19.32.Amazon_food_review_knn_v1.0

June 29, 2018

1 Amazon food review dataset apply knn to predict polarity review

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

2 Objective

Here try BOW,TFIDF,avg W2V, avg TFIDFW2V and split train test 70-30 10fold cross validation and find optimal k report test accuracy. Use brute force and kd-tree for building knn.

3 Import data and libraries

In [4]:
```
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
con = sqlite3.connect('database.sqlite')

#get only +ve and -ve review
raw_data = pd.read_sql_query("""SELECT * FROM Reviews WHERE Score != 3""", con)
```

4 Data preprocessing

In [5]:
```
filtered_data=raw_data

# Score>3 a positive rating, and score<3 a negative rating.
def partition(x):
```

```
    if x < 3:
        return 'negative'
    return 'positive'

#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
filtered_data.sample(2)
filtered_data['Score'].value_counts()

#Sorting data according to ProductId in ascending order
sorted_data=filtered_data.sort_values('ProductId', axis=0, ascending=True, inplace=Fals

#Deduplication of entries for same profilename,userid, time, text and take first eleme
sorted_data=sorted_data.drop_duplicates(subset={"UserId","ProfileName","Time","Text"},

#Get straritied sampling
from sklearn.cross_validation import train_test_split
_ , clean_data = train_test_split(sorted_data, test_size = 10000, random_state=0,strati
clean_data['Score'].value_counts()


# Clean html tag and punctuation
import re
import string
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer
from nltk.stem.wordnet import WordNetLemmatizer

stop = set(stopwords.words('english')) #set of stopwords
sno = nltk.stem.SnowballStemmer('english') #initialising the snowball stemmer

#substitute html tag and punctuation
def cleanhtml(sentence): #function to clean the word of any html-tags
    cleanr = re.compile('<.*?>')
    cleantext = re.sub(cleanr, ' ', sentence)
    return cleantext
def cleanpunc(sentence): #function to clean the word of any punctuation or special cha
    cleaned = re.sub(r'[?|!|\'|"|#]',r'',sentence)
    cleaned = re.sub(r'[.|,|)|(|\|/]',r' ',cleaned)
    return  cleaned
#print(sno.stem('tasty'))

i=0
str1=' '
final_string=[]
all_positive_words=[] # store words from +ve reviews here
```

```
all_negative_words=[] # store words from -ve reviews here.
s=''

#Create new catagory as Cleanedtext after removing htmltag and punctuation and upperca
for sent in clean_data['Text'].values:
    filtered_sentence=[]
    sent=cleanhtml(sent) # remove HTMl tags
    for w in sent.split():
        for cleaned_words in cleanpunc(w).split():
            if((cleaned_words.isalpha()) & (len(cleaned_words)>2)):
                if(cleaned_words.lower() not in stop):
                    s=(sno.stem(cleaned_words.lower())).encode('utf8')
                    filtered_sentence.append(s)
                    if (clean_data['Score'].values)[i] == 'positive':
                        all_positive_words.append(s) #list of all words used to descri
                    if(clean_data['Score'].values)[i] == 'negative':
                        all_negative_words.append(s) #list of all words used to descri
                else:
                    continue
            else:
                continue
    str1 = b" ".join(filtered_sentence) #final string of cleaned words

    final_string.append(str1)
    i+=1

clean_data['CleanedText']=final_string
#store for future use
#conn = sqlite3.connect('clean_data.sqlite')
#c=conn.cursor()
#conn.text_factory = str
#clean_data.to_sql('Reviews1', conn, flavor=None, schema=None, if_exists='replace', in
#con = sqlite3.connect('clean_data.sqlite')
#clean_data = pd.read_sql_query("""SELECT * FROM Reviews1 WHERE Score != 3""", con)
print(clean_data.shape)

#Sort data on timestamp descending
clean_data=clean_data.sort_values(by=['Time'],ascending=False)
clean_data.sample(2)
```

```
(10000, 11)
```

```
C:\Users\suman\Anaconda3\lib\site-packages\ipykernel_launcher.py:79: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/indexing.html
```

```
Out[5]:            Id   ProductId          UserId ProfileName  HelpfulnessNumerator  \
        309932  335613  B004B4368O  AXG1FSS19B9QL  chai lover                     0
        188229  204159  B0009F3QKW  AX75O9MUM3MAH      daisey                     0

                HelpfulnessDenominator     Score        Time                Summary  \
        309932                       0  positive  1292025600         Delicious Chai
        188229                       1  negative  1294444800  A little too sweet...

                                                        Text  \
        309932  I have tried so many different brands of Chai ...
        188229  This tea would be nice if wasn't so sweet.  Th...

                                                  CleanedText
        309932  b'tri mani differ brand chai far favorit easi ...
        188229  b'tea would nice wasnt sweet cinnamon tast gre...
```

5 Split train and test

```
In [7]: x=clean_data['CleanedText'].values
        y = clean_data['Score']
        #time=time.reset_index(drop=True)
        n=x.shape[0]
        n1=int(n*.3)
        X_test_raw = x[0:n1]
        X_train_raw= x[n1:n+1]
        y_test=y[0:n1]
        y_train=y[n1:n+1]
        print('size of X_train, X_test, y_train , y_test ',X_train_raw.shape, X_test_raw.shape
        print("positive and negative review in train and test\n",y_train.value_counts(),"\n",y_
```

```
size of X_train, X_test, y_train , y_test  (7000,) (3000,) (7000,) (3000,)
positive and negative review in train and test
 positive    5939
negative    1061
Name: Score, dtype: int64
 positive    2493
negative     507
Name: Score, dtype: int64
```

6 Model using BOW knn

```
In [8]: #now convert CleanedText to TDM
        count_vect = CountVectorizer() #in scikit-learn
        X_train = count_vect.fit_transform(X_train_raw)

        #use the same vectors to convert test data
```

```
        X_test=count_vect.transform(X_test_raw)
        print(X_train.get_shape(),X_test.get_shape())
        #print(final_counts[[1]])
        #print(final_counts[0,:])# this is stored like dict format only non zero values. spars
        #x = pd.DataFrame(final_counts.toarray())#this is stored like dataframe format all 0 a
        # sparse matrix in csr format works faster compare to dense format
        #print(x.shape,x.loc[0])
```

```
(7000, 11134) (3000, 11134)
```

In [9]:
```
        #x=final_counts
        #y = clean_data['Score']
        #n=x.shape[0]
        #n1=int(n*.3)
        #X_test = x[0:n1,:]
        #X_train= x[n1:n+1,:]
        #y_test=y[0:n1]
        #y_train=y[n1:n+1]
        #print('size of X_train, X_test, y_train , y_test ',X_train.shape, X_test.shape,y_trai
        #print("positive and negative review in train and test\n",y_train.value_counts(),"\n",
```

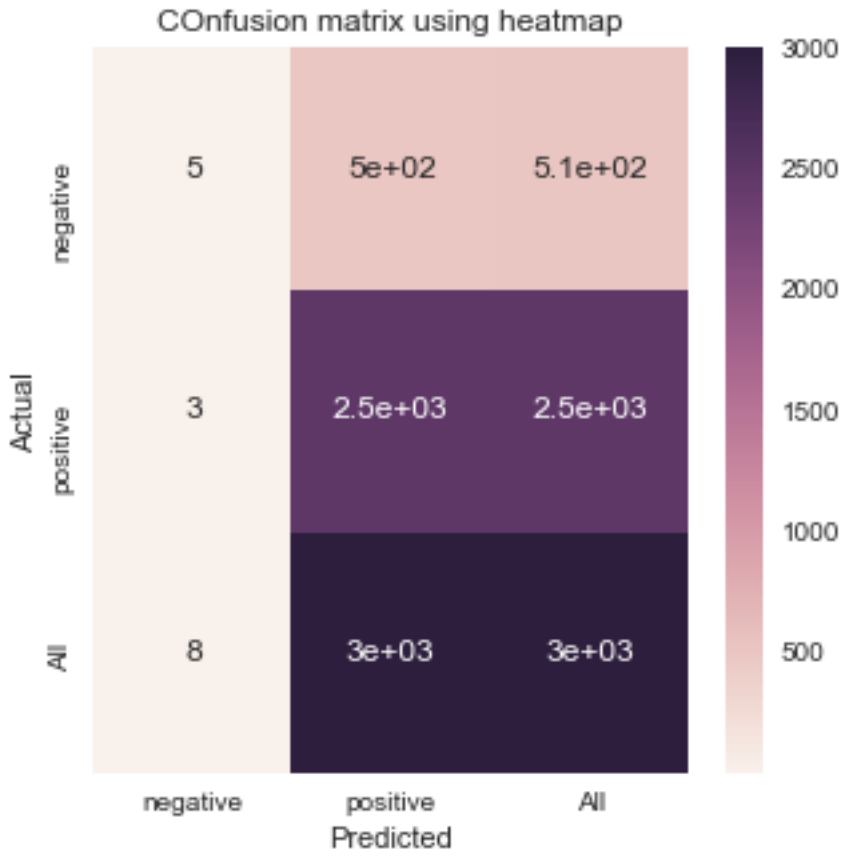
In [10]:
```
        from sklearn.cross_validation import train_test_split
        from sklearn.neighbors import KNeighborsClassifier
        from sklearn.metrics import accuracy_score
        from sklearn.cross_validation import cross_val_score
        from collections import Counter
        from sklearn.metrics import accuracy_score
        from sklearn import cross_validation
```

In [11]:
```
        # Create 10 fold cross validation
        myList = list(range(0,10))
        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,algorithm='brute')
            scores = cross_val_score(knn, X_train, y_train, cv=10, 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 and misclassification error using brute is',
```

```
The optimal number of neighbors and misclassification error using brute is 9 4
```

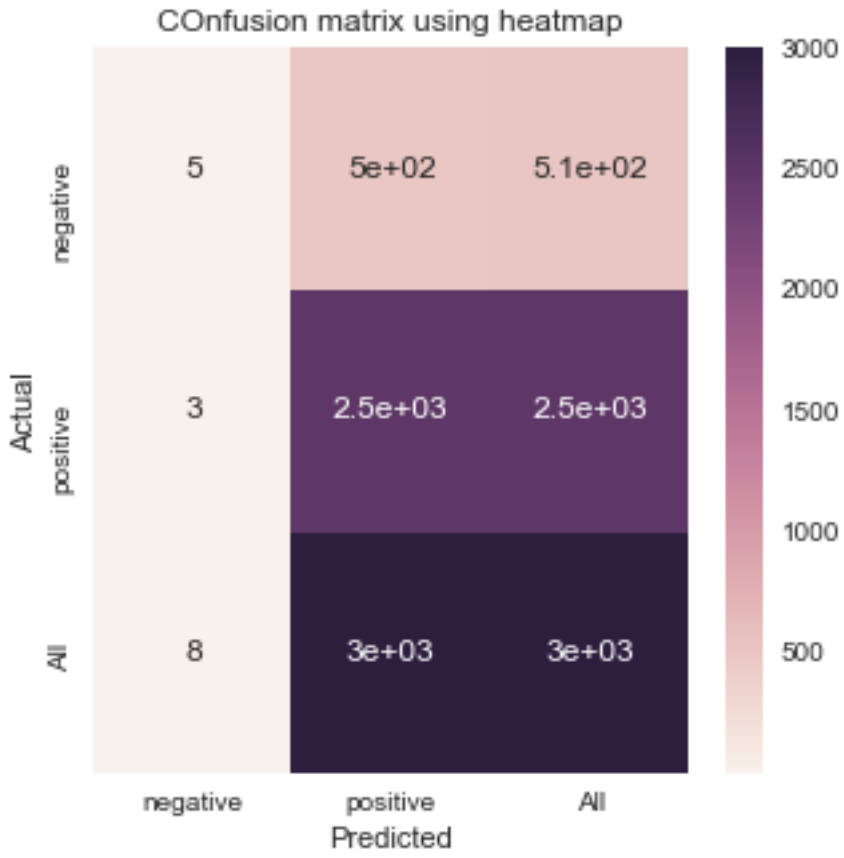
In [12]:
```
# ============================== KNN with k = optimal_k ==============================
# instantiate learning model k = optimal_k
knn_optimal = KNeighborsClassifier(n_neighbors=optimal_k,algorithm='brute')

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

pred = knn_optimal.predict(X_train)
acc1 = accuracy_score(y_train, pred) * 100
pred = knn_optimal.predict(X_test)
acc = accuracy_score(y_test, pred) * 100

aa=pd.DataFrame({'type':['BOW brute'],'train_score':[acc1],'test_score':[acc],'K':[op
#confusion matrix using heatmap seaboarn
mat=pd.crosstab(y_test, pred, rownames=['Actual'], colnames=['Predicted'], margins=Tr
plt.figure(figsize=(5,5))
sns.heatmap(mat,annot=True)
plt.title("COnfusion matrix using heatmap")
plt.show()
```



In [13]:
```
#ignore warning
import warnings
warnings.filterwarnings('ignore')

# Use KDtree
# Create 10 fold cross validation
myList = list(range(0,10))
neighbors = list(filter(lambda x: x % 2 != 0, myList))
cv_scores = []
for k in neighbors:
    knn = KNeighborsClassifier(n_neighbors=k,algorithm='kd_tree')
    scores = cross_val_score(knn, X_train, y_train, cv=10, 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 and misclassification error using kd-tree is
```

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

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

#print('\nThe accuracy of the knn classifier using kd-tree for k = %d is %f%%' % (opt
pred = knn_optimal.predict(X_train)
acctrain = accuracy_score(y_train, pred) * 100
predtest = knn_optimal.predict(X_test)
acc = accuracy_score(y_test, predtest) * 100


bb=pd.DataFrame({'type':['BOW kdtree'],'train_score':[acctrain],'test_score':[acc],'K
aa=aa.append(bb)

#create confusion matrix
mat=pd.crosstab(y_test, predtest, rownames=['Actual'], colnames=['Predicted'], margins
print(mat);
plt.figure(figsize=(5,5))
sns.heatmap(mat,annot=True)
plt.title("COnfusion matrix using heatmap")
plt.show()
```

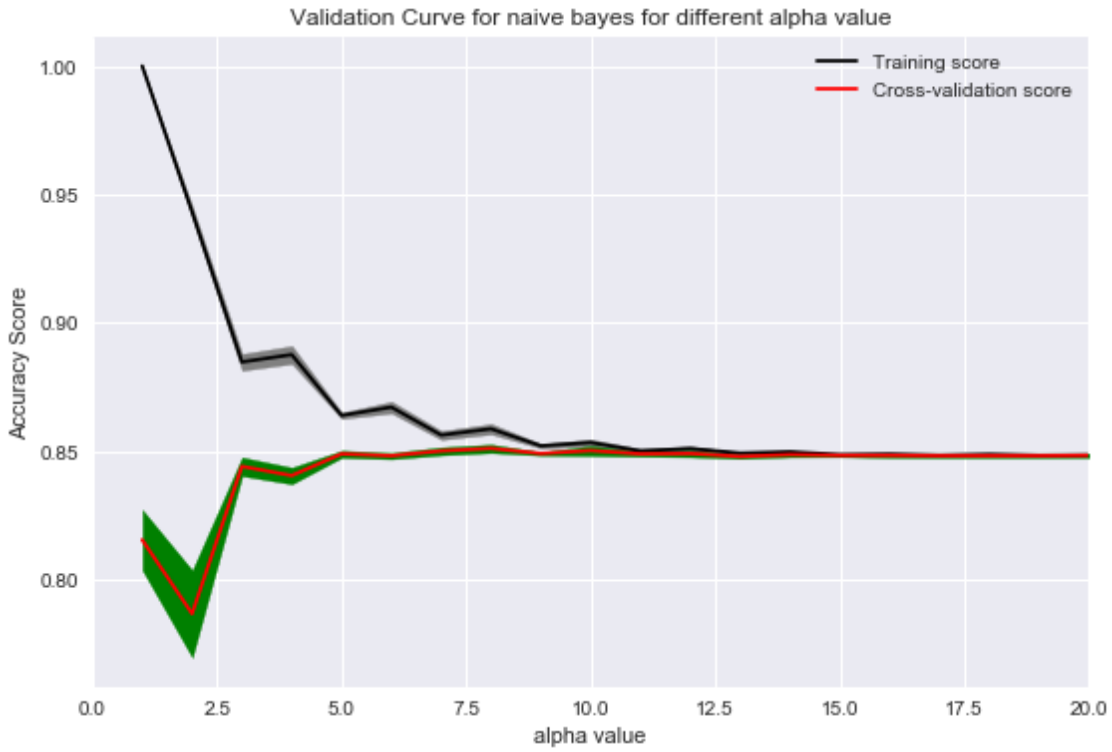
```
The optimal number of neighbors and misclassification error using kd-tree is 9 4
Predicted  negative  positive   All
Actual
negative          5       502   507
positive          3      2490  2493
All               8      2992  3000
```



7 plot accuracy with k

```
In [14]: import warnings
         warnings.filterwarnings('ignore')
         from sklearn.model_selection import validation_curve

         #create plot for training and test validation
         # We cannot put 0 in parameter it will give error while validation_curve
         n_neighbors=[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20]
         param_range=[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20]

         train_scores, test_scores = validation_curve(KNeighborsClassifier(), X_train, y_train
         train_scores_mean = np.mean(train_scores, axis=1)
         train_scores_std = np.std(train_scores, axis=1)
         test_scores_mean = np.mean(test_scores, axis=1)
         test_scores_std = np.std(test_scores, axis=1)

         plt.plot(param_range, train_scores_mean, label="Training score", color="black")
         plt.plot(param_range, test_scores_mean, label="Cross-validation score", color="red")
```

```
plt.fill_between(param_range, train_scores_mean - train_scores_std, train_scores_mean
plt.fill_between(param_range, test_scores_mean - test_scores_std, test_scores_mean + t
plt.title("Validation Curve for naive bayes for different alpha value")
plt.xlabel("alpha value")
plt.ylabel("Accuracy Score")
plt.xlim(0,20)
plt.tight_layout()
plt.legend(loc="best")
plt.show()
```



8 Model using TFIDF

In [15]:
```
#now convert CleanedText to TDM
tf_idf_vect = TfidfVectorizer()
X_train = tf_idf_vect.fit_transform(X_train_raw)
#Use train vector to create vector from test
X_test=tf_idf_vect.transform(X_test_raw)
```

In [16]:
```
#x = pd.DataFrame(final_counts.toarray())
#x=final_counts
#y = clean_data['Score']
#time=time.reset_index(drop=True)
```

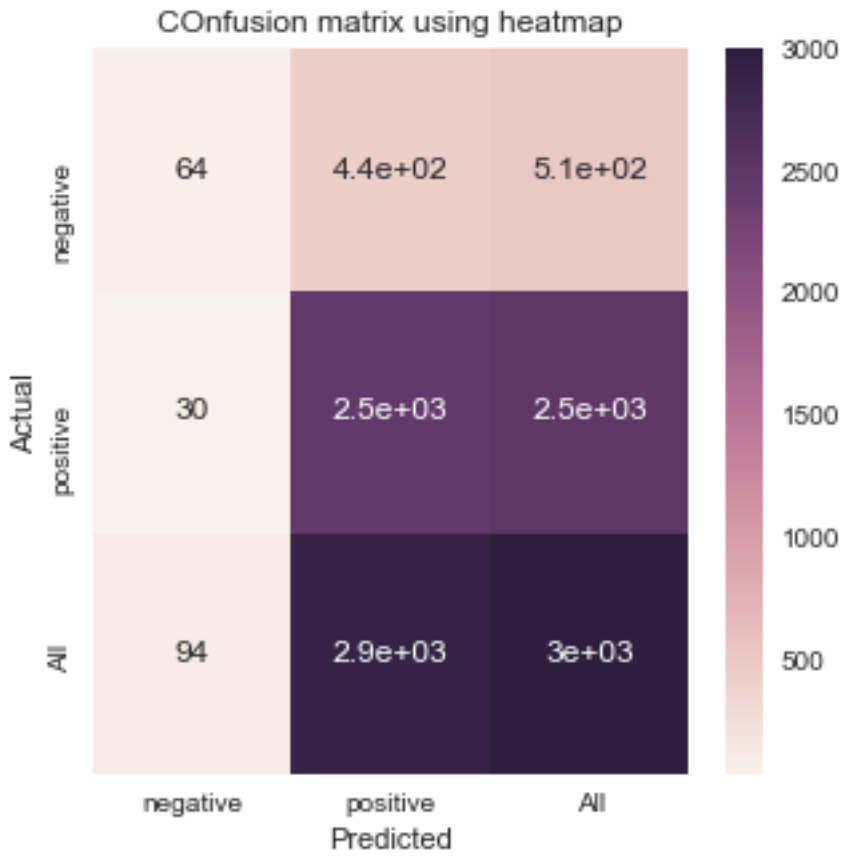
```
        #n=x.shape[0]
        #n1=int(n*.3)
        #X_test = x[0:n1]
        #X_train= x[n1:n+1]
        #X_test = x[0:n1,:]
        #X_train= x[n1:n+1,:]


        #y_test=y[0:n1]
        #y_train=y[n1:n+1]
        #print('size of train, test, X , y ',X_train.shape, X_test.shape,y_train.shape,y_test
```

In [17]:
```
        # Create 10 fold cross validation
        myList = list(range(0,10))
        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,algorithm='kd_tree')
            scores = cross_val_score(knn, X_train, y_train, cv=10, 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 and misclassification error using kd-tree is
```

```
The optimal number of neighbors and misclassification error using kd-tree is 7 3
```

In [18]:
```
        #ignore warning
        import warnings
        warnings.filterwarnings('ignore')

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

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

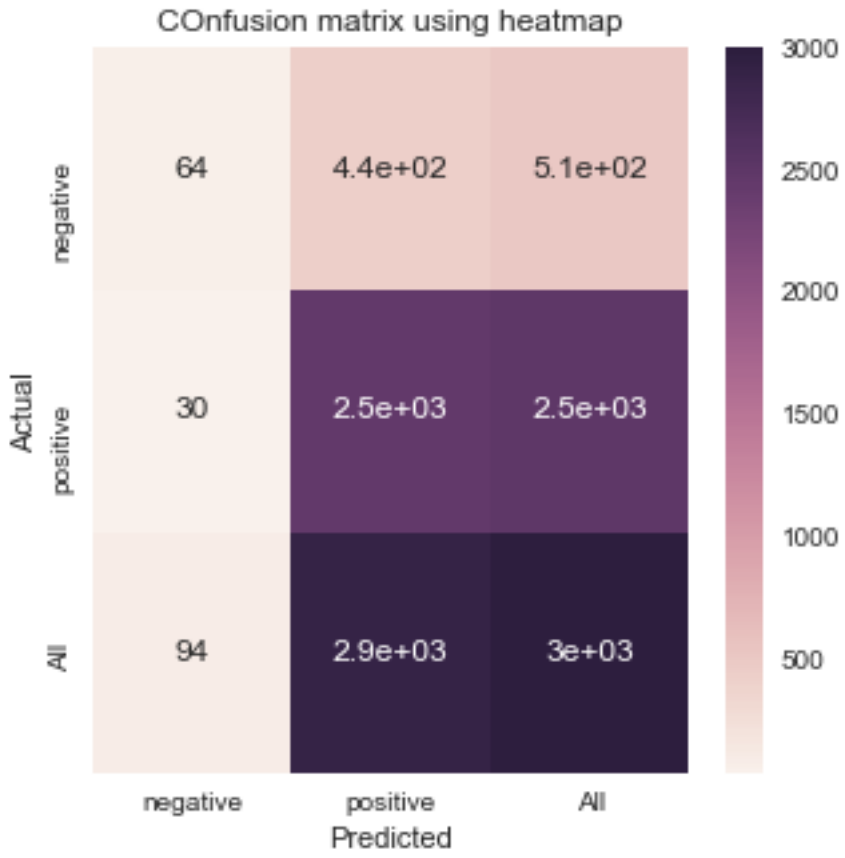
```
#print('\nThe accuracy of the knn classifier using kd-tree for k = %d is %f%%' % (opt
pred = knn_optimal.predict(X_train)
acc1 = accuracy_score(y_train, pred) * 100
pred = knn_optimal.predict(X_test)
acc = accuracy_score(y_test, pred) * 100


bb=pd.DataFrame({'type':['TFIDF kd_tree'],'train_score':[acc1],'test_score':[acc],'K'
aa=aa.append(bb)
#confusion matrix using heatmap seaboarn
mat=pd.crosstab(y_test, pred, rownames=['Actual'], colnames=['Predicted'], margins=Tru
plt.figure(figsize=(5,5))
sns.heatmap(mat,annot=True)
plt.title("COnfusion matrix using heatmap")
plt.show()
```



In [19]:
```
#ignore warning
import warnings
warnings.filterwarnings('ignore')
```

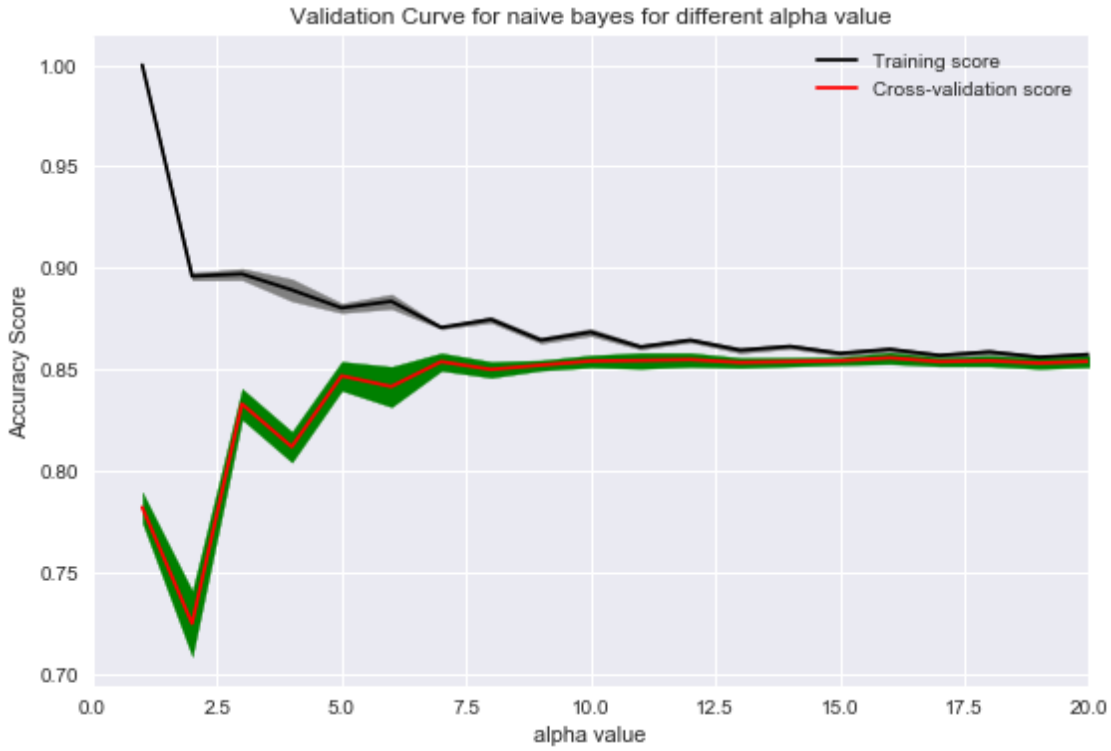
```
# Use brute
# Create 10 fold cross validation
myList = list(range(0,10))
neighbors = list(filter(lambda x: x % 2 != 0, myList))
cv_scores = []
for k in neighbors:
    knn = KNeighborsClassifier(n_neighbors=k,algorithm='brute')
    scores = cross_val_score(knn, X_train, y_train, cv=10, scoring='accuracy')
    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 and misclassification error using brute is',

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

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

pred = knn_optimal.predict(X_test)
acc = accuracy_score(y_test, pred) * 100
#print('\nThe accuracy of the knn classifier using brute for k = %d is %f%%' % (optim
pred = knn_optimal.predict(X_test)
acctrain = accuracy_score(y_test, pred) * 100

bb=pd.DataFrame({'type':['TFIDF brute'],'train_score':[acctrain],'test_score':[acc],'
aa=aa.append(bb)
#confusion matrix
mat=pd.crosstab(y_test, pred, rownames=['Actual'], colnames=['Predicted'], margins=Tru
print(mat);
plt.figure(figsize=(5,5))
sns.heatmap(mat,annot=True)
plt.title("COnfusion matrix using heatmap")
plt.show()
```

```
The optimal number of neighbors and misclassification error using brute is 7 3
Predicted  negative  positive   All
Actual
negative         64       443   507
positive         30      2463  2493
All              94      2906  3000
```



In [20]:
```
import warnings
warnings.filterwarnings('ignore')
from sklearn.model_selection import validation_curve
#create plot for training and test validation
# We cannot put 0 in parameter it will give error while validation_curve
n_neighbors=[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20]
param_range=[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20]

train_scores, test_scores = validation_curve(KNeighborsClassifier(), X_train, y_train
#print(train_scores,test_scores)
train_scores_mean = np.mean(train_scores, axis=1)
train_scores_std = np.std(train_scores, axis=1)
test_scores_mean = np.mean(test_scores, axis=1)
test_scores_std = np.std(test_scores, axis=1)

plt.plot(param_range, train_scores_mean, label="Training score", color="black")
plt.plot(param_range, test_scores_mean, label="Cross-validation score", color="red")
plt.fill_between(param_range, train_scores_mean - train_scores_std, train_scores_mean
plt.fill_between(param_range, test_scores_mean - test_scores_std, test_scores_mean + t
plt.title("Validation Curve for naive bayes for different alpha value")
```

```
plt.xlabel("alpha value")
plt.ylabel("Accuracy Score")
plt.xlim(0,20)
plt.tight_layout()
plt.legend(loc="best")
plt.show()
```



9 Build model using avg W2V

In [21]:
```
#ignore warning
import warnings
warnings.filterwarnings('ignore')


from gensim.models import Word2Vec
from gensim.models import KeyedVectors
import pickle
model = KeyedVectors.load_word2vec_format('GoogleNews-vectors-negative300.bin.gz', bi
import gensim

#convert W2V train data
i=0
```

```
#create a list of list to be used in W2V
list_of_sent_train=[]
for sent in X_train_raw:  #clean_data['CleanedText'].values:
    filtered_sentence=[]
    #sent=cleanhtml(sent)
    for w in sent.split():
        #for cleaned_words in cleanpunc(w).split():
         for cleaned_words in w.split():
            if(cleaned_words.isalpha()):
                filtered_sentence.append(cleaned_words.lower().decode('utf8'))
            else:
                continue
    list_of_sent_train.append(filtered_sentence)
#convert each sentence's words to a vector of 50 dimension. Dont construct vec if wor
#and 4 core processor
w2v_model=gensim.models.Word2Vec(list_of_sent_train,min_count=5,size=50, workers=4)

# average Word2Vec
# for each sentence make average of vectors by (vectors of each words)/(total no of w
# compute average word2vec for each review.
sent_vectors_train = []; # the avg-w2v for each sentence/review is stored in this lis
for sent in list_of_sent_train: # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length
    cnt_words =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        try:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
        except:
            pass
    sent_vec /= cnt_words
    sent_vectors_train.append(sent_vec)


#convert W2V test data
i=0
#create a list of list to be used in W2V
list_of_sent_test=[]
for sent in X_test_raw:  #clean_data['CleanedText'].values:
    filtered_sentence=[]
    #sent=cleanhtml(sent)
    for w in sent.split():
        #for cleaned_words in cleanpunc(w).split():
         for cleaned_words in w.split():
            if(cleaned_words.isalpha()):
                filtered_sentence.append(cleaned_words.lower().decode('utf8'))
            else:
```

```
                    continue
            list_of_sent_test.append(filtered_sentence)
        #convert each sentence's words to a vector of 50 dimension. Dont construct vec if wor
        #and 4 core processor
        w2v_model=gensim.models.Word2Vec(list_of_sent_test,min_count=5,size=50, workers=4)

        # average Word2Vec
        # for each sentence make average of vectors by (vectors of each words)/(total no of w
        # compute average word2vec for each review.
        sent_vectors_test = []; # the avg-w2v for each sentence/review is stored in this list
        for sent in list_of_sent_test: # for each review/sentence
            sent_vec = np.zeros(50) # as word vectors are of zero length
            cnt_words =0; # num of words with a valid vector in the sentence/review
            for word in sent: # for each word in a review/sentence
                try:
                    vec = w2v_model.wv[word]
                    sent_vec += vec
                    cnt_words += 1
                except:
                    pass
            sent_vec /= cnt_words
            sent_vectors_test.append(sent_vec)

        # try
        X_train = pd.DataFrame(sent_vectors_train)
        X_test = pd.DataFrame(sent_vectors_test)
```

In [22]:
```
X_train = pd.DataFrame(sent_vectors_train)
X_test = pd.DataFrame(sent_vectors_test)
print(X_train.shape,X_test.shape)
print(y_train.shape,y_test.shape)
#print(y_train)
```

```
(7000, 50) (3000, 50)
(7000,) (3000,)
```

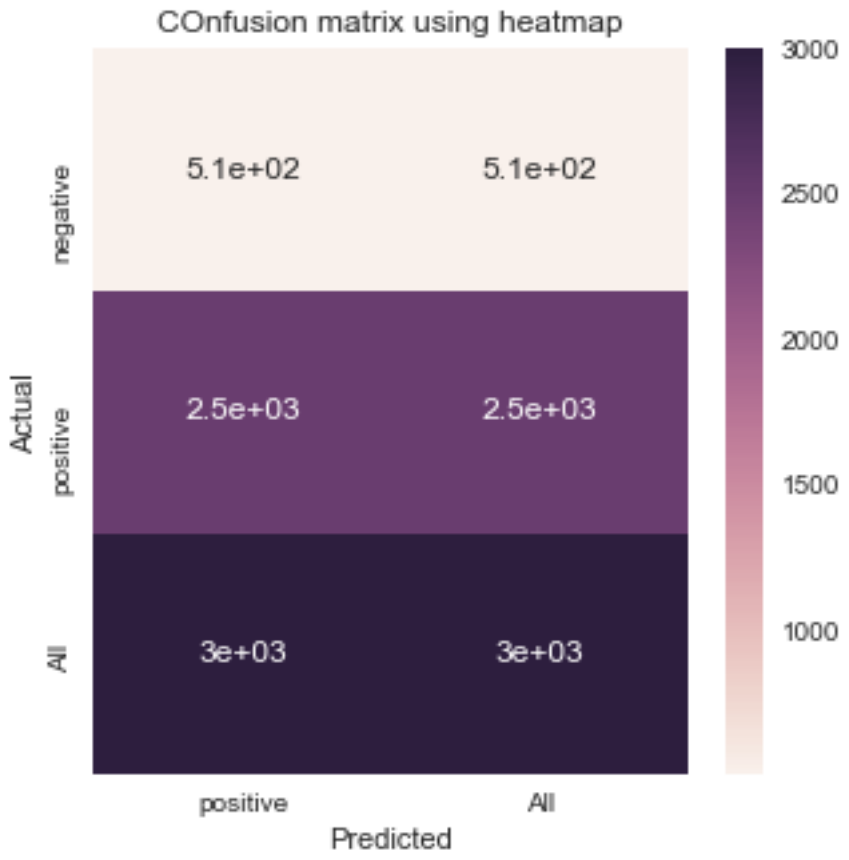
In [23]:
```
#ignore warning
import warnings
warnings.filterwarnings('ignore')

#x = pd.DataFrame(sent_vectors)
#y = clean_data['Score']
#n=x.shape[0]
#n1=int(n*.3)
#X_test = x[0:n1]
#X_train= x[n1:n+1]
#y_test=y[0:n1]
```

```
#y_train=y[n1:n+1]
#print('train and test X y',X_train.shape,X_test.shape,y_train.shape,y_test.shape)



# Create 10 fold cross validation
myList = list(range(0,10))
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,algorithm='kd_tree')
    scores = cross_val_score(knn, X_train, y_train, cv=10, 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 and misclassification error usinf kd-tree is


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

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

# predict the response
pred = knn_optimal.predict(X_test)
acc = accuracy_score(y_test, pred) * 100
pred = knn_optimal.predict(X_test)
acctrain = accuracy_score(y_test, pred) * 100

bb=pd.DataFrame({'type':['avg W2V kd-tree'],'train_score':[acctrain],'test_score':[ac
aa=aa.append(bb)
#confusion matrix
mat=pd.crosstab(y_test, pred, rownames=['Actual'], colnames=['Predicted'], margins=Tr
print(mat);
plt.figure(figsize=(5,5))
sns.heatmap(mat,annot=True)
```

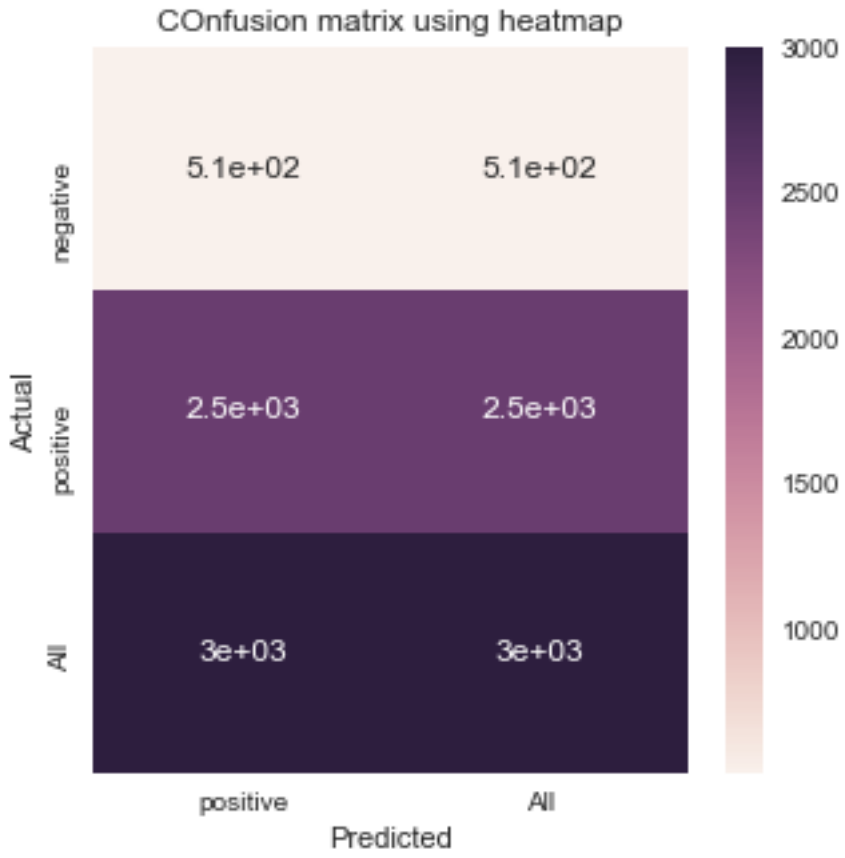
```
plt.title("COnfusion matrix using heatmap")
plt.show()

# Use brute
# Create 10 fold cross validation
myList = list(range(0,10))
neighbors = list(filter(lambda x: x % 2 != 0, myList))
cv_scores = []
for k in neighbors:
    knn = KNeighborsClassifier(n_neighbors=k,algorithm='brute')
    scores = cross_val_score(knn, X_train, y_train, cv=10, 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 and misclassification error using brute  is'

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

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

# predict the response
pred = knn_optimal.predict(X_test)
acc = accuracy_score(y_test, pred) * 100
#print('\nThe accuracy of the knn classifier using brute for k = %d is %f%%' % (optim
pred = knn_optimal.predict(X_test)
acctrain = accuracy_score(y_test, pred) * 100

bb=pd.DataFrame({'type':['avg W2V brute'],'train_score':[acctrain],'test_score':[acc]
aa=aa.append(bb)
#confusion matrix
mat=pd.crosstab(y_test, pred, rownames=['Actual'], colnames=['Predicted'], margins=Tru
print(mat);
plt.figure(figsize=(5,5))
sns.heatmap(mat,annot=True)
plt.title("COnfusion matrix using heatmap")
plt.show()
```

```
The optimal number of neighbors and misclassification error usinf kd-tree is 9 4
Predicted  positive   All
Actual
```

```
negative         507   507
positive        2493  2493
All             3000  3000
```



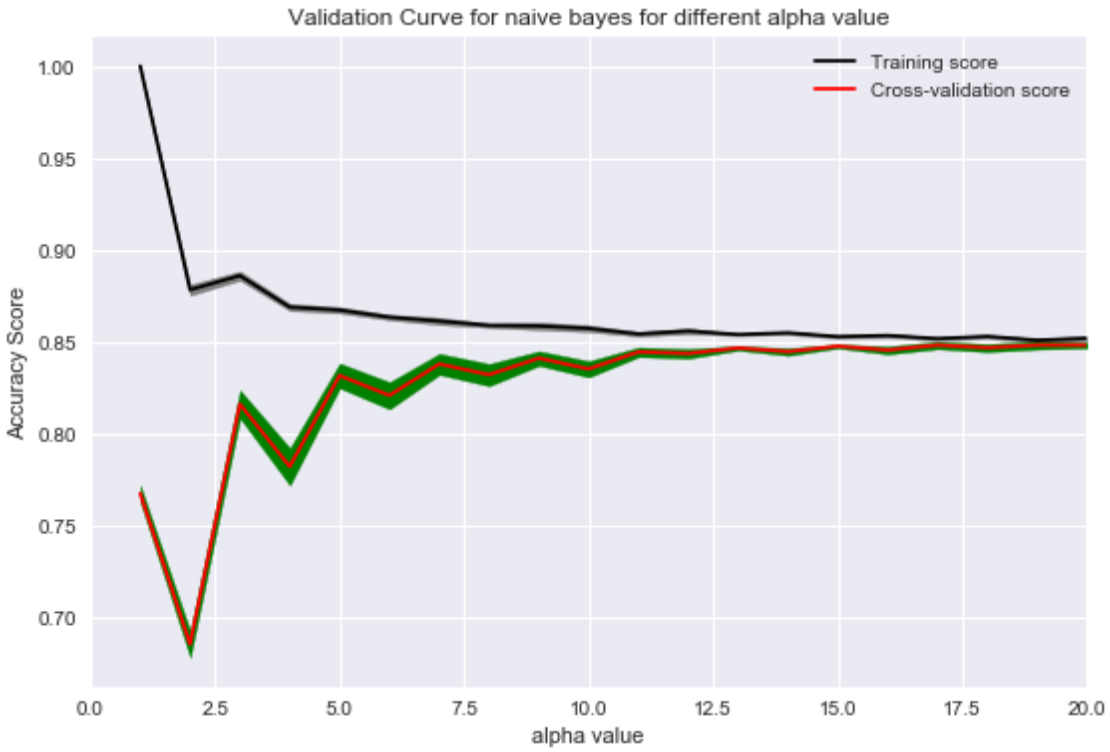

```
The optimal number of neighbors and misclassification error using brute  is 9 4
Predicted  positive   All
Actual
negative         507   507
positive        2493  2493
All             3000  3000
```



10 plot accuracy with k value

In [24]:
```
import warnings
warnings.filterwarnings('ignore')
from sklearn.model_selection import validation_curve
#create plot for training and test validation
# We cannot put 0 in parameter it will give error while validation_curve
n_neighbors=[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20]
param_range=[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20]

train_scores, test_scores = validation_curve(KNeighborsClassifier(), X_train, y_train
#print(train_scores,test_scores)
train_scores_mean = np.mean(train_scores, axis=1)
train_scores_std = np.std(train_scores, axis=1)
test_scores_mean = np.mean(test_scores, axis=1)
test_scores_std = np.std(test_scores, axis=1)

plt.plot(param_range, train_scores_mean, label="Training score", color="black")
plt.plot(param_range, test_scores_mean, label="Cross-validation score", color="red")
```

```
plt.fill_between(param_range, train_scores_mean - train_scores_std, train_scores_mean
plt.fill_between(param_range, test_scores_mean - test_scores_std, test_scores_mean + t
plt.title("Validation Curve for naive bayes for different alpha value")
plt.xlabel("alpha value")
plt.ylabel("Accuracy Score")
plt.xlim(0,20)
plt.tight_layout()
plt.legend(loc="best")
plt.show()
```



11 Build model using avg tfidf w2v

In [25]:
```
#ignore warning
import warnings
warnings.filterwarnings('ignore')


# TF-IDF weighted Word2Vec
tf_idf_vect = TfidfVectorizer()
final_tf_idf=tf_idf_vect.fit_transform(X_train_raw)
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
```

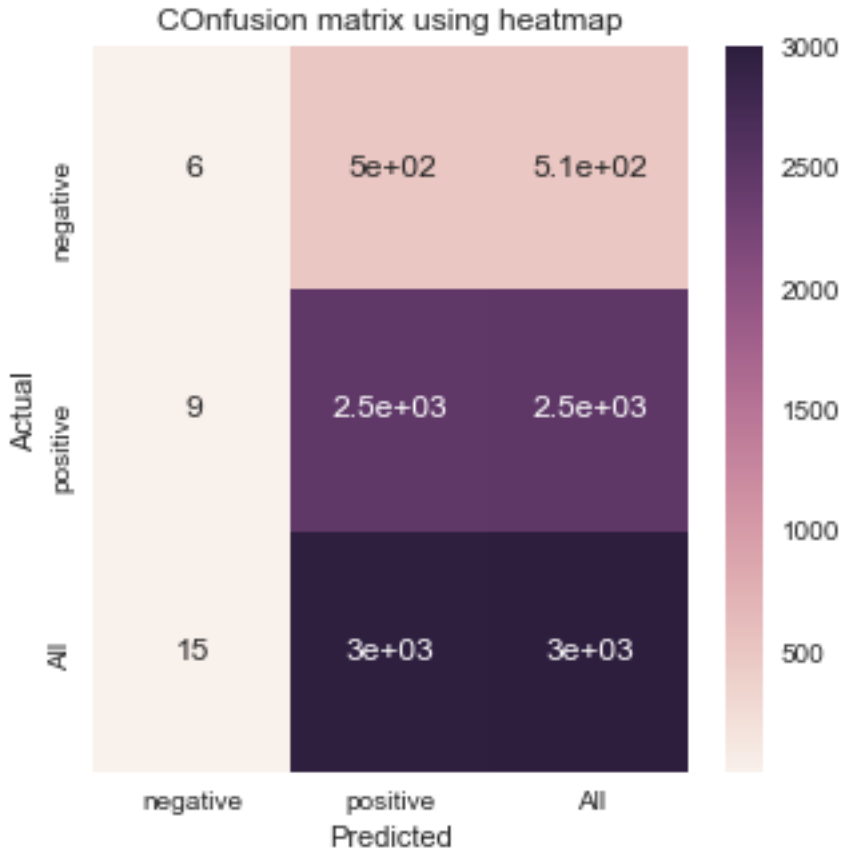
```
tfidf_sent_vectors_train = []; # the tfidf-w2v for each sentence/review is stored in
row=0;
#calculate avg tfidf score for each sentences
for sent in list_of_sent_train: # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        try:
            vec = w2v_model.wv[word]#calculate w2v for each word
            # obtain the tf_idfidf of a word in a sentence/review
            tf_idf = final_tf_idf[row, tfidf_feat.index(word)]#get tfidf score of eac
            sent_vec += (vec * tf_idf) # multiply vec with tfidf of each word and cum
            weight_sum += tf_idf # also add tfidf sums in each sentence
        except:
            pass
    sent_vec /= weight_sum
    tfidf_sent_vectors_train.append(sent_vec)
    row += 1
#tfidf_sent_vectors.

# do for test
final_tf_idf=tf_idf_vect.transform(X_test_raw)
tfidf_sent_vectors_test = []; # the tfidf-w2v for each sentence/review is stored in t
row=0;
#calculate avg tfidf score for each sentences
for sent in list_of_sent_test: # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        try:
            vec = w2v_model.wv[word]#calculate w2v for each word
            # obtain the tf_idfidf of a word in a sentence/review
            tf_idf = final_tf_idf[row, tfidf_feat.index(word)]#get tfidf score of eac
            sent_vec += (vec * tf_idf) # multiply vec with tfidf of each word and cum
            weight_sum += tf_idf # also add tfidf sums in each sentence
        except:
            pass
    sent_vec /= weight_sum
    tfidf_sent_vectors_test.append(sent_vec)
    row += 1



#x=tfidf_sent_vectors
#y = clean_data['Score']
#n=len(x)
#n1=int(n*.3)
```

```
#X_test = x[0:n1]
#X_train= x[n1:n+1]
#y_test=y[0:n1]
#y_train=y[n1:n+1]
#print('X y train test ',len(X_train),len(X_test),y_train.shape,y_test.shape)
X_train = pd.DataFrame(tfidf_sent_vectors_train)
X_test = pd.DataFrame(tfidf_sent_vectors_test)
print(X_train.shape,X_test.shape)
print(y_train.shape,y_test.shape)



# Create 10 fold cross validation
myList = list(range(0,10))
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,algorithm='kd_tree')
    scores = cross_val_score(knn, X_train, y_train, cv=10, 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 and misclassification error using kd-tree is


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

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

# predict the response
pred = knn_optimal.predict(X_test)
acc = accuracy_score(y_test, pred) * 100
#print('\nThe accuracy of the knn classifier using kd-tree for k = %d is %f%%' % (opt
pred = knn_optimal.predict(X_test)
acctrain = accuracy_score(y_test, pred) * 100
```

```
bb=pd.DataFrame({'type':['avg tfidf W2V kdtree'],'train_score':[acctrain],'test_score
aa=aa.append(bb)
#confusion matrix
mat=pd.crosstab(y_test, pred, rownames=['Actual'], colnames=['Predicted'], margins=Tru
print(mat);
plt.figure(figsize=(5,5))
sns.heatmap(mat,annot=True)
plt.title("COnfusion matrix using heatmap")
plt.show()


# Use brute
# Create 10 fold cross validation
myList = list(range(0,10))
neighbors = list(filter(lambda x: x % 2 != 0, myList))
cv_scores = []
for k in neighbors:
    knn = KNeighborsClassifier(n_neighbors=k,algorithm='brute')
    scores = cross_val_score(knn, X_train, y_train, cv=10, 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 and misclassification error using brute  is'

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

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

# predict the response
pred = knn_optimal.predict(X_test)

# evaluate accuracy
acc = accuracy_score(y_test, pred) * 100
#print('\nThe accuracy of the knn classifier using brute for k = %d is %f%%' % (optim
pred = knn_optimal.predict(X_test)
acctrain = accuracy_score(y_test, pred) * 100

bb=pd.DataFrame({'type':['avg tfidf W2V brute'],'train_score':[acctrain],'test_score'
aa=aa.append(bb)
#confusion matrix
mat=pd.crosstab(y_test, pred, rownames=['Actual'], colnames=['Predicted'], margins=Tru
print(mat);
```

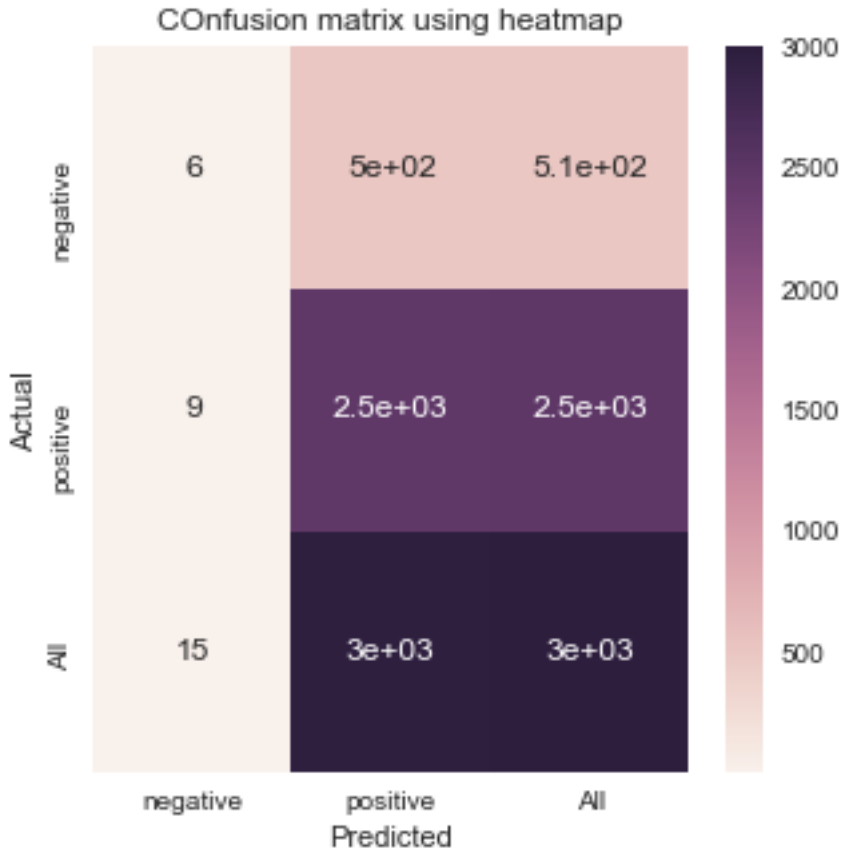
```
        plt.figure(figsize=(5,5))
        sns.heatmap(mat,annot=True)
        plt.title("COnfusion matrix using heatmap")
        plt.show()
```

```
(7000, 50) (3000, 50)
(7000,) (3000,)

The optimal number of neighbors and misclassification error using kd-tree is 9 4
Predicted  negative  positive   All
Actual
negative          6       501   507
positive          9      2484  2493
All              15      2985  3000
```



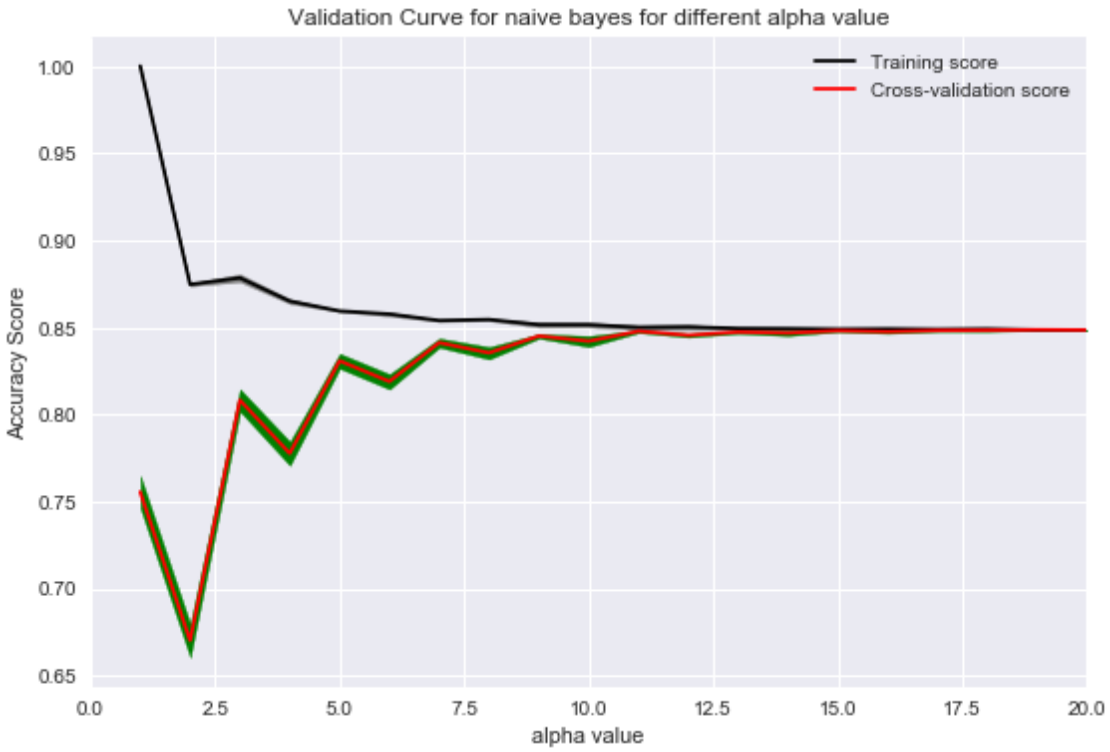

```
The optimal number of neighbors and misclassification error using brute  is 9 4
```

```
Predicted  negative  positive   All
Actual
negative          6       501   507
positive          9      2484  2493
All              15      2985  3000
```



In [26]:
```
import warnings
warnings.filterwarnings('ignore')
from sklearn.model_selection import validation_curve
#create plot for training and test validation
# We cannot put 0 in parameter it will give error while validation_curve
n_neighbors=[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20]
param_range=[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20]

train_scores, test_scores = validation_curve(KNeighborsClassifier(), X_train, y_train
#print(train_scores,test_scores)
train_scores_mean = np.mean(train_scores, axis=1)
train_scores_std = np.std(train_scores, axis=1)
test_scores_mean = np.mean(test_scores, axis=1)
```

```
test_scores_std = np.std(test_scores, axis=1)

plt.plot(param_range, train_scores_mean, label="Training score", color="black")
plt.plot(param_range, test_scores_mean, label="Cross-validation score", color="red")
plt.fill_between(param_range, train_scores_mean - train_scores_std, train_scores_mean
plt.fill_between(param_range, test_scores_mean - test_scores_std, test_scores_mean + t
plt.title("Validation Curve for naive bayes for different alpha value")
plt.xlabel("alpha value")
plt.ylabel("Accuracy Score")
plt.xlim(0,20)
plt.tight_layout()
plt.legend(loc="best")
plt.show()
```



12 Conclusion

The knn is very slow compare to other model

12.1 Below are the steps followed

Only !=3 reviews are taken Mark >3 as positive and <3 as negative. 1 Sort data as per product id in ascending order Deduplication of entries for same profilename,userid, time, text and take first

element Get stratified sampling of 10000 data Clean html and punctuation Convert to uppercase and word<3 are rejected data sorted on time Split the data in train and test to 70:30

BOW BOW vec created using train data test data is converted using above For different value of k and cv=10 bet k is choosen for brute and kd-tree accuracy matrix is saved in dataframe, cnfusion matrix is plot using seaborn. plot accuracy for different k

TFIDF vec created using train data same applied to test text rest are same as BOW

AVG W2V gensim is used to create avg W2V for each sentence of train and test data. rest are same as above

Avg TFIDF W2V tfidf is created from train data, that data and gensim is used to calculate sent_vect avg tfidf w2v for train and test. rest are same

12.2 The performance of each model below

```
In [27]: aa
```

Out[27]:

	K	test_score	train_score	type
0	9	83.166667	85.357143	BOW brute
0	9	83.166667	85.357143	BOW kdtree
0	7	84.233333	87.000000	TFIDF kd_tree
0	7	84.233333	84.233333	TFIDF brute
0	9	83.100000	83.100000	avg W2V kd-tree
0	9	83.100000	83.100000	avg W2V brute
0	9	83.000000	83.000000	avg tfidf W2V kdtree
0	9	83.000000	83.000000	avg tfidf W2V brute