DENSE NET

1. Please visit this link to access the state-of-art DenseNet code for reference - DenseNet - cifar10 notebook link
2. You need to create a copy of this and "retrain" this model to achieve 90+ test accuracy.
3. You cannot use Dense Layers (also called fully connected layers), or DropOut.
4. You MUST use Image Augmentation Techniques.
5. You cannot use an already trained model as a beginning points, you have to initilize as your own
6. You cannot run the program for more than 300 Epochs, and it should be clear from your log, that you have only used 300 Epochs
7. You cannot use test images for training the model.
8. You cannot change the general architecture of DenseNet (which means you must use Dense Block, Transition and Output blocks as mentioned in the code)
9. You are free to change Convolution types (e.g. from 3x3 normal convolution to Depthwise Separable, etc)
10. You cannot have more than 1 Million parameters in total
11. You are free to move the code from Keras to Tensorflow, Pytorch, MXNET etc.
12. You can use any optimization algorithm you need.
13. You can checkpoint your model and retrain the model from that checkpoint so that no need of training the model from first if you lost at any epoch while training. You can directly load that model and Train from that epoch.

In [1]:

```python
import tensorflow as tf
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
import cv2
```

1. Load dataset

In [2]:

```python
(X_train, y_train), (X_test, y_test) = tf.keras.datasets.cifar10.load_data()

print(X_train.shape)
print(y_train.shape)
print(X_test.shape)
print(y_test.shape)
```

```
(50000, 32, 32, 3)
(50000, 1)
(10000, 32, 32, 3)
(10000, 1)
```

2. Look at some random images

In [3]:

```python
random_num = np.random.randint(0, len(X_train))

plt.figure(figsize=(4,4))
plt.imshow(cv2.cvtColor(X_train[random_num], cv2.COLOR_BGR2RGB))
plt.title(y_train[random_num])
plt.show()
```

```
/home/ubuntu/anaconda3/envs/tensorflow2_p36/lib/python3.6/site-packages/matplotlib/text.py:1150: F
utureWarning: elementwise comparison failed; returning scalar instead, but in the future will perf
orm elementwise comparison
  if s != self._text:
```
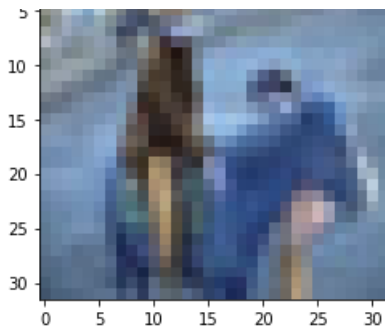
3. Normalise the data

```python
X_train = X_train/255.0
X_test = X_test/255.0
```

4. Reshaping the data

```python
img_height = 32
img_width = 32
channels = 3
```

```python
import tensorflow.keras.backend as K

if K.image_data_format() == 'channels_first':
    X_train = X_train.reshape(X_train.shape[0], channels, img_height, img_width).astype('float32')
    X_test = X_test.reshape(X_test.shape[0], channels, img_height, img_width).astype('float32')
    input_size = (channels, img_height, img_width)

else:
    X_train = X_train.reshape(X_train.shape[0], img_height, img_width, channels).astype('float32')
    X_test = X_test.reshape(X_test.shape[0], img_height, img_width, channels).astype('float32')
    input_size = (img_height, img_width, channels)
```

```python
print(X_train.shape)
print(y_train.shape)
print(X_test.shape)
print(y_test.shape)
print(input_size)
```

```
(50000, 32, 32, 3)
(50000, 1)
(10000, 32, 32, 3)
(10000, 1)
(32, 32, 3)
```

5. Convert y to 10 classes

```python
#convert y to 10 categories
y_train = tf.keras.utils.to_categorical(y_train, num_classes=10)
y_test = tf.keras.utils.to_categorical(y_test, num_classes=10)

print(y_train.shape)
print(y_test.shape)
```

```
(50000, 10)
(10000, 10)
```

6. Data Augmentation

```python
from tensorflow.keras.preprocessing.image import ImageDataGenerator

data_generator = ImageDataGenerator(
                        featurewise_center=False,
                        featurewise_std_normalization=False,
                        rotation_range=10,
                        width_shift_range=0.1,
                        height_shift_range=0.1,
                        zoom_range=.1,
                        horizontal_flip=True)
```

7. Model- Architecture

1. Dense Block
2. Transition Block
3. Output layer ### Refer: https://www.pluralsight.com/guides/introduction-to-densenet-with-tensorflow
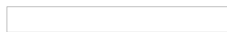
7.1 Dense Block

- https://images.app.goo.gl/VDzxZGQUEL7kt5N58

```python
from tensorflow.keras import layers
from tensorflow.keras.models import Model
num_classes = 10
```

```python
#BN-->ReLU-->Conv2D-->Dropout-->concat(input, output)-->(put in loop)

def denseblock(input, num_filter, dropout_rate):
    global compression       # to keep the growth rate of number of filters
    temp = input
    for _ in range(l):
        BatchNorm = layers.BatchNormalization()(temp)
        relu = layers.Activation('relu')(BatchNorm)
        Conv2D_3_3 = layers.Conv2D(int(num_filter*compression), (3,3), use_bias=False ,padding='sam
e')(relu)
        if dropout_rate>0:
            Conv2D_3_3 = layers.Dropout(dropout_rate)(Conv2D_3_3)

        #concat the input(temp) and output(conv2d_3_3) , in resnet we add but here we concat
        concat = layers.Concatenate(axis=-1)([temp,Conv2D_3_3])

        #change the concat as input
        temp = concat

    return temp
```

7.2 Transition Block

- https://images.app.goo.gl/7ETwBQqHKwQwXPH26
- Conv 1x1 is the bottle neck layer here like in resnet

```python
#BN-->relu-->conv2d(1x1)-->dropout-->avg_pool
def transition(input, num_filter, dropout_rate):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    Conv2D_BottleNeck = layers.Conv2D(int(num_filter*compression), (1,1), use_bias=False ,padding='same')(relu)
    if dropout_rate>0:
        Conv2D_BottleNeck = layers.Dropout(dropout_rate)(Conv2D_BottleNeck)
    avg = layers.AveragePooling2D(pool_size=(2,2))(Conv2D_BottleNeck)
    return avg
```

7.3 Output layer

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

7.4 Full Architecture

```python
# Hyperparameters
l = 12
num_filter = 12
compression = 0.5
dropout_rate = 0.2
num_classes = 10
```

```python
input = layers.Input(shape=(input_size))
First_Conv2D = layers.Conv2D(num_filter, (3,3), use_bias=False ,padding='same')(input)

#First dense and transition block
First_Block = denseblock(First_Conv2D, num_filter, dropout_rate)
First_Transition = transition(First_Block, num_filter, dropout_rate)

#Second dense and transition block
Second_Block = denseblock(First_Transition, num_filter, dropout_rate)
Second_Transition = transition(Second_Block, num_filter, dropout_rate)

#Third dense and transition block
Third_Block = denseblock(Second_Transition, num_filter, dropout_rate)
Third_Transition = transition(Third_Block, num_filter, dropout_rate)

#last dense and output block
Last_Block = denseblock(Third_Transition,  num_filter, dropout_rate)
output = output_layer(Last_Block)
```

```python
model = tf.keras.models.Model(inputs=[input], outputs=[output])
model.summary()
```

Model: "model"
_____
Layer (type)   Output Shape   Param #   Connected to

```
==================================================================================================
input_1 (InputLayer)            [(None, 32, 32, 3)]  0
_____
conv2d (Conv2D)                 (None, 32, 32, 12)   324         input_1[0][0]
_____
batch_normalization (BatchNorma (None, 32, 32, 12)   48          conv2d[0][0]
_____
activation (Activation)         (None, 32, 32, 12)   0           batch_normalization[0][0]
_____
conv2d_1 (Conv2D)               (None, 32, 32, 6)    648         activation[0][0]
_____
dropout (Dropout)               (None, 32, 32, 6)    0           conv2d_1[0][0]
_____
concatenate (Concatenate)       (None, 32, 32, 18)   0           conv2d[0][0]
                                                                 dropout[0][0]
_____
batch_normalization_1 (BatchNor (None, 32, 32, 18)   72          concatenate[0][0]
_____
activation_1 (Activation)       (None, 32, 32, 18)   0           batch_normalization_1[0][0]
_____
conv2d_2 (Conv2D)               (None, 32, 32, 6)    972         activation_1[0][0]
_____
dropout_1 (Dropout)             (None, 32, 32, 6)    0           conv2d_2[0][0]
_____
concatenate_1 (Concatenate)     (None, 32, 32, 24)   0           concatenate[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, 6)    1296        activation_2[0][0]
_____
dropout_2 (Dropout)             (None, 32, 32, 6)    0           conv2d_3[0][0]
_____
concatenate_2 (Concatenate)     (None, 32, 32, 30)   0           concatenate_1[0][0]
                                                                 dropout_2[0][0]
_____
batch_normalization_3 (BatchNor (None, 32, 32, 30)   120         concatenate_2[0][0]
_____
activation_3 (Activation)       (None, 32, 32, 30)   0           batch_normalization_3[0][0]
_____
conv2d_4 (Conv2D)               (None, 32, 32, 6)    1620        activation_3[0][0]
_____
dropout_3 (Dropout)             (None, 32, 32, 6)    0           conv2d_4[0][0]
_____
concatenate_3 (Concatenate)     (None, 32, 32, 36)   0           concatenate_2[0][0]
                                                                 dropout_3[0][0]
_____
batch_normalization_4 (BatchNor (None, 32, 32, 36)   144         concatenate_3[0][0]
_____
activation_4 (Activation)       (None, 32, 32, 36)   0           batch_normalization_4[0][0]
_____
conv2d_5 (Conv2D)               (None, 32, 32, 6)    1944        activation_4[0][0]
_____
dropout_4 (Dropout)             (None, 32, 32, 6)    0           conv2d_5[0][0]
_____
concatenate_4 (Concatenate)     (None, 32, 32, 42)   0           concatenate_3[0][0]
                                                                 dropout_4[0][0]
_____
batch_normalization_5 (BatchNor (None, 32, 32, 42)   168         concatenate_4[0][0]
_____
activation_5 (Activation)       (None, 32, 32, 42)   0           batch_normalization_5[0][0]
_____
conv2d_6 (Conv2D)               (None, 32, 32, 6)    2268        activation_5[0][0]
_____
dropout_5 (Dropout)             (None, 32, 32, 6)    0           conv2d_6[0][0]
_____
concatenate_5 (Concatenate)     (None, 32, 32, 48)   0           concatenate_4[0][0]
                                                                 dropout_5[0][0]
_____
batch_normalization_6 (BatchNor (None, 32, 32, 48)   192         concatenate_5[0][0]
_____
activation_6 (Activation)       (None, 32, 32, 48)   0           batch_normalization_6[0][0]
_____
conv2d_7 (Conv2D)               (None, 32, 32, 6)    2592        activation_6[0][0]
_____
```

dropout_6 (Dropout)	(None, 32, 32, 6)	0	conv2d_7[0][0]	
concatenate_6 (Concatenate)	(None, 32, 32, 54)	0	concatenate_5[0][0] dropout_6[0][0]	
batch_normalization_7 (BatchNor	(None, 32, 32, 54)	216	concatenate_6[0][0]	
activation_7 (Activation)	(None, 32, 32, 54)	0	batch_normalization_7[0][0]	
conv2d_8 (Conv2D)	(None, 32, 32, 6)	2916	activation_7[0][0]	
dropout_7 (Dropout)	(None, 32, 32, 6)	0	conv2d_8[0][0]	
concatenate_7 (Concatenate)	(None, 32, 32, 60)	0	concatenate_6[0][0] dropout_7[0][0]	
batch_normalization_8 (BatchNor	(None, 32, 32, 60)	240	concatenate_7[0][0]	
activation_8 (Activation)	(None, 32, 32, 60)	0	batch_normalization_8[0][0]	
conv2d_9 (Conv2D)	(None, 32, 32, 6)	3240	activation_8[0][0]	
dropout_8 (Dropout)	(None, 32, 32, 6)	0	conv2d_9[0][0]	
concatenate_8 (Concatenate)	(None, 32, 32, 66)	0	concatenate_7[0][0] dropout_8[0][0]	
batch_normalization_9 (BatchNor	(None, 32, 32, 66)	264	concatenate_8[0][0]	
activation_9 (Activation)	(None, 32, 32, 66)	0	batch_normalization_9[0][0]	
conv2d_10 (Conv2D)	(None, 32, 32, 6)	3564	activation_9[0][0]	
dropout_9 (Dropout)	(None, 32, 32, 6)	0	conv2d_10[0][0]	
concatenate_9 (Concatenate)	(None, 32, 32, 72)	0	concatenate_8[0][0] dropout_9[0][0]	
batch_normalization_10 (BatchNo	(None, 32, 32, 72)	288	concatenate_9[0][0]	
activation_10 (Activation)	(None, 32, 32, 72)	0	batch_normalization_10[0][0]	
conv2d_11 (Conv2D)	(None, 32, 32, 6)	3888	activation_10[0][0]	
dropout_10 (Dropout)	(None, 32, 32, 6)	0	conv2d_11[0][0]	
concatenate_10 (Concatenate)	(None, 32, 32, 78)	0	concatenate_9[0][0] dropout_10[0][0]	
batch_normalization_11 (BatchNo	(None, 32, 32, 78)	312	concatenate_10[0][0]	
activation_11 (Activation)	(None, 32, 32, 78)	0	batch_normalization_11[0][0]	
conv2d_12 (Conv2D)	(None, 32, 32, 6)	4212	activation_11[0][0]	
dropout_11 (Dropout)	(None, 32, 32, 6)	0	conv2d_12[0][0]	
concatenate_11 (Concatenate)	(None, 32, 32, 84)	0	concatenate_10[0][0] dropout_11[0][0]	
batch_normalization_12 (BatchNo	(None, 32, 32, 84)	336	concatenate_11[0][0]	
activation_12 (Activation)	(None, 32, 32, 84)	0	batch_normalization_12[0][0]	
conv2d_13 (Conv2D)	(None, 32, 32, 6)	504	activation_12[0][0]	
dropout_12 (Dropout)	(None, 32, 32, 6)	0	conv2d_13[0][0]	
average_pooling2d (AveragePooli	(None, 16, 16, 6)	0	dropout_12[0][0]	
batch_normalization_13 (BatchNo	(None, 16, 16, 6)	24	average_pooling2d[0][0]	
activation_13 (Activation)	(None, 16, 16, 6)	0	batch_normalization_13[0][0]	
conv2d_14 (Conv2D)	(None, 16, 16, 6)	324	activation_13[0][0]	
dropout_13 (Dropout)	(None, 16, 16, 6)	0	conv2d_14[0][0]	

Layer (type)	Output Shape	Param #	Connected to
concatenate_12 (Concatenate)	(None, 16, 16, 12)	0	average_pooling2d[0][0] dropout_13[0][0]
batch_normalization_14 (BatchNo	(None, 16, 16, 12)	48	concatenate_12[0][0]
activation_14 (Activation)	(None, 16, 16, 12)	0	batch_normalization_14[0][0]
conv2d_15 (Conv2D)	(None, 16, 16, 6)	648	activation_14[0][0]
dropout_14 (Dropout)	(None, 16, 16, 6)	0	conv2d_15[0][0]
concatenate_13 (Concatenate)	(None, 16, 16, 18)	0	concatenate_12[0][0] dropout_14[0][0]
batch_normalization_15 (BatchNo	(None, 16, 16, 18)	72	concatenate_13[0][0]
activation_15 (Activation)	(None, 16, 16, 18)	0	batch_normalization_15[0][0]
conv2d_16 (Conv2D)	(None, 16, 16, 6)	972	activation_15[0][0]
dropout_15 (Dropout)	(None, 16, 16, 6)	0	conv2d_16[0][0]
concatenate_14 (Concatenate)	(None, 16, 16, 24)	0	concatenate_13[0][0] dropout_15[0][0]
batch_normalization_16 (BatchNo	(None, 16, 16, 24)	96	concatenate_14[0][0]
activation_16 (Activation)	(None, 16, 16, 24)	0	batch_normalization_16[0][0]
conv2d_17 (Conv2D)	(None, 16, 16, 6)	1296	activation_16[0][0]
dropout_16 (Dropout)	(None, 16, 16, 6)	0	conv2d_17[0][0]
concatenate_15 (Concatenate)	(None, 16, 16, 30)	0	concatenate_14[0][0] dropout_16[0][0]
batch_normalization_17 (BatchNo	(None, 16, 16, 30)	120	concatenate_15[0][0]
activation_17 (Activation)	(None, 16, 16, 30)	0	batch_normalization_17[0][0]
conv2d_18 (Conv2D)	(None, 16, 16, 6)	1620	activation_17[0][0]
dropout_17 (Dropout)	(None, 16, 16, 6)	0	conv2d_18[0][0]
concatenate_16 (Concatenate)	(None, 16, 16, 36)	0	concatenate_15[0][0] dropout_17[0][0]
batch_normalization_18 (BatchNo	(None, 16, 16, 36)	144	concatenate_16[0][0]
activation_18 (Activation)	(None, 16, 16, 36)	0	batch_normalization_18[0][0]
conv2d_19 (Conv2D)	(None, 16, 16, 6)	1944	activation_18[0][0]
dropout_18 (Dropout)	(None, 16, 16, 6)	0	conv2d_19[0][0]
concatenate_17 (Concatenate)	(None, 16, 16, 42)	0	concatenate_16[0][0] dropout_18[0][0]
batch_normalization_19 (BatchNo	(None, 16, 16, 42)	168	concatenate_17[0][0]
activation_19 (Activation)	(None, 16, 16, 42)	0	batch_normalization_19[0][0]
conv2d_20 (Conv2D)	(None, 16, 16, 6)	2268	activation_19[0][0]
dropout_19 (Dropout)	(None, 16, 16, 6)	0	conv2d_20[0][0]
concatenate_18 (Concatenate)	(None, 16, 16, 48)	0	concatenate_17[0][0] dropout_19[0][0]
batch_normalization_20 (BatchNo	(None, 16, 16, 48)	192	concatenate_18[0][0]
activation_20 (Activation)	(None, 16, 16, 48)	0	batch_normalization_20[0][0]
conv2d_21 (Conv2D)	(None, 16, 16, 6)	2592	activation_20[0][0]
dropout_20 (Dropout)	(None, 16, 16, 6)	0	conv2d_21[0][0]

Layer (type)	Output Shape	Param #	Connected to
concatenate_19 (Concatenate)	(None, 16, 16, 54)	0	concatenate_18[0][0] dropout_20[0][0]
batch_normalization_21 (BatchNo	(None, 16, 16, 54)	216	concatenate_19[0][0]
activation_21 (Activation)	(None, 16, 16, 54)	0	batch_normalization_21[0][0]
conv2d_22 (Conv2D)	(None, 16, 16, 6)	2916	activation_21[0][0]
dropout_21 (Dropout)	(None, 16, 16, 6)	0	conv2d_22[0][0]
concatenate_20 (Concatenate)	(None, 16, 16, 60)	0	concatenate_19[0][0] dropout_21[0][0]
batch_normalization_22 (BatchNo	(None, 16, 16, 60)	240	concatenate_20[0][0]
activation_22 (Activation)	(None, 16, 16, 60)	0	batch_normalization_22[0][0]
conv2d_23 (Conv2D)	(None, 16, 16, 6)	3240	activation_22[0][0]
dropout_22 (Dropout)	(None, 16, 16, 6)	0	conv2d_23[0][0]
concatenate_21 (Concatenate)	(None, 16, 16, 66)	0	concatenate_20[0][0] dropout_22[0][0]
batch_normalization_23 (BatchNo	(None, 16, 16, 66)	264	concatenate_21[0][0]
activation_23 (Activation)	(None, 16, 16, 66)	0	batch_normalization_23[0][0]
conv2d_24 (Conv2D)	(None, 16, 16, 6)	3564	activation_23[0][0]
dropout_23 (Dropout)	(None, 16, 16, 6)	0	conv2d_24[0][0]
concatenate_22 (Concatenate)	(None, 16, 16, 72)	0	concatenate_21[0][0] dropout_23[0][0]
batch_normalization_24 (BatchNo	(None, 16, 16, 72)	288	concatenate_22[0][0]
activation_24 (Activation)	(None, 16, 16, 72)	0	batch_normalization_24[0][0]
conv2d_25 (Conv2D)	(None, 16, 16, 6)	3888	activation_24[0][0]
dropout_24 (Dropout)	(None, 16, 16, 6)	0	conv2d_25[0][0]
concatenate_23 (Concatenate)	(None, 16, 16, 78)	0	concatenate_22[0][0] dropout_24[0][0]
batch_normalization_25 (BatchNo	(None, 16, 16, 78)	312	concatenate_23[0][0]
activation_25 (Activation)	(None, 16, 16, 78)	0	batch_normalization_25[0][0]
conv2d_26 (Conv2D)	(None, 16, 16, 6)	468	activation_25[0][0]
dropout_25 (Dropout)	(None, 16, 16, 6)	0	conv2d_26[0][0]
average_pooling2d_1 (AveragePoo	(None, 8, 8, 6)	0	dropout_25[0][0]
batch_normalization_26 (BatchNo	(None, 8, 8, 6)	24	average_pooling2d_1[0][0]
activation_26 (Activation)	(None, 8, 8, 6)	0	batch_normalization_26[0][0]
conv2d_27 (Conv2D)	(None, 8, 8, 6)	324	activation_26[0][0]
dropout_26 (Dropout)	(None, 8, 8, 6)	0	conv2d_27[0][0]
concatenate_24 (Concatenate)	(None, 8, 8, 12)	0	average_pooling2d_1[0][0] dropout_26[0][0]
batch_normalization_27 (BatchNo	(None, 8, 8, 12)	48	concatenate_24[0][0]
activation_27 (Activation)	(None, 8, 8, 12)	0	batch_normalization_27[0][0]
conv2d_28 (Conv2D)	(None, 8, 8, 6)	648	activation_27[0][0]
dropout_27 (Dropout)	(None, 8, 8, 6)	0	conv2d_28[0][0]

concatenate_25 (Concatenate)	(None, 8, 8, 18)	0	concatenate_24[0][0] dropout_27[0][0]
batch_normalization_28 (BatchNo	(None, 8, 8, 18)	72	concatenate_25[0][0]
activation_28 (Activation)	(None, 8, 8, 18)	0	batch_normalization_28[0][0]
conv2d_29 (Conv2D)	(None, 8, 8, 6)	972	activation_28[0][0]
dropout_28 (Dropout)	(None, 8, 8, 6)	0	conv2d_29[0][0]
concatenate_26 (Concatenate)	(None, 8, 8, 24)	0	concatenate_25[0][0] dropout_28[0][0]
batch_normalization_29 (BatchNo	(None, 8, 8, 24)	96	concatenate_26[0][0]
activation_29 (Activation)	(None, 8, 8, 24)	0	batch_normalization_29[0][0]
conv2d_30 (Conv2D)	(None, 8, 8, 6)	1296	activation_29[0][0]
dropout_29 (Dropout)	(None, 8, 8, 6)	0	conv2d_30[0][0]
concatenate_27 (Concatenate)	(None, 8, 8, 30)	0	concatenate_26[0][0] dropout_29[0][0]
batch_normalization_30 (BatchNo	(None, 8, 8, 30)	120	concatenate_27[0][0]
activation_30 (Activation)	(None, 8, 8, 30)	0	batch_normalization_30[0][0]
conv2d_31 (Conv2D)	(None, 8, 8, 6)	1620	activation_30[0][0]
dropout_30 (Dropout)	(None, 8, 8, 6)	0	conv2d_31[0][0]
concatenate_28 (Concatenate)	(None, 8, 8, 36)	0	concatenate_27[0][0] dropout_30[0][0]
batch_normalization_31 (BatchNo	(None, 8, 8, 36)	144	concatenate_28[0][0]
activation_31 (Activation)	(None, 8, 8, 36)	0	batch_normalization_31[0][0]
conv2d_32 (Conv2D)	(None, 8, 8, 6)	1944	activation_31[0][0]
dropout_31 (Dropout)	(None, 8, 8, 6)	0	conv2d_32[0][0]
concatenate_29 (Concatenate)	(None, 8, 8, 42)	0	concatenate_28[0][0] dropout_31[0][0]
batch_normalization_32 (BatchNo	(None, 8, 8, 42)	168	concatenate_29[0][0]
activation_32 (Activation)	(None, 8, 8, 42)	0	batch_normalization_32[0][0]
conv2d_33 (Conv2D)	(None, 8, 8, 6)	2268	activation_32[0][0]
dropout_32 (Dropout)	(None, 8, 8, 6)	0	conv2d_33[0][0]
concatenate_30 (Concatenate)	(None, 8, 8, 48)	0	concatenate_29[0][0] dropout_32[0][0]
batch_normalization_33 (BatchNo	(None, 8, 8, 48)	192	concatenate_30[0][0]
activation_33 (Activation)	(None, 8, 8, 48)	0	batch_normalization_33[0][0]
conv2d_34 (Conv2D)	(None, 8, 8, 6)	2592	activation_33[0][0]
dropout_33 (Dropout)	(None, 8, 8, 6)	0	conv2d_34[0][0]
concatenate_31 (Concatenate)	(None, 8, 8, 54)	0	concatenate_30[0][0] dropout_33[0][0]
batch_normalization_34 (BatchNo	(None, 8, 8, 54)	216	concatenate_31[0][0]
activation_34 (Activation)	(None, 8, 8, 54)	0	batch_normalization_34[0][0]
conv2d_35 (Conv2D)	(None, 8, 8, 6)	2916	activation_34[0][0]
dropout_34 (Dropout)	(None, 8, 8, 6)	0	conv2d_35[0][0]

Layer (type)	Output Shape	Param #	Connected to
concatenate_32 (Concatenate)	(None, 8, 8, 60)	0	concatenate_31[0][0] dropout_34[0][0]
batch_normalization_35 (BatchNo	(None, 8, 8, 60)	240	concatenate_32[0][0]
activation_35 (Activation)	(None, 8, 8, 60)	0	batch_normalization_35[0][0]
conv2d_36 (Conv2D)	(None, 8, 8, 6)	3240	activation_35[0][0]
dropout_35 (Dropout)	(None, 8, 8, 6)	0	conv2d_36[0][0]
concatenate_33 (Concatenate)	(None, 8, 8, 66)	0	concatenate_32[0][0] dropout_35[0][0]
batch_normalization_36 (BatchNo	(None, 8, 8, 66)	264	concatenate_33[0][0]
activation_36 (Activation)	(None, 8, 8, 66)	0	batch_normalization_36[0][0]
conv2d_37 (Conv2D)	(None, 8, 8, 6)	3564	activation_36[0][0]
dropout_36 (Dropout)	(None, 8, 8, 6)	0	conv2d_37[0][0]
concatenate_34 (Concatenate)	(None, 8, 8, 72)	0	concatenate_33[0][0] dropout_36[0][0]
batch_normalization_37 (BatchNo	(None, 8, 8, 72)	288	concatenate_34[0][0]
activation_37 (Activation)	(None, 8, 8, 72)	0	batch_normalization_37[0][0]
conv2d_38 (Conv2D)	(None, 8, 8, 6)	3888	activation_37[0][0]
dropout_37 (Dropout)	(None, 8, 8, 6)	0	conv2d_38[0][0]
concatenate_35 (Concatenate)	(None, 8, 8, 78)	0	concatenate_34[0][0] dropout_37[0][0]
batch_normalization_38 (BatchNo	(None, 8, 8, 78)	312	concatenate_35[0][0]
activation_38 (Activation)	(None, 8, 8, 78)	0	batch_normalization_38[0][0]
conv2d_39 (Conv2D)	(None, 8, 8, 6)	468	activation_38[0][0]
dropout_38 (Dropout)	(None, 8, 8, 6)	0	conv2d_39[0][0]
average_pooling2d_2 (AveragePoo	(None, 4, 4, 6)	0	dropout_38[0][0]
batch_normalization_39 (BatchNo	(None, 4, 4, 6)	24	average_pooling2d_2[0][0]
activation_39 (Activation)	(None, 4, 4, 6)	0	batch_normalization_39[0][0]
conv2d_40 (Conv2D)	(None, 4, 4, 6)	324	activation_39[0][0]
dropout_39 (Dropout)	(None, 4, 4, 6)	0	conv2d_40[0][0]
concatenate_36 (Concatenate)	(None, 4, 4, 12)	0	average_pooling2d_2[0][0] dropout_39[0][0]
batch_normalization_40 (BatchNo	(None, 4, 4, 12)	48	concatenate_36[0][0]
activation_40 (Activation)	(None, 4, 4, 12)	0	batch_normalization_40[0][0]
conv2d_41 (Conv2D)	(None, 4, 4, 6)	648	activation_40[0][0]
dropout_40 (Dropout)	(None, 4, 4, 6)	0	conv2d_41[0][0]
concatenate_37 (Concatenate)	(None, 4, 4, 18)	0	concatenate_36[0][0] dropout_40[0][0]
batch_normalization_41 (BatchNo	(None, 4, 4, 18)	72	concatenate_37[0][0]
activation_41 (Activation)	(None, 4, 4, 18)	0	batch_normalization_41[0][0]
conv2d_42 (Conv2D)	(None, 4, 4, 6)	972	activation_41[0][0]
dropout_41 (Dropout)	(None, 4, 4, 6)	0	conv2d_42[0][0]
concatenate_38 (Concatenate)	(None, 4, 4, 24)	0	concatenate_37[0][0]

Layer (type)	Output Shape	Param #	Connected to
concatenate_38 (Concatenate)	(None, 4, 4, 24)	0	concatenate_37[0][0] dropout_41[0][0]
batch_normalization_42 (BatchNo	(None, 4, 4, 24)	96	concatenate_38[0][0]
activation_42 (Activation)	(None, 4, 4, 24)	0	batch_normalization_42[0][0]
conv2d_43 (Conv2D)	(None, 4, 4, 6)	1296	activation_42[0][0]
dropout_42 (Dropout)	(None, 4, 4, 6)	0	conv2d_43[0][0]
concatenate_39 (Concatenate)	(None, 4, 4, 30)	0	concatenate_38[0][0] dropout_42[0][0]
batch_normalization_43 (BatchNo	(None, 4, 4, 30)	120	concatenate_39[0][0]
activation_43 (Activation)	(None, 4, 4, 30)	0	batch_normalization_43[0][0]
conv2d_44 (Conv2D)	(None, 4, 4, 6)	1620	activation_43[0][0]
dropout_43 (Dropout)	(None, 4, 4, 6)	0	conv2d_44[0][0]
concatenate_40 (Concatenate)	(None, 4, 4, 36)	0	concatenate_39[0][0] dropout_43[0][0]
batch_normalization_44 (BatchNo	(None, 4, 4, 36)	144	concatenate_40[0][0]
activation_44 (Activation)	(None, 4, 4, 36)	0	batch_normalization_44[0][0]
conv2d_45 (Conv2D)	(None, 4, 4, 6)	1944	activation_44[0][0]
dropout_44 (Dropout)	(None, 4, 4, 6)	0	conv2d_45[0][0]
concatenate_41 (Concatenate)	(None, 4, 4, 42)	0	concatenate_40[0][0] dropout_44[0][0]
batch_normalization_45 (BatchNo	(None, 4, 4, 42)	168	concatenate_41[0][0]
activation_45 (Activation)	(None, 4, 4, 42)	0	batch_normalization_45[0][0]
conv2d_46 (Conv2D)	(None, 4, 4, 6)	2268	activation_45[0][0]
dropout_45 (Dropout)	(None, 4, 4, 6)	0	conv2d_46[0][0]
concatenate_42 (Concatenate)	(None, 4, 4, 48)	0	concatenate_41[0][0] dropout_45[0][0]
batch_normalization_46 (BatchNo	(None, 4, 4, 48)	192	concatenate_42[0][0]
activation_46 (Activation)	(None, 4, 4, 48)	0	batch_normalization_46[0][0]
conv2d_47 (Conv2D)	(None, 4, 4, 6)	2592	activation_46[0][0]
dropout_46 (Dropout)	(None, 4, 4, 6)	0	conv2d_47[0][0]
concatenate_43 (Concatenate)	(None, 4, 4, 54)	0	concatenate_42[0][0] dropout_46[0][0]
batch_normalization_47 (BatchNo	(None, 4, 4, 54)	216	concatenate_43[0][0]
activation_47 (Activation)	(None, 4, 4, 54)	0	batch_normalization_47[0][0]
conv2d_48 (Conv2D)	(None, 4, 4, 6)	2916	activation_47[0][0]
dropout_47 (Dropout)	(None, 4, 4, 6)	0	conv2d_48[0][0]
concatenate_44 (Concatenate)	(None, 4, 4, 60)	0	concatenate_43[0][0] dropout_47[0][0]
batch_normalization_48 (BatchNo	(None, 4, 4, 60)	240	concatenate_44[0][0]
activation_48 (Activation)	(None, 4, 4, 60)	0	batch_normalization_48[0][0]
conv2d_49 (Conv2D)	(None, 4, 4, 6)	3240	activation_48[0][0]
dropout_48 (Dropout)	(None, 4, 4, 6)	0	conv2d_49[0][0]
concatenate_45 (Concatenate)	(None, 4, 4, 66)	0	concatenate_44[0][0]

```
concatenate_45 (Concatenate)     (None, 4, 4, 66)    0         concatenate_44[0][0]
                                                                dropout_48[0][0]
_____
batch_normalization_49 (BatchNo  (None, 4, 4, 66)    264       concatenate_45[0][0]
_____
activation_49 (Activation)       (None, 4, 4, 66)    0         batch_normalization_49[0][0]
_____
conv2d_50 (Conv2D)               (None, 4, 4, 6)     3564      activation_49[0][0]
_____
dropout_49 (Dropout)             (None, 4, 4, 6)     0         conv2d_50[0][0]
_____
concatenate_46 (Concatenate)     (None, 4, 4, 72)    0         concatenate_45[0][0]
                                                                dropout_49[0][0]
_____
batch_normalization_50 (BatchNo  (None, 4, 4, 72)    288       concatenate_46[0][0]
_____
activation_50 (Activation)       (None, 4, 4, 72)    0         batch_normalization_50[0][0]
_____
conv2d_51 (Conv2D)               (None, 4, 4, 6)     3888      activation_50[0][0]
_____
dropout_50 (Dropout)             (None, 4, 4, 6)     0         conv2d_51[0][0]
_____
concatenate_47 (Concatenate)     (None, 4, 4, 78)    0         concatenate_46[0][0]
                                                                dropout_50[0][0]
_____
batch_normalization_51 (BatchNo  (None, 4, 4, 78)    312       concatenate_47[0][0]
_____
activation_51 (Activation)       (None, 4, 4, 78)    0         batch_normalization_51[0][0]
_____
average_pooling2d_3 (AveragePoo  (None, 2, 2, 78)    0         activation_51[0][0]
_____
flatten (Flatten)                (None, 312)         0         average_pooling2d_3[0][0]
_____
dense (Dense)                    (None, 10)          3130      flatten[0][0]
====================================================================================================
Total params: 118,918
Trainable params: 114,394
Non-trainable params: 4,524
_____
```

8. Model Compile

In [17]:

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

9. Callbacks

In [29]:

```python
from tensorflow.keras.callbacks import ModelCheckpoint, EarlyStopping, ReduceLROnPlateau
patience = 50
base_path = '/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/'
checkpoint_file_name = base_path + 'CIFAR' + '_{epoch:02d}-{val_loss:.2f}.hdf5'

model_checkpoint = ModelCheckpoint(checkpoint_file_name, monitor='val_loss', verbose=1, save_best_o
nly=True)
early_stop = EarlyStopping('val_loss', patience = patience)
reduce_LR = ReduceLROnPlateau(monitor='val_loss', factor=0.1, patience=int(patience/3))
```

In [30]:

```python
callbacks = [model_checkpoint, early_stop, reduce_LR]
```

10. Train the model

In [22]:

```
epochs = 300
```

```
batch_size = 128
```

```python
#https://keras.io/api/preprocessing/image/#flow-method

history = model.fit(data_generator.flow(X_train, y_train, batch_size),
                    steps_per_epoch = int(len(X_train)/batch_size),
                    epochs = epochs,
                    callbacks = callbacks,
                    validation_data = (X_test, y_test), verbose=1)
```

```
WARNING:tensorflow:sample_weight modes were coerced from
  ...
    to
  ['...']
Train for 390 steps, validate on 10000 samples
Epoch 1/300
389/390 [============================>.] - ETA: 0s - loss: 1.3848 - accuracy: 0.4909
Epoch 00001: val_loss improved from inf to 1.78309, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_01-1.78.hdf5
390/390 [==============================] - 29s 73ms/step - loss: 1.3847 - accuracy: 0.4911 - val_l
oss: 1.7831 - val_accuracy: 0.4376
Epoch 2/300
389/390 [============================>.] - ETA: 0s - loss: 1.2734 - accuracy: 0.5363
Epoch 00002: val_loss improved from 1.78309 to 1.33771, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_02-1.34.hdf5
390/390 [==============================] - 28s 73ms/step - loss: 1.2729 - accuracy: 0.5363 - val_l
oss: 1.3377 - val_accuracy: 0.5480
Epoch 3/300
389/390 [============================>.] - ETA: 0s - loss: 1.1915 - accuracy: 0.5660
Epoch 00003: val_loss improved from 1.33771 to 1.29796, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_03-1.30.hdf5
390/390 [==============================] - 29s 73ms/step - loss: 1.1918 - accuracy: 0.5658 - val_l
oss: 1.2980 - val_accuracy: 0.5614
Epoch 4/300
389/390 [============================>.] - ETA: 0s - loss: 1.1337 - accuracy: 0.5858
Epoch 00004: val_loss did not improve from 1.29796
390/390 [==============================] - 28s 72ms/step - loss: 1.1334 - accuracy: 0.5860 - val_l
oss: 1.3236 - val_accuracy: 0.5745
Epoch 5/300
389/390 [============================>.] - ETA: 0s - loss: 1.0955 - accuracy: 0.6046
Epoch 00005: val_loss did not improve from 1.29796
390/390 [==============================] - 28s 72ms/step - loss: 1.0954 - accuracy: 0.6046 - val_l
oss: 1.9929 - val_accuracy: 0.4908
Epoch 6/300
389/390 [============================>.] - ETA: 0s - loss: 1.0594 - accuracy: 0.6175
Epoch 00006: val_loss improved from 1.29796 to 1.18068, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_06-1.18.hdf5
390/390 [==============================] - 29s 74ms/step - loss: 1.0590 - accuracy: 0.6177 - val_l
oss: 1.1807 - val_accuracy: 0.6074
Epoch 7/300
389/390 [============================>.] - ETA: 0s - loss: 1.0249 - accuracy: 0.6278
Epoch 00007: val_loss did not improve from 1.18068
390/390 [==============================] - 28s 72ms/step - loss: 1.0251 - accuracy: 0.6277 - val_l
oss: 1.2659 - val_accuracy: 0.5894
Epoch 8/300
389/390 [============================>.] - ETA: 0s - loss: 1.0049 - accuracy: 0.6378
Epoch 00008: val_loss did not improve from 1.18068
390/390 [==============================] - 28s 72ms/step - loss: 1.0050 - accuracy: 0.6379 - val_l
oss: 1.1914 - val_accuracy: 0.6099
Epoch 9/300
389/390 [============================>.] - ETA: 0s - loss: 0.9846 - accuracy: 0.6446
Epoch 00009: val_loss did not improve from 1.18068
390/390 [==============================] - 28s 72ms/step - loss: 0.9845 - accuracy: 0.6447 - val_l
oss: 1.3551 - val_accuracy: 0.5842
Epoch 10/300
389/390 [============================>.] - ETA: 0s - loss: 0.9545 - accuracy: 0.6587
Epoch 00010: val_loss improved from 1.18068 to 1.10336, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_10-1.10.hdf5
390/390 [==============================] - 29s 73ms/step - loss: 0.9545 - accuracy: 0.6586 - val_l
oss: 1.1034 - val_accuracy: 0.6427
Epoch 11/300
389/390 [============================>.] - ETA: 0s - loss: 0.9394 - accuracy: 0.6630
Epoch 00011: val_loss improved from 1.10336 to 0.94139, saving model to
```

```
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_11-0.94.hdf5
390/390 [==============================] - 29s 74ms/step - loss: 0.9396 - accuracy: 0.6629 - val_l
oss: 0.9414 - val_accuracy: 0.6786
Epoch 12/300
389/390 [=============================>.] - ETA: 0s - loss: 0.9245 - accuracy: 0.6696
Epoch 00012: val_loss did not improve from 0.94139
390/390 [==============================] - 28s 72ms/step - loss: 0.9247 - accuracy: 0.6695 - val_l
oss: 1.0617 - val_accuracy: 0.6490
Epoch 13/300
389/390 [=============================>.] - ETA: 0s - loss: 0.9047 - accuracy: 0.6767
Epoch 00013: val_loss did not improve from 0.94139
390/390 [==============================] - 28s 73ms/step - loss: 0.9049 - accuracy: 0.6767 - val_l
oss: 1.1002 - val_accuracy: 0.6536
Epoch 14/300
389/390 [=============================>.] - ETA: 0s - loss: 0.8909 - accuracy: 0.6834
Epoch 00014: val_loss did not improve from 0.94139
390/390 [==============================] - 28s 72ms/step - loss: 0.8906 - accuracy: 0.6835 - val_l
oss: 1.0150 - val_accuracy: 0.6749
Epoch 15/300
389/390 [=============================>.] - ETA: 0s - loss: 0.8734 - accuracy: 0.6898
Epoch 00015: val_loss did not improve from 0.94139
390/390 [==============================] - 28s 72ms/step - loss: 0.8739 - accuracy: 0.6895 - val_l
oss: 1.1756 - val_accuracy: 0.6430
Epoch 16/300
389/390 [=============================>.] - ETA: 0s - loss: 0.8600 - accuracy: 0.6926
Epoch 00016: val_loss did not improve from 0.94139
390/390 [==============================] - 28s 72ms/step - loss: 0.8600 - accuracy: 0.6927 - val_l
oss: 1.0592 - val_accuracy: 0.6671
Epoch 17/300
389/390 [=============================>.] - ETA: 0s - loss: 0.8465 - accuracy: 0.6996
Epoch 00017: val_loss did not improve from 0.94139
390/390 [==============================] - 28s 72ms/step - loss: 0.8465 - accuracy: 0.6996 - val_l
oss: 1.2268 - val_accuracy: 0.6355
Epoch 18/300
389/390 [=============================>.] - ETA: 0s - loss: 0.8321 - accuracy: 0.7059
Epoch 00018: val_loss did not improve from 0.94139
390/390 [==============================] - 28s 72ms/step - loss: 0.8323 - accuracy: 0.7059 - val_l
oss: 1.2344 - val_accuracy: 0.6350
Epoch 19/300
389/390 [=============================>.] - ETA: 0s - loss: 0.8191 - accuracy: 0.7082
Epoch 00019: val_loss did not improve from 0.94139
390/390 [==============================] - 28s 72ms/step - loss: 0.8188 - accuracy: 0.7083 - val_l
oss: 1.2781 - val_accuracy: 0.6406
Epoch 20/300
389/390 [=============================>.] - ETA: 0s - loss: 0.8106 - accuracy: 0.7138
Epoch 00020: val_loss did not improve from 0.94139
390/390 [==============================] - 28s 72ms/step - loss: 0.8106 - accuracy: 0.7139 - val_l
oss: 1.2194 - val_accuracy: 0.6414
Epoch 21/300
389/390 [=============================>.] - ETA: 0s - loss: 0.8049 - accuracy: 0.7149
Epoch 00021: val_loss did not improve from 0.94139
390/390 [==============================] - 28s 72ms/step - loss: 0.8046 - accuracy: 0.7150 - val_l
oss: 1.2590 - val_accuracy: 0.6343
Epoch 22/300
389/390 [=============================>.] - ETA: 0s - loss: 0.7908 - accuracy: 0.7202
Epoch 00022: val_loss improved from 0.94139 to 0.87153, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_22-0.87.hdf5
390/390 [==============================] - 29s 73ms/step - loss: 0.7912 - accuracy: 0.7201 - val_l
oss: 0.8715 - val_accuracy: 0.7155
Epoch 23/300
389/390 [=============================>.] - ETA: 0s - loss: 0.7823 - accuracy: 0.7232
Epoch 00023: val_loss did not improve from 0.87153
390/390 [==============================] - 28s 72ms/step - loss: 0.7823 - accuracy: 0.7232 - val_l
oss: 1.0189 - val_accuracy: 0.6918
Epoch 24/300
389/390 [=============================>.] - ETA: 0s - loss: 0.7748 - accuracy: 0.7264
Epoch 00024: val_loss improved from 0.87153 to 0.81352, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_24-0.81.hdf5
390/390 [==============================] - 29s 74ms/step - loss: 0.7747 - accuracy: 0.7263 - val_l
oss: 0.8135 - val_accuracy: 0.7388
Epoch 25/300
389/390 [=============================>.] - ETA: 0s - loss: 0.7626 - accuracy: 0.7287
Epoch 00025: val_loss did not improve from 0.81352
390/390 [==============================] - 28s 72ms/step - loss: 0.7628 - accuracy: 0.7287 - val_l
oss: 0.8556 - val_accuracy: 0.7213
Epoch 26/300
389/390 [=============================>.] - ETA: 0s - loss: 0.7562 - accuracy: 0.7340
```

```
Epoch 00026: val_loss did not improve from 0.81352
390/390 [==============================] - 28s 72ms/step - loss: 0.7563 - accuracy: 0.7339 - val_l
oss: 0.8655 - val_accuracy: 0.7198
Epoch 27/300
389/390 [=============================>.] - ETA: 0s - loss: 0.7543 - accuracy: 0.7345
Epoch 00027: val_loss did not improve from 0.81352
390/390 [==============================] - 28s 72ms/step - loss: 0.7546 - accuracy: 0.7343 - val_l
oss: 0.8424 - val_accuracy: 0.7317
Epoch 28/300
389/390 [=============================>.] - ETA: 0s - loss: 0.7436 - accuracy: 0.7358
Epoch 00028: val_loss did not improve from 0.81352
390/390 [==============================] - 28s 72ms/step - loss: 0.7435 - accuracy: 0.7358 - val_l
oss: 0.8330 - val_accuracy: 0.7308
Epoch 29/300
389/390 [=============================>.] - ETA: 0s - loss: 0.7377 - accuracy: 0.7401
Epoch 00029: val_loss did not improve from 0.81352
390/390 [==============================] - 28s 72ms/step - loss: 0.7380 - accuracy: 0.7401 - val_l
oss: 0.8146 - val_accuracy: 0.7381
Epoch 30/300
389/390 [=============================>.] - ETA: 0s - loss: 0.7251 - accuracy: 0.7444
Epoch 00030: val_loss did not improve from 0.81352
390/390 [==============================] - 28s 72ms/step - loss: 0.7254 - accuracy: 0.7443 - val_l
oss: 0.8778 - val_accuracy: 0.7308
Epoch 31/300
389/390 [=============================>.] - ETA: 0s - loss: 0.7246 - accuracy: 0.7457
Epoch 00031: val_loss did not improve from 0.81352
390/390 [==============================] - 28s 72ms/step - loss: 0.7245 - accuracy: 0.7457 - val_l
oss: 0.9214 - val_accuracy: 0.7228
Epoch 32/300
389/390 [=============================>.] - ETA: 0s - loss: 0.7206 - accuracy: 0.7465
Epoch 00032: val_loss did not improve from 0.81352
390/390 [==============================] - 28s 72ms/step - loss: 0.7204 - accuracy: 0.7467 - val_l
oss: 0.9153 - val_accuracy: 0.7089
Epoch 33/300
389/390 [=============================>.] - ETA: 0s - loss: 0.7189 - accuracy: 0.7475
Epoch 00033: val_loss improved from 0.81352 to 0.77029, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_33-0.77.hdf5
390/390 [==============================] - 29s 73ms/step - loss: 0.7190 - accuracy: 0.7473 - val_l
oss: 0.7703 - val_accuracy: 0.7468
Epoch 34/300
389/390 [=============================>.] - ETA: 0s - loss: 0.7063 - accuracy: 0.7501
Epoch 00034: val_loss did not improve from 0.77029
390/390 [==============================] - 28s 72ms/step - loss: 0.7063 - accuracy: 0.7502 - val_l
oss: 1.1673 - val_accuracy: 0.6510
Epoch 35/300
389/390 [=============================>.] - ETA: 0s - loss: 0.7024 - accuracy: 0.7526
Epoch 00035: val_loss did not improve from 0.77029
390/390 [==============================] - 28s 73ms/step - loss: 0.7026 - accuracy: 0.7526 - val_l
oss: 0.8781 - val_accuracy: 0.7302
Epoch 36/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6992 - accuracy: 0.7558
Epoch 00036: val_loss did not improve from 0.77029
390/390 [==============================] - 28s 72ms/step - loss: 0.6992 - accuracy: 0.7558 - val_l
oss: 0.8242 - val_accuracy: 0.7402
Epoch 37/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6883 - accuracy: 0.7576
Epoch 00037: val_loss did not improve from 0.77029
390/390 [==============================] - 28s 72ms/step - loss: 0.6885 - accuracy: 0.7575 - val_l
oss: 1.0020 - val_accuracy: 0.7077
Epoch 38/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6875 - accuracy: 0.7587
Epoch 00038: val_loss did not improve from 0.77029
390/390 [==============================] - 28s 72ms/step - loss: 0.6877 - accuracy: 0.7586 - val_l
oss: 0.8783 - val_accuracy: 0.7372
Epoch 39/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6794 - accuracy: 0.7622
Epoch 00039: val_loss did not improve from 0.77029
390/390 [==============================] - 28s 73ms/step - loss: 0.6794 - accuracy: 0.7623 - val_l
oss: 1.0037 - val_accuracy: 0.7105
Epoch 40/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6805 - accuracy: 0.7613
Epoch 00040: val_loss did not improve from 0.77029
390/390 [==============================] - 28s 72ms/step - loss: 0.6804 - accuracy: 0.7613 - val_l
oss: 0.9206 - val_accuracy: 0.7253
Epoch 41/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6700 - accuracy: 0.7626
Epoch 00041: val_loss did not improve from 0.77029
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390/390 [==============================] - 28s 72ms/step - loss: 0.6699 - accuracy: 0.7627 - val_l
oss: 0.8955 - val_accuracy: 0.7375
Epoch 42/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6690 - accuracy: 0.7654
Epoch 00042: val_loss did not improve from 0.77029
390/390 [==============================] - 28s 72ms/step - loss: 0.6693 - accuracy: 0.7653 - val_l
oss: 0.8193 - val_accuracy: 0.7536
Epoch 43/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6670 - accuracy: 0.7661
Epoch 00043: val_loss did not improve from 0.77029
390/390 [==============================] - 28s 72ms/step - loss: 0.6675 - accuracy: 0.7660 - val_l
oss: 0.9809 - val_accuracy: 0.7126
Epoch 44/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6590 - accuracy: 0.7683
Epoch 00044: val_loss improved from 0.77029 to 0.71524, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_44-0.72.hdf5
390/390 [==============================] - 29s 74ms/step - loss: 0.6588 - accuracy: 0.7683 - val_l
oss: 0.7152 - val_accuracy: 0.7723
Epoch 45/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6596 - accuracy: 0.7676
Epoch 00045: val_loss did not improve from 0.71524
390/390 [==============================] - 28s 72ms/step - loss: 0.6592 - accuracy: 0.7678 - val_l
oss: 0.8049 - val_accuracy: 0.7541
Epoch 46/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6559 - accuracy: 0.7695
Epoch 00046: val_loss improved from 0.71524 to 0.67775, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_46-0.68.hdf5
390/390 [==============================] - 28s 73ms/step - loss: 0.6561 - accuracy: 0.7695 - val_l
oss: 0.6777 - val_accuracy: 0.7879
Epoch 47/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6484 - accuracy: 0.7718
Epoch 00047: val_loss did not improve from 0.67775
390/390 [==============================] - 28s 72ms/step - loss: 0.6484 - accuracy: 0.7720 - val_l
oss: 0.8008 - val_accuracy: 0.7513
Epoch 48/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6476 - accuracy: 0.7728
Epoch 00048: val_loss did not improve from 0.67775
390/390 [==============================] - 28s 72ms/step - loss: 0.6475 - accuracy: 0.7729 - val_l
oss: 0.7841 - val_accuracy: 0.7539
Epoch 49/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6424 - accuracy: 0.7738
Epoch 00049: val_loss did not improve from 0.67775
390/390 [==============================] - 28s 72ms/step - loss: 0.6425 - accuracy: 0.7738 - val_l
oss: 0.9057 - val_accuracy: 0.7353
Epoch 50/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6407 - accuracy: 0.7738
Epoch 00050: val_loss did not improve from 0.67775
390/390 [==============================] - 28s 72ms/step - loss: 0.6406 - accuracy: 0.7739 - val_l
oss: 0.8436 - val_accuracy: 0.7444
Epoch 51/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6338 - accuracy: 0.7779
Epoch 00051: val_loss did not improve from 0.67775
390/390 [==============================] - 28s 72ms/step - loss: 0.6336 - accuracy: 0.7779 - val_l
oss: 0.9483 - val_accuracy: 0.7206
Epoch 52/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6318 - accuracy: 0.7778
Epoch 00052: val_loss did not improve from 0.67775
390/390 [==============================] - 28s 72ms/step - loss: 0.6318 - accuracy: 0.7779 - val_l
oss: 1.0205 - val_accuracy: 0.7098
Epoch 53/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6314 - accuracy: 0.7780
Epoch 00053: val_loss did not improve from 0.67775
390/390 [==============================] - 28s 71ms/step - loss: 0.6314 - accuracy: 0.7781 - val_l
oss: 0.7074 - val_accuracy: 0.7772
Epoch 54/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6308 - accuracy: 0.7782
Epoch 00054: val_loss did not improve from 0.67775
390/390 [==============================] - 28s 72ms/step - loss: 0.6308 - accuracy: 0.7783 - val_l
oss: 0.8820 - val_accuracy: 0.7428
Epoch 55/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6277 - accuracy: 0.7795
Epoch 00055: val_loss did not improve from 0.67775
390/390 [==============================] - 28s 72ms/step - loss: 0.6281 - accuracy: 0.7794 - val_l
oss: 0.9102 - val_accuracy: 0.7383
Epoch 56/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6222 - accuracy: 0.7822
Epoch 00057: val_loss did not improve from 0.67775
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390/390 [==============================] - 28s 72ms/step - loss: 0.6223 - accuracy: 0.7821 - val_l
oss: 0.8572 - val_accuracy: 0.7502
Epoch 58/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6216 - accuracy: 0.7836
Epoch 00058: val_loss did not improve from 0.67775
390/390 [==============================] - 28s 72ms/step - loss: 0.6216 - accuracy: 0.7836 - val_l
oss: 0.7145 - val_accuracy: 0.7728
Epoch 59/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6186 - accuracy: 0.7839
Epoch 00059: val_loss did not improve from 0.67775
390/390 [==============================] - 28s 72ms/step - loss: 0.6186 - accuracy: 0.7838 - val_l
oss: 0.6832 - val_accuracy: 0.7870
Epoch 60/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6119 - accuracy: 0.7862
Epoch 00060: val_loss did not improve from 0.67775
390/390 [==============================] - 28s 72ms/step - loss: 0.6118 - accuracy: 0.7861 - val_l
oss: 0.8445 - val_accuracy: 0.7423
Epoch 61/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6129 - accuracy: 0.7835
Epoch 00061: val_loss did not improve from 0.67775
390/390 [==============================] - 28s 72ms/step - loss: 0.6130 - accuracy: 0.7834 - val_l
oss: 0.7096 - val_accuracy: 0.7794
Epoch 62/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6093 - accuracy: 0.7868
Epoch 00062: val_loss did not improve from 0.67775
390/390 [==============================] - 28s 72ms/step - loss: 0.6091 - accuracy: 0.7869 - val_l
oss: 0.6784 - val_accuracy: 0.7823
Epoch 63/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5725 - accuracy: 0.7984
Epoch 00063: val_loss improved from 0.67775 to 0.64425, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_63-0.64.hdf5
390/390 [==============================] - 28s 73ms/step - loss: 0.5722 - accuracy: 0.7986 - val_l
oss: 0.6443 - val_accuracy: 0.8006
Epoch 64/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5617 - accuracy: 0.8050
Epoch 00064: val_loss improved from 0.64425 to 0.63837, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_64-0.64.hdf5
390/390 [==============================] - 29s 75ms/step - loss: 0.5612 - accuracy: 0.8052 - val_l
oss: 0.6384 - val_accuracy: 0.8023
Epoch 65/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5654 - accuracy: 0.8026
Epoch 00065: val_loss improved from 0.63837 to 0.63668, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_65-0.64.hdf5
390/390 [==============================] - 29s 74ms/step - loss: 0.5651 - accuracy: 0.8026 - val_l
oss: 0.6367 - val_accuracy: 0.8006
Epoch 66/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5588 - accuracy: 0.8060
Epoch 00066: val_loss improved from 0.63668 to 0.61334, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_66-0.61.hdf5
390/390 [==============================] - 29s 74ms/step - loss: 0.5592 - accuracy: 0.8059 - val_l
oss: 0.6133 - val_accuracy: 0.8083
Epoch 67/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5551 - accuracy: 0.8055
Epoch 00067: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5551 - accuracy: 0.8056 - val_l
oss: 0.6187 - val_accuracy: 0.8103
Epoch 68/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5554 - accuracy: 0.8054
Epoch 00068: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5552 - accuracy: 0.8055 - val_l
oss: 0.6215 - val_accuracy: 0.8081
Epoch 69/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5520 - accuracy: 0.8078
Epoch 00069: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5519 - accuracy: 0.8079 - val_l
oss: 0.6524 - val_accuracy: 0.8005
Epoch 70/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5526 - accuracy: 0.8078
Epoch 00070: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5526 - accuracy: 0.8079 - val_l
oss: 0.6199 - val_accuracy: 0.8097
Epoch 71/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5509 - accuracy: 0.8086
Epoch 00071: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5509 - accuracy: 0.8086 - val_l
oss: 0.6481 - val_accuracy: 0.8015
Epoch 72/300
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389/390 [============================>.] - ETA: 0s - loss: 0.5506 - accuracy: 0.8066
Epoch 00072: val_loss did not improve from 0.61334
390/390 [============================] - 28s 72ms/step - loss: 0.5508 - accuracy: 0.8065 - val_l
oss: 0.6337 - val_accuracy: 0.8084
Epoch 73/300
389/390 [============================>.] - ETA: 0s - loss: 0.5497 - accuracy: 0.8080
Epoch 00073: val_loss did not improve from 0.61334
390/390 [============================] - 28s 72ms/step - loss: 0.5500 - accuracy: 0.8079 - val_l
oss: 0.6421 - val_accuracy: 0.8075
Epoch 74/300
389/390 [============================>.] - ETA: 0s - loss: 0.5547 - accuracy: 0.8057
Epoch 00074: val_loss did not improve from 0.61334
390/390 [============================] - 28s 72ms/step - loss: 0.5547 - accuracy: 0.8057 - val_l
oss: 0.6373 - val_accuracy: 0.8060
Epoch 75/300
389/390 [============================>.] - ETA: 0s - loss: 0.5483 - accuracy: 0.8092
Epoch 00075: val_loss did not improve from 0.61334
390/390 [============================] - 28s 72ms/step - loss: 0.5483 - accuracy: 0.8092 - val_l
oss: 0.6167 - val_accuracy: 0.8111
Epoch 76/300
389/390 [============================>.] - ETA: 0s - loss: 0.5500 - accuracy: 0.8074
Epoch 00076: val_loss did not improve from 0.61334
390/390 [============================] - 28s 73ms/step - loss: 0.5498 - accuracy: 0.8074 - val_l
oss: 0.6347 - val_accuracy: 0.8072
Epoch 77/300
389/390 [============================>.] - ETA: 0s - loss: 0.5490 - accuracy: 0.8063
Epoch 00077: val_loss did not improve from 0.61334
390/390 [============================] - 28s 72ms/step - loss: 0.5492 - accuracy: 0.8062 - val_l
oss: 0.6422 - val_accuracy: 0.8064
Epoch 78/300
389/390 [============================>.] - ETA: 0s - loss: 0.5466 - accuracy: 0.8081
Epoch 00078: val_loss did not improve from 0.61334
390/390 [============================] - 28s 72ms/step - loss: 0.5468 - accuracy: 0.8080 - val_l
oss: 0.6581 - val_accuracy: 0.8033
Epoch 79/300
389/390 [============================>.] - ETA: 0s - loss: 0.5482 - accuracy: 0.8071
Epoch 00079: val_loss did not improve from 0.61334
390/390 [============================] - 28s 72ms/step - loss: 0.5482 - accuracy: 0.8072 - val_l
oss: 0.6333 - val_accuracy: 0.8066
Epoch 80/300
389/390 [============================>.] - ETA: 0s - loss: 0.5440 - accuracy: 0.8101
Epoch 00080: val_loss did not improve from 0.61334
390/390 [============================] - 28s 72ms/step - loss: 0.5442 - accuracy: 0.8100 - val_l
oss: 0.6199 - val_accuracy: 0.8100
Epoch 81/300
389/390 [============================>.] - ETA: 0s - loss: 0.5473 - accuracy: 0.8087
Epoch 00081: val_loss did not improve from 0.61334
390/390 [============================] - 28s 72ms/step - loss: 0.5475 - accuracy: 0.8087 - val_l
oss: 0.6548 - val_accuracy: 0.8027
Epoch 82/300
389/390 [============================>.] - ETA: 0s - loss: 0.5432 - accuracy: 0.8098
Epoch 00082: val_loss did not improve from 0.61334
390/390 [============================] - 28s 72ms/step - loss: 0.5432 - accuracy: 0.8097 - val_l
oss: 0.6311 - val_accuracy: 0.8073
Epoch 83/300
389/390 [============================>.] - ETA: 0s - loss: 0.5412 - accuracy: 0.8100
Epoch 00083: val_loss did not improve from 0.61334
390/390 [============================] - 28s 72ms/step - loss: 0.5410 - accuracy: 0.8101 - val_l
oss: 0.6273 - val_accuracy: 0.8099
Epoch 84/300
389/390 [============================>.] - ETA: 0s - loss: 0.5421 - accuracy: 0.8094
Epoch 00084: val_loss did not improve from 0.61334
390/390 [============================] - 28s 72ms/step - loss: 0.5423 - accuracy: 0.8093 - val_l
oss: 0.6330 - val_accuracy: 0.8076
Epoch 85/300
389/390 [============================>.] - ETA: 0s - loss: 0.5415 - accuracy: 0.8098
Epoch 00085: val_loss did not improve from 0.61334
390/390 [============================] - 28s 72ms/step - loss: 0.5416 - accuracy: 0.8098 - val_l
oss: 0.6334 - val_accuracy: 0.8071
Epoch 86/300
389/390 [============================>.] - ETA: 0s - loss: 0.5345 - accuracy: 0.8111
Epoch 00086: val_loss did not improve from 0.61334
390/390 [============================] - 28s 72ms/step - loss: 0.5345 - accuracy: 0.8112 - val_l
oss: 0.6329 - val_accuracy: 0.8076
Epoch 87/300
389/390 [============================>.] - ETA: 0s - loss: 0.5400 - accuracy: 0.8103
Epoch 00087: val_loss did not improve from 0.61334
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390/390 [==============================] - 28s 72ms/step - loss: 0.5405 - accuracy: 0.8102 - val_l
oss: 0.6290 - val_accuracy: 0.8083
Epoch 88/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5397 - accuracy: 0.8104
Epoch 00088: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5397 - accuracy: 0.8104 - val_l
oss: 0.6333 - val_accuracy: 0.8077
Epoch 89/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5407 - accuracy: 0.8104
Epoch 00089: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5406 - accuracy: 0.8104 - val_l
oss: 0.6309 - val_accuracy: 0.8078
Epoch 90/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5407 - accuracy: 0.8108
Epoch 00090: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5406 - accuracy: 0.8108 - val_l
oss: 0.6319 - val_accuracy: 0.8083
Epoch 91/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5386 - accuracy: 0.8113
Epoch 00091: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5386 - accuracy: 0.8112 - val_l
oss: 0.6342 - val_accuracy: 0.8079
Epoch 92/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5425 - accuracy: 0.8111
Epoch 00092: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5429 - accuracy: 0.8110 - val_l
oss: 0.6361 - val_accuracy: 0.8075
Epoch 93/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5433 - accuracy: 0.8110
Epoch 00093: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5434 - accuracy: 0.8111 - val_l
oss: 0.6344 - val_accuracy: 0.8078
Epoch 94/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5339 - accuracy: 0.8139
Epoch 00094: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5340 - accuracy: 0.8138 - val_l
oss: 0.6330 - val_accuracy: 0.8086
Epoch 95/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5400 - accuracy: 0.8112
Epoch 00095: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5401 - accuracy: 0.8111 - val_l
oss: 0.6314 - val_accuracy: 0.8095
Epoch 96/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5386 - accuracy: 0.8127
Epoch 00096: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5385 - accuracy: 0.8127 - val_l
oss: 0.6285 - val_accuracy: 0.8104
Epoch 97/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5371 - accuracy: 0.8094
Epoch 00097: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5365 - accuracy: 0.8097 - val_l
oss: 0.6297 - val_accuracy: 0.8098
Epoch 98/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5337 - accuracy: 0.8133
Epoch 00098: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5332 - accuracy: 0.8136 - val_l
oss: 0.6319 - val_accuracy: 0.8098
Epoch 99/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5353 - accuracy: 0.8129
Epoch 00099: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5355 - accuracy: 0.8129 - val_l
oss: 0.6303 - val_accuracy: 0.8106
Epoch 100/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5371 - accuracy: 0.8118
Epoch 00100: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5376 - accuracy: 0.8117 - val_l
oss: 0.6304 - val_accuracy: 0.8101
Epoch 101/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5376 - accuracy: 0.8116
Epoch 00101: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5375 - accuracy: 0.8117 - val_l
oss: 0.6314 - val_accuracy: 0.8097
Epoch 102/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5374 - accuracy: 0.8120
Epoch 00102: val_loss did not improve from 0.61334
390/390 [==============================] - 28s 72ms/step - loss: 0.5374 - accuracy: 0.8120 - val_l
oss: 0.6313 - val_accuracy: 0.8096
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Epoch 103/300
389/390 [============================>.] - ETA: 0s - loss: 0.5401 - accuracy: 0.8105
Epoch 00103: val_loss did not improve from 0.61334
390/390 [=============================] - 28s 72ms/step - loss: 0.5402 - accuracy: 0.8104 - val_l
oss: 0.6311 - val_accuracy: 0.8095
Epoch 104/300
389/390 [============================>.] - ETA: 0s - loss: 0.5383 - accuracy: 0.8105
Epoch 00104: val_loss did not improve from 0.61334
390/390 [=============================] - 28s 71ms/step - loss: 0.5385 - accuracy: 0.8105 - val_l
oss: 0.6305 - val_accuracy: 0.8094
Epoch 105/300
389/390 [============================>.] - ETA: 0s - loss: 0.5389 - accuracy: 0.8092
Epoch 00105: val_loss did not improve from 0.61334
390/390 [=============================] - 28s 71ms/step - loss: 0.5388 - accuracy: 0.8093 - val_l
oss: 0.6312 - val_accuracy: 0.8102
Epoch 106/300
389/390 [============================>.] - ETA: 0s - loss: 0.5379 - accuracy: 0.8111
Epoch 00106: val_loss did not improve from 0.61334
390/390 [=============================] - 28s 72ms/step - loss: 0.5380 - accuracy: 0.8111 - val_l
oss: 0.6300 - val_accuracy: 0.8101
Epoch 107/300
389/390 [============================>.] - ETA: 0s - loss: 0.5384 - accuracy: 0.8112
Epoch 00107: val_loss did not improve from 0.61334
390/390 [=============================] - 28s 72ms/step - loss: 0.5383 - accuracy: 0.8113 - val_l
oss: 0.6302 - val_accuracy: 0.8101
Epoch 108/300
389/390 [============================>.] - ETA: 0s - loss: 0.5387 - accuracy: 0.8119
Epoch 00108: val_loss did not improve from 0.61334
390/390 [=============================] - 28s 72ms/step - loss: 0.5387 - accuracy: 0.8119 - val_l
oss: 0.6306 - val_accuracy: 0.8096
Epoch 109/300
389/390 [============================>.] - ETA: 0s - loss: 0.5403 - accuracy: 0.8100
Epoch 00109: val_loss did not improve from 0.61334
390/390 [=============================] - 28s 72ms/step - loss: 0.5400 - accuracy: 0.8101 - val_l
oss: 0.6319 - val_accuracy: 0.8096
Epoch 110/300
389/390 [============================>.] - ETA: 0s - loss: 0.5367 - accuracy: 0.8115
Epoch 00110: val_loss did not improve from 0.61334
390/390 [=============================] - 28s 72ms/step - loss: 0.5369 - accuracy: 0.8115 - val_l
oss: 0.6307 - val_accuracy: 0.8096
Epoch 111/300
389/390 [============================>.] - ETA: 0s - loss: 0.5384 - accuracy: 0.8111
Epoch 00111: val_loss did not improve from 0.61334
390/390 [=============================] - 28s 71ms/step - loss: 0.5382 - accuracy: 0.8111 - val_l
oss: 0.6308 - val_accuracy: 0.8099
Epoch 112/300
389/390 [============================>.] - ETA: 0s - loss: 0.5396 - accuracy: 0.8110
Epoch 00112: val_loss did not improve from 0.61334
390/390 [=============================] - 28s 72ms/step - loss: 0.5395 - accuracy: 0.8109 - val_l
oss: 0.6310 - val_accuracy: 0.8094
Epoch 113/300
389/390 [============================>.] - ETA: 0s - loss: 0.5375 - accuracy: 0.8116
Epoch 00113: val_loss did not improve from 0.61334
390/390 [=============================] - 28s 72ms/step - loss: 0.5376 - accuracy: 0.8116 - val_l
oss: 0.6309 - val_accuracy: 0.8096
Epoch 114/300
389/390 [============================>.] - ETA: 0s - loss: 0.5408 - accuracy: 0.8107
Epoch 00114: val_loss did not improve from 0.61334
390/390 [=============================] - 28s 72ms/step - loss: 0.5413 - accuracy: 0.8105 - val_l
oss: 0.6318 - val_accuracy: 0.8089
Epoch 115/300
389/390 [============================>.] - ETA: 0s - loss: 0.5329 - accuracy: 0.8126
Epoch 00115: val_loss did not improve from 0.61334
390/390 [=============================] - 28s 72ms/step - loss: 0.5333 - accuracy: 0.8126 - val_l
oss: 0.6309 - val_accuracy: 0.8096
Epoch 116/300
389/390 [============================>.] - ETA: 0s - loss: 0.5349 - accuracy: 0.8118
Epoch 00116: val_loss did not improve from 0.61334
390/390 [=============================] - 28s 72ms/step - loss: 0.5351 - accuracy: 0.8117 - val_l
oss: 0.6307 - val_accuracy: 0.8094
```

