

```
In [ ]: !wget -O "dataset.zip" "https://data.mendeley.com/public-files/datasets/tywbtsjrjv/files/b4e3a32f-c0bd-4060-81e
--2024-12-10 13:52:58-- https://data.mendeley.com/public-files/datasets/tywbtsjrjv/files/b4e3a32f-c0bd-4060-81e
9-6144231f2520/file_downloaded
Resolving data.mendeley.com (data.mendeley.com)... 162.159.133.86, 162.159.130.86
Connecting to data.mendeley.com (data.mendeley.com)|162.159.133.86|:443... connected.
HTTP request sent, awaiting response... 302 Found
Location: https://prod-dcd-datasets-public-files-eu-west-1.s3.eu-west-1.amazonaws.com/349ac012-2948-4172-bbba-3b
f8f76596fd [following]
--2024-12-10 13:52:59-- https://prod-dcd-datasets-public-files-eu-west-1.s3.eu-west-1.amazonaws.com/349ac012-29
48-4172-bbba-3bf8f76596fd
Resolving prod-dcd-datasets-public-files-eu-west-1.s3.eu-west-1.amazonaws.com (prod-dcd-datasets-public-files-eu
-west-1.s3.eu-west-1.amazonaws.com)... 3.5.70.244, 3.5.71.202, 3.5.66.102, ...
Connecting to prod-dcd-datasets-public-files-eu-west-1.s3.eu-west-1.amazonaws.com (prod-dcd-datasets-public-file
s-eu-west-1.s3.eu-west-1.amazonaws.com)|3.5.70.244|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 949267727 (905M) [application/zip]
Saving to: 'dataset.zip'

dataset.zip          100%[=====>] 905.29M  24.5MB/s   in 40s

2024-12-10 13:53:40 (22.4 MB/s) - 'dataset.zip' saved [949267727/949267727]
```

```
In [ ]: !unzip /content/dataset.zip
```

Streaming output truncated to the last 5000 lines.

```
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (132).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1320).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1321).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1322).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1323).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1324).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1325).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1326).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1327).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1328).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1329).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (133).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1330).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1331).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1332).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1333).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1334).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1335).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1336).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1337).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1338).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1339).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (134).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1340).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1341).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1342).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1343).
JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (1344).
```

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (972).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (973).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (974).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (975).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (976).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (977).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (978).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (979).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (98).JP
G
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (980).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (981).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (982).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (983).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (984).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (985).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (986).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (987).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (988).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (989).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (99).JP
G
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (990).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (991).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (992).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (993).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (994).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (995).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (996).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (997).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (998).J
PG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (999).J
PG

```
In [ ]: import matplotlib.pyplot as plt
import numpy as np
import os
import tensorflow as tf
```

```
In [ ]: !pip install split-folders
```

Collecting split-folders
Downloading split_folders-0.5.1-py3-none-any.whl.metadata (6.2 kB)
Downloading split_folders-0.5.1-py3-none-any.whl (8.4 kB)
Installing collected packages: split-folders
Successfully installed split-folders-0.5.1

```
In [ ]: import splitfolders
splitfolders.ratio('/content/Plant_leave_diseases_dataset_with_augmentation', output="dataset", seed=1337, rati
```

Copying files: 61486 files [00:11, 5287.96 files/s]

Data Preprocessing

```
In [ ]: train_dir = "/content/dataset/train"
```

```
validation_dir = "/content/dataset/val"

BATCH_SIZE = 32
IMG_SIZE = (160, 160)

train_dataset = tf.keras.utils.image_dataset_from_directory(train_dir,
                                                            shuffle=True,
                                                            batch_size=BATCH_SIZE,
                                                            image_size=IMG_SIZE)
```

Found 49179 files belonging to 39 classes.

```
In [ ]: validation_dataset = tf.keras.utils.image_dataset_from_directory(validation_dir,
                                                                    shuffle=True,
                                                                    batch_size=BATCH_SIZE,
                                                                    image_size=IMG_SIZE)

test_dir = "/content/dataset/test"
test_dataset = tf.keras.utils.image_dataset_from_directory(test_dir,
                                                            batch_size=BATCH_SIZE,
                                                            image_size=IMG_SIZE)
```

Found 6139 files belonging to 39 classes.

Found 6168 files belonging to 39 classes.

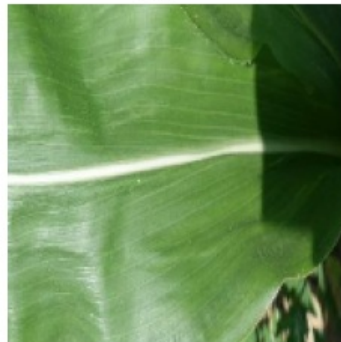
```
In [ ]: class_names = train_dataset.class_names

plt.figure(figsize=(10, 10))
for images, labels in train_dataset.take(1):
    for i in range(9):
        ax = plt.subplot(3, 3, i + 1)
        plt.imshow(images[i].numpy().astype("uint8"))
        plt.title(class_names[labels[i]])
        plt.axis("off")
```

Tomato__Tomato_Yellow_Leaf_Curl_Virus



Corn__healthy



Grape__healthy



Tomato__healthy



Tomato__Septoria_leaf_spot



Tomato__Tomato_Yellow_Leaf_Curl_Virus



Raspberry__healthy



Pepper,_bell__healthy



Potato__Early_blight



```
In [ ]: class_names
```

```
Out[ ]: ['Apple__Apple_scab',
        'Apple__Black_rot',
        'Apple__Cedar_apple_rust',
        'Apple__healthy',
        'Background_without_leaves',
        'Blueberry__healthy',
        'Cherry__Powdery_mildew',
        'Cherry__healthy',
        'Corn__Cercospora_leaf_spot Gray_leaf_spot',
        'Corn__Common_rust',
        'Corn__Northern_Leaf_Blight',
        'Corn__healthy',
        'Grape__Black_rot',
        'Grape__Esca_(Black_Measles)',
        'Grape__Leaf_blight_(Isariopsis_Leaf_Spot)',
        'Grape__healthy',
        'Orange__Haunglongbing_(Citrus_greening)',
        'Peach__Bacterial_spot',
        'Peach__healthy',
        'Pepper_bell__Bacterial_spot',
        'Pepper_bell__healthy',
        'Potato__Early_blight',
        'Potato__Late_blight',
        'Potato__healthy',
        'Raspberry__healthy',
        'Soybean__healthy',
        'Squash__Powdery_mildew',
        'Strawberry__Leaf_scorch',
        'Strawberry__healthy',
        'Tomato__Bacterial_spot',
        'Tomato__Early_blight',
        'Tomato__Late_blight',
        'Tomato__Leaf_Mold',
        'Tomato__Septoria_leaf_spot',
        'Tomato__Spider_mites Two-spotted_spider_mite',
        'Tomato__Target_Spot',
        'Tomato__Tomato_Yellow_Leaf_Curl_Virus',
        'Tomato__Tomato_mosaic_virus',
        'Tomato__healthy']
```

```
In [ ]: AUTOTUNE = tf.data.AUTOTUNE

train_dataset = train_dataset.prefetch(buffer_size=AUTOTUNE)
validation_dataset = validation_dataset.prefetch(buffer_size=AUTOTUNE)
test_dataset = test_dataset.prefetch(buffer_size=AUTOTUNE)
```

```
In [ ]: preprocess_input = tf.keras.applications.efficientnet.preprocess_input
```

Create the base model from the pre-trained convnets

```
In [ ]: IMG_SHAPE = IMG_SIZE + (3,)
base_model = tf.keras.applications.EfficientNetB4(
    input_shape=IMG_SHAPE,
    include_top=False,
    weights='imagenet',
)
```

```
In [ ]: image_batch, label_batch = next(iter(train_dataset))
feature_batch = base_model(image_batch)
print(feature_batch.shape)

(32, 5, 5, 1792)
```

Feature extraction

Freeze the convolutional base

```
In [ ]: base_model.trainable = False
```

```
In [ ]: base_model.summary()
```

Model: "efficientnetb4"

Layer (type)	Output Shape	Param #	Connected to
input_layer_5 (InputLayer)	(None, 160, 160, 3)	0	-
rescaling_4 (Rescaling)	(None, 160, 160, 3)	0	input_layer_5[0][0]

normalization_2 (Normalization)	(None, 160, 160, 3)	7	rescaling_4[0][0]
rescaling_5 (Rescaling)	(None, 160, 160, 3)	0	normalization_2[0][0]
stem_conv_pad (ZeroPadding2D)	(None, 161, 161, 3)	0	rescaling_5[0][0]
stem_conv (Conv2D)	(None, 80, 80, 48)	1,296	stem_conv_pad[0][0]
stem_bn (BatchNormalization)	(None, 80, 80, 48)	192	stem_conv[0][0]
stem_activation (Activation)	(None, 80, 80, 48)	0	stem_bn[0][0]
block1a_dwconv (DepthwiseConv2D)	(None, 80, 80, 48)	432	stem_activation[0][0]
block1a_bn (BatchNormalization)	(None, 80, 80, 48)	192	block1a_dwconv[0][0]
block1a_activation (Activation)	(None, 80, 80, 48)	0	block1a_bn[0][0]
block1a_se_squeeze (GlobalAveragePooling2D)	(None, 48)	0	block1a_activation[0]...
block1a_se_reshape (Reshape)	(None, 1, 1, 48)	0	block1a_se_squeeze[0]...
block1a_se_reduce (Conv2D)	(None, 1, 1, 12)	588	block1a_se_reshape[0]...
block1a_se_expand (Conv2D)	(None, 1, 1, 48)	624	block1a_se_reduce[0][...
block1a_se_excite (Multiply)	(None, 80, 80, 48)	0	block1a_activation[0]... block1a_se_expand[0][...
block1a_project_conv (Conv2D)	(None, 80, 80, 24)	1,152	block1a_se_excite[0][...
block1a_project_bn (BatchNormalization)	(None, 80, 80, 24)	96	block1a_project_conv[...
block1b_dwconv (DepthwiseConv2D)	(None, 80, 80, 24)	216	block1a_project_bn[0]...
block1b_bn (BatchNormalization)	(None, 80, 80, 24)	96	block1b_dwconv[0][0]
block1b_activation (Activation)	(None, 80, 80, 24)	0	block1b_bn[0][0]
block1b_se_squeeze (GlobalAveragePooling2D)	(None, 24)	0	block1b_activation[0]...
block1b_se_reshape (Reshape)	(None, 1, 1, 24)	0	block1b_se_squeeze[0]...
block1b_se_reduce (Conv2D)	(None, 1, 1, 6)	150	block1b_se_reshape[0]...
block1b_se_expand (Conv2D)	(None, 1, 1, 24)	168	block1b_se_reduce[0][...
block1b_se_excite (Multiply)	(None, 80, 80, 24)	0	block1b_activation[0]... block1b_se_expand[0][...
block1b_project_conv (Conv2D)	(None, 80, 80, 24)	576	block1b_se_excite[0][...
block1b_project_bn (BatchNormalization)	(None, 80, 80, 24)	96	block1b_project_conv[...
block1b_drop (Dropout)	(None, 80, 80, 24)	0	block1b_project_bn[0]...
block1b_add (Add)	(None, 80, 80, 24)	0	block1b_drop[0][0], block1a_project_bn[0]...
block2a_expand_conv	(None, 80, 80, 144)	3,456	block1b_add[0][0]

(Conv2D)			
block2a_expand_bn (BatchNormalization)	(None, 80, 80, 144)	576	block2a_expand_conv[0...
block2a_expand_activation (Activation)	(None, 80, 80, 144)	0	block2a_expand_bn[0][...
block2a_dwconv_pad (ZeroPadding2D)	(None, 81, 81, 144)	0	block2a_expand_activa...
block2a_dwconv (DepthwiseConv2D)	(None, 40, 40, 144)	1,296	block2a_dwconv_pad[0]...
block2a_bn (BatchNormalization)	(None, 40, 40, 144)	576	block2a_dwconv[0][0]
block2a_activation (Activation)	(None, 40, 40, 144)	0	block2a_bn[0][0]
block2a_se_squeeze (GlobalAveragePooling2D)	(None, 144)	0	block2a_activation[0]...
block2a_se_reshape (Reshape)	(None, 1, 1, 144)	0	block2a_se_squeeze[0]...
block2a_se_reduce (Conv2D)	(None, 1, 1, 6)	870	block2a_se_reshape[0]...
block2a_se_expand (Conv2D)	(None, 1, 1, 144)	1,008	block2a_se_reduce[0][...
block2a_se_excite (Multiply)	(None, 40, 40, 144)	0	block2a_activation[0]... block2a_se_expand[0][...
block2a_project_conv (Conv2D)	(None, 40, 40, 32)	4,608	block2a_se_excite[0][...
block2a_project_bn (BatchNormalization)	(None, 40, 40, 32)	128	block2a_project_conv[...
block2b_expand_conv (Conv2D)	(None, 40, 40, 192)	6,144	block2a_project_bn[0]...
block2b_expand_bn (BatchNormalization)	(None, 40, 40, 192)	768	block2b_expand_conv[0...
block2b_expand_activation (Activation)	(None, 40, 40, 192)	0	block2b_expand_bn[0][...
block2b_dwconv (DepthwiseConv2D)	(None, 40, 40, 192)	1,728	block2b_expand_activa...
block2b_bn (BatchNormalization)	(None, 40, 40, 192)	768	block2b_dwconv[0][0]
block2b_activation (Activation)	(None, 40, 40, 192)	0	block2b_bn[0][0]
block2b_se_squeeze (GlobalAveragePooling2D)	(None, 192)	0	block2b_activation[0]...
block2b_se_reshape (Reshape)	(None, 1, 1, 192)	0	block2b_se_squeeze[0]...
block2b_se_reduce (Conv2D)	(None, 1, 1, 8)	1,544	block2b_se_reshape[0]...
block2b_se_expand (Conv2D)	(None, 1, 1, 192)	1,728	block2b_se_reduce[0][...
block2b_se_excite (Multiply)	(None, 40, 40, 192)	0	block2b_activation[0]... block2b_se_expand[0][...
block2b_project_conv (Conv2D)	(None, 40, 40, 32)	6,144	block2b_se_excite[0][...
block2b_project_bn (BatchNormalization)	(None, 40, 40, 32)	128	block2b_project_conv[...
block2b_drop (Dropout)	(None, 40, 40, 32)	0	block2b_project_bn[0]...
block2b_add (Add)	(None, 40, 40, 32)	0	block2b_drop[0][0],

			block2a_project_bn[0]...
block2c_expand_conv (Conv2D)	(None, 40, 40, 192)	6,144	block2b_add[0][0]
block2c_expand_bn (BatchNormalization)	(None, 40, 40, 192)	768	block2c_expand_conv[0]...
block2c_expand_activation (Activation)	(None, 40, 40, 192)	0	block2c_expand_bn[0][...
block2c_dwconv (DepthwiseConv2D)	(None, 40, 40, 192)	1,728	block2c_expand_activa...
block2c_bn (BatchNormalization)	(None, 40, 40, 192)	768	block2c_dwconv[0][0]
block2c_activation (Activation)	(None, 40, 40, 192)	0	block2c_bn[0][0]
block2c_se_squeeze (GlobalAveragePooling2D)	(None, 192)	0	block2c_activation[0]...
block2c_se_reshape (Reshape)	(None, 1, 1, 192)	0	block2c_se_squeeze[0]...
block2c_se_reduce (Conv2D)	(None, 1, 1, 8)	1,544	block2c_se_reshape[0]...
block2c_se_expand (Conv2D)	(None, 1, 1, 192)	1,728	block2c_se_reduce[0][...
block2c_se_excite (Multiply)	(None, 40, 40, 192)	0	block2c_activation[0]... block2c_se_expand[0][...
block2c_project_conv (Conv2D)	(None, 40, 40, 32)	6,144	block2c_se_excite[0][...
block2c_project_bn (BatchNormalization)	(None, 40, 40, 32)	128	block2c_project_conv[...
block2c_drop (Dropout)	(None, 40, 40, 32)	0	block2c_project_bn[0]...
block2c_add (Add)	(None, 40, 40, 32)	0	block2c_drop[0][0], block2b_add[0][0]
block2d_expand_conv (Conv2D)	(None, 40, 40, 192)	6,144	block2c_add[0][0]
block2d_expand_bn (BatchNormalization)	(None, 40, 40, 192)	768	block2d_expand_conv[0]...
block2d_expand_activation (Activation)	(None, 40, 40, 192)	0	block2d_expand_bn[0][...
block2d_dwconv (DepthwiseConv2D)	(None, 40, 40, 192)	1,728	block2d_expand_activa...
block2d_bn (BatchNormalization)	(None, 40, 40, 192)	768	block2d_dwconv[0][0]
block2d_activation (Activation)	(None, 40, 40, 192)	0	block2d_bn[0][0]
block2d_se_squeeze (GlobalAveragePooling2D)	(None, 192)	0	block2d_activation[0]...
block2d_se_reshape (Reshape)	(None, 1, 1, 192)	0	block2d_se_squeeze[0]...
block2d_se_reduce (Conv2D)	(None, 1, 1, 8)	1,544	block2d_se_reshape[0]...
block2d_se_expand (Conv2D)	(None, 1, 1, 192)	1,728	block2d_se_reduce[0][...
block2d_se_excite (Multiply)	(None, 40, 40, 192)	0	block2d_activation[0]... block2d_se_expand[0][...
block2d_project_conv (Conv2D)	(None, 40, 40, 32)	6,144	block2d_se_excite[0][...
block2d_project_bn	(None, 40, 40, 32)	128	block2d_project_conv[...

(BatchNormalization)			
block2d_drop (Dropout)	(None, 40, 40, 32)	0	block2d_project_bn[0]...
block2d_add (Add)	(None, 40, 40, 32)	0	block2d_drop[0][0], block2c_add[0][0]
block3a_expand_conv (Conv2D)	(None, 40, 40, 192)	6,144	block2d_add[0][0]
block3a_expand_bn (BatchNormalization)	(None, 40, 40, 192)	768	block3a_expand_conv[0...
block3a_expand_activation (Activation)	(None, 40, 40, 192)	0	block3a_expand_bn[0][...
block3a_dwconv_pad (ZeroPadding2D)	(None, 43, 43, 192)	0	block3a_expand_activa...
block3a_dwconv (DepthwiseConv2D)	(None, 20, 20, 192)	4,800	block3a_dwconv_pad[0]...
block3a_bn (BatchNormalization)	(None, 20, 20, 192)	768	block3a_dwconv[0][0]
block3a_activation (Activation)	(None, 20, 20, 192)	0	block3a_bn[0][0]
block3a_se_squeeze (GlobalAveragePooling2D)	(None, 192)	0	block3a_activation[0]...
block3a_se_reshape (Reshape)	(None, 1, 1, 192)	0	block3a_se_squeeze[0]...
block3a_se_reduce (Conv2D)	(None, 1, 1, 8)	1,544	block3a_se_reshape[0]...
block3a_se_expand (Conv2D)	(None, 1, 1, 192)	1,728	block3a_se_reduce[0][...
block3a_se_excite (Multiply)	(None, 20, 20, 192)	0	block3a_activation[0]... block3a_se_expand[0][...
block3a_project_conv (Conv2D)	(None, 20, 20, 56)	10,752	block3a_se_excite[0][...
block3a_project_bn (BatchNormalization)	(None, 20, 20, 56)	224	block3a_project_conv[...
block3b_expand_conv (Conv2D)	(None, 20, 20, 336)	18,816	block3a_project_bn[0]...
block3b_expand_bn (BatchNormalization)	(None, 20, 20, 336)	1,344	block3b_expand_conv[0...
block3b_expand_activation (Activation)	(None, 20, 20, 336)	0	block3b_expand_bn[0][...
block3b_dwconv (DepthwiseConv2D)	(None, 20, 20, 336)	8,400	block3b_expand_activa...
block3b_bn (BatchNormalization)	(None, 20, 20, 336)	1,344	block3b_dwconv[0][0]
block3b_activation (Activation)	(None, 20, 20, 336)	0	block3b_bn[0][0]
block3b_se_squeeze (GlobalAveragePooling2D)	(None, 336)	0	block3b_activation[0]...
block3b_se_reshape (Reshape)	(None, 1, 1, 336)	0	block3b_se_squeeze[0]...
block3b_se_reduce (Conv2D)	(None, 1, 1, 14)	4,718	block3b_se_reshape[0]...
block3b_se_expand (Conv2D)	(None, 1, 1, 336)	5,040	block3b_se_reduce[0][...
block3b_se_excite (Multiply)	(None, 20, 20, 336)	0	block3b_activation[0]... block3b_se_expand[0][...
block3b_project_conv	(None, 20, 20, 56)	18,816	block3b_se_excite[0][...

(Conv2D)			
block3b_project_bn (BatchNormalization)	(None, 20, 20, 56)	224	block3b_project_conv[...
block3b_drop (Dropout)	(None, 20, 20, 56)	0	block3b_project_bn[0]...
block3b_add (Add)	(None, 20, 20, 56)	0	block3b_drop[0][0], block3a_project_bn[0]...
block3c_expand_conv (Conv2D)	(None, 20, 20, 336)	18,816	block3b_add[0][0]
block3c_expand_bn (BatchNormalization)	(None, 20, 20, 336)	1,344	block3c_expand_conv[0...
block3c_expand_activation (Activation)	(None, 20, 20, 336)	0	block3c_expand_bn[0][...
block3c_dwconv (DepthwiseConv2D)	(None, 20, 20, 336)	8,400	block3c_expand_activa...
block3c_bn (BatchNormalization)	(None, 20, 20, 336)	1,344	block3c_dwconv[0][0]
block3c_activation (Activation)	(None, 20, 20, 336)	0	block3c_bn[0][0]
block3c_se_squeeze (GlobalAveragePooling2D)	(None, 336)	0	block3c_activation[0]...
block3c_se_reshape (Reshape)	(None, 1, 1, 336)	0	block3c_se_squeeze[0]...
block3c_se_reduce (Conv2D)	(None, 1, 1, 14)	4,718	block3c_se_reshape[0]...
block3c_se_expand (Conv2D)	(None, 1, 1, 336)	5,040	block3c_se_reduce[0][...
block3c_se_excite (Multiply)	(None, 20, 20, 336)	0	block3c_activation[0]... block3c_se_expand[0][...
block3c_project_conv (Conv2D)	(None, 20, 20, 56)	18,816	block3c_se_excite[0][...
block3c_project_bn (BatchNormalization)	(None, 20, 20, 56)	224	block3c_project_conv[...
block3c_drop (Dropout)	(None, 20, 20, 56)	0	block3c_project_bn[0]...
block3c_add (Add)	(None, 20, 20, 56)	0	block3c_drop[0][0], block3b_add[0][0]
block3d_expand_conv (Conv2D)	(None, 20, 20, 336)	18,816	block3c_add[0][0]
block3d_expand_bn (BatchNormalization)	(None, 20, 20, 336)	1,344	block3d_expand_conv[0...
block3d_expand_activation (Activation)	(None, 20, 20, 336)	0	block3d_expand_bn[0][...
block3d_dwconv (DepthwiseConv2D)	(None, 20, 20, 336)	8,400	block3d_expand_activa...
block3d_bn (BatchNormalization)	(None, 20, 20, 336)	1,344	block3d_dwconv[0][0]
block3d_activation (Activation)	(None, 20, 20, 336)	0	block3d_bn[0][0]
block3d_se_squeeze (GlobalAveragePooling2D)	(None, 336)	0	block3d_activation[0]...
block3d_se_reshape (Reshape)	(None, 1, 1, 336)	0	block3d_se_squeeze[0]...
block3d_se_reduce (Conv2D)	(None, 1, 1, 14)	4,718	block3d_se_reshape[0]...
block3d_se_expand (Conv2D)	(None, 1, 1, 336)	5,040	block3d_se_reduce[0][...

block3d_se_excite (Multiply)	(None, 20, 20, 336)	0	block3d_activation[0]... block3d_se_expand[0][...
block3d_project_conv (Conv2D)	(None, 20, 20, 56)	18,816	block3d_se_excite[0][...
block3d_project_bn (BatchNormalization)	(None, 20, 20, 56)	224	block3d_project_conv[...
block3d_drop (Dropout)	(None, 20, 20, 56)	0	block3d_project_bn[0]...
block3d_add (Add)	(None, 20, 20, 56)	0	block3d_drop[0][0], block3c_add[0][0]
block4a_expand_conv (Conv2D)	(None, 20, 20, 336)	18,816	block3d_add[0][0]
block4a_expand_bn (BatchNormalization)	(None, 20, 20, 336)	1,344	block4a_expand_conv[0...
block4a_expand_activation (Activation)	(None, 20, 20, 336)	0	block4a_expand_bn[0][...
block4a_dwconv_pad (ZeroPadding2D)	(None, 21, 21, 336)	0	block4a_expand_activa...
block4a_dwconv (DepthwiseConv2D)	(None, 10, 10, 336)	3,024	block4a_dwconv_pad[0]...
block4a_bn (BatchNormalization)	(None, 10, 10, 336)	1,344	block4a_dwconv[0][0]
block4a_activation (Activation)	(None, 10, 10, 336)	0	block4a_bn[0][0]
block4a_se_squeeze (GlobalAveragePooling2D)	(None, 336)	0	block4a_activation[0]...
block4a_se_reshape (Reshape)	(None, 1, 1, 336)	0	block4a_se_squeeze[0]...
block4a_se_reduce (Conv2D)	(None, 1, 1, 14)	4,718	block4a_se_reshape[0]...
block4a_se_expand (Conv2D)	(None, 1, 1, 336)	5,040	block4a_se_reduce[0][...
block4a_se_excite (Multiply)	(None, 10, 10, 336)	0	block4a_activation[0]... block4a_se_expand[0][...
block4a_project_conv (Conv2D)	(None, 10, 10, 112)	37,632	block4a_se_excite[0][...
block4a_project_bn (BatchNormalization)	(None, 10, 10, 112)	448	block4a_project_conv[...
block4b_expand_conv (Conv2D)	(None, 10, 10, 672)	75,264	block4a_project_bn[0]...
block4b_expand_bn (BatchNormalization)	(None, 10, 10, 672)	2,688	block4b_expand_conv[0...
block4b_expand_activation (Activation)	(None, 10, 10, 672)	0	block4b_expand_bn[0][...
block4b_dwconv (DepthwiseConv2D)	(None, 10, 10, 672)	6,048	block4b_expand_activa...
block4b_bn (BatchNormalization)	(None, 10, 10, 672)	2,688	block4b_dwconv[0][0]
block4b_activation (Activation)	(None, 10, 10, 672)	0	block4b_bn[0][0]
block4b_se_squeeze (GlobalAveragePooling2D)	(None, 672)	0	block4b_activation[0]...
block4b_se_reshape (Reshape)	(None, 1, 1, 672)	0	block4b_se_squeeze[0]...
block4b_se_reduce (Conv2D)	(None, 1, 1, 28)	18,844	block4b_se_reshape[0]...

block4b_se_expand (Conv2D)	(None, 1, 1, 672)	19,488	block4b_se_reduce[0][...
block4b_se_excite (Multiply)	(None, 10, 10, 672)	0	block4b_activation[0]... block4b_se_expand[0][...
block4b_project_conv (Conv2D)	(None, 10, 10, 112)	75,264	block4b_se_excite[0][...
block4b_project_bn (BatchNormalization)	(None, 10, 10, 112)	448	block4b_project_conv[...
block4b_drop (Dropout)	(None, 10, 10, 112)	0	block4b_project_bn[0]...
block4b_add (Add)	(None, 10, 10, 112)	0	block4b_drop[0][0], block4a_project_bn[0]...
block4c_expand_conv (Conv2D)	(None, 10, 10, 672)	75,264	block4b_add[0][0]
block4c_expand_bn (BatchNormalization)	(None, 10, 10, 672)	2,688	block4c_expand_conv[0...
block4c_expand_activation (Activation)	(None, 10, 10, 672)	0	block4c_expand_bn[0][...
block4c_dwconv (DepthwiseConv2D)	(None, 10, 10, 672)	6,048	block4c_expand_activa...
block4c_bn (BatchNormalization)	(None, 10, 10, 672)	2,688	block4c_dwconv[0][0]
block4c_activation (Activation)	(None, 10, 10, 672)	0	block4c_bn[0][0]
block4c_se_squeeze (GlobalAveragePooling2D)	(None, 672)	0	block4c_activation[0]...
block4c_se_reshape (Reshape)	(None, 1, 1, 672)	0	block4c_se_squeeze[0]...
block4c_se_reduce (Conv2D)	(None, 1, 1, 28)	18,844	block4c_se_reshape[0]...
block4c_se_expand (Conv2D)	(None, 1, 1, 672)	19,488	block4c_se_reduce[0][...
block4c_se_excite (Multiply)	(None, 10, 10, 672)	0	block4c_activation[0]... block4c_se_expand[0][...
block4c_project_conv (Conv2D)	(None, 10, 10, 112)	75,264	block4c_se_excite[0][...
block4c_project_bn (BatchNormalization)	(None, 10, 10, 112)	448	block4c_project_conv[...
block4c_drop (Dropout)	(None, 10, 10, 112)	0	block4c_project_bn[0]...
block4c_add (Add)	(None, 10, 10, 112)	0	block4c_drop[0][0], block4b_add[0][0]
block4d_expand_conv (Conv2D)	(None, 10, 10, 672)	75,264	block4c_add[0][0]
block4d_expand_bn (BatchNormalization)	(None, 10, 10, 672)	2,688	block4d_expand_conv[0...
block4d_expand_activation (Activation)	(None, 10, 10, 672)	0	block4d_expand_bn[0][...
block4d_dwconv (DepthwiseConv2D)	(None, 10, 10, 672)	6,048	block4d_expand_activa...
block4d_bn (BatchNormalization)	(None, 10, 10, 672)	2,688	block4d_dwconv[0][0]
block4d_activation (Activation)	(None, 10, 10, 672)	0	block4d_bn[0][0]
block4d_se_squeeze (GlobalAveragePooling2D)	(None, 672)	0	block4d_activation[0]...

block4d_se_reshape (Reshape)	(None, 1, 1, 672)	0	block4d_se_squeeze[0]...
block4d_se_reduce (Conv2D)	(None, 1, 1, 28)	18,844	block4d_se_reshape[0]...
block4d_se_expand (Conv2D)	(None, 1, 1, 672)	19,488	block4d_se_reduce[0][...
block4d_se_excite (Multiply)	(None, 10, 10, 672)	0	block4d_activation[0]... block4d_se_expand[0][...
block4d_project_conv (Conv2D)	(None, 10, 10, 112)	75,264	block4d_se_excite[0][...
block4d_project_bn (BatchNormalization)	(None, 10, 10, 112)	448	block4d_project_conv[...
block4d_drop (Dropout)	(None, 10, 10, 112)	0	block4d_project_bn[0]...
block4d_add (Add)	(None, 10, 10, 112)	0	block4d_drop[0][0], block4c_add[0][0]
block4e_expand_conv (Conv2D)	(None, 10, 10, 672)	75,264	block4d_add[0][0]
block4e_expand_bn (BatchNormalization)	(None, 10, 10, 672)	2,688	block4e_expand_conv[0...
block4e_expand_activation (Activation)	(None, 10, 10, 672)	0	block4e_expand_bn[0][...
block4e_dwconv (DepthwiseConv2D)	(None, 10, 10, 672)	6,048	block4e_expand_activa...
block4e_bn (BatchNormalization)	(None, 10, 10, 672)	2,688	block4e_dwconv[0][0]
block4e_activation (Activation)	(None, 10, 10, 672)	0	block4e_bn[0][0]
block4e_se_squeeze (GlobalAveragePooling2D)	(None, 672)	0	block4e_activation[0]...
block4e_se_reshape (Reshape)	(None, 1, 1, 672)	0	block4e_se_squeeze[0]...
block4e_se_reduce (Conv2D)	(None, 1, 1, 28)	18,844	block4e_se_reshape[0]...
block4e_se_expand (Conv2D)	(None, 1, 1, 672)	19,488	block4e_se_reduce[0][...
block4e_se_excite (Multiply)	(None, 10, 10, 672)	0	block4e_activation[0]... block4e_se_expand[0][...
block4e_project_conv (Conv2D)	(None, 10, 10, 112)	75,264	block4e_se_excite[0][...
block4e_project_bn (BatchNormalization)	(None, 10, 10, 112)	448	block4e_project_conv[...
block4e_drop (Dropout)	(None, 10, 10, 112)	0	block4e_project_bn[0]...
block4e_add (Add)	(None, 10, 10, 112)	0	block4e_drop[0][0], block4d_add[0][0]
block4f_expand_conv (Conv2D)	(None, 10, 10, 672)	75,264	block4e_add[0][0]
block4f_expand_bn (BatchNormalization)	(None, 10, 10, 672)	2,688	block4f_expand_conv[0...
block4f_expand_activation (Activation)	(None, 10, 10, 672)	0	block4f_expand_bn[0][...
block4f_dwconv (DepthwiseConv2D)	(None, 10, 10, 672)	6,048	block4f_expand_activa...
block4f_bn (BatchNormalization)	(None, 10, 10, 672)	2,688	block4f_dwconv[0][0]
block4f_activation	(None, 10, 10, 672)	0	block4f_bn[0][0]

(Activation)			
block4f_se_squeeze (GlobalAveragePooling2D)	(None, 672)	0	block4f_activation[0]...
block4f_se_reshape (Reshape)	(None, 1, 1, 672)	0	block4f_se_squeeze[0]...
block4f_se_reduce (Conv2D)	(None, 1, 1, 28)	18,844	block4f_se_reshape[0]...
block4f_se_expand (Conv2D)	(None, 1, 1, 672)	19,488	block4f_se_reduce[0][...
block4f_se_excite (Multiply)	(None, 10, 10, 672)	0	block4f_activation[0]... block4f_se_expand[0][...
block4f_project_conv (Conv2D)	(None, 10, 10, 112)	75,264	block4f_se_excite[0][...
block4f_project_bn (BatchNormalization)	(None, 10, 10, 112)	448	block4f_project_conv[...
block4f_drop (Dropout)	(None, 10, 10, 112)	0	block4f_project_bn[0]...
block4f_add (Add)	(None, 10, 10, 112)	0	block4f_drop[0][0], block4e_add[0][0]
block5a_expand_conv (Conv2D)	(None, 10, 10, 672)	75,264	block4f_add[0][0]
block5a_expand_bn (BatchNormalization)	(None, 10, 10, 672)	2,688	block5a_expand_conv[0...
block5a_expand_activation (Activation)	(None, 10, 10, 672)	0	block5a_expand_bn[0][...
block5a_dwconv (DepthwiseConv2D)	(None, 10, 10, 672)	16,800	block5a_expand_activa...
block5a_bn (BatchNormalization)	(None, 10, 10, 672)	2,688	block5a_dwconv[0][0]
block5a_activation (Activation)	(None, 10, 10, 672)	0	block5a_bn[0][0]
block5a_se_squeeze (GlobalAveragePooling2D)	(None, 672)	0	block5a_activation[0]...
block5a_se_reshape (Reshape)	(None, 1, 1, 672)	0	block5a_se_squeeze[0]...
block5a_se_reduce (Conv2D)	(None, 1, 1, 28)	18,844	block5a_se_reshape[0]...
block5a_se_expand (Conv2D)	(None, 1, 1, 672)	19,488	block5a_se_reduce[0][...
block5a_se_excite (Multiply)	(None, 10, 10, 672)	0	block5a_activation[0]... block5a_se_expand[0][...
block5a_project_conv (Conv2D)	(None, 10, 10, 160)	107,520	block5a_se_excite[0][...
block5a_project_bn (BatchNormalization)	(None, 10, 10, 160)	640	block5a_project_conv[...
block5b_expand_conv (Conv2D)	(None, 10, 10, 960)	153,600	block5a_project_bn[0]...
block5b_expand_bn (BatchNormalization)	(None, 10, 10, 960)	3,840	block5b_expand_conv[0...
block5b_expand_activation (Activation)	(None, 10, 10, 960)	0	block5b_expand_bn[0][...
block5b_dwconv (DepthwiseConv2D)	(None, 10, 10, 960)	24,000	block5b_expand_activa...
block5b_bn (BatchNormalization)	(None, 10, 10, 960)	3,840	block5b_dwconv[0][0]
block5b_activation	(None, 10, 10, 960)	0	block5b_bn[0][0]

(Activation)			
block5b_se_squeeze (GlobalAveragePooling2D)	(None, 960)	0	block5b_activation[0]...
block5b_se_reshape (Reshape)	(None, 1, 1, 960)	0	block5b_se_squeeze[0]...
block5b_se_reduce (Conv2D)	(None, 1, 1, 40)	38,440	block5b_se_reshape[0]...
block5b_se_expand (Conv2D)	(None, 1, 1, 960)	39,360	block5b_se_reduce[0][...
block5b_se_excite (Multiply)	(None, 10, 10, 960)	0	block5b_activation[0]... block5b_se_expand[0][...
block5b_project_conv (Conv2D)	(None, 10, 10, 160)	153,600	block5b_se_excite[0][...
block5b_project_bn (BatchNormalization)	(None, 10, 10, 160)	640	block5b_project_conv[...
block5b_drop (Dropout)	(None, 10, 10, 160)	0	block5b_project_bn[0]...
block5b_add (Add)	(None, 10, 10, 160)	0	block5b_drop[0][0], block5a_project_bn[0]...
block5c_expand_conv (Conv2D)	(None, 10, 10, 960)	153,600	block5b_add[0][0]
block5c_expand_bn (BatchNormalization)	(None, 10, 10, 960)	3,840	block5c_expand_conv[0...
block5c_expand_activation (Activation)	(None, 10, 10, 960)	0	block5c_expand_bn[0][...
block5c_dwconv (DepthwiseConv2D)	(None, 10, 10, 960)	24,000	block5c_expand_activa...
block5c_bn (BatchNormalization)	(None, 10, 10, 960)	3,840	block5c_dwconv[0][0]
block5c_activation (Activation)	(None, 10, 10, 960)	0	block5c_bn[0][0]
block5c_se_squeeze (GlobalAveragePooling2D)	(None, 960)	0	block5c_activation[0]...
block5c_se_reshape (Reshape)	(None, 1, 1, 960)	0	block5c_se_squeeze[0]...
block5c_se_reduce (Conv2D)	(None, 1, 1, 40)	38,440	block5c_se_reshape[0]...
block5c_se_expand (Conv2D)	(None, 1, 1, 960)	39,360	block5c_se_reduce[0][...
block5c_se_excite (Multiply)	(None, 10, 10, 960)	0	block5c_activation[0]... block5c_se_expand[0][...
block5c_project_conv (Conv2D)	(None, 10, 10, 160)	153,600	block5c_se_excite[0][...
block5c_project_bn (BatchNormalization)	(None, 10, 10, 160)	640	block5c_project_conv[...
block5c_drop (Dropout)	(None, 10, 10, 160)	0	block5c_project_bn[0]...
block5c_add (Add)	(None, 10, 10, 160)	0	block5c_drop[0][0], block5b_add[0][0]
block5d_expand_conv (Conv2D)	(None, 10, 10, 960)	153,600	block5c_add[0][0]
block5d_expand_bn (BatchNormalization)	(None, 10, 10, 960)	3,840	block5d_expand_conv[0...
block5d_expand_activation (Activation)	(None, 10, 10, 960)	0	block5d_expand_bn[0][...
block5d_dwconv (DepthwiseConv2D)	(None, 10, 10, 960)	24,000	block5d_expand_activa...

block5d_bn (BatchNormalization)	(None, 10, 10, 960)	3,840	block5d_dwconv[0][0]
block5d_activation (Activation)	(None, 10, 10, 960)	0	block5d_bn[0][0]
block5d_se_squeeze (GlobalAveragePooling2D)	(None, 960)	0	block5d_activation[0]...
block5d_se_reshape (Reshape)	(None, 1, 1, 960)	0	block5d_se_squeeze[0]...
block5d_se_reduce (Conv2D)	(None, 1, 1, 40)	38,440	block5d_se_reshape[0]...
block5d_se_expand (Conv2D)	(None, 1, 1, 960)	39,360	block5d_se_reduce[0][...
block5d_se_excite (Multiply)	(None, 10, 10, 960)	0	block5d_activation[0]... block5d_se_expand[0][...
block5d_project_conv (Conv2D)	(None, 10, 10, 160)	153,600	block5d_se_excite[0][...
block5d_project_bn (BatchNormalization)	(None, 10, 10, 160)	640	block5d_project_conv[...
block5d_drop (Dropout)	(None, 10, 10, 160)	0	block5d_project_bn[0]...
block5d_add (Add)	(None, 10, 10, 160)	0	block5d_drop[0][0], block5c_add[0][0]
block5e_expand_conv (Conv2D)	(None, 10, 10, 960)	153,600	block5d_add[0][0]
block5e_expand_bn (BatchNormalization)	(None, 10, 10, 960)	3,840	block5e_expand_conv[0...
block5e_expand_activation (Activation)	(None, 10, 10, 960)	0	block5e_expand_bn[0][...
block5e_dwconv (DepthwiseConv2D)	(None, 10, 10, 960)	24,000	block5e_expand_activa...
block5e_bn (BatchNormalization)	(None, 10, 10, 960)	3,840	block5e_dwconv[0][0]
block5e_activation (Activation)	(None, 10, 10, 960)	0	block5e_bn[0][0]
block5e_se_squeeze (GlobalAveragePooling2D)	(None, 960)	0	block5e_activation[0]...
block5e_se_reshape (Reshape)	(None, 1, 1, 960)	0	block5e_se_squeeze[0]...
block5e_se_reduce (Conv2D)	(None, 1, 1, 40)	38,440	block5e_se_reshape[0]...
block5e_se_expand (Conv2D)	(None, 1, 1, 960)	39,360	block5e_se_reduce[0][...
block5e_se_excite (Multiply)	(None, 10, 10, 960)	0	block5e_activation[0]... block5e_se_expand[0][...
block5e_project_conv (Conv2D)	(None, 10, 10, 160)	153,600	block5e_se_excite[0][...
block5e_project_bn (BatchNormalization)	(None, 10, 10, 160)	640	block5e_project_conv[...
block5e_drop (Dropout)	(None, 10, 10, 160)	0	block5e_project_bn[0]...
block5e_add (Add)	(None, 10, 10, 160)	0	block5e_drop[0][0], block5d_add[0][0]
block5f_expand_conv (Conv2D)	(None, 10, 10, 960)	153,600	block5e_add[0][0]
block5f_expand_bn (BatchNormalization)	(None, 10, 10, 960)	3,840	block5f_expand_conv[0...

block5f_expand_activation (Activation)	(None, 10, 10, 960)	0	block5f_expand_bn[0][...
block5f_dwconv (DepthwiseConv2D)	(None, 10, 10, 960)	24,000	block5f_expand_activa...
block5f_bn (BatchNormalization)	(None, 10, 10, 960)	3,840	block5f_dwconv[0][0]
block5f_activation (Activation)	(None, 10, 10, 960)	0	block5f_bn[0][0]
block5f_se_squeeze (GlobalAveragePooling2D)	(None, 960)	0	block5f_activation[0]...
block5f_se_reshape (Reshape)	(None, 1, 1, 960)	0	block5f_se_squeeze[0]...
block5f_se_reduce (Conv2D)	(None, 1, 1, 40)	38,440	block5f_se_reshape[0]...
block5f_se_expand (Conv2D)	(None, 1, 1, 960)	39,360	block5f_se_reduce[0][...
block5f_se_excite (Multiply)	(None, 10, 10, 960)	0	block5f_activation[0]... block5f_se_expand[0][...
block5f_project_conv (Conv2D)	(None, 10, 10, 160)	153,600	block5f_se_excite[0][...
block5f_project_bn (BatchNormalization)	(None, 10, 10, 160)	640	block5f_project_conv[...
block5f_drop (Dropout)	(None, 10, 10, 160)	0	block5f_project_bn[0]...
block5f_add (Add)	(None, 10, 10, 160)	0	block5f_drop[0][0], block5e_add[0][0]
block6a_expand_conv (Conv2D)	(None, 10, 10, 960)	153,600	block5f_add[0][0]
block6a_expand_bn (BatchNormalization)	(None, 10, 10, 960)	3,840	block6a_expand_conv[0...
block6a_expand_activation (Activation)	(None, 10, 10, 960)	0	block6a_expand_bn[0][...
block6a_dwconv_pad (ZeroPadding2D)	(None, 13, 13, 960)	0	block6a_expand_activa...
block6a_dwconv (DepthwiseConv2D)	(None, 5, 5, 960)	24,000	block6a_dwconv_pad[0]...
block6a_bn (BatchNormalization)	(None, 5, 5, 960)	3,840	block6a_dwconv[0][0]
block6a_activation (Activation)	(None, 5, 5, 960)	0	block6a_bn[0][0]
block6a_se_squeeze (GlobalAveragePooling2D)	(None, 960)	0	block6a_activation[0]...
block6a_se_reshape (Reshape)	(None, 1, 1, 960)	0	block6a_se_squeeze[0]...
block6a_se_reduce (Conv2D)	(None, 1, 1, 40)	38,440	block6a_se_reshape[0]...
block6a_se_expand (Conv2D)	(None, 1, 1, 960)	39,360	block6a_se_reduce[0][...
block6a_se_excite (Multiply)	(None, 5, 5, 960)	0	block6a_activation[0]... block6a_se_expand[0][...
block6a_project_conv (Conv2D)	(None, 5, 5, 272)	261,120	block6a_se_excite[0][...
block6a_project_bn (BatchNormalization)	(None, 5, 5, 272)	1,088	block6a_project_conv[...
block6b_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6a_project_bn[0]...

block6b_expand_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block6b_expand_conv[0]...
block6b_expand_activation (Activation)	(None, 5, 5, 1632)	0	block6b_expand_bn[0][...
block6b_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	40,800	block6b_expand_activa...
block6b_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block6b_dwconv[0][0]
block6b_activation (Activation)	(None, 5, 5, 1632)	0	block6b_bn[0][0]
block6b_se_squeeze (GlobalAveragePooling2D)	(None, 1632)	0	block6b_activation[0]...
block6b_se_reshape (Reshape)	(None, 1, 1, 1632)	0	block6b_se_squeeze[0]...
block6b_se_reduce (Conv2D)	(None, 1, 1, 68)	111,044	block6b_se_reshape[0]...
block6b_se_expand (Conv2D)	(None, 1, 1, 1632)	112,608	block6b_se_reduce[0][...
block6b_se_excite (Multiply)	(None, 5, 5, 1632)	0	block6b_activation[0]... block6b_se_expand[0][...
block6b_project_conv (Conv2D)	(None, 5, 5, 272)	443,904	block6b_se_excite[0][...
block6b_project_bn (BatchNormalization)	(None, 5, 5, 272)	1,088	block6b_project_conv[...
block6b_drop (Dropout)	(None, 5, 5, 272)	0	block6b_project_bn[0]...
block6b_add (Add)	(None, 5, 5, 272)	0	block6b_drop[0][0], block6a_project_bn[0]...
block6c_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6b_add[0][0]
block6c_expand_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block6c_expand_conv[0]...
block6c_expand_activation (Activation)	(None, 5, 5, 1632)	0	block6c_expand_bn[0][...
block6c_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	40,800	block6c_expand_activa...
block6c_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block6c_dwconv[0][0]
block6c_activation (Activation)	(None, 5, 5, 1632)	0	block6c_bn[0][0]
block6c_se_squeeze (GlobalAveragePooling2D)	(None, 1632)	0	block6c_activation[0]...
block6c_se_reshape (Reshape)	(None, 1, 1, 1632)	0	block6c_se_squeeze[0]...
block6c_se_reduce (Conv2D)	(None, 1, 1, 68)	111,044	block6c_se_reshape[0]...
block6c_se_expand (Conv2D)	(None, 1, 1, 1632)	112,608	block6c_se_reduce[0][...
block6c_se_excite (Multiply)	(None, 5, 5, 1632)	0	block6c_activation[0]... block6c_se_expand[0][...
block6c_project_conv (Conv2D)	(None, 5, 5, 272)	443,904	block6c_se_excite[0][...
block6c_project_bn (BatchNormalization)	(None, 5, 5, 272)	1,088	block6c_project_conv[...
block6c_drop (Dropout)	(None, 5, 5, 272)	0	block6c_project_bn[0]...
block6c_add (Add)	(None, 5, 5, 272)	0	block6c_drop[0][0],

			block6b_add[0][0]
block6d_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6c_add[0][0]
block6d_expand_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block6d_expand_conv[0]...
block6d_expand_activation (Activation)	(None, 5, 5, 1632)	0	block6d_expand_bn[0][...
block6d_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	40,800	block6d_expand_activa...
block6d_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block6d_dwconv[0][0]
block6d_activation (Activation)	(None, 5, 5, 1632)	0	block6d_bn[0][0]
block6d_se_squeeze (GlobalAveragePooling2D)	(None, 1632)	0	block6d_activation[0]...
block6d_se_reshape (Reshape)	(None, 1, 1, 1632)	0	block6d_se_squeeze[0]...
block6d_se_reduce (Conv2D)	(None, 1, 1, 68)	111,044	block6d_se_reshape[0]...
block6d_se_expand (Conv2D)	(None, 1, 1, 1632)	112,608	block6d_se_reduce[0][...
block6d_se_excite (Multiply)	(None, 5, 5, 1632)	0	block6d_activation[0]... block6d_se_expand[0][...
block6d_project_conv (Conv2D)	(None, 5, 5, 272)	443,904	block6d_se_excite[0][...
block6d_project_bn (BatchNormalization)	(None, 5, 5, 272)	1,088	block6d_project_conv[...
block6d_drop (Dropout)	(None, 5, 5, 272)	0	block6d_project_bn[0]...
block6d_add (Add)	(None, 5, 5, 272)	0	block6d_drop[0][0], block6c_add[0][0]
block6e_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6d_add[0][0]
block6e_expand_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block6e_expand_conv[0]...
block6e_expand_activation (Activation)	(None, 5, 5, 1632)	0	block6e_expand_bn[0][...
block6e_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	40,800	block6e_expand_activa...
block6e_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block6e_dwconv[0][0]
block6e_activation (Activation)	(None, 5, 5, 1632)	0	block6e_bn[0][0]
block6e_se_squeeze (GlobalAveragePooling2D)	(None, 1632)	0	block6e_activation[0]...
block6e_se_reshape (Reshape)	(None, 1, 1, 1632)	0	block6e_se_squeeze[0]...
block6e_se_reduce (Conv2D)	(None, 1, 1, 68)	111,044	block6e_se_reshape[0]...
block6e_se_expand (Conv2D)	(None, 1, 1, 1632)	112,608	block6e_se_reduce[0][...
block6e_se_excite (Multiply)	(None, 5, 5, 1632)	0	block6e_activation[0]... block6e_se_expand[0][...
block6e_project_conv (Conv2D)	(None, 5, 5, 272)	443,904	block6e_se_excite[0][...
block6e_project_bn	(None, 5, 5, 272)	1,088	block6e_project_conv[...

(BatchNormalization)			
block6e_drop (Dropout)	(None, 5, 5, 272)	0	block6e_project_bn[0]...
block6e_add (Add)	(None, 5, 5, 272)	0	block6e_drop[0][0], block6d_add[0][0]
block6f_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6e_add[0][0]
block6f_expand_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block6f_expand_conv[0...
block6f_expand_activation (Activation)	(None, 5, 5, 1632)	0	block6f_expand_bn[0][...
block6f_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	40,800	block6f_expand_activa...
block6f_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block6f_dwconv[0][0]
block6f_activation (Activation)	(None, 5, 5, 1632)	0	block6f_bn[0][0]
block6f_se_squeeze (GlobalAveragePooling2D)	(None, 1632)	0	block6f_activation[0]...
block6f_se_reshape (Reshape)	(None, 1, 1, 1632)	0	block6f_se_squeeze[0]...
block6f_se_reduce (Conv2D)	(None, 1, 1, 68)	111,044	block6f_se_reshape[0]...
block6f_se_expand (Conv2D)	(None, 1, 1, 1632)	112,608	block6f_se_reduce[0][...
block6f_se_excite (Multiply)	(None, 5, 5, 1632)	0	block6f_activation[0]... block6f_se_expand[0][...
block6f_project_conv (Conv2D)	(None, 5, 5, 272)	443,904	block6f_se_excite[0][...
block6f_project_bn (BatchNormalization)	(None, 5, 5, 272)	1,088	block6f_project_conv[...
block6f_drop (Dropout)	(None, 5, 5, 272)	0	block6f_project_bn[0]...
block6f_add (Add)	(None, 5, 5, 272)	0	block6f_drop[0][0], block6e_add[0][0]
block6g_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6f_add[0][0]
block6g_expand_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block6g_expand_conv[0...
block6g_expand_activation (Activation)	(None, 5, 5, 1632)	0	block6g_expand_bn[0][...
block6g_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	40,800	block6g_expand_activa...
block6g_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block6g_dwconv[0][0]
block6g_activation (Activation)	(None, 5, 5, 1632)	0	block6g_bn[0][0]
block6g_se_squeeze (GlobalAveragePooling2D)	(None, 1632)	0	block6g_activation[0]...
block6g_se_reshape (Reshape)	(None, 1, 1, 1632)	0	block6g_se_squeeze[0]...
block6g_se_reduce (Conv2D)	(None, 1, 1, 68)	111,044	block6g_se_reshape[0]...
block6g_se_expand (Conv2D)	(None, 1, 1, 1632)	112,608	block6g_se_reduce[0][...
block6g_se_excite (Multiply)	(None, 5, 5, 1632)	0	block6g_activation[0]... block6g_se_expand[0][...

block6g_project_conv (Conv2D)	(None, 5, 5, 272)	443,904	block6g_se_excite[0][...
block6g_project_bn (BatchNormalization)	(None, 5, 5, 272)	1,088	block6g_project_conv[...
block6g_drop (Dropout)	(None, 5, 5, 272)	0	block6g_project_bn[0]...
block6g_add (Add)	(None, 5, 5, 272)	0	block6g_drop[0][0], block6f_add[0][0]
block6h_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6g_add[0][0]
block6h_expand_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block6h_expand_conv[0...
block6h_expand_activation (Activation)	(None, 5, 5, 1632)	0	block6h_expand_bn[0][...
block6h_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	40,800	block6h_expand_activa...
block6h_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block6h_dwconv[0][0]
block6h_activation (Activation)	(None, 5, 5, 1632)	0	block6h_bn[0][0]
block6h_se_squeeze (GlobalAveragePooling2D)	(None, 1632)	0	block6h_activation[0]...
block6h_se_reshape (Reshape)	(None, 1, 1, 1632)	0	block6h_se_squeeze[0]...
block6h_se_reduce (Conv2D)	(None, 1, 1, 68)	111,044	block6h_se_reshape[0]...
block6h_se_expand (Conv2D)	(None, 1, 1, 1632)	112,608	block6h_se_reduce[0][...
block6h_se_excite (Multiply)	(None, 5, 5, 1632)	0	block6h_activation[0]... block6h_se_expand[0][...
block6h_project_conv (Conv2D)	(None, 5, 5, 272)	443,904	block6h_se_excite[0][...
block6h_project_bn (BatchNormalization)	(None, 5, 5, 272)	1,088	block6h_project_conv[...
block6h_drop (Dropout)	(None, 5, 5, 272)	0	block6h_project_bn[0]...
block6h_add (Add)	(None, 5, 5, 272)	0	block6h_drop[0][0], block6g_add[0][0]
block7a_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6h_add[0][0]
block7a_expand_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block7a_expand_conv[0...
block7a_expand_activation (Activation)	(None, 5, 5, 1632)	0	block7a_expand_bn[0][...
block7a_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	14,688	block7a_expand_activa...
block7a_bn (BatchNormalization)	(None, 5, 5, 1632)	6,528	block7a_dwconv[0][0]
block7a_activation (Activation)	(None, 5, 5, 1632)	0	block7a_bn[0][0]
block7a_se_squeeze (GlobalAveragePooling2D)	(None, 1632)	0	block7a_activation[0]...
block7a_se_reshape (Reshape)	(None, 1, 1, 1632)	0	block7a_se_squeeze[0]...
block7a_se_reduce (Conv2D)	(None, 1, 1, 68)	111,044	block7a_se_reshape[0]...

block7a_se_expand (Conv2D)	(None, 1, 1, 1632)	112,608	block7a_se_reduce[0][...]
block7a_se_excite (Multiply)	(None, 5, 5, 1632)	0	block7a_activation[0]... block7a_se_expand[0][...]
block7a_project_conv (Conv2D)	(None, 5, 5, 448)	731,136	block7a_se_excite[0][...]
block7a_project_bn (BatchNormalization)	(None, 5, 5, 448)	1,792	block7a_project_conv[...]
block7b_expand_conv (Conv2D)	(None, 5, 5, 2688)	1,204,224	block7a_project_bn[0]...
block7b_expand_bn (BatchNormalization)	(None, 5, 5, 2688)	10,752	block7b_expand_conv[0...
block7b_expand_activation (Activation)	(None, 5, 5, 2688)	0	block7b_expand_bn[0][...]
block7b_dwconv (DepthwiseConv2D)	(None, 5, 5, 2688)	24,192	block7b_expand_activa...
block7b_bn (BatchNormalization)	(None, 5, 5, 2688)	10,752	block7b_dwconv[0][0]
block7b_activation (Activation)	(None, 5, 5, 2688)	0	block7b_bn[0][0]
block7b_se_squeeze (GlobalAveragePooling2D)	(None, 2688)	0	block7b_activation[0]...
block7b_se_reshape (Reshape)	(None, 1, 1, 2688)	0	block7b_se_squeeze[0]...
block7b_se_reduce (Conv2D)	(None, 1, 1, 112)	301,168	block7b_se_reshape[0]...
block7b_se_expand (Conv2D)	(None, 1, 1, 2688)	303,744	block7b_se_reduce[0][...]
block7b_se_excite (Multiply)	(None, 5, 5, 2688)	0	block7b_activation[0]... block7b_se_expand[0][...]
block7b_project_conv (Conv2D)	(None, 5, 5, 448)	1,204,224	block7b_se_excite[0][...]
block7b_project_bn (BatchNormalization)	(None, 5, 5, 448)	1,792	block7b_project_conv[...]
block7b_drop (Dropout)	(None, 5, 5, 448)	0	block7b_project_bn[0]...
block7b_add (Add)	(None, 5, 5, 448)	0	block7b_drop[0][0], block7a_project_bn[0]...
top_conv (Conv2D)	(None, 5, 5, 1792)	802,816	block7b_add[0][0]
top_bn (BatchNormalization)	(None, 5, 5, 1792)	7,168	top_conv[0][0]
top_activation (Activation)	(None, 5, 5, 1792)	0	top_bn[0][0]

Total params: 17,673,823 (67.42 MB)

Trainable params: 0 (0.00 B)

Non-trainable params: 17,673,823 (67.42 MB)

```
In [ ]: global_average_layer = tf.keras.layers.GlobalAveragePooling2D()
feature_batch_average = global_average_layer(feature_batch)
print(feature_batch_average.shape)
```

(32, 1792)

```
In [ ]: prediction_layer = tf.keras.layers.Dense(len(class_names), activation='sigmoid')
prediction_batch = prediction_layer(feature_batch_average)
print(prediction_batch.shape)
```

(32, 39)

```
In [ ]: inputs = tf.keras.Input(shape=(160, 160, 3))
x = preprocess_input(inputs)
x = base_model(x, training=False)
```

```
x = global_average_layer(x)
x = tf.keras.layers.Dropout(0.2)(x)
outputs = prediction_layer(x)
model = tf.keras.Model(inputs, outputs)
```

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

Model: "functional_3"

Layer (type)	Output Shape	Param #
input_layer_6 (InputLayer)	(None, 160, 160, 3)	0
efficientnetb4 (Functional)	(None, 5, 5, 1792)	17,673,823
global_average_pooling2d_1 (GlobalAveragePooling2D)	(None, 1792)	0
dropout_3 (Dropout)	(None, 1792)	0
dense_1 (Dense)	(None, 39)	69,927

Total params: 17,743,750 (67.69 MB)

Trainable params: 69,927 (273.15 KB)

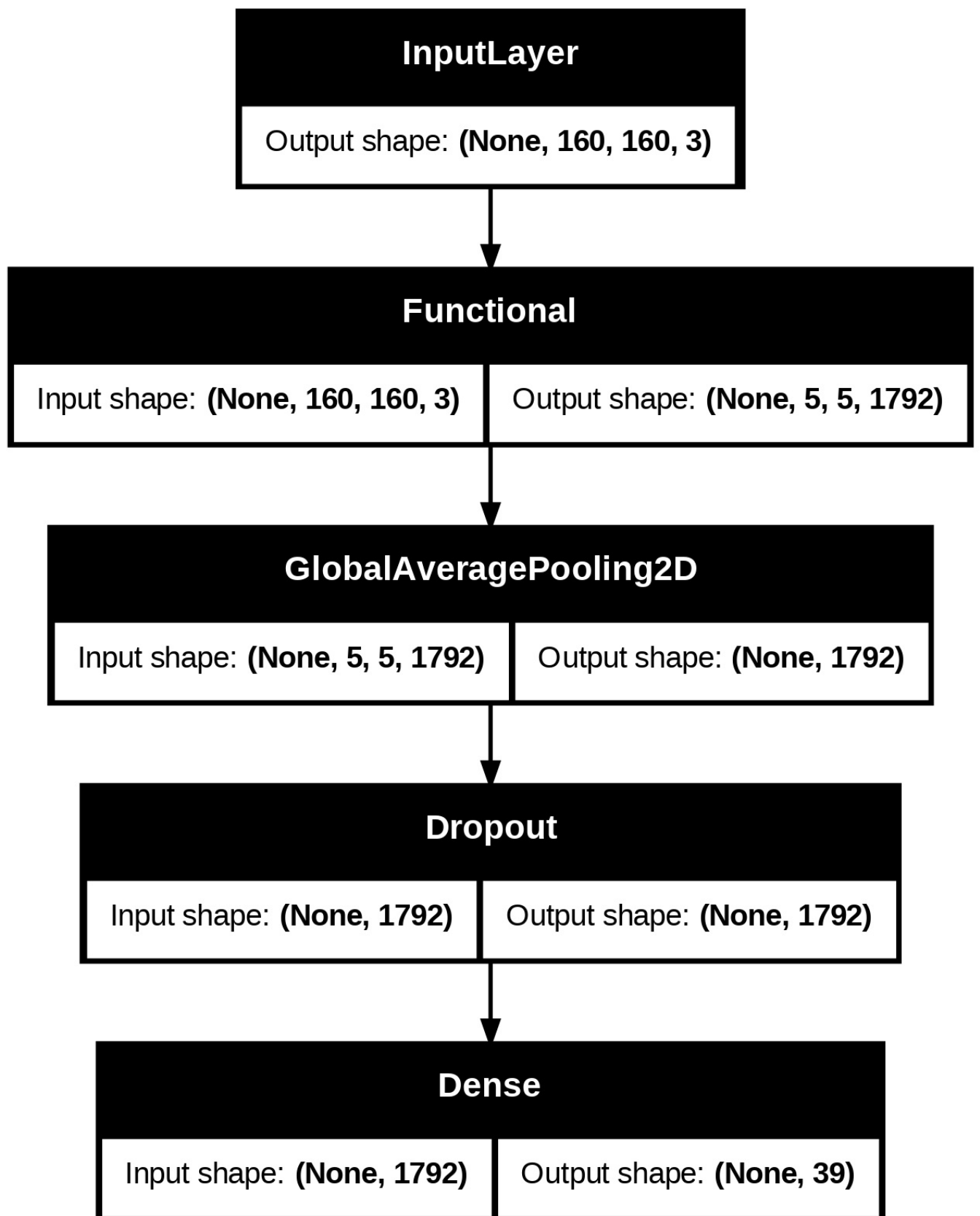
Non-trainable params: 17,673,823 (67.42 MB)

```
In [ ]: len(model.trainable_variables)
```

```
Out[ ]: 2
```

```
In [ ]: tf.keras.utils.plot_model(model, show_shapes=True)
```

```
Out[ ]:
```



```
In [ ]: model.compile(optimizer=tf.keras.optimizers.Adam(),  
                    loss=tf.keras.losses.SparseCategoricalCrossentropy(),  
                    metrics=[tf.keras.metrics.SparseCategoricalAccuracy(name='accuracy')])
```


```
In [ ]: initial_epochs = 6  
  
        loss0, accuracy0 = model.evaluate(validation_dataset)  
  
192/192 ————— 25s 80ms/step - accuracy: 0.0184 - loss: 3.7205
```

```
In [ ]: print("initial loss: {:.2f}".format(loss0))  
        print("initial accuracy: {:.2f}".format(accuracy0))  
  
initial loss: 3.72  
initial accuracy: 0.02
```


```
In [ ]: history = model.fit(train_dataset,  
                           epochs=initial_epochs,
```

```
validation_data=validation_dataset)
```


Epoch 1/6

1537/1537  **156s** 77ms/step - accuracy: 0.6928 - loss: 1.2347 - val_accuracy: 0.9060 - val_loss: 0.3458


Epoch 2/6

1537/1537  **103s** 65ms/step - accuracy: 0.8957 - loss: 0.3725 - val_accuracy: 0.9280 - val_loss: 0.2492


Epoch 3/6

1537/1537  **142s** 65ms/step - accuracy: 0.9184 - loss: 0.2810 - val_accuracy: 0.9355 - val_loss: 0.2124


Epoch 4/6

1537/1537  **100s** 65ms/step - accuracy: 0.9255 - loss: 0.2491 - val_accuracy: 0.9410 - val_loss: 0.1906

Epoch 5/6

1537/1537  **98s** 64ms/step - accuracy: 0.9293 - loss: 0.2245 - val_accuracy: 0.9456 - val_loss: 0.1731

Epoch 6/6

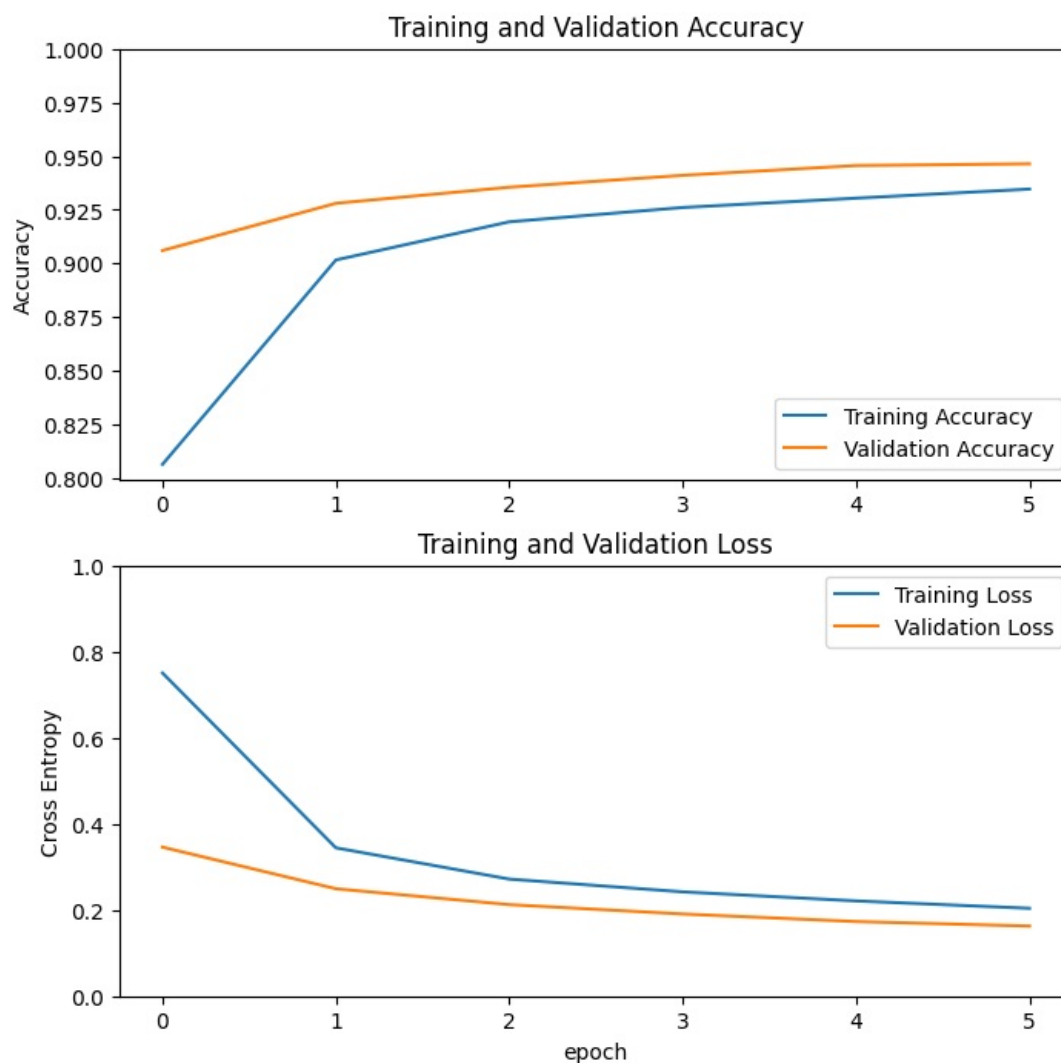
1537/1537  **143s** 64ms/step - accuracy: 0.9349 - loss: 0.2062 - val_accuracy: 0.9464 - val_loss: 0.1626

```
In [ ]: acc = history.history['accuracy']
val_acc = history.history['val_accuracy']

loss = history.history['loss']
val_loss = history.history['val_loss']

plt.figure(figsize=(8, 8))
plt.subplot(2, 1, 1)
plt.plot(acc, label='Training Accuracy')
plt.plot(val_acc, label='Validation Accuracy')
plt.legend(loc='lower right')
plt.ylabel('Accuracy')
plt.ylim([min(plt.ylim()),1])
plt.title('Training and Validation Accuracy')

plt.subplot(2, 1, 2)
plt.plot(loss, label='Training Loss')
plt.plot(val_loss, label='Validation Loss')
plt.legend(loc='upper right')
plt.ylabel('Cross Entropy')
plt.ylim([0,1.0])
plt.title('Training and Validation Loss')
plt.xlabel('epoch')
plt.show()
```



Fine tuning

```
In [ ]: base_model.trainable = True
```

```
In [ ]: # Let's take a look to see how many layers are in the base model
print("Number of layers in the base model: ", len(base_model.layers))

# Fine-tune from this layer onwards
fine_tune_at = 100

# Freeze all the layers before the `fine_tune_at` layer
for layer in base_model.layers[:fine_tune_at]:
    layer.trainable = False
```

Number of layers in the base model: 475

```
In [ ]: model.compile(optimizer=tf.keras.optimizers.Adam(),
                    loss=tf.keras.losses.SparseCategoricalCrossentropy(),
                    metrics=[tf.keras.metrics.SparseCategoricalAccuracy(name='accuracy')])
```

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

Model: "functional_3"

Layer (type)	Output Shape	Param #
input_layer_6 (InputLayer)	(None, 160, 160, 3)	0
efficientnetb4 (Functional)	(None, 5, 5, 1792)	17,673,823
global_average_pooling2d_1 (GlobalAveragePooling2D)	(None, 1792)	0
dropout_3 (Dropout)	(None, 1792)	0
dense_1 (Dense)	(None, 39)	69,927

Total params: 17,743,750 (67.69 MB)

Trainable params: 17,531,783 (66.88 MB)
Non-trainable params: 211,967 (828.00 KB)

```
In [ ]: len(model.trainable_variables)
```

```
Out[ ]: 333
```

```
In [ ]: fine_tune_epochs = 10
total_epochs = initial_epochs + fine_tune_epochs

history_fine = model.fit(train_dataset,
                        epochs=total_epochs,
                        initial_epoch=len(history.epoch),
                        validation_data=validation_dataset)
```

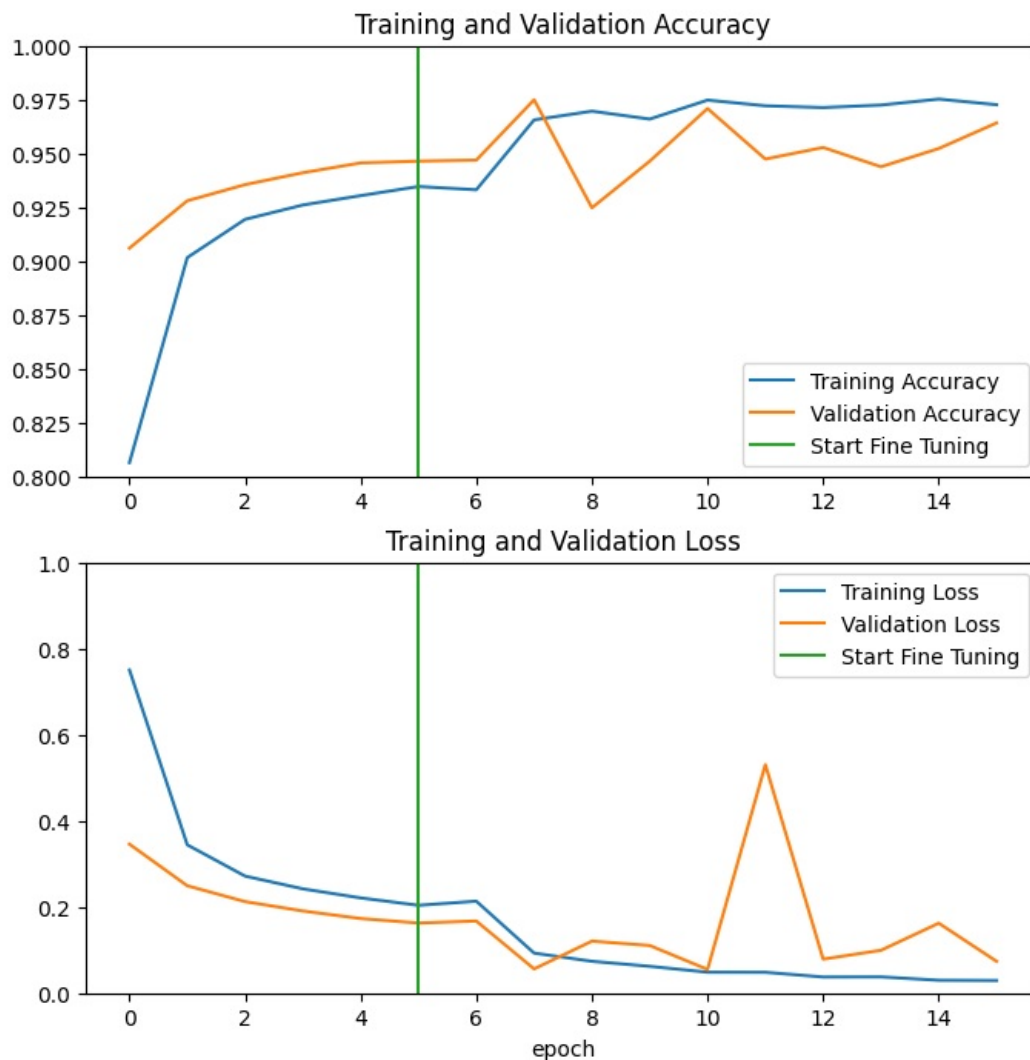
```
Epoch 7/16
1537/1537 ————— 469s 229ms/step - accuracy: 0.8891 - loss: 0.3985 - val_accuracy: 0.9469 - val_lo
ss: 0.1673
Epoch 8/16
1537/1537 ————— 282s 164ms/step - accuracy: 0.9608 - loss: 0.1067 - val_accuracy: 0.9749 - val_lo
ss: 0.0561
Epoch 9/16
1537/1537 ————— 261s 163ms/step - accuracy: 0.9695 - loss: 0.0758 - val_accuracy: 0.9247 - val_lo
ss: 0.1206
Epoch 10/16
1537/1537 ————— 261s 162ms/step - accuracy: 0.9645 - loss: 0.0675 - val_accuracy: 0.9464 - val_lo
ss: 0.1105
Epoch 11/16
1537/1537 ————— 263s 163ms/step - accuracy: 0.9710 - loss: 0.0591 - val_accuracy: 0.9708 - val_lo
ss: 0.0548
Epoch 12/16
1537/1537 ————— 261s 162ms/step - accuracy: 0.9744 - loss: 0.0476 - val_accuracy: 0.9474 - val_lo
ss: 0.5304
Epoch 13/16
1537/1537 ————— 263s 163ms/step - accuracy: 0.9700 - loss: 0.0372 - val_accuracy: 0.9528 - val_lo
ss: 0.0788
Epoch 14/16
1537/1537 ————— 263s 164ms/step - accuracy: 0.9718 - loss: 0.0376 - val_accuracy: 0.9438 - val_lo
ss: 0.0993
Epoch 15/16
1537/1537 ————— 260s 162ms/step - accuracy: 0.9743 - loss: 0.0299 - val_accuracy: 0.9523 - val_lo
ss: 0.1623
Epoch 16/16
1537/1537 ————— 261s 162ms/step - accuracy: 0.9751 - loss: 0.0308 - val_accuracy: 0.9642 - val_lo
ss: 0.0736
```

```
In [ ]: acc += history_fine.history['accuracy']
val_acc += history_fine.history['val_accuracy']

loss += history_fine.history['loss']
val_loss += history_fine.history['val_loss']
```

```
In [ ]: plt.figure(figsize=(8, 8))
plt.subplot(2, 1, 1)
plt.plot(acc, label='Training Accuracy')
plt.plot(val_acc, label='Validation Accuracy')
plt.ylim([0.8, 1])
plt.plot([initial_epochs-1, initial_epochs-1],
         plt.ylim(), label='Start Fine Tuning')
plt.legend(loc='lower right')
plt.title('Training and Validation Accuracy')

plt.subplot(2, 1, 2)
plt.plot(loss, label='Training Loss')
plt.plot(val_loss, label='Validation Loss')
plt.ylim([0, 1.0])
plt.plot([initial_epochs-1, initial_epochs-1],
         plt.ylim(), label='Start Fine Tuning')
plt.legend(loc='upper right')
plt.title('Training and Validation Loss')
plt.xlabel('epoch')
plt.show()
```



```
In [ ]: loss, accuracy = model.evaluate(test_dataset)
print('Test accuracy:', accuracy)
```

193/193 ————— 20s 103ms/step - accuracy: 0.9651 - loss: 0.0604
Test accuracy : 0.9644941687583923

```
In [ ]: # Retrieve a batch of images from the test set
image_batch, label_batch = test_dataset.as_numpy_iterator().next()
predictions = model.predict_on_batch(image_batch)
predictions = tf.argmax(predictions, axis=1)

print('Predictions:\n', predictions.numpy())
print('Labels:\n', label_batch)

plt.figure(figsize=(10, 10))
for i in range(9):
    ax = plt.subplot(3, 3, i + 1)
    plt.imshow(image_batch[i].astype("uint8"))
    plt.title(class_names[predictions[i]])
    plt.axis("off")
```

Predictions:
[35 26 17 19 1 33 11 29 29 13 26 9 26 25 35 0 0 16 24 9 29 35 9 12
14 6 2 33 21 16 1 14]

Labels:
[35 26 17 19 1 33 11 29 29 13 26 9 28 25 35 0 0 16 24 9 29 35 9 12
14 6 2 33 21 16 1 14]

Tomato__Target_Spot



Squash__Powdery_mildew



Peach__Bacterial_spot



Pepper,_bell__Bacterial_spot



Apple__Black_rot



Tomato__Septoria_leaf_spot



Corn__healthy



Tomato__Bacterial_spot



Tomato__Bacterial_spot



Saving Model

In []:

In []: