SPAM DETECTION PROJECT

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 according being ham (legitimate) or spam.

Spam Detector is used to detect unwanted, malicious and virus infected texts and helps to separate them from the nonspam texts. It uses a binary type of classification containing the labels such as ‘ham’ (nonspam) and spam. Application of this can be seen in Google Mail (GMAIL) where it segregates the spam emails in order to prevent them from getting into the user’s inbox.

A collection of 5573 rows SMS spam messages was manually extracted from the Grumbletext Web site. This is a UK forum in which cell phone users make public claims about SMS spam messages, most of them without reporting the very spam message received. The identification of the text of spam messages in the claims is a very hard and time-consuming task, and it involved carefully scanning hundreds of web pages.

A subset of 3,375 SMS randomly chosen ham messages of the NUS SMS Corpus (NSC), which is a dataset of about 10,000 legitimate messages collected for research at the Department of Computer Science at the National University of Singapore. The messages largely originate from Singaporeans and mostly from students attending the University. These messages were collected from volunteers who were made aware that their contributions were going to be made publicly available.

Importing Libraries

In [5]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')
```

In [8]:
```
!pip install lightgbm
```

```
Collecting lightgbm
  Downloading lightgbm-3.3.5-py3-none-win_amd64.whl (1.0 MB)
Requirement already satisfied: scipy in c:\users\hp\anaconda3\lib\site-packages
(from lightgbm) (1.5.2)
Requirement already satisfied: scikit-learn!=0.22.0 in c:\users\hp\anaconda3\li
b\site-packages (from lightgbm) (1.1.3)
Requirement already satisfied: numpy in c:\users\hp\anaconda3\lib\site-packages
(from lightgbm) (1.19.2)
Requirement already satisfied: wheel in c:\users\hp\anaconda3\lib\site-packages
(from lightgbm) (0.35.1)
Requirement already satisfied: joblib>=1.0.0 in c:\users\hp\anaconda3\lib\site-
packages (from scikit-learn!=0.22.0->lightgbm) (1.2.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\users\hp\anaconda3\li
b\site-packages (from scikit-learn!=0.22.0->lightgbm) (2.1.0)
Installing collected packages: lightgbm
Successfully installed lightgbm-3.3.5
```

In [12]:
```
pip install xgboost
```

```
Collecting xgboost
  Downloading xgboost-1.7.3-py3-none-win_amd64.whl (89.1 MB)
Requirement already satisfied: scipy in c:\users\hp\anaconda3\lib\site-packages
(from xgboost) (1.5.2)
Requirement already satisfied: numpy in c:\users\hp\anaconda3\lib\site-packages
(from xgboost) (1.19.2)
Installing collected packages: xgboost
Successfully installed xgboost-1.7.3
Note: you may need to restart the kernel to use updated packages.
```

In [16]:
```
from sklearn.model_selection import train_test_split, GridSearchCV,cross_val_scor
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, confusion_matrix, precision_score,cla
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import GaussianNB, MultinomialNB, BernoulliNB

import lightgbm
from sklearn.svm import LinearSVC
from sklearn.linear_model import SGDClassifier
import xgboost
from xgboost import XGBClassifier
!pip install scikit-plot
import scikitplot as skplt
```

```
Collecting scikit-plot
  Downloading scikit_plot-0.3.7-py3-none-any.whl (33 kB)
Requirement already satisfied: scipy>=0.9 in c:\users\hp\anaconda3\lib\site-pac
kages (from scikit-plot) (1.5.2)
Requirement already satisfied: scikit-learn>=0.18 in c:\users\hp\anaconda3\lib
\site-packages (from scikit-plot) (1.1.3)
Requirement already satisfied: joblib>=0.10 in c:\users\hp\anaconda3\lib\site-p
ackages (from scikit-plot) (1.2.0)
Requirement already satisfied: matplotlib>=1.4.0 in c:\users\hp\anaconda3\lib\s
ite-packages (from scikit-plot) (3.3.2)
Requirement already satisfied: numpy>=1.14.5 in c:\users\hp\anaconda3\lib\site-
packages (from scipy>=0.9->scikit-plot) (1.19.2)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\users\hp\anaconda3\li
b\site-packages (from scikit-learn>=0.18->scikit-plot) (2.1.0)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.3 in c:\u
sers\hp\anaconda3\lib\site-packages (from matplotlib>=1.4.0->scikit-plot) (2.4.
7)
Requirement already satisfied: cycler>=0.10 in c:\users\hp\anaconda3\lib\site-p
ackages (from matplotlib>=1.4.0->scikit-plot) (0.10.0)
Requirement already satisfied: pillow>=6.2.0 in c:\users\hp\anaconda3\lib\site-
packages (from matplotlib>=1.4.0->scikit-plot) (8.0.1)
Requirement already satisfied: python-dateutil>=2.1 in c:\users\hp\anaconda3\li
b\site-packages (from matplotlib>=1.4.0->scikit-plot) (2.8.1)
Requirement already satisfied: kiwisolver>=1.0.1 in c:\users\hp\anaconda3\lib\s
ite-packages (from matplotlib>=1.4.0->scikit-plot) (1.3.0)
Requirement already satisfied: certifi>=2020.06.20 in c:\users\hp\anaconda3\lib
\site-packages (from matplotlib>=1.4.0->scikit-plot) (2022.9.24)
Requirement already satisfied: six in c:\users\hp\anaconda3\lib\site-packages
(from cycler>=0.10->matplotlib>=1.4.0->scikit-plot) (1.15.0)
Installing collected packages: scikit-plot
Successfully installed scikit-plot-0.3.7
```

In [102]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')

from sklearn.model_selection import train_test_split, GridSearchCV,cross_val_scor
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import accuracy_score, confusion_matrix, precision_score,cla
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import GaussianNB, MultinomialNB, BernoulliNB
import lightgbm
from sklearn.svm import LinearSVC
from sklearn.linear_model import SGDClassifier
from xgboost import XGBClassifier
import scikitplot as skplt
```

In [26]:
```
import nltk
import re
import string
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer, WordNetLemmatizer

from sklearn.feature_extraction.text import TfidfVectorizer

!pip install wordcloud

from wordcloud import WordCloud
from sklearn.feature_extraction.text import CountVectorizer

import joblib
```

```
Requirement already satisfied: wordcloud in c:\users\hp\anaconda3\lib\site-pack
ages (1.8.2.2)
Requirement already satisfied: pillow in c:\users\hp\anaconda3\lib\site-package
s (from wordcloud) (8.0.1)
Requirement already satisfied: numpy>=1.6.1 in c:\users\hp\anaconda3\lib\site-p
ackages (from wordcloud) (1.19.2)
Requirement already satisfied: matplotlib in c:\users\hp\anaconda3\lib\site-pac
kages (from wordcloud) (3.3.2)
Requirement already satisfied: python-dateutil>=2.1 in c:\users\hp\anaconda3\li
b\site-packages (from matplotlib->wordcloud) (2.8.1)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.3 in c:\u
sers\hp\anaconda3\lib\site-packages (from matplotlib->wordcloud) (2.4.7)
Requirement already satisfied: kiwisolver>=1.0.1 in c:\users\hp\anaconda3\lib\s
ite-packages (from matplotlib->wordcloud) (1.3.0)
Requirement already satisfied: cycler>=0.10 in c:\users\hp\anaconda3\lib\site-p
ackages (from matplotlib->wordcloud) (0.10.0)
Requirement already satisfied: certifi>=2020.06.20 in c:\users\hp\anaconda3\lib
\site-packages (from matplotlib->wordcloud) (2022.9.24)
Requirement already satisfied: six>=1.5 in c:\users\hp\anaconda3\lib\site-packa
ges (from python-dateutil>=2.1->matplotlib->wordcloud) (1.15.0)
```

Importing the DATASET

In [28]:
```
spam_data=pd.read_csv(r"E:\DS Intenship projects\Project form Mentor\Email spam 0
```

In [29]:
```
spam_data
```

Out[29]:

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

5572 rows × 5 columns

Checkinf some top 5 rows

In [30]:
```
spam_data.head()
```

Out[30]:

	v1	v2	Unnamed: 2	Unnamed: 3	Unnamed: 4
0	ham	Go until jurong point, crazy.. Available only ...	NaN	NaN	NaN
1	ham	Ok lar... Joking wif u oni...	NaN	NaN	NaN
2	spam	Free entry in 2 a wkly comp to win FA Cup fina...	NaN	NaN	NaN
3	ham	U dun say so early hor... U c already then say...	NaN	NaN	NaN
4	ham	Nah I don't think he goes to usf, he lives aro...	NaN	NaN	NaN

We have some unesessary columns which we should be drop

EDA

In [31]:
```
spam_data.shape
```

Out[31]:
```
(5572, 5)
```

We have total 5572 rows and 5 columns

Checking All Column Name

In [32]:
```
spam_data.columns
```

Out[32]:
```
Index(['v1', 'v2', 'Unnamed: 2', 'Unnamed: 3', 'Unnamed: 4'], dtype='object')
```

Checking Data Type of All Data

In [33]:
```
spam_data.dtypes
```

Out[33]:
```
v1            object
v2            object
Unnamed: 2    object
Unnamed: 3    object
Unnamed: 4    object
dtype: object
```

As we can see all are object hence we need to treat them so that ML models can understand

Checking for Null Values

In [34]:
```
spam_data.isnull().sum()
```

Out[34]:
```
v1               0
v2               0
Unnamed: 2    5522
Unnamed: 3    5560
Unnamed: 4    5566
dtype: int64
```

We Have null values in some unnecessary column which we are going to drop and there is not missing values present in actual important Data

In [35]:
```
#droping irrelevant column
spam_data=spam_data.drop(columns=['Unnamed: 2','Unnamed: 3','Unnamed: 4'])
```

In [36]:
```
#renaming column v1 and v2 for better understanding
spam_data=spam_data.rename(columns={'v1' : 'target','v2' : 'message'})
spam_data
```

Out[36]:

	target	message
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 × 2 columns

Lets check Uniqueness of value

In [37]:
```
spam_data['target'].nunique()
```

Out[37]:
```
2
```

In [38]:
```
spam_data['target'].unique()
```

Out[38]:
```
array(['ham', 'spam'], dtype=object)
```

In [39]:
```
spam_data['target'].value_counts()
```

Out[39]:
```
ham     4825
spam     747
Name: target, dtype: int64
```

We can see that How unique values are distributed in all over dataset so that we can get little idea.

Describing Dataset

In [40]:
```
spam_data.describe()
```

Out[40]:

	target	message
count	5572	5572
unique	2	5169
top	ham	Sorry, I'll call later
freq	4825	30

In [42]:
```
spam_data.duplicated().sum()
```

Out[42]:
```
403
```

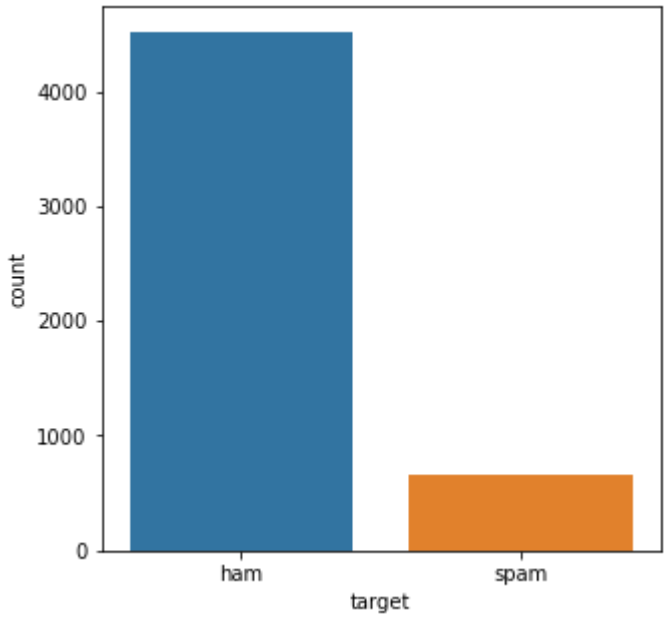
In [43]:
```
# Dropping duplicate rows
spam_data.drop_duplicates(inplace = True)
```

Visualization

In [44]:
```
print(spam_data['target'].value_counts())
plt.figure(figsize=(5,5))
sns.countplot('target', data=spam_data)
```

```
ham     4516
spam     653
Name: target, dtype: int64
```

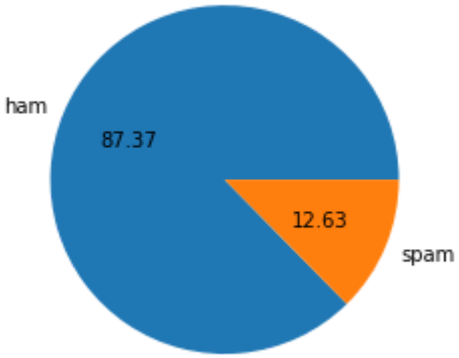
Out[44]:
```
<AxesSubplot:xlabel='target', ylabel='count'>
```



As we can see tnat most of emails are ham which means not spam and there are some spam email present in Data set and they are our targets.

Using Pie-Plot

In [45]:
```
plt.pie(spam_data['target'].value_counts(), labels =['ham', 'spam'], autopct= "%.
plt.show()
```



The above barplot and pie chart shows that our data is highly imbalanced as spam is 12.63% and ham is 87.37%

In [46]:
```
# creating coloumn which will contain the no. of characters
spam_data['length'] = spam_data['message'].str.len()
```

In [53]:
```
!pip install nltk
```

```
Requirement already satisfied: nltk in c:\users\hp\anaconda3\lib\site-packages
(3.5)
Requirement already satisfied: joblib in c:\users\hp\anaconda3\lib\site-package
s (from nltk) (1.2.0)
Requirement already satisfied: tqdm in c:\users\hp\anaconda3\lib\site-packages
(from nltk) (4.50.2)
Requirement already satisfied: click in c:\users\hp\anaconda3\lib\site-packages
(from nltk) (7.1.2)
Requirement already satisfied: regex in c:\users\hp\anaconda3\lib\site-packages
(from nltk) (2020.10.15)
```

In [54]:
```
import nltk
```

In [56]:
```
nltk.download('all')
```

```
[nltk_data]    |     C:\Users\HP\AppData\Roaming\nltk_data...
[nltk_data]    |   Unzipping misc\perluniprops.zip.
[nltk_data]    | Downloading package pil to
[nltk_data]    |     C:\Users\HP\AppData\Roaming\nltk_data...
[nltk_data]    |   Unzipping corpora\pil.zip.
[nltk_data]    | Downloading package pl196x to
[nltk_data]    |     C:\Users\HP\AppData\Roaming\nltk_data...
[nltk_data]    |   Unzipping corpora\pl196x.zip.
[nltk_data]    | Downloading package porter_test to
[nltk_data]    |     C:\Users\HP\AppData\Roaming\nltk_data...
[nltk_data]    |   Unzipping stemmers\porter_test.zip.
[nltk_data]    | Downloading package ppattach to
[nltk_data]    |     C:\Users\HP\AppData\Roaming\nltk_data...
[nltk_data]    |   Unzipping corpora\ppattach.zip.
[nltk_data]    | Downloading package problem_reports to
[nltk_data]    |     C:\Users\HP\AppData\Roaming\nltk_data...
[nltk_data]    |   Unzipping corpora\problem_reports.zip.
[nltk_data]    | Downloading package product_reviews_1 to
[nltk_data]    |     C:\Users\HP\AppData\Roaming\nltk_data...
[nltk_data]    |   Unzipping corpora\product_reviews_1.zip.
```

In [57]:
```
# creating coloumn which will fetch no. of words
spam_data['num_words'] = spam_data['message'].apply(lambda x: len(nltk.word_toker
```

In [58]:
```
# creating coloumn which will fetch no. of sentences
spam_data['num_sent'] = spam_data['message'].apply(lambda x: len(nltk.sent_tokeni
```

In [59]:
```
spam_data.head()
```

Out[59]:

	target	message	length	num_words	num_sent
0	ham	Go until jurong point, crazy.. Available only ...	111	24	2
1	ham	Ok lar... Joking wif u oni...	29	8	2
2	spam	Free entry in 2 a wkly comp to win FA Cup fina...	155	37	2
3	ham	U dun say so early hor... U c already then say...	49	13	1
4	ham	Nah I don't think he goes to usf, he lives aro...	61	15	1

In [60]:
```
#describing data for all messages
spam_data[['length','num_words','num_sent']].describe()
```

Out[60]:

	length	num_words	num_sent
count	5169.000000	5169.000000	5169.000000
mean	78.977945	18.455407	1.961308
std	58.236293	13.322448	1.432583
min	2.000000	1.000000	1.000000
25%	36.000000	9.000000	1.000000
50%	60.000000	15.000000	1.000000
75%	117.000000	26.000000	2.000000
max	910.000000	220.000000	38.000000

In [62]:
```
# mapping labels to 1 and 0
spam_data['target'] = spam_data.target.map({'ham':0, 'spam':1})
```

In [63]:
```
spam_data.head()
```

Out[63]:

	target	message	length	num_words	num_sent
0	0	Go until jurong point, crazy.. Available only ...	111	24	2
1	0	Ok lar... Joking wif u oni...	29	8	2
2	1	Free entry in 2 a wkly comp to win FA Cup fina...	155	37	2
3	0	U dun say so early hor... U c already then say...	49	13	1
4	0	Nah I don't think he goes to usf, he lives aro...	61	15	1

In [64]:
```
#describing data for ham messages
spam_data[spam_data['target'] == 0][['length','num_words','num_sent']].describe()
```

Out[64]:

	length	num_words	num_sent
count	4516.000000	4516.000000	4516.000000
mean	70.459256	17.123339	1.815545
std	56.358207	13.491315	1.364098
min	2.000000	1.000000	1.000000
25%	34.000000	8.000000	1.000000
50%	52.000000	13.000000	1.000000
75%	90.000000	22.000000	2.000000
max	910.000000	220.000000	38.000000

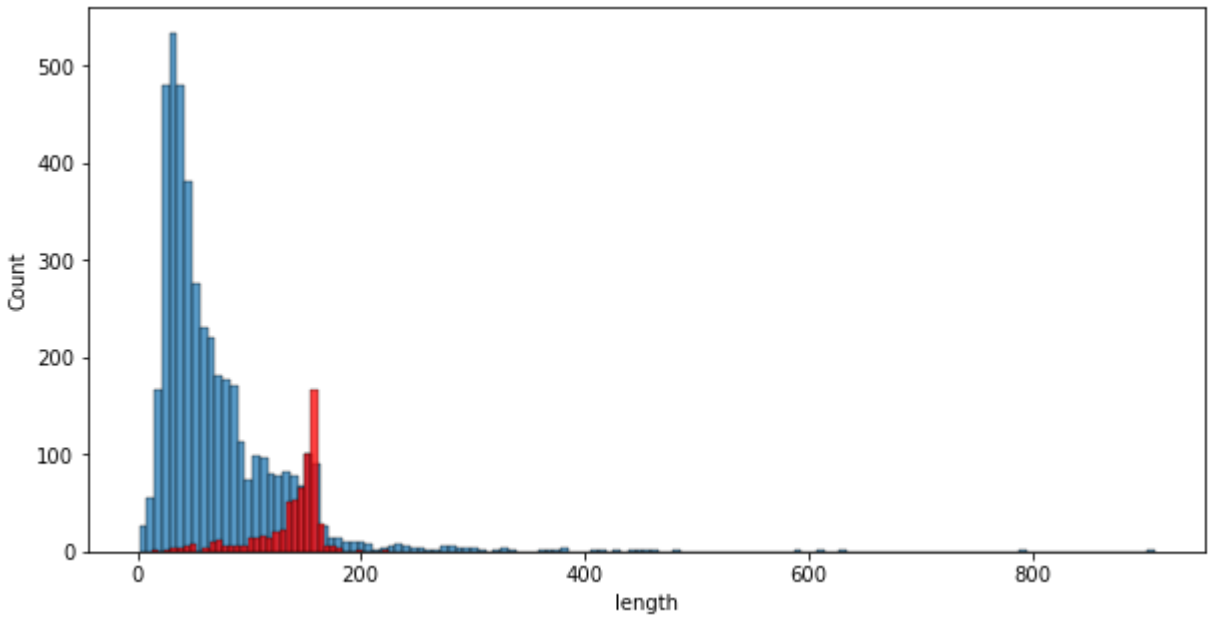
In [65]:
```
#describing data for spam messages
spam_data[spam_data['target'] == 1][['length','num_words','num_sent']].describe()
```

Out[65]:

	length	num_words	num_sent
count	653.000000	653.000000	653.000000
mean	137.891271	27.667688	2.969372
std	30.137753	7.008418	1.488910
min	13.000000	2.000000	1.000000
25%	132.000000	25.000000	2.000000
50%	149.000000	29.000000	3.000000
75%	157.000000	32.000000	4.000000
max	224.000000	46.000000	9.000000

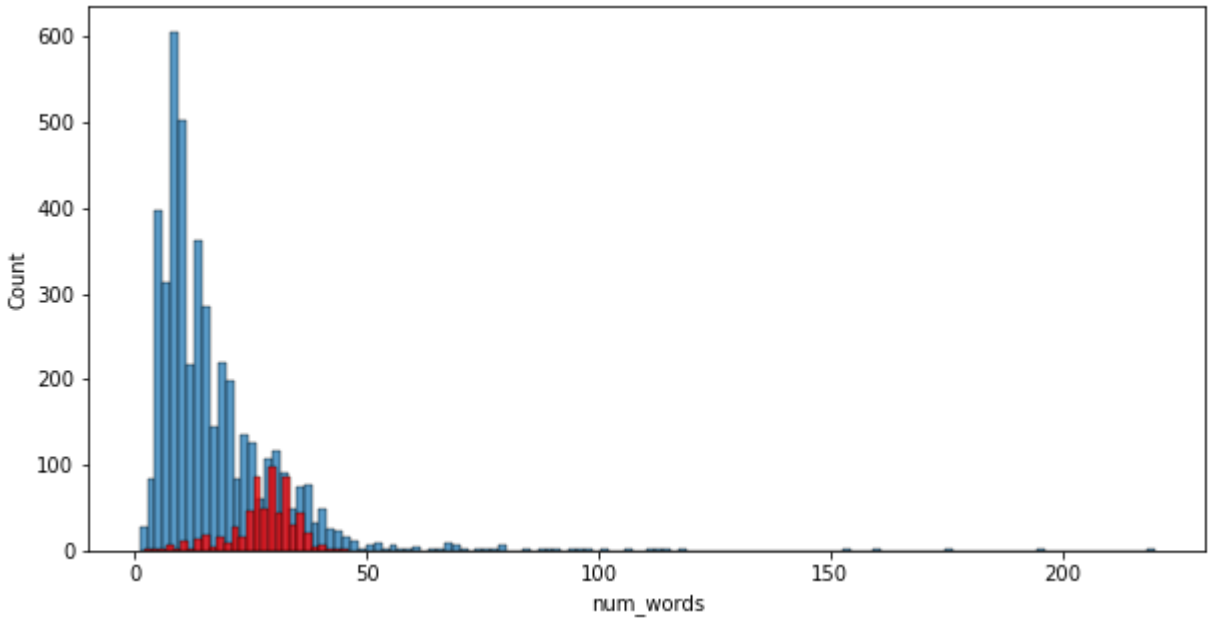
In [66]:
```
#plotting histogram
plt.figure(figsize=(10,5))
sns.histplot(spam_data[spam_data['target']==0]['length'])
sns.histplot(spam_data[spam_data['target']==1]['length'],color = 'red')
```

Out[66]: <AxesSubplot:xlabel='length', ylabel='Count'>



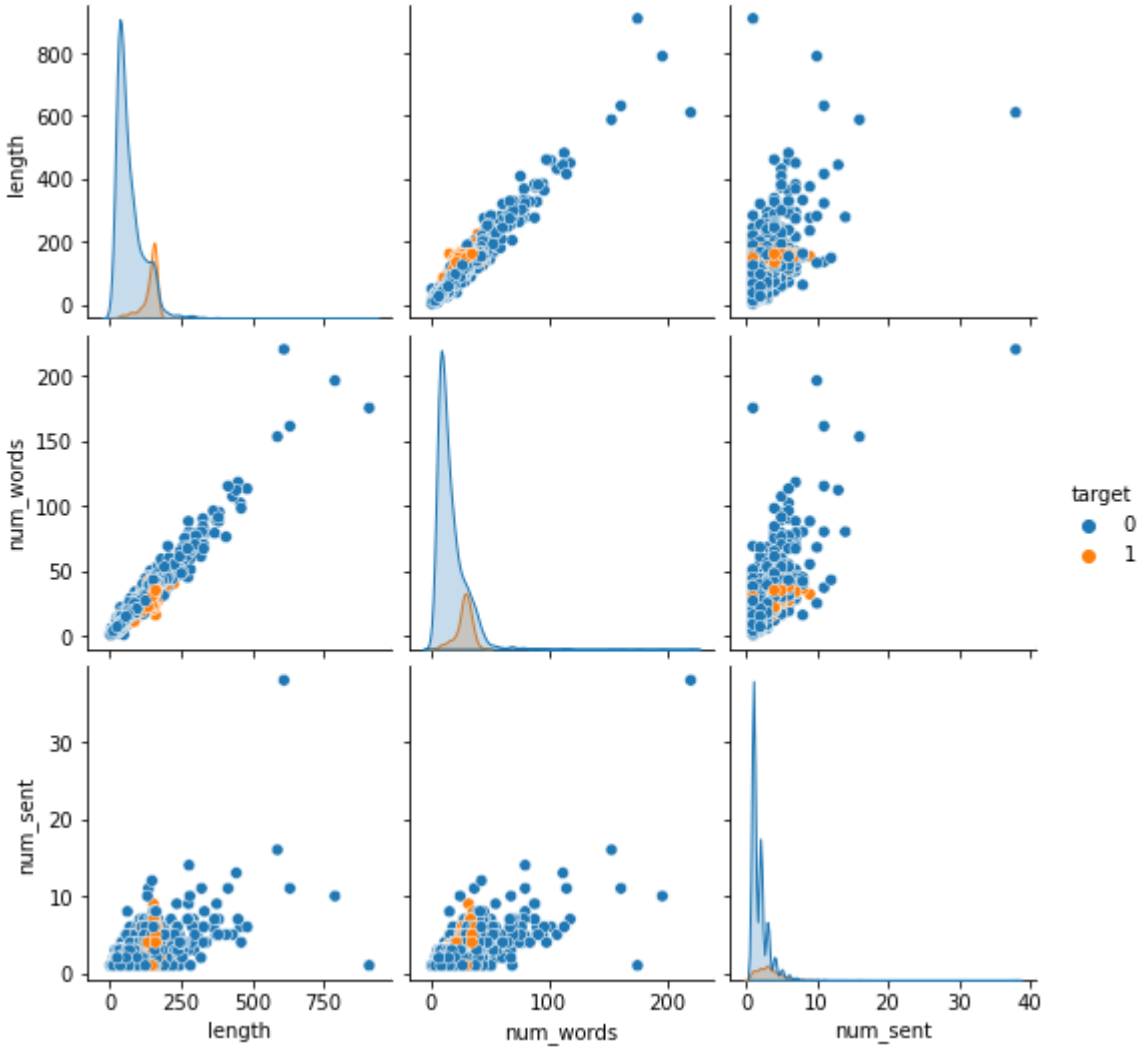
In [67]:
```
plt.figure(figsize=(10,5))
sns.histplot(spam_data[spam_data['target']==0]['num_words'])
sns.histplot(spam_data[spam_data['target']==1]['num_words'],color = 'red')
```

Out[67]: <AxesSubplot:xlabel='num_words', ylabel='Count'>



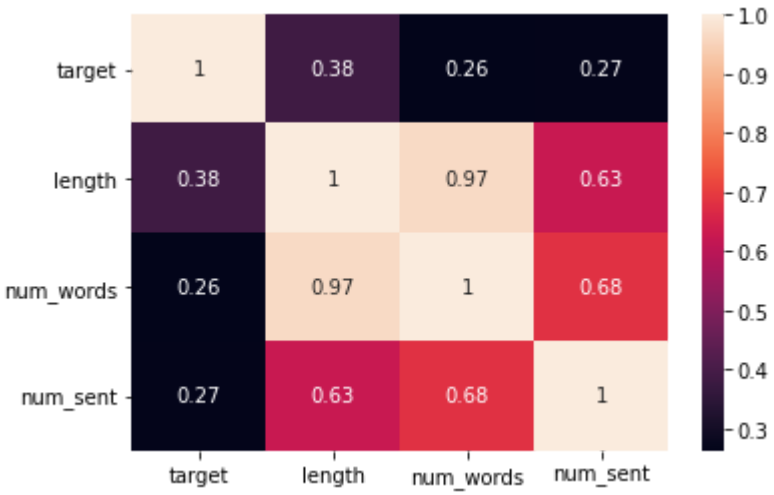
In [68]:
```
#pairplot for relationship between each column
sns.pairplot(spam_data, hue = 'target')
```

Out[68]: <seaborn.axisgrid.PairGrid at 0x212925601f0>



In [69]:
```
#Using heatmap for corelations between columns
sns.heatmap(spam_data.corr(), annot = True)
```

Out[69]: <AxesSubplot:>



Data preprocessing

In [70]:
```
ps= PorterStemmer()
```

In [71]:
```
# defining function to apply functions: Lowercase, Tokenize, Alphanumeric, Stopwo

def transform_text(message):
    message = message.lower()
    message = nltk.word_tokenize(message)
    y=[]
    for i in message:
        if i.isalnum():
            y.append(i)
    message = y[:]
    y.clear()

    for i in message:
        if i not in stopwords.words('english')and i not in string.punctuation:
            y.append(i)

    message = y[:]
    y.clear()

    for i in message:
        y.append(ps.stem(i))


    return " ".join(y)
```

In [72]:
```
spam_data["transformed_text"] = spam_data['message'].apply(transform_text)
```

In [73]:
```
spam_data.head()
```

Out[73]:

	target	message	length	num_words	num_sent	transformed_text
0	0	Go until jurong point, crazy.. Available only ...	111	24	2	go jurong point crazi avail bugi n great world...
1	0	Ok lar... Joking wif u oni...	29	8	2	ok lar joke wif u oni
2	1	Free entry in 2 a wkly comp to win FA Cup fina...	155	37	2	free entri 2 wkli comp win fa cup final tkt 21...
3	0	U dun say so early hor... U c already then say...	49	13	1	u dun say earli hor u c alreadi say
4	0	Nah I don't think he goes to usf, he lives aro...	61	15	1	nah think goe usf live around though

In [74]:
```
spam_data.shape
```

Out[74]:
```
(5169, 6)
```

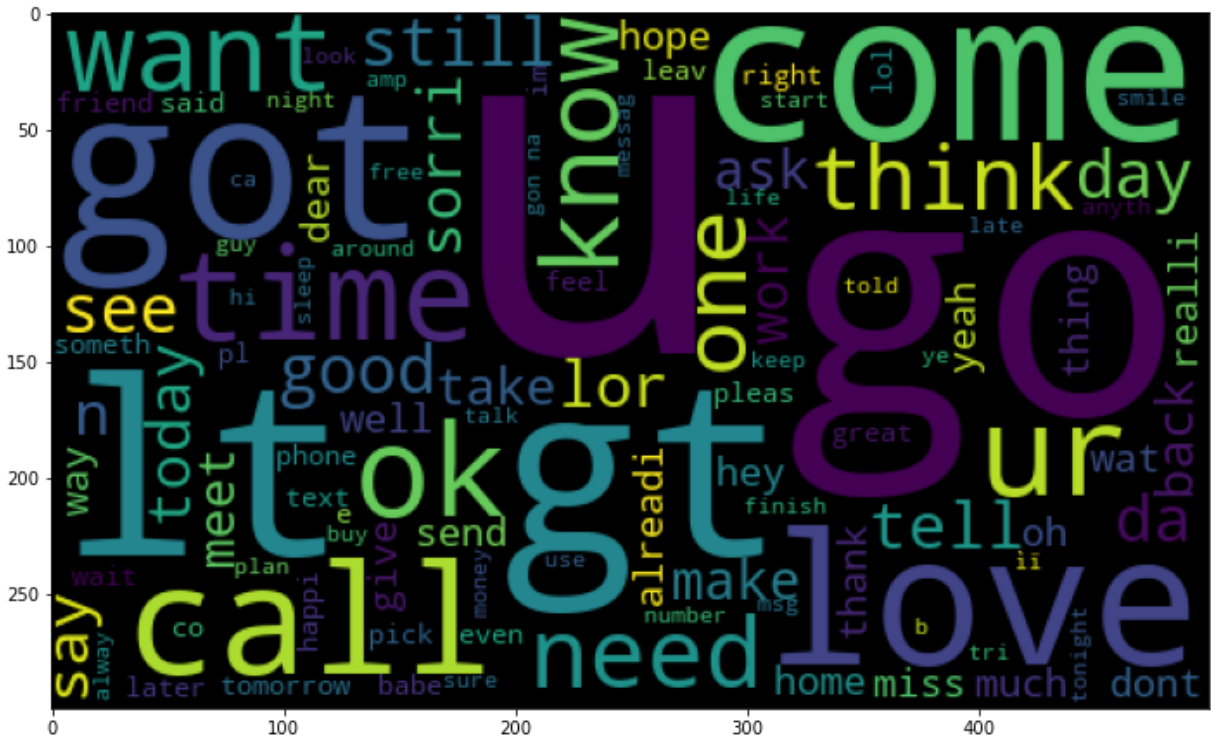
Wordcloud

In [75]:
```
wc = WordCloud(width = 500, height = 300, min_font_size= 10, background_color= 'b
```

In [76]:
```
#Generating Word Cloud for Spam Messages
spam_wordcloud = wc.generate(spam_data[spam_data['target']==1]['transformed_text'
plt.figure(figsize=(12,8))
plt.imshow(spam_wordcloud)
plt.show()
```

In the above Word Cloud, we can clearly see the words like text, free, reply, call, claim..etc. these words are generally seen in the SPAM Msgs.

In [77]:
```
#Generating Word Cloud for Ham Messages
ham_wordcloud = wc.generate(spam_data[spam_data['target']==0]['transformed_text']
plt.figure(figsize=(12,8))
plt.imshow(ham_wordcloud)
plt.show()
```



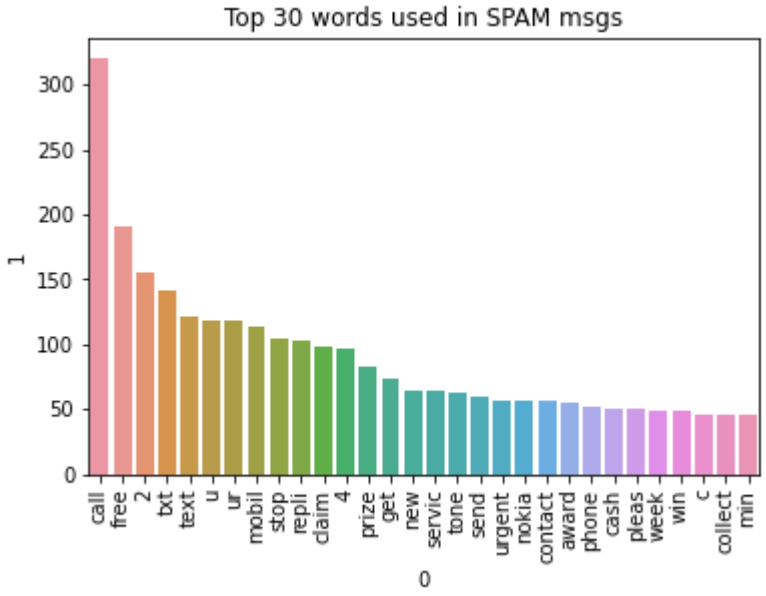
In the above Word Cloud, we can clearly see the words like love, come, go, call, time..etc. these words are generally seen in the Ham Msgs.

Top 30 words used in HAM and SPAM messaegs

In [78]:
```
spam_corpus = []
for msg in spam_data[spam_data['target']==1]['transformed_text'].tolist():
    for word in msg.split():
        spam_corpus.append(word)
```

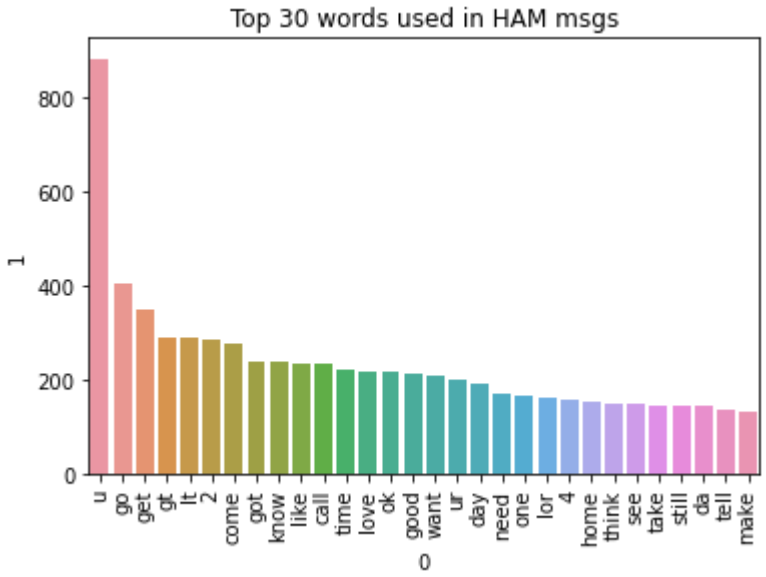
In [79]:
```
from collections import Counter
sns.barplot(pd.DataFrame(Counter(spam_corpus).most_common(30))[0] , pd.DataFrame(
plt.title("Top 30 words used in SPAM msgs")
plt.xticks(rotation = "vertical")
plt.show
```

Out[79]:
```
<function matplotlib.pyplot.show(close=None, block=None)>
```



In [80]:
```
ham_corpus = []
for msg in spam_data[spam_data['target']==0]['transformed_text'].tolist():
    for word in msg.split():
        ham_corpus.append(word)

sns.barplot(pd.DataFrame(Counter(ham_corpus).most_common(30))[0] , pd.DataFrame(C
plt.title("Top 30 words used in HAM msgs")
plt.xticks(rotation = "vertical")
plt.show
```

Out[80]:
```
<function matplotlib.pyplot.show(close=None, block=None)>
```



Creating Model

In [81]:
```
X=spam_data['message']
y=spam_data['target']
```

In [83]:
```
X
```

Out[83]:
```
0       Go until jurong point, crazy.. Available only ...
1                           Ok lar... Joking wif u oni...
2       Free entry in 2 a wkly comp to win FA Cup fina...
3       U dun say so early hor... U c already then say...
4       Nah I don't think he goes to usf, he lives aro...
                              ...
5567    This is the 2nd time we have tried 2 contact u...
5568                Will Ì_ b going to esplanade fr home?
5569    Pity, * was in mood for that. So...any other s...
5570    The guy did some bitching but I acted like i'd...
5571                            Rofl. Its true to its name
Name: message, Length: 5169, dtype: object
```

In [85]:
```
y
```

Out[85]:
```
0       0
1       0
2       1
3       0
4       0
       ..
5567    1
5568    0
5569    0
5570    0
5571    0
Name: target, Length: 5169, dtype: int64
```

Splitting Data into Train and Test

In [86]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y, random_state=20)
```

In [87]:
```
print (X.shape)
print (X_train.shape)
print (X_test.shape)
```

```
(5169,)
(3876,)
(1293,)
```

CountVectorizer

In [88]:
```
#Tokenization (a list of tokens), will be used as the analyzer
def process_text(text):

    #1 Remove Punctuation
    nopunc = [char for char in text if char not in string.punctuation]
    nopunc = ''.join(nopunc)

    #2 Remove Stop Words
    clean_words = [word for word in nopunc.split() if word.lower() not in stopwor

    #3 Return a list of clean words
    return clean_words
```

In [89]:
```
# Text Vectorization
cv = CountVectorizer()

messages_bow = CountVectorizer(analyzer=process_text).fit_transform(spam_data['me

X=messages_bow
y=spam_data['target']
```

In [90]:
```
#Splitting again data into train and test
X_train, X_test, y_train, y_test = train_test_split(X, y, random_state = 20)
```

In [91]:
```
# Defining the Classification Machine Learning Algorithms
lr = LogisticRegression(solver='lbfgs')
svc = LinearSVC()
bnb = BernoulliNB()
mnb = MultinomialNB()
xgb = XGBClassifier(verbosity=0)
sgd= SGDClassifier()

# Creating a function to train and test the model with evaluation metrics
def BuiltModel(model):
    print('*'*30+model.__class__.__name__+'*'*30)
    model.fit(X_train, y_train)
    y_pred = model.predict(X_train)
    pred = model.predict(X_test)
    accuracy = accuracy_score(y_test, pred)*100
    print(f"ACCURACY SCORE PERCENTAGE:", accuracy)
    # Confusion matrix and Classification report
    print(f"CLASSIFICATION REPORT: \n {classification_report(y_test, pred)}")
    print(f"CONFUSION MATRIX: \n {confusion_matrix(y_test, pred)}\n")
    print("-"*120)
    print("\n")
```

Training and testing of all the classification algorithms

In [92]:
```
for model in [lr,svc,bnb,mnb,xgb,sgd]:
    BuiltModel(model)
```

```
 [[1125    4]
 [  41  123]]

--------------------------------------------------------------------------------
----------------------------------------


******************************SGDClassifier******************************
ACCURACY SCORE PERCENTAGE: 97.52513534416086
CLASSIFICATION REPORT:
              precision    recall  f1-score   support

           0       0.97      1.00      0.99      1129
           1       0.99      0.82      0.89       164

    accuracy                           0.98      1293
   macro avg       0.98      0.91      0.94      1293
weighted avg       0.98      0.98      0.97      1293

CONFUSION MATRIX:
```

Cross validation score for best score models

In [93]:
```
def cross_val(model):
    print('*'*30+model.__class__.__name__+'*'*30)
    scores = cross_val_score(model,X,y, cv = 5).mean()
    print("Cross validation score:", scores)
    print("\n")

for model in [lr,svc,bnb,mnb,xgb,sgd]:
    cross_val(model)
```

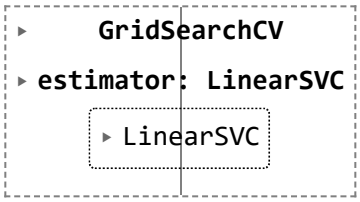
```
******************************LogisticRegression******************************
Cross validation score: 0.9729156407226889


******************************LinearSVC******************************
Cross validation score: 0.9775587432896243


******************************BernoulliNB******************************
Cross validation score: 0.9626630665785368


******************************MultinomialNB******************************
Cross validation score: 0.9649817155718168


******************************XGBClassifier******************************
Cross validation score: 0.9692405923667895


******************************SGDClassifier******************************
Cross validation score: 0.9748502511885346
```

HyperParameter Tuning

Linear SVC with GridSearchCV

In [94]:
```
# Lets select the different parameters for tuning our best model (Linear SVC)
grid_params =  {'C':(0.001, 0.01, 0.1, 1, 10),
                    'penalty':('l1','l2'),
                   'loss':('hinge','squared_hinge')}

# Train the model with given parameters using GridSearchCV
LSVC =  GridSearchCV(svc, grid_params, cv=3)
LSVC.fit(X_train, y_train)
```

Out[94]:



In [95]:
```
# Selecting the best parameters found by GridSearchCV
print(LSVC.best_params_)
print(LSVC.best_score_)
```

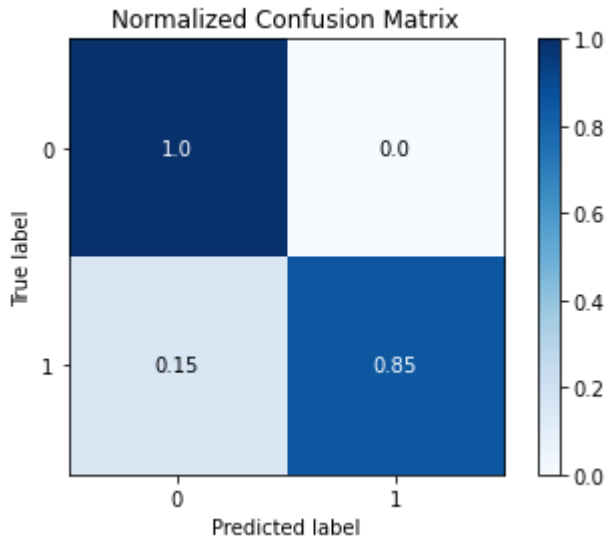
```
{'C': 1, 'loss': 'squared_hinge', 'penalty': 'l2'}
0.9721362229102167
```

In [96]:
```
# Final Model with the best chosen parameters list
best_model = LinearSVC(C= 1, loss= 'squared_hinge', penalty= 'l2')
best_model.fit(X_train,y_train) # fitting data to the best model
pred = best_model.predict(X_test)
accuracy = accuracy_score(y_test, pred)*100
# Printing the accuracy score
print("ACCURACY SCORE:", accuracy)
# Printing the classification report
print(f"\nCLASSIFICATION REPORT: \n {classification_report(y_test, pred)}")
# Printing the Confusion matrix
print(f"\nCONFUSION MATRIX: \n {confusion_matrix(y_test, pred)}")
```

```
ACCURACY SCORE: 98.06651198762569

CLASSIFICATION REPORT:
               precision    recall  f1-score   support

           0       0.98      1.00      0.99      1129
           1       1.00      0.85      0.92       164

    accuracy                           0.98      1293
   macro avg       0.99      0.92      0.95      1293
weighted avg       0.98      0.98      0.98      1293


CONFUSION MATRIX:
 [[1129    0]
 [  25  139]]
```

In [97]:
```
# Creating a normalized confusion matrix here
skplt.metrics.plot_confusion_matrix(y_test, pred, normalize=True)
```

Out[97]:
```
<AxesSubplot:title={'center':'Normalized Confusion Matrix'}, xlabel='Predicted
label', ylabel='True label'>
```



We got final 98% accuracy

Saving the Model

In [98]:
```
joblib.dump(best_model, "Email_Spam_Classifier.pkl")
```

Out[98]:
```
['Email_Spam_Classifier.pkl']
```

Best Model

In [99]:
```
Model = joblib.load("Email_Spam_Classifier.pkl")
# Predicting test data using loaded model
prediction = Model.predict(X_test)
# Analysing Predicted vs Actual results
Email_Spam_Detection_Classifier = pd.DataFrame()
Email_Spam_Detection_Classifier['Predicted Spam Messages Detection'] = predictior
Email_Spam_Detection_Classifier['Actual Spam Messages Detection'] = y
Email_Spam_Detection_Classifier
```

Out[99]:

	Predicted Spam Messages Detection	Actual Spam Messages Detection
0	0	0.0
1	0	0.0
2	1	1.0
3	0	0.0
4	0	0.0
...	...	...
1288	0	0.0
1289	0	0.0
1290	0	0.0
1291	0	0.0
1292	0	0.0

1293 rows × 2 columns

In [100]:
```
# Converting the dataframe into CSV format and saving it
Email_Spam_Detection_Classifier.to_csv('Email_Spam_Detection_Classifier.csv', inc
```

After applying the hyper parameter tuning the best accuracy score obtained was 98.06651198762569% which can be further improved by obtaining more data and working up through other parameter combinations.

Thank You

In [ ]:
```

```