# 19.32.Amazon_food_review_knn

June 8, 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 [1]: from sklearn.manifold import TSNE
        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 [2]: 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(5)
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=Fal

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

```
In [44]: #take only 5000 + 5000 data
         clean_data=sorted_data.sample(frac=1).groupby('Score').head(5000)
         clean_data['Score'].value_counts()
```

```
Out[44]: positive    5000
         negative    5000
         Name: Score, dtype: int64
```

```
In [45]: # 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 ch
             cleaned = re.sub(r'[?|!|\'|"|#]',r'',sentence)
             cleaned = re.sub(r'[.|,|)|(|\|/]',r' ',cleaned)
             return  cleaned
         #print(sno.stem('tasty'))
```

```
In [46]: 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 upperc
         for sent in clean_data['Text'].values:
             filtered_sentence=[]
             #print(sent);
             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 descr
                             if(clean_data['Score'].values)[i] == 'negative':
                                 all_negative_words.append(s) #list of all words used to descr
                         else:
                             continue
                     else:
                         continue
             str1 = b" ".join(filtered_sentence) #final string of cleaned words

             final_string.append(str1)
             i+=1
```

```
In [47]: 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', i
         #con = sqlite3.connect('clean_data.sqlite')
         #clean_data = pd.read_sql_query("""SELECT * FROM Reviews1 WHERE Score != 3""", con)
         #clean_data['CleanedText'].sample(15)
         clean_data.shape
         #Sort data on timestamp
         clean_data=clean_data.sort_values(by=['Time'],ascending=False)
         #clean_data
         clean_data.sample(5)
```

```
Out[47]:             Id   ProductId          UserId  \
         237501  257668  B003LJB8C6  A3JH9ICLEYSESN
```

```
377514  408224  B003VWBZJO  A3U73Z1BCQMDXV
385644  417006  B0026VM19Y    AW46UWA0D6YH
82694    90006  B0046GRD00  A1QG2M87WNG28D
10970    11967  B001P1V2UK   AV43UL9S8TUK8

                               ProfileName  HelpfulnessNumerator  \
237501                               David                     3
377514  James E. Langsford "I love music!"                     1
385644                    Katherine Thomas                     2
82694                      Anne in Florida                     4
10970                      Andrew D. Frost                     0

        HelpfulnessDenominator     Score        Time  \
237501                       3  positive  1327363200
377514                       1  positive  1314835200
385644                       3  positive  1266883200
82694                        4  positive  1345161600
10970                        0  negative  1322438400

                                    Summary  \
237501  Excellent Asian Formulation of Milo
377514                           Dog treats
385644                  Surprisingly good!!
82694                   Cacao BLISS indeed!
10970       Not a genuine Terrafina product

                                                      Text  \
237501  This product is made in Malaysia and is the sa...
377514  I bought the Sweet Potato Chicken Jerky Twists...
385644  A great addition to a shake, and is wonderful ...
82694   Holy moly this stuff is delicious!  I am a tot...
10970   I purchased this product from Otto's because t...

                                               CleanedText
237501  b'product made malaysia exact product would bu...
377514  b'bought sweet potato chicken jerki twist dog ...
385644              b'great addit shake wonder top jello'
82694   b'holi moli stuff delici total sucker anyth ch...
10970   b'purchas product otto offer via amazon prime ...
```

## 5 Model using BOW knn

```
In [48]: #now convert CleanedText to TDM
         count_vect = CountVectorizer() #in scikit-learn
         final_counts = count_vect.fit_transform(clean_data['CleanedText'].values)
         print(final_counts.get_shape())
         print(type(final_counts))
         #print(final_counts[[1]])
         #print(final_counts[0,:])# this is stored like dict format only non zero values. spar
         #x = pd.DataFrame(final_counts.toarray())#this is stored like dataframe format all 0
         # sparse matrix in csr format works faster compare to dense format
         #print(x.shape,x.loc[0])
```

```
(10000, 13326)
<class 'scipy.sparse.csr.csr_matrix'>
```

```
In [49]: #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 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",y
```

```
size of X_train, X_test, y_train , y_test  (7000, 13326) (3000, 13326) (7000,) (3000,)
positive and negative review in train and test
 positive    3582
negative    3418
Name: Score, dtype: int64
 negative    1582
positive    1418
Name: Score, dtype: int64
```

```
In [50]: 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 [51]: # 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 [52]: # ============================== 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)

         # 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%%' % (optima
```

```
The accuracy of the knn classifier using brute for k = 9 is 69.066667%
```

