DenseNet_CIFAR_Final

July 6, 2021

1 Implement DenseNet on CIFAR-10

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1.2 1. Assignment instructions

1. Please visit this link to access the state-of-art DenseNet code for reference - DenseNet - cifar10 notebook link
2. You need to create a copy of this and "retrain" this model to achieve 90+ test accuracy.
3. You cannot use DropOut layers.
4. You MUST use Image Augmentation Techniques.
5. You cannot use an already trained model as a beginning points, you have to initilize as your own
6. You cannot run the program for more than 300 Epochs, and it should be clear from your log, that you have only used 300 Epochs
7. You cannot use test images for training the model.
8. You cannot change the general architecture of DenseNet (which means you must use Dense Block, Transition and Output blocks as mentioned in the code)
9. You are free to change Convolution types (e.g. from 3x3 normal convolution to Depthwise Separable, etc)
10. You cannot have more than 1 Million parameters in total
11. You are free to move the code from Keras to Tensorflow, Pytorch, MXNET etc.
12. You can use any optimization algorithm you need.

13. You can checkpoint your model and retrain the model from that checkpoint so that no need of training the model from first if you lost at any epoch while training. You can directly load that model and Train from that epoch.

1.3 2. Assignment

[ ]:
```
# import keras
# from keras.datasets import cifar10
# from keras.models import Model, Sequential
# from keras.layers import Dense, Dropout, Flatten, Input, AveragePooling2D,␣
 ↪merge, Activation
# from keras.layers import Conv2D, MaxPooling2D, BatchNormalization
# from keras.layers import Concatenate
# from keras.optimizers import Adam
from tensorflow.keras import models, layers
from tensorflow.keras.models import Model
from tensorflow.keras.layers import BatchNormalization, Activation, Flatten
from tensorflow.keras.optimizers import Adam
```

[ ]:
```
# this part will prevent tensorflow to allocate all the avaliable GPU Memory
# backend
import tensorflow as tf
```

[ ]:
```
# Load CIFAR10 Data
(X_train, y_train), (X_test, y_test) = tf.keras.datasets.cifar10.load_data()
img_height, img_width, channel = X_train.shape[1],X_train.shape[2],X_train.
 ↪shape[3]

#scale the data (images) to [0,1] range
X_train = X_train.astype("float32")/255
X_test = X_test.astype("float32")/255

# convert to one hot encoding
num_classes = 10
y_train = tf.keras.utils.to_categorical(y_train, num_classes)
y_test = tf.keras.utils.to_categorical(y_test, num_classes)
```

```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz
170500096/170498071 [==============================] - 2s 0us/step
```

[ ]:
```
X_train.shape
```

[ ]:
```
(50000, 32, 32, 3)
```

[ ]:
```
X_test.shape
```

[ ]: (10000, 32, 32, 3)

1.3.1 2.1 Defining Dense Block, Transition Block and Output Block

[ ]:
```
# Dense Block
def denseblock(input, num_filter = 12, dropout_rate = 0.2):
    global compression
    temp = input
    for _ in range(l):
        BatchNorm = layers.BatchNormalization()(temp)
        relu = layers.Activation('relu')(BatchNorm)
        Conv2D_1_1 = layers.Conv2D(int(num_filter*compression),␣
 ↪(1,1),use_bias=False,padding='same')(relu)
        BatchNorm1 = layers.BatchNormalization()(Conv2D_1_1)
        relu1 = layers.Activation('relu')(BatchNorm1)
        Conv2D_3_3 = layers.Conv2D(int(num_filter*compression), (3,3),␣
 ↪use_bias=False ,padding='same')(relu1)
        if dropout_rate>0:
            Conv2D_3_3 = layers.Dropout(dropout_rate)(Conv2D_3_3)
        concat = layers.Concatenate(axis=-1)([temp,Conv2D_3_3])

        temp = concat

    return temp

## transition Block
def transition(input, num_filter = 12, dropout_rate = 0.2):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    Conv2D_BottleNeck = layers.Conv2D(int(num_filter*compression), (1,1),␣
 ↪use_bias=False ,padding='same')(relu)
    if dropout_rate>0:
         Conv2D_BottleNeck = layers.Dropout(dropout_rate)(Conv2D_BottleNeck)
    avg = layers.AveragePooling2D(pool_size=(2,2))(Conv2D_BottleNeck)
    return avg

#output layer
def output_layer(input):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    AvgPooling = layers.AveragePooling2D(pool_size=(2,2))(relu)
    flat = layers.Flatten()(AvgPooling)
    output = layers.Dense(num_classes, activation='softmax')(flat)
    return output
```

1.3.2 2.2 Using Data Augmentation for training the DenseNet

[ ]:
```
#https://www.pyimagesearch.com/2018/12/24/
 ↪how-to-use-keras-fit-and-fit_generator-a-hands-on-tutorial/
from tensorflow.keras.preprocessing.image import ImageDataGenerator
#creating a training image generator for data augmentation
aug = ImageDataGenerator(rotation_range=0.20,width_shift_range=0.
 ↪20,height_shift_range=0.15,shear_range=0.15,
                         zoom_range=0.30,horizontal_flip=True)
```

1.3.3 2.3 Using LearningRateScheduler, ReduceLROnPlateau,CSVLogger in callbacks

[ ]:
```
#https://keras.io/api/callbacks/reduce_lr_on_plateau/
from tensorflow.keras.callbacks import ReduceLROnPlateau

reduce_lr = ReduceLROnPlateau(monitor='val_loss', factor=0.2, patience=5,␣
 ↪min_lr=0.001)
```

[ ]:
```
#https://keras.io/api/callbacks/learning_rate_scheduler/
from tensorflow.keras.callbacks import LearningRateScheduler
lr_list = [0.01,0.001,0.0001]
def scheduler(epoch,lr):
  if epoch<25:
    return lr_list[0]
  if epoch>=25 and epoch<50:
    return lr_list[1]
  else:
    return lr_list[2]


lr_scheduler = LearningRateScheduler(scheduler)
```

[ ]:
```
#https://keras.io/api/callbacks/csv_logger/
from tensorflow.keras.callbacks import CSVLogger

csv_logger = CSVLogger('training.log')
```

[ ]:
```
#https://keras.io/api/callbacks/early_stopping/
from tensorflow.keras.callbacks import EarlyStopping

early_stop = EarlyStopping(monitor='loss',patience=10)
```

[ ]:
```
from tensorflow.keras.callbacks import ModelCheckpoint
#https://machinelearningmastery.com/check-point-deep-learning-models-keras/
filepath="weights.best.hdf5"
```

```
model_checkpoint =␣
 ↪ModelCheckpoint(filepath,monitor='val_accuracy',save_best_only=True,verbose=1)
```

1.3.4 2.4 Growth rate(num_filter)=24, compression = 0.5, number of blocks = 12

[ ]:
```
# Hyperparameters
batch_size = 128
num_classes = 10
nb_epoch = 100
l = 12
num_filter = 24
compression = 0.5
dropout_rate = 0.2
```

[ ]:
```
input = layers.Input(shape=(img_height, img_width, channel,))
First_Conv2D = layers.Conv2D(num_filter, (3,3), use_bias=False␣
 ↪,padding='same')(input)

First_Block = denseblock(First_Conv2D, num_filter, dropout_rate)
First_Transition = transition(First_Block, num_filter, dropout_rate)

Second_Block = denseblock(First_Transition, num_filter, dropout_rate)
Second_Transition = transition(Second_Block, num_filter, dropout_rate)

Third_Block = denseblock(Second_Transition, num_filter, dropout_rate)
Third_Transition = transition(Third_Block, num_filter, dropout_rate)

Last_Block = denseblock(Third_Transition,  num_filter, dropout_rate)
output = output_layer(Last_Block)
```

[ ]:
```
model3 = Model(inputs = [input], outputs = [output])
model3.summary()
```

```
Model: "model"
__________________________________________________________________________________
__________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================
==================
input_1 (InputLayer)            [(None, 32, 32, 3)]  0
__________________________________________________________________________________
__________________
conv2d (Conv2D)                 (None, 32, 32, 24)   648         input_1[0][0]
__________________________________________________________________________________
__________________
batch_normalization (BatchNorma (None, 32, 32, 24)   96          conv2d[0][0]
```

```
____________________________________________________________________________
__________________
activation (Activation)         (None, 32, 32, 24)   0
batch_normalization[0][0]
____________________________________________________________________________
__________________
conv2d_1 (Conv2D)               (None, 32, 32, 12)   288
activation[0][0]
____________________________________________________________________________
__________________
batch_normalization_1 (BatchNor (None, 32, 32, 12)   48          conv2d_1[0][0]
____________________________________________________________________________
__________________
activation_1 (Activation)       (None, 32, 32, 12)   0
batch_normalization_1[0][0]
____________________________________________________________________________
__________________
conv2d_2 (Conv2D)               (None, 32, 32, 12)   1296
activation_1[0][0]
____________________________________________________________________________
__________________
dropout (Dropout)               (None, 32, 32, 12)   0           conv2d_2[0][0]
____________________________________________________________________________
__________________
concatenate (Concatenate)       (None, 32, 32, 36)   0           conv2d[0][0]
                                                                 dropout[0][0]
____________________________________________________________________________
__________________
batch_normalization_2 (BatchNor (None, 32, 32, 36)   144
concatenate[0][0]
____________________________________________________________________________
__________________
activation_2 (Activation)       (None, 32, 32, 36)   0
batch_normalization_2[0][0]
____________________________________________________________________________
__________________
conv2d_3 (Conv2D)               (None, 32, 32, 12)   432
activation_2[0][0]
____________________________________________________________________________
__________________
batch_normalization_3 (BatchNor (None, 32, 32, 12)   48          conv2d_3[0][0]
____________________________________________________________________________
__________________
activation_3 (Activation)       (None, 32, 32, 12)   0
batch_normalization_3[0][0]
____________________________________________________________________________
__________________
conv2d_4 (Conv2D)               (None, 32, 32, 12)   1296
```

```
activation_3[0][0]
__________________________________________________________________________________________________
dropout_1 (Dropout)             (None, 32, 32, 12)   0           conv2d_4[0][0]
__________________________________________________________________________________________________
concatenate_1 (Concatenate)     (None, 32, 32, 48)   0
concatenate[0][0]
                                                                 dropout_1[0][0]
__________________________________________________________________________________________________
batch_normalization_4 (BatchNor (None, 32, 32, 48)   192
concatenate_1[0][0]
__________________________________________________________________________________________________
activation_4 (Activation)       (None, 32, 32, 48)   0
batch_normalization_4[0][0]
__________________________________________________________________________________________________
conv2d_5 (Conv2D)               (None, 32, 32, 12)   576
activation_4[0][0]
__________________________________________________________________________________________________
batch_normalization_5 (BatchNor (None, 32, 32, 12)   48          conv2d_5[0][0]
__________________________________________________________________________________________________
activation_5 (Activation)       (None, 32, 32, 12)   0
batch_normalization_5[0][0]
__________________________________________________________________________________________________
conv2d_6 (Conv2D)               (None, 32, 32, 12)   1296
activation_5[0][0]
__________________________________________________________________________________________________
dropout_2 (Dropout)             (None, 32, 32, 12)   0           conv2d_6[0][0]
__________________________________________________________________________________________________
concatenate_2 (Concatenate)     (None, 32, 32, 60)   0
concatenate_1[0][0]
                                                                 dropout_2[0][0]
__________________________________________________________________________________________________
batch_normalization_6 (BatchNor (None, 32, 32, 60)   240
concatenate_2[0][0]
__________________________________________________________________________________________________
activation_6 (Activation)       (None, 32, 32, 60)   0
batch_normalization_6[0][0]
```

```
____________________________________________________________________________
__________________
conv2d_7 (Conv2D)               (None, 32, 32, 12)   720
activation_6[0][0]
____________________________________________________________________________
__________________
batch_normalization_7 (BatchNor (None, 32, 32, 12)   48          conv2d_7[0][0]
____________________________________________________________________________
__________________
activation_7 (Activation)       (None, 32, 32, 12)   0
batch_normalization_7[0][0]
____________________________________________________________________________
__________________
conv2d_8 (Conv2D)               (None, 32, 32, 12)   1296
activation_7[0][0]
____________________________________________________________________________
__________________
dropout_3 (Dropout)             (None, 32, 32, 12)   0           conv2d_8[0][0]
____________________________________________________________________________
__________________
concatenate_3 (Concatenate)     (None, 32, 32, 72)   0
concatenate_2[0][0]
                                                                 dropout_3[0][0]
____________________________________________________________________________
__________________
batch_normalization_8 (BatchNor (None, 32, 32, 72)   288
concatenate_3[0][0]
____________________________________________________________________________
__________________
activation_8 (Activation)       (None, 32, 32, 72)   0
batch_normalization_8[0][0]
____________________________________________________________________________
__________________
conv2d_9 (Conv2D)               (None, 32, 32, 12)   864
activation_8[0][0]
____________________________________________________________________________
__________________
batch_normalization_9 (BatchNor (None, 32, 32, 12)   48          conv2d_9[0][0]
____________________________________________________________________________
__________________
activation_9 (Activation)       (None, 32, 32, 12)   0
batch_normalization_9[0][0]
____________________________________________________________________________
__________________
conv2d_10 (Conv2D)              (None, 32, 32, 12)   1296
activation_9[0][0]
____________________________________________________________________________
__________________
```

```
dropout_4 (Dropout)             (None, 32, 32, 12)   0           conv2d_10[0][0]
__________________________________________________________________________________________
__________________
concatenate_4 (Concatenate)     (None, 32, 32, 84)   0
concatenate_3[0][0]
                                                                 dropout_4[0][0]
__________________________________________________________________________________________
__________________
batch_normalization_10 (BatchNo (None, 32, 32, 84)   336
concatenate_4[0][0]
__________________________________________________________________________________________
__________________
activation_10 (Activation)      (None, 32, 32, 84)   0
batch_normalization_10[0][0]
__________________________________________________________________________________________
__________________
conv2d_11 (Conv2D)              (None, 32, 32, 12)   1008
activation_10[0][0]
__________________________________________________________________________________________
__________________
batch_normalization_11 (BatchNo (None, 32, 32, 12)   48          conv2d_11[0][0]
__________________________________________________________________________________________
__________________
activation_11 (Activation)      (None, 32, 32, 12)   0
batch_normalization_11[0][0]
__________________________________________________________________________________________
__________________
conv2d_12 (Conv2D)              (None, 32, 32, 12)   1296
activation_11[0][0]
__________________________________________________________________________________________
__________________
dropout_5 (Dropout)             (None, 32, 32, 12)   0           conv2d_12[0][0]
__________________________________________________________________________________________
__________________
concatenate_5 (Concatenate)     (None, 32, 32, 96)   0
concatenate_4[0][0]
                                                                 dropout_5[0][0]
__________________________________________________________________________________________
__________________
batch_normalization_12 (BatchNo (None, 32, 32, 96)   384
concatenate_5[0][0]
__________________________________________________________________________________________
__________________
activation_12 (Activation)      (None, 32, 32, 96)   0
batch_normalization_12[0][0]
__________________________________________________________________________________________
__________________
conv2d_13 (Conv2D)              (None, 32, 32, 12)   1152
```

```
activation_12[0][0]
__________________________________________________________________________________________________
batch_normalization_13 (BatchNo (None, 32, 32, 12)   48          conv2d_13[0][0]
__________________________________________________________________________________________________
activation_13 (Activation)      (None, 32, 32, 12)   0
batch_normalization_13[0][0]
__________________________________________________________________________________________________
conv2d_14 (Conv2D)              (None, 32, 32, 12)   1296
activation_13[0][0]
__________________________________________________________________________________________________
dropout_6 (Dropout)             (None, 32, 32, 12)   0           conv2d_14[0][0]
__________________________________________________________________________________________________
concatenate_6 (Concatenate)     (None, 32, 32, 108)  0
concatenate_5[0][0]
                                                                 dropout_6[0][0]
__________________________________________________________________________________________________
batch_normalization_14 (BatchNo (None, 32, 32, 108)  432
concatenate_6[0][0]
__________________________________________________________________________________________________
activation_14 (Activation)      (None, 32, 32, 108)  0
batch_normalization_14[0][0]
__________________________________________________________________________________________________
conv2d_15 (Conv2D)              (None, 32, 32, 12)   1296
activation_14[0][0]
__________________________________________________________________________________________________
batch_normalization_15 (BatchNo (None, 32, 32, 12)   48          conv2d_15[0][0]
__________________________________________________________________________________________________
activation_15 (Activation)      (None, 32, 32, 12)   0
batch_normalization_15[0][0]
__________________________________________________________________________________________________
conv2d_16 (Conv2D)              (None, 32, 32, 12)   1296
activation_15[0][0]
__________________________________________________________________________________________________
dropout_7 (Dropout)             (None, 32, 32, 12)   0           conv2d_16[0][0]
__________________________________________________________________________________________________
```

```
concatenate_7 (Concatenate)     (None, 32, 32, 120)  0
concatenate_6[0][0]
                                                                 dropout_7[0][0]
__________________________________________________________________________________
__________________
batch_normalization_16 (BatchNo (None, 32, 32, 120)  480
concatenate_7[0][0]
__________________________________________________________________________________
__________________
activation_16 (Activation)      (None, 32, 32, 120)  0
batch_normalization_16[0][0]
__________________________________________________________________________________
__________________
conv2d_17 (Conv2D)              (None, 32, 32, 12)   1440
activation_16[0][0]
__________________________________________________________________________________
__________________
batch_normalization_17 (BatchNo (None, 32, 32, 12)   48          conv2d_17[0][0]
__________________________________________________________________________________
__________________
activation_17 (Activation)      (None, 32, 32, 12)   0
batch_normalization_17[0][0]
__________________________________________________________________________________
__________________
conv2d_18 (Conv2D)              (None, 32, 32, 12)   1296
activation_17[0][0]
__________________________________________________________________________________
__________________
dropout_8 (Dropout)             (None, 32, 32, 12)   0           conv2d_18[0][0]
__________________________________________________________________________________
__________________
concatenate_8 (Concatenate)     (None, 32, 32, 132)  0
concatenate_7[0][0]
                                                                 dropout_8[0][0]
__________________________________________________________________________________
__________________
batch_normalization_18 (BatchNo (None, 32, 32, 132)  528
concatenate_8[0][0]
__________________________________________________________________________________
__________________
activation_18 (Activation)      (None, 32, 32, 132)  0
batch_normalization_18[0][0]
__________________________________________________________________________________
__________________
conv2d_19 (Conv2D)              (None, 32, 32, 12)   1584
activation_18[0][0]
__________________________________________________________________________________
__________________
```

```
batch_normalization_19 (BatchNo (None, 32, 32, 12)   48          conv2d_19[0][0]
__________________________________________________________________________________
__________________
activation_19 (Activation)      (None, 32, 32, 12)   0
batch_normalization_19[0][0]
__________________________________________________________________________________
__________________
conv2d_20 (Conv2D)              (None, 32, 32, 12)   1296
activation_19[0][0]
__________________________________________________________________________________
__________________
dropout_9 (Dropout)             (None, 32, 32, 12)   0           conv2d_20[0][0]
__________________________________________________________________________________
__________________
concatenate_9 (Concatenate)     (None, 32, 32, 144)  0
concatenate_8[0][0]
                                                                 dropout_9[0][0]
__________________________________________________________________________________
__________________
batch_normalization_20 (BatchNo (None, 32, 32, 144)  576
concatenate_9[0][0]
__________________________________________________________________________________
__________________
activation_20 (Activation)      (None, 32, 32, 144)  0
batch_normalization_20[0][0]
__________________________________________________________________________________
__________________
conv2d_21 (Conv2D)              (None, 32, 32, 12)   1728
activation_20[0][0]
__________________________________________________________________________________
__________________
batch_normalization_21 (BatchNo (None, 32, 32, 12)   48          conv2d_21[0][0]
__________________________________________________________________________________
__________________
activation_21 (Activation)      (None, 32, 32, 12)   0
batch_normalization_21[0][0]
__________________________________________________________________________________
__________________
conv2d_22 (Conv2D)              (None, 32, 32, 12)   1296
activation_21[0][0]
__________________________________________________________________________________
__________________
dropout_10 (Dropout)            (None, 32, 32, 12)   0           conv2d_22[0][0]
__________________________________________________________________________________
__________________
concatenate_10 (Concatenate)    (None, 32, 32, 156)  0
concatenate_9[0][0]
dropout_10[0][0]
```

```
__________________________________________________________________________________
__________________
batch_normalization_22 (BatchNo (None, 32, 32, 156)  624
concatenate_10[0][0]
__________________________________________________________________________________
__________________
activation_22 (Activation)      (None, 32, 32, 156)  0
batch_normalization_22[0][0]
__________________________________________________________________________________
__________________
conv2d_23 (Conv2D)              (None, 32, 32, 12)   1872
activation_22[0][0]
__________________________________________________________________________________
__________________
batch_normalization_23 (BatchNo (None, 32, 32, 12)   48          conv2d_23[0][0]
__________________________________________________________________________________
__________________
activation_23 (Activation)      (None, 32, 32, 12)   0
batch_normalization_23[0][0]
__________________________________________________________________________________
__________________
conv2d_24 (Conv2D)              (None, 32, 32, 12)   1296
activation_23[0][0]
__________________________________________________________________________________
__________________
dropout_11 (Dropout)            (None, 32, 32, 12)   0           conv2d_24[0][0]
__________________________________________________________________________________
__________________
concatenate_11 (Concatenate)    (None, 32, 32, 168)  0
concatenate_10[0][0]
dropout_11[0][0]
__________________________________________________________________________________
__________________
batch_normalization_24 (BatchNo (None, 32, 32, 168)  672
concatenate_11[0][0]
__________________________________________________________________________________
__________________
activation_24 (Activation)      (None, 32, 32, 168)  0
batch_normalization_24[0][0]
__________________________________________________________________________________
__________________
conv2d_25 (Conv2D)              (None, 32, 32, 12)   2016
activation_24[0][0]
__________________________________________________________________________________
__________________
dropout_12 (Dropout)            (None, 32, 32, 12)   0           conv2d_25[0][0]
__________________________________________________________________________________
__________________
```

```
average_pooling2d (AveragePooli (None, 16, 16, 12)   0
dropout_12[0][0]
__________________________________________________________________________________
__________________
batch_normalization_25 (BatchNo (None, 16, 16, 12)   48
average_pooling2d[0][0]
__________________________________________________________________________________
__________________
activation_25 (Activation)      (None, 16, 16, 12)   0
batch_normalization_25[0][0]
__________________________________________________________________________________
__________________
conv2d_26 (Conv2D)              (None, 16, 16, 12)   144
activation_25[0][0]
__________________________________________________________________________________
__________________
batch_normalization_26 (BatchNo (None, 16, 16, 12)   48          conv2d_26[0][0]
__________________________________________________________________________________
__________________
activation_26 (Activation)      (None, 16, 16, 12)   0
batch_normalization_26[0][0]
__________________________________________________________________________________
__________________
conv2d_27 (Conv2D)              (None, 16, 16, 12)   1296
activation_26[0][0]
__________________________________________________________________________________
__________________
dropout_13 (Dropout)            (None, 16, 16, 12)   0           conv2d_27[0][0]
__________________________________________________________________________________
__________________
concatenate_12 (Concatenate)    (None, 16, 16, 24)   0
average_pooling2d[0][0]
dropout_13[0][0]
__________________________________________________________________________________
__________________
batch_normalization_27 (BatchNo (None, 16, 16, 24)   96
concatenate_12[0][0]
__________________________________________________________________________________
__________________
activation_27 (Activation)      (None, 16, 16, 24)   0
batch_normalization_27[0][0]
__________________________________________________________________________________
__________________
conv2d_28 (Conv2D)              (None, 16, 16, 12)   288
activation_27[0][0]
__________________________________________________________________________________
__________________
batch_normalization_28 (BatchNo (None, 16, 16, 12)   48          conv2d_28[0][0]
```

```
__________________________________________________________________________________
__________________
activation_28 (Activation)      (None, 16, 16, 12)   0
batch_normalization_28[0][0]
__________________________________________________________________________________
__________________
conv2d_29 (Conv2D)              (None, 16, 16, 12)   1296
activation_28[0][0]
__________________________________________________________________________________
__________________
dropout_14 (Dropout)            (None, 16, 16, 12)   0           conv2d_29[0][0]
__________________________________________________________________________________
__________________
concatenate_13 (Concatenate)    (None, 16, 16, 36)   0
concatenate_12[0][0]
dropout_14[0][0]
__________________________________________________________________________________
__________________
batch_normalization_29 (BatchNo (None, 16, 16, 36)   144
concatenate_13[0][0]
__________________________________________________________________________________
__________________
activation_29 (Activation)      (None, 16, 16, 36)   0
batch_normalization_29[0][0]
__________________________________________________________________________________
__________________
conv2d_30 (Conv2D)              (None, 16, 16, 12)   432
activation_29[0][0]
__________________________________________________________________________________
__________________
batch_normalization_30 (BatchNo (None, 16, 16, 12)   48          conv2d_30[0][0]
__________________________________________________________________________________
__________________
activation_30 (Activation)      (None, 16, 16, 12)   0
batch_normalization_30[0][0]
__________________________________________________________________________________
__________________
conv2d_31 (Conv2D)              (None, 16, 16, 12)   1296
activation_30[0][0]
__________________________________________________________________________________
__________________
dropout_15 (Dropout)            (None, 16, 16, 12)   0           conv2d_31[0][0]
__________________________________________________________________________________
__________________
concatenate_14 (Concatenate)    (None, 16, 16, 48)   0
concatenate_13[0][0]
dropout_15[0][0]
__________________________________________________________________________________
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__________________
batch_normalization_31 (BatchNo (None, 16, 16, 48)   192
concatenate_14[0][0]
__________________________________________________________________________________
__________________
activation_31 (Activation)      (None, 16, 16, 48)   0
batch_normalization_31[0][0]
__________________________________________________________________________________
__________________
conv2d_32 (Conv2D)              (None, 16, 16, 12)   576
activation_31[0][0]
__________________________________________________________________________________
__________________
batch_normalization_32 (BatchNo (None, 16, 16, 12)   48          conv2d_32[0][0]
__________________________________________________________________________________
__________________
activation_32 (Activation)      (None, 16, 16, 12)   0
batch_normalization_32[0][0]
__________________________________________________________________________________
__________________
conv2d_33 (Conv2D)              (None, 16, 16, 12)   1296
activation_32[0][0]
__________________________________________________________________________________
__________________
dropout_16 (Dropout)            (None, 16, 16, 12)   0           conv2d_33[0][0]
__________________________________________________________________________________
__________________
concatenate_15 (Concatenate)    (None, 16, 16, 60)   0
concatenate_14[0][0]
dropout_16[0][0]
__________________________________________________________________________________
__________________
batch_normalization_33 (BatchNo (None, 16, 16, 60)   240
concatenate_15[0][0]
__________________________________________________________________________________
__________________
activation_33 (Activation)      (None, 16, 16, 60)   0
batch_normalization_33[0][0]
__________________________________________________________________________________
__________________
conv2d_34 (Conv2D)              (None, 16, 16, 12)   720
activation_33[0][0]
__________________________________________________________________________________
__________________
batch_normalization_34 (BatchNo (None, 16, 16, 12)   48          conv2d_34[0][0]
__________________________________________________________________________________
__________________
activation_34 (Activation)      (None, 16, 16, 12)   0
```

