In [1]:
```
#pip install numpy opencv-python pillow tensorflow keras imutils scikit-learn ma
```

Impoted Libraries

In [2]:
```
import psutil
import humanize
import os
from IPython.display import display_html
import numpy as np
import pandas as pd
import os
import numpy as np
import keras
from keras import backend as K
from keras.models import Sequential
from keras.models import Model
from keras.layers import Activation
from keras.layers.core import Dense, Flatten
from keras.optimizers import Adam
from keras.metrics import categorical_crossentropy
from keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.layers import BatchNormalization
from keras.layers.core import Dropout
from keras.layers.convolutional import *
from keras.callbacks import ModelCheckpoint
from keras.applications.inception_v3 import InceptionV3
from keras.applications.inception_v3 import preprocess_input
from keras.applications.inception_v3 import decode_predictions
from sklearn.metrics import confusion_matrix
from sklearn.metrics import average_precision_score
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import accuracy_score
from sklearn.metrics import classification_report
from keras.models import model_from_json
import itertools
import matplotlib.pyplot as plt
import time
import pandas as pd
%matplotlib inline
import tensorflow as tf
```

In [3]:
```
dataDirectory= "C:\\Users\\91810\\OneDrive\\Desktop\\Research\\data"
print(os.listdir(dataDirectory))
```

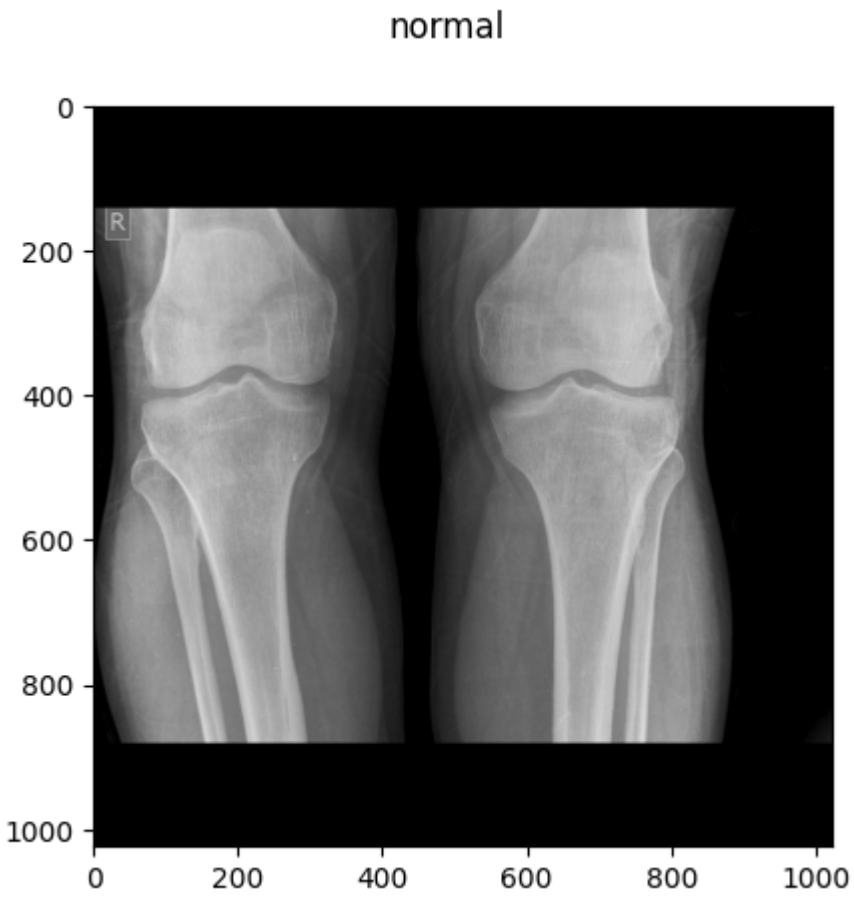
```
['normal', 'osteopenia', 'osteoporosis']
```

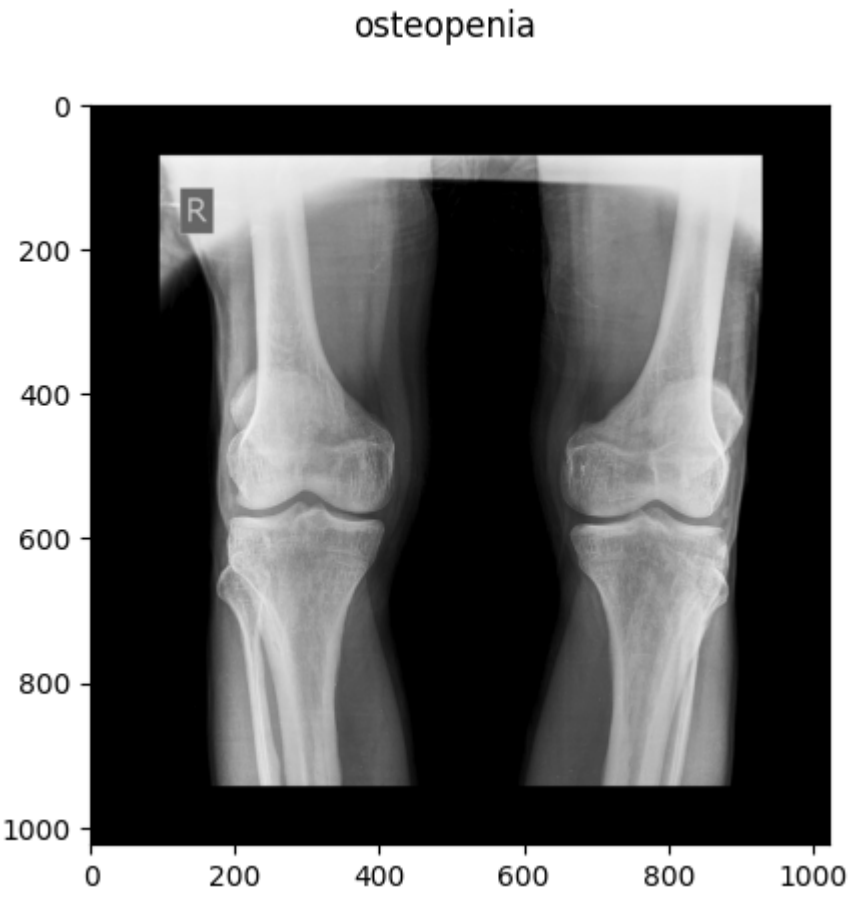
Sample Images

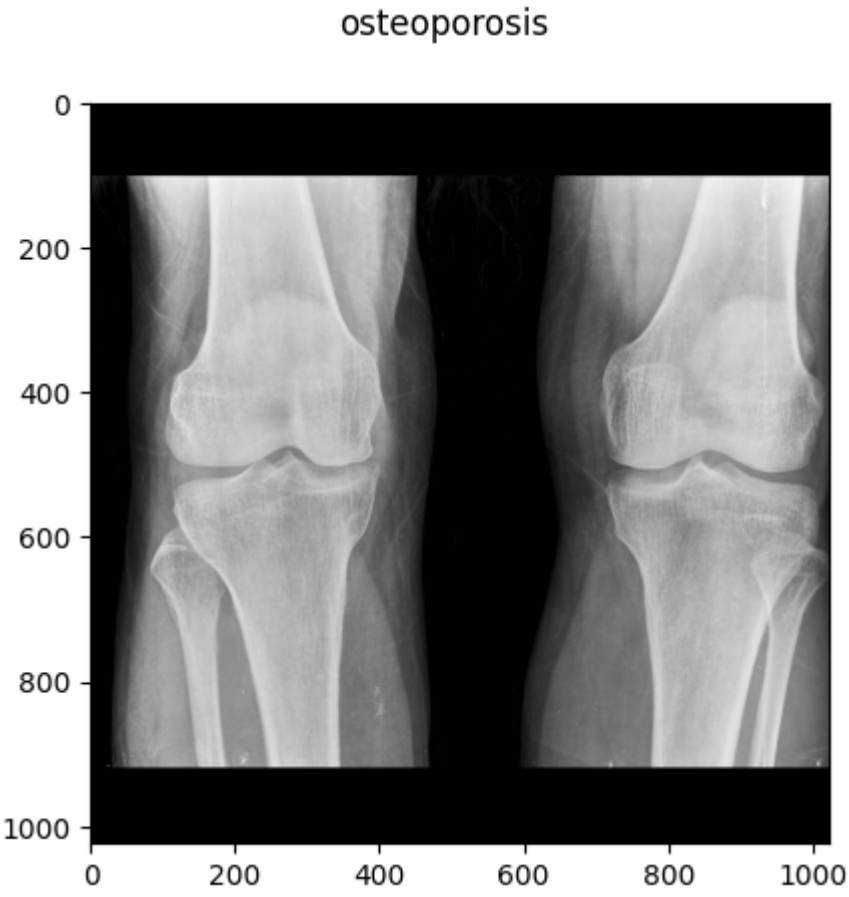
In [4]:
```
import glob
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
%matplotlib inline
```

```
normal_images = []
for img_path in glob.glob(dataDirectory + '/normal/*'):
    normal_images.append(mpimg.imread(img_path))

fig = plt.figure()
fig.suptitle('normal')
plt.imshow(normal_images[0], cmap='gray')

osteopenia_images = []
for img_path in glob.glob(dataDirectory + '/osteopenia/*'):
    osteopenia_images.append(mpimg.imread(img_path))

fig = plt.figure()
fig.suptitle('osteopenia')
plt.imshow(osteopenia_images[0], cmap='gray')

osteoporosis_images = []
for img_path in glob.glob(dataDirectory + '/osteoporosis/*'):
    osteoporosis_images.append(mpimg.imread(img_path))

fig = plt.figure()
fig.suptitle('osteoporosis')
plt.imshow(osteoporosis_images[0], cmap='gray')
```

Out[4]: <matplotlib.figure.AxesImage at 0x24450a5b350>







In [5]:
```
print(len(normal_images))
print(len(osteopenia_images))
print(len( osteoporosis_images))
```

```
36
154
49
```

In [6]:
```
IMG_W = 150
IMG_H = 150
CHANNELS = 3

INPUT_SHAPE = (IMG_W, IMG_H, CHANNELS)
NB_CLASSES = 3
EPOCHS = 3
batchSize = 6
BATCH_SIZE = 6
```

Data Generator

In [7]:
```
train_datagen = ImageDataGenerator(rescale=1./255,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,
    validation_split=0.3)

train_generator = train_datagen.flow_from_directory(
    dataDirectory,
    target_size=(IMG_H, IMG_W),
    batch_size=BATCH_SIZE,
    class_mode='binary',
    subset='training')

validation_generator = train_datagen.flow_from_directory(
   dataDirectory,
    target_size=(IMG_H, IMG_W),
    batch_size=BATCH_SIZE,
    class_mode='binary',
    shuffle= False,
    subset='validation')
```

```
Found 169 images belonging to 3 classes.
Found 70 images belonging to 3 classes.
```

Load data from directory

In [8]:
```
selectedClasses = ['normal', 'osteopenia','osteoporosis']
```

In [9]:
```
print ("In train_generator ")
for cls in range(len (train_generator.class_indices)):
    print(selectedClasses[cls],":\t",list(train_generator.classes).count(cls))
print ("")

print ("In validation_generator ")
for cls in range(len (validation_generator.class_indices)):
    print(selectedClasses[cls],":\t",list(validation_generator.classes).count(cl
print ("")
```

```
In train_generator
normal :          26
osteopenia :      108
osteoporosis :    35

In validation_generator
normal :          10
osteopenia :      46
osteoporosis :    14
```

Auxilary Functions for ploting images

In [10]:
```python
#plots images with labels within jupyter notebook
def plots(ims, figsize = (22,22), rows=4, interp=False, titles=None, maxNum = 9):
    if type(ims[0] is np.ndarray):
        ims = np.array(ims).astype(np.uint8)
        if(ims.shape[-1] != 3):
            ims = ims.transpose((0,2,3,1))

    f = plt.figure(figsize=figsize)
    #cols = len(ims) //rows if len(ims) % 2 == 0 else len(ims)//rows + 1
    cols = maxNum // rows if maxNum % 2 == 0 else maxNum//rows + 1
    #for i in range(len(ims)):
    for i in range(maxNum):
        sp = f.add_subplot(rows, cols, i+1)
        sp.axis('Off')
        if titles is not None:
            sp.set_title(titles[i], fontsize=20)
        plt.imshow(ims[i], interpolation = None if interp else 'none')
```

Create model by Transfer Learning from InceptionV3

VGG 16

In [11]:
```python
baseVGG16=tf.keras.applications.VGG16(
    include_top=False,
    weights="imagenet",
    input_tensor=None,
    input_shape=(224,224,3),
    pooling=None,
    classes=1000,
    classifier_activation="softmax",
)
baseVGG16.trainable = False

x = baseVGG16.output
x = keras.layers.GlobalAveragePooling2D()(x)
x = Dropout(0.5)(x)
predictions = Dense(len(selectedClasses), activation='softmax')(x)

model_VGG16 = Model(inputs=baseVGG16.input, outputs=predictions)
```

```
model_VGG16.summary()
```

```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 224, 224, 3)]     0

 block1_conv1 (Conv2D)       (None, 224, 224, 64)      1792

 block1_conv2 (Conv2D)       (None, 224, 224, 64)      36928

 block1_pool (MaxPooling2D)  (None, 112, 112, 64)      0

 block2_conv1 (Conv2D)       (None, 112, 112, 128)     73856

 block2_conv2 (Conv2D)       (None, 112, 112, 128)     147584

 block2_pool (MaxPooling2D)  (None, 56, 56, 128)       0

 block3_conv1 (Conv2D)       (None, 56, 56, 256)       295168

 block3_conv2 (Conv2D)       (None, 56, 56, 256)       590080

 block3_conv3 (Conv2D)       (None, 56, 56, 256)       590080

 block3_pool (MaxPooling2D)  (None, 28, 28, 256)       0

 block4_conv1 (Conv2D)       (None, 28, 28, 512)       1180160

 block4_conv2 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_conv3 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_pool (MaxPooling2D)  (None, 14, 14, 512)       0

 block5_conv1 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv2 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv3 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_pool (MaxPooling2D)  (None, 7, 7, 512)         0

 global_average_pooling2d (G  (None, 512)              0
 lobalAveragePooling2D)

 dropout (Dropout)           (None, 512)               0

 dense (Dense)               (None, 3)                 1539

=================================================================
Total params: 14,716,227
Trainable params: 1,539
Non-trainable params: 14,714,688
_________________________________________________________________
```

VGG19

In [12]:

```
baseVGG19 = tf.keras.applications.VGG19(
    include_top=False,
    weights="imagenet",
    input_tensor=None,
    input_shape=None,
    pooling=None,
    classes=1000,
    classifier_activation="softmax",
)
baseVGG19.trainable = False

x = baseVGG19.output
x = keras.layers.GlobalAveragePooling2D()(x)
# let's add a fully-connected layer
x = Dropout(0.5)(x)
# and a sofymax/logistic layer -- we have 3 classes
predictions = Dense(len(selectedClasses), activation='softmax')(x)

# this is the model we will train
model_VGG19 = Model(inputs=baseVGG19.input, outputs=predictions)


model_VGG19.summary()
```

```
Model: "model_1"
_________________________________________________________________
 Layer (type)                 Output Shape              Param #
=================================================================
 input_2 (InputLayer)         [(None, None, None, 3)]   0

 block1_conv1 (Conv2D)        (None, None, None, 64)    1792

 block1_conv2 (Conv2D)        (None, None, None, 64)    36928

 block1_pool (MaxPooling2D)   (None, None, None, 64)    0

 block2_conv1 (Conv2D)        (None, None, None, 128)   73856

 block2_conv2 (Conv2D)        (None, None, None, 128)   147584

 block2_pool (MaxPooling2D)   (None, None, None, 128)   0

 block3_conv1 (Conv2D)        (None, None, None, 256)   295168

 block3_conv2 (Conv2D)        (None, None, None, 256)   590080

 block3_conv3 (Conv2D)        (None, None, None, 256)   590080

 block3_conv4 (Conv2D)        (None, None, None, 256)   590080

 block3_pool (MaxPooling2D)   (None, None, None, 256)   0

 block4_conv1 (Conv2D)        (None, None, None, 512)   1180160

 block4_conv2 (Conv2D)        (None, None, None, 512)   2359808

 block4_conv3 (Conv2D)        (None, None, None, 512)   2359808

 block4_conv4 (Conv2D)        (None, None, None, 512)   2359808

 block4_pool (MaxPooling2D)   (None, None, None, 512)   0

 block5_conv1 (Conv2D)        (None, None, None, 512)   2359808

 block5_conv2 (Conv2D)        (None, None, None, 512)   2359808

 block5_conv3 (Conv2D)        (None, None, None, 512)   2359808

 block5_conv4 (Conv2D)        (None, None, None, 512)   2359808

 block5_pool (MaxPooling2D)   (None, None, None, 512)   0

 global_average_pooling2d_1   (None, 512)               0
 (GlobalAveragePooling2D)

 dropout_1 (Dropout)          (None, 512)               0

 dense_1 (Dense)              (None, 3)                 1539

=================================================================
Total params: 20,025,923
Trainable params: 1,539
Non-trainable params: 20,024,384
_________________________________________________________________
```

DenseNet169

In [13]:
```
baseDenseNet169 = tf.keras.applications.DenseNet169(
    include_top=False,
    weights="imagenet",
    input_tensor=None,
    input_shape=None,
    pooling=None,
    classes=1000,
    classifier_activation="softmax",
)
baseDenseNet169.trainable = False

x = baseDenseNet169.output
x = keras.layers.GlobalAveragePooling2D()(x)
# let's add a fully-connected layer
x = Dropout(0.5)(x)
# and a sofymax/logistic layer -- we have 3 classes
predictions = Dense(len(selectedClasses), activation='softmax')(x)

# this is the model we will train
model_DenseNet169 = Model(inputs=baseDenseNet169.input, outputs=predictions)


model_DenseNet169.summary()
```

```
Model: "model_2"
_________________________________________________________________
 Layer (type)                Output Shape              Param #   Connected to
=================================================================
 input_3 (InputLayer)        [(None, None, None,  0           []
                              3)]

 zero_padding2d (ZeroPadding2D)  (None, None, None,   0          ['input_3[0]
[0]']
                              3)

 conv1/conv (Conv2D)         (None, None, None,   9408        ['zero_padding2d
[0][0]']
                              64)

 conv1/bn (BatchNormalization)  (None, None, None,   256         ['conv1/conv[0]
[0]']
                              64)

 conv1/relu (Activation)     (None, None, None,   0           ['conv1/bn[0]
[0]']
                              64)

 zero_padding2d_1 (ZeroPadding2  (None, None, None,   0          ['conv1/relu[0]
[0]']
 D)                           64)

 pool1 (MaxPooling2D)        (None, None, None,   0           ['zero_padding2d
_1[0][0]']
                              64)

 conv2_block1_0_bn (BatchNormal  (None, None, None,   256        ['pool1[0][0]']
 ization)                    64)

 conv2_block1_0_relu (Activatio  (None, None, None,   0          ['conv2_block1_0
_bn[0][0]']
 n)                          64)

 conv2_block1_1_conv (Conv2D)   (None, None, None,   8192        ['conv2_block1_0
_relu[0][0]']
                              128)

 conv2_block1_1_bn (BatchNormal  (None, None, None,   512        ['conv2_block1_1
_conv[0][0]']
 ization)                    128)

 conv2_block1_1_relu (Activatio  (None, None, None,   0          ['conv2_block1_1
_bn[0][0]']
 n)                          128)

 conv2_block1_2_conv (Conv2D)   (None, None, None,   36864       ['conv2_block1_1
_relu[0][0]']
                              32)

 conv2_block1_concat (Concatena  (None, None, None,   0          ['pool1[0][0]',
 te)                         96)                                  'conv2_block1_2
_conv[0][0]']
```

```
 conv2_block2_0_bn (BatchNormal  (None, None, None,   384        ['conv2_block1_c
oncat[0][0]']
 ization)                       96)

 conv2_block2_0_relu (Activatio  (None, None, None,   0          ['conv2_block2_0
_bn[0][0]']
 n)                             96)

 conv2_block2_1_conv (Conv2D)   (None, None, None,   12288      ['conv2_block2_0
_relu[0][0]']
                                128)

 conv2_block2_1_bn (BatchNormal  (None, None, None,   512        ['conv2_block2_1
_conv[0][0]']
 ization)                       128)

 conv2_block2_1_relu (Activatio  (None, None, None,   0          ['conv2_block2_1
_bn[0][0]']
 n)                             128)

 conv2_block2_2_conv (Conv2D)   (None, None, None,   36864      ['conv2_block2_1
_relu[0][0]']
                                32)

 conv2_block2_concat (Concatena  (None, None, None,   0          ['conv2_block1_c
oncat[0][0]',
 te)                            128)                             'conv2_block2_2
_conv[0][0]']

 conv2_block3_0_bn (BatchNormal  (None, None, None,   512        ['conv2_block2_c
oncat[0][0]']
 ization)                       128)

 conv2_block3_0_relu (Activatio  (None, None, None,   0          ['conv2_block3_0
_bn[0][0]']
 n)                             128)

 conv2_block3_1_conv (Conv2D)   (None, None, None,   16384      ['conv2_block3_0
_relu[0][0]']
                                128)

 conv2_block3_1_bn (BatchNormal  (None, None, None,   512        ['conv2_block3_1
_conv[0][0]']
 ization)                       128)

 conv2_block3_1_relu (Activatio  (None, None, None,   0          ['conv2_block3_1
_bn[0][0]']
 n)                             128)

 conv2_block3_2_conv (Conv2D)   (None, None, None,   36864      ['conv2_block3_1
_relu[0][0]']
                                32)

 conv2_block3_concat (Concatena  (None, None, None,   0          ['conv2_block2_c
oncat[0][0]',
 te)                            160)                             'conv2_block3_2
_conv[0][0]']

 conv2_block4_0_bn (BatchNormal  (None, None, None,   640        ['conv2_block3_c
oncat[0][0]']
```

```
 ization)                       160)

 conv2_block4_0_relu (Activatio  (None, None, None,   0          ['conv2_block4_0
_bn[0][0]']
 n)                             160)

 conv2_block4_1_conv (Conv2D)   (None, None, None,   20480       ['conv2_block4_0
_relu[0][0]']
                                128)

 conv2_block4_1_bn (BatchNormal  (None, None, None,   512        ['conv2_block4_1
_conv[0][0]']
 ization)                       128)

 conv2_block4_1_relu (Activatio  (None, None, None,   0          ['conv2_block4_1
_bn[0][0]']
 n)                             128)

 conv2_block4_2_conv (Conv2D)   (None, None, None,   36864       ['conv2_block4_1
_relu[0][0]']
                                32)

 conv2_block4_concat (Concatena  (None, None, None,   0          ['conv2_block3_c
oncat[0][0]',
 te)                            192)                             'conv2_block4_2
_conv[0][0]']

 conv2_block5_0_bn (BatchNormal  (None, None, None,   768        ['conv2_block4_c
oncat[0][0]']
 ization)                       192)

 conv2_block5_0_relu (Activatio  (None, None, None,   0          ['conv2_block5_0
_bn[0][0]']
 n)                             192)

 conv2_block5_1_conv (Conv2D)   (None, None, None,   24576       ['conv2_block5_0
_relu[0][0]']
                                128)

 conv2_block5_1_bn (BatchNormal  (None, None, None,   512        ['conv2_block5_1
_conv[0][0]']
 ization)                       128)

 conv2_block5_1_relu (Activatio  (None, None, None,   0          ['conv2_block5_1
_bn[0][0]']
 n)                             128)

 conv2_block5_2_conv (Conv2D)   (None, None, None,   36864       ['conv2_block5_1
_relu[0][0]']
                                32)

 conv2_block5_concat (Concatena  (None, None, None,   0          ['conv2_block4_c
oncat[0][0]',
 te)                            224)                             'conv2_block5_2
_conv[0][0]']

 conv2_block6_0_bn (BatchNormal  (None, None, None,   896        ['conv2_block5_c
oncat[0][0]']
 ization)                       224)
```

```
 conv2_block6_0_relu (Activatio  (None, None, None,   0          ['conv2_block6_0
_bn[0][0]']
 n)                             224)

 conv2_block6_1_conv (Conv2D)   (None, None, None,   28672       ['conv2_block6_0
_relu[0][0]']
                                128)

 conv2_block6_1_bn (BatchNormal  (None, None, None,   512        ['conv2_block6_1
_conv[0][0]']
 ization)                       128)

 conv2_block6_1_relu (Activatio  (None, None, None,   0          ['conv2_block6_1
_bn[0][0]']
 n)                             128)

 conv2_block6_2_conv (Conv2D)   (None, None, None,   36864       ['conv2_block6_1
_relu[0][0]']
                                32)

 conv2_block6_concat (Concatena  (None, None, None,   0          ['conv2_block5_c
oncat[0][0]',
 te)                            256)                             'conv2_block6_2
_conv[0][0]']

 pool2_bn (BatchNormalization)  (None, None, None,   1024        ['conv2_block6_c
oncat[0][0]']
                                256)

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

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

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

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

 conv3_block1_0_relu (Activatio  (None, None, None,   0          ['conv3_block1_0
_bn[0][0]']
 n)                             128)

 conv3_block1_1_conv (Conv2D)   (None, None, None,   16384       ['conv3_block1_0
_relu[0][0]']
                                128)

 conv3_block1_1_bn (BatchNormal  (None, None, None,   512        ['conv3_block1_1
_conv[0][0]']
 ization)                       128)

 conv3_block1_1_relu (Activatio  (None, None, None,   0          ['conv3_block1_1
_bn[0][0]']
 n)                             128)
```

```
 conv3_block1_2_conv (Conv2D)   (None, None, None,   36864       ['conv3_block1_1
_relu[0][0]']
                                32)

 conv3_block1_concat (Concatena  (None, None, None,   0          ['pool2_pool[0]
[0]',
 te)                            160)                             'conv3_block1_2
_conv[0][0]']

 conv3_block2_0_bn (BatchNormal  (None, None, None,   640        ['conv3_block1_c
oncat[0][0]']
 ization)                       160)

 conv3_block2_0_relu (Activatio  (None, None, None,   0          ['conv3_block2_0
_bn[0][0]']
 n)                             160)

 conv3_block2_1_conv (Conv2D)   (None, None, None,   20480       ['conv3_block2_0
_relu[0][0]']
                                128)

 conv3_block2_1_bn (BatchNormal  (None, None, None,   512        ['conv3_block2_1
_conv[0][0]']
 ization)                       128)

 conv3_block2_1_relu (Activatio  (None, None, None,   0          ['conv3_block2_1
_bn[0][0]']
 n)                             128)

 conv3_block2_2_conv (Conv2D)   (None, None, None,   36864       ['conv3_block2_1
_relu[0][0]']
                                32)

 conv3_block2_concat (Concatena  (None, None, None,   0          ['conv3_block1_c
oncat[0][0]',
 te)                            192)                             'conv3_block2_2
_conv[0][0]']

 conv3_block3_0_bn (BatchNormal  (None, None, None,   768        ['conv3_block2_c
oncat[0][0]']
 ization)                       192)

 conv3_block3_0_relu (Activatio  (None, None, None,   0          ['conv3_block3_0
_bn[0][0]']
 n)                             192)

 conv3_block3_1_conv (Conv2D)   (None, None, None,   24576       ['conv3_block3_0
_relu[0][0]']
                                128)

 conv3_block3_1_bn (BatchNormal  (None, None, None,   512        ['conv3_block3_1
_conv[0][0]']
 ization)                       128)

 conv3_block3_1_relu (Activatio  (None, None, None,   0          ['conv3_block3_1
_bn[0][0]']
 n)                             128)

 conv3_block3_2_conv (Conv2D)   (None, None, None,   36864       ['conv3_block3_1
```

```
_relu[0][0]']
                                32)

 conv3_block3_concat (Concatena  (None, None, None,   0          ['conv3_block2_c
oncat[0][0]',
 te)                            224)                              'conv3_block3_2
_conv[0][0]']

 conv3_block4_0_bn (BatchNormal  (None, None, None,   896        ['conv3_block3_c
oncat[0][0]']
 ization)                       224)

 conv3_block4_0_relu (Activatio  (None, None, None,   0          ['conv3_block4_0
_bn[0][0]']
 n)                             224)

 conv3_block4_1_conv (Conv2D)   (None, None, None,   28672       ['conv3_block4_0
_relu[0][0]']
                                128)

 conv3_block4_1_bn (BatchNormal  (None, None, None,   512        ['conv3_block4_1
_conv[0][0]']
 ization)                       128)

 conv3_block4_1_relu (Activatio  (None, None, None,   0          ['conv3_block4_1
_bn[0][0]']
 n)                             128)

 conv3_block4_2_conv (Conv2D)   (None, None, None,   36864       ['conv3_block4_1
_relu[0][0]']
                                32)

 conv3_block4_concat (Concatena  (None, None, None,   0          ['conv3_block3_c
oncat[0][0]',
 te)                            256)                              'conv3_block4_2
_conv[0][0]']

 conv3_block5_0_bn (BatchNormal  (None, None, None,   1024       ['conv3_block4_c
oncat[0][0]']
 ization)                       256)

 conv3_block5_0_relu (Activatio  (None, None, None,   0          ['conv3_block5_0
_bn[0][0]']
 n)                             256)

 conv3_block5_1_conv (Conv2D)   (None, None, None,   32768       ['conv3_block5_0
_relu[0][0]']
                                128)

 conv3_block5_1_bn (BatchNormal  (None, None, None,   512        ['conv3_block5_1
_conv[0][0]']
 ization)                       128)

 conv3_block5_1_relu (Activatio  (None, None, None,   0          ['conv3_block5_1
_bn[0][0]']
 n)                             128)

 conv3_block5_2_conv (Conv2D)   (None, None, None,   36864       ['conv3_block5_1
_relu[0][0]']
                                32)
```

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 conv3_block5_concat (Concatena  (None, None, None,   0          ['conv3_block4_c
oncat[0][0]',
 te)                            288)                              'conv3_block5_2
_conv[0][0]']

 conv3_block6_0_bn (BatchNormal  (None, None, None,   1152       ['conv3_block5_c
oncat[0][0]']
 ization)                       288)

 conv3_block6_0_relu (Activatio  (None, None, None,   0          ['conv3_block6_0
_bn[0][0]']
 n)                             288)

 conv3_block6_1_conv (Conv2D)   (None, None, None,   36864       ['conv3_block6_0
_relu[0][0]']
                                128)

 conv3_block6_1_bn (BatchNormal  (None, None, None,   512        ['conv3_block6_1
_conv[0][0]']
 ization)                       128)

 conv3_block6_1_relu (Activatio  (None, None, None,   0          ['conv3_block6_1
_bn[0][0]']
 n)                             128)

 conv3_block6_2_conv (Conv2D)   (None, None, None,   36864       ['conv3_block6_1
_relu[0][0]']
                                32)

 conv3_block6_concat (Concatena  (None, None, None,   0          ['conv3_block5_c
oncat[0][0]',
 te)                            320)                              'conv3_block6_2
_conv[0][0]']

 conv3_block7_0_bn (BatchNormal  (None, None, None,   1280       ['conv3_block6_c
oncat[0][0]']
 ization)                       320)

 conv3_block7_0_relu (Activatio  (None, None, None,   0          ['conv3_block7_0
_bn[0][0]']
 n)                             320)

 conv3_block7_1_conv (Conv2D)   (None, None, None,   40960       ['conv3_block7_0
_relu[0][0]']
                                128)

 conv3_block7_1_bn (BatchNormal  (None, None, None,   512        ['conv3_block7_1
_conv[0][0]']
 ization)                       128)

 conv3_block7_1_relu (Activatio  (None, None, None,   0          ['conv3_block7_1
_bn[0][0]']
 n)                             128)

 conv3_block7_2_conv (Conv2D)   (None, None, None,   36864       ['conv3_block7_1
_relu[0][0]']
                                32)

 conv3_block7_concat (Concatena  (None, None, None,   0          ['conv3_block6_c
```

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oncat[0][0]',
 te)                            352)                                 'conv3_block7_2
_conv[0][0]']

 conv3_block8_0_bn (BatchNormal  (None, None, None,   1408       ['conv3_block7_c
oncat[0][0]']
 ization)                       352)

 conv3_block8_0_relu (Activatio  (None, None, None,   0          ['conv3_block8_0
_bn[0][0]']
 n)                             352)

 conv3_block8_1_conv (Conv2D)   (None, None, None,   45056       ['conv3_block8_0
_relu[0][0]']
                                128)

 conv3_block8_1_bn (BatchNormal  (None, None, None,   512        ['conv3_block8_1
_conv[0][0]']
 ization)                       128)

 conv3_block8_1_relu (Activatio  (None, None, None,   0          ['conv3_block8_1
_bn[0][0]']
 n)                             128)

 conv3_block8_2_conv (Conv2D)   (None, None, None,   36864       ['conv3_block8_1
_relu[0][0]']
                                32)

 conv3_block8_concat (Concatena  (None, None, None,   0          ['conv3_block7_c
oncat[0][0]',
 te)                            384)                                 'conv3_block8_2
_conv[0][0]']

 conv3_block9_0_bn (BatchNormal  (None, None, None,   1536       ['conv3_block8_c
oncat[0][0]']
 ization)                       384)

 conv3_block9_0_relu (Activatio  (None, None, None,   0          ['conv3_block9_0
_bn[0][0]']
 n)                             384)

 conv3_block9_1_conv (Conv2D)   (None, None, None,   49152       ['conv3_block9_0
_relu[0][0]']
                                128)

 conv3_block9_1_bn (BatchNormal  (None, None, None,   512        ['conv3_block9_1
_conv[0][0]']
 ization)                       128)

 conv3_block9_1_relu (Activatio  (None, None, None,   0          ['conv3_block9_1
_bn[0][0]']
 n)                             128)

 conv3_block9_2_conv (Conv2D)   (None, None, None,   36864       ['conv3_block9_1
_relu[0][0]']
                                32)

 conv3_block9_concat (Concatena  (None, None, None,   0          ['conv3_block8_c
oncat[0][0]',
 te)                            416)                                 'conv3_block9_2
```

```
_conv[0][0]']

 conv3_block10_0_bn (BatchNorma  (None, None, None,   1664       ['conv3_block9_c
oncat[0][0]']
 lization)                      416)

 conv3_block10_0_relu (Activati  (None, None, None,   0          ['conv3_block10_
0_bn[0][0]']
 on)                            416)

 conv3_block10_1_conv (Conv2D)  (None, None, None,   53248      ['conv3_block10_
0_relu[0][0]']
                                128)

 conv3_block10_1_bn (BatchNorma  (None, None, None,   512        ['conv3_block10_
1_conv[0][0]']
 lization)                      128)

 conv3_block10_1_relu (Activati  (None, None, None,   0          ['conv3_block10_
1_bn[0][0]']
 on)                            128)

 conv3_block10_2_conv (Conv2D)  (None, None, None,   36864      ['conv3_block10_
1_relu[0][0]']
                                32)

 conv3_block10_concat (Concaten  (None, None, None,   0          ['conv3_block9_c
oncat[0][0]',
 ate)                           448)                             'conv3_block10_
2_conv[0][0]']

 conv3_block11_0_bn (BatchNorma  (None, None, None,   1792       ['conv3_block10_
concat[0][0]']
 lization)                      448)

 conv3_block11_0_relu (Activati  (None, None, None,   0          ['conv3_block11_
0_bn[0][0]']
 on)                            448)

 conv3_block11_1_conv (Conv2D)  (None, None, None,   57344      ['conv3_block11_
0_relu[0][0]']
                                128)

 conv3_block11_1_bn (BatchNorma  (None, None, None,   512        ['conv3_block11_
1_conv[0][0]']
 lization)                      128)

 conv3_block11_1_relu (Activati  (None, None, None,   0          ['conv3_block11_
1_bn[0][0]']
 on)                            128)

 conv3_block11_2_conv (Conv2D)  (None, None, None,   36864      ['conv3_block11_
1_relu[0][0]']
                                32)

 conv3_block11_concat (Concaten  (None, None, None,   0          ['conv3_block10_
concat[0][0]',
 ate)                           480)                             'conv3_block11_
2_conv[0][0]']
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 conv3_block12_0_bn (BatchNorma  (None, None, None,   1920       ['conv3_block11_
concat[0][0]']
 lization)                      480)

 conv3_block12_0_relu (Activati  (None, None, None,   0          ['conv3_block12_
0_bn[0][0]']
 on)                            480)

 conv3_block12_1_conv (Conv2D)  (None, None, None,   61440       ['conv3_block12_
0_relu[0][0]']
                                128)

 conv3_block12_1_bn (BatchNorma  (None, None, None,   512        ['conv3_block12_
1_conv[0][0]']
 lization)                      128)

 conv3_block12_1_relu (Activati  (None, None, None,   0          ['conv3_block12_
1_bn[0][0]']
 on)                            128)

 conv3_block12_2_conv (Conv2D)  (None, None, None,   36864       ['conv3_block12_
1_relu[0][0]']
                                32)

 conv3_block12_concat (Concaten  (None, None, None,   0          ['conv3_block11_
concat[0][0]',
 ate)                           512)                             'conv3_block12_
2_conv[0][0]']

 pool3_bn (BatchNormalization)  (None, None, None,   2048        ['conv3_block12_
concat[0][0]']
                                512)

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

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

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

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

 conv4_block1_0_relu (Activatio  (None, None, None,   0          ['conv4_block1_0
_bn[0][0]']
 n)                             256)

 conv4_block1_1_conv (Conv2D)   (None, None, None,   32768       ['conv4_block1_0
_relu[0][0]']
                                128)

 conv4_block1_1_bn (BatchNormal  (None, None, None,   512        ['conv4_block1_1
_conv[0][0]']
 ization)                       128)
```

```
 conv4_block1_1_relu (Activatio  (None, None, None,   0          ['conv4_block1_1
_bn[0][0]']
 n)                             128)

 conv4_block1_2_conv (Conv2D)   (None, None, None,   36864       ['conv4_block1_1
_relu[0][0]']
                                32)

 conv4_block1_concat (Concatena  (None, None, None,   0          ['pool3_pool[0]
[0]',
 te)                            288)                             'conv4_block1_2
_conv[0][0]']

 conv4_block2_0_bn (BatchNormal  (None, None, None,   1152       ['conv4_block1_c
oncat[0][0]']
 ization)                       288)

 conv4_block2_0_relu (Activatio  (None, None, None,   0          ['conv4_block2_0
_bn[0][0]']
 n)                             288)

 conv4_block2_1_conv (Conv2D)   (None, None, None,   36864       ['conv4_block2_0
_relu[0][0]']
                                128)

 conv4_block2_1_bn (BatchNormal  (None, None, None,   512        ['conv4_block2_1
_conv[0][0]']
 ization)                       128)

 conv4_block2_1_relu (Activatio  (None, None, None,   0          ['conv4_block2_1
_bn[0][0]']
 n)                             128)

 conv4_block2_2_conv (Conv2D)   (None, None, None,   36864       ['conv4_block2_1
_relu[0][0]']
                                32)

 conv4_block2_concat (Concatena  (None, None, None,   0          ['conv4_block1_c
oncat[0][0]',
 te)                            320)                             'conv4_block2_2
_conv[0][0]']

 conv4_block3_0_bn (BatchNormal  (None, None, None,   1280       ['conv4_block2_c
oncat[0][0]']
 ization)                       320)

 conv4_block3_0_relu (Activatio  (None, None, None,   0          ['conv4_block3_0
_bn[0][0]']
 n)                             320)

 conv4_block3_1_conv (Conv2D)   (None, None, None,   40960       ['conv4_block3_0
_relu[0][0]']
                                128)

 conv4_block3_1_bn (BatchNormal  (None, None, None,   512        ['conv4_block3_1
_conv[0][0]']
 ization)                       128)

 conv4_block3_1_relu (Activatio  (None, None, None,   0          ['conv4_block3_1
```

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_bn[0][0]']
 n)                             128)

 conv4_block3_2_conv (Conv2D)   (None, None, None,   36864       ['conv4_block3_1
_relu[0][0]']
                                32)

 conv4_block3_concat (Concatena  (None, None, None,   0          ['conv4_block2_c
oncat[0][0]',
 te)                            352)                             'conv4_block3_2
_conv[0][0]']

 conv4_block4_0_bn (BatchNormal  (None, None, None,   1408       ['conv4_block3_c
oncat[0][0]']
 ization)                       352)

 conv4_block4_0_relu (Activatio  (None, None, None,   0          ['conv4_block4_0
_bn[0][0]']
 n)                             352)

 conv4_block4_1_conv (Conv2D)   (None, None, None,   45056       ['conv4_block4_0
_relu[0][0]']
                                128)

 conv4_block4_1_bn (BatchNormal  (None, None, None,   512        ['conv4_block4_1
_conv[0][0]']
 ization)                       128)

 conv4_block4_1_relu (Activatio  (None, None, None,   0          ['conv4_block4_1
_bn[0][0]']
 n)                             128)

 conv4_block4_2_conv (Conv2D)   (None, None, None,   36864       ['conv4_block4_1
_relu[0][0]']
                                32)

 conv4_block4_concat (Concatena  (None, None, None,   0          ['conv4_block3_c
oncat[0][0]',
 te)                            384)                             'conv4_block4_2
_conv[0][0]']

 conv4_block5_0_bn (BatchNormal  (None, None, None,   1536       ['conv4_block4_c
oncat[0][0]']
 ization)                       384)

 conv4_block5_0_relu (Activatio  (None, None, None,   0          ['conv4_block5_0
_bn[0][0]']
 n)                             384)

 conv4_block5_1_conv (Conv2D)   (None, None, None,   49152       ['conv4_block5_0
_relu[0][0]']
                                128)

 conv4_block5_1_bn (BatchNormal  (None, None, None,   512        ['conv4_block5_1
_conv[0][0]']
 ization)                       128)

 conv4_block5_1_relu (Activatio  (None, None, None,   0          ['conv4_block5_1
_bn[0][0]']
 n)                             128)
```

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 conv4_block5_2_conv (Conv2D)   (None, None, None,   36864       ['conv4_block5_1
_relu[0][0]']
                                32)

 conv4_block5_concat (Concatena  (None, None, None,   0          ['conv4_block4_c
oncat[0][0]',
 te)                            416)                             'conv4_block5_2
_conv[0][0]']

 conv4_block6_0_bn (BatchNormal  (None, None, None,   1664       ['conv4_block5_c
oncat[0][0]']
 ization)                       416)

 conv4_block6_0_relu (Activatio  (None, None, None,   0          ['conv4_block6_0
_bn[0][0]']
 n)                             416)

 conv4_block6_1_conv (Conv2D)   (None, None, None,   53248       ['conv4_block6_0
_relu[0][0]']
                                128)

 conv4_block6_1_bn (BatchNormal  (None, None, None,   512        ['conv4_block6_1
_conv[0][0]']
 ization)                       128)

 conv4_block6_1_relu (Activatio  (None, None, None,   0          ['conv4_block6_1
_bn[0][0]']
 n)                             128)

 conv4_block6_2_conv (Conv2D)   (None, None, None,   36864       ['conv4_block6_1
_relu[0][0]']
                                32)

 conv4_block6_concat (Concatena  (None, None, None,   0          ['conv4_block5_c
oncat[0][0]',
 te)                            448)                             'conv4_block6_2
_conv[0][0]']

 conv4_block7_0_bn (BatchNormal  (None, None, None,   1792       ['conv4_block6_c
oncat[0][0]']
 ization)                       448)

 conv4_block7_0_relu (Activatio  (None, None, None,   0          ['conv4_block7_0
_bn[0][0]']
 n)                             448)

 conv4_block7_1_conv (Conv2D)   (None, None, None,   57344       ['conv4_block7_0
_relu[0][0]']
                                128)

 conv4_block7_1_bn (BatchNormal  (None, None, None,   512        ['conv4_block7_1
_conv[0][0]']
 ization)                       128)

 conv4_block7_1_relu (Activatio  (None, None, None,   0          ['conv4_block7_1
_bn[0][0]']
 n)                             128)

 conv4_block7_2_conv (Conv2D)   (None, None, None,   36864       ['conv4_block7_1
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```
_relu[0][0]']
                                32)

 conv4_block7_concat (Concatena  (None, None, None,   0          ['conv4_block6_c
oncat[0][0]',
 te)                            480)                              'conv4_block7_2
_conv[0][0]']

 conv4_block8_0_bn (BatchNormal  (None, None, None,   1920       ['conv4_block7_c
oncat[0][0]']
 ization)                       480)

 conv4_block8_0_relu (Activatio  (None, None, None,   0          ['conv4_block8_0
_bn[0][0]']
 n)                             480)

 conv4_block8_1_conv (Conv2D)   (None, None, None,   61440       ['conv4_block8_0
_relu[0][0]']
                                128)

 conv4_block8_1_bn (BatchNormal  (None, None, None,   512        ['conv4_block8_1
_conv[0][0]']
 ization)                       128)

 conv4_block8_1_relu (Activatio  (None, None, None,   0          ['conv4_block8_1
_bn[0][0]']
 n)                             128)

 conv4_block8_2_conv (Conv2D)   (None, None, None,   36864       ['conv4_block8_1
_relu[0][0]']
                                32)

 conv4_block8_concat (Concatena  (None, None, None,   0          ['conv4_block7_c
oncat[0][0]',
 te)                            512)                              'conv4_block8_2
_conv[0][0]']

 conv4_block9_0_bn (BatchNormal  (None, None, None,   2048       ['conv4_block8_c
oncat[0][0]']
 ization)                       512)

 conv4_block9_0_relu (Activatio  (None, None, None,   0          ['conv4_block9_0
_bn[0][0]']
 n)                             512)

 conv4_block9_1_conv (Conv2D)   (None, None, None,   65536       ['conv4_block9_0
_relu[0][0]']
                                128)

 conv4_block9_1_bn (BatchNormal  (None, None, None,   512        ['conv4_block9_1
_conv[0][0]']
 ization)                       128)

 conv4_block9_1_relu (Activatio  (None, None, None,   0          ['conv4_block9_1
_bn[0][0]']
 n)                             128)

 conv4_block9_2_conv (Conv2D)   (None, None, None,   36864       ['conv4_block9_1
_relu[0][0]']
                                32)
```

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 conv4_block9_concat (Concatena  (None, None, None,   0          ['conv4_block8_c
oncat[0][0]',
 te)                            544)                              'conv4_block9_2
_conv[0][0]']

 conv4_block10_0_bn (BatchNorma  (None, None, None,   2176       ['conv4_block9_c
oncat[0][0]']
 lization)                      544)

 conv4_block10_0_relu (Activati  (None, None, None,   0          ['conv4_block10_
0_bn[0][0]']
 on)                            544)

 conv4_block10_1_conv (Conv2D)  (None, None, None,   69632       ['conv4_block10_
0_relu[0][0]']
                                128)

 conv4_block10_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block10_
1_conv[0][0]']
 lization)                      128)

 conv4_block10_1_relu (Activati  (None, None, None,   0          ['conv4_block10_
1_bn[0][0]']
 on)                            128)

 conv4_block10_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block10_
1_relu[0][0]']
                                32)

 conv4_block10_concat (Concaten  (None, None, None,   0          ['conv4_block9_c
oncat[0][0]',
 ate)                           576)                              'conv4_block10_
2_conv[0][0]']

 conv4_block11_0_bn (BatchNorma  (None, None, None,   2304       ['conv4_block10_
concat[0][0]']
 lization)                      576)

 conv4_block11_0_relu (Activati  (None, None, None,   0          ['conv4_block11_
0_bn[0][0]']
 on)                            576)

 conv4_block11_1_conv (Conv2D)  (None, None, None,   73728       ['conv4_block11_
0_relu[0][0]']
                                128)

 conv4_block11_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block11_
1_conv[0][0]']
 lization)                      128)

 conv4_block11_1_relu (Activati  (None, None, None,   0          ['conv4_block11_
1_bn[0][0]']
 on)                            128)

 conv4_block11_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block11_
1_relu[0][0]']
                                32)

 conv4_block11_concat (Concaten  (None, None, None,   0          ['conv4_block10_
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concat[0][0]',
 ate)                           608)                                'conv4_block11_
2_conv[0][0]']

 conv4_block12_0_bn (BatchNorma  (None, None, None,   2432       ['conv4_block11_
concat[0][0]']
 lization)                      608)

 conv4_block12_0_relu (Activati  (None, None, None,   0          ['conv4_block12_
0_bn[0][0]']
 on)                            608)

 conv4_block12_1_conv (Conv2D)  (None, None, None,   77824       ['conv4_block12_
0_relu[0][0]']
                                128)

 conv4_block12_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block12_
1_conv[0][0]']
 lization)                      128)

 conv4_block12_1_relu (Activati  (None, None, None,   0          ['conv4_block12_
1_bn[0][0]']
 on)                            128)

 conv4_block12_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block12_
1_relu[0][0]']
                                32)

 conv4_block12_concat (Concaten  (None, None, None,   0          ['conv4_block11_
concat[0][0]',
 ate)                           640)                                'conv4_block12_
2_conv[0][0]']

 conv4_block13_0_bn (BatchNorma  (None, None, None,   2560       ['conv4_block12_
concat[0][0]']
 lization)                      640)

 conv4_block13_0_relu (Activati  (None, None, None,   0          ['conv4_block13_
0_bn[0][0]']
 on)                            640)

 conv4_block13_1_conv (Conv2D)  (None, None, None,   81920       ['conv4_block13_
0_relu[0][0]']
                                128)

 conv4_block13_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block13_
1_conv[0][0]']
 lization)                      128)

 conv4_block13_1_relu (Activati  (None, None, None,   0          ['conv4_block13_
1_bn[0][0]']
 on)                            128)

 conv4_block13_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block13_
1_relu[0][0]']
                                32)

 conv4_block13_concat (Concaten  (None, None, None,   0          ['conv4_block12_
concat[0][0]',
 ate)                           672)                                'conv4_block13_
```

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2_conv[0][0]']

 conv4_block14_0_bn (BatchNorma  (None, None, None,   2688       ['conv4_block13_
concat[0][0]']
 lization)                      672)

 conv4_block14_0_relu (Activati  (None, None, None,   0          ['conv4_block14_
0_bn[0][0]']
 on)                            672)

 conv4_block14_1_conv (Conv2D)  (None, None, None,   86016       ['conv4_block14_
0_relu[0][0]']
                                128)

 conv4_block14_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block14_
1_conv[0][0]']
 lization)                      128)

 conv4_block14_1_relu (Activati  (None, None, None,   0          ['conv4_block14_
1_bn[0][0]']
 on)                            128)

 conv4_block14_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block14_
1_relu[0][0]']
                                32)

 conv4_block14_concat (Concaten  (None, None, None,   0          ['conv4_block13_
concat[0][0]',
 ate)                           704)                             'conv4_block14_
2_conv[0][0]']

 conv4_block15_0_bn (BatchNorma  (None, None, None,   2816       ['conv4_block14_
concat[0][0]']
 lization)                      704)

 conv4_block15_0_relu (Activati  (None, None, None,   0          ['conv4_block15_
0_bn[0][0]']
 on)                            704)

 conv4_block15_1_conv (Conv2D)  (None, None, None,   90112       ['conv4_block15_
0_relu[0][0]']
                                128)

 conv4_block15_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block15_
1_conv[0][0]']
 lization)                      128)

 conv4_block15_1_relu (Activati  (None, None, None,   0          ['conv4_block15_
1_bn[0][0]']
 on)                            128)

 conv4_block15_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block15_
1_relu[0][0]']
                                32)

 conv4_block15_concat (Concaten  (None, None, None,   0          ['conv4_block14_
concat[0][0]',
 ate)                           736)                             'conv4_block15_
2_conv[0][0]']
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 conv4_block16_0_bn (BatchNorma  (None, None, None,   2944       ['conv4_block15_
concat[0][0]']
 lization)                      736)

 conv4_block16_0_relu (Activati  (None, None, None,   0          ['conv4_block16_
0_bn[0][0]']
 on)                            736)

 conv4_block16_1_conv (Conv2D)  (None, None, None,   94208       ['conv4_block16_
0_relu[0][0]']
                                128)

 conv4_block16_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block16_
1_conv[0][0]']
 lization)                      128)

 conv4_block16_1_relu (Activati  (None, None, None,   0          ['conv4_block16_
1_bn[0][0]']
 on)                            128)

 conv4_block16_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block16_
1_relu[0][0]']
                                32)

 conv4_block16_concat (Concaten  (None, None, None,   0          ['conv4_block15_
concat[0][0]',
 ate)                           768)                             'conv4_block16_
2_conv[0][0]']

 conv4_block17_0_bn (BatchNorma  (None, None, None,   3072       ['conv4_block16_
concat[0][0]']
 lization)                      768)

 conv4_block17_0_relu (Activati  (None, None, None,   0          ['conv4_block17_
0_bn[0][0]']
 on)                            768)

 conv4_block17_1_conv (Conv2D)  (None, None, None,   98304       ['conv4_block17_
0_relu[0][0]']
                                128)

 conv4_block17_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block17_
1_conv[0][0]']
 lization)                      128)

 conv4_block17_1_relu (Activati  (None, None, None,   0          ['conv4_block17_
1_bn[0][0]']
 on)                            128)

 conv4_block17_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block17_
1_relu[0][0]']
                                32)

 conv4_block17_concat (Concaten  (None, None, None,   0          ['conv4_block16_
concat[0][0]',
 ate)                           800)                             'conv4_block17_
2_conv[0][0]']

 conv4_block18_0_bn (BatchNorma  (None, None, None,   3200       ['conv4_block17_
concat[0][0]']
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 lization)                      800)

 conv4_block18_0_relu (Activati  (None, None, None,   0          ['conv4_block18_
0_bn[0][0]']
 on)                            800)

 conv4_block18_1_conv (Conv2D)  (None, None, None,   102400      ['conv4_block18_
0_relu[0][0]']
                                128)

 conv4_block18_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block18_
1_conv[0][0]']
 lization)                      128)

 conv4_block18_1_relu (Activati  (None, None, None,   0          ['conv4_block18_
1_bn[0][0]']
 on)                            128)

 conv4_block18_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block18_
1_relu[0][0]']
                                32)

 conv4_block18_concat (Concaten  (None, None, None,   0          ['conv4_block17_
concat[0][0]',
 ate)                           832)                             'conv4_block18_
2_conv[0][0]']

 conv4_block19_0_bn (BatchNorma  (None, None, None,   3328       ['conv4_block18_
concat[0][0]']
 lization)                      832)

 conv4_block19_0_relu (Activati  (None, None, None,   0          ['conv4_block19_
0_bn[0][0]']
 on)                            832)

 conv4_block19_1_conv (Conv2D)  (None, None, None,   106496      ['conv4_block19_
0_relu[0][0]']
                                128)

 conv4_block19_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block19_
1_conv[0][0]']
 lization)                      128)

 conv4_block19_1_relu (Activati  (None, None, None,   0          ['conv4_block19_
1_bn[0][0]']
 on)                            128)

 conv4_block19_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block19_
1_relu[0][0]']
                                32)

 conv4_block19_concat (Concaten  (None, None, None,   0          ['conv4_block18_
concat[0][0]',
 ate)                           864)                             'conv4_block19_
2_conv[0][0]']

 conv4_block20_0_bn (BatchNorma  (None, None, None,   3456       ['conv4_block19_
concat[0][0]']
 lization)                      864)
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 conv4_block20_0_relu (Activati  (None, None, None,   0          ['conv4_block20_
0_bn[0][0]']
 on)                            864)

 conv4_block20_1_conv (Conv2D)  (None, None, None,   110592      ['conv4_block20_
0_relu[0][0]']
                                128)

 conv4_block20_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block20_
1_conv[0][0]']
 lization)                      128)

 conv4_block20_1_relu (Activati  (None, None, None,   0          ['conv4_block20_
1_bn[0][0]']
 on)                            128)

 conv4_block20_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block20_
1_relu[0][0]']
                                32)

 conv4_block20_concat (Concaten  (None, None, None,   0          ['conv4_block19_
concat[0][0]',
 ate)                           896)                             'conv4_block20_
2_conv[0][0]']

 conv4_block21_0_bn (BatchNorma  (None, None, None,   3584       ['conv4_block20_
concat[0][0]']
 lization)                      896)

 conv4_block21_0_relu (Activati  (None, None, None,   0          ['conv4_block21_
0_bn[0][0]']
 on)                            896)

 conv4_block21_1_conv (Conv2D)  (None, None, None,   114688      ['conv4_block21_
0_relu[0][0]']
                                128)

 conv4_block21_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block21_
1_conv[0][0]']
 lization)                      128)

 conv4_block21_1_relu (Activati  (None, None, None,   0          ['conv4_block21_
1_bn[0][0]']
 on)                            128)

 conv4_block21_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block21_
1_relu[0][0]']
                                32)

 conv4_block21_concat (Concaten  (None, None, None,   0          ['conv4_block20_
concat[0][0]',
 ate)                           928)                             'conv4_block21_
2_conv[0][0]']

 conv4_block22_0_bn (BatchNorma  (None, None, None,   3712       ['conv4_block21_
concat[0][0]']
 lization)                      928)

 conv4_block22_0_relu (Activati  (None, None, None,   0          ['conv4_block22_
0_bn[0][0]']
```

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 on)                            928)

 conv4_block22_1_conv (Conv2D)  (None, None, None,   118784      ['conv4_block22_
0_relu[0][0]']
                                128)

 conv4_block22_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block22_
1_conv[0][0]']
 lization)                      128)

 conv4_block22_1_relu (Activati  (None, None, None,   0          ['conv4_block22_
1_bn[0][0]']
 on)                            128)

 conv4_block22_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block22_
1_relu[0][0]']
                                32)

 conv4_block22_concat (Concaten  (None, None, None,   0          ['conv4_block21_
concat[0][0]',
 ate)                           960)                             'conv4_block22_
2_conv[0][0]']

 conv4_block23_0_bn (BatchNorma  (None, None, None,   3840       ['conv4_block22_
concat[0][0]']
 lization)                      960)

 conv4_block23_0_relu (Activati  (None, None, None,   0          ['conv4_block23_
0_bn[0][0]']
 on)                            960)

 conv4_block23_1_conv (Conv2D)  (None, None, None,   122880      ['conv4_block23_
0_relu[0][0]']
                                128)

 conv4_block23_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block23_
1_conv[0][0]']
 lization)                      128)

 conv4_block23_1_relu (Activati  (None, None, None,   0          ['conv4_block23_
1_bn[0][0]']
 on)                            128)

 conv4_block23_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block23_
1_relu[0][0]']
                                32)

 conv4_block23_concat (Concaten  (None, None, None,   0          ['conv4_block22_
concat[0][0]',
 ate)                           992)                             'conv4_block23_
2_conv[0][0]']

 conv4_block24_0_bn (BatchNorma  (None, None, None,   3968       ['conv4_block23_
concat[0][0]']
 lization)                      992)

 conv4_block24_0_relu (Activati  (None, None, None,   0          ['conv4_block24_
0_bn[0][0]']
 on)                            992)
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 conv4_block24_1_conv (Conv2D)  (None, None, None,   126976      ['conv4_block24_
0_relu[0][0]']
                                128)

 conv4_block24_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block24_
1_conv[0][0]']
 lization)                      128)

 conv4_block24_1_relu (Activati  (None, None, None,   0          ['conv4_block24_
1_bn[0][0]']
 on)                            128)

 conv4_block24_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block24_
1_relu[0][0]']
                                32)

 conv4_block24_concat (Concaten  (None, None, None,   0          ['conv4_block23_
concat[0][0]',
 ate)                           1024)                            'conv4_block24_
2_conv[0][0]']

 conv4_block25_0_bn (BatchNorma  (None, None, None,   4096       ['conv4_block24_
concat[0][0]']
 lization)                      1024)

 conv4_block25_0_relu (Activati  (None, None, None,   0          ['conv4_block25_
0_bn[0][0]']
 on)                            1024)

 conv4_block25_1_conv (Conv2D)  (None, None, None,   131072      ['conv4_block25_
0_relu[0][0]']
                                128)

 conv4_block25_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block25_
1_conv[0][0]']
 lization)                      128)

 conv4_block25_1_relu (Activati  (None, None, None,   0          ['conv4_block25_
1_bn[0][0]']
 on)                            128)

 conv4_block25_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block25_
1_relu[0][0]']
                                32)

 conv4_block25_concat (Concaten  (None, None, None,   0          ['conv4_block24_
concat[0][0]',
 ate)                           1056)                            'conv4_block25_
2_conv[0][0]']

 conv4_block26_0_bn (BatchNorma  (None, None, None,   4224       ['conv4_block25_
concat[0][0]']
 lization)                      1056)

 conv4_block26_0_relu (Activati  (None, None, None,   0          ['conv4_block26_
0_bn[0][0]']
 on)                            1056)

 conv4_block26_1_conv (Conv2D)  (None, None, None,   135168      ['conv4_block26_
0_relu[0][0]']
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                                128)

 conv4_block26_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block26_
1_conv[0][0]']
 lization)                      128)

 conv4_block26_1_relu (Activati  (None, None, None,   0          ['conv4_block26_
1_bn[0][0]']
 on)                            128)

 conv4_block26_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block26_
1_relu[0][0]']
                                32)

 conv4_block26_concat (Concaten  (None, None, None,   0          ['conv4_block25_
concat[0][0]',
 ate)                           1088)                            'conv4_block26_
2_conv[0][0]']

 conv4_block27_0_bn (BatchNorma  (None, None, None,   4352       ['conv4_block26_
concat[0][0]']
 lization)                      1088)

 conv4_block27_0_relu (Activati  (None, None, None,   0          ['conv4_block27_
0_bn[0][0]']
 on)                            1088)

 conv4_block27_1_conv (Conv2D)  (None, None, None,   139264      ['conv4_block27_
0_relu[0][0]']
                                128)

 conv4_block27_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block27_
1_conv[0][0]']
 lization)                      128)

 conv4_block27_1_relu (Activati  (None, None, None,   0          ['conv4_block27_
1_bn[0][0]']
 on)                            128)

 conv4_block27_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block27_
1_relu[0][0]']
                                32)

 conv4_block27_concat (Concaten  (None, None, None,   0          ['conv4_block26_
concat[0][0]',
 ate)                           1120)                            'conv4_block27_
2_conv[0][0]']

 conv4_block28_0_bn (BatchNorma  (None, None, None,   4480       ['conv4_block27_
concat[0][0]']
 lization)                      1120)

 conv4_block28_0_relu (Activati  (None, None, None,   0          ['conv4_block28_
0_bn[0][0]']
 on)                            1120)

 conv4_block28_1_conv (Conv2D)  (None, None, None,   143360      ['conv4_block28_
0_relu[0][0]']
                                128)
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 conv4_block28_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block28_
1_conv[0][0]']
 lization)                      128)

 conv4_block28_1_relu (Activati  (None, None, None,   0          ['conv4_block28_
1_bn[0][0]']
 on)                            128)

 conv4_block28_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block28_
1_relu[0][0]']
                                32)

 conv4_block28_concat (Concaten  (None, None, None,   0          ['conv4_block27_
concat[0][0]',
 ate)                           1152)                            'conv4_block28_
2_conv[0][0]']

 conv4_block29_0_bn (BatchNorma  (None, None, None,   4608       ['conv4_block28_
concat[0][0]']
 lization)                      1152)

 conv4_block29_0_relu (Activati  (None, None, None,   0          ['conv4_block29_
0_bn[0][0]']
 on)                            1152)

 conv4_block29_1_conv (Conv2D)  (None, None, None,   147456      ['conv4_block29_
0_relu[0][0]']
                                128)

 conv4_block29_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block29_
1_conv[0][0]']
 lization)                      128)

 conv4_block29_1_relu (Activati  (None, None, None,   0          ['conv4_block29_
1_bn[0][0]']
 on)                            128)

 conv4_block29_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block29_
1_relu[0][0]']
                                32)

 conv4_block29_concat (Concaten  (None, None, None,   0          ['conv4_block28_
concat[0][0]',
 ate)                           1184)                            'conv4_block29_
2_conv[0][0]']

 conv4_block30_0_bn (BatchNorma  (None, None, None,   4736       ['conv4_block29_
concat[0][0]']
 lization)                      1184)

 conv4_block30_0_relu (Activati  (None, None, None,   0          ['conv4_block30_
0_bn[0][0]']
 on)                            1184)

 conv4_block30_1_conv (Conv2D)  (None, None, None,   151552      ['conv4_block30_
0_relu[0][0]']
                                128)

 conv4_block30_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block30_
1_conv[0][0]']
```

```
 lization)                      128)

 conv4_block30_1_relu (Activati  (None, None, None,   0          ['conv4_block30_
1_bn[0][0]']
 on)                            128)

 conv4_block30_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block30_
1_relu[0][0]']
                                32)

 conv4_block30_concat (Concaten  (None, None, None,   0          ['conv4_block29_
concat[0][0]',
 ate)                           1216)                            'conv4_block30_
2_conv[0][0]']

 conv4_block31_0_bn (BatchNorma  (None, None, None,   4864       ['conv4_block30_
concat[0][0]']
 lization)                      1216)

 conv4_block31_0_relu (Activati  (None, None, None,   0          ['conv4_block31_
0_bn[0][0]']
 on)                            1216)

 conv4_block31_1_conv (Conv2D)  (None, None, None,   155648      ['conv4_block31_
0_relu[0][0]']
                                128)

 conv4_block31_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block31_
1_conv[0][0]']
 lization)                      128)

 conv4_block31_1_relu (Activati  (None, None, None,   0          ['conv4_block31_
1_bn[0][0]']
 on)                            128)

 conv4_block31_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block31_
1_relu[0][0]']
                                32)

 conv4_block31_concat (Concaten  (None, None, None,   0          ['conv4_block30_
concat[0][0]',
 ate)                           1248)                            'conv4_block31_
2_conv[0][0]']

 conv4_block32_0_bn (BatchNorma  (None, None, None,   4992       ['conv4_block31_
concat[0][0]']
 lization)                      1248)

 conv4_block32_0_relu (Activati  (None, None, None,   0          ['conv4_block32_
0_bn[0][0]']
 on)                            1248)

 conv4_block32_1_conv (Conv2D)  (None, None, None,   159744      ['conv4_block32_
0_relu[0][0]']
                                128)

 conv4_block32_1_bn (BatchNorma  (None, None, None,   512        ['conv4_block32_
1_conv[0][0]']
 lization)                      128)
```

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 conv4_block32_1_relu (Activati  (None, None, None,   0          ['conv4_block32_
1_bn[0][0]']
 on)                            128)

 conv4_block32_2_conv (Conv2D)  (None, None, None,   36864       ['conv4_block32_
1_relu[0][0]']
                                32)

 conv4_block32_concat (Concaten  (None, None, None,   0          ['conv4_block31_
concat[0][0]',
 ate)                           1280)                            'conv4_block32_
2_conv[0][0]']

 pool4_bn (BatchNormalization)  (None, None, None,   5120        ['conv4_block32_
concat[0][0]']
                                1280)

 pool4_relu (Activation)        (None, None, None,   0           ['pool4_bn[0]
[0]']
                                1280)

 pool4_conv (Conv2D)            (None, None, None,   819200      ['pool4_relu[0]
[0]']
                                640)

 pool4_pool (AveragePooling2D)  (None, None, None,   0           ['pool4_conv[0]
[0]']
                                640)

 conv5_block1_0_bn (BatchNormal  (None, None, None,   2560       ['pool4_pool[0]
[0]']
 ization)                       640)

 conv5_block1_0_relu (Activatio  (None, None, None,   0          ['conv5_block1_0
_bn[0][0]']
 n)                             640)

 conv5_block1_1_conv (Conv2D)   (None, None, None,   81920       ['conv5_block1_0
_relu[0][0]']
                                128)

 conv5_block1_1_bn (BatchNormal  (None, None, None,   512        ['conv5_block1_1
_conv[0][0]']
 ization)                       128)

 conv5_block1_1_relu (Activatio  (None, None, None,   0          ['conv5_block1_1
_bn[0][0]']
 n)                             128)

 conv5_block1_2_conv (Conv2D)   (None, None, None,   36864       ['conv5_block1_1
_relu[0][0]']
                                32)

 conv5_block1_concat (Concatena  (None, None, None,   0          ['pool4_pool[0]
[0]',
 te)                            672)                             'conv5_block1_2
_conv[0][0]']

 conv5_block2_0_bn (BatchNormal  (None, None, None,   2688       ['conv5_block1_c
oncat[0][0]']
```

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 ization)                       672)

 conv5_block2_0_relu (Activatio  (None, None, None,   0          ['conv5_block2_0
_bn[0][0]']
 n)                             672)

 conv5_block2_1_conv (Conv2D)   (None, None, None,   86016       ['conv5_block2_0
_relu[0][0]']
                                128)

 conv5_block2_1_bn (BatchNormal  (None, None, None,   512        ['conv5_block2_1
_conv[0][0]']
 ization)                       128)

 conv5_block2_1_relu (Activatio  (None, None, None,   0          ['conv5_block2_1
_bn[0][0]']
 n)                             128)

 conv5_block2_2_conv (Conv2D)   (None, None, None,   36864       ['conv5_block2_1
_relu[0][0]']
                                32)

 conv5_block2_concat (Concatena  (None, None, None,   0          ['conv5_block1_c
oncat[0][0]',
 te)                            704)                             'conv5_block2_2
_conv[0][0]']

 conv5_block3_0_bn (BatchNormal  (None, None, None,   2816       ['conv5_block2_c
oncat[0][0]']
 ization)                       704)

 conv5_block3_0_relu (Activatio  (None, None, None,   0          ['conv5_block3_0
_bn[0][0]']
 n)                             704)

 conv5_block3_1_conv (Conv2D)   (None, None, None,   90112       ['conv5_block3_0
_relu[0][0]']
                                128)

 conv5_block3_1_bn (BatchNormal  (None, None, None,   512        ['conv5_block3_1
_conv[0][0]']
 ization)                       128)

 conv5_block3_1_relu (Activatio  (None, None, None,   0          ['conv5_block3_1
_bn[0][0]']
 n)                             128)

 conv5_block3_2_conv (Conv2D)   (None, None, None,   36864       ['conv5_block3_1
_relu[0][0]']
                                32)

 conv5_block3_concat (Concatena  (None, None, None,   0          ['conv5_block2_c
oncat[0][0]',
 te)                            736)                             'conv5_block3_2
_conv[0][0]']

 conv5_block4_0_bn (BatchNormal  (None, None, None,   2944       ['conv5_block3_c
oncat[0][0]']
 ization)                       736)
```

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 conv5_block4_0_relu (Activatio  (None, None, None,   0          ['conv5_block4_0
_bn[0][0]']
 n)                             736)

 conv5_block4_1_conv (Conv2D)   (None, None, None,   94208       ['conv5_block4_0
_relu[0][0]']
                                128)

 conv5_block4_1_bn (BatchNormal  (None, None, None,   512        ['conv5_block4_1
_conv[0][0]']
 ization)                       128)

 conv5_block4_1_relu (Activatio  (None, None, None,   0          ['conv5_block4_1
_bn[0][0]']
 n)                             128)

 conv5_block4_2_conv (Conv2D)   (None, None, None,   36864       ['conv5_block4_1
_relu[0][0]']
                                32)

 conv5_block4_concat (Concatena  (None, None, None,   0          ['conv5_block3_c
oncat[0][0]',
 te)                            768)                             'conv5_block4_2
_conv[0][0]']

 conv5_block5_0_bn (BatchNormal  (None, None, None,   3072       ['conv5_block4_c
oncat[0][0]']
 ization)                       768)

 conv5_block5_0_relu (Activatio  (None, None, None,   0          ['conv5_block5_0
_bn[0][0]']
 n)                             768)

 conv5_block5_1_conv (Conv2D)   (None, None, None,   98304       ['conv5_block5_0
_relu[0][0]']
                                128)

 conv5_block5_1_bn (BatchNormal  (None, None, None,   512        ['conv5_block5_1
_conv[0][0]']
 ization)                       128)

 conv5_block5_1_relu (Activatio  (None, None, None,   0          ['conv5_block5_1
_bn[0][0]']
 n)                             128)

 conv5_block5_2_conv (Conv2D)   (None, None, None,   36864       ['conv5_block5_1
_relu[0][0]']
                                32)

 conv5_block5_concat (Concatena  (None, None, None,   0          ['conv5_block4_c
oncat[0][0]',
 te)                            800)                             'conv5_block5_2
_conv[0][0]']

 conv5_block6_0_bn (BatchNormal  (None, None, None,   3200       ['conv5_block5_c
oncat[0][0]']
 ization)                       800)

 conv5_block6_0_relu (Activatio  (None, None, None,   0          ['conv5_block6_0
_bn[0][0]']
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 n)                             800)

 conv5_block6_1_conv (Conv2D)   (None, None, None,   102400      ['conv5_block6_0
_relu[0][0]']
                                128)

 conv5_block6_1_bn (BatchNormal  (None, None, None,   512        ['conv5_block6_1
_conv[0][0]']
 ization)                       128)

 conv5_block6_1_relu (Activatio  (None, None, None,   0          ['conv5_block6_1
_bn[0][0]']
 n)                             128)

 conv5_block6_2_conv (Conv2D)   (None, None, None,   36864       ['conv5_block6_1
_relu[0][0]']
                                32)

 conv5_block6_concat (Concatena  (None, None, None,   0          ['conv5_block5_c
oncat[0][0]',
 te)                            832)                             'conv5_block6_2
_conv[0][0]']

 conv5_block7_0_bn (BatchNormal  (None, None, None,   3328       ['conv5_block6_c
oncat[0][0]']
 ization)                       832)

 conv5_block7_0_relu (Activatio  (None, None, None,   0          ['conv5_block7_0
_bn[0][0]']
 n)                             832)

 conv5_block7_1_conv (Conv2D)   (None, None, None,   106496      ['conv5_block7_0
_relu[0][0]']
                                128)

 conv5_block7_1_bn (BatchNormal  (None, None, None,   512        ['conv5_block7_1
_conv[0][0]']
 ization)                       128)

 conv5_block7_1_relu (Activatio  (None, None, None,   0          ['conv5_block7_1
_bn[0][0]']
 n)                             128)

 conv5_block7_2_conv (Conv2D)   (None, None, None,   36864       ['conv5_block7_1
_relu[0][0]']
                                32)

 conv5_block7_concat (Concatena  (None, None, None,   0          ['conv5_block6_c
oncat[0][0]',
 te)                            864)                             'conv5_block7_2
_conv[0][0]']

 conv5_block8_0_bn (BatchNormal  (None, None, None,   3456       ['conv5_block7_c
oncat[0][0]']
 ization)                       864)

 conv5_block8_0_relu (Activatio  (None, None, None,   0          ['conv5_block8_0
_bn[0][0]']
 n)                             864)
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 conv5_block8_1_conv (Conv2D)   (None, None, None,   110592      ['conv5_block8_0
_relu[0][0]']
                                128)

 conv5_block8_1_bn (BatchNormal  (None, None, None,   512        ['conv5_block8_1
_conv[0][0]']
 ization)                       128)

 conv5_block8_1_relu (Activatio  (None, None, None,   0          ['conv5_block8_1
_bn[0][0]']
 n)                             128)

 conv5_block8_2_conv (Conv2D)   (None, None, None,   36864       ['conv5_block8_1
_relu[0][0]']
                                32)

 conv5_block8_concat (Concatena  (None, None, None,   0          ['conv5_block7_c
oncat[0][0]',
 te)                            896)                             'conv5_block8_2
_conv[0][0]']

 conv5_block9_0_bn (BatchNormal  (None, None, None,   3584       ['conv5_block8_c
oncat[0][0]']
 ization)                       896)

 conv5_block9_0_relu (Activatio  (None, None, None,   0          ['conv5_block9_0
_bn[0][0]']
 n)                             896)

 conv5_block9_1_conv (Conv2D)   (None, None, None,   114688      ['conv5_block9_0
_relu[0][0]']
                                128)

 conv5_block9_1_bn (BatchNormal  (None, None, None,   512        ['conv5_block9_1
_conv[0][0]']
 ization)                       128)

 conv5_block9_1_relu (Activatio  (None, None, None,   0          ['conv5_block9_1
_bn[0][0]']
 n)                             128)

 conv5_block9_2_conv (Conv2D)   (None, None, None,   36864       ['conv5_block9_1
_relu[0][0]']
                                32)

 conv5_block9_concat (Concatena  (None, None, None,   0          ['conv5_block8_c
oncat[0][0]',
 te)                            928)                             'conv5_block9_2
_conv[0][0]']

 conv5_block10_0_bn (BatchNorma  (None, None, None,   3712       ['conv5_block9_c
oncat[0][0]']
 lization)                      928)

 conv5_block10_0_relu (Activati  (None, None, None,   0          ['conv5_block10_
0_bn[0][0]']
 on)                            928)

 conv5_block10_1_conv (Conv2D)  (None, None, None,   118784      ['conv5_block10_
0_relu[0][0]']
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                                128)

 conv5_block10_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block10_
1_conv[0][0]']
 lization)                      128)

 conv5_block10_1_relu (Activati  (None, None, None,   0          ['conv5_block10_
1_bn[0][0]']
 on)                            128)

 conv5_block10_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block10_
1_relu[0][0]']
                                32)

 conv5_block10_concat (Concaten  (None, None, None,   0          ['conv5_block9_c
oncat[0][0]',
 ate)                           960)                             'conv5_block10_
2_conv[0][0]']

 conv5_block11_0_bn (BatchNorma  (None, None, None,   3840       ['conv5_block10_
concat[0][0]']
 lization)                      960)

 conv5_block11_0_relu (Activati  (None, None, None,   0          ['conv5_block11_
0_bn[0][0]']
 on)                            960)

 conv5_block11_1_conv (Conv2D)  (None, None, None,   122880      ['conv5_block11_
0_relu[0][0]']
                                128)

 conv5_block11_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block11_
1_conv[0][0]']
 lization)                      128)

 conv5_block11_1_relu (Activati  (None, None, None,   0          ['conv5_block11_
1_bn[0][0]']
 on)                            128)

 conv5_block11_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block11_
1_relu[0][0]']
                                32)

 conv5_block11_concat (Concaten  (None, None, None,   0          ['conv5_block10_
concat[0][0]',
 ate)                           992)                             'conv5_block11_
2_conv[0][0]']

 conv5_block12_0_bn (BatchNorma  (None, None, None,   3968       ['conv5_block11_
concat[0][0]']
 lization)                      992)

 conv5_block12_0_relu (Activati  (None, None, None,   0          ['conv5_block12_
0_bn[0][0]']
 on)                            992)

 conv5_block12_1_conv (Conv2D)  (None, None, None,   126976      ['conv5_block12_
0_relu[0][0]']
                                128)
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 conv5_block12_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block12_
1_conv[0][0]']
 lization)                      128)

 conv5_block12_1_relu (Activati  (None, None, None,   0          ['conv5_block12_
1_bn[0][0]']
 on)                            128)

 conv5_block12_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block12_
1_relu[0][0]']
                                32)

 conv5_block12_concat (Concaten  (None, None, None,   0          ['conv5_block11_
concat[0][0]',
 ate)                           1024)                            'conv5_block12_
2_conv[0][0]']

 conv5_block13_0_bn (BatchNorma  (None, None, None,   4096       ['conv5_block12_
concat[0][0]']
 lization)                      1024)

 conv5_block13_0_relu (Activati  (None, None, None,   0          ['conv5_block13_
0_bn[0][0]']
 on)                            1024)

 conv5_block13_1_conv (Conv2D)  (None, None, None,   131072      ['conv5_block13_
0_relu[0][0]']
                                128)

 conv5_block13_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block13_
1_conv[0][0]']
 lization)                      128)

 conv5_block13_1_relu (Activati  (None, None, None,   0          ['conv5_block13_
1_bn[0][0]']
 on)                            128)

 conv5_block13_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block13_
1_relu[0][0]']
                                32)

 conv5_block13_concat (Concaten  (None, None, None,   0          ['conv5_block12_
concat[0][0]',
 ate)                           1056)                            'conv5_block13_
2_conv[0][0]']

 conv5_block14_0_bn (BatchNorma  (None, None, None,   4224       ['conv5_block13_
concat[0][0]']
 lization)                      1056)

 conv5_block14_0_relu (Activati  (None, None, None,   0          ['conv5_block14_
0_bn[0][0]']
 on)                            1056)

 conv5_block14_1_conv (Conv2D)  (None, None, None,   135168      ['conv5_block14_
0_relu[0][0]']
                                128)

 conv5_block14_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block14_
1_conv[0][0]']
```

```
 lization)                      128)

 conv5_block14_1_relu (Activati  (None, None, None,   0          ['conv5_block14_
1_bn[0][0]']
 on)                            128)

 conv5_block14_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block14_
1_relu[0][0]']
                                32)

 conv5_block14_concat (Concaten  (None, None, None,   0          ['conv5_block13_
concat[0][0]',
 ate)                           1088)                            'conv5_block14_
2_conv[0][0]']

 conv5_block15_0_bn (BatchNorma  (None, None, None,   4352       ['conv5_block14_
concat[0][0]']
 lization)                      1088)

 conv5_block15_0_relu (Activati  (None, None, None,   0          ['conv5_block15_
0_bn[0][0]']
 on)                            1088)

 conv5_block15_1_conv (Conv2D)  (None, None, None,   139264      ['conv5_block15_
0_relu[0][0]']
                                128)

 conv5_block15_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block15_
1_conv[0][0]']
 lization)                      128)

 conv5_block15_1_relu (Activati  (None, None, None,   0          ['conv5_block15_
1_bn[0][0]']
 on)                            128)

 conv5_block15_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block15_
1_relu[0][0]']
                                32)

 conv5_block15_concat (Concaten  (None, None, None,   0          ['conv5_block14_
concat[0][0]',
 ate)                           1120)                            'conv5_block15_
2_conv[0][0]']

 conv5_block16_0_bn (BatchNorma  (None, None, None,   4480       ['conv5_block15_
concat[0][0]']
 lization)                      1120)

 conv5_block16_0_relu (Activati  (None, None, None,   0          ['conv5_block16_
0_bn[0][0]']
 on)                            1120)

 conv5_block16_1_conv (Conv2D)  (None, None, None,   143360      ['conv5_block16_
0_relu[0][0]']
                                128)

 conv5_block16_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block16_
1_conv[0][0]']
 lization)                      128)
```

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 conv5_block16_1_relu (Activati  (None, None, None,   0          ['conv5_block16_
1_bn[0][0]']
 on)                            128)

 conv5_block16_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block16_
1_relu[0][0]']
                                32)

 conv5_block16_concat (Concaten  (None, None, None,   0          ['conv5_block15_
concat[0][0]',
 ate)                           1152)                            'conv5_block16_
2_conv[0][0]']

 conv5_block17_0_bn (BatchNorma  (None, None, None,   4608       ['conv5_block16_
concat[0][0]']
 lization)                      1152)

 conv5_block17_0_relu (Activati  (None, None, None,   0          ['conv5_block17_
0_bn[0][0]']
 on)                            1152)

 conv5_block17_1_conv (Conv2D)  (None, None, None,   147456      ['conv5_block17_
0_relu[0][0]']
                                128)

 conv5_block17_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block17_
1_conv[0][0]']
 lization)                      128)

 conv5_block17_1_relu (Activati  (None, None, None,   0          ['conv5_block17_
1_bn[0][0]']
 on)                            128)

 conv5_block17_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block17_
1_relu[0][0]']
                                32)

 conv5_block17_concat (Concaten  (None, None, None,   0          ['conv5_block16_
concat[0][0]',
 ate)                           1184)                            'conv5_block17_
2_conv[0][0]']

 conv5_block18_0_bn (BatchNorma  (None, None, None,   4736       ['conv5_block17_
concat[0][0]']
 lization)                      1184)

 conv5_block18_0_relu (Activati  (None, None, None,   0          ['conv5_block18_
0_bn[0][0]']
 on)                            1184)

 conv5_block18_1_conv (Conv2D)  (None, None, None,   151552      ['conv5_block18_
0_relu[0][0]']
                                128)

 conv5_block18_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block18_
1_conv[0][0]']
 lization)                      128)

 conv5_block18_1_relu (Activati  (None, None, None,   0          ['conv5_block18_
1_bn[0][0]']
```

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 on)                            128)

 conv5_block18_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block18_
1_relu[0][0]']
                                32)

 conv5_block18_concat (Concaten  (None, None, None,   0          ['conv5_block17_
concat[0][0]',
 ate)                           1216)                            'conv5_block18_
2_conv[0][0]']

 conv5_block19_0_bn (BatchNorma  (None, None, None,   4864       ['conv5_block18_
concat[0][0]']
 lization)                      1216)

 conv5_block19_0_relu (Activati  (None, None, None,   0          ['conv5_block19_
0_bn[0][0]']
 on)                            1216)

 conv5_block19_1_conv (Conv2D)  (None, None, None,   155648      ['conv5_block19_
0_relu[0][0]']
                                128)

 conv5_block19_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block19_
1_conv[0][0]']
 lization)                      128)

 conv5_block19_1_relu (Activati  (None, None, None,   0          ['conv5_block19_
1_bn[0][0]']
 on)                            128)

 conv5_block19_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block19_
1_relu[0][0]']
                                32)

 conv5_block19_concat (Concaten  (None, None, None,   0          ['conv5_block18_
concat[0][0]',
 ate)                           1248)                            'conv5_block19_
2_conv[0][0]']

 conv5_block20_0_bn (BatchNorma  (None, None, None,   4992       ['conv5_block19_
concat[0][0]']
 lization)                      1248)

 conv5_block20_0_relu (Activati  (None, None, None,   0          ['conv5_block20_
0_bn[0][0]']
 on)                            1248)

 conv5_block20_1_conv (Conv2D)  (None, None, None,   159744      ['conv5_block20_
0_relu[0][0]']
                                128)

 conv5_block20_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block20_
1_conv[0][0]']
 lization)                      128)

 conv5_block20_1_relu (Activati  (None, None, None,   0          ['conv5_block20_
1_bn[0][0]']
 on)                            128)
```

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 conv5_block20_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block20_
1_relu[0][0]']
                                32)

 conv5_block20_concat (Concaten  (None, None, None,   0          ['conv5_block19_
concat[0][0]',
 ate)                           1280)                            'conv5_block20_
2_conv[0][0]']

 conv5_block21_0_bn (BatchNorma  (None, None, None,   5120       ['conv5_block20_
concat[0][0]']
 lization)                      1280)

 conv5_block21_0_relu (Activati  (None, None, None,   0          ['conv5_block21_
0_bn[0][0]']
 on)                            1280)

 conv5_block21_1_conv (Conv2D)  (None, None, None,   163840      ['conv5_block21_
0_relu[0][0]']
                                128)

 conv5_block21_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block21_
1_conv[0][0]']
 lization)                      128)

 conv5_block21_1_relu (Activati  (None, None, None,   0          ['conv5_block21_
1_bn[0][0]']
 on)                            128)

 conv5_block21_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block21_
1_relu[0][0]']
                                32)

 conv5_block21_concat (Concaten  (None, None, None,   0          ['conv5_block20_
concat[0][0]',
 ate)                           1312)                            'conv5_block21_
2_conv[0][0]']

 conv5_block22_0_bn (BatchNorma  (None, None, None,   5248       ['conv5_block21_
concat[0][0]']
 lization)                      1312)

 conv5_block22_0_relu (Activati  (None, None, None,   0          ['conv5_block22_
0_bn[0][0]']
 on)                            1312)

 conv5_block22_1_conv (Conv2D)  (None, None, None,   167936      ['conv5_block22_
0_relu[0][0]']
                                128)

 conv5_block22_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block22_
1_conv[0][0]']
 lization)                      128)

 conv5_block22_1_relu (Activati  (None, None, None,   0          ['conv5_block22_
1_bn[0][0]']
 on)                            128)

 conv5_block22_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block22_
1_relu[0][0]']
```

```
                                32)

 conv5_block22_concat (Concaten  (None, None, None,   0          ['conv5_block21_
concat[0][0]',
 ate)                           1344)                             'conv5_block22_
2_conv[0][0]']

 conv5_block23_0_bn (BatchNorma  (None, None, None,   5376       ['conv5_block22_
concat[0][0]']
 lization)                      1344)

 conv5_block23_0_relu (Activati  (None, None, None,   0          ['conv5_block23_
0_bn[0][0]']
 on)                            1344)

 conv5_block23_1_conv (Conv2D)  (None, None, None,   172032      ['conv5_block23_
0_relu[0][0]']
                                128)

 conv5_block23_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block23_
1_conv[0][0]']
 lization)                      128)

 conv5_block23_1_relu (Activati  (None, None, None,   0          ['conv5_block23_
1_bn[0][0]']
 on)                            128)

 conv5_block23_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block23_
1_relu[0][0]']
                                32)

 conv5_block23_concat (Concaten  (None, None, None,   0          ['conv5_block22_
concat[0][0]',
 ate)                           1376)                             'conv5_block23_
2_conv[0][0]']

 conv5_block24_0_bn (BatchNorma  (None, None, None,   5504       ['conv5_block23_
concat[0][0]']
 lization)                      1376)

 conv5_block24_0_relu (Activati  (None, None, None,   0          ['conv5_block24_
0_bn[0][0]']
 on)                            1376)

 conv5_block24_1_conv (Conv2D)  (None, None, None,   176128      ['conv5_block24_
0_relu[0][0]']
                                128)

 conv5_block24_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block24_
1_conv[0][0]']
 lization)                      128)

 conv5_block24_1_relu (Activati  (None, None, None,   0          ['conv5_block24_
1_bn[0][0]']
 on)                            128)

 conv5_block24_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block24_
1_relu[0][0]']
                                32)
```

```
 conv5_block24_concat (Concaten  (None, None, None,   0          ['conv5_block23_
concat[0][0]',
 ate)                           1408)                             'conv5_block24_
2_conv[0][0]']

 conv5_block25_0_bn (BatchNorma  (None, None, None,   5632       ['conv5_block24_
concat[0][0]']
 lization)                      1408)

 conv5_block25_0_relu (Activati  (None, None, None,   0          ['conv5_block25_
0_bn[0][0]']
 on)                            1408)

 conv5_block25_1_conv (Conv2D)  (None, None, None,   180224      ['conv5_block25_
0_relu[0][0]']
                                128)

 conv5_block25_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block25_
1_conv[0][0]']
 lization)                      128)

 conv5_block25_1_relu (Activati  (None, None, None,   0          ['conv5_block25_
1_bn[0][0]']
 on)                            128)

 conv5_block25_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block25_
1_relu[0][0]']
                                32)

 conv5_block25_concat (Concaten  (None, None, None,   0          ['conv5_block24_
concat[0][0]',
 ate)                           1440)                             'conv5_block25_
2_conv[0][0]']

 conv5_block26_0_bn (BatchNorma  (None, None, None,   5760       ['conv5_block25_
concat[0][0]']
 lization)                      1440)

 conv5_block26_0_relu (Activati  (None, None, None,   0          ['conv5_block26_
0_bn[0][0]']
 on)                            1440)

 conv5_block26_1_conv (Conv2D)  (None, None, None,   184320      ['conv5_block26_
0_relu[0][0]']
                                128)

 conv5_block26_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block26_
1_conv[0][0]']
 lization)                      128)

 conv5_block26_1_relu (Activati  (None, None, None,   0          ['conv5_block26_
1_bn[0][0]']
 on)                            128)

 conv5_block26_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block26_
1_relu[0][0]']
                                32)

 conv5_block26_concat (Concaten  (None, None, None,   0          ['conv5_block25_
concat[0][0]',
```

```
 ate)                           1472)                              'conv5_block26_
2_conv[0][0]']

 conv5_block27_0_bn (BatchNorma  (None, None, None,   5888       ['conv5_block26_
concat[0][0]']
 lization)                      1472)

 conv5_block27_0_relu (Activati  (None, None, None,   0          ['conv5_block27_
0_bn[0][0]']
 on)                            1472)

 conv5_block27_1_conv (Conv2D)  (None, None, None,   188416      ['conv5_block27_
0_relu[0][0]']
                                128)

 conv5_block27_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block27_
1_conv[0][0]']
 lization)                      128)

 conv5_block27_1_relu (Activati  (None, None, None,   0          ['conv5_block27_
1_bn[0][0]']
 on)                            128)

 conv5_block27_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block27_
1_relu[0][0]']
                                32)

 conv5_block27_concat (Concaten  (None, None, None,   0          ['conv5_block26_
concat[0][0]',
 ate)                           1504)                              'conv5_block27_
2_conv[0][0]']

 conv5_block28_0_bn (BatchNorma  (None, None, None,   6016       ['conv5_block27_
concat[0][0]']
 lization)                      1504)

 conv5_block28_0_relu (Activati  (None, None, None,   0          ['conv5_block28_
0_bn[0][0]']
 on)                            1504)

 conv5_block28_1_conv (Conv2D)  (None, None, None,   192512      ['conv5_block28_
0_relu[0][0]']
                                128)

 conv5_block28_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block28_
1_conv[0][0]']
 lization)                      128)

 conv5_block28_1_relu (Activati  (None, None, None,   0          ['conv5_block28_
1_bn[0][0]']
 on)                            128)

 conv5_block28_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block28_
1_relu[0][0]']
                                32)

 conv5_block28_concat (Concaten  (None, None, None,   0          ['conv5_block27_
concat[0][0]',
 ate)                           1536)                              'conv5_block28_
2_conv[0][0]']
```

```
 conv5_block29_0_bn (BatchNorma  (None, None, None,   6144       ['conv5_block28_
concat[0][0]']
 lization)                      1536)

 conv5_block29_0_relu (Activati  (None, None, None,   0          ['conv5_block29_
0_bn[0][0]']
 on)                            1536)

 conv5_block29_1_conv (Conv2D)  (None, None, None,   196608     ['conv5_block29_
0_relu[0][0]']
                                128)

 conv5_block29_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block29_
1_conv[0][0]']
 lization)                      128)

 conv5_block29_1_relu (Activati  (None, None, None,   0          ['conv5_block29_
1_bn[0][0]']
 on)                            128)

 conv5_block29_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block29_
1_relu[0][0]']
                                32)

 conv5_block29_concat (Concaten  (None, None, None,   0          ['conv5_block28_
concat[0][0]',
 ate)                           1568)                            'conv5_block29_
2_conv[0][0]']

 conv5_block30_0_bn (BatchNorma  (None, None, None,   6272       ['conv5_block29_
concat[0][0]']
 lization)                      1568)

 conv5_block30_0_relu (Activati  (None, None, None,   0          ['conv5_block30_
0_bn[0][0]']
 on)                            1568)

 conv5_block30_1_conv (Conv2D)  (None, None, None,   200704     ['conv5_block30_
0_relu[0][0]']
                                128)

 conv5_block30_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block30_
1_conv[0][0]']
 lization)                      128)

 conv5_block30_1_relu (Activati  (None, None, None,   0          ['conv5_block30_
1_bn[0][0]']
 on)                            128)

 conv5_block30_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block30_
1_relu[0][0]']
                                32)

 conv5_block30_concat (Concaten  (None, None, None,   0          ['conv5_block29_
concat[0][0]',
 ate)                           1600)                            'conv5_block30_
2_conv[0][0]']

 conv5_block31_0_bn (BatchNorma  (None, None, None,   6400       ['conv5_block30_
```

```
concat[0][0]']
 lization)                      1600)

 conv5_block31_0_relu (Activati  (None, None, None,   0          ['conv5_block31_
0_bn[0][0]']
 on)                            1600)

 conv5_block31_1_conv (Conv2D)  (None, None, None,   204800      ['conv5_block31_
0_relu[0][0]']
                                128)

 conv5_block31_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block31_
1_conv[0][0]']
 lization)                      128)

 conv5_block31_1_relu (Activati  (None, None, None,   0          ['conv5_block31_
1_bn[0][0]']
 on)                            128)

 conv5_block31_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block31_
1_relu[0][0]']
                                32)

 conv5_block31_concat (Concaten  (None, None, None,   0          ['conv5_block30_
concat[0][0]',
 ate)                           1632)                            'conv5_block31_
2_conv[0][0]']

 conv5_block32_0_bn (BatchNorma  (None, None, None,   6528       ['conv5_block31_
concat[0][0]']
 lization)                      1632)

 conv5_block32_0_relu (Activati  (None, None, None,   0          ['conv5_block32_
0_bn[0][0]']
 on)                            1632)

 conv5_block32_1_conv (Conv2D)  (None, None, None,   208896      ['conv5_block32_
0_relu[0][0]']
                                128)

 conv5_block32_1_bn (BatchNorma  (None, None, None,   512        ['conv5_block32_
1_conv[0][0]']
 lization)                      128)

 conv5_block32_1_relu (Activati  (None, None, None,   0          ['conv5_block32_
1_bn[0][0]']
 on)                            128)

 conv5_block32_2_conv (Conv2D)  (None, None, None,   36864       ['conv5_block32_
1_relu[0][0]']
                                32)

 conv5_block32_concat (Concaten  (None, None, None,   0          ['conv5_block31_
concat[0][0]',
 ate)                           1664)                            'conv5_block32_
2_conv[0][0]']

 bn (BatchNormalization)        (None, None, None,   6656        ['conv5_block32_
concat[0][0]']
                                1664)
```

```
 relu (Activation)              (None, None, None,   0           ['bn[0][0]']
                                1664)

 global_average_pooling2d_2 (Gl  (None, 1664)        0           ['relu[0][0]']
 obalAveragePooling2D)

 dropout_2 (Dropout)            (None, 1664)         0           ['global_average
_pooling2d_2[0][0
                                                                 ]']

 dense_2 (Dense)                (None, 3)            4995        ['dropout_2[0]
[0]']

==================================================================================
Total params: 12,647,875
Trainable params: 4,995
Non-trainable params: 12,642,880
__________________________________________________________________________________
```

ConvNeXtTiny

In [14]:

```
baseConvNeXtTiny = tf.keras.applications.ConvNeXtTiny(
    model_name="convnext_tiny",
    include_top=False,
    include_preprocessing=True,
    weights="imagenet",
    input_tensor=None,
    input_shape=None,
    pooling=None,
    classes=1000,
    classifier_activation="softmax",
)

baseConvNeXtTiny.trainable = False

x = baseConvNeXtTiny.output
x = keras.layers.GlobalAveragePooling2D()(x)
# let's add a fully-connected layer
x = Dropout(0.5)(x)
# and a sofymax/logistic layer -- we have 3 classes
predictions = Dense(len(selectedClasses), activation='softmax')(x)

# this is the model we will train
model_ConvNeXtTiny = Model(inputs=baseConvNeXtTiny.input, outputs=predictions)


model_ConvNeXtTiny.summary()
```

```
Model: "model_3"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_4 (InputLayer)        [(None, None, None, 3)]   0

 convnext_tiny_prestem_normaliz  (None, None, None, 3)   0
ation (Normalization)

 convnext_tiny_stem (Sequential  (None, None, None, 96)   4896
)

 convnext_tiny_stage_0_block_0_  (None, None, None, 96)   4800
depthwise_conv (Conv2D)

 convnext_tiny_stage_0_block_0_  (None, None, None, 96)   192
layernorm (LayerNormalization)

 convnext_tiny_stage_0_block_0_  (None, None, None, 384)  37248
pointwise_conv_1 (Dense)

 convnext_tiny_stage_0_block_0_  (None, None, None, 384)  0
gelu (Activation)

 convnext_tiny_stage_0_block_0_  (None, None, None, 96)   36960
pointwise_conv_2 (Dense)

 convnext_tiny_stage_0_block_0_  (None, None, None, 96)   96
layer_scale (LayerScale)

 convnext_tiny_stage_0_block_0_  (None, None, None, 96)   0
identity (Activation)

 tf.__operators__.add (TFOpLamb  (None, None, None, 96)   0
da)

 convnext_tiny_stage_0_block_1_  (None, None, None, 96)   4800
depthwise_conv (Conv2D)

 convnext_tiny_stage_0_block_1_  (None, None, None, 192)  192
```

```
stage_0_block_1_d
 layernorm (LayerNormalization)  96)                             epthwise_conv[0]
[0]']

 convnext_tiny_stage_0_block_1_  (None, None, None,   37248      ['convnext_tiny_
stage_0_block_1_l
 pointwise_conv_1 (Dense)       384)                             ayernorm[0][0]']

 convnext_tiny_stage_0_block_1_  (None, None, None,   0          ['convnext_tiny_
stage_0_block_1_p
 gelu (Activation)              384)                             ointwise_conv_1
[0][0]']

 convnext_tiny_stage_0_block_1_  (None, None, None,   36960      ['convnext_tiny_
stage_0_block_1_g
 pointwise_conv_2 (Dense)       96)                              elu[0][0]']

 convnext_tiny_stage_0_block_1_  (None, None, None,   96         ['convnext_tiny_
stage_0_block_1_p
 layer_scale (LayerScale)       96)                              ointwise_conv_2
[0][0]']

 convnext_tiny_stage_0_block_1_  (None, None, None,   0          ['convnext_tiny_
stage_0_block_1_l
 identity (Activation)          96)                              ayer_scale[0]
[0]']

 tf.__operators__.add_1 (TFOpLa  (None, None, None,   0          ['tf.__operators
__.add[0][0]',
 mbda)                          96)                               'convnext_tiny_
stage_0_block_1_i
                                                                 dentity[0][0]']

 convnext_tiny_stage_0_block_2_  (None, None, None,   4800       ['tf.__operators
__.add_1[0][0]']
 depthwise_conv (Conv2D)        96)

 convnext_tiny_stage_0_block_2_  (None, None, None,   192        ['convnext_tiny_
stage_0_block_2_d
 layernorm (LayerNormalization)  96)                             epthwise_conv[0]
[0]']

 convnext_tiny_stage_0_block_2_  (None, None, None,   37248      ['convnext_tiny_
stage_0_block_2_l
 pointwise_conv_1 (Dense)       384)                             ayernorm[0][0]']

 convnext_tiny_stage_0_block_2_  (None, None, None,   0          ['convnext_tiny_
stage_0_block_2_p
 gelu (Activation)              384)                             ointwise_conv_1
[0][0]']

 convnext_tiny_stage_0_block_2_  (None, None, None,   36960      ['convnext_tiny_
stage_0_block_2_g
 pointwise_conv_2 (Dense)       96)                              elu[0][0]']

 convnext_tiny_stage_0_block_2_  (None, None, None,   96         ['convnext_tiny_
stage_0_block_2_p
 layer_scale (LayerScale)       96)                              ointwise_conv_2
[0][0]']
```

```
 convnext_tiny_stage_0_block_2_  (None, None, None,   0          ['convnext_tiny_
stage_0_block_2_l
 identity (Activation)          96)                               ayer_scale[0]
[0]']

 tf.__operators__.add_2 (TFOpLa  (None, None, None,   0          ['tf.__operators
__.add_1[0][0]',
 mbda)                          96)                               'convnext_tiny_
stage_0_block_2_i
                                                                  dentity[0][0]']

 convnext_tiny_downsampling_blo  (None, None, None,   74112      ['tf.__operators
__.add_2[0][0]']
 ck_0 (Sequential)              192)

 convnext_tiny_stage_1_block_0_  (None, None, None,   9600       ['convnext_tiny_
downsampling_bloc
 depthwise_conv (Conv2D)        192)                              k_0[0][0]']

 convnext_tiny_stage_1_block_0_  (None, None, None,   384        ['convnext_tiny_
stage_1_block_0_d
 layernorm (LayerNormalization)  192)                             epthwise_conv[0]
[0]']

 convnext_tiny_stage_1_block_0_  (None, None, None,   148224     ['convnext_tiny_
stage_1_block_0_l
 pointwise_conv_1 (Dense)       768)                              ayernorm[0][0]']

 convnext_tiny_stage_1_block_0_  (None, None, None,   0          ['convnext_tiny_
stage_1_block_0_p
 gelu (Activation)              768)                              ointwise_conv_1
[0][0]']

 convnext_tiny_stage_1_block_0_  (None, None, None,   147648     ['convnext_tiny_
stage_1_block_0_g
 pointwise_conv_2 (Dense)       192)                              elu[0][0]']

 convnext_tiny_stage_1_block_0_  (None, None, None,   192        ['convnext_tiny_
stage_1_block_0_p
 layer_scale (LayerScale)       192)                              ointwise_conv_2
[0][0]']

 convnext_tiny_stage_1_block_0_  (None, None, None,   0          ['convnext_tiny_
stage_1_block_0_l
 identity (Activation)          192)                              ayer_scale[0]
[0]']

 tf.__operators__.add_3 (TFOpLa  (None, None, None,   0          ['convnext_tiny_
downsampling_bloc
 mbda)                          192)                              k_0[0][0]',
                                                                   'convnext_tiny_
stage_1_block_0_i
                                                                  dentity[0][0]']

 convnext_tiny_stage_1_block_1_  (None, None, None,   9600       ['tf.__operators
__.add_3[0][0]']
 depthwise_conv (Conv2D)        192)

 convnext_tiny_stage_1_block_1_  (None, None, None,   384        ['convnext_tiny_
stage_1_block_1_d
```

```
 layernorm (LayerNormalization)  192)                          epthwise_conv[0]
[0]']

 convnext_tiny_stage_1_block_1_  (None, None, None,   148224     ['convnext_tiny_
stage_1_block_1_l
 pointwise_conv_1 (Dense)       768)                           ayernorm[0][0]']

 convnext_tiny_stage_1_block_1_  (None, None, None,   0          ['convnext_tiny_
stage_1_block_1_p
 gelu (Activation)              768)                           ointwise_conv_1
[0][0]']

 convnext_tiny_stage_1_block_1_  (None, None, None,   147648     ['convnext_tiny_
stage_1_block_1_g
 pointwise_conv_2 (Dense)       192)                           elu[0][0]']

 convnext_tiny_stage_1_block_1_  (None, None, None,   192        ['convnext_tiny_
stage_1_block_1_p
 layer_scale (LayerScale)       192)                           ointwise_conv_2
[0][0]']

 convnext_tiny_stage_1_block_1_  (None, None, None,   0          ['convnext_tiny_
stage_1_block_1_l
 identity (Activation)          192)                           ayer_scale[0]
[0]']

 tf.__operators__.add_4 (TFOpLa  (None, None, None,   0          ['tf.__operators
__.add_3[0][0]',
 mbda)                          192)                            'convnext_tiny_
stage_1_block_1_i
                                                               dentity[0][0]']

 convnext_tiny_stage_1_block_2_  (None, None, None,   9600       ['tf.__operators
__.add_4[0][0]']
 depthwise_conv (Conv2D)        192)

 convnext_tiny_stage_1_block_2_  (None, None, None,   384        ['convnext_tiny_
stage_1_block_2_d
 layernorm (LayerNormalization)  192)                          epthwise_conv[0]
[0]']

 convnext_tiny_stage_1_block_2_  (None, None, None,   148224     ['convnext_tiny_
stage_1_block_2_l
 pointwise_conv_1 (Dense)       768)                           ayernorm[0][0]']

 convnext_tiny_stage_1_block_2_  (None, None, None,   0          ['convnext_tiny_
stage_1_block_2_p
 gelu (Activation)              768)                           ointwise_conv_1
[0][0]']

 convnext_tiny_stage_1_block_2_  (None, None, None,   147648     ['convnext_tiny_
stage_1_block_2_g
 pointwise_conv_2 (Dense)       192)                           elu[0][0]']

 convnext_tiny_stage_1_block_2_  (None, None, None,   192        ['convnext_tiny_
stage_1_block_2_p
 layer_scale (LayerScale)       192)                           ointwise_conv_2
[0][0]']

 convnext_tiny_stage_1_block_2_  (None, None, None,   0          ['convnext_tiny_
```

```
stage_1_block_2_l
 identity (Activation)          192)                            ayer_scale[0]
[0]']

 tf.__operators__.add_5 (TFOpLa  (None, None, None,   0          ['tf.__operators
__.add_4[0][0]',
 mbda)                          192)                             'convnext_tiny_
stage_1_block_2_i
                                                                 dentity[0][0]']

 convnext_tiny_downsampling_blo  (None, None, None,   295680     ['tf.__operators
__.add_5[0][0]']
 ck_1 (Sequential)              384)

 convnext_tiny_stage_2_block_0_  (None, None, None,   19200      ['convnext_tiny_
downsampling_bloc
 depthwise_conv (Conv2D)        384)                             k_1[0][0]']

 convnext_tiny_stage_2_block_0_  (None, None, None,   768        ['convnext_tiny_
stage_2_block_0_d
 layernorm (LayerNormalization)  384)                            epthwise_conv[0]
[0]']

 convnext_tiny_stage_2_block_0_  (None, None, None,   591360     ['convnext_tiny_
stage_2_block_0_l
 pointwise_conv_1 (Dense)       1536)                            ayernorm[0][0]']

 convnext_tiny_stage_2_block_0_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_0_p
 gelu (Activation)              1536)                            ointwise_conv_1
[0][0]']

 convnext_tiny_stage_2_block_0_  (None, None, None,   590208     ['convnext_tiny_
stage_2_block_0_g
 pointwise_conv_2 (Dense)       384)                             elu[0][0]']

 convnext_tiny_stage_2_block_0_  (None, None, None,   384        ['convnext_tiny_
stage_2_block_0_p
 layer_scale (LayerScale)       384)                             ointwise_conv_2
[0][0]']

 convnext_tiny_stage_2_block_0_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_0_l
 identity (Activation)          384)                             ayer_scale[0]
[0]']

 tf.__operators__.add_6 (TFOpLa  (None, None, None,   0          ['convnext_tiny_
downsampling_bloc
 mbda)                          384)                             k_1[0][0]',
                                                                  'convnext_tiny_
stage_2_block_0_i
                                                                 dentity[0][0]']

 convnext_tiny_stage_2_block_1_  (None, None, None,   19200      ['tf.__operators
__.add_6[0][0]']
 depthwise_conv (Conv2D)        384)

 convnext_tiny_stage_2_block_1_  (None, None, None,   768        ['convnext_tiny_
stage_2_block_1_d
 layernorm (LayerNormalization)  384)                            epthwise_conv[0]
```

```
[0]']

 convnext_tiny_stage_2_block_1_  (None, None, None,   591360     ['convnext_tiny_
stage_2_block_1_l
 pointwise_conv_1 (Dense)       1536)                            ayernorm[0][0]']

 convnext_tiny_stage_2_block_1_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_1_p
 gelu (Activation)              1536)                            ointwise_conv_1
[0][0]']

 convnext_tiny_stage_2_block_1_  (None, None, None,   590208     ['convnext_tiny_
stage_2_block_1_g
 pointwise_conv_2 (Dense)       384)                             elu[0][0]']

 convnext_tiny_stage_2_block_1_  (None, None, None,   384        ['convnext_tiny_
stage_2_block_1_p
 layer_scale (LayerScale)       384)                             ointwise_conv_2
[0][0]']

 convnext_tiny_stage_2_block_1_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_1_l
 identity (Activation)          384)                             ayer_scale[0]
[0]']

 tf.__operators__.add_7 (TFOpLa  (None, None, None,   0          ['tf.__operators
__.add_6[0][0]',
 mbda)                          384)                              'convnext_tiny_
stage_2_block_1_i
                                                                 dentity[0][0]']

 convnext_tiny_stage_2_block_2_  (None, None, None,   19200      ['tf.__operators
__.add_7[0][0]']
 depthwise_conv (Conv2D)        384)

 convnext_tiny_stage_2_block_2_  (None, None, None,   768        ['convnext_tiny_
stage_2_block_2_d
 layernorm (LayerNormalization)  384)                            epthwise_conv[0]
[0]']

 convnext_tiny_stage_2_block_2_  (None, None, None,   591360     ['convnext_tiny_
stage_2_block_2_l
 pointwise_conv_1 (Dense)       1536)                            ayernorm[0][0]']

 convnext_tiny_stage_2_block_2_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_2_p
 gelu (Activation)              1536)                            ointwise_conv_1
[0][0]']

 convnext_tiny_stage_2_block_2_  (None, None, None,   590208     ['convnext_tiny_
stage_2_block_2_g
 pointwise_conv_2 (Dense)       384)                             elu[0][0]']

 convnext_tiny_stage_2_block_2_  (None, None, None,   384        ['convnext_tiny_
stage_2_block_2_p
 layer_scale (LayerScale)       384)                             ointwise_conv_2
[0][0]']

 convnext_tiny_stage_2_block_2_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_2_l
```

```
 identity (Activation)          384)                                ayer_scale[0]
[0]']

 tf.__operators__.add_8 (TFOpLa  (None, None, None,   0          ['tf.__operators
__.add_7[0][0]',
 mbda)                          384)                                'convnext_tiny_
stage_2_block_2_i
                                                                   dentity[0][0]']

 convnext_tiny_stage_2_block_3_  (None, None, None,   19200      ['tf.__operators
__.add_8[0][0]']
 depthwise_conv (Conv2D)        384)

 convnext_tiny_stage_2_block_3_  (None, None, None,   768        ['convnext_tiny_
stage_2_block_3_d
 layernorm (LayerNormalization)  384)                               epthwise_conv[0]
[0]']

 convnext_tiny_stage_2_block_3_  (None, None, None,   591360     ['convnext_tiny_
stage_2_block_3_l
 pointwise_conv_1 (Dense)       1536)                               ayernorm[0][0]']

 convnext_tiny_stage_2_block_3_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_3_p
 gelu (Activation)              1536)                               ointwise_conv_1
[0][0]']

 convnext_tiny_stage_2_block_3_  (None, None, None,   590208     ['convnext_tiny_
stage_2_block_3_g
 pointwise_conv_2 (Dense)       384)                                elu[0][0]']

 convnext_tiny_stage_2_block_3_  (None, None, None,   384        ['convnext_tiny_
stage_2_block_3_p
 layer_scale (LayerScale)       384)                                ointwise_conv_2
[0][0]']

 convnext_tiny_stage_2_block_3_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_3_l
 identity (Activation)          384)                                ayer_scale[0]
[0]']

 tf.__operators__.add_9 (TFOpLa  (None, None, None,   0          ['tf.__operators
__.add_8[0][0]',
 mbda)                          384)                                'convnext_tiny_
stage_2_block_3_i
                                                                   dentity[0][0]']

 convnext_tiny_stage_2_block_4_  (None, None, None,   19200      ['tf.__operators
__.add_9[0][0]']
 depthwise_conv (Conv2D)        384)

 convnext_tiny_stage_2_block_4_  (None, None, None,   768        ['convnext_tiny_
stage_2_block_4_d
 layernorm (LayerNormalization)  384)                               epthwise_conv[0]
[0]']

 convnext_tiny_stage_2_block_4_  (None, None, None,   591360     ['convnext_tiny_
stage_2_block_4_l
 pointwise_conv_1 (Dense)       1536)                               ayernorm[0][0]']
```

```
 convnext_tiny_stage_2_block_4_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_4_p
 gelu (Activation)              1536)                             ointwise_conv_1
[0][0]']

 convnext_tiny_stage_2_block_4_  (None, None, None,   590208     ['convnext_tiny_
stage_2_block_4_g
 pointwise_conv_2 (Dense)       384)                              elu[0][0]']

 convnext_tiny_stage_2_block_4_  (None, None, None,   384        ['convnext_tiny_
stage_2_block_4_p
 layer_scale (LayerScale)       384)                              ointwise_conv_2
[0][0]']

 convnext_tiny_stage_2_block_4_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_4_l
 identity (Activation)          384)                              ayer_scale[0]
[0]']

 tf.__operators__.add_10 (TFOpL  (None, None, None,   0          ['tf.__operators
__.add_9[0][0]',
 ambda)                         384)                               'convnext_tiny_
stage_2_block_4_i
                                                                  dentity[0][0]']

 convnext_tiny_stage_2_block_5_  (None, None, None,   19200      ['tf.__operators
__.add_10[0][0]']
 depthwise_conv (Conv2D)        384)

 convnext_tiny_stage_2_block_5_  (None, None, None,   768        ['convnext_tiny_
stage_2_block_5_d
 layernorm (LayerNormalization)  384)                             epthwise_conv[0]
[0]']

 convnext_tiny_stage_2_block_5_  (None, None, None,   591360     ['convnext_tiny_
stage_2_block_5_l
 pointwise_conv_1 (Dense)       1536)                             ayernorm[0][0]']

 convnext_tiny_stage_2_block_5_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_5_p
 gelu (Activation)              1536)                             ointwise_conv_1
[0][0]']

 convnext_tiny_stage_2_block_5_  (None, None, None,   590208     ['convnext_tiny_
stage_2_block_5_g
 pointwise_conv_2 (Dense)       384)                              elu[0][0]']

 convnext_tiny_stage_2_block_5_  (None, None, None,   384        ['convnext_tiny_
stage_2_block_5_p
 layer_scale (LayerScale)       384)                              ointwise_conv_2
[0][0]']

 convnext_tiny_stage_2_block_5_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_5_l
 identity (Activation)          384)                              ayer_scale[0]
[0]']

 tf.__operators__.add_11 (TFOpL  (None, None, None,   0          ['tf.__operators
__.add_10[0][0]',
 ambda)                         384)                               'convnext_tiny_
```

```
stage_2_block_5_i                                                    dentity[0][0]']

 convnext_tiny_stage_2_block_6_  (None, None, None,   19200      ['tf.__operators
__.add_11[0][0]']
 depthwise_conv (Conv2D)        384)

 convnext_tiny_stage_2_block_6_  (None, None, None,   768        ['convnext_tiny_
stage_2_block_6_d
 layernorm (LayerNormalization)  384)                            epthwise_conv[0]
[0]']

 convnext_tiny_stage_2_block_6_  (None, None, None,   591360     ['convnext_tiny_
stage_2_block_6_l
 pointwise_conv_1 (Dense)       1536)                            ayernorm[0][0]']

 convnext_tiny_stage_2_block_6_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_6_p
 gelu (Activation)              1536)                            ointwise_conv_1
[0][0]']

 convnext_tiny_stage_2_block_6_  (None, None, None,   590208     ['convnext_tiny_
stage_2_block_6_g
 pointwise_conv_2 (Dense)       384)                             elu[0][0]']

 convnext_tiny_stage_2_block_6_  (None, None, None,   384        ['convnext_tiny_
stage_2_block_6_p
 layer_scale (LayerScale)       384)                             ointwise_conv_2
[0][0]']

 convnext_tiny_stage_2_block_6_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_6_l
 identity (Activation)          384)                             ayer_scale[0]
[0]']

 tf.__operators__.add_12 (TFOpL  (None, None, None,   0          ['tf.__operators
__.add_11[0][0]',
 ambda)                         384)                              'convnext_tiny_
stage_2_block_6_i
                                                                 dentity[0][0]']

 convnext_tiny_stage_2_block_7_  (None, None, None,   19200      ['tf.__operators
__.add_12[0][0]']
 depthwise_conv (Conv2D)        384)

 convnext_tiny_stage_2_block_7_  (None, None, None,   768        ['convnext_tiny_
stage_2_block_7_d
 layernorm (LayerNormalization)  384)                            epthwise_conv[0]
[0]']

 convnext_tiny_stage_2_block_7_  (None, None, None,   591360     ['convnext_tiny_
stage_2_block_7_l
 pointwise_conv_1 (Dense)       1536)                            ayernorm[0][0]']

 convnext_tiny_stage_2_block_7_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_7_p
 gelu (Activation)              1536)                            ointwise_conv_1
[0][0]']

 convnext_tiny_stage_2_block_7_  (None, None, None,   590208     ['convnext_tiny_
```

```
stage_2_block_7_g
 pointwise_conv_2 (Dense)       384)                            elu[0][0]']

 convnext_tiny_stage_2_block_7_  (None, None, None,   384        ['convnext_tiny_
stage_2_block_7_p
 layer_scale (LayerScale)       384)                            ointwise_conv_2
[0][0]']

 convnext_tiny_stage_2_block_7_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_7_l
 identity (Activation)          384)                            ayer_scale[0]
[0]']

 tf.__operators__.add_13 (TFOpL  (None, None, None,   0          ['tf.__operators
__.add_12[0][0]',
 ambda)                         384)                             'convnext_tiny_
stage_2_block_7_i
                                                                 dentity[0][0]']

 convnext_tiny_stage_2_block_8_  (None, None, None,   19200      ['tf.__operators
__.add_13[0][0]']
 depthwise_conv (Conv2D)        384)

 convnext_tiny_stage_2_block_8_  (None, None, None,   768        ['convnext_tiny_
stage_2_block_8_d
 layernorm (LayerNormalization)  384)                           epthwise_conv[0]
[0]']

 convnext_tiny_stage_2_block_8_  (None, None, None,   591360     ['convnext_tiny_
stage_2_block_8_l
 pointwise_conv_1 (Dense)       1536)                           ayernorm[0][0]']

 convnext_tiny_stage_2_block_8_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_8_p
 gelu (Activation)              1536)                           ointwise_conv_1
[0][0]']

 convnext_tiny_stage_2_block_8_  (None, None, None,   590208     ['convnext_tiny_
stage_2_block_8_g
 pointwise_conv_2 (Dense)       384)                            elu[0][0]']

 convnext_tiny_stage_2_block_8_  (None, None, None,   384        ['convnext_tiny_
stage_2_block_8_p
 layer_scale (LayerScale)       384)                            ointwise_conv_2
[0][0]']

 convnext_tiny_stage_2_block_8_  (None, None, None,   0          ['convnext_tiny_
stage_2_block_8_l
 identity (Activation)          384)                            ayer_scale[0]
[0]']

 tf.__operators__.add_14 (TFOpL  (None, None, None,   0          ['tf.__operators
__.add_13[0][0]',
 ambda)                         384)                             'convnext_tiny_
stage_2_block_8_i
                                                                 dentity[0][0]']

 convnext_tiny_downsampling_blo  (None, None, None,   1181184    ['tf.__operators
__.add_14[0][0]']
 ck_2 (Sequential)              768)
```

```
 convnext_tiny_stage_3_block_0_  (None, None, None,   38400      ['convnext_tiny_
downsampling_bloc
 depthwise_conv (Conv2D)        768)                             k_2[0][0]']

 convnext_tiny_stage_3_block_0_  (None, None, None,   1536       ['convnext_tiny_
stage_3_block_0_d
 layernorm (LayerNormalization)  768)                            epthwise_conv[0]
[0]']

 convnext_tiny_stage_3_block_0_  (None, None, None,   2362368    ['convnext_tiny_
stage_3_block_0_l
 pointwise_conv_1 (Dense)       3072)                            ayernorm[0][0]']

 convnext_tiny_stage_3_block_0_  (None, None, None,   0          ['convnext_tiny_
stage_3_block_0_p
 gelu (Activation)              3072)                            ointwise_conv_1
[0][0]']

 convnext_tiny_stage_3_block_0_  (None, None, None,   2360064    ['convnext_tiny_
stage_3_block_0_g
 pointwise_conv_2 (Dense)       768)                             elu[0][0]']

 convnext_tiny_stage_3_block_0_  (None, None, None,   768        ['convnext_tiny_
stage_3_block_0_p
 layer_scale (LayerScale)       768)                             ointwise_conv_2
[0][0]']

 convnext_tiny_stage_3_block_0_  (None, None, None,   0          ['convnext_tiny_
stage_3_block_0_l
 identity (Activation)          768)                             ayer_scale[0]
[0]']

 tf.__operators__.add_15 (TFOpL  (None, None, None,   0          ['convnext_tiny_
downsampling_bloc
 ambda)                         768)                             k_2[0][0]',
                                                                  'convnext_tiny_
stage_3_block_0_i
                                                                 dentity[0][0]']

 convnext_tiny_stage_3_block_1_  (None, None, None,   38400      ['tf.__operators
__.add_15[0][0]']
 depthwise_conv (Conv2D)        768)

 convnext_tiny_stage_3_block_1_  (None, None, None,   1536       ['convnext_tiny_
stage_3_block_1_d
 layernorm (LayerNormalization)  768)                            epthwise_conv[0]
[0]']

 convnext_tiny_stage_3_block_1_  (None, None, None,   2362368    ['convnext_tiny_
stage_3_block_1_l
 pointwise_conv_1 (Dense)       3072)                            ayernorm[0][0]']

 convnext_tiny_stage_3_block_1_  (None, None, None,   0          ['convnext_tiny_
stage_3_block_1_p
 gelu (Activation)              3072)                            ointwise_conv_1
[0][0]']

 convnext_tiny_stage_3_block_1_  (None, None, None,   2360064    ['convnext_tiny_
stage_3_block_1_g
```

```
 pointwise_conv_2 (Dense)       768)                              elu[0][0]']

 convnext_tiny_stage_3_block_1_  (None, None, None,   768        ['convnext_tiny_
stage_3_block_1_p
 layer_scale (LayerScale)       768)                              ointwise_conv_2
[0][0]']

 convnext_tiny_stage_3_block_1_  (None, None, None,   0          ['convnext_tiny_
stage_3_block_1_l
 identity (Activation)          768)                              ayer_scale[0]
[0]']

 tf.__operators__.add_16 (TFOpL  (None, None, None,   0          ['tf.__operators
__.add_15[0][0]',
 ambda)                         768)                               'convnext_tiny_
stage_3_block_1_i
                                                                  dentity[0][0]']

 convnext_tiny_stage_3_block_2_  (None, None, None,   38400      ['tf.__operators
__.add_16[0][0]']
 depthwise_conv (Conv2D)        768)

 convnext_tiny_stage_3_block_2_  (None, None, None,   1536       ['convnext_tiny_
stage_3_block_2_d
 layernorm (LayerNormalization)  768)                             epthwise_conv[0]
[0]']

 convnext_tiny_stage_3_block_2_  (None, None, None,   2362368    ['convnext_tiny_
stage_3_block_2_l
 pointwise_conv_1 (Dense)       3072)                             ayernorm[0][0]']

 convnext_tiny_stage_3_block_2_  (None, None, None,   0          ['convnext_tiny_
stage_3_block_2_p
 gelu (Activation)              3072)                             ointwise_conv_1
[0][0]']

 convnext_tiny_stage_3_block_2_  (None, None, None,   2360064    ['convnext_tiny_
stage_3_block_2_g
 pointwise_conv_2 (Dense)       768)                              elu[0][0]']

 convnext_tiny_stage_3_block_2_  (None, None, None,   768        ['convnext_tiny_
stage_3_block_2_p
 layer_scale (LayerScale)       768)                              ointwise_conv_2
[0][0]']

 convnext_tiny_stage_3_block_2_  (None, None, None,   0          ['convnext_tiny_
stage_3_block_2_l
 identity (Activation)          768)                              ayer_scale[0]
[0]']

 tf.__operators__.add_17 (TFOpL  (None, None, None,   0          ['tf.__operators
__.add_16[0][0]',
 ambda)                         768)                               'convnext_tiny_
stage_3_block_2_i
                                                                  dentity[0][0]']

 layer_normalization (LayerNorm  (None, None, None,   1536       ['tf.__operators
__.add_17[0][0]']
 alization)                     768)
```

```
 global_average_pooling2d_3 (Gl  (None, 768)         0           ['layer_normaliz
ation[0][0]']
 obalAveragePooling2D)

 dropout_3 (Dropout)            (None, 768)         0           ['global_average
_pooling2d_3[0][0
                                                                ]']

 dense_3 (Dense)                (None, 3)           2307        ['dropout_3[0]
[0]']

==================================================================================
================
Total params: 27,822,435
Trainable params: 2,307
Non-trainable params: 27,820,128
__________________________________________________________________________________
________________
```

Model checkpoint

In [15]:
```
modelName= "InceptionTutorial"
#save the best weights over the same file with the model name

#filepath="checkpoints/"+modelName+"_bestweights.hdf5"
filepath=modelName+"_bestweights.hdf5"
checkpoint = ModelCheckpoint(filepath, monitor='val_accuracy', verbose=1, save_b
callbacks_list = [checkpoint]
```

Compile the model

In [16]:
```
model_VGG16.compile(loss = 'sparse_categorical_crossentropy', optimizer = 'adam'
model_VGG19.compile(loss = 'sparse_categorical_crossentropy', optimizer = 'adam'
model_DenseNet169.compile(loss = 'sparse_categorical_crossentropy', optimizer =
model_ConvNeXtTiny.compile(loss = 'sparse_categorical_crossentropy', optimizer =
```

Train the model

In [17]:
```
stepsPerEpoch= (train_generator.samples+ (batchSize-1)) // batchSize
print("stepsPerEpoch: ", stepsPerEpoch)

validationSteps=(validation_generator.samples+ (batchSize-1)) // batchSize
print("validationSteps: ", validationSteps)
```

```
stepsPerEpoch:  29
validationSteps:  12
```

VGG 16

In [18]:
```
train_generator.reset()
validation_generator.reset()

# Fit the model
```

```
history_VGG16 = model_VGG16.fit(
    train_generator,
    validation_data = validation_generator,
    epochs = 25,
    steps_per_epoch = stepsPerEpoch,
    validation_steps= validationSteps,
    callbacks=callbacks_list,
    verbose=1)
```

```
Epoch 1/25
29/29 [==============================] - ETA: 0s - loss: 1.4375 - accuracy: 0.408
3
Epoch 1: val_accuracy improved from -inf to 0.65714, saving model to InceptionTut
orial_bestweights.hdf5
29/29 [==============================] - 35s 1s/step - loss: 1.4375 - accuracy:
0.4083 - val_loss: 0.9662 - val_accuracy: 0.6571
Epoch 2/25
29/29 [==============================] - ETA: 0s - loss: 1.0398 - accuracy: 0.556
2
Epoch 2: val_accuracy did not improve from 0.65714
29/29 [==============================] - 31s 1s/step - loss: 1.0398 - accuracy:
0.5562 - val_loss: 0.9159 - val_accuracy: 0.6571
Epoch 3/25
29/29 [==============================] - ETA: 0s - loss: 0.9402 - accuracy: 0.597
6
Epoch 3: val_accuracy did not improve from 0.65714
29/29 [==============================] - 32s 1s/step - loss: 0.9402 - accuracy:
0.5976 - val_loss: 0.9571 - val_accuracy: 0.6571
Epoch 4/25
29/29 [==============================] - ETA: 0s - loss: 0.8942 - accuracy: 0.627
2
Epoch 4: val_accuracy did not improve from 0.65714
29/29 [==============================] - 31s 1s/step - loss: 0.8942 - accuracy:
0.6272 - val_loss: 0.9904 - val_accuracy: 0.6571
Epoch 5/25
29/29 [==============================] - ETA: 0s - loss: 0.9258 - accuracy: 0.650
9
Epoch 5: val_accuracy did not improve from 0.65714
29/29 [==============================] - 31s 1s/step - loss: 0.9258 - accuracy:
0.6509 - val_loss: 1.0287 - val_accuracy: 0.6571
Epoch 6/25
29/29 [==============================] - ETA: 0s - loss: 0.8832 - accuracy: 0.627
2
Epoch 6: val_accuracy did not improve from 0.65714
29/29 [==============================] - 31s 1s/step - loss: 0.8832 - accuracy:
0.6272 - val_loss: 1.0653 - val_accuracy: 0.6571
Epoch 7/25
29/29 [==============================] - ETA: 0s - loss: 0.8432 - accuracy: 0.650
9
Epoch 7: val_accuracy did not improve from 0.65714
29/29 [==============================] - 31s 1s/step - loss: 0.8432 - accuracy:
0.6509 - val_loss: 1.1031 - val_accuracy: 0.6571
Epoch 8/25
29/29 [==============================] - ETA: 0s - loss: 0.8347 - accuracy: 0.656
8
Epoch 8: val_accuracy did not improve from 0.65714
29/29 [==============================] - 32s 1s/step - loss: 0.8347 - accuracy:
0.6568 - val_loss: 1.1139 - val_accuracy: 0.6571
Epoch 9/25
29/29 [==============================] - ETA: 0s - loss: 0.7967 - accuracy: 0.656
8
Epoch 9: val_accuracy did not improve from 0.65714
29/29 [==============================] - 32s 1s/step - loss: 0.7967 - accuracy:
0.6568 - val_loss: 1.1536 - val_accuracy: 0.6429
Epoch 10/25
29/29 [==============================] - ETA: 0s - loss: 0.8211 - accuracy: 0.639
1
Epoch 10: val_accuracy did not improve from 0.65714
29/29 [==============================] - 31s 1s/step - loss: 0.8211 - accuracy:
```

```
0.6391 - val_loss: 1.1871 - val_accuracy: 0.6000
Epoch 11/25
29/29 [==============================] - ETA: 0s - loss: 0.8279 - accuracy: 0.633
1
Epoch 11: val_accuracy did not improve from 0.65714
29/29 [==============================] - 32s 1s/step - loss: 0.8279 - accuracy:
0.6331 - val_loss: 1.1912 - val_accuracy: 0.6000
Epoch 12/25
29/29 [==============================] - ETA: 0s - loss: 0.8056 - accuracy: 0.650
9
Epoch 12: val_accuracy did not improve from 0.65714
29/29 [==============================] - 32s 1s/step - loss: 0.8056 - accuracy:
0.6509 - val_loss: 1.2130 - val_accuracy: 0.5714
Epoch 13/25
29/29 [==============================] - ETA: 0s - loss: 0.8407 - accuracy: 0.656
8
Epoch 13: val_accuracy did not improve from 0.65714
29/29 [==============================] - 31s 1s/step - loss: 0.8407 - accuracy:
0.6568 - val_loss: 1.2133 - val_accuracy: 0.5714
Epoch 14/25
29/29 [==============================] - ETA: 0s - loss: 0.7760 - accuracy: 0.680
5
Epoch 14: val_accuracy did not improve from 0.65714
29/29 [==============================] - 31s 1s/step - loss: 0.7760 - accuracy:
0.6805 - val_loss: 1.2237 - val_accuracy: 0.5857
Epoch 15/25
29/29 [==============================] - ETA: 0s - loss: 0.7581 - accuracy: 0.656
8
Epoch 15: val_accuracy did not improve from 0.65714
29/29 [==============================] - 31s 1s/step - loss: 0.7581 - accuracy:
0.6568 - val_loss: 1.2369 - val_accuracy: 0.5143
Epoch 16/25
29/29 [==============================] - ETA: 0s - loss: 0.8025 - accuracy: 0.621
3
Epoch 16: val_accuracy did not improve from 0.65714
29/29 [==============================] - 31s 1s/step - loss: 0.8025 - accuracy:
0.6213 - val_loss: 1.2462 - val_accuracy: 0.5714
Epoch 17/25
29/29 [==============================] - ETA: 0s - loss: 0.8056 - accuracy: 0.668
6
Epoch 17: val_accuracy did not improve from 0.65714
29/29 [==============================] - 31s 1s/step - loss: 0.8056 - accuracy:
0.6686 - val_loss: 1.2793 - val_accuracy: 0.5429
Epoch 18/25
29/29 [==============================] - ETA: 0s - loss: 0.7918 - accuracy: 0.674
6
Epoch 18: val_accuracy did not improve from 0.65714
29/29 [==============================] - 32s 1s/step - loss: 0.7918 - accuracy:
0.6746 - val_loss: 1.3078 - val_accuracy: 0.3429
Epoch 19/25
29/29 [==============================] - ETA: 0s - loss: 0.8184 - accuracy: 0.662
7
Epoch 19: val_accuracy did not improve from 0.65714
29/29 [==============================] - 32s 1s/step - loss: 0.8184 - accuracy:
0.6627 - val_loss: 1.2772 - val_accuracy: 0.5857
Epoch 20/25
29/29 [==============================] - ETA: 0s - loss: 0.8016 - accuracy: 0.668
6
Epoch 20: val_accuracy did not improve from 0.65714
29/29 [==============================] - 32s 1s/step - loss: 0.8016 - accuracy:
```

```
0.6686 - val_loss: 1.3017 - val_accuracy: 0.4143
Epoch 21/25
29/29 [==============================] - ETA: 0s - loss: 0.7616 - accuracy: 0.686
4
Epoch 21: val_accuracy did not improve from 0.65714
29/29 [==============================] - 32s 1s/step - loss: 0.7616 - accuracy:
0.6864 - val_loss: 1.3130 - val_accuracy: 0.4429
Epoch 22/25
29/29 [==============================] - ETA: 0s - loss: 0.8046 - accuracy: 0.645
0
Epoch 22: val_accuracy did not improve from 0.65714
29/29 [==============================] - 32s 1s/step - loss: 0.8046 - accuracy:
0.6450 - val_loss: 1.2936 - val_accuracy: 0.5429
Epoch 23/25
29/29 [==============================] - ETA: 0s - loss: 0.7719 - accuracy: 0.674
6
Epoch 23: val_accuracy did not improve from 0.65714
29/29 [==============================] - 32s 1s/step - loss: 0.7719 - accuracy:
0.6746 - val_loss: 1.3382 - val_accuracy: 0.2714
Epoch 24/25
29/29 [==============================] - ETA: 0s - loss: 0.8127 - accuracy: 0.645
0
Epoch 24: val_accuracy did not improve from 0.65714
29/29 [==============================] - 32s 1s/step - loss: 0.8127 - accuracy:
0.6450 - val_loss: 1.2864 - val_accuracy: 0.3857
Epoch 25/25
29/29 [==============================] - ETA: 0s - loss: 0.7701 - accuracy: 0.680
5
Epoch 25: val_accuracy did not improve from 0.65714
29/29 [==============================] - 32s 1s/step - loss: 0.7701 - accuracy:
0.6805 - val_loss: 1.2979 - val_accuracy: 0.5857
```

VGG 19

In [19]:

```
train_generator.reset()
validation_generator.reset()

# Fit the model
history_VGG19 = model_VGG19.fit(
    train_generator,
    validation_data = validation_generator,
    epochs = 25,
    steps_per_epoch = stepsPerEpoch,
    validation_steps= validationSteps,
    callbacks=callbacks_list,
    verbose=1)
```

```
Epoch 1/25
29/29 [==============================] - ETA: 0s - loss: 1.2515 - accuracy: 0.325
4
Epoch 1: val_accuracy did not improve from 0.65714
29/29 [==============================] - 39s 1s/step - loss: 1.2515 - accuracy:
0.3254 - val_loss: 0.8990 - val_accuracy: 0.6571
Epoch 2/25
29/29 [==============================] - ETA: 0s - loss: 0.9959 - accuracy: 0.621
3
Epoch 2: val_accuracy did not improve from 0.65714
29/29 [==============================] - 37s 1s/step - loss: 0.9959 - accuracy:
0.6213 - val_loss: 0.9309 - val_accuracy: 0.6571
Epoch 3/25
29/29 [==============================] - ETA: 0s - loss: 0.9251 - accuracy: 0.633
1
Epoch 3: val_accuracy did not improve from 0.65714
29/29 [==============================] - 37s 1s/step - loss: 0.9251 - accuracy:
0.6331 - val_loss: 0.9840 - val_accuracy: 0.6571
Epoch 4/25
29/29 [==============================] - ETA: 0s - loss: 0.9336 - accuracy: 0.645
0
Epoch 4: val_accuracy did not improve from 0.65714
29/29 [==============================] - 37s 1s/step - loss: 0.9336 - accuracy:
0.6450 - val_loss: 1.0145 - val_accuracy: 0.6571
Epoch 5/25
29/29 [==============================] - ETA: 0s - loss: 0.8759 - accuracy: 0.627
2
Epoch 5: val_accuracy did not improve from 0.65714
29/29 [==============================] - 37s 1s/step - loss: 0.8759 - accuracy:
0.6272 - val_loss: 1.0506 - val_accuracy: 0.6571
Epoch 6/25
29/29 [==============================] - ETA: 0s - loss: 0.8790 - accuracy: 0.656
8
Epoch 6: val_accuracy did not improve from 0.65714
29/29 [==============================] - 39s 1s/step - loss: 0.8790 - accuracy:
0.6568 - val_loss: 1.0612 - val_accuracy: 0.6571
Epoch 7/25
29/29 [==============================] - ETA: 0s - loss: 0.8749 - accuracy: 0.627
2
Epoch 7: val_accuracy did not improve from 0.65714
29/29 [==============================] - 38s 1s/step - loss: 0.8749 - accuracy:
0.6272 - val_loss: 1.1132 - val_accuracy: 0.6429
Epoch 8/25
29/29 [==============================] - ETA: 0s - loss: 0.8560 - accuracy: 0.645
0
Epoch 8: val_accuracy did not improve from 0.65714
29/29 [==============================] - 38s 1s/step - loss: 0.8560 - accuracy:
0.6450 - val_loss: 1.1070 - val_accuracy: 0.6571
Epoch 9/25
29/29 [==============================] - ETA: 0s - loss: 0.8634 - accuracy: 0.674
6
Epoch 9: val_accuracy did not improve from 0.65714
29/29 [==============================] - 38s 1s/step - loss: 0.8634 - accuracy:
0.6746 - val_loss: 1.1397 - val_accuracy: 0.6571
Epoch 10/25
29/29 [==============================] - ETA: 0s - loss: 0.8130 - accuracy: 0.633
1
Epoch 10: val_accuracy did not improve from 0.65714
29/29 [==============================] - 38s 1s/step - loss: 0.8130 - accuracy:
0.6331 - val_loss: 1.1633 - val_accuracy: 0.6571
```

```
Epoch 11/25
29/29 [==============================] - ETA: 0s - loss: 0.8353 - accuracy: 0.656
8
Epoch 11: val_accuracy did not improve from 0.65714
29/29 [==============================] - 37s 1s/step - loss: 0.8353 - accuracy:
0.6568 - val_loss: 1.1902 - val_accuracy: 0.6429
Epoch 12/25
29/29 [==============================] - ETA: 0s - loss: 0.8134 - accuracy: 0.650
9
Epoch 12: val_accuracy did not improve from 0.65714
29/29 [==============================] - 37s 1s/step - loss: 0.8134 - accuracy:
0.6509 - val_loss: 1.1816 - val_accuracy: 0.6571
Epoch 13/25
29/29 [==============================] - ETA: 0s - loss: 0.8256 - accuracy: 0.662
7
Epoch 13: val_accuracy did not improve from 0.65714
29/29 [==============================] - 37s 1s/step - loss: 0.8256 - accuracy:
0.6627 - val_loss: 1.2056 - val_accuracy: 0.6143
Epoch 14/25
29/29 [==============================] - ETA: 0s - loss: 0.8212 - accuracy: 0.627
2
Epoch 14: val_accuracy did not improve from 0.65714
29/29 [==============================] - 37s 1s/step - loss: 0.8212 - accuracy:
0.6272 - val_loss: 1.2180 - val_accuracy: 0.6571
Epoch 15/25
29/29 [==============================] - ETA: 0s - loss: 0.8191 - accuracy: 0.650
9
Epoch 15: val_accuracy did not improve from 0.65714
29/29 [==============================] - 37s 1s/step - loss: 0.8191 - accuracy:
0.6509 - val_loss: 1.2247 - val_accuracy: 0.5714
Epoch 16/25
29/29 [==============================] - ETA: 0s - loss: 0.8038 - accuracy: 0.704
1
Epoch 16: val_accuracy did not improve from 0.65714
29/29 [==============================] - 38s 1s/step - loss: 0.8038 - accuracy:
0.7041 - val_loss: 1.2662 - val_accuracy: 0.6286
Epoch 17/25
29/29 [==============================] - ETA: 0s - loss: 0.8354 - accuracy: 0.633
1
Epoch 17: val_accuracy did not improve from 0.65714
29/29 [==============================] - 37s 1s/step - loss: 0.8354 - accuracy:
0.6331 - val_loss: 1.2801 - val_accuracy: 0.5857
Epoch 18/25
29/29 [==============================] - ETA: 0s - loss: 0.7892 - accuracy: 0.662
7
Epoch 18: val_accuracy did not improve from 0.65714
29/29 [==============================] - 38s 1s/step - loss: 0.7892 - accuracy:
0.6627 - val_loss: 1.2790 - val_accuracy: 0.4000
Epoch 19/25
29/29 [==============================] - ETA: 0s - loss: 0.8300 - accuracy: 0.662
7
Epoch 19: val_accuracy did not improve from 0.65714
29/29 [==============================] - 38s 1s/step - loss: 0.8300 - accuracy:
0.6627 - val_loss: 1.2713 - val_accuracy: 0.3714
Epoch 20/25
29/29 [==============================] - ETA: 0s - loss: 0.7847 - accuracy: 0.656
8
Epoch 20: val_accuracy did not improve from 0.65714
29/29 [==============================] - 38s 1s/step - loss: 0.7847 - accuracy:
0.6568 - val_loss: 1.2928 - val_accuracy: 0.4143
```

```
Epoch 21/25
29/29 [==============================] - ETA: 0s - loss: 0.8126 - accuracy: 0.645
0
Epoch 21: val_accuracy did not improve from 0.65714
29/29 [==============================] - 38s 1s/step - loss: 0.8126 - accuracy:
0.6450 - val_loss: 1.2914 - val_accuracy: 0.6143
Epoch 22/25
29/29 [==============================] - ETA: 0s - loss: 0.7631 - accuracy: 0.650
9
Epoch 22: val_accuracy did not improve from 0.65714
29/29 [==============================] - 38s 1s/step - loss: 0.7631 - accuracy:
0.6509 - val_loss: 1.3011 - val_accuracy: 0.3571
Epoch 23/25
29/29 [==============================] - ETA: 0s - loss: 0.8076 - accuracy: 0.698
2
Epoch 23: val_accuracy did not improve from 0.65714
29/29 [==============================] - 38s 1s/step - loss: 0.8076 - accuracy:
0.6982 - val_loss: 1.3141 - val_accuracy: 0.2714
Epoch 24/25
29/29 [==============================] - ETA: 0s - loss: 0.8045 - accuracy: 0.662
7
Epoch 24: val_accuracy did not improve from 0.65714
29/29 [==============================] - 39s 1s/step - loss: 0.8045 - accuracy:
0.6627 - val_loss: 1.2870 - val_accuracy: 0.4714
Epoch 25/25
29/29 [==============================] - ETA: 0s - loss: 0.8056 - accuracy: 0.668
6
Epoch 25: val_accuracy did not improve from 0.65714
29/29 [==============================] - 39s 1s/step - loss: 0.8056 - accuracy:
0.6686 - val_loss: 1.3396 - val_accuracy: 0.4571
```

DenseNet169

In [20]:

```
train_generator.reset()
validation_generator.reset()

# Fit the model
history_DenseNet169 = model_DenseNet169.fit(
    train_generator,
    validation_data = validation_generator,
    epochs = 25,
    steps_per_epoch = stepsPerEpoch,
    validation_steps= validationSteps,
    callbacks=callbacks_list,
    verbose=1)
```

```
Epoch 1/25
29/29 [==============================] - ETA: 0s - loss: 1.5919 - accuracy: 0.532
5
Epoch 1: val_accuracy did not improve from 0.65714
29/29 [==============================] - 40s 666ms/step - loss: 1.5919 - accurac
y: 0.5325 - val_loss: 1.6497 - val_accuracy: 0.3429
Epoch 2/25
29/29 [==============================] - ETA: 0s - loss: 1.2537 - accuracy: 0.621
3
Epoch 2: val_accuracy did not improve from 0.65714
29/29 [==============================] - 12s 426ms/step - loss: 1.2537 - accurac
y: 0.6213 - val_loss: 1.9093 - val_accuracy: 0.6000
Epoch 3/25
29/29 [==============================] - ETA: 0s - loss: 1.0792 - accuracy: 0.603
6
Epoch 3: val_accuracy did not improve from 0.65714
29/29 [==============================] - 15s 516ms/step - loss: 1.0792 - accurac
y: 0.6036 - val_loss: 2.0445 - val_accuracy: 0.1571
Epoch 4/25
29/29 [==============================] - ETA: 0s - loss: 1.1669 - accuracy: 0.579
9
Epoch 4: val_accuracy did not improve from 0.65714
29/29 [==============================] - 13s 452ms/step - loss: 1.1669 - accurac
y: 0.5799 - val_loss: 1.7613 - val_accuracy: 0.3571
Epoch 5/25
29/29 [==============================] - ETA: 0s - loss: 1.1071 - accuracy: 0.645
0
Epoch 5: val_accuracy did not improve from 0.65714
29/29 [==============================] - 13s 434ms/step - loss: 1.1071 - accurac
y: 0.6450 - val_loss: 2.0588 - val_accuracy: 0.2429
Epoch 6/25
29/29 [==============================] - ETA: 0s - loss: 1.0582 - accuracy: 0.609
5
Epoch 6: val_accuracy did not improve from 0.65714
29/29 [==============================] - 15s 526ms/step - loss: 1.0582 - accurac
y: 0.6095 - val_loss: 1.9440 - val_accuracy: 0.2000
Epoch 7/25
29/29 [==============================] - ETA: 0s - loss: 1.0626 - accuracy: 0.621
3
Epoch 7: val_accuracy did not improve from 0.65714
29/29 [==============================] - 18s 605ms/step - loss: 1.0626 - accurac
y: 0.6213 - val_loss: 1.7492 - val_accuracy: 0.6429
Epoch 8/25
29/29 [==============================] - ETA: 0s - loss: 0.9228 - accuracy: 0.656
8
Epoch 8: val_accuracy did not improve from 0.65714
29/29 [==============================] - 17s 584ms/step - loss: 0.9228 - accurac
y: 0.6568 - val_loss: 1.8185 - val_accuracy: 0.1429
Epoch 9/25
29/29 [==============================] - ETA: 0s - loss: 0.8980 - accuracy: 0.633
1
Epoch 9: val_accuracy did not improve from 0.65714
29/29 [==============================] - 16s 557ms/step - loss: 0.8980 - accurac
y: 0.6331 - val_loss: 1.8041 - val_accuracy: 0.2571
Epoch 10/25
29/29 [==============================] - ETA: 0s - loss: 0.8031 - accuracy: 0.645
0
Epoch 10: val_accuracy did not improve from 0.65714
29/29 [==============================] - 16s 548ms/step - loss: 0.8031 - accurac
y: 0.6450 - val_loss: 1.7205 - val_accuracy: 0.4714
```

```
Epoch 11/25
29/29 [==============================] - ETA: 0s - loss: 0.8770 - accuracy: 0.650
9
Epoch 11: val_accuracy did not improve from 0.65714
29/29 [==============================] - 16s 538ms/step - loss: 0.8770 - accurac
y: 0.6509 - val_loss: 1.8756 - val_accuracy: 0.5000
Epoch 12/25
29/29 [==============================] - ETA: 0s - loss: 0.8566 - accuracy: 0.645
0
Epoch 12: val_accuracy did not improve from 0.65714
29/29 [==============================] - 17s 579ms/step - loss: 0.8566 - accurac
y: 0.6450 - val_loss: 1.8244 - val_accuracy: 0.1857
Epoch 13/25
29/29 [==============================] - ETA: 0s - loss: 0.9217 - accuracy: 0.645
0
Epoch 13: val_accuracy did not improve from 0.65714
29/29 [==============================] - 16s 559ms/step - loss: 0.9217 - accurac
y: 0.6450 - val_loss: 1.9972 - val_accuracy: 0.0857
Epoch 14/25
29/29 [==============================] - ETA: 0s - loss: 0.8580 - accuracy: 0.674
6
Epoch 14: val_accuracy did not improve from 0.65714
29/29 [==============================] - 16s 561ms/step - loss: 0.8580 - accurac
y: 0.6746 - val_loss: 1.7876 - val_accuracy: 0.2429
Epoch 15/25
29/29 [==============================] - ETA: 0s - loss: 0.8537 - accuracy: 0.650
9
Epoch 15: val_accuracy did not improve from 0.65714
29/29 [==============================] - 17s 573ms/step - loss: 0.8537 - accurac
y: 0.6509 - val_loss: 1.8839 - val_accuracy: 0.6000
Epoch 16/25
29/29 [==============================] - ETA: 0s - loss: 0.9041 - accuracy: 0.656
8
Epoch 16: val_accuracy did not improve from 0.65714
29/29 [==============================] - 21s 716ms/step - loss: 0.9041 - accurac
y: 0.6568 - val_loss: 1.9169 - val_accuracy: 0.5000
Epoch 17/25
29/29 [==============================] - ETA: 0s - loss: 0.8462 - accuracy: 0.674
6
Epoch 17: val_accuracy did not improve from 0.65714
29/29 [==============================] - 20s 679ms/step - loss: 0.8462 - accurac
y: 0.6746 - val_loss: 1.8629 - val_accuracy: 0.5429
Epoch 18/25
29/29 [==============================] - ETA: 0s - loss: 0.7017 - accuracy: 0.721
9
Epoch 18: val_accuracy did not improve from 0.65714
29/29 [==============================] - 20s 693ms/step - loss: 0.7017 - accurac
y: 0.7219 - val_loss: 1.7813 - val_accuracy: 0.3429
Epoch 19/25
29/29 [==============================] - ETA: 0s - loss: 0.8371 - accuracy: 0.674
6
Epoch 19: val_accuracy did not improve from 0.65714
29/29 [==============================] - 20s 684ms/step - loss: 0.8371 - accurac
y: 0.6746 - val_loss: 1.7821 - val_accuracy: 0.2286
Epoch 20/25
29/29 [==============================] - ETA: 0s - loss: 0.7825 - accuracy: 0.692
3
Epoch 20: val_accuracy did not improve from 0.65714
29/29 [==============================] - 17s 595ms/step - loss: 0.7825 - accurac
y: 0.6923 - val_loss: 1.9088 - val_accuracy: 0.2857
```

```
Epoch 21/25
29/29 [==============================] - ETA: 0s - loss: 0.8128 - accuracy: 0.650
9
Epoch 21: val_accuracy did not improve from 0.65714
29/29 [==============================] - 17s 579ms/step - loss: 0.8128 - accurac
y: 0.6509 - val_loss: 1.8543 - val_accuracy: 0.3000
Epoch 22/25
29/29 [==============================] - ETA: 0s - loss: 0.7635 - accuracy: 0.704
1
Epoch 22: val_accuracy did not improve from 0.65714
29/29 [==============================] - 17s 581ms/step - loss: 0.7635 - accurac
y: 0.7041 - val_loss: 1.9559 - val_accuracy: 0.3286
Epoch 23/25
29/29 [==============================] - ETA: 0s - loss: 0.7164 - accuracy: 0.710
1
Epoch 23: val_accuracy did not improve from 0.65714
29/29 [==============================] - 17s 594ms/step - loss: 0.7164 - accurac
y: 0.7101 - val_loss: 1.8367 - val_accuracy: 0.5143
Epoch 24/25
29/29 [==============================] - ETA: 0s - loss: 0.7264 - accuracy: 0.704
1
Epoch 24: val_accuracy did not improve from 0.65714
29/29 [==============================] - 19s 659ms/step - loss: 0.7264 - accurac
y: 0.7041 - val_loss: 1.7275 - val_accuracy: 0.5286
Epoch 25/25
29/29 [==============================] - ETA: 0s - loss: 0.7638 - accuracy: 0.710
1
Epoch 25: val_accuracy did not improve from 0.65714
29/29 [==============================] - 19s 651ms/step - loss: 0.7638 - accurac
y: 0.7101 - val_loss: 1.7474 - val_accuracy: 0.5714
```

ConvNeXtTiny

In [21]:

```
train_generator.reset()
validation_generator.reset()

# Fit the model
history_ConvNeXtTiny = model_ConvNeXtTiny.fit(
    train_generator,
    validation_data = validation_generator,
    epochs = 25,
    steps_per_epoch = stepsPerEpoch,
    validation_steps= validationSteps,
    callbacks=callbacks_list,
    verbose=1)
```

```
Epoch 1/25
29/29 [==============================] - ETA: 0s - loss: 1.2950 - accuracy: 0.473
4
Epoch 1: val_accuracy did not improve from 0.65714
29/29 [==============================] - 95s 3s/step - loss: 1.2950 - accuracy:
0.4734 - val_loss: 1.1595 - val_accuracy: 0.6571
Epoch 2/25
29/29 [==============================] - ETA: 0s - loss: 1.3073 - accuracy: 0.538
5
Epoch 2: val_accuracy did not improve from 0.65714
29/29 [==============================] - 87s 3s/step - loss: 1.3073 - accuracy:
0.5385 - val_loss: 1.0297 - val_accuracy: 0.6571
Epoch 3/25
29/29 [==============================] - ETA: 0s - loss: 1.0629 - accuracy: 0.550
3
Epoch 3: val_accuracy did not improve from 0.65714
29/29 [==============================] - 89s 3s/step - loss: 1.0629 - accuracy:
0.5503 - val_loss: 1.0834 - val_accuracy: 0.6571
Epoch 4/25
29/29 [==============================] - ETA: 0s - loss: 1.0190 - accuracy: 0.603
6
Epoch 4: val_accuracy did not improve from 0.65714
29/29 [==============================] - 85s 3s/step - loss: 1.0190 - accuracy:
0.6036 - val_loss: 1.1419 - val_accuracy: 0.6571
Epoch 5/25
29/29 [==============================] - ETA: 0s - loss: 1.0113 - accuracy: 0.526
6
Epoch 5: val_accuracy did not improve from 0.65714
29/29 [==============================] - 92s 3s/step - loss: 1.0113 - accuracy:
0.5266 - val_loss: 1.1101 - val_accuracy: 0.6571
Epoch 6/25
29/29 [==============================] - ETA: 0s - loss: 0.9706 - accuracy: 0.650
9
Epoch 6: val_accuracy did not improve from 0.65714
29/29 [==============================] - 94s 3s/step - loss: 0.9706 - accuracy:
0.6509 - val_loss: 1.1166 - val_accuracy: 0.6571
Epoch 7/25
29/29 [==============================] - ETA: 0s - loss: 0.9151 - accuracy: 0.609
5
Epoch 7: val_accuracy did not improve from 0.65714
29/29 [==============================] - 84s 3s/step - loss: 0.9151 - accuracy:
0.6095 - val_loss: 1.1170 - val_accuracy: 0.6571
Epoch 8/25
29/29 [==============================] - ETA: 0s - loss: 0.8995 - accuracy: 0.603
6
Epoch 8: val_accuracy did not improve from 0.65714
29/29 [==============================] - 83s 3s/step - loss: 0.8995 - accuracy:
0.6036 - val_loss: 1.1883 - val_accuracy: 0.6571
Epoch 9/25
29/29 [==============================] - ETA: 0s - loss: 0.8606 - accuracy: 0.639
1
Epoch 9: val_accuracy did not improve from 0.65714
29/29 [==============================] - 82s 3s/step - loss: 0.8606 - accuracy:
0.6391 - val_loss: 1.2190 - val_accuracy: 0.6571
Epoch 10/25
29/29 [==============================] - ETA: 0s - loss: 0.8943 - accuracy: 0.650
9
Epoch 10: val_accuracy did not improve from 0.65714
29/29 [==============================] - 119s 4s/step - loss: 0.8943 - accuracy:
0.6509 - val_loss: 1.2346 - val_accuracy: 0.6571
```

```
Epoch 11/25
29/29 [==============================] - ETA: 0s - loss: 0.8621 - accuracy: 0.591
7
Epoch 11: val_accuracy did not improve from 0.65714
29/29 [==============================] - 105s 4s/step - loss: 0.8621 - accuracy:
0.5917 - val_loss: 1.1844 - val_accuracy: 0.6571
Epoch 12/25
29/29 [==============================] - ETA: 0s - loss: 0.9032 - accuracy: 0.585
8
Epoch 12: val_accuracy did not improve from 0.65714
29/29 [==============================] - 83s 3s/step - loss: 0.9032 - accuracy:
0.5858 - val_loss: 1.1758 - val_accuracy: 0.6571
Epoch 13/25
29/29 [==============================] - ETA: 0s - loss: 0.8806 - accuracy: 0.621
3
Epoch 13: val_accuracy did not improve from 0.65714
29/29 [==============================] - 87s 3s/step - loss: 0.8806 - accuracy:
0.6213 - val_loss: 1.1795 - val_accuracy: 0.6571
Epoch 14/25
29/29 [==============================] - ETA: 0s - loss: 0.8884 - accuracy: 0.633
1
Epoch 14: val_accuracy did not improve from 0.65714
29/29 [==============================] - 96s 3s/step - loss: 0.8884 - accuracy:
0.6331 - val_loss: 1.2050 - val_accuracy: 0.6571
Epoch 15/25
29/29 [==============================] - ETA: 0s - loss: 0.9193 - accuracy: 0.574
0
Epoch 15: val_accuracy did not improve from 0.65714
29/29 [==============================] - 112s 4s/step - loss: 0.9193 - accuracy:
0.5740 - val_loss: 1.1527 - val_accuracy: 0.6571
Epoch 16/25
29/29 [==============================] - ETA: 0s - loss: 0.8959 - accuracy: 0.615
4
Epoch 16: val_accuracy did not improve from 0.65714
29/29 [==============================] - 86s 3s/step - loss: 0.8959 - accuracy:
0.6154 - val_loss: 1.1917 - val_accuracy: 0.6571
Epoch 17/25
29/29 [==============================] - ETA: 0s - loss: 0.8551 - accuracy: 0.627
2
Epoch 17: val_accuracy did not improve from 0.65714
29/29 [==============================] - 83s 3s/step - loss: 0.8551 - accuracy:
0.6272 - val_loss: 1.1815 - val_accuracy: 0.6571
Epoch 18/25
29/29 [==============================] - ETA: 0s - loss: 0.8076 - accuracy: 0.668
6
Epoch 18: val_accuracy did not improve from 0.65714
29/29 [==============================] - 82s 3s/step - loss: 0.8076 - accuracy:
0.6686 - val_loss: 1.2470 - val_accuracy: 0.3857
Epoch 19/25
29/29 [==============================] - ETA: 0s - loss: 0.8870 - accuracy: 0.609
5
Epoch 19: val_accuracy did not improve from 0.65714
29/29 [==============================] - 83s 3s/step - loss: 0.8870 - accuracy:
0.6095 - val_loss: 1.2125 - val_accuracy: 0.6571
Epoch 20/25
29/29 [==============================] - ETA: 0s - loss: 0.8808 - accuracy: 0.603
6
Epoch 20: val_accuracy did not improve from 0.65714
29/29 [==============================] - 84s 3s/step - loss: 0.8808 - accuracy:
0.6036 - val_loss: 1.2966 - val_accuracy: 0.6571
```

```
Epoch 21/25
29/29 [==============================] - ETA: 0s - loss: 0.8776 - accuracy: 0.609
5
Epoch 21: val_accuracy did not improve from 0.65714
29/29 [==============================] - 85s 3s/step - loss: 0.8776 - accuracy:
0.6095 - val_loss: 1.2429 - val_accuracy: 0.6571
Epoch 22/25
29/29 [==============================] - ETA: 0s - loss: 0.8527 - accuracy: 0.627
2
Epoch 22: val_accuracy did not improve from 0.65714
29/29 [==============================] - 83s 3s/step - loss: 0.8527 - accuracy:
0.6272 - val_loss: 1.2518 - val_accuracy: 0.6571
Epoch 23/25
29/29 [==============================] - ETA: 0s - loss: 0.9124 - accuracy: 0.615
4
Epoch 23: val_accuracy did not improve from 0.65714
29/29 [==============================] - 78s 3s/step - loss: 0.9124 - accuracy:
0.6154 - val_loss: 1.2946 - val_accuracy: 0.3000
Epoch 24/25
29/29 [==============================] - ETA: 0s - loss: 0.8680 - accuracy: 0.609
5
Epoch 24: val_accuracy did not improve from 0.65714
29/29 [==============================] - 82s 3s/step - loss: 0.8680 - accuracy:
0.6095 - val_loss: 1.3025 - val_accuracy: 0.4143
Epoch 25/25
29/29 [==============================] - ETA: 0s - loss: 0.8525 - accuracy: 0.603
6
Epoch 25: val_accuracy did not improve from 0.65714
29/29 [==============================] - 103s 4s/step - loss: 0.8525 - accuracy:
0.6036 - val_loss: 1.2635 - val_accuracy: 0.6571
```

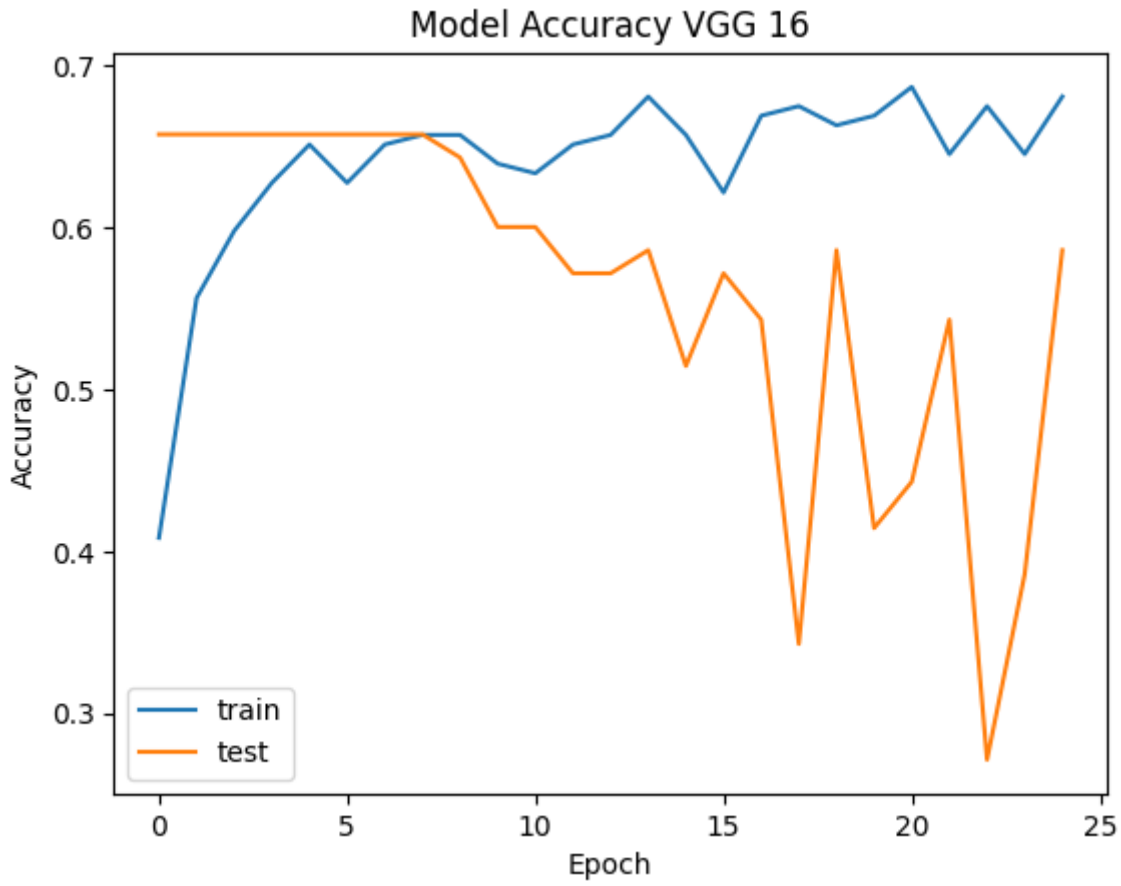
Show Training History

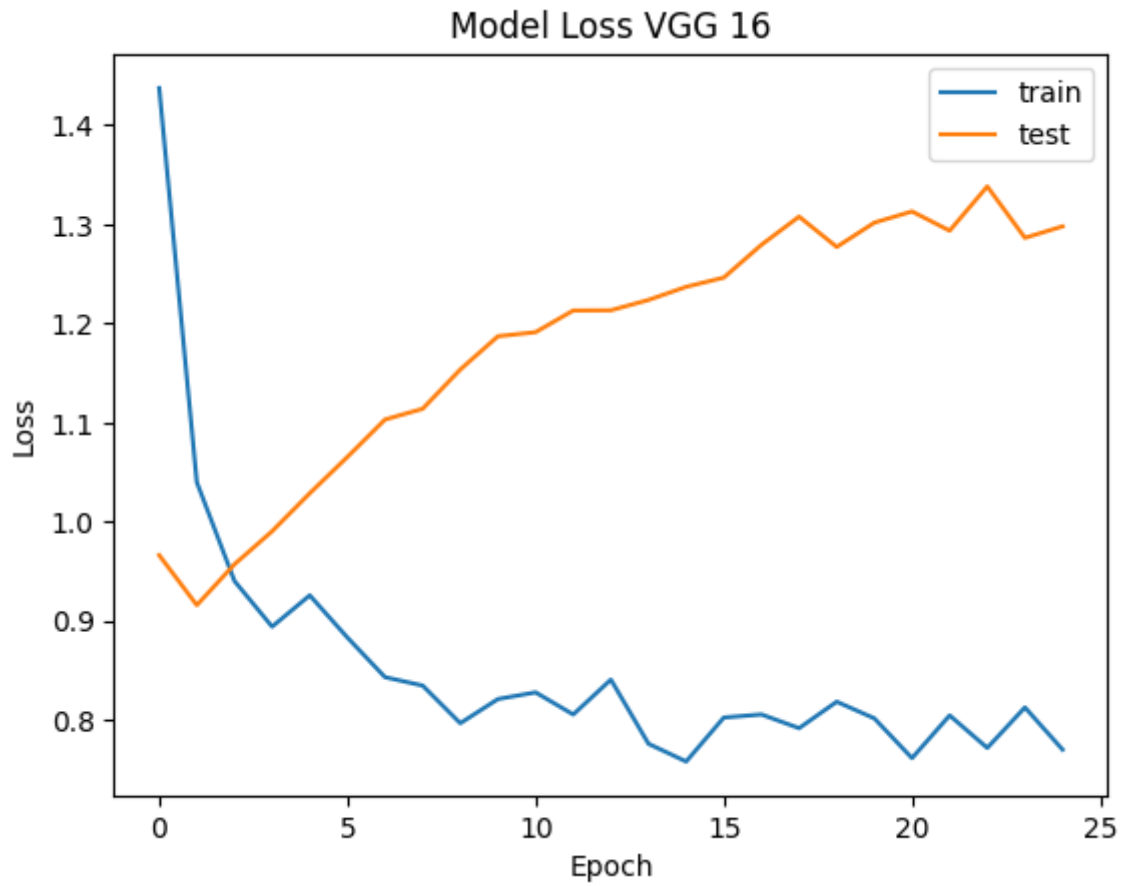
VGG 16

In [22]:

```
# list all data in history
print(history_VGG16.history.keys())
# summarize history for accuracy
plt.plot(history_VGG16.history['accuracy'])
plt.plot(history_VGG16.history['val_accuracy'])
plt.title('Model Accuracy VGG 16')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['train', 'test'], loc='best')
plt.show()
# summarize history for loss
plt.plot(history_VGG16.history['loss'])
plt.plot(history_VGG16.history['val_loss'])
plt.title('Model Loss VGG 16')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['train', 'test'], loc='best')
plt.show()
```

```
dict_keys(['loss', 'accuracy', 'val_loss', 'val_accuracy'])
```



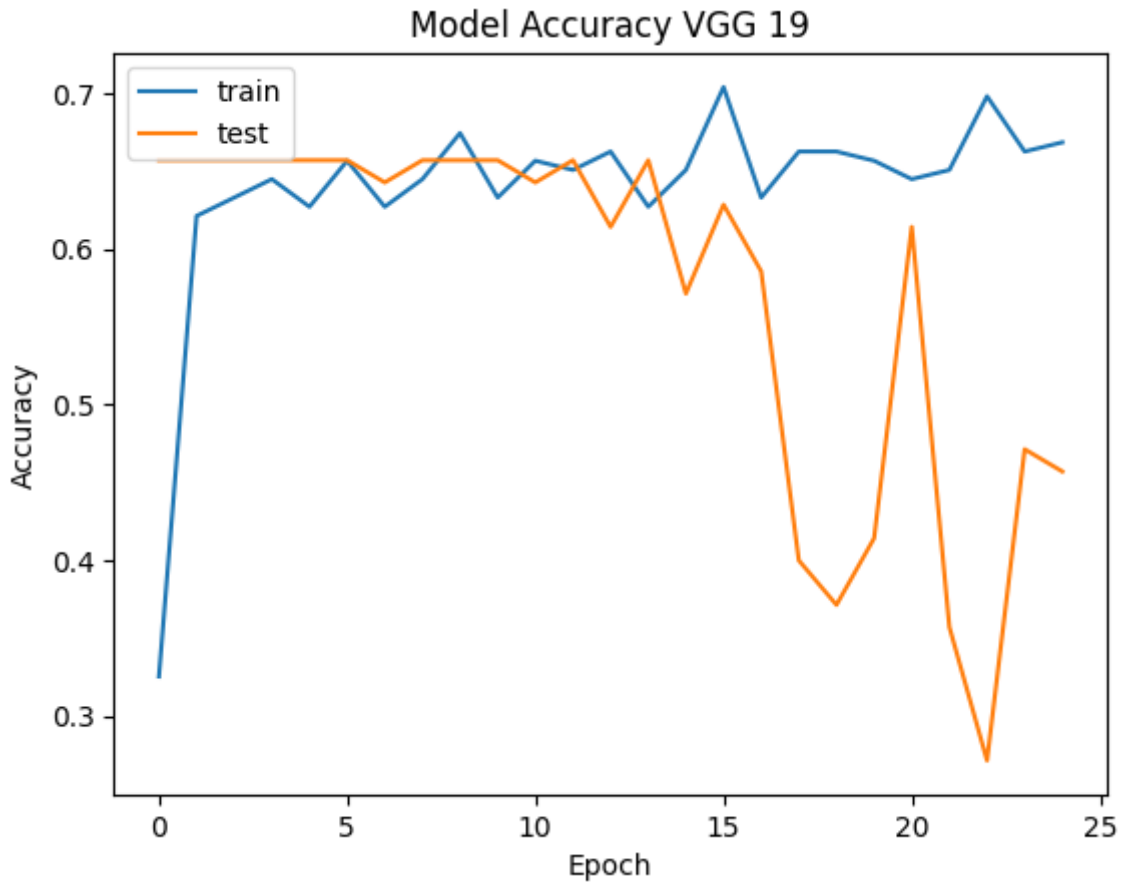


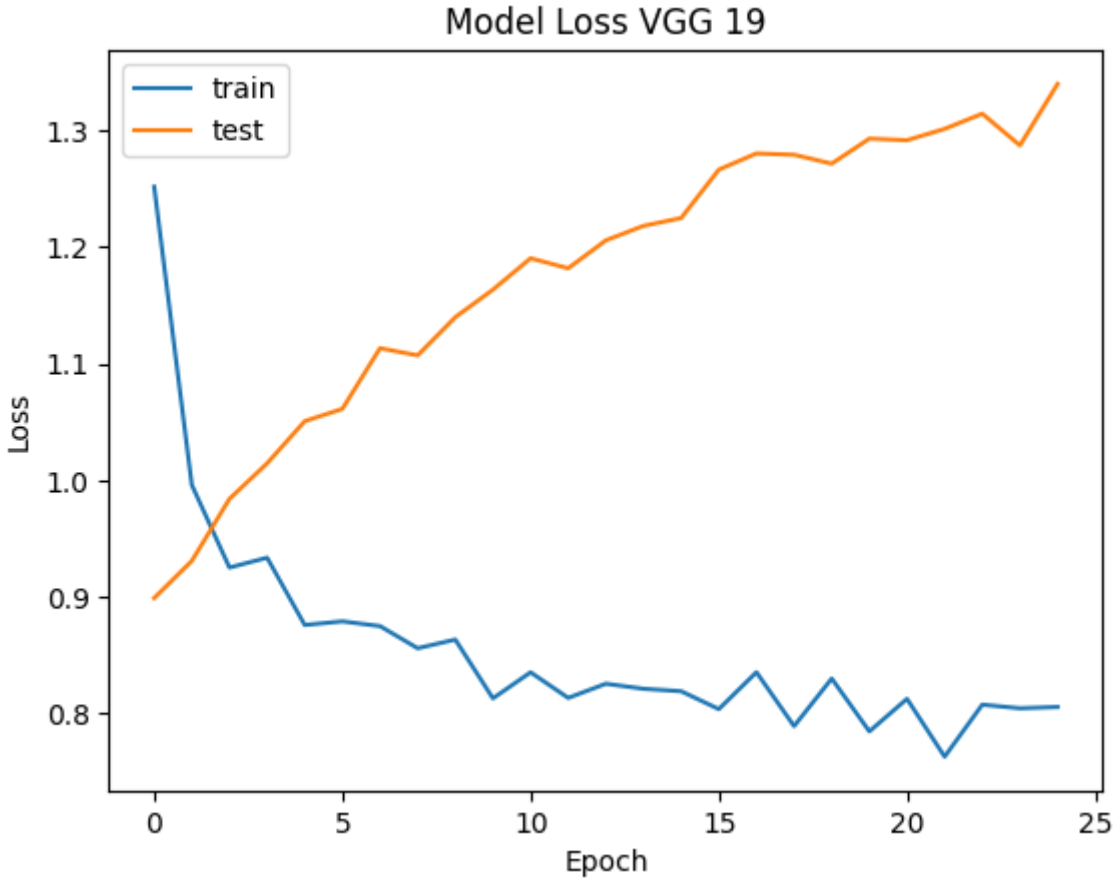
VGG 19

In [23]:
```
# list all data in history
print(history_VGG19.history.keys())
# summarize history for accuracy
```

```
plt.plot(history_VGG19.history['accuracy'])
plt.plot(history_VGG19.history['val_accuracy'])
plt.title('Model Accuracy VGG 19')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['train', 'test'], loc='best')
plt.show()
# summarize history for loss
plt.plot(history_VGG19.history['loss'])
plt.plot(history_VGG19.history['val_loss'])
plt.title('Model Loss VGG 19')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['train', 'test'], loc='best')
plt.show()
```

```
dict_keys(['loss', 'accuracy', 'val_loss', 'val_accuracy'])
```

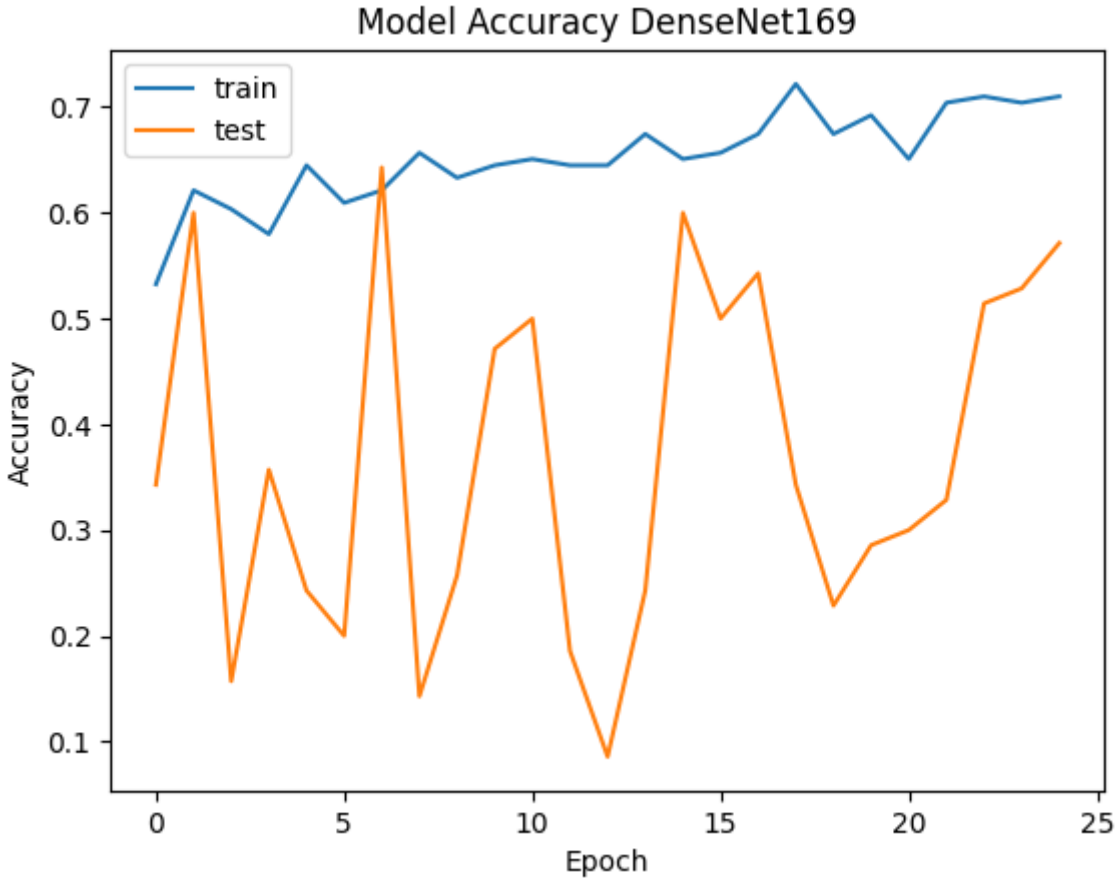


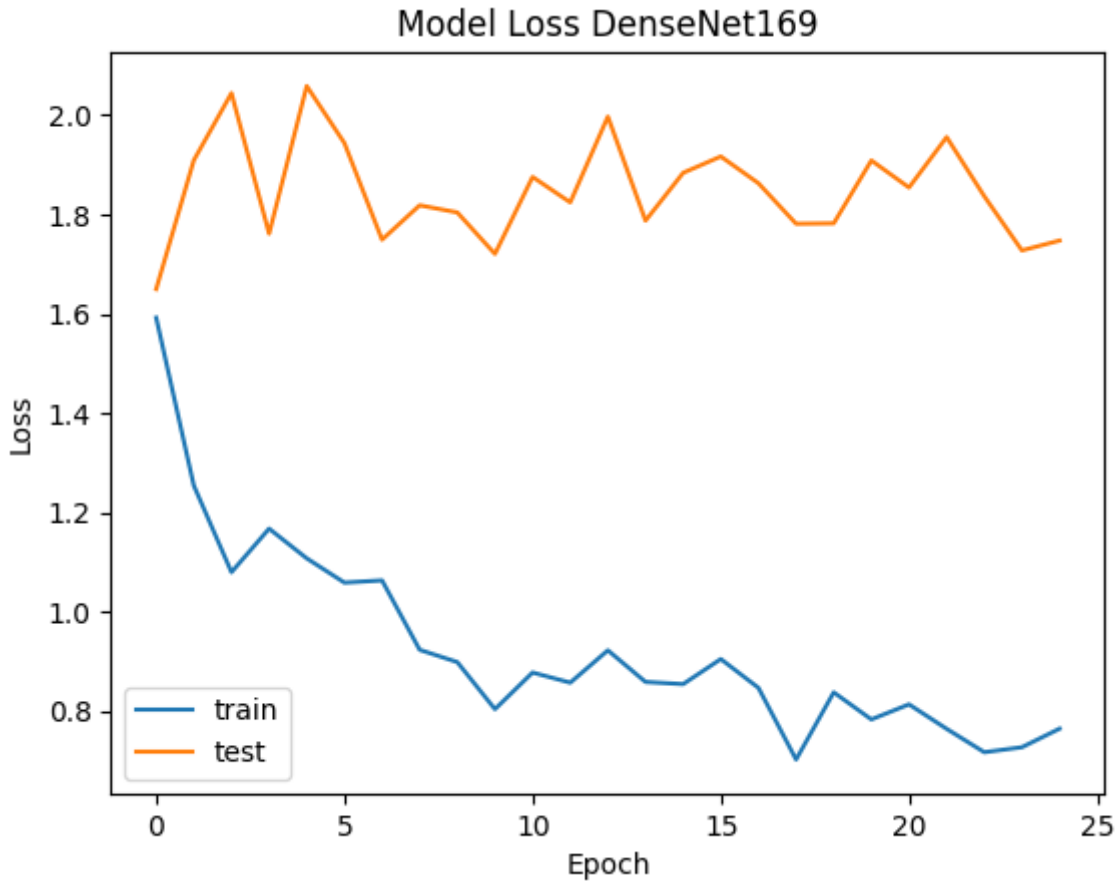


DenseNet169

In [24]:
```
# list all data in history
print(history_DenseNet169.history.keys())
# summarize history for accuracy
plt.plot(history_DenseNet169.history['accuracy'])
plt.plot(history_DenseNet169.history['val_accuracy'])
plt.title('Model Accuracy DenseNet169')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['train', 'test'], loc='best')
plt.show()
# summarize history for loss
plt.plot(history_DenseNet169.history['loss'])
plt.plot(history_DenseNet169.history['val_loss'])
plt.title('Model Loss DenseNet169')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['train', 'test'], loc='best')
plt.show()
```

```
dict_keys(['loss', 'accuracy', 'val_loss', 'val_accuracy'])
```



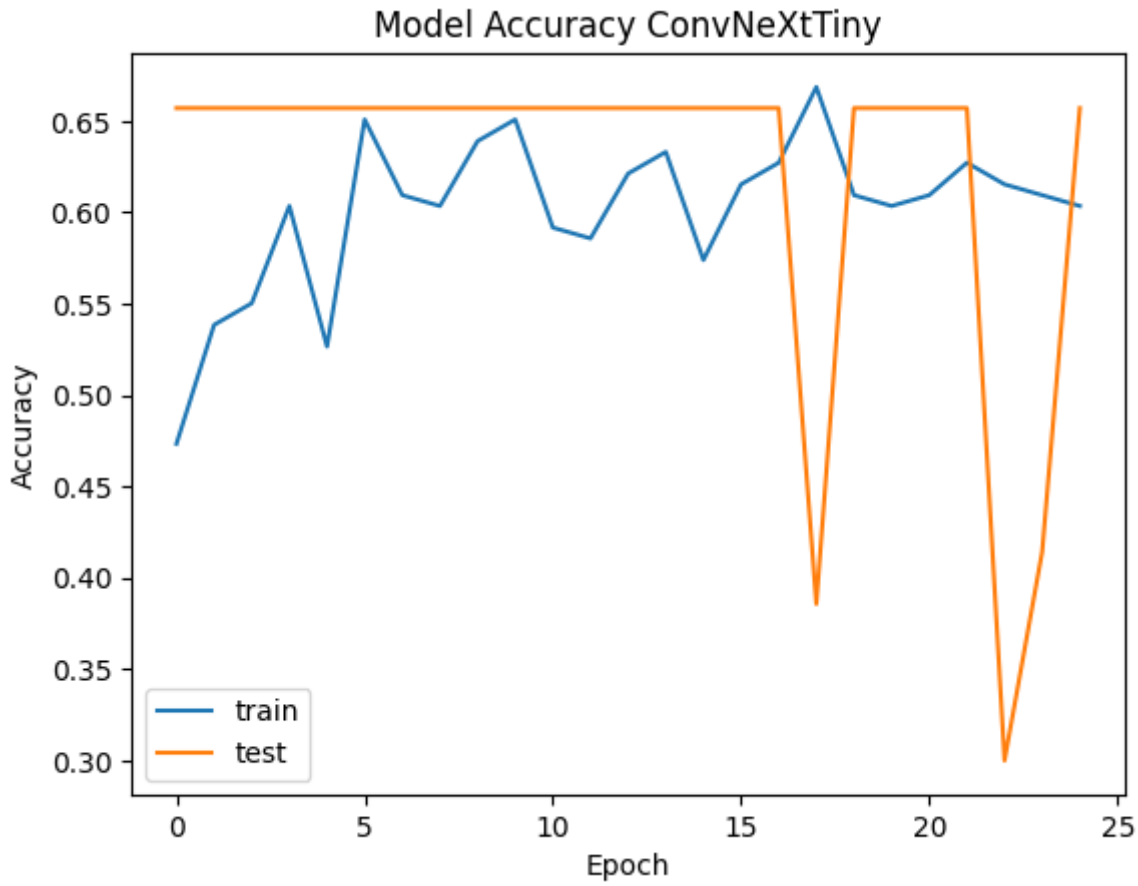


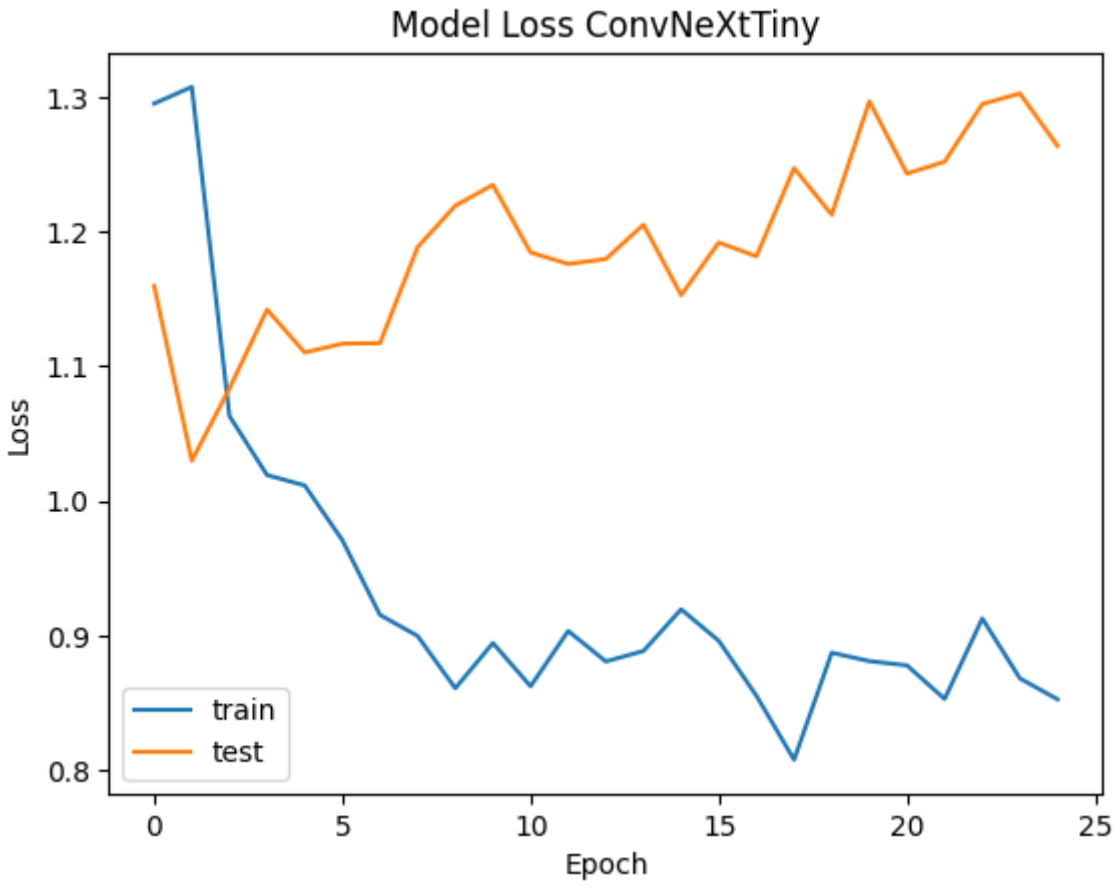
ConvNeXtTiny

In [25]:
```
# list all data in history
print(history_ConvNeXtTiny.history.keys())
# summarize history for accuracy
```

```
plt.plot(history_ConvNeXtTiny.history['accuracy'])
plt.plot(history_ConvNeXtTiny.history['val_accuracy'])
plt.title('Model Accuracy ConvNeXtTiny')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['train', 'test'], loc='best')
plt.show()
# summarize history for loss
plt.plot(history_ConvNeXtTiny.history['loss'])
plt.plot(history_ConvNeXtTiny.history['val_loss'])
plt.title('Model Loss ConvNeXtTiny')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['train', 'test'], loc='best')
plt.show()
```

```
dict_keys(['loss', 'accuracy', 'val_loss', 'val_accuracy'])
```





Save the model and last weights

In [27]:
```
timestr = time.strftime("%Y%m%d_%H%M%S")

# serialize model to JSON
model_VGG16_json = model_VGG16.to_json()
with open(timestr+"_"+modelName+"_MODEL_3"+".json", "w") as json_file:
    json_file.write(model_VGG16_json)
# serialize weights to HDF5
model_VGG16.save_weights(timestr+"_"+modelName+"_3_LAST_WEIGHTS_"+".h5")

model_VGG19_json = model_VGG19.to_json()
with open(timestr+"_"+modelName+"_MODEL_3"+".json", "w") as json_file:
    json_file.write(model_VGG19_json)
model_VGG19.save_weights(timestr+"_"+modelName+"_3_LAST_WEIGHTS_"+".h5")

model_DenseNet169_json = model_DenseNet169.to_json()
with open(timestr+"_"+modelName+"_MODEL_3"+".json", "w") as json_file:
    json_file.write(model_DenseNet169_json)
model_DenseNet169.save_weights(timestr+"_"+modelName+"_3_LAST_WEIGHTS_"+".h5")

model_ConvNeXtTiny_json = model_ConvNeXtTiny.to_json()
with open(timestr+"_"+modelName+"_MODEL_3"+".json", "w") as json_file:
    json_file.write(model_ConvNeXtTiny_json)
model_ConvNeXtTiny.save_weights(timestr+"_"+modelName+"_3_LAST_WEIGHTS_"+".h5")
```

Evaulate the model

In [29]:
```
validation_generator.reset()

score_VGG16 = model_VGG16.evaluate_generator(validation_generator, (validation_g
print("VGG 16:")
print("For validation data set\nLoss: ",score_VGG16[0],"\nAccuracy: ", score_VGG

score_VGG19 = model_VGG19.evaluate_generator(validation_generator, (validation_g
print("VGG 19:")
print("For validation data set\nLoss: ",score_VGG19[0],"\nAccuracy: ", score_VGG

score_DenseNet169 = model_DenseNet169.evaluate_generator(validation_generator, (
print("DenseNet169:")
print("For validation data set\nLoss: ",score_DenseNet169[0],"\nAccuracy: ", scc

score_ConvNeXtTiny = model_ConvNeXtTiny.evaluate_generator(validation_generator,
print("ConvNeXtTiny:")
print("For validation data set\nLoss: ",score_ConvNeXtTiny[0]," \nAccuracy: ", s
```

```
C:\Users\91810\AppData\Local\Temp\ipykernel_19040\3530192685.py:3: UserWarning: `
Model.evaluate_generator` is deprecated and will be removed in a future version.
Please use `Model.evaluate`, which supports generators.
  score_VGG16 = model_VGG16.evaluate_generator(validation_generator, (validation_
generator.samples + (batchSize-1)) //batchSize)
VGG 16:
For validation data set
Loss:  1.3162914514541626
Accuracy:  0.5714285969734192
C:\Users\91810\AppData\Local\Temp\ipykernel_19040\3530192685.py:7: UserWarning: `
Model.evaluate_generator` is deprecated and will be removed in a future version.
Please use `Model.evaluate`, which supports generators.
  score_VGG19 = model_VGG19.evaluate_generator(validation_generator, (validation_
generator.samples + (batchSize-1)) //batchSize)
VGG 19:
For validation data set
Loss:  1.300829291343689
Accuracy:  0.5
C:\Users\91810\AppData\Local\Temp\ipykernel_19040\3530192685.py:11: UserWarning:
`Model.evaluate_generator` is deprecated and will be removed in a future version.
Please use `Model.evaluate`, which supports generators.
  score_DenseNet169 = model_DenseNet169.evaluate_generator(validation_generator,
(validation_generator.samples + (batchSize-1)) //batchSize)
DenseNet169:
For validation data set
Loss:  1.721852421760559
Accuracy:  0.5857142806053162
C:\Users\91810\AppData\Local\Temp\ipykernel_19040\3530192685.py:15: UserWarning:
`Model.evaluate_generator` is deprecated and will be removed in a future version.
Please use `Model.evaluate`, which supports generators.
  score_ConvNeXtTiny = model_ConvNeXtTiny.evaluate_generator(validation_generato
r, (validation_generator.samples + (batchSize-1)) //batchSize)
ConvNeXtTiny:
For validation data set
Loss:  1.249577283859253
Accuracy:  0.6571428775787354
```

Make Predictions

In [30]:
```
validation_generator.reset()
testStep = (validation_generator.samples + (batchSize-1)) // batchSize
print("testStep: ", testStep)

print("VGG 16:")
predictions_VGG16 = model_VGG16.predict_generator(validation_generator, steps =
print(len(predictions_VGG16))

print("VGG 19:")
predictions_VGG19 = model_VGG19.predict_generator(validation_generator, steps =
print(len(predictions_VGG19))

print("DenseNet169:")
predictions_DenseNet169 = model_DenseNet169.predict_generator(validation_generat
print(len(predictions_DenseNet169))

print("ConvNeXtTiny:")
predictions_ConvNeXtTiny = model_ConvNeXtTiny.predict_generator(validation_gener
print(len(predictions_ConvNeXtTiny))
```

```
testStep:  12
VGG 16:
C:\Users\91810\AppData\Local\Temp\ipykernel_19040\1241048804.py:6: UserWarning: `
Model.predict_generator` is deprecated and will be removed in a future version. P
lease use `Model.predict`, which supports generators.
  predictions_VGG16 = model_VGG16.predict_generator(validation_generator, steps =
testStep ,  verbose = 1)
12/12 [==============================] - 5s 364ms/step
70
VGG 19:
C:\Users\91810\AppData\Local\Temp\ipykernel_19040\1241048804.py:10: UserWarning:
`Model.predict_generator` is deprecated and will be removed in a future version.
Please use `Model.predict`, which supports generators.
  predictions_VGG19 = model_VGG19.predict_generator(validation_generator, steps =
testStep ,  verbose = 1)
12/12 [==============================] - 8s 657ms/step
70
DenseNet169:
C:\Users\91810\AppData\Local\Temp\ipykernel_19040\1241048804.py:14: UserWarning:
`Model.predict_generator` is deprecated and will be removed in a future version.
Please use `Model.predict`, which supports generators.
  predictions_DenseNet169 = model_DenseNet169.predict_generator(validation_genera
tor, steps = testStep ,  verbose = 1)
12/12 [==============================] - 7s 329ms/step
70
ConvNeXtTiny:
C:\Users\91810\AppData\Local\Temp\ipykernel_19040\1241048804.py:18: UserWarning:
`Model.predict_generator` is deprecated and will be removed in a future version.
Please use `Model.predict`, which supports generators.
  predictions_ConvNeXtTiny = model_ConvNeXtTiny.predict_generator(validation_gene
rator, steps = testStep ,  verbose = 1)
12/12 [==============================] - 26s 2s/step
70
```

Decode Labels

In [31]:
```
print("VGG 16:")
predicted_class_indices_VGG16=np.argmax(predictions_VGG16,axis=1)
print(predicted_class_indices_VGG16)
len(predicted_class_indices_VGG16)

print("VGG 19:")
predicted_class_indices_VGG19=np.argmax(predictions_VGG19,axis=1)
print(predicted_class_indices_VGG19)
len(predicted_class_indices_VGG19)

print("DenseNet169:")
predicted_class_indices_DenseNet169=np.argmax(predictions_DenseNet169,axis=1)
print(predicted_class_indices_DenseNet169)
len(predicted_class_indices_DenseNet169)

print("ConvNeXtTiny:")
predicted_class_indices_ConvNeXtTiny=np.argmax(predictions_ConvNeXtTiny,axis=1)
print(predicted_class_indices_ConvNeXtTiny)
len(predicted_class_indices_ConvNeXtTiny)
```

```
VGG 16:
[1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 1 2 1 1 1 1 1 1 1 2 1 1 2 1 1 1 1 1 1 1
 1 1 1 1 1 1 2 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1]
VGG 19:
[1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 1 1 1 1 1 2 1 2 1 2 1 2 1 2 1 1 1 1
 1 2 1 1 2 1 1 1 1 2 2 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1]
DenseNet169:
[1 1 1 1 1 1 1 1 1 1 1 1 1 0 2 1 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1 0 1 1 1 1
 1 1 1 1 1 2 1 1 1 1 1 1 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1]
ConvNeXtTiny:
[1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1]
```

Out[31]: 70

In [32]:
```
labels = (validation_generator.class_indices)
print(labels)
```

```
{'normal': 0, 'osteopenia': 1, 'osteoporosis': 2}
```

In [36]:
```
labels = dict((v,k) for k,v in labels.items())
print(labels)
```

```
{0: 'normal', 1: 'osteopenia', 2: 'osteoporosis'}
```

In [37]:
```
print("VGG 16:")
predictedLables_VGG16= [labels[k] for k in predicted_class_indices_VGG16]
print(predictedLables_VGG16)
print(len(predictedLables_VGG16))

print("VGG 19:")
predictedLables_VGG19= [labels[k] for k in predicted_class_indices_VGG19]
print(predictedLables_VGG19)
print(len(predictedLables_VGG19))

print("DenseNet169:")
predictedLables_DenseNet169= [labels[k] for k in predicted_class_indices_DenseNe
print(predictedLables_DenseNet169)
print(len(predictedLables_DenseNet169))

print("ConvNeXtTiny:")
```

```
predictedLables_ConvNeXtTiny= [labels[k] for k in predicted_class_indices_ConvNe
print(predictedLables_ConvNeXtTiny)
print(len(predictedLables_ConvNeXtTiny))
```

```
VGG 16:
['osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteop
enia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteoporosis', 'o
steopenia', 'osteoporosis', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteopenia', 'osteopenia', 'osteoporosis', 'osteopenia', 'oste
openia', 'osteoporosis', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia',
'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteopenia', 'osteopenia', 'osteoporosis', 'osteopenia', 'oste
openia', 'osteopenia', 'osteoporosis', 'osteopenia', 'osteopenia', 'osteopenia',
'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteop
enia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'ost
eopenia', 'osteopenia']
70
VGG 19:
['osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteop
enia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteoporosis', 'o
steoporosis', 'osteoporosis', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopen
ia', 'osteopenia', 'osteoporosis', 'osteopenia', 'osteoporosis', 'osteopenia', 'o
steoporosis', 'osteopenia', 'osteoporosis', 'osteopenia', 'osteoporosis', 'osteop
enia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteoporosis', 'o
steopenia', 'osteopenia', 'osteoporosis', 'osteopenia', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteoporosis', 'osteoporosis', 'osteopenia', 'osteopenia', 'os
teopenia', 'osteoporosis', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteop
enia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'ost
eopenia', 'osteopenia', 'osteopenia']
70
DenseNet169:
['osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteop
enia', 'osteopenia', 'normal', 'osteoporosis', 'osteopenia', 'osteopenia', 'osteo
penia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'os
teopenia', 'osteopenia', 'osteopenia', 'osteoporosis', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteopenia', 'osteopenia', 'normal', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteop
enia', 'osteopenia', 'osteoporosis', 'osteopenia', 'osteopenia', 'osteopenia', 'o
steopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'normal', 'osteopenia', 'os
teopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia',
'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteop
enia']
70
ConvNeXtTiny:
['osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteop
enia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'ost
eopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia',
'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteop
enia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'ost
eopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia',
'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteop
enia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'ost
eopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia',
'osteopenia']
70
```

In [38]:
```
actualLables= [labels[k] for k in validation_generator.classes]
print(actualLables)
len(actualLables)
```

```
['normal', 'normal', 'normal', 'normal', 'normal', 'normal', 'normal', 'normal',
'normal', 'normal', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'oste
openia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'o
steopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia',
'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteop
enia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'ost
eopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia',
'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopenia', 'osteopeni
a', 'osteopenia', 'osteoporosis', 'osteoporosis', 'osteoporosis', 'osteoporosis',
'osteoporosis', 'osteoporosis', 'osteoporosis', 'osteoporosis', 'osteoporosis',
'osteoporosis', 'osteoporosis', 'osteoporosis', 'osteoporosis', 'osteoporosis']
```

Out[38]: 70

Accuracy

In [41]:
```
print("Accuracy scores : \n")
print("VGG 16 :")
print (accuracy_score(actualLables, predictedLables_VGG16))

print("VGG 19:")
print (accuracy_score(actualLables, predictedLables_VGG19))

print("DenseNet169:")
print (accuracy_score(actualLables, predictedLables_DenseNet169))

print("ConvNeXtTiny:")
print (accuracy_score(actualLables, predictedLables_ConvNeXtTiny))
```

```
Accuracy scores :

VGG 16 :
0.5714285714285714
VGG 19:
0.4714285714285714
DenseNet169:
0.5714285714285714
ConvNeXtTiny:
0.6571428571428571
```

Evaluation metrics based on a confusion matrix

In [44]:
```
print(labels)

print("\nVGG 16 :")
matrix_VGG16 = confusion_matrix(actualLables, predictedLables_VGG16)
print(matrix_VGG16)

print("\nVGG 19:")
matrix_VGG19 = confusion_matrix(actualLables, predictedLables_VGG19)
```

```
print(matrix_VGG19)

print("\nDenseNet169:")
matrix_DenseNet169 = confusion_matrix(actualLables, predictedLables_DenseNet169)
print(matrix_DenseNet169)

print("\nConvNeXtTiny:")
matrix_ConvNeXtTiny = confusion_matrix(actualLables, predictedLables_ConvNeXtTin
print(matrix_ConvNeXtTiny)
```

```
{0: 'normal', 1: 'osteopenia', 2: 'osteoporosis'}

VGG 16 :
[[ 0 10  0]
 [ 0 40  6]
 [ 0 14  0]]

VGG 19:
[[ 0 10  0]
 [ 0 33 13]
 [ 0 14  0]]

DenseNet169:
[[ 0 10  0]
 [ 3 40  3]
 [ 0 14  0]]

ConvNeXtTiny:
[[ 0 10  0]
 [ 0 46  0]
 [ 0 14  0]]
```

The precision and recall metrics

VGG 16

In [45]:
```
print(classification_report(actualLables, predictedLables_VGG16))
print("Recall score: ")
print(recall_score( actualLables, predictedLables_VGG16,average='weighted') )
print("Precision score: ")
print(precision_score( actualLables, predictedLables_VGG16,average='weighted') )
```

```
              precision    recall  f1-score   support

      normal       0.00      0.00      0.00        10
  osteopenia       0.62      0.87      0.73        46
osteoporosis       0.00      0.00      0.00        14

    accuracy                           0.57        70
   macro avg       0.21      0.29      0.24        70
weighted avg       0.41      0.57      0.48        70

Recall score:
0.5714285714285714
Precision score:
0.4107142857142857
```

```
C:\Users\91810\AppData\Local\Programs\Python\Python311\Lib\site-packages\sklearn
\metrics\_classification.py:1344: UndefinedMetricWarning: Precision and F-score a
re ill-defined and being set to 0.0 in labels with no predicted samples. Use `zer
o_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\91810\AppData\Local\Programs\Python\Python311\Lib\site-packages\sklearn
\metrics\_classification.py:1344: UndefinedMetricWarning: Precision and F-score a
re ill-defined and being set to 0.0 in labels with no predicted samples. Use `zer
o_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\91810\AppData\Local\Programs\Python\Python311\Lib\site-packages\sklearn
\metrics\_classification.py:1344: UndefinedMetricWarning: Precision and F-score a
re ill-defined and being set to 0.0 in labels with no predicted samples. Use `zer
o_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\91810\AppData\Local\Programs\Python\Python311\Lib\site-packages\sklearn
\metrics\_classification.py:1344: UndefinedMetricWarning: Precision is ill-define
d and being set to 0.0 in labels with no predicted samples. Use `zero_division` p
arameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

VGG 19

In [46]:

```python
print(classification_report(actualLables, predictedLables_VGG19))
print("Recall score: ")
print(recall_score( actualLables, predictedLables_VGG19,average='weighted') )
print("Precision score: ")
print(precision_score( actualLables, predictedLables_VGG19,average='weighted') )
```

```
              precision    recall  f1-score   support

      normal       0.00      0.00      0.00        10
  osteopenia       0.58      0.72      0.64        46
osteoporosis       0.00      0.00      0.00        14

    accuracy                           0.47        70
   macro avg       0.19      0.24      0.21        70
weighted avg       0.38      0.47      0.42        70

Recall score: 
0.4714285714285714
Precision score: 
0.3804511278195489
```

```
C:\Users\91810\AppData\Local\Programs\Python\Python311\Lib\site-packages\sklearn
\metrics\_classification.py:1344: UndefinedMetricWarning: Precision and F-score a
re ill-defined and being set to 0.0 in labels with no predicted samples. Use `zer
o_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\91810\AppData\Local\Programs\Python\Python311\Lib\site-packages\sklearn
\metrics\_classification.py:1344: UndefinedMetricWarning: Precision and F-score a
re ill-defined and being set to 0.0 in labels with no predicted samples. Use `zer
o_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\91810\AppData\Local\Programs\Python\Python311\Lib\site-packages\sklearn
\metrics\_classification.py:1344: UndefinedMetricWarning: Precision and F-score a
re ill-defined and being set to 0.0 in labels with no predicted samples. Use `zer
o_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\91810\AppData\Local\Programs\Python\Python311\Lib\site-packages\sklearn
\metrics\_classification.py:1344: UndefinedMetricWarning: Precision is ill-define
d and being set to 0.0 in labels with no predicted samples. Use `zero_division` p
arameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

DenseNet169

In [47]:

```
print(classification_report(actualLables, predictedLables_DenseNet169))
print("Recall score: ")
print(recall_score( actualLables, predictedLables_DenseNet169,average='weighted'
print("Precision score: ")
print(precision_score( actualLables, predictedLables_DenseNet169,average='weight
```

```
              precision    recall  f1-score   support

      normal       0.00      0.00      0.00        10
  osteopenia       0.62      0.87      0.73        46
osteoporosis       0.00      0.00      0.00        14

    accuracy                           0.57        70
   macro avg       0.21      0.29      0.24        70
weighted avg       0.41      0.57      0.48        70

Recall score: 
0.5714285714285714
Precision score: 
0.4107142857142857
```

ConvNeXtTiny

In [48]:

```
print(classification_report(actualLables, predictedLables_ConvNeXtTiny))
print("Recall score: ")
print(recall_score( actualLables, predictedLables_ConvNeXtTiny,average='weightec
print("Precision score: ")
print(precision_score( actualLables, predictedLables_ConvNeXtTiny,average='weigh
```

```
              precision    recall  f1-score   support

      normal       0.00      0.00      0.00        10
  osteopenia       0.66      1.00      0.79        46
osteoporosis       0.00      0.00      0.00        14

    accuracy                           0.66        70
   macro avg       0.22      0.33      0.26        70
weighted avg       0.43      0.66      0.52        70

Recall score:
0.6571428571428571
Precision score:
0.43183673469387757
```

```
C:\Users\91810\AppData\Local\Programs\Python\Python311\Lib\site-packages\sklearn
\metrics\_classification.py:1344: UndefinedMetricWarning: Precision and F-score a
re ill-defined and being set to 0.0 in labels with no predicted samples. Use `zer
o_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\91810\AppData\Local\Programs\Python\Python311\Lib\site-packages\sklearn
\metrics\_classification.py:1344: UndefinedMetricWarning: Precision and F-score a
re ill-defined and being set to 0.0 in labels with no predicted samples. Use `zer
o_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\91810\AppData\Local\Programs\Python\Python311\Lib\site-packages\sklearn
\metrics\_classification.py:1344: UndefinedMetricWarning: Precision and F-score a
re ill-defined and being set to 0.0 in labels with no predicted samples. Use `zer
o_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\91810\AppData\Local\Programs\Python\Python311\Lib\site-packages\sklearn
\metrics\_classification.py:1344: UndefinedMetricWarning: Precision is ill-define
d and being set to 0.0 in labels with no predicted samples. Use `zero_division` p
arameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

Plot the confusion matrix

In [49]:

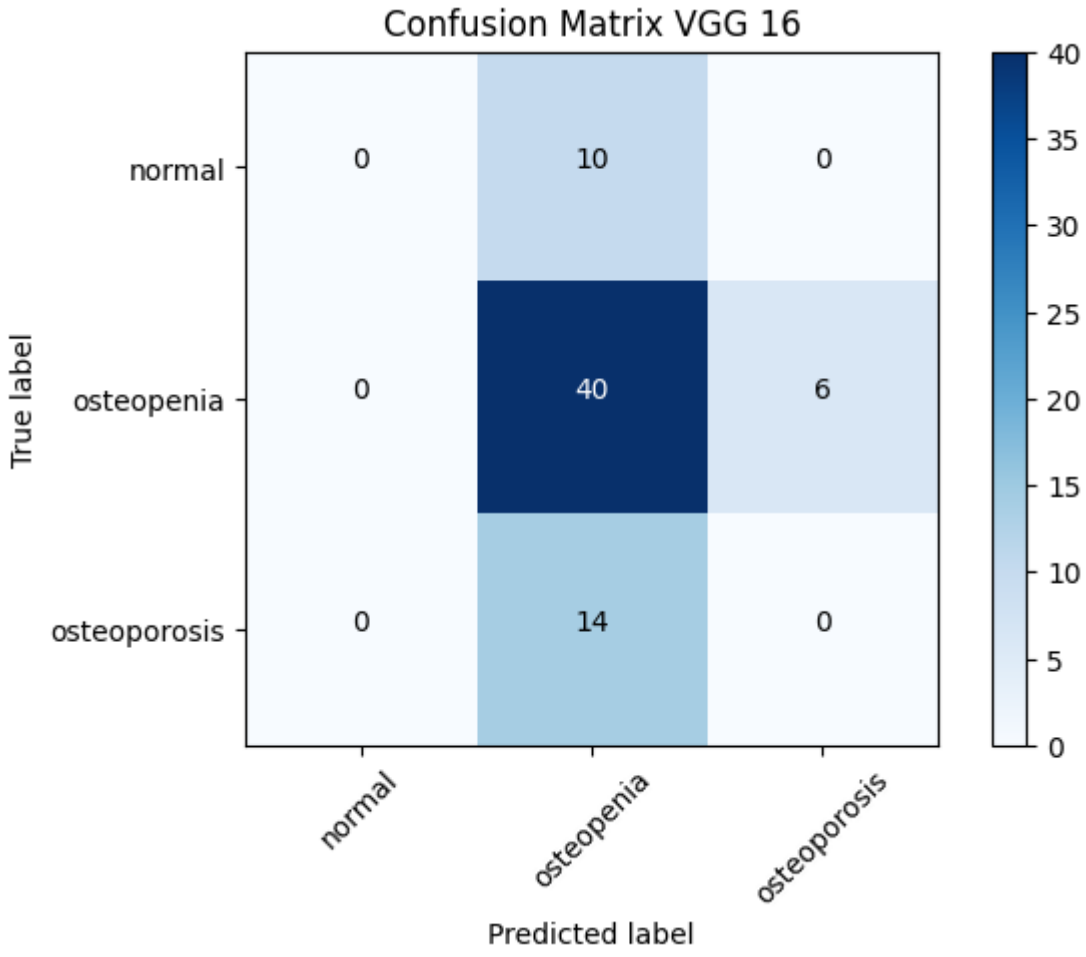
```python
#Prepared code that is taken from SKLearn Website, Creates Confusion Matrix
def plot_confusion_matrix(cm, classes,
                          normalize=False,
                          title='Confusion matrix',
                          cmap=plt.cm.Blues):
    """
    This function prints and plots the confusion matrix.
    Normalization can be applied by setting `normalize=True`.
    """
    if normalize:
        cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]
        print("Normalized confusion matrix")
    else:
        print('Confusion matrix, without normalization')

    print(cm)

    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(classes))
```

```
    plt.xticks(tick_marks, classes, rotation=45)
    plt.yticks(tick_marks, classes)

    fmt = '.2f' if normalize else 'd'
    thresh = cm.max() / 2.
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, format(cm[i, j], fmt),
                 horizontalalignment="center",
                 color="white" if cm[i, j] > thresh else "black")

    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')
```

VGG 16

In [50]:
```
cm_plot_labels = selectedClasses
plot_confusion_matrix(matrix_VGG16,cm_plot_labels, normalize=False
                      , title = 'Confusion Matrix VGG 16')
```

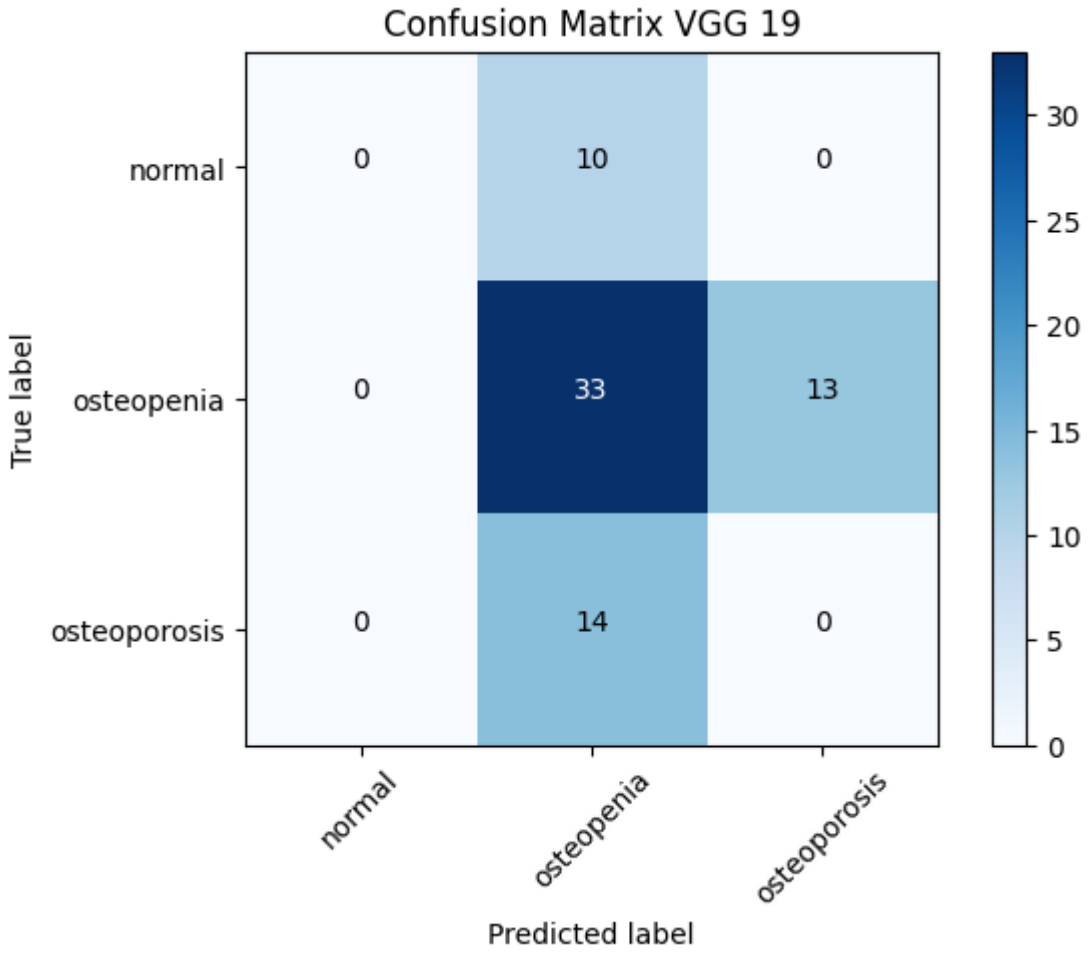
```
Confusion matrix, without normalization
[[ 0 10  0]
 [ 0 40  6]
 [ 0 14  0]]
```



VGG 19

In [51]:
```
cm_plot_labels = selectedClasses
plot_confusion_matrix(matrix_VGG19,cm_plot_labels, normalize=False
                      , title = 'Confusion Matrix VGG 19')
```

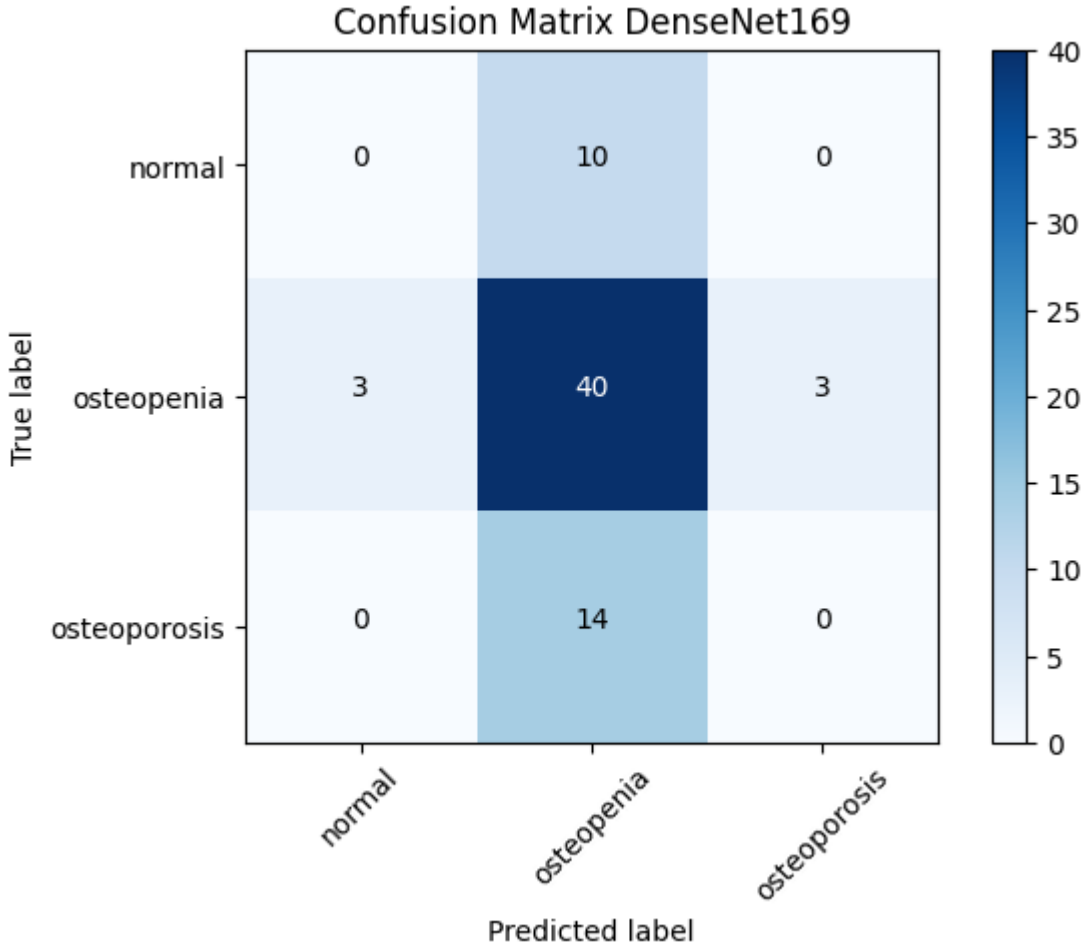
```
Confusion matrix, without normalization
[[ 0 10  0]
 [ 0 33 13]
 [ 0 14  0]]
```



DenseNet169

In [52]:
```
cm_plot_labels = selectedClasses
plot_confusion_matrix(matrix_DenseNet169,cm_plot_labels, normalize=False
                      , title = 'Confusion Matrix DenseNet169')
```

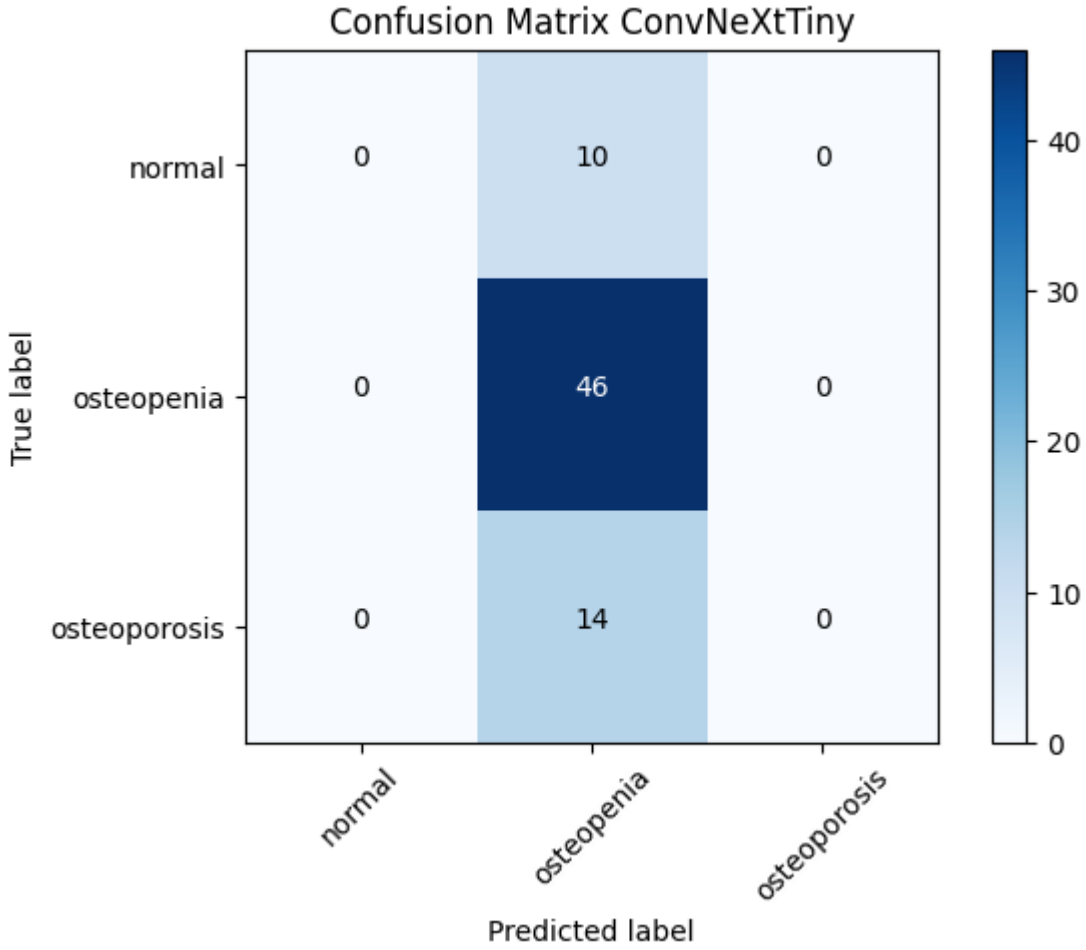
```
Confusion matrix, without normalization
[[ 0 10  0]
 [ 3 40  3]
 [ 0 14  0]]
```



ConvNeXtTiny

In [53]:
```
cm_plot_labels = selectedClasses
plot_confusion_matrix(matrix_ConvNeXtTiny,cm_plot_labels, normalize=False
                      , title = 'Confusion Matrix ConvNeXtTiny')
```

```
Confusion matrix, without normalization
[[ 0 10  0]
 [ 0 46  0]
 [ 0 14  0]]
```



Save Predictions

In [56]:
```
filenames=validation_generator.filenames
directory= validation_generator.directory

results_VGG16=pd.DataFrame({"Directory":directory,
                        "Filename":filenames,
                        "Predictions":predictedLables_VGG16,
                       "Actuals": actualLables })
results_VGG16.to_csv("results_VGG16.csv",index=False)

results_VGG19=pd.DataFrame({"Directory":directory,
                        "Filename":filenames,
                        "Predictions":predictedLables_VGG19,
                       "Actuals": actualLables })
results_VGG19.to_csv("results_VGG19.csv",index=False)

results_DenseNet169=pd.DataFrame({"Directory":directory,
                        "Filename":filenames,
                        "Predictions":predictedLables_DenseNet169,
                       "Actuals": actualLables })
results_DenseNet169.to_csv("results_DenseNet169.csv",index=False)

results_ConvNeXtTiny=pd.DataFrame({"Directory":directory,
                        "Filename":filenames,
                        "Predictions":predictedLables_ConvNeXtTiny,
                       "Actuals": actualLables })
results_ConvNeXtTiny.to_csv("results_ConvNeXtTiny.csv",index=False)
```

Show some sample predictions with corresponding true

In [57]:
```
#import glob
#import matplotlib.pyplot as plt
import matplotlib.image as mpimg
%matplotlib inline

res = results[260:280]

images = []
#for img_path in glob.glob('images/*.jpg'):
for img_path in "./"+res['Directory']+"/"+res['Filename']:
    images.append(mpimg.imread(img_path))

plt.figure(figsize=(80,80))
columns = 4
for i, image in enumerate(images):
    ax= plt.subplot(len(images) / columns + 1, columns, i + 1)
    ax.set_title(res['Actuals'].iloc[i]+" "+res['Predictions'].iloc[i], fontsize
    plt.imshow(image)
```

```
<Figure size 8000x8000 with 0 Axes>
```

In [ ]:

In [ ]: