Configuration

In [1]:
```
# Parameters
PROJECT_NAME = 'ML1010-Group-Project'
ENABLE_COLAB = False

#Root Machine Learning Directory. Projects appear underneath
GOOGLE_DRIVE_MOUNT = '/content/gdrive'
COLAB_ROOT_DIR = GOOGLE_DRIVE_MOUNT + '/MyDrive/Colab Notebooks'
COLAB_INIT_DIR = COLAB_ROOT_DIR + '/utility_files'

LOCAL_ROOT_DIR = '/home/magni//ML_Root/project_root'
LOCAL_INIT_DIR = LOCAL_ROOT_DIR + '/utility_files'
```

Bootstrap Environment

In [2]:
```
#add in support for utility file directory and importing
import sys
import os

if ENABLE_COLAB:
  #Need access to drive
  from google.colab import drive
  drive.mount(GOOGLE_DRIVE_MOUNT, force_remount=True)

  #add in utility directory to syspath to import
  INIT_DIR = COLAB_INIT_DIR
  sys.path.append(os.path.abspath(INIT_DIR))

  #Config environment variables
  ROOT_DIR = COLAB_ROOT_DIR

else:
  #add in utility directory to syspath to import
  INIT_DIR = LOCAL_INIT_DIR
  sys.path.append(os.path.abspath(INIT_DIR))

  #Config environment variables
  ROOT_DIR = LOCAL_ROOT_DIR

#Import Utility Support
from jarvis import Jarvis
jarvis = Jarvis(ROOT_DIR, PROJECT_NAME)

import mv_python_utils as mvutils
```

```
Wha...where am I?
I am awake now.

I have set your current working directory to /home/magni/ML_Root/project_root
/ML1010-Group-Project
The current time is 13:32
```

```
Hello sir. Reminder, no more coffee.
```

Setup Runtime Environment

In [3]:

```
if ENABLE_COLAB:
  #!pip install scipy -q
  #!pip install scikit-learn -q
  #!pip install pycaret -q
  #!pip install matplotlib -q
  #!pip install joblib -q
  #!pip install pandasql -q

  display('Google Colab enabled')
else:
  display('Google Colab not enabled')

#Common imports
import json
import gzip
import pandas as pd
import numpy as np
import matplotlib
import re
import nltk
import matplotlib.pyplot as plt

pd.set_option('mode.chained_assignment', None)
nltk.download('stopwords')
%matplotlib inline
```

```
'Google Colab not enabled'
```

```
[nltk_data] Downloading package stopwords to /home/magni/nltk_data...
[nltk_data]   Package stopwords is already up-to-date!
```

Import necessary depencencies

In [4]:

```
import pandas as pd
import numpy as np
import text_normalizer as tn
from tensorflow import keras
#import model_evaluation_utils as meu

np.set_printoptions(precision=2, linewidth=80)
```

```
2022-01-11 13:32:23.061281: W tensorflow/stream_executor/platform/default/dso
_loader.cc:64] Could not load dynamic library 'libcudart.so.11.0'; dlerror: l
ibcudart.so.11.0: cannot open shared object file: No such file or directory
2022-01-11 13:32:23.061307: I tensorflow/stream_executor/cuda/cudart_stub.cc:
29] Ignore above cudart dlerror if you do not have a GPU set up on your machi
ne.
```

Load and normalize data

In [5]:
```
dataset = pd.read_csv(r'/home/magni/ML_Root/project_root/data/ML1010_Weekly/m

# take a peek at the data
print(dataset.head())
reviews = np.array(dataset['review'])
sentiments = np.array(dataset['sentiment'])

# build train and test datasets
#train_reviews = reviews[:35000]
#train_sentiments = sentiments[:35000]
#test_reviews = reviews[35000:]
#test_sentiments = sentiments[35000:]

train_reviews = reviews[:5000]
train_sentiments = sentiments[:5000]
test_reviews = reviews[5000:]
test_sentiments = sentiments[5000:]



# normalize datasets
#norm_train_reviews = tn.normalize_corpus(train_reviews)
#norm_test_reviews = tn.normalize_corpus(test_reviews)
norm_train_reviews = train_reviews
norm_test_reviews = test_reviews
```

```
                                              review sentiment
0  not bother think would see movie great supspen...  negative
1  careful one get mitt change way look kung fu f...  positive
2  chili palmer tired movie know want success mus...  negative
3  follow little know 1998 british film make budg...  positive
4  dark angel cross huxley brave new world percys...  positive
```

In [6]:
```
print(train_sentiments)
print(test_sentiments)
```

```
['negative' 'positive' 'negative' ... 'positive' 'negative' 'negative']
['negative' 'negative' 'negative' ... 'negative' 'positive' 'negative']
```

Tokenize train & test datasets

In [7]:
```
from nltk.tokenize import word_tokenize
#word_tokenize(text)

tokenized_train = [word_tokenize(text) for text in norm_train_reviews]
tokenized_test = [word_tokenize(text) for text in norm_test_reviews]
```

In [26]:
```
print(len(tokenized_train))
print(len(tokenized_test))
print(len(norm_test_reviews))
```

```
5000
45000
```

45000

Build Vocabulary Mapping (word to index)

In [8]:
```
from collections import Counter

# build word to index vocabulary
token_counter = Counter([token for review in tokenized_train for token in rev
vocab_map = {item[0]: index+1 for index, item in enumerate(dict(token_counter
max_index = np.max(list(vocab_map.values()))
vocab_map['PAD_INDEX'] = 0
vocab_map['NOT_FOUND_INDEX'] = max_index+1
vocab_size = len(vocab_map)
# view vocabulary size and part of the vocabulary map
print('Vocabulary Size:', vocab_size)
print('Sample slice of vocabulary map:', dict(list(vocab_map.items())[10:20])
```

```
Vocabulary Size: 32182
Sample slice of vocabulary map: {'boring': 11, 'terribly': 12, 'predictable':
13, 'interesting': 14, 'start': 15, 'middle': 16, 'film': 17, 'little': 18, '
social': 19, 'drama': 20}
```

Encode and Pad datasets & Encode prediction class labels

In [9]:
```
from keras.preprocessing import sequence
from sklearn.preprocessing import LabelEncoder

le = LabelEncoder()

# get max length of train corpus and initialize label encoder
num_classes=2 # positive -> 1, negative -> 0
max_len = np.max([len(review) for review in tokenized_train])

## Train reviews data corpus
# Convert tokenized text reviews to numeric vectors
train_X = [[vocab_map[token] for token in tokenized_review] for tokenized_rev
train_X = sequence.pad_sequences(train_X, maxlen=max_len) # pad
## Train prediction class labels
# Convert text sentiment labels (negative\positive) to binary encodings (0/1)
#train_y = le.fit_transform(train_sentiments)
train_y = le.fit_transform(train_sentiments)


## Test reviews data corpus
# Convert tokenized text reviews to numeric vectors
test_X = [[vocab_map[token] if vocab_map.get(token) else vocab_map['NOT_FOUND
           for token in tokenized_review]
              for tokenized_review in tokenized_test]
test_X = sequence.pad_sequences(test_X, maxlen=max_len)
## Test prediction class labels
# Convert text sentiment labels (negative\positive) to binary encodings (0/1)
test_y = le.transform(test_sentiments)

# view vector shapes
print('Max length of train review vectors:', max_len)
print('Train review vectors shape:', train_X.shape, ' Test review vectors sha
```

```
Max length of train review vectors: 627
Train review vectors shape: (5000, 627)  Test review vectors shape: (45000, 6
27)
```

Build the LSTM Model Architecture

In [10]:
```
from keras.models import Sequential
from keras.layers import Dense, Embedding, Dropout, SpatialDropout1D
from keras.layers import LSTM

EMBEDDING_DIM = 128 # dimension for dense embeddings for each token
LSTM_DIM = 64 # total LSTM units

model = Sequential()
model.add(Embedding(input_dim=vocab_size, output_dim=EMBEDDING_DIM, input_len
model.add(SpatialDropout1D(0.2))
model.add(LSTM(LSTM_DIM, dropout=0.2, recurrent_dropout=0.2))
model.add(Dense(1, activation="sigmoid"))

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

```
2022-01-11 13:32:41.472754: W tensorflow/stream_executor/platform/default/dso
_loader.cc:64] Could not load dynamic library 'libcuda.so.1'; dlerror: libcud
a.so.1: cannot open shared object file: No such file or directory
2022-01-11 13:32:41.472792: W tensorflow/stream_executor/cuda/cuda_driver.cc:
269] failed call to cuInit: UNKNOWN ERROR (303)
2022-01-11 13:32:41.472808: I tensorflow/stream_executor/cuda/cuda_diagnostic
s.cc:156] kernel driver does not appear to be running on this host (localhos
t.localdomain): /proc/driver/nvidia/version does not exist
2022-01-11 13:32:41.473043: I tensorflow/core/platform/cpu_feature_guard.cc:1
51] This TensorFlow binary is optimized with oneAPI Deep Neural Network Libra
ry (oneDNN) to use the following CPU instructions in performance-critical ope
rations:  AVX2 FMA
To enable them in other operations, rebuild TensorFlow with the appropriate c
ompiler flags.
```

In [11]:

```
print(model.summary())
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 embedding (Embedding)       (None, 627, 128)          4119296

 spatial_dropout1d (SpatialD  (None, 627, 128)         0
 ropout1D)

 lstm (LSTM)                 (None, 64)                49408

 dense (Dense)               (None, 1)                 65

=================================================================
Total params: 4,168,769
Trainable params: 4,168,769
Non-trainable params: 0
_________________________________________________________________
None
```

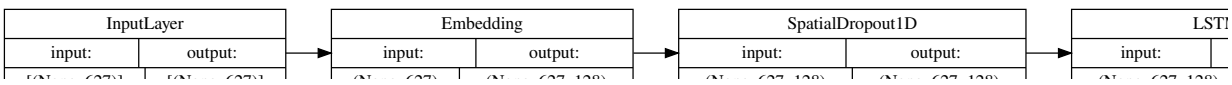
Visualize model architecture

In [12]:

```
from IPython.display import SVG
from keras.utils.vis_utils import model_to_dot

SVG(model_to_dot(model, show_shapes=True, show_layer_names=False,
                 rankdir='LR').create(prog='dot', format='svg'))
```

Out[12]:



Train the model

In [13]:

```
batch_size = 100
history = model.fit(train_X,
          train_y,
          epochs=5,
          batch_size=batch_size,
          shuffle=True,
          validation_split=0.1,
          verbose=1)
```

```
Epoch 1/5
45/45 [==============================] - 21s 420ms/step - loss: 0.6536 - accu
racy: 0.6658 - val_loss: 0.5803 - val_accuracy: 0.7560
Epoch 2/5
45/45 [==============================] - 18s 392ms/step - loss: 0.3688 - accu
racy: 0.8682 - val_loss: 0.3769 - val_accuracy: 0.8300
Epoch 3/5
45/45 [==============================] - 18s 407ms/step - loss: 0.1635 - accu
racy: 0.9484 - val_loss: 0.3444 - val_accuracy: 0.8520
Epoch 4/5
45/45 [==============================] - 18s 396ms/step - loss: 0.0721 - accu
racy: 0.9818 - val_loss: 0.4656 - val_accuracy: 0.8380
Epoch 5/5
45/45 [==============================] - 18s 404ms/step - loss: 0.0318 - accu
racy: 0.9936 - val_loss: 0.4996 - val_accuracy: 0.8220
```

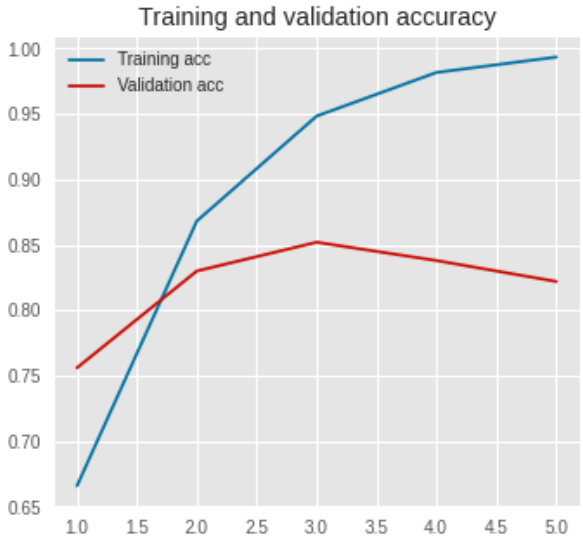
In [14]:

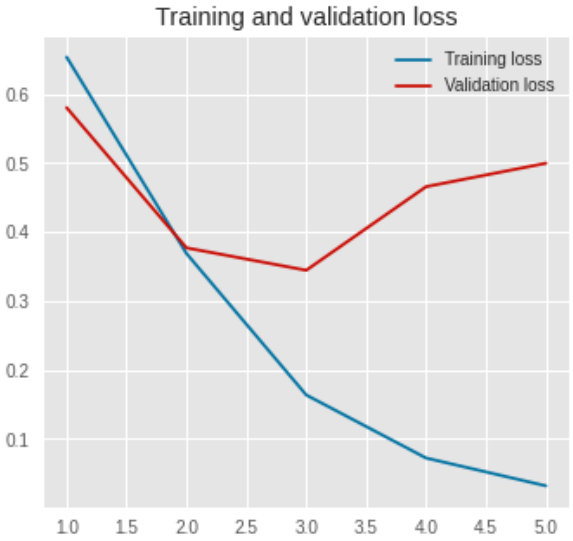
```
import matplotlib.pyplot as plt
plt.style.use('ggplot')

def plot_history(history):
    acc = history.history['accuracy']
    val_acc = history.history['val_accuracy']
    loss = history.history['loss']
    val_loss = history.history['val_loss']
    x = range(1, len(acc) + 1)

    plt.figure(figsize=(12, 5))
    plt.subplot(1, 2, 1)
    plt.plot(x, acc, 'b', label='Training acc')
    plt.plot(x, val_acc, 'r', label='Validation acc')
    plt.title('Training and validation accuracy')
    plt.legend()
    plt.subplot(1, 2, 2)
    plt.plot(x, loss, 'b', label='Training loss')
    plt.plot(x, val_loss, 'r', label='Validation loss')
    plt.title('Training and validation loss')
    plt.legend()

plot_history(history)
```





Predict and Evaluate Model Performance

In [16]:
```
pred_test = model.predict(test_X)
```

In [21]:
```
pred_test = np.round(pred_test).astype(int)

pred_test_flat = pred_test.flatten()
print(pred_test_flat)
print(len(pred_test_flat))
print(len(test_X))
```

```
[0 0 1 ... 0 1 0]
45000
45000
```

In [18]:
```
predictions = le.inverse_transform(pred_test.flatten())
```

In [23]:
```
import model_evaluation_utils as meu
meu.display_model_performance_metrics(true_labels=test_sentiments, predicted_
                                      classes=['positive', 'negative'])
```

```
Model Performance metrics:
------------------------------
Accuracy: 0.8497
Precision: 0.8497
Recall: 0.8497
F1 Score: 0.8497

Model Classification report:
------------------------------
              precision    recall  f1-score   support

    positive       0.85      0.84      0.85     22497
    negative       0.85      0.85      0.85     22503
```

```
    accuracy                           0.85     45000
   macro avg       0.85      0.85      0.85     45000
weighted avg       0.85      0.85      0.85     45000


Prediction Confusion Matrix:
------------------------------
                 Predicted:
                   positive negative
Actual: positive      19000     3497
        negative       3266    19237
```