VGG19-Final Working-Copy2

February 16, 2020

In [1]:
```
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
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
```

Using TensorFlow backend.

In [2]:
```
# create the base pre-trained model
# build the VGG19 network
base_model = applications.VGG19(weights='imagenet', include_top=False,
                                input_shape=(150,150,3))
print('Model loaded.')
base_model.summary()
```

WARNING: Logging before flag parsing goes to stderr.
W0215 20:49:58.230795 140433961994048 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

W0215 20:49:58.240654 140433961994048 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

W0215 20:49:58.242392 140433961994048 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

W0215 20:49:58.261255 140433961994048 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

Downloading data from https://github.com/fchollet/deep-learning-models/releases/download/v0.1/vgg19_weight
80142336/80134624 [==============================] - 2s 0us/step

W0215 20:50:01.102874 140433961994048 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

W0215 20:50:01.103497 140433961994048 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

Model loaded.

Layer (type)	Output Shape	Param #
input_1 (InputLayer)	(None, 150, 150, 3)	0
block1_conv1 (Conv2D)	(None, 150, 150, 64)	1792
block1_conv2 (Conv2D)	(None, 150, 150, 64)	36928
block1_pool (MaxPooling2D)	(None, 75, 75, 64)	0
block2_conv1 (Conv2D)	(None, 75, 75, 128)	73856
block2_conv2 (Conv2D)	(None, 75, 75, 128)	147584
block2_pool (MaxPooling2D)	(None, 37, 37, 128)	0
block3_conv1 (Conv2D)	(None, 37, 37, 256)	295168
block3_conv2 (Conv2D)	(None, 37, 37, 256)	590080
block3_conv3 (Conv2D)	(None, 37, 37, 256)	590080
block3_conv4 (Conv2D)	(None, 37, 37, 256)	590080
block3_pool (MaxPooling2D)	(None, 18, 18, 256)	0
block4_conv1 (Conv2D)	(None, 18, 18, 512)	1180160
block4_conv2 (Conv2D)	(None, 18, 18, 512)	2359808
block4_conv3 (Conv2D)	(None, 18, 18, 512)	2359808

```
_________________________________________________________________
block4_conv4 (Conv2D)        (None, 18, 18, 512)       2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 9, 9, 512)         0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 9, 9, 512)         2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 9, 9, 512)         2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 9, 9, 512)         2359808
_________________________________________________________________
block5_conv4 (Conv2D)        (None, 9, 9, 512)         2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 4, 4, 512)         0
=================================================================
Total params: 20,024,384
Trainable params: 20,024,384
Non-trainable params: 0
_________________________________________________________________
```

In [3]:
```
# this is the model we will train
model =Sequential()
model.add(base_model)
model.add(Flatten())
model.add(Dense(256,activation='relu'))
model.add(Dense(1, activation='sigmoid'))

model.summary()
```

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
vgg19 (Model)                (None, 4, 4, 512)         20024384
_________________________________________________________________
flatten_1 (Flatten)          (None, 8192)              0
_________________________________________________________________
dense_1 (Dense)              (None, 256)               2097408
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 257
=================================================================
Total params: 22,122,049
Trainable params: 22,122,049
Non-trainable params: 0
_________________________________________________________________
```

In [4]:
```
print('Number of trainable weights before freezing: ', len(model.trainable_weights))
```

```
        ## to freesze all convolutional layers in pretrained network method 1
        # base_model.trainable=False
```

```
Number of trainable weights before freezing:  36
```

```
In [5]: # def recall_m(y_true, y_pred):
        #     true_positives = K.sum(K.round(K.clip(y_true * y_pred,0,1)))
        #     possible_positives = K.sum(K.round(K.clip(y_true,0,1)))
        #     recall = true_positives / (possible_positives + K.epsilon())
        #     return recall
        # def precision_m(y_true, ypred):
        #     true_positives = K.sum(K.round(K.clip(y_true * y_pred,0,1)))
        #     predicted_positives = K.sum(K.round(K.clip(y_pred,0,1)))
        #     precision = true_positives/(predicted_positives+K.epsilon())
        #     return precision

        # first: train only the top layers (which were randomly initialized)
        # i.e. freeze all convolutional pretrained layers method 2
        for layer in base_model.layers:
            layer.trainable = False
        print('After freezing: ', len(model.trainable_weights))
        # compile the model (should be done *after* setting layers to non-trainable)
        model.compile(optimizer=optimizers.Adam(lr=1e-4),metrics=['acc'], loss='binary_crossentropy')
```

```
W0215 20:50:01.589701 140433961994048 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python
```

```
W0215 20:50:01.596862 140433961994048 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
```

```
After freezing:  4
```

```
In [6]: 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 [7]:
```
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 [8]:
```
# 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 [==============================] - 1702s 5s/step - loss: 0.5645 - acc: 0.6924 - val_lo
Epoch 2/8
351/351 [==============================] - 1655s 5s/step - loss: 0.4993 - acc: 0.7454 - val_lo
Epoch 3/8
351/351 [==============================] - 1654s 5s/step - loss: 0.4677 - acc: 0.7682 - val_lo
Epoch 4/8
351/351 [==============================] - 1654s 5s/step - loss: 0.4455 - acc: 0.7829 - val_lo
Epoch 5/8
351/351 [==============================] - 1655s 5s/step - loss: 0.4265 - acc: 0.7959 - val_lo
Epoch 6/8
351/351 [==============================] - 1654s 5s/step - loss: 0.4104 - acc: 0.8041 - val_lo
Epoch 7/8
351/351 [==============================] - 1655s 5s/step - loss: 0.3992 - acc: 0.8116 - val_lo
```

```
Epoch 8/8
351/351 [==============================] - 1654s 5s/step - loss: 0.3868 - acc: 0.8177 - val_l
```

```
In [9]: 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 [10]: #Confution Matrix and Classification Report
         Y_pred = model.predict_generator(validation_generator, nb_validation_samples // batch_size+1)
```

```
In [11]: # 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 [12]: # print(validation_generator.classes)
```

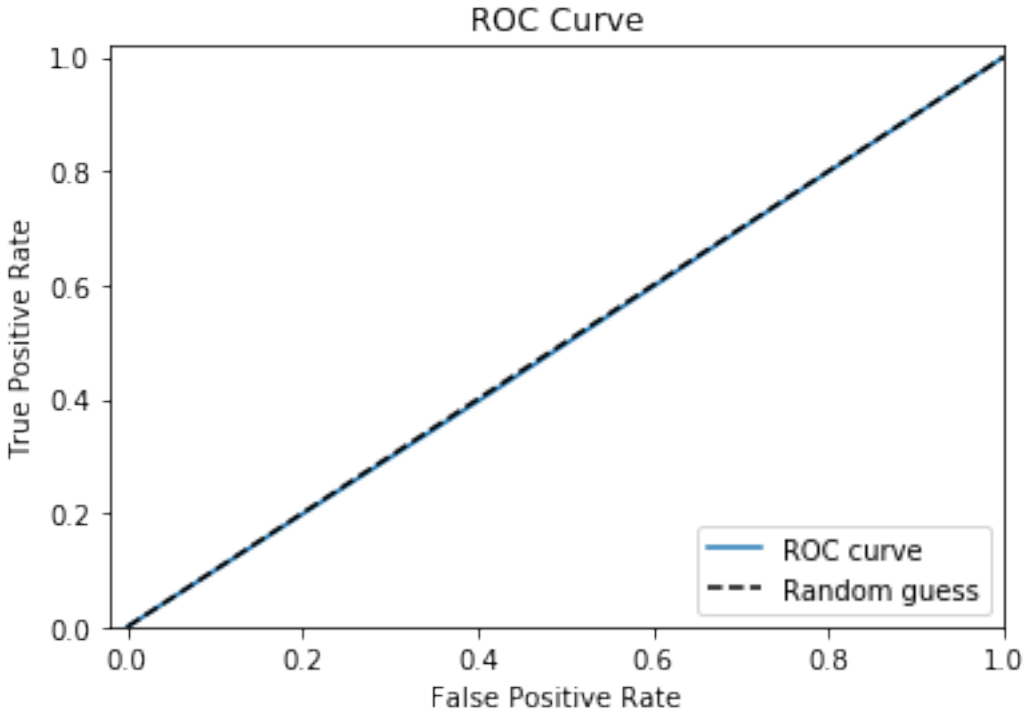
```
In [13]: confusion_matrix = metrics.confusion_matrix(true_classes_1,y_pred)
         print(confusion_matrix)
```

```
[[1624 1151]
 [1675 1166]]
```

```
In [14]: 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      0.59      0.53      2775
         low       0.50      0.41      0.45      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 [15]:
```
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 [16]:
```
roc_auc_score(validation_generator.classes, y_pred)
```

Out[16]: 0.4978220459107471

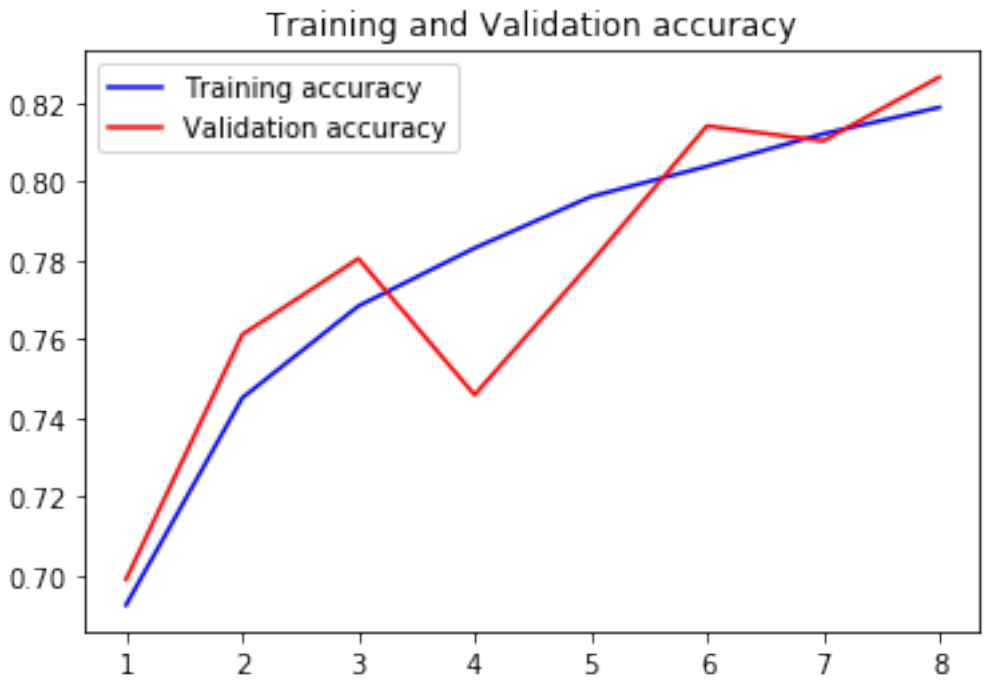
In [17]:
```
batchX, batchy = train_generator.next()
_, accuracy = model.evaluate(batchX, batchy)
print('Accuracy training: %.2f' % (accuracy*100))
batchXv, batchyv = validation_generator.next()
_, accuracy = model.evaluate(batchXv, batchyv)
print('Accuracy val: %.2f' % (accuracy*100))
```

```
128/128 [==============================] - 4s 32ms/step
Accuracy training: 83.59
```

```
128/128 [==============================] - 4s 32ms/step
Accuracy val: 80.47
```

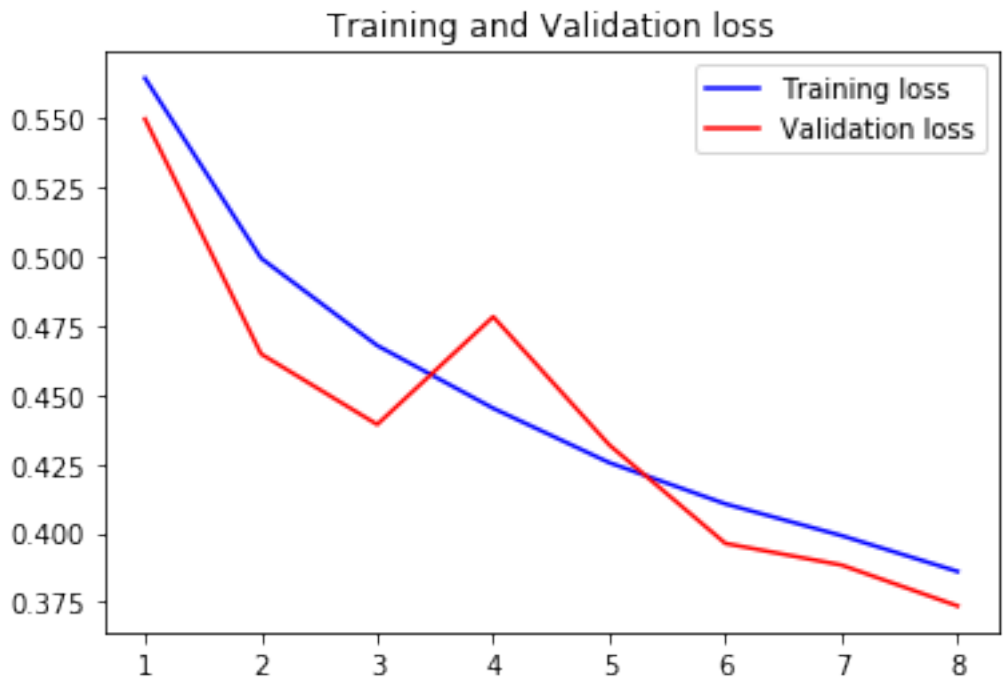
In [18]:
```
#plot the train and val curve
#get the details from the history object
acc = history.history['acc']
val_acc=history.history['val_acc']
loss = history.history['loss']
val_loss = history.history['val_loss']

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[18]: <matplotlib.legend.Legend at 0x7fb8e0ca2908>



In [19]:
```
#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 [20]:
```
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))
scores = model.evaluate_generator(test_generator, steps=nb_validation_samples//batch_size)
```

Found 5619 images belonging to 2 classes.

In [21]:
```
print("%s: %.2f%%" % (model.metrics_names[1], scores[1]*100))
```

acc: 81.89%

In [22]:
```
# 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 [23]:
```
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 [24]:
```
# 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 [25]:
```
confusion_matrix1 = metrics.confusion_matrix(true_classes_2,y_pred1)
print(confusion_matrix1)
```

```
[[1638 1138]
 [1666 1177]]
```

In [26]:
```
report1= sklearn.metrics.classification_report(true_classes_2, y_pred1,
                                               target_names = class_labels_2)
print(report1)
```

```
              precision    recall  f1-score   support

        high       0.50      0.59      0.54      2776
         low       0.51      0.41      0.46      2843

   micro avg       0.50      0.50      0.50      5619
   macro avg       0.50      0.50      0.50      5619
weighted avg       0.50      0.50      0.50      5619
```

In [27]:
```
print(" Loss: ", scores[0],"\n","Accuracy: ", scores[1])
```

```
 Loss:  0.3795007598954578
 Accuracy:  0.818859011627907
```