image_classification

January 14, 2019

0.1 Project: Image Classification

In this project, I have classified images from the CIFAR-10 dataset (https://www.cs.toronto.edu/~kriz/cifar.html). The dataset consists of airplanes, dogs, cats, and other objects.

In this project I have used Keras a framework which supports convolutional neural network for classifying images form CIFAR-10 dataset. I have developed my onw model based on Keras and used it for training and testing.

I have used following steps in the project

- Download Keras
- Import all the modules
- Download the images from CIFAR-10 dataset
- Augment the images dataset by performing operations like rotation
- Define Keras model
- Train and test the dataset

I have run this on my laptop (Lenovo Legin Y720) which has 6 GB GPU.

0.2 Install Keras

In [1]:
```
# https://keras.io/
!pip install -q keras
import keras
```

```
notebook 5.4.0 requires ipykernel, which is not installed.
jupyter 1.0.0 requires ipykernel, which is not installed.
jupyter-console 5.2.0 requires ipykernel, which is not installed.
ipywidgets 7.1.1 requires ipykernel>=4.5.1, which is not installed.
tensorflow-gpu 1.9.0 has requirement tensorboard<1.10.0,>=1.9.0, but you'll have tensorboard 1
You are using pip version 10.0.1, however version 18.1 is available.
You should consider upgrading via the 'python -m pip install --upgrade pip' command.
E:\anaconda\lib\site-packages\h5py\__init__.py:36: FutureWarning: Conversion of the second argu
  from ._conv import register_converters as _register_converters
Using TensorFlow backend.
```

0.3 Import all the modules

In [2]:
```
import keras
from keras.datasets import cifar10
from keras.models import Model, Sequential
from keras.layers import Dense, Dropout, Flatten, Input, AveragePooling2D, merge, Activ
from keras.layers import Conv2D, MaxPooling2D, BatchNormalization
from keras.layers import Concatenate
from keras.optimizers import Adam
from keras.optimizers import SGD
```

0.4 Tensorflow configuration changes for GPU

In [3]:
```
# this part will prevent tensorflow to allocate all the avaliable GPU Memory
# backend
import tensorflow as tf
from keras import backend as k

# Don't pre-allocate memory; allocate as-needed
config = tf.ConfigProto()
config.gpu_options.allow_growth = True

# Create a session with the above options specified.
k.tensorflow_backend.set_session(tf.Session(config=config))
```

0.5 Define Hyper parameters to be used

Following hyper parameters are used:

- batch_size - Batch size
- num_classes - Number of classes (10)
- epochs - Number of epochs (250)
- l - Number of layers
- num_filter - Number of filters
- compression
- dropout_rate

In [4]:
```
# Hyperparameters
batch_size = 64
num_classes = 10
epochs = 250
l = 22
num_filter = 16
compression = 0.5
dropout_rate = 0.25
```

0.6 Download the dataset and perform one hot encoding

In this step, I have downloaded the cifar10 training and test data

Next, performed one-hot encoding on target labels train_y and test_y to get the resultant train_y, test_y which will be used for processing

```
In [5]: # Load CIFAR10 Data
        (x_train, y_train), (x_test, y_test) = cifar10.load_data()
        img_height, img_width, channel = x_train.shape[1],x_train.shape[2],x_train.shape[3]

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

0.7 Perform Image augmentation of images

1. Peform image augmentation by rotating 45 degrees for a randomly selected 1000 images and append the augmented images
2. Perform image augmentation by rotating 45 degrees for a randomly selected 1000 images and append the augmented images

```
In [6]: from keras.preprocessing.image import ImageDataGenerator
        import numpy as np

        # Rotate images by 45 degrees
        datagen1 = ImageDataGenerator(rotation_range=45)

        # fit parameters from data
        datagen1.fit(x_train)

        # Get 1000 augmented images and append to the training data
        for x_rotated_images_batch, y_rotated_images_batch in datagen1.flow(x_train, y_train, l
            x_train = np.append(x_train, x_rotated_images_batch, axis=0)
            y_train = np.append(y_train, y_rotated_images_batch, axis=0)
            break

        # Horizontally flip image
        datagen2 = ImageDataGenerator(horizontal_flip=True)

        # fit parameters from data
        datagen2.fit(x_train)

        # Get 1000 augmented horizontally flipped images and append to the training data
        for x_flipped_images_batch, y_flipped_images_batch in datagen2.flow(x_train, y_train, l
            x_train = np.append(x_train, x_flipped_images_batch, axis=0)
            y_train = np.append(y_train, y_flipped_images_batch, axis=0)
            break
```

0.8 Create building blocks for model

1. Create a method for add_denseblock of layers where each layer has following operations: perform Batch Normalization, Perform relu Activation Apply 3x3 convolution of a number

of filters num_filter*compression Add dropout

All the layers are concated to form a dense block

2. Create a method add_transition which does the folloiwng:

   perform Batch Normalization, Perform relu Activation Apply 1x1 convolution of a number of filters num_filter*compression Add dropout Perform 2x2 Average Pooling

3. Create a method output_layer which does the folloiwng:

   perform Batch Normalization, Perform relu Activation Perform 2x2 Average Pooling Flatten Dense layer of 10 classes with softmax activation

```
In [7]: # Dense Block
        def add_denseblock(input, num_filter = 12, dropout_rate = 0.2):
            global compression
            temp = input
            for _ in range(l):
                BatchNorm = BatchNormalization()(temp)
                relu = Activation('relu')(BatchNorm)
                Conv2D_3_3 = Conv2D(int(num_filter*compression), (3,3), use_bias=False ,padding
                if dropout_rate>0:
                  Conv2D_3_3 = Dropout(dropout_rate)(Conv2D_3_3)
                concat = Concatenate(axis=-1)([temp,Conv2D_3_3])

                temp = concat

            return temp

In [8]: def add_transition(input, num_filter = 12, dropout_rate = 0.2):
            global compression
            BatchNorm = BatchNormalization()(input)
            relu = Activation('relu')(BatchNorm)
            Conv2D_BottleNeck = Conv2D(int(num_filter*compression), (1,1), use_bias=False ,pado
            if dropout_rate>0:
              Conv2D_BottleNeck = Dropout(dropout_rate)(Conv2D_BottleNeck)
            AvgPooling = AveragePooling2D(pool_size=(2,2))(Conv2D_BottleNeck)

            return AvgPooling

In [9]: def output_layer(input):
            global compression
            BatchNorm = BatchNormalization()(input)
            relu = Activation('relu')(BatchNorm)
            AvgPooling = AveragePooling2D(pool_size=(2,2))(relu)
            flat = Flatten()(AvgPooling)
            output = Dense(num_classes, activation='softmax')(flat)

            return output
```

0.9 Create Final Model

Apply building blocks of dense_block, transtion blocks and 3x3 convolution filters to create the final model

```
In [10]: input = Input(shape=(img_height, img_width, channel,))
         layer1_transition = Conv2D(num_filter, (3,3), use_bias=False ,padding='same')(input)

         layer2_block = add_denseblock(layer1_transition, num_filter, dropout_rate)
         layer2_transition = add_transition(layer2_block, num_filter, dropout_rate)
         skip_connection1 = layer2_transition

         layer3_block = add_denseblock(layer2_transition, num_filter, dropout_rate)
         layer3_transition = add_transition(layer3_block, num_filter, dropout_rate)

         layer4_block = add_denseblock(layer3_transition, num_filter, dropout_rate)
         layer4_transition = add_transition(layer4_block, num_filter, dropout_rate)

         layer5_skip_connection_block = add_denseblock(skip_connection1, num_filter, dropout_ra
         layer5_skip_connection_block = Conv2D(int(num_filter*compression), (5,5), use_bias=Fal
         layer5_skip_connection_block = Conv2D(int(num_filter*compression), (5,5), use_bias=Fal
         layer5_skip_connection_block = Conv2D(int(num_filter*compression), (5,5), use_bias=Fal
         layer5_block = Concatenate(axis=-1)([layer5_skip_connection_block, layer4_transition])
         layer5_transition = add_transition(layer5_block, num_filter, dropout_rate)

         layer6_block = add_denseblock(layer5_transition,  num_filter, dropout_rate)
         output = output_layer(layer6_block)

In [11]: model = Model(inputs=[input], outputs=[output])
         model.summary()
```

```
_________________________________________________________________________________________________
Layer (type)                 Output Shape              Param #     Connected to
=================================================================================================
input_1 (InputLayer)         (None, 32, 32, 3)         0
_________________________________________________________________________________________________
conv2d_1 (Conv2D)            (None, 32, 32, 16)        432         input_1[0][0]
_________________________________________________________________________________________________
batch_normalization_1 (BatchNor (None, 32, 32, 16)     64          conv2d_1[0][0]
_________________________________________________________________________________________________
activation_1 (Activation)    (None, 32, 32, 16)        0           batch_normalization_1[0][0]
_________________________________________________________________________________________________
conv2d_2 (Conv2D)            (None, 32, 32, 8)         1152        activation_1[0][0]
_________________________________________________________________________________________________
dropout_1 (Dropout)          (None, 32, 32, 8)         0           conv2d_2[0][0]
_________________________________________________________________________________________________
concatenate_1 (Concatenate)  (None, 32, 32, 24)        0           conv2d_1[0][0]
                                                                   dropout_1[0][0]
_________________________________________________________________________________________________
```

```
batch_normalization_2 (BatchNor (None, 32, 32, 24)   96          concatenate_1[0][0]
--------------------------------------------------------------------------------------------
activation_2 (Activation)       (None, 32, 32, 24)   0           batch_normalization_2[0][0]
--------------------------------------------------------------------------------------------
conv2d_3 (Conv2D)               (None, 32, 32, 8)    1728        activation_2[0][0]
--------------------------------------------------------------------------------------------
dropout_2 (Dropout)             (None, 32, 32, 8)    0           conv2d_3[0][0]
--------------------------------------------------------------------------------------------
concatenate_2 (Concatenate)     (None, 32, 32, 32)   0           concatenate_1[0][0]
                                                                 dropout_2[0][0]
--------------------------------------------------------------------------------------------
batch_normalization_3 (BatchNor (None, 32, 32, 32)   128         concatenate_2[0][0]
--------------------------------------------------------------------------------------------
activation_3 (Activation)       (None, 32, 32, 32)   0           batch_normalization_3[0][0]
--------------------------------------------------------------------------------------------
conv2d_4 (Conv2D)               (None, 32, 32, 8)    2304        activation_3[0][0]
--------------------------------------------------------------------------------------------
dropout_3 (Dropout)             (None, 32, 32, 8)    0           conv2d_4[0][0]
--------------------------------------------------------------------------------------------
concatenate_3 (Concatenate)     (None, 32, 32, 40)   0           concatenate_2[0][0]
                                                                 dropout_3[0][0]
--------------------------------------------------------------------------------------------
batch_normalization_4 (BatchNor (None, 32, 32, 40)   160         concatenate_3[0][0]
--------------------------------------------------------------------------------------------
activation_4 (Activation)       (None, 32, 32, 40)   0           batch_normalization_4[0][0]
--------------------------------------------------------------------------------------------
conv2d_5 (Conv2D)               (None, 32, 32, 8)    2880        activation_4[0][0]
--------------------------------------------------------------------------------------------
dropout_4 (Dropout)             (None, 32, 32, 8)    0           conv2d_5[0][0]
--------------------------------------------------------------------------------------------
concatenate_4 (Concatenate)     (None, 32, 32, 48)   0           concatenate_3[0][0]
                                                                 dropout_4[0][0]
--------------------------------------------------------------------------------------------
batch_normalization_5 (BatchNor (None, 32, 32, 48)   192         concatenate_4[0][0]
--------------------------------------------------------------------------------------------
activation_5 (Activation)       (None, 32, 32, 48)   0           batch_normalization_5[0][0]
--------------------------------------------------------------------------------------------
conv2d_6 (Conv2D)               (None, 32, 32, 8)    3456        activation_5[0][0]
--------------------------------------------------------------------------------------------
dropout_5 (Dropout)             (None, 32, 32, 8)    0           conv2d_6[0][0]
--------------------------------------------------------------------------------------------
concatenate_5 (Concatenate)     (None, 32, 32, 56)   0           concatenate_4[0][0]
                                                                 dropout_5[0][0]
--------------------------------------------------------------------------------------------
batch_normalization_6 (BatchNor (None, 32, 32, 56)   224         concatenate_5[0][0]
--------------------------------------------------------------------------------------------
activation_6 (Activation)       (None, 32, 32, 56)   0           batch_normalization_6[0][0]
--------------------------------------------------------------------------------------------
```

```
conv2d_7 (Conv2D)               (None, 32, 32, 8)    4032        activation_6[0][0]
____________________________________________________________________________________________
dropout_6 (Dropout)             (None, 32, 32, 8)    0           conv2d_7[0][0]
____________________________________________________________________________________________
concatenate_6 (Concatenate)     (None, 32, 32, 64)   0           concatenate_5[0][0]
                                                                 dropout_6[0][0]
____________________________________________________________________________________________
batch_normalization_7 (BatchNor (None, 32, 32, 64)   256         concatenate_6[0][0]
____________________________________________________________________________________________
activation_7 (Activation)       (None, 32, 32, 64)   0           batch_normalization_7[0][0]
____________________________________________________________________________________________
conv2d_8 (Conv2D)               (None, 32, 32, 8)    4608        activation_7[0][0]
____________________________________________________________________________________________
dropout_7 (Dropout)             (None, 32, 32, 8)    0           conv2d_8[0][0]
____________________________________________________________________________________________
concatenate_7 (Concatenate)     (None, 32, 32, 72)   0           concatenate_6[0][0]
                                                                 dropout_7[0][0]
____________________________________________________________________________________________
batch_normalization_8 (BatchNor (None, 32, 32, 72)   288         concatenate_7[0][0]
____________________________________________________________________________________________
activation_8 (Activation)       (None, 32, 32, 72)   0           batch_normalization_8[0][0]
____________________________________________________________________________________________
conv2d_9 (Conv2D)               (None, 32, 32, 8)    5184        activation_8[0][0]
____________________________________________________________________________________________
dropout_8 (Dropout)             (None, 32, 32, 8)    0           conv2d_9[0][0]
____________________________________________________________________________________________
concatenate_8 (Concatenate)     (None, 32, 32, 80)   0           concatenate_7[0][0]
                                                                 dropout_8[0][0]
____________________________________________________________________________________________
batch_normalization_9 (BatchNor (None, 32, 32, 80)   320         concatenate_8[0][0]
____________________________________________________________________________________________
activation_9 (Activation)       (None, 32, 32, 80)   0           batch_normalization_9[0][0]
____________________________________________________________________________________________
conv2d_10 (Conv2D)              (None, 32, 32, 8)    5760        activation_9[0][0]
____________________________________________________________________________________________
dropout_9 (Dropout)             (None, 32, 32, 8)    0           conv2d_10[0][0]
____________________________________________________________________________________________
concatenate_9 (Concatenate)     (None, 32, 32, 88)   0           concatenate_8[0][0]
                                                                 dropout_9[0][0]
____________________________________________________________________________________________
batch_normalization_10 (BatchNo (None, 32, 32, 88)   352         concatenate_9[0][0]
____________________________________________________________________________________________
activation_10 (Activation)      (None, 32, 32, 88)   0           batch_normalization_10[0][0]
____________________________________________________________________________________________
conv2d_11 (Conv2D)              (None, 32, 32, 8)    6336        activation_10[0][0]
____________________________________________________________________________________________
dropout_10 (Dropout)            (None, 32, 32, 8)    0           conv2d_11[0][0]
____________________________________________________________________________________________
```