In [35]:

```python
#history plot for accyracy
plt.figure(figsize=(16,4))
plt.plot(history.history['accuracy'])
```

```
plt.plot(history.history['val_accuracy'])
plt.title("Model Accuracy")
plt.xlabel("Epoch")
plt.ylabel("Accuracy")
plt.legend(["train", "test"], loc="upper left")
plt.show()

# history plot for accuracy
plt.figure(figsize=(16,4))
plt.plot(history.history["loss"])
plt.plot(history.history["val_loss"])
plt.title("Model Loss")
plt.xlabel("Epoch")
plt.ylabel("Loss")
plt.legend(["train", "test"], loc="upper left")
plt.show()
```
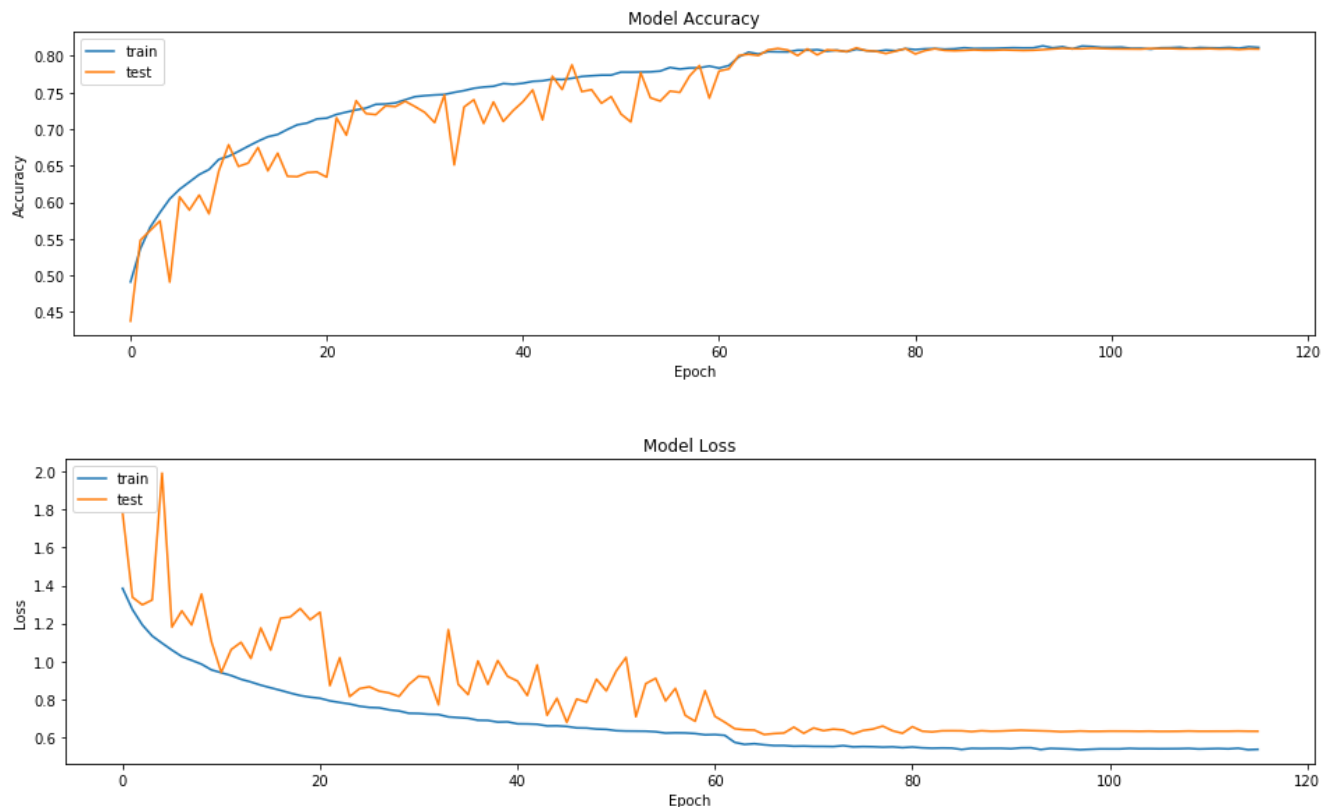

In [38]:

```
model.metrics_names
```

Out[38]:

```
['loss', 'accuracy']
```

In [40]:

```
best_model_1 =
tf.keras.models.load_model('/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_66-0.61.hdf5')
scores = best_model_1.evaluate(X_test, y_test, verbose=1)
print(scores)
```

```
10000/10000 [==============================] - 3s 348us/sample - loss: 0.6133 - accuracy: 0.8083
[0.6133434212684631, 0.8083]
```

Summary:

- The model early stopped because the val loss is not reducing for 50 epochs. The best model is at epoch 66 and it gives the test accuracy of 0.8083. We can improve the accuracy further

11. By trying different learning rate

```
model_2 = tf.keras.models.load_model('/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_66-0
.61.hdf5')
model_2.summary()
```

```
Model: "model"
```

Layer (type)	Output Shape	Param #	Connected to
input_1 (InputLayer)	[(None, 32, 32, 3)]	0	
conv2d (Conv2D)	(None, 32, 32, 12)	324	input_1[0][0]
batch_normalization (BatchNorma	(None, 32, 32, 12)	48	conv2d[0][0]
activation (Activation)	(None, 32, 32, 12)	0	batch_normalization[0][0]
conv2d_1 (Conv2D)	(None, 32, 32, 6)	648	activation[0][0]
dropout (Dropout)	(None, 32, 32, 6)	0	conv2d_1[0][0]
concatenate (Concatenate)	(None, 32, 32, 18)	0	conv2d[0][0] dropout[0][0]
batch_normalization_1 (BatchNor	(None, 32, 32, 18)	72	concatenate[0][0]
activation_1 (Activation)	(None, 32, 32, 18)	0	batch_normalization_1[0][0]
conv2d_2 (Conv2D)	(None, 32, 32, 6)	972	activation_1[0][0]
dropout_1 (Dropout)	(None, 32, 32, 6)	0	conv2d_2[0][0]
concatenate_1 (Concatenate)	(None, 32, 32, 24)	0	concatenate[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, 6)	1296	activation_2[0][0]
dropout_2 (Dropout)	(None, 32, 32, 6)	0	conv2d_3[0][0]
concatenate_2 (Concatenate)	(None, 32, 32, 30)	0	concatenate_1[0][0] dropout_2[0][0]
batch_normalization_3 (BatchNor	(None, 32, 32, 30)	120	concatenate_2[0][0]
activation_3 (Activation)	(None, 32, 32, 30)	0	batch_normalization_3[0][0]
conv2d_4 (Conv2D)	(None, 32, 32, 6)	1620	activation_3[0][0]
dropout_3 (Dropout)	(None, 32, 32, 6)	0	conv2d_4[0][0]
concatenate_3 (Concatenate)	(None, 32, 32, 36)	0	concatenate_2[0][0] dropout_3[0][0]
batch_normalization_4 (BatchNor	(None, 32, 32, 36)	144	concatenate_3[0][0]
activation_4 (Activation)	(None, 32, 32, 36)	0	batch_normalization_4[0][0]
conv2d_5 (Conv2D)	(None, 32, 32, 6)	1944	activation_4[0][0]
dropout_4 (Dropout)	(None, 32, 32, 6)	0	conv2d_5[0][0]
concatenate_4 (Concatenate)	(None, 32, 32, 42)	0	concatenate_3[0][0] dropout_4[0][0]
batch_normalization_5 (BatchNor	(None, 32, 32, 42)	168	concatenate_4[0][0]
activation_5 (Activation)	(None, 32, 32, 42)	0	batch_normalization_5[0][0]

activation_5 (Activation)	(None, 32, 32, 42)	0	batch_normalization_5[0][0]
conv2d_6 (Conv2D)	(None, 32, 32, 6)	2268	activation_5[0][0]
dropout_5 (Dropout)	(None, 32, 32, 6)	0	conv2d_6[0][0]
concatenate_5 (Concatenate)	(None, 32, 32, 48)	0	concatenate_4[0][0] dropout_5[0][0]
batch_normalization_6 (BatchNor	(None, 32, 32, 48)	192	concatenate_5[0][0]
activation_6 (Activation)	(None, 32, 32, 48)	0	batch_normalization_6[0][0]
conv2d_7 (Conv2D)	(None, 32, 32, 6)	2592	activation_6[0][0]
dropout_6 (Dropout)	(None, 32, 32, 6)	0	conv2d_7[0][0]
concatenate_6 (Concatenate)	(None, 32, 32, 54)	0	concatenate_5[0][0] dropout_6[0][0]
batch_normalization_7 (BatchNor	(None, 32, 32, 54)	216	concatenate_6[0][0]
activation_7 (Activation)	(None, 32, 32, 54)	0	batch_normalization_7[0][0]
conv2d_8 (Conv2D)	(None, 32, 32, 6)	2916	activation_7[0][0]
dropout_7 (Dropout)	(None, 32, 32, 6)	0	conv2d_8[0][0]
concatenate_7 (Concatenate)	(None, 32, 32, 60)	0	concatenate_6[0][0] dropout_7[0][0]
batch_normalization_8 (BatchNor	(None, 32, 32, 60)	240	concatenate_7[0][0]
activation_8 (Activation)	(None, 32, 32, 60)	0	batch_normalization_8[0][0]
conv2d_9 (Conv2D)	(None, 32, 32, 6)	3240	activation_8[0][0]
dropout_8 (Dropout)	(None, 32, 32, 6)	0	conv2d_9[0][0]
concatenate_8 (Concatenate)	(None, 32, 32, 66)	0	concatenate_7[0][0] dropout_8[0][0]
batch_normalization_9 (BatchNor	(None, 32, 32, 66)	264	concatenate_8[0][0]
activation_9 (Activation)	(None, 32, 32, 66)	0	batch_normalization_9[0][0]
conv2d_10 (Conv2D)	(None, 32, 32, 6)	3564	activation_9[0][0]
dropout_9 (Dropout)	(None, 32, 32, 6)	0	conv2d_10[0][0]
concatenate_9 (Concatenate)	(None, 32, 32, 72)	0	concatenate_8[0][0] dropout_9[0][0]
batch_normalization_10 (BatchNo	(None, 32, 32, 72)	288	concatenate_9[0][0]
activation_10 (Activation)	(None, 32, 32, 72)	0	batch_normalization_10[0][0]
conv2d_11 (Conv2D)	(None, 32, 32, 6)	3888	activation_10[0][0]
dropout_10 (Dropout)	(None, 32, 32, 6)	0	conv2d_11[0][0]
concatenate_10 (Concatenate)	(None, 32, 32, 78)	0	concatenate_9[0][0] dropout_10[0][0]
batch_normalization_11 (BatchNo	(None, 32, 32, 78)	312	concatenate_10[0][0]
activation_11 (Activation)	(None, 32, 32, 78)	0	batch_normalization_11[0][0]
conv2d_12 (Conv2D)	(None, 32, 32, 6)	4212	activation_11[0][0]
dropout_11 (Dropout)	(None, 32, 32, 6)	0	conv2d_12[0][0]
concatenate_11 (Concatenate)	(None, 32, 32, 84)	0	concatenate_10[0][0] dropout_11[0][0]
batch_normalization_12 (BatchNo	(None, 32, 32, 84)	336	concatenate_11[0][0]
activation_12 (Activation)	(None, 32, 32, 84)	0	batch_normalization_12[0][0]

Layer	Output Shape	Param #	Connected to
activation_12 (Activation)	(None, 32, 32, 6)	0	batch_normalization_12[0][0]
conv2d_13 (Conv2D)	(None, 32, 32, 6)	504	activation_12[0][0]
dropout_12 (Dropout)	(None, 32, 32, 6)	0	conv2d_13[0][0]
average_pooling2d (AveragePooli	(None, 16, 16, 6)	0	dropout_12[0][0]
batch_normalization_13 (BatchNo	(None, 16, 16, 6)	24	average_pooling2d[0][0]
activation_13 (Activation)	(None, 16, 16, 6)	0	batch_normalization_13[0][0]
conv2d_14 (Conv2D)	(None, 16, 16, 6)	324	activation_13[0][0]
dropout_13 (Dropout)	(None, 16, 16, 6)	0	conv2d_14[0][0]
concatenate_12 (Concatenate)	(None, 16, 16, 12)	0	average_pooling2d[0][0] dropout_13[0][0]
batch_normalization_14 (BatchNo	(None, 16, 16, 12)	48	concatenate_12[0][0]
activation_14 (Activation)	(None, 16, 16, 12)	0	batch_normalization_14[0][0]
conv2d_15 (Conv2D)	(None, 16, 16, 6)	648	activation_14[0][0]
dropout_14 (Dropout)	(None, 16, 16, 6)	0	conv2d_15[0][0]
concatenate_13 (Concatenate)	(None, 16, 16, 18)	0	concatenate_12[0][0] dropout_14[0][0]
batch_normalization_15 (BatchNo	(None, 16, 16, 18)	72	concatenate_13[0][0]
activation_15 (Activation)	(None, 16, 16, 18)	0	batch_normalization_15[0][0]
conv2d_16 (Conv2D)	(None, 16, 16, 6)	972	activation_15[0][0]
dropout_15 (Dropout)	(None, 16, 16, 6)	0	conv2d_16[0][0]
concatenate_14 (Concatenate)	(None, 16, 16, 24)	0	concatenate_13[0][0] dropout_15[0][0]
batch_normalization_16 (BatchNo	(None, 16, 16, 24)	96	concatenate_14[0][0]
activation_16 (Activation)	(None, 16, 16, 24)	0	batch_normalization_16[0][0]
conv2d_17 (Conv2D)	(None, 16, 16, 6)	1296	activation_16[0][0]
dropout_16 (Dropout)	(None, 16, 16, 6)	0	conv2d_17[0][0]
concatenate_15 (Concatenate)	(None, 16, 16, 30)	0	concatenate_14[0][0] dropout_16[0][0]
batch_normalization_17 (BatchNo	(None, 16, 16, 30)	120	concatenate_15[0][0]
activation_17 (Activation)	(None, 16, 16, 30)	0	batch_normalization_17[0][0]
conv2d_18 (Conv2D)	(None, 16, 16, 6)	1620	activation_17[0][0]
dropout_17 (Dropout)	(None, 16, 16, 6)	0	conv2d_18[0][0]
concatenate_16 (Concatenate)	(None, 16, 16, 36)	0	concatenate_15[0][0] dropout_17[0][0]
batch_normalization_18 (BatchNo	(None, 16, 16, 36)	144	concatenate_16[0][0]
activation_18 (Activation)	(None, 16, 16, 36)	0	batch_normalization_18[0][0]
conv2d_19 (Conv2D)	(None, 16, 16, 6)	1944	activation_18[0][0]
dropout_18 (Dropout)	(None, 16, 16, 6)	0	conv2d_19[0][0]
concatenate_17 (Concatenate)	(None, 16, 16, 42)	0	concatenate_16[0][0] dropout_18[0][0]
batch_normalization_19 (BatchNo	(None, 16, 16, 42)	168	concatenate_17[0][0]
activation_19 (Activation)	(None, 16, 16, 42)	0	batch_normalization_19[0][0]

conv2d_20 (Conv2D)	(None, 16, 16, 6)	2268	activation_19[0][0]
dropout_19 (Dropout)	(None, 16, 16, 6)	0	conv2d_20[0][0]
concatenate_18 (Concatenate)	(None, 16, 16, 48)	0	concatenate_17[0][0] dropout_19[0][0]
batch_normalization_20 (BatchNo	(None, 16, 16, 48)	192	concatenate_18[0][0]
activation_20 (Activation)	(None, 16, 16, 48)	0	batch_normalization_20[0][0]
conv2d_21 (Conv2D)	(None, 16, 16, 6)	2592	activation_20[0][0]
dropout_20 (Dropout)	(None, 16, 16, 6)	0	conv2d_21[0][0]
concatenate_19 (Concatenate)	(None, 16, 16, 54)	0	concatenate_18[0][0] dropout_20[0][0]
batch_normalization_21 (BatchNo	(None, 16, 16, 54)	216	concatenate_19[0][0]
activation_21 (Activation)	(None, 16, 16, 54)	0	batch_normalization_21[0][0]
conv2d_22 (Conv2D)	(None, 16, 16, 6)	2916	activation_21[0][0]
dropout_21 (Dropout)	(None, 16, 16, 6)	0	conv2d_22[0][0]
concatenate_20 (Concatenate)	(None, 16, 16, 60)	0	concatenate_19[0][0] dropout_21[0][0]
batch_normalization_22 (BatchNo	(None, 16, 16, 60)	240	concatenate_20[0][0]
activation_22 (Activation)	(None, 16, 16, 60)	0	batch_normalization_22[0][0]
conv2d_23 (Conv2D)	(None, 16, 16, 6)	3240	activation_22[0][0]
dropout_22 (Dropout)	(None, 16, 16, 6)	0	conv2d_23[0][0]
concatenate_21 (Concatenate)	(None, 16, 16, 66)	0	concatenate_20[0][0] dropout_22[0][0]
batch_normalization_23 (BatchNo	(None, 16, 16, 66)	264	concatenate_21[0][0]
activation_23 (Activation)	(None, 16, 16, 66)	0	batch_normalization_23[0][0]
conv2d_24 (Conv2D)	(None, 16, 16, 6)	3564	activation_23[0][0]
dropout_23 (Dropout)	(None, 16, 16, 6)	0	conv2d_24[0][0]
concatenate_22 (Concatenate)	(None, 16, 16, 72)	0	concatenate_21[0][0] dropout_23[0][0]
batch_normalization_24 (BatchNo	(None, 16, 16, 72)	288	concatenate_22[0][0]
activation_24 (Activation)	(None, 16, 16, 72)	0	batch_normalization_24[0][0]
conv2d_25 (Conv2D)	(None, 16, 16, 6)	3888	activation_24[0][0]
dropout_24 (Dropout)	(None, 16, 16, 6)	0	conv2d_25[0][0]
concatenate_23 (Concatenate)	(None, 16, 16, 78)	0	concatenate_22[0][0] dropout_24[0][0]
batch_normalization_25 (BatchNo	(None, 16, 16, 78)	312	concatenate_23[0][0]
activation_25 (Activation)	(None, 16, 16, 78)	0	batch_normalization_25[0][0]
conv2d_26 (Conv2D)	(None, 16, 16, 6)	468	activation_25[0][0]
dropout_25 (Dropout)	(None, 16, 16, 6)	0	conv2d_26[0][0]
average_pooling2d_1 (AveragePoo	(None, 8, 8, 6)	0	dropout_25[0][0]
batch_normalization_26 (BatchNo	(None, 8, 8, 6)	24	average_pooling2d_1[0][0]
activation_26 (Activation)	(None, 8, 8, 6)	0	batch_normalization_26[0][0]
conv2d_27 (Conv2D)	(None, 8, 8, 6)	324	activation_26[0][0]

conv2d_27 (Conv2D)	(None, 8, 8, 6)	324	activation_26[0][0]
dropout_26 (Dropout)	(None, 8, 8, 6)	0	conv2d_27[0][0]
concatenate_24 (Concatenate)	(None, 8, 8, 12)	0	average_pooling2d_1[0][0] dropout_26[0][0]
batch_normalization_27 (BatchNo	(None, 8, 8, 12)	48	concatenate_24[0][0]
activation_27 (Activation)	(None, 8, 8, 12)	0	batch_normalization_27[0][0]
conv2d_28 (Conv2D)	(None, 8, 8, 6)	648	activation_27[0][0]
dropout_27 (Dropout)	(None, 8, 8, 6)	0	conv2d_28[0][0]
concatenate_25 (Concatenate)	(None, 8, 8, 18)	0	concatenate_24[0][0] dropout_27[0][0]
batch_normalization_28 (BatchNo	(None, 8, 8, 18)	72	concatenate_25[0][0]
activation_28 (Activation)	(None, 8, 8, 18)	0	batch_normalization_28[0][0]
conv2d_29 (Conv2D)	(None, 8, 8, 6)	972	activation_28[0][0]
dropout_28 (Dropout)	(None, 8, 8, 6)	0	conv2d_29[0][0]
concatenate_26 (Concatenate)	(None, 8, 8, 24)	0	concatenate_25[0][0] dropout_28[0][0]
batch_normalization_29 (BatchNo	(None, 8, 8, 24)	96	concatenate_26[0][0]
activation_29 (Activation)	(None, 8, 8, 24)	0	batch_normalization_29[0][0]
conv2d_30 (Conv2D)	(None, 8, 8, 6)	1296	activation_29[0][0]
dropout_29 (Dropout)	(None, 8, 8, 6)	0	conv2d_30[0][0]
concatenate_27 (Concatenate)	(None, 8, 8, 30)	0	concatenate_26[0][0] dropout_29[0][0]
batch_normalization_30 (BatchNo	(None, 8, 8, 30)	120	concatenate_27[0][0]
activation_30 (Activation)	(None, 8, 8, 30)	0	batch_normalization_30[0][0]
conv2d_31 (Conv2D)	(None, 8, 8, 6)	1620	activation_30[0][0]
dropout_30 (Dropout)	(None, 8, 8, 6)	0	conv2d_31[0][0]
concatenate_28 (Concatenate)	(None, 8, 8, 36)	0	concatenate_27[0][0] dropout_30[0][0]
batch_normalization_31 (BatchNo	(None, 8, 8, 36)	144	concatenate_28[0][0]
activation_31 (Activation)	(None, 8, 8, 36)	0	batch_normalization_31[0][0]
conv2d_32 (Conv2D)	(None, 8, 8, 6)	1944	activation_31[0][0]
dropout_31 (Dropout)	(None, 8, 8, 6)	0	conv2d_32[0][0]
concatenate_29 (Concatenate)	(None, 8, 8, 42)	0	concatenate_28[0][0] dropout_31[0][0]
batch_normalization_32 (BatchNo	(None, 8, 8, 42)	168	concatenate_29[0][0]
activation_32 (Activation)	(None, 8, 8, 42)	0	batch_normalization_32[0][0]
conv2d_33 (Conv2D)	(None, 8, 8, 6)	2268	activation_32[0][0]
dropout_32 (Dropout)	(None, 8, 8, 6)	0	conv2d_33[0][0]
concatenate_30 (Concatenate)	(None, 8, 8, 48)	0	concatenate_29[0][0] dropout_32[0][0]
batch_normalization_33 (BatchNo	(None, 8, 8, 48)	192	concatenate_30[0][0]
activation_33 (Activation)	(None, 8, 8, 48)	0	batch_normalization_33[0][0]
conv2d_34 (Conv2D)	(None, 8, 8, 6)	2592	activation_33[0][0]

Layer	Output Shape	Param #	Connected to
conv2d_34 (Conv2D)	(None, 8, 8, 6)	2592	activation_33[0][0]
dropout_33 (Dropout)	(None, 8, 8, 6)	0	conv2d_34[0][0]
concatenate_31 (Concatenate)	(None, 8, 8, 54)	0	concatenate_30[0][0] dropout_33[0][0]
batch_normalization_34 (BatchNo	(None, 8, 8, 54)	216	concatenate_31[0][0]
activation_34 (Activation)	(None, 8, 8, 54)	0	batch_normalization_34[0][0]
conv2d_35 (Conv2D)	(None, 8, 8, 6)	2916	activation_34[0][0]
dropout_34 (Dropout)	(None, 8, 8, 6)	0	conv2d_35[0][0]
concatenate_32 (Concatenate)	(None, 8, 8, 60)	0	concatenate_31[0][0] dropout_34[0][0]
batch_normalization_35 (BatchNo	(None, 8, 8, 60)	240	concatenate_32[0][0]
activation_35 (Activation)	(None, 8, 8, 60)	0	batch_normalization_35[0][0]
conv2d_36 (Conv2D)	(None, 8, 8, 6)	3240	activation_35[0][0]
dropout_35 (Dropout)	(None, 8, 8, 6)	0	conv2d_36[0][0]
concatenate_33 (Concatenate)	(None, 8, 8, 66)	0	concatenate_32[0][0] dropout_35[0][0]
batch_normalization_36 (BatchNo	(None, 8, 8, 66)	264	concatenate_33[0][0]
activation_36 (Activation)	(None, 8, 8, 66)	0	batch_normalization_36[0][0]
conv2d_37 (Conv2D)	(None, 8, 8, 6)	3564	activation_36[0][0]
dropout_36 (Dropout)	(None, 8, 8, 6)	0	conv2d_37[0][0]
concatenate_34 (Concatenate)	(None, 8, 8, 72)	0	concatenate_33[0][0] dropout_36[0][0]
batch_normalization_37 (BatchNo	(None, 8, 8, 72)	288	concatenate_34[0][0]
activation_37 (Activation)	(None, 8, 8, 72)	0	batch_normalization_37[0][0]
conv2d_38 (Conv2D)	(None, 8, 8, 6)	3888	activation_37[0][0]
dropout_37 (Dropout)	(None, 8, 8, 6)	0	conv2d_38[0][0]
concatenate_35 (Concatenate)	(None, 8, 8, 78)	0	concatenate_34[0][0] dropout_37[0][0]
batch_normalization_38 (BatchNo	(None, 8, 8, 78)	312	concatenate_35[0][0]
activation_38 (Activation)	(None, 8, 8, 78)	0	batch_normalization_38[0][0]
conv2d_39 (Conv2D)	(None, 8, 8, 6)	468	activation_38[0][0]
dropout_38 (Dropout)	(None, 8, 8, 6)	0	conv2d_39[0][0]
average_pooling2d_2 (AveragePoo	(None, 4, 4, 6)	0	dropout_38[0][0]
batch_normalization_39 (BatchNo	(None, 4, 4, 6)	24	average_pooling2d_2[0][0]
activation_39 (Activation)	(None, 4, 4, 6)	0	batch_normalization_39[0][0]
conv2d_40 (Conv2D)	(None, 4, 4, 6)	324	activation_39[0][0]
dropout_39 (Dropout)	(None, 4, 4, 6)	0	conv2d_40[0][0]
concatenate_36 (Concatenate)	(None, 4, 4, 12)	0	average_pooling2d_2[0][0] dropout_39[0][0]
batch_normalization_40 (BatchNo	(None, 4, 4, 12)	48	concatenate_36[0][0]
activation_40 (Activation)	(None, 4, 4, 12)	0	batch_normalization_40[0][0]
conv2d_41 (Conv2D)	(None, 4, 4, 6)	648	activation_40[0][0]

dropout_40 (Dropout)	(None, 4, 4, 6)	0	conv2d_41[0][0]
concatenate_37 (Concatenate)	(None, 4, 4, 18)	0	concatenate_36[0][0] dropout_40[0][0]
batch_normalization_41 (BatchNo	(None, 4, 4, 18)	72	concatenate_37[0][0]
activation_41 (Activation)	(None, 4, 4, 18)	0	batch_normalization_41[0][0]
conv2d_42 (Conv2D)	(None, 4, 4, 6)	972	activation_41[0][0]
dropout_41 (Dropout)	(None, 4, 4, 6)	0	conv2d_42[0][0]
concatenate_38 (Concatenate)	(None, 4, 4, 24)	0	concatenate_37[0][0] dropout_41[0][0]
batch_normalization_42 (BatchNo	(None, 4, 4, 24)	96	concatenate_38[0][0]
activation_42 (Activation)	(None, 4, 4, 24)	0	batch_normalization_42[0][0]
conv2d_43 (Conv2D)	(None, 4, 4, 6)	1296	activation_42[0][0]
dropout_42 (Dropout)	(None, 4, 4, 6)	0	conv2d_43[0][0]
concatenate_39 (Concatenate)	(None, 4, 4, 30)	0	concatenate_38[0][0] dropout_42[0][0]
batch_normalization_43 (BatchNo	(None, 4, 4, 30)	120	concatenate_39[0][0]
activation_43 (Activation)	(None, 4, 4, 30)	0	batch_normalization_43[0][0]
conv2d_44 (Conv2D)	(None, 4, 4, 6)	1620	activation_43[0][0]
dropout_43 (Dropout)	(None, 4, 4, 6)	0	conv2d_44[0][0]
concatenate_40 (Concatenate)	(None, 4, 4, 36)	0	concatenate_39[0][0] dropout_43[0][0]
batch_normalization_44 (BatchNo	(None, 4, 4, 36)	144	concatenate_40[0][0]
activation_44 (Activation)	(None, 4, 4, 36)	0	batch_normalization_44[0][0]
conv2d_45 (Conv2D)	(None, 4, 4, 6)	1944	activation_44[0][0]
dropout_44 (Dropout)	(None, 4, 4, 6)	0	conv2d_45[0][0]
concatenate_41 (Concatenate)	(None, 4, 4, 42)	0	concatenate_40[0][0] dropout_44[0][0]
batch_normalization_45 (BatchNo	(None, 4, 4, 42)	168	concatenate_41[0][0]
activation_45 (Activation)	(None, 4, 4, 42)	0	batch_normalization_45[0][0]
conv2d_46 (Conv2D)	(None, 4, 4, 6)	2268	activation_45[0][0]
dropout_45 (Dropout)	(None, 4, 4, 6)	0	conv2d_46[0][0]
concatenate_42 (Concatenate)	(None, 4, 4, 48)	0	concatenate_41[0][0] dropout_45[0][0]
batch_normalization_46 (BatchNo	(None, 4, 4, 48)	192	concatenate_42[0][0]
activation_46 (Activation)	(None, 4, 4, 48)	0	batch_normalization_46[0][0]
conv2d_47 (Conv2D)	(None, 4, 4, 6)	2592	activation_46[0][0]
dropout_46 (Dropout)	(None, 4, 4, 6)	0	conv2d_47[0][0]
concatenate_43 (Concatenate)	(None, 4, 4, 54)	0	concatenate_42[0][0] dropout_46[0][0]
batch_normalization_47 (BatchNo	(None, 4, 4, 54)	216	concatenate_43[0][0]
activation_47 (Activation)	(None, 4, 4, 54)	0	batch_normalization_47[0][0]
conv2d_48 (Conv2D)	(None, 4, 4, 6)	2916	activation_47[0][0]

```
dropout_47 (Dropout)             (None, 4, 4, 6)      0      conv2d_48[0][0]
_____
concatenate_44 (Concatenate)     (None, 4, 4, 60)     0      concatenate_43[0][0]
                                                             dropout_47[0][0]
_____
batch_normalization_48 (BatchNo  (None, 4, 4, 60)     240    concatenate_44[0][0]
_____
activation_48 (Activation)       (None, 4, 4, 60)     0      batch_normalization_48[0][0]
_____
conv2d_49 (Conv2D)               (None, 4, 4, 6)      3240   activation_48[0][0]
_____
dropout_48 (Dropout)             (None, 4, 4, 6)      0      conv2d_49[0][0]
_____
concatenate_45 (Concatenate)     (None, 4, 4, 66)     0      concatenate_44[0][0]
                                                             dropout_48[0][0]
_____
batch_normalization_49 (BatchNo  (None, 4, 4, 66)     264    concatenate_45[0][0]
_____
activation_49 (Activation)       (None, 4, 4, 66)     0      batch_normalization_49[0][0]
_____
conv2d_50 (Conv2D)               (None, 4, 4, 6)      3564   activation_49[0][0]
_____
dropout_49 (Dropout)             (None, 4, 4, 6)      0      conv2d_50[0][0]
_____
concatenate_46 (Concatenate)     (None, 4, 4, 72)     0      concatenate_45[0][0]
                                                             dropout_49[0][0]
_____
batch_normalization_50 (BatchNo  (None, 4, 4, 72)     288    concatenate_46[0][0]
_____
activation_50 (Activation)       (None, 4, 4, 72)     0      batch_normalization_50[0][0]
_____
conv2d_51 (Conv2D)               (None, 4, 4, 6)      3888   activation_50[0][0]
_____
dropout_50 (Dropout)             (None, 4, 4, 6)      0      conv2d_51[0][0]
_____
concatenate_47 (Concatenate)     (None, 4, 4, 78)     0      concatenate_46[0][0]
                                                             dropout_50[0][0]
_____
batch_normalization_51 (BatchNo  (None, 4, 4, 78)     312    concatenate_47[0][0]
_____
activation_51 (Activation)       (None, 4, 4, 78)     0      batch_normalization_51[0][0]
_____
average_pooling2d_3 (AveragePoo  (None, 2, 2, 78)     0      activation_51[0][0]
_____
flatten (Flatten)                (None, 312)          0      average_pooling2d_3[0][0]
_____
dense (Dense)                    (None, 10)           3130   flatten[0][0]
================================================================================
Total params: 118,918
Trainable params: 114,394
Non-trainable params: 4,524
_____
```

In [42]:

```
model_2.compile(optimizer=tf.keras.optimizers.Adam(learning_rate=0.0001),
loss='categorical_crossentropy', metrics=['accuracy'])
```

In [43]:

```
from tensorflow.keras.callbacks import ModelCheckpoint, EarlyStopping, ReduceLROnPlateau
patience = 50
base_path = '/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/'
checkpoint_file_name = base_path + 'CIFAR_model2' + '_{epoch:02d}-{val_accuracy:.2f}.hdf5'

model_checkpoint = ModelCheckpoint(checkpoint_file_name, monitor='val_accuracy', mode='max', verbos
e=1, save_best_only=True)
early_stop = EarlyStopping('val_accuracy', mode='max', patience = patience)
reduce_LR = ReduceLROnPlateau(monitor='val_accuracy', mode='max', factor=0.1, patience=int(patience
/3))
```

In [44]:

```
callbacks = [model_checkpoint, early_stop, reduce_LR]
```

In [45]:

```
epochs = 300
batch_size = 128
```

In [46]:

```
#https://keras.io/api/preprocessing/image/#flow-method

history_2 = model_2.fit(data_generator.flow(X_train, y_train, batch_size),
                        steps_per_epoch = int(len(X_train)/batch_size),
                        epochs = epochs,
                        callbacks = callbacks,
                        validation_data = (X_test, y_test), verbose=1)
```

```
WARNING:tensorflow:sample_weight modes were coerced from
  ...
    to
  ['...']
Train for 390 steps, validate on 10000 samples
Epoch 1/300
389/390 [============================>.] - ETA: 0s - loss: 0.5581 - accuracy: 0.8033
Epoch 00001: val_accuracy improved from -inf to 0.80040, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model2_01-0.80.hdf5
390/390 [==============================] - 37s 95ms/step - loss: 0.5583 - accuracy: 0.8032 - val_l
oss: 0.6419 - val_accuracy: 0.8004
Epoch 2/300
389/390 [============================>.] - ETA: 0s - loss: 0.5614 - accuracy: 0.8053
Epoch 00002: val_accuracy improved from 0.80040 to 0.80220, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model2_02-0.80.hdf5
390/390 [==============================] - 29s 74ms/step - loss: 0.5614 - accuracy: 0.8053 - val_l
oss: 0.6375 - val_accuracy: 0.8022
Epoch 3/300
389/390 [============================>.] - ETA: 0s - loss: 0.5594 - accuracy: 0.8042
Epoch 00003: val_accuracy did not improve from 0.80220
390/390 [==============================] - 28s 72ms/step - loss: 0.5594 - accuracy: 0.8043 - val_l
oss: 0.6571 - val_accuracy: 0.7997
Epoch 4/300
389/390 [============================>.] - ETA: 0s - loss: 0.5554 - accuracy: 0.8039
Epoch 00004: val_accuracy improved from 0.80220 to 0.81070, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model2_04-0.81.hdf5
390/390 [==============================] - 29s 74ms/step - loss: 0.5556 - accuracy: 0.8038 - val_l
oss: 0.6188 - val_accuracy: 0.8107
Epoch 5/300
389/390 [============================>.] - ETA: 0s - loss: 0.5544 - accuracy: 0.8040
Epoch 00005: val_accuracy did not improve from 0.81070
390/390 [==============================] - 28s 72ms/step - loss: 0.5543 - accuracy: 0.8040 - val_l
oss: 0.6297 - val_accuracy: 0.8076
Epoch 6/300
389/390 [============================>.] - ETA: 0s - loss: 0.5526 - accuracy: 0.8050
Epoch 00006: val_accuracy did not improve from 0.81070
390/390 [==============================] - 28s 73ms/step - loss: 0.5526 - accuracy: 0.8050 - val_l
oss: 0.6591 - val_accuracy: 0.8010
Epoch 7/300
389/390 [============================>.] - ETA: 0s - loss: 0.5490 - accuracy: 0.8075
Epoch 00007: val_accuracy did not improve from 0.81070
390/390 [==============================] - 28s 72ms/step - loss: 0.5492 - accuracy: 0.8074 - val_l
oss: 0.6238 - val_accuracy: 0.8076
Epoch 8/300
389/390 [============================>.] - ETA: 0s - loss: 0.5464 - accuracy: 0.8093
Epoch 00008: val_accuracy did not improve from 0.81070
390/390 [==============================] - 28s 72ms/step - loss: 0.5467 - accuracy: 0.8092 - val_l
oss: 0.6312 - val_accuracy: 0.8067
Epoch 9/300
389/390 [============================>.] - ETA: 0s - loss: 0.5498 - accuracy: 0.8046
Epoch 00009: val_accuracy did not improve from 0.81070
390/390 [==============================] - 28s 72ms/step - loss: 0.5501 - accuracy: 0.8045 - val_l
oss: 0.6622 - val_accuracy: 0.8012
Epoch 10/300
389/390 [============================>.] - ETA: 0s - loss: 0.5455 - accuracy: 0.8087
Epoch 00010: val_accuracy did not improve from 0.81070
390/390 [==============================] - 28s 72ms/step - loss: 0.5454 - accuracy: 0.8088 - val_l
oss: 0.6520 - val accuracy: 0.8009
```

```
oss: 0.0520 - val_accuracy: 0.0009
Epoch 11/300
389/390 [============================>.] - ETA: 0s - loss: 0.5481 - accuracy: 0.8091
Epoch 00011: val_accuracy did not improve from 0.81070
390/390 [==============================] - 28s 72ms/step - loss: 0.5481 - accuracy: 0.8091 - val_l
oss: 0.6431 - val_accuracy: 0.8018
Epoch 12/300
389/390 [============================>.] - ETA: 0s - loss: 0.5409 - accuracy: 0.8104
Epoch 00012: val_accuracy did not improve from 0.81070
390/390 [==============================] - 28s 72ms/step - loss: 0.5409 - accuracy: 0.8104 - val_l
oss: 0.6439 - val_accuracy: 0.8050
Epoch 13/300
389/390 [============================>.] - ETA: 0s - loss: 0.5465 - accuracy: 0.8081
Epoch 00013: val_accuracy did not improve from 0.81070
390/390 [==============================] - 28s 72ms/step - loss: 0.5463 - accuracy: 0.8081 - val_l
oss: 0.6619 - val_accuracy: 0.8008
Epoch 14/300
389/390 [============================>.] - ETA: 0s - loss: 0.5451 - accuracy: 0.8081
Epoch 00014: val_accuracy did not improve from 0.81070
390/390 [==============================] - 28s 72ms/step - loss: 0.5452 - accuracy: 0.8081 - val_l
oss: 0.6316 - val_accuracy: 0.8095
Epoch 15/300
389/390 [============================>.] - ETA: 0s - loss: 0.5490 - accuracy: 0.8098
Epoch 00015: val_accuracy improved from 0.81070 to 0.81330, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model2_15-0.81.hdf5
390/390 [==============================] - 29s 74ms/step - loss: 0.5492 - accuracy: 0.8097 - val_l
oss: 0.6198 - val_accuracy: 0.8133
Epoch 16/300
389/390 [============================>.] - ETA: 0s - loss: 0.5428 - accuracy: 0.8093
Epoch 00016: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5433 - accuracy: 0.8091 - val_l
oss: 0.6484 - val_accuracy: 0.8048
Epoch 17/300
389/390 [============================>.] - ETA: 0s - loss: 0.5452 - accuracy: 0.8111
Epoch 00017: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5447 - accuracy: 0.8112 - val_l
oss: 0.6252 - val_accuracy: 0.8105
Epoch 18/300
389/390 [============================>.] - ETA: 0s - loss: 0.5454 - accuracy: 0.8068
Epoch 00018: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5451 - accuracy: 0.8070 - val_l
oss: 0.6236 - val_accuracy: 0.8098
Epoch 19/300
389/390 [============================>.] - ETA: 0s - loss: 0.5433 - accuracy: 0.8096
Epoch 00019: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5432 - accuracy: 0.8096 - val_l
oss: 0.6261 - val_accuracy: 0.8099
Epoch 20/300
389/390 [============================>.] - ETA: 0s - loss: 0.5443 - accuracy: 0.8093
Epoch 00020: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5447 - accuracy: 0.8092 - val_l
oss: 0.6298 - val_accuracy: 0.8111
Epoch 21/300
389/390 [============================>.] - ETA: 0s - loss: 0.5438 - accuracy: 0.8087
Epoch 00021: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5438 - accuracy: 0.8088 - val_l
oss: 0.6196 - val_accuracy: 0.8110
Epoch 22/300
389/390 [============================>.] - ETA: 0s - loss: 0.5457 - accuracy: 0.8086
Epoch 00022: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5456 - accuracy: 0.8085 - val_l
oss: 0.6491 - val_accuracy: 0.8020
Epoch 23/300
389/390 [============================>.] - ETA: 0s - loss: 0.5433 - accuracy: 0.8101
Epoch 00023: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5433 - accuracy: 0.8100 - val_l
oss: 0.6528 - val_accuracy: 0.8067
Epoch 24/300
389/390 [============================>.] - ETA: 0s - loss: 0.5456 - accuracy: 0.8086
Epoch 00024: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5454 - accuracy: 0.8087 - val_l
oss: 0.6227 - val_accuracy: 0.8119
Epoch 25/300
389/390 [============================>.] - ETA: 0s - loss: 0.5426 - accuracy: 0.8093
Epoch 00025: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5426 - accuracy: 0.8093 - val_l
oss: 0.6399 - val_accuracy: 0.8086
Epoch 26/300
```

```
Epoch 26/300
389/390 [============================>.] - ETA: 0s - loss: 0.5419 - accuracy: 0.8092
Epoch 00026: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5416 - accuracy: 0.8092 - val_l
oss: 0.6489 - val_accuracy: 0.8045
Epoch 27/300
389/390 [============================>.] - ETA: 0s - loss: 0.5459 - accuracy: 0.8083
Epoch 00027: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 73ms/step - loss: 0.5461 - accuracy: 0.8083 - val_l
oss: 0.6226 - val_accuracy: 0.8121
Epoch 28/300
389/390 [============================>.] - ETA: 0s - loss: 0.5440 - accuracy: 0.8079
Epoch 00028: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5439 - accuracy: 0.8079 - val_l
oss: 0.6395 - val_accuracy: 0.8060
Epoch 29/300
389/390 [============================>.] - ETA: 0s - loss: 0.5365 - accuracy: 0.8132
Epoch 00029: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 73ms/step - loss: 0.5368 - accuracy: 0.8132 - val_l
oss: 0.6366 - val_accuracy: 0.8097
Epoch 30/300
389/390 [============================>.] - ETA: 0s - loss: 0.5392 - accuracy: 0.8124
Epoch 00030: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5390 - accuracy: 0.8125 - val_l
oss: 0.6457 - val_accuracy: 0.8061
Epoch 31/300
389/390 [============================>.] - ETA: 0s - loss: 0.5378 - accuracy: 0.8101
Epoch 00031: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5379 - accuracy: 0.8101 - val_l
oss: 0.6383 - val_accuracy: 0.8075
Epoch 32/300
389/390 [============================>.] - ETA: 0s - loss: 0.5366 - accuracy: 0.8110
Epoch 00032: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 71ms/step - loss: 0.5366 - accuracy: 0.8110 - val_l
oss: 0.6434 - val_accuracy: 0.8048
Epoch 33/300
389/390 [============================>.] - ETA: 0s - loss: 0.5380 - accuracy: 0.8124
Epoch 00033: val_accuracy did not improve from 0.81330
390/390 [==============================] - 27s 70ms/step - loss: 0.5378 - accuracy: 0.8125 - val_l
oss: 0.6457 - val_accuracy: 0.8052
Epoch 34/300
389/390 [============================>.] - ETA: 0s - loss: 0.5308 - accuracy: 0.8136
Epoch 00034: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 71ms/step - loss: 0.5308 - accuracy: 0.8135 - val_l
oss: 0.6438 - val_accuracy: 0.8054
Epoch 35/300
389/390 [============================>.] - ETA: 0s - loss: 0.5358 - accuracy: 0.8119
Epoch 00035: val_accuracy did not improve from 0.81330
390/390 [==============================] - 27s 70ms/step - loss: 0.5360 - accuracy: 0.8118 - val_l
oss: 0.6379 - val_accuracy: 0.8071
Epoch 36/300
389/390 [============================>.] - ETA: 0s - loss: 0.5380 - accuracy: 0.8110
Epoch 00036: val_accuracy did not improve from 0.81330
390/390 [==============================] - 27s 70ms/step - loss: 0.5380 - accuracy: 0.8111 - val_l
oss: 0.6425 - val_accuracy: 0.8069
Epoch 37/300
389/390 [============================>.] - ETA: 0s - loss: 0.5303 - accuracy: 0.8142
Epoch 00037: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 71ms/step - loss: 0.5303 - accuracy: 0.8142 - val_l
oss: 0.6417 - val_accuracy: 0.8068
Epoch 38/300
389/390 [============================>.] - ETA: 0s - loss: 0.5342 - accuracy: 0.8135
Epoch 00038: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 71ms/step - loss: 0.5344 - accuracy: 0.8134 - val_l
oss: 0.6397 - val_accuracy: 0.8076
Epoch 39/300
389/390 [============================>.] - ETA: 0s - loss: 0.5352 - accuracy: 0.8128
Epoch 00039: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 71ms/step - loss: 0.5353 - accuracy: 0.8127 - val_l
oss: 0.6358 - val_accuracy: 0.8082
Epoch 40/300
389/390 [============================>.] - ETA: 0s - loss: 0.5310 - accuracy: 0.8140
Epoch 00040: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 71ms/step - loss: 0.5308 - accuracy: 0.8141 - val_l
oss: 0.6359 - val_accuracy: 0.8076
Epoch 41/300
389/390 [============================>.] - ETA: 0s - loss: 0.5309 - accuracy: 0.8153
Epoch 00041: val_accuracy did not improve from 0.81330
```

```
Epoch 00041: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5308 - accuracy: 0.8154 - val_l
oss: 0.6379 - val_accuracy: 0.8082
Epoch 42/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5322 - accuracy: 0.8146
Epoch 00042: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5318 - accuracy: 0.8147 - val_l
oss: 0.6380 - val_accuracy: 0.8082
Epoch 43/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5333 - accuracy: 0.8116
Epoch 00043: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5334 - accuracy: 0.8116 - val_l
oss: 0.6386 - val_accuracy: 0.8086
Epoch 44/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5337 - accuracy: 0.8135
Epoch 00044: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5340 - accuracy: 0.8133 - val_l
oss: 0.6378 - val_accuracy: 0.8076
Epoch 45/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5355 - accuracy: 0.8113
Epoch 00045: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5355 - accuracy: 0.8113 - val_l
oss: 0.6396 - val_accuracy: 0.8072
Epoch 46/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5328 - accuracy: 0.8158
Epoch 00046: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 73ms/step - loss: 0.5324 - accuracy: 0.8159 - val_l
oss: 0.6391 - val_accuracy: 0.8070
Epoch 47/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5281 - accuracy: 0.8146
Epoch 00047: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5280 - accuracy: 0.8145 - val_l
oss: 0.6334 - val_accuracy: 0.8089
Epoch 48/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5326 - accuracy: 0.8127
Epoch 00048: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5326 - accuracy: 0.8127 - val_l
oss: 0.6348 - val_accuracy: 0.8083
Epoch 49/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5293 - accuracy: 0.8127
Epoch 00049: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5292 - accuracy: 0.8127 - val_l
oss: 0.6332 - val_accuracy: 0.8091
Epoch 50/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5316 - accuracy: 0.8149
Epoch 00050: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5318 - accuracy: 0.8148 - val_l
oss: 0.6348 - val_accuracy: 0.8085
Epoch 51/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5313 - accuracy: 0.8131
Epoch 00051: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 73ms/step - loss: 0.5313 - accuracy: 0.8131 - val_l
oss: 0.6352 - val_accuracy: 0.8082
Epoch 52/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5248 - accuracy: 0.8156
Epoch 00052: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5252 - accuracy: 0.8154 - val_l
oss: 0.6336 - val_accuracy: 0.8087
Epoch 53/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5272 - accuracy: 0.8158
Epoch 00053: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5272 - accuracy: 0.8158 - val_l
oss: 0.6357 - val_accuracy: 0.8085
Epoch 54/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5305 - accuracy: 0.8145
Epoch 00054: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5308 - accuracy: 0.8143 - val_l
oss: 0.6346 - val_accuracy: 0.8083
Epoch 55/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5306 - accuracy: 0.8148
Epoch 00055: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 73ms/step - loss: 0.5308 - accuracy: 0.8147 - val_l
oss: 0.6348 - val_accuracy: 0.8086
Epoch 56/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5336 - accuracy: 0.8118
Epoch 00056: val_accuracy did not improve from 0.81330
390/390 [==============================] - 28s 72ms/step - loss: 0.5336 - accuracy: 0.8118 - val_l
oss: 0.6343 - val_accuracy: 0.8083
```

```
oss: 0.6342 - val_accuracy: 0.8092
Epoch 57/300
389/390 [============================>.] - ETA: 0s - loss: 0.5297 - accuracy: 0.8140
Epoch 00057: val_accuracy did not improve from 0.81330
390/390 [=============================] - 28s 72ms/step - loss: 0.5298 - accuracy: 0.8141 - val_l
oss: 0.6349 - val_accuracy: 0.8082
Epoch 58/300
389/390 [============================>.] - ETA: 0s - loss: 0.5317 - accuracy: 0.8150
Epoch 00058: val_accuracy did not improve from 0.81330
390/390 [=============================] - 28s 73ms/step - loss: 0.5318 - accuracy: 0.8148 - val_l
oss: 0.6356 - val_accuracy: 0.8085
Epoch 59/300
389/390 [============================>.] - ETA: 0s - loss: 0.5347 - accuracy: 0.8130
Epoch 00059: val_accuracy did not improve from 0.81330
390/390 [=============================] - 28s 72ms/step - loss: 0.5346 - accuracy: 0.8130 - val_l
oss: 0.6365 - val_accuracy: 0.8081
Epoch 60/300
389/390 [============================>.] - ETA: 0s - loss: 0.5304 - accuracy: 0.8126
Epoch 00060: val_accuracy did not improve from 0.81330
390/390 [=============================] - 28s 72ms/step - loss: 0.5304 - accuracy: 0.8126 - val_l
oss: 0.6335 - val_accuracy: 0.8082
Epoch 61/300
389/390 [============================>.] - ETA: 0s - loss: 0.5296 - accuracy: 0.8138
Epoch 00061: val_accuracy did not improve from 0.81330
390/390 [=============================] - 28s 72ms/step - loss: 0.5297 - accuracy: 0.8136 - val_l
oss: 0.6367 - val_accuracy: 0.8081
Epoch 62/300
389/390 [============================>.] - ETA: 0s - loss: 0.5310 - accuracy: 0.8135
Epoch 00062: val_accuracy did not improve from 0.81330
390/390 [=============================] - 28s 72ms/step - loss: 0.5312 - accuracy: 0.8134 - val_l
oss: 0.6355 - val_accuracy: 0.8080
Epoch 63/300
389/390 [============================>.] - ETA: 0s - loss: 0.5334 - accuracy: 0.8119
Epoch 00063: val_accuracy did not improve from 0.81330
390/390 [=============================] - 28s 72ms/step - loss: 0.5335 - accuracy: 0.8119 - val_l
oss: 0.6378 - val_accuracy: 0.8079
Epoch 64/300
389/390 [============================>.] - ETA: 0s - loss: 0.5328 - accuracy: 0.8157
Epoch 00064: val_accuracy did not improve from 0.81330
390/390 [=============================] - 28s 73ms/step - loss: 0.5326 - accuracy: 0.8157 - val_l
oss: 0.6364 - val_accuracy: 0.8078
Epoch 65/300
389/390 [============================>.] - ETA: 0s - loss: 0.5313 - accuracy: 0.8158
Epoch 00065: val_accuracy did not improve from 0.81330
390/390 [=============================] - 28s 72ms/step - loss: 0.5312 - accuracy: 0.8159 - val_l
oss: 0.6366 - val_accuracy: 0.8083
```

In [47]:

```python
#history plot for accyracy
plt.figure(figsize=(16,4))
plt.plot(history_2.history['accuracy'])
plt.plot(history_2.history['val_accuracy'])
plt.title("Model Accuracy")
plt.xlabel("Epoch")
plt.ylabel("Accuracy")
plt.legend(["train", "test"], loc="upper left")
plt.show()

# history plot for accuracy
plt.figure(figsize=(16,4))
plt.plot(history_2.history["loss"])
plt.plot(history_2.history["val_loss"])
plt.title("Model Loss")
plt.xlabel("Epoch")
plt.ylabel("Loss")
plt.legend(["train", "test"], loc="upper left")
plt.show()
```
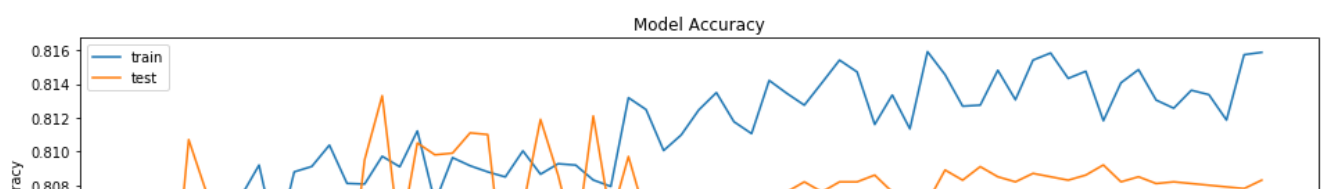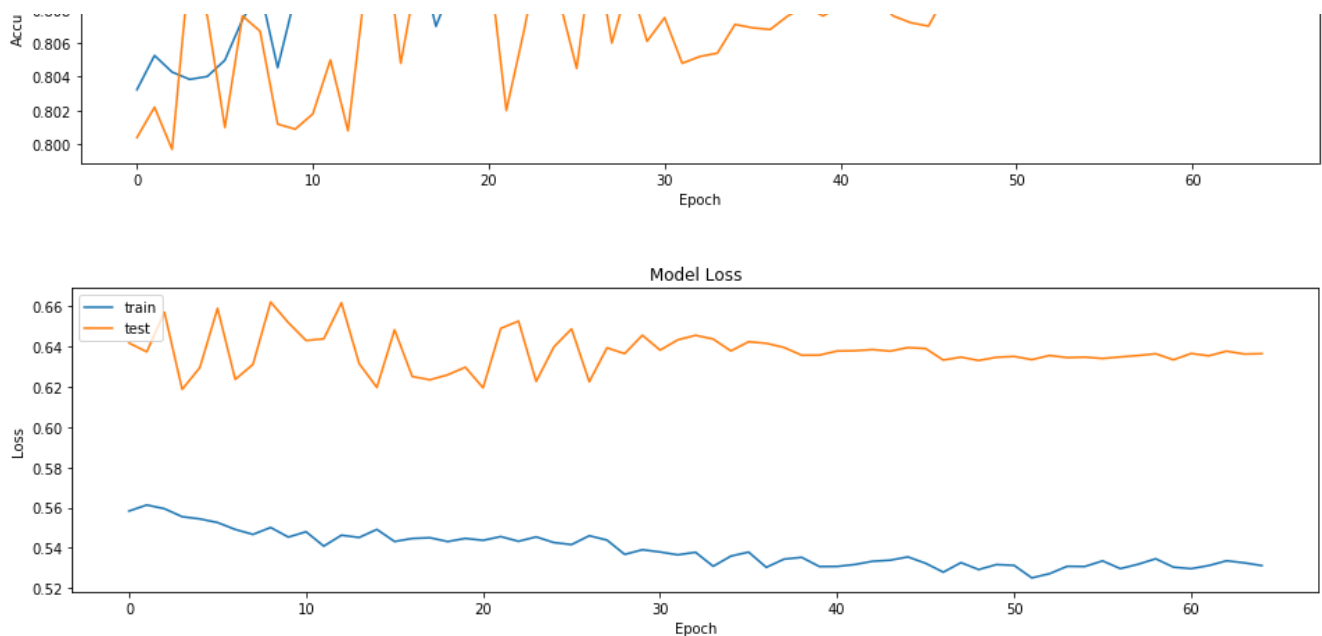
Summary:

- Even after changing the learning rate the model accuracy is not improved. Next we can try is different convolution and different num of filters

In [65]:

```
best_model_2 =
tf.keras.models.load_model('/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model2_15-0.81
.hdf5')
scores = best_model_2.evaluate(X_test, y_test, verbose=1)
print(scores)
```

```
10000/10000 [==============================] - 3s 347us/sample - loss: 0.6198 - accuracy: 0.8133
[0.6198125976085663, 0.8133]
```

12. Model-3

- Seperable convolution
- num filters 32

In [52]:

```python
#BN-->ReLU-->Conv2D-->Dropout-->concat(input, output)-->(put in loop)

def denseblock(input, num_filter, dropout_rate = 0.2):
    global compression      # to keep the growth rate of number of filters
    temp = input
    for _ in range(l):
        BatchNorm = layers.BatchNormalization()(temp)
        relu = layers.Activation('relu')(BatchNorm)
        Conv2D_5_5= layers.SeparableConv2D(int(num_filter*compression), (5,5), use_bias=False, padd
ing='same')(relu)
        #Conv2D_3_3 = layers.Conv2D(int(num_filter*compression), (3,3), use_bias=False
,padding='same')(relu)
        if dropout_rate>0:
            Conv2D_5_5 = layers.Dropout(dropout_rate)(Conv2D_5_5)

        #concat the input(temp) and output(conv2d_3_3) , in resnet we add but here we concat
        concat = layers.Concatenate(axis=-1)([temp,Conv2D_5_5])

        #change the concat as input
        temp = concat

    return temp
```

```
#BN-->relu-->conv2d(1x1)-->dropout-->avg_pool
def transition(input, num_filter, dropout_rate = 0.2):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    #Conv2D_BottleNeck = layers.Conv2D(int(num_filter*compression), (1,1), use_bias=False
,padding='same')(relu)
    Conv2D_BottleNeck = layers.SeparableConvolution2D(int(num_filter*compression), (1,1), use_bias=
False ,padding='same')(relu)
    if dropout_rate>0:
        Conv2D_BottleNeck = layers.Dropout(dropout_rate)(Conv2D_BottleNeck)
    avg = layers.AveragePooling2D(pool_size=(2,2))(Conv2D_BottleNeck)
    return avg

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

# Hyperparameters
l = 12
num_filter = 32
compression = 0.5
dropout_rate = 0.2
num_classes = 10

input = layers.Input(shape=(input_size))
First_Conv2D = layers.Conv2D(num_filter, (5,5), use_bias=False ,padding='same')(input)

#First dense and transition block
First_Block = denseblock(First_Conv2D, num_filter, dropout_rate)
First_Transition = transition(First_Block, num_filter, dropout_rate)

#Second dense and transition block
Second_Block = denseblock(First_Transition, num_filter, dropout_rate)
Second_Transition = transition(Second_Block, num_filter, dropout_rate)

#Third dense and transition block
Third_Block = denseblock(Second_Transition, num_filter, dropout_rate)
Third_Transition = transition(Third_Block, num_filter, dropout_rate)

#last dense and output block
Last_Block = denseblock(Third_Transition,  num_filter, dropout_rate)
output = output_layer(Last_Block)
```

In [53]:

```
model_3 = tf.keras.models.Model(inputs=[input], outputs=[output])
model_3.summary()
```

Model: "model_2"

Layer (type)	Output Shape	Param #	Connected to
input_3 (InputLayer)	[(None, 32, 32, 3)]	0	
conv2d_53 (Conv2D)	(None, 32, 32, 32)	2400	input_3[0][0]
batch_normalization_104 (BatchN	(None, 32, 32, 32)	128	conv2d_53[0][0]
activation_104 (Activation)	(None, 32, 32, 32)	0	batch_normalization_104[0][0]
separable_conv2d_51 (SeparableC	(None, 32, 32, 16)	1312	activation_104[0][0]
dropout_102 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_51[0][0]
concatenate_96 (Concatenate)	(None, 32, 32, 48)	0	conv2d_53[0][0] dropout_102[0][0]
batch_normalization_105 (BatchN	(None, 32, 32, 48)	192	concatenate_96[0][0]

Layer	Output Shape	Param	Connected to
activation_105 (Activation)	(None, 32, 32, 48)	0	batch_normalization_105[0][0]
separable_conv2d_52 (SeparableC	(None, 32, 32, 16)	1968	activation_105[0][0]
dropout_103 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_52[0][0]
concatenate_97 (Concatenate)	(None, 32, 32, 64)	0	concatenate_96[0][0] dropout_103[0][0]
batch_normalization_106 (BatchN	(None, 32, 32, 64)	256	concatenate_97[0][0]
activation_106 (Activation)	(None, 32, 32, 64)	0	batch_normalization_106[0][0]
separable_conv2d_53 (SeparableC	(None, 32, 32, 16)	2624	activation_106[0][0]
dropout_104 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_53[0][0]
concatenate_98 (Concatenate)	(None, 32, 32, 80)	0	concatenate_97[0][0] dropout_104[0][0]
batch_normalization_107 (BatchN	(None, 32, 32, 80)	320	concatenate_98[0][0]
activation_107 (Activation)	(None, 32, 32, 80)	0	batch_normalization_107[0][0]
separable_conv2d_54 (SeparableC	(None, 32, 32, 16)	3280	activation_107[0][0]
dropout_105 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_54[0][0]
concatenate_99 (Concatenate)	(None, 32, 32, 96)	0	concatenate_98[0][0] dropout_105[0][0]
batch_normalization_108 (BatchN	(None, 32, 32, 96)	384	concatenate_99[0][0]
activation_108 (Activation)	(None, 32, 32, 96)	0	batch_normalization_108[0][0]
separable_conv2d_55 (SeparableC	(None, 32, 32, 16)	3936	activation_108[0][0]
dropout_106 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_55[0][0]
concatenate_100 (Concatenate)	(None, 32, 32, 112)	0	concatenate_99[0][0] dropout_106[0][0]
batch_normalization_109 (BatchN	(None, 32, 32, 112)	448	concatenate_100[0][0]
activation_109 (Activation)	(None, 32, 32, 112)	0	batch_normalization_109[0][0]
separable_conv2d_56 (SeparableC	(None, 32, 32, 16)	4592	activation_109[0][0]
dropout_107 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_56[0][0]
concatenate_101 (Concatenate)	(None, 32, 32, 128)	0	concatenate_100[0][0] dropout_107[0][0]
batch_normalization_110 (BatchN	(None, 32, 32, 128)	512	concatenate_101[0][0]
activation_110 (Activation)	(None, 32, 32, 128)	0	batch_normalization_110[0][0]
separable_conv2d_57 (SeparableC	(None, 32, 32, 16)	5248	activation_110[0][0]
dropout_108 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_57[0][0]
concatenate_102 (Concatenate)	(None, 32, 32, 144)	0	concatenate_101[0][0] dropout_108[0][0]
batch_normalization_111 (BatchN	(None, 32, 32, 144)	576	concatenate_102[0][0]
activation_111 (Activation)	(None, 32, 32, 144)	0	batch_normalization_111[0][0]
separable_conv2d_58 (SeparableC	(None, 32, 32, 16)	5904	activation_111[0][0]
dropout_109 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_58[0][0]
concatenate_103 (Concatenate)	(None, 32, 32, 160)	0	concatenate_102[0][0] dropout_109[0][0]
batch_normalization_112 (BatchN	(None, 32, 32, 160)	640	concatenate_103[0][0]

Layer	Output Shape	Param #	Connected to
activation_112 (Activation)	(None, 32, 32, 160)	0	batch_normalization_112[0][0]
separable_conv2d_59 (SeparableC	(None, 32, 32, 16)	6560	activation_112[0][0]
dropout_110 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_59[0][0]
concatenate_104 (Concatenate)	(None, 32, 32, 176)	0	concatenate_103[0][0] dropout_110[0][0]
batch_normalization_113 (BatchN	(None, 32, 32, 176)	704	concatenate_104[0][0]
activation_113 (Activation)	(None, 32, 32, 176)	0	batch_normalization_113[0][0]
separable_conv2d_60 (SeparableC	(None, 32, 32, 16)	7216	activation_113[0][0]
dropout_111 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_60[0][0]
concatenate_105 (Concatenate)	(None, 32, 32, 192)	0	concatenate_104[0][0] dropout_111[0][0]
batch_normalization_114 (BatchN	(None, 32, 32, 192)	768	concatenate_105[0][0]
activation_114 (Activation)	(None, 32, 32, 192)	0	batch_normalization_114[0][0]
separable_conv2d_61 (SeparableC	(None, 32, 32, 16)	7872	activation_114[0][0]
dropout_112 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_61[0][0]
concatenate_106 (Concatenate)	(None, 32, 32, 208)	0	concatenate_105[0][0] dropout_112[0][0]
batch_normalization_115 (BatchN	(None, 32, 32, 208)	832	concatenate_106[0][0]
activation_115 (Activation)	(None, 32, 32, 208)	0	batch_normalization_115[0][0]
separable_conv2d_62 (SeparableC	(None, 32, 32, 16)	8528	activation_115[0][0]
dropout_113 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_62[0][0]
concatenate_107 (Concatenate)	(None, 32, 32, 224)	0	concatenate_106[0][0] dropout_113[0][0]
batch_normalization_116 (BatchN	(None, 32, 32, 224)	896	concatenate_107[0][0]
activation_116 (Activation)	(None, 32, 32, 224)	0	batch_normalization_116[0][0]
separable_conv2d_63 (SeparableC	(None, 32, 32, 16)	3808	activation_116[0][0]
dropout_114 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_63[0][0]
average_pooling2d_8 (AveragePoo	(None, 16, 16, 16)	0	dropout_114[0][0]
batch_normalization_117 (BatchN	(None, 16, 16, 16)	64	average_pooling2d_8[0][0]
activation_117 (Activation)	(None, 16, 16, 16)	0	batch_normalization_117[0][0]
separable_conv2d_64 (SeparableC	(None, 16, 16, 16)	656	activation_117[0][0]
dropout_115 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_64[0][0]
concatenate_108 (Concatenate)	(None, 16, 16, 32)	0	average_pooling2d_8[0][0] dropout_115[0][0]
batch_normalization_118 (BatchN	(None, 16, 16, 32)	128	concatenate_108[0][0]
activation_118 (Activation)	(None, 16, 16, 32)	0	batch_normalization_118[0][0]
separable_conv2d_65 (SeparableC	(None, 16, 16, 16)	1312	activation_118[0][0]
dropout_116 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_65[0][0]
concatenate_109 (Concatenate)	(None, 16, 16, 48)	0	concatenate_108[0][0] dropout_116[0][0]
batch_normalization_119 (BatchN	(None, 16, 16, 48)	192	concatenate_109[0][0]

activation_119 (Activation)	(None, 16, 16, 48)	0	batch_normalization_119[0][0]
separable_conv2d_66 (SeparableC	(None, 16, 16, 16)	1968	activation_119[0][0]
dropout_117 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_66[0][0]
concatenate_110 (Concatenate)	(None, 16, 16, 64)	0	concatenate_109[0][0] dropout_117[0][0]
batch_normalization_120 (BatchN	(None, 16, 16, 64)	256	concatenate_110[0][0]
activation_120 (Activation)	(None, 16, 16, 64)	0	batch_normalization_120[0][0]
separable_conv2d_67 (SeparableC	(None, 16, 16, 16)	2624	activation_120[0][0]
dropout_118 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_67[0][0]
concatenate_111 (Concatenate)	(None, 16, 16, 80)	0	concatenate_110[0][0] dropout_118[0][0]
batch_normalization_121 (BatchN	(None, 16, 16, 80)	320	concatenate_111[0][0]
activation_121 (Activation)	(None, 16, 16, 80)	0	batch_normalization_121[0][0]
separable_conv2d_68 (SeparableC	(None, 16, 16, 16)	3280	activation_121[0][0]
dropout_119 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_68[0][0]
concatenate_112 (Concatenate)	(None, 16, 16, 96)	0	concatenate_111[0][0] dropout_119[0][0]
batch_normalization_122 (BatchN	(None, 16, 16, 96)	384	concatenate_112[0][0]
activation_122 (Activation)	(None, 16, 16, 96)	0	batch_normalization_122[0][0]
separable_conv2d_69 (SeparableC	(None, 16, 16, 16)	3936	activation_122[0][0]
dropout_120 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_69[0][0]
concatenate_113 (Concatenate)	(None, 16, 16, 112)	0	concatenate_112[0][0] dropout_120[0][0]
batch_normalization_123 (BatchN	(None, 16, 16, 112)	448	concatenate_113[0][0]
activation_123 (Activation)	(None, 16, 16, 112)	0	batch_normalization_123[0][0]
separable_conv2d_70 (SeparableC	(None, 16, 16, 16)	4592	activation_123[0][0]
dropout_121 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_70[0][0]
concatenate_114 (Concatenate)	(None, 16, 16, 128)	0	concatenate_113[0][0] dropout_121[0][0]
batch_normalization_124 (BatchN	(None, 16, 16, 128)	512	concatenate_114[0][0]
activation_124 (Activation)	(None, 16, 16, 128)	0	batch_normalization_124[0][0]
separable_conv2d_71 (SeparableC	(None, 16, 16, 16)	5248	activation_124[0][0]
dropout_122 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_71[0][0]
concatenate_115 (Concatenate)	(None, 16, 16, 144)	0	concatenate_114[0][0] dropout_122[0][0]
batch_normalization_125 (BatchN	(None, 16, 16, 144)	576	concatenate_115[0][0]
activation_125 (Activation)	(None, 16, 16, 144)	0	batch_normalization_125[0][0]
separable_conv2d_72 (SeparableC	(None, 16, 16, 16)	5904	activation_125[0][0]
dropout_123 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_72[0][0]
concatenate_116 (Concatenate)	(None, 16, 16, 160)	0	concatenate_115[0][0] dropout_123[0][0]
batch_normalization_126 (BatchN	(None, 16, 16, 160)	640	concatenate_116[0][0]

activation_126 (Activation)	(None, 16, 16, 160)	0	batch_normalization_126[0][0]
separable_conv2d_73 (SeparableC	(None, 16, 16, 16)	6560	activation_126[0][0]
dropout_124 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_73[0][0]
concatenate_117 (Concatenate)	(None, 16, 16, 176)	0	concatenate_116[0][0] dropout_124[0][0]
batch_normalization_127 (BatchN	(None, 16, 16, 176)	704	concatenate_117[0][0]
activation_127 (Activation)	(None, 16, 16, 176)	0	batch_normalization_127[0][0]
separable_conv2d_74 (SeparableC	(None, 16, 16, 16)	7216	activation_127[0][0]
dropout_125 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_74[0][0]
concatenate_118 (Concatenate)	(None, 16, 16, 192)	0	concatenate_117[0][0] dropout_125[0][0]
batch_normalization_128 (BatchN	(None, 16, 16, 192)	768	concatenate_118[0][0]
activation_128 (Activation)	(None, 16, 16, 192)	0	batch_normalization_128[0][0]
separable_conv2d_75 (SeparableC	(None, 16, 16, 16)	7872	activation_128[0][0]
dropout_126 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_75[0][0]
concatenate_119 (Concatenate)	(None, 16, 16, 208)	0	concatenate_118[0][0] dropout_126[0][0]
batch_normalization_129 (BatchN	(None, 16, 16, 208)	832	concatenate_119[0][0]
activation_129 (Activation)	(None, 16, 16, 208)	0	batch_normalization_129[0][0]
separable_conv2d_76 (SeparableC	(None, 16, 16, 16)	3536	activation_129[0][0]
dropout_127 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_76[0][0]
average_pooling2d_9 (AveragePoo	(None, 8, 8, 16)	0	dropout_127[0][0]
batch_normalization_130 (BatchN	(None, 8, 8, 16)	64	average_pooling2d_9[0][0]
activation_130 (Activation)	(None, 8, 8, 16)	0	batch_normalization_130[0][0]
separable_conv2d_77 (SeparableC	(None, 8, 8, 16)	656	activation_130[0][0]
dropout_128 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_77[0][0]
concatenate_120 (Concatenate)	(None, 8, 8, 32)	0	average_pooling2d_9[0][0] dropout_128[0][0]
batch_normalization_131 (BatchN	(None, 8, 8, 32)	128	concatenate_120[0][0]
activation_131 (Activation)	(None, 8, 8, 32)	0	batch_normalization_131[0][0]
separable_conv2d_78 (SeparableC	(None, 8, 8, 16)	1312	activation_131[0][0]
dropout_129 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_78[0][0]
concatenate_121 (Concatenate)	(None, 8, 8, 48)	0	concatenate_120[0][0] dropout_129[0][0]
batch_normalization_132 (BatchN	(None, 8, 8, 48)	192	concatenate_121[0][0]
activation_132 (Activation)	(None, 8, 8, 48)	0	batch_normalization_132[0][0]
separable_conv2d_79 (SeparableC	(None, 8, 8, 16)	1968	activation_132[0][0]
dropout_130 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_79[0][0]
concatenate_122 (Concatenate)	(None, 8, 8, 64)	0	concatenate_121[0][0] dropout_130[0][0]
batch_normalization_133 (BatchN	(None, 8, 8, 64)	256	concatenate_122[0][0]
activation_133 (Activation)	(None, 8, 8, 64)	0	batch_normalization_133[0][0]

separable_conv2d_80 (SeparableC	(None, 8, 8, 16)	2624	activation_133[0][0]
dropout_131 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_80[0][0]
concatenate_123 (Concatenate)	(None, 8, 8, 80)	0	concatenate_122[0][0] dropout_131[0][0]
batch_normalization_134 (BatchN	(None, 8, 8, 80)	320	concatenate_123[0][0]
activation_134 (Activation)	(None, 8, 8, 80)	0	batch_normalization_134[0][0]
separable_conv2d_81 (SeparableC	(None, 8, 8, 16)	3280	activation_134[0][0]
dropout_132 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_81[0][0]
concatenate_124 (Concatenate)	(None, 8, 8, 96)	0	concatenate_123[0][0] dropout_132[0][0]
batch_normalization_135 (BatchN	(None, 8, 8, 96)	384	concatenate_124[0][0]
activation_135 (Activation)	(None, 8, 8, 96)	0	batch_normalization_135[0][0]
separable_conv2d_82 (SeparableC	(None, 8, 8, 16)	3936	activation_135[0][0]
dropout_133 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_82[0][0]
concatenate_125 (Concatenate)	(None, 8, 8, 112)	0	concatenate_124[0][0] dropout_133[0][0]
batch_normalization_136 (BatchN	(None, 8, 8, 112)	448	concatenate_125[0][0]
activation_136 (Activation)	(None, 8, 8, 112)	0	batch_normalization_136[0][0]
separable_conv2d_83 (SeparableC	(None, 8, 8, 16)	4592	activation_136[0][0]
dropout_134 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_83[0][0]
concatenate_126 (Concatenate)	(None, 8, 8, 128)	0	concatenate_125[0][0] dropout_134[0][0]
batch_normalization_137 (BatchN	(None, 8, 8, 128)	512	concatenate_126[0][0]
activation_137 (Activation)	(None, 8, 8, 128)	0	batch_normalization_137[0][0]
separable_conv2d_84 (SeparableC	(None, 8, 8, 16)	5248	activation_137[0][0]
dropout_135 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_84[0][0]
concatenate_127 (Concatenate)	(None, 8, 8, 144)	0	concatenate_126[0][0] dropout_135[0][0]
batch_normalization_138 (BatchN	(None, 8, 8, 144)	576	concatenate_127[0][0]
activation_138 (Activation)	(None, 8, 8, 144)	0	batch_normalization_138[0][0]
separable_conv2d_85 (SeparableC	(None, 8, 8, 16)	5904	activation_138[0][0]
dropout_136 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_85[0][0]
concatenate_128 (Concatenate)	(None, 8, 8, 160)	0	concatenate_127[0][0] dropout_136[0][0]
batch_normalization_139 (BatchN	(None, 8, 8, 160)	640	concatenate_128[0][0]
activation_139 (Activation)	(None, 8, 8, 160)	0	batch_normalization_139[0][0]
separable_conv2d_86 (SeparableC	(None, 8, 8, 16)	6560	activation_139[0][0]
dropout_137 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_86[0][0]
concatenate_129 (Concatenate)	(None, 8, 8, 176)	0	concatenate_128[0][0] dropout_137[0][0]
batch_normalization_140 (BatchN	(None, 8, 8, 176)	704	concatenate_129[0][0]
activation_140 (Activation)	(None, 8, 8, 176)	0	batch_normalization_140[0][0]

separable_conv2d_87 (SeparableC	(None, 8, 8, 16)	7216	activation_140[0][0]
dropout_138 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_87[0][0]
concatenate_130 (Concatenate)	(None, 8, 8, 192)	0	concatenate_129[0][0] dropout_138[0][0]
batch_normalization_141 (BatchN	(None, 8, 8, 192)	768	concatenate_130[0][0]
activation_141 (Activation)	(None, 8, 8, 192)	0	batch_normalization_141[0][0]
separable_conv2d_88 (SeparableC	(None, 8, 8, 16)	7872	activation_141[0][0]
dropout_139 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_88[0][0]
concatenate_131 (Concatenate)	(None, 8, 8, 208)	0	concatenate_130[0][0] dropout_139[0][0]
batch_normalization_142 (BatchN	(None, 8, 8, 208)	832	concatenate_131[0][0]
activation_142 (Activation)	(None, 8, 8, 208)	0	batch_normalization_142[0][0]
separable_conv2d_89 (SeparableC	(None, 8, 8, 16)	3536	activation_142[0][0]
dropout_140 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_89[0][0]
average_pooling2d_10 (AveragePo	(None, 4, 4, 16)	0	dropout_140[0][0]
batch_normalization_143 (BatchN	(None, 4, 4, 16)	64	average_pooling2d_10[0][0]
activation_143 (Activation)	(None, 4, 4, 16)	0	batch_normalization_143[0][0]
separable_conv2d_90 (SeparableC	(None, 4, 4, 16)	656	activation_143[0][0]
dropout_141 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_90[0][0]
concatenate_132 (Concatenate)	(None, 4, 4, 32)	0	average_pooling2d_10[0][0] dropout_141[0][0]
batch_normalization_144 (BatchN	(None, 4, 4, 32)	128	concatenate_132[0][0]
activation_144 (Activation)	(None, 4, 4, 32)	0	batch_normalization_144[0][0]
separable_conv2d_91 (SeparableC	(None, 4, 4, 16)	1312	activation_144[0][0]
dropout_142 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_91[0][0]
concatenate_133 (Concatenate)	(None, 4, 4, 48)	0	concatenate_132[0][0] dropout_142[0][0]
batch_normalization_145 (BatchN	(None, 4, 4, 48)	192	concatenate_133[0][0]
activation_145 (Activation)	(None, 4, 4, 48)	0	batch_normalization_145[0][0]
separable_conv2d_92 (SeparableC	(None, 4, 4, 16)	1968	activation_145[0][0]
dropout_143 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_92[0][0]
concatenate_134 (Concatenate)	(None, 4, 4, 64)	0	concatenate_133[0][0] dropout_143[0][0]
batch_normalization_146 (BatchN	(None, 4, 4, 64)	256	concatenate_134[0][0]
activation_146 (Activation)	(None, 4, 4, 64)	0	batch_normalization_146[0][0]
separable_conv2d_93 (SeparableC	(None, 4, 4, 16)	2624	activation_146[0][0]
dropout_144 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_93[0][0]
concatenate_135 (Concatenate)	(None, 4, 4, 80)	0	concatenate_134[0][0] dropout_144[0][0]
batch_normalization_147 (BatchN	(None, 4, 4, 80)	320	concatenate_135[0][0]
activation_147 (Activation)	(None, 4, 4, 80)	0	batch_normalization_147[0][0]

separable_conv2d_94 (SeparableC	(None, 4, 4, 16)	3280	activation_147[0][0]
dropout_145 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_94[0][0]
concatenate_136 (Concatenate)	(None, 4, 4, 96)	0	concatenate_135[0][0] dropout_145[0][0]
batch_normalization_148 (BatchN	(None, 4, 4, 96)	384	concatenate_136[0][0]
activation_148 (Activation)	(None, 4, 4, 96)	0	batch_normalization_148[0][0]
separable_conv2d_95 (SeparableC	(None, 4, 4, 16)	3936	activation_148[0][0]
dropout_146 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_95[0][0]
concatenate_137 (Concatenate)	(None, 4, 4, 112)	0	concatenate_136[0][0] dropout_146[0][0]
batch_normalization_149 (BatchN	(None, 4, 4, 112)	448	concatenate_137[0][0]
activation_149 (Activation)	(None, 4, 4, 112)	0	batch_normalization_149[0][0]
separable_conv2d_96 (SeparableC	(None, 4, 4, 16)	4592	activation_149[0][0]
dropout_147 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_96[0][0]
concatenate_138 (Concatenate)	(None, 4, 4, 128)	0	concatenate_137[0][0] dropout_147[0][0]
batch_normalization_150 (BatchN	(None, 4, 4, 128)	512	concatenate_138[0][0]
activation_150 (Activation)	(None, 4, 4, 128)	0	batch_normalization_150[0][0]
separable_conv2d_97 (SeparableC	(None, 4, 4, 16)	5248	activation_150[0][0]
dropout_148 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_97[0][0]
concatenate_139 (Concatenate)	(None, 4, 4, 144)	0	concatenate_138[0][0] dropout_148[0][0]
batch_normalization_151 (BatchN	(None, 4, 4, 144)	576	concatenate_139[0][0]
activation_151 (Activation)	(None, 4, 4, 144)	0	batch_normalization_151[0][0]
separable_conv2d_98 (SeparableC	(None, 4, 4, 16)	5904	activation_151[0][0]
dropout_149 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_98[0][0]
concatenate_140 (Concatenate)	(None, 4, 4, 160)	0	concatenate_139[0][0] dropout_149[0][0]
batch_normalization_152 (BatchN	(None, 4, 4, 160)	640	concatenate_140[0][0]
activation_152 (Activation)	(None, 4, 4, 160)	0	batch_normalization_152[0][0]
separable_conv2d_99 (SeparableC	(None, 4, 4, 16)	6560	activation_152[0][0]
dropout_150 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_99[0][0]
concatenate_141 (Concatenate)	(None, 4, 4, 176)	0	concatenate_140[0][0] dropout_150[0][0]
batch_normalization_153 (BatchN	(None, 4, 4, 176)	704	concatenate_141[0][0]
activation_153 (Activation)	(None, 4, 4, 176)	0	batch_normalization_153[0][0]
separable_conv2d_100 (Separable	(None, 4, 4, 16)	7216	activation_153[0][0]
dropout_151 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_100[0][0]
concatenate_142 (Concatenate)	(None, 4, 4, 192)	0	concatenate_141[0][0] dropout_151[0][0]
batch_normalization_154 (BatchN	(None, 4, 4, 192)	768	concatenate_142[0][0]
activation_154 (Activation)	(None, 4, 4, 192)	0	batch_normalization_154[0][0]

```
separable_conv2d_101 (Separable (None, 4, 4, 16)      7872        activation_154[0][0]
_____
dropout_152 (Dropout)           (None, 4, 4, 16)      0           separable_conv2d_101[0][0]
_____
concatenate_143 (Concatenate)   (None, 4, 4, 208)     0           concatenate_142[0][0]
                                                                  dropout_152[0][0]
_____
batch_normalization_155 (BatchN (None, 4, 4, 208)     832         concatenate_143[0][0]
_____
activation_155 (Activation)     (None, 4, 4, 208)     0           batch_normalization_155[0][0]
_____
average_pooling2d_11 (AveragePo (None, 2, 2, 208)     0           activation_155[0][0]
_____
flatten_2 (Flatten)             (None, 832)           0           average_pooling2d_11[0][0]
_____
dense_2 (Dense)                 (None, 10)            8330        flatten_2[0][0]
=======================================================================================
Total params: 258,282
Trainable params: 246,218
Non-trainable params: 12,064
```
_____

In [54]:

```python
model_3.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])

from tensorflow.keras.callbacks import ModelCheckpoint, EarlyStopping, ReduceLROnPlateau
patience = 50
base_path = '/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/'
checkpoint_file_name = base_path + 'CIFAR_model3' + '_{epoch:02d}-{val_accuracy:.2f}.hdf5'

model_checkpoint = ModelCheckpoint(checkpoint_file_name, monitor='val_accuracy', verbose=1, save_be
st_only=True)
early_stop = EarlyStopping('val_accuracy', mode='max', patience = patience)
reduce_LR = ReduceLROnPlateau(monitor='val_accuracy', mode='max', factor=0.1, patience=int(patience
/3), verbose=1)

callbacks = [model_checkpoint, early_stop, reduce_LR]

epochs = 300
batch_size = 256

#https://keras.io/api/preprocessing/image/#flow-method

history_3 = model_3.fit(data_generator.flow(X_train, y_train, batch_size),
                    steps_per_epoch = int(len(X_train)/batch_size),
                    epochs = epochs,
                    callbacks = callbacks,
                    validation_data = (X_test, y_test), verbose=1)
```

```
WARNING:tensorflow:sample_weight modes were coerced from
  ...
    to
  ['...']
Train for 195 steps, validate on 10000 samples
Epoch 1/300
194/195 [============================>.] - ETA: 0s - loss: 1.6785 - accuracy: 0.3742
Epoch 00001: val_accuracy improved from -inf to 0.10000, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_01-0.10.hdf5
195/195 [=============================] - 41s 208ms/step - loss: 1.6764 - accuracy: 0.3745 - val_
loss: 2.3508 - val_accuracy: 0.1000
Epoch 2/300
194/195 [============================>.] - ETA: 0s - loss: 1.3361 - accuracy: 0.5122
Epoch 00002: val_accuracy improved from 0.10000 to 0.13040, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_02-0.13.hdf5
195/195 [=============================] - 28s 145ms/step - loss: 1.3360 - accuracy: 0.5123 - val_
loss: 2.6361 - val_accuracy: 0.1304
Epoch 3/300
194/195 [============================>.] - ETA: 0s - loss: 1.1621 - accuracy: 0.5800
Epoch 00003: val_accuracy improved from 0.13040 to 0.54500, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_03-0.55.hdf5
195/195 [=============================] - 28s 145ms/step - loss: 1.1613 - accuracy: 0.5804 - val_
loss: 1.3663 - val_accuracy: 0.5450
Epoch 4/300
194/195 [============================>.] - ETA: 0s - loss: 1.0322 - accuracy: 0.6288
```

```
Epoch 00004: val_accuracy did not improve from 0.54500
195/195 [==============================] - 28s 142ms/step - loss: 1.0319 - accuracy: 0.6293 - val_
loss: 1.7844 - val_accuracy: 0.5219
Epoch 5/300
194/195 [=============================>.] - ETA: 0s - loss: 0.9398 - accuracy: 0.6622
Epoch 00005: val_accuracy improved from 0.54500 to 0.59910, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_05-0.60.hdf5
195/195 [==============================] - 28s 145ms/step - loss: 0.9401 - accuracy: 0.6621 - val_
loss: 1.2854 - val_accuracy: 0.5991
Epoch 6/300
194/195 [=============================>.] - ETA: 0s - loss: 0.8755 - accuracy: 0.6872
Epoch 00006: val_accuracy did not improve from 0.59910
195/195 [==============================] - 28s 142ms/step - loss: 0.8745 - accuracy: 0.6874 - val_
loss: 1.6606 - val_accuracy: 0.5682
Epoch 7/300
194/195 [=============================>.] - ETA: 0s - loss: 0.8165 - accuracy: 0.7100
Epoch 00007: val_accuracy improved from 0.59910 to 0.64520, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_07-0.65.hdf5
195/195 [==============================] - 28s 146ms/step - loss: 0.8160 - accuracy: 0.7102 - val_
loss: 1.2518 - val_accuracy: 0.6452
Epoch 8/300
194/195 [=============================>.] - ETA: 0s - loss: 0.7745 - accuracy: 0.7274
Epoch 00008: val_accuracy improved from 0.64520 to 0.67210, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_08-0.67.hdf5
195/195 [==============================] - 28s 145ms/step - loss: 0.7748 - accuracy: 0.7274 - val_
loss: 1.1228 - val_accuracy: 0.6721
Epoch 9/300
194/195 [=============================>.] - ETA: 0s - loss: 0.7389 - accuracy: 0.7384
Epoch 00009: val_accuracy did not improve from 0.67210
195/195 [==============================] - 28s 142ms/step - loss: 0.7385 - accuracy: 0.7386 - val_
loss: 1.2116 - val_accuracy: 0.6537
Epoch 10/300
194/195 [=============================>.] - ETA: 0s - loss: 0.7091 - accuracy: 0.7485
Epoch 00010: val_accuracy did not improve from 0.67210
195/195 [==============================] - 28s 142ms/step - loss: 0.7087 - accuracy: 0.7486 - val_
loss: 1.6817 - val_accuracy: 0.5975
Epoch 11/300
194/195 [=============================>.] - ETA: 0s - loss: 0.6844 - accuracy: 0.7588
Epoch 00011: val_accuracy improved from 0.67210 to 0.71550, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_11-0.72.hdf5
195/195 [==============================] - 28s 145ms/step - loss: 0.6845 - accuracy: 0.7588 - val_
loss: 0.9364 - val_accuracy: 0.7155
Epoch 12/300
194/195 [=============================>.] - ETA: 0s - loss: 0.6538 - accuracy: 0.7710
Epoch 00012: val_accuracy did not improve from 0.71550
195/195 [==============================] - 28s 142ms/step - loss: 0.6535 - accuracy: 0.7712 - val_
loss: 1.4434 - val_accuracy: 0.6396
Epoch 13/300
194/195 [=============================>.] - ETA: 0s - loss: 0.6384 - accuracy: 0.7773
Epoch 00013: val_accuracy did not improve from 0.71550
195/195 [==============================] - 28s 142ms/step - loss: 0.6383 - accuracy: 0.7775 - val_
loss: 1.2199 - val_accuracy: 0.6821
Epoch 14/300
194/195 [=============================>.] - ETA: 0s - loss: 0.6177 - accuracy: 0.7850
Epoch 00014: val_accuracy did not improve from 0.71550
195/195 [==============================] - 28s 142ms/step - loss: 0.6181 - accuracy: 0.7849 - val_
loss: 1.4715 - val_accuracy: 0.6352
Epoch 15/300
194/195 [=============================>.] - ETA: 0s - loss: 0.5979 - accuracy: 0.7906
Epoch 00015: val_accuracy did not improve from 0.71550
195/195 [==============================] - 28s 142ms/step - loss: 0.5980 - accuracy: 0.7905 - val_
loss: 1.2906 - val_accuracy: 0.6463
Epoch 16/300
194/195 [=============================>.] - ETA: 0s - loss: 0.5799 - accuracy: 0.7985
Epoch 00016: val_accuracy improved from 0.71550 to 0.72990, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_16-0.73.hdf5
195/195 [==============================] - 28s 146ms/step - loss: 0.5801 - accuracy: 0.7983 - val_
loss: 0.9909 - val_accuracy: 0.7299
Epoch 17/300
194/195 [=============================>.] - ETA: 0s - loss: 0.5756 - accuracy: 0.8000
Epoch 00017: val_accuracy improved from 0.72990 to 0.75800, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_17-0.76.hdf5
195/195 [==============================] - 28s 145ms/step - loss: 0.5755 - accuracy: 0.8001 - val_
loss: 0.8110 - val_accuracy: 0.7580
Epoch 18/300
194/195 [=============================>.] - ETA: 0s - loss: 0.5569 - accuracy: 0.8053
Epoch 00018: val_accuracy did not improve from 0.75800
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195/195 [==============================] - 28s 142ms/step - loss: 0.5567 - accuracy: 0.8054 - val_
loss: 1.0143 - val_accuracy: 0.7238
Epoch 19/300
194/195 [============================>.] - ETA: 0s - loss: 0.5450 - accuracy: 0.8104
Epoch 00019: val_accuracy improved from 0.75800 to 0.78400, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_19-0.78.hdf5
195/195 [==============================] - 28s 146ms/step - loss: 0.5454 - accuracy: 0.8102 - val_
loss: 0.7006 - val_accuracy: 0.7840
Epoch 20/300
194/195 [============================>.] - ETA: 0s - loss: 0.5347 - accuracy: 0.8134
Epoch 00020: val_accuracy did not improve from 0.78400
195/195 [==============================] - 28s 142ms/step - loss: 0.5345 - accuracy: 0.8134 - val_
loss: 0.8453 - val_accuracy: 0.7636
Epoch 21/300
194/195 [============================>.] - ETA: 0s - loss: 0.5244 - accuracy: 0.8169
Epoch 00021: val_accuracy did not improve from 0.78400
195/195 [==============================] - 28s 142ms/step - loss: 0.5242 - accuracy: 0.8170 - val_
loss: 1.2476 - val_accuracy: 0.6963
Epoch 22/300
194/195 [============================>.] - ETA: 0s - loss: 0.5153 - accuracy: 0.8187
Epoch 00022: val_accuracy did not improve from 0.78400
195/195 [==============================] - 28s 142ms/step - loss: 0.5154 - accuracy: 0.8187 - val_
loss: 0.7055 - val_accuracy: 0.7833
Epoch 23/300
194/195 [============================>.] - ETA: 0s - loss: 0.5022 - accuracy: 0.8246
Epoch 00023: val_accuracy did not improve from 0.78400
195/195 [==============================] - 28s 142ms/step - loss: 0.5024 - accuracy: 0.8245 - val_
loss: 0.9178 - val_accuracy: 0.7420
Epoch 24/300
194/195 [============================>.] - ETA: 0s - loss: 0.4994 - accuracy: 0.8256
Epoch 00024: val_accuracy did not improve from 0.78400
195/195 [==============================] - 28s 142ms/step - loss: 0.4993 - accuracy: 0.8256 - val_
loss: 0.8734 - val_accuracy: 0.7555
Epoch 25/300
194/195 [============================>.] - ETA: 0s - loss: 0.4891 - accuracy: 0.8278
Epoch 00025: val_accuracy did not improve from 0.78400
195/195 [==============================] - 28s 142ms/step - loss: 0.4895 - accuracy: 0.8276 - val_
loss: 1.1021 - val_accuracy: 0.7249
Epoch 26/300
194/195 [============================>.] - ETA: 0s - loss: 0.4821 - accuracy: 0.8319
Epoch 00026: val_accuracy did not improve from 0.78400
195/195 [==============================] - 28s 142ms/step - loss: 0.4822 - accuracy: 0.8319 - val_
loss: 0.7443 - val_accuracy: 0.7774
Epoch 27/300
194/195 [============================>.] - ETA: 0s - loss: 0.4708 - accuracy: 0.8359
Epoch 00027: val_accuracy did not improve from 0.78400
195/195 [==============================] - 28s 142ms/step - loss: 0.4706 - accuracy: 0.8361 - val_
loss: 0.8986 - val_accuracy: 0.7506
Epoch 28/300
194/195 [============================>.] - ETA: 0s - loss: 0.4754 - accuracy: 0.8355
Epoch 00028: val_accuracy did not improve from 0.78400
195/195 [==============================] - 28s 142ms/step - loss: 0.4756 - accuracy: 0.8353 - val_
loss: 0.7706 - val_accuracy: 0.7776
Epoch 29/300
194/195 [============================>.] - ETA: 0s - loss: 0.4600 - accuracy: 0.8393
Epoch 00029: val_accuracy improved from 0.78400 to 0.80120, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_29-0.80.hdf5
195/195 [==============================] - 28s 146ms/step - loss: 0.4601 - accuracy: 0.8394 - val_
loss: 0.6982 - val_accuracy: 0.8012
Epoch 30/300
194/195 [============================>.] - ETA: 0s - loss: 0.4511 - accuracy: 0.8430
Epoch 00030: val_accuracy did not improve from 0.80120
195/195 [==============================] - 28s 142ms/step - loss: 0.4511 - accuracy: 0.8428 - val_
loss: 1.0080 - val_accuracy: 0.7376
Epoch 31/300
194/195 [============================>.] - ETA: 0s - loss: 0.4443 - accuracy: 0.8438
Epoch 00031: val_accuracy improved from 0.80120 to 0.81090, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_31-0.81.hdf5
195/195 [==============================] - 28s 146ms/step - loss: 0.4442 - accuracy: 0.8439 - val_
loss: 0.6098 - val_accuracy: 0.8109
Epoch 32/300
194/195 [============================>.] - ETA: 0s - loss: 0.4417 - accuracy: 0.8466
Epoch 00032: val_accuracy did not improve from 0.81090
195/195 [==============================] - 28s 142ms/step - loss: 0.4417 - accuracy: 0.8467 - val_
loss: 0.7732 - val_accuracy: 0.7825
Epoch 33/300
194/195 [============================>.] - ETA: 0s - loss: 0.4375 - accuracy: 0.8479
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Epoch 00033: val_accuracy did not improve from 0.81090
195/195 [==============================] - 28s 142ms/step - loss: 0.4371 - accuracy: 0.8480 - val_
loss: 0.8289 - val_accuracy: 0.7722
Epoch 34/300
194/195 [==============================>.] - ETA: 0s - loss: 0.4349 - accuracy: 0.8495
Epoch 00034: val_accuracy did not improve from 0.81090
195/195 [==============================] - 28s 142ms/step - loss: 0.4346 - accuracy: 0.8496 - val_
loss: 0.7130 - val_accuracy: 0.7963
Epoch 35/300
194/195 [==============================>.] - ETA: 0s - loss: 0.4251 - accuracy: 0.8524
Epoch 00035: val_accuracy did not improve from 0.81090
195/195 [==============================] - 28s 142ms/step - loss: 0.4256 - accuracy: 0.8523 - val_
loss: 0.7658 - val_accuracy: 0.7869
Epoch 36/300
194/195 [==============================>.] - ETA: 0s - loss: 0.4234 - accuracy: 0.8526
Epoch 00036: val_accuracy did not improve from 0.81090
195/195 [==============================] - 28s 142ms/step - loss: 0.4230 - accuracy: 0.8528 - val_
loss: 0.9025 - val_accuracy: 0.7674
Epoch 37/300
194/195 [==============================>.] - ETA: 0s - loss: 0.4136 - accuracy: 0.8553
Epoch 00037: val_accuracy did not improve from 0.81090
195/195 [==============================] - 28s 142ms/step - loss: 0.4136 - accuracy: 0.8552 - val_
loss: 0.6681 - val_accuracy: 0.8063
Epoch 38/300
194/195 [==============================>.] - ETA: 0s - loss: 0.4137 - accuracy: 0.8573
Epoch 00038: val_accuracy did not improve from 0.81090
195/195 [==============================] - 28s 142ms/step - loss: 0.4138 - accuracy: 0.8572 - val_
loss: 0.8125 - val_accuracy: 0.7778
Epoch 39/300
194/195 [==============================>.] - ETA: 0s - loss: 0.4021 - accuracy: 0.8593
Epoch 00039: val_accuracy did not improve from 0.81090
195/195 [==============================] - 28s 142ms/step - loss: 0.4022 - accuracy: 0.8592 - val_
loss: 0.9117 - val_accuracy: 0.7663
Epoch 40/300
194/195 [==============================>.] - ETA: 0s - loss: 0.4021 - accuracy: 0.8583
Epoch 00040: val_accuracy improved from 0.81090 to 0.84530, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_40-0.85.hdf5
195/195 [==============================] - 28s 146ms/step - loss: 0.4023 - accuracy: 0.8583 - val_
loss: 0.5169 - val_accuracy: 0.8453
Epoch 41/300
194/195 [==============================>.] - ETA: 0s - loss: 0.3989 - accuracy: 0.8601
Epoch 00041: val_accuracy did not improve from 0.84530
195/195 [==============================] - 28s 142ms/step - loss: 0.3986 - accuracy: 0.8603 - val_
loss: 0.7346 - val_accuracy: 0.7989
Epoch 42/300
194/195 [==============================>.] - ETA: 0s - loss: 0.3965 - accuracy: 0.8604
Epoch 00042: val_accuracy did not improve from 0.84530
195/195 [==============================] - 28s 142ms/step - loss: 0.3971 - accuracy: 0.8601 - val_
loss: 0.7958 - val_accuracy: 0.7897
Epoch 43/300
194/195 [==============================>.] - ETA: 0s - loss: 0.3900 - accuracy: 0.8652
Epoch 00043: val_accuracy did not improve from 0.84530
195/195 [==============================] - 28s 142ms/step - loss: 0.3899 - accuracy: 0.8653 - val_
loss: 0.7988 - val_accuracy: 0.7866
Epoch 44/300
194/195 [==============================>.] - ETA: 0s - loss: 0.3837 - accuracy: 0.8646
Epoch 00044: val_accuracy did not improve from 0.84530
195/195 [==============================] - 28s 142ms/step - loss: 0.3836 - accuracy: 0.8646 - val_
loss: 0.8270 - val_accuracy: 0.7836
Epoch 45/300
194/195 [==============================>.] - ETA: 0s - loss: 0.3881 - accuracy: 0.8646
Epoch 00045: val_accuracy did not improve from 0.84530
195/195 [==============================] - 28s 142ms/step - loss: 0.3878 - accuracy: 0.8646 - val_
loss: 1.0867 - val_accuracy: 0.7382
Epoch 46/300
194/195 [==============================>.] - ETA: 0s - loss: 0.3794 - accuracy: 0.8677
Epoch 00046: val_accuracy did not improve from 0.84530
195/195 [==============================] - 28s 142ms/step - loss: 0.3794 - accuracy: 0.8677 - val_
loss: 0.6583 - val_accuracy: 0.8115
Epoch 47/300
194/195 [==============================>.] - ETA: 0s - loss: 0.3724 - accuracy: 0.8705
Epoch 00047: val_accuracy did not improve from 0.84530
195/195 [==============================] - 28s 142ms/step - loss: 0.3722 - accuracy: 0.8706 - val_
loss: 0.6326 - val_accuracy: 0.8270
Epoch 48/300
194/195 [==============================>.] - ETA: 0s - loss: 0.3743 - accuracy: 0.8688
Epoch 00048: val_accuracy did not improve from 0.84530
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195/195 [==============================] - 28s 142ms/step - loss: 0.3745 - accuracy: 0.8687 - val_
loss: 0.7164 - val_accuracy: 0.8055
Epoch 49/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3685 - accuracy: 0.8697
Epoch 00049: val_accuracy did not improve from 0.84530
195/195 [==============================] - 28s 142ms/step - loss: 0.3683 - accuracy: 0.8699 - val_
loss: 0.5649 - val_accuracy: 0.8385
Epoch 50/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3636 - accuracy: 0.8741
Epoch 00050: val_accuracy did not improve from 0.84530
195/195 [==============================] - 28s 142ms/step - loss: 0.3638 - accuracy: 0.8739 - val_
loss: 0.6285 - val_accuracy: 0.8294
Epoch 51/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3600 - accuracy: 0.8742
Epoch 00051: val_accuracy did not improve from 0.84530
195/195 [==============================] - 28s 142ms/step - loss: 0.3603 - accuracy: 0.8741 - val_
loss: 0.8583 - val_accuracy: 0.7843
Epoch 52/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3578 - accuracy: 0.8742
Epoch 00052: val_accuracy did not improve from 0.84530
195/195 [==============================] - 28s 142ms/step - loss: 0.3581 - accuracy: 0.8742 - val_
loss: 0.7306 - val_accuracy: 0.8084
Epoch 53/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3515 - accuracy: 0.8762
Epoch 00053: val_accuracy did not improve from 0.84530
195/195 [==============================] - 28s 142ms/step - loss: 0.3517 - accuracy: 0.8761 - val_
loss: 0.6683 - val_accuracy: 0.8223
Epoch 54/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3529 - accuracy: 0.8762
Epoch 00054: val_accuracy did not improve from 0.84530
195/195 [==============================] - 28s 142ms/step - loss: 0.3527 - accuracy: 0.8762 - val_
loss: 0.6907 - val_accuracy: 0.8068
Epoch 55/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3511 - accuracy: 0.8764
Epoch 00055: val_accuracy did not improve from 0.84530
195/195 [==============================] - 28s 142ms/step - loss: 0.3508 - accuracy: 0.8765 - val_
loss: 0.8694 - val_accuracy: 0.7840
Epoch 56/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3438 - accuracy: 0.8799
Epoch 00056: val_accuracy did not improve from 0.84530
195/195 [==============================] - 28s 142ms/step - loss: 0.3436 - accuracy: 0.8800 - val_
loss: 0.8278 - val_accuracy: 0.7906
Epoch 57/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3016 - accuracy: 0.8932
Epoch 00057: val_accuracy improved from 0.84530 to 0.85590, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_57-0.86.hdf5
195/195 [==============================] - 28s 145ms/step - loss: 0.3015 - accuracy: 0.8933 - val_
loss: 0.5141 - val_accuracy: 0.8559
Epoch 58/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2892 - accuracy: 0.8981
Epoch 00058: val_accuracy did not improve from 0.85590
195/195 [==============================] - 28s 142ms/step - loss: 0.2890 - accuracy: 0.8982 - val_
loss: 0.5282 - val_accuracy: 0.8504
Epoch 59/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2818 - accuracy: 0.9017
Epoch 00059: val_accuracy improved from 0.85590 to 0.85790, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_59-0.86.hdf5
195/195 [==============================] - 28s 145ms/step - loss: 0.2822 - accuracy: 0.9014 - val_
loss: 0.5006 - val_accuracy: 0.8579
Epoch 60/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2814 - accuracy: 0.9005
Epoch 00060: val_accuracy did not improve from 0.85790
195/195 [==============================] - 28s 142ms/step - loss: 0.2814 - accuracy: 0.9006 - val_
loss: 0.5421 - val_accuracy: 0.8481
Epoch 61/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2794 - accuracy: 0.9006
Epoch 00061: val_accuracy did not improve from 0.85790
195/195 [==============================] - 28s 142ms/step - loss: 0.2792 - accuracy: 0.9007 - val_
loss: 0.5408 - val_accuracy: 0.8508
Epoch 62/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2739 - accuracy: 0.9040
Epoch 00062: val_accuracy did not improve from 0.85790
195/195 [==============================] - 28s 142ms/step - loss: 0.2739 - accuracy: 0.9039 - val_
loss: 0.5336 - val_accuracy: 0.8522
Epoch 63/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2726 - accuracy: 0.9040
Epoch 00063: val_accuracy improved from 0.85790 to 0.86340, saving model to
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/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_63-0.86.hdf5
195/195 [==============================] - 28s 145ms/step - loss: 0.2727 - accuracy: 0.9039 - val_
loss: 0.4907 - val_accuracy: 0.8634
Epoch 64/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2733 - accuracy: 0.9046
Epoch 00064: val_accuracy did not improve from 0.86340
195/195 [==============================] - 28s 142ms/step - loss: 0.2732 - accuracy: 0.9046 - val_
loss: 0.5027 - val_accuracy: 0.8614
Epoch 65/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2686 - accuracy: 0.9054
Epoch 00065: val_accuracy did not improve from 0.86340
195/195 [==============================] - 28s 142ms/step - loss: 0.2686 - accuracy: 0.9055 - val_
loss: 0.5090 - val_accuracy: 0.8563
Epoch 66/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2699 - accuracy: 0.9052
Epoch 00066: val_accuracy did not improve from 0.86340
195/195 [==============================] - 28s 142ms/step - loss: 0.2699 - accuracy: 0.9052 - val_
loss: 0.5374 - val_accuracy: 0.8527
Epoch 67/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2657 - accuracy: 0.9074
Epoch 00067: val_accuracy did not improve from 0.86340
195/195 [==============================] - 28s 142ms/step - loss: 0.2658 - accuracy: 0.9074 - val_
loss: 0.5612 - val_accuracy: 0.8500
Epoch 68/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2683 - accuracy: 0.9056
Epoch 00068: val_accuracy did not improve from 0.86340
195/195 [==============================] - 28s 142ms/step - loss: 0.2682 - accuracy: 0.9056 - val_
loss: 0.5471 - val_accuracy: 0.8542
Epoch 69/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2657 - accuracy: 0.9060
Epoch 00069: val_accuracy did not improve from 0.86340
195/195 [==============================] - 28s 142ms/step - loss: 0.2656 - accuracy: 0.9060 - val_
loss: 0.4954 - val_accuracy: 0.8631
Epoch 70/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2658 - accuracy: 0.9046
Epoch 00070: val_accuracy improved from 0.86340 to 0.86810, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_70-0.87.hdf5
195/195 [==============================] - 28s 145ms/step - loss: 0.2663 - accuracy: 0.9045 - val_
loss: 0.4829 - val_accuracy: 0.8681
Epoch 71/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2643 - accuracy: 0.9067
Epoch 00071: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2640 - accuracy: 0.9069 - val_
loss: 0.4899 - val_accuracy: 0.8635
Epoch 72/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2650 - accuracy: 0.9073
Epoch 00072: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2653 - accuracy: 0.9072 - val_
loss: 0.5181 - val_accuracy: 0.8581
Epoch 73/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2616 - accuracy: 0.9079
Epoch 00073: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2617 - accuracy: 0.9078 - val_
loss: 0.5228 - val_accuracy: 0.8574
Epoch 74/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2562 - accuracy: 0.9111
Epoch 00074: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2567 - accuracy: 0.9108 - val_
loss: 0.5139 - val_accuracy: 0.8611
Epoch 75/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2587 - accuracy: 0.9086
Epoch 00075: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2588 - accuracy: 0.9086 - val_
loss: 0.5706 - val_accuracy: 0.8453
Epoch 76/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2561 - accuracy: 0.9096
Epoch 00076: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2559 - accuracy: 0.9097 - val_
loss: 0.5191 - val_accuracy: 0.8594
Epoch 77/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2613 - accuracy: 0.9065
Epoch 00077: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2615 - accuracy: 0.9064 - val_
loss: 0.4882 - val_accuracy: 0.8658
Epoch 78/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2567 - accuracy: 0.9107
Epoch 00078: val_accuracy did not improve from 0.86810
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195/195 [==============================] - 28s 142ms/step - loss: 0.2567 - accuracy: 0.9107 - val_
loss: 0.5592 - val_accuracy: 0.8509
Epoch 79/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2566 - accuracy: 0.9111
Epoch 00079: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2562 - accuracy: 0.9112 - val_
loss: 0.5144 - val_accuracy: 0.8605
Epoch 80/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2532 - accuracy: 0.9104
Epoch 00080: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2529 - accuracy: 0.9106 - val_
loss: 0.4895 - val_accuracy: 0.8679
Epoch 81/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2556 - accuracy: 0.9099
Epoch 00081: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2556 - accuracy: 0.9099 - val_
loss: 0.4984 - val_accuracy: 0.8678
Epoch 82/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2567 - accuracy: 0.9098
Epoch 00082: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2564 - accuracy: 0.9099 - val_
loss: 0.5619 - val_accuracy: 0.8555
Epoch 83/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2532 - accuracy: 0.9116
Epoch 00083: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2535 - accuracy: 0.9115 - val_
loss: 0.5114 - val_accuracy: 0.8643
Epoch 84/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2533 - accuracy: 0.9100
Epoch 00084: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2530 - accuracy: 0.9102 - val_
loss: 0.5042 - val_accuracy: 0.8651
Epoch 85/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2532 - accuracy: 0.9111
Epoch 00085: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2536 - accuracy: 0.9109 - val_
loss: 0.5573 - val_accuracy: 0.8531
Epoch 86/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2545 - accuracy: 0.9097
Epoch 00086: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2547 - accuracy: 0.9096 - val_
loss: 0.5333 - val_accuracy: 0.8605
Epoch 87/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2463 - accuracy: 0.9124
Epoch 00087: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2462 - accuracy: 0.9125 - val_
loss: 0.5121 - val_accuracy: 0.8645
Epoch 88/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2469 - accuracy: 0.9134
Epoch 00088: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2470 - accuracy: 0.9134 - val_
loss: 0.5187 - val_accuracy: 0.8627
Epoch 89/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2499 - accuracy: 0.9106
Epoch 00089: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2499 - accuracy: 0.9107 - val_
loss: 0.5168 - val_accuracy: 0.8628
Epoch 90/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2448 - accuracy: 0.9122
Epoch 00090: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2446 - accuracy: 0.9123 - val_
loss: 0.5122 - val_accuracy: 0.8639
Epoch 91/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2454 - accuracy: 0.9127
Epoch 00091: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2454 - accuracy: 0.9127 - val_
loss: 0.5102 - val_accuracy: 0.8649
Epoch 92/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2440 - accuracy: 0.9139
Epoch 00092: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2439 - accuracy: 0.9140 - val_
loss: 0.5104 - val_accuracy: 0.8641
Epoch 93/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2465 - accuracy: 0.9126
Epoch 00093: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2467 - accuracy: 0.9125 - val_
loss: 0.5185 - val accuracy: 0.8630
```

```
loss: 0.0100 val_accuracy: 0.8888
Epoch 94/300
194/195 [============================>.] - ETA: 0s - loss: 0.2477 - accuracy: 0.9114
Epoch 00094: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 143ms/step - loss: 0.2476 - accuracy: 0.9114 - val_
loss: 0.5174 - val_accuracy: 0.8647
Epoch 95/300
194/195 [============================>.] - ETA: 0s - loss: 0.2485 - accuracy: 0.9130
Epoch 00095: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2485 - accuracy: 0.9130 - val_
loss: 0.5254 - val_accuracy: 0.8620
Epoch 96/300
194/195 [============================>.] - ETA: 0s - loss: 0.2460 - accuracy: 0.9128
Epoch 00096: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2460 - accuracy: 0.9127 - val_
loss: 0.5124 - val_accuracy: 0.8654
Epoch 97/300
194/195 [============================>.] - ETA: 0s - loss: 0.2454 - accuracy: 0.9134
Epoch 00097: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2454 - accuracy: 0.9134 - val_
loss: 0.5062 - val_accuracy: 0.8655
Epoch 98/300
194/195 [============================>.] - ETA: 0s - loss: 0.2442 - accuracy: 0.9128
Epoch 00098: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2441 - accuracy: 0.9128 - val_
loss: 0.5155 - val_accuracy: 0.8645
Epoch 99/300
194/195 [============================>.] - ETA: 0s - loss: 0.2392 - accuracy: 0.9147
Epoch 00099: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2394 - accuracy: 0.9147 - val_
loss: 0.5068 - val_accuracy: 0.8655
Epoch 100/300
194/195 [============================>.] - ETA: 0s - loss: 0.2443 - accuracy: 0.9137
Epoch 00100: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2445 - accuracy: 0.9137 - val_
loss: 0.5099 - val_accuracy: 0.8650
Epoch 101/300
194/195 [============================>.] - ETA: 0s - loss: 0.2448 - accuracy: 0.9136
Epoch 00101: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2448 - accuracy: 0.9135 - val_
loss: 0.5109 - val_accuracy: 0.8643
Epoch 102/300
194/195 [============================>.] - ETA: 0s - loss: 0.2467 - accuracy: 0.9120
Epoch 00102: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2467 - accuracy: 0.9119 - val_
loss: 0.5141 - val_accuracy: 0.8636
Epoch 103/300
194/195 [============================>.] - ETA: 0s - loss: 0.2415 - accuracy: 0.9145
Epoch 00103: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2416 - accuracy: 0.9145 - val_
loss: 0.5122 - val_accuracy: 0.8637
Epoch 104/300
194/195 [============================>.] - ETA: 0s - loss: 0.2450 - accuracy: 0.9127
Epoch 00104: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2452 - accuracy: 0.9127 - val_
loss: 0.5127 - val_accuracy: 0.8637
Epoch 105/300
194/195 [============================>.] - ETA: 0s - loss: 0.2438 - accuracy: 0.9144
Epoch 00105: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2435 - accuracy: 0.9144 - val_
loss: 0.5129 - val_accuracy: 0.8636
Epoch 106/300
194/195 [============================>.] - ETA: 0s - loss: 0.2473 - accuracy: 0.9123
Epoch 00106: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2472 - accuracy: 0.9123 - val_
loss: 0.5113 - val_accuracy: 0.8641
Epoch 107/300
194/195 [============================>.] - ETA: 0s - loss: 0.2412 - accuracy: 0.9147
Epoch 00107: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2412 - accuracy: 0.9147 - val_
loss: 0.5136 - val_accuracy: 0.8635
Epoch 108/300
194/195 [============================>.] - ETA: 0s - loss: 0.2461 - accuracy: 0.9138
Epoch 00108: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2453 - accuracy: 0.9139 - val_
loss: 0.5126 - val_accuracy: 0.8637
Epoch 109/300
194/195 [============================>.] - ETA: 0s - loss: 0.2437 - accuracy: 0.9148
```

```
Epoch 00109: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2435 - accuracy: 0.9148 - val_
loss: 0.5131 - val_accuracy: 0.8638
Epoch 110/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2428 - accuracy: 0.9140
Epoch 00110: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2427 - accuracy: 0.9140 - val_
loss: 0.5118 - val_accuracy: 0.8638
Epoch 111/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2440 - accuracy: 0.9140
Epoch 00111: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2442 - accuracy: 0.9140 - val_
loss: 0.5127 - val_accuracy: 0.8638
Epoch 112/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2459 - accuracy: 0.9122
Epoch 00112: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2460 - accuracy: 0.9121 - val_
loss: 0.5135 - val_accuracy: 0.8633
Epoch 113/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2430 - accuracy: 0.9147
Epoch 00113: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2429 - accuracy: 0.9148 - val_
loss: 0.5138 - val_accuracy: 0.8636
Epoch 114/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2464 - accuracy: 0.9145
Epoch 00114: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2462 - accuracy: 0.9145 - val_
loss: 0.5128 - val_accuracy: 0.8638
Epoch 115/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2433 - accuracy: 0.9149
Epoch 00115: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2433 - accuracy: 0.9149 - val_
loss: 0.5123 - val_accuracy: 0.8640
Epoch 116/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2432 - accuracy: 0.9134
Epoch 00116: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2430 - accuracy: 0.9134 - val_
loss: 0.5144 - val_accuracy: 0.8631
Epoch 117/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2433 - accuracy: 0.9130
Epoch 00117: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2432 - accuracy: 0.9130 - val_
loss: 0.5135 - val_accuracy: 0.8640
Epoch 118/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2467 - accuracy: 0.9131
Epoch 00118: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 143ms/step - loss: 0.2466 - accuracy: 0.9131 - val_
loss: 0.5135 - val_accuracy: 0.8638
Epoch 119/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2416 - accuracy: 0.9146
Epoch 00119: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2416 - accuracy: 0.9146 - val_
loss: 0.5127 - val_accuracy: 0.8642
Epoch 120/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2444 - accuracy: 0.9138
Epoch 00120: val_accuracy did not improve from 0.86810
195/195 [==============================] - 28s 142ms/step - loss: 0.2446 - accuracy: 0.9138 - val_
loss: 0.5135 - val_accuracy: 0.8637
```

In [55]:

```python
#history plot for accyracy
plt.figure(figsize=(16,4))
plt.plot(history_3.history['accuracy'])
plt.plot(history_3.history['val_accuracy'])
plt.title("Model Accuracy")
plt.xlabel("Epoch")
plt.ylabel("Accuracy")
plt.legend(["train", "test"], loc="upper left")
plt.show()

# history plot for accuracy
plt.figure(figsize=(16,4))
plt.plot(history_3.history["loss"])
plt.plot(history_3.history["val_loss"])
plt.title("Model Loss")
```
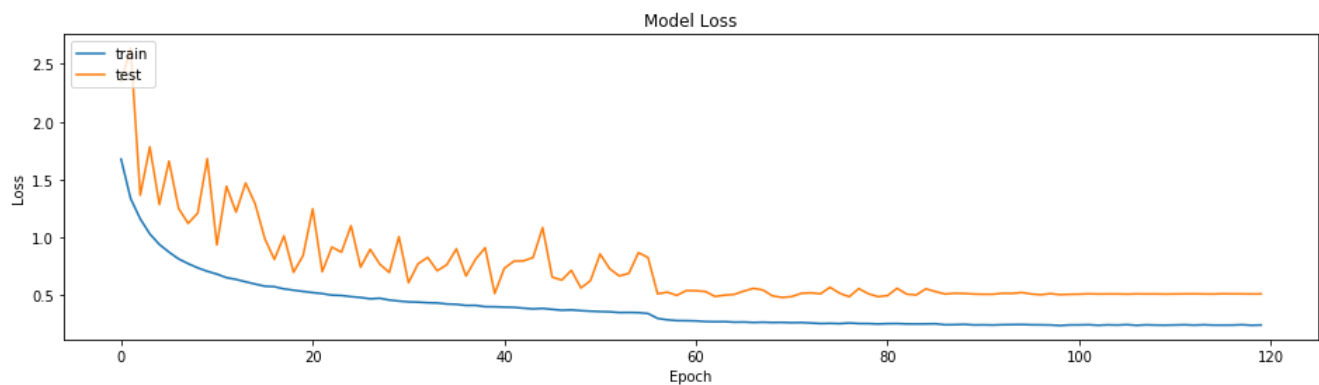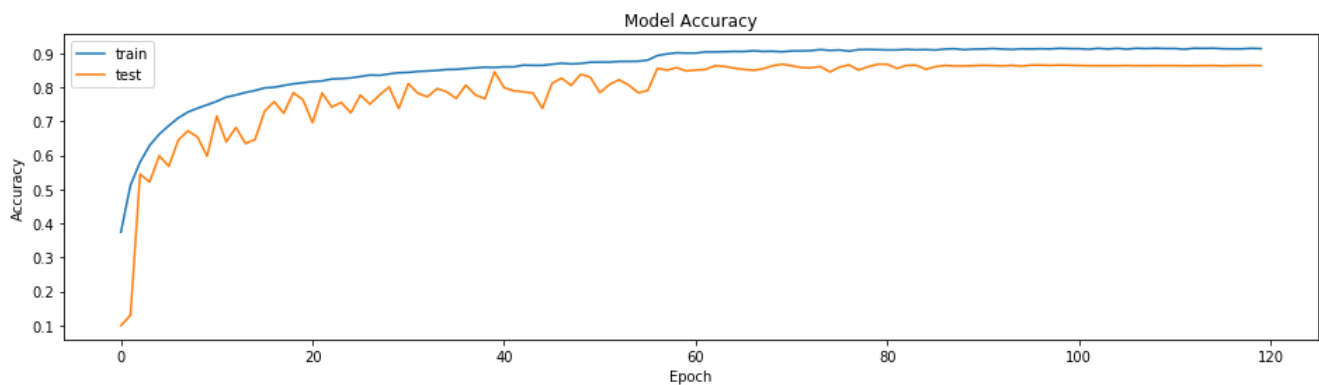
```
plt.title("Model Loss")
plt.xlabel("Epoch")
plt.ylabel("Loss")
plt.legend(["train", "test"], loc="upper left")
plt.show()
```


Model Accuracy

Model Loss

```
best_model_3 =
tf.keras.models.load_model('/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model3_70-0.87
.hdf5')
scores = best_model_3.evaluate(X_test, y_test, verbose=1)
print(scores)
```

```
10000/10000 [==============================] - 4s 438us/sample - loss: 0.4829 - accuracy: 0.8681
[0.48287300192117694, 0.8681]
```

Model -4

```
#BN-->ReLU-->Conv2D-->Dropout-->concat(input, output)-->(put in loop)

def denseblock(input, num_filter, dropout_rate = 0.2):
    global compression      # to keep the growth rate of number of filters
    temp = input
    for _ in range(l):
        BatchNorm = layers.BatchNormalization()(temp)
        relu = layers.Activation('relu')(BatchNorm)
        Conv2D_7_7= layers.SeparableConv2D(int(num_filter*compression), (7,7), use_bias=False, padd
ing='same')(relu)
        #Conv2D_3_3 = layers.Conv2D(int(num_filter*compression), (3,3), use_bias=False
,padding='same')(relu)
        if dropout_rate>0:
            Conv2D_7_7 = layers.Dropout(dropout_rate)(Conv2D_7_7)

        #concat the input(temp) and output(conv2d_3_3) , in resnet we add but here we concat
        concat = layers.Concatenate(axis=-1)([temp,Conv2D_7_7])

        #change the concat as input
        temp = concat
```

```
        return temp

#BN-->relu-->conv2d(1x1)-->dropout-->avg_pool
def transition(input, num_filter, dropout_rate = 0.2):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    #Conv2D_BottleNeck = layers.Conv2D(int(num_filter*compression), (1,1), use_bias=False
,padding='same')(relu)
    Conv2D_BottleNeck = layers.SeparableConvolution2D(int(num_filter*compression), (1,1), use_bias=
False ,padding='same')(relu)
    if dropout_rate>0:
        Conv2D_BottleNeck = layers.Dropout(dropout_rate)(Conv2D_BottleNeck)
    avg = layers.AveragePooling2D(pool_size=(2,2))(Conv2D_BottleNeck)
    return avg

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

# Hyperparameters
l = 12
num_filter = 32
compression = 0.5
dropout_rate = 0.2
num_classes = 10

input = layers.Input(shape=(input_size))
First_Conv2D = layers.Conv2D(num_filter, (7,7), use_bias=False ,padding='same')(input)

#First dense and transition block
First_Block = denseblock(First_Conv2D, num_filter, dropout_rate)
First_Transition = transition(First_Block, num_filter, dropout_rate)

#Second dense and transition block
Second_Block = denseblock(First_Transition, num_filter, dropout_rate)
Second_Transition = transition(Second_Block, num_filter, dropout_rate)

#Third dense and transition block
Third_Block = denseblock(Second_Transition, num_filter, dropout_rate)
Third_Transition = transition(Third_Block, num_filter, dropout_rate)

#last dense and output block
Last_Block = denseblock(Third_Transition,  num_filter, dropout_rate)
output = output_layer(Last_Block)
```

In [59]:

```
model_4 = tf.keras.models.Model(inputs=[input], outputs=[output])
model_4.summary()
```

Model: "model_3"

Layer (type)	Output Shape	Param #	Connected to
input_4 (InputLayer)	[(None, 32, 32, 3)]	0	
conv2d_54 (Conv2D)	(None, 32, 32, 32)	4704	input_4[0][0]
batch_normalization_156 (BatchN	(None, 32, 32, 32)	128	conv2d_54[0][0]
activation_156 (Activation)	(None, 32, 32, 32)	0	batch_normalization_156[0][0]
separable_conv2d_102 (Separable	(None, 32, 32, 16)	2080	activation_156[0][0]
dropout_153 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_102[0][0]
concatenate_144 (Concatenate)	(None, 32, 32, 48)	0	conv2d_54[0][0] dropout_153[0][0]

Layer (type)	Output Shape	Param #	Connected to
batch_normalization_157 (BatchN	(None, 32, 32, 48)	192	concatenate_144[0][0]
activation_157 (Activation)	(None, 32, 32, 48)	0	batch_normalization_157[0][0]
separable_conv2d_103 (Separable	(None, 32, 32, 16)	3120	activation_157[0][0]
dropout_154 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_103[0][0]
concatenate_145 (Concatenate)	(None, 32, 32, 64)	0	concatenate_144[0][0] dropout_154[0][0]
batch_normalization_158 (BatchN	(None, 32, 32, 64)	256	concatenate_145[0][0]
activation_158 (Activation)	(None, 32, 32, 64)	0	batch_normalization_158[0][0]
separable_conv2d_104 (Separable	(None, 32, 32, 16)	4160	activation_158[0][0]
dropout_155 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_104[0][0]
concatenate_146 (Concatenate)	(None, 32, 32, 80)	0	concatenate_145[0][0] dropout_155[0][0]
batch_normalization_159 (BatchN	(None, 32, 32, 80)	320	concatenate_146[0][0]
activation_159 (Activation)	(None, 32, 32, 80)	0	batch_normalization_159[0][0]
separable_conv2d_105 (Separable	(None, 32, 32, 16)	5200	activation_159[0][0]
dropout_156 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_105[0][0]
concatenate_147 (Concatenate)	(None, 32, 32, 96)	0	concatenate_146[0][0] dropout_156[0][0]
batch_normalization_160 (BatchN	(None, 32, 32, 96)	384	concatenate_147[0][0]
activation_160 (Activation)	(None, 32, 32, 96)	0	batch_normalization_160[0][0]
separable_conv2d_106 (Separable	(None, 32, 32, 16)	6240	activation_160[0][0]
dropout_157 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_106[0][0]
concatenate_148 (Concatenate)	(None, 32, 32, 112)	0	concatenate_147[0][0] dropout_157[0][0]
batch_normalization_161 (BatchN	(None, 32, 32, 112)	448	concatenate_148[0][0]
activation_161 (Activation)	(None, 32, 32, 112)	0	batch_normalization_161[0][0]
separable_conv2d_107 (Separable	(None, 32, 32, 16)	7280	activation_161[0][0]
dropout_158 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_107[0][0]
concatenate_149 (Concatenate)	(None, 32, 32, 128)	0	concatenate_148[0][0] dropout_158[0][0]
batch_normalization_162 (BatchN	(None, 32, 32, 128)	512	concatenate_149[0][0]
activation_162 (Activation)	(None, 32, 32, 128)	0	batch_normalization_162[0][0]
separable_conv2d_108 (Separable	(None, 32, 32, 16)	8320	activation_162[0][0]
dropout_159 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_108[0][0]
concatenate_150 (Concatenate)	(None, 32, 32, 144)	0	concatenate_149[0][0] dropout_159[0][0]
batch_normalization_163 (BatchN	(None, 32, 32, 144)	576	concatenate_150[0][0]
activation_163 (Activation)	(None, 32, 32, 144)	0	batch_normalization_163[0][0]
separable_conv2d_109 (Separable	(None, 32, 32, 16)	9360	activation_163[0][0]
dropout_160 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_109[0][0]
concatenate_151 (Concatenate)	(None, 32, 32, 160)	0	concatenate_150[0][0] dropout_160[0][0]

batch_normalization_164 (BatchN	(None, 32, 32, 160)	640	concatenate_151[0][0]
activation_164 (Activation)	(None, 32, 32, 160)	0	batch_normalization_164[0][0]
separable_conv2d_110 (Separable	(None, 32, 32, 16)	10400	activation_164[0][0]
dropout_161 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_110[0][0]
concatenate_152 (Concatenate)	(None, 32, 32, 176)	0	concatenate_151[0][0] dropout_161[0][0]
batch_normalization_165 (BatchN	(None, 32, 32, 176)	704	concatenate_152[0][0]
activation_165 (Activation)	(None, 32, 32, 176)	0	batch_normalization_165[0][0]
separable_conv2d_111 (Separable	(None, 32, 32, 16)	11440	activation_165[0][0]
dropout_162 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_111[0][0]
concatenate_153 (Concatenate)	(None, 32, 32, 192)	0	concatenate_152[0][0] dropout_162[0][0]
batch_normalization_166 (BatchN	(None, 32, 32, 192)	768	concatenate_153[0][0]
activation_166 (Activation)	(None, 32, 32, 192)	0	batch_normalization_166[0][0]
separable_conv2d_112 (Separable	(None, 32, 32, 16)	12480	activation_166[0][0]
dropout_163 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_112[0][0]
concatenate_154 (Concatenate)	(None, 32, 32, 208)	0	concatenate_153[0][0] dropout_163[0][0]
batch_normalization_167 (BatchN	(None, 32, 32, 208)	832	concatenate_154[0][0]
activation_167 (Activation)	(None, 32, 32, 208)	0	batch_normalization_167[0][0]
separable_conv2d_113 (Separable	(None, 32, 32, 16)	13520	activation_167[0][0]
dropout_164 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_113[0][0]
concatenate_155 (Concatenate)	(None, 32, 32, 224)	0	concatenate_154[0][0] dropout_164[0][0]
batch_normalization_168 (BatchN	(None, 32, 32, 224)	896	concatenate_155[0][0]
activation_168 (Activation)	(None, 32, 32, 224)	0	batch_normalization_168[0][0]
separable_conv2d_114 (Separable	(None, 32, 32, 16)	3808	activation_168[0][0]
dropout_165 (Dropout)	(None, 32, 32, 16)	0	separable_conv2d_114[0][0]
average_pooling2d_12 (AveragePo	(None, 16, 16, 16)	0	dropout_165[0][0]
batch_normalization_169 (BatchN	(None, 16, 16, 16)	64	average_pooling2d_12[0][0]
activation_169 (Activation)	(None, 16, 16, 16)	0	batch_normalization_169[0][0]
separable_conv2d_115 (Separable	(None, 16, 16, 16)	1040	activation_169[0][0]
dropout_166 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_115[0][0]
concatenate_156 (Concatenate)	(None, 16, 16, 32)	0	average_pooling2d_12[0][0] dropout_166[0][0]
batch_normalization_170 (BatchN	(None, 16, 16, 32)	128	concatenate_156[0][0]
activation_170 (Activation)	(None, 16, 16, 32)	0	batch_normalization_170[0][0]
separable_conv2d_116 (Separable	(None, 16, 16, 16)	2080	activation_170[0][0]
dropout_167 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_116[0][0]
concatenate_157 (Concatenate)	(None, 16, 16, 48)	0	concatenate_156[0][0] dropout_167[0][0]

batch_normalization_171 (BatchN	(None, 16, 16, 48)	192	concatenate_157[0][0]
activation_171 (Activation)	(None, 16, 16, 48)	0	batch_normalization_171[0][0]
separable_conv2d_117 (Separable	(None, 16, 16, 16)	3120	activation_171[0][0]
dropout_168 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_117[0][0]
concatenate_158 (Concatenate)	(None, 16, 16, 64)	0	concatenate_157[0][0] dropout_168[0][0]
batch_normalization_172 (BatchN	(None, 16, 16, 64)	256	concatenate_158[0][0]
activation_172 (Activation)	(None, 16, 16, 64)	0	batch_normalization_172[0][0]
separable_conv2d_118 (Separable	(None, 16, 16, 16)	4160	activation_172[0][0]
dropout_169 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_118[0][0]
concatenate_159 (Concatenate)	(None, 16, 16, 80)	0	concatenate_158[0][0] dropout_169[0][0]
batch_normalization_173 (BatchN	(None, 16, 16, 80)	320	concatenate_159[0][0]
activation_173 (Activation)	(None, 16, 16, 80)	0	batch_normalization_173[0][0]
separable_conv2d_119 (Separable	(None, 16, 16, 16)	5200	activation_173[0][0]
dropout_170 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_119[0][0]
concatenate_160 (Concatenate)	(None, 16, 16, 96)	0	concatenate_159[0][0] dropout_170[0][0]
batch_normalization_174 (BatchN	(None, 16, 16, 96)	384	concatenate_160[0][0]
activation_174 (Activation)	(None, 16, 16, 96)	0	batch_normalization_174[0][0]
separable_conv2d_120 (Separable	(None, 16, 16, 16)	6240	activation_174[0][0]
dropout_171 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_120[0][0]
concatenate_161 (Concatenate)	(None, 16, 16, 112)	0	concatenate_160[0][0] dropout_171[0][0]
batch_normalization_175 (BatchN	(None, 16, 16, 112)	448	concatenate_161[0][0]
activation_175 (Activation)	(None, 16, 16, 112)	0	batch_normalization_175[0][0]
separable_conv2d_121 (Separable	(None, 16, 16, 16)	7280	activation_175[0][0]
dropout_172 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_121[0][0]
concatenate_162 (Concatenate)	(None, 16, 16, 128)	0	concatenate_161[0][0] dropout_172[0][0]
batch_normalization_176 (BatchN	(None, 16, 16, 128)	512	concatenate_162[0][0]
activation_176 (Activation)	(None, 16, 16, 128)	0	batch_normalization_176[0][0]
separable_conv2d_122 (Separable	(None, 16, 16, 16)	8320	activation_176[0][0]
dropout_173 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_122[0][0]
concatenate_163 (Concatenate)	(None, 16, 16, 144)	0	concatenate_162[0][0] dropout_173[0][0]
batch_normalization_177 (BatchN	(None, 16, 16, 144)	576	concatenate_163[0][0]
activation_177 (Activation)	(None, 16, 16, 144)	0	batch_normalization_177[0][0]
separable_conv2d_123 (Separable	(None, 16, 16, 16)	9360	activation_177[0][0]
dropout_174 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_123[0][0]
concatenate_164 (Concatenate)	(None, 16, 16, 160)	0	concatenate_163[0][0] dropout_174[0][0]

Layer	Output Shape	Param #	Connected to
batch_normalization_178 (BatchN	(None, 16, 16, 160)	640	concatenate_164[0][0]
activation_178 (Activation)	(None, 16, 16, 160)	0	batch_normalization_178[0][0]
separable_conv2d_124 (Separable	(None, 16, 16, 16)	10400	activation_178[0][0]
dropout_175 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_124[0][0]
concatenate_165 (Concatenate)	(None, 16, 16, 176)	0	concatenate_164[0][0] dropout_175[0][0]
batch_normalization_179 (BatchN	(None, 16, 16, 176)	704	concatenate_165[0][0]
activation_179 (Activation)	(None, 16, 16, 176)	0	batch_normalization_179[0][0]
separable_conv2d_125 (Separable	(None, 16, 16, 16)	11440	activation_179[0][0]
dropout_176 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_125[0][0]
concatenate_166 (Concatenate)	(None, 16, 16, 192)	0	concatenate_165[0][0] dropout_176[0][0]
batch_normalization_180 (BatchN	(None, 16, 16, 192)	768	concatenate_166[0][0]
activation_180 (Activation)	(None, 16, 16, 192)	0	batch_normalization_180[0][0]
separable_conv2d_126 (Separable	(None, 16, 16, 16)	12480	activation_180[0][0]
dropout_177 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_126[0][0]
concatenate_167 (Concatenate)	(None, 16, 16, 208)	0	concatenate_166[0][0] dropout_177[0][0]
batch_normalization_181 (BatchN	(None, 16, 16, 208)	832	concatenate_167[0][0]
activation_181 (Activation)	(None, 16, 16, 208)	0	batch_normalization_181[0][0]
separable_conv2d_127 (Separable	(None, 16, 16, 16)	3536	activation_181[0][0]
dropout_178 (Dropout)	(None, 16, 16, 16)	0	separable_conv2d_127[0][0]
average_pooling2d_13 (AveragePo	(None, 8, 8, 16)	0	dropout_178[0][0]
batch_normalization_182 (BatchN	(None, 8, 8, 16)	64	average_pooling2d_13[0][0]
activation_182 (Activation)	(None, 8, 8, 16)	0	batch_normalization_182[0][0]
separable_conv2d_128 (Separable	(None, 8, 8, 16)	1040	activation_182[0][0]
dropout_179 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_128[0][0]
concatenate_168 (Concatenate)	(None, 8, 8, 32)	0	average_pooling2d_13[0][0] dropout_179[0][0]
batch_normalization_183 (BatchN	(None, 8, 8, 32)	128	concatenate_168[0][0]
activation_183 (Activation)	(None, 8, 8, 32)	0	batch_normalization_183[0][0]
separable_conv2d_129 (Separable	(None, 8, 8, 16)	2080	activation_183[0][0]
dropout_180 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_129[0][0]
concatenate_169 (Concatenate)	(None, 8, 8, 48)	0	concatenate_168[0][0] dropout_180[0][0]
batch_normalization_184 (BatchN	(None, 8, 8, 48)	192	concatenate_169[0][0]
activation_184 (Activation)	(None, 8, 8, 48)	0	batch_normalization_184[0][0]
separable_conv2d_130 (Separable	(None, 8, 8, 16)	3120	activation_184[0][0]
dropout_181 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_130[0][0]
concatenate_170 (Concatenate)	(None, 8, 8, 64)	0	concatenate_169[0][0] dropout_181[0][0]
batch_normalization_185 (BatchN	(None, 8, 8, 64)	256	concatenate_170[0][0]

batch_normalization_185 (BatchN	(None, 8, 8, 64)	256	concatenate_170[0][0]
activation_185 (Activation)	(None, 8, 8, 64)	0	batch_normalization_185[0][0]
separable_conv2d_131 (Separable	(None, 8, 8, 16)	4160	activation_185[0][0]
dropout_182 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_131[0][0]
concatenate_171 (Concatenate)	(None, 8, 8, 80)	0	concatenate_170[0][0] dropout_182[0][0]
batch_normalization_186 (BatchN	(None, 8, 8, 80)	320	concatenate_171[0][0]
activation_186 (Activation)	(None, 8, 8, 80)	0	batch_normalization_186[0][0]
separable_conv2d_132 (Separable	(None, 8, 8, 16)	5200	activation_186[0][0]
dropout_183 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_132[0][0]
concatenate_172 (Concatenate)	(None, 8, 8, 96)	0	concatenate_171[0][0] dropout_183[0][0]
batch_normalization_187 (BatchN	(None, 8, 8, 96)	384	concatenate_172[0][0]
activation_187 (Activation)	(None, 8, 8, 96)	0	batch_normalization_187[0][0]
separable_conv2d_133 (Separable	(None, 8, 8, 16)	6240	activation_187[0][0]
dropout_184 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_133[0][0]
concatenate_173 (Concatenate)	(None, 8, 8, 112)	0	concatenate_172[0][0] dropout_184[0][0]
batch_normalization_188 (BatchN	(None, 8, 8, 112)	448	concatenate_173[0][0]
activation_188 (Activation)	(None, 8, 8, 112)	0	batch_normalization_188[0][0]
separable_conv2d_134 (Separable	(None, 8, 8, 16)	7280	activation_188[0][0]
dropout_185 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_134[0][0]
concatenate_174 (Concatenate)	(None, 8, 8, 128)	0	concatenate_173[0][0] dropout_185[0][0]
batch_normalization_189 (BatchN	(None, 8, 8, 128)	512	concatenate_174[0][0]
activation_189 (Activation)	(None, 8, 8, 128)	0	batch_normalization_189[0][0]
separable_conv2d_135 (Separable	(None, 8, 8, 16)	8320	activation_189[0][0]
dropout_186 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_135[0][0]
concatenate_175 (Concatenate)	(None, 8, 8, 144)	0	concatenate_174[0][0] dropout_186[0][0]
batch_normalization_190 (BatchN	(None, 8, 8, 144)	576	concatenate_175[0][0]
activation_190 (Activation)	(None, 8, 8, 144)	0	batch_normalization_190[0][0]
separable_conv2d_136 (Separable	(None, 8, 8, 16)	9360	activation_190[0][0]
dropout_187 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_136[0][0]
concatenate_176 (Concatenate)	(None, 8, 8, 160)	0	concatenate_175[0][0] dropout_187[0][0]
batch_normalization_191 (BatchN	(None, 8, 8, 160)	640	concatenate_176[0][0]
activation_191 (Activation)	(None, 8, 8, 160)	0	batch_normalization_191[0][0]
separable_conv2d_137 (Separable	(None, 8, 8, 16)	10400	activation_191[0][0]
dropout_188 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_137[0][0]
concatenate_177 (Concatenate)	(None, 8, 8, 176)	0	concatenate_176[0][0] dropout_188[0][0]
batch_normalization_192 (BatchN	(None, 8, 8, 176)	704	concatenate_177[0][0]

batch_normalization_192 (BatchN	(None, 8, 8, 176)	704	concatenate_177[0][0]
activation_192 (Activation)	(None, 8, 8, 176)	0	batch_normalization_192[0][0]
separable_conv2d_138 (Separable	(None, 8, 8, 16)	11440	activation_192[0][0]
dropout_189 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_138[0][0]
concatenate_178 (Concatenate)	(None, 8, 8, 192)	0	concatenate_177[0][0] dropout_189[0][0]
batch_normalization_193 (BatchN	(None, 8, 8, 192)	768	concatenate_178[0][0]
activation_193 (Activation)	(None, 8, 8, 192)	0	batch_normalization_193[0][0]
separable_conv2d_139 (Separable	(None, 8, 8, 16)	12480	activation_193[0][0]
dropout_190 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_139[0][0]
concatenate_179 (Concatenate)	(None, 8, 8, 208)	0	concatenate_178[0][0] dropout_190[0][0]
batch_normalization_194 (BatchN	(None, 8, 8, 208)	832	concatenate_179[0][0]
activation_194 (Activation)	(None, 8, 8, 208)	0	batch_normalization_194[0][0]
separable_conv2d_140 (Separable	(None, 8, 8, 16)	3536	activation_194[0][0]
dropout_191 (Dropout)	(None, 8, 8, 16)	0	separable_conv2d_140[0][0]
average_pooling2d_14 (AveragePo	(None, 4, 4, 16)	0	dropout_191[0][0]
batch_normalization_195 (BatchN	(None, 4, 4, 16)	64	average_pooling2d_14[0][0]
activation_195 (Activation)	(None, 4, 4, 16)	0	batch_normalization_195[0][0]
separable_conv2d_141 (Separable	(None, 4, 4, 16)	1040	activation_195[0][0]
dropout_192 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_141[0][0]
concatenate_180 (Concatenate)	(None, 4, 4, 32)	0	average_pooling2d_14[0][0] dropout_192[0][0]
batch_normalization_196 (BatchN	(None, 4, 4, 32)	128	concatenate_180[0][0]
activation_196 (Activation)	(None, 4, 4, 32)	0	batch_normalization_196[0][0]
separable_conv2d_142 (Separable	(None, 4, 4, 16)	2080	activation_196[0][0]
dropout_193 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_142[0][0]
concatenate_181 (Concatenate)	(None, 4, 4, 48)	0	concatenate_180[0][0] dropout_193[0][0]
batch_normalization_197 (BatchN	(None, 4, 4, 48)	192	concatenate_181[0][0]
activation_197 (Activation)	(None, 4, 4, 48)	0	batch_normalization_197[0][0]
separable_conv2d_143 (Separable	(None, 4, 4, 16)	3120	activation_197[0][0]
dropout_194 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_143[0][0]
concatenate_182 (Concatenate)	(None, 4, 4, 64)	0	concatenate_181[0][0] dropout_194[0][0]
batch_normalization_198 (BatchN	(None, 4, 4, 64)	256	concatenate_182[0][0]
activation_198 (Activation)	(None, 4, 4, 64)	0	batch_normalization_198[0][0]
separable_conv2d_144 (Separable	(None, 4, 4, 16)	4160	activation_198[0][0]
dropout_195 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_144[0][0]
concatenate_183 (Concatenate)	(None, 4, 4, 80)	0	concatenate_182[0][0] dropout_195[0][0]
batch_normalization_199 (BatchN	(None, 4, 4, 80)	320	concatenate_183[0][0]

Layer	Output Shape	Param #	Connected to
activation_199 (Activation)	(None, 4, 4, 80)	0	batch_normalization_199[0][0]
separable_conv2d_145 (Separable	(None, 4, 4, 16)	5200	activation_199[0][0]
dropout_196 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_145[0][0]
concatenate_184 (Concatenate)	(None, 4, 4, 96)	0	concatenate_183[0][0] dropout_196[0][0]
batch_normalization_200 (BatchN	(None, 4, 4, 96)	384	concatenate_184[0][0]
activation_200 (Activation)	(None, 4, 4, 96)	0	batch_normalization_200[0][0]
separable_conv2d_146 (Separable	(None, 4, 4, 16)	6240	activation_200[0][0]
dropout_197 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_146[0][0]
concatenate_185 (Concatenate)	(None, 4, 4, 112)	0	concatenate_184[0][0] dropout_197[0][0]
batch_normalization_201 (BatchN	(None, 4, 4, 112)	448	concatenate_185[0][0]
activation_201 (Activation)	(None, 4, 4, 112)	0	batch_normalization_201[0][0]
separable_conv2d_147 (Separable	(None, 4, 4, 16)	7280	activation_201[0][0]
dropout_198 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_147[0][0]
concatenate_186 (Concatenate)	(None, 4, 4, 128)	0	concatenate_185[0][0] dropout_198[0][0]
batch_normalization_202 (BatchN	(None, 4, 4, 128)	512	concatenate_186[0][0]
activation_202 (Activation)	(None, 4, 4, 128)	0	batch_normalization_202[0][0]
separable_conv2d_148 (Separable	(None, 4, 4, 16)	8320	activation_202[0][0]
dropout_199 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_148[0][0]
concatenate_187 (Concatenate)	(None, 4, 4, 144)	0	concatenate_186[0][0] dropout_199[0][0]
batch_normalization_203 (BatchN	(None, 4, 4, 144)	576	concatenate_187[0][0]
activation_203 (Activation)	(None, 4, 4, 144)	0	batch_normalization_203[0][0]
separable_conv2d_149 (Separable	(None, 4, 4, 16)	9360	activation_203[0][0]
dropout_200 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_149[0][0]
concatenate_188 (Concatenate)	(None, 4, 4, 160)	0	concatenate_187[0][0] dropout_200[0][0]
batch_normalization_204 (BatchN	(None, 4, 4, 160)	640	concatenate_188[0][0]
activation_204 (Activation)	(None, 4, 4, 160)	0	batch_normalization_204[0][0]
separable_conv2d_150 (Separable	(None, 4, 4, 16)	10400	activation_204[0][0]
dropout_201 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_150[0][0]
concatenate_189 (Concatenate)	(None, 4, 4, 176)	0	concatenate_188[0][0] dropout_201[0][0]
batch_normalization_205 (BatchN	(None, 4, 4, 176)	704	concatenate_189[0][0]
activation_205 (Activation)	(None, 4, 4, 176)	0	batch_normalization_205[0][0]
separable_conv2d_151 (Separable	(None, 4, 4, 16)	11440	activation_205[0][0]
dropout_202 (Dropout)	(None, 4, 4, 16)	0	separable_conv2d_151[0][0]
concatenate_190 (Concatenate)	(None, 4, 4, 192)	0	concatenate_189[0][0] dropout_202[0][0]
batch_normalization_206 (BatchN	(None, 4, 4, 192)	768	concatenate_190[0][0]

```
activation_206 (Activation)      (None, 4, 4, 192)    0         batch_normalization_206[0][0]
_____
separable_conv2d_152 (Separable  (None, 4, 4, 16)     12480     activation_206[0][0]
_____
dropout_203 (Dropout)            (None, 4, 4, 16)     0         separable_conv2d_152[0][0]
_____
concatenate_191 (Concatenate)    (None, 4, 4, 208)    0         concatenate_190[0][0]
                                                                dropout_203[0][0]
_____
batch_normalization_207 (BatchN  (None, 4, 4, 208)    832       concatenate_191[0][0]
_____
activation_207 (Activation)      (None, 4, 4, 208)    0         batch_normalization_207[0][0]
_____
average_pooling2d_15 (AveragePo  (None, 2, 2, 208)    0         activation_207[0][0]
_____
flatten_3 (Flatten)              (None, 832)          0         average_pooling2d_15[0][0]
_____
dense_3 (Dense)                  (None, 10)           8330      flatten_3[0][0]
================================================================================================
Total params: 385,002
Trainable params: 372,938
Non-trainable params: 12,064
_____
```

In [60]:

```python
model_4.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])

from tensorflow.keras.callbacks import ModelCheckpoint, EarlyStopping, ReduceLROnPlateau
patience = 50
base_path = '/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/'
checkpoint_file_name = base_path + 'CIFAR_model4' + '_{epoch:02d}-{val_accuracy:.2f}.hdf5'

model_checkpoint = ModelCheckpoint(checkpoint_file_name, monitor='val_accuracy', verbose=1, save_be
st_only=True)
early_stop = EarlyStopping('val_accuracy', mode='max', patience = patience)
reduce_LR = ReduceLROnPlateau(monitor='val_accuracy', mode='max', factor=0.1, patience=int(patience
/3), verbose=1)

callbacks = [model_checkpoint, early_stop, reduce_LR]

epochs = 300
batch_size = 256

#https://keras.io/api/preprocessing/image/#flow-method

history_4 = model_4.fit(data_generator.flow(X_train, y_train, batch_size),
                    steps_per_epoch = int(len(X_train)/batch_size),
                    epochs = epochs,
                    callbacks = callbacks,
                    validation_data = (X_test, y_test), verbose=1)
```

```
WARNING:tensorflow:sample_weight modes were coerced from
  ...
    to
  ['...']
Train for 195 steps, validate on 10000 samples
Epoch 1/300
194/195 [============================>.] - ETA: 0s - loss: 1.7070 - accuracy: 0.3639
Epoch 00001: val_accuracy improved from -inf to 0.10000, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_01-0.10.hdf5
195/195 [==============================] - 70s 359ms/step - loss: 1.7059 - accuracy: 0.3643 - val_
loss: 2.3413 - val_accuracy: 0.1000
Epoch 2/300
194/195 [============================>.] - ETA: 0s - loss: 1.3666 - accuracy: 0.5033
Epoch 00002: val_accuracy improved from 0.10000 to 0.19030, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_02-0.19.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 1.3661 - accuracy: 0.5034 - val_
loss: 2.2503 - val_accuracy: 0.1903
Epoch 3/300
194/195 [============================>.] - ETA: 0s - loss: 1.1866 - accuracy: 0.5744
Epoch 00003: val_accuracy improved from 0.19030 to 0.44100, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_03-0.44.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 1.1869 - accuracy: 0.5743 - val_
loss: 1.9132 - val_accuracy: 0.4410
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Epoch 4/300
194/195 [=============================>.] - ETA: 0s - loss: 1.0686 - accuracy: 0.6165
Epoch 00004: val_accuracy improved from 0.44100 to 0.48850, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_04-0.49.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 1.0680 - accuracy: 0.6166 - val_
loss: 2.1404 - val_accuracy: 0.4885
Epoch 5/300
194/195 [=============================>.] - ETA: 0s - loss: 0.9866 - accuracy: 0.6485
Epoch 00005: val_accuracy improved from 0.48850 to 0.62000, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_05-0.62.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.9866 - accuracy: 0.6484 - val_
loss: 1.2004 - val_accuracy: 0.6200
Epoch 6/300
194/195 [=============================>.] - ETA: 0s - loss: 0.9110 - accuracy: 0.6794
Epoch 00006: val_accuracy did not improve from 0.62000
195/195 [==============================] - 58s 298ms/step - loss: 0.9108 - accuracy: 0.6794 - val_
loss: 1.5936 - val_accuracy: 0.5615
Epoch 7/300
194/195 [=============================>.] - ETA: 0s - loss: 0.8595 - accuracy: 0.6966
Epoch 00007: val_accuracy improved from 0.62000 to 0.65450, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_07-0.65.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.8598 - accuracy: 0.6964 - val_
loss: 1.1688 - val_accuracy: 0.6545
Epoch 8/300
194/195 [=============================>.] - ETA: 0s - loss: 0.8077 - accuracy: 0.7151
Epoch 00008: val_accuracy did not improve from 0.65450
195/195 [==============================] - 58s 298ms/step - loss: 0.8076 - accuracy: 0.7152 - val_
loss: 1.9574 - val_accuracy: 0.5217
Epoch 9/300
194/195 [=============================>.] - ETA: 0s - loss: 0.7670 - accuracy: 0.7304
Epoch 00009: val_accuracy improved from 0.65450 to 0.70890, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_09-0.71.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.7668 - accuracy: 0.7304 - val_
loss: 0.9380 - val_accuracy: 0.7089
Epoch 10/300
194/195 [=============================>.] - ETA: 0s - loss: 0.7375 - accuracy: 0.7394
Epoch 00010: val_accuracy did not improve from 0.70890
195/195 [==============================] - 58s 298ms/step - loss: 0.7381 - accuracy: 0.7393 - val_
loss: 2.8126 - val_accuracy: 0.4757
Epoch 11/300
194/195 [=============================>.] - ETA: 0s - loss: 0.7033 - accuracy: 0.7523
Epoch 00011: val_accuracy improved from 0.70890 to 0.73420, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_11-0.73.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.7030 - accuracy: 0.7523 - val_
loss: 0.8638 - val_accuracy: 0.7342
Epoch 12/300
194/195 [=============================>.] - ETA: 0s - loss: 0.6767 - accuracy: 0.7622
Epoch 00012: val_accuracy did not improve from 0.73420
195/195 [==============================] - 58s 298ms/step - loss: 0.6764 - accuracy: 0.7623 - val_
loss: 1.4645 - val_accuracy: 0.6306
Epoch 13/300
194/195 [=============================>.] - ETA: 0s - loss: 0.6520 - accuracy: 0.7728
Epoch 00013: val_accuracy did not improve from 0.73420
195/195 [==============================] - 58s 298ms/step - loss: 0.6517 - accuracy: 0.7731 - val_
loss: 1.1560 - val_accuracy: 0.6718
Epoch 14/300
194/195 [=============================>.] - ETA: 0s - loss: 0.6347 - accuracy: 0.7785
Epoch 00014: val_accuracy did not improve from 0.73420
195/195 [==============================] - 58s 298ms/step - loss: 0.6350 - accuracy: 0.7784 - val_
loss: 1.1602 - val_accuracy: 0.6892
Epoch 15/300
194/195 [=============================>.] - ETA: 0s - loss: 0.6167 - accuracy: 0.7845
Epoch 00015: val_accuracy did not improve from 0.73420
195/195 [==============================] - 58s 298ms/step - loss: 0.6167 - accuracy: 0.7845 - val_
loss: 1.3772 - val_accuracy: 0.6478
Epoch 16/300
194/195 [=============================>.] - ETA: 0s - loss: 0.5980 - accuracy: 0.7921
Epoch 00016: val_accuracy did not improve from 0.73420
195/195 [==============================] - 58s 298ms/step - loss: 0.5975 - accuracy: 0.7923 - val_
loss: 1.0045 - val_accuracy: 0.7176
Epoch 17/300
194/195 [=============================>.] - ETA: 0s - loss: 0.5810 - accuracy: 0.7972
Epoch 00017: val_accuracy did not improve from 0.73420
195/195 [==============================] - 58s 298ms/step - loss: 0.5808 - accuracy: 0.7973 - val_
loss: 1.4011 - val_accuracy: 0.6322
Epoch 18/300
194/195 [=============================>.] - ETA: 0s - loss: 0.5676 - accuracy: 0.8023
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Epoch 00018: val_accuracy did not improve from 0.73420
195/195 [==============================] - 58s 298ms/step - loss: 0.5677 - accuracy: 0.8023 - val_
loss: 1.0604 - val_accuracy: 0.7087
Epoch 19/300
194/195 [=============================>.] - ETA: 0s - loss: 0.5529 - accuracy: 0.8073
Epoch 00019: val_accuracy improved from 0.73420 to 0.74620, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_19-0.75.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.5527 - accuracy: 0.8075 - val_
loss: 0.8668 - val_accuracy: 0.7462
Epoch 20/300
194/195 [=============================>.] - ETA: 0s - loss: 0.5429 - accuracy: 0.8106
Epoch 00020: val_accuracy did not improve from 0.74620
195/195 [==============================] - 58s 298ms/step - loss: 0.5430 - accuracy: 0.8106 - val_
loss: 0.8953 - val_accuracy: 0.7378
Epoch 21/300
194/195 [=============================>.] - ETA: 0s - loss: 0.5328 - accuracy: 0.8126
Epoch 00021: val_accuracy did not improve from 0.74620
195/195 [==============================] - 58s 298ms/step - loss: 0.5326 - accuracy: 0.8127 - val_
loss: 1.0524 - val_accuracy: 0.7157
Epoch 22/300
194/195 [=============================>.] - ETA: 0s - loss: 0.5231 - accuracy: 0.8184
Epoch 00022: val_accuracy did not improve from 0.74620
195/195 [==============================] - 58s 298ms/step - loss: 0.5239 - accuracy: 0.8180 - val_
loss: 1.0577 - val_accuracy: 0.7269
Epoch 23/300
194/195 [=============================>.] - ETA: 0s - loss: 0.5083 - accuracy: 0.8210
Epoch 00023: val_accuracy did not improve from 0.74620
195/195 [==============================] - 58s 298ms/step - loss: 0.5085 - accuracy: 0.8212 - val_
loss: 1.1614 - val_accuracy: 0.7007
Epoch 24/300
194/195 [=============================>.] - ETA: 0s - loss: 0.5025 - accuracy: 0.8272
Epoch 00024: val_accuracy improved from 0.74620 to 0.76850, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_24-0.77.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.5025 - accuracy: 0.8273 - val_
loss: 0.7614 - val_accuracy: 0.7685
Epoch 25/300
194/195 [=============================>.] - ETA: 0s - loss: 0.4883 - accuracy: 0.8285
Epoch 00025: val_accuracy did not improve from 0.76850
195/195 [==============================] - 58s 298ms/step - loss: 0.4886 - accuracy: 0.8283 - val_
loss: 0.8801 - val_accuracy: 0.7589
Epoch 26/300
194/195 [=============================>.] - ETA: 0s - loss: 0.4774 - accuracy: 0.8336
Epoch 00026: val_accuracy improved from 0.76850 to 0.79270, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_26-0.79.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.4771 - accuracy: 0.8336 - val_
loss: 0.7050 - val_accuracy: 0.7927
Epoch 27/300
194/195 [=============================>.] - ETA: 0s - loss: 0.4795 - accuracy: 0.8326
Epoch 00027: val_accuracy did not improve from 0.79270
195/195 [==============================] - 58s 298ms/step - loss: 0.4795 - accuracy: 0.8327 - val_
loss: 1.1469 - val_accuracy: 0.7176
Epoch 28/300
194/195 [=============================>.] - ETA: 0s - loss: 0.4654 - accuracy: 0.8384
Epoch 00028: val_accuracy did not improve from 0.79270
195/195 [==============================] - 58s 298ms/step - loss: 0.4654 - accuracy: 0.8384 - val_
loss: 1.2111 - val_accuracy: 0.7168
Epoch 29/300
194/195 [=============================>.] - ETA: 0s - loss: 0.4614 - accuracy: 0.8398
Epoch 00029: val_accuracy did not improve from 0.79270
195/195 [==============================] - 58s 298ms/step - loss: 0.4619 - accuracy: 0.8396 - val_
loss: 0.7486 - val_accuracy: 0.7850
Epoch 30/300
194/195 [=============================>.] - ETA: 0s - loss: 0.4497 - accuracy: 0.8432
Epoch 00030: val_accuracy improved from 0.79270 to 0.79300, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_30-0.79.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.4493 - accuracy: 0.8433 - val_
loss: 0.7231 - val_accuracy: 0.7930
Epoch 31/300
194/195 [=============================>.] - ETA: 0s - loss: 0.4472 - accuracy: 0.8442
Epoch 00031: val_accuracy did not improve from 0.79300
195/195 [==============================] - 58s 298ms/step - loss: 0.4471 - accuracy: 0.8444 - val_
loss: 0.8326 - val_accuracy: 0.7646
Epoch 32/300
194/195 [=============================>.] - ETA: 0s - loss: 0.4424 - accuracy: 0.8449
Epoch 00032: val_accuracy did not improve from 0.79300
195/195 [==============================] - 58s 298ms/step - loss: 0.4422 - accuracy: 0.8449 - val_
loss: 1.0786 - val_accuracy: 0.7239
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loss: 1.0700 - val_accuracy: 0.7209
Epoch 33/300
194/195 [============================>.] - ETA: 0s - loss: 0.4374 - accuracy: 0.8469
Epoch 00033: val_accuracy improved from 0.79300 to 0.80390, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_33-0.80.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.4377 - accuracy: 0.8469 - val_
loss: 0.6970 - val_accuracy: 0.8039
Epoch 34/300
194/195 [============================>.] - ETA: 0s - loss: 0.4279 - accuracy: 0.8509
Epoch 00034: val_accuracy did not improve from 0.80390
195/195 [==============================] - 58s 298ms/step - loss: 0.4280 - accuracy: 0.8509 - val_
loss: 1.1122 - val_accuracy: 0.7356
Epoch 35/300
194/195 [============================>.] - ETA: 0s - loss: 0.4265 - accuracy: 0.8507
Epoch 00035: val_accuracy did not improve from 0.80390
195/195 [==============================] - 58s 298ms/step - loss: 0.4261 - accuracy: 0.8507 - val_
loss: 0.9059 - val_accuracy: 0.7630
Epoch 36/300
194/195 [============================>.] - ETA: 0s - loss: 0.4150 - accuracy: 0.8539
Epoch 00036: val_accuracy did not improve from 0.80390
195/195 [==============================] - 58s 298ms/step - loss: 0.4151 - accuracy: 0.8539 - val_
loss: 1.1688 - val_accuracy: 0.7184
Epoch 37/300
194/195 [============================>.] - ETA: 0s - loss: 0.4095 - accuracy: 0.8566
Epoch 00037: val_accuracy improved from 0.80390 to 0.80720, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_37-0.81.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.4094 - accuracy: 0.8567 - val_
loss: 0.6776 - val_accuracy: 0.8072
Epoch 38/300
194/195 [============================>.] - ETA: 0s - loss: 0.4063 - accuracy: 0.8573
Epoch 00038: val_accuracy improved from 0.80720 to 0.81510, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_38-0.82.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.4062 - accuracy: 0.8573 - val_
loss: 0.6534 - val_accuracy: 0.8151
Epoch 39/300
194/195 [============================>.] - ETA: 0s - loss: 0.4013 - accuracy: 0.8591
Epoch 00039: val_accuracy did not improve from 0.81510
195/195 [==============================] - 58s 298ms/step - loss: 0.4013 - accuracy: 0.8591 - val_
loss: 0.8656 - val_accuracy: 0.7855
Epoch 40/300
194/195 [============================>.] - ETA: 0s - loss: 0.3940 - accuracy: 0.8613
Epoch 00040: val_accuracy did not improve from 0.81510
195/195 [==============================] - 58s 298ms/step - loss: 0.3940 - accuracy: 0.8612 - val_
loss: 0.8044 - val_accuracy: 0.7890
Epoch 41/300
194/195 [============================>.] - ETA: 0s - loss: 0.3918 - accuracy: 0.8624
Epoch 00041: val_accuracy did not improve from 0.81510
195/195 [==============================] - 58s 298ms/step - loss: 0.3922 - accuracy: 0.8621 - val_
loss: 1.1655 - val_accuracy: 0.7376
Epoch 42/300
194/195 [============================>.] - ETA: 0s - loss: 0.3905 - accuracy: 0.8637
Epoch 00042: val_accuracy did not improve from 0.81510
195/195 [==============================] - 58s 298ms/step - loss: 0.3907 - accuracy: 0.8635 - val_
loss: 0.6769 - val_accuracy: 0.8106
Epoch 43/300
194/195 [============================>.] - ETA: 0s - loss: 0.3829 - accuracy: 0.8653
Epoch 00043: val_accuracy did not improve from 0.81510
195/195 [==============================] - 58s 298ms/step - loss: 0.3825 - accuracy: 0.8655 - val_
loss: 0.8867 - val_accuracy: 0.7758
Epoch 44/300
194/195 [============================>.] - ETA: 0s - loss: 0.3794 - accuracy: 0.8673
Epoch 00044: val_accuracy did not improve from 0.81510
195/195 [==============================] - 58s 299ms/step - loss: 0.3797 - accuracy: 0.8674 - val_
loss: 0.6781 - val_accuracy: 0.8115
Epoch 45/300
194/195 [============================>.] - ETA: 0s - loss: 0.3766 - accuracy: 0.8672
Epoch 00045: val_accuracy did not improve from 0.81510
195/195 [==============================] - 58s 298ms/step - loss: 0.3766 - accuracy: 0.8672 - val_
loss: 0.8694 - val_accuracy: 0.7861
Epoch 46/300
194/195 [============================>.] - ETA: 0s - loss: 0.3701 - accuracy: 0.8698
Epoch 00046: val_accuracy did not improve from 0.81510
195/195 [==============================] - 58s 298ms/step - loss: 0.3699 - accuracy: 0.8699 - val_
loss: 1.1198 - val_accuracy: 0.7407
Epoch 47/300
194/195 [============================>.] - ETA: 0s - loss: 0.3703 - accuracy: 0.8698
Epoch 00047: val_accuracy did not improve from 0.81510
195/195 [==============================] - 58s 298ms/step - loss: 0.3700 - accuracy: 0.8699 - val
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195/195 [==============================] - 58s 298ms/step - loss: 0.5700 - accuracy: 0.8099 - val_
loss: 0.7218 - val_accuracy: 0.8016
Epoch 48/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3670 - accuracy: 0.8714
Epoch 00048: val_accuracy did not improve from 0.81510
195/195 [==============================] - 58s 298ms/step - loss: 0.3672 - accuracy: 0.8714 - val_
loss: 0.7497 - val_accuracy: 0.8040
Epoch 49/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3571 - accuracy: 0.8752
Epoch 00049: val_accuracy improved from 0.81510 to 0.82350, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_49-0.82.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.3571 - accuracy: 0.8751 - val_
loss: 0.6711 - val_accuracy: 0.8235
Epoch 50/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3542 - accuracy: 0.8739
Epoch 00050: val_accuracy did not improve from 0.82350
195/195 [==============================] - 58s 298ms/step - loss: 0.3541 - accuracy: 0.8739 - val_
loss: 0.7510 - val_accuracy: 0.8079
Epoch 51/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3522 - accuracy: 0.8754
Epoch 00051: val_accuracy improved from 0.82350 to 0.83610, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_51-0.84.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.3524 - accuracy: 0.8754 - val_
loss: 0.5678 - val_accuracy: 0.8361
Epoch 52/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3508 - accuracy: 0.8760
Epoch 00052: val_accuracy did not improve from 0.83610
195/195 [==============================] - 58s 298ms/step - loss: 0.3508 - accuracy: 0.8760 - val_
loss: 0.7490 - val_accuracy: 0.8012
Epoch 53/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3455 - accuracy: 0.8780
Epoch 00053: val_accuracy did not improve from 0.83610
195/195 [==============================] - 58s 298ms/step - loss: 0.3456 - accuracy: 0.8781 - val_
loss: 0.7325 - val_accuracy: 0.8150
Epoch 54/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3437 - accuracy: 0.8782
Epoch 00054: val_accuracy did not improve from 0.83610
195/195 [==============================] - 58s 298ms/step - loss: 0.3435 - accuracy: 0.8782 - val_
loss: 0.6157 - val_accuracy: 0.8282
Epoch 55/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3383 - accuracy: 0.8809
Epoch 00055: val_accuracy did not improve from 0.83610
195/195 [==============================] - 58s 298ms/step - loss: 0.3381 - accuracy: 0.8810 - val_
loss: 0.7196 - val_accuracy: 0.8118
Epoch 56/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3415 - accuracy: 0.8801
Epoch 00056: val_accuracy did not improve from 0.83610
195/195 [==============================] - 58s 298ms/step - loss: 0.3416 - accuracy: 0.8800 - val_
loss: 0.9316 - val_accuracy: 0.7835
Epoch 57/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3349 - accuracy: 0.8812
Epoch 00057: val_accuracy did not improve from 0.83610
195/195 [==============================] - 58s 298ms/step - loss: 0.3346 - accuracy: 0.8813 - val_
loss: 1.0981 - val_accuracy: 0.7480
Epoch 58/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3320 - accuracy: 0.8827
Epoch 00058: val_accuracy did not improve from 0.83610
195/195 [==============================] - 58s 298ms/step - loss: 0.3318 - accuracy: 0.8828 - val_
loss: 0.7190 - val_accuracy: 0.8167
Epoch 59/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3301 - accuracy: 0.8842
Epoch 00059: val_accuracy did not improve from 0.83610
195/195 [==============================] - 58s 298ms/step - loss: 0.3297 - accuracy: 0.8842 - val_
loss: 0.8712 - val_accuracy: 0.7893
Epoch 60/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3267 - accuracy: 0.8835
Epoch 00060: val_accuracy did not improve from 0.83610
195/195 [==============================] - 58s 298ms/step - loss: 0.3266 - accuracy: 0.8836 - val_
loss: 0.8914 - val_accuracy: 0.7858
Epoch 61/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3261 - accuracy: 0.8850
Epoch 00061: val_accuracy did not improve from 0.83610
195/195 [==============================] - 58s 298ms/step - loss: 0.3258 - accuracy: 0.8851 - val_
loss: 0.6456 - val_accuracy: 0.8250
Epoch 62/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3209 - accuracy: 0.8865
Epoch 00062: val_accuracy did not improve from 0.83610
195/195 [==============================] - 58s 298ms/step - loss: 0.3210 - accuracy: 0.8865 - val_
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195/195 [==============================] - 58s 298ms/step - loss: 0.3210 - accuracy: 0.8865 - val_
loss: 0.6300 - val_accuracy: 0.8296
Epoch 63/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3216 - accuracy: 0.8856
Epoch 00063: val_accuracy did not improve from 0.83610
195/195 [==============================] - 58s 298ms/step - loss: 0.3212 - accuracy: 0.8857 - val_
loss: 0.6779 - val_accuracy: 0.8112
Epoch 64/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3155 - accuracy: 0.8876
Epoch 00064: val_accuracy did not improve from 0.83610
195/195 [==============================] - 58s 298ms/step - loss: 0.3154 - accuracy: 0.8876 - val_
loss: 0.7649 - val_accuracy: 0.8134
Epoch 65/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3082 - accuracy: 0.8911
Epoch 00065: val_accuracy did not improve from 0.83610
195/195 [==============================] - 58s 298ms/step - loss: 0.3090 - accuracy: 0.8909 - val_
loss: 0.9613 - val_accuracy: 0.7889
Epoch 66/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3109 - accuracy: 0.8895
Epoch 00066: val_accuracy did not improve from 0.83610
195/195 [==============================] - 58s 298ms/step - loss: 0.3115 - accuracy: 0.8893 - val_
loss: 0.6972 - val_accuracy: 0.8156
Epoch 67/300
194/195 [=============================>.] - ETA: 0s - loss: 0.3104 - accuracy: 0.8899
Epoch 00067: val_accuracy did not improve from 0.83610

Epoch 00067: ReduceLROnPlateau reducing learning rate to 0.00010000000474974513.
195/195 [==============================] - 58s 298ms/step - loss: 0.3105 - accuracy: 0.8899 - val_
loss: 0.9667 - val_accuracy: 0.7855
Epoch 68/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2654 - accuracy: 0.9045
Epoch 00068: val_accuracy improved from 0.83610 to 0.86340, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_68-0.86.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.2658 - accuracy: 0.9044 - val_
loss: 0.4823 - val_accuracy: 0.8634
Epoch 69/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2482 - accuracy: 0.9120
Epoch 00069: val_accuracy improved from 0.86340 to 0.86590, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_69-0.87.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.2480 - accuracy: 0.9121 - val_
loss: 0.4892 - val_accuracy: 0.8659
Epoch 70/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2426 - accuracy: 0.9132
Epoch 00070: val_accuracy did not improve from 0.86590
195/195 [==============================] - 58s 298ms/step - loss: 0.2424 - accuracy: 0.9133 - val_
loss: 0.4795 - val_accuracy: 0.8637
Epoch 71/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2418 - accuracy: 0.9133
Epoch 00071: val_accuracy did not improve from 0.86590
195/195 [==============================] - 58s 298ms/step - loss: 0.2415 - accuracy: 0.9134 - val_
loss: 0.5331 - val_accuracy: 0.8573
Epoch 72/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2363 - accuracy: 0.9162
Epoch 00072: val_accuracy did not improve from 0.86590
195/195 [==============================] - 58s 298ms/step - loss: 0.2360 - accuracy: 0.9162 - val_
loss: 0.5086 - val_accuracy: 0.8637
Epoch 73/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2360 - accuracy: 0.9164
Epoch 00073: val_accuracy did not improve from 0.86590
195/195 [==============================] - 58s 298ms/step - loss: 0.2360 - accuracy: 0.9165 - val_
loss: 0.5293 - val_accuracy: 0.8612
Epoch 74/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2334 - accuracy: 0.9181
Epoch 00074: val_accuracy did not improve from 0.86590
195/195 [==============================] - 58s 298ms/step - loss: 0.2332 - accuracy: 0.9182 - val_
loss: 0.5277 - val_accuracy: 0.8602
Epoch 75/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2312 - accuracy: 0.9174
Epoch 00075: val_accuracy improved from 0.86590 to 0.86890, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_75-0.87.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.2314 - accuracy: 0.9174 - val_
loss: 0.4848 - val_accuracy: 0.8689
Epoch 76/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2255 - accuracy: 0.9198
Epoch 00076: val_accuracy did not improve from 0.86890
195/195 [==============================] - 58s 298ms/step - loss: 0.2257 - accuracy: 0.9198 - val_
loss: 0.5205 - val_accuracy: 0.8607
Epoch 77/300
```

Epoch 77/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2259 - accuracy: 0.9200
Epoch 00077: val_accuracy did not improve from 0.86890
195/195 [==============================] - 58s 298ms/step - loss: 0.2256 - accuracy: 0.9200 - val_
loss: 0.5112 - val_accuracy: 0.8644
Epoch 78/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2261 - accuracy: 0.9203
Epoch 00078: val_accuracy improved from 0.86890 to 0.87080, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_78-0.87.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.2260 - accuracy: 0.9204 - val_
loss: 0.4802 - val_accuracy: 0.8708
Epoch 79/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2258 - accuracy: 0.9193
Epoch 00079: val_accuracy did not improve from 0.87080
195/195 [==============================] - 58s 298ms/step - loss: 0.2260 - accuracy: 0.9192 - val_
loss: 0.5028 - val_accuracy: 0.8660
Epoch 80/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2245 - accuracy: 0.9203
Epoch 00080: val_accuracy improved from 0.87080 to 0.87160, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_80-0.87.hdf5
195/195 [==============================] - 59s 301ms/step - loss: 0.2247 - accuracy: 0.9203 - val_
loss: 0.4873 - val_accuracy: 0.8716
Epoch 81/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2219 - accuracy: 0.9209
Epoch 00081: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2218 - accuracy: 0.9209 - val_
loss: 0.5059 - val_accuracy: 0.8672
Epoch 82/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2209 - accuracy: 0.9214
Epoch 00082: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2209 - accuracy: 0.9214 - val_
loss: 0.4989 - val_accuracy: 0.8686
Epoch 83/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2227 - accuracy: 0.9212
Epoch 00083: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2224 - accuracy: 0.9213 - val_
loss: 0.5171 - val_accuracy: 0.8645
Epoch 84/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2201 - accuracy: 0.9219
Epoch 00084: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2202 - accuracy: 0.9220 - val_
loss: 0.4935 - val_accuracy: 0.8711
Epoch 85/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2187 - accuracy: 0.9222
Epoch 00085: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2188 - accuracy: 0.9221 - val_
loss: 0.5030 - val_accuracy: 0.8680
Epoch 86/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2159 - accuracy: 0.9217
Epoch 00086: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2162 - accuracy: 0.9216 - val_
loss: 0.5246 - val_accuracy: 0.8655
Epoch 87/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2202 - accuracy: 0.9222
Epoch 00087: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2201 - accuracy: 0.9222 - val_
loss: 0.5086 - val_accuracy: 0.8635
Epoch 88/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2198 - accuracy: 0.9213
Epoch 00088: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2200 - accuracy: 0.9212 - val_
loss: 0.5080 - val_accuracy: 0.8695
Epoch 89/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2152 - accuracy: 0.9224
Epoch 00089: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2150 - accuracy: 0.9224 - val_
loss: 0.5341 - val_accuracy: 0.8611
Epoch 90/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2167 - accuracy: 0.9217
Epoch 00090: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2169 - accuracy: 0.9218 - val_
loss: 0.5030 - val_accuracy: 0.8675
Epoch 91/300
194/195 [=============================>.] - ETA: 0s - loss: 0.2169 - accuracy: 0.9234
Epoch 00091: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2168 - accuracy: 0.9234 - val_
loss: 0.5199 - val_accuracy: 0.8657
Epoch 92/300

```
Epoch 92/300
194/195 [============================>.] - ETA: 0s - loss: 0.2134 - accuracy: 0.9233
Epoch 00092: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2128 - accuracy: 0.9236 - val_
loss: 0.5178 - val_accuracy: 0.8633
Epoch 93/300
194/195 [============================>.] - ETA: 0s - loss: 0.2140 - accuracy: 0.9238
Epoch 00093: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2139 - accuracy: 0.9239 - val_
loss: 0.5139 - val_accuracy: 0.8652
Epoch 94/300
194/195 [============================>.] - ETA: 0s - loss: 0.2125 - accuracy: 0.9242
Epoch 00094: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2127 - accuracy: 0.9241 - val_
loss: 0.5276 - val_accuracy: 0.8646
Epoch 95/300
194/195 [============================>.] - ETA: 0s - loss: 0.2139 - accuracy: 0.9230
Epoch 00095: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2136 - accuracy: 0.9231 - val_
loss: 0.5513 - val_accuracy: 0.8597
Epoch 96/300
194/195 [============================>.] - ETA: 0s - loss: 0.2139 - accuracy: 0.9249
Epoch 00096: val_accuracy did not improve from 0.87160

Epoch 00096: ReduceLROnPlateau reducing learning rate to 1.0000000474974514e-05.
195/195 [==============================] - 58s 298ms/step - loss: 0.2138 - accuracy: 0.9250 - val_
loss: 0.4776 - val_accuracy: 0.8710
Epoch 97/300
194/195 [============================>.] - ETA: 0s - loss: 0.2061 - accuracy: 0.9265
Epoch 00097: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2068 - accuracy: 0.9263 - val_
loss: 0.5014 - val_accuracy: 0.8693
Epoch 98/300
194/195 [============================>.] - ETA: 0s - loss: 0.2035 - accuracy: 0.9262
Epoch 00098: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2036 - accuracy: 0.9261 - val_
loss: 0.5089 - val_accuracy: 0.8675
Epoch 99/300
194/195 [============================>.] - ETA: 0s - loss: 0.2038 - accuracy: 0.9263
Epoch 00099: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2036 - accuracy: 0.9264 - val_
loss: 0.5057 - val_accuracy: 0.8687
Epoch 100/300
194/195 [============================>.] - ETA: 0s - loss: 0.2046 - accuracy: 0.9265
Epoch 00100: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2046 - accuracy: 0.9265 - val_
loss: 0.5033 - val_accuracy: 0.8694
Epoch 101/300
194/195 [============================>.] - ETA: 0s - loss: 0.2084 - accuracy: 0.9248
Epoch 00101: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2083 - accuracy: 0.9248 - val_
loss: 0.5015 - val_accuracy: 0.8692
Epoch 102/300
194/195 [============================>.] - ETA: 0s - loss: 0.2031 - accuracy: 0.9265
Epoch 00102: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2035 - accuracy: 0.9264 - val_
loss: 0.5028 - val_accuracy: 0.8675
Epoch 103/300
194/195 [============================>.] - ETA: 0s - loss: 0.2034 - accuracy: 0.9260
Epoch 00103: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2036 - accuracy: 0.9260 - val_
loss: 0.4995 - val_accuracy: 0.8694
Epoch 104/300
194/195 [============================>.] - ETA: 0s - loss: 0.2068 - accuracy: 0.9257
Epoch 00104: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 297ms/step - loss: 0.2067 - accuracy: 0.9258 - val_
loss: 0.5052 - val_accuracy: 0.8681
Epoch 105/300
194/195 [============================>.] - ETA: 0s - loss: 0.1997 - accuracy: 0.9285
Epoch 00105: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.1996 - accuracy: 0.9285 - val_
loss: 0.4970 - val_accuracy: 0.8693
Epoch 106/300
194/195 [============================>.] - ETA: 0s - loss: 0.2010 - accuracy: 0.9282
Epoch 00106: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2009 - accuracy: 0.9283 - val_
loss: 0.5043 - val_accuracy: 0.8687
Epoch 107/300
```

```
Epoch 107/300
194/195 [============================>.] - ETA: 0s - loss: 0.2033 - accuracy: 0.9276
Epoch 00107: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2033 - accuracy: 0.9275 - val_
loss: 0.5058 - val_accuracy: 0.8691
Epoch 108/300
194/195 [============================>.] - ETA: 0s - loss: 0.2052 - accuracy: 0.9271
Epoch 00108: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2054 - accuracy: 0.9271 - val_
loss: 0.5037 - val_accuracy: 0.8693
Epoch 109/300
194/195 [============================>.] - ETA: 0s - loss: 0.2053 - accuracy: 0.9273
Epoch 00109: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2052 - accuracy: 0.9272 - val_
loss: 0.5083 - val_accuracy: 0.8674
Epoch 110/300
194/195 [============================>.] - ETA: 0s - loss: 0.2042 - accuracy: 0.9278
Epoch 00110: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2043 - accuracy: 0.9278 - val_
loss: 0.5007 - val_accuracy: 0.8695
Epoch 111/300
194/195 [============================>.] - ETA: 0s - loss: 0.2026 - accuracy: 0.9277
Epoch 00111: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2028 - accuracy: 0.9276 - val_
loss: 0.5015 - val_accuracy: 0.8693
Epoch 112/300
194/195 [============================>.] - ETA: 0s - loss: 0.1986 - accuracy: 0.9288
Epoch 00112: val_accuracy did not improve from 0.87160

Epoch 00112: ReduceLROnPlateau reducing learning rate to 1.0000000656873453e-06.
195/195 [==============================] - 58s 298ms/step - loss: 0.1986 - accuracy: 0.9288 - val_
loss: 0.4992 - val_accuracy: 0.8702
Epoch 113/300
194/195 [============================>.] - ETA: 0s - loss: 0.2035 - accuracy: 0.9259
Epoch 00113: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2035 - accuracy: 0.9259 - val_
loss: 0.5008 - val_accuracy: 0.8696
Epoch 114/300
194/195 [============================>.] - ETA: 0s - loss: 0.2050 - accuracy: 0.9258
Epoch 00114: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2047 - accuracy: 0.9259 - val_
loss: 0.5029 - val_accuracy: 0.8694
Epoch 115/300
194/195 [============================>.] - ETA: 0s - loss: 0.2030 - accuracy: 0.9261
Epoch 00115: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2029 - accuracy: 0.9262 - val_
loss: 0.5032 - val_accuracy: 0.8692
Epoch 116/300
194/195 [============================>.] - ETA: 0s - loss: 0.2024 - accuracy: 0.9281
Epoch 00116: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2022 - accuracy: 0.9281 - val_
loss: 0.5033 - val_accuracy: 0.8690
Epoch 117/300
194/195 [============================>.] - ETA: 0s - loss: 0.2003 - accuracy: 0.9288
Epoch 00117: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2003 - accuracy: 0.9288 - val_
loss: 0.5030 - val_accuracy: 0.8694
Epoch 118/300
194/195 [============================>.] - ETA: 0s - loss: 0.2015 - accuracy: 0.9259
Epoch 00118: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2018 - accuracy: 0.9259 - val_
loss: 0.5023 - val_accuracy: 0.8689
Epoch 119/300
194/195 [============================>.] - ETA: 0s - loss: 0.2014 - accuracy: 0.9274
Epoch 00119: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2014 - accuracy: 0.9273 - val_
loss: 0.5032 - val_accuracy: 0.8689
Epoch 120/300
194/195 [============================>.] - ETA: 0s - loss: 0.1993 - accuracy: 0.9284
Epoch 00120: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.1995 - accuracy: 0.9284 - val_
loss: 0.5026 - val_accuracy: 0.8690
Epoch 121/300
194/195 [============================>.] - ETA: 0s - loss: 0.2035 - accuracy: 0.9273
Epoch 00121: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2033 - accuracy: 0.9274 - val_
loss: 0.5038 - val_accuracy: 0.8691
```

```
Epoch 122/300
194/195 [============================>.] - ETA: 0s - loss: 0.2032 - accuracy: 0.9267
Epoch 00122: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2031 - accuracy: 0.9267 - val_
loss: 0.5021 - val_accuracy: 0.8689
Epoch 123/300
194/195 [============================>.] - ETA: 0s - loss: 0.2034 - accuracy: 0.9276
Epoch 00123: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2038 - accuracy: 0.9274 - val_
loss: 0.5026 - val_accuracy: 0.8691
Epoch 124/300
194/195 [============================>.] - ETA: 0s - loss: 0.2046 - accuracy: 0.9264
Epoch 00124: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2047 - accuracy: 0.9263 - val_
loss: 0.5015 - val_accuracy: 0.8693
Epoch 125/300
194/195 [============================>.] - ETA: 0s - loss: 0.2022 - accuracy: 0.9271
Epoch 00125: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2022 - accuracy: 0.9271 - val_
loss: 0.5024 - val_accuracy: 0.8689
Epoch 126/300
194/195 [============================>.] - ETA: 0s - loss: 0.2028 - accuracy: 0.9281
Epoch 00126: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2027 - accuracy: 0.9282 - val_
loss: 0.5033 - val_accuracy: 0.8689
Epoch 127/300
194/195 [============================>.] - ETA: 0s - loss: 0.2030 - accuracy: 0.9271
Epoch 00127: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 298ms/step - loss: 0.2027 - accuracy: 0.9273 - val_
loss: 0.5031 - val_accuracy: 0.8690
Epoch 128/300
194/195 [============================>.] - ETA: 0s - loss: 0.1997 - accuracy: 0.9286
Epoch 00128: val_accuracy did not improve from 0.87160

Epoch 00128: ReduceLROnPlateau reducing learning rate to 1.0000001111620805e-07.
195/195 [==============================] - 58s 298ms/step - loss: 0.1997 - accuracy: 0.9286 - val_
loss: 0.5039 - val_accuracy: 0.8688
Epoch 129/300
194/195 [============================>.] - ETA: 0s - loss: 0.2047 - accuracy: 0.9263
Epoch 00129: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 297ms/step - loss: 0.2046 - accuracy: 0.9264 - val_
loss: 0.5036 - val_accuracy: 0.8690
Epoch 130/300
194/195 [============================>.] - ETA: 0s - loss: 0.2025 - accuracy: 0.9284
Epoch 00130: val_accuracy did not improve from 0.87160
195/195 [==============================] - 58s 297ms/step - loss: 0.2025 - accuracy: 0.9284 - val_
loss: 0.5010 - val_accuracy: 0.8690
```

In [61]:

```python
#history plot for accyracy
plt.figure(figsize=(16,4))
plt.plot(history_3.history['accuracy'])
plt.plot(history_3.history['val_accuracy'])
plt.title("Model Accuracy")
plt.xlabel("Epoch")
plt.ylabel("Accuracy")
plt.legend(["train", "test"], loc="upper left")
plt.show()

# history plot for accuracy
plt.figure(figsize=(16,4))
plt.plot(history_3.history["loss"])
plt.plot(history_3.history["val_loss"])
plt.title("Model Loss")
plt.xlabel("Epoch")
plt.ylabel("Loss")
plt.legend(["train", "test"], loc="upper left")
plt.show()
```

Model Loss
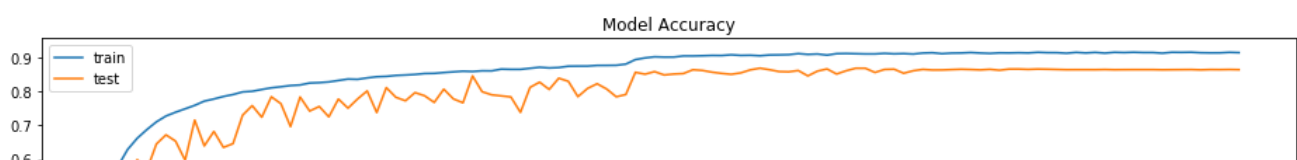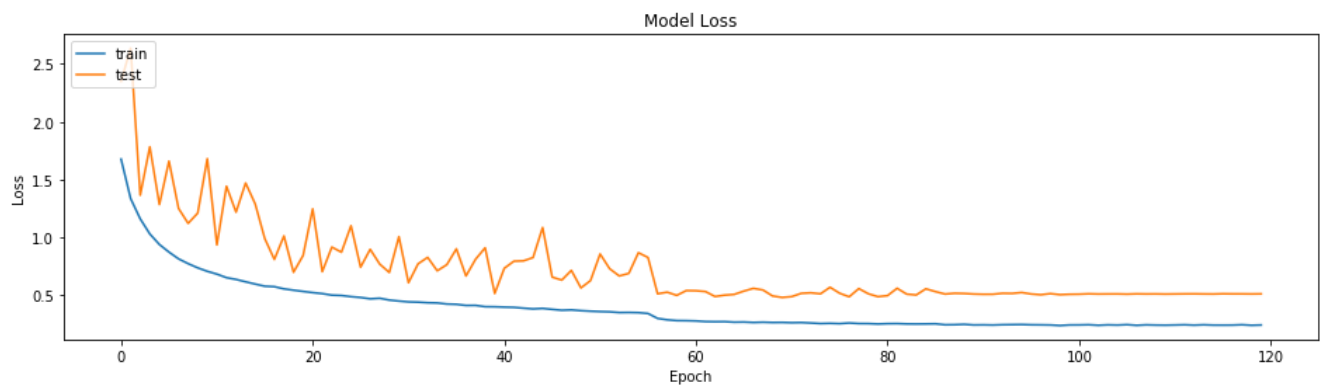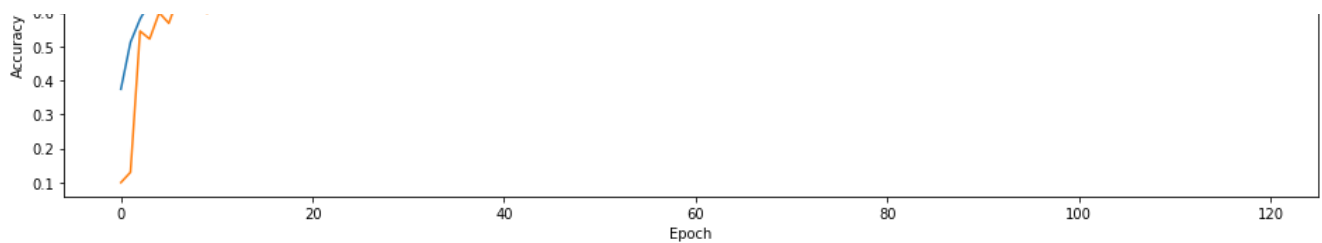
```
best_model_4 =
tf.keras.models.load_model('/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model4_80-0.87
.hdf5')
scores = best_model_4.evaluate(X_test, y_test, verbose=1)
print(scores)
```

```
10000/10000 [==============================] - 4s 432us/sample - loss: 0.4873 - accuracy: 0.8716
[0.487310631595552, 0.8716]
```

Model -5:

- dropout = 0.2
- compression = 0.3
- using conv instead of fully connected layers

```python
#BN-->ReLU-->Conv2D-->Dropout-->concat(input, output)-->(put in loop)
from tensorflow.keras import layers
from tensorflow.keras.models import Model
num_classes = 10

def denseblock(input, num_filter, dropout_rate):
    global compression      # to keep the growth rate of number of filters
    temp = input
    for _ in range(l):
        BatchNorm = layers.BatchNormalization()(temp)
        relu = layers.Activation('relu')(BatchNorm)
        Conv2D_7_7= layers.SeparableConv2D(int(num_filter*compression), (7,7), use_bias=False, padd
ing='same')(relu)
        if dropout_rate>0:
            Conv2D_7_7 = layers.Dropout(dropout_rate)(Conv2D_7_7)

        #concat the input(temp) and output(conv2d_7_7) , in resnet we add but here we concat
        concat = layers.Concatenate(axis=-1)([temp,Conv2D_7_7])

        #change the concat as input
        temp = concat

    return temp

#BN-->relu-->conv2d(1x1)-->dropout-->avg_pool
def transition(input, num_filter, dropout_rate):
    global compression
```

```
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    Conv2D_BottleNeck = layers.SeparableConvolution2D(int(num_filter*compression), (1,1), use_bias=
False ,padding='same')(relu)
    if dropout_rate>0:
        Conv2D_BottleNeck = layers.Dropout(dropout_rate)(Conv2D_BottleNeck)
    avg = layers.AveragePooling2D(pool_size=(2,2))(Conv2D_BottleNeck)
    return avg

#BN-->relu-->avgpool-->flat-->softmax
def output_layer(input):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    AvgPooling = layers.AveragePooling2D(pool_size=(2,2))(relu)
    conv_op = layers.SeparableConvolution2D(num_classes, (2,2), padding='valid')(AvgPooling)
    flat = layers.Flatten()(conv_op)
    output = layers.Dense(num_classes, activation='softmax')(flat)
    return output

# Hyperparameters
l = 21
num_filter = 48
compression = 0.3
dropout_rate = 0.2
num_classes = 10

input = layers.Input(shape=(input_size))
First_Conv2D = layers.Conv2D(num_filter, (7,7), use_bias=False ,padding='same')(input)

#First dense and transition block
First_Block = denseblock(First_Conv2D, num_filter, dropout_rate)
First_Transition = transition(First_Block, num_filter, dropout_rate)

#Second dense and transition block
Second_Block = denseblock(First_Transition, num_filter, dropout_rate)
Second_Transition = transition(Second_Block, num_filter, dropout_rate)

#Third dense and transition block
Third_Block = denseblock(Second_Transition, num_filter, dropout_rate)
Third_Transition = transition(Third_Block, num_filter, dropout_rate)

#last dense and output block
Last_Block = denseblock(Third_Transition,  num_filter, dropout_rate)
output = output_layer(Last_Block)
```

In [68]:

```
model_5 = tf.keras.models.Model(inputs=[input], outputs=[output])
model_5.summary()
```

Model: "model_20"

Layer (type)	Output Shape	Param #	Connected to
input_24 (InputLayer)	[(None, 32, 32, 3)]	0	
conv2d_32 (Conv2D)	(None, 32, 32, 48)	7056	input_24[0][0]
batch_normalization_2476 (Batch	(None, 32, 32, 48)	192	conv2d_32[0][0]
activation_2476 (Activation)	(None, 32, 32, 48)	0	batch_normalization_2476[0][0]
separable_conv2d_2463 (Separabl	(None, 32, 32, 14)	3024	activation_2476[0][0]
dropout_1339 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2463[0][0]
concatenate_2384 (Concatenate)	(None, 32, 32, 62)	0	conv2d_32[0][0] dropout_1339[0][0]
batch_normalization_2477 (Batch	(None, 32, 32, 62)	248	concatenate_2384[0][0]
activation_2477 (Activation)	(None, 32, 32, 62)	0	batch_normalization_2477[0][0]
separable_conv2d_2464 (Separabl	(None, 32, 32, 14)	3906	activation_2477[0][0]

dropout_1340 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2464[0][0]
concatenate_2385 (Concatenate)	(None, 32, 32, 76)	0	concatenate_2384[0][0] dropout_1340[0][0]
batch_normalization_2478 (Batch	(None, 32, 32, 76)	304	concatenate_2385[0][0]
activation_2478 (Activation)	(None, 32, 32, 76)	0	batch_normalization_2478[0][0]
separable_conv2d_2465 (Separabl	(None, 32, 32, 14)	4788	activation_2478[0][0]
dropout_1341 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2465[0][0]
concatenate_2386 (Concatenate)	(None, 32, 32, 90)	0	concatenate_2385[0][0] dropout_1341[0][0]
batch_normalization_2479 (Batch	(None, 32, 32, 90)	360	concatenate_2386[0][0]
activation_2479 (Activation)	(None, 32, 32, 90)	0	batch_normalization_2479[0][0]
separable_conv2d_2466 (Separabl	(None, 32, 32, 14)	5670	activation_2479[0][0]
dropout_1342 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2466[0][0]
concatenate_2387 (Concatenate)	(None, 32, 32, 104)	0	concatenate_2386[0][0] dropout_1342[0][0]
batch_normalization_2480 (Batch	(None, 32, 32, 104)	416	concatenate_2387[0][0]
activation_2480 (Activation)	(None, 32, 32, 104)	0	batch_normalization_2480[0][0]
separable_conv2d_2467 (Separabl	(None, 32, 32, 14)	6552	activation_2480[0][0]
dropout_1343 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2467[0][0]
concatenate_2388 (Concatenate)	(None, 32, 32, 118)	0	concatenate_2387[0][0] dropout_1343[0][0]
batch_normalization_2481 (Batch	(None, 32, 32, 118)	472	concatenate_2388[0][0]
activation_2481 (Activation)	(None, 32, 32, 118)	0	batch_normalization_2481[0][0]
separable_conv2d_2468 (Separabl	(None, 32, 32, 14)	7434	activation_2481[0][0]
dropout_1344 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2468[0][0]
concatenate_2389 (Concatenate)	(None, 32, 32, 132)	0	concatenate_2388[0][0] dropout_1344[0][0]
batch_normalization_2482 (Batch	(None, 32, 32, 132)	528	concatenate_2389[0][0]
activation_2482 (Activation)	(None, 32, 32, 132)	0	batch_normalization_2482[0][0]
separable_conv2d_2469 (Separabl	(None, 32, 32, 14)	8316	activation_2482[0][0]
dropout_1345 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2469[0][0]
concatenate_2390 (Concatenate)	(None, 32, 32, 146)	0	concatenate_2389[0][0] dropout_1345[0][0]
batch_normalization_2483 (Batch	(None, 32, 32, 146)	584	concatenate_2390[0][0]
activation_2483 (Activation)	(None, 32, 32, 146)	0	batch_normalization_2483[0][0]
separable_conv2d_2470 (Separabl	(None, 32, 32, 14)	9198	activation_2483[0][0]
dropout_1346 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2470[0][0]
concatenate_2391 (Concatenate)	(None, 32, 32, 160)	0	concatenate_2390[0][0] dropout_1346[0][0]
batch_normalization_2484 (Batch	(None, 32, 32, 160)	640	concatenate_2391[0][0]
activation_2484 (Activation)	(None, 32, 32, 160)	0	batch_normalization_2484[0][0]
separable_conv2d_2471 (Separabl	(None, 32, 32, 14)	10080	activation_2484[0][0]

dropout_1347 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2471[0][0]
concatenate_2392 (Concatenate)	(None, 32, 32, 174)	0	concatenate_2391[0][0] dropout_1347[0][0]
batch_normalization_2485 (Batch	(None, 32, 32, 174)	696	concatenate_2392[0][0]
activation_2485 (Activation)	(None, 32, 32, 174)	0	batch_normalization_2485[0][0]
separable_conv2d_2472 (Separabl	(None, 32, 32, 14)	10962	activation_2485[0][0]
dropout_1348 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2472[0][0]
concatenate_2393 (Concatenate)	(None, 32, 32, 188)	0	concatenate_2392[0][0] dropout_1348[0][0]
batch_normalization_2486 (Batch	(None, 32, 32, 188)	752	concatenate_2393[0][0]
activation_2486 (Activation)	(None, 32, 32, 188)	0	batch_normalization_2486[0][0]
separable_conv2d_2473 (Separabl	(None, 32, 32, 14)	11844	activation_2486[0][0]
dropout_1349 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2473[0][0]
concatenate_2394 (Concatenate)	(None, 32, 32, 202)	0	concatenate_2393[0][0] dropout_1349[0][0]
batch_normalization_2487 (Batch	(None, 32, 32, 202)	808	concatenate_2394[0][0]
activation_2487 (Activation)	(None, 32, 32, 202)	0	batch_normalization_2487[0][0]
separable_conv2d_2474 (Separabl	(None, 32, 32, 14)	12726	activation_2487[0][0]
dropout_1350 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2474[0][0]
concatenate_2395 (Concatenate)	(None, 32, 32, 216)	0	concatenate_2394[0][0] dropout_1350[0][0]
batch_normalization_2488 (Batch	(None, 32, 32, 216)	864	concatenate_2395[0][0]
activation_2488 (Activation)	(None, 32, 32, 216)	0	batch_normalization_2488[0][0]
separable_conv2d_2475 (Separabl	(None, 32, 32, 14)	13608	activation_2488[0][0]
dropout_1351 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2475[0][0]
concatenate_2396 (Concatenate)	(None, 32, 32, 230)	0	concatenate_2395[0][0] dropout_1351[0][0]
batch_normalization_2489 (Batch	(None, 32, 32, 230)	920	concatenate_2396[0][0]
activation_2489 (Activation)	(None, 32, 32, 230)	0	batch_normalization_2489[0][0]
separable_conv2d_2476 (Separabl	(None, 32, 32, 14)	14490	activation_2489[0][0]
dropout_1352 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2476[0][0]
concatenate_2397 (Concatenate)	(None, 32, 32, 244)	0	concatenate_2396[0][0] dropout_1352[0][0]
batch_normalization_2490 (Batch	(None, 32, 32, 244)	976	concatenate_2397[0][0]
activation_2490 (Activation)	(None, 32, 32, 244)	0	batch_normalization_2490[0][0]
separable_conv2d_2477 (Separabl	(None, 32, 32, 14)	15372	activation_2490[0][0]
dropout_1353 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2477[0][0]
concatenate_2398 (Concatenate)	(None, 32, 32, 258)	0	concatenate_2397[0][0] dropout_1353[0][0]
batch_normalization_2491 (Batch	(None, 32, 32, 258)	1032	concatenate_2398[0][0]
activation_2491 (Activation)	(None, 32, 32, 258)	0	batch_normalization_2491[0][0]
separable_conv2d_2478 (Separabl	(None, 32, 32, 14)	16254	activation_2491[0][0]

Layer	Output Shape	Param #	Connected to
dropout_1354 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2478[0][0]
concatenate_2399 (Concatenate)	(None, 32, 32, 272)	0	concatenate_2398[0][0] dropout_1354[0][0]
batch_normalization_2492 (Batch	(None, 32, 32, 272)	1088	concatenate_2399[0][0]
activation_2492 (Activation)	(None, 32, 32, 272)	0	batch_normalization_2492[0][0]
separable_conv2d_2479 (Separabl	(None, 32, 32, 14)	17136	activation_2492[0][0]
dropout_1355 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2479[0][0]
concatenate_2400 (Concatenate)	(None, 32, 32, 286)	0	concatenate_2399[0][0] dropout_1355[0][0]
batch_normalization_2493 (Batch	(None, 32, 32, 286)	1144	concatenate_2400[0][0]
activation_2493 (Activation)	(None, 32, 32, 286)	0	batch_normalization_2493[0][0]
separable_conv2d_2480 (Separabl	(None, 32, 32, 14)	18018	activation_2493[0][0]
dropout_1356 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2480[0][0]
concatenate_2401 (Concatenate)	(None, 32, 32, 300)	0	concatenate_2400[0][0] dropout_1356[0][0]
batch_normalization_2494 (Batch	(None, 32, 32, 300)	1200	concatenate_2401[0][0]
activation_2494 (Activation)	(None, 32, 32, 300)	0	batch_normalization_2494[0][0]
separable_conv2d_2481 (Separabl	(None, 32, 32, 14)	18900	activation_2494[0][0]
dropout_1357 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2481[0][0]
concatenate_2402 (Concatenate)	(None, 32, 32, 314)	0	concatenate_2401[0][0] dropout_1357[0][0]
batch_normalization_2495 (Batch	(None, 32, 32, 314)	1256	concatenate_2402[0][0]
activation_2495 (Activation)	(None, 32, 32, 314)	0	batch_normalization_2495[0][0]
separable_conv2d_2482 (Separabl	(None, 32, 32, 14)	19782	activation_2495[0][0]
dropout_1358 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2482[0][0]
concatenate_2403 (Concatenate)	(None, 32, 32, 328)	0	concatenate_2402[0][0] dropout_1358[0][0]
batch_normalization_2496 (Batch	(None, 32, 32, 328)	1312	concatenate_2403[0][0]
activation_2496 (Activation)	(None, 32, 32, 328)	0	batch_normalization_2496[0][0]
separable_conv2d_2483 (Separabl	(None, 32, 32, 14)	20664	activation_2496[0][0]
dropout_1359 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2483[0][0]
concatenate_2404 (Concatenate)	(None, 32, 32, 342)	0	concatenate_2403[0][0] dropout_1359[0][0]
batch_normalization_2497 (Batch	(None, 32, 32, 342)	1368	concatenate_2404[0][0]
activation_2497 (Activation)	(None, 32, 32, 342)	0	batch_normalization_2497[0][0]
separable_conv2d_2484 (Separabl	(None, 32, 32, 14)	5130	activation_2497[0][0]
dropout_1360 (Dropout)	(None, 32, 32, 14)	0	separable_conv2d_2484[0][0]
average_pooling2d_92 (AveragePo	(None, 16, 16, 14)	0	dropout_1360[0][0]
batch_normalization_2498 (Batch	(None, 16, 16, 14)	56	average_pooling2d_92[0][0]
activation_2498 (Activation)	(None, 16, 16, 14)	0	batch_normalization_2498[0][0]
separable_conv2d_2485 (Separabl	(None, 16, 16, 14)	882	activation_2498[0][0]
dropout_1361 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2485[0][0]

dropout_1361 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2485[0][0]
concatenate_2405 (Concatenate)	(None, 16, 16, 28)	0	average_pooling2d_92[0][0] dropout_1361[0][0]
batch_normalization_2499 (Batch	(None, 16, 16, 28)	112	concatenate_2405[0][0]
activation_2499 (Activation)	(None, 16, 16, 28)	0	batch_normalization_2499[0][0]
separable_conv2d_2486 (Separabl	(None, 16, 16, 14)	1764	activation_2499[0][0]
dropout_1362 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2486[0][0]
concatenate_2406 (Concatenate)	(None, 16, 16, 42)	0	concatenate_2405[0][0] dropout_1362[0][0]
batch_normalization_2500 (Batch	(None, 16, 16, 42)	168	concatenate_2406[0][0]
activation_2500 (Activation)	(None, 16, 16, 42)	0	batch_normalization_2500[0][0]
separable_conv2d_2487 (Separabl	(None, 16, 16, 14)	2646	activation_2500[0][0]
dropout_1363 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2487[0][0]
concatenate_2407 (Concatenate)	(None, 16, 16, 56)	0	concatenate_2406[0][0] dropout_1363[0][0]
batch_normalization_2501 (Batch	(None, 16, 16, 56)	224	concatenate_2407[0][0]
activation_2501 (Activation)	(None, 16, 16, 56)	0	batch_normalization_2501[0][0]
separable_conv2d_2488 (Separabl	(None, 16, 16, 14)	3528	activation_2501[0][0]
dropout_1364 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2488[0][0]
concatenate_2408 (Concatenate)	(None, 16, 16, 70)	0	concatenate_2407[0][0] dropout_1364[0][0]
batch_normalization_2502 (Batch	(None, 16, 16, 70)	280	concatenate_2408[0][0]
activation_2502 (Activation)	(None, 16, 16, 70)	0	batch_normalization_2502[0][0]
separable_conv2d_2489 (Separabl	(None, 16, 16, 14)	4410	activation_2502[0][0]
dropout_1365 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2489[0][0]
concatenate_2409 (Concatenate)	(None, 16, 16, 84)	0	concatenate_2408[0][0] dropout_1365[0][0]
batch_normalization_2503 (Batch	(None, 16, 16, 84)	336	concatenate_2409[0][0]
activation_2503 (Activation)	(None, 16, 16, 84)	0	batch_normalization_2503[0][0]
separable_conv2d_2490 (Separabl	(None, 16, 16, 14)	5292	activation_2503[0][0]
dropout_1366 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2490[0][0]
concatenate_2410 (Concatenate)	(None, 16, 16, 98)	0	concatenate_2409[0][0] dropout_1366[0][0]
batch_normalization_2504 (Batch	(None, 16, 16, 98)	392	concatenate_2410[0][0]
activation_2504 (Activation)	(None, 16, 16, 98)	0	batch_normalization_2504[0][0]
separable_conv2d_2491 (Separabl	(None, 16, 16, 14)	6174	activation_2504[0][0]
dropout_1367 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2491[0][0]
concatenate_2411 (Concatenate)	(None, 16, 16, 112)	0	concatenate_2410[0][0] dropout_1367[0][0]
batch_normalization_2505 (Batch	(None, 16, 16, 112)	448	concatenate_2411[0][0]
activation_2505 (Activation)	(None, 16, 16, 112)	0	batch_normalization_2505[0][0]
separable_conv2d_2492 (Separabl	(None, 16, 16, 14)	7056	activation_2505[0][0]
dropout_1368 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2492[0][0]

dropout_1368 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2492[0][0]
concatenate_2412 (Concatenate)	(None, 16, 16, 126)	0	concatenate_2411[0][0] dropout_1368[0][0]
batch_normalization_2506 (Batch	(None, 16, 16, 126)	504	concatenate_2412[0][0]
activation_2506 (Activation)	(None, 16, 16, 126)	0	batch_normalization_2506[0][0]
separable_conv2d_2493 (Separabl	(None, 16, 16, 14)	7938	activation_2506[0][0]
dropout_1369 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2493[0][0]
concatenate_2413 (Concatenate)	(None, 16, 16, 140)	0	concatenate_2412[0][0] dropout_1369[0][0]
batch_normalization_2507 (Batch	(None, 16, 16, 140)	560	concatenate_2413[0][0]
activation_2507 (Activation)	(None, 16, 16, 140)	0	batch_normalization_2507[0][0]
separable_conv2d_2494 (Separabl	(None, 16, 16, 14)	8820	activation_2507[0][0]
dropout_1370 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2494[0][0]
concatenate_2414 (Concatenate)	(None, 16, 16, 154)	0	concatenate_2413[0][0] dropout_1370[0][0]
batch_normalization_2508 (Batch	(None, 16, 16, 154)	616	concatenate_2414[0][0]
activation_2508 (Activation)	(None, 16, 16, 154)	0	batch_normalization_2508[0][0]
separable_conv2d_2495 (Separabl	(None, 16, 16, 14)	9702	activation_2508[0][0]
dropout_1371 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2495[0][0]
concatenate_2415 (Concatenate)	(None, 16, 16, 168)	0	concatenate_2414[0][0] dropout_1371[0][0]
batch_normalization_2509 (Batch	(None, 16, 16, 168)	672	concatenate_2415[0][0]
activation_2509 (Activation)	(None, 16, 16, 168)	0	batch_normalization_2509[0][0]
separable_conv2d_2496 (Separabl	(None, 16, 16, 14)	10584	activation_2509[0][0]
dropout_1372 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2496[0][0]
concatenate_2416 (Concatenate)	(None, 16, 16, 182)	0	concatenate_2415[0][0] dropout_1372[0][0]
batch_normalization_2510 (Batch	(None, 16, 16, 182)	728	concatenate_2416[0][0]
activation_2510 (Activation)	(None, 16, 16, 182)	0	batch_normalization_2510[0][0]
separable_conv2d_2497 (Separabl	(None, 16, 16, 14)	11466	activation_2510[0][0]
dropout_1373 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2497[0][0]
concatenate_2417 (Concatenate)	(None, 16, 16, 196)	0	concatenate_2416[0][0] dropout_1373[0][0]
batch_normalization_2511 (Batch	(None, 16, 16, 196)	784	concatenate_2417[0][0]
activation_2511 (Activation)	(None, 16, 16, 196)	0	batch_normalization_2511[0][0]
separable_conv2d_2498 (Separabl	(None, 16, 16, 14)	12348	activation_2511[0][0]
dropout_1374 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2498[0][0]
concatenate_2418 (Concatenate)	(None, 16, 16, 210)	0	concatenate_2417[0][0] dropout_1374[0][0]
batch_normalization_2512 (Batch	(None, 16, 16, 210)	840	concatenate_2418[0][0]
activation_2512 (Activation)	(None, 16, 16, 210)	0	batch_normalization_2512[0][0]
separable_conv2d_2499 (Separabl	(None, 16, 16, 14)	13230	activation_2512[0][0]
dropout_1375 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2499[0][0]

Layer	Output Shape	Param #	Connected to
dropout_1375 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2499[0][0]
concatenate_2419 (Concatenate)	(None, 16, 16, 224)	0	concatenate_2418[0][0] dropout_1375[0][0]
batch_normalization_2513 (Batch	(None, 16, 16, 224)	896	concatenate_2419[0][0]
activation_2513 (Activation)	(None, 16, 16, 224)	0	batch_normalization_2513[0][0]
separable_conv2d_2500 (Separabl	(None, 16, 16, 14)	14112	activation_2513[0][0]
dropout_1376 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2500[0][0]
concatenate_2420 (Concatenate)	(None, 16, 16, 238)	0	concatenate_2419[0][0] dropout_1376[0][0]
batch_normalization_2514 (Batch	(None, 16, 16, 238)	952	concatenate_2420[0][0]
activation_2514 (Activation)	(None, 16, 16, 238)	0	batch_normalization_2514[0][0]
separable_conv2d_2501 (Separabl	(None, 16, 16, 14)	14994	activation_2514[0][0]
dropout_1377 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2501[0][0]
concatenate_2421 (Concatenate)	(None, 16, 16, 252)	0	concatenate_2420[0][0] dropout_1377[0][0]
batch_normalization_2515 (Batch	(None, 16, 16, 252)	1008	concatenate_2421[0][0]
activation_2515 (Activation)	(None, 16, 16, 252)	0	batch_normalization_2515[0][0]
separable_conv2d_2502 (Separabl	(None, 16, 16, 14)	15876	activation_2515[0][0]
dropout_1378 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2502[0][0]
concatenate_2422 (Concatenate)	(None, 16, 16, 266)	0	concatenate_2421[0][0] dropout_1378[0][0]
batch_normalization_2516 (Batch	(None, 16, 16, 266)	1064	concatenate_2422[0][0]
activation_2516 (Activation)	(None, 16, 16, 266)	0	batch_normalization_2516[0][0]
separable_conv2d_2503 (Separabl	(None, 16, 16, 14)	16758	activation_2516[0][0]
dropout_1379 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2503[0][0]
concatenate_2423 (Concatenate)	(None, 16, 16, 280)	0	concatenate_2422[0][0] dropout_1379[0][0]
batch_normalization_2517 (Batch	(None, 16, 16, 280)	1120	concatenate_2423[0][0]
activation_2517 (Activation)	(None, 16, 16, 280)	0	batch_normalization_2517[0][0]
separable_conv2d_2504 (Separabl	(None, 16, 16, 14)	17640	activation_2517[0][0]
dropout_1380 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2504[0][0]
concatenate_2424 (Concatenate)	(None, 16, 16, 294)	0	concatenate_2423[0][0] dropout_1380[0][0]
batch_normalization_2518 (Batch	(None, 16, 16, 294)	1176	concatenate_2424[0][0]
activation_2518 (Activation)	(None, 16, 16, 294)	0	batch_normalization_2518[0][0]
separable_conv2d_2505 (Separabl	(None, 16, 16, 14)	18522	activation_2518[0][0]
dropout_1381 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2505[0][0]
concatenate_2425 (Concatenate)	(None, 16, 16, 308)	0	concatenate_2424[0][0] dropout_1381[0][0]
batch_normalization_2519 (Batch	(None, 16, 16, 308)	1232	concatenate_2425[0][0]
activation_2519 (Activation)	(None, 16, 16, 308)	0	batch_normalization_2519[0][0]
separable_conv2d_2506 (Separabl	(None, 16, 16, 14)	4620	activation_2519[0][0]
dropout_1382 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2506[0][0]

dropout_1382 (Dropout)	(None, 16, 16, 14)	0	separable_conv2d_2506[0][0]
average_pooling2d_93 (AveragePo	(None, 8, 8, 14)	0	dropout_1382[0][0]
batch_normalization_2520 (Batch	(None, 8, 8, 14)	56	average_pooling2d_93[0][0]
activation_2520 (Activation)	(None, 8, 8, 14)	0	batch_normalization_2520[0][0]
separable_conv2d_2507 (Separabl	(None, 8, 8, 14)	882	activation_2520[0][0]
dropout_1383 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2507[0][0]
concatenate_2426 (Concatenate)	(None, 8, 8, 28)	0	average_pooling2d_93[0][0] dropout_1383[0][0]
batch_normalization_2521 (Batch	(None, 8, 8, 28)	112	concatenate_2426[0][0]
activation_2521 (Activation)	(None, 8, 8, 28)	0	batch_normalization_2521[0][0]
separable_conv2d_2508 (Separabl	(None, 8, 8, 14)	1764	activation_2521[0][0]
dropout_1384 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2508[0][0]
concatenate_2427 (Concatenate)	(None, 8, 8, 42)	0	concatenate_2426[0][0] dropout_1384[0][0]
batch_normalization_2522 (Batch	(None, 8, 8, 42)	168	concatenate_2427[0][0]
activation_2522 (Activation)	(None, 8, 8, 42)	0	batch_normalization_2522[0][0]
separable_conv2d_2509 (Separabl	(None, 8, 8, 14)	2646	activation_2522[0][0]
dropout_1385 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2509[0][0]
concatenate_2428 (Concatenate)	(None, 8, 8, 56)	0	concatenate_2427[0][0] dropout_1385[0][0]
batch_normalization_2523 (Batch	(None, 8, 8, 56)	224	concatenate_2428[0][0]
activation_2523 (Activation)	(None, 8, 8, 56)	0	batch_normalization_2523[0][0]
separable_conv2d_2510 (Separabl	(None, 8, 8, 14)	3528	activation_2523[0][0]
dropout_1386 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2510[0][0]
concatenate_2429 (Concatenate)	(None, 8, 8, 70)	0	concatenate_2428[0][0] dropout_1386[0][0]
batch_normalization_2524 (Batch	(None, 8, 8, 70)	280	concatenate_2429[0][0]
activation_2524 (Activation)	(None, 8, 8, 70)	0	batch_normalization_2524[0][0]
separable_conv2d_2511 (Separabl	(None, 8, 8, 14)	4410	activation_2524[0][0]
dropout_1387 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2511[0][0]
concatenate_2430 (Concatenate)	(None, 8, 8, 84)	0	concatenate_2429[0][0] dropout_1387[0][0]
batch_normalization_2525 (Batch	(None, 8, 8, 84)	336	concatenate_2430[0][0]
activation_2525 (Activation)	(None, 8, 8, 84)	0	batch_normalization_2525[0][0]
separable_conv2d_2512 (Separabl	(None, 8, 8, 14)	5292	activation_2525[0][0]
dropout_1388 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2512[0][0]
concatenate_2431 (Concatenate)	(None, 8, 8, 98)	0	concatenate_2430[0][0] dropout_1388[0][0]
batch_normalization_2526 (Batch	(None, 8, 8, 98)	392	concatenate_2431[0][0]
activation_2526 (Activation)	(None, 8, 8, 98)	0	batch_normalization_2526[0][0]
separable_conv2d_2513 (Separabl	(None, 8, 8, 14)	6174	activation_2526[0][0]
dropout_1389 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2513[0][0]

concatenate_2432 (Concatenate)	(None, 8, 8, 112)	0	concatenate_2431[0][0] dropout_1389[0][0]
batch_normalization_2527 (Batch	(None, 8, 8, 112)	448	concatenate_2432[0][0]
activation_2527 (Activation)	(None, 8, 8, 112)	0	batch_normalization_2527[0][0]
separable_conv2d_2514 (Separabl	(None, 8, 8, 14)	7056	activation_2527[0][0]
dropout_1390 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2514[0][0]
concatenate_2433 (Concatenate)	(None, 8, 8, 126)	0	concatenate_2432[0][0] dropout_1390[0][0]
batch_normalization_2528 (Batch	(None, 8, 8, 126)	504	concatenate_2433[0][0]
activation_2528 (Activation)	(None, 8, 8, 126)	0	batch_normalization_2528[0][0]
separable_conv2d_2515 (Separabl	(None, 8, 8, 14)	7938	activation_2528[0][0]
dropout_1391 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2515[0][0]
concatenate_2434 (Concatenate)	(None, 8, 8, 140)	0	concatenate_2433[0][0] dropout_1391[0][0]
batch_normalization_2529 (Batch	(None, 8, 8, 140)	560	concatenate_2434[0][0]
activation_2529 (Activation)	(None, 8, 8, 140)	0	batch_normalization_2529[0][0]
separable_conv2d_2516 (Separabl	(None, 8, 8, 14)	8820	activation_2529[0][0]
dropout_1392 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2516[0][0]
concatenate_2435 (Concatenate)	(None, 8, 8, 154)	0	concatenate_2434[0][0] dropout_1392[0][0]
batch_normalization_2530 (Batch	(None, 8, 8, 154)	616	concatenate_2435[0][0]
activation_2530 (Activation)	(None, 8, 8, 154)	0	batch_normalization_2530[0][0]
separable_conv2d_2517 (Separabl	(None, 8, 8, 14)	9702	activation_2530[0][0]
dropout_1393 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2517[0][0]
concatenate_2436 (Concatenate)	(None, 8, 8, 168)	0	concatenate_2435[0][0] dropout_1393[0][0]
batch_normalization_2531 (Batch	(None, 8, 8, 168)	672	concatenate_2436[0][0]
activation_2531 (Activation)	(None, 8, 8, 168)	0	batch_normalization_2531[0][0]
separable_conv2d_2518 (Separabl	(None, 8, 8, 14)	10584	activation_2531[0][0]
dropout_1394 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2518[0][0]
concatenate_2437 (Concatenate)	(None, 8, 8, 182)	0	concatenate_2436[0][0] dropout_1394[0][0]
batch_normalization_2532 (Batch	(None, 8, 8, 182)	728	concatenate_2437[0][0]
activation_2532 (Activation)	(None, 8, 8, 182)	0	batch_normalization_2532[0][0]
separable_conv2d_2519 (Separabl	(None, 8, 8, 14)	11466	activation_2532[0][0]
dropout_1395 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2519[0][0]
concatenate_2438 (Concatenate)	(None, 8, 8, 196)	0	concatenate_2437[0][0] dropout_1395[0][0]
batch_normalization_2533 (Batch	(None, 8, 8, 196)	784	concatenate_2438[0][0]
activation_2533 (Activation)	(None, 8, 8, 196)	0	batch_normalization_2533[0][0]
separable_conv2d_2520 (Separabl	(None, 8, 8, 14)	12348	activation_2533[0][0]
dropout_1396 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2520[0][0]

concatenate_2439 (Concatenate)	(None, 8, 8, 210)	0	concatenate_2438[0][0]
			dropout_1396[0][0]
batch_normalization_2534 (Batch	(None, 8, 8, 210)	840	concatenate_2439[0][0]
activation_2534 (Activation)	(None, 8, 8, 210)	0	batch_normalization_2534[0][0]
separable_conv2d_2521 (Separabl	(None, 8, 8, 14)	13230	activation_2534[0][0]
dropout_1397 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2521[0][0]
concatenate_2440 (Concatenate)	(None, 8, 8, 224)	0	concatenate_2439[0][0]
			dropout_1397[0][0]
batch_normalization_2535 (Batch	(None, 8, 8, 224)	896	concatenate_2440[0][0]
activation_2535 (Activation)	(None, 8, 8, 224)	0	batch_normalization_2535[0][0]
separable_conv2d_2522 (Separabl	(None, 8, 8, 14)	14112	activation_2535[0][0]
dropout_1398 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2522[0][0]
concatenate_2441 (Concatenate)	(None, 8, 8, 238)	0	concatenate_2440[0][0]
			dropout_1398[0][0]
batch_normalization_2536 (Batch	(None, 8, 8, 238)	952	concatenate_2441[0][0]
activation_2536 (Activation)	(None, 8, 8, 238)	0	batch_normalization_2536[0][0]
separable_conv2d_2523 (Separabl	(None, 8, 8, 14)	14994	activation_2536[0][0]
dropout_1399 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2523[0][0]
concatenate_2442 (Concatenate)	(None, 8, 8, 252)	0	concatenate_2441[0][0]
			dropout_1399[0][0]
batch_normalization_2537 (Batch	(None, 8, 8, 252)	1008	concatenate_2442[0][0]
activation_2537 (Activation)	(None, 8, 8, 252)	0	batch_normalization_2537[0][0]
separable_conv2d_2524 (Separabl	(None, 8, 8, 14)	15876	activation_2537[0][0]
dropout_1400 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2524[0][0]
concatenate_2443 (Concatenate)	(None, 8, 8, 266)	0	concatenate_2442[0][0]
			dropout_1400[0][0]
batch_normalization_2538 (Batch	(None, 8, 8, 266)	1064	concatenate_2443[0][0]
activation_2538 (Activation)	(None, 8, 8, 266)	0	batch_normalization_2538[0][0]
separable_conv2d_2525 (Separabl	(None, 8, 8, 14)	16758	activation_2538[0][0]
dropout_1401 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2525[0][0]
concatenate_2444 (Concatenate)	(None, 8, 8, 280)	0	concatenate_2443[0][0]
			dropout_1401[0][0]
batch_normalization_2539 (Batch	(None, 8, 8, 280)	1120	concatenate_2444[0][0]
activation_2539 (Activation)	(None, 8, 8, 280)	0	batch_normalization_2539[0][0]
separable_conv2d_2526 (Separabl	(None, 8, 8, 14)	17640	activation_2539[0][0]
dropout_1402 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2526[0][0]
concatenate_2445 (Concatenate)	(None, 8, 8, 294)	0	concatenate_2444[0][0]
			dropout_1402[0][0]
batch_normalization_2540 (Batch	(None, 8, 8, 294)	1176	concatenate_2445[0][0]
activation_2540 (Activation)	(None, 8, 8, 294)	0	batch_normalization_2540[0][0]
separable_conv2d_2527 (Separabl	(None, 8, 8, 14)	18522	activation_2540[0][0]
dropout_1403 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2527[0][0]

Layer	Output Shape	Param #	Connected to
concatenate_2446 (Concatenate)	(None, 8, 8, 308)	0	concatenate_2445[0][0] dropout_1403[0][0]
batch_normalization_2541 (Batch	(None, 8, 8, 308)	1232	concatenate_2446[0][0]
activation_2541 (Activation)	(None, 8, 8, 308)	0	batch_normalization_2541[0][0]
separable_conv2d_2528 (Separabl	(None, 8, 8, 14)	4620	activation_2541[0][0]
dropout_1404 (Dropout)	(None, 8, 8, 14)	0	separable_conv2d_2528[0][0]
average_pooling2d_94 (AveragePo	(None, 4, 4, 14)	0	dropout_1404[0][0]
batch_normalization_2542 (Batch	(None, 4, 4, 14)	56	average_pooling2d_94[0][0]
activation_2542 (Activation)	(None, 4, 4, 14)	0	batch_normalization_2542[0][0]
separable_conv2d_2529 (Separabl	(None, 4, 4, 14)	882	activation_2542[0][0]
dropout_1405 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2529[0][0]
concatenate_2447 (Concatenate)	(None, 4, 4, 28)	0	average_pooling2d_94[0][0] dropout_1405[0][0]
batch_normalization_2543 (Batch	(None, 4, 4, 28)	112	concatenate_2447[0][0]
activation_2543 (Activation)	(None, 4, 4, 28)	0	batch_normalization_2543[0][0]
separable_conv2d_2530 (Separabl	(None, 4, 4, 14)	1764	activation_2543[0][0]
dropout_1406 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2530[0][0]
concatenate_2448 (Concatenate)	(None, 4, 4, 42)	0	concatenate_2447[0][0] dropout_1406[0][0]
batch_normalization_2544 (Batch	(None, 4, 4, 42)	168	concatenate_2448[0][0]
activation_2544 (Activation)	(None, 4, 4, 42)	0	batch_normalization_2544[0][0]
separable_conv2d_2531 (Separabl	(None, 4, 4, 14)	2646	activation_2544[0][0]
dropout_1407 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2531[0][0]
concatenate_2449 (Concatenate)	(None, 4, 4, 56)	0	concatenate_2448[0][0] dropout_1407[0][0]
batch_normalization_2545 (Batch	(None, 4, 4, 56)	224	concatenate_2449[0][0]
activation_2545 (Activation)	(None, 4, 4, 56)	0	batch_normalization_2545[0][0]
separable_conv2d_2532 (Separabl	(None, 4, 4, 14)	3528	activation_2545[0][0]
dropout_1408 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2532[0][0]
concatenate_2450 (Concatenate)	(None, 4, 4, 70)	0	concatenate_2449[0][0] dropout_1408[0][0]
batch_normalization_2546 (Batch	(None, 4, 4, 70)	280	concatenate_2450[0][0]
activation_2546 (Activation)	(None, 4, 4, 70)	0	batch_normalization_2546[0][0]
separable_conv2d_2533 (Separabl	(None, 4, 4, 14)	4410	activation_2546[0][0]
dropout_1409 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2533[0][0]
concatenate_2451 (Concatenate)	(None, 4, 4, 84)	0	concatenate_2450[0][0] dropout_1409[0][0]
batch_normalization_2547 (Batch	(None, 4, 4, 84)	336	concatenate_2451[0][0]
activation_2547 (Activation)	(None, 4, 4, 84)	0	batch_normalization_2547[0][0]
separable_conv2d_2534 (Separabl	(None, 4, 4, 14)	5292	activation_2547[0][0]
dropout_1410 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2534[0][0]

concatenate_2452 (Concatenate)	(None, 4, 4, 98)	0	concatenate_2451[0][0]
			dropout_1410[0][0]
batch_normalization_2548 (Batch	(None, 4, 4, 98)	392	concatenate_2452[0][0]
activation_2548 (Activation)	(None, 4, 4, 98)	0	batch_normalization_2548[0][0]
separable_conv2d_2535 (Separabl	(None, 4, 4, 14)	6174	activation_2548[0][0]
dropout_1411 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2535[0][0]
concatenate_2453 (Concatenate)	(None, 4, 4, 112)	0	concatenate_2452[0][0]
			dropout_1411[0][0]
batch_normalization_2549 (Batch	(None, 4, 4, 112)	448	concatenate_2453[0][0]
activation_2549 (Activation)	(None, 4, 4, 112)	0	batch_normalization_2549[0][0]
separable_conv2d_2536 (Separabl	(None, 4, 4, 14)	7056	activation_2549[0][0]
dropout_1412 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2536[0][0]
concatenate_2454 (Concatenate)	(None, 4, 4, 126)	0	concatenate_2453[0][0]
			dropout_1412[0][0]
batch_normalization_2550 (Batch	(None, 4, 4, 126)	504	concatenate_2454[0][0]
activation_2550 (Activation)	(None, 4, 4, 126)	0	batch_normalization_2550[0][0]
separable_conv2d_2537 (Separabl	(None, 4, 4, 14)	7938	activation_2550[0][0]
dropout_1413 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2537[0][0]
concatenate_2455 (Concatenate)	(None, 4, 4, 140)	0	concatenate_2454[0][0]
			dropout_1413[0][0]
batch_normalization_2551 (Batch	(None, 4, 4, 140)	560	concatenate_2455[0][0]
activation_2551 (Activation)	(None, 4, 4, 140)	0	batch_normalization_2551[0][0]
separable_conv2d_2538 (Separabl	(None, 4, 4, 14)	8820	activation_2551[0][0]
dropout_1414 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2538[0][0]
concatenate_2456 (Concatenate)	(None, 4, 4, 154)	0	concatenate_2455[0][0]
			dropout_1414[0][0]
batch_normalization_2552 (Batch	(None, 4, 4, 154)	616	concatenate_2456[0][0]
activation_2552 (Activation)	(None, 4, 4, 154)	0	batch_normalization_2552[0][0]
separable_conv2d_2539 (Separabl	(None, 4, 4, 14)	9702	activation_2552[0][0]
dropout_1415 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2539[0][0]
concatenate_2457 (Concatenate)	(None, 4, 4, 168)	0	concatenate_2456[0][0]
			dropout_1415[0][0]
batch_normalization_2553 (Batch	(None, 4, 4, 168)	672	concatenate_2457[0][0]
activation_2553 (Activation)	(None, 4, 4, 168)	0	batch_normalization_2553[0][0]
separable_conv2d_2540 (Separabl	(None, 4, 4, 14)	10584	activation_2553[0][0]
dropout_1416 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2540[0][0]
concatenate_2458 (Concatenate)	(None, 4, 4, 182)	0	concatenate_2457[0][0]
			dropout_1416[0][0]
batch_normalization_2554 (Batch	(None, 4, 4, 182)	728	concatenate_2458[0][0]
activation_2554 (Activation)	(None, 4, 4, 182)	0	batch_normalization_2554[0][0]
separable_conv2d_2541 (Separabl	(None, 4, 4, 14)	11466	activation_2554[0][0]
dropout_1417 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2541[0][0]

Layer	Output Shape	Param #	Connected to
concatenate_2459 (Concatenate)	(None, 4, 4, 196)	0	concatenate_2458[0][0] dropout_1417[0][0]
batch_normalization_2555 (Batch	(None, 4, 4, 196)	784	concatenate_2459[0][0]
activation_2555 (Activation)	(None, 4, 4, 196)	0	batch_normalization_2555[0][0]
separable_conv2d_2542 (Separabl	(None, 4, 4, 14)	12348	activation_2555[0][0]
dropout_1418 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2542[0][0]
concatenate_2460 (Concatenate)	(None, 4, 4, 210)	0	concatenate_2459[0][0] dropout_1418[0][0]
batch_normalization_2556 (Batch	(None, 4, 4, 210)	840	concatenate_2460[0][0]
activation_2556 (Activation)	(None, 4, 4, 210)	0	batch_normalization_2556[0][0]
separable_conv2d_2543 (Separabl	(None, 4, 4, 14)	13230	activation_2556[0][0]
dropout_1419 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2543[0][0]
concatenate_2461 (Concatenate)	(None, 4, 4, 224)	0	concatenate_2460[0][0] dropout_1419[0][0]
batch_normalization_2557 (Batch	(None, 4, 4, 224)	896	concatenate_2461[0][0]
activation_2557 (Activation)	(None, 4, 4, 224)	0	batch_normalization_2557[0][0]
separable_conv2d_2544 (Separabl	(None, 4, 4, 14)	14112	activation_2557[0][0]
dropout_1420 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2544[0][0]
concatenate_2462 (Concatenate)	(None, 4, 4, 238)	0	concatenate_2461[0][0] dropout_1420[0][0]
batch_normalization_2558 (Batch	(None, 4, 4, 238)	952	concatenate_2462[0][0]
activation_2558 (Activation)	(None, 4, 4, 238)	0	batch_normalization_2558[0][0]
separable_conv2d_2545 (Separabl	(None, 4, 4, 14)	14994	activation_2558[0][0]
dropout_1421 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2545[0][0]
concatenate_2463 (Concatenate)	(None, 4, 4, 252)	0	concatenate_2462[0][0] dropout_1421[0][0]
batch_normalization_2559 (Batch	(None, 4, 4, 252)	1008	concatenate_2463[0][0]
activation_2559 (Activation)	(None, 4, 4, 252)	0	batch_normalization_2559[0][0]
separable_conv2d_2546 (Separabl	(None, 4, 4, 14)	15876	activation_2559[0][0]
dropout_1422 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2546[0][0]
concatenate_2464 (Concatenate)	(None, 4, 4, 266)	0	concatenate_2463[0][0] dropout_1422[0][0]
batch_normalization_2560 (Batch	(None, 4, 4, 266)	1064	concatenate_2464[0][0]
activation_2560 (Activation)	(None, 4, 4, 266)	0	batch_normalization_2560[0][0]
separable_conv2d_2547 (Separabl	(None, 4, 4, 14)	16758	activation_2560[0][0]
dropout_1423 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2547[0][0]
concatenate_2465 (Concatenate)	(None, 4, 4, 280)	0	concatenate_2464[0][0] dropout_1423[0][0]
batch_normalization_2561 (Batch	(None, 4, 4, 280)	1120	concatenate_2465[0][0]
activation_2561 (Activation)	(None, 4, 4, 280)	0	batch_normalization_2561[0][0]
separable_conv2d_2548 (Separabl	(None, 4, 4, 14)	17640	activation_2561[0][0]
dropout_1424 (Dropout)	(None, 4, 4, 14)	0	separable_conv2d_2548[0][0]

```
concatenate_2466 (Concatenate)    (None, 4, 4, 294)    0        concatenate_2465[0][0]
                                                                 dropout_1424[0][0]
_____
batch_normalization_2562 (Batch   (None, 4, 4, 294)    1176     concatenate_2466[0][0]
_____
activation_2562 (Activation)      (None, 4, 4, 294)    0        batch_normalization_2562[0][0]
_____
separable_conv2d_2549 (Separabl   (None, 4, 4, 14)     18522    activation_2562[0][0]
_____
dropout_1425 (Dropout)            (None, 4, 4, 14)     0        separable_conv2d_2549[0][0]
_____
concatenate_2467 (Concatenate)    (None, 4, 4, 308)    0        concatenate_2466[0][0]
                                                                 dropout_1425[0][0]
_____
batch_normalization_2563 (Batch   (None, 4, 4, 308)    1232     concatenate_2467[0][0]
_____
activation_2563 (Activation)      (None, 4, 4, 308)    0        batch_normalization_2563[0][0]
_____
average_pooling2d_95 (AveragePo   (None, 2, 2, 308)    0        activation_2563[0][0]
_____
separable_conv2d_2550 (Separabl   (None, 1, 1, 10)     4322     average_pooling2d_95[0][0]
_____
flatten_15 (Flatten)              (None, 10)           0        separable_conv2d_2550[0][0]
_____
dense_17 (Dense)                  (None, 10)           110      flatten_15[0][0]
======================================================================================
Total params: 945,472
Trainable params: 915,640
Non-trainable params: 29,832
_____
```

In [69]:

```python
model_5.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])

from tensorflow.keras.callbacks import ModelCheckpoint, EarlyStopping, ReduceLROnPlateau
patience = 50
base_path = '/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/'
checkpoint_file_name = base_path + 'CIFAR_model5' + '_{epoch:02d}-{val_accuracy:.2f}.hdf5'

model_checkpoint = ModelCheckpoint(checkpoint_file_name, monitor='val_accuracy', verbose=1, save_be
st_only=True)
early_stop = EarlyStopping('val_accuracy', mode='max', patience = patience)
reduce_LR = ReduceLROnPlateau(monitor='val_accuracy', mode='max', factor=0.1, patience=int(patience
/3), verbose=1)

callbacks = [model_checkpoint, early_stop, reduce_LR]

epochs = 300
batch_size = 128

#https://keras.io/api/preprocessing/image/#flow-method
history_5 = model_5.fit(data_generator.flow(X_train, y_train, batch_size),
                steps_per_epoch = int(len(X_train)/batch_size),
                epochs = epochs,
                callbacks = callbacks,
                validation_data = (X_test, y_test), verbose=1)
```

```
WARNING:tensorflow:sample_weight modes were coerced from
  ...
    to
  ['...']
Train for 390 steps, validate on 10000 samples
Epoch 1/300
389/390 [=============================>.] - ETA: 0s - loss: 1.7504 - accuracy: 0.3315
Epoch 00001: val_accuracy improved from -inf to 0.22800, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_01-0.23.hdf5
390/390 [==============================] - 156s 401ms/step - loss: 1.7500 - accuracy: 0.3316 - val
_loss: 2.3646 - val_accuracy: 0.2280
Epoch 2/300
389/390 [=============================>.] - ETA: 0s - loss: 1.3674 - accuracy: 0.4987
Epoch 00002: val_accuracy improved from 0.22800 to 0.30130, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_02-0.30.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 1.3671 - accuracy: 0.4989 - val
_loss: 3.2475 - val_accuracy: 0.3013
```

```
Epoch 3/300
389/390 [============================>.] - ETA: 0s - loss: 1.1433 - accuracy: 0.5880
Epoch 00003: val_accuracy improved from 0.30130 to 0.41590, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_03-0.42.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 1.1434 - accuracy: 0.5881 - val
_loss: 2.5937 - val_accuracy: 0.4159
Epoch 4/300
389/390 [============================>.] - ETA: 0s - loss: 1.0125 - accuracy: 0.6385
Epoch 00004: val_accuracy improved from 0.41590 to 0.57930, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_04-0.58.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 1.0122 - accuracy: 0.6385 - val
_loss: 1.4217 - val_accuracy: 0.5793
Epoch 5/300
389/390 [============================>.] - ETA: 0s - loss: 0.9161 - accuracy: 0.6739
Epoch 00005: val_accuracy improved from 0.57930 to 0.61120, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_05-0.61.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.9160 - accuracy: 0.6739 - val
_loss: 1.3084 - val_accuracy: 0.6112
Epoch 6/300
389/390 [============================>.] - ETA: 0s - loss: 0.8343 - accuracy: 0.7069
Epoch 00006: val_accuracy improved from 0.61120 to 0.62680, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_06-0.63.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.8343 - accuracy: 0.7069 - val
_loss: 1.3066 - val_accuracy: 0.6268
Epoch 7/300
389/390 [============================>.] - ETA: 0s - loss: 0.7774 - accuracy: 0.7297
Epoch 00007: val_accuracy did not improve from 0.62680
390/390 [==============================] - 135s 347ms/step - loss: 0.7776 - accuracy: 0.7296 - val
_loss: 2.7267 - val_accuracy: 0.4788
Epoch 8/300
389/390 [============================>.] - ETA: 0s - loss: 0.7255 - accuracy: 0.7453
Epoch 00008: val_accuracy improved from 0.62680 to 0.65880, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_08-0.66.hdf5
390/390 [==============================] - 136s 350ms/step - loss: 0.7254 - accuracy: 0.7452 - val
_loss: 1.2443 - val_accuracy: 0.6588
Epoch 9/300
389/390 [============================>.] - ETA: 0s - loss: 0.6863 - accuracy: 0.7620
Epoch 00009: val_accuracy improved from 0.65880 to 0.71540, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_09-0.72.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.6860 - accuracy: 0.7621 - val
_loss: 0.9944 - val_accuracy: 0.7154
Epoch 10/300
389/390 [============================>.] - ETA: 0s - loss: 0.6442 - accuracy: 0.7771
Epoch 00010: val_accuracy did not improve from 0.71540
390/390 [==============================] - 135s 346ms/step - loss: 0.6442 - accuracy: 0.7772 - val
_loss: 2.1131 - val_accuracy: 0.5154
Epoch 11/300
389/390 [============================>.] - ETA: 0s - loss: 0.6251 - accuracy: 0.7823
Epoch 00011: val_accuracy improved from 0.71540 to 0.74050, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_11-0.74.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.6253 - accuracy: 0.7823 - val
_loss: 0.8934 - val_accuracy: 0.7405
Epoch 12/300
389/390 [============================>.] - ETA: 0s - loss: 0.5946 - accuracy: 0.7925
Epoch 00012: val_accuracy improved from 0.74050 to 0.74180, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_12-0.74.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.5945 - accuracy: 0.7925 - val
_loss: 0.8817 - val_accuracy: 0.7418
Epoch 13/300
389/390 [============================>.] - ETA: 0s - loss: 0.5669 - accuracy: 0.8030
Epoch 00013: val_accuracy did not improve from 0.74180
390/390 [==============================] - 135s 346ms/step - loss: 0.5668 - accuracy: 0.8030 - val
_loss: 1.1154 - val_accuracy: 0.7084
Epoch 14/300
389/390 [============================>.] - ETA: 0s - loss: 0.5533 - accuracy: 0.8072
Epoch 00014: val_accuracy improved from 0.74180 to 0.77990, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_14-0.78.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.5532 - accuracy: 0.8072 - val
_loss: 0.7306 - val_accuracy: 0.7799
Epoch 15/300
389/390 [============================>.] - ETA: 0s - loss: 0.5356 - accuracy: 0.8134
Epoch 00015: val_accuracy did not improve from 0.77990
390/390 [==============================] - 135s 346ms/step - loss: 0.5359 - accuracy: 0.8134 - val
_loss: 0.8631 - val_accuracy: 0.7554
Epoch 16/300
389/390 [============================>.] - ETA: 0s - loss: 0.5176 - accuracy: 0.8205
Epoch 00016: val_accuracy did not improve from 0.77990
```

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390/390 [==============================] - 135s 347ms/step - loss: 0.5176 - accuracy: 0.8206 - val
_loss: 0.8329 - val_accuracy: 0.7669
Epoch 17/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5048 - accuracy: 0.8245
Epoch 00017: val_accuracy did not improve from 0.77990
390/390 [==============================] - 135s 347ms/step - loss: 0.5050 - accuracy: 0.8245 - val
_loss: 0.8937 - val_accuracy: 0.7489
Epoch 18/300
389/390 [=============================>.] - ETA: 0s - loss: 0.4842 - accuracy: 0.8322
Epoch 00018: val_accuracy did not improve from 0.77990
390/390 [==============================] - 135s 346ms/step - loss: 0.4845 - accuracy: 0.8321 - val
_loss: 0.7822 - val_accuracy: 0.7752
Epoch 19/300
389/390 [=============================>.] - ETA: 0s - loss: 0.4731 - accuracy: 0.8352
Epoch 00019: val_accuracy did not improve from 0.77990
390/390 [==============================] - 135s 347ms/step - loss: 0.4740 - accuracy: 0.8350 - val
_loss: 0.9793 - val_accuracy: 0.7411
Epoch 20/300
389/390 [=============================>.] - ETA: 0s - loss: 0.4562 - accuracy: 0.8389
Epoch 00020: val_accuracy did not improve from 0.77990
390/390 [==============================] - 135s 347ms/step - loss: 0.4564 - accuracy: 0.8387 - val
_loss: 1.3204 - val_accuracy: 0.6897
Epoch 21/300
389/390 [=============================>.] - ETA: 0s - loss: 0.4459 - accuracy: 0.8457
Epoch 00021: val_accuracy improved from 0.77990 to 0.78290, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_21-0.78.hdf5
390/390 [==============================] - 136s 350ms/step - loss: 0.4460 - accuracy: 0.8455 - val
_loss: 0.7568 - val_accuracy: 0.7829
Epoch 22/300
389/390 [=============================>.] - ETA: 0s - loss: 0.4319 - accuracy: 0.8502
Epoch 00022: val_accuracy did not improve from 0.78290
390/390 [==============================] - 135s 347ms/step - loss: 0.4321 - accuracy: 0.8501 - val
_loss: 0.9390 - val_accuracy: 0.7539
Epoch 23/300
389/390 [=============================>.] - ETA: 0s - loss: 0.4252 - accuracy: 0.8521
Epoch 00023: val_accuracy improved from 0.78290 to 0.78860, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_23-0.79.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.4254 - accuracy: 0.8521 - val
_loss: 0.7675 - val_accuracy: 0.7886
Epoch 24/300
389/390 [=============================>.] - ETA: 0s - loss: 0.4141 - accuracy: 0.8549
Epoch 00024: val_accuracy improved from 0.78860 to 0.79390, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_24-0.79.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.4142 - accuracy: 0.8548 - val
_loss: 0.7512 - val_accuracy: 0.7939
Epoch 25/300
389/390 [=============================>.] - ETA: 0s - loss: 0.4040 - accuracy: 0.8593
Epoch 00025: val_accuracy improved from 0.79390 to 0.81740, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_25-0.82.hdf5
390/390 [==============================] - 136s 350ms/step - loss: 0.4041 - accuracy: 0.8593 - val
_loss: 0.6412 - val_accuracy: 0.8174
Epoch 26/300
389/390 [=============================>.] - ETA: 0s - loss: 0.3986 - accuracy: 0.8614
Epoch 00026: val_accuracy did not improve from 0.81740
390/390 [==============================] - 135s 346ms/step - loss: 0.3988 - accuracy: 0.8614 - val
_loss: 1.0172 - val_accuracy: 0.7459
Epoch 27/300
389/390 [=============================>.] - ETA: 0s - loss: 0.3840 - accuracy: 0.8657
Epoch 00027: val_accuracy did not improve from 0.81740
390/390 [==============================] - 135s 347ms/step - loss: 0.3837 - accuracy: 0.8658 - val
_loss: 1.0873 - val_accuracy: 0.7225
Epoch 28/300
389/390 [=============================>.] - ETA: 0s - loss: 0.3809 - accuracy: 0.8669
Epoch 00028: val_accuracy improved from 0.81740 to 0.81910, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_28-0.82.hdf5
390/390 [==============================] - 136s 350ms/step - loss: 0.3807 - accuracy: 0.8671 - val
_loss: 0.6226 - val_accuracy: 0.8191
Epoch 29/300
389/390 [=============================>.] - ETA: 0s - loss: 0.3718 - accuracy: 0.8699
Epoch 00029: val_accuracy did not improve from 0.81910
390/390 [==============================] - 135s 346ms/step - loss: 0.3719 - accuracy: 0.8699 - val
_loss: 0.8904 - val_accuracy: 0.7752
Epoch 30/300
389/390 [=============================>.] - ETA: 0s - loss: 0.3669 - accuracy: 0.8716
Epoch 00030: val_accuracy did not improve from 0.81910
390/390 [==============================] - 135s 347ms/step - loss: 0.3669 - accuracy: 0.8716 - val
_loss: 0.7723 - val_accuracy: 0.7989
```

```
Epoch 31/300
389/390 [============================>.] - ETA: 0s - loss: 0.3615 - accuracy: 0.8746
Epoch 00031: val_accuracy did not improve from 0.81910
390/390 [==============================] - 135s 347ms/step - loss: 0.3614 - accuracy: 0.8746 - val
_loss: 0.6521 - val_accuracy: 0.8153
Epoch 32/300
389/390 [============================>.] - ETA: 0s - loss: 0.3501 - accuracy: 0.8779
Epoch 00032: val_accuracy did not improve from 0.81910
390/390 [==============================] - 135s 347ms/step - loss: 0.3500 - accuracy: 0.8779 - val
_loss: 0.6707 - val_accuracy: 0.8131
Epoch 33/300
389/390 [============================>.] - ETA: 0s - loss: 0.3462 - accuracy: 0.8785
Epoch 00033: val_accuracy did not improve from 0.81910
390/390 [==============================] - 135s 347ms/step - loss: 0.3460 - accuracy: 0.8786 - val
_loss: 0.7479 - val_accuracy: 0.7991
Epoch 34/300
389/390 [============================>.] - ETA: 0s - loss: 0.3364 - accuracy: 0.8807
Epoch 00034: val_accuracy did not improve from 0.81910
390/390 [==============================] - 135s 347ms/step - loss: 0.3367 - accuracy: 0.8807 - val
_loss: 0.8278 - val_accuracy: 0.7911
Epoch 35/300
389/390 [============================>.] - ETA: 0s - loss: 0.3383 - accuracy: 0.8822
Epoch 00035: val_accuracy did not improve from 0.81910
390/390 [==============================] - 135s 347ms/step - loss: 0.3384 - accuracy: 0.8821 - val
_loss: 1.0773 - val_accuracy: 0.7542
Epoch 36/300
389/390 [============================>.] - ETA: 0s - loss: 0.3266 - accuracy: 0.8842
Epoch 00036: val_accuracy did not improve from 0.81910
390/390 [==============================] - 135s 347ms/step - loss: 0.3267 - accuracy: 0.8842 - val
_loss: 0.8458 - val_accuracy: 0.7917
Epoch 37/300
389/390 [============================>.] - ETA: 0s - loss: 0.3233 - accuracy: 0.8864
Epoch 00037: val_accuracy did not improve from 0.81910
390/390 [==============================] - 135s 346ms/step - loss: 0.3232 - accuracy: 0.8864 - val
_loss: 1.1717 - val_accuracy: 0.7484
Epoch 38/300
389/390 [============================>.] - ETA: 0s - loss: 0.3153 - accuracy: 0.8904
Epoch 00038: val_accuracy did not improve from 0.81910
390/390 [==============================] - 135s 346ms/step - loss: 0.3151 - accuracy: 0.8904 - val
_loss: 0.9669 - val_accuracy: 0.7775
Epoch 39/300
389/390 [============================>.] - ETA: 0s - loss: 0.3130 - accuracy: 0.8904
Epoch 00039: val_accuracy did not improve from 0.81910
390/390 [==============================] - 135s 347ms/step - loss: 0.3132 - accuracy: 0.8904 - val
_loss: 0.9023 - val_accuracy: 0.7860
Epoch 40/300
389/390 [============================>.] - ETA: 0s - loss: 0.3064 - accuracy: 0.8922
Epoch 00040: val_accuracy improved from 0.81910 to 0.83030, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_40-0.83.hdf5
390/390 [==============================] - 136s 350ms/step - loss: 0.3063 - accuracy: 0.8923 - val
_loss: 0.6351 - val_accuracy: 0.8303
Epoch 41/300
389/390 [============================>.] - ETA: 0s - loss: 0.3006 - accuracy: 0.8934
Epoch 00041: val_accuracy did not improve from 0.83030
390/390 [==============================] - 135s 346ms/step - loss: 0.3008 - accuracy: 0.8933 - val
_loss: 0.8391 - val_accuracy: 0.7941
Epoch 42/300
389/390 [============================>.] - ETA: 0s - loss: 0.2982 - accuracy: 0.8949
Epoch 00042: val_accuracy improved from 0.83030 to 0.83730, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_42-0.84.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.2983 - accuracy: 0.8949 - val
_loss: 0.6109 - val_accuracy: 0.8373
Epoch 43/300
389/390 [============================>.] - ETA: 0s - loss: 0.2919 - accuracy: 0.8967
Epoch 00043: val_accuracy did not improve from 0.83730
390/390 [==============================] - 135s 347ms/step - loss: 0.2916 - accuracy: 0.8968 - val
_loss: 0.7076 - val_accuracy: 0.8122
Epoch 44/300
389/390 [============================>.] - ETA: 0s - loss: 0.2868 - accuracy: 0.8986
Epoch 00044: val_accuracy did not improve from 0.83730
390/390 [==============================] - 135s 347ms/step - loss: 0.2867 - accuracy: 0.8987 - val
_loss: 0.9944 - val_accuracy: 0.7681
Epoch 45/300
389/390 [============================>.] - ETA: 0s - loss: 0.2853 - accuracy: 0.8989
Epoch 00045: val_accuracy improved from 0.83730 to 0.83780, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_45-0.84.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.2853 - accuracy: 0.8989 - val
```

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_loss: 0.6084 - val_accuracy: 0.8378
Epoch 46/300
389/390 [============================>.] - ETA: 0s - loss: 0.2780 - accuracy: 0.9024
Epoch 00046: val_accuracy improved from 0.83780 to 0.84870, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_46-0.85.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.2780 - accuracy: 0.9024 - val
_loss: 0.5594 - val_accuracy: 0.8487
Epoch 47/300
389/390 [============================>.] - ETA: 0s - loss: 0.2783 - accuracy: 0.9028
Epoch 00047: val_accuracy did not improve from 0.84870
390/390 [==============================] - 135s 346ms/step - loss: 0.2781 - accuracy: 0.9028 - val
_loss: 0.8282 - val_accuracy: 0.8057
Epoch 48/300
389/390 [============================>.] - ETA: 0s - loss: 0.2725 - accuracy: 0.9053
Epoch 00048: val_accuracy did not improve from 0.84870
390/390 [==============================] - 135s 346ms/step - loss: 0.2731 - accuracy: 0.9052 - val
_loss: 0.6938 - val_accuracy: 0.8179
Epoch 49/300
389/390 [============================>.] - ETA: 0s - loss: 0.2669 - accuracy: 0.9069
Epoch 00049: val_accuracy did not improve from 0.84870
390/390 [==============================] - 135s 347ms/step - loss: 0.2668 - accuracy: 0.9069 - val
_loss: 0.6449 - val_accuracy: 0.8359
Epoch 50/300
389/390 [============================>.] - ETA: 0s - loss: 0.2633 - accuracy: 0.9072
Epoch 00050: val_accuracy did not improve from 0.84870
390/390 [==============================] - 135s 346ms/step - loss: 0.2632 - accuracy: 0.9073 - val
_loss: 0.8866 - val_accuracy: 0.8046
Epoch 51/300
389/390 [============================>.] - ETA: 0s - loss: 0.2622 - accuracy: 0.9066
Epoch 00051: val_accuracy did not improve from 0.84870
390/390 [==============================] - 135s 346ms/step - loss: 0.2622 - accuracy: 0.9066 - val
_loss: 0.8214 - val_accuracy: 0.8092
Epoch 52/300
389/390 [============================>.] - ETA: 0s - loss: 0.2595 - accuracy: 0.9074
Epoch 00052: val_accuracy did not improve from 0.84870
390/390 [==============================] - 135s 347ms/step - loss: 0.2594 - accuracy: 0.9074 - val
_loss: 0.8079 - val_accuracy: 0.8077
Epoch 53/300
389/390 [============================>.] - ETA: 0s - loss: 0.2511 - accuracy: 0.9123
Epoch 00053: val_accuracy did not improve from 0.84870
390/390 [==============================] - 135s 347ms/step - loss: 0.2511 - accuracy: 0.9123 - val
_loss: 0.9002 - val_accuracy: 0.7969
Epoch 54/300
389/390 [============================>.] - ETA: 0s - loss: 0.2515 - accuracy: 0.9117
Epoch 00054: val_accuracy did not improve from 0.84870
390/390 [==============================] - 135s 346ms/step - loss: 0.2516 - accuracy: 0.9117 - val
_loss: 0.6637 - val_accuracy: 0.8340
Epoch 55/300
389/390 [============================>.] - ETA: 0s - loss: 0.2464 - accuracy: 0.9133
Epoch 00055: val_accuracy did not improve from 0.84870
390/390 [==============================] - 136s 347ms/step - loss: 0.2464 - accuracy: 0.9133 - val
_loss: 0.8131 - val_accuracy: 0.8097
Epoch 56/300
389/390 [============================>.] - ETA: 0s - loss: 0.2462 - accuracy: 0.9137
Epoch 00056: val_accuracy did not improve from 0.84870
390/390 [==============================] - 135s 347ms/step - loss: 0.2464 - accuracy: 0.9136 - val
_loss: 0.6043 - val_accuracy: 0.8413
Epoch 57/300
389/390 [============================>.] - ETA: 0s - loss: 0.2449 - accuracy: 0.9135
Epoch 00057: val_accuracy did not improve from 0.84870
390/390 [==============================] - 135s 347ms/step - loss: 0.2449 - accuracy: 0.9135 - val
_loss: 0.8142 - val_accuracy: 0.8151
Epoch 58/300
389/390 [============================>.] - ETA: 0s - loss: 0.2384 - accuracy: 0.9164
Epoch 00058: val_accuracy did not improve from 0.84870
390/390 [==============================] - 135s 347ms/step - loss: 0.2388 - accuracy: 0.9163 - val
_loss: 0.6324 - val_accuracy: 0.8385
Epoch 59/300
389/390 [============================>.] - ETA: 0s - loss: 0.2323 - accuracy: 0.9178
Epoch 00059: val_accuracy improved from 0.84870 to 0.84920, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_59-0.85.hdf5
390/390 [==============================] - 136s 348ms/step - loss: 0.2324 - accuracy: 0.9178 - val
_loss: 0.5738 - val_accuracy: 0.8492
Epoch 60/300
389/390 [============================>.] - ETA: 0s - loss: 0.2327 - accuracy: 0.9179
Epoch 00060: val_accuracy did not improve from 0.84920
390/390 [==============================] - 135s 346ms/step - loss: 0.2325 - accuracy: 0.9179 - val
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_loss: 0.7680 - val_accuracy: 0.8197
Epoch 61/300
389/390 [============================>.] - ETA: 0s - loss: 0.2295 - accuracy: 0.9193
Epoch 00061: val_accuracy did not improve from 0.84920
390/390 [==============================] - 135s 347ms/step - loss: 0.2296 - accuracy: 0.9193 - val
_loss: 0.7218 - val_accuracy: 0.8255
Epoch 62/300
389/390 [============================>.] - ETA: 0s - loss: 0.2295 - accuracy: 0.9200
Epoch 00062: val_accuracy did not improve from 0.84920
390/390 [==============================] - 135s 347ms/step - loss: 0.2295 - accuracy: 0.9200 - val
_loss: 0.7827 - val_accuracy: 0.8194
Epoch 63/300
389/390 [============================>.] - ETA: 0s - loss: 0.2216 - accuracy: 0.9221
Epoch 00063: val_accuracy improved from 0.84920 to 0.86040, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_63-0.86.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.2217 - accuracy: 0.9221 - val
_loss: 0.5561 - val_accuracy: 0.8604
Epoch 64/300
389/390 [============================>.] - ETA: 0s - loss: 0.2215 - accuracy: 0.9226
Epoch 00064: val_accuracy did not improve from 0.86040
390/390 [==============================] - 135s 346ms/step - loss: 0.2215 - accuracy: 0.9227 - val
_loss: 0.7433 - val_accuracy: 0.8266
Epoch 65/300
389/390 [============================>.] - ETA: 0s - loss: 0.2196 - accuracy: 0.9216
Epoch 00065: val_accuracy did not improve from 0.86040
390/390 [==============================] - 135s 347ms/step - loss: 0.2195 - accuracy: 0.9216 - val
_loss: 0.6962 - val_accuracy: 0.8417
Epoch 66/300
389/390 [============================>.] - ETA: 0s - loss: 0.2181 - accuracy: 0.9217
Epoch 00066: val_accuracy did not improve from 0.86040
390/390 [==============================] - 135s 347ms/step - loss: 0.2181 - accuracy: 0.9217 - val
_loss: 0.5255 - val_accuracy: 0.8593
Epoch 67/300
389/390 [============================>.] - ETA: 0s - loss: 0.2160 - accuracy: 0.9228
Epoch 00067: val_accuracy did not improve from 0.86040
390/390 [==============================] - 135s 347ms/step - loss: 0.2160 - accuracy: 0.9228 - val
_loss: 0.8274 - val_accuracy: 0.8146
Epoch 68/300
389/390 [============================>.] - ETA: 0s - loss: 0.2127 - accuracy: 0.9250
Epoch 00068: val_accuracy did not improve from 0.86040
390/390 [==============================] - 135s 346ms/step - loss: 0.2127 - accuracy: 0.9251 - val
_loss: 0.8970 - val_accuracy: 0.7974
Epoch 69/300
389/390 [============================>.] - ETA: 0s - loss: 0.2093 - accuracy: 0.9258
Epoch 00069: val_accuracy did not improve from 0.86040
390/390 [==============================] - 135s 346ms/step - loss: 0.2094 - accuracy: 0.9258 - val
_loss: 0.7490 - val_accuracy: 0.8222
Epoch 70/300
389/390 [============================>.] - ETA: 0s - loss: 0.2079 - accuracy: 0.9262
Epoch 00070: val_accuracy improved from 0.86040 to 0.86540, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_70-0.87.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.2077 - accuracy: 0.9262 - val
_loss: 0.5319 - val_accuracy: 0.8654
Epoch 71/300
389/390 [============================>.] - ETA: 0s - loss: 0.2056 - accuracy: 0.9275
Epoch 00071: val_accuracy did not improve from 0.86540
390/390 [==============================] - 135s 346ms/step - loss: 0.2055 - accuracy: 0.9276 - val
_loss: 0.7056 - val_accuracy: 0.8340
Epoch 72/300
389/390 [============================>.] - ETA: 0s - loss: 0.2037 - accuracy: 0.9278
Epoch 00072: val_accuracy did not improve from 0.86540
390/390 [==============================] - 135s 346ms/step - loss: 0.2038 - accuracy: 0.9278 - val
_loss: 0.6550 - val_accuracy: 0.8428
Epoch 73/300
389/390 [============================>.] - ETA: 0s - loss: 0.1998 - accuracy: 0.9295
Epoch 00073: val_accuracy did not improve from 0.86540
390/390 [==============================] - 135s 347ms/step - loss: 0.1997 - accuracy: 0.9295 - val
_loss: 0.7607 - val_accuracy: 0.8217
Epoch 74/300
389/390 [============================>.] - ETA: 0s - loss: 0.1994 - accuracy: 0.9293
Epoch 00074: val_accuracy did not improve from 0.86540
390/390 [==============================] - 135s 346ms/step - loss: 0.1995 - accuracy: 0.9293 - val
_loss: 0.5658 - val_accuracy: 0.8615
Epoch 75/300
389/390 [============================>.] - ETA: 0s - loss: 0.1976 - accuracy: 0.9299
Epoch 00075: val_accuracy improved from 0.86540 to 0.86740, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_75-0.87.hdf5
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390/390 [==============================] - 136s 350ms/step - loss: 0.1975 - accuracy: 0.9299 - val
_loss: 0.5567 - val_accuracy: 0.8674
Epoch 76/300
389/390 [============================>.] - ETA: 0s - loss: 0.1907 - accuracy: 0.9325
Epoch 00076: val_accuracy did not improve from 0.86740
390/390 [==============================] - 135s 347ms/step - loss: 0.1906 - accuracy: 0.9325 - val
_loss: 0.5900 - val_accuracy: 0.8640
Epoch 77/300
389/390 [============================>.] - ETA: 0s - loss: 0.1913 - accuracy: 0.9317
Epoch 00077: val_accuracy did not improve from 0.86740
390/390 [==============================] - 135s 346ms/step - loss: 0.1912 - accuracy: 0.9317 - val
_loss: 0.7853 - val_accuracy: 0.8285
Epoch 78/300
389/390 [============================>.] - ETA: 0s - loss: 0.1943 - accuracy: 0.9305
Epoch 00078: val_accuracy did not improve from 0.86740
390/390 [==============================] - 135s 346ms/step - loss: 0.1941 - accuracy: 0.9305 - val
_loss: 0.8347 - val_accuracy: 0.8214
Epoch 79/300
389/390 [============================>.] - ETA: 0s - loss: 0.1904 - accuracy: 0.9321
Epoch 00079: val_accuracy did not improve from 0.86740
390/390 [==============================] - 135s 347ms/step - loss: 0.1904 - accuracy: 0.9321 - val
_loss: 0.6842 - val_accuracy: 0.8546
Epoch 80/300
389/390 [============================>.] - ETA: 0s - loss: 0.1905 - accuracy: 0.9324
Epoch 00080: val_accuracy did not improve from 0.86740
390/390 [==============================] - 135s 346ms/step - loss: 0.1906 - accuracy: 0.9324 - val
_loss: 0.7611 - val_accuracy: 0.8312
Epoch 81/300
389/390 [============================>.] - ETA: 0s - loss: 0.1864 - accuracy: 0.9337
Epoch 00081: val_accuracy did not improve from 0.86740
390/390 [==============================] - 135s 347ms/step - loss: 0.1863 - accuracy: 0.9337 - val
_loss: 0.5795 - val_accuracy: 0.8579
Epoch 82/300
389/390 [============================>.] - ETA: 0s - loss: 0.1832 - accuracy: 0.9345
Epoch 00082: val_accuracy did not improve from 0.86740
390/390 [==============================] - 135s 347ms/step - loss: 0.1832 - accuracy: 0.9344 - val
_loss: 0.6056 - val_accuracy: 0.8547
Epoch 83/300
389/390 [============================>.] - ETA: 0s - loss: 0.1780 - accuracy: 0.9364
Epoch 00083: val_accuracy did not improve from 0.86740
390/390 [==============================] - 135s 346ms/step - loss: 0.1780 - accuracy: 0.9364 - val
_loss: 0.7099 - val_accuracy: 0.8408
Epoch 84/300
389/390 [============================>.] - ETA: 0s - loss: 0.1774 - accuracy: 0.9365
Epoch 00084: val_accuracy did not improve from 0.86740
390/390 [==============================] - 135s 347ms/step - loss: 0.1776 - accuracy: 0.9364 - val
_loss: 0.8617 - val_accuracy: 0.8185
Epoch 85/300
389/390 [============================>.] - ETA: 0s - loss: 0.1784 - accuracy: 0.9380
Epoch 00085: val_accuracy did not improve from 0.86740
390/390 [==============================] - 135s 347ms/step - loss: 0.1784 - accuracy: 0.9380 - val
_loss: 0.5710 - val_accuracy: 0.8667
Epoch 86/300
389/390 [============================>.] - ETA: 0s - loss: 0.1809 - accuracy: 0.9349
Epoch 00086: val_accuracy did not improve from 0.86740
390/390 [==============================] - 135s 346ms/step - loss: 0.1809 - accuracy: 0.9349 - val
_loss: 0.7086 - val_accuracy: 0.8446
Epoch 87/300
389/390 [============================>.] - ETA: 0s - loss: 0.1765 - accuracy: 0.9363
Epoch 00087: val_accuracy improved from 0.86740 to 0.87590, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_87-0.88.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.1766 - accuracy: 0.9362 - val
_loss: 0.5157 - val_accuracy: 0.8759
Epoch 88/300
389/390 [============================>.] - ETA: 0s - loss: 0.1737 - accuracy: 0.9378
Epoch 00088: val_accuracy did not improve from 0.87590
390/390 [==============================] - 135s 347ms/step - loss: 0.1737 - accuracy: 0.9379 - val
_loss: 0.6484 - val_accuracy: 0.8519
Epoch 89/300
389/390 [============================>.] - ETA: 0s - loss: 0.1694 - accuracy: 0.9401
Epoch 00089: val_accuracy did not improve from 0.87590
390/390 [==============================] - 135s 346ms/step - loss: 0.1695 - accuracy: 0.9401 - val
_loss: 0.5067 - val_accuracy: 0.8738
Epoch 90/300
389/390 [============================>.] - ETA: 0s - loss: 0.1695 - accuracy: 0.9403
Epoch 00090: val_accuracy did not improve from 0.87590
390/390 [==============================] - 135s 346ms/step - loss: 0.1693 - accuracy: 0.9403 - val
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_loss: 0.7201 - val_accuracy: 0.8429
Epoch 91/300
389/390 [============================>.] - ETA: 0s - loss: 0.1711 - accuracy: 0.9394
Epoch 00091: val_accuracy did not improve from 0.87590
390/390 [==============================] - 135s 347ms/step - loss: 0.1712 - accuracy: 0.9394 - val
_loss: 0.5750 - val_accuracy: 0.8631
Epoch 92/300
389/390 [============================>.] - ETA: 0s - loss: 0.1710 - accuracy: 0.9390
Epoch 00092: val_accuracy did not improve from 0.87590
390/390 [==============================] - 135s 346ms/step - loss: 0.1711 - accuracy: 0.9390 - val
_loss: 0.6479 - val_accuracy: 0.8540
Epoch 93/300
389/390 [============================>.] - ETA: 0s - loss: 0.1673 - accuracy: 0.9399
Epoch 00093: val_accuracy did not improve from 0.87590
390/390 [==============================] - 135s 346ms/step - loss: 0.1674 - accuracy: 0.9398 - val
_loss: 0.6256 - val_accuracy: 0.8624
Epoch 94/300
389/390 [============================>.] - ETA: 0s - loss: 0.1638 - accuracy: 0.9416
Epoch 00094: val_accuracy did not improve from 0.87590
390/390 [==============================] - 135s 347ms/step - loss: 0.1640 - accuracy: 0.9415 - val
_loss: 0.6470 - val_accuracy: 0.8616
Epoch 95/300
389/390 [============================>.] - ETA: 0s - loss: 0.1665 - accuracy: 0.9409
Epoch 00095: val_accuracy did not improve from 0.87590
390/390 [==============================] - 135s 346ms/step - loss: 0.1664 - accuracy: 0.9408 - val
_loss: 0.5145 - val_accuracy: 0.8746
Epoch 96/300
389/390 [============================>.] - ETA: 0s - loss: 0.1627 - accuracy: 0.9419
Epoch 00096: val_accuracy did not improve from 0.87590
390/390 [==============================] - 135s 346ms/step - loss: 0.1628 - accuracy: 0.9419 - val
_loss: 0.7455 - val_accuracy: 0.8394
Epoch 97/300
389/390 [============================>.] - ETA: 0s - loss: 0.1622 - accuracy: 0.9427
Epoch 00097: val_accuracy did not improve from 0.87590
390/390 [==============================] - 135s 347ms/step - loss: 0.1623 - accuracy: 0.9427 - val
_loss: 0.5512 - val_accuracy: 0.8722
Epoch 98/300
389/390 [============================>.] - ETA: 0s - loss: 0.1611 - accuracy: 0.9422
Epoch 00098: val_accuracy did not improve from 0.87590
390/390 [==============================] - 135s 346ms/step - loss: 0.1613 - accuracy: 0.9421 - val
_loss: 0.7458 - val_accuracy: 0.8387
Epoch 99/300
389/390 [============================>.] - ETA: 0s - loss: 0.1568 - accuracy: 0.9436
Epoch 00099: val_accuracy did not improve from 0.87590
390/390 [==============================] - 135s 346ms/step - loss: 0.1567 - accuracy: 0.9436 - val
_loss: 0.7160 - val_accuracy: 0.8471
Epoch 100/300
389/390 [============================>.] - ETA: 0s - loss: 0.1551 - accuracy: 0.9456
Epoch 00100: val_accuracy did not improve from 0.87590
390/390 [==============================] - 135s 347ms/step - loss: 0.1551 - accuracy: 0.9455 - val
_loss: 0.8331 - val_accuracy: 0.8279
Epoch 101/300
389/390 [============================>.] - ETA: 0s - loss: 0.1580 - accuracy: 0.9440
Epoch 00101: val_accuracy did not improve from 0.87590
390/390 [==============================] - 135s 346ms/step - loss: 0.1583 - accuracy: 0.9440 - val
_loss: 0.7311 - val_accuracy: 0.8441
Epoch 102/300
389/390 [============================>.] - ETA: 0s - loss: 0.1513 - accuracy: 0.9472
Epoch 00102: val_accuracy did not improve from 0.87590
390/390 [==============================] - 135s 346ms/step - loss: 0.1512 - accuracy: 0.9472 - val
_loss: 0.6692 - val_accuracy: 0.8583
Epoch 103/300
389/390 [============================>.] - ETA: 0s - loss: 0.1545 - accuracy: 0.9451
Epoch 00103: val_accuracy did not improve from 0.87590

Epoch 00103: ReduceLROnPlateau reducing learning rate to 0.00010000000474974513.
390/390 [==============================] - 135s 347ms/step - loss: 0.1543 - accuracy: 0.9452 - val
_loss: 0.6255 - val_accuracy: 0.8603
Epoch 104/300
389/390 [============================>.] - ETA: 0s - loss: 0.1180 - accuracy: 0.9588
Epoch 00104: val_accuracy improved from 0.87590 to 0.89080, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_104-0.89.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.1180 - accuracy: 0.9588 - val
_loss: 0.4858 - val_accuracy: 0.8908
Epoch 105/300
389/390 [============================>.] - ETA: 0s - loss: 0.1009 - accuracy: 0.9637
Epoch 00105: val_accuracy did not improve from 0.89080
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390/390 [==============================] - 135s 347ms/step - loss: 0.1008 - accuracy: 0.9637 - val
_loss: 0.4950 - val_accuracy: 0.8906
Epoch 106/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0979 - accuracy: 0.9653
Epoch 00106: val_accuracy improved from 0.89080 to 0.89100, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_106-0.89.hdf5
390/390 [==============================] - 136s 350ms/step - loss: 0.0979 - accuracy: 0.9653 - val
_loss: 0.5031 - val_accuracy: 0.8910
Epoch 107/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0912 - accuracy: 0.9671
Epoch 00107: val_accuracy did not improve from 0.89100
390/390 [==============================] - 135s 346ms/step - loss: 0.0913 - accuracy: 0.9671 - val
_loss: 0.5264 - val_accuracy: 0.8891
Epoch 108/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0850 - accuracy: 0.9702
Epoch 00108: val_accuracy did not improve from 0.89100
390/390 [==============================] - 135s 346ms/step - loss: 0.0850 - accuracy: 0.9703 - val
_loss: 0.5278 - val_accuracy: 0.8897
Epoch 109/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0852 - accuracy: 0.9699
Epoch 00109: val_accuracy did not improve from 0.89100
390/390 [==============================] - 135s 347ms/step - loss: 0.0853 - accuracy: 0.9699 - val
_loss: 0.5183 - val_accuracy: 0.8910
Epoch 110/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0859 - accuracy: 0.9699
Epoch 00110: val_accuracy did not improve from 0.89100
390/390 [==============================] - 135s 347ms/step - loss: 0.0859 - accuracy: 0.9700 - val
_loss: 0.5395 - val_accuracy: 0.8886
Epoch 111/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0830 - accuracy: 0.9701
Epoch 00111: val_accuracy did not improve from 0.89100
390/390 [==============================] - 135s 347ms/step - loss: 0.0829 - accuracy: 0.9702 - val
_loss: 0.5458 - val_accuracy: 0.8909
Epoch 112/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0806 - accuracy: 0.9720
Epoch 00112: val_accuracy improved from 0.89100 to 0.89150, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_112-0.89.hdf5
390/390 [==============================] - 136s 350ms/step - loss: 0.0806 - accuracy: 0.9720 - val
_loss: 0.5410 - val_accuracy: 0.8915
Epoch 113/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0809 - accuracy: 0.9711
Epoch 00113: val_accuracy did not improve from 0.89150
390/390 [==============================] - 135s 347ms/step - loss: 0.0812 - accuracy: 0.9710 - val
_loss: 0.5522 - val_accuracy: 0.8909
Epoch 114/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0790 - accuracy: 0.9719
Epoch 00114: val_accuracy improved from 0.89150 to 0.89180, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_114-0.89.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.0790 - accuracy: 0.9719 - val
_loss: 0.5481 - val_accuracy: 0.8918
Epoch 115/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0768 - accuracy: 0.9733
Epoch 00115: val_accuracy did not improve from 0.89180
390/390 [==============================] - 135s 347ms/step - loss: 0.0770 - accuracy: 0.9734 - val
_loss: 0.5404 - val_accuracy: 0.8915
Epoch 116/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0781 - accuracy: 0.9723
Epoch 00116: val_accuracy did not improve from 0.89180
390/390 [==============================] - 135s 347ms/step - loss: 0.0780 - accuracy: 0.9724 - val
_loss: 0.5824 - val_accuracy: 0.8865
Epoch 117/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0797 - accuracy: 0.9721
Epoch 00117: val_accuracy did not improve from 0.89180
390/390 [==============================] - 135s 347ms/step - loss: 0.0798 - accuracy: 0.9720 - val
_loss: 0.5693 - val_accuracy: 0.8873
Epoch 118/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0773 - accuracy: 0.9722
Epoch 00118: val_accuracy did not improve from 0.89180
390/390 [==============================] - 135s 347ms/step - loss: 0.0775 - accuracy: 0.9721 - val
_loss: 0.5688 - val_accuracy: 0.8904
Epoch 119/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0734 - accuracy: 0.9744
Epoch 00119: val_accuracy did not improve from 0.89180
390/390 [==============================] - 135s 347ms/step - loss: 0.0734 - accuracy: 0.9745 - val
_loss: 0.5809 - val_accuracy: 0.8889
Epoch 120/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0755 - accuracy: 0.9727
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Epoch 00120: val_accuracy did not improve from 0.89180
390/390 [==============================] - 135s 347ms/step - loss: 0.0755 - accuracy: 0.9727 - val
_loss: 0.5653 - val_accuracy: 0.8902
Epoch 121/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0716 - accuracy: 0.9742
Epoch 00121: val_accuracy did not improve from 0.89180
390/390 [==============================] - 135s 347ms/step - loss: 0.0716 - accuracy: 0.9742 - val
_loss: 0.5992 - val_accuracy: 0.8856
Epoch 122/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0735 - accuracy: 0.9730
Epoch 00122: val_accuracy did not improve from 0.89180
390/390 [==============================] - 135s 347ms/step - loss: 0.0735 - accuracy: 0.9730 - val
_loss: 0.6007 - val_accuracy: 0.8868
Epoch 123/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0697 - accuracy: 0.9752
Epoch 00123: val_accuracy did not improve from 0.89180
390/390 [==============================] - 135s 347ms/step - loss: 0.0698 - accuracy: 0.9751 - val
_loss: 0.6243 - val_accuracy: 0.8824
Epoch 124/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0709 - accuracy: 0.9748
Epoch 00124: val_accuracy did not improve from 0.89180
390/390 [==============================] - 135s 347ms/step - loss: 0.0710 - accuracy: 0.9747 - val
_loss: 0.5675 - val_accuracy: 0.8918
Epoch 125/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0696 - accuracy: 0.9750
Epoch 00125: val_accuracy improved from 0.89180 to 0.89210, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_125-0.89.hdf5
390/390 [==============================] - 136s 349ms/step - loss: 0.0695 - accuracy: 0.9750 - val
_loss: 0.5825 - val_accuracy: 0.8921
Epoch 126/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0690 - accuracy: 0.9761
Epoch 00126: val_accuracy did not improve from 0.89210
390/390 [==============================] - 136s 348ms/step - loss: 0.0691 - accuracy: 0.9760 - val
_loss: 0.6159 - val_accuracy: 0.8876
Epoch 127/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0708 - accuracy: 0.9746
Epoch 00127: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0709 - accuracy: 0.9746 - val
_loss: 0.6079 - val_accuracy: 0.8850
Epoch 128/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0699 - accuracy: 0.9747
Epoch 00128: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0699 - accuracy: 0.9747 - val
_loss: 0.6289 - val_accuracy: 0.8841
Epoch 129/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0681 - accuracy: 0.9754
Epoch 00129: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0680 - accuracy: 0.9754 - val
_loss: 0.6260 - val_accuracy: 0.8868
Epoch 130/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0685 - accuracy: 0.9760
Epoch 00130: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0685 - accuracy: 0.9759 - val
_loss: 0.6424 - val_accuracy: 0.8821
Epoch 131/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0637 - accuracy: 0.9768
Epoch 00131: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0638 - accuracy: 0.9768 - val
_loss: 0.6219 - val_accuracy: 0.8863
Epoch 132/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0664 - accuracy: 0.9763
Epoch 00132: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0664 - accuracy: 0.9763 - val
_loss: 0.6491 - val_accuracy: 0.8841
Epoch 133/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0641 - accuracy: 0.9771
Epoch 00133: val_accuracy did not improve from 0.89210
390/390 [==============================] - 136s 348ms/step - loss: 0.0640 - accuracy: 0.9772 - val
_loss: 0.6434 - val_accuracy: 0.8854
Epoch 134/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0652 - accuracy: 0.9771
Epoch 00134: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0651 - accuracy: 0.9771 - val
_loss: 0.6236 - val_accuracy: 0.8865
Epoch 135/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0664 - accuracy: 0.9768
Epoch 00135: val_accuracy did not improve from 0.89210
```

```
390/390 [==============================] - 135s 347ms/step - loss: 0.0665 - accuracy: 0.9768 - val
_loss: 0.6119 - val_accuracy: 0.8880
Epoch 136/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0660 - accuracy: 0.9766
Epoch 00136: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0660 - accuracy: 0.9767 - val
_loss: 0.6272 - val_accuracy: 0.8867
Epoch 137/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0648 - accuracy: 0.9765
Epoch 00137: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0648 - accuracy: 0.9765 - val
_loss: 0.6227 - val_accuracy: 0.8883
Epoch 138/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0663 - accuracy: 0.9762
Epoch 00138: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0663 - accuracy: 0.9762 - val
_loss: 0.6828 - val_accuracy: 0.8830
Epoch 139/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0642 - accuracy: 0.9773
Epoch 00139: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0641 - accuracy: 0.9773 - val
_loss: 0.6671 - val_accuracy: 0.8811
Epoch 140/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0627 - accuracy: 0.9773
Epoch 00140: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0629 - accuracy: 0.9773 - val
_loss: 0.6484 - val_accuracy: 0.8865
Epoch 141/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0650 - accuracy: 0.9771
Epoch 00141: val_accuracy did not improve from 0.89210

Epoch 00141: ReduceLROnPlateau reducing learning rate to 1.0000000474974514e-05.
390/390 [==============================] - 135s 347ms/step - loss: 0.0651 - accuracy: 0.9770 - val
_loss: 0.6447 - val_accuracy: 0.8866
Epoch 142/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0603 - accuracy: 0.9787
Epoch 00142: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0603 - accuracy: 0.9787 - val
_loss: 0.6345 - val_accuracy: 0.8887
Epoch 143/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0602 - accuracy: 0.9785
Epoch 00143: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0602 - accuracy: 0.9785 - val
_loss: 0.6355 - val_accuracy: 0.8880
Epoch 144/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0600 - accuracy: 0.9781
Epoch 00144: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0600 - accuracy: 0.9781 - val
_loss: 0.6335 - val_accuracy: 0.8887
Epoch 145/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0586 - accuracy: 0.9793
Epoch 00145: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0586 - accuracy: 0.9793 - val
_loss: 0.6340 - val_accuracy: 0.8878
Epoch 146/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0597 - accuracy: 0.9789
Epoch 00146: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0598 - accuracy: 0.9789 - val
_loss: 0.6390 - val_accuracy: 0.8873
Epoch 147/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0585 - accuracy: 0.9791
Epoch 00147: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0584 - accuracy: 0.9792 - val
_loss: 0.6372 - val_accuracy: 0.8878
Epoch 148/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0585 - accuracy: 0.9791
Epoch 00148: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0585 - accuracy: 0.9791 - val
_loss: 0.6324 - val_accuracy: 0.8883
Epoch 149/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0589 - accuracy: 0.9786
Epoch 00149: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0588 - accuracy: 0.9786 - val
_loss: 0.6336 - val_accuracy: 0.8888
Epoch 150/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0561 - accuracy: 0.9797
Epoch 00150: val_accuracy did not improve from 0.89210
```

```
390/390 [==============================] - 135s 347ms/step - loss: 0.0561 - accuracy: 0.9796 - val
_loss: 0.6279 - val_accuracy: 0.8890
Epoch 151/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0568 - accuracy: 0.9794
Epoch 00151: val_accuracy did not improve from 0.89210
390/390 [==============================] - 136s 348ms/step - loss: 0.0568 - accuracy: 0.9794 - val
_loss: 0.6345 - val_accuracy: 0.8883
Epoch 152/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0563 - accuracy: 0.9799
Epoch 00152: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0564 - accuracy: 0.9799 - val
_loss: 0.6357 - val_accuracy: 0.8890
Epoch 153/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0549 - accuracy: 0.9811
Epoch 00153: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0548 - accuracy: 0.9811 - val
_loss: 0.6367 - val_accuracy: 0.8892
Epoch 154/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0597 - accuracy: 0.9786
Epoch 00154: val_accuracy did not improve from 0.89210
390/390 [==============================] - 136s 348ms/step - loss: 0.0597 - accuracy: 0.9786 - val
_loss: 0.6346 - val_accuracy: 0.8890
Epoch 155/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0566 - accuracy: 0.9803
Epoch 00155: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0566 - accuracy: 0.9803 - val
_loss: 0.6294 - val_accuracy: 0.8892
Epoch 156/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0592 - accuracy: 0.9791
Epoch 00156: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0591 - accuracy: 0.9792 - val
_loss: 0.6295 - val_accuracy: 0.8899
Epoch 157/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0569 - accuracy: 0.9795
Epoch 00157: val_accuracy did not improve from 0.89210

Epoch 00157: ReduceLROnPlateau reducing learning rate to 1.0000000656873453e-06.
390/390 [==============================] - 135s 347ms/step - loss: 0.0569 - accuracy: 0.9795 - val
_loss: 0.6296 - val_accuracy: 0.8905
Epoch 158/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0564 - accuracy: 0.9796
Epoch 00158: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0563 - accuracy: 0.9797 - val
_loss: 0.6307 - val_accuracy: 0.8903
Epoch 159/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0574 - accuracy: 0.9792
Epoch 00159: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0574 - accuracy: 0.9791 - val
_loss: 0.6280 - val_accuracy: 0.8900
Epoch 160/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0568 - accuracy: 0.9797
Epoch 00160: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0569 - accuracy: 0.9796 - val
_loss: 0.6276 - val_accuracy: 0.8908
Epoch 161/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0579 - accuracy: 0.9789
Epoch 00161: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0578 - accuracy: 0.9788 - val
_loss: 0.6288 - val_accuracy: 0.8903
Epoch 162/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0589 - accuracy: 0.9787
Epoch 00162: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0589 - accuracy: 0.9787 - val
_loss: 0.6321 - val_accuracy: 0.8902
Epoch 163/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0564 - accuracy: 0.9799
Epoch 00163: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0563 - accuracy: 0.9800 - val
_loss: 0.6301 - val_accuracy: 0.8898
Epoch 164/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0584 - accuracy: 0.9789
Epoch 00164: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0584 - accuracy: 0.9789 - val
_loss: 0.6253 - val_accuracy: 0.8903
Epoch 165/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0559 - accuracy: 0.9808
Epoch 00165: val_accuracy did not improve from 0.89210
```

390/390 [==============================] - 135s 347ms/step - loss: 0.0559 - accuracy: 0.9808 - val_loss: 0.6271 - val_accuracy: 0.8904
Epoch 166/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0579 - accuracy: 0.9793
Epoch 00166: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0580 - accuracy: 0.9793 - val_loss: 0.6305 - val_accuracy: 0.8906
Epoch 167/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0542 - accuracy: 0.9804
Epoch 00167: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0541 - accuracy: 0.9805 - val_loss: 0.6304 - val_accuracy: 0.8903
Epoch 168/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0567 - accuracy: 0.9790
Epoch 00168: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0567 - accuracy: 0.9790 - val_loss: 0.6275 - val_accuracy: 0.8910
Epoch 169/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0588 - accuracy: 0.9790
Epoch 00169: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0587 - accuracy: 0.9790 - val_loss: 0.6263 - val_accuracy: 0.8912
Epoch 170/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0587 - accuracy: 0.9789
Epoch 00170: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0587 - accuracy: 0.9789 - val_loss: 0.6336 - val_accuracy: 0.8901
Epoch 171/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0565 - accuracy: 0.9798
Epoch 00171: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0565 - accuracy: 0.9799 - val_loss: 0.6327 - val_accuracy: 0.8901
Epoch 172/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0595 - accuracy: 0.9792
Epoch 00172: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0595 - accuracy: 0.9792 - val_loss: 0.6267 - val_accuracy: 0.8905
Epoch 173/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0556 - accuracy: 0.9805
Epoch 00173: val_accuracy did not improve from 0.89210

Epoch 00173: ReduceLROnPlateau reducing learning rate to 1.0000001111620805e-07.
390/390 [==============================] - 135s 347ms/step - loss: 0.0556 - accuracy: 0.9805 - val_loss: 0.6276 - val_accuracy: 0.8906
Epoch 174/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0571 - accuracy: 0.9797
Epoch 00174: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0570 - accuracy: 0.9797 - val_loss: 0.6287 - val_accuracy: 0.8908
Epoch 175/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0567 - accuracy: 0.9807
Epoch 00175: val_accuracy did not improve from 0.89210
390/390 [==============================] - 135s 347ms/step - loss: 0.0567 - accuracy: 0.9806 - val_loss: 0.6282 - val_accuracy: 0.8906


In [70]:

```python
#history plot for accyracy
plt.figure(figsize=(16,4))
plt.plot(history_5.history['accuracy'])
plt.plot(history_5.history['val_accuracy'])
plt.title("Model Accuracy")
plt.xlabel("Epoch")
plt.ylabel("Accuracy")
plt.legend(["train", "test"], loc="upper left")
plt.show()

# history plot for accuracy
plt.figure(figsize=(16,4))
plt.plot(history_5.history["loss"])
plt.plot(history_5.history["val_loss"])
plt.title("Model Loss")
plt.xlabel("Epoch")
plt.ylabel("Loss")
plt.legend(["train", "test"], loc="upper left")
plt.show()
```

Model Accuracy

Model Loss
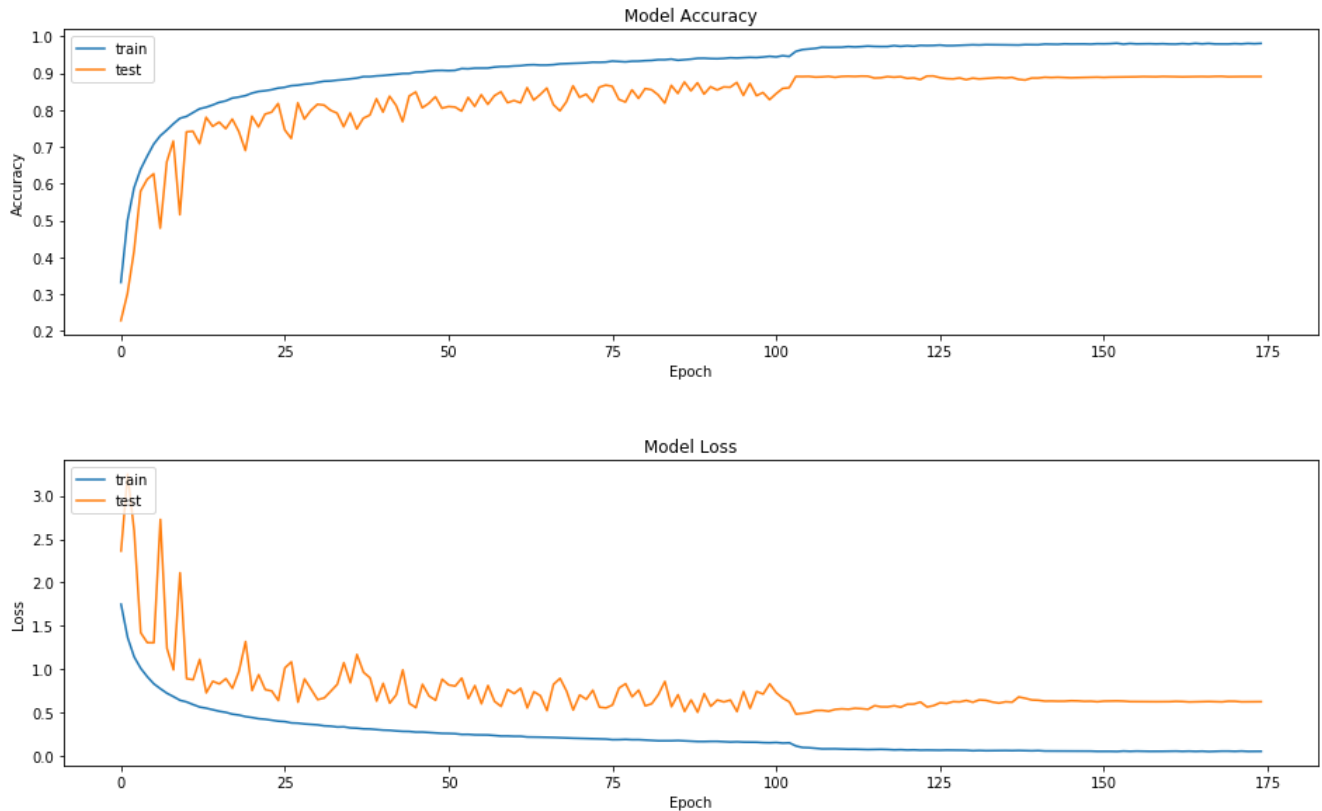
```
best_model_5 =
tf.keras.models.load_model('/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model5_125-0.8
9.hdf5')
scores = best_model_5.evaluate(X_test, y_test, verbose=1)
print(scores)
```

```
10000/10000 [==============================] - 9s 878us/sample - loss: 0.5825 - accuracy: 0.8921
[0.5824969663321972, 0.8921]
```

6. Model -6

- Model-5 without dropouts

```
#BN-->ReLU-->Conv2D-->Dropout-->concat(input, output)-->(put in loop)
from tensorflow.keras import layers
from tensorflow.keras.models import Model
num_classes = 10

def denseblock(input, num_filter, dropout_rate):
    global compression        # to keep the growth rate of number of filters
    temp = input
    for _ in range(l):
        BatchNorm = layers.BatchNormalization()(temp)
        relu = layers.Activation('relu')(BatchNorm)
        Conv2D_7_7= layers.SeparableConv2D(int(num_filter*compression), (7,7), use_bias=False, padd
ing='same')(relu)
        if dropout_rate>0:
            Conv2D_7_7 = layers.Dropout(dropout_rate)(Conv2D_7_7)

        #concat the input(temp) and output(conv2d_7_7) , in resnet we add but here we concat
        concat = layers.Concatenate(axis=-1)([temp,Conv2D_7_7])

        #change the concat as input
        temp = concat
```

```
        return temp

#BN-->relu-->conv2d(1x1)-->dropout-->avg_pool
def transition(input, num_filter, dropout_rate):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    Conv2D_BottleNeck = layers.SeparableConvolution2D(int(num_filter*compression), (1,1), use_bias=
False ,padding='same')(relu)
    if dropout_rate>0:
        Conv2D_BottleNeck = layers.Dropout(dropout_rate)(Conv2D_BottleNeck)
    avg = layers.AveragePooling2D(pool_size=(2,2))(Conv2D_BottleNeck)
    return avg

#BN-->relu-->avgpool-->flat-->softmax
def output_layer(input):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    AvgPooling = layers.AveragePooling2D(pool_size=(2,2))(relu)
    conv_op = layers.SeparableConvolution2D(num_classes, (2,2), padding='valid')(AvgPooling)
    flat = layers.Flatten()(conv_op)
    output = layers.Dense(num_classes, activation='softmax')(flat)
    return output

# Hyperparameters
l = 21
num_filter = 48
compression = 0.3
dropout_rate = 0
num_classes = 10

input = layers.Input(shape=(input_size))
First_Conv2D = layers.Conv2D(num_filter, (7,7), use_bias=False ,padding='same')(input)

#First dense and transition block
First_Block = denseblock(First_Conv2D, num_filter, dropout_rate)
First_Transition = transition(First_Block, num_filter, dropout_rate)

#Second dense and transition block
Second_Block = denseblock(First_Transition, num_filter, dropout_rate)
Second_Transition = transition(Second_Block, num_filter, dropout_rate)

#Third dense and transition block
Third_Block = denseblock(Second_Transition, num_filter, dropout_rate)
Third_Transition = transition(Third_Block, num_filter, dropout_rate)

#last dense and output block
Last_Block = denseblock(Third_Transition,  num_filter, dropout_rate)
output = output_layer(Last_Block)
```

In [12]:

```
model_6 = tf.keras.models.Model(inputs=[input], outputs=[output])
model_6.summary()
```

Model: "model"

Layer (type)	Output Shape	Param #	Connected to
input_1 (InputLayer)	[(None, 32, 32, 3)]	0	
conv2d (Conv2D)	(None, 32, 32, 48)	7056	input_1[0][0]
batch_normalization (BatchNorma	(None, 32, 32, 48)	192	conv2d[0][0]
activation (Activation)	(None, 32, 32, 48)	0	batch_normalization[0][0]
separable_conv2d (SeparableConv	(None, 32, 32, 14)	3024	activation[0][0]
concatenate (Concatenate)	(None, 32, 32, 62)	0	conv2d[0][0] separable_conv2d[0][0]
batch_normalization_1 (BatchNor	(None, 32, 32, 62)	248	concatenate[0][0]
activation_1 (Activation)	(None, 32, 32, 62)	0	batch_normalization_1[0][0]

Layer (type)	Output Shape	Param #	Connected to
activation_1 (Activation)	(None, 32, 32, 62)	0	batch_normalization_1[0][0]
separable_conv2d_1 (SeparableCo	(None, 32, 32, 14)	3906	activation_1[0][0]
concatenate_1 (Concatenate)	(None, 32, 32, 76)	0	concatenate[0][0] separable_conv2d_1[0][0]
batch_normalization_2 (BatchNor	(None, 32, 32, 76)	304	concatenate_1[0][0]
activation_2 (Activation)	(None, 32, 32, 76)	0	batch_normalization_2[0][0]
separable_conv2d_2 (SeparableCo	(None, 32, 32, 14)	4788	activation_2[0][0]
concatenate_2 (Concatenate)	(None, 32, 32, 90)	0	concatenate_1[0][0] separable_conv2d_2[0][0]
batch_normalization_3 (BatchNor	(None, 32, 32, 90)	360	concatenate_2[0][0]
activation_3 (Activation)	(None, 32, 32, 90)	0	batch_normalization_3[0][0]
separable_conv2d_3 (SeparableCo	(None, 32, 32, 14)	5670	activation_3[0][0]
concatenate_3 (Concatenate)	(None, 32, 32, 104)	0	concatenate_2[0][0] separable_conv2d_3[0][0]
batch_normalization_4 (BatchNor	(None, 32, 32, 104)	416	concatenate_3[0][0]
activation_4 (Activation)	(None, 32, 32, 104)	0	batch_normalization_4[0][0]
separable_conv2d_4 (SeparableCo	(None, 32, 32, 14)	6552	activation_4[0][0]
concatenate_4 (Concatenate)	(None, 32, 32, 118)	0	concatenate_3[0][0] separable_conv2d_4[0][0]
batch_normalization_5 (BatchNor	(None, 32, 32, 118)	472	concatenate_4[0][0]
activation_5 (Activation)	(None, 32, 32, 118)	0	batch_normalization_5[0][0]
separable_conv2d_5 (SeparableCo	(None, 32, 32, 14)	7434	activation_5[0][0]
concatenate_5 (Concatenate)	(None, 32, 32, 132)	0	concatenate_4[0][0] separable_conv2d_5[0][0]
batch_normalization_6 (BatchNor	(None, 32, 32, 132)	528	concatenate_5[0][0]
activation_6 (Activation)	(None, 32, 32, 132)	0	batch_normalization_6[0][0]
separable_conv2d_6 (SeparableCo	(None, 32, 32, 14)	8316	activation_6[0][0]
concatenate_6 (Concatenate)	(None, 32, 32, 146)	0	concatenate_5[0][0] separable_conv2d_6[0][0]
batch_normalization_7 (BatchNor	(None, 32, 32, 146)	584	concatenate_6[0][0]
activation_7 (Activation)	(None, 32, 32, 146)	0	batch_normalization_7[0][0]
separable_conv2d_7 (SeparableCo	(None, 32, 32, 14)	9198	activation_7[0][0]
concatenate_7 (Concatenate)	(None, 32, 32, 160)	0	concatenate_6[0][0] separable_conv2d_7[0][0]
batch_normalization_8 (BatchNor	(None, 32, 32, 160)	640	concatenate_7[0][0]
activation_8 (Activation)	(None, 32, 32, 160)	0	batch_normalization_8[0][0]
separable_conv2d_8 (SeparableCo	(None, 32, 32, 14)	10080	activation_8[0][0]
concatenate_8 (Concatenate)	(None, 32, 32, 174)	0	concatenate_7[0][0] separable_conv2d_8[0][0]
batch_normalization_9 (BatchNor	(None, 32, 32, 174)	696	concatenate_8[0][0]
activation_9 (Activation)	(None, 32, 32, 174)	0	batch_normalization_9[0][0]
separable_conv2d_9 (SeparableCo	(None, 32, 32, 14)	10962	activation_9[0][0]
concatenate_9 (Concatenate)	(None, 32, 32, 188)	0	concatenate_8[0][0] separable_conv2d_9[0][0]

batch_normalization_10 (BatchNo	(None, 32, 32, 188)	752	concatenate_9[0][0]
activation_10 (Activation)	(None, 32, 32, 188)	0	batch_normalization_10[0][0]
separable_conv2d_10 (SeparableC	(None, 32, 32, 14)	11844	activation_10[0][0]
concatenate_10 (Concatenate)	(None, 32, 32, 202)	0	concatenate_9[0][0] separable_conv2d_10[0][0]
batch_normalization_11 (BatchNo	(None, 32, 32, 202)	808	concatenate_10[0][0]
activation_11 (Activation)	(None, 32, 32, 202)	0	batch_normalization_11[0][0]
separable_conv2d_11 (SeparableC	(None, 32, 32, 14)	12726	activation_11[0][0]
concatenate_11 (Concatenate)	(None, 32, 32, 216)	0	concatenate_10[0][0] separable_conv2d_11[0][0]
batch_normalization_12 (BatchNo	(None, 32, 32, 216)	864	concatenate_11[0][0]
activation_12 (Activation)	(None, 32, 32, 216)	0	batch_normalization_12[0][0]
separable_conv2d_12 (SeparableC	(None, 32, 32, 14)	13608	activation_12[0][0]
concatenate_12 (Concatenate)	(None, 32, 32, 230)	0	concatenate_11[0][0] separable_conv2d_12[0][0]
batch_normalization_13 (BatchNo	(None, 32, 32, 230)	920	concatenate_12[0][0]
activation_13 (Activation)	(None, 32, 32, 230)	0	batch_normalization_13[0][0]
separable_conv2d_13 (SeparableC	(None, 32, 32, 14)	14490	activation_13[0][0]
concatenate_13 (Concatenate)	(None, 32, 32, 244)	0	concatenate_12[0][0] separable_conv2d_13[0][0]
batch_normalization_14 (BatchNo	(None, 32, 32, 244)	976	concatenate_13[0][0]
activation_14 (Activation)	(None, 32, 32, 244)	0	batch_normalization_14[0][0]
separable_conv2d_14 (SeparableC	(None, 32, 32, 14)	15372	activation_14[0][0]
concatenate_14 (Concatenate)	(None, 32, 32, 258)	0	concatenate_13[0][0] separable_conv2d_14[0][0]
batch_normalization_15 (BatchNo	(None, 32, 32, 258)	1032	concatenate_14[0][0]
activation_15 (Activation)	(None, 32, 32, 258)	0	batch_normalization_15[0][0]
separable_conv2d_15 (SeparableC	(None, 32, 32, 14)	16254	activation_15[0][0]
concatenate_15 (Concatenate)	(None, 32, 32, 272)	0	concatenate_14[0][0] separable_conv2d_15[0][0]
batch_normalization_16 (BatchNo	(None, 32, 32, 272)	1088	concatenate_15[0][0]
activation_16 (Activation)	(None, 32, 32, 272)	0	batch_normalization_16[0][0]
separable_conv2d_16 (SeparableC	(None, 32, 32, 14)	17136	activation_16[0][0]
concatenate_16 (Concatenate)	(None, 32, 32, 286)	0	concatenate_15[0][0] separable_conv2d_16[0][0]
batch_normalization_17 (BatchNo	(None, 32, 32, 286)	1144	concatenate_16[0][0]
activation_17 (Activation)	(None, 32, 32, 286)	0	batch_normalization_17[0][0]
separable_conv2d_17 (SeparableC	(None, 32, 32, 14)	18018	activation_17[0][0]
concatenate_17 (Concatenate)	(None, 32, 32, 300)	0	concatenate_16[0][0] separable_conv2d_17[0][0]
batch_normalization_18 (BatchNo	(None, 32, 32, 300)	1200	concatenate_17[0][0]
activation_18 (Activation)	(None, 32, 32, 300)	0	batch_normalization_18[0][0]

separable_conv2d_18 (SeparableC	(None, 32, 32, 14)	18900	activation_18[0][0]
concatenate_18 (Concatenate)	(None, 32, 32, 314)	0	concatenate_17[0][0] separable_conv2d_18[0][0]
batch_normalization_19 (BatchNo	(None, 32, 32, 314)	1256	concatenate_18[0][0]
activation_19 (Activation)	(None, 32, 32, 314)	0	batch_normalization_19[0][0]
separable_conv2d_19 (SeparableC	(None, 32, 32, 14)	19782	activation_19[0][0]
concatenate_19 (Concatenate)	(None, 32, 32, 328)	0	concatenate_18[0][0] separable_conv2d_19[0][0]
batch_normalization_20 (BatchNo	(None, 32, 32, 328)	1312	concatenate_19[0][0]
activation_20 (Activation)	(None, 32, 32, 328)	0	batch_normalization_20[0][0]
separable_conv2d_20 (SeparableC	(None, 32, 32, 14)	20664	activation_20[0][0]
concatenate_20 (Concatenate)	(None, 32, 32, 342)	0	concatenate_19[0][0] separable_conv2d_20[0][0]
batch_normalization_21 (BatchNo	(None, 32, 32, 342)	1368	concatenate_20[0][0]
activation_21 (Activation)	(None, 32, 32, 342)	0	batch_normalization_21[0][0]
separable_conv2d_21 (SeparableC	(None, 32, 32, 14)	5130	activation_21[0][0]
average_pooling2d (AveragePooli	(None, 16, 16, 14)	0	separable_conv2d_21[0][0]
batch_normalization_22 (BatchNo	(None, 16, 16, 14)	56	average_pooling2d[0][0]
activation_22 (Activation)	(None, 16, 16, 14)	0	batch_normalization_22[0][0]
separable_conv2d_22 (SeparableC	(None, 16, 16, 14)	882	activation_22[0][0]
concatenate_21 (Concatenate)	(None, 16, 16, 28)	0	average_pooling2d[0][0] separable_conv2d_22[0][0]
batch_normalization_23 (BatchNo	(None, 16, 16, 28)	112	concatenate_21[0][0]
activation_23 (Activation)	(None, 16, 16, 28)	0	batch_normalization_23[0][0]
separable_conv2d_23 (SeparableC	(None, 16, 16, 14)	1764	activation_23[0][0]
concatenate_22 (Concatenate)	(None, 16, 16, 42)	0	concatenate_21[0][0] separable_conv2d_23[0][0]
batch_normalization_24 (BatchNo	(None, 16, 16, 42)	168	concatenate_22[0][0]
activation_24 (Activation)	(None, 16, 16, 42)	0	batch_normalization_24[0][0]
separable_conv2d_24 (SeparableC	(None, 16, 16, 14)	2646	activation_24[0][0]
concatenate_23 (Concatenate)	(None, 16, 16, 56)	0	concatenate_22[0][0] separable_conv2d_24[0][0]
batch_normalization_25 (BatchNo	(None, 16, 16, 56)	224	concatenate_23[0][0]
activation_25 (Activation)	(None, 16, 16, 56)	0	batch_normalization_25[0][0]
separable_conv2d_25 (SeparableC	(None, 16, 16, 14)	3528	activation_25[0][0]
concatenate_24 (Concatenate)	(None, 16, 16, 70)	0	concatenate_23[0][0] separable_conv2d_25[0][0]
batch_normalization_26 (BatchNo	(None, 16, 16, 70)	280	concatenate_24[0][0]
activation_26 (Activation)	(None, 16, 16, 70)	0	batch_normalization_26[0][0]
separable_conv2d_26 (SeparableC	(None, 16, 16, 14)	4410	activation_26[0][0]
concatenate_25 (Concatenate)	(None, 16, 16, 84)	0	concatenate_24[0][0] separable_conv2d_26[0][0]

batch_normalization_27 (BatchNo	(None, 16, 16, 84)	336	concatenate_25[0][0]
activation_27 (Activation)	(None, 16, 16, 84)	0	batch_normalization_27[0][0]
separable_conv2d_27 (SeparableC	(None, 16, 16, 14)	5292	activation_27[0][0]
concatenate_26 (Concatenate)	(None, 16, 16, 98)	0	concatenate_25[0][0] separable_conv2d_27[0][0]
batch_normalization_28 (BatchNo	(None, 16, 16, 98)	392	concatenate_26[0][0]
activation_28 (Activation)	(None, 16, 16, 98)	0	batch_normalization_28[0][0]
separable_conv2d_28 (SeparableC	(None, 16, 16, 14)	6174	activation_28[0][0]
concatenate_27 (Concatenate)	(None, 16, 16, 112)	0	concatenate_26[0][0] separable_conv2d_28[0][0]
batch_normalization_29 (BatchNo	(None, 16, 16, 112)	448	concatenate_27[0][0]
activation_29 (Activation)	(None, 16, 16, 112)	0	batch_normalization_29[0][0]
separable_conv2d_29 (SeparableC	(None, 16, 16, 14)	7056	activation_29[0][0]
concatenate_28 (Concatenate)	(None, 16, 16, 126)	0	concatenate_27[0][0] separable_conv2d_29[0][0]
batch_normalization_30 (BatchNo	(None, 16, 16, 126)	504	concatenate_28[0][0]
activation_30 (Activation)	(None, 16, 16, 126)	0	batch_normalization_30[0][0]
separable_conv2d_30 (SeparableC	(None, 16, 16, 14)	7938	activation_30[0][0]
concatenate_29 (Concatenate)	(None, 16, 16, 140)	0	concatenate_28[0][0] separable_conv2d_30[0][0]
batch_normalization_31 (BatchNo	(None, 16, 16, 140)	560	concatenate_29[0][0]
activation_31 (Activation)	(None, 16, 16, 140)	0	batch_normalization_31[0][0]
separable_conv2d_31 (SeparableC	(None, 16, 16, 14)	8820	activation_31[0][0]
concatenate_30 (Concatenate)	(None, 16, 16, 154)	0	concatenate_29[0][0] separable_conv2d_31[0][0]
batch_normalization_32 (BatchNo	(None, 16, 16, 154)	616	concatenate_30[0][0]
activation_32 (Activation)	(None, 16, 16, 154)	0	batch_normalization_32[0][0]
separable_conv2d_32 (SeparableC	(None, 16, 16, 14)	9702	activation_32[0][0]
concatenate_31 (Concatenate)	(None, 16, 16, 168)	0	concatenate_30[0][0] separable_conv2d_32[0][0]
batch_normalization_33 (BatchNo	(None, 16, 16, 168)	672	concatenate_31[0][0]
activation_33 (Activation)	(None, 16, 16, 168)	0	batch_normalization_33[0][0]
separable_conv2d_33 (SeparableC	(None, 16, 16, 14)	10584	activation_33[0][0]
concatenate_32 (Concatenate)	(None, 16, 16, 182)	0	concatenate_31[0][0] separable_conv2d_33[0][0]
batch_normalization_34 (BatchNo	(None, 16, 16, 182)	728	concatenate_32[0][0]
activation_34 (Activation)	(None, 16, 16, 182)	0	batch_normalization_34[0][0]
separable_conv2d_34 (SeparableC	(None, 16, 16, 14)	11466	activation_34[0][0]
concatenate_33 (Concatenate)	(None, 16, 16, 196)	0	concatenate_32[0][0] separable_conv2d_34[0][0]
batch_normalization_35 (BatchNo	(None, 16, 16, 196)	784	concatenate_33[0][0]
activation_35 (Activation)	(None, 16, 16, 196)	0	batch_normalization_35[0][0]
separable_conv2d_35 (SeparableC	(None, 16, 16, 14)	12348	activation_35[0][0]

concatenate_34 (Concatenate)	(None, 16, 16, 210)	0	concatenate_33[0][0]
			separable_conv2d_35[0][0]
batch_normalization_36 (BatchNo	(None, 16, 16, 210)	840	concatenate_34[0][0]
activation_36 (Activation)	(None, 16, 16, 210)	0	batch_normalization_36[0][0]
separable_conv2d_36 (SeparableC	(None, 16, 16, 14)	13230	activation_36[0][0]
concatenate_35 (Concatenate)	(None, 16, 16, 224)	0	concatenate_34[0][0]
			separable_conv2d_36[0][0]
batch_normalization_37 (BatchNo	(None, 16, 16, 224)	896	concatenate_35[0][0]
activation_37 (Activation)	(None, 16, 16, 224)	0	batch_normalization_37[0][0]
separable_conv2d_37 (SeparableC	(None, 16, 16, 14)	14112	activation_37[0][0]
concatenate_36 (Concatenate)	(None, 16, 16, 238)	0	concatenate_35[0][0]
			separable_conv2d_37[0][0]
batch_normalization_38 (BatchNo	(None, 16, 16, 238)	952	concatenate_36[0][0]
activation_38 (Activation)	(None, 16, 16, 238)	0	batch_normalization_38[0][0]
separable_conv2d_38 (SeparableC	(None, 16, 16, 14)	14994	activation_38[0][0]
concatenate_37 (Concatenate)	(None, 16, 16, 252)	0	concatenate_36[0][0]
			separable_conv2d_38[0][0]
batch_normalization_39 (BatchNo	(None, 16, 16, 252)	1008	concatenate_37[0][0]
activation_39 (Activation)	(None, 16, 16, 252)	0	batch_normalization_39[0][0]
separable_conv2d_39 (SeparableC	(None, 16, 16, 14)	15876	activation_39[0][0]
concatenate_38 (Concatenate)	(None, 16, 16, 266)	0	concatenate_37[0][0]
			separable_conv2d_39[0][0]
batch_normalization_40 (BatchNo	(None, 16, 16, 266)	1064	concatenate_38[0][0]
activation_40 (Activation)	(None, 16, 16, 266)	0	batch_normalization_40[0][0]
separable_conv2d_40 (SeparableC	(None, 16, 16, 14)	16758	activation_40[0][0]
concatenate_39 (Concatenate)	(None, 16, 16, 280)	0	concatenate_38[0][0]
			separable_conv2d_40[0][0]
batch_normalization_41 (BatchNo	(None, 16, 16, 280)	1120	concatenate_39[0][0]
activation_41 (Activation)	(None, 16, 16, 280)	0	batch_normalization_41[0][0]
separable_conv2d_41 (SeparableC	(None, 16, 16, 14)	17640	activation_41[0][0]
concatenate_40 (Concatenate)	(None, 16, 16, 294)	0	concatenate_39[0][0]
			separable_conv2d_41[0][0]
batch_normalization_42 (BatchNo	(None, 16, 16, 294)	1176	concatenate_40[0][0]
activation_42 (Activation)	(None, 16, 16, 294)	0	batch_normalization_42[0][0]
separable_conv2d_42 (SeparableC	(None, 16, 16, 14)	18522	activation_42[0][0]
concatenate_41 (Concatenate)	(None, 16, 16, 308)	0	concatenate_40[0][0]
			separable_conv2d_42[0][0]
batch_normalization_43 (BatchNo	(None, 16, 16, 308)	1232	concatenate_41[0][0]
activation_43 (Activation)	(None, 16, 16, 308)	0	batch_normalization_43[0][0]
separable_conv2d_43 (SeparableC	(None, 16, 16, 14)	4620	activation_43[0][0]
average_pooling2d_1 (AveragePoo	(None, 8, 8, 14)	0	separable_conv2d_43[0][0]
batch_normalization_44 (BatchNo	(None, 8, 8, 14)	56	average_pooling2d_1[0][0]

activation_44 (Activation)	(None, 8, 8, 14)	0	batch_normalization_44[0][0]
separable_conv2d_44 (SeparableC	(None, 8, 8, 14)	882	activation_44[0][0]
concatenate_42 (Concatenate)	(None, 8, 8, 28)	0	average_pooling2d_1[0][0] separable_conv2d_44[0][0]
batch_normalization_45 (BatchNo	(None, 8, 8, 28)	112	concatenate_42[0][0]
activation_45 (Activation)	(None, 8, 8, 28)	0	batch_normalization_45[0][0]
separable_conv2d_45 (SeparableC	(None, 8, 8, 14)	1764	activation_45[0][0]
concatenate_43 (Concatenate)	(None, 8, 8, 42)	0	concatenate_42[0][0] separable_conv2d_45[0][0]
batch_normalization_46 (BatchNo	(None, 8, 8, 42)	168	concatenate_43[0][0]
activation_46 (Activation)	(None, 8, 8, 42)	0	batch_normalization_46[0][0]
separable_conv2d_46 (SeparableC	(None, 8, 8, 14)	2646	activation_46[0][0]
concatenate_44 (Concatenate)	(None, 8, 8, 56)	0	concatenate_43[0][0] separable_conv2d_46[0][0]
batch_normalization_47 (BatchNo	(None, 8, 8, 56)	224	concatenate_44[0][0]
activation_47 (Activation)	(None, 8, 8, 56)	0	batch_normalization_47[0][0]
separable_conv2d_47 (SeparableC	(None, 8, 8, 14)	3528	activation_47[0][0]
concatenate_45 (Concatenate)	(None, 8, 8, 70)	0	concatenate_44[0][0] separable_conv2d_47[0][0]
batch_normalization_48 (BatchNo	(None, 8, 8, 70)	280	concatenate_45[0][0]
activation_48 (Activation)	(None, 8, 8, 70)	0	batch_normalization_48[0][0]
separable_conv2d_48 (SeparableC	(None, 8, 8, 14)	4410	activation_48[0][0]
concatenate_46 (Concatenate)	(None, 8, 8, 84)	0	concatenate_45[0][0] separable_conv2d_48[0][0]
batch_normalization_49 (BatchNo	(None, 8, 8, 84)	336	concatenate_46[0][0]
activation_49 (Activation)	(None, 8, 8, 84)	0	batch_normalization_49[0][0]
separable_conv2d_49 (SeparableC	(None, 8, 8, 14)	5292	activation_49[0][0]
concatenate_47 (Concatenate)	(None, 8, 8, 98)	0	concatenate_46[0][0] separable_conv2d_49[0][0]
batch_normalization_50 (BatchNo	(None, 8, 8, 98)	392	concatenate_47[0][0]
activation_50 (Activation)	(None, 8, 8, 98)	0	batch_normalization_50[0][0]
separable_conv2d_50 (SeparableC	(None, 8, 8, 14)	6174	activation_50[0][0]
concatenate_48 (Concatenate)	(None, 8, 8, 112)	0	concatenate_47[0][0] separable_conv2d_50[0][0]
batch_normalization_51 (BatchNo	(None, 8, 8, 112)	448	concatenate_48[0][0]
activation_51 (Activation)	(None, 8, 8, 112)	0	batch_normalization_51[0][0]
separable_conv2d_51 (SeparableC	(None, 8, 8, 14)	7056	activation_51[0][0]
concatenate_49 (Concatenate)	(None, 8, 8, 126)	0	concatenate_48[0][0] separable_conv2d_51[0][0]
batch_normalization_52 (BatchNo	(None, 8, 8, 126)	504	concatenate_49[0][0]
activation_52 (Activation)	(None, 8, 8, 126)	0	batch_normalization_52[0][0]
separable_conv2d_52 (SeparableC	(None, 8, 8, 14)	7938	activation_52[0][0]
concatenate_50 (Concatenate)	(None, 8, 8, 140)	0	concatenate_49[0][0]

			separable_conv2d_52[0][0]
batch_normalization_53 (BatchNo	(None, 8, 8, 140)	560	concatenate_50[0][0]
activation_53 (Activation)	(None, 8, 8, 140)	0	batch_normalization_53[0][0]
separable_conv2d_53 (SeparableC	(None, 8, 8, 14)	8820	activation_53[0][0]
concatenate_51 (Concatenate)	(None, 8, 8, 154)	0	concatenate_50[0][0] separable_conv2d_53[0][0]
batch_normalization_54 (BatchNo	(None, 8, 8, 154)	616	concatenate_51[0][0]
activation_54 (Activation)	(None, 8, 8, 154)	0	batch_normalization_54[0][0]
separable_conv2d_54 (SeparableC	(None, 8, 8, 14)	9702	activation_54[0][0]
concatenate_52 (Concatenate)	(None, 8, 8, 168)	0	concatenate_51[0][0] separable_conv2d_54[0][0]
batch_normalization_55 (BatchNo	(None, 8, 8, 168)	672	concatenate_52[0][0]
activation_55 (Activation)	(None, 8, 8, 168)	0	batch_normalization_55[0][0]
separable_conv2d_55 (SeparableC	(None, 8, 8, 14)	10584	activation_55[0][0]
concatenate_53 (Concatenate)	(None, 8, 8, 182)	0	concatenate_52[0][0] separable_conv2d_55[0][0]
batch_normalization_56 (BatchNo	(None, 8, 8, 182)	728	concatenate_53[0][0]
activation_56 (Activation)	(None, 8, 8, 182)	0	batch_normalization_56[0][0]
separable_conv2d_56 (SeparableC	(None, 8, 8, 14)	11466	activation_56[0][0]
concatenate_54 (Concatenate)	(None, 8, 8, 196)	0	concatenate_53[0][0] separable_conv2d_56[0][0]
batch_normalization_57 (BatchNo	(None, 8, 8, 196)	784	concatenate_54[0][0]
activation_57 (Activation)	(None, 8, 8, 196)	0	batch_normalization_57[0][0]
separable_conv2d_57 (SeparableC	(None, 8, 8, 14)	12348	activation_57[0][0]
concatenate_55 (Concatenate)	(None, 8, 8, 210)	0	concatenate_54[0][0] separable_conv2d_57[0][0]
batch_normalization_58 (BatchNo	(None, 8, 8, 210)	840	concatenate_55[0][0]
activation_58 (Activation)	(None, 8, 8, 210)	0	batch_normalization_58[0][0]
separable_conv2d_58 (SeparableC	(None, 8, 8, 14)	13230	activation_58[0][0]
concatenate_56 (Concatenate)	(None, 8, 8, 224)	0	concatenate_55[0][0] separable_conv2d_58[0][0]
batch_normalization_59 (BatchNo	(None, 8, 8, 224)	896	concatenate_56[0][0]
activation_59 (Activation)	(None, 8, 8, 224)	0	batch_normalization_59[0][0]
separable_conv2d_59 (SeparableC	(None, 8, 8, 14)	14112	activation_59[0][0]
concatenate_57 (Concatenate)	(None, 8, 8, 238)	0	concatenate_56[0][0] separable_conv2d_59[0][0]
batch_normalization_60 (BatchNo	(None, 8, 8, 238)	952	concatenate_57[0][0]
activation_60 (Activation)	(None, 8, 8, 238)	0	batch_normalization_60[0][0]
separable_conv2d_60 (SeparableC	(None, 8, 8, 14)	14994	activation_60[0][0]
concatenate_58 (Concatenate)	(None, 8, 8, 252)	0	concatenate_57[0][0] separable_conv2d_60[0][0]
batch_normalization_61 (BatchNo	(None, 8, 8, 252)	1008	concatenate_58[0][0]
activation_61 (Activation)	(None, 8, 8, 252)	0	batch_normalization_61[0][0]

separable_conv2d_61 (SeparableC	(None, 8, 8, 14)	15876	activation_61[0][0]
concatenate_59 (Concatenate)	(None, 8, 8, 266)	0	concatenate_58[0][0] separable_conv2d_61[0][0]
batch_normalization_62 (BatchNo	(None, 8, 8, 266)	1064	concatenate_59[0][0]
activation_62 (Activation)	(None, 8, 8, 266)	0	batch_normalization_62[0][0]
separable_conv2d_62 (SeparableC	(None, 8, 8, 14)	16758	activation_62[0][0]
concatenate_60 (Concatenate)	(None, 8, 8, 280)	0	concatenate_59[0][0] separable_conv2d_62[0][0]
batch_normalization_63 (BatchNo	(None, 8, 8, 280)	1120	concatenate_60[0][0]
activation_63 (Activation)	(None, 8, 8, 280)	0	batch_normalization_63[0][0]
separable_conv2d_63 (SeparableC	(None, 8, 8, 14)	17640	activation_63[0][0]
concatenate_61 (Concatenate)	(None, 8, 8, 294)	0	concatenate_60[0][0] separable_conv2d_63[0][0]
batch_normalization_64 (BatchNo	(None, 8, 8, 294)	1176	concatenate_61[0][0]
activation_64 (Activation)	(None, 8, 8, 294)	0	batch_normalization_64[0][0]
separable_conv2d_64 (SeparableC	(None, 8, 8, 14)	18522	activation_64[0][0]
concatenate_62 (Concatenate)	(None, 8, 8, 308)	0	concatenate_61[0][0] separable_conv2d_64[0][0]
batch_normalization_65 (BatchNo	(None, 8, 8, 308)	1232	concatenate_62[0][0]
activation_65 (Activation)	(None, 8, 8, 308)	0	batch_normalization_65[0][0]
separable_conv2d_65 (SeparableC	(None, 8, 8, 14)	4620	activation_65[0][0]
average_pooling2d_2 (AveragePoo	(None, 4, 4, 14)	0	separable_conv2d_65[0][0]
batch_normalization_66 (BatchNo	(None, 4, 4, 14)	56	average_pooling2d_2[0][0]
activation_66 (Activation)	(None, 4, 4, 14)	0	batch_normalization_66[0][0]
separable_conv2d_66 (SeparableC	(None, 4, 4, 14)	882	activation_66[0][0]
concatenate_63 (Concatenate)	(None, 4, 4, 28)	0	average_pooling2d_2[0][0] separable_conv2d_66[0][0]
batch_normalization_67 (BatchNo	(None, 4, 4, 28)	112	concatenate_63[0][0]
activation_67 (Activation)	(None, 4, 4, 28)	0	batch_normalization_67[0][0]
separable_conv2d_67 (SeparableC	(None, 4, 4, 14)	1764	activation_67[0][0]
concatenate_64 (Concatenate)	(None, 4, 4, 42)	0	concatenate_63[0][0] separable_conv2d_67[0][0]
batch_normalization_68 (BatchNo	(None, 4, 4, 42)	168	concatenate_64[0][0]
activation_68 (Activation)	(None, 4, 4, 42)	0	batch_normalization_68[0][0]
separable_conv2d_68 (SeparableC	(None, 4, 4, 14)	2646	activation_68[0][0]
concatenate_65 (Concatenate)	(None, 4, 4, 56)	0	concatenate_64[0][0] separable_conv2d_68[0][0]
batch_normalization_69 (BatchNo	(None, 4, 4, 56)	224	concatenate_65[0][0]
activation_69 (Activation)	(None, 4, 4, 56)	0	batch_normalization_69[0][0]
separable_conv2d_69 (SeparableC	(None, 4, 4, 14)	3528	activation_69[0][0]
concatenate_66 (Concatenate)	(None, 4, 4, 70)	0	concatenate_65[0][0] separable_conv2d_69[0][0]

batch_normalization_70 (BatchNo	(None, 4, 4, 70)	280	concatenate_66[0][0]
activation_70 (Activation)	(None, 4, 4, 70)	0	batch_normalization_70[0][0]
separable_conv2d_70 (SeparableC	(None, 4, 4, 14)	4410	activation_70[0][0]
concatenate_67 (Concatenate)	(None, 4, 4, 84)	0	concatenate_66[0][0] separable_conv2d_70[0][0]
batch_normalization_71 (BatchNo	(None, 4, 4, 84)	336	concatenate_67[0][0]
activation_71 (Activation)	(None, 4, 4, 84)	0	batch_normalization_71[0][0]
separable_conv2d_71 (SeparableC	(None, 4, 4, 14)	5292	activation_71[0][0]
concatenate_68 (Concatenate)	(None, 4, 4, 98)	0	concatenate_67[0][0] separable_conv2d_71[0][0]
batch_normalization_72 (BatchNo	(None, 4, 4, 98)	392	concatenate_68[0][0]
activation_72 (Activation)	(None, 4, 4, 98)	0	batch_normalization_72[0][0]
separable_conv2d_72 (SeparableC	(None, 4, 4, 14)	6174	activation_72[0][0]
concatenate_69 (Concatenate)	(None, 4, 4, 112)	0	concatenate_68[0][0] separable_conv2d_72[0][0]
batch_normalization_73 (BatchNo	(None, 4, 4, 112)	448	concatenate_69[0][0]
activation_73 (Activation)	(None, 4, 4, 112)	0	batch_normalization_73[0][0]
separable_conv2d_73 (SeparableC	(None, 4, 4, 14)	7056	activation_73[0][0]
concatenate_70 (Concatenate)	(None, 4, 4, 126)	0	concatenate_69[0][0] separable_conv2d_73[0][0]
batch_normalization_74 (BatchNo	(None, 4, 4, 126)	504	concatenate_70[0][0]
activation_74 (Activation)	(None, 4, 4, 126)	0	batch_normalization_74[0][0]
separable_conv2d_74 (SeparableC	(None, 4, 4, 14)	7938	activation_74[0][0]
concatenate_71 (Concatenate)	(None, 4, 4, 140)	0	concatenate_70[0][0] separable_conv2d_74[0][0]
batch_normalization_75 (BatchNo	(None, 4, 4, 140)	560	concatenate_71[0][0]
activation_75 (Activation)	(None, 4, 4, 140)	0	batch_normalization_75[0][0]
separable_conv2d_75 (SeparableC	(None, 4, 4, 14)	8820	activation_75[0][0]
concatenate_72 (Concatenate)	(None, 4, 4, 154)	0	concatenate_71[0][0] separable_conv2d_75[0][0]
batch_normalization_76 (BatchNo	(None, 4, 4, 154)	616	concatenate_72[0][0]
activation_76 (Activation)	(None, 4, 4, 154)	0	batch_normalization_76[0][0]
separable_conv2d_76 (SeparableC	(None, 4, 4, 14)	9702	activation_76[0][0]
concatenate_73 (Concatenate)	(None, 4, 4, 168)	0	concatenate_72[0][0] separable_conv2d_76[0][0]
batch_normalization_77 (BatchNo	(None, 4, 4, 168)	672	concatenate_73[0][0]
activation_77 (Activation)	(None, 4, 4, 168)	0	batch_normalization_77[0][0]
separable_conv2d_77 (SeparableC	(None, 4, 4, 14)	10584	activation_77[0][0]
concatenate_74 (Concatenate)	(None, 4, 4, 182)	0	concatenate_73[0][0] separable_conv2d_77[0][0]
batch_normalization_78 (BatchNo	(None, 4, 4, 182)	728	concatenate_74[0][0]
activation_78 (Activation)	(None, 4, 4, 182)	0	batch_normalization_78[0][0]
separable_conv2d_78 (SeparableC	(None, 4, 4, 14)	11466	activation_78[0][0]

concatenate_75 (Concatenate)	(None, 4, 4, 196)	0	concatenate_74[0][0] separable_conv2d_78[0][0]	
batch_normalization_79 (BatchNo	(None, 4, 4, 196)	784	concatenate_75[0][0]	
activation_79 (Activation)	(None, 4, 4, 196)	0	batch_normalization_79[0][0]	
separable_conv2d_79 (SeparableC	(None, 4, 4, 14)	12348	activation_79[0][0]	
concatenate_76 (Concatenate)	(None, 4, 4, 210)	0	concatenate_75[0][0] separable_conv2d_79[0][0]	
batch_normalization_80 (BatchNo	(None, 4, 4, 210)	840	concatenate_76[0][0]	
activation_80 (Activation)	(None, 4, 4, 210)	0	batch_normalization_80[0][0]	
separable_conv2d_80 (SeparableC	(None, 4, 4, 14)	13230	activation_80[0][0]	
concatenate_77 (Concatenate)	(None, 4, 4, 224)	0	concatenate_76[0][0] separable_conv2d_80[0][0]	
batch_normalization_81 (BatchNo	(None, 4, 4, 224)	896	concatenate_77[0][0]	
activation_81 (Activation)	(None, 4, 4, 224)	0	batch_normalization_81[0][0]	
separable_conv2d_81 (SeparableC	(None, 4, 4, 14)	14112	activation_81[0][0]	
concatenate_78 (Concatenate)	(None, 4, 4, 238)	0	concatenate_77[0][0] separable_conv2d_81[0][0]	
batch_normalization_82 (BatchNo	(None, 4, 4, 238)	952	concatenate_78[0][0]	
activation_82 (Activation)	(None, 4, 4, 238)	0	batch_normalization_82[0][0]	
separable_conv2d_82 (SeparableC	(None, 4, 4, 14)	14994	activation_82[0][0]	
concatenate_79 (Concatenate)	(None, 4, 4, 252)	0	concatenate_78[0][0] separable_conv2d_82[0][0]	
batch_normalization_83 (BatchNo	(None, 4, 4, 252)	1008	concatenate_79[0][0]	
activation_83 (Activation)	(None, 4, 4, 252)	0	batch_normalization_83[0][0]	
separable_conv2d_83 (SeparableC	(None, 4, 4, 14)	15876	activation_83[0][0]	
concatenate_80 (Concatenate)	(None, 4, 4, 266)	0	concatenate_79[0][0] separable_conv2d_83[0][0]	
batch_normalization_84 (BatchNo	(None, 4, 4, 266)	1064	concatenate_80[0][0]	
activation_84 (Activation)	(None, 4, 4, 266)	0	batch_normalization_84[0][0]	
separable_conv2d_84 (SeparableC	(None, 4, 4, 14)	16758	activation_84[0][0]	
concatenate_81 (Concatenate)	(None, 4, 4, 280)	0	concatenate_80[0][0] separable_conv2d_84[0][0]	
batch_normalization_85 (BatchNo	(None, 4, 4, 280)	1120	concatenate_81[0][0]	
activation_85 (Activation)	(None, 4, 4, 280)	0	batch_normalization_85[0][0]	
separable_conv2d_85 (SeparableC	(None, 4, 4, 14)	17640	activation_85[0][0]	
concatenate_82 (Concatenate)	(None, 4, 4, 294)	0	concatenate_81[0][0] separable_conv2d_85[0][0]	
batch_normalization_86 (BatchNo	(None, 4, 4, 294)	1176	concatenate_82[0][0]	
activation_86 (Activation)	(None, 4, 4, 294)	0	batch_normalization_86[0][0]	
separable_conv2d_86 (SeparableC	(None, 4, 4, 14)	18522	activation_86[0][0]	
concatenate_83 (Concatenate)	(None, 4, 4, 308)	0	concatenate_82[0][0] separable_conv2d_86[0][0]	
batch normalization 87 (BatchNo	(None, 4, 4, 308)	1232	concatenate 83[0][0]	

```
activation_87 (Activation)       (None, 4, 4, 308)    0          batch_normalization_87[0][0]
_____
average_pooling2d_3 (AveragePoo  (None, 2, 2, 308)    0          activation_87[0][0]
_____
separable_conv2d_87 (SeparableC  (None, 1, 1, 10)     4322       average_pooling2d_3[0][0]
_____
flatten (Flatten)                (None, 10)           0          separable_conv2d_87[0][0]
_____
dense (Dense)                    (None, 10)           110        flatten[0][0]
================================================================================================
Total params: 945,472
Trainable params: 915,640
Non-trainable params: 29,832
_____
```

In [13]:

```python
model_6.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])

from tensorflow.keras.callbacks import ModelCheckpoint, EarlyStopping, ReduceLROnPlateau
patience = 50
base_path = '/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/'
checkpoint_file_name = base_path + 'CIFAR_model6' + '_{epoch:02d}-{val_accuracy:.2f}.hdf5'

model_checkpoint = ModelCheckpoint(checkpoint_file_name, monitor='val_accuracy', verbose=1, save_be
st_only=True)
early_stop = EarlyStopping('val_accuracy', mode='max', patience = patience)
reduce_LR = ReduceLROnPlateau(monitor='val_accuracy', mode='max', factor=0.1, patience=int(patience
/3), verbose=1)

callbacks = [model_checkpoint, early_stop, reduce_LR]

epochs = 300
batch_size = 128

#https://keras.io/api/preprocessing/image/#flow-method
history_6 = model_6.fit(data_generator.flow(X_train, y_train, batch_size),
                    steps_per_epoch = int(len(X_train)/batch_size),
                    epochs = epochs,
                    callbacks = callbacks,
                    validation_data = (X_test, y_test), verbose=1)
```

```
WARNING:tensorflow:sample_weight modes were coerced from
  ...
    to
  ['...']
Train for 390 steps, validate on 10000 samples
Epoch 1/300
389/390 [=============================>.] - ETA: 0s - loss: 1.6755 - accuracy: 0.3733
Epoch 00001: val_accuracy improved from -inf to 0.28830, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_01-0.29.hdf5
390/390 [==============================] - 161s 413ms/step - loss: 1.6753 - accuracy: 0.3734 - val
_loss: 1.9707 - val_accuracy: 0.2883
Epoch 2/300
389/390 [=============================>.] - ETA: 0s - loss: 1.2802 - accuracy: 0.5367
Epoch 00002: val_accuracy improved from 0.28830 to 0.50130, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_02-0.50.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 1.2799 - accuracy: 0.5369 - val
_loss: 1.4081 - val_accuracy: 0.5013
Epoch 3/300
389/390 [=============================>.] - ETA: 0s - loss: 1.0749 - accuracy: 0.6182
Epoch 00003: val_accuracy improved from 0.50130 to 0.55070, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_03-0.55.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 1.0746 - accuracy: 0.6183 - val
_loss: 1.3930 - val_accuracy: 0.5507
Epoch 4/300
389/390 [=============================>.] - ETA: 0s - loss: 0.9171 - accuracy: 0.6761
Epoch 00004: val_accuracy improved from 0.55070 to 0.56570, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_04-0.57.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.9169 - accuracy: 0.6762 - val
_loss: 1.3800 - val_accuracy: 0.5657
Epoch 5/300
389/390 [=============================>.] - ETA: 0s - loss: 0.8098 - accuracy: 0.7160
Epoch 00005: val_accuracy improved from 0.56570 to 0.67600, saving model to
```

```
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_05-0.68.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.8097 - accuracy: 0.7159 - val
_loss: 0.9822 - val_accuracy: 0.6760
Epoch 6/300
389/390 [=============================>.] - ETA: 0s - loss: 0.7262 - accuracy: 0.7463
Epoch 00006: val_accuracy did not improve from 0.67600
390/390 [==============================] - 137s 351ms/step - loss: 0.7262 - accuracy: 0.7463 - val
_loss: 1.1215 - val_accuracy: 0.6348
Epoch 7/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6702 - accuracy: 0.7648
Epoch 00007: val_accuracy improved from 0.67600 to 0.73430, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_07-0.73.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.6701 - accuracy: 0.7649 - val
_loss: 0.7764 - val_accuracy: 0.7343
Epoch 8/300
389/390 [=============================>.] - ETA: 0s - loss: 0.6188 - accuracy: 0.7824
Epoch 00008: val_accuracy improved from 0.73430 to 0.77720, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_08-0.78.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.6186 - accuracy: 0.7825 - val
_loss: 0.6698 - val_accuracy: 0.7772
Epoch 9/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5802 - accuracy: 0.7982
Epoch 00009: val_accuracy did not improve from 0.77720
390/390 [==============================] - 137s 351ms/step - loss: 0.5798 - accuracy: 0.7984 - val
_loss: 0.8203 - val_accuracy: 0.7292
Epoch 10/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5451 - accuracy: 0.8106
Epoch 00010: val_accuracy did not improve from 0.77720
390/390 [==============================] - 137s 352ms/step - loss: 0.5450 - accuracy: 0.8105 - val
_loss: 0.7036 - val_accuracy: 0.7676
Epoch 11/300
389/390 [=============================>.] - ETA: 0s - loss: 0.5137 - accuracy: 0.8217
Epoch 00011: val_accuracy improved from 0.77720 to 0.79050, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_11-0.79.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.5137 - accuracy: 0.8217 - val
_loss: 0.6237 - val_accuracy: 0.7905
Epoch 12/300
389/390 [=============================>.] - ETA: 0s - loss: 0.4874 - accuracy: 0.8314
Epoch 00012: val_accuracy did not improve from 0.79050
390/390 [==============================] - 137s 351ms/step - loss: 0.4872 - accuracy: 0.8315 - val
_loss: 0.6534 - val_accuracy: 0.7857
Epoch 13/300
389/390 [=============================>.] - ETA: 0s - loss: 0.4676 - accuracy: 0.8383
Epoch 00013: val_accuracy improved from 0.79050 to 0.80100, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_13-0.80.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.4674 - accuracy: 0.8384 - val
_loss: 0.6053 - val_accuracy: 0.8010
Epoch 14/300
389/390 [=============================>.] - ETA: 0s - loss: 0.4518 - accuracy: 0.8422
Epoch 00014: val_accuracy did not improve from 0.80100
390/390 [==============================] - 137s 351ms/step - loss: 0.4516 - accuracy: 0.8422 - val
_loss: 0.6065 - val_accuracy: 0.8000
Epoch 15/300
389/390 [=============================>.] - ETA: 0s - loss: 0.4317 - accuracy: 0.8496
Epoch 00015: val_accuracy did not improve from 0.80100
390/390 [==============================] - 137s 351ms/step - loss: 0.4318 - accuracy: 0.8495 - val
_loss: 0.8728 - val_accuracy: 0.7389
Epoch 16/300
389/390 [=============================>.] - ETA: 0s - loss: 0.4150 - accuracy: 0.8558
Epoch 00016: val_accuracy did not improve from 0.80100
390/390 [==============================] - 137s 352ms/step - loss: 0.4149 - accuracy: 0.8558 - val
_loss: 0.6928 - val_accuracy: 0.7833
Epoch 17/300
389/390 [=============================>.] - ETA: 0s - loss: 0.3964 - accuracy: 0.8626
Epoch 00017: val_accuracy did not improve from 0.80100
390/390 [==============================] - 137s 351ms/step - loss: 0.3961 - accuracy: 0.8628 - val
_loss: 0.9070 - val_accuracy: 0.7273
Epoch 18/300
389/390 [=============================>.] - ETA: 0s - loss: 0.3868 - accuracy: 0.8666
Epoch 00018: val_accuracy improved from 0.80100 to 0.80490, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_18-0.80.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.3868 - accuracy: 0.8667 - val
_loss: 0.6350 - val_accuracy: 0.8049
Epoch 19/300
389/390 [=============================>.] - ETA: 0s - loss: 0.3678 - accuracy: 0.8715
Epoch 00019: val_accuracy improved from 0.80490 to 0.81600, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_19-0.82.hdf5
```

```
390/390 [==============================] - 138s 355ms/step - loss: 0.3677 - accuracy: 0.8714 - val
_loss: 0.5698 - val_accuracy: 0.8160
Epoch 20/300
389/390 [=============================>.] - ETA: 0s - loss: 0.3596 - accuracy: 0.8734
Epoch 00020: val_accuracy improved from 0.81600 to 0.82040, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_20-0.82.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.3594 - accuracy: 0.8735 - val
_loss: 0.5517 - val_accuracy: 0.8204
Epoch 21/300
389/390 [=============================>.] - ETA: 0s - loss: 0.3471 - accuracy: 0.8786
Epoch 00021: val_accuracy did not improve from 0.82040
390/390 [==============================] - 137s 351ms/step - loss: 0.3474 - accuracy: 0.8784 - val
_loss: 0.6536 - val_accuracy: 0.7993
Epoch 22/300
389/390 [=============================>.] - ETA: 0s - loss: 0.3368 - accuracy: 0.8832
Epoch 00022: val_accuracy did not improve from 0.82040
390/390 [==============================] - 137s 352ms/step - loss: 0.3370 - accuracy: 0.8830 - val
_loss: 0.6179 - val_accuracy: 0.8077
Epoch 23/300
389/390 [=============================>.] - ETA: 0s - loss: 0.3237 - accuracy: 0.8878
Epoch 00023: val_accuracy did not improve from 0.82040
390/390 [==============================] - 137s 351ms/step - loss: 0.3240 - accuracy: 0.8877 - val
_loss: 0.7175 - val_accuracy: 0.7860
Epoch 24/300
389/390 [=============================>.] - ETA: 0s - loss: 0.3189 - accuracy: 0.8880
Epoch 00024: val_accuracy did not improve from 0.82040
390/390 [==============================] - 137s 351ms/step - loss: 0.3189 - accuracy: 0.8880 - val
_loss: 0.5838 - val_accuracy: 0.8171
Epoch 25/300
389/390 [=============================>.] - ETA: 0s - loss: 0.3098 - accuracy: 0.8920
Epoch 00025: val_accuracy improved from 0.82040 to 0.82790, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_25-0.83.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.3098 - accuracy: 0.8921 - val
_loss: 0.5647 - val_accuracy: 0.8279
Epoch 26/300
389/390 [=============================>.] - ETA: 0s - loss: 0.2966 - accuracy: 0.8960
Epoch 00026: val_accuracy did not improve from 0.82790
390/390 [==============================] - 137s 351ms/step - loss: 0.2965 - accuracy: 0.8961 - val
_loss: 0.5734 - val_accuracy: 0.8218
Epoch 27/300
389/390 [=============================>.] - ETA: 0s - loss: 0.2893 - accuracy: 0.8979
Epoch 00027: val_accuracy did not improve from 0.82790
390/390 [==============================] - 137s 351ms/step - loss: 0.2893 - accuracy: 0.8979 - val
_loss: 0.5820 - val_accuracy: 0.8230
Epoch 28/300
389/390 [=============================>.] - ETA: 0s - loss: 0.2768 - accuracy: 0.9022
Epoch 00028: val_accuracy did not improve from 0.82790
390/390 [==============================] - 137s 352ms/step - loss: 0.2770 - accuracy: 0.9021 - val
_loss: 0.6923 - val_accuracy: 0.8024
Epoch 29/300
389/390 [=============================>.] - ETA: 0s - loss: 0.2752 - accuracy: 0.9051
Epoch 00029: val_accuracy did not improve from 0.82790
390/390 [==============================] - 137s 351ms/step - loss: 0.2754 - accuracy: 0.9049 - val
_loss: 0.6549 - val_accuracy: 0.8176
Epoch 30/300
389/390 [=============================>.] - ETA: 0s - loss: 0.2652 - accuracy: 0.9073
Epoch 00030: val_accuracy improved from 0.82790 to 0.83870, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_30-0.84.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.2654 - accuracy: 0.9073 - val
_loss: 0.5280 - val_accuracy: 0.8387
Epoch 31/300
389/390 [=============================>.] - ETA: 0s - loss: 0.2660 - accuracy: 0.9066
Epoch 00031: val_accuracy did not improve from 0.83870
390/390 [==============================] - 137s 352ms/step - loss: 0.2660 - accuracy: 0.9066 - val
_loss: 0.5413 - val_accuracy: 0.8364
Epoch 32/300
389/390 [=============================>.] - ETA: 0s - loss: 0.2543 - accuracy: 0.9105
Epoch 00032: val_accuracy did not improve from 0.83870
390/390 [==============================] - 137s 351ms/step - loss: 0.2543 - accuracy: 0.9106 - val
_loss: 0.5786 - val_accuracy: 0.8306
Epoch 33/300
389/390 [=============================>.] - ETA: 0s - loss: 0.2454 - accuracy: 0.9140
Epoch 00033: val_accuracy improved from 0.83870 to 0.84930, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_33-0.85.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.2453 - accuracy: 0.9141 - val
_loss: 0.5121 - val_accuracy: 0.8493
Epoch 34/300
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389/390 [============================>.] - ETA: 0s - loss: 0.2444 - accuracy: 0.9137
Epoch 00034: val_accuracy did not improve from 0.84930
390/390 [==============================] - 137s 352ms/step - loss: 0.2445 - accuracy: 0.9136 - val
_loss: 0.6663 - val_accuracy: 0.8154
Epoch 35/300
389/390 [============================>.] - ETA: 0s - loss: 0.2369 - accuracy: 0.9168
Epoch 00035: val_accuracy did not improve from 0.84930
390/390 [==============================] - 137s 351ms/step - loss: 0.2369 - accuracy: 0.9168 - val
_loss: 0.7122 - val_accuracy: 0.8040
Epoch 36/300
389/390 [============================>.] - ETA: 0s - loss: 0.2324 - accuracy: 0.9187
Epoch 00036: val_accuracy did not improve from 0.84930
390/390 [==============================] - 137s 351ms/step - loss: 0.2322 - accuracy: 0.9188 - val
_loss: 0.5439 - val_accuracy: 0.8392
Epoch 37/300
389/390 [============================>.] - ETA: 0s - loss: 0.2264 - accuracy: 0.9202
Epoch 00037: val_accuracy did not improve from 0.84930
390/390 [==============================] - 137s 352ms/step - loss: 0.2263 - accuracy: 0.9202 - val
_loss: 0.7712 - val_accuracy: 0.7727
Epoch 38/300
389/390 [============================>.] - ETA: 0s - loss: 0.2230 - accuracy: 0.9224
Epoch 00038: val_accuracy did not improve from 0.84930
390/390 [==============================] - 137s 351ms/step - loss: 0.2228 - accuracy: 0.9225 - val
_loss: 0.5727 - val_accuracy: 0.8386
Epoch 39/300
389/390 [============================>.] - ETA: 0s - loss: 0.2154 - accuracy: 0.9225
Epoch 00039: val_accuracy did not improve from 0.84930
390/390 [==============================] - 137s 351ms/step - loss: 0.2155 - accuracy: 0.9225 - val
_loss: 0.5577 - val_accuracy: 0.8404
Epoch 40/300
389/390 [============================>.] - ETA: 0s - loss: 0.2102 - accuracy: 0.9266
Epoch 00040: val_accuracy did not improve from 0.84930
390/390 [==============================] - 137s 352ms/step - loss: 0.2102 - accuracy: 0.9266 - val
_loss: 0.4954 - val_accuracy: 0.8489
Epoch 41/300
389/390 [============================>.] - ETA: 0s - loss: 0.2030 - accuracy: 0.9282
Epoch 00041: val_accuracy did not improve from 0.84930
390/390 [==============================] - 137s 351ms/step - loss: 0.2030 - accuracy: 0.9281 - val
_loss: 0.6793 - val_accuracy: 0.8150
Epoch 42/300
389/390 [============================>.] - ETA: 0s - loss: 0.1999 - accuracy: 0.9299
Epoch 00042: val_accuracy did not improve from 0.84930
390/390 [==============================] - 137s 351ms/step - loss: 0.2002 - accuracy: 0.9299 - val
_loss: 0.6001 - val_accuracy: 0.8385
Epoch 43/300
389/390 [============================>.] - ETA: 0s - loss: 0.1982 - accuracy: 0.9293
Epoch 00043: val_accuracy did not improve from 0.84930
390/390 [==============================] - 137s 352ms/step - loss: 0.1981 - accuracy: 0.9293 - val
_loss: 0.5893 - val_accuracy: 0.8382
Epoch 44/300
389/390 [============================>.] - ETA: 0s - loss: 0.1929 - accuracy: 0.9331
Epoch 00044: val_accuracy did not improve from 0.84930
390/390 [==============================] - 137s 351ms/step - loss: 0.1928 - accuracy: 0.9331 - val
_loss: 0.5809 - val_accuracy: 0.8305
Epoch 45/300
389/390 [============================>.] - ETA: 0s - loss: 0.1906 - accuracy: 0.9325
Epoch 00045: val_accuracy did not improve from 0.84930
390/390 [==============================] - 137s 351ms/step - loss: 0.1903 - accuracy: 0.9325 - val
_loss: 0.5722 - val_accuracy: 0.8367
Epoch 46/300
389/390 [============================>.] - ETA: 0s - loss: 0.1847 - accuracy: 0.9349
Epoch 00046: val_accuracy did not improve from 0.84930
390/390 [==============================] - 137s 352ms/step - loss: 0.1849 - accuracy: 0.9349 - val
_loss: 0.6191 - val_accuracy: 0.8349
Epoch 47/300
389/390 [============================>.] - ETA: 0s - loss: 0.1850 - accuracy: 0.9340
Epoch 00047: val_accuracy did not improve from 0.84930
390/390 [==============================] - 137s 351ms/step - loss: 0.1848 - accuracy: 0.9342 - val
_loss: 0.5609 - val_accuracy: 0.8484
Epoch 48/300
389/390 [============================>.] - ETA: 0s - loss: 0.1780 - accuracy: 0.9370
Epoch 00048: val_accuracy did not improve from 0.84930
390/390 [==============================] - 137s 351ms/step - loss: 0.1782 - accuracy: 0.9370 - val
_loss: 0.5538 - val_accuracy: 0.8435
Epoch 49/300
389/390 [============================>.] - ETA: 0s - loss: 0.1703 - accuracy: 0.9397
Epoch 00049: val_accuracy improved from 0.84930 to 0.86030, saving model to
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/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_49-0.86.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.1705 - accuracy: 0.9397 - val
_loss: 0.5008 - val_accuracy: 0.8603
Epoch 50/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1727 - accuracy: 0.9391
Epoch 00050: val_accuracy did not improve from 0.86030
390/390 [==============================] - 137s 351ms/step - loss: 0.1728 - accuracy: 0.9391 - val
_loss: 0.5259 - val_accuracy: 0.8520
Epoch 51/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1671 - accuracy: 0.9415
Epoch 00051: val_accuracy did not improve from 0.86030
390/390 [==============================] - 137s 351ms/step - loss: 0.1672 - accuracy: 0.9415 - val
_loss: 0.5809 - val_accuracy: 0.8392
Epoch 52/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1682 - accuracy: 0.9409
Epoch 00052: val_accuracy did not improve from 0.86030
390/390 [==============================] - 137s 352ms/step - loss: 0.1684 - accuracy: 0.9409 - val
_loss: 0.6328 - val_accuracy: 0.8346
Epoch 53/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1616 - accuracy: 0.9423
Epoch 00053: val_accuracy improved from 0.86030 to 0.86160, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_53-0.86.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.1621 - accuracy: 0.9421 - val
_loss: 0.5077 - val_accuracy: 0.8616
Epoch 54/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1586 - accuracy: 0.9440
Epoch 00054: val_accuracy did not improve from 0.86160
390/390 [==============================] - 137s 351ms/step - loss: 0.1585 - accuracy: 0.9440 - val
_loss: 0.5327 - val_accuracy: 0.8547
Epoch 55/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1549 - accuracy: 0.9452
Epoch 00055: val_accuracy improved from 0.86160 to 0.86380, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_55-0.86.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.1549 - accuracy: 0.9452 - val
_loss: 0.5082 - val_accuracy: 0.8638
Epoch 56/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1561 - accuracy: 0.9444
Epoch 00056: val_accuracy improved from 0.86380 to 0.87290, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_56-0.87.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.1560 - accuracy: 0.9444 - val
_loss: 0.4334 - val_accuracy: 0.8729
Epoch 57/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1516 - accuracy: 0.9462
Epoch 00057: val_accuracy did not improve from 0.87290
390/390 [==============================] - 137s 351ms/step - loss: 0.1515 - accuracy: 0.9462 - val
_loss: 0.4645 - val_accuracy: 0.8719
Epoch 58/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1458 - accuracy: 0.9487
Epoch 00058: val_accuracy did not improve from 0.87290
390/390 [==============================] - 137s 351ms/step - loss: 0.1457 - accuracy: 0.9488 - val
_loss: 0.5121 - val_accuracy: 0.8672
Epoch 59/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1464 - accuracy: 0.9487
Epoch 00059: val_accuracy did not improve from 0.87290
390/390 [==============================] - 137s 351ms/step - loss: 0.1467 - accuracy: 0.9487 - val
_loss: 0.5502 - val_accuracy: 0.8542
Epoch 60/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1432 - accuracy: 0.9486
Epoch 00060: val_accuracy did not improve from 0.87290
390/390 [==============================] - 137s 351ms/step - loss: 0.1431 - accuracy: 0.9486 - val
_loss: 0.5808 - val_accuracy: 0.8520
Epoch 61/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1422 - accuracy: 0.9504
Epoch 00061: val_accuracy did not improve from 0.87290
390/390 [==============================] - 137s 351ms/step - loss: 0.1423 - accuracy: 0.9504 - val
_loss: 0.5301 - val_accuracy: 0.8596
Epoch 62/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1401 - accuracy: 0.9504
Epoch 00062: val_accuracy did not improve from 0.87290
390/390 [==============================] - 137s 351ms/step - loss: 0.1401 - accuracy: 0.9504 - val
_loss: 0.6384 - val_accuracy: 0.8413
Epoch 63/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1371 - accuracy: 0.9509
Epoch 00063: val_accuracy did not improve from 0.87290
390/390 [==============================] - 137s 351ms/step - loss: 0.1373 - accuracy: 0.9509 - val
_loss: 0.5965 - val_accuracy: 0.8532
Epoch 64/300
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389/390 [=============================>.] - ETA: 0s - loss: 0.1314 - accuracy: 0.9535
Epoch 00064: val_accuracy did not improve from 0.87290
390/390 [==============================] - 137s 351ms/step - loss: 0.1316 - accuracy: 0.9535 - val
_loss: 0.5519 - val_accuracy: 0.8591
Epoch 65/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1301 - accuracy: 0.9530
Epoch 00065: val_accuracy did not improve from 0.87290
390/390 [==============================] - 137s 351ms/step - loss: 0.1300 - accuracy: 0.9530 - val
_loss: 0.6794 - val_accuracy: 0.8387
Epoch 66/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1320 - accuracy: 0.9533
Epoch 00066: val_accuracy did not improve from 0.87290
390/390 [==============================] - 137s 351ms/step - loss: 0.1321 - accuracy: 0.9532 - val
_loss: 0.5336 - val_accuracy: 0.8595
Epoch 67/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1286 - accuracy: 0.9544
Epoch 00067: val_accuracy did not improve from 0.87290
390/390 [==============================] - 137s 351ms/step - loss: 0.1287 - accuracy: 0.9543 - val
_loss: 0.5444 - val_accuracy: 0.8577
Epoch 68/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1263 - accuracy: 0.9548
Epoch 00068: val_accuracy did not improve from 0.87290
390/390 [==============================] - 137s 351ms/step - loss: 0.1263 - accuracy: 0.9548 - val
_loss: 0.5496 - val_accuracy: 0.8597
Epoch 69/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1257 - accuracy: 0.9546
Epoch 00069: val_accuracy did not improve from 0.87290
390/390 [==============================] - 137s 351ms/step - loss: 0.1259 - accuracy: 0.9546 - val
_loss: 0.5733 - val_accuracy: 0.8591
Epoch 70/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1251 - accuracy: 0.9554
Epoch 00070: val_accuracy did not improve from 0.87290
390/390 [==============================] - 137s 352ms/step - loss: 0.1250 - accuracy: 0.9554 - val
_loss: 0.5491 - val_accuracy: 0.8535
Epoch 71/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1243 - accuracy: 0.9560
Epoch 00071: val_accuracy did not improve from 0.87290
390/390 [==============================] - 137s 351ms/step - loss: 0.1243 - accuracy: 0.9560 - val
_loss: 0.5506 - val_accuracy: 0.8616
Epoch 72/300
389/390 [=============================>.] - ETA: 0s - loss: 0.1219 - accuracy: 0.9565
Epoch 00072: val_accuracy did not improve from 0.87290

Epoch 00072: ReduceLROnPlateau reducing learning rate to 0.00010000000474974513.
390/390 [==============================] - 137s 351ms/step - loss: 0.1221 - accuracy: 0.9564 - val
_loss: 0.7693 - val_accuracy: 0.8225
Epoch 73/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0768 - accuracy: 0.9740
Epoch 00073: val_accuracy improved from 0.87290 to 0.89580, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_73-0.90.hdf5
390/390 [==============================] - 138s 355ms/step - loss: 0.0767 - accuracy: 0.9740 - val
_loss: 0.4004 - val_accuracy: 0.8958
Epoch 74/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0613 - accuracy: 0.9795
Epoch 00074: val_accuracy did not improve from 0.89580
390/390 [==============================] - 137s 351ms/step - loss: 0.0614 - accuracy: 0.9795 - val
_loss: 0.4125 - val_accuracy: 0.8946
Epoch 75/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0567 - accuracy: 0.9807
Epoch 00075: val_accuracy did not improve from 0.89580
390/390 [==============================] - 137s 351ms/step - loss: 0.0566 - accuracy: 0.9807 - val
_loss: 0.4108 - val_accuracy: 0.8951
Epoch 76/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0528 - accuracy: 0.9819
Epoch 00076: val_accuracy improved from 0.89580 to 0.89610, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_76-0.90.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.0528 - accuracy: 0.9819 - val
_loss: 0.4177 - val_accuracy: 0.8961
Epoch 77/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0472 - accuracy: 0.9841
Epoch 00077: val_accuracy did not improve from 0.89610
390/390 [==============================] - 137s 351ms/step - loss: 0.0473 - accuracy: 0.9841 - val
_loss: 0.4338 - val_accuracy: 0.8952
Epoch 78/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0447 - accuracy: 0.9851
Epoch 00078: val_accuracy did not improve from 0.89610
390/390 [==============================] - 137s 351ms/step - loss: 0.0447 - accuracy: 0.9851 - val
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_loss: 0.4628 - val_accuracy: 0.8919
Epoch 79/300
389/390 [============================>.] - ETA: 0s - loss: 0.0448 - accuracy: 0.9846
Epoch 00079: val_accuracy did not improve from 0.89610
390/390 [==============================] - 137s 352ms/step - loss: 0.0447 - accuracy: 0.9846 - val
_loss: 0.4731 - val_accuracy: 0.8919
Epoch 80/300
389/390 [============================>.] - ETA: 0s - loss: 0.0397 - accuracy: 0.9865
Epoch 00080: val_accuracy did not improve from 0.89610
390/390 [==============================] - 137s 351ms/step - loss: 0.0397 - accuracy: 0.9865 - val
_loss: 0.4634 - val_accuracy: 0.8931
Epoch 81/300
389/390 [============================>.] - ETA: 0s - loss: 0.0375 - accuracy: 0.9872
Epoch 00081: val_accuracy improved from 0.89610 to 0.89920, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_81-0.90.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.0375 - accuracy: 0.9872 - val
_loss: 0.4493 - val_accuracy: 0.8992
Epoch 82/300
389/390 [============================>.] - ETA: 0s - loss: 0.0364 - accuracy: 0.9880
Epoch 00082: val_accuracy improved from 0.89920 to 0.89990, saving model to
/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_82-0.90.hdf5
390/390 [==============================] - 138s 354ms/step - loss: 0.0364 - accuracy: 0.9880 - val
_loss: 0.4682 - val_accuracy: 0.8999
Epoch 83/300
389/390 [============================>.] - ETA: 0s - loss: 0.0360 - accuracy: 0.9875
Epoch 00083: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0360 - accuracy: 0.9875 - val
_loss: 0.4960 - val_accuracy: 0.8919
Epoch 84/300
389/390 [============================>.] - ETA: 0s - loss: 0.0371 - accuracy: 0.9872
Epoch 00084: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0371 - accuracy: 0.9872 - val
_loss: 0.5114 - val_accuracy: 0.8920
Epoch 85/300
389/390 [============================>.] - ETA: 0s - loss: 0.0366 - accuracy: 0.9872
Epoch 00085: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 352ms/step - loss: 0.0366 - accuracy: 0.9872 - val
_loss: 0.4935 - val_accuracy: 0.8941
Epoch 86/300
389/390 [============================>.] - ETA: 0s - loss: 0.0352 - accuracy: 0.9876
Epoch 00086: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0351 - accuracy: 0.9876 - val
_loss: 0.5134 - val_accuracy: 0.8921
Epoch 87/300
389/390 [============================>.] - ETA: 0s - loss: 0.0338 - accuracy: 0.9881
Epoch 00087: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0338 - accuracy: 0.9881 - val
_loss: 0.4842 - val_accuracy: 0.8960
Epoch 88/300
389/390 [============================>.] - ETA: 0s - loss: 0.0344 - accuracy: 0.9883
Epoch 00088: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 352ms/step - loss: 0.0344 - accuracy: 0.9883 - val
_loss: 0.5214 - val_accuracy: 0.8917
Epoch 89/300
389/390 [============================>.] - ETA: 0s - loss: 0.0317 - accuracy: 0.9891
Epoch 00089: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0317 - accuracy: 0.9891 - val
_loss: 0.5089 - val_accuracy: 0.8964
Epoch 90/300
389/390 [============================>.] - ETA: 0s - loss: 0.0305 - accuracy: 0.9897
Epoch 00090: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0305 - accuracy: 0.9897 - val
_loss: 0.5021 - val_accuracy: 0.8962
Epoch 91/300
389/390 [============================>.] - ETA: 0s - loss: 0.0304 - accuracy: 0.9902
Epoch 00091: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0305 - accuracy: 0.9901 - val
_loss: 0.5550 - val_accuracy: 0.8916
Epoch 92/300
389/390 [============================>.] - ETA: 0s - loss: 0.0297 - accuracy: 0.9898
Epoch 00092: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0298 - accuracy: 0.9898 - val
_loss: 0.5071 - val_accuracy: 0.8972
Epoch 93/300
389/390 [============================>.] - ETA: 0s - loss: 0.0296 - accuracy: 0.9901
Epoch 00093: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0297 - accuracy: 0.9901 - val
```

```
_loss: 0.5258 - val_accuracy: 0.8939
Epoch 94/300
389/390 [============================>.] - ETA: 0s - loss: 0.0284 - accuracy: 0.9903
Epoch 00094: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 352ms/step - loss: 0.0286 - accuracy: 0.9903 - val
_loss: 0.5146 - val_accuracy: 0.8958
Epoch 95/300
389/390 [============================>.] - ETA: 0s - loss: 0.0277 - accuracy: 0.9909
Epoch 00095: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0277 - accuracy: 0.9909 - val
_loss: 0.5141 - val_accuracy: 0.8984
Epoch 96/300
389/390 [============================>.] - ETA: 0s - loss: 0.0275 - accuracy: 0.9907
Epoch 00096: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0276 - accuracy: 0.9907 - val
_loss: 0.5237 - val_accuracy: 0.8962
Epoch 97/300
389/390 [============================>.] - ETA: 0s - loss: 0.0282 - accuracy: 0.9899
Epoch 00097: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 352ms/step - loss: 0.0282 - accuracy: 0.9899 - val
_loss: 0.5292 - val_accuracy: 0.8979
Epoch 98/300
389/390 [============================>.] - ETA: 0s - loss: 0.0269 - accuracy: 0.9909
Epoch 00098: val_accuracy did not improve from 0.89990

Epoch 00098: ReduceLROnPlateau reducing learning rate to 1.0000000474974514e-05.
390/390 [==============================] - 137s 351ms/step - loss: 0.0269 - accuracy: 0.9909 - val
_loss: 0.5317 - val_accuracy: 0.8951
Epoch 99/300
389/390 [============================>.] - ETA: 0s - loss: 0.0271 - accuracy: 0.9906
Epoch 00099: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0271 - accuracy: 0.9906 - val
_loss: 0.5343 - val_accuracy: 0.8962
Epoch 100/300
389/390 [============================>.] - ETA: 0s - loss: 0.0243 - accuracy: 0.9920
Epoch 00100: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0243 - accuracy: 0.9920 - val
_loss: 0.5313 - val_accuracy: 0.8969
Epoch 101/300
389/390 [============================>.] - ETA: 0s - loss: 0.0237 - accuracy: 0.9914
Epoch 00101: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0236 - accuracy: 0.9914 - val
_loss: 0.5344 - val_accuracy: 0.8961
Epoch 102/300
389/390 [============================>.] - ETA: 0s - loss: 0.0240 - accuracy: 0.9918
Epoch 00102: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0240 - accuracy: 0.9918 - val
_loss: 0.5361 - val_accuracy: 0.8971
Epoch 103/300
389/390 [============================>.] - ETA: 0s - loss: 0.0225 - accuracy: 0.9925
Epoch 00103: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0225 - accuracy: 0.9925 - val
_loss: 0.5332 - val_accuracy: 0.8971
Epoch 104/300
389/390 [============================>.] - ETA: 0s - loss: 0.0259 - accuracy: 0.9914
Epoch 00104: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0259 - accuracy: 0.9914 - val
_loss: 0.5336 - val_accuracy: 0.8972
Epoch 105/300
389/390 [============================>.] - ETA: 0s - loss: 0.0233 - accuracy: 0.9921
Epoch 00105: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0233 - accuracy: 0.9921 - val
_loss: 0.5345 - val_accuracy: 0.8969
Epoch 106/300
389/390 [============================>.] - ETA: 0s - loss: 0.0224 - accuracy: 0.9918
Epoch 00106: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0225 - accuracy: 0.9918 - val
_loss: 0.5367 - val_accuracy: 0.8972
Epoch 107/300
389/390 [============================>.] - ETA: 0s - loss: 0.0215 - accuracy: 0.9931
Epoch 00107: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0216 - accuracy: 0.9931 - val
_loss: 0.5334 - val_accuracy: 0.8979
Epoch 108/300
389/390 [============================>.] - ETA: 0s - loss: 0.0215 - accuracy: 0.9927
Epoch 00108: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0215 - accuracy: 0.9927 - val
```

```
_loss: 0.5375 - val_accuracy: 0.8961
Epoch 109/300
389/390 [============================>.] - ETA: 0s - loss: 0.0219 - accuracy: 0.9928
Epoch 00109: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0219 - accuracy: 0.9927 - val
_loss: 0.5292 - val_accuracy: 0.8986
Epoch 110/300
389/390 [============================>.] - ETA: 0s - loss: 0.0221 - accuracy: 0.9925
Epoch 00110: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0221 - accuracy: 0.9925 - val
_loss: 0.5354 - val_accuracy: 0.8982
Epoch 111/300
389/390 [============================>.] - ETA: 0s - loss: 0.0236 - accuracy: 0.9918
Epoch 00111: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0236 - accuracy: 0.9918 - val
_loss: 0.5348 - val_accuracy: 0.8974
Epoch 112/300
389/390 [============================>.] - ETA: 0s - loss: 0.0218 - accuracy: 0.9926
Epoch 00112: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0218 - accuracy: 0.9926 - val
_loss: 0.5355 - val_accuracy: 0.8981
Epoch 113/300
389/390 [============================>.] - ETA: 0s - loss: 0.0209 - accuracy: 0.9929
Epoch 00113: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0209 - accuracy: 0.9929 - val
_loss: 0.5347 - val_accuracy: 0.8971
Epoch 114/300
389/390 [============================>.] - ETA: 0s - loss: 0.0213 - accuracy: 0.9926
Epoch 00114: val_accuracy did not improve from 0.89990

Epoch 00114: ReduceLROnPlateau reducing learning rate to 1.0000000656873453e-06.
390/390 [==============================] - 137s 351ms/step - loss: 0.0214 - accuracy: 0.9926 - val
_loss: 0.5340 - val_accuracy: 0.8975
Epoch 115/300
389/390 [============================>.] - ETA: 0s - loss: 0.0223 - accuracy: 0.9926
Epoch 00115: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0223 - accuracy: 0.9926 - val
_loss: 0.5359 - val_accuracy: 0.8975
Epoch 116/300
389/390 [============================>.] - ETA: 0s - loss: 0.0229 - accuracy: 0.9922
Epoch 00116: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 352ms/step - loss: 0.0229 - accuracy: 0.9923 - val
_loss: 0.5363 - val_accuracy: 0.8971
Epoch 117/300
389/390 [============================>.] - ETA: 0s - loss: 0.0217 - accuracy: 0.9928
Epoch 00117: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0217 - accuracy: 0.9928 - val
_loss: 0.5350 - val_accuracy: 0.8975
Epoch 118/300
389/390 [============================>.] - ETA: 0s - loss: 0.0194 - accuracy: 0.9936
Epoch 00118: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0194 - accuracy: 0.9937 - val
_loss: 0.5358 - val_accuracy: 0.8971
Epoch 119/300
389/390 [============================>.] - ETA: 0s - loss: 0.0216 - accuracy: 0.9925
Epoch 00119: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 352ms/step - loss: 0.0216 - accuracy: 0.9925 - val
_loss: 0.5338 - val_accuracy: 0.8978
Epoch 120/300
389/390 [============================>.] - ETA: 0s - loss: 0.0222 - accuracy: 0.9924
Epoch 00120: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0222 - accuracy: 0.9924 - val
_loss: 0.5363 - val_accuracy: 0.8974
Epoch 121/300
389/390 [============================>.] - ETA: 0s - loss: 0.0201 - accuracy: 0.9932
Epoch 00121: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0201 - accuracy: 0.9932 - val
_loss: 0.5330 - val_accuracy: 0.8979
Epoch 122/300
389/390 [============================>.] - ETA: 0s - loss: 0.0216 - accuracy: 0.9926
Epoch 00122: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 352ms/step - loss: 0.0215 - accuracy: 0.9926 - val
_loss: 0.5376 - val_accuracy: 0.8965
Epoch 123/300
389/390 [============================>.] - ETA: 0s - loss: 0.0213 - accuracy: 0.9928
Epoch 00123: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0212 - accuracy: 0.9929 - val
```

```
_loss: 0.5361 - val_accuracy: 0.8972
Epoch 124/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0208 - accuracy: 0.9931
Epoch 00124: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0208 - accuracy: 0.9931 - val
_loss: 0.5376 - val_accuracy: 0.8967
Epoch 125/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0202 - accuracy: 0.9933
Epoch 00125: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0202 - accuracy: 0.9933 - val
_loss: 0.5372 - val_accuracy: 0.8971
Epoch 126/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0199 - accuracy: 0.9929
Epoch 00126: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0199 - accuracy: 0.9929 - val
_loss: 0.5341 - val_accuracy: 0.8977
Epoch 127/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0220 - accuracy: 0.9923
Epoch 00127: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0222 - accuracy: 0.9923 - val
_loss: 0.5363 - val_accuracy: 0.8966
Epoch 128/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0213 - accuracy: 0.9927
Epoch 00128: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0212 - accuracy: 0.9927 - val
_loss: 0.5334 - val_accuracy: 0.8975
Epoch 129/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0230 - accuracy: 0.9923
Epoch 00129: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0230 - accuracy: 0.9923 - val
_loss: 0.5349 - val_accuracy: 0.8973
Epoch 130/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0214 - accuracy: 0.9926
Epoch 00130: val_accuracy did not improve from 0.89990

Epoch 00130: ReduceLROnPlateau reducing learning rate to 1.0000001111620805e-07.
390/390 [==============================] - 137s 351ms/step - loss: 0.0214 - accuracy: 0.9925 - val
_loss: 0.5356 - val_accuracy: 0.8976
Epoch 131/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0201 - accuracy: 0.9932
Epoch 00131: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 352ms/step - loss: 0.0201 - accuracy: 0.9932 - val
_loss: 0.5365 - val_accuracy: 0.8970
Epoch 132/300
389/390 [=============================>.] - ETA: 0s - loss: 0.0216 - accuracy: 0.9921
Epoch 00132: val_accuracy did not improve from 0.89990
390/390 [==============================] - 137s 351ms/step - loss: 0.0217 - accuracy: 0.9921 - val
_loss: 0.5356 - val_accuracy: 0.8976
```

In [14]:

```python
#history plot for accyracy
plt.figure(figsize=(16,4))
plt.plot(history_6.history['accuracy'])
plt.plot(history_6.history['val_accuracy'])
plt.title("Model Accuracy")
plt.xlabel("Epoch")
plt.ylabel("Accuracy")
plt.legend(["train", "test"], loc="upper left")
plt.show()

# history plot for accuracy
plt.figure(figsize=(16,4))
plt.plot(history_6.history["loss"])
plt.plot(history_6.history["val_loss"])
plt.title("Model Loss")
plt.xlabel("Epoch")
plt.ylabel("Loss")
plt.legend(["train", "test"], loc="upper left")
plt.show()
```

Model Loss
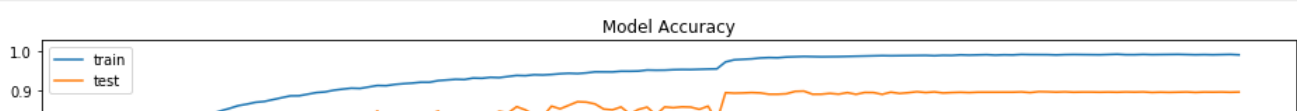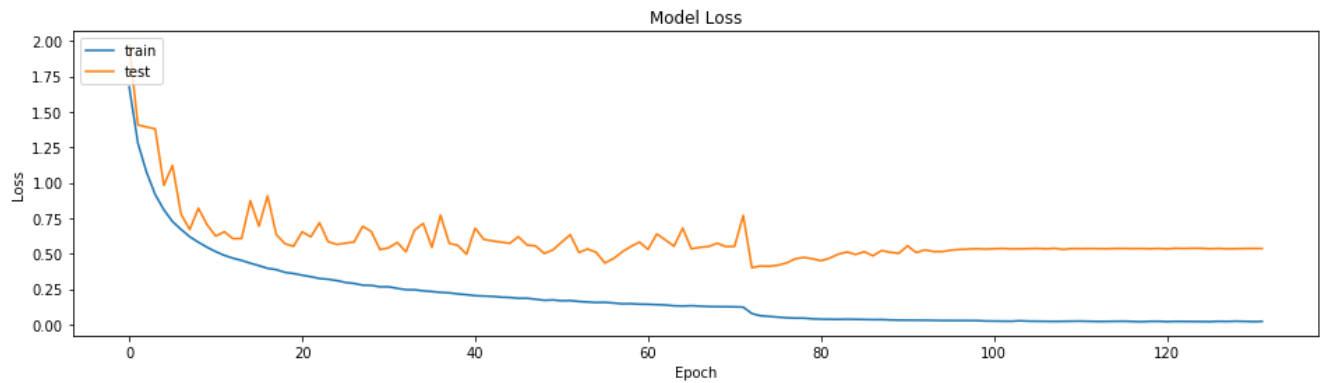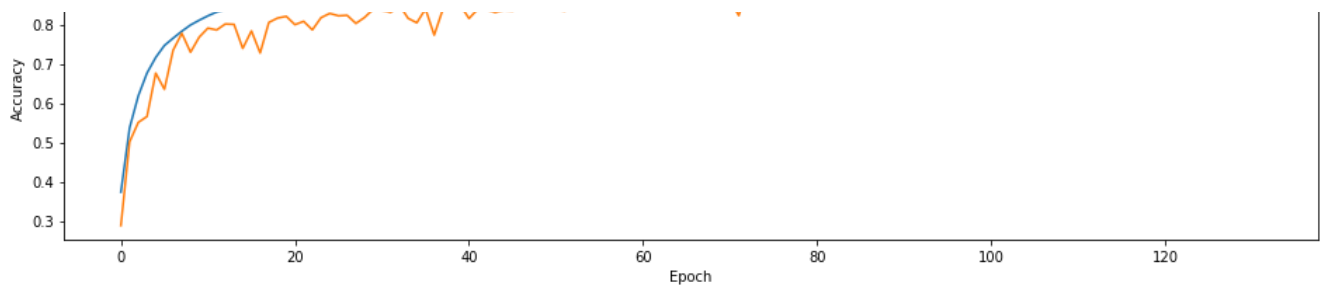
```
best_model_6 =
tf.keras.models.load_model('/home/ubuntu/Project/my_data/CNN_CIFAR/checkpoint/CIFAR_model6_82-0.90
.hdf5')
scores = best_model_6.evaluate(X_test, y_test, verbose=1)
print(scores)
```

```
10000/10000 [==============================] - 9s 854us/sample - loss: 0.4682 - accuracy: 0.8999
[0.46815555404126646, 0.8999]
```

Summary:

In [16]:

```python
from prettytable import PrettyTable

x = PrettyTable()

x.field_names = ["Model", "Conv", 'final_layer', "kernel_size", 'dropout', 'No of parameters', "Tes
t Accuracy"]
x.add_row(['model_1','Conv2D','dense', '3x3', '118,918', '0.2','80.83%'])
x.add_row(['model_2','Conv2D','dense', '3x3', '118,918', '0.2','81.33%'])
x.add_row(['model_3','SeparableConvolution2D', 'dense', '5x5', '0.2','258,282', '86.81%'])
x.add_row(['model_4','SeparableConvolution2D', 'dense', '7x7', '0.2','385,002', '87.16%'])
x.add_row(['model_5','SeparableConvolution2D', 'Conv2D', '7x7', '0.2','945,472', '89.21%'])
x.add_row(['model_5','SeparableConvolution2D', 'Conv2D', '7x7', '0','945,472', '89.999%'])

print(x)
```

Model	Conv	final_layer	kernel_size	dropout	No of parameters	Test Accuracy
model_1	Conv2D	dense	3x3	118,918	0.2	8.83%
model_2	Conv2D	dense	3x3	118,918	0.2	8.33%
model_3	SeparableConvolution2D	dense	5x5	0.2	258,282	8.81%
model_4	SeparableConvolution2D	dense	7x7	0.2	385,002	8.16%
model_5	SeparableConvolution2D	Conv2D	7x7	0.2	945,472	

```
89.21%    |
| model_5 | SeparableConvolution2D |    Conv2D    |    7x7    |    0    |    945,472    |
89.999%    |
+--------+----------------------+------------+------------+---------+----------------+------
------+
```

Note:

- After tried, final layer as Conv2D instead of flatten layer without dropout i have achieved test accuracy of 89.999%