In [1]:
```
import tensorflow as tf
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from keras.metrics import Precision, Recall
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import classification_report, accuracy_score

import seaborn as sns
import cv2
import pathlib
import os

test = pd.read_csv("C:/Users/ADMIN/Desktop/dataset/train.csv")
test.head()
```

Out[1]:

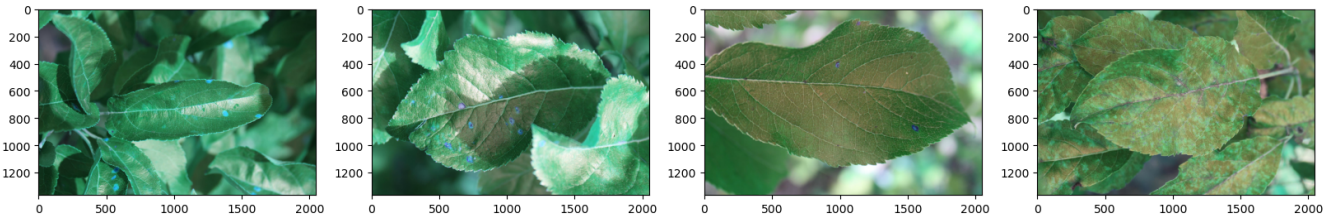
	image_id	healthy	multiple_diseases	rust	scab
0	Train_0	0	0	0	1
1	Train_1	0	1	0	0
2	Train_2	1	0	0	0
3	Train_3	0	0	1	0
4	Train_4	1	0	0	0

In [2]:
```
train = pd.read_csv("C:/Users/ADMIN/Desktop/dataset/test.csv")
train.head()
```

Out[2]:

	image_id
0	Test_0
1	Test_1
2	Test_2
3	Test_3
4	Test_4

In [3]:
```
dataset_folder = os.path.join("C:/Users/ADMIN/Desktop/dataset")
imagesDataset = pathlib.Path(os.path.join(dataset_folder, "images"))
listImages = list(imagesDataset.glob("*.*"))
plt.figure(figsize = (20, 6))
for i in range(4):
    plt.subplot(1, 4, i + 1)
    img = cv2.imread(str(listImages[i]))
    plt.imshow(img)
plt.show()
```

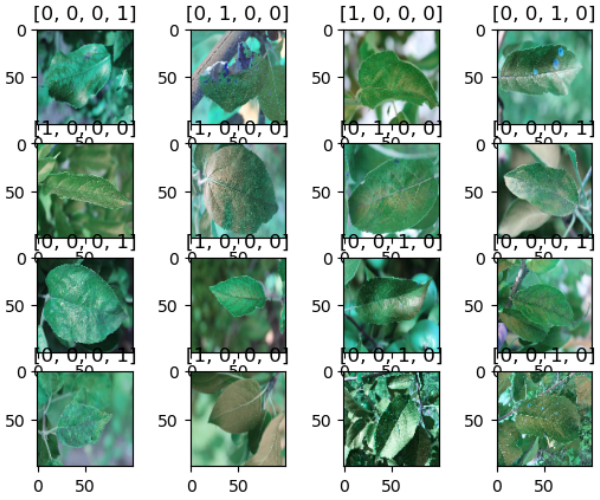


In [4]:
```
images_id_csv = test['image_id']
healthy_csv = test['healthy']
multiple_diseases_csv =test['multiple_diseases']
rust_csv = test['rust']
scab_csv = test['scab']
images = []
labels = []
for index, values in enumerate(images_id_csv):
    img = cv2.imread(os.path.join(dataset_folder, "images", "{}.jpg".format(values)))
    img = cv2.resize(img, (100, 100))
    img = img/255
    labels.append([healthy_csv[index], multiple_diseases_csv[index], rust_csv[index],
                scab_csv[index]])
    images.append(img)
plt.figure(figsize = (12, 8))
```

Out[4]:
```
<Figure size 1200x800 with 0 Axes>

<Figure size 1200x800 with 0 Axes>
```

In [5]:
```
for i in range(16):
  plt.subplot(4, 4, i + 1)
  plt.imshow(images[i])
  plt.title(labels[i])
plt.show()
```



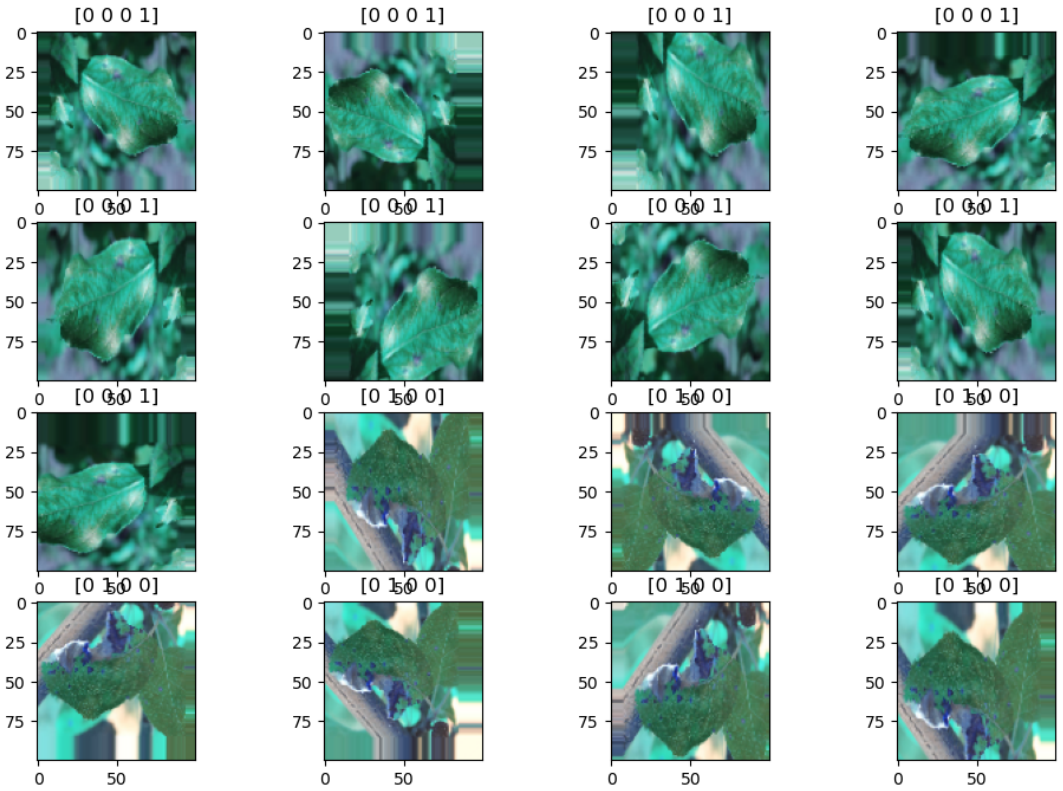
In [6]:
```
img_data_g = tf.keras.preprocessing.image.ImageDataGenerator(
        rotation_range=0.35,
        zoom_range=0.2,
        horizontal_flip=True,
        vertical_flip=True,
        shear_range=0.2,
        width_shift_range=0.15,
        height_shift_range=0.15,
        rescale=None)
images_after_aug = []
labels_after_aug = []
```

In [7]:
```
for index, image in enumerate(images):
  for i in range(9):
      img = img_data_g.flow(np.reshape(image, (1, 100, 100, 3))).next()
      images_after_aug.append(np.reshape(img, (100, 100, 3)))
      labels_after_aug.append(labels[index])
labels = np.asarray(labels_after_aug)
images = np.asarray(images_after_aug)
images.shape
```

Out[7]:
```
(16389, 100, 100, 3)
```

In [8]:
```
plt.figure(figsize = (12, 8))
for i in range(16):
  plt.subplot(4, 4, i + 1)
  plt.imshow(images[i])
  plt.title(labels[i])
plt.show()
```

```
C:\Users\ADMIN\anaconda3\lib\site-packages\matplotlib\text.py:1223: FutureWarning: elementwise comparison failed; returning scalar instead, but in the future will perform elementwise comparison
  if s != self._text:
```



In [9]:
```
train
```

Out[9]:

	image_id
0	Test_0
1	Test_1
2	Test_2
3	Test_3
4	Test_4
...	...
1816	Test_1816
1817	Test_1817
1818	Test_1818
1819	Test_1819
1820	Test_1820

1821 rows × 1 columns

In [10]:
```
test
```

Out[10]:

	image_id	healthy	multiple_diseases	rust	scab
0	Train_0	0	0	0	1
1	Train_1	0	1	0	0
2	Train_2	1	0	0	0
3	Train_3	0	0	1	0
4	Train_4	1	0	0	0
...	...	...	...	...	...
1816	Train_1816	0	0	0	1
1817	Train_1817	1	0	0	0
1818	Train_1818	1	0	0	0
1819	Train_1819	0	0	1	0
1820	Train_1820	0	0	0	1

1821 rows × 5 columns

In [11]:
```
labels
```

Out[11]:
```
array([[0, 0, 0, 1],
       [0, 0, 0, 1],
       [0, 0, 0, 1],
       ...,
       [0, 0, 0, 1],
       [0, 0, 0, 1],
       [0, 0, 0, 1]], dtype=int64)
```

In [12]:
```
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(images, labels, test_size = 0.15, random_state = 42)
x_train.shape
```

Out[12]:
```
(13930, 100, 100, 3)
```

In [13]:
```
x_test.shape
```

Out[13]:
```
(2459, 100, 100, 3)
```

In [14]:
```
x_test
```

Out[14]:
```
array([[[[0.3019608 , 0.63529414, 0.5764706 ],
         [0.3019608 , 0.63529414, 0.5764706 ],
         [0.3019608 , 0.63529414, 0.5764706 ],
         ...,
         [0.6862745 , 0.9490196 , 0.8862745 ],
         [0.6862745 , 0.9490196 , 0.8862745 ],
         [0.6862745 , 0.9490196 , 0.8862745 ]],

        [[0.3019608 , 0.63529414, 0.5764706 ],
         [0.3019608 , 0.63529414, 0.5764706 ],
         [0.3019608 , 0.63529414, 0.5764706 ],
         ...,
         [0.6862745 , 0.9490196 , 0.8862745 ],
         [0.6862745 , 0.9490196 , 0.8862745 ],
         [0.6862745 , 0.9490196 , 0.8862745 ]],

        [[0.3019608 , 0.63529414, 0.5764706 ],
         [0.3019608 , 0.63529414, 0.5764706 ],
         [0.3019608 , 0.63529414, 0.5764706 ],
         ...,
         [0.6862745 , 0.9490196 , 0.8862745 ],
         [0.6862745 , 0.9490196 , 0.8862745 ],
         [0.6862745 , 0.9490196 , 0.8862745 ]],

        ...,

        [[0.56223905, 0.89949393, 0.86027825],
         [0.5623346 , 0.8995895 , 0.8603738 ],
         [0.5624301 , 0.89968497, 0.8604693 ],
         ...,
         [0.11372549, 0.2901961 , 0.20554267],
         [0.11372549, 0.2901961 , 0.20546626],
         [0.11372549, 0.2901961 , 0.20538986]],

        [[0.54279244, 0.88108516, 0.8418695 ],
         [0.542907  , 0.8811807 , 0.841965  ],
         [0.5430216 , 0.8812762 , 0.8420605 ],
         ...,
         [0.12925868, 0.35854208, 0.29172233],
         [0.12916318, 0.35812187, 0.2912066 ],
         [0.12906767, 0.35770166, 0.29069087]],

        [[0.5207019 , 0.8634744 , 0.82425874],
         [0.5208165 , 0.86355084, 0.82433516],
         [0.5209311 , 0.86362725, 0.8244116 ],
         ...,
         [0.14480063, 0.45387486, 0.37966245],
         [0.14472423, 0.45335913, 0.37922314],
         [0.14464782, 0.4528434 , 0.3787838 ]]],


       [[[0.19586687, 0.3968166 , 0.33753377],
         [0.12363452, 0.2991335 , 0.20941822],
         [0.09161205, 0.25529173, 0.15813132],
         ...,
         [0.3539049 , 0.46820015, 0.42898446],
         [0.35394478, 0.46821722, 0.42900154],
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        [[0.20615925, 0.41017517, 0.36001897],
         [0.13757518, 0.31288144, 0.23528153],
         [0.0884153 , 0.24416009, 0.16100046],
         ...,
         [0.33021927, 0.45961446, 0.41100687],
         [0.3302591 , 0.45962587, 0.41105244],
         [0.330299  , 0.45963725, 0.411098  ]],

        [[0.20436232, 0.40839064, 0.36470515],
         [0.14940561, 0.32627267, 0.25956434],
         [0.08586818, 0.23589009, 0.16273086],
         ...,
         [0.30961585, 0.45181972, 0.38804722],
         [0.30963862, 0.45183682, 0.38807   ],
         [0.30966142, 0.4518539 , 0.3880928 ]],

        ...,

        [[0.16468643, 0.39436162, 0.24198623],
         [0.18039216, 0.43359467, 0.2747189 ],
         [0.17804395, 0.44078904, 0.2893976 ],
         ...,
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         [0.10588235, 0.31764707, 0.1882353 ],
         [0.10588235, 0.31764707, 0.1882353 ]],

        [[0.16467217, 0.39433515, 0.24196382],
         [0.18039216, 0.4335845 , 0.27471074],
         [0.17804599, 0.44079107, 0.2893915 ],
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         [0.10588235, 0.31764707, 0.1882353 ],
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         [0.10588235, 0.31764707, 0.1882353 ]]],
```

```
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  ...,
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 ...,

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  [0.27450982, 0.5882353 , 0.44313726],
  ...,
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  [0.09685183, 0.32038125, 0.23450252],
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```

