Author: Ashish Toppo

Type :NLP

Algorithm :Naive Bayes

Language :Python

IDE :Jupyter Notebook

Description: Naive Bayes classifier assumes that the presence of a particular feature in a class is unrelated to the presence of any other feature. For example, a fruit may be considered to be an apple if it is red, round, and about 3 inches in diameter. It's based on bayes theorem.

Work Done:

1. Cleaned the text: 1.1 Removed the Punctuations using regex. 1.2 Removed the stop words. 1.3 Rooted the words using lemmatization
2. Converted the text data to both bag of words data and tfidf data.
3. Done hyperparameter tuning using GridSearchCv for both bow and tfidf data.
4. Confusion matrix and ROC-AUC curve for validation.

In [1]:
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns
import warnings
warnings.filterwarnings("ignore")
```

In [2]:
```
#reading up the .csv file
data = pd.read_csv("spam_ham_dataset.csv")
```

In [3]:
```
#peeping into data
data.head()
```

Out[3]:

	Unnamed: 0	label	text	label_num
0	605	ham	Subject: enron methanol ; meter # : 988291\r\n...	0
1	2349	ham	Subject: hpl nom for january 9 , 2001\r\n(see...	0
2	3624	ham	Subject: neon retreat\r\nho ho ho , we ' re ar...	0
3	4685	spam	Subject: photoshop , windows , office . cheap ...	1
4	2030	ham	Subject: re : indian springs\r\nthis deal is t...	0

In [4]:
```
#what to expect
for i in data["text"].sample(5):
    print(i)
    print("****"*20)
```

```
Subject: hpl nom for march 3 - 5 , 2001
( see attached file : hplno 303 . xls )
- hplno 303 . xls
****************************************************************
Subject: valentines day help
red - neck valentine ' s love poem
collards is green
my dog ' s name is blue
and i ' m so lucky
to have a sweet thang like you .
yore hair is like cornsilk
a - flapping in the breeze
softer than old blue ' s
and without all them fleas .
you move like the bass ,
which excite me in may .
you ain ' t got no scales
but i luv you anyway .
yo ' re as satisfy ' n as okry
jist a - fry ' n in the pan .
yo ' re as fragrant as " snuff "
right out of the can .
you have som ' a yore teeth ,
for which i am proud ;
i hold my head high
when we ' re in a crowd .
on special occasions ,
when you shave under yore arms ,
well , i ' m in hawg heaven ,
and awed by yore charms .
still them fellers at work ,
they all want to know ,
what i did to deserve
such a purdy , young doe .
like a good roll of duct tape
yo ' re there fer yore man ,
to patch up life ' s troubles
and fix what you can .
yo ' re as cute as a junebug
a - buzzin ' overhead .
you ain ' t mean like those far ants
i found in my bed .
cut from the best cloth
like a plaid flannel shirt ,
you spark up my life
more than a fresh load of dirt .
when you hold me real tight
like a padded gunrack ,
my life is complete ;
ain ' t nuttin ' i lack .
yore complexion , it ' s perfection ,
like the best vinyl sidin ' .
despite all the years ,
yore age , it keeps hidin ' .
me ' n ' you ' s we go together
just like a moon pie
with a rc cold drank ,
yep , we go together
like a skunk goes with stank .
some men , they buy chocolate
for valentine ' s day ;
they git it at wal - mart ,
it ' s romantic that way .
some men git roses
on that special day
from the cooler at kroger .
" that ' s impressive , " i say .
some men buy fine diamonds
from a flea market booth .
" diamonds are forever , "
they explain , suave and couth .
but for this man , honey ,
these won ' t do .
cause yo ' re too special ,
you sweet thang you .
i got you a gift ,
without taste nor odor ,
more useful than diamonds . . .
it ' s a new trollin ' motor ! !
l shore due luv you darling ,
aint love grand ! ! ! ! . . . . .
bubba
****************************************************************
Subject: fwd : resume
trying to help outta friend .
i ' ll take 40 % of your referral fee . . . lol ; )
- dukeresume . doc
****************************************************************
Subject: re : intraday eastrans nomination change for 9 / 6 / 00
10 , 545 will be delivered to mobil beaumont from cipco for 6 th only .
| - - - - - - - - + - - - - - - - - - - - - - - - - - - - - - - - - >
| | marta k |
| | henderson |
| | |
| | 09 / 06 / 00 |
| | 09 : 21 am |
| | |
| - - - - - - - - + - - - - - - - - - - - - - - - - - - - - - - - - >
| |
| to : darrel f . bane / easttexas / pefs / pec @ pec , john
a . |
| bretz / gcs / cec / pec @ pec , chad w . cass / gcs / cec / pec @ pec , michael
r . |
| cherry / easttexas / pefs / pec @ pec , bruce
mcmills / ftworth / pefs / pec @ pec , |
| william e . speckels / gcs / cec / pec @ pec , donna
c . |
| spencer / gcs / cec / pec @ pec , julia a . urbanek / gcs / cec / pec @ pec , dora
j . |
| levy / gcs / cec / pec @ pec , briley @ enron . com ,
dfarmer @ enron . com , |
| carlos . j . rodriguez @ enron . com , sharon
beemer / ftworth / pefs / pec @ pec , |
| connie
wester / easttexas / pefs / pec @ pec |
|
cc : |
| subject : intraday eastrans nomination change for
9 / 6 / 00 |
deliveries continue to be 30 , 000
****************************************************************
Subject: out of the office
please note that i will be out of the on tuesday , july 11 th through friday ,
july 14 th . i will return on monday the 17 th . in my absense , my desk will be
covered as follows :
tom acton :
980067 lonestar katy - - - - daily confirmations
980072 aquila header - - daily confirmations
980069 trunkline - - daily confirmations
986780 oasis katy - - daily confirmations
oneok transport - - daily scheduling
western transport - - daily scheduling
midcon transport - - daily scheduling
carlos rodriguez :
lonestar pipe line - - offsystem scheduling / pathing
midcon pipe line - - offsystem scheduling / pathing
dow pipe line - - offsystem scheduling / pathing
eddie janzen / mary poorman :
oasis pipe line - - offsystem nominations / scheduling / pathing
thanks ,
mark
x 33396
****************************************************************
```

Observations

1. The mails have phone no's, hyperlinks, email addresses, punctuations
2. But as these might increase my no. of words in corpus i'll be getting rid of these using **Regular Expressions**.
3. Numbers Won't be of any help so i'll be rooting up for the words.

In [5]:
```
data.columns
```

Out[5]:
```
Index(['Unnamed: 0', 'label', 'text', 'label_num'], dtype='object')
```

In [6]:
```
#dropping Columns Unnames and label as we have similar columns for them
data.drop(columns=['Unnamed: 0', 'label'], inplace=True)
```

In [7]:
```
data.head()
```

Out[7]:

	text	label_num
0	Subject: enron methanol ; meter # : 988291\r\n...	0
1	Subject: hpl nom for january 9 , 2001\r\n(see...	0
2	Subject: neon retreat\r\nho ho ho , we ' re ar...	0
3	Subject: photoshop , windows , office . cheap ...	1
4	Subject: re : indian springs\r\nthis deal is t...	0

In [8]:
```
# regular experession
data["Rtext"]=data["text"].replace("[^a-zA-Z]"," ", regex=True)
```

In [9]:
```
data.head()
```

Out[9]:

	text	label_num	Rtext
0	Subject: enron methanol ; meter # : 988291\r\n...	0	Subject enron methanol meter th...
1	Subject: hpl nom for january 9 , 2001\r\n(see...	0	Subject hpl nom for january see a...
2	Subject: neon retreat\r\nho ho ho , we ' re ar...	0	Subject neon retreat ho ho ho we re arou...
3	Subject: photoshop , windows , office . cheap ...	1	Subject photoshop windows office cheap ...
4	Subject: re : indian springs\r\nthis deal is t...	0	Subject re indian springs this deal is to ...

In [10]:
```
#data after removal of punctuations
data.iloc[0][2]
```

Out[10]:
```
'Subject  enron methanol   meter              this is a follow up to the note i gave you on monday                 preliminary  flow data provided by daren      please override pop   s daily volume   presently zero   to reflect dai
ly  activity you can obtain from gas control    this change is needed asap for economics purposes  '
```

In [11]:
```
from nltk.corpus import stopwords
stop_words = set(stopwords.words("english"))
```

In [12]:
```
list(stop_words)[:10]
```

Out[12]:
```
['y',
 "weren't",
 "wouldn't",
 'the',
 'hasn',
 'so',
 'can',
 "mightn't",
 'why',
 'more']
```

In [13]:
```
from nltk.stem import WordNetLemmatizer
wnl = WordNetLemmatizer()
```

In [14]:
```
#this code below removes stop words and also lemmatizes the words
for i in range(len(data)):
    review=data["Rtext"][i]
    review=review.split()
    review=[wnl.lemmatize(word) for word in review if word not in stop_words]
    review=" ".join(review)
    data["Rtext"][i]=review
```

In [15]:
```
#data after removal of stop words and lemmatizing
data.iloc[0][2]
```

Out[15]:
```
'Subject enron methanol meter follow note gave monday preliminary flow data provided daren please override pop daily volume presently zero reflect daily activity obtain gas control change needed asap economics purpose'
```

In [16]:
```
from sklearn.feature_extraction.text import CountVectorizer, TfidfVectorizer
from sklearn.model_selection import train_test_split
```

In [17]:
```
X_train,X_test,y_train,y_test=train_test_split(data["Rtext"],data["label_num"],test_size=.3)
```

In [18]:
```
print(X_train.shape,X_test.shape,y_train.shape,y_test.shape)
```

```
(3619,) (1552,) (3619,) (1552,)
```

In [19]:
```
# bag of words data
count = CountVectorizer()
count.fit(X_train)
bow_train = count.transform(X_train).toarray()
bow_test = count.transform(X_test).toarray()
```

In [20]:
```
bow_train = pd.DataFrame(bow_train,columns=count.get_feature_names())
bow_test = pd.DataFrame(bow_test,columns=count.get_feature_names())
```

In [21]:
```
bow_train.shape
```

Out[21]:
```
(3619, 36138)
```

In [22]:
```
from sklearn.naive_bayes import MultinomialNB
from sklearn.metrics import ConfusionMatrixDisplay, confusion_matrix, accuracy_score, precision_score, recall_score
```

In [23]:
```
#Hyperparameter tuning for bag of word data
from sklearn.model_selection import GridSearchCV
clf = GridSearchCV(MultinomialNB(),{
    "alpha":np.linspace(0,1,11)
}, cv=5)
```

In [24]:
```
clf.fit(bow_train,y_train)
```

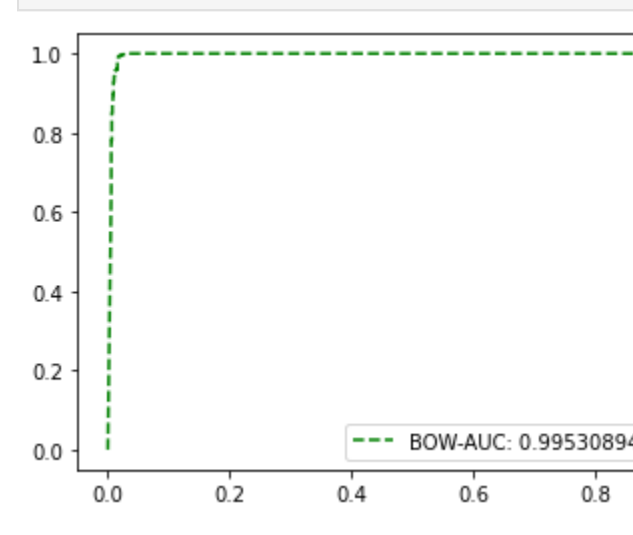
Out[24]:
```
GridSearchCV(cv=5, estimator=MultinomialNB(),
             param_grid={'alpha': array([0. , 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1. ])})
```

In [25]:
```
clf.best_params_
```

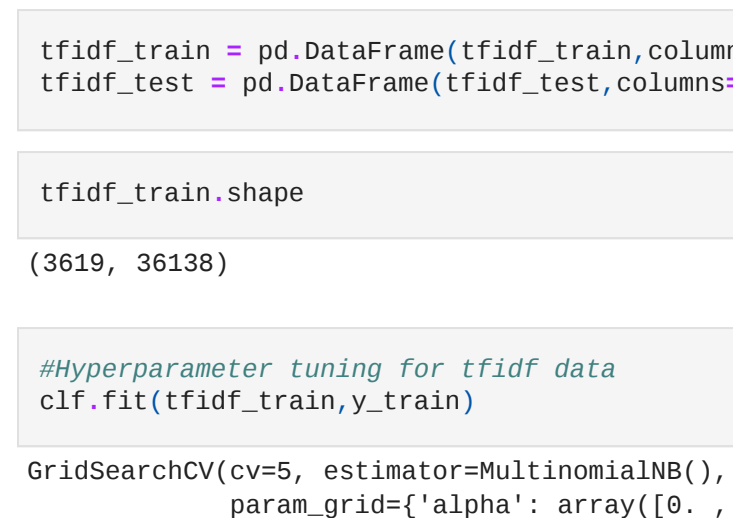
Out[25]:
```
{'alpha': 0.1}
```

In [26]:
```
model1 = MultinomialNB(alpha=clf.best_params_["alpha"])
model1.fit(bow_train,y_train)
pred1 = model1.predict(bow_test)
predprob1 = model1.predict_proba(bow_test)
print(f"accuracy:{accuracy_score(y_test,pred1)}, recall: {recall_score(y_test,pred1)}, precision {precision_score(y_test,pred1)}")
cm1 = confusion_matrix(y_test,pred1)
disp1 = ConfusionMatrixDisplay(cm1,display_labels=model1.classes_)
disp1.plot()
plt.show()
```

```
accuracy:0.9780927835051546, recall: 0.9556962025316456, precision 0.9721030042918455
```



In [27]:
```
from sklearn.metrics import roc_curve, roc_auc_score
fpr,tpr,_=roc_curve(y_test,predprob1[:,1])
plt.plot(fpr,tpr,"--",color="green", label=f"BOW-AUC: {roc_auc_score(y_test,predprob1[:,1])}")
plt.legend()
plt.show()
```



In [28]:
```
# tfidf data
tfidf = TfidfVectorizer()
tfidf.fit(X_train)
tfidf_train = tfidf.transform(X_train).toarray()
tfidf_test = tfidf.transform(X_test).toarray()
```

In [29]:
```
tfidf_train = pd.DataFrame(tfidf_train,columns=tfidf.get_feature_names())
tfidf_test = pd.DataFrame(tfidf_test,columns=tfidf.get_feature_names())
```

In [30]:
```
tfidf_train.shape
```

Out[30]:
```
(3619, 36138)
```

In [31]:
```
#Hyperparameter tuning for tfidf data
clf.fit(tfidf_train,y_train)
```

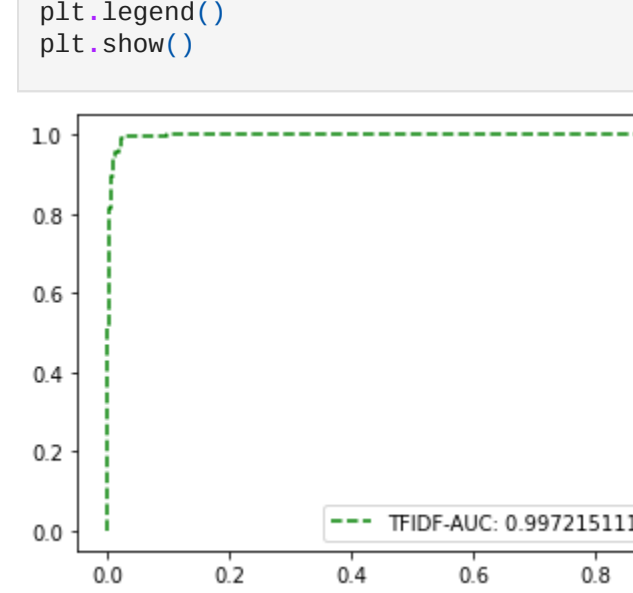
Out[31]:
```
GridSearchCV(cv=5, estimator=MultinomialNB(),
             param_grid={'alpha': array([0. , 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1. ])})
```

In [32]:
```
clf.best_params_
```

Out[32]:
```
{'alpha': 0.1}
```

In [33]:
```
model2 = MultinomialNB(alpha=clf.best_params_["alpha"])
model2.fit(tfidf_train,y_train)
pred2 = model2.predict(tfidf_test)
predprob2 = model1.predict_proba(tfidf_test)
cm2 = confusion_matrix(y_test,pred2)
print(f"accuracy:{accuracy_score(y_test,pred2)}, recall: {recall_score(y_test,pred2)}, precision {precision_score(y_test,pred2)}")
disp2 = ConfusionMatrixDisplay(cm2,display_labels=model2.classes_)
disp2.plot()
plt.show()
```

```
accuracy:0.976159793814433, recall: 0.9345991561181435, precision 0.9866369710467706
```



In [34]:
```
fpr,tpr,_=roc_curve(y_test,predprob2[:,1])
plt.plot(fpr,tpr,"--",color="green", label=f"TFIDF-AUC: {roc_auc_score(y_test,predprob2[:,1])}")
plt.legend()
plt.show()
```