

CIND 820 Initial Results and Code

November 15, 2020

```
[69]: import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

import string
from string import punctuation
import re
from textblob import TextBlob
from wordcloud import WordCloud, STOPWORDS

from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.naive_bayes import MultinomialNB, BernoulliNB
from sklearn import svm
from sklearn.pipeline import Pipeline

from sklearn.metrics import confusion_matrix
from sklearn.metrics import f1_score
from sklearn.metrics import matthews_corrcoef

from mlxtend.preprocessing import DenseTransformer
from sklearn.feature_extraction.text import TfidfTransformer
```

1 Data Preparation

```
[2]: #Importing Data
shakira = pd.read_csv('Youtube05-Shakira.csv',encoding='utf-8-sig')
shakira.head()
```

```
[2]:
```

	COMMENT_ID	AUTHOR \
0	z13lgffb5w3ddx1ul22qy1wxspy5cpkz504	dharma pal
1	z123dbgb0mqjfbtz22ucjc5jvzcv3ykj	Tiza Arellano
2	z12quxxp2vutflkxv04cihggt2azl34pms0k	Priñceśś Āliś Łøvê Dømíñø Mādiś
3	z12icv3ysqvlwth2c23eddlykyqut5z1h	Eric Gonzalez
4	z133stly3kete3tly22petvwdpmghrlli	Analena López

	DATE \
0	2015-05-29T02:30:18.971000
1	2015-05-29T00:14:48.748000
2	2015-05-28T21:00:08.607000
3	2015-05-28T20:47:12.193000
4	2015-05-28T17:08:29.827000

	CONTENT	CLASS
0	Nice song	0
1	I love song	0
2	I love song	0
3	860,000,000 lets make it first female to reach...	0
4	shakira is best for worldcup	0

1.1 Attributes

```
[5]: shakira.shape
```

```
[5]: (370, 5)
```

There are 370 observations and 5 attributes

```
[6]: shakira.dtypes
```

```
[6]: COMMENT_ID    object
AUTHOR           object
DATE             object
CONTENT          object
CLASS            int64
dtype: object
```

```
[3]: #Changing Datatype of Date Attribute
shakira['DATE']=shakira['DATE'].astype('datetime64[ns]')
shakira.head(3)
```

```
[3]:
```

	COMMENT_ID	AUTHOR \
0	z131gffb5w3ddx1ul22qy1wxspy5cpkz504	dharma pal
1	z123dbgb0mqjfbtz22ucjc5jvzcv3ykj	Tiza Arellano
2	z12quxxp2vutflkxv04cihggt2azl34pms0k	Priñceśś Āliś Łøvê Dømiñø Mâdiś

	DATE	CONTENT	CLASS
0	2015-05-29 02:30:18.971	Nice song	0
1	2015-05-29 00:14:48.748	I love song	0
2	2015-05-28 21:00:08.607	I love song	0

All the attributes except for Class are measured as an object. Class is a categorical variable because it represents spam vs non-spam, however it doesn't need to be converted from integer to object

because the classifiers that will be used later on in the project needs the variable to be measured as an integer. Date is also read as an object, however I converted it to datetime to be more accurate.

```
[8]: shakira.describe(include='all')
```

```
C:\Users\Vanessa\Anaconda3\lib\site-packages\ipykernel_launcher.py:1:
FutureWarning: Treating datetime data as categorical rather than numeric in
`.describe` is deprecated and will be removed in a future version of pandas.
Specify `datetime_is_numeric=True` to silence this warning and adopt the future
behavior now.
```

```
"""Entry point for launching an IPython kernel.
```

```
[8]:
```

	COMMENT_ID	AUTHOR	\
count	370	370	
unique	369	319	
top	_2viQ_Qnc68fX3dYsfYuM-m4ELMJvxOQBmBOFHqG0k0	5000palo	
freq	2	7	
first	NaN	NaN	
last	NaN	NaN	
mean	NaN	NaN	
std	NaN	NaN	
min	NaN	NaN	
25%	NaN	NaN	
50%	NaN	NaN	
75%	NaN	NaN	
max	NaN	NaN	

	DATE	CONTENT	\
count	370	370	
unique	369	331	
top	2013-10-05 00:57:25.078000	Hi. Check out and share our songs.	
freq	2	4	
first	2013-07-12 22:33:27.916000	NaN	
last	2015-05-29 02:30:18.971000	NaN	
mean	NaN	NaN	
std	NaN	NaN	
min	NaN	NaN	
25%	NaN	NaN	
50%	NaN	NaN	
75%	NaN	NaN	
max	NaN	NaN	

	CLASS
count	370.000000
unique	NaN
top	NaN
freq	NaN
first	NaN

```

last          NaN
mean          0.470270
std           0.499791
min           0.000000
25%           0.000000
50%           0.000000
75%           1.000000
max           1.000000

```

From the summary of all the attributes you can already see in that in Content there are comments that appear multiple times which could be an indicator of spam. There is also at least 1 Author that posts multiple comments which is also an indicator of spam. The dataset also has a Comment_ID which appears twice which could be a duplicate.

1.2 Looking for Duplicates

```
[4]: print("Total Number of Comment_IDs:", shakira.AUTHOR.shape[0])
      print("Total Number of Unique Comment_IDs:" , shakira['COMMENT_ID'].nunique())
```

```

Total Number of Comment_IDs: 370
Total Number of Unique Comment_IDs: 369

```

```
[5]: #Checking for Duplicates
      duplicated_row = shakira[shakira.duplicated()]
      print(duplicated_row)
      #passes over the first occurrence of the duplicate and prints the second
      ↳ occurrence
```

	COMMENT_ID	AUTHOR \
212	_2viQ_Qnc68fX3dYsfYuM-m4ELMJvx0QBmBOFHqG0k0	tyler sleetway

	DATE	CONTENT	CLASS
212	2013-10-05 00:57:25.078	so beutiful	0

```
[6]: shakira.
      ↳loc[(shakira['COMMENT_ID']=='_2viQ_Qnc68fX3dYsfYuM-m4ELMJvx0QBmBOFHqG0k0')]
```

```
[6]:
```

	COMMENT_ID	AUTHOR \
211	_2viQ_Qnc68fX3dYsfYuM-m4ELMJvx0QBmBOFHqG0k0	tyler sleetway
212	_2viQ_Qnc68fX3dYsfYuM-m4ELMJvx0QBmBOFHqG0k0	tyler sleetway

	DATE	CONTENT	CLASS
211	2013-10-05 00:57:25.078	so beutiful	0
212	2013-10-05 00:57:25.078	so beutiful	0

```
[7]: #Removing the duplicate
      shakira = shakira.drop([212])
```

```
shakira.shape
```

```
[7]: (369, 5)
```

I choose to remove the duplicate because seems to be a duplicate due to error and not an act of spam because the Class is ham, the comment is related to the video, it was posted at the same exact time and the Comment_ID such is supposed to be unique is not.

1.3 Missing Values

```
[12]: shakira.isnull().sum(axis=0)
```

```
[12]: COMMENT_ID    0
      AUTHOR        0
      DATE          0
      CONTENT       0
      CLASS         0
      dtype: int64
```

There are no missing values

1.4 Imbalance in Data

```
[13]: sns.countplot(x='CLASS', data= shakira)
      plt.title("Imbalance in Class Attribute")
      plt.xticks([0, 1], ['Ham', 'Spam'])
```

```
[13]: ([<matplotlib.axis.XTick at 0x1da25114208>,
      <matplotlib.axis.XTick at 0x1da25109da0>],
      [Text(0, 0, 'Ham'), Text(1, 0, 'Spam')])
```

```
[14]: shakira['CLASS'].value_counts()
```

```
[14]: 0    196  
      1    174  
      Name: CLASS, dtype: int64
```

```
[15]: print("Percentage of Ham:",round(((195/shakira.shape[0])*100),2))  
      print("Percentage of Spam:",round(((174/shakira.shape[0])*100),2))
```

```
Percentage of Ham: 52.7  
Percentage of Spam: 47.03
```

The data is balanced

2 Exploratory Analysis

2.1 Univariate Analysis

2.1.1 Comment Length

```
[17]: shakira['CONTENT_LENGTH'] = shakira.CONTENT.apply(lambda x: x.split()  
      #Create a new column based on CONTENT and tokenize the text  
      shakira['CONTENT_LENGTH'] = shakira.CONTENT.apply(lambda x: x.lower()  
      #convert all the characters to lowercase
```

```

shakira['CONTENT_LENGTH'] = shakira.CONTENT.apply(lambda x: ''.join([c for c in x
↪ if c not in punctuation]))
#Remove the puncutation
shakira['CONTENT_LENGTH']=shakira.CONTENT.apply(lambda x:len(x))
#Find the length of each comment
shakira.head()

```

```

[17]:
          COMMENT_ID          AUTHOR \
0    z13lgffb5w3ddx1ul22qy1wxspy5cpkz504    dharma pal
1    z123dbgb0mqjfbtz22ucjc5jvzcv3ykj    Tiza Arellano
2    z12quxxp2vutflkxv04cihggzt2azl34pms0k    Priñçeśś Âliś Łøvê Dømiñø Mãdiś
3    z12icv3ysqvlwth2c23eddlykyqut5z1h    Eric Gonzalez
4    z133stly3kete3tly22petvwdpmghrlli    Analena López

```

```

          DATE          CONTENT \
0 2015-05-29 02:30:18.971    Nice song
1 2015-05-29 00:14:48.748    I love song
2 2015-05-28 21:00:08.607    I love song
3 2015-05-28 20:47:12.193    860,000,000 lets make it first female to reach...
4 2015-05-28 17:08:29.827    shakira is best for worldcup

```

```

    CLASS  CONTENT_LENGTH
0      0             10
1      0             13
2      0             13
3      0             86
4      0             29

```

```

[18]: print("Average Comment Length:",shakira['CONTENT_LENGTH'].mean())
print("Minimum Comment Length:",shakira['CONTENT_LENGTH'].min())
print("Maximum Comment Length:",shakira['CONTENT_LENGTH'].max())

```

```

Average Comment Length: 108.92432432432433
Minimum Comment Length: 2
Maximum Comment Length: 1125

```

```

[19]: shakira['CONTENT_LENGTH'].hist(bins=20)
plt.title('Distribution of comment length')

```

```

[19]: Text(0.5, 1.0, 'Distribution of comment length')

```

Most comments in the dataset are less than 50 words meaning that most users leave shorter comments.

