```
import keras
from tensorflow.keras.layers import Dense, Conv2D, BatchNormalization
from tensorflow.keras.layers import MaxPooling2D, AveragePooling2D
from tensorflow.keras.layers import Input, Flatten, Dropout
from tensorflow.keras.layers import concatenate, Activation
from tensorflow.keras.optimizers import RMSprop,Adam
from tensorflow.keras.callbacks import ModelCheckpoint, ReduceLROnPlateau
from tensorflow.keras.callbacks import LearningRateScheduler ,EarlyStopping
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.models import Model
from tensorflow.keras.datasets import cifar10
from tensorflow.keras.utils import plot_model
from tensorflow.keras.utils import to_categorical
import os
import numpy as np
```

```
Using TensorFlow backend.
```

The default version of TensorFlow in Colab will soon switch to TensorFlow 2.x.
We recommend you upgrade now or ensure your notebook will continue to use TensorFlow 1.x via the `%tensorflow_version 1.x` magic: more info.

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

```
# training parameters
epochs = 100
# network parameters
num_classes = 10
num_dense_blocks = 3
growth_rate = 12
depth = 100
num_bottleneck_layers = (depth - 4) // (2 * num_dense_blocks)

num_filters_bef_dense_block = 2 * growth_rate
compression_factor = 0.5
```

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

from sklearn.model_selection import train_test_split
from sklearn.utils import resample
X_train, X_cv, y_train, y_cv = train_test_split(X_train, y_train, test_size=10/50, random_

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

```
# convert from integers to floats
train_norm = X_train.astype('float32')
test_norm = X_test.astype('float32')
cv_norm = X_cv.astype('float32')
# normalize to range 0-1
X_train = train_norm / 255.0
X_test = test_norm / 255.0
X_cv = cv_norm /255.0
```

```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz
170500096/170498071 [==============================] - 4s 0us/step
```

```
X_train.shape , X_cv.shape
```

```
((40000, 32, 32, 3), (10000, 32, 32, 3))
```

```
X_test.shape
```

```
(10000, 32, 32, 3)
```

```
 # start model definition
# densenet CNNs (composite function) are made of BN-ReLU-Conv2D

inputs = Input(shape=input_shape)
x = BatchNormalization()(inputs)
x = Activation('relu')(x)
x = Conv2D(num_filters_bef_dense_block,
           kernel_size=3,
           padding='same',
           kernel_initializer='he_normal')(x)
x = concatenate([inputs, x])

# stack of dense blocks bridged by transition layers
for i in range(num_dense_blocks):
    # a dense block is a stack of bottleneck layers
    for j in range(num_bottleneck_layers):
        y = BatchNormalization()(x)
        y = Activation('relu')(y)
        y = Conv2D(4 * growth_rate,
                   kernel_size=1,
                   padding='same',
                   kernel_initializer='he_normal')(y)
        y = BatchNormalization()(y)
        y = Activation('relu')(y)
        y = Conv2D(growth_rate,
                   kernel_size=3,
                   padding='same',
                   kernel_initializer='he_normal')(y)
        x = concatenate([x, y])

    # no transition layer after the last dense block
    if i == num_dense_blocks - 1:
```

```
        continue

    # transition layer compresses num of feature maps and reduces the size by 2
    num_filters_bef_dense_block += num_bottleneck_layers * growth_rate
    num_filters_bef_dense_block = int(num_filters_bef_dense_block * compression_factor)
    y = BatchNormalization()(x)
    y = Conv2D(num_filters_bef_dense_block,
               kernel_size=1,
               padding='same',
               kernel_initializer='he_normal')(y)
    x = AveragePooling2D()(y)


# add classifier on top
# after average pooling, size of feature map is 1 x 1
x = AveragePooling2D(pool_size=8)(x)
x= Conv2D(num_classes,kernel_size=1,padding='valid',
                kernel_initializer='he_normal',
                activation='softmax')(x)
outputs = Flatten()(x)
#outputs = Dense(num_classes,kernel_initializer='he_normal',activation='softmax')(x)

# instantiate and compile model
model = Model(inputs=inputs, outputs=outputs)
model.compile(loss='categorical_crossentropy',
              optimizer=Adam(learning_rate=0.001),
              metrics=['accuracy'])
model.summary()
```

