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.

[1]. Reading Data

[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 [0]:

```
%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.model_selection import train_test_split

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
```

In [4]:

```
# need to mount with drive
from google.colab import drive
drive.mount('/content/drive')
```

```
Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_id=947318989803-6bn6
qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercontent.com&redirect_uri=urn%3Aietf%3Awg%3Aoauth%3A2.0%
b&scope=email%20https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fdocs.test%20https%3A%2F%2Fwww.googleapis.
2Fauth%2Fdrive%20https%3A%2F%2Fwww.googleapis.com%2Fauth%2Fdrive.photos.readonly%20https%3A%2F%2Fww
ogleapis.com%2Fauth%2Fpeopleapi.readonly&response_type=code

Enter your authorization code:
··········
Mounted at /content/drive
```

In [5]:

```
# using SQLite Table to read data.
#while using with drive copy the path from copy path by right clicking the database.sqlite file
con = sqlite3.connect('drive/My Drive/Colab Notebooks/Assign - 3/database.sqlite')

filtered_data = pd.read_sql_query(""" SELECT * FROM Reviews WHERE Score != 3 LIMIT 100000  """,
con)

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[5]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDenominator	Score	Time
0	1	B001E4KFG0	A3SGXH7AUHU8GW	delmartian	1	1	1	130386240(

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDenominator	Score	Time
1	2	B00813GRG4	A1D87F6ZCVE5NK	dll pa	0	0	0	1346976000
2	3	B000LQOCH0	ABXLMWJIXXAIN	Natalia Corres "Natalia Corres"	1	1	1	1219017600

In [0]:

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

In [7]:

```
print(display.shape)
display.head()
```

```
(80668, 7)
```

Out[7]:

	UserId	ProductId	ProfileName	Time	Score	Text	COUNT(*)
0	#oc-R115TNMSPFT9I7	B007Y59HVM	Breyton	1331510400	2	Overall its just OK when considering the price...	2
1	#oc-R11D9D7SHXIJB9	B005HG9ET0	Louis E. Emory "hoppy"	1342396800	5	My wife has recurring extreme muscle spasms, u...	3
2	#oc-R11DNU2NBKQ23Z	B007Y59HVM	Kim Cieszykowski	1348531200	1	This coffee is horrible and unfortunately not ...	2
3	#oc-R11O5J5ZVQE25C	B005HG9ET0	Penguin Chick	1346889600	5	This will be the bottle that you grab from the...	3
4	#oc-R12KPBODL2B5ZD	B007OSBE1U	Christopher P. Presta	1348617600	1	I didnt like this coffee. Instead of telling y...	2

In [8]:

```
display[display['UserId']=='AZY10LLTJ71NX']
```

Out[8]:

	UserId	ProductId	ProfileName	Time	Score	Text	COUNT(*)
80638	AZY10LLTJ71NX	B006P7E5ZI	undertheshrine "undertheshrine"	1334707200	5	I was recommended to try green tea extract to ...	5

In [9]:

```
display['COUNT(*)'].sum()
```

Out[9]:

393063

[2] Exploratory Data Analysis

[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 [10]:

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

Out[10]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDenominator	Score	Ti
0	78445	B000HDL1RQ	AR5J8UI46CURR	Geetha Krishnan	2	2	5	1199577
1	138317	B000HDOPYC	AR5J8UI46CURR	Geetha Krishnan	2	2	5	1199577
2	138277	B000HDOPYM	AR5J8UI46CURR	Geetha Krishnan	2	2	5	1199577
3	73791	B000HDOPZG	AR5J8UI46CURR	Geetha Krishnan	2	2	5	1199577
4	155049	B000PAQ75C	AR5J8UI46CURR	Geetha Krishnan	2	2	5	1199577

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 [0]:

```
#Sorting data according to ProductId in ascending order
sorted_data=filtered_data.sort_values('ProductId', axis=0, ascending=True, inplace=False, kind='quicksort', na_position='last')
```

In [12]:

```
#Deduplication of entries
final=sorted_data.drop_duplicates(subset={"UserId","ProfileName","Time","Text"}, keep='first', inplace=False)
final.shape
```

Out[12]:

```
(87775, 10)
```

In [13]:

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

Out[13]:

```
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 [14]:

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

display.head()
```

Out[14]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDenominator	Score	Ti
0	64422	B000MIDROQ	A161DK06JJMCYF	J. E. Stephens "Jeanne"	3	1	5	1224892
1	44737	B001EQ55RW	A2V0I904FH7ABY	Ram	3	2	4	1212883

In [0]:

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

In [16]:

In [16]:

```
#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[16]:

```
1    73592
0    14181
Name: Score, dtype: int64
```

[3] Preprocessing

[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 [17]:

```
# 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 ver
y hard to find any chicken products made in the USA but they are out there, but this one isnt.  It
s too bad too because its a good product but I wont take any chances till they know what is going
on with the china imports.
==================================================
The Candy Blocks were a nice visual for the Lego Birthday party but the candy has little taste to
it.  Very little of the 2 lbs that I bought were eaten and I threw the rest away.  I would not buy
the candy again.
==================================================
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 afraid of
the fishy smell, don't get it. But I think my dog likes it because of the smell. These treats are
really small in size. They are great for training. You can give your dog several of these without
worrying about him over eating. Amazon's price was much more reasonable than any other retailer. Y
ou can buy a 1 pound bag on Amazon for almost the same price as a 6 ounce bag at other retailers.
It's definitely worth it to buy a big bag if your dog eats them a lot.
```

==

In [18]:

```
# 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 ver
y hard to find any chicken products made in the USA but they are out there, but this one isnt.  It
s too bad too because its a good product but I wont take any chances till they know what is going
on with the china imports.
```

In [19]:

```
# https://stackoverflow.com/questions/16206380/python-beautifulsoup-how-to-remove-all-tags-from-an
-element
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 ver
y hard to find any chicken products made in the USA but they are out there, but this one isnt.  It
s too bad too because its a good product but I wont take any chances till they know what is going
on with the china imports.
==================================================
The Candy Blocks were a nice visual for the Lego Birthday party but the candy has little taste to
it.  Very little of the 2 lbs that I bought were eaten and I threw the rest away.  I would not buy
the candy again.
==================================================
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 afraid of
the fishy smell, don't get it. But I think my dog likes it because of the smell. These treats are
really small in size. They are great for training. You can give your dog several of these without
worrying about him over eating. Amazon's price was much more reasonable than any other retailer. Y
ou can buy a 1 pound bag on Amazon for almost the same price as a 6 ounce bag at other retailers.
It's definitely worth it to buy a big bag if your dog eats them a lot.
```

In [0]:

```
# 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 [21]:

```
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 [22]:

```
#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 ver
y hard to find any chicken products made in the USA but they are out there, but this one isnt.  It
s too bad too because its a good product but I wont take any chances till they know what is going
on with the china imports.
```

In [23]:

```
#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 [0]:

```
# 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', 'ourselves', 'you', "y
ou're", "you've",\
            "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', 'him', 'his',
'himself', \
            'she', "she's", 'her', 'hers', 'herself', 'it', "it's", 'its', 'itself', 'they', 'them',
'their',\
            'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that', "that'll",
'these', 'those', \
            'am', 'is', 'are', 'was', 'were', 'be', 'been', 'being', 'have', 'has', 'had', 'having',
'do', 'does', \
            'did', 'doing', 'a', 'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as', 'until', '
while', 'of', \
            'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through', 'during',
'before', 'after',\
            'above', 'below', 'to', 'from', 'up', 'down', 'in', 'out', 'on', 'off', 'over', 'under'
, 'again', 'further',\
            'then', 'once', 'here', 'there', 'when', 'where', 'why', 'how', 'all', 'any', 'both', 'e
ach', 'few', 'more',\
            'most', 'other', 'some', 'such', 'only', 'own', 'same', 'so', 'than', 'too', 'very', \
            's', 't', 'can', 'will', 'just', 'don', "don't", 'should', "should've", 'now', 'd', 'll'
, 'm', 'o', 're', \
            've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't", 'doesn', "d
esn't", 'hadn',\
            "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'mightn',
"mightn't", 'mustn',\
            "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", 'wasn',
"wasn't", 'weren', "weren't", \
```

```
            'won', "won't", 'wouldn', "wouldn't"])
```

[3.2] Preprocessing Review Summary

In [0]:

```
## Similarly you can do preprocessing for review summary also.
```

[5] Assignment 3: KNN

1. **Apply Knn(brute force version) on these feature sets**

   - SET 1:Review text, preprocessed one converted into vectors using (BOW)
   - SET 2:Review text, preprocessed one converted into vectors using (TFIDF)
   - SET 3:Review text, preprocessed one converted into vectors using (AVG W2v)
   - SET 4:Review text, preprocessed one converted into vectors using (TFIDF W2v)

2. **Apply Knn(kd tree version) on these feature sets**
   NOTE: sklearn implementation of kd-tree accepts only dense matrices, you need to convert the sparse matrices of CountVectorizer/TfidfVectorizer into dense matices. You can convert sparse matrices to dense using .toarray() attribute. For more information please visit this link

   - SET 5:Review text, preprocessed one converted into vectors using (BOW) but with restriction on maximum features generated.

     ```
     count_vect = CountVectorizer(min_df=10, max_features=500)
     count_vect.fit(preprocessed_reviews)
     ```

   - SET 6:Review text, preprocessed one converted into vectors using (TFIDF) but with restriction on maximum features generated.

     ```
     tf_idf_vect = TfidfVectorizer(min_df=10, max_features=500)
     tf_idf_vect.fit(preprocessed_reviews)
     ```

   - SET 3:Review text, preprocessed one converted into vectors using (AVG W2v)
   - SET 4:Review text, preprocessed one converted into vectors using (TFIDF W2v)

3. **The hyper paramter tuning(find best K)**

   - Find the best hyper parameter which will give the maximum AUC value
   - Find the best hyper paramter using k-fold cross validation or simple cross validation data
   - Use gridsearch cv or randomsearch cv or you can also write your own for loops to do this task of hyperparameter tuning

4. **Representation of results**

   - You need to plot the performance of model both on train data and cross validation data for each hyper parameter, like shown in the figure
   - Once after you found the best hyper parameter, you need to train your model with it, and find the AUC on test data and plot the ROC curve on both train and test.
   - Along with plotting ROC curve, you need to print the confusion matrix with predicted and original labels of test data points

5. **Conclusion**

   - You need to summarize the results at the end of the notebook, summarize it in the table format. To print out a table please refer to this prettytable library link

Note: Data Leakage

1. There will be an issue of data-leakage if you vectorize the entire data and then split it into train/cv/test.
2. To avoid the issue of data-leakag, make sure to split your data first and then vectorize it.
3. While vectorizing your data, apply the method fit_transform() on you train data, and apply the method transform() on cv/test data.
4. For more details please go through this link.

[5.1] Applying KNN brute force

[5.1.1] Applying KNN brute force on BOW, SET 1

In [0]:

