25.21.Amazon_food_review_naive_bayes

June 7, 2018

1 Amazon food review dataset apply naive bayes

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

2 Objective

1. Try predicting review using naive bayes and tunning alpha
2. Get important features of positive and negative review
3. Check accuracy using precision recall F1 score
4. Plot errors for train and CV

3 Import data and libraries

```
In [82]: 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 [83]:
```
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 elem
sorted_data=sorted_data.drop_duplicates(subset={"UserId","ProfileName","Time","Text"}
```

In [117]:
```
#take only 10000 + 10000 data
#clean_data=sorted_data.sample(frac=1).groupby('Score').head(100)
_ , clean_data = train_test_split(sorted_data, test_size = 20000, stratify = sorted_d
clean_data['Score'].value_counts()
```

Out[117]:
```
positive    16864
negative     3136
Name: Score, dtype: int64
```

In [118]:
```
# 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 c
```

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

In [119]:
```
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 upper
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 desc
                    if(clean_data['Score'].values)[i] == 'negative':
                        all_negative_words.append(s) #list of all words used to desc
                else:
                    continue
            else:
                continue
    str1 = b" ".join(filtered_sentence) #final string of cleaned words

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

In [120]:
```
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',
#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[120]:

```
            Id   ProductId          UserId ProfileName  HelpfulnessNumerator  \
294199  318702  B001E5E33U   AOWITT8WA9BME       scott                     1
316516  342683  B000FIY3FK  A2RJKJCBQ9H62K  Mary Dryer                     0
178608  193673  B005IW4WFY   AOAOARIH72UWI          jt                     0
148916  161584  B000GPM9IK   A5G977UGFTVT1        Zach                     0
388286  419857  B00153Y3IQ  A1Q0YMVAI71R20    S. Lewis                     0

        HelpfulnessDenominator     Score        Time  \
294199                       2  negative  1325980800
316516                       0  positive  1297209600
178608                       0  positive  1321401600
148916                       0  positive  1283990400
388286                       0  positive  1342224000

                                                  Summary  \
294199            Packaging creates terrible tea leaf mess
316516                                       Fructose-50
178608                   Great Snack or Mixed with Yogurt
148916                               Best pre-workout mix
388286  This is a first - MY CATS ASKED ME TO SUBMIT T...

                                                     Text  \
294199  Every single K-cup I put in breaks open during...
316516  I saddened by the fact I had to go to Amazon t...
178608  This is a great tasting granola that can be ea...
148916  I used to workout when i played baseball, but ...
388286  WE (3 of us) love this stuff.  The little mors...

                                              CleanedText
294199  b'everi singl put break open brew alway end ho...
316516  b'sadden fact amazon get use purchas groceri s...
178608  b'great tast granola easili enjoy great yogurt...
148916  b'use workout play basebal stop play gain lot ...
388286  b'love stuff littl morsel pretti small get the...
```

5 Model using BOW naive bayes

In [121]:

```
#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. spa
```

```
#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])
```

```
(20000, 18058)
<class 'scipy.sparse.csr.csr_matrix'>
```

In [122]:
```
#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_tra
print("positive and negative review in train and test\n",y_train.value_counts(),"\n"
```

```
size of X_train, X_test, y_train , y_test  (14000, 18058) (6000, 18058) (14000,) (6000,)
positive and negative review in train and test
 positive    11907
negative     2093
Name: Score, dtype: int64
 positive    4957
negative    1043
Name: Score, dtype: int64
```

In [123]:
```
from sklearn.cross_validation import train_test_split,KFold
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
from sklearn.naive_bayes import MultinomialNB
```

In [124]:
```
# Create 10 fold cross validation for different alpha

cv_score=[]
a=[]
for alphaval in range(1,30):
  clf = MultinomialNB(alpha=alphaval)
```

```
    clf.fit(X_train,y_train)
    score= cross_val_score(clf, X_train, y_train, cv=10, scoring='accuracy')
    cv_score.append(score.mean())
    a.append(alphaval)
    #print('score with alpha=',alphaval,score.mean())

print('best score and alpha',cv_score[cv_score.index(max(cv_score))],a[cv_score.inde
optimalpha=a[cv_score.index(max(cv_score))]
```

```
best score and alpha 0.889284048323 1
```

```
In [125]: # ============================== naive bayes with optimum alpha ====================
          clf = MultinomialNB(alpha=optimalpha)
          clf.fit(X_train,y_train)
          # fitting the model
          clf.fit(X_train, y_train)
          print(clf)
          clf1=clf

          pred = clf.predict(X_train)
          mat=pd.crosstab(y_train, pred, rownames=['Actual'], colnames=['Predicted'], margins=
          tp=mat.iloc[1,1];tn=mat.iloc[0,0];fp=mat.iloc[0,1];fn=mat.iloc[1,0];precision=tp/(tp
          fscoretrain=2*precision*recall/(precision+recall)