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python
Instructions for updating:
If using Keras pass *_constraint arguments to layers.
Model: "model"
```

Layer (type)	Output Shape	Param #	Connected to
input_1 (InputLayer)	[(None, 32, 32, 3)]	0	
batch_normalization (BatchNorma	(None, 32, 32, 3)	12	input_1[0][0]
activation (Activation)	(None, 32, 32, 3)	0	batch_normalization[
conv2d (Conv2D)	(None, 32, 32, 24)	672	activation[0][0]
concatenate (Concatenate)	(None, 32, 32, 27)	0	input_1[0][0] conv2d[0][0]
batch_normalization_1 (BatchNor	(None, 32, 32, 27)	108	concatenate[0][0]
activation_1 (Activation)	(None, 32, 32, 27)	0	batch_normalization_
conv2d_1 (Conv2D)	(None, 32, 32, 48)	1344	activation_1[0][0]
batch_normalization_2 (BatchNor	(None, 32, 32, 48)	192	conv2d_1[0][0]
activation_2 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_2 (Conv2D)	(None, 32, 32, 12)	5196	activation_2[0][0]
concatenate_1 (Concatenate)	(None, 32, 32, 39)	0	concatenate[0][0] conv2d_2[0][0]
batch_normalization_3 (BatchNor	(None, 32, 32, 39)	156	concatenate_1[0][0]
activation_3 (Activation)	(None, 32, 32, 39)	0	batch_normalization_
conv2d_3 (Conv2D)	(None, 32, 32, 48)	1920	activation_3[0][0]
batch_normalization_4 (BatchNor	(None, 32, 32, 48)	192	conv2d_3[0][0]
activation_4 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_4 (Conv2D)	(None, 32, 32, 12)	5196	activation_4[0][0]
concatenate_2 (Concatenate)	(None, 32, 32, 51)	0	concatenate_1[0][0] conv2d_4[0][0]
batch_normalization_5 (BatchNor	(None, 32, 32, 51)	204	concatenate_2[0][0]
activation_5 (Activation)	(None, 32, 32, 51)	0	batch_normalization_
conv2d_5 (Conv2D)	(None, 32, 32, 48)	2496	activation_5[0][0]
batch_normalization_6 (BatchNor	(None, 32, 32, 48)	192	conv2d_5[0][0]
activation_6 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_6 (Conv2D)	(None, 32, 32, 12)	5196	activation_6[0][0]
concatenate_3 (Concatenate)	(None, 32, 32, 63)	0	concatenate_2[0][0]

			conv2d_6[0][0]
batch_normalization_7 (BatchNor	(None, 32, 32, 63)	252	concatenate_3[0][0]
activation_7 (Activation)	(None, 32, 32, 63)	0	batch_normalization_
conv2d_7 (Conv2D)	(None, 32, 32, 48)	3072	activation_7[0][0]
batch_normalization_8 (BatchNor	(None, 32, 32, 48)	192	conv2d_7[0][0]
activation_8 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_8 (Conv2D)	(None, 32, 32, 12)	5196	activation_8[0][0]
concatenate_4 (Concatenate)	(None, 32, 32, 75)	0	concatenate_3[0][0] conv2d_8[0][0]
batch_normalization_9 (BatchNor	(None, 32, 32, 75)	300	concatenate_4[0][0]
activation_9 (Activation)	(None, 32, 32, 75)	0	batch_normalization_
conv2d_9 (Conv2D)	(None, 32, 32, 48)	3648	activation_9[0][0]
batch_normalization_10 (BatchNo	(None, 32, 32, 48)	192	conv2d_9[0][0]
activation_10 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_10 (Conv2D)	(None, 32, 32, 12)	5196	activation_10[0][0]
concatenate_5 (Concatenate)	(None, 32, 32, 87)	0	concatenate_4[0][0] conv2d_10[0][0]
batch_normalization_11 (BatchNo	(None, 32, 32, 87)	348	concatenate_5[0][0]
activation_11 (Activation)	(None, 32, 32, 87)	0	batch_normalization_
conv2d_11 (Conv2D)	(None, 32, 32, 48)	4224	activation_11[0][0]
batch_normalization_12 (BatchNo	(None, 32, 32, 48)	192	conv2d_11[0][0]
activation_12 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_12 (Conv2D)	(None, 32, 32, 12)	5196	activation_12[0][0]
concatenate_6 (Concatenate)	(None, 32, 32, 99)	0	concatenate_5[0][0] conv2d_12[0][0]
batch_normalization_13 (BatchNo	(None, 32, 32, 99)	396	concatenate_6[0][0]
activation_13 (Activation)	(None, 32, 32, 99)	0	batch_normalization_
conv2d_13 (Conv2D)	(None, 32, 32, 48)	4800	activation_13[0][0]
batch_normalization_14 (BatchNo	(None, 32, 32, 48)	192	conv2d_13[0][0]
activation_14 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_14 (Conv2D)	(None, 32, 32, 12)	5196	activation_14[0][0]
concatenate_7 (Concatenate)	(None, 32, 32, 111)	0	concatenate_6[0][0] conv2d_14[0][0]

batch_normalization_15 (BatchNo	(None, 32, 32, 111)	444	concatenate_7[0][0]
activation_15 (Activation)	(None, 32, 32, 111)	0	batch_normalization_
conv2d_15 (Conv2D)	(None, 32, 32, 48)	5376	activation_15[0][0]
batch_normalization_16 (BatchNo	(None, 32, 32, 48)	192	conv2d_15[0][0]
activation_16 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_16 (Conv2D)	(None, 32, 32, 12)	5196	activation_16[0][0]
concatenate_8 (Concatenate)	(None, 32, 32, 123)	0	concatenate_7[0][0] conv2d_16[0][0]
batch_normalization_17 (BatchNo	(None, 32, 32, 123)	492	concatenate_8[0][0]
activation_17 (Activation)	(None, 32, 32, 123)	0	batch_normalization_
conv2d_17 (Conv2D)	(None, 32, 32, 48)	5952	activation_17[0][0]
batch_normalization_18 (BatchNo	(None, 32, 32, 48)	192	conv2d_17[0][0]
activation_18 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_18 (Conv2D)	(None, 32, 32, 12)	5196	activation_18[0][0]
concatenate_9 (Concatenate)	(None, 32, 32, 135)	0	concatenate_8[0][0] conv2d_18[0][0]
batch_normalization_19 (BatchNo	(None, 32, 32, 135)	540	concatenate_9[0][0]
activation_19 (Activation)	(None, 32, 32, 135)	0	batch_normalization_
conv2d_19 (Conv2D)	(None, 32, 32, 48)	6528	activation_19[0][0]
batch_normalization_20 (BatchNo	(None, 32, 32, 48)	192	conv2d_19[0][0]
activation_20 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_20 (Conv2D)	(None, 32, 32, 12)	5196	activation_20[0][0]
concatenate_10 (Concatenate)	(None, 32, 32, 147)	0	concatenate_9[0][0] conv2d_20[0][0]
batch_normalization_21 (BatchNo	(None, 32, 32, 147)	588	concatenate_10[0][0]
activation_21 (Activation)	(None, 32, 32, 147)	0	batch_normalization_
conv2d_21 (Conv2D)	(None, 32, 32, 48)	7104	activation_21[0][0]
batch_normalization_22 (BatchNo	(None, 32, 32, 48)	192	conv2d_21[0][0]
activation_22 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_22 (Conv2D)	(None, 32, 32, 12)	5196	activation_22[0][0]
concatenate_11 (Concatenate)	(None, 32, 32, 159)	0	concatenate_10[0][0] conv2d_22[0][0]
batch_normalization_23 (BatchNo	(None, 32, 32, 159)	636	concatenate_11[0][0]

activation_23 (Activation)	(None, 32, 32, 159)	0	batch_normalization_
conv2d_23 (Conv2D)	(None, 32, 32, 48)	7680	activation_23[0][0]
batch_normalization_24 (BatchNo	(None, 32, 32, 48)	192	conv2d_23[0][0]
activation_24 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_24 (Conv2D)	(None, 32, 32, 12)	5196	activation_24[0][0]
concatenate_12 (Concatenate)	(None, 32, 32, 171)	0	concatenate_11[0][0] conv2d_24[0][0]
batch_normalization_25 (BatchNo	(None, 32, 32, 171)	684	concatenate_12[0][0]
activation_25 (Activation)	(None, 32, 32, 171)	0	batch_normalization_
conv2d_25 (Conv2D)	(None, 32, 32, 48)	8256	activation_25[0][0]
batch_normalization_26 (BatchNo	(None, 32, 32, 48)	192	conv2d_25[0][0]
activation_26 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_26 (Conv2D)	(None, 32, 32, 12)	5196	activation_26[0][0]
concatenate_13 (Concatenate)	(None, 32, 32, 183)	0	concatenate_12[0][0] conv2d_26[0][0]
batch_normalization_27 (BatchNo	(None, 32, 32, 183)	732	concatenate_13[0][0]
activation_27 (Activation)	(None, 32, 32, 183)	0	batch_normalization_
conv2d_27 (Conv2D)	(None, 32, 32, 48)	8832	activation_27[0][0]
batch_normalization_28 (BatchNo	(None, 32, 32, 48)	192	conv2d_27[0][0]
activation_28 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_28 (Conv2D)	(None, 32, 32, 12)	5196	activation_28[0][0]
concatenate_14 (Concatenate)	(None, 32, 32, 195)	0	concatenate_13[0][0] conv2d_28[0][0]
batch_normalization_29 (BatchNo	(None, 32, 32, 195)	780	concatenate_14[0][0]
activation_29 (Activation)	(None, 32, 32, 195)	0	batch_normalization_
conv2d_29 (Conv2D)	(None, 32, 32, 48)	9408	activation_29[0][0]
batch_normalization_30 (BatchNo	(None, 32, 32, 48)	192	conv2d_29[0][0]
activation_30 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_30 (Conv2D)	(None, 32, 32, 12)	5196	activation_30[0][0]
concatenate_15 (Concatenate)	(None, 32, 32, 207)	0	concatenate_14[0][0] conv2d_30[0][0]
batch_normalization_31 (BatchNo	(None, 32, 32, 207)	828	concatenate_15[0][0]
activation_31 (Activation)	(None, 32, 32, 207)	0	batch_normalization

activation_31 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_31 (Conv2D)	(None, 32, 32, 48)	9984	activation_31[0][0]
batch_normalization_32 (BatchNo	(None, 32, 32, 48)	192	conv2d_31[0][0]
activation_32 (Activation)	(None, 32, 32, 48)	0	batch_normalization_
conv2d_32 (Conv2D)	(None, 32, 32, 12)	5196	activation_32[0][0]
concatenate_16 (Concatenate)	(None, 32, 32, 219)	0	concatenate_15[0][0] conv2d_32[0][0]
batch_normalization_33 (BatchNo	(None, 32, 32, 219)	876	concatenate_16[0][0]
conv2d_33 (Conv2D)	(None, 32, 32, 108)	23760	batch_normalization_
average_pooling2d (AveragePooli	(None, 16, 16, 108)	0	conv2d_33[0][0]
batch_normalization_34 (BatchNo	(None, 16, 16, 108)	432	average_pooling2d[0]
activation_33 (Activation)	(None, 16, 16, 108)	0	batch_normalization_
conv2d_34 (Conv2D)	(None, 16, 16, 48)	5232	activation_33[0][0]
batch_normalization_35 (BatchNo	(None, 16, 16, 48)	192	conv2d_34[0][0]
activation_34 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_35 (Conv2D)	(None, 16, 16, 12)	5196	activation_34[0][0]
concatenate_17 (Concatenate)	(None, 16, 16, 120)	0	average_pooling2d[0] conv2d_35[0][0]
batch_normalization_36 (BatchNo	(None, 16, 16, 120)	480	concatenate_17[0][0]
activation_35 (Activation)	(None, 16, 16, 120)	0	batch_normalization_
conv2d_36 (Conv2D)	(None, 16, 16, 48)	5808	activation_35[0][0]
batch_normalization_37 (BatchNo	(None, 16, 16, 48)	192	conv2d_36[0][0]
activation_36 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_37 (Conv2D)	(None, 16, 16, 12)	5196	activation_36[0][0]
concatenate_18 (Concatenate)	(None, 16, 16, 132)	0	concatenate_17[0][0] conv2d_37[0][0]
batch_normalization_38 (BatchNo	(None, 16, 16, 132)	528	concatenate_18[0][0]
activation_37 (Activation)	(None, 16, 16, 132)	0	batch_normalization_
conv2d_38 (Conv2D)	(None, 16, 16, 48)	6384	activation_37[0][0]
batch_normalization_39 (BatchNo	(None, 16, 16, 48)	192	conv2d_38[0][0]
activation_38 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_39 (Conv2D)	(None, 16, 16, 12)	5196	activation_38[0][0]
concatenate_19 (Concatenate)	(None, 16, 16, 144)	0	concatenate_18[0][0]

			conv2d_39[0][0]
batch_normalization_40 (BatchNo	(None, 16, 16, 144)	576	concatenate_19[0][0]
activation_39 (Activation)	(None, 16, 16, 144)	0	batch_normalization_
conv2d_40 (Conv2D)	(None, 16, 16, 48)	6960	activation_39[0][0]
batch_normalization_41 (BatchNo	(None, 16, 16, 48)	192	conv2d_40[0][0]
activation_40 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_41 (Conv2D)	(None, 16, 16, 12)	5196	activation_40[0][0]
concatenate_20 (Concatenate)	(None, 16, 16, 156)	0	concatenate_19[0][0] conv2d_41[0][0]
batch_normalization_42 (BatchNo	(None, 16, 16, 156)	624	concatenate_20[0][0]
activation_41 (Activation)	(None, 16, 16, 156)	0	batch_normalization_
conv2d_42 (Conv2D)	(None, 16, 16, 48)	7536	activation_41[0][0]
batch_normalization_43 (BatchNo	(None, 16, 16, 48)	192	conv2d_42[0][0]
activation_42 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_43 (Conv2D)	(None, 16, 16, 12)	5196	activation_42[0][0]
concatenate_21 (Concatenate)	(None, 16, 16, 168)	0	concatenate_20[0][0] conv2d_43[0][0]
batch_normalization_44 (BatchNo	(None, 16, 16, 168)	672	concatenate_21[0][0]
activation_43 (Activation)	(None, 16, 16, 168)	0	batch_normalization_
conv2d_44 (Conv2D)	(None, 16, 16, 48)	8112	activation_43[0][0]
batch_normalization_45 (BatchNo	(None, 16, 16, 48)	192	conv2d_44[0][0]
activation_44 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_45 (Conv2D)	(None, 16, 16, 12)	5196	activation_44[0][0]
concatenate_22 (Concatenate)	(None, 16, 16, 180)	0	concatenate_21[0][0] conv2d_45[0][0]
batch_normalization_46 (BatchNo	(None, 16, 16, 180)	720	concatenate_22[0][0]
activation_45 (Activation)	(None, 16, 16, 180)	0	batch_normalization_
conv2d_46 (Conv2D)	(None, 16, 16, 48)	8688	activation_45[0][0]
batch_normalization_47 (BatchNo	(None, 16, 16, 48)	192	conv2d_46[0][0]
activation_46 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_47 (Conv2D)	(None, 16, 16, 12)	5196	activation_46[0][0]
concatenate_23 (Concatenate)	(None, 16, 16, 192)	0	concatenate_22[0][0] conv2d_47[0][0]

batch_normalization_48 (BatchNo	(None, 16, 16, 192)	768	concatenate_23[0][0]
activation_47 (Activation)	(None, 16, 16, 192)	0	batch_normalization_
conv2d_48 (Conv2D)	(None, 16, 16, 48)	9264	activation_47[0][0]
batch_normalization_49 (BatchNo	(None, 16, 16, 48)	192	conv2d_48[0][0]
activation_48 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_49 (Conv2D)	(None, 16, 16, 12)	5196	activation_48[0][0]
concatenate_24 (Concatenate)	(None, 16, 16, 204)	0	concatenate_23[0][0] conv2d_49[0][0]
batch_normalization_50 (BatchNo	(None, 16, 16, 204)	816	concatenate_24[0][0]
activation_49 (Activation)	(None, 16, 16, 204)	0	batch_normalization_
conv2d_50 (Conv2D)	(None, 16, 16, 48)	9840	activation_49[0][0]
batch_normalization_51 (BatchNo	(None, 16, 16, 48)	192	conv2d_50[0][0]
activation_50 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_51 (Conv2D)	(None, 16, 16, 12)	5196	activation_50[0][0]
concatenate_25 (Concatenate)	(None, 16, 16, 216)	0	concatenate_24[0][0] conv2d_51[0][0]
batch_normalization_52 (BatchNo	(None, 16, 16, 216)	864	concatenate_25[0][0]
activation_51 (Activation)	(None, 16, 16, 216)	0	batch_normalization_
conv2d_52 (Conv2D)	(None, 16, 16, 48)	10416	activation_51[0][0]
batch_normalization_53 (BatchNo	(None, 16, 16, 48)	192	conv2d_52[0][0]
activation_52 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_53 (Conv2D)	(None, 16, 16, 12)	5196	activation_52[0][0]
concatenate_26 (Concatenate)	(None, 16, 16, 228)	0	concatenate_25[0][0] conv2d_53[0][0]
batch_normalization_54 (BatchNo	(None, 16, 16, 228)	912	concatenate_26[0][0]
activation_53 (Activation)	(None, 16, 16, 228)	0	batch_normalization_
conv2d_54 (Conv2D)	(None, 16, 16, 48)	10992	activation_53[0][0]
batch_normalization_55 (BatchNo	(None, 16, 16, 48)	192	conv2d_54[0][0]
activation_54 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_55 (Conv2D)	(None, 16, 16, 12)	5196	activation_54[0][0]
concatenate_27 (Concatenate)	(None, 16, 16, 240)	0	concatenate_26[0][0] conv2d_55[0][0]
batch_normalization_56 (BatchNo	(None, 16, 16, 240)	960	concatenate_27[0][0]

activation_55 (Activation)	(None, 16, 16, 240)	0	batch_normalization_
conv2d_56 (Conv2D)	(None, 16, 16, 48)	11568	activation_55[0][0]
batch_normalization_57 (BatchNo	(None, 16, 16, 48)	192	conv2d_56[0][0]
activation_56 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_57 (Conv2D)	(None, 16, 16, 12)	5196	activation_56[0][0]
concatenate_28 (Concatenate)	(None, 16, 16, 252)	0	concatenate_27[0][0] conv2d_57[0][0]
batch_normalization_58 (BatchNo	(None, 16, 16, 252)	1008	concatenate_28[0][0]
activation_57 (Activation)	(None, 16, 16, 252)	0	batch_normalization_
conv2d_58 (Conv2D)	(None, 16, 16, 48)	12144	activation_57[0][0]
batch_normalization_59 (BatchNo	(None, 16, 16, 48)	192	conv2d_58[0][0]
activation_58 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_59 (Conv2D)	(None, 16, 16, 12)	5196	activation_58[0][0]
concatenate_29 (Concatenate)	(None, 16, 16, 264)	0	concatenate_28[0][0] conv2d_59[0][0]
batch_normalization_60 (BatchNo	(None, 16, 16, 264)	1056	concatenate_29[0][0]
activation_59 (Activation)	(None, 16, 16, 264)	0	batch_normalization_
conv2d_60 (Conv2D)	(None, 16, 16, 48)	12720	activation_59[0][0]
batch_normalization_61 (BatchNo	(None, 16, 16, 48)	192	conv2d_60[0][0]
activation_60 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_61 (Conv2D)	(None, 16, 16, 12)	5196	activation_60[0][0]
concatenate_30 (Concatenate)	(None, 16, 16, 276)	0	concatenate_29[0][0] conv2d_61[0][0]
batch_normalization_62 (BatchNo	(None, 16, 16, 276)	1104	concatenate_30[0][0]
activation_61 (Activation)	(None, 16, 16, 276)	0	batch_normalization_
conv2d_62 (Conv2D)	(None, 16, 16, 48)	13296	activation_61[0][0]
batch_normalization_63 (BatchNo	(None, 16, 16, 48)	192	conv2d_62[0][0]
activation_62 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_63 (Conv2D)	(None, 16, 16, 12)	5196	activation_62[0][0]
concatenate_31 (Concatenate)	(None, 16, 16, 288)	0	concatenate_30[0][0] conv2d_63[0][0]
batch_normalization_64 (BatchNo	(None, 16, 16, 288)	1152	concatenate_31[0][0]
activation_63 (Activation)	(None, 16, 16, 288)	0	batch_normalization

