

# AI for Medicine Course 1 Week 1 lecture exercises

## Densenet

In this week's assignment, you'll be using a pre-trained Densenet model for image classification.

Densenet is a convolutional network where each layer is connected to all other layers that are deeper in the network

- The first layer is connected to the 2nd, 3rd, 4th etc.
- The second layer is connected to the 3rd, 4th, 5th etc.

Like this:

U-net Image

For a detailed explanation of Densenet, check out the source of the image above, a paper by Gao Huang et al. 2018 called [Densely Connected Convolutional Networks](#).

The cells below are set up to provide an exploration of the Keras densenet implementation that you'll be using in the assignment. Run these cells to gain some insight into the network architecture.

In [1]:

```
# Import Densenet from Keras
from keras.applications.densenet import DenseNet121
from keras.layers import Dense, GlobalAveragePooling2D
from keras.models import Model
from keras import backend as K
```

Using TensorFlow backend.

For your work in the assignment, you'll be loading a set of pre-trained weights to reduce training time.

In [2]:

```
# Create the base pre-trained model
base_model = DenseNet121(weights='./nih/densenet.hdf5', include_top=False);
```

WARNING:tensorflow:From /opt/conda/lib/python3.6/site-packages/tensorflow\_core/python/ops/resource\_variable\_ops.py:1630: calling BaseResourceVariable.\_\_init\_\_ (from tensorflow.python.ops.resource\_variable\_ops) with constraint is deprecated and will be removed in a future version.  
Instructions for updating:  
If using Keras pass \*\_constraint arguments to layers.  
WARNING:tensorflow:From /opt/conda/lib/python3.6/site-packages/keras/backend/tensorflow\_backend.py:4070: The name tf.nn.max\_pool is deprecated. Please use tf.nn.max\_pool2d instead.

WARNING:tensorflow:From /opt/conda/lib/python3.6/site-packages/keras/backend/tensorflow\_backend.py:4074: The name tf.nn.avg\_pool is deprecated. Please use tf.nn.avg\_pool2d instead.

View a summary of the model

In [3]:

```
# Print the model summary
base_model.summary()
```

Model: "densenet121"

Layer (type)	Output Shape	Param #	Connected to
input_1 (TensorFlow)	(None, None, None, 3, 0)		

input_1 (InputLayer)	(None, None, None, 3 0)	
zero_padding2d_1 (ZeroPadding2D)	(None, None, None, 3 0)	input_1[0][0]
conv1/conv (Conv2D)	(None, None, None, 6 9408)	zero_padding2d_1[0][0]
conv1/bn (BatchNormalization)	(None, None, None, 6 256)	conv1/conv[0][0]
conv1/relu (Activation)	(None, None, None, 6 0)	conv1/bn[0][0]
zero_padding2d_2 (ZeroPadding2D)	(None, None, None, 6 0)	conv1/relu[0][0]
pool1 (MaxPooling2D)	(None, None, None, 6 0)	zero_padding2d_2[0][0]
conv2_block1_0_bn (BatchNormali	(None, None, None, 6 256)	pool1[0][0]
conv2_block1_0_relu (Activation	(None, None, None, 6 0)	conv2_block1_0_bn[0][0]
conv2_block1_1_conv (Conv2D)	(None, None, None, 1 8192)	conv2_block1_0_relu[0][0]
conv2_block1_1_bn (BatchNormali	(None, None, None, 1 512)	conv2_block1_1_conv[0][0]
conv2_block1_1_relu (Activation	(None, None, None, 1 0)	conv2_block1_1_bn[0][0]
conv2_block1_2_conv (Conv2D)	(None, None, None, 3 36864)	conv2_block1_1_relu[0][0]
conv2_block1_concat (Concatenat	(None, None, None, 9 0)	pool1[0][0] conv2_block1_2_conv[0][0]
conv2_block2_0_bn (BatchNormali	(None, None, None, 9 384)	conv2_block1_concat[0][0]
conv2_block2_0_relu (Activation	(None, None, None, 9 0)	conv2_block2_0_bn[0][0]
conv2_block2_1_conv (Conv2D)	(None, None, None, 1 12288)	conv2_block2_0_relu[0][0]
conv2_block2_1_bn (BatchNormali	(None, None, None, 1 512)	conv2_block2_1_conv[0][0]
conv2_block2_1_relu (Activation	(None, None, None, 1 0)	conv2_block2_1_bn[0][0]
conv2_block2_2_conv (Conv2D)	(None, None, None, 3 36864)	conv2_block2_1_relu[0][0]
conv2_block2_concat (Concatenat	(None, None, None, 1 0)	conv2_block1_concat[0][0] conv2_block2_2_conv[0][0]
conv2_block3_0_bn (BatchNormali	(None, None, None, 1 512)	conv2_block2_concat[0][0]
conv2_block3_0_relu (Activation	(None, None, None, 1 0)	conv2_block3_0_bn[0][0]
conv2_block3_1_conv (Conv2D)	(None, None, None, 1 16384)	conv2_block3_0_relu[0][0]
conv2_block3_1_bn (BatchNormali	(None, None, None, 1 512)	conv2_block3_1_conv[0][0]
conv2_block3_1_relu (Activation	(None, None, None, 1 0)	conv2_block3_1_bn[0][0]
conv2_block3_2_conv (Conv2D)	(None, None, None, 3 36864)	conv2_block3_1_relu[0][0]
conv2_block3_concat (Concatenat	(None, None, None, 1 0)	conv2_block2_concat[0][0] conv2_block3_2_conv[0][0]
conv2_block4_0_bn (BatchNormali	(None, None, None, 1 640)	conv2_block3_concat[0][0]
conv2_block4_0_relu (Activation	(None, None, None, 1 0)	conv2_block4_0_bn[0][0]
conv2_block4_1_conv (Conv2D)	(None, None, None, 1 20480)	conv2_block4_0_relu[0][0]
conv2_block4_1_bn (BatchNormali	(None, None, None, 1 512)	conv2_block4_1_conv[0][0]
conv2_block4_1_relu (Activation	(None, None, None, 1 0)	conv2_block4_1_bn[0][0]
conv2_block4_2_conv (Conv2D)	(None, None, None, 3 36864)	conv2_block4_1_relu[0][0]
conv2_block4_concat (Concatenat	(None, None, None, 1 0)	conv2_block3_concat[0][0] conv2_block4_2_conv[0][0]
conv2_block5_0_bn (BatchNormali	(None, None, None, 1 768)	conv2_block4_concat[0][0]
conv2_block5_0_relu (Activation	(None, None, None, 1 0)	conv2_block5_0_bn[0][0]

conv2_block5_1_conv (Conv2D)	(None, None, None, 1 24576	conv2_block5_0_relu[0][0]
conv2_block5_1_bn (BatchNormali	(None, None, None, 1 512	conv2_block5_1_conv[0][0]
conv2_block5_1_relu (Activation	(None, None, None, 1 0	conv2_block5_1_bn[0][0]
conv2_block5_2_conv (Conv2D)	(None, None, None, 3 36864	conv2_block5_1_relu[0][0]
conv2_block5_concat (Concatenat	(None, None, None, 2 0	conv2_block4_concat[0][0] conv2_block5_2_conv[0][0]
conv2_block6_0_bn (BatchNormali	(None, None, None, 2 896	conv2_block5_concat[0][0]
conv2_block6_0_relu (Activation	(None, None, None, 2 0	conv2_block6_0_bn[0][0]
conv2_block6_1_conv (Conv2D)	(None, None, None, 1 28672	conv2_block6_0_relu[0][0]
conv2_block6_1_bn (BatchNormali	(None, None, None, 1 512	conv2_block6_1_conv[0][0]
conv2_block6_1_relu (Activation	(None, None, None, 1 0	conv2_block6_1_bn[0][0]
conv2_block6_2_conv (Conv2D)	(None, None, None, 3 36864	conv2_block6_1_relu[0][0]
conv2_block6_concat (Concatenat	(None, None, None, 2 0	conv2_block5_concat[0][0] conv2_block6_2_conv[0][0]
pool2_bn (BatchNormalization)	(None, None, None, 2 1024	conv2_block6_concat[0][0]
pool2_relu (Activation)	(None, None, None, 2 0	pool2_bn[0][0]
pool2_conv (Conv2D)	(None, None, None, 1 32768	pool2_relu[0][0]
pool2_pool (AveragePooling2D)	(None, None, None, 1 0	pool2_conv[0][0]
conv3_block1_0_bn (BatchNormali	(None, None, None, 1 512	pool2_pool[0][0]
conv3_block1_0_relu (Activation	(None, None, None, 1 0	conv3_block1_0_bn[0][0]
conv3_block1_1_conv (Conv2D)	(None, None, None, 1 16384	conv3_block1_0_relu[0][0]
conv3_block1_1_bn (BatchNormali	(None, None, None, 1 512	conv3_block1_1_conv[0][0]
conv3_block1_1_relu (Activation	(None, None, None, 1 0	conv3_block1_1_bn[0][0]
conv3_block1_2_conv (Conv2D)	(None, None, None, 3 36864	conv3_block1_1_relu[0][0]
conv3_block1_concat (Concatenat	(None, None, None, 1 0	pool2_pool[0][0] conv3_block1_2_conv[0][0]
conv3_block2_0_bn (BatchNormali	(None, None, None, 1 640	conv3_block1_concat[0][0]
conv3_block2_0_relu (Activation	(None, None, None, 1 0	conv3_block2_0_bn[0][0]
conv3_block2_1_conv (Conv2D)	(None, None, None, 1 20480	conv3_block2_0_relu[0][0]
conv3_block2_1_bn (BatchNormali	(None, None, None, 1 512	conv3_block2_1_conv[0][0]
conv3_block2_1_relu (Activation	(None, None, None, 1 0	conv3_block2_1_bn[0][0]
conv3_block2_2_conv (Conv2D)	(None, None, None, 3 36864	conv3_block2_1_relu[0][0]
conv3_block2_concat (Concatenat	(None, None, None, 1 0	conv3_block1_concat[0][0] conv3_block2_2_conv[0][0]
conv3_block3_0_bn (BatchNormali	(None, None, None, 1 768	conv3_block2_concat[0][0]
conv3_block3_0_relu (Activation	(None, None, None, 1 0	conv3_block3_0_bn[0][0]
conv3_block3_1_conv (Conv2D)	(None, None, None, 1 24576	conv3_block3_0_relu[0][0]
conv3_block3_1_bn (BatchNormali	(None, None, None, 1 512	conv3_block3_1_conv[0][0]
conv3_block3_1_relu (Activation	(None, None, None, 1 0	conv3_block3_1_bn[0][0]
conv3_block3_2_conv (Conv2D)	(None, None, None, 3 36864	conv3_block3_1_relu[0][0]

conv3_block3_concat	(Concatenat	(None, None, None, 2 0	conv3_block2_concat[0][0] conv3_block3_2_conv[0][0]
conv3_block4_0_bn	(BatchNormali	(None, None, None, 2 896	conv3_block3_concat[0][0]
conv3_block4_0_relu	(Activation	(None, None, None, 2 0	conv3_block4_0_bn[0][0]
conv3_block4_1_conv	(Conv2D)	(None, None, None, 1 28672	conv3_block4_0_relu[0][0]
conv3_block4_1_bn	(BatchNormali	(None, None, None, 1 512	conv3_block4_1_conv[0][0]
conv3_block4_1_relu	(Activation	(None, None, None, 1 0	conv3_block4_1_bn[0][0]
conv3_block4_2_conv	(Conv2D)	(None, None, None, 3 36864	conv3_block4_1_relu[0][0]
conv3_block4_concat	(Concatenat	(None, None, None, 2 0	conv3_block3_concat[0][0] conv3_block4_2_conv[0][0]
conv3_block5_0_bn	(BatchNormali	(None, None, None, 2 1024	conv3_block4_concat[0][0]
conv3_block5_0_relu	(Activation	(None, None, None, 2 0	conv3_block5_0_bn[0][0]
conv3_block5_1_conv	(Conv2D)	(None, None, None, 1 32768	conv3_block5_0_relu[0][0]
conv3_block5_1_bn	(BatchNormali	(None, None, None, 1 512	conv3_block5_1_conv[0][0]
conv3_block5_1_relu	(Activation	(None, None, None, 1 0	conv3_block5_1_bn[0][0]
conv3_block5_2_conv	(Conv2D)	(None, None, None, 3 36864	conv3_block5_1_relu[0][0]
conv3_block5_concat	(Concatenat	(None, None, None, 2 0	conv3_block4_concat[0][0] conv3_block5_2_conv[0][0]
conv3_block6_0_bn	(BatchNormali	(None, None, None, 2 1152	conv3_block5_concat[0][0]
conv3_block6_0_relu	(Activation	(None, None, None, 2 0	conv3_block6_0_bn[0][0]
conv3_block6_1_conv	(Conv2D)	(None, None, None, 1 36864	conv3_block6_0_relu[0][0]
conv3_block6_1_bn	(BatchNormali	(None, None, None, 1 512	conv3_block6_1_conv[0][0]
conv3_block6_1_relu	(Activation	(None, None, None, 1 0	conv3_block6_1_bn[0][0]
conv3_block6_2_conv	(Conv2D)	(None, None, None, 3 36864	conv3_block6_1_relu[0][0]
conv3_block6_concat	(Concatenat	(None, None, None, 3 0	conv3_block5_concat[0][0] conv3_block6_2_conv[0][0]
conv3_block7_0_bn	(BatchNormali	(None, None, None, 3 1280	conv3_block6_concat[0][0]
conv3_block7_0_relu	(Activation	(None, None, None, 3 0	conv3_block7_0_bn[0][0]
conv3_block7_1_conv	(Conv2D)	(None, None, None, 1 40960	conv3_block7_0_relu[0][0]
conv3_block7_1_bn	(BatchNormali	(None, None, None, 1 512	conv3_block7_1_conv[0][0]
conv3_block7_1_relu	(Activation	(None, None, None, 1 0	conv3_block7_1_bn[0][0]
conv3_block7_2_conv	(Conv2D)	(None, None, None, 3 36864	conv3_block7_1_relu[0][0]
conv3_block7_concat	(Concatenat	(None, None, None, 3 0	conv3_block6_concat[0][0] conv3_block7_2_conv[0][0]
conv3_block8_0_bn	(BatchNormali	(None, None, None, 3 1408	conv3_block7_concat[0][0]
conv3_block8_0_relu	(Activation	(None, None, None, 3 0	conv3_block8_0_bn[0][0]
conv3_block8_1_conv	(Conv2D)	(None, None, None, 1 45056	conv3_block8_0_relu[0][0]
conv3_block8_1_bn	(BatchNormali	(None, None, None, 1 512	conv3_block8_1_conv[0][0]
conv3_block8_1_relu	(Activation	(None, None, None, 1 0	conv3_block8_1_bn[0][0]
conv3_block8_2_conv	(Conv2D)	(None, None, None, 3 36864	conv3_block8_1_relu[0][0]
conv3_block8_concat	(Concatenat	(None, None, None, 3 0	conv3_block7_concat[0][0] conv3_block8_2_conv[0][0]

conv3_block9_0_bn	(BatchNormali	(None, None, None, 3 1536	conv3_block8_concat[0][0]
conv3_block9_0_relu	(Activation	(None, None, None, 3 0	conv3_block9_0_bn[0][0]
conv3_block9_1_conv	(Conv2D)	(None, None, None, 1 49152	conv3_block9_0_relu[0][0]
conv3_block9_1_bn	(BatchNormali	(None, None, None, 1 512	conv3_block9_1_conv[0][0]
conv3_block9_1_relu	(Activation	(None, None, None, 1 0	conv3_block9_1_bn[0][0]
conv3_block9_2_conv	(Conv2D)	(None, None, None, 3 36864	conv3_block9_1_relu[0][0]
conv3_block9_concat	(Concatenat	(None, None, None, 4 0	conv3_block8_concat[0][0] conv3_block9_2_conv[0][0]
conv3_block10_0_bn	(BatchNormal	(None, None, None, 4 1664	conv3_block9_concat[0][0]
conv3_block10_0_relu	(Activatio	(None, None, None, 4 0	conv3_block10_0_bn[0][0]
conv3_block10_1_conv	(Conv2D)	(None, None, None, 1 53248	conv3_block10_0_relu[0][0]
conv3_block10_1_bn	(BatchNormal	(None, None, None, 1 512	conv3_block10_1_conv[0][0]
conv3_block10_1_relu	(Activatio	(None, None, None, 1 0	conv3_block10_1_bn[0][0]
conv3_block10_2_conv	(Conv2D)	(None, None, None, 3 36864	conv3_block10_1_relu[0][0]
conv3_block10_concat	(Concatena	(None, None, None, 4 0	conv3_block9_concat[0][0] conv3_block10_2_conv[0][0]
conv3_block11_0_bn	(BatchNormal	(None, None, None, 4 1792	conv3_block10_concat[0][0]
conv3_block11_0_relu	(Activatio	(None, None, None, 4 0	conv3_block11_0_bn[0][0]
conv3_block11_1_conv	(Conv2D)	(None, None, None, 1 57344	conv3_block11_0_relu[0][0]
conv3_block11_1_bn	(BatchNormal	(None, None, None, 1 512	conv3_block11_1_conv[0][0]
conv3_block11_1_relu	(Activatio	(None, None, None, 1 0	conv3_block11_1_bn[0][0]
conv3_block11_2_conv	(Conv2D)	(None, None, None, 3 36864	conv3_block11_1_relu[0][0]
conv3_block11_concat	(Concatena	(None, None, None, 4 0	conv3_block10_concat[0][0] conv3_block11_2_conv[0][0]
conv3_block12_0_bn	(BatchNormal	(None, None, None, 4 1920	conv3_block11_concat[0][0]
conv3_block12_0_relu	(Activatio	(None, None, None, 4 0	conv3_block12_0_bn[0][0]
conv3_block12_1_conv	(Conv2D)	(None, None, None, 1 61440	conv3_block12_0_relu[0][0]
conv3_block12_1_bn	(BatchNormal	(None, None, None, 1 512	conv3_block12_1_conv[0][0]
conv3_block12_1_relu	(Activatio	(None, None, None, 1 0	conv3_block12_1_bn[0][0]
conv3_block12_2_conv	(Conv2D)	(None, None, None, 3 36864	conv3_block12_1_relu[0][0]
conv3_block12_concat	(Concatena	(None, None, None, 5 0	conv3_block11_concat[0][0] conv3_block12_2_conv[0][0]
pool3_bn	(BatchNormalization)	(None, None, None, 5 2048	conv3_block12_concat[0][0]
pool3_relu	(Activation)	(None, None, None, 5 0	pool3_bn[0][0]
pool3_conv	(Conv2D)	(None, None, None, 2 131072	pool3_relu[0][0]
pool3_pool	(AveragePooling2D)	(None, None, None, 2 0	pool3_conv[0][0]
conv4_block1_0_bn	(BatchNormali	(None, None, None, 2 1024	pool3_pool[0][0]
conv4_block1_0_relu	(Activation	(None, None, None, 2 0	conv4_block1_0_bn[0][0]
conv4_block1_1_conv	(Conv2D)	(None, None, None, 1 32768	conv4_block1_0_relu[0][0]
conv4_block1_1_bn	(BatchNormali	(None, None, None, 1 512	conv4_block1_1_conv[0][0]

conv4_block1_1_relu	(Activation	(None, None, None, 1 0	conv4_block1_1_bn[0][0]
conv4_block1_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block1_1_relu[0][0]
conv4_block1_concat	(Concatenat	(None, None, None, 2 0	pool3_pool[0][0] conv4_block1_2_conv[0][0]
conv4_block2_0_bn	(BatchNormali	(None, None, None, 2 1152	conv4_block1_concat[0][0]
conv4_block2_0_relu	(Activation	(None, None, None, 2 0	conv4_block2_0_bn[0][0]
conv4_block2_1_conv	(Conv2D)	(None, None, None, 1 36864	conv4_block2_0_relu[0][0]
conv4_block2_1_bn	(BatchNormali	(None, None, None, 1 512	conv4_block2_1_conv[0][0]
conv4_block2_1_relu	(Activation	(None, None, None, 1 0	conv4_block2_1_bn[0][0]
conv4_block2_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block2_1_relu[0][0]
conv4_block2_concat	(Concatenat	(None, None, None, 3 0	conv4_block1_concat[0][0] conv4_block2_2_conv[0][0]
conv4_block3_0_bn	(BatchNormali	(None, None, None, 3 1280	conv4_block2_concat[0][0]
conv4_block3_0_relu	(Activation	(None, None, None, 3 0	conv4_block3_0_bn[0][0]
conv4_block3_1_conv	(Conv2D)	(None, None, None, 1 40960	conv4_block3_0_relu[0][0]
conv4_block3_1_bn	(BatchNormali	(None, None, None, 1 512	conv4_block3_1_conv[0][0]
conv4_block3_1_relu	(Activation	(None, None, None, 1 0	conv4_block3_1_bn[0][0]
conv4_block3_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block3_1_relu[0][0]
conv4_block3_concat	(Concatenat	(None, None, None, 3 0	conv4_block2_concat[0][0] conv4_block3_2_conv[0][0]
conv4_block4_0_bn	(BatchNormali	(None, None, None, 3 1408	conv4_block3_concat[0][0]
conv4_block4_0_relu	(Activation	(None, None, None, 3 0	conv4_block4_0_bn[0][0]
conv4_block4_1_conv	(Conv2D)	(None, None, None, 1 45056	conv4_block4_0_relu[0][0]
conv4_block4_1_bn	(BatchNormali	(None, None, None, 1 512	conv4_block4_1_conv[0][0]
conv4_block4_1_relu	(Activation	(None, None, None, 1 0	conv4_block4_1_bn[0][0]
conv4_block4_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block4_1_relu[0][0]
conv4_block4_concat	(Concatenat	(None, None, None, 3 0	conv4_block3_concat[0][0] conv4_block4_2_conv[0][0]
conv4_block5_0_bn	(BatchNormali	(None, None, None, 3 1536	conv4_block4_concat[0][0]
conv4_block5_0_relu	(Activation	(None, None, None, 3 0	conv4_block5_0_bn[0][0]
conv4_block5_1_conv	(Conv2D)	(None, None, None, 1 49152	conv4_block5_0_relu[0][0]
conv4_block5_1_bn	(BatchNormali	(None, None, None, 1 512	conv4_block5_1_conv[0][0]
conv4_block5_1_relu	(Activation	(None, None, None, 1 0	conv4_block5_1_bn[0][0]
conv4_block5_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block5_1_relu[0][0]
conv4_block5_concat	(Concatenat	(None, None, None, 4 0	conv4_block4_concat[0][0] conv4_block5_2_conv[0][0]
conv4_block6_0_bn	(BatchNormali	(None, None, None, 4 1664	conv4_block5_concat[0][0]
conv4_block6_0_relu	(Activation	(None, None, None, 4 0	conv4_block6_0_bn[0][0]
conv4_block6_1_conv	(Conv2D)	(None, None, None, 1 53248	conv4_block6_0_relu[0][0]
conv4_block6_1_bn	(BatchNormali	(None, None, None, 1 512	conv4_block6_1_conv[0][0]
conv4_block6_1_relu	(Activation	(None, None, None, 1 0	conv4_block6_1_bn[0][0]

conv4_block6_2_conv (Conv2D)	(None, None, None, 3 36864	conv4_block6_1_relu[0][0]
conv4_block6_concat (Concatenat	(None, None, None, 4 0	conv4_block5_concat[0][0] conv4_block6_2_conv[0][0]
conv4_block7_0_bn (BatchNormali	(None, None, None, 4 1792	conv4_block6_concat[0][0]
conv4_block7_0_relu (Activation	(None, None, None, 4 0	conv4_block7_0_bn[0][0]
conv4_block7_1_conv (Conv2D)	(None, None, None, 1 57344	conv4_block7_0_relu[0][0]
conv4_block7_1_bn (BatchNormali	(None, None, None, 1 512	conv4_block7_1_conv[0][0]
conv4_block7_1_relu (Activation	(None, None, None, 1 0	conv4_block7_1_bn[0][0]
conv4_block7_2_conv (Conv2D)	(None, None, None, 3 36864	conv4_block7_1_relu[0][0]
conv4_block7_concat (Concatenat	(None, None, None, 4 0	conv4_block6_concat[0][0] conv4_block7_2_conv[0][0]
conv4_block8_0_bn (BatchNormali	(None, None, None, 4 1920	conv4_block7_concat[0][0]
conv4_block8_0_relu (Activation	(None, None, None, 4 0	conv4_block8_0_bn[0][0]
conv4_block8_1_conv (Conv2D)	(None, None, None, 1 61440	conv4_block8_0_relu[0][0]
conv4_block8_1_bn (BatchNormali	(None, None, None, 1 512	conv4_block8_1_conv[0][0]
conv4_block8_1_relu (Activation	(None, None, None, 1 0	conv4_block8_1_bn[0][0]
conv4_block8_2_conv (Conv2D)	(None, None, None, 3 36864	conv4_block8_1_relu[0][0]
conv4_block8_concat (Concatenat	(None, None, None, 5 0	conv4_block7_concat[0][0] conv4_block8_2_conv[0][0]
conv4_block9_0_bn (BatchNormali	(None, None, None, 5 2048	conv4_block8_concat[0][0]
conv4_block9_0_relu (Activation	(None, None, None, 5 0	conv4_block9_0_bn[0][0]
conv4_block9_1_conv (Conv2D)	(None, None, None, 1 65536	conv4_block9_0_relu[0][0]
conv4_block9_1_bn (BatchNormali	(None, None, None, 1 512	conv4_block9_1_conv[0][0]
conv4_block9_1_relu (Activation	(None, None, None, 1 0	conv4_block9_1_bn[0][0]
conv4_block9_2_conv (Conv2D)	(None, None, None, 3 36864	conv4_block9_1_relu[0][0]
conv4_block9_concat (Concatenat	(None, None, None, 5 0	conv4_block8_concat[0][0] conv4_block9_2_conv[0][0]
conv4_block10_0_bn (BatchNormal	(None, None, None, 5 2176	conv4_block9_concat[0][0]
conv4_block10_0_relu (Activatio	(None, None, None, 5 0	conv4_block10_0_bn[0][0]
conv4_block10_1_conv (Conv2D)	(None, None, None, 1 69632	conv4_block10_0_relu[0][0]
conv4_block10_1_bn (BatchNormal	(None, None, None, 1 512	conv4_block10_1_conv[0][0]
conv4_block10_1_relu (Activatio	(None, None, None, 1 0	conv4_block10_1_bn[0][0]
conv4_block10_2_conv (Conv2D)	(None, None, None, 3 36864	conv4_block10_1_relu[0][0]
conv4_block10_concat (Concatena	(None, None, None, 5 0	conv4_block9_concat[0][0] conv4_block10_2_conv[0][0]
conv4_block11_0_bn (BatchNormal	(None, None, None, 5 2304	conv4_block10_concat[0][0]
conv4_block11_0_relu (Activatio	(None, None, None, 5 0	conv4_block11_0_bn[0][0]
conv4_block11_1_conv (Conv2D)	(None, None, None, 1 73728	conv4_block11_0_relu[0][0]
conv4_block11_1_bn (BatchNormal	(None, None, None, 1 512	conv4_block11_1_conv[0][0]
conv4_block11_1_relu (Activatio	(None, None, None, 1 0	conv4_block11_1_bn[0][0]
conv4_block11_2_conv (Conv2D)	(None, None, None, 3 36864	conv4_block11_1_relu[0][0]

conv4_block11_concat	(Concatena	(None, None, None, 6 0	conv4_block10_concat[0][0] conv4_block11_2_conv[0][0]
conv4_block12_0_bn	(BatchNormal	(None, None, None, 6 2432	conv4_block11_concat[0][0]
conv4_block12_0_relu	(Activatio	(None, None, None, 6 0	conv4_block12_0_bn[0][0]
conv4_block12_1_conv	(Conv2D)	(None, None, None, 1 77824	conv4_block12_0_relu[0][0]
conv4_block12_1_bn	(BatchNormal	(None, None, None, 1 512	conv4_block12_1_conv[0][0]
conv4_block12_1_relu	(Activatio	(None, None, None, 1 0	conv4_block12_1_bn[0][0]
conv4_block12_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block12_1_relu[0][0]
conv4_block12_concat	(Concatena	(None, None, None, 6 0	conv4_block11_concat[0][0] conv4_block12_2_conv[0][0]
conv4_block13_0_bn	(BatchNormal	(None, None, None, 6 2560	conv4_block12_concat[0][0]
conv4_block13_0_relu	(Activatio	(None, None, None, 6 0	conv4_block13_0_bn[0][0]
conv4_block13_1_conv	(Conv2D)	(None, None, None, 1 81920	conv4_block13_0_relu[0][0]
conv4_block13_1_bn	(BatchNormal	(None, None, None, 1 512	conv4_block13_1_conv[0][0]
conv4_block13_1_relu	(Activatio	(None, None, None, 1 0	conv4_block13_1_bn[0][0]
conv4_block13_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block13_1_relu[0][0]
conv4_block13_concat	(Concatena	(None, None, None, 6 0	conv4_block12_concat[0][0] conv4_block13_2_conv[0][0]
conv4_block14_0_bn	(BatchNormal	(None, None, None, 6 2688	conv4_block13_concat[0][0]
conv4_block14_0_relu	(Activatio	(None, None, None, 6 0	conv4_block14_0_bn[0][0]
conv4_block14_1_conv	(Conv2D)	(None, None, None, 1 86016	conv4_block14_0_relu[0][0]
conv4_block14_1_bn	(BatchNormal	(None, None, None, 1 512	conv4_block14_1_conv[0][0]
conv4_block14_1_relu	(Activatio	(None, None, None, 1 0	conv4_block14_1_bn[0][0]
conv4_block14_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block14_1_relu[0][0]
conv4_block14_concat	(Concatena	(None, None, None, 7 0	conv4_block13_concat[0][0] conv4_block14_2_conv[0][0]
conv4_block15_0_bn	(BatchNormal	(None, None, None, 7 2816	conv4_block14_concat[0][0]
conv4_block15_0_relu	(Activatio	(None, None, None, 7 0	conv4_block15_0_bn[0][0]
conv4_block15_1_conv	(Conv2D)	(None, None, None, 1 90112	conv4_block15_0_relu[0][0]
conv4_block15_1_bn	(BatchNormal	(None, None, None, 1 512	conv4_block15_1_conv[0][0]
conv4_block15_1_relu	(Activatio	(None, None, None, 1 0	conv4_block15_1_bn[0][0]
conv4_block15_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block15_1_relu[0][0]
conv4_block15_concat	(Concatena	(None, None, None, 7 0	conv4_block14_concat[0][0] conv4_block15_2_conv[0][0]
conv4_block16_0_bn	(BatchNormal	(None, None, None, 7 2944	conv4_block15_concat[0][0]
conv4_block16_0_relu	(Activatio	(None, None, None, 7 0	conv4_block16_0_bn[0][0]
conv4_block16_1_conv	(Conv2D)	(None, None, None, 1 94208	conv4_block16_0_relu[0][0]
conv4_block16_1_bn	(BatchNormal	(None, None, None, 1 512	conv4_block16_1_conv[0][0]
conv4_block16_1_relu	(Activatio	(None, None, None, 1 0	conv4_block16_1_bn[0][0]
conv4_block16_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block16_1_relu[0][0]
conv4_block16_concat	(Concatena	(None, None, None, 7 0	conv4_block15_concat[0][0] conv4_block16_2_conv[0][0]



conv4_block17_0_bn	(BatchNormal	(None, None, None, 7 3072	conv4_block16_concat[0][0]
conv4_block17_0_relu	(Activatio	(None, None, None, 7 0	conv4_block17_0_bn[0][0]
conv4_block17_1_conv	(Conv2D)	(None, None, None, 1 98304	conv4_block17_0_relu[0][0]
conv4_block17_1_bn	(BatchNormal	(None, None, None, 1 512	conv4_block17_1_conv[0][0]
conv4_block17_1_relu	(Activatio	(None, None, None, 1 0	conv4_block17_1_bn[0][0]
conv4_block17_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block17_1_relu[0][0]
conv4_block17_concat	(Concatena	(None, None, None, 8 0	conv4_block16_concat[0][0] conv4_block17_2_conv[0][0]
conv4_block18_0_bn	(BatchNormal	(None, None, None, 8 3200	conv4_block17_concat[0][0]
conv4_block18_0_relu	(Activatio	(None, None, None, 8 0	conv4_block18_0_bn[0][0]
conv4_block18_1_conv	(Conv2D)	(None, None, None, 1 102400	conv4_block18_0_relu[0][0]
conv4_block18_1_bn	(BatchNormal	(None, None, None, 1 512	conv4_block18_1_conv[0][0]
conv4_block18_1_relu	(Activatio	(None, None, None, 1 0	conv4_block18_1_bn[0][0]
conv4_block18_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block18_1_relu[0][0]
conv4_block18_concat	(Concatena	(None, None, None, 8 0	conv4_block17_concat[0][0] conv4_block18_2_conv[0][0]
conv4_block19_0_bn	(BatchNormal	(None, None, None, 8 3328	conv4_block18_concat[0][0]
conv4_block19_0_relu	(Activatio	(None, None, None, 8 0	conv4_block19_0_bn[0][0]
conv4_block19_1_conv	(Conv2D)	(None, None, None, 1 106496	conv4_block19_0_relu[0][0]
conv4_block19_1_bn	(BatchNormal	(None, None, None, 1 512	conv4_block19_1_conv[0][0]
conv4_block19_1_relu	(Activatio	(None, None, None, 1 0	conv4_block19_1_bn[0][0]
conv4_block19_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block19_1_relu[0][0]
conv4_block19_concat	(Concatena	(None, None, None, 8 0	conv4_block18_concat[0][0] conv4_block19_2_conv[0][0]
conv4_block20_0_bn	(BatchNormal	(None, None, None, 8 3456	conv4_block19_concat[0][0]
conv4_block20_0_relu	(Activatio	(None, None, None, 8 0	conv4_block20_0_bn[0][0]
conv4_block20_1_conv	(Conv2D)	(None, None, None, 1 110592	conv4_block20_0_relu[0][0]
conv4_block20_1_bn	(BatchNormal	(None, None, None, 1 512	conv4_block20_1_conv[0][0]
conv4_block20_1_relu	(Activatio	(None, None, None, 1 0	conv4_block20_1_bn[0][0]
conv4_block20_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block20_1_relu[0][0]
conv4_block20_concat	(Concatena	(None, None, None, 8 0	conv4_block19_concat[0][0] conv4_block20_2_conv[0][0]
conv4_block21_0_bn	(BatchNormal	(None, None, None, 8 3584	conv4_block20_concat[0][0]
conv4_block21_0_relu	(Activatio	(None, None, None, 8 0	conv4_block21_0_bn[0][0]
conv4_block21_1_conv	(Conv2D)	(None, None, None, 1 114688	conv4_block21_0_relu[0][0]
conv4_block21_1_bn	(BatchNormal	(None, None, None, 1 512	conv4_block21_1_conv[0][0]
conv4_block21_1_relu	(Activatio	(None, None, None, 1 0	conv4_block21_1_bn[0][0]
conv4_block21_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block21_1_relu[0][0]
conv4_block21_concat	(Concatena	(None, None, None, 9 0	conv4_block20_concat[0][0] conv4_block21_2_conv[0][0]
conv4_block22_0_bn	(BatchNormal	(None, None, None, 9 3712	conv4_block21_concat[0][0]

conv4_block22_0_relu	(Activatio	(None, None, None, 9 0	conv4_block22_0_bn[0][0]
conv4_block22_1_conv	(Conv2D)	(None, None, None, 1 118784	conv4_block22_0_relu[0][0]
conv4_block22_1_bn	(BatchNormal	(None, None, None, 1 512	conv4_block22_1_conv[0][0]
conv4_block22_1_relu	(Activatio	(None, None, None, 1 0	conv4_block22_1_bn[0][0]
conv4_block22_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block22_1_relu[0][0]
conv4_block22_concat	(Concatena	(None, None, None, 9 0	conv4_block21_concat[0][0] conv4_block22_2_conv[0][0]
conv4_block23_0_bn	(BatchNormal	(None, None, None, 9 3840	conv4_block22_concat[0][0]
conv4_block23_0_relu	(Activatio	(None, None, None, 9 0	conv4_block23_0_bn[0][0]
conv4_block23_1_conv	(Conv2D)	(None, None, None, 1 122880	conv4_block23_0_relu[0][0]
conv4_block23_1_bn	(BatchNormal	(None, None, None, 1 512	conv4_block23_1_conv[0][0]
conv4_block23_1_relu	(Activatio	(None, None, None, 1 0	conv4_block23_1_bn[0][0]
conv4_block23_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block23_1_relu[0][0]
conv4_block23_concat	(Concatena	(None, None, None, 9 0	conv4_block22_concat[0][0] conv4_block23_2_conv[0][0]
conv4_block24_0_bn	(BatchNormal	(None, None, None, 9 3968	conv4_block23_concat[0][0]
conv4_block24_0_relu	(Activatio	(None, None, None, 9 0	conv4_block24_0_bn[0][0]
conv4_block24_1_conv	(Conv2D)	(None, None, None, 1 126976	conv4_block24_0_relu[0][0]
conv4_block24_1_bn	(BatchNormal	(None, None, None, 1 512	conv4_block24_1_conv[0][0]
conv4_block24_1_relu	(Activatio	(None, None, None, 1 0	conv4_block24_1_bn[0][0]
conv4_block24_2_conv	(Conv2D)	(None, None, None, 3 36864	conv4_block24_1_relu[0][0]
conv4_block24_concat	(Concatena	(None, None, None, 1 0	conv4_block23_concat[0][0] conv4_block24_2_conv[0][0]
pool4_bn	(BatchNormalization)	(None, None, None, 1 4096	conv4_block24_concat[0][0]
pool4_relu	(Activation)	(None, None, None, 1 0	pool4_bn[0][0]
pool4_conv	(Conv2D)	(None, None, None, 5 524288	pool4_relu[0][0]
pool4_pool	(AveragePooling2D)	(None, None, None, 5 0	pool4_conv[0][0]
conv5_block1_0_bn	(BatchNormali	(None, None, None, 5 2048	pool4_pool[0][0]
conv5_block1_0_relu	(Activation	(None, None, None, 5 0	conv5_block1_0_bn[0][0]
conv5_block1_1_conv	(Conv2D)	(None, None, None, 1 65536	conv5_block1_0_relu[0][0]
conv5_block1_1_bn	(BatchNormali	(None, None, None, 1 512	conv5_block1_1_conv[0][0]
conv5_block1_1_relu	(Activation	(None, None, None, 1 0	conv5_block1_1_bn[0][0]
conv5_block1_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block1_1_relu[0][0]
conv5_block1_concat	(Concatenat	(None, None, None, 5 0	pool4_pool[0][0] conv5_block1_2_conv[0][0]
conv5_block2_0_bn	(BatchNormali	(None, None, None, 5 2176	conv5_block1_concat[0][0]
conv5_block2_0_relu	(Activation	(None, None, None, 5 0	conv5_block2_0_bn[0][0]
conv5_block2_1_conv	(Conv2D)	(None, None, None, 1 69632	conv5_block2_0_relu[0][0]
conv5_block2_1_bn	(BatchNormali	(None, None, None, 1 512	conv5_block2_1_conv[0][0]
conv5_block2_1_relu	(Activation	(None, None, None, 1 0	conv5_block2_1_bn[0][0]

conv5_block2_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block2_1_relu[0][0]
conv5_block2_concat	(Concatenat	(None, None, None, 5 0	conv5_block1_concat[0][0] conv5_block2_2_conv[0][0]
conv5_block3_0_bn	(BatchNormali	(None, None, None, 5 2304	conv5_block2_concat[0][0]
conv5_block3_0_relu	(Activation	(None, None, None, 5 0	conv5_block3_0_bn[0][0]
conv5_block3_1_conv	(Conv2D)	(None, None, None, 1 73728	conv5_block3_0_relu[0][0]
conv5_block3_1_bn	(BatchNormali	(None, None, None, 1 512	conv5_block3_1_conv[0][0]
conv5_block3_1_relu	(Activation	(None, None, None, 1 0	conv5_block3_1_bn[0][0]
conv5_block3_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block3_1_relu[0][0]
conv5_block3_concat	(Concatenat	(None, None, None, 6 0	conv5_block2_concat[0][0] conv5_block3_2_conv[0][0]
conv5_block4_0_bn	(BatchNormali	(None, None, None, 6 2432	conv5_block3_concat[0][0]
conv5_block4_0_relu	(Activation	(None, None, None, 6 0	conv5_block4_0_bn[0][0]
conv5_block4_1_conv	(Conv2D)	(None, None, None, 1 77824	conv5_block4_0_relu[0][0]
conv5_block4_1_bn	(BatchNormali	(None, None, None, 1 512	conv5_block4_1_conv[0][0]
conv5_block4_1_relu	(Activation	(None, None, None, 1 0	conv5_block4_1_bn[0][0]
conv5_block4_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block4_1_relu[0][0]
conv5_block4_concat	(Concatenat	(None, None, None, 6 0	conv5_block3_concat[0][0] conv5_block4_2_conv[0][0]
conv5_block5_0_bn	(BatchNormali	(None, None, None, 6 2560	conv5_block4_concat[0][0]
conv5_block5_0_relu	(Activation	(None, None, None, 6 0	conv5_block5_0_bn[0][0]
conv5_block5_1_conv	(Conv2D)	(None, None, None, 1 81920	conv5_block5_0_relu[0][0]
conv5_block5_1_bn	(BatchNormali	(None, None, None, 1 512	conv5_block5_1_conv[0][0]
conv5_block5_1_relu	(Activation	(None, None, None, 1 0	conv5_block5_1_bn[0][0]
conv5_block5_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block5_1_relu[0][0]
conv5_block5_concat	(Concatenat	(None, None, None, 6 0	conv5_block4_concat[0][0] conv5_block5_2_conv[0][0]
conv5_block6_0_bn	(BatchNormali	(None, None, None, 6 2688	conv5_block5_concat[0][0]
conv5_block6_0_relu	(Activation	(None, None, None, 6 0	conv5_block6_0_bn[0][0]
conv5_block6_1_conv	(Conv2D)	(None, None, None, 1 86016	conv5_block6_0_relu[0][0]
conv5_block6_1_bn	(BatchNormali	(None, None, None, 1 512	conv5_block6_1_conv[0][0]
conv5_block6_1_relu	(Activation	(None, None, None, 1 0	conv5_block6_1_bn[0][0]
conv5_block6_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block6_1_relu[0][0]
conv5_block6_concat	(Concatenat	(None, None, None, 7 0	conv5_block5_concat[0][0] conv5_block6_2_conv[0][0]
conv5_block7_0_bn	(BatchNormali	(None, None, None, 7 2816	conv5_block6_concat[0][0]
conv5_block7_0_relu	(Activation	(None, None, None, 7 0	conv5_block7_0_bn[0][0]
conv5_block7_1_conv	(Conv2D)	(None, None, None, 1 90112	conv5_block7_0_relu[0][0]
conv5_block7_1_bn	(BatchNormali	(None, None, None, 1 512	conv5_block7_1_conv[0][0]
conv5_block7_1_relu	(Activation	(None, None, None, 1 0	conv5_block7_1_bn[0][0]
conv5_block7_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block7_1_relu[0][0]

conv5_block7_concat	(Concatenat	(None, None, None, 7 0	conv5_block6_concat[0][0] conv5_block7_2_conv[0][0]
conv5_block8_0_bn	(BatchNormali	(None, None, None, 7 2944	conv5_block7_concat[0][0]
conv5_block8_0_relu	(Activation	(None, None, None, 7 0	conv5_block8_0_bn[0][0]
conv5_block8_1_conv	(Conv2D)	(None, None, None, 1 94208	conv5_block8_0_relu[0][0]
conv5_block8_1_bn	(BatchNormali	(None, None, None, 1 512	conv5_block8_1_conv[0][0]
conv5_block8_1_relu	(Activation	(None, None, None, 1 0	conv5_block8_1_bn[0][0]
conv5_block8_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block8_1_relu[0][0]
conv5_block8_concat	(Concatenat	(None, None, None, 7 0	conv5_block7_concat[0][0] conv5_block8_2_conv[0][0]
conv5_block9_0_bn	(BatchNormali	(None, None, None, 7 3072	conv5_block8_concat[0][0]
conv5_block9_0_relu	(Activation	(None, None, None, 7 0	conv5_block9_0_bn[0][0]
conv5_block9_1_conv	(Conv2D)	(None, None, None, 1 98304	conv5_block9_0_relu[0][0]
conv5_block9_1_bn	(BatchNormali	(None, None, None, 1 512	conv5_block9_1_conv[0][0]
conv5_block9_1_relu	(Activation	(None, None, None, 1 0	conv5_block9_1_bn[0][0]
conv5_block9_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block9_1_relu[0][0]
conv5_block9_concat	(Concatenat	(None, None, None, 8 0	conv5_block8_concat[0][0] conv5_block9_2_conv[0][0]
conv5_block10_0_bn	(BatchNormal	(None, None, None, 8 3200	conv5_block9_concat[0][0]
conv5_block10_0_relu	(Activatio	(None, None, None, 8 0	conv5_block10_0_bn[0][0]
conv5_block10_1_conv	(Conv2D)	(None, None, None, 1 102400	conv5_block10_0_relu[0][0]
conv5_block10_1_bn	(BatchNormal	(None, None, None, 1 512	conv5_block10_1_conv[0][0]
conv5_block10_1_relu	(Activatio	(None, None, None, 1 0	conv5_block10_1_bn[0][0]
conv5_block10_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block10_1_relu[0][0]
conv5_block10_concat	(Concatena	(None, None, None, 8 0	conv5_block9_concat[0][0] conv5_block10_2_conv[0][0]
conv5_block11_0_bn	(BatchNormal	(None, None, None, 8 3328	conv5_block10_concat[0][0]
conv5_block11_0_relu	(Activatio	(None, None, None, 8 0	conv5_block11_0_bn[0][0]
conv5_block11_1_conv	(Conv2D)	(None, None, None, 1 106496	conv5_block11_0_relu[0][0]
conv5_block11_1_bn	(BatchNormal	(None, None, None, 1 512	conv5_block11_1_conv[0][0]
conv5_block11_1_relu	(Activatio	(None, None, None, 1 0	conv5_block11_1_bn[0][0]
conv5_block11_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block11_1_relu[0][0]
conv5_block11_concat	(Concatena	(None, None, None, 8 0	conv5_block10_concat[0][0] conv5_block11_2_conv[0][0]
conv5_block12_0_bn	(BatchNormal	(None, None, None, 8 3456	conv5_block11_concat[0][0]
conv5_block12_0_relu	(Activatio	(None, None, None, 8 0	conv5_block12_0_bn[0][0]
conv5_block12_1_conv	(Conv2D)	(None, None, None, 1 110592	conv5_block12_0_relu[0][0]
conv5_block12_1_bn	(BatchNormal	(None, None, None, 1 512	conv5_block12_1_conv[0][0]
conv5_block12_1_relu	(Activatio	(None, None, None, 1 0	conv5_block12_1_bn[0][0]
conv5_block12_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block12_1_relu[0][0]
conv5_block12_concat	(Concatena	(None, None, None, 8 0	conv5_block11_concat[0][0] conv5_block12_2_conv[0][0]

conv5_block13_0_bn	(BatchNormal	(None, None, None, 8 3584	conv5_block12_concat[0][0]
conv5_block13_0_relu	(Activatio	(None, None, None, 8 0	conv5_block13_0_bn[0][0]
conv5_block13_1_conv	(Conv2D)	(None, None, None, 1 114688	conv5_block13_0_relu[0][0]
conv5_block13_1_bn	(BatchNormal	(None, None, None, 1 512	conv5_block13_1_conv[0][0]
conv5_block13_1_relu	(Activatio	(None, None, None, 1 0	conv5_block13_1_bn[0][0]
conv5_block13_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block13_1_relu[0][0]
conv5_block13_concat	(Concatena	(None, None, None, 9 0	conv5_block12_concat[0][0] conv5_block13_2_conv[0][0]
conv5_block14_0_bn	(BatchNormal	(None, None, None, 9 3712	conv5_block13_concat[0][0]
conv5_block14_0_relu	(Activatio	(None, None, None, 9 0	conv5_block14_0_bn[0][0]
conv5_block14_1_conv	(Conv2D)	(None, None, None, 1 118784	conv5_block14_0_relu[0][0]
conv5_block14_1_bn	(BatchNormal	(None, None, None, 1 512	conv5_block14_1_conv[0][0]
conv5_block14_1_relu	(Activatio	(None, None, None, 1 0	conv5_block14_1_bn[0][0]
conv5_block14_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block14_1_relu[0][0]
conv5_block14_concat	(Concatena	(None, None, None, 9 0	conv5_block13_concat[0][0] conv5_block14_2_conv[0][0]
conv5_block15_0_bn	(BatchNormal	(None, None, None, 9 3840	conv5_block14_concat[0][0]
conv5_block15_0_relu	(Activatio	(None, None, None, 9 0	conv5_block15_0_bn[0][0]
conv5_block15_1_conv	(Conv2D)	(None, None, None, 1 122880	conv5_block15_0_relu[0][0]
conv5_block15_1_bn	(BatchNormal	(None, None, None, 1 512	conv5_block15_1_conv[0][0]
conv5_block15_1_relu	(Activatio	(None, None, None, 1 0	conv5_block15_1_bn[0][0]
conv5_block15_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block15_1_relu[0][0]
conv5_block15_concat	(Concatena	(None, None, None, 9 0	conv5_block14_concat[0][0] conv5_block15_2_conv[0][0]
conv5_block16_0_bn	(BatchNormal	(None, None, None, 9 3968	conv5_block15_concat[0][0]
conv5_block16_0_relu	(Activatio	(None, None, None, 9 0	conv5_block16_0_bn[0][0]
conv5_block16_1_conv	(Conv2D)	(None, None, None, 1 126976	conv5_block16_0_relu[0][0]
conv5_block16_1_bn	(BatchNormal	(None, None, None, 1 512	conv5_block16_1_conv[0][0]
conv5_block16_1_relu	(Activatio	(None, None, None, 1 0	conv5_block16_1_bn[0][0]
conv5_block16_2_conv	(Conv2D)	(None, None, None, 3 36864	conv5_block16_1_relu[0][0]
conv5_block16_concat	(Concatena	(None, None, None, 1 0	conv5_block15_concat[0][0] conv5_block16_2_conv[0][0]
bn	(BatchNormalization)	(None, None, None, 1 4096	conv5_block16_concat[0][0]
relu	(Activation)	(None, None, None, 1 0	bn[0][0]
=====			
Total params: 7,037,504			
Trainable params: 6,953,856			
Non-trainable params: 83,648			

In [4]:

```
# Print out the first five layers
layers_1 = base_model.layers

print("First 5 layers")
```

```
layers_1[0:5]
```

First 5 layers

Out[4]:

```
[<keras.engine.input_layer.InputLayer at 0x7falc38562b0>,  
<keras.layers.convolutional.ZeroPadding2D at 0x7falc3856588>,  
<keras.layers.convolutional.Conv2D at 0x7falc38566a0>,  
<keras.layers.normalization.BatchNormalization at 0x7falc3856d30>,  
<keras.layers.core.Activation at 0x7falc3856c50>]
```

In [5]:

```
# Print out the last five layers  
print("Last 5 layers")  
layers_1[-6:-1]
```

Last 5 layers

Out[5]:

```
[<keras.layers.normalization.BatchNormalization at 0x7fa02c770a20>,  
<keras.layers.core.Activation at 0x7fa02c770b38>,  
<keras.layers.convolutional.Conv2D at 0x7fa02c701470>,  
<keras.layers.merge.Concatenate at 0x7fa02c72a668>,  
<keras.layers.normalization.BatchNormalization at 0x7fa02c72a780>]
```

In [6]:

```
# Get the convolutional layers and print the first 5  
conv2D_layers = [layer for layer in base_model.layers  
                  if str(type(layer)).find('Conv2D') > -1]  
print("The first five conv2D layers")  
conv2D_layers[0:5]
```

The first five conv2D layers

Out[6]:

```
[<keras.layers.convolutional.Conv2D at 0x7falc38566a0>,  
<keras.layers.convolutional.Conv2D at 0x7falc15c9dd8>,  
<keras.layers.convolutional.Conv2D at 0x7falc157df98>,  
<keras.layers.convolutional.Conv2D at 0x7falc1537710>,  
<keras.layers.convolutional.Conv2D at 0x7falc14f3860>]
```

In [7]:

```
# Print out the total number of convolutional layers  
print(f"There are {len(conv2D_layers)} convolutional layers")
```

There are 120 convolutional layers

In [8]:

```
# Print the number of channels in the input  
print("The input has 3 channels")  
base_model.input
```

The input has 3 channels

Out[8]:

```
<tf.Tensor 'input_1:0' shape=(?, ?, ?, 3) dtype=float32>
```

In [9]:

```
# Print the number of output channels  
print("The output has 1024 channels")
```

```
# Print the output has 1024 channels
x = base_model.output
x
```

The output has 1024 channels

Out[9]:

```
<tf.Tensor 'relu/Relu:0' shape=(?, ?, ?, 1024) dtype=float32>
```

In [10]:

```
# Add a global spatial average pooling layer
x_pool = GlobalAveragePooling2D()(x)
x_pool
```

Out[10]:

```
<tf.Tensor 'global_average_pooling2d_1/Mean:0' shape=(?, 1024) dtype=float32>
```

In [11]:

```
# Define a set of five class labels to use as an example
labels = ['Emphysema',
          'Hernia',
          'Mass',
          'Pneumonia',
          'Edema']
n_classes = len(labels)
print(f"In this example, you want your model to identify {n_classes} classes")
```

In this example, you want your model to identify 5 classes

In [12]:

```
# Add a logistic layer the same size as the number of classes you're trying to predict
predictions = Dense(n_classes, activation="sigmoid")(x_pool)
print(f"Predictions have {n_classes} units, one for each class")
predictions
```

Predictions have 5 units, one for each class

Out[12]:

```
<tf.Tensor 'dense_1/Sigmoid:0' shape=(?, 5) dtype=float32>
```

In [13]:

```
# Create an updated model
model = Model(inputs=base_model.input, outputs=predictions)
```

In [14]:

```
# Compile the model
model.compile(optimizer='adam',
              loss='categorical_crossentropy')
# (You'll customize the loss function in the assignment!)
```

**This has been a brief exploration of the Densenet architecture you'll use in this week's graded assignment!**