In [34]:

```
%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
#taking cleaned data i.e in Reviews table  from final sql database
#making connection with database
conn = sqlite3.connect('final.sqlite')
final = pd.read_sql_query(""" SELECT * FROM Reviews ORDER BY Time""", conn)
```

In [35]:

```
final = final[:60000]
print(len(final))
```

```
60000
```

In [36]:

```
print(len(final))
```

```
60000
```

In [37]:

```
CleanedText = final['CleanedText'];
#print(CleanedText)
```

In [38]:

```
CleanedText_Class = [];
for i in final['Score']:
    if (i == 'positive'):
        CleanedText_Class.append(1)
    else:
        CleanedText_Class.append(0)


CleanedText_Class
type(CleanedText_Class)
```

Out[38]:

```
list
```

In [39]:

```
text=final.CleanedText.values
print(type(text))
```

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

In [40]:

```
# =============================== loading libraries ============================================
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from sklearn.cross_validation import train_test_split
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import accuracy_score
from sklearn.cross_validation import cross_val_score
from collections import Counter
from sklearn.metrics import accuracy_score
from sklearn import cross_validation
# =====================================
# split the data set into train and test for BoW
#X_1, X_test, y_1, y_test = cross_validation.train_test_split(X, y, test_size=0.3, random_state=0)
X_1, X_test, y_1, y_test = cross_validation.train_test_split(text, CleanedText_Class, test_size=0.3
, random_state=0)

# split the train data set into cross validation train and cross validation test
X_tr, X_cv, y_tr, y_cv = cross_validation.train_test_split(X_1, y_1, test_size=0.3)
```

In [41]:

```
y_tr = np.array(y_tr)
print(y_tr.shape)
```

```
(29400,)
```

In [42]:

```
y_cv = np.array(y_cv)
```

In [43]:

```
y_1 = np.array(y_1)
```

BOW

In [44]:

```
#BOW
from sklearn.feature_extraction.text import CountVectorizer
vectorizer = CountVectorizer()
vocabulary= vectorizer.fit(X_tr)
#print("the shape of out text BOW vectorizer ",vocabulary.get_shape())
#bow_x_tr.shape
# bow_tr_array
```

In [45]:

```
bow_x_tr= vectorizer.transform(X_tr)
print("the shape of out text BOW vectorizer ",bow_x_tr.get_shape())
```

```
the shape of out text BOW vectorizer  (29400, 21148)
```

In [74]:

```
# from sklearn.feature_extraction.text import CountVectorizer
# vectorizer = CountVectorizer()
# bow_x_tr= vectorizer.fit_transform(X_tr)
# print("the shape of out text BOW vectorizer ",bow_x_tr.get_shape())
#bow_x_tr.shape
# bow_tr_array
```

CV to BOW

In [46]:

```
bow_x_cv= vectorizer.transform(X_cv)
print("the shape of out text BOW vectorizer ",bow_x_cv.get_shape())
```

```
the shape of out text BOW vectorizer  (12600, 21148)
```

test to bow

In [47]:

```
bow_x_test= vectorizer.transform(X_test)
print("the shape of out text BOW vectorizer ",bow_x_test.get_shape())
```

```
the shape of out text BOW vectorizer  (18000, 21148)
```

whole training data without cv

In [48]:

```
#whole training data without cv
bow_x_1= vectorizer.fit_transform(X_1)
print("the shape of out text BOW vectorizer ",bow_x_1.get_shape())
```

```
the shape of out text BOW vectorizer  (42000, 24834)
```

finding optimal k with train and cv data by applying knn with accuracy

In [49]:

```
for i in range(1,30,2):
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i)

    # fitting the model on crossvalidation train
    knn.fit(bow_x_tr, y_tr)

    # predict the response on the crossvalidation train
    pred = knn.predict(bow_x_cv)

    # evaluate CV accuracy
    acc = accuracy_score(y_cv, pred, normalize=True) * float(100)
    print('\nCV accuracy for k = %d is %d%%' % (i, acc))

# knn = KNeighborsClassifier(1)
# knn.fit(X_tr,y_tr)
# pred = knn.predict(X_test)
# acc = accuracy_score(y_test, pred, normalize=True) * float(100)
# print('\n****Test accuracy for k = 1 is %d%%' % (acc))
```

```
CV accuracy for k = 1 is 85%

CV accuracy for k = 3 is 88%
```

```
CV accuracy for k = 5 is 88%

CV accuracy for k = 7 is 88%

CV accuracy for k = 9 is 88%

CV accuracy for k = 11 is 88%

CV accuracy for k = 13 is 88%

CV accuracy for k = 15 is 88%

CV accuracy for k = 17 is 88%

CV accuracy for k = 19 is 88%

CV accuracy for k = 21 is 88%

CV accuracy for k = 23 is 88%

CV accuracy for k = 25 is 88%

CV accuracy for k = 27 is 88%

CV accuracy for k = 29 is 88%
```

finding optimal k with train and cv data by applying knn with micro f1_score

In [56]:

```
from sklearn.metrics import f1_score
for i in range(1,30,2):
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i)

    # fitting the model on crossvalidation train
    knn.fit(bow_x_tr, y_tr)

    # predict the response on the crossvalidation train
    pred = knn.predict(bow_x_cv)

    # evaluate CV accuracy
    acc = f1_score(y_cv, pred, average='micro') * float(100)
    print('\nCV macro f1_score for k = %d is %d%%' % (i, acc))
```

```
CV macro f1_score for k = 1 is 85%

CV macro f1_score for k = 3 is 88%

CV macro f1_score for k = 5 is 88%

CV macro f1_score for k = 7 is 88%

CV macro f1_score for k = 9 is 88%

CV macro f1_score for k = 11 is 88%

CV macro f1_score for k = 13 is 88%

CV macro f1_score for k = 15 is 88%

CV macro f1_score for k = 17 is 88%

CV macro f1_score for k = 19 is 88%

CV macro f1_score for k = 21 is 88%

CV macro f1_score for k = 23 is 88%

CV macro f1_score for k = 25 is 88%
```

CV macro f1_score for k = 27 is 88%

CV macro f1_score for k = 29 is 88%

finding optimal k with train and cv data by applying knn with algo kdtree

In [145]:

```
for i in tqdm(range(1,30,2)):
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i,algorithm='kd_tree', leaf_size=30)

    # fitting the model on crossvalidation train
    knn.fit(bow_x_tr, y_tr)

    # predict the response on the crossvalidation train
    pred = knn.predict(bow_x_cv)

    # evaluate CV accuracy
    acc = accuracy_score(y_cv, pred, normalize=True) * float(100)
    print('\nCV accuracy for k = %d is %d%%' % (i, acc))
```

```
  0%|                                                                                        | C
[00:00<?, ?it/s]
```

```
CV accuracy for k = 1 is 85%
```

```
  7%|█████                                                                  | 1/15 [00:
03:43, 15.98s/it]
```

```
CV accuracy for k = 3 is 88%
```

```
 13%|███████████                                                            | 2/15 [00:
03:28, 16.07s/it]
```

```
CV accuracy for k = 5 is 88%
```

```
 20%|████████████████                                                       | 3/15
[00:51<03:23, 16.95s/it]
```

```
CV accuracy for k = 7 is 88%
```

```
 27%|██████████████████████                                                 | 4/15 [01:
<03:13, 17.55s/it]
```

```
CV accuracy for k = 9 is 88%
```

```
 33%|███████████████████████████                                            | 5/15 [01:
<03:01, 18.12s/it]
```

```
CV accuracy for k = 11 is 88%
```

```
 40%|█████████████████████████████████                                      | 6/15
[01:48<02:45, 18.42s/it]
```

```
CV accuracy for k = 13 is 88%
```

```
 47%|██████████████████████████████████████                                 | 7/15
[02:08<02:30, 18.81s/it]
```

```
CV accuracy for k = 15 is 88%
```

```
 53%|████████████████████████████████████████████                           | 8/15 [02:
7<02:11, 18.81s/it]
```

```
CV accuracy for k = 17 is 88%
```

```
 60%|██████████████████████████████████████████████████                                | 9/15 [02:
6<01:54, 19.00s/it]
```

```
CV accuracy for k = 19 is 88%
```

```
 67%|███████████████████████████████████████████████████████                          | 10/15
[03:06<01:36, 19.25s/it]
```

```
CV accuracy for k = 21 is 88%
```

```
 73%|████████████████████████████████████████████████████████████                     | 11/15 [03:
26<01:17, 19.37s/it]
```

```
CV accuracy for k = 23 is 88%
```

```
 80%|██████████████████████████████████████████████████████████████████               | 12/15 [03:
46<00:58, 19.65s/it]
```

```
CV accuracy for k = 25 is 88%
```

```
 87%|███████████████████████████████████████████████████████████████████████          | 13/15 [04:
05<00:39, 19.52s/it]
```

```
CV accuracy for k = 27 is 88%
```

```
 93%|█████████████████████████████████████████████████████████████████████████████    | 14/15
[04:24<00:19, 19.30s/it]
```

```
CV accuracy for k = 29 is 88%
```

```
100%|██████████████████████████████████████████████████████████████████████████████████| 15/15
[04:43<00:00, 19.31s/it]
```

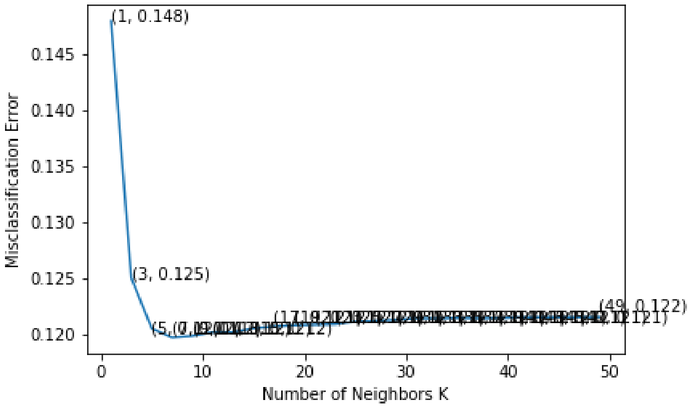
getting optimal value of k

In [94]:

```python
# creating odd list of K for KNN for BoW
myList = list(range(0,50))
neighbors = list(filter(lambda x: x % 2 != 0, myList))

# empty list that will hold cv scores
cv_scores = []

# perform 10-fold cross validation
for k in neighbors:
    knn = KNeighborsClassifier(n_neighbors=k)
    scores = cross_val_score(knn, bow_x_1, y_1, cv=3, scoring='accuracy')
    cv_scores.append(scores.mean())

# changing to misclassification error
MSE = [1 - x for x in cv_scores]

# determining best k
optimal_k = neighbors[MSE.index(min(MSE))]
print('\nThe optimal number of neighbors is %d.' % optimal_k)

# plot misclassification error vs k
plt.plot(neighbors, MSE)

for xy in zip(neighbors, np.round(MSE,3)):
    plt.annotate('(%s, %s)' % xy, xy=xy, textcoords='data')

plt.xlabel('Number of Neighbors K')
```

```
plt.ylabel('Misclassification Error')
plt.show()

print("the misclassification error for each k value is : ", np.round(MSE,3))
```

```
The optimal number of neighbors is 7.
```




```
the misclassification error for each k value is :  [0.148 0.125 0.12  0.12  0.12  0.12  0.12  0.12
0.121 0.121 0.121 0.121
 0.121 0.121 0.121 0.121 0.121 0.121 0.121 0.121 0.121 0.121 0.121 0.121
 0.122]
```

Applying optimal k on test data to get the accuracy with optimal k=7

In [50]:

```
knn = KNeighborsClassifier(7)
knn.fit(bow_x_tr,y_tr)
pred = knn.predict(bow_x_test)
acc = accuracy_score(y_test, pred, normalize=True) * float(100)
print('\n****Test accuracy for k = 7 is %d%%' % (acc))
```

```
****Test accuracy for k = 7 is 89%
```

Applying optimal k with knn(kd-tree) on test data to get the accuracy with optimal k=3

In [147]:

```
knn = KNeighborsClassifier(3,algorithm='kd_tree', leaf_size=30)
knn.fit(bow_x_tr,y_tr)
pred = knn.predict(bow_x_test)
acc = accuracy_score(y_test, pred, normalize=True) * float(100)
print('\n****Test accuracy for k = 3 is %d%%' % (acc))
```

```
****Test accuracy for k = 3 is 88%
```

Applying optimal k on test data to get micro the f1_score with optimal k=7

In [121]:

```
knn = KNeighborsClassifier(7)
knn.fit(bow_x_tr,y_tr)
pred = knn.predict(bow_x_test)
acc = f1_score(y_test, pred,  average='micro') * float(100)
print('\n****Test micro f1_acore for k = 7 is %d%%' % (acc))
```

```
****Test micro f1_acore for k = 7 is 89%
```

knn(kd-tree) finding optimal k with train and cv data by applying knn with micro f1_score

In [164]:

```
for i in range(1,30,2):
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i,algorithm='kd_tree', leaf_size=30)

    # fitting the model on crossvalidation train
    knn.fit(bow_x_tr, y_tr)

    # predict the response on the crossvalidation train
    pred = knn.predict(bow_x_cv)

    # evaluate CV accuracy
    acc = f1_score(y_cv, pred, average='micro') * float(100)
    print('\nkd-tree CV macro f1_score for k = %d is %d%%' % (i, acc))
```

```
kd-tree CV macro f1_score for k = 1 is 85%

kd-tree CV macro f1_score for k = 3 is 88%

kd-tree CV macro f1_score for k = 5 is 88%

kd-tree CV macro f1_score for k = 7 is 88%

kd-tree CV macro f1_score for k = 9 is 88%

kd-tree CV macro f1_score for k = 11 is 88%

kd-tree CV macro f1_score for k = 13 is 88%

kd-tree CV macro f1_score for k = 15 is 88%

kd-tree CV macro f1_score for k = 17 is 88%

kd-tree CV macro f1_score for k = 19 is 88%

kd-tree CV macro f1_score for k = 21 is 88%

kd-tree CV macro f1_score for k = 23 is 88%

kd-tree CV macro f1_score for k = 25 is 88%

kd-tree CV macro f1_score for k = 27 is 88%

kd-tree CV macro f1_score for k = 29 is 88%
```

Applying optimal on knn(kd-tree) k on test data to get micro the f1_score with optimal k=3

In [148]:

```
knn = KNeighborsClassifier(3,algorithm='kd_tree', leaf_size=30)
knn.fit(bow_x_tr,y_tr)
pred = knn.predict(bow_x_test)
acc = f1_score(y_test, pred,  average='micro') * float(100)
print('\n****knn kd-tree Test micro f1_acore for k = 3 is %d%%' % (acc))
```

```
****knn kd-tree Test micro f1_acore for k = 3 is 88%
```

apply confusion matrix on bow

In [52]:

```
# apply confusion matrix
from sklearn.metrics import confusion_matrix
knn = KNeighborsClassifier(7)
```

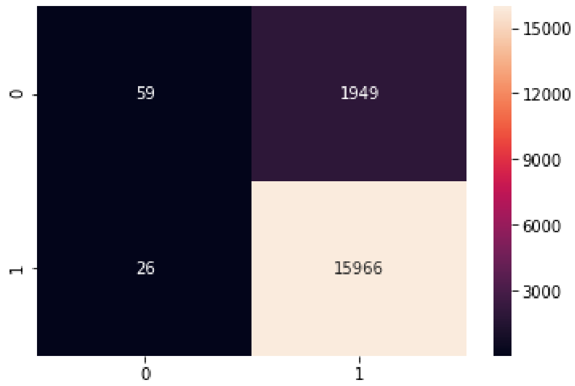
```
knn = KNeighborsClassifier(7)
knn.fit(bow_x_tr,y_tr)
pred = knn.predict(bow_x_test)
# acc = accuracy_score(y_test, pred, normalize=True) * float(100)
# print('\n****Test accuracy for k = 5 is %d%%' % (acc))
bow_confusion_matrix = confusion_matrix(y_test, pred)
bow_confusion_matrix
```

Out[52]:

```
array([[   59,  1949],
       [   26, 15966]], dtype=int64)
```

In [53]:

```
import seaborn as sns;
ax = sns.heatmap(bow_confusion_matrix,annot=bow_confusion_matrix, fmt='')
```



tfidf

In [59]:

```
#tfidf
tf_idf_vect = TfidfVectorizer(ngram_range=(1,2))
vocabulary = tf_idf_vect.fit(X_tr)
#print("the shape of out text BOW vectorizer ",tf_idf_x_tr.get_shape())
```

In [60]:

```
tf_idf_x_tr = tf_idf_vect.transform(X_tr)
print("the shape of out text BOW vectorizer ",tf_idf_x_tr.get_shape())
```

```
the shape of out text BOW vectorizer  (29400, 492757)
```

In [61]:

```
tf_idf_x_cv = tf_idf_vect.transform(X_cv)
print("the shape of out text BOW vectorizer ",tf_idf_x_cv.get_shape())
```

```
the shape of out text BOW vectorizer  (12600, 492757)
```

In [62]:

```
tf_idf_x_test= tf_idf_vect.transform(X_test)
print("the shape of out text BOW vectorizer ",tf_idf_x_test.get_shape())
```

```
the shape of out text BOW vectorizer  (18000, 492757)
```

In [63]:

```
tf_idf_x_1= tf_idf_vect.transform(X_1)
print("the shape of out text BOW vectorizer ",tf_idf_x_1.get_shape())
```

```
the shape of out text BOW vectorizer  (42000, 492757)
```

In [64]:

```
for i in range(1,30,2):
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i)

    # fitting the model on crossvalidation train
    knn.fit(tf_idf_x_tr, y_tr)

    # predict the response on the crossvalidation train
    pred = knn.predict(tf_idf_x_cv)

    # evaluate CV accuracy
    acc = accuracy_score(y_cv, pred, normalize=True) * float(100)
    print('\nCV accuracy for k = %d is %d%%' % (i, acc))

# knn = KNeighborsClassifier(1)
# knn.fit(X_tr,y_tr)
# pred = knn.predict(X_test)
# acc = accuracy_score(y_test, pred, normalize=True) * float(100)
# print('\n****Test accuracy for k = 1 is %d%%' % (acc))
```

```
CV accuracy for k = 1 is 85%

CV accuracy for k = 3 is 88%

CV accuracy for k = 5 is 89%

CV accuracy for k = 7 is 89%

CV accuracy for k = 9 is 89%

CV accuracy for k = 11 is 89%

CV accuracy for k = 13 is 89%

CV accuracy for k = 15 is 89%

CV accuracy for k = 17 is 89%

CV accuracy for k = 19 is 89%

CV accuracy for k = 21 is 89%

CV accuracy for k = 23 is 89%

CV accuracy for k = 25 is 89%

CV accuracy for k = 27 is 89%

CV accuracy for k = 29 is 89%
```

getting optimal k with acc on train and cv with knn kd-tree

In [151]:

```
for i in range(1,30,2):
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i,algorithm='kd_tree', leaf_size=30)

    # fitting the model on crossvalidation train
    knn.fit(tf_idf_x_tr, y_tr)

    # predict the response on the crossvalidation train
    pred = knn.predict(tf_idf_x_cv)

    # evaluate CV accuracy
    acc = accuracy_score(y_cv, pred, normalize=True) * float(100)
    print('\nkd-tree CV accuracy for k = %d is %d%%' % (i, acc))
```

```
# knn = KNeighborsClassifier(1)
# knn.fit(X_tr,y_tr)
# pred = knn.predict(X_test)
# acc = accuracy_score(y_test, pred, normalize=True) * float(100)
# print('\n****Test accuracy for k = 1 is %d%%' % (acc))
```

```
kd-tree CV accuracy for k = 1 is 85%

kd-tree CV accuracy for k = 3 is 88%

kd-tree CV accuracy for k = 5 is 89%

kd-tree CV accuracy for k = 7 is 89%

kd-tree CV accuracy for k = 9 is 89%

kd-tree CV accuracy for k = 11 is 89%

kd-tree CV accuracy for k = 13 is 89%

kd-tree CV accuracy for k = 15 is 89%

kd-tree CV accuracy for k = 17 is 89%

kd-tree CV accuracy for k = 19 is 89%

kd-tree CV accuracy for k = 21 is 89%

kd-tree CV accuracy for k = 23 is 89%

kd-tree CV accuracy for k = 25 is 89%

kd-tree CV accuracy for k = 27 is 89%

kd-tree CV accuracy for k = 29 is 89%
```

(tfidf) finding optimal k with train and cv data by applying knn with micro f1_score

In [65]:

```
for i in range(1,30,2):
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i)

    # fitting the model on crossvalidation train
    knn.fit(tf_idf_x_tr, y_tr)

    # predict the response on the crossvalidation train
    pred = knn.predict(tf_idf_x_cv)

    # evaluate CV accuracy
    acc = f1_score(y_cv, pred, average='micro') * float(100)
    print('\nCV accuracy for k = %d is %d%%' % (i, acc))
```

```
CV accuracy for k = 1 is 85%

CV accuracy for k = 3 is 88%

CV accuracy for k = 5 is 89%

CV accuracy for k = 7 is 89%

CV accuracy for k = 9 is 89%

CV accuracy for k = 11 is 89%

CV accuracy for k = 13 is 89%

CV accuracy for k = 15 is 89%

CV accuracy for k = 17 is 89%
```

```
CV accuracy for k = 19 is 89%

CV accuracy for k = 21 is 89%

CV accuracy for k = 23 is 89%

CV accuracy for k = 25 is 89%

CV accuracy for k = 27 is 89%

CV accuracy for k = 29 is 89%
```

getting optimal k with f1_score on train and cv with knn kd-tree

In [152]:

```
for i in range(1,30,2):
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i,algorithm='kd_tree', leaf_size=30)

    # fitting the model on crossvalidation train
    knn.fit(tf_idf_x_tr, y_tr)

    # predict the response on the crossvalidation train
    pred = knn.predict(tf_idf_x_cv)

    # evaluate CV accuracy
    acc = f1_score(y_cv, pred, average='micro') * float(100)
    print('\nCV accuracy for k = %d is %d%%' % (i, acc))
```

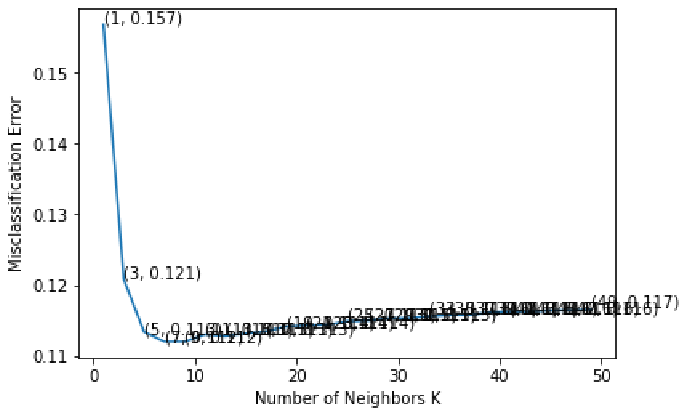
```
CV accuracy for k = 1 is 85%

CV accuracy for k = 3 is 88%

CV accuracy for k = 5 is 89%

CV accuracy for k = 7 is 89%

CV accuracy for k = 9 is 89%

CV accuracy for k = 11 is 89%

CV accuracy for k = 13 is 89%

CV accuracy for k = 15 is 89%

CV accuracy for k = 17 is 89%

CV accuracy for k = 19 is 89%

CV accuracy for k = 21 is 89%

CV accuracy for k = 23 is 89%

CV accuracy for k = 25 is 89%

CV accuracy for k = 27 is 89%

CV accuracy for k = 29 is 89%
```

In [175]:

```
# creating odd list of K for KNN for tfidf
myList = list(range(0,50))
neighbors = list(filter(lambda x: x % 2 != 0, myList))

# empty list that will hold cv scores
cv_scores = []

# perform 10-fold cross validation
for k in neighbors:
    knn = KNeighborsClassifier(n_neighbors=k)
    scores = cross_val_score(knn, tf_idf_x_1, y_1, cv=3, scoring='accuracy')
```

```
    scores = cross_val_score(knn, tf_idf_x_1, y_1, cv=3, scoring='accuracy')
    cv_scores.append(scores.mean())

# changing to misclassification error
MSE = [1 - x for x in cv_scores]

# determining best k
optimal_k = neighbors[MSE.index(min(MSE))]
print('\nThe optimal number of neighbors is %d.' % optimal_k)

# plot misclassification error vs k
plt.plot(neighbors, MSE)

for xy in zip(neighbors, np.round(MSE,3)):
    plt.annotate('(%s, %s)' % xy, xy=xy, textcoords='data')

plt.xlabel('Number of Neighbors K')
plt.ylabel('Misclassification Error')
plt.show()

print("the misclassification error for each k value is : ", np.round(MSE,3))
```

```
The optimal number of neighbors is 7.
```




```
the misclassification error for each k value is :  [0.157 0.121 0.113 0.112 0.112 0.113 0.113 0.113
0.113 0.114 0.114 0.114
 0.115 0.115 0.115 0.115 0.116 0.116 0.116 0.116 0.116 0.116 0.116 0.116
 0.117]
```

(tfidf)now with optimal value of k applying it on test dataset i.e k= 7

In [66]:

```
knn = KNeighborsClassifier(7)
knn.fit(tf_idf_x_tr,y_tr)
pred = knn.predict(tf_idf_x_test)
acc = accuracy_score(y_test, pred, normalize=True) * float(100)
print('\n****Test accuracy for k = 7 is %d%%' % (acc))
```

```
****Test accuracy for k = 7 is 89%
```

(tfidf knn(kd-tree))now with optimal value of k applying it on test dataset i.e k= 5

In [154]:

```
knn = KNeighborsClassifier(5,algorithm='kd_tree', leaf_size=30)
knn.fit(tf_idf_x_tr,y_tr)
pred = knn.predict(tf_idf_x_test)
acc = accuracy_score(y_test, pred, normalize=True) * float(100)
print('\n****kd-tree Test accuracy for k = 5 is %d%%' % (acc))
```

```
****kd-tree Test accuracy for k = 5 is 89%
```

(tfidf)now with optimal value of k applying micro f1_score it on test dataset i.e k= 7

In [119]:

```
knn = KNeighborsClassifier(7)
knn.fit(tf_idf_x_tr,y_tr)
pred = knn.predict(tf_idf_x_test)
acc = f1_score(y_test, pred, average='micro') * float(100)
print('\n****Test micro f1_score for k = 7 is %d%%' % (acc))
```

```
****Test micro f1_score for k = 7 is 89%
```

(tfidf kd-tree)now with optimal value of k applying micro f1_score it on test dataset i.e k= 5

In [155]:

```
knn = KNeighborsClassifier(5,algorithm='kd_tree', leaf_size=30)
knn.fit(tf_idf_x_tr,y_tr)
pred = knn.predict(tf_idf_x_test)
acc = f1_score(y_test, pred, average='micro') * float(100)
print('\n****Test micro f1_score for k = 5 is %d%%' % (acc))
```

```
****Test micro f1_score for k = 5 is 89%
```

apply confusion matrix on tfidf

In [68]:

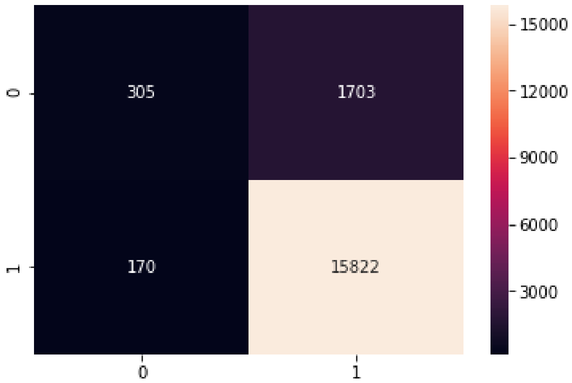
```
# apply confusion matrix
from sklearn.metrics import confusion_matrix
knn = KNeighborsClassifier(5)
knn.fit(tf_idf_x_tr,y_tr)
pred = knn.predict(tf_idf_x_test)
# acc = accuracy_score(y_test, pred, normalize=True) * float(100)
# print('\n****Test accuracy for k = 5 is %d%%' % (acc))
tfidf_coufusion_matrix = confusion_matrix(y_test, pred)
tfidf_coufusion_matrix
```

Out[68]:

```
array([[  305,  1703],
       [  170, 15822]], dtype=int64)
```

In [69]:

```
ax = sns.heatmap(tfidf_coufusion_matrix,annot=tfidf_coufusion_matrix, fmt='')
```



Word2Vec

In [80]:

```
#Word2Vec mode
# Train your own Word2Vec model using your own text corpus
i=0
X_tr_list_of_sent=[]
for sent in X_tr:
    X_tr_list_of_sent.append(sent.split())

print(len(X_tr))
print("\n--------------Spliting each sentence into words--------word list of ie data corpus-------
-\n")
print(X_tr_list_of_sent[:2])
#word list of ie data corpus
```

```
29400

--------------Spliting each sentence into words--------word list of ie data corpus---------

[['fantast', 'green', 'oliv', 'flavour', 'put', 'salad', 'kill', 'tast'], ['big', 'fan', 'salad',
'dress', 'made', 'tasti', 'stuff', 'tangi', 'without', 'vinegar', 'tast', 'wont', 'eat', 'anyth',
'els', 'salad']]
```

In [79]:

```
#The Word to Vec model produces a vocabulary, with each word being represented by
#an n-dimensional numpy array
X_tr_w2v_model=Word2Vec(X_tr_list_of_sent,min_count=1,size=50, workers=4)
X_tr_w2v_model.wv['man']
wlist =list(X_tr_w2v_model.wv.vocab)
# wlist is a list of words
len(wlist)
```

Out[79]:

```
21148
```

avg-w2v

In [138]:

```
#avg-w2v
#labels = []
X_tr_w2v_model_tokens = []

for word in X_tr_w2v_model.wv.vocab:
    X_tr_w2v_model_tokens.append(X_tr_w2v_model[word])
    #labels.append(word)

# print(len(tokens));
X_tr_w2v_model_tokens = np.array(X_tr_w2v_model_tokens)
X_tr_w2v_model_tokens
print("the shape of out text BOW vectorizer ",X_tr_w2v_model_tokens.shape)
```

```
the shape of out text BOW vectorizer  (26698, 50)
```

CALCULATE AVG WORD2VEC FOR x_tr

In [84]:

```
#CALCULATE AVG WORD2VEC FOR x_tr
w2v_words = list(X_tr_w2v_model.wv.vocab)
# print("number of words that occured minimum 5 times ",len(w2v_words))
# print("sample words ", w2v_words[0:50])
# average Word2Vec
# compute average word2vec for each review.
```

```
X_tr_sent_vectors = []; # the avg-w2v for each sentence/review is stored in this list
for sent in tqdm(X_tr_list_of_sent): # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words:
            vec = X_tr_w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    X_tr_sent_vectors.append(sent_vec)
print(len(X_tr_sent_vectors))
print(len(X_tr_sent_vectors[0]))
```

```
100%|██████████████████████████████████████████████████████████████████████████████| 29400/29400 [00:
52<00:00, 565.22it/s]
```

```
29400
50
```

In [122]:

```
#X_tr_sent_vectors[0]
```

cv for Avgword2vec

In [87]:

```
# Train your own Word2Vec model using your own text corpus
i=0
X_cv_list_of_sent=[]
for sent in X_cv:
    X_cv_list_of_sent.append(sent.split())

print(X_cv[0])
print("\n--------------Spliting each sentence into words--------word list of ie data corpus-------
-\n")
print(X_cv_list_of_sent[:2])
#word list of ie data corpus
```

```
love snapea crisp daughter friend want case birthday shipment quick perfect condit delici usual

--------------Spliting each sentence into words--------word list of ie data corpus---------

[['love', 'snapea', 'crisp', 'daughter', 'friend', 'want', 'case', 'birthday', 'shipment', 'quick'
, 'perfect', 'condit', 'delici', 'usual'], ['receiv', 'sampl', 'babi', 'fair', 'first', 'cup', 'th
ird', 'day', 'low', 'lot', 'stress', 'sleep', 'etc', 'five', 'hour', 'drink', 'tea', 'use', 'pump'
, 'quantiti', 'notic', 'amaz', 'increas', 'convinc', 'custom']]
```

CALCULATE AVG WORD2VEC FOR x_cv

In [92]:

```
#CALCULATE AVG WORD2VEC FOR x_tr
# w2v_words = list(X_cv_w2v_model.wv.vocab)
w2v_words = list(X_tr_w2v_model.wv.vocab)

# print("number of words that occured minimum 5 times ",len(w2v_words))
# print("sample words ", w2v_words[0:50])
# average Word2Vec
# compute average word2vec for each review.
X_cv_sent_vectors = []; # the avg-w2v for each sentence/review is stored in this list
for sent in tqdm(X_cv_list_of_sent): # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words:
#             vec = X_cv_w2v_model.wv[word]
```

```
            vec = X_tr_w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    X_cv_sent_vectors.append(sent_vec)
print(len(X_cv_sent_vectors))
print(len(X_cv_sent_vectors[0]))
```

```
100%|██████████████████████████████████████████████████████████████████████████| 12600/12600 [00:
28<00:00, 437.55it/s]
```

```
12600
50
```

Test for Avgword2vec

In [94]:

```
# Train your own Word2Vec model using your own text corpus
i=0
X_test_list_of_sent=[]
for sent in X_test:
    X_test_list_of_sent.append(sent.split())

print(X_cv[0])
print("\n--------------Spliting each sentence into words--------word list of ie data corpus--------
-\n")
print(X_test_list_of_sent[:2])
#word list of ie data corpus

#The Word to Vec model produces a vocabulary, with each word being represented by
#an n-dimensional numpy array

#change

# X_test_w2v_model=Word2Vec(X_test_list_of_sent,min_count=5,size=50, workers=4)
# X_test_w2v_model.wv['man']
```

```
love snapea crisp daughter friend want case birthday shipment quick perfect condit delici usual

--------------Spliting each sentence into words--------word list of ie data corpus---------

[['pretzel', 'suppos', 'salti', 'tad', 'salti', 'also', 'burnt', 'flavor', 'could', 'say', 'distin
ct', 'smokey', 'flavor', 'bag', 'ahead', 'prospect', 'unsatisfi', 'pallett', 'mighti', 'tall', 'or
der', 'hand', 'subtl', 'sweet', 'flavor', 'good', 'ordinari', 'pretzel', 'tri', 'safeti', 'first',
'instead', 'buy', 'bag', 'also', 'note', 'groceri', 'item', 'cannot', 'return', 'amazon'],
['tabbi', 'usual', 'find', 'treat', 'food', 'interest', 'week', 'could', 'care', 'less', 'greeni',
'mark', 'yet', 'refus', 'treat', 'twice', 'day', 'compli', 'demand', 'hit', 'toss', 'treat', 'cubb
i', 'aka', 'crack', 'hous', 'gotta', 'get', 'hand', 'fast', 'greeni', 'defin', 'worth', 'happi', '
albeit', 'addict', 'cat']]
```

In [95]:

```
#labels = []

#chnage

# X_test_w2v_model_tokens = []

# for word in X_test_w2v_model.wv.vocab:
#     X_test_w2v_model_tokens.append(X_test_w2v_model[word])

# X_test_w2v_model_tokens = np.array(X_test_w2v_model_tokens)
# X_test_w2v_model_tokens
# print("the shape of out text BOW vectorizer ",X_cv_w2v_model_tokens.shape)
```

CALCULATE AVG WORD2VEC FOR x_test

In [96]:

```
#CALCULATE AVG WORD2VEC FOR x_test
# w2v_words = list(X_test_w2v_model.wv.vocab)

w2v_words = list(X_tr_w2v_model.wv.vocab)
# print("number of words that occured minimum 5 times ",len(w2v_words))
# print("sample words ", w2v_words[0:50])
# average Word2Vec
# compute average word2vec for each review.
X_test_sent_vectors = []; # the avg-w2v for each sentence/review is stored in this list
for sent in tqdm(X_test_list_of_sent): # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words:
#             vec = X_test_w2v_model.wv[word]
            vec = X_tr_w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    X_test_sent_vectors.append(sent_vec)
print(len(X_test_sent_vectors))
print(len(X_test_sent_vectors[0]))
```

```
100%|██████████████████████████████████████████████████████████████████████████| 18000/18000 [00:
36<00:00, 499.96it/s]
```

```
18000
50
```

In [ ]:

```
X_test_sent_vectors[0]
```

now finding the optimal K with acc matrix on avg w2vec

In [97]:

```
for i in range(1,30,2):
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i)

    # fitting the model on crossvalidation train
    knn.fit(X_tr_sent_vectors, y_tr)

    # predict the response on the crossvalidation train
    pred = knn.predict(X_cv_sent_vectors)

    # evaluate CV accuracy
    acc = accuracy_score(y_cv, pred, normalize=True) * float(100)
    print('\nCV accuracy for k = %d is %d%%' % (i, acc))
```

```
CV accuracy for k = 1 is 85%

CV accuracy for k = 3 is 88%

CV accuracy for k = 5 is 89%

CV accuracy for k = 7 is 89%

CV accuracy for k = 9 is 89%

CV accuracy for k = 11 is 89%

CV accuracy for k = 13 is 89%

CV accuracy for k = 15 is 89%

CV accuracy for k = 17 is 89%
```

```
CV accuracy for k = 19 is 89%

CV accuracy for k = 21 is 89%

CV accuracy for k = 23 is 89%

CV accuracy for k = 25 is 89%

CV accuracy for k = 27 is 89%

CV accuracy for k = 29 is 89%
```

now knn(kd-tree) finding the optimal K with acc matrix on avg w2vec

In [156]:

```
for i in range(1,30,2):
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i,algorithm='kd_tree', leaf_size=30)

    # fitting the model on crossvalidation train
    knn.fit(X_tr_sent_vectors, y_tr)

    # predict the response on the crossvalidation train
    pred = knn.predict(X_cv_sent_vectors)

    # evaluate CV accuracy
    acc = accuracy_score(y_cv, pred, normalize=True) * float(100)
    print('\nkd-tree CV accuracy for k = %d is %d%%' % (i, acc))
```

```
kd-tree CV accuracy for k = 1 is 85%

kd-tree CV accuracy for k = 3 is 88%

kd-tree CV accuracy for k = 5 is 89%

kd-tree CV accuracy for k = 7 is 89%

kd-tree CV accuracy for k = 9 is 89%

kd-tree CV accuracy for k = 11 is 89%

kd-tree CV accuracy for k = 13 is 89%

kd-tree CV accuracy for k = 15 is 89%

kd-tree CV accuracy for k = 17 is 89%

kd-tree CV accuracy for k = 19 is 89%

kd-tree CV accuracy for k = 21 is 89%

kd-tree CV accuracy for k = 23 is 89%

kd-tree CV accuracy for k = 25 is 89%

kd-tree CV accuracy for k = 27 is 89%

kd-tree CV accuracy for k = 29 is 89%
```

applying optimal value of k on the test data i.e k = 5

In [99]:

```
knn = KNeighborsClassifier(5)
knn.fit(X_tr_sent_vectors,y_tr)
pred = knn.predict(X_test_sent_vectors)
acc = accuracy_score(y_test, pred, normalize=True) * float(100)
print('\n****Test accuracy for k = 5 is %d%%' % (acc))
```

```
****Test accuracy for k = 5 is [illegible]%
```

```
****Test accuracy for k = 5 is 89%
```

knn(kd-tree) applying optimal value of k on the test data i.e k = 5

In [157]:

```
knn = KNeighborsClassifier(5,algorithm='kd_tree', leaf_size=30)
knn.fit(X_tr_sent_vectors,y_tr)
pred = knn.predict(X_test_sent_vectors)
acc = accuracy_score(y_test, pred, normalize=True) * float(100)
print('\n****kd-tree Test accuracy for k = 5 is %d%%' % (acc))
```

```
****kd-tree Test accuracy for k = 5 is 89%
```

now finding the optimal K with micro f1_score matrix on avg w2vec

In [117]:

```
for i in range(1,30,2):
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i)

    # fitting the model on crossvalidation train
    knn.fit(X_tr_sent_vectors, y_tr)

    # predict the response on the crossvalidation train
    pred = knn.predict(X_cv_sent_vectors)

    # evaluate CV accuracy
    acc = f1_score(y_cv, pred, average='micro') * float(100)
    print('\nCV micro f1_score for k = %d is %d%%' % (i, acc))
```

```
CV micro f1_score for k = 1 is 85%

CV micro f1_score for k = 3 is 88%

CV micro f1_score for k = 5 is 89%

CV micro f1_score for k = 7 is 89%

CV micro f1_score for k = 9 is 89%

CV micro f1_score for k = 11 is 89%

CV micro f1_score for k = 13 is 89%

CV micro f1_score for k = 15 is 89%

CV micro f1_score for k = 17 is 89%

CV micro f1_score for k = 19 is 89%

CV micro f1_score for k = 21 is 89%

CV micro f1_score for k = 23 is 89%

CV micro f1_score for k = 25 is 89%

CV micro f1_score for k = 27 is 89%

CV micro f1_score for k = 29 is 89%
```

knn(kd-tree) now finding the optimal K with micro f1_score matrix on avg w2vec

In [158]:

```
for i in range(1,30,2):
```

```
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i,algorithm='kd_tree', leaf_size=30)

    # fitting the model on crossvalidation train
    knn.fit(X_tr_sent_vectors, y_tr)

    # predict the response on the crossvalidation train
    pred = knn.predict(X_cv_sent_vectors)

    # evaluate CV accuracy
    acc = f1_score(y_cv, pred, average='micro') * float(100)
    print('\nCV micro f1_score for k = %d is %d%%' % (i, acc))
```

```
CV micro f1_score for k = 1 is 85%

CV micro f1_score for k = 3 is 88%

CV micro f1_score for k = 5 is 89%

CV micro f1_score for k = 7 is 89%

CV micro f1_score for k = 9 is 89%

CV micro f1_score for k = 11 is 89%

CV micro f1_score for k = 13 is 89%

CV micro f1_score for k = 15 is 89%

CV micro f1_score for k = 17 is 89%

CV micro f1_score for k = 19 is 89%

CV micro f1_score for k = 21 is 89%

CV micro f1_score for k = 23 is 89%

CV micro f1_score for k = 25 is 89%

CV micro f1_score for k = 27 is 89%

CV micro f1_score for k = 29 is 89%
```

applying optimal value of k on the test data for micro f1_score i.e k = 5

In [118]:

```
knn = KNeighborsClassifier(5)
knn.fit(X_tr_sent_vectors,y_tr)
pred = knn.predict(X_test_sent_vectors)
acc = f1_score(y_test, pred, average='micro') * float(100)
print('\n****Test f1_score for k = 5 is %d%%' % (acc))
```

```
****Test f1_score for k = 5 is 89%
```

knn(kd-tree) applying optimal value of k on the test data for micro f1_score i.e k = 5

In [160]:

```
knn = KNeighborsClassifier(5,algorithm='kd_tree', leaf_size=30)
knn.fit(X_tr_sent_vectors,y_tr)
pred = knn.predict(X_test_sent_vectors)
acc = f1_score(y_test, pred, average='micro') * float(100)
print('\n****kd-tree Test f1_score for k = 5 is %d%%' % (acc))
```

```
****kd-tree Test f1_score for k = 5 is 89%
```

apply confusion matrix on avg w2vec

In [100]:

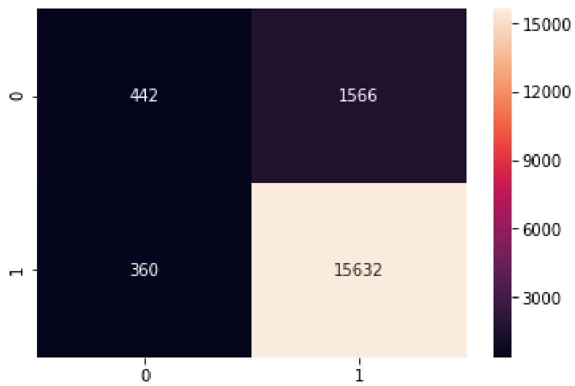
```
# apply confusion matrix
from sklearn.metrics import confusion_matrix
knn = KNeighborsClassifier(5)
knn.fit(X_tr_sent_vectors,y_tr)
pred = knn.predict(X_test_sent_vectors)
# acc = accuracy_score(y_test, pred, normalize=True) * float(100)
# print('\n****Test accuracy for k = 5 is %d%%' % (acc))
avgw2vec_confusion_matrix = confusion_matrix(y_test, pred)
avgw2vec_confusion_matrix
```

Out[100]:

```
array([[  442,  1566],
       [  360, 15632]], dtype=int64)
```

In [101]:

```
ax = sns.heatmap(avgw2vec_confusion_matrix,annot=avgw2vec_confusion_matrix, fmt='')
```



TF-IDF weighted Word2Vec

TF-IDF weighted Word2Vec for c_tr ie train

In [104]:

```
# 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 [105]:

```
#--new way TF-IDF weighted Word2Vec
   # TF-IDF weighted Word2Vec
tfidf_feat = tf_idf_vect.get_feature_names() # tfidf words/col-names
# final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf

X_tr_tfidf_sent_vectors = []; # the tfidf-w2v for each sentence/review is stored in this list
row=0;
for sent in tqdm(X_tr_list_of_sent): # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words:
            vec = X_tr_w2v_model.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:
```

```
    if weight_sum != 0:
        sent_vec /= weight_sum
    X_tr_tfidf_sent_vectors.append(sent_vec)
    row += 1

#---------------------------------------------------new way
```

```
100%|██████████████████████████████████████████████████| 29400/29400 [01:00<00:00, 483.38it/s]
```

In [106]:

```
print(len(X_tr_tfidf_sent_vectors))
print(len(X_tr_tfidf_sent_vectors[0]))
```

```
29400
50
```

In [107]:

```
X_tr_tfidf_sent_vectors[0]
```

Out[107]:

```
array([-6.61325196e-01,  4.27122573e-01, -6.17071775e-02,  4.26272240e-01,
        2.96406332e-01,  1.33749806e-01,  1.90408915e-02,  1.17200801e+00,
       -5.88594656e-01,  1.08146709e+00,  3.38193973e-01,  1.07745229e+00,
        3.01946412e-01,  3.64909926e-01,  1.02687939e+00,  7.08874548e-01,
       -8.28193983e-01,  4.42295794e-02, -5.91197902e-01, -5.93715859e-01,
       -2.71983118e-01,  3.91163739e-01,  7.25811769e-01,  3.88467067e-02,
       -5.35117497e-01,  4.42828302e-01,  5.89562812e-04, -3.22835917e-01,
       -3.25983744e-01, -7.43865234e-01, -8.88674506e-01,  6.42316537e-01,
        9.43803343e-01,  3.87417376e-01, -2.87904865e-01, -4.44882784e-01,
        3.20912573e-01,  2.88022084e-01, -1.25983951e+00, -4.24662029e-01,
       -8.60205668e-01, -7.80621078e-02, -5.59232485e-03,  3.64157690e-01,
       -2.22466741e-01,  1.59019920e-01, -1.40498116e-02,  1.97809404e-01,
        8.48159916e-01,  4.71295370e-01])
```

TF-IDF weighted Word2Vec for cv

In [108]:

```
#--new way TF-IDF weighted Word2Vec for cv with train data
   # TF-IDF weighted Word2Vec
tfidf_feat = tf_idf_vect.get_feature_names() # tfidf words/col-names
# final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf

X_cv_tfidf_sent_vectors = []; # the tfidf-w2v for each sentence/review is stored in this list
row=0;
for sent in tqdm(X_cv_list_of_sent): # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words:
            vec = X_tr_w2v_model.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
    X_cv_tfidf_sent_vectors.append(sent_vec)
    row += 1

#---------------------------------------------------new way
print(len(X_cv_tfidf_sent_vectors))
print(len(X_cv_tfidf_sent_vectors[0]))
```

```
100%|██████████████████████████████████████████████████| 12600/12600 [00:
28<00:00, 436.72it/s]
```

```
12600
50
```

TF-IDF weighted Word2Vec for X_test ie test

In [205]:

```python
# TF-IDF weighted Word2Vec for X_test ie test
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 = tfidf

X_test_tfidf_sent_vectors = []; # the tfidf-w2v for each sentence/review is stored in this list
row=0;
for sent in X_test_list_of_sent: # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        try:
            vec = X_test_w2v_model.wv[word]
            # obtain the tf_idfidf of a word in a sentence/review
            tf_idf = tf_idf_x_test[row, tfidf_feat.index(word)]
            sent_vec += (vec * tf_idf)
            weight_sum += tf_idf
        except:
            pass

    sent_vec /= weight_sum
    X_test_tfidf_sent_vectors.append(sent_vec)
    row += 1

print(len(X_test_tfidf_sent_vectors))
print(len(X_test_tfidf_sent_vectors[0]))
```

```
30000
50
```

In [109]:

```python
#--new way TF-IDF weighted Word2Vec for cv with train data
   # TF-IDF weighted Word2Vec
tfidf_feat = tf_idf_vect.get_feature_names() # tfidf words/col-names
# final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf

X_test_tfidf_sent_vectors = []; # the tfidf-w2v for each sentence/review is stored in this list
row=0;
for sent in tqdm(X_test_list_of_sent): # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words:
            vec = X_tr_w2v_model.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
    X_test_tfidf_sent_vectors.append(sent_vec)
    row += 1

#---------------------------------------------------new way
print(len(X_test_tfidf_sent_vectors))
print(len(X_test_tfidf_sent_vectors[0]))
```

```
100%|██████████████████████████████████████████████████| 18000/18000 [00:
40<00:00, 441.17it/s]
```

```
18000
50
```

apply knn on TF-IDF weighted Word2Vec for train and cv to get optimal k with acc matrix

In [110]:

```
for i in range(1,30,2):
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i)

    # fitting the model on crossvalidation train
    knn.fit(X_tr_tfidf_sent_vectors, y_tr)

    # predict the response on the crossvalidation train
    pred = knn.predict(X_cv_tfidf_sent_vectors)

    # evaluate CV accuracy
    acc = accuracy_score(y_cv, pred, normalize=True) * float(100)
    print('\nCV accuracy for k = %d is %d%%' % (i, acc))
```

```
CV accuracy for k = 1 is 84%

CV accuracy for k = 3 is 87%

CV accuracy for k = 5 is 88%

CV accuracy for k = 7 is 88%

CV accuracy for k = 9 is 89%

CV accuracy for k = 11 is 89%

CV accuracy for k = 13 is 89%

CV accuracy for k = 15 is 89%

CV accuracy for k = 17 is 89%

CV accuracy for k = 19 is 89%

CV accuracy for k = 21 is 89%

CV accuracy for k = 23 is 89%

CV accuracy for k = 25 is 89%

CV accuracy for k = 27 is 89%

CV accuracy for k = 29 is 89%
```

knn(kd-tree) apply knn on TF-IDF weighted Word2Vec for train and cv to get optimal k with acc matrix

In [159]:

```
for i in range(1,30,2):
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i,algorithm='kd_tree', leaf_size=30)

    # fitting the model on crossvalidation train
    knn.fit(X_tr_tfidf_sent_vectors, y_tr)

    # predict the response on the crossvalidation train
    pred = knn.predict(X_cv_tfidf_sent_vectors)

    # evaluate CV accuracy
    acc = accuracy_score(y_cv, pred, normalize=True) * float(100)
```

```
    print('\nkd-tree CV accuracy for k = %d is %d%%' % (i, acc))
```

```
kd-tree CV accuracy for k = 1 is 84%

kd-tree CV accuracy for k = 3 is 87%

kd-tree CV accuracy for k = 5 is 88%

kd-tree CV accuracy for k = 7 is 88%

kd-tree CV accuracy for k = 9 is 89%

kd-tree CV accuracy for k = 11 is 89%

kd-tree CV accuracy for k = 13 is 89%

kd-tree CV accuracy for k = 15 is 89%

kd-tree CV accuracy for k = 17 is 89%

kd-tree CV accuracy for k = 19 is 89%

kd-tree CV accuracy for k = 21 is 89%

kd-tree CV accuracy for k = 23 is 89%

kd-tree CV accuracy for k = 25 is 89%

kd-tree CV accuracy for k = 27 is 89%

kd-tree CV accuracy for k = 29 is 89%
```

now with optimal value of k apply it on test data i.e k = 9

In [111]:

```
knn = KNeighborsClassifier(9)
knn.fit(X_tr_tfidf_sent_vectors,y_tr)
pred = knn.predict(X_test_tfidf_sent_vectors)
acc = accuracy_score(y_test, pred, normalize=True) * float(100)
print('\n****Test accuracy for k = 9 is %d%%' % (acc))
```

```
****Test accuracy for k = 9 is 89%
```

kd-tree now with optimal value of k apply it on test data i.e k = 9

In [161]:

```
knn = KNeighborsClassifier(9,algorithm='kd_tree', leaf_size=30)
knn.fit(X_tr_tfidf_sent_vectors,y_tr)
pred = knn.predict(X_test_tfidf_sent_vectors)
acc = accuracy_score(y_test, pred, normalize=True) * float(100)
print('\n****kd-tree Test accuracy for k = 9 is %d%%' % (acc))
```

```
****kd-tree Test accuracy for k = 9 is 89%
```

apply knn on TF-IDF weighted Word2Vec for train and cv to get optimal k with micro F1_Score matrix

In [114]:

```
for i in range(1,30,2):
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i)

    # fitting the model on crossvalidation train
    knn.fit(X_tr_tfidf_sent_vectors, y_tr)
```

```python
    # predict the response on the crossvalidation train
    pred = knn.predict(X_cv_tfidf_sent_vectors)

    # evaluate CV accuracy
    acc = f1_score(y_cv, pred, average='micro') * float(100)
    print('\nCV micro f1_score  for k = %d is %d%%' % (i, acc))
```

```
CV micro f1_score  for k = 1 is 84%

CV micro f1_score  for k = 3 is 87%

CV micro f1_score  for k = 5 is 88%

CV micro f1_score  for k = 7 is 88%

CV micro f1_score  for k = 9 is 89%

CV micro f1_score  for k = 11 is 89%

CV micro f1_score  for k = 13 is 89%

CV micro f1_score  for k = 15 is 89%

CV micro f1_score  for k = 17 is 89%

CV micro f1_score  for k = 19 is 89%

CV micro f1_score  for k = 21 is 89%

CV micro f1_score  for k = 23 is 89%

CV micro f1_score  for k = 25 is 89%

CV micro f1_score  for k = 27 is 89%

CV micro f1_score  for k = 29 is 89%
```

apply knn(kd-tree) on TF-IDF weighted Word2Vec for train and cv to get optimal k with micro F1_Score matrix

In [162]:

```python
for i in range(1,30,2):
    # instantiate learning model (k = 30)
    knn = KNeighborsClassifier(n_neighbors=i,algorithm='kd_tree', leaf_size=30)

    # fitting the model on crossvalidation train
    knn.fit(X_tr_tfidf_sent_vectors, y_tr)

    # predict the response on the crossvalidation train
    pred = knn.predict(X_cv_tfidf_sent_vectors)

    # evaluate CV accuracy
    acc = f1_score(y_cv, pred, average='micro') * float(100)
    print('\nkd-tree CV micro f1_score  for k = %d is %d%%' % (i, acc))
```

```
kd-tree CV micro f1_score  for k = 1 is 84%

kd-tree CV micro f1_score  for k = 3 is 87%

kd-tree CV micro f1_score  for k = 5 is 88%

kd-tree CV micro f1_score  for k = 7 is 88%

kd-tree CV micro f1_score  for k = 9 is 89%

kd-tree CV micro f1_score  for k = 11 is 89%

kd-tree CV micro f1_score  for k = 13 is 89%

kd-tree CV micro f1_score  for k = 15 is 89%
```

```
kd-tree CV micro f1_score  for k = 17 is 89%

kd-tree CV micro f1_score  for k = 19 is 89%

kd-tree CV micro f1_score  for k = 21 is 89%

kd-tree CV micro f1_score  for k = 23 is 89%

kd-tree CV micro f1_score  for k = 25 is 89%

kd-tree CV micro f1_score  for k = 27 is 89%

kd-tree CV micro f1_score  for k = 29 is 89%
```

now with optimal value of k apply it on test data i.e k = 9 with micro f1_score

In [128]:

```
knn = KNeighborsClassifier(9)
knn.fit(X_tr_tfidf_sent_vectors, y_tr)
pred = knn.predict(X_test_tfidf_sent_vectors)
acc = f1_score(y_test, pred, average='micro') * float(100)
print('\nCV micro f1_score  for k = 9 is %d%%' % ( acc))
```

```
CV micro f1_score  for k = 9 is 89%
```

knn(kd-tree) now with optimal value of k apply it on test data i.e k = 9 with micro f1_score

In [163]:

```
knn = KNeighborsClassifier(9,algorithm='kd_tree', leaf_size=30)
knn.fit(X_tr_tfidf_sent_vectors, y_tr)
pred = knn.predict(X_test_tfidf_sent_vectors)
acc = f1_score(y_test, pred, average='micro') * float(100)
print('\nkd-tree CV micro f1_score  for k = 9 is %d%%' % ( acc))
```

```
kd-tree CV micro f1_score  for k = 9 is 89%
```

apply confusion matrix on tfidf_avg_w2vec

In [112]:

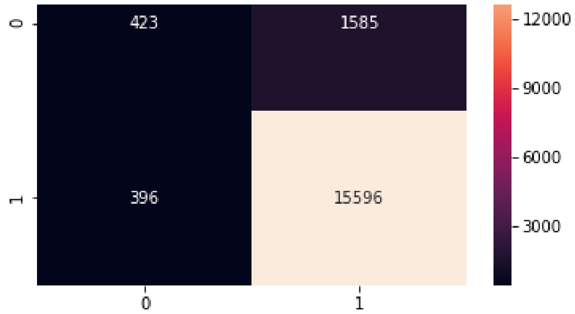
```
# apply confusion matrix
from sklearn.metrics import confusion_matrix
knn = KNeighborsClassifier(5)
knn.fit(X_tr_tfidf_sent_vectors,y_tr)
pred = knn.predict(X_test_tfidf_sent_vectors)
# acc = accuracy_score(y_test, pred, normalize=True) * float(100)
# print('\n****Test accuracy for k = 5 is %d%%' % (acc))
tfidf_avg_w2vec_confusion_matrix = confusion_matrix(y_test, pred)
tfidf_avg_w2vec_confusion_matrix
```

Out[112]:

```
array([[  423,  1585],
       [  396, 15596]], dtype=int64)
```

In [113]:

```
ax = sns.heatmap(tfidf_avg_w2vec_confusion_matrix,annot=tfidf_avg_w2vec_confusion_matrix, fmt='')
```



conclusions section

In [165]:

```
from prettytable import PrettyTable

x = PrettyTable()

x.field_names = ["Model", "FE","opt k(acc)", "train acc", " test acc","opt k(f1_score)","train f1_s
core", " test f1_score"]

x.add_row(["knn ","BOW","k=7 ", "88%","89%" ,"k=7" ,"88%","89%"])
x.add_row(["knn ","TFIDF","k=7 ", "89%","89%" ,"k=7" ,"89%","89%"])
x.add_row(["knn ","avg-w2v","k=5 ", "89%","89%" ,"k=5" ,"89%","89%"])
x.add_row(["knn ","TF-IDF wei W2Vec","k=9 ", "89%","89%" ,"k=9" ,"89%","89%"])
x.add_row(["knn (kd-tree) ","BOW","k=3 ", "88%","88%" ,"k=3" ,"88%","88%"])
x.add_row(["knn (kd-tree)","TFIDF","k=5 ", "89%","89%" ,"k=5" ,"89%","89%"])
x.add_row(["knn (kd-tree) ","avg-w2v","k=5 ", "89%","89%" ,"k=5" ,"89%","89%"])
x.add_row(["knn (kd-tree)","TF-IDF wei W2Vec","k=9 ", "89%","89%" ,"k=9" ,"89%","89%"])


print(x)
```

```
+-----------------+------------------+------------+-----------+-----------+-----------------+-------
------+----------------+
|      Model      |        FE        | opt k(acc) | train acc |  test acc | opt k(f1_score) | train
f1_score |  test f1_score |
+-----------------+------------------+------------+-----------+-----------+-----------------+-------
------+----------------+
|       knn       |       BOW        |    k=7     |    88%    |    89%    |       k=7       |      8
|       89%       |
|       knn       |      TFIDF       |    k=7     |    89%    |    89%    |       k=7       |      8
|       89%       |
|       knn       |     avg-w2v      |    k=5     |    89%    |    89%    |       k=5       |
89%        |       89%        |
|       knn       | TF-IDF wei W2Vec |    k=9     |    89%    |    89%    |       k=9       |      8
%       |      89%        |
| knn (kd-tree)   |       BOW        |    k=3     |    88%    |    88%    |       k=3       |      8
%       |      88%        |
| knn (kd-tree)   |      TFIDF       |    k=5     |    89%    |    89%    |       k=5       |      8
%       |      89%        |
| knn (kd-tree)   |     avg-w2v      |    k=5     |    89%    |    89%    |       k=5       |      8
%       |      89%        |
| knn (kd-tree)   | TF-IDF wei W2Vec |    k=9     |    89%    |    89%    |       k=9       |      8
%       |      89%        |
+-----------------+------------------+------------+-----------+-----------+-----------------+-------
------+----------------+
```