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batch_normalization_34[0][0]
__________________________________________________________________________________________________
conv2d_35 (Conv2D)              (None, 16, 16, 12)   1296
activation_34[0][0]
__________________________________________________________________________________________________
dropout_17 (Dropout)            (None, 16, 16, 12)   0           conv2d_35[0][0]
__________________________________________________________________________________________________
concatenate_16 (Concatenate)    (None, 16, 16, 72)   0
concatenate_15[0][0]
dropout_17[0][0]
__________________________________________________________________________________________________
batch_normalization_35 (BatchNo (None, 16, 16, 72)   288
concatenate_16[0][0]
__________________________________________________________________________________________________
activation_35 (Activation)      (None, 16, 16, 72)   0
batch_normalization_35[0][0]
__________________________________________________________________________________________________
conv2d_36 (Conv2D)              (None, 16, 16, 12)   864
activation_35[0][0]
__________________________________________________________________________________________________
batch_normalization_36 (BatchNo (None, 16, 16, 12)   48          conv2d_36[0][0]
__________________________________________________________________________________________________
activation_36 (Activation)      (None, 16, 16, 12)   0
batch_normalization_36[0][0]
__________________________________________________________________________________________________
conv2d_37 (Conv2D)              (None, 16, 16, 12)   1296
activation_36[0][0]
__________________________________________________________________________________________________
dropout_18 (Dropout)            (None, 16, 16, 12)   0           conv2d_37[0][0]
__________________________________________________________________________________________________
concatenate_17 (Concatenate)    (None, 16, 16, 84)   0
concatenate_16[0][0]
dropout_18[0][0]
__________________________________________________________________________________________________
batch_normalization_37 (BatchNo (None, 16, 16, 84)   336
concatenate_17[0][0]
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__________________________________________________________________________________
__________________
activation_37 (Activation)      (None, 16, 16, 84)   0
batch_normalization_37[0][0]
__________________________________________________________________________________
__________________
conv2d_38 (Conv2D)              (None, 16, 16, 12)   1008
activation_37[0][0]
__________________________________________________________________________________
__________________
batch_normalization_38 (BatchNo (None, 16, 16, 12)   48          conv2d_38[0][0]
__________________________________________________________________________________
__________________
activation_38 (Activation)      (None, 16, 16, 12)   0
batch_normalization_38[0][0]
__________________________________________________________________________________
__________________
conv2d_39 (Conv2D)              (None, 16, 16, 12)   1296
activation_38[0][0]
__________________________________________________________________________________
__________________
dropout_19 (Dropout)            (None, 16, 16, 12)   0           conv2d_39[0][0]
__________________________________________________________________________________
__________________
concatenate_18 (Concatenate)    (None, 16, 16, 96)   0
concatenate_17[0][0]
dropout_19[0][0]
__________________________________________________________________________________
__________________
batch_normalization_39 (BatchNo (None, 16, 16, 96)   384
concatenate_18[0][0]
__________________________________________________________________________________
__________________
activation_39 (Activation)      (None, 16, 16, 96)   0
batch_normalization_39[0][0]
__________________________________________________________________________________
__________________
conv2d_40 (Conv2D)              (None, 16, 16, 12)   1152
activation_39[0][0]
__________________________________________________________________________________
__________________
batch_normalization_40 (BatchNo (None, 16, 16, 12)   48          conv2d_40[0][0]
__________________________________________________________________________________
__________________
activation_40 (Activation)      (None, 16, 16, 12)   0
batch_normalization_40[0][0]
__________________________________________________________________________________
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conv2d_41 (Conv2D)              (None, 16, 16, 12)   1296
activation_40[0][0]
__________________________________________________________________________________
__________________
dropout_20 (Dropout)            (None, 16, 16, 12)   0           conv2d_41[0][0]
__________________________________________________________________________________
__________________
concatenate_19 (Concatenate)    (None, 16, 16, 108)  0
concatenate_18[0][0]
dropout_20[0][0]
__________________________________________________________________________________
__________________
batch_normalization_41 (BatchNo (None, 16, 16, 108)  432
concatenate_19[0][0]
__________________________________________________________________________________
__________________
activation_41 (Activation)      (None, 16, 16, 108)  0
batch_normalization_41[0][0]
__________________________________________________________________________________
__________________
conv2d_42 (Conv2D)              (None, 16, 16, 12)   1296
activation_41[0][0]
__________________________________________________________________________________
__________________
batch_normalization_42 (BatchNo (None, 16, 16, 12)   48          conv2d_42[0][0]
__________________________________________________________________________________
__________________
activation_42 (Activation)      (None, 16, 16, 12)   0
batch_normalization_42[0][0]
__________________________________________________________________________________
__________________
conv2d_43 (Conv2D)              (None, 16, 16, 12)   1296
activation_42[0][0]
__________________________________________________________________________________
__________________
dropout_21 (Dropout)            (None, 16, 16, 12)   0           conv2d_43[0][0]
__________________________________________________________________________________
__________________
concatenate_20 (Concatenate)    (None, 16, 16, 120)  0
concatenate_19[0][0]
dropout_21[0][0]
__________________________________________________________________________________
__________________
batch_normalization_43 (BatchNo (None, 16, 16, 120)  480
concatenate_20[0][0]
__________________________________________________________________________________
__________________
activation_43 (Activation)      (None, 16, 16, 120)  0
```

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batch_normalization_43[0][0]
__________________________________________________________________________________________________
conv2d_44 (Conv2D)              (None, 16, 16, 12)   1440
activation_43[0][0]
__________________________________________________________________________________________________
batch_normalization_44 (BatchNo (None, 16, 16, 12)   48          conv2d_44[0][0]
__________________________________________________________________________________________________
activation_44 (Activation)      (None, 16, 16, 12)   0
batch_normalization_44[0][0]
__________________________________________________________________________________________________
conv2d_45 (Conv2D)              (None, 16, 16, 12)   1296
activation_44[0][0]
__________________________________________________________________________________________________
dropout_22 (Dropout)            (None, 16, 16, 12)   0           conv2d_45[0][0]
__________________________________________________________________________________________________
concatenate_21 (Concatenate)    (None, 16, 16, 132)  0
concatenate_20[0][0]
dropout_22[0][0]
__________________________________________________________________________________________________
batch_normalization_45 (BatchNo (None, 16, 16, 132)  528
concatenate_21[0][0]
__________________________________________________________________________________________________
activation_45 (Activation)      (None, 16, 16, 132)  0
batch_normalization_45[0][0]
__________________________________________________________________________________________________
conv2d_46 (Conv2D)              (None, 16, 16, 12)   1584
activation_45[0][0]
__________________________________________________________________________________________________
batch_normalization_46 (BatchNo (None, 16, 16, 12)   48          conv2d_46[0][0]
__________________________________________________________________________________________________
activation_46 (Activation)      (None, 16, 16, 12)   0
batch_normalization_46[0][0]
__________________________________________________________________________________________________
conv2d_47 (Conv2D)              (None, 16, 16, 12)   1296
activation_46[0][0]
__________________________________________________________________________________________________
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__________________
dropout_23 (Dropout)            (None, 16, 16, 12)   0           conv2d_47[0][0]
__________________________________________________________________________________
__________________
concatenate_22 (Concatenate)    (None, 16, 16, 144)  0
concatenate_21[0][0]
dropout_23[0][0]
__________________________________________________________________________________
__________________
batch_normalization_47 (BatchNo (None, 16, 16, 144)  576
concatenate_22[0][0]
__________________________________________________________________________________
__________________
activation_47 (Activation)      (None, 16, 16, 144)  0
batch_normalization_47[0][0]
__________________________________________________________________________________
__________________
conv2d_48 (Conv2D)              (None, 16, 16, 12)   1728
activation_47[0][0]
__________________________________________________________________________________
__________________
batch_normalization_48 (BatchNo (None, 16, 16, 12)   48          conv2d_48[0][0]
__________________________________________________________________________________
__________________
activation_48 (Activation)      (None, 16, 16, 12)   0
batch_normalization_48[0][0]
__________________________________________________________________________________
__________________
conv2d_49 (Conv2D)              (None, 16, 16, 12)   1296
activation_48[0][0]
__________________________________________________________________________________
__________________
dropout_24 (Dropout)            (None, 16, 16, 12)   0           conv2d_49[0][0]
__________________________________________________________________________________
__________________
concatenate_23 (Concatenate)    (None, 16, 16, 156)  0
concatenate_22[0][0]
dropout_24[0][0]
__________________________________________________________________________________
__________________
batch_normalization_49 (BatchNo (None, 16, 16, 156)  624
concatenate_23[0][0]
__________________________________________________________________________________
__________________
activation_49 (Activation)      (None, 16, 16, 156)  0
batch_normalization_49[0][0]
__________________________________________________________________________________
__________________
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conv2d_50 (Conv2D)              (None, 16, 16, 12)   1872
activation_49[0][0]
__________________________________________________________________________________
__________________
dropout_25 (Dropout)            (None, 16, 16, 12)   0           conv2d_50[0][0]
__________________________________________________________________________________
__________________
average_pooling2d_1 (AveragePoo (None, 8, 8, 12)     0
dropout_25[0][0]
__________________________________________________________________________________
__________________
batch_normalization_50 (BatchNo (None, 8, 8, 12)     48
average_pooling2d_1[0][0]
__________________________________________________________________________________
__________________
activation_50 (Activation)      (None, 8, 8, 12)     0
batch_normalization_50[0][0]
__________________________________________________________________________________
__________________
conv2d_51 (Conv2D)              (None, 8, 8, 12)     144
activation_50[0][0]
__________________________________________________________________________________
__________________
batch_normalization_51 (BatchNo (None, 8, 8, 12)     48          conv2d_51[0][0]
__________________________________________________________________________________
__________________
activation_51 (Activation)      (None, 8, 8, 12)     0
batch_normalization_51[0][0]
__________________________________________________________________________________
__________________
conv2d_52 (Conv2D)              (None, 8, 8, 12)     1296
activation_51[0][0]
__________________________________________________________________________________
__________________
dropout_26 (Dropout)            (None, 8, 8, 12)     0           conv2d_52[0][0]
__________________________________________________________________________________
__________________
concatenate_24 (Concatenate)    (None, 8, 8, 24)     0
average_pooling2d_1[0][0]
dropout_26[0][0]
__________________________________________________________________________________
__________________
batch_normalization_52 (BatchNo (None, 8, 8, 24)     96
concatenate_24[0][0]
__________________________________________________________________________________
__________________
activation_52 (Activation)      (None, 8, 8, 24)     0
batch_normalization_52[0][0]
```

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__________________________________________________________________________________
__________________
conv2d_53 (Conv2D)              (None, 8, 8, 12)     288
activation_52[0][0]
__________________________________________________________________________________
__________________
batch_normalization_53 (BatchNo (None, 8, 8, 12)     48          conv2d_53[0][0]
__________________________________________________________________________________
__________________
activation_53 (Activation)      (None, 8, 8, 12)     0
batch_normalization_53[0][0]
__________________________________________________________________________________
__________________
conv2d_54 (Conv2D)              (None, 8, 8, 12)     1296
activation_53[0][0]
__________________________________________________________________________________
__________________
dropout_27 (Dropout)            (None, 8, 8, 12)     0           conv2d_54[0][0]
__________________________________________________________________________________
__________________
concatenate_25 (Concatenate)    (None, 8, 8, 36)     0
concatenate_24[0][0]
dropout_27[0][0]
__________________________________________________________________________________
__________________
batch_normalization_54 (BatchNo (None, 8, 8, 36)     144
concatenate_25[0][0]
__________________________________________________________________________________
__________________
activation_54 (Activation)      (None, 8, 8, 36)     0
batch_normalization_54[0][0]
__________________________________________________________________________________
__________________
conv2d_55 (Conv2D)              (None, 8, 8, 12)     432
activation_54[0][0]
__________________________________________________________________________________
__________________
batch_normalization_55 (BatchNo (None, 8, 8, 12)     48          conv2d_55[0][0]
__________________________________________________________________________________
__________________
activation_55 (Activation)      (None, 8, 8, 12)     0
batch_normalization_55[0][0]
__________________________________________________________________________________
__________________
conv2d_56 (Conv2D)              (None, 8, 8, 12)     1296
activation_55[0][0]
__________________________________________________________________________________
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dropout_28 (Dropout)            (None, 8, 8, 12)     0           conv2d_56[0][0]
__________________________________________________________________________________________________
concatenate_26 (Concatenate)    (None, 8, 8, 48)     0
concatenate_25[0][0]
dropout_28[0][0]
__________________________________________________________________________________________________
batch_normalization_56 (BatchNo (None, 8, 8, 48)     192
concatenate_26[0][0]
__________________________________________________________________________________________________
activation_56 (Activation)      (None, 8, 8, 48)     0
batch_normalization_56[0][0]
__________________________________________________________________________________________________
conv2d_57 (Conv2D)              (None, 8, 8, 12)     576
activation_56[0][0]
__________________________________________________________________________________________________
batch_normalization_57 (BatchNo (None, 8, 8, 12)     48          conv2d_57[0][0]
__________________________________________________________________________________________________
activation_57 (Activation)      (None, 8, 8, 12)     0
batch_normalization_57[0][0]
__________________________________________________________________________________________________
conv2d_58 (Conv2D)              (None, 8, 8, 12)     1296
activation_57[0][0]
__________________________________________________________________________________________________
dropout_29 (Dropout)            (None, 8, 8, 12)     0           conv2d_58[0][0]
__________________________________________________________________________________________________
concatenate_27 (Concatenate)    (None, 8, 8, 60)     0
concatenate_26[0][0]
dropout_29[0][0]
__________________________________________________________________________________________________
batch_normalization_58 (BatchNo (None, 8, 8, 60)     240
concatenate_27[0][0]
__________________________________________________________________________________________________
activation_58 (Activation)      (None, 8, 8, 60)     0
batch_normalization_58[0][0]
__________________________________________________________________________________________________
conv2d_59 (Conv2D)              (None, 8, 8, 12)     720
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activation_58[0][0]
__________________________________________________________________________________________________
batch_normalization_59 (BatchNo (None, 8, 8, 12)     48          conv2d_59[0][0]
__________________________________________________________________________________________________
activation_59 (Activation)      (None, 8, 8, 12)     0
batch_normalization_59[0][0]
__________________________________________________________________________________________________
conv2d_60 (Conv2D)              (None, 8, 8, 12)     1296
activation_59[0][0]
__________________________________________________________________________________________________
dropout_30 (Dropout)            (None, 8, 8, 12)     0           conv2d_60[0][0]
__________________________________________________________________________________________________
concatenate_28 (Concatenate)    (None, 8, 8, 72)     0
concatenate_27[0][0]
dropout_30[0][0]
__________________________________________________________________________________________________
batch_normalization_60 (BatchNo (None, 8, 8, 72)     288
concatenate_28[0][0]
__________________________________________________________________________________________________
activation_60 (Activation)      (None, 8, 8, 72)     0
batch_normalization_60[0][0]
__________________________________________________________________________________________________
conv2d_61 (Conv2D)              (None, 8, 8, 12)     864
activation_60[0][0]
__________________________________________________________________________________________________
batch_normalization_61 (BatchNo (None, 8, 8, 12)     48          conv2d_61[0][0]
__________________________________________________________________________________________________
activation_61 (Activation)      (None, 8, 8, 12)     0
batch_normalization_61[0][0]
__________________________________________________________________________________________________
conv2d_62 (Conv2D)              (None, 8, 8, 12)     1296
activation_61[0][0]
__________________________________________________________________________________________________
dropout_31 (Dropout)            (None, 8, 8, 12)     0           conv2d_62[0][0]
__________________________________________________________________________________________________
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concatenate_29 (Concatenate)    (None, 8, 8, 84)     0
concatenate_28[0][0]
dropout_31[0][0]
__________________________________________________________________________________
__________________
batch_normalization_62 (BatchNo (None, 8, 8, 84)     336
concatenate_29[0][0]
__________________________________________________________________________________
__________________
activation_62 (Activation)      (None, 8, 8, 84)     0
batch_normalization_62[0][0]
__________________________________________________________________________________
__________________
conv2d_63 (Conv2D)              (None, 8, 8, 12)     1008
activation_62[0][0]
__________________________________________________________________________________
__________________
batch_normalization_63 (BatchNo (None, 8, 8, 12)     48          conv2d_63[0][0]
__________________________________________________________________________________
__________________
activation_63 (Activation)      (None, 8, 8, 12)     0
batch_normalization_63[0][0]
__________________________________________________________________________________
__________________
conv2d_64 (Conv2D)              (None, 8, 8, 12)     1296
activation_63[0][0]
__________________________________________________________________________________
__________________
dropout_32 (Dropout)            (None, 8, 8, 12)     0           conv2d_64[0][0]
__________________________________________________________________________________
__________________
concatenate_30 (Concatenate)    (None, 8, 8, 96)     0
concatenate_29[0][0]
dropout_32[0][0]
__________________________________________________________________________________
__________________
batch_normalization_64 (BatchNo (None, 8, 8, 96)     384
concatenate_30[0][0]
__________________________________________________________________________________
__________________
activation_64 (Activation)      (None, 8, 8, 96)     0
batch_normalization_64[0][0]
__________________________________________________________________________________
__________________
conv2d_65 (Conv2D)              (None, 8, 8, 12)     1152
activation_64[0][0]
__________________________________________________________________________________
__________________
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batch_normalization_65 (BatchNo (None, 8, 8, 12)     48          conv2d_65[0][0]
__________________________________________________________________________________
__________________
activation_65 (Activation)      (None, 8, 8, 12)     0
batch_normalization_65[0][0]
__________________________________________________________________________________
__________________
conv2d_66 (Conv2D)              (None, 8, 8, 12)     1296
activation_65[0][0]
__________________________________________________________________________________
__________________
dropout_33 (Dropout)            (None, 8, 8, 12)     0           conv2d_66[0][0]
__________________________________________________________________________________
__________________
concatenate_31 (Concatenate)    (None, 8, 8, 108)    0
concatenate_30[0][0]
dropout_33[0][0]
__________________________________________________________________________________
__________________
batch_normalization_66 (BatchNo (None, 8, 8, 108)    432
concatenate_31[0][0]
__________________________________________________________________________________
__________________
activation_66 (Activation)      (None, 8, 8, 108)    0
batch_normalization_66[0][0]
__________________________________________________________________________________
__________________
conv2d_67 (Conv2D)              (None, 8, 8, 12)     1296
activation_66[0][0]
__________________________________________________________________________________
__________________
batch_normalization_67 (BatchNo (None, 8, 8, 12)     48          conv2d_67[0][0]
__________________________________________________________________________________
__________________
activation_67 (Activation)      (None, 8, 8, 12)     0
batch_normalization_67[0][0]
__________________________________________________________________________________
__________________
conv2d_68 (Conv2D)              (None, 8, 8, 12)     1296
activation_67[0][0]
__________________________________________________________________________________
__________________
dropout_34 (Dropout)            (None, 8, 8, 12)     0           conv2d_68[0][0]
__________________________________________________________________________________
__________________
concatenate_32 (Concatenate)    (None, 8, 8, 120)    0
concatenate_31[0][0]
dropout_34[0][0]
```

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__________________________________________________________________________________
__________________
batch_normalization_68 (BatchNo (None, 8, 8, 120)    480
concatenate_32[0][0]
__________________________________________________________________________________
__________________
activation_68 (Activation)      (None, 8, 8, 120)    0
batch_normalization_68[0][0]
__________________________________________________________________________________
__________________
conv2d_69 (Conv2D)              (None, 8, 8, 12)     1440
activation_68[0][0]
__________________________________________________________________________________
__________________
batch_normalization_69 (BatchNo (None, 8, 8, 12)     48          conv2d_69[0][0]
__________________________________________________________________________________
__________________
activation_69 (Activation)      (None, 8, 8, 12)     0
batch_normalization_69[0][0]
__________________________________________________________________________________
__________________
conv2d_70 (Conv2D)              (None, 8, 8, 12)     1296
activation_69[0][0]
__________________________________________________________________________________
__________________
dropout_35 (Dropout)            (None, 8, 8, 12)     0           conv2d_70[0][0]
__________________________________________________________________________________
__________________
concatenate_33 (Concatenate)    (None, 8, 8, 132)    0
concatenate_32[0][0]
dropout_35[0][0]
__________________________________________________________________________________
__________________
batch_normalization_70 (BatchNo (None, 8, 8, 132)    528
concatenate_33[0][0]
__________________________________________________________________________________
__________________
activation_70 (Activation)      (None, 8, 8, 132)    0
batch_normalization_70[0][0]
__________________________________________________________________________________
__________________
conv2d_71 (Conv2D)              (None, 8, 8, 12)     1584
activation_70[0][0]
__________________________________________________________________________________
__________________
batch_normalization_71 (BatchNo (None, 8, 8, 12)     48          conv2d_71[0][0]
__________________________________________________________________________________
__________________
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activation_71 (Activation)      (None, 8, 8, 12)     0
batch_normalization_71[0][0]
__________________________________________________________________________________
__________________
conv2d_72 (Conv2D)              (None, 8, 8, 12)     1296
activation_71[0][0]
__________________________________________________________________________________
__________________
dropout_36 (Dropout)            (None, 8, 8, 12)     0           conv2d_72[0][0]
__________________________________________________________________________________
__________________
concatenate_34 (Concatenate)    (None, 8, 8, 144)    0
concatenate_33[0][0]
dropout_36[0][0]
__________________________________________________________________________________
__________________
batch_normalization_72 (BatchNo (None, 8, 8, 144)    576
concatenate_34[0][0]
__________________________________________________________________________________
__________________
activation_72 (Activation)      (None, 8, 8, 144)    0
batch_normalization_72[0][0]
__________________________________________________________________________________
__________________
conv2d_73 (Conv2D)              (None, 8, 8, 12)     1728
activation_72[0][0]
__________________________________________________________________________________
__________________
batch_normalization_73 (BatchNo (None, 8, 8, 12)     48          conv2d_73[0][0]
__________________________________________________________________________________
__________________
activation_73 (Activation)      (None, 8, 8, 12)     0
batch_normalization_73[0][0]
__________________________________________________________________________________
__________________
conv2d_74 (Conv2D)              (None, 8, 8, 12)     1296
activation_73[0][0]
__________________________________________________________________________________
__________________
dropout_37 (Dropout)            (None, 8, 8, 12)     0           conv2d_74[0][0]
__________________________________________________________________________________
__________________
concatenate_35 (Concatenate)    (None, 8, 8, 156)    0
concatenate_34[0][0]
dropout_37[0][0]
__________________________________________________________________________________
__________________
batch_normalization_74 (BatchNo (None, 8, 8, 156)    624
```

```
concatenate_35[0][0]
__________________________________________________________________________________
__________________
activation_74 (Activation)      (None, 8, 8, 156)    0
batch_normalization_74[0][0]
__________________________________________________________________________________
__________________
conv2d_75 (Conv2D)              (None, 8, 8, 12)     1872
activation_74[0][0]
__________________________________________________________________________________
__________________
dropout_38 (Dropout)            (None, 8, 8, 12)     0           conv2d_75[0][0]
__________________________________________________________________________________
__________________
average_pooling2d_2 (AveragePoo (None, 4, 4, 12)     0
dropout_38[0][0]
__________________________________________________________________________________
__________________
batch_normalization_75 (BatchNo (None, 4, 4, 12)     48
average_pooling2d_2[0][0]
__________________________________________________________________________________
__________________
activation_75 (Activation)      (None, 4, 4, 12)     0
batch_normalization_75[0][0]
__________________________________________________________________________________
__________________
conv2d_76 (Conv2D)              (None, 4, 4, 12)     144
activation_75[0][0]
__________________________________________________________________________________
__________________
batch_normalization_76 (BatchNo (None, 4, 4, 12)     48          conv2d_76[0][0]
__________________________________________________________________________________
__________________
activation_76 (Activation)      (None, 4, 4, 12)     0
batch_normalization_76[0][0]
__________________________________________________________________________________
__________________
conv2d_77 (Conv2D)              (None, 4, 4, 12)     1296
activation_76[0][0]
__________________________________________________________________________________
__________________
dropout_39 (Dropout)            (None, 4, 4, 12)     0           conv2d_77[0][0]
__________________________________________________________________________________
__________________
concatenate_36 (Concatenate)    (None, 4, 4, 24)     0
average_pooling2d_2[0][0]
dropout_39[0][0]
__________________________________________________________________________________
```

```
------------------
batch_normalization_77 (BatchNo (None, 4, 4, 24)     96
concatenate_36[0][0]
--------------------------------------------------------------------------------
------------------
activation_77 (Activation)      (None, 4, 4, 24)     0
batch_normalization_77[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_78 (Conv2D)              (None, 4, 4, 12)     288
activation_77[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_78 (BatchNo (None, 4, 4, 12)     48          conv2d_78[0][0]
--------------------------------------------------------------------------------
------------------
activation_78 (Activation)      (None, 4, 4, 12)     0
batch_normalization_78[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_79 (Conv2D)              (None, 4, 4, 12)     1296
activation_78[0][0]
--------------------------------------------------------------------------------
------------------
dropout_40 (Dropout)            (None, 4, 4, 12)     0           conv2d_79[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_37 (Concatenate)    (None, 4, 4, 36)     0
concatenate_36[0][0]
dropout_40[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_79 (BatchNo (None, 4, 4, 36)     144
concatenate_37[0][0]
--------------------------------------------------------------------------------
------------------
activation_79 (Activation)      (None, 4, 4, 36)     0
batch_normalization_79[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_80 (Conv2D)              (None, 4, 4, 12)     432
activation_79[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_80 (BatchNo (None, 4, 4, 12)     48          conv2d_80[0][0]
--------------------------------------------------------------------------------
------------------
activation_80 (Activation)      (None, 4, 4, 12)     0
```

```
batch_normalization_80[0][0]
__________________________________________________________________________________________________
conv2d_81 (Conv2D)              (None, 4, 4, 12)     1296
activation_80[0][0]
__________________________________________________________________________________________________
dropout_41 (Dropout)            (None, 4, 4, 12)     0           conv2d_81[0][0]
__________________________________________________________________________________________________
concatenate_38 (Concatenate)    (None, 4, 4, 48)     0
concatenate_37[0][0]
dropout_41[0][0]
__________________________________________________________________________________________________
batch_normalization_81 (BatchNo (None, 4, 4, 48)     192
concatenate_38[0][0]
__________________________________________________________________________________________________
activation_81 (Activation)      (None, 4, 4, 48)     0
batch_normalization_81[0][0]
__________________________________________________________________________________________________
conv2d_82 (Conv2D)              (None, 4, 4, 12)     576
activation_81[0][0]
__________________________________________________________________________________________________
batch_normalization_82 (BatchNo (None, 4, 4, 12)     48          conv2d_82[0][0]
__________________________________________________________________________________________________
activation_82 (Activation)      (None, 4, 4, 12)     0
batch_normalization_82[0][0]
__________________________________________________________________________________________________
conv2d_83 (Conv2D)              (None, 4, 4, 12)     1296
activation_82[0][0]
__________________________________________________________________________________________________
dropout_42 (Dropout)            (None, 4, 4, 12)     0           conv2d_83[0][0]
__________________________________________________________________________________________________
concatenate_39 (Concatenate)    (None, 4, 4, 60)     0
concatenate_38[0][0]
dropout_42[0][0]
__________________________________________________________________________________________________
batch_normalization_83 (BatchNo (None, 4, 4, 60)     240
concatenate_39[0][0]
```

```
__________________________________________________________________________________
__________________
activation_83 (Activation)      (None, 4, 4, 60)     0
batch_normalization_83[0][0]
__________________________________________________________________________________
__________________
conv2d_84 (Conv2D)              (None, 4, 4, 12)     720
activation_83[0][0]
__________________________________________________________________________________
__________________
batch_normalization_84 (BatchNo (None, 4, 4, 12)     48          conv2d_84[0][0]
__________________________________________________________________________________
__________________
activation_84 (Activation)      (None, 4, 4, 12)     0
batch_normalization_84[0][0]
__________________________________________________________________________________
__________________
conv2d_85 (Conv2D)              (None, 4, 4, 12)     1296
activation_84[0][0]
__________________________________________________________________________________
__________________
dropout_43 (Dropout)            (None, 4, 4, 12)     0           conv2d_85[0][0]
__________________________________________________________________________________
__________________
concatenate_40 (Concatenate)    (None, 4, 4, 72)     0
concatenate_39[0][0]
dropout_43[0][0]
__________________________________________________________________________________
__________________
batch_normalization_85 (BatchNo (None, 4, 4, 72)     288
concatenate_40[0][0]
__________________________________________________________________________________
__________________
activation_85 (Activation)      (None, 4, 4, 72)     0
batch_normalization_85[0][0]
__________________________________________________________________________________
__________________
conv2d_86 (Conv2D)              (None, 4, 4, 12)     864
activation_85[0][0]
__________________________________________________________________________________
__________________
batch_normalization_86 (BatchNo (None, 4, 4, 12)     48          conv2d_86[0][0]
__________________________________________________________________________________
__________________
activation_86 (Activation)      (None, 4, 4, 12)     0
batch_normalization_86[0][0]
__________________________________________________________________________________
__________________
```

```
conv2d_87 (Conv2D)              (None, 4, 4, 12)     1296
activation_86[0][0]
__________________________________________________________________________________
__________________
dropout_44 (Dropout)            (None, 4, 4, 12)     0           conv2d_87[0][0]
__________________________________________________________________________________
__________________
concatenate_41 (Concatenate)    (None, 4, 4, 84)     0
concatenate_40[0][0]
dropout_44[0][0]
__________________________________________________________________________________
__________________
batch_normalization_87 (BatchNo (None, 4, 4, 84)     336
concatenate_41[0][0]
__________________________________________________________________________________
__________________
activation_87 (Activation)      (None, 4, 4, 84)     0
batch_normalization_87[0][0]
__________________________________________________________________________________
__________________
conv2d_88 (Conv2D)              (None, 4, 4, 12)     1008
activation_87[0][0]
__________________________________________________________________________________
__________________
batch_normalization_88 (BatchNo (None, 4, 4, 12)     48          conv2d_88[0][0]
__________________________________________________________________________________
__________________
activation_88 (Activation)      (None, 4, 4, 12)     0
batch_normalization_88[0][0]
__________________________________________________________________________________
__________________
conv2d_89 (Conv2D)              (None, 4, 4, 12)     1296
activation_88[0][0]
__________________________________________________________________________________
__________________
dropout_45 (Dropout)            (None, 4, 4, 12)     0           conv2d_89[0][0]
__________________________________________________________________________________
__________________
concatenate_42 (Concatenate)    (None, 4, 4, 96)     0
concatenate_41[0][0]
dropout_45[0][0]
__________________________________________________________________________________
__________________
batch_normalization_89 (BatchNo (None, 4, 4, 96)     384
concatenate_42[0][0]
__________________________________________________________________________________
__________________
activation_89 (Activation)      (None, 4, 4, 96)     0
```

```
batch_normalization_89[0][0]
__________________________________________________________________________________________________
conv2d_90 (Conv2D)              (None, 4, 4, 12)     1152
activation_89[0][0]
__________________________________________________________________________________________________
batch_normalization_90 (BatchNo (None, 4, 4, 12)     48          conv2d_90[0][0]
__________________________________________________________________________________________________
activation_90 (Activation)      (None, 4, 4, 12)     0
batch_normalization_90[0][0]
__________________________________________________________________________________________________
conv2d_91 (Conv2D)              (None, 4, 4, 12)     1296
activation_90[0][0]
__________________________________________________________________________________________________
dropout_46 (Dropout)            (None, 4, 4, 12)     0           conv2d_91[0][0]
__________________________________________________________________________________________________
concatenate_43 (Concatenate)    (None, 4, 4, 108)    0
concatenate_42[0][0]
dropout_46[0][0]
__________________________________________________________________________________________________
batch_normalization_91 (BatchNo (None, 4, 4, 108)    432
concatenate_43[0][0]
__________________________________________________________________________________________________
activation_91 (Activation)      (None, 4, 4, 108)    0
batch_normalization_91[0][0]
__________________________________________________________________________________________________
conv2d_92 (Conv2D)              (None, 4, 4, 12)     1296
activation_91[0][0]
__________________________________________________________________________________________________
batch_normalization_92 (BatchNo (None, 4, 4, 12)     48          conv2d_92[0][0]
__________________________________________________________________________________________________
activation_92 (Activation)      (None, 4, 4, 12)     0
batch_normalization_92[0][0]
__________________________________________________________________________________________________
conv2d_93 (Conv2D)              (None, 4, 4, 12)     1296
activation_92[0][0]
__________________________________________________________________________________________________
```

```
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dropout_47 (Dropout)            (None, 4, 4, 12)     0           conv2d_93[0][0]
__________________________________________________________________________________
------------------
concatenate_44 (Concatenate)    (None, 4, 4, 120)    0
concatenate_43[0][0]
dropout_47[0][0]
__________________________________________________________________________________
------------------
batch_normalization_93 (BatchNo (None, 4, 4, 120)    480
concatenate_44[0][0]
__________________________________________________________________________________
------------------
activation_93 (Activation)      (None, 4, 4, 120)    0
batch_normalization_93[0][0]
__________________________________________________________________________________
------------------
conv2d_94 (Conv2D)              (None, 4, 4, 12)     1440
activation_93[0][0]
__________________________________________________________________________________
------------------
batch_normalization_94 (BatchNo (None, 4, 4, 12)     48          conv2d_94[0][0]
__________________________________________________________________________________
------------------
activation_94 (Activation)      (None, 4, 4, 12)     0
batch_normalization_94[0][0]
__________________________________________________________________________________
------------------
conv2d_95 (Conv2D)              (None, 4, 4, 12)     1296
activation_94[0][0]
__________________________________________________________________________________
------------------
dropout_48 (Dropout)            (None, 4, 4, 12)     0           conv2d_95[0][0]
__________________________________________________________________________________
------------------
concatenate_45 (Concatenate)    (None, 4, 4, 132)    0
concatenate_44[0][0]
dropout_48[0][0]
__________________________________________________________________________________
------------------
batch_normalization_95 (BatchNo (None, 4, 4, 132)    528
concatenate_45[0][0]
__________________________________________________________________________________
------------------
activation_95 (Activation)      (None, 4, 4, 132)    0
batch_normalization_95[0][0]
__________________________________________________________________________________
------------------
```

```
conv2d_96 (Conv2D)              (None, 4, 4, 12)     1584
activation_95[0][0]
__________________________________________________________________________________
__________________
batch_normalization_96 (BatchNo (None, 4, 4, 12)     48          conv2d_96[0][0]
__________________________________________________________________________________
__________________
activation_96 (Activation)      (None, 4, 4, 12)     0
batch_normalization_96[0][0]
__________________________________________________________________________________
__________________
conv2d_97 (Conv2D)              (None, 4, 4, 12)     1296
activation_96[0][0]
__________________________________________________________________________________
__________________
dropout_49 (Dropout)            (None, 4, 4, 12)     0           conv2d_97[0][0]
__________________________________________________________________________________
__________________
concatenate_46 (Concatenate)    (None, 4, 4, 144)    0
concatenate_45[0][0]
dropout_49[0][0]
__________________________________________________________________________________
__________________
batch_normalization_97 (BatchNo (None, 4, 4, 144)    576
concatenate_46[0][0]
__________________________________________________________________________________
__________________
activation_97 (Activation)      (None, 4, 4, 144)    0
batch_normalization_97[0][0]
__________________________________________________________________________________
__________________
conv2d_98 (Conv2D)              (None, 4, 4, 12)     1728
activation_97[0][0]
__________________________________________________________________________________
__________________
batch_normalization_98 (BatchNo (None, 4, 4, 12)     48          conv2d_98[0][0]
__________________________________________________________________________________
__________________
activation_98 (Activation)      (None, 4, 4, 12)     0
batch_normalization_98[0][0]
__________________________________________________________________________________
__________________
conv2d_99 (Conv2D)              (None, 4, 4, 12)     1296
activation_98[0][0]
__________________________________________________________________________________
__________________
dropout_50 (Dropout)            (None, 4, 4, 12)     0           conv2d_99[0][0]
__________________________________________________________________________________
```

```
------------------
concatenate_47 (Concatenate)    (None, 4, 4, 156)    0
concatenate_46[0][0]
dropout_50[0][0]
------------------------------------------------------------------------------------------
------------------
batch_normalization_99 (BatchNo (None, 4, 4, 156)    624
concatenate_47[0][0]
------------------------------------------------------------------------------------------
------------------
activation_99 (Activation)      (None, 4, 4, 156)    0
batch_normalization_99[0][0]
------------------------------------------------------------------------------------------
------------------
average_pooling2d_3 (AveragePoo (None, 2, 2, 156)    0
activation_99[0][0]
------------------------------------------------------------------------------------------
------------------
flatten (Flatten)               (None, 624)          0
average_pooling2d_3[0][0]
------------------------------------------------------------------------------------------
------------------
dense (Dense)                   (None, 10)           6250        flatten[0][0]
==========================================================================================
==================
Total params: 141,922
Trainable params: 131,722
Non-trainable params: 10,200
------------------------------------------------------------------------------------------
------------------
```

[ ]:
```
print(len(model3.layers))
```

```
406
```

[ ]:
```
model3.
 ↪compile(optimizer='adam',loss='categorical_crossentropy',metrics=['accuracy'])

model3.fit(aug.
 ↪flow(X_train,y_train,batch_size=batch_size),epochs=nb_epoch,batch_size=batch_size,verbose=1
          steps_per_epoch=(len(X_train)//batch_size),
          ␣
 ↪callbacks=[reduce_lr,lr_scheduler,csv_logger,early_stop,model_checkpoint],
          validation_data=(X_test,y_test))
```

```
Epoch 1/100
390/390 [==============================] - 76s 174ms/step - loss: 1.8787 -
accuracy: 0.3063 - val_loss: 6.2094 - val_accuracy: 0.1329
```

```
Epoch 00001: val_accuracy improved from -inf to 0.13290, saving model to
weights.best.hdf5
Epoch 2/100
390/390 [==============================] - 65s 166ms/step - loss: 1.5245 -
accuracy: 0.4403 - val_loss: 1.9439 - val_accuracy: 0.4002

Epoch 00002: val_accuracy improved from 0.13290 to 0.40020, saving model to
weights.best.hdf5
Epoch 3/100
390/390 [==============================] - 65s 167ms/step - loss: 1.3421 -
accuracy: 0.5108 - val_loss: 3.8294 - val_accuracy: 0.3237

Epoch 00003: val_accuracy did not improve from 0.40020
Epoch 4/100
390/390 [==============================] - 65s 167ms/step - loss: 1.2104 -
accuracy: 0.5635 - val_loss: 2.2493 - val_accuracy: 0.4519

Epoch 00004: val_accuracy improved from 0.40020 to 0.45190, saving model to
weights.best.hdf5
Epoch 5/100
390/390 [==============================] - 65s 166ms/step - loss: 1.1075 -
accuracy: 0.6057 - val_loss: 1.7633 - val_accuracy: 0.5227

Epoch 00005: val_accuracy improved from 0.45190 to 0.52270, saving model to
weights.best.hdf5
Epoch 6/100
390/390 [==============================] - 65s 166ms/step - loss: 1.0290 -
accuracy: 0.6315 - val_loss: 1.4483 - val_accuracy: 0.5767

Epoch 00006: val_accuracy improved from 0.52270 to 0.57670, saving model to
weights.best.hdf5
Epoch 7/100
390/390 [==============================] - 65s 165ms/step - loss: 0.9777 -
accuracy: 0.6519 - val_loss: 2.5660 - val_accuracy: 0.4636

Epoch 00007: val_accuracy did not improve from 0.57670
Epoch 8/100
390/390 [==============================] - 64s 164ms/step - loss: 0.9328 -
accuracy: 0.6688 - val_loss: 1.8276 - val_accuracy: 0.5384

Epoch 00008: val_accuracy did not improve from 0.57670
Epoch 9/100
390/390 [==============================] - 65s 165ms/step - loss: 0.8982 -
accuracy: 0.6822 - val_loss: 1.6682 - val_accuracy: 0.5601

Epoch 00009: val_accuracy did not improve from 0.57670
Epoch 10/100
```

```
390/390 [==============================] - 64s 165ms/step - loss: 0.8749 -
accuracy: 0.6896 - val_loss: 1.3930 - val_accuracy: 0.6313

Epoch 00010: val_accuracy improved from 0.57670 to 0.63130, saving model to
weights.best.hdf5
Epoch 11/100
390/390 [==============================] - 64s 165ms/step - loss: 0.8522 -
accuracy: 0.6970 - val_loss: 1.1654 - val_accuracy: 0.6492

Epoch 00011: val_accuracy improved from 0.63130 to 0.64920, saving model to
weights.best.hdf5
Epoch 12/100
390/390 [==============================] - 64s 165ms/step - loss: 0.8241 -
accuracy: 0.7086 - val_loss: 1.5537 - val_accuracy: 0.6059

Epoch 00012: val_accuracy did not improve from 0.64920
Epoch 13/100
390/390 [==============================] - 65s 166ms/step - loss: 0.8022 -
accuracy: 0.7167 - val_loss: 1.3158 - val_accuracy: 0.5879

Epoch 00013: val_accuracy did not improve from 0.64920
Epoch 14/100
390/390 [==============================] - 65s 165ms/step - loss: 0.7882 -
accuracy: 0.7229 - val_loss: 1.4757 - val_accuracy: 0.6051

Epoch 00014: val_accuracy did not improve from 0.64920
Epoch 15/100
390/390 [==============================] - 65s 166ms/step - loss: 0.7644 -
accuracy: 0.7320 - val_loss: 0.9961 - val_accuracy: 0.6942

Epoch 00015: val_accuracy improved from 0.64920 to 0.69420, saving model to
weights.best.hdf5
Epoch 16/100
390/390 [==============================] - 65s 166ms/step - loss: 0.7446 -
accuracy: 0.7390 - val_loss: 1.0217 - val_accuracy: 0.7059

Epoch 00016: val_accuracy improved from 0.69420 to 0.70590, saving model to
weights.best.hdf5
Epoch 17/100
390/390 [==============================] - 65s 166ms/step - loss: 0.7307 -
accuracy: 0.7432 - val_loss: 0.9654 - val_accuracy: 0.6975

Epoch 00017: val_accuracy did not improve from 0.70590
Epoch 18/100
390/390 [==============================] - 65s 166ms/step - loss: 0.7159 -
accuracy: 0.7480 - val_loss: 1.2995 - val_accuracy: 0.6513

Epoch 00018: val_accuracy did not improve from 0.70590
```

```
Epoch 19/100
390/390 [==============================] - 64s 165ms/step - loss: 0.7013 -
accuracy: 0.7530 - val_loss: 1.0214 - val_accuracy: 0.6978

Epoch 00019: val_accuracy did not improve from 0.70590
Epoch 20/100
390/390 [==============================] - 64s 164ms/step - loss: 0.6920 -
accuracy: 0.7567 - val_loss: 1.3233 - val_accuracy: 0.6280

Epoch 00020: val_accuracy did not improve from 0.70590
Epoch 21/100
390/390 [==============================] - 64s 163ms/step - loss: 0.6844 -
accuracy: 0.7609 - val_loss: 0.9723 - val_accuracy: 0.7109

Epoch 00021: val_accuracy improved from 0.70590 to 0.71090, saving model to
weights.best.hdf5
Epoch 22/100
390/390 [==============================] - 64s 163ms/step - loss: 0.6724 -
accuracy: 0.7660 - val_loss: 0.7707 - val_accuracy: 0.7574

Epoch 00022: val_accuracy improved from 0.71090 to 0.75740, saving model to
weights.best.hdf5
Epoch 23/100
390/390 [==============================] - 64s 163ms/step - loss: 0.6639 -
accuracy: 0.7681 - val_loss: 0.9687 - val_accuracy: 0.7260

Epoch 00023: val_accuracy did not improve from 0.75740
Epoch 24/100
390/390 [==============================] - 64s 164ms/step - loss: 0.6538 -
accuracy: 0.7721 - val_loss: 0.9126 - val_accuracy: 0.7317

Epoch 00024: val_accuracy did not improve from 0.75740
Epoch 25/100
390/390 [==============================] - 64s 163ms/step - loss: 0.6481 -
accuracy: 0.7726 - val_loss: 1.8253 - val_accuracy: 0.6180

Epoch 00025: val_accuracy did not improve from 0.75740
Epoch 26/100
390/390 [==============================] - 64s 163ms/step - loss: 0.5803 -
accuracy: 0.7983 - val_loss: 0.6085 - val_accuracy: 0.8065

Epoch 00026: val_accuracy improved from 0.75740 to 0.80650, saving model to
weights.best.hdf5
Epoch 27/100
390/390 [==============================] - 64s 164ms/step - loss: 0.5542 -
accuracy: 0.8054 - val_loss: 0.6685 - val_accuracy: 0.7945

Epoch 00027: val_accuracy did not improve from 0.80650
```

```
Epoch 28/100
390/390 [==============================] - 64s 163ms/step - loss: 0.5452 -
accuracy: 0.8079 - val_loss: 0.7349 - val_accuracy: 0.7816

Epoch 00028: val_accuracy did not improve from 0.80650
Epoch 29/100
390/390 [==============================] - 63s 163ms/step - loss: 0.5400 -
accuracy: 0.8101 - val_loss: 0.7039 - val_accuracy: 0.7900

Epoch 00029: val_accuracy did not improve from 0.80650
Epoch 30/100
390/390 [==============================] - 63s 163ms/step - loss: 0.5333 -
accuracy: 0.8130 - val_loss: 0.6732 - val_accuracy: 0.7933

Epoch 00030: val_accuracy did not improve from 0.80650
Epoch 31/100
390/390 [==============================] - 63s 162ms/step - loss: 0.5295 -
accuracy: 0.8153 - val_loss: 0.5967 - val_accuracy: 0.8126

Epoch 00031: val_accuracy improved from 0.80650 to 0.81260, saving model to
weights.best.hdf5
Epoch 32/100
390/390 [==============================] - 64s 163ms/step - loss: 0.5266 -
accuracy: 0.8149 - val_loss: 0.6517 - val_accuracy: 0.8036

Epoch 00032: val_accuracy did not improve from 0.81260
Epoch 33/100
390/390 [==============================] - 63s 162ms/step - loss: 0.5259 -
accuracy: 0.8179 - val_loss: 0.7121 - val_accuracy: 0.7878

Epoch 00033: val_accuracy did not improve from 0.81260
Epoch 34/100
390/390 [==============================] - 63s 162ms/step - loss: 0.5200 -
accuracy: 0.8164 - val_loss: 0.6949 - val_accuracy: 0.7905

Epoch 00034: val_accuracy did not improve from 0.81260
Epoch 35/100
390/390 [==============================] - 64s 164ms/step - loss: 0.5119 -
accuracy: 0.8211 - val_loss: 0.6087 - val_accuracy: 0.8097

Epoch 00035: val_accuracy did not improve from 0.81260
Epoch 36/100
390/390 [==============================] - 64s 164ms/step - loss: 0.5189 -
accuracy: 0.8174 - val_loss: 0.5921 - val_accuracy: 0.8145

Epoch 00036: val_accuracy improved from 0.81260 to 0.81450, saving model to
weights.best.hdf5
Epoch 37/100
```

```
390/390 [==============================] - 64s 164ms/step - loss: 0.5131 -
accuracy: 0.8210 - val_loss: 0.6484 - val_accuracy: 0.8044

Epoch 00037: val_accuracy did not improve from 0.81450
Epoch 38/100
390/390 [==============================] - 64s 165ms/step - loss: 0.5070 -
accuracy: 0.8235 - val_loss: 0.6497 - val_accuracy: 0.8017

Epoch 00038: val_accuracy did not improve from 0.81450
Epoch 39/100
390/390 [==============================] - 64s 165ms/step - loss: 0.5071 -
accuracy: 0.8247 - val_loss: 0.6591 - val_accuracy: 0.8039

Epoch 00039: val_accuracy did not improve from 0.81450
Epoch 40/100
390/390 [==============================] - 64s 165ms/step - loss: 0.5062 -
accuracy: 0.8222 - val_loss: 0.6059 - val_accuracy: 0.8115

Epoch 00040: val_accuracy did not improve from 0.81450
Epoch 41/100
390/390 [==============================] - 64s 163ms/step - loss: 0.5033 -
accuracy: 0.8236 - val_loss: 0.6382 - val_accuracy: 0.8071

Epoch 00041: val_accuracy did not improve from 0.81450
Epoch 42/100
390/390 [==============================] - 63s 162ms/step - loss: 0.5019 -
accuracy: 0.8264 - val_loss: 0.6656 - val_accuracy: 0.8002

Epoch 00042: val_accuracy did not improve from 0.81450
Epoch 43/100
390/390 [==============================] - 64s 163ms/step - loss: 0.5012 -
accuracy: 0.8257 - val_loss: 0.6749 - val_accuracy: 0.7962

Epoch 00043: val_accuracy did not improve from 0.81450
Epoch 44/100
390/390 [==============================] - 64s 163ms/step - loss: 0.5013 -
accuracy: 0.8232 - val_loss: 0.6785 - val_accuracy: 0.7997

Epoch 00044: val_accuracy did not improve from 0.81450
Epoch 45/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4997 -
accuracy: 0.8261 - val_loss: 0.5985 - val_accuracy: 0.8147

Epoch 00045: val_accuracy improved from 0.81450 to 0.81470, saving model to
weights.best.hdf5
Epoch 46/100
390/390 [==============================] - 63s 162ms/step - loss: 0.4949 -
accuracy: 0.8271 - val_loss: 0.6376 - val_accuracy: 0.8057
```

```
Epoch 00046: val_accuracy did not improve from 0.81470
Epoch 47/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4920 -
accuracy: 0.8272 - val_loss: 0.6769 - val_accuracy: 0.8001

Epoch 00047: val_accuracy did not improve from 0.81470
Epoch 48/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4907 -
accuracy: 0.8269 - val_loss: 0.5599 - val_accuracy: 0.8259

Epoch 00048: val_accuracy improved from 0.81470 to 0.82590, saving model to
weights.best.hdf5
Epoch 49/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4904 -
accuracy: 0.8281 - val_loss: 0.5944 - val_accuracy: 0.8191

Epoch 00049: val_accuracy did not improve from 0.82590
Epoch 50/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4923 -
accuracy: 0.8295 - val_loss: 0.6196 - val_accuracy: 0.8115

Epoch 00050: val_accuracy did not improve from 0.82590
Epoch 51/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4771 -
accuracy: 0.8336 - val_loss: 0.5877 - val_accuracy: 0.8199

Epoch 00051: val_accuracy did not improve from 0.82590
Epoch 52/100
390/390 [==============================] - 64s 164ms/step - loss: 0.4797 -
accuracy: 0.8317 - val_loss: 0.5976 - val_accuracy: 0.8197

Epoch 00052: val_accuracy did not improve from 0.82590
Epoch 53/100
390/390 [==============================] - 63s 163ms/step - loss: 0.4778 -
accuracy: 0.8332 - val_loss: 0.6047 - val_accuracy: 0.8172

Epoch 00053: val_accuracy did not improve from 0.82590
Epoch 54/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4803 -
accuracy: 0.8328 - val_loss: 0.5944 - val_accuracy: 0.8193

Epoch 00054: val_accuracy did not improve from 0.82590
Epoch 55/100
390/390 [==============================] - 64s 164ms/step - loss: 0.4740 -
accuracy: 0.8350 - val_loss: 0.6027 - val_accuracy: 0.8182

Epoch 00055: val_accuracy did not improve from 0.82590
```

```
Epoch 56/100
390/390 [==============================] - 63s 162ms/step - loss: 0.4762 -
accuracy: 0.8324 - val_loss: 0.5926 - val_accuracy: 0.8200

Epoch 00056: val_accuracy did not improve from 0.82590
Epoch 57/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4754 -
accuracy: 0.8337 - val_loss: 0.5978 - val_accuracy: 0.8182

Epoch 00057: val_accuracy did not improve from 0.82590
Epoch 58/100
390/390 [==============================] - 64s 164ms/step - loss: 0.4789 -
accuracy: 0.8337 - val_loss: 0.5979 - val_accuracy: 0.8188

Epoch 00058: val_accuracy did not improve from 0.82590
Epoch 59/100
390/390 [==============================] - 64s 164ms/step - loss: 0.4787 -
accuracy: 0.8340 - val_loss: 0.6087 - val_accuracy: 0.8176

Epoch 00059: val_accuracy did not improve from 0.82590
Epoch 60/100
390/390 [==============================] - 64s 165ms/step - loss: 0.4762 -
accuracy: 0.8338 - val_loss: 0.6094 - val_accuracy: 0.8173

Epoch 00060: val_accuracy did not improve from 0.82590
Epoch 61/100
390/390 [==============================] - 64s 165ms/step - loss: 0.4764 -
accuracy: 0.8326 - val_loss: 0.6118 - val_accuracy: 0.8167

Epoch 00061: val_accuracy did not improve from 0.82590
Epoch 62/100
390/390 [==============================] - 64s 164ms/step - loss: 0.4737 -
accuracy: 0.8348 - val_loss: 0.5979 - val_accuracy: 0.8186

Epoch 00062: val_accuracy did not improve from 0.82590
Epoch 63/100
390/390 [==============================] - 64s 164ms/step - loss: 0.4763 -
accuracy: 0.8335 - val_loss: 0.5987 - val_accuracy: 0.8196

Epoch 00063: val_accuracy did not improve from 0.82590
Epoch 64/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4751 -
accuracy: 0.8336 - val_loss: 0.5927 - val_accuracy: 0.8203

Epoch 00064: val_accuracy did not improve from 0.82590
Epoch 65/100
390/390 [==============================] - 63s 162ms/step - loss: 0.4737 -
accuracy: 0.8345 - val_loss: 0.6007 - val_accuracy: 0.8183
```

```
Epoch 00065: val_accuracy did not improve from 0.82590
Epoch 66/100
390/390 [==============================] - 63s 162ms/step - loss: 0.4755 -
accuracy: 0.8351 - val_loss: 0.6137 - val_accuracy: 0.8152

Epoch 00066: val_accuracy did not improve from 0.82590
Epoch 67/100
390/390 [==============================] - 63s 162ms/step - loss: 0.4724 -
accuracy: 0.8345 - val_loss: 0.6001 - val_accuracy: 0.8194

Epoch 00067: val_accuracy did not improve from 0.82590
Epoch 68/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4731 -
accuracy: 0.8344 - val_loss: 0.5974 - val_accuracy: 0.8187

Epoch 00068: val_accuracy did not improve from 0.82590
Epoch 69/100
390/390 [==============================] - 63s 162ms/step - loss: 0.4721 -
accuracy: 0.8328 - val_loss: 0.6013 - val_accuracy: 0.8185

Epoch 00069: val_accuracy did not improve from 0.82590
Epoch 70/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4708 -
accuracy: 0.8332 - val_loss: 0.5925 - val_accuracy: 0.8204

Epoch 00070: val_accuracy did not improve from 0.82590
Epoch 71/100
390/390 [==============================] - 64s 164ms/step - loss: 0.4703 -
accuracy: 0.8352 - val_loss: 0.5956 - val_accuracy: 0.8200

Epoch 00071: val_accuracy did not improve from 0.82590
Epoch 72/100
390/390 [==============================] - 63s 163ms/step - loss: 0.4741 -
accuracy: 0.8340 - val_loss: 0.6019 - val_accuracy: 0.8192

Epoch 00072: val_accuracy did not improve from 0.82590
Epoch 73/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4769 -
accuracy: 0.8342 - val_loss: 0.5974 - val_accuracy: 0.8196

Epoch 00073: val_accuracy did not improve from 0.82590
Epoch 74/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4732 -
accuracy: 0.8349 - val_loss: 0.6004 - val_accuracy: 0.8193

Epoch 00074: val_accuracy did not improve from 0.82590
Epoch 75/100
```

```
390/390 [==============================] - 64s 164ms/step - loss: 0.4754 -
accuracy: 0.8328 - val_loss: 0.6164 - val_accuracy: 0.8165

Epoch 00075: val_accuracy did not improve from 0.82590
Epoch 76/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4711 -
accuracy: 0.8346 - val_loss: 0.5940 - val_accuracy: 0.8194

Epoch 00076: val_accuracy did not improve from 0.82590
Epoch 77/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4659 -
accuracy: 0.8373 - val_loss: 0.6167 - val_accuracy: 0.8164

Epoch 00077: val_accuracy did not improve from 0.82590
Epoch 78/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4644 -
accuracy: 0.8376 - val_loss: 0.5916 - val_accuracy: 0.8205

Epoch 00078: val_accuracy did not improve from 0.82590
Epoch 79/100
390/390 [==============================] - 64s 164ms/step - loss: 0.4671 -
accuracy: 0.8366 - val_loss: 0.5899 - val_accuracy: 0.8204

Epoch 00079: val_accuracy did not improve from 0.82590
Epoch 80/100
390/390 [==============================] - 64s 165ms/step - loss: 0.4735 -
accuracy: 0.8352 - val_loss: 0.5945 - val_accuracy: 0.8196

Epoch 00080: val_accuracy did not improve from 0.82590
Epoch 81/100
390/390 [==============================] - 64s 165ms/step - loss: 0.4684 -
accuracy: 0.8353 - val_loss: 0.5949 - val_accuracy: 0.8207

Epoch 00081: val_accuracy did not improve from 0.82590
Epoch 82/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4709 -
accuracy: 0.8374 - val_loss: 0.5980 - val_accuracy: 0.8203

Epoch 00082: val_accuracy did not improve from 0.82590
Epoch 83/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4705 -
accuracy: 0.8367 - val_loss: 0.5977 - val_accuracy: 0.8198

Epoch 00083: val_accuracy did not improve from 0.82590
Epoch 84/100
390/390 [==============================] - 64s 164ms/step - loss: 0.4679 -
accuracy: 0.8338 - val_loss: 0.5871 - val_accuracy: 0.8220
```

```
Epoch 00084: val_accuracy did not improve from 0.82590
Epoch 85/100
390/390 [==============================] - 63s 162ms/step - loss: 0.4693 -
accuracy: 0.8369 - val_loss: 0.5832 - val_accuracy: 0.8221

Epoch 00085: val_accuracy did not improve from 0.82590
Epoch 86/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4712 -
accuracy: 0.8348 - val_loss: 0.5976 - val_accuracy: 0.8199

Epoch 00086: val_accuracy did not improve from 0.82590
Epoch 87/100
390/390 [==============================] - 64s 164ms/step - loss: 0.4734 -
accuracy: 0.8344 - val_loss: 0.5842 - val_accuracy: 0.8223

Epoch 00087: val_accuracy did not improve from 0.82590
Epoch 88/100
390/390 [==============================] - 64s 163ms/step - loss: 0.4667 -
accuracy: 0.8361 - val_loss: 0.6003 - val_accuracy: 0.8187

Epoch 00088: val_accuracy did not improve from 0.82590
```

[ ]:
```
<tensorflow.python.keras.callbacks.History at 0x7f58c765c350>
```

1.3.5 2.5 Growth rate(num_filter)=32, compression = 0.7, Number of blocks = 12

[ ]:
```
# Hyperparameters
batch_size = 64
num_classes = 10
nb_epoch = 100
l = 12
num_filter = 32
compression = 0.7
dropout_rate = 0.2
```

[ ]:
```
from tensorflow.keras.callbacks import ModelCheckpoint
#https://machinelearningmastery.com/check-point-deep-learning-models-keras/
filepath="model4_weights.best.hdf5"
model_checkpoint =␣
 ↪ModelCheckpoint(filepath,monitor='val_accuracy',save_best_only=True,verbose=1)
```

[ ]:
```
input = layers.Input(shape=(img_height, img_width, channel,))
First_Conv2D = layers.Conv2D(num_filter, (3,3), use_bias=False␣
 ↪,padding='same')(input)

First_Block = denseblock(First_Conv2D, num_filter, dropout_rate)
```

```
First_Transition = transition(First_Block, num_filter, dropout_rate)

Second_Block = denseblock(First_Transition, num_filter, dropout_rate)
Second_Transition = transition(Second_Block, num_filter, dropout_rate)

Third_Block = denseblock(Second_Transition, num_filter, dropout_rate)
Third_Transition = transition(Third_Block, num_filter, dropout_rate)

Last_Block = denseblock(Third_Transition,  num_filter, dropout_rate)
output = output_layer(Last_Block)
```

[ ]:
```
model4 = Model(inputs = [input], outputs = [output])
model4.summary()
```

```
Model: "model"
__________________________________________________________________________________
__________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================
==================
input_2 (InputLayer)            [(None, 32, 32, 3)]  0
__________________________________________________________________________________
__________________
conv2d (Conv2D)                 (None, 32, 32, 32)   864         input_2[0][0]
__________________________________________________________________________________
__________________
batch_normalization (BatchNorma (None, 32, 32, 32)   128         conv2d[0][0]
__________________________________________________________________________________
__________________
activation (Activation)         (None, 32, 32, 32)   0
batch_normalization[0][0]
__________________________________________________________________________________
__________________
conv2d_1 (Conv2D)               (None, 32, 32, 22)   704
activation[0][0]
__________________________________________________________________________________
__________________
batch_normalization_1 (BatchNor (None, 32, 32, 22)   88          conv2d_1[0][0]
__________________________________________________________________________________
__________________
activation_1 (Activation)       (None, 32, 32, 22)   0
batch_normalization_1[0][0]
__________________________________________________________________________________
__________________
conv2d_2 (Conv2D)               (None, 32, 32, 22)   4356
activation_1[0][0]
__________________________________________________________________________________
```

```
__________________
dropout (Dropout)               (None, 32, 32, 22)   0           conv2d_2[0][0]
____________________________________________________________________________
__________________
concatenate (Concatenate)       (None, 32, 32, 54)   0           conv2d[0][0]
                                                                 dropout[0][0]
____________________________________________________________________________
__________________
batch_normalization_2 (BatchNor (None, 32, 32, 54)   216
concatenate[0][0]
____________________________________________________________________________
__________________
activation_2 (Activation)       (None, 32, 32, 54)   0
batch_normalization_2[0][0]
____________________________________________________________________________
__________________
conv2d_3 (Conv2D)               (None, 32, 32, 22)   1188
activation_2[0][0]
____________________________________________________________________________
__________________
batch_normalization_3 (BatchNor (None, 32, 32, 22)   88          conv2d_3[0][0]
____________________________________________________________________________
__________________
activation_3 (Activation)       (None, 32, 32, 22)   0
batch_normalization_3[0][0]
____________________________________________________________________________
__________________
conv2d_4 (Conv2D)               (None, 32, 32, 22)   4356
activation_3[0][0]
____________________________________________________________________________
__________________
dropout_1 (Dropout)             (None, 32, 32, 22)   0           conv2d_4[0][0]
____________________________________________________________________________
__________________
concatenate_1 (Concatenate)     (None, 32, 32, 76)   0
concatenate[0][0]
                                                                 dropout_1[0][0]
____________________________________________________________________________
__________________
batch_normalization_4 (BatchNor (None, 32, 32, 76)   304
concatenate_1[0][0]
____________________________________________________________________________
__________________
activation_4 (Activation)       (None, 32, 32, 76)   0
batch_normalization_4[0][0]
____________________________________________________________________________
__________________
conv2d_5 (Conv2D)               (None, 32, 32, 22)   1672
```

```
activation_4[0][0]
__________________________________________________________________________________
__________________
batch_normalization_5 (BatchNor (None, 32, 32, 22)   88          conv2d_5[0][0]
__________________________________________________________________________________
__________________
activation_5 (Activation)       (None, 32, 32, 22)   0
batch_normalization_5[0][0]
__________________________________________________________________________________
__________________
conv2d_6 (Conv2D)               (None, 32, 32, 22)   4356
activation_5[0][0]
__________________________________________________________________________________
__________________
dropout_2 (Dropout)             (None, 32, 32, 22)   0           conv2d_6[0][0]
__________________________________________________________________________________
__________________
concatenate_2 (Concatenate)     (None, 32, 32, 98)   0
concatenate_1[0][0]
                                                                 dropout_2[0][0]
__________________________________________________________________________________
__________________
batch_normalization_6 (BatchNor (None, 32, 32, 98)   392
concatenate_2[0][0]
__________________________________________________________________________________
__________________
activation_6 (Activation)       (None, 32, 32, 98)   0
batch_normalization_6[0][0]
__________________________________________________________________________________
__________________
conv2d_7 (Conv2D)               (None, 32, 32, 22)   2156
activation_6[0][0]
__________________________________________________________________________________
__________________
batch_normalization_7 (BatchNor (None, 32, 32, 22)   88          conv2d_7[0][0]
__________________________________________________________________________________
__________________
activation_7 (Activation)       (None, 32, 32, 22)   0
batch_normalization_7[0][0]
__________________________________________________________________________________
__________________
conv2d_8 (Conv2D)               (None, 32, 32, 22)   4356
activation_7[0][0]
__________________________________________________________________________________
__________________
dropout_3 (Dropout)             (None, 32, 32, 22)   0           conv2d_8[0][0]
__________________________________________________________________________________
__________________
```

```
concatenate_3 (Concatenate)     (None, 32, 32, 120)  0
concatenate_2[0][0]
                                                                 dropout_3[0][0]
__________________________________________________________________________________
__________________
batch_normalization_8 (BatchNor (None, 32, 32, 120)  480
concatenate_3[0][0]
__________________________________________________________________________________
__________________
activation_8 (Activation)       (None, 32, 32, 120)  0
batch_normalization_8[0][0]
__________________________________________________________________________________
__________________
conv2d_9 (Conv2D)               (None, 32, 32, 22)   2640
activation_8[0][0]
__________________________________________________________________________________
__________________
batch_normalization_9 (BatchNor (None, 32, 32, 22)   88          conv2d_9[0][0]
__________________________________________________________________________________
__________________
activation_9 (Activation)       (None, 32, 32, 22)   0
batch_normalization_9[0][0]
__________________________________________________________________________________
__________________
conv2d_10 (Conv2D)              (None, 32, 32, 22)   4356
activation_9[0][0]
__________________________________________________________________________________
__________________
dropout_4 (Dropout)             (None, 32, 32, 22)   0           conv2d_10[0][0]
__________________________________________________________________________________
__________________
concatenate_4 (Concatenate)     (None, 32, 32, 142)  0
concatenate_3[0][0]
                                                                 dropout_4[0][0]
__________________________________________________________________________________
__________________
batch_normalization_10 (BatchNo (None, 32, 32, 142)  568
concatenate_4[0][0]
__________________________________________________________________________________
__________________
activation_10 (Activation)      (None, 32, 32, 142)  0
batch_normalization_10[0][0]
__________________________________________________________________________________
__________________
conv2d_11 (Conv2D)              (None, 32, 32, 22)   3124
activation_10[0][0]
__________________________________________________________________________________
__________________
```

```
batch_normalization_11 (BatchNo (None, 32, 32, 22)   88          conv2d_11[0][0]
__________________________________________________________________________________________
__________________
activation_11 (Activation)      (None, 32, 32, 22)   0
batch_normalization_11[0][0]
__________________________________________________________________________________________
__________________
conv2d_12 (Conv2D)              (None, 32, 32, 22)   4356
activation_11[0][0]
__________________________________________________________________________________________
__________________
dropout_5 (Dropout)             (None, 32, 32, 22)   0           conv2d_12[0][0]
__________________________________________________________________________________________
__________________
concatenate_5 (Concatenate)     (None, 32, 32, 164)  0
concatenate_4[0][0]
                                                                 dropout_5[0][0]
__________________________________________________________________________________________
__________________
batch_normalization_12 (BatchNo (None, 32, 32, 164)  656
concatenate_5[0][0]
__________________________________________________________________________________________
__________________
activation_12 (Activation)      (None, 32, 32, 164)  0
batch_normalization_12[0][0]
__________________________________________________________________________________________
__________________
conv2d_13 (Conv2D)              (None, 32, 32, 22)   3608
activation_12[0][0]
__________________________________________________________________________________________
__________________
batch_normalization_13 (BatchNo (None, 32, 32, 22)   88          conv2d_13[0][0]
__________________________________________________________________________________________
__________________
activation_13 (Activation)      (None, 32, 32, 22)   0
batch_normalization_13[0][0]
__________________________________________________________________________________________
__________________
conv2d_14 (Conv2D)              (None, 32, 32, 22)   4356
activation_13[0][0]
__________________________________________________________________________________________
__________________
dropout_6 (Dropout)             (None, 32, 32, 22)   0           conv2d_14[0][0]
__________________________________________________________________________________________
__________________
concatenate_6 (Concatenate)     (None, 32, 32, 186)  0
concatenate_5[0][0]
                                                                 dropout_6[0][0]
```

```
__________________________________________________________________________________
__________________
batch_normalization_14 (BatchNo (None, 32, 32, 186)  744
concatenate_6[0][0]
__________________________________________________________________________________
__________________
activation_14 (Activation)      (None, 32, 32, 186)  0
batch_normalization_14[0][0]
__________________________________________________________________________________
__________________
conv2d_15 (Conv2D)              (None, 32, 32, 22)   4092
activation_14[0][0]
__________________________________________________________________________________
__________________
batch_normalization_15 (BatchNo (None, 32, 32, 22)   88          conv2d_15[0][0]
__________________________________________________________________________________
__________________
activation_15 (Activation)      (None, 32, 32, 22)   0
batch_normalization_15[0][0]
__________________________________________________________________________________
__________________
conv2d_16 (Conv2D)              (None, 32, 32, 22)   4356
activation_15[0][0]
__________________________________________________________________________________
__________________
dropout_7 (Dropout)             (None, 32, 32, 22)   0           conv2d_16[0][0]
__________________________________________________________________________________
__________________
concatenate_7 (Concatenate)     (None, 32, 32, 208)  0
concatenate_6[0][0]
                                                                 dropout_7[0][0]
__________________________________________________________________________________
__________________
batch_normalization_16 (BatchNo (None, 32, 32, 208)  832
concatenate_7[0][0]
__________________________________________________________________________________
__________________
activation_16 (Activation)      (None, 32, 32, 208)  0
batch_normalization_16[0][0]
__________________________________________________________________________________
__________________
conv2d_17 (Conv2D)              (None, 32, 32, 22)   4576
activation_16[0][0]
__________________________________________________________________________________
__________________
batch_normalization_17 (BatchNo (None, 32, 32, 22)   88          conv2d_17[0][0]
__________________________________________________________________________________
__________________
```

```
activation_17 (Activation)      (None, 32, 32, 22)   0
batch_normalization_17[0][0]
__________________________________________________________________________________
__________________
conv2d_18 (Conv2D)              (None, 32, 32, 22)   4356
activation_17[0][0]
__________________________________________________________________________________
__________________
dropout_8 (Dropout)             (None, 32, 32, 22)   0           conv2d_18[0][0]
__________________________________________________________________________________
__________________
concatenate_8 (Concatenate)     (None, 32, 32, 230)  0
concatenate_7[0][0]
                                                                 dropout_8[0][0]
__________________________________________________________________________________
__________________
batch_normalization_18 (BatchNo (None, 32, 32, 230)  920
concatenate_8[0][0]
__________________________________________________________________________________
__________________
activation_18 (Activation)      (None, 32, 32, 230)  0
batch_normalization_18[0][0]
__________________________________________________________________________________
__________________
conv2d_19 (Conv2D)              (None, 32, 32, 22)   5060
activation_18[0][0]
__________________________________________________________________________________
__________________
batch_normalization_19 (BatchNo (None, 32, 32, 22)   88          conv2d_19[0][0]
__________________________________________________________________________________
__________________
activation_19 (Activation)      (None, 32, 32, 22)   0
batch_normalization_19[0][0]
__________________________________________________________________________________
__________________
conv2d_20 (Conv2D)              (None, 32, 32, 22)   4356
activation_19[0][0]
__________________________________________________________________________________
__________________
dropout_9 (Dropout)             (None, 32, 32, 22)   0           conv2d_20[0][0]
__________________________________________________________________________________
__________________
concatenate_9 (Concatenate)     (None, 32, 32, 252)  0
concatenate_8[0][0]
                                                                 dropout_9[0][0]
__________________________________________________________________________________
__________________
batch_normalization_20 (BatchNo (None, 32, 32, 252)  1008
```

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concatenate_9[0][0]
__________________________________________________________________________________
__________________
activation_20 (Activation)      (None, 32, 32, 252)  0
batch_normalization_20[0][0]
__________________________________________________________________________________
__________________
conv2d_21 (Conv2D)              (None, 32, 32, 22)   5544
activation_20[0][0]
__________________________________________________________________________________
__________________
batch_normalization_21 (BatchNo (None, 32, 32, 22)   88          conv2d_21[0][0]
__________________________________________________________________________________
__________________
activation_21 (Activation)      (None, 32, 32, 22)   0
batch_normalization_21[0][0]
__________________________________________________________________________________
__________________
conv2d_22 (Conv2D)              (None, 32, 32, 22)   4356
activation_21[0][0]
__________________________________________________________________________________
__________________
dropout_10 (Dropout)            (None, 32, 32, 22)   0           conv2d_22[0][0]
__________________________________________________________________________________
__________________
concatenate_10 (Concatenate)    (None, 32, 32, 274)  0
concatenate_9[0][0]
dropout_10[0][0]
__________________________________________________________________________________
__________________
batch_normalization_22 (BatchNo (None, 32, 32, 274)  1096
concatenate_10[0][0]
__________________________________________________________________________________
__________________
activation_22 (Activation)      (None, 32, 32, 274)  0
batch_normalization_22[0][0]
__________________________________________________________________________________
__________________
conv2d_23 (Conv2D)              (None, 32, 32, 22)   6028
activation_22[0][0]
__________________________________________________________________________________
__________________
batch_normalization_23 (BatchNo (None, 32, 32, 22)   88          conv2d_23[0][0]
__________________________________________________________________________________
__________________
activation_23 (Activation)      (None, 32, 32, 22)   0
batch_normalization_23[0][0]
__________________________________________________________________________________
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__________________
conv2d_24 (Conv2D)              (None, 32, 32, 22)   4356
activation_23[0][0]
__________________________________________________________________________________
__________________
dropout_11 (Dropout)            (None, 32, 32, 22)   0           conv2d_24[0][0]
__________________________________________________________________________________
__________________
concatenate_11 (Concatenate)    (None, 32, 32, 296)  0
concatenate_10[0][0]
dropout_11[0][0]
__________________________________________________________________________________
__________________
batch_normalization_24 (BatchNo (None, 32, 32, 296)  1184
concatenate_11[0][0]
__________________________________________________________________________________
__________________
activation_24 (Activation)      (None, 32, 32, 296)  0
batch_normalization_24[0][0]
__________________________________________________________________________________
__________________
conv2d_25 (Conv2D)              (None, 32, 32, 22)   6512
activation_24[0][0]
__________________________________________________________________________________
__________________
dropout_12 (Dropout)            (None, 32, 32, 22)   0           conv2d_25[0][0]
__________________________________________________________________________________
__________________
average_pooling2d (AveragePooli (None, 16, 16, 22)   0
dropout_12[0][0]
__________________________________________________________________________________
__________________
batch_normalization_25 (BatchNo (None, 16, 16, 22)   88
average_pooling2d[0][0]
__________________________________________________________________________________
__________________
activation_25 (Activation)      (None, 16, 16, 22)   0
batch_normalization_25[0][0]
__________________________________________________________________________________
__________________
conv2d_26 (Conv2D)              (None, 16, 16, 22)   484
activation_25[0][0]
__________________________________________________________________________________
__________________
batch_normalization_26 (BatchNo (None, 16, 16, 22)   88          conv2d_26[0][0]
__________________________________________________________________________________
__________________
activation_26 (Activation)      (None, 16, 16, 22)   0
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batch_normalization_26[0][0]
__________________________________________________________________________________________________
conv2d_27 (Conv2D)              (None, 16, 16, 22)   4356
activation_26[0][0]
__________________________________________________________________________________________________
dropout_13 (Dropout)            (None, 16, 16, 22)   0           conv2d_27[0][0]
__________________________________________________________________________________________________
concatenate_12 (Concatenate)    (None, 16, 16, 44)   0
average_pooling2d[0][0]
dropout_13[0][0]
__________________________________________________________________________________________________
batch_normalization_27 (BatchNo (None, 16, 16, 44)   176
concatenate_12[0][0]
__________________________________________________________________________________________________
activation_27 (Activation)      (None, 16, 16, 44)   0
batch_normalization_27[0][0]
__________________________________________________________________________________________________
conv2d_28 (Conv2D)              (None, 16, 16, 22)   968
activation_27[0][0]
__________________________________________________________________________________________________
batch_normalization_28 (BatchNo (None, 16, 16, 22)   88          conv2d_28[0][0]
__________________________________________________________________________________________________
activation_28 (Activation)      (None, 16, 16, 22)   0
batch_normalization_28[0][0]
__________________________________________________________________________________________________
conv2d_29 (Conv2D)              (None, 16, 16, 22)   4356
activation_28[0][0]
__________________________________________________________________________________________________
dropout_14 (Dropout)            (None, 16, 16, 22)   0           conv2d_29[0][0]
__________________________________________________________________________________________________
concatenate_13 (Concatenate)    (None, 16, 16, 66)   0
concatenate_12[0][0]
dropout_14[0][0]
__________________________________________________________________________________________________
batch_normalization_29 (BatchNo (None, 16, 16, 66)   264
concatenate_13[0][0]
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____________________________________________________________________________
__________________
activation_29 (Activation)      (None, 16, 16, 66)   0
batch_normalization_29[0][0]
____________________________________________________________________________
__________________
conv2d_30 (Conv2D)              (None, 16, 16, 22)   1452
activation_29[0][0]
____________________________________________________________________________
__________________
batch_normalization_30 (BatchNo (None, 16, 16, 22)   88          conv2d_30[0][0]
____________________________________________________________________________
__________________
activation_30 (Activation)      (None, 16, 16, 22)   0
batch_normalization_30[0][0]
____________________________________________________________________________
__________________
conv2d_31 (Conv2D)              (None, 16, 16, 22)   4356
activation_30[0][0]
____________________________________________________________________________
__________________
dropout_15 (Dropout)            (None, 16, 16, 22)   0           conv2d_31[0][0]
____________________________________________________________________________
__________________
concatenate_14 (Concatenate)    (None, 16, 16, 88)   0
concatenate_13[0][0]
dropout_15[0][0]
____________________________________________________________________________
__________________
batch_normalization_31 (BatchNo (None, 16, 16, 88)   352
concatenate_14[0][0]
____________________________________________________________________________
__________________
activation_31 (Activation)      (None, 16, 16, 88)   0
batch_normalization_31[0][0]
____________________________________________________________________________
__________________
conv2d_32 (Conv2D)              (None, 16, 16, 22)   1936
activation_31[0][0]
____________________________________________________________________________
__________________
batch_normalization_32 (BatchNo (None, 16, 16, 22)   88          conv2d_32[0][0]
____________________________________________________________________________
__________________
activation_32 (Activation)      (None, 16, 16, 22)   0
batch_normalization_32[0][0]
____________________________________________________________________________
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conv2d_33 (Conv2D)              (None, 16, 16, 22)   4356
activation_32[0][0]
__________________________________________________________________________________
__________________
dropout_16 (Dropout)            (None, 16, 16, 22)   0           conv2d_33[0][0]
__________________________________________________________________________________
__________________
concatenate_15 (Concatenate)    (None, 16, 16, 110)  0
concatenate_14[0][0]
dropout_16[0][0]
__________________________________________________________________________________
__________________
batch_normalization_33 (BatchNo (None, 16, 16, 110)  440
concatenate_15[0][0]
__________________________________________________________________________________
__________________
activation_33 (Activation)      (None, 16, 16, 110)  0
batch_normalization_33[0][0]
__________________________________________________________________________________
__________________
conv2d_34 (Conv2D)              (None, 16, 16, 22)   2420
activation_33[0][0]
__________________________________________________________________________________
__________________
batch_normalization_34 (BatchNo (None, 16, 16, 22)   88          conv2d_34[0][0]
__________________________________________________________________________________
__________________
activation_34 (Activation)      (None, 16, 16, 22)   0
batch_normalization_34[0][0]
__________________________________________________________________________________
__________________
conv2d_35 (Conv2D)              (None, 16, 16, 22)   4356
activation_34[0][0]
__________________________________________________________________________________
__________________
dropout_17 (Dropout)            (None, 16, 16, 22)   0           conv2d_35[0][0]
__________________________________________________________________________________
__________________
concatenate_16 (Concatenate)    (None, 16, 16, 132)  0
concatenate_15[0][0]
dropout_17[0][0]
__________________________________________________________________________________
__________________
batch_normalization_35 (BatchNo (None, 16, 16, 132)  528
concatenate_16[0][0]
__________________________________________________________________________________
__________________
activation_35 (Activation)      (None, 16, 16, 132)  0
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batch_normalization_35[0][0]
__________________________________________________________________________________________________
conv2d_36 (Conv2D)              (None, 16, 16, 22)   2904
activation_35[0][0]
__________________________________________________________________________________________________
batch_normalization_36 (BatchNo (None, 16, 16, 22)   88          conv2d_36[0][0]
__________________________________________________________________________________________________
activation_36 (Activation)      (None, 16, 16, 22)   0
batch_normalization_36[0][0]
__________________________________________________________________________________________________
conv2d_37 (Conv2D)              (None, 16, 16, 22)   4356
activation_36[0][0]
__________________________________________________________________________________________________
dropout_18 (Dropout)            (None, 16, 16, 22)   0           conv2d_37[0][0]
__________________________________________________________________________________________________
concatenate_17 (Concatenate)    (None, 16, 16, 154)  0
concatenate_16[0][0]
dropout_18[0][0]
__________________________________________________________________________________________________
batch_normalization_37 (BatchNo (None, 16, 16, 154)  616
concatenate_17[0][0]
__________________________________________________________________________________________________
activation_37 (Activation)      (None, 16, 16, 154)  0
batch_normalization_37[0][0]
__________________________________________________________________________________________________
conv2d_38 (Conv2D)              (None, 16, 16, 22)   3388
activation_37[0][0]
__________________________________________________________________________________________________
batch_normalization_38 (BatchNo (None, 16, 16, 22)   88          conv2d_38[0][0]
__________________________________________________________________________________________________
activation_38 (Activation)      (None, 16, 16, 22)   0
batch_normalization_38[0][0]
__________________________________________________________________________________________________
conv2d_39 (Conv2D)              (None, 16, 16, 22)   4356
activation_38[0][0]
__________________________________________________________________________________________________
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dropout_19 (Dropout)            (None, 16, 16, 22)   0           conv2d_39[0][0]
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------------------
concatenate_18 (Concatenate)    (None, 16, 16, 176)  0
concatenate_17[0][0]
dropout_19[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_39 (BatchNo (None, 16, 16, 176)  704
concatenate_18[0][0]
--------------------------------------------------------------------------------
------------------
activation_39 (Activation)      (None, 16, 16, 176)  0
batch_normalization_39[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_40 (Conv2D)              (None, 16, 16, 22)   3872
activation_39[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_40 (BatchNo (None, 16, 16, 22)   88          conv2d_40[0][0]
--------------------------------------------------------------------------------
------------------
activation_40 (Activation)      (None, 16, 16, 22)   0
batch_normalization_40[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_41 (Conv2D)              (None, 16, 16, 22)   4356
activation_40[0][0]
--------------------------------------------------------------------------------
------------------
dropout_20 (Dropout)            (None, 16, 16, 22)   0           conv2d_41[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_19 (Concatenate)    (None, 16, 16, 198)  0
concatenate_18[0][0]
dropout_20[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_41 (BatchNo (None, 16, 16, 198)  792
concatenate_19[0][0]
--------------------------------------------------------------------------------
------------------
activation_41 (Activation)      (None, 16, 16, 198)  0
batch_normalization_41[0][0]
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conv2d_42 (Conv2D)              (None, 16, 16, 22)   4356
activation_41[0][0]
__________________________________________________________________________________
__________________
batch_normalization_42 (BatchNo (None, 16, 16, 22)   88          conv2d_42[0][0]
__________________________________________________________________________________
__________________
activation_42 (Activation)      (None, 16, 16, 22)   0
batch_normalization_42[0][0]
__________________________________________________________________________________
__________________
conv2d_43 (Conv2D)              (None, 16, 16, 22)   4356
activation_42[0][0]
__________________________________________________________________________________
__________________
dropout_21 (Dropout)            (None, 16, 16, 22)   0           conv2d_43[0][0]
__________________________________________________________________________________
__________________
concatenate_20 (Concatenate)    (None, 16, 16, 220)  0
concatenate_19[0][0]
dropout_21[0][0]
__________________________________________________________________________________
__________________
batch_normalization_43 (BatchNo (None, 16, 16, 220)  880
concatenate_20[0][0]
__________________________________________________________________________________
__________________
activation_43 (Activation)      (None, 16, 16, 220)  0
batch_normalization_43[0][0]
__________________________________________________________________________________
__________________
conv2d_44 (Conv2D)              (None, 16, 16, 22)   4840
activation_43[0][0]
__________________________________________________________________________________
__________________
batch_normalization_44 (BatchNo (None, 16, 16, 22)   88          conv2d_44[0][0]
__________________________________________________________________________________
__________________
activation_44 (Activation)      (None, 16, 16, 22)   0
batch_normalization_44[0][0]
__________________________________________________________________________________
__________________
conv2d_45 (Conv2D)              (None, 16, 16, 22)   4356
activation_44[0][0]
__________________________________________________________________________________
__________________
dropout_22 (Dropout)            (None, 16, 16, 22)   0           conv2d_45[0][0]
__________________________________________________________________________________
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__________________
concatenate_21 (Concatenate)    (None, 16, 16, 242)  0
concatenate_20[0][0]
dropout_22[0][0]
__________________________________________________________________________________
__________________
batch_normalization_45 (BatchNo (None, 16, 16, 242)  968
concatenate_21[0][0]
__________________________________________________________________________________
__________________
activation_45 (Activation)      (None, 16, 16, 242)  0
batch_normalization_45[0][0]
__________________________________________________________________________________
__________________
conv2d_46 (Conv2D)              (None, 16, 16, 22)   5324
activation_45[0][0]
__________________________________________________________________________________
__________________
batch_normalization_46 (BatchNo (None, 16, 16, 22)   88          conv2d_46[0][0]
__________________________________________________________________________________
__________________
activation_46 (Activation)      (None, 16, 16, 22)   0
batch_normalization_46[0][0]
__________________________________________________________________________________
__________________
conv2d_47 (Conv2D)              (None, 16, 16, 22)   4356
activation_46[0][0]
__________________________________________________________________________________
__________________
dropout_23 (Dropout)            (None, 16, 16, 22)   0           conv2d_47[0][0]
__________________________________________________________________________________
__________________
concatenate_22 (Concatenate)    (None, 16, 16, 264)  0
concatenate_21[0][0]
dropout_23[0][0]
__________________________________________________________________________________
__________________
batch_normalization_47 (BatchNo (None, 16, 16, 264)  1056
concatenate_22[0][0]
__________________________________________________________________________________
__________________
activation_47 (Activation)      (None, 16, 16, 264)  0
batch_normalization_47[0][0]
__________________________________________________________________________________
__________________
conv2d_48 (Conv2D)              (None, 16, 16, 22)   5808
activation_47[0][0]
__________________________________________________________________________________
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batch_normalization_48 (BatchNo (None, 16, 16, 22)   88          conv2d_48[0][0]
--------------------------------------------------------------------------------
------------------
activation_48 (Activation)      (None, 16, 16, 22)   0
batch_normalization_48[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_49 (Conv2D)              (None, 16, 16, 22)   4356
activation_48[0][0]
--------------------------------------------------------------------------------
------------------
dropout_24 (Dropout)            (None, 16, 16, 22)   0           conv2d_49[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_23 (Concatenate)    (None, 16, 16, 286)  0
concatenate_22[0][0]
dropout_24[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_49 (BatchNo (None, 16, 16, 286)  1144
concatenate_23[0][0]
--------------------------------------------------------------------------------
------------------
activation_49 (Activation)      (None, 16, 16, 286)  0
batch_normalization_49[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_50 (Conv2D)              (None, 16, 16, 22)   6292
activation_49[0][0]
--------------------------------------------------------------------------------
------------------
dropout_25 (Dropout)            (None, 16, 16, 22)   0           conv2d_50[0][0]
--------------------------------------------------------------------------------
------------------
average_pooling2d_1 (AveragePoo (None, 8, 8, 22)     0
dropout_25[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_50 (BatchNo (None, 8, 8, 22)     88
average_pooling2d_1[0][0]
--------------------------------------------------------------------------------
------------------
activation_50 (Activation)      (None, 8, 8, 22)     0
batch_normalization_50[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_51 (Conv2D)              (None, 8, 8, 22)     484
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activation_50[0][0]
__________________________________________________________________________________________________
batch_normalization_51 (BatchNo (None, 8, 8, 22)     88          conv2d_51[0][0]
__________________________________________________________________________________________________
activation_51 (Activation)      (None, 8, 8, 22)     0
batch_normalization_51[0][0]
__________________________________________________________________________________________________
conv2d_52 (Conv2D)              (None, 8, 8, 22)     4356
activation_51[0][0]
__________________________________________________________________________________________________
dropout_26 (Dropout)            (None, 8, 8, 22)     0           conv2d_52[0][0]
__________________________________________________________________________________________________
concatenate_24 (Concatenate)    (None, 8, 8, 44)     0
average_pooling2d_1[0][0]
dropout_26[0][0]
__________________________________________________________________________________________________
batch_normalization_52 (BatchNo (None, 8, 8, 44)     176
concatenate_24[0][0]
__________________________________________________________________________________________________
activation_52 (Activation)      (None, 8, 8, 44)     0
batch_normalization_52[0][0]
__________________________________________________________________________________________________
conv2d_53 (Conv2D)              (None, 8, 8, 22)     968
activation_52[0][0]
__________________________________________________________________________________________________
batch_normalization_53 (BatchNo (None, 8, 8, 22)     88          conv2d_53[0][0]
__________________________________________________________________________________________________
activation_53 (Activation)      (None, 8, 8, 22)     0
batch_normalization_53[0][0]
__________________________________________________________________________________________________
conv2d_54 (Conv2D)              (None, 8, 8, 22)     4356
activation_53[0][0]
__________________________________________________________________________________________________
dropout_27 (Dropout)            (None, 8, 8, 22)     0           conv2d_54[0][0]
__________________________________________________________________________________________________
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concatenate_25 (Concatenate)    (None, 8, 8, 66)     0
concatenate_24[0][0]
dropout_27[0][0]
__________________________________________________________________________________
__________________
batch_normalization_54 (BatchNo (None, 8, 8, 66)     264
concatenate_25[0][0]
__________________________________________________________________________________
__________________
activation_54 (Activation)      (None, 8, 8, 66)     0
batch_normalization_54[0][0]
__________________________________________________________________________________
__________________
conv2d_55 (Conv2D)              (None, 8, 8, 22)     1452
activation_54[0][0]
__________________________________________________________________________________
__________________
batch_normalization_55 (BatchNo (None, 8, 8, 22)     88          conv2d_55[0][0]
__________________________________________________________________________________
__________________
activation_55 (Activation)      (None, 8, 8, 22)     0
batch_normalization_55[0][0]
__________________________________________________________________________________
__________________
conv2d_56 (Conv2D)              (None, 8, 8, 22)     4356
activation_55[0][0]
__________________________________________________________________________________
__________________
dropout_28 (Dropout)            (None, 8, 8, 22)     0           conv2d_56[0][0]
__________________________________________________________________________________
__________________
concatenate_26 (Concatenate)    (None, 8, 8, 88)     0
concatenate_25[0][0]
dropout_28[0][0]
__________________________________________________________________________________
__________________
batch_normalization_56 (BatchNo (None, 8, 8, 88)     352
concatenate_26[0][0]
__________________________________________________________________________________
__________________
activation_56 (Activation)      (None, 8, 8, 88)     0
batch_normalization_56[0][0]
__________________________________________________________________________________
__________________
conv2d_57 (Conv2D)              (None, 8, 8, 22)     1936
activation_56[0][0]
__________________________________________________________________________________
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batch_normalization_57 (BatchNo (None, 8, 8, 22)     88          conv2d_57[0][0]
__________________________________________________________________________________
__________________
activation_57 (Activation)      (None, 8, 8, 22)     0
batch_normalization_57[0][0]
__________________________________________________________________________________
__________________
conv2d_58 (Conv2D)              (None, 8, 8, 22)     4356
activation_57[0][0]
__________________________________________________________________________________
__________________
dropout_29 (Dropout)            (None, 8, 8, 22)     0           conv2d_58[0][0]
__________________________________________________________________________________
__________________
concatenate_27 (Concatenate)    (None, 8, 8, 110)    0
concatenate_26[0][0]
dropout_29[0][0]
__________________________________________________________________________________
__________________
batch_normalization_58 (BatchNo (None, 8, 8, 110)    440
concatenate_27[0][0]
__________________________________________________________________________________
__________________
activation_58 (Activation)      (None, 8, 8, 110)    0
batch_normalization_58[0][0]
__________________________________________________________________________________
__________________
conv2d_59 (Conv2D)              (None, 8, 8, 22)     2420
activation_58[0][0]
__________________________________________________________________________________
__________________
batch_normalization_59 (BatchNo (None, 8, 8, 22)     88          conv2d_59[0][0]
__________________________________________________________________________________
__________________
activation_59 (Activation)      (None, 8, 8, 22)     0
batch_normalization_59[0][0]
__________________________________________________________________________________
__________________
conv2d_60 (Conv2D)              (None, 8, 8, 22)     4356
activation_59[0][0]
__________________________________________________________________________________
__________________
dropout_30 (Dropout)            (None, 8, 8, 22)     0           conv2d_60[0][0]
__________________________________________________________________________________
__________________
concatenate_28 (Concatenate)    (None, 8, 8, 132)    0
concatenate_27[0][0]
dropout_30[0][0]
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__________________________________________________________________________________
__________________
batch_normalization_60 (BatchNo (None, 8, 8, 132)    528
concatenate_28[0][0]
__________________________________________________________________________________
__________________
activation_60 (Activation)      (None, 8, 8, 132)    0
batch_normalization_60[0][0]
__________________________________________________________________________________
__________________
conv2d_61 (Conv2D)              (None, 8, 8, 22)     2904
activation_60[0][0]
__________________________________________________________________________________
__________________
batch_normalization_61 (BatchNo (None, 8, 8, 22)     88          conv2d_61[0][0]
__________________________________________________________________________________
__________________
activation_61 (Activation)      (None, 8, 8, 22)     0
batch_normalization_61[0][0]
__________________________________________________________________________________
__________________
conv2d_62 (Conv2D)              (None, 8, 8, 22)     4356
activation_61[0][0]
__________________________________________________________________________________
__________________
dropout_31 (Dropout)            (None, 8, 8, 22)     0           conv2d_62[0][0]
__________________________________________________________________________________
__________________
concatenate_29 (Concatenate)    (None, 8, 8, 154)    0
concatenate_28[0][0]
dropout_31[0][0]
__________________________________________________________________________________
__________________
batch_normalization_62 (BatchNo (None, 8, 8, 154)    616
concatenate_29[0][0]
__________________________________________________________________________________
__________________
activation_62 (Activation)      (None, 8, 8, 154)    0
batch_normalization_62[0][0]
__________________________________________________________________________________
__________________
conv2d_63 (Conv2D)              (None, 8, 8, 22)     3388
activation_62[0][0]
__________________________________________________________________________________
__________________
batch_normalization_63 (BatchNo (None, 8, 8, 22)     88          conv2d_63[0][0]
__________________________________________________________________________________
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activation_63 (Activation)      (None, 8, 8, 22)     0
batch_normalization_63[0][0]
__________________________________________________________________________________
__________________
conv2d_64 (Conv2D)              (None, 8, 8, 22)     4356
activation_63[0][0]
__________________________________________________________________________________
__________________
dropout_32 (Dropout)            (None, 8, 8, 22)     0           conv2d_64[0][0]
__________________________________________________________________________________
__________________
concatenate_30 (Concatenate)    (None, 8, 8, 176)    0
concatenate_29[0][0]
dropout_32[0][0]
__________________________________________________________________________________
__________________
batch_normalization_64 (BatchNo (None, 8, 8, 176)    704
concatenate_30[0][0]
__________________________________________________________________________________
__________________
activation_64 (Activation)      (None, 8, 8, 176)    0
batch_normalization_64[0][0]
__________________________________________________________________________________
__________________
conv2d_65 (Conv2D)              (None, 8, 8, 22)     3872
activation_64[0][0]
__________________________________________________________________________________
__________________
batch_normalization_65 (BatchNo (None, 8, 8, 22)     88          conv2d_65[0][0]
__________________________________________________________________________________
__________________
activation_65 (Activation)      (None, 8, 8, 22)     0
batch_normalization_65[0][0]
__________________________________________________________________________________
__________________
conv2d_66 (Conv2D)              (None, 8, 8, 22)     4356
activation_65[0][0]
__________________________________________________________________________________
__________________
dropout_33 (Dropout)            (None, 8, 8, 22)     0           conv2d_66[0][0]
__________________________________________________________________________________
__________________
concatenate_31 (Concatenate)    (None, 8, 8, 198)    0
concatenate_30[0][0]
dropout_33[0][0]
__________________________________________________________________________________
__________________
batch_normalization_66 (BatchNo (None, 8, 8, 198)    792
```

```
concatenate_31[0][0]
__________________________________________________________________________________
__________________
activation_66 (Activation)      (None, 8, 8, 198)    0
batch_normalization_66[0][0]
__________________________________________________________________________________
__________________
conv2d_67 (Conv2D)              (None, 8, 8, 22)     4356
activation_66[0][0]
__________________________________________________________________________________
__________________
batch_normalization_67 (BatchNo (None, 8, 8, 22)     88          conv2d_67[0][0]
__________________________________________________________________________________
__________________
activation_67 (Activation)      (None, 8, 8, 22)     0
batch_normalization_67[0][0]
__________________________________________________________________________________
__________________
conv2d_68 (Conv2D)              (None, 8, 8, 22)     4356
activation_67[0][0]
__________________________________________________________________________________
__________________
dropout_34 (Dropout)            (None, 8, 8, 22)     0           conv2d_68[0][0]
__________________________________________________________________________________
__________________
concatenate_32 (Concatenate)    (None, 8, 8, 220)    0
concatenate_31[0][0]
dropout_34[0][0]
__________________________________________________________________________________
__________________
batch_normalization_68 (BatchNo (None, 8, 8, 220)    880
concatenate_32[0][0]
__________________________________________________________________________________
__________________
activation_68 (Activation)      (None, 8, 8, 220)    0
batch_normalization_68[0][0]
__________________________________________________________________________________
__________________
conv2d_69 (Conv2D)              (None, 8, 8, 22)     4840
activation_68[0][0]
__________________________________________________________________________________
__________________
batch_normalization_69 (BatchNo (None, 8, 8, 22)     88          conv2d_69[0][0]
__________________________________________________________________________________
__________________
activation_69 (Activation)      (None, 8, 8, 22)     0
batch_normalization_69[0][0]
__________________________________________________________________________________
```

```
__________________
conv2d_70 (Conv2D)              (None, 8, 8, 22)     4356
activation_69[0][0]
__________________________________________________________________________________
__________________
dropout_35 (Dropout)            (None, 8, 8, 22)     0           conv2d_70[0][0]
__________________________________________________________________________________
__________________
concatenate_33 (Concatenate)    (None, 8, 8, 242)    0
concatenate_32[0][0]
dropout_35[0][0]
__________________________________________________________________________________
__________________
batch_normalization_70 (BatchNo (None, 8, 8, 242)    968
concatenate_33[0][0]
__________________________________________________________________________________
__________________
activation_70 (Activation)      (None, 8, 8, 242)    0
batch_normalization_70[0][0]
__________________________________________________________________________________
__________________
conv2d_71 (Conv2D)              (None, 8, 8, 22)     5324
activation_70[0][0]
__________________________________________________________________________________
__________________
batch_normalization_71 (BatchNo (None, 8, 8, 22)     88          conv2d_71[0][0]
__________________________________________________________________________________
__________________
activation_71 (Activation)      (None, 8, 8, 22)     0
batch_normalization_71[0][0]
__________________________________________________________________________________
__________________
conv2d_72 (Conv2D)              (None, 8, 8, 22)     4356
activation_71[0][0]
__________________________________________________________________________________
__________________
dropout_36 (Dropout)            (None, 8, 8, 22)     0           conv2d_72[0][0]
__________________________________________________________________________________
__________________
concatenate_34 (Concatenate)    (None, 8, 8, 264)    0
concatenate_33[0][0]
dropout_36[0][0]
__________________________________________________________________________________
__________________
batch_normalization_72 (BatchNo (None, 8, 8, 264)    1056
concatenate_34[0][0]
__________________________________________________________________________________
__________________
```

```
activation_72 (Activation)      (None, 8, 8, 264)    0
batch_normalization_72[0][0]
__________________________________________________________________________________
__________________
conv2d_73 (Conv2D)              (None, 8, 8, 22)     5808
activation_72[0][0]
__________________________________________________________________________________
__________________
batch_normalization_73 (BatchNo (None, 8, 8, 22)     88          conv2d_73[0][0]
__________________________________________________________________________________
__________________
activation_73 (Activation)      (None, 8, 8, 22)     0
batch_normalization_73[0][0]
__________________________________________________________________________________
__________________
conv2d_74 (Conv2D)              (None, 8, 8, 22)     4356
activation_73[0][0]
__________________________________________________________________________________
__________________
dropout_37 (Dropout)            (None, 8, 8, 22)     0           conv2d_74[0][0]
__________________________________________________________________________________
__________________
concatenate_35 (Concatenate)    (None, 8, 8, 286)    0
concatenate_34[0][0]
dropout_37[0][0]
__________________________________________________________________________________
__________________
batch_normalization_74 (BatchNo (None, 8, 8, 286)    1144
concatenate_35[0][0]
__________________________________________________________________________________
__________________
activation_74 (Activation)      (None, 8, 8, 286)    0
batch_normalization_74[0][0]
__________________________________________________________________________________
__________________
conv2d_75 (Conv2D)              (None, 8, 8, 22)     6292
activation_74[0][0]
__________________________________________________________________________________
__________________
dropout_38 (Dropout)            (None, 8, 8, 22)     0           conv2d_75[0][0]
__________________________________________________________________________________
__________________
average_pooling2d_2 (AveragePoo (None, 4, 4, 22)     0
dropout_38[0][0]
__________________________________________________________________________________
__________________
batch_normalization_75 (BatchNo (None, 4, 4, 22)     88
average_pooling2d_2[0][0]
```

```
__________________________________________________________________________________
__________________
activation_75 (Activation)      (None, 4, 4, 22)     0
batch_normalization_75[0][0]
__________________________________________________________________________________
__________________
conv2d_76 (Conv2D)              (None, 4, 4, 22)     484
activation_75[0][0]
__________________________________________________________________________________
__________________
batch_normalization_76 (BatchNo (None, 4, 4, 22)     88          conv2d_76[0][0]
__________________________________________________________________________________
__________________
activation_76 (Activation)      (None, 4, 4, 22)     0
batch_normalization_76[0][0]
__________________________________________________________________________________
__________________
conv2d_77 (Conv2D)              (None, 4, 4, 22)     4356
activation_76[0][0]
__________________________________________________________________________________
__________________
dropout_39 (Dropout)            (None, 4, 4, 22)     0           conv2d_77[0][0]
__________________________________________________________________________________
__________________
concatenate_36 (Concatenate)    (None, 4, 4, 44)     0
average_pooling2d_2[0][0]
dropout_39[0][0]
__________________________________________________________________________________
__________________
batch_normalization_77 (BatchNo (None, 4, 4, 44)     176
concatenate_36[0][0]
__________________________________________________________________________________
__________________
activation_77 (Activation)      (None, 4, 4, 44)     0
batch_normalization_77[0][0]
__________________________________________________________________________________
__________________
conv2d_78 (Conv2D)              (None, 4, 4, 22)     968
activation_77[0][0]
__________________________________________________________________________________
__________________
batch_normalization_78 (BatchNo (None, 4, 4, 22)     88          conv2d_78[0][0]
__________________________________________________________________________________
__________________
activation_78 (Activation)      (None, 4, 4, 22)     0
batch_normalization_78[0][0]
__________________________________________________________________________________
__________________
```

```
conv2d_79 (Conv2D)              (None, 4, 4, 22)     4356
activation_78[0][0]
--------------------------------------------------------------------------------
------------------
dropout_40 (Dropout)            (None, 4, 4, 22)     0           conv2d_79[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_37 (Concatenate)    (None, 4, 4, 66)     0
concatenate_36[0][0]
dropout_40[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_79 (BatchNo (None, 4, 4, 66)     264
concatenate_37[0][0]
--------------------------------------------------------------------------------
------------------
activation_79 (Activation)      (None, 4, 4, 66)     0
batch_normalization_79[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_80 (Conv2D)              (None, 4, 4, 22)     1452
activation_79[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_80 (BatchNo (None, 4, 4, 22)     88          conv2d_80[0][0]
--------------------------------------------------------------------------------
------------------
activation_80 (Activation)      (None, 4, 4, 22)     0
batch_normalization_80[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_81 (Conv2D)              (None, 4, 4, 22)     4356
activation_80[0][0]
--------------------------------------------------------------------------------
------------------
dropout_41 (Dropout)            (None, 4, 4, 22)     0           conv2d_81[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_38 (Concatenate)    (None, 4, 4, 88)     0
concatenate_37[0][0]
dropout_41[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_81 (BatchNo (None, 4, 4, 88)     352
concatenate_38[0][0]
--------------------------------------------------------------------------------
------------------
activation_81 (Activation)      (None, 4, 4, 88)     0
```

```
batch_normalization_81[0][0]
__________________________________________________________________________________________________
conv2d_82 (Conv2D)              (None, 4, 4, 22)     1936
activation_81[0][0]
__________________________________________________________________________________________________
batch_normalization_82 (BatchNo (None, 4, 4, 22)     88          conv2d_82[0][0]
__________________________________________________________________________________________________
activation_82 (Activation)      (None, 4, 4, 22)     0
batch_normalization_82[0][0]
__________________________________________________________________________________________________
conv2d_83 (Conv2D)              (None, 4, 4, 22)     4356
activation_82[0][0]
__________________________________________________________________________________________________
dropout_42 (Dropout)            (None, 4, 4, 22)     0           conv2d_83[0][0]
__________________________________________________________________________________________________
concatenate_39 (Concatenate)    (None, 4, 4, 110)    0
concatenate_38[0][0]
dropout_42[0][0]
__________________________________________________________________________________________________
batch_normalization_83 (BatchNo (None, 4, 4, 110)    440
concatenate_39[0][0]
__________________________________________________________________________________________________
activation_83 (Activation)      (None, 4, 4, 110)    0
batch_normalization_83[0][0]
__________________________________________________________________________________________________
conv2d_84 (Conv2D)              (None, 4, 4, 22)     2420
activation_83[0][0]
__________________________________________________________________________________________________
batch_normalization_84 (BatchNo (None, 4, 4, 22)     88          conv2d_84[0][0]
__________________________________________________________________________________________________
activation_84 (Activation)      (None, 4, 4, 22)     0
batch_normalization_84[0][0]
__________________________________________________________________________________________________
conv2d_85 (Conv2D)              (None, 4, 4, 22)     4356
activation_84[0][0]
__________________________________________________________________________________________________
```

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__________________
dropout_43 (Dropout)            (None, 4, 4, 22)     0           conv2d_85[0][0]
__________________________________________________________________________________
__________________
concatenate_40 (Concatenate)    (None, 4, 4, 132)    0
concatenate_39[0][0]
dropout_43[0][0]
__________________________________________________________________________________
__________________
batch_normalization_85 (BatchNo (None, 4, 4, 132)    528
concatenate_40[0][0]
__________________________________________________________________________________
__________________
activation_85 (Activation)      (None, 4, 4, 132)    0
batch_normalization_85[0][0]
__________________________________________________________________________________
__________________
conv2d_86 (Conv2D)              (None, 4, 4, 22)     2904
activation_85[0][0]
__________________________________________________________________________________
__________________
batch_normalization_86 (BatchNo (None, 4, 4, 22)     88          conv2d_86[0][0]
__________________________________________________________________________________
__________________
activation_86 (Activation)      (None, 4, 4, 22)     0
batch_normalization_86[0][0]
__________________________________________________________________________________
__________________
conv2d_87 (Conv2D)              (None, 4, 4, 22)     4356
activation_86[0][0]
__________________________________________________________________________________
__________________
dropout_44 (Dropout)            (None, 4, 4, 22)     0           conv2d_87[0][0]
__________________________________________________________________________________
__________________
concatenate_41 (Concatenate)    (None, 4, 4, 154)    0
concatenate_40[0][0]
dropout_44[0][0]
__________________________________________________________________________________
__________________
batch_normalization_87 (BatchNo (None, 4, 4, 154)    616
concatenate_41[0][0]
__________________________________________________________________________________
__________________
activation_87 (Activation)      (None, 4, 4, 154)    0
batch_normalization_87[0][0]
__________________________________________________________________________________
__________________
```

```
conv2d_88 (Conv2D)              (None, 4, 4, 22)     3388
activation_87[0][0]
__________________________________________________________________________________
__________________
batch_normalization_88 (BatchNo (None, 4, 4, 22)     88          conv2d_88[0][0]
__________________________________________________________________________________
__________________
activation_88 (Activation)      (None, 4, 4, 22)     0
batch_normalization_88[0][0]
__________________________________________________________________________________
__________________
conv2d_89 (Conv2D)              (None, 4, 4, 22)     4356
activation_88[0][0]
__________________________________________________________________________________
__________________
dropout_45 (Dropout)            (None, 4, 4, 22)     0           conv2d_89[0][0]
__________________________________________________________________________________
__________________
concatenate_42 (Concatenate)    (None, 4, 4, 176)    0
concatenate_41[0][0]
dropout_45[0][0]
__________________________________________________________________________________
__________________
batch_normalization_89 (BatchNo (None, 4, 4, 176)    704
concatenate_42[0][0]
__________________________________________________________________________________
__________________
activation_89 (Activation)      (None, 4, 4, 176)    0
batch_normalization_89[0][0]
__________________________________________________________________________________
__________________
conv2d_90 (Conv2D)              (None, 4, 4, 22)     3872
activation_89[0][0]
__________________________________________________________________________________
__________________
batch_normalization_90 (BatchNo (None, 4, 4, 22)     88          conv2d_90[0][0]
__________________________________________________________________________________
__________________
activation_90 (Activation)      (None, 4, 4, 22)     0
batch_normalization_90[0][0]
__________________________________________________________________________________
__________________
conv2d_91 (Conv2D)              (None, 4, 4, 22)     4356
activation_90[0][0]
__________________________________________________________________________________
__________________
dropout_46 (Dropout)            (None, 4, 4, 22)     0           conv2d_91[0][0]
__________________________________________________________________________________
```

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__________________
concatenate_43 (Concatenate)    (None, 4, 4, 198)    0
concatenate_42[0][0]
dropout_46[0][0]
__________________________________________________________________________________
__________________
batch_normalization_91 (BatchNo (None, 4, 4, 198)    792
concatenate_43[0][0]
__________________________________________________________________________________
__________________
activation_91 (Activation)      (None, 4, 4, 198)    0
batch_normalization_91[0][0]
__________________________________________________________________________________
__________________
conv2d_92 (Conv2D)              (None, 4, 4, 22)     4356
activation_91[0][0]
__________________________________________________________________________________
__________________
batch_normalization_92 (BatchNo (None, 4, 4, 22)     88          conv2d_92[0][0]
__________________________________________________________________________________
__________________
activation_92 (Activation)      (None, 4, 4, 22)     0
batch_normalization_92[0][0]
__________________________________________________________________________________
__________________
conv2d_93 (Conv2D)              (None, 4, 4, 22)     4356
activation_92[0][0]
__________________________________________________________________________________
__________________
dropout_47 (Dropout)            (None, 4, 4, 22)     0           conv2d_93[0][0]
__________________________________________________________________________________
__________________
concatenate_44 (Concatenate)    (None, 4, 4, 220)    0
concatenate_43[0][0]
dropout_47[0][0]
__________________________________________________________________________________
__________________
batch_normalization_93 (BatchNo (None, 4, 4, 220)    880
concatenate_44[0][0]
__________________________________________________________________________________
__________________
activation_93 (Activation)      (None, 4, 4, 220)    0
batch_normalization_93[0][0]
__________________________________________________________________________________
__________________
conv2d_94 (Conv2D)              (None, 4, 4, 22)     4840
activation_93[0][0]
__________________________________________________________________________________
```

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------------------
batch_normalization_94 (BatchNo (None, 4, 4, 22)     88          conv2d_94[0][0]
__________________________________________________________________________________
------------------
activation_94 (Activation)      (None, 4, 4, 22)     0
batch_normalization_94[0][0]
__________________________________________________________________________________
------------------
conv2d_95 (Conv2D)              (None, 4, 4, 22)     4356
activation_94[0][0]
__________________________________________________________________________________
------------------
dropout_48 (Dropout)            (None, 4, 4, 22)     0           conv2d_95[0][0]
__________________________________________________________________________________
------------------
concatenate_45 (Concatenate)    (None, 4, 4, 242)    0
concatenate_44[0][0]
dropout_48[0][0]
__________________________________________________________________________________
------------------
batch_normalization_95 (BatchNo (None, 4, 4, 242)    968
concatenate_45[0][0]
__________________________________________________________________________________
------------------
activation_95 (Activation)      (None, 4, 4, 242)    0
batch_normalization_95[0][0]
__________________________________________________________________________________
------------------
conv2d_96 (Conv2D)              (None, 4, 4, 22)     5324
activation_95[0][0]
__________________________________________________________________________________
------------------
batch_normalization_96 (BatchNo (None, 4, 4, 22)     88          conv2d_96[0][0]
__________________________________________________________________________________
------------------
activation_96 (Activation)      (None, 4, 4, 22)     0
batch_normalization_96[0][0]
__________________________________________________________________________________
------------------
conv2d_97 (Conv2D)              (None, 4, 4, 22)     4356
activation_96[0][0]
__________________________________________________________________________________
------------------
dropout_49 (Dropout)            (None, 4, 4, 22)     0           conv2d_97[0][0]
__________________________________________________________________________________
------------------
concatenate_46 (Concatenate)    (None, 4, 4, 264)    0
concatenate_45[0][0]
```

```
dropout_49[0][0]
__________________________________________________________________________________
__________________
batch_normalization_97 (BatchNo (None, 4, 4, 264)    1056
concatenate_46[0][0]
__________________________________________________________________________________
__________________
activation_97 (Activation)      (None, 4, 4, 264)    0
batch_normalization_97[0][0]
__________________________________________________________________________________
__________________
conv2d_98 (Conv2D)              (None, 4, 4, 22)     5808
activation_97[0][0]
__________________________________________________________________________________
__________________
batch_normalization_98 (BatchNo (None, 4, 4, 22)     88          conv2d_98[0][0]
__________________________________________________________________________________
__________________
activation_98 (Activation)      (None, 4, 4, 22)     0
batch_normalization_98[0][0]
__________________________________________________________________________________
__________________
conv2d_99 (Conv2D)              (None, 4, 4, 22)     4356
activation_98[0][0]
__________________________________________________________________________________
__________________
dropout_50 (Dropout)            (None, 4, 4, 22)     0           conv2d_99[0][0]
__________________________________________________________________________________
__________________
concatenate_47 (Concatenate)    (None, 4, 4, 286)    0
concatenate_46[0][0]
dropout_50[0][0]
__________________________________________________________________________________
__________________
batch_normalization_99 (BatchNo (None, 4, 4, 286)    1144
concatenate_47[0][0]
__________________________________________________________________________________
__________________
activation_99 (Activation)      (None, 4, 4, 286)    0
batch_normalization_99[0][0]
__________________________________________________________________________________
__________________
average_pooling2d_3 (AveragePoo (None, 2, 2, 286)    0
activation_99[0][0]
__________________________________________________________________________________
__________________
flatten (Flatten)               (None, 1144)         0
average_pooling2d_3[0][0]
```

```
--------------------------------------------------------------------------------
------------------
dense (Dense)                   (None, 10)           11450       flatten[0][0]
================================================================================
==================
Total params: 430,922
Trainable params: 412,534
Non-trainable params: 18,388
--------------------------------------------------------------------------------
------------------
```

[ ]:
```
print(len(model4.layers))
```

```
406
```

[ ]:
```
model4.
 ↪compile(optimizer='adam',loss='categorical_crossentropy',metrics=['accuracy'])

model4.fit(aug.
 ↪flow(X_train,y_train,batch_size=batch_size),epochs=nb_epoch,batch_size=batch_size,verbose=1
          steps_per_epoch=(len(X_train)//batch_size),
          ␣
 ↪callbacks=[reduce_lr,lr_scheduler,csv_logger,early_stop,model_checkpoint],
          validation_data=(X_test,y_test))
```

```
Epoch 1/100
781/781 [==============================] - 156s 147ms/step - loss: 1.8745 -
accuracy: 0.3166 - val_loss: 1.5755 - val_accuracy: 0.4120

Epoch 00001: val_accuracy improved from -inf to 0.41200, saving model to
model4_weights.best.hdf5
Epoch 2/100
781/781 [==============================] - 113s 144ms/step - loss: 1.5134 -
accuracy: 0.4476 - val_loss: 2.1495 - val_accuracy: 0.3897

Epoch 00002: val_accuracy did not improve from 0.41200
Epoch 3/100
781/781 [==============================] - 113s 145ms/step - loss: 1.2878 -
accuracy: 0.5322 - val_loss: 1.3345 - val_accuracy: 0.5544

Epoch 00003: val_accuracy improved from 0.41200 to 0.55440, saving model to
model4_weights.best.hdf5
Epoch 4/100
781/781 [==============================] - 113s 144ms/step - loss: 1.1293 -
accuracy: 0.5937 - val_loss: 1.5858 - val_accuracy: 0.5304

Epoch 00004: val_accuracy did not improve from 0.55440
Epoch 5/100
```

```
781/781 [==============================] - 112s 144ms/step - loss: 1.0299 -
accuracy: 0.6319 - val_loss: 1.9975 - val_accuracy: 0.5153

Epoch 00005: val_accuracy did not improve from 0.55440
Epoch 6/100
781/781 [==============================] - 111s 142ms/step - loss: 0.9488 -
accuracy: 0.6613 - val_loss: 1.9263 - val_accuracy: 0.5524

Epoch 00006: val_accuracy did not improve from 0.55440
Epoch 7/100
781/781 [==============================] - 113s 145ms/step - loss: 0.8844 -
accuracy: 0.6872 - val_loss: 1.7518 - val_accuracy: 0.5706

Epoch 00007: val_accuracy improved from 0.55440 to 0.57060, saving model to
model4_weights.best.hdf5
Epoch 8/100
781/781 [==============================] - 112s 144ms/step - loss: 0.8365 -
accuracy: 0.7077 - val_loss: 1.0898 - val_accuracy: 0.6690

Epoch 00008: val_accuracy improved from 0.57060 to 0.66900, saving model to
model4_weights.best.hdf5
Epoch 9/100
781/781 [==============================] - 112s 143ms/step - loss: 0.7971 -
accuracy: 0.7210 - val_loss: 1.0606 - val_accuracy: 0.6947

Epoch 00009: val_accuracy improved from 0.66900 to 0.69470, saving model to
model4_weights.best.hdf5
Epoch 10/100
781/781 [==============================] - 112s 143ms/step - loss: 0.7677 -
accuracy: 0.7309 - val_loss: 1.2691 - val_accuracy: 0.6506

Epoch 00010: val_accuracy did not improve from 0.69470
Epoch 11/100
781/781 [==============================] - 111s 143ms/step - loss: 0.7344 -
accuracy: 0.7426 - val_loss: 1.2606 - val_accuracy: 0.6762

Epoch 00011: val_accuracy did not improve from 0.69470
Epoch 12/100
781/781 [==============================] - 111s 142ms/step - loss: 0.6964 -
accuracy: 0.7563 - val_loss: 1.0189 - val_accuracy: 0.7016

Epoch 00012: val_accuracy improved from 0.69470 to 0.70160, saving model to
model4_weights.best.hdf5
Epoch 13/100
781/781 [==============================] - 111s 141ms/step - loss: 0.6829 -
accuracy: 0.7622 - val_loss: 1.1461 - val_accuracy: 0.6758

Epoch 00013: val_accuracy did not improve from 0.70160
```

```
Epoch 14/100
781/781 [==============================] - 110s 141ms/step - loss: 0.6550 -
accuracy: 0.7730 - val_loss: 0.6706 - val_accuracy: 0.7818

Epoch 00014: val_accuracy improved from 0.70160 to 0.78180, saving model to
model4_weights.best.hdf5
Epoch 15/100
781/781 [==============================] - 111s 143ms/step - loss: 0.6381 -
accuracy: 0.7790 - val_loss: 0.8606 - val_accuracy: 0.7516

Epoch 00015: val_accuracy did not improve from 0.78180
Epoch 16/100
781/781 [==============================] - 110s 141ms/step - loss: 0.6196 -
accuracy: 0.7846 - val_loss: 0.7987 - val_accuracy: 0.7640

Epoch 00016: val_accuracy did not improve from 0.78180
Epoch 17/100
781/781 [==============================] - 111s 142ms/step - loss: 0.5988 -
accuracy: 0.7919 - val_loss: 1.0603 - val_accuracy: 0.7108

Epoch 00017: val_accuracy did not improve from 0.78180
Epoch 18/100
781/781 [==============================] - 110s 141ms/step - loss: 0.5874 -
accuracy: 0.7963 - val_loss: 0.7823 - val_accuracy: 0.7798

Epoch 00018: val_accuracy did not improve from 0.78180
Epoch 19/100
781/781 [==============================] - 110s 141ms/step - loss: 0.5753 -
accuracy: 0.8027 - val_loss: 1.0639 - val_accuracy: 0.7091

Epoch 00019: val_accuracy did not improve from 0.78180
Epoch 20/100
781/781 [==============================] - 111s 142ms/step - loss: 0.5601 -
accuracy: 0.8059 - val_loss: 0.8634 - val_accuracy: 0.7545

Epoch 00020: val_accuracy did not improve from 0.78180
Epoch 21/100
781/781 [==============================] - 110s 141ms/step - loss: 0.5575 -
accuracy: 0.8075 - val_loss: 0.5594 - val_accuracy: 0.8232

Epoch 00021: val_accuracy improved from 0.78180 to 0.82320, saving model to
model4_weights.best.hdf5
Epoch 22/100
781/781 [==============================] - 110s 141ms/step - loss: 0.5381 -
accuracy: 0.8136 - val_loss: 1.3817 - val_accuracy: 0.6963

Epoch 00022: val_accuracy did not improve from 0.82320
Epoch 23/100
```

```
781/781 [==============================] - 111s 143ms/step - loss: 0.5261 -
accuracy: 0.8193 - val_loss: 0.7018 - val_accuracy: 0.7932

Epoch 00023: val_accuracy did not improve from 0.82320
Epoch 24/100
781/781 [==============================] - 111s 142ms/step - loss: 0.5167 -
accuracy: 0.8212 - val_loss: 0.5503 - val_accuracy: 0.8296

Epoch 00024: val_accuracy improved from 0.82320 to 0.82960, saving model to
model4_weights.best.hdf5
Epoch 25/100
781/781 [==============================] - 111s 143ms/step - loss: 0.5086 -
accuracy: 0.8253 - val_loss: 0.6031 - val_accuracy: 0.8230

Epoch 00025: val_accuracy did not improve from 0.82960
Epoch 26/100
781/781 [==============================] - 111s 142ms/step - loss: 0.4321 -
accuracy: 0.8503 - val_loss: 0.5011 - val_accuracy: 0.8493

Epoch 00026: val_accuracy improved from 0.82960 to 0.84930, saving model to
model4_weights.best.hdf5
Epoch 27/100
781/781 [==============================] - 111s 142ms/step - loss: 0.4076 -
accuracy: 0.8589 - val_loss: 0.5119 - val_accuracy: 0.8483

Epoch 00027: val_accuracy did not improve from 0.84930
Epoch 28/100
781/781 [==============================] - 111s 142ms/step - loss: 0.4057 -
accuracy: 0.8594 - val_loss: 0.5179 - val_accuracy: 0.8472

Epoch 00028: val_accuracy did not improve from 0.84930
Epoch 29/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3879 -
accuracy: 0.8648 - val_loss: 0.4711 - val_accuracy: 0.8602

Epoch 00029: val_accuracy improved from 0.84930 to 0.86020, saving model to
model4_weights.best.hdf5
Epoch 30/100
781/781 [==============================] - 111s 142ms/step - loss: 0.3886 -
accuracy: 0.8649 - val_loss: 0.5071 - val_accuracy: 0.8506

Epoch 00030: val_accuracy did not improve from 0.86020
Epoch 31/100
781/781 [==============================] - 112s 144ms/step - loss: 0.3812 -
accuracy: 0.8668 - val_loss: 0.4773 - val_accuracy: 0.8555

Epoch 00031: val_accuracy did not improve from 0.86020
Epoch 32/100
```

```
781/781 [==============================] - 112s 143ms/step - loss: 0.3778 -
accuracy: 0.8697 - val_loss: 0.4644 - val_accuracy: 0.8615

Epoch 00032: val_accuracy improved from 0.86020 to 0.86150, saving model to
model4_weights.best.hdf5
Epoch 33/100
781/781 [==============================] - 113s 144ms/step - loss: 0.3708 -
accuracy: 0.8713 - val_loss: 0.4852 - val_accuracy: 0.8567

Epoch 00033: val_accuracy did not improve from 0.86150
Epoch 34/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3701 -
accuracy: 0.8716 - val_loss: 0.4682 - val_accuracy: 0.8628

Epoch 00034: val_accuracy improved from 0.86150 to 0.86280, saving model to
model4_weights.best.hdf5
Epoch 35/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3693 -
accuracy: 0.8707 - val_loss: 0.4320 - val_accuracy: 0.8683

Epoch 00035: val_accuracy improved from 0.86280 to 0.86830, saving model to
model4_weights.best.hdf5
Epoch 36/100
781/781 [==============================] - 113s 144ms/step - loss: 0.3677 -
accuracy: 0.8723 - val_loss: 0.4543 - val_accuracy: 0.8612

Epoch 00036: val_accuracy did not improve from 0.86830
Epoch 37/100
781/781 [==============================] - 111s 142ms/step - loss: 0.3629 -
accuracy: 0.8740 - val_loss: 0.4707 - val_accuracy: 0.8607

Epoch 00037: val_accuracy did not improve from 0.86830
Epoch 38/100
781/781 [==============================] - 111s 142ms/step - loss: 0.3639 -
accuracy: 0.8720 - val_loss: 0.4179 - val_accuracy: 0.8723

Epoch 00038: val_accuracy improved from 0.86830 to 0.87230, saving model to
model4_weights.best.hdf5
Epoch 39/100
781/781 [==============================] - 111s 142ms/step - loss: 0.3587 -
accuracy: 0.8753 - val_loss: 0.4980 - val_accuracy: 0.8545

Epoch 00039: val_accuracy did not improve from 0.87230
Epoch 40/100
781/781 [==============================] - 111s 142ms/step - loss: 0.3590 -
accuracy: 0.8754 - val_loss: 0.4487 - val_accuracy: 0.8654

Epoch 00040: val_accuracy did not improve from 0.87230
```

```
Epoch 41/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3584 -
accuracy: 0.8753 - val_loss: 0.4502 - val_accuracy: 0.8675

Epoch 00041: val_accuracy did not improve from 0.87230
Epoch 42/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3542 -
accuracy: 0.8765 - val_loss: 0.4410 - val_accuracy: 0.8695

Epoch 00042: val_accuracy did not improve from 0.87230
Epoch 43/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3493 -
accuracy: 0.8794 - val_loss: 0.4599 - val_accuracy: 0.8645

Epoch 00043: val_accuracy did not improve from 0.87230
Epoch 44/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3514 -
accuracy: 0.8775 - val_loss: 0.4182 - val_accuracy: 0.8739

Epoch 00044: val_accuracy improved from 0.87230 to 0.87390, saving model to
model4_weights.best.hdf5
Epoch 45/100
781/781 [==============================] - 111s 142ms/step - loss: 0.3435 -
accuracy: 0.8812 - val_loss: 0.4750 - val_accuracy: 0.8621

Epoch 00045: val_accuracy did not improve from 0.87390
Epoch 46/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3432 -
accuracy: 0.8806 - val_loss: 0.4735 - val_accuracy: 0.8647

Epoch 00046: val_accuracy did not improve from 0.87390
Epoch 47/100
781/781 [==============================] - 112s 144ms/step - loss: 0.3459 -
accuracy: 0.8795 - val_loss: 0.4101 - val_accuracy: 0.8783

Epoch 00047: val_accuracy improved from 0.87390 to 0.87830, saving model to
model4_weights.best.hdf5
Epoch 48/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3429 -
accuracy: 0.8806 - val_loss: 0.4195 - val_accuracy: 0.8758

Epoch 00048: val_accuracy did not improve from 0.87830
Epoch 49/100
781/781 [==============================] - 111s 143ms/step - loss: 0.3411 -
accuracy: 0.8811 - val_loss: 0.4149 - val_accuracy: 0.8765

Epoch 00049: val_accuracy did not improve from 0.87830
Epoch 50/100
```

```
781/781 [==============================] - 111s 143ms/step - loss: 0.3400 -
accuracy: 0.8812 - val_loss: 0.4378 - val_accuracy: 0.8727

Epoch 00050: val_accuracy did not improve from 0.87830
Epoch 51/100
781/781 [==============================] - 112s 144ms/step - loss: 0.3305 -
accuracy: 0.8839 - val_loss: 0.4342 - val_accuracy: 0.8747

Epoch 00051: val_accuracy did not improve from 0.87830
Epoch 52/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3309 -
accuracy: 0.8839 - val_loss: 0.4376 - val_accuracy: 0.8740

Epoch 00052: val_accuracy did not improve from 0.87830
Epoch 53/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3282 -
accuracy: 0.8860 - val_loss: 0.4272 - val_accuracy: 0.8764

Epoch 00053: val_accuracy did not improve from 0.87830
Epoch 54/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3270 -
accuracy: 0.8854 - val_loss: 0.4354 - val_accuracy: 0.8747

Epoch 00054: val_accuracy did not improve from 0.87830
Epoch 55/100
781/781 [==============================] - 112s 144ms/step - loss: 0.3290 -
accuracy: 0.8861 - val_loss: 0.4283 - val_accuracy: 0.8758

Epoch 00055: val_accuracy did not improve from 0.87830
Epoch 56/100
781/781 [==============================] - 113s 144ms/step - loss: 0.3254 -
accuracy: 0.8854 - val_loss: 0.4209 - val_accuracy: 0.8769

Epoch 00056: val_accuracy did not improve from 0.87830
Epoch 57/100
781/781 [==============================] - 113s 144ms/step - loss: 0.3272 -
accuracy: 0.8857 - val_loss: 0.4203 - val_accuracy: 0.8762

Epoch 00057: val_accuracy did not improve from 0.87830
Epoch 58/100
781/781 [==============================] - 113s 144ms/step - loss: 0.3252 -
accuracy: 0.8862 - val_loss: 0.4251 - val_accuracy: 0.8750

Epoch 00058: val_accuracy did not improve from 0.87830
Epoch 59/100
781/781 [==============================] - 112s 144ms/step - loss: 0.3272 -
accuracy: 0.8863 - val_loss: 0.4227 - val_accuracy: 0.8766
```

```
Epoch 00059: val_accuracy did not improve from 0.87830
Epoch 60/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3245 -
accuracy: 0.8865 - val_loss: 0.4110 - val_accuracy: 0.8793

Epoch 00060: val_accuracy improved from 0.87830 to 0.87930, saving model to
model4_weights.best.hdf5
Epoch 61/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3223 -
accuracy: 0.8853 - val_loss: 0.4218 - val_accuracy: 0.8763

Epoch 00061: val_accuracy did not improve from 0.87930
Epoch 62/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3241 -
accuracy: 0.8875 - val_loss: 0.4214 - val_accuracy: 0.8776

Epoch 00062: val_accuracy did not improve from 0.87930
Epoch 63/100
781/781 [==============================] - 113s 144ms/step - loss: 0.3159 -
accuracy: 0.8897 - val_loss: 0.4203 - val_accuracy: 0.8772

Epoch 00063: val_accuracy did not improve from 0.87930
Epoch 64/100
781/781 [==============================] - 113s 144ms/step - loss: 0.3170 -
accuracy: 0.8894 - val_loss: 0.4326 - val_accuracy: 0.8756

Epoch 00064: val_accuracy did not improve from 0.87930
Epoch 65/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3238 -
accuracy: 0.8863 - val_loss: 0.4230 - val_accuracy: 0.8780

Epoch 00065: val_accuracy did not improve from 0.87930
Epoch 66/100
781/781 [==============================] - 112s 144ms/step - loss: 0.3202 -
accuracy: 0.8885 - val_loss: 0.4199 - val_accuracy: 0.8773

Epoch 00066: val_accuracy did not improve from 0.87930
Epoch 67/100
781/781 [==============================] - 113s 145ms/step - loss: 0.3236 -
accuracy: 0.8879 - val_loss: 0.4251 - val_accuracy: 0.8763

Epoch 00067: val_accuracy did not improve from 0.87930
Epoch 68/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3223 -
accuracy: 0.8871 - val_loss: 0.4196 - val_accuracy: 0.8784

Epoch 00068: val_accuracy did not improve from 0.87930
Epoch 69/100
```

```
781/781 [==============================] - 112s 143ms/step - loss: 0.3236 -
accuracy: 0.8870 - val_loss: 0.4162 - val_accuracy: 0.8787

Epoch 00069: val_accuracy did not improve from 0.87930
Epoch 70/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3185 -
accuracy: 0.8889 - val_loss: 0.4195 - val_accuracy: 0.8776

Epoch 00070: val_accuracy did not improve from 0.87930
Epoch 71/100
781/781 [==============================] - 111s 143ms/step - loss: 0.3236 -
accuracy: 0.8878 - val_loss: 0.4258 - val_accuracy: 0.8761

Epoch 00071: val_accuracy did not improve from 0.87930
Epoch 72/100
781/781 [==============================] - 113s 144ms/step - loss: 0.3148 -
accuracy: 0.8906 - val_loss: 0.4257 - val_accuracy: 0.8770

Epoch 00072: val_accuracy did not improve from 0.87930
Epoch 73/100
781/781 [==============================] - 113s 145ms/step - loss: 0.3217 -
accuracy: 0.8883 - val_loss: 0.4205 - val_accuracy: 0.8779

Epoch 00073: val_accuracy did not improve from 0.87930
Epoch 74/100
781/781 [==============================] - 114s 146ms/step - loss: 0.3227 -
accuracy: 0.8872 - val_loss: 0.4192 - val_accuracy: 0.8773

Epoch 00074: val_accuracy did not improve from 0.87930
Epoch 75/100
781/781 [==============================] - 113s 144ms/step - loss: 0.3201 -
accuracy: 0.8880 - val_loss: 0.4136 - val_accuracy: 0.8799

Epoch 00075: val_accuracy improved from 0.87930 to 0.87990, saving model to
model4_weights.best.hdf5
Epoch 76/100
781/781 [==============================] - 113s 144ms/step - loss: 0.3209 -
accuracy: 0.8875 - val_loss: 0.4124 - val_accuracy: 0.8793

Epoch 00076: val_accuracy did not improve from 0.87990
Epoch 77/100
781/781 [==============================] - 113s 145ms/step - loss: 0.3179 -
accuracy: 0.8881 - val_loss: 0.4118 - val_accuracy: 0.8793

Epoch 00077: val_accuracy did not improve from 0.87990
Epoch 78/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3236 -
accuracy: 0.8860 - val_loss: 0.4153 - val_accuracy: 0.8780
```

```
Epoch 00078: val_accuracy did not improve from 0.87990
Epoch 79/100
781/781 [==============================] - 113s 144ms/step - loss: 0.3209 -
accuracy: 0.8888 - val_loss: 0.4224 - val_accuracy: 0.8780

Epoch 00079: val_accuracy did not improve from 0.87990
Epoch 80/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3206 -
accuracy: 0.8882 - val_loss: 0.4182 - val_accuracy: 0.8777

Epoch 00080: val_accuracy did not improve from 0.87990
Epoch 81/100
781/781 [==============================] - 112s 144ms/step - loss: 0.3177 -
accuracy: 0.8892 - val_loss: 0.4137 - val_accuracy: 0.8793

Epoch 00081: val_accuracy did not improve from 0.87990
Epoch 82/100
781/781 [==============================] - 112s 143ms/step - loss: 0.3198 -
accuracy: 0.8883 - val_loss: 0.4240 - val_accuracy: 0.8772

Epoch 00082: val_accuracy did not improve from 0.87990
```

[ ]:
```
<tensorflow.python.keras.callbacks.History at 0x7f01140b5b90>
```

1.3.6 2.6 Growth Rate(num_filter) = 36, compression = 0.7, Number of blocks = 12

[ ]:
```
# Hyperparameters
batch_size = 64
num_classes = 10
nb_epoch = 100
l = 12
num_filter = 36
compression = 0.7
dropout_rate = 0.2
```

[ ]:
```
from tensorflow.keras.callbacks import ModelCheckpoint
#https://machinelearningmastery.com/check-point-deep-learning-models-keras/
filepath="model5_weights.best.hdf5"
model_checkpoint =␣
 ↪ModelCheckpoint(filepath,monitor='val_accuracy',save_best_only=True,verbose=1)
```

[ ]:
```
input = layers.Input(shape=(img_height, img_width, channel,))
First_Conv2D = layers.Conv2D(num_filter, (3,3), use_bias=False␣
 ↪,padding='same')(input)
```

```
First_Block = denseblock(First_Conv2D, num_filter, dropout_rate)
First_Transition = transition(First_Block, num_filter, dropout_rate)

Second_Block = denseblock(First_Transition, num_filter, dropout_rate)
Second_Transition = transition(Second_Block, num_filter, dropout_rate)

Third_Block = denseblock(Second_Transition, num_filter, dropout_rate)
Third_Transition = transition(Third_Block, num_filter, dropout_rate)

Last_Block = denseblock(Third_Transition,  num_filter, dropout_rate)
output = output_layer(Last_Block)
```

[ ]:
```
model5 = Model(inputs = [input], outputs = [output])
model5.summary()
```

```
Model: "model"
__________________________________________________________________________________
__________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================
==================
input_1 (InputLayer)            [(None, 32, 32, 3)]  0
__________________________________________________________________________________
__________________
conv2d (Conv2D)                 (None, 32, 32, 36)   972         input_1[0][0]
__________________________________________________________________________________
__________________
batch_normalization (BatchNorma (None, 32, 32, 36)   144         conv2d[0][0]
__________________________________________________________________________________
__________________
activation (Activation)         (None, 32, 32, 36)   0
batch_normalization[0][0]
__________________________________________________________________________________
__________________
conv2d_1 (Conv2D)               (None, 32, 32, 25)   900
activation[0][0]
__________________________________________________________________________________
__________________
batch_normalization_1 (BatchNor (None, 32, 32, 25)   100         conv2d_1[0][0]
__________________________________________________________________________________
__________________
activation_1 (Activation)       (None, 32, 32, 25)   0
batch_normalization_1[0][0]
__________________________________________________________________________________
__________________
conv2d_2 (Conv2D)               (None, 32, 32, 25)   5625
activation_1[0][0]
```

```
____________________________________________________________________________
__________________
dropout (Dropout)               (None, 32, 32, 25)   0           conv2d_2[0][0]
____________________________________________________________________________
__________________
concatenate (Concatenate)       (None, 32, 32, 61)   0           conv2d[0][0]
                                                                 dropout[0][0]
____________________________________________________________________________
__________________
batch_normalization_2 (BatchNor (None, 32, 32, 61)   244
concatenate[0][0]
____________________________________________________________________________
__________________
activation_2 (Activation)       (None, 32, 32, 61)   0
batch_normalization_2[0][0]
____________________________________________________________________________
__________________
conv2d_3 (Conv2D)               (None, 32, 32, 25)   1525
activation_2[0][0]
____________________________________________________________________________
__________________
batch_normalization_3 (BatchNor (None, 32, 32, 25)   100         conv2d_3[0][0]
____________________________________________________________________________
__________________
activation_3 (Activation)       (None, 32, 32, 25)   0
batch_normalization_3[0][0]
____________________________________________________________________________
__________________
conv2d_4 (Conv2D)               (None, 32, 32, 25)   5625
activation_3[0][0]
____________________________________________________________________________
__________________
dropout_1 (Dropout)             (None, 32, 32, 25)   0           conv2d_4[0][0]
____________________________________________________________________________
__________________
concatenate_1 (Concatenate)     (None, 32, 32, 86)   0
concatenate[0][0]
                                                                 dropout_1[0][0]
____________________________________________________________________________
__________________
batch_normalization_4 (BatchNor (None, 32, 32, 86)   344
concatenate_1[0][0]
____________________________________________________________________________
__________________
activation_4 (Activation)       (None, 32, 32, 86)   0
batch_normalization_4[0][0]
____________________________________________________________________________
__________________
```

```
conv2d_5 (Conv2D)               (None, 32, 32, 25)   2150
activation_4[0][0]
__________________________________________________________________________________
__________________
batch_normalization_5 (BatchNor (None, 32, 32, 25)   100         conv2d_5[0][0]
__________________________________________________________________________________
__________________
activation_5 (Activation)       (None, 32, 32, 25)   0
batch_normalization_5[0][0]
__________________________________________________________________________________
__________________
conv2d_6 (Conv2D)               (None, 32, 32, 25)   5625
activation_5[0][0]
__________________________________________________________________________________
__________________
dropout_2 (Dropout)             (None, 32, 32, 25)   0           conv2d_6[0][0]
__________________________________________________________________________________
__________________
concatenate_2 (Concatenate)     (None, 32, 32, 111)  0
concatenate_1[0][0]
                                                                 dropout_2[0][0]
__________________________________________________________________________________
__________________
batch_normalization_6 (BatchNor (None, 32, 32, 111)  444
concatenate_2[0][0]
__________________________________________________________________________________
__________________
activation_6 (Activation)       (None, 32, 32, 111)  0
batch_normalization_6[0][0]
__________________________________________________________________________________
__________________
conv2d_7 (Conv2D)               (None, 32, 32, 25)   2775
activation_6[0][0]
__________________________________________________________________________________
__________________
batch_normalization_7 (BatchNor (None, 32, 32, 25)   100         conv2d_7[0][0]
__________________________________________________________________________________
__________________
activation_7 (Activation)       (None, 32, 32, 25)   0
batch_normalization_7[0][0]
__________________________________________________________________________________
__________________
conv2d_8 (Conv2D)               (None, 32, 32, 25)   5625
activation_7[0][0]
__________________________________________________________________________________
__________________
dropout_3 (Dropout)             (None, 32, 32, 25)   0           conv2d_8[0][0]
__________________________________________________________________________________
```

```
__________________
concatenate_3 (Concatenate)     (None, 32, 32, 136)  0
concatenate_2[0][0]
                                                                 dropout_3[0][0]
__________________________________________________________________________________
__________________
batch_normalization_8 (BatchNor (None, 32, 32, 136)  544
concatenate_3[0][0]
__________________________________________________________________________________
__________________
activation_8 (Activation)       (None, 32, 32, 136)  0
batch_normalization_8[0][0]
__________________________________________________________________________________
__________________
conv2d_9 (Conv2D)               (None, 32, 32, 25)   3400
activation_8[0][0]
__________________________________________________________________________________
__________________
batch_normalization_9 (BatchNor (None, 32, 32, 25)   100         conv2d_9[0][0]
__________________________________________________________________________________
__________________
activation_9 (Activation)       (None, 32, 32, 25)   0
batch_normalization_9[0][0]
__________________________________________________________________________________
__________________
conv2d_10 (Conv2D)              (None, 32, 32, 25)   5625
activation_9[0][0]
__________________________________________________________________________________
__________________
dropout_4 (Dropout)             (None, 32, 32, 25)   0           conv2d_10[0][0]
__________________________________________________________________________________
__________________
concatenate_4 (Concatenate)     (None, 32, 32, 161)  0
concatenate_3[0][0]
                                                                 dropout_4[0][0]
__________________________________________________________________________________
__________________
batch_normalization_10 (BatchNo (None, 32, 32, 161)  644
concatenate_4[0][0]
__________________________________________________________________________________
__________________
activation_10 (Activation)      (None, 32, 32, 161)  0
batch_normalization_10[0][0]
__________________________________________________________________________________
__________________
conv2d_11 (Conv2D)              (None, 32, 32, 25)   4025
activation_10[0][0]
__________________________________________________________________________________
```

```
------------------
batch_normalization_11 (BatchNo (None, 32, 32, 25)   100         conv2d_11[0][0]
--------------------------------------------------------------------------------
------------------
activation_11 (Activation)      (None, 32, 32, 25)   0
batch_normalization_11[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_12 (Conv2D)              (None, 32, 32, 25)   5625
activation_11[0][0]
--------------------------------------------------------------------------------
------------------
dropout_5 (Dropout)             (None, 32, 32, 25)   0           conv2d_12[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_5 (Concatenate)     (None, 32, 32, 186)  0
concatenate_4[0][0]
                                                                 dropout_5[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_12 (BatchNo (None, 32, 32, 186)  744
concatenate_5[0][0]
--------------------------------------------------------------------------------
------------------
activation_12 (Activation)      (None, 32, 32, 186)  0
batch_normalization_12[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_13 (Conv2D)              (None, 32, 32, 25)   4650
activation_12[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_13 (BatchNo (None, 32, 32, 25)   100         conv2d_13[0][0]
--------------------------------------------------------------------------------
------------------
activation_13 (Activation)      (None, 32, 32, 25)   0
batch_normalization_13[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_14 (Conv2D)              (None, 32, 32, 25)   5625
activation_13[0][0]
--------------------------------------------------------------------------------
------------------
dropout_6 (Dropout)             (None, 32, 32, 25)   0           conv2d_14[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_6 (Concatenate)     (None, 32, 32, 211)  0
concatenate_5[0][0]
```

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                                                                    dropout_6[0][0]
__________________________________________________________________________________
__________________
batch_normalization_14 (BatchNo (None, 32, 32, 211)  844
concatenate_6[0][0]
__________________________________________________________________________________
__________________
activation_14 (Activation)      (None, 32, 32, 211)  0
batch_normalization_14[0][0]
__________________________________________________________________________________
__________________
conv2d_15 (Conv2D)              (None, 32, 32, 25)   5275
activation_14[0][0]
__________________________________________________________________________________
__________________
batch_normalization_15 (BatchNo (None, 32, 32, 25)   100         conv2d_15[0][0]
__________________________________________________________________________________
__________________
activation_15 (Activation)      (None, 32, 32, 25)   0
batch_normalization_15[0][0]
__________________________________________________________________________________
__________________
conv2d_16 (Conv2D)              (None, 32, 32, 25)   5625
activation_15[0][0]
__________________________________________________________________________________
__________________
dropout_7 (Dropout)             (None, 32, 32, 25)   0           conv2d_16[0][0]
__________________________________________________________________________________
__________________
concatenate_7 (Concatenate)     (None, 32, 32, 236)  0
concatenate_6[0][0]
                                                                    dropout_7[0][0]
__________________________________________________________________________________
__________________
batch_normalization_16 (BatchNo (None, 32, 32, 236)  944
concatenate_7[0][0]
__________________________________________________________________________________
__________________
activation_16 (Activation)      (None, 32, 32, 236)  0
batch_normalization_16[0][0]
__________________________________________________________________________________
__________________
conv2d_17 (Conv2D)              (None, 32, 32, 25)   5900
activation_16[0][0]
__________________________________________________________________________________
__________________
batch_normalization_17 (BatchNo (None, 32, 32, 25)   100         conv2d_17[0][0]
__________________________________________________________________________________
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__________________
activation_17 (Activation)      (None, 32, 32, 25)   0
batch_normalization_17[0][0]

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__________________
conv2d_18 (Conv2D)              (None, 32, 32, 25)   5625
activation_17[0][0]

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__________________
dropout_8 (Dropout)             (None, 32, 32, 25)   0           conv2d_18[0][0]

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__________________
concatenate_8 (Concatenate)     (None, 32, 32, 261)  0
concatenate_7[0][0]
                                                                 dropout_8[0][0]

____________________________________________________________________________
__________________
batch_normalization_18 (BatchNo (None, 32, 32, 261)  1044
concatenate_8[0][0]

____________________________________________________________________________
__________________
activation_18 (Activation)      (None, 32, 32, 261)  0
batch_normalization_18[0][0]

____________________________________________________________________________
__________________
conv2d_19 (Conv2D)              (None, 32, 32, 25)   6525
activation_18[0][0]

____________________________________________________________________________
__________________
batch_normalization_19 (BatchNo (None, 32, 32, 25)   100         conv2d_19[0][0]

____________________________________________________________________________
__________________
activation_19 (Activation)      (None, 32, 32, 25)   0
batch_normalization_19[0][0]

____________________________________________________________________________
__________________
conv2d_20 (Conv2D)              (None, 32, 32, 25)   5625
activation_19[0][0]

____________________________________________________________________________
__________________
dropout_9 (Dropout)             (None, 32, 32, 25)   0           conv2d_20[0][0]

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__________________
concatenate_9 (Concatenate)     (None, 32, 32, 286)  0
concatenate_8[0][0]
                                                                 dropout_9[0][0]

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batch_normalization_20 (BatchNo (None, 32, 32, 286)  1144
concatenate_9[0][0]
__________________________________________________________________________________
__________________
activation_20 (Activation)      (None, 32, 32, 286)  0
batch_normalization_20[0][0]
__________________________________________________________________________________
__________________
conv2d_21 (Conv2D)              (None, 32, 32, 25)   7150
activation_20[0][0]
__________________________________________________________________________________
__________________
batch_normalization_21 (BatchNo (None, 32, 32, 25)   100         conv2d_21[0][0]
__________________________________________________________________________________
__________________
activation_21 (Activation)      (None, 32, 32, 25)   0
batch_normalization_21[0][0]
__________________________________________________________________________________
__________________
conv2d_22 (Conv2D)              (None, 32, 32, 25)   5625
activation_21[0][0]
__________________________________________________________________________________
__________________
dropout_10 (Dropout)            (None, 32, 32, 25)   0           conv2d_22[0][0]
__________________________________________________________________________________
__________________
concatenate_10 (Concatenate)    (None, 32, 32, 311)  0
concatenate_9[0][0]
dropout_10[0][0]
__________________________________________________________________________________
__________________
batch_normalization_22 (BatchNo (None, 32, 32, 311)  1244
concatenate_10[0][0]
__________________________________________________________________________________
__________________
activation_22 (Activation)      (None, 32, 32, 311)  0
batch_normalization_22[0][0]
__________________________________________________________________________________
__________________
conv2d_23 (Conv2D)              (None, 32, 32, 25)   7775
activation_22[0][0]
__________________________________________________________________________________
__________________
batch_normalization_23 (BatchNo (None, 32, 32, 25)   100         conv2d_23[0][0]
__________________________________________________________________________________
__________________
activation_23 (Activation)      (None, 32, 32, 25)   0
batch_normalization_23[0][0]
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__________________
conv2d_24 (Conv2D)              (None, 32, 32, 25)   5625
activation_23[0][0]
____________________________________________________________________________
__________________
dropout_11 (Dropout)            (None, 32, 32, 25)   0           conv2d_24[0][0]
____________________________________________________________________________
__________________
concatenate_11 (Concatenate)    (None, 32, 32, 336)  0
concatenate_10[0][0]
dropout_11[0][0]
____________________________________________________________________________
__________________
batch_normalization_24 (BatchNo (None, 32, 32, 336)  1344
concatenate_11[0][0]
____________________________________________________________________________
__________________
activation_24 (Activation)      (None, 32, 32, 336)  0
batch_normalization_24[0][0]
____________________________________________________________________________
__________________
conv2d_25 (Conv2D)              (None, 32, 32, 25)   8400
activation_24[0][0]
____________________________________________________________________________
__________________
dropout_12 (Dropout)            (None, 32, 32, 25)   0           conv2d_25[0][0]
____________________________________________________________________________
__________________
average_pooling2d (AveragePooli (None, 16, 16, 25)   0
dropout_12[0][0]
____________________________________________________________________________
__________________
batch_normalization_25 (BatchNo (None, 16, 16, 25)   100
average_pooling2d[0][0]
____________________________________________________________________________
__________________
activation_25 (Activation)      (None, 16, 16, 25)   0
batch_normalization_25[0][0]
____________________________________________________________________________
__________________
conv2d_26 (Conv2D)              (None, 16, 16, 25)   625
activation_25[0][0]
____________________________________________________________________________
__________________
batch_normalization_26 (BatchNo (None, 16, 16, 25)   100         conv2d_26[0][0]
____________________________________________________________________________
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activation_26 (Activation)      (None, 16, 16, 25)   0
batch_normalization_26[0][0]
__________________________________________________________________________________
__________________
conv2d_27 (Conv2D)              (None, 16, 16, 25)   5625
activation_26[0][0]
__________________________________________________________________________________
__________________
dropout_13 (Dropout)            (None, 16, 16, 25)   0           conv2d_27[0][0]
__________________________________________________________________________________
__________________
concatenate_12 (Concatenate)    (None, 16, 16, 50)   0
average_pooling2d[0][0]
dropout_13[0][0]
__________________________________________________________________________________
__________________
batch_normalization_27 (BatchNo (None, 16, 16, 50)   200
concatenate_12[0][0]
__________________________________________________________________________________
__________________
activation_27 (Activation)      (None, 16, 16, 50)   0
batch_normalization_27[0][0]
__________________________________________________________________________________
__________________
conv2d_28 (Conv2D)              (None, 16, 16, 25)   1250
activation_27[0][0]
__________________________________________________________________________________
__________________
batch_normalization_28 (BatchNo (None, 16, 16, 25)   100         conv2d_28[0][0]
__________________________________________________________________________________
__________________
activation_28 (Activation)      (None, 16, 16, 25)   0
batch_normalization_28[0][0]
__________________________________________________________________________________
__________________
conv2d_29 (Conv2D)              (None, 16, 16, 25)   5625
activation_28[0][0]
__________________________________________________________________________________
__________________
dropout_14 (Dropout)            (None, 16, 16, 25)   0           conv2d_29[0][0]
__________________________________________________________________________________
__________________
concatenate_13 (Concatenate)    (None, 16, 16, 75)   0
concatenate_12[0][0]
dropout_14[0][0]
__________________________________________________________________________________
__________________
batch_normalization_29 (BatchNo (None, 16, 16, 75)   300
```

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concatenate_13[0][0]
__________________________________________________________________________________
__________________
activation_29 (Activation)      (None, 16, 16, 75)   0
batch_normalization_29[0][0]
__________________________________________________________________________________
__________________
conv2d_30 (Conv2D)              (None, 16, 16, 25)   1875
activation_29[0][0]
__________________________________________________________________________________
__________________
batch_normalization_30 (BatchNo (None, 16, 16, 25)   100         conv2d_30[0][0]
__________________________________________________________________________________
__________________
activation_30 (Activation)      (None, 16, 16, 25)   0
batch_normalization_30[0][0]
__________________________________________________________________________________
__________________
conv2d_31 (Conv2D)              (None, 16, 16, 25)   5625
activation_30[0][0]
__________________________________________________________________________________
__________________
dropout_15 (Dropout)            (None, 16, 16, 25)   0           conv2d_31[0][0]
__________________________________________________________________________________
__________________
concatenate_14 (Concatenate)    (None, 16, 16, 100)  0
concatenate_13[0][0]
dropout_15[0][0]
__________________________________________________________________________________
__________________
batch_normalization_31 (BatchNo (None, 16, 16, 100)  400
concatenate_14[0][0]
__________________________________________________________________________________
__________________
activation_31 (Activation)      (None, 16, 16, 100)  0
batch_normalization_31[0][0]
__________________________________________________________________________________
__________________
conv2d_32 (Conv2D)              (None, 16, 16, 25)   2500
activation_31[0][0]
__________________________________________________________________________________
__________________
batch_normalization_32 (BatchNo (None, 16, 16, 25)   100         conv2d_32[0][0]
__________________________________________________________________________________
__________________
activation_32 (Activation)      (None, 16, 16, 25)   0
batch_normalization_32[0][0]
__________________________________________________________________________________
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__________________
conv2d_33 (Conv2D)              (None, 16, 16, 25)   5625
activation_32[0][0]

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__________________
dropout_16 (Dropout)            (None, 16, 16, 25)   0           conv2d_33[0][0]

__________________________________________________________________________________
__________________
concatenate_15 (Concatenate)    (None, 16, 16, 125)  0
concatenate_14[0][0]
dropout_16[0][0]

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__________________
batch_normalization_33 (BatchNo (None, 16, 16, 125)  500
concatenate_15[0][0]

__________________________________________________________________________________
__________________
activation_33 (Activation)      (None, 16, 16, 125)  0
batch_normalization_33[0][0]

__________________________________________________________________________________
__________________
conv2d_34 (Conv2D)              (None, 16, 16, 25)   3125
activation_33[0][0]

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__________________
batch_normalization_34 (BatchNo (None, 16, 16, 25)   100         conv2d_34[0][0]

__________________________________________________________________________________
__________________
activation_34 (Activation)      (None, 16, 16, 25)   0
batch_normalization_34[0][0]

__________________________________________________________________________________
__________________
conv2d_35 (Conv2D)              (None, 16, 16, 25)   5625
activation_34[0][0]

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__________________
dropout_17 (Dropout)            (None, 16, 16, 25)   0           conv2d_35[0][0]

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__________________
concatenate_16 (Concatenate)    (None, 16, 16, 150)  0
concatenate_15[0][0]
dropout_17[0][0]

__________________________________________________________________________________
__________________
batch_normalization_35 (BatchNo (None, 16, 16, 150)  600
concatenate_16[0][0]

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```
activation_35 (Activation)      (None, 16, 16, 150)  0
batch_normalization_35[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_36 (Conv2D)              (None, 16, 16, 25)   3750
activation_35[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_36 (BatchNo (None, 16, 16, 25)   100         conv2d_36[0][0]
--------------------------------------------------------------------------------
------------------
activation_36 (Activation)      (None, 16, 16, 25)   0
batch_normalization_36[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_37 (Conv2D)              (None, 16, 16, 25)   5625
activation_36[0][0]
--------------------------------------------------------------------------------
------------------
dropout_18 (Dropout)            (None, 16, 16, 25)   0           conv2d_37[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_17 (Concatenate)    (None, 16, 16, 175)  0
concatenate_16[0][0]
dropout_18[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_37 (BatchNo (None, 16, 16, 175)  700
concatenate_17[0][0]
--------------------------------------------------------------------------------
------------------
activation_37 (Activation)      (None, 16, 16, 175)  0
batch_normalization_37[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_38 (Conv2D)              (None, 16, 16, 25)   4375
activation_37[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_38 (BatchNo (None, 16, 16, 25)   100         conv2d_38[0][0]
--------------------------------------------------------------------------------
------------------
activation_38 (Activation)      (None, 16, 16, 25)   0
batch_normalization_38[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_39 (Conv2D)              (None, 16, 16, 25)   5625
activation_38[0][0]
```

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__________________________________________________________________________________
__________________
dropout_19 (Dropout)            (None, 16, 16, 25)   0           conv2d_39[0][0]
__________________________________________________________________________________
__________________
concatenate_18 (Concatenate)    (None, 16, 16, 200)  0
concatenate_17[0][0]
dropout_19[0][0]
__________________________________________________________________________________
__________________
batch_normalization_39 (BatchNo (None, 16, 16, 200)  800
concatenate_18[0][0]
__________________________________________________________________________________
__________________
activation_39 (Activation)      (None, 16, 16, 200)  0
batch_normalization_39[0][0]
__________________________________________________________________________________
__________________
conv2d_40 (Conv2D)              (None, 16, 16, 25)   5000
activation_39[0][0]
__________________________________________________________________________________
__________________
batch_normalization_40 (BatchNo (None, 16, 16, 25)   100         conv2d_40[0][0]
__________________________________________________________________________________
__________________
activation_40 (Activation)      (None, 16, 16, 25)   0
batch_normalization_40[0][0]
__________________________________________________________________________________
__________________
conv2d_41 (Conv2D)              (None, 16, 16, 25)   5625
activation_40[0][0]
__________________________________________________________________________________
__________________
dropout_20 (Dropout)            (None, 16, 16, 25)   0           conv2d_41[0][0]
__________________________________________________________________________________
__________________
concatenate_19 (Concatenate)    (None, 16, 16, 225)  0
concatenate_18[0][0]
dropout_20[0][0]
__________________________________________________________________________________
__________________
batch_normalization_41 (BatchNo (None, 16, 16, 225)  900
concatenate_19[0][0]
__________________________________________________________________________________
__________________
activation_41 (Activation)      (None, 16, 16, 225)  0
batch_normalization_41[0][0]
__________________________________________________________________________________
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conv2d_42 (Conv2D)              (None, 16, 16, 25)   5625
activation_41[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_42 (BatchNo (None, 16, 16, 25)   100         conv2d_42[0][0]
--------------------------------------------------------------------------------
------------------
activation_42 (Activation)      (None, 16, 16, 25)   0
batch_normalization_42[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_43 (Conv2D)              (None, 16, 16, 25)   5625
activation_42[0][0]
--------------------------------------------------------------------------------
------------------
dropout_21 (Dropout)            (None, 16, 16, 25)   0           conv2d_43[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_20 (Concatenate)    (None, 16, 16, 250)  0
concatenate_19[0][0]
dropout_21[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_43 (BatchNo (None, 16, 16, 250)  1000
concatenate_20[0][0]
--------------------------------------------------------------------------------
------------------
activation_43 (Activation)      (None, 16, 16, 250)  0
batch_normalization_43[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_44 (Conv2D)              (None, 16, 16, 25)   6250
activation_43[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_44 (BatchNo (None, 16, 16, 25)   100         conv2d_44[0][0]
--------------------------------------------------------------------------------
------------------
activation_44 (Activation)      (None, 16, 16, 25)   0
batch_normalization_44[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_45 (Conv2D)              (None, 16, 16, 25)   5625
activation_44[0][0]
--------------------------------------------------------------------------------
------------------
dropout_22 (Dropout)            (None, 16, 16, 25)   0           conv2d_45[0][0]
```

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__________________
concatenate_21 (Concatenate)    (None, 16, 16, 275)  0
concatenate_20[0][0]
dropout_22[0][0]
__________________________________________________________________________________
__________________
batch_normalization_45 (BatchNo (None, 16, 16, 275)  1100
concatenate_21[0][0]
__________________________________________________________________________________
__________________
activation_45 (Activation)      (None, 16, 16, 275)  0
batch_normalization_45[0][0]
__________________________________________________________________________________
__________________
conv2d_46 (Conv2D)              (None, 16, 16, 25)   6875
activation_45[0][0]
__________________________________________________________________________________
__________________
batch_normalization_46 (BatchNo (None, 16, 16, 25)   100         conv2d_46[0][0]
__________________________________________________________________________________
__________________
activation_46 (Activation)      (None, 16, 16, 25)   0
batch_normalization_46[0][0]
__________________________________________________________________________________
__________________
conv2d_47 (Conv2D)              (None, 16, 16, 25)   5625
activation_46[0][0]
__________________________________________________________________________________
__________________
dropout_23 (Dropout)            (None, 16, 16, 25)   0           conv2d_47[0][0]
__________________________________________________________________________________
__________________
concatenate_22 (Concatenate)    (None, 16, 16, 300)  0
concatenate_21[0][0]
dropout_23[0][0]
__________________________________________________________________________________
__________________
batch_normalization_47 (BatchNo (None, 16, 16, 300)  1200
concatenate_22[0][0]
__________________________________________________________________________________
__________________
activation_47 (Activation)      (None, 16, 16, 300)  0
batch_normalization_47[0][0]
__________________________________________________________________________________
__________________
conv2d_48 (Conv2D)              (None, 16, 16, 25)   7500
activation_47[0][0]
```

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____________________________________________________________________________
__________________
batch_normalization_48 (BatchNo (None, 16, 16, 25)   100         conv2d_48[0][0]
____________________________________________________________________________
__________________
activation_48 (Activation)      (None, 16, 16, 25)   0
batch_normalization_48[0][0]
____________________________________________________________________________
__________________
conv2d_49 (Conv2D)              (None, 16, 16, 25)   5625
activation_48[0][0]
____________________________________________________________________________
__________________
dropout_24 (Dropout)            (None, 16, 16, 25)   0           conv2d_49[0][0]
____________________________________________________________________________
__________________
concatenate_23 (Concatenate)    (None, 16, 16, 325)  0
concatenate_22[0][0]
dropout_24[0][0]
____________________________________________________________________________
__________________
batch_normalization_49 (BatchNo (None, 16, 16, 325)  1300
concatenate_23[0][0]
____________________________________________________________________________
__________________
activation_49 (Activation)      (None, 16, 16, 325)  0
batch_normalization_49[0][0]
____________________________________________________________________________
__________________
conv2d_50 (Conv2D)              (None, 16, 16, 25)   8125
activation_49[0][0]
____________________________________________________________________________
__________________
dropout_25 (Dropout)            (None, 16, 16, 25)   0           conv2d_50[0][0]
____________________________________________________________________________
__________________
average_pooling2d_1 (AveragePoo (None, 8, 8, 25)     0
dropout_25[0][0]
____________________________________________________________________________
__________________
batch_normalization_50 (BatchNo (None, 8, 8, 25)     100
average_pooling2d_1[0][0]
____________________________________________________________________________
__________________
activation_50 (Activation)      (None, 8, 8, 25)     0
batch_normalization_50[0][0]
____________________________________________________________________________
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conv2d_51 (Conv2D)              (None, 8, 8, 25)     625
activation_50[0][0]
__________________________________________________________________________________
__________________
batch_normalization_51 (BatchNo (None, 8, 8, 25)     100         conv2d_51[0][0]
__________________________________________________________________________________
__________________
activation_51 (Activation)      (None, 8, 8, 25)     0
batch_normalization_51[0][0]
__________________________________________________________________________________
__________________
conv2d_52 (Conv2D)              (None, 8, 8, 25)     5625
activation_51[0][0]
__________________________________________________________________________________
__________________
dropout_26 (Dropout)            (None, 8, 8, 25)     0           conv2d_52[0][0]
__________________________________________________________________________________
__________________
concatenate_24 (Concatenate)    (None, 8, 8, 50)     0
average_pooling2d_1[0][0]
dropout_26[0][0]
__________________________________________________________________________________
__________________
batch_normalization_52 (BatchNo (None, 8, 8, 50)     200
concatenate_24[0][0]
__________________________________________________________________________________
__________________
activation_52 (Activation)      (None, 8, 8, 50)     0
batch_normalization_52[0][0]
__________________________________________________________________________________
__________________
conv2d_53 (Conv2D)              (None, 8, 8, 25)     1250
activation_52[0][0]
__________________________________________________________________________________
__________________
batch_normalization_53 (BatchNo (None, 8, 8, 25)     100         conv2d_53[0][0]
__________________________________________________________________________________
__________________
activation_53 (Activation)      (None, 8, 8, 25)     0
batch_normalization_53[0][0]
__________________________________________________________________________________
__________________
conv2d_54 (Conv2D)              (None, 8, 8, 25)     5625
activation_53[0][0]
__________________________________________________________________________________
__________________
dropout_27 (Dropout)            (None, 8, 8, 25)     0           conv2d_54[0][0]
__________________________________________________________________________________
```

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__________________
concatenate_25 (Concatenate)    (None, 8, 8, 75)     0
concatenate_24[0][0]
dropout_27[0][0]
__________________________________________________________________________________
__________________
batch_normalization_54 (BatchNo (None, 8, 8, 75)     300
concatenate_25[0][0]
__________________________________________________________________________________
__________________
activation_54 (Activation)      (None, 8, 8, 75)     0
batch_normalization_54[0][0]
__________________________________________________________________________________
__________________
conv2d_55 (Conv2D)              (None, 8, 8, 25)     1875
activation_54[0][0]
__________________________________________________________________________________
__________________
batch_normalization_55 (BatchNo (None, 8, 8, 25)     100         conv2d_55[0][0]
__________________________________________________________________________________
__________________
activation_55 (Activation)      (None, 8, 8, 25)     0
batch_normalization_55[0][0]
__________________________________________________________________________________
__________________
conv2d_56 (Conv2D)              (None, 8, 8, 25)     5625
activation_55[0][0]
__________________________________________________________________________________
__________________
dropout_28 (Dropout)            (None, 8, 8, 25)     0           conv2d_56[0][0]
__________________________________________________________________________________
__________________
concatenate_26 (Concatenate)    (None, 8, 8, 100)    0
concatenate_25[0][0]
dropout_28[0][0]
__________________________________________________________________________________
__________________
batch_normalization_56 (BatchNo (None, 8, 8, 100)    400
concatenate_26[0][0]
__________________________________________________________________________________
__________________
activation_56 (Activation)      (None, 8, 8, 100)    0
batch_normalization_56[0][0]
__________________________________________________________________________________
__________________
conv2d_57 (Conv2D)              (None, 8, 8, 25)     2500
activation_56[0][0]
__________________________________________________________________________________
```

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__________________
batch_normalization_57 (BatchNo (None, 8, 8, 25)     100         conv2d_57[0][0]
_____________________________________________________________________________
__________________
activation_57 (Activation)      (None, 8, 8, 25)     0
batch_normalization_57[0][0]
_____________________________________________________________________________
__________________
conv2d_58 (Conv2D)              (None, 8, 8, 25)     5625
activation_57[0][0]
_____________________________________________________________________________
__________________
dropout_29 (Dropout)            (None, 8, 8, 25)     0           conv2d_58[0][0]
_____________________________________________________________________________
__________________
concatenate_27 (Concatenate)    (None, 8, 8, 125)    0
concatenate_26[0][0]
dropout_29[0][0]
_____________________________________________________________________________
__________________
batch_normalization_58 (BatchNo (None, 8, 8, 125)    500
concatenate_27[0][0]
_____________________________________________________________________________
__________________
activation_58 (Activation)      (None, 8, 8, 125)    0
batch_normalization_58[0][0]
_____________________________________________________________________________
__________________
conv2d_59 (Conv2D)              (None, 8, 8, 25)     3125
activation_58[0][0]
_____________________________________________________________________________
__________________
batch_normalization_59 (BatchNo (None, 8, 8, 25)     100         conv2d_59[0][0]
_____________________________________________________________________________
__________________
activation_59 (Activation)      (None, 8, 8, 25)     0
batch_normalization_59[0][0]
_____________________________________________________________________________
__________________
conv2d_60 (Conv2D)              (None, 8, 8, 25)     5625
activation_59[0][0]
_____________________________________________________________________________
__________________
dropout_30 (Dropout)            (None, 8, 8, 25)     0           conv2d_60[0][0]
_____________________________________________________________________________
__________________
concatenate_28 (Concatenate)    (None, 8, 8, 150)    0
concatenate_27[0][0]
```

```
dropout_30[0][0]
__________________________________________________________________________________________
__________________
batch_normalization_60 (BatchNo (None, 8, 8, 150)    600
concatenate_28[0][0]
__________________________________________________________________________________________
__________________
activation_60 (Activation)      (None, 8, 8, 150)    0
batch_normalization_60[0][0]
__________________________________________________________________________________________
__________________
conv2d_61 (Conv2D)              (None, 8, 8, 25)     3750
activation_60[0][0]
__________________________________________________________________________________________
__________________
batch_normalization_61 (BatchNo (None, 8, 8, 25)     100         conv2d_61[0][0]
__________________________________________________________________________________________
__________________
activation_61 (Activation)      (None, 8, 8, 25)     0
batch_normalization_61[0][0]
__________________________________________________________________________________________
__________________
conv2d_62 (Conv2D)              (None, 8, 8, 25)     5625
activation_61[0][0]
__________________________________________________________________________________________
__________________
dropout_31 (Dropout)            (None, 8, 8, 25)     0           conv2d_62[0][0]
__________________________________________________________________________________________
__________________
concatenate_29 (Concatenate)    (None, 8, 8, 175)    0
concatenate_28[0][0]
dropout_31[0][0]
__________________________________________________________________________________________
__________________
batch_normalization_62 (BatchNo (None, 8, 8, 175)    700
concatenate_29[0][0]
__________________________________________________________________________________________
__________________
activation_62 (Activation)      (None, 8, 8, 175)    0
batch_normalization_62[0][0]
__________________________________________________________________________________________
__________________
conv2d_63 (Conv2D)              (None, 8, 8, 25)     4375
activation_62[0][0]
__________________________________________________________________________________________
__________________
batch_normalization_63 (BatchNo (None, 8, 8, 25)     100         conv2d_63[0][0]
__________________________________________________________________________________________
```

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__________________
activation_63 (Activation)      (None, 8, 8, 25)     0
batch_normalization_63[0][0]

____________________________________________________________________________
__________________
conv2d_64 (Conv2D)              (None, 8, 8, 25)     5625
activation_63[0][0]

____________________________________________________________________________
__________________
dropout_32 (Dropout)            (None, 8, 8, 25)     0           conv2d_64[0][0]

____________________________________________________________________________
__________________
concatenate_30 (Concatenate)    (None, 8, 8, 200)    0
concatenate_29[0][0]
dropout_32[0][0]

____________________________________________________________________________
__________________
batch_normalization_64 (BatchNo (None, 8, 8, 200)    800
concatenate_30[0][0]

____________________________________________________________________________
__________________
activation_64 (Activation)      (None, 8, 8, 200)    0
batch_normalization_64[0][0]

____________________________________________________________________________
__________________
conv2d_65 (Conv2D)              (None, 8, 8, 25)     5000
activation_64[0][0]

____________________________________________________________________________
__________________
batch_normalization_65 (BatchNo (None, 8, 8, 25)     100         conv2d_65[0][0]

____________________________________________________________________________
__________________
activation_65 (Activation)      (None, 8, 8, 25)     0
batch_normalization_65[0][0]

____________________________________________________________________________
__________________
conv2d_66 (Conv2D)              (None, 8, 8, 25)     5625
activation_65[0][0]

____________________________________________________________________________
__________________
dropout_33 (Dropout)            (None, 8, 8, 25)     0           conv2d_66[0][0]

____________________________________________________________________________
__________________
concatenate_31 (Concatenate)    (None, 8, 8, 225)    0
concatenate_30[0][0]
dropout_33[0][0]

____________________________________________________________________________
__________________
```

```
batch_normalization_66 (BatchNo (None, 8, 8, 225)    900
concatenate_31[0][0]
__________________________________________________________________________________
__________________
activation_66 (Activation)      (None, 8, 8, 225)    0
batch_normalization_66[0][0]
__________________________________________________________________________________
__________________
conv2d_67 (Conv2D)              (None, 8, 8, 25)     5625
activation_66[0][0]
__________________________________________________________________________________
__________________
batch_normalization_67 (BatchNo (None, 8, 8, 25)     100         conv2d_67[0][0]
__________________________________________________________________________________
__________________
activation_67 (Activation)      (None, 8, 8, 25)     0
batch_normalization_67[0][0]
__________________________________________________________________________________
__________________
conv2d_68 (Conv2D)              (None, 8, 8, 25)     5625
activation_67[0][0]
__________________________________________________________________________________
__________________
dropout_34 (Dropout)            (None, 8, 8, 25)     0           conv2d_68[0][0]
__________________________________________________________________________________
__________________
concatenate_32 (Concatenate)    (None, 8, 8, 250)    0
concatenate_31[0][0]
dropout_34[0][0]
__________________________________________________________________________________
__________________
batch_normalization_68 (BatchNo (None, 8, 8, 250)    1000
concatenate_32[0][0]
__________________________________________________________________________________
__________________
activation_68 (Activation)      (None, 8, 8, 250)    0
batch_normalization_68[0][0]
__________________________________________________________________________________
__________________
conv2d_69 (Conv2D)              (None, 8, 8, 25)     6250
activation_68[0][0]
__________________________________________________________________________________
__________________
batch_normalization_69 (BatchNo (None, 8, 8, 25)     100         conv2d_69[0][0]
__________________________________________________________________________________
__________________
activation_69 (Activation)      (None, 8, 8, 25)     0
batch_normalization_69[0][0]
```

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____________________________________________________________________________
__________________
conv2d_70 (Conv2D)              (None, 8, 8, 25)     5625
activation_69[0][0]
____________________________________________________________________________
__________________
dropout_35 (Dropout)            (None, 8, 8, 25)     0           conv2d_70[0][0]
____________________________________________________________________________
__________________
concatenate_33 (Concatenate)    (None, 8, 8, 275)    0
concatenate_32[0][0]
dropout_35[0][0]
____________________________________________________________________________
__________________
batch_normalization_70 (BatchNo (None, 8, 8, 275)    1100
concatenate_33[0][0]
____________________________________________________________________________
__________________
activation_70 (Activation)      (None, 8, 8, 275)    0
batch_normalization_70[0][0]
____________________________________________________________________________
__________________
conv2d_71 (Conv2D)              (None, 8, 8, 25)     6875
activation_70[0][0]
____________________________________________________________________________
__________________
batch_normalization_71 (BatchNo (None, 8, 8, 25)     100         conv2d_71[0][0]
____________________________________________________________________________
__________________
activation_71 (Activation)      (None, 8, 8, 25)     0
batch_normalization_71[0][0]
____________________________________________________________________________
__________________
conv2d_72 (Conv2D)              (None, 8, 8, 25)     5625
activation_71[0][0]
____________________________________________________________________________
__________________
dropout_36 (Dropout)            (None, 8, 8, 25)     0           conv2d_72[0][0]
____________________________________________________________________________
__________________
concatenate_34 (Concatenate)    (None, 8, 8, 300)    0
concatenate_33[0][0]
dropout_36[0][0]
____________________________________________________________________________
__________________
batch_normalization_72 (BatchNo (None, 8, 8, 300)    1200
concatenate_34[0][0]
____________________________________________________________________________
```

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------------------
activation_72 (Activation)      (None, 8, 8, 300)    0
batch_normalization_72[0][0]

------------------------------------------------------------------------------
------------------
conv2d_73 (Conv2D)              (None, 8, 8, 25)     7500
activation_72[0][0]

------------------------------------------------------------------------------
------------------
batch_normalization_73 (BatchNo (None, 8, 8, 25)     100         conv2d_73[0][0]

------------------------------------------------------------------------------
------------------
activation_73 (Activation)      (None, 8, 8, 25)     0
batch_normalization_73[0][0]

------------------------------------------------------------------------------
------------------
conv2d_74 (Conv2D)              (None, 8, 8, 25)     5625
activation_73[0][0]

------------------------------------------------------------------------------
------------------
dropout_37 (Dropout)            (None, 8, 8, 25)     0           conv2d_74[0][0]

------------------------------------------------------------------------------
------------------
concatenate_35 (Concatenate)    (None, 8, 8, 325)    0
concatenate_34[0][0]
dropout_37[0][0]

------------------------------------------------------------------------------
------------------
batch_normalization_74 (BatchNo (None, 8, 8, 325)    1300
concatenate_35[0][0]

------------------------------------------------------------------------------
------------------
activation_74 (Activation)      (None, 8, 8, 325)    0
batch_normalization_74[0][0]

------------------------------------------------------------------------------
------------------
conv2d_75 (Conv2D)              (None, 8, 8, 25)     8125
activation_74[0][0]

------------------------------------------------------------------------------
------------------
dropout_38 (Dropout)            (None, 8, 8, 25)     0           conv2d_75[0][0]

------------------------------------------------------------------------------
------------------
average_pooling2d_2 (AveragePoo (None, 4, 4, 25)     0
dropout_38[0][0]

------------------------------------------------------------------------------
------------------
batch_normalization_75 (BatchNo (None, 4, 4, 25)     100
```

```
average_pooling2d_2[0][0]
__________________________________________________________________________________________________
activation_75 (Activation)      (None, 4, 4, 25)     0
batch_normalization_75[0][0]
__________________________________________________________________________________________________
conv2d_76 (Conv2D)              (None, 4, 4, 25)     625
activation_75[0][0]
__________________________________________________________________________________________________
batch_normalization_76 (BatchNo (None, 4, 4, 25)     100         conv2d_76[0][0]
__________________________________________________________________________________________________
activation_76 (Activation)      (None, 4, 4, 25)     0
batch_normalization_76[0][0]
__________________________________________________________________________________________________
conv2d_77 (Conv2D)              (None, 4, 4, 25)     5625
activation_76[0][0]
__________________________________________________________________________________________________
dropout_39 (Dropout)            (None, 4, 4, 25)     0           conv2d_77[0][0]
__________________________________________________________________________________________________
concatenate_36 (Concatenate)    (None, 4, 4, 50)     0
average_pooling2d_2[0][0]
dropout_39[0][0]
__________________________________________________________________________________________________
batch_normalization_77 (BatchNo (None, 4, 4, 50)     200
concatenate_36[0][0]
__________________________________________________________________________________________________
activation_77 (Activation)      (None, 4, 4, 50)     0
batch_normalization_77[0][0]
__________________________________________________________________________________________________
conv2d_78 (Conv2D)              (None, 4, 4, 25)     1250
activation_77[0][0]
__________________________________________________________________________________________________
batch_normalization_78 (BatchNo (None, 4, 4, 25)     100         conv2d_78[0][0]
__________________________________________________________________________________________________
activation_78 (Activation)      (None, 4, 4, 25)     0
batch_normalization_78[0][0]
__________________________________________________________________________________________________
```

```
__________________
conv2d_79 (Conv2D)              (None, 4, 4, 25)     5625
activation_78[0][0]
__________________________________________________________________________________
__________________
dropout_40 (Dropout)            (None, 4, 4, 25)     0           conv2d_79[0][0]
__________________________________________________________________________________
__________________
concatenate_37 (Concatenate)    (None, 4, 4, 75)     0
concatenate_36[0][0]
dropout_40[0][0]
__________________________________________________________________________________
__________________
batch_normalization_79 (BatchNo (None, 4, 4, 75)     300
concatenate_37[0][0]
__________________________________________________________________________________
__________________
activation_79 (Activation)      (None, 4, 4, 75)     0
batch_normalization_79[0][0]
__________________________________________________________________________________
__________________
conv2d_80 (Conv2D)              (None, 4, 4, 25)     1875
activation_79[0][0]
__________________________________________________________________________________
__________________
batch_normalization_80 (BatchNo (None, 4, 4, 25)     100         conv2d_80[0][0]
__________________________________________________________________________________
__________________
activation_80 (Activation)      (None, 4, 4, 25)     0
batch_normalization_80[0][0]
__________________________________________________________________________________
__________________
conv2d_81 (Conv2D)              (None, 4, 4, 25)     5625
activation_80[0][0]
__________________________________________________________________________________
__________________
dropout_41 (Dropout)            (None, 4, 4, 25)     0           conv2d_81[0][0]
__________________________________________________________________________________
__________________
concatenate_38 (Concatenate)    (None, 4, 4, 100)    0
concatenate_37[0][0]
dropout_41[0][0]
__________________________________________________________________________________
__________________
batch_normalization_81 (BatchNo (None, 4, 4, 100)    400
concatenate_38[0][0]
__________________________________________________________________________________
__________________
```

```
activation_81 (Activation)      (None, 4, 4, 100)    0
batch_normalization_81[0][0]
__________________________________________________________________________________
__________________
conv2d_82 (Conv2D)              (None, 4, 4, 25)     2500
activation_81[0][0]
__________________________________________________________________________________
__________________
batch_normalization_82 (BatchNo (None, 4, 4, 25)     100         conv2d_82[0][0]
__________________________________________________________________________________
__________________
activation_82 (Activation)      (None, 4, 4, 25)     0
batch_normalization_82[0][0]
__________________________________________________________________________________
__________________
conv2d_83 (Conv2D)              (None, 4, 4, 25)     5625
activation_82[0][0]
__________________________________________________________________________________
__________________
dropout_42 (Dropout)            (None, 4, 4, 25)     0           conv2d_83[0][0]
__________________________________________________________________________________
__________________
concatenate_39 (Concatenate)    (None, 4, 4, 125)    0
concatenate_38[0][0]
dropout_42[0][0]
__________________________________________________________________________________
__________________
batch_normalization_83 (BatchNo (None, 4, 4, 125)    500
concatenate_39[0][0]
__________________________________________________________________________________
__________________
activation_83 (Activation)      (None, 4, 4, 125)    0
batch_normalization_83[0][0]
__________________________________________________________________________________
__________________
conv2d_84 (Conv2D)              (None, 4, 4, 25)     3125
activation_83[0][0]
__________________________________________________________________________________
__________________
batch_normalization_84 (BatchNo (None, 4, 4, 25)     100         conv2d_84[0][0]
__________________________________________________________________________________
__________________
activation_84 (Activation)      (None, 4, 4, 25)     0
batch_normalization_84[0][0]
__________________________________________________________________________________
__________________
conv2d_85 (Conv2D)              (None, 4, 4, 25)     5625
activation_84[0][0]
```

```
__________________________________________________________________________________
__________________
dropout_43 (Dropout)            (None, 4, 4, 25)     0           conv2d_85[0][0]
__________________________________________________________________________________
__________________
concatenate_40 (Concatenate)    (None, 4, 4, 150)    0
concatenate_39[0][0]
dropout_43[0][0]
__________________________________________________________________________________
__________________
batch_normalization_85 (BatchNo (None, 4, 4, 150)    600
concatenate_40[0][0]
__________________________________________________________________________________
__________________
activation_85 (Activation)      (None, 4, 4, 150)    0
batch_normalization_85[0][0]
__________________________________________________________________________________
__________________
conv2d_86 (Conv2D)              (None, 4, 4, 25)     3750
activation_85[0][0]
__________________________________________________________________________________
__________________
batch_normalization_86 (BatchNo (None, 4, 4, 25)     100         conv2d_86[0][0]
__________________________________________________________________________________
__________________
activation_86 (Activation)      (None, 4, 4, 25)     0
batch_normalization_86[0][0]
__________________________________________________________________________________
__________________
conv2d_87 (Conv2D)              (None, 4, 4, 25)     5625
activation_86[0][0]
__________________________________________________________________________________
__________________
dropout_44 (Dropout)            (None, 4, 4, 25)     0           conv2d_87[0][0]
__________________________________________________________________________________
__________________
concatenate_41 (Concatenate)    (None, 4, 4, 175)    0
concatenate_40[0][0]
dropout_44[0][0]
__________________________________________________________________________________
__________________
batch_normalization_87 (BatchNo (None, 4, 4, 175)    700
concatenate_41[0][0]
__________________________________________________________________________________
__________________
activation_87 (Activation)      (None, 4, 4, 175)    0
batch_normalization_87[0][0]
__________________________________________________________________________________
```

```
__________________
conv2d_88 (Conv2D)              (None, 4, 4, 25)     4375
activation_87[0][0]
__________________________________________________________________________________
__________________
batch_normalization_88 (BatchNo (None, 4, 4, 25)     100         conv2d_88[0][0]
__________________________________________________________________________________
__________________
activation_88 (Activation)      (None, 4, 4, 25)     0
batch_normalization_88[0][0]
__________________________________________________________________________________
__________________
conv2d_89 (Conv2D)              (None, 4, 4, 25)     5625
activation_88[0][0]
__________________________________________________________________________________
__________________
dropout_45 (Dropout)            (None, 4, 4, 25)     0           conv2d_89[0][0]
__________________________________________________________________________________
__________________
concatenate_42 (Concatenate)    (None, 4, 4, 200)    0
concatenate_41[0][0]
dropout_45[0][0]
__________________________________________________________________________________
__________________
batch_normalization_89 (BatchNo (None, 4, 4, 200)    800
concatenate_42[0][0]
__________________________________________________________________________________
__________________
activation_89 (Activation)      (None, 4, 4, 200)    0
batch_normalization_89[0][0]
__________________________________________________________________________________
__________________
conv2d_90 (Conv2D)              (None, 4, 4, 25)     5000
activation_89[0][0]
__________________________________________________________________________________
__________________
batch_normalization_90 (BatchNo (None, 4, 4, 25)     100         conv2d_90[0][0]
__________________________________________________________________________________
__________________
activation_90 (Activation)      (None, 4, 4, 25)     0
batch_normalization_90[0][0]
__________________________________________________________________________________
__________________
conv2d_91 (Conv2D)              (None, 4, 4, 25)     5625
activation_90[0][0]
__________________________________________________________________________________
__________________
dropout_46 (Dropout)            (None, 4, 4, 25)     0           conv2d_91[0][0]
```

```
__________________________________________________________________________________
__________________
concatenate_43 (Concatenate)    (None, 4, 4, 225)    0
concatenate_42[0][0]
dropout_46[0][0]
__________________________________________________________________________________
__________________
batch_normalization_91 (BatchNo (None, 4, 4, 225)    900
concatenate_43[0][0]
__________________________________________________________________________________
__________________
activation_91 (Activation)      (None, 4, 4, 225)    0
batch_normalization_91[0][0]
__________________________________________________________________________________
__________________
conv2d_92 (Conv2D)              (None, 4, 4, 25)     5625
activation_91[0][0]
__________________________________________________________________________________
__________________
batch_normalization_92 (BatchNo (None, 4, 4, 25)     100          conv2d_92[0][0]
__________________________________________________________________________________
__________________
activation_92 (Activation)      (None, 4, 4, 25)     0
batch_normalization_92[0][0]
__________________________________________________________________________________
__________________
conv2d_93 (Conv2D)              (None, 4, 4, 25)     5625
activation_92[0][0]
__________________________________________________________________________________
__________________
dropout_47 (Dropout)            (None, 4, 4, 25)     0            conv2d_93[0][0]
__________________________________________________________________________________
__________________
concatenate_44 (Concatenate)    (None, 4, 4, 250)    0
concatenate_43[0][0]
dropout_47[0][0]
__________________________________________________________________________________
__________________
batch_normalization_93 (BatchNo (None, 4, 4, 250)    1000
concatenate_44[0][0]
__________________________________________________________________________________
__________________
activation_93 (Activation)      (None, 4, 4, 250)    0
batch_normalization_93[0][0]
__________________________________________________________________________________
__________________
conv2d_94 (Conv2D)              (None, 4, 4, 25)     6250
activation_93[0][0]
```

```
__________________________________________________________________________________
__________________
batch_normalization_94 (BatchNo (None, 4, 4, 25)     100         conv2d_94[0][0]
__________________________________________________________________________________
__________________
activation_94 (Activation)      (None, 4, 4, 25)     0
batch_normalization_94[0][0]
__________________________________________________________________________________
__________________
conv2d_95 (Conv2D)              (None, 4, 4, 25)     5625
activation_94[0][0]
__________________________________________________________________________________
__________________
dropout_48 (Dropout)            (None, 4, 4, 25)     0           conv2d_95[0][0]
__________________________________________________________________________________
__________________
concatenate_45 (Concatenate)    (None, 4, 4, 275)    0
concatenate_44[0][0]
dropout_48[0][0]
__________________________________________________________________________________
__________________
batch_normalization_95 (BatchNo (None, 4, 4, 275)    1100
concatenate_45[0][0]
__________________________________________________________________________________
__________________
activation_95 (Activation)      (None, 4, 4, 275)    0
batch_normalization_95[0][0]
__________________________________________________________________________________
__________________
conv2d_96 (Conv2D)              (None, 4, 4, 25)     6875
activation_95[0][0]
__________________________________________________________________________________
__________________
batch_normalization_96 (BatchNo (None, 4, 4, 25)     100         conv2d_96[0][0]
__________________________________________________________________________________
__________________
activation_96 (Activation)      (None, 4, 4, 25)     0
batch_normalization_96[0][0]
__________________________________________________________________________________
__________________
conv2d_97 (Conv2D)              (None, 4, 4, 25)     5625
activation_96[0][0]
__________________________________________________________________________________
__________________
dropout_49 (Dropout)            (None, 4, 4, 25)     0           conv2d_97[0][0]
__________________________________________________________________________________
__________________
concatenate_46 (Concatenate)    (None, 4, 4, 300)    0
```

```
concatenate_45[0][0]
dropout_49[0][0]
__________________________________________________________________________________
__________________
batch_normalization_97 (BatchNo (None, 4, 4, 300)    1200
concatenate_46[0][0]
__________________________________________________________________________________
__________________
activation_97 (Activation)      (None, 4, 4, 300)    0
batch_normalization_97[0][0]
__________________________________________________________________________________
__________________
conv2d_98 (Conv2D)              (None, 4, 4, 25)     7500
activation_97[0][0]
__________________________________________________________________________________
__________________
batch_normalization_98 (BatchNo (None, 4, 4, 25)     100          conv2d_98[0][0]
__________________________________________________________________________________
__________________
activation_98 (Activation)      (None, 4, 4, 25)     0
batch_normalization_98[0][0]
__________________________________________________________________________________
__________________
conv2d_99 (Conv2D)              (None, 4, 4, 25)     5625
activation_98[0][0]
__________________________________________________________________________________
__________________
dropout_50 (Dropout)            (None, 4, 4, 25)     0            conv2d_99[0][0]
__________________________________________________________________________________
__________________
concatenate_47 (Concatenate)    (None, 4, 4, 325)    0
concatenate_46[0][0]
dropout_50[0][0]
__________________________________________________________________________________
__________________
batch_normalization_99 (BatchNo (None, 4, 4, 325)    1300
concatenate_47[0][0]
__________________________________________________________________________________
__________________
activation_99 (Activation)      (None, 4, 4, 325)    0
batch_normalization_99[0][0]
__________________________________________________________________________________
__________________
average_pooling2d_3 (AveragePoo (None, 2, 2, 325)    0
activation_99[0][0]
__________________________________________________________________________________
__________________
flatten (Flatten)               (None, 1300)         0
```

```
average_pooling2d_3[0][0]
__________________________________________________________________________________
__________________
dense (Dense)                   (None, 10)           13010       flatten[0][0]
==================================================================================
==================
Total params: 548,704
Trainable params: 527,818
Non-trainable params: 20,886
__________________________________________________________________________________
__________________
```

[ ]:
```
print(len(model5.layers))
```

```
406
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[ ]:
```
model5.
 ↪compile(optimizer='adam',loss='categorical_crossentropy',metrics=['accuracy'])

model5.fit(aug.
 ↪flow(X_train,y_train,batch_size=batch_size),epochs=nb_epoch,batch_size=batch_size,verbose=1
           steps_per_epoch=(len(X_train)//batch_size),
          ␣
 ↪callbacks=[reduce_lr,lr_scheduler,csv_logger,early_stop,model_checkpoint],
           validation_data=(X_test,y_test))
```

```
Epoch 1/100
781/781 [==============================] - 168s 163ms/step - loss: 1.9539 -
accuracy: 0.2869 - val_loss: 1.8601 - val_accuracy: 0.3451

Epoch 00001: val_accuracy improved from -inf to 0.34510, saving model to
model5_weights.best.hdf5
Epoch 2/100
781/781 [==============================] - 125s 161ms/step - loss: 1.5744 -
accuracy: 0.4215 - val_loss: 2.7340 - val_accuracy: 0.2778

Epoch 00002: val_accuracy did not improve from 0.34510
Epoch 3/100
781/781 [==============================] - 126s 161ms/step - loss: 1.3330 -
accuracy: 0.5172 - val_loss: 2.8528 - val_accuracy: 0.3612

Epoch 00003: val_accuracy improved from 0.34510 to 0.36120, saving model to
model5_weights.best.hdf5
Epoch 4/100
781/781 [==============================] - 126s 161ms/step - loss: 1.1693 -
accuracy: 0.5798 - val_loss: 1.3349 - val_accuracy: 0.5871

Epoch 00004: val_accuracy improved from 0.36120 to 0.58710, saving model to
```

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model5_weights.best.hdf5
Epoch 5/100
781/781 [==============================] - 126s 161ms/step - loss: 1.0555 -
accuracy: 0.6220 - val_loss: 1.4948 - val_accuracy: 0.5794

Epoch 00005: val_accuracy did not improve from 0.58710
Epoch 6/100
781/781 [==============================] - 125s 160ms/step - loss: 0.9628 -
accuracy: 0.6577 - val_loss: 3.3519 - val_accuracy: 0.3629

Epoch 00006: val_accuracy did not improve from 0.58710
Epoch 7/100
781/781 [==============================] - 125s 160ms/step - loss: 0.8920 -
accuracy: 0.6870 - val_loss: 1.3352 - val_accuracy: 0.6218

Epoch 00007: val_accuracy improved from 0.58710 to 0.62180, saving model to
model5_weights.best.hdf5
Epoch 8/100
781/781 [==============================] - 125s 160ms/step - loss: 0.8268 -
accuracy: 0.7100 - val_loss: 1.1063 - val_accuracy: 0.6978

Epoch 00008: val_accuracy improved from 0.62180 to 0.69780, saving model to
model5_weights.best.hdf5
Epoch 9/100
781/781 [==============================] - 125s 160ms/step - loss: 0.7805 -
accuracy: 0.7263 - val_loss: 1.5754 - val_accuracy: 0.5854

Epoch 00009: val_accuracy did not improve from 0.69780
Epoch 10/100
781/781 [==============================] - 125s 160ms/step - loss: 0.7375 -
accuracy: 0.7439 - val_loss: 1.3145 - val_accuracy: 0.6552

Epoch 00010: val_accuracy did not improve from 0.69780
Epoch 11/100
781/781 [==============================] - 124s 159ms/step - loss: 0.7026 -
accuracy: 0.7547 - val_loss: 1.6132 - val_accuracy: 0.6050

Epoch 00011: val_accuracy did not improve from 0.69780
Epoch 12/100
781/781 [==============================] - 124s 159ms/step - loss: 0.6798 -
accuracy: 0.7638 - val_loss: 0.6869 - val_accuracy: 0.7797

Epoch 00012: val_accuracy improved from 0.69780 to 0.77970, saving model to
model5_weights.best.hdf5
Epoch 13/100
781/781 [==============================] - 125s 160ms/step - loss: 0.6541 -
accuracy: 0.7721 - val_loss: 1.0733 - val_accuracy: 0.6972
```

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Epoch 00013: val_accuracy did not improve from 0.77970
Epoch 14/100
781/781 [==============================] - 125s 160ms/step - loss: 0.6308 -
accuracy: 0.7798 - val_loss: 1.0946 - val_accuracy: 0.7073

Epoch 00014: val_accuracy did not improve from 0.77970
Epoch 15/100
781/781 [==============================] - 124s 159ms/step - loss: 0.6116 -
accuracy: 0.7886 - val_loss: 0.6905 - val_accuracy: 0.7832

Epoch 00015: val_accuracy improved from 0.77970 to 0.78320, saving model to
model5_weights.best.hdf5
Epoch 16/100
781/781 [==============================] - 124s 159ms/step - loss: 0.5951 -
accuracy: 0.7928 - val_loss: 1.1738 - val_accuracy: 0.6919

Epoch 00016: val_accuracy did not improve from 0.78320
Epoch 17/100
781/781 [==============================] - 125s 160ms/step - loss: 0.5798 -
accuracy: 0.7982 - val_loss: 0.7496 - val_accuracy: 0.7758

Epoch 00017: val_accuracy did not improve from 0.78320
Epoch 18/100
781/781 [==============================] - 125s 160ms/step - loss: 0.5659 -
accuracy: 0.8046 - val_loss: 0.6886 - val_accuracy: 0.7975

Epoch 00018: val_accuracy improved from 0.78320 to 0.79750, saving model to
model5_weights.best.hdf5
Epoch 19/100
781/781 [==============================] - 125s 160ms/step - loss: 0.5497 -
accuracy: 0.8112 - val_loss: 0.8661 - val_accuracy: 0.7550

Epoch 00019: val_accuracy did not improve from 0.79750
Epoch 20/100
781/781 [==============================] - 124s 159ms/step - loss: 0.5350 -
accuracy: 0.8157 - val_loss: 1.1197 - val_accuracy: 0.7082

Epoch 00020: val_accuracy did not improve from 0.79750
Epoch 21/100
781/781 [==============================] - 125s 160ms/step - loss: 0.5278 -
accuracy: 0.8173 - val_loss: 0.6811 - val_accuracy: 0.7966

Epoch 00021: val_accuracy did not improve from 0.79750
Epoch 22/100
781/781 [==============================] - 125s 159ms/step - loss: 0.5154 -
accuracy: 0.8207 - val_loss: 0.7040 - val_accuracy: 0.7911

Epoch 00022: val_accuracy did not improve from 0.79750
```

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Epoch 23/100
781/781 [==============================] - 125s 160ms/step - loss: 0.5016 -
accuracy: 0.8256 - val_loss: 0.6738 - val_accuracy: 0.8055

Epoch 00023: val_accuracy improved from 0.79750 to 0.80550, saving model to
model5_weights.best.hdf5
Epoch 24/100
781/781 [==============================] - 124s 159ms/step - loss: 0.4982 -
accuracy: 0.8278 - val_loss: 1.3099 - val_accuracy: 0.7262

Epoch 00024: val_accuracy did not improve from 0.80550
Epoch 25/100
781/781 [==============================] - 125s 160ms/step - loss: 0.4934 -
accuracy: 0.8297 - val_loss: 0.5844 - val_accuracy: 0.8245

Epoch 00025: val_accuracy improved from 0.80550 to 0.82450, saving model to
model5_weights.best.hdf5
Epoch 26/100
781/781 [==============================] - 125s 159ms/step - loss: 0.4094 -
accuracy: 0.8584 - val_loss: 0.4688 - val_accuracy: 0.8598

Epoch 00026: val_accuracy improved from 0.82450 to 0.85980, saving model to
model5_weights.best.hdf5
Epoch 27/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3893 -
accuracy: 0.8632 - val_loss: 0.4260 - val_accuracy: 0.8694

Epoch 00027: val_accuracy improved from 0.85980 to 0.86940, saving model to
model5_weights.best.hdf5
Epoch 28/100
781/781 [==============================] - 125s 160ms/step - loss: 0.3821 -
accuracy: 0.8683 - val_loss: 0.4430 - val_accuracy: 0.8650

Epoch 00028: val_accuracy did not improve from 0.86940
Epoch 29/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3752 -
accuracy: 0.8703 - val_loss: 0.4483 - val_accuracy: 0.8640

Epoch 00029: val_accuracy did not improve from 0.86940
Epoch 30/100
781/781 [==============================] - 125s 159ms/step - loss: 0.3675 -
accuracy: 0.8719 - val_loss: 0.4330 - val_accuracy: 0.8685

Epoch 00030: val_accuracy did not improve from 0.86940
Epoch 31/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3609 -
accuracy: 0.8746 - val_loss: 0.4285 - val_accuracy: 0.8714
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Epoch 00031: val_accuracy improved from 0.86940 to 0.87140, saving model to
model5_weights.best.hdf5
Epoch 32/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3572 -
accuracy: 0.8765 - val_loss: 0.4048 - val_accuracy: 0.8776

Epoch 00032: val_accuracy improved from 0.87140 to 0.87760, saving model to
model5_weights.best.hdf5
Epoch 33/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3538 -
accuracy: 0.8764 - val_loss: 0.4468 - val_accuracy: 0.8666

Epoch 00033: val_accuracy did not improve from 0.87760
Epoch 34/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3451 -
accuracy: 0.8806 - val_loss: 0.4183 - val_accuracy: 0.8751

Epoch 00034: val_accuracy did not improve from 0.87760
Epoch 35/100
781/781 [==============================] - 125s 160ms/step - loss: 0.3463 -
accuracy: 0.8809 - val_loss: 0.4134 - val_accuracy: 0.8743

Epoch 00035: val_accuracy did not improve from 0.87760
Epoch 36/100
781/781 [==============================] - 125s 160ms/step - loss: 0.3373 -
accuracy: 0.8829 - val_loss: 0.4375 - val_accuracy: 0.8720

Epoch 00036: val_accuracy did not improve from 0.87760
Epoch 37/100
781/781 [==============================] - 125s 160ms/step - loss: 0.3428 -
accuracy: 0.8805 - val_loss: 0.4091 - val_accuracy: 0.8754

Epoch 00037: val_accuracy did not improve from 0.87760
Epoch 38/100
781/781 [==============================] - 125s 160ms/step - loss: 0.3376 -
accuracy: 0.8825 - val_loss: 0.3819 - val_accuracy: 0.8815

Epoch 00038: val_accuracy improved from 0.87760 to 0.88150, saving model to
model5_weights.best.hdf5
Epoch 39/100
781/781 [==============================] - 125s 160ms/step - loss: 0.3375 -
accuracy: 0.8821 - val_loss: 0.4721 - val_accuracy: 0.8637

Epoch 00039: val_accuracy did not improve from 0.88150
Epoch 40/100
781/781 [==============================] - 125s 160ms/step - loss: 0.3339 -
accuracy: 0.8854 - val_loss: 0.4030 - val_accuracy: 0.8788
```

```
Epoch 00040: val_accuracy did not improve from 0.88150
Epoch 41/100
781/781 [==============================] - 125s 160ms/step - loss: 0.3334 -
accuracy: 0.8832 - val_loss: 0.4245 - val_accuracy: 0.8726

Epoch 00041: val_accuracy did not improve from 0.88150
Epoch 42/100
781/781 [==============================] - 125s 160ms/step - loss: 0.3289 -
accuracy: 0.8873 - val_loss: 0.4051 - val_accuracy: 0.8773

Epoch 00042: val_accuracy did not improve from 0.88150
Epoch 43/100
781/781 [==============================] - 125s 160ms/step - loss: 0.3271 -
accuracy: 0.8861 - val_loss: 0.4003 - val_accuracy: 0.8798

Epoch 00043: val_accuracy did not improve from 0.88150
Epoch 44/100
781/781 [==============================] - 125s 160ms/step - loss: 0.3262 -
accuracy: 0.8862 - val_loss: 0.4186 - val_accuracy: 0.8755

Epoch 00044: val_accuracy did not improve from 0.88150
Epoch 45/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3253 -
accuracy: 0.8862 - val_loss: 0.4137 - val_accuracy: 0.8778

Epoch 00045: val_accuracy did not improve from 0.88150
Epoch 46/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3198 -
accuracy: 0.8879 - val_loss: 0.3992 - val_accuracy: 0.8838

Epoch 00046: val_accuracy improved from 0.88150 to 0.88380, saving model to
model5_weights.best.hdf5
Epoch 47/100
781/781 [==============================] - 125s 160ms/step - loss: 0.3146 -
accuracy: 0.8895 - val_loss: 0.3991 - val_accuracy: 0.8800

Epoch 00047: val_accuracy did not improve from 0.88380
Epoch 48/100
781/781 [==============================] - 125s 159ms/step - loss: 0.3127 -
accuracy: 0.8908 - val_loss: 0.3981 - val_accuracy: 0.8810

Epoch 00048: val_accuracy did not improve from 0.88380
Epoch 49/100
781/781 [==============================] - 125s 160ms/step - loss: 0.3180 -
accuracy: 0.8898 - val_loss: 0.4189 - val_accuracy: 0.8791

Epoch 00049: val_accuracy did not improve from 0.88380
Epoch 50/100
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781/781 [==============================] - 125s 160ms/step - loss: 0.3189 -
accuracy: 0.8886 - val_loss: 0.4156 - val_accuracy: 0.8764

Epoch 00050: val_accuracy did not improve from 0.88380
Epoch 51/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3109 -
accuracy: 0.8916 - val_loss: 0.3908 - val_accuracy: 0.8856

Epoch 00051: val_accuracy improved from 0.88380 to 0.88560, saving model to
model5_weights.best.hdf5
Epoch 52/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3118 -
accuracy: 0.8902 - val_loss: 0.3922 - val_accuracy: 0.8845

Epoch 00052: val_accuracy did not improve from 0.88560
Epoch 53/100
781/781 [==============================] - 124s 158ms/step - loss: 0.3063 -
accuracy: 0.8922 - val_loss: 0.3903 - val_accuracy: 0.8857

Epoch 00053: val_accuracy improved from 0.88560 to 0.88570, saving model to
model5_weights.best.hdf5
Epoch 54/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3006 -
accuracy: 0.8950 - val_loss: 0.3903 - val_accuracy: 0.8863

Epoch 00054: val_accuracy improved from 0.88570 to 0.88630, saving model to
model5_weights.best.hdf5
Epoch 55/100
781/781 [==============================] - 124s 158ms/step - loss: 0.3004 -
accuracy: 0.8947 - val_loss: 0.3926 - val_accuracy: 0.8850

Epoch 00055: val_accuracy did not improve from 0.88630
Epoch 56/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3010 -
accuracy: 0.8934 - val_loss: 0.3814 - val_accuracy: 0.8881

Epoch 00056: val_accuracy improved from 0.88630 to 0.88810, saving model to
model5_weights.best.hdf5
Epoch 57/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2998 -
accuracy: 0.8943 - val_loss: 0.3942 - val_accuracy: 0.8854

Epoch 00057: val_accuracy did not improve from 0.88810
Epoch 58/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3010 -
accuracy: 0.8955 - val_loss: 0.3848 - val_accuracy: 0.8866

Epoch 00058: val_accuracy did not improve from 0.88810
```

```
Epoch 59/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3007 -
accuracy: 0.8941 - val_loss: 0.3823 - val_accuracy: 0.8879

Epoch 00059: val_accuracy did not improve from 0.88810
Epoch 60/100
781/781 [==============================] - 124s 158ms/step - loss: 0.3023 -
accuracy: 0.8946 - val_loss: 0.3821 - val_accuracy: 0.8867

Epoch 00060: val_accuracy did not improve from 0.88810
Epoch 61/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2990 -
accuracy: 0.8958 - val_loss: 0.3833 - val_accuracy: 0.8874

Epoch 00061: val_accuracy did not improve from 0.88810
Epoch 62/100
781/781 [==============================] - 125s 159ms/step - loss: 0.2999 -
accuracy: 0.8951 - val_loss: 0.3818 - val_accuracy: 0.8864

Epoch 00062: val_accuracy did not improve from 0.88810
Epoch 63/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3023 -
accuracy: 0.8949 - val_loss: 0.3909 - val_accuracy: 0.8843

Epoch 00063: val_accuracy did not improve from 0.88810
Epoch 64/100
781/781 [==============================] - 124s 158ms/step - loss: 0.3020 -
accuracy: 0.8942 - val_loss: 0.3879 - val_accuracy: 0.8865

Epoch 00064: val_accuracy did not improve from 0.88810
Epoch 65/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2994 -
accuracy: 0.8946 - val_loss: 0.3842 - val_accuracy: 0.8877

Epoch 00065: val_accuracy did not improve from 0.88810
Epoch 66/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3017 -
accuracy: 0.8944 - val_loss: 0.3793 - val_accuracy: 0.8889

Epoch 00066: val_accuracy improved from 0.88810 to 0.88890, saving model to
model5_weights.best.hdf5
Epoch 67/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2956 -
accuracy: 0.8963 - val_loss: 0.3826 - val_accuracy: 0.8870

Epoch 00067: val_accuracy did not improve from 0.88890
Epoch 68/100
781/781 [==============================] - 124s 159ms/step - loss: 0.3012 -
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accuracy: 0.8942 - val_loss: 0.3844 - val_accuracy: 0.8867

Epoch 00068: val_accuracy did not improve from 0.88890
Epoch 69/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2973 -
accuracy: 0.8974 - val_loss: 0.3888 - val_accuracy: 0.8860

Epoch 00069: val_accuracy did not improve from 0.88890
Epoch 70/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2982 -
accuracy: 0.8953 - val_loss: 0.3884 - val_accuracy: 0.8866

Epoch 00070: val_accuracy did not improve from 0.88890
Epoch 71/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2997 -
accuracy: 0.8946 - val_loss: 0.3878 - val_accuracy: 0.8866

Epoch 00071: val_accuracy did not improve from 0.88890
Epoch 72/100
781/781 [==============================] - 125s 160ms/step - loss: 0.2992 -
accuracy: 0.8974 - val_loss: 0.3867 - val_accuracy: 0.8876

Epoch 00072: val_accuracy did not improve from 0.88890
Epoch 73/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2951 -
accuracy: 0.8963 - val_loss: 0.3813 - val_accuracy: 0.8890

Epoch 00073: val_accuracy improved from 0.88890 to 0.88900, saving model to
model5_weights.best.hdf5
Epoch 74/100
781/781 [==============================] - 125s 159ms/step - loss: 0.2981 -
accuracy: 0.8955 - val_loss: 0.3842 - val_accuracy: 0.8868

Epoch 00074: val_accuracy did not improve from 0.88900
Epoch 75/100
781/781 [==============================] - 125s 159ms/step - loss: 0.2970 -
accuracy: 0.8969 - val_loss: 0.3855 - val_accuracy: 0.8867

Epoch 00075: val_accuracy did not improve from 0.88900
Epoch 76/100
781/781 [==============================] - 125s 159ms/step - loss: 0.2939 -
accuracy: 0.8969 - val_loss: 0.3881 - val_accuracy: 0.8884

Epoch 00076: val_accuracy did not improve from 0.88900
Epoch 77/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2957 -
accuracy: 0.8960 - val_loss: 0.3855 - val_accuracy: 0.8890
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Epoch 00077: val_accuracy did not improve from 0.88900
Epoch 78/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2948 -
accuracy: 0.8967 - val_loss: 0.3896 - val_accuracy: 0.8878

Epoch 00078: val_accuracy did not improve from 0.88900
Epoch 79/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2965 -
accuracy: 0.8962 - val_loss: 0.3808 - val_accuracy: 0.8890

Epoch 00079: val_accuracy did not improve from 0.88900
Epoch 80/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2952 -
accuracy: 0.8980 - val_loss: 0.3862 - val_accuracy: 0.8879

Epoch 00080: val_accuracy did not improve from 0.88900
Epoch 81/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2949 -
accuracy: 0.8969 - val_loss: 0.3879 - val_accuracy: 0.8863

Epoch 00081: val_accuracy did not improve from 0.88900
Epoch 82/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2986 -
accuracy: 0.8959 - val_loss: 0.3815 - val_accuracy: 0.8891

Epoch 00082: val_accuracy improved from 0.88900 to 0.88910, saving model to
model5_weights.best.hdf5
Epoch 83/100
781/781 [==============================] - 125s 160ms/step - loss: 0.2974 -
accuracy: 0.8958 - val_loss: 0.3891 - val_accuracy: 0.8873

Epoch 00083: val_accuracy did not improve from 0.88910
Epoch 84/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2946 -
accuracy: 0.8971 - val_loss: 0.3838 - val_accuracy: 0.8889

Epoch 00084: val_accuracy did not improve from 0.88910
Epoch 85/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2971 -
accuracy: 0.8969 - val_loss: 0.3807 - val_accuracy: 0.8887

Epoch 00085: val_accuracy did not improve from 0.88910
Epoch 86/100
781/781 [==============================] - 125s 159ms/step - loss: 0.2908 -
accuracy: 0.8973 - val_loss: 0.3842 - val_accuracy: 0.8889

Epoch 00086: val_accuracy did not improve from 0.88910
Epoch 87/100
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781/781 [==============================] - 124s 159ms/step - loss: 0.2960 -
accuracy: 0.8954 - val_loss: 0.3871 - val_accuracy: 0.8878

Epoch 00087: val_accuracy did not improve from 0.88910
Epoch 88/100
781/781 [==============================] - 125s 160ms/step - loss: 0.2933 -
accuracy: 0.8969 - val_loss: 0.3809 - val_accuracy: 0.8880

Epoch 00088: val_accuracy did not improve from 0.88910
Epoch 89/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2929 -
accuracy: 0.8979 - val_loss: 0.3799 - val_accuracy: 0.8892

Epoch 00089: val_accuracy improved from 0.88910 to 0.88920, saving model to
model5_weights.best.hdf5
Epoch 90/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2910 -
accuracy: 0.8989 - val_loss: 0.3807 - val_accuracy: 0.8908

Epoch 00090: val_accuracy improved from 0.88920 to 0.89080, saving model to
model5_weights.best.hdf5
Epoch 91/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2920 -
accuracy: 0.8975 - val_loss: 0.3795 - val_accuracy: 0.8902

Epoch 00091: val_accuracy did not improve from 0.89080
Epoch 92/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2921 -
accuracy: 0.8981 - val_loss: 0.3800 - val_accuracy: 0.8899

Epoch 00092: val_accuracy did not improve from 0.89080
Epoch 93/100
781/781 [==============================] - 125s 160ms/step - loss: 0.2974 -
accuracy: 0.8960 - val_loss: 0.3842 - val_accuracy: 0.8883

Epoch 00093: val_accuracy did not improve from 0.89080
Epoch 94/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2936 -
accuracy: 0.8975 - val_loss: 0.3880 - val_accuracy: 0.8876

Epoch 00094: val_accuracy did not improve from 0.89080
Epoch 95/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2912 -
accuracy: 0.8979 - val_loss: 0.3797 - val_accuracy: 0.8896

Epoch 00095: val_accuracy did not improve from 0.89080
Epoch 96/100
781/781 [==============================] - 124s 159ms/step - loss: 0.2941 -
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accuracy: 0.8977 - val_loss: 0.3795 - val_accuracy: 0.8900

Epoch 00096: val_accuracy did not improve from 0.89080
```

[ ]:
```
<tensorflow.python.keras.callbacks.History at 0x7f175e69a550>
```

[ ]:
```
import pandas as pd
import numpy as np
training_log = pd.read_csv('/content/training_model5.log')
training_log.head(100)
```

[ ]:

	epoch	accuracy	loss	lr	val_accuracy	val_loss
0	0	0.286867	1.953920	0.0100	0.3451	1.860124
1	1	0.421540	1.574372	0.0100	0.2778	2.734015
2	2	0.517222	1.333009	0.0100	0.3612	2.852820
3	3	0.579842	1.169290	0.0100	0.5871	1.334862
4	4	0.622016	1.055502	0.0100	0.5794	1.494813
..	…	…	…	…	…	…
91	91	0.898130	0.292132	0.0001	0.8899	0.380016
92	92	0.896007	0.297427	0.0001	0.8883	0.384248
93	93	0.897529	0.293597	0.0001	0.8876	0.387959
94	94	0.897889	0.291213	0.0001	0.8896	0.379663
95	95	0.897749	0.294055	0.0001	0.8900	0.379485

[96 rows x 6 columns]

[ ]:
```
model5.load_weights('/content/model5_weights.best.hdf5')
model5.
 ↪compile(optimizer='adam',loss='categorical_crossentropy',metrics=['accuracy'])
print("Model created and weights loaded from file")
```

```
Model created and weights loaded from file
```

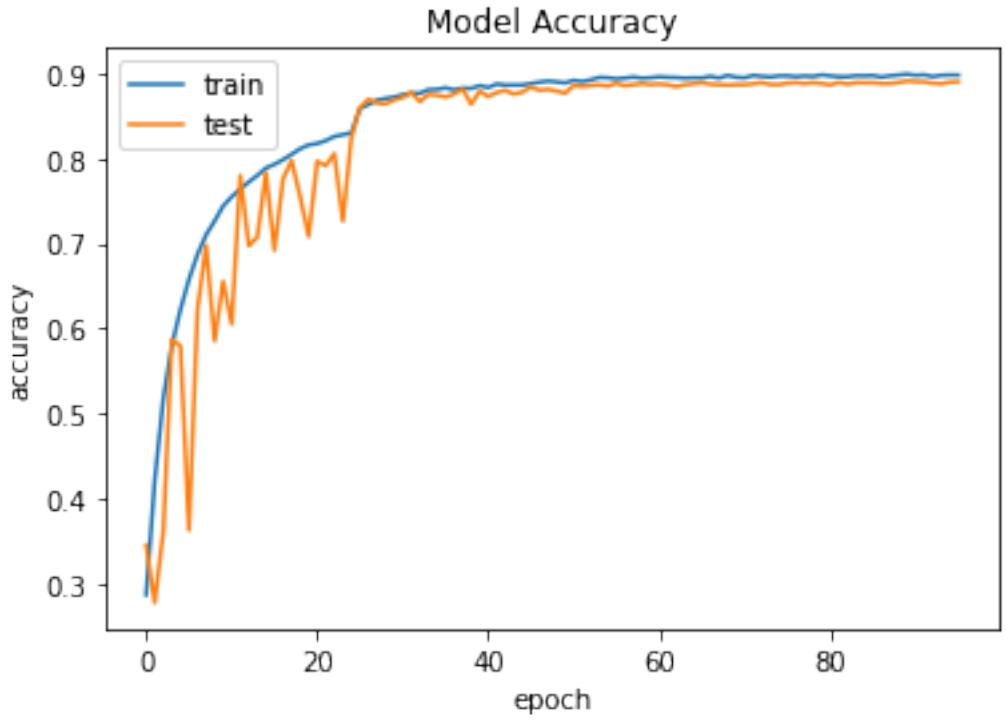
[ ]:
```
score = model5.evaluate(X_test,y_test,verbose=0)
print("Test loss = ",score[0])
print("Test accuracy = ",score[1])
```

```
Test loss =  0.3807081878185272
Test accuracy =  0.8907999992370605
```

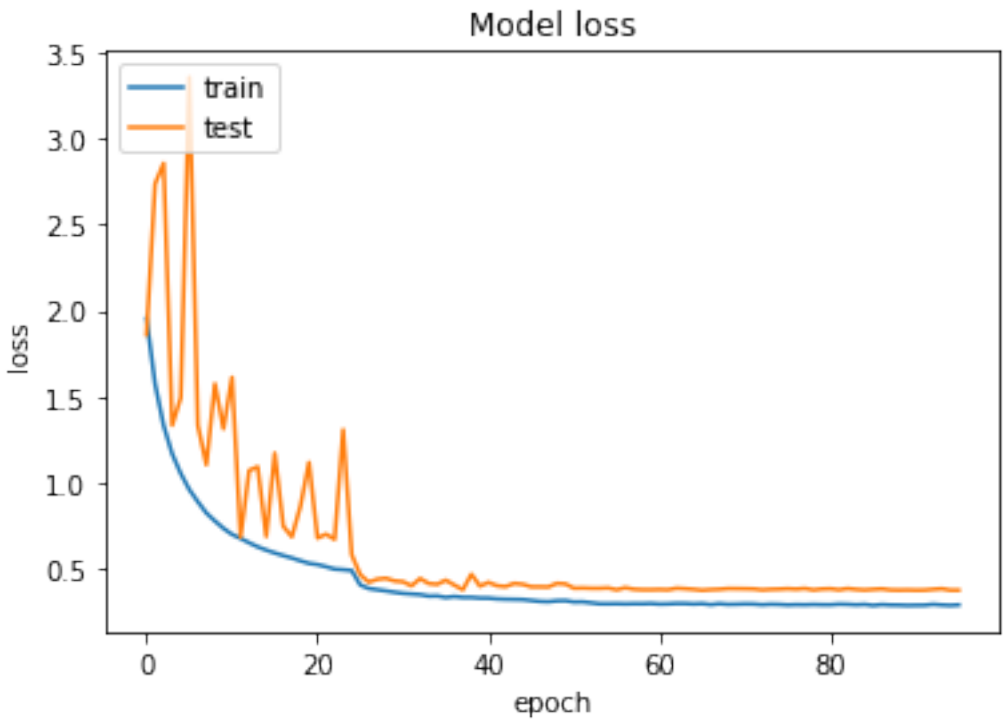
1.3.7 2.7 Plotting loss and accuracy of Model 5 above

[ ]:
```
%matplotlib notebook
%matplotlib inline
import matplotlib.pyplot as plt
import numpy as np
import time
```

[ ]:
```
#https://machinelearningmastery.com/
 ↪display-deep-learning-model-training-history-in-keras/
plt.plot(training_log['accuracy'])
plt.plot(training_log['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['train','test'],loc='upper left')
plt.show()
```



[ ]:
```
#https://machinelearningmastery.com/
 ↪display-deep-learning-model-training-history-in-keras/
plt.plot(training_log['loss'])
plt.plot(training_log['val_loss'])
plt.title('Model loss')
plt.xlabel('epoch')
plt.ylabel('loss')
plt.legend(['train','test'],loc='upper left')
plt.show()
```



1.4 3. Conclusion

[6]:
```
from prettytable import PrettyTable

x = PrettyTable()
x.field_names = ['Growth Rate','Compression','# of Blocks','Test Accuracy']
x.add_row([24,0.5,12,82.590])
x.add_row([32,0.7,12,87.990])
x.add_row([36,0.7,12,89.079])

print(x)
```

```
+-------------+-------------+-------------+---------------+
| Growth Rate | Compression | # of Blocks | Test Accuracy |
+-------------+-------------+-------------+---------------+
|      24     |     0.5     |      12     |     82.59     |
|      32     |     0.7     |      12     |     87.99     |
|      36     |     0.7     |      12     |     89.079    |
+-------------+-------------+-------------+---------------+
```

[7]:
```
from prettytable import PrettyTable
```

```
x1 = PrettyTable()
x1.field_names = ['Growth Rate','Compression','# of Blocks','Test Accuracy']
x1.add_row([24,0.5,12,82.590])
x1.add_row([32,0.7,12,87.990])
x1.add_row([36,0.7,12,89.079])

print(x1)
```

```
+-------------+-------------+-------------+---------------+
| Growth Rate | Compression | # of Blocks | Test Accuracy |
+-------------+-------------+-------------+---------------+
|      24     |     0.5     |      12     |     82.59     |
|      32     |     0.7     |      12     |     87.99     |
|      36     |     0.7     |      12     |     89.079    |
+-------------+-------------+-------------+---------------+
```

Summary:

1. I have used Keras callbacks to adjust the learning rate as per the performance of the model(ReduceLRonPlateau,LearningRate Sceduler).
2. Increase in Growth rate along with an increase with compression rate has led to improvement in test accuracy scores.

Additional links and resuorces:

1. 2016 DenseNet paper summary: https://www.youtube.com/watch?v=hSC_0S8Zf9s
2. Separable Depth wise convolutions: https://towardsdatascience.com/a-basic-introduction-to-separable-convolutions-b99ec3102728
3. Review DenseNet image classification: https://towardsdatascience.com/review-densenet-image-classification-b6631a8ef803

[ ]:

[ ]: