

## Assignment – 4

### Python Programming

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Maximum Mark	2 Mark

```
In [1]: import pandas as pd
import numpy as np
from keras import utils
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder
from keras.models import Model
from keras.layers import LSTM, Activation, Dense, Dropout, Input, Embedding
from keras.optimizers import RMSprop
from keras.preprocessing.text import Tokenizer
from keras.preprocessing import sequence
from keras.utils import to_categorical
%matplotlib inline
```

```
In [4]: df = pd.read_csv('spam.csv',delimiter=',',encoding='latin-1')
df.head()
```

```
Out[4]:
```

	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

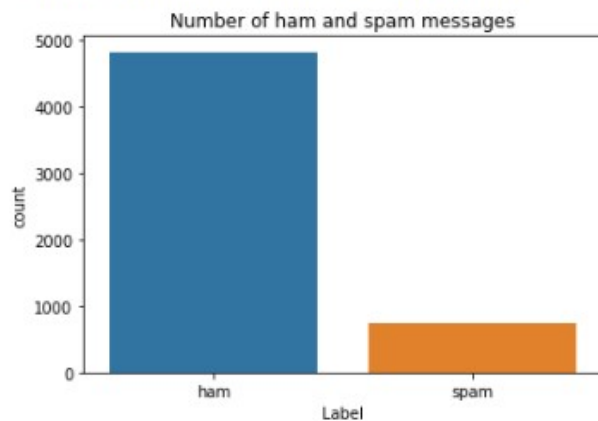
### Preprocessing

```
In [5]: df.drop(['Unnamed: 2', 'Unnamed: 3', 'Unnamed: 4'],axis=1,inplace=True)
df.info()
```

```
RangeIndex: 5572 entries, 0 to 5571
Data columns (total 2 columns):
#   Column  Non-Null Count  Dtype
---  ------  -
0    v1      5572 non-null     object
1    v2      5572 non-null     object
dtypes: object(2)
memory usage: 87.2+ KB
```

```
In [6]: sns.countplot(df.v1)
plt.xlabel('Label')
plt.title('Number of ham and spam messages')
```

Out[6]: Text(0.5, 1.0, 'Number of ham and spam messages')



```
In [7]: X = df.v2
Y = df.v1
le = LabelEncoder()
Y = le.fit_transform(Y)
Y = Y.reshape(-1,1)
```

```
In [8]: X_train,X_test,Y_train,Y_test = train_test_split(X,Y,test_size=0.15)
```

```
In [8]: X_train,X_test,Y_train,Y_test = train_test_split(X,Y,test_size=0.15)
```

```
In [9]: max_words = 1000
max_len = 150
tok = Tokenizer(num_words=max_words)
tok.fit_on_texts(X_train)
sequences = tok.texts_to_sequences(X_train)
sequences_matrix = utils.pad_sequences(sequences,maxlen=max_len)
```

```
In [10]: sequences_matrix.shape
```

Out[10]: (4736, 150)

```
In [11]: sequences_matrix.ndim
```

Out[11]: 2

```
In [12]: sequences_matrix = np.reshape(sequences_matrix,(4736,150,1))
```

```
In [13]: sequences_matrix.ndim #3d shape verification to proceed to RNN LSTM
```

Out[13]: 3

## RNN Construction

```
In [14]: from keras.models import Sequential
        from keras.layers import Dense
        from keras.layers import LSTM
        from keras.layers import Embedding
```

```
In [15]: model = Sequential()
        model.add(Embedding(max_words,50,input_length=max_len))
```

```
In [16]: model.add(LSTM(units=64,input_shape = (sequences_matrix.shape[1],1),return_sequences=True))
        model.add(LSTM(units=64,return_sequences=True))
        model.add(LSTM(units=64,return_sequences=True))
        model.add(LSTM(units=64))
        model.add(Dense(units = 256,activation = 'relu'))
        model.add(Dense(units = 1,activation = 'sigmoid'))
```

```
In [17]: model.summary()
        model.compile(loss='binary_crossentropy',optimizer=RMSprop(),metrics=['accuracy'])
```

Model: "sequential"

Layer (type)	Output Shape	Param #
=====		
embedding (Embedding)	(None, 150, 50)	50000
lstm (LSTM)	(None, 150, 64)	29440
lstm_1 (LSTM)	(None, 150, 64)	33024
lstm_2 (LSTM)	(None, 150, 64)	33024
lstm_3 (LSTM)	(None, 64)	33024
dense (Dense)	(None, 256)	16640
dense_1 (Dense)	(None, 1)	257

=====

Total params: 195,409  
Trainable params: 195,409  
Non-trainable params: 0

=====

### Fit on the training data

```
In [18]: M = model.fit(sequences_matrix,Y_train,batch_size=128,epochs=5,validation_split=0.2)

Epoch 1/5
30/30 [=====] - 39s 1s/step - loss: 0.3358 - accuracy: 0.8691 - val_loss: 0.1724 - val_accuracy: 0.9536
Epoch 2/5
30/30 [=====] - 29s 972ms/step - loss: 0.0913 - accuracy: 0.9736 - val_loss: 0.0774 - val_accuracy: 0.9768
Epoch 3/5
30/30 [=====] - 32s 1s/step - loss: 0.0592 - accuracy: 0.9842 - val_loss: 0.0669 - val_accuracy: 0.9831
Epoch 4/5
30/30 [=====] - 29s 959ms/step - loss: 0.0458 - accuracy: 0.9865 - val_loss: 0.0678 - val_accuracy: 0.9810
Epoch 5/5
30/30 [=====] - 29s 980ms/step - loss: 0.0378 - accuracy: 0.9889 - val_loss: 0.0700 - val_accuracy: 0.9810
```

### Saving the model

```
In [19]: model.save
```

```
Out[19]: >
```

### Evaluate the model on test set data

```
In [20]: test_sequences = tok.texts_to_sequences(X_test)
test_sequences_matrix = utils.pad_sequences(test_sequences,maxlen=max_len)
```

```
In [21]: accr = model.evaluate(test_sequences_matrix,Y_test)
```

```
27/27 [=====] - 4s 81ms/step - loss: 0.0649 - accuracy: 0.9785
```

```
In [22]: l = accr[0]
a = accr[1]
print('Test set\n Loss: {:.3f}\n Accuracy: {:.3f}'.format(l,a))
```

```
Test set
Loss: 0.065
Accuracy: 0.978
```

### Accuracy and Loss Graph

```
In [23]: results = pd.DataFrame({"Train Loss": M.history['loss'], "Validation Loss": M.history['val_loss'],
                                "Train Accuracy": M.history['accuracy'], "Validation Accuracy": M.history['val_accuracy']}
                                })
fig, ax = plt.subplots(nrows=2, figsize=(16, 9))
results[["Train Loss", "Validation Loss"]].plot(ax=ax[0])
results[["Train Accuracy", "Validation Accuracy"]].plot(ax=ax[1])
ax[0].set_xlabel("Epoch")
ax[1].set_xlabel("Epoch")
plt.show()
```

