NB on Amazon fine food dataset

Data Source: https://www.kaggle.com/snap/amazon-fine-food-reviews (https://www.kaggle.com/snap/amazon-fine-food-reviews)

The Amazon Fine Food Reviews dataset consists of reviews of fine foods from Amazon.

Number of reviews: 568,454
Number of users: 256,059
Number of products: 74,258
Timespan: Oct 1999 - Oct 2012
Number of Attributes/Columns in data: 10

Attribute Information:

1. Id
2. ProductId - unique identifier for the product
3. UserId - unqiue identifier for the user
4. ProfileName
5. HelpfulnessNumerator - number of users who found the review helpful
6. HelpfulnessDenominator - number of users who indicated whether they found the review helpful or not
7. Score - rating between 1 and 5
8. Time - timestamp for the review
9. Summary - brief summary of the review
10. Text - text of the review

Objective:

To perform NB on different vectors like BOW, Tf-idf, Avg-W2vec & Tf-idf_W2vec.

```
%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

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
```

```
C:\Users\deepak\Anaconda3\lib\site-packages\gensim\utils.py:1209: UserWarning: detected Windows; aliasing chunkize to chunk
ize_serial
  warnings.warn("detected Windows; aliasing chunkize to chunkize_serial")
```

```
#Importing Train and test dataset
train_data=pd.read_csv("E:/Applied AI assignments/Amazon_fine_train_data.csv")
test_data=pd.read_csv("E:/Applied AI assignments/Amazon_fine_test_data.csv")
```

```
train_data=train_data.astype(str)
test_data=test_data.astype(str)
```

```
train_data.shape
```

```
(80000, 13)
```

```
train_data['Score'].value_counts()
```

```
positive    70407
negative     9593
Name: Score, dtype: int64
```

```
test_data.shape
```

```
(20000, 13)
```

```
test_data['Score'].value_counts()
```

```
positive    17322
negative     2678
Name: Score, dtype: int64
```

```
#Train data
y_train = train_data['Score']
x_train = train_data['CleanedText']

#Test data
y_test = test_data['Score']
x_test = test_data['CleanedText']
```

```
#Replacing Positive score with 0 and negative score with 1
y_train.replace('negative',1,inplace=True)
y_train.replace('positive',0,inplace=True)

y_test.replace('negative',1,inplace=True)
y_test.replace('positive',0,inplace=True)
```

```
from sklearn.naive_bayes import BernoulliNB
from sklearn.naive_bayes import MultinomialNB
from sklearn.model_selection import TimeSeriesSplit
from sklearn.model_selection import GridSearchCV
from sklearn.metrics import accuracy_score
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import f1_score
from sklearn.metrics import make_scorer
from sklearn.metrics import confusion_matrix
from sklearn.cross_validation import cross_val_score
from collections import Counter
from sklearn import cross_validation
from wordcloud import WordCloud
import matplotlib.pyplot as plt
```

Using Bernauli NB

Running Gridsearch CV

```
alpha_range = [0.000001,0.00001,0.0001,0.001,0.01,0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,1.0,10,20,30,40,5(
T= TimeSeriesSplit(n_splits=5)

param_grid = dict(alpha=alpha_range)
print(param_grid)

# instantiate and fit the grid
grid = GridSearchCV(BernoulliNB(), param_grid, cv=T, scoring='accuracy', return_train_score=False,n_jobs
```

```
{'alpha': [1e-06, 1e-05, 0.0001, 0.001, 0.01, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 10, 20, 30, 40, 50]}
```

Binary Bow

```
count_vect = CountVectorizer(binary=True)

#Train data
vocabulary = count_vect.fit(x_train) #in scikit-learn
Bow_x_train= count_vect.transform(x_train)
print("the type of count vectorizer ",type(Bow_x_train))
print("the shape of out text BOW vectorizer ",Bow_x_train.get_shape())
print("the number of unique words ", Bow_x_train.get_shape()[1])
```

```
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text BOW vectorizer  (80000, 33433)
the number of unique words  33433
```

```
#Test data
Bow_x_test = count_vect.transform(x_test)
print("the type of count vectorizer ",type(Bow_x_test))
print("the shape of out text BOW vectorizer ",Bow_x_test.get_shape())
print("the number of unique words ", Bow_x_test.get_shape()[1])
```

```
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text BOW vectorizer  (20000, 33433)
the number of unique words  33433
```

Fitting Grid Search CV on BOW

```
grid.fit(Bow_x_train, y_train)

# examine the best model
print(grid.best_score_)
print(grid.best_params_)
```

```
0.8992424810620265
{'alpha': 0.1}
```

```
# Naive bayes
Bnb_optimal=BernoulliNB(alpha=0.1, binarize=0.0, fit_prior=True)

# fitting the model
Bnb_optimal.fit(Bow_x_train, y_train)

# predict the response
pred_bow = Bnb_optimal.predict(Bow_x_test)

# evaluate accuracy
acc = accuracy_score(y_test, pred_bow) * 100
print('\nThe accuracy of the Bernaulli NB classifier for a = %d is %f%%' % (0.1, acc))
```

```
The accuracy of the Bernaulli NB classifier for a = 0 is 90.045000%
```

```
# Train & Test Error
print("The overall accuracy score for the Train Data is : ", metrics.accuracy_score(y_train,Bnb_optimal
print("The overall accuracy score for the Test Data is : ", metrics.accuracy_score(y_test,pred_bow))
```

```
The overall accuracy score for the Train Data is :  0.9273625
The overall accuracy score for the Test Data is :  0.90045
```

```
#Feature importance
neg_class_prob_sorted = Bnb_optimal.feature_log_prob_[1, :].argsort()
pos_class_prob_sorted = Bnb_optimal.feature_log_prob_[0, :].argsort()

neg_bow_bnb=neg_class_prob_sorted[::-1]
pos_bow_bnb=pos_class_prob_sorted[::-1]
```

```
#Top 20 negative words
n=(np.take(count_vect.get_feature_names(), neg_bow_bnb[:20]))
sn = ""
for i in n:
    sn += str(i)+","
print(sn)
```

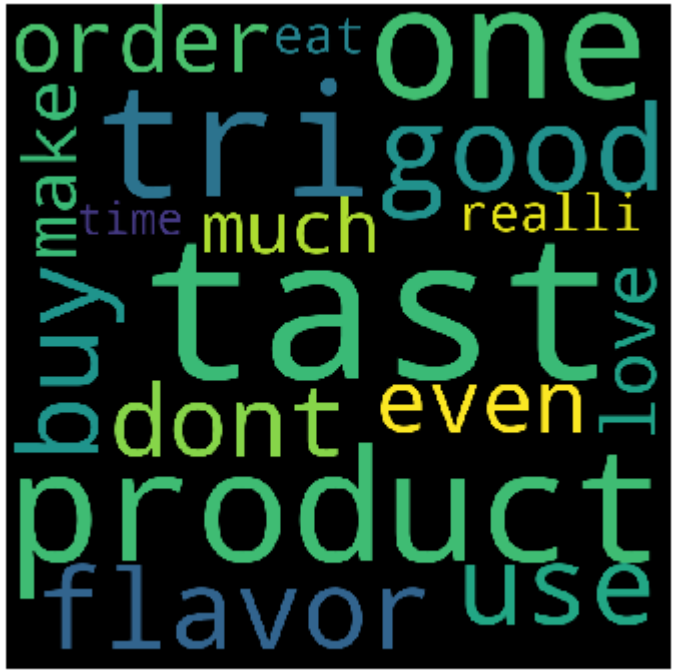
```
tast,like,product,one,would,tri,good,flavor,buy,get,use,dont,order,even,much,make,love,realli,eat,time,
```

```
#Top 20 positive words
p=(np.take(count_vect.get_feature_names(), pos_bow_bnb[:20]))
sp = ""
for i in p:
    sp += str(i)+","
print(sp)
```

```
tast,like,great,good,love,flavor,one,use,product,tri,make,get,best,time,buy,find,amazon,eat,realli,also,
```

```
print("************ Top 20 Negative words ******************")
wordcloud = WordCloud(width = 800, height = 800,
                background_color ='black',
                min_font_size = 10).generate(sn)

# plot the WordCloud image
plt.figure(figsize = (5,5), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)
plt.show()


print("************ Top 20 Positive words ******************")
wordcloud = WordCloud(width = 800, height = 800,
                background_color ='black',
                min_font_size = 10).generate(sp)

# plot the WordCloud image
plt.figure(figsize = (5,5), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)
plt.show()
```

```
************ Top 20 Negative words ******************
```

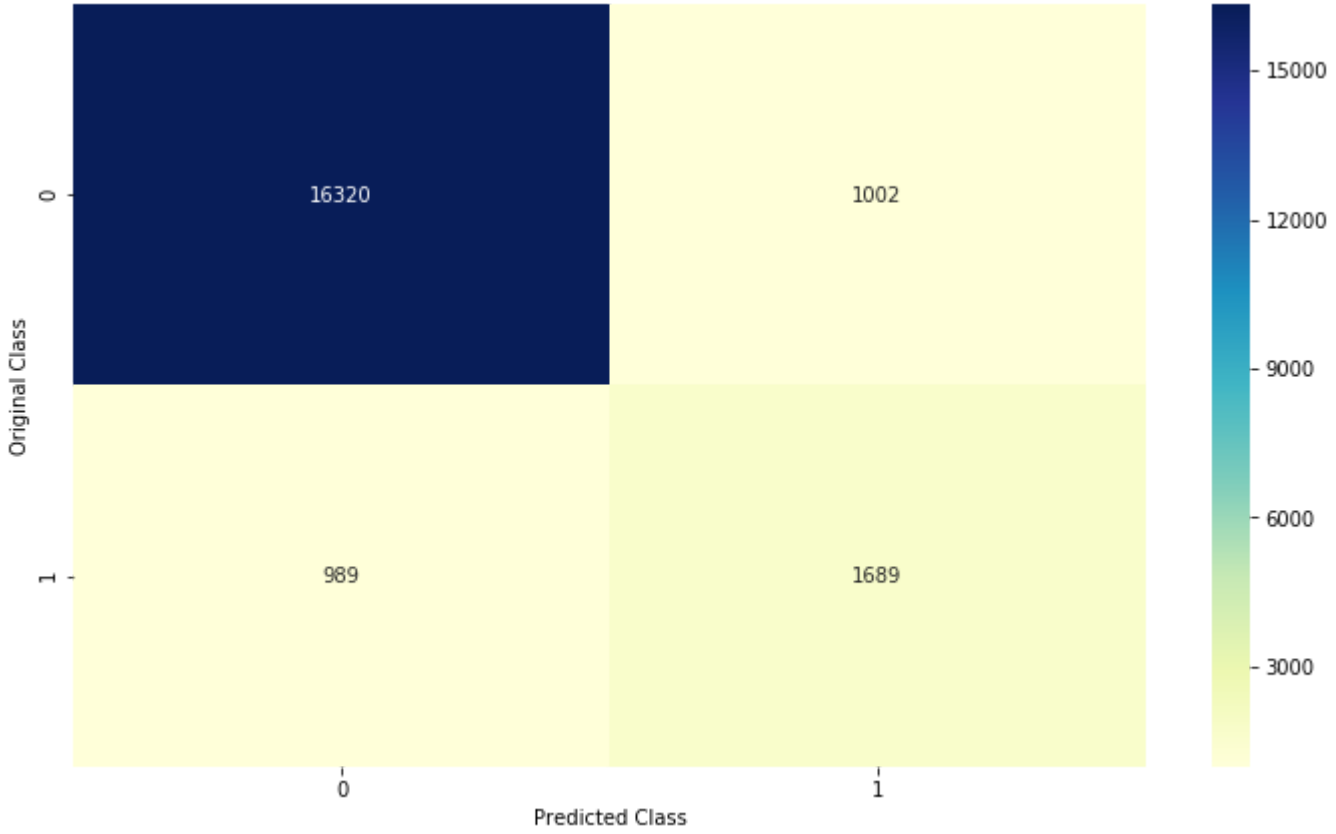


********** Top 20 Positive words **********

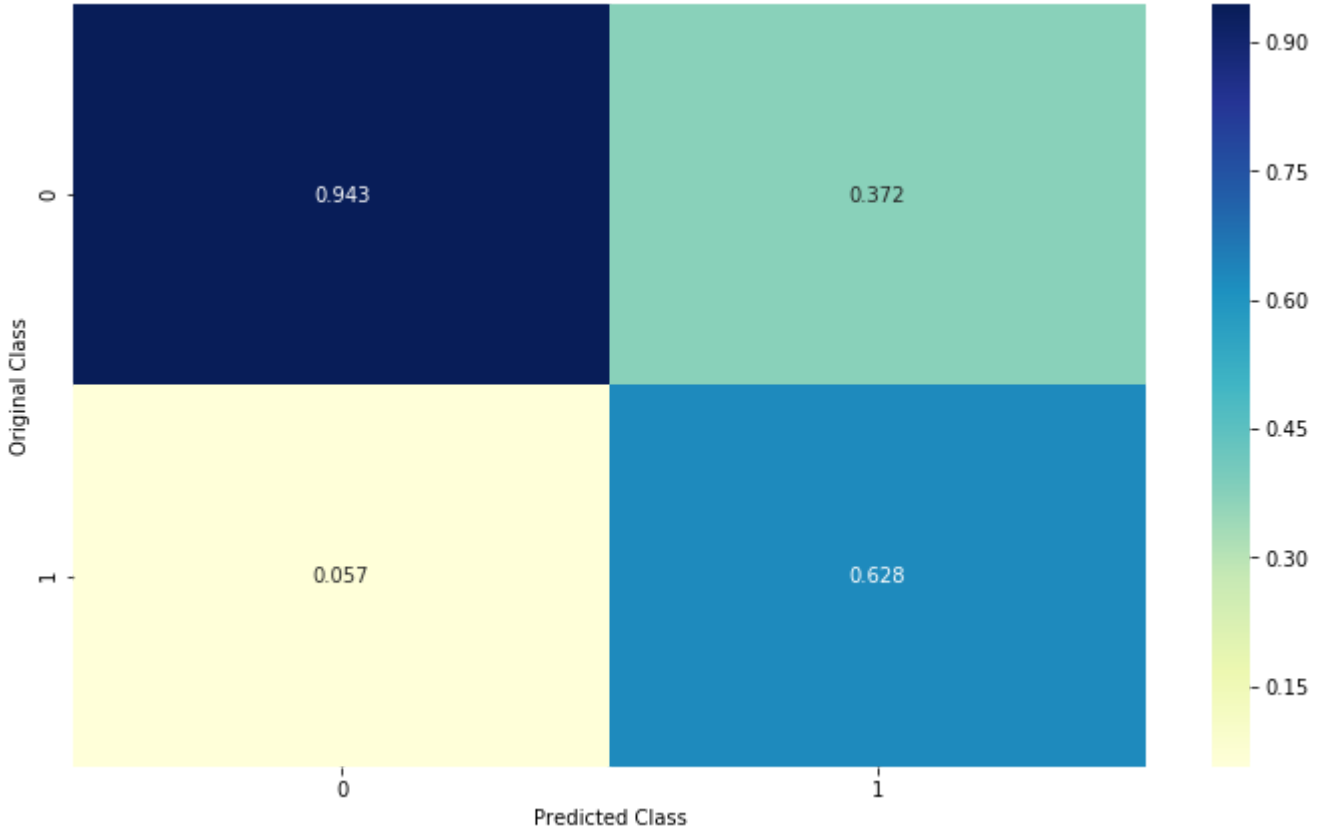

```
#confusion matrix, Precision score & Recall score
C = confusion_matrix(y_test, pred_bow)
A =(((C.T)/(C.sum(axis=1))).T)
B =(C/C.sum(axis=0))
labels = [0,1]
```

```
 print("-"*20, "Confusion matrix", "-"*20)
plt.figure(figsize=(12,7))
sns.heatmap(C, annot=True, cmap="YlGnBu", fmt="g", xticklabels=labels, yticklabels=labels)
plt.xlabel('Predicted Class')
plt.ylabel('Original Class')
plt.show()

print("-"*20, "Precision matrix (Columm Sum=1)", "-"*20)
plt.figure(figsize=(12,7))
sns.heatmap(B, annot=True, cmap="YlGnBu", fmt=".3f", xticklabels=labels, yticklabels=labels)
 plt.xlabel('Predicted Class')
plt.ylabel('Original Class')
plt.show()

    # representing B in heatmap format
print("-"*20, "Recall matrix (Row sum=1)", "-"*20)
plt.figure(figsize=(12,7))
sns.heatmap(A, annot=True, cmap="YlGnBu", fmt=".3f", xticklabels=labels, yticklabels=labels)
plt.xlabel('Predicted Class')
plt.ylabel('Original Class')
plt.show()
```

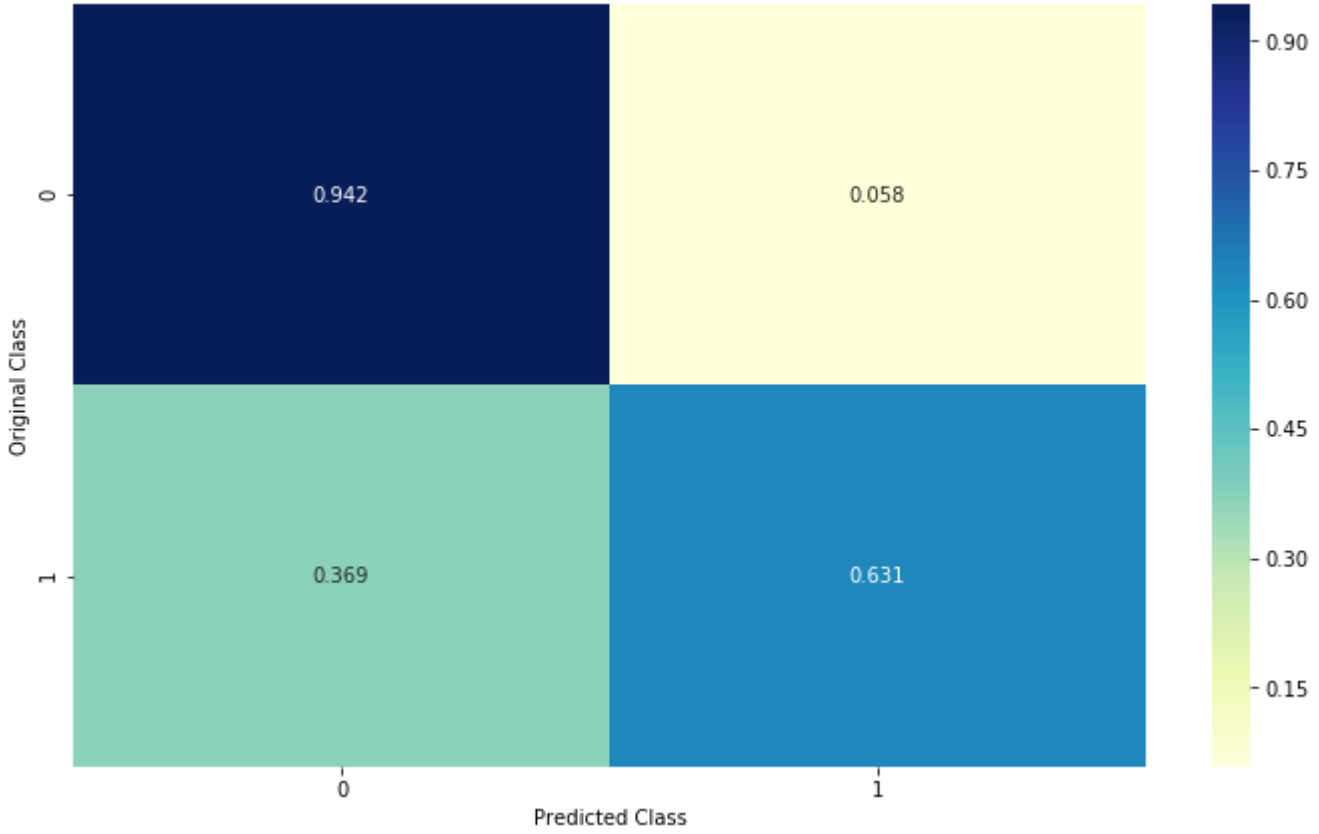
```
-------------------- Confusion matrix --------------------
```



---------- Precision matrix (Columm Sum=1) ----------




```
-------------------- Recall matrix (Row sum=1) --------------------
```


0.942
0.058
0.369
0.631
Original Class
Predicted Class
0
1
0.90
0.75
0.60
0.45
0.30
0.15

Tf-Idf

```
#Initiating Vectorizer
count_vect = CountVectorizer(ngram_range=(1,2))

#Train data
vocabulary = count_vect.fit(x_train)
Tfidf_x_train= count_vect.transform(x_train)
print("the type of count vectorizer ",type(Tfidf_x_train))
print("the shape of out text BOW vectorizer ",Tfidf_x_train.get_shape())
print("the number of unique words ", Tfidf_x_train.get_shape()[1])
```

```
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text BOW vectorizer  (80000, 1013943)
the number of unique words  1013943
```

```
#Test data
Tfidf_x_test= count_vect.transform(x_test)
print("the type of count vectorizer ",type(Tfidf_x_test))
print("the shape of out text BOW vectorizer ",Tfidf_x_test.get_shape())
print("the number of unique words ", Tfidf_x_test.get_shape()[1])
```

```
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text BOW vectorizer  (20000, 1013943)
the number of unique words  1013943
```

Fitting Grid Search CV on Tf-Idf

```
grid.fit(Tfidf_x_train, y_train)

# examine the best model
print(grid.best_score_)
print(grid.best_params_)
```

```
0.8943373584339609
{'alpha': 0.0001}
```

```
# Naive bayes
Bnb_optimal=BernoulliNB(alpha=0.0001, binarize=0.0, fit_prior=True)

# fitting the model
Bnb_optimal.fit(Tfidf_x_train, y_train)

# predict the response
pred_tfidf = Bnb_optimal.predict(Tfidf_x_test)

# evaluate accuracy
acc = accuracy_score(y_test, pred_tfidf) * 100
print('\nThe accuracy of the Bernoulli NB classifier for a = %d is %f%%' % (0.0001, acc))
```

```
The accuracy of the Bernoulli NB classifier for a = 0 is 88.180000%
```

```
# Train & Test Error
print("The overall accuracy score for the Train Data is : ", metrics.accuracy_score(y_train,Bnb_optimal
print("The overall accuracy score for the Test Data is : ", metrics.accuracy_score(y_test,pred_tfidf))
```

```
The overall accuracy score for the Train Data is :  0.998775
The overall accuracy score for the Test Data is :  0.8818
```

```
#Feature importance
neg_class_prob_sorted = Bnb_optimal.feature_log_prob_[1, :].argsort()
pos_class_prob_sorted = Bnb_optimal.feature_log_prob_[0, :].argsort()

neg_tfidf_bnb=neg_class_prob_sorted[::-1]
pos_tfidf_bnb=pos_class_prob_sorted[::-1]
```

```
#Top 20 negative words
n=(np.take(count_vect.get_feature_names(), neg_tfidf_bnb[:20]))
sn = ""
for i in n:
    sn += str(i)+","
print(sn)
```

```
tast,like,product,one,would,tri,good,flavor,buy,get,use,dont,order,even,much,make,love,realli,eat,time,
```

```
#Top 20 positive words
p=(np.take(count_vect.get_feature_names(), pos_tfidf_bnb[:20]))
sp = ""
for i in p:
    sp += str(i)+","
print(sp)
```

```
tast,like,great,good,love,flavor,one,use,product,tri,make,get,best,time,buy,find,amazon,eat,realli,also,
```

```
print("************ Top 20 Negative words ******************")
wordcloud = WordCloud(width = 800, height = 800,
                background_color ='black',
                min_font_size = 10).generate(sn)

# plot the WordCloud image
plt.figure(figsize = (5,5), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)
plt.show()


print("************ Top 20 Positive words ******************")
wordcloud = WordCloud(width = 800, height = 800,
                background_color ='black',
                min_font_size = 10).generate(sp)

# plot the WordCloud image
plt.figure(figsize = (5,5), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)
plt.show()
```

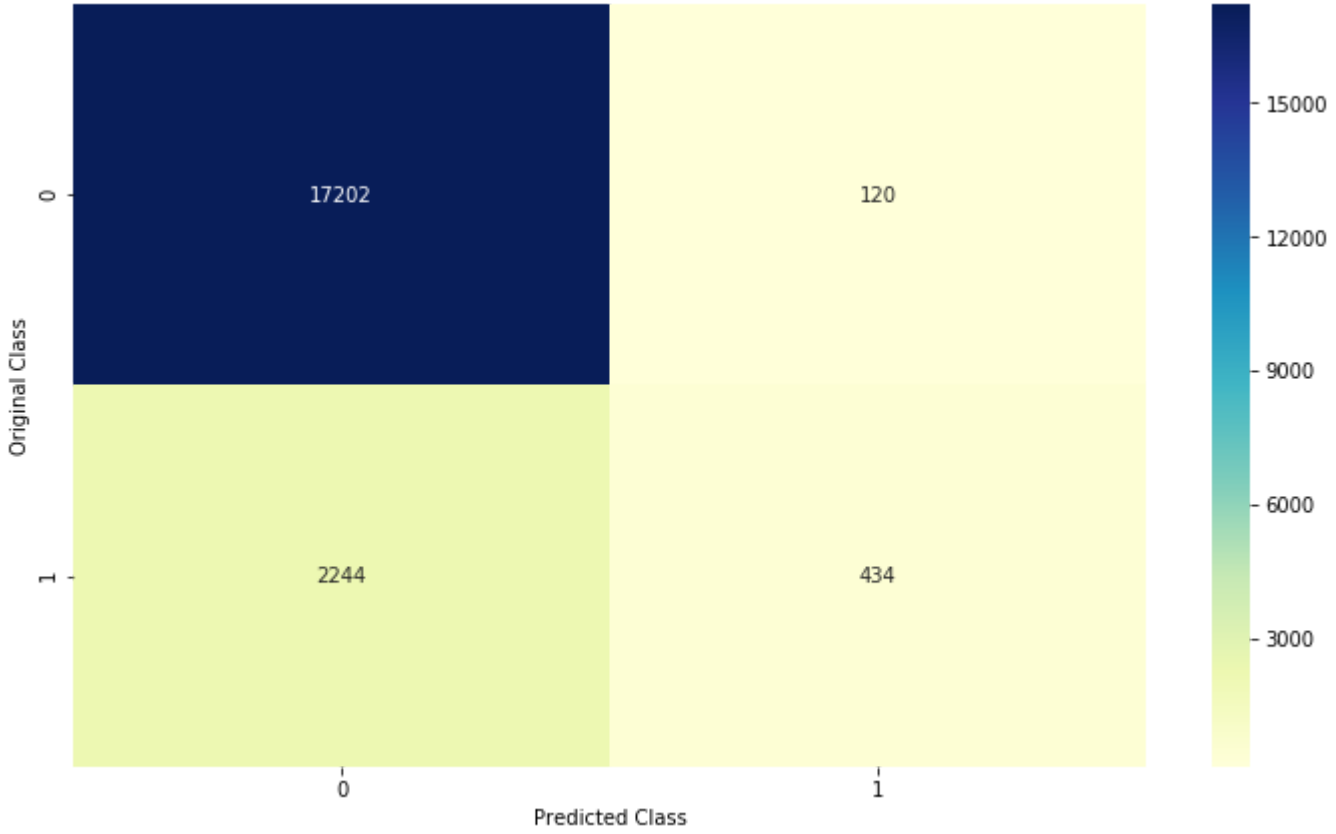
```
************ Top 20 Negative words ******************
```

********** Top 20 Positive words **********

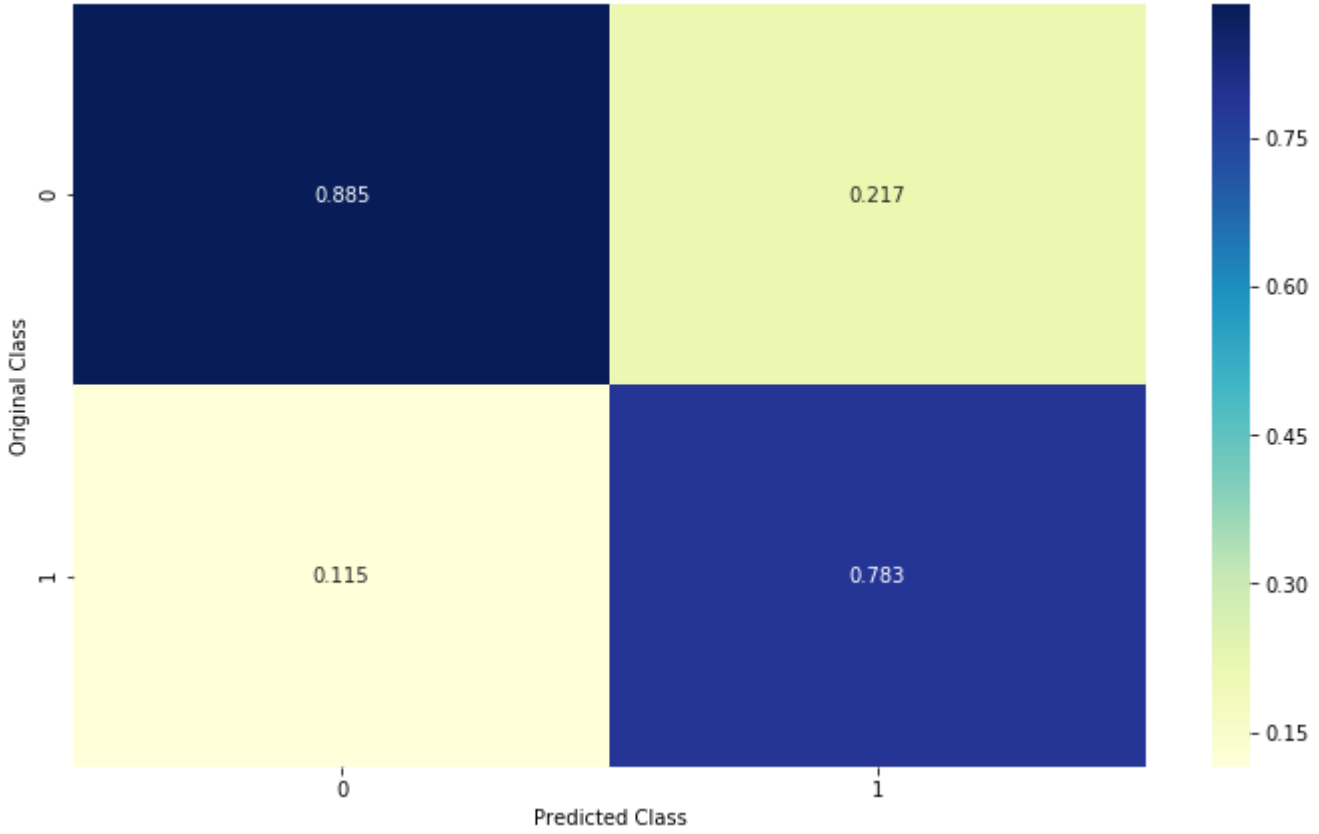

```
#confusion matrix, Precision score & Recall score
C = confusion_matrix(y_test, pred_tfidf)
A =(((C.T)/(C.sum(axis=1))).T)
B =(C/C.sum(axis=0))
labels = [0,1]
```

```
 print("-"*20, "Confusion matrix", "-"*20)
plt.figure(figsize=(12,7))
sns.heatmap(C, annot=True, cmap="YlGnBu", fmt="g", xticklabels=labels, yticklabels=labels)
plt.xlabel('Predicted Class')
plt.ylabel('Original Class')
plt.show()

print("-"*20, "Precision matrix (Columm Sum=1)", "-"*20)
plt.figure(figsize=(12,7))
sns.heatmap(B, annot=True, cmap="YlGnBu", fmt=".3f", xticklabels=labels, yticklabels=labels)
 plt.xlabel('Predicted Class')
plt.ylabel('Original Class')
plt.show()

    # representing B in heatmap format
print("-"*20, "Recall matrix (Row sum=1)", "-"*20)
plt.figure(figsize=(12,7))
sns.heatmap(A, annot=True, cmap="YlGnBu", fmt=".3f", xticklabels=labels, yticklabels=labels)
plt.xlabel('Predicted Class')
plt.ylabel('Original Class')
plt.show()
```

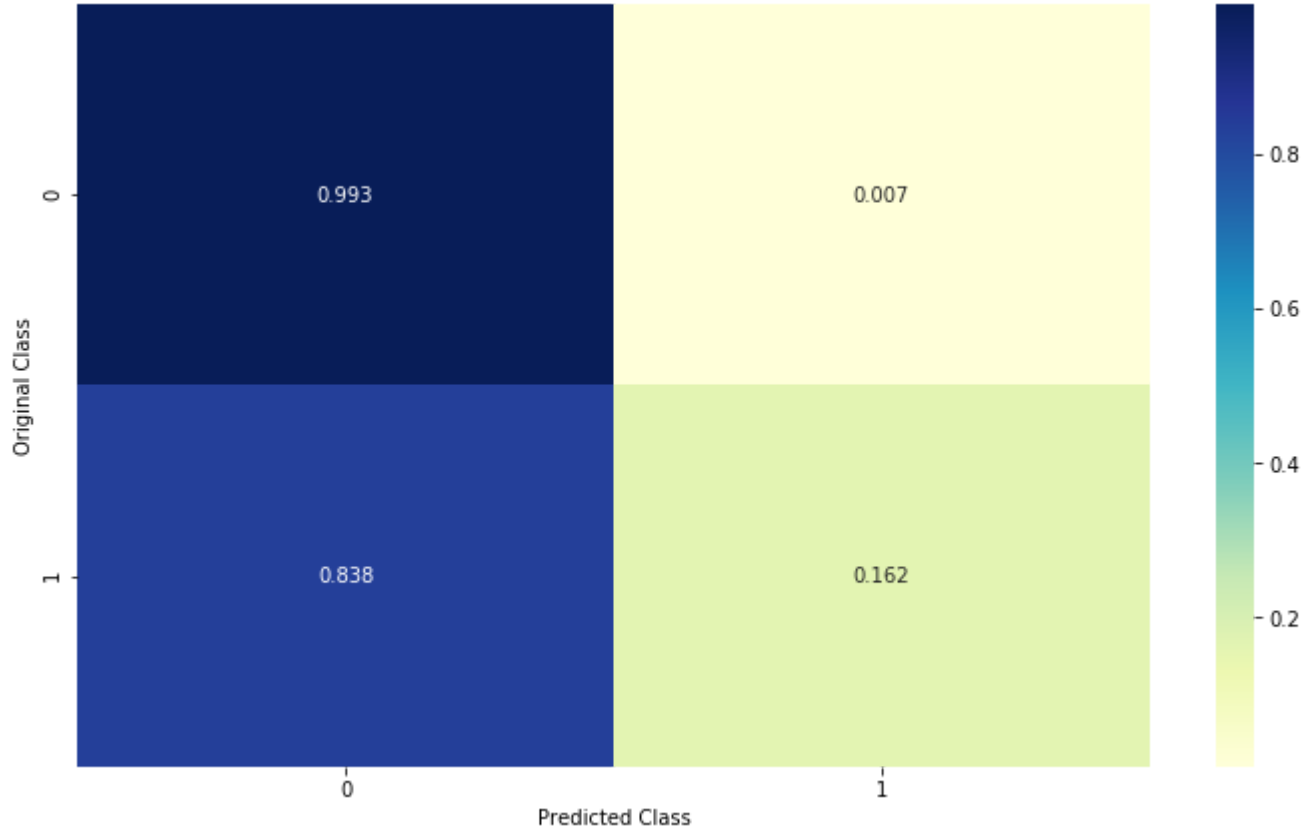
```
-------------------- Confusion matrix --------------------
```




```
-------------------- Precision matrix (Columm Sum=1) --------------------
```



---------- Recall matrix (Row sum=1) ----------



Using MultinomialNB

Running Gridsearch CV

```
alpha_range = [0.000001,0.00001,0.0001,0.001,0.01,0.1,0.2,0.3,0.4,0.5,0.6,0.7,0.8,0.9,1.0,10,20,30,40,5(
T= TimeSeriesSplit(n_splits=5)

param_grid = dict(alpha=alpha_range)
print(param_grid)

# instantiate and fit the grid
grid = GridSearchCV(MultinomialNB(), param_grid, cv=T, scoring='accuracy', return_train_score=False,n_j(
```

```
{'alpha': [1e-06, 1e-05, 0.0001, 0.001, 0.01, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 10, 20, 30, 40, 50]}
```

Fitting Grid Search CV on BOW

```
grid.fit(Bow_x_train, y_train)

# examine the best model
print(grid.best_score_)
print(grid.best_params_)
```

```
0.9072976824420611
{'alpha': 0.5}
```

```
# Naive bayes
Mnb_optimal=MultinomialNB(alpha=0.5,fit_prior=True)

# fitting the model
Mnb_optimal.fit(Bow_x_train, y_train)

# predict the response
pred_bow = Mnb_optimal.predict(Bow_x_test)

# evaluate accuracy
acc = accuracy_score(y_test, pred_bow) * 100
print('\nThe accuracy of the Multinomial NB classifier for a = %d is %f%%' % (0.5, acc))
```

```
The accuracy of the Multinomial NB classifier for a = 0 is 90.920000%
```

```
# Train & Test Error
print("The overall accuracy score for the Train Data is : ", metrics.accuracy_score(y_train,Mnb_optimal
print("The overall accuracy score for the Test Data is : ", metrics.accuracy_score(y_test,pred_bow))
```

```
The overall accuracy score for the Train Data is :  0.9290625
The overall accuracy score for the Test Data is :  0.9092
```

```
#Feature importance
neg_class_prob_sorted = Mnb_optimal.feature_log_prob_[1, :].argsort()
pos_class_prob_sorted = Mnb_optimal.feature_log_prob_[0, :].argsort()

neg_bow_Mnb=neg_class_prob_sorted[::-1]
pos_bow_Mnb=pos_class_prob_sorted[::-1]
```

```
#Top 20 negative words
n=(np.take(count_vect.get_feature_names(), neg_bow_Mnb[:20]))
sn = ""
for i in n:
    sn += str(i)+","
print(sn)
```

```
amazon high,airplan littl,also artist,almost fudgi,anim peopl,america particular,affect glucos,adult athlet,across fri,advi
s singl,amount even,addict mani,almost mexican,adequ expir,allow around,alchohol breath,ala packet,also marathon,addit cris
p,amazon tabasco,
```

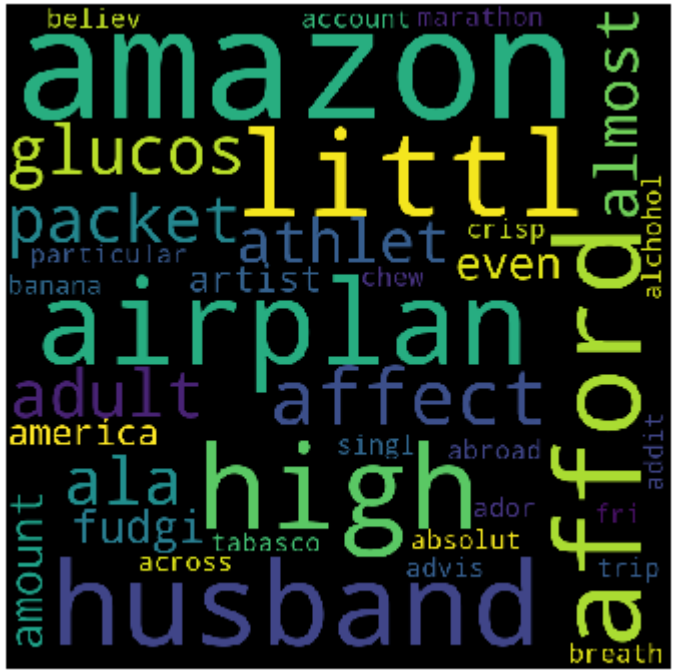
```
#Top 20 positive words
p=(np.take(count_vect.get_feature_names(), pos_bow_Mnb[:20]))
sp = ""
for i in p:
    sp += str(i)+","
print(sp)
```

```
amazon high,airplan littl,afford husband,affect glucos,ala packet,adult athlet,almost fudgi,amount even,also artist,america
particular,alchohol breath,advis singl,account believ,amazon tabasco,across fri,ador chew,absolut banana,addit crisp,also m
arathon,abroad trip,
```

```
print("************ Top 20 Negative words ******************")
wordcloud = WordCloud(width = 800, height = 800,
                background_color ='black',
                min_font_size = 10).generate(sn)

# plot the WordCloud image
plt.figure(figsize = (5,5), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)
plt.show()


print("************ Top 20 Positive words ******************")
wordcloud = WordCloud(width = 800, height = 800,
                background_color ='black',
                min_font_size = 10).generate(sp)

# plot the WordCloud image
plt.figure(figsize = (5,5), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)
plt.show()
```

```
************ Top 20 Negative words ******************
```

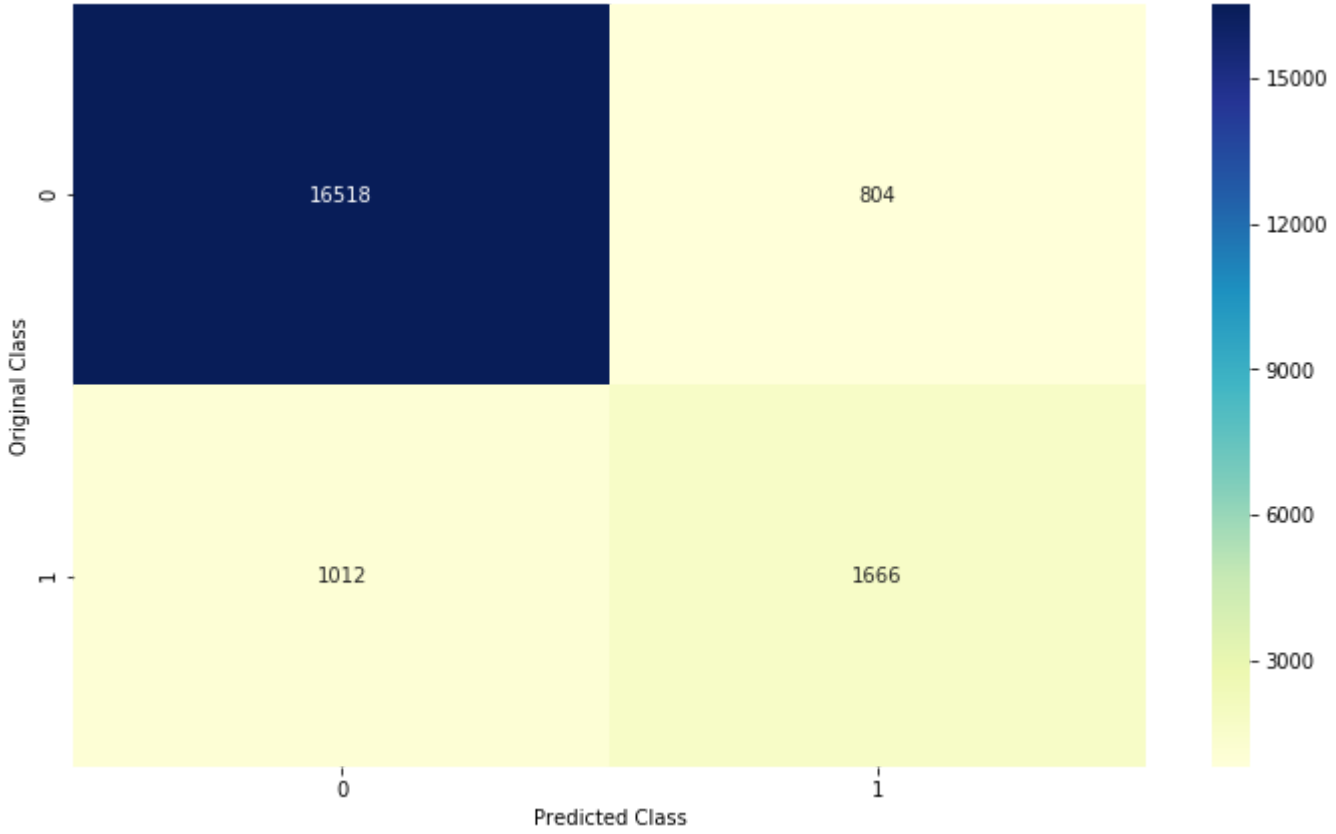
********** Top 20 Positive words **********



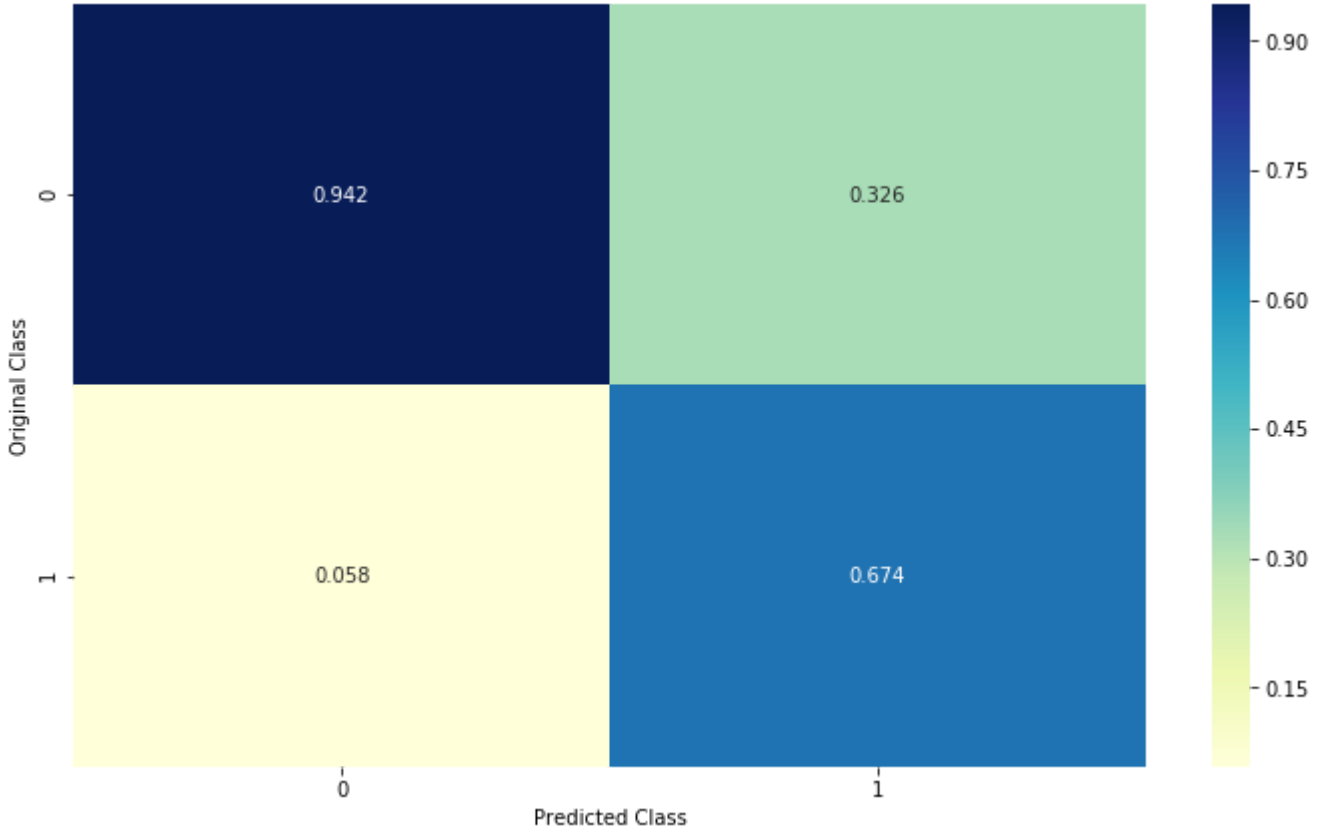

```
#confusion matrix, Precision score & Recall score
C = confusion_matrix(y_test, pred_bow)
A =(((C.T)/(C.sum(axis=1))).T)
B =(C/C.sum(axis=0))
labels = [0,1]
```

```
 print("-"*20, "Confusion matrix", "-"*20)
plt.figure(figsize=(12,7))
sns.heatmap(C, annot=True, cmap="YlGnBu", fmt="g", xticklabels=labels, yticklabels=labels)
plt.xlabel('Predicted Class')
plt.ylabel('Original Class')
plt.show()

print("-"*20, "Precision matrix (Columm Sum=1)", "-"*20)
plt.figure(figsize=(12,7))
sns.heatmap(B, annot=True, cmap="YlGnBu", fmt=".3f", xticklabels=labels, yticklabels=labels)
 plt.xlabel('Predicted Class')
plt.ylabel('Original Class')
plt.show()

    # representing B in heatmap format
print("-"*20, "Recall matrix (Row sum=1)", "-"*20)
plt.figure(figsize=(12,7))
sns.heatmap(A, annot=True, cmap="YlGnBu", fmt=".3f", xticklabels=labels, yticklabels=labels)
plt.xlabel('Predicted Class')
plt.ylabel('Original Class')
plt.show()
```

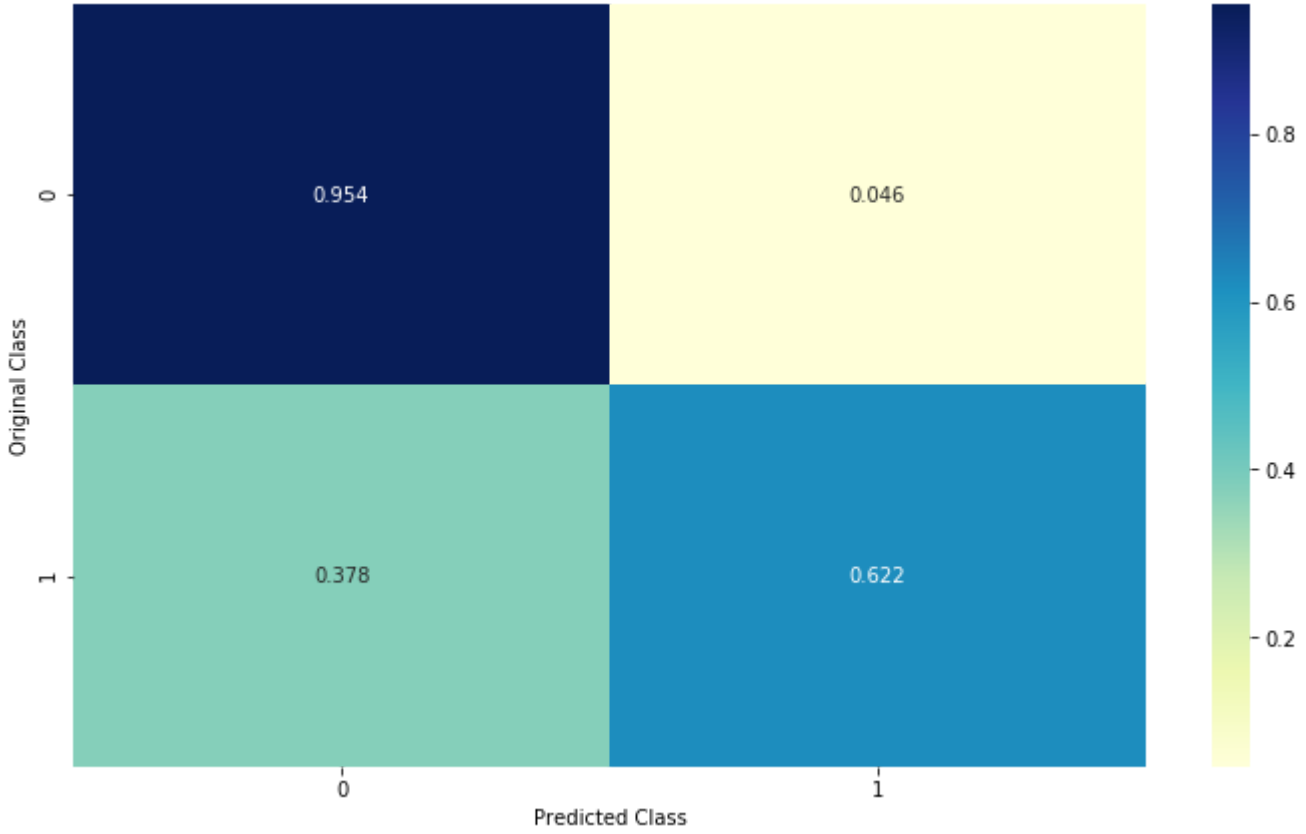
```
-------------------- Confusion matrix --------------------
```




```
-------------------- Precision matrix (Columm Sum=1) --------------------
```




```
-------------------- Recall matrix (Row sum=1) --------------------
```



Fitting gridsearch cv on Tfidf

```
grid.fit(Tfidf_x_train, y_train)

# examine the best model
print(grid.best_score_)
print(grid.best_params_)
```

```
0.8972174304357609
{'alpha': 0.5}
```

```
# Naive bayes
mnb_optimal=BernoulliNB(alpha=0.5, binarize=0.0, fit_prior=True)

# fitting the model
mnb_optimal.fit(Tfidf_x_train, y_train)

# predict the response
pred_tfidf = mnb_optimal.predict(Tfidf_x_test)

# evaluate accuracy
acc = accuracy_score(y_test, pred_tfidf) * 100
print('\nThe accuracy of the Multinomial NB classifier for a = %d is %f%%' % (0.0001, acc))
```

```
The accuracy of the Multinomial NB classifier for a = 0 is 87.305000%
```

```
# Train & Test Error
print("The overall accuracy score for the Train Data is : ", metrics.accuracy_score(y_train,mnb_optimal
print("The overall accuracy score for the Test Data is : ", metrics.accuracy_score(y_test,pred_tfidf))
```

```
The overall accuracy score for the Train Data is :  0.9253375
The overall accuracy score for the Test Data is :  0.87305
```

```
#Feature importance
neg_class_prob_sorted = Mnb_optimal.feature_log_prob_[1, :].argsort()
pos_class_prob_sorted = Mnb_optimal.feature_log_prob_[0, :].argsort()

neg_bow_Mnb=neg_class_prob_sorted[::-1]
pos_bow_Mnb=pos_class_prob_sorted[::-1]
```

```
#Top 20 negative words
n=(np.take(count_vect.get_feature_names(), neg_bow_Mnb[:20]))
sn = ""
for i in n:
    sn += str(i)+","
print(sn)
```

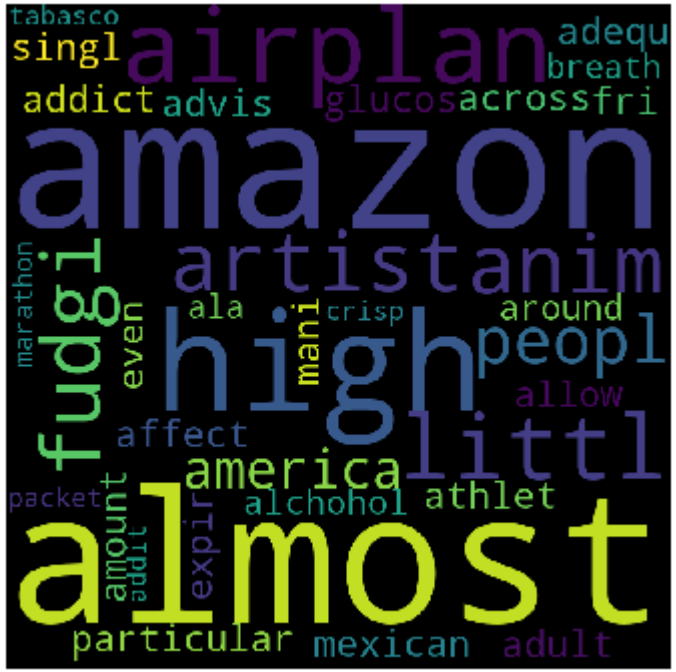
```
amazon high,airplan littl,also artist,almost fudgi,anim peopl,america particular,affect glucos,adult athlet,across fri,advi
s singl,amount even,addict mani,almost mexican,adequ expir,allow around,alchohol breath,ala packet,also marathon,addit cris
p,amazon tabasco,
```

```
#Top 20 positive words
p=(np.take(count_vect.get_feature_names(), pos_bow_Mnb[:20]))
sp = ""
for i in p:
    sp += str(i)+","
print(sp)
```

```
amazon high,airplan littl,afford husband,affect glucos,ala packet,adult athlet,almost fudgi,amount even,also artist,america
particular,alchohol breath,advis singl,account believ,amazon tabasco,across fri,ador chew,absolut banana,addit crisp,also m
arathon,abroad trip,
```

```
print("************ Top 20 Negative words ******************")
wordcloud = WordCloud(width = 800, height = 800,
                background_color ='black',
                min_font_size = 10).generate(sn)

# plot the WordCloud image
plt.figure(figsize = (5,5), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)
plt.show()


print("************ Top 20 Positive words ******************")
wordcloud = WordCloud(width = 800, height = 800,
                background_color ='black',
                min_font_size = 10).generate(sp)

# plot the WordCloud image
plt.figure(figsize = (5,5), facecolor = None)
plt.imshow(wordcloud)
plt.axis("off")
plt.tight_layout(pad = 0)
plt.show()
```

```
************ Top 20 Negative words ******************
```

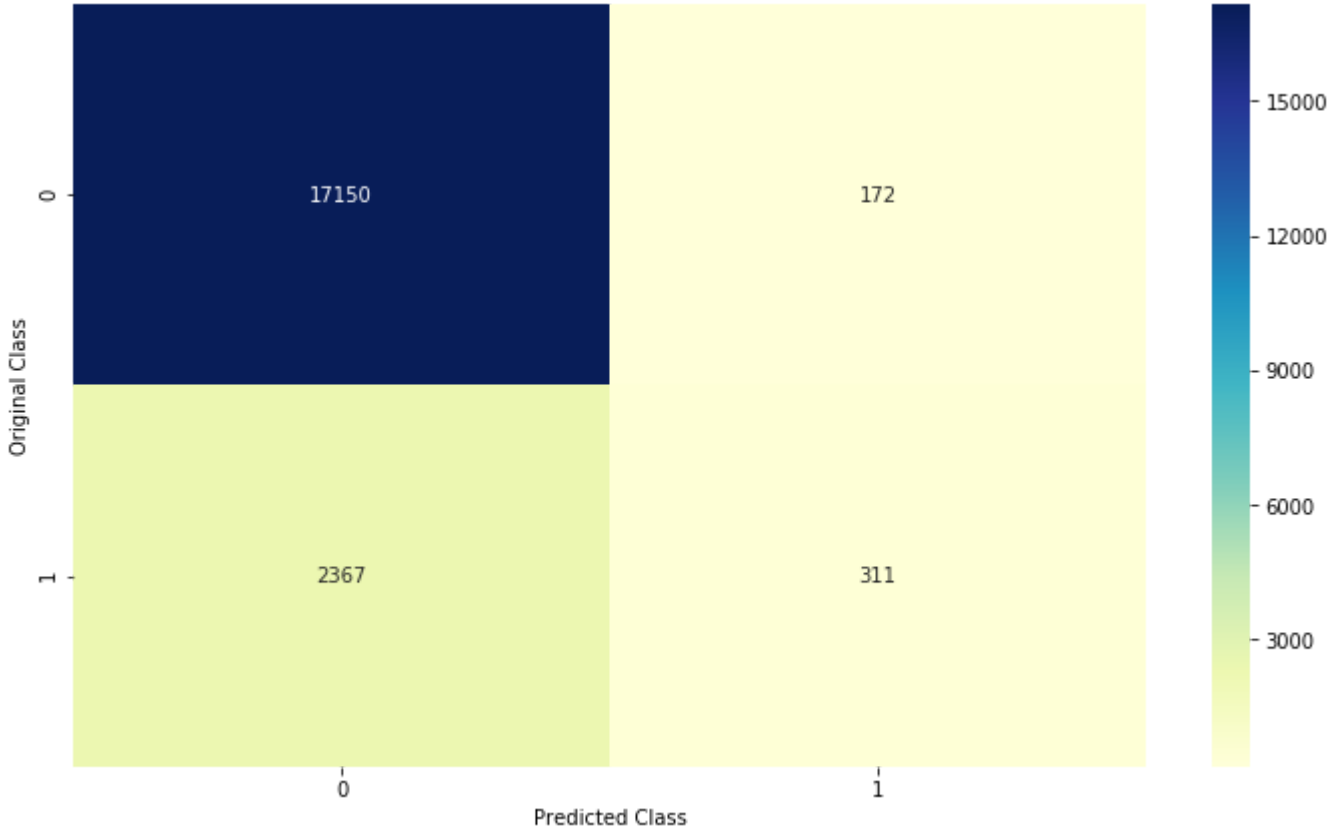


********** Top 20 Positive words **********

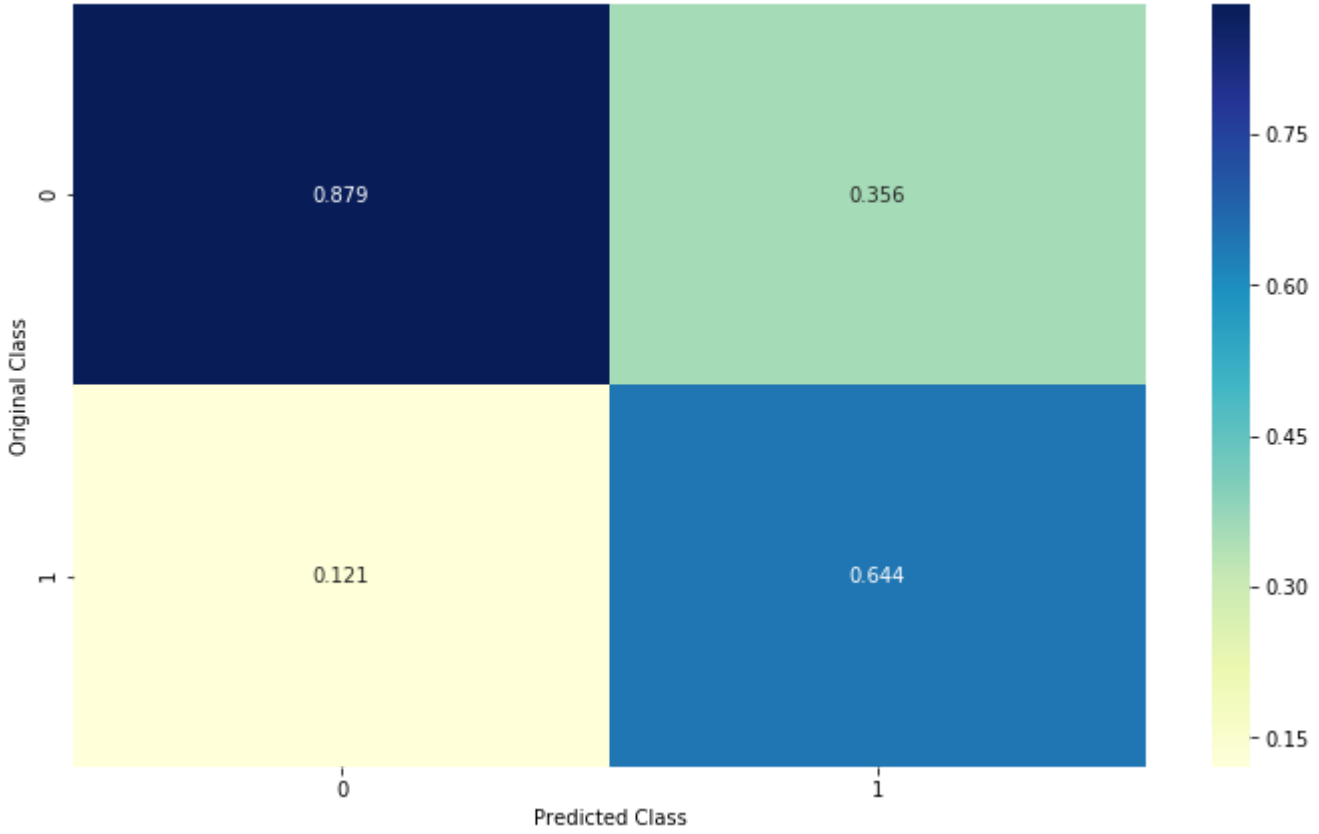

```
#confusion matrix, Precision score & Recall score
C = confusion_matrix(y_test, pred_tfidf)
A =(((C.T)/(C.sum(axis=1))).T)
B =(C/C.sum(axis=0))
labels = [0,1]
```

```
 print("-"*20, "Confusion matrix", "-"*20)
plt.figure(figsize=(12,7))
sns.heatmap(C, annot=True, cmap="YlGnBu", fmt="g", xticklabels=labels, yticklabels=labels)
plt.xlabel('Predicted Class')
plt.ylabel('Original Class')
plt.show()

print("-"*20, "Precision matrix (Columm Sum=1)", "-"*20)
plt.figure(figsize=(12,7))
sns.heatmap(B, annot=True, cmap="YlGnBu", fmt=".3f", xticklabels=labels, yticklabels=labels)
 plt.xlabel('Predicted Class')
plt.ylabel('Original Class')
plt.show()

    # representing B in heatmap format
print("-"*20, "Recall matrix (Row sum=1)", "-"*20)
plt.figure(figsize=(12,7))
sns.heatmap(A, annot=True, cmap="YlGnBu", fmt=".3f", xticklabels=labels, yticklabels=labels)
plt.xlabel('Predicted Class')
plt.ylabel('Original Class')
plt.show()
```

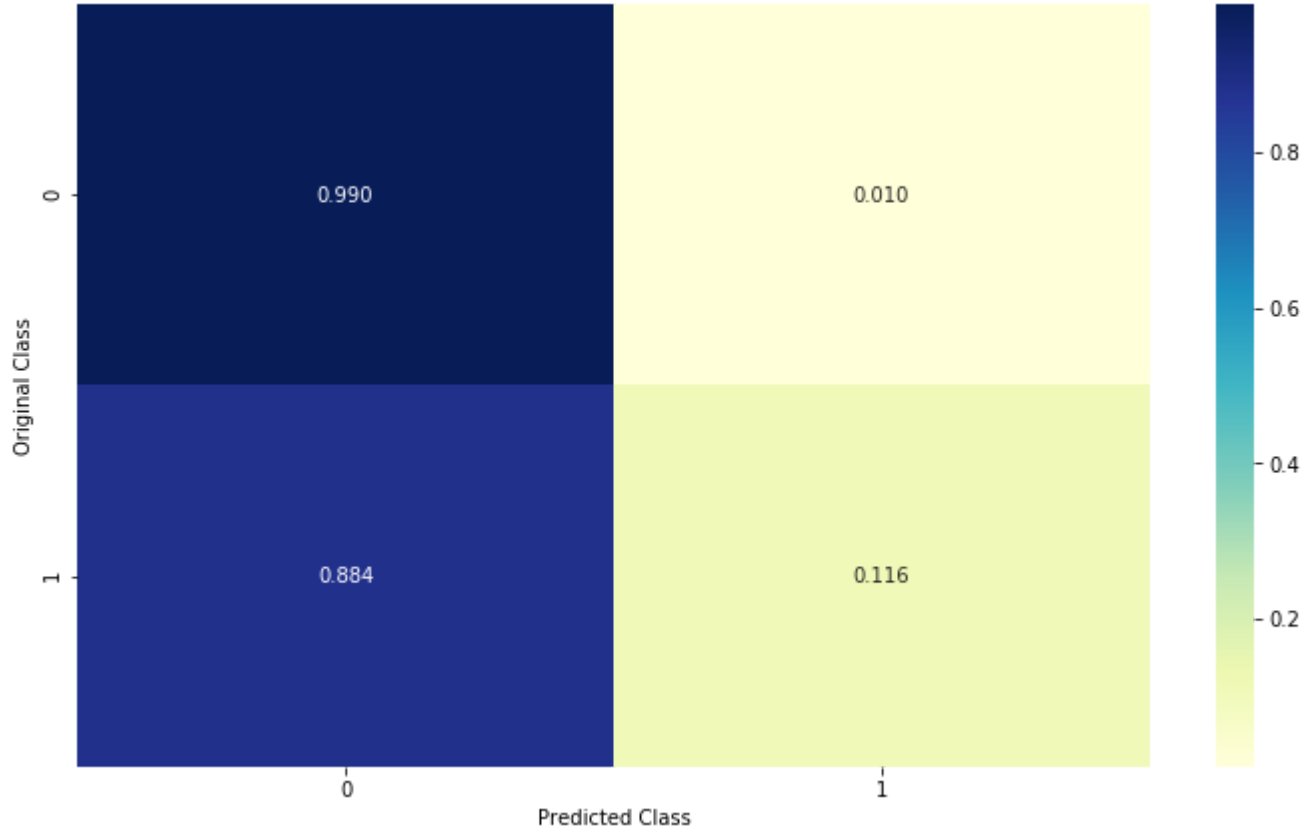
```
-------------------- Confusion matrix --------------------
```




```
-------------------- Precision matrix (Columm Sum=1) --------------------
```



---------- Recall matrix (Row sum=1) ----------



Bernaulli NB v/s Multinomial NB

```
1 !pip install prettytable
```

```
Collecting prettytable
  Downloading https://files.pythonhosted.org/packages/ef/30/4b0746848746ed5941f052479e7c23d2b56d174b82f4fd34a25e389831f5/prettytable-0.7.2.tar.bz2 (https://files.pythonhosted.org/packages/ef/30/4b0746848746ed5941f052479e7c23d2b56d174b82f4fd34a25e389831f5/prettytable-0.7.2.tar.bz2)
Building wheels for collected packages: prettytable
  Running setup.py bdist_wheel for prettytable: started
  Running setup.py bdist_wheel for prettytable: finished with status 'done'
  Stored in directory: C:\Users\deepak\AppData\Local\pip\Cache\wheels\80\34\1c\3967380d9676d162cb59513bd9dc862d0584e045a162095606
Successfully built prettytable
Installing collected packages: prettytable
Successfully installed prettytable-0.7.2
```

```
from prettytable import PrettyTable
```

```
x=PrettyTable()
x.field_names = ["Model","BernualliNB_BOW", "BernualliNB_tfidf", "MultinomialNB_BOW", "MultinomialNB_Tf
x.add_row(["Hyperparameter",0.1,0.0001,0.5,0.5])
x.add_row(["Train Error",0.927,0.998,0.929,0.925])
x.add_row(["Test Error",0.900,0.881,0.909,0.873])

print(x)
```

```
+----------------+-----------------+-------------------+-------------------+---------------------+
|     Model      | BernualliNB_BOW | BernualliNB_tfidf | MultinomialNB_BOW | MultinomialNB_Tfidf |
+----------------+-----------------+-------------------+-------------------+---------------------+
| Hyperparameter |       0.1       |       0.0001      |        0.5        |         0.5         |
|  Train Error   |      0.927      |       0.998       |       0.929       |        0.925        |
|   Test Error   |       0.9       |       0.881       |       0.909       |        0.873        |
+----------------+-----------------+-------------------+-------------------+---------------------+
```