cnn_model_1-Fixed_for_final

February 16, 2020

In [8]:
```
import matplotlib.pyplot as plt
from keras import applications
from keras.preprocessing.image import ImageDataGenerator
from keras import optimizers
from keras.models import Sequential
from keras.layers import Dropout, Flatten, Dense, Conv2D, MaxPooling2D
from keras.applications.inception_v3 import InceptionV3
from keras.preprocessing import image
from keras.models import Model
from keras.layers import Dense, Flatten
from keras import backend as K
import numpy as np
import pandas as pd
import os
from sklearn.metrics import classification_report, confusion_matrix
import sklearn.metrics as metrics
import sklearn
from sklearn.metrics import roc_auc_score
from sklearn.metrics import roc_curve
import matplotlib.pyplot as plt
%matplotlib inline
```

In [9]:
```
train_data_dir = '/home/mlab/Documents/brats_hl_data/train'
validation_data_dir = '/home/mlab/Documents/brats_hl_data/val'
# 44938
# 5616
nb_train_samples = 44938
nb_validation_samples = 5616
epochs = 8
batch_size = 128
# prepare data augmentation configuration
train_datagen = ImageDataGenerator(
    rescale=1. / 255,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True)

test_datagen = ImageDataGenerator(rescale=1. / 255)
```

```
train_generator = train_datagen.flow_from_directory(
    train_data_dir,
    target_size=(150, 150),
    batch_size=batch_size,
    class_mode='binary')

validation_generator = test_datagen.flow_from_directory(
    validation_data_dir,
    target_size=(150, 150),
    batch_size=batch_size,
    class_mode='binary')
```

```
Found 44938 images belonging to 2 classes.
Found 5616 images belonging to 2 classes.
```

In [10]:
```
#uses a smal vggnet
#32->64->128->512
model = Sequential()
model.add(Conv2D(32,(3,3),activation='relu',input_shape=(150,150,3)))
model.add(MaxPooling2D((2,2)))
model.add(Conv2D(64,(3,3),activation='relu'))
model.add(MaxPooling2D((2,2)))
model.add(Conv2D(128,(3,3),activation='relu'))
model.add(MaxPooling2D((2,2)))
model.add(Conv2D(512,(3,3),activation='relu'))
model.add(MaxPooling2D((2,2)))
model.add(Flatten())
model.add(Dropout(0.5))
model.add(Dense(512,activation='relu'))
model.add(Dense(1,activation='sigmoid')) #uses sigmoid at the end because we onlu have two classes
```

```
W0216 09:35:28.779163 140375213623104 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

W0216 09:35:28.817338 140375213623104 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

W0216 09:35:28.822030 140375213623104 deprecation.py:506] From /home/mlab/anaconda3/lib/python3.7/site-p
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob`.
```

In [11]:
```
model.summary()
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_2 (Conv2D)            (None, 148, 148, 32)      896
_________________________________________________________________
```

```
max_pooling2d_1 (MaxPooling2 (None, 74, 74, 32)        0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 72, 72, 64)        18496
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 36, 36, 64)        0
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 34, 34, 128)       73856
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 17, 17, 128)       0
_________________________________________________________________
conv2d_5 (Conv2D)            (None, 15, 15, 512)       590336
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 7, 7, 512)         0
_________________________________________________________________
flatten_1 (Flatten)          (None, 25088)             0
_________________________________________________________________
dropout_1 (Dropout)          (None, 25088)             0
_________________________________________________________________
dense_1 (Dense)              (None, 512)               12845568
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 513
=================================================================
Total params: 13,529,665
Trainable params: 13,529,665
Non-trainable params: 0
_________________________________________________________________
```

In [12]:
```
#We use the RMSprop optimizer with a learning rate of 0.0001
#We use ninary_crossentropy loss because its a binary classification
#optimizer = Adam(learning_rate=lr_schedule(0))
model.compile(loss='binary_crossentropy',optimizer=optimizers.Adam(lr=1e-4),metrics=['acc'])
```

```
W0216 09:35:28.871100 140375213623104 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

W0216 09:35:28.874930 140375213623104 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

W0216 09:35:28.878212 140375213623104 deprecation.py:323] From /home/mlab/anaconda3/lib/python3.7/site-p
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
```

In [13]:
```
true_classes = train_generator.classes
print(true_classes)
class_labels = list(train_generator.class_indices.keys())
print(class_labels)
```

```
[0 0 0 ... 1 1 1]
['high', 'low']
```

In [14]:
```
# train the model on the new data for a few epochs
history =model.fit_generator(train_generator,
                             steps_per_epoch=nb_train_samples//batch_size,
                             epochs=epochs,
                             validation_data=validation_generator,
                             validation_steps=nb_validation_samples//batch_size)
```

```
Epoch 1/8
351/351 [==============================] - 568s 2s/step - loss: 0.6214 - acc: 0.6449 - val_los
Epoch 2/8
351/351 [==============================] - 559s 2s/step - loss: 0.5550 - acc: 0.7023 - val_los
Epoch 3/8
351/351 [==============================] - 557s 2s/step - loss: 0.5288 - acc: 0.7244 - val_los
Epoch 4/8
351/351 [==============================] - 558s 2s/step - loss: 0.5031 - acc: 0.7394 - val_los
Epoch 5/8
351/351 [==============================] - 558s 2s/step - loss: 0.4801 - acc: 0.7558 - val_los
Epoch 6/8
351/351 [==============================] - 558s 2s/step - loss: 0.4581 - acc: 0.7704 - val_los
Epoch 7/8
351/351 [==============================] - 557s 2s/step - loss: 0.4400 - acc: 0.7801 - val_los
Epoch 8/8
351/351 [==============================] - 557s 2s/step - loss: 0.4195 - acc: 0.7948 - val_los
```

In [15]:
```
# # #save the model
# model.save_weights('model_weights.h5')
# model.save('model_keras.h5')
```

In [16]:
```
#Confution Matrix and Classification Report
Y_pred = model.predict_generator(validation_generator, nb_validation_samples // batch_size+1)
```

In [17]:
```
# y_pred = np.argmax(Y_pred, axis=1)
y_pred = (Y_pred<0.475).astype(np.int)

# print('Confusion Matrix')
# print(confusion_matrix(true_classes_1, y_pred))
# print('Classification Report')
# print(classification_report(validation_generator.classes, y_pred,
#                             target_names=class_labels_1))
```

In [19]:
```
true_classes_1 = validation_generator.classes
print(true_classes)
class_labels_1 = list(validation_generator.class_indices.keys())
print(class_labels_1)
```

```
[0 0 0 ... 1 1 1]
['high', 'low']
```

In [20]:
```
confusion_matrix = metrics.confusion_matrix(true_classes_1,y_pred)
print(confusion_matrix)
```

```
[[1563 1212]
 [1618 1223]]
```

In [21]:
```
report= sklearn.metrics.classification_report(true_classes_1, y_pred,
                                              target_names = class_labels_1)
print(report)
```

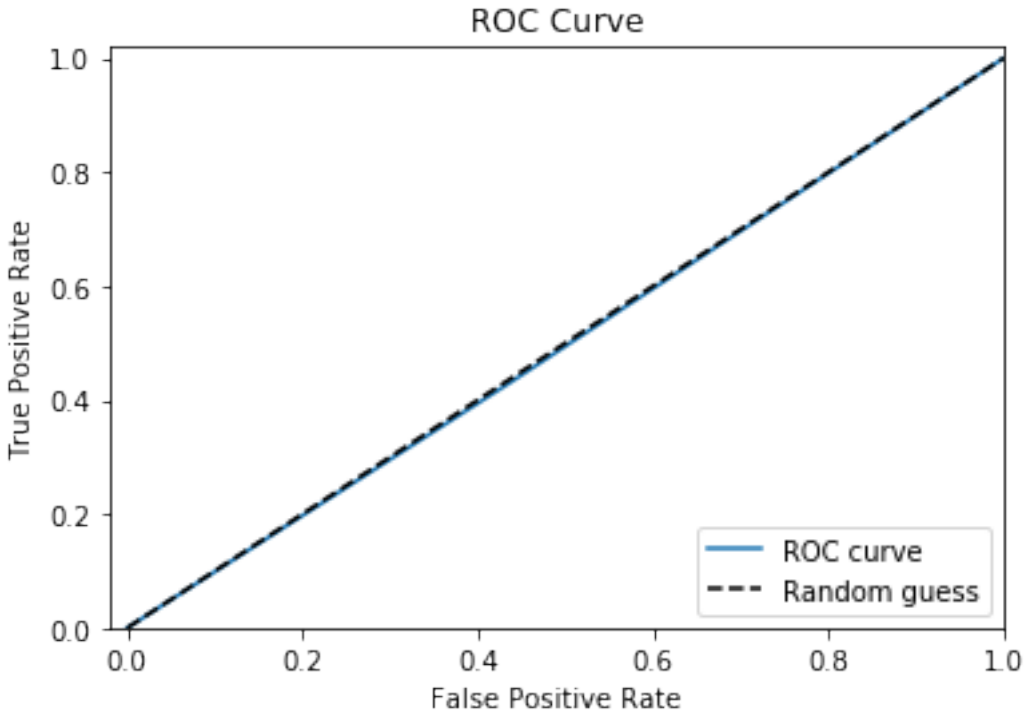
```
              precision    recall  f1-score   support

        high       0.49      0.56      0.52      2775
         low       0.50      0.43      0.46      2841

   micro avg       0.50      0.50      0.50      5616
   macro avg       0.50      0.50      0.49      5616
weighted avg       0.50      0.50      0.49      5616
```

In [22]:
```
fpr, tpr, thresholds = roc_curve(validation_generator.classes, y_pred)

# create plot
plt.plot(fpr, tpr, label='ROC curve')
plt.plot([0, 1], [0, 1], 'k--', label='Random guess')
_ = plt.xlabel('False Positive Rate')
_ = plt.ylabel('True Positive Rate')
_ = plt.title('ROC Curve')
_ = plt.xlim([-0.02, 1])
_ = plt.ylim([0, 1.02])
_ = plt.legend(loc="lower right")
```



In [23]: roc_auc_score(validation_generator.classes, y_pred)

Out[23]: 0.49686273390602853

In [24]:
```
batchX, batchy = train_generator.next()
_, accuracy = model.evaluate(batchX, batchy)
print('Accuracy training: %.2f' % (accuracy*100))
batchXv, batchyv = validation_generator.next()
_, accuracy = model.evaluate(batchXv, batchyv)
print('Accuracy val: %.2f' % (accuracy*100))
```

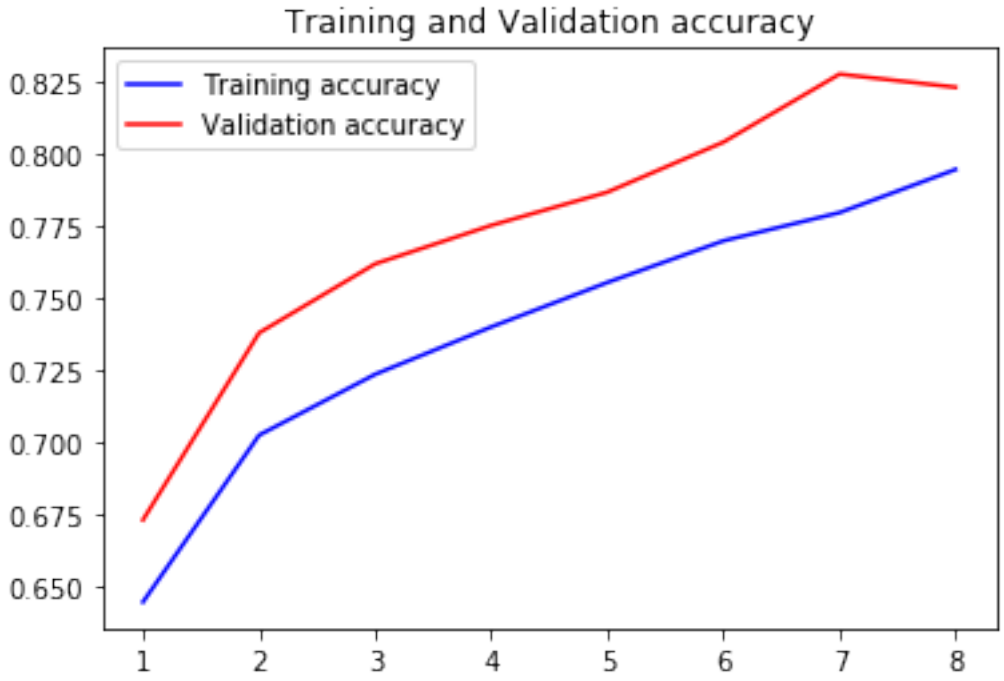
```
128/128 [==============================] - 0s 3ms/step
Accuracy training: 80.47
128/128 [==============================] - 0s 3ms/step
Accuracy val: 78.91
```

In [25]:
```
#plot the train and val curve
#get the details from the history object
acc = history.history['acc']
val_acc=history.history['val_acc']
loss = history.history['loss']
val_loss = history.history['val_loss']
```

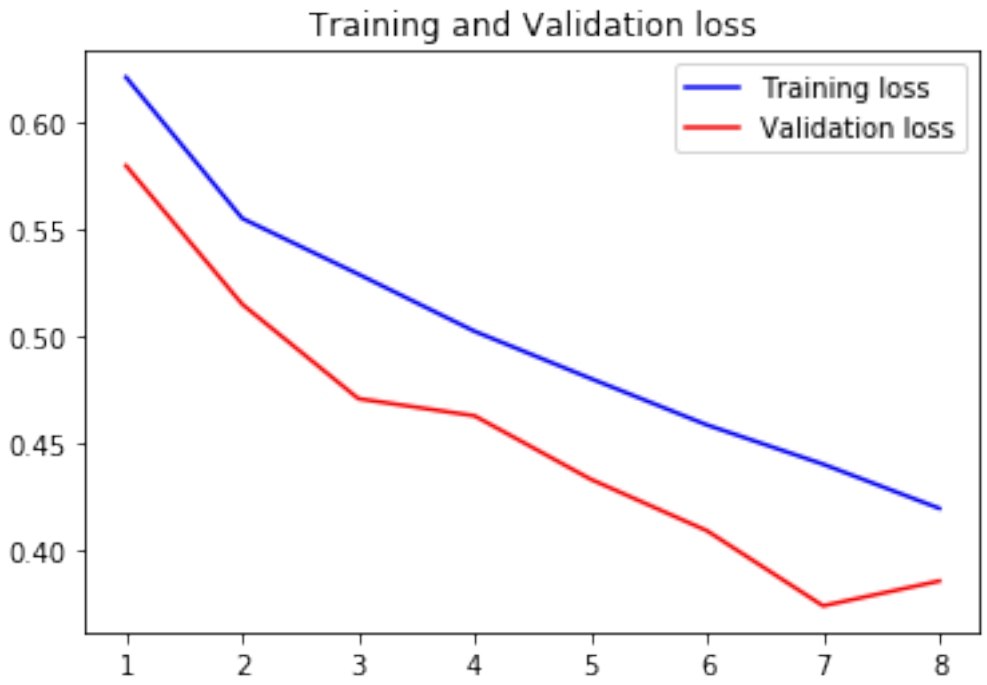
```
epochs = range(1,len(acc)+1)

#train and validation accuracy
plt.plot(epochs,acc,'b',label='Training accuracy')
plt.plot(epochs,val_acc,'r',label='Validation accuracy')
plt.title('Training and Validation accuracy')
plt.legend()
```

Out[25]: <matplotlib.legend.Legend at 0x7fab34e13da0>



In [26]:
```
#train and validation loss
plt.plot(epochs, loss, 'b',label='Training loss')
plt.plot(epochs, val_loss, 'r',label='Validation loss')
plt.title('Training and Validation loss')
plt.legend()
plt.show()
```



In [27]:
```
test_generator = test_datagen.flow_from_directory('/home/mlab/Documents/brats_hl_data/test',
                                                  class_mode='binary',
                                                  batch_size=batch_size,
                                                  target_size=(150,150))
```

Found 5619 images belonging to 2 classes.

In [28]:
```
scores = model.evaluate_generator(test_generator, steps=nb_validation_samples//batch_size)
```

In [29]:
```
print("%s: %.2f%%" % (model.metrics_names[1], scores[1]*100))
```

acc: 81.16%

In [30]:
```
#Confution Matrix and Classification Report
# Y_pred = model.predict_generator(val_generator, 5616 // batch_size)
nb_test_samples=5619
Y_pred1 = model.predict_generator(test_generator,nb_test_samples//batch_size+1)
# y_pred = np.argmax(Y_pred,axis=1)
```

In [31]:
```
true_classes_2 = test_generator.classes
print(true_classes_2)
class_labels_2 = list(test_generator.class_indices.keys())
print(class_labels_2)
```

```
[0 0 0 ... 1 1 1]
['high', 'low']
```

```
In [32]: # y_pred1 = (Y_pred1<0.5).astype(np.int)
         y_pred1 = (Y_pred1 < 0.475).astype(np.int)
         # print(y_pred)
         # print('Confusion Matrix')
         # print(confusion_matrix(true_classes_2, y_pred1))
         # print('Classification Report')
         # print(classification_report(true_classes_2, y_pred1, target_names=class_labels_2))
```

```
In [33]: confusion_matrix1 = metrics.confusion_matrix(true_classes_2,y_pred1)
         print(confusion_matrix1)
```

```
[[1574 1202]
 [1660 1183]]
```

```
In [34]: report1= sklearn.metrics.classification_report(true_classes_2, y_pred1,
                                                       target_names = class_labels_2)
         print(report1)
```

	precision	recall	f1-score	support
high	0.49	0.57	0.52	2776
low	0.50	0.42	0.45	2843
micro avg	0.49	0.49	0.49	5619
macro avg	0.49	0.49	0.49	5619
weighted avg	0.49	0.49	0.49	5619

```
In [35]: print(" Loss: ", scores[0],"\n","Accuracy: ", scores[1])
```

```
 Loss:  0.39541898078696675
 Accuracy:  0.8115915697674418
```