ResNet15V2-Final Working-V2

February 15, 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.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]:
```
help(applications)
# import sys
# !{sys.executable} -m pip install keras.applications
```

Help on package keras.applications in keras:

NAME
    keras.applications

PACKAGE CONTENTS
    densenet
    imagenet_utils
    inception_resnet_v2
    inception_v3

mobilenet
mobilenet_v2
mobilenetv2
nasnet
resnet50
vgg16
vgg19
xception

FUNCTIONS
DenseNet121 = wrapper(*args, **kwargs)

DenseNet169 = wrapper(*args, **kwargs)

DenseNet201 = wrapper(*args, **kwargs)

InceptionResNetV2 = wrapper(*args, **kwargs)

InceptionV3 = wrapper(*args, **kwargs)

MobileNet = wrapper(*args, **kwargs)

MobileNetV2 = wrapper(*args, **kwargs)

NASNetLarge = wrapper(*args, **kwargs)

NASNetMobile = wrapper(*args, **kwargs)

ResNet50 = wrapper(*args, **kwargs)

VGG16 = wrapper(*args, **kwargs)

VGG19 = wrapper(*args, **kwargs)

Xception = wrapper(*args, **kwargs)

keras_modules_injection(base_fun)

DATA
absolute_import = _Feature((2, 5, 0, 'alpha', 1), (3, 0, 0, 'alpha', 0...
division = _Feature((2, 2, 0, 'alpha', 2), (3, 0, 0, 'alpha', 0), 8192...
print_function = _Feature((2, 6, 0, 'alpha', 2), (3, 0, 0, 'alpha', 0)...

FILE
/home/mlab/anaconda3/lib/python3.7/site-packages/keras/applications/__init__.py

In [3]:
```
## create the base pre-trained model
# build the VGG16 network
base_model = applications.ResNet50(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 16:32:21.521459 139777111516992 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

W0215 16:32:21.532786 139777111516992 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

W0215 16:32:21.536382 139777111516992 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

W0215 16:32:21.554043 139777111516992 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

W0215 16:32:21.554604 139777111516992 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

W0215 16:32:21.672361 139777111516992 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

W0215 16:32:21.724693 139777111516992 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

/home/mlab/anaconda3/lib/python3.7/site-packages/keras_applications/resnet50.py:265: UserWarning: The outp
  warnings.warn('The output shape of `ResNet50(include_top=False)` '


Model loaded.
```

Layer (type)	Output Shape	Param #	Connected to
input_1 (InputLayer)	(None, 150, 150, 3)	0	
conv1_pad (ZeroPadding2D)	(None, 156, 156, 3)	0	input_1[0][0]
conv1 (Conv2D)	(None, 75, 75, 64)	9472	conv1_pad[0][0]
bn_conv1 (BatchNormalization)	(None, 75, 75, 64)	256	conv1[0][0]
activation_1 (Activation)	(None, 75, 75, 64)	0	bn_conv1[0][0]
pool1_pad (ZeroPadding2D)	(None, 77, 77, 64)	0	activation_1[0][0]
max_pooling2d_1 (MaxPooling2D)	(None, 38, 38, 64)	0	pool1_pad[0][0]
res2a_branch2a (Conv2D)	(None, 38, 38, 64)	4160	max_pooling2d_1[0][0]
bn2a_branch2a (BatchNormalizati	(None, 38, 38, 64)	256	res2a_branch2a[0][0]

activation_2 (Activation) (None, 38, 38, 64) 0 bn2a_branch2a[0][0]

res2a_branch2b (Conv2D) (None, 38, 38, 64) 36928 activation_2[0][0]

bn2a_branch2b (BatchNormalizati (None, 38, 38, 64) 256 res2a_branch2b[0][0]

activation_3 (Activation) (None, 38, 38, 64) 0 bn2a_branch2b[0][0]

res2a_branch2c (Conv2D) (None, 38, 38, 256) 16640 activation_3[0][0]

res2a_branch1 (Conv2D) (None, 38, 38, 256) 16640 max_pooling2d_1[0][0]

bn2a_branch2c (BatchNormalizati (None, 38, 38, 256) 1024 res2a_branch2c[0][0]

bn2a_branch1 (BatchNormalizatio (None, 38, 38, 256) 1024 res2a_branch1[0][0]

add_1 (Add) (None, 38, 38, 256) 0 bn2a_branch2c[0][0]
bn2a_branch1[0][0]

activation_4 (Activation) (None, 38, 38, 256) 0 add_1[0][0]

res2b_branch2a (Conv2D) (None, 38, 38, 64) 16448 activation_4[0][0]

bn2b_branch2a (BatchNormalizati (None, 38, 38, 64) 256 res2b_branch2a[0][0]

activation_5 (Activation) (None, 38, 38, 64) 0 bn2b_branch2a[0][0]

res2b_branch2b (Conv2D) (None, 38, 38, 64) 36928 activation_5[0][0]

bn2b_branch2b (BatchNormalizati (None, 38, 38, 64) 256 res2b_branch2b[0][0]

activation_6 (Activation) (None, 38, 38, 64) 0 bn2b_branch2b[0][0]

res2b_branch2c (Conv2D) (None, 38, 38, 256) 16640 activation_6[0][0]

bn2b_branch2c (BatchNormalizati (None, 38, 38, 256) 1024 res2b_branch2c[0][0]

add_2 (Add) (None, 38, 38, 256) 0 bn2b_branch2c[0][0]
activation_4[0][0]

activation_7 (Activation) (None, 38, 38, 256) 0 add_2[0][0]

res2c_branch2a (Conv2D) (None, 38, 38, 64) 16448 activation_7[0][0]

bn2c_branch2a (BatchNormalizati (None, 38, 38, 64) 256 res2c_branch2a[0][0]

activation_8 (Activation) (None, 38, 38, 64) 0 bn2c_branch2a[0][0]

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res2c_branch2b (Conv2D)          (None, 38, 38, 64)   36928       activation_8[0][0]
_____________________________________________________________________________________
bn2c_branch2b (BatchNormalizati (None, 38, 38, 64)   256         res2c_branch2b[0][0]
_____________________________________________________________________________________
activation_9 (Activation)        (None, 38, 38, 64)   0           bn2c_branch2b[0][0]
_____________________________________________________________________________________
res2c_branch2c (Conv2D)          (None, 38, 38, 256)  16640       activation_9[0][0]
_____________________________________________________________________________________
bn2c_branch2c (BatchNormalizati (None, 38, 38, 256)  1024        res2c_branch2c[0][0]
_____________________________________________________________________________________
add_3 (Add)                      (None, 38, 38, 256)  0           bn2c_branch2c[0][0]
                                                                  activation_7[0][0]
_____________________________________________________________________________________
activation_10 (Activation)       (None, 38, 38, 256)  0           add_3[0][0]
_____________________________________________________________________________________
res3a_branch2a (Conv2D)          (None, 19, 19, 128)  32896       activation_10[0][0]
_____________________________________________________________________________________
bn3a_branch2a (BatchNormalizati (None, 19, 19, 128)  512         res3a_branch2a[0][0]
_____________________________________________________________________________________
activation_11 (Activation)       (None, 19, 19, 128)  0           bn3a_branch2a[0][0]
_____________________________________________________________________________________
res3a_branch2b (Conv2D)          (None, 19, 19, 128)  147584      activation_11[0][0]
_____________________________________________________________________________________
bn3a_branch2b (BatchNormalizati (None, 19, 19, 128)  512         res3a_branch2b[0][0]
_____________________________________________________________________________________
activation_12 (Activation)       (None, 19, 19, 128)  0           bn3a_branch2b[0][0]
_____________________________________________________________________________________
res3a_branch2c (Conv2D)          (None, 19, 19, 512)  66048       activation_12[0][0]
_____________________________________________________________________________________
res3a_branch1 (Conv2D)           (None, 19, 19, 512)  131584      activation_10[0][0]
_____________________________________________________________________________________
bn3a_branch2c (BatchNormalizati (None, 19, 19, 512)  2048        res3a_branch2c[0][0]
_____________________________________________________________________________________
bn3a_branch1 (BatchNormalizatio (None, 19, 19, 512)  2048        res3a_branch1[0][0]
_____________________________________________________________________________________
add_4 (Add)                      (None, 19, 19, 512)  0           bn3a_branch2c[0][0]
                                                                  bn3a_branch1[0][0]
_____________________________________________________________________________________
activation_13 (Activation)       (None, 19, 19, 512)  0           add_4[0][0]
_____________________________________________________________________________________
res3b_branch2a (Conv2D)          (None, 19, 19, 128)  65664       activation_13[0][0]
_____________________________________________________________________________________
bn3b_branch2a (BatchNormalizati (None, 19, 19, 128)  512         res3b_branch2a[0][0]
_____________________________________________________________________________________
activation_14 (Activation)       (None, 19, 19, 128)  0           bn3b_branch2a[0][0]
_____________________________________________________________________________________
res3b_branch2b (Conv2D)          (None, 19, 19, 128)  147584      activation_14[0][0]
_____________________________________________________________________________________
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bn3b_branch2b (BatchNormalizati (None, 19, 19, 128)  512         res3b_branch2b[0][0]
__________________________________________________________________________________________
activation_15 (Activation)      (None, 19, 19, 128)  0           bn3b_branch2b[0][0]
__________________________________________________________________________________________
res3b_branch2c (Conv2D)         (None, 19, 19, 512)  66048       activation_15[0][0]
__________________________________________________________________________________________
bn3b_branch2c (BatchNormalizati (None, 19, 19, 512)  2048        res3b_branch2c[0][0]
__________________________________________________________________________________________
add_5 (Add)                     (None, 19, 19, 512)  0           bn3b_branch2c[0][0]
                                                                 activation_13[0][0]
__________________________________________________________________________________________
activation_16 (Activation)      (None, 19, 19, 512)  0           add_5[0][0]
__________________________________________________________________________________________
res3c_branch2a (Conv2D)         (None, 19, 19, 128)  65664       activation_16[0][0]
__________________________________________________________________________________________
bn3c_branch2a (BatchNormalizati (None, 19, 19, 128)  512         res3c_branch2a[0][0]
__________________________________________________________________________________________
activation_17 (Activation)      (None, 19, 19, 128)  0           bn3c_branch2a[0][0]
__________________________________________________________________________________________
res3c_branch2b (Conv2D)         (None, 19, 19, 128)  147584      activation_17[0][0]
__________________________________________________________________________________________
bn3c_branch2b (BatchNormalizati (None, 19, 19, 128)  512         res3c_branch2b[0][0]
__________________________________________________________________________________________
activation_18 (Activation)      (None, 19, 19, 128)  0           bn3c_branch2b[0][0]
__________________________________________________________________________________________
res3c_branch2c (Conv2D)         (None, 19, 19, 512)  66048       activation_18[0][0]
__________________________________________________________________________________________
bn3c_branch2c (BatchNormalizati (None, 19, 19, 512)  2048        res3c_branch2c[0][0]
__________________________________________________________________________________________
add_6 (Add)                     (None, 19, 19, 512)  0           bn3c_branch2c[0][0]
                                                                 activation_16[0][0]
__________________________________________________________________________________________
activation_19 (Activation)      (None, 19, 19, 512)  0           add_6[0][0]
__________________________________________________________________________________________
res3d_branch2a (Conv2D)         (None, 19, 19, 128)  65664       activation_19[0][0]
__________________________________________________________________________________________
bn3d_branch2a (BatchNormalizati (None, 19, 19, 128)  512         res3d_branch2a[0][0]
__________________________________________________________________________________________
activation_20 (Activation)      (None, 19, 19, 128)  0           bn3d_branch2a[0][0]
__________________________________________________________________________________________
res3d_branch2b (Conv2D)         (None, 19, 19, 128)  147584      activation_20[0][0]
__________________________________________________________________________________________
bn3d_branch2b (BatchNormalizati (None, 19, 19, 128)  512         res3d_branch2b[0][0]
__________________________________________________________________________________________
activation_21 (Activation)      (None, 19, 19, 128)  0           bn3d_branch2b[0][0]
__________________________________________________________________________________________
res3d_branch2c (Conv2D)         (None, 19, 19, 512)  66048       activation_21[0][0]
__________________________________________________________________________________________
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bn3d_branch2c (BatchNormalizati (None, 19, 19, 512)  2048        res3d_branch2c[0][0]
__________________________________________________________________________________________
add_7 (Add)                     (None, 19, 19, 512)  0           bn3d_branch2c[0][0]
                                                                 activation_19[0][0]
__________________________________________________________________________________________
activation_22 (Activation)      (None, 19, 19, 512)  0           add_7[0][0]
__________________________________________________________________________________________
res4a_branch2a (Conv2D)         (None, 10, 10, 256)  131328      activation_22[0][0]
__________________________________________________________________________________________
bn4a_branch2a (BatchNormalizati (None, 10, 10, 256)  1024        res4a_branch2a[0][0]
__________________________________________________________________________________________
activation_23 (Activation)      (None, 10, 10, 256)  0           bn4a_branch2a[0][0]
__________________________________________________________________________________________
res4a_branch2b (Conv2D)         (None, 10, 10, 256)  590080      activation_23[0][0]
__________________________________________________________________________________________
bn4a_branch2b (BatchNormalizati (None, 10, 10, 256)  1024        res4a_branch2b[0][0]
__________________________________________________________________________________________
activation_24 (Activation)      (None, 10, 10, 256)  0           bn4a_branch2b[0][0]
__________________________________________________________________________________________
res4a_branch2c (Conv2D)         (None, 10, 10, 1024) 263168      activation_24[0][0]
__________________________________________________________________________________________
res4a_branch1 (Conv2D)          (None, 10, 10, 1024) 525312      activation_22[0][0]
__________________________________________________________________________________________
bn4a_branch2c (BatchNormalizati (None, 10, 10, 1024) 4096        res4a_branch2c[0][0]
__________________________________________________________________________________________
bn4a_branch1 (BatchNormalizatio (None, 10, 10, 1024) 4096        res4a_branch1[0][0]
__________________________________________________________________________________________
add_8 (Add)                     (None, 10, 10, 1024) 0           bn4a_branch2c[0][0]
                                                                 bn4a_branch1[0][0]
__________________________________________________________________________________________
activation_25 (Activation)      (None, 10, 10, 1024) 0           add_8[0][0]
__________________________________________________________________________________________
res4b_branch2a (Conv2D)         (None, 10, 10, 256)  262400      activation_25[0][0]
__________________________________________________________________________________________
bn4b_branch2a (BatchNormalizati (None, 10, 10, 256)  1024        res4b_branch2a[0][0]
__________________________________________________________________________________________
activation_26 (Activation)      (None, 10, 10, 256)  0           bn4b_branch2a[0][0]
__________________________________________________________________________________________
res4b_branch2b (Conv2D)         (None, 10, 10, 256)  590080      activation_26[0][0]
__________________________________________________________________________________________
bn4b_branch2b (BatchNormalizati (None, 10, 10, 256)  1024        res4b_branch2b[0][0]
__________________________________________________________________________________________
activation_27 (Activation)      (None, 10, 10, 256)  0           bn4b_branch2b[0][0]
__________________________________________________________________________________________
res4b_branch2c (Conv2D)         (None, 10, 10, 1024) 263168      activation_27[0][0]
__________________________________________________________________________________________
bn4b_branch2c (BatchNormalizati (None, 10, 10, 1024) 4096        res4b_branch2c[0][0]
__________________________________________________________________________________________
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add_9 (Add)                  (None, 10, 10, 1024) 0           bn4b_branch2c[0][0]
                                                              activation_25[0][0]
__________________________________________________________________________________________
activation_28 (Activation)   (None, 10, 10, 1024) 0           add_9[0][0]
__________________________________________________________________________________________
res4c_branch2a (Conv2D)      (None, 10, 10, 256)  262400      activation_28[0][0]
__________________________________________________________________________________________
bn4c_branch2a (BatchNormalizati (None, 10, 10, 256)  1024        res4c_branch2a[0][0]
__________________________________________________________________________________________
activation_29 (Activation)   (None, 10, 10, 256)  0           bn4c_branch2a[0][0]
__________________________________________________________________________________________
res4c_branch2b (Conv2D)      (None, 10, 10, 256)  590080      activation_29[0][0]
__________________________________________________________________________________________
bn4c_branch2b (BatchNormalizati (None, 10, 10, 256)  1024        res4c_branch2b[0][0]
__________________________________________________________________________________________
activation_30 (Activation)   (None, 10, 10, 256)  0           bn4c_branch2b[0][0]
__________________________________________________________________________________________
res4c_branch2c (Conv2D)      (None, 10, 10, 1024) 263168      activation_30[0][0]
__________________________________________________________________________________________
bn4c_branch2c (BatchNormalizati (None, 10, 10, 1024) 4096        res4c_branch2c[0][0]
__________________________________________________________________________________________
add_10 (Add)                 (None, 10, 10, 1024) 0           bn4c_branch2c[0][0]
                                                              activation_28[0][0]
__________________________________________________________________________________________
activation_31 (Activation)   (None, 10, 10, 1024) 0           add_10[0][0]
__________________________________________________________________________________________
res4d_branch2a (Conv2D)      (None, 10, 10, 256)  262400      activation_31[0][0]
__________________________________________________________________________________________
bn4d_branch2a (BatchNormalizati (None, 10, 10, 256)  1024        res4d_branch2a[0][0]
__________________________________________________________________________________________
activation_32 (Activation)   (None, 10, 10, 256)  0           bn4d_branch2a[0][0]
__________________________________________________________________________________________
res4d_branch2b (Conv2D)      (None, 10, 10, 256)  590080      activation_32[0][0]
__________________________________________________________________________________________
bn4d_branch2b (BatchNormalizati (None, 10, 10, 256)  1024        res4d_branch2b[0][0]
__________________________________________________________________________________________
activation_33 (Activation)   (None, 10, 10, 256)  0           bn4d_branch2b[0][0]
__________________________________________________________________________________________
res4d_branch2c (Conv2D)      (None, 10, 10, 1024) 263168      activation_33[0][0]
__________________________________________________________________________________________
bn4d_branch2c (BatchNormalizati (None, 10, 10, 1024) 4096        res4d_branch2c[0][0]
__________________________________________________________________________________________
add_11 (Add)                 (None, 10, 10, 1024) 0           bn4d_branch2c[0][0]
                                                              activation_31[0][0]
__________________________________________________________________________________________
activation_34 (Activation)   (None, 10, 10, 1024) 0           add_11[0][0]
__________________________________________________________________________________________
res4e_branch2a (Conv2D)      (None, 10, 10, 256)  262400      activation_34[0][0]
```

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bn4e_branch2a (BatchNormalizati (None, 10, 10, 256)  1024        res4e_branch2a[0][0]
activation_35 (Activation)      (None, 10, 10, 256)  0           bn4e_branch2a[0][0]
res4e_branch2b (Conv2D)         (None, 10, 10, 256)  590080      activation_35[0][0]
bn4e_branch2b (BatchNormalizati (None, 10, 10, 256)  1024        res4e_branch2b[0][0]
activation_36 (Activation)      (None, 10, 10, 256)  0           bn4e_branch2b[0][0]
res4e_branch2c (Conv2D)         (None, 10, 10, 1024) 263168      activation_36[0][0]
bn4e_branch2c (BatchNormalizati (None, 10, 10, 1024) 4096        res4e_branch2c[0][0]
add_12 (Add)                    (None, 10, 10, 1024) 0           bn4e_branch2c[0][0]
                                                                 activation_34[0][0]
activation_37 (Activation)      (None, 10, 10, 1024) 0           add_12[0][0]
res4f_branch2a (Conv2D)         (None, 10, 10, 256)  262400      activation_37[0][0]
bn4f_branch2a (BatchNormalizati (None, 10, 10, 256)  1024        res4f_branch2a[0][0]
activation_38 (Activation)      (None, 10, 10, 256)  0           bn4f_branch2a[0][0]
res4f_branch2b (Conv2D)         (None, 10, 10, 256)  590080      activation_38[0][0]
bn4f_branch2b (BatchNormalizati (None, 10, 10, 256)  1024        res4f_branch2b[0][0]
activation_39 (Activation)      (None, 10, 10, 256)  0           bn4f_branch2b[0][0]
res4f_branch2c (Conv2D)         (None, 10, 10, 1024) 263168      activation_39[0][0]
bn4f_branch2c (BatchNormalizati (None, 10, 10, 1024) 4096        res4f_branch2c[0][0]
add_13 (Add)                    (None, 10, 10, 1024) 0           bn4f_branch2c[0][0]
                                                                 activation_37[0][0]
activation_40 (Activation)      (None, 10, 10, 1024) 0           add_13[0][0]
res5a_branch2a (Conv2D)         (None, 5, 5, 512)    524800      activation_40[0][0]
bn5a_branch2a (BatchNormalizati (None, 5, 5, 512)    2048        res5a_branch2a[0][0]
activation_41 (Activation)      (None, 5, 5, 512)    0           bn5a_branch2a[0][0]
res5a_branch2b (Conv2D)         (None, 5, 5, 512)    2359808     activation_41[0][0]
```

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bn5a_branch2b (BatchNormalizati (None, 5, 5, 512)    2048        res5a_branch2b[0][0]
activation_42 (Activation)      (None, 5, 5, 512)    0           bn5a_branch2b[0][0]
res5a_branch2c (Conv2D)         (None, 5, 5, 2048)   1050624     activation_42[0][0]
res5a_branch1 (Conv2D)          (None, 5, 5, 2048)   2099200     activation_40[0][0]
bn5a_branch2c (BatchNormalizati (None, 5, 5, 2048)   8192        res5a_branch2c[0][0]
bn5a_branch1 (BatchNormalizatio (None, 5, 5, 2048)   8192        res5a_branch1[0][0]
add_14 (Add)                    (None, 5, 5, 2048)   0           bn5a_branch2c[0][0]
                                                                 bn5a_branch1[0][0]
activation_43 (Activation)      (None, 5, 5, 2048)   0           add_14[0][0]
res5b_branch2a (Conv2D)         (None, 5, 5, 512)    1049088     activation_43[0][0]
bn5b_branch2a (BatchNormalizati (None, 5, 5, 512)    2048        res5b_branch2a[0][0]
activation_44 (Activation)      (None, 5, 5, 512)    0           bn5b_branch2a[0][0]
res5b_branch2b (Conv2D)         (None, 5, 5, 512)    2359808     activation_44[0][0]
bn5b_branch2b (BatchNormalizati (None, 5, 5, 512)    2048        res5b_branch2b[0][0]
activation_45 (Activation)      (None, 5, 5, 512)    0           bn5b_branch2b[0][0]
res5b_branch2c (Conv2D)         (None, 5, 5, 2048)   1050624     activation_45[0][0]
bn5b_branch2c (BatchNormalizati (None, 5, 5, 2048)   8192        res5b_branch2c[0][0]
add_15 (Add)                    (None, 5, 5, 2048)   0           bn5b_branch2c[0][0]
                                                                 activation_43[0][0]
activation_46 (Activation)      (None, 5, 5, 2048)   0           add_15[0][0]
res5c_branch2a (Conv2D)         (None, 5, 5, 512)    1049088     activation_46[0][0]
bn5c_branch2a (BatchNormalizati (None, 5, 5, 512)    2048        res5c_branch2a[0][0]
activation_47 (Activation)      (None, 5, 5, 512)    0           bn5c_branch2a[0][0]
res5c_branch2b (Conv2D)         (None, 5, 5, 512)    2359808     activation_47[0][0]
bn5c_branch2b (BatchNormalizati (None, 5, 5, 512)    2048        res5c_branch2b[0][0]
```

```
activation_48 (Activation)      (None, 5, 5, 512)    0           bn5c_branch2b[0][0]
res5c_branch2c (Conv2D)         (None, 5, 5, 2048)   1050624     activation_48[0][0]
bn5c_branch2c (BatchNormalizati (None, 5, 5, 2048)   8192        res5c_branch2c[0][0]
add_16 (Add)                    (None, 5, 5, 2048)   0           bn5c_branch2c[0][0]
                                                                 activation_46[0][0]
activation_49 (Activation)      (None, 5, 5, 2048)   0           add_16[0][0]
==================================================================================
Total params: 23,587,712
Trainable params: 23,534,592
Non-trainable params: 53,120
```

In [4]:
```
# 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 #
=================================================================
resnet50 (Model)             (None, 5, 5, 2048)        23587712
_________________________________________________________________
flatten_1 (Flatten)          (None, 51200)             0
_________________________________________________________________
dense_1 (Dense)              (None, 256)               13107456
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 257
=================================================================
Total params: 36,695,425
Trainable params: 36,642,305
Non-trainable params: 53,120
_________________________________________________________________
```

In [5]:
```
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:  216
```

In [6]:
```
# 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 16:32:30.244230 139777111516992 deprecation_wrapper.py:119] From /home/mlab/anaconda3/lib/python

W0215 16:32:30.250418 139777111516992 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 [7]:
```
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 [8]:
```
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 [9]:
```
# 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 [==============================] - 1117s 3s/step - loss: 0.5311 - acc: 0.7401 - val_lo
Epoch 2/8
351/351 [==============================] - 1082s 3s/step - loss: 0.3625 - acc: 0.8261 - val_lo
Epoch 3/8
351/351 [==============================] - 1085s 3s/step - loss: 0.3120 - acc: 0.8561 - val_lo
Epoch 4/8
351/351 [==============================] - 1086s 3s/step - loss: 0.2779 - acc: 0.8760 - val_lo
Epoch 5/8
351/351 [==============================] - 1087s 3s/step - loss: 0.2471 - acc: 0.8895 - val_lo
Epoch 6/8
351/351 [==============================] - 1095s 3s/step - loss: 0.2231 - acc: 0.9041 - val_lo
Epoch 7/8
351/351 [==============================] - 1114s 3s/step - loss: 0.2082 - acc: 0.9117 - val_lo
Epoch 8/8
351/351 [==============================] - 1121s 3s/step - loss: 0.1936 - acc: 0.9172 - val_lo
```

In [10]:
```
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 [11]:
```
#Confution Matrix and Classification Report
Y_pred = model.predict_generator(validation_generator, nb_validation_samples // batch_size+1)
```

In [12]:
```
# 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 [13]:
```
# print(validation_generator.classes)
```

In [14]:
```
confusion_matrix = metrics.confusion_matrix(true_classes_1,y_pred)
print(confusion_matrix)
```

```
[[1432 1343]
 [1473 1368]]
```

In [15]:
```
report= sklearn.metrics.classification_report(true_classes_1, y_pred,
                                              target_names = class_labels_1)
print(report)
```

```
              precision    recall  f1-score   support

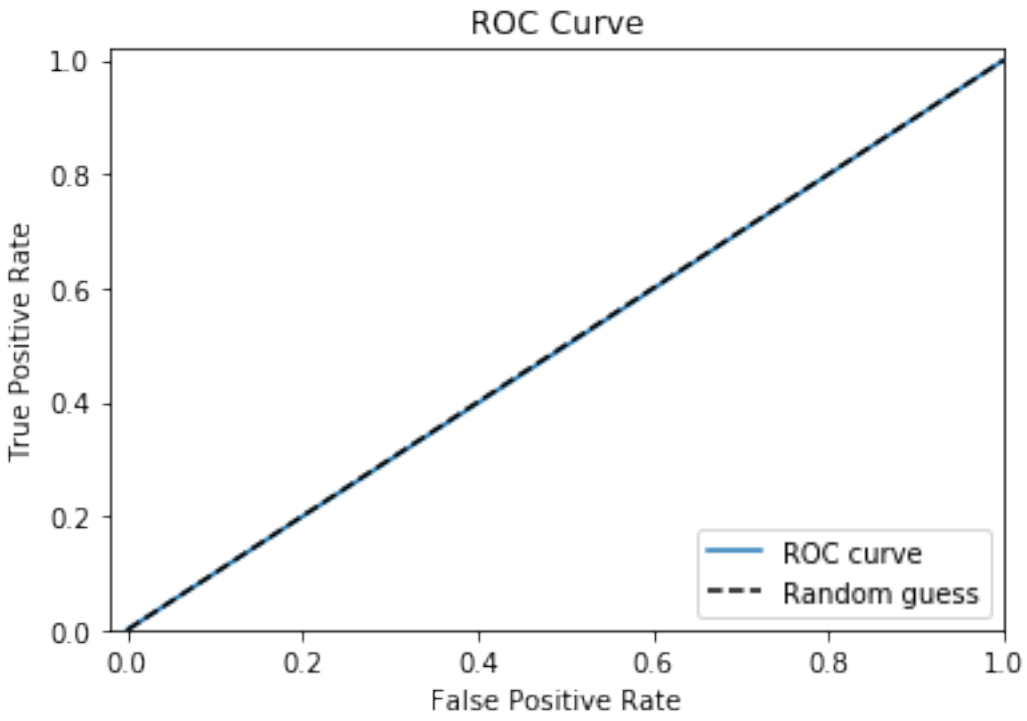
        high       0.49      0.52      0.50      2775
         low       0.50      0.48      0.49      2841

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

In [16]:
```
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 [17]:
```
roc_auc_score(validation_generator.classes, y_pred)
```

Out[17]: 0.49877831368855663

In [18]:
```
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 [==============================] - 3s 26ms/step
Accuracy training: 92.97
128/128 [==============================] - 3s 26ms/step
Accuracy val: 87.50
```

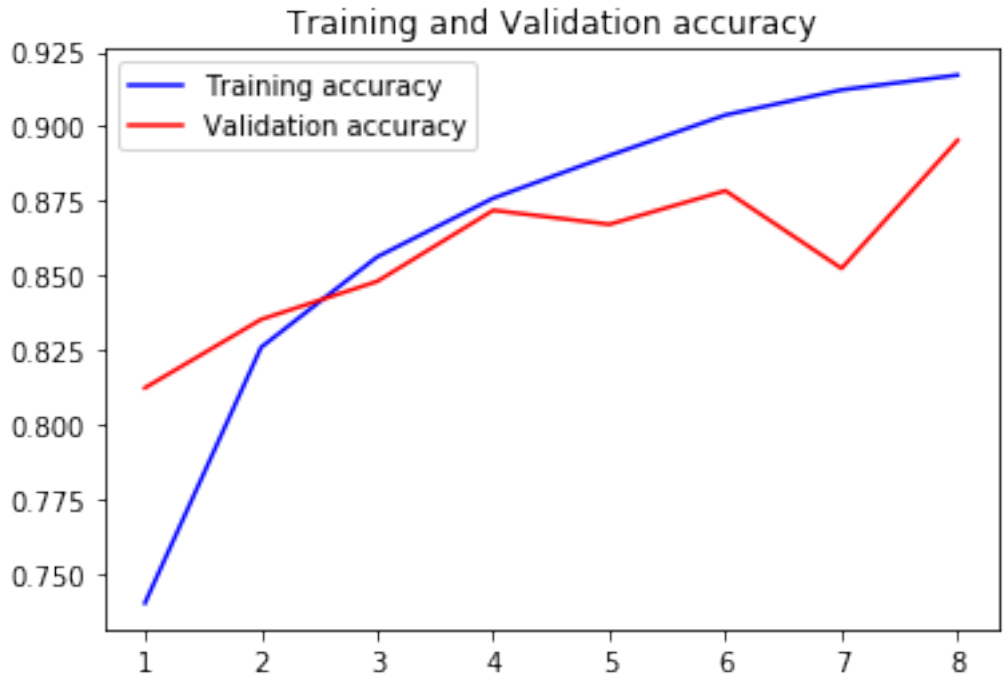
In [19]:
```
#plot the train and val curve
#get the details from the history object
```

```
acc = history.history['acc']
val_acc=history.history['val_acc']
loss = history.history['loss']
val_loss = history.history['val_loss']

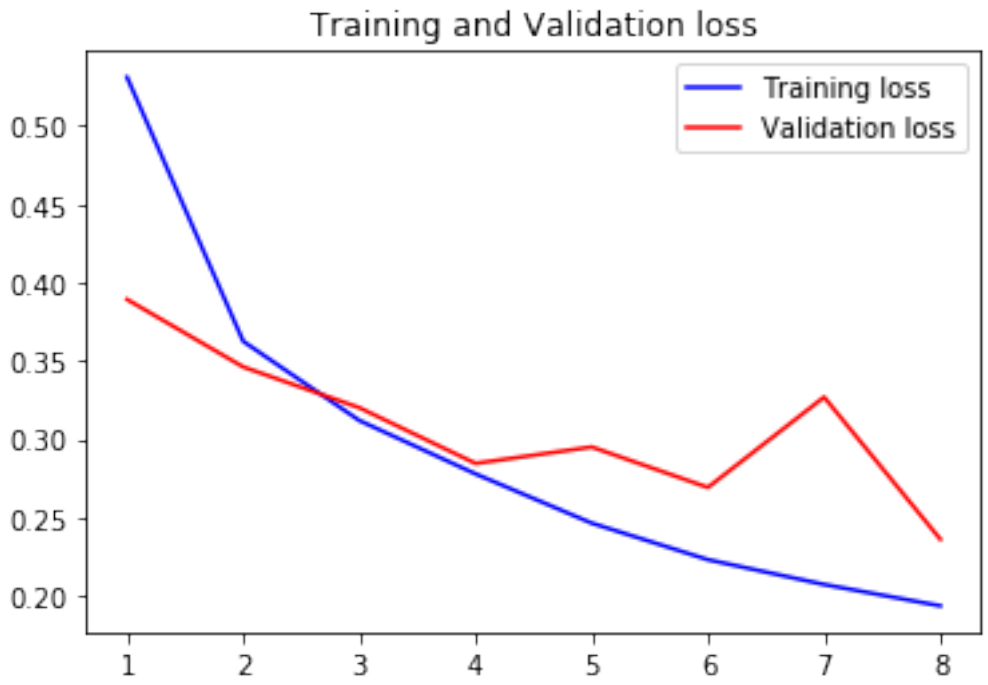
epochs = range(1,len(acc)+1)

#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[19]: <matplotlib.legend.Legend at 0x7f1f4bfb4358>



In [20]:
```
#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 [21]: 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 [22]: print("%s: %.2f%%" % (model.metrics_names[1], scores[1]*100))
```

acc: 88.24%

```
In [23]: #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 [24]: 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 [25]: # 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 [26]: confusion_matrix1 = metrics.confusion_matrix(true_classes_2,y_pred1)
         print(confusion_matrix1)
```

```
[[1484 1292]
 [1495 1348]]
```

```
In [27]: 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	0.53	0.52	2776
low	0.51	0.47	0.49	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 [28]: print(" Loss: ", scores[0],"\n","Accuracy: ", scores[1])
```

```
 Loss:  0.26137544769187304
 Accuracy:  0.8824491279069767
```