```
# Please write all the code with proper documentation
```

In [25]:

```
final.shape
#final.head(3)
```

Out[25]:

```
(87773, 10)
```

In [26]:

```
# Combining all the above stundents and preprocessing the Review text data
from tqdm import tqdm
preprocessed_reviews = []
# tqdm is for printing the status bar
for sentance in tqdm(final['Text'].values):
    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 stopwords)
    preprocessed_reviews.append(sentance.strip())
```

```
100%|██████████| 87773/87773 [00:39<00:00, 2199.72it/s]
```

In [27]:

```
# Combining all the above stundents and preprocessing the summary data
from tqdm import tqdm
preprocessed_summary = []
# tqdm is for printing the status bar
for sentance in tqdm(final['Summary'].values):
    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 stopwords)
    preprocessed_summary.append(sentance.strip())
```

```
100%|██████████| 87773/87773 [00:28<00:00, 3067.37it/s]
```

In [28]:

```
#added preprocessed reviews
#sample_preproc_revi
final['PreprocessedText'] = preprocessed_reviews
final['PreprocessedSummary'] = preprocessed_summary
final['Final_Text'] = final['PreprocessedText'] + final['PreprocessedSummary']
```

```
final.head(3)
```

Out[28]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDenominator	Score	
22620	24750	2734888454	A13ISQV0U9GZIC	Sandikaye	1	1	0	1192(
22621	24751	2734888454	A1C298ITT645B6	Hugh G. Pritchard	0	0	1	1195(
70677	76870	B00002N8SM	A19Q006CSFT011	Arlielle	0	0	0	1288(

In [0]:

```
#sorting based on time
final["Time"] = pd.to_datetime(final["Time"],unit="s")
final = final.sort_values( by ="Time")
```

In [30]:

```
#splitting data into train , test
X_train, X_test, y_train, y_test = train_test_split(
    final['Final_Text'], final['Score'], test_size=0.30, random_state=0)

X_train_cv, X_cv, y_train_cv, y_cv = train_test_split(X_train, y_train, test_size=0.33)

print(X_train.shape, y_train.shape)
print(X_train_cv.shape,y_train_cv.shape)
print(X_cv.shape, y_cv.shape)
print(X_test.shape, y_test.shape)
```

```
(61441,) (61441,)
(41165,) (41165,)
(20276,) (20276,)
(26332,) (26332,)
```

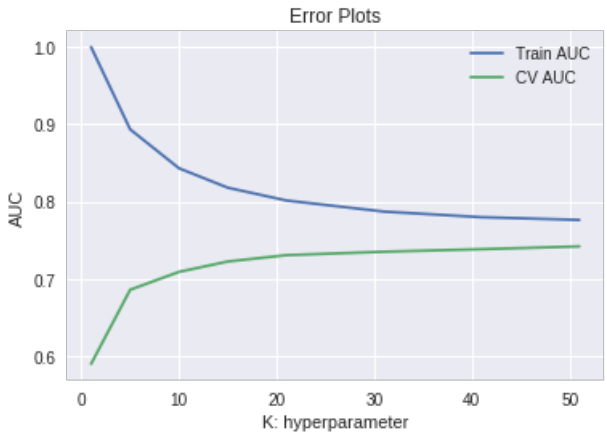
In [34]:

```
vectorizer = CountVectorizer()
vectorizer.fit(X_train_cv)

X_train_cv_bow = vectorizer.transform(X_train_cv)
X_cv_bow = vectorizer.transform(X_cv)
X_test_bow = vectorizer.transform(X_test)

print("After vectorizations")
print(X_train_cv_bow.shape, y_train_cv.shape)
print(X_cv_bow.shape, y_cv.shape)
print(X_test_bow.shape, y_test.shape)
```

```
After vectorizations
(41165, 68770) (41165,)
(20276, 68770) (20276,)
(26332, 68770) (26332,)
```

In [35]:

```
#finding best k- value using loop

from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt


train_auc = []
cv_auc = []
K = [1, 5, 10, 15, 21, 31, 41, 51]
for i in K:
    neigh = KNeighborsClassifier(n_neighbors=i , algorithm = "brute")
    neigh.fit(X_train_cv_bow, y_train_cv)
    y_train_pred = []
    y_train_pred.extend(neigh.predict_proba(X_train_cv_bow)[:,1])
    y_cv_pred = []
    y_cv_pred.extend(neigh.predict_proba(X_cv_bow)[:,1])

    train_auc.append(roc_auc_score(y_train_cv,y_train_pred))
    cv_auc.append(roc_auc_score(y_cv, y_cv_pred))

plt.plot(K, train_auc, label='Train AUC')
plt.plot(K, cv_auc, label='CV AUC')
plt.legend()
plt.xlabel("K: hyperparameter")
plt.ylabel("AUC")
plt.title("Error Plots")
plt.show()
```



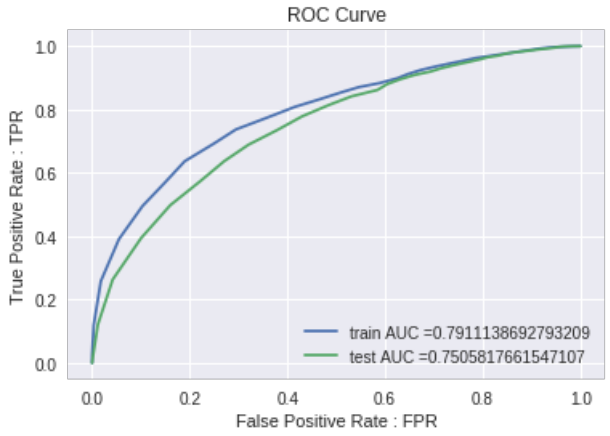
In [0]:

```
best_k_bow = 51
```

In [88]:

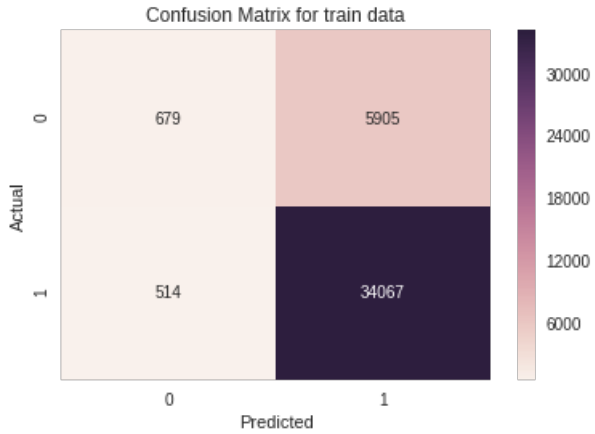
```
#testing the data
from sklearn.metrics import roc_curve, auc


neigh = KNeighborsClassifier(n_neighbors=best_k_bow)
neigh.fit(X_train_cv_bow, y_train_cv)


train_fpr, train_tpr, thresholds = roc_curve(y_train_cv, neigh.predict_proba(X_train_cv_bow)[:,1])
test_fpr, test_tpr, thresholds = roc_curve(y_test, neigh.predict_proba(X_test_bow)[:,1])

train_BOW_Acc = auc(train_fpr, train_tpr)
test_BOW_Acc = auc(test_fpr, test_tpr)

plt.plot(train_fpr, train_tpr, label="train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.xlabel("False Positive Rate : FPR")
plt.ylabel("True Positive Rate : TPR")
plt.title("ROC Curve")
```

```
plt.show()
```



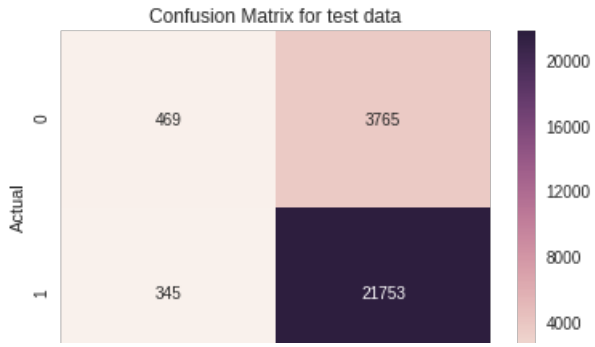
In [40]:

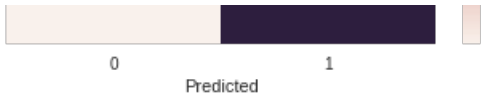
```
conf_matrix = confusion_matrix(y_train_cv, neigh.predict(X_train_cv_bow))
class_label = [0, 1]
df_conf_matrix = pd.DataFrame(
    conf_matrix, index=class_label, columns=class_label)
sns.heatmap(df_conf_matrix, annot=True, fmt='d')
plt.title("Confusion Matrix for train data")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```



In [41]:

```
conf_matrix = confusion_matrix(y_test, neigh.predict(X_test_bow))
class_label = [0, 1]
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 for test data")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```





In [42]:

```
# Calculating TPR , FPR , TNR , FNR
TrueNeg,FalseNeg,FalsePos, TruePos = confusion_matrix(y_test, neigh.predict(X_test_bow)).ravel()

# TPR (TPR = TP/(FN+TP))
TPR = TruePos/(FalseNeg + TruePos)
print("TPR " , TPR)

# FPR (FPR = FP/(TN+FP))
FPR = FalsePos/(TrueNeg + FalsePos)
print("FPR " , FPR)

# TNR (TNR = TN/(TN+FP))
TNR = TrueNeg/(TrueNeg + FalsePos)
print("TNR " , TNR)

# FNR (FNR = TN/(FN+TP))
FNR = FalseNeg/(FalseNeg + TruePos)
print("FNR " , FNR)
```

```
TPR  0.8524570891135669
FPR  0.4238329238329238
TNR  0.5761670761670762
FNR  0.1475429108864331
```

To suit for best model , we need more TPR and TNR and less FPR and FNR. from the above observation TPR and TNR are more and FPR and FNR are less.

[5.1.2] Applying KNN brute force on TFIDF, SET 2

In [0]:

```
# Please write all the code with proper documentation
```

In [44]:

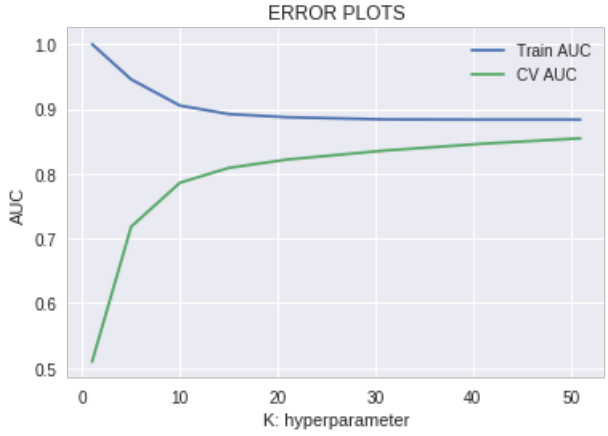
```
#fitting to train data
tf_idf_vect = TfidfVectorizer(ngram_range=(1,2), min_df=10)
tf_idf_vect.fit(X_train_cv)

X_train_tfidf = tf_idf_vect.transform(X_train_cv)
X_CV_tfidf = tf_idf_vect.transform(X_cv)
X_test_tfidf = tf_idf_vect.transform(X_test)

print("After vectorizations")
print(X_train_tfidf.shape, y_train_cv.shape)
print(X_CV_tfidf.shape, y_cv.shape)
print(X_test_tfidf.shape, y_test.shape)
```

```
After vectorizations
(41165, 24624) (41165,)
(20276, 24624) (20276,)
(26332, 24624) (26332,)
```

In [45]:

```
#finding best k- value using loop

from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt

train_auc = []
cv_auc = []
```

```
K = [1, 5, 10, 15, 21, 31, 41, 51]
for i in K:
  neigh = KNeighborsClassifier(n_neighbors=i,algorithm = "brute")
  neigh.fit(X_train_tfidf, y_train_cv)
  y_train_pred = []
  y_train_pred.extend(neigh.predict_proba(X_train_tfidf)[:,1])
  y_cv_pred = []
  y_cv_pred.extend(neigh.predict_proba(X_CV_tfidf)[:,1])
  train_auc.append(roc_auc_score(y_train_cv,y_train_pred))
  cv_auc.append(roc_auc_score(y_cv, y_cv_pred))


plt.plot(K, train_auc, label='Train AUC')
plt.plot(K, cv_auc, label='CV AUC')
plt.legend()
plt.xlabel("K: hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.show()
```

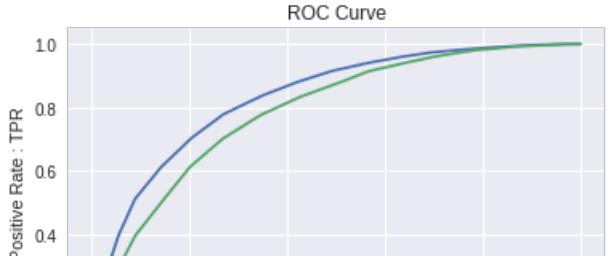


In [0]:

```
best_k_tfidf = 51
```

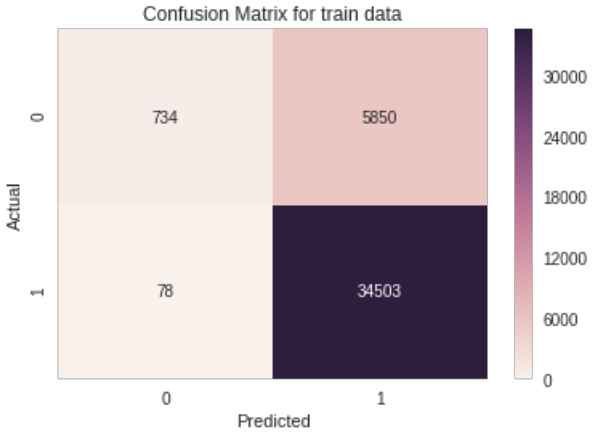
In [90]:

```
#testing the data
from sklearn.metrics import roc_curve, auc


neigh = KNeighborsClassifier(n_neighbors=best_k_tfidf)
neigh.fit(X_train_tfidf, y_train_cv)

train_fpr, train_tpr, thresholds = roc_curve(y_train_cv, neigh.predict_proba(X_train_tfidf)[:,1])
test_fpr, test_tpr, thresholds = roc_curve(y_test, neigh.predict_proba(X_test_tfidf)[:,1])

train_tfidf_Acc = auc(train_fpr, train_tpr)
test_tfidf_Acc = auc(test_fpr, test_tpr)

plt.plot(train_fpr, train_tpr, label="train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.xlabel("False Positive Rate : FPR")
plt.ylabel("True Positive Rate : TPR")
plt.title("ROC Curve")
plt.show()
```



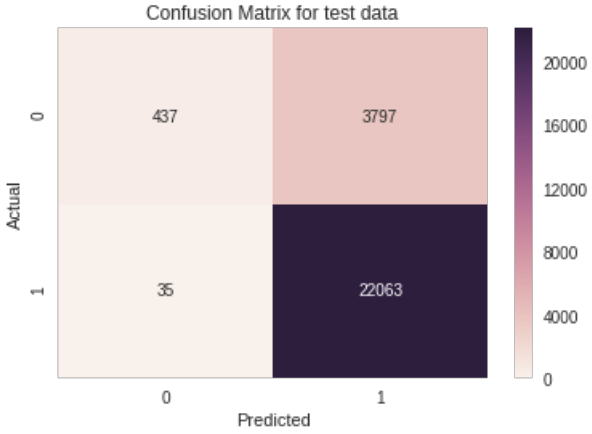
In [48]:

```
conf_matrix = confusion_matrix(y_train_cv, neigh.predict(X_train_tfidf))
class_label = [0, 1]
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 for train data")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```



In [49]:

```
conf_matrix = confusion_matrix(y_test, neigh.predict(X_test_tfidf))
class_label = [0, 1]
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 for test data")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```



In [50]:

```
# Calculating TPR , FPR , TNR , FNR
TrueNeg,FalseNeg,FalsePos, TruePos = confusion_matrix(y_test, neigh.predict(X_test_tfidf)).ravel()

# TPR (TPR = TP/(FN+TP))
TPR = TruePos/(FalseNeg + TruePos)
```

```
print("TPR " , TPR)

# FPR (FPR = FP/(TN+FP))
FPR = FalsePos/(TrueNeg + FalsePos)
print("FPR " , FPR)

# TNR (TNR = TN/(TN+FP))
TNR = TrueNeg/(TrueNeg + FalsePos)
print("TNR " , TNR)

# FNR (FNR = TN/(FN+TP))
FNR = FalseNeg/(FalseNeg + TruePos)
print("FNR " , FNR)
```

```
TPR  0.8531709203402938
FPR  0.07415254237288135
TNR  0.9258474576271186
FNR  0.1468290796597061
```

[5.1.3] Applying KNN brute force on AVG W2V, SET 3

In [0]:

```
# Please write all the code with proper documentation
```

In [52]:

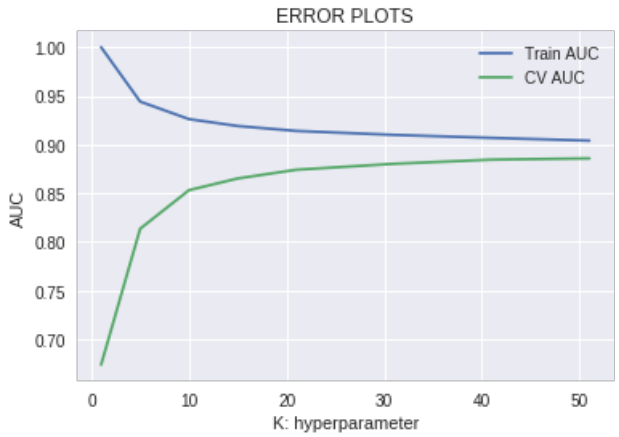
```
# Train your own Word2Vec model using your own text corpus

X_train_sentance=[]
for sentance in X_train_cv:
    X_train_sentance.append(sentance.split())

X_test_sentance=[]
for sentance in X_test:
    X_test_sentance.append(sentance.split())

X_cv_sentance=[]
for sentance in X_cv:
    X_cv_sentance.append(sentance.split())

w2v_model=Word2Vec(X_train_sentance,min_count=5,size=100, workers=4)


w2v_words = list(w2v_model.wv.vocab)
print("number of words that occured minimum 5 times ",len(w2v_words))

X_train_vectors = []
for sent in X_train_sentance:
    sent_vec = np.zeros(100)
    cnt_words =0;
    for word in sent: #
        if word in w2v_words:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    X_train_vectors.append(sent_vec)


X_test_vectors = []
for sent in X_test_sentance:
    sent_vec = np.zeros(100)
    cnt_words =0;
    for word in sent: #
        if word in w2v_words:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    X_test_vectors.append(sent_vec)
```

```
X_cv_vectors = []
for sent in X_cv_sentance:
    sent_vec = np.zeros(100)
    cnt_words =0;
    for word in sent: #
        if word in w2v_words:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    X_cv_vectors.append(sent_vec)
```

```
number of words that occured minimum 5 times  12938
```

In [53]:

