Model Development Phase Template

Date	15 March 2024
Team ID	SWTID1720033149
Project Title	Visual Diagnostics: Detecting Tomato Plant Diseases With Leaf Image Analysis
Maximum Marks	10 Marks

Initial Model Training Code, Model Validation and Evaluation Report

The initial model training code will be showcased in the future through a screenshot. The model validation and evaluation report will include a summary and training and validation performance metrics for multiple models, presented through respective screenshots.

Initial Model Training Code (5 marks):

```python
import numpy as np
import pandas as pd
import os
os.chdir('/kaggle/input/tomatoleaf/tomato/')
os.listdir()
```

```python
import warnings
warnings.filterwarnings('ignore')
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from PIL import Image
from tensorflow import keras
from tensorflow.keras.applications import ResNet152V2
from tensorflow.keras.layers import GlobalAveragePooling2D, Dense
from tensorflow.keras.models import Model
```

```python
datagen = keras.preprocessing.image.ImageDataGenerator(rescale=1/255, validation_split=0.3)
datagen2 = keras.preprocessing.image.ImageDataGenerator(rescale=1/255)
```

```python
#Training and validation dataset
train = datagen.flow_from_directory('./train', seed=123, subset='training')

val = datagen.flow_from_directory('./train', seed=123, subset='validation')

#Test dataset for evaluation
test = datagen2.flow_from_directory('./val')
```

```python
from tensorflow.keras.applications import ResNet152V2

# Define the base model with pre-trained weights, excluding the top layers
base_model = ResNet152V2(input_shape=(256,256,3), include_top=False)

# Freeze the layers up to the 140th layer
for layer in base_model.layers[:140]:
    layer.trainable = False

# Unfreeze the layers from the 140th layer onwards
for layer in base_model.layers[140:]:
    layer.trainable = True
```

```python
# Add your custom classification head
x = GlobalAveragePooling2D()(base_model.output)
x = Dense(1000, activation='relu')(x)  # Adjust units as needed
predictions = Dense(10, activation='softmax')(x)  # Adjust number of classes accordingly

# Create the final model
model = Model(inputs=base_model.input, outputs=predictions)
model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])
```

```python
model.summary()
```

```python
# Assuming 'train' and 'val' are your defined data generators
model.fit(train, batch_size=80, epochs=15, validation_data=val)
```

Model Validation and Evaluation Report (5 marks):

Model	Summary	Training and Validation Performance Metrics
Model 1		

Summary (Model 1):

Layer (type)	Output Shape	Param #	Connected to
input_layer (InputLayer)	(None, 256, 256, 3)	0	-
conv1_pad (ZeroPadding2D)	(None, 262, 262, 3)	0	input_layer[0][0]
conv1_conv (Conv2D)	(None, 128, 128, 64)	9,472	conv1_pad[0][0]
pool1_pad (ZeroPadding2D)	(None, 130, 130, 64)	0	conv1_conv[0][0]
pool1_pool (MaxPooling2D)	(None, 64, 64, 64)	0	pool1_pad[0][0]
conv2_block1_preac... (BatchNormalizatio...)	(None, 64, 64, 64)	256	pool1_pool[0][0]
conv2_block1_preac... (Activation)	(None, 64, 64, 64)	0	conv2_block1_pre...
conv2_block1_1_conv (Conv2D)	(None, 64, 64, 64)	4,096	conv2_block1_pre...
conv2_block1_1_bn (BatchNormalizatio...)	(None, 64, 64, 64)	256	conv2_block1_1_c...
conv2_block1_1_relu (Activation)	(None, 64, 64, 64)	0	conv2_block1_1_b...
conv2_block1_2_pad (ZeroPadding2D)	(None, 66, 66, 64)	0	conv2_block1_1_r...
conv2_block1_2_conv (Conv2D)	(None, 64, 64, 64)	36,864	conv2_block1_2_p...
conv2_block1_2_bn (BatchNormalizatio...)	(None, 64, 64, 64)	256	conv2_block1_2_c...
conv2_block1_2_relu (Activation)	(None, 64, 64, 64)	0	conv2_block1_2_b...
conv2_block1_0_conv (Conv2D)	(None, 64, 64, 256)	16,640	conv2_block1_pre...
conv2_block1_3_conv (Conv2D)	(None, 64, 64, 256)	16,640	conv2_block1_2_r...
conv2_block1_out (Add)	(None, 64, 64, 256)	0	conv2_block1_0_c... conv2_block1_3_c...
conv2_block2_preac... (BatchNormalizatio...)	(None, 64, 64, 256)	1,024	conv2_block1_out...
conv2_block2_preac... (Activation)	(None, 64, 64, 256)	0	conv2_block2_pre...
conv2_block2_1_conv (Conv2D)	(None, 64, 64, 64)	16,384	conv2_block2_pre...
conv2_block2_1_bn (BatchNormalizatio...)	(None, 64, 64, 64)	256	conv2_block2_1_c...
conv2_block2_1_relu (Activation)	(None, 64, 64, 64)	0	conv2_block2_1_b...
conv2_block2_2_pad (ZeroPadding2D)	(None, 66, 66, 64)	0	conv2_block2_1_r...
conv2_block2_2_conv (Conv2D)	(None, 64, 64, 64)	36,864	conv2_block2_2_p...
conv2_block2_2_bn (BatchNormalizatio...)	(None, 64, 64, 64)	256	conv2_block2_2_c...
conv2_block2_2_relu (Activation)	(None, 64, 64, 64)	0	conv2_block2_2_b...
conv2_block2_3_conv (Conv2D)	(None, 64, 64, 256)	16,640	conv2_block2_2_r...

Training and Validation Performance Metrics:

```
Epoch 1/15
219/219 ━━━━━━━━━━━━━━━━━━━━ 87s 397ms/step - accuracy: 0.9888 - loss: 0.0340 - val_accuracy: 0.9103 - val_loss: 0.3881
Epoch 2/15
219/219 ━━━━━━━━━━━━━━━━━━━━ 87s 396ms/step - accuracy: 0.9840 - loss: 0.0452 - val_accuracy: 0.9560 - val_loss: 0.1672
Epoch 3/15
219/219 ━━━━━━━━━━━━━━━━━━━━ 87s 395ms/step - accuracy: 0.9855 - loss: 0.0410 - val_accuracy: 0.9687 - val_loss: 0.1012
Epoch 4/15
219/219 ━━━━━━━━━━━━━━━━━━━━ 87s 395ms/step - accuracy: 0.9905 - loss: 0.0258 - val_accuracy: 0.9427 - val_loss: 0.2292
Epoch 5/15
219/219 ━━━━━━━━━━━━━━━━━━━━ 87s 395ms/step - accuracy: 0.9894 - loss: 0.0297 - val_accuracy: 0.9750 - val_loss: 0.0940
Epoch 6/15
219/219 ━━━━━━━━━━━━━━━━━━━━ 87s 395ms/step - accuracy: 0.9885 - loss: 0.0355 - val_accuracy: 0.9143 - val_loss: 0.3908
Epoch 7/15
219/219 ━━━━━━━━━━━━━━━━━━━━ 87s 395ms/step - accuracy: 0.9882 - loss: 0.0366 - val_accuracy: 0.9673 - val_loss: 0.1012
Epoch 8/15
219/219 ━━━━━━━━━━━━━━━━━━━━ 87s 394ms/step - accuracy: 0.9793 - loss: 0.0722 - val_accuracy: 0.9700 - val_loss: 0.1053
Epoch 9/15
219/219 ━━━━━━━━━━━━━━━━━━━━ 87s 394ms/step - accuracy: 0.9951 - loss: 0.0153 - val_accuracy: 0.9760 - val_loss: 0.0824
Epoch 10/15
219/219 ━━━━━━━━━━━━━━━━━━━━ 87s 394ms/step - accuracy: 0.9945 - loss: 0.0145 - val_accuracy: 0.9747 - val_loss: 0.0904
Epoch 11/15
219/219 ━━━━━━━━━━━━━━━━━━━━ 87s 394ms/step - accuracy: 0.9905 - loss: 0.0238 - val_accuracy: 0.9117 - val_loss: 0.4472
Epoch 12/15
219/219 ━━━━━━━━━━━━━━━━━━━━ 87s 394ms/step - accuracy: 0.9870 - loss: 0.0416 - val_accuracy: 0.9757 - val_loss: 0.0835
Epoch 13/15
219/219 ━━━━━━━━━━━━━━━━━━━━ 87s 394ms/step - accuracy: 0.9916 - loss: 0.0290 - val_accuracy: 0.9683 - val_loss: 0.1024
Epoch 14/15
219/219 ━━━━━━━━━━━━━━━━━━━━ 87s 394ms/step - accuracy: 0.9958 - loss: 0.0144 - val_accuracy: 0.9597 - val_loss: 0.1516
Epoch 15/15
219/219 ━━━━━━━━━━━━━━━━━━━━ 142s 394ms/step - accuracy: 0.9974 - loss: 0.0124 - val_accuracy: 0.9713 - val_loss: 0.1061
<keras.src.callbacks.history.History at 0x7fd0b02703a0>
```

Layer	Output Shape	Param #	Connected to
conv2_block2_out (Add)	(None, 64, 64, 256)	0	conv2_block1_out… conv2_block2_3_c…
conv2_block3_preac… (BatchNormalizatio…	(None, 64, 64, 256)	1,024	conv2_block2_out…
conv2_block3_preac… (Activation)	(None, 64, 64, 256)	0	conv2_block3_pre…
conv2_block3_1_conv (Conv2D)	(None, 64, 64, 64)	16,384	conv2_block3_pre…
conv2_block3_1_bn (BatchNormalizatio…	(None, 64, 64, 64)	256	conv2_block3_1_c…
conv2_block3_1_relu (Activation)	(None, 64, 64, 64)	0	conv2_block3_1_b…
conv2_block3_2_pad (ZeroPadding2D)	(None, 66, 66, 64)	0	conv2_block3_1_r…
conv2_block3_2_conv (Conv2D)	(None, 32, 32, 64)	36,864	conv2_block3_2_p…
conv2_block3_2_bn (BatchNormalizatio…	(None, 32, 32, 64)	256	conv2_block3_2_c…
conv2_block3_2_relu (Activation)	(None, 32, 32, 64)	0	conv2_block3_2_b…
max_pooling2d (MaxPooling2D)	(None, 32, 32, 256)	0	conv2_block2_out…
conv2_block3_3_conv (Conv2D)	(None, 32, 32, 256)	16,640	conv2_block3_2_r…
conv2_block3_out (Add)	(None, 32, 32, 256)	0	max_pooling2d[0]… conv2_block3_3_c…
conv3_block1_preac… (BatchNormalizatio…	(None, 32, 32, 256)	1,024	conv2_block3_out…

Layer	Output Shape	Param #	Connected to
conv3_block1_preac… (Activation)	(None, 32, 32, 256)	0	conv3_block1_pre…
conv3_block1_1_conv (Conv2D)	(None, 32, 32, 128)	32,768	conv3_block1_pre…
conv3_block1_1_bn (BatchNormalizatio…	(None, 32, 32, 128)	512	conv3_block1_1_c…
conv3_block1_1_relu (Activation)	(None, 32, 32, 128)	0	conv3_block1_1_b…
conv3_block1_2_pad (ZeroPadding2D)	(None, 34, 34, 128)	0	conv3_block1_1_r…
conv3_block1_2_conv (Conv2D)	(None, 32, 32, 128)	147,456	conv3_block1_2_p…
conv3_block1_2_bn (BatchNormalizatio…	(None, 32, 32, 128)	512	conv3_block1_2_c…
conv3_block1_2_relu (Activation)	(None, 32, 32, 128)	0	conv3_block1_2_b…
conv3_block1_0_conv (Conv2D)	(None, 32, 32, 512)	131,584	conv3_block1_pre…
conv3_block1_3_conv (Conv2D)	(None, 32, 32, 512)	66,048	conv3_block1_2_r…
conv3_block1_out (Add)	(None, 32, 32, 512)	0	conv3_block1_0_c… conv3_block1_3_c…
conv3_block2_preac… (BatchNormalizatio…	(None, 32, 32, 512)	2,048	conv3_block1_out…
conv3_block2_preac… (Activation)	(None, 32, 32, 512)	0	conv3_block2_pre…
conv3_block2_1_conv (Conv2D)	(None, 32, 32, 128)	65,536	conv3_block2_pre…

Layer (type)	Output Shape	Param #	Connected to
conv3_block1_out (Add)	(None, 32, 32, 512)	0	conv3_block1_0_c... conv3_block1_3_c...
conv3_block2_preac... (BatchNormalizatio...)	(None, 32, 32, 512)	2,048	conv3_block1_out...
conv3_block2_preac... (Activation)	(None, 32, 32, 512)	0	conv3_block2_prea...
conv3_block2_1_conv (Conv2D)	(None, 32, 32, 128)	65,536	conv3_block2_pre...
conv3_block2_1_bn (BatchNormalizatio...)	(None, 32, 32, 128)	512	conv3_block2_1_c...
conv3_block2_1_relu (Activation)	(None, 32, 32, 128)	0	conv3_block2_1_b...
conv3_block2_2_pad (ZeroPadding2D)	(None, 34, 34, 128)	0	conv3_block2_1_r...
conv3_block2_2_conv (Conv2D)	(None, 32, 32, 128)	147,456	conv3_block2_2_p...
conv3_block2_2_bn (BatchNormalizatio...)	(None, 32, 32, 128)	512	conv3_block2_2_c...
conv3_block2_2_relu (Activation)	(None, 32, 32, 128)	0	conv3_block2_2_b...
conv3_block2_3_conv (Conv2D)	(None, 32, 32, 512)	66,048	conv3_block2_2_r...
conv3_block2_out (Add)	(None, 32, 32, 512)	0	conv3_block1_out... conv3_block2_3_c...
conv3_block3_preac... (BatchNormalizatio...)	(None, 32, 32, 512)	2,048	conv3_block2_out...
conv3_block3_preac... (Activation)	(None, 32, 32, 512)	0	conv3_block3_pre...

Layer (type)	Output Shape	Param #	Connected to
conv3_block3_1_conv (Conv2D)	(None, 32, 32, 128)	65,536	conv3_block3_pre...
conv3_block3_1_bn (BatchNormalizatio...)	(None, 32, 32, 128)	512	conv3_block3_1_c...
conv3_block3_1_relu (Activation)	(None, 32, 32, 128)	0	conv3_block3_1_b...
conv3_block3_2_pad (ZeroPadding2D)	(None, 34, 34, 128)	0	conv3_block3_1_r...
conv3_block3_2_conv (Conv2D)	(None, 32, 32, 128)	147,456	conv3_block3_2_p...
conv3_block3_2_bn (BatchNormalizatio...)	(None, 32, 32, 128)	512	conv3_block3_2_c...
conv3_block3_2_relu (Activation)	(None, 32, 32, 128)	0	conv3_block3_2_b...
conv3_block3_3_conv (Conv2D)	(None, 32, 32, 512)	66,048	conv3_block3_2_r...
conv3_block3_out (Add)	(None, 32, 32, 512)	0	conv3_block2_out... conv3_block3_3_c...
conv3_block4_preac... (BatchNormalizatio...)	(None, 32, 32, 512)	2,048	conv3_block3_out...
conv3_block4_preac... (Activation)	(None, 32, 32, 512)	0	conv3_block4_pre...
conv3_block4_1_conv (Conv2D)	(None, 32, 32, 128)	65,536	conv3_block4_pre...
conv3_block4_1_bn (BatchNormalizatio...)	(None, 32, 32, 128)	512	conv3_block4_1_c...
conv3_block4_1_relu (Activation)	(None, 32, 32, 128)	0	conv3_block4_1_b...

Layer (type)	Output Shape	Param #	Connected to
conv3_block4_2_pad (ZeroPadding2D)	(None, 34, 34, 128)	0	conv3_block4_1_r…
conv3_block4_2_conv (Conv2D)	(None, 32, 32, 128)	147,456	conv3_block4_2_p…
conv3_block4_2_bn (BatchNormalizatio…)	(None, 32, 32, 128)	512	conv3_block4_2_c…
conv3_block4_2_relu (Activation)	(None, 32, 32, 128)	0	conv3_block4_2_b…
conv3_block4_3_conv (Conv2D)	(None, 32, 32, 512)	66,048	conv3_block4_2_r…
conv3_block4_out (Add)	(None, 32, 32, 512)	0	conv3_block3_out… conv3_block4_3_c…
conv3_block5_preac… (BatchNormalizatio…)	(None, 32, 32, 512)	2,048	conv3_block4_out…
conv3_block5_preac… (Activation)	(None, 32, 32, 512)	0	conv3_block5_pre…
conv3_block5_1_conv (Conv2D)	(None, 32, 32, 128)	65,536	conv3_block5_pre…
conv3_block5_1_bn (BatchNormalizatio…)	(None, 32, 32, 128)	512	conv3_block5_1_c…
conv3_block5_1_relu (Activation)	(None, 32, 32, 128)	0	conv3_block5_1_b…
conv3_block5_2_pad (ZeroPadding2D)	(None, 34, 34, 128)	0	conv3_block5_1_r…
conv3_block5_2_conv (Conv2D)	(None, 32, 32, 128)	147,456	conv3_block5_2_p…
conv3_block5_2_bn (BatchNormalizatio…)	(None, 32, 32, 128)	512	conv3_block5_2_c…

Layer (type)	Output Shape	Param #	Connected to
conv3_block5_1_relu (Activation)	(None, 32, 32, 128)	0	conv3_block5_1_b…
conv3_block5_2_pad (ZeroPadding2D)	(None, 34, 34, 128)	0	conv3_block5_1_r…
conv3_block5_2_conv (Conv2D)	(None, 32, 32, 128)	147,456	conv3_block5_2_p…
conv3_block5_2_bn (BatchNormalizatio…)	(None, 32, 32, 128)	512	conv3_block5_2_c…
conv3_block5_2_relu (Activation)	(None, 32, 32, 128)	0	conv3_block5_2_b…
conv3_block5_3_conv (Conv2D)	(None, 32, 32, 512)	66,048	conv3_block5_2_r…
conv3_block5_out (Add)	(None, 32, 32, 512)	0	conv3_block4_out… conv3_block5_3_c…
conv3_block6_preac… (BatchNormalizatio…)	(None, 32, 32, 512)	2,048	conv3_block5_out…
conv3_block6_preac… (Activation)	(None, 32, 32, 512)	0	conv3_block6_pre…
conv3_block6_1_conv (Conv2D)	(None, 32, 32, 128)	65,536	conv3_block6_pre…
conv3_block6_1_bn (BatchNormalizatio…)	(None, 32, 32, 128)	512	conv3_block6_1_c…
conv3_block6_1_relu (Activation)	(None, 32, 32, 128)	0	conv3_block6_1_b…
conv3_block6_2_pad (ZeroPadding2D)	(None, 34, 34, 128)	0	conv3_block6_1_r…
conv3_block6_2_conv (Conv2D)	(None, 32, 32, 128)	147,456	conv3_block6_2_p…

Layer (type)	Output Shape	Param #	Connected to
conv3_block6_2_bn (BatchNormalizatio…	(None, 32, 32, 128)	512	conv3_block6_2_c…
conv3_block6_2_relu (Activation)	(None, 32, 32, 128)	0	conv3_block6_2_b…
conv3_block6_3_conv (Conv2D)	(None, 32, 32, 512)	66,048	conv3_block6_2_r…
conv3_block6_out (Add)	(None, 32, 32, 512)	0	conv3_block5_out… conv3_block6_3_c…
conv3_block7_preac… (BatchNormalizatio…	(None, 32, 32, 512)	2,048	conv3_block6_out…
conv3_block7_preac… (Activation)	(None, 32, 32, 512)	0	conv3_block7_pre…
conv3_block7_1_conv (Conv2D)	(None, 32, 32, 128)	65,536	conv3_block7_pre…
conv3_block7_1_bn (BatchNormalizatio…	(None, 32, 32, 128)	512	conv3_block7_1_c…
conv3_block7_1_relu (Activation)	(None, 32, 32, 128)	0	conv3_block7_1_b…
conv3_block7_2_pad (ZeroPadding2D)	(None, 34, 34, 128)	0	conv3_block7_1_r…
conv3_block7_2_conv (Conv2D)	(None, 32, 32, 128)	147,456	conv3_block7_2_p…
conv3_block7_2_bn (BatchNormalizatio…	(None, 32, 32, 128)	512	conv3_block7_2_c…
conv3_block7_2_relu (Activation)	(None, 32, 32, 128)	0	conv3_block7_2_b…
conv3_block7_3_conv (Conv2D)	(None, 32, 32, 512)	66,048	conv3_block7_2_r…

Layer (type)	Output Shape	Param #	Connected to
conv3_block7_out (Add)	(None, 32, 32, 512)	0	conv3_block6_out… conv3_block7_3_c…
conv3_block8_preac… (BatchNormalizatio…	(None, 32, 32, 512)	2,048	conv3_block7_out…
conv3_block8_preac… (Activation)	(None, 32, 32, 512)	0	conv3_block8_pre…
conv3_block8_1_conv (Conv2D)	(None, 32, 32, 128)	65,536	conv3_block8_pre…
conv3_block8_1_bn (BatchNormalizatio…	(None, 32, 32, 128)	512	conv3_block8_1_c…
conv3_block8_1_relu (Activation)	(None, 32, 32, 128)	0	conv3_block8_1_b…
conv3_block8_2_pad (ZeroPadding2D)	(None, 34, 34, 128)	0	conv3_block8_1_r…
conv3_block8_2_conv (Conv2D)	(None, 16, 16, 128)	147,456	conv3_block8_2_p…
conv3_block8_2_bn (BatchNormalizatio…	(None, 16, 16, 128)	512	conv3_block8_2_c…
conv3_block8_2_relu (Activation)	(None, 16, 16, 128)	0	conv3_block8_2_b…
max_pooling2d_1 (MaxPooling2D)	(None, 16, 16, 512)	0	conv3_block7_out…
conv3_block8_3_conv (Conv2D)	(None, 16, 16, 512)	66,048	conv3_block8_2_r…
conv3_block8_out (Add)	(None, 16, 16, 512)	0	max_pooling2d_1[… conv3_block8_3_c…
conv4_block1_preac… (BatchNormalizatio…	(None, 16, 16, 512)	2,048	conv3_block8_out…

Layer	Output Shape	Param #	Connected to
conv4_block1_preac… (Activation)	(None, 16, 16, 512)	0	conv4_block1_pre…
conv4_block1_1_conv (Conv2D)	(None, 16, 16, 256)	131,072	conv4_block1_pre…
conv4_block1_1_bn (BatchNormalizatio…)	(None, 16, 16, 256)	1,024	conv4_block1_1_c…
conv4_block1_1_relu (Activation)	(None, 16, 16, 256)	0	conv4_block1_1_b…
conv4_block1_2_pad (ZeroPadding2D)	(None, 18, 18, 256)	0	conv4_block1_1_r…
conv4_block1_2_conv (Conv2D)	(None, 16, 16, 256)	589,824	conv4_block1_2_p…
conv4_block1_2_bn (BatchNormalizatio…)	(None, 16, 16, 256)	1,024	conv4_block1_2_c…
conv4_block1_2_relu (Activation)	(None, 16, 16, 256)	0	conv4_block1_2_b…
conv4_block1_0_conv (Conv2D)	(None, 16, 16, 1024)	525,312	conv4_block1_pre…
conv4_block1_3_conv (Conv2D)	(None, 16, 16, 1024)	263,168	conv4_block1_2_r…
conv4_block1_out (Add)	(None, 16, 16, 1024)	0	conv4_block1_0_c… conv4_block1_3_c…
conv4_block2_preac… (BatchNormalizatio…)	(None, 16, 16, 1024)	4,096	conv4_block1_out…
conv4_block2_preac… (Activation)	(None, 16, 16, 1024)	0	conv4_block2_pre…
conv4_block2_1_conv (Conv2D)	(None, 16, 16, 256)	262,144	conv4_block2_pre…
conv4_block2_1_bn (BatchNormalizatio…)	(None, 16, 16, 256)	1,024	conv4_block2_1_c…
conv4_block2_1_relu (Activation)	(None, 16, 16, 256)	0	conv4_block2_1_b…
conv4_block2_2_pad (ZeroPadding2D)	(None, 18, 18, 256)	0	conv4_block2_1_r…
conv4_block2_2_conv (Conv2D)	(None, 16, 16, 256)	589,824	conv4_block2_2_p…
conv4_block2_2_bn (BatchNormalizatio…)	(None, 16, 16, 256)	1,024	conv4_block2_2_c…
conv4_block2_2_relu (Activation)	(None, 16, 16, 256)	0	conv4_block2_2_b…
conv4_block2_3_conv (Conv2D)	(None, 16, 16, 1024)	263,168	conv4_block2_2_r…
conv4_block2_out (Add)	(None, 16, 16, 1024)	0	conv4_block1_out… conv4_block2_3_c…
conv4_block3_preac… (BatchNormalizatio…)	(None, 16, 16, 1024)	4,096	conv4_block2_out…
conv4_block3_preac… (Activation)	(None, 16, 16, 1024)	0	conv4_block3_pre…
conv4_block3_1_conv (Conv2D)	(None, 16, 16, 256)	262,144	conv4_block3_pre…
conv4_block3_1_bn (BatchNormalizatio…)	(None, 16, 16, 256)	1,024	conv4_block3_1_c…
conv4_block3_1_relu (Activation)	(None, 16, 16, 256)	0	conv4_block3_1_b…
conv4_block3_2_pad (ZeroPadding2D)	(None, 18, 18, 256)	0	conv4_block3_1_r…

Layer (type)	Output Shape	Param #	Connected to
conv4_block3_2_conv (Conv2D)	(None, 16, 16, 256)	589,824	conv4_block3_2_p…
conv4_block3_2_bn (BatchNormalizatio…)	(None, 16, 16, 256)	1,024	conv4_block3_2_c…
conv4_block3_2_relu (Activation)	(None, 16, 16, 256)	0	conv4_block3_2_b…
conv4_block3_3_conv (Conv2D)	(None, 16, 16, 1024)	263,168	conv4_block3_2_r…
conv4_block3_out (Add)	(None, 16, 16, 1024)	0	conv4_block2_out… conv4_block3_3_c…
conv4_block4_preac… (BatchNormalizatio…)	(None, 16, 16, 1024)	4,096	conv4_block3_out…
conv4_block4_preac… (Activation)	(None, 16, 16, 1024)	0	conv4_block4_pre…
conv4_block4_1_conv (Conv2D)	(None, 16, 16, 256)	262,144	conv4_block4_pre…
conv4_block4_1_bn (BatchNormalizatio…)	(None, 16, 16, 256)	1,024	conv4_block4_1_c…
conv4_block4_1_relu (Activation)	(None, 16, 16, 256)	0	conv4_block4_1_b…
conv4_block4_2_pad (ZeroPadding2D)	(None, 18, 18, 256)	0	conv4_block4_1_r…
conv4_block4_2_conv (Conv2D)	(None, 16, 16, 256)	589,824	conv4_block4_2_p…
conv4_block4_2_bn (BatchNormalizatio…)	(None, 16, 16, 256)	1,024	conv4_block4_2_c…
conv4_block4_2_relu (Activation)	(None, 16, 16, 256)	0	conv4_block4_2_b…

Layer (type)	Output Shape	Param #	Connected to
conv4_block4_3_conv (Conv2D)	(None, 16, 16, 1024)	263,168	conv4_block4_2_r…
conv4_block4_out (Add)	(None, 16, 16, 1024)	0	conv4_block3_out… conv4_block4_3_c…
conv4_block5_preac… (BatchNormalizatio…)	(None, 16, 16, 1024)	4,096	conv4_block4_out…
conv4_block5_preac… (Activation)	(None, 16, 16, 1024)	0	conv4_block5_pre…
conv4_block5_1_conv (Conv2D)	(None, 16, 16, 256)	262,144	conv4_block5_pre…
conv4_block5_1_bn (BatchNormalizatio…)	(None, 16, 16, 256)	1,024	conv4_block5_1_c…
conv4_block5_1_relu (Activation)	(None, 16, 16, 256)	0	conv4_block5_1_b…
conv4_block5_2_pad (ZeroPadding2D)	(None, 18, 18, 256)	0	conv4_block5_1_r…
conv4_block5_2_conv (Conv2D)	(None, 16, 16, 256)	589,824	conv4_block5_2_p…
conv4_block5_2_bn (BatchNormalizatio…)	(None, 16, 16, 256)	1,024	conv4_block5_2_c…
conv4_block5_2_relu (Activation)	(None, 16, 16, 256)	0	conv4_block5_2_b…
conv4_block5_3_conv (Conv2D)	(None, 16, 16, 1024)	263,168	conv4_block5_2_r…
conv4_block5_out (Add)	(None, 16, 16, 1024)	0	conv4_block4_out… conv4_block5_3_c…
conv4_block6_preac… (BatchNormalizatio…)	(None, 16, 16, 1024)	4,096	conv4_block5_out…

Layer	Output Shape	Param #	Connected to
conv4_block36_3_co... (Conv2D)	(None, 8, 8, 1024)	263,168	conv4_block36_2_...
conv4_block36_out (Add)	(None, 8, 8, 1024)	0	max_pooling2d_2[... conv4_block36_3_...
conv5_block1_preac... (BatchNormalizatio...)	(None, 8, 8, 1024)	4,096	conv4_block36_ou...
conv5_block1_preac... (Activation)	(None, 8, 8, 1024)	0	conv5_block1_pre...
conv5_block1_1_conv (Conv2D)	(None, 8, 8, 512)	524,288	conv5_block1_pre...
conv5_block1_1_bn (BatchNormalizatio...)	(None, 8, 8, 512)	2,048	conv5_block1_1_c...
conv5_block1_1_relu (Activation)	(None, 8, 8, 512)	0	conv5_block1_1_b...
conv5_block1_2_pad (ZeroPadding2D)	(None, 10, 10, 512)	0	conv5_block1_1_r...
conv5_block1_2_conv (Conv2D)	(None, 8, 8, 512)	2,359,296	conv5_block1_2_p...
conv5_block1_2_bn (BatchNormalizatio...)	(None, 8, 8, 512)	2,048	conv5_block1_2_c...
conv5_block1_2_relu (Activation)	(None, 8, 8, 512)	0	conv5_block1_2_b...
conv5_block1_0_conv (Conv2D)	(None, 8, 8, 2048)	2,099,200	conv5_block1_pre...
conv5_block1_3_conv	(None, 8, 8,	1,050,624	conv5_block1_2_r...

Layer	Output Shape	Param #	Connected to
conv5_block2_preac... (Activation)	(None, 8, 8, 2048)	0	conv5_block2_pre...
conv5_block2_1_conv (Conv2D)	(None, 8, 8, 512)	1,048,576	conv5_block2_pre...
conv5_block2_1_bn (BatchNormalizatio...)	(None, 8, 8, 512)	2,048	conv5_block2_1_c...
conv5_block2_1_relu (Activation)	(None, 8, 8, 512)	0	conv5_block2_1_b...
conv5_block2_2_pad (ZeroPadding2D)	(None, 10, 10, 512)	0	conv5_block2_1_r...
conv5_block2_2_conv (Conv2D)	(None, 8, 8, 512)	2,359,296	conv5_block2_2_p...
conv5_block2_2_bn (BatchNormalizatio...)	(None, 8, 8, 512)	2,048	conv5_block2_2_c...
conv5_block2_2_relu (Activation)	(None, 8, 8, 512)	0	conv5_block2_2_b...
conv5_block2_3_conv (Conv2D)	(None, 8, 8, 2048)	1,050,624	conv5_block2_2_r...
conv5_block2_out (Add)	(None, 8, 8, 2048)	0	conv5_block1_out... conv5_block2_3_c...
conv5_block3_preac... (BatchNormalizatio...)	(None, 8, 8, 2048)	8,192	conv5_block2_out...
conv5_block3_preac... (Activation)	(None, 8, 8, 2048)	0	conv5_block3_pre...
conv5_block3_1_conv (Conv2D)	(None, 8, 8, 512)	1,048,576	conv5_block3_pre...
conv5_block3_1_bn (BatchNormalizatio...)	(None, 8, 8, 512)	2,048	conv5_block3_1_c...

Layer (type)	Output Shape	Param #	Connected to
conv5_block3_1_relu (Activation)	(None, 8, 8, 512)	0	conv5_block3_1_b…
conv5_block3_2_pad (ZeroPadding2D)	(None, 10, 10, 512)	0	conv5_block3_1_r…
conv5_block3_2_conv (Conv2D)	(None, 8, 8, 512)	2,359,296	conv5_block3_2_p…
conv5_block3_2_bn (BatchNormalizatio…)	(None, 8, 8, 512)	2,048	conv5_block3_2_c…
conv5_block3_2_relu (Activation)	(None, 8, 8, 512)	0	conv5_block3_2_b…
conv5_block3_3_conv (Conv2D)	(None, 8, 8, 2048)	1,050,624	conv5_block3_2_r…
conv5_block3_out (Add)	(None, 8, 8, 2048)	0	conv5_block2_out… conv5_block3_3_c…
post_bn (BatchNormalizatio…)	(None, 8, 8, 2048)	8,192	conv5_block3_out…
post_relu (Activation)	(None, 8, 8, 2048)	0	post_bn[0][0]
global_average_poo… (GlobalAveragePool…)	(None, 2048)	0	post_relu[0][0]
dense (Dense)	(None, 1000)	2,049,000	global_average_p…
dense_1 (Dense)	(None, 10)	10,010	dense[0][0]

Total params: 60,390,658 (230.37 MB)
Trainable params: 56,430,338 (215.26 MB)
Non-trainable params: 3,960,320 (15.11 MB)