```
concatenate_10 (Concatenate)    (None, 32, 32, 96)   0           concatenate_9[0][0]
                                                                 dropout_10[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_11 (BatchNo (None, 32, 32, 96)   384         concatenate_10[0][0]
--------------------------------------------------------------------------------------------------
activation_11 (Activation)      (None, 32, 32, 96)   0           batch_normalization_11[0][0]
--------------------------------------------------------------------------------------------------
conv2d_12 (Conv2D)              (None, 32, 32, 8)    6912        activation_11[0][0]
--------------------------------------------------------------------------------------------------
dropout_11 (Dropout)            (None, 32, 32, 8)    0           conv2d_12[0][0]
--------------------------------------------------------------------------------------------------
concatenate_11 (Concatenate)    (None, 32, 32, 104)  0           concatenate_10[0][0]
                                                                 dropout_11[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_12 (BatchNo (None, 32, 32, 104)  416         concatenate_11[0][0]
--------------------------------------------------------------------------------------------------
activation_12 (Activation)      (None, 32, 32, 104)  0           batch_normalization_12[0][0]
--------------------------------------------------------------------------------------------------
conv2d_13 (Conv2D)              (None, 32, 32, 8)    7488        activation_12[0][0]
--------------------------------------------------------------------------------------------------
dropout_12 (Dropout)            (None, 32, 32, 8)    0           conv2d_13[0][0]
--------------------------------------------------------------------------------------------------
concatenate_12 (Concatenate)    (None, 32, 32, 112)  0           concatenate_11[0][0]
                                                                 dropout_12[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_13 (BatchNo (None, 32, 32, 112)  448         concatenate_12[0][0]
--------------------------------------------------------------------------------------------------
activation_13 (Activation)      (None, 32, 32, 112)  0           batch_normalization_13[0][0]
--------------------------------------------------------------------------------------------------
conv2d_14 (Conv2D)              (None, 32, 32, 8)    8064        activation_13[0][0]
--------------------------------------------------------------------------------------------------
dropout_13 (Dropout)            (None, 32, 32, 8)    0           conv2d_14[0][0]
--------------------------------------------------------------------------------------------------
concatenate_13 (Concatenate)    (None, 32, 32, 120)  0           concatenate_12[0][0]
                                                                 dropout_13[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_14 (BatchNo (None, 32, 32, 120)  480         concatenate_13[0][0]
--------------------------------------------------------------------------------------------------
activation_14 (Activation)      (None, 32, 32, 120)  0           batch_normalization_14[0][0]
--------------------------------------------------------------------------------------------------
conv2d_15 (Conv2D)              (None, 32, 32, 8)    8640        activation_14[0][0]
--------------------------------------------------------------------------------------------------
dropout_14 (Dropout)            (None, 32, 32, 8)    0           conv2d_15[0][0]
--------------------------------------------------------------------------------------------------
concatenate_14 (Concatenate)    (None, 32, 32, 128)  0           concatenate_13[0][0]
                                                                 dropout_14[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_15 (BatchNo (None, 32, 32, 128)  512         concatenate_14[0][0]
```

activation_15 (Activation)	(None, 32, 32, 128)	0	batch_normalization_15[0][0]
conv2d_16 (Conv2D)	(None, 32, 32, 8)	9216	activation_15[0][0]
dropout_15 (Dropout)	(None, 32, 32, 8)	0	conv2d_16[0][0]
concatenate_15 (Concatenate)	(None, 32, 32, 136)	0	concatenate_14[0][0] dropout_15[0][0]
batch_normalization_16 (BatchNo	(None, 32, 32, 136)	544	concatenate_15[0][0]
activation_16 (Activation)	(None, 32, 32, 136)	0	batch_normalization_16[0][0]
conv2d_17 (Conv2D)	(None, 32, 32, 8)	9792	activation_16[0][0]
dropout_16 (Dropout)	(None, 32, 32, 8)	0	conv2d_17[0][0]
concatenate_16 (Concatenate)	(None, 32, 32, 144)	0	concatenate_15[0][0] dropout_16[0][0]
batch_normalization_17 (BatchNo	(None, 32, 32, 144)	576	concatenate_16[0][0]
activation_17 (Activation)	(None, 32, 32, 144)	0	batch_normalization_17[0][0]
conv2d_18 (Conv2D)	(None, 32, 32, 8)	10368	activation_17[0][0]
dropout_17 (Dropout)	(None, 32, 32, 8)	0	conv2d_18[0][0]
concatenate_17 (Concatenate)	(None, 32, 32, 152)	0	concatenate_16[0][0] dropout_17[0][0]
batch_normalization_18 (BatchNo	(None, 32, 32, 152)	608	concatenate_17[0][0]
activation_18 (Activation)	(None, 32, 32, 152)	0	batch_normalization_18[0][0]
conv2d_19 (Conv2D)	(None, 32, 32, 8)	10944	activation_18[0][0]
dropout_18 (Dropout)	(None, 32, 32, 8)	0	conv2d_19[0][0]
concatenate_18 (Concatenate)	(None, 32, 32, 160)	0	concatenate_17[0][0] dropout_18[0][0]
batch_normalization_19 (BatchNo	(None, 32, 32, 160)	640	concatenate_18[0][0]
activation_19 (Activation)	(None, 32, 32, 160)	0	batch_normalization_19[0][0]
conv2d_20 (Conv2D)	(None, 32, 32, 8)	11520	activation_19[0][0]

```
dropout_19 (Dropout)            (None, 32, 32, 8)    0           conv2d_20[0][0]
concatenate_19 (Concatenate)    (None, 32, 32, 168)  0           concatenate_18[0][0]
                                                                 dropout_19[0][0]
batch_normalization_20 (BatchNo (None, 32, 32, 168)  672         concatenate_19[0][0]
activation_20 (Activation)      (None, 32, 32, 168)  0           batch_normalization_20[0][0]
conv2d_21 (Conv2D)              (None, 32, 32, 8)    12096       activation_20[0][0]
dropout_20 (Dropout)            (None, 32, 32, 8)    0           conv2d_21[0][0]
concatenate_20 (Concatenate)    (None, 32, 32, 176)  0           concatenate_19[0][0]
                                                                 dropout_20[0][0]
batch_normalization_21 (BatchNo (None, 32, 32, 176)  704         concatenate_20[0][0]
activation_21 (Activation)      (None, 32, 32, 176)  0           batch_normalization_21[0][0]
conv2d_22 (Conv2D)              (None, 32, 32, 8)    12672       activation_21[0][0]
dropout_21 (Dropout)            (None, 32, 32, 8)    0           conv2d_22[0][0]
concatenate_21 (Concatenate)    (None, 32, 32, 184)  0           concatenate_20[0][0]
                                                                 dropout_21[0][0]
batch_normalization_22 (BatchNo (None, 32, 32, 184)  736         concatenate_21[0][0]
activation_22 (Activation)      (None, 32, 32, 184)  0           batch_normalization_22[0][0]
conv2d_23 (Conv2D)              (None, 32, 32, 8)    13248       activation_22[0][0]
dropout_22 (Dropout)            (None, 32, 32, 8)    0           conv2d_23[0][0]
concatenate_22 (Concatenate)    (None, 32, 32, 192)  0           concatenate_21[0][0]
                                                                 dropout_22[0][0]
batch_normalization_23 (BatchNo (None, 32, 32, 192)  768         concatenate_22[0][0]
activation_23 (Activation)      (None, 32, 32, 192)  0           batch_normalization_23[0][0]
conv2d_24 (Conv2D)              (None, 32, 32, 8)    1536        activation_23[0][0]
dropout_23 (Dropout)            (None, 32, 32, 8)    0           conv2d_24[0][0]
average_pooling2d_1 (AveragePoo (None, 16, 16, 8)    0           dropout_23[0][0]
```

```
batch_normalization_24 (BatchNo (None, 16, 16, 8)    32          average_pooling2d_1[0][0]
activation_24 (Activation)      (None, 16, 16, 8)    0           batch_normalization_24[0][0]
conv2d_25 (Conv2D)              (None, 16, 16, 8)    576         activation_24[0][0]
dropout_24 (Dropout)            (None, 16, 16, 8)    0           conv2d_25[0][0]
concatenate_23 (Concatenate)    (None, 16, 16, 16)   0           average_pooling2d_1[0][0]
                                                                 dropout_24[0][0]
batch_normalization_25 (BatchNo (None, 16, 16, 16)   64          concatenate_23[0][0]
activation_25 (Activation)      (None, 16, 16, 16)   0           batch_normalization_25[0][0]
conv2d_26 (Conv2D)              (None, 16, 16, 8)    1152        activation_25[0][0]
dropout_25 (Dropout)            (None, 16, 16, 8)    0           conv2d_26[0][0]
concatenate_24 (Concatenate)    (None, 16, 16, 24)   0           concatenate_23[0][0]
                                                                 dropout_25[0][0]
batch_normalization_26 (BatchNo (None, 16, 16, 24)   96          concatenate_24[0][0]
activation_26 (Activation)      (None, 16, 16, 24)   0           batch_normalization_26[0][0]
conv2d_27 (Conv2D)              (None, 16, 16, 8)    1728        activation_26[0][0]
dropout_26 (Dropout)            (None, 16, 16, 8)    0           conv2d_27[0][0]
concatenate_25 (Concatenate)    (None, 16, 16, 32)   0           concatenate_24[0][0]
                                                                 dropout_26[0][0]
batch_normalization_27 (BatchNo (None, 16, 16, 32)   128         concatenate_25[0][0]
activation_27 (Activation)      (None, 16, 16, 32)   0           batch_normalization_27[0][0]
conv2d_28 (Conv2D)              (None, 16, 16, 8)    2304        activation_27[0][0]
dropout_27 (Dropout)            (None, 16, 16, 8)    0           conv2d_28[0][0]
concatenate_26 (Concatenate)    (None, 16, 16, 40)   0           concatenate_25[0][0]
                                                                 dropout_27[0][0]
batch_normalization_28 (BatchNo (None, 16, 16, 40)   160         concatenate_26[0][0]
activation_28 (Activation)      (None, 16, 16, 40)   0           batch_normalization_28[0][0]
```

```
conv2d_29 (Conv2D)              (None, 16, 16, 8)    2880        activation_28[0][0]
dropout_28 (Dropout)            (None, 16, 16, 8)    0           conv2d_29[0][0]
concatenate_27 (Concatenate)    (None, 16, 16, 48)   0           concatenate_26[0][0]
                                                                 dropout_28[0][0]
batch_normalization_29 (BatchNo (None, 16, 16, 48)   192         concatenate_27[0][0]
activation_29 (Activation)      (None, 16, 16, 48)   0           batch_normalization_29[0][0]
conv2d_30 (Conv2D)              (None, 16, 16, 8)    3456        activation_29[0][0]
dropout_29 (Dropout)            (None, 16, 16, 8)    0           conv2d_30[0][0]
concatenate_28 (Concatenate)    (None, 16, 16, 56)   0           concatenate_27[0][0]
                                                                 dropout_29[0][0]
batch_normalization_30 (BatchNo (None, 16, 16, 56)   224         concatenate_28[0][0]
activation_30 (Activation)      (None, 16, 16, 56)   0           batch_normalization_30[0][0]
conv2d_31 (Conv2D)              (None, 16, 16, 8)    4032        activation_30[0][0]
dropout_30 (Dropout)            (None, 16, 16, 8)    0           conv2d_31[0][0]
concatenate_29 (Concatenate)    (None, 16, 16, 64)   0           concatenate_28[0][0]
                                                                 dropout_30[0][0]
batch_normalization_31 (BatchNo (None, 16, 16, 64)   256         concatenate_29[0][0]
activation_31 (Activation)      (None, 16, 16, 64)   0           batch_normalization_31[0][0]
conv2d_32 (Conv2D)              (None, 16, 16, 8)    4608        activation_31[0][0]
dropout_31 (Dropout)            (None, 16, 16, 8)    0           conv2d_32[0][0]
concatenate_30 (Concatenate)    (None, 16, 16, 72)   0           concatenate_29[0][0]
                                                                 dropout_31[0][0]
batch_normalization_32 (BatchNo (None, 16, 16, 72)   288         concatenate_30[0][0]
activation_32 (Activation)      (None, 16, 16, 72)   0           batch_normalization_32[0][0]
conv2d_33 (Conv2D)              (None, 16, 16, 8)    5184        activation_32[0][0]
dropout_32 (Dropout)            (None, 16, 16, 8)    0           conv2d_33[0][0]
```

```
concatenate_31 (Concatenate)    (None, 16, 16, 80)   0           concatenate_30[0][0]
                                                                 dropout_32[0][0]
batch_normalization_33 (BatchNo (None, 16, 16, 80)   320         concatenate_31[0][0]
activation_33 (Activation)      (None, 16, 16, 80)   0           batch_normalization_33[0][0]
conv2d_34 (Conv2D)              (None, 16, 16, 8)    5760        activation_33[0][0]
dropout_33 (Dropout)            (None, 16, 16, 8)    0           conv2d_34[0][0]
concatenate_32 (Concatenate)    (None, 16, 16, 88)   0           concatenate_31[0][0]
                                                                 dropout_33[0][0]
batch_normalization_34 (BatchNo (None, 16, 16, 88)   352         concatenate_32[0][0]
activation_34 (Activation)      (None, 16, 16, 88)   0           batch_normalization_34[0][0]
conv2d_35 (Conv2D)              (None, 16, 16, 8)    6336        activation_34[0][0]
dropout_34 (Dropout)            (None, 16, 16, 8)    0           conv2d_35[0][0]
concatenate_33 (Concatenate)    (None, 16, 16, 96)   0           concatenate_32[0][0]
                                                                 dropout_34[0][0]
batch_normalization_35 (BatchNo (None, 16, 16, 96)   384         concatenate_33[0][0]
activation_35 (Activation)      (None, 16, 16, 96)   0           batch_normalization_35[0][0]
conv2d_36 (Conv2D)              (None, 16, 16, 8)    6912        activation_35[0][0]
dropout_35 (Dropout)            (None, 16, 16, 8)    0           conv2d_36[0][0]
concatenate_34 (Concatenate)    (None, 16, 16, 104)  0           concatenate_33[0][0]
                                                                 dropout_35[0][0]
batch_normalization_36 (BatchNo (None, 16, 16, 104)  416         concatenate_34[0][0]
activation_36 (Activation)      (None, 16, 16, 104)  0           batch_normalization_36[0][0]
conv2d_37 (Conv2D)              (None, 16, 16, 8)    7488        activation_36[0][0]
dropout_36 (Dropout)            (None, 16, 16, 8)    0           conv2d_37[0][0]
concatenate_35 (Concatenate)    (None, 16, 16, 112)  0           concatenate_34[0][0]
                                                                 dropout_36[0][0]
```

```
batch_normalization_37 (BatchNo (None, 16, 16, 112)  448         concatenate_35[0][0]
__________________________________________________________________________________________________
activation_37 (Activation)      (None, 16, 16, 112)  0           batch_normalization_37[0][0]
__________________________________________________________________________________________________
conv2d_38 (Conv2D)              (None, 16, 16, 8)    8064        activation_37[0][0]
__________________________________________________________________________________________________
dropout_37 (Dropout)            (None, 16, 16, 8)    0           conv2d_38[0][0]
__________________________________________________________________________________________________
concatenate_36 (Concatenate)    (None, 16, 16, 120)  0           concatenate_35[0][0]
                                                                 dropout_37[0][0]
__________________________________________________________________________________________________
batch_normalization_38 (BatchNo (None, 16, 16, 120)  480         concatenate_36[0][0]
__________________________________________________________________________________________________
activation_38 (Activation)      (None, 16, 16, 120)  0           batch_normalization_38[0][0]
__________________________________________________________________________________________________
conv2d_39 (Conv2D)              (None, 16, 16, 8)    8640        activation_38[0][0]
__________________________________________________________________________________________________
dropout_38 (Dropout)            (None, 16, 16, 8)    0           conv2d_39[0][0]
__________________________________________________________________________________________________
concatenate_37 (Concatenate)    (None, 16, 16, 128)  0           concatenate_36[0][0]
                                                                 dropout_38[0][0]
__________________________________________________________________________________________________
batch_normalization_39 (BatchNo (None, 16, 16, 128)  512         concatenate_37[0][0]
__________________________________________________________________________________________________
activation_39 (Activation)      (None, 16, 16, 128)  0           batch_normalization_39[0][0]
__________________________________________________________________________________________________
conv2d_40 (Conv2D)              (None, 16, 16, 8)    9216        activation_39[0][0]
__________________________________________________________________________________________________
dropout_39 (Dropout)            (None, 16, 16, 8)    0           conv2d_40[0][0]
__________________________________________________________________________________________________
concatenate_38 (Concatenate)    (None, 16, 16, 136)  0           concatenate_37[0][0]
                                                                 dropout_39[0][0]
__________________________________________________________________________________________________
batch_normalization_40 (BatchNo (None, 16, 16, 136)  544         concatenate_38[0][0]
__________________________________________________________________________________________________
activation_40 (Activation)      (None, 16, 16, 136)  0           batch_normalization_40[0][0]
__________________________________________________________________________________________________
conv2d_41 (Conv2D)              (None, 16, 16, 8)    9792        activation_40[0][0]
__________________________________________________________________________________________________
dropout_40 (Dropout)            (None, 16, 16, 8)    0           conv2d_41[0][0]
__________________________________________________________________________________________________
concatenate_39 (Concatenate)    (None, 16, 16, 144)  0           concatenate_38[0][0]
                                                                 dropout_40[0][0]
__________________________________________________________________________________________________
batch_normalization_41 (BatchNo (None, 16, 16, 144)  576         concatenate_39[0][0]
__________________________________________________________________________________________________
activation_41 (Activation)      (None, 16, 16, 144)  0           batch_normalization_41[0][0]
__________________________________________________________________________________________________
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conv2d_42 (Conv2D)              (None, 16, 16, 8)    10368       activation_41[0][0]
--------------------------------------------------------------------------------------------------
dropout_41 (Dropout)            (None, 16, 16, 8)    0           conv2d_42[0][0]
--------------------------------------------------------------------------------------------------
concatenate_40 (Concatenate)    (None, 16, 16, 152)  0           concatenate_39[0][0]
                                                                 dropout_41[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_42 (BatchNo (None, 16, 16, 152)  608         concatenate_40[0][0]
--------------------------------------------------------------------------------------------------
activation_42 (Activation)      (None, 16, 16, 152)  0           batch_normalization_42[0][0]
--------------------------------------------------------------------------------------------------
conv2d_43 (Conv2D)              (None, 16, 16, 8)    10944       activation_42[0][0]
--------------------------------------------------------------------------------------------------
dropout_42 (Dropout)            (None, 16, 16, 8)    0           conv2d_43[0][0]
--------------------------------------------------------------------------------------------------
concatenate_41 (Concatenate)    (None, 16, 16, 160)  0           concatenate_40[0][0]
                                                                 dropout_42[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_43 (BatchNo (None, 16, 16, 160)  640         concatenate_41[0][0]
--------------------------------------------------------------------------------------------------
activation_43 (Activation)      (None, 16, 16, 160)  0           batch_normalization_43[0][0]
--------------------------------------------------------------------------------------------------
conv2d_44 (Conv2D)              (None, 16, 16, 8)    11520       activation_43[0][0]
--------------------------------------------------------------------------------------------------
dropout_43 (Dropout)            (None, 16, 16, 8)    0           conv2d_44[0][0]
--------------------------------------------------------------------------------------------------
concatenate_42 (Concatenate)    (None, 16, 16, 168)  0           concatenate_41[0][0]
                                                                 dropout_43[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_44 (BatchNo (None, 16, 16, 168)  672         concatenate_42[0][0]
--------------------------------------------------------------------------------------------------
activation_44 (Activation)      (None, 16, 16, 168)  0           batch_normalization_44[0][0]
--------------------------------------------------------------------------------------------------
conv2d_45 (Conv2D)              (None, 16, 16, 8)    12096       activation_44[0][0]
--------------------------------------------------------------------------------------------------
dropout_44 (Dropout)            (None, 16, 16, 8)    0           conv2d_45[0][0]
--------------------------------------------------------------------------------------------------
concatenate_43 (Concatenate)    (None, 16, 16, 176)  0           concatenate_42[0][0]
                                                                 dropout_44[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_45 (BatchNo (None, 16, 16, 176)  704         concatenate_43[0][0]
--------------------------------------------------------------------------------------------------
activation_45 (Activation)      (None, 16, 16, 176)  0           batch_normalization_45[0][0]
--------------------------------------------------------------------------------------------------
conv2d_46 (Conv2D)              (None, 16, 16, 8)    12672       activation_45[0][0]
--------------------------------------------------------------------------------------------------
dropout_45 (Dropout)            (None, 16, 16, 8)    0           conv2d_46[0][0]
--------------------------------------------------------------------------------------------------
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concatenate_44 (Concatenate)    (None, 16, 16, 184)  0           concatenate_43[0][0]
                                                                 dropout_45[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_46 (BatchNo (None, 16, 16, 184)  736         concatenate_44[0][0]
--------------------------------------------------------------------------------------------------
activation_46 (Activation)      (None, 16, 16, 184)  0           batch_normalization_46[0][0]
--------------------------------------------------------------------------------------------------
conv2d_47 (Conv2D)              (None, 16, 16, 8)    1472        activation_46[0][0]
--------------------------------------------------------------------------------------------------
dropout_46 (Dropout)            (None, 16, 16, 8)    0           conv2d_47[0][0]
--------------------------------------------------------------------------------------------------
average_pooling2d_2 (AveragePoo (None, 8, 8, 8)      0           dropout_46[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_47 (BatchNo (None, 8, 8, 8)      32          average_pooling2d_2[0][0]
--------------------------------------------------------------------------------------------------
activation_47 (Activation)      (None, 8, 8, 8)      0           batch_normalization_47[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_70 (BatchNo (None, 16, 16, 8)    32          average_pooling2d_1[0][0]
--------------------------------------------------------------------------------------------------
conv2d_48 (Conv2D)              (None, 8, 8, 8)      576         activation_47[0][0]
--------------------------------------------------------------------------------------------------
activation_70 (Activation)      (None, 16, 16, 8)    0           batch_normalization_70[0][0]
--------------------------------------------------------------------------------------------------
dropout_47 (Dropout)            (None, 8, 8, 8)      0           conv2d_48[0][0]
--------------------------------------------------------------------------------------------------
conv2d_71 (Conv2D)              (None, 16, 16, 8)    576         activation_70[0][0]
--------------------------------------------------------------------------------------------------
concatenate_45 (Concatenate)    (None, 8, 8, 16)     0           average_pooling2d_2[0][0]
                                                                 dropout_47[0][0]
--------------------------------------------------------------------------------------------------
dropout_70 (Dropout)            (None, 16, 16, 8)    0           conv2d_71[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_48 (BatchNo (None, 8, 8, 16)     64          concatenate_45[0][0]
--------------------------------------------------------------------------------------------------
concatenate_67 (Concatenate)    (None, 16, 16, 16)   0           average_pooling2d_1[0][0]
                                                                 dropout_70[0][0]
--------------------------------------------------------------------------------------------------
activation_48 (Activation)      (None, 8, 8, 16)     0           batch_normalization_48[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_71 (BatchNo (None, 16, 16, 16)   64          concatenate_67[0][0]
--------------------------------------------------------------------------------------------------
conv2d_49 (Conv2D)              (None, 8, 8, 8)      1152        activation_48[0][0]
--------------------------------------------------------------------------------------------------
activation_71 (Activation)      (None, 16, 16, 16)   0           batch_normalization_71[0][0]
--------------------------------------------------------------------------------------------------
dropout_48 (Dropout)            (None, 8, 8, 8)      0           conv2d_49[0][0]
--------------------------------------------------------------------------------------------------
conv2d_72 (Conv2D)              (None, 16, 16, 8)    1152        activation_71[0][0]
```

concatenate_46 (Concatenate)	(None, 8, 8, 24)	0	concatenate_45[0][0] dropout_48[0][0]
dropout_71 (Dropout)	(None, 16, 16, 8)	0	conv2d_72[0][0]
batch_normalization_49 (BatchNo	(None, 8, 8, 24)	96	concatenate_46[0][0]
concatenate_68 (Concatenate)	(None, 16, 16, 24)	0	concatenate_67[0][0] dropout_71[0][0]
activation_49 (Activation)	(None, 8, 8, 24)	0	batch_normalization_49[0][0]
batch_normalization_72 (BatchNo	(None, 16, 16, 24)	96	concatenate_68[0][0]
conv2d_50 (Conv2D)	(None, 8, 8, 8)	1728	activation_49[0][0]
activation_72 (Activation)	(None, 16, 16, 24)	0	batch_normalization_72[0][0]
dropout_49 (Dropout)	(None, 8, 8, 8)	0	conv2d_50[0][0]
conv2d_73 (Conv2D)	(None, 16, 16, 8)	1728	activation_72[0][0]
concatenate_47 (Concatenate)	(None, 8, 8, 32)	0	concatenate_46[0][0] dropout_49[0][0]
dropout_72 (Dropout)	(None, 16, 16, 8)	0	conv2d_73[0][0]
batch_normalization_50 (BatchNo	(None, 8, 8, 32)	128	concatenate_47[0][0]
concatenate_69 (Concatenate)	(None, 16, 16, 32)	0	concatenate_68[0][0] dropout_72[0][0]
activation_50 (Activation)	(None, 8, 8, 32)	0	batch_normalization_50[0][0]
batch_normalization_73 (BatchNo	(None, 16, 16, 32)	128	concatenate_69[0][0]
conv2d_51 (Conv2D)	(None, 8, 8, 8)	2304	activation_50[0][0]
activation_73 (Activation)	(None, 16, 16, 32)	0	batch_normalization_73[0][0]
dropout_50 (Dropout)	(None, 8, 8, 8)	0	conv2d_51[0][0]
conv2d_74 (Conv2D)	(None, 16, 16, 8)	2304	activation_73[0][0]
concatenate_48 (Concatenate)	(None, 8, 8, 40)	0	concatenate_47[0][0] dropout_50[0][0]

```
dropout_73 (Dropout)            (None, 16, 16, 8)    0           conv2d_74[0][0]
__________________________________________________________________________________________
batch_normalization_51 (BatchNo (None, 8, 8, 40)     160         concatenate_48[0][0]
__________________________________________________________________________________________
concatenate_70 (Concatenate)    (None, 16, 16, 40)   0           concatenate_69[0][0]
                                                                 dropout_73[0][0]
__________________________________________________________________________________________
activation_51 (Activation)      (None, 8, 8, 40)     0           batch_normalization_51[0][0]
__________________________________________________________________________________________
batch_normalization_74 (BatchNo (None, 16, 16, 40)   160         concatenate_70[0][0]
__________________________________________________________________________________________
conv2d_52 (Conv2D)              (None, 8, 8, 8)      2880        activation_51[0][0]
__________________________________________________________________________________________
activation_74 (Activation)      (None, 16, 16, 40)   0           batch_normalization_74[0][0]
__________________________________________________________________________________________
dropout_51 (Dropout)            (None, 8, 8, 8)      0           conv2d_52[0][0]
__________________________________________________________________________________________
conv2d_75 (Conv2D)              (None, 16, 16, 8)    2880        activation_74[0][0]
__________________________________________________________________________________________
concatenate_49 (Concatenate)    (None, 8, 8, 48)     0           concatenate_48[0][0]
                                                                 dropout_51[0][0]
__________________________________________________________________________________________
dropout_74 (Dropout)            (None, 16, 16, 8)    0           conv2d_75[0][0]
__________________________________________________________________________________________
batch_normalization_52 (BatchNo (None, 8, 8, 48)     192         concatenate_49[0][0]
__________________________________________________________________________________________
concatenate_71 (Concatenate)    (None, 16, 16, 48)   0           concatenate_70[0][0]
                                                                 dropout_74[0][0]
__________________________________________________________________________________________
activation_52 (Activation)      (None, 8, 8, 48)     0           batch_normalization_52[0][0]
__________________________________________________________________________________________
batch_normalization_75 (BatchNo (None, 16, 16, 48)   192         concatenate_71[0][0]
__________________________________________________________________________________________
conv2d_53 (Conv2D)              (None, 8, 8, 8)      3456        activation_52[0][0]
__________________________________________________________________________________________
activation_75 (Activation)      (None, 16, 16, 48)   0           batch_normalization_75[0][0]
__________________________________________________________________________________________
dropout_52 (Dropout)            (None, 8, 8, 8)      0           conv2d_53[0][0]
__________________________________________________________________________________________
conv2d_76 (Conv2D)              (None, 16, 16, 8)    3456        activation_75[0][0]
__________________________________________________________________________________________
concatenate_50 (Concatenate)    (None, 8, 8, 56)     0           concatenate_49[0][0]
                                                                 dropout_52[0][0]
__________________________________________________________________________________________
dropout_75 (Dropout)            (None, 16, 16, 8)    0           conv2d_76[0][0]
__________________________________________________________________________________________
batch_normalization_53 (BatchNo (None, 8, 8, 56)     224         concatenate_50[0][0]
__________________________________________________________________________________________
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concatenate_72 (Concatenate)    (None, 16, 16, 56)   0           concatenate_71[0][0]
                                                                 dropout_75[0][0]
--------------------------------------------------------------------------------------------------
activation_53 (Activation)      (None, 8, 8, 56)     0           batch_normalization_53[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_76 (BatchNo (None, 16, 16, 56)   224         concatenate_72[0][0]
--------------------------------------------------------------------------------------------------
conv2d_54 (Conv2D)              (None, 8, 8, 8)      4032        activation_53[0][0]
--------------------------------------------------------------------------------------------------
activation_76 (Activation)      (None, 16, 16, 56)   0           batch_normalization_76[0][0]
--------------------------------------------------------------------------------------------------
dropout_53 (Dropout)            (None, 8, 8, 8)      0           conv2d_54[0][0]
--------------------------------------------------------------------------------------------------
conv2d_77 (Conv2D)              (None, 16, 16, 8)    4032        activation_76[0][0]
--------------------------------------------------------------------------------------------------
concatenate_51 (Concatenate)    (None, 8, 8, 64)     0           concatenate_50[0][0]
                                                                 dropout_53[0][0]
--------------------------------------------------------------------------------------------------
dropout_76 (Dropout)            (None, 16, 16, 8)    0           conv2d_77[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_54 (BatchNo (None, 8, 8, 64)     256         concatenate_51[0][0]
--------------------------------------------------------------------------------------------------
concatenate_73 (Concatenate)    (None, 16, 16, 64)   0           concatenate_72[0][0]
                                                                 dropout_76[0][0]
--------------------------------------------------------------------------------------------------
activation_54 (Activation)      (None, 8, 8, 64)     0           batch_normalization_54[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_77 (BatchNo (None, 16, 16, 64)   256         concatenate_73[0][0]
--------------------------------------------------------------------------------------------------
conv2d_55 (Conv2D)              (None, 8, 8, 8)      4608        activation_54[0][0]
--------------------------------------------------------------------------------------------------
activation_77 (Activation)      (None, 16, 16, 64)   0           batch_normalization_77[0][0]
--------------------------------------------------------------------------------------------------
dropout_54 (Dropout)            (None, 8, 8, 8)      0           conv2d_55[0][0]
--------------------------------------------------------------------------------------------------
conv2d_78 (Conv2D)              (None, 16, 16, 8)    4608        activation_77[0][0]
--------------------------------------------------------------------------------------------------
concatenate_52 (Concatenate)    (None, 8, 8, 72)     0           concatenate_51[0][0]
                                                                 dropout_54[0][0]
--------------------------------------------------------------------------------------------------
dropout_77 (Dropout)            (None, 16, 16, 8)    0           conv2d_78[0][0]
--------------------------------------------------------------------------------------------------
batch_normalization_55 (BatchNo (None, 8, 8, 72)     288         concatenate_52[0][0]
--------------------------------------------------------------------------------------------------
concatenate_74 (Concatenate)    (None, 16, 16, 72)   0           concatenate_73[0][0]
                                                                 dropout_77[0][0]
--------------------------------------------------------------------------------------------------
activation_55 (Activation)      (None, 8, 8, 72)     0           batch_normalization_55[0][0]
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batch_normalization_78 (BatchNo (None, 16, 16, 72)   288         concatenate_74[0][0]
conv2d_56 (Conv2D)              (None, 8, 8, 8)      5184        activation_55[0][0]
activation_78 (Activation)      (None, 16, 16, 72)   0           batch_normalization_78[0][0]
dropout_55 (Dropout)            (None, 8, 8, 8)      0           conv2d_56[0][0]
conv2d_79 (Conv2D)              (None, 16, 16, 8)    5184        activation_78[0][0]
concatenate_53 (Concatenate)    (None, 8, 8, 80)     0           concatenate_52[0][0]
                                                                 dropout_55[0][0]
dropout_78 (Dropout)            (None, 16, 16, 8)    0           conv2d_79[0][0]
batch_normalization_56 (BatchNo (None, 8, 8, 80)     320         concatenate_53[0][0]
concatenate_75 (Concatenate)    (None, 16, 16, 80)   0           concatenate_74[0][0]
                                                                 dropout_78[0][0]
activation_56 (Activation)      (None, 8, 8, 80)     0           batch_normalization_56[0][0]
batch_normalization_79 (BatchNo (None, 16, 16, 80)   320         concatenate_75[0][0]
conv2d_57 (Conv2D)              (None, 8, 8, 8)      5760        activation_56[0][0]
activation_79 (Activation)      (None, 16, 16, 80)   0           batch_normalization_79[0][0]
dropout_56 (Dropout)            (None, 8, 8, 8)      0           conv2d_57[0][0]
conv2d_80 (Conv2D)              (None, 16, 16, 8)    5760        activation_79[0][0]
concatenate_54 (Concatenate)    (None, 8, 8, 88)     0           concatenate_53[0][0]
                                                                 dropout_56[0][0]
dropout_79 (Dropout)            (None, 16, 16, 8)    0           conv2d_80[0][0]
batch_normalization_57 (BatchNo (None, 8, 8, 88)     352         concatenate_54[0][0]
concatenate_76 (Concatenate)    (None, 16, 16, 88)   0           concatenate_75[0][0]
                                                                 dropout_79[0][0]
activation_57 (Activation)      (None, 8, 8, 88)     0           batch_normalization_57[0][0]
batch_normalization_80 (BatchNo (None, 16, 16, 88)   352         concatenate_76[0][0]
conv2d_58 (Conv2D)              (None, 8, 8, 8)      6336        activation_57[0][0]
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activation_80 (Activation)      (None, 16, 16, 88)   0           batch_normalization_80[0][0]
dropout_57 (Dropout)            (None, 8, 8, 8)      0           conv2d_58[0][0]
conv2d_81 (Conv2D)              (None, 16, 16, 8)    6336        activation_80[0][0]
concatenate_55 (Concatenate)    (None, 8, 8, 96)     0           concatenate_54[0][0]
                                                                 dropout_57[0][0]
dropout_80 (Dropout)            (None, 16, 16, 8)    0           conv2d_81[0][0]
batch_normalization_58 (BatchNo (None, 8, 8, 96)     384         concatenate_55[0][0]
concatenate_77 (Concatenate)    (None, 16, 16, 96)   0           concatenate_76[0][0]
                                                                 dropout_80[0][0]
activation_58 (Activation)      (None, 8, 8, 96)     0           batch_normalization_58[0][0]
batch_normalization_81 (BatchNo (None, 16, 16, 96)   384         concatenate_77[0][0]
conv2d_59 (Conv2D)              (None, 8, 8, 8)      6912        activation_58[0][0]
activation_81 (Activation)      (None, 16, 16, 96)   0           batch_normalization_81[0][0]
dropout_58 (Dropout)            (None, 8, 8, 8)      0           conv2d_59[0][0]
conv2d_82 (Conv2D)              (None, 16, 16, 8)    6912        activation_81[0][0]
concatenate_56 (Concatenate)    (None, 8, 8, 104)    0           concatenate_55[0][0]
                                                                 dropout_58[0][0]
dropout_81 (Dropout)            (None, 16, 16, 8)    0           conv2d_82[0][0]
batch_normalization_59 (BatchNo (None, 8, 8, 104)    416         concatenate_56[0][0]
concatenate_78 (Concatenate)    (None, 16, 16, 104)  0           concatenate_77[0][0]
                                                                 dropout_81[0][0]
activation_59 (Activation)      (None, 8, 8, 104)    0           batch_normalization_59[0][0]
batch_normalization_82 (BatchNo (None, 16, 16, 104)  416         concatenate_78[0][0]
conv2d_60 (Conv2D)              (None, 8, 8, 8)      7488        activation_59[0][0]
activation_82 (Activation)      (None, 16, 16, 104)  0           batch_normalization_82[0][0]
dropout_59 (Dropout)            (None, 8, 8, 8)      0           conv2d_60[0][0]
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conv2d_83 (Conv2D)              (None, 16, 16, 8)    7488        activation_82[0][0]
concatenate_57 (Concatenate)    (None, 8, 8, 112)    0           concatenate_56[0][0]
                                                                 dropout_59[0][0]
dropout_82 (Dropout)            (None, 16, 16, 8)    0           conv2d_83[0][0]
batch_normalization_60 (BatchNo (None, 8, 8, 112)    448         concatenate_57[0][0]
concatenate_79 (Concatenate)    (None, 16, 16, 112)  0           concatenate_78[0][0]
                                                                 dropout_82[0][0]
activation_60 (Activation)      (None, 8, 8, 112)    0           batch_normalization_60[0][0]
batch_normalization_83 (BatchNo (None, 16, 16, 112)  448         concatenate_79[0][0]
conv2d_61 (Conv2D)              (None, 8, 8, 8)      8064        activation_60[0][0]
activation_83 (Activation)      (None, 16, 16, 112)  0           batch_normalization_83[0][0]
dropout_60 (Dropout)            (None, 8, 8, 8)      0           conv2d_61[0][0]
conv2d_84 (Conv2D)              (None, 16, 16, 8)    8064        activation_83[0][0]
concatenate_58 (Concatenate)    (None, 8, 8, 120)    0           concatenate_57[0][0]
                                                                 dropout_60[0][0]
dropout_83 (Dropout)            (None, 16, 16, 8)    0           conv2d_84[0][0]
batch_normalization_61 (BatchNo (None, 8, 8, 120)    480         concatenate_58[0][0]
concatenate_80 (Concatenate)    (None, 16, 16, 120)  0           concatenate_79[0][0]
                                                                 dropout_83[0][0]
activation_61 (Activation)      (None, 8, 8, 120)    0           batch_normalization_61[0][0]
batch_normalization_84 (BatchNo (None, 16, 16, 120)  480         concatenate_80[0][0]
conv2d_62 (Conv2D)              (None, 8, 8, 8)      8640        activation_61[0][0]
activation_84 (Activation)      (None, 16, 16, 120)  0           batch_normalization_84[0][0]
dropout_61 (Dropout)            (None, 8, 8, 8)      0           conv2d_62[0][0]
conv2d_85 (Conv2D)              (None, 16, 16, 8)    8640        activation_84[0][0]
concatenate_59 (Concatenate)    (None, 8, 8, 128)    0           concatenate_58[0][0]
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                                                                 dropout_61[0][0]
__________________________________________________________________________________________________
dropout_84 (Dropout)            (None, 16, 16, 8)    0           conv2d_85[0][0]
__________________________________________________________________________________________________
batch_normalization_62 (BatchNo (None, 8, 8, 128)    512         concatenate_59[0][0]
__________________________________________________________________________________________________
concatenate_81 (Concatenate)    (None, 16, 16, 128)  0           concatenate_80[0][0]
                                                                 dropout_84[0][0]
__________________________________________________________________________________________________
activation_62 (Activation)      (None, 8, 8, 128)    0           batch_normalization_62[0][0]
__________________________________________________________________________________________________
batch_normalization_85 (BatchNo (None, 16, 16, 128)  512         concatenate_81[0][0]
__________________________________________________________________________________________________
conv2d_63 (Conv2D)              (None, 8, 8, 8)      9216        activation_62[0][0]
__________________________________________________________________________________________________
activation_85 (Activation)      (None, 16, 16, 128)  0           batch_normalization_85[0][0]
__________________________________________________________________________________________________
dropout_62 (Dropout)            (None, 8, 8, 8)      0           conv2d_63[0][0]
__________________________________________________________________________________________________
conv2d_86 (Conv2D)              (None, 16, 16, 8)    9216        activation_85[0][0]
__________________________________________________________________________________________________
concatenate_60 (Concatenate)    (None, 8, 8, 136)    0           concatenate_59[0][0]
                                                                 dropout_62[0][0]
__________________________________________________________________________________________________
dropout_85 (Dropout)            (None, 16, 16, 8)    0           conv2d_86[0][0]
__________________________________________________________________________________________________
batch_normalization_63 (BatchNo (None, 8, 8, 136)    544         concatenate_60[0][0]
__________________________________________________________________________________________________
concatenate_82 (Concatenate)    (None, 16, 16, 136)  0           concatenate_81[0][0]
                                                                 dropout_85[0][0]
__________________________________________________________________________________________________
activation_63 (Activation)      (None, 8, 8, 136)    0           batch_normalization_63[0][0]
__________________________________________________________________________________________________
batch_normalization_86 (BatchNo (None, 16, 16, 136)  544         concatenate_82[0][0]
__________________________________________________________________________________________________
conv2d_64 (Conv2D)              (None, 8, 8, 8)      9792        activation_63[0][0]
__________________________________________________________________________________________________
activation_86 (Activation)      (None, 16, 16, 136)  0           batch_normalization_86[0][0]
__________________________________________________________________________________________________
dropout_63 (Dropout)            (None, 8, 8, 8)      0           conv2d_64[0][0]
__________________________________________________________________________________________________
conv2d_87 (Conv2D)              (None, 16, 16, 8)    9792        activation_86[0][0]
__________________________________________________________________________________________________
concatenate_61 (Concatenate)    (None, 8, 8, 144)    0           concatenate_60[0][0]
                                                                 dropout_63[0][0]
__________________________________________________________________________________________________
dropout_86 (Dropout)            (None, 16, 16, 8)    0           conv2d_87[0][0]
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batch_normalization_64 (BatchNo (None, 8, 8, 144)    576         concatenate_61[0][0]
__________________________________________________________________________________________
concatenate_83 (Concatenate)    (None, 16, 16, 144)  0           concatenate_82[0][0]
                                                                 dropout_86[0][0]
__________________________________________________________________________________________
activation_64 (Activation)      (None, 8, 8, 144)    0           batch_normalization_64[0][0]
__________________________________________________________________________________________
batch_normalization_87 (BatchNo (None, 16, 16, 144)  576         concatenate_83[0][0]
__________________________________________________________________________________________
conv2d_65 (Conv2D)              (None, 8, 8, 8)      10368       activation_64[0][0]
__________________________________________________________________________________________
activation_87 (Activation)      (None, 16, 16, 144)  0           batch_normalization_87[0][0]
__________________________________________________________________________________________
dropout_64 (Dropout)            (None, 8, 8, 8)      0           conv2d_65[0][0]
__________________________________________________________________________________________
conv2d_88 (Conv2D)              (None, 16, 16, 8)    10368       activation_87[0][0]
__________________________________________________________________________________________
concatenate_62 (Concatenate)    (None, 8, 8, 152)    0           concatenate_61[0][0]
                                                                 dropout_64[0][0]
__________________________________________________________________________________________
dropout_87 (Dropout)            (None, 16, 16, 8)    0           conv2d_88[0][0]
__________________________________________________________________________________________
batch_normalization_65 (BatchNo (None, 8, 8, 152)    608         concatenate_62[0][0]
__________________________________________________________________________________________
concatenate_84 (Concatenate)    (None, 16, 16, 152)  0           concatenate_83[0][0]
                                                                 dropout_87[0][0]
__________________________________________________________________________________________
activation_65 (Activation)      (None, 8, 8, 152)    0           batch_normalization_65[0][0]
__________________________________________________________________________________________
batch_normalization_88 (BatchNo (None, 16, 16, 152)  608         concatenate_84[0][0]
__________________________________________________________________________________________
conv2d_66 (Conv2D)              (None, 8, 8, 8)      10944       activation_65[0][0]
__________________________________________________________________________________________
activation_88 (Activation)      (None, 16, 16, 152)  0           batch_normalization_88[0][0]
__________________________________________________________________________________________
dropout_65 (Dropout)            (None, 8, 8, 8)      0           conv2d_66[0][0]
__________________________________________________________________________________________
conv2d_89 (Conv2D)              (None, 16, 16, 8)    10944       activation_88[0][0]
__________________________________________________________________________________________
concatenate_63 (Concatenate)    (None, 8, 8, 160)    0           concatenate_62[0][0]
                                                                 dropout_65[0][0]
__________________________________________________________________________________________
dropout_88 (Dropout)            (None, 16, 16, 8)    0           conv2d_89[0][0]
__________________________________________________________________________________________
batch_normalization_66 (BatchNo (None, 8, 8, 160)    640         concatenate_63[0][0]
__________________________________________________________________________________________
concatenate_85 (Concatenate)    (None, 16, 16, 160)  0           concatenate_84[0][0]
                                                                 dropout_88[0][0]
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activation_66 (Activation)      (None, 8, 8, 160)    0           batch_normalization_66[0][0]
batch_normalization_89 (BatchNo (None, 16, 16, 160)  640         concatenate_85[0][0]
conv2d_67 (Conv2D)              (None, 8, 8, 8)      11520       activation_66[0][0]
activation_89 (Activation)      (None, 16, 16, 160)  0           batch_normalization_89[0][0]
dropout_66 (Dropout)            (None, 8, 8, 8)      0           conv2d_67[0][0]
conv2d_90 (Conv2D)              (None, 16, 16, 8)    11520       activation_89[0][0]
concatenate_64 (Concatenate)    (None, 8, 8, 168)    0           concatenate_63[0][0]
                                                                 dropout_66[0][0]
dropout_89 (Dropout)            (None, 16, 16, 8)    0           conv2d_90[0][0]
batch_normalization_67 (BatchNo (None, 8, 8, 168)    672         concatenate_64[0][0]
concatenate_86 (Concatenate)    (None, 16, 16, 168)  0           concatenate_85[0][0]
                                                                 dropout_89[0][0]
activation_67 (Activation)      (None, 8, 8, 168)    0           batch_normalization_67[0][0]
batch_normalization_90 (BatchNo (None, 16, 16, 168)  672         concatenate_86[0][0]
conv2d_68 (Conv2D)              (None, 8, 8, 8)      12096       activation_67[0][0]
activation_90 (Activation)      (None, 16, 16, 168)  0           batch_normalization_90[0][0]
dropout_67 (Dropout)            (None, 8, 8, 8)      0           conv2d_68[0][0]
conv2d_91 (Conv2D)              (None, 16, 16, 8)    12096       activation_90[0][0]
concatenate_65 (Concatenate)    (None, 8, 8, 176)    0           concatenate_64[0][0]
                                                                 dropout_67[0][0]
dropout_90 (Dropout)            (None, 16, 16, 8)    0           conv2d_91[0][0]
batch_normalization_68 (BatchNo (None, 8, 8, 176)    704         concatenate_65[0][0]
concatenate_87 (Concatenate)    (None, 16, 16, 176)  0           concatenate_86[0][0]
                                                                 dropout_90[0][0]
activation_68 (Activation)      (None, 8, 8, 176)    0           batch_normalization_68[0][0]
batch_normalization_91 (BatchNo (None, 16, 16, 176)  704         concatenate_87[0][0]
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conv2d_69 (Conv2D)              (None, 8, 8, 8)      12672       activation_68[0][0]
activation_91 (Activation)      (None, 16, 16, 176)  0           batch_normalization_91[0][0]
dropout_68 (Dropout)            (None, 8, 8, 8)      0           conv2d_69[0][0]
conv2d_92 (Conv2D)              (None, 16, 16, 8)    12672       activation_91[0][0]
concatenate_66 (Concatenate)    (None, 8, 8, 184)    0           concatenate_65[0][0]
                                                                 dropout_68[0][0]
dropout_91 (Dropout)            (None, 16, 16, 8)    0           conv2d_92[0][0]
batch_normalization_69 (BatchNo (None, 8, 8, 184)    736         concatenate_66[0][0]
concatenate_88 (Concatenate)    (None, 16, 16, 184)  0           concatenate_87[0][0]
                                                                 dropout_91[0][0]
activation_69 (Activation)      (None, 8, 8, 184)    0           batch_normalization_69[0][0]
conv2d_93 (Conv2D)              (None, 12, 12, 8)    36800       concatenate_88[0][0]
conv2d_70 (Conv2D)              (None, 8, 8, 8)      1472        activation_69[0][0]
conv2d_94 (Conv2D)              (None, 8, 8, 8)      1600        conv2d_93[0][0]
dropout_69 (Dropout)            (None, 8, 8, 8)      0           conv2d_70[0][0]
conv2d_95 (Conv2D)              (None, 4, 4, 8)      1600        conv2d_94[0][0]
average_pooling2d_3 (AveragePoo (None, 4, 4, 8)      0           dropout_69[0][0]
concatenate_89 (Concatenate)    (None, 4, 4, 16)     0           conv2d_95[0][0]
                                                                 average_pooling2d_3[0][0]
batch_normalization_92 (BatchNo (None, 4, 4, 16)     64          concatenate_89[0][0]
activation_92 (Activation)      (None, 4, 4, 16)     0           batch_normalization_92[0][0]
conv2d_96 (Conv2D)              (None, 4, 4, 8)      128         activation_92[0][0]
dropout_92 (Dropout)            (None, 4, 4, 8)      0           conv2d_96[0][0]
average_pooling2d_4 (AveragePoo (None, 2, 2, 8)      0           dropout_92[0][0]
batch_normalization_93 (BatchNo (None, 2, 2, 8)      32          average_pooling2d_4[0][0]
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activation_93 (Activation)      (None, 2, 2, 8)      0           batch_normalization_93[0][0]
__________________________________________________________________________________________
conv2d_97 (Conv2D)              (None, 2, 2, 8)      576         activation_93[0][0]
__________________________________________________________________________________________
dropout_93 (Dropout)            (None, 2, 2, 8)      0           conv2d_97[0][0]
__________________________________________________________________________________________
concatenate_90 (Concatenate)    (None, 2, 2, 16)     0           average_pooling2d_4[0][0]
                                                                 dropout_93[0][0]
__________________________________________________________________________________________
batch_normalization_94 (BatchNo (None, 2, 2, 16)     64          concatenate_90[0][0]
__________________________________________________________________________________________
activation_94 (Activation)      (None, 2, 2, 16)     0           batch_normalization_94[0][0]
__________________________________________________________________________________________
conv2d_98 (Conv2D)              (None, 2, 2, 8)      1152        activation_94[0][0]
__________________________________________________________________________________________
dropout_94 (Dropout)            (None, 2, 2, 8)      0           conv2d_98[0][0]
__________________________________________________________________________________________
concatenate_91 (Concatenate)    (None, 2, 2, 24)     0           concatenate_90[0][0]
                                                                 dropout_94[0][0]
__________________________________________________________________________________________
batch_normalization_95 (BatchNo (None, 2, 2, 24)     96          concatenate_91[0][0]
__________________________________________________________________________________________
activation_95 (Activation)      (None, 2, 2, 24)     0           batch_normalization_95[0][0]
__________________________________________________________________________________________
conv2d_99 (Conv2D)              (None, 2, 2, 8)      1728        activation_95[0][0]
__________________________________________________________________________________________
dropout_95 (Dropout)            (None, 2, 2, 8)      0           conv2d_99[0][0]
__________________________________________________________________________________________
concatenate_92 (Concatenate)    (None, 2, 2, 32)     0           concatenate_91[0][0]
                                                                 dropout_95[0][0]
__________________________________________________________________________________________
batch_normalization_96 (BatchNo (None, 2, 2, 32)     128         concatenate_92[0][0]
__________________________________________________________________________________________
activation_96 (Activation)      (None, 2, 2, 32)     0           batch_normalization_96[0][0]
__________________________________________________________________________________________
conv2d_100 (Conv2D)             (None, 2, 2, 8)      2304        activation_96[0][0]
__________________________________________________________________________________________
dropout_96 (Dropout)            (None, 2, 2, 8)      0           conv2d_100[0][0]
__________________________________________________________________________________________
concatenate_93 (Concatenate)    (None, 2, 2, 40)     0           concatenate_92[0][0]
                                                                 dropout_96[0][0]
__________________________________________________________________________________________
batch_normalization_97 (BatchNo (None, 2, 2, 40)     160         concatenate_93[0][0]
__________________________________________________________________________________________
activation_97 (Activation)      (None, 2, 2, 40)     0           batch_normalization_97[0][0]
__________________________________________________________________________________________
conv2d_101 (Conv2D)             (None, 2, 2, 8)      2880        activation_97[0][0]
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dropout_97 (Dropout)            (None, 2, 2, 8)      0           conv2d_101[0][0]
__________________________________________________________________________________________
concatenate_94 (Concatenate)    (None, 2, 2, 48)     0           concatenate_93[0][0]
                                                                 dropout_97[0][0]
__________________________________________________________________________________________
batch_normalization_98 (BatchNo (None, 2, 2, 48)     192         concatenate_94[0][0]
__________________________________________________________________________________________
activation_98 (Activation)      (None, 2, 2, 48)     0           batch_normalization_98[0][0]
__________________________________________________________________________________________
conv2d_102 (Conv2D)             (None, 2, 2, 8)      3456        activation_98[0][0]
__________________________________________________________________________________________
dropout_98 (Dropout)            (None, 2, 2, 8)      0           conv2d_102[0][0]
__________________________________________________________________________________________
concatenate_95 (Concatenate)    (None, 2, 2, 56)     0           concatenate_94[0][0]
                                                                 dropout_98[0][0]
__________________________________________________________________________________________
batch_normalization_99 (BatchNo (None, 2, 2, 56)     224         concatenate_95[0][0]
__________________________________________________________________________________________
activation_99 (Activation)      (None, 2, 2, 56)     0           batch_normalization_99[0][0]
__________________________________________________________________________________________
conv2d_103 (Conv2D)             (None, 2, 2, 8)      4032        activation_99[0][0]
__________________________________________________________________________________________
dropout_99 (Dropout)            (None, 2, 2, 8)      0           conv2d_103[0][0]
__________________________________________________________________________________________
concatenate_96 (Concatenate)    (None, 2, 2, 64)     0           concatenate_95[0][0]
                                                                 dropout_99[0][0]
__________________________________________________________________________________________
batch_normalization_100 (BatchN (None, 2, 2, 64)     256         concatenate_96[0][0]
__________________________________________________________________________________________
activation_100 (Activation)     (None, 2, 2, 64)     0           batch_normalization_100[0][0]
__________________________________________________________________________________________
conv2d_104 (Conv2D)             (None, 2, 2, 8)      4608        activation_100[0][0]
__________________________________________________________________________________________
dropout_100 (Dropout)           (None, 2, 2, 8)      0           conv2d_104[0][0]
__________________________________________________________________________________________
concatenate_97 (Concatenate)    (None, 2, 2, 72)     0           concatenate_96[0][0]
                                                                 dropout_100[0][0]
__________________________________________________________________________________________
batch_normalization_101 (BatchN (None, 2, 2, 72)     288         concatenate_97[0][0]
__________________________________________________________________________________________
activation_101 (Activation)     (None, 2, 2, 72)     0           batch_normalization_101[0][0]
__________________________________________________________________________________________
conv2d_105 (Conv2D)             (None, 2, 2, 8)      5184        activation_101[0][0]
__________________________________________________________________________________________
dropout_101 (Dropout)           (None, 2, 2, 8)      0           conv2d_105[0][0]
__________________________________________________________________________________________
concatenate_98 (Concatenate)    (None, 2, 2, 80)     0           concatenate_97[0][0]
                                                                 dropout_101[0][0]
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batch_normalization_102 (BatchN (None, 2, 2, 80)     320         concatenate_98[0][0]
activation_102 (Activation)     (None, 2, 2, 80)     0           batch_normalization_102[0][0]
conv2d_106 (Conv2D)             (None, 2, 2, 8)      5760        activation_102[0][0]
dropout_102 (Dropout)           (None, 2, 2, 8)      0           conv2d_106[0][0]
concatenate_99 (Concatenate)    (None, 2, 2, 88)     0           concatenate_98[0][0]
                                                                 dropout_102[0][0]
batch_normalization_103 (BatchN (None, 2, 2, 88)     352         concatenate_99[0][0]
activation_103 (Activation)     (None, 2, 2, 88)     0           batch_normalization_103[0][0]
conv2d_107 (Conv2D)             (None, 2, 2, 8)      6336        activation_103[0][0]
dropout_103 (Dropout)           (None, 2, 2, 8)      0           conv2d_107[0][0]
concatenate_100 (Concatenate)   (None, 2, 2, 96)     0           concatenate_99[0][0]
                                                                 dropout_103[0][0]
batch_normalization_104 (BatchN (None, 2, 2, 96)     384         concatenate_100[0][0]
activation_104 (Activation)     (None, 2, 2, 96)     0           batch_normalization_104[0][0]
conv2d_108 (Conv2D)             (None, 2, 2, 8)      6912        activation_104[0][0]
dropout_104 (Dropout)           (None, 2, 2, 8)      0           conv2d_108[0][0]
concatenate_101 (Concatenate)   (None, 2, 2, 104)    0           concatenate_100[0][0]
                                                                 dropout_104[0][0]
batch_normalization_105 (BatchN (None, 2, 2, 104)    416         concatenate_101[0][0]
activation_105 (Activation)     (None, 2, 2, 104)    0           batch_normalization_105[0][0]
conv2d_109 (Conv2D)             (None, 2, 2, 8)      7488        activation_105[0][0]
dropout_105 (Dropout)           (None, 2, 2, 8)      0           conv2d_109[0][0]
concatenate_102 (Concatenate)   (None, 2, 2, 112)    0           concatenate_101[0][0]
                                                                 dropout_105[0][0]
batch_normalization_106 (BatchN (None, 2, 2, 112)    448         concatenate_102[0][0]
activation_106 (Activation)     (None, 2, 2, 112)    0           batch_normalization_106[0][0]
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conv2d_110 (Conv2D)             (None, 2, 2, 8)      8064        activation_106[0][0]
dropout_106 (Dropout)           (None, 2, 2, 8)      0           conv2d_110[0][0]
concatenate_103 (Concatenate)   (None, 2, 2, 120)    0           concatenate_102[0][0]
                                                                 dropout_106[0][0]
batch_normalization_107 (BatchN (None, 2, 2, 120)    480         concatenate_103[0][0]
activation_107 (Activation)     (None, 2, 2, 120)    0           batch_normalization_107[0][0]
conv2d_111 (Conv2D)             (None, 2, 2, 8)      8640        activation_107[0][0]
dropout_107 (Dropout)           (None, 2, 2, 8)      0           conv2d_111[0][0]
concatenate_104 (Concatenate)   (None, 2, 2, 128)    0           concatenate_103[0][0]
                                                                 dropout_107[0][0]
batch_normalization_108 (BatchN (None, 2, 2, 128)    512         concatenate_104[0][0]
activation_108 (Activation)     (None, 2, 2, 128)    0           batch_normalization_108[0][0]
conv2d_112 (Conv2D)             (None, 2, 2, 8)      9216        activation_108[0][0]
dropout_108 (Dropout)           (None, 2, 2, 8)      0           conv2d_112[0][0]
concatenate_105 (Concatenate)   (None, 2, 2, 136)    0           concatenate_104[0][0]
                                                                 dropout_108[0][0]
batch_normalization_109 (BatchN (None, 2, 2, 136)    544         concatenate_105[0][0]
activation_109 (Activation)     (None, 2, 2, 136)    0           batch_normalization_109[0][0]
conv2d_113 (Conv2D)             (None, 2, 2, 8)      9792        activation_109[0][0]
dropout_109 (Dropout)           (None, 2, 2, 8)      0           conv2d_113[0][0]
concatenate_106 (Concatenate)   (None, 2, 2, 144)    0           concatenate_105[0][0]
                                                                 dropout_109[0][0]
batch_normalization_110 (BatchN (None, 2, 2, 144)    576         concatenate_106[0][0]
activation_110 (Activation)     (None, 2, 2, 144)    0           batch_normalization_110[0][0]
conv2d_114 (Conv2D)             (None, 2, 2, 8)      10368       activation_110[0][0]
dropout_110 (Dropout)           (None, 2, 2, 8)      0           conv2d_114[0][0]
```

```
concatenate_107 (Concatenate)   (None, 2, 2, 152)    0           concatenate_106[0][0]
                                                                 dropout_110[0][0]
batch_normalization_111 (BatchN (None, 2, 2, 152)    608         concatenate_107[0][0]
activation_111 (Activation)     (None, 2, 2, 152)    0           batch_normalization_111[0][0]
conv2d_115 (Conv2D)             (None, 2, 2, 8)      10944       activation_111[0][0]
dropout_111 (Dropout)           (None, 2, 2, 8)      0           conv2d_115[0][0]
concatenate_108 (Concatenate)   (None, 2, 2, 160)    0           concatenate_107[0][0]
                                                                 dropout_111[0][0]
batch_normalization_112 (BatchN (None, 2, 2, 160)    640         concatenate_108[0][0]
activation_112 (Activation)     (None, 2, 2, 160)    0           batch_normalization_112[0][0]
conv2d_116 (Conv2D)             (None, 2, 2, 8)      11520       activation_112[0][0]
dropout_112 (Dropout)           (None, 2, 2, 8)      0           conv2d_116[0][0]
concatenate_109 (Concatenate)   (None, 2, 2, 168)    0           concatenate_108[0][0]
                                                                 dropout_112[0][0]
batch_normalization_113 (BatchN (None, 2, 2, 168)    672         concatenate_109[0][0]
activation_113 (Activation)     (None, 2, 2, 168)    0           batch_normalization_113[0][0]
conv2d_117 (Conv2D)             (None, 2, 2, 8)      12096       activation_113[0][0]
dropout_113 (Dropout)           (None, 2, 2, 8)      0           conv2d_117[0][0]
concatenate_110 (Concatenate)   (None, 2, 2, 176)    0           concatenate_109[0][0]
                                                                 dropout_113[0][0]
batch_normalization_114 (BatchN (None, 2, 2, 176)    704         concatenate_110[0][0]
activation_114 (Activation)     (None, 2, 2, 176)    0           batch_normalization_114[0][0]
conv2d_118 (Conv2D)             (None, 2, 2, 8)      12672       activation_114[0][0]
dropout_114 (Dropout)           (None, 2, 2, 8)      0           conv2d_118[0][0]
concatenate_111 (Concatenate)   (None, 2, 2, 184)    0           concatenate_110[0][0]
                                                                 dropout_114[0][0]
```

```
batch_normalization_115 (BatchN (None, 2, 2, 184)    736         concatenate_111[0][0]
__________________________________________________________________________________________________
activation_115 (Activation)     (None, 2, 2, 184)    0           batch_normalization_115[0][0]
__________________________________________________________________________________________________
average_pooling2d_5 (AveragePoo (None, 1, 1, 184)    0           activation_115[0][0]
__________________________________________________________________________________________________
flatten_1 (Flatten)             (None, 184)          0           average_pooling2d_5[0][0]
__________________________________________________________________________________________________
dense_1 (Dense)                 (None, 10)           1850        flatten_1[0][0]
==================================================================================================
Total params: 832,426
Trainable params: 810,314
Non-trainable params: 22,112
__________________________________________________________________________________________________
```

0.10 Compile the model

```
In [12]: # determine Loss function and Optimizer
         model.compile(loss='categorical_crossentropy',
                       optimizer=SGD(),
                       metrics=['accuracy'])
```

0.11 Callbacks For Early Stopping and Saving the Best Model

```
In [13]: from keras.callbacks import Callback
         class EarlyStoppingByValidationAccuracy(Callback):
             def __init__(self, monitor='val_acc', value=1.0, verbose=0):
                 super(Callback, self).__init__()
                 self.monitor = monitor
                 self.value = value
                 self.verbose = verbose

             def on_epoch_end(self, epoch, logs={}):
                 accuracy_value= logs.get(self.monitor)

                 if accuracy_value >= self.value:
                     self.model.stop_training = True
                     if self.verbose == 1:
                         print("Epoch %d: Threshold for early stopping has reached" % (epoch +

In [14]: from keras.callbacks import ModelCheckpoint
         callbacks_list=[]
         model_save_path= "best_model-CIFAR10-monimoy-my_computer2.h5"
         callbacks_list.append(EarlyStoppingByValidationAccuracy(monitor='val_acc',  value=0.9
         callbacks_list.append(ModelCheckpoint(model_save_path, monitor='val_acc', verbose=1, s
```

0.12 Fit the model on the train data and calculate metrics (Training Loss, Training Accuracy, Validation Losss, Validation Accuracy)

```
In [15]: model.fit(x_train, y_train,
                           batch_size=batch_size,
                           epochs=epochs,
                           verbose=1,
                           validation_data=(x_test, y_test),
                           callbacks=callbacks_list)
```

```
Train on 52000 samples, validate on 10000 samples
Epoch 1/250
52000/52000 [==============================] - 338s 7ms/step - loss: 1.9728 - acc: 0.2591 - val

Epoch 00001: val_acc improved from -inf to 0.20550, saving model to best_model-CIFAR10-monimoy
Epoch 2/250
52000/52000 [==============================] - 305s 6ms/step - loss: 1.6869 - acc: 0.3636 - val

Epoch 00002: val_acc improved from 0.20550 to 0.35920, saving model to best_model-CIFAR10-monim
Epoch 3/250
52000/52000 [==============================] - 307s 6ms/step - loss: 1.5632 - acc: 0.4158 - val

Epoch 00003: val_acc improved from 0.35920 to 0.40760, saving model to best_model-CIFAR10-monim
Epoch 4/250
52000/52000 [==============================] - 307s 6ms/step - loss: 1.4708 - acc: 0.4556 - val

Epoch 00004: val_acc did not improve from 0.40760
Epoch 5/250
52000/52000 [==============================] - 308s 6ms/step - loss: 1.3925 - acc: 0.4900 - val

Epoch 00005: val_acc improved from 0.40760 to 0.47370, saving model to best_model-CIFAR10-monim
Epoch 6/250
52000/52000 [==============================] - 309s 6ms/step - loss: 1.3306 - acc: 0.5184 - val

Epoch 00006: val_acc improved from 0.47370 to 0.48630, saving model to best_model-CIFAR10-monim
Epoch 7/250
52000/52000 [==============================] - 307s 6ms/step - loss: 1.2738 - acc: 0.5388 - val

Epoch 00007: val_acc improved from 0.48630 to 0.49210, saving model to best_model-CIFAR10-monim
Epoch 8/250
52000/52000 [==============================] - 308s 6ms/step - loss: 1.2285 - acc: 0.5573 - val

Epoch 00008: val_acc did not improve from 0.49210
Epoch 9/250
52000/52000 [==============================] - 308s 6ms/step - loss: 1.1824 - acc: 0.5765 - val

Epoch 00009: val_acc did not improve from 0.49210
Epoch 10/250
```

```
52000/52000 [==============================] - 310s 6ms/step - loss: 1.1463 - acc: 0.5898 - val

Epoch 00010: val_acc improved from 0.49210 to 0.49990, saving model to best_model-CIFAR10-monit
Epoch 11/250
52000/52000 [==============================] - 310s 6ms/step - loss: 1.1156 - acc: 0.6045 - val

Epoch 00011: val_acc did not improve from 0.49990
Epoch 12/250
52000/52000 [==============================] - 310s 6ms/step - loss: 1.0906 - acc: 0.6128 - val

Epoch 00012: val_acc did not improve from 0.49990
Epoch 13/250
52000/52000 [==============================] - 311s 6ms/step - loss: 1.0628 - acc: 0.6212 - val

Epoch 00013: val_acc improved from 0.49990 to 0.60330, saving model to best_model-CIFAR10-monit
Epoch 14/250
52000/52000 [==============================] - 311s 6ms/step - loss: 1.0353 - acc: 0.6324 - val

Epoch 00014: val_acc did not improve from 0.60330
Epoch 15/250
52000/52000 [==============================] - 311s 6ms/step - loss: 1.0178 - acc: 0.6399 - val

Epoch 00015: val_acc did not improve from 0.60330
Epoch 16/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.9955 - acc: 0.6460 - val

Epoch 00016: val_acc did not improve from 0.60330
Epoch 17/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.9795 - acc: 0.6508 - val

Epoch 00017: val_acc did not improve from 0.60330
Epoch 18/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.9599 - acc: 0.6580 - val

Epoch 00018: val_acc improved from 0.60330 to 0.65160, saving model to best_model-CIFAR10-monit
Epoch 19/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.9456 - acc: 0.6663 - val

Epoch 00019: val_acc did not improve from 0.65160
Epoch 20/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.9261 - acc: 0.6717 - val

Epoch 00020: val_acc did not improve from 0.65160
Epoch 21/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.9108 - acc: 0.6755 - val

Epoch 00021: val_acc improved from 0.65160 to 0.65300, saving model to best_model-CIFAR10-monit
Epoch 22/250
```

```
52000/52000 [==============================] - 311s 6ms/step - loss: 0.8968 - acc: 0.6796 - val

Epoch 00022: val_acc did not improve from 0.65300
Epoch 23/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.8917 - acc: 0.6822 - val

Epoch 00023: val_acc did not improve from 0.65300
Epoch 24/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.8764 - acc: 0.6862 - val

Epoch 00024: val_acc did not improve from 0.65300
Epoch 25/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.8623 - acc: 0.6937 - val

Epoch 00025: val_acc improved from 0.65300 to 0.66890, saving model to best_model-CIFAR10-monit
Epoch 26/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.8519 - acc: 0.6953 - val

Epoch 00026: val_acc did not improve from 0.66890
Epoch 27/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.8404 - acc: 0.7015 - val

Epoch 00027: val_acc did not improve from 0.66890
Epoch 28/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.8385 - acc: 0.7013 - val

Epoch 00028: val_acc did not improve from 0.66890
Epoch 29/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.8195 - acc: 0.7052 - val

Epoch 00029: val_acc did not improve from 0.66890
Epoch 30/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.8165 - acc: 0.7087 - val

Epoch 00030: val_acc did not improve from 0.66890
Epoch 31/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.8031 - acc: 0.7146 - val

Epoch 00031: val_acc did not improve from 0.66890
Epoch 32/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.7944 - acc: 0.7171 - val

Epoch 00032: val_acc improved from 0.66890 to 0.68370, saving model to best_model-CIFAR10-monit
Epoch 33/250
52000/52000 [==============================] - 312s 6ms/step - loss: 0.7858 - acc: 0.7199 - val

Epoch 00033: val_acc improved from 0.68370 to 0.70340, saving model to best_model-CIFAR10-monit
Epoch 34/250
```

```
52000/52000 [==============================] - 311s 6ms/step - loss: 0.7827 - acc: 0.7217 - val

Epoch 00034: val_acc did not improve from 0.70340
Epoch 35/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.7675 - acc: 0.7265 - val

Epoch 00035: val_acc did not improve from 0.70340
Epoch 36/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.7578 - acc: 0.7308 - val

Epoch 00036: val_acc did not improve from 0.70340
Epoch 37/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.7541 - acc: 0.7312 - val

Epoch 00037: val_acc did not improve from 0.70340
Epoch 38/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.7456 - acc: 0.7349 - val

Epoch 00038: val_acc did not improve from 0.70340
Epoch 39/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.7387 - acc: 0.7355 - val

Epoch 00039: val_acc improved from 0.70340 to 0.72470, saving model to best_model-CIFAR10-monin
Epoch 40/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.7272 - acc: 0.7408 - val

Epoch 00040: val_acc did not improve from 0.72470
Epoch 41/250
52000/52000 [==============================] - 309s 6ms/step - loss: 0.7251 - acc: 0.7425 - val

Epoch 00041: val_acc did not improve from 0.72470
Epoch 42/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.7174 - acc: 0.7453 - val

Epoch 00042: val_acc did not improve from 0.72470
Epoch 43/250
52000/52000 [==============================] - 309s 6ms/step - loss: 0.7081 - acc: 0.7498 - val

Epoch 00043: val_acc did not improve from 0.72470
Epoch 44/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.7044 - acc: 0.7497 - val

Epoch 00044: val_acc did not improve from 0.72470
Epoch 45/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6994 - acc: 0.7528 - val

Epoch 00045: val_acc did not improve from 0.72470
Epoch 46/250
```

```
52000/52000 [==============================] - 309s 6ms/step - loss: 0.6894 - acc: 0.7568 - val

Epoch 00046: val_acc improved from 0.72470 to 0.72540, saving model to best_model-CIFAR10-monit
Epoch 47/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6847 - acc: 0.7572 - val

Epoch 00047: val_acc did not improve from 0.72540
Epoch 48/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6772 - acc: 0.7602 - val

Epoch 00048: val_acc did not improve from 0.72540
Epoch 49/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6697 - acc: 0.7624 - val

Epoch 00049: val_acc improved from 0.72540 to 0.73430, saving model to best_model-CIFAR10-monit
Epoch 50/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6696 - acc: 0.7630 - val

Epoch 00050: val_acc did not improve from 0.73430
Epoch 51/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6595 - acc: 0.7673 - val

Epoch 00051: val_acc did not improve from 0.73430
Epoch 52/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6551 - acc: 0.7679 - val

Epoch 00052: val_acc did not improve from 0.73430
Epoch 53/250
52000/52000 [==============================] - 309s 6ms/step - loss: 0.6495 - acc: 0.7709 - val

Epoch 00053: val_acc improved from 0.73430 to 0.74760, saving model to best_model-CIFAR10-monit
Epoch 54/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6439 - acc: 0.7734 - val

Epoch 00054: val_acc did not improve from 0.74760
Epoch 55/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6397 - acc: 0.7743 - val

Epoch 00055: val_acc improved from 0.74760 to 0.75290, saving model to best_model-CIFAR10-monit
Epoch 56/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6361 - acc: 0.7747 - val

Epoch 00056: val_acc did not improve from 0.75290
Epoch 57/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6293 - acc: 0.7779 - val

Epoch 00057: val_acc did not improve from 0.75290
Epoch 58/250
```

```
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6206 - acc: 0.7810 - val

Epoch 00058: val_acc improved from 0.75290 to 0.75320, saving model to best_model-CIFAR10-monit
Epoch 59/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6187 - acc: 0.7837 - val

Epoch 00059: val_acc did not improve from 0.75320
Epoch 60/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6076 - acc: 0.7860 - val

Epoch 00060: val_acc did not improve from 0.75320
Epoch 61/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6041 - acc: 0.7884 - val

Epoch 00061: val_acc did not improve from 0.75320
Epoch 62/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.6013 - acc: 0.7893 - val

Epoch 00062: val_acc did not improve from 0.75320
Epoch 63/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5989 - acc: 0.7907 - val

Epoch 00063: val_acc improved from 0.75320 to 0.76500, saving model to best_model-CIFAR10-monit
Epoch 64/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5952 - acc: 0.7915 - val

Epoch 00064: val_acc did not improve from 0.76500
Epoch 65/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5858 - acc: 0.7937 - val

Epoch 00065: val_acc did not improve from 0.76500
Epoch 66/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5863 - acc: 0.7948 - val

Epoch 00066: val_acc improved from 0.76500 to 0.76610, saving model to best_model-CIFAR10-monit
Epoch 67/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5806 - acc: 0.7955 - val

Epoch 00067: val_acc did not improve from 0.76610
Epoch 68/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5764 - acc: 0.7987 - val

Epoch 00068: val_acc improved from 0.76610 to 0.77680, saving model to best_model-CIFAR10-monit
Epoch 69/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5684 - acc: 0.8016 - val

Epoch 00069: val_acc did not improve from 0.77680
Epoch 70/250
```

```
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5640 - acc: 0.8064 - val

Epoch 00070: val_acc did not improve from 0.77680
Epoch 71/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5642 - acc: 0.8023 - val

Epoch 00071: val_acc did not improve from 0.77680
Epoch 72/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5568 - acc: 0.8055 - val

Epoch 00072: val_acc did not improve from 0.77680
Epoch 73/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5528 - acc: 0.8070 - val

Epoch 00073: val_acc improved from 0.77680 to 0.79500, saving model to best_model-CIFAR10-monit
Epoch 74/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5520 - acc: 0.8063 - val

Epoch 00074: val_acc did not improve from 0.79500
Epoch 75/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5484 - acc: 0.8094 - val

Epoch 00075: val_acc did not improve from 0.79500
Epoch 76/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5442 - acc: 0.8111 - val

Epoch 00076: val_acc did not improve from 0.79500
Epoch 77/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5374 - acc: 0.8118 - val

Epoch 00077: val_acc did not improve from 0.79500
Epoch 78/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5291 - acc: 0.8154 - val

Epoch 00078: val_acc did not improve from 0.79500
Epoch 79/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5294 - acc: 0.8159 - val

Epoch 00079: val_acc did not improve from 0.79500
Epoch 80/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5233 - acc: 0.8164 - val

Epoch 00080: val_acc did not improve from 0.79500
Epoch 81/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5249 - acc: 0.8179 - val

Epoch 00081: val_acc did not improve from 0.79500
Epoch 82/250
```

```
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5246 - acc: 0.8166 - val

Epoch 00082: val_acc did not improve from 0.79500
Epoch 83/250
52000/52000 [==============================] - 309s 6ms/step - loss: 0.5162 - acc: 0.8208 - val

Epoch 00083: val_acc did not improve from 0.79500
Epoch 84/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5162 - acc: 0.8194 - val

Epoch 00084: val_acc did not improve from 0.79500
Epoch 85/250
52000/52000 [==============================] - 309s 6ms/step - loss: 0.5080 - acc: 0.8245 - val

Epoch 00085: val_acc did not improve from 0.79500
Epoch 86/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5042 - acc: 0.8247 - val

Epoch 00086: val_acc did not improve from 0.79500
Epoch 87/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.5028 - acc: 0.8251 - val

Epoch 00087: val_acc did not improve from 0.79500
Epoch 88/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.4998 - acc: 0.8233 - val

Epoch 00088: val_acc did not improve from 0.79500
Epoch 89/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.4955 - acc: 0.8257 - val

Epoch 00089: val_acc did not improve from 0.79500
Epoch 90/250
52000/52000 [==============================] - 309s 6ms/step - loss: 0.4958 - acc: 0.8270 - val

Epoch 00090: val_acc did not improve from 0.79500
Epoch 91/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.4940 - acc: 0.8284 - val

Epoch 00091: val_acc did not improve from 0.79500
Epoch 92/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.4809 - acc: 0.8324 - val

Epoch 00092: val_acc did not improve from 0.79500
Epoch 93/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.4803 - acc: 0.8304 - val

Epoch 00093: val_acc improved from 0.79500 to 0.80770, saving model to best_model-CIFAR10-monit
Epoch 94/250
```

```
52000/52000 [==============================] - 310s 6ms/step - loss: 0.4807 - acc: 0.8334 - val

Epoch 00094: val_acc did not improve from 0.80770
Epoch 95/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.4751 - acc: 0.8338 - val

Epoch 00095: val_acc did not improve from 0.80770
Epoch 96/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.4777 - acc: 0.8359 - val

Epoch 00096: val_acc did not improve from 0.80770
Epoch 97/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.4734 - acc: 0.8350 - val

Epoch 00097: val_acc did not improve from 0.80770
Epoch 98/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.4750 - acc: 0.8342 - val

Epoch 00098: val_acc did not improve from 0.80770
Epoch 99/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.4669 - acc: 0.8384 - val

Epoch 00099: val_acc did not improve from 0.80770
Epoch 100/250
52000/52000 [==============================] - 316s 6ms/step - loss: 0.4616 - acc: 0.8396 - val

Epoch 00100: val_acc did not improve from 0.80770
Epoch 101/250
52000/52000 [==============================] - 312s 6ms/step - loss: 0.4661 - acc: 0.8390 - val

Epoch 00101: val_acc did not improve from 0.80770
Epoch 102/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.4626 - acc: 0.8388 - val

Epoch 00102: val_acc did not improve from 0.80770
Epoch 103/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.4558 - acc: 0.8396 - val

Epoch 00103: val_acc did not improve from 0.80770
Epoch 104/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.4590 - acc: 0.8400 - val

Epoch 00104: val_acc did not improve from 0.80770
Epoch 105/250
52000/52000 [==============================] - 309s 6ms/step - loss: 0.4488 - acc: 0.8447 - val

Epoch 00105: val_acc did not improve from 0.80770
Epoch 106/250
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52000/52000 [==============================] - 313s 6ms/step - loss: 0.4494 - acc: 0.8440 - val

Epoch 00106: val_acc did not improve from 0.80770
Epoch 107/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.4498 - acc: 0.8446 - val

Epoch 00107: val_acc did not improve from 0.80770
Epoch 108/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.4459 - acc: 0.8445 - val

Epoch 00108: val_acc did not improve from 0.80770
Epoch 109/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.4370 - acc: 0.8474 - val

Epoch 00109: val_acc did not improve from 0.80770
Epoch 110/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.4399 - acc: 0.8475 - val

Epoch 00110: val_acc did not improve from 0.80770
Epoch 111/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.4419 - acc: 0.8464 - val

Epoch 00111: val_acc did not improve from 0.80770
Epoch 112/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.4353 - acc: 0.8486 - val

Epoch 00112: val_acc did not improve from 0.80770
Epoch 113/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.4293 - acc: 0.8518 - val

Epoch 00113: val_acc did not improve from 0.80770
Epoch 114/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.4377 - acc: 0.8504 - val

Epoch 00114: val_acc did not improve from 0.80770
Epoch 115/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.4248 - acc: 0.8515 - val

Epoch 00115: val_acc did not improve from 0.80770
Epoch 116/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.4245 - acc: 0.8525 - val

Epoch 00116: val_acc did not improve from 0.80770
Epoch 117/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.4207 - acc: 0.8539 - val

Epoch 00117: val_acc did not improve from 0.80770
Epoch 118/250
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52000/52000 [==============================] - 313s 6ms/step - loss: 0.4216 - acc: 0.8542 - val

Epoch 00118: val_acc did not improve from 0.80770
Epoch 119/250
52000/52000 [==============================] - 314s 6ms/step - loss: 0.4202 - acc: 0.8522 - val

Epoch 00119: val_acc did not improve from 0.80770
Epoch 120/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.4161 - acc: 0.8546 - val

Epoch 00120: val_acc did not improve from 0.80770
Epoch 121/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.4173 - acc: 0.8553 - val

Epoch 00121: val_acc did not improve from 0.80770
Epoch 122/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.4114 - acc: 0.8573 - val

Epoch 00122: val_acc did not improve from 0.80770
Epoch 123/250
52000/52000 [==============================] - 312s 6ms/step - loss: 0.4092 - acc: 0.8582 - val

Epoch 00123: val_acc did not improve from 0.80770
Epoch 124/250
52000/52000 [==============================] - 314s 6ms/step - loss: 0.4133 - acc: 0.8555 - val

Epoch 00124: val_acc did not improve from 0.80770
Epoch 125/250
52000/52000 [==============================] - 314s 6ms/step - loss: 0.4092 - acc: 0.8552 - val

Epoch 00125: val_acc did not improve from 0.80770
Epoch 126/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.4029 - acc: 0.8596 - val

Epoch 00126: val_acc improved from 0.80770 to 0.81100, saving model to best_model-CIFAR10-monin
Epoch 127/250
52000/52000 [==============================] - 314s 6ms/step - loss: 0.4009 - acc: 0.8608 - val

Epoch 00127: val_acc did not improve from 0.81100
Epoch 128/250
52000/52000 [==============================] - 314s 6ms/step - loss: 0.3985 - acc: 0.8619 - val

Epoch 00128: val_acc did not improve from 0.81100
Epoch 129/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.3979 - acc: 0.8610 - val

Epoch 00129: val_acc did not improve from 0.81100
Epoch 130/250
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52000/52000 [==============================] - 311s 6ms/step - loss: 0.3953 - acc: 0.8622 - val

Epoch 00130: val_acc did not improve from 0.81100
Epoch 131/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.3961 - acc: 0.8618 - val

Epoch 00131: val_acc improved from 0.81100 to 0.81210, saving model to best_model-CIFAR10-monit
Epoch 132/250
52000/52000 [==============================] - 312s 6ms/step - loss: 0.3937 - acc: 0.8637 - val

Epoch 00132: val_acc did not improve from 0.81210
Epoch 133/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.3909 - acc: 0.8639 - val

Epoch 00133: val_acc did not improve from 0.81210
Epoch 134/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.3874 - acc: 0.8642 - val

Epoch 00134: val_acc improved from 0.81210 to 0.81610, saving model to best_model-CIFAR10-monit
Epoch 135/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.3876 - acc: 0.8629 - val

Epoch 00135: val_acc did not improve from 0.81610
Epoch 136/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.3884 - acc: 0.8654 - val

Epoch 00136: val_acc did not improve from 0.81610
Epoch 137/250
52000/52000 [==============================] - 311s 6ms/step - loss: 0.3803 - acc: 0.8661 - val

Epoch 00137: val_acc did not improve from 0.81610
Epoch 138/250
52000/52000 [==============================] - 312s 6ms/step - loss: 0.3822 - acc: 0.8679 - val

Epoch 00138: val_acc improved from 0.81610 to 0.82030, saving model to best_model-CIFAR10-monit
Epoch 139/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.3846 - acc: 0.8655 - val

Epoch 00139: val_acc did not improve from 0.82030
Epoch 140/250
52000/52000 [==============================] - 312s 6ms/step - loss: 0.3764 - acc: 0.8682 - val

Epoch 00140: val_acc did not improve from 0.82030
Epoch 141/250
52000/52000 [==============================] - 312s 6ms/step - loss: 0.3775 - acc: 0.8679 - val

Epoch 00141: val_acc did not improve from 0.82030
Epoch 142/250
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52000/52000 [==============================] - 312s 6ms/step - loss: 0.3742 - acc: 0.8694 - val

Epoch 00142: val_acc did not improve from 0.82030
Epoch 143/250
52000/52000 [==============================] - 309s 6ms/step - loss: 0.3734 - acc: 0.8693 - val

Epoch 00143: val_acc did not improve from 0.82030
Epoch 144/250
52000/52000 [==============================] - 308s 6ms/step - loss: 0.3672 - acc: 0.8718 - val

Epoch 00144: val_acc improved from 0.82030 to 0.82210, saving model to best_model-CIFAR10-monin
Epoch 145/250
52000/52000 [==============================] - 308s 6ms/step - loss: 0.3710 - acc: 0.8713 - val

Epoch 00145: val_acc did not improve from 0.82210
Epoch 146/250
52000/52000 [==============================] - 308s 6ms/step - loss: 0.3645 - acc: 0.8726 - val

Epoch 00146: val_acc did not improve from 0.82210
Epoch 147/250
52000/52000 [==============================] - 307s 6ms/step - loss: 0.3648 - acc: 0.8725 - val

Epoch 00147: val_acc did not improve from 0.82210
Epoch 148/250
52000/52000 [==============================] - 307s 6ms/step - loss: 0.3649 - acc: 0.8744 - val

Epoch 00148: val_acc did not improve from 0.82210
Epoch 149/250
52000/52000 [==============================] - 308s 6ms/step - loss: 0.3623 - acc: 0.8741 - val

Epoch 00149: val_acc did not improve from 0.82210
Epoch 150/250
52000/52000 [==============================] - 307s 6ms/step - loss: 0.3625 - acc: 0.8721 - val

Epoch 00150: val_acc did not improve from 0.82210
Epoch 151/250
52000/52000 [==============================] - 307s 6ms/step - loss: 0.3637 - acc: 0.8735 - val

Epoch 00151: val_acc did not improve from 0.82210
Epoch 152/250
52000/52000 [==============================] - 307s 6ms/step - loss: 0.3618 - acc: 0.8749 - val

Epoch 00152: val_acc did not improve from 0.82210
Epoch 153/250
52000/52000 [==============================] - 307s 6ms/step - loss: 0.3575 - acc: 0.8749 - val

Epoch 00153: val_acc did not improve from 0.82210
Epoch 154/250
```

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52000/52000 [==============================] - 307s 6ms/step - loss: 0.3498 - acc: 0.8777 - val

Epoch 00154: val_acc did not improve from 0.82210
Epoch 155/250
52000/52000 [==============================] - 307s 6ms/step - loss: 0.3535 - acc: 0.8782 - val

Epoch 00155: val_acc did not improve from 0.82210
Epoch 156/250
52000/52000 [==============================] - 306s 6ms/step - loss: 0.3512 - acc: 0.8769 - val

Epoch 00156: val_acc did not improve from 0.82210
Epoch 157/250
52000/52000 [==============================] - 307s 6ms/step - loss: 0.3497 - acc: 0.8788 - val

Epoch 00157: val_acc did not improve from 0.82210
Epoch 158/250
52000/52000 [==============================] - 307s 6ms/step - loss: 0.3507 - acc: 0.8785 - val

Epoch 00158: val_acc did not improve from 0.82210
Epoch 159/250
52000/52000 [==============================] - 309s 6ms/step - loss: 0.3438 - acc: 0.8783 - val

Epoch 00159: val_acc improved from 0.82210 to 0.82780, saving model to best_model-CIFAR10-monin
Epoch 160/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.3456 - acc: 0.8789 - val

Epoch 00160: val_acc did not improve from 0.82780
Epoch 161/250
52000/52000 [==============================] - 309s 6ms/step - loss: 0.3444 - acc: 0.8796 - val

Epoch 00161: val_acc did not improve from 0.82780
Epoch 162/250
52000/52000 [==============================] - 308s 6ms/step - loss: 0.3493 - acc: 0.8785 - val

Epoch 00162: val_acc did not improve from 0.82780
Epoch 163/250
52000/52000 [==============================] - 307s 6ms/step - loss: 0.3417 - acc: 0.8804 - val

Epoch 00163: val_acc did not improve from 0.82780
Epoch 164/250
52000/52000 [==============================] - 306s 6ms/step - loss: 0.3418 - acc: 0.8824 - val

Epoch 00164: val_acc did not improve from 0.82780
Epoch 165/250
52000/52000 [==============================] - 308s 6ms/step - loss: 0.3357 - acc: 0.8848 - val

Epoch 00165: val_acc did not improve from 0.82780
Epoch 166/250
```

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52000/52000 [==============================] - 307s 6ms/step - loss: 0.3355 - acc: 0.8829 - val

Epoch 00166: val_acc did not improve from 0.82780
Epoch 167/250
52000/52000 [==============================] - 308s 6ms/step - loss: 0.3405 - acc: 0.8812 - val

Epoch 00167: val_acc did not improve from 0.82780
Epoch 168/250
52000/52000 [==============================] - 308s 6ms/step - loss: 0.3345 - acc: 0.8823 - val

Epoch 00168: val_acc did not improve from 0.82780
Epoch 169/250
52000/52000 [==============================] - 309s 6ms/step - loss: 0.3352 - acc: 0.8823 - val

Epoch 00169: val_acc did not improve from 0.82780
Epoch 170/250
52000/52000 [==============================] - 308s 6ms/step - loss: 0.3339 - acc: 0.8835 - val

Epoch 00170: val_acc did not improve from 0.82780
Epoch 171/250
52000/52000 [==============================] - 308s 6ms/step - loss: 0.3326 - acc: 0.8845 - val

Epoch 00171: val_acc did not improve from 0.82780
Epoch 172/250
52000/52000 [==============================] - 314s 6ms/step - loss: 0.3333 - acc: 0.8841 - val

Epoch 00172: val_acc did not improve from 0.82780
Epoch 173/250
52000/52000 [==============================] - 310s 6ms/step - loss: 0.3276 - acc: 0.8853 - val

Epoch 00173: val_acc did not improve from 0.82780
Epoch 174/250
52000/52000 [==============================] - 316s 6ms/step - loss: 0.3249 - acc: 0.8865 - val

Epoch 00174: val_acc did not improve from 0.82780
Epoch 175/250
52000/52000 [==============================] - 313s 6ms/step - loss: 0.3296 - acc: 0.8850 - val

Epoch 00175: val_acc did not improve from 0.82780
Epoch 176/250
52000/52000 [==============================] - 312s 6ms/step - loss: 0.3216 - acc: 0.8882 - val

Epoch 00176: val_acc did not improve from 0.82780
Epoch 177/250
52000/52000 [==============================] - 432s 8ms/step - loss: 0.3283 - acc: 0.8843 - val

Epoch 00177: val_acc did not improve from 0.82780
Epoch 178/250
```

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52000/52000 [==============================] - 1133s 22ms/step - loss: 0.3212 - acc: 0.8874 - v

Epoch 00178: val_acc did not improve from 0.82780
Epoch 179/250
52000/52000 [==============================] - 1413s 27ms/step - loss: 0.3217 - acc: 0.8880 - v

Epoch 00179: val_acc did not improve from 0.82780
Epoch 180/250
52000/52000 [==============================] - 1415s 27ms/step - loss: 0.3185 - acc: 0.8888 - v

Epoch 00180: val_acc did not improve from 0.82780
Epoch 181/250
52000/52000 [==============================] - 1419s 27ms/step - loss: 0.3186 - acc: 0.8882 - v

Epoch 00181: val_acc did not improve from 0.82780
Epoch 182/250
52000/52000 [==============================] - 1417s 27ms/step - loss: 0.3152 - acc: 0.8901 - v

Epoch 00182: val_acc did not improve from 0.82780
Epoch 183/250
52000/52000 [==============================] - 1421s 27ms/step - loss: 0.3159 - acc: 0.8906 - v

Epoch 00183: val_acc did not improve from 0.82780
Epoch 184/250
52000/52000 [==============================] - 1416s 27ms/step - loss: 0.3130 - acc: 0.8888 - v

Epoch 00184: val_acc did not improve from 0.82780
Epoch 185/250
52000/52000 [==============================] - 1423s 27ms/step - loss: 0.3079 - acc: 0.8930 - v

Epoch 00185: val_acc did not improve from 0.82780
Epoch 186/250
52000/52000 [==============================] - 1421s 27ms/step - loss: 0.3084 - acc: 0.8923 - v

Epoch 00186: val_acc did not improve from 0.82780
Epoch 187/250
52000/52000 [==============================] - 1422s 27ms/step - loss: 0.3078 - acc: 0.8917 - v

Epoch 00187: val_acc did not improve from 0.82780
Epoch 188/250
52000/52000 [==============================] - 1417s 27ms/step - loss: 0.3128 - acc: 0.8890 - v

Epoch 00188: val_acc did not improve from 0.82780
Epoch 189/250
52000/52000 [==============================] - 1421s 27ms/step - loss: 0.3089 - acc: 0.8910 - v

Epoch 00189: val_acc did not improve from 0.82780
Epoch 190/250
```

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52000/52000 [==============================] - 1427s 27ms/step - loss: 0.3067 - acc: 0.8928 - v

Epoch 00190: val_acc improved from 0.82780 to 0.83050, saving model to best_model-CIFAR10-monir
Epoch 191/250
52000/52000 [==============================] - 1420s 27ms/step - loss: 0.3055 - acc: 0.8928 - v

Epoch 00191: val_acc did not improve from 0.83050
Epoch 192/250
52000/52000 [==============================] - 1422s 27ms/step - loss: 0.3052 - acc: 0.8934 - v

Epoch 00192: val_acc did not improve from 0.83050
Epoch 193/250
52000/52000 [==============================] - 1422s 27ms/step - loss: 0.3025 - acc: 0.8947 - v

Epoch 00193: val_acc did not improve from 0.83050
Epoch 194/250
52000/52000 [==============================] - 1421s 27ms/step - loss: 0.2994 - acc: 0.8952 - v

Epoch 00194: val_acc improved from 0.83050 to 0.83240, saving model to best_model-CIFAR10-monir
Epoch 195/250
52000/52000 [==============================] - 1422s 27ms/step - loss: 0.3048 - acc: 0.8934 - v

Epoch 00195: val_acc did not improve from 0.83240
Epoch 196/250
52000/52000 [==============================] - 1412s 27ms/step - loss: 0.3036 - acc: 0.8934 - v

Epoch 00196: val_acc did not improve from 0.83240
Epoch 197/250
52000/52000 [==============================] - 1415s 27ms/step - loss: 0.3003 - acc: 0.8936 - v

Epoch 00197: val_acc did not improve from 0.83240
Epoch 198/250
52000/52000 [==============================] - 1418s 27ms/step - loss: 0.2978 - acc: 0.8964 - v

Epoch 00198: val_acc did not improve from 0.83240
Epoch 199/250
52000/52000 [==============================] - 1404s 27ms/step - loss: 0.2968 - acc: 0.8961 - v

Epoch 00199: val_acc did not improve from 0.83240
Epoch 200/250
52000/52000 [==============================] - 1430s 28ms/step - loss: 0.2949 - acc: 0.8970 - v

Epoch 00200: val_acc did not improve from 0.83240
Epoch 201/250
52000/52000 [==============================] - 1431s 28ms/step - loss: 0.2953 - acc: 0.8976 - v

Epoch 00201: val_acc did not improve from 0.83240
Epoch 202/250
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52000/52000 [==============================] - 1433s 28ms/step - loss: 0.2962 - acc: 0.8964 - v

Epoch 00202: val_acc did not improve from 0.83240
Epoch 203/250
52000/52000 [==============================] - 1431s 28ms/step - loss: 0.2916 - acc: 0.8980 - v

Epoch 00203: val_acc did not improve from 0.83240
Epoch 204/250
52000/52000 [==============================] - 1430s 28ms/step - loss: 0.2879 - acc: 0.8993 - v

Epoch 00204: val_acc did not improve from 0.83240
Epoch 205/250
52000/52000 [==============================] - 1430s 27ms/step - loss: 0.2863 - acc: 0.8983 - v

Epoch 00205: val_acc did not improve from 0.83240
Epoch 206/250
52000/52000 [==============================] - 1432s 28ms/step - loss: 0.2883 - acc: 0.8983 - v

Epoch 00206: val_acc did not improve from 0.83240
Epoch 207/250
52000/52000 [==============================] - 1414s 27ms/step - loss: 0.2894 - acc: 0.8981 - v

Epoch 00207: val_acc did not improve from 0.83240
Epoch 208/250
52000/52000 [==============================] - 1408s 27ms/step - loss: 0.2851 - acc: 0.9014 - v

Epoch 00208: val_acc did not improve from 0.83240
Epoch 209/250
52000/52000 [==============================] - 1414s 27ms/step - loss: 0.2898 - acc: 0.8979 - v

Epoch 00209: val_acc did not improve from 0.83240
Epoch 210/250
52000/52000 [==============================] - 1413s 27ms/step - loss: 0.2861 - acc: 0.8987 - v

Epoch 00210: val_acc did not improve from 0.83240
Epoch 211/250
52000/52000 [==============================] - 1410s 27ms/step - loss: 0.2855 - acc: 0.8995 - v

Epoch 00211: val_acc did not improve from 0.83240
Epoch 212/250
52000/52000 [==============================] - 1410s 27ms/step - loss: 0.2802 - acc: 0.9024 - v

Epoch 00212: val_acc improved from 0.83240 to 0.83460, saving model to best_model-CIFAR10-monit
Epoch 213/250
52000/52000 [==============================] - 1415s 27ms/step - loss: 0.2812 - acc: 0.9010 - v

Epoch 00213: val_acc did not improve from 0.83460
Epoch 214/250
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52000/52000 [==============================] - 1414s 27ms/step - loss: 0.2826 - acc: 0.9014 - v

Epoch 00214: val_acc did not improve from 0.83460
Epoch 215/250
52000/52000 [==============================] - 1411s 27ms/step - loss: 0.2817 - acc: 0.9014 - v

Epoch 00215: val_acc did not improve from 0.83460
Epoch 216/250
52000/52000 [==============================] - 1414s 27ms/step - loss: 0.2779 - acc: 0.9025 - v

Epoch 00216: val_acc did not improve from 0.83460
Epoch 217/250
52000/52000 [==============================] - 1413s 27ms/step - loss: 0.2783 - acc: 0.9020 - v

Epoch 00217: val_acc improved from 0.83460 to 0.83800, saving model to best_model-CIFAR10-monin
Epoch 218/250
52000/52000 [==============================] - 1410s 27ms/step - loss: 0.2749 - acc: 0.9017 - v

Epoch 00218: val_acc did not improve from 0.83800
Epoch 219/250
52000/52000 [==============================] - 1407s 27ms/step - loss: 0.2730 - acc: 0.9037 - v

Epoch 00219: val_acc did not improve from 0.83800
Epoch 220/250
52000/52000 [==============================] - 1404s 27ms/step - loss: 0.2745 - acc: 0.9037 - v

Epoch 00220: val_acc did not improve from 0.83800
Epoch 221/250
52000/52000 [==============================] - 1394s 27ms/step - loss: 0.2711 - acc: 0.9048 - v

Epoch 00221: val_acc improved from 0.83800 to 0.83910, saving model to best_model-CIFAR10-monin
Epoch 222/250
52000/52000 [==============================] - 1394s 27ms/step - loss: 0.2774 - acc: 0.9022 - v

Epoch 00222: val_acc did not improve from 0.83910
Epoch 223/250
52000/52000 [==============================] - 1392s 27ms/step - loss: 0.2730 - acc: 0.9024 - v

Epoch 00223: val_acc improved from 0.83910 to 0.84350, saving model to best_model-CIFAR10-monin
Epoch 224/250
52000/52000 [==============================] - 1389s 27ms/step - loss: 0.2736 - acc: 0.9038 - v

Epoch 00224: val_acc did not improve from 0.84350
Epoch 225/250
52000/52000 [==============================] - 1397s 27ms/step - loss: 0.2721 - acc: 0.9047 - v

Epoch 00225: val_acc did not improve from 0.84350
Epoch 226/250
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52000/52000 [==============================] - 1388s 27ms/step - loss: 0.2653 - acc: 0.9070 - v

Epoch 00226: val_acc did not improve from 0.84350
Epoch 227/250
52000/52000 [==============================] - 1392s 27ms/step - loss: 0.2698 - acc: 0.9043 - v

Epoch 00227: val_acc did not improve from 0.84350
Epoch 228/250
52000/52000 [==============================] - 1390s 27ms/step - loss: 0.2662 - acc: 0.9057 - v

Epoch 00228: val_acc did not improve from 0.84350
Epoch 229/250
52000/52000 [==============================] - 1393s 27ms/step - loss: 0.2670 - acc: 0.9063 - v

Epoch 00229: val_acc did not improve from 0.84350
Epoch 230/250
52000/52000 [==============================] - 1387s 27ms/step - loss: 0.2688 - acc: 0.9064 - v

Epoch 00230: val_acc did not improve from 0.84350
Epoch 231/250
52000/52000 [==============================] - 1399s 27ms/step - loss: 0.2662 - acc: 0.9067 - v

Epoch 00231: val_acc did not improve from 0.84350
Epoch 232/250
52000/52000 [==============================] - 1398s 27ms/step - loss: 0.2631 - acc: 0.9070 - v

Epoch 00232: val_acc did not improve from 0.84350
Epoch 233/250
52000/52000 [==============================] - 1423s 27ms/step - loss: 0.2624 - acc: 0.9075 - v

Epoch 00233: val_acc did not improve from 0.84350
Epoch 234/250
52000/52000 [==============================] - 1394s 27ms/step - loss: 0.2621 - acc: 0.9091 - v

Epoch 00234: val_acc improved from 0.84350 to 0.84530, saving model to best_model-CIFAR10-monit
Epoch 235/250
52000/52000 [==============================] - 1411s 27ms/step - loss: 0.2617 - acc: 0.9082 - v

Epoch 00235: val_acc did not improve from 0.84530
Epoch 236/250
52000/52000 [==============================] - 1405s 27ms/step - loss: 0.2621 - acc: 0.9088 - v

Epoch 00236: val_acc did not improve from 0.84530
Epoch 237/250
52000/52000 [==============================] - 1409s 27ms/step - loss: 0.2622 - acc: 0.9076 - v

Epoch 00237: val_acc did not improve from 0.84530
Epoch 238/250
```

```
52000/52000 [==============================] - 1409s 27ms/step - loss: 0.2553 - acc: 0.9101 - v

Epoch 00238: val_acc did not improve from 0.84530
Epoch 239/250
52000/52000 [==============================] - 1406s 27ms/step - loss: 0.2597 - acc: 0.9110 - v

Epoch 00239: val_acc did not improve from 0.84530
Epoch 240/250
52000/52000 [==============================] - 1404s 27ms/step - loss: 0.2586 - acc: 0.9096 - v

Epoch 00240: val_acc did not improve from 0.84530
Epoch 241/250
52000/52000 [==============================] - 1402s 27ms/step - loss: 0.2543 - acc: 0.9110 - v

Epoch 00241: val_acc did not improve from 0.84530
Epoch 242/250
52000/52000 [==============================] - 1402s 27ms/step - loss: 0.2503 - acc: 0.9122 - v

Epoch 00242: val_acc did not improve from 0.84530
Epoch 243/250
52000/52000 [==============================] - 1404s 27ms/step - loss: 0.2537 - acc: 0.9108 - v

Epoch 00243: val_acc did not improve from 0.84530
Epoch 244/250
52000/52000 [==============================] - 1407s 27ms/step - loss: 0.2555 - acc: 0.9102 - v

Epoch 00244: val_acc did not improve from 0.84530
Epoch 245/250
52000/52000 [==============================] - 1401s 27ms/step - loss: 0.2518 - acc: 0.9121 - v

Epoch 00245: val_acc did not improve from 0.84530
Epoch 246/250
52000/52000 [==============================] - 1403s 27ms/step - loss: 0.2515 - acc: 0.9132 - v

Epoch 00246: val_acc did not improve from 0.84530
Epoch 247/250
52000/52000 [==============================] - 1403s 27ms/step - loss: 0.2509 - acc: 0.9113 - v

Epoch 00247: val_acc did not improve from 0.84530
Epoch 248/250
52000/52000 [==============================] - 1409s 27ms/step - loss: 0.2499 - acc: 0.9127 - v

Epoch 00248: val_acc did not improve from 0.84530
Epoch 249/250
52000/52000 [==============================] - 1403s 27ms/step - loss: 0.2509 - acc: 0.9118 - v

Epoch 00249: val_acc did not improve from 0.84530
Epoch 250/250
```

```
52000/52000 [==============================] - 1403s 27ms/step - loss: 0.2541 - acc: 0.9108 - v

Epoch 00250: val_acc did not improve from 0.84530


Out[15]: <keras.callbacks.History at 0x27fc1c35f28>

In [16]: # Test the model
         score = model.evaluate(x_test, y_test, verbose=1)
         print('Test loss:', score[0])
         print('Test accuracy:', score[1])

10000/10000 [==============================] - 64s 6ms/step
Test loss: 0.5730056409597397
Test accuracy: 0.8451


In [17]: # Save the trained weights in to .h5 format
         model.save_weights("DNST_model.h5")
         print("Saved model to disk")

Saved model to disk
```

0.13 Conclusion:

On the CIFAR image dataset using Keras based Convolution Neural Network I have achieved testing accuracy of 84.51%