

## ▼ Download data set from :

- <https://data.mendeley.com/datasets/tywbtsjrjv/1>
- [https://www.tensorflow.org/datasets/catalog/plant\\_village](https://www.tensorflow.org/datasets/catalog/plant_village)

```
!wget -O "plant_village_dataset.zip" "https://data.mendeley.com/public-files/datasets/tywbtsjrjv/files/b4e3a32f-c0bd-4060-81e9-6144231f2520/file
--2025-04-15 07:38:04-- https://data.mendeley.com/public-files/datasets/tywbtsjrjv/files/b4e3a32f-c0bd-4060-81e9-6144231f2520/file
Resolving data.mendeley.com (data.mendeley.com)... 162.159.130.86, 162.159.133.86
Connecting to data.mendeley.com (data.mendeley.com)|162.159.130.86|: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-3bf8f76596fd [following]
--2025-04-15 07:38:05-- https://prod-dcd-datasets-public-files-eu-west-1.s3.eu-west-1.amazonaws.com/349ac012-2948-4172-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)... 162.159.130.86, 162.159.133.86
Connecting to 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)... connected.
HTTP request sent, awaiting response... 200 OK
Length: 949267727 (905M) [application/zip]
Saving to: 'plant_village_dataset.zip'

plant_village_datas 100%[=====>] 905.29M  18.8MB/s   in 50s

2025-04-15 07:38:56 (18.2 MB/s) - 'plant_village_dataset.zip' saved [949267727/949267727]
```

Unzip the dataset

```
!unzip /content/plant_village_dataset.zip
```



```

inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (997).JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (998).JPG
inflating: Plant_leave_diseases_dataset_with_augmentation/Tomato___Tomato_Yellow_Leaf_Curl_Virus/image (999).JPG

```

## Following Transfer learning and fine-tuning

- [https://www.tensorflow.org/tutorials/images/transfer\\_learning](https://www.tensorflow.org/tutorials/images/transfer_learning)

```

import matplotlib.pyplot as plt
import numpy as np
import os
import tensorflow as tf

```

First, splitting the dataset into 3 directories.

```
!pip install split-folders
```

```
Requirement already satisfied: split-folders in /usr/local/lib/python3.11/dist-packages (0.5.1)
```

```

from posixpath import split
import splitfolders
splitfolders.ratio('/content/Plant_leave_diseases_dataset_with_augmentation', output="dataset", seed=1337, ratio=(.8, .1, .1)) # 80% tra

```

```
Copying files: 61486 files [00:14, 4157.70 files/s]
```

## Data preprocessing

```

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.
```

```

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.

```

Show the first nine images and labels from the training set:

```

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\_\_Late\_blight



Squash\_\_Powdery\_mildew



Apple\_\_Apple\_scab



Soybean\_\_healthy



Tomato\_\_Target\_Spot



Cherry\_\_healthy



Soybean\_\_healthy



Raspberry\_\_healthy



Squash\_\_Powdery\_mildew



class\_names



Show hidden output

## ✓ Configure the dataset for performance

```
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)
```

## ✓ Rescale pixel values

```
preprocess_input = tf.keras.applications.efficientnet.preprocess_input
```


## ✓ Create the base model from the pre-trained convnets

```
# Create the base model from the pre-trained model MobileNet V2
IMG_SHAPE = IMG_SIZE + (3,)
base_model = tf.keras.applications.EfficientNetB4(input_shape=IMG_SHAPE,
                                                    include_top=False,
                                                    weights='imagenet')
```



Downloading data from [https://storage.googleapis.com/keras-applications/efficientnetb4\\_notop.h5](https://storage.googleapis.com/keras-applications/efficientnetb4_notop.h5)  
71686520/71686520 ————— 4s 0us/step

```
image_batch, label_batch = next(iter(train_dataset))
feature_batch = base_model(image_batch)
print(feature_batch.shape)
```

 (32, 5, 5, 1792)

## ✓ Feature extraction

- In this step, you will freeze the convolutional base created from the previous step and to use as a feature extractor. Additionally, you add a classifier on top of it and train the top-level classifier.
- Freeze the convolutional base It is important to freeze the convolutional base before you compile and train the model. Freezing (by setting `layer.trainable = False`) prevents the weights in a given layer from being updated during training. MobileNet V2 has many layers, so setting the entire model's trainable flag to False will freeze all of them.

```
base_model.trainable = False
```

```
# Let's take a look at the base model architecture
base_model.summary()
```

 Model: "efficientnetb4"

Layer (type)	Output Shape	Param #	Connected to
input_layer_2 (InputLayer)	(None, 160, 160, 3)	0	-
rescaling (Rescaling)	(None, 160, 160, 3)	0	input_layer_2[0]...
normalization (Normalization)	(None, 160, 160, 3)	7	rescaling[0][0]
rescaling_1 (Rescaling)	(None, 160, 160, 3)	0	normalization[0]...
stem_conv_pad (ZeroPadding2D)	(None, 161, 161, 3)	0	rescaling_1[0][0]
stem_conv (Conv2D)	(None, 80, 80, 48)	1,296	stem_conv_pad[0]...
stem_bn (BatchNormalizatio...	(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[...
block1a_bn (BatchNormalizatio...	(None, 80, 80, 48)	192	block1a_dwconv[0...
block1a_activation (Activation)	(None, 80, 80, 48)	0	block1a_bn[0][0]
block1a_se_squeeze (GlobalAveragePool...	(None, 48)	0	block1a_activati...
block1a_se_reshape (Reshape)	(None, 1, 1, 48)	0	block1a_se_squee...
block1a_se_reduce (Conv2D)	(None, 1, 1, 12)	588	block1a_se_resha...
block1a_se_expand (Conv2D)	(None, 1, 1, 48)	624	block1a_se_reduc...
block1a_se_excite (Multiply)	(None, 80, 80, 48)	0	block1a_activati... block1a_se_expan...
block1a_project_co... (Conv2D)	(None, 80, 80, 24)	1,152	block1a_se_excit...
block1a_project_bn (BatchNormalizatio...	(None, 80, 80, 24)	96	block1a_project_...
block1b_dwconv (DepthwiseConv2D)	(None, 80, 80, 24)	216	block1a_project_...
block1b_bn (BatchNormalizatio...	(None, 80, 80, 24)	96	block1b_dwconv[0...
block1b_activation (Activation)	(None, 80, 80, 24)	0	block1b_bn[0][0]
block1b_se_squeeze (GlobalAveragePool...	(None, 24)	0	block1b_activati...
block1b_se_reshape (Reshape)	(None, 1, 1, 24)	0	block1b_se_squee...
block1b_se_reduce (Conv2D)	(None, 1, 1, 6)	150	block1b_se_resha...
block1b_se_expand (Conv2D)	(None, 1, 1, 24)	168	block1b_se_reduc...
block1b_se_excite (Multiply)	(None, 80, 80, 24)	0	block1b_activati... block1b_se_expan...
block1b_project_co... (Conv2D)	(None, 80, 80, 24)	576	block1b_se_excit...
block1b_project_bn (BatchNormalizatio...	(None, 80, 80, 24)	96	block1b_project_...
block1b_drop (Dropout)	(None, 80, 80, 24)	0	block1b_project_...
block1b_add (Add)	(None, 80, 80, 24)	0	block1b_drop[0][...

	24)		block1a_project_...
block2a_expand_conv (Conv2D)	(None, 80, 80, 144)	3,456	block1b_add[0][0]
block2a_expand_bn (BatchNormalizatio...	(None, 80, 80, 144)	576	block2a_expand_c...
block2a_expand_act... (Activation)	(None, 80, 80, 144)	0	block2a_expand_b...
block2a_dwconv_pad (ZeroPadding2D)	(None, 81, 81, 144)	0	block2a_expand_a...
block2a_dwconv (DepthwiseConv2D)	(None, 40, 40, 144)	1,296	block2a_dwconv_p...
block2a_bn (BatchNormalizatio...	(None, 40, 40, 144)	576	block2a_dwconv[0...
block2a_activation (Activation)	(None, 40, 40, 144)	0	block2a_bn[0][0]
block2a_se_squeeze (GlobalAveragePool...	(None, 144)	0	block2a_activati...
block2a_se_reshape (Reshape)	(None, 1, 1, 144)	0	block2a_se_squee...
block2a_se_reduce (Conv2D)	(None, 1, 1, 6)	870	block2a_se_resha...
block2a_se_expand (Conv2D)	(None, 1, 1, 144)	1,008	block2a_se_reduc...
block2a_se_excite (Multiply)	(None, 40, 40, 144)	0	block2a_activati... block2a_se_expan...
block2a_project_co... (Conv2D)	(None, 40, 40, 32)	4,608	block2a_se_excit...
block2a_project_bn (BatchNormalizatio...	(None, 40, 40, 32)	128	block2a_project_...
block2b_expand_conv (Conv2D)	(None, 40, 40, 192)	6,144	block2a_project_...
block2b_expand_bn (BatchNormalizatio...	(None, 40, 40, 192)	768	block2b_expand_c...
block2b_expand_act... (Activation)	(None, 40, 40, 192)	0	block2b_expand_b...
block2b_dwconv (DepthwiseConv2D)	(None, 40, 40, 192)	1,728	block2b_expand_a...
block2b_bn (BatchNormalizatio...	(None, 40, 40, 192)	768	block2b_dwconv[0...
block2b_activation (Activation)	(None, 40, 40, 192)	0	block2b_bn[0][0]
block2b_se_squeeze (GlobalAveragePool...	(None, 192)	0	block2b_activati...
block2b_se_reshape (Reshape)	(None, 1, 1, 192)	0	block2b_se_squee...
block2b_se_reduce (Conv2D)	(None, 1, 1, 8)	1,544	block2b_se_resha...
block2b_se_expand (Conv2D)	(None, 1, 1, 192)	1,728	block2b_se_reduc...
block2b_se_excite (Multiply)	(None, 40, 40, 192)	0	block2b_activati... block2b_se_expan...
block2b_project_co... (Conv2D)	(None, 40, 40, 32)	6,144	block2b_se_excit...
block2b_project_bn (BatchNormalizatio...	(None, 40, 40, 32)	128	block2b_project_...
block2b_drop (Dropout)	(None, 40, 40, 32)	0	block2b_project_...
block2b_add (Add)	(None, 40, 40, 32)	0	block2b_drop[0][... block2a_project_...
block2c_expand_conv (Conv2D)	(None, 40, 40, 192)	6,144	block2b_add[0][0]

block2c_expand_bn (BatchNormalizatio...	(None, 40, 40, 192)	768	block2c_expand_c...
block2c_expand_act... (Activation)	(None, 40, 40, 192)	0	block2c_expand_b...
block2c_dwconv (DepthwiseConv2D)	(None, 40, 40, 192)	1,728	block2c_expand_a...
block2c_bn (BatchNormalizatio...	(None, 40, 40, 192)	768	block2c_dwconv[0...
block2c_activation (Activation)	(None, 40, 40, 192)	0	block2c_bn[0][0]
block2c_se_squeeze (GlobalAveragePool...	(None, 192)	0	block2c_activati...
block2c_se_reshape (Reshape)	(None, 1, 1, 192)	0	block2c_se_squee...
block2c_se_reduce (Conv2D)	(None, 1, 1, 8)	1,544	block2c_se_resha...
block2c_se_expand (Conv2D)	(None, 1, 1, 192)	1,728	block2c_se_reduc...
block2c_se_excite (Multiply)	(None, 40, 40, 192)	0	block2c_activati... block2c_se_expan...
block2c_project_co... (Conv2D)	(None, 40, 40, 32)	6,144	block2c_se_excit...
block2c_project_bn (BatchNormalizatio...	(None, 40, 40, 32)	128	block2c_project_...
block2c_drop (Dropout)	(None, 40, 40, 32)	0	block2c_project_...
block2c_add (Add)	(None, 40, 40, 32)	0	block2c_drop[0][... block2b_add[0][0]
block2d_expand_conv (Conv2D)	(None, 40, 40, 192)	6,144	block2c_add[0][0]
block2d_expand_bn (BatchNormalizatio...	(None, 40, 40, 192)	768	block2d_expand_c...
block2d_expand_act... (Activation)	(None, 40, 40, 192)	0	block2d_expand_b...
block2d_dwconv (DepthwiseConv2D)	(None, 40, 40, 192)	1,728	block2d_expand_a...
block2d_bn (BatchNormalizatio...	(None, 40, 40, 192)	768	block2d_dwconv[0...
block2d_activation (Activation)	(None, 40, 40, 192)	0	block2d_bn[0][0]
block2d_se_squeeze (GlobalAveragePool...	(None, 192)	0	block2d_activati...
block2d_se_reshape (Reshape)	(None, 1, 1, 192)	0	block2d_se_squee...
block2d_se_reduce (Conv2D)	(None, 1, 1, 8)	1,544	block2d_se_resha...
block2d_se_expand (Conv2D)	(None, 1, 1, 192)	1,728	block2d_se_reduc...
block2d_se_excite (Multiply)	(None, 40, 40, 192)	0	block2d_activati... block2d_se_expan...
block2d_project_co... (Conv2D)	(None, 40, 40, 32)	6,144	block2d_se_excit...
block2d_project_bn (BatchNormalizatio...	(None, 40, 40, 32)	128	block2d_project_...
block2d_drop (Dropout)	(None, 40, 40, 32)	0	block2d_project_...
block2d_add (Add)	(None, 40, 40, 32)	0	block2d_drop[0][... block2c_add[0][0]
block3a_expand_conv (Conv2D)	(None, 40, 40, 192)	6,144	block2d_add[0][0]
block3a_expand_bn (BatchNormalizatio...	(None, 40, 40, 192)	768	block3a_expand_c...

block3a_expand_act... (Activation)	(None, 40, 40, 192)	0	block3a_expand_b...
block3a_dwconv_pad (ZeroPadding2D)	(None, 43, 43, 192)	0	block3a_expand_a...
block3a_dwconv (DepthwiseConv2D)	(None, 20, 20, 192)	4,800	block3a_dwconv_p...
block3a_bn (BatchNormalizatio...	(None, 20, 20, 192)	768	block3a_dwconv[0...
block3a_activation (Activation)	(None, 20, 20, 192)	0	block3a_bn[0][0]
block3a_se_squeeze (GlobalAveragePool...	(None, 192)	0	block3a_activati...
block3a_se_reshape (Reshape)	(None, 1, 1, 192)	0	block3a_se_squee...
block3a_se_reduce (Conv2D)	(None, 1, 1, 8)	1,544	block3a_se_resha...
block3a_se_expand (Conv2D)	(None, 1, 1, 192)	1,728	block3a_se_reduc...
block3a_se_excite (Multiply)	(None, 20, 20, 192)	0	block3a_activati... block3a_se_expan...
block3a_project_co... (Conv2D)	(None, 20, 20, 56)	10,752	block3a_se_excit...
block3a_project_bn (BatchNormalizatio...	(None, 20, 20, 56)	224	block3a_project_...
block3b_expand_conv (Conv2D)	(None, 20, 20, 336)	18,816	block3a_project_...
block3b_expand_bn (BatchNormalizatio...	(None, 20, 20, 336)	1,344	block3b_expand_c...
block3b_expand_act... (Activation)	(None, 20, 20, 336)	0	block3b_expand_b...
block3b_dwconv (DepthwiseConv2D)	(None, 20, 20, 336)	8,400	block3b_expand_a...
block3b_bn (BatchNormalizatio...	(None, 20, 20, 336)	1,344	block3b_dwconv[0...
block3b_activation (Activation)	(None, 20, 20, 336)	0	block3b_bn[0][0]
block3b_se_squeeze (GlobalAveragePool...	(None, 336)	0	block3b_activati...
block3b_se_reshape (Reshape)	(None, 1, 1, 336)	0	block3b_se_squee...
block3b_se_reduce (Conv2D)	(None, 1, 1, 14)	4,718	block3b_se_resha...
block3b_se_expand (Conv2D)	(None, 1, 1, 336)	5,040	block3b_se_reduc...
block3b_se_excite (Multiply)	(None, 20, 20, 336)	0	block3b_activati... block3b_se_expan...
block3b_project_co... (Conv2D)	(None, 20, 20, 56)	18,816	block3b_se_excit...
block3b_project_bn (BatchNormalizatio...	(None, 20, 20, 56)	224	block3b_project_...
block3b_drop (Dropout)	(None, 20, 20, 56)	0	block3b_project_...
block3b_add (Add)	(None, 20, 20, 56)	0	block3b_drop[0][... block3a_project_...
block3c_expand_conv (Conv2D)	(None, 20, 20, 336)	18,816	block3b_add[0][0]
block3c_expand_bn (BatchNormalizatio...	(None, 20, 20, 336)	1,344	block3c_expand_c...
block3c_expand_act... (Activation)	(None, 20, 20, 336)	0	block3c_expand_b...
block3c_dwconv (DepthwiseConv2D)	(None, 20, 20, 336)	8,400	block3c_expand_a...



block3c_bn (BatchNormalizatio...	(None, 20, 20, 336)	1,344	block3c_dwconv[0...
block3c_activation (Activation)	(None, 20, 20, 336)	0	block3c_bn[0][0]
block3c_se_squeeze (GlobalAveragePool...	(None, 336)	0	block3c_activati...
block3c_se_reshape (Reshape)	(None, 1, 1, 336)	0	block3c_se_squee...
block3c_se_reduce (Conv2D)	(None, 1, 1, 14)	4,718	block3c_se_resha...
block3c_se_expand (Conv2D)	(None, 1, 1, 336)	5,040	block3c_se_reduc...
block3c_se_excite (Multiply)	(None, 20, 20, 336)	0	block3c_activati... block3c_se_expan...
block3c_project_co... (Conv2D)	(None, 20, 20, 56)	18,816	block3c_se_excit...
block3c_project_bn (BatchNormalizatio...	(None, 20, 20, 56)	224	block3c_project_...
block3c_drop (Dropout)	(None, 20, 20, 56)	0	block3c_project_...
block3c_add (Add)	(None, 20, 20, 56)	0	block3c_drop[0][... block3b_add[0][0]
block3d_expand_conv (Conv2D)	(None, 20, 20, 336)	18,816	block3c_add[0][0]
block3d_expand_bn (BatchNormalizatio...	(None, 20, 20, 336)	1,344	block3d_expand_c...
block3d_expand_act... (Activation)	(None, 20, 20, 336)	0	block3d_expand_b...
block3d_dwconv (DepthwiseConv2D)	(None, 20, 20, 336)	8,400	block3d_expand_a...
block3d_bn (BatchNormalizatio...	(None, 20, 20, 336)	1,344	block3d_dwconv[0...
block3d_activation (Activation)	(None, 20, 20, 336)	0	block3d_bn[0][0]
block3d_se_squeeze (GlobalAveragePool...	(None, 336)	0	block3d_activati...
block3d_se_reshape (Reshape)	(None, 1, 1, 336)	0	block3d_se_squee...
block3d_se_reduce (Conv2D)	(None, 1, 1, 14)	4,718	block3d_se_resha...
block3d_se_expand (Conv2D)	(None, 1, 1, 336)	5,040	block3d_se_reduc...
block3d_se_excite (Multiply)	(None, 20, 20, 336)	0	block3d_activati... block3d_se_expan...
block3d_project_co... (Conv2D)	(None, 20, 20, 56)	18,816	block3d_se_excit...
block3d_project_bn (BatchNormalizatio...	(None, 20, 20, 56)	224	block3d_project_...
block3d_drop (Dropout)	(None, 20, 20, 56)	0	block3d_project_...
block3d_add (Add)	(None, 20, 20, 56)	0	block3d_drop[0][... block3c_add[0][0]
block4a_expand_conv (Conv2D)	(None, 20, 20, 336)	18,816	block3d_add[0][0]
block4a_expand_bn (BatchNormalizatio...	(None, 20, 20, 336)	1,344	block4a_expand_c...
block4a_expand_act... (Activation)	(None, 20, 20, 336)	0	block4a_expand_b...
block4a_dwconv_pad (ZeroPadding2D)	(None, 21, 21, 336)	0	block4a_expand_a...
block4a_dwconv (DepthwiseConv2D)	(None, 10, 10, 336)	3,024	block4a_dwconv_p...

block4a_bn (BatchNormalizatio...	(None, 10, 10, 336)	1,344	block4a_dwconv[0...
block4a_activation (Activation)	(None, 10, 10, 336)	0	block4a_bn[0][0]
block4a_se_squeeze (GlobalAveragePool...	(None, 336)	0	block4a_activati...
block4a_se_reshape (Reshape)	(None, 1, 1, 336)	0	block4a_se_squee...
block4a_se_reduce (Conv2D)	(None, 1, 1, 14)	4,718	block4a_se_resha...
block4a_se_expand (Conv2D)	(None, 1, 1, 336)	5,040	block4a_se_reduc...
block4a_se_excite (Multiply)	(None, 10, 10, 336)	0	block4a_activati... block4a_se_expan...
block4a_project_co... (Conv2D)	(None, 10, 10, 112)	37,632	block4a_se_excit...
block4a_project_bn (BatchNormalizatio...	(None, 10, 10, 112)	448	block4a_project_...
block4b_expand_conv (Conv2D)	(None, 10, 10, 672)	75,264	block4a_project_...
block4b_expand_bn (BatchNormalizatio...	(None, 10, 10, 672)	2,688	block4b_expand_c...
block4b_expand_act... (Activation)	(None, 10, 10, 672)	0	block4b_expand_b...
block4b_dwconv (DepthwiseConv2D)	(None, 10, 10, 672)	6,048	block4b_expand_a...
block4b_bn (BatchNormalizatio...	(None, 10, 10, 672)	2,688	block4b_dwconv[0...
block4b_activation (Activation)	(None, 10, 10, 672)	0	block4b_bn[0][0]
block4b_se_squeeze (GlobalAveragePool...	(None, 672)	0	block4b_activati...
block4b_se_reshape (Reshape)	(None, 1, 1, 672)	0	block4b_se_squee...
block4b_se_reduce (Conv2D)	(None, 1, 1, 28)	18,844	block4b_se_resha...
block4b_se_expand (Conv2D)	(None, 1, 1, 672)	19,488	block4b_se_reduc...
block4b_se_excite (Multiply)	(None, 10, 10, 672)	0	block4b_activati... block4b_se_expan...
block4b_project_co... (Conv2D)	(None, 10, 10, 112)	75,264	block4b_se_excit...
block4b_project_bn (BatchNormalizatio...	(None, 10, 10, 112)	448	block4b_project_...
block4b_drop (Dropout)	(None, 10, 10, 112)	0	block4b_project_...
block4b_add (Add)	(None, 10, 10, 112)	0	block4b_drop[0][... block4a_project_...
block4c_expand_conv (Conv2D)	(None, 10, 10, 672)	75,264	block4b_add[0][0]
block4c_expand_bn (BatchNormalizatio...	(None, 10, 10, 672)	2,688	block4c_expand_c...
block4c_expand_act... (Activation)	(None, 10, 10, 672)	0	block4c_expand_b...
block4c_dwconv (DepthwiseConv2D)	(None, 10, 10, 672)	6,048	block4c_expand_a...
block4c_bn (BatchNormalizatio...	(None, 10, 10, 672)	2,688	block4c_dwconv[0...
block4c_activation (Activation)	(None, 10, 10, 672)	0	block4c_bn[0][0]
block4c_se_squeeze	(None, 672)	0	block4c_activati...

(GlobalAveragePool...			
block4c_se_reshape (Reshape)	(None, 1, 1, 672)	0	block4c_se_squee...
block4c_se_reduce (Conv2D)	(None, 1, 1, 28)	18,844	block4c_se_resha...
block4c_se_expand (Conv2D)	(None, 1, 1, 672)	19,488	block4c_se_reduc...
block4c_se_excite (Multiply)	(None, 10, 10, 672)	0	block4c_activati... block4c_se_expan...
block4c_project_co... (Conv2D)	(None, 10, 10, 112)	75,264	block4c_se_excit...
block4c_project_bn (BatchNormalizatio...	(None, 10, 10, 112)	448	block4c_project_...
block4c_drop (Dropout)	(None, 10, 10, 112)	0	block4c_project_...
block4c_add (Add)	(None, 10, 10, 112)	0	block4c_drop[0][... block4b_add[0][0]
block4d_expand_conv (Conv2D)	(None, 10, 10, 672)	75,264	block4c_add[0][0]
block4d_expand_bn (BatchNormalizatio...	(None, 10, 10, 672)	2,688	block4d_expand_c...
block4d_expand_act... (Activation)	(None, 10, 10, 672)	0	block4d_expand_b...
block4d_dwconv (DepthwiseConv2D)	(None, 10, 10, 672)	6,048	block4d_expand_a...
block4d_bn (BatchNormalizatio...	(None, 10, 10, 672)	2,688	block4d_dwconv[0...
block4d_activation (Activation)	(None, 10, 10, 672)	0	block4d_bn[0][0]
block4d_se_squeeze (GlobalAveragePool...	(None, 672)	0	block4d_activati...
block4d_se_reshape (Reshape)	(None, 1, 1, 672)	0	block4d_se_squee...
block4d_se_reduce (Conv2D)	(None, 1, 1, 28)	18,844	block4d_se_resha...
block4d_se_expand (Conv2D)	(None, 1, 1, 672)	19,488	block4d_se_reduc...
block4d_se_excite (Multiply)	(None, 10, 10, 672)	0	block4d_activati... block4d_se_expan...
block4d_project_co... (Conv2D)	(None, 10, 10, 112)	75,264	block4d_se_excit...
block4d_project_bn (BatchNormalizatio...	(None, 10, 10, 112)	448	block4d_project_...
block4d_drop (Dropout)	(None, 10, 10, 112)	0	block4d_project_...
block4d_add (Add)	(None, 10, 10, 112)	0	block4d_drop[0][... block4c_add[0][0]
block4e_expand_conv (Conv2D)	(None, 10, 10, 672)	75,264	block4d_add[0][0]
block4e_expand_bn (BatchNormalizatio...	(None, 10, 10, 672)	2,688	block4e_expand_c...
block4e_expand_act... (Activation)	(None, 10, 10, 672)	0	block4e_expand_b...
block4e_dwconv (DepthwiseConv2D)	(None, 10, 10, 672)	6,048	block4e_expand_a...
block4e_bn (BatchNormalizatio...	(None, 10, 10, 672)	2,688	block4e_dwconv[0...
block4e_activation (Activation)	(None, 10, 10, 672)	0	block4e_bn[0][0]
block4e_se_squeeze (GlobalAveragePool...	(None, 672)	0	block4e_activati...

block4e_se_reshape (Reshape)	(None, 1, 1, 0/2)	0	block4e_se_squee...
block4e_se_reduce (Conv2D)	(None, 1, 1, 28)	18,844	block4e_se_resa...
block4e_se_expand (Conv2D)	(None, 1, 1, 672)	19,488	block4e_se_reduc...
block4e_se_excite (Multiply)	(None, 10, 10, 672)	0	block4e_activati... block4e_se_expan...
block4e_project_co... (Conv2D)	(None, 10, 10, 112)	75,264	block4e_se_excit...
block4e_project_bn (BatchNormalizatio...	(None, 10, 10, 112)	448	block4e_project_...
block4e_drop (Dropout)	(None, 10, 10, 112)	0	block4e_project_...
block4e_add (Add)	(None, 10, 10, 112)	0	block4e_drop[0][... block4d_add[0][0]
block4f_expand_conv (Conv2D)	(None, 10, 10, 672)	75,264	block4e_add[0][0]
block4f_expand_bn (BatchNormalizatio...	(None, 10, 10, 672)	2,688	block4f_expand_c...
block4f_expand_act... (Activation)	(None, 10, 10, 672)	0	block4f_expand_b...
block4f_dwconv (DepthwiseConv2D)	(None, 10, 10, 672)	6,048	block4f_expand_a...
block4f_bn (BatchNormalizatio...	(None, 10, 10, 672)	2,688	block4f_dwconv[0...
block4f_activation (Activation)	(None, 10, 10, 672)	0	block4f_bn[0][0]
block4f_se_squeeze (GlobalAveragePool...	(None, 672)	0	block4f_activati...
block4f_se_reshape (Reshape)	(None, 1, 1, 672)	0	block4f_se_squee...
block4f_se_reduce (Conv2D)	(None, 1, 1, 28)	18,844	block4f_se_resa...
block4f_se_expand (Conv2D)	(None, 1, 1, 672)	19,488	block4f_se_reduc...
block4f_se_excite (Multiply)	(None, 10, 10, 672)	0	block4f_activati... block4f_se_expan...
block4f_project_co... (Conv2D)	(None, 10, 10, 112)	75,264	block4f_se_excit...
block4f_project_bn (BatchNormalizatio...	(None, 10, 10, 112)	448	block4f_project_...
block4f_drop (Dropout)	(None, 10, 10, 112)	0	block4f_project_...
block4f_add (Add)	(None, 10, 10, 112)	0	block4f_drop[0][... block4e_add[0][0]
block5a_expand_conv (Conv2D)	(None, 10, 10, 672)	75,264	block4f_add[0][0]
block5a_expand_bn (BatchNormalizatio...	(None, 10, 10, 672)	2,688	block5a_expand_c...
block5a_expand_act... (Activation)	(None, 10, 10, 672)	0	block5a_expand_b...
block5a_dwconv (DepthwiseConv2D)	(None, 10, 10, 672)	16,800	block5a_expand_a...
block5a_bn (BatchNormalizatio...	(None, 10, 10, 672)	2,688	block5a_dwconv[0...
block5a_activation (Activation)	(None, 10, 10, 672)	0	block5a_bn[0][0]
block5a_se_squeeze (GlobalAveragePool...	(None, 672)	0	block5a_activati...
block5a_se_reshape (Reshape)	(None, 1, 1, 672)	0	block5a_se_squee...

block5a_se_reduce (Conv2D)	(None, 1, 1, 28)	18,844	block5a_se_resha...
block5a_se_expand (Conv2D)	(None, 1, 1, 672)	19,488	block5a_se_reduc...
block5a_se_excite (Multiply)	(None, 10, 10, 672)	0	block5a_activati... block5a_se_expan...
block5a_project_co... (Conv2D)	(None, 10, 10, 160)	107,520	block5a_se_excit...
block5a_project_bn (BatchNormalizatio...	(None, 10, 10, 160)	640	block5a_project_...
block5b_expand_conv (Conv2D)	(None, 10, 10, 960)	153,600	block5a_project_...
block5b_expand_bn (BatchNormalizatio...	(None, 10, 10, 960)	3,840	block5b_expand_c...
block5b_expand_act... (Activation)	(None, 10, 10, 960)	0	block5b_expand_b...
block5b_dwconv (DepthwiseConv2D)	(None, 10, 10, 960)	24,000	block5b_expand_a...
block5b_bn (BatchNormalizatio...	(None, 10, 10, 960)	3,840	block5b_dwconv[0...
block5b_activation (Activation)	(None, 10, 10, 960)	0	block5b_bn[0][0]
block5b_se_squeeze (GlobalAveragePool...	(None, 960)	0	block5b_activati...
block5b_se_reshape (Reshape)	(None, 1, 1, 960)	0	block5b_se_squee...
block5b_se_reduce (Conv2D)	(None, 1, 1, 40)	38,440	block5b_se_resha...
block5b_se_expand (Conv2D)	(None, 1, 1, 960)	39,360	block5b_se_reduc...
block5b_se_excite (Multiply)	(None, 10, 10, 960)	0	block5b_activati... block5b_se_expan...
block5b_project_co... (Conv2D)	(None, 10, 10, 160)	153,600	block5b_se_excit...
block5b_project_bn (BatchNormalizatio...	(None, 10, 10, 160)	640	block5b_project_...
block5b_drop (Dropout)	(None, 10, 10, 160)	0	block5b_project_...
block5b_add (Add)	(None, 10, 10, 160)	0	block5b_drop[0][... block5a_project_...
block5c_expand_conv (Conv2D)	(None, 10, 10, 960)	153,600	block5b_add[0][0]
block5c_expand_bn (BatchNormalizatio...	(None, 10, 10, 960)	3,840	block5c_expand_c...
block5c_expand_act... (Activation)	(None, 10, 10, 960)	0	block5c_expand_b...
block5c_dwconv (DepthwiseConv2D)	(None, 10, 10, 960)	24,000	block5c_expand_a...
block5c_bn (BatchNormalizatio...	(None, 10, 10, 960)	3,840	block5c_dwconv[0...
block5c_activation (Activation)	(None, 10, 10, 960)	0	block5c_bn[0][0]
block5c_se_squeeze (GlobalAveragePool...	(None, 960)	0	block5c_activati...
block5c_se_reshape (Reshape)	(None, 1, 1, 960)	0	block5c_se_squee...
block5c_se_reduce (Conv2D)	(None, 1, 1, 40)	38,440	block5c_se_resha...
block5c_se_expand (Conv2D)	(None, 1, 1, 960)	39,360	block5c_se_reduc...
block5c_se_excite (Multiply)	(None, 10, 10, 960)	0	block5c_activati... block5c_se_expan...

block5c_project_co... (Conv2D)	(None, 10, 10, 160)	153,600	block5c_se_excit...
block5c_project_bn (BatchNormalizatio...	(None, 10, 10, 160)	640	block5c_project_...
block5c_drop (Dropout)	(None, 10, 10, 160)	0	block5c_project_...
block5c_add (Add)	(None, 10, 10, 160)	0	block5c_drop[0][... block5b_add[0][0]
block5d_expand_conv (Conv2D)	(None, 10, 10, 960)	153,600	block5c_add[0][0]
block5d_expand_bn (BatchNormalizatio...	(None, 10, 10, 960)	3,840	block5d_expand_c...
block5d_expand_act... (Activation)	(None, 10, 10, 960)	0	block5d_expand_b...
block5d_dwconv (DepthwiseConv2D)	(None, 10, 10, 960)	24,000	block5d_expand_a...
block5d_bn (BatchNormalizatio...	(None, 10, 10, 960)	3,840	block5d_dwconv[0...
block5d_activation (Activation)	(None, 10, 10, 960)	0	block5d_bn[0][0]
block5d_se_squeeze (GlobalAveragePool...	(None, 960)	0	block5d_activati...
block5d_se_reshape (Reshape)	(None, 1, 1, 960)	0	block5d_se_squee...
block5d_se_reduce (Conv2D)	(None, 1, 1, 40)	38,440	block5d_se_resha...
block5d_se_expand (Conv2D)	(None, 1, 1, 960)	39,360	block5d_se_reduc...
block5d_se_excite (Multiply)	(None, 10, 10, 960)	0	block5d_activati... block5d_se_expan...
block5d_project_co... (Conv2D)	(None, 10, 10, 160)	153,600	block5d_se_excit...
block5d_project_bn (BatchNormalizatio...	(None, 10, 10, 160)	640	block5d_project_...
block5d_drop (Dropout)	(None, 10, 10, 160)	0	block5d_project_...
block5d_add (Add)	(None, 10, 10, 160)	0	block5d_drop[0][... block5c_add[0][0]
block5e_expand_conv (Conv2D)	(None, 10, 10, 960)	153,600	block5d_add[0][0]
block5e_expand_bn (BatchNormalizatio...	(None, 10, 10, 960)	3,840	block5e_expand_c...
block5e_expand_act... (Activation)	(None, 10, 10, 960)	0	block5e_expand_b...
block5e_dwconv (DepthwiseConv2D)	(None, 10, 10, 960)	24,000	block5e_expand_a...
block5e_bn (BatchNormalizatio...	(None, 10, 10, 960)	3,840	block5e_dwconv[0...
block5e_activation (Activation)	(None, 10, 10, 960)	0	block5e_bn[0][0]
block5e_se_squeeze (GlobalAveragePool...	(None, 960)	0	block5e_activati...
block5e_se_reshape (Reshape)	(None, 1, 1, 960)	0	block5e_se_squee...
block5e_se_reduce (Conv2D)	(None, 1, 1, 40)	38,440	block5e_se_resha...
block5e_se_expand (Conv2D)	(None, 1, 1, 960)	39,360	block5e_se_reduc...
block5e_se_excite (Multiply)	(None, 10, 10, 960)	0	block5e_activati... block5e_se_expan...
block5e_project_co... (Conv2D)	(None, 10, 10, 160)	153,600	block5e_se_excit...

block5e_project_bn (BatchNormalizatio...	(None, 10, 10, 160)	640	block5e_project_...
block5e_drop (Dropout)	(None, 10, 10, 160)	0	block5e_project_...
block5e_add (Add)	(None, 10, 10, 160)	0	block5e_drop[0][...] block5d_add[0][0]
block5f_expand_conv (Conv2D)	(None, 10, 10, 960)	153,600	block5e_add[0][0]
block5f_expand_bn (BatchNormalizatio...	(None, 10, 10, 960)	3,840	block5f_expand_c...
block5f_expand_act... (Activation)	(None, 10, 10, 960)	0	block5f_expand_b...
block5f_dwconv (DepthwiseConv2D)	(None, 10, 10, 960)	24,000	block5f_expand_a...
block5f_bn (BatchNormalizatio...	(None, 10, 10, 960)	3,840	block5f_dwconv[0...
block5f_activation (Activation)	(None, 10, 10, 960)	0	block5f_bn[0][0]
block5f_se_squeeze (GlobalAveragePool...	(None, 960)	0	block5f_activati...
block5f_se_reshape (Reshape)	(None, 1, 1, 960)	0	block5f_se_squee...
block5f_se_reduce (Conv2D)	(None, 1, 1, 40)	38,440	block5f_se_resha...
block5f_se_expand (Conv2D)	(None, 1, 1, 960)	39,360	block5f_se_reduc...
block5f_se_excite (Multiply)	(None, 10, 10, 960)	0	block5f_activati... block5f_se_expan...
block5f_project_co... (Conv2D)	(None, 10, 10, 160)	153,600	block5f_se_excit...
block5f_project_bn (BatchNormalizatio...	(None, 10, 10, 160)	640	block5f_project_...
block5f_drop (Dropout)	(None, 10, 10, 160)	0	block5f_project_...
block5f_add (Add)	(None, 10, 10, 160)	0	block5f_drop[0][...] block5e_add[0][0]
block6a_expand_conv (Conv2D)	(None, 10, 10, 960)	153,600	block5f_add[0][0]
block6a_expand_bn (BatchNormalizatio...	(None, 10, 10, 960)	3,840	block6a_expand_c...
block6a_expand_act... (Activation)	(None, 10, 10, 960)	0	block6a_expand_b...
block6a_dwconv_pad (ZeroPadding2D)	(None, 13, 13, 960)	0	block6a_expand_a...
block6a_dwconv (DepthwiseConv2D)	(None, 5, 5, 960)	24,000	block6a_dwconv_p...
block6a_bn (BatchNormalizatio...	(None, 5, 5, 960)	3,840	block6a_dwconv[0...
block6a_activation (Activation)	(None, 5, 5, 960)	0	block6a_bn[0][0]
block6a_se_squeeze (GlobalAveragePool...	(None, 960)	0	block6a_activati...
block6a_se_reshape (Reshape)	(None, 1, 1, 960)	0	block6a_se_squee...
block6a_se_reduce (Conv2D)	(None, 1, 1, 40)	38,440	block6a_se_resha...
block6a_se_expand (Conv2D)	(None, 1, 1, 960)	39,360	block6a_se_reduc...
block6a_se_excite (Multiply)	(None, 5, 5, 960)	0	block6a_activati... block6a_se_expan...
block6a_project_co...	(None, 5, 5, 272)	261,120	block6a_se_excit...

(Conv2D)			
block6a_project_bn (BatchNormalizatio...	(None, 5, 5, 272)	1,088	block6a_project_...
block6b_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6a_project_...
block6b_expand_bn (BatchNormalizatio...	(None, 5, 5, 1632)	6,528	block6b_expand_c...
block6b_expand_act... (Activation)	(None, 5, 5, 1632)	0	block6b_expand_b...
block6b_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	40,800	block6b_expand_a...
block6b_bn (BatchNormalizatio...	(None, 5, 5, 1632)	6,528	block6b_dwconv[0...
block6b_activation (Activation)	(None, 5, 5, 1632)	0	block6b_bn[0][0]
block6b_se_squeeze (GlobalAveragePool...	(None, 1632)	0	block6b_activati...
block6b_se_reshape (Reshape)	(None, 1, 1, 1632)	0	block6b_se_squee...
block6b_se_reduce (Conv2D)	(None, 1, 1, 68)	111,044	block6b_se_resha...
block6b_se_expand (Conv2D)	(None, 1, 1, 1632)	112,608	block6b_se_reduc...
block6b_se_excite (Multiply)	(None, 5, 5, 1632)	0	block6b_activati... block6b_se_expan...
block6b_project_co... (Conv2D)	(None, 5, 5, 272)	443,904	block6b_se_excit...
block6b_project_bn (BatchNormalizatio...	(None, 5, 5, 272)	1,088	block6b_project_...
block6b_drop (Dropout)	(None, 5, 5, 272)	0	block6b_project_...
block6b_add (Add)	(None, 5, 5, 272)	0	block6b_drop[0][... block6a_project_...
block6c_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6b_add[0][0]
block6c_expand_bn (BatchNormalizatio...	(None, 5, 5, 1632)	6,528	block6c_expand_c...
block6c_expand_act... (Activation)	(None, 5, 5, 1632)	0	block6c_expand_b...
block6c_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	40,800	block6c_expand_a...
block6c_bn (BatchNormalizatio...	(None, 5, 5, 1632)	6,528	block6c_dwconv[0...
block6c_activation (Activation)	(None, 5, 5, 1632)	0	block6c_bn[0][0]
block6c_se_squeeze (GlobalAveragePool...	(None, 1632)	0	block6c_activati...
block6c_se_reshape (Reshape)	(None, 1, 1, 1632)	0	block6c_se_squee...
block6c_se_reduce (Conv2D)	(None, 1, 1, 68)	111,044	block6c_se_resha...
block6c_se_expand (Conv2D)	(None, 1, 1, 1632)	112,608	block6c_se_reduc...
block6c_se_excite (Multiply)	(None, 5, 5, 1632)	0	block6c_activati... block6c_se_expan...
block6c_project_co... (Conv2D)	(None, 5, 5, 272)	443,904	block6c_se_excit...
block6c_project_bn (BatchNormalizatio...	(None, 5, 5, 272)	1,088	block6c_project_...
block6c_drop (Dropout)	(None, 5, 5, 272)	0	block6c_project_...
block6c_add (Add)	(None, 5, 5, 272)	0	block6c_drop[0][...



block6d_add (Add)	(None, 5, 5, 272)	0	block6b_add[0][0]
block6d_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6c_add[0][0]
block6d_expand_bn (BatchNormalizatio...	(None, 5, 5, 1632)	6,528	block6d_expand_c...
block6d_expand_act... (Activation)	(None, 5, 5, 1632)	0	block6d_expand_b...
block6d_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	40,800	block6d_expand_a...
block6d_bn (BatchNormalizatio...	(None, 5, 5, 1632)	6,528	block6d_dwconv[0...
block6d_activation (Activation)	(None, 5, 5, 1632)	0	block6d_bn[0][0]
block6d_se_squeeze (GlobalAveragePool...	(None, 1632)	0	block6d_activati...
block6d_se_reshape (Reshape)	(None, 1, 1, 1632)	0	block6d_se_squee...
block6d_se_reduce (Conv2D)	(None, 1, 1, 68)	111,044	block6d_se_resha...
block6d_se_expand (Conv2D)	(None, 1, 1, 1632)	112,608	block6d_se_reduc...
block6d_se_excite (Multiply)	(None, 5, 5, 1632)	0	block6d_activati... block6d_se_expan...
block6d_project_co... (Conv2D)	(None, 5, 5, 272)	443,904	block6d_se_excit...
block6d_project_bn (BatchNormalizatio...	(None, 5, 5, 272)	1,088	block6d_project_...
block6d_drop (Dropout)	(None, 5, 5, 272)	0	block6d_project_...
block6d_add (Add)	(None, 5, 5, 272)	0	block6d_drop[0][... block6c_add[0][0]
block6e_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6d_add[0][0]
block6e_expand_bn (BatchNormalizatio...	(None, 5, 5, 1632)	6,528	block6e_expand_c...
block6e_expand_act... (Activation)	(None, 5, 5, 1632)	0	block6e_expand_b...
block6e_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	40,800	block6e_expand_a...
block6e_bn (BatchNormalizatio...	(None, 5, 5, 1632)	6,528	block6e_dwconv[0...
block6e_activation (Activation)	(None, 5, 5, 1632)	0	block6e_bn[0][0]
block6e_se_squeeze (GlobalAveragePool...	(None, 1632)	0	block6e_activati...
block6e_se_reshape (Reshape)	(None, 1, 1, 1632)	0	block6e_se_squee...
block6e_se_reduce (Conv2D)	(None, 1, 1, 68)	111,044	block6e_se_resha...
block6e_se_expand (Conv2D)	(None, 1, 1, 1632)	112,608	block6e_se_reduc...
block6e_se_excite (Multiply)	(None, 5, 5, 1632)	0	block6e_activati... block6e_se_expan...
block6e_project_co... (Conv2D)	(None, 5, 5, 272)	443,904	block6e_se_excit...
block6e_project_bn (BatchNormalizatio...	(None, 5, 5, 272)	1,088	block6e_project_...
block6e_drop (Dropout)	(None, 5, 5, 272)	0	block6e_project_...
block6e_add (Add)	(None, 5, 5, 272)	0	block6e_drop[0][... block6d_add[0][0]

block6f_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6e_add[0][0]
block6f_expand_bn (BatchNormalizatio...	(None, 5, 5, 1632)	6,528	block6f_expand_c...
block6f_expand_act... (Activation)	(None, 5, 5, 1632)	0	block6f_expand_b...
block6f_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	40,800	block6f_expand_a...
block6f_bn (BatchNormalizatio...	(None, 5, 5, 1632)	6,528	block6f_dwconv[0...
block6f_activation (Activation)	(None, 5, 5, 1632)	0	block6f_bn[0][0]
block6f_se_squeeze (GlobalAveragePool...	(None, 1632)	0	block6f_activati...
block6f_se_reshape (Reshape)	(None, 1, 1, 1632)	0	block6f_se_squee...
block6f_se_reduce (Conv2D)	(None, 1, 1, 68)	111,044	block6f_se_resha...
block6f_se_expand (Conv2D)	(None, 1, 1, 1632)	112,608	block6f_se_reduc...
block6f_se_excite (Multiply)	(None, 5, 5, 1632)	0	block6f_activati... block6f_se_expan...
block6f_project_co... (Conv2D)	(None, 5, 5, 272)	443,904	block6f_se_excit...
block6f_project_bn (BatchNormalizatio...	(None, 5, 5, 272)	1,088	block6f_project_...
block6f_drop (Dropout)	(None, 5, 5, 272)	0	block6f_project_...
block6f_add (Add)	(None, 5, 5, 272)	0	block6f_drop[0][... block6e_add[0][0]
block6g_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6f_add[0][0]
block6g_expand_bn (BatchNormalizatio...	(None, 5, 5, 1632)	6,528	block6g_expand_c...
block6g_expand_act... (Activation)	(None, 5, 5, 1632)	0	block6g_expand_b...
block6g_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	40,800	block6g_expand_a...
block6g_bn (BatchNormalizatio...	(None, 5, 5, 1632)	6,528	block6g_dwconv[0...
block6g_activation (Activation)	(None, 5, 5, 1632)	0	block6g_bn[0][0]
block6g_se_squeeze (GlobalAveragePool...	(None, 1632)	0	block6g_activati...
block6g_se_reshape (Reshape)	(None, 1, 1, 1632)	0	block6g_se_squee...
block6g_se_reduce (Conv2D)	(None, 1, 1, 68)	111,044	block6g_se_resha...
block6g_se_expand (Conv2D)	(None, 1, 1, 1632)	112,608	block6g_se_reduc...
block6g_se_excite (Multiply)	(None, 5, 5, 1632)	0	block6g_activati... block6g_se_expan...
block6g_project_co... (Conv2D)	(None, 5, 5, 272)	443,904	block6g_se_excit...
block6g_project_bn (BatchNormalizatio...	(None, 5, 5, 272)	1,088	block6g_project_...
block6g_drop (Dropout)	(None, 5, 5, 272)	0	block6g_project_...
block6g_add (Add)	(None, 5, 5, 272)	0	block6g_drop[0][... block6f_add[0][0]
block6h_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6g_add[0][0]

block6h_expand_bn (BatchNormalizatio...	(None, 5, 5, 1632)	6,528	block6h_expand_c...
block6h_expand_act... (Activation)	(None, 5, 5, 1632)	0	block6h_expand_b...
block6h_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	40,800	block6h_expand_a...
block6h_bn (BatchNormalizatio...	(None, 5, 5, 1632)	6,528	block6h_dwconv[0...
block6h_activation (Activation)	(None, 5, 5, 1632)	0	block6h_bn[0][0]
block6h_se_squeeze (GlobalAveragePool...	(None, 1632)	0	block6h_activati...
block6h_se_reshape (Reshape)	(None, 1, 1, 1632)	0	block6h_se_squee...
block6h_se_reduce (Conv2D)	(None, 1, 1, 68)	111,044	block6h_se_resha...
block6h_se_expand (Conv2D)	(None, 1, 1, 1632)	112,608	block6h_se_reduc...
block6h_se_excite (Multiply)	(None, 5, 5, 1632)	0	block6h_activati... block6h_se_expan...
block6h_project_co... (Conv2D)	(None, 5, 5, 272)	443,904	block6h_se_excit...
block6h_project_bn (BatchNormalizatio...	(None, 5, 5, 272)	1,088	block6h_project_...
block6h_drop (Dropout)	(None, 5, 5, 272)	0	block6h_project_...
block6h_add (Add)	(None, 5, 5, 272)	0	block6h_drop[0][... block6g_add[0][0]
block7a_expand_conv (Conv2D)	(None, 5, 5, 1632)	443,904	block6h_add[0][0]
block7a_expand_bn (BatchNormalizatio...	(None, 5, 5, 1632)	6,528	block7a_expand_c...
block7a_expand_act... (Activation)	(None, 5, 5, 1632)	0	block7a_expand_b...
block7a_dwconv (DepthwiseConv2D)	(None, 5, 5, 1632)	14,688	block7a_expand_a...

## ✓ Add a classification head

- To generate predictions from the block of features, average over the spatial 5x5 spatial locations, using a `tf.keras.layers.GlobalAveragePooling2D` layer to convert the features to a single 1280-element vector per image.

```
global_average_layer = tf.keras.layers.GlobalAveragePooling2D()
feature_batch_average = global_average_layer(feature_batch)
print(feature_batch_average.shape)
```

↗ (32, 1792)

- Apply a `tf.keras.layers.Dense` layer to convert these features into a single prediction per image. You don't need an activation function here because this prediction will be treated as a logit, or a raw prediction value. Positive numbers predict class 1, negative numbers predict class 0.

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

↗ (32, 39)

- Build a model by chaining together the data augmentation, rescaling, `base_model` and feature extractor layers using the Keras Functional API. As previously mentioned, use `training=False` as our model contains a `BatchNormalization` layer.

```
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)
```

```
model.summary()
```

↗ Model: "functional\_1"

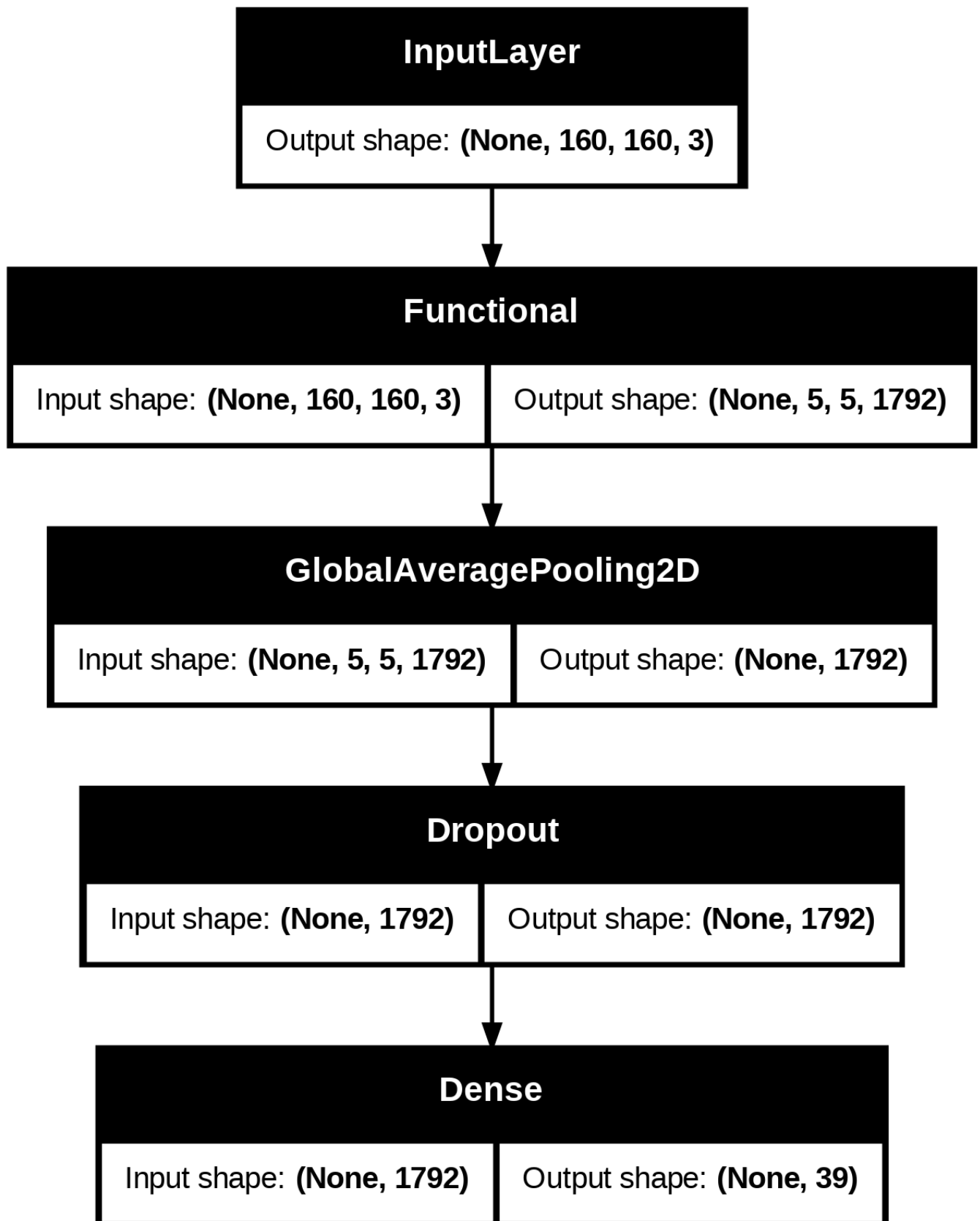
Layer (type)	Output Shape	Param #
input_layer_3 ( <a href="#">InputLayer</a> )	(None, 160, 160, 3)	0
efficientnetb4 ( <a href="#">Functional</a> )	(None, 5, 5, 1792)	17,673,823
global_average_pooling2d_1 ( <a href="#">GlobalAveragePooling2D</a> )	(None, 1792)	0
dropout_1 ( <a href="#">Dropout</a> )	(None, 1792)	0
dense_1 ( <a href="#">Dense</a> )	(None, 39)	69,927

Total params: 17,743,750 (67.69 MB)  
Trainable params: 69,927 (273.15 KB)

```
len(model.trainable_variables)
```

↗ 2

```
tf.keras.utils.plot_model(model, show_shapes=True)
```



## ✓ Compile the model

- Compile the model before training it. Since there are two classes and a sigmoid output, use the BinaryAccuracy.

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

## ✓ Train the model

```
initial_epochs = 10
```

```
loss0, accuracy0 = model.evaluate(validation_dataset)
```

```
🔄 192/192 ————— 10s 53ms/step - accuracy: 0.0206 - loss: 3.7635
```

```
print("initial loss: {:.2f}".format(loss0))
print("initial accuracy: {:.2f}".format(accuracy0))
```

```
🔄 initial loss: 3.77
   initial accuracy: 0.02
```

```
history = model.fit(train_dataset,
                    epochs=initial_epochs,
                    validation_data=validation_dataset)
```

```
🔄 Epoch 1/10
   1537/1537 ————— 156s 74ms/step - accuracy: 0.7054 - loss: 1.1849 - val_accuracy: 0.9133 - val_loss: 0.3198
Epoch 2/10
   1537/1537 ————— 103s 62ms/step - accuracy: 0.9053 - loss: 0.3388 - val_accuracy: 0.9335 - val_loss: 0.2280
Epoch 3/10
   1537/1537 ————— 142s 62ms/step - accuracy: 0.9221 - loss: 0.2621 - val_accuracy: 0.9423 - val_loss: 0.1871
Epoch 4/10
   1537/1537 ————— 95s 62ms/step - accuracy: 0.9311 - loss: 0.2255 - val_accuracy: 0.9462 - val_loss: 0.1696
Epoch 5/10
   1537/1537 ————— 142s 62ms/step - accuracy: 0.9372 - loss: 0.2022 - val_accuracy: 0.9489 - val_loss: 0.1618
Epoch 6/10
   1537/1537 ————— 142s 62ms/step - accuracy: 0.9413 - loss: 0.1849 - val_accuracy: 0.9519 - val_loss: 0.1476
Epoch 7/10
   1537/1537 ————— 141s 61ms/step - accuracy: 0.9425 - loss: 0.1762 - val_accuracy: 0.9547 - val_loss: 0.1384
Epoch 8/10
   1537/1537 ————— 142s 62ms/step - accuracy: 0.9433 - loss: 0.1705 - val_accuracy: 0.9552 - val_loss: 0.1326
Epoch 9/10
   1537/1537 ————— 142s 62ms/step - accuracy: 0.9476 - loss: 0.1584 - val_accuracy: 0.9580 - val_loss: 0.1229
Epoch 10/10
   1537/1537 ————— 141s 62ms/step - accuracy: 0.9468 - loss: 0.1540 - val_accuracy: 0.9576 - val_loss: 0.1247
```

## ✓ Learning curves

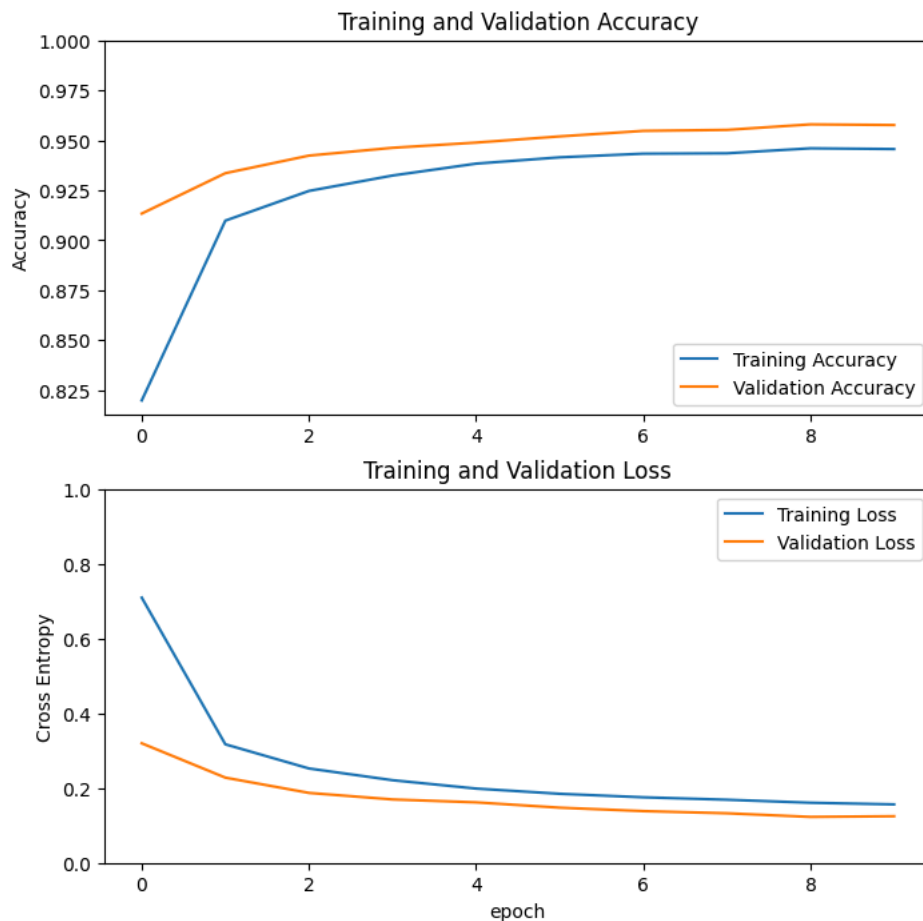
- Let's take a look at the learning curves of the training and validation accuracy/loss when using the MobileNetV2 base model as a fixed feature extractor.

```
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

```
base_model.trainable = True
```

```
# 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

## ✓ Compile the model

- As you are training a much larger model and want to readapt the pretrained weights, it is important to use a lower learning rate at this stage. Otherwise, your model could overfit very quickly.

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

```
model.summary()
```

Model: "functional\_1"

Layer (type)	Output Shape	Param #
input_layer_3 (InputLayer)	(None, 160, 160, 3)	0
efficientnetb4 (Functional)	(None, 5, 5, 1792)	17,673,823
global_average_pooling2d_1 (GlobalAveragePooling2D)	(None, 1792)	0
dropout_1 (Dropout)	(None, 1792)	0
dense_1 (Dense)	(None, 39)	69,927

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

```
len(model.trainable_variables)
```

333

- Continue training the model If you trained to convergence earlier, this step will improve your accuracy by a few percentage points.

```
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 11/20
1537/1537 ————— 462s 220ms/step - accuracy: 0.8824 - loss: 0.4166 - val_accuracy: 0.8060 - val_loss: 0.5688
Epoch 12/20
1537/1537 ————— 291s 159ms/step - accuracy: 0.9621 - loss: 0.1013 - val_accuracy: 0.9532 - val_loss: 0.0753
Epoch 13/20
1537/1537 ————— 263s 159ms/step - accuracy: 0.9675 - loss: 0.0671 - val_accuracy: 0.9783 - val_loss: 0.0583
Epoch 14/20
1537/1537 ————— 261s 159ms/step - accuracy: 0.9708 - loss: 0.0588 - val_accuracy: 0.9327 - val_loss: 0.1685
Epoch 15/20
1537/1537 ————— 261s 158ms/step - accuracy: 0.9714 - loss: 0.0574 - val_accuracy: 0.9730 - val_loss: 0.0270
Epoch 16/20
1537/1537 ————— 244s 159ms/step - accuracy: 0.9679 - loss: 0.0425 - val_accuracy: 0.8944 - val_loss: 0.1029
Epoch 17/20
1537/1537 ————— 262s 159ms/step - accuracy: 0.9569 - loss: 0.0546 - val_accuracy: 0.9728 - val_loss: 0.0399
Epoch 18/20
1537/1537 ————— 243s 158ms/step - accuracy: 0.9769 - loss: 0.0365 - val_accuracy: 0.9590 - val_loss: 0.0383
Epoch 19/20
1537/1537 ————— 262s 159ms/step - accuracy: 0.9690 - loss: 0.0292 - val_accuracy: 0.9326 - val_loss: 0.0510
Epoch 20/20
1537/1537 ————— 261s 158ms/step - accuracy: 0.9598 - loss: 0.0291 - val_accuracy: 0.9321 - val_loss: 0.0529
```

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

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