```
#finding best k- value using loop

from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt

train_auc = []
cv_auc = []
K = [1, 5, 10, 15, 21, 31, 41, 51]
for i in K:
  neigh = KNeighborsClassifier(n_neighbors=i,algorithm = "brute")
  neigh.fit(X_train_vectors, y_train_cv)
  y_train_pred = []
  y_train_pred.extend(neigh.predict_proba(X_train_vectors)[:,1])
  y_cv_pred = []
  y_cv_pred.extend(neigh.predict_proba(X_cv_vectors)[:,1])
  train_auc.append(roc_auc_score(y_train_cv,y_train_pred))
  cv_auc.append(roc_auc_score(y_cv, y_cv_pred))

plt.plot(K, train_auc, label='Train AUC')
plt.plot(K, cv_auc, label='CV AUC')
plt.legend()
plt.xlabel("K: hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.show()
```



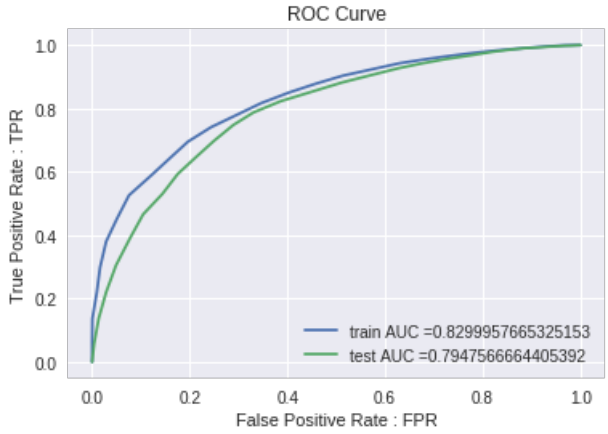
In [0]:

```
best_k_AVGW2V = 51
```

In [92]:

```
#testing the data
from sklearn.metrics import roc_curve, auc
```

```
neigh = KNeighborsClassifier(n_neighbors=best_k_AVGW2V)
neigh.fit(X_train_vectors, y_train_cv)

train_fpr, train_tpr, thresholds = roc_curve(y_train_cv, neigh.predict_proba(X_train_vectors)
[:,1])
test_fpr, test_tpr, thresholds = roc_curve(y_test, neigh.predict_proba(X_test_vectors)[:,1])

train_AVGW2V_Acc = auc(train_fpr, train_tpr)
test_AVGW2V_Acc = auc(test_fpr, test_tpr)

plt.plot(train_fpr, train_tpr, label="train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.xlabel("False Positive Rate : FPR")
plt.ylabel("True Positive Rate : TPR")
plt.title("ROC Curve")
plt.show()
```



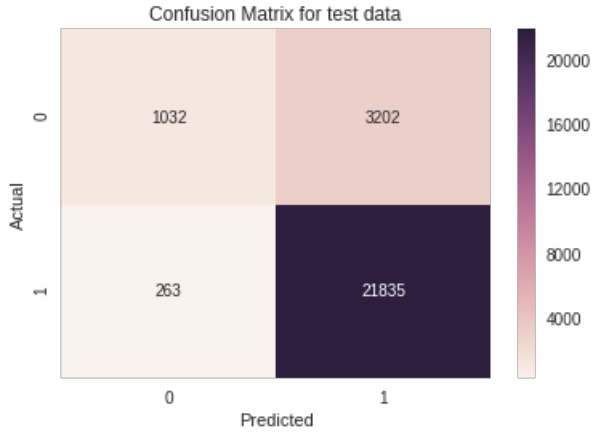
In [56]:

```
conf_matrix = confusion_matrix(y_train_cv, neigh.predict(X_train_vectors))
class_label = [0, 1]
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 for train data")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```

In [57]:

```
conf_matrix = confusion_matrix(y_test, neigh.predict(X_test_vectors))
class_label = [0, 1]
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 for test data")
```

```
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```



In [58]:

```
# Calculating TPR , FPR , TNR , FNR
TrueNeg,FalseNeg,FalsePos, TruePos = confusion_matrix(y_test, neigh.predict(X_test_vectors)).ravel(
)

# TPR (TPR = TP/(FN+TP))
TPR = TruePos/(FalseNeg + TruePos)
print("TPR " , TPR)

# FPR (FPR = FP/(TN+FP))
FPR = FalsePos/(TrueNeg + FalsePos)
print("FPR " , FPR)

# TNR (TNR = TN/(TN+FP))
TNR = TrueNeg/(TrueNeg + FalsePos)
print("TNR " , TNR)

# FNR (FNR = TN/(FN+TP))
FNR = FalseNeg/(FalseNeg + TruePos)
print("FNR " , FNR)
```

```
TPR  0.8721092782681631
FPR  0.2030888030888031
TNR  0.7969111969111969
FNR  0.12789072173183688
```

[5.1.4] Applying KNN brute force on TFIDF W2V, SET 4

In [0]:

```
# Please write all the code with proper documentation
```

In [60]:

```
# Please write all the code with proper documentation

model = TfidfVectorizer()
tf_idf_matrix = model.fit_transform(X_train_cv)
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(model.get_feature_names(), list(model.idf_)))

tfidf_feat = model.get_feature_names() # tfidf words/col-names
# final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf

X_train_tfidfw2v = []; # the tfidf-w2v for each sentence/review is stored in this list
row=0;
for sent in tqdm(X_train_sentance): # for each review/sentence
    sent_vec = np.zeros(100) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
```

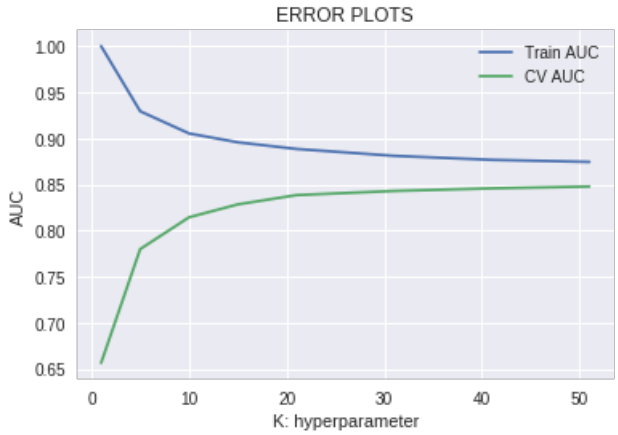
```
    for word in sent: # for each word in a review/sentence
        if word in w2v_words and word in tfidf_feat:
            vec = w2v_model.wv[word]

            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
    X_train_tfidfw2v.append(sent_vec)
    row += 1


X_test_tfidfw2v = []; # the tfidf-w2v for each sentence/review is stored in this list
row=0;
for sent in tqdm(X_test_sentance): # for each review/sentence
    sent_vec = np.zeros(100) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words and word in tfidf_feat:
            vec = w2v_model.wv[word]

            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
    X_test_tfidfw2v.append(sent_vec)
    row += 1



X_cv_tfidfw2v = []; # the tfidf-w2v for each sentence/review is stored in this list
row=0;
for sent in tqdm(X_cv_sentance): # for each review/sentence
    sent_vec = np.zeros(100) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words and word in tfidf_feat:
            vec = w2v_model.wv[word]

            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
    X_cv_tfidfw2v.append(sent_vec)
    row += 1
```

```
100%|██████████| 41165/41165 [21:52<00:00, 31.36it/s]
100%|██████████| 26332/26332 [14:14<00:00, 31.13it/s]
100%|██████████| 20276/20276 [10:48<00:00, 31.28it/s]
```

In [61]:

```
#finding best k- value using loop

from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt

train_auc = []
cv_auc = []
K = [1, 5, 10, 15, 21, 31, 41, 51]
for i in K:
  neigh = KNeighborsClassifier(n_neighbors=i,algorithm = "brute")
  neigh.fit(X_train_tfidfw2v, y_train_cv)
  y_train_pred = []
  y_train_pred.extend(neigh.predict_proba(X_train_tfidfw2v)[:,1])
  y_cv_pred = []
  y_cv_pred.extend(neigh.predict_proba(X_cv_tfidfw2v)[:,1])
  train_auc.append(roc_auc_score(y_train_cv,y_train_pred))
  cv_auc.append(roc_auc_score(y_cv, y_cv_pred))

plt.plot(K, train_auc, label='Train AUC')
```

```
plt.plot(K, cv_auc, label='CV AUC')
plt.legend()
plt.xlabel("K: hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.show()
```

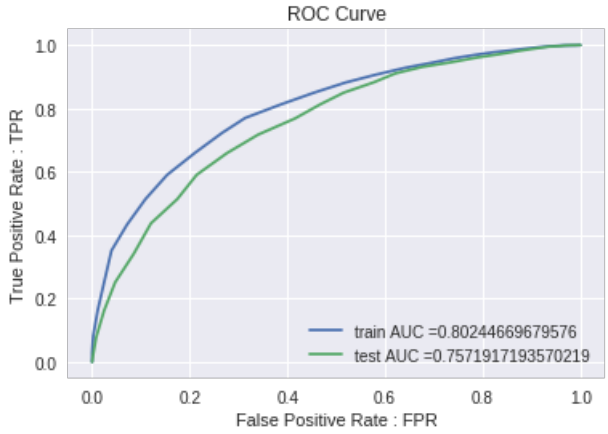


In [0]:

```
best_k_tfidfW2V = 51
```

In [94]:

```
#testing the data

from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import roc_curve, auc


neigh = KNeighborsClassifier(n_neighbors=best_k_tfidfW2V)
neigh.fit(X_train_tfidfw2v, y_train_cv)

train_fpr, train_tpr, thresholds = roc_curve(y_train_cv, neigh.predict_proba(X_train_tfidfw2v)[:,1]
)
test_fpr, test_tpr, thresholds = roc_curve(y_test, neigh.predict_proba(X_test_tfidfw2v)[:,1])

train_tfidfW2V_Acc = auc(train_fpr, train_tpr)
test_tfidfW2V_Acc = auc(test_fpr, test_tpr)

plt.plot(train_fpr, train_tpr, label="train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.xlabel("False Positive Rate : FPR")
plt.ylabel("True Positive Rate : TPR")
plt.title("ROC Curve")
plt.show()
```

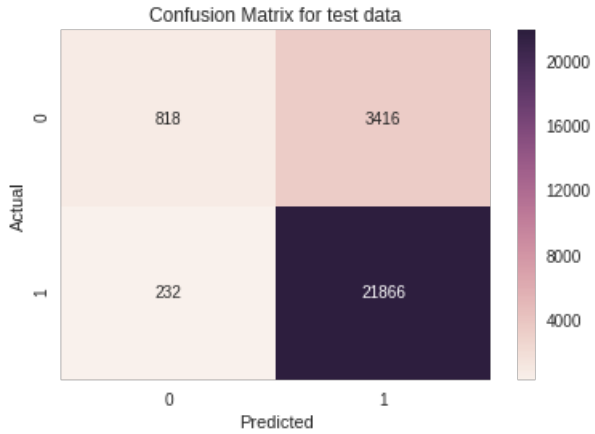


In [64]:

