SpamDetector

August 10, 2023

1 Spam Detection

1.1 Objective :

Given a labelled dataset containing spam and legitimate messages train a ML model that can identify that a given message is spam or not

[2]:
```
#installing required packages
#Uncomment following line and run this cell to install required dependencies
#pip install wordcloud
```

[3]:
```
#importing necessary libraries for reading cleaning and visulaising the data
import pandas as pd
import numpy as np
import nltk
import string
import warnings
warnings.filterwarnings('ignore')
from wordcloud import WordCloud
import matplotlib.pyplot as plt
import seaborn as sns
```

1.2 Reading data

Dataset is in *spam.csv* file with latin-1 encoding

[4]:
```
#read the data
df = pd.read_csv('spam.csv',encoding='latin-1')
df
```

[4]:
```
        v1                                                 v2 Unnamed: 2  \
0      ham  Go until jurong point, crazy.. Available only …         NaN
1      ham                      Ok lar… Joking wif u oni…        NaN
2     spam  Free entry in 2 a wkly comp to win FA Cup fina…         NaN
3      ham  U dun say so early hor… U c already then say…        NaN
4      ham  Nah I don't think he goes to usf, he lives aro…         NaN
…    …                                                  …        …
5567  spam  This is the 2nd time we have tried 2 contact u…         NaN
5568   ham              Will Ì_ b going to esplanade fr home?          NaN
```

```
5569   ham  Pity, * was in mood for that. So…any other s…        NaN
5570   ham  The guy did some bitching but I acted like i'd…       NaN
5571   ham                         Rofl. Its true to its name      NaN

     Unnamed: 3 Unnamed: 4
0           NaN        NaN
1           NaN        NaN
2           NaN        NaN
3           NaN        NaN
4           NaN        NaN
…           …          …
5567        NaN        NaN
5568        NaN        NaN
5569        NaN        NaN
5570        NaN        NaN
5571        NaN        NaN

[5572 rows x 5 columns]
```

1.3 Data Cleaning

[5]:
```
#deleting unnecessary columns
df = df.drop(["Unnamed: 2", "Unnamed: 3", "Unnamed: 4"], axis=1)
df
```

[5]:
```
        v1                                                  v2
0      ham  Go until jurong point, crazy.. Available only …
1      ham                      Ok lar… Joking wif u oni…
2     spam  Free entry in 2 a wkly comp to win FA Cup fina…
3      ham  U dun say so early hor… U c already then say…
4      ham  Nah I don't think he goes to usf, he lives aro…
…    …                                                   …
5567  spam  This is the 2nd time we have tried 2 contact u…
5568   ham              Will Ì_ b going to esplanade fr home?
5569   ham  Pity, * was in mood for that. So…any other s…
5570   ham  The guy did some bitching but I acted like i'd…
5571   ham                         Rofl. Its true to its name

[5572 rows x 2 columns]
```

[6]:
```
#renaming columns with meaningful headings
df = df.rename(columns={"v2" : "text", "v1":"label"})
df
```

[6]:
```
     label                                               text
0      ham  Go until jurong point, crazy.. Available only …
1      ham                      Ok lar… Joking wif u oni…
```

```
2     spam  Free entry in 2 a wkly comp to win FA Cup fina…
3      ham  U dun say so early hor… U c already then say…
4      ham  Nah I don't think he goes to usf, he lives aro…
…      …                                                  …
5567  spam  This is the 2nd time we have tried 2 contact u…
5568   ham              Will Ì_ b going to esplanade fr home?
5569   ham  Pity, * was in mood for that. So…any other s…
5570   ham  The guy did some bitching but I acted like i'd…
5571   ham                         Rofl. Its true to its name

[5572 rows x 2 columns]
```

[7]:
```
# Encoding text labels with numerical label
# not spam - 0
# spam - 1
df = df.replace(['ham','spam'],[0,1])
```

[8]:
```
#Uncomment the following line if stopwords is not downloaded
#nltk.download('stopwords')

#Uncomment the following line for toeknizer to work
#nltk.download('punkt')

from nltk.corpus import stopwords

#remove the punctuations
df['text'] = df['text'].str.replace('[^\w\s]','')

#function to remove stopwords
def filter_stopwords(text):
    text = [word for word in text.split() if word.lower() not in stopwords.
 ↪words('english')]
    return " ".join(text)

df['text'] = df['text'].apply(filter_stopwords) #removing stopwords from each␣
 ↪sms
df
```

[8]:
```
      label                                               text
0         0  Go jurong point crazy Available bugis n great …
1         0                            Ok lar Joking wif u oni
2         1  Free entry 2 wkly comp win FA Cup final tkts 2…
3         0                U dun say early hor U c already say
4         0       Nah dont think goes usf lives around though
…     …                                                   …
5567      1  2nd time tried 2 contact u U å750 Pound prize …
5568      0                       Ì_ b going esplanade fr home
```

```
5569      0                          Pity mood Soany suggestions
5570      0  guy bitching acted like id interested buying s…
5571      0                                    Rofl true name

[5572 rows x 2 columns]
```

1.4 Visualisation

[20]:
```
# Accumulating all words contained in spam messages
df_spam = df[df['label'] == 1] # all rows with spam
spam_words = ''
for sms in df_spam['text']:
    tokens = nltk.word_tokenize(sms.lower())
    spam_words += ' '.join(tokens) + ' '
print(*spam_words.split()[:300])
```

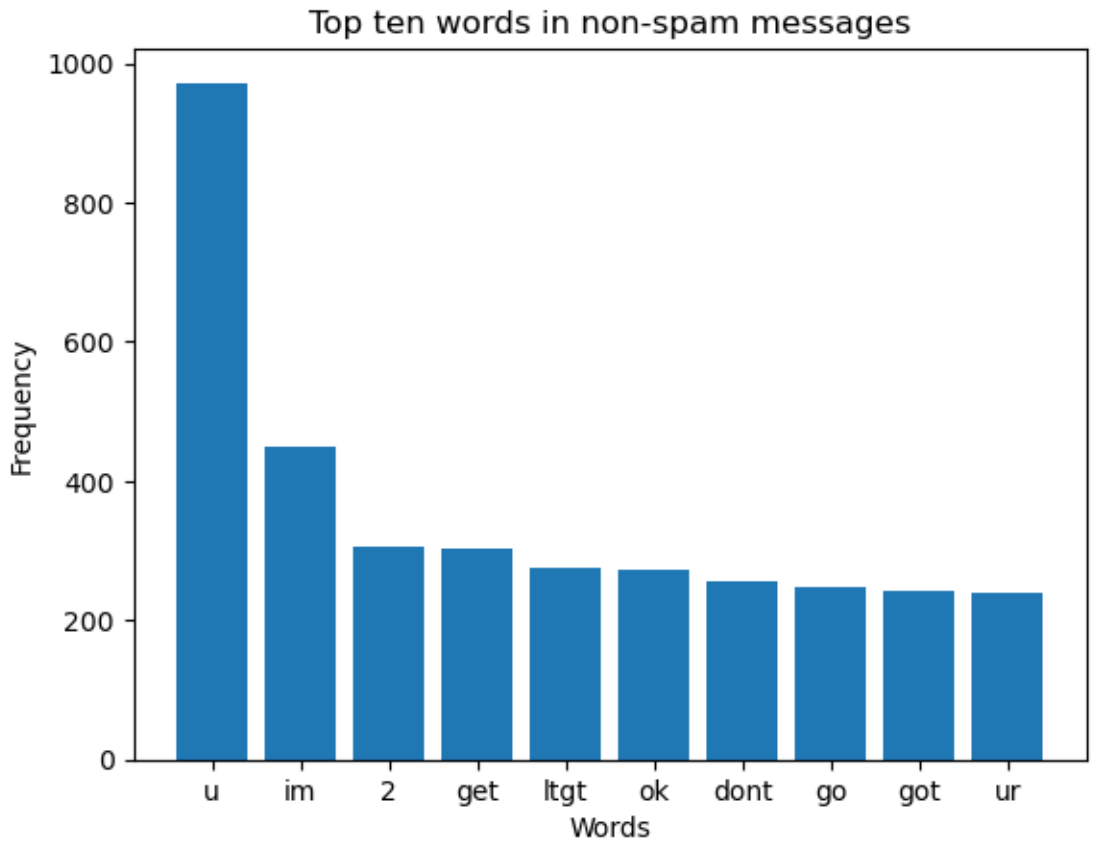
```
free entry 2 wkly comp win fa cup final tkts 21st may 2005 text fa 87121 receive
entry questionstd txt ratetcs apply 08452810075over18s freemsg hey darling 3
