Exam Task - Spam Message Classifier

December 19, 2018

1 SPAM message classifier

This task is based on the spam message dataset provided at http://www.dt.fee.unicamp.br/~tiago/smsspamcollection/ . "The SMS Spam Collection is a set of SMS tagged messages that have been collected for SMS Spam research. It contains one set of SMS messages in English of 5,574 messages, tagged acording being ham (legitimate) or spam."

The data is being used to train a couple of our models as well check the accuracy of prediction. Then we this model will be integrated into our simple web application where you can input a text string get prediction results, if the message is indeed a spam.

1.1 1. Import and manipulate/check data

```
In [1]: import pandas as pd
        import numpy as np
        import matplotlib.pyplot as plt
        import seaborn as sns
        %matplotlib inline

In [2]: # load data from csv file
        data = pd.read_csv("./data/spam.csv",encoding='latin-1')

In [3]: data.shape

Out[3]: (5572, 5)

In [4]: data.head(5)

Out[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

          Unnamed: 3 Unnamed: 4
        0        NaN        NaN
        1        NaN        NaN
        2        NaN        NaN
        3         NaN         NaN
        4         NaN         NaN
```

```
In [5]: # select and rename the columns relevant to us
        data = data[['v2','v1']]
        data = data.rename(columns={"v1":"label", "v2":"text"})

        print(data.groupby('label').size())
```

```
label
ham     4825
spam     747
dtype: int64
```

```
In [6]: data.isnull().values.any()
```

```
Out[6]: False
```

```
In [7]: # convert the output data/ label to binary value
        data['label'] = data.label.replace(to_replace=['ham', 'spam'], value=[0, 1])
```

```
In [8]: data.head(5)
```

```
Out[8]:                                                      text  label
        0  Go until jurong point, crazy.. Available only ...      0
        1                      Ok lar... Joking wif u oni...      0
        2  Free entry in 2 a wkly comp to win FA Cup fina...      1
        3  U dun say so early hor... U c already then say...      0
        4  Nah I don't think he goes to usf, he lives aro...      0
```

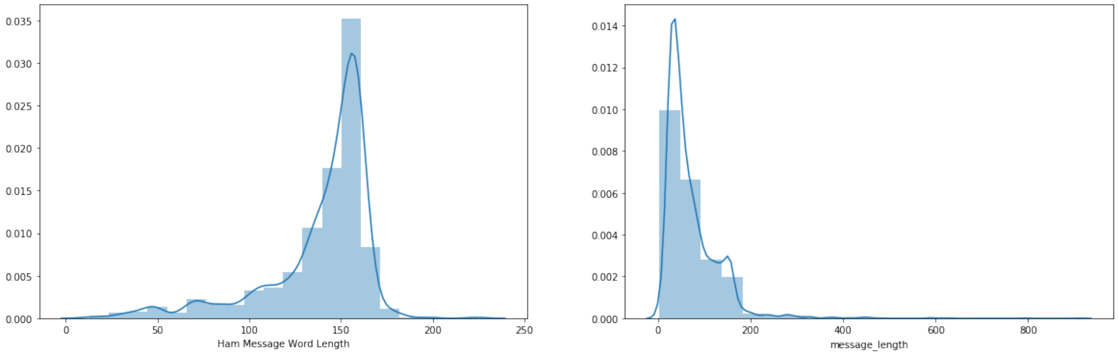
1.2 2. Visualization of data

We used a visualization example for wordcloud to get an overview of the words present in the spam and legitimate messages

1.2.1 2.1 Message length distribution per category

```
In [9]: plotdata = data
        plotdata["message_length"] = data["text"].apply(len)

        f, ax = plt.subplots(1, 2, figsize = (20, 6))


        sns.distplot(plotdata[plotdata["label"] == 1]["message_length"], bins = 20, ax = ax[0]
        ax[0].set_xlabel("Spam Message Word Length")

        sns.distplot(plotdata[plotdata["label"]== 0]["message_length"], bins = 20, ax = ax[1])
        ax[0].set_xlabel("Ham Message Word Length")

        plt.show()
```

```
C:\ProgramData\Anaconda3\lib\site-packages\matplotlib\axes\_axes.py:6462: UserWarning: The 'no
  warnings.warn("The 'normed' kwarg is deprecated, and has been "
C:\ProgramData\Anaconda3\lib\site-packages\matplotlib\axes\_axes.py:6462: UserWarning: The 'no
  warnings.warn("The 'normed' kwarg is deprecated, and has been "
```



1.2.2 2.2 Word Cloud

```
In [10]: ham_words = ''
         spam_words = ''
         spam = data[data.label == 1]
         ham = data[data.label ==0]
```

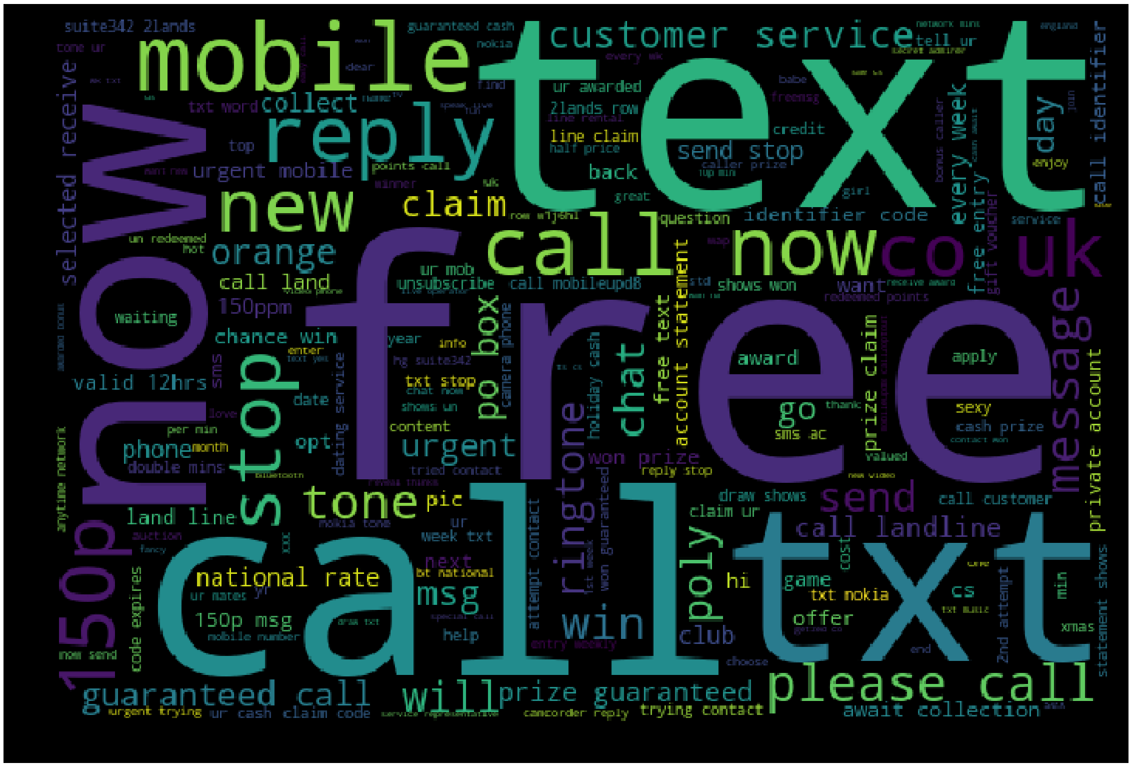
```
In [11]: import nltk
```

```
In [12]: for val in spam.text:
             text = val.lower()
             tokens = nltk.word_tokenize(text)
             for words in tokens:
                 spam_words = spam_words + words + ' '

         for val in ham.text:
             text = val.lower()
             tokens = nltk.word_tokenize(text)
             for words in tokens:
                 ham_words = ham_words + words + ' '
```

```
In [13]: from wordcloud import WordCloud
```

```
In [14]: spam_wordcloud = WordCloud(width=600, height=400).generate(spam_words)
         ham_wordcloud = WordCloud(width=600, height=400).generate(ham_words)
```

```
In [15]: #Spam Word cloud
         plt.figure( figsize=(10,8), facecolor='k')
         plt.imshow(spam_wordcloud)
         plt.axis("off")
         plt.tight_layout(pad=0)
         plt.show()
```



```
In [16]: #legitimate/ham word cloud
         plt.figure( figsize=(10,8), facecolor='k')
         plt.imshow(ham_wordcloud)
         plt.axis("off")
         plt.tight_layout(pad=0)
         plt.show()
```

will
ok
gt
lt
ur
go
one
now
got
love
come
n't
time
need
day
going
good
today
call
home
back
know
want
well
already
take
see
think
hope
make
sorry
send
lor
da
still
number
say
work
dont
yeah
later
lol
much
oh
way
wat
re
thing
really
tonight
hey
yes
life
hi
night
something
money
stuff
babe
free
find
help
hello
many
hour
talk
text
soon
went
ll
haha
next
happy
place
fine
co
cant
meet
phone
week
better
long
give
pl
try
guy
class
keep
buy
wait
leave
quite
bit
im
around
sent
ready
every
told
ask
said
sure
best
tell
always
sorry ll
ya
msg
jus
late
tomorrow
check
friend
plan
dear
great
thank
boy
good morning
ca n't
see
take
big
god
yet
might
someone
dat
thought
first
nice
car
person
message
people
stop
miss
lot
done
thk
feel
look
please
gon na
room
year
bring
sleep
shit
yo
let know
getting
may
right now
eat
actually
house
dinner
heart
meeting
anything
us
end
ll call
den
smile
ve
early
pick
lar
ii
finish
right
even
problem
month
mean
job
amp
reply
let
girl
yup
mind
ah
remember
take care
call later
coming
morning
wish
wont
word
anyway
thanx
use
nothing
sir
never
start

1.3 3. Stemming the text messages

We are using the nltk module to create corpus (removing special characters and punctuation) from the text messages and convert the text to lowercase. Then the stopwords (most common words) are filtered out and stemming (converting words to thier stem/base word) is performed. The stemming makes the text dense and reduces the size of dictionary and takes different variations of words as one. This might sometimes reduces the accuracy of prediction due to different meaing between the form of words.

```
In [17]: import re
         import os
         from nltk.corpus import stopwords
         from nltk.stem.porter import PorterStemmer
```

```
In [18]: portstemmer = PorterStemmer()
         stop = stopwords.words('english')
         corpus = []
         for i in range (0,len(data)):
             mess = re.sub('[^a-zA-Z]',repl = ' ',string = data['text'][i])
             mess.lower()
             mess = mess.split()
             mess = [portstemmer.stem(word) for word in mess if word not in set(stop)]
             mess = ' '.join(mess)
             corpus.append(mess)
```

```
In [19]: corpus[0]

Out[19]: 'Go jurong point crazi avail bugi n great world la e buffet cine got amor wat'
```

1.4 4. Create a sparse matrix by vectorizing words

```
In [20]: from sklearn.feature_extraction.text import CountVectorizer

         vectorizer = CountVectorizer()

In [21]: X, y = vectorizer.fit_transform(corpus).toarray(), data['label'].values

In [22]: X[1]

Out[22]: array([0, 0, 0, ..., 0, 0, 0], dtype=int64)
```

1.5 5. Split the data

```
In [23]: # Splitting the dataset into the Training set and Test set
         from sklearn.model_selection import train_test_split

         X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=

In [24]: print('Number of rows in the total set: {}'.format(data.shape[0]))
         print('Number of rows in the training set: {}'.format(X_train.shape[0]))
         print('Number of rows in the test set: {}'.format(X_test.shape[0]))

Number of rows in the total set: 5572
Number of rows in the training set: 3900
Number of rows in the test set: 1672
```

1.6 6. Bayes with MultinomialNB

```
In [25]: from sklearn import tree
         from sklearn import model_selection
         from sklearn.metrics import classification_report
         from sklearn.metrics import confusion_matrix
         from sklearn.metrics import accuracy_score
         from sklearn.tree import DecisionTreeClassifier

In [26]: from sklearn.naive_bayes import MultinomialNB
         classifier = MultinomialNB()

         classifier.fit(X_train, y_train)
         predictions = classifier.predict(X_test)
         print(predictions)

[0 0 0 ... 0 0 0]
```

```
In [27]: # Validate the accuracy of the predictions
         from sklearn.metrics import accuracy_score, precision_score, recall_score, f1_score
         print('Accuracy score: ', format(accuracy_score(y_test, predictions)))
         print('Precision score: ', format(precision_score(y_test, predictions)))
         print('Recall score: ', format(recall_score(y_test, predictions)))
         print('F1 score: ', format(f1_score(y_test, predictions)))
```

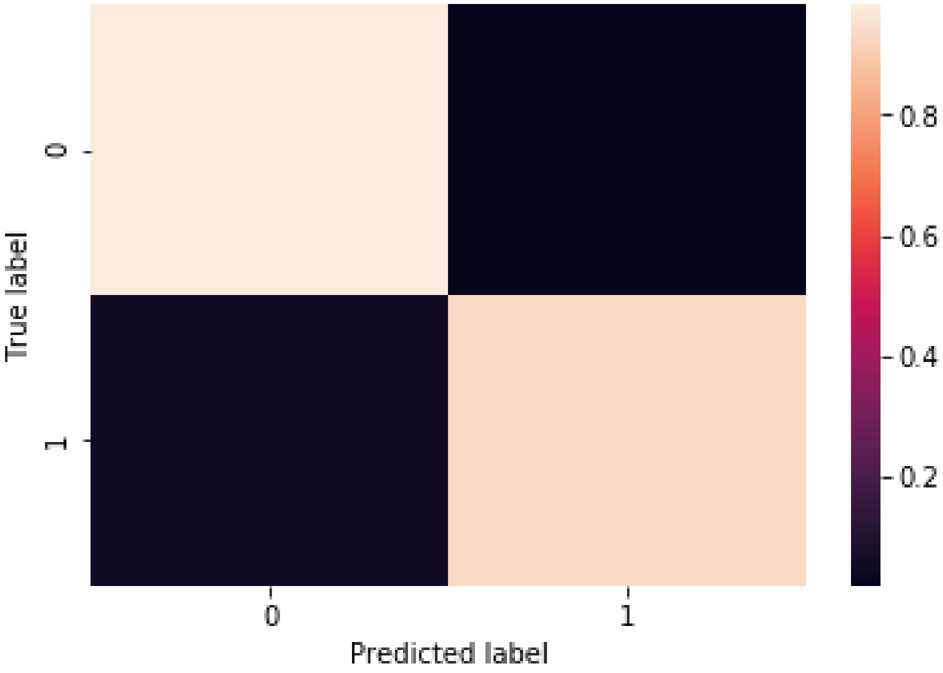
```
Accuracy score:  0.9766746411483254
Precision score:  0.8874458874458875
Recall score:  0.9403669724770642
F1 score:  0.9131403118040089
```

We observed the predictions to be quite accurate even when the dataset was split into halves for train and test.

1.6.1 6.1 Confusion matrix

```
In [28]: conf_mat = confusion_matrix(y_test, predictions)
         conf_mat_normalized = conf_mat.astype('float') / conf_mat.sum(axis=1)[:, np.newaxis]

         sns.heatmap(conf_mat_normalized)
         plt.ylabel('True label')
         plt.xlabel('Predicted label')
```

```
Out[28]: Text(0.5,15,'Predicted label')
```



1.6.2 6.2 Using the model in new set of data

```
In [29]: data_new = pd.read_csv("./data/spam_source_2.csv",encoding='latin-1')
```

```
In [30]: data_new.head(5)
```

```
Out[30]:    type                                               text
         0   ham  Hope you are having a good week. Just checking in
         1   ham                          K..give back my thanks.
         2   ham        Am also doing in cbe only. But have to pay.
         3  spam  complimentary 4 STAR Ibiza Holiday or Ãč10,000...
         4  spam  okmail: Dear Dave this is your final notice to...
```

```
In [31]: # select and rename the columns relevant to us
         data_new = data_new.rename(columns={"type":"label"})

         print(data_new.groupby('label').size())
```

```
label
ham     4812
spam     747
dtype: int64
```

```
In [32]: data_new.isnull().values.any()
```

```
Out[32]: False
```

```
In [33]: data_new.head(5)
```

```
Out[33]:   label                                               text
         0   ham  Hope you are having a good week. Just checking in
         1   ham                          K..give back my thanks.
         2   ham        Am also doing in cbe only. But have to pay.
         3  spam  complimentary 4 STAR Ibiza Holiday or Ãč10,000...
         4  spam  okmail: Dear Dave this is your final notice to...
```

```
In [34]: # convert the output data/ label to binary value
         data_new['label'] = data_new.label.replace(to_replace=['ham', 'spam'], value=[0, 1])
```

```
In [35]: corpus_new = []
         for i in range (0,len(data_new)):
             mess_new = re.sub('[^a-zA-Z]',repl = ' ',string = data_new['text'][i])
             mess_new.lower()
             mess_new = mess_new.split()
             mess_new = [portstemmer.stem(word) for word in mess_new if word not in set(stop)]
             mess_new = ' '.join(mess_new)
             corpus_new.append(mess_new)
```

```
In [36]: X_new, y_new = vectorizer.transform(corpus_new), data_new['label'].values
In [37]: X_new.shape
```

```
Out[37]: (5559, 6304)
```

```
In [38]: y_new.shape
```

```
Out[38]: (5559,)
```

```
In [39]: predictions_new = classifier.predict(X_new)
         print(predictions_new)
```

```
[0 0 0 ... 1 1 0]
```

```
In [40]: # Validate the accuracy of the predictions
         print('Accuracy score: ', format(accuracy_score(y_new, predictions_new)))
         print('Precision score: ', format(precision_score(y_new, predictions_new)))
         print('Recall score: ', format(recall_score(y_new, predictions_new)))
         print('F1 score: ', format(f1_score(y_new, predictions_new)))
```

```
Accuracy score:  0.9883072495053067
Precision score:  0.94750656167979
Recall score:  0.9665327978580991
F1 score:  0.9569251159708415
```

We observed the model to perform good predictions on the spam dataset from different source

1.6.3 6.2 Save the model

```
In [41]: import pickle

         pickle.dump(classifier, open("bayes_classifier.pickle", "wb"))

         pickle.dump(vectorizer, open("vector.pickle", "wb"))

         pickle.dump(stop, open("stop.pickle", "wb"))
```

```
In [42]: # test load the classifier
         classifier = pickle.load(open('bayes_classifier.pickle', 'rb'))

         vectorizer = pickle.load(open('vector.pickle', 'rb'))

         stop = pickle.load(open('stop.pickle', 'rb'))

         predictions = classifier.predict(X_test)
         print('Accuracy score: ', format(accuracy_score(y_test, predictions)))
```

```
Accuracy score:  0.9766746411483254
```

1.6.4 Function to corpus a input message

```
In [43]: def corpus_message(text):
             mess = re.sub('[^a-zA-Z]',repl = ' ',string = text)
             mess.lower()
             mess = mess.split()
             mess = [portstemmer.stem(word) for word in mess if word not in set(stop)]
             mess = ' '.join(mess)
             mess_array=  np.array([mess])
             print(mess_array[0])
             return mess_array
```

1.6.5 Custom text test

```
In [44]: test_string = 'text for free prize'
         test_corpus = corpus_message(test_string)
         test_vector = vectorizer.transform(test_corpus)
         test_vector
```

```
text free prize
```

```
Out[44]: <1x6304 sparse matrix of type '<class 'numpy.int64'>'
                 with 3 stored elements in Compressed Sparse Row format>
```

```
In [45]: predictions = classifier.predict(test_vector)
         predictions
```

```
Out[45]: array([1], dtype=int64)
```

1.7 7. Ensemble Random Forest classifier

```
In [46]: # create and train the model

         from sklearn.ensemble import RandomForestClassifier
         model = RandomForestClassifier()
         model.fit(X_train,y_train)
```

```
Out[46]: RandomForestClassifier(bootstrap=True, class_weight=None, criterion='gini',
                     max_depth=None, max_features='auto', max_leaf_nodes=None,
                     min_impurity_decrease=0.0, min_impurity_split=None,
                     min_samples_leaf=1, min_samples_split=2,
                     min_weight_fraction_leaf=0.0, n_estimators=10, n_jobs=1,
                     oob_score=False, random_state=None, verbose=0,
                     warm_start=False)
```

```
In [47]: predictions = model.predict(X_test)
         predictions
```

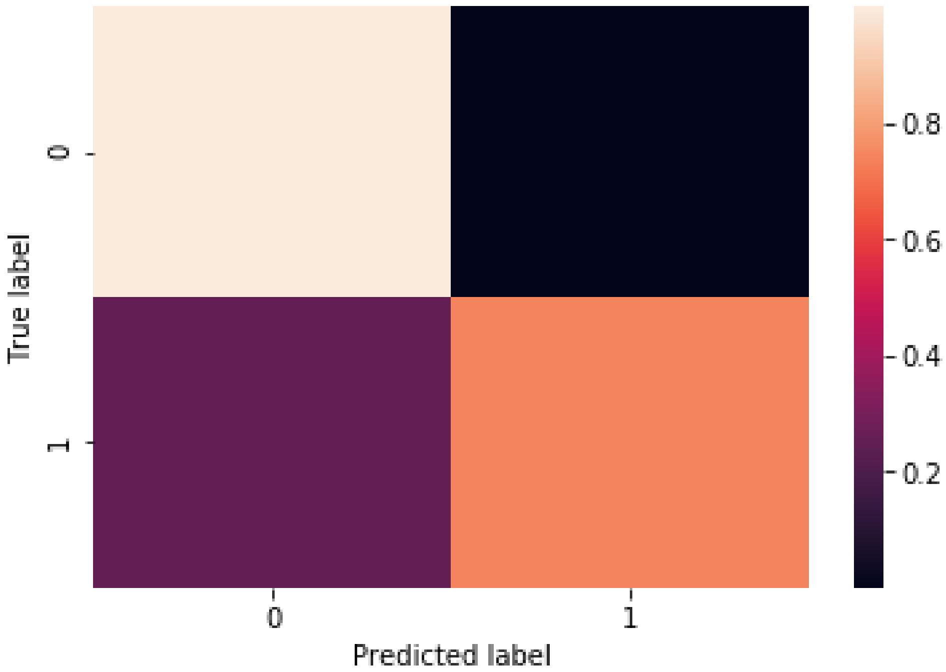
```
Out[47]: array([0, 0, 0, ..., 0, 0, 0], dtype=int64)
```

```
In [48]: # Validate the accuracy of the predictions
         print('Accuracy score: ', format(accuracy_score(y_test, predictions)))
         print('Precision score: ', format(precision_score(y_test, predictions)))
         print('Recall score: ', format(recall_score(y_test, predictions)))
         print('F1 score: ', format(f1_score(y_test, predictions)))
```

```
Accuracy score:  0.965311004784689
Precision score:  0.9878048780487805
Recall score:  0.7431192660550459
F1 score:  0.8481675392670157
```

```
In [49]: conf_mat = confusion_matrix(y_test, predictions)
         conf_mat_normalized = conf_mat.astype('float') / conf_mat.sum(axis=1)[:, np.newaxis]

         sns.heatmap(conf_mat_normalized)
         plt.ylabel('True label')
         plt.xlabel('Predicted label')
```

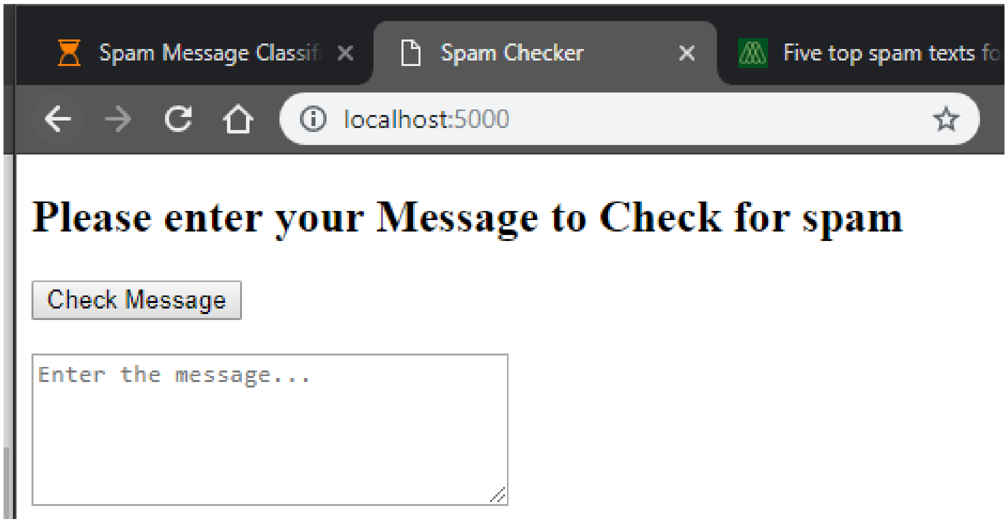
```
Out[49]: Text(0.5,15,'Predicted label')
```



1.8 8. Web App

```
In [50]: %%writefile mywebapp.py
```

```
from flask import Flask, render_template, request
from wtforms import Form, TextAreaField, validators
import pickle
import os
import re
import numpy as np
from nltk.stem.porter import PorterStemmer


portstemmer = PorterStemmer()


# loading the serialized classifier, vectorizer and stopwords
classifier = pickle.load(open('bayes_classifier.pickle', 'rb'))

vectorizer = pickle.load(open('vector.pickle', 'rb'))

stop = pickle.load(open('stop.pickle', 'rb'))


def corpus_message(text):
    mess = re.sub('[^a-zA-Z]',repl = ' ',string = text)
    mess.lower()
    mess = mess.split()
    mess = [portstemmer.stem(word) for word in mess if word not in set(stop)]
    mess = ' '.join(mess)
    mess_array=  np.array([mess])
    return mess_array

def classify(message):
    label = {0: 'ham', 1: 'spam'}
    document = corpus_message(message)
    X = vectorizer.transform(document)
    y = classifier.predict(X)[0]
    proba = np.max(classifier.predict_proba(X))
    return label[y], proba



# create an instance (our app)
app = Flask(__name__)

@app.route('/', methods=['GET', 'POST'])
def index():
    form = None
    if request.method == 'POST' and 'spam' in request.form:
        form = request.form['spam']
    return render_template('default.html', form=form)
```



Please enter your Message to Check for spam

```
        @app.route('/results', methods=['POST'])
        def results():
            form = request.form
            if request.method == 'POST':
                message = request.form['spam']
                y, proba = classify(message)
                return render_template('results.html',
                                        content=message,
                                        prediction=y,
                                        probability=round(proba*100, 2))
            return render_template('results.html', name=name)

        if __name__ == '__main__':
            app.run(port=5000,debug=True);
```

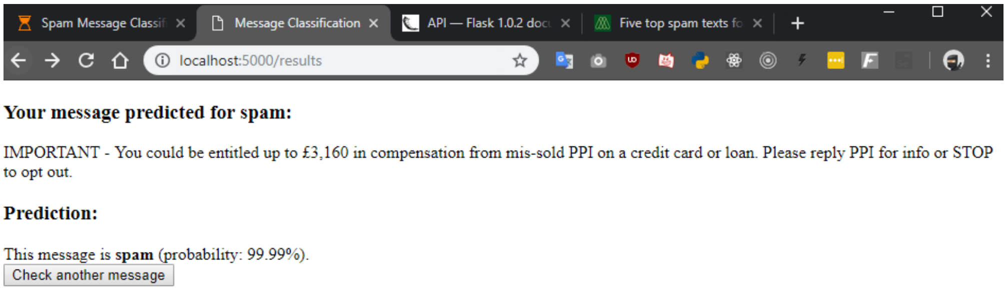
```
Overwriting mywebapp.py
```

```
In [51]: #!python mywebapp.py
```

1.9 9. Conclusion

The predictions generated from both the models were quite remarkable on both the test and externald dataset. However, the dataset was not overly complex to warrant huge failures in predictions. Finally, we are happy with the results obtained.

1.10 10 Web App preview

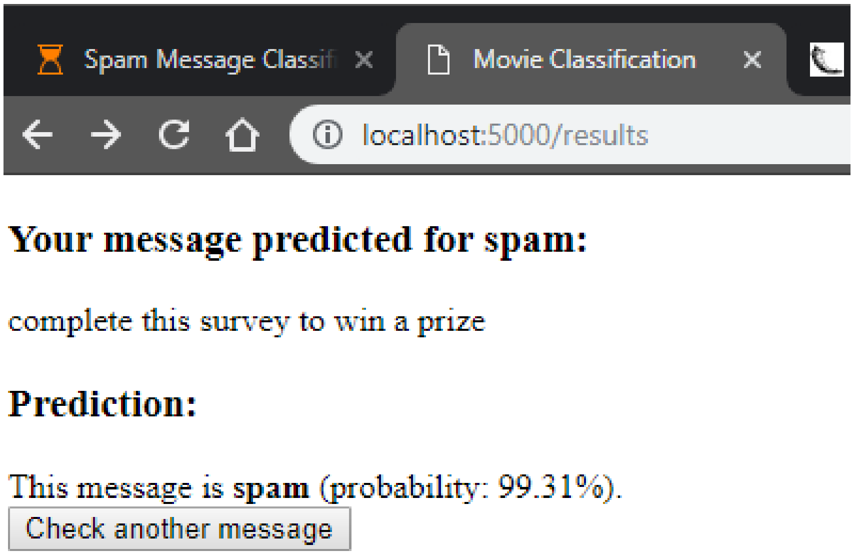


Your message predicted for spam:

IMPORTANT - You could be entitled up to £3,160 in compensation from mis-sold PPI on a credit card or loan. Please reply PPI for info or STOP to opt out.

Prediction:

This message is **spam** (probability: 99.99%).

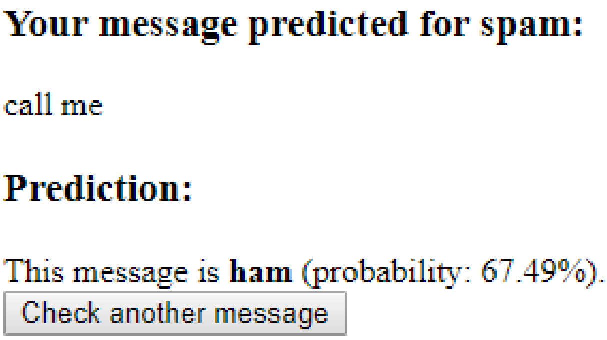


Your message predicted for spam:

complete this survey to win a prize

Prediction:

This message is **spam** (probability: 99.31%).



Your message predicted for spam:

call me

Prediction:

This message is **ham** (probability: 67.49%).