```
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  [0.08696648, 0.25834304, 0.17285024],
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  [0.1118663 , 0.25300696, 0.16796766]],

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  ...,
  [0.16986851, 0.30113253, 0.20699745],
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```

```
        [0.0635916 , 0.13862188, 0.07991182],
        [0.05717573, 0.15587594, 0.09400713]]]], dtype=float32)
```

In [15]:

```
d = tf.keras.applications.DenseNet121(include_top=False,
                  input_shape=(100,100,3),
                  pooling=None,
                  weights='imagenet')
for i in d.layers:
  i.trainable = True
output_avg = tf.keras.layers.GlobalAveragePooling2D()(d.output)
output_max = tf.keras.layers.GlobalMaxPooling2D()(d.output)
m = tf.keras.layers.minimum([output_avg, output_max])
m = tf.keras.layers.Dropout(0.5)(m)
m = tf.keras.layers.Dense(128, activation = "sigmoid")(m)
m = tf.keras.layers.Dropout(0.3)(m)
m = tf.keras.layers.Dense(256, activation = "relu")(m)
m = tf.keras.layers.Dropout(0.3)(m)
m = tf.keras.layers.Dense(512, activation = "relu")(m)
m = tf.keras.layers.Dropout(0.3)(m)
m = tf.keras.layers.Dense(4, activation= "softmax")(m)
m = tf.keras.models.Model(inputs = d.input, outputs = m)
m.compile(optimizer = tf.keras.optimizers.Adam(0.001),
          loss = "categorical_crossentropy",
          metrics =["accuracy",
                    Precision(name='precision'),
                    Recall(name='recall')])
m.summary()
```

Model: "model"

Layer (type)	Output Shape	Param #	Connected to
input_1 (InputLayer)	[(None, 100, 100, 3)]	0	[]
zero_padding2d (ZeroPadding2D)	(None, 106, 106, 3)	0	['input_1[0][0]']
conv1/conv (Conv2D)	(None, 50, 50, 64)	9408	['zero_padding2d[0][0]']
conv1/bn (BatchNormalization)	(None, 50, 50, 64)	256	['conv1/conv[0][0]']
conv1/relu (Activation)	(None, 50, 50, 64)	0	['conv1/bn[0][0]']
zero_padding2d_1 (ZeroPadding2D)	(None, 52, 52, 64)	0	['conv1/relu[0][0]']
pool1 (MaxPooling2D)	(None, 25, 25, 64)	0	['zero_padding2d_1[0][0]']
conv2_block1_0_bn (BatchNormalization)	(None, 25, 25, 64)	256	['pool1[0][0]']
conv2_block1_0_relu (Activation)	(None, 25, 25, 64)	0	['conv2_block1_0_bn[0][0]']
conv2_block1_1_conv (Conv2D)	(None, 25, 25, 128)	8192	['conv2_block1_0_relu[0][0]']
conv2_block1_1_bn (BatchNormalization)	(None, 25, 25, 128)	512	['conv2_block1_1_conv[0][0]']
conv2_block1_1_relu (Activation)	(None, 25, 25, 128)	0	['conv2_block1_1_bn[0][0]']
conv2_block1_2_conv (Conv2D)	(None, 25, 25, 32)	36864	['conv2_block1_1_relu[0][0]']
conv2_block1_concat (Concatenate)	(None, 25, 25, 96)	0	['pool1[0][0]', 'conv2_block1_2_conv[0][0]']
conv2_block2_0_bn (BatchNormalization)	(None, 25, 25, 96)	384	['conv2_block1_concat[0][0]']
conv2_block2_0_relu (Activation)	(None, 25, 25, 96)	0	['conv2_block2_0_bn[0][0]']
conv2_block2_1_conv (Conv2D)	(None, 25, 25, 128)	12288	['conv2_block2_0_relu[0][0]']
conv2_block2_1_bn (BatchNormalization)	(None, 25, 25, 128)	512	['conv2_block2_1_conv[0][0]']
conv2_block2_1_relu (Activation)	(None, 25, 25, 128)	0	['conv2_block2_1_bn[0][0]']
conv2_block2_2_conv (Conv2D)	(None, 25, 25, 32)	36864	['conv2_block2_1_relu[0][0]']
conv2_block2_concat (Concatenate)	(None, 25, 25, 128)	0	['conv2_block1_concat[0][0]', 'conv2_block2_2_conv[0][0]']
conv2_block3_0_bn (BatchNormalization)	(None, 25, 25, 128)	512	['conv2_block2_concat[0][0]']
conv2_block3_0_relu (Activation)	(None, 25, 25, 128)	0	['conv2_block3_0_bn[0][0]']
conv2_block3_1_conv (Conv2D)	(None, 25, 25, 128)	16384	['conv2_block3_0_relu[0][0]']
conv2_block3_1_bn (BatchNormalization)	(None, 25, 25, 128)	512	['conv2_block3_1_conv[0][0]']
conv2_block3_1_relu (Activation)	(None, 25, 25, 128)	0	['conv2_block3_1_bn[0][0]']
conv2_block3_2_conv (Conv2D)	(None, 25, 25, 32)	36864	['conv2_block3_1_relu[0][0]']
conv2_block3_concat (Concatenate)	(None, 25, 25, 160)	0	['conv2_block2_concat[0][0]', 'conv2_block3_2_conv[0][0]']
conv2_block4_0_bn (BatchNormalization)	(None, 25, 25, 160)	640	['conv2_block3_concat[0][0]']
conv2_block4_0_relu (Activation)	(None, 25, 25, 160)	0	['conv2_block4_0_bn[0][0]']
conv2_block4_1_conv (Conv2D)	(None, 25, 25, 128)	20480	['conv2_block4_0_relu[0][0]']
conv2_block4_1_bn (BatchNormalization)	(None, 25, 25, 128)	512	['conv2_block4_1_conv[0][0]']
conv2_block4_1_relu (Activation)	(None, 25, 25, 128)	0	['conv2_block4_1_bn[0][0]']
conv2_block4_2_conv (Conv2D)	(None, 25, 25, 32)	36864	['conv2_block4_1_relu[0][0]']
conv2_block4_concat (Concatenate)	(None, 25, 25, 192)	0	['conv2_block3_concat[0][0]', 'conv2_block4_2_conv[0][0]']
conv2_block5_0_bn (BatchNormalization)	(None, 25, 25, 192)	768	['conv2_block4_concat[0][0]']
conv2_block5_0_relu (Activation)	(None, 25, 25, 192)	0	['conv2_block5_0_bn[0][0]']

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conv2_block5_1_conv (Conv2D)   (None, 25, 25, 128)  24576       ['conv2_block5_0_relu[0][0]']

conv2_block5_1_bn (BatchNormal  (None, 25, 25, 128)  512        ['conv2_block5_1_conv[0][0]']
ization)

conv2_block5_1_relu (Activatio  (None, 25, 25, 128)  0          ['conv2_block5_1_bn[0][0]']
n)

conv2_block5_2_conv (Conv2D)   (None, 25, 25, 32)   36864       ['conv2_block5_1_relu[0][0]']

conv2_block5_concat (Concatena  (None, 25, 25, 224)  0          ['conv2_block4_concat[0][0]',
te)                                                              'conv2_block5_2_conv[0][0]']

conv2_block6_0_bn (BatchNormal  (None, 25, 25, 224)  896        ['conv2_block5_concat[0][0]']
ization)

conv2_block6_0_relu (Activatio  (None, 25, 25, 224)  0          ['conv2_block6_0_bn[0][0]']
n)

conv2_block6_1_conv (Conv2D)   (None, 25, 25, 128)  28672       ['conv2_block6_0_relu[0][0]']

conv2_block6_1_bn (BatchNormal  (None, 25, 25, 128)  512        ['conv2_block6_1_conv[0][0]']
ization)

conv2_block6_1_relu (Activatio  (None, 25, 25, 128)  0          ['conv2_block6_1_bn[0][0]']
n)

conv2_block6_2_conv (Conv2D)   (None, 25, 25, 32)   36864       ['conv2_block6_1_relu[0][0]']

conv2_block6_concat (Concatena  (None, 25, 25, 256)  0          ['conv2_block5_concat[0][0]',
te)                                                              'conv2_block6_2_conv[0][0]']

pool2_bn (BatchNormalization)  (None, 25, 25, 256)  1024        ['conv2_block6_concat[0][0]']

pool2_relu (Activation)        (None, 25, 25, 256)  0           ['pool2_bn[0][0]']

pool2_conv (Conv2D)            (None, 25, 25, 128)  32768       ['pool2_relu[0][0]']

pool2_pool (AveragePooling2D)  (None, 12, 12, 128)  0           ['pool2_conv[0][0]']

conv3_block1_0_bn (BatchNormal  (None, 12, 12, 128)  512        ['pool2_pool[0][0]']
ization)

conv3_block1_0_relu (Activatio  (None, 12, 12, 128)  0          ['conv3_block1_0_bn[0][0]']
n)

conv3_block1_1_conv (Conv2D)   (None, 12, 12, 128)  16384       ['conv3_block1_0_relu[0][0]']

conv3_block1_1_bn (BatchNormal  (None, 12, 12, 128)  512        ['conv3_block1_1_conv[0][0]']
ization)

conv3_block1_1_relu (Activatio  (None, 12, 12, 128)  0          ['conv3_block1_1_bn[0][0]']
n)

conv3_block1_2_conv (Conv2D)   (None, 12, 12, 32)   36864       ['conv3_block1_1_relu[0][0]']

conv3_block1_concat (Concatena  (None, 12, 12, 160)  0          ['pool2_pool[0][0]',
te)                                                              'conv3_block1_2_conv[0][0]']

conv3_block2_0_bn (BatchNormal  (None, 12, 12, 160)  640        ['conv3_block1_concat[0][0]']
ization)

conv3_block2_0_relu (Activatio  (None, 12, 12, 160)  0          ['conv3_block2_0_bn[0][0]']
n)

conv3_block2_1_conv (Conv2D)   (None, 12, 12, 128)  20480       ['conv3_block2_0_relu[0][0]']

conv3_block2_1_bn (BatchNormal  (None, 12, 12, 128)  512        ['conv3_block2_1_conv[0][0]']
ization)

conv3_block2_1_relu (Activatio  (None, 12, 12, 128)  0          ['conv3_block2_1_bn[0][0]']
n)

conv3_block2_2_conv (Conv2D)   (None, 12, 12, 32)   36864       ['conv3_block2_1_relu[0][0]']

conv3_block2_concat (Concatena  (None, 12, 12, 192)  0          ['conv3_block1_concat[0][0]',
te)                                                              'conv3_block2_2_conv[0][0]']

conv3_block3_0_bn (BatchNormal  (None, 12, 12, 192)  768        ['conv3_block2_concat[0][0]']
ization)

conv3_block3_0_relu (Activatio  (None, 12, 12, 192)  0          ['conv3_block3_0_bn[0][0]']
n)

conv3_block3_1_conv (Conv2D)   (None, 12, 12, 128)  24576       ['conv3_block3_0_relu[0][0]']

conv3_block3_1_bn (BatchNormal  (None, 12, 12, 128)  512        ['conv3_block3_1_conv[0][0]']
ization)

conv3_block3_1_relu (Activatio  (None, 12, 12, 128)  0          ['conv3_block3_1_bn[0][0]']
n)

conv3_block3_2_conv (Conv2D)   (None, 12, 12, 32)   36864       ['conv3_block3_1_relu[0][0]']

conv3_block3_concat (Concatena  (None, 12, 12, 224)  0          ['conv3_block2_concat[0][0]',
te)                                                              'conv3_block3_2_conv[0][0]']

conv3_block4_0_bn (BatchNormal  (None, 12, 12, 224)  896        ['conv3_block3_concat[0][0]']
ization)

conv3_block4_0_relu (Activatio  (None, 12, 12, 224)  0          ['conv3_block4_0_bn[0][0]']
n)
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conv3_block4_1_conv (Conv2D)   (None, 12, 12, 128)  28672       ['conv3_block4_0_relu[0][0]']

conv3_block4_1_bn (BatchNormal  (None, 12, 12, 128)  512        ['conv3_block4_1_conv[0][0]']
ization)

conv3_block4_1_relu (Activatio  (None, 12, 12, 128)  0          ['conv3_block4_1_bn[0][0]']
n)

conv3_block4_2_conv (Conv2D)   (None, 12, 12, 32)   36864       ['conv3_block4_1_relu[0][0]']

conv3_block4_concat (Concatena  (None, 12, 12, 256)  0          ['conv3_block3_concat[0][0]',
te)                                                              'conv3_block4_2_conv[0][0]']

conv3_block5_0_bn (BatchNormal  (None, 12, 12, 256)  1024       ['conv3_block4_concat[0][0]']
ization)

conv3_block5_0_relu (Activatio  (None, 12, 12, 256)  0          ['conv3_block5_0_bn[0][0]']
n)

conv3_block5_1_conv (Conv2D)   (None, 12, 12, 128)  32768       ['conv3_block5_0_relu[0][0]']

conv3_block5_1_bn (BatchNormal  (None, 12, 12, 128)  512        ['conv3_block5_1_conv[0][0]']
ization)

conv3_block5_1_relu (Activatio  (None, 12, 12, 128)  0          ['conv3_block5_1_bn[0][0]']
n)

conv3_block5_2_conv (Conv2D)   (None, 12, 12, 32)   36864       ['conv3_block5_1_relu[0][0]']

conv3_block5_concat (Concatena  (None, 12, 12, 288)  0          ['conv3_block4_concat[0][0]',
te)                                                              'conv3_block5_2_conv[0][0]']

conv3_block6_0_bn (BatchNormal  (None, 12, 12, 288)  1152       ['conv3_block5_concat[0][0]']
ization)

conv3_block6_0_relu (Activatio  (None, 12, 12, 288)  0          ['conv3_block6_0_bn[0][0]']
n)

conv3_block6_1_conv (Conv2D)   (None, 12, 12, 128)  36864       ['conv3_block6_0_relu[0][0]']

conv3_block6_1_bn (BatchNormal  (None, 12, 12, 128)  512        ['conv3_block6_1_conv[0][0]']
ization)

conv3_block6_1_relu (Activatio  (None, 12, 12, 128)  0          ['conv3_block6_1_bn[0][0]']
n)

conv3_block6_2_conv (Conv2D)   (None, 12, 12, 32)   36864       ['conv3_block6_1_relu[0][0]']

conv3_block6_concat (Concatena  (None, 12, 12, 320)  0          ['conv3_block5_concat[0][0]',
te)                                                              'conv3_block6_2_conv[0][0]']

conv3_block7_0_bn (BatchNormal  (None, 12, 12, 320)  1280       ['conv3_block6_concat[0][0]']
ization)

conv3_block7_0_relu (Activatio  (None, 12, 12, 320)  0          ['conv3_block7_0_bn[0][0]']
n)

conv3_block7_1_conv (Conv2D)   (None, 12, 12, 128)  40960       ['conv3_block7_0_relu[0][0]']

conv3_block7_1_bn (BatchNormal  (None, 12, 12, 128)  512        ['conv3_block7_1_conv[0][0]']
ization)

conv3_block7_1_relu (Activatio  (None, 12, 12, 128)  0          ['conv3_block7_1_bn[0][0]']
n)

conv3_block7_2_conv (Conv2D)   (None, 12, 12, 32)   36864       ['conv3_block7_1_relu[0][0]']

conv3_block7_concat (Concatena  (None, 12, 12, 352)  0          ['conv3_block6_concat[0][0]',
te)                                                              'conv3_block7_2_conv[0][0]']

conv3_block8_0_bn (BatchNormal  (None, 12, 12, 352)  1408       ['conv3_block7_concat[0][0]']
ization)

conv3_block8_0_relu (Activatio  (None, 12, 12, 352)  0          ['conv3_block8_0_bn[0][0]']
n)

conv3_block8_1_conv (Conv2D)   (None, 12, 12, 128)  45056       ['conv3_block8_0_relu[0][0]']

conv3_block8_1_bn (BatchNormal  (None, 12, 12, 128)  512        ['conv3_block8_1_conv[0][0]']
ization)

conv3_block8_1_relu (Activatio  (None, 12, 12, 128)  0          ['conv3_block8_1_bn[0][0]']
n)

conv3_block8_2_conv (Conv2D)   (None, 12, 12, 32)   36864       ['conv3_block8_1_relu[0][0]']

conv3_block8_concat (Concatena  (None, 12, 12, 384)  0          ['conv3_block7_concat[0][0]',
te)                                                              'conv3_block8_2_conv[0][0]']

conv3_block9_0_bn (BatchNormal  (None, 12, 12, 384)  1536       ['conv3_block8_concat[0][0]']
ization)

conv3_block9_0_relu (Activatio  (None, 12, 12, 384)  0          ['conv3_block9_0_bn[0][0]']
n)

conv3_block9_1_conv (Conv2D)   (None, 12, 12, 128)  49152       ['conv3_block9_0_relu[0][0]']

conv3_block9_1_bn (BatchNormal  (None, 12, 12, 128)  512        ['conv3_block9_1_conv[0][0]']
ization)

conv3_block9_1_relu (Activatio  (None, 12, 12, 128)  0          ['conv3_block9_1_bn[0][0]']
```

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n)

conv3_block9_2_conv (Conv2D)   (None, 12, 12, 32)   36864       ['conv3_block9_1_relu[0][0]']

conv3_block9_concat (Concatena  (None, 12, 12, 416)  0          ['conv3_block8_concat[0][0]',
te)                                                              'conv3_block9_2_conv[0][0]']

conv3_block10_0_bn (BatchNorma  (None, 12, 12, 416)  1664       ['conv3_block9_concat[0][0]']
lization)

conv3_block10_0_relu (Activati  (None, 12, 12, 416)  0          ['conv3_block10_0_bn[0][0]']
on)

conv3_block10_1_conv (Conv2D)  (None, 12, 12, 128)  53248       ['conv3_block10_0_relu[0][0]']

conv3_block10_1_bn (BatchNorma  (None, 12, 12, 128)  512        ['conv3_block10_1_conv[0][0]']
lization)

conv3_block10_1_relu (Activati  (None, 12, 12, 128)  0          ['conv3_block10_1_bn[0][0]']
on)

conv3_block10_2_conv (Conv2D)  (None, 12, 12, 32)   36864       ['conv3_block10_1_relu[0][0]']

conv3_block10_concat (Concaten  (None, 12, 12, 448)  0          ['conv3_block9_concat[0][0]',
ate)                                                             'conv3_block10_2_conv[0][0]']

conv3_block11_0_bn (BatchNorma  (None, 12, 12, 448)  1792       ['conv3_block10_concat[0][0]']
lization)

conv3_block11_0_relu (Activati  (None, 12, 12, 448)  0          ['conv3_block11_0_bn[0][0]']
on)

conv3_block11_1_conv (Conv2D)  (None, 12, 12, 128)  57344       ['conv3_block11_0_relu[0][0]']

conv3_block11_1_bn (BatchNorma  (None, 12, 12, 128)  512        ['conv3_block11_1_conv[0][0]']
lization)

conv3_block11_1_relu (Activati  (None, 12, 12, 128)  0          ['conv3_block11_1_bn[0][0]']
on)

conv3_block11_2_conv (Conv2D)  (None, 12, 12, 32)   36864       ['conv3_block11_1_relu[0][0]']

conv3_block11_concat (Concaten  (None, 12, 12, 480)  0          ['conv3_block10_concat[0][0]',
ate)                                                             'conv3_block11_2_conv[0][0]']

conv3_block12_0_bn (BatchNorma  (None, 12, 12, 480)  1920       ['conv3_block11_concat[0][0]']
lization)

conv3_block12_0_relu (Activati  (None, 12, 12, 480)  0          ['conv3_block12_0_bn[0][0]']
on)

conv3_block12_1_conv (Conv2D)  (None, 12, 12, 128)  61440       ['conv3_block12_0_relu[0][0]']

conv3_block12_1_bn (BatchNorma  (None, 12, 12, 128)  512        ['conv3_block12_1_conv[0][0]']
lization)

conv3_block12_1_relu (Activati  (None, 12, 12, 128)  0          ['conv3_block12_1_bn[0][0]']
on)

conv3_block12_2_conv (Conv2D)  (None, 12, 12, 32)   36864       ['conv3_block12_1_relu[0][0]']

conv3_block12_concat (Concaten  (None, 12, 12, 512)  0          ['conv3_block11_concat[0][0]',
ate)                                                             'conv3_block12_2_conv[0][0]']

pool3_bn (BatchNormalization)  (None, 12, 12, 512)  2048        ['conv3_block12_concat[0][0]']

pool3_relu (Activation)        (None, 12, 12, 512)  0           ['pool3_bn[0][0]']

pool3_conv (Conv2D)            (None, 12, 12, 256)  131072      ['pool3_relu[0][0]']

pool3_pool (AveragePooling2D)  (None, 6, 6, 256)    0           ['pool3_conv[0][0]']

conv4_block1_0_bn (BatchNormal  (None, 6, 6, 256)   1024        ['pool3_pool[0][0]']
ization)

conv4_block1_0_relu (Activatio  (None, 6, 6, 256)   0           ['conv4_block1_0_bn[0][0]']
n)

conv4_block1_1_conv (Conv2D)   (None, 6, 6, 128)    32768       ['conv4_block1_0_relu[0][0]']

conv4_block1_1_bn (BatchNormal  (None, 6, 6, 128)   512         ['conv4_block1_1_conv[0][0]']
ization)

conv4_block1_1_relu (Activatio  (None, 6, 6, 128)   0           ['conv4_block1_1_bn[0][0]']
n)

conv4_block1_2_conv (Conv2D)   (None, 6, 6, 32)     36864       ['conv4_block1_1_relu[0][0]']

conv4_block1_concat (Concatena  (None, 6, 6, 288)   0           ['pool3_pool[0][0]',
te)                                                              'conv4_block1_2_conv[0][0]']

conv4_block2_0_bn (BatchNormal  (None, 6, 6, 288)   1152        ['conv4_block1_concat[0][0]']
ization)

conv4_block2_0_relu (Activatio  (None, 6, 6, 288)   0           ['conv4_block2_0_bn[0][0]']
n)

conv4_block2_1_conv (Conv2D)   (None, 6, 6, 128)    36864       ['conv4_block2_0_relu[0][0]']

conv4_block2_1_bn (BatchNormal  (None, 6, 6, 128)   512         ['conv4_block2_1_conv[0][0]']
ization)
```

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conv4_block2_1_relu (Activatio  (None, 6, 6, 128)   0           ['conv4_block2_1_bn[0][0]']
n)

conv4_block2_2_conv (Conv2D)   (None, 6, 6, 32)     36864       ['conv4_block2_1_relu[0][0]']

conv4_block2_concat (Concatena  (None, 6, 6, 320)   0           ['conv4_block1_concat[0][0]',
te)                                                              'conv4_block2_2_conv[0][0]']

conv4_block3_0_bn (BatchNormal  (None, 6, 6, 320)   1280        ['conv4_block2_concat[0][0]']
ization)

conv4_block3_0_relu (Activatio  (None, 6, 6, 320)   0           ['conv4_block3_0_bn[0][0]']
n)

conv4_block3_1_conv (Conv2D)   (None, 6, 6, 128)    40960       ['conv4_block3_0_relu[0][0]']

conv4_block3_1_bn (BatchNormal  (None, 6, 6, 128)   512         ['conv4_block3_1_conv[0][0]']
ization)

conv4_block3_1_relu (Activatio  (None, 6, 6, 128)   0           ['conv4_block3_1_bn[0][0]']
n)

conv4_block3_2_conv (Conv2D)   (None, 6, 6, 32)     36864       ['conv4_block3_1_relu[0][0]']

conv4_block3_concat (Concatena  (None, 6, 6, 352)   0           ['conv4_block2_concat[0][0]',
te)                                                              'conv4_block3_2_conv[0][0]']

conv4_block4_0_bn (BatchNormal  (None, 6, 6, 352)   1408        ['conv4_block3_concat[0][0]']
ization)

conv4_block4_0_relu (Activatio  (None, 6, 6, 352)   0           ['conv4_block4_0_bn[0][0]']
n)

conv4_block4_1_conv (Conv2D)   (None, 6, 6, 128)    45056       ['conv4_block4_0_relu[0][0]']

conv4_block4_1_bn (BatchNormal  (None, 6, 6, 128)   512         ['conv4_block4_1_conv[0][0]']
ization)

conv4_block4_1_relu (Activatio  (None, 6, 6, 128)   0           ['conv4_block4_1_bn[0][0]']
n)

conv4_block4_2_conv (Conv2D)   (None, 6, 6, 32)     36864       ['conv4_block4_1_relu[0][0]']

conv4_block4_concat (Concatena  (None, 6, 6, 384)   0           ['conv4_block3_concat[0][0]',
te)                                                              'conv4_block4_2_conv[0][0]']

conv4_block5_0_bn (BatchNormal  (None, 6, 6, 384)   1536        ['conv4_block4_concat[0][0]']
ization)

conv4_block5_0_relu (Activatio  (None, 6, 6, 384)   0           ['conv4_block5_0_bn[0][0]']
n)

conv4_block5_1_conv (Conv2D)   (None, 6, 6, 128)    49152       ['conv4_block5_0_relu[0][0]']

conv4_block5_1_bn (BatchNormal  (None, 6, 6, 128)   512         ['conv4_block5_1_conv[0][0]']
ization)

conv4_block5_1_relu (Activatio  (None, 6, 6, 128)   0           ['conv4_block5_1_bn[0][0]']
n)

conv4_block5_2_conv (Conv2D)   (None, 6, 6, 32)     36864       ['conv4_block5_1_relu[0][0]']

conv4_block5_concat (Concatena  (None, 6, 6, 416)   0           ['conv4_block4_concat[0][0]',
te)                                                              'conv4_block5_2_conv[0][0]']

conv4_block6_0_bn (BatchNormal  (None, 6, 6, 416)   1664        ['conv4_block5_concat[0][0]']
ization)

conv4_block6_0_relu (Activatio  (None, 6, 6, 416)   0           ['conv4_block6_0_bn[0][0]']
n)

conv4_block6_1_conv (Conv2D)   (None, 6, 6, 128)    53248       ['conv4_block6_0_relu[0][0]']

conv4_block6_1_bn (BatchNormal  (None, 6, 6, 128)   512         ['conv4_block6_1_conv[0][0]']
ization)

conv4_block6_1_relu (Activatio  (None, 6, 6, 128)   0           ['conv4_block6_1_bn[0][0]']
n)

conv4_block6_2_conv (Conv2D)   (None, 6, 6, 32)     36864       ['conv4_block6_1_relu[0][0]']

conv4_block6_concat (Concatena  (None, 6, 6, 448)   0           ['conv4_block5_concat[0][0]',
te)                                                              'conv4_block6_2_conv[0][0]']

conv4_block7_0_bn (BatchNormal  (None, 6, 6, 448)   1792        ['conv4_block6_concat[0][0]']
ization)

conv4_block7_0_relu (Activatio  (None, 6, 6, 448)   0           ['conv4_block7_0_bn[0][0]']
n)

conv4_block7_1_conv (Conv2D)   (None, 6, 6, 128)    57344       ['conv4_block7_0_relu[0][0]']

conv4_block7_1_bn (BatchNormal  (None, 6, 6, 128)   512         ['conv4_block7_1_conv[0][0]']
ization)

conv4_block7_1_relu (Activatio  (None, 6, 6, 128)   0           ['conv4_block7_1_bn[0][0]']
n)

conv4_block7_2_conv (Conv2D)   (None, 6, 6, 32)     36864       ['conv4_block7_1_relu[0][0]']

conv4_block7_concat (Concatena  (None, 6, 6, 480)   0           ['conv4_block6_concat[0][0]',
te)                                                              'conv4_block7_2_conv[0][0]']
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conv4_block8_0_bn (BatchNormal  (None, 6, 6, 480)   1920        ['conv4_block7_concat[0][0]']
ization)

conv4_block8_0_relu (Activatio  (None, 6, 6, 480)   0           ['conv4_block8_0_bn[0][0]']
n)

conv4_block8_1_conv (Conv2D)   (None, 6, 6, 128)    61440       ['conv4_block8_0_relu[0][0]']

conv4_block8_1_bn (BatchNormal  (None, 6, 6, 128)   512         ['conv4_block8_1_conv[0][0]']
ization)

conv4_block8_1_relu (Activatio  (None, 6, 6, 128)   0           ['conv4_block8_1_bn[0][0]']
n)

conv4_block8_2_conv (Conv2D)   (None, 6, 6, 32)     36864       ['conv4_block8_1_relu[0][0]']

conv4_block8_concat (Concatena  (None, 6, 6, 512)   0           ['conv4_block7_concat[0][0]',
te)                                                              'conv4_block8_2_conv[0][0]']

conv4_block9_0_bn (BatchNormal  (None, 6, 6, 512)   2048        ['conv4_block8_concat[0][0]']
ization)

conv4_block9_0_relu (Activatio  (None, 6, 6, 512)   0           ['conv4_block9_0_bn[0][0]']
n)

conv4_block9_1_conv (Conv2D)   (None, 6, 6, 128)    65536       ['conv4_block9_0_relu[0][0]']

conv4_block9_1_bn (BatchNormal  (None, 6, 6, 128)   512         ['conv4_block9_1_conv[0][0]']
ization)

conv4_block9_1_relu (Activatio  (None, 6, 6, 128)   0           ['conv4_block9_1_bn[0][0]']
n)

conv4_block9_2_conv (Conv2D)   (None, 6, 6, 32)     36864       ['conv4_block9_1_relu[0][0]']

conv4_block9_concat (Concatena  (None, 6, 6, 544)   0           ['conv4_block8_concat[0][0]',
te)                                                              'conv4_block9_2_conv[0][0]']

conv4_block10_0_bn (BatchNorma  (None, 6, 6, 544)   2176        ['conv4_block9_concat[0][0]']
lization)

conv4_block10_0_relu (Activati  (None, 6, 6, 544)   0           ['conv4_block10_0_bn[0][0]']
on)

conv4_block10_1_conv (Conv2D)  (None, 6, 6, 128)    69632       ['conv4_block10_0_relu[0][0]']

conv4_block10_1_bn (BatchNorma  (None, 6, 6, 128)   512         ['conv4_block10_1_conv[0][0]']
lization)

conv4_block10_1_relu (Activati  (None, 6, 6, 128)   0           ['conv4_block10_1_bn[0][0]']
on)

conv4_block10_2_conv (Conv2D)  (None, 6, 6, 32)     36864       ['conv4_block10_1_relu[0][0]']

conv4_block10_concat (Concaten  (None, 6, 6, 576)   0           ['conv4_block9_concat[0][0]',
ate)                                                             'conv4_block10_2_conv[0][0]']

conv4_block11_0_bn (BatchNorma  (None, 6, 6, 576)   2304        ['conv4_block10_concat[0][0]']
lization)

conv4_block11_0_relu (Activati  (None, 6, 6, 576)   0           ['conv4_block11_0_bn[0][0]']
on)

conv4_block11_1_conv (Conv2D)  (None, 6, 6, 128)    73728       ['conv4_block11_0_relu[0][0]']

conv4_block11_1_bn (BatchNorma  (None, 6, 6, 128)   512         ['conv4_block11_1_conv[0][0]']
lization)

conv4_block11_1_relu (Activati  (None, 6, 6, 128)   0           ['conv4_block11_1_bn[0][0]']
on)

conv4_block11_2_conv (Conv2D)  (None, 6, 6, 32)     36864       ['conv4_block11_1_relu[0][0]']

conv4_block11_concat (Concaten  (None, 6, 6, 608)   0           ['conv4_block10_concat[0][0]',
ate)                                                             'conv4_block11_2_conv[0][0]']

conv4_block12_0_bn (BatchNorma  (None, 6, 6, 608)   2432        ['conv4_block11_concat[0][0]']
lization)

conv4_block12_0_relu (Activati  (None, 6, 6, 608)   0           ['conv4_block12_0_bn[0][0]']
on)

conv4_block12_1_conv (Conv2D)  (None, 6, 6, 128)    77824       ['conv4_block12_0_relu[0][0]']

conv4_block12_1_bn (BatchNorma  (None, 6, 6, 128)   512         ['conv4_block12_1_conv[0][0]']
lization)

conv4_block12_1_relu (Activati  (None, 6, 6, 128)   0           ['conv4_block12_1_bn[0][0]']
on)

conv4_block12_2_conv (Conv2D)  (None, 6, 6, 32)     36864       ['conv4_block12_1_relu[0][0]']

conv4_block12_concat (Concaten  (None, 6, 6, 640)   0           ['conv4_block11_concat[0][0]',
ate)                                                             'conv4_block12_2_conv[0][0]']

conv4_block13_0_bn (BatchNorma  (None, 6, 6, 640)   2560        ['conv4_block12_concat[0][0]']
lization)

conv4_block13_0_relu (Activati  (None, 6, 6, 640)   0           ['conv4_block13_0_bn[0][0]']
on)
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conv4_block13_1_conv (Conv2D)  (None, 6, 6, 128)    81920       ['conv4_block13_0_relu[0][0]']

conv4_block13_1_bn (BatchNorma  (None, 6, 6, 128)   512         ['conv4_block13_1_conv[0][0]']
lization)

conv4_block13_1_relu (Activati  (None, 6, 6, 128)   0           ['conv4_block13_1_bn[0][0]']
on)

conv4_block13_2_conv (Conv2D)  (None, 6, 6, 32)     36864       ['conv4_block13_1_relu[0][0]']

conv4_block13_concat (Concaten  (None, 6, 6, 672)   0           ['conv4_block12_concat[0][0]',
ate)                                                             'conv4_block13_2_conv[0][0]']

conv4_block14_0_bn (BatchNorma  (None, 6, 6, 672)   2688        ['conv4_block13_concat[0][0]']
lization)

conv4_block14_0_relu (Activati  (None, 6, 6, 672)   0           ['conv4_block14_0_bn[0][0]']
on)

conv4_block14_1_conv (Conv2D)  (None, 6, 6, 128)    86016       ['conv4_block14_0_relu[0][0]']

conv4_block14_1_bn (BatchNorma  (None, 6, 6, 128)   512         ['conv4_block14_1_conv[0][0]']
lization)

conv4_block14_1_relu (Activati  (None, 6, 6, 128)   0           ['conv4_block14_1_bn[0][0]']
on)

conv4_block14_2_conv (Conv2D)  (None, 6, 6, 32)     36864       ['conv4_block14_1_relu[0][0]']

conv4_block14_concat (Concaten  (None, 6, 6, 704)   0           ['conv4_block13_concat[0][0]',
ate)                                                             'conv4_block14_2_conv[0][0]']

conv4_block15_0_bn (BatchNorma  (None, 6, 6, 704)   2816        ['conv4_block14_concat[0][0]']
lization)

conv4_block15_0_relu (Activati  (None, 6, 6, 704)   0           ['conv4_block15_0_bn[0][0]']
on)

conv4_block15_1_conv (Conv2D)  (None, 6, 6, 128)    90112       ['conv4_block15_0_relu[0][0]']

conv4_block15_1_bn (BatchNorma  (None, 6, 6, 128)   512         ['conv4_block15_1_conv[0][0]']
lization)

conv4_block15_1_relu (Activati  (None, 6, 6, 128)   0           ['conv4_block15_1_bn[0][0]']
on)

conv4_block15_2_conv (Conv2D)  (None, 6, 6, 32)     36864       ['conv4_block15_1_relu[0][0]']

conv4_block15_concat (Concaten  (None, 6, 6, 736)   0           ['conv4_block14_concat[0][0]',
ate)                                                             'conv4_block15_2_conv[0][0]']

conv4_block16_0_bn (BatchNorma  (None, 6, 6, 736)   2944        ['conv4_block15_concat[0][0]']
lization)

conv4_block16_0_relu (Activati  (None, 6, 6, 736)   0           ['conv4_block16_0_bn[0][0]']
on)

conv4_block16_1_conv (Conv2D)  (None, 6, 6, 128)    94208       ['conv4_block16_0_relu[0][0]']

conv4_block16_1_bn (BatchNorma  (None, 6, 6, 128)   512         ['conv4_block16_1_conv[0][0]']
lization)

conv4_block16_1_relu (Activati  (None, 6, 6, 128)   0           ['conv4_block16_1_bn[0][0]']
on)

conv4_block16_2_conv (Conv2D)  (None, 6, 6, 32)     36864       ['conv4_block16_1_relu[0][0]']

conv4_block16_concat (Concaten  (None, 6, 6, 768)   0           ['conv4_block15_concat[0][0]',
ate)                                                             'conv4_block16_2_conv[0][0]']

conv4_block17_0_bn (BatchNorma  (None, 6, 6, 768)   3072        ['conv4_block16_concat[0][0]']
lization)

conv4_block17_0_relu (Activati  (None, 6, 6, 768)   0           ['conv4_block17_0_bn[0][0]']
on)

conv4_block17_1_conv (Conv2D)  (None, 6, 6, 128)    98304       ['conv4_block17_0_relu[0][0]']

conv4_block17_1_bn (BatchNorma  (None, 6, 6, 128)   512         ['conv4_block17_1_conv[0][0]']
lization)

conv4_block17_1_relu (Activati  (None, 6, 6, 128)   0           ['conv4_block17_1_bn[0][0]']
on)

conv4_block17_2_conv (Conv2D)  (None, 6, 6, 32)     36864       ['conv4_block17_1_relu[0][0]']

conv4_block17_concat (Concaten  (None, 6, 6, 800)   0           ['conv4_block16_concat[0][0]',
ate)                                                             'conv4_block17_2_conv[0][0]']

conv4_block18_0_bn (BatchNorma  (None, 6, 6, 800)   3200        ['conv4_block17_concat[0][0]']
lization)

conv4_block18_0_relu (Activati  (None, 6, 6, 800)   0           ['conv4_block18_0_bn[0][0]']
on)

conv4_block18_1_conv (Conv2D)  (None, 6, 6, 128)    102400      ['conv4_block18_0_relu[0][0]']

conv4_block18_1_bn (BatchNorma  (None, 6, 6, 128)   512         ['conv4_block18_1_conv[0][0]']
lization)

conv4_block18_1_relu (Activati  (None, 6, 6, 128)   0           ['conv4_block18_1_bn[0][0]']
on)
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conv4_block18_2_conv (Conv2D)  (None, 6, 6, 32)     36864       ['conv4_block18_1_relu[0][0]']

conv4_block18_concat (Concaten  (None, 6, 6, 832)   0           ['conv4_block17_concat[0][0]',
ate)                                                             'conv4_block18_2_conv[0][0]']

conv4_block19_0_bn (BatchNorma  (None, 6, 6, 832)   3328        ['conv4_block18_concat[0][0]']
lization)

conv4_block19_0_relu (Activati  (None, 6, 6, 832)   0           ['conv4_block19_0_bn[0][0]']
on)

conv4_block19_1_conv (Conv2D)  (None, 6, 6, 128)    106496      ['conv4_block19_0_relu[0][0]']

conv4_block19_1_bn (BatchNorma  (None, 6, 6, 128)   512         ['conv4_block19_1_conv[0][0]']
lization)