2.1.2 Dates

```
[20]: #extracting the year and month from the DATE attribute
shakira['YEAR_MONTH'] = shakira['DATE'].dt.strftime('%Y-%m')
shakira.head()
```

```
[20]:
```

	COMMENT_ID	AUTHOR \
0	z13lgffb5w3ddx1ul22qy1wxspy5cpkz504	dharma pal
1	z123dbgb0mqjfbtz22ucjc5jvzcv3ykj	Tiza Arellano
2	z12quxxp2vutflkxv04cihggzt2azl34pms0k	Priñceśś Āliś Łøvē Dømiñø Mādiś
3	z12icv3ysqvlwth2c23eddlykyqt5z1h	Eric Gonzalez
4	z133stly3kete3tly22petvwdpmghrlli	Analena López

	DATE	CONTENT \
0	2015-05-29 02:30:18.971	Nice song
1	2015-05-29 00:14:48.748	I love song
2	2015-05-28 21:00:08.607	I love song
3	2015-05-28 20:47:12.193	860,000,000 lets make it first female to reach...
4	2015-05-28 17:08:29.827	shakira is best for worldcup

	CLASS	CONTENT_LENGTH	YEAR_MONTH
0	0	10	2015-05

1	0	13	2015-05
2	0	13	2015-05
3	0	86	2015-05
4	0	29	2015-05

```
[21]: shakira['YEAR_MONTH'].value_counts()
```

```
[21]: 2015-05    162
      2013-10     73
      2013-09     43
      2013-08     39
      2013-07     38
      2015-04      8
      2013-11      7
      Name: YEAR_MONTH, dtype: int64
```

```
[22]: sns.countplot(y='YEAR_MONTH', data= shakira)
      plt.xlabel('Count')
      plt.ylabel('Date')
      plt.title('Date of Comments')
```

```
[22]: Text(0.5, 1.0, 'Date of Comments')
```

Most of the observations in the dataset are from May of 2015 and the least observations are from

November of 2013.

2.1.3 Frequency of Comments

```
[23]: shakira.AUTHOR.value_counts()
```

```
[23]: 5000palo                7
      Shadrach Grentz        7
      Hidden Love           5
      James Cook             4
      ricky swaggz           3
      ..
      Karol Martinez Restrepo Martinez  1
      twee gekkos           1
      redouane najja         1
      liliana ciancio        1
      rachel perez           1
      Name: AUTHOR, Length: 319, dtype: int64
```

```
[25]: sns.countplot(y='AUTHOR', data=shakira,
                    order=shakira.AUTHOR.value_counts().iloc[:11].index)
```

```
[25]: <AxesSubplot:xlabel='count', ylabel='AUTHOR'>
```

```
[26]: shakira.loc[(shakira['AUTHOR']=='Shadrach Grentz')]
      #Comments from the top commenter
```

```
[26]:
```

	COMMENT_ID	AUTHOR	\
250	_2viQ_Qnc68dceJbTRNTP2sksMxa_lm35LaCu_jPluY	Shadrach	Grentz
328	_2viQ_Qnc69zyetF6GsHRzYGyXl4u5kg0Sm-nP-pupI	Shadrach	Grentz
329	_2viQ_Qnc699u36gNm3NRoq1quIaJWRNrftGEEZM3J4	Shadrach	Grentz
330	_2viQ_Qnc68LqKGb40V2ImKQYcp1ZqpHrCCMFqMCcA4	Shadrach	Grentz
334	_2viQ_Qnc69Nq0Ytk1jCpzWPCrpGEk6T7cdVAxfSlAk	Shadrach	Grentz
341	_2viQ_Qnc6_YN7xFNAg14zX99Y614Salf57y0crBRSw	Shadrach	Grentz
358	_2viQ_Qnc6-jk58CPwBnqfbM6oByJH5oPvCtKecLQyo	Shadrach	Grentz

	DATE	\
250	2013-09-29 13:59:42.162	
328	2013-08-02 03:15:46.914	
329	2013-08-01 21:43:52.122	
330	2013-08-01 20:39:15.325	
334	2013-07-29 17:39:24.876	
341	2013-07-21 12:21:37.898	
358	2013-07-14 03:11:20.243	

	CONTENT	CLASS	CONTENT_LENGTH	\
250	Hey Music Fans I really appreciate any of you ...	1	506	
328	Hey Music Fans I really appreciate any of you ...	1	505	
329	Hey Music Fans I really appreciate any of you ...	1	506	
330	Hey Music Fans I really appreciate any of you ...	1	506	
334	Hey Music Fans I really appreciate any of you ...	1	506	
341	Hey Music Fans I really appreciate all of you ...	1	504	
358	Hey Music Fans I really appreciate all of you ...	1	504	

	YEAR_MONTH
250	2013-09
328	2013-08
329	2013-08
330	2013-08
334	2013-07
341	2013-07
358	2013-07

The user, Shadrach Grentz, left the most comments. All of them are also marked as spam.

2.2 Bivariate Analysis

Separated spam from non-spam comments in the Class attribute for further analysis

```
[27]: nonspam_comments = shakira.loc[(shakira['CLASS'] == 0)]
      nonspam_comments.head(3)
```

```
[27]:
```

	COMMENT_ID	AUTHOR	\
0	z13lgffb5w3ddx1ul22qy1wxspy5cpkz504	dharm	pal
1	z123dbgb0mqjfbtz22ucjc5jvzc3ykj	Tiza	Arellano

2 z12quxxp2vutflkxv04cihggt2azl34pms0k Priñçeśś Āliś Łøvê Dømiñø Mâdiś

	DATE	CONTENT	CLASS	CONTENT_LENGTH	YEAR_MONTH
0	2015-05-29 02:30:18.971	Nice song	0	10	2015-05
1	2015-05-29 00:14:48.748	I love song	0	13	2015-05
2	2015-05-28 21:00:08.607	I love song	0	13	2015-05

```
[28]: spam_comments = shakira.loc[(shakira['CLASS']==1)]
spam_comments.head(3)
```

```
[28]:
```

	COMMENT_ID	AUTHOR \
7	z12uujnj2sifvzvav04chpypvofvexpoggg	Sudheer Yadav
22	z13zjlpo2nbehxwf322gelhzwmqwggn1mt	Raafat saeed
31	z13uhhxp5nvig15yc04citszvtagwtmpqcc	Terry Short

	DATE	CONTENT \
7	2015-05-28 10:28:25.133	SEE SOME MORE SONG OPEN GOOGLE AND TYPE Shakir...
22	2015-05-27 04:19:29.178	Check out this playlist on YouTube:
31	2015-05-26 14:33:52.496	Support the fight for your 4th amendment right...

	CLASS	CONTENT_LENGTH	YEAR_MONTH
7	1	60	2015-05
22	1	36	2015-05
31	1	1125	2015-05

2.2.1 Content vs Class

Spam Comments

```
[100]: def deEmojify(text):
    regex_pattern = re.compile(pattern = "["
        u"\U0001F600-\U0001F64F" # emoticons
        u"\U0001F300-\U0001F5FF" # symbols & pictographs
        u"\U0001F680-\U0001F6FF" # transport & map symbols
        u"\U0001F1E0-\U0001F1FF" # flags (iOS)
        "]+", flags = re.UNICODE)
    return regex_pattern.sub(r'',text)
```

```
[101]: #text cleaning on spam comments for word cloud
spam_content = spam_comments['CONTENT'] #pulling comments from the dataframe
spam_content = " ".join(comment for comment in spam_content) #convert to a
    ↳ string object
spam_content = spam_content.split() #word tokenization
table = str.maketrans('', '', string.punctuation)
spam_content = [sc.translate(table) for sc in spam_content] #removing
    ↳ punctuation
spam_content = [sc.lower() for sc in spam_content] #converting all text to
    ↳ lowercase
```

```
spam_content = ','.join(spam_content) #returns to string object
print(deEmojify(spam_content)) #removing emojis
```

