

DenseNet on CIFAR - 10 dataset

In a learnable approach brought you by Jayati Vijaywargiya

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Step 1: Importing libraries

Here we have used following libraries

For better understanding it is recommended to read the text below, if you are already well acquainted - PLEASE SKIP.....

1. Keras: Keras is a neural networks library written in Python, simple and instinctual to use
2. Tensorflow: Python library for fast numerical computing, it is a foundation library that can be used to create Deep Learning models directly or by using wrapper libraries that simplify the process built on top of TensorFlow Here Keras is used as a library over tensorflow
3. matplotlib.pyplot is a collection of functions and is used to create a figure, create a plotting area in a figure, plots some lines in a plotting area, decorates the plot with labels, etc
4. keras.layers, keras.models are used to create and implement deep neural models, and they have relevant functionalities like 2D convolution, max pooling, average pooling, batch normalization, activation functions like ReLu, etc.
5. Python pickle module is used for serializing and de-serializing python object structures. The process to converts any kind of python objects (list, dict, etc.) into byte streams (0s and 1s) is called pickling or serialization or flattening or marshalling

```
In [2]: import tensorflow.keras
import tensorflow.keras.backend as K
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Input, Dense, Conv2D, Conv3D, DepthwiseConv2D, SeparableConv2D, Conv3DTranspose
from tensorflow.keras.layers import Flatten, MaxPool2D, AvgPool2D, GlobalAvgPool2D, UpSampling2D, BatchNormalization
from tensorflow.keras.layers import Concatenate, Add, Dropout, ReLU, Lambda, Activation, LeakyReLU, PReLU
import matplotlib.pyplot as plt
import pickle
```

Step 2: Loading CIFAR - 10 dataset

About CIFAR - 10 dataset:

It is collection of 60,000 images

They are classified into 10 different classes

The classes are : airplane, automobile, bird, cat, deer, dog, frog, horse, ship and truck.

Data is divided into training and testing data

The dataset has
50,000 training
data and 10,000
testing data

>
Each
image
/
data
is
of
size
32x32

```
In [3]: import tensorflow as tf  
(x_train, y_train), (x_test, y_test)=tf.keras.datasets.cifar10.load_data()  
class_names = ['airplane', 'automobile', 'bird', 'cat', 'deer',  
    'dog', 'frog', 'horse', 'ship', 'truck']
```

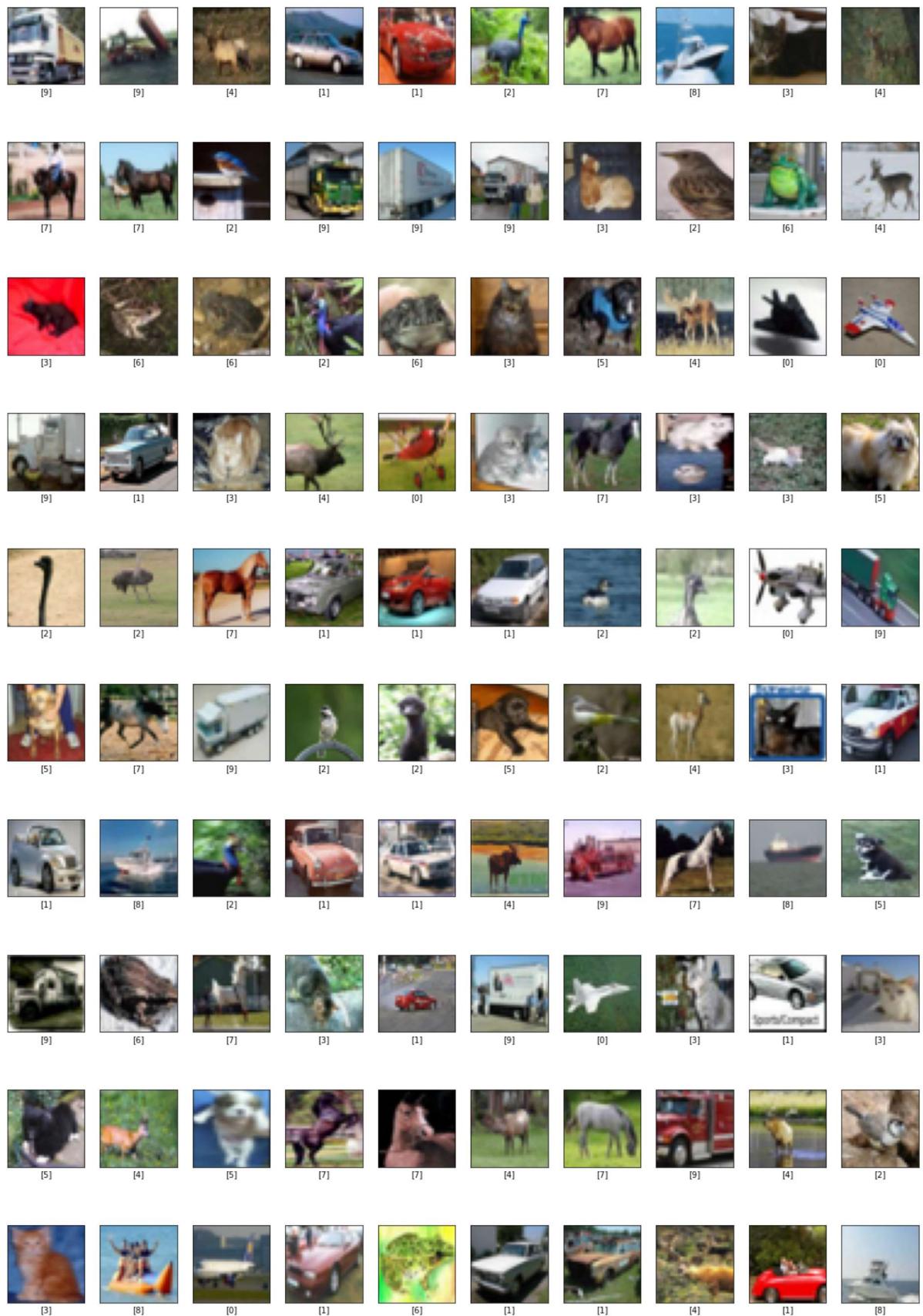
Downloading data from <https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz>
170500096/170498071 [=====] - 4s 0us/step

Step 3. Plotting or vizualizing the dataset

Here we have used matplotlib.pyplot and have displayed, first 100 images in the traing datset

```
In [14]: plt.figure(figsize=(20,30))
for i in range(100):
    plt.subplot(10,10,i+1)
    plt.xticks([])
    plt.yticks([])
    plt.grid(False)
    plt.imshow(x_train[i+1], cmap=plt.cm.binary)
    plt.xlabel(y_train[i+1])
plt.show()
```

```
/usr/local/lib/python3.6/dist-packages/matplotlib/text.py:1165: FutureWarning: elementwise comparison failed; returning scalar instead, but in the future will perform elementwise comparison
  if s != self._text:
```



Densenet

1. It is mainly used for object detection
2. It is one of the classic networks
3. The network consist of 5 layers of dense block
4. Here, output of the previous layer acts as an input of the second layer by using composite function operation.
5. Composite operation consists of the convolution layer, pooling layer, batch normalization, and non-linear activation layer.
6. It also has different versions like, DenseNet-121, DenseNet-160, DenseNet-201, etc

Lets get started with the implementation

```
In [4]: def densenet(img_shape, n_classes, f=32):
    repetitions = 6, 12, 24, 16

    def bn_rl_conv(x, f, k=1, s=1, p='same'):
        x = BatchNormalization()(x)
        x = ReLU()(x)
        x = Conv2D(f, k, strides=s, padding=p)(x)
        return x

    def dense_block(tensor, r):
        for _ in range(r):
            x = bn_rl_conv(tensor, 4*f)
            x = bn_rl_conv(x, f, 3)
            tensor = Concatenate()([tensor, x])
        return tensor

    def transition_block(x):
        x = bn_rl_conv(x, K.int_shape(x)[-1] // 2)
        x = AvgPool2D(2, strides=2, padding='same')(x)
        return x

    input = Input(img_shape)

    x = Conv2D(64, 7, strides=2, padding='same')(input)
    x = MaxPool2D(3, strides=2, padding='same')(x)

    for r in repetitions:
        d = dense_block(x, r)
        x = transition_block(d)

    x = GlobalAvgPool2D()(d)

    output = Dense(n_classes, activation='softmax')(x)

    model = Model(input, output)
    return model
```

DenseNet architechture

The above architechture can be intuited as :

A convolution layer -> Pooling layer 0 -> Dense block -> Transition layer -> Dense block -> transition layer -> (Multiple layers of Dense block followed by transition layer) -> Average pooling layer taking input as the output of last transition layer -> Fully connected layer which is the last layer or the output layer

Each dense block layer for repeated times : Does,

Batch normalization

Relu activation

2D convolution

>on
the
input
tensor(x)

Each transition layer has a,

A convolution layer

and a Average pooling layer

The network ends with a fully connected dense layer which uses a softmax function to do the classification

```
In [5]: input_shape = 256, 256, 3
n_classes = 10
model = densenet(input_shape, n_classes)
model.summary()

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

history = model.fit(x_train, y_train, epochs=30, validation_data=(x_test,y_test
))
```

