

11_satellite_images

September 29, 2021

1 How to classify satellite images

1.1 Imports & Settings

```
[1]: import warnings
warnings.filterwarnings('ignore')
```

```
[2]: %matplotlib inline

from pathlib import Path
import pandas as pd
import matplotlib.pyplot as plt
from matplotlib.ticker import FuncFormatter
import seaborn as sns

import tensorflow as tf
from tensorflow.keras.applications.densenet import DenseNet201
from tensorflow.keras.layers import Dense, BatchNormalization
from tensorflow.keras.models import Sequential
from tensorflow.keras.callbacks import ModelCheckpoint, EarlyStopping
from tensorflow.keras.regularizers import l1_l2
from tensorflow.keras.optimizers import Adam

import tensorflow_datasets as tfds
```

```
[3]: gpu_devices = tf.config.experimental.list_physical_devices('GPU')
if gpu_devices:
    print('Using GPU')
    tf.config.experimental.set_memory_growth(gpu_devices[0], True)
else:
    print('Using CPU')
```

Using CPU

```
[4]: sns.set_style('whitegrid')
```

```
[5]: results_path = Path ('results', 'euosat')
if not results_path.exists():
```

```
results_path.mkdir(parents=True)
```

1.2 Load EuroSat Dataset

```
[6]: (raw_train, raw_validation), metadata = tfds.load('eurosat',
                                                    split=[
                                                        tfds.Split.TRAIN.subsplit(
                                                            tfds.percent[:90]),
                                                        tfds.Split.TRAIN.subsplit(
                                                            tfds.percent[90:])
                                                    ],
                                                    with_info=True,
                                                    shuffle_files=False,
                                                    as_supervised=True,
                                                    data_dir='../data/tensorflow')
```

1.2.1 Inspect MetaData

```
[7]: metadata
```

```
[7]: tfds.core.DatasetInfo(
      name='eurosat',
      version=0.0.1,
      description='EuroSAT dataset is based on Sentinel-2 satellite images
covering 13 spectral
bands and consisting of 10 classes with 27000 labeled and
geo-referenced samples.
```

Two datasets are offered:

- rgb: Contains only the optical R, G, B frequency bands encoded as JPEG image.
- all: Contains all 13 bands in the original value range (float32).

URL: <https://github.com/phelber/eurosat>

```
',
  urls=['https://github.com/phelber/eurosat'],
  features=FeaturesDict({
    'filename': Text(shape=(), dtype=tf.string),
    'image': Image(shape=(64, 64, 3), dtype=tf.uint8),
    'label': ClassLabel(shape=(), dtype=tf.int64, num_classes=10),
  }),
  total_num_examples=27000,
  splits={
    'train': 27000,
  },
  supervised_keys=('image', 'label'),
  citation="""@misc{helber2017eurosat,
```

```

        title={EuroSAT: A Novel Dataset and Deep Learning Benchmark for Land Use
and Land Cover Classification},
        author={Patrick Helber and Benjamin Bischke and Andreas Dengel and
Damian Borth},
        year={2017},
        eprint={1709.00029},
        archivePrefix={arXiv},
        primaryClass={cs.CV}
}""",
        redistribution_info=,
)

```

```

[8]: print('Train:\t', raw_train)
      print('Valid:\t', raw_validation)

```

```

Train:  <_OptionsDataset shapes: ((64, 64, 3), ()), types: (tf.uint8,
tf.int64)>
Valid:  <_OptionsDataset shapes: ((64, 64, 3), ()), types: (tf.uint8,
tf.int64)>

```

1.2.2 Show sample images

```

[9]: fig, axes = plt.subplots(figsize=(15, 7), ncols=5, nrows=2)
      axes = axes.flatten()
      get_label_name = metadata.features['label'].int2str
      labels = set()
      c = 0
      for img, label in raw_train.as_numpy_iterator():
          if label not in labels:
              axes[c].imshow(img)
              axes[c].set_title(get_label_name(label))
              axes[c].grid(False)
              axes[c].tick_params(axis='both',
                                  which='both',
                                  bottom=False,
                                  top=False,
                                  labelbottom=False,
                                  right=False,
                                  left=False,
                                  labelleft=False)

              labels.add(label)
              c += 1
              if c == 10:
                  break
      fig.suptitle('EuroSat Satellite Images', fontsize=16)
      fig.tight_layout()
      fig.subplots_adjust(top=.92);

```

```
# fig.savefig(results_path / 'eurosat_samples', dpi=300);
```



1.3 Preprocessing

All images will be resized to 160x160:

```
[10]: IMG_SIZE = 64  
      IMG_SHAPE = (IMG_SIZE, IMG_SIZE, 3)
```

```
[11]: def format_example(image, label):  
      image = tf.cast(image, tf.float32)  
      image = (image/127.5) - 1  
      return image, label
```

```
[12]: train = raw_train.map(format_example)  
      validation = raw_validation.map(format_example)
```

```
[13]: BATCH_SIZE = 32  
      SHUFFLE_BUFFER_SIZE = 1000
```

```
[14]: train_batches = train.shuffle(SHUFFLE_BUFFER_SIZE).batch(BATCH_SIZE)  
      validation_batches = validation.batch(BATCH_SIZE)
```

```
[15]: for image_batch, label_batch in train_batches.take(1):  
      pass  
  
      image_batch.shape
```

```
[15]: TensorShape([32, 64, 64, 3])
```

1.4 Load the DenseNet201 Bottleneck Features

```
[16]: densenet = DenseNet201(input_shape=IMG_SHAPE,
                             include_top=False,
                             weights='imagenet',
                             pooling='max',
                             classes=1000)

densenet.summary()
```

Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/densenet/densenet201_weights_tf_dim_ordering_tf_kernels_notop.h5
74842112/74836368 [=====] - 1s 0us/step
Model: "densenet201"

| Layer (type) | Output Shape | Param # | Connected to |
|----------------------------------|---------------------|---------|-------------------------|
| input_1 (InputLayer) | [(None, 64, 64, 3)] | 0 | |
| zero_padding2d (ZeroPadding2D) | (None, 70, 70, 3) | 0 | input_1[0][0] |
| conv1/conv (Conv2D) | (None, 32, 32, 64) | 9408 | zero_padding2d[0][0] |
| conv1/bn (BatchNormalization) | (None, 32, 32, 64) | 256 | conv1/conv[0][0] |
| conv1/relu (Activation) | (None, 32, 32, 64) | 0 | conv1/bn[0][0] |
| zero_padding2d_1 (ZeroPadding2D) | (None, 34, 34, 64) | 0 | conv1/relu[0][0] |
| pool1 (MaxPooling2D) | (None, 16, 16, 64) | 0 | zero_padding2d_1[0][0] |
| conv2_block1_0_bn (BatchNormali | (None, 16, 16, 64) | 256 | pool1[0][0] |
| conv2_block1_0_relu (Activation | (None, 16, 16, 64) | 0 | conv2_block1_0_bn[0][0] |

```

conv2_block1_0_bn[0][0]
-----
conv2_block1_1_conv (Conv2D)      (None, 16, 16, 128)  8192
conv2_block1_0_relu[0][0]
-----
conv2_block1_1_bn (BatchNormaliz (None, 16, 16, 128)  512
conv2_block1_1_conv[0][0]
-----
conv2_block1_1_relu (Activation) (None, 16, 16, 128)  0
conv2_block1_1_bn[0][0]
-----
conv2_block1_2_conv (Conv2D)      (None, 16, 16, 32)   36864
conv2_block1_1_relu[0][0]
-----
conv2_block1_concat (Concatenati (None, 16, 16, 96)   0           pool1[0][0]
conv2_block1_2_conv[0][0]
-----
conv2_block2_0_bn (BatchNormaliz (None, 16, 16, 96)   384
conv2_block1_concat[0][0]
-----
conv2_block2_0_relu (Activation) (None, 16, 16, 96)   0
conv2_block2_0_bn[0][0]
-----
conv2_block2_1_conv (Conv2D)      (None, 16, 16, 128)  12288
conv2_block2_0_relu[0][0]
-----
conv2_block2_1_bn (BatchNormaliz (None, 16, 16, 128)  512
conv2_block2_1_conv[0][0]
-----
conv2_block2_1_relu (Activation) (None, 16, 16, 128)  0
conv2_block2_1_bn[0][0]
-----
conv2_block2_2_conv (Conv2D)      (None, 16, 16, 32)   36864
conv2_block2_1_relu[0][0]
-----
conv2_block2_concat (Concatenati (None, 16, 16, 128)  0

```

```

conv2_block1_concat[0][0]
conv2_block2_2_conv[0][0]
-----
conv2_block3_0_bn (BatchNormali (None, 16, 16, 128) 512
conv2_block2_concat[0][0]
-----
conv2_block3_0_relu (Activation (None, 16, 16, 128) 0
conv2_block3_0_bn[0][0]
-----
conv2_block3_1_conv (Conv2D) (None, 16, 16, 128) 16384
conv2_block3_0_relu[0][0]
-----
conv2_block3_1_bn (BatchNormali (None, 16, 16, 128) 512
conv2_block3_1_conv[0][0]
-----
conv2_block3_1_relu (Activation (None, 16, 16, 128) 0
conv2_block3_1_bn[0][0]
-----
conv2_block3_2_conv (Conv2D) (None, 16, 16, 32) 36864
conv2_block3_1_relu[0][0]
-----
conv2_block3_concat (Concatenat (None, 16, 16, 160) 0
conv2_block2_concat[0][0]
conv2_block3_2_conv[0][0]
-----
conv2_block4_0_bn (BatchNormali (None, 16, 16, 160) 640
conv2_block3_concat[0][0]
-----
conv2_block4_0_relu (Activation (None, 16, 16, 160) 0
conv2_block4_0_bn[0][0]
-----
conv2_block4_1_conv (Conv2D) (None, 16, 16, 128) 20480
conv2_block4_0_relu[0][0]
-----
conv2_block4_1_bn (BatchNormali (None, 16, 16, 128) 512
conv2_block4_1_conv[0][0]
-----

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```

-----
conv2_block4_1_relu (Activation (None, 16, 16, 128) 0
conv2_block4_1_bn[0][0]
-----

-----
conv2_block4_2_conv (Conv2D) (None, 16, 16, 32) 36864
conv2_block4_1_relu[0][0]
-----

-----
conv2_block4_concat (Concatenat (None, 16, 16, 192) 0
conv2_block3_concat[0][0]
conv2_block4_2_conv[0][0]
-----

-----
conv2_block5_0_bn (BatchNormali (None, 16, 16, 192) 768
conv2_block4_concat[0][0]
-----

-----
conv2_block5_0_relu (Activation (None, 16, 16, 192) 0
conv2_block5_0_bn[0][0]
-----

-----
conv2_block5_1_conv (Conv2D) (None, 16, 16, 128) 24576
conv2_block5_0_relu[0][0]
-----

-----
conv2_block5_1_bn (BatchNormali (None, 16, 16, 128) 512
conv2_block5_1_conv[0][0]
-----

-----
conv2_block5_1_relu (Activation (None, 16, 16, 128) 0
conv2_block5_1_bn[0][0]
-----

-----
conv2_block5_2_conv (Conv2D) (None, 16, 16, 32) 36864
conv2_block5_1_relu[0][0]
-----

-----
conv2_block5_concat (Concatenat (None, 16, 16, 224) 0
conv2_block4_concat[0][0]
conv2_block5_2_conv[0][0]
-----

-----
conv2_block6_0_bn (BatchNormali (None, 16, 16, 224) 896
conv2_block5_concat[0][0]
-----

-----
conv2_block6_0_relu (Activation (None, 16, 16, 224) 0

```



```

conv2_block6_0_bn[0][0]
-----
-----
conv2_block6_1_conv (Conv2D)      (None, 16, 16, 128) 28672
conv2_block6_0_relu[0][0]
-----
-----
conv2_block6_1_bn (BatchNormaliz (None, 16, 16, 128) 512
conv2_block6_1_conv[0][0]
-----
-----
conv2_block6_1_relu (Activation (None, 16, 16, 128) 0
conv2_block6_1_bn[0][0]
-----
-----
conv2_block6_2_conv (Conv2D)      (None, 16, 16, 32) 36864
conv2_block6_1_relu[0][0]
-----
-----
conv2_block6_concat (Concatenat (None, 16, 16, 256) 0
conv2_block5_concat[0][0]
conv2_block6_2_conv[0][0]
-----
-----
pool2_bn (BatchNormalization)     (None, 16, 16, 256) 1024
conv2_block6_concat[0][0]
-----
-----
pool2_relu (Activation)           (None, 16, 16, 256) 0          pool2_bn[0][0]
-----
-----
pool2_conv (Conv2D)               (None, 16, 16, 128) 32768
pool2_relu[0][0]
-----
-----
pool2_pool (AveragePooling2D)     (None, 8, 8, 128) 0
pool2_conv[0][0]
-----
-----
conv3_block1_0_bn (BatchNormaliz (None, 8, 8, 128) 512
pool2_pool[0][0]
-----
-----
conv3_block1_0_relu (Activation (None, 8, 8, 128) 0
conv3_block1_0_bn[0][0]
-----
-----
conv3_block1_1_conv (Conv2D)      (None, 8, 8, 128) 16384