conv4_block19_1_relu (Activati  (None, 6, 6, 128)   0           ['conv4_block19_1_bn[0][0]']
on)

conv4_block19_2_conv (Conv2D)  (None, 6, 6, 32)     36864       ['conv4_block19_1_relu[0][0]']

conv4_block19_concat (Concaten  (None, 6, 6, 864)   0           ['conv4_block18_concat[0][0]',
ate)                                                             'conv4_block19_2_conv[0][0]']

conv4_block20_0_bn (BatchNorma  (None, 6, 6, 864)   3456        ['conv4_block19_concat[0][0]']
lization)

conv4_block20_0_relu (Activati  (None, 6, 6, 864)   0           ['conv4_block20_0_bn[0][0]']
on)

conv4_block20_1_conv (Conv2D)  (None, 6, 6, 128)    110592      ['conv4_block20_0_relu[0][0]']

conv4_block20_1_bn (BatchNorma  (None, 6, 6, 128)   512         ['conv4_block20_1_conv[0][0]']
lization)

conv4_block20_1_relu (Activati  (None, 6, 6, 128)   0           ['conv4_block20_1_bn[0][0]']
on)

conv4_block20_2_conv (Conv2D)  (None, 6, 6, 32)     36864       ['conv4_block20_1_relu[0][0]']

conv4_block20_concat (Concaten  (None, 6, 6, 896)   0           ['conv4_block19_concat[0][0]',
ate)                                                             'conv4_block20_2_conv[0][0]']

conv4_block21_0_bn (BatchNorma  (None, 6, 6, 896)   3584        ['conv4_block20_concat[0][0]']
lization)

conv4_block21_0_relu (Activati  (None, 6, 6, 896)   0           ['conv4_block21_0_bn[0][0]']
on)

conv4_block21_1_conv (Conv2D)  (None, 6, 6, 128)    114688      ['conv4_block21_0_relu[0][0]']

conv4_block21_1_bn (BatchNorma  (None, 6, 6, 128)   512         ['conv4_block21_1_conv[0][0]']
lization)

conv4_block21_1_relu (Activati  (None, 6, 6, 128)   0           ['conv4_block21_1_bn[0][0]']
on)

conv4_block21_2_conv (Conv2D)  (None, 6, 6, 32)     36864       ['conv4_block21_1_relu[0][0]']

conv4_block21_concat (Concaten  (None, 6, 6, 928)   0           ['conv4_block20_concat[0][0]',
ate)                                                             'conv4_block21_2_conv[0][0]']

conv4_block22_0_bn (BatchNorma  (None, 6, 6, 928)   3712        ['conv4_block21_concat[0][0]']
lization)

conv4_block22_0_relu (Activati  (None, 6, 6, 928)   0           ['conv4_block22_0_bn[0][0]']
on)

conv4_block22_1_conv (Conv2D)  (None, 6, 6, 128)    118784      ['conv4_block22_0_relu[0][0]']

conv4_block22_1_bn (BatchNorma  (None, 6, 6, 128)   512         ['conv4_block22_1_conv[0][0]']
lization)

conv4_block22_1_relu (Activati  (None, 6, 6, 128)   0           ['conv4_block22_1_bn[0][0]']
on)

conv4_block22_2_conv (Conv2D)  (None, 6, 6, 32)     36864       ['conv4_block22_1_relu[0][0]']

conv4_block22_concat (Concaten  (None, 6, 6, 960)   0           ['conv4_block21_concat[0][0]',
ate)                                                             'conv4_block22_2_conv[0][0]']

conv4_block23_0_bn (BatchNorma  (None, 6, 6, 960)   3840        ['conv4_block22_concat[0][0]']
lization)

conv4_block23_0_relu (Activati  (None, 6, 6, 960)   0           ['conv4_block23_0_bn[0][0]']
on)

conv4_block23_1_conv (Conv2D)  (None, 6, 6, 128)    122880      ['conv4_block23_0_relu[0][0]']

conv4_block23_1_bn (BatchNorma  (None, 6, 6, 128)   512         ['conv4_block23_1_conv[0][0]']
lization)

conv4_block23_1_relu (Activati  (None, 6, 6, 128)   0           ['conv4_block23_1_bn[0][0]']
on)

conv4_block23_2_conv (Conv2D)  (None, 6, 6, 32)     36864       ['conv4_block23_1_relu[0][0]']

conv4_block23_concat (Concaten  (None, 6, 6, 992)   0           ['conv4_block22_concat[0][0]',
ate)                                                             'conv4_block23_2_conv[0][0]']

conv4_block24_0_bn (BatchNorma  (None, 6, 6, 992)   3968        ['conv4_block23_concat[0][0]']
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lization)

conv4_block24_0_relu (Activati  (None, 6, 6, 992)   0           ['conv4_block24_0_bn[0][0]']
on)

conv4_block24_1_conv (Conv2D)  (None, 6, 6, 128)    126976      ['conv4_block24_0_relu[0][0]']

conv4_block24_1_bn (BatchNorma  (None, 6, 6, 128)   512         ['conv4_block24_1_conv[0][0]']
lization)

conv4_block24_1_relu (Activati  (None, 6, 6, 128)   0           ['conv4_block24_1_bn[0][0]']
on)

conv4_block24_2_conv (Conv2D)  (None, 6, 6, 32)     36864       ['conv4_block24_1_relu[0][0]']

conv4_block24_concat (Concaten  (None, 6, 6, 1024)  0           ['conv4_block23_concat[0][0]',
ate)                                                             'conv4_block24_2_conv[0][0]']

pool4_bn (BatchNormalization)  (None, 6, 6, 1024)   4096        ['conv4_block24_concat[0][0]']

pool4_relu (Activation)        (None, 6, 6, 1024)   0           ['pool4_bn[0][0]']

pool4_conv (Conv2D)            (None, 6, 6, 512)    524288      ['pool4_relu[0][0]']

pool4_pool (AveragePooling2D)  (None, 3, 3, 512)    0           ['pool4_conv[0][0]']

conv5_block1_0_bn (BatchNormal  (None, 3, 3, 512)   2048        ['pool4_pool[0][0]']
ization)

conv5_block1_0_relu (Activatio  (None, 3, 3, 512)   0           ['conv5_block1_0_bn[0][0]']
n)

conv5_block1_1_conv (Conv2D)   (None, 3, 3, 128)    65536       ['conv5_block1_0_relu[0][0]']

conv5_block1_1_bn (BatchNormal  (None, 3, 3, 128)   512         ['conv5_block1_1_conv[0][0]']
ization)

conv5_block1_1_relu (Activatio  (None, 3, 3, 128)   0           ['conv5_block1_1_bn[0][0]']
n)

conv5_block1_2_conv (Conv2D)   (None, 3, 3, 32)     36864       ['conv5_block1_1_relu[0][0]']

conv5_block1_concat (Concatena  (None, 3, 3, 544)   0           ['pool4_pool[0][0]',
te)                                                              'conv5_block1_2_conv[0][0]']

conv5_block2_0_bn (BatchNormal  (None, 3, 3, 544)   2176        ['conv5_block1_concat[0][0]']
ization)

conv5_block2_0_relu (Activatio  (None, 3, 3, 544)   0           ['conv5_block2_0_bn[0][0]']
n)

conv5_block2_1_conv (Conv2D)   (None, 3, 3, 128)    69632       ['conv5_block2_0_relu[0][0]']

conv5_block2_1_bn (BatchNormal  (None, 3, 3, 128)   512         ['conv5_block2_1_conv[0][0]']
ization)

conv5_block2_1_relu (Activatio  (None, 3, 3, 128)   0           ['conv5_block2_1_bn[0][0]']
n)

conv5_block2_2_conv (Conv2D)   (None, 3, 3, 32)     36864       ['conv5_block2_1_relu[0][0]']

conv5_block2_concat (Concatena  (None, 3, 3, 576)   0           ['conv5_block1_concat[0][0]',
te)                                                              'conv5_block2_2_conv[0][0]']

conv5_block3_0_bn (BatchNormal  (None, 3, 3, 576)   2304        ['conv5_block2_concat[0][0]']
ization)

conv5_block3_0_relu (Activatio  (None, 3, 3, 576)   0           ['conv5_block3_0_bn[0][0]']
n)

conv5_block3_1_conv (Conv2D)   (None, 3, 3, 128)    73728       ['conv5_block3_0_relu[0][0]']

conv5_block3_1_bn (BatchNormal  (None, 3, 3, 128)   512         ['conv5_block3_1_conv[0][0]']
ization)

conv5_block3_1_relu (Activatio  (None, 3, 3, 128)   0           ['conv5_block3_1_bn[0][0]']
n)

conv5_block3_2_conv (Conv2D)   (None, 3, 3, 32)     36864       ['conv5_block3_1_relu[0][0]']

conv5_block3_concat (Concatena  (None, 3, 3, 608)   0           ['conv5_block2_concat[0][0]',
te)                                                              'conv5_block3_2_conv[0][0]']

conv5_block4_0_bn (BatchNormal  (None, 3, 3, 608)   2432        ['conv5_block3_concat[0][0]']
ization)

conv5_block4_0_relu (Activatio  (None, 3, 3, 608)   0           ['conv5_block4_0_bn[0][0]']
n)

conv5_block4_1_conv (Conv2D)   (None, 3, 3, 128)    77824       ['conv5_block4_0_relu[0][0]']

conv5_block4_1_bn (BatchNormal  (None, 3, 3, 128)   512         ['conv5_block4_1_conv[0][0]']
ization)

conv5_block4_1_relu (Activatio  (None, 3, 3, 128)   0           ['conv5_block4_1_bn[0][0]']
n)

conv5_block4_2_conv (Conv2D)   (None, 3, 3, 32)     36864       ['conv5_block4_1_relu[0][0]']

conv5_block4_concat (Concatena  (None, 3, 3, 640)   0           ['conv5_block3_concat[0][0]',
te)                                                              'conv5_block4_2_conv[0][0]']
```

```
conv5_block5_0_bn (BatchNormal  (None, 3, 3, 640)   2560        ['conv5_block4_concat[0][0]']
ization)

conv5_block5_0_relu (Activatio  (None, 3, 3, 640)   0           ['conv5_block5_0_bn[0][0]']
n)

conv5_block5_1_conv (Conv2D)   (None, 3, 3, 128)    81920       ['conv5_block5_0_relu[0][0]']

conv5_block5_1_bn (BatchNormal  (None, 3, 3, 128)   512         ['conv5_block5_1_conv[0][0]']
ization)

conv5_block5_1_relu (Activatio  (None, 3, 3, 128)   0           ['conv5_block5_1_bn[0][0]']
n)

conv5_block5_2_conv (Conv2D)   (None, 3, 3, 32)     36864       ['conv5_block5_1_relu[0][0]']

conv5_block5_concat (Concatena  (None, 3, 3, 672)   0           ['conv5_block4_concat[0][0]',
te)                                                              'conv5_block5_2_conv[0][0]']

conv5_block6_0_bn (BatchNormal  (None, 3, 3, 672)   2688        ['conv5_block5_concat[0][0]']
ization)

conv5_block6_0_relu (Activatio  (None, 3, 3, 672)   0           ['conv5_block6_0_bn[0][0]']
n)

conv5_block6_1_conv (Conv2D)   (None, 3, 3, 128)    86016       ['conv5_block6_0_relu[0][0]']

conv5_block6_1_bn (BatchNormal  (None, 3, 3, 128)   512         ['conv5_block6_1_conv[0][0]']
ization)

conv5_block6_1_relu (Activatio  (None, 3, 3, 128)   0           ['conv5_block6_1_bn[0][0]']
n)

conv5_block6_2_conv (Conv2D)   (None, 3, 3, 32)     36864       ['conv5_block6_1_relu[0][0]']

conv5_block6_concat (Concatena  (None, 3, 3, 704)   0           ['conv5_block5_concat[0][0]',
te)                                                              'conv5_block6_2_conv[0][0]']

conv5_block7_0_bn (BatchNormal  (None, 3, 3, 704)   2816        ['conv5_block6_concat[0][0]']
ization)

conv5_block7_0_relu (Activatio  (None, 3, 3, 704)   0           ['conv5_block7_0_bn[0][0]']
n)

conv5_block7_1_conv (Conv2D)   (None, 3, 3, 128)    90112       ['conv5_block7_0_relu[0][0]']

conv5_block7_1_bn (BatchNormal  (None, 3, 3, 128)   512         ['conv5_block7_1_conv[0][0]']
ization)

conv5_block7_1_relu (Activatio  (None, 3, 3, 128)   0           ['conv5_block7_1_bn[0][0]']
n)

conv5_block7_2_conv (Conv2D)   (None, 3, 3, 32)     36864       ['conv5_block7_1_relu[0][0]']

conv5_block7_concat (Concatena  (None, 3, 3, 736)   0           ['conv5_block6_concat[0][0]',
te)                                                              'conv5_block7_2_conv[0][0]']

conv5_block8_0_bn (BatchNormal  (None, 3, 3, 736)   2944        ['conv5_block7_concat[0][0]']
ization)

conv5_block8_0_relu (Activatio  (None, 3, 3, 736)   0           ['conv5_block8_0_bn[0][0]']
n)

conv5_block8_1_conv (Conv2D)   (None, 3, 3, 128)    94208       ['conv5_block8_0_relu[0][0]']

conv5_block8_1_bn (BatchNormal  (None, 3, 3, 128)   512         ['conv5_block8_1_conv[0][0]']
ization)

conv5_block8_1_relu (Activatio  (None, 3, 3, 128)   0           ['conv5_block8_1_bn[0][0]']
n)

conv5_block8_2_conv (Conv2D)   (None, 3, 3, 32)     36864       ['conv5_block8_1_relu[0][0]']

conv5_block8_concat (Concatena  (None, 3, 3, 768)   0           ['conv5_block7_concat[0][0]',
te)                                                              'conv5_block8_2_conv[0][0]']

conv5_block9_0_bn (BatchNormal  (None, 3, 3, 768)   3072        ['conv5_block8_concat[0][0]']
ization)

conv5_block9_0_relu (Activatio  (None, 3, 3, 768)   0           ['conv5_block9_0_bn[0][0]']
n)

conv5_block9_1_conv (Conv2D)   (None, 3, 3, 128)    98304       ['conv5_block9_0_relu[0][0]']

conv5_block9_1_bn (BatchNormal  (None, 3, 3, 128)   512         ['conv5_block9_1_conv[0][0]']
ization)

conv5_block9_1_relu (Activatio  (None, 3, 3, 128)   0           ['conv5_block9_1_bn[0][0]']
n)

conv5_block9_2_conv (Conv2D)   (None, 3, 3, 32)     36864       ['conv5_block9_1_relu[0][0]']

conv5_block9_concat (Concatena  (None, 3, 3, 800)   0           ['conv5_block8_concat[0][0]',
te)                                                              'conv5_block9_2_conv[0][0]']

conv5_block10_0_bn (BatchNorma  (None, 3, 3, 800)   3200        ['conv5_block9_concat[0][0]']
lization)

conv5_block10_0_relu (Activati  (None, 3, 3, 800)   0           ['conv5_block10_0_bn[0][0]']
on)

conv5_block10_1_conv (Conv2D)  (None, 3, 3, 128)    102400      ['conv5_block10_0_relu[0][0]']
```

```
conv5_block10_1_bn (BatchNorma  (None, 3, 3, 128)   512         ['conv5_block10_1_conv[0][0]']
lization)

conv5_block10_1_relu (Activati  (None, 3, 3, 128)   0           ['conv5_block10_1_bn[0][0]']
on)

conv5_block10_2_conv (Conv2D)  (None, 3, 3, 32)     36864       ['conv5_block10_1_relu[0][0]']

conv5_block10_concat (Concaten  (None, 3, 3, 832)   0           ['conv5_block9_concat[0][0]',
ate)                                                             'conv5_block10_2_conv[0][0]']

conv5_block11_0_bn (BatchNorma  (None, 3, 3, 832)   3328        ['conv5_block10_concat[0][0]']
lization)

conv5_block11_0_relu (Activati  (None, 3, 3, 832)   0           ['conv5_block11_0_bn[0][0]']
on)

conv5_block11_1_conv (Conv2D)  (None, 3, 3, 128)    106496      ['conv5_block11_0_relu[0][0]']

conv5_block11_1_bn (BatchNorma  (None, 3, 3, 128)   512         ['conv5_block11_1_conv[0][0]']
lization)

conv5_block11_1_relu (Activati  (None, 3, 3, 128)   0           ['conv5_block11_1_bn[0][0]']
on)

conv5_block11_2_conv (Conv2D)  (None, 3, 3, 32)     36864       ['conv5_block11_1_relu[0][0]']

conv5_block11_concat (Concaten  (None, 3, 3, 864)   0           ['conv5_block10_concat[0][0]',
ate)                                                             'conv5_block11_2_conv[0][0]']

conv5_block12_0_bn (BatchNorma  (None, 3, 3, 864)   3456        ['conv5_block11_concat[0][0]']
lization)

conv5_block12_0_relu (Activati  (None, 3, 3, 864)   0           ['conv5_block12_0_bn[0][0]']
on)

conv5_block12_1_conv (Conv2D)  (None, 3, 3, 128)    110592      ['conv5_block12_0_relu[0][0]']

conv5_block12_1_bn (BatchNorma  (None, 3, 3, 128)   512         ['conv5_block12_1_conv[0][0]']
lization)

conv5_block12_1_relu (Activati  (None, 3, 3, 128)   0           ['conv5_block12_1_bn[0][0]']
on)

conv5_block12_2_conv (Conv2D)  (None, 3, 3, 32)     36864       ['conv5_block12_1_relu[0][0]']

conv5_block12_concat (Concaten  (None, 3, 3, 896)   0           ['conv5_block11_concat[0][0]',
ate)                                                             'conv5_block12_2_conv[0][0]']

conv5_block13_0_bn (BatchNorma  (None, 3, 3, 896)   3584        ['conv5_block12_concat[0][0]']
lization)

conv5_block13_0_relu (Activati  (None, 3, 3, 896)   0           ['conv5_block13_0_bn[0][0]']
on)

conv5_block13_1_conv (Conv2D)  (None, 3, 3, 128)    114688      ['conv5_block13_0_relu[0][0]']

conv5_block13_1_bn (BatchNorma  (None, 3, 3, 128)   512         ['conv5_block13_1_conv[0][0]']
lization)

conv5_block13_1_relu (Activati  (None, 3, 3, 128)   0           ['conv5_block13_1_bn[0][0]']
on)

conv5_block13_2_conv (Conv2D)  (None, 3, 3, 32)     36864       ['conv5_block13_1_relu[0][0]']

conv5_block13_concat (Concaten  (None, 3, 3, 928)   0           ['conv5_block12_concat[0][0]',
ate)                                                             'conv5_block13_2_conv[0][0]']

conv5_block14_0_bn (BatchNorma  (None, 3, 3, 928)   3712        ['conv5_block13_concat[0][0]']
lization)

conv5_block14_0_relu (Activati  (None, 3, 3, 928)   0           ['conv5_block14_0_bn[0][0]']
on)

conv5_block14_1_conv (Conv2D)  (None, 3, 3, 128)    118784      ['conv5_block14_0_relu[0][0]']

conv5_block14_1_bn (BatchNorma  (None, 3, 3, 128)   512         ['conv5_block14_1_conv[0][0]']
lization)

conv5_block14_1_relu (Activati  (None, 3, 3, 128)   0           ['conv5_block14_1_bn[0][0]']
on)

conv5_block14_2_conv (Conv2D)  (None, 3, 3, 32)     36864       ['conv5_block14_1_relu[0][0]']

conv5_block14_concat (Concaten  (None, 3, 3, 960)   0           ['conv5_block13_concat[0][0]',
ate)                                                             'conv5_block14_2_conv[0][0]']

conv5_block15_0_bn (BatchNorma  (None, 3, 3, 960)   3840        ['conv5_block14_concat[0][0]']
lization)

conv5_block15_0_relu (Activati  (None, 3, 3, 960)   0           ['conv5_block15_0_bn[0][0]']
on)

conv5_block15_1_conv (Conv2D)  (None, 3, 3, 128)    122880      ['conv5_block15_0_relu[0][0]']

conv5_block15_1_bn (BatchNorma  (None, 3, 3, 128)   512         ['conv5_block15_1_conv[0][0]']
lization)

conv5_block15_1_relu (Activati  (None, 3, 3, 128)   0           ['conv5_block15_1_bn[0][0]']
on)
```

```
conv5_block15_2_conv (Conv2D)  (None, 3, 3, 32)     36864       ['conv5_block15_1_relu[0][0]']

conv5_block15_concat (Concaten  (None, 3, 3, 992)   0           ['conv5_block14_concat[0][0]',
ate)                                                             'conv5_block15_2_conv[0][0]']

conv5_block16_0_bn (BatchNorma  (None, 3, 3, 992)   3968        ['conv5_block15_concat[0][0]']
lization)

conv5_block16_0_relu (Activati  (None, 3, 3, 992)   0           ['conv5_block16_0_bn[0][0]']
on)

conv5_block16_1_conv (Conv2D)  (None, 3, 3, 128)    126976      ['conv5_block16_0_relu[0][0]']

conv5_block16_1_bn (BatchNorma  (None, 3, 3, 128)   512         ['conv5_block16_1_conv[0][0]']
lization)

conv5_block16_1_relu (Activati  (None, 3, 3, 128)   0           ['conv5_block16_1_bn[0][0]']
on)

conv5_block16_2_conv (Conv2D)  (None, 3, 3, 32)     36864       ['conv5_block16_1_relu[0][0]']

conv5_block16_concat (Concaten  (None, 3, 3, 1024)  0           ['conv5_block15_concat[0][0]',
ate)                                                             'conv5_block16_2_conv[0][0]']

bn (BatchNormalization)        (None, 3, 3, 1024)   4096        ['conv5_block16_concat[0][0]']

relu (Activation)              (None, 3, 3, 1024)   0           ['bn[0][0]']

global_average_pooling2d (Glob  (None, 1024)        0           ['relu[0][0]']
alAveragePooling2D)

global_max_pooling2d (GlobalMa  (None, 1024)        0           ['relu[0][0]']
xPooling2D)

minimum (Minimum)              (None, 1024)         0           ['global_average_pooling2d[0][0]'
                                                                , 'global_max_pooling2d[0][0]']

dropout (Dropout)              (None, 1024)         0           ['minimum[0][0]']

dense (Dense)                  (None, 128)          131200      ['dropout[0][0]']

dropout_1 (Dropout)            (None, 128)          0           ['dense[0][0]']

dense_1 (Dense)                (None, 256)          33024       ['dropout_1[0][0]']

dropout_2 (Dropout)            (None, 256)          0           ['dense_1[0][0]']

dense_2 (Dense)                (None, 512)          131584      ['dropout_2[0][0]']

dropout_3 (Dropout)            (None, 512)          0           ['dense_2[0][0]']

dense_3 (Dense)                (None, 4)            2052        ['dropout_3[0][0]']

==================================================================================================
Total params: 7,335,364
Trainable params: 7,251,716
Non-trainable params: 83,648
__________________________________________________________________________________________________
```

In [28]:

```
import os
import gc
import re

import cv2
import math
import numpy as np
import scipy as sp
import pandas as pd

import tensorflow as tf
from IPython.display import SVG
import efficientnet.tfkeras as efn
from keras.utils import plot_model
import tensorflow.keras.layers as L
from keras.utils import model_to_dot
import tensorflow.keras.backend as K
from tensorflow.keras.models import Model
from tensorflow.keras.applications import DenseNet121

import seaborn as sns
from tqdm import tqdm
import matplotlib.cm as cm
from sklearn import metrics
import matplotlib.pyplot as plt
from sklearn.utils import shuffle
from sklearn.model_selection import train_test_split

tqdm.pandas()
import plotly.express as px
import plotly.graph_objects as go
import plotly.figure_factory as ff
from plotly.subplots import make_subplots

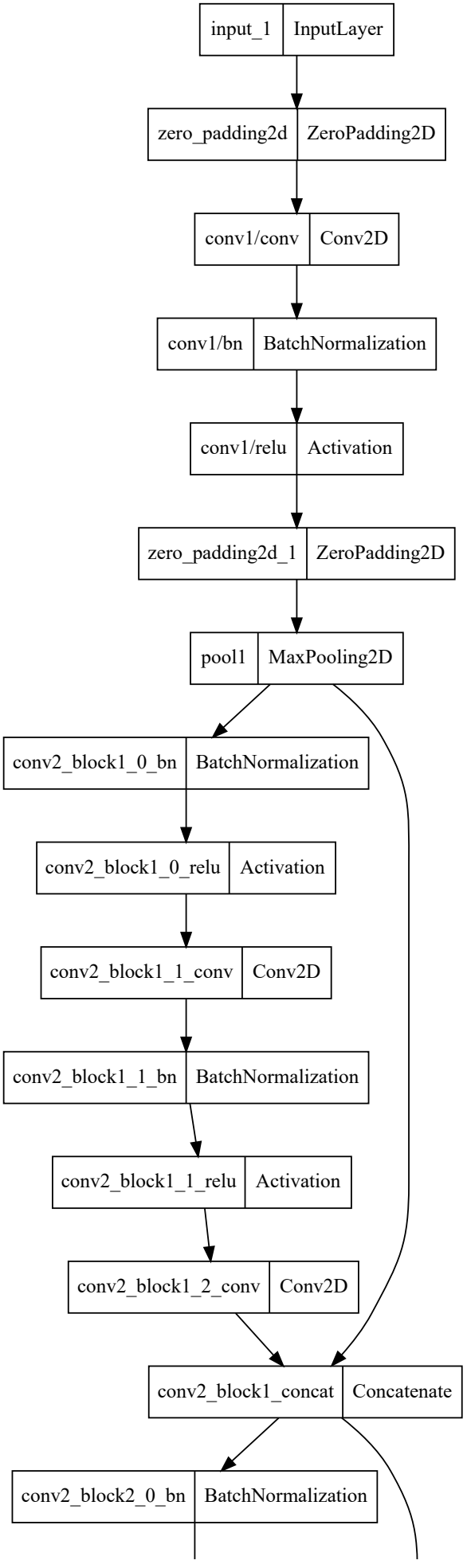
np.random.seed(0)
tf.random.set_seed(0)

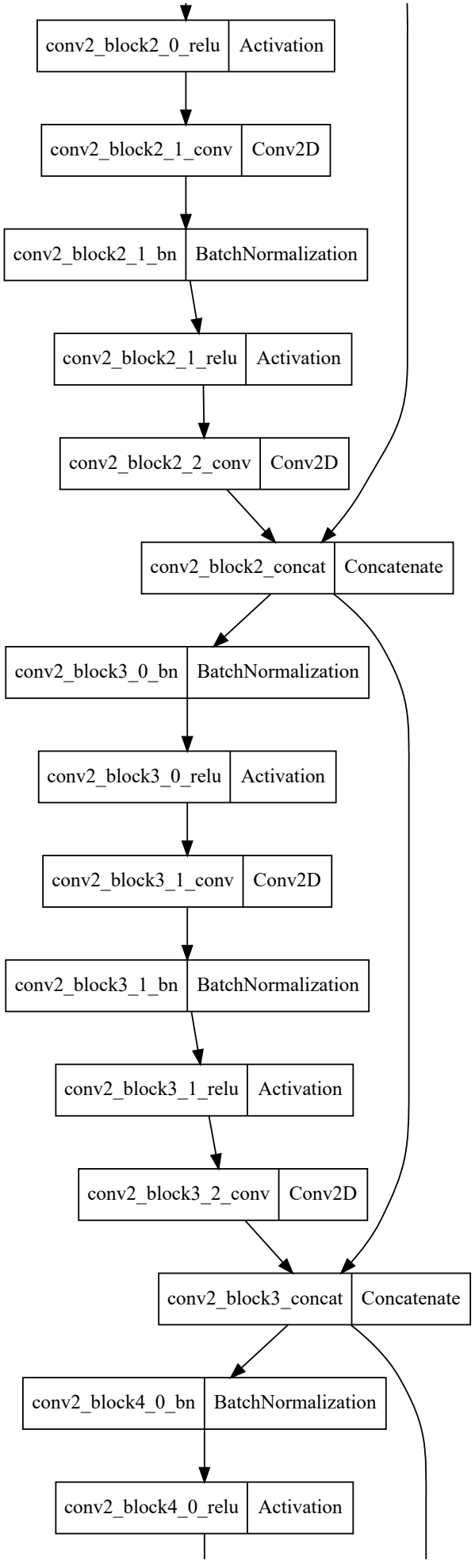
import warnings
warnings.filterwarnings("ignore")
```

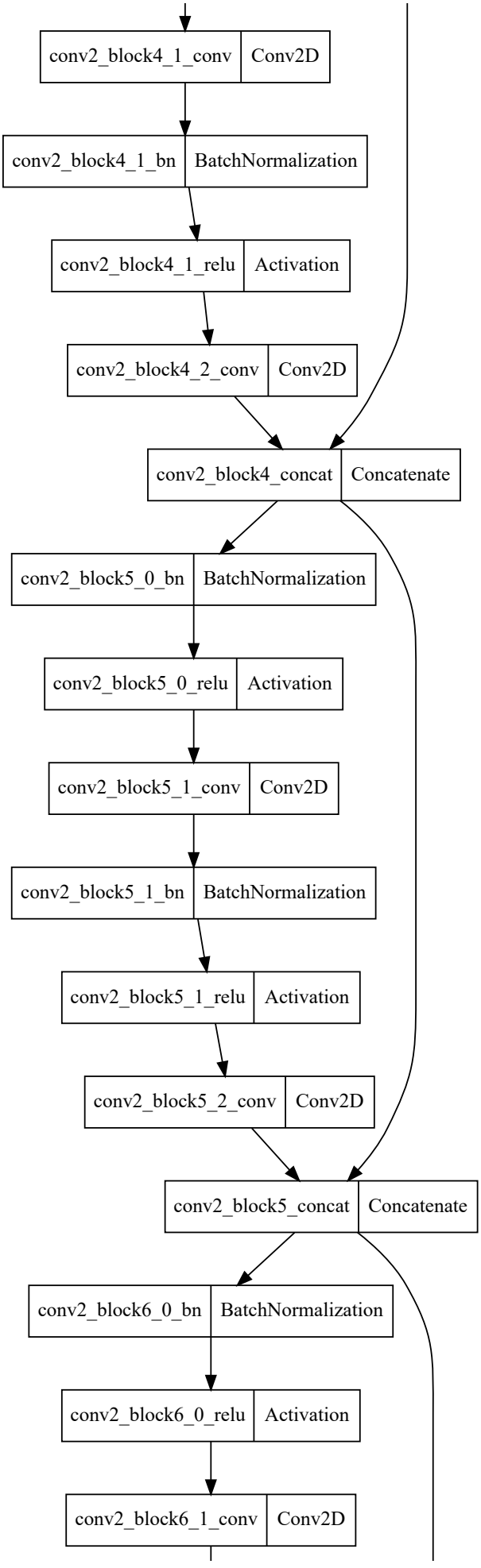
In [48]:

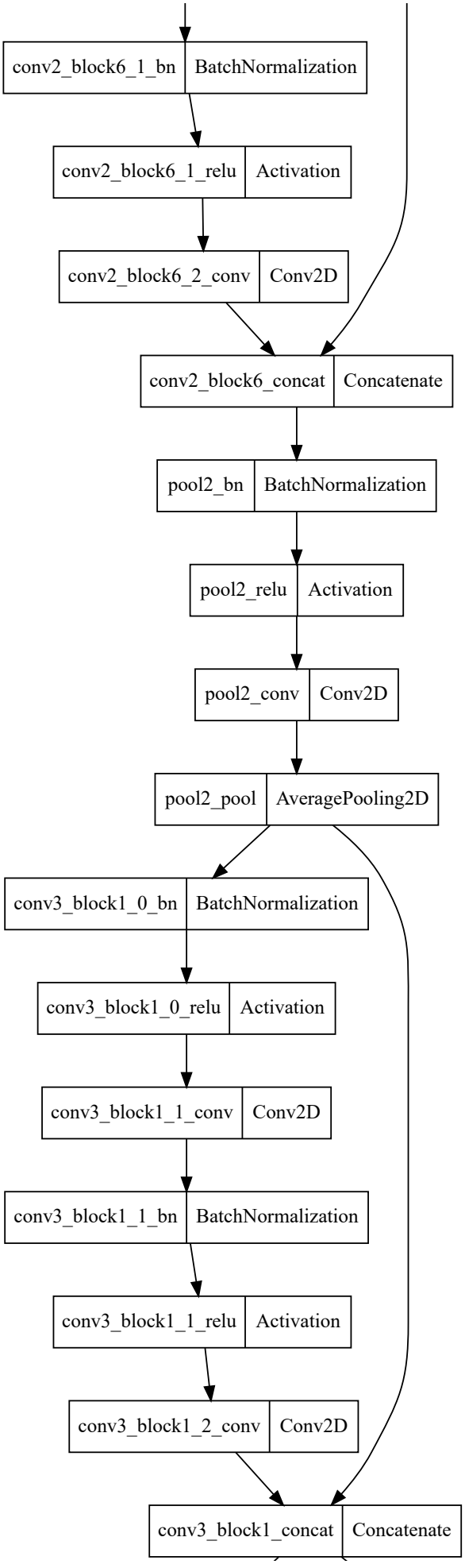
```
SVG(tf.keras.utils.model_to_dot(m).create(prog='dot', format='svg'))
```

Out[48]:


input_1 InputLayer
zero_padding2d ZeroPadding2D
conv1/conv Conv2D
conv1/bn BatchNormalization
conv1/relu Activation
zero_padding2d_1 ZeroPadding2D
pool1 MaxPooling2D
conv2_block1_0_bn BatchNormalization
conv2_block1_0_relu Activation
conv2_block1_1_conv Conv2D
conv2_block1_1_bn BatchNormalization
conv2_block1_1_relu Activation
conv2_block1_2_conv Conv2D
conv2_block1_concat Concatenate
conv2_block2_0_bn BatchNormalization


conv2_block2_0_relu
Activation
conv2_block2_1_conv
Conv2D
conv2_block2_1_bn
BatchNormalization
conv2_block2_1_relu
Activation
conv2_block2_2_conv
Conv2D
conv2_block2_concat
Concatenate
conv2_block3_0_bn
BatchNormalization
conv2_block3_0_relu
Activation
conv2_block3_1_conv
Conv2D
conv2_block3_1_bn
BatchNormalization
conv2_block3_1_relu
Activation
conv2_block3_2_conv
Conv2D
conv2_block3_concat
Concatenate
conv2_block4_0_bn
BatchNormalization
conv2_block4_0_relu
Activation


conv2_block4_1_conv
Conv2D
conv2_block4_1_bn
BatchNormalization
conv2_block4_1_relu
Activation
conv2_block4_2_conv
Conv2D
conv2_block4_concat
Concatenate
conv2_block5_0_bn
BatchNormalization
conv2_block5_0_relu
Activation
conv2_block5_1_conv
Conv2D
conv2_block5_1_bn
BatchNormalization
conv2_block5_1_relu
Activation
conv2_block5_2_conv
Conv2D
conv2_block5_concat
Concatenate
conv2_block6_0_bn
BatchNormalization
conv2_block6_0_relu
Activation
conv2_block6_1_conv
Conv2D


conv2_block6_1_bn
BatchNormalization
conv2_block6_1_relu
Activation
conv2_block6_2_conv
Conv2D
conv2_block6_concat
Concatenate
pool2_bn
BatchNormalization
pool2_relu
Activation
pool2_conv
Conv2D
pool2_pool
AveragePooling2D
conv3_block1_0_bn
BatchNormalization
conv3_block1_0_relu
Activation
conv3_block1_1_conv
Conv2D
conv3_block1_1_bn
BatchNormalization
conv3_block1_1_relu
Activation
conv3_block1_2_conv
Conv2D
conv3_block1_concat
Concatenate

In [33]:
```
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(images, labels, test_size = 0.15, random_state = 42)
x_train.shape
```

Out[33]:
```
(13930, 100, 100, 3)
```

In [34]:
```
x_test.shape
```

Out[34]:
```
(2459, 100, 100, 3)
```

In [45]:
```
y_test.shape
```

Out[45]:
```
(2459,)
```

In [46]:
```
y_train.shape
```

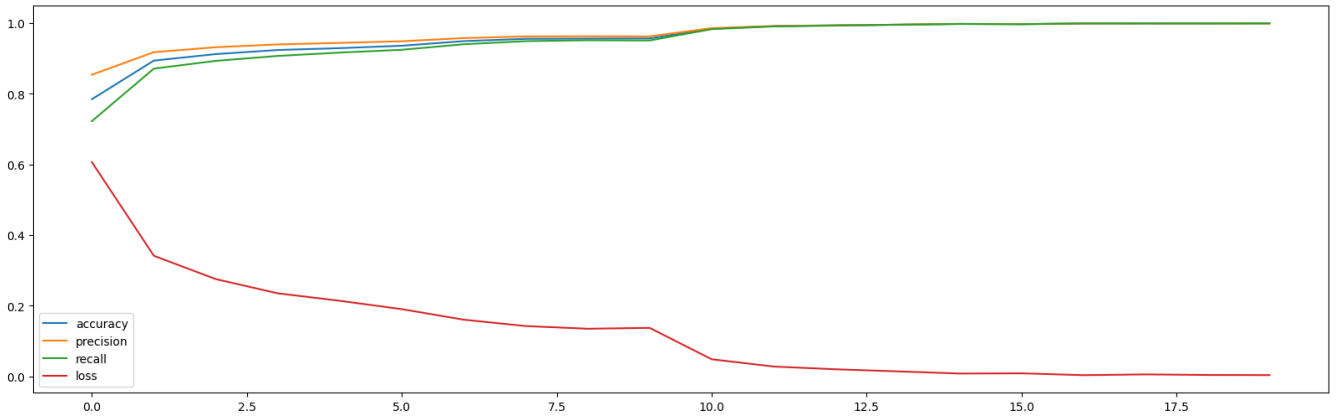
Out[46]:
```
(13930, 4)
```

In [35]:
```
history = m.fit(x_train, y_train, epochs = 20, batch_size = 32,
                callbacks = [
                    tf.keras.callbacks.ReduceLROnPlateau(monitor='loss', factor=0.1, mode = 'min',
                                                         patience= 1),
                    tf.keras.callbacks.EarlyStopping(monitor = 'loss', patience = 3, mode = 'min', restore_best_weights = True)
                ])
```

```
Epoch 1/20
436/436 [==============================] - 653s 1s/step - loss: 0.6066 - accuracy: 0.7844 - precision: 0.8538 - recall: 0.7223 - lr: 0.0010
Epoch 2/20
436/436 [==============================] - 892s 2s/step - loss: 0.3415 - accuracy: 0.8938 - precision: 0.9176 - recall: 0.8711 - lr: 0.0010
Epoch 3/20
436/436 [==============================] - 832s 2s/step - loss: 0.2755 - accuracy: 0.9122 - precision: 0.9316 - recall: 0.8930 - lr: 0.0010
Epoch 4/20
436/436 [==============================] - 797s 2s/step - loss: 0.2353 - accuracy: 0.9238 - precision: 0.9395 - recall: 0.9070 - lr: 0.0010
Epoch 5/20
436/436 [==============================] - 508s 1s/step - loss: 0.2141 - accuracy: 0.9290 - precision: 0.9439 - recall: 0.9164 - lr: 0.0010
Epoch 6/20
436/436 [==============================] - 435s 999ms/step - loss: 0.1905 - accuracy: 0.9358 - precision: 0.9485 - recall: 0.9244 - lr: 0.0010
Epoch 7/20
436/436 [==============================] - 666s 2s/step - loss: 0.1607 - accuracy: 0.9489 - precision: 0.9574 - recall: 0.9401 - lr: 0.0010
Epoch 8/20
436/436 [==============================] - 443s 1s/step - loss: 0.1426 - accuracy: 0.9553 - precision: 0.9621 - recall: 0.9488 - lr: 0.0010
Epoch 9/20
436/436 [==============================] - 419s 961ms/step - loss: 0.1351 - accuracy: 0.9559 - precision: 0.9626 - recall: 0.9513 - lr: 0.0010
Epoch 10/20
436/436 [==============================] - 497s 1s/step - loss: 0.1374 - accuracy: 0.9564 - precision: 0.9624 - recall: 0.9507 - lr: 0.0010
Epoch 11/20
436/436 [==============================] - 474s 1s/step - loss: 0.0487 - accuracy: 0.9841 - precision: 0.9856 - recall: 0.9828 - lr: 1.0000e-04
Epoch 12/20
436/436 [==============================] - 465s 1s/step - loss: 0.0281 - accuracy: 0.9911 - precision: 0.9916 - recall: 0.9905 - lr: 1.0000e-04
Epoch 13/20
436/436 [==============================] - 409s 931ms/step - loss: 0.0203 - accuracy: 0.9933 - precision: 0.9937 - recall: 0.9930 - lr: 1.0000e-04
Epoch 14/20
436/436 [==============================] - 388s 890ms/step - loss: 0.0144 - accuracy: 0.9953 - precision: 0.9954 - recall: 0.9953 - lr: 1.0000e-04
Epoch 15/20
436/436 [==============================] - 451s 1s/step - loss: 0.0083 - accuracy: 0.9976 - precision: 0.9976 - recall: 0.9975 - lr: 1.0000e-04
Epoch 16/20
436/436 [==============================] - 452s 1s/step - loss: 0.0089 - accuracy: 0.9968 - precision: 0.9969 - recall: 0.9968 - lr: 1.0000e-04
Epoch 17/20
436/436 [==============================] - 409s 937ms/step - loss: 0.0037 - accuracy: 0.9989 - precision: 0.9989 - recall: 0.9989 - lr: 1.0000e-05
Epoch 18/20
436/436 [==============================] - 410s 941ms/step - loss: 0.0058 - accuracy: 0.9990 - precision: 0.9990 - recall: 0.9989 - lr: 1.0000e-05
Epoch 19/20
436/436 [==============================] - 512s 1s/step - loss: 0.0043 - accuracy: 0.9989 - precision: 0.9989 - recall: 0.9989 - lr: 1.0000e-06
Epoch 20/20
436/436 [==============================] - 533s 1s/step - loss: 0.0038 - accuracy: 0.9991 - precision: 0.9991 - recall: 0.9990 - lr: 1.0000e-07
```

In [36]:
```
plt.figure(figsize = (20, 6))
plt.plot(history.history['accuracy'], label = "accuracy")
plt.plot(history.history['precision'], label = "precision")
plt.plot(history.history['recall'], label = "recall")
plt.plot(history.history['loss'], label = "loss")
plt.legend()
```

Out[36]:
```
<matplotlib.legend.Legend at 0x1e9667c0a00>
```



In [37]:
```
m.evaluate(x_test, y_test, batch_size= 32)
```

Out[37]:
```
77/77 [==============================] - 20s 169ms/step - loss: 0.0660 - accuracy: 0.9829 - precision: 0.9841 - recall: 0.9821
[0.06595262885093689,
 0.9829198718070984,
 0.9841075539588928,
 0.9821065664291382]
```

In [38]:
```
y_pred = m.predict(x_test)
y_pred = np.argmax(y_pred, axis = 1)
```

```
77/77 [==============================] - 16s 170ms/step
```

In [39]:
```
y_pred
```

Out[39]:
```
array([3, 3, 2, ..., 2, 0, 0], dtype=int64)
```

In [40]:
```
y_pred
y_test = np.argmax(y_test, axis = 1)
cnn_standard_acc = accuracy_score(y_pred, y_test)
print(cnn_standard_acc)
```

```
0.9829198861325742
```

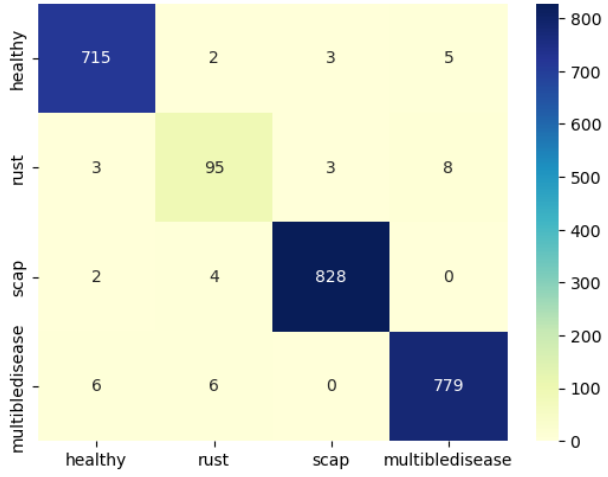
In [42]:
```
from sklearn.metrics import confusion_matrix

cm = confusion_matrix(y_test, y_pred)
```

In [43]:
```
from sklearn.metrics import confusion_matrix
import seaborn as sns
cm_matrix = pd.DataFrame(data=cm, columns=['healthy', 'rust','scap','multibledisease'],
                         index=['healthy', 'rust','scap','multibledisease'])

sns.heatmap(cm_matrix, annot=True, fmt='d', cmap='YlGnBu')
```

Out[43]:
```
<AxesSubplot:>
```



In [44]:
```
print(classification_report(y_pred, y_test))
```

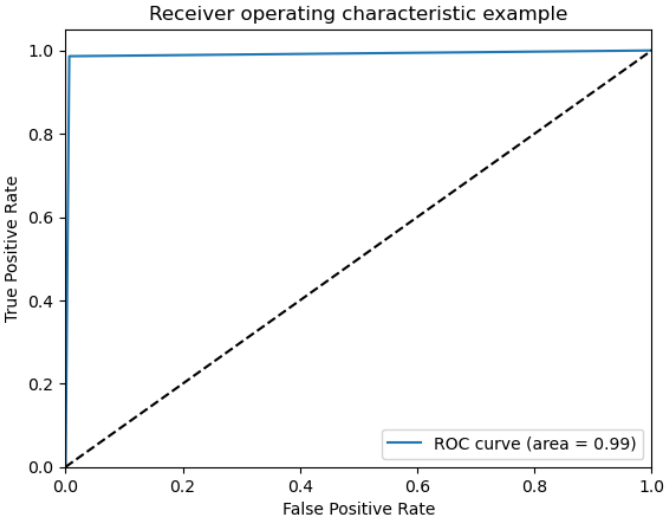
```
              precision    recall  f1-score   support

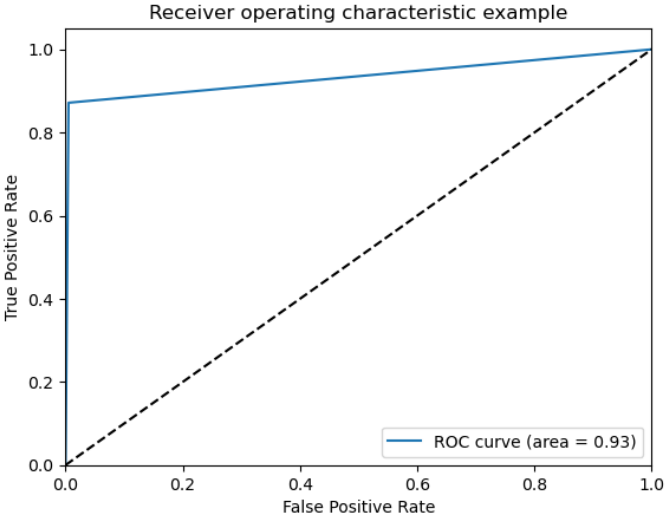
           0       0.99      0.98      0.99       726
           1       0.87      0.89      0.88       107
           2       0.99      0.99      0.99       834
           3       0.98      0.98      0.98       792

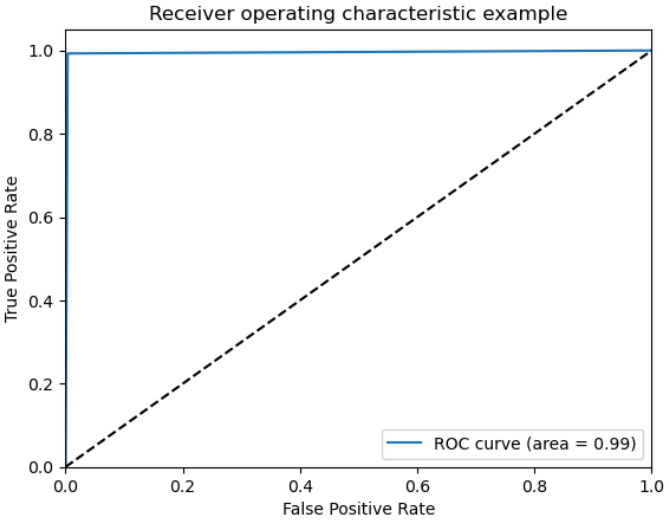
    accuracy                           0.98      2459
   macro avg       0.96      0.96      0.96      2459
weighted avg       0.98      0.98      0.98      2459
```

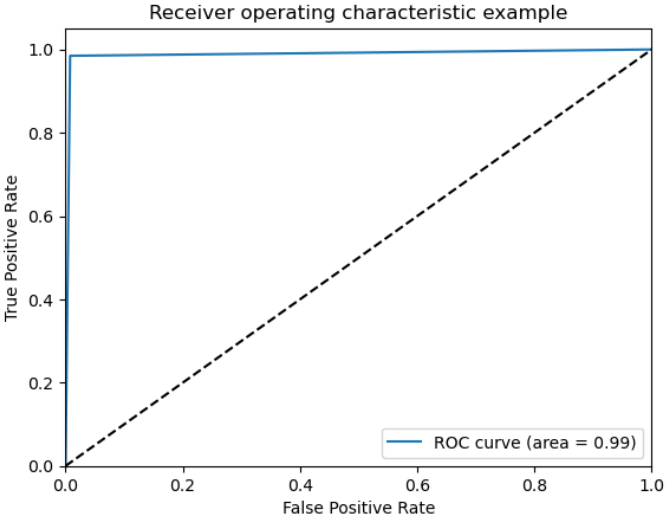
In [47]:
```
from sklearn.preprocessing import label_binarize
from sklearn import metrics
```

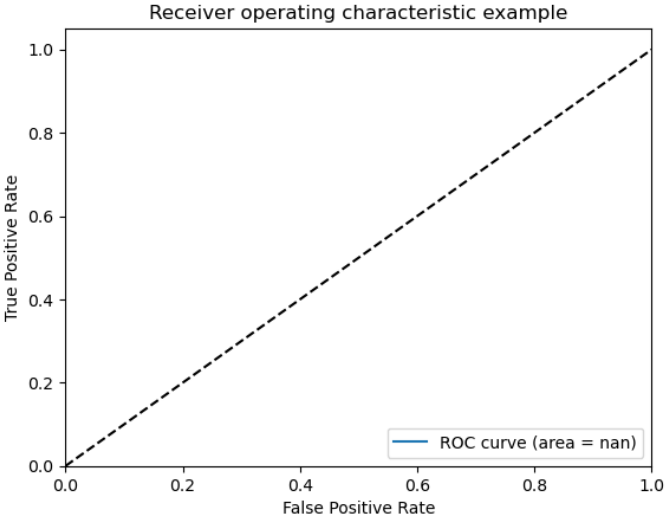
```
n_classes=4;
test_y2 = label_binarize(y_test, classes=[0,1,2,3,4])
pred2 = label_binarize(y_pred, classes=[0,1,2,3,4])
fpr = dict()
tpr = dict()
roc_auc = dict()
for i in range(5):
    fpr[i], tpr[i], _ =metrics.roc_curve(test_y2[:, i], pred2[:, i])
    roc_auc[i] = metrics.auc(fpr[i], tpr[i])
# Plot of a ROC curve for a specific class
for i in range(5):
    plt.figure()
    plt.plot(fpr[i], tpr[i], label='ROC curve (area = %0.2f)' % roc_auc[i])
    plt.plot([0, 1], [0, 1], 'k--')
    plt.xlim([0.0, 1.0])
    plt.ylim([0.0, 1.05])
    plt.xlabel('False Positive Rate')
    plt.ylabel('True Positive Rate')
    plt.title('Receiver operating characteristic example')
    plt.legend(loc="lower right")
    plt.show()
```






Receiver operating characteristic example
True Positive Rate
False Positive Rate
ROC curve (area = 0.99)
0.0
0.2
0.4
0.6
0.8
1.0


Receiver operating characteristic example
True Positive Rate
False Positive Rate
ROC curve (area = 0.99)
0.0
0.2
0.4
0.6
0.8
1.0


Receiver operating characteristic example
True Positive Rate
False Positive Rate
ROC curve (area = nan)
0.0
0.2
0.4
0.6
0.8
1.0