In [1]:
```
import os
from pathlib import Path
import pandas as pd
import re
import sklearn
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.naive_bayes import MultinomialNB
from sklearn.metrics import accuracy_score
from sklearn.metrics import roc_auc_score
from sklearn.svm import SVC
from scipy.sparse import csr_matrix, hstack
from sklearn.metrics import confusion_matrix
from sklearn.linear_model import LogisticRegression
from sklearn.metrics import classification_report
from sklearn.metrics import f1_score
import nltk
import time
import numpy as np

from nltk.corpus import stopwords
nltk.download('stopwords')
from nltk.tokenize import word_tokenize

current_dir = Path(os.getcwd()).absolute()
data_dir = current_dir.joinpath('data')
file = data_dir.joinpath('spam.csv')

spam = pd.read_csv(file, encoding = 'Windows-1252')
cleanup_spam = {'v1':     {'spam': 1, 'ham': 0}}
```

```
[nltk_data] Downloading package stopwords to C:\Users\Kyle
[nltk_data]     Morris\AppData\Roaming\nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
```

In [2]:
```
spam = spam.replace(cleanup_spam)
```

In [3]:
```
spam['text'] = spam['v2']
spam['class'] = spam['v1']

data = spam.drop(['v1', 'v2'], axis = 1)
```

In [4]:
```
data['class'].mean()
```

Out[4]:
```
0.13406317300789664
```

In [5]:
```
data['len'] = [len(row) for row in data['text']]
```

In [ ]:
```

```

In [ ]:
```

```

In [6]:

```
def clean_text(text):

    text = ' '.join(re.sub("(@[A-Za-z0-9]+)|([^0-9A-Za-z \t])|(\w+:\/\/\S+)", " ", text).split())
    text_tokens = word_tokenize(text)

    tokens_without_sw = [word for word in text_tokens if not word in stopwords.words()]
    joined_text = (" ").join(tokens_without_sw)
    clean_text.counter += 1
    if (clean_text.length - clean_text.counter) % 100 == 0:
        elapsed = time.perf_counter() - clean_text.start
        remaining = clean_text.length - clean_text.counter
        print('Row: ', remaining, ' Completion: ', clean_text.counter / clean_text.length * 100, '%')
        timeleft = remaining / clean_text.counter * elapsed
        print('Time elapsed: ', elapsed, ' seconds.\nTime remaining: ', timeleft, 'seconds.')

    return joined_text
clean_text.start = time.perf_counter()
clean_text.elapsed = 0
clean_text.counter = 0
clean_text.length = len(data)
data['text'] = data.apply(lambda row: clean_text(str(row['text'])), axis = 1)
```

```
Time elapsed:  369.12009559999996  seconds.
Time remaining:  279.2838049936948 seconds.
Row:  2300  Completion:  58.72218234027279 %
Time elapsed:  379.4046962  seconds.
Time remaining:  266.6964551528117 seconds.
Row:  2200  Completion:  60.51687006460876 %
Time elapsed:  390.665529  seconds.
Time remaining:  254.88261085409252 seconds.
Row:  2100  Completion:  62.311557788944725 %
Time elapsed:  401.2724624  seconds.
Time remaining:  242.70511838709677 seconds.
Row:  2000  Completion:  64.1062455132807 %
Time elapsed:  412.1834024  seconds.

Time remaining:  230.7857796192609 seconds.
Row:  1900  Completion:  65.90093323761666 %
Time elapsed:  422.5250828  seconds.
Time remaining:  218.62681299564272 seconds.
Row:  1800  Completion:  67.69562096195261 %
Time elapsed:  431.7983895  seconds.
```

In [7]:
```
X_train, X_test, y_train, y_test = train_test_split(data['text'], data['class'], random_state=0)
```

In [8]:
```
spamdata = data[data['class'] == 1]
nonspamdata = data[data['class'] == 0]

spamlength = spamdata['len'].mean()
nonspamlength = nonspamdata['len'].mean()
```

In [9]:
```
data['class'].value_counts()
```

Out[9]:
```
0    4825
1     747
Name: class, dtype: int64
```

In [10]:
```
spam_list = spamdata['text'].tolist()
spam_string = ""
for row in spam_list:
    spam_string += row

spam_string = spam_string.lower()
spam_string = ' '.join(re.sub("(@[A-Za-z0-9]+)|([^0-9A-Za-z \t])|(\w+:\/\/\S+)", " ", spam_string).split())

nonspam_list = nonspamdata['text'].tolist()
nonspam_string = ""
for row in nonspam_list:
    nonspam_string += row

nonspam_string = nonspam_string.lower()
nonspam_string = ' '.join(re.sub("(@[A-Za-z0-9]+)|([^0-9A-Za-z \t])|(\w+:\/\/\S+)", " ", nonspam_string).split()
```

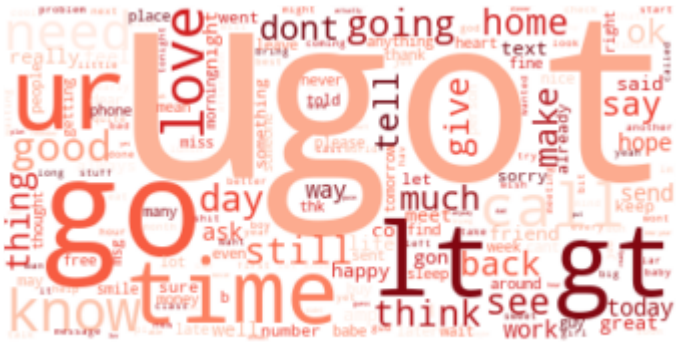
In [11]:
```
nonspam_string
```

```
taking class usummma call check life begin qatar pls pray haruk deleted contactsindu got job birla sorthe w
ine flowing neveringyup thk better cos need 2 go 2 plaza mahok ur typical replyas request melle melle oru mi
nnaminunginte nurungu vettam set callertune callers press 9 copy friends callertuneyou everywhere dirt floor
windows even shirt and sometimes open mouth comes flowing i dream world without half chores a time joy lots
tv shows see but guess like things must exist like rain hail mist time done becomeaaoooooright worki leaving
househello love what did get interview today are happy are good boy do think are missingkeep safe i need i m
iss already i envy everyone see real lifenew car house parents new job handi love i excited day spend you ma
ke happyi place ur points cultures module alreadyhi frnd best way avoid missunderstding wit belovedgreat esc
ape i fancy bridge needs lager see tomoyes completely form clark utter wastesir i need axis bank account ban
k addresshmmm thk sure got time hop ard ya go 4 free abt muz call discuss liaowhat time coming laterbloody h
ell cant believe forgot surname mr ill give clue spanish beginswell gon finish bath have good fine nightlet
know got money carlos make callu still going mallturns friends staying whole show back lt gt feel free go ah
ead smoke lt gt worthtext if doesnt reply let know loghi you spoke maneesha v we like know satisfied experie
nce reply toll free yes noyou lifted hopes offer money i need especially month approaches hurts studying any
ways gr8 weekendlol u trustok i gentleman treat dignity respecthe guys closegoing nothing great byehello han
dsome are finding job not lazy working towards getting back net mummy where boytoy does misshaha awesome min
utehave got xmas radio times if geti jus reached home i go bathe first but sis using net tell finishesi sorr
y i joined league people dont keep touch you mean great deal you friend times even great personal cost do gr
eat weekhi finally completed courseit stop i however suggest stays someone able give ors every stoolhow hope
settled new school year just wishin gr8 daygud mrng dear hav nice daydid got persons storyhamster dead hey t
```

In [12]:
```
import os
from wordcloud import WordCloud
import matplotlib.pyplot as plt

wordcloud = WordCloud(max_font_size = 160, margin=0, background_color = "white", colormap="Reds").generate(spam_

plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```

```
<Figure size 640x480 with 1 Axes>
```

In [13]:
```
wordcloud = WordCloud(max_font_size = 160, margin=0, background_color = "white", colormap="Reds").generate(nonsp

plt.imshow(wordcloud, interpolation='bilinear')
plt.axis("off")
plt.show()
```



In [14]:
```
print('rows in test set: ' + str(X_test.shape))
print('rows in train set: ' + str(X_train.shape))
```

```
rows in test set: (1393,)
rows in train set: (4179,)
```

In [15]:
```
xlist = X_train.tolist()
vectorizer = TfidfVectorizer(
    input= xlist)

features_train_transformed = vectorizer.fit_transform(xlist)
features_test_transformed  = vectorizer.transform(X_test)
```

In [16]:
```
classifier = MultinomialNB()
classifier.fit(features_train_transformed, y_train)
```

Out[16]:
```
MultinomialNB(alpha=1.0, class_prior=None, fit_prior=True)
```

In [17]:
```
print('Multinomial NB accuracy: ', classifier.score(features_test_transformed, y_test) * 100, '%')
```

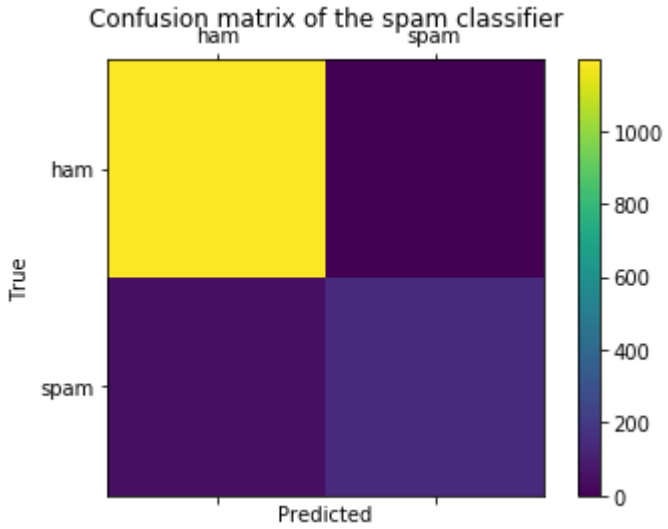
```
Multinomial NB accuracy:  96.33883704235463 %
```

In [18]:
```
test_labels = classifier.predict(features_test_transformed)

actuals = y_test.tolist()
predictions = test_labels
labels = ['ham', 'spam']

results = confusion_matrix(actuals, predictions)
```

In [19]:

```
print(results)
fig = plt.figure()
ax = fig.add_subplot(111)
cax = ax.matshow(results)
plt.title('Confusion matrix of the spam classifier')
fig.colorbar(cax)
ax.set_xticklabels([''] + labels)
ax.set_yticklabels([''] + labels)
plt.xlabel('Predicted')
plt.ylabel('True')
plt.show()
```

```
[[1196    0]
 [  51  146]]
```



In [20]:
```
print ('Accuracy Score :',accuracy_score(actuals, predictions))
print ('Report : ')
print (classification_report(actuals, predictions) )
score_2 = f1_score(actuals, predictions, average = 'binary')
print('F-Measure: %.3f' % score_2)
```

```
Accuracy Score : 0.9633883704235463
Report :
              precision    recall  f1-score   support

           0       0.96      1.00      0.98      1196
           1       1.00      0.74      0.85       197

   micro avg       0.96      0.96      0.96      1393
   macro avg       0.98      0.87      0.92      1393
weighted avg       0.96      0.96      0.96      1393

F-Measure: 0.851
```

In [21]:
```
def add_feature(X, feature):


    return hstack([X, csr_matrix(feature).T], 'csr')
vectorizer = TfidfVectorizer(min_df=5, ngram_range=[1,3])
X_train_transformed = vectorizer.fit_transform(X_train)
X_train_transformed_with_length = add_feature(X_train_transformed, [X_train.str.len(),
                                                                    X_train.apply(lambda x: len(''.join([a for a

X_test_transformed = vectorizer.transform(X_test)
X_test_transformed_with_length = add_feature(X_test_transformed, [X_test.str.len(),
                                                                  X_test.apply(lambda x: len(''.join([a for a in
```

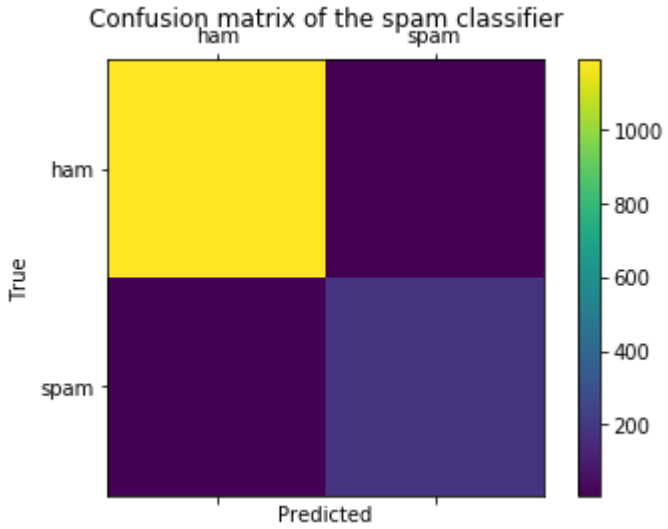
In [22]:
```
log = LogisticRegression(C = 100)

log.fit(X_train_transformed_with_length, y_train)

y_predicted = log.predict(X_test_transformed_with_length)

roc_auc_score(y_test, y_predicted)
```

```
C:\ProgramData\Anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:433: FutureWarning: Default solver
will be changed to 'lbfgs' in 0.22. Specify a solver to silence this warning.
  FutureWarning)
```

Out[22]:
```
0.9666167258034396
```

In [23]:
```
results = confusion_matrix(y_test, y_predicted)
print(results)
fig = plt.figure()
ax = fig.add_subplot(111)
cax = ax.matshow(results)
plt.title('Confusion matrix of the spam classifier')
fig.colorbar(cax)
ax.set_xticklabels([''] + labels)
ax.set_yticklabels([''] + labels)
plt.xlabel('Predicted')
plt.ylabel('True')
plt.show()
```

```
[[1189    7]
 [  12  185]]
```



In [24]:
```
print ('Accuracy Score :',accuracy_score(y_test, y_predicted))
print ('Report : ')
print (classification_report(y_test, y_predicted) )
score_2 = f1_score(y_test, y_predicted, average = 'binary')
print('F-Measure: %.3f' % score_2)
```

```
Accuracy Score : 0.9863603732950467
Report :
              precision    recall  f1-score   support

           0       0.99      0.99      0.99      1196
           1       0.96      0.94      0.95       197

   micro avg       0.99      0.99      0.99      1393
   macro avg       0.98      0.97      0.97      1393
weighted avg       0.99      0.99      0.99      1393

F-Measure: 0.951
```

In [25]:
```
nonspamlength
```

Out[25]:
```
71.62818652849741
```

In [26]:
```
spamlength
```

Out[26]:
```
139.15127175368139
```

In [ ]:
```

```