weeks word back id like fun still tb ok xxx std chgs send å150 rcv winner valued
network customer selected receivea å900 prize reward claim call 09061701461
claim code kl341 valid 12 hours mobile 11 months u r entitled update latest
colour mobiles camera free call mobile update co free 08002986030 six chances
win cash 100 20000 pounds txt csh11 send 87575 cost 150pday 6days 16 tsandcs
apply reply hl 4 info urgent 1 week free membership å100000 prize jackpot txt
word claim 81010 tc wwwdbuknet lccltd pobox 4403ldnw1a7rw18 xxxmobilemovieclub
use credit click wap link next txt message click httpwap
xxxmobilemovieclubcomnqjkgighjjgcbl england v macedonia dont miss goalsteam news
txt ur national team 87077 eg england 87077 trywales scotland 4txtì¼120
poboxox36504w45wq 16 thanks subscription ringtone uk mobile charged å5month
please confirm replying yes reply charged 07732584351 rodger burns msg tried
call reply sms free nokia mobile free camcorder please call 08000930705 delivery
tomorrow sms ac sptv new jersey devils detroit red wings play ice hockey correct
incorrect end reply end sptv congrats 1 year special cinema pass 2 call
09061209465 c suprman v matrix3 starwars3 etc 4 free bx420ip45we 150pm dont miss
valued customer pleased advise following recent review mob awarded å1500 bonus
prize call 09066364589 urgent ur awarded complimentary trip eurodisinc trav
acoentry41 å1000 claim txt dis 87121 186å150morefrmmob shracomorsglsuplt10 ls1
3aj hear new divorce barbie comes kens stuff please call customer service
representative 0800 169 6031 10am9pm guaranteed å1000 cash å5000 prize free
ringtone waiting collected simply text password mix 85069 verify get usher
britney fml gent trying contact last weekends draw shows å1000 prize guaranteed
call 09064012160 claim code k52 valid
```

[21]:
```
# Accumulating all words contained in legitimate messages
df_legit = df[df['label'] == 0] # all rows with no spam
legit_words = ''
for sms in df_legit['text']:
    tokens = nltk.word_tokenize(sms.lower())
```

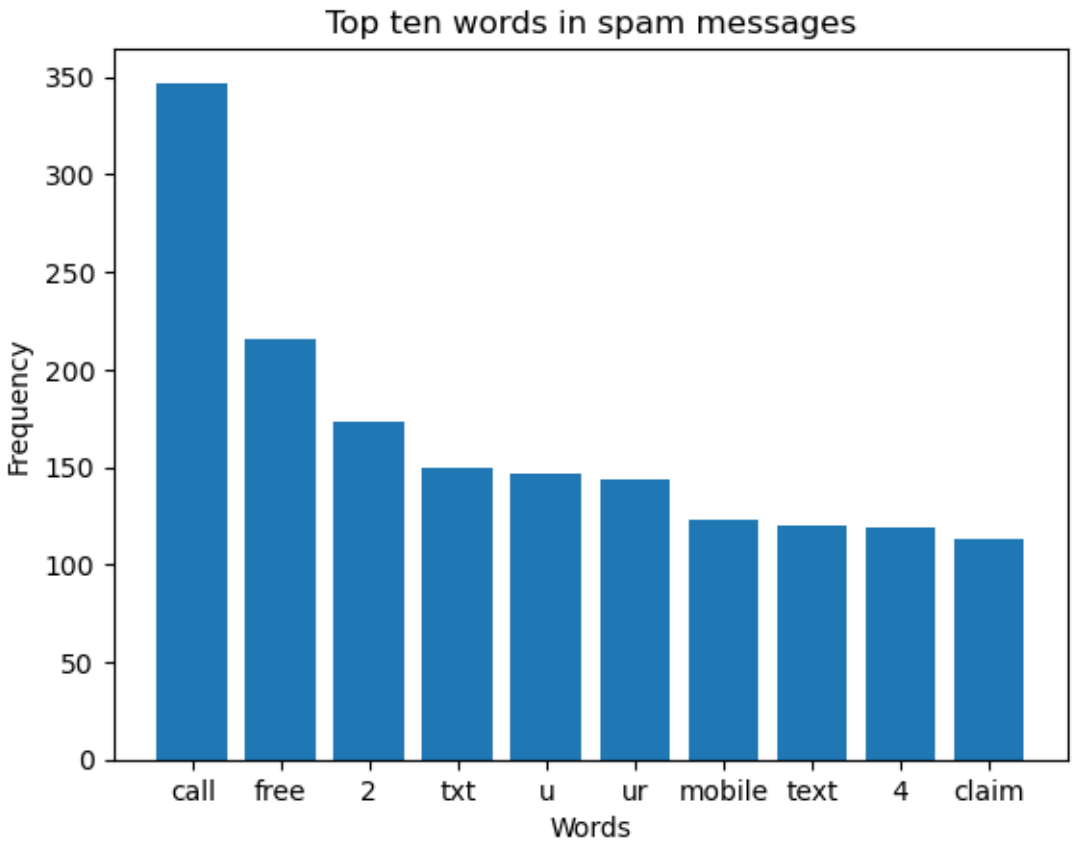
```
    legit_words += ' '.join(tokens) + ' '
print(*legit_words.split()[:300])
```

```
go jurong point crazy available bugis n great world la e buffet cine got amore
wat ok lar joking wif u oni u dun say early hor u c already say nah dont think
goes usf lives around though even brother like speak treat like aids patent per
request melle melle oru minnaminunginte nurungu vettam set callertune callers
press 9 copy friends callertune im gon na home soon dont want talk stuff anymore
tonight k ive cried enough today ive searching right words thank breather
promise wont take help granted fulfil promise wonderful blessing times date
sunday oh kim watching eh u remember 2 spell name yes v naughty make v wet fine
thatåõs way u feel thatåõs way gota b seriously spell name iûm going try 2
months ha ha joking ì_ pay first lar da stock comin aft finish lunch go str lor
ard 3 smth lor u finish ur lunch already ffffffffff alright way meet sooner
forced eat slice im really hungry tho sucks mark getting worried knows im sick
turn pizza lol lol always convincing catch bus frying egg make tea eating moms
left dinner feel love im back amp packing car ill let know theres room ahhh work
vaguely remember feel like lol wait thats still clear sure sarcastic thats x
doesnt want live us yeah got 2 v apologetic n fallen actin like spoilt child got
caught till 2 wont go badly cheers k tell anything fear fainting housework quick
cuppa yup ok go home look timings msg ì_ xuhui going learn 2nd may lesson 8am
oops ill let know roommates done see letter b car anything lor u decide hello
hows saturday go texting see youd decided anything tomo im trying invite
anything pls go ahead watts wanted sure great weekend abiola forget
```

[11]:
```
frq_dist = nltk.FreqDist(nltk.tokenize.word_tokenize(legit_words))
top_ten = frq_dist.most_common(10)
x = [wf_pair[0] for wf_pair in top_ten]
y = [wf_pair[1] for wf_pair in top_ten]
plt.title('Top ten words in non-spam messages')
plt.bar(x,y)
plt.xlabel('Words')
plt.ylabel('Frequency')
plt.show()
```



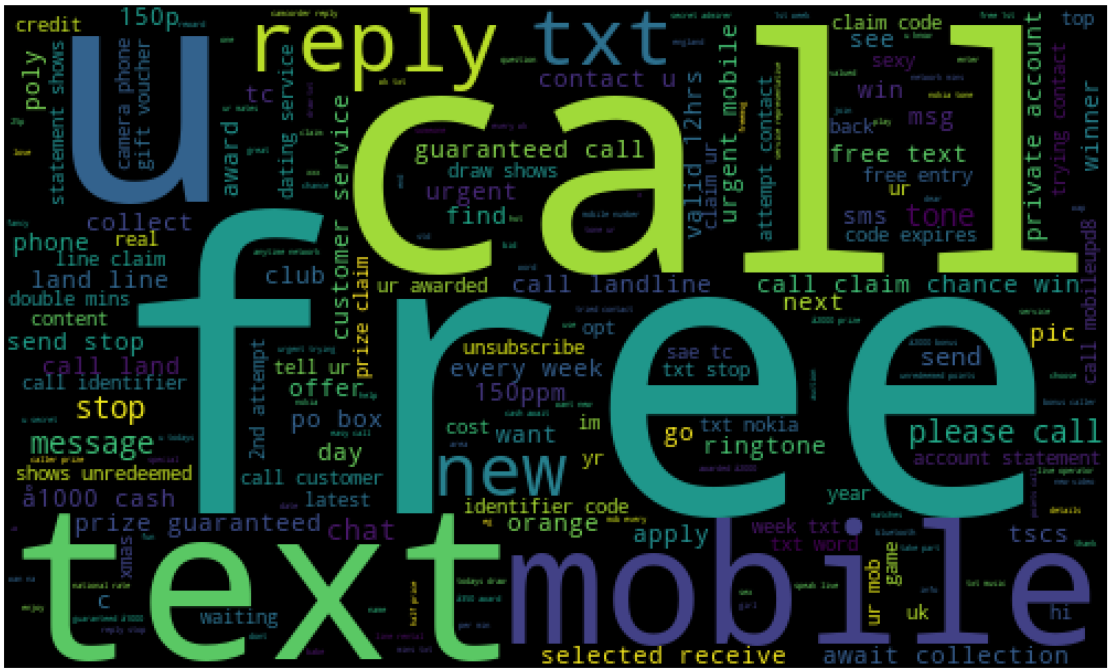
[12]:
```
frq_dist = nltk.FreqDist(nltk.tokenize.word_tokenize(spam_words))
top_ten = frq_dist.most_common(10)
x = [wf_pair[0] for wf_pair in top_ten]
y = [wf_pair[1] for wf_pair in top_ten]
plt.bar(x,y)
plt.title('Top ten words in spam messages')
plt.xlabel('Words')
plt.ylabel('Frequency')
plt.show()
```



[13]:
```
#creating word clouds for visualisation
spam_wordcloud = WordCloud(width=500, height=300).generate(spam_words)
legit_wordcloud = WordCloud(width=500, height=300).generate(legit_words)
```

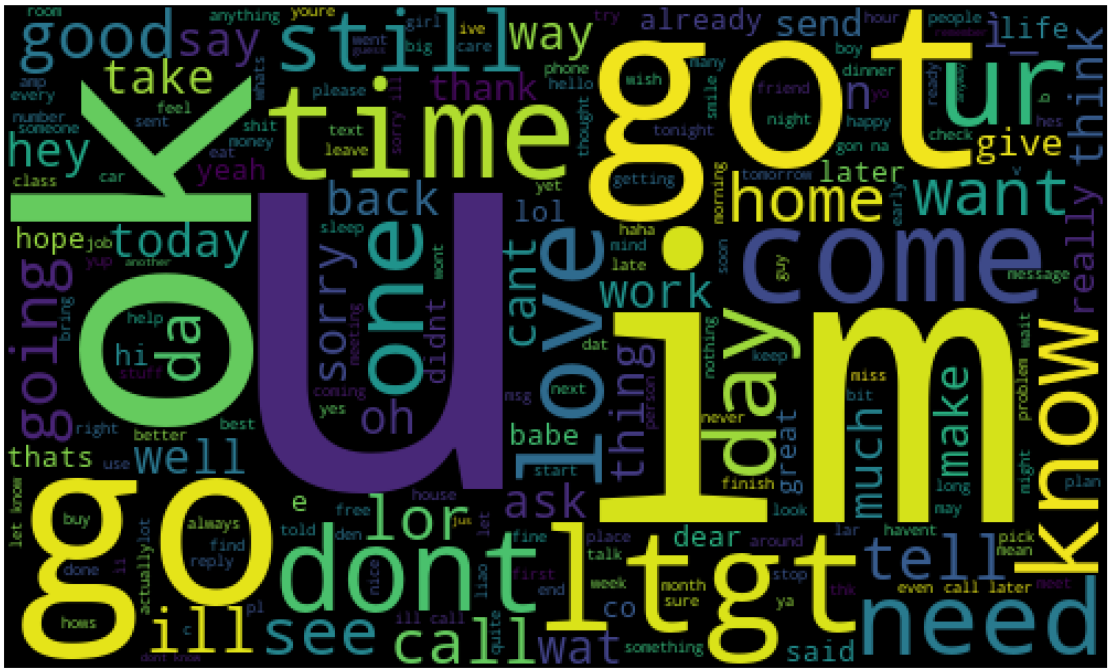
[22]:
```
#Displaying word cloud for spam words
plt.figure( figsize=(10,8), facecolor='w')
plt.title('Word cloud for spam-words')
plt.imshow(spam_wordcloud)
plt.axis("off")
plt.tight_layout(pad=0)
plt.show()
```

Word cloud for spam-words



[23]:
```
#Displaying word cloud for non-spam words
plt.figure( figsize=(10,8), facecolor='w')
plt.title('Word cloud for non-spam words')
plt.imshow(legit_wordcloud)
plt.axis("off")
plt.tight_layout(pad=0)
plt.show()
```

Word cloud for non-spam words



1.5 Vectorizing

Converting words to numerical data
Count vectorization is basically a way to turn words in documents into numbers, making it easier for computers to understand and analyze the text.
Steps to create count vector
- **Vocabulary Creation:** Make a list of unique words from the documents.
- **Word Counting:** Count how many times each word appears in each document.
- **Vector Creation:** Turn word counts into numbers, creating a table (matrix).

[24]:
```
#converting text to count vector
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.model_selection import train_test_split
vectorizer = CountVectorizer()
x = vectorizer.fit_transform(df['text'])
#splitting data into train and test set
X_train, X_test, y_train, y_test = train_test_split(x, df['label'], test_size=0.
↪25, random_state=42)
```

[25]:
```
#import classification models
from sklearn.linear_model import LogisticRegression
from sklearn.naive_bayes import MultinomialNB, BernoulliNB, GaussianNB
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score, confusion_matrix
```

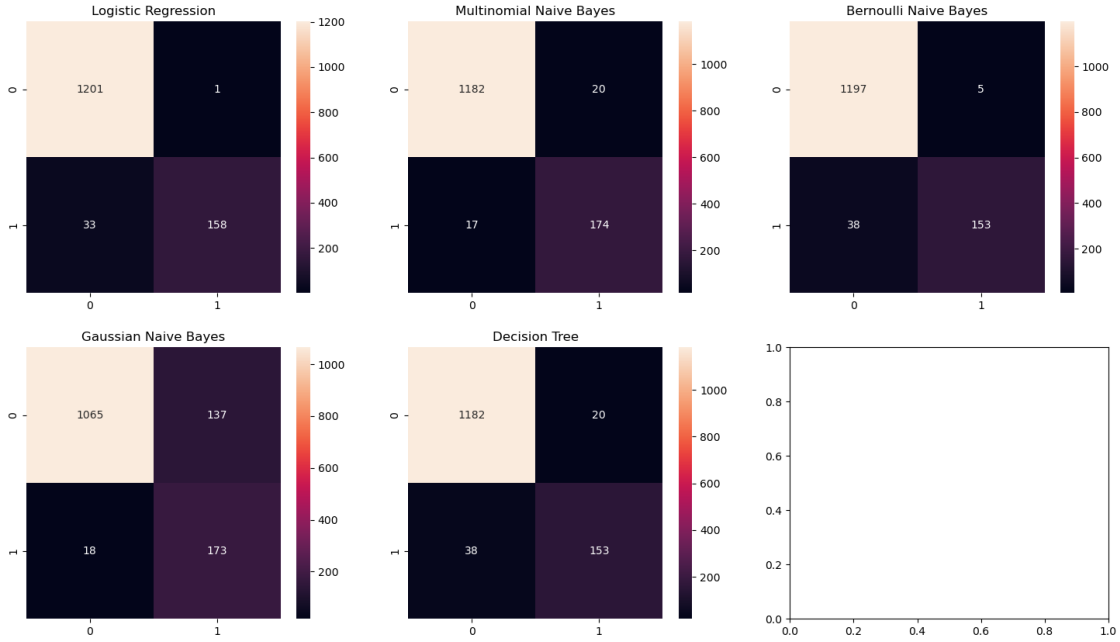
```
#initialize multiple classification models
lr = LogisticRegression()
mnb = MultinomialNB()
bnb = BernoulliNB()
gnb = GaussianNB()
dtc = DecisionTreeClassifier(min_samples_split=7, random_state=111)

models = [lr, mnb, bnb, gnb, dtc]

#trains given model on training data and prints accuracy score and confusion␣
 ↪matrix
def use_model(model,X_train,X_test,y_train,y_test):
    model.fit(X_train.toarray(), y_train)
    y_pred = model.predict(X_test.toarray())
    acc = accuracy_score(y_test,y_pred)
    print(f'Accuracy of model {model} is {acc*100:.2f}%')
    cm = confusion_matrix(y_test,y_pred)
    print('Confusion matrix: ')
    print(cm)
    return cm
```

[26]:
```
#train each model on training data and draw confusion matrix
cms=[]
fig, axes = plt.subplots(2,3, figsize=(18, 10))
for model in models:
    cm = use_model(model,X_train,X_test,y_train,y_test)
    cms.append(cm)
sns.heatmap(cms[0], annot = True,fmt = ".0f", ax=axes[0, 0]).
 ↪set_title('Logistic Regression')
sns.heatmap(cms[1], annot = True,fmt = ".0f", ax=axes[0, 1]).
 ↪set_title('Multinomial Naive Bayes')
sns.heatmap(cms[2], annot = True,fmt = ".0f", ax=axes[0, 2]).
 ↪set_title('Bernoulli Naive Bayes')
sns.heatmap(cms[3], annot = True,fmt = ".0f", ax=axes[1, 0]).
 ↪set_title('Gaussian Naive Bayes')
sns.heatmap(cms[4], annot = True,fmt = ".0f", ax=axes[1, 1]).
 ↪set_title('Decision Tree')
```

```
Accuracy of model LogisticRegression() is 97.56%
Confusion matrix:
[[1201    1]
 [  33  158]]
Accuracy of model MultinomialNB() is 97.34%
Confusion matrix:
[[1182   20]
 [  17  174]]
```

```
Accuracy of model BernoulliNB() is 96.91%
Confusion matrix:
[[1197    5]
 [  38  153]]
Accuracy of model GaussianNB() is 88.87%
Confusion matrix:
[[1065  137]
 [  18  173]]
Accuracy of model DecisionTreeClassifier(min_samples_split=7, random_state=111)
is 95.84%
Confusion matrix:
[[1182   20]
 [  38  153]]
```

[26]:
```
Text(0.5, 1.0, 'Decision Tree')
```



[27]:
```
#checks if message is spam or not using given model and using naive bayes as default model
def is_spam(text,model_name='naive_bayes'):
    model = None
    if model_name == 'logistic_regression':
        model = models[0]
    elif model_name == 'naive_bayes':
        model = models[1]
    elif model_name == 'bernoulli_naive_bayes':
        model = models[2]
```

```
    elif model_name == 'gaussian_naive_bayes':
        model = models[3]
    elif model_name == 'decision_tree':
        model = models[4]

    if model == None:
        print('Invalid model name')
        return
    is_spam = model.predict(vectorizer.transform([text.lower()]).toarray())[0]␣
↪== 1
    return is_spam
```

1.6 Examples

[28]:
```
is_spam('Congratulations, You have won in lucky draw!')
```

[28]:
```
True
```

[29]:
```
is_spam('hello there')
```

[29]:
```
False
```

2 Credits

- Almeida,Tiago and Hidalgo,Jos. (2012). SMS Spam Collection. UCI Machine Learning Repository. https://doi.org/10.24432/C5CC84.