see,some,more,song,open,google,and,type,shakira,guruofmovie,check,out,this,play
list,on,youtube,support,the,fight,for,your,4th,amendment,right,to,privacy,in,yo
ur,home,stop,the,nsa,spying,on,americans,with,the,un,patriot,act,renewal,rand,pa
ul,has,spent,105,hours,on,the,senate,floor,in,a,protest,and,filibuster,fighting,
for,our,constitution,that,this,nation,is,founded,on,join,the,fight,at,rand,paul,
dot,com,spread,the,word,we,have,someone,that,cares,about,our,nation,email,your,s
enators,congress,men,and,women,tell,them,to,support,rand,tell,the,news,to,suppor
t,rand,too,senator,rand,paul,was,up,until,a,hrefhttpwwwoutubecomwatchvprpeedmmm
q0ampt1m00s100a,am,this,passed,saturday,morning,fighting,for,our,constitution,bu
y,postponing,the,vote,until,this,week,our,constitution,matters,join,rand,in,the,
fight,to,protect,a,hrefhttpithtithta,to,privacy,in,your,home,and,business,senato
r,rand,paul,was,up,until,a,hrefhttpwwwoutubecomwatchvprpeedmmmq0ampt1m00s100a,a
m,this,passed,saturday,morning,fighting,for,our,constitution,buy,postponing,the,
vote,until,this,week,our,constitution,matters,to,all,of,us,help,rand,protect,it,
by,joining,the,fright,for,it,check,out,this,video,on,youtube,coby,this,usl,and
,past,br,a,hrefhttpadflyhttpadflya,1hmvtxbr,delete,space,after,y,see,thisbr,a,h
refhttpadflyhttpadflya,1hmvtx,thumbs,up,if,your,watching,in,2015,subscribe,me,
please,i39ll,promise,i39ll,sub,back,check,out,this,video,on,youtube,my,uncle,s
aid,he,will,stop,smoking,if,this,comment,gets,500,likes,please,like,this,comment
,thanks,definitley,the,song,for,2010,when,im,not,listening,to,gypsy,shakira,roc
ksbr,span,classproflinkwrapperspan,classproflinkprefixspana,classproflink,hrefht
tpsplusgooglecom101721377578919894134,oid101721377578919894134shakiravevoaspan,
thank,you,please,give,your,email,,fuck,it,was,the,best,ever,0687119038,nummber,
of,patrik,kluivert,his,son,share,,yea,stil,the,best,wk,song,everbr,thumbs,up,of
,you,think,the,samebr,,subscribe,my,channel,i,recording,fifa,15,goals,watch,now
,d,subscribe,to,me,and,i,wil,subscribe,to,you,back,gusttavo,lima,você,não,me,c
onhece,br,check,out,help,shakira39s,waka,waka,be,the,first,song,by,a,female,art
ist,to,reach,1,billion,viewsbr,dark,horse,is,ahead,by,roughly,100,million,more,v
iews,and,roar,has,only,50,million,more,viewsbr,a,hrefhttpswwwwoutubecomwatchvprp
eedmmmq0httpswwwwoutubecomwatchvprpeedmmmq0a,i,subscribed,itbr,,check,out,this
,playlist,on,youtubembr,,top,three,shakira,songs,my,choice,br,br,1,waka,waka,it3
9s,time,for,africabr,br,2,can39t,remember,to,forget,you,br,br,3,empirebr,br,like
,this,comment,if,u,like,shakira,,check,out,this,video,on,youtube,check,out,thi
s,playlist,on,youtubecentral,,if,you,could,take,time,amp,spare,a,min,to,read,th
is,then,thank,you,br,br,im,a,rapper,if,we39re,gonna,be,honest,theres,thousands,m
aybe,even,millionsbr,br,of,those,in,the,world,but,not,too,many,with,ambition,ded
ication,amp,passionbr,br,i,don39t,have,money,for,huge,youtube,advertisements,or,
incredible,music,videosbr,br,so,all,im,left,with,is,comments,to,expose,my,musicb
r,br,if,you,could,take,a,moment,and,give,me,a,chance,ill,make,you,a,believerbr,b
r,i,would,love,nothing,more,than,a,loyal,following,on,youtube,for,anyone,who,br,
br,reads,this,could,you,press,the,quotthumbs,upquot,others,will,see,itbr,br,doin
g,so,will,help,me,push,closer,to,my,dream,,thank,you,please,visit,my,channel,p
leas,subscribe,my,channel,gamezzmta,pleas,subscribe,my,channel,pleas,subscribe
,gamezz,mta,my,channelbr,,cool,song,check,out,my,animal,trafficking,petitionbr,

a,hrefhttpwwthepetitionsitecom387433550stopanimaltraffickingcidheaderclickhttpwwthepetitionsitecom387433550stopanimaltraffickingcidheaderclicka,check,out,thi
s,video,on,youtube,,subscribe,and,win,a,capbr,, ,check,out,this,playlist,o
n,youtube,hey,guys,love,this,but,check,out,this,girl,name,cause,she,knows,how,t
o,dance,so,search,up,ej,ba,dancing,if,you,want,to,win,money,at,hopme,click,here
,a,hrefhttpswwwpaidvertscomrefsihaam01httpswwwpaidvertscomrefsihaam01a,it39s,wor
k,100100,i,am,from,brazil,please,subscribe,my,channel,love,you,all,could,spani
sh,people,understand,thisbr,br,any,way39s,i,how,you,doing,subscribe,to,me,i,brak
e,thingsbr,br,,pleasssssssssssssssss,subscribeeeeeeeeeee,my,channnnnnelll,plzz,c
heck,out,this,video,on,youtube,new,way,to,make,money,easily,and,spending,20,min
utes,daily,gt,a,hrefhttpswwwpaidvertscomrefmarius1533httpswwwpaidvertscomrefmari
us1533a,there,are,beautiful,songs,please,subscribe,can,this,channel,get,500,su
bscribers,you,can,make,that,happen,d,i,really,love,watching,football,and,also,i
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might, not, be, the, best, but, my, voice, is, different, in, a, good, way, and, i39ll, work, har
der, than, anyone, out, there, to, get, better, 39cuz, quotyeahquot, i, have, a, dream, a, huge
, one, who, doesn39t, so, please, take, 3, minutes, of, your, time, to, check, out, my, covers, g
ive, me, a, chance, you, won39t, regret, it, if, you, feel, like, subscribing, that39d, be, awe
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they, are, unique, that39s, the, reason, why, they, also, refused, to, have, euro, €, as, money
, subscribe, now, love, the, song, love, football, 1,753,682,421, gangnam, style, , believe,
that, jesus, christ, is, your, savior, for, all, your, sins, if, you, truly, believe, in, jesus
, christ, to, be, your, savior, for, all, your, sins, then, you, will, go, to, heaven, if, you, be
lieve, in, jesus, christ, then, you, are, saved, and, you, are, in, salvation, and, you, have, g
ained, god's, righteousness, it, matters, not, how, much, you, have, sinned, in, the, past, in
, the, present, and, especially, in, the, future, believe, that, jesus, christ, is, your, savi
or, and, you, will, go, to, heaven, forever, and, that, is, the, whole, truth, spread, the, trut
h, perhaps, you, have, seen, the, newest, miley, cyrus, secret, video, , she39s, sucking, an, o
ld, man39s, cock, , if, you, wish, to, see, her, , check, out, the, celebrity, website, beneath,
, mileysecretvideocouk, haha, , miley, cyrus, has, done, it, once, again, today, someone, lee
ched, a, porno, video, with, her, on, a, celeb, site, i, believe, the, website, link, is, , miley
celebnewscouk, in, case, you, want, to, view, it, i, really, can39t, comprehend, miley, cyrus
, , she, actually, is, a, high, profile, and, she, tapes, herself, banging, today, a, video, was
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, website, under, , mileycelebnewscouk, check, out, daneja, good, girl, check, out, my, cover
s, please, hey, music, fans, i, really, appreciate, any, of, you, who, will, take, the, time, to
, read, this, and, check, my, music, out, i39m, just, a, 15, year, old, boy, dreaming, of, being,
a, successful, musician, in, the, music, world, i, do, lots, of, covers, and, piano, covers, bu
t, i, don39t, have, money, to, advertise, a, simple, thumbs, up, to, my, comment, a, comment, on

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ecommend,apple,ipad,4th,gen,32gb,unlocked,wifi4g,97in,white,price390,apple,iphone,5,latest,model,,32gb,,black,price385,samsung,galaxy,s4,s,iv,4,with,16gb,new,white,price360,sony,60inch,3d,led,hdtv,price510,allinone,pcs,apple,macbook,pro,apple,macbook,air,price320,camera,nikon,d90,slr,camera,1855mm,55200mm,32gb,price390,ultrabooks,sony,vaio,pro,13,intel,core,i5,4gb,128gb,price515,,purchase,online,website,is,taaeecom,quothelp,the,humanity,with,your,sign,in,to,this,link,with,your,wholehearted,support,if,you,say,quotnoquot,to,discrimination,"united,we,stand",we,will,bring,the,change,together,impossible,itself,says,i,m,possiblequot,you,are,the,winners,of,my,successeers,to,all,my,loving,brothers,and,sisters,,please,share,this,link,on,facebook,to,support,against,discrimination,tinyurldotcomslashmxh2y77,fear,none,but,god,,part,5,comforter,of,the,afflicted,pray,for,us,help,of,christians,pray,for,us,queen,of,angels,pray,for,us,queen,of,patriarchs,pray,for,us,queen,of,prophets,pray,for,us,queen,of,apostles,pray,for,us,queen,of,martyrs,pray,for,us,queen,of,confessors,pray,for,us,queen,of,virgins,pray,for,us,queen,of,all,saints,pray,for,us,queen,conceived,without,original,sin,pray,for,us,queen,of,the,most,holy,rosary,pray,for,us,queen,of,the,family,pray,for,us,queen,of,peace,pray,for,us,part,2,holy,mary,pray,for,us,holy,mother,of,god,pray,for,us,holy,virgin,of,virgins,pray,for,us,mother,of,christ,pray,for,us,mother,of,divine,grace,pray,for,us,mother,most,pure,pray,for,us,mother,most,chaste,pray,for,us,mother,inviolate,pray,for,us,mother,undefiled,pray,for,us,mother,most,amiable,pray,for,us,mother,most,admirable,pray,for,us,mother,of,good,counsel,pray,for,us,mother,of,our,creator,pray,for,us,mother,of,our,redeemer,pray,for,us,hi,everyone,if,anyone,after,real,online,work,i,can,help,u,earn,lots,of,money,it39s,fun,it39s,real,and,affiliated,company,u,not,think,u,r,working,it39s,easy,and,enjoyable,for,more,info,contact,me,,neeru105,gmailcom,hey,youtubers,and,all,music,lover39s,guests,most,of,you,all,skip,these,comments,but,for,you,who,is,still,reading,this,thanks,,i,dont,have,any,money,for,advertisements,no,chance,of,getting,heard,nothing,all,that39s,left,is,spam,sorry,im,17,rappersinger,from,estonia,please,listen,my,new,cover,on,my,account,you,won't,regret,it,give,me,just,a,chance,please,take,half,a,second,of,your,life,and,thumb,this,comment,up,it,will,maybe,change,my,life,for,real,thank,you,wafence,do,you,want,to,make,some,easy,money,check,out,my,page,

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,my,channel,subscribe,if,you,like,and,thumb,this,comment,up,so,everyone,can,see,thank,you,hello,everyone,,i,know,most,of,you,probably,pass,up,these,kind,of,comments,but,for,those,who,are,still,reading,this,thanks,i,don't,have,any,money,for,advertisements,no,chance,of,getting,heard,nothing,if,this,comes,off,as,spam,sorry,i,am,a,video,animator,just,trying,to,make,it,up,into,the,video,animation,industry,please,give,me,the,chance,to,prove,myself,to,you,please,visit,my,channel,subscribe,if,you,like,and,thumb,this,comment,up,so,everyone,can,see,thank,you,hey,youtubers,i,really,appreciate,all,of,you,who,took,the,time,to,read,this,i,am,just,a,19,year,old,boy,who,wants,to,be,a,successful,musician,in,the,music,world,i,don't,have,any,money,to,advertise,my,channel,if,you,could,just,visit,my,channel,comment,on,my,video,or,subscribe,that,would,be,great,it,will,only,be,few,seconds,of,your,life,thank,u,to,all,the,people,who,just,gave,me,a,chance,i,really,appreciate,it,subscribe,to,my,page,please,please,subscribe,to,my,page,thanks,hey,hit,this,shit,up,while,yall,can,they,killed,the,versace,remix,just,type,in,cge,quotversace,freestyle,get,moneyquot,shot,by,jawan,gardner,and,help,them,reach,1,million,views,hey,guys,and,girls,check,out,comedy,recipe,for,hilarious,you,tube,videos,pranks,and,crank,calls,subscribe,me,i,will,subscribe,you,back,subscribe,me,i,will,subscribe,you,back,please,check,my,channel,out,i,subscribe,back,i,really,ask,nicely,to,view,my,vids,i,subscribe,back,,facebook,is,lame,and,so,2004,check,out,,swagfriends,com,make,thousands,of,cool,new,friends,everyday,join,this,new,movement,hi,check,out,and,share,our,songs,check,out,partyman318,fr,good,tunez,d,hey,youtubers,i,really,appreciate,all,of,you,who,took,the,time,to,read,this,i,am,just,a,19,year,old,boy,who,wants,to,be,a,successful,musician,in,the,music,world,i,don't,have,any,money,to,advertise,my,channel,if,you,could,just,visit,my,channel,comment,on,my,video,or,subscribe,that,would,be,great,it,will,only,be,few,seconds,of,your,life,thank,u,to,all,the,people,who,just,gave,me,a,chance,i,really,appreciate,it,hey,music,fans,i,really,appreciate,any,of,you,who,will,take,the,time,to,read,this,and,check,my,music,out,i39m,just,a,15,year,old,boy,dreaming,of,being,a,successful,musician,in,the,music,world,i,do,lots,of,covers,and,piano,covers,but,i,don39t,have,money,to,advertise,a,simple,thumbs,up,to,my,comment,a,comment,on,my,videos,or,a,subscription,would,be,a,step,forward,it,will,only,be,a,few,seconds,of,your,life,that,you,won39t,regret,thank,u,to,all,the,people,who,just,give,me,a,chance,,hey,music,fans,i,really,appreciate,any,of,you,who,will,take,the,time,to,read,this,and,check,my,music,out,i39m,just,a,15,year,old,boy,dreaming,of,being,a,successful,musician,in,the,music,world,i,do,lots,of,covers,and,piano,covers,but,i,don39t,have,money,to,advertise,a,simple,thumbs,up,to,my,comment,a,comment,on,my,videos,or,a,subscription,would,be,a,step,forward,it,will,only,be,a,few,seconds,of,your,life,that,you,won39t,regret,thank,u,to,all,the,people,who,just,give,me,a,chance,,hey,music,fans,i,really,appreciate,any,of,you,who,will,take,the,time,to,read,this,and,check,my,music,out,i39m,just,a,15,year,old,boy,dreaming,of,being,a,successful,musician,in,the,music,world,i,do,lots,of,covers,and,piano,covers,but,i,don39t,have,money,to,advertise,a,simple,thumbs,up,to,my,comment,a,comment,on,my,videos,or,a,subscription,would,be,a,step,forward,it,will,only,be,a,few,seconds,of,your,life,that,you,won39t,regret,thank,u,to,all,the,people,who,just,give,me,a,chance,,hi,check,out,and,share,our,songs,hi,check,out,and,share,our,songs,hicheck,out,and,share,our,songs,hey,music,fans,i,really,appreciate,any,of,you,who,will,take,the,time,to,read,this,and,check,my,music,out,i39m,just,a,15,year,old,boy,dreaming,of,being,a,successful,musician,in,the,music,world,i,do,lots,of,cov

ers, and, piano, covers, but, i, don39t, have, money, to, advertise, a, simple, thumbs, up, to, my, comment, a, comment, on, my, videos, or, a, subscription, would, be, a, step, forward, it, will, only, be, a, few, seconds, of, your, life, that, you, won39t, regret, thank, u, to, all, the, people, who, just, give, me, a, chance, , hey, i, am, doing, the, forty, hour, famine, so, i39ll, be, giving, up, on, food, and, social, working, for, 40, hours, i39m, doing, this, to, raise, money, for, african, people, who, can39t, experience, the, luxuries, that, we, can, so, can, you, donate, to, give, them, a, chance, any, amount, would, do, , click, on, the, link, and, donate, , h, t, t, p, , , 4, 0, h, f, , c, o, m, , a, u, , a, n, t, h, o, n, y, l, a, m, thanks, , love, itt, and, ppl, check, out, my, channel, subscribe, my, channel, adfly, , kld3y, adfly, , kld3y, check, out, my, new, video, hey, music, fans, i, really, appreciate, all, of, you, who, take, time, to, read, this, and, check, my, music, out, i39m, just, a, 15, year, old, boy, dreaming, of, being, a, successful, musician, in, the, music, world, i, do, lots, of, covers, and, piano, covers, but, i, dont, have, money, to, advertise, a, simple, thumbs, up, to, my, comment, a, comment, on, my, videos, or, a, subscription, would, be, a, step, forward, it, will, only, be, a, few, seconds, of, your, life, that, u, won39t, regret, thank, u, to, all, the, people, who, just, give, me, a, chance, it, means, a, lot, , hello, everyone, it, is, not, my, intention, to, spam, and, am, truly, sorry, if, anyone, is, annoyed, by, this, but, just, please, hear, me, out, i, am, a, rapper, singer, music, producer, and, a, song, writer, and, have, been, making, music, for, a, while, now, eight, years, to, be, exact, i, enjoy, making, all, types, of, music, that, anyone, can, listen, to, doesn39t, have, me, talking, about, killing, anyone, and, most, importantly, focuses, on, the, quality, of, the, music, please, check, out, my, page, it39s, only, a, click, away, thank, you, and, have, a, nice, day, , facebook, is, lame, and, so, 2004, check, out, , swagfriends, com, make, thousands, of, cool, new, friends, everyday, join, this, new, movement, please, check, out, , and, send, to, others, freedom, and, justice, are, on, the, line, please, google, steven, l, reed, case, lands, in, supreme, court, thanks, nice, to, meet, you, , this, is, johnny, 1, if, you, already, know, my, music, , thumb, this, up, because, you, found, it, this, way, too, 2, if, you, want, to, hear, original, songs, completely, made, by, 1, person, continue, reading, i, sing, write, original, music, lyrics, amp, play, guitar, bass, drums, amp, keyboards, i39m, a, 1manband, and, my, music, is, completely, independent, amp, 100, listeners supported, if, you, want, to, hear, it, amp, if, you39re, willing, to, help, record, new, album, , click, on, my, name, picture, , enjoy, the, music, , wish, you, awesome, day, hey, you, , check, out, the, channel, of, alvar, lake, , hi, this, is, johnny, 1, if, you, already, know, my, music, , thumb, this, up, because, you, found, it, this, way, too, 2, if, you, want, to, hear, original, songs, completely, made, by, 1, person, continue, reading, i, sing, write, original, music, lyrics, amp, play, guitar, bass, drums, amp, keyboards, i39m, a, 1manband, my, music, is, completely, independent, amp, 100, listeners supported, if, you, want, to, hear, it, amp, if, you39re, willing, to, help, record, new, album, , click, on, my, name, picture, thank, you, amp, enjoy, the, music, , wish, you, awesome, day, check, out, this, video, on, youtube, br, quot this, time, for, africa quot, one, for, trayvon, and, our, motherland, br, thank you, shakira, o, peoples, of, the, earth, i, have, seen, how, you, perform, every, form, of, evil, at, your, leisure, you, cease, not, from, reveling, in, that, which, i, hate, behold, you, murder, the, innocent, day, and, night, and, plot, evil, against, your, neighbor, you, stand, up, for, the, rights, of, those, who, commit, abomination, and, clap, your, hands, as, wickedness, is, celebrated, openly, in, the, streets, o, most, perverse, and, abominable, generation, shall, i, not, repay, hear, the, word, of, the, lord, , trumpet, call of god online, com, i, will, never, forget, this, song, in, my, life, like, this, comment, of, your, hearing, this, song, for, like, a, year, omg, facebook, is, old, check, out, gt, swagfriends, com, make, thousands, of, cool, new, friends, everyday, join, the, movement, hey, music, fans, i, really, appreciate, all, of, you, who, take, time, to, read, this, and, check, m

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ck,out,my,new,mixtape,check,out,my,new,mixtape,check,out,my,new,mixtape

```
[102]: #Building word cloud
stopwords = set(STOPWORDS) #remove stop-words
wordcloud_spam = WordCloud(max_words=20,
                             background_color='white',
                             stopwords = stopwords).generate(spam_content)
plt.imshow(wordcloud_spam)
plt.axis("off")
plt.show()
```

The top 20 most common words in the spam comments are shown in the word cloud and include:

mixtape, check out, subscribe and my music

Non-Spam Comments

```
[105]: #text cleaning on non-spam comments for word cloud
nonspam_content = nonspam_comments['CONTENT'] #pulling non-spam comments from
↳ dataframe
nonspam_content = " ".join(comment for comment in nonspam_content) #convert to
↳ a string object
nonspam_content = nonspam_content.split() #word tokenization
nonspam_content = [nsc.translate(table) for nsc in nonspam_content] #removing
↳ punctuation
nonspam_content = [nsc.lower() for nsc in nonspam_content] #converting all text
↳ to lowercase
nonspam_content = ','.join(nonspam_content) #returns to string object
print(deEmojify(nonspam_content)) #removing emojis
nonspam_content[:100]
```

nice,song,i,love,song,,i,love,song,,860000000,lets,make,it,first,female,to,reach,one,billion,share,it,and,replay,it,,shakira,is,best,for,worldcup,the,best,world,cup,song,ever,i,love,awesome,,i,like,shakira,shakira,,waka,waka,br,love,this,song,why,so,many,disliked,i,don39t,think,this,song,will,ever,get,old,,love,song,wery,good,every,time,i,hear,this,song,i,think,about,iniesta39s,goal,against,the,netherlands,whose,watching,this,in,2015,if,so,hi5,i,love,this,song,so,much,lt3br,keep,em39,coming,i,love,this,song,thumbsb,up,to,you,waka,best,on e,5,years,later,i,still,love,this,song,br,axy665,like,her,voice,sounds,weird, and,plus,she39s,cute,for,a,blonde,why,there,are,so,many,dislikes,this,song,is,s o,awesome,it,sounds,like,we,must,stop,be,racists,if,i,could,i,would,like,it,1000 000000,times,nice,love,ittttttttt,wurkkkkkkkkkkkkkkkkkkkkkkkkkkkkkkkkkkkkk kkk still,watching,in,20 15,shakira,is,my,favourite,singer,wooooo,i,remember,this,song,like,whose,who, are,watching,this,in,2015,like,best,song,in,world,beautiful,good,song,she39s, such,an,awesome,entertainer,and,pretty,too,lt3,shakira,love,this,song,love,thi s,song,my,soccer,team,made,a,cd,for,our,couch,with,this,song,on,it,fave,song,w atching,in,2015,i,felt,old,when,i,realized,that,this,song,was,5,years,old,love ,shakira,one,of,the,best,song,of,all,the,time,i,really,am,madly,in,love,with,t his,woman,i,totally,love,this,song,absolutely,fantastic,i,love,ya,shakira,im,s till,watching,in,2015,the,song,is,sad,goood,the,best,fifa,world,cup,song,for, sure,nice,vídeo,shakira,good,waka,waka,she,is,beautiful,but,it,is,not,america n,ilovethissong,lamest,world,cup,song,ever,this,time,for,africa,you,mean,in,af rica,it,wasn39t,a,live,aid,event,or,something,she,made,it,seem,like,a,charity,ca se,for,them,instead,of,a,proud,moment,where,was,ricky,martin,when,you,needed,him ,smh,my,friend,sam,loves,this,song,i,love,you,to,help,shakira,become,the,firs t,female,to,hit,1billiom,views,i39ve,decided,to,watch,this,video,at,least,one,a, day,everyday,shakifans,we,r,so,close,just,hit,the,replay,button,,ilove,shakira, ,it,was,cool,the,best,song,ever,,omg,listen,to,this,its,soo,good,d,nice,song ,waka,waka,super,music,how,could,108k,people,dislike,this,song,or,video,love, it,i,swear,shakira,keeps,getting,more,and,more,gorgeous,she,definitely,looks,mo

re, gorgeous, with, her, hair, this, way, than, super, curly, youtube, comments, be, likebr,
 this, is, so, 5, years, ago, , it, pisses, me, off, a, bit, that, blank, space, has, more, views,
 868, mio, than, this, meh, , your, the, best , i, love, you, p, i, love, shakira, , , this, s
 ong, is, special, because, is, a, song, for, africa, and, i, am, an, african, , lt3, this, song,
 so, much shakira, your, a, really, good, artist, i, love, shakira, , i, remember, that
 , tournament, like, it, was, today, beautiful, like, shakira, you, are, so, beautiful, you
 , are, lovely, lively, we, love, you, great, best, world, cup, song, this, song, is, so, beau
 ty, i, heard, this, when, i, was, only, 6, years, old, and, i, still, love, it, nice, song, waka
 , waka, oh, my, god, go, to, 1, billion, of, replay, i, love, shakira, i, love, her, i, love, th
 is, song, ampi, love, shakira, 333 , i, liked, , i, like, this, song, ,
 i, like, it, , waka, waka, , amazing, song, cool, song, , i, love, u, shakira, waka, waka, ,
 this, song, sucks, lol, i, love, this, song, shakira, wow, 5, years, , you, best, singer,
 5, years, soon, like, wonderful, is, love, or, music, waka, waka, best, song, ever, x3333
 333333, very, pleasant, to, hear, haha, good, love, wow, waka, waka, eh, eh, cutie, girl, a
 nd, beautiful, song, love, you, shakira, i, believe, that, soccer, promotes, terrorism, bad,
 choice, shakira, i, loved, this, song, when, i, was, in, my, teenage, years, lip, synch, is, t
 errible, shakira, is, different, , she, is, so, happy, all, the, time, and, she, is, spending,
 for, africa, br, she, can, dance, , sing, and, she, speaks, 4, languages, best, world, cup, off
 icial, song, 5, years, ago, damn, , very, nice, like, me, shakira, song, waka, waka, so, unde
 rrated, better, than, katy, perry, , but, in, not, saying, katy, is, bad, but, she, has, no, me
 aning, to, her, songs, shakira, has, meaningful, songs, these, are, the, songs, which, brin
 g, memories, and, vibe, i, will, miss, it, br, , i, love, this, song, and, expect, the, worl
 d, cup, , good, times, , it, makes, me, happy, instantly, and, makes, me, forgot, everything,
 bad, happening, love, this, song, so, much, one, of, my, faves, xxx, hi, nice, song, shakira,
 sorry, for, bad, brazilian, best, song, go, shaki, d, this, is, shit, and, sooooo, autotuned
 , i, stil, lisening, this, , sexy, shakira, i, love, you, shakira, me, and, my, aunt, love,
 this, song, so, beautiful, she, so, pretty, i, like, she, is, perfect, your, a, fucking, bit
 ch, this, song, is, racist, where, are, shakira fans, like, i, want, new, song, shakira, is, perfe
 ct, shakira, , i, remember, this, d, waka, waka, this, makes, me, miss, the, world, cup, best, so
 ng, eva, i, love, it, her, voice, is, so, wow, shakira, , , wow, i, love, you, i, like, and, love, so
 , much, people, all, friends, i, love, shakira, , , shakira, i, love, you, beautiful, shakira, i
 s, very, beautiful, she, is, good, god, she, is, so, hot, she, is, perfect, lt3, wow, shakira, vo
 ice, sound, spanish, but, that, is, what, make, the, music, sound, amazing, i, love, it, she, i
 s, perfect, beautiful, song, beautiful, girl, it, works, shakira, , omg, love, this, ouf, ouf,
 ouffffff, awesome, cool, this, song, will, never, get, old, i, always, have, go
 ose, bumps, at, that, part, love, it, i, love, this, song, i, want, to, see, shakira, not, footba
 ll, , good, nice, song, , god, she, is, so, sexy, drives, me, crazy, wow, shakira, is, the, best, n
 ice, shakira, shakira, , the, best, wow, love, this, song, love, this, song, , i, watched, this,
 because, of, the, large, amount, of, views, and, now, i, am, convinced, it, is, because, that, g
 irl, is, so, hot, this, song, always, gives, me, chills, , i, love, dis, song, 3, waka, waka, she,
 rules, she, is, sooooo, beautiful, well, done, shakira, i, love, this, song, because, we, sing
 , it, at, camp, all, the, time, i, love, this, song, for, two, reasons, 1, it, is, about, africa, 2,
 i, was, born, in, beautiful, south, africa, wow, shakira, u, are, so, wired, shakira, is, the, b
 est, dancer

[105]: 'nice, song\uffeff, i, love, song, \uffeff, i, love, song, \uffeff, 860000000, lets, make, it, fi
 rst, female, to, reach, one, billion, shar'

```
[106]: stopwords = set(STOPWORDS)
wordcloud_nospam = WordCloud(max_words=20,
                             background_color='white',
                             stopwords = stopwords).generate(nospam_content)
plt.imshow(wordcloud_nospam)
plt.axis("off")
plt.show()
```

For non-spam comments, the words/phrases used are related to the video like the name of the artist, the name of the song or the users personal thoughts on the song/video. The most frequently used words include: Shakira, love, song and beautiful.

2.2.2 Author vs Class

Spam Comments

```
[29]: spam_comments['AUTHOR'].value_counts()
```

```
[29]: Shadrach Grentz      7
      Hidden Love        5
      James Cook         4
      ThirdDegr3e        3
      Louis Bryant       3
      ..
      Lisa Matthews      1
      gamila Khalil      1
      Sudheer Yadav      1
      Mazacar Cfc        1
      Pauline Martinez   1
      Name: AUTHOR, Length: 135, dtype: int64
```



```
[30]: sns.countplot(y='AUTHOR', data=spam_comments,
                    order=spam_comments.AUTHOR.value_counts().iloc[:11].index)
```

```
[30]: <AxesSubplot:xlabel='count', ylabel='AUTHOR'>
```

```
[43]: spam_comments.loc[(spam_comments['AUTHOR']=='Shadrach Grentz')]
```

```
[43]:
```

	COMMENT_ID	AUTHOR \
250	_2viQ_Qnc68dceJbTRNTP2sksMxa_lm35LaCu_jPluY	Shadrach Grentz
328	_2viQ_Qnc69zyetF6GsHRzYGyXl4u5kgOSm-nP-pupI	Shadrach Grentz
329	_2viQ_Qnc699u36gNm3NRoq1quIaJWRNrftGEEZM3J4	Shadrach Grentz
330	_2viQ_Qnc68LqKgb4OV2ImKQYcp1ZqpHrCCMFqMCcA4	Shadrach Grentz
334	_2viQ_Qnc69Nq0Ytk1jCpzWPCrpGEk6T7cdVAxfSlAk	Shadrach Grentz
341	_2viQ_Qnc6_YN7xFNAg14zX99Y614SalF57yOcrBRsw	Shadrach Grentz
358	_2viQ_Qnc6-jk58CPwBnqfbM6oByJH5oPvCtKecLQyo	Shadrach Grentz

```
DATE \
```

250	2013-09-29 13:59:42.162
328	2013-08-02 03:15:46.914
329	2013-08-01 21:43:52.122
330	2013-08-01 20:39:15.325
334	2013-07-29 17:39:24.876
341	2013-07-21 12:21:37.898
358	2013-07-14 03:11:20.243

```
CONTENT CLASS CONTENT_LENGTH \
```

250	Hey Music Fans I really appreciate any of you ...	1	506
328	Hey Music Fans I really appreciate any of you ...	1	505
329	Hey Music Fans I really appreciate any of you ...	1	506
330	Hey Music Fans I really appreciate any of you ...	1	506
334	Hey Music Fans I really appreciate any of you ...	1	506
341	Hey Music Fans I really appreciate all of you ...	1	504
358	Hey Music Fans I really appreciate all of you ...	1	504

	YEAR_MONTH
250	2013-09
328	2013-08
329	2013-08
330	2013-08
334	2013-07
341	2013-07
358	2013-07

```
[42]: spam_comments.loc[(spam_comments['AUTHOR']=='Hidden Love')]
```

```
[42]:
```

	COMMENT_ID	AUTHOR \
253	_2viQ_Qnc6_onwOgxju-DV6WkqHZE0ztCXD04EgEFBU	Hidden Love
325	_2viQ_Qnc69r15LuL8TDbIsnTJ_hf5RfcyJAyoMC5eo	Hidden Love
331	_2viQ_Qnc68Qq98mOmmx4rlprYiD6aYgMb2x3bdupEM	Hidden Love
332	_2viQ_Qnc698fLCQzZmRt1CqPhf0L6mchwWG5gsUlzk	Hidden Love
333	_2viQ_Qnc68sxLpsBQ1cPk_LLH91SMsRav51KmhIoQw	Hidden Love

	DATE	CONTENT	CLASS \
253	2013-09-24 14:29:54.072	Hi. Check out and share our songs.	1
325	2013-08-06 11:40:05.581	Hi. Check out and share our songs.	1
331	2013-08-01 09:19:56.654	Hi. Check out and share our songs.	1
332	2013-07-31 10:22:02.628	Hi. Check out and share our songs.	1
333	2013-07-30 11:22:57.091	Hi. Check out and share our songs.	1

	CONTENT_LENGTH	YEAR_MONTH
253	34	2013-09
325	34	2013-08
331	34	2013-08
332	34	2013-07
333	33	2013-07

```
[41]: spam_comments.loc[(spam_comments['AUTHOR']=='James Cook')]
```

```
[41]:
```

	COMMENT_ID	AUTHOR \
186	_2viQ_Qnc69ShtSmsaBOGFHrTAVCkLAtp0r40oiL5Yg	James Cook
192	_2viQ_Qnc68eqIzELH0Orh9umG1UKSRuQvWZAXhr_qM	James Cook
194	_2viQ_Qnc6-grcnVFTtwnhvC9tpgVG33p5a0AZHK1LI	James Cook
200	_2viQ_Qnc69BVRuBYCJ6ik7gdMwTiBRS9DDnTjNs-Gg	James Cook

	DATE \
186	2013-10-20 13:31:10.083
192	2013-10-15 17:00:04.573
194	2013-10-14 10:35:03.861
200	2013-10-10 18:08:07.815

	CONTENT	CLASS	CONTENT_LENGTH \
186	Stop Wasting Up Your Time and Get Paid To Mes...	1	478
192	Stop Wasting Up Your Time and Get Paid To Mes...	1	478
194	Hello Guys...I Found a Way to Make Money Onlin...	1	498
200	Hello Guys...I Found a Way to Make Money Onlin...	1	498

	YEAR_MONTH
186	2013-10
192	2013-10
194	2013-10
200	2013-10

The top 3 of the spam comment authors post comments directing users to check out their own music or about making money online. They each also post the exact same comment over and over again at different times and on different days.

Non-Spam Comments

```
[34]: nonspam_comments['AUTHOR'].value_counts()
```

```
[34]: 5000palo          7
      tyler sleetway    2
      Alain Bruno      2
      Athena Gomez     2
      LiveLikeLien x    2
      ..
      Laura Gray        1
      hsn moghrbi       1
      Aliens Studios    1
      Trygve Nilsen     1
      marko kacar        1
      Name: AUTHOR, Length: 184, dtype: int64
```

```
[35]: sns.countplot(y='AUTHOR', data=nonspam_comments,
                    order=nonspam_comments.AUTHOR.value_counts().iloc[:11].index)
```

```
[35]: <AxesSubplot:xlabel='count', ylabel='AUTHOR'>
```

```
[36]: nonspam_comments.loc[(nonspam_comments['AUTHOR']=='5000palo']]['CONTENT'][:50]
```

```
[36]: 215      She is perfect
      221      I want new song
      223      Shakira :-*
      234      Shakira :-*
      261      She is perfect
      264      Shakira :-*
      286      Shakira :-*
      Name: CONTENT, dtype: object
```

```
[37]: nonspam_comments.loc[(nonspam_comments['AUTHOR']=='LaiLa Steudle']]['CONTENT'][:
      ↪50]
```

```
[37]: 145      I love you Shakiria!!!!
      146      Me and my aunt love this song!!!!
      Name: CONTENT, dtype: object
```

One the other hand the non-spam users post comments related to the song or video and about their love for the artist. Also, leaving more than 2 comments is considered an outlier.

2.2.3 Comment Length vs Class

Spam Comments

```
[44]: spam_comments['CONTENT_LENGTH'].hist(bins=20)
      plt.title('Distribution of Spam Comment Length')
```

```
[44]: Text(0.5, 1.0, 'Distribution of Spam Comment Length')
```

```
[45]: print("Average Comment Length:",spam_comments['CONTENT_LENGTH'].mean())  
      print("Minimum Comment Length:",spam_comments['CONTENT_LENGTH'].min())  
      print("Maximum Comment Length:",spam_comments['CONTENT_LENGTH'].max())
```

Average Comment Length: 196.33908045977012

Minimum Comment Length: 13

Maximum Comment Length: 1125

Non-Spam Comments

```
[46]: nonspam_comments['CONTENT_LENGTH'].hist(bins=20)  
      plt.title('Distribution of Non-Spam Comment Length')
```

```
[46]: Text(0.5, 1.0, 'Distribution of Non-Spam Comment Length')
```

```
[47]: print("Average Comment Length:",nonspam_comments['CONTENT_LENGTH'].mean())
      print("Minimum Comment Length:",nonspam_comments['CONTENT_LENGTH'].min())
      print("Maximum Comment Length:",nonspam_comments['CONTENT_LENGTH'].max())
```

```
Average Comment Length: 31.321428571428573
Minimum Comment Length: 2
Maximum Comment Length: 236
```

Most users leave short comments, however based on the average, minimum and maximum comment length along with the second peak that appears around 450-500 words, spam comments do seem to be longer than non-spam.

3 Text Preprocessing

```
[55]: #Convert into lowercase
      shakira.loc[:, "CLEANED_CONTENT"] = shakira.CONTENT.apply(lambda x : str.
      ↪lower(x))
      shakira.head(3)
```

```
[55]:
```

	COMMENT_ID	AUTHOR \
0	z13lgffb5w3ddx1ul22qy1wxspy5cpkz504	dharmalpal
1	z123dbgb0mqjfxbtz22ucjc5jvzcv3ykj	Tiza Arellano
2	z12quxxp2vutflkxv04cihggzt2azl34pms0k	Priñçesís Âlis Løvê Dømiñø Mãdiís

	DATE	CONTENT	CLASS	CLEANED_CONTENT
0	2015-05-29 02:30:18.971	Nice song	0	nice song
1	2015-05-29 00:14:48.748	I love song	0	i love song
2	2015-05-28 21:00:08.607	I love song	0	i love song

```
[56]: #Remove punctuation and emojis
shakira.loc[:, "CLEANED_CONTENT"] = shakira.CLEANED_CONTENT.apply(lambda x : " ".
    ↪join(re.findall('[\w]+', x)))
shakira.head(6)[['CONTENT', 'CLEANED_CONTENT']]
```

```
[56]:
```

	CONTENT \
0	Nice song
1	I love song
2	I love song
3	860,000,000 lets make it first female to reach...
4	shakira is best for worldcup
5	The best world cup song ever!!!!

	CLEANED_CONTENT
0	nice song
1	i love song
2	i love song
3	860 000 000 lets make it first female to reach...
4	shakira is best for worldcup
5	the best world cup song ever

```
[57]: #remove stop words
from nltk.corpus import stopwords
stop_words = stopwords.words('english')
print('List of Stop Words:', stop_words)

shakira['CLEANED_CONTENT'] = shakira.CLEANED_CONTENT.apply(lambda x: ' '.
    ↪join([word for word in x.split() if word not in (stop_words)]))
shakira.head(5)
```

```
List of Stop Words: ['i', 'me', 'my', 'myself', 'we', 'our', 'ours',
'ourselves', 'you', "you're", "you've", "you'll", "you'd", 'your', 'yours',
'yourself', 'yourselves', 'he', 'him', 'his', 'himself', 'she', "she's", 'her',
'hers', 'herself', 'it', "it's", 'its', 'itself', 'they', 'them', 'their',
'theirs', 'themselves', 'what', 'which', 'who', 'whom', 'this', 'that',
"that'll", 'these', 'those', 'am', 'is', 'are', 'was', 'were', 'be', 'been',
'being', 'have', 'has', 'had', 'having', 'do', 'does', 'did', 'doing', 'a',
'an', 'the', 'and', 'but', 'if', 'or', 'because', 'as', 'until', 'while', 'of',
'at', 'by', 'for', 'with', 'about', 'against', 'between', 'into', 'through',
'during', 'before', 'after', 'above', 'below', 'to', 'from', 'up', 'down', 'in',
'out', 'on', 'off', 'over', 'under', 'again', 'further', 'then', 'once', 'here',
'there', 'when', 'where', 'why', 'how', 'all', 'any', 'both', 'each', 'few',
```

'more', 'most', 'other', 'some', 'such', 'no', 'nor', 'not', 'only', 'own', 'same', 'so', 'than', 'too', 'very', 's', 't', 'can', 'will', 'just', 'don', 'don't', 'should', "should've", 'now', 'd', 'll', 'm', 'o', 're', 've', 'y', 'ain', 'aren', "aren't", 'couldn', "couldn't", 'didn', "didn't", 'doesn', "doesn't", 'hadn', "hadn't", 'hasn', "hasn't", 'haven', "haven't", 'isn', "isn't", 'ma', 'mightn', "mightn't", 'mustn', "mustn't", 'needn', "needn't", 'shan', "shan't", 'shouldn', "shouldn't", 'wasn', "wasn't", 'weren', "weren't", 'won', "won't", 'wouldn', "wouldn't"]

```
[57]:                                     COMMENT_ID      AUTHOR \
0      z13lgffb5w3ddx1ul22qy1wxspy5cpkz504      dharma pal
1      z123dbgb0mqjfxbtz22ucjc5jvzcv3ykj      Tiza Arellano
2      z12quxxp2vutflkxv04cihggt2azl34pms0k      Priñçeśś Āliś Łøvê Dømiñø Mâdiś
3      z12icv3ysqvlwth2c23eddlykyqut5z1h      Eric Gonzalez
4      z133stly3kete3tly22petvwdpmghrlli      Analena López
```

```
                                     DATE      CONTENT \
0 2015-05-29 02:30:18.971      Nice song
1 2015-05-29 00:14:48.748      I love song
2 2015-05-28 21:00:08.607      I love song
3 2015-05-28 20:47:12.193 860,000,000 lets make it first female to reach...
4 2015-05-28 17:08:29.827      shakira is best for worldcup
```

```
      CLASS      CLEANED_CONTENT
0      0      nice song
1      0      love song
2      0      love song
3      0 860 000 000 lets make first female reach one b...
4      0      shakira best worldcup
```

```
[58]: #Stemming
import nltk
porter = nltk.PorterStemmer()
shakira['CLEANED_CONTENT'] = shakira.CLEANED_CONTENT.apply(lambda x: ' '.
    ↳join(porter.stem(word) for word in x.split()))
shakira.head(3)
#converts youtube to youtub
```

```
[58]:                                     COMMENT_ID      AUTHOR \
0      z13lgffb5w3ddx1ul22qy1wxspy5cpkz504      dharma pal
1      z123dbgb0mqjfxbtz22ucjc5jvzcv3ykj      Tiza Arellano
2      z12quxxp2vutflkxv04cihggt2azl34pms0k      Priñçeśś Āliś Łøvê Dømiñø Mâdiś
```

```
      DATE      CONTENT      CLASS      CLEANED_CONTENT
0 2015-05-29 02:30:18.971      Nice song      0      nice song
1 2015-05-29 00:14:48.748      I love song      0      love song
2 2015-05-28 21:00:08.607      I love song      0      love song
```



```
[59]: # normalization simplify websites
shakira['CLEANED_CONTENT'] = shakira['CLEANED_CONTENT'].str.replace(r'(http[s]?
↳\S+)|(\w+\.[A-Za-z]{2,4}\S*)', 'httpaddr')
shakira.head(3)
```

```
[59]:
```

	COMMENT_ID	AUTHOR \
0	z13lgffb5w3ddx1ul22qy1wxspy5cpkz504	dharma pal
1	z123dbgb0mqjfbtz22ucjc5jvzcv3ykj	Tiza Arellano
2	z12quxxp2vutflkxv04cihggt2azl34pms0k	Priñceśś Āliś Łøvê Dømiñø Mâdiś

	DATE	CONTENT	CLASS	CLEANED_CONTENT
0	2015-05-29 02:30:18.971	Nice song	0	nice song
1	2015-05-29 00:14:48.748	I love song	0	love song
2	2015-05-28 21:00:08.607	I love song	0	love song

```
[60]: # normalization simplify numbers
shakira['CLEANED_CONTENT'] = shakira['CLEANED_CONTENT'].str.replace(r'\d+(\.
↳\d+)?', 'numbr')
shakira.head(3)
```

```
[60]:
```

	COMMENT_ID	AUTHOR \
0	z13lgffb5w3ddx1ul22qy1wxspy5cpkz504	dharma pal
1	z123dbgb0mqjfbtz22ucjc5jvzcv3ykj	Tiza Arellano
2	z12quxxp2vutflkxv04cihggt2azl34pms0k	Priñceśś Āliś Łøvê Dømiñø Mâdiś

	DATE	CONTENT	CLASS	CLEANED_CONTENT
0	2015-05-29 02:30:18.971	Nice song	0	nice song
1	2015-05-29 00:14:48.748	I love song	0	love song
2	2015-05-28 21:00:08.607	I love song	0	love song

```
[61]: #Fix spelling/slang for some words
shakira['CLEANED_CONTENT'] = shakira['CLEANED_CONTENT'].str.replace(r'goo+', '
↳'goo')
#shakira['CLEANED_CONTENT'] = shakira['CLEANED_CONTENT'].str.replace(r'luv', '
↳'love') no luv in text
#can fix itttttttt
shakira.head(3)
```

```
[61]:
```

	COMMENT_ID	AUTHOR \
0	z13lgffb5w3ddx1ul22qy1wxspy5cpkz504	dharma pal
1	z123dbgb0mqjfbtz22ucjc5jvzcv3ykj	Tiza Arellano
2	z12quxxp2vutflkxv04cihggt2azl34pms0k	Priñceśś Āliś Łøvê Dømiñø Mâdiś

	DATE	CONTENT	CLASS	CLEANED_CONTENT
0	2015-05-29 02:30:18.971	Nice song	0	nice song
1	2015-05-29 00:14:48.748	I love song	0	love song
2	2015-05-28 21:00:08.607	I love song	0	love song

```
[62]: #Remove whitespace at the beginning or end of a line
shakira['CLEANED_CONTENT'] = shakira.CLEANED_CONTENT.str.replace(r'\s+', ' ')
processed = shakira.CLEANED_CONTENT.str.replace(r'^\s+|\s+?$', '')
shakira.head(3)
```

```
[62]:
```

	COMMENT_ID	AUTHOR \
0	z13lgffb5w3ddx1ul22qy1wxspy5cpkz504	dharma pal
1	z123dbgb0mqjfbtz22ucjc5jvzcv3ykj	Tiza Arellano
2	z12quxxp2vutflkxv04cihggzt2azl34pms0k	Priñçeśś Āliś Łøvê Dømiñø Mâdiś

	DATE	CONTENT	CLASS	CLEANED_CONTENT
0	2015-05-29 02:30:18.971	Nice song	0	nice song
1	2015-05-29 00:14:48.748	I love song	0	love song
2	2015-05-28 21:00:08.607	I love song	0	love song

```
[71]: shakira.head(15)[['CONTENT', 'CLEANED_CONTENT']]
```

```
[71]:
```

	CONTENT \
0	Nice song
1	I love song
2	I love song
3	860,000,000 lets make it first female to reach...
4	shakira is best for worldcup
5	The best world cup song ever!!!!
6	I love
7	SEE SOME MORE SONG OPEN GOOGLE AND TYPE Shakir...
8	Awesome
9	I like shakira..
10	Shakira - Waka Waka LOVE THIS SONG!!!!!!...
11	Why so many disliked????????!!!!!!
12	I don't think this song will ever get old
13	Love song
14	wery good

	CLEANED_CONTENT
0	nice song
1	love song
2	love song
3	numbr numbr numbr let make first femal reach o...
4	shakira best worldcup
5	best world cup song ever
6	love
7	see song open googl type shakira guruofmovi
8	awesom
9	like shakira
10	shakira waka waka br love song
11	mani dislik

```

12             numbr think song ever get old
13                                     love song
14                                     weri good

```

4 Model - Prediction Results

4.1 Splitting Data

```

[9]: from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(shakira.CONTENT, shakira.
    ↳ CLASS, test_size=0.30, random_state = 100)

```

```

[64]: Xc_train, Xc_test, yc_train, yc_test = train_test_split(shakira.
    ↳ CLEANED_CONTENT, shakira.CLASS, test_size=0.30, random_state = 101)

```

4.2 TF-IDF vs Bag-of-Words

Before beginning the models, I wanted to test whether TF-IDF or Bag-of-Words (BoW) would be more appropriate for representing the text data. BoW focused solely on term frequency while TF-IDF puts more weight on words that occur infrequently.

```

[21]: from sklearn.feature_extraction.text import CountVectorizer
v = CountVectorizer()
X_train_count = v.fit_transform(Xc_train.values)

```

```

[22]: from sklearn.feature_extraction.text import TfidfTransformer
tfidf_transformer = TfidfTransformer(smooth_idf=True, use_idf=True)
tfidf_transformer.fit(X_train_count)

```

```

[22]: TfidfTransformer()

```

```

[23]: # print idf values
df_idf = pd.DataFrame(tfidf_transformer.idf_, index=v.
    ↳ get_feature_names(), columns=["idf_weights"])

# sort ascending
df_idf.sort_values(by=['idf_weights'], ascending = True).head(10)

```

```

[23]:      idf_weights
numbr      2.266369
song       2.531476
check       2.605584
love        2.893266
shakira     3.001480
subscrib    3.091092
money       3.155631

```

```
make          3.260991
pleas         3.298732
like          3.298732
```

Based on testing with TF-IDF and exploratory analysis results from the word clouds, the words that were given lower IDF scores were words that occurred frequently in either the spam or ham class and although IDF did not see it as important, it was important to distinguishing between classes. For instance, the words “song”, “love” and “Shakira” were among the 10 most frequent words used in the Ham class, however they were also the top 10 lowest IDF scores. On the other hand, the words “check”, “subscribe”, “money” and “please” were among the 10 most frequent words used in the Spam comment but also received the top 10 lowest IDF scores. Therefore, these words are valuable to distinguish the classes but are suppressed by IDF, therefore I chose to use BoW for modelling.

4.3 Modelling - Uncleaned Data

4.3.1 Multinomial Naïve Bayes

```
[24]: from sklearn.feature_extraction.text import CountVectorizer
      from sklearn.naive_bayes import MultinomialNB, BernoulliNB
      from sklearn.pipeline import Pipeline
      clf_umn = Pipeline([
          ('vectorizer', CountVectorizer()), #convert text to countvectorizer
          ('nb', MultinomialNB()) #then apply multinomial naive bayes
      ])
```

```
[25]: clf_umn.fit(X_train, y_train)
```

```
[25]: Pipeline(steps=[('vectorizer', CountVectorizer()), ('nb', MultinomialNB())])
```

```
[30]: clf_umn.score(X_test, y_test)
```

```
[30]: 0.9099099099099099
```

```
[26]: from sklearn.metrics import confusion_matrix
      y_pred_umn=clf_umn.predict(X_test)
      confusion_matrix(y_test, y_pred_umn, labels=[0,1])
```

```
[26]: array([[56,  2],
           [ 8, 45]], dtype=int64)
```

```
[35]: from sklearn.metrics import f1_score
      f1_score(y_test, y_pred_umn, average='weighted')
```

```
[35]: 0.9094225372913897
```

```
[33]: from sklearn.metrics import matthews_corrcoef
      matthews_corrcoef(y_test, y_pred_umn)
```

```
[33]: 0.8234618374240342
```

4.3.2 Bernoulli Naïve Bayes

```
[30]: from sklearn.pipeline import Pipeline
      clf_ub = Pipeline([
          ('vectorizer', CountVectorizer()), #convert text to countvectorizer
          ('nb', BernoulliNB()) #then apply bernoulli naive bayes
      ])
```

```
[31]: clf_ub.fit(X_train, y_train)
```

```
[31]: Pipeline(steps=[('vectorizer', CountVectorizer()), ('nb', BernoulliNB())])
```

```
[38]: clf_ub.score(X_test, y_test)
```

```
[38]: 0.7117117117117117
```

```
[32]: y_pred_ub=clf_ub.predict(X_test)
      confusion_matrix(y_test, y_pred_ub)
```

```
[32]: array([[58,  0],
          [32, 21]], dtype=int64)
```

```
[40]: f1_score(y_test, y_pred_ub, average='weighted')
```

```
[40]: 0.68054541027514
```

```
[41]: from sklearn.metrics import matthews_corrcoef
      matthews_corrcoef(y_test, y_pred_ub)
```

```
[41]: 0.5053176347107683
```

4.3.3 Linear SVM

```
[34]: clf_usvm = Pipeline([
          ('vect', CountVectorizer()),
          ('clf', svm.SVC(kernel='linear'))
      ])
```

```
[35]: clf_usvm.fit(X_train, y_train)
```

```
[35]: Pipeline(steps=[('vect', CountVectorizer()), ('clf', SVC(kernel='linear'))])
```

```
[36]: y_pred_usvm = clf_usvm.predict(X_test)
      confusion_matrix(y_test, y_pred_usvm)
```

```
[36]: array([[57,  1],
           [ 6, 47]], dtype=int64)
```

```
[79]: print("Accuracy:", clf_usvm.score(X_test, y_test))
      print("F1-Score:", f1_score(y_test, y_pred_usvm, average='weighted'))
      print("MCC:", matthews_corrcoef(y_test, y_pred_usvm))
```

```
Accuracy: 0.9369369369369369
F1-Score: 0.9366789258778457
MCC: 0.8767103502300952
```

4.4 Modelling - Cleaned Data

4.4.1 Multinomial Naïve Bayes

```
[38]: clf_cmn = Pipeline([
      ('vectorizer', CountVectorizer()), #convert text to countvectorizer
      ('nb', MultinomialNB()) #then apply multinomial naive bayes
    ])
```

```
[39]: clf_cmn.fit(Xc_train, yc_train)
```

```
[39]: Pipeline(steps=[('vectorizer', CountVectorizer()), ('nb', MultinomialNB())])
```

```
[65]: clf_cmn.score(Xc_test, yc_test)
```

```
[65]: 0.8918918918918919
```

```
[40]: y_pred_cmn=clf_cmn.predict(Xc_test)
      confusion_matrix(yc_test, y_pred_cmn)
```

```
[40]: array([[50,  6],
           [ 6, 49]], dtype=int64)
```

```
[67]: f1_score(yc_test, y_pred_cmn, average='weighted')
```

```
[67]: 0.8918918918918919
```

```
[68]: matthews_corrcoef(yc_test, y_pred_cmn)
```

```
[68]: 0.7837662337662338
```

4.4.2 Bernoulli Naïve Bayes

```
[43]: clf_cb = Pipeline([
        ('vectorizer', CountVectorizer()), #convert text to countvectorizer
        ('nb', BernoulliNB()) #then apply bernoulli naive bayes
    ])
```

```
[44]: clf_cb.fit(Xc_train, yc_train)
```

```
[44]: Pipeline(steps=[('vectorizer', CountVectorizer()), ('nb', BernoulliNB())])
```

```
[71]: clf_cb.score(Xc_test, yc_test)
```

```
[71]: 0.6846846846846847
```

```
[45]: y_pred_cb=clf_cb.predict(Xc_test)
      confusion_matrix(yc_test, y_pred_cb)
```

```
[45]: array([[56,  0],
          [35, 20]], dtype=int64)
```

```
[73]: f1_score(yc_test, y_pred_cb, average='weighted')
```

```
[73]: 0.6486486486486487
```

```
[74]: matthews_corrcoef(yc_test, y_pred_cb)
```

```
[74]: 0.4730499167912661
```

4.4.3 Linear SVM

```
[65]: clf_csvm = Pipeline([
        ('vect', CountVectorizer()),
        ('clf', svm.SVC(kernel='linear'))
    ])
```

```
[66]: clf_csvm.fit(Xc_train, yc_train)
```

```
[66]: Pipeline(steps=[('vect', CountVectorizer()), ('clf', SVC(kernel='linear'))])
```

```
[67]: y_pred_csvm=clf_csvm.predict(Xc_test)
      confusion_matrix(yc_test, y_pred_csvm)
```

```
[67]: array([[55,  1],
          [ 5, 50]], dtype=int64)
```

```
[84]: print("Accuracy:", clf_csvm.score(Xc_test, yc_test))
      print("F1-Score:", f1_score(yc_test, y_pred_csvm, average='weighted'))
      print("MCC:", matthews_corrcoef(yc_test, y_pred_csvm))
```

Accuracy: 0.9459459459459459
F1-Score: 0.9458580245828131
MCC: 0.8941415513370068