Assignment Instructions:

CNN on CIFR Assignment:

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

Importing Libraries & Callbacks:

In [ ]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=True).
```

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

```
import warnings
warnings.filterwarnings("ignore")
```

In [ ]:

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

# Don't pre-allocate memory; allocate as-needed
config = tf.compat.v1.ConfigProto()
config.gpu_options.allow_growth = True

# Create a session with the above options specified.
session = tf.compat.v1.Session(config=config)
```

In [ ]:

```
#https://stackoverflow.com/questions/39779710/setting-up-a-learningratescheduler-in-keras
from tensorflow.keras.callbacks import LearningRateScheduler, ModelCheckpoint, EarlyStopping,ReduceLROnPlateau
def scheduler(epoch, lr):
  if epoch % 10 ==0:
    return lr*0.95
  else:
    return lr
lr_scheduler = LearningRateScheduler(scheduler, verbose=1)


#earlystop = EarlyStopping(monitor='accuracy', patience=50, verbose=1)
decay_lr = ReduceLROnPlateau(monitor='val_accuracy', factor=0.9, patience=10,
                                            verbose=0, mode='auto', min_delta=0.001,
                                            cooldown=0, min_lr=1e-6)


#callback_list = [lr_scheduler, decay_lr, checkpoint, tensorboard_callback]
```

In [ ]:

```
#Reference:https://machinelearningmastery.com/how-to-develop-a-cnn-from-scratch-for-cifar-10-photo-classification/
# plot diagnostic learning curves
import matplotlib.pyplot as plt
def summarize_diagnostics(history):
  #plot Loss
  plt.figure(figsize=(10,10))
  plt.subplot(211)
  plt.title('Cross Entropy Loss')
  plt.plot(history.history['loss'], color='blue', label='train')
  plt.plot(history.history['val_loss'], color='orange', label='test')
  plt.xlabel("Epochs")
```

```
  # plot accuracy
  plt.subplot(212)
  plt.title('Classification Accuracy')
  plt.plot(history.history['accuracy'], color='blue', label='train')
  plt.plot(history.history['val_accuracy'], color='orange', label='test')
  plt.xlabel("Epochs")

  plt.show()
```

Importing various optimizers for experiment:

In [ ]:

```
import tensorflow as tf
optimizer_SGD = tf.keras.optimizers.SGD(
    learning_rate=0.01, momentum=0.7, nesterov=True,
    name='SGD')

optimizer_aadam = tf.keras.optimizers.Adam(
    learning_rate=0.001, beta_1=0.9, beta_2=0.999, epsilon=1e-07, amsgrad=False,
    name='Adam')

optimizer_adamax = tf.keras.optimizers.Adamax(
    learning_rate=0.1, beta_1=0.9, beta_2=0.999, epsilon=1e-07,
    name='Adamax')

optimizer_RMSprop = tf.keras.optimizers.RMSprop(
    learning_rate=0.001, rho=0.9, momentum=0.8, epsilon=1e-06, centered=False,
    name='RMSprop')

optimizer_adagrad = tf.keras.optimizers.Adagrad(
    learning_rate=0.1, initial_accumulator_value=0.1, epsilon=1e-07,
    name='Adagrad')

optimizer_adadelta = tf.keras.optimizers.Adadelta(
    learning_rate=0.1, rho=0.95, epsilon=1e-07, name='Adadelta')
```

Importing Data

In [ ]:

```
num_classes=10
# Load CIFAR10 Data
(X_train, y_train), (X_test, y_test) = tf.keras.datasets.cifar10.load_data()
img_height, img_width, channel = X_train.shape[1],X_train.shape[2],X_train.shape[3]

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

```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz
```

```
170500096/170498071 [==============================] - 2s 0us/step
170508288/170498071 [==============================] - 2s 0us/step
```

Given Model: Baseline Model

In [ ]:
```
# Hyperparameters
batch_size = 128
num_classes = 10
epochs = 10
l = 40
num_filter = 12
compression = 0.5
dropout_rate = 0.2
```

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

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

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

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

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

        temp = concat

    return temp

## transition Blosck
def transition(input, num_filter = 12, dropout_rate = 0.2):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    Conv2D_BottleNeck = layers.Conv2D(int(num_filter*compression), (1,1), use_bias=False ,padding='same')(relu)
```

```
    if dropout_rate>0:
         Conv2D_BottleNeck = layers.Dropout(dropout_rate)(Conv2D_BottleNeck)
    avg = layers.AveragePooling2D(pool_size=(2,2))(Conv2D_BottleNeck)
    return avg

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

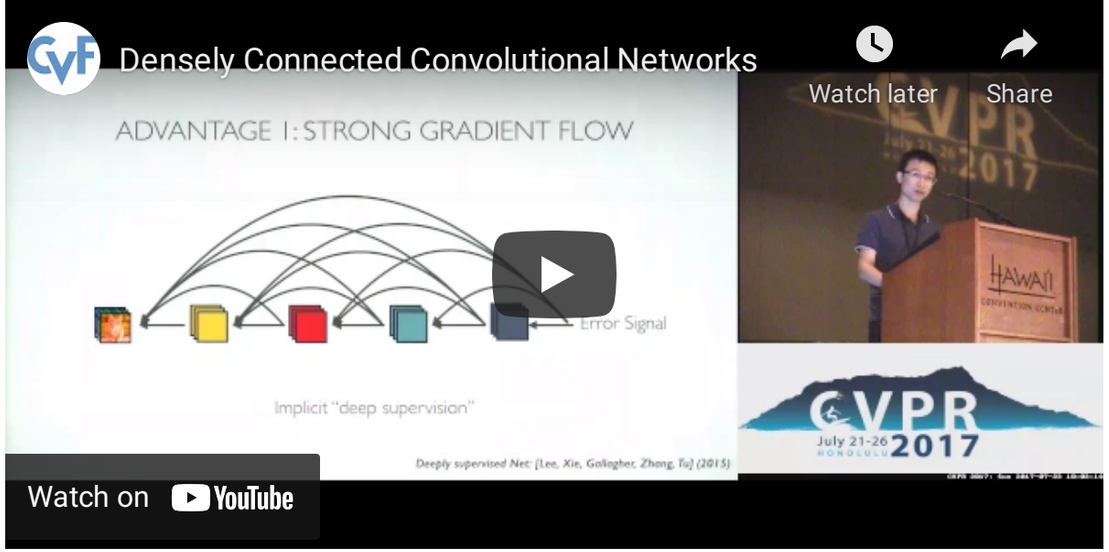
In [ ]:

```
num_filter = 32
dropout_rate = 0.2
l = 12
input = layers.Input(shape=(img_height, img_width, channel,))
First_Conv2D = layers.Conv2D(num_filter, (3,3), use_bias=False ,padding='same')(input)

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

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

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

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

In [ ]:

```
#https://arxiv.org/pdf/1608.06993.pdf
from IPython.display import IFrame, YouTubeVideo
YouTubeVideo(id='-W6y8xnd--U', width=600)
```

Out[ ]:



In [ ]:

```
model = 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, 32)        864         ['input_1[0][0]']

 batch_normalization (BatchNorm  (None, 32, 32, 32)    128         ['conv2d[0][0]']
 alization)

 activation (Activation)     (None, 32, 32, 32)        0           ['batch_normalization[0][0]']

 conv2d_1 (Conv2D)           (None, 32, 32, 16)        4608        ['activation[0][0]']

 dropout (Dropout)           (None, 32, 32, 16)        0           ['conv2d_1[0][0]']

 concatenate (Concatenate)   (None, 32, 32, 48)        0           ['conv2d[0][0]',
                                                                   'dropout[0][0]']

 batch_normalization_1 (BatchNo  (None, 32, 32, 48)    192         ['concatenate[0][0]']
 rmalization)

 activation_1 (Activation)   (None, 32, 32, 48)        0           ['batch_normalization_1[0][0]']

 conv2d_2 (Conv2D)           (None, 32, 32, 16)        6912        ['activation_1[0][0]']

 dropout_1 (Dropout)         (None, 32, 32, 16)        0           ['conv2d_2[0][0]']
```

```
concatenate_1 (Concatenate)    (None, 32, 32, 64)   0           ['concatenate[0][0]',
                                                                 'dropout_1[0][0]']

batch_normalization_2 (BatchNo  (None, 32, 32, 64)  256         ['concatenate_1[0][0]']
rmalization)

activation_2 (Activation)      (None, 32, 32, 64)   0           ['batch_normalization_2[0][0]']

conv2d_3 (Conv2D)              (None, 32, 32, 16)   9216        ['activation_2[0][0]']

dropout_2 (Dropout)            (None, 32, 32, 16)   0           ['conv2d_3[0][0]']

concatenate_2 (Concatenate)    (None, 32, 32, 80)   0           ['concatenate_1[0][0]',
                                                                 'dropout_2[0][0]']

batch_normalization_3 (BatchNo  (None, 32, 32, 80)  320         ['concatenate_2[0][0]']
rmalization)

activation_3 (Activation)      (None, 32, 32, 80)   0           ['batch_normalization_3[0][0]']

conv2d_4 (Conv2D)              (None, 32, 32, 16)   11520       ['activation_3[0][0]']

dropout_3 (Dropout)            (None, 32, 32, 16)   0           ['conv2d_4[0][0]']

concatenate_3 (Concatenate)    (None, 32, 32, 96)   0           ['concatenate_2[0][0]',
                                                                 'dropout_3[0][0]']

batch_normalization_4 (BatchNo  (None, 32, 32, 96)  384         ['concatenate_3[0][0]']
rmalization)

activation_4 (Activation)      (None, 32, 32, 96)   0           ['batch_normalization_4[0][0]']

conv2d_5 (Conv2D)              (None, 32, 32, 16)   13824       ['activation_4[0][0]']

dropout_4 (Dropout)            (None, 32, 32, 16)   0           ['conv2d_5[0][0]']

concatenate_4 (Concatenate)    (None, 32, 32, 112)  0           ['concatenate_3[0][0]',
                                                                 'dropout_4[0][0]']

batch_normalization_5 (BatchNo  (None, 32, 32, 112)  448        ['concatenate_4[0][0]']
rmalization)

activation_5 (Activation)      (None, 32, 32, 112)  0           ['batch_normalization_5[0][0]']

conv2d_6 (Conv2D)              (None, 32, 32, 16)   16128       ['activation_5[0][0]']

dropout_5 (Dropout)            (None, 32, 32, 16)   0           ['conv2d_6[0][0]']

concatenate_5 (Concatenate)    (None, 32, 32, 128)  0           ['concatenate_4[0][0]',
                                                                 'dropout_5[0][0]']

batch_normalization_6 (BatchNo  (None, 32, 32, 128)  512        ['concatenate_5[0][0]']
rmalization)
```

```
activation_6 (Activation)      (None, 32, 32, 128)  0           ['batch_normalization_6[0][0]']

conv2d_7 (Conv2D)              (None, 32, 32, 16)   18432       ['activation_6[0][0]']

dropout_6 (Dropout)            (None, 32, 32, 16)   0           ['conv2d_7[0][0]']

concatenate_6 (Concatenate)    (None, 32, 32, 144)  0           ['concatenate_5[0][0]',
                                                                 'dropout_6[0][0]']

batch_normalization_7 (BatchNo  (None, 32, 32, 144)  576        ['concatenate_6[0][0]']
rmalization)

activation_7 (Activation)      (None, 32, 32, 144)  0           ['batch_normalization_7[0][0]']

conv2d_8 (Conv2D)              (None, 32, 32, 16)   20736       ['activation_7[0][0]']

dropout_7 (Dropout)            (None, 32, 32, 16)   0           ['conv2d_8[0][0]']

concatenate_7 (Concatenate)    (None, 32, 32, 160)  0           ['concatenate_6[0][0]',
                                                                 'dropout_7[0][0]']

batch_normalization_8 (BatchNo  (None, 32, 32, 160)  640        ['concatenate_7[0][0]']
rmalization)

activation_8 (Activation)      (None, 32, 32, 160)  0           ['batch_normalization_8[0][0]']

conv2d_9 (Conv2D)              (None, 32, 32, 16)   23040       ['activation_8[0][0]']

dropout_8 (Dropout)            (None, 32, 32, 16)   0           ['conv2d_9[0][0]']

concatenate_8 (Concatenate)    (None, 32, 32, 176)  0           ['concatenate_7[0][0]',
                                                                 'dropout_8[0][0]']

batch_normalization_9 (BatchNo  (None, 32, 32, 176)  704        ['concatenate_8[0][0]']
rmalization)

activation_9 (Activation)      (None, 32, 32, 176)  0           ['batch_normalization_9[0][0]']

conv2d_10 (Conv2D)             (None, 32, 32, 16)   25344       ['activation_9[0][0]']

dropout_9 (Dropout)            (None, 32, 32, 16)   0           ['conv2d_10[0][0]']

concatenate_9 (Concatenate)    (None, 32, 32, 192)  0           ['concatenate_8[0][0]',
                                                                 'dropout_9[0][0]']

batch_normalization_10 (BatchN  (None, 32, 32, 192)  768        ['concatenate_9[0][0]']
ormalization)

activation_10 (Activation)     (None, 32, 32, 192)  0           ['batch_normalization_10[0][0]']

conv2d_11 (Conv2D)             (None, 32, 32, 16)   27648       ['activation_10[0][0]']

dropout_10 (Dropout)           (None, 32, 32, 16)   0           ['conv2d_11[0][0]']
```

```
concatenate_10 (Concatenate)   (None, 32, 32, 208)  0           ['concatenate_9[0][0]',
                                                                 'dropout_10[0][0]']

batch_normalization_11 (BatchN  (None, 32, 32, 208)  832        ['concatenate_10[0][0]']
ormalization)

activation_11 (Activation)     (None, 32, 32, 208)  0           ['batch_normalization_11[0][0]']

conv2d_12 (Conv2D)             (None, 32, 32, 16)   29952       ['activation_11[0][0]']

dropout_11 (Dropout)           (None, 32, 32, 16)   0           ['conv2d_12[0][0]']

concatenate_11 (Concatenate)   (None, 32, 32, 224)  0           ['concatenate_10[0][0]',
                                                                 'dropout_11[0][0]']

batch_normalization_12 (BatchN  (None, 32, 32, 224)  896        ['concatenate_11[0][0]']
ormalization)

activation_12 (Activation)     (None, 32, 32, 224)  0           ['batch_normalization_12[0][0]']

conv2d_13 (Conv2D)             (None, 32, 32, 16)   3584        ['activation_12[0][0]']

dropout_12 (Dropout)           (None, 32, 32, 16)   0           ['conv2d_13[0][0]']

average_pooling2d (AveragePool  (None, 16, 16, 16)  0           ['dropout_12[0][0]']
ing2D)

batch_normalization_13 (BatchN  (None, 16, 16, 16)  64          ['average_pooling2d[0][0]']
ormalization)

activation_13 (Activation)     (None, 16, 16, 16)   0           ['batch_normalization_13[0][0]']

conv2d_14 (Conv2D)             (None, 16, 16, 16)   2304        ['activation_13[0][0]']

dropout_13 (Dropout)           (None, 16, 16, 16)   0           ['conv2d_14[0][0]']

concatenate_12 (Concatenate)   (None, 16, 16, 32)   0           ['average_pooling2d[0][0]',
                                                                 'dropout_13[0][0]']

batch_normalization_14 (BatchN  (None, 16, 16, 32)  128         ['concatenate_12[0][0]']
ormalization)

activation_14 (Activation)     (None, 16, 16, 32)   0           ['batch_normalization_14[0][0]']

conv2d_15 (Conv2D)             (None, 16, 16, 16)   4608        ['activation_14[0][0]']

dropout_14 (Dropout)           (None, 16, 16, 16)   0           ['conv2d_15[0][0]']

concatenate_13 (Concatenate)   (None, 16, 16, 48)   0           ['concatenate_12[0][0]',
                                                                 'dropout_14[0][0]']

batch_normalization_15 (BatchN  (None, 16, 16, 48)  192         ['concatenate_13[0][0]']
ormalization)
```

```
activation_15 (Activation)     (None, 16, 16, 48)   0           ['batch_normalization_15[0][0]']

conv2d_16 (Conv2D)             (None, 16, 16, 16)   6912        ['activation_15[0][0]']

dropout_15 (Dropout)           (None, 16, 16, 16)   0           ['conv2d_16[0][0]']

concatenate_14 (Concatenate)   (None, 16, 16, 64)   0           ['concatenate_13[0][0]',
                                                                 'dropout_15[0][0]']

batch_normalization_16 (BatchN  (None, 16, 16, 64)  256         ['concatenate_14[0][0]']
ormalization)

activation_16 (Activation)     (None, 16, 16, 64)   0           ['batch_normalization_16[0][0]']

conv2d_17 (Conv2D)             (None, 16, 16, 16)   9216        ['activation_16[0][0]']

dropout_16 (Dropout)           (None, 16, 16, 16)   0           ['conv2d_17[0][0]']

concatenate_15 (Concatenate)   (None, 16, 16, 80)   0           ['concatenate_14[0][0]',
                                                                 'dropout_16[0][0]']

batch_normalization_17 (BatchN  (None, 16, 16, 80)  320         ['concatenate_15[0][0]']
ormalization)

activation_17 (Activation)     (None, 16, 16, 80)   0           ['batch_normalization_17[0][0]']

conv2d_18 (Conv2D)             (None, 16, 16, 16)   11520       ['activation_17[0][0]']

dropout_17 (Dropout)           (None, 16, 16, 16)   0           ['conv2d_18[0][0]']

concatenate_16 (Concatenate)   (None, 16, 16, 96)   0           ['concatenate_15[0][0]',
                                                                 'dropout_17[0][0]']

batch_normalization_18 (BatchN  (None, 16, 16, 96)  384         ['concatenate_16[0][0]']
ormalization)

activation_18 (Activation)     (None, 16, 16, 96)   0           ['batch_normalization_18[0][0]']

conv2d_19 (Conv2D)             (None, 16, 16, 16)   13824       ['activation_18[0][0]']

dropout_18 (Dropout)           (None, 16, 16, 16)   0           ['conv2d_19[0][0]']

concatenate_17 (Concatenate)   (None, 16, 16, 112)  0           ['concatenate_16[0][0]',
                                                                 'dropout_18[0][0]']

batch_normalization_19 (BatchN  (None, 16, 16, 112)  448        ['concatenate_17[0][0]']
ormalization)

activation_19 (Activation)     (None, 16, 16, 112)  0           ['batch_normalization_19[0][0]']

conv2d_20 (Conv2D)             (None, 16, 16, 16)   16128       ['activation_19[0][0]']

dropout_19 (Dropout)           (None, 16, 16, 16)   0           ['conv2d_20[0][0]']
```

```
concatenate_18 (Concatenate)   (None, 16, 16, 128)  0           ['concatenate_17[0][0]',
                                                                 'dropout_19[0][0]']

batch_normalization_20 (BatchN  (None, 16, 16, 128)  512        ['concatenate_18[0][0]']
ormalization)

activation_20 (Activation)     (None, 16, 16, 128)  0           ['batch_normalization_20[0][0]']

conv2d_21 (Conv2D)             (None, 16, 16, 16)   18432       ['activation_20[0][0]']

dropout_20 (Dropout)           (None, 16, 16, 16)   0           ['conv2d_21[0][0]']

concatenate_19 (Concatenate)   (None, 16, 16, 144)  0           ['concatenate_18[0][0]',
                                                                 'dropout_20[0][0]']

batch_normalization_21 (BatchN  (None, 16, 16, 144)  576        ['concatenate_19[0][0]']
ormalization)

activation_21 (Activation)     (None, 16, 16, 144)  0           ['batch_normalization_21[0][0]']

conv2d_22 (Conv2D)             (None, 16, 16, 16)   20736       ['activation_21[0][0]']

dropout_21 (Dropout)           (None, 16, 16, 16)   0           ['conv2d_22[0][0]']

concatenate_20 (Concatenate)   (None, 16, 16, 160)  0           ['concatenate_19[0][0]',
                                                                 'dropout_21[0][0]']

batch_normalization_22 (BatchN  (None, 16, 16, 160)  640        ['concatenate_20[0][0]']
ormalization)

activation_22 (Activation)     (None, 16, 16, 160)  0           ['batch_normalization_22[0][0]']

conv2d_23 (Conv2D)             (None, 16, 16, 16)   23040       ['activation_22[0][0]']

dropout_22 (Dropout)           (None, 16, 16, 16)   0           ['conv2d_23[0][0]']

concatenate_21 (Concatenate)   (None, 16, 16, 176)  0           ['concatenate_20[0][0]',
                                                                 'dropout_22[0][0]']

batch_normalization_23 (BatchN  (None, 16, 16, 176)  704        ['concatenate_21[0][0]']
ormalization)

activation_23 (Activation)     (None, 16, 16, 176)  0           ['batch_normalization_23[0][0]']

conv2d_24 (Conv2D)             (None, 16, 16, 16)   25344       ['activation_23[0][0]']

dropout_23 (Dropout)           (None, 16, 16, 16)   0           ['conv2d_24[0][0]']

concatenate_22 (Concatenate)   (None, 16, 16, 192)  0           ['concatenate_21[0][0]',
                                                                 'dropout_23[0][0]']

batch_normalization_24 (BatchN  (None, 16, 16, 192)  768        ['concatenate_22[0][0]']
ormalization)
```

```
activation_24 (Activation)     (None, 16, 16, 192)  0           ['batch_normalization_24[0][0]']

conv2d_25 (Conv2D)             (None, 16, 16, 16)   27648       ['activation_24[0][0]']

dropout_24 (Dropout)           (None, 16, 16, 16)   0           ['conv2d_25[0][0]']

concatenate_23 (Concatenate)   (None, 16, 16, 208)  0           ['concatenate_22[0][0]',
                                                                 'dropout_24[0][0]']

batch_normalization_25 (BatchN  (None, 16, 16, 208)  832        ['concatenate_23[0][0]']
ormalization)

activation_25 (Activation)     (None, 16, 16, 208)  0           ['batch_normalization_25[0][0]']

conv2d_26 (Conv2D)             (None, 16, 16, 16)   3328        ['activation_25[0][0]']

dropout_25 (Dropout)           (None, 16, 16, 16)   0           ['conv2d_26[0][0]']

average_pooling2d_1 (AveragePo  (None, 8, 8, 16)    0           ['dropout_25[0][0]']
oling2D)

batch_normalization_26 (BatchN  (None, 8, 8, 16)    64          ['average_pooling2d_1[0][0]']
ormalization)

activation_26 (Activation)     (None, 8, 8, 16)     0           ['batch_normalization_26[0][0]']

conv2d_27 (Conv2D)             (None, 8, 8, 16)     2304        ['activation_26[0][0]']

dropout_26 (Dropout)           (None, 8, 8, 16)     0           ['conv2d_27[0][0]']

concatenate_24 (Concatenate)   (None, 8, 8, 32)     0           ['average_pooling2d_1[0][0]',
                                                                 'dropout_26[0][0]']

batch_normalization_27 (BatchN  (None, 8, 8, 32)    128         ['concatenate_24[0][0]']
ormalization)

activation_27 (Activation)     (None, 8, 8, 32)     0           ['batch_normalization_27[0][0]']

conv2d_28 (Conv2D)             (None, 8, 8, 16)     4608        ['activation_27[0][0]']

dropout_27 (Dropout)           (None, 8, 8, 16)     0           ['conv2d_28[0][0]']

concatenate_25 (Concatenate)   (None, 8, 8, 48)     0           ['concatenate_24[0][0]',
                                                                 'dropout_27[0][0]']

batch_normalization_28 (BatchN  (None, 8, 8, 48)    192         ['concatenate_25[0][0]']
ormalization)

activation_28 (Activation)     (None, 8, 8, 48)     0           ['batch_normalization_28[0][0]']

conv2d_29 (Conv2D)             (None, 8, 8, 16)     6912        ['activation_28[0][0]']

dropout_28 (Dropout)           (None, 8, 8, 16)     0           ['conv2d_29[0][0]']
```

```
concatenate_26 (Concatenate)   (None, 8, 8, 64)     0          ['concatenate_25[0][0]',
                                                                 'dropout_28[0][0]']

batch_normalization_29 (BatchN  (None, 8, 8, 64)    256        ['concatenate_26[0][0]']
ormalization)

activation_29 (Activation)     (None, 8, 8, 64)     0          ['batch_normalization_29[0][0]']

conv2d_30 (Conv2D)             (None, 8, 8, 16)     9216       ['activation_29[0][0]']

dropout_29 (Dropout)           (None, 8, 8, 16)     0          ['conv2d_30[0][0]']

concatenate_27 (Concatenate)   (None, 8, 8, 80)     0          ['concatenate_26[0][0]',
                                                                 'dropout_29[0][0]']

batch_normalization_30 (BatchN  (None, 8, 8, 80)    320        ['concatenate_27[0][0]']
ormalization)

activation_30 (Activation)     (None, 8, 8, 80)     0          ['batch_normalization_30[0][0]']

conv2d_31 (Conv2D)             (None, 8, 8, 16)     11520      ['activation_30[0][0]']

dropout_30 (Dropout)           (None, 8, 8, 16)     0          ['conv2d_31[0][0]']

concatenate_28 (Concatenate)   (None, 8, 8, 96)     0          ['concatenate_27[0][0]',
                                                                 'dropout_30[0][0]']

batch_normalization_31 (BatchN  (None, 8, 8, 96)    384        ['concatenate_28[0][0]']
ormalization)

activation_31 (Activation)     (None, 8, 8, 96)     0          ['batch_normalization_31[0][0]']

conv2d_32 (Conv2D)             (None, 8, 8, 16)     13824      ['activation_31[0][0]']

dropout_31 (Dropout)           (None, 8, 8, 16)     0          ['conv2d_32[0][0]']

concatenate_29 (Concatenate)   (None, 8, 8, 112)    0          ['concatenate_28[0][0]',
                                                                 'dropout_31[0][0]']

batch_normalization_32 (BatchN  (None, 8, 8, 112)   448        ['concatenate_29[0][0]']
ormalization)

activation_32 (Activation)     (None, 8, 8, 112)    0          ['batch_normalization_32[0][0]']

conv2d_33 (Conv2D)             (None, 8, 8, 16)     16128      ['activation_32[0][0]']

dropout_32 (Dropout)           (None, 8, 8, 16)     0          ['conv2d_33[0][0]']

concatenate_30 (Concatenate)   (None, 8, 8, 128)    0          ['concatenate_29[0][0]',
                                                                 'dropout_32[0][0]']

batch_normalization_33 (BatchN  (None, 8, 8, 128)   512        ['concatenate_30[0][0]']
ormalization)
```

```
activation_33 (Activation)     (None, 8, 8, 128)    0           ['batch_normalization_33[0][0]']

conv2d_34 (Conv2D)             (None, 8, 8, 16)     18432       ['activation_33[0][0]']

dropout_33 (Dropout)           (None, 8, 8, 16)     0           ['conv2d_34[0][0]']

concatenate_31 (Concatenate)   (None, 8, 8, 144)    0           ['concatenate_30[0][0]',
                                                                 'dropout_33[0][0]']

batch_normalization_34 (BatchN  (None, 8, 8, 144)   576         ['concatenate_31[0][0]']
ormalization)

activation_34 (Activation)     (None, 8, 8, 144)    0           ['batch_normalization_34[0][0]']

conv2d_35 (Conv2D)             (None, 8, 8, 16)     20736       ['activation_34[0][0]']

dropout_34 (Dropout)           (None, 8, 8, 16)     0           ['conv2d_35[0][0]']

concatenate_32 (Concatenate)   (None, 8, 8, 160)    0           ['concatenate_31[0][0]',
                                                                 'dropout_34[0][0]']

batch_normalization_35 (BatchN  (None, 8, 8, 160)   640         ['concatenate_32[0][0]']
ormalization)

activation_35 (Activation)     (None, 8, 8, 160)    0           ['batch_normalization_35[0][0]']

conv2d_36 (Conv2D)             (None, 8, 8, 16)     23040       ['activation_35[0][0]']

dropout_35 (Dropout)           (None, 8, 8, 16)     0           ['conv2d_36[0][0]']

concatenate_33 (Concatenate)   (None, 8, 8, 176)    0           ['concatenate_32[0][0]',
                                                                 'dropout_35[0][0]']

batch_normalization_36 (BatchN  (None, 8, 8, 176)   704         ['concatenate_33[0][0]']
ormalization)

activation_36 (Activation)     (None, 8, 8, 176)    0           ['batch_normalization_36[0][0]']

conv2d_37 (Conv2D)             (None, 8, 8, 16)     25344       ['activation_36[0][0]']

dropout_36 (Dropout)           (None, 8, 8, 16)     0           ['conv2d_37[0][0]']

concatenate_34 (Concatenate)   (None, 8, 8, 192)    0           ['concatenate_33[0][0]',
                                                                 'dropout_36[0][0]']

batch_normalization_37 (BatchN  (None, 8, 8, 192)   768         ['concatenate_34[0][0]']
ormalization)

activation_37 (Activation)     (None, 8, 8, 192)    0           ['batch_normalization_37[0][0]']

conv2d_38 (Conv2D)             (None, 8, 8, 16)     27648       ['activation_37[0][0]']

dropout_37 (Dropout)           (None, 8, 8, 16)     0           ['conv2d_38[0][0]']
```

```
concatenate_35 (Concatenate)   (None, 8, 8, 208)    0           ['concatenate_34[0][0]',
                                                                 'dropout_37[0][0]']

batch_normalization_38 (BatchN  (None, 8, 8, 208)   832         ['concatenate_35[0][0]']
ormalization)

activation_38 (Activation)     (None, 8, 8, 208)    0           ['batch_normalization_38[0][0]']

conv2d_39 (Conv2D)             (None, 8, 8, 16)     3328        ['activation_38[0][0]']

dropout_38 (Dropout)           (None, 8, 8, 16)     0           ['conv2d_39[0][0]']

average_pooling2d_2 (AveragePo  (None, 4, 4, 16)    0           ['dropout_38[0][0]']
oling2D)

batch_normalization_39 (BatchN  (None, 4, 4, 16)    64          ['average_pooling2d_2[0][0]']
ormalization)

activation_39 (Activation)     (None, 4, 4, 16)     0           ['batch_normalization_39[0][0]']

conv2d_40 (Conv2D)             (None, 4, 4, 16)     2304        ['activation_39[0][0]']

dropout_39 (Dropout)           (None, 4, 4, 16)     0           ['conv2d_40[0][0]']

concatenate_36 (Concatenate)   (None, 4, 4, 32)     0           ['average_pooling2d_2[0][0]',
                                                                 'dropout_39[0][0]']

batch_normalization_40 (BatchN  (None, 4, 4, 32)    128         ['concatenate_36[0][0]']
ormalization)

activation_40 (Activation)     (None, 4, 4, 32)     0           ['batch_normalization_40[0][0]']

conv2d_41 (Conv2D)             (None, 4, 4, 16)     4608        ['activation_40[0][0]']

dropout_40 (Dropout)           (None, 4, 4, 16)     0           ['conv2d_41[0][0]']

concatenate_37 (Concatenate)   (None, 4, 4, 48)     0           ['concatenate_36[0][0]',
                                                                 'dropout_40[0][0]']

batch_normalization_41 (BatchN  (None, 4, 4, 48)    192         ['concatenate_37[0][0]']
ormalization)

activation_41 (Activation)     (None, 4, 4, 48)     0           ['batch_normalization_41[0][0]']

conv2d_42 (Conv2D)             (None, 4, 4, 16)     6912        ['activation_41[0][0]']

dropout_41 (Dropout)           (None, 4, 4, 16)     0           ['conv2d_42[0][0]']

concatenate_38 (Concatenate)   (None, 4, 4, 64)     0           ['concatenate_37[0][0]',
                                                                 'dropout_41[0][0]']

batch_normalization_42 (BatchN  (None, 4, 4, 64)    256         ['concatenate_38[0][0]']
ormalization)
```

```
activation_42 (Activation)     (None, 4, 4, 64)     0           ['batch_normalization_42[0][0]']

conv2d_43 (Conv2D)             (None, 4, 4, 16)     9216        ['activation_42[0][0]']

dropout_42 (Dropout)           (None, 4, 4, 16)     0           ['conv2d_43[0][0]']

concatenate_39 (Concatenate)   (None, 4, 4, 80)     0           ['concatenate_38[0][0]',
                                                                 'dropout_42[0][0]']

batch_normalization_43 (BatchN  (None, 4, 4, 80)    320         ['concatenate_39[0][0]']
ormalization)

activation_43 (Activation)     (None, 4, 4, 80)     0           ['batch_normalization_43[0][0]']

conv2d_44 (Conv2D)             (None, 4, 4, 16)     11520       ['activation_43[0][0]']

dropout_43 (Dropout)           (None, 4, 4, 16)     0           ['conv2d_44[0][0]']

concatenate_40 (Concatenate)   (None, 4, 4, 96)     0           ['concatenate_39[0][0]',
                                                                 'dropout_43[0][0]']

batch_normalization_44 (BatchN  (None, 4, 4, 96)    384         ['concatenate_40[0][0]']
ormalization)

activation_44 (Activation)     (None, 4, 4, 96)     0           ['batch_normalization_44[0][0]']

conv2d_45 (Conv2D)             (None, 4, 4, 16)     13824       ['activation_44[0][0]']

dropout_44 (Dropout)           (None, 4, 4, 16)     0           ['conv2d_45[0][0]']

concatenate_41 (Concatenate)   (None, 4, 4, 112)    0           ['concatenate_40[0][0]',
                                                                 'dropout_44[0][0]']

batch_normalization_45 (BatchN  (None, 4, 4, 112)   448         ['concatenate_41[0][0]']
ormalization)

activation_45 (Activation)     (None, 4, 4, 112)    0           ['batch_normalization_45[0][0]']

conv2d_46 (Conv2D)             (None, 4, 4, 16)     16128       ['activation_45[0][0]']

dropout_45 (Dropout)           (None, 4, 4, 16)     0           ['conv2d_46[0][0]']

concatenate_42 (Concatenate)   (None, 4, 4, 128)    0           ['concatenate_41[0][0]',
                                                                 'dropout_45[0][0]']

batch_normalization_46 (BatchN  (None, 4, 4, 128)   512         ['concatenate_42[0][0]']
ormalization)

activation_46 (Activation)     (None, 4, 4, 128)    0           ['batch_normalization_46[0][0]']

conv2d_47 (Conv2D)             (None, 4, 4, 16)     18432       ['activation_46[0][0]']

dropout_46 (Dropout)           (None, 4, 4, 16)     0           ['conv2d_47[0][0]']
```

```
concatenate_43 (Concatenate)   (None, 4, 4, 144)    0           ['concatenate_42[0][0]',
                                                                 'dropout_46[0][0]']

batch_normalization_47 (BatchN  (None, 4, 4, 144)   576         ['concatenate_43[0][0]']
ormalization)

activation_47 (Activation)     (None, 4, 4, 144)    0           ['batch_normalization_47[0][0]']

conv2d_48 (Conv2D)             (None, 4, 4, 16)     20736       ['activation_47[0][0]']

dropout_47 (Dropout)           (None, 4, 4, 16)     0           ['conv2d_48[0][0]']

concatenate_44 (Concatenate)   (None, 4, 4, 160)    0           ['concatenate_43[0][0]',
                                                                 'dropout_47[0][0]']

batch_normalization_48 (BatchN  (None, 4, 4, 160)   640         ['concatenate_44[0][0]']
ormalization)

activation_48 (Activation)     (None, 4, 4, 160)    0           ['batch_normalization_48[0][0]']

conv2d_49 (Conv2D)             (None, 4, 4, 16)     23040       ['activation_48[0][0]']

dropout_48 (Dropout)           (None, 4, 4, 16)     0           ['conv2d_49[0][0]']

concatenate_45 (Concatenate)   (None, 4, 4, 176)    0           ['concatenate_44[0][0]',
                                                                 'dropout_48[0][0]']

batch_normalization_49 (BatchN  (None, 4, 4, 176)   704         ['concatenate_45[0][0]']
ormalization)

activation_49 (Activation)     (None, 4, 4, 176)    0           ['batch_normalization_49[0][0]']

conv2d_50 (Conv2D)             (None, 4, 4, 16)     25344       ['activation_49[0][0]']

dropout_49 (Dropout)           (None, 4, 4, 16)     0           ['conv2d_50[0][0]']

concatenate_46 (Concatenate)   (None, 4, 4, 192)    0           ['concatenate_45[0][0]',
                                                                 'dropout_49[0][0]']

batch_normalization_50 (BatchN  (None, 4, 4, 192)   768         ['concatenate_46[0][0]']
ormalization)

activation_50 (Activation)     (None, 4, 4, 192)    0           ['batch_normalization_50[0][0]']

conv2d_51 (Conv2D)             (None, 4, 4, 16)     27648       ['activation_50[0][0]']

dropout_50 (Dropout)           (None, 4, 4, 16)     0           ['conv2d_51[0][0]']

concatenate_47 (Concatenate)   (None, 4, 4, 208)    0           ['concatenate_46[0][0]',
                                                                 'dropout_50[0][0]']

batch_normalization_51 (BatchN  (None, 4, 4, 208)   832         ['concatenate_47[0][0]']
ormalization)
```

```
 activation_51 (Activation)     (None, 4, 4, 208)    0           ['batch_normalization_51[0][0]']

 average_pooling2d_3 (AveragePo  (None, 2, 2, 208)   0           ['activation_51[0][0]']
 oling2D)

 flatten (Flatten)              (None, 832)          0           ['average_pooling2d_3[0][0]']

 dense (Dense)                  (None, 10)           8330        ['flatten[0][0]']

==================================================================================================
Total params: 790,058
Trainable params: 777,994
Non-trainable params: 12,064
__________________________________________________________________________________________________
```