conv2d_64 (Conv2D)	(None, 16, 16, 48)	13872	activation_63[0][0]
batch_normalization_65 (BatchNo	(None, 16, 16, 48)	192	conv2d_64[0][0]
activation_64 (Activation)	(None, 16, 16, 48)	0	batch_normalization_
conv2d_65 (Conv2D)	(None, 16, 16, 12)	5196	activation_64[0][0]
concatenate_32 (Concatenate)	(None, 16, 16, 300)	0	concatenate_31[0][0] conv2d_65[0][0]
batch_normalization_66 (BatchNo	(None, 16, 16, 300)	1200	concatenate_32[0][0]
conv2d_66 (Conv2D)	(None, 16, 16, 150)	45150	batch_normalization_
average_pooling2d_1 (AveragePoo	(None, 8, 8, 150)	0	conv2d_66[0][0]
batch_normalization_67 (BatchNo	(None, 8, 8, 150)	600	average_pooling2d_1[
activation_65 (Activation)	(None, 8, 8, 150)	0	batch_normalization_
conv2d_67 (Conv2D)	(None, 8, 8, 48)	7248	activation_65[0][0]
batch_normalization_68 (BatchNo	(None, 8, 8, 48)	192	conv2d_67[0][0]
activation_66 (Activation)	(None, 8, 8, 48)	0	batch_normalization_
conv2d_68 (Conv2D)	(None, 8, 8, 12)	5196	activation_66[0][0]
concatenate_33 (Concatenate)	(None, 8, 8, 162)	0	average_pooling2d_1[conv2d_68[0][0]
batch_normalization_69 (BatchNo	(None, 8, 8, 162)	648	concatenate_33[0][0]
activation_67 (Activation)	(None, 8, 8, 162)	0	batch_normalization_
conv2d_69 (Conv2D)	(None, 8, 8, 48)	7824	activation_67[0][0]
batch_normalization_70 (BatchNo	(None, 8, 8, 48)	192	conv2d_69[0][0]
activation_68 (Activation)	(None, 8, 8, 48)	0	batch_normalization_
conv2d_70 (Conv2D)	(None, 8, 8, 12)	5196	activation_68[0][0]
concatenate_34 (Concatenate)	(None, 8, 8, 174)	0	concatenate_33[0][0] conv2d_70[0][0]
batch_normalization_71 (BatchNo	(None, 8, 8, 174)	696	concatenate_34[0][0]
activation_69 (Activation)	(None, 8, 8, 174)	0	batch_normalization_
conv2d_71 (Conv2D)	(None, 8, 8, 48)	8400	activation_69[0][0]
batch_normalization_72 (BatchNo	(None, 8, 8, 48)	192	conv2d_71[0][0]
activation_70 (Activation)	(None, 8, 8, 48)	0	batch_normalization_
conv2d_72 (Conv2D)	(None, 8, 8, 12)	5196	activation_70[0][0]
concatenate_35 (Concatenate)	(None, 8, 8, 186)	0	concatenate_34[0][0]

			conv2d_72[0][0]
batch_normalization_73 (BatchNo	(None, 8, 8, 186)	744	concatenate_35[0][0]
activation_71 (Activation)	(None, 8, 8, 186)	0	batch_normalization_
conv2d_73 (Conv2D)	(None, 8, 8, 48)	8976	activation_71[0][0]
batch_normalization_74 (BatchNo	(None, 8, 8, 48)	192	conv2d_73[0][0]
activation_72 (Activation)	(None, 8, 8, 48)	0	batch_normalization_
conv2d_74 (Conv2D)	(None, 8, 8, 12)	5196	activation_72[0][0]
concatenate_36 (Concatenate)	(None, 8, 8, 198)	0	concatenate_35[0][0] conv2d_74[0][0]
batch_normalization_75 (BatchNo	(None, 8, 8, 198)	792	concatenate_36[0][0]
activation_73 (Activation)	(None, 8, 8, 198)	0	batch_normalization_
conv2d_75 (Conv2D)	(None, 8, 8, 48)	9552	activation_73[0][0]
batch_normalization_76 (BatchNo	(None, 8, 8, 48)	192	conv2d_75[0][0]
activation_74 (Activation)	(None, 8, 8, 48)	0	batch_normalization_
conv2d_76 (Conv2D)	(None, 8, 8, 12)	5196	activation_74[0][0]
concatenate_37 (Concatenate)	(None, 8, 8, 210)	0	concatenate_36[0][0] conv2d_76[0][0]
batch_normalization_77 (BatchNo	(None, 8, 8, 210)	840	concatenate_37[0][0]
activation_75 (Activation)	(None, 8, 8, 210)	0	batch_normalization_
conv2d_77 (Conv2D)	(None, 8, 8, 48)	10128	activation_75[0][0]
batch_normalization_78 (BatchNo	(None, 8, 8, 48)	192	conv2d_77[0][0]
activation_76 (Activation)	(None, 8, 8, 48)	0	batch_normalization_
conv2d_78 (Conv2D)	(None, 8, 8, 12)	5196	activation_76[0][0]
concatenate_38 (Concatenate)	(None, 8, 8, 222)	0	concatenate_37[0][0] conv2d_78[0][0]
batch_normalization_79 (BatchNo	(None, 8, 8, 222)	888	concatenate_38[0][0]
activation_77 (Activation)	(None, 8, 8, 222)	0	batch_normalization_
conv2d_79 (Conv2D)	(None, 8, 8, 48)	10704	activation_77[0][0]
batch_normalization_80 (BatchNo	(None, 8, 8, 48)	192	conv2d_79[0][0]
activation_78 (Activation)	(None, 8, 8, 48)	0	batch_normalization_
conv2d_80 (Conv2D)	(None, 8, 8, 12)	5196	activation_78[0][0]
concatenate_39 (Concatenate)	(None, 8, 8, 234)	0	concatenate_38[0][0] conv2d_80[0][0]

batch_normalization_81 (BatchNo	(None, 8, 8, 234)	936	concatenate_39[0][0]
activation_79 (Activation)	(None, 8, 8, 234)	0	batch_normalization_
conv2d_81 (Conv2D)	(None, 8, 8, 48)	11280	activation_79[0][0]
batch_normalization_82 (BatchNo	(None, 8, 8, 48)	192	conv2d_81[0][0]
activation_80 (Activation)	(None, 8, 8, 48)	0	batch_normalization_
conv2d_82 (Conv2D)	(None, 8, 8, 12)	5196	activation_80[0][0]
concatenate_40 (Concatenate)	(None, 8, 8, 246)	0	concatenate_39[0][0] conv2d_82[0][0]
batch_normalization_83 (BatchNo	(None, 8, 8, 246)	984	concatenate_40[0][0]
activation_81 (Activation)	(None, 8, 8, 246)	0	batch_normalization_
conv2d_83 (Conv2D)	(None, 8, 8, 48)	11856	activation_81[0][0]
batch_normalization_84 (BatchNo	(None, 8, 8, 48)	192	conv2d_83[0][0]
activation_82 (Activation)	(None, 8, 8, 48)	0	batch_normalization_
conv2d_84 (Conv2D)	(None, 8, 8, 12)	5196	activation_82[0][0]
concatenate_41 (Concatenate)	(None, 8, 8, 258)	0	concatenate_40[0][0] conv2d_84[0][0]
batch_normalization_85 (BatchNo	(None, 8, 8, 258)	1032	concatenate_41[0][0]
activation_83 (Activation)	(None, 8, 8, 258)	0	batch_normalization_
conv2d_85 (Conv2D)	(None, 8, 8, 48)	12432	activation_83[0][0]
batch_normalization_86 (BatchNo	(None, 8, 8, 48)	192	conv2d_85[0][0]
activation_84 (Activation)	(None, 8, 8, 48)	0	batch_normalization_
conv2d_86 (Conv2D)	(None, 8, 8, 12)	5196	activation_84[0][0]
concatenate_42 (Concatenate)	(None, 8, 8, 270)	0	concatenate_41[0][0] conv2d_86[0][0]
batch_normalization_87 (BatchNo	(None, 8, 8, 270)	1080	concatenate_42[0][0]
activation_85 (Activation)	(None, 8, 8, 270)	0	batch_normalization_
conv2d_87 (Conv2D)	(None, 8, 8, 48)	13008	activation_85[0][0]
batch_normalization_88 (BatchNo	(None, 8, 8, 48)	192	conv2d_87[0][0]
activation_86 (Activation)	(None, 8, 8, 48)	0	batch_normalization_
conv2d_88 (Conv2D)	(None, 8, 8, 12)	5196	activation_86[0][0]
concatenate_43 (Concatenate)	(None, 8, 8, 282)	0	concatenate_42[0][0] conv2d_88[0][0]
batch_normalization_89 (BatchNo	(None, 8, 8, 282)	1128	concatenate_43[0][0]

activation_87 (Activation)	(None, 8, 8, 282)	0	batch_normalization_
conv2d_89 (Conv2D)	(None, 8, 8, 48)	13584	activation_87[0][0]
batch_normalization_90 (BatchNo	(None, 8, 8, 48)	192	conv2d_89[0][0]
activation_88 (Activation)	(None, 8, 8, 48)	0	batch_normalization_
conv2d_90 (Conv2D)	(None, 8, 8, 12)	5196	activation_88[0][0]
concatenate_44 (Concatenate)	(None, 8, 8, 294)	0	concatenate_43[0][0] conv2d_90[0][0]
batch_normalization_91 (BatchNo	(None, 8, 8, 294)	1176	concatenate_44[0][0]
activation_89 (Activation)	(None, 8, 8, 294)	0	batch_normalization_
conv2d_91 (Conv2D)	(None, 8, 8, 48)	14160	activation_89[0][0]
batch_normalization_92 (BatchNo	(None, 8, 8, 48)	192	conv2d_91[0][0]
activation_90 (Activation)	(None, 8, 8, 48)	0	batch_normalization_
conv2d_92 (Conv2D)	(None, 8, 8, 12)	5196	activation_90[0][0]
concatenate_45 (Concatenate)	(None, 8, 8, 306)	0	concatenate_44[0][0] conv2d_92[0][0]
batch_normalization_93 (BatchNo	(None, 8, 8, 306)	1224	concatenate_45[0][0]
activation_91 (Activation)	(None, 8, 8, 306)	0	batch_normalization_
conv2d_93 (Conv2D)	(None, 8, 8, 48)	14736	activation_91[0][0]
batch_normalization_94 (BatchNo	(None, 8, 8, 48)	192	conv2d_93[0][0]
activation_92 (Activation)	(None, 8, 8, 48)	0	batch_normalization_
conv2d_94 (Conv2D)	(None, 8, 8, 12)	5196	activation_92[0][0]
concatenate_46 (Concatenate)	(None, 8, 8, 318)	0	concatenate_45[0][0] conv2d_94[0][0]
batch_normalization_95 (BatchNo	(None, 8, 8, 318)	1272	concatenate_46[0][0]
activation_93 (Activation)	(None, 8, 8, 318)	0	batch_normalization_
conv2d_95 (Conv2D)	(None, 8, 8, 48)	15312	activation_93[0][0]
batch_normalization_96 (BatchNo	(None, 8, 8, 48)	192	conv2d_95[0][0]
activation_94 (Activation)	(None, 8, 8, 48)	0	batch_normalization_
conv2d_96 (Conv2D)	(None, 8, 8, 12)	5196	activation_94[0][0]
concatenate_47 (Concatenate)	(None, 8, 8, 330)	0	concatenate_46[0][0] conv2d_96[0][0]
batch_normalization_97 (BatchNo	(None, 8, 8, 330)	1320	concatenate_47[0][0]
activation_95 (Activation)	(None, 8, 8, 330)	0	batch_normalization_