```

```

conv3_block1_0_relu[0][0]
-----
-----
conv3_block1_1_bn (BatchNormali (None, 8, 8, 128)    512
conv3_block1_1_conv[0][0]
-----
-----
conv3_block1_1_relu (Activation (None, 8, 8, 128)    0
conv3_block1_1_bn[0][0]
-----
-----
conv3_block1_2_conv (Conv2D)      (None, 8, 8, 32)    36864
conv3_block1_1_relu[0][0]
-----
-----
conv3_block1_concat (Concatenat (None, 8, 8, 160)    0
pool2_pool[0][0]
conv3_block1_2_conv[0][0]
-----
-----
conv3_block2_0_bn (BatchNormali (None, 8, 8, 160)    640
conv3_block1_concat[0][0]
-----
-----
conv3_block2_0_relu (Activation (None, 8, 8, 160)    0
conv3_block2_0_bn[0][0]
-----
-----
conv3_block2_1_conv (Conv2D)      (None, 8, 8, 128)    20480
conv3_block2_0_relu[0][0]
-----
-----
conv3_block2_1_bn (BatchNormali (None, 8, 8, 128)    512
conv3_block2_1_conv[0][0]
-----
-----
conv3_block2_1_relu (Activation (None, 8, 8, 128)    0
conv3_block2_1_bn[0][0]
-----
-----
conv3_block2_2_conv (Conv2D)      (None, 8, 8, 32)    36864
conv3_block2_1_relu[0][0]
-----
-----
conv3_block2_concat (Concatenat (None, 8, 8, 192)    0
conv3_block1_concat[0][0]
conv3_block2_2_conv[0][0]
-----
-----

```

```

-----
conv3_block3_0_bn (BatchNormali (None, 8, 8, 192)    768
conv3_block2_concat[0][0]
-----

conv3_block3_0_relu (Activation (None, 8, 8, 192)    0
conv3_block3_0_bn[0][0]
-----

conv3_block3_1_conv (Conv2D)      (None, 8, 8, 128)    24576
conv3_block3_0_relu[0][0]
-----

conv3_block3_1_bn (BatchNormali (None, 8, 8, 128)    512
conv3_block3_1_conv[0][0]
-----

conv3_block3_1_relu (Activation (None, 8, 8, 128)    0
conv3_block3_1_bn[0][0]
-----

conv3_block3_2_conv (Conv2D)      (None, 8, 8, 32)     36864
conv3_block3_1_relu[0][0]
-----

conv3_block3_concat (Concatenat (None, 8, 8, 224)    0
conv3_block2_concat[0][0]
conv3_block3_2_conv[0][0]
-----

conv3_block4_0_bn (BatchNormali (None, 8, 8, 224)    896
conv3_block3_concat[0][0]
-----

conv3_block4_0_relu (Activation (None, 8, 8, 224)    0
conv3_block4_0_bn[0][0]
-----

conv3_block4_1_conv (Conv2D)      (None, 8, 8, 128)    28672
conv3_block4_0_relu[0][0]
-----

conv3_block4_1_bn (BatchNormali (None, 8, 8, 128)    512
conv3_block4_1_conv[0][0]
-----

conv3_block4_1_relu (Activation (None, 8, 8, 128)    0
conv3_block4_1_bn[0][0]

```

```

-----
conv3_block4_2_conv (Conv2D)      (None, 8, 8, 32)      36864
conv3_block4_1_relu[0][0]
-----
conv3_block4_concat (Concatenat (None, 8, 8, 256)      0
conv3_block3_concat[0][0]
conv3_block4_2_conv[0][0]
-----
conv3_block5_0_bn (BatchNormali (None, 8, 8, 256)      1024
conv3_block4_concat[0][0]
-----
conv3_block5_0_relu (Activation (None, 8, 8, 256)      0
conv3_block5_0_bn[0][0]
-----
conv3_block5_1_conv (Conv2D)      (None, 8, 8, 128)     32768
conv3_block5_0_relu[0][0]
-----
conv3_block5_1_bn (BatchNormali (None, 8, 8, 128)      512
conv3_block5_1_conv[0][0]
-----
conv3_block5_1_relu (Activation (None, 8, 8, 128)      0
conv3_block5_1_bn[0][0]
-----
conv3_block5_2_conv (Conv2D)      (None, 8, 8, 32)      36864
conv3_block5_1_relu[0][0]
-----
conv3_block5_concat (Concatenat (None, 8, 8, 288)      0
conv3_block4_concat[0][0]
conv3_block5_2_conv[0][0]
-----
conv3_block6_0_bn (BatchNormali (None, 8, 8, 288)     1152
conv3_block5_concat[0][0]
-----
conv3_block6_0_relu (Activation (None, 8, 8, 288)      0
conv3_block6_0_bn[0][0]
-----

```

| | | |
|---------------------------------|-------------------|-------|
| conv3_block6_1_conv (Conv2D) | (None, 8, 8, 128) | 36864 |
| conv3_block6_0_relu[0][0] | | |
| ----- | | |
| conv3_block6_1_bn (BatchNormali | (None, 8, 8, 128) | 512 |
| conv3_block6_1_conv[0][0] | | |
| ----- | | |
| conv3_block6_1_relu (Activation | (None, 8, 8, 128) | 0 |
| conv3_block6_1_bn[0][0] | | |
| ----- | | |
| conv3_block6_2_conv (Conv2D) | (None, 8, 8, 32) | 36864 |
| conv3_block6_1_relu[0][0] | | |
| ----- | | |
| conv3_block6_concat (Concatenat | (None, 8, 8, 320) | 0 |
| conv3_block5_concat[0][0] | | |
| conv3_block6_2_conv[0][0] | | |
| ----- | | |
| conv3_block7_0_bn (BatchNormali | (None, 8, 8, 320) | 1280 |
| conv3_block6_concat[0][0] | | |
| ----- | | |
| conv3_block7_0_relu (Activation | (None, 8, 8, 320) | 0 |
| conv3_block7_0_bn[0][0] | | |
| ----- | | |
| conv3_block7_1_conv (Conv2D) | (None, 8, 8, 128) | 40960 |
| conv3_block7_0_relu[0][0] | | |
| ----- | | |
| conv3_block7_1_bn (BatchNormali | (None, 8, 8, 128) | 512 |
| conv3_block7_1_conv[0][0] | | |
| ----- | | |
| conv3_block7_1_relu (Activation | (None, 8, 8, 128) | 0 |
| conv3_block7_1_bn[0][0] | | |
| ----- | | |
| conv3_block7_2_conv (Conv2D) | (None, 8, 8, 32) | 36864 |
| conv3_block7_1_relu[0][0] | | |
| ----- | | |
| conv3_block7_concat (Concatenat | (None, 8, 8, 352) | 0 |
| conv3_block6_concat[0][0] | | |
| conv3_block7_2_conv[0][0] | | |

```

-----
-----
conv3_block8_0_bn (BatchNormali (None, 8, 8, 352)    1408
conv3_block7_concat[0][0]
-----
-----
conv3_block8_0_relu (Activation (None, 8, 8, 352)    0
conv3_block8_0_bn[0][0]
-----
-----
conv3_block8_1_conv (Conv2D)      (None, 8, 8, 128)    45056
conv3_block8_0_relu[0][0]
-----
-----
conv3_block8_1_bn (BatchNormali (None, 8, 8, 128)    512
conv3_block8_1_conv[0][0]
-----
-----
conv3_block8_1_relu (Activation (None, 8, 8, 128)    0
conv3_block8_1_bn[0][0]
-----
-----
conv3_block8_2_conv (Conv2D)      (None, 8, 8, 32)    36864
conv3_block8_1_relu[0][0]
-----
-----
conv3_block8_concat (Concatenat (None, 8, 8, 384)    0
conv3_block7_concat[0][0]
conv3_block8_2_conv[0][0]
-----
-----
conv3_block9_0_bn (BatchNormali (None, 8, 8, 384)    1536
conv3_block8_concat[0][0]
-----
-----
conv3_block9_0_relu (Activation (None, 8, 8, 384)    0
conv3_block9_0_bn[0][0]
-----
-----
conv3_block9_1_conv (Conv2D)      (None, 8, 8, 128)    49152
conv3_block9_0_relu[0][0]
-----
-----
conv3_block9_1_bn (BatchNormali (None, 8, 8, 128)    512
conv3_block9_1_conv[0][0]
-----
-----
conv3_block9_1_relu (Activation (None, 8, 8, 128)    0

```

conv3_block9_1_bn[0][0]

conv3_block9_2_conv (Conv2D) (None, 8, 8, 32) 36864
conv3_block9_1_relu[0][0]

conv3_block9_concat (Concatenat (None, 8, 8, 416) 0
conv3_block8_concat[0][0]
conv3_block9_2_conv[0][0]

conv3_block10_0_bn (BatchNormal (None, 8, 8, 416) 1664
conv3_block9_concat[0][0]

conv3_block10_0_relu (Activatio (None, 8, 8, 416) 0
conv3_block10_0_bn[0][0]

conv3_block10_1_conv (Conv2D) (None, 8, 8, 128) 53248
conv3_block10_0_relu[0][0]

conv3_block10_1_bn (BatchNormal (None, 8, 8, 128) 512
conv3_block10_1_conv[0][0]

conv3_block10_1_relu (Activatio (None, 8, 8, 128) 0
conv3_block10_1_bn[0][0]

conv3_block10_2_conv (Conv2D) (None, 8, 8, 32) 36864
conv3_block10_1_relu[0][0]

conv3_block10_concat (Concatena (None, 8, 8, 448) 0
conv3_block9_concat[0][0]
conv3_block10_2_conv[0][0]

conv3_block11_0_bn (BatchNormal (None, 8, 8, 448) 1792
conv3_block10_concat[0][0]

conv3_block11_0_relu (Activatio (None, 8, 8, 448) 0
conv3_block11_0_bn[0][0]

```

-----
conv3_block11_1_conv (Conv2D)    (None, 8, 8, 128)    57344
conv3_block11_0_relu[0][0]
-----

-----
conv3_block11_1_bn (BatchNormal (None, 8, 8, 128)    512
conv3_block11_1_conv[0][0]
-----

-----
conv3_block11_1_relu (Activatio (None, 8, 8, 128)    0
conv3_block11_1_bn[0][0]
-----

-----
conv3_block11_2_conv (Conv2D)    (None, 8, 8, 32)     36864
conv3_block11_1_relu[0][0]
-----

-----
conv3_block11_concat (Concatena (None, 8, 8, 480)    0
conv3_block10_concat[0][0]
conv3_block11_2_conv[0][0]
-----

-----
conv3_block12_0_bn (BatchNormal (None, 8, 8, 480)    1920
conv3_block11_concat[0][0]
-----

-----
conv3_block12_0_relu (Activatio (None, 8, 8, 480)    0
conv3_block12_0_bn[0][0]
-----

-----
conv3_block12_1_conv (Conv2D)    (None, 8, 8, 128)    61440
conv3_block12_0_relu[0][0]
-----

-----
conv3_block12_1_bn (BatchNormal (None, 8, 8, 128)    512
conv3_block12_1_conv[0][0]
-----

-----
conv3_block12_1_relu (Activatio (None, 8, 8, 128)    0
conv3_block12_1_bn[0][0]
-----

-----
conv3_block12_2_conv (Conv2D)    (None, 8, 8, 32)     36864
conv3_block12_1_relu[0][0]
-----

-----
conv3_block12_concat (Concatena (None, 8, 8, 512)    0
conv3_block11_concat[0][0]

```



```

conv3_block12_2_conv[0][0]
-----
-----
pool3_bn (BatchNormalization) (None, 8, 8, 512) 2048
conv3_block12_concat[0][0]
-----
-----
pool3_relu (Activation) (None, 8, 8, 512) 0 pool3_bn[0][0]
-----
-----
pool3_conv (Conv2D) (None, 8, 8, 256) 131072
pool3_relu[0][0]
-----
-----
pool3_pool (AveragePooling2D) (None, 4, 4, 256) 0
pool3_conv[0][0]
-----
-----
conv4_block1_0_bn (BatchNormali (None, 4, 4, 256) 1024
pool3_pool[0][0]
-----
-----
conv4_block1_0_relu (Activation (None, 4, 4, 256) 0
conv4_block1_0_bn[0][0]
-----
-----
conv4_block1_1_conv (Conv2D) (None, 4, 4, 128) 32768
conv4_block1_0_relu[0][0]
-----
-----
conv4_block1_1_bn (BatchNormali (None, 4, 4, 128) 512
conv4_block1_1_conv[0][0]
-----
-----
conv4_block1_1_relu (Activation (None, 4, 4, 128) 0
conv4_block1_1_bn[0][0]
-----
-----
conv4_block1_2_conv (Conv2D) (None, 4, 4, 32) 36864
conv4_block1_1_relu[0][0]
-----
-----
conv4_block1_concat (Concatenat (None, 4, 4, 288) 0
pool3_pool[0][0]
conv4_block1_2_conv[0][0]
-----
-----
conv4_block2_0_bn (BatchNormali (None, 4, 4, 288) 1152

```

```

conv4_block1_concat[0][0]
-----
-----
conv4_block2_0_relu (Activation (None, 4, 4, 288)    0
conv4_block2_0_bn[0][0]
-----
-----
conv4_block2_1_conv (Conv2D)      (None, 4, 4, 128)    36864
conv4_block2_0_relu[0][0]
-----
-----
conv4_block2_1_bn (BatchNormali (None, 4, 4, 128)    512
conv4_block2_1_conv[0][0]
-----
-----
conv4_block2_1_relu (Activation (None, 4, 4, 128)    0
conv4_block2_1_bn[0][0]
-----
-----
conv4_block2_2_conv (Conv2D)      (None, 4, 4, 32)     36864
conv4_block2_1_relu[0][0]
-----
-----
conv4_block2_concat (Concatenat (None, 4, 4, 320)    0
conv4_block1_concat[0][0]
conv4_block2_2_conv[0][0]
-----
-----
conv4_block3_0_bn (BatchNormali (None, 4, 4, 320)    1280
conv4_block2_concat[0][0]
-----
-----
conv4_block3_0_relu (Activation (None, 4, 4, 320)    0
conv4_block3_0_bn[0][0]
-----
-----
conv4_block3_1_conv (Conv2D)      (None, 4, 4, 128)    40960
conv4_block3_0_relu[0][0]
-----
-----
conv4_block3_1_bn (BatchNormali (None, 4, 4, 128)    512
conv4_block3_1_conv[0][0]
-----
-----
conv4_block3_1_relu (Activation (None, 4, 4, 128)    0
conv4_block3_1_bn[0][0]
-----
-----

```

| | | |
|---------------------------------|-------------------|-------|
| conv4_block3_2_conv (Conv2D) | (None, 4, 4, 32) | 36864 |
| conv4_block3_1_relu[0][0] | | |
| ----- | | |
| conv4_block3_concat (Concatenat | (None, 4, 4, 352) | 0 |
| conv4_block2_concat[0][0] | | |
| conv4_block3_2_conv[0][0] | | |
| ----- | | |
| conv4_block4_0_bn (BatchNormali | (None, 4, 4, 352) | 1408 |
| conv4_block3_concat[0][0] | | |
| ----- | | |
| conv4_block4_0_relu (Activation | (None, 4, 4, 352) | 0 |
| conv4_block4_0_bn[0][0] | | |
| ----- | | |
| conv4_block4_1_conv (Conv2D) | (None, 4, 4, 128) | 45056 |
| conv4_block4_0_relu[0][0] | | |
| ----- | | |
| conv4_block4_1_bn (BatchNormali | (None, 4, 4, 128) | 512 |
| conv4_block4_1_conv[0][0] | | |
| ----- | | |
| conv4_block4_1_relu (Activation | (None, 4, 4, 128) | 0 |
| conv4_block4_1_bn[0][0] | | |
| ----- | | |
| conv4_block4_2_conv (Conv2D) | (None, 4, 4, 32) | 36864 |
| conv4_block4_1_relu[0][0] | | |
| ----- | | |
| conv4_block4_concat (Concatenat | (None, 4, 4, 384) | 0 |
| conv4_block3_concat[0][0] | | |
| conv4_block4_2_conv[0][0] | | |
| ----- | | |
| conv4_block5_0_bn (BatchNormali | (None, 4, 4, 384) | 1536 |
| conv4_block4_concat[0][0] | | |
| ----- | | |
| conv4_block5_0_relu (Activation | (None, 4, 4, 384) | 0 |
| conv4_block5_0_bn[0][0] | | |
| ----- | | |
| conv4_block5_1_conv (Conv2D) | (None, 4, 4, 128) | 49152 |
| conv4_block5_0_relu[0][0] | | |

```

-----
conv4_block5_1_bn (BatchNormali (None, 4, 4, 128)    512
conv4_block5_1_conv[0][0]
-----
conv4_block5_1_relu (Activation (None, 4, 4, 128)    0
conv4_block5_1_bn[0][0]
-----
conv4_block5_2_conv (Conv2D)      (None, 4, 4, 32)    36864
conv4_block5_1_relu[0][0]
-----
conv4_block5_concat (Concatenat (None, 4, 4, 416)    0
conv4_block4_concat[0][0]
conv4_block5_2_conv[0][0]
-----
conv4_block6_0_bn (BatchNormali (None, 4, 4, 416)    1664
conv4_block5_concat[0][0]
-----
conv4_block6_0_relu (Activation (None, 4, 4, 416)    0
conv4_block6_0_bn[0][0]
-----
conv4_block6_1_conv (Conv2D)      (None, 4, 4, 128)    53248
conv4_block6_0_relu[0][0]
-----
conv4_block6_1_bn (BatchNormali (None, 4, 4, 128)    512
conv4_block6_1_conv[0][0]
-----
conv4_block6_1_relu (Activation (None, 4, 4, 128)    0
conv4_block6_1_bn[0][0]
-----
conv4_block6_2_conv (Conv2D)      (None, 4, 4, 32)    36864
conv4_block6_1_relu[0][0]
-----
conv4_block6_concat (Concatenat (None, 4, 4, 448)    0
conv4_block5_concat[0][0]
conv4_block6_2_conv[0][0]
-----

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conv4_block7_0_bn (BatchNormali (None, 4, 4, 448)    1792
conv4_block6_concat[0][0]
-----

conv4_block7_0_relu (Activation (None, 4, 4, 448)    0
conv4_block7_0_bn[0][0]
-----

conv4_block7_1_conv (Conv2D)      (None, 4, 4, 128)    57344
conv4_block7_0_relu[0][0]
-----

conv4_block7_1_bn (BatchNormali (None, 4, 4, 128)    512
conv4_block7_1_conv[0][0]
-----

conv4_block7_1_relu (Activation (None, 4, 4, 128)    0
conv4_block7_1_bn[0][0]
-----

conv4_block7_2_conv (Conv2D)      (None, 4, 4, 32)     36864
conv4_block7_1_relu[0][0]
-----

conv4_block7_concat (Concatenat (None, 4, 4, 480)    0
conv4_block6_concat[0][0]
conv4_block7_2_conv[0][0]
-----

conv4_block8_0_bn (BatchNormali (None, 4, 4, 480)    1920
conv4_block7_concat[0][0]
-----

conv4_block8_0_relu (Activation (None, 4, 4, 480)    0
conv4_block8_0_bn[0][0]
-----

conv4_block8_1_conv (Conv2D)      (None, 4, 4, 128)    61440
conv4_block8_0_relu[0][0]
-----

conv4_block8_1_bn (BatchNormali (None, 4, 4, 128)    512
conv4_block8_1_conv[0][0]
-----

conv4_block8_1_relu (Activation (None, 4, 4, 128)    0
conv4_block8_1_bn[0][0]
-----

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```

-----
conv4_block8_2_conv (Conv2D)      (None, 4, 4, 32)      36864
conv4_block8_1_relu[0][0]
-----

-----
conv4_block8_concat (Concatenat (None, 4, 4, 512)      0
conv4_block7_concat[0][0]
conv4_block8_2_conv[0][0]
-----

-----
conv4_block9_0_bn (BatchNormali (None, 4, 4, 512)      2048
conv4_block8_concat[0][0]
-----

-----
conv4_block9_0_relu (Activation (None, 4, 4, 512)      0
conv4_block9_0_bn[0][0]
-----

-----
conv4_block9_1_conv (Conv2D)      (None, 4, 4, 128)     65536
conv4_block9_0_relu[0][0]
-----

-----
conv4_block9_1_bn (BatchNormali (None, 4, 4, 128)      512
conv4_block9_1_conv[0][0]
-----

-----
conv4_block9_1_relu (Activation (None, 4, 4, 128)      0
conv4_block9_1_bn[0][0]
-----

-----
conv4_block9_2_conv (Conv2D)      (None, 4, 4, 32)      36864
conv4_block9_1_relu[0][0]
-----

-----
conv4_block9_concat (Concatenat (None, 4, 4, 544)      0
conv4_block8_concat[0][0]
conv4_block9_2_conv[0][0]
-----

-----
conv4_block10_0_bn (BatchNormal (None, 4, 4, 544)      2176
conv4_block9_concat[0][0]
-----

-----
conv4_block10_0_relu (Activatio (None, 4, 4, 544)      0
conv4_block10_0_bn[0][0]
-----

-----
conv4_block10_1_conv (Conv2D)      (None, 4, 4, 128)     69632

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conv4_block10_0_relu[0][0]
-----
-----
conv4_block10_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block10_1_conv[0][0]
-----
-----
conv4_block10_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block10_1_bn[0][0]
-----
-----
conv4_block10_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block10_1_relu[0][0]
-----
-----
conv4_block10_concat (Concatena (None, 4, 4, 576)    0
conv4_block9_concat[0][0]
conv4_block10_2_conv[0][0]
-----
-----
conv4_block11_0_bn (BatchNormal (None, 4, 4, 576)    2304
conv4_block10_concat[0][0]
-----
-----
conv4_block11_0_relu (Activatio (None, 4, 4, 576)    0
conv4_block11_0_bn[0][0]
-----
-----
conv4_block11_1_conv (Conv2D)    (None, 4, 4, 128)    73728
conv4_block11_0_relu[0][0]
-----
-----
conv4_block11_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block11_1_conv[0][0]
-----
-----
conv4_block11_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block11_1_bn[0][0]
-----
-----
conv4_block11_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block11_1_relu[0][0]
-----
-----
conv4_block11_concat (Concatena (None, 4, 4, 608)    0
conv4_block10_concat[0][0]
conv4_block11_2_conv[0][0]
-----
-----

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-----
conv4_block12_0_bn (BatchNormal (None, 4, 4, 608)    2432
conv4_block11_concat[0][0]
-----

-----
conv4_block12_0_relu (Activatio (None, 4, 4, 608)    0
conv4_block12_0_bn[0][0]
-----

-----
conv4_block12_1_conv (Conv2D)    (None, 4, 4, 128)    77824
conv4_block12_0_relu[0][0]
-----

-----
conv4_block12_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block12_1_conv[0][0]
-----

-----
conv4_block12_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block12_1_bn[0][0]
-----

-----
conv4_block12_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block12_1_relu[0][0]
-----

-----
conv4_block12_concat (Concatena (None, 4, 4, 640)    0
conv4_block11_concat[0][0]
conv4_block12_2_conv[0][0]
-----

-----
conv4_block13_0_bn (BatchNormal (None, 4, 4, 640)    2560
conv4_block12_concat[0][0]
-----

-----
conv4_block13_0_relu (Activatio (None, 4, 4, 640)    0
conv4_block13_0_bn[0][0]
-----

-----
conv4_block13_1_conv (Conv2D)    (None, 4, 4, 128)    81920
conv4_block13_0_relu[0][0]
-----

-----
conv4_block13_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block13_1_conv[0][0]
-----

-----
conv4_block13_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block13_1_bn[0][0]

```



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-----
-----
conv4_block13_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block13_1_relu[0][0]
-----
-----
conv4_block13_concat (Concatena (None, 4, 4, 672)    0
conv4_block12_concat[0][0]
conv4_block13_2_conv[0][0]
-----
-----
conv4_block14_0_bn (BatchNormal (None, 4, 4, 672)    2688
conv4_block13_concat[0][0]
-----
-----
conv4_block14_0_relu (Activatio (None, 4, 4, 672)    0
conv4_block14_0_bn[0][0]
-----
-----
conv4_block14_1_conv (Conv2D)    (None, 4, 4, 128)    86016
conv4_block14_0_relu[0][0]
-----
-----
conv4_block14_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block14_1_conv[0][0]
-----
-----
conv4_block14_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block14_1_bn[0][0]
-----
-----
conv4_block14_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block14_1_relu[0][0]
-----
-----
conv4_block14_concat (Concatena (None, 4, 4, 704)    0
conv4_block13_concat[0][0]
conv4_block14_2_conv[0][0]
-----
-----
conv4_block15_0_bn (BatchNormal (None, 4, 4, 704)    2816
conv4_block14_concat[0][0]
-----
-----
conv4_block15_0_relu (Activatio (None, 4, 4, 704)    0
conv4_block15_0_bn[0][0]
-----
-----

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conv4_block15_1_conv (Conv2D)    (None, 4, 4, 128)    90112
conv4_block15_0_relu[0][0]

-----

conv4_block15_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block15_1_conv[0][0]

-----

conv4_block15_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block15_1_bn[0][0]

-----

conv4_block15_2_conv (Conv2D)    (None, 4, 4, 32)     36864
conv4_block15_1_relu[0][0]

-----

conv4_block15_concat (Concatena (None, 4, 4, 736)    0
conv4_block14_concat[0][0]
conv4_block15_2_conv[0][0]

-----

conv4_block16_0_bn (BatchNormal (None, 4, 4, 736)    2944
conv4_block15_concat[0][0]

-----

conv4_block16_0_relu (Activatio (None, 4, 4, 736)    0
conv4_block16_0_bn[0][0]

-----

conv4_block16_1_conv (Conv2D)    (None, 4, 4, 128)    94208
conv4_block16_0_relu[0][0]

-----

conv4_block16_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block16_1_conv[0][0]

-----

conv4_block16_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block16_1_bn[0][0]

-----

conv4_block16_2_conv (Conv2D)    (None, 4, 4, 32)     36864
conv4_block16_1_relu[0][0]

-----

conv4_block16_concat (Concatena (None, 4, 4, 768)    0
conv4_block15_concat[0][0]
conv4_block16_2_conv[0][0]

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```

-----
conv4_block17_0_bn (BatchNormal (None, 4, 4, 768)    3072
conv4_block16_concat[0][0]
-----
conv4_block17_0_relu (Activatio (None, 4, 4, 768)    0
conv4_block17_0_bn[0][0]
-----
conv4_block17_1_conv (Conv2D)    (None, 4, 4, 128)    98304
conv4_block17_0_relu[0][0]
-----
conv4_block17_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block17_1_conv[0][0]
-----
conv4_block17_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block17_1_bn[0][0]
-----
conv4_block17_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block17_1_relu[0][0]
-----
conv4_block17_concat (Concatena (None, 4, 4, 800)    0
conv4_block16_concat[0][0]
conv4_block17_2_conv[0][0]
-----
conv4_block18_0_bn (BatchNormal (None, 4, 4, 800)    3200
conv4_block17_concat[0][0]
-----
conv4_block18_0_relu (Activatio (None, 4, 4, 800)    0
conv4_block18_0_bn[0][0]
-----
conv4_block18_1_conv (Conv2D)    (None, 4, 4, 128)    102400
conv4_block18_0_relu[0][0]
-----
conv4_block18_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block18_1_conv[0][0]
-----
conv4_block18_1_relu (Activatio (None, 4, 4, 128)    0

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conv4_block18_1_bn[0][0]
-----
-----
conv4_block18_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block18_1_relu[0][0]
-----
-----
conv4_block18_concat (Concatena (None, 4, 4, 832)    0
conv4_block17_concat[0][0]
conv4_block18_2_conv[0][0]
-----
-----
conv4_block19_0_bn (BatchNormal (None, 4, 4, 832)    3328
conv4_block18_concat[0][0]
-----
-----
conv4_block19_0_relu (Activatio (None, 4, 4, 832)    0
conv4_block19_0_bn[0][0]
-----
-----
conv4_block19_1_conv (Conv2D)    (None, 4, 4, 128)    106496
conv4_block19_0_relu[0][0]
-----
-----
conv4_block19_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block19_1_conv[0][0]
-----
-----
conv4_block19_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block19_1_bn[0][0]
-----
-----
conv4_block19_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block19_1_relu[0][0]
-----
-----
conv4_block19_concat (Concatena (None, 4, 4, 864)    0
conv4_block18_concat[0][0]
conv4_block19_2_conv[0][0]
-----
-----
conv4_block20_0_bn (BatchNormal (None, 4, 4, 864)    3456
conv4_block19_concat[0][0]
-----
-----
conv4_block20_0_relu (Activatio (None, 4, 4, 864)    0
conv4_block20_0_bn[0][0]
-----

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-----
conv4_block20_1_conv (Conv2D)    (None, 4, 4, 128)    110592
conv4_block20_0_relu[0][0]
-----

-----
conv4_block20_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block20_1_conv[0][0]
-----

-----
conv4_block20_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block20_1_bn[0][0]
-----

-----
conv4_block20_2_conv (Conv2D)    (None, 4, 4, 32)     36864
conv4_block20_1_relu[0][0]
-----

-----
conv4_block20_concat (Concatena (None, 4, 4, 896)    0
conv4_block19_concat[0][0]
conv4_block20_2_conv[0][0]
-----

-----
conv4_block21_0_bn (BatchNormal (None, 4, 4, 896)    3584
conv4_block20_concat[0][0]
-----

-----
conv4_block21_0_relu (Activatio (None, 4, 4, 896)    0
conv4_block21_0_bn[0][0]
-----

-----
conv4_block21_1_conv (Conv2D)    (None, 4, 4, 128)    114688
conv4_block21_0_relu[0][0]
-----

-----
conv4_block21_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block21_1_conv[0][0]
-----

-----
conv4_block21_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block21_1_bn[0][0]
-----

-----
conv4_block21_2_conv (Conv2D)    (None, 4, 4, 32)     36864
conv4_block21_1_relu[0][0]
-----

-----
conv4_block21_concat (Concatena (None, 4, 4, 928)    0
conv4_block20_concat[0][0]

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conv4_block21_2_conv[0][0]
-----

conv4_block22_0_bn (BatchNormal (None, 4, 4, 928)    3712
conv4_block21_concat[0][0]
-----

conv4_block22_0_relu (Activatio (None, 4, 4, 928)    0
conv4_block22_0_bn[0][0]
-----

conv4_block22_1_conv (Conv2D)    (None, 4, 4, 128)    118784
conv4_block22_0_relu[0][0]
-----

conv4_block22_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block22_1_conv[0][0]
-----

conv4_block22_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block22_1_bn[0][0]
-----

conv4_block22_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block22_1_relu[0][0]
-----

conv4_block22_concat (Concatena (None, 4, 4, 960)    0
conv4_block21_concat[0][0]
conv4_block22_2_conv[0][0]
-----

conv4_block23_0_bn (BatchNormal (None, 4, 4, 960)    3840
conv4_block22_concat[0][0]
-----

conv4_block23_0_relu (Activatio (None, 4, 4, 960)    0
conv4_block23_0_bn[0][0]
-----

conv4_block23_1_conv (Conv2D)    (None, 4, 4, 128)    122880
conv4_block23_0_relu[0][0]
-----

conv4_block23_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block23_1_conv[0][0]
-----

```

```

conv4_block23_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block23_1_bn[0][0]
-----

conv4_block23_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block23_1_relu[0][0]
-----

conv4_block23_concat (Concatena (None, 4, 4, 992)    0
conv4_block22_concat[0][0]
conv4_block23_2_conv[0][0]
-----

conv4_block24_0_bn (BatchNormal (None, 4, 4, 992)    3968
conv4_block23_concat[0][0]
-----

conv4_block24_0_relu (Activatio (None, 4, 4, 992)    0
conv4_block24_0_bn[0][0]
-----

conv4_block24_1_conv (Conv2D)    (None, 4, 4, 128)    126976
conv4_block24_0_relu[0][0]
-----

conv4_block24_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block24_1_conv[0][0]
-----

conv4_block24_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block24_1_bn[0][0]
-----

conv4_block24_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block24_1_relu[0][0]
-----

conv4_block24_concat (Concatena (None, 4, 4, 1024)    0
conv4_block23_concat[0][0]
conv4_block24_2_conv[0][0]
-----

conv4_block25_0_bn (BatchNormal (None, 4, 4, 1024)    4096
conv4_block24_concat[0][0]
-----

conv4_block25_0_relu (Activatio (None, 4, 4, 1024)    0
conv4_block25_0_bn[0][0]

```

```

-----
conv4_block25_1_conv (Conv2D) (None, 4, 4, 128) 131072
conv4_block25_0_relu[0][0]
-----
conv4_block25_1_bn (BatchNormal (None, 4, 4, 128) 512
conv4_block25_1_conv[0][0]
-----
conv4_block25_1_relu (Activatio (None, 4, 4, 128) 0
conv4_block25_1_bn[0][0]
-----
conv4_block25_2_conv (Conv2D) (None, 4, 4, 32) 36864
conv4_block25_1_relu[0][0]
-----
conv4_block25_concat (Concatena (None, 4, 4, 1056) 0
conv4_block24_concat[0][0]
conv4_block25_2_conv[0][0]
-----
conv4_block26_0_bn (BatchNormal (None, 4, 4, 1056) 4224
conv4_block25_concat[0][0]
-----
conv4_block26_0_relu (Activatio (None, 4, 4, 1056) 0
conv4_block26_0_bn[0][0]
-----
conv4_block26_1_conv (Conv2D) (None, 4, 4, 128) 135168
conv4_block26_0_relu[0][0]
-----
conv4_block26_1_bn (BatchNormal (None, 4, 4, 128) 512
conv4_block26_1_conv[0][0]
-----
conv4_block26_1_relu (Activatio (None, 4, 4, 128) 0
conv4_block26_1_bn[0][0]
-----
conv4_block26_2_conv (Conv2D) (None, 4, 4, 32) 36864
conv4_block26_1_relu[0][0]
-----
conv4_block26_concat (Concatena (None, 4, 4, 1088) 0

```



```

conv4_block25_concat[0][0]
conv4_block26_2_conv[0][0]
-----
conv4_block27_0_bn (BatchNormal (None, 4, 4, 1088) 4352
conv4_block26_concat[0][0]
-----
conv4_block27_0_relu (Activatio (None, 4, 4, 1088) 0
conv4_block27_0_bn[0][0]
-----
conv4_block27_1_conv (Conv2D) (None, 4, 4, 128) 139264
conv4_block27_0_relu[0][0]
-----
conv4_block27_1_bn (BatchNormal (None, 4, 4, 128) 512
conv4_block27_1_conv[0][0]
-----
conv4_block27_1_relu (Activatio (None, 4, 4, 128) 0
conv4_block27_1_bn[0][0]
-----
conv4_block27_2_conv (Conv2D) (None, 4, 4, 32) 36864
conv4_block27_1_relu[0][0]
-----
conv4_block27_concat (Concatena (None, 4, 4, 1120) 0
conv4_block26_concat[0][0]
conv4_block27_2_conv[0][0]
-----
conv4_block28_0_bn (BatchNormal (None, 4, 4, 1120) 4480
conv4_block27_concat[0][0]
-----
conv4_block28_0_relu (Activatio (None, 4, 4, 1120) 0
conv4_block28_0_bn[0][0]
-----
conv4_block28_1_conv (Conv2D) (None, 4, 4, 128) 143360
conv4_block28_0_relu[0][0]
-----
conv4_block28_1_bn (BatchNormal (None, 4, 4, 128) 512
conv4_block28_1_conv[0][0]
-----

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```

-----
conv4_block28_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block28_1_bn[0][0]

-----

conv4_block28_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block28_1_relu[0][0]

-----

conv4_block28_concat (Concatena (None, 4, 4, 1152)    0
conv4_block27_concat[0][0]
conv4_block28_2_conv[0][0]

-----

conv4_block29_0_bn (BatchNormal (None, 4, 4, 1152)    4608
conv4_block28_concat[0][0]

-----

conv4_block29_0_relu (Activatio (None, 4, 4, 1152)    0
conv4_block29_0_bn[0][0]

-----

conv4_block29_1_conv (Conv2D)    (None, 4, 4, 128)    147456
conv4_block29_0_relu[0][0]

-----

conv4_block29_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block29_1_conv[0][0]

-----

conv4_block29_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block29_1_bn[0][0]

-----

conv4_block29_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block29_1_relu[0][0]

-----

conv4_block29_concat (Concatena (None, 4, 4, 1184)    0
conv4_block28_concat[0][0]
conv4_block29_2_conv[0][0]

-----

conv4_block30_0_bn (BatchNormal (None, 4, 4, 1184)    4736
conv4_block29_concat[0][0]

-----

conv4_block30_0_relu (Activatio (None, 4, 4, 1184)    0

```

conv4_block30_0_bn[0][0]

conv4_block30_1_conv (Conv2D) (None, 4, 4, 128) 151552
conv4_block30_0_relu[0][0]

conv4_block30_1_bn (BatchNormal (None, 4, 4, 128) 512
conv4_block30_1_conv[0][0]

conv4_block30_1_relu (Activatio (None, 4, 4, 128) 0
conv4_block30_1_bn[0][0]

conv4_block30_2_conv (Conv2D) (None, 4, 4, 32) 36864
conv4_block30_1_relu[0][0]

conv4_block30_concat (Concatena (None, 4, 4, 1216) 0
conv4_block29_concat[0][0]
conv4_block30_2_conv[0][0]

conv4_block31_0_bn (BatchNormal (None, 4, 4, 1216) 4864
conv4_block30_concat[0][0]

conv4_block31_0_relu (Activatio (None, 4, 4, 1216) 0
conv4_block31_0_bn[0][0]

conv4_block31_1_conv (Conv2D) (None, 4, 4, 128) 155648
conv4_block31_0_relu[0][0]

conv4_block31_1_bn (BatchNormal (None, 4, 4, 128) 512
conv4_block31_1_conv[0][0]

conv4_block31_1_relu (Activatio (None, 4, 4, 128) 0
conv4_block31_1_bn[0][0]

conv4_block31_2_conv (Conv2D) (None, 4, 4, 32) 36864
conv4_block31_1_relu[0][0]

```

conv4_block31_concat (Concatena (None, 4, 4, 1248)    0
conv4_block30_concat[0][0]
conv4_block31_2_conv[0][0]
-----

conv4_block32_0_bn (BatchNormal (None, 4, 4, 1248)    4992
conv4_block31_concat[0][0]
-----

conv4_block32_0_relu (Activatio (None, 4, 4, 1248)    0
conv4_block32_0_bn[0][0]
-----

conv4_block32_1_conv (Conv2D)    (None, 4, 4, 128)    159744
conv4_block32_0_relu[0][0]
-----

conv4_block32_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block32_1_conv[0][0]
-----

conv4_block32_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block32_1_bn[0][0]
-----

conv4_block32_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block32_1_relu[0][0]
-----

conv4_block32_concat (Concatena (None, 4, 4, 1280)    0
conv4_block31_concat[0][0]
conv4_block32_2_conv[0][0]
-----

conv4_block33_0_bn (BatchNormal (None, 4, 4, 1280)    5120
conv4_block32_concat[0][0]
-----

conv4_block33_0_relu (Activatio (None, 4, 4, 1280)    0
conv4_block33_0_bn[0][0]
-----

conv4_block33_1_conv (Conv2D)    (None, 4, 4, 128)    163840
conv4_block33_0_relu[0][0]
-----

conv4_block33_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block33_1_conv[0][0]

```

```

-----
conv4_block33_1_relu (Activation (None, 4, 4, 128)) 0
conv4_block33_1_bn[0][0]
-----
conv4_block33_2_conv (Conv2D) (None, 4, 4, 32) 36864
conv4_block33_1_relu[0][0]
-----
conv4_block33_concat (Concatenation (None, 4, 4, 1312)) 0
conv4_block32_concat[0][0]
conv4_block33_2_conv[0][0]
-----
conv4_block34_0_bn (BatchNormal (None, 4, 4, 1312)) 5248
conv4_block33_concat[0][0]
-----
conv4_block34_0_relu (Activation (None, 4, 4, 1312)) 0
conv4_block34_0_bn[0][0]
-----
conv4_block34_1_conv (Conv2D) (None, 4, 4, 128) 167936
conv4_block34_0_relu[0][0]
-----
conv4_block34_1_bn (BatchNormal (None, 4, 4, 128)) 512
conv4_block34_1_conv[0][0]
-----
conv4_block34_1_relu (Activation (None, 4, 4, 128)) 0
conv4_block34_1_bn[0][0]
-----
conv4_block34_2_conv (Conv2D) (None, 4, 4, 32) 36864
conv4_block34_1_relu[0][0]
-----
conv4_block34_concat (Concatenation (None, 4, 4, 1344)) 0
conv4_block33_concat[0][0]
conv4_block34_2_conv[0][0]
-----
conv4_block35_0_bn (BatchNormal (None, 4, 4, 1344)) 5376
conv4_block34_concat[0][0]
-----

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conv4_block35_0_relu (Activatio (None, 4, 4, 1344)    0
conv4_block35_0_bn[0][0]
-----

conv4_block35_1_conv (Conv2D)    (None, 4, 4, 128)    172032
conv4_block35_0_relu[0][0]
-----

conv4_block35_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block35_1_conv[0][0]
-----

conv4_block35_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block35_1_bn[0][0]
-----

conv4_block35_2_conv (Conv2D)    (None, 4, 4, 32)     36864
conv4_block35_1_relu[0][0]
-----

conv4_block35_concat (Concatena (None, 4, 4, 1376)    0
conv4_block34_concat[0][0]
conv4_block35_2_conv[0][0]
-----

conv4_block36_0_bn (BatchNormal (None, 4, 4, 1376)    5504
conv4_block35_concat[0][0]
-----

conv4_block36_0_relu (Activatio (None, 4, 4, 1376)    0
conv4_block36_0_bn[0][0]
-----

conv4_block36_1_conv (Conv2D)    (None, 4, 4, 128)    176128
conv4_block36_0_relu[0][0]
-----

conv4_block36_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block36_1_conv[0][0]
-----

conv4_block36_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block36_1_bn[0][0]
-----

conv4_block36_2_conv (Conv2D)    (None, 4, 4, 32)     36864
conv4_block36_1_relu[0][0]
-----

```

```

-----
conv4_block36_concat (Concatena (None, 4, 4, 1408)    0
conv4_block35_concat[0][0]
conv4_block36_2_conv[0][0]

-----

conv4_block37_0_bn (BatchNormal (None, 4, 4, 1408)    5632
conv4_block36_concat[0][0]

-----

conv4_block37_0_relu (Activatio (None, 4, 4, 1408)    0
conv4_block37_0_bn[0][0]

-----

conv4_block37_1_conv (Conv2D)    (None, 4, 4, 128)    180224
conv4_block37_0_relu[0][0]

-----

conv4_block37_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block37_1_conv[0][0]

-----

conv4_block37_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block37_1_bn[0][0]

-----

conv4_block37_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block37_1_relu[0][0]

-----

conv4_block37_concat (Concatena (None, 4, 4, 1440)    0
conv4_block36_concat[0][0]
conv4_block37_2_conv[0][0]

-----

conv4_block38_0_bn (BatchNormal (None, 4, 4, 1440)    5760
conv4_block37_concat[0][0]

-----

conv4_block38_0_relu (Activatio (None, 4, 4, 1440)    0
conv4_block38_0_bn[0][0]

-----

conv4_block38_1_conv (Conv2D)    (None, 4, 4, 128)    184320
conv4_block38_0_relu[0][0]

-----

conv4_block38_1_bn (BatchNormal (None, 4, 4, 128)    512

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```

conv4_block38_1_conv[0][0]
-----
-----
conv4_block38_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block38_1_bn[0][0]
-----
-----
conv4_block38_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block38_1_relu[0][0]
-----
-----
conv4_block38_concat (Concatena (None, 4, 4, 1472)    0
conv4_block37_concat[0][0]
conv4_block38_2_conv[0][0]
-----
-----
conv4_block39_0_bn (BatchNormal (None, 4, 4, 1472)    5888
conv4_block38_concat[0][0]
-----
-----
conv4_block39_0_relu (Activatio (None, 4, 4, 1472)    0
conv4_block39_0_bn[0][0]
-----
-----
conv4_block39_1_conv (Conv2D)    (None, 4, 4, 128)    188416
conv4_block39_0_relu[0][0]
-----
-----
conv4_block39_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block39_1_conv[0][0]
-----
-----
conv4_block39_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block39_1_bn[0][0]
-----
-----
conv4_block39_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block39_1_relu[0][0]
-----
-----
conv4_block39_concat (Concatena (None, 4, 4, 1504)    0
conv4_block38_concat[0][0]
conv4_block39_2_conv[0][0]
-----
-----
conv4_block40_0_bn (BatchNormal (None, 4, 4, 1504)    6016
conv4_block39_concat[0][0]
-----

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-----
conv4_block40_0_relu (Activatio (None, 4, 4, 1504)    0
conv4_block40_0_bn[0][0]
-----

-----
conv4_block40_1_conv (Conv2D)    (None, 4, 4, 128)    192512
conv4_block40_0_relu[0][0]
-----

-----
conv4_block40_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block40_1_conv[0][0]
-----

-----
conv4_block40_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block40_1_bn[0][0]
-----

-----
conv4_block40_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block40_1_relu[0][0]
-----

-----
conv4_block40_concat (Concatena (None, 4, 4, 1536)    0
conv4_block39_concat[0][0]
conv4_block40_2_conv[0][0]
-----

-----
conv4_block41_0_bn (BatchNormal (None, 4, 4, 1536)    6144
conv4_block40_concat[0][0]
-----

-----
conv4_block41_0_relu (Activatio (None, 4, 4, 1536)    0
conv4_block41_0_bn[0][0]
-----

-----
conv4_block41_1_conv (Conv2D)    (None, 4, 4, 128)    196608
conv4_block41_0_relu[0][0]
-----

-----
conv4_block41_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block41_1_conv[0][0]
-----

-----
conv4_block41_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block41_1_bn[0][0]
-----

-----
conv4_block41_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block41_1_relu[0][0]

```

```

-----
-----
conv4_block41_concat (Concatena (None, 4, 4, 1568)    0
conv4_block40_concat[0][0]
conv4_block41_2_conv[0][0]
-----
-----
conv4_block42_0_bn (BatchNormal (None, 4, 4, 1568)    6272
conv4_block41_concat[0][0]
-----
-----
conv4_block42_0_relu (Activatio (None, 4, 4, 1568)    0
conv4_block42_0_bn[0][0]
-----
-----
conv4_block42_1_conv (Conv2D)    (None, 4, 4, 128)    200704
conv4_block42_0_relu[0][0]
-----
-----
conv4_block42_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block42_1_conv[0][0]
-----
-----
conv4_block42_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block42_1_bn[0][0]
-----
-----
conv4_block42_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block42_1_relu[0][0]
-----
-----
conv4_block42_concat (Concatena (None, 4, 4, 1600)    0
conv4_block41_concat[0][0]
conv4_block42_2_conv[0][0]
-----
-----
conv4_block43_0_bn (BatchNormal (None, 4, 4, 1600)    6400
conv4_block42_concat[0][0]
-----
-----
conv4_block43_0_relu (Activatio (None, 4, 4, 1600)    0
conv4_block43_0_bn[0][0]
-----
-----
conv4_block43_1_conv (Conv2D)    (None, 4, 4, 128)    204800
conv4_block43_0_relu[0][0]
-----
-----

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```

conv4_block43_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block43_1_conv[0][0]
-----
conv4_block43_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block43_1_bn[0][0]
-----
conv4_block43_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block43_1_relu[0][0]
-----
conv4_block43_concat (Concatena (None, 4, 4, 1632)    0
conv4_block42_concat[0][0]
conv4_block43_2_conv[0][0]
-----
conv4_block44_0_bn (BatchNormal (None, 4, 4, 1632)    6528
conv4_block43_concat[0][0]
-----
conv4_block44_0_relu (Activatio (None, 4, 4, 1632)    0
conv4_block44_0_bn[0][0]
-----
conv4_block44_1_conv (Conv2D)    (None, 4, 4, 128)    208896
conv4_block44_0_relu[0][0]
-----
conv4_block44_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block44_1_conv[0][0]
-----
conv4_block44_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block44_1_bn[0][0]
-----
conv4_block44_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block44_1_relu[0][0]
-----
conv4_block44_concat (Concatena (None, 4, 4, 1664)    0
conv4_block43_concat[0][0]
conv4_block44_2_conv[0][0]
-----
conv4_block45_0_bn (BatchNormal (None, 4, 4, 1664)    6656
conv4_block44_concat[0][0]

```

```

-----
conv4_block45_0_relu (Activatio (None, 4, 4, 1664)    0
conv4_block45_0_bn[0][0]

-----

conv4_block45_1_conv (Conv2D)    (None, 4, 4, 128)    212992
conv4_block45_0_relu[0][0]

-----

conv4_block45_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block45_1_conv[0][0]

-----

conv4_block45_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block45_1_bn[0][0]

-----

conv4_block45_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block45_1_relu[0][0]

-----

conv4_block45_concat (Concatena (None, 4, 4, 1696)    0
conv4_block44_concat[0][0]
conv4_block45_2_conv[0][0]

-----

conv4_block46_0_bn (BatchNormal (None, 4, 4, 1696)    6784
conv4_block45_concat[0][0]

-----

conv4_block46_0_relu (Activatio (None, 4, 4, 1696)    0
conv4_block46_0_bn[0][0]

-----

conv4_block46_1_conv (Conv2D)    (None, 4, 4, 128)    217088
conv4_block46_0_relu[0][0]

-----

conv4_block46_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block46_1_conv[0][0]

-----

conv4_block46_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block46_1_bn[0][0]

-----

conv4_block46_2_conv (Conv2D)    (None, 4, 4, 32)    36864

```

```

conv4_block46_1_relu[0][0]
-----
-----
conv4_block46_concat (Concatena (None, 4, 4, 1728)    0
conv4_block45_concat[0][0]
conv4_block46_2_conv[0][0]
-----
-----
conv4_block47_0_bn (BatchNormal (None, 4, 4, 1728)    6912
conv4_block46_concat[0][0]
-----
-----
conv4_block47_0_relu (Activatio (None, 4, 4, 1728)    0
conv4_block47_0_bn[0][0]
-----
-----
conv4_block47_1_conv (Conv2D)    (None, 4, 4, 128)    221184
conv4_block47_0_relu[0][0]
-----
-----
conv4_block47_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block47_1_conv[0][0]
-----
-----
conv4_block47_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block47_1_bn[0][0]
-----
-----
conv4_block47_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block47_1_relu[0][0]
-----
-----
conv4_block47_concat (Concatena (None, 4, 4, 1760)    0
conv4_block46_concat[0][0]
conv4_block47_2_conv[0][0]
-----
-----
conv4_block48_0_bn (BatchNormal (None, 4, 4, 1760)    7040
conv4_block47_concat[0][0]
-----
-----
conv4_block48_0_relu (Activatio (None, 4, 4, 1760)    0
conv4_block48_0_bn[0][0]
-----
-----
conv4_block48_1_conv (Conv2D)    (None, 4, 4, 128)    225280
conv4_block48_0_relu[0][0]
-----

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```

-----
conv4_block48_1_bn (BatchNormal (None, 4, 4, 128)    512
conv4_block48_1_conv[0][0]
-----

-----
conv4_block48_1_relu (Activatio (None, 4, 4, 128)    0
conv4_block48_1_bn[0][0]
-----

-----
conv4_block48_2_conv (Conv2D)    (None, 4, 4, 32)    36864
conv4_block48_1_relu[0][0]
-----

-----
conv4_block48_concat (Concatena (None, 4, 4, 1792)    0
conv4_block47_concat[0][0]
conv4_block48_2_conv[0][0]
-----

-----
pool4_bn (BatchNormalization)    (None, 4, 4, 1792)    7168
conv4_block48_concat[0][0]
-----

-----
pool4_relu (Activation)          (None, 4, 4, 1792)    0          pool4_bn[0][0]
-----

-----
pool4_conv (Conv2D)              (None, 4, 4, 896)    1605632
pool4_relu[0][0]
-----

-----
pool4_pool (AveragePooling2D)    (None, 2, 2, 896)    0
pool4_conv[0][0]
-----

-----
conv5_block1_0_bn (BatchNormali (None, 2, 2, 896)    3584
pool4_pool[0][0]
-----

-----
conv5_block1_0_relu (Activation (None, 2, 2, 896)    0
conv5_block1_0_bn[0][0]
-----

-----
conv5_block1_1_conv (Conv2D)    (None, 2, 2, 128)    114688
conv5_block1_0_relu[0][0]
-----

-----
conv5_block1_1_bn (BatchNormali (None, 2, 2, 128)    512
conv5_block1_1_conv[0][0]
-----

```

```

-----
conv5_block1_1_relu (Activation (None, 2, 2, 128)    0
conv5_block1_1_bn[0][0]

-----

conv5_block1_2_conv (Conv2D)      (None, 2, 2, 32)    36864
conv5_block1_1_relu[0][0]

-----

conv5_block1_concat (Concatenat (None, 2, 2, 928)    0
pool4_pool[0][0]
conv5_block1_2_conv[0][0]

-----

conv5_block2_0_bn (BatchNormali (None, 2, 2, 928)    3712
conv5_block1_concat[0][0]

-----

conv5_block2_0_relu (Activation (None, 2, 2, 928)    0
conv5_block2_0_bn[0][0]

-----

conv5_block2_1_conv (Conv2D)      (None, 2, 2, 128)    118784
conv5_block2_0_relu[0][0]

-----

conv5_block2_1_bn (BatchNormali (None, 2, 2, 128)    512
conv5_block2_1_conv[0][0]

-----

conv5_block2_1_relu (Activation (None, 2, 2, 128)    0
conv5_block2_1_bn[0][0]

-----

conv5_block2_2_conv (Conv2D)      (None, 2, 2, 32)    36864
conv5_block2_1_relu[0][0]

-----

conv5_block2_concat (Concatenat (None, 2, 2, 960)    0
conv5_block1_concat[0][0]
conv5_block2_2_conv[0][0]

-----

conv5_block3_0_bn (BatchNormali (None, 2, 2, 960)    3840
conv5_block2_concat[0][0]

-----

conv5_block3_0_relu (Activation (None, 2, 2, 960)    0

```

conv5_block3_0_bn[0][0]

conv5_block3_1_conv (Conv2D) (None, 2, 2, 128) 122880
conv5_block3_0_relu[0][0]

conv5_block3_1_bn (BatchNormali (None, 2, 2, 128) 512
conv5_block3_1_conv[0][0]

conv5_block3_1_relu (Activation (None, 2, 2, 128) 0
conv5_block3_1_bn[0][0]

conv5_block3_2_conv (Conv2D) (None, 2, 2, 32) 36864
conv5_block3_1_relu[0][0]

conv5_block3_concat (Concatenat (None, 2, 2, 992) 0
conv5_block2_concat[0][0]
conv5_block3_2_conv[0][0]

conv5_block4_0_bn (BatchNormali (None, 2, 2, 992) 3968
conv5_block3_concat[0][0]

conv5_block4_0_relu (Activation (None, 2, 2, 992) 0
conv5_block4_0_bn[0][0]

conv5_block4_1_conv (Conv2D) (None, 2, 2, 128) 126976
conv5_block4_0_relu[0][0]

conv5_block4_1_bn (BatchNormali (None, 2, 2, 128) 512
conv5_block4_1_conv[0][0]

conv5_block4_1_relu (Activation (None, 2, 2, 128) 0
conv5_block4_1_bn[0][0]

conv5_block4_2_conv (Conv2D) (None, 2, 2, 32) 36864
conv5_block4_1_relu[0][0]


```

conv5_block4_concat (Concatenat (None, 2, 2, 1024)    0
conv5_block3_concat[0][0]
conv5_block4_2_conv[0][0]
-----

conv5_block5_0_bn (BatchNormali (None, 2, 2, 1024)    4096
conv5_block4_concat[0][0]
-----

conv5_block5_0_relu (Activation (None, 2, 2, 1024)    0
conv5_block5_0_bn[0][0]
-----

conv5_block5_1_conv (Conv2D)      (None, 2, 2, 128)    131072
conv5_block5_0_relu[0][0]
-----

conv5_block5_1_bn (BatchNormali (None, 2, 2, 128)    512
conv5_block5_1_conv[0][0]
-----

conv5_block5_1_relu (Activation (None, 2, 2, 128)    0
conv5_block5_1_bn[0][0]
-----

conv5_block5_2_conv (Conv2D)      (None, 2, 2, 32)    36864
conv5_block5_1_relu[0][0]
-----

conv5_block5_concat (Concatenat (None, 2, 2, 1056)    0
conv5_block4_concat[0][0]
conv5_block5_2_conv[0][0]
-----

conv5_block6_0_bn (BatchNormali (None, 2, 2, 1056)    4224
conv5_block5_concat[0][0]
-----

conv5_block6_0_relu (Activation (None, 2, 2, 1056)    0
conv5_block6_0_bn[0][0]
-----

conv5_block6_1_conv (Conv2D)      (None, 2, 2, 128)    135168
conv5_block6_0_relu[0][0]
-----

conv5_block6_1_bn (BatchNormali (None, 2, 2, 128)    512
conv5_block6_1_conv[0][0]

```

```

-----
conv5_block6_1_relu (Activation (None, 2, 2, 128)    0
conv5_block6_1_bn[0][0]
-----
conv5_block6_2_conv (Conv2D)      (None, 2, 2, 32)    36864
conv5_block6_1_relu[0][0]
-----
conv5_block6_concat (Concatenat (None, 2, 2, 1088)   0
conv5_block5_concat[0][0]
conv5_block6_2_conv[0][0]
-----
conv5_block7_0_bn (BatchNormali (None, 2, 2, 1088)   4352
conv5_block6_concat[0][0]
-----
conv5_block7_0_relu (Activation (None, 2, 2, 1088)   0
conv5_block7_0_bn[0][0]
-----
conv5_block7_1_conv (Conv2D)      (None, 2, 2, 128)   139264
conv5_block7_0_relu[0][0]
-----
conv5_block7_1_bn (BatchNormali (None, 2, 2, 128)    512
conv5_block7_1_conv[0][0]
-----
conv5_block7_1_relu (Activation (None, 2, 2, 128)    0
conv5_block7_1_bn[0][0]
-----
conv5_block7_2_conv (Conv2D)      (None, 2, 2, 32)    36864
conv5_block7_1_relu[0][0]
-----
conv5_block7_concat (Concatenat (None, 2, 2, 1120)   0
conv5_block6_concat[0][0]
conv5_block7_2_conv[0][0]
-----
conv5_block8_0_bn (BatchNormali (None, 2, 2, 1120)   4480
conv5_block7_concat[0][0]
-----

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```

conv5_block8_0_relu (Activation (None, 2, 2, 1120)    0
conv5_block8_0_bn[0][0]
-----

conv5_block8_1_conv (Conv2D)      (None, 2, 2, 128)    143360
conv5_block8_0_relu[0][0]
-----

conv5_block8_1_bn (BatchNormaliz (None, 2, 2, 128)    512
conv5_block8_1_conv[0][0]
-----

conv5_block8_1_relu (Activation (None, 2, 2, 128)    0
conv5_block8_1_bn[0][0]
-----

conv5_block8_2_conv (Conv2D)      (None, 2, 2, 32)     36864
conv5_block8_1_relu[0][0]
-----

conv5_block8_concat (Concatenat (None, 2, 2, 1152)    0
conv5_block7_concat[0][0]
conv5_block8_2_conv[0][0]
-----

conv5_block9_0_bn (BatchNormaliz (None, 2, 2, 1152)    4608
conv5_block8_concat[0][0]
-----

conv5_block9_0_relu (Activation (None, 2, 2, 1152)    0
conv5_block9_0_bn[0][0]
-----

conv5_block9_1_conv (Conv2D)      (None, 2, 2, 128)    147456
conv5_block9_0_relu[0][0]
-----

conv5_block9_1_bn (BatchNormaliz (None, 2, 2, 128)    512
conv5_block9_1_conv[0][0]
-----

conv5_block9_1_relu (Activation (None, 2, 2, 128)    0
conv5_block9_1_bn[0][0]
-----

conv5_block9_2_conv (Conv2D)      (None, 2, 2, 32)     36864
conv5_block9_1_relu[0][0]
-----

```

```

-----
conv5_block9_concat (Concatenat (None, 2, 2, 1184)    0
conv5_block8_concat[0][0]
conv5_block9_2_conv[0][0]
-----

-----
conv5_block10_0_bn (BatchNormal (None, 2, 2, 1184)    4736
conv5_block9_concat[0][0]
-----

-----
conv5_block10_0_relu (Activatio (None, 2, 2, 1184)    0
conv5_block10_0_bn[0][0]
-----

-----
conv5_block10_1_conv (Conv2D)    (None, 2, 2, 128)    151552
conv5_block10_0_relu[0][0]
-----

-----
conv5_block10_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block10_1_conv[0][0]
-----

-----
conv5_block10_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block10_1_bn[0][0]
-----

-----
conv5_block10_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block10_1_relu[0][0]
-----

-----
conv5_block10_concat (Concatena (None, 2, 2, 1216)    0
conv5_block9_concat[0][0]
conv5_block10_2_conv[0][0]
-----

-----
conv5_block11_0_bn (BatchNormal (None, 2, 2, 1216)    4864
conv5_block10_concat[0][0]
-----

-----
conv5_block11_0_relu (Activatio (None, 2, 2, 1216)    0
conv5_block11_0_bn[0][0]
-----

-----
conv5_block11_1_conv (Conv2D)    (None, 2, 2, 128)    155648
conv5_block11_0_relu[0][0]
-----

-----
conv5_block11_1_bn (BatchNormal (None, 2, 2, 128)    512

```

```

conv5_block11_1_conv[0][0]
-----
-----
conv5_block11_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block11_1_bn[0][0]
-----
-----
conv5_block11_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block11_1_relu[0][0]
-----
-----
conv5_block11_concat (Concatena (None, 2, 2, 1248)    0
conv5_block10_concat[0][0]
conv5_block11_2_conv[0][0]
-----
-----
conv5_block12_0_bn (BatchNormal (None, 2, 2, 1248)    4992
conv5_block11_concat[0][0]
-----
-----
conv5_block12_0_relu (Activatio (None, 2, 2, 1248)    0
conv5_block12_0_bn[0][0]
-----
-----
conv5_block12_1_conv (Conv2D)    (None, 2, 2, 128)    159744
conv5_block12_0_relu[0][0]
-----
-----
conv5_block12_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block12_1_conv[0][0]
-----
-----
conv5_block12_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block12_1_bn[0][0]
-----
-----
conv5_block12_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block12_1_relu[0][0]
-----
-----
conv5_block12_concat (Concatena (None, 2, 2, 1280)    0
conv5_block11_concat[0][0]
conv5_block12_2_conv[0][0]
-----
-----
conv5_block13_0_bn (BatchNormal (None, 2, 2, 1280)    5120
conv5_block12_concat[0][0]
-----

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```

-----
conv5_block13_0_relu (Activatio (None, 2, 2, 1280)    0
conv5_block13_0_bn[0][0]
-----

-----
conv5_block13_1_conv (Conv2D)    (None, 2, 2, 128)    163840
conv5_block13_0_relu[0][0]
-----

-----
conv5_block13_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block13_1_conv[0][0]
-----

-----
conv5_block13_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block13_1_bn[0][0]
-----

-----
conv5_block13_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block13_1_relu[0][0]
-----

-----
conv5_block13_concat (Concatena (None, 2, 2, 1312)    0
conv5_block12_concat[0][0]
conv5_block13_2_conv[0][0]
-----

-----
conv5_block14_0_bn (BatchNormal (None, 2, 2, 1312)    5248
conv5_block13_concat[0][0]
-----

-----
conv5_block14_0_relu (Activatio (None, 2, 2, 1312)    0
conv5_block14_0_bn[0][0]
-----

-----
conv5_block14_1_conv (Conv2D)    (None, 2, 2, 128)    167936
conv5_block14_0_relu[0][0]
-----

-----
conv5_block14_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block14_1_conv[0][0]
-----

-----
conv5_block14_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block14_1_bn[0][0]
-----

-----
conv5_block14_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block14_1_relu[0][0]

```

```

-----
conv5_block14_concat (Concatena (None, 2, 2, 1344)    0
conv5_block13_concat[0][0]
conv5_block14_2_conv[0][0]
-----

conv5_block15_0_bn (BatchNormal (None, 2, 2, 1344)    5376
conv5_block14_concat[0][0]
-----

conv5_block15_0_relu (Activatio (None, 2, 2, 1344)    0
conv5_block15_0_bn[0][0]
-----

conv5_block15_1_conv (Conv2D)    (None, 2, 2, 128)    172032
conv5_block15_0_relu[0][0]
-----

conv5_block15_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block15_1_conv[0][0]
-----

conv5_block15_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block15_1_bn[0][0]
-----

conv5_block15_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block15_1_relu[0][0]
-----

conv5_block15_concat (Concatena (None, 2, 2, 1376)    0
conv5_block14_concat[0][0]
conv5_block15_2_conv[0][0]
-----

conv5_block16_0_bn (BatchNormal (None, 2, 2, 1376)    5504
conv5_block15_concat[0][0]
-----

conv5_block16_0_relu (Activatio (None, 2, 2, 1376)    0
conv5_block16_0_bn[0][0]
-----

conv5_block16_1_conv (Conv2D)    (None, 2, 2, 128)    176128
conv5_block16_0_relu[0][0]
-----

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```

conv5_block16_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block16_1_conv[0][0]
-----
conv5_block16_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block16_1_bn[0][0]
-----
conv5_block16_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block16_1_relu[0][0]
-----
conv5_block16_concat (Concatena (None, 2, 2, 1408)    0
conv5_block15_concat[0][0]
conv5_block16_2_conv[0][0]
-----
conv5_block17_0_bn (BatchNormal (None, 2, 2, 1408)    5632
conv5_block16_concat[0][0]
-----
conv5_block17_0_relu (Activatio (None, 2, 2, 1408)    0
conv5_block17_0_bn[0][0]
-----
conv5_block17_1_conv (Conv2D)    (None, 2, 2, 128)    180224
conv5_block17_0_relu[0][0]
-----
conv5_block17_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block17_1_conv[0][0]
-----
conv5_block17_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block17_1_bn[0][0]
-----
conv5_block17_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block17_1_relu[0][0]
-----
conv5_block17_concat (Concatena (None, 2, 2, 1440)    0
conv5_block16_concat[0][0]
conv5_block17_2_conv[0][0]
-----
conv5_block18_0_bn (BatchNormal (None, 2, 2, 1440)    5760
conv5_block17_concat[0][0]

```



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-----
conv5_block18_0_relu (Activatio (None, 2, 2, 1440)    0
conv5_block18_0_bn[0][0]
-----
conv5_block18_1_conv (Conv2D)    (None, 2, 2, 128)    184320
conv5_block18_0_relu[0][0]
-----
conv5_block18_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block18_1_conv[0][0]
-----
conv5_block18_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block18_1_bn[0][0]
-----
conv5_block18_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block18_1_relu[0][0]
-----
conv5_block18_concat (Concatena (None, 2, 2, 1472)    0
conv5_block17_concat[0][0]
conv5_block18_2_conv[0][0]
-----
conv5_block19_0_bn (BatchNormal (None, 2, 2, 1472)    5888
conv5_block18_concat[0][0]
-----
conv5_block19_0_relu (Activatio (None, 2, 2, 1472)    0
conv5_block19_0_bn[0][0]
-----
conv5_block19_1_conv (Conv2D)    (None, 2, 2, 128)    188416
conv5_block19_0_relu[0][0]
-----
conv5_block19_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block19_1_conv[0][0]
-----
conv5_block19_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block19_1_bn[0][0]
-----
conv5_block19_2_conv (Conv2D)    (None, 2, 2, 32)    36864

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conv5_block19_1_relu[0][0]
-----
-----
conv5_block19_concat (Concatena (None, 2, 2, 1504)    0
conv5_block18_concat[0][0]
conv5_block19_2_conv[0][0]
-----
-----
conv5_block20_0_bn (BatchNormal (None, 2, 2, 1504)    6016
conv5_block19_concat[0][0]
-----
-----
conv5_block20_0_relu (Activatio (None, 2, 2, 1504)    0
conv5_block20_0_bn[0][0]
-----
-----
conv5_block20_1_conv (Conv2D)    (None, 2, 2, 128)    192512
conv5_block20_0_relu[0][0]
-----
-----
conv5_block20_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block20_1_conv[0][0]
-----
-----
conv5_block20_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block20_1_bn[0][0]
-----
-----
conv5_block20_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block20_1_relu[0][0]
-----
-----
conv5_block20_concat (Concatena (None, 2, 2, 1536)    0
conv5_block19_concat[0][0]
conv5_block20_2_conv[0][0]
-----
-----
conv5_block21_0_bn (BatchNormal (None, 2, 2, 1536)    6144
conv5_block20_concat[0][0]
-----
-----
conv5_block21_0_relu (Activatio (None, 2, 2, 1536)    0
conv5_block21_0_bn[0][0]
-----
-----
conv5_block21_1_conv (Conv2D)    (None, 2, 2, 128)    196608
conv5_block21_0_relu[0][0]
-----

```

```

-----
conv5_block21_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block21_1_conv[0][0]
-----

-----
conv5_block21_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block21_1_bn[0][0]
-----

-----
conv5_block21_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block21_1_relu[0][0]
-----

-----
conv5_block21_concat (Concatena (None, 2, 2, 1568)    0
conv5_block20_concat[0][0]
conv5_block21_2_conv[0][0]
-----

-----
conv5_block22_0_bn (BatchNormal (None, 2, 2, 1568)    6272
conv5_block21_concat[0][0]
-----

-----
conv5_block22_0_relu (Activatio (None, 2, 2, 1568)    0
conv5_block22_0_bn[0][0]
-----

-----
conv5_block22_1_conv (Conv2D)    (None, 2, 2, 128)    200704
conv5_block22_0_relu[0][0]
-----

-----
conv5_block22_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block22_1_conv[0][0]
-----

-----
conv5_block22_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block22_1_bn[0][0]
-----

-----
conv5_block22_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block22_1_relu[0][0]
-----

-----
conv5_block22_concat (Concatena (None, 2, 2, 1600)    0
conv5_block21_concat[0][0]
conv5_block22_2_conv[0][0]
-----

-----
conv5_block23_0_bn (BatchNormal (None, 2, 2, 1600)    6400

```

```

conv5_block22_concat[0][0]
-----
-----
conv5_block23_0_relu (Activatio (None, 2, 2, 1600)    0
conv5_block23_0_bn[0][0]
-----
-----
conv5_block23_1_conv (Conv2D)    (None, 2, 2, 128)    204800
conv5_block23_0_relu[0][0]
-----
-----
conv5_block23_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block23_1_conv[0][0]
-----
-----
conv5_block23_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block23_1_bn[0][0]
-----
-----
conv5_block23_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block23_1_relu[0][0]
-----
-----
conv5_block23_concat (Concatena (None, 2, 2, 1632)    0
conv5_block22_concat[0][0]
conv5_block23_2_conv[0][0]
-----
-----
conv5_block24_0_bn (BatchNormal (None, 2, 2, 1632)    6528
conv5_block23_concat[0][0]
-----
-----
conv5_block24_0_relu (Activatio (None, 2, 2, 1632)    0
conv5_block24_0_bn[0][0]
-----
-----
conv5_block24_1_conv (Conv2D)    (None, 2, 2, 128)    208896
conv5_block24_0_relu[0][0]
-----
-----
conv5_block24_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block24_1_conv[0][0]
-----
-----
conv5_block24_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block24_1_bn[0][0]
-----
-----

```

```

conv5_block24_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block24_1_relu[0][0]
-----

conv5_block24_concat (Concatenation) (None, 2, 2, 1664)  0
conv5_block23_concat[0][0]
conv5_block24_2_conv[0][0]
-----

conv5_block25_0_bn (BatchNormalisation) (None, 2, 2, 1664)  6656
conv5_block24_concat[0][0]
-----

conv5_block25_0_relu (Activation) (None, 2, 2, 1664)  0
conv5_block25_0_bn[0][0]
-----

conv5_block25_1_conv (Conv2D)    (None, 2, 2, 128)    212992
conv5_block25_0_relu[0][0]
-----

conv5_block25_1_bn (BatchNormalisation) (None, 2, 2, 128)    512
conv5_block25_1_conv[0][0]
-----

conv5_block25_1_relu (Activation) (None, 2, 2, 128)    0
conv5_block25_1_bn[0][0]
-----

conv5_block25_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block25_1_relu[0][0]
-----

conv5_block25_concat (Concatenation) (None, 2, 2, 1696)  0
conv5_block24_concat[0][0]
conv5_block25_2_conv[0][0]
-----

conv5_block26_0_bn (BatchNormalisation) (None, 2, 2, 1696)  6784
conv5_block25_concat[0][0]
-----

conv5_block26_0_relu (Activation) (None, 2, 2, 1696)  0
conv5_block26_0_bn[0][0]
-----

conv5_block26_1_conv (Conv2D)    (None, 2, 2, 128)    217088
conv5_block26_0_relu[0][0]

```

```

-----
conv5_block26_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block26_1_conv[0][0]
-----
conv5_block26_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block26_1_bn[0][0]
-----
conv5_block26_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block26_1_relu[0][0]
-----
conv5_block26_concat (Concatena (None, 2, 2, 1728)    0
conv5_block25_concat[0][0]
conv5_block26_2_conv[0][0]
-----
conv5_block27_0_bn (BatchNormal (None, 2, 2, 1728)    6912
conv5_block26_concat[0][0]
-----
conv5_block27_0_relu (Activatio (None, 2, 2, 1728)    0
conv5_block27_0_bn[0][0]
-----
conv5_block27_1_conv (Conv2D)    (None, 2, 2, 128)    221184
conv5_block27_0_relu[0][0]
-----
conv5_block27_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block27_1_conv[0][0]
-----
conv5_block27_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block27_1_bn[0][0]
-----
conv5_block27_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block27_1_relu[0][0]
-----
conv5_block27_concat (Concatena (None, 2, 2, 1760)    0
conv5_block26_concat[0][0]
conv5_block27_2_conv[0][0]
-----

```

```

conv5_block28_0_bn (BatchNormal (None, 2, 2, 1760)    7040
conv5_block27_concat[0][0]
-----
conv5_block28_0_relu (Activatio (None, 2, 2, 1760)    0
conv5_block28_0_bn[0][0]
-----
conv5_block28_1_conv (Conv2D)    (None, 2, 2, 128)    225280
conv5_block28_0_relu[0][0]
-----
conv5_block28_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block28_1_conv[0][0]
-----
conv5_block28_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block28_1_bn[0][0]
-----
conv5_block28_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block28_1_relu[0][0]
-----
conv5_block28_concat (Concatena (None, 2, 2, 1792)    0
conv5_block27_concat[0][0]
conv5_block28_2_conv[0][0]
-----
conv5_block29_0_bn (BatchNormal (None, 2, 2, 1792)    7168
conv5_block28_concat[0][0]
-----
conv5_block29_0_relu (Activatio (None, 2, 2, 1792)    0
conv5_block29_0_bn[0][0]
-----
conv5_block29_1_conv (Conv2D)    (None, 2, 2, 128)    229376
conv5_block29_0_relu[0][0]
-----
conv5_block29_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block29_1_conv[0][0]
-----
conv5_block29_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block29_1_bn[0][0]
-----

```

conv5_block29_2_conv (Conv2D) (None, 2, 2, 32) 36864
conv5_block29_1_relu[0][0]

conv5_block29_concat (Concatenation) (None, 2, 2, 1824) 0
conv5_block28_concat[0][0]
conv5_block29_2_conv[0][0]

conv5_block30_0_bn (BatchNormalisation) (None, 2, 2, 1824) 7296
conv5_block29_concat[0][0]

conv5_block30_0_relu (Activation) (None, 2, 2, 1824) 0
conv5_block30_0_bn[0][0]

conv5_block30_1_conv (Conv2D) (None, 2, 2, 128) 233472
conv5_block30_0_relu[0][0]

conv5_block30_1_bn (BatchNormalisation) (None, 2, 2, 128) 512
conv5_block30_1_conv[0][0]

conv5_block30_1_relu (Activation) (None, 2, 2, 128) 0
conv5_block30_1_bn[0][0]

conv5_block30_2_conv (Conv2D) (None, 2, 2, 32) 36864
conv5_block30_1_relu[0][0]

conv5_block30_concat (Concatenation) (None, 2, 2, 1856) 0
conv5_block29_concat[0][0]
conv5_block30_2_conv[0][0]

conv5_block31_0_bn (BatchNormalisation) (None, 2, 2, 1856) 7424
conv5_block30_concat[0][0]

conv5_block31_0_relu (Activation) (None, 2, 2, 1856) 0
conv5_block31_0_bn[0][0]

conv5_block31_1_conv (Conv2D) (None, 2, 2, 128) 237568


```

conv5_block31_0_relu[0][0]
-----
-----
conv5_block31_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block31_1_conv[0][0]
-----
-----
conv5_block31_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block31_1_bn[0][0]
-----
-----
conv5_block31_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block31_1_relu[0][0]
-----
-----
conv5_block31_concat (Concatena (None, 2, 2, 1888)    0
conv5_block30_concat[0][0]
conv5_block31_2_conv[0][0]
-----
-----
conv5_block32_0_bn (BatchNormal (None, 2, 2, 1888)    7552
conv5_block31_concat[0][0]
-----
-----
conv5_block32_0_relu (Activatio (None, 2, 2, 1888)    0
conv5_block32_0_bn[0][0]
-----
-----
conv5_block32_1_conv (Conv2D)    (None, 2, 2, 128)    241664
conv5_block32_0_relu[0][0]
-----
-----
conv5_block32_1_bn (BatchNormal (None, 2, 2, 128)    512
conv5_block32_1_conv[0][0]
-----
-----
conv5_block32_1_relu (Activatio (None, 2, 2, 128)    0
conv5_block32_1_bn[0][0]
-----
-----
conv5_block32_2_conv (Conv2D)    (None, 2, 2, 32)    36864
conv5_block32_1_relu[0][0]
-----
-----
conv5_block32_concat (Concatena (None, 2, 2, 1920)    0
conv5_block31_concat[0][0]
conv5_block32_2_conv[0][0]
-----
-----

```

```

-----
bn (BatchNormalization)          (None, 2, 2, 1920)    7680
conv5_block32_concat[0][0]
-----
-----
relu (Activation)                (None, 2, 2, 1920)    0          bn[0][0]
-----
-----
max_pool (GlobalMaxPooling2D)    (None, 1920)          0          relu[0][0]
=====
=====
Total params: 18,321,984
Trainable params: 18,092,928
Non-trainable params: 229,056
-----
-----

```

```
[17]: feature_batch = densenet(image_batch)
      feature_batch.shape
```

```
[17]: TensorShape([32, 1920])
```

```
[18]: len(densenet.layers)
```

```
[18]: 708
```

1.5 Add new layers to model

```
[19]: model = Sequential([
      densenet,
      BatchNormalization(),
      Dense(2048, activation='relu', kernel_regularizer=l1_l2(0.01)),
      BatchNormalization(),
      Dense(2048, activation='relu', kernel_regularizer=l1_l2(0.01)),
      BatchNormalization(),
      Dense(2048, activation='relu', kernel_regularizer=l1_l2(0.01)),
      BatchNormalization(),
      Dense(2048, activation='relu', kernel_regularizer=l1_l2(0.01)),
      BatchNormalization(),
      Dense(10, activation='softmax')
  ])
```

```
[20]: for layer in model.layers:
      layer.trainable = True
```

```
[21]: model.compile(loss='sparse_categorical_crossentropy',
      optimizer=Adam(lr=1e-4),
```

```
metrics=['accuracy'])
```

```
[22]: model.summary()
```

Model: "sequential"

| Layer (type) | Output Shape | Param # |
|---|--------------|----------|
| densenet201 (Functional) | (None, 1920) | 18321984 |
| batch_normalization (Batch Normalization) | (None, 1920) | 7680 |
| dense (Dense) | (None, 2048) | 3934208 |
| batch_normalization_1 (Batch Normalization) | (None, 2048) | 8192 |
| dense_1 (Dense) | (None, 2048) | 4196352 |
| batch_normalization_2 (Batch Normalization) | (None, 2048) | 8192 |
| dense_2 (Dense) | (None, 2048) | 4196352 |
| batch_normalization_3 (Batch Normalization) | (None, 2048) | 8192 |
| dense_3 (Dense) | (None, 2048) | 4196352 |
| batch_normalization_4 (Batch Normalization) | (None, 2048) | 8192 |
| dense_4 (Dense) | (None, 10) | 20490 |

Total params: 34,906,186
Trainable params: 34,656,906
Non-trainable params: 249,280

1.5.1 Compute baseline metrics

```
[23]: initial_epochs = 10
      validation_steps = 20

      initial_loss, initial_accuracy = model.evaluate(validation_batches, steps =
      ↪validation_steps)
```

20/20 [=====] - 3s 140ms/step - loss: 3256.2627 - accuracy: 0.1109

```
[24]: print(f'Initial loss: {initial_loss:.2f} | initial_accuracy accuracy: 11.09%  
      ↪ {initial_accuracy:.2%}')
```

Initial loss: 3256.26 | initial_accuracy accuracy: 11.09%

1.6 Train model

1.6.1 Define Callbacks

```
[25]: early_stopping = EarlyStopping(monitor='val_accuracy',  
                                     patience=10)
```

```
[26]: eurosat_path = (results_path / 'cnn.weights.best.hdf5').as_posix()  
checkpointer = ModelCheckpoint(filepath=eurosat_path,  
                               verbose=1,  
                               monitor='val_accuracy',  
                               save_best_only=True)
```

```
[27]: epochs = 100
```

```
[28]: history = model.fit(train_batches,  
                          epochs=epochs,  
                          validation_data=validation_batches,  
                          callbacks=[checkpointer,  
                                    early_stopping])
```

Epoch 1/100

760/Unknown - 70s 92ms/step - loss: 700.4531 - accuracy: 0.8181

Epoch 00001: val_accuracy improved from -inf to 0.94444, saving model to results/eurosat/cnn.weights.best.hdf5

760/760 [=====] - 74s 97ms/step - loss: 700.4531 - accuracy: 0.8181 - val_loss: 4.1437 - val_accuracy: 0.9444

Epoch 2/100

760/760 [=====] - ETA: 0s - loss: 2.5708 - accuracy: 0.9230

Epoch 00002: val_accuracy improved from 0.94444 to 0.94963, saving model to results/eurosat/cnn.weights.best.hdf5

760/760 [=====] - 75s 98ms/step - loss: 2.5708 - accuracy: 0.9230 - val_loss: 2.3430 - val_accuracy: 0.9496

Epoch 3/100

760/760 [=====] - ETA: 0s - loss: 2.3192 - accuracy: 0.9536

Epoch 00003: val_accuracy did not improve from 0.94963

760/760 [=====] - 71s 94ms/step - loss: 2.3192 - accuracy: 0.9536 - val_loss: 2.5888 - val_accuracy: 0.9107

Epoch 4/100

760/760 [=====] - ETA: 0s - loss: 2.3036 - accuracy: 0.9686

Epoch 00004: val_accuracy improved from 0.94963 to 0.96407, saving model to results/eurosat/cnn.weights.best.hdf5
760/760 [=====] - 83s 109ms/step - loss: 2.3036 - accuracy: 0.9686 - val_loss: 2.5276 - val_accuracy: 0.9641
Epoch 5/100
760/760 [=====] - ETA: 0s - loss: 2.1611 - accuracy: 0.9746
Epoch 00005: val_accuracy did not improve from 0.96407
760/760 [=====] - 102s 134ms/step - loss: 2.1611 - accuracy: 0.9746 - val_loss: 2.2576 - val_accuracy: 0.9496
Epoch 6/100
760/760 [=====] - ETA: 0s - loss: 2.1564 - accuracy: 0.9795
Epoch 00006: val_accuracy did not improve from 0.96407
760/760 [=====] - 101s 133ms/step - loss: 2.1564 - accuracy: 0.9795 - val_loss: 2.3695 - val_accuracy: 0.9633
Epoch 7/100
760/760 [=====] - ETA: 0s - loss: 2.0421 - accuracy: 0.9819
Epoch 00007: val_accuracy did not improve from 0.96407
760/760 [=====] - 102s 134ms/step - loss: 2.0421 - accuracy: 0.9819 - val_loss: 2.0737 - val_accuracy: 0.9641
Epoch 8/100
760/760 [=====] - ETA: 0s - loss: 2.0481 - accuracy: 0.9845
Epoch 00008: val_accuracy did not improve from 0.96407
760/760 [=====] - 102s 135ms/step - loss: 2.0481 - accuracy: 0.9845 - val_loss: 2.3596 - val_accuracy: 0.9385
Epoch 9/100
760/760 [=====] - ETA: 0s - loss: 2.2188 - accuracy: 0.9676
Epoch 00009: val_accuracy did not improve from 0.96407
760/760 [=====] - 101s 133ms/step - loss: 2.2188 - accuracy: 0.9676 - val_loss: 2.5635 - val_accuracy: 0.8733
Epoch 10/100
760/760 [=====] - ETA: 0s - loss: 2.0949 - accuracy: 0.9826
Epoch 00010: val_accuracy did not improve from 0.96407
760/760 [=====] - 102s 134ms/step - loss: 2.0949 - accuracy: 0.9826 - val_loss: 2.3571 - val_accuracy: 0.9470
Epoch 11/100
760/760 [=====] - ETA: 0s - loss: 2.0105 - accuracy: 0.9886
Epoch 00011: val_accuracy improved from 0.96407 to 0.96704, saving model to results/eurosat/cnn.weights.best.hdf5
760/760 [=====] - 105s 138ms/step - loss: 2.0105 - accuracy: 0.9886 - val_loss: 2.0671 - val_accuracy: 0.9670
Epoch 12/100

760/760 [=====] - ETA: 0s - loss: 1.9271 - accuracy: 0.9895
Epoch 00012: val_accuracy improved from 0.96704 to 0.97630, saving model to results/eurosat/cnn.weights.best.hdf5
760/760 [=====] - 106s 140ms/step - loss: 1.9271 - accuracy: 0.9895 - val_loss: 1.9610 - val_accuracy: 0.9763
Epoch 13/100
760/760 [=====] - ETA: 0s - loss: 2.0319 - accuracy: 0.9854
Epoch 00013: val_accuracy did not improve from 0.97630
760/760 [=====] - 102s 134ms/step - loss: 2.0319 - accuracy: 0.9854 - val_loss: 2.4892 - val_accuracy: 0.9419
Epoch 14/100
760/760 [=====] - ETA: 0s - loss: 2.0903 - accuracy: 0.9786
Epoch 00014: val_accuracy improved from 0.97630 to 0.97704, saving model to results/eurosat/cnn.weights.best.hdf5
760/760 [=====] - 102s 134ms/step - loss: 2.0903 - accuracy: 0.9786 - val_loss: 2.0443 - val_accuracy: 0.9770
Epoch 15/100
760/760 [=====] - ETA: 0s - loss: 1.9076 - accuracy: 0.9940
Epoch 00015: val_accuracy improved from 0.97704 to 0.98074, saving model to results/eurosat/cnn.weights.best.hdf5
760/760 [=====] - 104s 137ms/step - loss: 1.9076 - accuracy: 0.9940 - val_loss: 1.9274 - val_accuracy: 0.9807
Epoch 16/100
760/760 [=====] - ETA: 0s - loss: 2.0973 - accuracy: 0.9888
Epoch 00016: val_accuracy did not improve from 0.98074
760/760 [=====] - 103s 135ms/step - loss: 2.0973 - accuracy: 0.9888 - val_loss: 2.2508 - val_accuracy: 0.9648
Epoch 17/100
760/760 [=====] - ETA: 0s - loss: 2.0802 - accuracy: 0.9858
Epoch 00017: val_accuracy did not improve from 0.98074
760/760 [=====] - 102s 135ms/step - loss: 2.0802 - accuracy: 0.9858 - val_loss: 2.0436 - val_accuracy: 0.9619
Epoch 18/100
760/760 [=====] - ETA: 0s - loss: 2.0126 - accuracy: 0.9894
Epoch 00018: val_accuracy did not improve from 0.98074
760/760 [=====] - 110s 145ms/step - loss: 2.0126 - accuracy: 0.9894 - val_loss: 2.0002 - val_accuracy: 0.9752
Epoch 19/100
760/760 [=====] - ETA: 0s - loss: 2.0331 - accuracy: 0.9859
Epoch 00019: val_accuracy did not improve from 0.98074

```

760/760 [=====] - 130s 170ms/step - loss: 2.0331 -
accuracy: 0.9859 - val_loss: 1.9779 - val_accuracy: 0.9726
Epoch 20/100
760/760 [=====] - ETA: 0s - loss: 1.9184 - accuracy:
0.9937
Epoch 00020: val_accuracy did not improve from 0.98074
760/760 [=====] - 131s 172ms/step - loss: 1.9184 -
accuracy: 0.9937 - val_loss: 1.9657 - val_accuracy: 0.9748
Epoch 21/100
760/760 [=====] - ETA: 0s - loss: 1.8805 - accuracy:
0.9951
Epoch 00021: val_accuracy did not improve from 0.98074
760/760 [=====] - 132s 173ms/step - loss: 1.8805 -
accuracy: 0.9951 - val_loss: 2.2087 - val_accuracy: 0.9204
Epoch 22/100
760/760 [=====] - ETA: 0s - loss: 2.3553 - accuracy:
0.9720
Epoch 00022: val_accuracy did not improve from 0.98074
760/760 [=====] - 105s 139ms/step - loss: 2.3553 -
accuracy: 0.9720 - val_loss: 4.7075 - val_accuracy: 0.8170
Epoch 23/100
760/760 [=====] - ETA: 0s - loss: 2.0543 - accuracy:
0.9889
Epoch 00023: val_accuracy did not improve from 0.98074
760/760 [=====] - 102s 134ms/step - loss: 2.0543 -
accuracy: 0.9889 - val_loss: 2.2079 - val_accuracy: 0.9737
Epoch 24/100
760/760 [=====] - ETA: 0s - loss: 1.9796 - accuracy:
0.9888
Epoch 00024: val_accuracy did not improve from 0.98074
760/760 [=====] - 103s 135ms/step - loss: 1.9796 -
accuracy: 0.9888 - val_loss: 7.1897 - val_accuracy: 0.7819
Epoch 25/100
760/760 [=====] - ETA: 0s - loss: 1.9561 - accuracy:
0.9883
Epoch 00025: val_accuracy did not improve from 0.98074
760/760 [=====] - 102s 134ms/step - loss: 1.9561 -
accuracy: 0.9883 - val_loss: 1.9583 - val_accuracy: 0.9763

```

1.6.2 Plot Learning Curves

```

[29]: def plot_learning_curves(df):
    fig, axes = plt.subplots(ncols=2, figsize=(15, 4))
    df[['accuracy', 'val_accuracy']].plot(ax=axes[0], title='Accuracy')
    df[['loss', 'val_loss']].plot(ax=axes[1], title='Cross-Entropy')
    for ax in axes:
        ax.legend(['Training', 'Validation'])

```

```
fig.tight_layout();
```

```
[30]: metrics = pd.DataFrame(history.history)
metrics.index = metrics.index.to_series().add(1)

fig, axes = plt.subplots(ncols=2, figsize=(15, 4))
metrics[['accuracy', 'val_accuracy']].plot(ax=axes[0],
                                             title=f'Accuracy (Best: {metrics.
↪val_accuracy.max():.2%})')
axes[0].axvline(metrics.val_accuracy.idxmax(), ls='--', lw=1, c='k')
metrics[['loss', 'val_loss']].plot(ax=axes[1], title='Cross-Entropy', logy=True)
for ax in axes:
    ax.legend(['Training', 'Validation'])
    ax.set_xlabel('Epoch')

axes[0].yaxis.set_major_formatter(FuncFormatter(lambda y, _: '{:.0%}'.
↪format(y)))
axes[0].set_ylabel('Accuracy')
axes[1].set_ylabel('Loss')
sns.despine()
fig.tight_layout()
fig.savefig(results_path / 'satellite_accuracy', dpi=300);
```

