

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

```
In [21]: import keras
from keras.datasets import cifar10
from keras.models import Model, Sequential
from keras.layers import Dense, Dropout, Flatten, Input, AveragePooling2D, merge
from keras.layers import Conv2D, MaxPooling2D, BatchNormalization
from keras.layers import Concatenate
from keras.optimizers import Adam
from tensorflow.keras import models, layers
from tensorflow.keras.models import Model
from tensorflow.keras.layers import BatchNormalization, Activation, Flatten
from tensorflow.keras.optimizers import Adam
import numpy as np
from tqdm import tqdm
from matplotlib import pyplot
```

```
In [22]: # this part will prevent tensorflow to allocate all the avaiiable GPU Memory
# backend
import tensorflow as tf
```

```
In [23]: # Hyperparameters
batch_size = 128
num_classes = 10
epochs = 10
l = 8

l = 8
num_filter = 27
#compression = 1
compression = 1
dropout_rate = 0.2
```

```
In [24]: from sklearn.model_selection import train_test_split
```

```
In [24]:
```

```
In [25]: # 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 encoding
y_train = tf.keras.utils.to_categorical(y_train, num_classes)
y_test = tf.keras.utils.to_categorical(y_test, num_classes)
```

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```
In [26]: y_cv.shape
```

```
Out[26]: (10000, 10)
```

```
In [27]: from keras.preprocessing.image import ImageDataGenerator
```

```
In [9]: #creating data for validation
X_train, X_cv, y_train, y_cv = train_test_split(X_train, y_train, test_size=0.2,
```

```
In [10]:
```

```
In [ ]:
```

```
In [ ]:
```

```

In [14]: # Dense Block
def denseblock(input, num_filter = 12, dropout_rate = 0.2):
    global compression
    temp = input
    for _ in range(1):
        BatchNorm = layers.BatchNormalization()(temp)
        relu = layers.Activation('relu')(BatchNorm)
        Conv2D_3_3 = layers.Conv2D(int(num_filter*compression), (3,3), use_bias=True)
        #if dropout_rate>0:
            # Conv2D_3_3 = layers.Dropout(dropout_rate)(Conv2D_3_3)
        concat = layers.Concatenate(axis=-1)([temp, Conv2D_3_3])

        temp = concat

    return temp

## transition Block
def transition(input, num_filter = 12, dropout_rate = 0.2):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    Conv2D_BottleNeck = layers.Conv2D(int(num_filter*compression), (1,1), use_bias=True)
    #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 [15]: #num_filter = 36
#dropout_rate = 0.2
#l = 12
input = layers.Input(shape=(img_height, img_width, channel,))
First_Conv2D = layers.Conv2D(num_filter, (2,2), 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)

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

Model: "functional_1"

Layer (type)	Output Shape	Param #	Connected to
=====			
input_1 (InputLayer)	[(None, 32, 32, 3)]	0	
=====			
conv2d (Conv2D)	(None, 32, 32, 27)	324	input_1[0][0]
=====			
batch_normalization (BatchNormaliza	(None, 32, 32, 27)	108	conv2d[0][0]
=====			
activation (Activation)	(None, 32, 32, 27)	0	batch_normaliz
ation[0][0]			
=====			
conv2d_1 (Conv2D)	(None, 32, 32, 27)	6561	activation[0]
[0]			
=====			
concatenate (Concatenate)	(None, 32, 32, 54)	0	conv2d[0][0] conv2d_1[0][0]
=====			
batch_normalization_1 (BatchNor	(None, 32, 32, 54)	216	concatenate[0]
[0]			
=====			
activation_1 (Activation)	(None, 32, 32, 54)	0	batch_normaliz
ation_1[0][0]			
=====			

conv2d_2 (Conv2D) [0][0]	(None, 32, 32, 27)	13122	activation_1
concatenate_1 (Concatenate) [0]	(None, 32, 32, 81)	0	concatenate[0] conv2d_2[0][0]
batch_normalization_2 (BatchNor [0][0]	(None, 32, 32, 81)	324	concatenate_1
activation_2 (Activation) activation_2[0][0]	(None, 32, 32, 81)	0	batch_normaliz
conv2d_3 (Conv2D) [0][0]	(None, 32, 32, 27)	19683	activation_2
concatenate_2 (Concatenate) [0][0]	(None, 32, 32, 108)	0	concatenate_1 conv2d_3[0][0]
batch_normalization_3 (BatchNor [0][0]	(None, 32, 32, 108)	432	concatenate_2
activation_3 (Activation) activation_3[0][0]	(None, 32, 32, 108)	0	batch_normaliz
conv2d_4 (Conv2D) [0][0]	(None, 32, 32, 27)	26244	activation_3
concatenate_3 (Concatenate) [0][0]	(None, 32, 32, 135)	0	concatenate_2 conv2d_4[0][0]
batch_normalization_4 (BatchNor [0][0]	(None, 32, 32, 135)	540	concatenate_3
activation_4 (Activation) activation_4[0][0]	(None, 32, 32, 135)	0	batch_normaliz
conv2d_5 (Conv2D) [0][0]	(None, 32, 32, 27)	32805	activation_4
concatenate_4 (Concatenate) [0][0]	(None, 32, 32, 162)	0	concatenate_3

			conv2d_5[0][0]
batch_normalization_5 (BatchNor	(None, 32, 32, 162)	648	concatenate_4
[0][0]			
activation_5 (Activation)	(None, 32, 32, 162)	0	batch_normaliz
ation_5[0][0]			
conv2d_6 (Conv2D)	(None, 32, 32, 27)	39366	activation_5
[0][0]			
concatenate_5 (Concatenate)	(None, 32, 32, 189)	0	concatenate_4
[0][0]			conv2d_6[0][0]
batch_normalization_6 (BatchNor	(None, 32, 32, 189)	756	concatenate_5
[0][0]			
activation_6 (Activation)	(None, 32, 32, 189)	0	batch_normaliz
ation_6[0][0]			
conv2d_7 (Conv2D)	(None, 32, 32, 27)	45927	activation_6
[0][0]			
concatenate_6 (Concatenate)	(None, 32, 32, 216)	0	concatenate_5
[0][0]			conv2d_7[0][0]
batch_normalization_7 (BatchNor	(None, 32, 32, 216)	864	concatenate_6
[0][0]			
activation_7 (Activation)	(None, 32, 32, 216)	0	batch_normaliz
ation_7[0][0]			
conv2d_8 (Conv2D)	(None, 32, 32, 27)	52488	activation_7
[0][0]			
concatenate_7 (Concatenate)	(None, 32, 32, 243)	0	concatenate_6
[0][0]			conv2d_8[0][0]
batch_normalization_8 (BatchNor	(None, 32, 32, 243)	972	concatenate_7
[0][0]			

<u>activation_8</u> (Activation)	(None, 32, 32, 243)	0	batch_normaliz
ation_8[0][0]			
<u>conv2d_9</u> (Conv2D)	(None, 32, 32, 27)	6561	activation_8
[0][0]			
<u>average_pooling2d</u> (AveragePooli	(None, 16, 16, 27)	0	conv2d_9[0][0]
<u>batch_normalization_9</u> (BatchNor	(None, 16, 16, 27)	108	average_poolin
g2d[0][0]			
<u>activation_9</u> (Activation)	(None, 16, 16, 27)	0	batch_normaliz
ation_9[0][0]			
<u>conv2d_10</u> (Conv2D)	(None, 16, 16, 27)	6561	activation_9
[0][0]			
<u>concatenate_8</u> (Concatenate)	(None, 16, 16, 54)	0	average_poolin
g2d[0][0]			conv2d_10[0]
[0]			
<u>batch_normalization_10</u> (BatchNo	(None, 16, 16, 54)	216	concatenate_8
[0][0]			
<u>activation_10</u> (Activation)	(None, 16, 16, 54)	0	batch_normaliz
ation_10[0][0]			
<u>conv2d_11</u> (Conv2D)	(None, 16, 16, 27)	13122	activation_10
[0][0]			
<u>concatenate_9</u> (Concatenate)	(None, 16, 16, 81)	0	concatenate_8
[0][0]			conv2d_11[0]
[0]			
<u>batch_normalization_11</u> (BatchNo	(None, 16, 16, 81)	324	concatenate_9
[0][0]			
<u>activation_11</u> (Activation)	(None, 16, 16, 81)	0	batch_normaliz
ation_11[0][0]			
<u>conv2d_12</u> (Conv2D)	(None, 16, 16, 27)	19683	activation_11

[0][0]

concatenate_10 (Concatenate) [0][0]	(None, 16, 16, 108) 0	concatenate_9 conv2d_12[0]
[0]		
batch_normalization_12 (Batch Normalization) [0][0]	(None, 16, 16, 108) 432	concatenate_10
activation_12 (Activation) activation_12[0][0]	(None, 16, 16, 108) 0	batch_normalization_12[0][0]
conv2d_13 (Conv2D) [0][0]	(None, 16, 16, 27) 26244	activation_12
concatenate_11 (Concatenate) [0][0]	(None, 16, 16, 135) 0	concatenate_10 conv2d_13[0]
[0]		
batch_normalization_13 (Batch Normalization) [0][0]	(None, 16, 16, 135) 540	concatenate_11
activation_13 (Activation) activation_13[0][0]	(None, 16, 16, 135) 0	batch_normalization_13[0][0]
conv2d_14 (Conv2D) [0][0]	(None, 16, 16, 27) 32805	activation_13
concatenate_12 (Concatenate) [0][0]	(None, 16, 16, 162) 0	concatenate_11 conv2d_14[0]
[0]		
batch_normalization_14 (Batch Normalization) [0][0]	(None, 16, 16, 162) 648	concatenate_12
activation_14 (Activation) activation_14[0][0]	(None, 16, 16, 162) 0	batch_normalization_14[0][0]
conv2d_15 (Conv2D) [0][0]	(None, 16, 16, 27) 39366	activation_14

concatenate_13 (Concatenate) [0][0]	(None, 16, 16, 189)	0	concatenate_12 conv2d_15[0]
[0]			
batch_normalization_15 (BatchNo [0][0])	(None, 16, 16, 189)	756	concatenate_13
activation_15 (Activation) activation_15[0][0]	(None, 16, 16, 189)	0	batch_normaliz
conv2d_16 (Conv2D) [0][0]	(None, 16, 16, 27)	45927	activation_15
concatenate_14 (Concatenate) [0][0]	(None, 16, 16, 216)	0	concatenate_13 conv2d_16[0]
[0]			
batch_normalization_16 (BatchNo [0][0])	(None, 16, 16, 216)	864	concatenate_14
activation_16 (Activation) ation_16[0][0]	(None, 16, 16, 216)	0	batch_normaliz
conv2d_17 (Conv2D) [0][0]	(None, 16, 16, 27)	52488	activation_16
concatenate_15 (Concatenate) [0][0]	(None, 16, 16, 243)	0	concatenate_14 conv2d_17[0]
[0]			
batch_normalization_17 (BatchNo [0][0])	(None, 16, 16, 243)	972	concatenate_15
activation_17 (Activation) ation_17[0][0]	(None, 16, 16, 243)	0	batch_normaliz
conv2d_18 (Conv2D) [0][0]	(None, 16, 16, 27)	6561	activation_17
average_pooling2d_1 (AveragePoo [0])	(None, 8, 8, 27)	0	conv2d_18[0]

batch_normalization_18 (BatchNo	(None, 8, 8, 27)	108	average_poolin g2d_1[0][0]
activation_18 (Activation)	(None, 8, 8, 27)	0	batch_normaliz ation_18[0][0]
conv2d_19 (Conv2D)	(None, 8, 8, 27)	6561	activation_18 [0][0]
concatenate_16 (Concatenate)	(None, 8, 8, 54)	0	average_poolin g2d_1[0][0] [0]
batch_normalization_19 (BatchNo	(None, 8, 8, 54)	216	concatenate_16 [0][0]
activation_19 (Activation)	(None, 8, 8, 54)	0	batch_normaliz ation_19[0][0]
conv2d_20 (Conv2D)	(None, 8, 8, 27)	13122	activation_19 [0][0]
concatenate_17 (Concatenate)	(None, 8, 8, 81)	0	concatenate_16 [0][0] [0]
batch_normalization_20 (BatchNo	(None, 8, 8, 81)	324	concatenate_17 [0][0]
activation_20 (Activation)	(None, 8, 8, 81)	0	batch_normaliz ation_20[0][0]
conv2d_21 (Conv2D)	(None, 8, 8, 27)	19683	activation_20 [0][0]
concatenate_18 (Concatenate)	(None, 8, 8, 108)	0	concatenate_17 [0][0] [0]
batch_normalization_21 (BatchNo	(None, 8, 8, 108)	432	concatenate_18 [0][0]

<u>activation_21</u> (Activation) activation_21[0][0]	(None, 8, 8, 108)	0	batch_normaliz
<u>conv2d_22</u> (Conv2D) conv2d_22[0][0]	(None, 8, 8, 27)	26244	activation_21
<u>concatenate_19</u> (Concatenate) concatenate_19[0][0] [0]	(None, 8, 8, 135)	0	concatenate_18 conv2d_22[0]
<u>batch_normalization_22</u> (BatchNo [0][0]	(None, 8, 8, 135)	540	concatenate_19
<u>activation_22</u> (Activation) activation_22[0][0]	(None, 8, 8, 135)	0	batch_normaliz
<u>conv2d_23</u> (Conv2D) conv2d_23[0][0]	(None, 8, 8, 27)	32805	activation_22
<u>concatenate_20</u> (Concatenate) concatenate_20[0][0] [0]	(None, 8, 8, 162)	0	concatenate_19 conv2d_23[0]
<u>batch_normalization_23</u> (BatchNo [0][0]	(None, 8, 8, 162)	648	concatenate_20
<u>activation_23</u> (Activation) activation_23[0][0]	(None, 8, 8, 162)	0	batch_normaliz
<u>conv2d_24</u> (Conv2D) conv2d_24[0][0]	(None, 8, 8, 27)	39366	activation_23
<u>concatenate_21</u> (Concatenate) concatenate_21[0][0] [0]	(None, 8, 8, 189)	0	concatenate_20 conv2d_24[0]
<u>batch_normalization_24</u> (BatchNo [0][0]	(None, 8, 8, 189)	756	concatenate_21
<u>activation_24</u> (Activation)	(None, 8, 8, 189)	0	batch_normaliz

ation_24[0][0]

conv2d_25 (Conv2D) [0][0]	(None, 8, 8, 27)	45927	activation_24
concatenate_22 (Concatenate) [0][0]	(None, 8, 8, 216)	0	concatenate_21 conv2d_25[0]
batch_normalization_25 (BatchNo [0][0]	(None, 8, 8, 216)	864	concatenate_22
activation_25 (Activation) ation_25[0][0]	(None, 8, 8, 216)	0	batch_normaliz
conv2d_26 (Conv2D) [0][0]	(None, 8, 8, 27)	52488	activation_25
concatenate_23 (Concatenate) [0][0]	(None, 8, 8, 243)	0	concatenate_22 conv2d_26[0]
batch_normalization_26 (BatchNo [0][0]	(None, 8, 8, 243)	972	concatenate_23
activation_26 (Activation) ation_26[0][0]	(None, 8, 8, 243)	0	batch_normaliz
conv2d_27 (Conv2D) [0][0]	(None, 8, 8, 27)	6561	activation_26
average_pooling2d_2 (AveragePoo [0]	(None, 4, 4, 27)	0	conv2d_27[0]
batch_normalization_27 (BatchNo g2d_2[0][0]	(None, 4, 4, 27)	108	average_poolin
activation_27 (Activation) ation_27[0][0]	(None, 4, 4, 27)	0	batch_normaliz
conv2d_28 (Conv2D) [0][0]	(None, 4, 4, 27)	6561	activation_27

<u>concatenate_24</u> (Concatenate) g2d_2[0][0]	(None, 4, 4, 54)	0	average_poolin conv2d_28[0]
<u>batch_normalization_28</u> (BatchNo [0][0])	(None, 4, 4, 54)	216	concatenate_24
<u>activation_28</u> (Activation) activation_28[0][0]	(None, 4, 4, 54)	0	batch_normaliz ation_28[0][0]
<u>conv2d_29</u> (Conv2D) [0][0]	(None, 4, 4, 27)	13122	activation_28
<u>concatenate_25</u> (Concatenate) [0][0]	(None, 4, 4, 81)	0	concatenate_24 conv2d_29[0]
<u>batch_normalization_29</u> (BatchNo [0][0])	(None, 4, 4, 81)	324	concatenate_25
<u>activation_29</u> (Activation) activation_29[0][0]	(None, 4, 4, 81)	0	batch_normaliz ation_29[0][0]
<u>conv2d_30</u> (Conv2D) [0][0]	(None, 4, 4, 27)	19683	activation_29
<u>concatenate_26</u> (Concatenate) [0][0]	(None, 4, 4, 108)	0	concatenate_25 conv2d_30[0]
<u>batch_normalization_30</u> (BatchNo [0][0])	(None, 4, 4, 108)	432	concatenate_26
<u>activation_30</u> (Activation) activation_30[0][0]	(None, 4, 4, 108)	0	batch_normaliz ation_30[0][0]
<u>conv2d_31</u> (Conv2D) [0][0]	(None, 4, 4, 27)	26244	activation_30
<u>concatenate_27</u> (Concatenate)	(None, 4, 4, 135)	0	concatenate_26

[0][0]

conv2d_31[0]

[0]

batch_normalization_31 (BatchNo (None, 4, 4, 135)
[0][0]

540

concatenate_27

activation_31 (Activation)
activation_31[0][0]

(None, 4, 4, 135)

0

batch_normaliz

conv2d_32 (Conv2D)
[0][0]

(None, 4, 4, 27)

32805

activation_31

concatenate_28 (Concatenate)
[0][0]

(None, 4, 4, 162)

0

concatenate_27

conv2d_32[0]

[0]

batch_normalization_32 (BatchNo (None, 4, 4, 162)
[0][0]

648

concatenate_28

activation_32 (Activation)
activation_32[0][0]

(None, 4, 4, 162)

0

batch_normaliz

conv2d_33 (Conv2D)
[0][0]

(None, 4, 4, 27)

39366

activation_32

concatenate_29 (Concatenate)
[0][0]

(None, 4, 4, 189)

0

concatenate_28

conv2d_33[0]

[0]

batch_normalization_33 (BatchNo (None, 4, 4, 189)
[0][0]

756

concatenate_29

activation_33 (Activation)
activation_33[0][0]

(None, 4, 4, 189)

0

batch_normaliz

conv2d_34 (Conv2D)
[0][0]

(None, 4, 4, 27)

45927

activation_33

concatenate_30 (Concatenate)
[0][0]

(None, 4, 4, 216)

0

concatenate_29

conv2d_34[0]

[0]

batch_normalization_34 (BatchNo	(None, 4, 4, 216)	864	concatenate_30[0][0]
activation_34 (Activation)	(None, 4, 4, 216)	0	batch_normaliz
conv2d_35 (Conv2D)	(None, 4, 4, 27)	52488	activation_34[0][0]
concatenate_31 (Concatenate)	(None, 4, 4, 243)	0	concatenate_30[0][0]
			conv2d_35[0]
batch_normalization_35 (BatchNo	(None, 4, 4, 243)	972	concatenate_31[0][0]
activation_35 (Activation)	(None, 4, 4, 243)	0	batch_normaliz
average_pooling2d_3 (AveragePoo	(None, 2, 2, 243)	0	activation_35[0][0]
flatten (Flatten)	(None, 972)	0	average_poolin
dense (Dense)	(None, 10)	9730	flatten[0][0]
=====			
Total params: 993,961			
Trainable params: 984,241			
Non-trainable params: 9,720			



In []:

In []: `base_model.output_shape`

Out[189]: (None, 10)


```
In [ ]: #removing the last dense layes with flatten
base_model.layers.pop()
model2 = Model(base_model.input, base_model.layers[-3].output)
model2.summary()
```

Model: "functional_47"

Layer (type)	Output Shape	Param #	Connected to
=====			
input_12 (InputLayer)	[(None, 32, 32, 3)]	0	
=====			
conv2d_319 (Conv2D)	(None, 32, 32, 35)	420	input_12[0][0]
=====			
batch_normalization_308 (Batch Normalization)	(None, 32, 32, 35)	140	conv2d_319[0]
=====			
activation_308 (Activation)	(None, 32, 32, 35)	0	batch_normalization_308[0][0]
=====			
conv2d_320 (Conv2D)	(None, 32, 32, 35)	11025	activation_308[0][0]
=====			
concatenate_264 (Concatenate)	(None, 32, 32, 70)	0	conv2d_319[0] conv2d_320[0]
=====			
batch_normalization_309 (Batch Normalization)	(None, 32, 32, 70)	280	concatenate_264[0][0]
=====			
activation_309 (Activation)	(None, 32, 32, 70)	0	batch_normalization_309[0][0]
=====			
conv2d_321 (Conv2D)	(None, 32, 32, 35)	22050	activation_309[0][0]
=====			
concatenate_265 (Concatenate)	(None, 32, 32, 105)	0	concatenate_264[0][0] conv2d_321[0]
=====			
batch_normalization_310 (Batch Normalization)	(None, 32, 32, 105)	420	concatenate_265[0][0]
=====			

activation_310 (Activation)	(None, 32, 32, 105)	0	batch_normaliz ation_310[0][0]
conv2d_322 (Conv2D)	(None, 32, 32, 35)	33075	activation_310 [0][0]
concatenate_266 (Concatenate)	(None, 32, 32, 140)	0	concatenate_26 5[0][0] conv2d_322[0] [0]
batch_normalization_311 (BatchN	(None, 32, 32, 140)	560	concatenate_26 6[0][0]
activation_311 (Activation)	(None, 32, 32, 140)	0	batch_normaliz ation_311[0][0]
conv2d_323 (Conv2D)	(None, 32, 32, 35)	44100	activation_311 [0][0]
concatenate_267 (Concatenate)	(None, 32, 32, 175)	0	concatenate_26 6[0][0] conv2d_323[0] [0]
batch_normalization_312 (BatchN	(None, 32, 32, 175)	700	concatenate_26 7[0][0]
activation_312 (Activation)	(None, 32, 32, 175)	0	batch_normaliz ation_312[0][0]
conv2d_324 (Conv2D)	(None, 32, 32, 35)	55125	activation_312 [0][0]
concatenate_268 (Concatenate)	(None, 32, 32, 210)	0	concatenate_26 7[0][0] conv2d_324[0] [0]
batch_normalization_313 (BatchN	(None, 32, 32, 210)	840	concatenate_26 8[0][0]
activation_313 (Activation)	(None, 32, 32, 210)	0	batch_normaliz ation_313[0][0]

conv2d_325 (Conv2D) [0][0]	(None, 32, 32, 35)	66150	activation_313
concatenate_269 (Concatenate) 8[0][0] [0]	(None, 32, 32, 245)	0	concatenate_26 conv2d_325[0]
batch_normalization_314 (BatchN 9[0][0]	(None, 32, 32, 245)	980	concatenate_26
activation_314 (Activation) ation_314[0][0]	(None, 32, 32, 245)	0	batch_normaliz ation_314[0][0]
conv2d_326 (Conv2D) [0][0]	(None, 32, 32, 35)	8575	activation_314
average_pooling2d_44 (AveragePo [0]	(None, 16, 16, 35)	0	conv2d_326[0]
batch_normalization_315 (BatchN g2d_44[0][0]	(None, 16, 16, 35)	140	average_poolin g2d_44[0][0]
activation_315 (Activation) ation_315[0][0]	(None, 16, 16, 35)	0	batch_normaliz ation_315[0][0]
conv2d_327 (Conv2D) [0][0]	(None, 16, 16, 35)	11025	activation_315
concatenate_270 (Concatenate) g2d_44[0][0] [0]	(None, 16, 16, 70)	0	average_poolin conv2d_327[0]
batch_normalization_316 (BatchN 0[0][0]	(None, 16, 16, 70)	280	concatenate_27 0[0][0]
activation_316 (Activation) ation_316[0][0]	(None, 16, 16, 70)	0	batch_normaliz ation_316[0][0]
conv2d_328 (Conv2D) [0][0]	(None, 16, 16, 35)	22050	activation_316

concatenate_271 (Concatenate)	(None, 16, 16, 105)	0	concatenate_27 0[0][0]
[0]			conv2d_328[0]
batch_normalization_317 (BatchN	(None, 16, 16, 105)	420	concatenate_27 1[0][0]
activation_317 (Activation)	(None, 16, 16, 105)	0	batch_normaliz ation_317[0][0]
conv2d_329 (Conv2D)	(None, 16, 16, 35)	33075	activation_317 [0][0]
concatenate_272 (Concatenate)	(None, 16, 16, 140)	0	concatenate_27 1[0][0]
[0]			conv2d_329[0]
batch_normalization_318 (BatchN	(None, 16, 16, 140)	560	concatenate_27 2[0][0]
activation_318 (Activation)	(None, 16, 16, 140)	0	batch_normaliz ation_318[0][0]
conv2d_330 (Conv2D)	(None, 16, 16, 35)	44100	activation_318 [0][0]
concatenate_273 (Concatenate)	(None, 16, 16, 175)	0	concatenate_27 2[0][0]
[0]			conv2d_330[0]
batch_normalization_319 (BatchN	(None, 16, 16, 175)	700	concatenate_27 3[0][0]
activation_319 (Activation)	(None, 16, 16, 175)	0	batch_normaliz ation_319[0][0]
conv2d_331 (Conv2D)	(None, 16, 16, 35)	55125	activation_319 [0][0]
concatenate_274 (Concatenate)	(None, 16, 16, 210)	0	concatenate_27 3[0][0]
			conv2d_331[0]

[0]

batch_normalization_320 (BatchN	(None, 16, 16, 210)	840	concatenate_27
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activation_320 (Activation)	(None, 16, 16, 210)	0	batch_normaliz
-----------------------------	---------------------	---	----------------

conv2d_332 (Conv2D)	(None, 16, 16, 35)	66150	activation_320
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concatenate_275 (Concatenate)	(None, 16, 16, 245)	0	concatenate_27
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[0]

batch_normalization_321 (BatchN	(None, 16, 16, 245)	980	concatenate_27
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activation_321 (Activation)	(None, 16, 16, 245)	0	batch_normaliz
-----------------------------	---------------------	---	----------------

conv2d_333 (Conv2D)	(None, 16, 16, 35)	8575	activation_321
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average_pooling2d_45 (AveragePo	(None, 8, 8, 35)	0	conv2d_333[0]
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batch_normalization_322 (BatchN	(None, 8, 8, 35)	140	average_poolin
---------------------------------	------------------	-----	----------------

activation_322 (Activation)	(None, 8, 8, 35)	0	batch_normaliz
-----------------------------	------------------	---	----------------

conv2d_334 (Conv2D)	(None, 8, 8, 35)	11025	activation_322
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concatenate_276 (Concatenate)	(None, 8, 8, 70)	0	average_poolin
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[0]

batch_normalization_323 (BatchN	(None, 8, 8, 70)	280	concatenate_27
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<u>activation_323</u> (Activation) activation_323[0][0]	(None, 8, 8, 70)	0	batch_normaliz
<u>conv2d_335</u> (Conv2D) conv2d_335[0][0]	(None, 8, 8, 35)	22050	activation_323
<u>concatenate_277</u> (Concatenate) concatenate_277[0][0]	(None, 8, 8, 105)	0	concatenate_27 conv2d_335[0]
<u>batch_normalization_324</u> (BatchN batch_normalization_324[0][0])	(None, 8, 8, 105)	420	concatenate_27
<u>activation_324</u> (Activation) activation_324[0][0]	(None, 8, 8, 105)	0	batch_normaliz
<u>conv2d_336</u> (Conv2D) conv2d_336[0][0]	(None, 8, 8, 35)	33075	activation_324
<u>concatenate_278</u> (Concatenate) concatenate_278[0][0]	(None, 8, 8, 140)	0	concatenate_27 conv2d_336[0]
<u>batch_normalization_325</u> (BatchN batch_normalization_325[0][0])	(None, 8, 8, 140)	560	concatenate_27
<u>activation_325</u> (Activation) activation_325[0][0]	(None, 8, 8, 140)	0	batch_normaliz
<u>conv2d_337</u> (Conv2D) conv2d_337[0][0]	(None, 8, 8, 35)	44100	activation_325
<u>concatenate_279</u> (Concatenate) concatenate_279[0][0]	(None, 8, 8, 175)	0	concatenate_27 conv2d_337[0]
<u>batch_normalization_326</u> (BatchN batch_normalization_326[0][0])	(None, 8, 8, 175)	700	concatenate_27
<u>activation_326</u> (Activation)	(None, 8, 8, 175)	0	batch_normaliz

ation_326[0][0]

conv2d_338 (Conv2D)	(None, 8, 8, 35)	55125	activation_326[0][0]
concatenate_280 (Concatenate)	(None, 8, 8, 210)	0	concatenate_279[0][0] conv2d_338[0]
batch_normalization_327 (Batch Normalization)	(None, 8, 8, 210)	840	concatenate_280[0][0]
activation_327 (Activation)	(None, 8, 8, 210)	0	batch_normalization_327[0][0]
conv2d_339 (Conv2D)	(None, 8, 8, 35)	66150	activation_327[0][0]
concatenate_281 (Concatenate)	(None, 8, 8, 245)	0	concatenate_280[0][0] conv2d_339[0]
batch_normalization_328 (Batch Normalization)	(None, 8, 8, 245)	980	concatenate_281[0][0]
activation_328 (Activation)	(None, 8, 8, 245)	0	batch_normalization_328[0][0]
conv2d_340 (Conv2D)	(None, 8, 8, 35)	8575	activation_328[0][0]
average_pooling2d_46 (Average Pooling)	(None, 4, 4, 35)	0	conv2d_340[0]
batch_normalization_329 (Batch Normalization)	(None, 4, 4, 35)	140	average_pooling2d_46[0][0]
activation_329 (Activation)	(None, 4, 4, 35)	0	batch_normalization_329[0][0]
conv2d_341 (Conv2D)	(None, 4, 4, 35)	11025	activation_329[0][0]

<u>concatenate_282</u> (Concatenate) g2d_46[0][0]	(None, 4, 4, 70)	0	average_poolin conv2d_341[0] [0]
<u>batch_normalization_330</u> (BatchN 2[0][0])	(None, 4, 4, 70)	280	concatenate_28
<u>activation_330</u> (Activation) ation_330[0][0]	(None, 4, 4, 70)	0	batch_normaliz
<u>conv2d_342</u> (Conv2D) [0][0]	(None, 4, 4, 35)	22050	activation_330
<u>concatenate_283</u> (Concatenate) 2[0][0] [0]	(None, 4, 4, 105)	0	concatenate_28 conv2d_342[0] [0]
<u>batch_normalization_331</u> (BatchN 3[0][0])	(None, 4, 4, 105)	420	concatenate_28
<u>activation_331</u> (Activation) ation_331[0][0]	(None, 4, 4, 105)	0	batch_normaliz
<u>conv2d_343</u> (Conv2D) [0][0]	(None, 4, 4, 35)	33075	activation_331
<u>concatenate_284</u> (Concatenate) 3[0][0] [0]	(None, 4, 4, 140)	0	concatenate_28 conv2d_343[0] [0]
<u>batch_normalization_332</u> (BatchN 4[0][0])	(None, 4, 4, 140)	560	concatenate_28
<u>activation_332</u> (Activation) ation_332[0][0]	(None, 4, 4, 140)	0	batch_normaliz
<u>conv2d_344</u> (Conv2D) [0][0]	(None, 4, 4, 35)	44100	activation_332
<u>concatenate_285</u> (Concatenate)	(None, 4, 4, 175)	0	concatenate_28

4[0][0]

conv2d_344[0]

[0]

batch_normalization_333 (BatchN	(None, 4, 4, 175)	700	concatenate_28
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activation_333 (Activation)	(None, 4, 4, 175)	0	batch_normaliz
-----------------------------	-------------------	---	----------------

conv2d_345 (Conv2D)	(None, 4, 4, 35)	55125	activation_333
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concatenate_286 (Concatenate)	(None, 4, 4, 210)	0	concatenate_28
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[0]

batch_normalization_334 (BatchN	(None, 4, 4, 210)	840	concatenate_28
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activation_334 (Activation)	(None, 4, 4, 210)	0	batch_normaliz
-----------------------------	-------------------	---	----------------

conv2d_346 (Conv2D)	(None, 4, 4, 35)	66150	activation_334
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concatenate_287 (Concatenate)	(None, 4, 4, 245)	0	concatenate_28
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[0]

batch_normalization_335 (BatchN	(None, 4, 4, 245)	980	concatenate_28
---------------------------------	-------------------	-----	----------------

activation_335 (Activation)	(None, 4, 4, 245)	0	batch_normaliz
-----------------------------	-------------------	---	----------------

average_pooling2d_47 (AveragePo	(None, 2, 2, 245)	0	activation_335
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=====

=====

Total params: 967,925

Trainable params: 960,085

Non-trainable params: 7,840



In []:

In []:

model2.outputs

Out[191]: [<tf.Tensor 'average_pooling2d_47/AvgPool:0' shape=(None, 2, 2, 245) dtype=float32>]

In []:

```
#adding a con layer at last
model = models.Sequential()
model.add(model2)
model.add(layers.Conv2D(10,(2,2),strides=[1,1],padding='valid',activation='softmax'))
model.add(layers.Flatten())
model.summary()
```

Model: "sequential_11"

Layer (type)	Output Shape	Param #
=====		
functional_47 (Functional)	(None, 2, 2, 245)	967925
=====		
conv2d_347 (Conv2D)	(None, 1, 1, 10)	9810
=====		
flatten_23 (Flatten)	(None, 10)	0
=====		
Total params: 977,735		
Trainable params: 969,895		
Non-trainable params: 7,840		
=====		

In []:

model2.output_shape

Out[193]: (None, 2, 2, 245)

In []:

In []:

```

In [ ]: # early_stop = EarlyStopping(monitor = "val_loss", patience = 10)

def decay_fn(epoch, lr):
    if epoch < 50:
        return 0.001
    elif epoch >= 50 and epoch < 75:
        return 0.0001
    else:
        return 0.00001

lr_scheduler = LearningRateScheduler(decay_fn)

csv_logger = CSVLogger('training.log')

from keras.callbacks import *
filepath="/content/gdrive/My Drive/MyCNN/epochs:{epoch:03d}-val_accuracy:{val_acc
checkpoint = ModelCheckpoint(filepath, monitor='val_accuracy', verbose=1, save_b
callbacks_list = [checkpoint]

model.load_weights('/content/gdrive/My Drive/MyCNN/epochs:004-val_accuracy:0.753
model.compile(loss='categorical_crossentropy',
              optimizer=Adam(),
              metrics=['accuracy'])

```

```

In [ ]: model.summary()

```

Model: "sequential_11"

Layer (type)	Output Shape	Param #
functional_47 (Functional)	(None, 2, 2, 245)	967925
conv2d_347 (Conv2D)	(None, 1, 1, 10)	9810
flatten_23 (Flatten)	(None, 10)	0
Total params: 977,735		
Trainable params: 969,895		
Non-trainable params: 7,840		

```
In [ ]: # test on 10 epochs
history= model.fit(datagen.flow(X_train, y_train, batch_size),
                    steps_per_epoch=len(X_train) / batch_size, epochs=10, validation_data=(X_val, y_val))
```

Epoch 1/10
391/390 [=====] - ETA: 0s - loss: 1.0175 - accuracy: 0.6435
Epoch 00001: val_accuracy improved from -inf to 0.62340, saving model to /content/gdrive/My Drive/MyCNN/epochs:001-val_accuracy:0.623.hdf5
391/390 [=====] - 132s 338ms/step - loss: 1.0175 - accuracy: 0.6435 - val_loss: 1.1844 - val_accuracy: 0.6234

Epoch 2/10
391/390 [=====] - ETA: 0s - loss: 0.8754 - accuracy: 0.6932
Epoch 00002: val_accuracy improved from 0.62340 to 0.68460, saving model to /content/gdrive/My Drive/MyCNN/epochs:002-val_accuracy:0.685.hdf5
391/390 [=====] - 129s 329ms/step - loss: 0.8754 - accuracy: 0.6932 - val_loss: 0.9796 - val_accuracy: 0.6846

Epoch 3/10
391/390 [=====] - ETA: 0s - loss: 0.8004 - accuracy: 0.7213
Epoch 00003: val_accuracy improved from 0.68460 to 0.71270, saving model to /content/gdrive/My Drive/MyCNN/epochs:003-val_accuracy:0.713.hdf5
391/390 [=====] - 129s 329ms/step - loss: 0.8004 - accuracy: 0.7213 - val_loss: 0.8710 - val_accuracy: 0.7127

Epoch 4/10
391/390 [=====] - ETA: 0s - loss: 0.7452 - accuracy: 0.7405
Epoch 00004: val_accuracy did not improve from 0.71270
391/390 [=====] - 128s 328ms/step - loss: 0.7452 - accuracy: 0.7405 - val_loss: 0.9037 - val_accuracy: 0.7064

Epoch 5/10
391/390 [=====] - ETA: 0s - loss: 0.7002 - accuracy: 0.7573
Epoch 00005: val_accuracy improved from 0.71270 to 0.73960, saving model to /content/gdrive/My Drive/MyCNN/epochs:005-val_accuracy:0.740.hdf5
391/390 [=====] - 129s 329ms/step - loss: 0.7002 - accuracy: 0.7573 - val_loss: 0.8318 - val_accuracy: 0.7396

Epoch 6/10
391/390 [=====] - ETA: 0s - loss: 0.6624 - accuracy: 0.7688
Epoch 00006: val_accuracy improved from 0.73960 to 0.79620, saving model to /content/gdrive/My Drive/MyCNN/epochs:006-val_accuracy:0.796.hdf5
391/390 [=====] - 129s 329ms/step - loss: 0.6624 - accuracy: 0.7688 - val_loss: 0.6004 - val_accuracy: 0.7962

Epoch 7/10
391/390 [=====] - ETA: 0s - loss: 0.6309 - accuracy: 0.7806
Epoch 00007: val_accuracy did not improve from 0.79620
391/390 [=====] - 128s 328ms/step - loss: 0.6309 - accuracy: 0.7806 - val_loss: 0.7625 - val_accuracy: 0.7527

Epoch 8/10
391/390 [=====] - ETA: 0s - loss: 0.6003 - accuracy: 0.7913
Epoch 00008: val_accuracy did not improve from 0.79620
391/390 [=====] - 128s 328ms/step - loss: 0.6003 - accuracy: 0.7913 - val_loss: 0.7666 - val_accuracy: 0.7568

```
Epoch 9/10
391/390 [=====] - ETA: 0s - loss: 0.5746 - accuracy:
0.8010
Epoch 00009: val_accuracy did not improve from 0.79620
391/390 [=====] - 128s 328ms/step - loss: 0.5746 - acc
uracy: 0.8010 - val_loss: 0.6197 - val_accuracy: 0.7935
Epoch 10/10
391/390 [=====] - ETA: 0s - loss: 0.5552 - accuracy:
0.8070
Epoch 00010: val_accuracy improved from 0.79620 to 0.80170, saving model to /co
ntent/gdrive/My Drive/MyCNN/epochs:010-val_accuracy:0.802.hdf5
391/390 [=====] - 129s 330ms/step - loss: 0.5552 - acc
uracy: 0.8070 - val_loss: 0.5779 - val_accuracy: 0.8017
```

In []:

In []: `X_test=X_test/255`

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

```
313/313 [=====] - 3s 11ms/step - loss: 0.7541 - accura
cy: 0.7849
Test loss: 0.7541395425796509
Test accuracy: 0.7849000096321106
```

In []: `%matplotlib inline`
`import matplotlib.pyplot as plt`
`import numpy as np`
`import time`
`# https://gist.github.com/greydanus/f6eee59eaf1d90fcb3b534a25362cea4`
`# https://stackoverflow.com/a/14434334`
`# this function is used to update the plots for each epoch and error`
`def plt_dynamic(x, vy, ty, ax, colors=['b']):`
 `ax.plot(x, vy, 'b', label="Validation Loss")`
 `ax.plot(x, ty, 'r', label="Train Loss")`
 `plt.legend()`
 `plt.grid()`
 `fig.canvas.draw()`

In []:

```

fig,ax = plt.subplots(1,1)
ax.set_xlabel('epoch') ; ax.set_ylabel('Categorical Crossentropy Loss')

# list of epoch numbers
x = list(range(1,10+1))

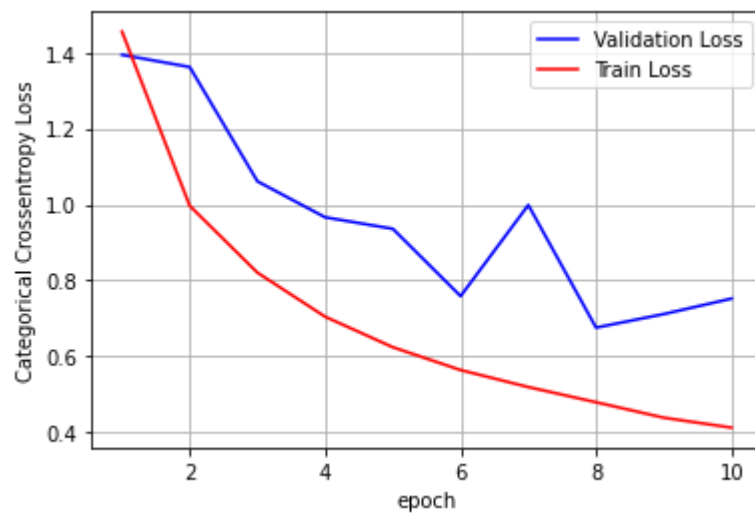
# print(history.history.keys())
# dict_keys(['val_loss', 'val_acc', 'loss', 'acc'])
# history = model_drop.fit(X_train, Y_train, batch_size=batch_size, epochs=nb_epochs)

# we will get val_loss and val_acc only when you pass the parameter validation_data
# val_loss : validation loss
# val_acc : validation accuracy

# loss : training loss
# acc : train accuracy
# for each key in history.history we will have a list of length equal to number of epochs

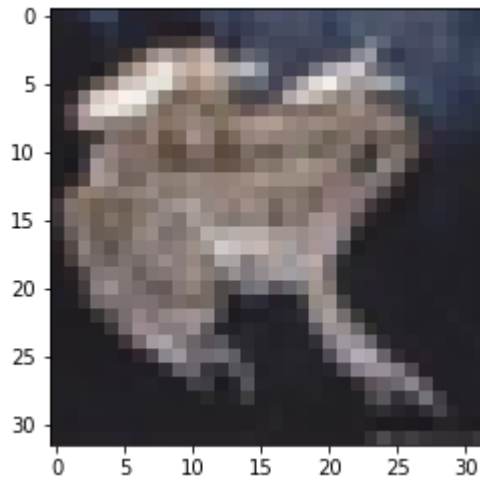
vy = history.history['val_loss']
ty = history.history['loss']
plt_dynamic(x, vy, ty, ax)