```
conv2d_97 (Conv2D)              (None, 8, 8, 48)     15888       activation_95[0][0]
batch_normalization_98 (BatchNo (None, 8, 8, 48)     192         conv2d_97[0][0]
activation_96 (Activation)      (None, 8, 8, 48)     0           batch_normalization_
conv2d_98 (Conv2D)              (None, 8, 8, 12)     5196        activation_96[0][0]
concatenate_48 (Concatenate)    (None, 8, 8, 342)    0           concatenate_47[0][0]
                                                                 conv2d_98[0][0]
average_pooling2d_2 (AveragePoo (None, 1, 1, 342)    0           concatenate_48[0][0]
conv2d_99 (Conv2D)              (None, 1, 1, 10)     3430        average_pooling2d_2[
flatten (Flatten)               (None, 10)           0           conv2d_99[0][0]
==================================================================================
Total params: 797,788
Trainable params: 774,376
Non-trainable params: 23,412
__________________________________________________________________________________
```

```
from time import time
from datetime import datetime


from tensorflow.python.keras.callbacks import TensorBoard

filepath = "weights_best.hdf5"
history = tf.keras.callbacks.History()

# tensorboard
tensorboard = TensorBoard(log_dir="model_logs/{}".format(time()))

learning_rate_reduction = tf.keras.callbacks.ReduceLROnPlateau(monitor='val_acc',
                                            patience=3,
                                            verbose=1,
                                            factor=0.3,
                                            min_lr=0.5e-6)
checkpoint_save = tf.keras.callbacks.ModelCheckpoint(filepath, monitor='val_acc', verbose=
earlyStopping = tf.keras.callbacks.EarlyStopping(monitor='val_acc', min_delta=0, patience=

callbacks_list = [checkpoint_save,learning_rate_reduction,history,tensorboard]
```

```
from keras.preprocessing.image import ImageDataGenerator
# create data generator
datagen = ImageDataGenerator(
        featurewise_center=False,  # set input mean to 0 over the dataset
        samplewise_center=False,  # set each sample mean to 0
        featurewise_std_normalization=False,  # divide inputs by std of dataset
        samplewise_std_normalization=False,  # divide each input by its std
        zca_whitening=False,  # apply ZCA whitening
        rotation_range=0,  # randomly rotate images in the range (deg 0 to 180)
```

```
        width_shift_range=0.1,  # randomly shift images horizontally
        height_shift_range=0.1,  # randomly shift images vertically
        horizontal_flip=True,  # randomly flip images
        vertical_flip=False)  # randomly flip images
datagen.fit(X_train)
```

```
# fit model
batch_size = 32
steps = X_train.shape[0]//batch_size


history = model.fit_generator(datagen.flow(X_train, y_train, batch_size=batch_size), steps
```

```
Epoch 1/100
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
1249/1250 [============================>.] - ETA: 0s - loss: 1.5886 - acc: 0.4242Epoc
10000/1250 [==============================================================================

Epoch 00001: val_acc improved from -inf to 0.48770, saving model to weights_best.hdf5
1250/1250 [==============================] - 216s 173ms/step - loss: 1.5884 - acc: 0.
Epoch 2/100
1249/1250 [============================>.] - ETA: 0s - loss: 1.1053 - acc: 0.6065Epoc
10000/1250 [==============================================================================

Epoch 00002: val_acc improved from 0.48770 to 0.56060, saving model to weights_best.h
1250/1250 [==============================] - 133s 106ms/step - loss: 1.1052 - acc: 0.
Epoch 3/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.8369 - acc: 0.7072Epoc
10000/1250 [==============================================================================

Epoch 00003: val_acc did not improve from 0.56060
1250/1250 [==============================] - 132s 105ms/step - loss: 0.8367 - acc: 0.
Epoch 4/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.7004 - acc: 0.7580Epoc
10000/1250 [==============================================================================

Epoch 00004: val_acc improved from 0.56060 to 0.73170, saving model to weights_best.h
1250/1250 [==============================] - 132s 106ms/step - loss: 0.7002 - acc: 0.
Epoch 5/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.6124 - acc: 0.7893Epoc
10000/1250 [==============================================================================

Epoch 00005: val_acc did not improve from 0.73170
1250/1250 [==============================] - 135s 108ms/step - loss: 0.6122 - acc: 0.
Epoch 6/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.5507 - acc: 0.8102Epoc
10000/1250 [==============================================================================

Epoch 00006: val_acc improved from 0.73170 to 0.79020, saving model to weights_best.h
1250/1250 [==============================] - 133s 106ms/step - loss: 0.5506 - acc: 0.
Epoch 7/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.5070 - acc: 0.8252Epoc
10000/1250 [==============================================================================

Epoch 00007: val_acc did not improve from 0.79020
1250/1250 [==============================] - 130s 104ms/step - loss: 0.5070 - acc: 0.
Epoch 8/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.4659 - acc: 0.8395Epoc
10000/1250 [==============================================================================

Epoch 00008: val_acc improved from 0.79020 to 0.81470, saving model to weights_best.h
1250/1250 [==============================] - 131s 105ms/step - loss: 0.4658 - acc: 0.
Epoch 9/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.4342 - acc: 0.8503Epoc
10000/1250 [==============================================================================

Epoch 00009: val_acc did not improve from 0.81470
1250/1250 [==============================] - 129s 103ms/step - loss: 0.4341 - acc: 0.
Epoch 10/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.4080 - acc: 0.8596Epoc
10000/1250 [==============================================================================
```

```
Epoch 00010: val_acc did not improve from 0.81470
1250/1250 [==============================] - 129s 103ms/step - loss: 0.4080 - acc: 0.
Epoch 11/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.3855 - acc: 0.8675Epoc
10000/1250 [==============================================================================

Epoch 00011: val_acc improved from 0.81470 to 0.81690, saving model to weights_best.h
1250/1250 [==============================] - 130s 104ms/step - loss: 0.3855 - acc: 0.
Epoch 12/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.3611 - acc: 0.8747Epoc
10000/1250 [==============================================================================

Epoch 00012: val_acc improved from 0.81690 to 0.81930, saving model to weights_best.h
1250/1250 [==============================] - 130s 104ms/step - loss: 0.3610 - acc: 0.
Epoch 13/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.3445 - acc: 0.8810Epoc
10000/1250 [==============================================================================

Epoch 00013: val_acc improved from 0.81930 to 0.86030, saving model to weights_best.h
1250/1250 [==============================] - 130s 104ms/step - loss: 0.3445 - acc: 0.
Epoch 14/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.3255 - acc: 0.8865Epoc
10000/1250 [==============================================================================

Epoch 00014: val_acc did not improve from 0.86030
1250/1250 [==============================] - 128s 103ms/step - loss: 0.3256 - acc: 0.
Epoch 15/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.3096 - acc: 0.8932Epoc
10000/1250 [==============================================================================

Epoch 00015: val_acc improved from 0.86030 to 0.86060, saving model to weights_best.h
1250/1250 [==============================] - 129s 103ms/step - loss: 0.3096 - acc: 0.
Epoch 16/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.2958 - acc: 0.8985Epoc
10000/1250 [==============================================================================

Epoch 00016: val_acc did not improve from 0.86060
1250/1250 [==============================] - 128s 102ms/step - loss: 0.2957 - acc: 0.
Epoch 17/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.2865 - acc: 0.9006Epoc
10000/1250 [==============================================================================

Epoch 00017: val_acc did not improve from 0.86060
1250/1250 [==============================] - 128s 103ms/step - loss: 0.2864 - acc: 0.
Epoch 18/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.2683 - acc: 0.9065Epoc
10000/1250 [==============================================================================

Epoch 00018: val_acc did not improve from 0.86060

Epoch 00018: ReduceLROnPlateau reducing learning rate to 0.0003000000142492354.
1250/1250 [==============================] - 130s 104ms/step - loss: 0.2682 - acc: 0.
Epoch 19/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.1785 - acc: 0.9387Epoc
10000/1250 [==============================================================================

Epoch 00019: val_acc improved from 0.86060 to 0.90310, saving model to weights_best.h
1250/1250 [==============================] - 134s 107ms/step - loss: 0.1785 - acc: 0.
Epoch 20/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.1545 - acc: 0.9465Epoc
10000/1250 [==============================================================================
```

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Epoch 00020: val_acc did not improve from 0.90310
1250/1250 [==============================] - 129s 103ms/step - loss: 0.1544 - acc: 0.
Epoch 21/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.1374 - acc: 0.9519Epoc
10000/1250 [==============================================================================

Epoch 00021: val_acc did not improve from 0.90310
1250/1250 [==============================] - 128s 103ms/step - loss: 0.1374 - acc: 0.
Epoch 22/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.1387 - acc: 0.9524Epoc
10000/1250 [==============================================================================

Epoch 00022: val_acc did not improve from 0.90310

Epoch 00022: ReduceLROnPlateau reducing learning rate to 9.000000427477062e-05.
1250/1250 [==============================] - 128s 103ms/step - loss: 0.1387 - acc: 0.
Epoch 23/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.1076 - acc: 0.9628Epoc
10000/1250 [==============================================================================

Epoch 00023: val_acc improved from 0.90310 to 0.91390, saving model to weights_best.h
1250/1250 [==============================] - 130s 104ms/step - loss: 0.1076 - acc: 0.
Epoch 24/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0998 - acc: 0.9657Epoc
10000/1250 [==============================================================================

Epoch 00024: val_acc did not improve from 0.91390
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0997 - acc: 0.
Epoch 25/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0941 - acc: 0.9676Epoc
10000/1250 [==============================================================================

Epoch 00025: val_acc improved from 0.91390 to 0.91490, saving model to weights_best.h
1250/1250 [==============================] - 129s 103ms/step - loss: 0.0941 - acc: 0.
Epoch 26/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0920 - acc: 0.9677Epoc
10000/1250 [==============================================================================

Epoch 00026: val_acc did not improve from 0.91490
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0919 - acc: 0.
Epoch 27/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0861 - acc: 0.9705Epoc
10000/1250 [==============================================================================

Epoch 00027: val_acc did not improve from 0.91490
1250/1250 [==============================] - 128s 103ms/step - loss: 0.0861 - acc: 0.
Epoch 28/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0808 - acc: 0.9718Epoc
10000/1250 [==============================================================================

Epoch 00028: val_acc did not improve from 0.91490

Epoch 00028: ReduceLROnPlateau reducing learning rate to 2.700000040931627e-05.
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0807 - acc: 0.
Epoch 29/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0769 - acc: 0.9732Epoc
10000/1250 [==============================================================================

Epoch 00029: val_acc improved from 0.91490 to 0.91590, saving model to weights_best.h
1250/1250 [==============================] - 129s 103ms/step - loss: 0.0770 - acc: 0.
Epoch 30/100
```

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1249/1250 [============================>.] - ETA: 0s - loss: 0.0716 - acc: 0.9752Epoc
10000/1250 [==============================================================================

Epoch 00030: val_acc improved from 0.91590 to 0.91600, saving model to weights_best.h
1250/1250 [==============================] - 128s 103ms/step - loss: 0.0716 - acc: 0.
Epoch 31/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0724 - acc: 0.9752Epoc
10000/1250 [==============================================================================

Epoch 00031: val_acc improved from 0.91600 to 0.91690, saving model to weights_best.h
1250/1250 [==============================] - 128s 103ms/step - loss: 0.0724 - acc: 0.
Epoch 32/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0700 - acc: 0.9760Epoc
10000/1250 [==============================================================================

Epoch 00032: val_acc improved from 0.91690 to 0.91770, saving model to weights_best.h
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0700 - acc: 0.
Epoch 33/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0689 - acc: 0.9765Epoc
10000/1250 [==============================================================================

Epoch 00033: val_acc did not improve from 0.91770
1250/1250 [==============================] - 131s 105ms/step - loss: 0.0689 - acc: 0.
Epoch 34/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0693 - acc: 0.9768Epoc
10000/1250 [==============================================================================

Epoch 00034: val_acc improved from 0.91770 to 0.91890, saving model to weights_best.h
1250/1250 [==============================] - 129s 103ms/step - loss: 0.0692 - acc: 0.
Epoch 35/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0664 - acc: 0.9777Epoc
10000/1250 [==============================================================================

Epoch 00035: val_acc did not improve from 0.91890
1250/1250 [==============================] - 126s 101ms/step - loss: 0.0664 - acc: 0.
Epoch 36/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0667 - acc: 0.9764Epoc
10000/1250 [==============================================================================

Epoch 00036: val_acc did not improve from 0.91890
1250/1250 [==============================] - 127s 101ms/step - loss: 0.0667 - acc: 0.
Epoch 37/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0668 - acc: 0.9768Epoc
10000/1250 [==============================================================================

Epoch 00037: val_acc did not improve from 0.91890

Epoch 00037: ReduceLROnPlateau reducing learning rate to 8.100000013655517e-06.
1250/1250 [==============================] - 126s 101ms/step - loss: 0.0667 - acc: 0.
Epoch 38/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0639 - acc: 0.9783Epoc
10000/1250 [==============================================================================

Epoch 00038: val_acc did not improve from 0.91890
1250/1250 [==============================] - 127s 101ms/step - loss: 0.0640 - acc: 0.
Epoch 39/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0631 - acc: 0.9779Epoc
10000/1250 [==============================================================================

Epoch 00039: val_acc did not improve from 0.91890
1250/1250 [==============================] - 127s 101ms/step - loss: 0.0631 - acc: 0.
Epoch 40/100
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1249/1250 [============================>.] - ETA: 0s - loss: 0.0664 - acc: 0.9770Epoc
10000/1250 [==============================================================================

Epoch 00040: val_acc did not improve from 0.91890

Epoch 00040: ReduceLROnPlateau reducing learning rate to 2.429999949526973e-06.
1250/1250 [==============================] - 127s 102ms/step - loss: 0.0664 - acc: 0.
Epoch 41/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0587 - acc: 0.9802Epoc
10000/1250 [==============================================================================

Epoch 00041: val_acc did not improve from 0.91890
1250/1250 [==============================] - 127s 101ms/step - loss: 0.0587 - acc: 0.
Epoch 42/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0621 - acc: 0.9787Epoc
10000/1250 [==============================================================================

Epoch 00042: val_acc did not improve from 0.91890
1250/1250 [==============================] - 127s 102ms/step - loss: 0.0621 - acc: 0.
Epoch 43/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0616 - acc: 0.9785Epoc
10000/1250 [==============================================================================

Epoch 00043: val_acc improved from 0.91890 to 0.91900, saving model to weights_best.h
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0616 - acc: 0.
Epoch 44/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0592 - acc: 0.9798Epoc
10000/1250 [==============================================================================

Epoch 00044: val_acc did not improve from 0.91900
1250/1250 [==============================] - 127s 102ms/step - loss: 0.0592 - acc: 0.
Epoch 45/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0616 - acc: 0.9791Epoc
10000/1250 [==============================================================================

Epoch 00045: val_acc did not improve from 0.91900
1250/1250 [==============================] - 127s 101ms/step - loss: 0.0616 - acc: 0.
Epoch 46/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0606 - acc: 0.9789Epoc
10000/1250 [==============================================================================

Epoch 00046: val_acc did not improve from 0.91900

Epoch 00046: ReduceLROnPlateau reducing learning rate to 7.289999985005124e-07.
1250/1250 [==============================] - 127s 102ms/step - loss: 0.0606 - acc: 0.
Epoch 47/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0607 - acc: 0.9791Epoc
10000/1250 [==============================================================================

Epoch 00047: val_acc did not improve from 0.91900
1250/1250 [==============================] - 132s 105ms/step - loss: 0.0607 - acc: 0.
Epoch 48/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0606 - acc: 0.9794Epoc
10000/1250 [==============================================================================

Epoch 00048: val_acc did not improve from 0.91900
1250/1250 [==============================] - 128s 103ms/step - loss: 0.0606 - acc: 0.
Epoch 49/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0609 - acc: 0.9788Epoc
10000/1250 [==============================================================================
```

```
Epoch 00049: val_acc did not improve from 0.91900

Epoch 00049: ReduceLROnPlateau reducing learning rate to 5e-07.
1250/1250 [==============================] - 127s 101ms/step - loss: 0.0609 - acc: 0.
Epoch 50/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0588 - acc: 0.9799Epoc
10000/1250 [==============================================================================

Epoch 00050: val_acc did not improve from 0.91900
1250/1250 [==============================] - 127s 102ms/step - loss: 0.0588 - acc: 0.
Epoch 51/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0621 - acc: 0.9789Epoc
10000/1250 [==============================================================================

Epoch 00051: val_acc did not improve from 0.91900
1250/1250 [==============================] - 127s 102ms/step - loss: 0.0621 - acc: 0.
Epoch 52/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0600 - acc: 0.9799Epoc
10000/1250 [==============================================================================

Epoch 00052: val_acc did not improve from 0.91900
1250/1250 [==============================] - 126s 101ms/step - loss: 0.0600 - acc: 0.
Epoch 53/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0604 - acc: 0.9791Epoc
10000/1250 [==============================================================================

Epoch 00053: val_acc did not improve from 0.91900
1250/1250 [==============================] - 127s 102ms/step - loss: 0.0604 - acc: 0.
Epoch 54/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0602 - acc: 0.9797Epoc
10000/1250 [==============================================================================

Epoch 00054: val_acc did not improve from 0.91900
1250/1250 [==============================] - 127s 102ms/step - loss: 0.0602 - acc: 0.
Epoch 55/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0611 - acc: 0.9796Epoc
10000/1250 [==============================================================================

Epoch 00055: val_acc did not improve from 0.91900
1250/1250 [==============================] - 127s 102ms/step - loss: 0.0611 - acc: 0.
Epoch 56/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0614 - acc: 0.9788Epoc
10000/1250 [==============================================================================

Epoch 00056: val_acc did not improve from 0.91900
1250/1250 [==============================] - 127s 102ms/step - loss: 0.0613 - acc: 0.
Epoch 57/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0622 - acc: 0.9788Epoc
10000/1250 [==============================================================================

Epoch 00057: val_acc did not improve from 0.91900
1250/1250 [==============================] - 127s 102ms/step - loss: 0.0622 - acc: 0.
Epoch 58/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0582 - acc: 0.9791Epoc
10000/1250 [==============================================================================

Epoch 00058: val_acc did not improve from 0.91900
1250/1250 [==============================] - 126s 101ms/step - loss: 0.0582 - acc: 0.
Epoch 59/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0616 - acc: 0.9784Epoc
10000/1250 [==============================================================================
```

```
Epoch 00059: val_acc did not improve from 0.91900
1250/1250 [==============================] - 129s 103ms/step - loss: 0.0616 - acc: 0.
Epoch 60/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0610 - acc: 0.9789Epoc
10000/1250 [==============================================================================

Epoch 00060: val_acc did not improve from 0.91900
1250/1250 [==============================] - 127s 102ms/step - loss: 0.0610 - acc: 0.
Epoch 61/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0589 - acc: 0.9803Epoc
10000/1250 [==============================================================================

Epoch 00061: val_acc did not improve from 0.91900
1250/1250 [==============================] - 131s 105ms/step - loss: 0.0589 - acc: 0.
Epoch 62/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0602 - acc: 0.9791Epoc
10000/1250 [==============================================================================

Epoch 00062: val_acc did not improve from 0.91900
1250/1250 [==============================] - 131s 105ms/step - loss: 0.0602 - acc: 0.
Epoch 63/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0599 - acc: 0.9797Epoc
10000/1250 [==============================================================================

Epoch 00063: val_acc did not improve from 0.91900
1250/1250 [==============================] - 127s 102ms/step - loss: 0.0598 - acc: 0.
Epoch 64/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0605 - acc: 0.9787Epoc
10000/1250 [==============================================================================

Epoch 00064: val_acc did not improve from 0.91900
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0606 - acc: 0.
Epoch 65/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0594 - acc: 0.9799Epoc
10000/1250 [==============================================================================

Epoch 00065: val_acc did not improve from 0.91900
1250/1250 [==============================] - 129s 103ms/step - loss: 0.0595 - acc: 0.
Epoch 66/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0606 - acc: 0.9798Epoc
10000/1250 [==============================================================================

Epoch 00066: val_acc did not improve from 0.91900
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0606 - acc: 0.
Epoch 67/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0604 - acc: 0.9792Epoc
10000/1250 [==============================================================================

Epoch 00067: val_acc did not improve from 0.91900
1250/1250 [==============================] - 128s 103ms/step - loss: 0.0603 - acc: 0.
Epoch 68/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0614 - acc: 0.9783Epoc
10000/1250 [==============================================================================

Epoch 00068: val_acc did not improve from 0.91900
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0614 - acc: 0.
Epoch 69/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0608 - acc: 0.9792Epoc
10000/1250 [==============================================================================

Epoch 00069: val_acc did not improve from 0.91900
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1250/1250 [==============================] - 128s 103ms/step - loss: 0.0608 - acc: 0.
Epoch 70/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0590 - acc: 0.9800Epoc
10000/1250 [==============================================================================

Epoch 00070: val_acc did not improve from 0.91900
1250/1250 [==============================] - 129s 103ms/step - loss: 0.0590 - acc: 0.
Epoch 71/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0625 - acc: 0.9779Epoc
10000/1250 [==============================================================================

Epoch 00071: val_acc did not improve from 0.91900
1250/1250 [==============================] - 128s 103ms/step - loss: 0.0628 - acc: 0.
Epoch 72/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0593 - acc: 0.9799Epoc
10000/1250 [==============================================================================

Epoch 00072: val_acc did not improve from 0.91900
1250/1250 [==============================] - 129s 103ms/step - loss: 0.0594 - acc: 0.
Epoch 73/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0604 - acc: 0.9796Epoc
10000/1250 [==============================================================================

Epoch 00073: val_acc did not improve from 0.91900
1250/1250 [==============================] - 130s 104ms/step - loss: 0.0604 - acc: 0.
Epoch 74/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0593 - acc: 0.9796Epoc
10000/1250 [==============================================================================

Epoch 00074: val_acc did not improve from 0.91900
1250/1250 [==============================] - 130s 104ms/step - loss: 0.0592 - acc: 0.
Epoch 75/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0612 - acc: 0.9789Epoc
10000/1250 [==============================================================================

Epoch 00075: val_acc did not improve from 0.91900
1250/1250 [==============================] - 134s 107ms/step - loss: 0.0612 - acc: 0.
Epoch 76/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0622 - acc: 0.9779Epoc
10000/1250 [==============================================================================

Epoch 00076: val_acc did not improve from 0.91900
1250/1250 [==============================] - 130s 104ms/step - loss: 0.0621 - acc: 0.
Epoch 77/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0601 - acc: 0.9793Epoc
10000/1250 [==============================================================================

Epoch 00077: val_acc did not improve from 0.91900
1250/1250 [==============================] - 128s 103ms/step - loss: 0.0601 - acc: 0.
Epoch 78/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0597 - acc: 0.9795Epoc
10000/1250 [==============================================================================

Epoch 00078: val_acc did not improve from 0.91900
1250/1250 [==============================] - 127s 102ms/step - loss: 0.0597 - acc: 0.
Epoch 79/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0581 - acc: 0.9798Epoc
10000/1250 [==============================================================================

Epoch 00079: val_acc did not improve from 0.91900
1250/1250 [==============================] - 128s 103ms/step - loss: 0.0581 - acc: 0.
Epoch 80/100
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1249/1250 [============================>.] - ETA: 0s - loss: 0.0594 - acc: 0.9796Epoc
10000/1250 [==============================================================================

Epoch 00080: val_acc did not improve from 0.91900
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0593 - acc: 0.
Epoch 81/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0596 - acc: 0.9798Epoc
10000/1250 [==============================================================================

Epoch 00081: val_acc did not improve from 0.91900
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0595 - acc: 0.
Epoch 82/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0602 - acc: 0.9790Epoc
10000/1250 [==============================================================================

Epoch 00082: val_acc did not improve from 0.91900
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0601 - acc: 0.
Epoch 83/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0633 - acc: 0.9782Epoc
10000/1250 [==============================================================================

Epoch 00083: val_acc did not improve from 0.91900
1250/1250 [==============================] - 128s 103ms/step - loss: 0.0634 - acc: 0.
Epoch 84/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0600 - acc: 0.9791Epoc
10000/1250 [==============================================================================

Epoch 00084: val_acc did not improve from 0.91900
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0600 - acc: 0.
Epoch 85/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0618 - acc: 0.9786Epoc
10000/1250 [==============================================================================

Epoch 00085: val_acc improved from 0.91900 to 0.91920, saving model to weights_best.h
1250/1250 [==============================] - 129s 103ms/step - loss: 0.0619 - acc: 0.
Epoch 86/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0603 - acc: 0.9800Epoc
10000/1250 [==============================================================================

Epoch 00086: val_acc did not improve from 0.91920
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0603 - acc: 0.
Epoch 87/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0588 - acc: 0.9794Epoc
10000/1250 [==============================================================================

Epoch 00087: val_acc did not improve from 0.91920
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0588 - acc: 0.
Epoch 88/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0606 - acc: 0.9781Epoc
10000/1250 [==============================================================================

Epoch 00088: val_acc did not improve from 0.91920
1250/1250 [==============================] - 128s 103ms/step - loss: 0.0606 - acc: 0.
Epoch 89/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0613 - acc: 0.9790Epoc
10000/1250 [==============================================================================

Epoch 00089: val_acc did not improve from 0.91920
1250/1250 [==============================] - 130s 104ms/step - loss: 0.0614 - acc: 0.
Epoch 90/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0599 - acc: 0.9801Epoc
```

```
10000/1250 [==============================================================================

Epoch 00090: val_acc did not improve from 0.91920
1250/1250 [==============================] - 129s 103ms/step - loss: 0.0600 - acc: 0.
Epoch 91/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0606 - acc: 0.9794Epoc
10000/1250 [==============================================================================

Epoch 00091: val_acc did not improve from 0.91920
1250/1250 [==============================] - 128s 103ms/step - loss: 0.0606 - acc: 0.
Epoch 92/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0594 - acc: 0.9791Epoc
10000/1250 [==============================================================================

Epoch 00092: val_acc improved from 0.91920 to 0.91930, saving model to weights_best.h
1250/1250 [==============================] - 129s 103ms/step - loss: 0.0595 - acc: 0.
Epoch 93/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0616 - acc: 0.9787Epoc
10000/1250 [==============================================================================

Epoch 00093: val_acc did not improve from 0.91930
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0616 - acc: 0.
Epoch 94/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0589 - acc: 0.9795Epoc
10000/1250 [==============================================================================

Epoch 00094: val_acc did not improve from 0.91930
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0588 - acc: 0.
Epoch 95/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0608 - acc: 0.9793Epoc
10000/1250 [==============================================================================

Epoch 00095: val_acc did not improve from 0.91930
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0607 - acc: 0.
Epoch 96/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0611 - acc: 0.9784Epoc
10000/1250 [==============================================================================

Epoch 00096: val_acc did not improve from 0.91930
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0611 - acc: 0.
Epoch 97/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0611 - acc: 0.9794Epoc
10000/1250 [==============================================================================

Epoch 00097: val_acc did not improve from 0.91930
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0610 - acc: 0.
Epoch 98/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0595 - acc: 0.9794Epoc
10000/1250 [==============================================================================

Epoch 00098: val_acc did not improve from 0.91930
1250/1250 [==============================] - 127s 102ms/step - loss: 0.0595 - acc: 0.
Epoch 99/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0621 - acc: 0.9794Epoc
10000/1250 [==============================================================================

Epoch 00099: val_acc did not improve from 0.91930
1250/1250 [==============================] - 128s 102ms/step - loss: 0.0621 - acc: 0.
Epoch 100/100
1249/1250 [============================>.] - ETA: 0s - loss: 0.0589 - acc: 0.9790Epoc
10000/1250 [==============================================================================
```

```
Epoch 00100: val_acc did not improve from 0.91930
1250/1250 [==============================] - 127s 101ms/step - loss: 0.0588 - acc: 0.
```

```
# Test the model
model.load_weights('weights_best.hdf5')
score = model.evaluate(X_test, y_test, verbose=1)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

```
10000/10000 [==============================] - 7s 681us/sample - loss: 0.3245 - acc:
Test loss: 0.3244841086283326
Test accuracy: 0.9127
```

- At epoch 93 I recieved the validation accuracy of 91.93 with the optimizer Adam which works with data augmentation.
- The test accuracy is 91.27% on 10,000 datapoints with 0.331 Test loss.