In [ ]:

```
print(len(model.layers))
```

```
262
```

In [ ]:

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

In [ ]:

```
history = model.fit(X_train, y_train,
                    batch_size=128,
                    epochs=15,
                    verbose=1,
                    validation_data=(X_test, y_test))
```

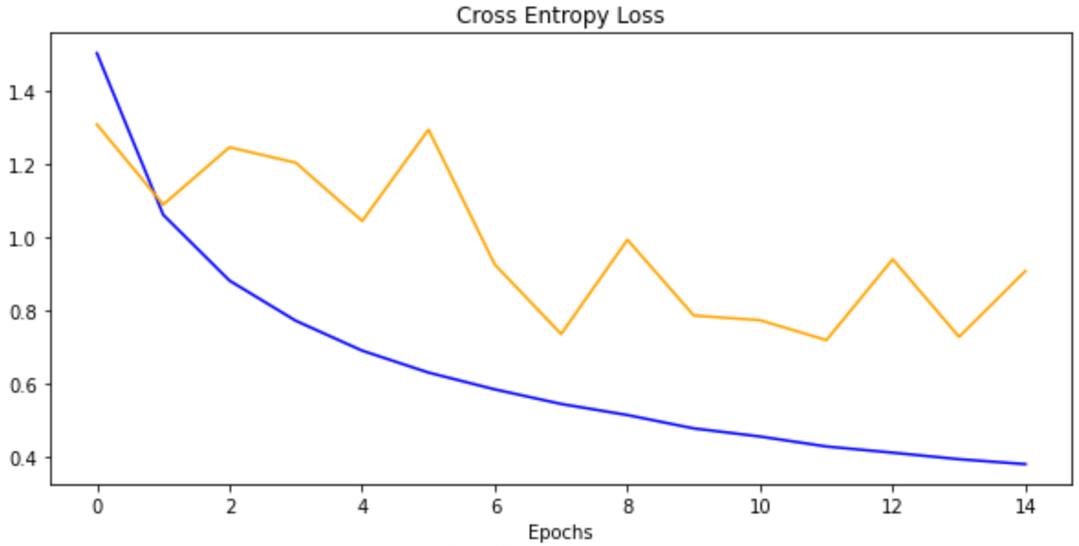
```
Epoch 1/15
391/391 [==============================] - 63s 123ms/step - loss: 1.5028 - accuracy: 0.4407 - val_loss: 1.3083 - val_accuracy: 0.5462
Epoch 2/15
391/391 [==============================] - 46s 118ms/step - loss: 1.0619 - accuracy: 0.6156 - val_loss: 1.0897 - val_accuracy: 0.6273
Epoch 3/15
391/391 [==============================] - 46s 118ms/step - loss: 0.8823 - accuracy: 0.6860 - val_loss: 1.2462 - val_accuracy: 0.6174
Epoch 4/15
391/391 [==============================] - 46s 118ms/step - loss: 0.7728 - accuracy: 0.7267 - val_loss: 1.2038 - val_accuracy: 0.6291
Epoch 5/15
391/391 [==============================] - 46s 118ms/step - loss: 0.6914 - accuracy: 0.7566 - val_loss: 1.0449 - val_accuracy: 0.6720
Epoch 6/15
391/391 [==============================] - 46s 118ms/step - loss: 0.6316 - accuracy: 0.7786 - val_loss: 1.2943 - val_accuracy: 0.6589
Epoch 7/15
391/391 [==============================] - 46s 118ms/step - loss: 0.5857 - accuracy: 0.7967 - val_loss: 0.9262 - val_accuracy: 0.7239
Epoch 8/15
391/391 [==============================] - 46s 118ms/step - loss: 0.5460 - accuracy: 0.8090 - val_loss: 0.7367 - val_accuracy: 0.7643
Epoch 9/15
391/391 [==============================] - 46s 118ms/step - loss: 0.5157 - accuracy: 0.8189 - val_loss: 0.9940 - val_accuracy: 0.7287
Epoch 10/15
```

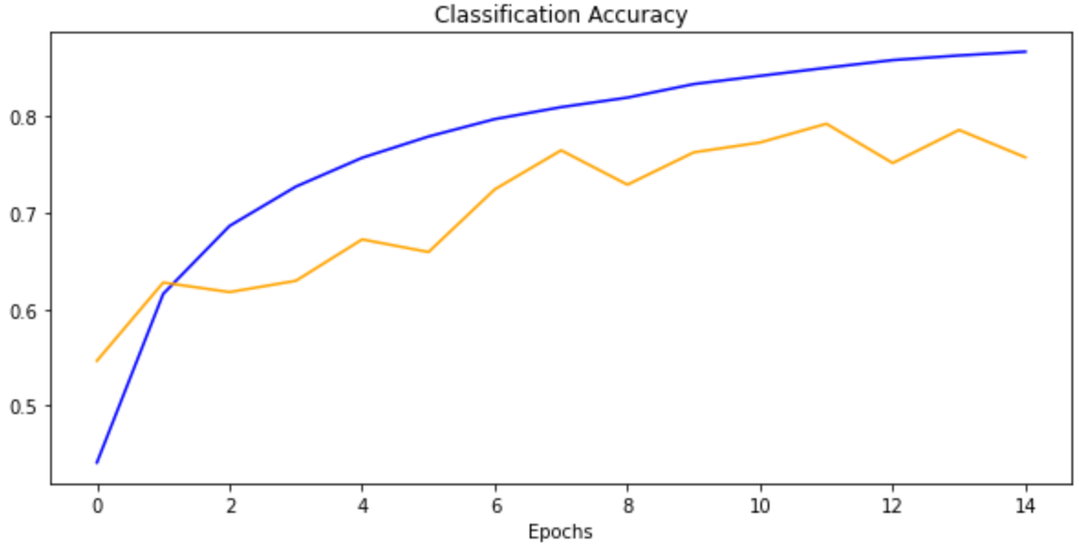
```
391/391 [==============================] - 46s 118ms/step - loss: 0.4793 - accuracy: 0.8329 - val_loss: 0.7871 - val_accuracy: 0.7622
Epoch 11/15
391/391 [==============================] - 46s 118ms/step - loss: 0.4572 - accuracy: 0.8414 - val_loss: 0.7744 - val_accuracy: 0.7724
Epoch 12/15
391/391 [==============================] - 46s 118ms/step - loss: 0.4300 - accuracy: 0.8498 - val_loss: 0.7201 - val_accuracy: 0.7918
Epoch 13/15
391/391 [==============================] - 46s 117ms/step - loss: 0.4131 - accuracy: 0.8578 - val_loss: 0.9406 - val_accuracy: 0.7511
Epoch 14/15
391/391 [==============================] - 46s 117ms/step - loss: 0.3953 - accuracy: 0.8626 - val_loss: 0.7291 - val_accuracy: 0.7854
Epoch 15/15
391/391 [==============================] - 46s 118ms/step - loss: 0.3818 - accuracy: 0.8665 - val_loss: 0.9087 - val_accuracy: 0.7570
```

In [ ]:

```python
# Testing the model
score = model.evaluate(X_test, y_test, verbose=1)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
print("--"*25)


summarize_diagnostics(history)
```

```
313/313 [==============================] - 4s 11ms/step - loss: 0.9087 - accuracy: 0.7570
Test loss: 0.9087499976158142
Test accuracy: 0.7570000290870667
--------------------------------------------------
```





In [ ]:

```
# Save the trained weights in to .h5 format
model.save_weights("DNST_model.h5")
print("Saved model to disk")
```

```
Saved model to disk
```

Model 1: Depthwise Seperable Conv2D + without Dropout + Without Dense Layer + Image

Augmentation + SGD + Weight Regularizer(L1+L2).

In [ ]:
```
tf.keras.backend.clear_session()

if 'model' in locals():
  del(model)
```

In [ ]:
```
# Hyperparameters
batch_size = 128
num_classes = 10
epochs =100
l = 12
num_filter = 36
compression = 0.5
dropout_rate = 0.0
```

In [ ]:
```
# Dense Block
def denseblock(input, num_filter = num_filter, dropout_rate = dropout_rate):
    global compression
    temp = input
    for _ in range(l):
        BatchNorm = layers.BatchNormalization()(temp)
        relu = layers.Activation('relu')(BatchNorm)
        Conv2D_3_3 = layers.SeparableConv2D(int(num_filter*compression), (3,3), use_bias=False ,padding='same',
                                   kernel_initializer='he_normal',kernel_regularizer=regularizers.L1L2(l1=0.000001, l2=0.00001))(relu)
        #Conv2D_3_3 = layers.Conv2D(int(num_filter*compression), (3,3), use_bias=False ,padding='same')(relu)
        if dropout_rate>0:
            Conv2D_3_3 = layers.Dropout(dropout_rate)(Conv2D_3_3)
        concat = layers.Concatenate(axis=-1)([temp,Conv2D_3_3])

        temp = concat

    return temp

## transition Blosck
def transition(input, num_filter = num_filter, dropout_rate = dropout_rate):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    Conv2D_BottleNeck = layers.SeparableConv2D(int(num_filter*compression), (1,1), use_bias=False ,padding='same',
                                               depthwise_initializer='he_normal', depthwise_regularizer=regularizers.L1L2(l1=0.0001, l2=0.0001),
                                               kernel_regularizer=regularizers.L2(l2=0.001))(relu)
    #Conv2D_BottleNeck =  Conv2D(int(num_filter*compression), (1,1), use_bias=False, kernel_regularizer = regularizers.l1() ,padding='same')(relu)
    if dropout_rate>0:
         Conv2D_BottleNeck = layers.Dropout(dropout_rate)(Conv2D_BottleNeck)
```

```
    avg = layers.AveragePooling2D(pool_size=(2,2))(Conv2D_BottleNeck)
    return avg

#output layer
def output_layer(input):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    AvgPooling = layers.AveragePooling2D(pool_size=(2,2))(relu)
    #flat = layers.Flatten()(AvgPooling)
    #output = layers.Dense(num_classes, activation='softmax')(flat)
    out_conv = layers.Conv2D(num_classes, kernel_size = (2,2), activation='softmax')(AvgPooling)
    output = layers.Flatten()(out_conv)


    return output
```

In [ ]:

```
#Model Architecture
input = layers.Input(shape=(img_height, img_width, channel,))
First_Conv2D = layers.Conv2D(num_filter, (3,3), use_bias=False ,padding='same')(input)
#First_Conv2D = layers.SeparableConv2D(int(num_filter), (3,3), use_bias=True ,padding='same',
                                      #kernel_regularizer=regularizers.L1L2(l1=0.0001, l2=0.0001))(input)

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

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

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

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

model = Model(inputs=[input], outputs=[output])
```

In [ ]:

```
# mormalize data
#X_train = X_train.astype('float32') / 255
#X_test = X_test.astype('float32') / 255
```

In [ ]:

```
###Image data Generator class
datagen = tf.keras.preprocessing.image.ImageDataGenerator(featurewise_center=False,
                                                          samplewise_center=False,
                                                          featurewise_std_normalization=False,
                                                          samplewise_std_normalization=False,
```

```
                                                    zca_whitening=False,
                                                    rotation_range=15,
                                                    width_shift_range=0.1,
                                                    height_shift_range=0.1,
                                                    horizontal_flip=True,
                                                    vertical_flip=False , zoom_range=0.2, shear_range=15)
##We are fitting the data to Image data generator.
#ImageGenerator = ImageFlow.flow(X_train,seed=10,batch_size=32)
datagen.fit(X_train, augment=False )
```

In [ ]:

```
#Saving Best Model and Representation of results
filepath = "/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01_depthwise.h5"
checkpoint = ModelCheckpoint(filepath= filepath, save_weights_only=True,
                             monitor='val_accuracy', verbose=1,
                             save_best_only=True, mode='max')

log_dir = "logs/model_7_Rev01_depthwise"
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir = log_dir, histogram_freq=1)
#callback_list = [checkpoint, tensorboard_callback, decay_lr]

#Model Compilation
model.compile(loss='categorical_crossentropy',
              optimizer=tf.keras.optimizers.SGD(0.01, momentum = 0.7),
              metrics=['accuracy'])
```

In [ ]:

```
model.summary()
```

```
Model: "model"
__________________________________________________________________________________________________
 Layer (type)                   Output Shape         Param #     Connected to
==================================================================================================
 input_1 (InputLayer)           [(None, 32, 32, 3)]  0           []

 conv2d (Conv2D)                (None, 32, 32, 36)   972         ['input_1[0][0]']

 batch_normalization (BatchNorm  (None, 32, 32, 36)  144         ['conv2d[0][0]']
 alization)

 activation (Activation)        (None, 32, 32, 36)   0           ['batch_normalization[0][0]']

 separable_conv2d (SeparableCon  (None, 32, 32, 18)  972         ['activation[0][0]']
 v2D)

 concatenate (Concatenate)      (None, 32, 32, 54)   0           ['conv2d[0][0]',
                                                                  'separable_conv2d[0][0]']

 batch_normalization_1 (BatchNo  (None, 32, 32, 54)  216         ['concatenate[0][0]']
 rmalization)
```

```
activation_1 (Activation)      (None, 32, 32, 54)   0           ['batch_normalization_1[0][0]']

separable_conv2d_1 (SeparableC  (None, 32, 32, 18)  1458        ['activation_1[0][0]']
onv2D)

concatenate_1 (Concatenate)    (None, 32, 32, 72)   0           ['concatenate[0][0]',
                                                                 'separable_conv2d_1[0][0]']

batch_normalization_2 (BatchNo  (None, 32, 32, 72)  288         ['concatenate_1[0][0]']
rmalization)

activation_2 (Activation)      (None, 32, 32, 72)   0           ['batch_normalization_2[0][0]']

separable_conv2d_2 (SeparableC  (None, 32, 32, 18)  1944        ['activation_2[0][0]']
onv2D)

concatenate_2 (Concatenate)    (None, 32, 32, 90)   0           ['concatenate_1[0][0]',
                                                                 'separable_conv2d_2[0][0]']

batch_normalization_3 (BatchNo  (None, 32, 32, 90)  360         ['concatenate_2[0][0]']
rmalization)

activation_3 (Activation)      (None, 32, 32, 90)   0           ['batch_normalization_3[0][0]']

separable_conv2d_3 (SeparableC  (None, 32, 32, 18)  2430        ['activation_3[0][0]']
onv2D)

concatenate_3 (Concatenate)    (None, 32, 32, 108)  0           ['concatenate_2[0][0]',
                                                                 'separable_conv2d_3[0][0]']

batch_normalization_4 (BatchNo  (None, 32, 32, 108)  432        ['concatenate_3[0][0]']
rmalization)

activation_4 (Activation)      (None, 32, 32, 108)  0           ['batch_normalization_4[0][0]']

separable_conv2d_4 (SeparableC  (None, 32, 32, 18)  2916        ['activation_4[0][0]']
onv2D)

concatenate_4 (Concatenate)    (None, 32, 32, 126)  0           ['concatenate_3[0][0]',
                                                                 'separable_conv2d_4[0][0]']

batch_normalization_5 (BatchNo  (None, 32, 32, 126)  504        ['concatenate_4[0][0]']
rmalization)

activation_5 (Activation)      (None, 32, 32, 126)  0           ['batch_normalization_5[0][0]']

separable_conv2d_5 (SeparableC  (None, 32, 32, 18)  3402        ['activation_5[0][0]']
onv2D)

concatenate_5 (Concatenate)    (None, 32, 32, 144)  0           ['concatenate_4[0][0]',
                                                                 'separable_conv2d_5[0][0]']

batch_normalization_6 (BatchNo  (None, 32, 32, 144)  576        ['concatenate_5[0][0]']
rmalization)
```

```
activation_6 (Activation)      (None, 32, 32, 144)  0           ['batch_normalization_6[0][0]']

separable_conv2d_6 (SeparableC  (None, 32, 32, 18)  3888        ['activation_6[0][0]']
onv2D)

concatenate_6 (Concatenate)    (None, 32, 32, 162)  0           ['concatenate_5[0][0]',
                                                                 'separable_conv2d_6[0][0]']

batch_normalization_7 (BatchNo  (None, 32, 32, 162)  648        ['concatenate_6[0][0]']
rmalization)

activation_7 (Activation)      (None, 32, 32, 162)  0           ['batch_normalization_7[0][0]']

separable_conv2d_7 (SeparableC  (None, 32, 32, 18)  4374        ['activation_7[0][0]']
onv2D)

concatenate_7 (Concatenate)    (None, 32, 32, 180)  0           ['concatenate_6[0][0]',
                                                                 'separable_conv2d_7[0][0]']

batch_normalization_8 (BatchNo  (None, 32, 32, 180)  720        ['concatenate_7[0][0]']
rmalization)

activation_8 (Activation)      (None, 32, 32, 180)  0           ['batch_normalization_8[0][0]']

separable_conv2d_8 (SeparableC  (None, 32, 32, 18)  4860        ['activation_8[0][0]']
onv2D)

concatenate_8 (Concatenate)    (None, 32, 32, 198)  0           ['concatenate_7[0][0]',
                                                                 'separable_conv2d_8[0][0]']

batch_normalization_9 (BatchNo  (None, 32, 32, 198)  792        ['concatenate_8[0][0]']
rmalization)

activation_9 (Activation)      (None, 32, 32, 198)  0           ['batch_normalization_9[0][0]']

separable_conv2d_9 (SeparableC  (None, 32, 32, 18)  5346        ['activation_9[0][0]']
onv2D)

concatenate_9 (Concatenate)    (None, 32, 32, 216)  0           ['concatenate_8[0][0]',
                                                                 'separable_conv2d_9[0][0]']

batch_normalization_10 (BatchN  (None, 32, 32, 216)  864        ['concatenate_9[0][0]']
ormalization)

activation_10 (Activation)     (None, 32, 32, 216)  0           ['batch_normalization_10[0][0]']

separable_conv2d_10 (Separable  (None, 32, 32, 18)  5832        ['activation_10[0][0]']
Conv2D)

concatenate_10 (Concatenate)   (None, 32, 32, 234)  0           ['concatenate_9[0][0]',
                                                                 'separable_conv2d_10[0][0]']

batch_normalization_11 (BatchN  (None, 32, 32, 234)  936        ['concatenate_10[0][0]']
```

```
ormalization)

activation_11 (Activation)     (None, 32, 32, 234)  0           ['batch_normalization_11[0][0]']

separable_conv2d_11 (Separable  (None, 32, 32, 18)  6318        ['activation_11[0][0]']
Conv2D)

concatenate_11 (Concatenate)   (None, 32, 32, 252)  0           ['concatenate_10[0][0]',
                                                                 'separable_conv2d_11[0][0]']

batch_normalization_12 (BatchN  (None, 32, 32, 252)  1008       ['concatenate_11[0][0]']
ormalization)

activation_12 (Activation)     (None, 32, 32, 252)  0           ['batch_normalization_12[0][0]']

separable_conv2d_12 (Separable  (None, 32, 32, 18)  4788        ['activation_12[0][0]']
Conv2D)

average_pooling2d (AveragePool  (None, 16, 16, 18)  0           ['separable_conv2d_12[0][0]']
ing2D)

batch_normalization_13 (BatchN  (None, 16, 16, 18)  72          ['average_pooling2d[0][0]']
ormalization)

activation_13 (Activation)     (None, 16, 16, 18)   0           ['batch_normalization_13[0][0]']

separable_conv2d_13 (Separable  (None, 16, 16, 18)  486         ['activation_13[0][0]']
Conv2D)

concatenate_12 (Concatenate)   (None, 16, 16, 36)   0           ['average_pooling2d[0][0]',
                                                                 'separable_conv2d_13[0][0]']

batch_normalization_14 (BatchN  (None, 16, 16, 36)  144         ['concatenate_12[0][0]']
ormalization)

activation_14 (Activation)     (None, 16, 16, 36)   0           ['batch_normalization_14[0][0]']

separable_conv2d_14 (Separable  (None, 16, 16, 18)  972         ['activation_14[0][0]']
Conv2D)

concatenate_13 (Concatenate)   (None, 16, 16, 54)   0           ['concatenate_12[0][0]',
                                                                 'separable_conv2d_14[0][0]']

batch_normalization_15 (BatchN  (None, 16, 16, 54)  216         ['concatenate_13[0][0]']
ormalization)

activation_15 (Activation)     (None, 16, 16, 54)   0           ['batch_normalization_15[0][0]']

separable_conv2d_15 (Separable  (None, 16, 16, 18)  1458        ['activation_15[0][0]']
Conv2D)

concatenate_14 (Concatenate)   (None, 16, 16, 72)   0           ['concatenate_13[0][0]',
                                                                 'separable_conv2d_15[0][0]']
```

```
batch_normalization_16 (BatchN  (None, 16, 16, 72)  288         ['concatenate_14[0][0]']
ormalization)

activation_16 (Activation)     (None, 16, 16, 72)   0           ['batch_normalization_16[0][0]']

separable_conv2d_16 (Separable  (None, 16, 16, 18)  1944        ['activation_16[0][0]']
Conv2D)

concatenate_15 (Concatenate)   (None, 16, 16, 90)   0           ['concatenate_14[0][0]',
                                                                 'separable_conv2d_16[0][0]']

batch_normalization_17 (BatchN  (None, 16, 16, 90)  360         ['concatenate_15[0][0]']
ormalization)

activation_17 (Activation)     (None, 16, 16, 90)   0           ['batch_normalization_17[0][0]']

separable_conv2d_17 (Separable  (None, 16, 16, 18)  2430        ['activation_17[0][0]']
Conv2D)

concatenate_16 (Concatenate)   (None, 16, 16, 108)  0          ['concatenate_15[0][0]',
                                                                 'separable_conv2d_17[0][0]']

batch_normalization_18 (BatchN  (None, 16, 16, 108)  432        ['concatenate_16[0][0]']
ormalization)

activation_18 (Activation)     (None, 16, 16, 108)  0          ['batch_normalization_18[0][0]']

separable_conv2d_18 (Separable  (None, 16, 16, 18)  2916        ['activation_18[0][0]']
Conv2D)

concatenate_17 (Concatenate)   (None, 16, 16, 126)  0          ['concatenate_16[0][0]',
                                                                 'separable_conv2d_18[0][0]']

batch_normalization_19 (BatchN  (None, 16, 16, 126)  504        ['concatenate_17[0][0]']
ormalization)

activation_19 (Activation)     (None, 16, 16, 126)  0          ['batch_normalization_19[0][0]']

separable_conv2d_19 (Separable  (None, 16, 16, 18)  3402        ['activation_19[0][0]']
Conv2D)

concatenate_18 (Concatenate)   (None, 16, 16, 144)  0          ['concatenate_17[0][0]',
                                                                 'separable_conv2d_19[0][0]']

batch_normalization_20 (BatchN  (None, 16, 16, 144)  576        ['concatenate_18[0][0]']
ormalization)

activation_20 (Activation)     (None, 16, 16, 144)  0          ['batch_normalization_20[0][0]']

separable_conv2d_20 (Separable  (None, 16, 16, 18)  3888        ['activation_20[0][0]']
Conv2D)

concatenate_19 (Concatenate)   (None, 16, 16, 162)  0          ['concatenate_18[0][0]',
                                                                 'separable_conv2d_20[0][0]']
```

```
batch_normalization_21 (BatchN  (None, 16, 16, 162)  648        ['concatenate_19[0][0]']
ormalization)

activation_21 (Activation)     (None, 16, 16, 162)  0          ['batch_normalization_21[0][0]']

separable_conv2d_21 (Separable  (None, 16, 16, 18)  4374        ['activation_21[0][0]']
Conv2D)

concatenate_20 (Concatenate)   (None, 16, 16, 180)  0          ['concatenate_19[0][0]',
                                                                 'separable_conv2d_21[0][0]']

batch_normalization_22 (BatchN  (None, 16, 16, 180)  720        ['concatenate_20[0][0]']
ormalization)

activation_22 (Activation)     (None, 16, 16, 180)  0          ['batch_normalization_22[0][0]']

separable_conv2d_22 (Separable  (None, 16, 16, 18)  4860        ['activation_22[0][0]']
Conv2D)

concatenate_21 (Concatenate)   (None, 16, 16, 198)  0          ['concatenate_20[0][0]',
                                                                 'separable_conv2d_22[0][0]']

batch_normalization_23 (BatchN  (None, 16, 16, 198)  792        ['concatenate_21[0][0]']
ormalization)

activation_23 (Activation)     (None, 16, 16, 198)  0          ['batch_normalization_23[0][0]']

separable_conv2d_23 (Separable  (None, 16, 16, 18)  5346        ['activation_23[0][0]']
Conv2D)

concatenate_22 (Concatenate)   (None, 16, 16, 216)  0          ['concatenate_21[0][0]',
                                                                 'separable_conv2d_23[0][0]']

batch_normalization_24 (BatchN  (None, 16, 16, 216)  864        ['concatenate_22[0][0]']
ormalization)

activation_24 (Activation)     (None, 16, 16, 216)  0          ['batch_normalization_24[0][0]']

separable_conv2d_24 (Separable  (None, 16, 16, 18)  5832        ['activation_24[0][0]']
Conv2D)

concatenate_23 (Concatenate)   (None, 16, 16, 234)  0          ['concatenate_22[0][0]',
                                                                 'separable_conv2d_24[0][0]']

batch_normalization_25 (BatchN  (None, 16, 16, 234)  936        ['concatenate_23[0][0]']
ormalization)

activation_25 (Activation)     (None, 16, 16, 234)  0          ['batch_normalization_25[0][0]']

separable_conv2d_25 (Separable  (None, 16, 16, 18)  4446        ['activation_25[0][0]']
Conv2D)

average_pooling2d_1 (AveragePo  (None, 8, 8, 18)    0          ['separable_conv2d_25[0][0]']
```

```
oling2D)

batch_normalization_26 (BatchN  (None, 8, 8, 18)    72          ['average_pooling2d_1[0][0]']
ormalization)

activation_26 (Activation)     (None, 8, 8, 18)     0           ['batch_normalization_26[0][0]']

separable_conv2d_26 (Separable  (None, 8, 8, 18)    486         ['activation_26[0][0]']
Conv2D)

concatenate_24 (Concatenate)   (None, 8, 8, 36)     0           ['average_pooling2d_1[0][0]',
                                                                 'separable_conv2d_26[0][0]']

batch_normalization_27 (BatchN  (None, 8, 8, 36)    144         ['concatenate_24[0][0]']
ormalization)

activation_27 (Activation)     (None, 8, 8, 36)     0           ['batch_normalization_27[0][0]']

separable_conv2d_27 (Separable  (None, 8, 8, 18)    972         ['activation_27[0][0]']
Conv2D)

concatenate_25 (Concatenate)   (None, 8, 8, 54)     0           ['concatenate_24[0][0]',
                                                                 'separable_conv2d_27[0][0]']

batch_normalization_28 (BatchN  (None, 8, 8, 54)    216         ['concatenate_25[0][0]']
ormalization)

activation_28 (Activation)     (None, 8, 8, 54)     0           ['batch_normalization_28[0][0]']

separable_conv2d_28 (Separable  (None, 8, 8, 18)    1458        ['activation_28[0][0]']
Conv2D)

concatenate_26 (Concatenate)   (None, 8, 8, 72)     0           ['concatenate_25[0][0]',
                                                                 'separable_conv2d_28[0][0]']

batch_normalization_29 (BatchN  (None, 8, 8, 72)    288         ['concatenate_26[0][0]']
ormalization)

activation_29 (Activation)     (None, 8, 8, 72)     0           ['batch_normalization_29[0][0]']

separable_conv2d_29 (Separable  (None, 8, 8, 18)    1944        ['activation_29[0][0]']
Conv2D)

concatenate_27 (Concatenate)   (None, 8, 8, 90)     0           ['concatenate_26[0][0]',
                                                                 'separable_conv2d_29[0][0]']

batch_normalization_30 (BatchN  (None, 8, 8, 90)    360         ['concatenate_27[0][0]']
ormalization)

activation_30 (Activation)     (None, 8, 8, 90)     0           ['batch_normalization_30[0][0]']

separable_conv2d_30 (Separable  (None, 8, 8, 18)    2430        ['activation_30[0][0]']
Conv2D)
```

```
concatenate_28 (Concatenate)   (None, 8, 8, 108)    0           ['concatenate_27[0][0]',
                                                                 'separable_conv2d_30[0][0]']

batch_normalization_31 (BatchN  (None, 8, 8, 108)   432         ['concatenate_28[0][0]']
ormalization)

activation_31 (Activation)     (None, 8, 8, 108)    0           ['batch_normalization_31[0][0]']

separable_conv2d_31 (Separable  (None, 8, 8, 18)    2916        ['activation_31[0][0]']
Conv2D)

concatenate_29 (Concatenate)   (None, 8, 8, 126)    0           ['concatenate_28[0][0]',
                                                                 'separable_conv2d_31[0][0]']

batch_normalization_32 (BatchN  (None, 8, 8, 126)   504         ['concatenate_29[0][0]']
ormalization)

activation_32 (Activation)     (None, 8, 8, 126)    0           ['batch_normalization_32[0][0]']

separable_conv2d_32 (Separable  (None, 8, 8, 18)    3402        ['activation_32[0][0]']
Conv2D)

concatenate_30 (Concatenate)   (None, 8, 8, 144)    0           ['concatenate_29[0][0]',
                                                                 'separable_conv2d_32[0][0]']

batch_normalization_33 (BatchN  (None, 8, 8, 144)   576         ['concatenate_30[0][0]']
ormalization)

activation_33 (Activation)     (None, 8, 8, 144)    0           ['batch_normalization_33[0][0]']

separable_conv2d_33 (Separable  (None, 8, 8, 18)    3888        ['activation_33[0][0]']
Conv2D)

concatenate_31 (Concatenate)   (None, 8, 8, 162)    0           ['concatenate_30[0][0]',
                                                                 'separable_conv2d_33[0][0]']

batch_normalization_34 (BatchN  (None, 8, 8, 162)   648         ['concatenate_31[0][0]']
ormalization)

activation_34 (Activation)     (None, 8, 8, 162)    0           ['batch_normalization_34[0][0]']

separable_conv2d_34 (Separable  (None, 8, 8, 18)    4374        ['activation_34[0][0]']
Conv2D)

concatenate_32 (Concatenate)   (None, 8, 8, 180)    0           ['concatenate_31[0][0]',
                                                                 'separable_conv2d_34[0][0]']

batch_normalization_35 (BatchN  (None, 8, 8, 180)   720         ['concatenate_32[0][0]']
ormalization)

activation_35 (Activation)     (None, 8, 8, 180)    0           ['batch_normalization_35[0][0]']

separable_conv2d_35 (Separable  (None, 8, 8, 18)    4860        ['activation_35[0][0]']
Conv2D)
```

```
concatenate_33 (Concatenate)   (None, 8, 8, 198)    0           ['concatenate_32[0][0]',
                                                                 'separable_conv2d_35[0][0]']

batch_normalization_36 (BatchN  (None, 8, 8, 198)   792         ['concatenate_33[0][0]']
ormalization)

activation_36 (Activation)     (None, 8, 8, 198)    0           ['batch_normalization_36[0][0]']

separable_conv2d_36 (Separable  (None, 8, 8, 18)    5346        ['activation_36[0][0]']
Conv2D)

concatenate_34 (Concatenate)   (None, 8, 8, 216)    0           ['concatenate_33[0][0]',
                                                                 'separable_conv2d_36[0][0]']

batch_normalization_37 (BatchN  (None, 8, 8, 216)   864         ['concatenate_34[0][0]']
ormalization)

activation_37 (Activation)     (None, 8, 8, 216)    0           ['batch_normalization_37[0][0]']

separable_conv2d_37 (Separable  (None, 8, 8, 18)    5832        ['activation_37[0][0]']
Conv2D)

concatenate_35 (Concatenate)   (None, 8, 8, 234)    0           ['concatenate_34[0][0]',
                                                                 'separable_conv2d_37[0][0]']

batch_normalization_38 (BatchN  (None, 8, 8, 234)   936         ['concatenate_35[0][0]']
ormalization)

activation_38 (Activation)     (None, 8, 8, 234)    0           ['batch_normalization_38[0][0]']

separable_conv2d_38 (Separable  (None, 8, 8, 18)    4446        ['activation_38[0][0]']
Conv2D)

average_pooling2d_2 (AveragePo  (None, 4, 4, 18)    0           ['separable_conv2d_38[0][0]']
oling2D)

batch_normalization_39 (BatchN  (None, 4, 4, 18)    72          ['average_pooling2d_2[0][0]']
ormalization)

activation_39 (Activation)     (None, 4, 4, 18)     0           ['batch_normalization_39[0][0]']

separable_conv2d_39 (Separable  (None, 4, 4, 18)    486         ['activation_39[0][0]']
Conv2D)

concatenate_36 (Concatenate)   (None, 4, 4, 36)     0           ['average_pooling2d_2[0][0]',
                                                                 'separable_conv2d_39[0][0]']

batch_normalization_40 (BatchN  (None, 4, 4, 36)    144         ['concatenate_36[0][0]']
ormalization)

activation_40 (Activation)     (None, 4, 4, 36)     0           ['batch_normalization_40[0][0]']

separable_conv2d_40 (Separable  (None, 4, 4, 18)    972         ['activation_40[0][0]']
```

```
Conv2D)

concatenate_37 (Concatenate)   (None, 4, 4, 54)     0           ['concatenate_36[0][0]',
                                                                 'separable_conv2d_40[0][0]']

batch_normalization_41 (BatchN  (None, 4, 4, 54)    216         ['concatenate_37[0][0]']
ormalization)

activation_41 (Activation)     (None, 4, 4, 54)     0           ['batch_normalization_41[0][0]']

separable_conv2d_41 (Separable  (None, 4, 4, 18)    1458        ['activation_41[0][0]']
Conv2D)

concatenate_38 (Concatenate)   (None, 4, 4, 72)     0           ['concatenate_37[0][0]',
                                                                 'separable_conv2d_41[0][0]']

batch_normalization_42 (BatchN  (None, 4, 4, 72)    288         ['concatenate_38[0][0]']
ormalization)

activation_42 (Activation)     (None, 4, 4, 72)     0           ['batch_normalization_42[0][0]']

separable_conv2d_42 (Separable  (None, 4, 4, 18)    1944        ['activation_42[0][0]']
Conv2D)

concatenate_39 (Concatenate)   (None, 4, 4, 90)     0           ['concatenate_38[0][0]',
                                                                 'separable_conv2d_42[0][0]']

batch_normalization_43 (BatchN  (None, 4, 4, 90)    360         ['concatenate_39[0][0]']
ormalization)

activation_43 (Activation)     (None, 4, 4, 90)     0           ['batch_normalization_43[0][0]']

separable_conv2d_43 (Separable  (None, 4, 4, 18)    2430        ['activation_43[0][0]']
Conv2D)

concatenate_40 (Concatenate)   (None, 4, 4, 108)    0           ['concatenate_39[0][0]',
                                                                 'separable_conv2d_43[0][0]']

batch_normalization_44 (BatchN  (None, 4, 4, 108)   432         ['concatenate_40[0][0]']
ormalization)

activation_44 (Activation)     (None, 4, 4, 108)    0           ['batch_normalization_44[0][0]']

separable_conv2d_44 (Separable  (None, 4, 4, 18)    2916        ['activation_44[0][0]']
Conv2D)

concatenate_41 (Concatenate)   (None, 4, 4, 126)    0           ['concatenate_40[0][0]',
                                                                 'separable_conv2d_44[0][0]']

batch_normalization_45 (BatchN  (None, 4, 4, 126)   504         ['concatenate_41[0][0]']
ormalization)

activation_45 (Activation)     (None, 4, 4, 126)    0           ['batch_normalization_45[0][0]']
```

```
separable_conv2d_45 (Separable  (None, 4, 4, 18)    3402        ['activation_45[0][0]']
Conv2D)

concatenate_42 (Concatenate)   (None, 4, 4, 144)    0           ['concatenate_41[0][0]',
                                                                 'separable_conv2d_45[0][0]']

batch_normalization_46 (BatchN  (None, 4, 4, 144)   576         ['concatenate_42[0][0]']
ormalization)

activation_46 (Activation)     (None, 4, 4, 144)    0           ['batch_normalization_46[0][0]']

separable_conv2d_46 (Separable  (None, 4, 4, 18)    3888        ['activation_46[0][0]']
Conv2D)

concatenate_43 (Concatenate)   (None, 4, 4, 162)    0           ['concatenate_42[0][0]',
                                                                 'separable_conv2d_46[0][0]']

batch_normalization_47 (BatchN  (None, 4, 4, 162)   648         ['concatenate_43[0][0]']
ormalization)

activation_47 (Activation)     (None, 4, 4, 162)    0           ['batch_normalization_47[0][0]']

separable_conv2d_47 (Separable  (None, 4, 4, 18)    4374        ['activation_47[0][0]']
Conv2D)

concatenate_44 (Concatenate)   (None, 4, 4, 180)    0           ['concatenate_43[0][0]',
                                                                 'separable_conv2d_47[0][0]']

batch_normalization_48 (BatchN  (None, 4, 4, 180)   720         ['concatenate_44[0][0]']
ormalization)

activation_48 (Activation)     (None, 4, 4, 180)    0           ['batch_normalization_48[0][0]']

separable_conv2d_48 (Separable  (None, 4, 4, 18)    4860        ['activation_48[0][0]']
Conv2D)

concatenate_45 (Concatenate)   (None, 4, 4, 198)    0           ['concatenate_44[0][0]',
                                                                 'separable_conv2d_48[0][0]']

batch_normalization_49 (BatchN  (None, 4, 4, 198)   792         ['concatenate_45[0][0]']
ormalization)

activation_49 (Activation)     (None, 4, 4, 198)    0           ['batch_normalization_49[0][0]']

separable_conv2d_49 (Separable  (None, 4, 4, 18)    5346        ['activation_49[0][0]']
Conv2D)

concatenate_46 (Concatenate)   (None, 4, 4, 216)    0           ['concatenate_45[0][0]',
                                                                 'separable_conv2d_49[0][0]']

batch_normalization_50 (BatchN  (None, 4, 4, 216)   864         ['concatenate_46[0][0]']
ormalization)

activation_50 (Activation)     (None, 4, 4, 216)    0           ['batch_normalization_50[0][0]']
```

```
separable_conv2d_50 (Separable  (None, 4, 4, 18)    5832        ['activation_50[0][0]']
Conv2D)

concatenate_47 (Concatenate)   (None, 4, 4, 234)    0           ['concatenate_46[0][0]',
                                                                 'separable_conv2d_50[0][0]']

batch_normalization_51 (BatchN  (None, 4, 4, 234)   936         ['concatenate_47[0][0]']
ormalization)

activation_51 (Activation)     (None, 4, 4, 234)    0           ['batch_normalization_51[0][0]']

average_pooling2d_3 (AveragePo  (None, 2, 2, 234)   0           ['activation_51[0][0]']
oling2D)

conv2d_1 (Conv2D)              (None, 1, 1, 10)     9370        ['average_pooling2d_3[0][0]']

flatten (Flatten)              (None, 10)           0           ['conv2d_1[0][0]']

==================================================================================================
Total params: 208,630
Trainable params: 195,058
Non-trainable params: 13,572
__________________________________________________________________________________________________
```

In [ ]:

```python
def lr_schedule(epoch):
    lr = 0.01
    if epoch > 180:
        lr *= 0.00001
    elif epoch > 180:
        lr *= 0.0001
    elif epoch > 120:
        lr *= 0.001
    print('\nLearning rate: ', lr)
    return lr
lr_scheduler = LearningRateScheduler(lr_schedule)
```

In [ ]:

```python
epochs = 30

decay_lr = ReduceLROnPlateau(monitor='val_accuracy', factor=0.95, patience=5,
                                            verbose=1, mode='auto', min_delta=0.001,
                                            cooldown=0, min_lr=0.000001)

callback_list = [checkpoint, lr_scheduler]

history = model.fit_generator(datagen.flow(X_train, y_train, batch_size=batch_size),\
                    steps_per_epoch=X_train.shape[0] // batch_size, epochs=epochs,\
                    verbose=1,validation_data=(X_test,y_test),callbacks=callback_list)

model.save_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_30Epoch_Rev01_depthwise.h5')
```

```
Learning rate:  0.01
Epoch 1/30
390/390 [==============================] - ETA: 0s - loss: 1.6673 - accuracy: 0.3875
Epoch 00001: val_accuracy improved from -inf to 0.12760, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 66s 155ms/step - loss: 1.6673 - accuracy: 0.3875 - val_loss: 2.3530 - val_accuracy: 0.1276 - lr: 0.0100

Learning rate:  0.01
Epoch 2/30
390/390 [==============================] - ETA: 0s - loss: 1.3880 - accuracy: 0.5001
Epoch 00002: val_accuracy improved from 0.12760 to 0.46130, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 152ms/step - loss: 1.3880 - accuracy: 0.5001 - val_loss: 1.5488 - val_accuracy: 0.4613 - lr: 0.0100

Learning rate:  0.01
Epoch 3/30
390/390 [==============================] - ETA: 0s - loss: 1.2415 - accuracy: 0.5559
Epoch 00003: val_accuracy improved from 0.46130 to 0.49820, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 151ms/step - loss: 1.2415 - accuracy: 0.5559 - val_loss: 1.5952 - val_accuracy: 0.4982 - lr: 0.0100

Learning rate:  0.01
Epoch 4/30
390/390 [==============================] - ETA: 0s - loss: 1.1398 - accuracy: 0.5923
Epoch 00004: val_accuracy improved from 0.49820 to 0.53900, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 152ms/step - loss: 1.1398 - accuracy: 0.5923 - val_loss: 1.3950 - val_accuracy: 0.5390 - lr: 0.0100

Learning rate:  0.01
Epoch 5/30
390/390 [==============================] - ETA: 0s - loss: 1.0685 - accuracy: 0.6192
Epoch 00005: val_accuracy improved from 0.53900 to 0.59340, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 151ms/step - loss: 1.0685 - accuracy: 0.6192 - val_loss: 1.1667 - val_accuracy: 0.5934 - lr: 0.0100

Learning rate:  0.01
Epoch 6/30
390/390 [==============================] - ETA: 0s - loss: 1.0012 - accuracy: 0.6434
Epoch 00006: val_accuracy improved from 0.59340 to 0.63320, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 151ms/step - loss: 1.0012 - accuracy: 0.6434 - val_loss: 1.0445 - val_accuracy: 0.6332 - lr: 0.0100

Learning rate:  0.01
Epoch 7/30
390/390 [==============================] - ETA: 0s - loss: 0.9542 - accuracy: 0.6631
Epoch 00007: val_accuracy did not improve from 0.63320
390/390 [==============================] - 58s 150ms/step - loss: 0.9542 - accuracy: 0.6631 - val_loss: 1.1392 - val_accuracy: 0.6128 - lr: 0.0100

Learning rate:  0.01
Epoch 8/30
390/390 [==============================] - ETA: 0s - loss: 0.9127 - accuracy: 0.6787
Epoch 00008: val_accuracy improved from 0.63320 to 0.67580, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 151ms/step - loss: 0.9127 - accuracy: 0.6787 - val_loss: 0.9296 - val_accuracy: 0.6758 - lr: 0.0100

Learning rate:  0.01
Epoch 9/30
390/390 [==============================] - ETA: 0s - loss: 0.8754 - accuracy: 0.6938
Epoch 00009: val_accuracy did not improve from 0.67580
390/390 [==============================] - 59s 150ms/step - loss: 0.8754 - accuracy: 0.6938 - val_loss: 1.2504 - val_accuracy: 0.6082 - lr: 0.0100
```

```
Learning rate:  0.01
Epoch 10/30
390/390 [==============================] - ETA: 0s - loss: 0.8376 - accuracy: 0.7044
Epoch 00010: val_accuracy did not improve from 0.67580
390/390 [==============================] - 58s 150ms/step - loss: 0.8376 - accuracy: 0.7044 - val_loss: 1.1419 - val_accuracy: 0.6225 - lr: 0.0100

Learning rate:  0.01
Epoch 11/30
390/390 [==============================] - ETA: 0s - loss: 0.8156 - accuracy: 0.7124
Epoch 00011: val_accuracy did not improve from 0.67580
390/390 [==============================] - 58s 150ms/step - loss: 0.8156 - accuracy: 0.7124 - val_loss: 1.0569 - val_accuracy: 0.6417 - lr: 0.0100

Learning rate:  0.01
Epoch 12/30
390/390 [==============================] - ETA: 0s - loss: 0.7899 - accuracy: 0.7233
Epoch 00012: val_accuracy improved from 0.67580 to 0.71180, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 151ms/step - loss: 0.7899 - accuracy: 0.7233 - val_loss: 0.8401 - val_accuracy: 0.7118 - lr: 0.0100

Learning rate:  0.01
Epoch 13/30
390/390 [==============================] - ETA: 0s - loss: 0.7743 - accuracy: 0.7289
Epoch 00013: val_accuracy did not improve from 0.71180
390/390 [==============================] - 58s 149ms/step - loss: 0.7743 - accuracy: 0.7289 - val_loss: 0.9355 - val_accuracy: 0.6992 - lr: 0.0100

Learning rate:  0.01
Epoch 14/30
390/390 [==============================] - ETA: 0s - loss: 0.7542 - accuracy: 0.7372
Epoch 00014: val_accuracy did not improve from 0.71180
390/390 [==============================] - 58s 150ms/step - loss: 0.7542 - accuracy: 0.7372 - val_loss: 1.1367 - val_accuracy: 0.6460 - lr: 0.0100

Learning rate:  0.01
Epoch 15/30
390/390 [==============================] - ETA: 0s - loss: 0.7266 - accuracy: 0.7467
Epoch 00015: val_accuracy did not improve from 0.71180
390/390 [==============================] - 58s 149ms/step - loss: 0.7266 - accuracy: 0.7467 - val_loss: 0.8953 - val_accuracy: 0.6999 - lr: 0.0100

Learning rate:  0.01
Epoch 16/30
390/390 [==============================] - ETA: 0s - loss: 0.7118 - accuracy: 0.7512
Epoch 00016: val_accuracy improved from 0.71180 to 0.71250, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 151ms/step - loss: 0.7118 - accuracy: 0.7512 - val_loss: 0.8671 - val_accuracy: 0.7125 - lr: 0.0100

Learning rate:  0.01
Epoch 17/30
390/390 [==============================] - ETA: 0s - loss: 0.6953 - accuracy: 0.7593
Epoch 00017: val_accuracy improved from 0.71250 to 0.72360, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 151ms/step - loss: 0.6953 - accuracy: 0.7593 - val_loss: 0.8412 - val_accuracy: 0.7236 - lr: 0.0100

Learning rate:  0.01
Epoch 18/30
390/390 [==============================] - ETA: 0s - loss: 0.6794 - accuracy: 0.7638
Epoch 00018: val_accuracy improved from 0.72360 to 0.77050, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 151ms/step - loss: 0.6794 - accuracy: 0.7638 - val_loss: 0.6945 - val_accuracy: 0.7705 - lr: 0.0100
```

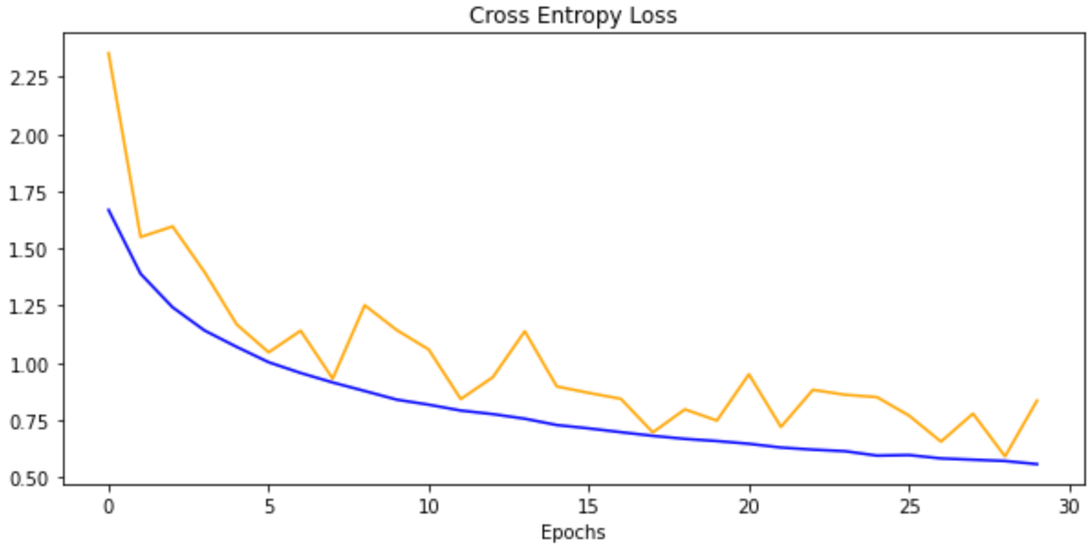
```
Learning rate:  0.01
Epoch 19/30
390/390 [==============================] - ETA: 0s - loss: 0.6660 - accuracy: 0.7700
Epoch 00019: val_accuracy did not improve from 0.77050
390/390 [==============================] - 59s 150ms/step - loss: 0.6660 - accuracy: 0.7700 - val_loss: 0.7951 - val_accuracy: 0.7422 - lr: 0.0100

Learning rate:  0.01
Epoch 20/30
390/390 [==============================] - ETA: 0s - loss: 0.6565 - accuracy: 0.7739
Epoch 00020: val_accuracy did not improve from 0.77050
390/390 [==============================] - 59s 150ms/step - loss: 0.6565 - accuracy: 0.7739 - val_loss: 0.7460 - val_accuracy: 0.7463 - lr: 0.0100

Learning rate:  0.01
Epoch 21/30
390/390 [==============================] - ETA: 0s - loss: 0.6446 - accuracy: 0.7765
Epoch 00021: val_accuracy did not improve from 0.77050
390/390 [==============================] - 58s 149ms/step - loss: 0.6446 - accuracy: 0.7765 - val_loss: 0.9485 - val_accuracy: 0.7015 - lr: 0.0100

Learning rate:  0.01
Epoch 22/30
390/390 [==============================] - ETA: 0s - loss: 0.6281 - accuracy: 0.7829
Epoch 00022: val_accuracy did not improve from 0.77050
390/390 [==============================] - 58s 149ms/step - loss: 0.6281 - accuracy: 0.7829 - val_loss: 0.7182 - val_accuracy: 0.7654 - lr: 0.0100

Learning rate:  0.01
Epoch 23/30
390/390 [==============================] - ETA: 0s - loss: 0.6190 - accuracy: 0.7859
Epoch 00023: val_accuracy did not improve from 0.77050
390/390 [==============================] - 58s 149ms/step - loss: 0.6190 - accuracy: 0.7859 - val_loss: 0.8807 - val_accuracy: 0.7232 - lr: 0.0100

Learning rate:  0.01
Epoch 24/30
390/390 [==============================] - ETA: 0s - loss: 0.6121 - accuracy: 0.7881
Epoch 00024: val_accuracy did not improve from 0.77050
390/390 [==============================] - 58s 149ms/step - loss: 0.6121 - accuracy: 0.7881 - val_loss: 0.8589 - val_accuracy: 0.7256 - lr: 0.0100

Learning rate:  0.01
Epoch 25/30
390/390 [==============================] - ETA: 0s - loss: 0.5928 - accuracy: 0.7960
Epoch 00025: val_accuracy did not improve from 0.77050
390/390 [==============================] - 58s 149ms/step - loss: 0.5928 - accuracy: 0.7960 - val_loss: 0.8485 - val_accuracy: 0.7223 - lr: 0.0100

Learning rate:  0.01
Epoch 26/30
390/390 [==============================] - ETA: 0s - loss: 0.5952 - accuracy: 0.7952
Epoch 00026: val_accuracy did not improve from 0.77050
390/390 [==============================] - 59s 151ms/step - loss: 0.5952 - accuracy: 0.7952 - val_loss: 0.7680 - val_accuracy: 0.7538 - lr: 0.0100

Learning rate:  0.01
Epoch 27/30
390/390 [==============================] - ETA: 0s - loss: 0.5806 - accuracy: 0.7991
Epoch 00027: val_accuracy improved from 0.77050 to 0.78570, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.5806 - accuracy: 0.7991 - val_loss: 0.6540 - val_accuracy: 0.7857 - lr: 0.0100
```

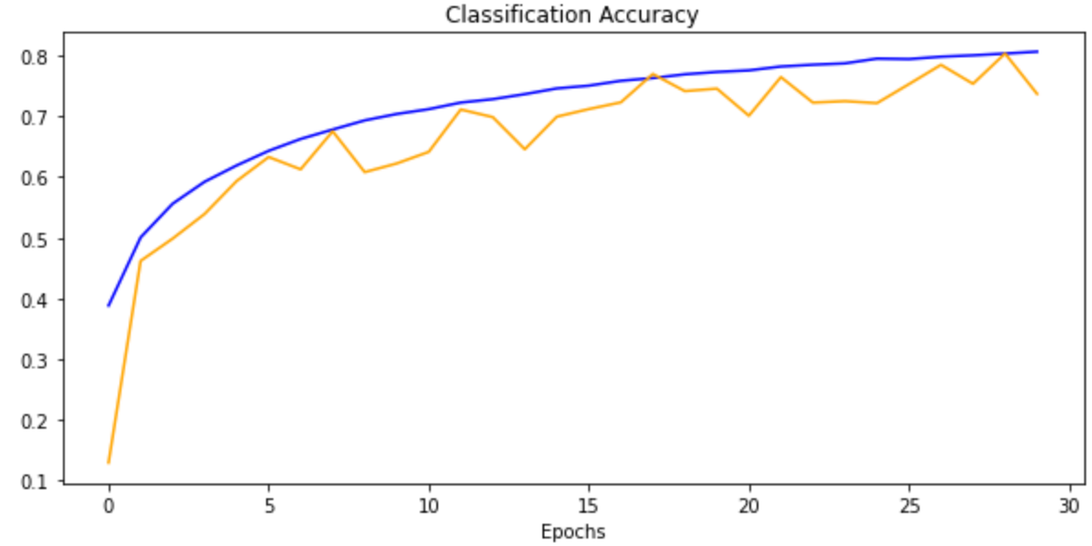
```
Learning rate:  0.01
Epoch 28/30
390/390 [==============================] - ETA: 0s - loss: 0.5749 - accuracy: 0.8014
Epoch 00028: val_accuracy did not improve from 0.78570
390/390 [==============================] - 59s 150ms/step - loss: 0.5749 - accuracy: 0.8014 - val_loss: 0.7764 - val_accuracy: 0.7543 - lr: 0.0100

Learning rate:  0.01
Epoch 29/30
390/390 [==============================] - ETA: 0s - loss: 0.5693 - accuracy: 0.8043
Epoch 00029: val_accuracy improved from 0.78570 to 0.80440, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.5693 - accuracy: 0.8043 - val_loss: 0.5894 - val_accuracy: 0.8044 - lr: 0.0100

Learning rate:  0.01
Epoch 30/30
390/390 [==============================] - ETA: 0s - loss: 0.5555 - accuracy: 0.8074
Epoch 00030: val_accuracy did not improve from 0.80440
390/390 [==============================] - 59s 150ms/step - loss: 0.5555 - accuracy: 0.8074 - val_loss: 0.8337 - val_accuracy: 0.7377 - lr: 0.0100
```

In [ ]:

```python
# Testing the model- Best Model
model.load_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5')
score = model.evaluate(X_test, y_test, verbose=1)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
print("--"*25)


summarize_diagnostics(history)
```

```
313/313 [==============================] - 4s 12ms/step - loss: 0.5894 - accuracy: 0.8044
Test loss: 0.5894258618354797
Test accuracy: 0.8044000267982483
--------------------------------------------------
```





▶ **Loading Model from 100th Epoch for further Training:**

In [ ]:

```
import tensorflow.keras.backend as k
k.set_value(model.optimizer.lr, 0.01)

callback_list = [checkpoint]
model.load_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_30Epoch_Rev01_depthwise.h5')
epochs = 60
history = model.fit_generator(datagen.flow(X_train, y_train, batch_size=batch_size),\
                    steps_per_epoch=X_train.shape[0] // batch_size,epochs=epochs,\
                    verbose=1,validation_data=(X_test,y_test),callbacks=callback_list)
```

```
model.save_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_90Epoch_Rev01_depthwise.h5')
```

```
Epoch 1/60
390/390 [==============================] - ETA: 0s - loss: 0.5568 - accuracy: 0.8081
Epoch 00001: val_accuracy did not improve from 0.80440
390/390 [==============================] - 59s 151ms/step - loss: 0.5568 - accuracy: 0.8081 - val_loss: 0.6223 - val_accuracy: 0.7954
Epoch 2/60
390/390 [==============================] - ETA: 0s - loss: 0.5425 - accuracy: 0.8139
Epoch 00002: val_accuracy did not improve from 0.80440
390/390 [==============================] - 59s 150ms/step - loss: 0.5425 - accuracy: 0.8139 - val_loss: 0.6359 - val_accuracy: 0.7921
Epoch 3/60
390/390 [==============================] - ETA: 0s - loss: 0.5372 - accuracy: 0.8150
Epoch 00003: val_accuracy did not improve from 0.80440
390/390 [==============================] - 58s 150ms/step - loss: 0.5372 - accuracy: 0.8150 - val_loss: 0.6458 - val_accuracy: 0.7857
Epoch 4/60
390/390 [==============================] - ETA: 0s - loss: 0.5257 - accuracy: 0.8170
Epoch 00004: val_accuracy did not improve from 0.80440
390/390 [==============================] - 58s 149ms/step - loss: 0.5257 - accuracy: 0.8170 - val_loss: 0.6106 - val_accuracy: 0.8014
Epoch 5/60
390/390 [==============================] - ETA: 0s - loss: 0.5275 - accuracy: 0.8183
Epoch 00005: val_accuracy did not improve from 0.80440
390/390 [==============================] - 59s 150ms/step - loss: 0.5275 - accuracy: 0.8183 - val_loss: 0.8104 - val_accuracy: 0.7517
Epoch 6/60
390/390 [==============================] - ETA: 0s - loss: 0.5188 - accuracy: 0.8225
Epoch 00006: val_accuracy did not improve from 0.80440
390/390 [==============================] - 59s 151ms/step - loss: 0.5188 - accuracy: 0.8225 - val_loss: 0.6442 - val_accuracy: 0.7918
Epoch 7/60
390/390 [==============================] - ETA: 0s - loss: 0.5165 - accuracy: 0.8242
Epoch 00007: val_accuracy improved from 0.80440 to 0.81350, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.5165 - accuracy: 0.8242 - val_loss: 0.5637 - val_accuracy: 0.8135
Epoch 8/60
390/390 [==============================] - ETA: 0s - loss: 0.5072 - accuracy: 0.8263
Epoch 00008: val_accuracy did not improve from 0.81350
390/390 [==============================] - 59s 150ms/step - loss: 0.5072 - accuracy: 0.8263 - val_loss: 0.6781 - val_accuracy: 0.7847
Epoch 9/60
390/390 [==============================] - ETA: 0s - loss: 0.5026 - accuracy: 0.8275
Epoch 00009: val_accuracy did not improve from 0.81350
390/390 [==============================] - 59s 150ms/step - loss: 0.5026 - accuracy: 0.8275 - val_loss: 0.6033 - val_accuracy: 0.8033
Epoch 10/60
390/390 [==============================] - ETA: 0s - loss: 0.4983 - accuracy: 0.8289
Epoch 00010: val_accuracy did not improve from 0.81350
390/390 [==============================] - 58s 150ms/step - loss: 0.4983 - accuracy: 0.8289 - val_loss: 0.6608 - val_accuracy: 0.7877
Epoch 11/60
390/390 [==============================] - ETA: 0s - loss: 0.4922 - accuracy: 0.8299
Epoch 00011: val_accuracy did not improve from 0.81350
390/390 [==============================] - 58s 150ms/step - loss: 0.4922 - accuracy: 0.8299 - val_loss: 0.6390 - val_accuracy: 0.7935
Epoch 12/60
390/390 [==============================] - ETA: 0s - loss: 0.4892 - accuracy: 0.8327
Epoch 00012: val_accuracy did not improve from 0.81350
390/390 [==============================] - 58s 149ms/step - loss: 0.4892 - accuracy: 0.8327 - val_loss: 0.7020 - val_accuracy: 0.7791
Epoch 13/60
390/390 [==============================] - ETA: 0s - loss: 0.4824 - accuracy: 0.8354
```

```
Epoch 00013: val_accuracy did not improve from 0.81350
390/390 [==============================] - 58s 149ms/step - loss: 0.4824 - accuracy: 0.8354 - val_loss: 0.5863 - val_accuracy: 0.8075
Epoch 14/60
390/390 [==============================] - ETA: 0s - loss: 0.4743 - accuracy: 0.8384
Epoch 00014: val_accuracy improved from 0.81350 to 0.81600, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.4743 - accuracy: 0.8384 - val_loss: 0.5677 - val_accuracy: 0.8160
Epoch 15/60
390/390 [==============================] - ETA: 0s - loss: 0.4753 - accuracy: 0.8364
Epoch 00015: val_accuracy did not improve from 0.81600
390/390 [==============================] - 58s 149ms/step - loss: 0.4753 - accuracy: 0.8364 - val_loss: 0.6107 - val_accuracy: 0.8028
Epoch 16/60
390/390 [==============================] - ETA: 0s - loss: 0.4636 - accuracy: 0.8409
Epoch 00016: val_accuracy improved from 0.81600 to 0.81860, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.4636 - accuracy: 0.8409 - val_loss: 0.5522 - val_accuracy: 0.8186
Epoch 17/60
390/390 [==============================] - ETA: 0s - loss: 0.4639 - accuracy: 0.8399
Epoch 00017: val_accuracy did not improve from 0.81860
390/390 [==============================] - 58s 150ms/step - loss: 0.4639 - accuracy: 0.8399 - val_loss: 0.6256 - val_accuracy: 0.7995
Epoch 18/60
390/390 [==============================] - ETA: 0s - loss: 0.4583 - accuracy: 0.8427
Epoch 00018: val_accuracy did not improve from 0.81860
390/390 [==============================] - 58s 149ms/step - loss: 0.4583 - accuracy: 0.8427 - val_loss: 0.5932 - val_accuracy: 0.8100
Epoch 19/60
390/390 [==============================] - ETA: 0s - loss: 0.4572 - accuracy: 0.8450
Epoch 00019: val_accuracy did not improve from 0.81860
390/390 [==============================] - 58s 149ms/step - loss: 0.4572 - accuracy: 0.8450 - val_loss: 0.6992 - val_accuracy: 0.7861
Epoch 20/60
390/390 [==============================] - ETA: 0s - loss: 0.4550 - accuracy: 0.8437
Epoch 00020: val_accuracy did not improve from 0.81860
390/390 [==============================] - 58s 149ms/step - loss: 0.4550 - accuracy: 0.8437 - val_loss: 0.6505 - val_accuracy: 0.7935
Epoch 21/60
390/390 [==============================] - ETA: 0s - loss: 0.4474 - accuracy: 0.8450
Epoch 00021: val_accuracy improved from 0.81860 to 0.84400, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 151ms/step - loss: 0.4474 - accuracy: 0.8450 - val_loss: 0.4762 - val_accuracy: 0.8440
Epoch 22/60
390/390 [==============================] - ETA: 0s - loss: 0.4426 - accuracy: 0.8476
Epoch 00022: val_accuracy did not improve from 0.84400
390/390 [==============================] - 58s 150ms/step - loss: 0.4426 - accuracy: 0.8476 - val_loss: 0.5812 - val_accuracy: 0.8140
Epoch 23/60
390/390 [==============================] - ETA: 0s - loss: 0.4350 - accuracy: 0.8499
Epoch 00023: val_accuracy did not improve from 0.84400
390/390 [==============================] - 58s 149ms/step - loss: 0.4350 - accuracy: 0.8499 - val_loss: 0.5185 - val_accuracy: 0.8280
Epoch 24/60
390/390 [==============================] - ETA: 0s - loss: 0.4342 - accuracy: 0.8503
Epoch 00024: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 150ms/step - loss: 0.4342 - accuracy: 0.8503 - val_loss: 0.5355 - val_accuracy: 0.8227
Epoch 25/60
390/390 [==============================] - ETA: 0s - loss: 0.4333 - accuracy: 0.8499
Epoch 00025: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 150ms/step - loss: 0.4333 - accuracy: 0.8499 - val_loss: 0.9520 - val_accuracy: 0.7374
Epoch 26/60
390/390 [==============================] - ETA: 0s - loss: 0.4227 - accuracy: 0.8544
Epoch 00026: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 150ms/step - loss: 0.4227 - accuracy: 0.8544 - val_loss: 0.5033 - val_accuracy: 0.8425
```

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Epoch 27/60
390/390 [==============================] - ETA: 0s - loss: 0.4248 - accuracy: 0.8557
Epoch 00027: val_accuracy did not improve from 0.84400
390/390 [==============================] - 58s 150ms/step - loss: 0.4248 - accuracy: 0.8557 - val_loss: 0.6383 - val_accuracy: 0.7968
Epoch 28/60
390/390 [==============================] - ETA: 0s - loss: 0.4230 - accuracy: 0.8555
Epoch 00028: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 150ms/step - loss: 0.4230 - accuracy: 0.8555 - val_loss: 0.5170 - val_accuracy: 0.8315
Epoch 29/60
390/390 [==============================] - ETA: 0s - loss: 0.4236 - accuracy: 0.8566
Epoch 00029: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 151ms/step - loss: 0.4236 - accuracy: 0.8566 - val_loss: 0.6148 - val_accuracy: 0.8075
Epoch 30/60
390/390 [==============================] - ETA: 0s - loss: 0.4151 - accuracy: 0.8593
Epoch 00030: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 150ms/step - loss: 0.4151 - accuracy: 0.8593 - val_loss: 0.7307 - val_accuracy: 0.7778
Epoch 31/60
390/390 [==============================] - ETA: 0s - loss: 0.4155 - accuracy: 0.8585
Epoch 00031: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 151ms/step - loss: 0.4155 - accuracy: 0.8585 - val_loss: 0.6505 - val_accuracy: 0.7997
Epoch 32/60
390/390 [==============================] - ETA: 0s - loss: 0.4131 - accuracy: 0.8595
Epoch 00032: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 150ms/step - loss: 0.4131 - accuracy: 0.8595 - val_loss: 0.5093 - val_accuracy: 0.8368
Epoch 33/60
390/390 [==============================] - ETA: 0s - loss: 0.4094 - accuracy: 0.8595
Epoch 00033: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 150ms/step - loss: 0.4094 - accuracy: 0.8595 - val_loss: 0.5817 - val_accuracy: 0.8165
Epoch 34/60
390/390 [==============================] - ETA: 0s - loss: 0.3996 - accuracy: 0.8644
Epoch 00034: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 150ms/step - loss: 0.3996 - accuracy: 0.8644 - val_loss: 0.5753 - val_accuracy: 0.8239
Epoch 35/60
390/390 [==============================] - ETA: 0s - loss: 0.4028 - accuracy: 0.8611
Epoch 00035: val_accuracy did not improve from 0.84400
390/390 [==============================] - 58s 149ms/step - loss: 0.4028 - accuracy: 0.8611 - val_loss: 0.5219 - val_accuracy: 0.8345
Epoch 36/60
390/390 [==============================] - ETA: 0s - loss: 0.4010 - accuracy: 0.8614
Epoch 00036: val_accuracy did not improve from 0.84400
390/390 [==============================] - 58s 149ms/step - loss: 0.4010 - accuracy: 0.8614 - val_loss: 0.5489 - val_accuracy: 0.8245
Epoch 37/60
390/390 [==============================] - ETA: 0s - loss: 0.3949 - accuracy: 0.8630
Epoch 00037: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 150ms/step - loss: 0.3949 - accuracy: 0.8630 - val_loss: 0.6574 - val_accuracy: 0.7968
Epoch 38/60
390/390 [==============================] - ETA: 0s - loss: 0.3930 - accuracy: 0.8645
Epoch 00038: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 150ms/step - loss: 0.3930 - accuracy: 0.8645 - val_loss: 0.6616 - val_accuracy: 0.8027
Epoch 39/60
390/390 [==============================] - ETA: 0s - loss: 0.3953 - accuracy: 0.8649
Epoch 00039: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 151ms/step - loss: 0.3953 - accuracy: 0.8649 - val_loss: 0.5605 - val_accuracy: 0.8268
Epoch 40/60
390/390 [==============================] - ETA: 0s - loss: 0.3893 - accuracy: 0.8671
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Epoch 00040: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 151ms/step - loss: 0.3893 - accuracy: 0.8671 - val_loss: 0.6029 - val_accuracy: 0.8138
Epoch 41/60
390/390 [==============================] - ETA: 0s - loss: 0.3843 - accuracy: 0.8669
Epoch 00041: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 150ms/step - loss: 0.3843 - accuracy: 0.8669 - val_loss: 0.5074 - val_accuracy: 0.8401
Epoch 42/60
390/390 [==============================] - ETA: 0s - loss: 0.3828 - accuracy: 0.8706
Epoch 00042: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 150ms/step - loss: 0.3828 - accuracy: 0.8706 - val_loss: 0.5885 - val_accuracy: 0.8113
Epoch 43/60
390/390 [==============================] - ETA: 0s - loss: 0.3796 - accuracy: 0.8709
Epoch 00043: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 150ms/step - loss: 0.3796 - accuracy: 0.8709 - val_loss: 0.6383 - val_accuracy: 0.8102
Epoch 44/60
390/390 [==============================] - ETA: 0s - loss: 0.3794 - accuracy: 0.8702
Epoch 00044: val_accuracy did not improve from 0.84400
390/390 [==============================] - 58s 149ms/step - loss: 0.3794 - accuracy: 0.8702 - val_loss: 0.6054 - val_accuracy: 0.8165
Epoch 45/60
390/390 [==============================] - ETA: 0s - loss: 0.3759 - accuracy: 0.8720
Epoch 00045: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 150ms/step - loss: 0.3759 - accuracy: 0.8720 - val_loss: 0.6385 - val_accuracy: 0.8083
Epoch 46/60
390/390 [==============================] - ETA: 0s - loss: 0.3746 - accuracy: 0.8733
Epoch 00046: val_accuracy did not improve from 0.84400
390/390 [==============================] - 59s 150ms/step - loss: 0.3746 - accuracy: 0.8733 - val_loss: 0.6052 - val_accuracy: 0.8187
Epoch 47/60
390/390 [==============================] - ETA: 0s - loss: 0.3712 - accuracy: 0.8744
Epoch 00047: val_accuracy improved from 0.84400 to 0.85730, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.3712 - accuracy: 0.8744 - val_loss: 0.4450 - val_accuracy: 0.8573
Epoch 48/60
390/390 [==============================] - ETA: 0s - loss: 0.3692 - accuracy: 0.8733
Epoch 00048: val_accuracy did not improve from 0.85730
390/390 [==============================] - 59s 150ms/step - loss: 0.3692 - accuracy: 0.8733 - val_loss: 0.5246 - val_accuracy: 0.8365
Epoch 49/60
390/390 [==============================] - ETA: 0s - loss: 0.3689 - accuracy: 0.8732
Epoch 00049: val_accuracy did not improve from 0.85730
390/390 [==============================] - 59s 150ms/step - loss: 0.3689 - accuracy: 0.8732 - val_loss: 0.5151 - val_accuracy: 0.8391
Epoch 50/60
390/390 [==============================] - ETA: 0s - loss: 0.3635 - accuracy: 0.8752
Epoch 00050: val_accuracy did not improve from 0.85730
390/390 [==============================] - 59s 150ms/step - loss: 0.3635 - accuracy: 0.8752 - val_loss: 0.5628 - val_accuracy: 0.8254
Epoch 51/60
390/390 [==============================] - ETA: 0s - loss: 0.3643 - accuracy: 0.8762
Epoch 00051: val_accuracy did not improve from 0.85730
390/390 [==============================] - 59s 151ms/step - loss: 0.3643 - accuracy: 0.8762 - val_loss: 0.5115 - val_accuracy: 0.8415
Epoch 52/60
390/390 [==============================] - ETA: 0s - loss: 0.3618 - accuracy: 0.8766
Epoch 00052: val_accuracy did not improve from 0.85730
390/390 [==============================] - 59s 150ms/step - loss: 0.3618 - accuracy: 0.8766 - val_loss: 0.6983 - val_accuracy: 0.8010
Epoch 53/60
390/390 [==============================] - ETA: 0s - loss: 0.3612 - accuracy: 0.8772
Epoch 00053: val_accuracy did not improve from 0.85730
390/390 [==============================] - 58s 150ms/step - loss: 0.3612 - accuracy: 0.8772 - val_loss: 0.4470 - val_accuracy: 0.8563
```

```
Epoch 54/60
390/390 [==============================] - ETA: 0s - loss: 0.3560 - accuracy: 0.8783
Epoch 00054: val_accuracy improved from 0.85730 to 0.86240, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 60s 153ms/step - loss: 0.3560 - accuracy: 0.8783 - val_loss: 0.4339 - val_accuracy: 0.8624
Epoch 55/60
390/390 [==============================] - ETA: 0s - loss: 0.3573 - accuracy: 0.8780
Epoch 00055: val_accuracy improved from 0.86240 to 0.86320, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.3573 - accuracy: 0.8780 - val_loss: 0.4298 - val_accuracy: 0.8632
Epoch 56/60
390/390 [==============================] - ETA: 0s - loss: 0.3529 - accuracy: 0.8794
Epoch 00056: val_accuracy did not improve from 0.86320
390/390 [==============================] - 58s 150ms/step - loss: 0.3529 - accuracy: 0.8794 - val_loss: 0.6363 - val_accuracy: 0.8093
Epoch 57/60
390/390 [==============================] - ETA: 0s - loss: 0.3536 - accuracy: 0.8781
Epoch 00057: val_accuracy did not improve from 0.86320
390/390 [==============================] - 59s 150ms/step - loss: 0.3536 - accuracy: 0.8781 - val_loss: 0.4800 - val_accuracy: 0.8471
Epoch 58/60
390/390 [==============================] - ETA: 0s - loss: 0.3454 - accuracy: 0.8827
Epoch 00058: val_accuracy did not improve from 0.86320
390/390 [==============================] - 59s 150ms/step - loss: 0.3454 - accuracy: 0.8827 - val_loss: 0.6286 - val_accuracy: 0.8142
Epoch 59/60
390/390 [==============================] - ETA: 0s - loss: 0.3470 - accuracy: 0.8814
Epoch 00059: val_accuracy did not improve from 0.86320
390/390 [==============================] - 59s 150ms/step - loss: 0.3470 - accuracy: 0.8814 - val_loss: 0.4674 - val_accuracy: 0.8505
Epoch 60/60
390/390 [==============================] - ETA: 0s - loss: 0.3462 - accuracy: 0.8807
Epoch 00060: val_accuracy did not improve from 0.86320
390/390 [==============================] - 59s 151ms/step - loss: 0.3462 - accuracy: 0.8807 - val_loss: 0.5054 - val_accuracy: 0.8441
```

▶ Training Model further from 115th Epoch :

Let's try changing learning rate

In [ ]:

```
import tensorflow.keras.backend as k
k.set_value(model.optimizer.lr, 0.01)
callback_list = [checkpoint]
model.load_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_90Epoch_Rev01_depthwise.h5')

epochs = 30
history = model.fit_generator(datagen.flow(X_train, y_train, batch_size=batch_size),\
                    steps_per_epoch=X_train.shape[0] // batch_size,epochs=epochs,\
                    verbose=1,validation_data=(X_test,y_test),callbacks=callback_list)

model.save_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_120Epoch_Rev01_depthwise.h5')
```

```
Epoch 1/30
390/390 [==============================] - ETA: 0s - loss: 0.3416 - accuracy: 0.8836
Epoch 00001: val_accuracy improved from 0.86320 to 0.87060, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.3416 - accuracy: 0.8836 - val_loss: 0.4056 - val_accuracy: 0.8706
Epoch 2/30
390/390 [==============================] - ETA: 0s - loss: 0.3406 - accuracy: 0.8837
Epoch 00002: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 150ms/step - loss: 0.3406 - accuracy: 0.8837 - val_loss: 0.5601 - val_accuracy: 0.8282
```

```
Epoch 3/30
390/390 [==============================] - ETA: 0s - loss: 0.3434 - accuracy: 0.8824
Epoch 00003: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 151ms/step - loss: 0.3434 - accuracy: 0.8824 - val_loss: 0.5448 - val_accuracy: 0.8301
Epoch 4/30
390/390 [==============================] - ETA: 0s - loss: 0.3381 - accuracy: 0.8855
Epoch 00004: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 150ms/step - loss: 0.3381 - accuracy: 0.8855 - val_loss: 0.7139 - val_accuracy: 0.7955
Epoch 5/30
390/390 [==============================] - ETA: 0s - loss: 0.3340 - accuracy: 0.8862
Epoch 00005: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 150ms/step - loss: 0.3340 - accuracy: 0.8862 - val_loss: 0.6740 - val_accuracy: 0.8042
Epoch 6/30
390/390 [==============================] - ETA: 0s - loss: 0.3317 - accuracy: 0.8865
Epoch 00006: val_accuracy did not improve from 0.87060
390/390 [==============================] - 58s 149ms/step - loss: 0.3317 - accuracy: 0.8865 - val_loss: 0.4712 - val_accuracy: 0.8500
Epoch 7/30
390/390 [==============================] - ETA: 0s - loss: 0.3351 - accuracy: 0.8869
Epoch 00007: val_accuracy did not improve from 0.87060
390/390 [==============================] - 58s 150ms/step - loss: 0.3351 - accuracy: 0.8869 - val_loss: 0.5234 - val_accuracy: 0.8430
Epoch 8/30
390/390 [==============================] - ETA: 0s - loss: 0.3270 - accuracy: 0.8893
Epoch 00008: val_accuracy did not improve from 0.87060
390/390 [==============================] - 58s 150ms/step - loss: 0.3270 - accuracy: 0.8893 - val_loss: 0.5646 - val_accuracy: 0.8264
Epoch 9/30
390/390 [==============================] - ETA: 0s - loss: 0.3336 - accuracy: 0.8869
Epoch 00009: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 150ms/step - loss: 0.3336 - accuracy: 0.8869 - val_loss: 0.4422 - val_accuracy: 0.8629
Epoch 10/30
390/390 [==============================] - ETA: 0s - loss: 0.3280 - accuracy: 0.8880
Epoch 00010: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 150ms/step - loss: 0.3280 - accuracy: 0.8880 - val_loss: 0.5410 - val_accuracy: 0.8325
Epoch 11/30
390/390 [==============================] - ETA: 0s - loss: 0.3310 - accuracy: 0.8864
Epoch 00011: val_accuracy did not improve from 0.87060
390/390 [==============================] - 58s 150ms/step - loss: 0.3310 - accuracy: 0.8864 - val_loss: 0.4628 - val_accuracy: 0.8569
Epoch 12/30
390/390 [==============================] - ETA: 0s - loss: 0.3238 - accuracy: 0.8888
Epoch 00012: val_accuracy did not improve from 0.87060
390/390 [==============================] - 58s 150ms/step - loss: 0.3238 - accuracy: 0.8888 - val_loss: 0.4227 - val_accuracy: 0.8636
Epoch 13/30
390/390 [==============================] - ETA: 0s - loss: 0.3250 - accuracy: 0.8889
Epoch 00013: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 150ms/step - loss: 0.3250 - accuracy: 0.8889 - val_loss: 0.4435 - val_accuracy: 0.8623
Epoch 14/30
390/390 [==============================] - ETA: 0s - loss: 0.3260 - accuracy: 0.8896
Epoch 00014: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 151ms/step - loss: 0.3260 - accuracy: 0.8896 - val_loss: 0.4894 - val_accuracy: 0.8495
Epoch 15/30
390/390 [==============================] - ETA: 0s - loss: 0.3193 - accuracy: 0.8900
Epoch 00015: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 150ms/step - loss: 0.3193 - accuracy: 0.8900 - val_loss: 0.4393 - val_accuracy: 0.8645
Epoch 16/30
390/390 [==============================] - ETA: 0s - loss: 0.3250 - accuracy: 0.8906
```

```
Epoch 00016: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 150ms/step - loss: 0.3250 - accuracy: 0.8906 - val_loss: 0.5289 - val_accuracy: 0.8381
Epoch 17/30
390/390 [==============================] - ETA: 0s - loss: 0.3221 - accuracy: 0.8903
Epoch 00017: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 150ms/step - loss: 0.3221 - accuracy: 0.8903 - val_loss: 0.4560 - val_accuracy: 0.8558
Epoch 18/30
390/390 [==============================] - ETA: 0s - loss: 0.3147 - accuracy: 0.8926
Epoch 00018: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 150ms/step - loss: 0.3147 - accuracy: 0.8926 - val_loss: 0.4962 - val_accuracy: 0.8429
Epoch 19/30
390/390 [==============================] - ETA: 0s - loss: 0.3154 - accuracy: 0.8917
Epoch 00019: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 150ms/step - loss: 0.3154 - accuracy: 0.8917 - val_loss: 0.4406 - val_accuracy: 0.8654
Epoch 20/30
390/390 [==============================] - ETA: 0s - loss: 0.3136 - accuracy: 0.8931
Epoch 00020: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 150ms/step - loss: 0.3136 - accuracy: 0.8931 - val_loss: 0.4639 - val_accuracy: 0.8550
Epoch 21/30
390/390 [==============================] - ETA: 0s - loss: 0.3162 - accuracy: 0.8922
Epoch 00021: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 151ms/step - loss: 0.3162 - accuracy: 0.8922 - val_loss: 0.4990 - val_accuracy: 0.8499
Epoch 22/30
390/390 [==============================] - ETA: 0s - loss: 0.3109 - accuracy: 0.8937
Epoch 00022: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 151ms/step - loss: 0.3109 - accuracy: 0.8937 - val_loss: 0.4361 - val_accuracy: 0.8627
Epoch 23/30
390/390 [==============================] - ETA: 0s - loss: 0.3127 - accuracy: 0.8935
Epoch 00023: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 151ms/step - loss: 0.3127 - accuracy: 0.8935 - val_loss: 0.5325 - val_accuracy: 0.8419
Epoch 24/30
390/390 [==============================] - ETA: 0s - loss: 0.3052 - accuracy: 0.8967
Epoch 00024: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 151ms/step - loss: 0.3052 - accuracy: 0.8967 - val_loss: 0.4713 - val_accuracy: 0.8578
Epoch 25/30
390/390 [==============================] - ETA: 0s - loss: 0.3072 - accuracy: 0.8955
Epoch 00025: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 151ms/step - loss: 0.3072 - accuracy: 0.8955 - val_loss: 0.4395 - val_accuracy: 0.8610
Epoch 26/30
390/390 [==============================] - ETA: 0s - loss: 0.3066 - accuracy: 0.8944
Epoch 00026: val_accuracy did not improve from 0.87060
390/390 [==============================] - 58s 150ms/step - loss: 0.3066 - accuracy: 0.8944 - val_loss: 0.4428 - val_accuracy: 0.8657
Epoch 27/30
390/390 [==============================] - ETA: 0s - loss: 0.3031 - accuracy: 0.8966
Epoch 00027: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 150ms/step - loss: 0.3031 - accuracy: 0.8966 - val_loss: 0.4589 - val_accuracy: 0.8577
Epoch 28/30
390/390 [==============================] - ETA: 0s - loss: 0.3031 - accuracy: 0.8975
Epoch 00028: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 151ms/step - loss: 0.3031 - accuracy: 0.8975 - val_loss: 0.4749 - val_accuracy: 0.8558
Epoch 29/30
390/390 [==============================] - ETA: 0s - loss: 0.3041 - accuracy: 0.8957
Epoch 00029: val_accuracy did not improve from 0.87060
390/390 [==============================] - 59s 151ms/step - loss: 0.3041 - accuracy: 0.8957 - val_loss: 0.4732 - val_accuracy: 0.8511
```

```
Epoch 30/30
390/390 [==============================] - ETA: 0s - loss: 0.3037 - accuracy: 0.8957
Epoch 00030: val_accuracy did not improve from 0.87060
390/390 [==============================] - 58s 149ms/step - loss: 0.3037 - accuracy: 0.8957 - val_loss: 0.5053 - val_accuracy: 0.8465
```

In [ ]:

```
import tensorflow.keras.backend as k
k.set_value(model.optimizer.lr, 0.001)

model.load_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_120Epoch_Rev01_depthwise.h5')

epochs = 60
history = model.fit_generator(datagen.flow(X_train, y_train, batch_size=batch_size),\
                    steps_per_epoch=X_train.shape[0] // batch_size,epochs=epochs,\
                    verbose=1,validation_data=(X_test,y_test),callbacks=callback_list)

model.save_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_180Epoch_Rev01_depthwise.h5')
```

```
Epoch 1/60
390/390 [==============================] - ETA: 0s - loss: 0.2677 - accuracy: 0.9087
Epoch 00001: val_accuracy improved from 0.87060 to 0.88380, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.2677 - accuracy: 0.9087 - val_loss: 0.3748 - val_accuracy: 0.8838
Epoch 2/60
390/390 [==============================] - ETA: 0s - loss: 0.2577 - accuracy: 0.9133
Epoch 00002: val_accuracy did not improve from 0.88380
390/390 [==============================] - 58s 150ms/step - loss: 0.2577 - accuracy: 0.9133 - val_loss: 0.3791 - val_accuracy: 0.8824
Epoch 3/60
390/390 [==============================] - ETA: 0s - loss: 0.2566 - accuracy: 0.9140
Epoch 00003: val_accuracy improved from 0.88380 to 0.88520, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.2566 - accuracy: 0.9140 - val_loss: 0.3706 - val_accuracy: 0.8852
Epoch 4/60
390/390 [==============================] - ETA: 0s - loss: 0.2502 - accuracy: 0.9164
Epoch 00004: val_accuracy did not improve from 0.88520
390/390 [==============================] - 59s 150ms/step - loss: 0.2502 - accuracy: 0.9164 - val_loss: 0.3929 - val_accuracy: 0.8810
Epoch 5/60
390/390 [==============================] - ETA: 0s - loss: 0.2522 - accuracy: 0.9145
Epoch 00005: val_accuracy improved from 0.88520 to 0.88790, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 60s 153ms/step - loss: 0.2522 - accuracy: 0.9145 - val_loss: 0.3698 - val_accuracy: 0.8879
Epoch 6/60
390/390 [==============================] - ETA: 0s - loss: 0.2466 - accuracy: 0.9171
Epoch 00006: val_accuracy did not improve from 0.88790
390/390 [==============================] - 59s 151ms/step - loss: 0.2466 - accuracy: 0.9171 - val_loss: 0.3780 - val_accuracy: 0.8846
Epoch 7/60
390/390 [==============================] - ETA: 0s - loss: 0.2494 - accuracy: 0.9152
Epoch 00007: val_accuracy did not improve from 0.88790
390/390 [==============================] - 59s 150ms/step - loss: 0.2494 - accuracy: 0.9152 - val_loss: 0.3777 - val_accuracy: 0.8841
Epoch 8/60
390/390 [==============================] - ETA: 0s - loss: 0.2436 - accuracy: 0.9174
Epoch 00008: val_accuracy did not improve from 0.88790
390/390 [==============================] - 59s 150ms/step - loss: 0.2436 - accuracy: 0.9174 - val_loss: 0.3704 - val_accuracy: 0.8865
Epoch 9/60
390/390 [==============================] - ETA: 0s - loss: 0.2434 - accuracy: 0.9168
Epoch 00009: val_accuracy did not improve from 0.88790
```

```
390/390 [==============================] - 59s 150ms/step - loss: 0.2434 - accuracy: 0.9168 - val_loss: 0.3737 - val_accuracy: 0.8858
Epoch 10/60
390/390 [==============================] - ETA: 0s - loss: 0.2486 - accuracy: 0.9155
Epoch 00010: val_accuracy improved from 0.88790 to 0.88850, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.2486 - accuracy: 0.9155 - val_loss: 0.3629 - val_accuracy: 0.8885
Epoch 11/60
390/390 [==============================] - ETA: 0s - loss: 0.2455 - accuracy: 0.9173
Epoch 00011: val_accuracy did not improve from 0.88850
390/390 [==============================] - 58s 149ms/step - loss: 0.2455 - accuracy: 0.9173 - val_loss: 0.3701 - val_accuracy: 0.8878
Epoch 12/60
390/390 [==============================] - ETA: 0s - loss: 0.2475 - accuracy: 0.9154
Epoch 00012: val_accuracy did not improve from 0.88850
390/390 [==============================] - 59s 151ms/step - loss: 0.2475 - accuracy: 0.9154 - val_loss: 0.3898 - val_accuracy: 0.8822
Epoch 13/60
390/390 [==============================] - ETA: 0s - loss: 0.2416 - accuracy: 0.9189
Epoch 00013: val_accuracy did not improve from 0.88850
390/390 [==============================] - 59s 150ms/step - loss: 0.2416 - accuracy: 0.9189 - val_loss: 0.3672 - val_accuracy: 0.8881
Epoch 14/60
390/390 [==============================] - ETA: 0s - loss: 0.2425 - accuracy: 0.9181
Epoch 00014: val_accuracy did not improve from 0.88850
390/390 [==============================] - 58s 149ms/step - loss: 0.2425 - accuracy: 0.9181 - val_loss: 0.3725 - val_accuracy: 0.8857
Epoch 15/60
390/390 [==============================] - ETA: 0s - loss: 0.2441 - accuracy: 0.9185
Epoch 00015: val_accuracy did not improve from 0.88850
390/390 [==============================] - 58s 150ms/step - loss: 0.2441 - accuracy: 0.9185 - val_loss: 0.3824 - val_accuracy: 0.8851
Epoch 16/60
390/390 [==============================] - ETA: 0s - loss: 0.2400 - accuracy: 0.9167
Epoch 00016: val_accuracy did not improve from 0.88850
390/390 [==============================] - 58s 150ms/step - loss: 0.2400 - accuracy: 0.9167 - val_loss: 0.3771 - val_accuracy: 0.8867
Epoch 17/60
390/390 [==============================] - ETA: 0s - loss: 0.2428 - accuracy: 0.9184
Epoch 00017: val_accuracy improved from 0.88850 to 0.88940, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.2428 - accuracy: 0.9184 - val_loss: 0.3664 - val_accuracy: 0.8894
Epoch 18/60
390/390 [==============================] - ETA: 0s - loss: 0.2400 - accuracy: 0.9186
Epoch 00018: val_accuracy did not improve from 0.88940
390/390 [==============================] - 59s 151ms/step - loss: 0.2400 - accuracy: 0.9186 - val_loss: 0.3826 - val_accuracy: 0.8845
Epoch 19/60
390/390 [==============================] - ETA: 0s - loss: 0.2409 - accuracy: 0.9190
Epoch 00019: val_accuracy improved from 0.88940 to 0.89020, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 60s 153ms/step - loss: 0.2409 - accuracy: 0.9190 - val_loss: 0.3640 - val_accuracy: 0.8902
Epoch 20/60
390/390 [==============================] - ETA: 0s - loss: 0.2389 - accuracy: 0.9191
Epoch 00020: val_accuracy did not improve from 0.89020
390/390 [==============================] - 58s 149ms/step - loss: 0.2389 - accuracy: 0.9191 - val_loss: 0.3827 - val_accuracy: 0.8843
Epoch 21/60
390/390 [==============================] - ETA: 0s - loss: 0.2375 - accuracy: 0.9195
Epoch 00021: val_accuracy did not improve from 0.89020
390/390 [==============================] - 59s 150ms/step - loss: 0.2375 - accuracy: 0.9195 - val_loss: 0.3655 - val_accuracy: 0.8891
Epoch 22/60
390/390 [==============================] - ETA: 0s - loss: 0.2381 - accuracy: 0.9173
Epoch 00022: val_accuracy did not improve from 0.89020
390/390 [==============================] - 58s 150ms/step - loss: 0.2381 - accuracy: 0.9173 - val_loss: 0.3804 - val_accuracy: 0.8846
Epoch 23/60
```

```
390/390 [==============================] - ETA: 0s - loss: 0.2355 - accuracy: 0.9196
Epoch 00023: val_accuracy did not improve from 0.89020
390/390 [==============================] - 59s 150ms/step - loss: 0.2355 - accuracy: 0.9196 - val_loss: 0.3986 - val_accuracy: 0.8807
Epoch 24/60
390/390 [==============================] - ETA: 0s - loss: 0.2370 - accuracy: 0.9196
Epoch 00024: val_accuracy did not improve from 0.89020
390/390 [==============================] - 58s 150ms/step - loss: 0.2370 - accuracy: 0.9196 - val_loss: 0.3743 - val_accuracy: 0.8848
Epoch 25/60
390/390 [==============================] - ETA: 0s - loss: 0.2364 - accuracy: 0.9197
Epoch 00025: val_accuracy did not improve from 0.89020
390/390 [==============================] - 59s 150ms/step - loss: 0.2364 - accuracy: 0.9197 - val_loss: 0.3767 - val_accuracy: 0.8840
Epoch 26/60
390/390 [==============================] - ETA: 0s - loss: 0.2365 - accuracy: 0.9190
Epoch 00026: val_accuracy did not improve from 0.89020
390/390 [==============================] - 59s 150ms/step - loss: 0.2365 - accuracy: 0.9190 - val_loss: 0.3861 - val_accuracy: 0.8873
Epoch 27/60
390/390 [==============================] - ETA: 0s - loss: 0.2339 - accuracy: 0.9211
Epoch 00027: val_accuracy did not improve from 0.89020
390/390 [==============================] - 59s 150ms/step - loss: 0.2339 - accuracy: 0.9211 - val_loss: 0.3710 - val_accuracy: 0.8881
Epoch 28/60
390/390 [==============================] - ETA: 0s - loss: 0.2332 - accuracy: 0.9214
Epoch 00028: val_accuracy did not improve from 0.89020
390/390 [==============================] - 59s 151ms/step - loss: 0.2332 - accuracy: 0.9214 - val_loss: 0.3917 - val_accuracy: 0.8830
Epoch 29/60
390/390 [==============================] - ETA: 0s - loss: 0.2339 - accuracy: 0.9213
Epoch 00029: val_accuracy did not improve from 0.89020
390/390 [==============================] - 59s 150ms/step - loss: 0.2339 - accuracy: 0.9213 - val_loss: 0.3724 - val_accuracy: 0.8874
Epoch 30/60
390/390 [==============================] - ETA: 0s - loss: 0.2349 - accuracy: 0.9205
Epoch 00030: val_accuracy improved from 0.89020 to 0.89200, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.2349 - accuracy: 0.9205 - val_loss: 0.3615 - val_accuracy: 0.8920
Epoch 31/60
390/390 [==============================] - ETA: 0s - loss: 0.2349 - accuracy: 0.9196
Epoch 00031: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 150ms/step - loss: 0.2349 - accuracy: 0.9196 - val_loss: 0.3892 - val_accuracy: 0.8837
Epoch 32/60
390/390 [==============================] - ETA: 0s - loss: 0.2378 - accuracy: 0.9202
Epoch 00032: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 151ms/step - loss: 0.2378 - accuracy: 0.9202 - val_loss: 0.3728 - val_accuracy: 0.8889
Epoch 33/60
390/390 [==============================] - ETA: 0s - loss: 0.2343 - accuracy: 0.9209
Epoch 00033: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 151ms/step - loss: 0.2343 - accuracy: 0.9209 - val_loss: 0.3783 - val_accuracy: 0.8872
Epoch 34/60
390/390 [==============================] - ETA: 0s - loss: 0.2362 - accuracy: 0.9196
Epoch 00034: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 150ms/step - loss: 0.2362 - accuracy: 0.9196 - val_loss: 0.3846 - val_accuracy: 0.8867
Epoch 35/60
390/390 [==============================] - ETA: 0s - loss: 0.2371 - accuracy: 0.9205
Epoch 00035: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 150ms/step - loss: 0.2371 - accuracy: 0.9205 - val_loss: 0.3786 - val_accuracy: 0.8854
Epoch 36/60
390/390 [==============================] - ETA: 0s - loss: 0.2332 - accuracy: 0.9214
Epoch 00036: val_accuracy did not improve from 0.89200
```

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390/390 [==============================] - 58s 150ms/step - loss: 0.2332 - accuracy: 0.9214 - val_loss: 0.3615 - val_accuracy: 0.8908
Epoch 37/60
390/390 [==============================] - ETA: 0s - loss: 0.2330 - accuracy: 0.9197
Epoch 00037: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 150ms/step - loss: 0.2330 - accuracy: 0.9197 - val_loss: 0.3931 - val_accuracy: 0.8834
Epoch 38/60
390/390 [==============================] - ETA: 0s - loss: 0.2358 - accuracy: 0.9206
Epoch 00038: val_accuracy did not improve from 0.89200
390/390 [==============================] - 58s 150ms/step - loss: 0.2358 - accuracy: 0.9206 - val_loss: 0.3619 - val_accuracy: 0.8892
Epoch 39/60
390/390 [==============================] - ETA: 0s - loss: 0.2309 - accuracy: 0.9216
Epoch 00039: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 151ms/step - loss: 0.2309 - accuracy: 0.9216 - val_loss: 0.3745 - val_accuracy: 0.8882
Epoch 40/60
390/390 [==============================] - ETA: 0s - loss: 0.2324 - accuracy: 0.9220
Epoch 00040: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 150ms/step - loss: 0.2324 - accuracy: 0.9220 - val_loss: 0.3897 - val_accuracy: 0.8834
Epoch 41/60
390/390 [==============================] - ETA: 0s - loss: 0.2362 - accuracy: 0.9194
Epoch 00041: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 150ms/step - loss: 0.2362 - accuracy: 0.9194 - val_loss: 0.3720 - val_accuracy: 0.8903
Epoch 42/60
390/390 [==============================] - ETA: 0s - loss: 0.2313 - accuracy: 0.9217
Epoch 00042: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 150ms/step - loss: 0.2313 - accuracy: 0.9217 - val_loss: 0.3786 - val_accuracy: 0.8885
Epoch 43/60
390/390 [==============================] - ETA: 0s - loss: 0.2337 - accuracy: 0.9202
Epoch 00043: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 150ms/step - loss: 0.2337 - accuracy: 0.9202 - val_loss: 0.3915 - val_accuracy: 0.8860
Epoch 44/60
390/390 [==============================] - ETA: 0s - loss: 0.2335 - accuracy: 0.9213
Epoch 00044: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 151ms/step - loss: 0.2335 - accuracy: 0.9213 - val_loss: 0.3730 - val_accuracy: 0.8894
Epoch 45/60
390/390 [==============================] - ETA: 0s - loss: 0.2267 - accuracy: 0.9235
Epoch 00045: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 151ms/step - loss: 0.2267 - accuracy: 0.9235 - val_loss: 0.3811 - val_accuracy: 0.8840
Epoch 46/60
390/390 [==============================] - ETA: 0s - loss: 0.2247 - accuracy: 0.9235
Epoch 00046: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 151ms/step - loss: 0.2247 - accuracy: 0.9235 - val_loss: 0.3786 - val_accuracy: 0.8857
Epoch 47/60
390/390 [==============================] - ETA: 0s - loss: 0.2307 - accuracy: 0.9226
Epoch 00047: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 150ms/step - loss: 0.2307 - accuracy: 0.9226 - val_loss: 0.3953 - val_accuracy: 0.8815
Epoch 48/60
390/390 [==============================] - ETA: 0s - loss: 0.2297 - accuracy: 0.9209
Epoch 00048: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 151ms/step - loss: 0.2297 - accuracy: 0.9209 - val_loss: 0.4200 - val_accuracy: 0.8750
Epoch 49/60
390/390 [==============================] - ETA: 0s - loss: 0.2310 - accuracy: 0.9216
Epoch 00049: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 151ms/step - loss: 0.2310 - accuracy: 0.9216 - val_loss: 0.3679 - val_accuracy: 0.8879
Epoch 50/60
```

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390/390 [==============================] - ETA: 0s - loss: 0.2305 - accuracy: 0.9224
Epoch 00050: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 150ms/step - loss: 0.2305 - accuracy: 0.9224 - val_loss: 0.3833 - val_accuracy: 0.8857
Epoch 51/60
390/390 [==============================] - ETA: 0s - loss: 0.2322 - accuracy: 0.9211
Epoch 00051: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 150ms/step - loss: 0.2322 - accuracy: 0.9211 - val_loss: 0.3803 - val_accuracy: 0.8855
Epoch 52/60
390/390 [==============================] - ETA: 0s - loss: 0.2303 - accuracy: 0.9218
Epoch 00052: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 150ms/step - loss: 0.2303 - accuracy: 0.9218 - val_loss: 0.3721 - val_accuracy: 0.8900
Epoch 53/60
390/390 [==============================] - ETA: 0s - loss: 0.2295 - accuracy: 0.9222
Epoch 00053: val_accuracy did not improve from 0.89200
390/390 [==============================] - 58s 150ms/step - loss: 0.2295 - accuracy: 0.9222 - val_loss: 0.3829 - val_accuracy: 0.8865
Epoch 54/60
390/390 [==============================] - ETA: 0s - loss: 0.2253 - accuracy: 0.9242
Epoch 00054: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 151ms/step - loss: 0.2253 - accuracy: 0.9242 - val_loss: 0.4043 - val_accuracy: 0.8786
Epoch 55/60
390/390 [==============================] - ETA: 0s - loss: 0.2279 - accuracy: 0.9226
Epoch 00055: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 150ms/step - loss: 0.2279 - accuracy: 0.9226 - val_loss: 0.3741 - val_accuracy: 0.8889
Epoch 56/60
390/390 [==============================] - ETA: 0s - loss: 0.2280 - accuracy: 0.9217
Epoch 00056: val_accuracy did not improve from 0.89200
390/390 [==============================] - 58s 150ms/step - loss: 0.2280 - accuracy: 0.9217 - val_loss: 0.3704 - val_accuracy: 0.8902
Epoch 57/60
390/390 [==============================] - ETA: 0s - loss: 0.2306 - accuracy: 0.9212
Epoch 00057: val_accuracy did not improve from 0.89200
390/390 [==============================] - 58s 149ms/step - loss: 0.2306 - accuracy: 0.9212 - val_loss: 0.3683 - val_accuracy: 0.8890
Epoch 58/60
390/390 [==============================] - ETA: 0s - loss: 0.2259 - accuracy: 0.9238
Epoch 00058: val_accuracy did not improve from 0.89200
390/390 [==============================] - 58s 150ms/step - loss: 0.2259 - accuracy: 0.9238 - val_loss: 0.3767 - val_accuracy: 0.8894
Epoch 59/60
390/390 [==============================] - ETA: 0s - loss: 0.2264 - accuracy: 0.9230
Epoch 00059: val_accuracy did not improve from 0.89200
390/390 [==============================] - 59s 150ms/step - loss: 0.2264 - accuracy: 0.9230 - val_loss: 0.3839 - val_accuracy: 0.8880
Epoch 60/60
390/390 [==============================] - ETA: 0s - loss: 0.2282 - accuracy: 0.9223
Epoch 00060: val_accuracy did not improve from 0.89200
390/390 [==============================] - 58s 149ms/step - loss: 0.2282 - accuracy: 0.9223 - val_loss: 0.3802 - val_accuracy: 0.8870
```

In [ ]:

```
import tensorflow.keras.backend as k
k.set_value(model.optimizer.lr, 0.0001)

#Model Compilation
#model.compile(loss='categorical_crossentropy',
              #optimizer=tf.keras.optimizers.Adam(learning_rate=0.00001, beta_1=0.9, beta_2=0.999, epsilon=1e-06, amsgrad=True, name='Adam'),
              #metrics=['accuracy'])

model.load_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_180Epoch_Rev01_depthwise.h5')
```

```
callback_list = [checkpoint]
epochs = 30
history = model.fit_generator(datagen.flow(X_train, y_train, batch_size=batch_size),\
                    steps_per_epoch=X_train.shape[0] // batch_size,epochs=epochs,\
                    verbose=1,validation_data=(X_test,y_test),callbacks=callback_list)

model.save_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_210Epoch_Rev01_depthwise.h5')
```

```
Epoch 1/30
390/390 [==============================] - ETA: 0s - loss: 0.2227 - accuracy: 0.9241
Epoch 00001: val_accuracy improved from -inf to 0.88980, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01_depthwise.h5
390/390 [==============================] - 68s 156ms/step - loss: 0.2227 - accuracy: 0.9241 - val_loss: 0.3760 - val_accuracy: 0.8898
Epoch 2/30
390/390 [==============================] - ETA: 0s - loss: 0.2249 - accuracy: 0.9241
Epoch 00002: val_accuracy improved from 0.88980 to 0.89020, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01_depthwise.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.2249 - accuracy: 0.9241 - val_loss: 0.3734 - val_accuracy: 0.8902
Epoch 3/30
390/390 [==============================] - ETA: 0s - loss: 0.2256 - accuracy: 0.9234
Epoch 00003: val_accuracy did not improve from 0.89020
390/390 [==============================] - 58s 149ms/step - loss: 0.2256 - accuracy: 0.9234 - val_loss: 0.3746 - val_accuracy: 0.8900
Epoch 4/30
390/390 [==============================] - ETA: 0s - loss: 0.2218 - accuracy: 0.9252
Epoch 00004: val_accuracy improved from 0.89020 to 0.89070, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01_depthwise.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.2218 - accuracy: 0.9252 - val_loss: 0.3735 - val_accuracy: 0.8907
Epoch 5/30
390/390 [==============================] - ETA: 0s - loss: 0.2209 - accuracy: 0.9249
Epoch 00005: val_accuracy improved from 0.89070 to 0.89100, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01_depthwise.h5
390/390 [==============================] - 59s 152ms/step - loss: 0.2209 - accuracy: 0.9249 - val_loss: 0.3701 - val_accuracy: 0.8910
Epoch 6/30
390/390 [==============================] - ETA: 0s - loss: 0.2253 - accuracy: 0.9234
Epoch 00006: val_accuracy did not improve from 0.89100
390/390 [==============================] - 58s 149ms/step - loss: 0.2253 - accuracy: 0.9234 - val_loss: 0.3725 - val_accuracy: 0.8905
Epoch 7/30
390/390 [==============================] - ETA: 0s - loss: 0.2193 - accuracy: 0.9271
Epoch 00007: val_accuracy did not improve from 0.89100
390/390 [==============================] - 58s 149ms/step - loss: 0.2193 - accuracy: 0.9271 - val_loss: 0.3728 - val_accuracy: 0.8903
Epoch 8/30
390/390 [==============================] - ETA: 0s - loss: 0.2223 - accuracy: 0.9253
Epoch 00008: val_accuracy did not improve from 0.89100
390/390 [==============================] - 58s 150ms/step - loss: 0.2223 - accuracy: 0.9253 - val_loss: 0.3729 - val_accuracy: 0.8899
Epoch 9/30
390/390 [==============================] - ETA: 0s - loss: 0.2236 - accuracy: 0.9234
Epoch 00009: val_accuracy improved from 0.89100 to 0.89120, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01_depthwise.h5
390/390 [==============================] - 59s 151ms/step - loss: 0.2236 - accuracy: 0.9234 - val_loss: 0.3708 - val_accuracy: 0.8912
Epoch 10/30
390/390 [==============================] - ETA: 0s - loss: 0.2240 - accuracy: 0.9248
Epoch 00010: val_accuracy did not improve from 0.89120
390/390 [==============================] - 58s 149ms/step - loss: 0.2240 - accuracy: 0.9248 - val_loss: 0.3726 - val_accuracy: 0.8907
Epoch 11/30
390/390 [==============================] - ETA: 0s - loss: 0.2263 - accuracy: 0.9232
Epoch 00011: val_accuracy improved from 0.89120 to 0.89130, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01_depthwise.h5
390/390 [==============================] - 59s 151ms/step - loss: 0.2263 - accuracy: 0.9232 - val_loss: 0.3706 - val_accuracy: 0.8913
Epoch 12/30
```

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390/390 [==============================] - ETA: 0s - loss: 0.2197 - accuracy: 0.9256
Epoch 00012: val_accuracy did not improve from 0.89130
390/390 [==============================] - 58s 149ms/step - loss: 0.2197 - accuracy: 0.9256 - val_loss: 0.3698 - val_accuracy: 0.8912
Epoch 13/30
390/390 [==============================] - ETA: 0s - loss: 0.2221 - accuracy: 0.9242
Epoch 00013: val_accuracy did not improve from 0.89130
390/390 [==============================] - 58s 149ms/step - loss: 0.2221 - accuracy: 0.9242 - val_loss: 0.3735 - val_accuracy: 0.8900
Epoch 14/30
390/390 [==============================] - ETA: 0s - loss: 0.2245 - accuracy: 0.9241
Epoch 00014: val_accuracy improved from 0.89130 to 0.89170, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01_depthwise.h5
390/390 [==============================] - 59s 151ms/step - loss: 0.2245 - accuracy: 0.9241 - val_loss: 0.3690 - val_accuracy: 0.8917
Epoch 15/30
390/390 [==============================] - ETA: 0s - loss: 0.2218 - accuracy: 0.9249
Epoch 00015: val_accuracy did not improve from 0.89170
390/390 [==============================] - 58s 150ms/step - loss: 0.2218 - accuracy: 0.9249 - val_loss: 0.3716 - val_accuracy: 0.8901
Epoch 16/30
390/390 [==============================] - ETA: 0s - loss: 0.2197 - accuracy: 0.9266
Epoch 00016: val_accuracy did not improve from 0.89170
390/390 [==============================] - 58s 149ms/step - loss: 0.2197 - accuracy: 0.9266 - val_loss: 0.3691 - val_accuracy: 0.8910
Epoch 17/30
390/390 [==============================] - ETA: 0s - loss: 0.2236 - accuracy: 0.9239
Epoch 00017: val_accuracy did not improve from 0.89170
390/390 [==============================] - 58s 149ms/step - loss: 0.2236 - accuracy: 0.9239 - val_loss: 0.3738 - val_accuracy: 0.8903
Epoch 18/30
390/390 [==============================] - ETA: 0s - loss: 0.2188 - accuracy: 0.9260
Epoch 00018: val_accuracy did not improve from 0.89170
390/390 [==============================] - 58s 149ms/step - loss: 0.2188 - accuracy: 0.9260 - val_loss: 0.3711 - val_accuracy: 0.8906
Epoch 19/30
390/390 [==============================] - ETA: 0s - loss: 0.2254 - accuracy: 0.9249
Epoch 00019: val_accuracy did not improve from 0.89170
390/390 [==============================] - 58s 150ms/step - loss: 0.2254 - accuracy: 0.9249 - val_loss: 0.3700 - val_accuracy: 0.8899
Epoch 20/30
390/390 [==============================] - ETA: 0s - loss: 0.2213 - accuracy: 0.9266
Epoch 00020: val_accuracy did not improve from 0.89170
390/390 [==============================] - 58s 149ms/step - loss: 0.2213 - accuracy: 0.9266 - val_loss: 0.3713 - val_accuracy: 0.8914
Epoch 21/30
390/390 [==============================] - ETA: 0s - loss: 0.2230 - accuracy: 0.9253
Epoch 00021: val_accuracy did not improve from 0.89170
390/390 [==============================] - 58s 149ms/step - loss: 0.2230 - accuracy: 0.9253 - val_loss: 0.3698 - val_accuracy: 0.8907
Epoch 22/30
390/390 [==============================] - ETA: 0s - loss: 0.2246 - accuracy: 0.9251
Epoch 00022: val_accuracy did not improve from 0.89170
390/390 [==============================] - 58s 149ms/step - loss: 0.2246 - accuracy: 0.9251 - val_loss: 0.3711 - val_accuracy: 0.8898
Epoch 23/30
390/390 [==============================] - ETA: 0s - loss: 0.2199 - accuracy: 0.9264
Epoch 00023: val_accuracy did not improve from 0.89170
390/390 [==============================] - 58s 149ms/step - loss: 0.2199 - accuracy: 0.9264 - val_loss: 0.3729 - val_accuracy: 0.8899
Epoch 24/30
390/390 [==============================] - ETA: 0s - loss: 0.2213 - accuracy: 0.9247
Epoch 00024: val_accuracy did not improve from 0.89170
390/390 [==============================] - 58s 149ms/step - loss: 0.2213 - accuracy: 0.9247 - val_loss: 0.3740 - val_accuracy: 0.8891
Epoch 25/30
390/390 [==============================] - ETA: 0s - loss: 0.2192 - accuracy: 0.9262
Epoch 00025: val_accuracy did not improve from 0.89170
```

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390/390 [==============================] - 58s 149ms/step - loss: 0.2192 - accuracy: 0.9262 - val_loss: 0.3705 - val_accuracy: 0.8903
Epoch 26/30
390/390 [==============================] - ETA: 0s - loss: 0.2197 - accuracy: 0.9260
Epoch 00026: val_accuracy did not improve from 0.89170
390/390 [==============================] - 58s 149ms/step - loss: 0.2197 - accuracy: 0.9260 - val_loss: 0.3706 - val_accuracy: 0.8898
Epoch 27/30
390/390 [==============================] - ETA: 0s - loss: 0.2189 - accuracy: 0.9241
Epoch 00027: val_accuracy did not improve from 0.89170
390/390 [==============================] - 58s 150ms/step - loss: 0.2189 - accuracy: 0.9241 - val_loss: 0.3695 - val_accuracy: 0.8911
Epoch 28/30
390/390 [==============================] - ETA: 0s - loss: 0.2218 - accuracy: 0.9248
Epoch 00028: val_accuracy did not improve from 0.89170
390/390 [==============================] - 58s 150ms/step - loss: 0.2218 - accuracy: 0.9248 - val_loss: 0.3740 - val_accuracy: 0.8890
Epoch 29/30
390/390 [==============================] - ETA: 0s - loss: 0.2220 - accuracy: 0.9231
Epoch 00029: val_accuracy did not improve from 0.89170
390/390 [==============================] - 58s 150ms/step - loss: 0.2220 - accuracy: 0.9231 - val_loss: 0.3715 - val_accuracy: 0.8899
Epoch 30/30
390/390 [==============================] - ETA: 0s - loss: 0.2184 - accuracy: 0.9260
Epoch 00030: val_accuracy did not improve from 0.89170
390/390 [==============================] - 58s 149ms/step - loss: 0.2184 - accuracy: 0.9260 - val_loss: 0.3726 - val_accuracy: 0.8901
```

In [ ]:

```
import tensorflow.keras.backend as k
k.set_value(model.optimizer.lr, 0.0001)


decay_lr = ReduceLROnPlateau(monitor='val_accuracy', factor=0.99, patience= 5,
                                            verbose=1, mode='auto', min_delta=0.001,
                                            cooldown=0, min_lr=0.000001)

callback_list = [checkpoint]


model.load_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_210Epoch_Rev01_depthwise.h5')

epochs = 90
history = model.fit_generator(datagen.flow(X_train, y_train, batch_size=batch_size),\
                    steps_per_epoch=0.05*X_train.shape[0] // batch_size,epochs=epochs,\
                    verbose=1,validation_data=(X_test,y_test),callbacks=callback_list)

model.save_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_300Epoch_Rev01_depthwise.h5')
```

```
Epoch 1/90
19/19 [==============================] - ETA: 0s - loss: 0.1987 - accuracy: 0.9387
Epoch 00001: val_accuracy improved from 0.89170 to 0.89250, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_7_Rev01_depthwise.h5
19/19 [==============================] - 7s 362ms/step - loss: 0.1987 - accuracy: 0.9387 - val_loss: 0.3623 - val_accuracy: 0.8925
Epoch 2/90
19/19 [==============================] - ETA: 0s - loss: 0.2205 - accuracy: 0.9248
Epoch 00002: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 317ms/step - loss: 0.2205 - accuracy: 0.9248 - val_loss: 0.3637 - val_accuracy: 0.8921
Epoch 3/90
```

```
19/19 [==============================] - ETA: 0s - loss: 0.2162 - accuracy: 0.9268
Epoch 00003: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 320ms/step - loss: 0.2162 - accuracy: 0.9268 - val_loss: 0.3645 - val_accuracy: 0.8913
Epoch 4/90
19/19 [==============================] - ETA: 0s - loss: 0.2100 - accuracy: 0.9243
Epoch 00004: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 318ms/step - loss: 0.2100 - accuracy: 0.9243 - val_loss: 0.3648 - val_accuracy: 0.8909
Epoch 5/90
19/19 [==============================] - ETA: 0s - loss: 0.1939 - accuracy: 0.9359
Epoch 00005: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 319ms/step - loss: 0.1939 - accuracy: 0.9359 - val_loss: 0.3661 - val_accuracy: 0.8911
Epoch 6/90
19/19 [==============================] - ETA: 0s - loss: 0.2042 - accuracy: 0.9272
Epoch 00006: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2042 - accuracy: 0.9272 - val_loss: 0.3675 - val_accuracy: 0.8906
Epoch 7/90
19/19 [==============================] - ETA: 0s - loss: 0.2145 - accuracy: 0.9280
Epoch 00007: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2145 - accuracy: 0.9280 - val_loss: 0.3675 - val_accuracy: 0.8911
Epoch 8/90
19/19 [==============================] - ETA: 0s - loss: 0.2424 - accuracy: 0.9198
Epoch 00008: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2424 - accuracy: 0.9198 - val_loss: 0.3705 - val_accuracy: 0.8897
Epoch 9/90
19/19 [==============================] - ETA: 0s - loss: 0.2104 - accuracy: 0.9276
Epoch 00009: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2104 - accuracy: 0.9276 - val_loss: 0.3696 - val_accuracy: 0.8901
Epoch 10/90
19/19 [==============================] - ETA: 0s - loss: 0.2302 - accuracy: 0.9211
Epoch 00010: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2302 - accuracy: 0.9211 - val_loss: 0.3683 - val_accuracy: 0.8911
Epoch 11/90
19/19 [==============================] - ETA: 0s - loss: 0.2244 - accuracy: 0.9215
Epoch 00011: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 317ms/step - loss: 0.2244 - accuracy: 0.9215 - val_loss: 0.3698 - val_accuracy: 0.8904
Epoch 12/90
19/19 [==============================] - ETA: 0s - loss: 0.2235 - accuracy: 0.9243
Epoch 00012: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 317ms/step - loss: 0.2235 - accuracy: 0.9243 - val_loss: 0.3715 - val_accuracy: 0.8896
Epoch 13/90
19/19 [==============================] - ETA: 0s - loss: 0.2310 - accuracy: 0.9211
Epoch 00013: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2310 - accuracy: 0.9211 - val_loss: 0.3713 - val_accuracy: 0.8897
Epoch 14/90
19/19 [==============================] - ETA: 0s - loss: 0.2189 - accuracy: 0.9317
Epoch 00014: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 318ms/step - loss: 0.2189 - accuracy: 0.9317 - val_loss: 0.3716 - val_accuracy: 0.8897
Epoch 15/90
19/19 [==============================] - ETA: 0s - loss: 0.2261 - accuracy: 0.9248
Epoch 00015: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 318ms/step - loss: 0.2261 - accuracy: 0.9248 - val_loss: 0.3721 - val_accuracy: 0.8901
Epoch 16/90
19/19 [==============================] - ETA: 0s - loss: 0.2139 - accuracy: 0.9309
Epoch 00016: val_accuracy did not improve from 0.89250
```

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19/19 [==============================] - 6s 317ms/step - loss: 0.2139 - accuracy: 0.9309 - val_loss: 0.3714 - val_accuracy: 0.8905
Epoch 17/90
19/19 [==============================] - ETA: 0s - loss: 0.2112 - accuracy: 0.9264
Epoch 00017: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 317ms/step - loss: 0.2112 - accuracy: 0.9264 - val_loss: 0.3705 - val_accuracy: 0.8910
Epoch 18/90
19/19 [==============================] - ETA: 0s - loss: 0.2335 - accuracy: 0.9198
Epoch 00018: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 318ms/step - loss: 0.2335 - accuracy: 0.9198 - val_loss: 0.3702 - val_accuracy: 0.8913
Epoch 19/90
19/19 [==============================] - ETA: 0s - loss: 0.2168 - accuracy: 0.9219
Epoch 00019: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 315ms/step - loss: 0.2168 - accuracy: 0.9219 - val_loss: 0.3710 - val_accuracy: 0.8905
Epoch 20/90
19/19 [==============================] - ETA: 0s - loss: 0.2396 - accuracy: 0.9165
Epoch 00020: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2396 - accuracy: 0.9165 - val_loss: 0.3698 - val_accuracy: 0.8909
Epoch 21/90
19/19 [==============================] - ETA: 0s - loss: 0.2228 - accuracy: 0.9268
Epoch 00021: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2228 - accuracy: 0.9268 - val_loss: 0.3707 - val_accuracy: 0.8908
Epoch 22/90
19/19 [==============================] - ETA: 0s - loss: 0.2155 - accuracy: 0.9350
Epoch 00022: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2155 - accuracy: 0.9350 - val_loss: 0.3711 - val_accuracy: 0.8904
Epoch 23/90
19/19 [==============================] - ETA: 0s - loss: 0.2207 - accuracy: 0.9215
Epoch 00023: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 317ms/step - loss: 0.2207 - accuracy: 0.9215 - val_loss: 0.3711 - val_accuracy: 0.8902
Epoch 24/90
19/19 [==============================] - ETA: 0s - loss: 0.2191 - accuracy: 0.9169
Epoch 00024: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 314ms/step - loss: 0.2191 - accuracy: 0.9169 - val_loss: 0.3720 - val_accuracy: 0.8903
Epoch 25/90
19/19 [==============================] - ETA: 0s - loss: 0.2310 - accuracy: 0.9231
Epoch 00025: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 317ms/step - loss: 0.2310 - accuracy: 0.9231 - val_loss: 0.3718 - val_accuracy: 0.8903
Epoch 26/90
19/19 [==============================] - ETA: 0s - loss: 0.2332 - accuracy: 0.9194
Epoch 00026: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2332 - accuracy: 0.9194 - val_loss: 0.3734 - val_accuracy: 0.8896
Epoch 27/90
19/19 [==============================] - ETA: 0s - loss: 0.2433 - accuracy: 0.9186
Epoch 00027: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2433 - accuracy: 0.9186 - val_loss: 0.3721 - val_accuracy: 0.8897
Epoch 28/90
19/19 [==============================] - ETA: 0s - loss: 0.2331 - accuracy: 0.9182
Epoch 00028: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 317ms/step - loss: 0.2331 - accuracy: 0.9182 - val_loss: 0.3718 - val_accuracy: 0.8906
Epoch 29/90
19/19 [==============================] - ETA: 0s - loss: 0.2536 - accuracy: 0.9190
Epoch 00029: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2536 - accuracy: 0.9190 - val_loss: 0.3730 - val_accuracy: 0.8895
Epoch 30/90
```

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19/19 [==============================] - ETA: 0s - loss: 0.2302 - accuracy: 0.9182
Epoch 00030: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 313ms/step - loss: 0.2302 - accuracy: 0.9182 - val_loss: 0.3727 - val_accuracy: 0.8898
Epoch 31/90
19/19 [==============================] - ETA: 0s - loss: 0.2047 - accuracy: 0.9297
Epoch 00031: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2047 - accuracy: 0.9297 - val_loss: 0.3730 - val_accuracy: 0.8900
Epoch 32/90
19/19 [==============================] - ETA: 0s - loss: 0.2347 - accuracy: 0.9227
Epoch 00032: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 318ms/step - loss: 0.2347 - accuracy: 0.9227 - val_loss: 0.3726 - val_accuracy: 0.8898
Epoch 33/90
19/19 [==============================] - ETA: 0s - loss: 0.2504 - accuracy: 0.9174
Epoch 00033: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 318ms/step - loss: 0.2504 - accuracy: 0.9174 - val_loss: 0.3700 - val_accuracy: 0.8907
Epoch 34/90
19/19 [==============================] - ETA: 0s - loss: 0.1957 - accuracy: 0.9293
Epoch 00034: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.1957 - accuracy: 0.9293 - val_loss: 0.3717 - val_accuracy: 0.8903
Epoch 35/90
19/19 [==============================] - ETA: 0s - loss: 0.2106 - accuracy: 0.9248
Epoch 00035: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 317ms/step - loss: 0.2106 - accuracy: 0.9248 - val_loss: 0.3717 - val_accuracy: 0.8907
Epoch 36/90
19/19 [==============================] - ETA: 0s - loss: 0.2178 - accuracy: 0.9241
Epoch 00036: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 313ms/step - loss: 0.2178 - accuracy: 0.9241 - val_loss: 0.3712 - val_accuracy: 0.8905
Epoch 37/90
19/19 [==============================] - ETA: 0s - loss: 0.2081 - accuracy: 0.9280
Epoch 00037: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2081 - accuracy: 0.9280 - val_loss: 0.3714 - val_accuracy: 0.8902
Epoch 38/90
19/19 [==============================] - ETA: 0s - loss: 0.2226 - accuracy: 0.9309
Epoch 00038: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2226 - accuracy: 0.9309 - val_loss: 0.3700 - val_accuracy: 0.8904
Epoch 39/90
19/19 [==============================] - ETA: 0s - loss: 0.2168 - accuracy: 0.9268
Epoch 00039: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 317ms/step - loss: 0.2168 - accuracy: 0.9268 - val_loss: 0.3713 - val_accuracy: 0.8899
Epoch 40/90
19/19 [==============================] - ETA: 0s - loss: 0.2315 - accuracy: 0.9211
Epoch 00040: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 317ms/step - loss: 0.2315 - accuracy: 0.9211 - val_loss: 0.3701 - val_accuracy: 0.8905
Epoch 41/90
19/19 [==============================] - ETA: 0s - loss: 0.2260 - accuracy: 0.9219
Epoch 00041: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 317ms/step - loss: 0.2260 - accuracy: 0.9219 - val_loss: 0.3714 - val_accuracy: 0.8903
Epoch 42/90
19/19 [==============================] - ETA: 0s - loss: 0.2365 - accuracy: 0.9202
Epoch 00042: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 318ms/step - loss: 0.2365 - accuracy: 0.9202 - val_loss: 0.3725 - val_accuracy: 0.8898
Epoch 43/90
19/19 [==============================] - ETA: 0s - loss: 0.1981 - accuracy: 0.9330
Epoch 00043: val_accuracy did not improve from 0.89250
```

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19/19 [==============================] - 6s 319ms/step - loss: 0.1981 - accuracy: 0.9330 - val_loss: 0.3725 - val_accuracy: 0.8895
Epoch 44/90
19/19 [==============================] - ETA: 0s - loss: 0.2218 - accuracy: 0.9252
Epoch 00044: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 319ms/step - loss: 0.2218 - accuracy: 0.9252 - val_loss: 0.3724 - val_accuracy: 0.8896
Epoch 45/90
19/19 [==============================] - ETA: 0s - loss: 0.2137 - accuracy: 0.9285
Epoch 00045: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 320ms/step - loss: 0.2137 - accuracy: 0.9285 - val_loss: 0.3728 - val_accuracy: 0.8897
Epoch 46/90
19/19 [==============================] - ETA: 0s - loss: 0.2152 - accuracy: 0.9223
Epoch 00046: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 322ms/step - loss: 0.2152 - accuracy: 0.9223 - val_loss: 0.3723 - val_accuracy: 0.8893
Epoch 47/90
19/19 [==============================] - ETA: 0s - loss: 0.2262 - accuracy: 0.9235
Epoch 00047: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 320ms/step - loss: 0.2262 - accuracy: 0.9235 - val_loss: 0.3731 - val_accuracy: 0.8894
Epoch 48/90
19/19 [==============================] - ETA: 0s - loss: 0.2114 - accuracy: 0.9248
Epoch 00048: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 319ms/step - loss: 0.2114 - accuracy: 0.9248 - val_loss: 0.3724 - val_accuracy: 0.8891
Epoch 49/90
19/19 [==============================] - ETA: 0s - loss: 0.2112 - accuracy: 0.9285
Epoch 00049: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 319ms/step - loss: 0.2112 - accuracy: 0.9285 - val_loss: 0.3725 - val_accuracy: 0.8896
Epoch 50/90
19/19 [==============================] - ETA: 0s - loss: 0.2170 - accuracy: 0.9268
Epoch 00050: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 318ms/step - loss: 0.2170 - accuracy: 0.9268 - val_loss: 0.3736 - val_accuracy: 0.8900
Epoch 51/90
19/19 [==============================] - ETA: 0s - loss: 0.2384 - accuracy: 0.9198
Epoch 00051: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2384 - accuracy: 0.9198 - val_loss: 0.3740 - val_accuracy: 0.8891
Epoch 52/90
19/19 [==============================] - ETA: 0s - loss: 0.2295 - accuracy: 0.9206
Epoch 00052: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 318ms/step - loss: 0.2295 - accuracy: 0.9206 - val_loss: 0.3745 - val_accuracy: 0.8890
Epoch 53/90
19/19 [==============================] - ETA: 0s - loss: 0.2068 - accuracy: 0.9280
Epoch 00053: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 318ms/step - loss: 0.2068 - accuracy: 0.9280 - val_loss: 0.3748 - val_accuracy: 0.8892
Epoch 54/90
19/19 [==============================] - ETA: 0s - loss: 0.2156 - accuracy: 0.9252
Epoch 00054: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 317ms/step - loss: 0.2156 - accuracy: 0.9252 - val_loss: 0.3754 - val_accuracy: 0.8890
Epoch 55/90
19/19 [==============================] - ETA: 0s - loss: 0.2376 - accuracy: 0.9178
Epoch 00055: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 317ms/step - loss: 0.2376 - accuracy: 0.9178 - val_loss: 0.3750 - val_accuracy: 0.8893
Epoch 56/90
19/19 [==============================] - ETA: 0s - loss: 0.2195 - accuracy: 0.9252
Epoch 00056: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 317ms/step - loss: 0.2195 - accuracy: 0.9252 - val_loss: 0.3753 - val_accuracy: 0.8899
Epoch 57/90
```

```
19/19 [==============================] - ETA: 0s - loss: 0.2054 - accuracy: 0.9322
Epoch 00057: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 316ms/step - loss: 0.2054 - accuracy: 0.9322 - val_loss: 0.3760 - val_accuracy: 0.8888
Epoch 58/90
19/19 [==============================] - ETA: 0s - loss: 0.2225 - accuracy: 0.9161
Epoch 00058: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 317ms/step - loss: 0.2225 - accuracy: 0.9161 - val_loss: 0.3747 - val_accuracy: 0.8896
Epoch 59/90
19/19 [==============================] - ETA: 0s - loss: 0.2158 - accuracy: 0.9313
Epoch 00059: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 318ms/step - loss: 0.2158 - accuracy: 0.9313 - val_loss: 0.3750 - val_accuracy: 0.8889
Epoch 60/90
19/19 [==============================] - ETA: 0s - loss: 0.2215 - accuracy: 0.9206
Epoch 00060: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 319ms/step - loss: 0.2215 - accuracy: 0.9206 - val_loss: 0.3765 - val_accuracy: 0.8887
Epoch 61/90
19/19 [==============================] - ETA: 0s - loss: 0.2144 - accuracy: 0.9289
Epoch 00061: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 319ms/step - loss: 0.2144 - accuracy: 0.9289 - val_loss: 0.3776 - val_accuracy: 0.8889
Epoch 62/90
19/19 [==============================] - ETA: 0s - loss: 0.2566 - accuracy: 0.9100
Epoch 00062: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 323ms/step - loss: 0.2566 - accuracy: 0.9100 - val_loss: 0.3785 - val_accuracy: 0.8885
Epoch 63/90
19/19 [==============================] - ETA: 0s - loss: 0.2093 - accuracy: 0.9305
Epoch 00063: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 321ms/step - loss: 0.2093 - accuracy: 0.9305 - val_loss: 0.3789 - val_accuracy: 0.8877
Epoch 64/90
19/19 [==============================] - ETA: 0s - loss: 0.2047 - accuracy: 0.9313
Epoch 00064: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 320ms/step - loss: 0.2047 - accuracy: 0.9313 - val_loss: 0.3772 - val_accuracy: 0.8882
Epoch 65/90
19/19 [==============================] - ETA: 0s - loss: 0.2111 - accuracy: 0.9280
Epoch 00065: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 321ms/step - loss: 0.2111 - accuracy: 0.9280 - val_loss: 0.3779 - val_accuracy: 0.8885
Epoch 66/90
19/19 [==============================] - ETA: 0s - loss: 0.2234 - accuracy: 0.9228
Epoch 00066: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 319ms/step - loss: 0.2234 - accuracy: 0.9228 - val_loss: 0.3762 - val_accuracy: 0.8888
Epoch 67/90
19/19 [==============================] - ETA: 0s - loss: 0.2429 - accuracy: 0.9190
Epoch 00067: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 323ms/step - loss: 0.2429 - accuracy: 0.9190 - val_loss: 0.3756 - val_accuracy: 0.8888
Epoch 68/90
19/19 [==============================] - ETA: 0s - loss: 0.2197 - accuracy: 0.9260
Epoch 00068: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 320ms/step - loss: 0.2197 - accuracy: 0.9260 - val_loss: 0.3752 - val_accuracy: 0.8887
Epoch 69/90
19/19 [==============================] - ETA: 0s - loss: 0.2242 - accuracy: 0.9252
Epoch 00069: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 320ms/step - loss: 0.2242 - accuracy: 0.9252 - val_loss: 0.3740 - val_accuracy: 0.8882
Epoch 70/90
19/19 [==============================] - ETA: 0s - loss: 0.2313 - accuracy: 0.9206
Epoch 00070: val_accuracy did not improve from 0.89250
```

```
19/19 [==============================] - 6s 320ms/step - loss: 0.2313 - accuracy: 0.9206 - val_loss: 0.3751 - val_accuracy: 0.8882
Epoch 71/90
19/19 [==============================] - ETA: 0s - loss: 0.2073 - accuracy: 0.9322
Epoch 00071: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 319ms/step - loss: 0.2073 - accuracy: 0.9322 - val_loss: 0.3757 - val_accuracy: 0.8885
Epoch 72/90
19/19 [==============================] - ETA: 0s - loss: 0.2299 - accuracy: 0.9174
Epoch 00072: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 320ms/step - loss: 0.2299 - accuracy: 0.9174 - val_loss: 0.3750 - val_accuracy: 0.8884
Epoch 73/90
19/19 [==============================] - ETA: 0s - loss: 0.2349 - accuracy: 0.9132
Epoch 00073: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 320ms/step - loss: 0.2349 - accuracy: 0.9132 - val_loss: 0.3773 - val_accuracy: 0.8882
Epoch 74/90
19/19 [==============================] - ETA: 0s - loss: 0.2116 - accuracy: 0.9239
Epoch 00074: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 322ms/step - loss: 0.2116 - accuracy: 0.9239 - val_loss: 0.3764 - val_accuracy: 0.8886
Epoch 75/90
19/19 [==============================] - ETA: 0s - loss: 0.2184 - accuracy: 0.9235
Epoch 00075: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 323ms/step - loss: 0.2184 - accuracy: 0.9235 - val_loss: 0.3757 - val_accuracy: 0.8887
Epoch 76/90
19/19 [==============================] - ETA: 0s - loss: 0.2332 - accuracy: 0.9199
Epoch 00076: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 319ms/step - loss: 0.2332 - accuracy: 0.9199 - val_loss: 0.3747 - val_accuracy: 0.8887
Epoch 77/90
19/19 [==============================] - ETA: 0s - loss: 0.2406 - accuracy: 0.9161
Epoch 00077: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 321ms/step - loss: 0.2406 - accuracy: 0.9161 - val_loss: 0.3728 - val_accuracy: 0.8891
Epoch 78/90
19/19 [==============================] - ETA: 0s - loss: 0.2212 - accuracy: 0.9224
Epoch 00078: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 320ms/step - loss: 0.2212 - accuracy: 0.9224 - val_loss: 0.3729 - val_accuracy: 0.8890
Epoch 79/90
19/19 [==============================] - ETA: 0s - loss: 0.2405 - accuracy: 0.9137
Epoch 00079: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 323ms/step - loss: 0.2405 - accuracy: 0.9137 - val_loss: 0.3732 - val_accuracy: 0.8894
Epoch 80/90
19/19 [==============================] - ETA: 0s - loss: 0.2042 - accuracy: 0.9297
Epoch 00080: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 322ms/step - loss: 0.2042 - accuracy: 0.9297 - val_loss: 0.3729 - val_accuracy: 0.8893
Epoch 81/90
19/19 [==============================] - ETA: 0s - loss: 0.2053 - accuracy: 0.9342
Epoch 00081: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 321ms/step - loss: 0.2053 - accuracy: 0.9342 - val_loss: 0.3729 - val_accuracy: 0.8895
Epoch 82/90
19/19 [==============================] - ETA: 0s - loss: 0.2236 - accuracy: 0.9235
Epoch 00082: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 321ms/step - loss: 0.2236 - accuracy: 0.9235 - val_loss: 0.3729 - val_accuracy: 0.8897
Epoch 83/90
19/19 [==============================] - ETA: 0s - loss: 0.2161 - accuracy: 0.9285
Epoch 00083: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 320ms/step - loss: 0.2161 - accuracy: 0.9285 - val_loss: 0.3723 - val_accuracy: 0.8901
Epoch 84/90
```

```
19/19 [==============================] - ETA: 0s - loss: 0.2323 - accuracy: 0.9206
Epoch 00084: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 323ms/step - loss: 0.2323 - accuracy: 0.9206 - val_loss: 0.3734 - val_accuracy: 0.8898
Epoch 85/90
19/19 [==============================] - ETA: 0s - loss: 0.2122 - accuracy: 0.9243
Epoch 00085: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 325ms/step - loss: 0.2122 - accuracy: 0.9243 - val_loss: 0.3735 - val_accuracy: 0.8900
Epoch 86/90
19/19 [==============================] - ETA: 0s - loss: 0.2171 - accuracy: 0.9322
Epoch 00086: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 320ms/step - loss: 0.2171 - accuracy: 0.9322 - val_loss: 0.3739 - val_accuracy: 0.8898
Epoch 87/90
19/19 [==============================] - ETA: 0s - loss: 0.2106 - accuracy: 0.9248
Epoch 00087: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 320ms/step - loss: 0.2106 - accuracy: 0.9248 - val_loss: 0.3734 - val_accuracy: 0.8903
Epoch 88/90
19/19 [==============================] - ETA: 0s - loss: 0.2285 - accuracy: 0.9219
Epoch 00088: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 319ms/step - loss: 0.2285 - accuracy: 0.9219 - val_loss: 0.3738 - val_accuracy: 0.8898
Epoch 89/90
19/19 [==============================] - ETA: 0s - loss: 0.2166 - accuracy: 0.9293
Epoch 00089: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 320ms/step - loss: 0.2166 - accuracy: 0.9293 - val_loss: 0.3756 - val_accuracy: 0.8887
Epoch 90/90
19/19 [==============================] - ETA: 0s - loss: 0.2297 - accuracy: 0.9252
Epoch 00090: val_accuracy did not improve from 0.89250
19/19 [==============================] - 6s 319ms/step - loss: 0.2297 - accuracy: 0.9252 - val_loss: 0.3757 - val_accuracy: 0.8893
```

Model 2: Depthwise Seperable Conv2D + without Dropout + Without Dense Layer + Image Augmentation + SGD + Weight Regularizer(L1+L2).

ADAM performs better than SGD ir seems. Let's using **more filters + bias=True + increased kernel size.**

In [ ]:
```
tf.keras.backend.clear_session()

if 'model' in locals():
  del(model)
```

In [ ]:
```
# Hyperparameters
batch_size = 128
num_classes = 10
epochs =100
l = 24
num_filter = 36
compression = 0.5
dropout_rate = 0.0
```

In [ ]:

```
# Dense Block
def denseblock(input, num_filter = num_filter, dropout_rate = dropout_rate):
    global compression
    temp = input
    for _ in range(l):
        BatchNorm = layers.BatchNormalization()(temp)
        relu = layers.Activation('relu')(BatchNorm)
        Conv2D_3_3 = layers.SeparableConv2D(int(num_filter*compression), (3,3), use_bias=False ,padding='same',
                                    kernel_initializer='he_normal',kernel_regularizer=regularizers.L1L2(l1=0.000001, l2=0.00001))(relu)
        #Conv2D_3_3 = layers.Conv2D(int(num_filter*compression), (3,3), use_bias=False ,padding='same')(relu)
        if dropout_rate>0:
            Conv2D_3_3 = layers.Dropout(dropout_rate)(Conv2D_3_3)
        concat = layers.Concatenate(axis=-1)([temp,Conv2D_3_3])

        temp = concat

    return temp

## transition Blosck
def transition(input, num_filter = num_filter, dropout_rate = dropout_rate):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    Conv2D_BottleNeck = layers.SeparableConv2D(int(num_filter*compression), (1,1), use_bias=False ,padding='same',
                                           depthwise_initializer='he_normal', depthwise_regularizer=regularizers.L1L2(l1=0.0001, l2=0.0001),
                                           kernel_regularizer=regularizers.L2(l2=0.001))(relu)
    #Conv2D_BottleNeck =  Conv2D(int(num_filter*compression), (1,1), use_bias=False, kernel_regularizer = regularizers.l1() ,padding='same')(relu)
    if dropout_rate>0:
         Conv2D_BottleNeck = layers.Dropout(dropout_rate)(Conv2D_BottleNeck)
    avg = layers.AveragePooling2D(pool_size=(2,2))(Conv2D_BottleNeck)
    return avg

#output layer
def output_layer(input):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    AvgPooling = layers.AveragePooling2D(pool_size=(2,2))(relu)
    #flat = layers.Flatten()(AvgPooling)
    #output = layers.Dense(num_classes, activation='softmax')(flat)
    out_conv = layers.Conv2D(num_classes, kernel_size = (2,2), activation='softmax')(AvgPooling)
    output = layers.Flatten()(out_conv)


    return output
```

In [ ]:

```
#Model Architecture
input = layers.Input(shape=(img_height, img_width, channel,))
```

```
First_Conv2D = layers.Conv2D(num_filter, (3,3), use_bias=False ,padding='same')(input)
#First_Conv2D = layers.SeparableConv2D(int(num_filter), (3,3), use_bias=True ,padding='same',
                                      #kernel_regularizer=regularizers.L1L2(l1=0.0001, l2=0.0001))(input)

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

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

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

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

model = Model(inputs=[input], outputs=[output])
```

In [ ]:

```
# mormalize data
#X_train = X_train.astype('float32') / 255
#X_test = X_test.astype('float32') / 255
```

In [ ]:

```
###Image data Generator class
datagen = tf.keras.preprocessing.image.ImageDataGenerator(featurewise_center=False,
                                                          samplewise_center=False,
                                                          featurewise_std_normalization=False,
                                                          samplewise_std_normalization=False,
                                                          zca_whitening=False,
                                                          rotation_range=15,
                                                          width_shift_range=0.1,
                                                          height_shift_range=0.1,
                                                          horizontal_flip=True,
                                                          vertical_flip=False , zoom_range=0.2, shear_range=15)
##We are fitting the data to Image data generator.
#ImageGenerator = ImageFlow.flow(X_train,seed=10,batch_size=32)
datagen.fit(X_train, augment=False )
```

In [ ]:

```
#Saving Best Model and Representation of results
filepath = "/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5"
checkpoint = ModelCheckpoint(filepath= filepath, save_weights_only=True,
                             monitor='val_accuracy', verbose=1,
                             save_best_only=True, mode='max')

log_dir = "logs/model_depthwise"
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir = log_dir, histogram_freq=1)
#callback_list = [checkpoint, tensorboard_callback, decay_lr]
```

```
#Model Compilation
model.compile(loss='categorical_crossentropy',
              optimizer=tf.keras.optimizers.SGD(0.01, momentum = 0.7),
              metrics=['accuracy'])
```

In [ ]:

```
model.summary()
```

```
Model: "model"
__________________________________________________________________________________________________
 Layer (type)                   Output Shape         Param #     Connected to
==================================================================================================
 input_1 (InputLayer)           [(None, 32, 32, 3)]  0           []

 conv2d (Conv2D)                (None, 32, 32, 36)   972         ['input_1[0][0]']

 batch_normalization (BatchNorm  (None, 32, 32, 36)  144         ['conv2d[0][0]']
 alization)

 activation (Activation)        (None, 32, 32, 36)   0           ['batch_normalization[0][0]']

 separable_conv2d (SeparableCon  (None, 32, 32, 18)  972         ['activation[0][0]']
 v2D)

 concatenate (Concatenate)      (None, 32, 32, 54)   0           ['conv2d[0][0]',
                                                                  'separable_conv2d[0][0]']

 batch_normalization_1 (BatchNo  (None, 32, 32, 54)  216         ['concatenate[0][0]']
 rmalization)

 activation_1 (Activation)      (None, 32, 32, 54)   0           ['batch_normalization_1[0][0]']

 separable_conv2d_1 (SeparableC  (None, 32, 32, 18)  1458        ['activation_1[0][0]']
 onv2D)

 concatenate_1 (Concatenate)    (None, 32, 32, 72)   0           ['concatenate[0][0]',
                                                                  'separable_conv2d_1[0][0]']

 batch_normalization_2 (BatchNo  (None, 32, 32, 72)  288         ['concatenate_1[0][0]']
 rmalization)

 activation_2 (Activation)      (None, 32, 32, 72)   0           ['batch_normalization_2[0][0]']

 separable_conv2d_2 (SeparableC  (None, 32, 32, 18)  1944        ['activation_2[0][0]']
 onv2D)

 concatenate_2 (Concatenate)    (None, 32, 32, 90)   0           ['concatenate_1[0][0]',
                                                                  'separable_conv2d_2[0][0]']

 batch_normalization_3 (BatchNo  (None, 32, 32, 90)  360         ['concatenate_2[0][0]']
 rmalization)
```

```
activation_3 (Activation)      (None, 32, 32, 90)   0           ['batch_normalization_3[0][0]']

separable_conv2d_3 (SeparableC  (None, 32, 32, 18)  2430        ['activation_3[0][0]']
onv2D)

concatenate_3 (Concatenate)    (None, 32, 32, 108)  0           ['concatenate_2[0][0]',
                                                                 'separable_conv2d_3[0][0]']

batch_normalization_4 (BatchNo  (None, 32, 32, 108)  432        ['concatenate_3[0][0]']
rmalization)

activation_4 (Activation)      (None, 32, 32, 108)  0           ['batch_normalization_4[0][0]']

separable_conv2d_4 (SeparableC  (None, 32, 32, 18)  2916        ['activation_4[0][0]']
onv2D)

concatenate_4 (Concatenate)    (None, 32, 32, 126)  0           ['concatenate_3[0][0]',
                                                                 'separable_conv2d_4[0][0]']

batch_normalization_5 (BatchNo  (None, 32, 32, 126)  504        ['concatenate_4[0][0]']
rmalization)

activation_5 (Activation)      (None, 32, 32, 126)  0           ['batch_normalization_5[0][0]']

separable_conv2d_5 (SeparableC  (None, 32, 32, 18)  3402        ['activation_5[0][0]']
onv2D)

concatenate_5 (Concatenate)    (None, 32, 32, 144)  0           ['concatenate_4[0][0]',
                                                                 'separable_conv2d_5[0][0]']

batch_normalization_6 (BatchNo  (None, 32, 32, 144)  576        ['concatenate_5[0][0]']
rmalization)

activation_6 (Activation)      (None, 32, 32, 144)  0           ['batch_normalization_6[0][0]']

separable_conv2d_6 (SeparableC  (None, 32, 32, 18)  3888        ['activation_6[0][0]']
onv2D)

concatenate_6 (Concatenate)    (None, 32, 32, 162)  0           ['concatenate_5[0][0]',
                                                                 'separable_conv2d_6[0][0]']

batch_normalization_7 (BatchNo  (None, 32, 32, 162)  648        ['concatenate_6[0][0]']
rmalization)

activation_7 (Activation)      (None, 32, 32, 162)  0           ['batch_normalization_7[0][0]']

separable_conv2d_7 (SeparableC  (None, 32, 32, 18)  4374        ['activation_7[0][0]']
onv2D)

concatenate_7 (Concatenate)    (None, 32, 32, 180)  0           ['concatenate_6[0][0]',
                                                                 'separable_conv2d_7[0][0]']

batch_normalization_8 (BatchNo  (None, 32, 32, 180)  720        ['concatenate_7[0][0]']
rmalization)
```

```
activation_8 (Activation)      (None, 32, 32, 180)  0           ['batch_normalization_8[0][0]']

separable_conv2d_8 (SeparableC  (None, 32, 32, 18)  4860        ['activation_8[0][0]']
onv2D)

concatenate_8 (Concatenate)    (None, 32, 32, 198)  0           ['concatenate_7[0][0]',
                                                                 'separable_conv2d_8[0][0]']

batch_normalization_9 (BatchNo  (None, 32, 32, 198)  792        ['concatenate_8[0][0]']
rmalization)

activation_9 (Activation)      (None, 32, 32, 198)  0           ['batch_normalization_9[0][0]']

separable_conv2d_9 (SeparableC  (None, 32, 32, 18)  5346        ['activation_9[0][0]']
onv2D)

concatenate_9 (Concatenate)    (None, 32, 32, 216)  0           ['concatenate_8[0][0]',
                                                                 'separable_conv2d_9[0][0]']

batch_normalization_10 (BatchN  (None, 32, 32, 216)  864        ['concatenate_9[0][0]']
ormalization)

activation_10 (Activation)     (None, 32, 32, 216)  0           ['batch_normalization_10[0][0]']

separable_conv2d_10 (Separable  (None, 32, 32, 18)  5832        ['activation_10[0][0]']
Conv2D)

concatenate_10 (Concatenate)   (None, 32, 32, 234)  0           ['concatenate_9[0][0]',
                                                                 'separable_conv2d_10[0][0]']

batch_normalization_11 (BatchN  (None, 32, 32, 234)  936        ['concatenate_10[0][0]']
ormalization)

activation_11 (Activation)     (None, 32, 32, 234)  0           ['batch_normalization_11[0][0]']

separable_conv2d_11 (Separable  (None, 32, 32, 18)  6318        ['activation_11[0][0]']
Conv2D)

concatenate_11 (Concatenate)   (None, 32, 32, 252)  0           ['concatenate_10[0][0]',
                                                                 'separable_conv2d_11[0][0]']

batch_normalization_12 (BatchN  (None, 32, 32, 252)  1008       ['concatenate_11[0][0]']
ormalization)

activation_12 (Activation)     (None, 32, 32, 252)  0           ['batch_normalization_12[0][0]']

separable_conv2d_12 (Separable  (None, 32, 32, 18)  6804        ['activation_12[0][0]']
Conv2D)

concatenate_12 (Concatenate)   (None, 32, 32, 270)  0           ['concatenate_11[0][0]',
                                                                 'separable_conv2d_12[0][0]']

batch_normalization_13 (BatchN  (None, 32, 32, 270)  1080       ['concatenate_12[0][0]']
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ormalization)

activation_13 (Activation)     (None, 32, 32, 270)  0           ['batch_normalization_13[0][0]']

separable_conv2d_13 (Separable  (None, 32, 32, 18)  7290        ['activation_13[0][0]']
Conv2D)

concatenate_13 (Concatenate)   (None, 32, 32, 288)  0           ['concatenate_12[0][0]',
                                                                 'separable_conv2d_13[0][0]']

batch_normalization_14 (BatchN  (None, 32, 32, 288)  1152       ['concatenate_13[0][0]']
ormalization)

activation_14 (Activation)     (None, 32, 32, 288)  0           ['batch_normalization_14[0][0]']

separable_conv2d_14 (Separable  (None, 32, 32, 18)  7776        ['activation_14[0][0]']
Conv2D)

concatenate_14 (Concatenate)   (None, 32, 32, 306)  0           ['concatenate_13[0][0]',
                                                                 'separable_conv2d_14[0][0]']

batch_normalization_15 (BatchN  (None, 32, 32, 306)  1224       ['concatenate_14[0][0]']
ormalization)

activation_15 (Activation)     (None, 32, 32, 306)  0           ['batch_normalization_15[0][0]']

separable_conv2d_15 (Separable  (None, 32, 32, 18)  8262        ['activation_15[0][0]']
Conv2D)

concatenate_15 (Concatenate)   (None, 32, 32, 324)  0           ['concatenate_14[0][0]',
                                                                 'separable_conv2d_15[0][0]']

batch_normalization_16 (BatchN  (None, 32, 32, 324)  1296       ['concatenate_15[0][0]']
ormalization)

activation_16 (Activation)     (None, 32, 32, 324)  0           ['batch_normalization_16[0][0]']

separable_conv2d_16 (Separable  (None, 32, 32, 18)  8748        ['activation_16[0][0]']
Conv2D)

concatenate_16 (Concatenate)   (None, 32, 32, 342)  0           ['concatenate_15[0][0]',
                                                                 'separable_conv2d_16[0][0]']

batch_normalization_17 (BatchN  (None, 32, 32, 342)  1368       ['concatenate_16[0][0]']
ormalization)

activation_17 (Activation)     (None, 32, 32, 342)  0           ['batch_normalization_17[0][0]']

separable_conv2d_17 (Separable  (None, 32, 32, 18)  9234        ['activation_17[0][0]']
Conv2D)

concatenate_17 (Concatenate)   (None, 32, 32, 360)  0           ['concatenate_16[0][0]',
                                                                 'separable_conv2d_17[0][0]']
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batch_normalization_18 (BatchN  (None, 32, 32, 360)  1440       ['concatenate_17[0][0]']
ormalization)

activation_18 (Activation)     (None, 32, 32, 360)  0          ['batch_normalization_18[0][0]']

separable_conv2d_18 (Separable  (None, 32, 32, 18)  9720       ['activation_18[0][0]']
Conv2D)

concatenate_18 (Concatenate)   (None, 32, 32, 378)  0          ['concatenate_17[0][0]',
                                                                'separable_conv2d_18[0][0]']

batch_normalization_19 (BatchN  (None, 32, 32, 378)  1512       ['concatenate_18[0][0]']
ormalization)

activation_19 (Activation)     (None, 32, 32, 378)  0          ['batch_normalization_19[0][0]']

separable_conv2d_19 (Separable  (None, 32, 32, 18)  10206      ['activation_19[0][0]']
Conv2D)

concatenate_19 (Concatenate)   (None, 32, 32, 396)  0          ['concatenate_18[0][0]',
                                                                'separable_conv2d_19[0][0]']

batch_normalization_20 (BatchN  (None, 32, 32, 396)  1584       ['concatenate_19[0][0]']
ormalization)

activation_20 (Activation)     (None, 32, 32, 396)  0          ['batch_normalization_20[0][0]']

separable_conv2d_20 (Separable  (None, 32, 32, 18)  10692      ['activation_20[0][0]']
Conv2D)

concatenate_20 (Concatenate)   (None, 32, 32, 414)  0          ['concatenate_19[0][0]',
                                                                'separable_conv2d_20[0][0]']

batch_normalization_21 (BatchN  (None, 32, 32, 414)  1656       ['concatenate_20[0][0]']
ormalization)

activation_21 (Activation)     (None, 32, 32, 414)  0          ['batch_normalization_21[0][0]']

separable_conv2d_21 (Separable  (None, 32, 32, 18)  11178      ['activation_21[0][0]']
Conv2D)

concatenate_21 (Concatenate)   (None, 32, 32, 432)  0          ['concatenate_20[0][0]',
                                                                'separable_conv2d_21[0][0]']

batch_normalization_22 (BatchN  (None, 32, 32, 432)  1728       ['concatenate_21[0][0]']
ormalization)

activation_22 (Activation)     (None, 32, 32, 432)  0          ['batch_normalization_22[0][0]']

separable_conv2d_22 (Separable  (None, 32, 32, 18)  11664      ['activation_22[0][0]']
Conv2D)

concatenate_22 (Concatenate)   (None, 32, 32, 450)  0          ['concatenate_21[0][0]',
                                                                'separable_conv2d_22[0][0]']
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batch_normalization_23 (BatchN  (None, 32, 32, 450)  1800       ['concatenate_22[0][0]']
ormalization)

activation_23 (Activation)     (None, 32, 32, 450)  0          ['batch_normalization_23[0][0]']

separable_conv2d_23 (Separable  (None, 32, 32, 18)  12150      ['activation_23[0][0]']
Conv2D)

concatenate_23 (Concatenate)   (None, 32, 32, 468)  0          ['concatenate_22[0][0]',
                                                                'separable_conv2d_23[0][0]']

batch_normalization_24 (BatchN  (None, 32, 32, 468)  1872       ['concatenate_23[0][0]']
ormalization)

activation_24 (Activation)     (None, 32, 32, 468)  0          ['batch_normalization_24[0][0]']

separable_conv2d_24 (Separable  (None, 32, 32, 18)  8892       ['activation_24[0][0]']
Conv2D)

average_pooling2d (AveragePool  (None, 16, 16, 18)  0          ['separable_conv2d_24[0][0]']
ing2D)

batch_normalization_25 (BatchN  (None, 16, 16, 18)  72         ['average_pooling2d[0][0]']
ormalization)

activation_25 (Activation)     (None, 16, 16, 18)   0          ['batch_normalization_25[0][0]']

separable_conv2d_25 (Separable  (None, 16, 16, 18)  486        ['activation_25[0][0]']
Conv2D)

concatenate_24 (Concatenate)   (None, 16, 16, 36)   0          ['average_pooling2d[0][0]',
                                                                'separable_conv2d_25[0][0]']

batch_normalization_26 (BatchN  (None, 16, 16, 36)  144        ['concatenate_24[0][0]']
ormalization)

activation_26 (Activation)     (None, 16, 16, 36)   0          ['batch_normalization_26[0][0]']

separable_conv2d_26 (Separable  (None, 16, 16, 18)  972        ['activation_26[0][0]']
Conv2D)

concatenate_25 (Concatenate)   (None, 16, 16, 54)   0          ['concatenate_24[0][0]',
                                                                'separable_conv2d_26[0][0]']

batch_normalization_27 (BatchN  (None, 16, 16, 54)  216        ['concatenate_25[0][0]']
ormalization)

activation_27 (Activation)     (None, 16, 16, 54)   0          ['batch_normalization_27[0][0]']

separable_conv2d_27 (Separable  (None, 16, 16, 18)  1458       ['activation_27[0][0]']
Conv2D)

concatenate_26 (Concatenate)   (None, 16, 16, 72)   0          ['concatenate_25[0][0]',
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                                                                  'separable_conv2d_27[0][0]']

batch_normalization_28 (BatchN  (None, 16, 16, 72)  288         ['concatenate_26[0][0]']
ormalization)

activation_28 (Activation)     (None, 16, 16, 72)   0           ['batch_normalization_28[0][0]']

separable_conv2d_28 (Separable  (None, 16, 16, 18)  1944        ['activation_28[0][0]']
Conv2D)

concatenate_27 (Concatenate)   (None, 16, 16, 90)   0           ['concatenate_26[0][0]',
                                                                 'separable_conv2d_28[0][0]']

batch_normalization_29 (BatchN  (None, 16, 16, 90)  360         ['concatenate_27[0][0]']
ormalization)

activation_29 (Activation)     (None, 16, 16, 90)   0           ['batch_normalization_29[0][0]']

separable_conv2d_29 (Separable  (None, 16, 16, 18)  2430        ['activation_29[0][0]']
Conv2D)

concatenate_28 (Concatenate)   (None, 16, 16, 108)  0          ['concatenate_27[0][0]',
                                                                 'separable_conv2d_29[0][0]']

batch_normalization_30 (BatchN  (None, 16, 16, 108)  432        ['concatenate_28[0][0]']
ormalization)

activation_30 (Activation)     (None, 16, 16, 108)  0           ['batch_normalization_30[0][0]']

separable_conv2d_30 (Separable  (None, 16, 16, 18)  2916        ['activation_30[0][0]']
Conv2D)

concatenate_29 (Concatenate)   (None, 16, 16, 126)  0          ['concatenate_28[0][0]',
                                                                 'separable_conv2d_30[0][0]']

batch_normalization_31 (BatchN  (None, 16, 16, 126)  504        ['concatenate_29[0][0]']
ormalization)

activation_31 (Activation)     (None, 16, 16, 126)  0           ['batch_normalization_31[0][0]']

separable_conv2d_31 (Separable  (None, 16, 16, 18)  3402        ['activation_31[0][0]']
Conv2D)

concatenate_30 (Concatenate)   (None, 16, 16, 144)  0          ['concatenate_29[0][0]',
                                                                 'separable_conv2d_31[0][0]']

batch_normalization_32 (BatchN  (None, 16, 16, 144)  576        ['concatenate_30[0][0]']
ormalization)

activation_32 (Activation)     (None, 16, 16, 144)  0           ['batch_normalization_32[0][0]']

separable_conv2d_32 (Separable  (None, 16, 16, 18)  3888        ['activation_32[0][0]']
Conv2D)
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concatenate_31 (Concatenate)   (None, 16, 16, 162)  0           ['concatenate_30[0][0]',
                                                                 'separable_conv2d_32[0][0]']

batch_normalization_33 (BatchN  (None, 16, 16, 162)  648        ['concatenate_31[0][0]']
ormalization)

activation_33 (Activation)     (None, 16, 16, 162)  0           ['batch_normalization_33[0][0]']

separable_conv2d_33 (Separable  (None, 16, 16, 18)  4374        ['activation_33[0][0]']
Conv2D)

concatenate_32 (Concatenate)   (None, 16, 16, 180)  0           ['concatenate_31[0][0]',
                                                                 'separable_conv2d_33[0][0]']

batch_normalization_34 (BatchN  (None, 16, 16, 180)  720        ['concatenate_32[0][0]']
ormalization)

activation_34 (Activation)     (None, 16, 16, 180)  0           ['batch_normalization_34[0][0]']

separable_conv2d_34 (Separable  (None, 16, 16, 18)  4860        ['activation_34[0][0]']
Conv2D)

concatenate_33 (Concatenate)   (None, 16, 16, 198)  0           ['concatenate_32[0][0]',
                                                                 'separable_conv2d_34[0][0]']

batch_normalization_35 (BatchN  (None, 16, 16, 198)  792        ['concatenate_33[0][0]']
ormalization)

activation_35 (Activation)     (None, 16, 16, 198)  0           ['batch_normalization_35[0][0]']

separable_conv2d_35 (Separable  (None, 16, 16, 18)  5346        ['activation_35[0][0]']
Conv2D)

concatenate_34 (Concatenate)   (None, 16, 16, 216)  0           ['concatenate_33[0][0]',
                                                                 'separable_conv2d_35[0][0]']

batch_normalization_36 (BatchN  (None, 16, 16, 216)  864        ['concatenate_34[0][0]']
ormalization)

activation_36 (Activation)     (None, 16, 16, 216)  0           ['batch_normalization_36[0][0]']

separable_conv2d_36 (Separable  (None, 16, 16, 18)  5832        ['activation_36[0][0]']
Conv2D)

concatenate_35 (Concatenate)   (None, 16, 16, 234)  0           ['concatenate_34[0][0]',
                                                                 'separable_conv2d_36[0][0]']

batch_normalization_37 (BatchN  (None, 16, 16, 234)  936        ['concatenate_35[0][0]']
ormalization)

activation_37 (Activation)     (None, 16, 16, 234)  0           ['batch_normalization_37[0][0]']

separable_conv2d_37 (Separable  (None, 16, 16, 18)  6318        ['activation_37[0][0]']
Conv2D)
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concatenate_36 (Concatenate)   (None, 16, 16, 252)  0           ['concatenate_35[0][0]',
                                                                 'separable_conv2d_37[0][0]']

batch_normalization_38 (BatchN  (None, 16, 16, 252)  1008       ['concatenate_36[0][0]']
ormalization)

activation_38 (Activation)     (None, 16, 16, 252)  0           ['batch_normalization_38[0][0]']

separable_conv2d_38 (Separable  (None, 16, 16, 18)  6804        ['activation_38[0][0]']
Conv2D)

concatenate_37 (Concatenate)   (None, 16, 16, 270)  0           ['concatenate_36[0][0]',
                                                                 'separable_conv2d_38[0][0]']

batch_normalization_39 (BatchN  (None, 16, 16, 270)  1080       ['concatenate_37[0][0]']
ormalization)

activation_39 (Activation)     (None, 16, 16, 270)  0           ['batch_normalization_39[0][0]']

separable_conv2d_39 (Separable  (None, 16, 16, 18)  7290        ['activation_39[0][0]']
Conv2D)

concatenate_38 (Concatenate)   (None, 16, 16, 288)  0           ['concatenate_37[0][0]',
                                                                 'separable_conv2d_39[0][0]']

batch_normalization_40 (BatchN  (None, 16, 16, 288)  1152       ['concatenate_38[0][0]']
ormalization)

activation_40 (Activation)     (None, 16, 16, 288)  0           ['batch_normalization_40[0][0]']

separable_conv2d_40 (Separable  (None, 16, 16, 18)  7776        ['activation_40[0][0]']
Conv2D)

concatenate_39 (Concatenate)   (None, 16, 16, 306)  0           ['concatenate_38[0][0]',
                                                                 'separable_conv2d_40[0][0]']

batch_normalization_41 (BatchN  (None, 16, 16, 306)  1224       ['concatenate_39[0][0]']
ormalization)

activation_41 (Activation)     (None, 16, 16, 306)  0           ['batch_normalization_41[0][0]']

separable_conv2d_41 (Separable  (None, 16, 16, 18)  8262        ['activation_41[0][0]']
Conv2D)

concatenate_40 (Concatenate)   (None, 16, 16, 324)  0           ['concatenate_39[0][0]',
                                                                 'separable_conv2d_41[0][0]']

batch_normalization_42 (BatchN  (None, 16, 16, 324)  1296       ['concatenate_40[0][0]']
ormalization)

activation_42 (Activation)     (None, 16, 16, 324)  0           ['batch_normalization_42[0][0]']

separable_conv2d_42 (Separable  (None, 16, 16, 18)  8748        ['activation_42[0][0]']
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Conv2D)

concatenate_41 (Concatenate)   (None, 16, 16, 342)  0           ['concatenate_40[0][0]',
                                                                 'separable_conv2d_42[0][0]']

batch_normalization_43 (BatchN  (None, 16, 16, 342)  1368       ['concatenate_41[0][0]']
ormalization)

activation_43 (Activation)     (None, 16, 16, 342)  0           ['batch_normalization_43[0][0]']

separable_conv2d_43 (Separable  (None, 16, 16, 18)  9234        ['activation_43[0][0]']
Conv2D)

concatenate_42 (Concatenate)   (None, 16, 16, 360)  0           ['concatenate_41[0][0]',
                                                                 'separable_conv2d_43[0][0]']

batch_normalization_44 (BatchN  (None, 16, 16, 360)  1440       ['concatenate_42[0][0]']
ormalization)

activation_44 (Activation)     (None, 16, 16, 360)  0           ['batch_normalization_44[0][0]']

separable_conv2d_44 (Separable  (None, 16, 16, 18)  9720        ['activation_44[0][0]']
Conv2D)

concatenate_43 (Concatenate)   (None, 16, 16, 378)  0           ['concatenate_42[0][0]',
                                                                 'separable_conv2d_44[0][0]']

batch_normalization_45 (BatchN  (None, 16, 16, 378)  1512       ['concatenate_43[0][0]']
ormalization)

activation_45 (Activation)     (None, 16, 16, 378)  0           ['batch_normalization_45[0][0]']

separable_conv2d_45 (Separable  (None, 16, 16, 18)  10206       ['activation_45[0][0]']
Conv2D)

concatenate_44 (Concatenate)   (None, 16, 16, 396)  0           ['concatenate_43[0][0]',
                                                                 'separable_conv2d_45[0][0]']

batch_normalization_46 (BatchN  (None, 16, 16, 396)  1584       ['concatenate_44[0][0]']
ormalization)

activation_46 (Activation)     (None, 16, 16, 396)  0           ['batch_normalization_46[0][0]']

separable_conv2d_46 (Separable  (None, 16, 16, 18)  10692       ['activation_46[0][0]']
Conv2D)

concatenate_45 (Concatenate)   (None, 16, 16, 414)  0           ['concatenate_44[0][0]',
                                                                 'separable_conv2d_46[0][0]']

batch_normalization_47 (BatchN  (None, 16, 16, 414)  1656       ['concatenate_45[0][0]']
ormalization)

activation_47 (Activation)     (None, 16, 16, 414)  0           ['batch_normalization_47[0][0]']
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separable_conv2d_47 (Separable  (None, 16, 16, 18)  11178       ['activation_47[0][0]']
Conv2D)

concatenate_46 (Concatenate)   (None, 16, 16, 432)  0           ['concatenate_45[0][0]',
                                                                 'separable_conv2d_47[0][0]']

batch_normalization_48 (BatchN  (None, 16, 16, 432)  1728       ['concatenate_46[0][0]']
ormalization)

activation_48 (Activation)     (None, 16, 16, 432)  0           ['batch_normalization_48[0][0]']

separable_conv2d_48 (Separable  (None, 16, 16, 18)  11664       ['activation_48[0][0]']
Conv2D)

concatenate_47 (Concatenate)   (None, 16, 16, 450)  0           ['concatenate_46[0][0]',
                                                                 'separable_conv2d_48[0][0]']

batch_normalization_49 (BatchN  (None, 16, 16, 450)  1800       ['concatenate_47[0][0]']
ormalization)

activation_49 (Activation)     (None, 16, 16, 450)  0           ['batch_normalization_49[0][0]']

separable_conv2d_49 (Separable  (None, 16, 16, 18)  8550        ['activation_49[0][0]']
Conv2D)

average_pooling2d_1 (AveragePo  (None, 8, 8, 18)    0           ['separable_conv2d_49[0][0]']
oling2D)

batch_normalization_50 (BatchN  (None, 8, 8, 18)    72          ['average_pooling2d_1[0][0]']
ormalization)

activation_50 (Activation)     (None, 8, 8, 18)     0           ['batch_normalization_50[0][0]']

separable_conv2d_50 (Separable  (None, 8, 8, 18)    486         ['activation_50[0][0]']
Conv2D)

concatenate_48 (Concatenate)   (None, 8, 8, 36)     0           ['average_pooling2d_1[0][0]',
                                                                 'separable_conv2d_50[0][0]']

batch_normalization_51 (BatchN  (None, 8, 8, 36)    144         ['concatenate_48[0][0]']
ormalization)

activation_51 (Activation)     (None, 8, 8, 36)     0           ['batch_normalization_51[0][0]']

separable_conv2d_51 (Separable  (None, 8, 8, 18)    972         ['activation_51[0][0]']
Conv2D)

concatenate_49 (Concatenate)   (None, 8, 8, 54)     0           ['concatenate_48[0][0]',
                                                                 'separable_conv2d_51[0][0]']

batch_normalization_52 (BatchN  (None, 8, 8, 54)    216         ['concatenate_49[0][0]']
ormalization)

activation_52 (Activation)     (None, 8, 8, 54)     0           ['batch_normalization_52[0][0]']
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separable_conv2d_52 (Separable  (None, 8, 8, 18)    1458        ['activation_52[0][0]']
Conv2D)

concatenate_50 (Concatenate)   (None, 8, 8, 72)     0           ['concatenate_49[0][0]',
                                                                 'separable_conv2d_52[0][0]']

batch_normalization_53 (BatchN  (None, 8, 8, 72)    288         ['concatenate_50[0][0]']
ormalization)

activation_53 (Activation)     (None, 8, 8, 72)     0           ['batch_normalization_53[0][0]']

separable_conv2d_53 (Separable  (None, 8, 8, 18)    1944        ['activation_53[0][0]']
Conv2D)

concatenate_51 (Concatenate)   (None, 8, 8, 90)     0           ['concatenate_50[0][0]',
                                                                 'separable_conv2d_53[0][0]']

batch_normalization_54 (BatchN  (None, 8, 8, 90)    360         ['concatenate_51[0][0]']
ormalization)

activation_54 (Activation)     (None, 8, 8, 90)     0           ['batch_normalization_54[0][0]']

separable_conv2d_54 (Separable  (None, 8, 8, 18)    2430        ['activation_54[0][0]']
Conv2D)

concatenate_52 (Concatenate)   (None, 8, 8, 108)    0           ['concatenate_51[0][0]',
                                                                 'separable_conv2d_54[0][0]']

batch_normalization_55 (BatchN  (None, 8, 8, 108)   432         ['concatenate_52[0][0]']
ormalization)

activation_55 (Activation)     (None, 8, 8, 108)    0           ['batch_normalization_55[0][0]']

separable_conv2d_55 (Separable  (None, 8, 8, 18)    2916        ['activation_55[0][0]']
Conv2D)

concatenate_53 (Concatenate)   (None, 8, 8, 126)    0           ['concatenate_52[0][0]',
                                                                 'separable_conv2d_55[0][0]']

batch_normalization_56 (BatchN  (None, 8, 8, 126)   504         ['concatenate_53[0][0]']
ormalization)

activation_56 (Activation)     (None, 8, 8, 126)    0           ['batch_normalization_56[0][0]']

separable_conv2d_56 (Separable  (None, 8, 8, 18)    3402        ['activation_56[0][0]']
Conv2D)

concatenate_54 (Concatenate)   (None, 8, 8, 144)    0           ['concatenate_53[0][0]',
                                                                 'separable_conv2d_56[0][0]']

batch_normalization_57 (BatchN  (None, 8, 8, 144)   576         ['concatenate_54[0][0]']
ormalization)
```

```
activation_57 (Activation)     (None, 8, 8, 144)    0           ['batch_normalization_57[0][0]']

separable_conv2d_57 (Separable  (None, 8, 8, 18)    3888        ['activation_57[0][0]']
Conv2D)

concatenate_55 (Concatenate)   (None, 8, 8, 162)    0           ['concatenate_54[0][0]',
                                                                 'separable_conv2d_57[0][0]']

batch_normalization_58 (BatchN  (None, 8, 8, 162)   648         ['concatenate_55[0][0]']
ormalization)

activation_58 (Activation)     (None, 8, 8, 162)    0           ['batch_normalization_58[0][0]']

separable_conv2d_58 (Separable  (None, 8, 8, 18)    4374        ['activation_58[0][0]']
Conv2D)

concatenate_56 (Concatenate)   (None, 8, 8, 180)    0           ['concatenate_55[0][0]',
                                                                 'separable_conv2d_58[0][0]']

batch_normalization_59 (BatchN  (None, 8, 8, 180)   720         ['concatenate_56[0][0]']
ormalization)

activation_59 (Activation)     (None, 8, 8, 180)    0           ['batch_normalization_59[0][0]']

separable_conv2d_59 (Separable  (None, 8, 8, 18)    4860        ['activation_59[0][0]']
Conv2D)

concatenate_57 (Concatenate)   (None, 8, 8, 198)    0           ['concatenate_56[0][0]',
                                                                 'separable_conv2d_59[0][0]']

batch_normalization_60 (BatchN  (None, 8, 8, 198)   792         ['concatenate_57[0][0]']
ormalization)

activation_60 (Activation)     (None, 8, 8, 198)    0           ['batch_normalization_60[0][0]']

separable_conv2d_60 (Separable  (None, 8, 8, 18)    5346        ['activation_60[0][0]']
Conv2D)

concatenate_58 (Concatenate)   (None, 8, 8, 216)    0           ['concatenate_57[0][0]',
                                                                 'separable_conv2d_60[0][0]']

batch_normalization_61 (BatchN  (None, 8, 8, 216)   864         ['concatenate_58[0][0]']
ormalization)

activation_61 (Activation)     (None, 8, 8, 216)    0           ['batch_normalization_61[0][0]']

separable_conv2d_61 (Separable  (None, 8, 8, 18)    5832        ['activation_61[0][0]']
Conv2D)

concatenate_59 (Concatenate)   (None, 8, 8, 234)    0           ['concatenate_58[0][0]',
                                                                 'separable_conv2d_61[0][0]']

batch_normalization_62 (BatchN  (None, 8, 8, 234)   936         ['concatenate_59[0][0]']
ormalization)
```

```
activation_62 (Activation)     (None, 8, 8, 234)    0           ['batch_normalization_62[0][0]']

separable_conv2d_62 (Separable  (None, 8, 8, 18)    6318        ['activation_62[0][0]']
Conv2D)

concatenate_60 (Concatenate)   (None, 8, 8, 252)    0           ['concatenate_59[0][0]',
                                                                 'separable_conv2d_62[0][0]']

batch_normalization_63 (BatchN  (None, 8, 8, 252)   1008        ['concatenate_60[0][0]']
ormalization)

activation_63 (Activation)     (None, 8, 8, 252)    0           ['batch_normalization_63[0][0]']

separable_conv2d_63 (Separable  (None, 8, 8, 18)    6804        ['activation_63[0][0]']
Conv2D)

concatenate_61 (Concatenate)   (None, 8, 8, 270)    0           ['concatenate_60[0][0]',
                                                                 'separable_conv2d_63[0][0]']

batch_normalization_64 (BatchN  (None, 8, 8, 270)   1080        ['concatenate_61[0][0]']
ormalization)

activation_64 (Activation)     (None, 8, 8, 270)    0           ['batch_normalization_64[0][0]']

separable_conv2d_64 (Separable  (None, 8, 8, 18)    7290        ['activation_64[0][0]']
Conv2D)

concatenate_62 (Concatenate)   (None, 8, 8, 288)    0           ['concatenate_61[0][0]',
                                                                 'separable_conv2d_64[0][0]']

batch_normalization_65 (BatchN  (None, 8, 8, 288)   1152        ['concatenate_62[0][0]']
ormalization)

activation_65 (Activation)     (None, 8, 8, 288)    0           ['batch_normalization_65[0][0]']

separable_conv2d_65 (Separable  (None, 8, 8, 18)    7776        ['activation_65[0][0]']
Conv2D)

concatenate_63 (Concatenate)   (None, 8, 8, 306)    0           ['concatenate_62[0][0]',
                                                                 'separable_conv2d_65[0][0]']

batch_normalization_66 (BatchN  (None, 8, 8, 306)   1224        ['concatenate_63[0][0]']
ormalization)

activation_66 (Activation)     (None, 8, 8, 306)    0           ['batch_normalization_66[0][0]']

separable_conv2d_66 (Separable  (None, 8, 8, 18)    8262        ['activation_66[0][0]']
Conv2D)

concatenate_64 (Concatenate)   (None, 8, 8, 324)    0           ['concatenate_63[0][0]',
                                                                 'separable_conv2d_66[0][0]']

batch_normalization_67 (BatchN  (None, 8, 8, 324)   1296        ['concatenate_64[0][0]']
```

```
ormalization)

activation_67 (Activation)     (None, 8, 8, 324)    0           ['batch_normalization_67[0][0]']

separable_conv2d_67 (Separable  (None, 8, 8, 18)    8748        ['activation_67[0][0]']
Conv2D)

concatenate_65 (Concatenate)   (None, 8, 8, 342)    0           ['concatenate_64[0][0]',
                                                                 'separable_conv2d_67[0][0]']

batch_normalization_68 (BatchN  (None, 8, 8, 342)   1368        ['concatenate_65[0][0]']
ormalization)

activation_68 (Activation)     (None, 8, 8, 342)    0           ['batch_normalization_68[0][0]']

separable_conv2d_68 (Separable  (None, 8, 8, 18)    9234        ['activation_68[0][0]']
Conv2D)

concatenate_66 (Concatenate)   (None, 8, 8, 360)    0           ['concatenate_65[0][0]',
                                                                 'separable_conv2d_68[0][0]']

batch_normalization_69 (BatchN  (None, 8, 8, 360)   1440        ['concatenate_66[0][0]']
ormalization)

activation_69 (Activation)     (None, 8, 8, 360)    0           ['batch_normalization_69[0][0]']

separable_conv2d_69 (Separable  (None, 8, 8, 18)    9720        ['activation_69[0][0]']
Conv2D)

concatenate_67 (Concatenate)   (None, 8, 8, 378)    0           ['concatenate_66[0][0]',
                                                                 'separable_conv2d_69[0][0]']

batch_normalization_70 (BatchN  (None, 8, 8, 378)   1512        ['concatenate_67[0][0]']
ormalization)

activation_70 (Activation)     (None, 8, 8, 378)    0           ['batch_normalization_70[0][0]']

separable_conv2d_70 (Separable  (None, 8, 8, 18)    10206       ['activation_70[0][0]']
Conv2D)

concatenate_68 (Concatenate)   (None, 8, 8, 396)    0           ['concatenate_67[0][0]',
                                                                 'separable_conv2d_70[0][0]']

batch_normalization_71 (BatchN  (None, 8, 8, 396)   1584        ['concatenate_68[0][0]']
ormalization)

activation_71 (Activation)     (None, 8, 8, 396)    0           ['batch_normalization_71[0][0]']

separable_conv2d_71 (Separable  (None, 8, 8, 18)    10692       ['activation_71[0][0]']
Conv2D)

concatenate_69 (Concatenate)   (None, 8, 8, 414)    0           ['concatenate_68[0][0]',
                                                                 'separable_conv2d_71[0][0]']
```

```
batch_normalization_72 (BatchN  (None, 8, 8, 414)   1656        ['concatenate_69[0][0]']
ormalization)

activation_72 (Activation)     (None, 8, 8, 414)    0           ['batch_normalization_72[0][0]']

separable_conv2d_72 (Separable  (None, 8, 8, 18)    11178       ['activation_72[0][0]']
Conv2D)

concatenate_70 (Concatenate)   (None, 8, 8, 432)    0           ['concatenate_69[0][0]',
                                                                 'separable_conv2d_72[0][0]']

batch_normalization_73 (BatchN  (None, 8, 8, 432)   1728        ['concatenate_70[0][0]']
ormalization)

activation_73 (Activation)     (None, 8, 8, 432)    0           ['batch_normalization_73[0][0]']

separable_conv2d_73 (Separable  (None, 8, 8, 18)    11664       ['activation_73[0][0]']
Conv2D)

concatenate_71 (Concatenate)   (None, 8, 8, 450)    0           ['concatenate_70[0][0]',
                                                                 'separable_conv2d_73[0][0]']

batch_normalization_74 (BatchN  (None, 8, 8, 450)   1800        ['concatenate_71[0][0]']
ormalization)

activation_74 (Activation)     (None, 8, 8, 450)    0           ['batch_normalization_74[0][0]']

separable_conv2d_74 (Separable  (None, 8, 8, 18)    8550        ['activation_74[0][0]']
Conv2D)

average_pooling2d_2 (AveragePo  (None, 4, 4, 18)    0           ['separable_conv2d_74[0][0]']
oling2D)

batch_normalization_75 (BatchN  (None, 4, 4, 18)    72          ['average_pooling2d_2[0][0]']
ormalization)

activation_75 (Activation)     (None, 4, 4, 18)     0           ['batch_normalization_75[0][0]']

separable_conv2d_75 (Separable  (None, 4, 4, 18)    486         ['activation_75[0][0]']
Conv2D)

concatenate_72 (Concatenate)   (None, 4, 4, 36)     0           ['average_pooling2d_2[0][0]',
                                                                 'separable_conv2d_75[0][0]']

batch_normalization_76 (BatchN  (None, 4, 4, 36)    144         ['concatenate_72[0][0]']
ormalization)

activation_76 (Activation)     (None, 4, 4, 36)     0           ['batch_normalization_76[0][0]']

separable_conv2d_76 (Separable  (None, 4, 4, 18)    972         ['activation_76[0][0]']
Conv2D)

concatenate_73 (Concatenate)   (None, 4, 4, 54)     0           ['concatenate_72[0][0]',
                                                                 'separable_conv2d_76[0][0]']
```

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batch_normalization_77 (BatchN  (None, 4, 4, 54)    216         ['concatenate_73[0][0]']
ormalization)

activation_77 (Activation)     (None, 4, 4, 54)     0           ['batch_normalization_77[0][0]']

separable_conv2d_77 (Separable  (None, 4, 4, 18)    1458        ['activation_77[0][0]']
Conv2D)

concatenate_74 (Concatenate)   (None, 4, 4, 72)     0           ['concatenate_73[0][0]',
                                                                 'separable_conv2d_77[0][0]']

batch_normalization_78 (BatchN  (None, 4, 4, 72)    288         ['concatenate_74[0][0]']
ormalization)

activation_78 (Activation)     (None, 4, 4, 72)     0           ['batch_normalization_78[0][0]']

separable_conv2d_78 (Separable  (None, 4, 4, 18)    1944        ['activation_78[0][0]']
Conv2D)

concatenate_75 (Concatenate)   (None, 4, 4, 90)     0           ['concatenate_74[0][0]',
                                                                 'separable_conv2d_78[0][0]']

batch_normalization_79 (BatchN  (None, 4, 4, 90)    360         ['concatenate_75[0][0]']
ormalization)

activation_79 (Activation)     (None, 4, 4, 90)     0           ['batch_normalization_79[0][0]']

separable_conv2d_79 (Separable  (None, 4, 4, 18)    2430        ['activation_79[0][0]']
Conv2D)

concatenate_76 (Concatenate)   (None, 4, 4, 108)    0           ['concatenate_75[0][0]',
                                                                 'separable_conv2d_79[0][0]']

batch_normalization_80 (BatchN  (None, 4, 4, 108)   432         ['concatenate_76[0][0]']
ormalization)

activation_80 (Activation)     (None, 4, 4, 108)    0           ['batch_normalization_80[0][0]']

separable_conv2d_80 (Separable  (None, 4, 4, 18)    2916        ['activation_80[0][0]']
Conv2D)

concatenate_77 (Concatenate)   (None, 4, 4, 126)    0           ['concatenate_76[0][0]',
                                                                 'separable_conv2d_80[0][0]']

batch_normalization_81 (BatchN  (None, 4, 4, 126)   504         ['concatenate_77[0][0]']
ormalization)

activation_81 (Activation)     (None, 4, 4, 126)    0           ['batch_normalization_81[0][0]']

separable_conv2d_81 (Separable  (None, 4, 4, 18)    3402        ['activation_81[0][0]']
Conv2D)

concatenate_78 (Concatenate)   (None, 4, 4, 144)    0           ['concatenate_77[0][0]',
```

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                                                                  'separable_conv2d_81[0][0]']

batch_normalization_82 (BatchN  (None, 4, 4, 144)   576         ['concatenate_78[0][0]']
ormalization)

activation_82 (Activation)     (None, 4, 4, 144)    0           ['batch_normalization_82[0][0]']

separable_conv2d_82 (Separable  (None, 4, 4, 18)    3888        ['activation_82[0][0]']
Conv2D)

concatenate_79 (Concatenate)   (None, 4, 4, 162)    0           ['concatenate_78[0][0]',
                                                                 'separable_conv2d_82[0][0]']

batch_normalization_83 (BatchN  (None, 4, 4, 162)   648         ['concatenate_79[0][0]']
ormalization)

activation_83 (Activation)     (None, 4, 4, 162)    0           ['batch_normalization_83[0][0]']

separable_conv2d_83 (Separable  (None, 4, 4, 18)    4374        ['activation_83[0][0]']
Conv2D)

concatenate_80 (Concatenate)   (None, 4, 4, 180)    0           ['concatenate_79[0][0]',
                                                                 'separable_conv2d_83[0][0]']

batch_normalization_84 (BatchN  (None, 4, 4, 180)   720         ['concatenate_80[0][0]']
ormalization)

activation_84 (Activation)     (None, 4, 4, 180)    0           ['batch_normalization_84[0][0]']

separable_conv2d_84 (Separable  (None, 4, 4, 18)    4860        ['activation_84[0][0]']
Conv2D)

concatenate_81 (Concatenate)   (None, 4, 4, 198)    0           ['concatenate_80[0][0]',
                                                                 'separable_conv2d_84[0][0]']

batch_normalization_85 (BatchN  (None, 4, 4, 198)   792         ['concatenate_81[0][0]']
ormalization)

activation_85 (Activation)     (None, 4, 4, 198)    0           ['batch_normalization_85[0][0]']

separable_conv2d_85 (Separable  (None, 4, 4, 18)    5346        ['activation_85[0][0]']
Conv2D)

concatenate_82 (Concatenate)   (None, 4, 4, 216)    0           ['concatenate_81[0][0]',
                                                                 'separable_conv2d_85[0][0]']

batch_normalization_86 (BatchN  (None, 4, 4, 216)   864         ['concatenate_82[0][0]']
ormalization)

activation_86 (Activation)     (None, 4, 4, 216)    0           ['batch_normalization_86[0][0]']

separable_conv2d_86 (Separable  (None, 4, 4, 18)    5832        ['activation_86[0][0]']
Conv2D)
```

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concatenate_83 (Concatenate)   (None, 4, 4, 234)    0           ['concatenate_82[0][0]',
                                                                 'separable_conv2d_86[0][0]']

batch_normalization_87 (BatchN  (None, 4, 4, 234)   936         ['concatenate_83[0][0]']
ormalization)

activation_87 (Activation)     (None, 4, 4, 234)    0           ['batch_normalization_87[0][0]']

separable_conv2d_87 (Separable  (None, 4, 4, 18)    6318        ['activation_87[0][0]']
Conv2D)

concatenate_84 (Concatenate)   (None, 4, 4, 252)    0           ['concatenate_83[0][0]',
                                                                 'separable_conv2d_87[0][0]']

batch_normalization_88 (BatchN  (None, 4, 4, 252)   1008        ['concatenate_84[0][0]']
ormalization)

activation_88 (Activation)     (None, 4, 4, 252)    0           ['batch_normalization_88[0][0]']

separable_conv2d_88 (Separable  (None, 4, 4, 18)    6804        ['activation_88[0][0]']
Conv2D)

concatenate_85 (Concatenate)   (None, 4, 4, 270)    0           ['concatenate_84[0][0]',
                                                                 'separable_conv2d_88[0][0]']

batch_normalization_89 (BatchN  (None, 4, 4, 270)   1080        ['concatenate_85[0][0]']
ormalization)

activation_89 (Activation)     (None, 4, 4, 270)    0           ['batch_normalization_89[0][0]']

separable_conv2d_89 (Separable  (None, 4, 4, 18)    7290        ['activation_89[0][0]']
Conv2D)

concatenate_86 (Concatenate)   (None, 4, 4, 288)    0           ['concatenate_85[0][0]',
                                                                 'separable_conv2d_89[0][0]']

batch_normalization_90 (BatchN  (None, 4, 4, 288)   1152        ['concatenate_86[0][0]']
ormalization)

activation_90 (Activation)     (None, 4, 4, 288)    0           ['batch_normalization_90[0][0]']

separable_conv2d_90 (Separable  (None, 4, 4, 18)    7776        ['activation_90[0][0]']
Conv2D)

concatenate_87 (Concatenate)   (None, 4, 4, 306)    0           ['concatenate_86[0][0]',
                                                                 'separable_conv2d_90[0][0]']

batch_normalization_91 (BatchN  (None, 4, 4, 306)   1224        ['concatenate_87[0][0]']
ormalization)

activation_91 (Activation)     (None, 4, 4, 306)    0           ['batch_normalization_91[0][0]']

separable_conv2d_91 (Separable  (None, 4, 4, 18)    8262        ['activation_91[0][0]']
Conv2D)
```

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concatenate_88 (Concatenate)   (None, 4, 4, 324)    0           ['concatenate_87[0][0]',
                                                                 'separable_conv2d_91[0][0]']

batch_normalization_92 (BatchN  (None, 4, 4, 324)   1296        ['concatenate_88[0][0]']
ormalization)

activation_92 (Activation)     (None, 4, 4, 324)    0           ['batch_normalization_92[0][0]']

separable_conv2d_92 (Separable  (None, 4, 4, 18)    8748        ['activation_92[0][0]']
Conv2D)

concatenate_89 (Concatenate)   (None, 4, 4, 342)    0           ['concatenate_88[0][0]',
                                                                 'separable_conv2d_92[0][0]']

batch_normalization_93 (BatchN  (None, 4, 4, 342)   1368        ['concatenate_89[0][0]']
ormalization)

activation_93 (Activation)     (None, 4, 4, 342)    0           ['batch_normalization_93[0][0]']

separable_conv2d_93 (Separable  (None, 4, 4, 18)    9234        ['activation_93[0][0]']
Conv2D)

concatenate_90 (Concatenate)   (None, 4, 4, 360)    0           ['concatenate_89[0][0]',
                                                                 'separable_conv2d_93[0][0]']

batch_normalization_94 (BatchN  (None, 4, 4, 360)   1440        ['concatenate_90[0][0]']
ormalization)

activation_94 (Activation)     (None, 4, 4, 360)    0           ['batch_normalization_94[0][0]']

separable_conv2d_94 (Separable  (None, 4, 4, 18)    9720        ['activation_94[0][0]']
Conv2D)

concatenate_91 (Concatenate)   (None, 4, 4, 378)    0           ['concatenate_90[0][0]',
                                                                 'separable_conv2d_94[0][0]']

batch_normalization_95 (BatchN  (None, 4, 4, 378)   1512        ['concatenate_91[0][0]']
ormalization)

activation_95 (Activation)     (None, 4, 4, 378)    0           ['batch_normalization_95[0][0]']

separable_conv2d_95 (Separable  (None, 4, 4, 18)    10206       ['activation_95[0][0]']
Conv2D)

concatenate_92 (Concatenate)   (None, 4, 4, 396)    0           ['concatenate_91[0][0]',
                                                                 'separable_conv2d_95[0][0]']

batch_normalization_96 (BatchN  (None, 4, 4, 396)   1584        ['concatenate_92[0][0]']
ormalization)

activation_96 (Activation)     (None, 4, 4, 396)    0           ['batch_normalization_96[0][0]']

separable_conv2d_96 (Separable  (None, 4, 4, 18)    10692       ['activation_96[0][0]']
```

```
Conv2D)

concatenate_93 (Concatenate)   (None, 4, 4, 414)    0           ['concatenate_92[0][0]',
                                                                 'separable_conv2d_96[0][0]']

batch_normalization_97 (BatchN  (None, 4, 4, 414)   1656        ['concatenate_93[0][0]']
ormalization)

activation_97 (Activation)     (None, 4, 4, 414)    0           ['batch_normalization_97[0][0]']

separable_conv2d_97 (Separable  (None, 4, 4, 18)    11178       ['activation_97[0][0]']
Conv2D)

concatenate_94 (Concatenate)   (None, 4, 4, 432)    0           ['concatenate_93[0][0]',
                                                                 'separable_conv2d_97[0][0]']

batch_normalization_98 (BatchN  (None, 4, 4, 432)   1728        ['concatenate_94[0][0]']
ormalization)

activation_98 (Activation)     (None, 4, 4, 432)    0           ['batch_normalization_98[0][0]']

separable_conv2d_98 (Separable  (None, 4, 4, 18)    11664       ['activation_98[0][0]']
Conv2D)

concatenate_95 (Concatenate)   (None, 4, 4, 450)    0           ['concatenate_94[0][0]',
                                                                 'separable_conv2d_98[0][0]']

batch_normalization_99 (BatchN  (None, 4, 4, 450)   1800        ['concatenate_95[0][0]']
ormalization)

activation_99 (Activation)     (None, 4, 4, 450)    0           ['batch_normalization_99[0][0]']

average_pooling2d_3 (AveragePo  (None, 2, 2, 450)   0           ['activation_99[0][0]']
oling2D)

conv2d_1 (Conv2D)              (None, 1, 1, 10)     18010       ['average_pooling2d_3[0][0]']

flatten (Flatten)              (None, 10)           0           ['conv2d_1[0][0]']

==================================================================================================
Total params: 735,238
Trainable params: 687,538
Non-trainable params: 47,700
__________________________________________________________________________________________________
```

In [ ]:

```python
def lr_schedule(epoch):
    lr = 0.01
    if epoch > 180:
        lr *= 0.00001
    elif epoch > 180:
        lr *= 0.0001
    elif epoch > 120:
        lr *= 0.001
```

```
    print('\nLearning rate: ', lr)
    return lr
lr_scheduler = LearningRateScheduler(lr_schedule)
```

In [ ]:

```
epochs = 120

decay_lr = ReduceLROnPlateau(monitor='val_accuracy', factor=0.95, patience=5,
                                                verbose=1, mode='auto', min_delta=0.001,
                                                cooldown=0, min_lr=0.000001)

callback_list = [checkpoint]

history = model.fit_generator(datagen.flow(X_train, y_train, batch_size=batch_size),\
                    steps_per_epoch=X_train.shape[0] // batch_size, epochs=epochs,\
                    verbose=1,validation_data=(X_test,y_test),callbacks=callback_list)

model.save_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_120Epoch.h5')
```

```
Epoch 1/120
390/390 [==============================] - ETA: 0s - loss: 1.6611 - accuracy: 0.3933
Epoch 00001: val_accuracy improved from -inf to 0.10000, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 213s 488ms/step - loss: 1.6611 - accuracy: 0.3933 - val_loss: 2.4854 - val_accuracy: 0.1000
Epoch 2/120
390/390 [==============================] - ETA: 0s - loss: 1.3546 - accuracy: 0.5116
Epoch 00002: val_accuracy improved from 0.10000 to 0.44030, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 476ms/step - loss: 1.3546 - accuracy: 0.5116 - val_loss: 1.5931 - val_accuracy: 0.4403
Epoch 3/120
390/390 [==============================] - ETA: 0s - loss: 1.1941 - accuracy: 0.5744
Epoch 00003: val_accuracy improved from 0.44030 to 0.58190, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 187s 480ms/step - loss: 1.1941 - accuracy: 0.5744 - val_loss: 1.2061 - val_accuracy: 0.5819
Epoch 4/120
390/390 [==============================] - ETA: 0s - loss: 1.0892 - accuracy: 0.6118
Epoch 00004: val_accuracy did not improve from 0.58190
390/390 [==============================] - 185s 473ms/step - loss: 1.0892 - accuracy: 0.6118 - val_loss: 1.2877 - val_accuracy: 0.5664
Epoch 5/120
390/390 [==============================] - ETA: 0s - loss: 0.9996 - accuracy: 0.6483
Epoch 00005: val_accuracy did not improve from 0.58190
390/390 [==============================] - 185s 473ms/step - loss: 0.9996 - accuracy: 0.6483 - val_loss: 1.3923 - val_accuracy: 0.5632
Epoch 6/120
390/390 [==============================] - ETA: 0s - loss: 0.9275 - accuracy: 0.6723
Epoch 00006: val_accuracy improved from 0.58190 to 0.60360, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 476ms/step - loss: 0.9275 - accuracy: 0.6723 - val_loss: 1.1891 - val_accuracy: 0.6036
Epoch 7/120
390/390 [==============================] - ETA: 0s - loss: 0.8729 - accuracy: 0.6930
Epoch 00007: val_accuracy improved from 0.60360 to 0.66520, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 476ms/step - loss: 0.8729 - accuracy: 0.6930 - val_loss: 0.9680 - val_accuracy: 0.6652
Epoch 8/120
390/390 [==============================] - ETA: 0s - loss: 0.8270 - accuracy: 0.7095
Epoch 00008: val_accuracy improved from 0.66520 to 0.70740, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 476ms/step - loss: 0.8270 - accuracy: 0.7095 - val_loss: 0.8591 - val_accuracy: 0.7074
Epoch 9/120
```

```
390/390 [==============================] - ETA: 0s - loss: 0.7892 - accuracy: 0.7253
Epoch 00009: val_accuracy did not improve from 0.70740
390/390 [==============================] - 185s 473ms/step - loss: 0.7892 - accuracy: 0.7253 - val_loss: 0.8957 - val_accuracy: 0.6951
Epoch 10/120
390/390 [==============================] - ETA: 0s - loss: 0.7582 - accuracy: 0.7359
Epoch 00010: val_accuracy did not improve from 0.70740
390/390 [==============================] - 185s 473ms/step - loss: 0.7582 - accuracy: 0.7359 - val_loss: 1.1198 - val_accuracy: 0.6504
Epoch 11/120
390/390 [==============================] - ETA: 0s - loss: 0.7295 - accuracy: 0.7472
Epoch 00011: val_accuracy did not improve from 0.70740
390/390 [==============================] - 185s 473ms/step - loss: 0.7295 - accuracy: 0.7472 - val_loss: 1.1119 - val_accuracy: 0.6518
Epoch 12/120
390/390 [==============================] - ETA: 0s - loss: 0.7007 - accuracy: 0.7563
Epoch 00012: val_accuracy improved from 0.70740 to 0.72800, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 476ms/step - loss: 0.7007 - accuracy: 0.7563 - val_loss: 0.8076 - val_accuracy: 0.7280
Epoch 13/120
390/390 [==============================] - ETA: 0s - loss: 0.6736 - accuracy: 0.7665
Epoch 00013: val_accuracy improved from 0.72800 to 0.73580, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 476ms/step - loss: 0.6736 - accuracy: 0.7665 - val_loss: 0.7925 - val_accuracy: 0.7358
Epoch 14/120
390/390 [==============================] - ETA: 0s - loss: 0.6562 - accuracy: 0.7725
Epoch 00014: val_accuracy did not improve from 0.73580
390/390 [==============================] - 185s 473ms/step - loss: 0.6562 - accuracy: 0.7725 - val_loss: 0.8319 - val_accuracy: 0.7329
Epoch 15/120
390/390 [==============================] - ETA: 0s - loss: 0.6376 - accuracy: 0.7785
Epoch 00015: val_accuracy improved from 0.73580 to 0.73740, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 476ms/step - loss: 0.6376 - accuracy: 0.7785 - val_loss: 0.8016 - val_accuracy: 0.7374
Epoch 16/120
390/390 [==============================] - ETA: 0s - loss: 0.6226 - accuracy: 0.7860
Epoch 00016: val_accuracy did not improve from 0.73740
390/390 [==============================] - 185s 474ms/step - loss: 0.6226 - accuracy: 0.7860 - val_loss: 1.3224 - val_accuracy: 0.6449
Epoch 17/120
390/390 [==============================] - ETA: 0s - loss: 0.6068 - accuracy: 0.7887
Epoch 00017: val_accuracy improved from 0.73740 to 0.75590, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 478ms/step - loss: 0.6068 - accuracy: 0.7887 - val_loss: 0.7673 - val_accuracy: 0.7559
Epoch 18/120
390/390 [==============================] - ETA: 0s - loss: 0.5910 - accuracy: 0.7963
Epoch 00018: val_accuracy did not improve from 0.75590
390/390 [==============================] - 185s 475ms/step - loss: 0.5910 - accuracy: 0.7963 - val_loss: 0.9394 - val_accuracy: 0.7052
Epoch 19/120
390/390 [==============================] - ETA: 0s - loss: 0.5725 - accuracy: 0.8025
Epoch 00019: val_accuracy did not improve from 0.75590
390/390 [==============================] - 185s 475ms/step - loss: 0.5725 - accuracy: 0.8025 - val_loss: 0.7819 - val_accuracy: 0.7477
Epoch 20/120
390/390 [==============================] - ETA: 0s - loss: 0.5653 - accuracy: 0.8048
Epoch 00020: val_accuracy improved from 0.75590 to 0.77590, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.5653 - accuracy: 0.8048 - val_loss: 0.6724 - val_accuracy: 0.7759
Epoch 21/120
390/390 [==============================] - ETA: 0s - loss: 0.5480 - accuracy: 0.8122
Epoch 00021: val_accuracy improved from 0.77590 to 0.78470, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.5480 - accuracy: 0.8122 - val_loss: 0.6766 - val_accuracy: 0.7847
Epoch 22/120
390/390 [==============================] - ETA: 0s - loss: 0.5346 - accuracy: 0.8178
Epoch 00022: val_accuracy did not improve from 0.78470
```

```
390/390 [==============================] - 185s 474ms/step - loss: 0.5346 - accuracy: 0.8178 - val_loss: 0.7045 - val_accuracy: 0.7700
Epoch 23/120
390/390 [==============================] - ETA: 0s - loss: 0.5234 - accuracy: 0.8214
Epoch 00023: val_accuracy did not improve from 0.78470
390/390 [==============================] - 185s 474ms/step - loss: 0.5234 - accuracy: 0.8214 - val_loss: 0.7636 - val_accuracy: 0.7567
Epoch 24/120
390/390 [==============================] - ETA: 0s - loss: 0.5171 - accuracy: 0.8228
Epoch 00024: val_accuracy improved from 0.78470 to 0.78860, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 478ms/step - loss: 0.5171 - accuracy: 0.8228 - val_loss: 0.6385 - val_accuracy: 0.7886
Epoch 25/120
390/390 [==============================] - ETA: 0s - loss: 0.5052 - accuracy: 0.8278
Epoch 00025: val_accuracy did not improve from 0.78860
390/390 [==============================] - 185s 475ms/step - loss: 0.5052 - accuracy: 0.8278 - val_loss: 0.6897 - val_accuracy: 0.7789
Epoch 26/120
390/390 [==============================] - ETA: 0s - loss: 0.4941 - accuracy: 0.8304
Epoch 00026: val_accuracy improved from 0.78860 to 0.80130, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.4941 - accuracy: 0.8304 - val_loss: 0.6022 - val_accuracy: 0.8013
Epoch 27/120
390/390 [==============================] - ETA: 0s - loss: 0.4864 - accuracy: 0.8342
Epoch 00027: val_accuracy improved from 0.80130 to 0.81040, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.4864 - accuracy: 0.8342 - val_loss: 0.5614 - val_accuracy: 0.8104
Epoch 28/120
390/390 [==============================] - ETA: 0s - loss: 0.4770 - accuracy: 0.8360
Epoch 00028: val_accuracy improved from 0.81040 to 0.81170, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 187s 478ms/step - loss: 0.4770 - accuracy: 0.8360 - val_loss: 0.5695 - val_accuracy: 0.8117
Epoch 29/120
390/390 [==============================] - ETA: 0s - loss: 0.4723 - accuracy: 0.8387
Epoch 00029: val_accuracy did not improve from 0.81170
390/390 [==============================] - 186s 476ms/step - loss: 0.4723 - accuracy: 0.8387 - val_loss: 0.6357 - val_accuracy: 0.8012
Epoch 30/120
390/390 [==============================] - ETA: 0s - loss: 0.4575 - accuracy: 0.8439
Epoch 00030: val_accuracy did not improve from 0.81170
390/390 [==============================] - 185s 475ms/step - loss: 0.4575 - accuracy: 0.8439 - val_loss: 0.6166 - val_accuracy: 0.7988
Epoch 31/120
390/390 [==============================] - ETA: 0s - loss: 0.4536 - accuracy: 0.8462
Epoch 00031: val_accuracy did not improve from 0.81170
390/390 [==============================] - 185s 475ms/step - loss: 0.4536 - accuracy: 0.8462 - val_loss: 0.7165 - val_accuracy: 0.7768
Epoch 32/120
390/390 [==============================] - ETA: 0s - loss: 0.4502 - accuracy: 0.8441
Epoch 00032: val_accuracy improved from 0.81170 to 0.81380, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.4502 - accuracy: 0.8441 - val_loss: 0.5728 - val_accuracy: 0.8138
Epoch 33/120
390/390 [==============================] - ETA: 0s - loss: 0.4376 - accuracy: 0.8493
Epoch 00033: val_accuracy did not improve from 0.81380
390/390 [==============================] - 185s 474ms/step - loss: 0.4376 - accuracy: 0.8493 - val_loss: 0.6174 - val_accuracy: 0.8000
Epoch 34/120
390/390 [==============================] - ETA: 0s - loss: 0.4328 - accuracy: 0.8529
Epoch 00034: val_accuracy improved from 0.81380 to 0.83510, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.4328 - accuracy: 0.8529 - val_loss: 0.5036 - val_accuracy: 0.8351
Epoch 35/120
390/390 [==============================] - ETA: 0s - loss: 0.4249 - accuracy: 0.8558
Epoch 00035: val_accuracy did not improve from 0.83510
390/390 [==============================] - 185s 474ms/step - loss: 0.4249 - accuracy: 0.8558 - val_loss: 0.6888 - val_accuracy: 0.7942
Epoch 36/120
```

```
390/390 [==============================] - ETA: 0s - loss: 0.4203 - accuracy: 0.8568
Epoch 00036: val_accuracy did not improve from 0.83510
390/390 [==============================] - 185s 474ms/step - loss: 0.4203 - accuracy: 0.8568 - val_loss: 0.6085 - val_accuracy: 0.8138
Epoch 37/120
390/390 [==============================] - ETA: 0s - loss: 0.4144 - accuracy: 0.8584
Epoch 00037: val_accuracy did not improve from 0.83510
390/390 [==============================] - 185s 474ms/step - loss: 0.4144 - accuracy: 0.8584 - val_loss: 0.6019 - val_accuracy: 0.8113
Epoch 38/120
390/390 [==============================] - ETA: 0s - loss: 0.4064 - accuracy: 0.8619
Epoch 00038: val_accuracy did not improve from 0.83510
390/390 [==============================] - 185s 474ms/step - loss: 0.4064 - accuracy: 0.8619 - val_loss: 0.7022 - val_accuracy: 0.7783
Epoch 39/120
390/390 [==============================] - ETA: 0s - loss: 0.4014 - accuracy: 0.8621
Epoch 00039: val_accuracy did not improve from 0.83510
390/390 [==============================] - 185s 474ms/step - loss: 0.4014 - accuracy: 0.8621 - val_loss: 0.5220 - val_accuracy: 0.8300
Epoch 40/120
390/390 [==============================] - ETA: 0s - loss: 0.3948 - accuracy: 0.8648
Epoch 00040: val_accuracy did not improve from 0.83510
390/390 [==============================] - 185s 474ms/step - loss: 0.3948 - accuracy: 0.8648 - val_loss: 0.5753 - val_accuracy: 0.8204
Epoch 41/120
390/390 [==============================] - ETA: 0s - loss: 0.3955 - accuracy: 0.8652
Epoch 00041: val_accuracy did not improve from 0.83510
390/390 [==============================] - 185s 474ms/step - loss: 0.3955 - accuracy: 0.8652 - val_loss: 0.5653 - val_accuracy: 0.8261
Epoch 42/120
390/390 [==============================] - ETA: 0s - loss: 0.3884 - accuracy: 0.8683
Epoch 00042: val_accuracy improved from 0.83510 to 0.83780, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.3884 - accuracy: 0.8683 - val_loss: 0.5248 - val_accuracy: 0.8378
Epoch 43/120
390/390 [==============================] - ETA: 0s - loss: 0.3811 - accuracy: 0.8712
Epoch 00043: val_accuracy did not improve from 0.83780
390/390 [==============================] - 185s 474ms/step - loss: 0.3811 - accuracy: 0.8712 - val_loss: 0.6033 - val_accuracy: 0.8204
Epoch 44/120
390/390 [==============================] - ETA: 0s - loss: 0.3741 - accuracy: 0.8725
Epoch 00044: val_accuracy did not improve from 0.83780
390/390 [==============================] - 185s 474ms/step - loss: 0.3741 - accuracy: 0.8725 - val_loss: 0.8690 - val_accuracy: 0.7456
Epoch 45/120
390/390 [==============================] - ETA: 0s - loss: 0.3683 - accuracy: 0.8747
Epoch 00045: val_accuracy did not improve from 0.83780
390/390 [==============================] - 185s 474ms/step - loss: 0.3683 - accuracy: 0.8747 - val_loss: 0.5235 - val_accuracy: 0.8307
Epoch 46/120
390/390 [==============================] - ETA: 0s - loss: 0.3729 - accuracy: 0.8727
Epoch 00046: val_accuracy improved from 0.83780 to 0.84870, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 476ms/step - loss: 0.3729 - accuracy: 0.8727 - val_loss: 0.4859 - val_accuracy: 0.8487
Epoch 47/120
390/390 [==============================] - ETA: 0s - loss: 0.3596 - accuracy: 0.8780
Epoch 00047: val_accuracy did not improve from 0.84870
390/390 [==============================] - 185s 474ms/step - loss: 0.3596 - accuracy: 0.8780 - val_loss: 0.7332 - val_accuracy: 0.7801
Epoch 48/120
390/390 [==============================] - ETA: 0s - loss: 0.3601 - accuracy: 0.8777
Epoch 00048: val_accuracy did not improve from 0.84870
390/390 [==============================] - 185s 474ms/step - loss: 0.3601 - accuracy: 0.8777 - val_loss: 0.6883 - val_accuracy: 0.7981
Epoch 49/120
390/390 [==============================] - ETA: 0s - loss: 0.3506 - accuracy: 0.8823
Epoch 00049: val_accuracy did not improve from 0.84870
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390/390 [==============================] - 185s 474ms/step - loss: 0.3506 - accuracy: 0.8823 - val_loss: 0.6375 - val_accuracy: 0.8092
Epoch 50/120
390/390 [==============================] - ETA: 0s - loss: 0.3468 - accuracy: 0.8813
Epoch 00050: val_accuracy improved from 0.84870 to 0.85650, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 476ms/step - loss: 0.3468 - accuracy: 0.8813 - val_loss: 0.4561 - val_accuracy: 0.8565
Epoch 51/120
390/390 [==============================] - ETA: 0s - loss: 0.3484 - accuracy: 0.8803
Epoch 00051: val_accuracy did not improve from 0.85650
390/390 [==============================] - 185s 474ms/step - loss: 0.3484 - accuracy: 0.8803 - val_loss: 0.4718 - val_accuracy: 0.8532
Epoch 52/120
390/390 [==============================] - ETA: 0s - loss: 0.3394 - accuracy: 0.8841
Epoch 00052: val_accuracy did not improve from 0.85650
390/390 [==============================] - 185s 474ms/step - loss: 0.3394 - accuracy: 0.8841 - val_loss: 0.5196 - val_accuracy: 0.8380
Epoch 53/120
390/390 [==============================] - ETA: 0s - loss: 0.3427 - accuracy: 0.8835
Epoch 00053: val_accuracy did not improve from 0.85650
390/390 [==============================] - 185s 474ms/step - loss: 0.3427 - accuracy: 0.8835 - val_loss: 0.4767 - val_accuracy: 0.8502
Epoch 54/120
390/390 [==============================] - ETA: 0s - loss: 0.3389 - accuracy: 0.8851
Epoch 00054: val_accuracy did not improve from 0.85650
390/390 [==============================] - 185s 474ms/step - loss: 0.3389 - accuracy: 0.8851 - val_loss: 0.4907 - val_accuracy: 0.8464
Epoch 55/120
390/390 [==============================] - ETA: 0s - loss: 0.3310 - accuracy: 0.8873
Epoch 00055: val_accuracy did not improve from 0.85650
390/390 [==============================] - 185s 474ms/step - loss: 0.3310 - accuracy: 0.8873 - val_loss: 0.5026 - val_accuracy: 0.8434
Epoch 56/120
390/390 [==============================] - ETA: 0s - loss: 0.3328 - accuracy: 0.8865
Epoch 00056: val_accuracy did not improve from 0.85650
390/390 [==============================] - 185s 474ms/step - loss: 0.3328 - accuracy: 0.8865 - val_loss: 0.5509 - val_accuracy: 0.8372
Epoch 57/120
390/390 [==============================] - ETA: 0s - loss: 0.3220 - accuracy: 0.8903
Epoch 00057: val_accuracy did not improve from 0.85650
390/390 [==============================] - 185s 474ms/step - loss: 0.3220 - accuracy: 0.8903 - val_loss: 0.5407 - val_accuracy: 0.8311
Epoch 58/120
390/390 [==============================] - ETA: 0s - loss: 0.3231 - accuracy: 0.8913
Epoch 00058: val_accuracy did not improve from 0.85650
390/390 [==============================] - 185s 474ms/step - loss: 0.3231 - accuracy: 0.8913 - val_loss: 0.5350 - val_accuracy: 0.8309
Epoch 59/120
390/390 [==============================] - ETA: 0s - loss: 0.3213 - accuracy: 0.8894
Epoch 00059: val_accuracy did not improve from 0.85650
390/390 [==============================] - 185s 474ms/step - loss: 0.3213 - accuracy: 0.8894 - val_loss: 0.4847 - val_accuracy: 0.8512
Epoch 60/120
390/390 [==============================] - ETA: 0s - loss: 0.3184 - accuracy: 0.8928
Epoch 00060: val_accuracy did not improve from 0.85650
390/390 [==============================] - 185s 474ms/step - loss: 0.3184 - accuracy: 0.8928 - val_loss: 0.4903 - val_accuracy: 0.8479
Epoch 61/120
390/390 [==============================] - ETA: 0s - loss: 0.3123 - accuracy: 0.8939
Epoch 00061: val_accuracy did not improve from 0.85650
390/390 [==============================] - 185s 474ms/step - loss: 0.3123 - accuracy: 0.8939 - val_loss: 0.4960 - val_accuracy: 0.8449
Epoch 62/120
390/390 [==============================] - ETA: 0s - loss: 0.3094 - accuracy: 0.8940
Epoch 00062: val_accuracy did not improve from 0.85650
390/390 [==============================] - 185s 474ms/step - loss: 0.3094 - accuracy: 0.8940 - val_loss: 0.6458 - val_accuracy: 0.8063
Epoch 63/120
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390/390 [==============================] - ETA: 0s - loss: 0.3052 - accuracy: 0.8964
Epoch 00063: val_accuracy improved from 0.85650 to 0.86140, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 476ms/step - loss: 0.3052 - accuracy: 0.8964 - val_loss: 0.4442 - val_accuracy: 0.8614
Epoch 64/120
390/390 [==============================] - ETA: 0s - loss: 0.3030 - accuracy: 0.8974
Epoch 00064: val_accuracy did not improve from 0.86140
390/390 [==============================] - 185s 474ms/step - loss: 0.3030 - accuracy: 0.8974 - val_loss: 0.5170 - val_accuracy: 0.8449
Epoch 65/120
390/390 [==============================] - ETA: 0s - loss: 0.2986 - accuracy: 0.8976
Epoch 00065: val_accuracy did not improve from 0.86140
390/390 [==============================] - 185s 474ms/step - loss: 0.2986 - accuracy: 0.8976 - val_loss: 0.5547 - val_accuracy: 0.8332
Epoch 66/120
390/390 [==============================] - ETA: 0s - loss: 0.2990 - accuracy: 0.8982
Epoch 00066: val_accuracy did not improve from 0.86140
390/390 [==============================] - 185s 475ms/step - loss: 0.2990 - accuracy: 0.8982 - val_loss: 0.4758 - val_accuracy: 0.8509
Epoch 67/120
390/390 [==============================] - ETA: 0s - loss: 0.2962 - accuracy: 0.9004
Epoch 00067: val_accuracy did not improve from 0.86140
390/390 [==============================] - 185s 475ms/step - loss: 0.2962 - accuracy: 0.9004 - val_loss: 0.4557 - val_accuracy: 0.8557
Epoch 68/120
390/390 [==============================] - ETA: 0s - loss: 0.2916 - accuracy: 0.9011
Epoch 00068: val_accuracy did not improve from 0.86140
390/390 [==============================] - 185s 475ms/step - loss: 0.2916 - accuracy: 0.9011 - val_loss: 0.7715 - val_accuracy: 0.7927
Epoch 69/120
390/390 [==============================] - ETA: 0s - loss: 0.2885 - accuracy: 0.9021
Epoch 00069: val_accuracy did not improve from 0.86140
390/390 [==============================] - 185s 475ms/step - loss: 0.2885 - accuracy: 0.9021 - val_loss: 0.4993 - val_accuracy: 0.8471
Epoch 70/120
390/390 [==============================] - ETA: 0s - loss: 0.2864 - accuracy: 0.9027
Epoch 00070: val_accuracy did not improve from 0.86140
390/390 [==============================] - 185s 475ms/step - loss: 0.2864 - accuracy: 0.9027 - val_loss: 0.5505 - val_accuracy: 0.8313
Epoch 71/120
390/390 [==============================] - ETA: 0s - loss: 0.2836 - accuracy: 0.9045
Epoch 00071: val_accuracy did not improve from 0.86140
390/390 [==============================] - 185s 475ms/step - loss: 0.2836 - accuracy: 0.9045 - val_loss: 0.6850 - val_accuracy: 0.8117
Epoch 72/120
390/390 [==============================] - ETA: 0s - loss: 0.2823 - accuracy: 0.9050
Epoch 00072: val_accuracy did not improve from 0.86140
390/390 [==============================] - 185s 475ms/step - loss: 0.2823 - accuracy: 0.9050 - val_loss: 0.5027 - val_accuracy: 0.8506
Epoch 73/120
390/390 [==============================] - ETA: 0s - loss: 0.2736 - accuracy: 0.9064
Epoch 00073: val_accuracy improved from 0.86140 to 0.86750, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.2736 - accuracy: 0.9064 - val_loss: 0.4331 - val_accuracy: 0.8675
Epoch 74/120
390/390 [==============================] - ETA: 0s - loss: 0.2746 - accuracy: 0.9066
Epoch 00074: val_accuracy did not improve from 0.86750
390/390 [==============================] - 185s 475ms/step - loss: 0.2746 - accuracy: 0.9066 - val_loss: 0.4294 - val_accuracy: 0.8674
Epoch 75/120
390/390 [==============================] - ETA: 0s - loss: 0.2756 - accuracy: 0.9063
Epoch 00075: val_accuracy did not improve from 0.86750
390/390 [==============================] - 185s 475ms/step - loss: 0.2756 - accuracy: 0.9063 - val_loss: 0.8485 - val_accuracy: 0.7797
Epoch 76/120
390/390 [==============================] - ETA: 0s - loss: 0.2726 - accuracy: 0.9079
Epoch 00076: val_accuracy improved from 0.86750 to 0.87120, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
```

```
390/390 [==============================] - 186s 478ms/step - loss: 0.2726 - accuracy: 0.9079 - val_loss: 0.4230 - val_accuracy: 0.8712
Epoch 77/120
390/390 [==============================] - ETA: 0s - loss: 0.2687 - accuracy: 0.9097
Epoch 00077: val_accuracy did not improve from 0.87120
390/390 [==============================] - 185s 475ms/step - loss: 0.2687 - accuracy: 0.9097 - val_loss: 0.5496 - val_accuracy: 0.8366
Epoch 78/120
390/390 [==============================] - ETA: 0s - loss: 0.2659 - accuracy: 0.9096
Epoch 00078: val_accuracy did not improve from 0.87120
390/390 [==============================] - 185s 475ms/step - loss: 0.2659 - accuracy: 0.9096 - val_loss: 0.4533 - val_accuracy: 0.8633
Epoch 79/120
390/390 [==============================] - ETA: 0s - loss: 0.2608 - accuracy: 0.9130
Epoch 00079: val_accuracy did not improve from 0.87120
390/390 [==============================] - 185s 475ms/step - loss: 0.2608 - accuracy: 0.9130 - val_loss: 0.6002 - val_accuracy: 0.8314
Epoch 80/120
390/390 [==============================] - ETA: 0s - loss: 0.2655 - accuracy: 0.9103
Epoch 00080: val_accuracy did not improve from 0.87120
390/390 [==============================] - 185s 475ms/step - loss: 0.2655 - accuracy: 0.9103 - val_loss: 0.5377 - val_accuracy: 0.8468
Epoch 81/120
390/390 [==============================] - ETA: 0s - loss: 0.2565 - accuracy: 0.9142
Epoch 00081: val_accuracy did not improve from 0.87120
390/390 [==============================] - 185s 475ms/step - loss: 0.2565 - accuracy: 0.9142 - val_loss: 0.4915 - val_accuracy: 0.8548
Epoch 82/120
390/390 [==============================] - ETA: 0s - loss: 0.2594 - accuracy: 0.9130
Epoch 00082: val_accuracy did not improve from 0.87120
390/390 [==============================] - 185s 475ms/step - loss: 0.2594 - accuracy: 0.9130 - val_loss: 0.4888 - val_accuracy: 0.8499
Epoch 83/120
390/390 [==============================] - ETA: 0s - loss: 0.2582 - accuracy: 0.9135
Epoch 00083: val_accuracy did not improve from 0.87120
390/390 [==============================] - 185s 475ms/step - loss: 0.2582 - accuracy: 0.9135 - val_loss: 0.4257 - val_accuracy: 0.8664
Epoch 84/120
390/390 [==============================] - ETA: 0s - loss: 0.2534 - accuracy: 0.9142
Epoch 00084: val_accuracy did not improve from 0.87120
390/390 [==============================] - 185s 475ms/step - loss: 0.2534 - accuracy: 0.9142 - val_loss: 0.4979 - val_accuracy: 0.8544
Epoch 85/120
390/390 [==============================] - ETA: 0s - loss: 0.2513 - accuracy: 0.9148
Epoch 00085: val_accuracy did not improve from 0.87120
390/390 [==============================] - 185s 475ms/step - loss: 0.2513 - accuracy: 0.9148 - val_loss: 0.4249 - val_accuracy: 0.8708
Epoch 86/120
390/390 [==============================] - ETA: 0s - loss: 0.2527 - accuracy: 0.9138
Epoch 00086: val_accuracy did not improve from 0.87120
390/390 [==============================] - 185s 475ms/step - loss: 0.2527 - accuracy: 0.9138 - val_loss: 0.4355 - val_accuracy: 0.8683
Epoch 87/120
390/390 [==============================] - ETA: 0s - loss: 0.2445 - accuracy: 0.9181
Epoch 00087: val_accuracy improved from 0.87120 to 0.87600, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 187s 478ms/step - loss: 0.2445 - accuracy: 0.9181 - val_loss: 0.4017 - val_accuracy: 0.8760
Epoch 88/120
390/390 [==============================] - ETA: 0s - loss: 0.2493 - accuracy: 0.9163
Epoch 00088: val_accuracy did not improve from 0.87600
390/390 [==============================] - 185s 475ms/step - loss: 0.2493 - accuracy: 0.9163 - val_loss: 0.4362 - val_accuracy: 0.8642
Epoch 89/120
390/390 [==============================] - ETA: 0s - loss: 0.2470 - accuracy: 0.9151
Epoch 00089: val_accuracy did not improve from 0.87600
390/390 [==============================] - 185s 475ms/step - loss: 0.2470 - accuracy: 0.9151 - val_loss: 0.5800 - val_accuracy: 0.8386
Epoch 90/120
```

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390/390 [==============================] - ETA: 0s - loss: 0.2393 - accuracy: 0.9189
Epoch 00090: val_accuracy did not improve from 0.87600
390/390 [==============================] - 185s 475ms/step - loss: 0.2393 - accuracy: 0.9189 - val_loss: 0.5216 - val_accuracy: 0.8492
Epoch 91/120
390/390 [==============================] - ETA: 0s - loss: 0.2383 - accuracy: 0.9192
Epoch 00091: val_accuracy did not improve from 0.87600
390/390 [==============================] - 185s 475ms/step - loss: 0.2383 - accuracy: 0.9192 - val_loss: 0.4995 - val_accuracy: 0.8551
Epoch 92/120
390/390 [==============================] - ETA: 0s - loss: 0.2369 - accuracy: 0.9211
Epoch 00092: val_accuracy did not improve from 0.87600
390/390 [==============================] - 185s 475ms/step - loss: 0.2369 - accuracy: 0.9211 - val_loss: 0.4381 - val_accuracy: 0.8721
Epoch 93/120
390/390 [==============================] - ETA: 0s - loss: 0.2386 - accuracy: 0.9191
Epoch 00093: val_accuracy did not improve from 0.87600
390/390 [==============================] - 185s 475ms/step - loss: 0.2386 - accuracy: 0.9191 - val_loss: 0.5462 - val_accuracy: 0.8428
Epoch 94/120
390/390 [==============================] - ETA: 0s - loss: 0.2325 - accuracy: 0.9223
Epoch 00094: val_accuracy did not improve from 0.87600
390/390 [==============================] - 185s 475ms/step - loss: 0.2325 - accuracy: 0.9223 - val_loss: 0.4295 - val_accuracy: 0.8696
Epoch 95/120
390/390 [==============================] - ETA: 0s - loss: 0.2300 - accuracy: 0.9218
Epoch 00095: val_accuracy did not improve from 0.87600
390/390 [==============================] - 185s 475ms/step - loss: 0.2300 - accuracy: 0.9218 - val_loss: 0.4453 - val_accuracy: 0.8694
Epoch 96/120
390/390 [==============================] - ETA: 0s - loss: 0.2321 - accuracy: 0.9201
Epoch 00096: val_accuracy did not improve from 0.87600
390/390 [==============================] - 185s 475ms/step - loss: 0.2321 - accuracy: 0.9201 - val_loss: 0.4882 - val_accuracy: 0.8553
Epoch 97/120
390/390 [==============================] - ETA: 0s - loss: 0.2275 - accuracy: 0.9240
Epoch 00097: val_accuracy did not improve from 0.87600
390/390 [==============================] - 185s 475ms/step - loss: 0.2275 - accuracy: 0.9240 - val_loss: 0.4246 - val_accuracy: 0.8742
Epoch 98/120
390/390 [==============================] - ETA: 0s - loss: 0.2256 - accuracy: 0.9240
Epoch 00098: val_accuracy improved from 0.87600 to 0.88100, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 187s 478ms/step - loss: 0.2256 - accuracy: 0.9240 - val_loss: 0.3941 - val_accuracy: 0.8810
Epoch 99/120
390/390 [==============================] - ETA: 0s - loss: 0.2284 - accuracy: 0.9227
Epoch 00099: val_accuracy did not improve from 0.88100
390/390 [==============================] - 185s 475ms/step - loss: 0.2284 - accuracy: 0.9227 - val_loss: 0.4796 - val_accuracy: 0.8569
Epoch 100/120
390/390 [==============================] - ETA: 0s - loss: 0.2228 - accuracy: 0.9240
Epoch 00100: val_accuracy did not improve from 0.88100
390/390 [==============================] - 185s 475ms/step - loss: 0.2228 - accuracy: 0.9240 - val_loss: 0.5142 - val_accuracy: 0.8510
Epoch 101/120
390/390 [==============================] - ETA: 0s - loss: 0.2239 - accuracy: 0.9239
Epoch 00101: val_accuracy did not improve from 0.88100
390/390 [==============================] - 185s 475ms/step - loss: 0.2239 - accuracy: 0.9239 - val_loss: 0.4337 - val_accuracy: 0.8683
Epoch 102/120
390/390 [==============================] - ETA: 0s - loss: 0.2221 - accuracy: 0.9250
Epoch 00102: val_accuracy did not improve from 0.88100
390/390 [==============================] - 185s 475ms/step - loss: 0.2221 - accuracy: 0.9250 - val_loss: 0.4211 - val_accuracy: 0.8762
Epoch 103/120
390/390 [==============================] - ETA: 0s - loss: 0.2224 - accuracy: 0.9254
Epoch 00103: val_accuracy did not improve from 0.88100
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390/390 [==============================] - 185s 475ms/step - loss: 0.2224 - accuracy: 0.9254 - val_loss: 0.6233 - val_accuracy: 0.8363
Epoch 104/120
390/390 [==============================] - ETA: 0s - loss: 0.2206 - accuracy: 0.9262
Epoch 00104: val_accuracy did not improve from 0.88100
390/390 [==============================] - 185s 475ms/step - loss: 0.2206 - accuracy: 0.9262 - val_loss: 0.3982 - val_accuracy: 0.8796
Epoch 105/120
390/390 [==============================] - ETA: 0s - loss: 0.2201 - accuracy: 0.9248
Epoch 00105: val_accuracy did not improve from 0.88100
390/390 [==============================] - 185s 475ms/step - loss: 0.2201 - accuracy: 0.9248 - val_loss: 0.4496 - val_accuracy: 0.8704
Epoch 106/120
390/390 [==============================] - ETA: 0s - loss: 0.2161 - accuracy: 0.9271
Epoch 00106: val_accuracy did not improve from 0.88100
390/390 [==============================] - 185s 475ms/step - loss: 0.2161 - accuracy: 0.9271 - val_loss: 0.4074 - val_accuracy: 0.8775
Epoch 107/120
390/390 [==============================] - ETA: 0s - loss: 0.2133 - accuracy: 0.9283
Epoch 00107: val_accuracy did not improve from 0.88100
390/390 [==============================] - 185s 475ms/step - loss: 0.2133 - accuracy: 0.9283 - val_loss: 0.4887 - val_accuracy: 0.8607
Epoch 108/120
390/390 [==============================] - ETA: 0s - loss: 0.2105 - accuracy: 0.9295
Epoch 00108: val_accuracy did not improve from 0.88100
390/390 [==============================] - 185s 475ms/step - loss: 0.2105 - accuracy: 0.9295 - val_loss: 0.5088 - val_accuracy: 0.8609
Epoch 109/120
390/390 [==============================] - ETA: 0s - loss: 0.2123 - accuracy: 0.9286
Epoch 00109: val_accuracy did not improve from 0.88100
390/390 [==============================] - 185s 475ms/step - loss: 0.2123 - accuracy: 0.9286 - val_loss: 0.4558 - val_accuracy: 0.8659
Epoch 110/120
390/390 [==============================] - ETA: 0s - loss: 0.2109 - accuracy: 0.9299
Epoch 00110: val_accuracy did not improve from 0.88100
390/390 [==============================] - 185s 475ms/step - loss: 0.2109 - accuracy: 0.9299 - val_loss: 0.4864 - val_accuracy: 0.8626
Epoch 111/120
390/390 [==============================] - ETA: 0s - loss: 0.2069 - accuracy: 0.9289
Epoch 00111: val_accuracy did not improve from 0.88100
390/390 [==============================] - 185s 475ms/step - loss: 0.2069 - accuracy: 0.9289 - val_loss: 0.4284 - val_accuracy: 0.8766
Epoch 112/120
390/390 [==============================] - ETA: 0s - loss: 0.2030 - accuracy: 0.9318
Epoch 00112: val_accuracy improved from 0.88100 to 0.88420, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 478ms/step - loss: 0.2030 - accuracy: 0.9318 - val_loss: 0.3927 - val_accuracy: 0.8842
Epoch 113/120
390/390 [==============================] - ETA: 0s - loss: 0.2090 - accuracy: 0.9291
Epoch 00113: val_accuracy did not improve from 0.88420
390/390 [==============================] - 185s 475ms/step - loss: 0.2090 - accuracy: 0.9291 - val_loss: 0.6420 - val_accuracy: 0.8298
Epoch 114/120
390/390 [==============================] - ETA: 0s - loss: 0.2019 - accuracy: 0.9319
Epoch 00114: val_accuracy did not improve from 0.88420
390/390 [==============================] - 185s 475ms/step - loss: 0.2019 - accuracy: 0.9319 - val_loss: 0.4881 - val_accuracy: 0.8620
Epoch 115/120
390/390 [==============================] - ETA: 0s - loss: 0.2011 - accuracy: 0.9328
Epoch 00115: val_accuracy did not improve from 0.88420
390/390 [==============================] - 185s 475ms/step - loss: 0.2011 - accuracy: 0.9328 - val_loss: 0.4231 - val_accuracy: 0.8748
Epoch 116/120
390/390 [==============================] - ETA: 0s - loss: 0.2009 - accuracy: 0.9318
Epoch 00116: val_accuracy did not improve from 0.88420
390/390 [==============================] - 185s 475ms/step - loss: 0.2009 - accuracy: 0.9318 - val_loss: 0.4611 - val_accuracy: 0.8682
Epoch 117/120
```

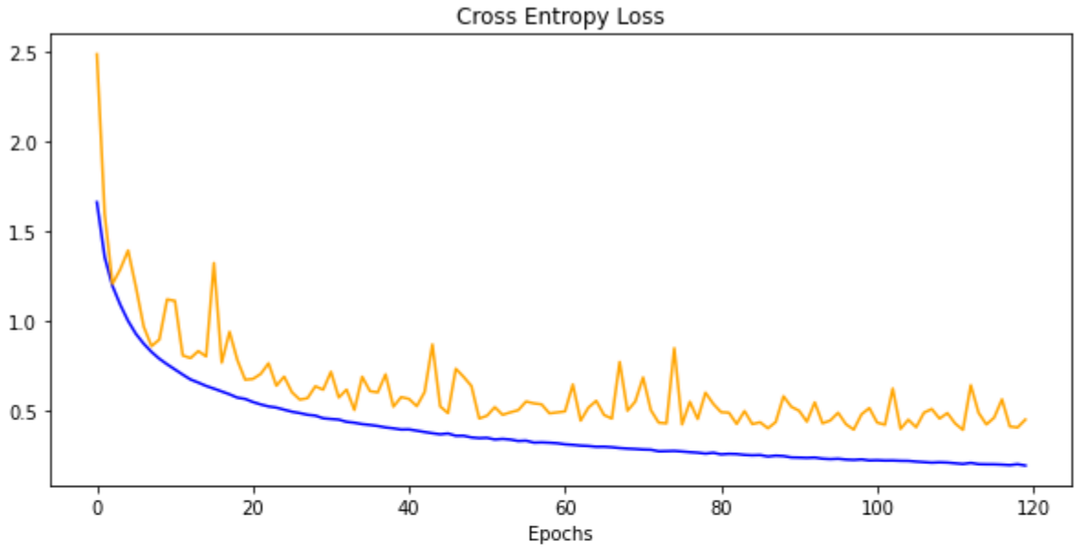
```
390/390 [==============================] - ETA: 0s - loss: 0.1992 - accuracy: 0.9324
Epoch 00117: val_accuracy did not improve from 0.88420
390/390 [==============================] - 185s 475ms/step - loss: 0.1992 - accuracy: 0.9324 - val_loss: 0.5630 - val_accuracy: 0.8456
Epoch 118/120
390/390 [==============================] - ETA: 0s - loss: 0.1966 - accuracy: 0.9339
Epoch 00118: val_accuracy did not improve from 0.88420
390/390 [==============================] - 185s 475ms/step - loss: 0.1966 - accuracy: 0.9339 - val_loss: 0.4118 - val_accuracy: 0.8805
Epoch 119/120
390/390 [==============================] - ETA: 0s - loss: 0.2016 - accuracy: 0.9324
Epoch 00119: val_accuracy did not improve from 0.88420
390/390 [==============================] - 185s 475ms/step - loss: 0.2016 - accuracy: 0.9324 - val_loss: 0.4062 - val_accuracy: 0.8792
Epoch 120/120
390/390 [==============================] - ETA: 0s - loss: 0.1941 - accuracy: 0.9339
Epoch 00120: val_accuracy did not improve from 0.88420
390/390 [==============================] - 185s 475ms/step - loss: 0.1941 - accuracy: 0.9339 - val_loss: 0.4500 - val_accuracy: 0.8703
```

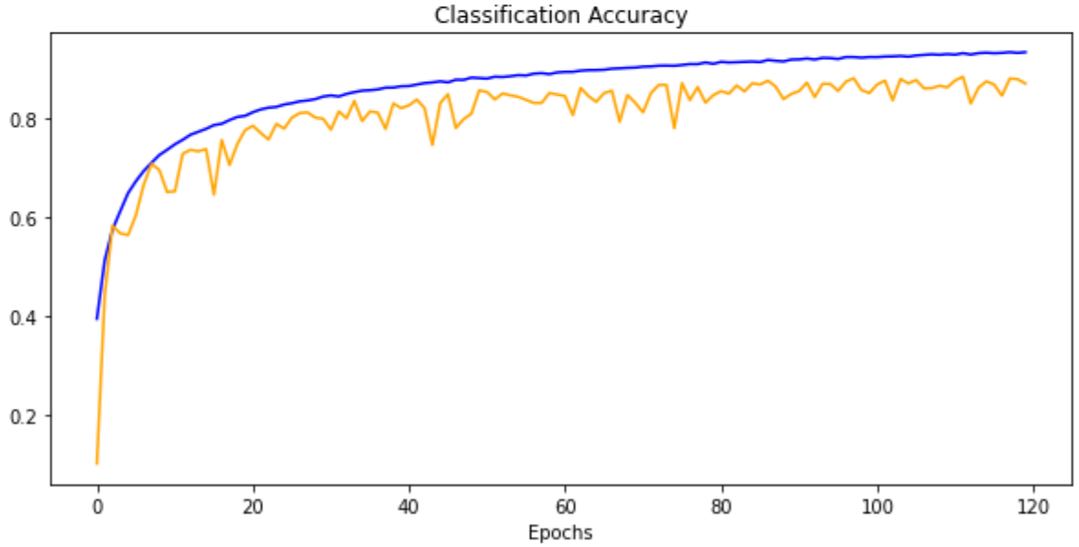
In [ ]:

```
# Testing the model- Best Model
model.load_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5')
score = model.evaluate(X_test, y_test, verbose=1)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
print("--"*25)


summarize_diagnostics(history)
```

```
313/313 [==============================] - 10s 31ms/step - loss: 0.3927 - accuracy: 0.8842
Test loss: 0.39271241426467896
Test accuracy: 0.8841999769210815
--------------------------------------------------
```





▶ **Loading Model from 120th Epoch for further Training:**

In [ ]:

```
import tensorflow.keras.backend as k
k.set_value(model.optimizer.lr, 0.001)

callback_list = [checkpoint]
model.load_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_120Epoch.h5')
epochs = 60
history = model.fit_generator(datagen.flow(X_train, y_train, batch_size=batch_size),\
                    steps_per_epoch=X_train.shape[0] // batch_size,epochs=epochs,\
                    verbose=1,validation_data=(X_test,y_test),callbacks=callback_list)
```

```
model.save_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_180Epoch.h5')
```

```
Epoch 1/60
390/390 [==============================] - ETA: 0s - loss: 0.1614 - accuracy: 0.9471
Epoch 00001: val_accuracy improved from 0.88420 to 0.89430, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.1614 - accuracy: 0.9471 - val_loss: 0.3525 - val_accuracy: 0.8943
Epoch 2/60
390/390 [==============================] - ETA: 0s - loss: 0.1478 - accuracy: 0.9517
Epoch 00002: val_accuracy improved from 0.89430 to 0.89690, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.1478 - accuracy: 0.9517 - val_loss: 0.3574 - val_accuracy: 0.8969
Epoch 3/60
390/390 [==============================] - ETA: 0s - loss: 0.1426 - accuracy: 0.9534
Epoch 00003: val_accuracy improved from 0.89690 to 0.89970, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.1426 - accuracy: 0.9534 - val_loss: 0.3429 - val_accuracy: 0.8997
Epoch 4/60
390/390 [==============================] - ETA: 0s - loss: 0.1411 - accuracy: 0.9544
Epoch 00004: val_accuracy did not improve from 0.89970
390/390 [==============================] - 185s 474ms/step - loss: 0.1411 - accuracy: 0.9544 - val_loss: 0.3505 - val_accuracy: 0.8978
Epoch 5/60
390/390 [==============================] - ETA: 0s - loss: 0.1412 - accuracy: 0.9541
Epoch 00005: val_accuracy did not improve from 0.89970
390/390 [==============================] - 185s 474ms/step - loss: 0.1412 - accuracy: 0.9541 - val_loss: 0.3423 - val_accuracy: 0.8994
Epoch 6/60
390/390 [==============================] - ETA: 0s - loss: 0.1351 - accuracy: 0.9567
Epoch 00006: val_accuracy improved from 0.89970 to 0.90020, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 187s 479ms/step - loss: 0.1351 - accuracy: 0.9567 - val_loss: 0.3438 - val_accuracy: 0.9002
Epoch 7/60
390/390 [==============================] - ETA: 0s - loss: 0.1367 - accuracy: 0.9551
Epoch 00007: val_accuracy improved from 0.90020 to 0.90080, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.1367 - accuracy: 0.9551 - val_loss: 0.3395 - val_accuracy: 0.9008
Epoch 8/60
390/390 [==============================] - ETA: 0s - loss: 0.1341 - accuracy: 0.9570
Epoch 00008: val_accuracy did not improve from 0.90080
390/390 [==============================] - 185s 474ms/step - loss: 0.1341 - accuracy: 0.9570 - val_loss: 0.3465 - val_accuracy: 0.8992
Epoch 9/60
390/390 [==============================] - ETA: 0s - loss: 0.1357 - accuracy: 0.9566
Epoch 00009: val_accuracy improved from 0.90080 to 0.90090, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.1357 - accuracy: 0.9566 - val_loss: 0.3422 - val_accuracy: 0.9009
Epoch 10/60
390/390 [==============================] - ETA: 0s - loss: 0.1311 - accuracy: 0.9578
Epoch 00010: val_accuracy did not improve from 0.90090
390/390 [==============================] - 185s 474ms/step - loss: 0.1311 - accuracy: 0.9578 - val_loss: 0.3462 - val_accuracy: 0.9005
Epoch 11/60
390/390 [==============================] - ETA: 0s - loss: 0.1326 - accuracy: 0.9575
Epoch 00011: val_accuracy did not improve from 0.90090
390/390 [==============================] - 185s 475ms/step - loss: 0.1326 - accuracy: 0.9575 - val_loss: 0.3407 - val_accuracy: 0.9004
Epoch 12/60
390/390 [==============================] - ETA: 0s - loss: 0.1270 - accuracy: 0.9594
Epoch 00012: val_accuracy improved from 0.90090 to 0.90120, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.1270 - accuracy: 0.9594 - val_loss: 0.3391 - val_accuracy: 0.9012
Epoch 13/60
390/390 [==============================] - ETA: 0s - loss: 0.1318 - accuracy: 0.9564
```

```
Epoch 00013: val_accuracy did not improve from 0.90120
390/390 [==============================] - 185s 474ms/step - loss: 0.1318 - accuracy: 0.9564 - val_loss: 0.3484 - val_accuracy: 0.8998
Epoch 14/60
390/390 [==============================] - ETA: 0s - loss: 0.1307 - accuracy: 0.9576
Epoch 00014: val_accuracy did not improve from 0.90120
390/390 [==============================] - 185s 474ms/step - loss: 0.1307 - accuracy: 0.9576 - val_loss: 0.3444 - val_accuracy: 0.9010
Epoch 15/60
390/390 [==============================] - ETA: 0s - loss: 0.1291 - accuracy: 0.9584
Epoch 00015: val_accuracy improved from 0.90120 to 0.90300, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.1291 - accuracy: 0.9584 - val_loss: 0.3345 - val_accuracy: 0.9030
Epoch 16/60
390/390 [==============================] - ETA: 0s - loss: 0.1308 - accuracy: 0.9575
Epoch 00016: val_accuracy did not improve from 0.90300
390/390 [==============================] - 185s 474ms/step - loss: 0.1308 - accuracy: 0.9575 - val_loss: 0.3390 - val_accuracy: 0.9018
Epoch 17/60
390/390 [==============================] - ETA: 0s - loss: 0.1278 - accuracy: 0.9581
Epoch 00017: val_accuracy did not improve from 0.90300
390/390 [==============================] - 185s 475ms/step - loss: 0.1278 - accuracy: 0.9581 - val_loss: 0.3462 - val_accuracy: 0.9004
Epoch 18/60
390/390 [==============================] - ETA: 0s - loss: 0.1277 - accuracy: 0.9585
Epoch 00018: val_accuracy did not improve from 0.90300
390/390 [==============================] - 185s 475ms/step - loss: 0.1277 - accuracy: 0.9585 - val_loss: 0.3532 - val_accuracy: 0.8990
Epoch 19/60
390/390 [==============================] - ETA: 0s - loss: 0.1281 - accuracy: 0.9590
Epoch 00019: val_accuracy did not improve from 0.90300
390/390 [==============================] - 185s 474ms/step - loss: 0.1281 - accuracy: 0.9590 - val_loss: 0.3538 - val_accuracy: 0.8999
Epoch 20/60
390/390 [==============================] - ETA: 0s - loss: 0.1258 - accuracy: 0.9588
Epoch 00020: val_accuracy did not improve from 0.90300
390/390 [==============================] - 185s 474ms/step - loss: 0.1258 - accuracy: 0.9588 - val_loss: 0.3436 - val_accuracy: 0.9009
Epoch 21/60
390/390 [==============================] - ETA: 0s - loss: 0.1265 - accuracy: 0.9598
Epoch 00021: val_accuracy did not improve from 0.90300
390/390 [==============================] - 185s 474ms/step - loss: 0.1265 - accuracy: 0.9598 - val_loss: 0.3548 - val_accuracy: 0.8988
Epoch 22/60
390/390 [==============================] - ETA: 0s - loss: 0.1251 - accuracy: 0.9602
Epoch 00022: val_accuracy improved from 0.90300 to 0.90420, saving model to /content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5
390/390 [==============================] - 186s 477ms/step - loss: 0.1251 - accuracy: 0.9602 - val_loss: 0.3327 - val_accuracy: 0.9042
Epoch 23/60
390/390 [==============================] - ETA: 0s - loss: 0.1233 - accuracy: 0.9611
Epoch 00023: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 475ms/step - loss: 0.1233 - accuracy: 0.9611 - val_loss: 0.3501 - val_accuracy: 0.9000
Epoch 24/60
390/390 [==============================] - ETA: 0s - loss: 0.1201 - accuracy: 0.9623
Epoch 00024: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1201 - accuracy: 0.9623 - val_loss: 0.3341 - val_accuracy: 0.9037
Epoch 25/60
390/390 [==============================] - ETA: 0s - loss: 0.1201 - accuracy: 0.9617
Epoch 00025: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1201 - accuracy: 0.9617 - val_loss: 0.3472 - val_accuracy: 0.9018
Epoch 26/60
390/390 [==============================] - ETA: 0s - loss: 0.1242 - accuracy: 0.9599
Epoch 00026: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1242 - accuracy: 0.9599 - val_loss: 0.3363 - val_accuracy: 0.9031
```

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Epoch 27/60
390/390 [==============================] - ETA: 0s - loss: 0.1213 - accuracy: 0.9617
Epoch 00027: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1213 - accuracy: 0.9617 - val_loss: 0.3518 - val_accuracy: 0.9006
Epoch 28/60
390/390 [==============================] - ETA: 0s - loss: 0.1210 - accuracy: 0.9608
Epoch 00028: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1210 - accuracy: 0.9608 - val_loss: 0.3456 - val_accuracy: 0.9014
Epoch 29/60
390/390 [==============================] - ETA: 0s - loss: 0.1210 - accuracy: 0.9610
Epoch 00029: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1210 - accuracy: 0.9610 - val_loss: 0.3410 - val_accuracy: 0.9024
Epoch 30/60
390/390 [==============================] - ETA: 0s - loss: 0.1209 - accuracy: 0.9615
Epoch 00030: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1209 - accuracy: 0.9615 - val_loss: 0.3570 - val_accuracy: 0.9001
Epoch 31/60
390/390 [==============================] - ETA: 0s - loss: 0.1176 - accuracy: 0.9616
Epoch 00031: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1176 - accuracy: 0.9616 - val_loss: 0.3540 - val_accuracy: 0.9015
Epoch 32/60
390/390 [==============================] - ETA: 0s - loss: 0.1189 - accuracy: 0.9613
Epoch 00032: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1189 - accuracy: 0.9613 - val_loss: 0.3469 - val_accuracy: 0.9010
Epoch 33/60
390/390 [==============================] - ETA: 0s - loss: 0.1173 - accuracy: 0.9617
Epoch 00033: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1173 - accuracy: 0.9617 - val_loss: 0.3454 - val_accuracy: 0.9022
Epoch 34/60
390/390 [==============================] - ETA: 0s - loss: 0.1214 - accuracy: 0.9597
Epoch 00034: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1214 - accuracy: 0.9597 - val_loss: 0.3557 - val_accuracy: 0.8989
Epoch 35/60
390/390 [==============================] - ETA: 0s - loss: 0.1183 - accuracy: 0.9619
Epoch 00035: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1183 - accuracy: 0.9619 - val_loss: 0.3544 - val_accuracy: 0.9000
Epoch 36/60
390/390 [==============================] - ETA: 0s - loss: 0.1174 - accuracy: 0.9619
Epoch 00036: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1174 - accuracy: 0.9619 - val_loss: 0.3545 - val_accuracy: 0.9004
Epoch 37/60
390/390 [==============================] - ETA: 0s - loss: 0.1193 - accuracy: 0.9614
Epoch 00037: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1193 - accuracy: 0.9614 - val_loss: 0.3419 - val_accuracy: 0.9007
Epoch 38/60
390/390 [==============================] - ETA: 0s - loss: 0.1152 - accuracy: 0.9609
Epoch 00038: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1152 - accuracy: 0.9609 - val_loss: 0.3489 - val_accuracy: 0.9021
Epoch 39/60
390/390 [==============================] - ETA: 0s - loss: 0.1196 - accuracy: 0.9612
Epoch 00039: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1196 - accuracy: 0.9612 - val_loss: 0.3407 - val_accuracy: 0.9003
Epoch 40/60
390/390 [==============================] - ETA: 0s - loss: 0.1159 - accuracy: 0.9634
```

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Epoch 00040: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1159 - accuracy: 0.9634 - val_loss: 0.3635 - val_accuracy: 0.8987
Epoch 41/60
390/390 [==============================] - ETA: 0s - loss: 0.1166 - accuracy: 0.9629
Epoch 00041: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1166 - accuracy: 0.9629 - val_loss: 0.3792 - val_accuracy: 0.8963
Epoch 42/60
390/390 [==============================] - ETA: 0s - loss: 0.1152 - accuracy: 0.9633
Epoch 00042: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1152 - accuracy: 0.9633 - val_loss: 0.3533 - val_accuracy: 0.9005
Epoch 43/60
390/390 [==============================] - ETA: 0s - loss: 0.1149 - accuracy: 0.9628
Epoch 00043: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1149 - accuracy: 0.9628 - val_loss: 0.3467 - val_accuracy: 0.9014
Epoch 44/60
390/390 [==============================] - ETA: 0s - loss: 0.1144 - accuracy: 0.9634
Epoch 00044: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1144 - accuracy: 0.9634 - val_loss: 0.3564 - val_accuracy: 0.8985
Epoch 45/60
390/390 [==============================] - ETA: 0s - loss: 0.1131 - accuracy: 0.9641
Epoch 00045: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1131 - accuracy: 0.9641 - val_loss: 0.3602 - val_accuracy: 0.9000
Epoch 46/60
390/390 [==============================] - ETA: 0s - loss: 0.1173 - accuracy: 0.9613
Epoch 00046: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1173 - accuracy: 0.9613 - val_loss: 0.3511 - val_accuracy: 0.9023
Epoch 47/60
390/390 [==============================] - ETA: 0s - loss: 0.1142 - accuracy: 0.9634
Epoch 00047: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1142 - accuracy: 0.9634 - val_loss: 0.3531 - val_accuracy: 0.8988
Epoch 48/60
390/390 [==============================] - ETA: 0s - loss: 0.1174 - accuracy: 0.9611
Epoch 00048: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1174 - accuracy: 0.9611 - val_loss: 0.3611 - val_accuracy: 0.8980
Epoch 49/60
390/390 [==============================] - ETA: 0s - loss: 0.1145 - accuracy: 0.9634
Epoch 00049: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1145 - accuracy: 0.9634 - val_loss: 0.3612 - val_accuracy: 0.8994
Epoch 50/60
390/390 [==============================] - ETA: 0s - loss: 0.1120 - accuracy: 0.9643
Epoch 00050: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1120 - accuracy: 0.9643 - val_loss: 0.3650 - val_accuracy: 0.8998
Epoch 51/60
390/390 [==============================] - ETA: 0s - loss: 0.1140 - accuracy: 0.9641
Epoch 00051: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1140 - accuracy: 0.9641 - val_loss: 0.3624 - val_accuracy: 0.8975
Epoch 52/60
390/390 [==============================] - ETA: 0s - loss: 0.1119 - accuracy: 0.9644
Epoch 00052: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1119 - accuracy: 0.9644 - val_loss: 0.3586 - val_accuracy: 0.8998
Epoch 53/60
390/390 [==============================] - ETA: 0s - loss: 0.1118 - accuracy: 0.9637
Epoch 00053: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1118 - accuracy: 0.9637 - val_loss: 0.3441 - val_accuracy: 0.9028
```

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Epoch 54/60
390/390 [==============================] - ETA: 0s - loss: 0.1112 - accuracy: 0.9652
Epoch 00054: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1112 - accuracy: 0.9652 - val_loss: 0.3623 - val_accuracy: 0.9005
Epoch 55/60
390/390 [==============================] - ETA: 0s - loss: 0.1106 - accuracy: 0.9643
Epoch 00055: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1106 - accuracy: 0.9643 - val_loss: 0.3746 - val_accuracy: 0.8959
Epoch 56/60
390/390 [==============================] - ETA: 0s - loss: 0.1145 - accuracy: 0.9630
Epoch 00056: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1145 - accuracy: 0.9630 - val_loss: 0.3562 - val_accuracy: 0.9014
Epoch 57/60
390/390 [==============================] - ETA: 0s - loss: 0.1134 - accuracy: 0.9637
Epoch 00057: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1134 - accuracy: 0.9637 - val_loss: 0.3528 - val_accuracy: 0.9035
Epoch 58/60
390/390 [==============================] - ETA: 0s - loss: 0.1133 - accuracy: 0.9627
Epoch 00058: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1133 - accuracy: 0.9627 - val_loss: 0.3682 - val_accuracy: 0.8988
Epoch 59/60
390/390 [==============================] - ETA: 0s - loss: 0.1117 - accuracy: 0.9637
Epoch 00059: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1117 - accuracy: 0.9637 - val_loss: 0.3598 - val_accuracy: 0.9006
Epoch 60/60
390/390 [==============================] - ETA: 0s - loss: 0.1133 - accuracy: 0.9630
Epoch 00060: val_accuracy did not improve from 0.90420
390/390 [==============================] - 185s 474ms/step - loss: 0.1133 - accuracy: 0.9630 - val_loss: 0.3538 - val_accuracy: 0.9013
```

Loading Best Model:

In [ ]:

```
import numpy as np
# Testing the model- Rev01 Model
model.load_weights('/content/drive/MyDrive/27 CNN on CIFR/Model Output/model_depthwise_best.h5')
score = model.evaluate(X_test, y_test, verbose=1)
print('Test loss:', np.round(score[0],2))
print('Test accuracy:', np.round(score[1],2))
print("--"*25)
```

```
313/313 [==============================] - 9s 30ms/step - loss: 0.3327 - accuracy: 0.9042
Test loss: 0.33
Test accuracy: 0.9
--------------------------------------------------
```

Representation of Results:

In [48]:

```
from prettytable import PrettyTable
results = PrettyTable()
results.field_names = ["Model Description", "Total Parameters","Hyperparams","Best Model Accuracy-Train", "Best Model Accuracy-Test"]
results.add_row([ "Depthwise Seperable Conv2D \n + Elastic Net\n" , "208,630", "Epoch   :300\n l      :12 \nfilters:36\n","\n 0.9387", "\n 0.8925" ])
```

```
results.add_row([ "Depthwise Seperable Conv2D \n + Elastic Net" , "735,238","Epoch   :144\n l      :24 \nfilters:36\n", "\n 0.9602", "\n 0.9042" ])
print(results)
```

```
+----------------------------+-----------------+--------------+---------------------------+--------------------------+
|      Model Description     | Total Parameters | Hyperparams  | Best Model Accuracy-Train | Best Model Accuracy-Test |
+----------------------------+-----------------+--------------+---------------------------+--------------------------+
| Depthwise Seperable Conv2D |     208,630     | Epoch   :300 |                           |                          |
|         + Elastic Net      |                 |  l      :12  |           0.9387          |          0.8925          |
|                            |                 |  filters:36  |                           |                          |
|                            |                 |              |                           |                          |
| Depthwise Seperable Conv2D |     735,238     | Epoch   :144 |                           |                          |
|         + Elastic Net      |                 |  l      :24  |           0.9602          |          0.9042          |
|                            |                 |  filters:36  |                           |                          |
|                            |                 |              |                           |                          |
+----------------------------+-----------------+--------------+---------------------------+--------------------------+
```

End