```
conf_matrix = confusion_matrix(y_train_cv, neigh.predict(X_train_tfidfw2v))
class_label = [0, 1]
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 for train data")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```

In [65]:

```
conf_matrix = confusion_matrix(y_test, neigh.predict(X_test_tfidfw2v))
class_label = [0, 1]
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 for test data")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```



In [66]:

```
# Calculating TPR , FPR , TNR , FNR
TrueNeg,FalseNeg,FalsePos, TruePos = confusion_matrix(y_test, neigh.predict(X_test_tfidfw2v)).ravel
()

# TPR (TPR = TP/(FN+TP))
TPR = TruePos/(FalseNeg + TruePos)
print("TPR " , TPR)

# FPR (FPR = FP/(TN+FP))
FPR = FalsePos/(TrueNeg + FalsePos)
print("FPR " , FPR)

# TNR (TNR = TN/(TN+FP))
TNR = TrueNeg/(TrueNeg + FalsePos)
print("TNR " , TNR)
```

```
# FNR (FNR = TN/(FN+TP))
FNR = FalseNeg/(FalseNeg + TruePos)
print("FNR " , FNR)
```

```
TPR  0.8648841072699944
FPR  0.22095238095238096
TNR  0.7790476190476191
FNR  0.13511589273000554
```

[5.2] Applying KNN kd-tree

[5.2.1] Applying KNN kd-tree on BOW, SET 5

In [0]:

```
# Please write all the code with proper documentation
```

In [68]:

```
final.shape
#final.head(3)
```

Out[68]:

```
(87773, 13)
```

In [0]:

```
final_25k = final[: 25000]
```

In [27]:

```
final_25k.shape
```

Out[27]:

```
(25000, 10)
```

In [28]:

```
# Combining all the above stundents and preprocessing the Review text data
from tqdm import tqdm
preprocessed_reviews = []
# tqdm is for printing the status bar
for sentance in tqdm(final_25k['Text'].values):
    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 stopwords)
    preprocessed_reviews.append(sentance.strip())
```

```
100%|██████████| 25000/25000 [00:10<00:00, 2325.43it/s]
```

In [29]:

```
# Combining all the above stundents and preprocessing the summary data
from tqdm import tqdm
preprocessed_summary = []
# tqdm is for printing the status bar
for sentance in tqdm(final_25k['Summary'].values):
    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 stopwords)
    preprocessed_summary.append(sentance.strip())
```

```
100%|██████████| 25000/25000 [00:08<00:00, 3101.25it/s]
```

In [30]:

```
#added preprocessed reviews
#sample_preproc_revi
final_25k['PreprocessedText'] = preprocessed_reviews
final_25k['PreprocessedSummary'] = preprocessed_summary
final_25k['Final_Text'] = final_25k['PreprocessedText'] + final_25k['PreprocessedSummary']
final_25k.head(3)
```

Out[30]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDenominator	Score	
22620	24750	2734888454	A13ISQV0U9GZIC	Sandikaye	1	1	0	11920
22621	24751	2734888454	A1C298ITT645B6	Hugh G. Pritchard	0	0	1	11959
70677	76870	B00002N8SM	A19Q006CSFT011	Arlielle	0	0	0	12883

In [0]:

```
#sorting based on time
final_25k["Time"] = pd.to_datetime(final_25k["Time"],unit="s")
final_25k = final_25k.sort_values( by ="Time")
```

In [32]:

```
#splitting data into train , test
X_train, X_test, y_train, y_test = train_test_split(
    final_25k['Final_Text'], final_25k['Score'], test_size=0.30, random_state=0)

X_train_cv, X_cv, y_train_cv, y_cv = train_test_split(X_train, y_train, test_size=0.33)

print(X_train.shape, y_train.shape)
print(X_train_cv.shape,y_train_cv.shape)
print(X_cv.shape, y_cv.shape)
print(X_test.shape, y_test.shape)
```

```
(17500,) (17500,)
(11725,) (11725,)
(5775,) (5775,)
(7500,) (7500,)
```

In [33]:

```
from sklearn.decomposition import  TruncatedSVD
```

```
vectorizer = CountVectorizer(min_df=10, max_features=500)
vectorizer.fit(X_train_cv)

X_train_cv_bow = vectorizer.transform(X_train_cv)
X_cv_bow = vectorizer.transform(X_cv)
X_test_bow = vectorizer.transform(X_test)

svd = TruncatedSVD(n_components=100)


x_train_dense_bow = svd.fit_transform(X_train_cv_bow)
x_test_dense_bow = svd.transform(X_test_bow)
x_cv_dense_bow = svd.transform(X_cv_bow)

print("After vectorizations")
print(x_train_dense_bow.shape, y_train_cv.shape)
print(x_cv_dense_bow.shape, y_cv.shape)
print(x_test_dense_bow.shape, y_test.shape)
```

```
After vectorizations
(11725, 100) (11725,)
(5775, 100) (5775,)
(7500, 100) (7500,)
```

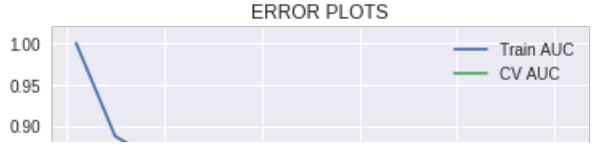
In [34]:

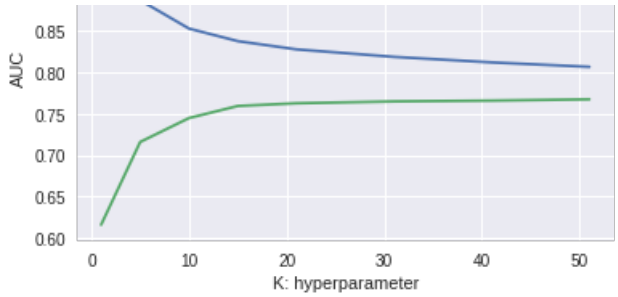
```
print(type(x_train_dense_bow))
print(type(x_cv_dense_bow))
print(type(x_test_dense_bow))
```

```
<class 'numpy.ndarray'>
<class 'numpy.ndarray'>
<class 'numpy.ndarray'>
```

In [35]:

```
#finding best k- value using loop

from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt


train_auc = []
cv_auc = []
K = [1, 5, 10, 15, 21, 31, 41, 51]
for i in K:
    neigh = KNeighborsClassifier(n_neighbors=i , algorithm = "kd_tree")
    neigh.fit(x_train_dense_bow, y_train_cv)

    y_train_pred = []
    y_train_pred.extend(neigh.predict_proba(x_train_dense_bow)[:,1])
    y_cv_pred = []
    y_cv_pred.extend(neigh.predict_proba(x_cv_dense_bow)[:,1])


    train_auc.append(roc_auc_score(y_train_cv,y_train_pred))
    cv_auc.append(roc_auc_score(y_cv, y_cv_pred))


plt.plot(K, train_auc, label='Train AUC')
plt.plot(K, cv_auc, label='CV AUC')
plt.legend()
plt.xlabel("K: hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.show()
```



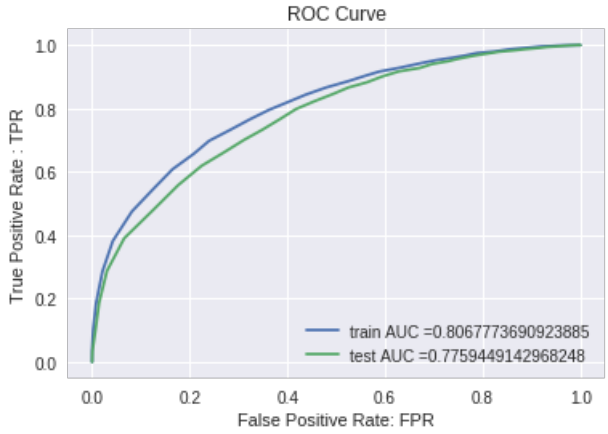


In [0]:

```
best_K_KD_BOW = 51
```

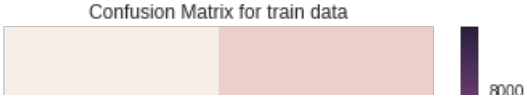
In [96]:

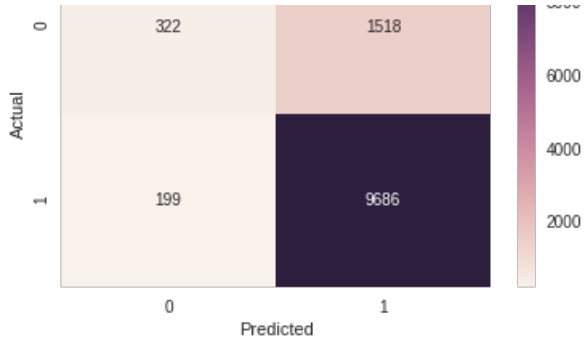
```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import roc_curve, auc


neigh = KNeighborsClassifier(n_neighbors=best_K_KD_BOW,algorithm = "kd_tree")
neigh.fit(x_train_dense_bow, y_train_cv)

train_fpr, train_tpr, thresholds = roc_curve(y_train_cv, neigh.predict_proba(x_train_dense_bow)[:,
1])
test_fpr, test_tpr, thresholds = roc_curve(y_test, neigh.predict_proba(x_test_dense_bow)[:,1])

train_BOW_KD_Acc = auc(train_fpr, train_tpr)
test_BOW_KD_Acc = auc(test_fpr, test_tpr)

plt.plot(train_fpr, train_tpr, label="train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.xlabel("False Positive Rate: FPR")
plt.ylabel("True Positive Rate : TPR")
plt.title("ROC Curve")
plt.show()
```



In [38]:

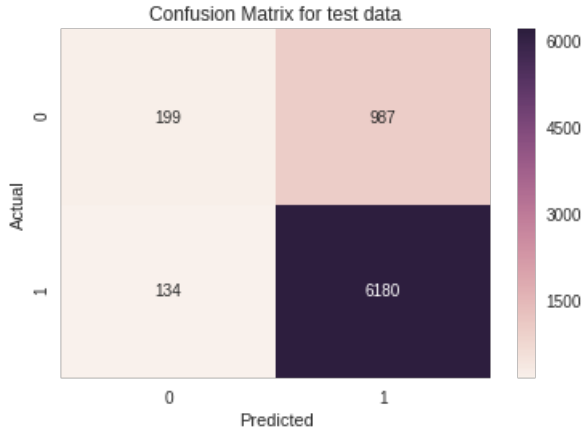
```
conf_matrix = confusion_matrix(y_train_cv, neigh.predict(x_train_dense_bow))
class_label = [0, 1]
df_conf_matrix = pd.DataFrame(
    conf_matrix, index=class_label, columns=class_label)
sns.heatmap(df_conf_matrix, annot=True, fmt='d')
plt.title("Confusion Matrix for train data")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```





In [40]:

```
conf_matrix = confusion_matrix(y_test, neigh.predict(x_test_dense_bow))
class_label = [0, 1]
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 for test data")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```



In [41]:

```
# Calculating TPR , FPR , TNR , FNR
TrueNeg,FalseNeg,FalsePos, TruePos = confusion_matrix(y_test, neigh.predict(x_test_dense_bow)).rave
l()

# TPR (TPR = TP/(FN+TP))
TPR = TruePos/(FalseNeg + TruePos)
print("TPR " , TPR)

# FPR (FPR = FP/(TN+FP))
FPR = FalsePos/(TrueNeg + FalsePos)
print("FPR " , FPR)

# TNR (TNR = TN/(TN+FP))
TNR = TrueNeg/(TrueNeg + FalsePos)
print("TNR " , TNR)

# FNR (FNR = TN/(FN+TP))
FNR = FalseNeg/(FalseNeg + TruePos)
print("FNR " , FNR)
```

```
TPR  0.8622854750941816
FPR  0.4024024024024024
TNR  0.5975975975975976
FNR  0.13771452490581834
```

[5.2.2] Applying KNN kd-tree on TFIDF, SET 6

In [0]:

```
# Please write all the code with proper documentation
```

In [43]:

```
#fitting to train data
tf_idf_vect = TfidfVectorizer(min_df=10 , max_features=500)
tf_idf_vect.fit(X_train_cv)

X_train_tfidf = tf_idf_vect.transform(X_train_cv)
X_CV_tfidf = tf_idf_vect.transform(X_cv)
X_test_tfidf = tf_idf_vect.transform(X_test)

svd2 = TruncatedSVD(n_components=100)

x_train_dense_tfidf = svd2.fit_transform(X_train_tfidf)
x_cv_dense_tfidf = svd2.transform(X_CV_tfidf)
x_test_dense_tfidf = svd2.transform(X_test_tfidf)

print("After vectorizations")
print(x_train_dense_tfidf.shape, y_train_cv.shape)
print(x_cv_dense_tfidf.shape, y_cv.shape)
print(x_test_dense_tfidf.shape, y_test.shape)
```

```
After vectorizations
(11725, 100) (11725,)
(5775, 100) (5775,)
(7500, 100) (7500,)
```

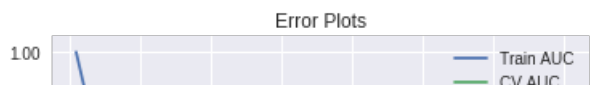
In [44]:

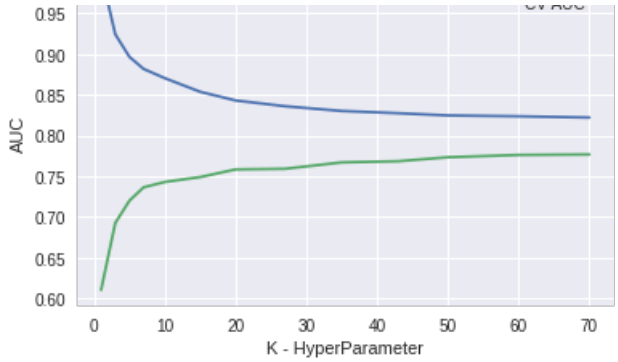
```
print(type(x_train_dense_tfidf))
print(type(x_cv_dense_tfidf))
print(type(x_test_dense_tfidf))
```

```
<class 'numpy.ndarray'>
<class 'numpy.ndarray'>
<class 'numpy.ndarray'>
```

In [45]:

```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt

train_auc = []
cv_auc=[]
k=[1,3,5,7,10,15,20,27,35,43,50,60,70]
for i in k:
  neigh = KNeighborsClassifier(n_neighbors=i , algorithm="kd_tree")
  neigh.fit(x_train_dense_tfidf,y_train_cv)
  y_train_pred = []
  y_train_pred.extend(neigh.predict_proba(x_train_dense_tfidf)[:,1])
  y_cv_pred = []
  y_cv_pred.extend(neigh.predict_proba(x_cv_dense_tfidf)[:,1])

  train_auc.append(roc_auc_score(y_train_cv,y_train_pred))
  cv_auc.append(roc_auc_score(y_cv , y_cv_pred))


plt.plot(k,train_auc , label = 'Train AUC')
plt.plot(k,cv_auc , label = 'CV AUC')
plt.legend()
plt.xlabel("K - HyperParameter")
plt.ylabel("AUC")
plt.title("Error Plots")
plt.show()
```



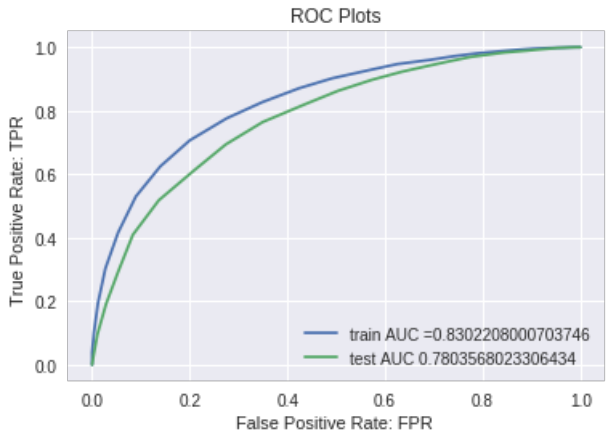


In [0]:

```
best_k_KD_tfidf = 35 # as the k value , this will leads to overfitting
```

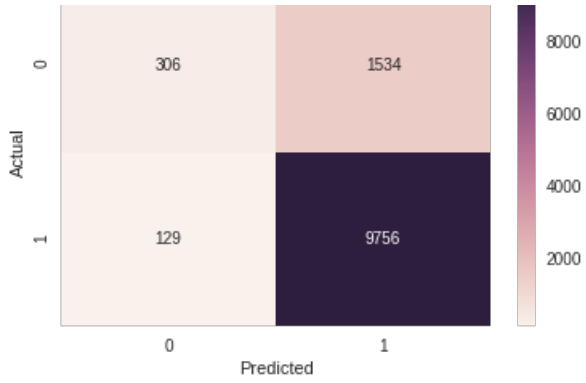
In [98]:

```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import roc_curve,auc

neigh = KNeighborsClassifier(n_neighbors=best_k_KD_tfidf,algorithm = "kd_tree")
neigh.fit(x_train_dense_tfidf,y_train_cv)

train_fpr , train_tpr , thresholds = roc_curve(y_train_cv , neigh.predict_proba(x_train_dense_tfidf
)[:,1])
test_fpr , test_tpr , thresholds = roc_curve(y_test, neigh.predict_proba(x_test_dense_tfidf)[:,1])

train_tfidf_KD_Acc = auc(train_fpr,train_tpr)
test_tfidf_KD_Acc = auc(test_fpr,test_tpr)

plt.plot(train_fpr , train_tpr , label = "train AUC ="+str(auc(train_fpr,train_tpr)))
plt.plot(test_fpr , test_tpr , label = "test AUC "+ str(auc(test_fpr,test_tpr)))
plt.legend()
plt.xlabel( "False Positive Rate: FPR " )
plt.ylabel("True Positive Rate: TPR ")
plt.title("ROC Plots")
plt.show()
```



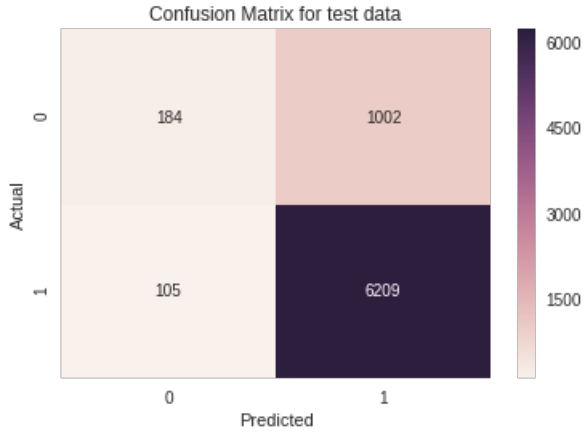
In [48]:

```
conf_matrix = confusion_matrix(y_train_cv, neigh.predict(x_train_dense_tfidf))
class_label = [0, 1]
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 for train data")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```



In [49]:

```
conf_matrix = confusion_matrix(y_test, neigh.predict(x_test_dense_tfidf))
class_label = [0, 1]
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 for test data")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```



In [50]:

```
# Calculating TPR , FPR , TNR , FNR
TrueNeg,FalseNeg,FalsePos, TruePos = confusion_matrix(y_test, neigh.predict(x_test_dense_tfidf)).ra
vel()

# TPR (TPR = TP/(FN+TP))
TPR = TruePos/(FalseNeg + TruePos)
print("TPR " , TPR)

# FPR (FPR = FP/(TN+FP))
FPR = FalsePos/(TrueNeg + FalsePos)
print("FPR " , FPR)

# TNR (TNR = TN/(TN+FP))
TNR = TrueNeg/(TrueNeg + FalsePos)
print("TNR " , TNR)

# FNR (FNR = TN/(FN+TP))
FNR = FalseNeg/(FalseNeg + TruePos)
print("FNR " , FNR)
```

```
TPR  0.8610456247399806
FPR  0.3633217993079585
TNR  0.6366782006920415
FNR  0.1389543752600194
```

[5.2.3] Applying KNN kd-tree on AVG W2V, SET 3

[5.2.3] Applying KNN kd-tree on AVG W2V, SET 3

In [0]:

```
# Please write all the code with proper documentation
```

In [52]:

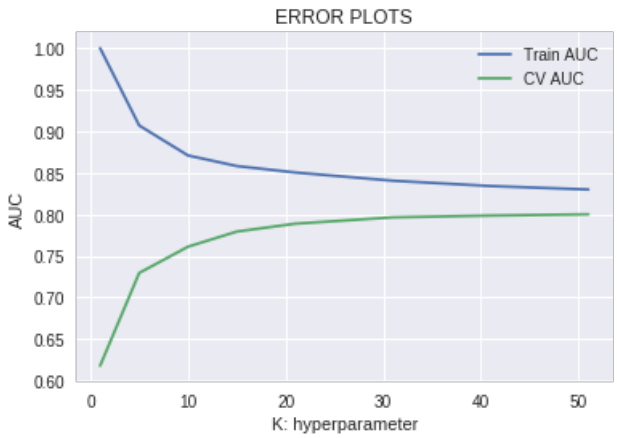
```
# Train your own Word2Vec model using your own text corpus

X_train_sentance=[]
for sentance in X_train_cv:
    X_train_sentance.append(sentance.split())

X_test_sentance=[]
for sentance in X_test:
    X_test_sentance.append(sentance.split())

X_cv_sentance=[]
for sentance in X_cv:
    X_cv_sentance.append(sentance.split())

w2v_model=Word2Vec(X_train_sentance,min_count=5,size=100, workers=4)


w2v_words = list(w2v_model.wv.vocab)
print("number of words that occured minimum 5 times ",len(w2v_words))

X_train_vectors = []
for sent in X_train_sentance:
    sent_vec = np.zeros(100)
    cnt_words =0;
    for word in sent: #
        if word in w2v_words:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    X_train_vectors.append(sent_vec)


X_test_vectors = []
for sent in X_test_sentance:
    sent_vec = np.zeros(100)
    cnt_words =0;
    for word in sent: #
        if word in w2v_words:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    X_test_vectors.append(sent_vec)


X_cv_vectors = []
for sent in X_cv_sentance:
    sent_vec = np.zeros(100)
    cnt_words =0;
    for word in sent: #
        if word in w2v_words:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    X_cv_vectors.append(sent_vec)
```

```
number of words that occured minimum 5 times  6800
```

In [53]:

```
train_auc = []
```

```
cv_auc = []
K = [1, 5, 10, 15, 21, 31, 41, 51]
for i in K:
    neigh = KNeighborsClassifier(n_neighbors=i,algorithm="kd_tree")
    neigh.fit(X_train_vectors, y_train_cv)
    # roc_auc_score(y_true, y_score) the 2nd parameter should be probability estimates of the posi
tive class
    # not the predicted outputs
    y_train_pred =  neigh.predict_proba(X_train_vectors)[:,1]
    y_cv_pred =  neigh.predict_proba(X_cv_vectors)[:,1]

    train_auc.append(roc_auc_score(y_train_cv,y_train_pred))
    cv_auc.append(roc_auc_score(y_cv, y_cv_pred))

plt.plot(K, train_auc, label='Train AUC')
plt.plot(K, cv_auc, label='CV AUC')
plt.legend()
plt.xlabel("K: hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.show()
```

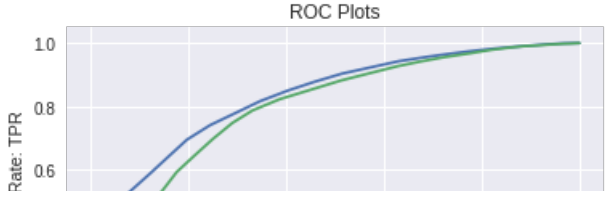


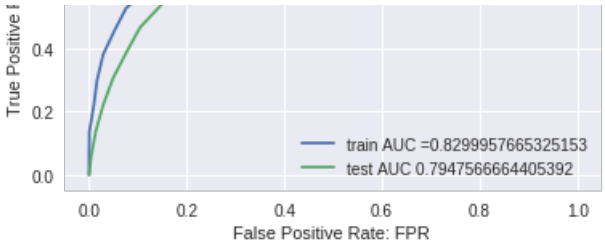
In [0]:

```
best_k_KD_AvgW2V = 51
```

In [100]:

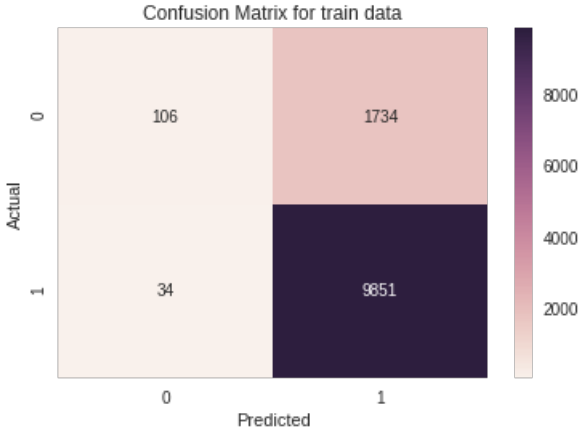
```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import roc_curve,auc

neigh = KNeighborsClassifier(n_neighbors=best_k_KD_AvgW2V,algorithm = "kd_tree")
neigh.fit(X_train_vectors,y_train_cv)

train_fpr , train_tpr , thresholds = roc_curve(y_train_cv , neigh.predict_proba(X_train_vectors)[:,
1])
test_fpr , test_tpr , thresholds = roc_curve(y_test, neigh.predict_proba(X_test_vectors)[:,1])

train_KD_AvgW2V_Acc = auc(train_fpr,train_tpr)
test_KD_AvgW2V_Acc = auc(test_fpr,test_tpr)

plt.plot(train_fpr , train_tpr , label = "train AUC ="+str(auc(train_fpr,train_tpr)))
plt.plot(test_fpr , test_tpr , label = "test AUC "+ str(auc(test_fpr,test_tpr)))
plt.legend()
plt.xlabel( "False Positive Rate: FPR " )
plt.ylabel("True Positive Rate: TPR ")
plt.title("ROC Plots")
plt.show()
```





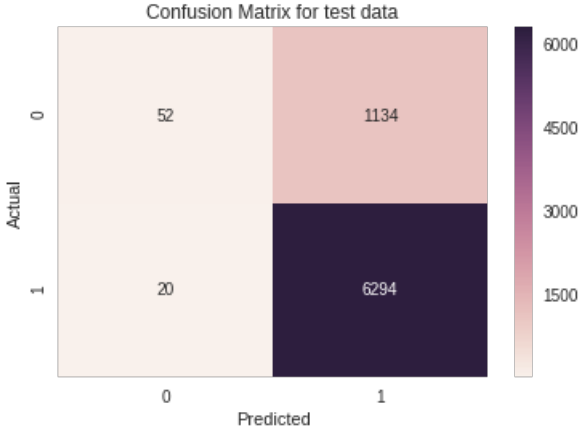
In [56]:

```
conf_matrix = confusion_matrix(y_train_cv, neigh.predict(X_train_vectors))
class_label = [0, 1]
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 for train data")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```



In [57]:

```
conf_matrix = confusion_matrix(y_test, neigh.predict(X_test_vectors))
class_label = [0, 1]
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 for test data")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```



In [58]:

```
# Calculating TPR , FPR , TNR , FNR
TrueNeg,FalseNeg,FalsePos, TruePos = confusion_matrix(y_test, neigh.predict(X_test_vectors)).ravel(
```

```
)

# TPR (TPR = TP/(FN+TP))
TPR = TruePos/(FalseNeg + TruePos)
print("TPR " , TPR)

# FPR (FPR = FP/(TN+FP))
FPR = FalsePos/(TrueNeg + FalsePos)
print("FPR " , FPR)

# TNR (TNR = TN/(TN+FP))
TNR = TrueNeg/(TrueNeg + FalsePos)
print("TNR " , TNR)

# FNR (FNR = TN/(FN+TP))
FNR = FalseNeg/(FalseNeg + TruePos)
print("FNR " , FNR)
```

```
TPR  0.8473344103392568
FPR  0.2777777777777778
TNR  0.7222222222222222
FNR  0.15266558966074315
```

[5.2.4] Applying KNN kd-tree on TFIDF W2V, SET 4

In [0]:

```
# Please write all the code with proper documentation
```

In [60]:

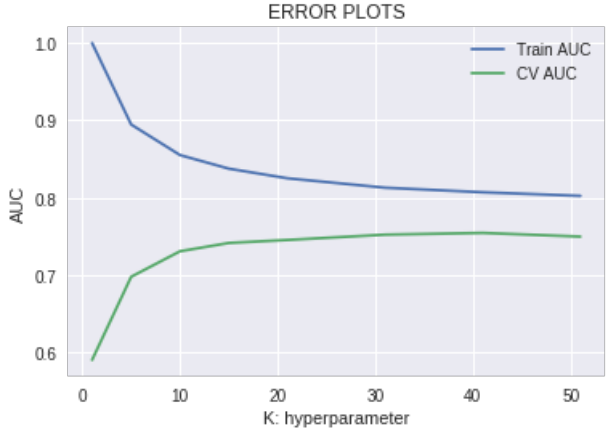
```
# Please write all the code with proper documentation

model = TfidfVectorizer()
tf_idf_matrix = model.fit_transform(X_train_cv)
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(model.get_feature_names(), list(model.idf_)))

tfidf_feat = model.get_feature_names() # tfidf words/col-names
# final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf

X_train_tfidfw2v = []; # the tfidf-w2v for each sentence/review is stored in this list
row=0;
for sent in tqdm(X_train_sentance): # for each review/sentence
    sent_vec = np.zeros(100) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words and word in tfidf_feat:
            vec = w2v_model.wv[word]

            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
    X_train_tfidfw2v.append(sent_vec)
    row += 1


X_test_tfidfw2v = []; # the tfidf-w2v for each sentence/review is stored in this list
row=0;
for sent in tqdm(X_test_sentance): # for each review/sentence
    sent_vec = np.zeros(100) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words and word in tfidf_feat:
            vec = w2v_model.wv[word]

            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
```

```
    X_test_tfidfw2v.append(sent_vec)
    row += 1



X_cv_tfidfw2v = []; # the tfidf-w2v for each sentence/review is stored in this list
row=0;
for sent in tqdm(X_cv_sentance): # for each review/sentence
    sent_vec = np.zeros(100) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words and word in tfidf_feat:
            vec = w2v_model.wv[word]

            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
    X_cv_tfidfw2v.append(sent_vec)
    row += 1
```

```
100%|██████████| 11725/11725 [03:14<00:00, 60.16it/s]
100%|██████████| 7500/7500 [01:57<00:00, 63.56it/s]
100%|██████████| 5775/5775 [01:33<00:00, 61.56it/s]
```

In [61]:

```
#finding best k- value using loop

from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import roc_auc_score
import matplotlib.pyplot as plt

train_auc = []
cv_auc = []
K = [1, 5, 10, 15, 21, 31, 41, 51]
for i in K:

    neigh = KNeighborsClassifier(n_neighbors=i,algorithm = "kd_tree")
    neigh.fit(X_train_tfidfw2v, y_train_cv)
    y_train_pred = []
    y_train_pred.extend(neigh.predict_proba(X_train_tfidfw2v)[:,1])
    y_cv_pred = []
    y_cv_pred.extend(neigh.predict_proba(X_cv_tfidfw2v)[:,1])
    train_auc.append(roc_auc_score(y_train_cv,y_train_pred))
    cv_auc.append(roc_auc_score(y_cv, y_cv_pred))

plt.plot(K, train_auc, label='Train AUC')
plt.plot(K, cv_auc, label='CV AUC')
plt.legend()
plt.xlabel("K: hyperparameter")
plt.ylabel("AUC")
plt.title("ERROR PLOTS")
plt.show()
```

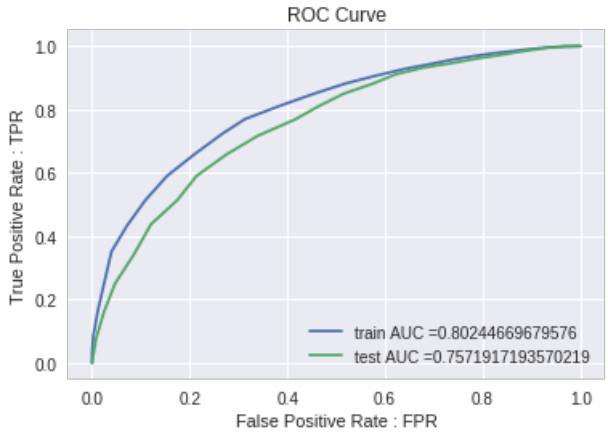


In [0]:

```
best_k_KD_tfidfw2v = 51
```

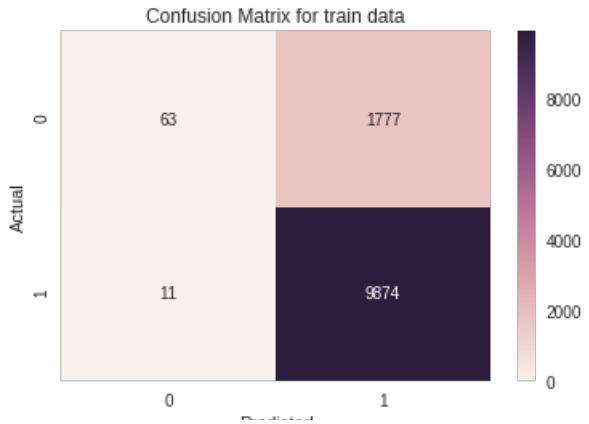
In [102]:

```
#testing the data

from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import roc_curve, auc


neigh = KNeighborsClassifier(n_neighbors=best_k_KD_tfidfw2v)
neigh.fit(X_train_tfidfw2v, y_train_cv)

train_fpr, train_tpr, thresholds = roc_curve(y_train_cv, neigh.predict_proba(X_train_tfidfw2v)[:,1]
)
test_fpr, test_tpr, thresholds = roc_curve(y_test, neigh.predict_proba(X_test_tfidfw2v)[:,1])

train_tfidfw2v_KD_Acc = auc(train_fpr, train_tpr)
test_tfidfw2v_KD_Acc = auc(test_fpr, test_tpr)

plt.plot(train_fpr, train_tpr, label="train AUC ="+str(auc(train_fpr, train_tpr)))
plt.plot(test_fpr, test_tpr, label="test AUC ="+str(auc(test_fpr, test_tpr)))
plt.legend()
plt.xlabel("False Positive Rate : FPR")
plt.ylabel("True Positive Rate : TPR")
plt.title("ROC Curve")
plt.show()
```



In [64]:

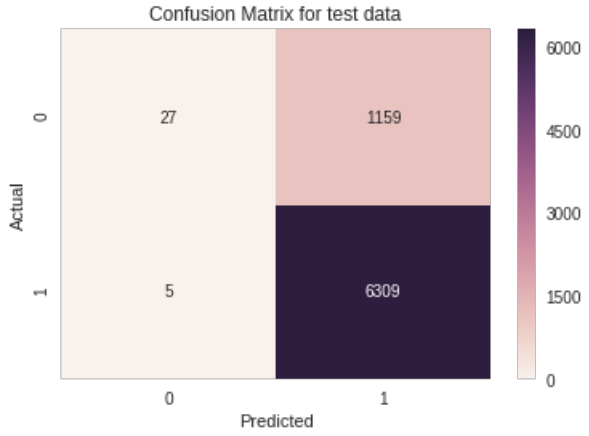
```
conf_matrix = confusion_matrix(y_train_cv, neigh.predict(X_train_tfidfw2v))
class_label = [0, 1]
df_conf_matrix = pd.DataFrame(
    conf_matrix, index=class_label, columns=class_label)
sns.heatmap(df_conf_matrix, annot=True, fmt='d')
plt.title("Confusion Matrix for train data")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```



Predicted

In [65]:

```
conf_matrix = confusion_matrix(y_test, neigh.predict(X_test_tfidfw2v))
class_label = [0, 1]
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 for test data")
plt.xlabel("Predicted")
plt.ylabel("Actual")
plt.show()
```



In [66]:

```
# Calculating TPR , FPR , TNR , FNR
TrueNeg,FalseNeg,FalsePos, TruePos = confusion_matrix(y_test, neigh.predict(X_test_tfidfw2v)).ravel
()

# TPR (TPR = TP/(FN+TP))
TPR = TruePos/(FalseNeg + TruePos)
print("TPR " , TPR)

# FPR (FPR = FP/(TN+FP))
FPR = FalsePos/(TrueNeg + FalsePos)
print("FPR " , FPR)

# TNR (TNR = TN/(TN+FP))
TNR = TrueNeg/(TrueNeg + FalsePos)
print("TNR " , TNR)

# FNR (FNR = TN/(FN+TP))
FNR = FalseNeg/(FalseNeg + TruePos)
print("FNR " , FNR)
```

```
TPR  0.8448044991965721
FPR  0.15625
TNR  0.84375
FNR  0.15519550080342795
```

[6] Conclusions

In [0]:

```
# Please compare all your models using Prettytable library
```

For Best Model , TPR and TNR shoud be high then FPR and FNR should be low.

Taken some references from Github and sample notebook provided by AAIC.

In [103]:

```
from prettytable import PrettyTable

names = ["KNN using 'brute' for BoW","KNN using 'brute' for TFIDF","KNN using 'brute' for Avg-Word
2Vec",
         "KNN using 'brute' for TFIDF-Word2Vec","KNN using 'kdTree' for BoW",
        "KNN using 'kdTree' for TFIDF",  "KNN using 'kdTree' for Avg-Word2Vec",
         "KNN using 'kdTree' for TFIDF-Word2Vec"]

optimal_K = [best_k_bow, best_k_tfidf, best_k_AVGW2V,best_k_tfidfW2V,
            best_K_KD_BOW, best_k_KD_tfidf,
            best_k_KD_AvgW2V,best_k_KD_tfidfw2v]

train_acc = [train_BOW_Acc, train_tfidf_Acc,train_AVGW2V_Acc, train_tfidfW2V_Acc,
             train_BOW_KD_Acc, train_tfidf_KD_Acc, train_KD_AvgW2V_Acc, train_tfidfw2v_KD_Acc]

test_acc = [test_BOW_Acc, test_tfidf_Acc, test_AVGW2V_Acc,test_tfidfW2V_Acc,
            test_BOW_KD_Acc, test_tfidf_KD_Acc, test_KD_AvgW2V_Acc, test_tfidfw2v_KD_Acc]

numbering = [1,2,3,4,5,6,7,8]

# Initializing prettytable
ptable = PrettyTable()

# Adding columns
ptable.add_column("S.NO.",numbering)
ptable.add_column("MODEL",names)
ptable.add_column("Best K",optimal_K)
ptable.add_column("Training Accuracy",train_acc)
ptable.add_column("Test Accuracy",test_acc)

# Printing the Table
print(ptable)
```

```
+-------+-----------------------------------------+--------+--------------------+--------------------
| S.NO. |                  MODEL                  | Best K | Training Accuracy  |   Test Accuracy
+-------+-----------------------------------------+--------+--------------------+--------------------
|   1   |       KNN using 'brute' for BoW         |   51   | 0.7911138692793209 | 0.7505817661547107
|
|   2   |      KNN using 'brute' for TFIDF        |   51   | 0.833249488685096  | 0.7871014971948629
|
|   3   |   KNN using 'brute' for Avg-Word2Vec    |   51   | 0.8299957665325153 | 0.7947566664405392
|
|   4   |  KNN using 'brute' for TFIDF-Word2Vec   |   51   |  0.80244669679576  | 0.7571917193570219
|
|   5   |       KNN using 'kdTree' for BoW        |   51   | 0.8067773690923885 | 0.7759449142968248
|
|   6   |      KNN using 'kdTree' for TFIDF       |   35   | 0.8302208000703746 | 0.7803568023306434
|
|   7   |  KNN using 'kdTree' for Avg-Word2Vec    |   51   | 0.8299957665325153 | 0.7947566664405392
|
|   8   | KNN using 'kdTree' for TFIDF-Word2Vec   |   51   |  0.80244669679576  | 0.7571917193570219
|
+-------+-----------------------------------------+--------+--------------------+--------------------
```