LSTM

February 2, 2018

```
In [1]: %matplotlib inline
        from imp import reload

        import itertools
        import numpy as np
        import utils; reload(utils)

        from utils import *
        from __future__ import print_function
        from sklearn.metrics import confusion_matrix, classification_report, f1_score
        import matplotlib.pyplot as plt
```

```
In [2]: from keras.preprocessing import sequence
        from keras.models import Sequential
        from keras.layers import Dense, Embedding
        from keras.layers import LSTM
        from keras.datasets import imdb
        from keras.utils import plot_model
        from keras.utils.vis_utils import model_to_dot

        from IPython.display import SVG
        from IPython.display import Image
```

```
/home/konstantin/.local/lib/python3.5/site-packages/h5py/__init__.py:36: FutureWarning: Conversi
  from ._conv import register_converters as _register_converters
Using TensorFlow backend.
```

```
In [3]: max_features = 20000
        embedding_size = 128
        lstm_output_size = 128
        maxlen = 80
        batch_size = 32
        epochs = 4
```

```
In [4]: print('Loading data...')
        (x_train, y_train), (x_test, y_test) = imdb.load_data(num_words=max_features)
        print(len(x_train), 'train sequences')
        print(len(x_test), 'test sequences')
```

```
Loading data...
25000 train sequences
25000 test sequences
```

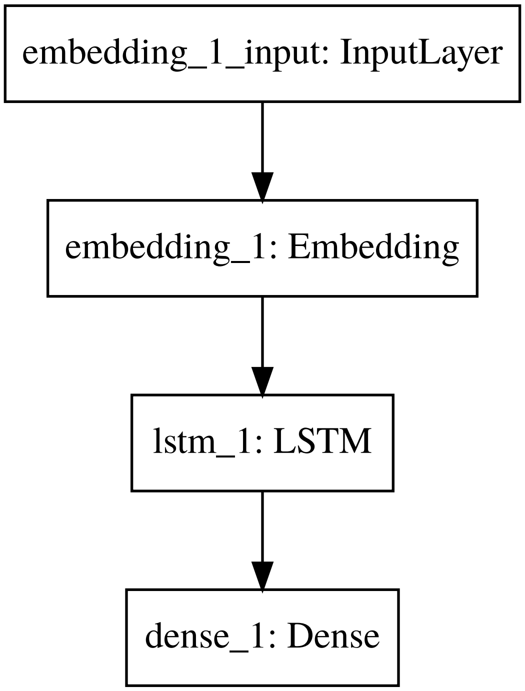
```
In [5]: print('Pad sequences (samples x time)')
        x_train = sequence.pad_sequences(x_train, maxlen=maxlen)
        x_test = sequence.pad_sequences(x_test, maxlen=maxlen)
        print('x_train shape:', x_train.shape)
        print('x_test shape:', x_test.shape)
```

```
Pad sequences (samples x time)
x_train shape: (25000, 80)
x_test shape: (25000, 80)
```

```
In [6]: print('Build model...')
        model = Sequential()
        model.add(Embedding(max_features, embedding_size))
        model.add(LSTM(lstm_output_size, dropout=0.2, recurrent_dropout=0.2))
        model.add(Dense(1, activation='sigmoid'))

        model.compile(loss='binary_crossentropy',
                      optimizer='adam',
                      metrics=['accuracy'])

        model.summary()

        plot_model(model, to_file='model.png', show_shapes=True)
        Image(filename = 'model.png')

        SVG(model_to_dot(model).create(prog='dot', format='svg'))
```

```
Build model...
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
embedding_1 (Embedding)      (None, None, 128)         2560000
_________________________________________________________________
lstm_1 (LSTM)                (None, 128)               131584
_________________________________________________________________
dense_1 (Dense)              (None, 1)                 129
=================================================================
Total params: 2,691,713
Trainable params: 2,691,713
Non-trainable params: 0
_________________________________________________________________
```

Out[6]:



```
In [7]: print('Train...')
        model.fit(x_train, y_train,
                  batch_size=batch_size,
                  epochs=epochs,
                  validation_data=(x_test, y_test))
```

```
Train...
Train on 25000 samples, validate on 25000 samples
Epoch 1/4
25000/25000 [==============================] - 82s 3ms/step - loss: 0.4576 - acc: 0.7841 - val_l
Epoch 2/4
25000/25000 [==============================] - 78s 3ms/step - loss: 0.2951 - acc: 0.8808 - val_l
Epoch 3/4
25000/25000 [==============================] - 80s 3ms/step - loss: 0.2160 - acc: 0.9158 - val_l
Epoch 4/4
25000/25000 [==============================] - 80s 3ms/step - loss: 0.1579 - acc: 0.9405 - val_l
```

```
Out[7]: <keras.callbacks.History at 0x7f7a7f946550>
```

```
In [8]: # Evaluate model
        score, acc = model.evaluate(x_test, y_test, batch_size=batch_size)
        preds = model.predict_classes(x_test, batch_size=batch_size)
```

```
25000/25000 [==============================] - 15s 582us/step
```

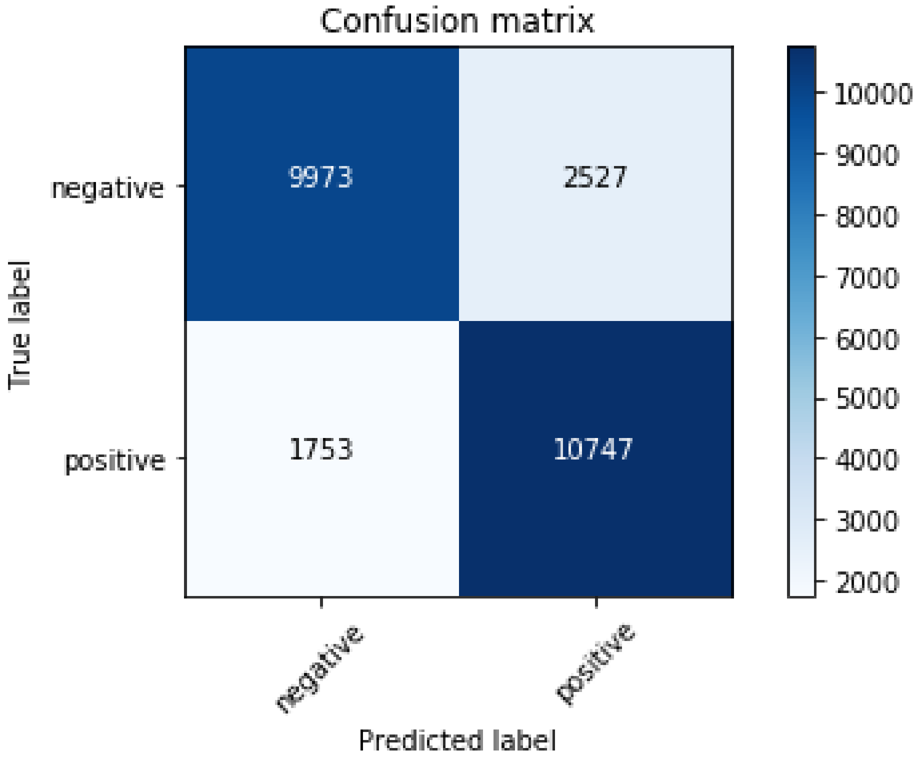
```
In [9]: # Save the model weights
        model_path = 'models/'
        model.save(model_path + 'lstm_model.h5')
        model.save_weights(model_path + 'lstm_weights.h5')
```

```
In [10]: def plot_confusion_matrix(cm, classes,
                                   normalize=False,
                                   title='Confusion matrix',
                                   cmap=plt.cm.Blues):
             """
             This function prints and plots the confusion matrix.
             Normalization can be applied by setting `normalize=True`.
             """
             if normalize:
                 cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]
                 print("Normalized confusion matrix")
             else:
                 print('Confusion matrix, without normalization')

             print(cm)

             plt.imshow(cm, interpolation='nearest', cmap=cmap)
             plt.title(title)
             plt.colorbar()
             tick_marks = np.arange(len(classes))
             plt.xticks(tick_marks, classes, rotation=45)
             plt.yticks(tick_marks, classes)

             fmt = '.2f' if normalize else 'd'
             thresh = cm.max() / 2.
             for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
                 plt.text(j, i, format(cm[i, j], fmt),
                          horizontalalignment="center",
                          color="white" if cm[i, j] > thresh else "black")

             plt.tight_layout()
             plt.ylabel('True label')
             plt.xlabel('Predicted label')
```

```
In [11]: # Confusion Matrix
         cm = confusion_matrix(y_test, preds)
         plot_confusion_matrix(cm, {'negative': 0, 'positive': 1})
```

```
Confusion matrix, without normalization
[[ 9973  2527]
```

```
 [ 1753 10747]]
```



```
In [12]: # F1 score
         f1_macro = f1_score(y_test, preds, average='macro')
         f1_micro = f1_score(y_test, preds, average='micro')

         print('Test accuracy:', acc)
         print('Test score (loss):', score)
         print('')
         print('F1 Score (Macro):', f1_macro)
         print('F1 Score (Micro):', f1_micro)
```

```
Test accuracy: 0.8288
Test score (loss): 0.4973752626895905

F1 Score (Macro): 0.8286357436588291
F1 Score (Micro): 0.8288
```