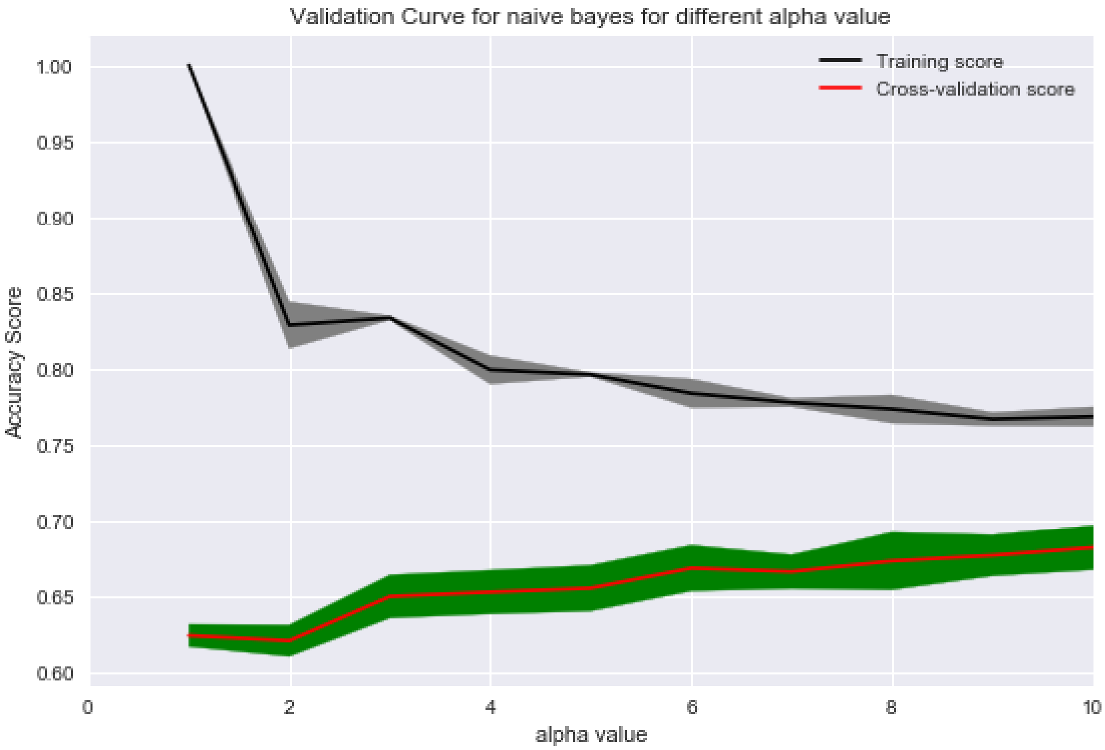
```
In [53]: #ignore warning
         import warnings
         warnings.filterwarnings('ignore')

             # 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)

# 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 kd-tree for k = %d is %f%%' % (opti
```

```

The optimal number of neighbors and misclassification error using kd-tree is 9 4

The accuracy of the knn classifier using kd-tree for k = 9 is 69.066667%
```

## 6 plot accuracy with k

```
In [54]: 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 +
         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()
```



## 7 Model using TFIDF

```
In [55]: #now convert CleanedText to TDM
         tf_idf_vect = TfidfVectorizer()
         final_counts = tf_idf_vect.fit_transform(clean_data['CleanedText'].values)
         #x = pd.DataFrame(final_counts.toarray())

In [56]: #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.s
```

```
size of train, test, X , y  (7000, 13326) (3000, 13326) (7000,) (3000,)
```

```
In [57]: # 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 9 4
```

```
In [58]: #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)
```

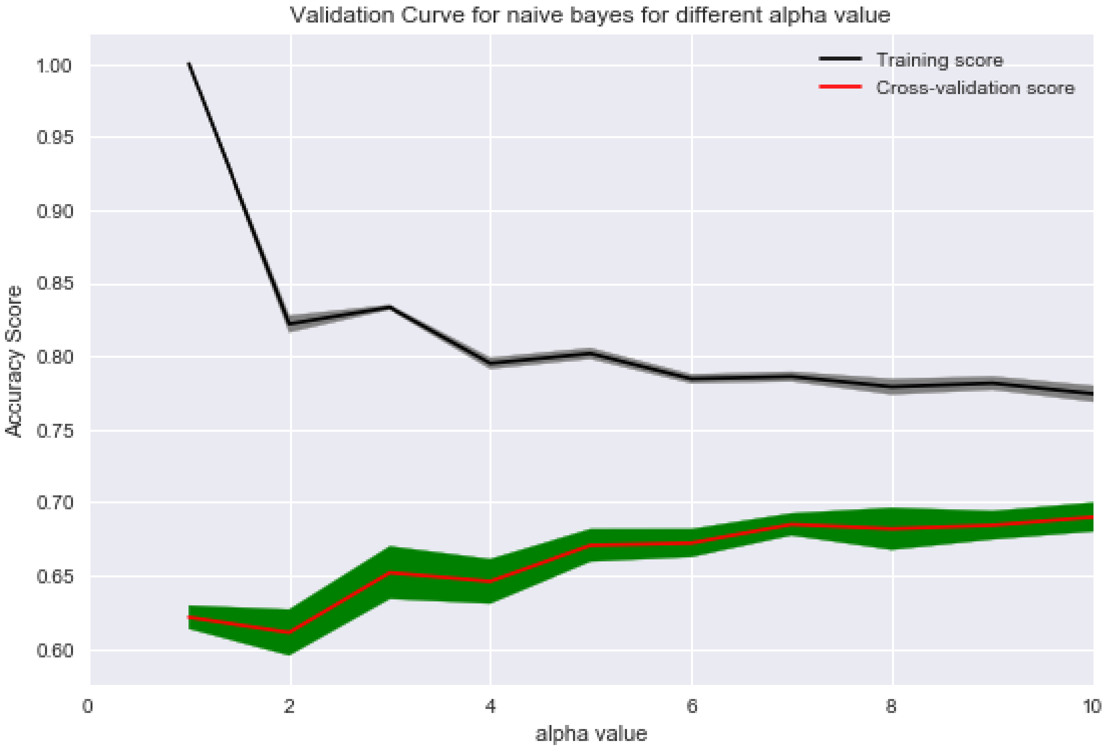
```
        # predict the response
        pred = knn_optimal.predict(X_test)

        # evaluate accuracy
        acc = accuracy_score(y_test, pred) * 100
        print('\nThe accuracy of the knn classifier using kd-tree for k = %d is %f%%' % (opti
```

```

The accuracy of the knn classifier using kd-tree for k = 9 is 68.366667%
```

```
In [59]: #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)

        # 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%%' % (optimal
```

```

The optimal number of neighbors and misclassification error using brute is 9 4
The accuracy of the knn classifier using brute for k = 9 is 68.366667%
```

```
In [60]: 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 +
         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 Build model using avg W2V

```
In [61]: #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
         i=0
         #create a list of list to be used in W2V
         list_of_sent=[]
         for sent in 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.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,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 = []; # the avg-w2v for each sentence/review is stored in this list
for sent in 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
        try:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
        except:
            pass
    sent_vec /= cnt_words
    sent_vectors.append(sent_vec)

#Sent_vectors ready for tsne
```

In [62]:

```
#ignore warning
import warnings
warnings.filterwarnings('ignore')

x = pd.DataFrame(sent_vectors)
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]
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))
```

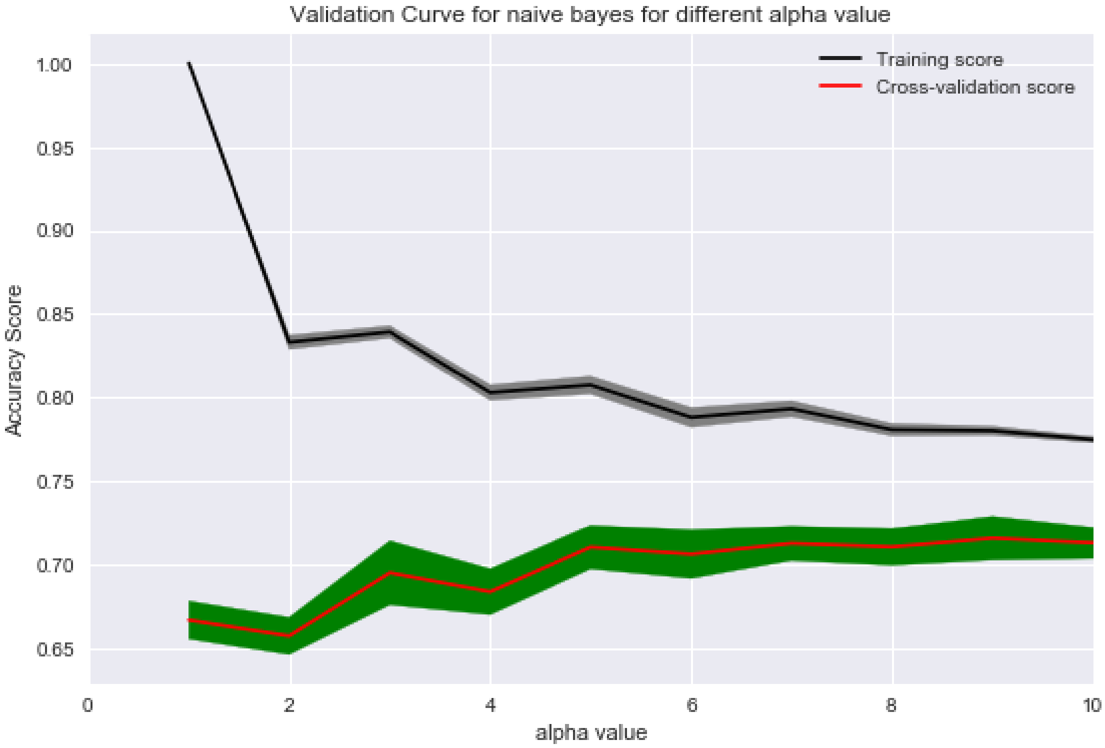
```
# empty list that will hold cv scores
cv_scores = []

# 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)

# evaluate accuracy
acc = accuracy_score(y_test, pred) * 100
print('\nThe accuracy of the knn classifier using kd-tree for k = %d is %f%%' % (opti


# 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%%' % (optima
```

```
train and test X y (7000, 50) (3000, 50) (7000,) (3000,)

The optimal number of neighbors and misclassification error usinf kd-tree is 9 4

The accuracy of the knn classifier using kd-tree for k = 9 is 71.666667%

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

The accuracy of the knn classifier using brute for k = 9 is 71.666667%
```

## 9 plot accuracy with k value

```
In [63]: 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()
```



## 10 Build model using avg tfidf w2v

In [64]:
```
#ignore warning
import warnings
warnings.filterwarnings('ignore')


# TF-IDF weighted Word2Vec
tf_idf_vect = TfidfVectorizer()
final_tf_idf=tf_idf_vect.fit_transform(clean_data['CleanedText'].values)
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 = []; # the tfidf-w2v for each sentence/review is stored in this l
row=0;
#calculate avg tfidf score for each sentences
for sent in 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 = 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.append(sent_vec)
    row += 1
#tfidf_sent_vectors.
```

```
x=tfidf_sent_vectors
y = clean_data['Score']
#time=time.reset_index(drop=True)
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)
```

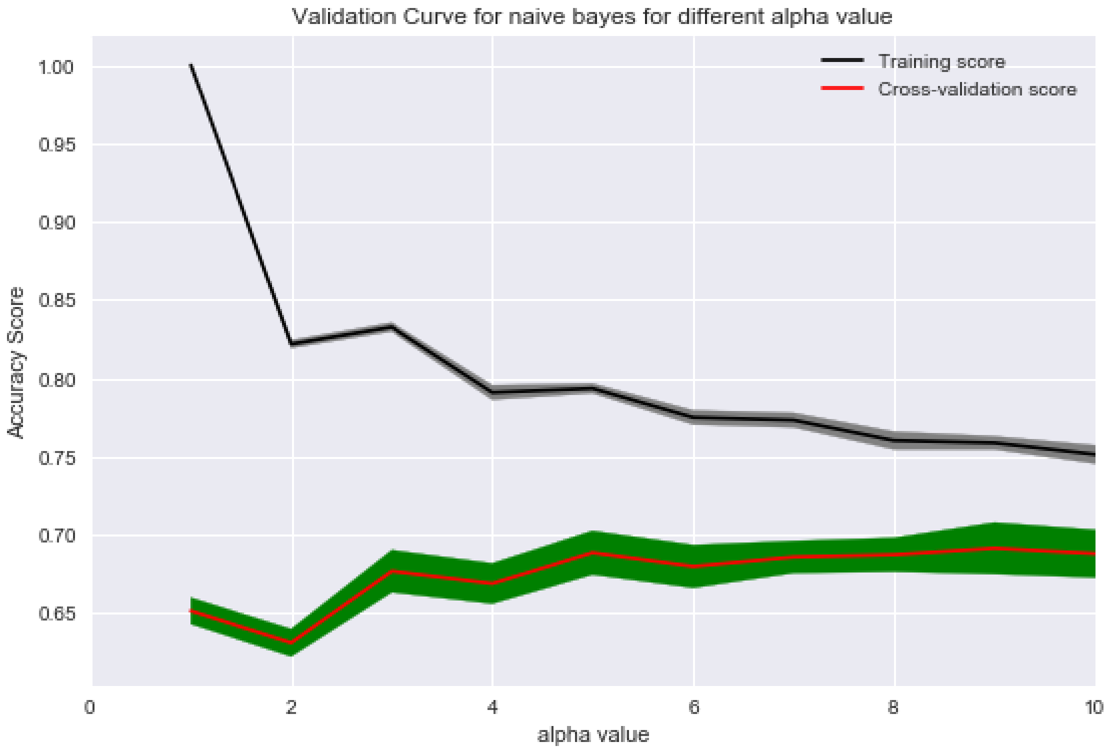
```
# Create 10 fold cross validation
myList = list(range(0,10))
neighbors = list(filter(lambda x: x % 2 != 0, myList))

# 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)

# evaluate accuracy
acc = accuracy_score(y_test, pred) * 100
print('\nThe accuracy of the knn classifier using kd-tree for k = %d is %f%%' % (opti

# 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%%' % (optima
```

```
X y train test  7000 3000 (7000,) (3000,)

The optimal number of neighbors and misclassification error using kd-tree is 9 4

The accuracy of the knn classifier using kd-tree for k = 9 is 68.266667%

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

The accuracy of the knn classifier using brute for k = 9 is 68.266667%
```

```
In [65]: 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 +
         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 Here is the performance accuracy

The knn is very slow compare to other model

For BOW brute/kd-tree k=9 69

TFIDF kd-tree/brute with k=9 and 68

sentence avg W2V kd-tree/brute k=9 71

sentence avg tfidf kd-tree/brute w2v k=9 68

So best is with W2V avg sentence with accuracy 71% and k=9