```



```
In [ ]: plt.imshow(X_train[0])
```

```
Out[125]: <matplotlib.image.AxesImage at 0x7f60ed8bde80>
```



```
In [ ]:
```

using image augmentation horizontal vertical shift

```
In [ ]: type(X_train[0])
```

```
Out[126]: numpy.ndarray
```

In [28]: *# Reff <https://machinelearningmastery.com/how-to-configure-image-data-augmentation>*

```
def vertical_horizontal_shift(arr_imgs):

    # convert to numpy array
    d_ar = arr_imgs.copy()

    for i in tqdm(range(d_ar.shape[0]), position=0):
        data = d_ar[i]
        # expand dimension to one sample
        samples = np.expand_dims(data, 0)
        # create image data augmentation generator
        datagen = ImageDataGenerator(width_shift_range=[-15,15], height_shift_
        # prepare iterator
        it = datagen.flow(samples, batch_size=1)
        # generate samples and plot
        # define subplot
        # pyplot.subplot(330 + 1 + i)
        # generate batch of images
        #for j in range(9):
        batch = it.next()
            #if j == 0:

                # convert to unsigned integers for viewing
            image = batch[0].astype('uint8')
            d_ar[i] = image
                # plot raw pixel data
                #break

    return d_ar
```

In []:

In [31]: X_train_hor_ver_shift=vertical_horizontal_shift(X_train)
X_cv_hor_ver_shift=vertical_horizontal_shift(X_cv)
X_test_hor_ver_shift=vertical_horizontal_shift(X_test)

```
100%|██████████| 50000/50000 [00:35<00:00, 1422.15it/s]
100%|██████████| 10000/10000 [00:06<00:00, 1435.51it/s]
100%|██████████| 10000/10000 [00:07<00:00, 1425.08it/s]
```



```

In [32]: # function which activate network and replace last dense layer with conv layer
def modell(X_train,X_cv,X_test,y_train,y_cv,y_test):      # Dense Block
    def denseblock(input, num_filter = 12, dropout_rate = 0.2):
        global compression
        temp = input
        for _ in range(1):
            BatchNorm = layers.BatchNormalization()(temp)
            relu = layers.Activation('relu')(BatchNorm)
            Conv2D_3_3 = layers.Conv2D(int(num_filter*compression), (3,3), use
            if dropout_rate>0:
                Conv2D_3_3 = layers.Dropout(dropout_rate)(Conv2D_3_3)
            concat = layers.Concatenate(axis=-1)([temp,Conv2D_3_3])

            temp = concat

        return temp

    ## transition Block
    def transition(input, num_filter = 12, dropout_rate = 0.2):
        global compression
        BatchNorm = layers.BatchNormalization()(input)
        relu = layers.Activation('relu')(BatchNorm)
        Conv2D_BottleNeck = layers.Conv2D(int(num_filter*compression), (1,1),
        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

    #num_filter = 36
    #dropout_rate = 0.2
    #l = 12
    input = layers.Input(shape=(img_height, img_width, channel,))
    First_Conv2D = layers.Conv2D(num_filter, (2,2), use_bias=False ,padding=

    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)

base_model = Model(inputs=[input], outputs=[output])
base_model.summary()
print("^"*100)
print("*****after removing last dense layer*****")
print("^"*100)
base_model.layers.pop()
model2 = Model(base_model.input, base_model.layers[-3].output)
model2.summary()

print("^"*100)
print("*****after adding conv2d layer*****")

model = models.Sequential()
model.add(model2)
model.add(layers.Conv2D(10,(2,2),strides=[1,1],padding='valid',activation='relu'))
model.add(layers.Flatten())
model.summary()
print("^"*100)
model.compile(loss='categorical_crossentropy',
              optimizer=Adam(),
              metrics=['accuracy'])
history= model.fit(X_train, y_train, batch_size=10,validation_data=(X_test, y_test))

score = model.evaluate(X_test, y_test, verbose=1)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
return model

```

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In [33]: `v_h_shift_model=model1(X_train_hor_ver_shift,X_cv_hor_ver_shift,X_test_hor_ver_sl`

Model: "functional_3"

Layer (type)	Output Shape	Param #	Connected to
input_2 (InputLayer)	[(None, 32, 32, 3)]	0	
conv2d_36 (Conv2D)	(None, 32, 32, 27)	324	input_2[0][0]
batch_normalization_36 (Batch Normalization)	(None, 32, 32, 27)	108	conv2d_36[0]
activation_36 (Activation)	(None, 32, 32, 27)	0	batch_normalization_36[0][0]
conv2d_37 (Conv2D)	(None, 32, 32, 27)	6561	activation_36[0][0]
dropout (Dropout)	(None, 32, 32, 27)	0	conv2d_37[0]
concatenate_32 (Concatenate)	(None, 32, 32, 54)	0	conv2d_36[0] dropout[0][0]
batch_normalization_37 (Batch Normalization)	(None, 32, 32, 54)	216	concatenate_32[0][0]
activation_37 (Activation)	(None, 32, 32, 54)	0	batch_normalization_37[0][0]
conv2d_38 (Conv2D)	(None, 32, 32, 27)	13122	activation_37[0][0]
dropout_1 (Dropout)	(None, 32, 32, 27)	0	conv2d_38[0]
concatenate_33 (Concatenate)	(None, 32, 32, 81)	0	concatenate_32[0][0] dropout_1[0]

batch_normalization_38 (BatchNo	(None, 32, 32, 81)	324	concatenate_33 [0][0]
activation_38 (Activation)	(None, 32, 32, 81)	0	batch_normaliz ation_38[0][0]
conv2d_39 (Conv2D)	(None, 32, 32, 27)	19683	activation_38 [0][0]
dropout_2 (Dropout)	(None, 32, 32, 27)	0	conv2d_39[0] [0]
concatenate_34 (Concatenate)	(None, 32, 32, 108)	0	concatenate_33 [0][0] dropout_2[0] [0]
batch_normalization_39 (BatchNo	(None, 32, 32, 108)	432	concatenate_34 [0][0]
activation_39 (Activation)	(None, 32, 32, 108)	0	batch_normaliz ation_39[0][0]
conv2d_40 (Conv2D)	(None, 32, 32, 27)	26244	activation_39 [0][0]
dropout_3 (Dropout)	(None, 32, 32, 27)	0	conv2d_40[0] [0]
concatenate_35 (Concatenate)	(None, 32, 32, 135)	0	concatenate_34 [0][0] dropout_3[0] [0]
batch_normalization_40 (BatchNo	(None, 32, 32, 135)	540	concatenate_35 [0][0]
activation_40 (Activation)	(None, 32, 32, 135)	0	batch_normaliz ation_40[0][0]
conv2d_41 (Conv2D)	(None, 32, 32, 27)	32805	activation_40 [0][0]
dropout_4 (Dropout)	(None, 32, 32, 27)	0	conv2d_41[0] [0]

[0]

concatenate_36 (Concatenate)	(None, 32, 32, 162)	0	concatenate_35
[0][0]			dropout_4[0]

[0]

batch_normalization_41 (BatchNo	(None, 32, 32, 162)	648	concatenate_36
[0][0]			

activation_41 (Activation)	(None, 32, 32, 162)	0	batch_normaliz
ation_41[0][0]			

conv2d_42 (Conv2D)	(None, 32, 32, 27)	39366	activation_41
[0][0]			

dropout_5 (Dropout)	(None, 32, 32, 27)	0	conv2d_42[0]
[0]			

concatenate_37 (Concatenate)	(None, 32, 32, 189)	0	concatenate_36
[0][0]			dropout_5[0]

[0]

batch_normalization_42 (BatchNo	(None, 32, 32, 189)	756	concatenate_37
[0][0]			

activation_42 (Activation)	(None, 32, 32, 189)	0	batch_normaliz
ation_42[0][0]			

conv2d_43 (Conv2D)	(None, 32, 32, 27)	45927	activation_42
[0][0]			

dropout_6 (Dropout)	(None, 32, 32, 27)	0	conv2d_43[0]
[0]			

concatenate_38 (Concatenate)	(None, 32, 32, 216)	0	concatenate_37
[0][0]			dropout_6[0]

[0]

batch_normalization_43 (BatchNo	(None, 32, 32, 216)	864	concatenate_38
[0][0]			

activation_43 (Activation)	(None, 32, 32, 216)	0	batch_normaliz
ation_43[0][0]			
conv2d_44 (Conv2D)	(None, 32, 32, 27)	52488	activation_43
[0][0]			
dropout_7 (Dropout)	(None, 32, 32, 27)	0	conv2d_44[0]
[0]			
concatenate_39 (Concatenate)	(None, 32, 32, 243)	0	concatenate_38
[0][0]			dropout_7[0]
[0]			
batch_normalization_44 (BatchNo	(None, 32, 32, 243)	972	concatenate_39
[0][0]			
activation_44 (Activation)	(None, 32, 32, 243)	0	batch_normaliz
ation_44[0][0]			
conv2d_45 (Conv2D)	(None, 32, 32, 27)	6561	activation_44
[0][0]			
dropout_8 (Dropout)	(None, 32, 32, 27)	0	conv2d_45[0]
[0]			
average_pooling2d_4 (AveragePoo	(None, 16, 16, 27)	0	dropout_8[0]
[0]			
batch_normalization_45 (BatchNo	(None, 16, 16, 27)	108	average_poolin
g2d_4[0][0]			
activation_45 (Activation)	(None, 16, 16, 27)	0	batch_normaliz
ation_45[0][0]			
conv2d_46 (Conv2D)	(None, 16, 16, 27)	6561	activation_45
[0][0]			
dropout_9 (Dropout)	(None, 16, 16, 27)	0	conv2d_46[0]
[0]			
concatenate_40 (Concatenate)	(None, 16, 16, 54)	0	average_poolin
g2d_4[0][0]			dropout_9[0]

[0]

batch_normalization_46 (BatchNo	(None, 16, 16, 54)	216	concatenate_40
[0][0]			
activation_46 (Activation)	(None, 16, 16, 54)	0	batch_normaliz
ation_46[0][0]			
conv2d_47 (Conv2D)	(None, 16, 16, 27)	13122	activation_46
[0][0]			
dropout_10 (Dropout)	(None, 16, 16, 27)	0	conv2d_47[0]
[0]			
concatenate_41 (Concatenate)	(None, 16, 16, 81)	0	concatenate_40
[0][0]			dropout_10[0]
[0]			
batch_normalization_47 (BatchNo	(None, 16, 16, 81)	324	concatenate_41
[0][0]			
activation_47 (Activation)	(None, 16, 16, 81)	0	batch_normaliz
ation_47[0][0]			
conv2d_48 (Conv2D)	(None, 16, 16, 27)	19683	activation_47
[0][0]			
dropout_11 (Dropout)	(None, 16, 16, 27)	0	conv2d_48[0]
[0]			
concatenate_42 (Concatenate)	(None, 16, 16, 108)	0	concatenate_41
[0][0]			dropout_11[0]
[0]			
batch_normalization_48 (BatchNo	(None, 16, 16, 108)	432	concatenate_42
[0][0]			
activation_48 (Activation)	(None, 16, 16, 108)	0	batch_normaliz
ation_48[0][0]			
conv2d_49 (Conv2D)	(None, 16, 16, 27)	26244	activation_48
[0][0]			

<u>dropout_12</u> (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_49[0]
<u>concatenate_43</u> (Concatenate) [0][0] [0]	(None, 16, 16, 135)	0	concatenate_42 dropout_12[0]
<u>batch_normalization_49</u> (BatchNo [0][0])	(None, 16, 16, 135)	540	concatenate_43
<u>activation_49</u> (Activation) activation_49[0][0]	(None, 16, 16, 135)	0	batch_normaliz
<u>conv2d_50</u> (Conv2D) [0][0]	(None, 16, 16, 27)	32805	activation_49
<u>dropout_13</u> (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_50[0]
<u>concatenate_44</u> (Concatenate) [0][0] [0]	(None, 16, 16, 162)	0	concatenate_43 dropout_13[0]
<u>batch_normalization_50</u> (BatchNo [0][0])	(None, 16, 16, 162)	648	concatenate_44
<u>activation_50</u> (Activation) activation_50[0][0]	(None, 16, 16, 162)	0	batch_normaliz
<u>conv2d_51</u> (Conv2D) [0][0]	(None, 16, 16, 27)	39366	activation_50
<u>dropout_14</u> (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_51[0]
<u>concatenate_45</u> (Concatenate) [0][0] [0]	(None, 16, 16, 189)	0	concatenate_44 dropout_14[0]
<u>batch_normalization_51</u> (BatchNo	(None, 16, 16, 189)	756	concatenate_45

[0][0]

activation_51 (Activation) activation_51[0][0]	(None, 16, 16, 189)	0	batch_normaliz
conv2d_52 (Conv2D) [0][0]	(None, 16, 16, 27)	45927	activation_51
dropout_15 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_52[0]
concatenate_46 (Concatenate) [0][0]	(None, 16, 16, 216)	0	concatenate_45 dropout_15[0]
batch_normalization_52 (BatchNo [0][0]	(None, 16, 16, 216)	864	concatenate_46
activation_52 (Activation) activation_52[0][0]	(None, 16, 16, 216)	0	batch_normaliz
conv2d_53 (Conv2D) [0][0]	(None, 16, 16, 27)	52488	activation_52
dropout_16 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_53[0]
concatenate_47 (Concatenate) [0][0]	(None, 16, 16, 243)	0	concatenate_46 dropout_16[0]
batch_normalization_53 (BatchNo [0][0]	(None, 16, 16, 243)	972	concatenate_47
activation_53 (Activation) activation_53[0][0]	(None, 16, 16, 243)	0	batch_normaliz
conv2d_54 (Conv2D) [0][0]	(None, 16, 16, 27)	6561	activation_53
dropout_17 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_54[0]

<u>average_pooling2d_5</u> (AveragePool)	(None, 8, 8, 27)	0	dropout_17[0]
<u>batch_normalization_54</u> (Batch Normalization)	(None, 8, 8, 27)	108	average_pooling2d_5[0][0]
<u>activation_54</u> (Activation)	(None, 8, 8, 27)	0	batch_normalization_54[0][0]
<u>conv2d_55</u> (Conv2D)	(None, 8, 8, 27)	6561	activation_54[0][0]
<u>dropout_18</u> (Dropout)	(None, 8, 8, 27)	0	conv2d_55[0]
<u>concatenate_48</u> (Concatenate)	(None, 8, 8, 54)	0	average_pooling2d_5[0][0] dropout_18[0]
<u>batch_normalization_55</u> (Batch Normalization)	(None, 8, 8, 54)	216	concatenate_48[0][0]
<u>activation_55</u> (Activation)	(None, 8, 8, 54)	0	batch_normalization_55[0][0]
<u>conv2d_56</u> (Conv2D)	(None, 8, 8, 27)	13122	activation_55[0][0]
<u>dropout_19</u> (Dropout)	(None, 8, 8, 27)	0	conv2d_56[0]
<u>concatenate_49</u> (Concatenate)	(None, 8, 8, 81)	0	concatenate_48[0][0] dropout_19[0]
<u>batch_normalization_56</u> (Batch Normalization)	(None, 8, 8, 81)	324	concatenate_49[0][0]
<u>activation_56</u> (Activation)	(None, 8, 8, 81)	0	batch_normalization_56[0][0]

conv2d_57 (Conv2D) [0][0]	(None, 8, 8, 27)	19683	activation_56
dropout_20 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_57[0]
concatenate_50 (Concatenate) [0][0] [0]	(None, 8, 8, 108)	0	concatenate_49 dropout_20[0]
batch_normalization_57 (Batch Normalization) [0][0]	(None, 8, 8, 108)	432	concatenate_50
activation_57 (Activation) activation_57[0][0]	(None, 8, 8, 108)	0	batch_normalization_57[0][0]
conv2d_58 (Conv2D) [0][0]	(None, 8, 8, 27)	26244	activation_57
dropout_21 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_58[0]
concatenate_51 (Concatenate) [0][0] [0]	(None, 8, 8, 135)	0	concatenate_50 dropout_21[0]
batch_normalization_58 (Batch Normalization) [0][0]	(None, 8, 8, 135)	540	concatenate_51
activation_58 (Activation) activation_58[0][0]	(None, 8, 8, 135)	0	batch_normalization_58[0][0]
conv2d_59 (Conv2D) [0][0]	(None, 8, 8, 27)	32805	activation_58
dropout_22 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_59[0]
concatenate_52 (Concatenate) [0][0] [0]	(None, 8, 8, 162)	0	concatenate_51 dropout_22[0]

batch_normalization_59 (BatchNo	(None, 8, 8, 162)	648	concatenate_52
[0][0]			
activation_59 (Activation)	(None, 8, 8, 162)	0	batch_normaliz
ation_59[0][0]			
conv2d_60 (Conv2D)	(None, 8, 8, 27)	39366	activation_59
[0][0]			
dropout_23 (Dropout)	(None, 8, 8, 27)	0	conv2d_60[0]
[0]			
concatenate_53 (Concatenate)	(None, 8, 8, 189)	0	concatenate_52
[0][0]			dropout_23[0]
[0]			
batch_normalization_60 (BatchNo	(None, 8, 8, 189)	756	concatenate_53
[0][0]			
activation_60 (Activation)	(None, 8, 8, 189)	0	batch_normaliz
ation_60[0][0]			
conv2d_61 (Conv2D)	(None, 8, 8, 27)	45927	activation_60
[0][0]			
dropout_24 (Dropout)	(None, 8, 8, 27)	0	conv2d_61[0]
[0]			
concatenate_54 (Concatenate)	(None, 8, 8, 216)	0	concatenate_53
[0][0]			dropout_24[0]
[0]			
batch_normalization_61 (BatchNo	(None, 8, 8, 216)	864	concatenate_54
[0][0]			
activation_61 (Activation)	(None, 8, 8, 216)	0	batch_normaliz
ation_61[0][0]			
conv2d_62 (Conv2D)	(None, 8, 8, 27)	52488	activation_61
[0][0]			

dropout_25 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_62[0]
concatenate_55 (Concatenate) [0][0]	(None, 8, 8, 243)	0	concatenate_54 dropout_25[0]
batch_normalization_62 (BatchNo [0][0])	(None, 8, 8, 243)	972	concatenate_55
activation_62 (Activation) activation_62[0][0]	(None, 8, 8, 243)	0	batch_normaliz ation_62[0][0]
conv2d_63 (Conv2D) [0][0]	(None, 8, 8, 27)	6561	activation_62
dropout_26 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_63[0]
average_pooling2d_6 (AveragePoo [0])	(None, 4, 4, 27)	0	dropout_26[0]
batch_normalization_63 (BatchNo g2d_6[0][0])	(None, 4, 4, 27)	108	average_poolin g2d_6[0][0]
activation_63 (Activation) activation_63[0][0]	(None, 4, 4, 27)	0	batch_normaliz ation_63[0][0]
conv2d_64 (Conv2D) [0][0]	(None, 4, 4, 27)	6561	activation_63
dropout_27 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_64[0]
concatenate_56 (Concatenate) g2d_6[0][0]	(None, 4, 4, 54)	0	average_poolin g2d_6[0][0]
			dropout_27[0]
batch_normalization_64 (BatchNo [0][0])	(None, 4, 4, 54)	216	concatenate_56

activation_64 (Activation) activation_64[0][0]	(None, 4, 4, 54)	0	batch_normaliz
conv2d_65 (Conv2D) [0][0]	(None, 4, 4, 27)	13122	activation_64
dropout_28 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_65[0]
concatenate_57 (Concatenate) [0][0] [0]	(None, 4, 4, 81)	0	concatenate_56 dropout_28[0]
batch_normalization_65 (BatchNo [0][0])	(None, 4, 4, 81)	324	concatenate_57
activation_65 (Activation) activation_65[0][0]	(None, 4, 4, 81)	0	batch_normaliz
conv2d_66 (Conv2D) [0][0]	(None, 4, 4, 27)	19683	activation_65
dropout_29 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_66[0]
concatenate_58 (Concatenate) [0][0] [0]	(None, 4, 4, 108)	0	concatenate_57 dropout_29[0]
batch_normalization_66 (BatchNo [0][0])	(None, 4, 4, 108)	432	concatenate_58
activation_66 (Activation) activation_66[0][0]	(None, 4, 4, 108)	0	batch_normaliz
conv2d_67 (Conv2D) [0][0]	(None, 4, 4, 27)	26244	activation_66
dropout_30 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_67[0]
concatenate_59 (Concatenate)	(None, 4, 4, 135)	0	concatenate_58

[0][0]			dropout_30[0]
[0]			
batch_normalization_67 (BatchNo	(None, 4, 4, 135)	540	concatenate_59
[0][0]			
activation_67 (Activation)	(None, 4, 4, 135)	0	batch_normaliz
ation_67[0][0]			
conv2d_68 (Conv2D)	(None, 4, 4, 27)	32805	activation_67
[0][0]			
dropout_31 (Dropout)	(None, 4, 4, 27)	0	conv2d_68[0]
[0]			
concatenate_60 (Concatenate)	(None, 4, 4, 162)	0	concatenate_59
[0][0]			dropout_31[0]
[0]			
batch_normalization_68 (BatchNo	(None, 4, 4, 162)	648	concatenate_60
[0][0]			
activation_68 (Activation)	(None, 4, 4, 162)	0	batch_normaliz
ation_68[0][0]			
conv2d_69 (Conv2D)	(None, 4, 4, 27)	39366	activation_68
[0][0]			
dropout_32 (Dropout)	(None, 4, 4, 27)	0	conv2d_69[0]
[0]			
concatenate_61 (Concatenate)	(None, 4, 4, 189)	0	concatenate_60
[0][0]			dropout_32[0]
[0]			
batch_normalization_69 (BatchNo	(None, 4, 4, 189)	756	concatenate_61
[0][0]			
activation_69 (Activation)	(None, 4, 4, 189)	0	batch_normaliz
ation_69[0][0]			

conv2d_70 (Conv2D) [0][0]	(None, 4, 4, 27)	45927	activation_69
dropout_33 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_70[0]
concatenate_62 (Concatenate) [0][0]	(None, 4, 4, 216)	0	concatenate_61 dropout_33[0]
batch_normalization_70 (BatchNo [0][0])	(None, 4, 4, 216)	864	concatenate_62
activation_70 (Activation) activation_70[0][0]	(None, 4, 4, 216)	0	batch_normaliz
conv2d_71 (Conv2D) [0][0]	(None, 4, 4, 27)	52488	activation_70
dropout_34 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_71[0]
concatenate_63 (Concatenate) [0][0]	(None, 4, 4, 243)	0	concatenate_62 dropout_34[0]
batch_normalization_71 (BatchNo [0][0])	(None, 4, 4, 243)	972	concatenate_63
activation_71 (Activation) activation_71[0][0]	(None, 4, 4, 243)	0	batch_normaliz
average_pooling2d_7 (AveragePoo [0][0])	(None, 2, 2, 243)	0	activation_71
flatten_1 (Flatten) g2d_7[0][0]	(None, 972)	0	average_poolin
dense_1 (Dense) [0]	(None, 10)	9730	flatten_1[0]

=====
Total params: 993,961

dropout_1 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_38[0]
concatenate_33 (Concatenate) [0][0]	(None, 32, 32, 81)	0	concatenate_32 dropout_1[0]
batch_normalization_38 (BatchNo [0][0])	(None, 32, 32, 81)	324	concatenate_33
activation_38 (Activation) activation_38[0][0]	(None, 32, 32, 81)	0	batch_normaliz ation_38[0][0]
conv2d_39 (Conv2D) [0][0]	(None, 32, 32, 27)	19683	activation_38
dropout_2 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_39[0]
concatenate_34 (Concatenate) [0][0]	(None, 32, 32, 108)	0	concatenate_33 dropout_2[0]
batch_normalization_39 (BatchNo [0][0])	(None, 32, 32, 108)	432	concatenate_34
activation_39 (Activation) activation_39[0][0]	(None, 32, 32, 108)	0	batch_normaliz ation_39[0][0]
conv2d_40 (Conv2D) [0][0]	(None, 32, 32, 27)	26244	activation_39
dropout_3 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_40[0]
concatenate_35 (Concatenate) [0][0]	(None, 32, 32, 135)	0	concatenate_34 dropout_3[0]
batch_normalization_40 (BatchNo [0][0])	(None, 32, 32, 135)	540	concatenate_35

activation_40 (Activation) activation_40[0][0]	(None, 32, 32, 135)	0	batch_normaliz
conv2d_41 (Conv2D) [0][0]	(None, 32, 32, 27)	32805	activation_40
dropout_4 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_41[0]
concatenate_36 (Concatenate) [0][0] [0]	(None, 32, 32, 162)	0	concatenate_35 dropout_4[0]
batch_normalization_41 (BatchNo [0][0])	(None, 32, 32, 162)	648	concatenate_36
activation_41 (Activation) activation_41[0][0]	(None, 32, 32, 162)	0	batch_normaliz
conv2d_42 (Conv2D) [0][0]	(None, 32, 32, 27)	39366	activation_41
dropout_5 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_42[0]
concatenate_37 (Concatenate) [0][0] [0]	(None, 32, 32, 189)	0	concatenate_36 dropout_5[0]
batch_normalization_42 (BatchNo [0][0])	(None, 32, 32, 189)	756	concatenate_37
activation_42 (Activation) activation_42[0][0]	(None, 32, 32, 189)	0	batch_normaliz
conv2d_43 (Conv2D) [0][0]	(None, 32, 32, 27)	45927	activation_42
dropout_6 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_43[0]

concatenate_38 (Concatenate) [0][0]	(None, 32, 32, 216)	0	concatenate_37 dropout_6[0]
batch_normalization_43 (BatchNo [0][0])	(None, 32, 32, 216)	864	concatenate_38
activation_43 (Activation) activation_43[0][0]	(None, 32, 32, 216)	0	batch_normaliz
conv2d_44 (Conv2D) [0][0]	(None, 32, 32, 27)	52488	activation_43
dropout_7 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_44[0]
concatenate_39 (Concatenate) [0][0]	(None, 32, 32, 243)	0	concatenate_38 dropout_7[0]
batch_normalization_44 (BatchNo [0][0])	(None, 32, 32, 243)	972	concatenate_39
activation_44 (Activation) activation_44[0][0]	(None, 32, 32, 243)	0	batch_normaliz
conv2d_45 (Conv2D) [0][0]	(None, 32, 32, 27)	6561	activation_44
dropout_8 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_45[0]
average_pooling2d_4 (AveragePoo [0])	(None, 16, 16, 27)	0	dropout_8[0]
batch_normalization_45 (BatchNo g2d_4[0][0])	(None, 16, 16, 27)	108	average_poolin
activation_45 (Activation) activation_45[0][0]	(None, 16, 16, 27)	0	batch_normaliz
conv2d_46 (Conv2D)	(None, 16, 16, 27)	6561	activation_45

[0][0]

dropout_9 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_46[0]
concatenate_40 (Concatenate) g2d_4[0][0] [0]	(None, 16, 16, 54)	0	average_poolin dropout_9[0]
batch_normalization_46 (BatchNo [0][0])	(None, 16, 16, 54)	216	concatenate_40
activation_46 (Activation) ation_46[0][0]	(None, 16, 16, 54)	0	batch_normaliz
conv2d_47 (Conv2D) [0][0]	(None, 16, 16, 27)	13122	activation_46
dropout_10 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_47[0]
concatenate_41 (Concatenate) [0][0] [0]	(None, 16, 16, 81)	0	concatenate_40 dropout_10[0]
batch_normalization_47 (BatchNo [0][0])	(None, 16, 16, 81)	324	concatenate_41
activation_47 (Activation) ation_47[0][0]	(None, 16, 16, 81)	0	batch_normaliz
conv2d_48 (Conv2D) [0][0]	(None, 16, 16, 27)	19683	activation_47
dropout_11 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_48[0]
concatenate_42 (Concatenate) [0][0] [0]	(None, 16, 16, 108)	0	concatenate_41 dropout_11[0]

batch_normalization_48 (BatchNo	(None, 16, 16, 108)	432	concatenate_42
[0][0]			
activation_48 (Activation)	(None, 16, 16, 108)	0	batch_normaliz
ation_48[0][0]			
conv2d_49 (Conv2D)	(None, 16, 16, 27)	26244	activation_48
[0][0]			
dropout_12 (Dropout)	(None, 16, 16, 27)	0	conv2d_49[0]
[0]			
concatenate_43 (Concatenate)	(None, 16, 16, 135)	0	concatenate_42
[0][0]			dropout_12[0]
[0]			
batch_normalization_49 (BatchNo	(None, 16, 16, 135)	540	concatenate_43
[0][0]			
activation_49 (Activation)	(None, 16, 16, 135)	0	batch_normaliz
ation_49[0][0]			
conv2d_50 (Conv2D)	(None, 16, 16, 27)	32805	activation_49
[0][0]			
dropout_13 (Dropout)	(None, 16, 16, 27)	0	conv2d_50[0]
[0]			
concatenate_44 (Concatenate)	(None, 16, 16, 162)	0	concatenate_43
[0][0]			dropout_13[0]
[0]			
batch_normalization_50 (BatchNo	(None, 16, 16, 162)	648	concatenate_44
[0][0]			
activation_50 (Activation)	(None, 16, 16, 162)	0	batch_normaliz
ation_50[0][0]			
conv2d_51 (Conv2D)	(None, 16, 16, 27)	39366	activation_50
[0][0]			
dropout_14 (Dropout)	(None, 16, 16, 27)	0	conv2d_51[0]

[0]

concatenate_45 (Concatenate)	(None, 16, 16, 189)	0	concatenate_44
[0][0]			dropout_14[0]

[0]

batch_normalization_51 (BatchNo	(None, 16, 16, 189)	756	concatenate_45
[0][0]			

activation_51 (Activation)	(None, 16, 16, 189)	0	batch_normaliz
ation_51[0][0]			ation_51[0][0]

conv2d_52 (Conv2D)	(None, 16, 16, 27)	45927	activation_51
[0][0]			

dropout_15 (Dropout)	(None, 16, 16, 27)	0	conv2d_52[0]
[0]			

concatenate_46 (Concatenate)	(None, 16, 16, 216)	0	concatenate_45
[0][0]			dropout_15[0]

[0]

batch_normalization_52 (BatchNo	(None, 16, 16, 216)	864	concatenate_46
[0][0]			

activation_52 (Activation)	(None, 16, 16, 216)	0	batch_normaliz
ation_52[0][0]			ation_52[0][0]

conv2d_53 (Conv2D)	(None, 16, 16, 27)	52488	activation_52
[0][0]			

dropout_16 (Dropout)	(None, 16, 16, 27)	0	conv2d_53[0]
[0]			

concatenate_47 (Concatenate)	(None, 16, 16, 243)	0	concatenate_46
[0][0]			dropout_16[0]

[0]

batch_normalization_53 (BatchNo	(None, 16, 16, 243)	972	concatenate_47
[0][0]			

activation_53 (Activation)	(None, 16, 16, 243)	0	batch_normaliz
ation_53[0][0]			
conv2d_54 (Conv2D)	(None, 16, 16, 27)	6561	activation_53
[0][0]			
dropout_17 (Dropout)	(None, 16, 16, 27)	0	conv2d_54[0]
[0]			
average_pooling2d_5 (AveragePoo	(None, 8, 8, 27)	0	dropout_17[0]
[0]			
batch_normalization_54 (BatchNo	(None, 8, 8, 27)	108	average_poolin
g2d_5[0][0]			
activation_54 (Activation)	(None, 8, 8, 27)	0	batch_normaliz
ation_54[0][0]			
conv2d_55 (Conv2D)	(None, 8, 8, 27)	6561	activation_54
[0][0]			
dropout_18 (Dropout)	(None, 8, 8, 27)	0	conv2d_55[0]
[0]			
concatenate_48 (Concatenate)	(None, 8, 8, 54)	0	average_poolin
g2d_5[0][0]			
[0]			dropout_18[0]
batch_normalization_55 (BatchNo	(None, 8, 8, 54)	216	concatenate_48
[0][0]			
activation_55 (Activation)	(None, 8, 8, 54)	0	batch_normaliz
ation_55[0][0]			
conv2d_56 (Conv2D)	(None, 8, 8, 27)	13122	activation_55
[0][0]			
dropout_19 (Dropout)	(None, 8, 8, 27)	0	conv2d_56[0]
[0]			
concatenate_49 (Concatenate)	(None, 8, 8, 81)	0	concatenate_48
[0][0]			
			dropout_19[0]

[0]

batch_normalization_56 (BatchNo [0][0])	(None, 8, 8, 81)	324	concatenate_49
activation_56 (Activation) activation_56[0][0]	(None, 8, 8, 81)	0	batch_normaliz
conv2d_57 (Conv2D) [0][0]	(None, 8, 8, 27)	19683	activation_56
dropout_20 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_57[0]
concatenate_50 (Concatenate) [0][0]	(None, 8, 8, 108)	0	concatenate_49 dropout_20[0]
batch_normalization_57 (BatchNo [0][0])	(None, 8, 8, 108)	432	concatenate_50
activation_57 (Activation) activation_57[0][0]	(None, 8, 8, 108)	0	batch_normaliz
conv2d_58 (Conv2D) [0][0]	(None, 8, 8, 27)	26244	activation_57
dropout_21 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_58[0]
concatenate_51 (Concatenate) [0][0]	(None, 8, 8, 135)	0	concatenate_50 dropout_21[0]
batch_normalization_58 (BatchNo [0][0])	(None, 8, 8, 135)	540	concatenate_51
activation_58 (Activation) activation_58[0][0]	(None, 8, 8, 135)	0	batch_normaliz
conv2d_59 (Conv2D) [0][0]	(None, 8, 8, 27)	32805	activation_58

<u>dropout_22</u> (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_59[0]
<u>concatenate_52</u> (Concatenate) [0][0] [0]	(None, 8, 8, 162)	0	concatenate_51 dropout_22[0]
<u>batch_normalization_59</u> (BatchNo [0][0])	(None, 8, 8, 162)	648	concatenate_52
<u>activation_59</u> (Activation) activation_59[0][0]	(None, 8, 8, 162)	0	batch_normaliz
<u>conv2d_60</u> (Conv2D) [0][0]	(None, 8, 8, 27)	39366	activation_59
<u>dropout_23</u> (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_60[0]
<u>concatenate_53</u> (Concatenate) [0][0] [0]	(None, 8, 8, 189)	0	concatenate_52 dropout_23[0]
<u>batch_normalization_60</u> (BatchNo [0][0])	(None, 8, 8, 189)	756	concatenate_53
<u>activation_60</u> (Activation) activation_60[0][0]	(None, 8, 8, 189)	0	batch_normaliz
<u>conv2d_61</u> (Conv2D) [0][0]	(None, 8, 8, 27)	45927	activation_60
<u>dropout_24</u> (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_61[0]
<u>concatenate_54</u> (Concatenate) [0][0] [0]	(None, 8, 8, 216)	0	concatenate_53 dropout_24[0]
<u>batch_normalization_61</u> (BatchNo	(None, 8, 8, 216)	864	concatenate_54

[0][0]

activation_61 (Activation) activation_61[0][0]	(None, 8, 8, 216)	0	batch_normaliz
conv2d_62 (Conv2D) [0][0]	(None, 8, 8, 27)	52488	activation_61
dropout_25 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_62[0]
concatenate_55 (Concatenate) [0][0]	(None, 8, 8, 243)	0	concatenate_54 dropout_25[0]
batch_normalization_62 (BatchNo [0][0]	(None, 8, 8, 243)	972	concatenate_55
activation_62 (Activation) activation_62[0][0]	(None, 8, 8, 243)	0	batch_normaliz
conv2d_63 (Conv2D) [0][0]	(None, 8, 8, 27)	6561	activation_62
dropout_26 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_63[0]
average_pooling2d_6 (AveragePoo [0]	(None, 4, 4, 27)	0	dropout_26[0]
batch_normalization_63 (BatchNo g2d_6[0][0]	(None, 4, 4, 27)	108	average_poolin
activation_63 (Activation) ation_63[0][0]	(None, 4, 4, 27)	0	batch_normaliz
conv2d_64 (Conv2D) [0][0]	(None, 4, 4, 27)	6561	activation_63
dropout_27 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_64[0]

concatenate_56 (Concatenate) g2d_6[0][0]	(None, 4, 4, 54)	0	average_poolin dropout_27[0]
[0]			
batch_normalization_64 (BatchNo [0][0])	(None, 4, 4, 54)	216	concatenate_56
activation_64 (Activation) ation_64[0][0]	(None, 4, 4, 54)	0	batch_normaliz
conv2d_65 (Conv2D) [0][0]	(None, 4, 4, 27)	13122	activation_64
dropout_28 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_65[0]
concatenate_57 (Concatenate) [0][0]	(None, 4, 4, 81)	0	concatenate_56 dropout_28[0]
[0]			
batch_normalization_65 (BatchNo [0][0])	(None, 4, 4, 81)	324	concatenate_57
activation_65 (Activation) ation_65[0][0]	(None, 4, 4, 81)	0	batch_normaliz
conv2d_66 (Conv2D) [0][0]	(None, 4, 4, 27)	19683	activation_65
dropout_29 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_66[0]
concatenate_58 (Concatenate) [0][0]	(None, 4, 4, 108)	0	concatenate_57 dropout_29[0]
[0]			
batch_normalization_66 (BatchNo [0][0])	(None, 4, 4, 108)	432	concatenate_58
activation_66 (Activation) ation_66[0][0]	(None, 4, 4, 108)	0	batch_normaliz

conv2d_67 (Conv2D) [0][0]	(None, 4, 4, 27)	26244	activation_66
dropout_30 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_67[0]
concatenate_59 (Concatenate) [0][0] [0]	(None, 4, 4, 135)	0	concatenate_58 dropout_30[0]
batch_normalization_67 (Batch Normalization) [0][0]	(None, 4, 4, 135)	540	concatenate_59
activation_67 (Activation) activation_67[0][0]	(None, 4, 4, 135)	0	batch_normalization_67[0][0]
conv2d_68 (Conv2D) [0][0]	(None, 4, 4, 27)	32805	activation_67
dropout_31 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_68[0]
concatenate_60 (Concatenate) [0][0] [0]	(None, 4, 4, 162)	0	concatenate_59 dropout_31[0]
batch_normalization_68 (Batch Normalization) [0][0]	(None, 4, 4, 162)	648	concatenate_60
activation_68 (Activation) activation_68[0][0]	(None, 4, 4, 162)	0	batch_normalization_68[0][0]
conv2d_69 (Conv2D) [0][0]	(None, 4, 4, 27)	39366	activation_68
dropout_32 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_69[0]
concatenate_61 (Concatenate) [0][0] [0]	(None, 4, 4, 189)	0	concatenate_60 dropout_32[0]

batch_normalization_69 (BatchNo (None, 4, 4, 189) [0][0])	756	concatenate_61
activation_69 (Activation) ation_69[0][0])	0	batch_normaliz
conv2d_70 (Conv2D) [0][0])	45927	activation_69
dropout_33 (Dropout) [0])	0	conv2d_70[0]
concatenate_62 (Concatenate) [0][0])	0	concatenate_61 dropout_33[0]
batch_normalization_70 (BatchNo (None, 4, 4, 216) [0][0])	864	concatenate_62
activation_70 (Activation) ation_70[0][0])	0	batch_normaliz
conv2d_71 (Conv2D) [0][0])	52488	activation_70
dropout_34 (Dropout) [0])	0	conv2d_71[0]
concatenate_63 (Concatenate) [0][0])	0	concatenate_62 dropout_34[0]
batch_normalization_71 (BatchNo (None, 4, 4, 243) [0][0])	972	concatenate_63
activation_71 (Activation) ation_71[0][0])	0	batch_normaliz
average_pooling2d_7 (AveragePoo (None, 2, 2, 243) [0][0])	0	activation_71

=====

```
=====
```

```
Total params: 984,231
Trainable params: 974,511
Non-trainable params: 9,720
```

```
*****
*****
*****
```

```
*****after adding conv2d layer*****
*****
```

```
Model: "sequential"
```

Layer (type)	Output Shape	Param #
=====		
functional_5 (Functional)	(None, 2, 2, 243)	984231

conv2d_72 (Conv2D)	(None, 1, 1, 10)	9730

flatten_2 (Flatten)	(None, 10)	0
=====		

```
Total params: 993,961
Trainable params: 984,241
Non-trainable params: 9,720
```

```
*****
*****
*****
```

```
Epoch 1/10
```

```
2/391 [.....] - ETA: 33s - loss: 2.5705 - accuracy:
0.1094WARNING:tensorflow:Callbacks method `on_train_batch_end` is slow compare
d to the batch time (batch time: 0.0608s vs `on_train_batch_end` time: 0.1048
s). Check your callbacks.
```

```
391/391 [=====] - 71s 183ms/step - loss: 2.0123 - accu
racy: 0.2608 - val_loss: 2.1333 - val_accuracy: 0.2932
```

```
Epoch 2/10
```

```
391/391 [=====] - 71s 181ms/step - loss: 1.7144 - accu
racy: 0.3684 - val_loss: 1.8513 - val_accuracy: 0.3589
```

```
Epoch 3/10
```

```
391/391 [=====] - 72s 184ms/step - loss: 1.5591 - accu
racy: 0.4290 - val_loss: 1.7719 - val_accuracy: 0.3882
```

```
Epoch 4/10
```

```
391/391 [=====] - 72s 185ms/step - loss: 1.4613 - accu
racy: 0.4681 - val_loss: 1.8698 - val_accuracy: 0.4131
```

```
Epoch 5/10
```

```
391/391 [=====] - 73s 186ms/step - loss: 1.3781 - accu
racy: 0.5009 - val_loss: 1.4719 - val_accuracy: 0.4841
```

```
Epoch 6/10
```

```
391/391 [=====] - 73s 186ms/step - loss: 1.3133 - accu
racy: 0.5245 - val_loss: 1.6696 - val_accuracy: 0.4614
```

```
Epoch 7/10
```

```
391/391 [=====] - 73s 186ms/step - loss: 1.2600 - accu
racy: 0.5482 - val_loss: 1.8897 - val_accuracy: 0.4513
```

```
Epoch 8/10
```

```
391/391 [=====] - 73s 186ms/step - loss: 1.2208 - accu
racy: 0.5621 - val_loss: 1.5176 - val_accuracy: 0.5132
```

```
Epoch 9/10
```

```

391/391 [=====] - 73s 186ms/step - loss: 1.1779 - accu
racy: 0.5808 - val_loss: 1.9051 - val_accuracy: 0.4623
Epoch 10/10
391/391 [=====] - 73s 186ms/step - loss: 1.1440 - accu
racy: 0.5896 - val_loss: 1.4295 - val_accuracy: 0.5387
313/313 [=====] - 3s 11ms/step - loss: 1.5103 - accura
cy: 0.5190
Test loss: 1.5103108882904053
Test accuracy: 0.5189999938011169

```

Image augmentation horizontal and vertical flip

In [36]: # Reff <https://machinelearningmastery.com/how-to-configure-image-data-augmentation/>

```

def vertical_horizontal_flip(arr_imgs):

    # convert to numpy array
    d_ar = arr_imgs.copy()

    for i in tqdm(range(d_ar.shape[0]), position=0):
        data = d_ar[i]
        # expand dimension to one sample
        samples = np.expand_dims(data, 0)
        # create image data augmentation generator
        datagen = ImageDataGenerator(horizontal_flip=True, vertical_flip=True)
        # prepare iterator
        it = datagen.flow(samples, batch_size=1)
        # generate samples and plot
        # define subplot
        # pyplot.subplot(330 + 1 + i)
        # generate batch of images
        for j in range(9):
            batch = it.next()
            if j == 0:
                # convert to unsigned integers for viewing
                image = batch[0].astype('uint8')
                d_ar[i] = image
                # plot raw pixel data
                #break
    return d_ar

```



```
In [37]: X_train_hor_ver_flip=vertical_horizontal_flip(X_train)
X_cv_hor_ver_flip=vertical_horizontal_flip(X_cv)
X_test_hor_ver_flip=vertical_horizontal_flip(X_test)
```

```
100%|██████████| 50000/50000 [00:11<00:00, 4254.57it/s]
100%|██████████| 10000/10000 [00:02<00:00, 4128.43it/s]
100%|██████████| 10000/10000 [00:02<00:00, 4373.36it/s]
```

In [38]: `v_h_flip_model=model1(X_train_hor_ver_flip,X_cv_hor_ver_flip,X_test_hor_ver_flip,`

Model: "functional_7"

Layer (type)	Output Shape	Param #	Connected to
input_3 (InputLayer)	[(None, 32, 32, 3)]	0	
conv2d_73 (Conv2D)	(None, 32, 32, 27)	324	input_3[0][0]
batch_normalization_72 (Batch Normalization)	(None, 32, 32, 27)	108	conv2d_73[0]
activation_72 (Activation)	(None, 32, 32, 27)	0	batch_normalization_72[0][0]
conv2d_74 (Conv2D)	(None, 32, 32, 27)	6561	activation_72[0][0]
dropout_35 (Dropout)	(None, 32, 32, 27)	0	conv2d_74[0]
concatenate_64 (Concatenate)	(None, 32, 32, 54)	0	conv2d_73[0] dropout_35[0]
batch_normalization_73 (Batch Normalization)	(None, 32, 32, 54)	216	concatenate_64[0][0]
activation_73 (Activation)	(None, 32, 32, 54)	0	batch_normalization_73[0][0]
conv2d_75 (Conv2D)	(None, 32, 32, 27)	13122	activation_73[0][0]
dropout_36 (Dropout)	(None, 32, 32, 27)	0	conv2d_75[0]
concatenate_65 (Concatenate)	(None, 32, 32, 81)	0	concatenate_64[0][0] dropout_36[0]

batch_normalization_74 (BatchNo	(None, 32, 32, 81)	324	concatenate_65
[0][0]			
activation_74 (Activation)	(None, 32, 32, 81)	0	batch_normaliz
ation_74[0][0]			
conv2d_76 (Conv2D)	(None, 32, 32, 27)	19683	activation_74
[0][0]			
dropout_37 (Dropout)	(None, 32, 32, 27)	0	conv2d_76[0]
[0]			
concatenate_66 (Concatenate)	(None, 32, 32, 108)	0	concatenate_65
[0][0]			dropout_37[0]
[0]			
batch_normalization_75 (BatchNo	(None, 32, 32, 108)	432	concatenate_66
[0][0]			
activation_75 (Activation)	(None, 32, 32, 108)	0	batch_normaliz
ation_75[0][0]			
conv2d_77 (Conv2D)	(None, 32, 32, 27)	26244	activation_75
[0][0]			
dropout_38 (Dropout)	(None, 32, 32, 27)	0	conv2d_77[0]
[0]			
concatenate_67 (Concatenate)	(None, 32, 32, 135)	0	concatenate_66
[0][0]			dropout_38[0]
[0]			
batch_normalization_76 (BatchNo	(None, 32, 32, 135)	540	concatenate_67
[0][0]			
activation_76 (Activation)	(None, 32, 32, 135)	0	batch_normaliz
ation_76[0][0]			
conv2d_78 (Conv2D)	(None, 32, 32, 27)	32805	activation_76
[0][0]			

dropout_39 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_78[0]
concatenate_68 (Concatenate) [0][0]	(None, 32, 32, 162)	0	concatenate_67 dropout_39[0]
batch_normalization_77 (Batch Normalization) [0][0]	(None, 32, 32, 162)	648	concatenate_68
activation_77 (Activation) activation_77[0][0]	(None, 32, 32, 162)	0	batch_normalization_77[0][0]
conv2d_79 (Conv2D) [0][0]	(None, 32, 32, 27)	39366	activation_77
dropout_40 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_79[0]
concatenate_69 (Concatenate) [0][0]	(None, 32, 32, 189)	0	concatenate_68 dropout_40[0]
batch_normalization_78 (Batch Normalization) [0][0]	(None, 32, 32, 189)	756	concatenate_69
activation_78 (Activation) activation_78[0][0]	(None, 32, 32, 189)	0	batch_normalization_78[0][0]
conv2d_80 (Conv2D) [0][0]	(None, 32, 32, 27)	45927	activation_78
dropout_41 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_80[0]
concatenate_70 (Concatenate) [0][0]	(None, 32, 32, 216)	0	concatenate_69 dropout_41[0]
batch_normalization_79 (Batch Normalization) [0][0]	(None, 32, 32, 216)	864	concatenate_70

activation_79 (Activation) activation_79[0][0]	(None, 32, 32, 216)	0	batch_normaliz
conv2d_81 (Conv2D) [0][0]	(None, 32, 32, 27)	52488	activation_79
dropout_42 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_81[0]
concatenate_71 (Concatenate) [0][0] [0]	(None, 32, 32, 243)	0	concatenate_70 dropout_42[0]
batch_normalization_80 (BatchNo [0][0])	(None, 32, 32, 243)	972	concatenate_71
activation_80 (Activation) activation_80[0][0]	(None, 32, 32, 243)	0	batch_normaliz
conv2d_82 (Conv2D) [0][0]	(None, 32, 32, 27)	6561	activation_80
dropout_43 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_82[0]
average_pooling2d_8 (AveragePoo [0])	(None, 16, 16, 27)	0	dropout_43[0]
batch_normalization_81 (BatchNo g2d_8[0][0])	(None, 16, 16, 27)	108	average_poolin
activation_81 (Activation) ation_81[0][0]	(None, 16, 16, 27)	0	batch_normaliz
conv2d_83 (Conv2D) [0][0]	(None, 16, 16, 27)	6561	activation_81
dropout_44 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_83[0]
concatenate_72 (Concatenate) g2d_8[0][0]	(None, 16, 16, 54)	0	average_poolin

dropout_44[0]

[0]

batch_normalization_82 (BatchNo	(None, 16, 16, 54)	216	concatenate_72
[0][0]			
activation_82 (Activation)	(None, 16, 16, 54)	0	batch_normaliz
ation_82[0][0]			
conv2d_84 (Conv2D)	(None, 16, 16, 27)	13122	activation_82
[0][0]			
dropout_45 (Dropout)	(None, 16, 16, 27)	0	conv2d_84[0]
[0]			
concatenate_73 (Concatenate)	(None, 16, 16, 81)	0	concatenate_72
[0][0]			dropout_45[0]
[0]			
batch_normalization_83 (BatchNo	(None, 16, 16, 81)	324	concatenate_73
[0][0]			
activation_83 (Activation)	(None, 16, 16, 81)	0	batch_normaliz
ation_83[0][0]			
conv2d_85 (Conv2D)	(None, 16, 16, 27)	19683	activation_83
[0][0]			
dropout_46 (Dropout)	(None, 16, 16, 27)	0	conv2d_85[0]
[0]			
concatenate_74 (Concatenate)	(None, 16, 16, 108)	0	concatenate_73
[0][0]			dropout_46[0]
[0]			
batch_normalization_84 (BatchNo	(None, 16, 16, 108)	432	concatenate_74
[0][0]			
activation_84 (Activation)	(None, 16, 16, 108)	0	batch_normaliz
ation_84[0][0]			
conv2d_86 (Conv2D)	(None, 16, 16, 27)	26244	activation_84

[0][0]

dropout_47 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_86[0]
concatenate_75 (Concatenate) [0][0]	(None, 16, 16, 135)	0	concatenate_74 dropout_47[0]
batch_normalization_85 (BatchNo [0][0]	(None, 16, 16, 135)	540	concatenate_75
activation_85 (Activation) ation_85[0][0]	(None, 16, 16, 135)	0	batch_normaliz
conv2d_87 (Conv2D) [0][0]	(None, 16, 16, 27)	32805	activation_85
dropout_48 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_87[0]
concatenate_76 (Concatenate) [0][0]	(None, 16, 16, 162)	0	concatenate_75 dropout_48[0]
batch_normalization_86 (BatchNo [0][0]	(None, 16, 16, 162)	648	concatenate_76
activation_86 (Activation) ation_86[0][0]	(None, 16, 16, 162)	0	batch_normaliz
conv2d_88 (Conv2D) [0][0]	(None, 16, 16, 27)	39366	activation_86
dropout_49 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_88[0]
concatenate_77 (Concatenate) [0][0]	(None, 16, 16, 189)	0	concatenate_76 dropout_49[0]

batch_normalization_87 (BatchNo	(None, 16, 16, 189)	756	concatenate_77 [0][0]
activation_87 (Activation)	(None, 16, 16, 189)	0	batch_normaliz ation_87[0][0]
conv2d_89 (Conv2D)	(None, 16, 16, 27)	45927	activation_87 [0][0]
dropout_50 (Dropout)	(None, 16, 16, 27)	0	conv2d_89[0]
concatenate_78 (Concatenate)	(None, 16, 16, 216)	0	concatenate_77 [0][0]
			dropout_50[0]
batch_normalization_88 (BatchNo	(None, 16, 16, 216)	864	concatenate_78 [0][0]
activation_88 (Activation)	(None, 16, 16, 216)	0	batch_normaliz ation_88[0][0]
conv2d_90 (Conv2D)	(None, 16, 16, 27)	52488	activation_88 [0][0]
dropout_51 (Dropout)	(None, 16, 16, 27)	0	conv2d_90[0]
concatenate_79 (Concatenate)	(None, 16, 16, 243)	0	concatenate_78 [0][0]
			dropout_51[0]
batch_normalization_89 (BatchNo	(None, 16, 16, 243)	972	concatenate_79 [0][0]
activation_89 (Activation)	(None, 16, 16, 243)	0	batch_normaliz ation_89[0][0]
conv2d_91 (Conv2D)	(None, 16, 16, 27)	6561	activation_89 [0][0]
dropout_52 (Dropout)	(None, 16, 16, 27)	0	conv2d_91[0]

[0]

average_pooling2d_9 (AveragePool)	(None, 8, 8, 27)	0	dropout_52[0]
batch_normalization_90 (Batch Normalization)	(None, 8, 8, 27)	108	average_pooling2d_9[0][0]
activation_90 (Activation)	(None, 8, 8, 27)	0	batch_normalization_90[0][0]
conv2d_92 (Conv2D)	(None, 8, 8, 27)	6561	activation_90[0][0]
dropout_53 (Dropout)	(None, 8, 8, 27)	0	conv2d_92[0]
concatenate_80 (Concatenate)	(None, 8, 8, 54)	0	average_pooling2d_9[0][0] dropout_53[0]
batch_normalization_91 (Batch Normalization)	(None, 8, 8, 54)	216	concatenate_80[0][0]
activation_91 (Activation)	(None, 8, 8, 54)	0	batch_normalization_91[0][0]
conv2d_93 (Conv2D)	(None, 8, 8, 27)	13122	activation_91[0][0]
dropout_54 (Dropout)	(None, 8, 8, 27)	0	conv2d_93[0]
concatenate_81 (Concatenate)	(None, 8, 8, 81)	0	concatenate_80[0][0] dropout_54[0]
batch_normalization_92 (Batch Normalization)	(None, 8, 8, 81)	324	concatenate_81[0][0]
activation_92 (Activation)	(None, 8, 8, 81)	0	batch_normalization_92[0][0]

<u>conv2d_94 (Conv2D)</u> [0][0]	(None, 8, 8, 27)	19683	activation_92
<u>dropout_55 (Dropout)</u> [0]	(None, 8, 8, 27)	0	conv2d_94[0]
<u>concatenate_82 (Concatenate)</u> [0][0] [0]	(None, 8, 8, 108)	0	concatenate_81 dropout_55[0]
<u>batch_normalization_93 (Batch Normalization)</u> [0][0]	(None, 8, 8, 108)	432	concatenate_82
<u>activation_93 (Activation)</u> [0][0]	(None, 8, 8, 108)	0	batch_normalization_93[0][0]
<u>conv2d_95 (Conv2D)</u> [0][0]	(None, 8, 8, 27)	26244	activation_93
<u>dropout_56 (Dropout)</u> [0]	(None, 8, 8, 27)	0	conv2d_95[0]
<u>concatenate_83 (Concatenate)</u> [0][0] [0]	(None, 8, 8, 135)	0	concatenate_82 dropout_56[0]
<u>batch_normalization_94 (Batch Normalization)</u> [0][0]	(None, 8, 8, 135)	540	concatenate_83
<u>activation_94 (Activation)</u> [0][0]	(None, 8, 8, 135)	0	batch_normalization_94[0][0]
<u>conv2d_96 (Conv2D)</u> [0][0]	(None, 8, 8, 27)	32805	activation_94
<u>dropout_57 (Dropout)</u> [0]	(None, 8, 8, 27)	0	conv2d_96[0]
<u>concatenate_84 (Concatenate)</u> [0][0]	(None, 8, 8, 162)	0	concatenate_83 dropout_57[0]

[0]

batch_normalization_95 (BatchNo	(None, 8, 8, 162)	648	concatenate_84
[0][0]			
activation_95 (Activation)	(None, 8, 8, 162)	0	batch_normaliz
ation_95[0][0]			
conv2d_97 (Conv2D)	(None, 8, 8, 27)	39366	activation_95
[0][0]			
dropout_58 (Dropout)	(None, 8, 8, 27)	0	conv2d_97[0]
[0]			
concatenate_85 (Concatenate)	(None, 8, 8, 189)	0	concatenate_84
[0][0]			dropout_58[0]
[0]			
batch_normalization_96 (BatchNo	(None, 8, 8, 189)	756	concatenate_85
[0][0]			
activation_96 (Activation)	(None, 8, 8, 189)	0	batch_normaliz
ation_96[0][0]			
conv2d_98 (Conv2D)	(None, 8, 8, 27)	45927	activation_96
[0][0]			
dropout_59 (Dropout)	(None, 8, 8, 27)	0	conv2d_98[0]
[0]			
concatenate_86 (Concatenate)	(None, 8, 8, 216)	0	concatenate_85
[0][0]			dropout_59[0]
[0]			
batch_normalization_97 (BatchNo	(None, 8, 8, 216)	864	concatenate_86
[0][0]			
activation_97 (Activation)	(None, 8, 8, 216)	0	batch_normaliz
ation_97[0][0]			
conv2d_99 (Conv2D)	(None, 8, 8, 27)	52488	activation_97
[0][0]			

<u>dropout_60</u> (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_99[0]
<u>concatenate_87</u> (Concatenate) [0][0] [0]	(None, 8, 8, 243)	0	concatenate_86 dropout_60[0]
<u>batch_normalization_98</u> (BatchNo [0][0])	(None, 8, 8, 243)	972	concatenate_87
<u>activation_98</u> (Activation) activation_98[0][0]	(None, 8, 8, 243)	0	batch_normaliz
<u>conv2d_100</u> (Conv2D) [0][0]	(None, 8, 8, 27)	6561	activation_98
<u>dropout_61</u> (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_100[0]
<u>average_pooling2d_10</u> (AveragePo [0])	(None, 4, 4, 27)	0	dropout_61[0]
<u>batch_normalization_99</u> (BatchNo g2d_10[0][0])	(None, 4, 4, 27)	108	average_poolin
<u>activation_99</u> (Activation) activation_99[0][0]	(None, 4, 4, 27)	0	batch_normaliz
<u>conv2d_101</u> (Conv2D) [0][0]	(None, 4, 4, 27)	6561	activation_99
<u>dropout_62</u> (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_101[0]
<u>concatenate_88</u> (Concatenate) g2d_10[0][0] [0]	(None, 4, 4, 54)	0	average_poolin dropout_62[0]
<u>batch_normalization_100</u> (BatchN [0][0])	(None, 4, 4, 54)	216	concatenate_88

activation_100 (Activation) activation_100[0][0]	(None, 4, 4, 54)	0	batch_normaliz
conv2d_102 (Conv2D) [0][0]	(None, 4, 4, 27)	13122	activation_100
dropout_63 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_102[0]
concatenate_89 (Concatenate) [0][0] [0]	(None, 4, 4, 81)	0	concatenate_88 dropout_63[0]
batch_normalization_101 (BatchN [0][0])	(None, 4, 4, 81)	324	concatenate_89
activation_101 (Activation) activation_101[0][0]	(None, 4, 4, 81)	0	batch_normaliz
conv2d_103 (Conv2D) [0][0]	(None, 4, 4, 27)	19683	activation_101
dropout_64 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_103[0]
concatenate_90 (Concatenate) [0][0] [0]	(None, 4, 4, 108)	0	concatenate_89 dropout_64[0]
batch_normalization_102 (BatchN [0][0])	(None, 4, 4, 108)	432	concatenate_90
activation_102 (Activation) activation_102[0][0]	(None, 4, 4, 108)	0	batch_normaliz
conv2d_104 (Conv2D) [0][0]	(None, 4, 4, 27)	26244	activation_102
dropout_65 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_104[0]

concatenate_91 (Concatenate) [0][0]	(None, 4, 4, 135)	0	concatenate_90 dropout_65[0]
[0]			
batch_normalization_103 (BatchN [0][0]	(None, 4, 4, 135)	540	concatenate_91
activation_103 (Activation) activation_103[0][0]	(None, 4, 4, 135)	0	batch_normaliz
conv2d_105 (Conv2D) [0][0]	(None, 4, 4, 27)	32805	activation_103
dropout_66 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_105[0]
concatenate_92 (Concatenate) [0][0]	(None, 4, 4, 162)	0	concatenate_91 dropout_66[0]
[0]			
batch_normalization_104 (BatchN [0][0]	(None, 4, 4, 162)	648	concatenate_92
activation_104 (Activation) activation_104[0][0]	(None, 4, 4, 162)	0	batch_normaliz
conv2d_106 (Conv2D) [0][0]	(None, 4, 4, 27)	39366	activation_104
dropout_67 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_106[0]
concatenate_93 (Concatenate) [0][0]	(None, 4, 4, 189)	0	concatenate_92 dropout_67[0]
[0]			
batch_normalization_105 (BatchN [0][0]	(None, 4, 4, 189)	756	concatenate_93
activation_105 (Activation) activation_105[0][0]	(None, 4, 4, 189)	0	batch_normaliz

conv2d_107 (Conv2D) [0][0]	(None, 4, 4, 27)	45927	activation_105
dropout_68 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_107[0]
concatenate_94 (Concatenate) [0][0] [0]	(None, 4, 4, 216)	0	concatenate_93 dropout_68[0]
batch_normalization_106 (BatchN [0][0])	(None, 4, 4, 216)	864	concatenate_94
activation_106 (Activation) ation_106[0][0]	(None, 4, 4, 216)	0	batch_normaliz
conv2d_108 (Conv2D) [0][0]	(None, 4, 4, 27)	52488	activation_106
dropout_69 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_108[0]
concatenate_95 (Concatenate) [0][0] [0]	(None, 4, 4, 243)	0	concatenate_94 dropout_69[0]
batch_normalization_107 (BatchN [0][0])	(None, 4, 4, 243)	972	concatenate_95
activation_107 (Activation) ation_107[0][0]	(None, 4, 4, 243)	0	batch_normaliz
average_pooling2d_11 (AveragePo [0][0])	(None, 2, 2, 243)	0	activation_107
flatten_3 (Flatten) g2d_11[0][0]	(None, 972)	0	average_poolin
dense_2 (Dense) [0]	(None, 10)	9730	flatten_3[0]
=====			
=====			

[illegible]

```
Model: "functional 9"
```

Layer (type)	Output Shape	Param #	Connected to
input_3 (InputLayer)	[(None, 32, 32, 3)]	0	
conv2d_73 (Conv2D)	(None, 32, 32, 27)	324	input_3[0][0]
batch_normalization_72 (Batch Normalization)	(None, 32, 32, 27)	108	conv2d_73[0]
activation_72 (Activation)	(None, 32, 32, 27)	0	batch_normalization_72[0][0]
conv2d_74 (Conv2D)	(None, 32, 32, 27)	6561	activation_72[0][0]
dropout_35 (Dropout)	(None, 32, 32, 27)	0	conv2d_74[0]
concatenate_64 (Concatenate)	(None, 32, 32, 54)	0	conv2d_73[0] dropout_35[0]
batch_normalization_73 (Batch Normalization)	(None, 32, 32, 54)	216	concatenate_64[0]
activation_73 (Activation)	(None, 32, 32, 54)	0	batch_normalization_73[0][0]
conv2d_75 (Conv2D)	(None, 32, 32, 27)	13122	activation_73[0][0]

<u>dropout_36</u> (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_75[0]
<u>concatenate_65</u> (Concatenate) [0][0] [0]	(None, 32, 32, 81)	0	concatenate_64 dropout_36[0]
<u>batch_normalization_74</u> (BatchNo [0][0])	(None, 32, 32, 81)	324	concatenate_65
<u>activation_74</u> (Activation) activation_74[0][0]	(None, 32, 32, 81)	0	batch_normaliz
<u>conv2d_76</u> (Conv2D) [0][0]	(None, 32, 32, 27)	19683	activation_74
<u>dropout_37</u> (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_76[0]
<u>concatenate_66</u> (Concatenate) [0][0] [0]	(None, 32, 32, 108)	0	concatenate_65 dropout_37[0]
<u>batch_normalization_75</u> (BatchNo [0][0])	(None, 32, 32, 108)	432	concatenate_66
<u>activation_75</u> (Activation) activation_75[0][0]	(None, 32, 32, 108)	0	batch_normaliz
<u>conv2d_77</u> (Conv2D) [0][0]	(None, 32, 32, 27)	26244	activation_75
<u>dropout_38</u> (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_77[0]
<u>concatenate_67</u> (Concatenate) [0][0] [0]	(None, 32, 32, 135)	0	concatenate_66 dropout_38[0]
<u>batch_normalization_76</u> (BatchNo	(None, 32, 32, 135)	540	concatenate_67

[0][0]

activation_76 (Activation) activation_76[0][0]	(None, 32, 32, 135)	0	batch_normaliz
conv2d_78 (Conv2D) [0][0]	(None, 32, 32, 27)	32805	activation_76
dropout_39 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_78[0]
concatenate_68 (Concatenate) [0][0]	(None, 32, 32, 162)	0	concatenate_67 dropout_39[0]
batch_normalization_77 (BatchNo [0][0]	(None, 32, 32, 162)	648	concatenate_68
activation_77 (Activation) activation_77[0][0]	(None, 32, 32, 162)	0	batch_normaliz
conv2d_79 (Conv2D) [0][0]	(None, 32, 32, 27)	39366	activation_77
dropout_40 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_79[0]
concatenate_69 (Concatenate) [0][0]	(None, 32, 32, 189)	0	concatenate_68 dropout_40[0]
batch_normalization_78 (BatchNo [0][0]	(None, 32, 32, 189)	756	concatenate_69
activation_78 (Activation) activation_78[0][0]	(None, 32, 32, 189)	0	batch_normaliz
conv2d_80 (Conv2D) [0][0]	(None, 32, 32, 27)	45927	activation_78
dropout_41 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_80[0]

concatenate_70 (Concatenate) [0][0]	(None, 32, 32, 216)	0	concatenate_69 dropout_41[0]
batch_normalization_79 (BatchNo [0][0])	(None, 32, 32, 216)	864	concatenate_70
activation_79 (Activation) [0][0]	(None, 32, 32, 216)	0	batch_normaliz ation_79[0][0]
conv2d_81 (Conv2D) [0][0]	(None, 32, 32, 27)	52488	activation_79
dropout_42 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_81[0]
concatenate_71 (Concatenate) [0][0]	(None, 32, 32, 243)	0	concatenate_70 dropout_42[0]
batch_normalization_80 (BatchNo [0][0])	(None, 32, 32, 243)	972	concatenate_71
activation_80 (Activation) [0][0]	(None, 32, 32, 243)	0	batch_normaliz ation_80[0][0]
conv2d_82 (Conv2D) [0][0]	(None, 32, 32, 27)	6561	activation_80
dropout_43 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_82[0]
average_pooling2d_8 (AveragePoo [0])	(None, 16, 16, 27)	0	dropout_43[0]
batch_normalization_81 (BatchNo g2d_8[0][0])	(None, 16, 16, 27)	108	average_poolin g2d_8[0][0]
activation_81 (Activation) [0][0]	(None, 16, 16, 27)	0	batch_normaliz ation_81[0][0]

conv2d_83 (Conv2D) [0][0]	(None, 16, 16, 27)	6561	activation_81
dropout_44 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_83[0]
concatenate_72 (Concatenate) g2d_8[0][0] [0]	(None, 16, 16, 54)	0	average_poolin dropout_44[0]
batch_normalization_82 (BatchNo [0][0]	(None, 16, 16, 54)	216	concatenate_72
activation_82 (Activation) ation_82[0][0]	(None, 16, 16, 54)	0	batch_normaliz
conv2d_84 (Conv2D) [0][0]	(None, 16, 16, 27)	13122	activation_82
dropout_45 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_84[0]
concatenate_73 (Concatenate) [0][0] [0]	(None, 16, 16, 81)	0	concatenate_72 dropout_45[0]
batch_normalization_83 (BatchNo [0][0]	(None, 16, 16, 81)	324	concatenate_73
activation_83 (Activation) ation_83[0][0]	(None, 16, 16, 81)	0	batch_normaliz
conv2d_85 (Conv2D) [0][0]	(None, 16, 16, 27)	19683	activation_83
dropout_46 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_85[0]
concatenate_74 (Concatenate) [0][0] [0]	(None, 16, 16, 108)	0	concatenate_73 dropout_46[0]

batch_normalization_84 (BatchNo	(None, 16, 16, 108)	432	concatenate_74 [0][0]
activation_84 (Activation)	(None, 16, 16, 108)	0	batch_normaliz ation_84[0][0]
conv2d_86 (Conv2D)	(None, 16, 16, 27)	26244	activation_84 [0][0]
dropout_47 (Dropout)	(None, 16, 16, 27)	0	conv2d_86[0] [0]
concatenate_75 (Concatenate)	(None, 16, 16, 135)	0	concatenate_74 [0][0] dropout_47[0] [0]
batch_normalization_85 (BatchNo	(None, 16, 16, 135)	540	concatenate_75 [0][0]
activation_85 (Activation)	(None, 16, 16, 135)	0	batch_normaliz ation_85[0][0]
conv2d_87 (Conv2D)	(None, 16, 16, 27)	32805	activation_85 [0][0]
dropout_48 (Dropout)	(None, 16, 16, 27)	0	conv2d_87[0] [0]
concatenate_76 (Concatenate)	(None, 16, 16, 162)	0	concatenate_75 [0][0] dropout_48[0] [0]
batch_normalization_86 (BatchNo	(None, 16, 16, 162)	648	concatenate_76 [0][0]
activation_86 (Activation)	(None, 16, 16, 162)	0	batch_normaliz ation_86[0][0]
conv2d_88 (Conv2D)	(None, 16, 16, 27)	39366	activation_86 [0][0]

<u>dropout_49 (Dropout)</u> [0]	(None, 16, 16, 27)	0	conv2d_88[0]
<u>concatenate_77 (Concatenate)</u> [0][0]	(None, 16, 16, 189)	0	concatenate_76 dropout_49[0]
<u>batch_normalization_87 (BatchNo</u> [0][0]	(None, 16, 16, 189)	756	concatenate_77
<u>activation_87 (Activation)</u> [0][0]	(None, 16, 16, 189)	0	batch_normaliz
<u>conv2d_89 (Conv2D)</u> [0][0]	(None, 16, 16, 27)	45927	activation_87
<u>dropout_50 (Dropout)</u> [0]	(None, 16, 16, 27)	0	conv2d_89[0]
<u>concatenate_78 (Concatenate)</u> [0][0]	(None, 16, 16, 216)	0	concatenate_77 dropout_50[0]
<u>batch_normalization_88 (BatchNo</u> [0][0]	(None, 16, 16, 216)	864	concatenate_78
<u>activation_88 (Activation)</u> [0][0]	(None, 16, 16, 216)	0	batch_normaliz
<u>conv2d_90 (Conv2D)</u> [0][0]	(None, 16, 16, 27)	52488	activation_88
<u>dropout_51 (Dropout)</u> [0]	(None, 16, 16, 27)	0	conv2d_90[0]
<u>concatenate_79 (Concatenate)</u> [0][0]	(None, 16, 16, 243)	0	concatenate_78 dropout_51[0]
<u>batch_normalization_89 (BatchNo</u> [0][0]	(None, 16, 16, 243)	972	concatenate_79

activation_89 (Activation) activation_89[0][0]	(None, 16, 16, 243)	0	batch_normaliz
conv2d_91 (Conv2D) [0][0]	(None, 16, 16, 27)	6561	activation_89
dropout_52 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_91[0]
average_pooling2d_9 (AveragePoo [0])	(None, 8, 8, 27)	0	dropout_52[0]
batch_normalization_90 (BatchNo g2d_9[0][0])	(None, 8, 8, 27)	108	average_poolin
activation_90 (Activation) activation_90[0][0]	(None, 8, 8, 27)	0	batch_normaliz
conv2d_92 (Conv2D) [0][0]	(None, 8, 8, 27)	6561	activation_90
dropout_53 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_92[0]
concatenate_80 (Concatenate) g2d_9[0][0] [0]	(None, 8, 8, 54)	0	average_poolin dropout_53[0]
batch_normalization_91 (BatchNo [0][0])	(None, 8, 8, 54)	216	concatenate_80
activation_91 (Activation) activation_91[0][0]	(None, 8, 8, 54)	0	batch_normaliz
conv2d_93 (Conv2D) [0][0]	(None, 8, 8, 27)	13122	activation_91
dropout_54 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_93[0]
concatenate_81 (Concatenate)	(None, 8, 8, 81)	0	concatenate_80

[0][0]			dropout_54[0]
[0]			
batch_normalization_92 (BatchNo	(None, 8, 8, 81)	324	concatenate_81
[0][0]			
activation_92 (Activation)	(None, 8, 8, 81)	0	batch_normaliz
ation_92[0][0]			
conv2d_94 (Conv2D)	(None, 8, 8, 27)	19683	activation_92
[0][0]			
dropout_55 (Dropout)	(None, 8, 8, 27)	0	conv2d_94[0]
[0]			
concatenate_82 (Concatenate)	(None, 8, 8, 108)	0	concatenate_81
[0][0]			dropout_55[0]
[0]			
batch_normalization_93 (BatchNo	(None, 8, 8, 108)	432	concatenate_82
[0][0]			
activation_93 (Activation)	(None, 8, 8, 108)	0	batch_normaliz
ation_93[0][0]			
conv2d_95 (Conv2D)	(None, 8, 8, 27)	26244	activation_93
[0][0]			
dropout_56 (Dropout)	(None, 8, 8, 27)	0	conv2d_95[0]
[0]			
concatenate_83 (Concatenate)	(None, 8, 8, 135)	0	concatenate_82
[0][0]			dropout_56[0]
[0]			
batch_normalization_94 (BatchNo	(None, 8, 8, 135)	540	concatenate_83
[0][0]			
activation_94 (Activation)	(None, 8, 8, 135)	0	batch_normaliz
ation_94[0][0]			

conv2d_96 (Conv2D) [0][0]	(None, 8, 8, 27)	32805	activation_94
dropout_57 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_96[0]
concatenate_84 (Concatenate) [0][0] [0]	(None, 8, 8, 162)	0	concatenate_83 dropout_57[0]
batch_normalization_95 (BatchNo [0][0])	(None, 8, 8, 162)	648	concatenate_84
activation_95 (Activation) ation_95[0][0]	(None, 8, 8, 162)	0	batch_normaliz
conv2d_97 (Conv2D) [0][0]	(None, 8, 8, 27)	39366	activation_95
dropout_58 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_97[0]
concatenate_85 (Concatenate) [0][0] [0]	(None, 8, 8, 189)	0	concatenate_84 dropout_58[0]
batch_normalization_96 (BatchNo [0][0])	(None, 8, 8, 189)	756	concatenate_85
activation_96 (Activation) ation_96[0][0]	(None, 8, 8, 189)	0	batch_normaliz
conv2d_98 (Conv2D) [0][0]	(None, 8, 8, 27)	45927	activation_96
dropout_59 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_98[0]
concatenate_86 (Concatenate) [0][0] [0]	(None, 8, 8, 216)	0	concatenate_85 dropout_59[0]

batch_normalization_97 (BatchNo	(None, 8, 8, 216)	864	concatenate_86
[0][0]			
activation_97 (Activation)	(None, 8, 8, 216)	0	batch_normaliz
ation_97[0][0]			
conv2d_99 (Conv2D)	(None, 8, 8, 27)	52488	activation_97
[0][0]			
dropout_60 (Dropout)	(None, 8, 8, 27)	0	conv2d_99[0]
[0]			
concatenate_87 (Concatenate)	(None, 8, 8, 243)	0	concatenate_86
[0][0]			dropout_60[0]
[0]			
batch_normalization_98 (BatchNo	(None, 8, 8, 243)	972	concatenate_87
[0][0]			
activation_98 (Activation)	(None, 8, 8, 243)	0	batch_normaliz
ation_98[0][0]			
conv2d_100 (Conv2D)	(None, 8, 8, 27)	6561	activation_98
[0][0]			
dropout_61 (Dropout)	(None, 8, 8, 27)	0	conv2d_100[0]
[0]			
average_pooling2d_10 (AveragePo	(None, 4, 4, 27)	0	dropout_61[0]
[0]			
batch_normalization_99 (BatchNo	(None, 4, 4, 27)	108	average_poolin
g2d_10[0][0]			
activation_99 (Activation)	(None, 4, 4, 27)	0	batch_normaliz
ation_99[0][0]			
conv2d_101 (Conv2D)	(None, 4, 4, 27)	6561	activation_99
[0][0]			
dropout_62 (Dropout)	(None, 4, 4, 27)	0	conv2d_101[0]
[0]			

<u>concatenate_88</u> (Concatenate) g2d_10[0][0]	(None, 4, 4, 54)	0	average_poolin dropout_62[0]
<u>batch_normalization_100</u> (BatchN [0][0])	(None, 4, 4, 54)	216	concatenate_88
<u>activation_100</u> (Activation) ation_100[0][0]	(None, 4, 4, 54)	0	batch_normaliz
<u>conv2d_102</u> (Conv2D) [0][0]	(None, 4, 4, 27)	13122	activation_100
<u>dropout_63</u> (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_102[0]
<u>concatenate_89</u> (Concatenate) [0][0]	(None, 4, 4, 81)	0	concatenate_88 dropout_63[0]
<u>batch_normalization_101</u> (BatchN [0][0])	(None, 4, 4, 81)	324	concatenate_89
<u>activation_101</u> (Activation) ation_101[0][0]	(None, 4, 4, 81)	0	batch_normaliz
<u>conv2d_103</u> (Conv2D) [0][0]	(None, 4, 4, 27)	19683	activation_101
<u>dropout_64</u> (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_103[0]
<u>concatenate_90</u> (Concatenate) [0][0]	(None, 4, 4, 108)	0	concatenate_89 dropout_64[0]
<u>batch_normalization_102</u> (BatchN [0][0])	(None, 4, 4, 108)	432	concatenate_90
<u>activation_102</u> (Activation)	(None, 4, 4, 108)	0	batch_normaliz

ation_102[0][0]

conv2d_104 (Conv2D) [0][0]	(None, 4, 4, 27)	26244	activation_102 [0][0]
dropout_65 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_104[0]
concatenate_91 (Concatenate) [0][0]	(None, 4, 4, 135)	0	concatenate_90 dropout_65[0]
batch_normalization_103 (BatchN [0][0])	(None, 4, 4, 135)	540	concatenate_91
activation_103 (Activation) [0][0]	(None, 4, 4, 135)	0	batch_normaliz
conv2d_105 (Conv2D) [0][0]	(None, 4, 4, 27)	32805	activation_103
dropout_66 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_105[0]
concatenate_92 (Concatenate) [0][0]	(None, 4, 4, 162)	0	concatenate_91 dropout_66[0]
batch_normalization_104 (BatchN [0][0])	(None, 4, 4, 162)	648	concatenate_92
activation_104 (Activation) [0][0]	(None, 4, 4, 162)	0	batch_normaliz
conv2d_106 (Conv2D) [0][0]	(None, 4, 4, 27)	39366	activation_104
dropout_67 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_106[0]
concatenate_93 (Concatenate) [0][0]	(None, 4, 4, 189)	0	concatenate_92

dropout_67[0]

[0]

batch_normalization_105 (BatchN (None, 4, 4, 189) [0][0]	756	concatenate_93
activation_105 (Activation) (None, 4, 4, 189) activation_105[0][0]	0	batch_normaliz
conv2d_107 (Conv2D) (None, 4, 4, 27) [0][0]	45927	activation_105
dropout_68 (Dropout) (None, 4, 4, 27) [0]	0	conv2d_107[0]
concatenate_94 (Concatenate) (None, 4, 4, 216) [0][0]	0	concatenate_93 dropout_68[0]
batch_normalization_106 (BatchN (None, 4, 4, 216) [0][0]	864	concatenate_94
activation_106 (Activation) (None, 4, 4, 216) activation_106[0][0]	0	batch_normaliz
conv2d_108 (Conv2D) (None, 4, 4, 27) [0][0]	52488	activation_106
dropout_69 (Dropout) (None, 4, 4, 27) [0]	0	conv2d_108[0]
concatenate_95 (Concatenate) (None, 4, 4, 243) [0][0]	0	concatenate_94 dropout_69[0]
batch_normalization_107 (BatchN (None, 4, 4, 243) [0][0]	972	concatenate_95
activation_107 (Activation) (None, 4, 4, 243) activation_107[0][0]	0	batch_normaliz
average_pooling2d_11 (AveragePo (None, 2, 2, 243)	0	activation_107

[0][0]

```

=====
Total params: 984,231
Trainable params: 974,511
Non-trainable params: 9,720

```

```

*****after adding conv2d layer*****
Model: "sequential_1"

```

Layer (type)	Output Shape	Param #
functional_9 (Functional)	(None, 2, 2, 243)	984231
conv2d_109 (Conv2D)	(None, 1, 1, 10)	9730
flatten_4 (Flatten)	(None, 10)	0

```

=====
Total params: 993,961
Trainable params: 984,241
Non-trainable params: 9,720

```

Epoch 1/10

```

2/391 [.....] - ETA: 1:03 - loss: 2.4208 - accuracy: 0.0938
WARNING:tensorflow:Callbacks method `on_train_batch_end` is slow compared to the batch time (batch time: 0.0617s vs `on_train_batch_end` time: 0.1070s).
Check your callbacks.

```

```

391/391 [=====] - 70s 179ms/step - loss: 1.5745 - accuracy: 0.4186 - val_loss: 2.4245 - val_accuracy: 0.3178

```

Epoch 2/10

```

391/391 [=====] - 71s 181ms/step - loss: 1.1657 - accuracy: 0.5767 - val_loss: 1.4428 - val_accuracy: 0.5289

```

Epoch 3/10

```

391/391 [=====] - 72s 184ms/step - loss: 0.9974 - accuracy: 0.6384 - val_loss: 1.6193 - val_accuracy: 0.4919

```

Epoch 4/10

```

391/391 [=====] - 72s 185ms/step - loss: 0.8951 - accuracy: 0.6760 - val_loss: 1.0396 - val_accuracy: 0.6429

```

Epoch 5/10

```

391/391 [=====] - 73s 186ms/step - loss: 0.8182 - accuracy: 0.7049 - val_loss: 1.0979 - val_accuracy: 0.6538

```

Epoch 6/10

```

391/391 [=====] - 73s 187ms/step - loss: 0.7572 - accuracy: 0.7287 - val_loss: 0.8281 - val_accuracy: 0.7200

```

Epoch 7/10

```

391/391 [=====] - 73s 187ms/step - loss: 0.7100 - accuracy: 0.7447 - val_loss: 0.8919 - val_accuracy: 0.7016

```

Epoch 8/10

```

391/391 [=====] - 73s 186ms/step - loss: 0.6686 - accuracy: 0.7600

```

```

racy: 0.7593 - val_loss: 1.1034 - val_accuracy: 0.6838
Epoch 9/10
391/391 [=====] - 73s 186ms/step - loss: 0.6262 - accu
racy: 0.7763 - val_loss: 1.9446 - val_accuracy: 0.5212
Epoch 10/10
391/391 [=====] - 73s 186ms/step - loss: 0.5946 - accu
racy: 0.7879 - val_loss: 0.7956 - val_accuracy: 0.7368
313/313 [=====] - 3s 11ms/step - loss: 0.8907 - accura
cy: 0.7170
Test loss: 0.8907139897346497
Test accuracy: 0.7170000076293945

```

image augmentation brightness

In [41]: [# Reff https://machinelearningmastery.com/how-to-configure-image-data-augmentation/](https://machinelearningmastery.com/how-to-configure-image-data-augmentation/)

```

def brightness(arr_imgs):

    # convert to numpy array
    d_ar = arr_imgs.copy()

    for i in tqdm(range(d_ar.shape[0]), position=0):
        data = d_ar[i]
        # expand dimension to one sample
        samples = np.expand_dims(data, 0)
        # create image data augmentation generator
        datagen = ImageDataGenerator(brightness_range=[0.2,1.0])
        # prepare iterator
        it = datagen.flow(samples, batch_size=1)
        # generate samples and plot
        # define subplot
        # pyplot.subplot(330 + 1 + i)
        # generate batch of images
        #for j in range(9):
        batch = it.next()
            #if j == 0:

                # convert to unsigned integers for viewing
            image = batch[0].astype('uint8')
            d_ar[i] = image
                # plot raw pixel data
                #break

    return d_ar

```

```
In [42]: X_train_bright=brightness(X_train)
X_cv_bright=brightness(X_cv)
X_test_bright=brightness(X_test)
```

```
100%|██████████| 50000/50000 [00:19<00:00, 2546.58it/s]
100%|██████████| 10000/10000 [00:03<00:00, 2511.73it/s]
100%|██████████| 10000/10000 [00:04<00:00, 2483.87it/s]
```


In [43]: `bright_model=model1(X_train_bright,X_cv_bright,X_test_bright,y_train,y_cv,y_test`

Model: "functional_11"

Layer (type)	Output Shape	Param #	Connected to
input_4 (InputLayer)	[(None, 32, 32, 3)]	0	
conv2d_110 (Conv2D)	(None, 32, 32, 27)	324	input_4[0][0]
batch_normalization_108 (Batch Normalization)	(None, 32, 32, 27)	108	conv2d_110[0]
activation_108 (Activation)	(None, 32, 32, 27)	0	batch_normalization_108[0][0]
conv2d_111 (Conv2D)	(None, 32, 32, 27)	6561	activation_108[0][0]
dropout_70 (Dropout)	(None, 32, 32, 27)	0	conv2d_111[0]
concatenate_96 (Concatenate)	(None, 32, 32, 54)	0	conv2d_110[0] dropout_70[0]
batch_normalization_109 (Batch Normalization)	(None, 32, 32, 54)	216	concatenate_96[0][0]
activation_109 (Activation)	(None, 32, 32, 54)	0	batch_normalization_109[0][0]
conv2d_112 (Conv2D)	(None, 32, 32, 27)	13122	activation_109[0][0]
dropout_71 (Dropout)	(None, 32, 32, 27)	0	conv2d_112[0]
concatenate_97 (Concatenate)	(None, 32, 32, 81)	0	concatenate_96[0][0] dropout_71[0]

batch_normalization_110 (Batch Normalization)	(None, 32, 32, 81)	324	concatenate_97[0][0]
activation_110 (Activation)	(None, 32, 32, 81)	0	batch_normalization_110[0][0]
conv2d_113 (Conv2D)	(None, 32, 32, 27)	19683	activation_110[0][0]
dropout_72 (Dropout)	(None, 32, 32, 27)	0	conv2d_113[0][0]
concatenate_98 (Concatenate)	(None, 32, 32, 108)	0	concatenate_97[0][0] dropout_72[0][0]
batch_normalization_111 (Batch Normalization)	(None, 32, 32, 108)	432	concatenate_98[0][0]
activation_111 (Activation)	(None, 32, 32, 108)	0	batch_normalization_111[0][0]
conv2d_114 (Conv2D)	(None, 32, 32, 27)	26244	activation_111[0][0]
dropout_73 (Dropout)	(None, 32, 32, 27)	0	conv2d_114[0][0]
concatenate_99 (Concatenate)	(None, 32, 32, 135)	0	concatenate_98[0][0] dropout_73[0][0]
batch_normalization_112 (Batch Normalization)	(None, 32, 32, 135)	540	concatenate_99[0][0]
activation_112 (Activation)	(None, 32, 32, 135)	0	batch_normalization_112[0][0]
conv2d_115 (Conv2D)	(None, 32, 32, 27)	32805	activation_112[0][0]

dropout_74 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_115[0]
concatenate_100 (Concatenate) [0][0]	(None, 32, 32, 162)	0	concatenate_99 dropout_74[0]
batch_normalization_113 (BatchN 0[0][0])	(None, 32, 32, 162)	648	concatenate_10
activation_113 (Activation) activation_113[0][0]	(None, 32, 32, 162)	0	batch_normaliz
conv2d_116 (Conv2D) [0][0]	(None, 32, 32, 27)	39366	activation_113
dropout_75 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_116[0]
concatenate_101 (Concatenate) 0[0][0]	(None, 32, 32, 189)	0	concatenate_10 dropout_75[0]
batch_normalization_114 (BatchN 1[0][0])	(None, 32, 32, 189)	756	concatenate_10
activation_114 (Activation) activation_114[0][0]	(None, 32, 32, 189)	0	batch_normaliz
conv2d_117 (Conv2D) [0][0]	(None, 32, 32, 27)	45927	activation_114
dropout_76 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_117[0]
concatenate_102 (Concatenate) 1[0][0]	(None, 32, 32, 216)	0	concatenate_10 dropout_76[0]
batch_normalization_115 (BatchN 2[0][0])	(None, 32, 32, 216)	864	concatenate_10

activation_115 (Activation) activation_115[0][0]	(None, 32, 32, 216)	0	batch_normaliz
conv2d_118 (Conv2D) [0][0]	(None, 32, 32, 27)	52488	activation_115
dropout_77 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_118[0]
concatenate_103 (Concatenate) 2[0][0] [0]	(None, 32, 32, 243)	0	concatenate_10 dropout_77[0]
batch_normalization_116 (BatchN 3[0][0]	(None, 32, 32, 243)	972	concatenate_10
activation_116 (Activation) activation_116[0][0]	(None, 32, 32, 243)	0	batch_normaliz
conv2d_119 (Conv2D) [0][0]	(None, 32, 32, 27)	6561	activation_116
dropout_78 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_119[0]
average_pooling2d_12 (AveragePo [0]	(None, 16, 16, 27)	0	dropout_78[0]
batch_normalization_117 (BatchN g2d_12[0][0]	(None, 16, 16, 27)	108	average_poolin
activation_117 (Activation) ation_117[0][0]	(None, 16, 16, 27)	0	batch_normaliz
conv2d_120 (Conv2D) [0][0]	(None, 16, 16, 27)	6561	activation_117
dropout_79 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_120[0]
concatenate_104 (Concatenate) g2d_12[0][0]	(None, 16, 16, 54)	0	average_poolin

dropout_79[0]

[0]

batch_normalization_118 (Batch Normalization)	(None, 16, 16, 54)	216	concatenate_104[0][0]
activation_118 (Activation)	(None, 16, 16, 54)	0	batch_normalization_118[0][0]
conv2d_121 (Conv2D)	(None, 16, 16, 27)	13122	activation_118[0][0]
dropout_80 (Dropout)	(None, 16, 16, 27)	0	conv2d_121[0]
concatenate_105 (Concatenate)	(None, 16, 16, 81)	0	concatenate_104[0][0] dropout_80[0]
batch_normalization_119 (Batch Normalization)	(None, 16, 16, 81)	324	concatenate_105[0][0]
activation_119 (Activation)	(None, 16, 16, 81)	0	batch_normalization_119[0][0]
conv2d_122 (Conv2D)	(None, 16, 16, 27)	19683	activation_119[0][0]
dropout_81 (Dropout)	(None, 16, 16, 27)	0	conv2d_122[0]
concatenate_106 (Concatenate)	(None, 16, 16, 108)	0	concatenate_105[0][0] dropout_81[0]
batch_normalization_120 (Batch Normalization)	(None, 16, 16, 108)	432	concatenate_106[0][0]
activation_120 (Activation)	(None, 16, 16, 108)	0	batch_normalization_120[0][0]
conv2d_123 (Conv2D)	(None, 16, 16, 27)	26244	activation_120[0][0]

[0][0]

dropout_82 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_123[0]
concatenate_107 (Concatenate) 6[0][0]	(None, 16, 16, 135)	0	concatenate_10 dropout_82[0]
batch_normalization_121 (BatchN 7[0][0])	(None, 16, 16, 135)	540	concatenate_10
activation_121 (Activation) ation_121[0][0]	(None, 16, 16, 135)	0	batch_normaliz
conv2d_124 (Conv2D) [0][0]	(None, 16, 16, 27)	32805	activation_121
dropout_83 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_124[0]
concatenate_108 (Concatenate) 7[0][0]	(None, 16, 16, 162)	0	concatenate_10 dropout_83[0]
batch_normalization_122 (BatchN 8[0][0])	(None, 16, 16, 162)	648	concatenate_10
activation_122 (Activation) ation_122[0][0]	(None, 16, 16, 162)	0	batch_normaliz
conv2d_125 (Conv2D) [0][0]	(None, 16, 16, 27)	39366	activation_122
dropout_84 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_125[0]
concatenate_109 (Concatenate) 8[0][0]	(None, 16, 16, 189)	0	concatenate_10 dropout_84[0]

[0]

batch_normalization_123 (BatchN	(None, 16, 16, 189)	756	concatenate_109[0][0]
activation_123 (Activation)	(None, 16, 16, 189)	0	batch_normalization_123[0][0]
conv2d_126 (Conv2D)	(None, 16, 16, 27)	45927	activation_123[0][0]
dropout_85 (Dropout)	(None, 16, 16, 27)	0	conv2d_126[0][0]
concatenate_110 (Concatenate)	(None, 16, 16, 216)	0	concatenate_109[0][0]
			dropout_85[0][0]
batch_normalization_124 (BatchN	(None, 16, 16, 216)	864	concatenate_110[0][0]
activation_124 (Activation)	(None, 16, 16, 216)	0	batch_normalization_124[0][0]
conv2d_127 (Conv2D)	(None, 16, 16, 27)	52488	activation_124[0][0]
dropout_86 (Dropout)	(None, 16, 16, 27)	0	conv2d_127[0][0]
concatenate_111 (Concatenate)	(None, 16, 16, 243)	0	concatenate_110[0][0]
			dropout_86[0][0]
batch_normalization_125 (BatchN	(None, 16, 16, 243)	972	concatenate_111[0][0]
activation_125 (Activation)	(None, 16, 16, 243)	0	batch_normalization_125[0][0]
conv2d_128 (Conv2D)	(None, 16, 16, 27)	6561	activation_125[0][0]
dropout_87 (Dropout)	(None, 16, 16, 27)	0	conv2d_128[0][0]

[0]

average_pooling2d_13 (AveragePo [0])	(None, 8, 8, 27)	0	dropout_87[0]
batch_normalization_126 (BatchN g2d_13[0])[0]	(None, 8, 8, 27)	108	average_poolin
activation_126 (Activation) ation_126[0][0]	(None, 8, 8, 27)	0	batch_normaliz
conv2d_129 (Conv2D) [0][0]	(None, 8, 8, 27)	6561	activation_126
dropout_88 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_129[0]
concatenate_112 (Concatenate) g2d_13[0][0]	(None, 8, 8, 54)	0	average_poolin dropout_88[0]
[0]			
batch_normalization_127 (BatchN 2[0])[0]	(None, 8, 8, 54)	216	concatenate_11
activation_127 (Activation) ation_127[0][0]	(None, 8, 8, 54)	0	batch_normaliz
conv2d_130 (Conv2D) [0][0]	(None, 8, 8, 27)	13122	activation_127
dropout_89 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_130[0]
concatenate_113 (Concatenate) 2[0][0]	(None, 8, 8, 81)	0	concatenate_11 dropout_89[0]
[0]			
batch_normalization_128 (BatchN 3[0])[0]	(None, 8, 8, 81)	324	concatenate_11
activation_128 (Activation) ation_128[0][0]	(None, 8, 8, 81)	0	batch_normaliz

conv2d_131 (Conv2D) [0][0]	(None, 8, 8, 27)	19683	activation_128
dropout_90 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_131[0]
concatenate_114 (Concatenate) 3[0][0] [0]	(None, 8, 8, 108)	0	concatenate_11 dropout_90[0]
batch_normalization_129 (BatchN 4[0][0]	(None, 8, 8, 108)	432	concatenate_11
activation_129 (Activation) ation_129[0][0]	(None, 8, 8, 108)	0	batch_normaliz
conv2d_132 (Conv2D) [0][0]	(None, 8, 8, 27)	26244	activation_129
dropout_91 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_132[0]
concatenate_115 (Concatenate) 4[0][0] [0]	(None, 8, 8, 135)	0	concatenate_11 dropout_91[0]
batch_normalization_130 (BatchN 5[0][0]	(None, 8, 8, 135)	540	concatenate_11
activation_130 (Activation) ation_130[0][0]	(None, 8, 8, 135)	0	batch_normaliz
conv2d_133 (Conv2D) [0][0]	(None, 8, 8, 27)	32805	activation_130
dropout_92 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_133[0]
concatenate_116 (Concatenate) 5[0][0]	(None, 8, 8, 162)	0	concatenate_11 dropout_92[0]

[0]

batch_normalization_131 (BatchN	(None, 8, 8, 162)	648	concatenate_116[0][0]
activation_131 (Activation)	(None, 8, 8, 162)	0	batch_normaliz
conv2d_134 (Conv2D)	(None, 8, 8, 27)	39366	activation_131[0][0]
dropout_93 (Dropout)	(None, 8, 8, 27)	0	conv2d_134[0]
concatenate_117 (Concatenate)	(None, 8, 8, 189)	0	concatenate_116[0][0]
			dropout_93[0]
batch_normalization_132 (BatchN	(None, 8, 8, 189)	756	concatenate_117[0][0]
activation_132 (Activation)	(None, 8, 8, 189)	0	batch_normaliz
conv2d_135 (Conv2D)	(None, 8, 8, 27)	45927	activation_132[0][0]
dropout_94 (Dropout)	(None, 8, 8, 27)	0	conv2d_135[0]
concatenate_118 (Concatenate)	(None, 8, 8, 216)	0	concatenate_117[0][0]
			dropout_94[0]
batch_normalization_133 (BatchN	(None, 8, 8, 216)	864	concatenate_118[0][0]
activation_133 (Activation)	(None, 8, 8, 216)	0	batch_normaliz
conv2d_136 (Conv2D)	(None, 8, 8, 27)	52488	activation_133[0][0]

<u>dropout_95</u> (Dropout)	(None, 8, 8, 27)	0	conv2d_136[0]
<u>concatenate_119</u> (Concatenate)	(None, 8, 8, 243)	0	concatenate_118[0][0]
			dropout_95[0]
<u>batch_normalization_134</u> (BatchN	(None, 8, 8, 243)	972	concatenate_119[0][0]
<u>activation_134</u> (Activation)	(None, 8, 8, 243)	0	batch_normaliz
ation_134[0][0]			
<u>conv2d_137</u> (Conv2D)	(None, 8, 8, 27)	6561	activation_134[0][0]
<u>dropout_96</u> (Dropout)	(None, 8, 8, 27)	0	conv2d_137[0]
<u>average_pooling2d_14</u> (AveragePo	(None, 4, 4, 27)	0	dropout_96[0]
0]			
<u>batch_normalization_135</u> (BatchN	(None, 4, 4, 27)	108	average_poolin
g2d_14[0][0]			
<u>activation_135</u> (Activation)	(None, 4, 4, 27)	0	batch_normaliz
ation_135[0][0]			
<u>conv2d_138</u> (Conv2D)	(None, 4, 4, 27)	6561	activation_135[0][0]
<u>dropout_97</u> (Dropout)	(None, 4, 4, 27)	0	conv2d_138[0]
<u>concatenate_120</u> (Concatenate)	(None, 4, 4, 54)	0	average_poolin
g2d_14[0][0]			dropout_97[0]
			[0]
<u>batch_normalization_136</u> (BatchN	(None, 4, 4, 54)	216	concatenate_120[0][0]

activation_136 (Activation) activation_136[0][0]	(None, 4, 4, 54)	0	batch_normaliz
conv2d_139 (Conv2D) [0][0]	(None, 4, 4, 27)	13122	activation_136
dropout_98 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_139[0]
concatenate_121 (Concatenate) 0[0][0] [0]	(None, 4, 4, 81)	0	concatenate_12 dropout_98[0]
batch_normalization_137 (BatchN 1[0][0])	(None, 4, 4, 81)	324	concatenate_12
activation_137 (Activation) activation_137[0][0]	(None, 4, 4, 81)	0	batch_normaliz
conv2d_140 (Conv2D) [0][0]	(None, 4, 4, 27)	19683	activation_137
dropout_99 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_140[0]
concatenate_122 (Concatenate) 1[0][0] [0]	(None, 4, 4, 108)	0	concatenate_12 dropout_99[0]
batch_normalization_138 (BatchN 2[0][0])	(None, 4, 4, 108)	432	concatenate_12
activation_138 (Activation) activation_138[0][0]	(None, 4, 4, 108)	0	batch_normaliz
conv2d_141 (Conv2D) [0][0]	(None, 4, 4, 27)	26244	activation_138
dropout_100 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_141[0]

concatenate_123 (Concatenate)	(None, 4, 4, 135)	0	concatenate_122[0][0]
			dropout_100[0]
			[0]
batch_normalization_139 (Batch Normalization)	(None, 4, 4, 135)	540	concatenate_123[0][0]
activation_139 (Activation)	(None, 4, 4, 135)	0	batch_normalization_139[0][0]
conv2d_142 (Conv2D)	(None, 4, 4, 27)	32805	activation_139[0][0]
dropout_101 (Dropout)	(None, 4, 4, 27)	0	conv2d_142[0]
			[0]
concatenate_124 (Concatenate)	(None, 4, 4, 162)	0	concatenate_123[0][0]
			dropout_101[0]
			[0]
batch_normalization_140 (Batch Normalization)	(None, 4, 4, 162)	648	concatenate_124[0][0]
activation_140 (Activation)	(None, 4, 4, 162)	0	batch_normalization_140[0][0]
conv2d_143 (Conv2D)	(None, 4, 4, 27)	39366	activation_140[0][0]
dropout_102 (Dropout)	(None, 4, 4, 27)	0	conv2d_143[0]
			[0]
concatenate_125 (Concatenate)	(None, 4, 4, 189)	0	concatenate_124[0][0]
			dropout_102[0]
			[0]
batch_normalization_141 (Batch Normalization)	(None, 4, 4, 189)	756	concatenate_125[0][0]
activation_141 (Activation)	(None, 4, 4, 189)	0	batch_normalization_141[0][0]

conv2d_144 (Conv2D) [0][0]	(None, 4, 4, 27)	45927	activation_141
dropout_103 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_144[0]
concatenate_126 (Concatenate) 5[0][0] [0]	(None, 4, 4, 216)	0	concatenate_12 dropout_103[0]
batch_normalization_142 (BatchN 6[0][0])	(None, 4, 4, 216)	864	concatenate_12
activation_142 (Activation) ation_142[0][0]	(None, 4, 4, 216)	0	batch_normaliz
conv2d_145 (Conv2D) [0][0]	(None, 4, 4, 27)	52488	activation_142
dropout_104 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_145[0]
concatenate_127 (Concatenate) 6[0][0] [0]	(None, 4, 4, 243)	0	concatenate_12 dropout_104[0]
batch_normalization_143 (BatchN 7[0][0])	(None, 4, 4, 243)	972	concatenate_12
activation_143 (Activation) ation_143[0][0]	(None, 4, 4, 243)	0	batch_normaliz
average_pooling2d_15 (AveragePo [0][0])	(None, 2, 2, 243)	0	activation_143
flatten_5 (Flatten) g2d_15[0][0]	(None, 972)	0	average_poolin
dense_3 (Dense) [0]	(None, 10)	9730	flatten_5[0]
=====			
=====			

[illegible]

Model: "functional_13"

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<u>dropout_71 (Dropout)</u> [0]	(None, 32, 32, 27)	0	conv2d_112[0]
<u>concatenate_97 (Concatenate)</u> [0][0] [0]	(None, 32, 32, 81)	0	concatenate_96 dropout_71[0]
<u>batch_normalization_110 (BatchN</u> [0][0]	(None, 32, 32, 81)	324	concatenate_97
<u>activation_110 (Activation)</u> [0][0]	(None, 32, 32, 81)	0	batch_normaliz
<u>conv2d_113 (Conv2D)</u> [0][0]	(None, 32, 32, 27)	19683	activation_110
<u>dropout_72 (Dropout)</u> [0]	(None, 32, 32, 27)	0	conv2d_113[0]
<u>concatenate_98 (Concatenate)</u> [0][0] [0]	(None, 32, 32, 108)	0	concatenate_97 dropout_72[0]
<u>batch_normalization_111 (BatchN</u> [0][0]	(None, 32, 32, 108)	432	concatenate_98
<u>activation_111 (Activation)</u> [0][0]	(None, 32, 32, 108)	0	batch_normaliz
<u>conv2d_114 (Conv2D)</u> [0][0]	(None, 32, 32, 27)	26244	activation_111
<u>dropout_73 (Dropout)</u> [0]	(None, 32, 32, 27)	0	conv2d_114[0]
<u>concatenate_99 (Concatenate)</u> [0][0] [0]	(None, 32, 32, 135)	0	concatenate_98 dropout_73[0]
<u>batch_normalization_112 (BatchN</u>	(None, 32, 32, 135)	540	concatenate_99

[0][0]

activation_112 (Activation) activation_112[0][0]	(None, 32, 32, 135)	0	batch_normaliz
conv2d_115 (Conv2D) [0][0]	(None, 32, 32, 27)	32805	activation_112
dropout_74 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_115[0]
concatenate_100 (Concatenate) [0][0]	(None, 32, 32, 162)	0	concatenate_99 dropout_74[0]
batch_normalization_113 (BatchN 0[0][0])	(None, 32, 32, 162)	648	concatenate_10
activation_113 (Activation) activation_113[0][0]	(None, 32, 32, 162)	0	batch_normaliz
conv2d_116 (Conv2D) [0][0]	(None, 32, 32, 27)	39366	activation_113
dropout_75 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_116[0]
concatenate_101 (Concatenate) 0[0][0]	(None, 32, 32, 189)	0	concatenate_10 dropout_75[0]
batch_normalization_114 (BatchN 1[0][0])	(None, 32, 32, 189)	756	concatenate_10
activation_114 (Activation) activation_114[0][0]	(None, 32, 32, 189)	0	batch_normaliz
conv2d_117 (Conv2D) [0][0]	(None, 32, 32, 27)	45927	activation_114
dropout_76 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_117[0]

<u>concatenate_102</u> (Concatenate)	(None, 32, 32, 216)	0	<u>concatenate_101[0][0]</u>
			<u>dropout_76[0]</u>
<u>batch_normalization_115</u> (BatchN	(None, 32, 32, 216)	864	<u>concatenate_102[0][0]</u>
<u>activation_115</u> (Activation)	(None, 32, 32, 216)	0	<u>batch_normaliz</u>
<u>ation_115[0][0]</u>			
<u>conv2d_118</u> (Conv2D)	(None, 32, 32, 27)	52488	<u>activation_115[0][0]</u>
<u>dropout_77</u> (Dropout)	(None, 32, 32, 27)	0	<u>conv2d_118[0]</u>
<u>[0]</u>			
<u>concatenate_103</u> (Concatenate)	(None, 32, 32, 243)	0	<u>concatenate_102[0][0]</u>
			<u>dropout_77[0]</u>
<u>[0]</u>			
<u>batch_normalization_116</u> (BatchN	(None, 32, 32, 243)	972	<u>concatenate_103[0][0]</u>
<u>activation_116</u> (Activation)	(None, 32, 32, 243)	0	<u>batch_normaliz</u>
<u>ation_116[0][0]</u>			
<u>conv2d_119</u> (Conv2D)	(None, 32, 32, 27)	6561	<u>activation_116[0][0]</u>
<u>dropout_78</u> (Dropout)	(None, 32, 32, 27)	0	<u>conv2d_119[0]</u>
<u>[0]</u>			
<u>average_pooling2d_12</u> (AveragePo	(None, 16, 16, 27)	0	<u>dropout_78[0]</u>
<u>[0]</u>			
<u>batch_normalization_117</u> (BatchN	(None, 16, 16, 27)	108	<u>average_poolin</u>
<u>g2d_12[0][0]</u>			
<u>activation_117</u> (Activation)	(None, 16, 16, 27)	0	<u>batch_normaliz</u>
<u>ation_117[0][0]</u>			

conv2d_120 (Conv2D) [0][0]	(None, 16, 16, 27)	6561	activation_117
dropout_79 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_120[0]
concatenate_104 (Concatenate) g2d_12[0][0] [0]	(None, 16, 16, 54)	0	average_poolin dropout_79[0]
batch_normalization_118 (BatchN 4[0][0]	(None, 16, 16, 54)	216	concatenate_10
activation_118 (Activation) ation_118[0][0]	(None, 16, 16, 54)	0	batch_normaliz
conv2d_121 (Conv2D) [0][0]	(None, 16, 16, 27)	13122	activation_118
dropout_80 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_121[0]
concatenate_105 (Concatenate) 4[0][0] [0]	(None, 16, 16, 81)	0	concatenate_10 dropout_80[0]
batch_normalization_119 (BatchN 5[0][0]	(None, 16, 16, 81)	324	concatenate_10
activation_119 (Activation) ation_119[0][0]	(None, 16, 16, 81)	0	batch_normaliz
conv2d_122 (Conv2D) [0][0]	(None, 16, 16, 27)	19683	activation_119
dropout_81 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_122[0]
concatenate_106 (Concatenate) 5[0][0] [0]	(None, 16, 16, 108)	0	concatenate_10 dropout_81[0]

batch_normalization_120 (Batch Normalization)	(None, 16, 16, 108)	432	concatenate_106[0][0]
activation_120 (Activation)	(None, 16, 16, 108)	0	batch_normalization_120[0][0]
conv2d_123 (Conv2D)	(None, 16, 16, 27)	26244	activation_120[0][0]
dropout_82 (Dropout)	(None, 16, 16, 27)	0	conv2d_123[0]
concatenate_107 (Concatenate)	(None, 16, 16, 135)	0	concatenate_106[0][0] dropout_82[0]
batch_normalization_121 (Batch Normalization)	(None, 16, 16, 135)	540	concatenate_107[0][0]
activation_121 (Activation)	(None, 16, 16, 135)	0	batch_normalization_121[0][0]
conv2d_124 (Conv2D)	(None, 16, 16, 27)	32805	activation_121[0][0]
dropout_83 (Dropout)	(None, 16, 16, 27)	0	conv2d_124[0]
concatenate_108 (Concatenate)	(None, 16, 16, 162)	0	concatenate_107[0][0] dropout_83[0]
batch_normalization_122 (Batch Normalization)	(None, 16, 16, 162)	648	concatenate_108[0][0]
activation_122 (Activation)	(None, 16, 16, 162)	0	batch_normalization_122[0][0]
conv2d_125 (Conv2D)	(None, 16, 16, 27)	39366	activation_122[0][0]

<u>dropout_84</u> (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_125[0]
<u>concatenate_109</u> (Concatenate) 8[0][0] [0]	(None, 16, 16, 189)	0	concatenate_108[0] dropout_84[0]
<u>batch_normalization_123</u> (BatchN 9[0][0])	(None, 16, 16, 189)	756	concatenate_109[0]
<u>activation_123</u> (Activation) activation_123[0][0]	(None, 16, 16, 189)	0	batch_normalization_123[0]
<u>conv2d_126</u> (Conv2D) [0][0]	(None, 16, 16, 27)	45927	activation_123[0]
<u>dropout_85</u> (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_126[0]
<u>concatenate_110</u> (Concatenate) 9[0][0] [0]	(None, 16, 16, 216)	0	concatenate_109[0] dropout_85[0]
<u>batch_normalization_124</u> (BatchN 0[0][0])	(None, 16, 16, 216)	864	concatenate_110[0]
<u>activation_124</u> (Activation) activation_124[0][0]	(None, 16, 16, 216)	0	batch_normalization_124[0]
<u>conv2d_127</u> (Conv2D) [0][0]	(None, 16, 16, 27)	52488	activation_124[0]
<u>dropout_86</u> (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_127[0]
<u>concatenate_111</u> (Concatenate) 0[0][0] [0]	(None, 16, 16, 243)	0	concatenate_110[0] dropout_86[0]
<u>batch_normalization_125</u> (BatchN 1[0][0])	(None, 16, 16, 243)	972	concatenate_111[0]

activation_125 (Activation) activation_125[0][0]	(None, 16, 16, 243)	0	batch_normaliz
conv2d_128 (Conv2D) [0][0]	(None, 16, 16, 27)	6561	activation_125
dropout_87 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_128[0]
average_pooling2d_13 (AveragePo [0]	(None, 8, 8, 27)	0	dropout_87[0]
batch_normalization_126 (BatchN g2d_13[0][0]	(None, 8, 8, 27)	108	average_poolin
activation_126 (Activation) activation_126[0][0]	(None, 8, 8, 27)	0	batch_normaliz
conv2d_129 (Conv2D) [0][0]	(None, 8, 8, 27)	6561	activation_126
dropout_88 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_129[0]
concatenate_112 (Concatenate) g2d_13[0][0] [0]	(None, 8, 8, 54)	0	average_poolin dropout_88[0]
batch_normalization_127 (BatchN 2[0][0]	(None, 8, 8, 54)	216	concatenate_11
activation_127 (Activation) activation_127[0][0]	(None, 8, 8, 54)	0	batch_normaliz
conv2d_130 (Conv2D) [0][0]	(None, 8, 8, 27)	13122	activation_127
dropout_89 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_130[0]
concatenate_113 (Concatenate)	(None, 8, 8, 81)	0	concatenate_11

2[0][0]

dropout_89[0]

[0]

batch_normalization_128 (Batch Normalization)	(None, 8, 8, 81)	324	concatenate_113[0][0]
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activation_128 (Activation)	(None, 8, 8, 81)	0	batch_normalization_128[0][0]
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conv2d_131 (Conv2D)	(None, 8, 8, 27)	19683	activation_128[0][0]
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dropout_90 (Dropout)	(None, 8, 8, 27)	0	conv2d_131[0]
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concatenate_114 (Concatenate)	(None, 8, 8, 108)	0	concatenate_113[0][0]
			dropout_90[0]

batch_normalization_129 (Batch Normalization)	(None, 8, 8, 108)	432	concatenate_114[0][0]
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activation_129 (Activation)	(None, 8, 8, 108)	0	batch_normalization_129[0][0]
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conv2d_132 (Conv2D)	(None, 8, 8, 27)	26244	activation_129[0][0]
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dropout_91 (Dropout)	(None, 8, 8, 27)	0	conv2d_132[0]
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concatenate_115 (Concatenate)	(None, 8, 8, 135)	0	concatenate_114[0][0]
			dropout_91[0]

batch_normalization_130 (Batch Normalization)	(None, 8, 8, 135)	540	concatenate_115[0][0]
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activation_130 (Activation)	(None, 8, 8, 135)	0	batch_normalization_130[0][0]
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conv2d_133 (Conv2D) [0][0]	(None, 8, 8, 27)	32805	activation_130
dropout_92 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_133[0]
concatenate_116 (Concatenate) 5[0][0] [0]	(None, 8, 8, 162)	0	concatenate_11 dropout_92[0]
batch_normalization_131 (BatchN 6[0][0]	(None, 8, 8, 162)	648	concatenate_11
activation_131 (Activation) ation_131[0][0]	(None, 8, 8, 162)	0	batch_normaliz
conv2d_134 (Conv2D) [0][0]	(None, 8, 8, 27)	39366	activation_131
dropout_93 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_134[0]
concatenate_117 (Concatenate) 6[0][0] [0]	(None, 8, 8, 189)	0	concatenate_11 dropout_93[0]
batch_normalization_132 (BatchN 7[0][0]	(None, 8, 8, 189)	756	concatenate_11
activation_132 (Activation) ation_132[0][0]	(None, 8, 8, 189)	0	batch_normaliz
conv2d_135 (Conv2D) [0][0]	(None, 8, 8, 27)	45927	activation_132
dropout_94 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_135[0]
concatenate_118 (Concatenate) 7[0][0] [0]	(None, 8, 8, 216)	0	concatenate_11 dropout_94[0]

batch_normalization_133 (BatchN	(None, 8, 8, 216)	864	concatenate_118[0][0]
activation_133 (Activation)	(None, 8, 8, 216)	0	batch_normaliz
conv2d_136 (Conv2D)	(None, 8, 8, 27)	52488	activation_133
dropout_95 (Dropout)	(None, 8, 8, 27)	0	conv2d_136[0]
concatenate_119 (Concatenate)	(None, 8, 8, 243)	0	concatenate_118[0][0]
			dropout_95[0]
batch_normalization_134 (BatchN	(None, 8, 8, 243)	972	concatenate_119[0][0]
activation_134 (Activation)	(None, 8, 8, 243)	0	batch_normaliz
conv2d_137 (Conv2D)	(None, 8, 8, 27)	6561	activation_134
dropout_96 (Dropout)	(None, 8, 8, 27)	0	conv2d_137[0]
average_pooling2d_14 (AveragePo	(None, 4, 4, 27)	0	dropout_96[0]
batch_normalization_135 (BatchN	(None, 4, 4, 27)	108	average_poolin
activation_135 (Activation)	(None, 4, 4, 27)	0	batch_normaliz
conv2d_138 (Conv2D)	(None, 4, 4, 27)	6561	activation_135
dropout_97 (Dropout)	(None, 4, 4, 27)	0	conv2d_138[0]

<u>concatenate_120</u> (Concatenate)	(None, 4, 4, 54)	0	average_pooling2d_14[0][0]
[0]			dropout_97[0]
<u>batch_normalization_136</u> (Batch Normalization)	(None, 4, 4, 54)	216	concatenate_120[0][0]
<u>activation_136</u> (Activation)	(None, 4, 4, 54)	0	batch_normalization_136[0][0]
<u>conv2d_139</u> (Conv2D)	(None, 4, 4, 27)	13122	activation_136[0][0]
<u>dropout_98</u> (Dropout)	(None, 4, 4, 27)	0	conv2d_139[0]
<u>concatenate_121</u> (Concatenate)	(None, 4, 4, 81)	0	concatenate_120[0][0]
[0]			dropout_98[0]
<u>batch_normalization_137</u> (Batch Normalization)	(None, 4, 4, 81)	324	concatenate_121[0][0]
<u>activation_137</u> (Activation)	(None, 4, 4, 81)	0	batch_normalization_137[0][0]
<u>conv2d_140</u> (Conv2D)	(None, 4, 4, 27)	19683	activation_137[0][0]
<u>dropout_99</u> (Dropout)	(None, 4, 4, 27)	0	conv2d_140[0]
<u>concatenate_122</u> (Concatenate)	(None, 4, 4, 108)	0	concatenate_121[0][0]
[0]			dropout_99[0]
<u>batch_normalization_138</u> (Batch Normalization)	(None, 4, 4, 108)	432	concatenate_122[0][0]
<u>activation_138</u> (Activation)	(None, 4, 4, 108)	0	batch_normalization_138[0][0]

ation_138[0][0]

conv2d_141 (Conv2D) [0][0]	(None, 4, 4, 27)	26244	activation_138
dropout_100 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_141[0]
concatenate_123 (Concatenate) 2[0][0] [0]	(None, 4, 4, 135)	0	concatenate_12 dropout_100[0]
batch_normalization_139 (BatchN 3[0][0]	(None, 4, 4, 135)	540	concatenate_12
activation_139 (Activation) ation_139[0][0]	(None, 4, 4, 135)	0	batch_normaliz
conv2d_142 (Conv2D) [0][0]	(None, 4, 4, 27)	32805	activation_139
dropout_101 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_142[0]
concatenate_124 (Concatenate) 3[0][0] [0]	(None, 4, 4, 162)	0	concatenate_12 dropout_101[0]
batch_normalization_140 (BatchN 4[0][0]	(None, 4, 4, 162)	648	concatenate_12
activation_140 (Activation) ation_140[0][0]	(None, 4, 4, 162)	0	batch_normaliz
conv2d_143 (Conv2D) [0][0]	(None, 4, 4, 27)	39366	activation_140
dropout_102 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_143[0]
concatenate_125 (Concatenate) 4[0][0]	(None, 4, 4, 189)	0	concatenate_12

dropout_102[0]

[0]

batch_normalization_141 (BatchN	(None, 4, 4, 189)	756	concatenate_125[0][0]
activation_141 (Activation)	(None, 4, 4, 189)	0	batch_normalization_141[0][0]
conv2d_144 (Conv2D)	(None, 4, 4, 27)	45927	activation_141[0][0]
dropout_103 (Dropout)	(None, 4, 4, 27)	0	conv2d_144[0]
concatenate_126 (Concatenate)	(None, 4, 4, 216)	0	concatenate_125[0][0]
			dropout_103[0]
			[0]
batch_normalization_142 (BatchN	(None, 4, 4, 216)	864	concatenate_126[0][0]
activation_142 (Activation)	(None, 4, 4, 216)	0	batch_normalization_142[0][0]
conv2d_145 (Conv2D)	(None, 4, 4, 27)	52488	activation_142[0][0]
dropout_104 (Dropout)	(None, 4, 4, 27)	0	conv2d_145[0]
concatenate_127 (Concatenate)	(None, 4, 4, 243)	0	concatenate_126[0][0]
			dropout_104[0]
			[0]
batch_normalization_143 (BatchN	(None, 4, 4, 243)	972	concatenate_127[0][0]
activation_143 (Activation)	(None, 4, 4, 243)	0	batch_normalization_143[0][0]
average_pooling2d_15 (AveragePo	(None, 2, 2, 243)	0	activation_143

```
[0][0]
```

```
=====
Total params: 984,231
Trainable params: 974,511
Non-trainable params: 9,720
```

```
*****after adding conv2d layer*****
Model: "sequential_2"
```

Layer (type)	Output Shape	Param #
functional_13 (Functional)	(None, 2, 2, 243)	984231
conv2d_146 (Conv2D)	(None, 1, 1, 10)	9730
flatten_6 (Flatten)	(None, 10)	0

```
=====
Total params: 993,961
Trainable params: 984,241
Non-trainable params: 9,720
```

```
Epoch 1/10
391/391 [=====] - 71s 182ms/step - loss: 1.5459 - accuracy: 0.4322 - val_loss: 1.3209 - val_accuracy: 0.5457
Epoch 2/10
391/391 [=====] - 72s 184ms/step - loss: 1.0373 - accuracy: 0.6293 - val_loss: 1.8431 - val_accuracy: 0.5328
Epoch 3/10
391/391 [=====] - 72s 185ms/step - loss: 0.8413 - accuracy: 0.7024 - val_loss: 0.8697 - val_accuracy: 0.7013
Epoch 4/10
391/391 [=====] - 73s 186ms/step - loss: 0.7266 - accuracy: 0.7434 - val_loss: 1.4639 - val_accuracy: 0.6153
Epoch 5/10
391/391 [=====] - 73s 187ms/step - loss: 0.6387 - accuracy: 0.7769 - val_loss: 0.7149 - val_accuracy: 0.7654
Epoch 6/10
391/391 [=====] - 73s 187ms/step - loss: 0.5828 - accuracy: 0.7957 - val_loss: 0.6961 - val_accuracy: 0.7709
Epoch 7/10
391/391 [=====] - 73s 187ms/step - loss: 0.5299 - accuracy: 0.8153 - val_loss: 0.5709 - val_accuracy: 0.8055
Epoch 8/10
391/391 [=====] - 73s 186ms/step - loss: 0.4907 - accuracy: 0.8284 - val_loss: 0.7061 - val_accuracy: 0.7735
Epoch 9/10
391/391 [=====] - 73s 187ms/step - loss: 0.4604 - accuracy: 0.8381 - val_loss: 0.4593 - val_accuracy: 0.8465
```

```

Epoch 10/10
391/391 [=====] - 73s 186ms/step - loss: 0.4344 - accu
racy: 0.8475 - val_loss: 0.5066 - val_accuracy: 0.8405
313/313 [=====] - 3s 11ms/step - loss: 0.6867 - accura
cy: 0.7968
Test loss: 0.6866834163665771
Test accuracy: 0.7968000173568726

```

image augumentation featurewise_std_normalization and featurewise_center

```

In [46]: # Reff https://machinelearningmastery.com/how-to-configure-image-data-augmentation/

def stand(arr_imgs):

    # convert to numpy array
    d_ar = arr_imgs.copy()

    for i in tqdm(range(d_ar.shape[0]), position=0):
        data = d_ar[i]
        # expand dimension to one sample
        samples = np.expand_dims(data, 0)
        # create image data augmentation generator
        datagen = ImageDataGenerator(featurewise_center=True, featurewise_std_normalization=True)
        # prepare iterator
        it = datagen.flow(samples, batch_size=1)
        # generate samples and plot
        # define subplot
        # pyplot.subplot(330 + 1 + i)
        # generate batch of images
        for j in range(9):
            batch = it.next()
            if j == 0:
                # convert to unsigned integers for viewing
                image = batch[0].astype('uint8')
                d_ar[i] = image
                # plot raw pixel data
                #break
        return d_ar

```

```
In [47]: X_train_stand=stand(X_train)
X_cv_stand=stand(X_cv)
X_test_stand=stand(X_test)
```

```
0%|          | 0/50000 [00:00<?, ?it/s]/usr/local/lib/python3.6/dist-package
s/keras_preprocessing/image/image_data_generator.py:720: UserWarning: This Imag
eDataGenerator specifies `featurewise_center`, but it hasn't been fit on any tr
aining data. Fit it first by calling `.fit(numpy_data)`.
```

```
warnings.warn('This ImageDataGenerator specifies '
/usr/local/lib/python3.6/dist-packages/keras_preprocessing/image/image_data_gen
erator.py:728: UserWarning: This ImageDataGenerator specifies `featurewise_std_
normalization`, but it hasn't been fit on any training data. Fit it first by ca
lling `.fit(numpy_data)`.
```

```
warnings.warn('This ImageDataGenerator specifies '
100%|██████████| 50000/50000 [00:11<00:00, 4526.63it/s]
100%|██████████| 10000/10000 [00:02<00:00, 4578.85it/s]
100%|██████████| 10000/10000 [00:02<00:00, 4306.21it/s]
```

In [48]: `bright_model=model1(X_train_stand,X_cv_stand,X_test_stand,y_train,y_cv,y_test)`

Model: "functional_15"

Layer (type)	Output Shape	Param #	Connected to
input_5 (InputLayer)	[(None, 32, 32, 3)]	0	
conv2d_147 (Conv2D)	(None, 32, 32, 27)	324	input_5[0][0]
batch_normalization_144 (Batch Normalization)	(None, 32, 32, 27)	108	conv2d_147[0]
activation_144 (Activation)	(None, 32, 32, 27)	0	batch_normalization_144[0][0]
conv2d_148 (Conv2D)	(None, 32, 32, 27)	6561	activation_144[0][0]
dropout_105 (Dropout)	(None, 32, 32, 27)	0	conv2d_148[0]
concatenate_128 (Concatenate)	(None, 32, 32, 54)	0	conv2d_147[0] dropout_105[0]
batch_normalization_145 (Batch Normalization)	(None, 32, 32, 54)	216	concatenate_128[0][0]
activation_145 (Activation)	(None, 32, 32, 54)	0	batch_normalization_145[0][0]
conv2d_149 (Conv2D)	(None, 32, 32, 27)	13122	activation_145[0][0]
dropout_106 (Dropout)	(None, 32, 32, 27)	0	conv2d_149[0]
concatenate_129 (Concatenate)	(None, 32, 32, 81)	0	concatenate_128[0][0] dropout_106[0]

batch_normalization_146 (BatchN	(None, 32, 32, 81)	324	concatenate_12
9[0][0]			
activation_146 (Activation)	(None, 32, 32, 81)	0	batch_normaliz
ation_146[0][0]			
conv2d_150 (Conv2D)	(None, 32, 32, 27)	19683	activation_146
[0][0]			
dropout_107 (Dropout)	(None, 32, 32, 27)	0	conv2d_150[0]
[0]			
concatenate_130 (Concatenate)	(None, 32, 32, 108)	0	concatenate_12
9[0][0]			
			dropout_107[0]
[0]			
batch_normalization_147 (BatchN	(None, 32, 32, 108)	432	concatenate_13
0[0][0]			
activation_147 (Activation)	(None, 32, 32, 108)	0	batch_normaliz
ation_147[0][0]			
conv2d_151 (Conv2D)	(None, 32, 32, 27)	26244	activation_147
[0][0]			
dropout_108 (Dropout)	(None, 32, 32, 27)	0	conv2d_151[0]
[0]			
concatenate_131 (Concatenate)	(None, 32, 32, 135)	0	concatenate_13
0[0][0]			
			dropout_108[0]
[0]			
batch_normalization_148 (BatchN	(None, 32, 32, 135)	540	concatenate_13
1[0][0]			
activation_148 (Activation)	(None, 32, 32, 135)	0	batch_normaliz
ation_148[0][0]			
conv2d_152 (Conv2D)	(None, 32, 32, 27)	32805	activation_148
[0][0]			

dropout_109 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_152[0]
concatenate_132 (Concatenate) 1[0][0]	(None, 32, 32, 162)	0	concatenate_13 dropout_109[0]
batch_normalization_149 (BatchN 2[0][0])	(None, 32, 32, 162)	648	concatenate_13
activation_149 (Activation) activation_149[0][0]	(None, 32, 32, 162)	0	batch_normaliz ation_149[0][0]
conv2d_153 (Conv2D) [0][0]	(None, 32, 32, 27)	39366	activation_149
dropout_110 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_153[0]
concatenate_133 (Concatenate) 2[0][0]	(None, 32, 32, 189)	0	concatenate_13 dropout_110[0]
batch_normalization_150 (BatchN 3[0][0])	(None, 32, 32, 189)	756	concatenate_13
activation_150 (Activation) activation_150[0][0]	(None, 32, 32, 189)	0	batch_normaliz ation_150[0][0]
conv2d_154 (Conv2D) [0][0]	(None, 32, 32, 27)	45927	activation_150
dropout_111 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_154[0]
concatenate_134 (Concatenate) 3[0][0]	(None, 32, 32, 216)	0	concatenate_13 dropout_111[0]
batch_normalization_151 (BatchN 4[0][0])	(None, 32, 32, 216)	864	concatenate_13

activation_151 (Activation) activation_151[0][0]	(None, 32, 32, 216)	0	batch_normaliz
conv2d_155 (Conv2D) [0][0]	(None, 32, 32, 27)	52488	activation_151
dropout_112 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_155[0]
concatenate_135 (Concatenate) 4[0][0] [0]	(None, 32, 32, 243)	0	concatenate_13 dropout_112[0]
batch_normalization_152 (BatchN 5[0][0]	(None, 32, 32, 243)	972	concatenate_13
activation_152 (Activation) activation_152[0][0]	(None, 32, 32, 243)	0	batch_normaliz
conv2d_156 (Conv2D) [0][0]	(None, 32, 32, 27)	6561	activation_152
dropout_113 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_156[0]
average_pooling2d_16 (AveragePo [0]	(None, 16, 16, 27)	0	dropout_113[0]
batch_normalization_153 (BatchN g2d_16[0][0]	(None, 16, 16, 27)	108	average_poolin
activation_153 (Activation) ation_153[0][0]	(None, 16, 16, 27)	0	batch_normaliz
conv2d_157 (Conv2D) [0][0]	(None, 16, 16, 27)	6561	activation_153
dropout_114 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_157[0]
concatenate_136 (Concatenate) g2d_16[0][0]	(None, 16, 16, 54)	0	average_poolin

dropout_114[0]

[0]

batch_normalization_154 (Batch Normalization)	(None, 16, 16, 54)	216	concatenate_136[0][0]
activation_154 (Activation)	(None, 16, 16, 54)	0	batch_normalization_154[0][0]
conv2d_158 (Conv2D)	(None, 16, 16, 27)	13122	activation_154[0][0]
dropout_115 (Dropout)	(None, 16, 16, 27)	0	conv2d_158[0]
concatenate_137 (Concatenate)	(None, 16, 16, 81)	0	concatenate_136[0][0] dropout_115[0]
batch_normalization_155 (Batch Normalization)	(None, 16, 16, 81)	324	concatenate_137[0][0]
activation_155 (Activation)	(None, 16, 16, 81)	0	batch_normalization_155[0][0]
conv2d_159 (Conv2D)	(None, 16, 16, 27)	19683	activation_155[0][0]
dropout_116 (Dropout)	(None, 16, 16, 27)	0	conv2d_159[0]
concatenate_138 (Concatenate)	(None, 16, 16, 108)	0	concatenate_137[0][0] dropout_116[0]
batch_normalization_156 (Batch Normalization)	(None, 16, 16, 108)	432	concatenate_138[0][0]
activation_156 (Activation)	(None, 16, 16, 108)	0	batch_normalization_156[0][0]
conv2d_160 (Conv2D)	(None, 16, 16, 27)	26244	activation_156[0][0]

[0][0]

dropout_117 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_160[0]
concatenate_139 (Concatenate) 8[0][0]	(None, 16, 16, 135)	0	concatenate_13 dropout_117[0]
batch_normalization_157 (BatchN 9[0][0])	(None, 16, 16, 135)	540	concatenate_13
activation_157 (Activation) ation_157[0][0]	(None, 16, 16, 135)	0	batch_normaliz
conv2d_161 (Conv2D) [0][0]	(None, 16, 16, 27)	32805	activation_157
dropout_118 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_161[0]
concatenate_140 (Concatenate) 9[0][0]	(None, 16, 16, 162)	0	concatenate_13 dropout_118[0]
batch_normalization_158 (BatchN 0[0][0])	(None, 16, 16, 162)	648	concatenate_14
activation_158 (Activation) ation_158[0][0]	(None, 16, 16, 162)	0	batch_normaliz
conv2d_162 (Conv2D) [0][0]	(None, 16, 16, 27)	39366	activation_158
dropout_119 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_162[0]
concatenate_141 (Concatenate) 0[0][0]	(None, 16, 16, 189)	0	concatenate_14 dropout_119[0]

batch_normalization_159 (BatchN	(None, 16, 16, 189)	756	concatenate_141[0][0]
activation_159 (Activation)	(None, 16, 16, 189)	0	batch_normalization_159[0][0]
conv2d_163 (Conv2D)	(None, 16, 16, 27)	45927	activation_159[0][0]
dropout_120 (Dropout)	(None, 16, 16, 27)	0	conv2d_163[0][0]
concatenate_142 (Concatenate)	(None, 16, 16, 216)	0	concatenate_141[0][0]
			dropout_120[0][0]
batch_normalization_160 (BatchN	(None, 16, 16, 216)	864	concatenate_142[0][0]
activation_160 (Activation)	(None, 16, 16, 216)	0	batch_normalization_160[0][0]
conv2d_164 (Conv2D)	(None, 16, 16, 27)	52488	activation_160[0][0]
dropout_121 (Dropout)	(None, 16, 16, 27)	0	conv2d_164[0][0]
concatenate_143 (Concatenate)	(None, 16, 16, 243)	0	concatenate_142[0][0]
			dropout_121[0][0]
batch_normalization_161 (BatchN	(None, 16, 16, 243)	972	concatenate_143[0][0]
activation_161 (Activation)	(None, 16, 16, 243)	0	batch_normalization_161[0][0]
conv2d_165 (Conv2D)	(None, 16, 16, 27)	6561	activation_161[0][0]
dropout_122 (Dropout)	(None, 16, 16, 27)	0	conv2d_165[0][0]

[0]

average_pooling2d_17 (AveragePo (None, 8, 8, 27)	0	dropout_122[0]
batch_normalization_162 (BatchN (None, 8, 8, 27)	108	average_poolin
activation_162 (Activation) (None, 8, 8, 27)	0	batch_normaliz
conv2d_166 (Conv2D) (None, 8, 8, 27)	6561	activation_162
dropout_123 (Dropout) (None, 8, 8, 27)	0	conv2d_166[0]
concatenate_144 (Concatenate) (None, 8, 8, 54)	0	average_poolin
batch_normalization_163 (BatchN (None, 8, 8, 54)	216	concatenate_14
activation_163 (Activation) (None, 8, 8, 54)	0	batch_normaliz
conv2d_167 (Conv2D) (None, 8, 8, 27)	13122	activation_163
dropout_124 (Dropout) (None, 8, 8, 27)	0	conv2d_167[0]
concatenate_145 (Concatenate) (None, 8, 8, 81)	0	concatenate_14
batch_normalization_164 (BatchN (None, 8, 8, 81)	324	concatenate_14
activation_164 (Activation) (None, 8, 8, 81)	0	batch_normaliz

conv2d_168 (Conv2D) [0][0]	(None, 8, 8, 27)	19683	activation_164
dropout_125 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_168[0]
concatenate_146 (Concatenate) 5[0][0] [0]	(None, 8, 8, 108)	0	concatenate_14 dropout_125[0]
batch_normalization_165 (BatchN 6[0][0]	(None, 8, 8, 108)	432	concatenate_14
activation_165 (Activation) ation_165[0][0]	(None, 8, 8, 108)	0	batch_normaliz
conv2d_169 (Conv2D) [0][0]	(None, 8, 8, 27)	26244	activation_165
dropout_126 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_169[0]
concatenate_147 (Concatenate) 6[0][0] [0]	(None, 8, 8, 135)	0	concatenate_14 dropout_126[0]
batch_normalization_166 (BatchN 7[0][0]	(None, 8, 8, 135)	540	concatenate_14
activation_166 (Activation) ation_166[0][0]	(None, 8, 8, 135)	0	batch_normaliz
conv2d_170 (Conv2D) [0][0]	(None, 8, 8, 27)	32805	activation_166
dropout_127 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_170[0]
concatenate_148 (Concatenate) 7[0][0]	(None, 8, 8, 162)	0	concatenate_14 dropout_127[0]

[0]

batch_normalization_167 (BatchN	(None, 8, 8, 162)	648	concatenate_148[0][0]
activation_167 (Activation)	(None, 8, 8, 162)	0	batch_normaliz
conv2d_171 (Conv2D)	(None, 8, 8, 27)	39366	activation_167
dropout_128 (Dropout)	(None, 8, 8, 27)	0	conv2d_171[0]
concatenate_149 (Concatenate)	(None, 8, 8, 189)	0	concatenate_148[0][0]
			dropout_128[0]
batch_normalization_168 (BatchN	(None, 8, 8, 189)	756	concatenate_149[0][0]
activation_168 (Activation)	(None, 8, 8, 189)	0	batch_normaliz
conv2d_172 (Conv2D)	(None, 8, 8, 27)	45927	activation_168
dropout_129 (Dropout)	(None, 8, 8, 27)	0	conv2d_172[0]
concatenate_150 (Concatenate)	(None, 8, 8, 216)	0	concatenate_149[0][0]
			dropout_129[0]
batch_normalization_169 (BatchN	(None, 8, 8, 216)	864	concatenate_150[0][0]
activation_169 (Activation)	(None, 8, 8, 216)	0	batch_normaliz
conv2d_173 (Conv2D)	(None, 8, 8, 27)	52488	activation_169

<u>dropout_130</u> (Dropout)	(None, 8, 8, 27)	0	conv2d_173[0]
<u>concatenate_151</u> (Concatenate)	(None, 8, 8, 243)	0	concatenate_150[0][0]
			dropout_130[0]
<u>batch_normalization_170</u> (BatchN	(None, 8, 8, 243)	972	concatenate_151[0][0]
<u>activation_170</u> (Activation)	(None, 8, 8, 243)	0	batch_normaliz
			ation_170[0][0]
<u>conv2d_174</u> (Conv2D)	(None, 8, 8, 27)	6561	activation_170[0][0]
<u>dropout_131</u> (Dropout)	(None, 8, 8, 27)	0	conv2d_174[0]
<u>average_pooling2d_18</u> (AveragePo	(None, 4, 4, 27)	0	dropout_131[0]
			[0]
<u>batch_normalization_171</u> (BatchN	(None, 4, 4, 27)	108	average_poolin
			g2d_18[0][0]
<u>activation_171</u> (Activation)	(None, 4, 4, 27)	0	batch_normaliz
			ation_171[0][0]
<u>conv2d_175</u> (Conv2D)	(None, 4, 4, 27)	6561	activation_171[0][0]
<u>dropout_132</u> (Dropout)	(None, 4, 4, 27)	0	conv2d_175[0]
<u>concatenate_152</u> (Concatenate)	(None, 4, 4, 54)	0	average_poolin
			g2d_18[0][0]
			dropout_132[0]
			[0]
<u>batch_normalization_172</u> (BatchN	(None, 4, 4, 54)	216	concatenate_152[0][0]

activation_172 (Activation) activation_172[0][0]	(None, 4, 4, 54)	0	batch_normaliz
conv2d_176 (Conv2D) [0][0]	(None, 4, 4, 27)	13122	activation_172
dropout_133 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_176[0]
concatenate_153 (Concatenate) 2[0][0] [0]	(None, 4, 4, 81)	0	concatenate_15 dropout_133[0]
batch_normalization_173 (BatchN 3[0][0])	(None, 4, 4, 81)	324	concatenate_15
activation_173 (Activation) activation_173[0][0]	(None, 4, 4, 81)	0	batch_normaliz
conv2d_177 (Conv2D) [0][0]	(None, 4, 4, 27)	19683	activation_173
dropout_134 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_177[0]
concatenate_154 (Concatenate) 3[0][0] [0]	(None, 4, 4, 108)	0	concatenate_15 dropout_134[0]
batch_normalization_174 (BatchN 4[0][0])	(None, 4, 4, 108)	432	concatenate_15
activation_174 (Activation) activation_174[0][0]	(None, 4, 4, 108)	0	batch_normaliz
conv2d_178 (Conv2D) [0][0]	(None, 4, 4, 27)	26244	activation_174
dropout_135 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_178[0]

concatenate_154 (Concatenate)	(None, 4, 4, 135)	0	concatenate_154[0][0]
			dropout_135[0]
			[0]
batch_normalization_175 (Batch Normalization)	(None, 4, 4, 135)	540	concatenate_155[0][0]
activation_175 (Activation)	(None, 4, 4, 135)	0	batch_normalization_175[0][0]
conv2d_179 (Conv2D)	(None, 4, 4, 27)	32805	activation_175[0][0]
dropout_136 (Dropout)	(None, 4, 4, 27)	0	conv2d_179[0]
			[0]
concatenate_156 (Concatenate)	(None, 4, 4, 162)	0	concatenate_155[0][0]
			dropout_136[0]
			[0]
batch_normalization_176 (Batch Normalization)	(None, 4, 4, 162)	648	concatenate_156[0][0]
activation_176 (Activation)	(None, 4, 4, 162)	0	batch_normalization_176[0][0]
conv2d_180 (Conv2D)	(None, 4, 4, 27)	39366	activation_176[0][0]
dropout_137 (Dropout)	(None, 4, 4, 27)	0	conv2d_180[0]
			[0]
concatenate_157 (Concatenate)	(None, 4, 4, 189)	0	concatenate_156[0][0]
			dropout_137[0]
			[0]
batch_normalization_177 (Batch Normalization)	(None, 4, 4, 189)	756	concatenate_157[0][0]
activation_177 (Activation)	(None, 4, 4, 189)	0	batch_normalization_177[0][0]

conv2d_181 (Conv2D) [0][0]	(None, 4, 4, 27)	45927	activation_177
dropout_138 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_181[0]
concatenate_158 (Concatenate) 7[0][0] [0]	(None, 4, 4, 216)	0	concatenate_15 dropout_138[0]
batch_normalization_178 (BatchN 8[0][0])	(None, 4, 4, 216)	864	concatenate_15
activation_178 (Activation) ation_178[0][0]	(None, 4, 4, 216)	0	batch_normaliz
conv2d_182 (Conv2D) [0][0]	(None, 4, 4, 27)	52488	activation_178
dropout_139 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_182[0]
concatenate_159 (Concatenate) 8[0][0] [0]	(None, 4, 4, 243)	0	concatenate_15 dropout_139[0]
batch_normalization_179 (BatchN 9[0][0])	(None, 4, 4, 243)	972	concatenate_15
activation_179 (Activation) ation_179[0][0]	(None, 4, 4, 243)	0	batch_normaliz
average_pooling2d_19 (AveragePo [0][0])	(None, 2, 2, 243)	0	activation_179
flatten_7 (Flatten) g2d_19[0][0]	(None, 972)	0	average_poolin
dense_4 (Dense) [0]	(None, 10)	9730	flatten_7[0]
=====			
=====			

[illegible]

Model: "functional_17"

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<u>dropout_106</u> (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_149[0]
<u>concatenate_129</u> (Concatenate) 8[0][0] [0]	(None, 32, 32, 81)	0	concatenate_12 dropout_106[0]
<u>batch_normalization_146</u> (BatchN 9[0][0])	(None, 32, 32, 81)	324	concatenate_12
<u>activation_146</u> (Activation) activation_146[0][0]	(None, 32, 32, 81)	0	batch_normaliz
<u>conv2d_150</u> (Conv2D) [0][0]	(None, 32, 32, 27)	19683	activation_146
<u>dropout_107</u> (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_150[0]
<u>concatenate_130</u> (Concatenate) 9[0][0] [0]	(None, 32, 32, 108)	0	concatenate_12 dropout_107[0]
<u>batch_normalization_147</u> (BatchN 0[0][0])	(None, 32, 32, 108)	432	concatenate_13
<u>activation_147</u> (Activation) activation_147[0][0]	(None, 32, 32, 108)	0	batch_normaliz
<u>conv2d_151</u> (Conv2D) [0][0]	(None, 32, 32, 27)	26244	activation_147
<u>dropout_108</u> (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_151[0]
<u>concatenate_131</u> (Concatenate) 0[0][0] [0]	(None, 32, 32, 135)	0	concatenate_13 dropout_108[0]
<u>batch_normalization_148</u> (BatchN	(None, 32, 32, 135)	540	concatenate_13

1[0][0]

activation_148 (Activation) activation_148[0][0]	(None, 32, 32, 135)	0	batch_normaliz
conv2d_152 (Conv2D) [0][0]	(None, 32, 32, 27)	32805	activation_148
dropout_109 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_152[0]
concatenate_132 (Concatenate) 1[0][0]	(None, 32, 32, 162)	0	concatenate_13 dropout_109[0]
batch_normalization_149 (BatchN 2[0][0]	(None, 32, 32, 162)	648	concatenate_13
activation_149 (Activation) activation_149[0][0]	(None, 32, 32, 162)	0	batch_normaliz
conv2d_153 (Conv2D) [0][0]	(None, 32, 32, 27)	39366	activation_149
dropout_110 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_153[0]
concatenate_133 (Concatenate) 2[0][0]	(None, 32, 32, 189)	0	concatenate_13 dropout_110[0]
batch_normalization_150 (BatchN 3[0][0]	(None, 32, 32, 189)	756	concatenate_13
activation_150 (Activation) activation_150[0][0]	(None, 32, 32, 189)	0	batch_normaliz
conv2d_154 (Conv2D) [0][0]	(None, 32, 32, 27)	45927	activation_150
dropout_111 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_154[0]

<u>concatenate_134</u> (Concatenate)	(None, 32, 32, 216)	0	<u>concatenate_133</u> [0][0]
			<u>dropout_111</u> [0]
<u>batch_normalization_151</u> (BatchN	(None, 32, 32, 216)	864	<u>concatenate_134</u> [0][0]
<u>activation_151</u> (Activation)	(None, 32, 32, 216)	0	<u>batch_normaliz</u>
<u>ation_151</u> [0][0]			
<u>conv2d_155</u> (Conv2D)	(None, 32, 32, 27)	52488	<u>activation_151</u>
<u>[0][0]</u>			
<u>dropout_112</u> (Dropout)	(None, 32, 32, 27)	0	<u>conv2d_155</u> [0]
<u>[0]</u>			
<u>concatenate_135</u> (Concatenate)	(None, 32, 32, 243)	0	<u>concatenate_134</u> [0][0]
			<u>dropout_112</u> [0]
<u>[0]</u>			
<u>batch_normalization_152</u> (BatchN	(None, 32, 32, 243)	972	<u>concatenate_135</u> [0][0]
<u>activation_152</u> (Activation)	(None, 32, 32, 243)	0	<u>batch_normaliz</u>
<u>ation_152</u> [0][0]			
<u>conv2d_156</u> (Conv2D)	(None, 32, 32, 27)	6561	<u>activation_152</u>
<u>[0][0]</u>			
<u>dropout_113</u> (Dropout)	(None, 32, 32, 27)	0	<u>conv2d_156</u> [0]
<u>[0]</u>			
<u>average_pooling2d_16</u> (AveragePo	(None, 16, 16, 27)	0	<u>dropout_113</u> [0]
<u>[0]</u>			
<u>batch_normalization_153</u> (BatchN	(None, 16, 16, 27)	108	<u>average_poolin</u>
<u>g2d_16</u> [0][0]			
<u>activation_153</u> (Activation)	(None, 16, 16, 27)	0	<u>batch_normaliz</u>
<u>ation_153</u> [0][0]			

conv2d_157 (Conv2D) [0][0]	(None, 16, 16, 27)	6561	activation_153
dropout_114 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_157[0]
concatenate_136 (Concatenate) g2d_16[0][0] [0]	(None, 16, 16, 54)	0	average_poolin dropout_114[0]
batch_normalization_154 (BatchN 6[0][0]	(None, 16, 16, 54)	216	concatenate_13
activation_154 (Activation) ation_154[0][0]	(None, 16, 16, 54)	0	batch_normaliz
conv2d_158 (Conv2D) [0][0]	(None, 16, 16, 27)	13122	activation_154
dropout_115 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_158[0]
concatenate_137 (Concatenate) 6[0][0] [0]	(None, 16, 16, 81)	0	concatenate_13 dropout_115[0]
batch_normalization_155 (BatchN 7[0][0]	(None, 16, 16, 81)	324	concatenate_13
activation_155 (Activation) ation_155[0][0]	(None, 16, 16, 81)	0	batch_normaliz
conv2d_159 (Conv2D) [0][0]	(None, 16, 16, 27)	19683	activation_155
dropout_116 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_159[0]
concatenate_138 (Concatenate) 7[0][0] [0]	(None, 16, 16, 108)	0	concatenate_13 dropout_116[0]

batch_normalization_156 (Batch Normalization)	(None, 16, 16, 108)	432	concatenate_138[0][0]
activation_156 (Activation)	(None, 16, 16, 108)	0	batch_normalization_156[0][0]
conv2d_160 (Conv2D)	(None, 16, 16, 27)	26244	activation_156[0][0]
dropout_117 (Dropout)	(None, 16, 16, 27)	0	conv2d_160[0]
concatenate_139 (Concatenate)	(None, 16, 16, 135)	0	concatenate_138[0][0] dropout_117[0]
batch_normalization_157 (Batch Normalization)	(None, 16, 16, 135)	540	concatenate_139[0][0]
activation_157 (Activation)	(None, 16, 16, 135)	0	batch_normalization_157[0][0]
conv2d_161 (Conv2D)	(None, 16, 16, 27)	32805	activation_157[0][0]
dropout_118 (Dropout)	(None, 16, 16, 27)	0	conv2d_161[0]
concatenate_140 (Concatenate)	(None, 16, 16, 162)	0	concatenate_139[0][0] dropout_118[0]
batch_normalization_158 (Batch Normalization)	(None, 16, 16, 162)	648	concatenate_140[0][0]
activation_158 (Activation)	(None, 16, 16, 162)	0	batch_normalization_158[0][0]
conv2d_162 (Conv2D)	(None, 16, 16, 27)	39366	activation_158[0][0]

<u>dropout_119</u> (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_162[0]
<u>concatenate_141</u> (Concatenate) 0[0][0]	(None, 16, 16, 189)	0	concatenate_14 dropout_119[0]
<u>batch_normalization_159</u> (BatchN 1[0][0])	(None, 16, 16, 189)	756	concatenate_14
<u>activation_159</u> (Activation) ation_159[0][0]	(None, 16, 16, 189)	0	batch_normaliz
<u>conv2d_163</u> (Conv2D) [0][0]	(None, 16, 16, 27)	45927	activation_159
<u>dropout_120</u> (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_163[0]
<u>concatenate_142</u> (Concatenate) 1[0][0]	(None, 16, 16, 216)	0	concatenate_14 dropout_120[0]
<u>batch_normalization_160</u> (BatchN 2[0][0])	(None, 16, 16, 216)	864	concatenate_14
<u>activation_160</u> (Activation) ation_160[0][0]	(None, 16, 16, 216)	0	batch_normaliz
<u>conv2d_164</u> (Conv2D) [0][0]	(None, 16, 16, 27)	52488	activation_160
<u>dropout_121</u> (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_164[0]
<u>concatenate_143</u> (Concatenate) 2[0][0]	(None, 16, 16, 243)	0	concatenate_14 dropout_121[0]
<u>batch_normalization_161</u> (BatchN 3[0][0])	(None, 16, 16, 243)	972	concatenate_14

<u>activation_161</u> (Activation) activation_161[0][0]	(None, 16, 16, 243)	0	batch_normaliz
<u>conv2d_165</u> (Conv2D) conv2d_165[0][0]	(None, 16, 16, 27)	6561	activation_161
<u>dropout_122</u> (Dropout) dropout_122[0]	(None, 16, 16, 27)	0	conv2d_165[0]
<u>average_pooling2d_17</u> (AveragePo average_pooling2d_17[0][0]	(None, 8, 8, 27)	0	dropout_122[0]
<u>batch_normalization_162</u> (BatchN batch_normalization_162[0][0]	(None, 8, 8, 27)	108	average_poolin
<u>activation_162</u> (Activation) activation_162[0][0]	(None, 8, 8, 27)	0	batch_normaliz
<u>conv2d_166</u> (Conv2D) conv2d_166[0][0]	(None, 8, 8, 27)	6561	activation_162
<u>dropout_123</u> (Dropout) dropout_123[0]	(None, 8, 8, 27)	0	conv2d_166[0]
<u>concatenate_144</u> (Concatenate) concatenate_144[0][0]	(None, 8, 8, 54)	0	average_poolin dropout_123[0]
<u>batch_normalization_163</u> (BatchN batch_normalization_163[0][0]	(None, 8, 8, 54)	216	concatenate_14
<u>activation_163</u> (Activation) activation_163[0][0]	(None, 8, 8, 54)	0	batch_normaliz
<u>conv2d_167</u> (Conv2D) conv2d_167[0][0]	(None, 8, 8, 27)	13122	activation_163
<u>dropout_124</u> (Dropout) dropout_124[0]	(None, 8, 8, 27)	0	conv2d_167[0]
<u>concatenate_145</u> (Concatenate) concatenate_145[0][0]	(None, 8, 8, 81)	0	concatenate_14

4[0][0]

dropout_124[0]

[0]

batch_normalization_164 (BatchN	(None, 8, 8, 81)	324	concatenate_14
5[0][0]			

activation_164 (Activation)	(None, 8, 8, 81)	0	batch_normaliz
ation_164[0][0]			

conv2d_168 (Conv2D)	(None, 8, 8, 27)	19683	activation_164
[0][0]			

dropout_125 (Dropout)	(None, 8, 8, 27)	0	conv2d_168[0]
[0]			

concatenate_146 (Concatenate)	(None, 8, 8, 108)	0	concatenate_14
5[0][0]			dropout_125[0]
[0]			

batch_normalization_165 (BatchN	(None, 8, 8, 108)	432	concatenate_14
6[0][0]			

activation_165 (Activation)	(None, 8, 8, 108)	0	batch_normaliz
ation_165[0][0]			

conv2d_169 (Conv2D)	(None, 8, 8, 27)	26244	activation_165
[0][0]			

dropout_126 (Dropout)	(None, 8, 8, 27)	0	conv2d_169[0]
[0]			

concatenate_147 (Concatenate)	(None, 8, 8, 135)	0	concatenate_14
6[0][0]			dropout_126[0]
[0]			

batch_normalization_166 (BatchN	(None, 8, 8, 135)	540	concatenate_14
7[0][0]			

activation_166 (Activation)	(None, 8, 8, 135)	0	batch_normaliz
ation_166[0][0]			

conv2d_170 (Conv2D) [0][0]	(None, 8, 8, 27)	32805	activation_166
dropout_127 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_170[0]
concatenate_148 (Concatenate) 7[0][0] [0]	(None, 8, 8, 162)	0	concatenate_14 dropout_127[0]
batch_normalization_167 (BatchN 8[0][0]	(None, 8, 8, 162)	648	concatenate_14
activation_167 (Activation) ation_167[0][0]	(None, 8, 8, 162)	0	batch_normaliz
conv2d_171 (Conv2D) [0][0]	(None, 8, 8, 27)	39366	activation_167
dropout_128 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_171[0]
concatenate_149 (Concatenate) 8[0][0] [0]	(None, 8, 8, 189)	0	concatenate_14 dropout_128[0]
batch_normalization_168 (BatchN 9[0][0]	(None, 8, 8, 189)	756	concatenate_14
activation_168 (Activation) ation_168[0][0]	(None, 8, 8, 189)	0	batch_normaliz
conv2d_172 (Conv2D) [0][0]	(None, 8, 8, 27)	45927	activation_168
dropout_129 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_172[0]
concatenate_150 (Concatenate) 9[0][0] [0]	(None, 8, 8, 216)	0	concatenate_14 dropout_129[0]

batch_normalization_169 (BatchN 0[0][0])	(None, 8, 8, 216)	864	concatenate_15
activation_169 (Activation) ation_169[0][0])	(None, 8, 8, 216)	0	batch_normaliz
conv2d_173 (Conv2D) [0][0])	(None, 8, 8, 27)	52488	activation_169
dropout_130 (Dropout) [0])	(None, 8, 8, 27)	0	conv2d_173[0]
concatenate_151 (Concatenate) 0[0][0])	(None, 8, 8, 243)	0	concatenate_15 dropout_130[0]
batch_normalization_170 (BatchN 1[0][0])	(None, 8, 8, 243)	972	concatenate_15
activation_170 (Activation) ation_170[0][0])	(None, 8, 8, 243)	0	batch_normaliz
conv2d_174 (Conv2D) [0][0])	(None, 8, 8, 27)	6561	activation_170
dropout_131 (Dropout) [0])	(None, 8, 8, 27)	0	conv2d_174[0]
average_pooling2d_18 (AveragePo [0])	(None, 4, 4, 27)	0	dropout_131[0]
batch_normalization_171 (BatchN g2d_18[0][0])	(None, 4, 4, 27)	108	average_poolin
activation_171 (Activation) ation_171[0][0])	(None, 4, 4, 27)	0	batch_normaliz
conv2d_175 (Conv2D) [0][0])	(None, 4, 4, 27)	6561	activation_171
dropout_132 (Dropout) [0])	(None, 4, 4, 27)	0	conv2d_175[0]

<u>concatenate_152</u> (Concatenate) g2d_18[0][0]	(None, 4, 4, 54)	0	average_pooling2d_18[0][0]
<u>batch_normalization_172</u> (Batch Normalization) 2[0][0]	(None, 4, 4, 54)	216	concatenate_152[0][0]
<u>activation_172</u> (Activation) activation_172[0][0]	(None, 4, 4, 54)	0	batch_normalization_172[0][0]
<u>conv2d_176</u> (Conv2D) [0][0]	(None, 4, 4, 27)	13122	activation_172[0][0]
<u>dropout_133</u> (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_176[0][0]
<u>concatenate_153</u> (Concatenate) 2[0][0]	(None, 4, 4, 81)	0	concatenate_152[0][0]
<u>batch_normalization_173</u> (Batch Normalization) 3[0][0]	(None, 4, 4, 81)	324	dropout_133[0][0]
<u>activation_173</u> (Activation) activation_173[0][0]	(None, 4, 4, 81)	0	concatenate_153[0][0]
<u>conv2d_177</u> (Conv2D) [0][0]	(None, 4, 4, 27)	19683	batch_normalization_173[0][0]
<u>dropout_134</u> (Dropout) [0]	(None, 4, 4, 27)	0	activation_173[0][0]
<u>concatenate_154</u> (Concatenate) 3[0][0]	(None, 4, 4, 108)	0	conv2d_177[0][0]
<u>batch_normalization_174</u> (Batch Normalization) 4[0][0]	(None, 4, 4, 108)	432	concatenate_153[0][0]
<u>activation_174</u> (Activation)	(None, 4, 4, 108)	0	dropout_134[0][0]

ation_174[0][0]

conv2d_178 (Conv2D) [0][0]	(None, 4, 4, 27)	26244	activation_174
dropout_135 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_178[0]
concatenate_155 (Concatenate) 4[0][0]	(None, 4, 4, 135)	0	concatenate_15 dropout_135[0]
batch_normalization_175 (BatchN 5[0][0]	(None, 4, 4, 135)	540	concatenate_15
activation_175 (Activation) ation_175[0][0]	(None, 4, 4, 135)	0	batch_normaliz
conv2d_179 (Conv2D) [0][0]	(None, 4, 4, 27)	32805	activation_175
dropout_136 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_179[0]
concatenate_156 (Concatenate) 5[0][0]	(None, 4, 4, 162)	0	concatenate_15 dropout_136[0]
batch_normalization_176 (BatchN 6[0][0]	(None, 4, 4, 162)	648	concatenate_15
activation_176 (Activation) ation_176[0][0]	(None, 4, 4, 162)	0	batch_normaliz
conv2d_180 (Conv2D) [0][0]	(None, 4, 4, 27)	39366	activation_176
dropout_137 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_180[0]
concatenate_157 (Concatenate) 6[0][0]	(None, 4, 4, 189)	0	concatenate_15

dropout_137[0]

[0]

batch_normalization_177 (BatchN	(None, 4, 4, 189)	756	concatenate_15
7[0][0]			
activation_177 (Activation)	(None, 4, 4, 189)	0	batch_normaliz
ation_177[0][0]			
conv2d_181 (Conv2D)	(None, 4, 4, 27)	45927	activation_177
[0][0]			
dropout_138 (Dropout)	(None, 4, 4, 27)	0	conv2d_181[0]
[0]			
concatenate_158 (Concatenate)	(None, 4, 4, 216)	0	concatenate_15
7[0][0]			dropout_138[0]
[0]			
batch_normalization_178 (BatchN	(None, 4, 4, 216)	864	concatenate_15
8[0][0]			
activation_178 (Activation)	(None, 4, 4, 216)	0	batch_normaliz
ation_178[0][0]			
conv2d_182 (Conv2D)	(None, 4, 4, 27)	52488	activation_178
[0][0]			
dropout_139 (Dropout)	(None, 4, 4, 27)	0	conv2d_182[0]
[0]			
concatenate_159 (Concatenate)	(None, 4, 4, 243)	0	concatenate_15
8[0][0]			dropout_139[0]
[0]			
batch_normalization_179 (BatchN	(None, 4, 4, 243)	972	concatenate_15
9[0][0]			
activation_179 (Activation)	(None, 4, 4, 243)	0	batch_normaliz
ation_179[0][0]			
average_pooling2d_19 (AveragePo	(None, 2, 2, 243)	0	activation_179

[0][0]

```

=====
Total params: 984,231
Trainable params: 974,511
Non-trainable params: 9,720

```

```

*****
*****after adding conv2d layer*****
*****
Model: "sequential_3"

```

Layer (type)	Output Shape	Param #
functional_17 (Functional)	(None, 2, 2, 243)	984231
conv2d_183 (Conv2D)	(None, 1, 1, 10)	9730
flatten_8 (Flatten)	(None, 10)	0

```

=====
Total params: 993,961
Trainable params: 984,241
Non-trainable params: 9,720

```

Epoch 1/10

```

2/391 [.....] - ETA: 1:04 - loss: 2.4377 - accuracy: 0.1055
WARNING:tensorflow:Callbacks method `on_train_batch_end` is slow compared
to the batch time (batch time: 0.0652s vs `on_train_batch_end` time: 0.1072s).
Check your callbacks.

```

```

391/391 [=====] - 71s 182ms/step - loss: 1.4240 - accuracy: 0.4759 - val_loss: 1.7229 - val_accuracy: 0.4057

```

Epoch 2/10

```

391/391 [=====] - 72s 184ms/step - loss: 0.9675 - accuracy: 0.6535 - val_loss: 1.3753 - val_accuracy: 0.5740

```

Epoch 3/10

```

391/391 [=====] - 72s 185ms/step - loss: 0.7972 - accuracy: 0.7160 - val_loss: 1.5148 - val_accuracy: 0.5801

```

Epoch 4/10

```

391/391 [=====] - 73s 186ms/step - loss: 0.6827 - accuracy: 0.7592 - val_loss: 0.9606 - val_accuracy: 0.6914

```

Epoch 5/10

```

391/391 [=====] - 73s 186ms/step - loss: 0.6128 - accuracy: 0.7846 - val_loss: 0.8330 - val_accuracy: 0.7385

```

Epoch 6/10

```

391/391 [=====] - 73s 187ms/step - loss: 0.5526 - accuracy: 0.8058 - val_loss: 0.8679 - val_accuracy: 0.7347

```

Epoch 7/10

```

391/391 [=====] - 73s 187ms/step - loss: 0.5095 - accuracy: 0.8211 - val_loss: 0.8415 - val_accuracy: 0.7274

```

Epoch 8/10

```

391/391 [=====] - 73s 187ms/step - loss: 0.4664 - accuracy: 0.8411 - val_loss: 0.8415 - val_accuracy: 0.7274

```

```

racy: 0.8361 - val_loss: 0.5420 - val_accuracy: 0.8235
Epoch 9/10
391/391 [=====] - 73s 186ms/step - loss: 0.4386 - accu
racy: 0.8453 - val_loss: 1.0687 - val_accuracy: 0.7146
Epoch 10/10
391/391 [=====] - 73s 186ms/step - loss: 0.4082 - accu
racy: 0.8575 - val_loss: 0.4853 - val_accuracy: 0.8381
313/313 [=====] - 3s 11ms/step - loss: 0.6650 - accura
cy: 0.7972
Test loss: 0.6649559140205383
Test accuracy: 0.7972000241279602

```

image augumentation zoom

In [49]: [# Reff https://machinelearningmastery.com/how-to-configure-image-data-augmentation/](https://machinelearningmastery.com/how-to-configure-image-data-augmentation/)

```

def zoom(arr_imgs):

    # convert to numpy array
    d_ar = arr_imgs.copy()

    for i in tqdm(range(d_ar.shape[0]), position=0):
        data = d_ar[i]
        # expand dimension to one sample
        samples = expand_dims(data, 0)
        # create image data augmentation generator
        datagen = ImageDataGenerator(zoom_range=[0.5,1.0])
        # prepare iterator
        it = datagen.flow(samples, batch_size=1)
        # generate samples and plot
        # define subplot
        # pyplot.subplot(330 + 1 + i)
        # generate batch of images
        for j in range(9):
            batch = it.next()
            #if j == 0:

                # convert to unsigned integers for viewing
            image = batch[0].astype('uint8')
            d_ar[i] = image
            # plot raw pixel data
            #break

    return d_ar

```

```
In [50]: X_train_zoom=stand(X_train)
X_cv_zoom=stand(X_cv)
X_test_zoom=stand(X_test)
```

```
0%|          | 0/50000 [00:00<?, ?it/s]/usr/local/lib/python3.6/dist-package
s/keras_preprocessing/image/image_data_generator.py:720: UserWarning: This Imag
eDataGenerator specifies `featurewise_center`, but it hasn't been fit on any tr
aining data. Fit it first by calling `.fit(numpy_data)`.
```

```
warnings.warn('This ImageDataGenerator specifies '
/usr/local/lib/python3.6/dist-packages/keras_preprocessing/image/image_data_gen
erator.py:728: UserWarning: This ImageDataGenerator specifies `featurewise_std_
normalization`, but it hasn't been fit on any training data. Fit it first by ca
lling `.fit(numpy_data)`.
```

```
warnings.warn('This ImageDataGenerator specifies '
100%|██████████| 50000/50000 [00:11<00:00, 4501.82it/s]
100%|██████████| 10000/10000 [00:02<00:00, 4436.12it/s]
100%|██████████| 10000/10000 [00:02<00:00, 4450.79it/s]
```

In [51]: `zoom_model=model1(X_train_zoom,X_cv_zoom,X_test_zoom,y_train,y_cv,y_test)`

Model: "functional_19"

Layer (type)	Output Shape	Param #	Connected to
input_6 (InputLayer)	[(None, 32, 32, 3)]	0	
conv2d_184 (Conv2D)	(None, 32, 32, 27)	324	input_6[0][0]
batch_normalization_180 (Batch Normalization)	(None, 32, 32, 27)	108	conv2d_184[0]
activation_180 (Activation)	(None, 32, 32, 27)	0	batch_normalization_180[0][0]
conv2d_185 (Conv2D)	(None, 32, 32, 27)	6561	activation_180[0][0]
dropout_140 (Dropout)	(None, 32, 32, 27)	0	conv2d_185[0]
concatenate_160 (Concatenate)	(None, 32, 32, 54)	0	conv2d_184[0] dropout_140[0]
batch_normalization_181 (Batch Normalization)	(None, 32, 32, 54)	216	concatenate_160[0][0]
activation_181 (Activation)	(None, 32, 32, 54)	0	batch_normalization_181[0][0]
conv2d_186 (Conv2D)	(None, 32, 32, 27)	13122	activation_181[0][0]
dropout_141 (Dropout)	(None, 32, 32, 27)	0	conv2d_186[0]
concatenate_161 (Concatenate)	(None, 32, 32, 81)	0	concatenate_160[0][0] dropout_141[0]

batch_normalization_182 (BatchN	(None, 32, 32, 81)	324	concatenate_161[0][0]
activation_182 (Activation)	(None, 32, 32, 81)	0	batch_normalization_182[0][0]
conv2d_187 (Conv2D)	(None, 32, 32, 27)	19683	activation_182[0][0]
dropout_142 (Dropout)	(None, 32, 32, 27)	0	conv2d_187[0][0]
concatenate_162 (Concatenate)	(None, 32, 32, 108)	0	concatenate_161[0][0]
			dropout_142[0][0]
batch_normalization_183 (BatchN	(None, 32, 32, 108)	432	concatenate_162[0][0]
activation_183 (Activation)	(None, 32, 32, 108)	0	batch_normalization_183[0][0]
conv2d_188 (Conv2D)	(None, 32, 32, 27)	26244	activation_183[0][0]
dropout_143 (Dropout)	(None, 32, 32, 27)	0	conv2d_188[0][0]
concatenate_163 (Concatenate)	(None, 32, 32, 135)	0	concatenate_162[0][0]
			dropout_143[0][0]
batch_normalization_184 (BatchN	(None, 32, 32, 135)	540	concatenate_163[0][0]
activation_184 (Activation)	(None, 32, 32, 135)	0	batch_normalization_184[0][0]
conv2d_189 (Conv2D)	(None, 32, 32, 27)	32805	activation_184[0][0]

dropout_144 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_189[0]
concatenate_164 (Concatenate) 3[0][0]	(None, 32, 32, 162)	0	concatenate_16 dropout_144[0]
batch_normalization_185 (BatchN 4[0][0])	(None, 32, 32, 162)	648	concatenate_16
activation_185 (Activation) ation_185[0][0]	(None, 32, 32, 162)	0	batch_normaliz
conv2d_190 (Conv2D) [0][0]	(None, 32, 32, 27)	39366	activation_185
dropout_145 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_190[0]
concatenate_165 (Concatenate) 4[0][0]	(None, 32, 32, 189)	0	concatenate_16 dropout_145[0]
batch_normalization_186 (BatchN 5[0][0])	(None, 32, 32, 189)	756	concatenate_16
activation_186 (Activation) ation_186[0][0]	(None, 32, 32, 189)	0	batch_normaliz
conv2d_191 (Conv2D) [0][0]	(None, 32, 32, 27)	45927	activation_186
dropout_146 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_191[0]
concatenate_166 (Concatenate) 5[0][0]	(None, 32, 32, 216)	0	concatenate_16 dropout_146[0]
batch_normalization_187 (BatchN 6[0][0])	(None, 32, 32, 216)	864	concatenate_16

activation_187 (Activation) activation_187[0][0]	(None, 32, 32, 216)	0	batch_normaliz
conv2d_192 (Conv2D) [0][0]	(None, 32, 32, 27)	52488	activation_187
dropout_147 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_192[0]
concatenate_167 (Concatenate) 6[0][0] [0]	(None, 32, 32, 243)	0	concatenate_16 dropout_147[0]
batch_normalization_188 (BatchN 7[0][0])	(None, 32, 32, 243)	972	concatenate_16
activation_188 (Activation) activation_188[0][0]	(None, 32, 32, 243)	0	batch_normaliz
conv2d_193 (Conv2D) [0][0]	(None, 32, 32, 27)	6561	activation_188
dropout_148 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_193[0]
average_pooling2d_20 (AveragePo [0])	(None, 16, 16, 27)	0	dropout_148[0]
batch_normalization_189 (BatchN g2d_20[0][0])	(None, 16, 16, 27)	108	average_poolin
activation_189 (Activation) ation_189[0][0]	(None, 16, 16, 27)	0	batch_normaliz
conv2d_194 (Conv2D) [0][0]	(None, 16, 16, 27)	6561	activation_189
dropout_149 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_194[0]
concatenate_168 (Concatenate) g2d_20[0][0]	(None, 16, 16, 54)	0	average_poolin

dropout_149[0]

[0]

batch_normalization_190 (Batch Normalization)	(None, 16, 16, 54)	216	concatenate_168[0][0]
activation_190 (Activation)	(None, 16, 16, 54)	0	batch_normalization_190[0][0]
conv2d_195 (Conv2D)	(None, 16, 16, 27)	13122	activation_190[0][0]
dropout_150 (Dropout)	(None, 16, 16, 27)	0	conv2d_195[0]
concatenate_169 (Concatenate)	(None, 16, 16, 81)	0	concatenate_168[0][0] dropout_150[0]
batch_normalization_191 (Batch Normalization)	(None, 16, 16, 81)	324	concatenate_169[0][0]
activation_191 (Activation)	(None, 16, 16, 81)	0	batch_normalization_191[0][0]
conv2d_196 (Conv2D)	(None, 16, 16, 27)	19683	activation_191[0][0]
dropout_151 (Dropout)	(None, 16, 16, 27)	0	conv2d_196[0]
concatenate_170 (Concatenate)	(None, 16, 16, 108)	0	concatenate_169[0][0] dropout_151[0]
batch_normalization_192 (Batch Normalization)	(None, 16, 16, 108)	432	concatenate_170[0][0]
activation_192 (Activation)	(None, 16, 16, 108)	0	batch_normalization_192[0][0]
conv2d_197 (Conv2D)	(None, 16, 16, 27)	26244	activation_192

[0][0]

dropout_152 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_197[0]
concatenate_171 (Concatenate) 0[0][0]	(None, 16, 16, 135)	0	concatenate_17 dropout_152[0]
batch_normalization_193 (BatchN 1[0][0])	(None, 16, 16, 135)	540	concatenate_17
activation_193 (Activation) ation_193[0][0]	(None, 16, 16, 135)	0	batch_normaliz
conv2d_198 (Conv2D) [0][0]	(None, 16, 16, 27)	32805	activation_193
dropout_153 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_198[0]
concatenate_172 (Concatenate) 1[0][0]	(None, 16, 16, 162)	0	concatenate_17 dropout_153[0]
batch_normalization_194 (BatchN 2[0][0])	(None, 16, 16, 162)	648	concatenate_17
activation_194 (Activation) ation_194[0][0]	(None, 16, 16, 162)	0	batch_normaliz
conv2d_199 (Conv2D) [0][0]	(None, 16, 16, 27)	39366	activation_194
dropout_154 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_199[0]
concatenate_173 (Concatenate) 2[0][0]	(None, 16, 16, 189)	0	concatenate_17 dropout_154[0]

[0]

batch_normalization_195 (BatchN	(None, 16, 16, 189)	756	concatenate_173[0][0]
activation_195 (Activation)	(None, 16, 16, 189)	0	batch_normalization_195[0][0]
conv2d_200 (Conv2D)	(None, 16, 16, 27)	45927	activation_195[0][0]
dropout_155 (Dropout)	(None, 16, 16, 27)	0	conv2d_200[0][0]
concatenate_174 (Concatenate)	(None, 16, 16, 216)	0	concatenate_173[0][0]
			dropout_155[0][0]
batch_normalization_196 (BatchN	(None, 16, 16, 216)	864	concatenate_174[0][0]
activation_196 (Activation)	(None, 16, 16, 216)	0	batch_normalization_196[0][0]
conv2d_201 (Conv2D)	(None, 16, 16, 27)	52488	activation_196[0][0]
dropout_156 (Dropout)	(None, 16, 16, 27)	0	conv2d_201[0][0]
concatenate_175 (Concatenate)	(None, 16, 16, 243)	0	concatenate_174[0][0]
			dropout_156[0][0]
batch_normalization_197 (BatchN	(None, 16, 16, 243)	972	concatenate_175[0][0]
activation_197 (Activation)	(None, 16, 16, 243)	0	batch_normalization_197[0][0]
conv2d_202 (Conv2D)	(None, 16, 16, 27)	6561	activation_197[0][0]
dropout_157 (Dropout)	(None, 16, 16, 27)	0	conv2d_202[0][0]

[0]

average_pooling2d_21 (AveragePo	(None, 8, 8, 27)	0	dropout_157[0]
batch_normalization_198 (BatchN	(None, 8, 8, 27)	108	average_poolin
activation_198 (Activation)	(None, 8, 8, 27)	0	batch_normaliz
conv2d_203 (Conv2D)	(None, 8, 8, 27)	6561	activation_198
dropout_158 (Dropout)	(None, 8, 8, 27)	0	conv2d_203[0]
concatenate_176 (Concatenate)	(None, 8, 8, 54)	0	average_poolin
batch_normalization_199 (BatchN	(None, 8, 8, 54)	216	concatenate_17
activation_199 (Activation)	(None, 8, 8, 54)	0	batch_normaliz
conv2d_204 (Conv2D)	(None, 8, 8, 27)	13122	activation_199
dropout_159 (Dropout)	(None, 8, 8, 27)	0	conv2d_204[0]
concatenate_177 (Concatenate)	(None, 8, 8, 81)	0	concatenate_17
batch_normalization_200 (BatchN	(None, 8, 8, 81)	324	concatenate_17
activation_200 (Activation)	(None, 8, 8, 81)	0	batch_normaliz

<u>conv2d_205 (Conv2D)</u> [0][0]	(None, 8, 8, 27)	19683	activation_200
<u>dropout_160 (Dropout)</u> [0]	(None, 8, 8, 27)	0	conv2d_205[0]
<u>concatenate_178 (Concatenate)</u> 7[0][0] [0]	(None, 8, 8, 108)	0	concatenate_17 dropout_160[0]
<u>batch_normalization_201 (BatchN</u> 8[0][0]	(None, 8, 8, 108)	432	concatenate_17
<u>activation_201 (Activation)</u> ation_201[0][0]	(None, 8, 8, 108)	0	batch_normaliz
<u>conv2d_206 (Conv2D)</u> [0][0]	(None, 8, 8, 27)	26244	activation_201
<u>dropout_161 (Dropout)</u> [0]	(None, 8, 8, 27)	0	conv2d_206[0]
<u>concatenate_179 (Concatenate)</u> 8[0][0] [0]	(None, 8, 8, 135)	0	concatenate_17 dropout_161[0]
<u>batch_normalization_202 (BatchN</u> 9[0][0]	(None, 8, 8, 135)	540	concatenate_17
<u>activation_202 (Activation)</u> ation_202[0][0]	(None, 8, 8, 135)	0	batch_normaliz
<u>conv2d_207 (Conv2D)</u> [0][0]	(None, 8, 8, 27)	32805	activation_202
<u>dropout_162 (Dropout)</u> [0]	(None, 8, 8, 27)	0	conv2d_207[0]
<u>concatenate_180 (Concatenate)</u> 9[0][0]	(None, 8, 8, 162)	0	concatenate_17 dropout_162[0]

[0]

batch_normalization_203 (BatchN	(None, 8, 8, 162)	648	concatenate_18
0[0][0]			
activation_203 (Activation)	(None, 8, 8, 162)	0	batch_normaliz
ation_203[0][0]			
conv2d_208 (Conv2D)	(None, 8, 8, 27)	39366	activation_203
[0][0]			
dropout_163 (Dropout)	(None, 8, 8, 27)	0	conv2d_208[0]
[0]			
concatenate_181 (Concatenate)	(None, 8, 8, 189)	0	concatenate_18
0[0][0]			dropout_163[0]
[0]			
batch_normalization_204 (BatchN	(None, 8, 8, 189)	756	concatenate_18
1[0][0]			
activation_204 (Activation)	(None, 8, 8, 189)	0	batch_normaliz
ation_204[0][0]			
conv2d_209 (Conv2D)	(None, 8, 8, 27)	45927	activation_204
[0][0]			
dropout_164 (Dropout)	(None, 8, 8, 27)	0	conv2d_209[0]
[0]			
concatenate_182 (Concatenate)	(None, 8, 8, 216)	0	concatenate_18
1[0][0]			dropout_164[0]
[0]			
batch_normalization_205 (BatchN	(None, 8, 8, 216)	864	concatenate_18
2[0][0]			
activation_205 (Activation)	(None, 8, 8, 216)	0	batch_normaliz
ation_205[0][0]			
conv2d_210 (Conv2D)	(None, 8, 8, 27)	52488	activation_205
[0][0]			

<u>dropout_165</u> (Dropout)	(None, 8, 8, 27)	0	conv2d_210[0]
<u>concatenate_183</u> (Concatenate)	(None, 8, 8, 243)	0	concatenate_182[0][0]
			dropout_165[0]
<u>batch_normalization_206</u> (BatchN	(None, 8, 8, 243)	972	concatenate_183[0][0]
<u>activation_206</u> (Activation)	(None, 8, 8, 243)	0	batch_normaliz
ation_206[0][0]			
<u>conv2d_211</u> (Conv2D)	(None, 8, 8, 27)	6561	activation_206
[0][0]			
<u>dropout_166</u> (Dropout)	(None, 8, 8, 27)	0	conv2d_211[0]
[0]			
<u>average_pooling2d_22</u> (AveragePo	(None, 4, 4, 27)	0	dropout_166[0]
[0]			
<u>batch_normalization_207</u> (BatchN	(None, 4, 4, 27)	108	average_poolin
g2d_22[0][0]			
<u>activation_207</u> (Activation)	(None, 4, 4, 27)	0	batch_normaliz
ation_207[0][0]			
<u>conv2d_212</u> (Conv2D)	(None, 4, 4, 27)	6561	activation_207
[0][0]			
<u>dropout_167</u> (Dropout)	(None, 4, 4, 27)	0	conv2d_212[0]
[0]			
<u>concatenate_184</u> (Concatenate)	(None, 4, 4, 54)	0	average_poolin
g2d_22[0][0]			dropout_167[0]
[0]			
<u>batch_normalization_208</u> (BatchN	(None, 4, 4, 54)	216	concatenate_184[0][0]
[0][0]			

activation_208 (Activation) activation_208[0][0]	(None, 4, 4, 54)	0	batch_normaliz
conv2d_213 (Conv2D) [0][0]	(None, 4, 4, 27)	13122	activation_208
dropout_168 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_213[0]
concatenate_185 (Concatenate) 4[0][0] [0]	(None, 4, 4, 81)	0	concatenate_18 dropout_168[0]
batch_normalization_209 (BatchN 5[0][0])	(None, 4, 4, 81)	324	concatenate_18
activation_209 (Activation) activation_209[0][0]	(None, 4, 4, 81)	0	batch_normaliz
conv2d_214 (Conv2D) [0][0]	(None, 4, 4, 27)	19683	activation_209
dropout_169 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_214[0]
concatenate_186 (Concatenate) 5[0][0] [0]	(None, 4, 4, 108)	0	concatenate_18 dropout_169[0]
batch_normalization_210 (BatchN 6[0][0])	(None, 4, 4, 108)	432	concatenate_18
activation_210 (Activation) activation_210[0][0]	(None, 4, 4, 108)	0	batch_normaliz
conv2d_215 (Conv2D) [0][0]	(None, 4, 4, 27)	26244	activation_210
dropout_170 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_215[0]

concatenate_187 (Concatenate)	(None, 4, 4, 135)	0	concatenate_186[0][0]
			dropout_170[0]
			[0]
batch_normalization_211 (Batch Normalization)	(None, 4, 4, 135)	540	concatenate_187[0][0]
activation_211 (Activation)	(None, 4, 4, 135)	0	batch_normalization_211[0][0]
conv2d_216 (Conv2D)	(None, 4, 4, 27)	32805	activation_211[0][0]
dropout_171 (Dropout)	(None, 4, 4, 27)	0	conv2d_216[0]
			[0]
concatenate_188 (Concatenate)	(None, 4, 4, 162)	0	concatenate_187[0][0]
			dropout_171[0]
			[0]
batch_normalization_212 (Batch Normalization)	(None, 4, 4, 162)	648	concatenate_188[0][0]
activation_212 (Activation)	(None, 4, 4, 162)	0	batch_normalization_212[0][0]
conv2d_217 (Conv2D)	(None, 4, 4, 27)	39366	activation_212[0][0]
dropout_172 (Dropout)	(None, 4, 4, 27)	0	conv2d_217[0]
			[0]
concatenate_189 (Concatenate)	(None, 4, 4, 189)	0	concatenate_188[0][0]
			dropout_172[0]
			[0]
batch_normalization_213 (Batch Normalization)	(None, 4, 4, 189)	756	concatenate_189[0][0]
activation_213 (Activation)	(None, 4, 4, 189)	0	batch_normalization_213[0][0]

conv2d_218 (Conv2D) [0][0]	(None, 4, 4, 27)	45927	activation_213
dropout_173 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_218[0]
concatenate_190 (Concatenate) 9[0][0] [0]	(None, 4, 4, 216)	0	concatenate_18 dropout_173[0]
batch_normalization_214 (BatchN 0[0][0]	(None, 4, 4, 216)	864	concatenate_19
activation_214 (Activation) ation_214[0][0]	(None, 4, 4, 216)	0	batch_normaliz
conv2d_219 (Conv2D) [0][0]	(None, 4, 4, 27)	52488	activation_214
dropout_174 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_219[0]
concatenate_191 (Concatenate) 0[0][0] [0]	(None, 4, 4, 243)	0	concatenate_19 dropout_174[0]
batch_normalization_215 (BatchN 1[0][0]	(None, 4, 4, 243)	972	concatenate_19
activation_215 (Activation) ation_215[0][0]	(None, 4, 4, 243)	0	batch_normaliz
average_pooling2d_23 (AveragePo [0][0]	(None, 2, 2, 243)	0	activation_215
flatten_9 (Flatten) g2d_23[0][0]	(None, 972)	0	average_poolin
dense_5 (Dense) [0]	(None, 10)	9730	flatten_9[0]
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[illegible]

Model: "functional_21"

Layer (type)	Output Shape	Param #	Connected to
input_6 (InputLayer)	[(None, 32, 32, 3)]	0	
conv2d_184 (Conv2D)	(None, 32, 32, 27)	324	input_6[0][0]
batch_normalization_180 (Batch Normalization)	(None, 32, 32, 27)	108	conv2d_184[0]
activation_180 (Activation)	(None, 32, 32, 27)	0	batch_normalization_180[0][0]
conv2d_185 (Conv2D)	(None, 32, 32, 27)	6561	activation_180[0][0]
dropout_140 (Dropout)	(None, 32, 32, 27)	0	conv2d_185[0]
concatenate_160 (Concatenate)	(None, 32, 32, 54)	0	conv2d_184[0] dropout_140[0]
batch_normalization_181 (Batch Normalization)	(None, 32, 32, 54)	216	concatenate_160[0][0]
activation_181 (Activation)	(None, 32, 32, 54)	0	batch_normalization_181[0][0]
conv2d_186 (Conv2D)	(None, 32, 32, 27)	13122	activation_181[0][0]

<u>dropout_141</u> (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_186[0]
<u>concatenate_161</u> (Concatenate) 0[0][0] [0]	(None, 32, 32, 81)	0	concatenate_16 dropout_141[0]
<u>batch_normalization_182</u> (BatchN 1[0][0])	(None, 32, 32, 81)	324	concatenate_16
<u>activation_182</u> (Activation) activation_182[0][0]	(None, 32, 32, 81)	0	batch_normaliz
<u>conv2d_187</u> (Conv2D) [0][0]	(None, 32, 32, 27)	19683	activation_182
<u>dropout_142</u> (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_187[0]
<u>concatenate_162</u> (Concatenate) 1[0][0] [0]	(None, 32, 32, 108)	0	concatenate_16 dropout_142[0]
<u>batch_normalization_183</u> (BatchN 2[0][0])	(None, 32, 32, 108)	432	concatenate_16
<u>activation_183</u> (Activation) activation_183[0][0]	(None, 32, 32, 108)	0	batch_normaliz
<u>conv2d_188</u> (Conv2D) [0][0]	(None, 32, 32, 27)	26244	activation_183
<u>dropout_143</u> (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_188[0]
<u>concatenate_163</u> (Concatenate) 2[0][0] [0]	(None, 32, 32, 135)	0	concatenate_16 dropout_143[0]
<u>batch_normalization_184</u> (BatchN	(None, 32, 32, 135)	540	concatenate_16

3[0][0]

activation_184 (Activation) activation_184[0][0]	(None, 32, 32, 135)	0	batch_normaliz
conv2d_189 (Conv2D) [0][0]	(None, 32, 32, 27)	32805	activation_184
dropout_144 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_189[0]
concatenate_164 (Concatenate) 3[0][0] [0]	(None, 32, 32, 162)	0	concatenate_16 dropout_144[0]
batch_normalization_185 (BatchN 4[0][0]	(None, 32, 32, 162)	648	concatenate_16
activation_185 (Activation) activation_185[0][0]	(None, 32, 32, 162)	0	batch_normaliz
conv2d_190 (Conv2D) [0][0]	(None, 32, 32, 27)	39366	activation_185
dropout_145 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_190[0]
concatenate_165 (Concatenate) 4[0][0] [0]	(None, 32, 32, 189)	0	concatenate_16 dropout_145[0]
batch_normalization_186 (BatchN 5[0][0]	(None, 32, 32, 189)	756	concatenate_16
activation_186 (Activation) activation_186[0][0]	(None, 32, 32, 189)	0	batch_normaliz
conv2d_191 (Conv2D) [0][0]	(None, 32, 32, 27)	45927	activation_186
dropout_146 (Dropout) [0]	(None, 32, 32, 27)	0	conv2d_191[0]

<u>concatenate_166</u> (Concatenate)	(None, 32, 32, 216)	0	<u>concatenate_165</u> [0][0]	<u>dropout_146</u> [0]
<u>batch_normalization_187</u> (BatchN	(None, 32, 32, 216)	864	<u>batch_normalization_187</u> [0][0]	<u>concatenate_166</u> [0][0]
<u>activation_187</u> (Activation)	(None, 32, 32, 216)	0	<u>activation_187</u> [0][0]	<u>batch_normalization_187</u> [0][0]
<u>conv2d_192</u> (Conv2D)	(None, 32, 32, 27)	52488	<u>conv2d_192</u> [0][0]	<u>activation_187</u> [0][0]
<u>dropout_147</u> (Dropout)	(None, 32, 32, 27)	0	<u>dropout_147</u> [0]	<u>conv2d_192</u> [0]
<u>concatenate_167</u> (Concatenate)	(None, 32, 32, 243)	0	<u>concatenate_166</u> [0][0]	<u>dropout_147</u> [0]
<u>batch_normalization_188</u> (BatchN	(None, 32, 32, 243)	972	<u>batch_normalization_188</u> [0][0]	<u>concatenate_167</u> [0][0]
<u>activation_188</u> (Activation)	(None, 32, 32, 243)	0	<u>activation_188</u> [0][0]	<u>batch_normalization_188</u> [0][0]
<u>conv2d_193</u> (Conv2D)	(None, 32, 32, 27)	6561	<u>conv2d_193</u> [0][0]	<u>activation_188</u> [0][0]
<u>dropout_148</u> (Dropout)	(None, 32, 32, 27)	0	<u>dropout_148</u> [0]	<u>conv2d_193</u> [0]
<u>average_pooling2d_20</u> (AveragePo	(None, 16, 16, 27)	0	<u>average_pooling2d_20</u> [0]	<u>dropout_148</u> [0]
<u>batch_normalization_189</u> (BatchN	(None, 16, 16, 27)	108	<u>batch_normalization_189</u> [0][0]	<u>average_pooling2d_20</u> [0][0]
<u>activation_189</u> (Activation)	(None, 16, 16, 27)	0	<u>activation_189</u> [0][0]	<u>batch_normalization_189</u> [0][0]

conv2d_194 (Conv2D) [0][0]	(None, 16, 16, 27)	6561	activation_189
dropout_149 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_194[0]
concatenate_168 (Concatenate) g2d_20[0][0] [0]	(None, 16, 16, 54)	0	average_poolin dropout_149[0]
batch_normalization_190 (BatchN 8[0][0]	(None, 16, 16, 54)	216	concatenate_16
activation_190 (Activation) ation_190[0][0]	(None, 16, 16, 54)	0	batch_normaliz
conv2d_195 (Conv2D) [0][0]	(None, 16, 16, 27)	13122	activation_190
dropout_150 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_195[0]
concatenate_169 (Concatenate) 8[0][0] [0]	(None, 16, 16, 81)	0	concatenate_16 dropout_150[0]
batch_normalization_191 (BatchN 9[0][0]	(None, 16, 16, 81)	324	concatenate_16
activation_191 (Activation) ation_191[0][0]	(None, 16, 16, 81)	0	batch_normaliz
conv2d_196 (Conv2D) [0][0]	(None, 16, 16, 27)	19683	activation_191
dropout_151 (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_196[0]
concatenate_170 (Concatenate) 9[0][0] [0]	(None, 16, 16, 108)	0	concatenate_16 dropout_151[0]

batch_normalization_192 (Batch Normalization)	(None, 16, 16, 108)	432	concatenate_170[0][0]
activation_192 (Activation)	(None, 16, 16, 108)	0	batch_normalization_192[0][0]
conv2d_197 (Conv2D)	(None, 16, 16, 27)	26244	activation_192[0][0]
dropout_152 (Dropout)	(None, 16, 16, 27)	0	conv2d_197[0]
concatenate_171 (Concatenate)	(None, 16, 16, 135)	0	concatenate_170[0][0] dropout_152[0]
batch_normalization_193 (Batch Normalization)	(None, 16, 16, 135)	540	concatenate_171[0][0]
activation_193 (Activation)	(None, 16, 16, 135)	0	batch_normalization_193[0][0]
conv2d_198 (Conv2D)	(None, 16, 16, 27)	32805	activation_193[0][0]
dropout_153 (Dropout)	(None, 16, 16, 27)	0	conv2d_198[0]
concatenate_172 (Concatenate)	(None, 16, 16, 162)	0	concatenate_171[0][0] dropout_153[0]
batch_normalization_194 (Batch Normalization)	(None, 16, 16, 162)	648	concatenate_172[0][0]
activation_194 (Activation)	(None, 16, 16, 162)	0	batch_normalization_194[0][0]
conv2d_199 (Conv2D)	(None, 16, 16, 27)	39366	activation_194[0][0]

<u>dropout_154</u> (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_199[0]
<u>concatenate_173</u> (Concatenate) 2[0][0] [0]	(None, 16, 16, 189)	0	concatenate_17 dropout_154[0]
<u>batch_normalization_195</u> (BatchN 3[0][0])	(None, 16, 16, 189)	756	concatenate_17
<u>activation_195</u> (Activation) activation_195[0][0]	(None, 16, 16, 189)	0	batch_normaliz ation_195[0][0]
<u>conv2d_200</u> (Conv2D) [0][0]	(None, 16, 16, 27)	45927	activation_195
<u>dropout_155</u> (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_200[0]
<u>concatenate_174</u> (Concatenate) 3[0][0] [0]	(None, 16, 16, 216)	0	concatenate_17 dropout_155[0]
<u>batch_normalization_196</u> (BatchN 4[0][0])	(None, 16, 16, 216)	864	concatenate_17
<u>activation_196</u> (Activation) activation_196[0][0]	(None, 16, 16, 216)	0	batch_normaliz ation_196[0][0]
<u>conv2d_201</u> (Conv2D) [0][0]	(None, 16, 16, 27)	52488	activation_196
<u>dropout_156</u> (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_201[0]
<u>concatenate_175</u> (Concatenate) 4[0][0] [0]	(None, 16, 16, 243)	0	concatenate_17 dropout_156[0]
<u>batch_normalization_197</u> (BatchN 5[0][0])	(None, 16, 16, 243)	972	concatenate_17

<u>activation_197</u> (Activation) activation_197[0][0]	(None, 16, 16, 243)	0	batch_normaliz
<u>conv2d_202</u> (Conv2D) [0][0]	(None, 16, 16, 27)	6561	activation_197
<u>dropout_157</u> (Dropout) [0]	(None, 16, 16, 27)	0	conv2d_202[0]
<u>average_pooling2d_21</u> (AveragePo [0]	(None, 8, 8, 27)	0	dropout_157[0]
<u>batch_normalization_198</u> (BatchN g2d_21[0][0]	(None, 8, 8, 27)	108	average_poolin
<u>activation_198</u> (Activation) activation_198[0][0]	(None, 8, 8, 27)	0	batch_normaliz
<u>conv2d_203</u> (Conv2D) [0][0]	(None, 8, 8, 27)	6561	activation_198
<u>dropout_158</u> (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_203[0]
<u>concatenate_176</u> (Concatenate) g2d_21[0][0] [0]	(None, 8, 8, 54)	0	average_poolin dropout_158[0]
<u>batch_normalization_199</u> (BatchN 6[0][0]	(None, 8, 8, 54)	216	concatenate_17
<u>activation_199</u> (Activation) activation_199[0][0]	(None, 8, 8, 54)	0	batch_normaliz
<u>conv2d_204</u> (Conv2D) [0][0]	(None, 8, 8, 27)	13122	activation_199
<u>dropout_159</u> (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_204[0]
<u>concatenate_177</u> (Concatenate)	(None, 8, 8, 81)	0	concatenate_17

6[0][0]

dropout_159[0]

[0]

batch_normalization_200 (BatchN	(None, 8, 8, 81)	324	concatenate_17
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activation_200 (Activation)	(None, 8, 8, 81)	0	batch_normaliz
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conv2d_205 (Conv2D)	(None, 8, 8, 27)	19683	activation_200
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dropout_160 (Dropout)	(None, 8, 8, 27)	0	conv2d_205[0]
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concatenate_178 (Concatenate)	(None, 8, 8, 108)	0	concatenate_17
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[0]

batch_normalization_201 (BatchN	(None, 8, 8, 108)	432	concatenate_17
---------------------------------	-------------------	-----	----------------

activation_201 (Activation)	(None, 8, 8, 108)	0	batch_normaliz
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conv2d_206 (Conv2D)	(None, 8, 8, 27)	26244	activation_201
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dropout_161 (Dropout)	(None, 8, 8, 27)	0	conv2d_206[0]
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concatenate_179 (Concatenate)	(None, 8, 8, 135)	0	concatenate_17
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[0]

batch_normalization_202 (BatchN	(None, 8, 8, 135)	540	concatenate_17
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activation_202 (Activation)	(None, 8, 8, 135)	0	batch_normaliz
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conv2d_207 (Conv2D) [0][0]	(None, 8, 8, 27)	32805	activation_202
dropout_162 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_207[0]
concatenate_180 (Concatenate) 9[0][0] [0]	(None, 8, 8, 162)	0	concatenate_17 dropout_162[0]
batch_normalization_203 (BatchN 0[0][0]	(None, 8, 8, 162)	648	concatenate_18
activation_203 (Activation) ation_203[0][0]	(None, 8, 8, 162)	0	batch_normaliz
conv2d_208 (Conv2D) [0][0]	(None, 8, 8, 27)	39366	activation_203
dropout_163 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_208[0]
concatenate_181 (Concatenate) 0[0][0] [0]	(None, 8, 8, 189)	0	concatenate_18 dropout_163[0]
batch_normalization_204 (BatchN 1[0][0]	(None, 8, 8, 189)	756	concatenate_18
activation_204 (Activation) ation_204[0][0]	(None, 8, 8, 189)	0	batch_normaliz
conv2d_209 (Conv2D) [0][0]	(None, 8, 8, 27)	45927	activation_204
dropout_164 (Dropout) [0]	(None, 8, 8, 27)	0	conv2d_209[0]
concatenate_182 (Concatenate) 1[0][0] [0]	(None, 8, 8, 216)	0	concatenate_18 dropout_164[0]

batch_normalization_205 (BatchN	(None, 8, 8, 216)	864	concatenate_18
2[0][0]			
activation_205 (Activation)	(None, 8, 8, 216)	0	batch_normaliz
ation_205[0][0]			
conv2d_210 (Conv2D)	(None, 8, 8, 27)	52488	activation_205
[0][0]			
dropout_165 (Dropout)	(None, 8, 8, 27)	0	conv2d_210[0]
[0]			
concatenate_183 (Concatenate)	(None, 8, 8, 243)	0	concatenate_18
2[0][0]			
			dropout_165[0]
[0]			
batch_normalization_206 (BatchN	(None, 8, 8, 243)	972	concatenate_18
3[0][0]			
activation_206 (Activation)	(None, 8, 8, 243)	0	batch_normaliz
ation_206[0][0]			
conv2d_211 (Conv2D)	(None, 8, 8, 27)	6561	activation_206
[0][0]			
dropout_166 (Dropout)	(None, 8, 8, 27)	0	conv2d_211[0]
[0]			
average_pooling2d_22 (AveragePo	(None, 4, 4, 27)	0	dropout_166[0]
[0]			
batch_normalization_207 (BatchN	(None, 4, 4, 27)	108	average_poolin
g2d_22[0][0]			
activation_207 (Activation)	(None, 4, 4, 27)	0	batch_normaliz
ation_207[0][0]			
conv2d_212 (Conv2D)	(None, 4, 4, 27)	6561	activation_207
[0][0]			
dropout_167 (Dropout)	(None, 4, 4, 27)	0	conv2d_212[0]
[0]			

<u>concatenate_184</u> (Concatenate) g2d_22[0][0]	(None, 4, 4, 54)	0	average_poolin dropout_167[0]
<u>batch_normalization_208</u> (BatchN 4[0][0])	(None, 4, 4, 54)	216	concatenate_18 4[0][0]
<u>activation_208</u> (Activation) ation_208[0][0]	(None, 4, 4, 54)	0	batch_normaliz ation_208[0][0]
<u>conv2d_213</u> (Conv2D) [0][0]	(None, 4, 4, 27)	13122	activation_208
<u>dropout_168</u> (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_213[0]
<u>concatenate_185</u> (Concatenate) 4[0][0]	(None, 4, 4, 81)	0	concatenate_18 dropout_168[0]
<u>batch_normalization_209</u> (BatchN 5[0][0])	(None, 4, 4, 81)	324	concatenate_18 5[0][0]
<u>activation_209</u> (Activation) ation_209[0][0]	(None, 4, 4, 81)	0	batch_normaliz ation_209[0][0]
<u>conv2d_214</u> (Conv2D) [0][0]	(None, 4, 4, 27)	19683	activation_209
<u>dropout_169</u> (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_214[0]
<u>concatenate_186</u> (Concatenate) 5[0][0]	(None, 4, 4, 108)	0	concatenate_18 dropout_169[0]
<u>batch_normalization_210</u> (BatchN 6[0][0])	(None, 4, 4, 108)	432	concatenate_18 6[0][0]
<u>activation_210</u> (Activation)	(None, 4, 4, 108)	0	batch_normaliz

ation_210[0][0]

conv2d_215 (Conv2D) [0][0]	(None, 4, 4, 27)	26244	activation_210 [0][0]
dropout_170 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_215[0]
concatenate_187 (Concatenate) 6[0][0] [0]	(None, 4, 4, 135)	0	concatenate_18 dropout_170[0]
batch_normalization_211 (BatchN 7[0][0]	(None, 4, 4, 135)	540	concatenate_18
activation_211 (Activation) ation_211[0][0]	(None, 4, 4, 135)	0	batch_normaliz
conv2d_216 (Conv2D) [0][0]	(None, 4, 4, 27)	32805	activation_211
dropout_171 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_216[0]
concatenate_188 (Concatenate) 7[0][0] [0]	(None, 4, 4, 162)	0	concatenate_18 dropout_171[0]
batch_normalization_212 (BatchN 8[0][0]	(None, 4, 4, 162)	648	concatenate_18
activation_212 (Activation) ation_212[0][0]	(None, 4, 4, 162)	0	batch_normaliz
conv2d_217 (Conv2D) [0][0]	(None, 4, 4, 27)	39366	activation_212
dropout_172 (Dropout) [0]	(None, 4, 4, 27)	0	conv2d_217[0]
concatenate_189 (Concatenate) 8[0][0]	(None, 4, 4, 189)	0	concatenate_18

dropout_172[0]

[0]

batch_normalization_213 (BatchN	(None, 4, 4, 189)	756	concatenate_189[0][0]
activation_213 (Activation)	(None, 4, 4, 189)	0	batch_normalization_213[0][0]
conv2d_218 (Conv2D)	(None, 4, 4, 27)	45927	activation_213[0][0]
dropout_173 (Dropout)	(None, 4, 4, 27)	0	conv2d_218[0]
concatenate_190 (Concatenate)	(None, 4, 4, 216)	0	concatenate_189[0][0]
			dropout_173[0]
			[0]
batch_normalization_214 (BatchN	(None, 4, 4, 216)	864	concatenate_190[0][0]
activation_214 (Activation)	(None, 4, 4, 216)	0	batch_normalization_214[0][0]
conv2d_219 (Conv2D)	(None, 4, 4, 27)	52488	activation_214[0][0]
dropout_174 (Dropout)	(None, 4, 4, 27)	0	conv2d_219[0]
concatenate_191 (Concatenate)	(None, 4, 4, 243)	0	concatenate_190[0][0]
			dropout_174[0]
			[0]
batch_normalization_215 (BatchN	(None, 4, 4, 243)	972	concatenate_191[0][0]
activation_215 (Activation)	(None, 4, 4, 243)	0	batch_normalization_215[0][0]
average_pooling2d_23 (AveragePo	(None, 2, 2, 243)	0	activation_215

[0][0]

```

=====
Total params: 984,231
Trainable params: 974,511
Non-trainable params: 9,720

```

```

*****after adding conv2d layer*****
Model: "sequential_4"

```

Layer (type)	Output Shape	Param #
functional_21 (Functional)	(None, 2, 2, 243)	984231
conv2d_220 (Conv2D)	(None, 1, 1, 10)	9730
flatten_10 (Flatten)	(None, 10)	0

```

Total params: 993,961
Trainable params: 984,241
Non-trainable params: 9,720

```

Epoch 1/10

```

2/391 [.....] - ETA: 1:00 - loss: 2.3922 - accuracy: 0.1133
WARNING:tensorflow:Callbacks method `on_train_batch_end` is slow compared
to the batch time (batch time: 0.0640s vs `on_train_batch_end` time: 0.1125s).
Check your callbacks.

```

Check your callbacks.

```

391/391 [=====] - 70s 179ms/step - loss: 1.3927 - accuracy: 0.4891 - val_loss: 1.5167 - val_accuracy: 0.5319

```

Epoch 2/10

```

391/391 [=====] - 71s 181ms/step - loss: 0.9652 - accuracy: 0.6538 - val_loss: 1.0307 - val_accuracy: 0.6496

```

Epoch 3/10

```

391/391 [=====] - 72s 184ms/step - loss: 0.7936 - accuracy: 0.7197 - val_loss: 0.8697 - val_accuracy: 0.7135

```

Epoch 4/10

```

391/391 [=====] - 72s 185ms/step - loss: 0.6904 - accuracy: 0.7550 - val_loss: 0.9004 - val_accuracy: 0.7335

```

Epoch 5/10

```

391/391 [=====] - 73s 186ms/step - loss: 0.6100 - accuracy: 0.7852 - val_loss: 0.6511 - val_accuracy: 0.7831

```

Epoch 6/10

```

391/391 [=====] - 73s 186ms/step - loss: 0.5501 - accuracy: 0.8064 - val_loss: 0.7025 - val_accuracy: 0.7700

```

Epoch 7/10

```

391/391 [=====] - 73s 186ms/step - loss: 0.5019 - accuracy: 0.8256 - val_loss: 0.7756 - val_accuracy: 0.7644

```

Epoch 8/10

```

391/391 [=====] - 73s 186ms/step - loss: 0.4642 - accuracy: 0.8456 - val_loss: 0.7756 - val_accuracy: 0.7644

```

```

racy: 0.8369 - val_loss: 0.4833 - val_accuracy: 0.8390
Epoch 9/10
391/391 [=====] - 73s 186ms/step - loss: 0.4341 - accu
racy: 0.8487 - val_loss: 0.4979 - val_accuracy: 0.8357
Epoch 10/10
391/391 [=====] - 73s 186ms/step - loss: 0.4054 - accu
racy: 0.8579 - val_loss: 0.3916 - val_accuracy: 0.8652
313/313 [=====] - 3s 11ms/step - loss: 0.5725 - accura
cy: 0.8204
Test loss: 0.5725135803222656
Test accuracy: 0.8203999996185303

```

```

In [4]: print("test accuracy without augumentation =", 0.7849000096321106)
print("test_accuracy with shifting =" , 0.5189999938011169)
print("test_accuracy with flipping =" , 0.7170000076293945)
print("test_accuracy with brightness =" , 0.7968000173568726)
print("test_accuracy with standadised =", 0.7972000241279602)
print("test_accuracy with zoom =", 0.8203999996185303)

```

```

test accuracy without augmentation = 0.7849000096321106
test_accuracy with shifting = 0.5189999938011169
test_accuracy with flipping = 0.7170000076293945
test_accuracy with brightness = 0.7968000173568726
test_accuracy with sytandadised = 0.7972000241279602
test_accuracy with zoom = 0.8203999996185303

```

Conclusion

- shifting perform worst
- so we can include rest other flipping ,brightness, zoom, standardize

Hyperparameters

- batch_size = 128
- num_classes = 10
- l = 8
- num_filter = 27
- compression = 1
- dropout_rate = 0.2

for me this configuration perform good as model also dont overfit

```

In [56]: # activate network as well as replace last dense layer with convet
input = layers.Input(shape=(img_height, img_width, channel,))
First_Conv2D = layers.Conv2D(num_filter, (2,2), use_bias=False ,padding='same')(

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)

base_model = Model(inputs=[input], outputs=[output])
base_model.summary()
print("^"*100)
print("*****after removing last dense layer*****")
print("^"*100)
base_model.layers.pop()
model2 = Model(base_model.input, base_model.layers[-3].output)
model2.summary()

print("^"*100)
print("*****after adding conv2d layer*****")

model = models.Sequential()
model.add(model2)
model.add(layers.Conv2D(10,(2,2),strides=[1,1],padding='valid',activation='softmax'))
model.add(layers.Flatten())
model.summary()
print("^"*100)

```

Model: "functional_23"

Layer (type)	Output Shape	Param #	Connected to
=====			
input_7 (InputLayer)	[(None, 32, 32, 3)]	0	
=====			
conv2d_221 (Conv2D)	(None, 32, 32, 27)	324	input_7[0][0]
=====			
batch_normalization_216 (Batch Normalization)	(None, 32, 32, 27)	108	conv2d_221[0]
=====			
activation_216 (Activation)	(None, 32, 32, 27)	0	batch_normalization_216[0][0]
=====			
conv2d_222 (Conv2D)	(None, 32, 32, 27)	6561	activation_216

[0][0]

concatenate_192 (Concatenate)	(None, 32, 32, 54)	0	conv2d_221[0]
[0]			conv2d_222[0]
[0]			
batch_normalization_217 (BatchN	(None, 32, 32, 54)	216	concatenate_19
2[0][0]			
activation_217 (Activation)	(None, 32, 32, 54)	0	batch_normaliz
ation_217[0][0]			
conv2d_223 (Conv2D)	(None, 32, 32, 27)	13122	activation_217
[0][0]			
concatenate_193 (Concatenate)	(None, 32, 32, 81)	0	concatenate_19
2[0][0]			conv2d_223[0]
[0]			
batch_normalization_218 (BatchN	(None, 32, 32, 81)	324	concatenate_19
3[0][0]			
activation_218 (Activation)	(None, 32, 32, 81)	0	batch_normaliz
ation_218[0][0]			
conv2d_224 (Conv2D)	(None, 32, 32, 27)	19683	activation_218
[0][0]			
concatenate_194 (Concatenate)	(None, 32, 32, 108)	0	concatenate_19
3[0][0]			conv2d_224[0]
[0]			
batch_normalization_219 (BatchN	(None, 32, 32, 108)	432	concatenate_19
4[0][0]			
activation_219 (Activation)	(None, 32, 32, 108)	0	batch_normaliz
ation_219[0][0]			
conv2d_225 (Conv2D)	(None, 32, 32, 27)	26244	activation_219
[0][0]			

concatenate_195 (Concatenate)	(None, 32, 32, 135)	0	concatenate_194[0][0]
			conv2d_225[0]
			[0]
batch_normalization_220 (Batch Normalization)	(None, 32, 32, 135)	540	concatenate_195[0][0]
activation_220 (Activation)	(None, 32, 32, 135)	0	batch_normalization_220[0][0]
conv2d_226 (Conv2D)	(None, 32, 32, 27)	32805	activation_220[0][0]
concatenate_196 (Concatenate)	(None, 32, 32, 162)	0	concatenate_195[0][0]
			conv2d_226[0]
			[0]
batch_normalization_221 (Batch Normalization)	(None, 32, 32, 162)	648	concatenate_196[0][0]
activation_221 (Activation)	(None, 32, 32, 162)	0	batch_normalization_221[0][0]
conv2d_227 (Conv2D)	(None, 32, 32, 27)	39366	activation_221[0][0]
concatenate_197 (Concatenate)	(None, 32, 32, 189)	0	concatenate_196[0][0]
			conv2d_227[0]
			[0]
batch_normalization_222 (Batch Normalization)	(None, 32, 32, 189)	756	concatenate_197[0][0]
activation_222 (Activation)	(None, 32, 32, 189)	0	batch_normalization_222[0][0]
conv2d_228 (Conv2D)	(None, 32, 32, 27)	45927	activation_222[0][0]
concatenate_198 (Concatenate)	(None, 32, 32, 216)	0	concatenate_197[0][0]
			conv2d_228[0]

[0]

batch_normalization_223 (BatchN	(None, 32, 32, 216)	864	concatenate_198[0][0]
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activation_223 (Activation)	(None, 32, 32, 216)	0	batch_normaliz
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conv2d_229 (Conv2D)	(None, 32, 32, 27)	52488	activation_223[0][0]
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concatenate_199 (Concatenate)	(None, 32, 32, 243)	0	concatenate_198[0][0]
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[0]

batch_normalization_224 (BatchN	(None, 32, 32, 243)	972	concatenate_199[0][0]
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activation_224 (Activation)	(None, 32, 32, 243)	0	batch_normaliz
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conv2d_230 (Conv2D)	(None, 32, 32, 27)	6561	activation_224[0][0]
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average_pooling2d_24 (AveragePo	(None, 16, 16, 27)	0	conv2d_230[0]
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batch_normalization_225 (BatchN	(None, 16, 16, 27)	108	average_poolin
---------------------------------	--------------------	-----	----------------

activation_225 (Activation)	(None, 16, 16, 27)	0	batch_normaliz
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conv2d_231 (Conv2D)	(None, 16, 16, 27)	6561	activation_225[0][0]
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concatenate_200 (Concatenate)	(None, 16, 16, 54)	0	average_poolin
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[0]

batch_normalization_226 (BatchN	(None, 16, 16, 54)	216	concatenate_200[0][0]
---------------------------------	--------------------	-----	-----------------------

<u>activation_226</u> (Activation)	(None, 16, 16, 54)	0	batch_normaliz
ation_226[0][0]			
<u>conv2d_232</u> (Conv2D)	(None, 16, 16, 27)	13122	activation_226
[0][0]			
<u>concatenate_201</u> (Concatenate)	(None, 16, 16, 81)	0	concatenate_20
0[0][0]			conv2d_232[0]
[0]			
<u>batch_normalization_227</u> (BatchN	(None, 16, 16, 81)	324	concatenate_20
1[0][0]			
<u>activation_227</u> (Activation)	(None, 16, 16, 81)	0	batch_normaliz
ation_227[0][0]			
<u>conv2d_233</u> (Conv2D)	(None, 16, 16, 27)	19683	activation_227
[0][0]			
<u>concatenate_202</u> (Concatenate)	(None, 16, 16, 108)	0	concatenate_20
1[0][0]			conv2d_233[0]
[0]			
<u>batch_normalization_228</u> (BatchN	(None, 16, 16, 108)	432	concatenate_20
2[0][0]			
<u>activation_228</u> (Activation)	(None, 16, 16, 108)	0	batch_normaliz
ation_228[0][0]			
<u>conv2d_234</u> (Conv2D)	(None, 16, 16, 27)	26244	activation_228
[0][0]			
<u>concatenate_203</u> (Concatenate)	(None, 16, 16, 135)	0	concatenate_20
2[0][0]			conv2d_234[0]
[0]			
<u>batch_normalization_229</u> (BatchN	(None, 16, 16, 135)	540	concatenate_20
3[0][0]			
<u>activation_229</u> (Activation)	(None, 16, 16, 135)	0	batch_normaliz

ation_229[0][0]

conv2d_235 (Conv2D) [0][0]	(None, 16, 16, 27)	32805	activation_229
concatenate_204 (Concatenate) 3[0][0]	(None, 16, 16, 162)	0	concatenate_20 conv2d_235[0]
batch_normalization_230 (BatchN 4[0][0]	(None, 16, 16, 162)	648	concatenate_20
activation_230 (Activation) ation_230[0][0]	(None, 16, 16, 162)	0	batch_normaliz
conv2d_236 (Conv2D) [0][0]	(None, 16, 16, 27)	39366	activation_230
concatenate_205 (Concatenate) 4[0][0]	(None, 16, 16, 189)	0	concatenate_20 conv2d_236[0]
batch_normalization_231 (BatchN 5[0][0]	(None, 16, 16, 189)	756	concatenate_20
activation_231 (Activation) ation_231[0][0]	(None, 16, 16, 189)	0	batch_normaliz
conv2d_237 (Conv2D) [0][0]	(None, 16, 16, 27)	45927	activation_231
concatenate_206 (Concatenate) 5[0][0]	(None, 16, 16, 216)	0	concatenate_20 conv2d_237[0]
batch_normalization_232 (BatchN 6[0][0]	(None, 16, 16, 216)	864	concatenate_20
activation_232 (Activation) ation_232[0][0]	(None, 16, 16, 216)	0	batch_normaliz

conv2d_238 (Conv2D)	(None, 16, 16, 27)	52488	activation_232 [0][0]
concatenate_207 (Concatenate)	(None, 16, 16, 243)	0	concatenate_20 6[0][0] [0]
batch_normalization_233 (BatchN	(None, 16, 16, 243)	972	concatenate_20 7[0][0]
activation_233 (Activation)	(None, 16, 16, 243)	0	batch_normaliz ation_233[0][0]
conv2d_239 (Conv2D)	(None, 16, 16, 27)	6561	activation_233 [0][0]
average_pooling2d_25 (AveragePo	(None, 8, 8, 27)	0	conv2d_239[0] [0]
batch_normalization_234 (BatchN	(None, 8, 8, 27)	108	average_poolin g2d_25[0][0]
activation_234 (Activation)	(None, 8, 8, 27)	0	batch_normaliz ation_234[0][0]
conv2d_240 (Conv2D)	(None, 8, 8, 27)	6561	activation_234 [0][0]
concatenate_208 (Concatenate)	(None, 8, 8, 54)	0	average_poolin g2d_25[0][0] [0]
batch_normalization_235 (BatchN	(None, 8, 8, 54)	216	concatenate_20 8[0][0]
activation_235 (Activation)	(None, 8, 8, 54)	0	batch_normaliz ation_235[0][0]
conv2d_241 (Conv2D)	(None, 8, 8, 27)	13122	activation_235 [0][0]
concatenate_209 (Concatenate)	(None, 8, 8, 81)	0	concatenate_20

8[0][0]

conv2d_241[0]

[0]

 batch_normalization_236 (BatchN (None, 8, 8, 81)
9[0][0]

324

concatenate_20

 activation_236 (Activation)
activation_236[0][0]

(None, 8, 8, 81)

0

batch_normaliz

 conv2d_242 (Conv2D)
[0][0]

(None, 8, 8, 27)

19683

activation_236

 concatenate_210 (Concatenate)
9[0][0]

(None, 8, 8, 108)

0

concatenate_20

[0]

conv2d_242[0]

 batch_normalization_237 (BatchN (None, 8, 8, 108)
0[0][0]

432

concatenate_21

 activation_237 (Activation)
ation_237[0][0]

(None, 8, 8, 108)

0

batch_normaliz

 conv2d_243 (Conv2D)
[0][0]

(None, 8, 8, 27)

26244

activation_237

 concatenate_211 (Concatenate)
0[0][0]

(None, 8, 8, 135)

0

concatenate_21

[0]

conv2d_243[0]

 batch_normalization_238 (BatchN (None, 8, 8, 135)
1[0][0]

540

concatenate_21

 activation_238 (Activation)
ation_238[0][0]

(None, 8, 8, 135)

0

batch_normaliz

 conv2d_244 (Conv2D)
[0][0]

(None, 8, 8, 27)

32805

activation_238

 concatenate_212 (Concatenate)
1[0][0]

(None, 8, 8, 162)

0

concatenate_21

[0]

conv2d_244[0]

<u>batch_normalization_239</u> (Batch Normalization)	(None, 8, 8, 162)	648	concatenate_212[0][0]
<u>activation_239</u> (Activation)	(None, 8, 8, 162)	0	batch_normalization_239[0][0]
<u>conv2d_245</u> (Conv2D)	(None, 8, 8, 27)	39366	activation_239[0][0]
<u>concatenate_213</u> (Concatenate)	(None, 8, 8, 189)	0	concatenate_212[0][0] conv2d_245[0]
<u>batch_normalization_240</u> (Batch Normalization)	(None, 8, 8, 189)	756	concatenate_213[0][0]
<u>activation_240</u> (Activation)	(None, 8, 8, 189)	0	batch_normalization_240[0][0]
<u>conv2d_246</u> (Conv2D)	(None, 8, 8, 27)	45927	activation_240[0][0]
<u>concatenate_214</u> (Concatenate)	(None, 8, 8, 216)	0	concatenate_213[0][0] conv2d_246[0]
<u>batch_normalization_241</u> (Batch Normalization)	(None, 8, 8, 216)	864	concatenate_214[0][0]
<u>activation_241</u> (Activation)	(None, 8, 8, 216)	0	batch_normalization_241[0][0]
<u>conv2d_247</u> (Conv2D)	(None, 8, 8, 27)	52488	activation_241[0][0]
<u>concatenate_215</u> (Concatenate)	(None, 8, 8, 243)	0	concatenate_214[0][0] conv2d_247[0]
<u>batch_normalization_242</u> (Batch Normalization)	(None, 8, 8, 243)	972	concatenate_215[0][0]

5[0][0]

activation_242 (Activation) activation_242[0][0]	(None, 8, 8, 243)	0	batch_normaliz
conv2d_248 (Conv2D) [0][0]	(None, 8, 8, 27)	6561	activation_242
average_pooling2d_26 (AveragePo [0]	(None, 4, 4, 27)	0	conv2d_248[0]
batch_normalization_243 (BatchN g2d_26[0][0]	(None, 4, 4, 27)	108	average_poolin
activation_243 (Activation) activation_243[0][0]	(None, 4, 4, 27)	0	batch_normaliz
conv2d_249 (Conv2D) [0][0]	(None, 4, 4, 27)	6561	activation_243
concatenate_216 (Concatenate) g2d_26[0][0] [0]	(None, 4, 4, 54)	0	average_poolin conv2d_249[0]
batch_normalization_244 (BatchN 6[0][0]	(None, 4, 4, 54)	216	concatenate_21
activation_244 (Activation) activation_244[0][0]	(None, 4, 4, 54)	0	batch_normaliz
conv2d_250 (Conv2D) [0][0]	(None, 4, 4, 27)	13122	activation_244
concatenate_217 (Concatenate) 6[0][0] [0]	(None, 4, 4, 81)	0	concatenate_21 conv2d_250[0]
batch_normalization_245 (BatchN 7[0][0]	(None, 4, 4, 81)	324	concatenate_21
activation_245 (Activation) activation_245[0][0]	(None, 4, 4, 81)	0	batch_normaliz

<u>conv2d_251</u> (Conv2D) [0][0]	(None, 4, 4, 27)	19683	activation_245
<u>concatenate_218</u> (Concatenate) 7[0][0] [0]	(None, 4, 4, 108)	0	concatenate_21 conv2d_251[0]
<u>batch_normalization_246</u> (BatchN 8[0][0]	(None, 4, 4, 108)	432	concatenate_21
<u>activation_246</u> (Activation) activation_246[0][0]	(None, 4, 4, 108)	0	batch_normaliz
<u>conv2d_252</u> (Conv2D) [0][0]	(None, 4, 4, 27)	26244	activation_246
<u>concatenate_219</u> (Concatenate) 8[0][0] [0]	(None, 4, 4, 135)	0	concatenate_21 conv2d_252[0]
<u>batch_normalization_247</u> (BatchN 9[0][0]	(None, 4, 4, 135)	540	concatenate_21
<u>activation_247</u> (Activation) activation_247[0][0]	(None, 4, 4, 135)	0	batch_normaliz
<u>conv2d_253</u> (Conv2D) [0][0]	(None, 4, 4, 27)	32805	activation_247
<u>concatenate_220</u> (Concatenate) 9[0][0] [0]	(None, 4, 4, 162)	0	concatenate_21 conv2d_253[0]
<u>batch_normalization_248</u> (BatchN 0[0][0]	(None, 4, 4, 162)	648	concatenate_22
<u>activation_248</u> (Activation) activation_248[0][0]	(None, 4, 4, 162)	0	batch_normaliz
<u>conv2d_254</u> (Conv2D)	(None, 4, 4, 27)	39366	activation_248

[0][0]

concatenate_221 (Concatenate)	(None, 4, 4, 189)	0	concatenate_22
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0[0][0]

conv2d_254[0]

[0]

batch_normalization_249 (BatchN	(None, 4, 4, 189)	756	concatenate_22
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1[0][0]

activation_249 (Activation)	(None, 4, 4, 189)	0	batch_normaliz
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ation_249[0][0]

conv2d_255 (Conv2D)	(None, 4, 4, 27)	45927	activation_249
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[0][0]

concatenate_222 (Concatenate)	(None, 4, 4, 216)	0	concatenate_22
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1[0][0]

conv2d_255[0]

[0]

batch_normalization_250 (BatchN	(None, 4, 4, 216)	864	concatenate_22
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2[0][0]

activation_250 (Activation)	(None, 4, 4, 216)	0	batch_normaliz
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ation_250[0][0]

conv2d_256 (Conv2D)	(None, 4, 4, 27)	52488	activation_250
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[0][0]

concatenate_223 (Concatenate)	(None, 4, 4, 243)	0	concatenate_22
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2[0][0]

conv2d_256[0]

[0]

batch_normalization_251 (BatchN	(None, 4, 4, 243)	972	concatenate_22
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3[0][0]

activation_251 (Activation)	(None, 4, 4, 243)	0	batch_normaliz
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ation_251[0][0]

average_pooling2d_27 (AveragePo	(None, 2, 2, 243)	0	activation_251
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[0][0]

<u>conv2d_223</u> (Conv2D) [0][0]	(None, 32, 32, 27)	13122	activation_217
<u>concatenate_193</u> (Concatenate) 2[0][0] [0]	(None, 32, 32, 81)	0	concatenate_19 2[0][0] conv2d_223[0]
<u>batch_normalization_218</u> (BatchN 3[0][0]	(None, 32, 32, 81)	324	concatenate_19 3[0][0]
<u>activation_218</u> (Activation) activation_218[0][0]	(None, 32, 32, 81)	0	batch_normaliz ation_218[0][0]
<u>conv2d_224</u> (Conv2D) [0][0]	(None, 32, 32, 27)	19683	activation_218
<u>concatenate_194</u> (Concatenate) 3[0][0] [0]	(None, 32, 32, 108)	0	concatenate_19 3[0][0] conv2d_224[0]
<u>batch_normalization_219</u> (BatchN 4[0][0]	(None, 32, 32, 108)	432	concatenate_19 4[0][0]
<u>activation_219</u> (Activation) activation_219[0][0]	(None, 32, 32, 108)	0	batch_normaliz ation_219[0][0]
<u>conv2d_225</u> (Conv2D) [0][0]	(None, 32, 32, 27)	26244	activation_219
<u>concatenate_195</u> (Concatenate) 4[0][0] [0]	(None, 32, 32, 135)	0	concatenate_19 4[0][0] conv2d_225[0]
<u>batch_normalization_220</u> (BatchN 5[0][0]	(None, 32, 32, 135)	540	concatenate_19 5[0][0]
<u>activation_220</u> (Activation) activation_220[0][0]	(None, 32, 32, 135)	0	batch_normaliz ation_220[0][0]
<u>conv2d_226</u> (Conv2D)	(None, 32, 32, 27)	32805	activation_220

[0][0]

concatenate_196 (Concatenate)	(None, 32, 32, 162)	0	concatenate_195[0][0]
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[0]

batch_normalization_221 (Batch Normalization)	(None, 32, 32, 162)	648	concatenate_196[0][0]
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activation_221 (Activation)	(None, 32, 32, 162)	0	batch_normalization_221[0][0]
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conv2d_227 (Conv2D)	(None, 32, 32, 27)	39366	activation_221[0][0]
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concatenate_197 (Concatenate)	(None, 32, 32, 189)	0	concatenate_196[0][0]
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[0]

batch_normalization_222 (Batch Normalization)	(None, 32, 32, 189)	756	concatenate_197[0][0]
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activation_222 (Activation)	(None, 32, 32, 189)	0	batch_normalization_222[0][0]
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conv2d_228 (Conv2D)	(None, 32, 32, 27)	45927	activation_222[0][0]
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concatenate_198 (Concatenate)	(None, 32, 32, 216)	0	concatenate_197[0][0]
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[0]

batch_normalization_223 (Batch Normalization)	(None, 32, 32, 216)	864	concatenate_198[0][0]
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activation_223 (Activation)	(None, 32, 32, 216)	0	batch_normalization_223[0][0]
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conv2d_229 (Conv2D)	(None, 32, 32, 27)	52488	activation_223[0][0]
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concatenate_199 (Concatenate)	(None, 32, 32, 243)	0	concatenate_198[0][0]
			conv2d_229[0]
			[0]
batch_normalization_224 (Batch Normalization)	(None, 32, 32, 243)	972	concatenate_199[0][0]
activation_224 (Activation)	(None, 32, 32, 243)	0	batch_normalization_224[0][0]
conv2d_230 (Conv2D)	(None, 32, 32, 27)	6561	activation_224[0][0]
average_pooling2d_24 (Average Pooling2D)	(None, 16, 16, 27)	0	conv2d_230[0]
			[0]
batch_normalization_225 (Batch Normalization)	(None, 16, 16, 27)	108	average_pooling2d_24[0][0]
activation_225 (Activation)	(None, 16, 16, 27)	0	batch_normalization_225[0][0]
conv2d_231 (Conv2D)	(None, 16, 16, 27)	6561	activation_225[0][0]
concatenate_200 (Concatenate)	(None, 16, 16, 54)	0	average_pooling2d_24[0][0]
			conv2d_231[0]
			[0]
batch_normalization_226 (Batch Normalization)	(None, 16, 16, 54)	216	concatenate_200[0][0]
activation_226 (Activation)	(None, 16, 16, 54)	0	batch_normalization_226[0][0]
conv2d_232 (Conv2D)	(None, 16, 16, 27)	13122	activation_226[0][0]
concatenate_201 (Concatenate)	(None, 16, 16, 81)	0	concatenate_200[0][0]
			conv2d_232[0]
			[0]

batch_normalization_227 (BatchN	(None, 16, 16, 81)	324	concatenate_201[0][0]
activation_227 (Activation)	(None, 16, 16, 81)	0	batch_normalization_227[0][0]
conv2d_233 (Conv2D)	(None, 16, 16, 27)	19683	activation_227[0][0]
concatenate_202 (Concatenate)	(None, 16, 16, 108)	0	concatenate_201[0][0]
			conv2d_233[0][0]
batch_normalization_228 (BatchN	(None, 16, 16, 108)	432	concatenate_202[0][0]
activation_228 (Activation)	(None, 16, 16, 108)	0	batch_normalization_228[0][0]
conv2d_234 (Conv2D)	(None, 16, 16, 27)	26244	activation_228[0][0]
concatenate_203 (Concatenate)	(None, 16, 16, 135)	0	concatenate_202[0][0]
			conv2d_234[0][0]
batch_normalization_229 (BatchN	(None, 16, 16, 135)	540	concatenate_203[0][0]
activation_229 (Activation)	(None, 16, 16, 135)	0	batch_normalization_229[0][0]
conv2d_235 (Conv2D)	(None, 16, 16, 27)	32805	activation_229[0][0]
concatenate_204 (Concatenate)	(None, 16, 16, 162)	0	concatenate_203[0][0]
			conv2d_235[0][0]
batch_normalization_230 (BatchN	(None, 16, 16, 162)	648	concatenate_204[0][0]

<u>activation_230</u> (Activation)	(None, 16, 16, 162)	0	batch_normaliz ation_230[0][0]
<u>conv2d_236</u> (Conv2D)	(None, 16, 16, 27)	39366	activation_230 [0][0]
<u>concatenate_205</u> (Concatenate)	(None, 16, 16, 189)	0	concatenate_20 4[0][0] [0]
<u>batch_normalization_231</u> (BatchN	(None, 16, 16, 189)	756	concatenate_20 5[0][0]
<u>activation_231</u> (Activation)	(None, 16, 16, 189)	0	batch_normaliz ation_231[0][0]
<u>conv2d_237</u> (Conv2D)	(None, 16, 16, 27)	45927	activation_231 [0][0]
<u>concatenate_206</u> (Concatenate)	(None, 16, 16, 216)	0	concatenate_20 5[0][0] [0]
<u>batch_normalization_232</u> (BatchN	(None, 16, 16, 216)	864	concatenate_20 6[0][0]
<u>activation_232</u> (Activation)	(None, 16, 16, 216)	0	batch_normaliz ation_232[0][0]
<u>conv2d_238</u> (Conv2D)	(None, 16, 16, 27)	52488	activation_232 [0][0]
<u>concatenate_207</u> (Concatenate)	(None, 16, 16, 243)	0	concatenate_20 6[0][0] [0]
<u>batch_normalization_233</u> (BatchN	(None, 16, 16, 243)	972	concatenate_20 7[0][0]
<u>activation_233</u> (Activation)	(None, 16, 16, 243)	0	batch_normaliz

ation_233[0][0]

conv2d_239 (Conv2D)	(None, 16, 16, 27)	6561	activation_233[0][0]
average_pooling2d_25 (AveragePo	(None, 8, 8, 27)	0	conv2d_239[0][0]
batch_normalization_234 (BatchN	(None, 8, 8, 27)	108	average_poolin g2d_25[0][0]
activation_234 (Activation)	(None, 8, 8, 27)	0	batch_normaliz ation_234[0][0]
conv2d_240 (Conv2D)	(None, 8, 8, 27)	6561	activation_234[0][0]
concatenate_208 (Concatenate)	(None, 8, 8, 54)	0	average_poolin g2d_25[0][0] [0]
batch_normalization_235 (BatchN	(None, 8, 8, 54)	216	concatenate_20 8[0][0]
activation_235 (Activation)	(None, 8, 8, 54)	0	batch_normaliz ation_235[0][0]
conv2d_241 (Conv2D)	(None, 8, 8, 27)	13122	activation_235[0][0]
concatenate_209 (Concatenate)	(None, 8, 8, 81)	0	concatenate_20 8[0][0] [0]
batch_normalization_236 (BatchN	(None, 8, 8, 81)	324	concatenate_20 9[0][0]
activation_236 (Activation)	(None, 8, 8, 81)	0	batch_normaliz ation_236[0][0]
conv2d_242 (Conv2D)	(None, 8, 8, 27)	19683	activation_236[0][0]

<u>concatenate_210</u> (Concatenate)	(None, 8, 8, 108)	0	<u>concatenate_209</u> [0][0]
[0]			conv2d_242[0]
<u>batch_normalization_237</u> (BatchN	(None, 8, 8, 108)	432	<u>concatenate_210</u> [0][0]
0][0]			
<u>activation_237</u> (Activation)	(None, 8, 8, 108)	0	<u>batch_normaliz</u>
ation_237[0][0]			ation_237[0][0]
<u>conv2d_243</u> (Conv2D)	(None, 8, 8, 27)	26244	<u>activation_237</u>
[0][0]			0][0]
<u>concatenate_211</u> (Concatenate)	(None, 8, 8, 135)	0	<u>concatenate_210</u> [0][0]
0][0]			conv2d_243[0]
[0]			
<u>batch_normalization_238</u> (BatchN	(None, 8, 8, 135)	540	<u>concatenate_211</u> [0][0]
1[0][0]			
<u>activation_238</u> (Activation)	(None, 8, 8, 135)	0	<u>batch_normaliz</u>
ation_238[0][0]			ation_238[0][0]
<u>conv2d_244</u> (Conv2D)	(None, 8, 8, 27)	32805	<u>activation_238</u>
[0][0]			0][0]
<u>concatenate_212</u> (Concatenate)	(None, 8, 8, 162)	0	<u>concatenate_211</u> [0][0]
1[0][0]			conv2d_244[0]
[0]			
<u>batch_normalization_239</u> (BatchN	(None, 8, 8, 162)	648	<u>concatenate_212</u> [0][0]
2[0][0]			
<u>activation_239</u> (Activation)	(None, 8, 8, 162)	0	<u>batch_normaliz</u>
ation_239[0][0]			ation_239[0][0]
<u>conv2d_245</u> (Conv2D)	(None, 8, 8, 27)	39366	<u>activation_239</u>
[0][0]			0][0]
<u>concatenate_213</u> (Concatenate)	(None, 8, 8, 189)	0	<u>concatenate_21</u>

2[0][0]

conv2d_245[0]

[0]

 batch_normalization_240 (BatchN (None, 8, 8, 189)
 3[0][0]

756

concatenate_21

 activation_240 (Activation)
 ation_240[0][0]

(None, 8, 8, 189)

0

batch_normaliz

 conv2d_246 (Conv2D)
 [0][0]

(None, 8, 8, 27)

45927

activation_240

 concatenate_214 (Concatenate)
 3[0][0]

(None, 8, 8, 216)

0

concatenate_21

conv2d_246[0]

[0]

 batch_normalization_241 (BatchN (None, 8, 8, 216)
 4[0][0]

864

concatenate_21

 activation_241 (Activation)
 ation_241[0][0]

(None, 8, 8, 216)

0

batch_normaliz

 conv2d_247 (Conv2D)
 [0][0]

(None, 8, 8, 27)

52488

activation_241

 concatenate_215 (Concatenate)
 4[0][0]

(None, 8, 8, 243)

0

concatenate_21

conv2d_247[0]

[0]

 batch_normalization_242 (BatchN (None, 8, 8, 243)
 5[0][0]

972

concatenate_21

 activation_242 (Activation)
 ation_242[0][0]

(None, 8, 8, 243)

0

batch_normaliz

 conv2d_248 (Conv2D)
 [0][0]

(None, 8, 8, 27)

6561

activation_242

 average_pooling2d_26 (AveragePo (None, 4, 4, 27)
 [0]

0

conv2d_248[0]

batch_normalization_243 (BatchN	(None, 4, 4, 27)	108	average_poolin g2d_26[0][0]
activation_243 (Activation)	(None, 4, 4, 27)	0	batch_normaliz ation_243[0][0]
conv2d_249 (Conv2D)	(None, 4, 4, 27)	6561	activation_243 [0][0]
concatenate_216 (Concatenate)	(None, 4, 4, 54)	0	average_poolin g2d_26[0][0] [0]
batch_normalization_244 (BatchN	(None, 4, 4, 54)	216	concatenate_21 6[0][0]
activation_244 (Activation)	(None, 4, 4, 54)	0	batch_normaliz ation_244[0][0]
conv2d_250 (Conv2D)	(None, 4, 4, 27)	13122	activation_244 [0][0]
concatenate_217 (Concatenate)	(None, 4, 4, 81)	0	concatenate_21 6[0][0] [0]
batch_normalization_245 (BatchN	(None, 4, 4, 81)	324	concatenate_21 7[0][0]
activation_245 (Activation)	(None, 4, 4, 81)	0	batch_normaliz ation_245[0][0]
conv2d_251 (Conv2D)	(None, 4, 4, 27)	19683	activation_245 [0][0]
concatenate_218 (Concatenate)	(None, 4, 4, 108)	0	concatenate_21 7[0][0] [0]
batch_normalization_246 (BatchN	(None, 4, 4, 108)	432	concatenate_21 8[0][0]

<u>activation_246</u> (Activation)	(None, 4, 4, 108)	0	batch_normaliz ation_246[0][0]
<u>conv2d_252</u> (Conv2D)	(None, 4, 4, 27)	26244	activation_246 [0][0]
<u>concatenate_219</u> (Concatenate)	(None, 4, 4, 135)	0	concatenate_21 8[0][0] conv2d_252[0] [0]
<u>batch_normalization_247</u> (BatchN	(None, 4, 4, 135)	540	concatenate_21 9[0][0]
<u>activation_247</u> (Activation)	(None, 4, 4, 135)	0	batch_normaliz ation_247[0][0]
<u>conv2d_253</u> (Conv2D)	(None, 4, 4, 27)	32805	activation_247 [0][0]
<u>concatenate_220</u> (Concatenate)	(None, 4, 4, 162)	0	concatenate_21 9[0][0] conv2d_253[0] [0]
<u>batch_normalization_248</u> (BatchN	(None, 4, 4, 162)	648	concatenate_22 0[0][0]
<u>activation_248</u> (Activation)	(None, 4, 4, 162)	0	batch_normaliz ation_248[0][0]
<u>conv2d_254</u> (Conv2D)	(None, 4, 4, 27)	39366	activation_248 [0][0]
<u>concatenate_221</u> (Concatenate)	(None, 4, 4, 189)	0	concatenate_22 0[0][0] conv2d_254[0] [0]
<u>batch_normalization_249</u> (BatchN	(None, 4, 4, 189)	756	concatenate_22 1[0][0]
<u>activation_249</u> (Activation)	(None, 4, 4, 189)	0	batch_normaliz ation_249[0][0]

conv2d_255 (Conv2D)	(None, 4, 4, 27)	45927	activation_249[0][0]
concatenate_222 (Concatenate)	(None, 4, 4, 216)	0	concatenate_221[0][0]
			conv2d_255[0]
batch_normalization_250 (BatchN	(None, 4, 4, 216)	864	concatenate_222[0][0]
activation_250 (Activation)	(None, 4, 4, 216)	0	batch_normaliz
			ation_250[0][0]
conv2d_256 (Conv2D)	(None, 4, 4, 27)	52488	activation_250[0][0]
concatenate_223 (Concatenate)	(None, 4, 4, 243)	0	concatenate_222[0][0]
			conv2d_256[0]
			[0]
batch_normalization_251 (BatchN	(None, 4, 4, 243)	972	concatenate_223[0][0]
activation_251 (Activation)	(None, 4, 4, 243)	0	batch_normaliz
			ation_251[0][0]
average_pooling2d_27 (AveragePo	(None, 2, 2, 243)	0	activation_251[0][0]
=====			
Total params: 984,231			
Trainable params: 974,511			
Non-trainable params: 9,720			
*****after adding conv2d layer*****			
Model: "sequential_5"			
Layer (type)	Output Shape	Param #	
=====			
functional_25 (Functional)	(None, 2, 2, 243)	984231	

conv2d_257 (Conv2D)	(None, 1, 1, 10)	9730
flatten_12 (Flatten)	(None, 10)	0
=====		
Total params: 993,961		
Trainable params: 984,241		
Non-trainable params: 9,720		

[illegible]

```
In [52]: datagen = ImageDataGenerator(
            featurewise_center=True,
            featurewise_std_normalization=True,

            horizontal_flip=True,
            vertical_flip=True,
            brightness_range=[0.2,1.0], zoom_range=[0.5,1.0])
```

```
In [53]: from google.colab import drive

drive.mount('/content/gdrive', force_remount=True)
```

Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_id=947318989803-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercontent.com&redirect_uri=urn%3aietf%3awg%3aoauth%3a2.0%3aob&scope=email%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdocs.test%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive.photos.readonly%20https%3a%2f%2fwww.googleapis.com%2fauth%2fpeopleapi.readonly&response_type=code (https://accounts.google.com/o/oauth2/auth?client_id=947318989803-6bn6qk8qdgf4n4g3pfee6491hc0brc4i.apps.googleusercontent.com&redirect_uri=urn%3aietf%3awg%3aoauth%3a2.0%3aob&scope=email%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdocs.test%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive%20https%3a%2f%2fwww.googleapis.com%2fauth%2fdrive.photos.readonly%20https%3a%2f%2fwww.googleapis.com%2fauth%2fpeopleapi.readonly&response_type=code)

```
Enter your authorization code:
.....
Mounted at /content/gdrive
```

```
In [54]: from keras.callbacks import ModelCheckpoint, LearningRateScheduler, CSVLogger, Cal
```

```
In [55]: reduce_lr = ReduceLRonPlateau(monitor = 'val_loss', factor = 0.1, patience = 5,

# early_stop = EarlyStopping(monitor = "val_loss", patience = 10)

def decay_fn(epoch, lr):
    if epoch < 50:
        return 0.001
    elif epoch >= 50 and epoch < 75:
        return 0.0001
    else:
        return 0.00001

lr_scheduler = LearningRateScheduler(decay_fn)

csv_logger = CSVLogger('training.log')
filepath="/content/drive/My Drive/MyCNN/model-{epoch:03d}-{accuracy:03f}-{val_acc
checkpoint = ModelCheckpoint(filepath, monitor='val_accuracy', verbose=1, save_b
callbacks_list = [checkpoint]
```

```
In [57]: model.compile(loss='categorical_crossentropy',
                        optimizer=Adam(),
                        metrics=['accuracy'])
```

In [58]:

```

model.fit_generator(
    datagen.flow(X_train, y_train, batch_size=128),
    steps_per_epoch=(len(X_train)/batch_size),
    epochs=300,
    verbose = 1,
    validation_data=(X_cv, y_cv),callbacks=[checkpoint])

```

WARNING:tensorflow:From <ipython-input-58-4dc71d79aaa8>:6: Model.fit_generator (from tensorflow.python.keras.engine.training) is deprecated and will be removed in a future version.

Instructions for updating:

Please use Model.fit, which supports generators.

Epoch 1/300

/usr/local/lib/python3.6/dist-packages/keras_preprocessing/image/image_data_generator.py:720: UserWarning: This ImageDataGenerator specifies `featurewise_center`, but it hasn't been fit on any training data. Fit it first by calling `.fit(numpy_data)`.

warnings.warn('This ImageDataGenerator specifies '

/usr/local/lib/python3.6/dist-packages/keras_preprocessing/image/image_data_generator.py:728: UserWarning: This ImageDataGenerator specifies `featurewise_std_normalization`, but it hasn't been fit on any training data. Fit it first by calling `.fit(numpy_data)`.

warnings.warn('This ImageDataGenerator specifies '

391/390 [=====] - ETA: 0s - loss: 1.7734 - accuracy: 0.3477

Epoch 00001: val_accuracy improved from -inf to 0.37620, saving model to /content/drive/My Drive/MyCNN/model-001-0.347740-0.376200.h5'

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow/python/training/tracking/tracking.py:111: Model.state_updates (from tensorflow.python.keras.engine.training) is deprecated and will be removed in a future version.

Instructions for updating:

This property should not be used in TensorFlow 2.0, as updates are applied automatically.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow/python/training/tracking/tracking.py:111: Layer.updates (from tensorflow.python.keras.engine.base_layer) is deprecated and will be removed in a future version.

Instructions for updating:

This property should not be used in TensorFlow 2.0, as updates are applied automatically.

INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-001-0.347740-0.376200.h5'/assets

391/390 [=====] - 82s 211ms/step - loss: 1.7734 - accuracy: 0.3477 - val_loss: 1.7534 - val_accuracy: 0.3762

Epoch 2/300

391/390 [=====] - ETA: 0s - loss: 1.3891 - accuracy: 0.5017

Epoch 00002: val_accuracy improved from 0.37620 to 0.47610, saving model to /content/drive/My Drive/MyCNN/model-002-0.501660-0.476100.h5'

INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-002-0.501660-0.476100.h5'/assets

391/390 [=====] - 83s 212ms/step - loss: 1.3891 - accuracy: 0.5017 - val_loss: 1.4594 - val_accuracy: 0.4761

Epoch 3/300

391/390 [=====] - ETA: 0s - loss: 1.1631 - accuracy: 0.5854

Epoch 00003: val_accuracy improved from 0.47610 to 0.54510, saving model to /content/drive/My Drive/MyCNN/model-003-0.585420-0.545100.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-003-0.585420-0.545100.h5'/assets
391/390 [=====] - 84s 214ms/step - loss: 1.1631 - accuracy: 0.5854 - val_loss: 1.3585 - val_accuracy: 0.5451
Epoch 4/300
391/390 [=====] - ETA: 0s - loss: 1.0245 - accuracy: 0.6352
Epoch 00004: val_accuracy improved from 0.54510 to 0.58050, saving model to /content/drive/My Drive/MyCNN/model-004-0.635240-0.580500.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-004-0.635240-0.580500.h5'/assets
391/390 [=====] - 84s 214ms/step - loss: 1.0245 - accuracy: 0.6352 - val_loss: 1.2581 - val_accuracy: 0.5805
Epoch 5/300
391/390 [=====] - ETA: 0s - loss: 0.9485 - accuracy: 0.6635
Epoch 00005: val_accuracy improved from 0.58050 to 0.59320, saving model to /content/drive/My Drive/MyCNN/model-005-0.663540-0.593200.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-005-0.663540-0.593200.h5'/assets
391/390 [=====] - 84s 215ms/step - loss: 0.9485 - accuracy: 0.6635 - val_loss: 1.2857 - val_accuracy: 0.5932
Epoch 6/300
391/390 [=====] - ETA: 0s - loss: 0.8854 - accuracy: 0.6864
Epoch 00006: val_accuracy improved from 0.59320 to 0.66820, saving model to /content/drive/My Drive/MyCNN/model-006-0.686420-0.668200.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-006-0.686420-0.668200.h5'/assets
391/390 [=====] - 84s 215ms/step - loss: 0.8854 - accuracy: 0.6864 - val_loss: 0.9889 - val_accuracy: 0.6682
Epoch 7/300
391/390 [=====] - ETA: 0s - loss: 0.8398 - accuracy: 0.7035
Epoch 00007: val_accuracy did not improve from 0.66820
391/390 [=====] - 69s 177ms/step - loss: 0.8398 - accuracy: 0.7035 - val_loss: 1.1797 - val_accuracy: 0.6053
Epoch 8/300
391/390 [=====] - ETA: 0s - loss: 0.7958 - accuracy: 0.7195
Epoch 00008: val_accuracy improved from 0.66820 to 0.69180, saving model to /content/drive/My Drive/MyCNN/model-008-0.719500-0.691800.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-008-0.719500-0.691800.h5'/assets
391/390 [=====] - 85s 217ms/step - loss: 0.7958 - accuracy: 0.7195 - val_loss: 0.8805 - val_accuracy: 0.6918
Epoch 9/300
391/390 [=====] - ETA: 0s - loss: 0.7551 - accuracy: 0.7341
Epoch 00009: val_accuracy did not improve from 0.69180
391/390 [=====] - 69s 177ms/step - loss: 0.7551 - accuracy: 0.7341 - val_loss: 1.0625 - val_accuracy: 0.6509
Epoch 10/300
391/390 [=====] - ETA: 0s - loss: 0.7378 - accuracy: 0.7390

Epoch 00010: val_accuracy did not improve from 0.69180
391/390 [=====] - 70s 178ms/step - loss: 0.7378 - accuracy: 0.7390 - val_loss: 1.0165 - val_accuracy: 0.6730
Epoch 11/300
391/390 [=====] - ETA: 0s - loss: 0.7025 - accuracy: 0.7509
Epoch 00011: val_accuracy improved from 0.69180 to 0.72910, saving model to /content/drive/My Drive/MyCNN/model-011-0.750940-0.729100.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-011-0.750940-0.729100.h5'/assets
391/390 [=====] - 85s 218ms/step - loss: 0.7025 - accuracy: 0.7509 - val_loss: 0.7849 - val_accuracy: 0.7291
Epoch 12/300
391/390 [=====] - ETA: 0s - loss: 0.6807 - accuracy: 0.7607
Epoch 00012: val_accuracy improved from 0.72910 to 0.75750, saving model to /content/drive/My Drive/MyCNN/model-012-0.760740-0.757500.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-012-0.760740-0.757500.h5'/assets
391/390 [=====] - 85s 218ms/step - loss: 0.6807 - accuracy: 0.7607 - val_loss: 0.7010 - val_accuracy: 0.7575
Epoch 13/300
391/390 [=====] - ETA: 0s - loss: 0.6642 - accuracy: 0.7667
Epoch 00013: val_accuracy did not improve from 0.75750
391/390 [=====] - 70s 178ms/step - loss: 0.6642 - accuracy: 0.7667 - val_loss: 0.7981 - val_accuracy: 0.7361
Epoch 14/300
391/390 [=====] - ETA: 0s - loss: 0.6443 - accuracy: 0.7749
Epoch 00014: val_accuracy did not improve from 0.75750
391/390 [=====] - 70s 178ms/step - loss: 0.6443 - accuracy: 0.7749 - val_loss: 0.7591 - val_accuracy: 0.7357
Epoch 15/300
391/390 [=====] - ETA: 0s - loss: 0.6220 - accuracy: 0.7820
Epoch 00015: val_accuracy did not improve from 0.75750
391/390 [=====] - 70s 179ms/step - loss: 0.6220 - accuracy: 0.7820 - val_loss: 0.8640 - val_accuracy: 0.7095
Epoch 16/300
391/390 [=====] - ETA: 0s - loss: 0.6111 - accuracy: 0.7853
Epoch 00016: val_accuracy did not improve from 0.75750
391/390 [=====] - 70s 179ms/step - loss: 0.6111 - accuracy: 0.7853 - val_loss: 0.7388 - val_accuracy: 0.7489
Epoch 17/300
391/390 [=====] - ETA: 0s - loss: 0.5929 - accuracy: 0.7904
Epoch 00017: val_accuracy did not improve from 0.75750
391/390 [=====] - 70s 179ms/step - loss: 0.5929 - accuracy: 0.7904 - val_loss: 0.7299 - val_accuracy: 0.7546
Epoch 18/300
391/390 [=====] - ETA: 0s - loss: 0.5740 - accuracy: 0.7976
Epoch 00018: val_accuracy improved from 0.75750 to 0.77200, saving model to /content/drive/My Drive/MyCNN/model-018-0.797600-0.772000.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-018-0.79

```
7600-0.772000.h5'/assets
391/390 [=====] - 85s 218ms/step - loss: 0.5740 - accu
racy: 0.7976 - val_loss: 0.6865 - val_accuracy: 0.7720
Epoch 19/300
391/390 [=====] - ETA: 0s - loss: 0.5602 - accuracy:
0.8033
Epoch 00019: val_accuracy did not improve from 0.77200
391/390 [=====] - 69s 177ms/step - loss: 0.5602 - accu
racy: 0.8033 - val_loss: 0.7116 - val_accuracy: 0.7571
Epoch 20/300
391/390 [=====] - ETA: 0s - loss: 0.5509 - accuracy:
0.8075
Epoch 00020: val_accuracy did not improve from 0.77200
391/390 [=====] - 70s 178ms/step - loss: 0.5509 - accu
racy: 0.8075 - val_loss: 0.7239 - val_accuracy: 0.7519
Epoch 21/300
391/390 [=====] - ETA: 0s - loss: 0.5361 - accuracy:
0.8127
Epoch 00021: val_accuracy did not improve from 0.77200
391/390 [=====] - 70s 178ms/step - loss: 0.5361 - accu
racy: 0.8127 - val_loss: 0.6994 - val_accuracy: 0.7683
Epoch 22/300
391/390 [=====] - ETA: 0s - loss: 0.5247 - accuracy:
0.8155
Epoch 00022: val_accuracy did not improve from 0.77200
391/390 [=====] - 70s 179ms/step - loss: 0.5247 - accu
racy: 0.8155 - val_loss: 0.7839 - val_accuracy: 0.7408
Epoch 23/300
391/390 [=====] - ETA: 0s - loss: 0.5138 - accuracy:
0.8179
Epoch 00023: val_accuracy improved from 0.77200 to 0.80800, saving model to /co
ntent/drive/My Drive/MyCNN/model-023-0.817940-0.808000.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-023-0.81
7940-0.808000.h5'/assets
391/390 [=====] - 85s 217ms/step - loss: 0.5138 - accu
racy: 0.8179 - val_loss: 0.5617 - val_accuracy: 0.8080
Epoch 24/300
391/390 [=====] - ETA: 0s - loss: 0.5040 - accuracy:
0.8232
Epoch 00024: val_accuracy did not improve from 0.80800
391/390 [=====] - 70s 179ms/step - loss: 0.5040 - accu
racy: 0.8232 - val_loss: 0.8523 - val_accuracy: 0.7206
Epoch 25/300
391/390 [=====] - ETA: 0s - loss: 0.4947 - accuracy:
0.8288
Epoch 00025: val_accuracy did not improve from 0.80800
391/390 [=====] - 70s 178ms/step - loss: 0.4947 - accu
racy: 0.8288 - val_loss: 0.5764 - val_accuracy: 0.7995
Epoch 26/300
391/390 [=====] - ETA: 0s - loss: 0.4891 - accuracy:
0.8277
Epoch 00026: val_accuracy did not improve from 0.80800
391/390 [=====] - 70s 178ms/step - loss: 0.4891 - accu
racy: 0.8277 - val_loss: 0.6192 - val_accuracy: 0.7827
Epoch 27/300
391/390 [=====] - ETA: 0s - loss: 0.4729 - accuracy:
0.8339
```

```
Epoch 00027: val_accuracy did not improve from 0.80800
391/390 [=====] - 70s 179ms/step - loss: 0.4729 - accuracy: 0.8339 - val_loss: 0.6097 - val_accuracy: 0.7892
Epoch 28/300
391/390 [=====] - ETA: 0s - loss: 0.4708 - accuracy: 0.8346
Epoch 00028: val_accuracy did not improve from 0.80800
391/390 [=====] - 70s 179ms/step - loss: 0.4708 - accuracy: 0.8346 - val_loss: 0.7420 - val_accuracy: 0.7609
Epoch 29/300
391/390 [=====] - ETA: 0s - loss: 0.4594 - accuracy: 0.8381
Epoch 00029: val_accuracy did not improve from 0.80800
391/390 [=====] - 70s 179ms/step - loss: 0.4594 - accuracy: 0.8381 - val_loss: 0.5913 - val_accuracy: 0.8011
Epoch 30/300
391/390 [=====] - ETA: 0s - loss: 0.4533 - accuracy: 0.8404
Epoch 00030: val_accuracy did not improve from 0.80800
391/390 [=====] - 70s 178ms/step - loss: 0.4533 - accuracy: 0.8404 - val_loss: 0.6015 - val_accuracy: 0.7982
Epoch 31/300
391/390 [=====] - ETA: 0s - loss: 0.4449 - accuracy: 0.8446
Epoch 00031: val_accuracy did not improve from 0.80800
391/390 [=====] - 70s 178ms/step - loss: 0.4449 - accuracy: 0.8446 - val_loss: 0.6799 - val_accuracy: 0.7764
Epoch 32/300
391/390 [=====] - ETA: 0s - loss: 0.4380 - accuracy: 0.8461
Epoch 00032: val_accuracy did not improve from 0.80800
391/390 [=====] - 70s 178ms/step - loss: 0.4380 - accuracy: 0.8461 - val_loss: 0.5862 - val_accuracy: 0.8024
Epoch 33/300
391/390 [=====] - ETA: 0s - loss: 0.4342 - accuracy: 0.8461
Epoch 00033: val_accuracy improved from 0.80800 to 0.81470, saving model to /content/drive/My Drive/MyCNN/model-033-0.846060-0.814700.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-033-0.846060-0.814700.h5'/assets
391/390 [=====] - 85s 218ms/step - loss: 0.4342 - accuracy: 0.8461 - val_loss: 0.5473 - val_accuracy: 0.8147
Epoch 34/300
391/390 [=====] - ETA: 0s - loss: 0.4269 - accuracy: 0.8499
Epoch 00034: val_accuracy did not improve from 0.81470
391/390 [=====] - 69s 177ms/step - loss: 0.4269 - accuracy: 0.8499 - val_loss: 0.6605 - val_accuracy: 0.7911
Epoch 35/300
391/390 [=====] - ETA: 0s - loss: 0.4181 - accuracy: 0.8549
Epoch 00035: val_accuracy improved from 0.81470 to 0.82450, saving model to /content/drive/My Drive/MyCNN/model-035-0.854920-0.824500.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-035-0.854920-0.824500.h5'/assets
391/390 [=====] - 84s 216ms/step - loss: 0.4181 - accuracy: 0.8549 - val_loss: 0.5045 - val_accuracy: 0.8245
```

```
Epoch 36/300
391/390 [=====] - ETA: 0s - loss: 0.4094 - accuracy:
0.8553
Epoch 00036: val_accuracy did not improve from 0.82450
391/390 [=====] - 69s 177ms/step - loss: 0.4094 - accu
racy: 0.8553 - val_loss: 0.7371 - val_accuracy: 0.7552
Epoch 37/300
391/390 [=====] - ETA: 0s - loss: 0.4079 - accuracy:
0.8570
Epoch 00037: val_accuracy improved from 0.82450 to 0.83650, saving model to /co
ntent/drive/My Drive/MyCNN/model-037-0.856960-0.836500.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-037-0.85
6960-0.836500.h5'/assets
391/390 [=====] - 85s 217ms/step - loss: 0.4079 - accu
racy: 0.8570 - val_loss: 0.4986 - val_accuracy: 0.8365
Epoch 38/300
391/390 [=====] - ETA: 0s - loss: 0.4057 - accuracy:
0.8561
Epoch 00038: val_accuracy did not improve from 0.83650
391/390 [=====] - 70s 179ms/step - loss: 0.4057 - accu
racy: 0.8561 - val_loss: 0.4896 - val_accuracy: 0.8312
Epoch 39/300
391/390 [=====] - ETA: 0s - loss: 0.3970 - accuracy:
0.8603
Epoch 00039: val_accuracy did not improve from 0.83650
391/390 [=====] - 70s 178ms/step - loss: 0.3970 - accu
racy: 0.8603 - val_loss: 0.5746 - val_accuracy: 0.8074
Epoch 40/300
391/390 [=====] - ETA: 0s - loss: 0.3920 - accuracy:
0.8621
Epoch 00040: val_accuracy did not improve from 0.83650
391/390 [=====] - 70s 178ms/step - loss: 0.3920 - accu
racy: 0.8621 - val_loss: 0.8043 - val_accuracy: 0.7640
Epoch 41/300
391/390 [=====] - ETA: 0s - loss: 0.3794 - accuracy:
0.8683
Epoch 00041: val_accuracy improved from 0.83650 to 0.84600, saving model to /co
ntent/drive/My Drive/MyCNN/model-041-0.868340-0.846000.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-041-0.86
8340-0.846000.h5'/assets
391/390 [=====] - 85s 217ms/step - loss: 0.3794 - accu
racy: 0.8683 - val_loss: 0.4603 - val_accuracy: 0.8460
Epoch 42/300
391/390 [=====] - ETA: 0s - loss: 0.3764 - accuracy:
0.8664
Epoch 00042: val_accuracy did not improve from 0.84600
391/390 [=====] - 69s 177ms/step - loss: 0.3764 - accu
racy: 0.8664 - val_loss: 0.6478 - val_accuracy: 0.7944
Epoch 43/300
391/390 [=====] - ETA: 0s - loss: 0.3704 - accuracy:
0.8692
Epoch 00043: val_accuracy did not improve from 0.84600
391/390 [=====] - 70s 178ms/step - loss: 0.3704 - accu
racy: 0.8692 - val_loss: 0.4941 - val_accuracy: 0.8326
Epoch 44/300
391/390 [=====] - ETA: 0s - loss: 0.3716 - accuracy:
0.8685
```

Epoch 00044: val_accuracy did not improve from 0.84600
391/390 [=====] - 70s 178ms/step - loss: 0.3716 - accuracy: 0.8685 - val_loss: 0.5154 - val_accuracy: 0.8244
Epoch 45/300
391/390 [=====] - ETA: 0s - loss: 0.3656 - accuracy: 0.8716
Epoch 00045: val_accuracy improved from 0.84600 to 0.86250, saving model to /content/drive/My Drive/MyCNN/model-045-0.871620-0.862500.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-045-0.871620-0.862500.h5'/assets
391/390 [=====] - 85s 218ms/step - loss: 0.3656 - accuracy: 0.8716 - val_loss: 0.4139 - val_accuracy: 0.8625
Epoch 46/300
391/390 [=====] - ETA: 0s - loss: 0.3586 - accuracy: 0.8736
Epoch 00046: val_accuracy did not improve from 0.86250
391/390 [=====] - 69s 177ms/step - loss: 0.3586 - accuracy: 0.8736 - val_loss: 0.5008 - val_accuracy: 0.8325
Epoch 47/300
391/390 [=====] - ETA: 0s - loss: 0.3572 - accuracy: 0.8737
Epoch 00047: val_accuracy did not improve from 0.86250
391/390 [=====] - 69s 178ms/step - loss: 0.3572 - accuracy: 0.8737 - val_loss: 0.4338 - val_accuracy: 0.8549
Epoch 48/300
391/390 [=====] - ETA: 0s - loss: 0.3490 - accuracy: 0.8776
Epoch 00048: val_accuracy did not improve from 0.86250
391/390 [=====] - 70s 178ms/step - loss: 0.3490 - accuracy: 0.8776 - val_loss: 0.4239 - val_accuracy: 0.8547
Epoch 49/300
391/390 [=====] - ETA: 0s - loss: 0.3484 - accuracy: 0.8800
Epoch 00049: val_accuracy did not improve from 0.86250
391/390 [=====] - 70s 178ms/step - loss: 0.3484 - accuracy: 0.8800 - val_loss: 0.4427 - val_accuracy: 0.8445
Epoch 50/300
391/390 [=====] - ETA: 0s - loss: 0.3486 - accuracy: 0.8770
Epoch 00050: val_accuracy did not improve from 0.86250
391/390 [=====] - 70s 179ms/step - loss: 0.3486 - accuracy: 0.8770 - val_loss: 0.4254 - val_accuracy: 0.8524
Epoch 51/300
391/390 [=====] - ETA: 0s - loss: 0.3382 - accuracy: 0.8800
Epoch 00051: val_accuracy did not improve from 0.86250
391/390 [=====] - 70s 178ms/step - loss: 0.3382 - accuracy: 0.8800 - val_loss: 0.4381 - val_accuracy: 0.8498
Epoch 52/300
391/390 [=====] - ETA: 0s - loss: 0.3395 - accuracy: 0.8807
Epoch 00052: val_accuracy did not improve from 0.86250
391/390 [=====] - 70s 178ms/step - loss: 0.3395 - accuracy: 0.8807 - val_loss: 0.4811 - val_accuracy: 0.8419
Epoch 53/300
391/390 [=====] - ETA: 0s - loss: 0.3336 - accuracy: 0.8812

Epoch 00053: val_accuracy did not improve from 0.86250
391/390 [=====] - 70s 178ms/step - loss: 0.3336 - accuracy: 0.8812 - val_loss: 0.3974 - val_accuracy: 0.8620
Epoch 54/300
391/390 [=====] - ETA: 0s - loss: 0.3282 - accuracy: 0.8862
Epoch 00054: val_accuracy improved from 0.86250 to 0.86260, saving model to /content/drive/My Drive/MyCNN/model-054-0.886160-0.862600.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-054-0.886160-0.862600.h5'/assets
391/390 [=====] - 85s 217ms/step - loss: 0.3282 - accuracy: 0.8862 - val_loss: 0.4030 - val_accuracy: 0.8626
Epoch 55/300
391/390 [=====] - ETA: 0s - loss: 0.3271 - accuracy: 0.8844
Epoch 00055: val_accuracy did not improve from 0.86260
391/390 [=====] - 69s 178ms/step - loss: 0.3271 - accuracy: 0.8844 - val_loss: 0.4242 - val_accuracy: 0.8538
Epoch 56/300
391/390 [=====] - ETA: 0s - loss: 0.3138 - accuracy: 0.8889
Epoch 00056: val_accuracy did not improve from 0.86260
391/390 [=====] - 70s 178ms/step - loss: 0.3138 - accuracy: 0.8889 - val_loss: 0.4589 - val_accuracy: 0.8440
Epoch 57/300
391/390 [=====] - ETA: 0s - loss: 0.3198 - accuracy: 0.8874
Epoch 00057: val_accuracy improved from 0.86260 to 0.86630, saving model to /content/drive/My Drive/MyCNN/model-057-0.887400-0.866300.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-057-0.887400-0.866300.h5'/assets
391/390 [=====] - 85s 218ms/step - loss: 0.3198 - accuracy: 0.8874 - val_loss: 0.3822 - val_accuracy: 0.8663
Epoch 58/300
391/390 [=====] - ETA: 0s - loss: 0.3116 - accuracy: 0.8891
Epoch 00058: val_accuracy did not improve from 0.86630
391/390 [=====] - 69s 177ms/step - loss: 0.3116 - accuracy: 0.8891 - val_loss: 0.4669 - val_accuracy: 0.8457
Epoch 59/300
391/390 [=====] - ETA: 0s - loss: 0.3125 - accuracy: 0.8901
Epoch 00059: val_accuracy did not improve from 0.86630
391/390 [=====] - 69s 178ms/step - loss: 0.3125 - accuracy: 0.8901 - val_loss: 0.4402 - val_accuracy: 0.8489
Epoch 60/300
391/390 [=====] - ETA: 0s - loss: 0.3139 - accuracy: 0.8904
Epoch 00060: val_accuracy improved from 0.86630 to 0.86830, saving model to /content/drive/My Drive/MyCNN/model-060-0.890420-0.868300.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-060-0.890420-0.868300.h5'/assets
391/390 [=====] - 84s 216ms/step - loss: 0.3139 - accuracy: 0.8904 - val_loss: 0.3915 - val_accuracy: 0.8683
Epoch 61/300
391/390 [=====] - ETA: 0s - loss: 0.3034 - accuracy: 0.8934

Epoch 00061: val_accuracy did not improve from 0.86830
391/390 [=====] - 69s 177ms/step - loss: 0.3034 - accuracy: 0.8934 - val_loss: 0.5545 - val_accuracy: 0.8254
Epoch 62/300
391/390 [=====] - ETA: 0s - loss: 0.3007 - accuracy: 0.8942
Epoch 00062: val_accuracy did not improve from 0.86830
391/390 [=====] - 69s 178ms/step - loss: 0.3007 - accuracy: 0.8942 - val_loss: 0.4904 - val_accuracy: 0.8425
Epoch 63/300
391/390 [=====] - ETA: 0s - loss: 0.3007 - accuracy: 0.8950
Epoch 00063: val_accuracy improved from 0.86830 to 0.87760, saving model to /content/drive/My Drive/MyCNN/model-063-0.894980-0.877600.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-063-0.894980-0.877600.h5'/assets
391/390 [=====] - 85s 218ms/step - loss: 0.3007 - accuracy: 0.8950 - val_loss: 0.3597 - val_accuracy: 0.8776
Epoch 64/300
391/390 [=====] - ETA: 0s - loss: 0.2947 - accuracy: 0.8950
Epoch 00064: val_accuracy improved from 0.87760 to 0.89160, saving model to /content/drive/My Drive/MyCNN/model-064-0.895000-0.891600.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-064-0.895000-0.891600.h5'/assets
391/390 [=====] - 85s 217ms/step - loss: 0.2947 - accuracy: 0.8950 - val_loss: 0.3220 - val_accuracy: 0.8916
Epoch 65/300
391/390 [=====] - ETA: 0s - loss: 0.2976 - accuracy: 0.8964
Epoch 00065: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 179ms/step - loss: 0.2976 - accuracy: 0.8964 - val_loss: 0.4008 - val_accuracy: 0.8661
Epoch 66/300
391/390 [=====] - ETA: 0s - loss: 0.2898 - accuracy: 0.8976
Epoch 00066: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2898 - accuracy: 0.8976 - val_loss: 0.3605 - val_accuracy: 0.8733
Epoch 67/300
391/390 [=====] - ETA: 0s - loss: 0.2861 - accuracy: 0.8992
Epoch 00067: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2861 - accuracy: 0.8992 - val_loss: 0.3833 - val_accuracy: 0.8706
Epoch 68/300
391/390 [=====] - ETA: 0s - loss: 0.2830 - accuracy: 0.9009
Epoch 00068: val_accuracy did not improve from 0.89160
391/390 [=====] - 69s 178ms/step - loss: 0.2830 - accuracy: 0.9009 - val_loss: 0.4644 - val_accuracy: 0.8485
Epoch 69/300
391/390 [=====] - ETA: 0s - loss: 0.2855 - accuracy: 0.9008
Epoch 00069: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2855 - accuracy: 0.9008 - val_loss: 0.3894 - val_accuracy: 0.8704

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Epoch 70/300
391/390 [=====] - ETA: 0s - loss: 0.2816 - accuracy:
0.8990
Epoch 00070: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2816 - accu
racy: 0.8990 - val_loss: 0.3718 - val_accuracy: 0.8760
Epoch 71/300
391/390 [=====] - ETA: 0s - loss: 0.2759 - accuracy:
0.9027
Epoch 00071: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2759 - accu
racy: 0.9027 - val_loss: 0.3099 - val_accuracy: 0.8891
Epoch 72/300
391/390 [=====] - ETA: 0s - loss: 0.2736 - accuracy:
0.9041
Epoch 00072: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2736 - accu
racy: 0.9041 - val_loss: 0.3670 - val_accuracy: 0.8776
Epoch 73/300
391/390 [=====] - ETA: 0s - loss: 0.2725 - accuracy:
0.9034
Epoch 00073: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2725 - accu
racy: 0.9034 - val_loss: 0.3426 - val_accuracy: 0.8782
Epoch 74/300
391/390 [=====] - ETA: 0s - loss: 0.2665 - accuracy:
0.9059
Epoch 00074: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2665 - accu
racy: 0.9059 - val_loss: 0.4320 - val_accuracy: 0.8542
Epoch 75/300
391/390 [=====] - ETA: 0s - loss: 0.2684 - accuracy:
0.9049
Epoch 00075: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2684 - accu
racy: 0.9049 - val_loss: 0.4885 - val_accuracy: 0.8374
Epoch 76/300
391/390 [=====] - ETA: 0s - loss: 0.2687 - accuracy:
0.9044
Epoch 00076: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2687 - accu
racy: 0.9044 - val_loss: 0.3393 - val_accuracy: 0.8859
Epoch 77/300
391/390 [=====] - ETA: 0s - loss: 0.2607 - accuracy:
0.9084
Epoch 00077: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2607 - accu
racy: 0.9084 - val_loss: 0.3593 - val_accuracy: 0.8783
Epoch 78/300
391/390 [=====] - ETA: 0s - loss: 0.2623 - accuracy:
0.9089
Epoch 00078: val_accuracy did not improve from 0.89160
391/390 [=====] - 69s 178ms/step - loss: 0.2623 - accu
racy: 0.9089 - val_loss: 0.3391 - val_accuracy: 0.8844
Epoch 79/300
391/390 [=====] - ETA: 0s - loss: 0.2607 - accuracy:
0.9070
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Epoch 00079: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2607 - accu
racy: 0.9070 - val_loss: 0.3874 - val_accuracy: 0.8700
Epoch 80/300
391/390 [=====] - ETA: 0s - loss: 0.2535 - accuracy:
0.9095
Epoch 00080: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2535 - accu
racy: 0.9095 - val_loss: 0.3706 - val_accuracy: 0.8748
Epoch 81/300
391/390 [=====] - ETA: 0s - loss: 0.2493 - accuracy:
0.9124
Epoch 00081: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2493 - accu
racy: 0.9124 - val_loss: 0.3599 - val_accuracy: 0.8806
Epoch 82/300
391/390 [=====] - ETA: 0s - loss: 0.2513 - accuracy:
0.9109
Epoch 00082: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2513 - accu
racy: 0.9109 - val_loss: 0.3505 - val_accuracy: 0.8837
Epoch 83/300
391/390 [=====] - ETA: 0s - loss: 0.2501 - accuracy:
0.9106
Epoch 00083: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2501 - accu
racy: 0.9106 - val_loss: 0.3788 - val_accuracy: 0.8732
Epoch 84/300
391/390 [=====] - ETA: 0s - loss: 0.2465 - accuracy:
0.9124
Epoch 00084: val_accuracy did not improve from 0.89160
391/390 [=====] - 69s 178ms/step - loss: 0.2465 - accu
racy: 0.9124 - val_loss: 0.3868 - val_accuracy: 0.8775
Epoch 85/300
391/390 [=====] - ETA: 0s - loss: 0.2445 - accuracy:
0.9128
Epoch 00085: val_accuracy did not improve from 0.89160
391/390 [=====] - 70s 178ms/step - loss: 0.2445 - accu
racy: 0.9128 - val_loss: 0.4038 - val_accuracy: 0.8686
Epoch 86/300
391/390 [=====] - ETA: 0s - loss: 0.2447 - accuracy:
0.9134
Epoch 00086: val_accuracy improved from 0.89160 to 0.89480, saving model to /co
ntent/drive/My Drive/MyCNN/model-086-0.913380-0.894800.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-086-0.91
3380-0.894800.h5'/assets
391/390 [=====] - 85s 217ms/step - loss: 0.2447 - accu
racy: 0.9134 - val_loss: 0.3044 - val_accuracy: 0.8948
Epoch 87/300
391/390 [=====] - ETA: 0s - loss: 0.2442 - accuracy:
0.9123
Epoch 00087: val_accuracy improved from 0.89480 to 0.90320, saving model to /co
ntent/drive/My Drive/MyCNN/model-087-0.912320-0.903200.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-087-0.91
2320-0.903200.h5'/assets
391/390 [=====] - 84s 215ms/step - loss: 0.2442 - accu
racy: 0.9123 - val_loss: 0.2758 - val_accuracy: 0.9032
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Epoch 88/300
391/390 [=====] - ETA: 0s - loss: 0.2395 - accuracy:
0.9146
Epoch 00088: val_accuracy did not improve from 0.90320
391/390 [=====] - 69s 176ms/step - loss: 0.2395 - accu
racy: 0.9146 - val_loss: 0.3196 - val_accuracy: 0.8929
Epoch 89/300
391/390 [=====] - ETA: 0s - loss: 0.2359 - accuracy:
0.9164
Epoch 00089: val_accuracy did not improve from 0.90320
391/390 [=====] - 70s 178ms/step - loss: 0.2359 - accu
racy: 0.9164 - val_loss: 0.3821 - val_accuracy: 0.8773
Epoch 90/300
391/390 [=====] - ETA: 0s - loss: 0.2347 - accuracy:
0.9176
Epoch 00090: val_accuracy did not improve from 0.90320
391/390 [=====] - 70s 178ms/step - loss: 0.2347 - accu
racy: 0.9176 - val_loss: 0.3048 - val_accuracy: 0.8953
Epoch 91/300
391/390 [=====] - ETA: 0s - loss: 0.2342 - accuracy:
0.9174
Epoch 00091: val_accuracy did not improve from 0.90320
391/390 [=====] - 69s 178ms/step - loss: 0.2342 - accu
racy: 0.9174 - val_loss: 0.3261 - val_accuracy: 0.8895
Epoch 92/300
391/390 [=====] - ETA: 0s - loss: 0.2348 - accuracy:
0.9162
Epoch 00092: val_accuracy did not improve from 0.90320
391/390 [=====] - 69s 178ms/step - loss: 0.2348 - accu
racy: 0.9162 - val_loss: 0.4568 - val_accuracy: 0.8589
Epoch 93/300
391/390 [=====] - ETA: 0s - loss: 0.2321 - accuracy:
0.9194
Epoch 00093: val_accuracy did not improve from 0.90320
391/390 [=====] - 69s 178ms/step - loss: 0.2321 - accu
racy: 0.9194 - val_loss: 0.3109 - val_accuracy: 0.8955
Epoch 94/300
391/390 [=====] - ETA: 0s - loss: 0.2293 - accuracy:
0.9189
Epoch 00094: val_accuracy did not improve from 0.90320
391/390 [=====] - 69s 177ms/step - loss: 0.2293 - accu
racy: 0.9189 - val_loss: 0.3207 - val_accuracy: 0.8900
Epoch 95/300
391/390 [=====] - ETA: 0s - loss: 0.2264 - accuracy:
0.9183
Epoch 00095: val_accuracy did not improve from 0.90320
391/390 [=====] - 69s 178ms/step - loss: 0.2264 - accu
racy: 0.9183 - val_loss: 0.3562 - val_accuracy: 0.8872
Epoch 96/300
391/390 [=====] - ETA: 0s - loss: 0.2244 - accuracy:
0.9215
Epoch 00096: val_accuracy did not improve from 0.90320
391/390 [=====] - 69s 178ms/step - loss: 0.2244 - accu
racy: 0.9215 - val_loss: 0.3337 - val_accuracy: 0.8884
Epoch 97/300
391/390 [=====] - ETA: 0s - loss: 0.2256 - accuracy:
0.9210
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Epoch 00097: val_accuracy did not improve from 0.90320
391/390 [=====] - 70s 178ms/step - loss: 0.2256 - accuracy: 0.9210 - val_loss: 0.3608 - val_accuracy: 0.8813
Epoch 98/300
391/390 [=====] - ETA: 0s - loss: 0.2239 - accuracy: 0.9215
Epoch 00098: val_accuracy did not improve from 0.90320
391/390 [=====] - 69s 178ms/step - loss: 0.2239 - accuracy: 0.9215 - val_loss: 0.3258 - val_accuracy: 0.8904
Epoch 99/300
391/390 [=====] - ETA: 0s - loss: 0.2145 - accuracy: 0.9230
Epoch 00099: val_accuracy did not improve from 0.90320
391/390 [=====] - 70s 178ms/step - loss: 0.2145 - accuracy: 0.9230 - val_loss: 0.3363 - val_accuracy: 0.8920
Epoch 100/300
391/390 [=====] - ETA: 0s - loss: 0.2180 - accuracy: 0.9226
Epoch 00100: val_accuracy did not improve from 0.90320
391/390 [=====] - 69s 177ms/step - loss: 0.2180 - accuracy: 0.9226 - val_loss: 0.3202 - val_accuracy: 0.8963
Epoch 101/300
391/390 [=====] - ETA: 0s - loss: 0.2162 - accuracy: 0.9226
Epoch 00101: val_accuracy improved from 0.90320 to 0.91450, saving model to /content/drive/My Drive/MyCNN/model-101-0.922640-0.914500.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-101-0.922640-0.914500.h5'/assets
391/390 [=====] - 85s 217ms/step - loss: 0.2162 - accuracy: 0.9226 - val_loss: 0.2527 - val_accuracy: 0.9145
Epoch 102/300
391/390 [=====] - ETA: 0s - loss: 0.2141 - accuracy: 0.9240
Epoch 00102: val_accuracy did not improve from 0.91450
391/390 [=====] - 70s 179ms/step - loss: 0.2141 - accuracy: 0.9240 - val_loss: 0.3216 - val_accuracy: 0.8925
Epoch 103/300
391/390 [=====] - ETA: 0s - loss: 0.2140 - accuracy: 0.9247
Epoch 00103: val_accuracy did not improve from 0.91450
391/390 [=====] - 69s 178ms/step - loss: 0.2140 - accuracy: 0.9247 - val_loss: 0.2884 - val_accuracy: 0.9011
Epoch 104/300
391/390 [=====] - ETA: 0s - loss: 0.2135 - accuracy: 0.9261
Epoch 00104: val_accuracy did not improve from 0.91450
391/390 [=====] - 69s 178ms/step - loss: 0.2135 - accuracy: 0.9261 - val_loss: 0.4126 - val_accuracy: 0.8702
Epoch 105/300
391/390 [=====] - ETA: 0s - loss: 0.2119 - accuracy: 0.9245
Epoch 00105: val_accuracy improved from 0.91450 to 0.91670, saving model to /content/drive/My Drive/MyCNN/model-105-0.924500-0.916700.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-105-0.924500-0.916700.h5'/assets
391/390 [=====] - 85s 216ms/step - loss: 0.2119 - accuracy: 0.9245 - val_loss: 0.2408 - val_accuracy: 0.9167
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Epoch 106/300
391/390 [=====] - ETA: 0s - loss: 0.2062 - accuracy: 0.9263
Epoch 00106: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 179ms/step - loss: 0.2062 - accuracy: 0.9263 - val_loss: 0.2836 - val_accuracy: 0.9041
Epoch 107/300
391/390 [=====] - ETA: 0s - loss: 0.2090 - accuracy: 0.9267
Epoch 00107: val_accuracy did not improve from 0.91670
391/390 [=====] - 69s 177ms/step - loss: 0.2090 - accuracy: 0.9267 - val_loss: 0.2960 - val_accuracy: 0.9009
Epoch 108/300
391/390 [=====] - ETA: 0s - loss: 0.2056 - accuracy: 0.9271
Epoch 00108: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.2056 - accuracy: 0.9271 - val_loss: 0.3302 - val_accuracy: 0.8908
Epoch 109/300
391/390 [=====] - ETA: 0s - loss: 0.2034 - accuracy: 0.9274
Epoch 00109: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.2034 - accuracy: 0.9274 - val_loss: 0.3411 - val_accuracy: 0.8892
Epoch 110/300
391/390 [=====] - ETA: 0s - loss: 0.2068 - accuracy: 0.9264
Epoch 00110: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.2068 - accuracy: 0.9264 - val_loss: 0.3806 - val_accuracy: 0.8794
Epoch 111/300
391/390 [=====] - ETA: 0s - loss: 0.1999 - accuracy: 0.9282
Epoch 00111: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.1999 - accuracy: 0.9282 - val_loss: 0.3141 - val_accuracy: 0.8992
Epoch 112/300
391/390 [=====] - ETA: 0s - loss: 0.2032 - accuracy: 0.9283
Epoch 00112: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.2032 - accuracy: 0.9283 - val_loss: 0.2640 - val_accuracy: 0.9074
Epoch 113/300
391/390 [=====] - ETA: 0s - loss: 0.2017 - accuracy: 0.9281
Epoch 00113: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.2017 - accuracy: 0.9281 - val_loss: 0.3242 - val_accuracy: 0.8934
Epoch 114/300
391/390 [=====] - ETA: 0s - loss: 0.2003 - accuracy: 0.9291
Epoch 00114: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.2003 - accuracy: 0.9291 - val_loss: 0.3175 - val_accuracy: 0.8957
Epoch 115/300
391/390 [=====] - ETA: 0s - loss: 0.1985 - accuracy: 0.9292

Epoch 00115: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.1985 - accuracy: 0.9292 - val_loss: 0.3056 - val_accuracy: 0.8993
Epoch 116/300
391/390 [=====] - ETA: 0s - loss: 0.1930 - accuracy: 0.9310
Epoch 00116: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.1930 - accuracy: 0.9310 - val_loss: 0.3012 - val_accuracy: 0.9007
Epoch 117/300
391/390 [=====] - ETA: 0s - loss: 0.1975 - accuracy: 0.9303
Epoch 00117: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.1975 - accuracy: 0.9303 - val_loss: 0.2920 - val_accuracy: 0.9002
Epoch 118/300
391/390 [=====] - ETA: 0s - loss: 0.1935 - accuracy: 0.9304
Epoch 00118: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.1935 - accuracy: 0.9304 - val_loss: 0.2797 - val_accuracy: 0.9074
Epoch 119/300
391/390 [=====] - ETA: 0s - loss: 0.1926 - accuracy: 0.9326
Epoch 00119: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.1926 - accuracy: 0.9326 - val_loss: 0.3697 - val_accuracy: 0.8802
Epoch 120/300
391/390 [=====] - ETA: 0s - loss: 0.1875 - accuracy: 0.9332
Epoch 00120: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 179ms/step - loss: 0.1875 - accuracy: 0.9332 - val_loss: 0.2655 - val_accuracy: 0.9096
Epoch 121/300
391/390 [=====] - ETA: 0s - loss: 0.1865 - accuracy: 0.9343
Epoch 00121: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.1865 - accuracy: 0.9343 - val_loss: 0.3716 - val_accuracy: 0.8866
Epoch 122/300
391/390 [=====] - ETA: 0s - loss: 0.1890 - accuracy: 0.9327
Epoch 00122: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.1890 - accuracy: 0.9327 - val_loss: 0.2660 - val_accuracy: 0.9088
Epoch 123/300
391/390 [=====] - ETA: 0s - loss: 0.1815 - accuracy: 0.9353
Epoch 00123: val_accuracy did not improve from 0.91670
391/390 [=====] - 69s 178ms/step - loss: 0.1815 - accuracy: 0.9353 - val_loss: 0.2903 - val_accuracy: 0.9078
Epoch 124/300
391/390 [=====] - ETA: 0s - loss: 0.1867 - accuracy: 0.9357
Epoch 00124: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 179ms/step - loss: 0.1867 - accuracy: 0.9357 - val_loss: 0.2912 - val_accuracy: 0.9025

```
Epoch 125/300
391/390 [=====] - ETA: 0s - loss: 0.1827 - accuracy:
0.9353
Epoch 00125: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.1827 - accu
racy: 0.9353 - val_loss: 0.3028 - val_accuracy: 0.8949
Epoch 126/300
391/390 [=====] - ETA: 0s - loss: 0.1847 - accuracy:
0.9341
Epoch 00126: val_accuracy did not improve from 0.91670
391/390 [=====] - 69s 177ms/step - loss: 0.1847 - accu
racy: 0.9341 - val_loss: 0.3078 - val_accuracy: 0.9004
Epoch 127/300
391/390 [=====] - ETA: 0s - loss: 0.1830 - accuracy:
0.9347
Epoch 00127: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.1830 - accu
racy: 0.9347 - val_loss: 0.3517 - val_accuracy: 0.8877
Epoch 128/300
391/390 [=====] - ETA: 0s - loss: 0.1786 - accuracy:
0.9354
Epoch 00128: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.1786 - accu
racy: 0.9354 - val_loss: 0.2638 - val_accuracy: 0.9125
Epoch 129/300
391/390 [=====] - ETA: 0s - loss: 0.1811 - accuracy:
0.9349
Epoch 00129: val_accuracy did not improve from 0.91670
391/390 [=====] - 69s 178ms/step - loss: 0.1811 - accu
racy: 0.9349 - val_loss: 0.3112 - val_accuracy: 0.9012
Epoch 130/300
391/390 [=====] - ETA: 0s - loss: 0.1785 - accuracy:
0.9359
Epoch 00130: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 179ms/step - loss: 0.1785 - accu
racy: 0.9359 - val_loss: 0.2824 - val_accuracy: 0.9076
Epoch 131/300
391/390 [=====] - ETA: 0s - loss: 0.1770 - accuracy:
0.9372
Epoch 00131: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.1770 - accu
racy: 0.9372 - val_loss: 0.4114 - val_accuracy: 0.8744
Epoch 132/300
391/390 [=====] - ETA: 0s - loss: 0.1777 - accuracy:
0.9376
Epoch 00132: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.1777 - accu
racy: 0.9376 - val_loss: 0.3475 - val_accuracy: 0.8932
Epoch 133/300
391/390 [=====] - ETA: 0s - loss: 0.1757 - accuracy:
0.9394
Epoch 00133: val_accuracy did not improve from 0.91670
391/390 [=====] - 70s 178ms/step - loss: 0.1757 - accu
racy: 0.9394 - val_loss: 0.2550 - val_accuracy: 0.9158
Epoch 134/300
391/390 [=====] - ETA: 0s - loss: 0.1753 - accuracy:
0.9368
```

Epoch 00134: val_accuracy improved from 0.91670 to 0.91930, saving model to /content/drive/My Drive/MyCNN/model-134-0.936820-0.919300.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-134-0.936820-0.919300.h5'/assets
391/390 [=====] - 85s 218ms/step - loss: 0.1753 - accuracy: 0.9368 - val_loss: 0.2411 - val_accuracy: 0.9193
Epoch 135/300
391/390 [=====] - ETA: 0s - loss: 0.1723 - accuracy: 0.9391
Epoch 00135: val_accuracy did not improve from 0.91930
391/390 [=====] - 70s 179ms/step - loss: 0.1723 - accuracy: 0.9391 - val_loss: 0.2574 - val_accuracy: 0.9147
Epoch 136/300
391/390 [=====] - ETA: 0s - loss: 0.1768 - accuracy: 0.9361
Epoch 00136: val_accuracy did not improve from 0.91930
391/390 [=====] - 70s 178ms/step - loss: 0.1768 - accuracy: 0.9361 - val_loss: 0.2785 - val_accuracy: 0.9098
Epoch 137/300
391/390 [=====] - ETA: 0s - loss: 0.1724 - accuracy: 0.9380
Epoch 00137: val_accuracy did not improve from 0.91930
391/390 [=====] - 70s 178ms/step - loss: 0.1724 - accuracy: 0.9380 - val_loss: 0.2832 - val_accuracy: 0.9080
Epoch 138/300
391/390 [=====] - ETA: 0s - loss: 0.1691 - accuracy: 0.9401
Epoch 00138: val_accuracy did not improve from 0.91930
391/390 [=====] - 70s 179ms/step - loss: 0.1691 - accuracy: 0.9401 - val_loss: 0.2672 - val_accuracy: 0.9112
Epoch 139/300
391/390 [=====] - ETA: 0s - loss: 0.1769 - accuracy: 0.9375
Epoch 00139: val_accuracy did not improve from 0.91930
391/390 [=====] - 70s 179ms/step - loss: 0.1769 - accuracy: 0.9375 - val_loss: 0.2952 - val_accuracy: 0.9060
Epoch 140/300
391/390 [=====] - ETA: 0s - loss: 0.1659 - accuracy: 0.9406
Epoch 00140: val_accuracy did not improve from 0.91930
391/390 [=====] - 70s 178ms/step - loss: 0.1659 - accuracy: 0.9406 - val_loss: 0.2970 - val_accuracy: 0.9026
Epoch 141/300
391/390 [=====] - ETA: 0s - loss: 0.1682 - accuracy: 0.9413
Epoch 00141: val_accuracy did not improve from 0.91930
391/390 [=====] - 70s 179ms/step - loss: 0.1682 - accuracy: 0.9413 - val_loss: 0.2337 - val_accuracy: 0.9180
Epoch 142/300
391/390 [=====] - ETA: 0s - loss: 0.1653 - accuracy: 0.9414
Epoch 00142: val_accuracy improved from 0.91930 to 0.92790, saving model to /content/drive/My Drive/MyCNN/model-142-0.941420-0.927900.h5'
INFO:tensorflow:Assets written to: /content/drive/My Drive/MyCNN/model-142-0.941420-0.927900.h5'/assets
391/390 [=====] - 85s 218ms/step - loss: 0.1653 - accuracy: 0.9414 - val_loss: 0.2083 - val_accuracy: 0.9279

```

Epoch 143/300
391/390 [=====] - ETA: 0s - loss: 0.1641 - accuracy:
0.9420
Epoch 00143: val_accuracy did not improve from 0.92790
391/390 [=====] - 70s 179ms/step - loss: 0.1641 - accu
racy: 0.9420 - val_loss: 0.2253 - val_accuracy: 0.9203
Epoch 144/300
391/390 [=====] - ETA: 0s - loss: 0.1620 - accuracy:
0.9426
Epoch 00144: val_accuracy did not improve from 0.92790
391/390 [=====] - 70s 178ms/step - loss: 0.1620 - accu
racy: 0.9426 - val_loss: 0.2483 - val_accuracy: 0.9193
Epoch 145/300
391/390 [=====] - ETA: 0s - loss: 0.1692 - accuracy:
0.9405
Epoch 00145: val_accuracy did not improve from 0.92790
391/390 [=====] - 70s 178ms/step - loss: 0.1692 - accu
racy: 0.9405 - val_loss: 0.2145 - val_accuracy: 0.9261
Epoch 146/300
391/390 [=====] - ETA: 0s - loss: 0.1618 - accuracy:
0.9416
Epoch 00146: val_accuracy did not improve from 0.92790
391/390 [=====] - 70s 178ms/step - loss: 0.1618 - accu
racy: 0.9416 - val_loss: 0.3028 - val_accuracy: 0.8990
Epoch 147/300
391/390 [=====] - ETA: 0s - loss: 0.1620 - accuracy:
0.9433
Epoch 00147: val_accuracy did not improve from 0.92790
391/390 [=====] - 70s 178ms/step - loss: 0.1620 - accu
racy: 0.9433 - val_loss: 0.2521 - val_accuracy: 0.9156
Epoch 148/300
391/390 [=====] - ETA: 0s - loss: 0.1625 - accuracy:
0.9423
Epoch 00148: val_accuracy did not improve from 0.92790
391/390 [=====] - 70s 178ms/step - loss: 0.1625 - accu
racy: 0.9423 - val_loss: 0.2622 - val_accuracy: 0.9145
Epoch 149/300
391/390 [=====] - ETA: 0s - loss: 0.1596 - accuracy:
0.9450
Epoch 00149: val_accuracy did not improve from 0.92790
391/390 [=====] - 70s 178ms/step - loss: 0.1596 - accu
racy: 0.9450 - val_loss: 0.2497 - val_accuracy: 0.9169
Epoch 150/300
10/390 [.....] - ETA: 1:02 - loss: 0.1735 - accuracy:
0.9422Buffered data was truncated after reaching the output size limit.

```

```

In [ ]: model.load_weights('/content/drive/My Drive/MyCNN/model-142-0.941420-0.927900.h5')
model.compile(loss='categorical_crossentropy',
              optimizer=Adam(),
              metrics=['accuracy'])

```



```
In [59]: score = model.evaluate(X_test, y_test, verbose=1)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

313/313 [=====] - 3s 11ms/step - loss: 0.2198 - accuracy: 0.9327

Test loss: 0.2197745144367218

Test accuracy: 0.932699978351593

RESULT

- my intention was to run this till 300 epochs
- due to colab time limit I able to train till 150 epochs but still able to achieve the **test accuracy=0.932699978351593**
- **Total params: 993,961**

Hyperparameters

- batch_size = 128
- num_classes = 10
- l = 8
- num_filter = 27
- compression = 1
- dropout_rate = 0.2

In []: