	0.91625	1.0000	0.84548

In [ ]: