Spam Detection

March 14, 2023

1 SMS Spam Detection

1.0.1 by Jason Paul Miller

03/14/23 PI Day

2 Important Imports

[ ]:
```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
pd.options.mode.chained_assignment = None  # removes false positive warning
import matplotlib.pyplot as plt
import re # Text cleanup
import string # Text cleanup
from gensim.models import Word2Vec
from sklearn.preprocessing import StandardScaler
from keras.models import Sequential
from keras.layers import Conv1D, GlobalMaxPooling1D, Dense
from sklearn.metrics import mean_squared_error
```

2.0.1 Read in the data

[ ]:
```
data = pd.read_csv('spam.csv', encoding='latin-1')
data
```

[ ]:
```
        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]
```

2.0.2 Clean up the data

[ ]:
```
# Remove unnecessary columns
data = data.drop(['Unnamed: 2', 'Unnamed: 3', 'Unnamed: 4'], axis = 1)
print(data.shape)
data
```

```
(5572, 2)
```

[ ]:
```
        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]
```

[ ]:
```
# Remove any duplicates
data = data.drop_duplicates()
print(data.shape)
```

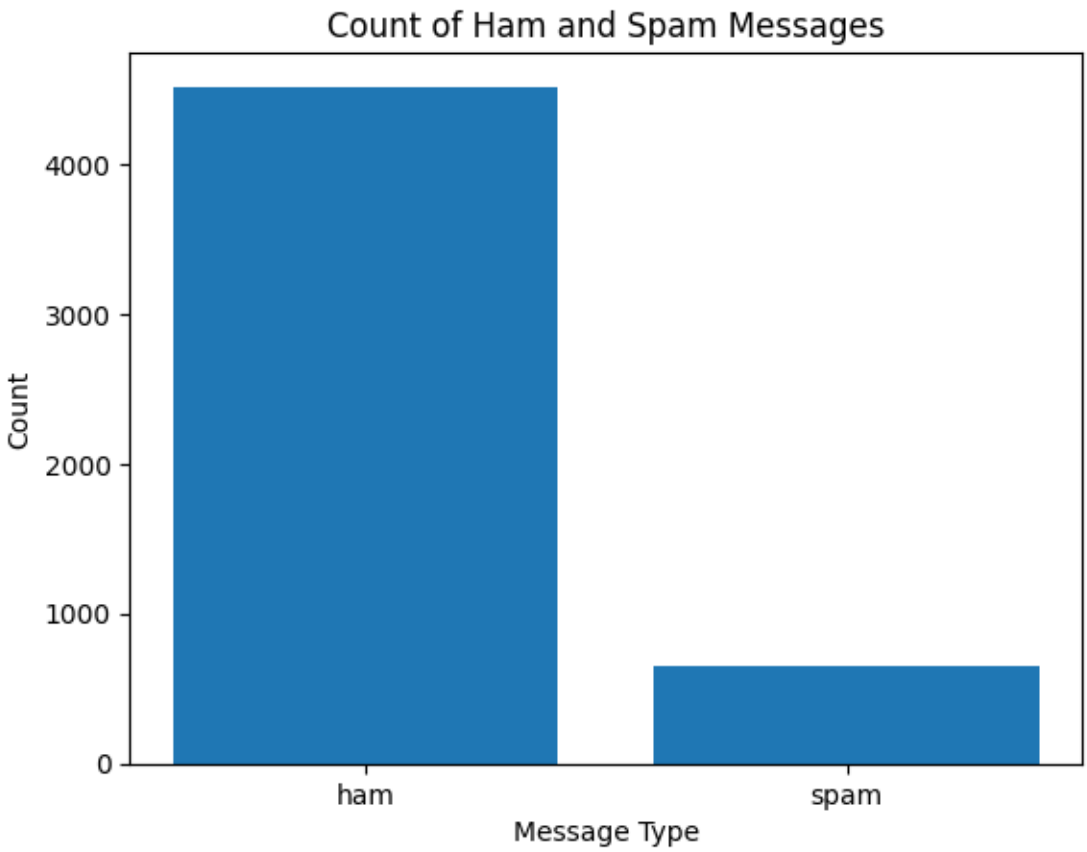
```
(5169, 2)
```

[ ]:
```
def clean_text(text):
    # Remove punctuation
    text = text.translate(str.maketrans('', '', string.punctuation))

    # Remove digits
    text = re.sub(r'\d+', '', text)

    # Convert to lowercase
    text = text.lower()

    return text

# Text Cleaning
data.loc[:, 'v2'] = data['v2'].apply(clean_text)
```

2.0.3 Visualize the data

[ ]:
```
# Count the number of 'ham' and 'spam' messages
ham_count = (data['v1'] == 'ham').sum()
spam_count = (data['v1'] == 'spam').sum()

# Plot a bar chart of the counts
labels = ['ham', 'spam']
counts = [ham_count, spam_count]
plt.bar(labels, counts)
plt.xlabel('Message Type')
plt.ylabel('Count')
plt.title('Count of Ham and Spam Messages')
```

[ ]:
```
Text(0.5, 1.0, 'Count of Ham and Spam Messages')
```



2.0.4 Split the Data

[ ]:
```
# Randomize the rows
data = data.sample(frac=1, random_state=42)

# Split the data into training and test sets
train_data = data[:int(0.9*len(data))]
test_data = data[int(0.9*len(data)):]

# Print the shapes of the training and test sets
print('Training data shape:', train_data.shape)
print('Test data shape:', test_data.shape)
```

```
Training data shape: (4652, 2)
Test data shape: (517, 2)
```

2.0.5 Word Embedding

[ ]:
```
# Train the model
model = Word2Vec(train_data['v2'], vector_size=100, window=5, min_count=1,␣
 ↪workers=4)

# Create a dictionary that maps each word to its corresponding vector␣
 ↪representation
word_vectors = model.wv

# Convert each text into a fixed-length vector by taking the mean of the word␣
 ↪vectors
text_vectors = []
for text in train_data['v2']:
    words = text.split()
    vectors = []
    for word in words:
        if word in word_vectors.key_to_index:
            vectors.append(word_vectors.get_vector(word))
    if len(vectors) > 0:
        text_vector = np.mean(vectors, axis=0)
    else:
        text_vector = np.zeros(100)
    text_vectors.append(text_vector)

X_train = np.array(text_vectors)
y_train = np.array([1 if label == 'spam' else 0 for label in train_data['v1']])
```

Do the same for the test data

[ ]:
```
# Train the model
model = Word2Vec(test_data['v2'], vector_size=100, window=5, min_count=1,␣
 ↪workers=4)

# Create a dictionary that maps each word to its corresponding vector␣
 ↪representation
word_vectors = model.wv

# Convert each text into a fixed-length vector by taking the mean of the word␣
 ↪vectors
text_vectors = []
for text in test_data['v2']:
    words = text.split()
    vectors = []
    for word in words:
        if word in word_vectors.key_to_index:
            vectors.append(word_vectors.get_vector(word))
```

```
    if len(vectors) > 0:
        text_vector = np.mean(vectors, axis=0)
    else:
        text_vector = np.zeros(100)
    text_vectors.append(text_vector)

X_test = np.array(text_vectors)
y_test = np.array([1 if label == 'spam' else 0 for label in test_data['v1']])
```

2.0.6 Train a CNN

[ ]:
```
# Create a simple CNN
model = Sequential()
model.add(Conv1D(filters=64, kernel_size=3, activation='relu',␣
 ↪input_shape=(X_train.shape[1], 1)))
model.add(GlobalMaxPooling1D())
model.add(Dense(units=1, activation='sigmoid'))

# Reshape X to a 3D numpy array with shape (num_samples, num_timesteps,␣
 ↪num_features)
X_reshaped = np.array(X_train).reshape((X_train.shape[0], X_train.shape[1], 1))

# Train the model
model.compile(loss='binary_crossentropy', optimizer='adam',␣
 ↪metrics=['accuracy'])
model.fit(X_reshaped, y_train, batch_size=32, epochs=10, validation_split=0.2)
```

```
Epoch 1/10
2023-03-14 18:51:16.590230: W
tensorflow/tsl/platform/profile_utils/cpu_utils.cc:128] Failed to get CPU
frequency: 0 Hz
117/117 [==============================] - 1s 2ms/step - loss: 0.5074 -
accuracy: 0.8573 - val_loss: 0.4172 - val_accuracy: 0.8668
Epoch 2/10
117/117 [==============================] - 0s 1ms/step - loss: 0.3961 -
accuracy: 0.8705 - val_loss: 0.3954 - val_accuracy: 0.8668
Epoch 3/10
117/117 [==============================] - 0s 2ms/step - loss: 0.3845 -
accuracy: 0.8705 - val_loss: 0.3872 - val_accuracy: 0.8668
Epoch 4/10
117/117 [==============================] - 0s 2ms/step - loss: 0.3775 -
accuracy: 0.8705 - val_loss: 0.3807 - val_accuracy: 0.8668
Epoch 5/10
117/117 [==============================] - 0s 2ms/step - loss: 0.3720 -
accuracy: 0.8705 - val_loss: 0.3762 - val_accuracy: 0.8668
Epoch 6/10
```

```
117/117 [==============================] - 0s 1ms/step - loss: 0.3677 -
accuracy: 0.8705 - val_loss: 0.3721 - val_accuracy: 0.8668
Epoch 7/10
117/117 [==============================] - 0s 1ms/step - loss: 0.3642 -
accuracy: 0.8705 - val_loss: 0.3689 - val_accuracy: 0.8668
Epoch 8/10
117/117 [==============================] - 0s 1ms/step - loss: 0.3609 -
accuracy: 0.8705 - val_loss: 0.3680 - val_accuracy: 0.8668
Epoch 9/10
117/117 [==============================] - 0s 2ms/step - loss: 0.3583 -
accuracy: 0.8702 - val_loss: 0.3645 - val_accuracy: 0.8647
Epoch 10/10
117/117 [==============================] - 0s 2ms/step - loss: 0.3565 -
accuracy: 0.8705 - val_loss: 0.3618 - val_accuracy: 0.8647
```

[ ]:
```
<keras.callbacks.History at 0x292be0850>
```

2.0.7 Test our model

[ ]:
```python
# Make predictions on the test set
y_pred = model.predict(X_test)
y_pred = np.round(y_pred).flatten()

# Calculate the MSE
mse = mean_squared_error(y_test, y_pred)
print("MSE:", mse)

# Compare the predicted labels with the actual labels
accuracy = (y_pred == y_test).mean()
print('Accuracy:', accuracy)
```

```
17/17 [==============================] - 0s 710us/step
17/17 [==============================] - 0s 710us/step
MSE: 0.09090909090909091
Accuracy: 0.9090909090909091
```