Cats-dogs

December 13, 2017

1 Cats vs. Dogs

```
In [1]: import numpy as np
        import matplotlib.pyplot as plt
        %matplotlib inline

        import os
        import os.path as op
        import shutil
```

1.1 Data processing

1. Divide training dataset into train/cats and train/dogs.
2. Create validation dataset.
3. Display one image.
4. Use `ImageDataGenerator` and `augmenting_datagen.flow` to do data augmenting for individual image.
5. Use `augmenting_datagen.flow_from_directory` to randomly choose one image from training set for dogs or cats, then do image augmenting.

```
In [2]: # Make data in different folder
        data_folder = op.expanduser('cats-dogs')
        train_folder = op.join(data_folder, 'train')

        def rearrange_folders(folder):
            image_filenames = [op.join(folder, fn) for fn in os.listdir(folder)
                               if fn.endswith('.jpg')]
            if len(image_filenames) == 0:
                return
            print("Rearranging %d images in %s into one subfolder per class..."
                  % (len(image_filenames), folder))
            for image_filename in image_filenames:
                subfolder, _ = image_filename.split('.', 1)
                if not op.exists(subfolder):
                    os.mkdir(subfolder)
                shutil.move(image_filename, subfolder)

        rearrange_folders('cats-dogs/train')
```

In [3]:
```
# Take 500 images of cats and 500 images of dogs as validation
n_validation = 500
validation_folder = op.join(data_folder, 'validation')
if not op.exists(validation_folder):
    os.mkdir(validation_folder)
    for class_name in ['dog', 'cat']:
        train_subfolder = op.join(train_folder, class_name)
        validation_subfolder = op.join(validation_folder, class_name)
        print("Populating %s..." % validation_subfolder)
        os.mkdir(validation_subfolder)
        images_filenames = sorted(os.listdir(train_subfolder))
        for image_filename in images_filenames[-n_validation:]:
            shutil.move(op.join(train_subfolder, image_filename),
                        validation_subfolder)
        print("Moved %d images" % len(os.listdir(validation_subfolder)))
```

In [4]:
```
from keras.preprocessing.image import array_to_img, img_to_array, load_img

img = load_img(op.join(train_folder, 'cat', 'cat.249.jpg'))
x = img_to_array(img)

print(x.shape)
```

```
Using TensorFlow backend.
```

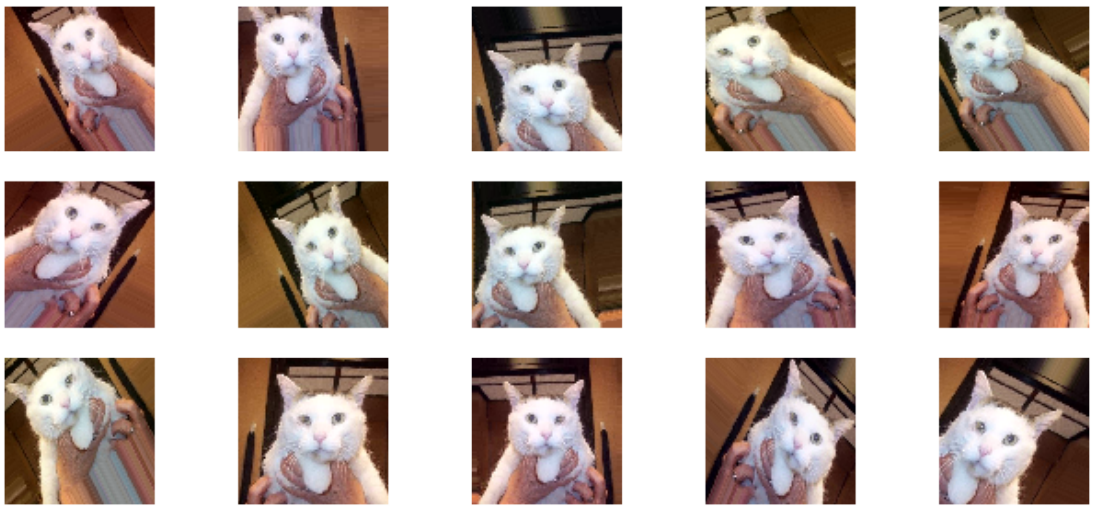
```
(336, 344, 3)
```

In [5]:
```
# Display the image
def disp_image(im):
    if (len(im.shape) == 2):
        # Gray scale image
        plt.imshow(im, cmap='gray')
    else:
        # Color image.
        im1 = (im-np.min(im))/(np.max(im)-np.min(im))*255
        im1 = im1.astype(np.uint8)
        plt.imshow(im1)
        # Remove axis ticks
        plt.xticks([])
        plt.yticks([])
disp_image(x)
```

In [6]:
```
# Image augmenting
from keras.preprocessing.image import ImageDataGenerator

augmenting_datagen = ImageDataGenerator(
    rescale=1. / 255,
    rotation_range=40,
    width_shift_range=0.2,
    height_shift_range=0.2,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,
    channel_shift_range=9,
    fill_mode='nearest'
)
```

In [7]:
```
# Plot image augmenting for 1 iamge
plt.figure(figsize=(11, 5))
flow = augmenting_datagen.flow(x[np.newaxis, :, :, :])
for i, x_augmented in zip(range(15), flow):
    plt.subplot(3, 5, i + 1)
    disp_image(x_augmented[0])
    plt.axis('off')
```



In [8]:
```
# Augmenting all images
flow_all = augmenting_datagen.flow_from_directory(train_folder, batch_size=1, target_si

# Display Image with their labels
plt.figure(figsize=(11, 5))
for i, (X, y) in zip(range(15), flow_all):
    plt.subplot(3, 5, i + 1)
    plt.imshow(X[0])
    plt.title (y[0])
    plt.axis('off')
# [0,1] shows the label for dogs while [1,0] shows the label for cats
```

```
Found 24000 images belonging to 2 classes.
```

1.2 Loading a pre-trained network

1. I used ResNet50 network whichi has 54 parameterized layers (53 convolutional + 1 fully connected for the softmax)
2. Remove the last layer

```
In [9]: import keras.backend as K
        K.clear_session()

        from keras.applications.resnet50 import ResNet50, preprocess_input
        full_imagenet_model = ResNet50(weights='imagenet')
        print(full_imagenet_model.summary())
```

```
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================================
input_1 (InputLayer)            (None, 224, 224, 3)  0
__________________________________________________________________________________________________
conv1 (Conv2D)                  (None, 112, 112, 64) 9472        input_1[0][0]
__________________________________________________________________________________________________
bn_conv1 (BatchNormalization)   (None, 112, 112, 64) 256         conv1[0][0]
__________________________________________________________________________________________________
activation_1 (Activation)       (None, 112, 112, 64) 0           bn_conv1[0][0]
__________________________________________________________________________________________________
max_pooling2d_1 (MaxPooling2D)  (None, 55, 55, 64)   0           activation_1[0][0]
__________________________________________________________________________________________________
res2a_branch2a (Conv2D)         (None, 55, 55, 64)   4160        max_pooling2d_1[0][0]
__________________________________________________________________________________________________
bn2a_branch2a (BatchNormalizatio (None, 55, 55, 64)   256         res2a_branch2a[0][0]
__________________________________________________________________________________________________
activation_2 (Activation)       (None, 55, 55, 64)   0           bn2a_branch2a[0][0]
__________________________________________________________________________________________________
res2a_branch2b (Conv2D)         (None, 55, 55, 64)   36928       activation_2[0][0]
__________________________________________________________________________________________________
bn2a_branch2b (BatchNormalizatio (None, 55, 55, 64)   256         res2a_branch2b[0][0]
__________________________________________________________________________________________________
activation_3 (Activation)       (None, 55, 55, 64)   0           bn2a_branch2b[0][0]
__________________________________________________________________________________________________
res2a_branch2c (Conv2D)         (None, 55, 55, 256)  16640       activation_3[0][0]
__________________________________________________________________________________________________
res2a_branch1 (Conv2D)          (None, 55, 55, 256)  16640       max_pooling2d_1[0][0]
__________________________________________________________________________________________________
bn2a_branch2c (BatchNormalizatio (None, 55, 55, 256)  1024        res2a_branch2c[0][0]
__________________________________________________________________________________________________
bn2a_branch1 (BatchNormalization (None, 55, 55, 256)  1024        res2a_branch1[0][0]
```

```
add_1 (Add)                     (None, 55, 55, 256)   0           bn2a_branch2c[0][0]
                                                                  bn2a_branch1[0][0]
activation_4 (Activation)       (None, 55, 55, 256)   0           add_1[0][0]
res2b_branch2a (Conv2D)         (None, 55, 55, 64)    16448       activation_4[0][0]
bn2b_branch2a (BatchNormalizatio (None, 55, 55, 64)    256         res2b_branch2a[0][0]
activation_5 (Activation)       (None, 55, 55, 64)    0           bn2b_branch2a[0][0]
res2b_branch2b (Conv2D)         (None, 55, 55, 64)    36928       activation_5[0][0]
bn2b_branch2b (BatchNormalizatio (None, 55, 55, 64)    256         res2b_branch2b[0][0]
activation_6 (Activation)       (None, 55, 55, 64)    0           bn2b_branch2b[0][0]
res2b_branch2c (Conv2D)         (None, 55, 55, 256)   16640       activation_6[0][0]
bn2b_branch2c (BatchNormalizatio (None, 55, 55, 256)   1024        res2b_branch2c[0][0]
add_2 (Add)                     (None, 55, 55, 256)   0           bn2b_branch2c[0][0]
                                                                  activation_4[0][0]
activation_7 (Activation)       (None, 55, 55, 256)   0           add_2[0][0]
res2c_branch2a (Conv2D)         (None, 55, 55, 64)    16448       activation_7[0][0]
bn2c_branch2a (BatchNormalizatio (None, 55, 55, 64)    256         res2c_branch2a[0][0]
activation_8 (Activation)       (None, 55, 55, 64)    0           bn2c_branch2a[0][0]
res2c_branch2b (Conv2D)         (None, 55, 55, 64)    36928       activation_8[0][0]
bn2c_branch2b (BatchNormalizatio (None, 55, 55, 64)    256         res2c_branch2b[0][0]
activation_9 (Activation)       (None, 55, 55, 64)    0           bn2c_branch2b[0][0]
res2c_branch2c (Conv2D)         (None, 55, 55, 256)   16640       activation_9[0][0]
bn2c_branch2c (BatchNormalizatio (None, 55, 55, 256)   1024        res2c_branch2c[0][0]
add_3 (Add)                     (None, 55, 55, 256)   0           bn2c_branch2c[0][0]
                                                                  activation_7[0][0]
activation_10 (Activation)      (None, 55, 55, 256)   0           add_3[0][0]
```

```
res3a_branch2a (Conv2D)          (None, 28, 28, 128)   32896       activation_10[0][0]
--------------------------------------------------------------------------------------------------
bn3a_branch2a (BatchNormalizatio (None, 28, 28, 128)   512         res3a_branch2a[0][0]
--------------------------------------------------------------------------------------------------
activation_11 (Activation)       (None, 28, 28, 128)   0           bn3a_branch2a[0][0]
--------------------------------------------------------------------------------------------------
res3a_branch2b (Conv2D)          (None, 28, 28, 128)   147584      activation_11[0][0]
--------------------------------------------------------------------------------------------------
bn3a_branch2b (BatchNormalizatio (None, 28, 28, 128)   512         res3a_branch2b[0][0]
--------------------------------------------------------------------------------------------------
activation_12 (Activation)       (None, 28, 28, 128)   0           bn3a_branch2b[0][0]
--------------------------------------------------------------------------------------------------
res3a_branch2c (Conv2D)          (None, 28, 28, 512)   66048       activation_12[0][0]
--------------------------------------------------------------------------------------------------
res3a_branch1 (Conv2D)           (None, 28, 28, 512)   131584      activation_10[0][0]
--------------------------------------------------------------------------------------------------
bn3a_branch2c (BatchNormalizatio (None, 28, 28, 512)   2048        res3a_branch2c[0][0]
--------------------------------------------------------------------------------------------------
bn3a_branch1 (BatchNormalization (None, 28, 28, 512)   2048        res3a_branch1[0][0]
--------------------------------------------------------------------------------------------------
add_4 (Add)                      (None, 28, 28, 512)   0           bn3a_branch2c[0][0]
                                                                   bn3a_branch1[0][0]
--------------------------------------------------------------------------------------------------
activation_13 (Activation)       (None, 28, 28, 512)   0           add_4[0][0]
--------------------------------------------------------------------------------------------------
res3b_branch2a (Conv2D)          (None, 28, 28, 128)   65664       activation_13[0][0]
--------------------------------------------------------------------------------------------------
bn3b_branch2a (BatchNormalizatio (None, 28, 28, 128)   512         res3b_branch2a[0][0]
--------------------------------------------------------------------------------------------------
activation_14 (Activation)       (None, 28, 28, 128)   0           bn3b_branch2a[0][0]
--------------------------------------------------------------------------------------------------
res3b_branch2b (Conv2D)          (None, 28, 28, 128)   147584      activation_14[0][0]
--------------------------------------------------------------------------------------------------
bn3b_branch2b (BatchNormalizatio (None, 28, 28, 128)   512         res3b_branch2b[0][0]
--------------------------------------------------------------------------------------------------
activation_15 (Activation)       (None, 28, 28, 128)   0           bn3b_branch2b[0][0]
--------------------------------------------------------------------------------------------------
res3b_branch2c (Conv2D)          (None, 28, 28, 512)   66048       activation_15[0][0]
--------------------------------------------------------------------------------------------------
bn3b_branch2c (BatchNormalizatio (None, 28, 28, 512)   2048        res3b_branch2c[0][0]
--------------------------------------------------------------------------------------------------
add_5 (Add)                      (None, 28, 28, 512)   0           bn3b_branch2c[0][0]
                                                                   activation_13[0][0]
--------------------------------------------------------------------------------------------------
activation_16 (Activation)       (None, 28, 28, 512)   0           add_5[0][0]
--------------------------------------------------------------------------------------------------
res3c_branch2a (Conv2D)          (None, 28, 28, 128)   65664       activation_16[0][0]
--------------------------------------------------------------------------------------------------
```

```
bn3c_branch2a (BatchNormalizatio (None, 28, 28, 128)   512         res3c_branch2a[0][0]
__________________________________________________________________________________________
activation_17 (Activation)       (None, 28, 28, 128)   0           bn3c_branch2a[0][0]
__________________________________________________________________________________________
res3c_branch2b (Conv2D)          (None, 28, 28, 128)   147584      activation_17[0][0]
__________________________________________________________________________________________
bn3c_branch2b (BatchNormalizatio (None, 28, 28, 128)   512         res3c_branch2b[0][0]
__________________________________________________________________________________________
activation_18 (Activation)       (None, 28, 28, 128)   0           bn3c_branch2b[0][0]
__________________________________________________________________________________________
res3c_branch2c (Conv2D)          (None, 28, 28, 512)   66048       activation_18[0][0]
__________________________________________________________________________________________
bn3c_branch2c (BatchNormalizatio (None, 28, 28, 512)   2048        res3c_branch2c[0][0]
__________________________________________________________________________________________
add_6 (Add)                      (None, 28, 28, 512)   0           bn3c_branch2c[0][0]
                                                                   activation_16[0][0]
__________________________________________________________________________________________
activation_19 (Activation)       (None, 28, 28, 512)   0           add_6[0][0]
__________________________________________________________________________________________
res3d_branch2a (Conv2D)          (None, 28, 28, 128)   65664       activation_19[0][0]
__________________________________________________________________________________________
bn3d_branch2a (BatchNormalizatio (None, 28, 28, 128)   512         res3d_branch2a[0][0]
__________________________________________________________________________________________
activation_20 (Activation)       (None, 28, 28, 128)   0           bn3d_branch2a[0][0]
__________________________________________________________________________________________
res3d_branch2b (Conv2D)          (None, 28, 28, 128)   147584      activation_20[0][0]
__________________________________________________________________________________________
bn3d_branch2b (BatchNormalizatio (None, 28, 28, 128)   512         res3d_branch2b[0][0]
__________________________________________________________________________________________
activation_21 (Activation)       (None, 28, 28, 128)   0           bn3d_branch2b[0][0]
__________________________________________________________________________________________
res3d_branch2c (Conv2D)          (None, 28, 28, 512)   66048       activation_21[0][0]
__________________________________________________________________________________________
bn3d_branch2c (BatchNormalizatio (None, 28, 28, 512)   2048        res3d_branch2c[0][0]
__________________________________________________________________________________________
add_7 (Add)                      (None, 28, 28, 512)   0           bn3d_branch2c[0][0]
                                                                   activation_19[0][0]
__________________________________________________________________________________________
activation_22 (Activation)       (None, 28, 28, 512)   0           add_7[0][0]
__________________________________________________________________________________________
res4a_branch2a (Conv2D)          (None, 14, 14, 256)   131328      activation_22[0][0]
__________________________________________________________________________________________
bn4a_branch2a (BatchNormalizatio (None, 14, 14, 256)   1024        res4a_branch2a[0][0]
__________________________________________________________________________________________
activation_23 (Activation)       (None, 14, 14, 256)   0           bn4a_branch2a[0][0]
__________________________________________________________________________________________
res4a_branch2b (Conv2D)          (None, 14, 14, 256)   590080      activation_23[0][0]
__________________________________________________________________________________________
```

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bn4a_branch2b (BatchNormalizatio (None, 14, 14, 256)   1024        res4a_branch2b[0][0]
____________________________________________________________________________________________
activation_24 (Activation)       (None, 14, 14, 256)   0           bn4a_branch2b[0][0]
____________________________________________________________________________________________
res4a_branch2c (Conv2D)          (None, 14, 14, 1024)  263168      activation_24[0][0]
____________________________________________________________________________________________
res4a_branch1 (Conv2D)           (None, 14, 14, 1024)  525312      activation_22[0][0]
____________________________________________________________________________________________
bn4a_branch2c (BatchNormalizatio (None, 14, 14, 1024)  4096        res4a_branch2c[0][0]
____________________________________________________________________________________________
bn4a_branch1 (BatchNormalization (None, 14, 14, 1024)  4096        res4a_branch1[0][0]
____________________________________________________________________________________________
add_8 (Add)                      (None, 14, 14, 1024)  0           bn4a_branch2c[0][0]
                                                                   bn4a_branch1[0][0]
____________________________________________________________________________________________
activation_25 (Activation)       (None, 14, 14, 1024)  0           add_8[0][0]
____________________________________________________________________________________________
res4b_branch2a (Conv2D)          (None, 14, 14, 256)   262400      activation_25[0][0]
____________________________________________________________________________________________
bn4b_branch2a (BatchNormalizatio (None, 14, 14, 256)   1024        res4b_branch2a[0][0]
____________________________________________________________________________________________
activation_26 (Activation)       (None, 14, 14, 256)   0           bn4b_branch2a[0][0]
____________________________________________________________________________________________
res4b_branch2b (Conv2D)          (None, 14, 14, 256)   590080      activation_26[0][0]
____________________________________________________________________________________________
bn4b_branch2b (BatchNormalizatio (None, 14, 14, 256)   1024        res4b_branch2b[0][0]
____________________________________________________________________________________________
activation_27 (Activation)       (None, 14, 14, 256)   0           bn4b_branch2b[0][0]
____________________________________________________________________________________________
res4b_branch2c (Conv2D)          (None, 14, 14, 1024)  263168      activation_27[0][0]
____________________________________________________________________________________________
bn4b_branch2c (BatchNormalizatio (None, 14, 14, 1024)  4096        res4b_branch2c[0][0]
____________________________________________________________________________________________
add_9 (Add)                      (None, 14, 14, 1024)  0           bn4b_branch2c[0][0]
                                                                   activation_25[0][0]
____________________________________________________________________________________________
activation_28 (Activation)       (None, 14, 14, 1024)  0           add_9[0][0]
____________________________________________________________________________________________
res4c_branch2a (Conv2D)          (None, 14, 14, 256)   262400      activation_28[0][0]
____________________________________________________________________________________________
bn4c_branch2a (BatchNormalizatio (None, 14, 14, 256)   1024        res4c_branch2a[0][0]
____________________________________________________________________________________________
activation_29 (Activation)       (None, 14, 14, 256)   0           bn4c_branch2a[0][0]
____________________________________________________________________________________________
res4c_branch2b (Conv2D)          (None, 14, 14, 256)   590080      activation_29[0][0]
____________________________________________________________________________________________
bn4c_branch2b (BatchNormalizatio (None, 14, 14, 256)   1024        res4c_branch2b[0][0]
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activation_30 (Activation)       (None, 14, 14, 256)   0           bn4c_branch2b[0][0]
____________________________________________________________________________________________
res4c_branch2c (Conv2D)          (None, 14, 14, 1024)  263168      activation_30[0][0]
____________________________________________________________________________________________
bn4c_branch2c (BatchNormalizatio (None, 14, 14, 1024)  4096        res4c_branch2c[0][0]
____________________________________________________________________________________________
add_10 (Add)                     (None, 14, 14, 1024)  0           bn4c_branch2c[0][0]
                                                                   activation_28[0][0]
____________________________________________________________________________________________
activation_31 (Activation)       (None, 14, 14, 1024)  0           add_10[0][0]
____________________________________________________________________________________________
res4d_branch2a (Conv2D)          (None, 14, 14, 256)   262400      activation_31[0][0]
____________________________________________________________________________________________
bn4d_branch2a (BatchNormalizatio (None, 14, 14, 256)   1024        res4d_branch2a[0][0]
____________________________________________________________________________________________
activation_32 (Activation)       (None, 14, 14, 256)   0           bn4d_branch2a[0][0]
____________________________________________________________________________________________
res4d_branch2b (Conv2D)          (None, 14, 14, 256)   590080      activation_32[0][0]
____________________________________________________________________________________________
bn4d_branch2b (BatchNormalizatio (None, 14, 14, 256)   1024        res4d_branch2b[0][0]
____________________________________________________________________________________________
activation_33 (Activation)       (None, 14, 14, 256)   0           bn4d_branch2b[0][0]
____________________________________________________________________________________________
res4d_branch2c (Conv2D)          (None, 14, 14, 1024)  263168      activation_33[0][0]
____________________________________________________________________________________________
bn4d_branch2c (BatchNormalizatio (None, 14, 14, 1024)  4096        res4d_branch2c[0][0]
____________________________________________________________________________________________
add_11 (Add)                     (None, 14, 14, 1024)  0           bn4d_branch2c[0][0]
                                                                   activation_31[0][0]
____________________________________________________________________________________________
activation_34 (Activation)       (None, 14, 14, 1024)  0           add_11[0][0]
____________________________________________________________________________________________
res4e_branch2a (Conv2D)          (None, 14, 14, 256)   262400      activation_34[0][0]
____________________________________________________________________________________________
bn4e_branch2a (BatchNormalizatio (None, 14, 14, 256)   1024        res4e_branch2a[0][0]
____________________________________________________________________________________________
activation_35 (Activation)       (None, 14, 14, 256)   0           bn4e_branch2a[0][0]
____________________________________________________________________________________________
res4e_branch2b (Conv2D)          (None, 14, 14, 256)   590080      activation_35[0][0]
____________________________________________________________________________________________
bn4e_branch2b (BatchNormalizatio (None, 14, 14, 256)   1024        res4e_branch2b[0][0]
____________________________________________________________________________________________
activation_36 (Activation)       (None, 14, 14, 256)   0           bn4e_branch2b[0][0]
____________________________________________________________________________________________
res4e_branch2c (Conv2D)          (None, 14, 14, 1024)  263168      activation_36[0][0]
____________________________________________________________________________________________
bn4e_branch2c (BatchNormalizatio (None, 14, 14, 1024)  4096        res4e_branch2c[0][0]
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add_12 (Add)                    (None, 14, 14, 1024)  0           bn4e_branch2c[0][0]
                                                                   activation_34[0][0]
__________________________________________________________________________________________
activation_37 (Activation)      (None, 14, 14, 1024)  0           add_12[0][0]
__________________________________________________________________________________________
res4f_branch2a (Conv2D)         (None, 14, 14, 256)   262400      activation_37[0][0]
__________________________________________________________________________________________
bn4f_branch2a (BatchNormalizatio (None, 14, 14, 256)   1024        res4f_branch2a[0][0]
__________________________________________________________________________________________
activation_38 (Activation)      (None, 14, 14, 256)   0           bn4f_branch2a[0][0]
__________________________________________________________________________________________
res4f_branch2b (Conv2D)         (None, 14, 14, 256)   590080      activation_38[0][0]
__________________________________________________________________________________________
bn4f_branch2b (BatchNormalizatio (None, 14, 14, 256)   1024        res4f_branch2b[0][0]
__________________________________________________________________________________________
activation_39 (Activation)      (None, 14, 14, 256)   0           bn4f_branch2b[0][0]
__________________________________________________________________________________________
res4f_branch2c (Conv2D)         (None, 14, 14, 1024)  263168      activation_39[0][0]
__________________________________________________________________________________________
bn4f_branch2c (BatchNormalizatio (None, 14, 14, 1024)  4096        res4f_branch2c[0][0]
__________________________________________________________________________________________
add_13 (Add)                    (None, 14, 14, 1024)  0           bn4f_branch2c[0][0]
                                                                   activation_37[0][0]
__________________________________________________________________________________________
activation_40 (Activation)      (None, 14, 14, 1024)  0           add_13[0][0]
__________________________________________________________________________________________
res5a_branch2a (Conv2D)         (None, 7, 7, 512)     524800      activation_40[0][0]
__________________________________________________________________________________________
bn5a_branch2a (BatchNormalizatio (None, 7, 7, 512)     2048        res5a_branch2a[0][0]
__________________________________________________________________________________________
activation_41 (Activation)      (None, 7, 7, 512)     0           bn5a_branch2a[0][0]
__________________________________________________________________________________________
res5a_branch2b (Conv2D)         (None, 7, 7, 512)     2359808     activation_41[0][0]
__________________________________________________________________________________________
bn5a_branch2b (BatchNormalizatio (None, 7, 7, 512)     2048        res5a_branch2b[0][0]
__________________________________________________________________________________________
activation_42 (Activation)      (None, 7, 7, 512)     0           bn5a_branch2b[0][0]
__________________________________________________________________________________________
res5a_branch2c (Conv2D)         (None, 7, 7, 2048)    1050624     activation_42[0][0]
__________________________________________________________________________________________
res5a_branch1 (Conv2D)          (None, 7, 7, 2048)    2099200     activation_40[0][0]
__________________________________________________________________________________________
bn5a_branch2c (BatchNormalizatio (None, 7, 7, 2048)    8192        res5a_branch2c[0][0]
__________________________________________________________________________________________
bn5a_branch1 (BatchNormalization (None, 7, 7, 2048)    8192        res5a_branch1[0][0]
__________________________________________________________________________________________
add_14 (Add)                    (None, 7, 7, 2048)    0           bn5a_branch2c[0][0]
                                                                   bn5a_branch1[0][0]
```

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activation_43 (Activation)       (None, 7, 7, 2048)    0           add_14[0][0]
res5b_branch2a (Conv2D)          (None, 7, 7, 512)     1049088     activation_43[0][0]
bn5b_branch2a (BatchNormalizatio (None, 7, 7, 512)     2048        res5b_branch2a[0][0]
activation_44 (Activation)       (None, 7, 7, 512)     0           bn5b_branch2a[0][0]
res5b_branch2b (Conv2D)          (None, 7, 7, 512)     2359808     activation_44[0][0]
bn5b_branch2b (BatchNormalizatio (None, 7, 7, 512)     2048        res5b_branch2b[0][0]
activation_45 (Activation)       (None, 7, 7, 512)     0           bn5b_branch2b[0][0]
res5b_branch2c (Conv2D)          (None, 7, 7, 2048)    1050624     activation_45[0][0]
bn5b_branch2c (BatchNormalizatio (None, 7, 7, 2048)    8192        res5b_branch2c[0][0]
add_15 (Add)                     (None, 7, 7, 2048)    0           bn5b_branch2c[0][0]
                                                                   activation_43[0][0]
activation_46 (Activation)       (None, 7, 7, 2048)    0           add_15[0][0]
res5c_branch2a (Conv2D)          (None, 7, 7, 512)     1049088     activation_46[0][0]
bn5c_branch2a (BatchNormalizatio (None, 7, 7, 512)     2048        res5c_branch2a[0][0]
activation_47 (Activation)       (None, 7, 7, 512)     0           bn5c_branch2a[0][0]
res5c_branch2b (Conv2D)          (None, 7, 7, 512)     2359808     activation_47[0][0]
bn5c_branch2b (BatchNormalizatio (None, 7, 7, 512)     2048        res5c_branch2b[0][0]
activation_48 (Activation)       (None, 7, 7, 512)     0           bn5c_branch2b[0][0]
res5c_branch2c (Conv2D)          (None, 7, 7, 2048)    1050624     activation_48[0][0]
bn5c_branch2c (BatchNormalizatio (None, 7, 7, 2048)    8192        res5c_branch2c[0][0]
add_16 (Add)                     (None, 7, 7, 2048)    0           bn5c_branch2c[0][0]
                                                                   activation_46[0][0]
activation_49 (Activation)       (None, 7, 7, 2048)    0           add_16[0][0]
avg_pool (AveragePooling2D)      (None, 1, 1, 2048)    0           activation_49[0][0]
flatten_1 (Flatten)              (None, 2048)          0           avg_pool[0][0]
```

```
fc1000 (Dense)                  (None, 1000)          2049000     flatten_1[0][0]
==================================================================================================
Total params: 25,636,712
Trainable params: 25,583,592
Non-trainable params: 53,120
__________________________________________________________________________________________________
None
```

```
In [10]: # Modify model (Remove the last layer)
         from keras.models import Model

         output = full_imagenet_model.layers[-2].output
         base_model = Model(full_imagenet_model.input, output)
```

```
In [11]: # Modify model (Add last layer)
         from keras.models import Sequential
         from keras.layers import Dense, Dropout
         from keras.optimizers import Adam

         top_model = Sequential()

         top_model.add(Dense(1, input_dim=2048, activation='sigmoid'))
         model = Model(base_model.input, top_model(base_model.output))
         print (model.summary())
```

```
__________________________________________________________________________________________________
Layer (type)                    Output Shape          Param #     Connected to
==================================================================================================
input_1 (InputLayer)            (None, 224, 224, 3)   0
__________________________________________________________________________________________________
conv1 (Conv2D)                  (None, 112, 112, 64)  9472        input_1[0][0]
__________________________________________________________________________________________________
bn_conv1 (BatchNormalization)   (None, 112, 112, 64)  256         conv1[0][0]
__________________________________________________________________________________________________
activation_1 (Activation)       (None, 112, 112, 64)  0           bn_conv1[0][0]
__________________________________________________________________________________________________
max_pooling2d_1 (MaxPooling2D)  (None, 55, 55, 64)    0           activation_1[0][0]
__________________________________________________________________________________________________
res2a_branch2a (Conv2D)         (None, 55, 55, 64)    4160        max_pooling2d_1[0][0]
__________________________________________________________________________________________________
bn2a_branch2a (BatchNormalizatio (None, 55, 55, 64)   256         res2a_branch2a[0][0]
__________________________________________________________________________________________________
activation_2 (Activation)       (None, 55, 55, 64)    0           bn2a_branch2a[0][0]
__________________________________________________________________________________________________
res2a_branch2b (Conv2D)         (None, 55, 55, 64)    36928       activation_2[0][0]
__________________________________________________________________________________________________
```

```
bn2a_branch2b (BatchNormalizatio (None, 55, 55, 64)    256         res2a_branch2b[0][0]
____________________________________________________________________________________________
activation_3 (Activation)        (None, 55, 55, 64)    0           bn2a_branch2b[0][0]
____________________________________________________________________________________________
res2a_branch2c (Conv2D)          (None, 55, 55, 256)   16640       activation_3[0][0]
____________________________________________________________________________________________
res2a_branch1 (Conv2D)           (None, 55, 55, 256)   16640       max_pooling2d_1[0][0]
____________________________________________________________________________________________
bn2a_branch2c (BatchNormalizatio (None, 55, 55, 256)   1024        res2a_branch2c[0][0]
____________________________________________________________________________________________
bn2a_branch1 (BatchNormalization (None, 55, 55, 256)   1024        res2a_branch1[0][0]
____________________________________________________________________________________________
add_1 (Add)                      (None, 55, 55, 256)   0           bn2a_branch2c[0][0]
                                                                   bn2a_branch1[0][0]
____________________________________________________________________________________________
activation_4 (Activation)        (None, 55, 55, 256)   0           add_1[0][0]
____________________________________________________________________________________________
res2b_branch2a (Conv2D)          (None, 55, 55, 64)    16448       activation_4[0][0]
____________________________________________________________________________________________
bn2b_branch2a (BatchNormalizatio (None, 55, 55, 64)    256         res2b_branch2a[0][0]
____________________________________________________________________________________________
activation_5 (Activation)        (None, 55, 55, 64)    0           bn2b_branch2a[0][0]
____________________________________________________________________________________________
res2b_branch2b (Conv2D)          (None, 55, 55, 64)    36928       activation_5[0][0]
____________________________________________________________________________________________
bn2b_branch2b (BatchNormalizatio (None, 55, 55, 64)    256         res2b_branch2b[0][0]
____________________________________________________________________________________________
activation_6 (Activation)        (None, 55, 55, 64)    0           bn2b_branch2b[0][0]
____________________________________________________________________________________________
res2b_branch2c (Conv2D)          (None, 55, 55, 256)   16640       activation_6[0][0]
____________________________________________________________________________________________
bn2b_branch2c (BatchNormalizatio (None, 55, 55, 256)   1024        res2b_branch2c[0][0]
____________________________________________________________________________________________
add_2 (Add)                      (None, 55, 55, 256)   0           bn2b_branch2c[0][0]
                                                                   activation_4[0][0]
____________________________________________________________________________________________
activation_7 (Activation)        (None, 55, 55, 256)   0           add_2[0][0]
____________________________________________________________________________________________
res2c_branch2a (Conv2D)          (None, 55, 55, 64)    16448       activation_7[0][0]
____________________________________________________________________________________________
bn2c_branch2a (BatchNormalizatio (None, 55, 55, 64)    256         res2c_branch2a[0][0]
____________________________________________________________________________________________
activation_8 (Activation)        (None, 55, 55, 64)    0           bn2c_branch2a[0][0]
____________________________________________________________________________________________
res2c_branch2b (Conv2D)          (None, 55, 55, 64)    36928       activation_8[0][0]
____________________________________________________________________________________________
bn2c_branch2b (BatchNormalizatio (None, 55, 55, 64)    256         res2c_branch2b[0][0]
____________________________________________________________________________________________
```

```
activation_9 (Activation)        (None, 55, 55, 64)    0           bn2c_branch2b[0][0]
__________________________________________________________________________________________
res2c_branch2c (Conv2D)          (None, 55, 55, 256)   16640       activation_9[0][0]
__________________________________________________________________________________________
bn2c_branch2c (BatchNormalizatio (None, 55, 55, 256)   1024        res2c_branch2c[0][0]
__________________________________________________________________________________________
add_3 (Add)                      (None, 55, 55, 256)   0           bn2c_branch2c[0][0]
                                                                   activation_7[0][0]
__________________________________________________________________________________________
activation_10 (Activation)       (None, 55, 55, 256)   0           add_3[0][0]
__________________________________________________________________________________________
res3a_branch2a (Conv2D)          (None, 28, 28, 128)   32896       activation_10[0][0]
__________________________________________________________________________________________
bn3a_branch2a (BatchNormalizatio (None, 28, 28, 128)   512         res3a_branch2a[0][0]
__________________________________________________________________________________________
activation_11 (Activation)       (None, 28, 28, 128)   0           bn3a_branch2a[0][0]
__________________________________________________________________________________________
res3a_branch2b (Conv2D)          (None, 28, 28, 128)   147584      activation_11[0][0]
__________________________________________________________________________________________
bn3a_branch2b (BatchNormalizatio (None, 28, 28, 128)   512         res3a_branch2b[0][0]
__________________________________________________________________________________________
activation_12 (Activation)       (None, 28, 28, 128)   0           bn3a_branch2b[0][0]
__________________________________________________________________________________________
res3a_branch2c (Conv2D)          (None, 28, 28, 512)   66048       activation_12[0][0]
__________________________________________________________________________________________
res3a_branch1 (Conv2D)           (None, 28, 28, 512)   131584      activation_10[0][0]
__________________________________________________________________________________________
bn3a_branch2c (BatchNormalizatio (None, 28, 28, 512)   2048        res3a_branch2c[0][0]
__________________________________________________________________________________________
bn3a_branch1 (BatchNormalization (None, 28, 28, 512)   2048        res3a_branch1[0][0]
__________________________________________________________________________________________
add_4 (Add)                      (None, 28, 28, 512)   0           bn3a_branch2c[0][0]
                                                                   bn3a_branch1[0][0]
__________________________________________________________________________________________
activation_13 (Activation)       (None, 28, 28, 512)   0           add_4[0][0]
__________________________________________________________________________________________
res3b_branch2a (Conv2D)          (None, 28, 28, 128)   65664       activation_13[0][0]
__________________________________________________________________________________________
bn3b_branch2a (BatchNormalizatio (None, 28, 28, 128)   512         res3b_branch2a[0][0]
__________________________________________________________________________________________
activation_14 (Activation)       (None, 28, 28, 128)   0           bn3b_branch2a[0][0]
__________________________________________________________________________________________
res3b_branch2b (Conv2D)          (None, 28, 28, 128)   147584      activation_14[0][0]
__________________________________________________________________________________________
bn3b_branch2b (BatchNormalizatio (None, 28, 28, 128)   512         res3b_branch2b[0][0]
__________________________________________________________________________________________
activation_15 (Activation)       (None, 28, 28, 128)   0           bn3b_branch2b[0][0]
__________________________________________________________________________________________
```

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res3b_branch2c (Conv2D)          (None, 28, 28, 512)   66048       activation_15[0][0]
--------------------------------------------------------------------------------------------------
bn3b_branch2c (BatchNormalizatio (None, 28, 28, 512)   2048        res3b_branch2c[0][0]
--------------------------------------------------------------------------------------------------
add_5 (Add)                      (None, 28, 28, 512)   0           bn3b_branch2c[0][0]
                                                                   activation_13[0][0]
--------------------------------------------------------------------------------------------------
activation_16 (Activation)       (None, 28, 28, 512)   0           add_5[0][0]
--------------------------------------------------------------------------------------------------
res3c_branch2a (Conv2D)          (None, 28, 28, 128)   65664       activation_16[0][0]
--------------------------------------------------------------------------------------------------
bn3c_branch2a (BatchNormalizatio (None, 28, 28, 128)   512         res3c_branch2a[0][0]
--------------------------------------------------------------------------------------------------
activation_17 (Activation)       (None, 28, 28, 128)   0           bn3c_branch2a[0][0]
--------------------------------------------------------------------------------------------------
res3c_branch2b (Conv2D)          (None, 28, 28, 128)   147584      activation_17[0][0]
--------------------------------------------------------------------------------------------------
bn3c_branch2b (BatchNormalizatio (None, 28, 28, 128)   512         res3c_branch2b[0][0]
--------------------------------------------------------------------------------------------------
activation_18 (Activation)       (None, 28, 28, 128)   0           bn3c_branch2b[0][0]
--------------------------------------------------------------------------------------------------
res3c_branch2c (Conv2D)          (None, 28, 28, 512)   66048       activation_18[0][0]
--------------------------------------------------------------------------------------------------
bn3c_branch2c (BatchNormalizatio (None, 28, 28, 512)   2048        res3c_branch2c[0][0]
--------------------------------------------------------------------------------------------------
add_6 (Add)                      (None, 28, 28, 512)   0           bn3c_branch2c[0][0]
                                                                   activation_16[0][0]
--------------------------------------------------------------------------------------------------
activation_19 (Activation)       (None, 28, 28, 512)   0           add_6[0][0]
--------------------------------------------------------------------------------------------------
res3d_branch2a (Conv2D)          (None, 28, 28, 128)   65664       activation_19[0][0]
--------------------------------------------------------------------------------------------------
bn3d_branch2a (BatchNormalizatio (None, 28, 28, 128)   512         res3d_branch2a[0][0]
--------------------------------------------------------------------------------------------------
activation_20 (Activation)       (None, 28, 28, 128)   0           bn3d_branch2a[0][0]
--------------------------------------------------------------------------------------------------
res3d_branch2b (Conv2D)          (None, 28, 28, 128)   147584      activation_20[0][0]
--------------------------------------------------------------------------------------------------
bn3d_branch2b (BatchNormalizatio (None, 28, 28, 128)   512         res3d_branch2b[0][0]
--------------------------------------------------------------------------------------------------
activation_21 (Activation)       (None, 28, 28, 128)   0           bn3d_branch2b[0][0]
--------------------------------------------------------------------------------------------------
res3d_branch2c (Conv2D)          (None, 28, 28, 512)   66048       activation_21[0][0]
--------------------------------------------------------------------------------------------------
bn3d_branch2c (BatchNormalizatio (None, 28, 28, 512)   2048        res3d_branch2c[0][0]
--------------------------------------------------------------------------------------------------
add_7 (Add)                      (None, 28, 28, 512)   0           bn3d_branch2c[0][0]
                                                                   activation_19[0][0]
```

```
activation_22 (Activation)       (None, 28, 28, 512)   0           add_7[0][0]
res4a_branch2a (Conv2D)          (None, 14, 14, 256)   131328      activation_22[0][0]
bn4a_branch2a (BatchNormalizatio (None, 14, 14, 256)   1024        res4a_branch2a[0][0]
activation_23 (Activation)       (None, 14, 14, 256)   0           bn4a_branch2a[0][0]
res4a_branch2b (Conv2D)          (None, 14, 14, 256)   590080      activation_23[0][0]
bn4a_branch2b (BatchNormalizatio (None, 14, 14, 256)   1024        res4a_branch2b[0][0]
activation_24 (Activation)       (None, 14, 14, 256)   0           bn4a_branch2b[0][0]
res4a_branch2c (Conv2D)          (None, 14, 14, 1024)  263168      activation_24[0][0]
res4a_branch1 (Conv2D)           (None, 14, 14, 1024)  525312      activation_22[0][0]
bn4a_branch2c (BatchNormalizatio (None, 14, 14, 1024)  4096        res4a_branch2c[0][0]
bn4a_branch1 (BatchNormalization (None, 14, 14, 1024)  4096        res4a_branch1[0][0]
add_8 (Add)                      (None, 14, 14, 1024)  0           bn4a_branch2c[0][0]
                                                                   bn4a_branch1[0][0]
activation_25 (Activation)       (None, 14, 14, 1024)  0           add_8[0][0]
res4b_branch2a (Conv2D)          (None, 14, 14, 256)   262400      activation_25[0][0]
bn4b_branch2a (BatchNormalizatio (None, 14, 14, 256)   1024        res4b_branch2a[0][0]
activation_26 (Activation)       (None, 14, 14, 256)   0           bn4b_branch2a[0][0]
res4b_branch2b (Conv2D)          (None, 14, 14, 256)   590080      activation_26[0][0]
bn4b_branch2b (BatchNormalizatio (None, 14, 14, 256)   1024        res4b_branch2b[0][0]
activation_27 (Activation)       (None, 14, 14, 256)   0           bn4b_branch2b[0][0]
res4b_branch2c (Conv2D)          (None, 14, 14, 1024)  263168      activation_27[0][0]
bn4b_branch2c (BatchNormalizatio (None, 14, 14, 1024)  4096        res4b_branch2c[0][0]
add_9 (Add)                      (None, 14, 14, 1024)  0           bn4b_branch2c[0][0]
                                                                   activation_25[0][0]
activation_28 (Activation)       (None, 14, 14, 1024)  0           add_9[0][0]
```

```
res4c_branch2a (Conv2D)          (None, 14, 14, 256)   262400      activation_28[0][0]
bn4c_branch2a (BatchNormalizatio (None, 14, 14, 256)   1024        res4c_branch2a[0][0]
activation_29 (Activation)       (None, 14, 14, 256)   0           bn4c_branch2a[0][0]
res4c_branch2b (Conv2D)          (None, 14, 14, 256)   590080      activation_29[0][0]
bn4c_branch2b (BatchNormalizatio (None, 14, 14, 256)   1024        res4c_branch2b[0][0]
activation_30 (Activation)       (None, 14, 14, 256)   0           bn4c_branch2b[0][0]
res4c_branch2c (Conv2D)          (None, 14, 14, 1024)  263168      activation_30[0][0]
bn4c_branch2c (BatchNormalizatio (None, 14, 14, 1024)  4096        res4c_branch2c[0][0]
add_10 (Add)                     (None, 14, 14, 1024)  0           bn4c_branch2c[0][0]
                                                                   activation_28[0][0]
activation_31 (Activation)       (None, 14, 14, 1024)  0           add_10[0][0]
res4d_branch2a (Conv2D)          (None, 14, 14, 256)   262400      activation_31[0][0]
bn4d_branch2a (BatchNormalizatio (None, 14, 14, 256)   1024        res4d_branch2a[0][0]
activation_32 (Activation)       (None, 14, 14, 256)   0           bn4d_branch2a[0][0]
res4d_branch2b (Conv2D)          (None, 14, 14, 256)   590080      activation_32[0][0]
bn4d_branch2b (BatchNormalizatio (None, 14, 14, 256)   1024        res4d_branch2b[0][0]
activation_33 (Activation)       (None, 14, 14, 256)   0           bn4d_branch2b[0][0]
res4d_branch2c (Conv2D)          (None, 14, 14, 1024)  263168      activation_33[0][0]
bn4d_branch2c (BatchNormalizatio (None, 14, 14, 1024)  4096        res4d_branch2c[0][0]
add_11 (Add)                     (None, 14, 14, 1024)  0           bn4d_branch2c[0][0]
                                                                   activation_31[0][0]
activation_34 (Activation)       (None, 14, 14, 1024)  0           add_11[0][0]
res4e_branch2a (Conv2D)          (None, 14, 14, 256)   262400      activation_34[0][0]
bn4e_branch2a (BatchNormalizatio (None, 14, 14, 256)   1024        res4e_branch2a[0][0]
activation_35 (Activation)       (None, 14, 14, 256)   0           bn4e_branch2a[0][0]
```

```
res4e_branch2b (Conv2D)          (None, 14, 14, 256)   590080      activation_35[0][0]
bn4e_branch2b (BatchNormalizatio (None, 14, 14, 256)   1024        res4e_branch2b[0][0]
activation_36 (Activation)       (None, 14, 14, 256)   0           bn4e_branch2b[0][0]
res4e_branch2c (Conv2D)          (None, 14, 14, 1024)  263168      activation_36[0][0]
bn4e_branch2c (BatchNormalizatio (None, 14, 14, 1024)  4096        res4e_branch2c[0][0]
add_12 (Add)                     (None, 14, 14, 1024)  0           bn4e_branch2c[0][0]
                                                                   activation_34[0][0]
activation_37 (Activation)       (None, 14, 14, 1024)  0           add_12[0][0]
res4f_branch2a (Conv2D)          (None, 14, 14, 256)   262400      activation_37[0][0]
bn4f_branch2a (BatchNormalizatio (None, 14, 14, 256)   1024        res4f_branch2a[0][0]
activation_38 (Activation)       (None, 14, 14, 256)   0           bn4f_branch2a[0][0]
res4f_branch2b (Conv2D)          (None, 14, 14, 256)   590080      activation_38[0][0]
bn4f_branch2b (BatchNormalizatio (None, 14, 14, 256)   1024        res4f_branch2b[0][0]
activation_39 (Activation)       (None, 14, 14, 256)   0           bn4f_branch2b[0][0]
res4f_branch2c (Conv2D)          (None, 14, 14, 1024)  263168      activation_39[0][0]
bn4f_branch2c (BatchNormalizatio (None, 14, 14, 1024)  4096        res4f_branch2c[0][0]
add_13 (Add)                     (None, 14, 14, 1024)  0           bn4f_branch2c[0][0]
                                                                   activation_37[0][0]
activation_40 (Activation)       (None, 14, 14, 1024)  0           add_13[0][0]
res5a_branch2a (Conv2D)          (None, 7, 7, 512)     524800      activation_40[0][0]
bn5a_branch2a (BatchNormalizatio (None, 7, 7, 512)     2048        res5a_branch2a[0][0]
activation_41 (Activation)       (None, 7, 7, 512)     0           bn5a_branch2a[0][0]
res5a_branch2b (Conv2D)          (None, 7, 7, 512)     2359808     activation_41[0][0]
bn5a_branch2b (BatchNormalizatio (None, 7, 7, 512)     2048        res5a_branch2b[0][0]
activation_42 (Activation)       (None, 7, 7, 512)     0           bn5a_branch2b[0][0]
```

```
res5a_branch2c (Conv2D)          (None, 7, 7, 2048)    1050624     activation_42[0][0]
res5a_branch1 (Conv2D)           (None, 7, 7, 2048)    2099200     activation_40[0][0]
bn5a_branch2c (BatchNormalizatio (None, 7, 7, 2048)    8192        res5a_branch2c[0][0]
bn5a_branch1 (BatchNormalization (None, 7, 7, 2048)    8192        res5a_branch1[0][0]
add_14 (Add)                     (None, 7, 7, 2048)    0           bn5a_branch2c[0][0]
                                                                   bn5a_branch1[0][0]
activation_43 (Activation)       (None, 7, 7, 2048)    0           add_14[0][0]
res5b_branch2a (Conv2D)          (None, 7, 7, 512)     1049088     activation_43[0][0]
bn5b_branch2a (BatchNormalizatio (None, 7, 7, 512)     2048        res5b_branch2a[0][0]
activation_44 (Activation)       (None, 7, 7, 512)     0           bn5b_branch2a[0][0]
res5b_branch2b (Conv2D)          (None, 7, 7, 512)     2359808     activation_44[0][0]
bn5b_branch2b (BatchNormalizatio (None, 7, 7, 512)     2048        res5b_branch2b[0][0]
activation_45 (Activation)       (None, 7, 7, 512)     0           bn5b_branch2b[0][0]
res5b_branch2c (Conv2D)          (None, 7, 7, 2048)    1050624     activation_45[0][0]
bn5b_branch2c (BatchNormalizatio (None, 7, 7, 2048)    8192        res5b_branch2c[0][0]
add_15 (Add)                     (None, 7, 7, 2048)    0           bn5b_branch2c[0][0]
                                                                   activation_43[0][0]
activation_46 (Activation)       (None, 7, 7, 2048)    0           add_15[0][0]
res5c_branch2a (Conv2D)          (None, 7, 7, 512)     1049088     activation_46[0][0]
bn5c_branch2a (BatchNormalizatio (None, 7, 7, 512)     2048        res5c_branch2a[0][0]
activation_47 (Activation)       (None, 7, 7, 512)     0           bn5c_branch2a[0][0]
res5c_branch2b (Conv2D)          (None, 7, 7, 512)     2359808     activation_47[0][0]
bn5c_branch2b (BatchNormalizatio (None, 7, 7, 512)     2048        res5c_branch2b[0][0]
activation_48 (Activation)       (None, 7, 7, 512)     0           bn5c_branch2b[0][0]
res5c_branch2c (Conv2D)          (None, 7, 7, 2048)    1050624     activation_48[0][0]
```

```
bn5c_branch2c (BatchNormalizatio (None, 7, 7, 2048)    8192        res5c_branch2c[0][0]
__________________________________________________________________________________________
add_16 (Add)                     (None, 7, 7, 2048)    0           bn5c_branch2c[0][0]
                                                                   activation_46[0][0]
__________________________________________________________________________________________
activation_49 (Activation)       (None, 7, 7, 2048)    0           add_16[0][0]
__________________________________________________________________________________________
avg_pool (AveragePooling2D)      (None, 1, 1, 2048)    0           activation_49[0][0]
__________________________________________________________________________________________
flatten_1 (Flatten)              (None, 2048)          0           avg_pool[0][0]
__________________________________________________________________________________________
sequential_1 (Sequential)        (None, 1)             2049        flatten_1[0][0]
==========================================================================================
Total params: 23,589,761
Trainable params: 23,536,641
Non-trainable params: 53,120
__________________________________________________________________________________________
None
```

In [12]:
```
# Load data

def preprocess_function(x):
    if x.ndim == 3:
        x = x[np.newaxis, :, :, :]
    return preprocess_input(x)

batch_size = 50

datagen = ImageDataGenerator(preprocessing_function=preprocess_function)

train_flow = datagen.flow_from_directory(
    train_folder,
    target_size=(224, 224),
    batch_size=batch_size,
    class_mode='binary',
    shuffle=True,
)

valgen = ImageDataGenerator(preprocessing_function=preprocess_function)
val_flow = valgen.flow_from_directory(validation_folder, batch_size=batch_size,
                                      target_size=(224, 224), shuffle=False,
                                      class_mode='binary')
```

```
Found 24000 images belonging to 2 classes.
Found 1000 images belonging to 2 classes.
```

```
In [13]: model.compile(optimizer=Adam(lr=1e-4),
                       loss='binary_crossentropy', metrics=['accuracy'])

         steps_per_epoch =  train_flow.n // batch_size
         validation_steps =  val_flow.n // batch_size

         model.fit_generator(train_flow, steps_per_epoch=steps_per_epoch, validation_data=val_
                   validation_steps=validation_steps, epochs=5)

Epoch 1/5
480/480 [==============================] - 29184s - loss: 0.0569 - acc: 0.9790 - val_loss: 0.0
Epoch 2/5
480/480 [==============================] - 31537s - loss: 0.0150 - acc: 0.9951 - val_loss: 0.0
Epoch 3/5
480/480 [==============================] - 37454s - loss: 0.0181 - acc: 0.9941 - val_loss: 0.0
Epoch 4/5
480/480 [==============================] - 28982s - loss: 0.0099 - acc: 0.9970 - val_loss: 0.1
Epoch 5/5
480/480 [==============================] - 31448s - loss: 0.0108 - acc: 0.9963 - val_loss: 0.0


Out[13]: <keras.callbacks.History at 0x1a205e9b38>

In [ ]:

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In [ ]:

In [ ]:
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