Model: "functional_1"

| Layer (type) | Output Shape | Param # | Connected to |
|---------------------------------|----------------------|---------|--------------|
| input_1 (InputLayer) | [None, 256, 256, 3] | 0 | |
| conv2d (Conv2D) | (None, 128, 128, 64) | 9472 | input_1[0] |
| max_pooling2d (MaxPooling2D) | (None, 64, 64, 64) | 0 | conv2d[0][0] |
| batch_normalization (BatchNorma | (None, 64, 64, 64) | 256 | max_pooling2 |
| re_lu (ReLU) | (None, 64, 64, 64) | 0 | batch_normal |
| conv2d_1 (Conv2D) | (None, 64, 64, 128) | 8320 | re_lu[0][0] |
| batch_normalization_1 (BatchNor | (None, 64, 64, 128) | 512 | conv2d_1[0] |
| re_lu_1 (ReLU) | (None, 64, 64, 128) | 0 | batch_normal |
| conv2d_2 (Conv2D) | (None, 64, 64, 32) | 36896 | re_lu_1[0] |
| concatenate (Concatenate) | (None, 64, 64, 96) | 0 | max_pooling2 |
| batch_normalization_2 (BatchNor | (None, 64, 64, 96) | 384 | conv2d_2[0] |
| re_lu_2 (ReLU) | (None, 64, 64, 96) | 0 | batch_normal |
| conv2d_3 (Conv2D) | (None, 64, 64, 128) | 12416 | re_lu_2[0] |

| | | |
|--|---------------------------|--------------------------|
| batch_normalization_3 (BatchNor (None, 64, 64, 128) [0] | 512 | conv2d_3[0] |
| re_lu_3 (ReLU) [0][0] | (None, 64, 64, 128) 0 | batch_normalization_3[0] |
| conv2d_4 (Conv2D) [0] | (None, 64, 64, 32) 36896 | re_lu_3[0] |
| concatenate_1 (Concatenate) [0][0] | (None, 64, 64, 128) 0 | concatenate [0] |
| batch_normalization_4 (BatchNor (None, 64, 64, 128) [0][0] | 512 | concatenate_1[0] |
| re_lu_4 (ReLU) [0][0] | (None, 64, 64, 128) 0 | batch_normalization_4[0] |
| conv2d_5 (Conv2D) [0] | (None, 64, 64, 128) 16512 | re_lu_4[0] |
| batch_normalization_5 (BatchNor (None, 64, 64, 128) [0] | 512 | conv2d_5[0] |
| re_lu_5 (ReLU) [0][0] | (None, 64, 64, 128) 0 | batch_normalization_5[0] |
| conv2d_6 (Conv2D) [0] | (None, 64, 64, 32) 36896 | re_lu_5[0] |
| concatenate_2 (Concatenate) [0][0] | (None, 64, 64, 160) 0 | concatenate_1[0] |
| batch_normalization_6 (BatchNor (None, 64, 64, 160) [0][0] | 640 | concatenate_2[0] |
| re_lu_6 (ReLU) [0][0] | (None, 64, 64, 160) 0 | batch_normalization_6[0] |
| conv2d_7 (Conv2D) | (None, 64, 64, 128) 20608 | re_lu_6[0] |

[0]

| | | |
|-------------------------------------|---------------------------|------------------------------|
| batch_normalization_7 (BatchNor [0] | (None, 64, 64, 128) 512 | conv2d_7[0] |
| re_lu_7 (ReLU) | (None, 64, 64, 128) 0 | batch_normalization_7[0][0] |
| conv2d_8 (Conv2D) [0] | (None, 64, 64, 32) 36896 | re_lu_7[0] |
| concatenate_3 (Concatenate) [0][0] | (None, 64, 64, 192) 0 | concatenate_2[0][0] |
| batch_normalization_8 (BatchNor [0] | (None, 64, 64, 192) 768 | concatenate_3[0][0] |
| re_lu_8 (ReLU) | (None, 64, 64, 192) 0 | batch_normalization_8[0][0] |
| conv2d_9 (Conv2D) [0] | (None, 64, 64, 128) 24704 | re_lu_8[0] |
| batch_normalization_9 (BatchNor [0] | (None, 64, 64, 128) 512 | conv2d_9[0] |
| re_lu_9 (ReLU) | (None, 64, 64, 128) 0 | batch_normalization_9[0][0] |
| conv2d_10 (Conv2D) [0] | (None, 64, 64, 32) 36896 | re_lu_9[0] |
| concatenate_4 (Concatenate) [0][0] | (None, 64, 64, 224) 0 | concatenate_3[0][0] |
| batch_normalization_10 (BatchNo [0] | (None, 64, 64, 224) 896 | concatenate_4[0][0] |
| re_lu_10 (ReLU) | (None, 64, 64, 224) 0 | batch_normalization_10[0][0] |

| | | | |
|---|---------------------|-------|------------------------------|
| conv2d_11 (Conv2D) [0] | (None, 64, 64, 128) | 28800 | re_lu_10[0] |
| batch_normalization_11 (BatchNo [0]) | (None, 64, 64, 128) | 512 | conv2d_11[0] |
| re_lu_11 (ReLU) batch_normalization_11[0][0] | (None, 64, 64, 128) | 0 | batch_normalization_11[0][0] |
| conv2d_12 (Conv2D) [0] | (None, 64, 64, 32) | 36896 | re_lu_11[0] |
| concatenate_5 (Concatenate) [0][0] | (None, 64, 64, 256) | 0 | concatenate_4[0][0] |
| batch_normalization_12 (BatchNo [0][0]) | (None, 64, 64, 256) | 1024 | concatenate_5[0][0] |
| re_lu_12 (ReLU) batch_normalization_12[0][0] | (None, 64, 64, 256) | 0 | batch_normalization_12[0][0] |
| conv2d_13 (Conv2D) [0] | (None, 64, 64, 128) | 32896 | re_lu_12[0] |
| average_pooling2d (AveragePooli [0]) | (None, 32, 32, 128) | 0 | conv2d_13[0] |
| batch_normalization_13 (BatchNo [0][0]) | (None, 32, 32, 128) | 512 | average_pooling2d[0][0] |
| re_lu_13 (ReLU) batch_normalization_13[0][0] | (None, 32, 32, 128) | 0 | batch_normalization_13[0][0] |
| conv2d_14 (Conv2D) [0] | (None, 32, 32, 128) | 16512 | re_lu_13[0] |
| batch_normalization_14 (BatchNo [0]) | (None, 32, 32, 128) | 512 | conv2d_14[0] |
| re_lu_14 (ReLU) | (None, 32, 32, 128) | 0 | batch_normalization_14[0] |

ization_14[0][0]

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|---|---------------------|-------|------------------------------|
| conv2d_15 (Conv2D) [0] | (None, 32, 32, 32) | 36896 | re_lu_14[0] |
| concatenate_6 (Concatenate) ing2d[0][0] [0] | (None, 32, 32, 160) | 0 | average_pool conv2d_15[0] |
| batch_normalization_15 (BatchNo 6[0][0] | (None, 32, 32, 160) | 640 | concatenate_ |
| re_lu_15 (ReLU) normalization_15[0][0] | (None, 32, 32, 160) | 0 | batch_normal |
| conv2d_16 (Conv2D) [0] | (None, 32, 32, 128) | 20608 | re_lu_15[0] |
| batch_normalization_16 (BatchNo [0] | (None, 32, 32, 128) | 512 | conv2d_16[0] |
| re_lu_16 (ReLU) normalization_16[0][0] | (None, 32, 32, 128) | 0 | batch_normal |
| conv2d_17 (Conv2D) [0] | (None, 32, 32, 32) | 36896 | re_lu_16[0] |
| concatenate_7 (Concatenate) 6[0][0] [0] | (None, 32, 32, 192) | 0 | concatenate_ |
| batch_normalization_17 (BatchNo 7[0][0] | (None, 32, 32, 192) | 768 | conv2d_17[0] |
| re_lu_17 (ReLU) normalization_17[0][0] | (None, 32, 32, 192) | 0 | batch_normal |
| conv2d_18 (Conv2D) [0] | (None, 32, 32, 128) | 24704 | re_lu_17[0] |
| batch_normalization_18 (BatchNo [0] | (None, 32, 32, 128) | 512 | conv2d_18[0] |