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

          # evaluate accuracy
          acc = accuracy_score(y_test, pred) * 100
          print('\nThe accuracy of the naive bayes classifier using alpha and accuracy respect
```

```
MultinomialNB(alpha=1, class_prior=None, fit_prior=True)

The accuracy of the naive bayes classifier using alpha and accuracy respectively become  1 88.
```

6 Check accuracy

```
In [126]: #Check accuracy
          print(confusion_matrix(y_test, pred))
          # try better way
          mat=pd.crosstab(y_test, pred, rownames=['Actual'], colnames=['Predicted'], margins=T
          print(mat)
          #positive is fraud, negative is not fraud
          tp=mat.iloc[1,1]
          tn=mat.iloc[0,0]
          fp=mat.iloc[0,1]
```

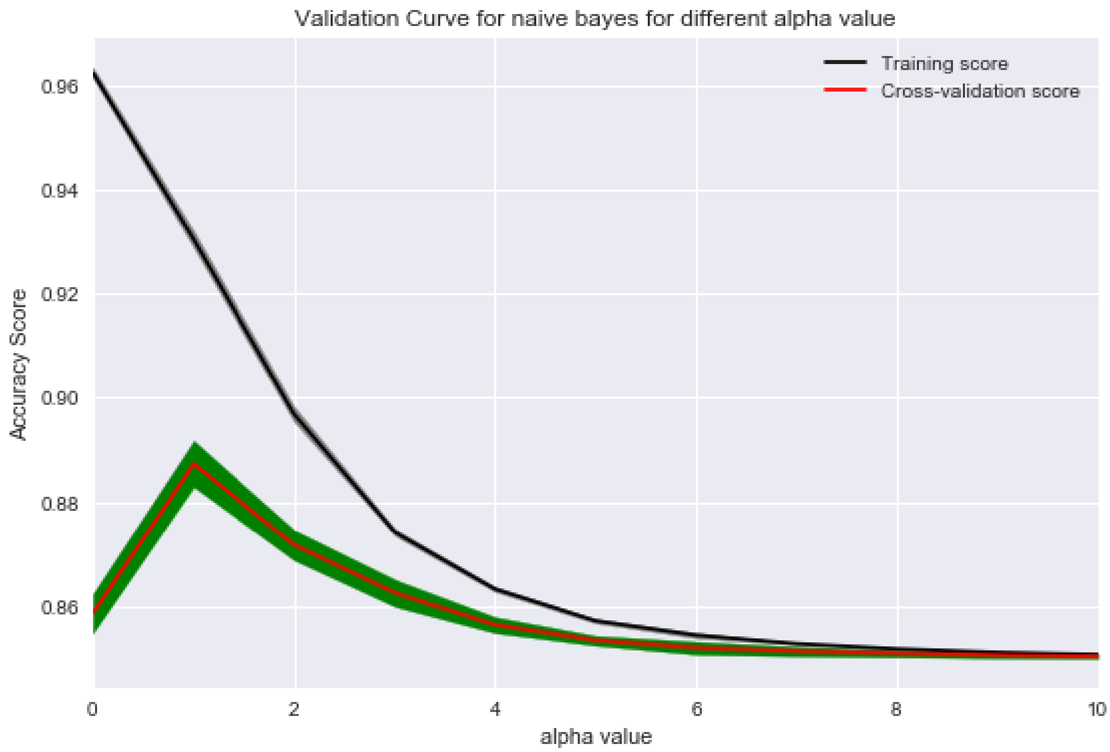
```
        fn=mat.iloc[1,0]
        precision=tp/(tp+fp)
        recall=tp/(tp+fn)
        fscore=2*precision*recall/(precision+recall)
        print('precision,racall,f1score',precision,recall,fscore)

        aa=pd.DataFrame({'type':['BOW '],'train_score_accuracy':[clf.score(X_train,y_train)]
```

```
[[ 534  509]
 [ 183 4774]]
Predicted  negative  positive   All
Actual
negative        534       509  1043
positive        183      4774  4957
All             717      5283  6000
precision,racall,f1score 0.903653227333 0.963082509582 0.932421875
```

7 Plot accuracy with train and CV error

```
In [127]: import warnings
          warnings.filterwarnings('ignore')

          from sklearn.model_selection import validation_curve

          #create plot for training and test validation
          # Calculate accuracy on training and test set using range of parameter values
          alpha=[0,1,2,3,4,5,6,7,8,9,10]
          param_range=[0,1,2,3,4,5,6,7,8,9,10]

          train_scores, test_scores = validation_curve(clf1, X_train, y_train, param_name="alpl

          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")

          #Plot accurancy bands for training and test sets
          plt.fill_between(param_range, train_scores_mean - train_scores_std, train_scores_mear
          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(0,10)
plt.tight_layout()
plt.legend(loc="best")
plt.show()
```



8 Show top 10 words in positive and negative review

```
In [128]: count_vect.vocabulary_
          print(len(clf.coef_[0]))
          print(clf.coef_.shape)
          print(clf.classes_)
          print(clf.coef_[0])

          def most_informative_feature_for_binary_classification(vectorizer, classifier, n=10)
              class_labels = classifier.classes_
              feature_names = vectorizer.get_feature_names()
              topn_class1 = sorted(zip(classifier.coef_[0], feature_names))[:n]
              #negative words are sorted with -ve
              topn_class2 = sorted(zip(classifier.coef_[0], feature_names))[-n:]

              for coef, feat in topn_class1:
                  print (class_labels[0], coef, feat)
```

```
        print("\n")

        for coef, feat in reversed(topn_class2):
            print (class_labels[1], coef, feat)

    print("Top 10 words for both review\n")
    most_informative_feature_for_binary_classification(count_vect, clf)
```

```
18058
(1, 18058)
['negative' 'positive']
[-12.3525943  -12.3525943  -13.04574148 ..., -12.3525943  -12.3525943
 -13.04574148]
Top 10 words for both review

negative -13.0457414788 aaah
negative -13.0457414788 aani
negative -13.0457414788 aappubl
negative -13.0457414788 abdomen
negative -13.0457414788 abit
negative -13.0457414788 ablaz
negative -13.0457414788 abomin
negative -13.0457414788 abot
negative -13.0457414788 abrotanum
negative -13.0457414788 abrupt


positive -4.48357492169 like
positive -4.52256621566 tast
positive -4.66574352651 good
positive -4.71898266424 flavor
positive -4.72480650987 great
positive -4.72919676082 love
positive -4.75997605824 use
positive -4.81276968816 one
positive -4.9392269625 product
positive -4.94436680752 tea
```

9 Use TFIDF and check performance

In [129]:
```
from sklearn.naive_bayes import GaussianNB
from sklearn.naive_bayes import MultinomialNB

tf_idf_vect = TfidfVectorizer()
final_counts = tf_idf_vect.fit_transform(clean_data['CleanedText'].values)
```

```
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"

# Create 10 fold cross validation for different alpha

cv_score=[]
a=[]
for alphaval in range(1,30):
  clf = MultinomialNB(alpha=alphaval)
  clf.fit(X_train,y_train)
  score= cross_val_score(clf, X_train, y_train, cv=10, scoring='accuracy')
  cv_score.append(score.mean())
  a.append(alphaval)
  #print('score with alpha=',alphaval,score.mean())

print('best score and alpha',cv_score[cv_score.index(max(cv_score))],a[cv_score.inde
optimalpha=a[cv_score.index(max(cv_score))]


# ============================== naive bayes with optimum alpha ====================
clf = MultinomialNB(alpha=optimalpha)
clf.fit(X_train,y_train)

pred = clf.predict(X_train)
mat=pd.crosstab(y_train, pred, rownames=['Actual'], colnames=['Predicted'], margins=
tp=mat.iloc[1,1];tn=mat.iloc[0,0];fp=mat.iloc[0,1];fn=mat.iloc[1,0];precision=tp/(tp
fscoretrain=2*precision*recall/(precision+recall)



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

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

# evaluate accuracy
acc = accuracy_score(y_test, pred) * 100
print('\nThe accuracy of the naive bayes classifier using alpha and accuracy respecti
```

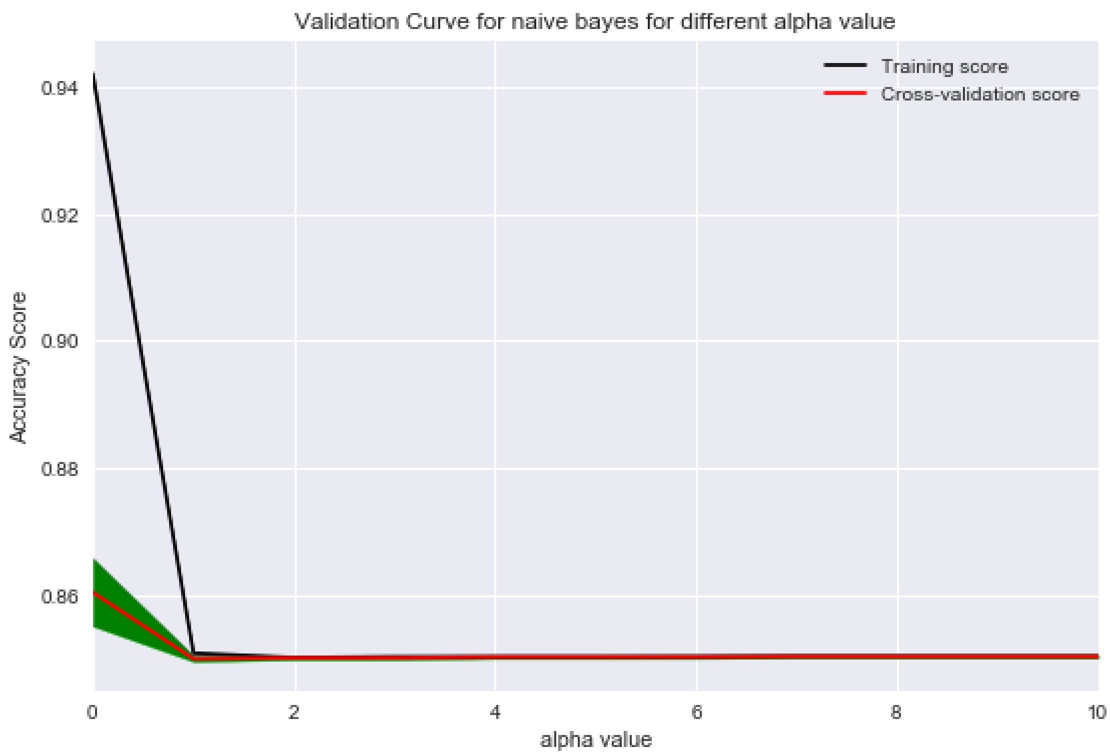
```
#Check accuracy
print(confusion_matrix(y_test, pred))
# try better way
mat=pd.crosstab(y_test, pred, rownames=['Actual'], colnames=['Predicted'], margins=Tr
print(mat)
#positive is fraud, negative is not fraud
tp=mat.iloc[1,1]
tn=mat.iloc[0,0]
fp=mat.iloc[0,1]
fn=mat.iloc[1,0]
precision=tp/(tp+fp)
recall=tp/(tp+fn)
fscore=2*precision*recall/(precision+recall)
print('precision,racall,f1score',precision,recall,fscore)

bb=pd.DataFrame({'type':['TFIDF '],'train_score_accuracy':[clf.score(X_train,y_train)
aa=aa.append(bb)
```

```
size of X_train, X_test, y_train , y_test  (14000, 18058) (6000, 18058) (14000,) (6000,)
positive and negative review in train and test
 positive    11907
negative     2093
Name: Score, dtype: int64
 positive    4957
negative    1043
Name: Score, dtype: int64
best score and alpha 0.850500107252 7

The accuracy of the naive bayes classifier using alpha and accuracy respectively become  7 82.6
[[   0 1043]
 [   0 4957]]
Predicted  positive   All
Actual
negative       1043  1043
positive       4957  4957
All            6000  6000
precision,racall,f1score 0.826166666667 0.5 0.622973482468
```

10 Plot accuracy with alpha

```
In [130]: import warnings
          warnings.filterwarnings('ignore')
          from sklearn.model_selection import validation_curve
```

```
#create plot for training and test validation
alpha=[0,1,2,3,4,5,6,7,8,9,10]
param_range=[0,1,2,3,4,5,6,7,8,9,10]

train_scores, test_scores = validation_curve(MultinomialNB(), X_train, y_train, param
#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(0,10)
plt.tight_layout()
plt.legend(loc="best")
plt.show()

#plt.title("Validation Curve with NB")
#plt.xlabel("alpha")
#plt.ylabel("Score")
#plt.ylim(0.0, 1.1)
#lw = 2
#plt.semilogx(param_range, train_scores_mean, label="Training score", color="darkora
#plt.fill_between(param_range, train_scores_mean - train_scores_std, train_scores_me
#plt.semilogx(param_range, test_scores_mean, label="Cross-validation score", color="
#plt.fill_between(param_range, test_scores_mean - test_scores_std, test_scores_mean
#plt.legend(loc="best")
#plt.show()
```



11 Here is the performance accuracy

Belo is the accuracy and f score of BOW and TFIDF

```
In [131]: aa

Out[131]:    Alpha  test_score_accuracy  test_score_fscore  train_score_accuracy  \
          0      1             0.884667           0.932422              0.931857
          0      7             0.826167           0.622973              0.850500

             train_score_fscore    type
          0            0.960815     BOW
          0            0.629767   TFIDF
```