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| re_lu_18 (ReLU) ization_18[0][0] | (None, 32, 32, 128) 0 | batch_normal |
| conv2d_19 (Conv2D) [0] | (None, 32, 32, 32) 36896 | re_lu_18[0] |
| concatenate_8 (Concatenate) 7[0][0] | (None, 32, 32, 224) 0 | concatenate_ conv2d_19[0] [0] |
| batch_normalization_19 (BatchNo 8[0][0] | (None, 32, 32, 224) 896 | concatenate_ |
| re_lu_19 (ReLU) ization_19[0][0] | (None, 32, 32, 224) 0 | batch_normal |
| conv2d_20 (Conv2D) [0] | (None, 32, 32, 128) 28800 | re_lu_19[0] |
| batch_normalization_20 (BatchNo [0] | (None, 32, 32, 128) 512 | conv2d_20[0] |
| re_lu_20 (ReLU) ization_20[0][0] | (None, 32, 32, 128) 0 | batch_normal |
| conv2d_21 (Conv2D) [0] | (None, 32, 32, 32) 36896 | re_lu_20[0] |
| concatenate_9 (Concatenate) 8[0][0] | (None, 32, 32, 256) 0 | concatenate_ conv2d_21[0] [0] |
| batch_normalization_21 (BatchNo 9[0][0] | (None, 32, 32, 256) 1024 | concatenate_ |
| re_lu_21 (ReLU) ization_21[0][0] | (None, 32, 32, 256) 0 | batch_normal |
| conv2d_22 (Conv2D) [0] | (None, 32, 32, 128) 32896 | re_lu_21[0] |

| | | | |
|--|---------------------|-------|------------------------------|
| batch_normalization_22 (BatchNo [0] | (None, 32, 32, 128) | 512 | conv2d_22[0] |
| re_lu_22 (ReLU) | (None, 32, 32, 128) | 0 | batch_normalization_22[0][0] |
| conv2d_23 (Conv2D) [0] | (None, 32, 32, 32) | 36896 | re_lu_22[0] |
| concatenate_10 (Concatenate) [0][0] | (None, 32, 32, 288) | 0 | concatenate_9[0][0] |
| batch_normalization_23 (BatchNo [0][0] | (None, 32, 32, 288) | 1152 | concatenate_10[0][0] |
| re_lu_23 (ReLU) | (None, 32, 32, 288) | 0 | batch_normalization_23[0][0] |
| conv2d_24 (Conv2D) [0] | (None, 32, 32, 128) | 36992 | re_lu_23[0] |
| batch_normalization_24 (BatchNo [0] | (None, 32, 32, 128) | 512 | conv2d_24[0] |
| re_lu_24 (ReLU) | (None, 32, 32, 128) | 0 | batch_normalization_24[0][0] |
| conv2d_25 (Conv2D) [0] | (None, 32, 32, 32) | 36896 | re_lu_24[0] |
| concatenate_11 (Concatenate) [0][0] | (None, 32, 32, 320) | 0 | concatenate_10[0][0] |
| batch_normalization_25 (BatchNo [0][0] | (None, 32, 32, 320) | 1280 | concatenate_11[0][0] |
| re_lu_25 (ReLU) | (None, 32, 32, 320) | 0 | batch_normalization_25[0][0] |

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|--|---------------------|-------|--------------|
| conv2d_26 (Conv2D) [0] | (None, 32, 32, 128) | 41088 | re_lu_25[0] |
| batch_normalization_26 (BatchNo [0]) | (None, 32, 32, 128) | 512 | conv2d_26[0] |
| re_lu_26 (ReLU) normalization_26[0][0] | (None, 32, 32, 128) | 0 | batch_normal |
| conv2d_27 (Conv2D) [0] | (None, 32, 32, 32) | 36896 | re_lu_26[0] |
| concatenate_12 (Concatenate) [0][0] | (None, 32, 32, 352) | 0 | concatenate_ |
| | | | conv2d_27[0] |
| batch_normalization_27 (BatchNo [0][0]) | (None, 32, 32, 352) | 1408 | concatenate_ |
| re_lu_27 (ReLU) normalization_27[0][0] | (None, 32, 32, 352) | 0 | batch_normal |
| conv2d_28 (Conv2D) [0] | (None, 32, 32, 128) | 45184 | re_lu_27[0] |
| batch_normalization_28 (BatchNo [0]) | (None, 32, 32, 128) | 512 | conv2d_28[0] |
| re_lu_28 (ReLU) normalization_28[0][0] | (None, 32, 32, 128) | 0 | batch_normal |
| conv2d_29 (Conv2D) [0] | (None, 32, 32, 32) | 36896 | re_lu_28[0] |
| concatenate_13 (Concatenate) [0][0] | (None, 32, 32, 384) | 0 | concatenate_ |
| | | | conv2d_29[0] |
| batch_normalization_29 (BatchNo [0][0]) | (None, 32, 32, 384) | 1536 | concatenate_ |
| re_lu_29 (ReLU) | (None, 32, 32, 384) | 0 | batch_normal |

ization_29[0][0]

| | | | |
|--|---------------------|-------|--------------|
| conv2d_30 (Conv2D) [0] | (None, 32, 32, 128) | 49280 | re_lu_29[0] |
| batch_normalization_30 (BatchNo [0]) | (None, 32, 32, 128) | 512 | conv2d_30[0] |
| re_lu_30 (ReLU) ization_30[0][0] | (None, 32, 32, 128) | 0 | batch_normal |
| conv2d_31 (Conv2D) [0] | (None, 32, 32, 32) | 36896 | re_lu_30[0] |
| concatenate_14 (Concatenate) 13[0][0] | (None, 32, 32, 416) | 0 | concatenate_ |
| [0] | | | conv2d_31[0] |
| batch_normalization_31 (BatchNo 14[0][0]) | (None, 32, 32, 416) | 1664 | concatenate_ |
| re_lu_31 (ReLU) ization_31[0][0] | (None, 32, 32, 416) | 0 | batch_normal |
| conv2d_32 (Conv2D) [0] | (None, 32, 32, 128) | 53376 | re_lu_31[0] |
| batch_normalization_32 (BatchNo [0]) | (None, 32, 32, 128) | 512 | conv2d_32[0] |
| re_lu_32 (ReLU) ization_32[0][0] | (None, 32, 32, 128) | 0 | batch_normal |
| conv2d_33 (Conv2D) [0] | (None, 32, 32, 32) | 36896 | re_lu_32[0] |
| concatenate_15 (Concatenate) 14[0][0] | (None, 32, 32, 448) | 0 | concatenate_ |
| [0] | | | conv2d_33[0] |
| batch_normalization_33 (BatchNo 15[0][0]) | (None, 32, 32, 448) | 1792 | concatenate_ |

| | | |
|--|---------------------------|-------------------|
| re_lu_33 (ReLU) ization_33[0][0] | (None, 32, 32, 448) 0 | batch_normal |
| conv2d_34 (Conv2D) [0] | (None, 32, 32, 128) 57472 | re_lu_33[0] |
| batch_normalization_34 (BatchNo [0]) | (None, 32, 32, 128) 512 | conv2d_34[0] |
| re_lu_34 (ReLU) ization_34[0][0] | (None, 32, 32, 128) 0 | batch_normal |
| conv2d_35 (Conv2D) [0] | (None, 32, 32, 32) 36896 | re_lu_34[0] |
| concatenate_16 (Concatenate) [0][0] | (None, 32, 32, 480) 0 | concatenate_15[0] |
| batch_normalization_35 (BatchNo [0][0]) | (None, 32, 32, 480) 1920 | concatenate_16[0] |
| re_lu_35 (ReLU) ization_35[0][0] | (None, 32, 32, 480) 0 | batch_normal |
| conv2d_36 (Conv2D) [0] | (None, 32, 32, 128) 61568 | re_lu_35[0] |
| batch_normalization_36 (BatchNo [0]) | (None, 32, 32, 128) 512 | conv2d_36[0] |
| re_lu_36 (ReLU) ization_36[0][0] | (None, 32, 32, 128) 0 | batch_normal |
| conv2d_37 (Conv2D) [0] | (None, 32, 32, 32) 36896 | re_lu_36[0] |
| concatenate_17 (Concatenate) [0][0] | (None, 32, 32, 512) 0 | concatenate_16[0] |
| | | conv2d_37[0] |

| | | |
|--|----------------------------|---------------------------|
| batch_normalization_37 (BatchNo (None, 32, 32, 512) 2048 17[0][0]) | | concatenate_17[0] |
| re_lu_37 (ReLU) batch_normalization_37[0][0]) | (None, 32, 32, 512) 0 | batch_normalization_37[0] |
| conv2d_38 (Conv2D) [0]) | (None, 32, 32, 256) 131328 | re_lu_37[0] |
| average_pooling2d_1 (AveragePoo (None, 16, 16, 256) 0 [0]) | | conv2d_38[0] |
| batch_normalization_38 (BatchNo (None, 16, 16, 256) 1024 average_pooling2d_1[0][0]) | | average_pooling2d_1[0] |
| re_lu_38 (ReLU) batch_normalization_38[0][0]) | (None, 16, 16, 256) 0 | batch_normalization_38[0] |
| conv2d_39 (Conv2D) [0]) | (None, 16, 16, 128) 32896 | re_lu_38[0] |
| batch_normalization_39 (BatchNo (None, 16, 16, 128) 512 [0]) | | conv2d_39[0] |
| re_lu_39 (ReLU) batch_normalization_39[0][0]) | (None, 16, 16, 128) 0 | batch_normalization_39[0] |
| conv2d_40 (Conv2D) [0]) | (None, 16, 16, 32) 36896 | re_lu_39[0] |
| concatenate_18 (Concatenate) [0]) | (None, 16, 16, 288) 0 | average_pooling2d_1[0] |
| batch_normalization_40 (BatchNo (None, 16, 16, 288) 1152 18[0][0]) | | concatenate_18[0] |
| re_lu_40 (ReLU) batch_normalization_40[0][0]) | (None, 16, 16, 288) 0 | batch_normalization_40[0] |
| conv2d_41 (Conv2D) [0]) | (None, 16, 16, 128) 36992 | re_lu_40[0] |

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|--|---------------------------|------------------------------|
| batch_normalization_41 (BatchNo (None, 16, 16, 128) 512 [0] | | conv2d_41[0] |
| re_lu_41 (ReLU) | (None, 16, 16, 128) 0 | batch_normalization_41[0][0] |
| conv2d_42 (Conv2D) | (None, 16, 16, 32) 36896 | re_lu_41[0] |
| [0] | | |
| concatenate_19 (Concatenate) | (None, 16, 16, 320) 0 | concatenate_18[0][0] |
| [0] | | conv2d_42[0] |
| batch_normalization_42 (BatchNo (None, 16, 16, 320) 1280 [0] | | concatenate_19[0][0] |
| | | |
| re_lu_42 (ReLU) | (None, 16, 16, 320) 0 | batch_normalization_42[0][0] |
| [0] | | |
| conv2d_43 (Conv2D) | (None, 16, 16, 128) 41088 | re_lu_42[0] |
| [0] | | |
| batch_normalization_43 (BatchNo (None, 16, 16, 128) 512 [0] | | conv2d_43[0] |
| | | |
| re_lu_43 (ReLU) | (None, 16, 16, 128) 0 | batch_normalization_43[0][0] |
| [0] | | |
| conv2d_44 (Conv2D) | (None, 16, 16, 32) 36896 | re_lu_43[0] |
| [0] | | |
| concatenate_20 (Concatenate) | (None, 16, 16, 352) 0 | concatenate_19[0][0] |
| [0] | | conv2d_44[0] |
| batch_normalization_44 (BatchNo (None, 16, 16, 352) 1408 [0] | | concatenate_20[0][0] |
| | | |
| re_lu_44 (ReLU) | (None, 16, 16, 352) 0 | batch_normalization_44[0][0] |
| [0] | | |

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| conv2d_45 (Conv2D) [0] | (None, 16, 16, 128) | 45184 | re_lu_44[0] |
| batch_normalization_45 (BatchNo [0]) | (None, 16, 16, 128) | 512 | conv2d_45[0] |
| re_lu_45 (ReLU) [0][0] | (None, 16, 16, 128) | 0 | batch_normalization_45[0][0] |
| conv2d_46 (Conv2D) [0] | (None, 16, 16, 32) | 36896 | re_lu_45[0] |
| concatenate_21 (Concatenate) [0] | (None, 16, 16, 384) | 0 | concatenate_20[0][0] |
| batch_normalization_46 (BatchNo [0][0]) | (None, 16, 16, 384) | 1536 | concatenate_21[0][0] |
| re_lu_46 (ReLU) [0][0] | (None, 16, 16, 384) | 0 | batch_normalization_46[0][0] |
| conv2d_47 (Conv2D) [0] | (None, 16, 16, 128) | 49280 | re_lu_46[0] |
| batch_normalization_47 (BatchNo [0]) | (None, 16, 16, 128) | 512 | conv2d_47[0] |
| re_lu_47 (ReLU) [0][0] | (None, 16, 16, 128) | 0 | batch_normalization_47[0][0] |
| conv2d_48 (Conv2D) [0] | (None, 16, 16, 32) | 36896 | re_lu_47[0] |
| concatenate_22 (Concatenate) [0] | (None, 16, 16, 416) | 0 | concatenate_21[0][0] |
| batch_normalization_48 (BatchNo [0][0]) | (None, 16, 16, 416) | 1664 | concatenate_22[0][0] |

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| re_lu_48 (ReLU) ization_48[0][0] | (None, 16, 16, 416) 0 | batch_normal |
| conv2d_49 (Conv2D) [0] | (None, 16, 16, 128) 53376 | re_lu_48[0] |
| batch_normalization_49 (BatchNo [0]) | (None, 16, 16, 128) 512 | conv2d_49[0] |
| re_lu_49 (ReLU) ization_49[0][0] | (None, 16, 16, 128) 0 | batch_normal |
| conv2d_50 (Conv2D) [0] | (None, 16, 16, 32) 36896 | re_lu_49[0] |
| concatenate_23 (Concatenate) [0][0] | (None, 16, 16, 448) 0 | concatenate_ conv2d_50[0] |
| batch_normalization_50 (BatchNo [0][0]) | (None, 16, 16, 448) 1792 | concatenate_ |
| re_lu_50 (ReLU) ization_50[0][0] | (None, 16, 16, 448) 0 | batch_normal |
| conv2d_51 (Conv2D) [0] | (None, 16, 16, 128) 57472 | re_lu_50[0] |
| batch_normalization_51 (BatchNo [0]) | (None, 16, 16, 128) 512 | conv2d_51[0] |
| re_lu_51 (ReLU) ization_51[0][0] | (None, 16, 16, 128) 0 | batch_normal |
| conv2d_52 (Conv2D) [0] | (None, 16, 16, 32) 36896 | re_lu_51[0] |
| concatenate_24 (Concatenate) [0][0] | (None, 16, 16, 480) 0 | concatenate_ conv2d_52[0] |
| batch_normalization_52 (BatchNo [0]) | (None, 16, 16, 480) 1920 | concatenate_ |

24[0][0]

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| re_lu_52 (ReLU) | (None, 16, 16, 480) | 0 | batch_normalization_52[0][0] |
| conv2d_53 (Conv2D) | (None, 16, 16, 128) | 61568 | re_lu_52[0] |
| batch_normalization_53 (BatchNo | (None, 16, 16, 128) | 512 | conv2d_53[0] |
| [0] | | | |
| re_lu_53 (ReLU) | (None, 16, 16, 128) | 0 | batch_normalization_53[0][0] |
| conv2d_54 (Conv2D) | (None, 16, 16, 32) | 36896 | re_lu_53[0] |
| [0] | | | |
| concatenate_25 (Concatenate) | (None, 16, 16, 512) | 0 | concatenate_ |
| 24[0][0] | | | conv2d_54[0] |
| [0] | | | |
| batch_normalization_54 (BatchNo | (None, 16, 16, 512) | 2048 | concatenate_ |
| [0][0] | | | |
| re_lu_54 (ReLU) | (None, 16, 16, 512) | 0 | batch_normalization_54[0][0] |
| conv2d_55 (Conv2D) | (None, 16, 16, 128) | 65664 | re_lu_54[0] |
| [0] | | | |
| batch_normalization_55 (BatchNo | (None, 16, 16, 128) | 512 | conv2d_55[0] |
| [0] | | | |
| re_lu_55 (ReLU) | (None, 16, 16, 128) | 0 | batch_normalization_55[0][0] |
| conv2d_56 (Conv2D) | (None, 16, 16, 32) | 36896 | re_lu_55[0] |
| [0] | | | |
| concatenate_26 (Concatenate) | (None, 16, 16, 544) | 0 | concatenate_ |
| 25[0][0] | | | conv2d_56[0] |
| [0] | | | |

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| batch_normalization_56 (BatchNo (None, 16, 16, 544) 2176 26[0][0]) | | concatenate_ |
| re_lu_56 (ReLU) batch_normalization_56[0][0] | (None, 16, 16, 544) 0 | batch_normal |
| conv2d_57 (Conv2D) [0] | (None, 16, 16, 128) 69760 | re_lu_56[0] |
| batch_normalization_57 (BatchNo (None, 16, 16, 128) 512 [0]) | | conv2d_57[0] |
| re_lu_57 (ReLU) batch_normalization_57[0][0] | (None, 16, 16, 128) 0 | batch_normal |
| conv2d_58 (Conv2D) [0] | (None, 16, 16, 32) 36896 | re_lu_57[0] |
| concatenate_27 (Concatenate) 26[0][0] | (None, 16, 16, 576) 0 | concatenate_ |
| [0] | | conv2d_58[0] |
| batch_normalization_58 (BatchNo (None, 16, 16, 576) 2304 27[0][0]) | | concatenate_ |
| re_lu_58 (ReLU) batch_normalization_58[0][0] | (None, 16, 16, 576) 0 | batch_normal |
| conv2d_59 (Conv2D) [0] | (None, 16, 16, 128) 73856 | re_lu_58[0] |
| batch_normalization_59 (BatchNo (None, 16, 16, 128) 512 [0]) | | conv2d_59[0] |
| re_lu_59 (ReLU) batch_normalization_59[0][0] | (None, 16, 16, 128) 0 | batch_normal |
| conv2d_60 (Conv2D) [0] | (None, 16, 16, 32) 36896 | re_lu_59[0] |
| concatenate_28 (Concatenate) | (None, 16, 16, 608) 0 | concatenate_ |

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| 27[0][0] | | | conv2d_60[0] |
| batch_normalization_60 (BatchNo (None, 16, 16, 608) 2432 | | | concatenate_28[0][0] |
| re_lu_60 (ReLU) | (None, 16, 16, 608) 0 | | batch_normalization_60[0][0] |
| conv2d_61 (Conv2D) | (None, 16, 16, 128) 77952 | | re_lu_60[0] |
| batch_normalization_61 (BatchNo (None, 16, 16, 128) 512 | | | conv2d_61[0] |
| re_lu_61 (ReLU) | (None, 16, 16, 128) 0 | | batch_normalization_61[0][0] |
| conv2d_62 (Conv2D) | (None, 16, 16, 32) 36896 | | re_lu_61[0] |
| concatenate_29 (Concatenate) | (None, 16, 16, 640) 0 | | concatenate_28[0][0] |
| conv2d_62[0] | | | [0] |
| batch_normalization_62 (BatchNo (None, 16, 16, 640) 2560 | | | concatenate_29[0][0] |
| re_lu_62 (ReLU) | (None, 16, 16, 640) 0 | | batch_normalization_62[0][0] |
| conv2d_63 (Conv2D) | (None, 16, 16, 128) 82048 | | re_lu_62[0] |
| batch_normalization_63 (BatchNo (None, 16, 16, 128) 512 | | | conv2d_63[0] |
| re_lu_63 (ReLU) | (None, 16, 16, 128) 0 | | batch_normalization_63[0][0] |
| conv2d_64 (Conv2D) | (None, 16, 16, 32) 36896 | | re_lu_63[0] |
| [0] | | | |

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| concatenate_30 (Concatenate) 29[0][0] | (None, 16, 16, 672) 0 | concatenate_ conv2d_64[0] [0] |
| batch_normalization_64 (BatchNo 30[0][0] | (None, 16, 16, 672) 2688 | concatenate_ |
| re_lu_64 (ReLU) batch_normalization_64[0][0] | (None, 16, 16, 672) 0 | batch_normal |
| conv2d_65 (Conv2D) [0] | (None, 16, 16, 128) 86144 | re_lu_64[0] |
| batch_normalization_65 (BatchNo [0] | (None, 16, 16, 128) 512 | conv2d_65[0] |
| re_lu_65 (ReLU) batch_normalization_65[0][0] | (None, 16, 16, 128) 0 | batch_normal |
| conv2d_66 (Conv2D) [0] | (None, 16, 16, 32) 36896 | re_lu_65[0] |
| concatenate_31 (Concatenate) 30[0][0] | (None, 16, 16, 704) 0 | concatenate_ conv2d_66[0] [0] |
| batch_normalization_66 (BatchNo 31[0][0] | (None, 16, 16, 704) 2816 | concatenate_ |
| re_lu_66 (ReLU) batch_normalization_66[0][0] | (None, 16, 16, 704) 0 | batch_normal |
| conv2d_67 (Conv2D) [0] | (None, 16, 16, 128) 90240 | re_lu_66[0] |
| batch_normalization_67 (BatchNo [0] | (None, 16, 16, 128) 512 | conv2d_67[0] |
| re_lu_67 (ReLU) batch_normalization_67[0][0] | (None, 16, 16, 128) 0 | batch_normal |

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| conv2d_68 (Conv2D) [0] | (None, 16, 16, 32) | 36896 | re_lu_67[0] |
| concatenate_32 (Concatenate) 31[0][0] | (None, 16, 16, 736) | 0 | concatenate_ conv2d_68[0] [0] |
| batch_normalization_68 (BatchNo 32[0][0]) | (None, 16, 16, 736) | 2944 | concatenate_ |
| re_lu_68 (ReLU) 68[0][0] | (None, 16, 16, 736) | 0 | batch_normal ization_68[0][0] |
| conv2d_69 (Conv2D) [0] | (None, 16, 16, 128) | 94336 | re_lu_68[0] |
| batch_normalization_69 (BatchNo [0]) | (None, 16, 16, 128) | 512 | conv2d_69[0] |
| re_lu_69 (ReLU) 69[0][0] | (None, 16, 16, 128) | 0 | batch_normal ization_69[0][0] |
| conv2d_70 (Conv2D) [0] | (None, 16, 16, 32) | 36896 | re_lu_69[0] |
| concatenate_33 (Concatenate) 32[0][0] | (None, 16, 16, 768) | 0 | concatenate_ conv2d_70[0] [0] |
| batch_normalization_70 (BatchNo 33[0][0]) | (None, 16, 16, 768) | 3072 | concatenate_ |
| re_lu_70 (ReLU) 70[0][0] | (None, 16, 16, 768) | 0 | batch_normal ization_70[0][0] |
| conv2d_71 (Conv2D) [0] | (None, 16, 16, 128) | 98432 | re_lu_70[0] |
| batch_normalization_71 (BatchNo [0]) | (None, 16, 16, 128) | 512 | conv2d_71[0] |

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| re_lu_71 (ReLU) ization_71[0][0] | (None, 16, 16, 128) 0 | batch_normal |
| conv2d_72 (Conv2D) [0] | (None, 16, 16, 32) 36896 | re_lu_71[0] |
| concatenate_34 (Concatenate) 33[0][0] | (None, 16, 16, 800) 0 | concatenate_ conv2d_72[0] |
| batch_normalization_72 (BatchNo 34[0][0]) | (None, 16, 16, 800) 3200 | concatenate_ |
| re_lu_72 (ReLU) ization_72[0][0] | (None, 16, 16, 800) 0 | batch_normal |
| conv2d_73 (Conv2D) [0] | (None, 16, 16, 128) 102528 | re_lu_72[0] |
| batch_normalization_73 (BatchNo [0]) | (None, 16, 16, 128) 512 | conv2d_73[0] |
| re_lu_73 (ReLU) ization_73[0][0] | (None, 16, 16, 128) 0 | batch_normal |
| conv2d_74 (Conv2D) [0] | (None, 16, 16, 32) 36896 | re_lu_73[0] |
| concatenate_35 (Concatenate) 34[0][0] | (None, 16, 16, 832) 0 | concatenate_ conv2d_74[0] |
| batch_normalization_74 (BatchNo 35[0][0]) | (None, 16, 16, 832) 3328 | concatenate_ |
| re_lu_74 (ReLU) ization_74[0][0] | (None, 16, 16, 832) 0 | batch_normal |
| conv2d_75 (Conv2D) [0] | (None, 16, 16, 128) 106624 | re_lu_74[0] |
| batch_normalization_75 (BatchNo [0]) | (None, 16, 16, 128) 512 | conv2d_75[0] |

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| re_lu_75 (ReLU) | (None, 16, 16, 128) | 0 | batch_normalization_75[0][0] |
| conv2d_76 (Conv2D) | (None, 16, 16, 32) | 36896 | re_lu_75[0] |
| concatenate_36 (Concatenate) | (None, 16, 16, 864) | 0 | concatenate_35[0][0] |
| conv2d_76[0] | | | [0] |
| batch_normalization_76 (BatchNo) | (None, 16, 16, 864) | 3456 | concatenate_36[0][0] |
| batch_normalization_76[0] | | | [0] |
| re_lu_76 (ReLU) | (None, 16, 16, 864) | 0 | batch_normalization_76[0][0] |
| conv2d_77 (Conv2D) | (None, 16, 16, 128) | 110720 | re_lu_76[0] |
| batch_normalization_77 (BatchNo) | (None, 16, 16, 128) | 512 | conv2d_77[0] |
| batch_normalization_77[0] | | | [0] |
| re_lu_77 (ReLU) | (None, 16, 16, 128) | 0 | batch_normalization_77[0][0] |
| conv2d_78 (Conv2D) | (None, 16, 16, 32) | 36896 | re_lu_77[0] |
| concatenate_37 (Concatenate) | (None, 16, 16, 896) | 0 | concatenate_36[0][0] |
| conv2d_78[0] | | | [0] |
| batch_normalization_78 (BatchNo) | (None, 16, 16, 896) | 3584 | concatenate_37[0][0] |
| batch_normalization_78[0] | | | [0] |
| re_lu_78 (ReLU) | (None, 16, 16, 896) | 0 | batch_normalization_78[0][0] |
| conv2d_79 (Conv2D) | (None, 16, 16, 128) | 114816 | re_lu_78[0] |
| conv2d_79[0] | | | [0] |

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| batch_normalization_79 (BatchNo (None, 16, 16, 128) 512 [0] | | conv2d_79[0] |
| re_lu_79 (ReLU) | (None, 16, 16, 128) 0 | batch_normalization_79[0][0] |
| conv2d_80 (Conv2D) | (None, 16, 16, 32) 36896 | re_lu_79[0] |
| [0] | | |
| concatenate_38 (Concatenate) | (None, 16, 16, 928) 0 | concatenate_37[0][0] |
| [0] | | conv2d_80[0] |
| batch_normalization_80 (BatchNo (None, 16, 16, 928) 3712 [0] | | concatenate_38[0][0] |
| | | |
| re_lu_80 (ReLU) | (None, 16, 16, 928) 0 | batch_normalization_80[0][0] |
| [0] | | |
| conv2d_81 (Conv2D) | (None, 16, 16, 128) 118912 | re_lu_80[0] |
| [0] | | |
| batch_normalization_81 (BatchNo (None, 16, 16, 128) 512 [0] | | conv2d_81[0] |
| | | |
| re_lu_81 (ReLU) | (None, 16, 16, 128) 0 | batch_normalization_81[0][0] |
| [0] | | |
| conv2d_82 (Conv2D) | (None, 16, 16, 32) 36896 | re_lu_81[0] |
| [0] | | |
| concatenate_39 (Concatenate) | (None, 16, 16, 960) 0 | concatenate_38[0][0] |
| [0] | | conv2d_82[0] |
| batch_normalization_82 (BatchNo (None, 16, 16, 960) 3840 [0] | | concatenate_39[0][0] |
| | | |
| re_lu_82 (ReLU) | (None, 16, 16, 960) 0 | batch_normalization_82[0][0] |
| [0] | | |

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| conv2d_83 (Conv2D) [0] | (None, 16, 16, 128) | 123008 | re_lu_82[0] |
| batch_normalization_83 (BatchNo [0]) | (None, 16, 16, 128) | 512 | conv2d_83[0] |
| re_lu_83 (ReLU) [0][0] | (None, 16, 16, 128) | 0 | batch_normalization_83[0][0] |
| conv2d_84 (Conv2D) [0] | (None, 16, 16, 32) | 36896 | re_lu_83[0] |
| concatenate_40 (Concatenate) [0] | (None, 16, 16, 992) | 0 | concatenate_39[0][0] |
| conv2d_84[0] | | | |
| batch_normalization_84 (BatchNo [0][0]) | (None, 16, 16, 992) | 3968 | concatenate_40[0][0] |
| batch_normalization_84[0][0] | (None, 16, 16, 992) | 0 | batch_normalization_84[0][0] |
| conv2d_85 (Conv2D) [0] | (None, 16, 16, 128) | 127104 | re_lu_84[0] |
| batch_normalization_85 (BatchNo [0]) | (None, 16, 16, 128) | 512 | conv2d_85[0] |
| re_lu_85 (ReLU) [0][0] | (None, 16, 16, 128) | 0 | batch_normalization_85[0][0] |
| conv2d_86 (Conv2D) [0] | (None, 16, 16, 32) | 36896 | re_lu_85[0] |
| concatenate_41 (Concatenate) [0] | (None, 16, 16, 1024) | 0 | concatenate_40[0][0] |
| conv2d_86[0] | | | |
| batch_normalization_86 (BatchNo [0][0]) | (None, 16, 16, 1024) | 4096 | concatenate_41[0][0] |
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| re_lu_86 (ReLU) ization_86[0][0] | (None, 16, 16, 1024) 0 | | batch_normal |
| conv2d_87 (Conv2D) [0] | (None, 16, 16, 512) 524800 | re_lu_86[0] | |
| average_pooling2d_2 (AveragePoo [0] | (None, 8, 8, 512) 0 | | conv2d_87[0] |
| batch_normalization_87 (BatchNo ing2d_2[0][0] | (None, 8, 8, 512) 2048 | average_pool | |
| re_lu_87 (ReLU) ization_87[0][0] | (None, 8, 8, 512) 0 | | batch_normal |
| conv2d_88 (Conv2D) [0] | (None, 8, 8, 128) 65664 | re_lu_87[0] | |
| batch_normalization_88 (BatchNo [0] | (None, 8, 8, 128) 512 | conv2d_88[0] | |
| re_lu_88 (ReLU) ization_88[0][0] | (None, 8, 8, 128) 0 | | batch_normal |
| conv2d_89 (Conv2D) [0] | (None, 8, 8, 32) 36896 | re_lu_88[0] | |
| concatenate_42 (Concatenate) [0] | (None, 8, 8, 544) 0 | average_pool conv2d_89[0] | |
| batch_normalization_89 (BatchNo 42[0][0] | (None, 8, 8, 544) 2176 | concatenate_ | |
| re_lu_89 (ReLU) ization_89[0][0] | (None, 8, 8, 544) 0 | | batch_normal |
| conv2d_90 (Conv2D) [0] | (None, 8, 8, 128) 69760 | re_lu_89[0] | |
| batch_normalization_90 (BatchNo [0] | (None, 8, 8, 128) 512 | conv2d_90[0] | |

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| re_lu_90 (ReLU) ization_90[0][0] | (None, 8, 8, 128) | 0 | batch_normal |
| conv2d_91 (Conv2D) [0] | (None, 8, 8, 32) | 36896 | re_lu_90[0] |
| concatenate_43 (Concatenate) 42[0][0] | (None, 8, 8, 576) | 0 | concatenate_ conv2d_91[0] [0] |
| batch_normalization_91 (BatchNo 43[0][0]) | (None, 8, 8, 576) | 2304 | concatenate_ |
| re_lu_91 (ReLU) ization_91[0][0] | (None, 8, 8, 576) | 0 | batch_normal |
| conv2d_92 (Conv2D) [0] | (None, 8, 8, 128) | 73856 | re_lu_91[0] |
| batch_normalization_92 (BatchNo [0]) | (None, 8, 8, 128) | 512 | conv2d_92[0] |
| re_lu_92 (ReLU) ization_92[0][0] | (None, 8, 8, 128) | 0 | batch_normal |
| conv2d_93 (Conv2D) [0] | (None, 8, 8, 32) | 36896 | re_lu_92[0] |
| concatenate_44 (Concatenate) 43[0][0] | (None, 8, 8, 608) | 0 | concatenate_ conv2d_93[0] [0] |
| batch_normalization_93 (BatchNo 44[0][0]) | (None, 8, 8, 608) | 2432 | concatenate_ |
| re_lu_93 (ReLU) ization_93[0][0] | (None, 8, 8, 608) | 0 | batch_normal |
| conv2d_94 (Conv2D) [0] | (None, 8, 8, 128) | 77952 | re_lu_93[0] |

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| batch_normalization_94 (BatchNo [0] | (None, 8, 8, 128) | 512 | conv2d_94[0] |
| re_lu_94 (ReLU) [0] | (None, 8, 8, 128) | 0 | batch_normalization_94[0][0] |
| conv2d_95 (Conv2D) [0] | (None, 8, 8, 32) | 36896 | re_lu_94[0] |
| concatenate_45 (Concatenate) [0] | (None, 8, 8, 640) | 0 | concatenate_44[0][0] |
| conv2d_95[0] | | | [0] |
| batch_normalization_95 (BatchNo [0] | (None, 8, 8, 640) | 2560 | concatenate_45[0][0] |
| re_lu_95 (ReLU) [0] | (None, 8, 8, 640) | 0 | batch_normalization_95[0][0] |
| conv2d_96 (Conv2D) [0] | (None, 8, 8, 128) | 82048 | re_lu_95[0] |
| batch_normalization_96 (BatchNo [0] | (None, 8, 8, 128) | 512 | conv2d_96[0] |
| re_lu_96 (ReLU) [0] | (None, 8, 8, 128) | 0 | batch_normalization_96[0][0] |
| conv2d_97 (Conv2D) [0] | (None, 8, 8, 32) | 36896 | re_lu_96[0] |
| concatenate_46 (Concatenate) [0] | (None, 8, 8, 672) | 0 | concatenate_45[0][0] |
| conv2d_97[0] | | | [0] |
| batch_normalization_97 (BatchNo [0] | (None, 8, 8, 672) | 2688 | concatenate_46[0][0] |
| re_lu_97 (ReLU) [0] | (None, 8, 8, 672) | 0 | batch_normalization_97[0][0] |
| conv2d_98 (Conv2D) | (None, 8, 8, 128) | 86144 | re_lu_97[0] |

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| | | |
|---|-------------------|--------------|
| batch_normalization_98 (BatchNo (None, 8, 8, 128) | 512 | conv2d_98[0] |
| [0] | | |
| re_lu_98 (ReLU) | (None, 8, 8, 128) | 0 |
| batch_normalization_98[0][0] | | batch_normal |
| conv2d_99 (Conv2D) | (None, 8, 8, 32) | 36896 |
| [0] | re_lu_98[0] | |
| concatenate_47 (Concatenate) | (None, 8, 8, 704) | 0 |
| 46[0][0] | | concatenate_ |
| [0] | | conv2d_99[0] |
| batch_normalization_99 (BatchNo (None, 8, 8, 704) | 2816 | concatenate_ |
| 47[0][0] | | |
| re_lu_99 (ReLU) | (None, 8, 8, 704) | 0 |
| batch_normalization_99[0][0] | | batch_normal |
| conv2d_100 (Conv2D) | (None, 8, 8, 128) | 90240 |
| [0] | re_lu_99[0] | |
| batch_normalization_100 (BatchN (None, 8, 8, 128) | 512 | conv2d_100 |
| [0][0] | | |
| re_lu_100 (ReLU) | (None, 8, 8, 128) | 0 |
| batch_normalization_100[0][0] | | batch_normal |
| conv2d_101 (Conv2D) | (None, 8, 8, 32) | 36896 |
| [0] | re_lu_100[0] | |
| concatenate_48 (Concatenate) | (None, 8, 8, 736) | 0 |
| 47[0][0] | | concatenate_ |
| [0][0] | | conv2d_101 |
| batch_normalization_101 (BatchN (None, 8, 8, 736) | 2944 | concatenate_ |
| 48[0][0] | | |
| re_lu_101 (ReLU) | (None, 8, 8, 736) | 0 |
| batch_normalization_101[0][0] | | batch_normal |

| | | | |
|---|-------------------|-------|-----------------------------------|
| conv2d_102 (Conv2D) [0] | (None, 8, 8, 128) | 94336 | re_lu_101[0] |
| batch_normalization_102 (BatchN [0][0] | (None, 8, 8, 128) | 512 | conv2d_102 [0][0] |
| re_lu_102 (ReLU) batch_normalization_102[0][0] | (None, 8, 8, 128) | 0 | batch_normal ization_102[0][0] |
| conv2d_103 (Conv2D) [0] | (None, 8, 8, 32) | 36896 | re_lu_102[0] |
| concatenate_49 (Concatenate) [0][0] | (None, 8, 8, 768) | 0 | concatenate_ 49[0][0] |
| batch_normalization_103 (BatchN [0][0] | (None, 8, 8, 768) | 3072 | concatenate_ 49[0][0] |
| re_lu_103 (ReLU) batch_normalization_103[0][0] | (None, 8, 8, 768) | 0 | batch_normal ization_103[0][0] |
| conv2d_104 (Conv2D) [0] | (None, 8, 8, 128) | 98432 | re_lu_103[0] |
| batch_normalization_104 (BatchN [0][0] | (None, 8, 8, 128) | 512 | conv2d_104 [0][0] |
| re_lu_104 (ReLU) batch_normalization_104[0][0] | (None, 8, 8, 128) | 0 | batch_normal ization_104[0][0] |
| conv2d_105 (Conv2D) [0] | (None, 8, 8, 32) | 36896 | re_lu_104[0] |
| concatenate_50 (Concatenate) [0][0] | (None, 8, 8, 800) | 0 | concatenate_ 50[0][0] |
| batch_normalization_105 (BatchN [0][0] | (None, 8, 8, 800) | 3200 | concatenate_ 50[0][0] |

| | | | |
|--|-------------------|--------|--------------|
| re_lu_105 (ReLU) ization_105[0][0] | (None, 8, 8, 800) | 0 | batch_normal |
| conv2d_106 (Conv2D) [0] | (None, 8, 8, 128) | 102528 | re_lu_105[0] |
| batch_normalization_106 (BatchN [0][0]) | (None, 8, 8, 128) | 512 | conv2d_106 |
| re_lu_106 (ReLU) ization_106[0][0] | (None, 8, 8, 128) | 0 | batch_normal |
| conv2d_107 (Conv2D) [0] | (None, 8, 8, 32) | 36896 | re_lu_106[0] |
| concatenate_51 (Concatenate) 50[0][0] | (None, 8, 8, 832) | 0 | concatenate_ |
| | | | conv2d_107 |
| [0][0] | | | |
| batch_normalization_107 (BatchN 51[0][0]) | (None, 8, 8, 832) | 3328 | concatenate_ |
| re_lu_107 (ReLU) ization_107[0][0] | (None, 8, 8, 832) | 0 | batch_normal |
| conv2d_108 (Conv2D) [0] | (None, 8, 8, 128) | 106624 | re_lu_107[0] |
| batch_normalization_108 (BatchN [0][0]) | (None, 8, 8, 128) | 512 | conv2d_108 |
| re_lu_108 (ReLU) ization_108[0][0] | (None, 8, 8, 128) | 0 | batch_normal |
| conv2d_109 (Conv2D) [0] | (None, 8, 8, 32) | 36896 | re_lu_108[0] |
| concatenate_52 (Concatenate) 51[0][0] | (None, 8, 8, 864) | 0 | concatenate_ |
| | | | conv2d_109 |
| [0][0] | | | |

| | | |
|--|-------------------|----------------------|
| batch_normalization_109 (BatchN (None, 8, 8, 864)) | 3456 | concatenate_52[0][0] |
| re_lu_109 (ReLU) | (None, 8, 8, 864) | 0 |
| batch_normalization_109[0][0] | | |
| conv2d_110 (Conv2D) | (None, 8, 8, 128) | 110720 |
| [0] | | re_lu_109[0] |
| batch_normalization_110 (BatchN (None, 8, 8, 128)) | 512 | conv2d_110[0][0] |
| re_lu_110 (ReLU) | (None, 8, 8, 128) | 0 |
| batch_normalization_110[0][0] | | |
| conv2d_111 (Conv2D) | (None, 8, 8, 32) | 36896 |
| [0] | | re_lu_110[0] |
| concatenate_53 (Concatenate) | (None, 8, 8, 896) | 0 |
| 52[0][0] | | concatenate_52[0][0] |
| batch_normalization_111 (BatchN (None, 8, 8, 896)) | 3584 | concatenate_53[0][0] |
| re_lu_111 (ReLU) | (None, 8, 8, 896) | 0 |
| batch_normalization_111[0][0] | | |
| conv2d_112 (Conv2D) | (None, 8, 8, 128) | 114816 |
| [0] | | re_lu_111[0] |
| batch_normalization_112 (BatchN (None, 8, 8, 128)) | 512 | conv2d_112[0][0] |
| re_lu_112 (ReLU) | (None, 8, 8, 128) | 0 |
| batch_normalization_112[0][0] | | |
| conv2d_113 (Conv2D) | (None, 8, 8, 32) | 36896 |
| [0] | | re_lu_112[0] |
| concatenate_54 (Concatenate) | (None, 8, 8, 928) | 0 |
| 53[0][0] | | concatenate_53[0][0] |
| batch_normalization_113 (BatchN (None, 8, 8, 928)) | 3584 | conv2d_113[0][0] |

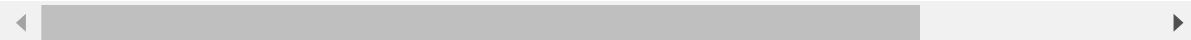
[0][0]

| | | |
|---|--------|-------------------------------|
| batch_normalization_113 (BatchN (None, 8, 8, 928) | 3712 | concatenate_54[0][0] |
| re_lu_113 (ReLU) (None, 8, 8, 928) | 0 | batch_normalization_113[0][0] |
| conv2d_114 (Conv2D) (None, 8, 8, 128) | 118912 | re_lu_113[0] |
| batch_normalization_114 (BatchN (None, 8, 8, 128) | 512 | conv2d_114[0][0] |
| re_lu_114 (ReLU) (None, 8, 8, 128) | 0 | batch_normalization_114[0][0] |
| conv2d_115 (Conv2D) (None, 8, 8, 32) | 36896 | re_lu_114[0] |
| concatenate_55 (Concatenate) (None, 8, 8, 960) | 0 | concatenate_54[0][0] |
| conv2d_115 (Conv2D) (None, 8, 8, 960) | 3840 | concatenate_55[0][0] |
| re_lu_115 (ReLU) (None, 8, 8, 960) | 0 | batch_normalization_115[0][0] |
| conv2d_116 (Conv2D) (None, 8, 8, 128) | 123008 | re_lu_115[0] |
| batch_normalization_116 (BatchN (None, 8, 8, 128) | 512 | conv2d_116[0][0] |
| re_lu_116 (ReLU) (None, 8, 8, 128) | 0 | batch_normalization_116[0][0] |
| conv2d_117 (Conv2D) (None, 8, 8, 32) | 36896 | re_lu_116[0] |

| | | | |
|---|--------------------|--------|--------------------------------------|
| concatenate_56 (Concatenate) 55[0][0] | (None, 8, 8, 992) | 0 | concatenate_ conv2d_117 [0][0] |
| batch_normalization_117 (BatchN 56[0][0]) | (None, 8, 8, 992) | 3968 | concatenate_ |
| re_lu_117 (ReLU) batch_normalization_117[0][0] | (None, 8, 8, 992) | 0 | batch_normal ization_117[0] |
| conv2d_118 (Conv2D) [0] | (None, 8, 8, 128) | 127104 | re_lu_117[0] |
| batch_normalization_118 (BatchN [0][0]) | (None, 8, 8, 128) | 512 | conv2d_118 [0][0] |
| re_lu_118 (ReLU) batch_normalization_118[0][0] | (None, 8, 8, 128) | 0 | batch_normal ization_118[0] |
| conv2d_119 (Conv2D) [0] | (None, 8, 8, 32) | 36896 | re_lu_118[0] |
| concatenate_57 (Concatenate) 56[0][0] | (None, 8, 8, 1024) | 0 | concatenate_ conv2d_119 [0][0] |
| global_average_pooling2d (Globa 57[0][0]) | (None, 1024) | 0 | concatenate_ |
| dense (Dense) ge_pooling2d[0][0] | (None, 10) | 10250 | global_aver age_pooling2d[0][0] |
| Total params: 7,053,642 | | | ===== |
| Trainable params: 6,972,170 | | | ===== |
| Non-trainable params: 81,472 | | | ===== |
| Epoch 1/30 | | | |
| WARNING:tensorflow:Model was constructed with shape (None, 256, 256, 3) for input Tensor("input_1:0", shape=(None, 256, 256, 3), dtype=float32), but it was called on an input with incompatible shape (None, 32, 32, 3). | | | |
| WARNING:tensorflow:Model was constructed with shape (None, 256, 256, 3) for input Tensor("input_1:0", shape=(None, 256, 256, 3), dtype=float32), but it was called on an input with incompatible shape (None, 32, 32, 3). | | | |
| 1563/1563 [=====] - ETA: 0s - loss: 1.5525 - accurac | | | |

y: 0.4535WARNING:tensorflow:Model was constructed with shape (None, 256, 256, 3) for input Tensor("input_1:0", shape=(None, 256, 256, 3), dtype=float32), but it was called on an input with incompatible shape (None, 32, 32, 3).
1563/1563 [=====] - 75s 48ms/step - loss: 1.5525 - accuracy: 0.4535 - val_loss: 1.7420 - val_accuracy: 0.4207
Epoch 2/30
1563/1563 [=====] - 68s 43ms/step - loss: 1.0693 - accuracy: 0.6232 - val_loss: 1.2588 - val_accuracy: 0.5623
Epoch 3/30
1563/1563 [=====] - 68s 43ms/step - loss: 0.8594 - accuracy: 0.6997 - val_loss: 1.2156 - val_accuracy: 0.6087
Epoch 4/30
1563/1563 [=====] - 66s 42ms/step - loss: 0.7375 - accuracy: 0.7427 - val_loss: 1.2604 - val_accuracy: 0.5955
Epoch 5/30
1563/1563 [=====] - 68s 43ms/step - loss: 0.6325 - accuracy: 0.7811 - val_loss: 0.8368 - val_accuracy: 0.7125
Epoch 6/30
1563/1563 [=====] - 67s 43ms/step - loss: 0.5448 - accuracy: 0.8091 - val_loss: 0.7410 - val_accuracy: 0.7489
Epoch 7/30
1563/1563 [=====] - 67s 43ms/step - loss: 0.4594 - accuracy: 0.8397 - val_loss: 0.7536 - val_accuracy: 0.7442
Epoch 8/30
1563/1563 [=====] - 69s 44ms/step - loss: 0.3937 - accuracy: 0.8631 - val_loss: 0.7689 - val_accuracy: 0.7550
Epoch 9/30
1563/1563 [=====] - 65s 42ms/step - loss: 0.3238 - accuracy: 0.8866 - val_loss: 0.8115 - val_accuracy: 0.7509
Epoch 10/30
1563/1563 [=====] - 66s 42ms/step - loss: 0.2744 - accuracy: 0.9031 - val_loss: 0.8909 - val_accuracy: 0.7483
Epoch 11/30
1563/1563 [=====] - 65s 42ms/step - loss: 0.2290 - accuracy: 0.9186 - val_loss: 0.8926 - val_accuracy: 0.7493
Epoch 12/30
1563/1563 [=====] - 65s 42ms/step - loss: 0.1868 - accuracy: 0.9352 - val_loss: 0.9719 - val_accuracy: 0.7538
Epoch 13/30
1563/1563 [=====] - 65s 41ms/step - loss: 0.1698 - accuracy: 0.9393 - val_loss: 0.9159 - val_accuracy: 0.7743
Epoch 14/30
1563/1563 [=====] - 67s 43ms/step - loss: 0.1454 - accuracy: 0.9491 - val_loss: 1.0750 - val_accuracy: 0.7530
Epoch 15/30
1563/1563 [=====] - 67s 43ms/step - loss: 0.1323 - accuracy: 0.9541 - val_loss: 1.2350 - val_accuracy: 0.7347
Epoch 16/30
1563/1563 [=====] - 65s 41ms/step - loss: 0.1175 - accuracy: 0.9585 - val_loss: 1.0900 - val_accuracy: 0.7504
Epoch 17/30
1563/1563 [=====] - 66s 43ms/step - loss: 0.1097 - accuracy: 0.9615 - val_loss: 0.9798 - val_accuracy: 0.7856
Epoch 18/30
1563/1563 [=====] - 67s 43ms/step - loss: 0.1006 - accuracy: 0.9649 - val_loss: 1.2601 - val_accuracy: 0.7429
Epoch 19/30

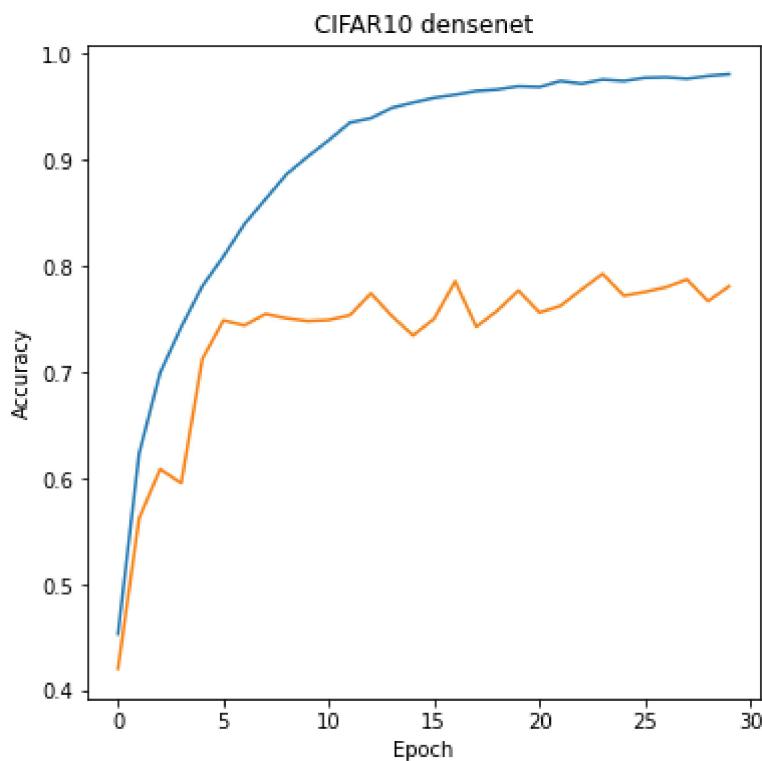
```
1563/1563 [=====] - 68s 43ms/step - loss: 0.0970 - accuracy: 0.9664 - val_loss: 1.1029 - val_accuracy: 0.7581
Epoch 20/30
1563/1563 [=====] - 66s 42ms/step - loss: 0.0875 - accuracy: 0.9695 - val_loss: 1.0983 - val_accuracy: 0.7769
Epoch 21/30
1563/1563 [=====] - 68s 44ms/step - loss: 0.0911 - accuracy: 0.9687 - val_loss: 1.0967 - val_accuracy: 0.7563
Epoch 22/30
1563/1563 [=====] - 68s 44ms/step - loss: 0.0737 - accuracy: 0.9744 - val_loss: 1.2275 - val_accuracy: 0.7626
Epoch 23/30
1563/1563 [=====] - 69s 44ms/step - loss: 0.0809 - accuracy: 0.9719 - val_loss: 1.0726 - val_accuracy: 0.7780
Epoch 24/30
1563/1563 [=====] - 70s 45ms/step - loss: 0.0712 - accuracy: 0.9758 - val_loss: 1.0229 - val_accuracy: 0.7928
Epoch 25/30
1563/1563 [=====] - 69s 44ms/step - loss: 0.0748 - accuracy: 0.9744 - val_loss: 1.1889 - val_accuracy: 0.7721
Epoch 26/30
1563/1563 [=====] - 66s 42ms/step - loss: 0.0663 - accuracy: 0.9775 - val_loss: 1.1396 - val_accuracy: 0.7756
Epoch 27/30
1563/1563 [=====] - 66s 42ms/step - loss: 0.0643 - accuracy: 0.9780 - val_loss: 1.1291 - val_accuracy: 0.7801
Epoch 28/30
1563/1563 [=====] - 66s 42ms/step - loss: 0.0683 - accuracy: 0.9765 - val_loss: 1.1473 - val_accuracy: 0.7874
Epoch 29/30
1563/1563 [=====] - 67s 43ms/step - loss: 0.0597 - accuracy: 0.9792 - val_loss: 1.2566 - val_accuracy: 0.7670
Epoch 30/30
1563/1563 [=====] - 70s 45ms/step - loss: 0.0567 - accuracy: 0.9809 - val_loss: 1.2615 - val_accuracy: 0.7810
```



Let us see the accuracy of the Densenet

```
In [6]: plt.figure(figsize=(6,6))
plt.plot(history.history['Accuracy'], label='Accuracy')
plt.plot(history.history['Test accuracy'], label = 'Test accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.title('CIFAR10 densenet')
```

Out[6]: Text(0.5, 1.0, 'CIFAR10 densenet')



This was all about Densenet on CIFAR - 10 Dataset

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<https://www.youtube.com/channel/UCfcRI0zI9RMOR11fH>

In []: