

```
In [1]: from tensorflow.keras.applications.mobilenet_v2 import MobileNetV2, preprocess_input
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.layers import Input, Dense, Flatten
from tensorflow.keras.models import Model
from sklearn.metrics import confusion_matrix
import numpy as np
import matplotlib.pyplot as plt
from glob import glob
```

```
In [3]: # Define the image size and paths to the datasets
IMAGE_SIZE = [224, 224]
train_path = '/Users/harikakakumanu/Downloads/Hair Diseases - Final/train'
test_path = '/Users/harikakakumanu/Downloads/Hair Diseases - Final/test'
val_path = '/Users/harikakakumanu/Downloads/Hair Diseases - Final/val'
```

EDA

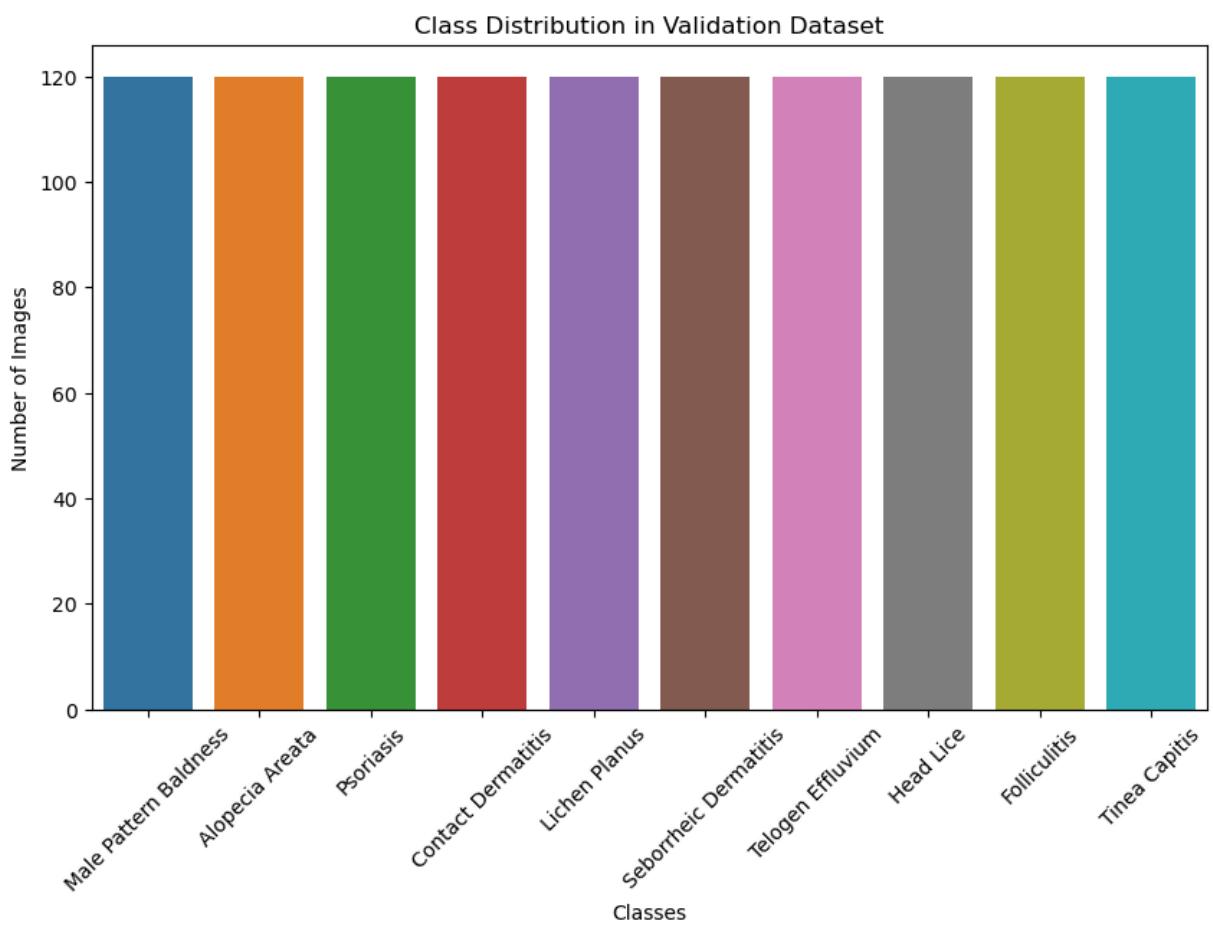
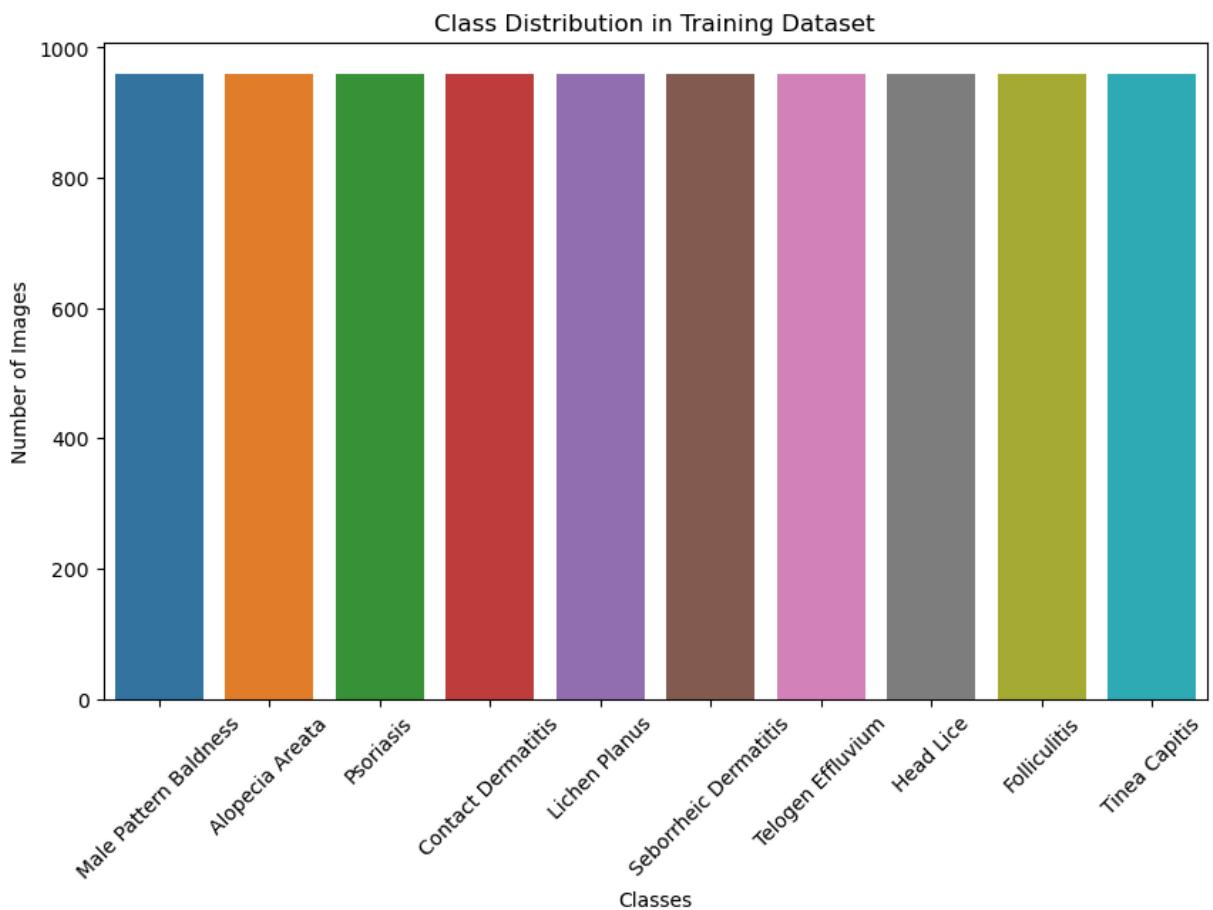
In [10]:

```
import os
import random
import matplotlib.pyplot as plt
import seaborn as sns

# Function to get the class distribution in a directory
def get_class_distribution(directory):
    class_distribution = {}
    try:
        for class_folder in os.listdir(directory):
            class_path = os.path.join(directory, class_folder)
            if os.path.isdir(class_path):
                class_distribution[class_folder] = len(os.listdir(class_path))
    except Exception as e:
        print(f"Error: {e}")
    return class_distribution

# Plot class distribution in training dataset
train_class_distribution = get_class_distribution(train_path)
plt.figure(figsize=(10, 6))
sns.barplot(x=list(train_class_distribution.keys()), y=list(train_class_distr.
plt.title('Class Distribution in Training Dataset')
plt.xlabel('Classes')
plt.ylabel('Number of Images')
plt.xticks(rotation=45)
plt.show()

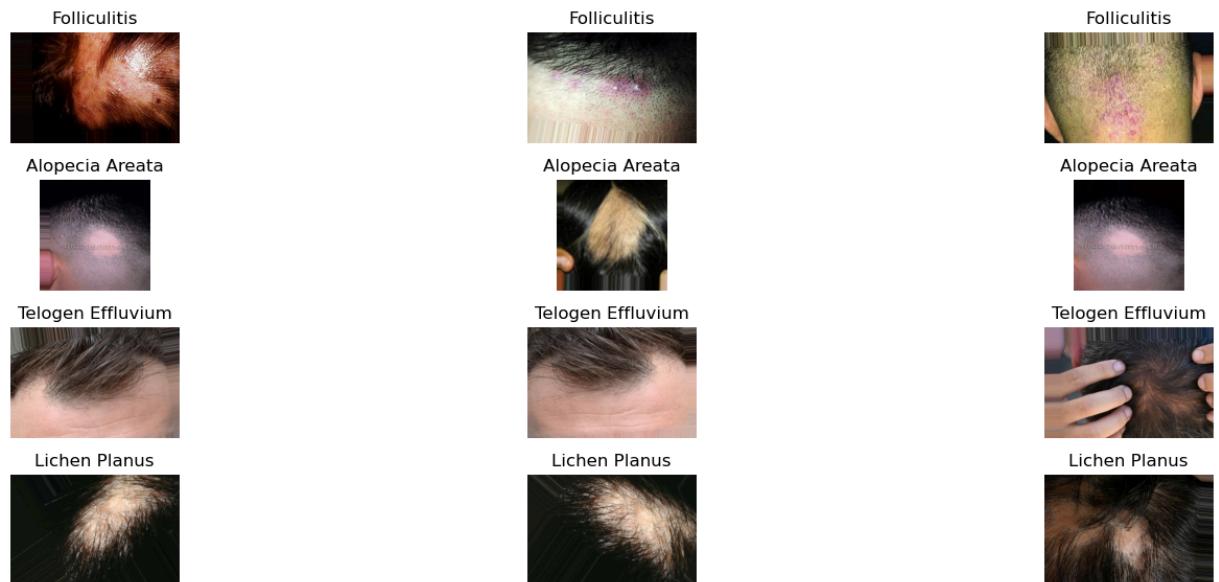
# Plot class distribution in validation dataset
val_class_distribution = get_class_distribution(val_path)
plt.figure(figsize=(10, 6))
sns.barplot(x=list(val_class_distribution.keys()), y=list(val_class_distribut.
plt.title('Class Distribution in Validation Dataset')
plt.xlabel('Classes')
plt.ylabel('Number of Images')
plt.xticks(rotation=45)
plt.show()
```



```
In [81]: import random
```

```
# Function to display sample images from a directory
def display_sample_images(directory, num_images_per_class=3, num_classes_to_d...
    plt.figure(figsize=(15, 7))
    classes = os.listdir(directory)
    classes_to_display = random.sample(classes, min(num_classes_to_display, len...
        for i, class_folder in enumerate(classes_to_display):
            class_path = os.path.join(directory, class_folder)
            if os.path.isdir(class_path):
                image_files = random.sample(os.listdir(class_path), min(num_image...
                    for j, image_file in enumerate(image_files):
                        img_path = os.path.join(class_path, image_file)
                        img = plt.imread(img_path)
                        plt.subplot(num_classes_to_display, num_images_per_class, i * ...
                            plt.imshow(img)
                            plt.title(class_folder)
                            plt.axis('off')
        plt.tight_layout()
        plt.show()

# Display sample images from training dataset
display_sample_images(train_path, num_images_per_class=3, num_classes_to_disp...
```



MODEL 1: MobileNetV2 model

```
In [16]: # Load the pre-trained MobileNetV2 model
base_model = MobileNetV2(input_shape=IMAGE_SIZE + [3], weights='imagenet', in...
```

```
In [17]: # Freeze the base model layers
for layer in base_model.layers:
    layer.trainable = False
```

```
In [18]: # Define your classes
classes = [
    'Alopecia Areata', 'Contact Dermatitis', 'Folliculitis', 'Head Lice',
    'Lichen Planus', 'Male Pattern Baldness', 'Psoriasis', 'Seborrheic Dermat',
    'Telogen Effluvium', 'Tinea Capitis'
]
```

```
In [19]: # Add custom top layers for our classification task
x = Flatten()(base_model.output)
prediction_layer = Dense(len(classes), activation='softmax')(x)
# Create model
model = Model(inputs=base_model.input, outputs=prediction_layer)
```

In [26]: `model.summary()`

Model: "functional_1"

Layer (type)	Output Shape	Param #	Connected to
input_layer_1 (InputLayer)	(None, 224, 224, 3)	0	-
Conv1 (Conv2D)	(None, 112, 112, 32)	864	input_layer_1[0]...
bn_Conv1 (BatchNormalizatio...)	(None, 112, 112, 32)	128	Conv1[0][0]
Conv1_relu (ReLU)	(None, 112, 112, 32)	0	bn_Conv1[0][0]
expanded_conv_dept... (DepthwiseConv2D)	(None, 112, 112, 32)	288	Conv1_relu[0][0]
expanded_conv_dept... (BatchNormalizatio...)	(None, 112, 112, 32)	128	expanded_conv_de...
expanded_conv_dept... (ReLU)	(None, 112, 112, 32)	0	expanded_conv_de...
expanded_conv_proj... (Conv2D)	(None, 112, 112, 16)	512	expanded_conv_de...
expanded_conv_proj... (BatchNormalizatio...)	(None, 112, 112, 16)	64	expanded_conv_pr...
block_1_expand (Conv2D)	(None, 112, 112, 96)	1,536	expanded_conv_pr...
block_1_expand_BN (BatchNormalizatio...)	(None, 112, 112, 96)	384	block_1_expand[0...
block_1_expand_relu (ReLU)	(None, 112, 112, 96)	0	block_1_expand_B...
block_1_pad (ZeroPadding2D)	(None, 113, 113, 96)	0	block_1_expand_r...
block_1_depthwise (DepthwiseConv2D)	(None, 56, 56, 96)	864	block_1_pad[0][0]
block_1_depthwise_... (BatchNormalizatio...)	(None, 56, 56, 96)	384	block_1_depthwis...
block_1_depthwise_... (ReLU)	(None, 56, 56, 96)	0	block_1_depthwis...
block_1_project (Conv2D)	(None, 56, 56, 24)	2,304	block_1_depthwis...
block_1_project_BN (BatchNormalizatio...)	(None, 56, 56, 24)	96	block_1_project[...
block_2_expand (Conv2D)	(None, 56, 56, 144)	3,456	block_1_project[...
block_2_expand_BN (BatchNormalizatio...)	(None, 56, 56, 144)	576	block_2_expand[0...
block_2_expand_relu	(None, 56, 56,	0	block_2_expand_B...

(ReLU)	144)		
block_2_depthwise (DepthwiseConv2D)	(None, 56, 56, 144)	1,296	block_2_expand_r...
block_2_depthwise_... (BatchNormalizatio...)	(None, 56, 56, 144)	576	block_2_depthwis...
block_2_depthwise_... (ReLU)	(None, 56, 56, 144)	0	block_2_depthwis...
block_2_project (Conv2D)	(None, 56, 56, 24)	3,456	block_2_depthwis...
block_2_project_BN (BatchNormalizatio...)	(None, 56, 56, 24)	96	block_2_project[...
block_2_add (Add)	(None, 56, 56, 24)	0	block_1_project_... block_2_project_...
block_3_expand (Conv2D)	(None, 56, 56, 144)	3,456	block_2_add[0][0]
block_3_expand_BN (BatchNormalizatio...)	(None, 56, 56, 144)	576	block_3_expand[0...]
block_3_expand_relu (ReLU)	(None, 56, 56, 144)	0	block_3_expand_B...
block_3_pad (ZeroPadding2D)	(None, 57, 57, 144)	0	block_3_expand_r...
block_3_depthwise (DepthwiseConv2D)	(None, 28, 28, 144)	1,296	block_3_pad[0][0]
block_3_depthwise_... (BatchNormalizatio...)	(None, 28, 28, 144)	576	block_3_depthwis...
block_3_depthwise_... (ReLU)	(None, 28, 28, 144)	0	block_3_depthwis...
block_3_project (Conv2D)	(None, 28, 28, 32)	4,608	block_3_depthwis...
block_3_project_BN (BatchNormalizatio...)	(None, 28, 28, 32)	128	block_3_project[...
block_4_expand (Conv2D)	(None, 28, 28, 192)	6,144	block_3_project_...
block_4_expand_BN (BatchNormalizatio...)	(None, 28, 28, 192)	768	block_4_expand[0...]
block_4_expand_relu (ReLU)	(None, 28, 28, 192)	0	block_4_expand_B...
block_4_depthwise (DepthwiseConv2D)	(None, 28, 28, 192)	1,728	block_4_expand_r...
block_4_depthwise_... (BatchNormalizatio...)	(None, 28, 28, 192)	768	block_4_depthwis...
block_4_depthwise_... (ReLU)	(None, 28, 28, 192)	0	block_4_depthwis...

block_4_project (Conv2D)	(None, 28, 28, 32)	6,144	block_4_depthwis...
block_4_project_BN (BatchNormalizatio...)	(None, 28, 28, 32)	128	block_4_project[...]
block_4_add (Add)	(None, 28, 28, 32)	0	block_3_project[...] block_4_project[...]
block_5_expand (Conv2D)	(None, 28, 28, 192)	6,144	block_4_add[0][0]
block_5_expand_BN (BatchNormalizatio...)	(None, 28, 28, 192)	768	block_5_expand[0...]
block_5_expand_relu (ReLU)	(None, 28, 28, 192)	0	block_5_expand_B...
block_5_depthwise (DepthwiseConv2D)	(None, 28, 28, 192)	1,728	block_5_expand_r...
block_5_depthwise_... (BatchNormalizatio...)	(None, 28, 28, 192)	768	block_5_depthwis...
block_5_depthwise_... (ReLU)	(None, 28, 28, 192)	0	block_5_depthwis...
block_5_project (Conv2D)	(None, 28, 28, 32)	6,144	block_5_depthwis...
block_5_project_BN (BatchNormalizatio...)	(None, 28, 28, 32)	128	block_5_project[...]
block_5_add (Add)	(None, 28, 28, 32)	0	block_4_add[0][0...] block_5_project[...]
block_6_expand (Conv2D)	(None, 28, 28, 192)	6,144	block_5_add[0][0]
block_6_expand_BN (BatchNormalizatio...)	(None, 28, 28, 192)	768	block_6_expand[0...]
block_6_expand_relu (ReLU)	(None, 28, 28, 192)	0	block_6_expand_B...
block_6_pad (ZeroPadding2D)	(None, 29, 29, 192)	0	block_6_expand_r...
block_6_depthwise (DepthwiseConv2D)	(None, 14, 14, 192)	1,728	block_6_pad[0][0]
block_6_depthwise_... (BatchNormalizatio...)	(None, 14, 14, 192)	768	block_6_depthwis...
block_6_depthwise_... (ReLU)	(None, 14, 14, 192)	0	block_6_depthwis...
block_6_project (Conv2D)	(None, 14, 14, 64)	12,288	block_6_depthwis...
block_6_project_BN (BatchNormalizatio...)	(None, 14, 14, 64)	256	block_6_project[...]

block_7_expand (Conv2D)	(None, 14, 14, 384)	24,576	block_6_project_...
block_7_expand_BN (BatchNormalizatio...)	(None, 14, 14, 384)	1,536	block_7_expand[0...]
block_7_expand_relu (ReLU)	(None, 14, 14, 384)	0	block_7_expand_B...
block_7_depthwise (DepthwiseConv2D)	(None, 14, 14, 384)	3,456	block_7_expand_r...
block_7_depthwise_... (BatchNormalizatio...)	(None, 14, 14, 384)	1,536	block_7_depthwis...
block_7_depthwise_... (ReLU)	(None, 14, 14, 384)	0	block_7_depthwis...
block_7_project (Conv2D)	(None, 14, 14, 64)	24,576	block_7_depthwis...
block_7_project_BN (BatchNormalizatio...)	(None, 14, 14, 64)	256	block_7_project[...]
block_7_add (Add)	(None, 14, 14, 64)	0	block_6_project_... block_7_project_...
block_8_expand (Conv2D)	(None, 14, 14, 384)	24,576	block_7_add[0][0]
block_8_expand_BN (BatchNormalizatio...)	(None, 14, 14, 384)	1,536	block_8_expand[0...]
block_8_expand_relu (ReLU)	(None, 14, 14, 384)	0	block_8_expand_B...
block_8_depthwise (DepthwiseConv2D)	(None, 14, 14, 384)	3,456	block_8_expand_r...
block_8_depthwise_... (BatchNormalizatio...)	(None, 14, 14, 384)	1,536	block_8_depthwis...
block_8_depthwise_... (ReLU)	(None, 14, 14, 384)	0	block_8_depthwis...
block_8_project (Conv2D)	(None, 14, 14, 64)	24,576	block_8_depthwis...
block_8_project_BN (BatchNormalizatio...)	(None, 14, 14, 64)	256	block_8_project[...]
block_8_add (Add)	(None, 14, 14, 64)	0	block_7_add[0][0...] block_8_project_...
block_9_expand (Conv2D)	(None, 14, 14, 384)	24,576	block_8_add[0][0]
block_9_expand_BN (BatchNormalizatio...)	(None, 14, 14, 384)	1,536	block_9_expand[0...]
block_9_expand_relu (ReLU)	(None, 14, 14, 384)	0	block_9_expand_B...
block_9_depthwise	(None, 14, 14,	3,456	block_9_expand_r...

(DepthwiseConv2D)	384)		
block_9_depthwise_(BatchNormalization)	(None, 14, 14, 384)	1,536	block_9_depthwis...
block_9_depthwise_(ReLU)	(None, 14, 14, 384)	0	block_9_depthwis...
block_9_project_(Conv2D)	(None, 14, 14, 64)	24,576	block_9_depthwis...
block_9_project_BN_(BatchNormalization)	(None, 14, 14, 64)	256	block_9_project[...]
block_9_add (Add)	(None, 14, 14, 64)	0	block_8_add[0][0]... block_9_project[...]
block_10_expand_(Conv2D)	(None, 14, 14, 384)	24,576	block_9_add[0][0]
block_10_expand_BN_(BatchNormalization)	(None, 14, 14, 384)	1,536	block_10_expand[...]
block_10_expand_re_(ReLU)	(None, 14, 14, 384)	0	block_10_expand[...]
block_10_depthwise_(DepthwiseConv2D)	(None, 14, 14, 384)	3,456	block_10_expand[...]
block_10_depthwise_(BatchNormalization)	(None, 14, 14, 384)	1,536	block_10_depthwi...
block_10_depthwise_(ReLU)	(None, 14, 14, 384)	0	block_10_depthwi...
block_10_project_(Conv2D)	(None, 14, 14, 96)	36,864	block_10_depthwi...
block_10_project_BN_(BatchNormalization)	(None, 14, 14, 96)	384	block_10_project[...]
block_11_expand_(Conv2D)	(None, 14, 14, 576)	55,296	block_10_project[...]
block_11_expand_BN_(BatchNormalization)	(None, 14, 14, 576)	2,304	block_11_expand[...]
block_11_expand_re_(ReLU)	(None, 14, 14, 576)	0	block_11_expand[...]
block_11_depthwise_(DepthwiseConv2D)	(None, 14, 14, 576)	5,184	block_11_expand[...]
block_11_depthwise_(BatchNormalization)	(None, 14, 14, 576)	2,304	block_11_depthwi...
block_11_depthwise_(ReLU)	(None, 14, 14, 576)	0	block_11_depthwi...
block_11_project_(Conv2D)	(None, 14, 14, 96)	55,296	block_11_depthwi...
block_11_project_BN_(BatchNormalization)	(None, 14, 14, 96)	384	block_11_project[...]

block_11_add (Add)	(None, 14, 14, 96)	0	block_10_project... block_11_project...
block_12_expand (Conv2D)	(None, 14, 14, 576)	55,296	block_11_add[0] [...]
block_12_expand_BN (BatchNormalizatio...)	(None, 14, 14, 576)	2,304	block_12_expand[...]
block_12_expand_re... (ReLU)	(None, 14, 14, 576)	0	block_12_expand_...
block_12_depthwise (DepthwiseConv2D)	(None, 14, 14, 576)	5,184	block_12_expand_...
block_12_depthwise... (BatchNormalizatio...)	(None, 14, 14, 576)	2,304	block_12_depthwi...
block_12_depthwise... (ReLU)	(None, 14, 14, 576)	0	block_12_depthwi...
block_12_project (Conv2D)	(None, 14, 14, 96)	55,296	block_12_depthwi...
block_12_project_BN (BatchNormalizatio...)	(None, 14, 14, 96)	384	block_12_project...
block_12_add (Add)	(None, 14, 14, 96)	0	block_11_add[0] [...] block_12_project...
block_13_expand (Conv2D)	(None, 14, 14, 576)	55,296	block_12_add[0] [...]
block_13_expand_BN (BatchNormalizatio...)	(None, 14, 14, 576)	2,304	block_13_expand[...]
block_13_expand_re... (ReLU)	(None, 14, 14, 576)	0	block_13_expand_...
block_13_pad (ZeroPadding2D)	(None, 15, 15, 576)	0	block_13_expand_...
block_13_depthwise (DepthwiseConv2D)	(None, 7, 7, 576)	5,184	block_13_pad[0] [...]
block_13_depthwise... (BatchNormalizatio...)	(None, 7, 7, 576)	2,304	block_13_depthwi...
block_13_depthwise... (ReLU)	(None, 7, 7, 576)	0	block_13_depthwi...
block_13_project (Conv2D)	(None, 7, 7, 160)	92,160	block_13_depthwi...
block_13_project_BN (BatchNormalizatio...)	(None, 7, 7, 160)	640	block_13_project...
block_14_expand (Conv2D)	(None, 7, 7, 960)	153,600	block_13_project...
block_14_expand_BN (BatchNormalizatio...)	(None, 7, 7, 960)	3,840	block_14_expand[...]

block_14_expand_re... (ReLU)	(None, 7, 7, 960)	0	block_14_expand_...
block_14_depthwise (DepthwiseConv2D)	(None, 7, 7, 960)	8,640	block_14_expand_...
block_14_depthwise... (BatchNormalizatio...)	(None, 7, 7, 960)	3,840	block_14_depthwi...
block_14_depthwise... (ReLU)	(None, 7, 7, 960)	0	block_14_depthwi...
block_14_project (Conv2D)	(None, 7, 7, 160)	153,600	block_14_depthwi...
block_14_project_BN (BatchNormalizatio...)	(None, 7, 7, 160)	640	block_14_project...
block_14_add (Add)	(None, 7, 7, 160)	0	block_13_project... block_14_project...
block_15_expand (Conv2D)	(None, 7, 7, 960)	153,600	block_14_add[0] [...]
block_15_expand_BN (BatchNormalizatio...)	(None, 7, 7, 960)	3,840	block_15_expand[...]
block_15_expand_re... (ReLU)	(None, 7, 7, 960)	0	block_15_expand_...
block_15_depthwise (DepthwiseConv2D)	(None, 7, 7, 960)	8,640	block_15_expand_...
block_15_depthwise... (BatchNormalizatio...)	(None, 7, 7, 960)	3,840	block_15_depthwi...
block_15_depthwise... (ReLU)	(None, 7, 7, 960)	0	block_15_depthwi...
block_15_project (Conv2D)	(None, 7, 7, 160)	153,600	block_15_depthwi...
block_15_project_BN (BatchNormalizatio...)	(None, 7, 7, 160)	640	block_15_project...
block_15_add (Add)	(None, 7, 7, 160)	0	block_14_add[0] [...] block_15_project...
block_16_expand (Conv2D)	(None, 7, 7, 960)	153,600	block_15_add[0] [...]
block_16_expand_BN (BatchNormalizatio...)	(None, 7, 7, 960)	3,840	block_16_expand[...]
block_16_expand_re... (ReLU)	(None, 7, 7, 960)	0	block_16_expand_...
block_16_depthwise (DepthwiseConv2D)	(None, 7, 7, 960)	8,640	block_16_expand_...
block_16_depthwise... (BatchNormalizatio...)	(None, 7, 7, 960)	3,840	block_16_depthwi...
block_16_depthwise... (ReLU)	(None, 7, 7, 960)	0	block_16_depthwi...

(ReLU)			
block_16_project (Conv2D)	(None, 7, 7, 320)	307,200	block_16_depthwi...
block_16_project_BN (BatchNormalizatio...)	(None, 7, 7, 320)	1,280	block_16_project...
Conv_1 (Conv2D)	(None, 7, 7, 1280)	409,600	block_16_project...
Conv_1_bn (BatchNormalizatio...)	(None, 7, 7, 1280)	5,120	Conv_1[0][0]
out_relu (ReLU)	(None, 7, 7, 1280)	0	Conv_1_bn[0][0]
flatten (Flatten)	(None, 62720)	0	out_relu[0][0]
dense (Dense)	(None, 10)	627,210	flatten[0][0]

Total params: 2,885,194 (11.01 MB)

Trainable params: 627,210 (2.39 MB)

Non-trainable params: 2,257,984 (8.61 MB)

```
In [28]: # Compile the model
model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['ac
```

```
In [29]: # Data Augmentation and Image Preprocessing
train_datagen = ImageDataGenerator(rescale=1./255)
test_datagen = ImageDataGenerator(rescale=1./255)
val_datagen = ImageDataGenerator(rescale=1./255)

# Define the data augmentation parameters
train_datagen = ImageDataGenerator(
    rescale=1./255,
    rotation_range=20,          # Randomly rotate images by up to 20 degrees
    width_shift_range=0.1,      # Randomly shift images horizontally (fraction of total width)
    height_shift_range=0.1,     # Randomly shift images vertically (fraction of total height)
    shear_range=0.1,            # Shear angle in counter-clockwise direction in degrees
    zoom_range=0.1,             # Randomly zoom image
    horizontal_flip=True,       # Randomly flip images horizontally
    vertical_flip=True,         # Randomly flip images vertically
    fill_mode='nearest'         # Strategy used for filling in newly created pixels
)

# Generate augmented batches of training data
training_set = train_datagen.flow_from_directory(
    directory=train_path,
    target_size=IMAGE_SIZE,
    batch_size=64,
    class_mode='categorical'
)

# Generate batches of augmented data for testing
test_set = test_datagen.flow_from_directory(
    directory=test_path,
    target_size=IMAGE_SIZE,
    batch_size=64,
    class_mode='categorical',
    shuffle=False
)

# Generate batches of augmented data for validation
val_set = val_datagen.flow_from_directory(
    directory=val_path,
    target_size=IMAGE_SIZE,
    batch_size=64,
    class_mode='categorical',
    shuffle=False
)

# Alternatively, you can define generators directly for train, test, and validation
train_generator = train_datagen.flow_from_directory(train_path, target_size=IMAGE_SIZE)
test_generator = test_datagen.flow_from_directory(test_path, target_size=IMAGE_SIZE)
val_generator = val_datagen.flow_from_directory(val_path, target_size=IMAGE_SIZE)
```

```
Found 9600 images belonging to 10 classes.
Found 1200 images belonging to 10 classes.
Found 1200 images belonging to 10 classes.
Found 9600 images belonging to 10 classes.
Found 1200 images belonging to 10 classes.
Found 1200 images belonging to 10 classes.
```

```
In [30]: # Train the model
```

```
history = model.fit(train_generator, validation_data=val_generator, epochs=20)
```

```
Epoch 1/20
```

```
/Users/harikakakumanu/anaconda3/lib/python3.11/site-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:120: UserWarning: Your `PyDataset` class should call `super().__init__(**kwargs)` in its constructor. `**kwargs` can include `workers`, `use_multiprocessing`, `max_queue_size`. Do not pass these arguments to `fit()`, as they will be ignored.
```

```
    self._warn_if_super_not_called()
```

300/300 ————— 90s 291ms/step – accuracy: 0.6347 – loss: 4.418
8 – val_accuracy: 0.8633 – val_loss: 1.2424
Epoch 2/20
300/300 ————— 89s 293ms/step – accuracy: 0.8765 – loss: 1.153
5 – val_accuracy: 0.8992 – val_loss: 1.2686
Epoch 3/20
300/300 ————— 91s 296ms/step – accuracy: 0.9143 – loss: 0.973
9 – val_accuracy: 0.9458 – val_loss: 0.5827
Epoch 4/20
300/300 ————— 91s 298ms/step – accuracy: 0.9379 – loss: 0.704
5 – val_accuracy: 0.9300 – val_loss: 0.9572
Epoch 5/20
300/300 ————— 184s 610ms/step – accuracy: 0.9436 – loss: 0.65
18 – val_accuracy: 0.9558 – val_loss: 0.5208
Epoch 6/20
300/300 ————— 92s 300ms/step – accuracy: 0.9491 – loss: 0.679
6 – val_accuracy: 0.9667 – val_loss: 0.4891
Epoch 7/20
300/300 ————— 99s 324ms/step – accuracy: 0.9523 – loss: 0.741
4 – val_accuracy: 0.9775 – val_loss: 0.3089
Epoch 8/20
300/300 ————— 112s 367ms/step – accuracy: 0.9579 – loss: 0.65
17 – val_accuracy: 0.9483 – val_loss: 0.8188
Epoch 9/20
300/300 ————— 129s 424ms/step – accuracy: 0.9637 – loss: 0.55
36 – val_accuracy: 0.9617 – val_loss: 0.6912
Epoch 10/20
300/300 ————— 122s 400ms/step – accuracy: 0.9671 – loss: 0.52
39 – val_accuracy: 0.9475 – val_loss: 1.0162
Epoch 11/20
300/300 ————— 109s 356ms/step – accuracy: 0.9637 – loss: 0.66
70 – val_accuracy: 0.9725 – val_loss: 0.5070
Epoch 12/20
300/300 ————— 281s 933ms/step – accuracy: 0.9735 – loss: 0.49
76 – val_accuracy: 0.9842 – val_loss: 0.2447
Epoch 13/20
300/300 ————— 93s 303ms/step – accuracy: 0.9696 – loss: 0.516
1 – val_accuracy: 0.9717 – val_loss: 0.6926
Epoch 14/20
300/300 ————— 98s 322ms/step – accuracy: 0.9748 – loss: 0.469
7 – val_accuracy: 0.9833 – val_loss: 0.2934
Epoch 15/20
300/300 ————— 110s 361ms/step – accuracy: 0.9713 – loss: 0.62
12 – val_accuracy: 0.9717 – val_loss: 0.5489
Epoch 16/20
300/300 ————— 117s 384ms/step – accuracy: 0.9702 – loss: 0.66
14 – val_accuracy: 0.9725 – val_loss: 0.5831
Epoch 17/20
300/300 ————— 122s 400ms/step – accuracy: 0.9707 – loss: 0.59
68 – val_accuracy: 0.9817 – val_loss: 0.3417
Epoch 18/20
300/300 ————— 120s 394ms/step – accuracy: 0.9753 – loss: 0.51
64 – val_accuracy: 0.9800 – val_loss: 0.2675
Epoch 19/20
300/300 ————— 122s 400ms/step – accuracy: 0.9785 – loss: 0.53
54 – val_accuracy: 0.9883 – val_loss: 0.1953
Epoch 20/20
300/300 ————— 123s 404ms/step – accuracy: 0.9778 – loss: 0.51
82 – val_accuracy: 0.9733 – val_loss: 0.6743

```
In [31]: # Plot the training history
plt.figure(figsize=(12, 5))
plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'], label='Train Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.title('Accuracy over epochs')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()

plt.subplot(1, 2, 2)
plt.plot(history.history['loss'], label='Train Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.title('Loss over epochs')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()
```

Out[31]: <matplotlib.legend.Legend at 0x166db6250>



```
In [32]: # Evaluate the model on the test set
test_loss, test_accuracy = model.evaluate(test_generator)
print('Test accuracy:', test_accuracy)
```

38/38 ━━━━━━━━ 8s 208ms/step - accuracy: 0.9923 - loss: 0.1577
Test accuracy: 0.9816666841506958

```
In [40]: from sklearn.metrics import classification_report

# Generate predictions on the test set
y_pred = model.predict(test_generator)
y_pred_classes = np.argmax(y_pred, axis=1)

# Obtain true labels from the test generator
y_true = test_generator.classes

# Generate classification report
classification_rep = classification_report(y_true, y_pred_classes, target_names)
print(classification_rep)
```

	precision	recall	f1-score	support
Alopecia Areata	0.94	1.00	0.97	120
Contact Dermatitis	1.00	1.00	1.00	120
Folliculitis	0.99	0.99	0.99	120
Head Lice	1.00	0.98	0.99	120
Lichen Planus	1.00	0.97	0.99	120
Male Pattern Baldness	1.00	1.00	1.00	120
Psoriasis	0.94	0.99	0.97	120
Seborrheic Dermatitis	0.95	0.99	0.97	120
Telogen Effluvium	1.00	0.94	0.97	120
Tinea Capitis	1.00	0.94	0.97	120
accuracy			0.98	1200
macro avg	0.98	0.98	0.98	1200
weighted avg	0.98	0.98	0.98	1200

```
In [34]: # Obtain true labels from the test generator
y_true = test_generator.classes
```

```
In [35]: # Calculate the confusion matrix
conf_matrix = confusion_matrix(y_true, y_pred_classes)
```

```
In [36]: # Function to plot the confusion matrix
def plot_confusion_matrix(cm, target_names, title='Confusion Matrix', cmap=None):
    import itertools
    if cmap is None:
        cmap = plt.get_cmap('Blues')
    plt.figure(figsize=(10, 8))
    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(target_names))
    plt.xticks(tick_marks, target_names, rotation=45)
    plt.yticks(tick_marks, target_names)
    if normalize:
        cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]
    thresh = cm.max() / 1.5 if normalize else cm.max() / 2
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, "{:.2f}".format(cm[i, j]) if normalize else "{:,}").format(
            horizontalalignment="center",
            color="white" if cm[i, j] > thresh else "black")
    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')
    plt.show()
```

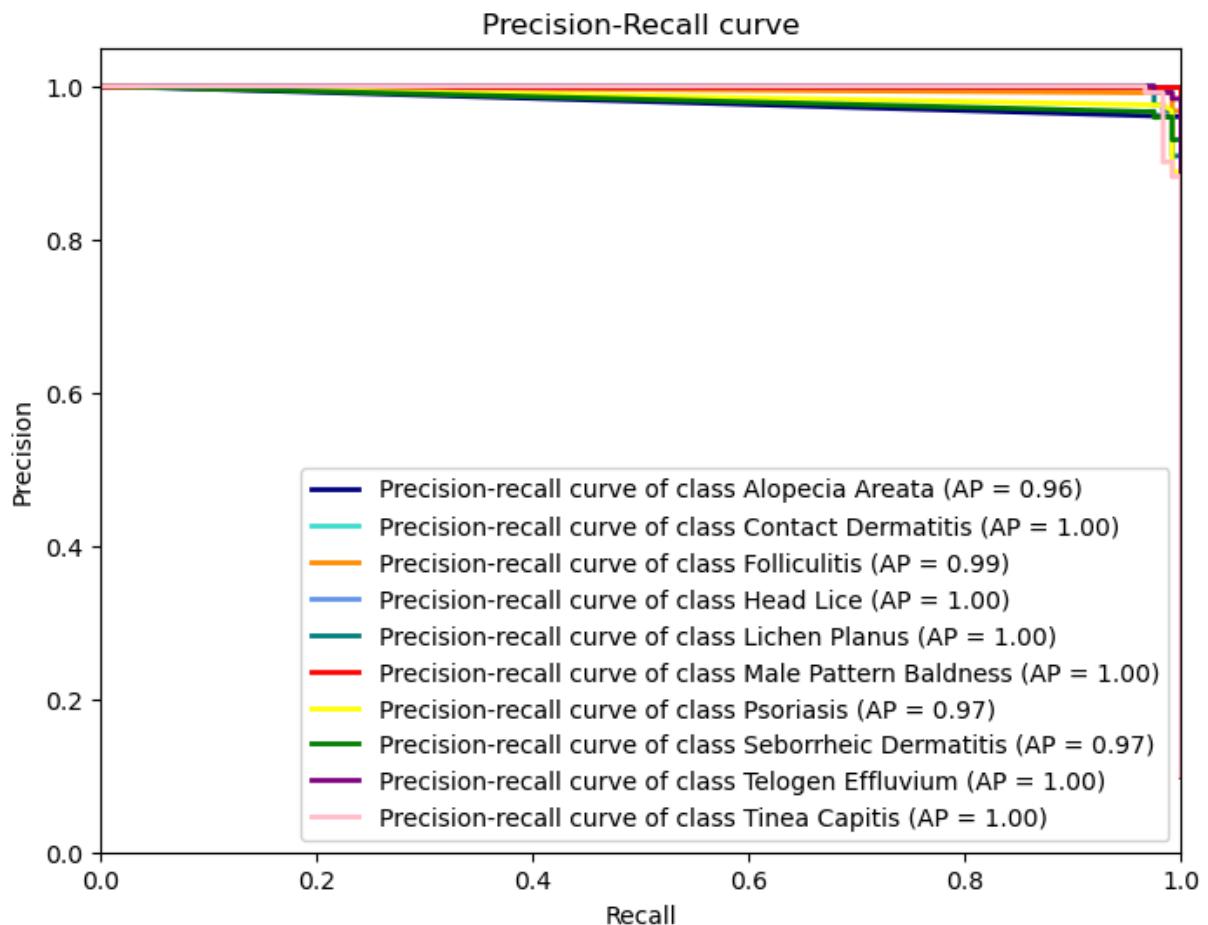
```
In [37]: from sklearn.metrics import precision_recall_curve, average_precision_score

def plot_precision_recall_curve(y_true, y_pred, classes):
    # Compute precision and recall for each class
    precision = dict()
    recall = dict()
    average_precision = dict()
    for i in range(len(classes)):
        precision[i], recall[i], _ = precision_recall_curve(y_true == i, y_pred)
        average_precision[i] = average_precision_score(y_true == i, y_pred[:, i])

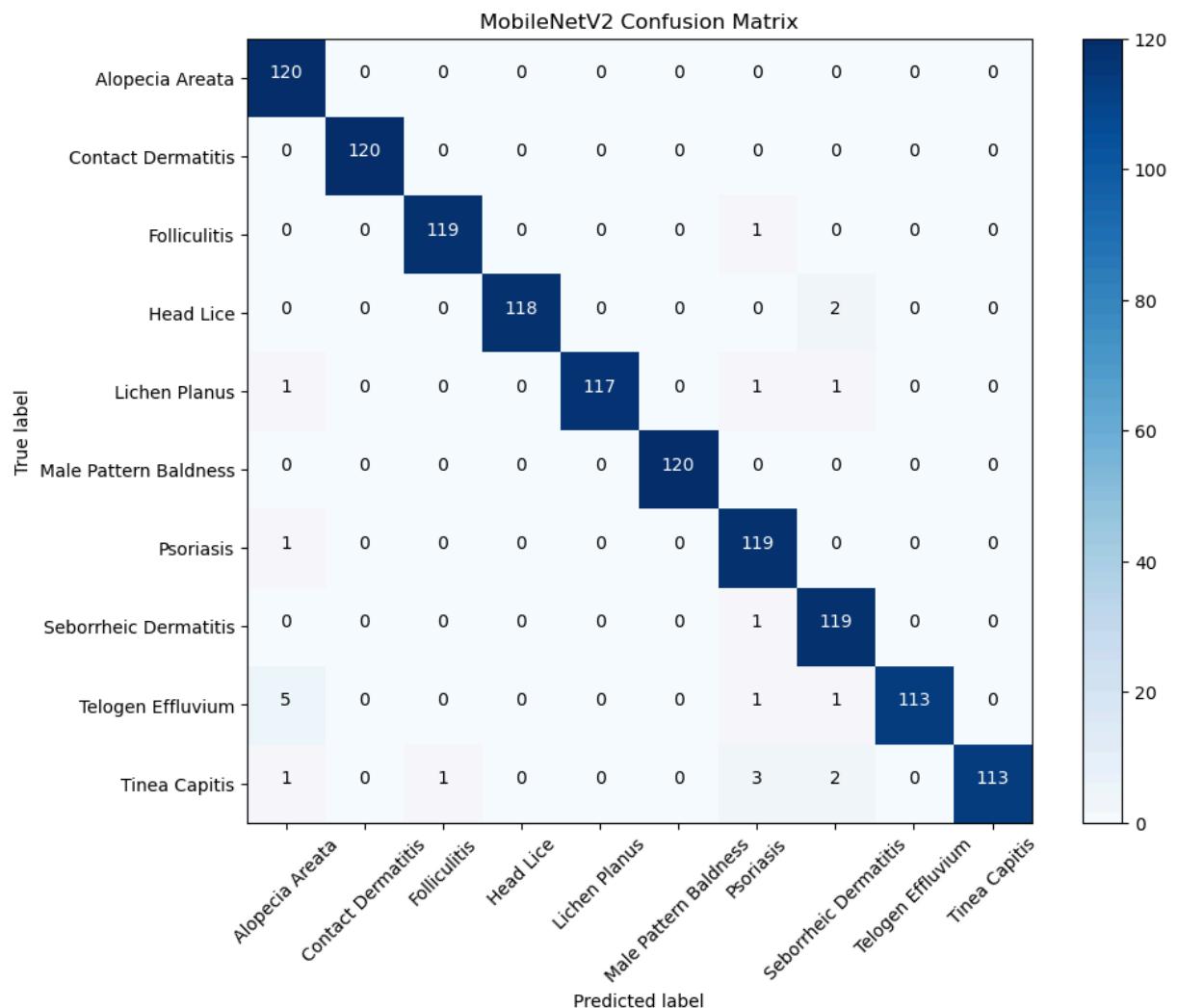
    # Plot precision-recall curve for each class
    plt.figure(figsize=(8, 6))
    colors = ['navy', 'turquoise', 'darkorange', 'cornflowerblue', 'teal', 'red',
              'purple', 'yellow', 'green', 'darkred']
    for i, color in zip(range(len(classes)), colors):
        plt.plot(recall[i], precision[i], color=color, lw=2,
                 label=f'Precision-recall curve of class {classes[i]} (AP = {average_precision[i]:.2f})')

    plt.xlabel('Recall')
    plt.ylabel('Precision')
    plt.xlim([0.0, 1.0])
    plt.ylim([0.0, 1.05])
    plt.title('Precision-Recall curve')
    plt.legend(loc="lower right")
    plt.show()

# Plot precision-recall curve
plot_precision_recall_curve(y_true, y_pred, classes)
```



```
In [39]: # Plot the confusion matrix  
plot_confusion_matrix(cm=conf_matrix, target_names=classes, title='MobileNetV2 Confusion Matrix')
```



MODEL2 : InceptionV3 model

```
In [55]: from tensorflow.keras.applications import InceptionV3
from tensorflow.keras.layers import Flatten, Dense, Dropout
from tensorflow.keras.models import Model
from tensorflow.keras.optimizers import Adam

# Define a function to adjust learning rate during training
def lr_schedule(epoch):
    lr = 0.001
    if epoch > 10:
        lr *= 0.1
    return lr

# Load the pre-trained InceptionV3 model
base_model = InceptionV3(input_shape=(224, 224, 3), weights='imagenet', include_top=False)

# Add custom top layers for classification
x = Flatten()(base_model.output)
x = Dense(512, activation='relu')(x)
x = Dropout(0.5)(x)
prediction_layer = Dense(len(classes), activation='softmax')(x)
model = Model(inputs=base_model.input, outputs=prediction_layer)

# Freeze base layers
for layer in base_model.layers:
    layer.trainable = False

# Compile the model with Adam optimizer and custom learning rate
model.compile(optimizer=Adam(), loss='categorical_crossentropy', metrics=['accuracy'])
model.summary()
```

Model: "functional_12"

Layer (type)	Output Shape	Param #	Connected to
input_layer_7 (InputLayer)	(None, 224, 224, 3)	0	-
conv2d_379 (Conv2D)	(None, 111, 111, 32)	864	input_layer_7[0]...
batch_normalizatio... (BatchNormalizatio...)	(None, 111, 111, 32)	96	conv2d_379[0][0]
activation_376 (Activation)	(None, 111, 111, 32)	0	batch_normalizat...
conv2d_380 (Conv2D)	(None, 109, 109, 32)	9,216	activation_376[0]...
batch_normalizatio... (BatchNormalizatio...)	(None, 109, 109, 32)	96	conv2d_380[0][0]
activation_377 (Activation)	(None, 109, 109, 32)	0	batch_normalizat...
conv2d_381 (Conv2D)	(None, 109, 109, 64)	18,432	activation_377[0]...
batch_normalizatio... (BatchNormalizatio...)	(None, 109, 109, 64)	192	conv2d_381[0][0]
activation_378 (Activation)	(None, 109, 109, 64)	0	batch_normalizat...
max_pooling2d_19 (MaxPooling2D)	(None, 54, 54, 64)	0	activation_378[0]...
conv2d_382 (Conv2D)	(None, 54, 54, 80)	5,120	max_pooling2d_19...
batch_normalizatio... (BatchNormalizatio...)	(None, 54, 54, 80)	240	conv2d_382[0][0]
activation_379 (Activation)	(None, 54, 54, 80)	0	batch_normalizat...
conv2d_383 (Conv2D)	(None, 52, 52, 192)	138,240	activation_379[0]...
batch_normalizatio... (BatchNormalizatio...)	(None, 52, 52, 192)	576	conv2d_383[0][0]
activation_380 (Activation)	(None, 52, 52, 192)	0	batch_normalizat...
max_pooling2d_20 (MaxPooling2D)	(None, 25, 25, 192)	0	activation_380[0]...
conv2d_387 (Conv2D)	(None, 25, 25, 64)	12,288	max_pooling2d_20...
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 64)	192	conv2d_387[0][0]
activation_384	(None, 25, 25,	0	batch_normalizat...

(Activation)	64)		
conv2d_385 (Conv2D)	(None, 25, 25, 48)	9,216	max_pooling2d_20...
conv2d_388 (Conv2D)	(None, 25, 25, 96)	55,296	activation_384[0...
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 48)	144	conv2d_385[0] [0]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 96)	288	conv2d_388[0] [0]
activation_382 (Activation)	(None, 25, 25, 48)	0	batch_normalizat...
activation_385 (Activation)	(None, 25, 25, 96)	0	batch_normalizat...
average_pooling2d_... (AveragePooling2D)	(None, 25, 25, 192)	0	max_pooling2d_20...
conv2d_384 (Conv2D)	(None, 25, 25, 64)	12,288	max_pooling2d_20...
conv2d_386 (Conv2D)	(None, 25, 25, 64)	76,800	activation_382[0...
conv2d_389 (Conv2D)	(None, 25, 25, 96)	82,944	activation_385[0...
conv2d_390 (Conv2D)	(None, 25, 25, 32)	6,144	average_pooling2...
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 64)	192	conv2d_384[0] [0]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 64)	192	conv2d_386[0] [0]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 96)	288	conv2d_389[0] [0]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 32)	96	conv2d_390[0] [0]
activation_381 (Activation)	(None, 25, 25, 64)	0	batch_normalizat...
activation_383 (Activation)	(None, 25, 25, 64)	0	batch_normalizat...
activation_386 (Activation)	(None, 25, 25, 96)	0	batch_normalizat...
activation_387 (Activation)	(None, 25, 25, 32)	0	batch_normalizat...
mixed0 (Concatenate)	(None, 25, 25, 256)	0	activation_381[0... activation_383[0... activation_386[0... activation_387[0...

conv2d_394 (Conv2D)	(None, 25, 25, 64)	16,384	mixed0[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 64)	192	conv2d_394[0][0]
activation_391 (Activation)	(None, 25, 25, 64)	0	batch_normalizat...
conv2d_392 (Conv2D)	(None, 25, 25, 48)	12,288	mixed0[0][0]
conv2d_395 (Conv2D)	(None, 25, 25, 96)	55,296	activation_391[0...]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 48)	144	conv2d_392[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 96)	288	conv2d_395[0][0]
activation_389 (Activation)	(None, 25, 25, 48)	0	batch_normalizat...
activation_392 (Activation)	(None, 25, 25, 96)	0	batch_normalizat...
average_pooling2d... (AveragePooling2D)	(None, 25, 25, 256)	0	mixed0[0][0]
conv2d_391 (Conv2D)	(None, 25, 25, 64)	16,384	mixed0[0][0]
conv2d_393 (Conv2D)	(None, 25, 25, 64)	76,800	activation_389[0...]
conv2d_396 (Conv2D)	(None, 25, 25, 96)	82,944	activation_392[0...]
conv2d_397 (Conv2D)	(None, 25, 25, 64)	16,384	average_pooling2...
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 64)	192	conv2d_391[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 64)	192	conv2d_393[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 96)	288	conv2d_396[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 64)	192	conv2d_397[0][0]
activation_388 (Activation)	(None, 25, 25, 64)	0	batch_normalizat...
activation_390 (Activation)	(None, 25, 25, 64)	0	batch_normalizat...
activation_393 (Activation)	(None, 25, 25, 96)	0	batch_normalizat...
activation_394	(None, 25, 25,	0	batch_normalizat...

(Activation)	64)		
mixed1 (Concatenate)	(None, 25, 25, 288)	0	activation_388[0... activation_390[0... activation_393[0... activation_394[0...
conv2d_401 (Conv2D)	(None, 25, 25, 64)	18,432	mixed1[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 64)	192	conv2d_401[0][0]
activation_398 (Activation)	(None, 25, 25, 64)	0	batch_normalizat...
conv2d_399 (Conv2D)	(None, 25, 25, 48)	13,824	mixed1[0][0]
conv2d_402 (Conv2D)	(None, 25, 25, 96)	55,296	activation_398[0...
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 48)	144	conv2d_399[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 96)	288	conv2d_402[0][0]
activation_396 (Activation)	(None, 25, 25, 48)	0	batch_normalizat...
activation_399 (Activation)	(None, 25, 25, 96)	0	batch_normalizat...
average_pooling2d... (AveragePooling2D)	(None, 25, 25, 288)	0	mixed1[0][0]
conv2d_398 (Conv2D)	(None, 25, 25, 64)	18,432	mixed1[0][0]
conv2d_400 (Conv2D)	(None, 25, 25, 64)	76,800	activation_396[0...
conv2d_403 (Conv2D)	(None, 25, 25, 96)	82,944	activation_399[0...
conv2d_404 (Conv2D)	(None, 25, 25, 64)	18,432	average_pooling2...
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 64)	192	conv2d_398[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 64)	192	conv2d_400[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 96)	288	conv2d_403[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 64)	192	conv2d_404[0][0]
activation_395 (Activation)	(None, 25, 25, 64)	0	batch_normalizat...

activation_397 (Activation)	(None, 25, 25, 64)	0	batch_normalizat...
activation_400 (Activation)	(None, 25, 25, 96)	0	batch_normalizat...
activation_401 (Activation)	(None, 25, 25, 64)	0	batch_normalizat...
mixed2 (Concatenate)	(None, 25, 25, 288)	0	activation_395[0... activation_397[0... activation_400[0... activation_401[0...
conv2d_406 (Conv2D)	(None, 25, 25, 64)	18,432	mixed2[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 64)	192	conv2d_406[0][0]
activation_403 (Activation)	(None, 25, 25, 64)	0	batch_normalizat...
conv2d_407 (Conv2D)	(None, 25, 25, 96)	55,296	activation_403[0...
batch_normalizatio... (BatchNormalizatio...)	(None, 25, 25, 96)	288	conv2d_407[0][0]
activation_404 (Activation)	(None, 25, 25, 96)	0	batch_normalizat...
conv2d_405 (Conv2D)	(None, 12, 12, 384)	995,328	mixed2[0][0]
conv2d_408 (Conv2D)	(None, 12, 12, 96)	82,944	activation_404[0...
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 384)	1,152	conv2d_405[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 96)	288	conv2d_408[0][0]
activation_402 (Activation)	(None, 12, 12, 384)	0	batch_normalizat...
activation_405 (Activation)	(None, 12, 12, 96)	0	batch_normalizat...
max_pooling2d_21 (MaxPooling2D)	(None, 12, 12, 288)	0	mixed2[0][0]
mixed3 (Concatenate)	(None, 12, 12, 768)	0	activation_402[0... activation_405[0... max_pooling2d_21...
conv2d_413 (Conv2D)	(None, 12, 12, 128)	98,304	mixed3[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 128)	384	conv2d_413[0][0]
activation_410	(None, 12, 12,	0	batch_normalizat...

(Activation)	128)		
conv2d_414 (Conv2D)	(None, 12, 12, 128)	114,688	activation_410[0...]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 128)	384	conv2d_414[0] [0]
activation_411 (Activation)	(None, 12, 12, 128)	0	batch_normalizat...
conv2d_410 (Conv2D)	(None, 12, 12, 128)	98,304	mixed3[0] [0]
conv2d_415 (Conv2D)	(None, 12, 12, 128)	114,688	activation_411[0...]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 128)	384	conv2d_410[0] [0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 128)	384	conv2d_415[0] [0]
activation_407 (Activation)	(None, 12, 12, 128)	0	batch_normalizat...
activation_412 (Activation)	(None, 12, 12, 128)	0	batch_normalizat...
conv2d_411 (Conv2D)	(None, 12, 12, 128)	114,688	activation_407[0...]
conv2d_416 (Conv2D)	(None, 12, 12, 128)	114,688	activation_412[0...]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 128)	384	conv2d_411[0] [0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 128)	384	conv2d_416[0] [0]
activation_408 (Activation)	(None, 12, 12, 128)	0	batch_normalizat...
activation_413 (Activation)	(None, 12, 12, 128)	0	batch_normalizat...
average_pooling2d... (AveragePooling2D)	(None, 12, 12, 768)	0	mixed3[0] [0]
conv2d_409 (Conv2D)	(None, 12, 12, 192)	147,456	mixed3[0] [0]
conv2d_412 (Conv2D)	(None, 12, 12, 192)	172,032	activation_408[0...]
conv2d_417 (Conv2D)	(None, 12, 12, 192)	172,032	activation_413[0...]
conv2d_418 (Conv2D)	(None, 12, 12, 192)	147,456	average_pooling2...
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_409[0] [0]

batch_normalization_412 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_412[0][0]
batch_normalization_417 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_417[0][0]
batch_normalization_418 (BatchNormalization)	(None, 12, 12, 192)	576	conv2d_418[0][0]
activation_406 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
activation_409 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
activation_414 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
activation_415 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
mixed4 (Concatenate)	(None, 12, 12, 768)	0	activation_406[0]... activation_409[0]... activation_414[0]... activation_415[0]...
conv2d_423 (Conv2D)	(None, 12, 12, 160)	122,880	mixed4[0][0]
batch_normalization_423 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_423[0][0]
activation_420 (Activation)	(None, 12, 12, 160)	0	batch_normalizat...
conv2d_424 (Conv2D)	(None, 12, 12, 160)	179,200	activation_420[0]...
batch_normalization_424 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_424[0][0]
activation_421 (Activation)	(None, 12, 12, 160)	0	batch_normalizat...
conv2d_420 (Conv2D)	(None, 12, 12, 160)	122,880	mixed4[0][0]
conv2d_425 (Conv2D)	(None, 12, 12, 160)	179,200	activation_421[0]...
batch_normalization_420 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_420[0][0]
batch_normalization_425 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_425[0][0]
activation_417 (Activation)	(None, 12, 12, 160)	0	batch_normalizat...
activation_422 (Activation)	(None, 12, 12, 160)	0	batch_normalizat...
conv2d_421 (Conv2D)	(None, 12, 12,	179,200	activation_417[0]...

	160)		
conv2d_426 (Conv2D)	(None, 12, 12, 160)	179,200	activation_422[0...]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 160)	480	conv2d_421[0] [0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 160)	480	conv2d_426[0] [0]
activation_418 (Activation)	(None, 12, 12, 160)	0	batch_normalizat...
activation_423 (Activation)	(None, 12, 12, 160)	0	batch_normalizat...
average_pooling2d... (AveragePooling2D)	(None, 12, 12, 768)	0	mixed4[0] [0]
conv2d_419 (Conv2D)	(None, 12, 12, 192)	147,456	mixed4[0] [0]
conv2d_422 (Conv2D)	(None, 12, 12, 192)	215,040	activation_418[0...]
conv2d_427 (Conv2D)	(None, 12, 12, 192)	215,040	activation_423[0...]
conv2d_428 (Conv2D)	(None, 12, 12, 192)	147,456	average_pooling2...
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_419[0] [0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_422[0] [0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_427[0] [0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_428[0] [0]
activation_416 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
activation_419 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
activation_424 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
activation_425 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
mixed5 (Concatenate)	(None, 12, 12, 768)	0	activation_416[0...] activation_419[0...] activation_424[0...] activation_425[0...]
conv2d_433 (Conv2D)	(None, 12, 12, 160)	122,880	mixed5[0] [0]

batch_normalization_430 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_433[0][0]
activation_430 (Activation)	(None, 12, 12, 160)	0	batch_normalizat...
conv2d_434 (Conv2D)	(None, 12, 12, 160)	179,200	activation_430[0...
batch_normalization_431 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_434[0][0]
activation_431 (Activation)	(None, 12, 12, 160)	0	batch_normalizat...
conv2d_430 (Conv2D)	(None, 12, 12, 160)	122,880	mixed5[0][0]
conv2d_435 (Conv2D)	(None, 12, 12, 160)	179,200	activation_431[0...
batch_normalization_432 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_430[0][0]
batch_normalization_433 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_435[0][0]
activation_427 (Activation)	(None, 12, 12, 160)	0	batch_normalizat...
activation_432 (Activation)	(None, 12, 12, 160)	0	batch_normalizat...
conv2d_431 (Conv2D)	(None, 12, 12, 160)	179,200	activation_427[0...
conv2d_436 (Conv2D)	(None, 12, 12, 160)	179,200	activation_432[0...
batch_normalization_434 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_431[0][0]
batch_normalization_435 (BatchNormalization)	(None, 12, 12, 160)	480	conv2d_436[0][0]
activation_428 (Activation)	(None, 12, 12, 160)	0	batch_normalizat...
activation_433 (Activation)	(None, 12, 12, 160)	0	batch_normalizat...
average_pooling2d_436 (AveragePooling2D)	(None, 12, 12, 768)	0	mixed5[0][0]
conv2d_429 (Conv2D)	(None, 12, 12, 192)	147,456	mixed5[0][0]
conv2d_432 (Conv2D)	(None, 12, 12, 192)	215,040	activation_428[0...
conv2d_437 (Conv2D)	(None, 12, 12, 192)	215,040	activation_433[0...
conv2d_438 (Conv2D)	(None, 12, 12,	147,456	average_pooling2...

	192)		
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_429[0] [0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_432[0] [0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_437[0] [0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_438[0] [0]
activation_426 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
activation_429 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
activation_434 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
activation_435 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
mixed6 (Concatenate)	(None, 12, 12, 768)	0	activation_426[0]... activation_429[0]... activation_434[0]... activation_435[0]...
conv2d_443 (Conv2D)	(None, 12, 12, 192)	147,456	mixed6[0] [0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_443[0] [0]
activation_440 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
conv2d_444 (Conv2D)	(None, 12, 12, 192)	258,048	activation_440[0]...
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_444[0] [0]
activation_441 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
conv2d_440 (Conv2D)	(None, 12, 12, 192)	147,456	mixed6[0] [0]
conv2d_445 (Conv2D)	(None, 12, 12, 192)	258,048	activation_441[0]...
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_440[0] [0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_445[0] [0]
activation_437 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...

activation_442 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
conv2d_441 (Conv2D)	(None, 12, 12, 192)	258,048	activation_437[0...]
conv2d_446 (Conv2D)	(None, 12, 12, 192)	258,048	activation_442[0...]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_441[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_446[0][0]
activation_438 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
activation_443 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
average_pooling2d_... (AveragePooling2D)	(None, 12, 12, 768)	0	mixed6[0][0]
conv2d_439 (Conv2D)	(None, 12, 12, 192)	147,456	mixed6[0][0]
conv2d_442 (Conv2D)	(None, 12, 12, 192)	258,048	activation_438[0...]
conv2d_447 (Conv2D)	(None, 12, 12, 192)	258,048	activation_443[0...]
conv2d_448 (Conv2D)	(None, 12, 12, 192)	147,456	average_pooling2...
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_439[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_442[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_447[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_448[0][0]
activation_436 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
activation_439 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
activation_444 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
activation_445 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
mixed7 (Concatenate)	(None, 12, 12, 768)	0	activation_436[0...] activation_439[0...] activation_444[0...] activation_445[0...]

conv2d_451 (Conv2D)	(None, 12, 12, 192)	147,456	mixed7[0][0]
batch_normalization... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_451[0][0]
activation_448 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
conv2d_452 (Conv2D)	(None, 12, 12, 192)	258,048	activation_448[0...
batch_normalization... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_452[0][0]
activation_449 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
conv2d_449 (Conv2D)	(None, 12, 12, 192)	147,456	mixed7[0][0]
conv2d_453 (Conv2D)	(None, 12, 12, 192)	258,048	activation_449[0...
batch_normalization... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_449[0][0]
batch_normalization... (BatchNormalizatio...)	(None, 12, 12, 192)	576	conv2d_453[0][0]
activation_446 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
activation_450 (Activation)	(None, 12, 12, 192)	0	batch_normalizat...
conv2d_450 (Conv2D)	(None, 5, 5, 320)	552,960	activation_446[0...
conv2d_454 (Conv2D)	(None, 5, 5, 192)	331,776	activation_450[0...
batch_normalization... (BatchNormalizatio...)	(None, 5, 5, 320)	960	conv2d_450[0][0]
batch_normalization... (BatchNormalizatio...)	(None, 5, 5, 192)	576	conv2d_454[0][0]
activation_447 (Activation)	(None, 5, 5, 320)	0	batch_normalizat...
activation_451 (Activation)	(None, 5, 5, 192)	0	batch_normalizat...
max_pooling2d_22 (MaxPooling2D)	(None, 5, 5, 768)	0	mixed7[0][0]
mixed8 (Concatenate)	(None, 5, 5, 1280)	0	activation_447[0... activation_451[0... max_pooling2d_22...
conv2d_459 (Conv2D)	(None, 5, 5, 448)	573,440	mixed8[0][0]
batch_normalization... (BatchNormalizatio...)	(None, 5, 5, 448)	1,344	conv2d_459[0][0]

activation_456 (Activation)	(None, 5, 5, 448)	0	batch_normalizat...
conv2d_456 (Conv2D)	(None, 5, 5, 384)	491,520	mixed8[0][0]
conv2d_460 (Conv2D)	(None, 5, 5, 384)	1,548,288	activation_456[0...]
batch_normalizatio... (BatchNormalizatio...)	(None, 5, 5, 384)	1,152	conv2d_456[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 5, 5, 384)	1,152	conv2d_460[0][0]
activation_453 (Activation)	(None, 5, 5, 384)	0	batch_normalizat...
activation_457 (Activation)	(None, 5, 5, 384)	0	batch_normalizat...
conv2d_457 (Conv2D)	(None, 5, 5, 384)	442,368	activation_453[0...]
conv2d_458 (Conv2D)	(None, 5, 5, 384)	442,368	activation_453[0...]
conv2d_461 (Conv2D)	(None, 5, 5, 384)	442,368	activation_457[0...]
conv2d_462 (Conv2D)	(None, 5, 5, 384)	442,368	activation_457[0...]
average_pooling2d_... (AveragePooling2D)	(None, 5, 5, 1280)	0	mixed8[0][0]
conv2d_455 (Conv2D)	(None, 5, 5, 320)	409,600	mixed8[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 5, 5, 384)	1,152	conv2d_457[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 5, 5, 384)	1,152	conv2d_458[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 5, 5, 384)	1,152	conv2d_461[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 5, 5, 384)	1,152	conv2d_462[0][0]
conv2d_463 (Conv2D)	(None, 5, 5, 192)	245,760	average_pooling2...
batch_normalizatio... (BatchNormalizatio...)	(None, 5, 5, 320)	960	conv2d_455[0][0]
activation_454 (Activation)	(None, 5, 5, 384)	0	batch_normalizat...
activation_455 (Activation)	(None, 5, 5, 384)	0	batch_normalizat...
activation_458 (Activation)	(None, 5, 5, 384)	0	batch_normalizat...
activation_459 (Activation)	(None, 5, 5, 384)	0	batch_normalizat...
batch_normalizatio... (BatchNormalizatio...)	(None, 5, 5, 192)	576	conv2d_463[0][0]

activation_452 (Activation)	(None, 5, 5, 320)	0	batch_normalizat...
mixed9_0 (Concatenate)	(None, 5, 5, 768)	0	activation_454[0... activation_455[0...
concatenate_8 (Concatenate)	(None, 5, 5, 768)	0	activation_458[0... activation_459[0...
activation_460 (Activation)	(None, 5, 5, 192)	0	batch_normalizat...
mixed9 (Concatenate)	(None, 5, 5, 2048)	0	activation_452[0... mixed9_0[0][0], concatenate_8[0]... activation_460[0...
conv2d_468 (Conv2D)	(None, 5, 5, 448)	917,504	mixed9[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 5, 5, 448)	1,344	conv2d_468[0][0]
activation_465 (Activation)	(None, 5, 5, 448)	0	batch_normalizat...
conv2d_465 (Conv2D)	(None, 5, 5, 384)	786,432	mixed9[0][0]
conv2d_469 (Conv2D)	(None, 5, 5, 384)	1,548,288	activation_465[0...
batch_normalizatio... (BatchNormalizatio...)	(None, 5, 5, 384)	1,152	conv2d_465[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 5, 5, 384)	1,152	conv2d_469[0][0]
activation_462 (Activation)	(None, 5, 5, 384)	0	batch_normalizat...
activation_466 (Activation)	(None, 5, 5, 384)	0	batch_normalizat...
conv2d_466 (Conv2D)	(None, 5, 5, 384)	442,368	activation_462[0...
conv2d_467 (Conv2D)	(None, 5, 5, 384)	442,368	activation_462[0...
conv2d_470 (Conv2D)	(None, 5, 5, 384)	442,368	activation_466[0...
conv2d_471 (Conv2D)	(None, 5, 5, 384)	442,368	activation_466[0...
average_pooling2d_... (AveragePooling2D)	(None, 5, 5, 2048)	0	mixed9[0][0]
conv2d_464 (Conv2D)	(None, 5, 5, 320)	655,360	mixed9[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 5, 5, 384)	1,152	conv2d_466[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 5, 5, 384)	1,152	conv2d_467[0][0]
batch_normalizatio... (BatchNormalizatio...)	(None, 5, 5, 384)	1,152	conv2d_470[0][0]

batch_normalization_463 (BatchNormalization)	(None, 5, 5, 384)	1,152	conv2d_471[0][0]
conv2d_472 (Conv2D)	(None, 5, 5, 192)	393,216	average_pooling2d_473[0][0]
batch_normalization_464 (BatchNormalization)	(None, 5, 5, 320)	960	conv2d_464[0][0]
activation_463 (Activation)	(None, 5, 5, 384)	0	batch_normalization_463[0][0]
activation_464 (Activation)	(None, 5, 5, 384)	0	batch_normalization_464[0][0]
activation_467 (Activation)	(None, 5, 5, 384)	0	batch_normalization_467[0][0]
activation_468 (Activation)	(None, 5, 5, 384)	0	batch_normalization_468[0][0]
batch_normalization_469 (BatchNormalization)	(None, 5, 5, 192)	576	conv2d_472[0][0]
activation_461 (Activation)	(None, 5, 5, 320)	0	batch_normalization_461[0][0]
mixed9_1 (Concatenate)	(None, 5, 5, 768)	0	activation_463[0][0], activation_464[0][0]
concatenate_9 (Concatenate)	(None, 5, 5, 768)	0	activation_467[0][0], activation_468[0][0]
activation_469 (Activation)	(None, 5, 5, 192)	0	batch_normalization_469[0][0]
mixed10 (Concatenate)	(None, 5, 5, 2048)	0	activation_461[0][0], mixed9_1[0][0], concatenate_9[0][0], activation_469[0][0]
flatten_6 (Flatten)	(None, 51200)	0	mixed10[0][0]
dense_11 (Dense)	(None, 512)	26,214,912	flatten_6[0][0]
dropout_6 (Dropout)	(None, 512)	0	dense_11[0][0]
dense_12 (Dense)	(None, 10)	5,130	dropout_6[0][0]

Total params: 48,022,826 (183.19 MB)

Trainable params: 26,220,042 (100.02 MB)

Non-trainable params: 21,802,784 (83.17 MB)

In [56]:

```
# Compile the model with Adam optimizer and the specified learning rate
model.compile(optimizer=Adam(learning_rate=learning_rate), loss='categorical_crossentropy')

# Define callbacks for learning rate scheduling
lr_scheduler = LearningRateScheduler(lr_schedule)

# Train the model with data augmentation and learning rate scheduling
history = model.fit(train_generator, validation_data=val_generator, epochs=20)

# Evaluate the model
test_loss, test_accuracy = model.evaluate(test_generator)
print('Test accuracy:', test_accuracy)
```

Epoch 1/20
300/300 516s 2s/step - accuracy: 0.2698 - loss: 8.1084
- val_accuracy: 0.5075 - val_loss: 1.4796 - learning_rate: 0.0010

Epoch 2/20
300/300 507s 2s/step - accuracy: 0.3724 - loss: 1.7239
- val_accuracy: 0.5767 - val_loss: 1.2835 - learning_rate: 0.0010

Epoch 3/20
300/300 497s 2s/step - accuracy: 0.4127 - loss: 1.5636
- val_accuracy: 0.7008 - val_loss: 0.9620 - learning_rate: 0.0010

Epoch 4/20
300/300 1541s 5s/step - accuracy: 0.4430 - loss: 1.4822
- val_accuracy: 0.7408 - val_loss: 0.7734 - learning_rate: 0.0010

Epoch 5/20
300/300 2470s 8s/step - accuracy: 0.4918 - loss: 1.3582
- val_accuracy: 0.7783 - val_loss: 0.7338 - learning_rate: 0.0010

Epoch 6/20
300/300 698s 2s/step - accuracy: 0.5052 - loss: 1.3216
- val_accuracy: 0.8100 - val_loss: 0.6887 - learning_rate: 0.0010

Epoch 7/20
300/300 750s 2s/step - accuracy: 0.5359 - loss: 1.2166
- val_accuracy: 0.7983 - val_loss: 0.6100 - learning_rate: 0.0010

Epoch 8/20
300/300 476s 2s/step - accuracy: 0.5362 - loss: 1.2341
- val_accuracy: 0.8217 - val_loss: 0.5859 - learning_rate: 0.0010

Epoch 9/20
300/300 379s 1s/step - accuracy: 0.5733 - loss: 1.1396
- val_accuracy: 0.8342 - val_loss: 0.5400 - learning_rate: 0.0010

Epoch 10/20
300/300 368s 1s/step - accuracy: 0.5798 - loss: 1.1041
- val_accuracy: 0.8508 - val_loss: 0.4613 - learning_rate: 0.0010

Epoch 11/20
300/300 358s 1s/step - accuracy: 0.5888 - loss: 1.0912
- val_accuracy: 0.8633 - val_loss: 0.4814 - learning_rate: 0.0010

Epoch 12/20
300/300 355s 1s/step - accuracy: 0.6296 - loss: 0.9735
- val_accuracy: 0.8867 - val_loss: 0.3743 - learning_rate: 1.0000e-04

Epoch 13/20
300/300 3160s 11s/step - accuracy: 0.6545 - loss: 0.912
1 - val_accuracy: 0.8933 - val_loss: 0.3694 - learning_rate: 1.0000e-04

Epoch 14/20
300/300 244s 801ms/step - accuracy: 0.6551 - loss: 0.91
57 - val_accuracy: 0.8958 - val_loss: 0.3523 - learning_rate: 1.0000e-04

Epoch 15/20
300/300 230s 761ms/step - accuracy: 0.6631 - loss: 0.87
48 - val_accuracy: 0.8858 - val_loss: 0.3581 - learning_rate: 1.0000e-04

Epoch 16/20
300/300 250s 827ms/step - accuracy: 0.6640 - loss: 0.86
91 - val_accuracy: 0.9075 - val_loss: 0.3235 - learning_rate: 1.0000e-04

Epoch 17/20
300/300 1509s 5s/step - accuracy: 0.6605 - loss: 0.8857
- val_accuracy: 0.9008 - val_loss: 0.3429 - learning_rate: 1.0000e-04

Epoch 18/20
300/300 227s 750ms/step - accuracy: 0.6738 - loss: 0.84
28 - val_accuracy: 0.9083 - val_loss: 0.3063 - learning_rate: 1.0000e-04

Epoch 19/20
300/300 240s 794ms/step - accuracy: 0.6992 - loss: 0.80
85 - val_accuracy: 0.9133 - val_loss: 0.3161 - learning_rate: 1.0000e-04

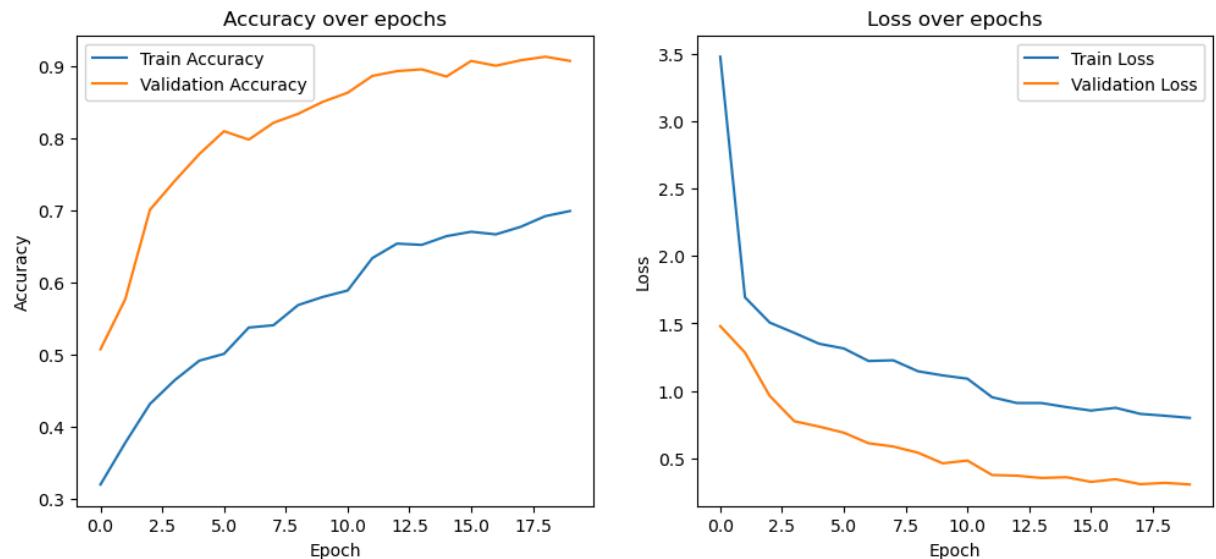
Epoch 20/20
300/300 1040s 3s/step - accuracy: 0.6993 - loss: 0.8039
- val_accuracy: 0.9075 - val_loss: 0.3040 - learning_rate: 1.0000e-04

38/38 ━━━━━━━━ 22s 583ms/step - accuracy: 0.9308 - loss: 0.2059
Test accuracy: 0.9024999737739563

```
In [57]: # Plot the training history
plt.figure(figsize=(12, 5))
plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'], label='Train Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.title('Accuracy over epochs')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()

plt.subplot(1, 2, 2)
plt.plot(history.history['loss'], label='Train Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.title('Loss over epochs')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()
```

Out[57]: <matplotlib.legend.Legend at 0x29f67f2d0>



```
In [58]: from sklearn.metrics import classification_report

# Generate predictions on the test set
y_pred = model.predict(test_generator)
y_pred_classes = np.argmax(y_pred, axis=1)

# Obtain true labels from the test generator
y_true = test_generator.classes

# Generate classification report
classification_rep = classification_report(y_true, y_pred_classes, target_names)
print(classification_rep)
```

	precision	recall	f1-score	support
Alopecia Areata	0.98	0.89	0.93	120
Contact Dermatitis	0.98	0.99	0.99	120
Folliculitis	0.95	0.99	0.97	120
Head Lice	0.97	0.97	0.97	120
Lichen Planus	0.95	0.88	0.91	120
Male Pattern Baldness	0.98	0.97	0.98	120
Psoriasis	0.67	0.89	0.77	120
Seborrheic Dermatitis	0.94	0.75	0.83	120
Telogen Effluvium	0.89	0.96	0.92	120
Tinea Capitis	0.79	0.72	0.76	120
accuracy			0.90	1200
macro avg	0.91	0.90	0.90	1200
weighted avg	0.91	0.90	0.90	1200

```
In [59]: # Obtain true labels from the test generator
y_true = test_generator.classes
```

```
In [60]: # Calculate the confusion matrix
conf_matrix = confusion_matrix(y_true, y_pred_classes)
```

```
In [82]: # Function to plot the confusion matrix
def plot_confusion_matrix(cm, target_names, title='Confusion Matrix', cmap=None):
    import itertools
    if cmap is None:
        cmap = plt.get_cmap('Oranges')
    plt.figure(figsize=(10, 8))
    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(target_names))
    plt.xticks(tick_marks, target_names, rotation=45)
    plt.yticks(tick_marks, target_names)
    if normalize:
        cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]
        thresh = cm.max() / 1.5 if normalize else cm.max() / 2
        for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
            plt.text(j, i, "{:.2f}".format(cm[i, j]) if normalize else "{:,}").format(
                horizontalalignment="center",
                color="white" if cm[i, j] > thresh else "black")
    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')
    plt.show()
```

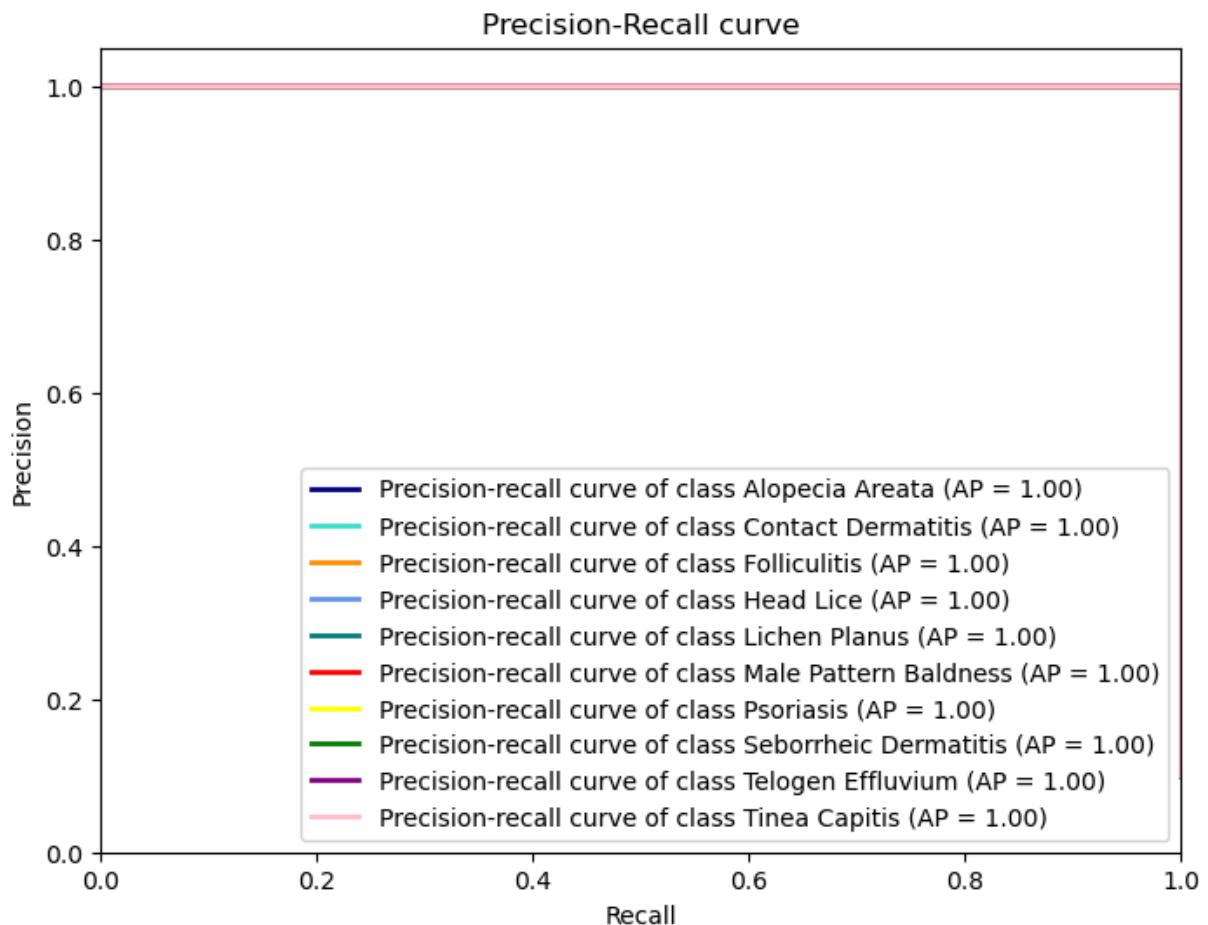
```
In [83]: from sklearn.metrics import precision_recall_curve, average_precision_score

def plot_precision_recall_curve(y_true, y_pred, classes):
    # Compute precision and recall for each class
    precision = dict()
    recall = dict()
    average_precision = dict()
    for i in range(len(classes)):
        precision[i], recall[i], _ = precision_recall_curve(y_true == i, y_pred)
        average_precision[i] = average_precision_score(y_true == i, y_pred[:, i])

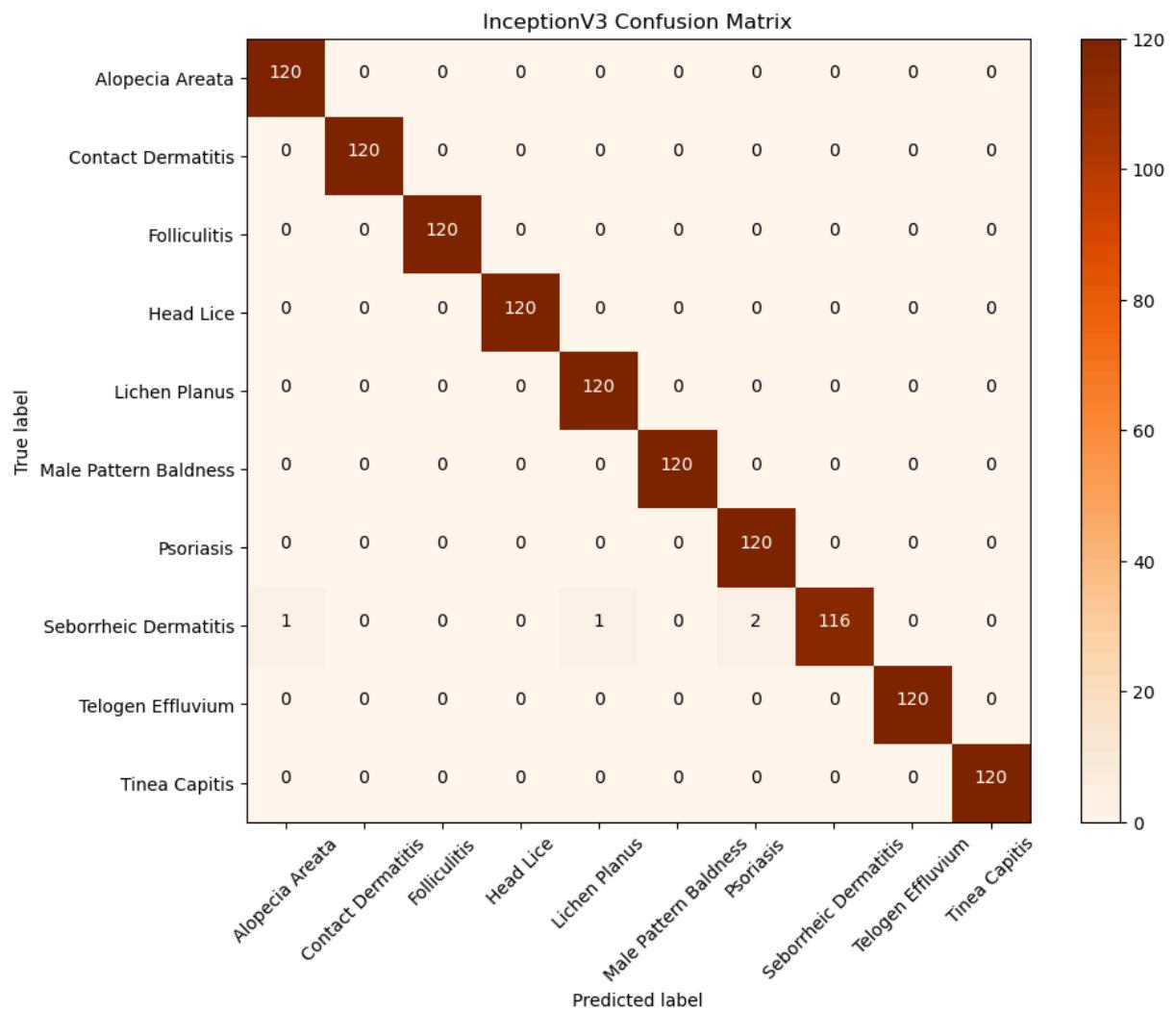
    # Plot precision-recall curve for each class
    plt.figure(figsize=(8, 6))
    colors = ['navy', 'turquoise', 'darkorange', 'cornflowerblue', 'teal', 'red',
              'purple', 'brown', 'pink', 'lightgreen']
    for i, color in zip(range(len(classes)), colors):
        plt.plot(recall[i], precision[i], color=color, lw=2,
                 label=f'Precision-recall curve of class {classes[i]} (AP = {average_precision[i]:.2f})')

    plt.xlabel('Recall')
    plt.ylabel('Precision')
    plt.xlim([0.0, 1.0])
    plt.ylim([0.0, 1.05])
    plt.title('Precision-Recall curve')
    plt.legend(loc="lower right")
    plt.show()

# Plot precision-recall curve
plot_precision_recall_curve(y_true, y_pred, classes)
```



```
In [84]: # Plot the confusion matrix  
plot_confusion_matrix(cm=conf_matrix, target_names=classes, title='InceptionV3 Confusion Matrix')
```



MODEL3 : DenseNet169 model

In [64]:

```
from tensorflow.keras.applications import DenseNet169
from tensorflow.keras.layers import Dense, GlobalAveragePooling2D, Dropout
from tensorflow.keras.models import Model
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.callbacks import LearningRateScheduler
from sklearn.metrics import classification_report

# Define a function to adjust learning rate during training
def lr_schedule(epoch):
    lr = 0.001
    if epoch > 10:
        lr *= 0.1
    return lr

# Load the pre-trained DenseNet169 model
base_model = DenseNet169(weights='imagenet', include_top=False)

# Add custom top layers for classification
x = base_model.output
x = GlobalAveragePooling2D()(x)
x = Dense(512, activation='relu')(x)
x = Dropout(0.5)(x)
predictions = Dense(len(classes), activation='softmax')(x)

# Create the model
model = Model(inputs=base_model.input, outputs=predictions)

# Freeze the base model layers
for layer in base_model.layers:
    layer.trainable = False

# Compile the model with Adam optimizer and custom learning rate
model.compile(optimizer=Adam(), loss='categorical_crossentropy', metrics=['accuracy'])

# Define callbacks for learning rate scheduling
lr_scheduler = LearningRateScheduler(lr_schedule)

model.summary()
```

Model: "functional_14"

Layer (type)	Output Shape	Param #	Connected to
input_layer_8 (InputLayer)	(None, None, None, 3)	0	-
zero_padding2d (ZeroPadding2D)	(None, None, None, 3)	0	input_layer_8[0]...
conv1_conv (Conv2D)	(None, None, None, 64)	9,408	zero_padding2d[0]...
conv1_bn (BatchNormalizatio...)	(None, None, None, 64)	256	conv1_conv[0][0]
conv1_relu (Activation)	(None, None, None, 64)	0	conv1_bn[0][0]
zero_padding2d_1 (ZeroPadding2D)	(None, None, None, 64)	0	conv1_relu[0][0]
pool1 (MaxPooling2D)	(None, None, None, 64)	0	zero_padding2d_1...
conv2_block1_0_bn (BatchNormalizatio...)	(None, None, None, 64)	256	pool1[0][0]
conv2_block1_0_relu (Activation)	(None, None, None, 64)	0	conv2_block1_0_b...
conv2_block1_1_conv (Conv2D)	(None, None, None, 128)	8,192	conv2_block1_0_r...
conv2_block1_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv2_block1_1_c...
conv2_block1_1_relu (Activation)	(None, None, None, 128)	0	conv2_block1_1_b...
conv2_block1_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv2_block1_1_r...
conv2_block1_concat (Concatenate)	(None, None, None, 96)	0	pool1[0][0], conv2_block1_2_c...
conv2_block2_0_bn (BatchNormalizatio...)	(None, None, None, 96)	384	conv2_block1_con...
conv2_block2_0_relu (Activation)	(None, None, None, 96)	0	conv2_block2_0_b...
conv2_block2_1_conv (Conv2D)	(None, None, None, 128)	12,288	conv2_block2_0_r...
conv2_block2_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv2_block2_1_c...
conv2_block2_1_relu (Activation)	(None, None, None, 128)	0	conv2_block2_1_b...
conv2_block2_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv2_block2_1_r...
conv2_block2_concat	(None, None,	0	conv2_block1_con...

(Concatenate)	None, 128)		conv2_block2_2_c...
conv2_block3_0_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv2_block2_con...
conv2_block3_0_relu (Activation)	(None, None, None, 128)	0	conv2_block3_0_b...
conv2_block3_1_conv (Conv2D)	(None, None, None, 128)	16,384	conv2_block3_0_r...
conv2_block3_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv2_block3_1_c...
conv2_block3_1_relu (Activation)	(None, None, None, 128)	0	conv2_block3_1_b...
conv2_block3_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv2_block3_1_r...
conv2_block3_concat (Concatenate)	(None, None, None, 160)	0	conv2_block2_con... conv2_block3_2_c...
conv2_block4_0_bn (BatchNormalizatio...)	(None, None, None, 160)	640	conv2_block3_con...
conv2_block4_0_relu (Activation)	(None, None, None, 160)	0	conv2_block4_0_b...
conv2_block4_1_conv (Conv2D)	(None, None, None, 128)	20,480	conv2_block4_0_r...
conv2_block4_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv2_block4_1_c...
conv2_block4_1_relu (Activation)	(None, None, None, 128)	0	conv2_block4_1_b...
conv2_block4_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv2_block4_1_r...
conv2_block4_concat (Concatenate)	(None, None, None, 192)	0	conv2_block3_con... conv2_block4_2_c...
conv2_block5_0_bn (BatchNormalizatio...)	(None, None, None, 192)	768	conv2_block4_con...
conv2_block5_0_relu (Activation)	(None, None, None, 192)	0	conv2_block5_0_b...
conv2_block5_1_conv (Conv2D)	(None, None, None, 128)	24,576	conv2_block5_0_r...
conv2_block5_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv2_block5_1_c...
conv2_block5_1_relu (Activation)	(None, None, None, 128)	0	conv2_block5_1_b...
conv2_block5_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv2_block5_1_r...
conv2_block5_concat (Concatenate)	(None, None, None, 224)	0	conv2_block4_con... conv2_block5_2_c...

conv2_block6_0_bn (BatchNormalizatio...)	(None, None, None, 224)	896	conv2_block5_con...
conv2_block6_0_relu (Activation)	(None, None, None, 224)	0	conv2_block6_0_b...
conv2_block6_1_conv (Conv2D)	(None, None, None, 128)	28,672	conv2_block6_0_r...
conv2_block6_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv2_block6_1_c...
conv2_block6_1_relu (Activation)	(None, None, None, 128)	0	conv2_block6_1_b...
conv2_block6_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv2_block6_1_r...
conv2_block6_concat (Concatenate)	(None, None, None, 256)	0	conv2_block5_con... conv2_block6_2_c...
pool2_bn (BatchNormalizatio...)	(None, None, None, 256)	1,024	conv2_block6_con...
pool2_relu (Activation)	(None, None, None, 256)	0	pool2_bn[0] [0]
pool2_conv (Conv2D)	(None, None, None, 128)	32,768	pool2_relu[0] [0]
pool2_pool (AveragePooling2D)	(None, None, None, 128)	0	pool2_conv[0] [0]
conv3_block1_0_bn (BatchNormalizatio...)	(None, None, None, 128)	512	pool2_pool[0] [0]
conv3_block1_0_relu (Activation)	(None, None, None, 128)	0	conv3_block1_0_b...
conv3_block1_1_conv (Conv2D)	(None, None, None, 128)	16,384	conv3_block1_0_r...
conv3_block1_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv3_block1_1_c...
conv3_block1_1_relu (Activation)	(None, None, None, 128)	0	conv3_block1_1_b...
conv3_block1_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv3_block1_1_r...
conv3_block1_concat (Concatenate)	(None, None, None, 160)	0	pool2_pool[0] [0], conv3_block1_2_c...
conv3_block2_0_bn (BatchNormalizatio...)	(None, None, None, 160)	640	conv3_block1_con...
conv3_block2_0_relu (Activation)	(None, None, None, 160)	0	conv3_block2_0_b...
conv3_block2_1_conv (Conv2D)	(None, None, None, 128)	20,480	conv3_block2_0_r...

conv3_block2_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv3_block2_1_c...
conv3_block2_1_relu (Activation)	(None, None, None, 128)	0	conv3_block2_1_b...
conv3_block2_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv3_block2_1_r...
conv3_block2_concat (Concatenate)	(None, None, None, 192)	0	conv3_block1_con... conv3_block2_2_c...
conv3_block3_0_bn (BatchNormalizatio...)	(None, None, None, 192)	768	conv3_block2_con...
conv3_block3_0_relu (Activation)	(None, None, None, 192)	0	conv3_block3_0_b...
conv3_block3_1_conv (Conv2D)	(None, None, None, 128)	24,576	conv3_block3_0_r...
conv3_block3_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv3_block3_1_c...
conv3_block3_1_relu (Activation)	(None, None, None, 128)	0	conv3_block3_1_b...
conv3_block3_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv3_block3_1_r...
conv3_block3_concat (Concatenate)	(None, None, None, 224)	0	conv3_block2_con... conv3_block3_2_c...
conv3_block4_0_bn (BatchNormalizatio...)	(None, None, None, 224)	896	conv3_block3_con...
conv3_block4_0_relu (Activation)	(None, None, None, 224)	0	conv3_block4_0_b...
conv3_block4_1_conv (Conv2D)	(None, None, None, 128)	28,672	conv3_block4_0_r...
conv3_block4_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv3_block4_1_c...
conv3_block4_1_relu (Activation)	(None, None, None, 128)	0	conv3_block4_1_b...
conv3_block4_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv3_block4_1_r...
conv3_block4_concat (Concatenate)	(None, None, None, 256)	0	conv3_block3_con... conv3_block4_2_c...
conv3_block5_0_bn (BatchNormalizatio...)	(None, None, None, 256)	1,024	conv3_block4_con...
conv3_block5_0_relu (Activation)	(None, None, None, 256)	0	conv3_block5_0_b...
conv3_block5_1_conv (Conv2D)	(None, None, None, 128)	32,768	conv3_block5_0_r...
conv3_block5_1_bn	(None, None,	512	conv3_block5_1_c...

(BatchNormalizatio...	None, 128)		
conv3_block5_1_relu (Activation)	(None, None, None, 128)	0	conv3_block5_1_b...
conv3_block5_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv3_block5_1_r...
conv3_block5_concat (Concatenate)	(None, None, None, 288)	0	conv3_block4_con... conv3_block5_2_c...
conv3_block6_0_bn (BatchNormalizatio...	(None, None, None, 288)	1,152	conv3_block5_con...
conv3_block6_0_relu (Activation)	(None, None, None, 288)	0	conv3_block6_0_b...
conv3_block6_1_conv (Conv2D)	(None, None, None, 128)	36,864	conv3_block6_0_r...
conv3_block6_1_bn (BatchNormalizatio...	(None, None, None, 128)	512	conv3_block6_1_c...
conv3_block6_1_relu (Activation)	(None, None, None, 128)	0	conv3_block6_1_b...
conv3_block6_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv3_block6_1_r...
conv3_block6_concat (Concatenate)	(None, None, None, 320)	0	conv3_block5_con... conv3_block6_2_c...
conv3_block7_0_bn (BatchNormalizatio...	(None, None, None, 320)	1,280	conv3_block6_con...
conv3_block7_0_relu (Activation)	(None, None, None, 320)	0	conv3_block7_0_b...
conv3_block7_1_conv (Conv2D)	(None, None, None, 128)	40,960	conv3_block7_0_r...
conv3_block7_1_bn (BatchNormalizatio...	(None, None, None, 128)	512	conv3_block7_1_c...
conv3_block7_1_relu (Activation)	(None, None, None, 128)	0	conv3_block7_1_b...
conv3_block7_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv3_block7_1_r...
conv3_block7_concat (Concatenate)	(None, None, None, 352)	0	conv3_block6_con... conv3_block7_2_c...
conv3_block8_0_bn (BatchNormalizatio...	(None, None, None, 352)	1,408	conv3_block7_con...
conv3_block8_0_relu (Activation)	(None, None, None, 352)	0	conv3_block8_0_b...
conv3_block8_1_conv (Conv2D)	(None, None, None, 128)	45,056	conv3_block8_0_r...
conv3_block8_1_bn (BatchNormalizatio...	(None, None, None, 128)	512	conv3_block8_1_c...

conv3_block8_1_relu (Activation)	(None, None, None, 128)	0	conv3_block8_1_b...
conv3_block8_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv3_block8_1_r...
conv3_block8_concat (Concatenate)	(None, None, None, 384)	0	conv3_block7_con... conv3_block8_2_c...
conv3_block9_0_bn (BatchNormalizatio...)	(None, None, None, 384)	1,536	conv3_block8_con...
conv3_block9_0_relu (Activation)	(None, None, None, 384)	0	conv3_block9_0_b...
conv3_block9_1_conv (Conv2D)	(None, None, None, 128)	49,152	conv3_block9_0_r...
conv3_block9_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv3_block9_1_c...
conv3_block9_1_relu (Activation)	(None, None, None, 128)	0	conv3_block9_1_b...
conv3_block9_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv3_block9_1_r...
conv3_block9_concat (Concatenate)	(None, None, None, 416)	0	conv3_block8_con... conv3_block9_2_c...
conv3_block10_0_bn (BatchNormalizatio...)	(None, None, None, 416)	1,664	conv3_block9_con...
conv3_block10_0_re... (Activation)	(None, None, None, 416)	0	conv3_block10_0_...
conv3_block10_1_co... (Conv2D)	(None, None, None, 128)	53,248	conv3_block10_0_...
conv3_block10_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv3_block10_1_...
conv3_block10_1_re... (Activation)	(None, None, None, 128)	0	conv3_block10_1_...
conv3_block10_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv3_block10_1_...
conv3_block10_concat... (Concatenate)	(None, None, None, 448)	0	conv3_block9_con... conv3_block10_2_...
conv3_block11_0_bn (BatchNormalizatio...)	(None, None, None, 448)	1,792	conv3_block10_co...
conv3_block11_0_re... (Activation)	(None, None, None, 448)	0	conv3_block11_0_...
conv3_block11_1_co... (Conv2D)	(None, None, None, 128)	57,344	conv3_block11_0_...
conv3_block11_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv3_block11_1_...

conv3_block11_1_re... (Activation)	(None, None, None, 128)	0	conv3_block11_1...
conv3_block11_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv3_block11_1...
conv3_block11_conc... (Concatenate)	(None, None, None, 480)	0	conv3_block10_co... conv3_block11_2...
conv3_block12_0_bn (BatchNormalizatio...)	(None, None, None, 480)	1,920	conv3_block11_co...
conv3_block12_0_re... (Activation)	(None, None, None, 480)	0	conv3_block12_0...
conv3_block12_1_co... (Conv2D)	(None, None, None, 128)	61,440	conv3_block12_0...
conv3_block12_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv3_block12_1...
conv3_block12_1_re... (Activation)	(None, None, None, 128)	0	conv3_block12_1...
conv3_block12_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv3_block12_1...
conv3_block12_conc... (Concatenate)	(None, None, None, 512)	0	conv3_block11_co... conv3_block12_2...
pool3_bn (BatchNormalizatio...)	(None, None, None, 512)	2,048	conv3_block12_co...
pool3_relu (Activation)	(None, None, None, 512)	0	pool3_bn[0] [0]
pool3_conv (Conv2D)	(None, None, None, 256)	131,072	pool3_relu[0] [0]
pool3_pool (AveragePooling2D)	(None, None, None, 256)	0	pool3_conv[0] [0]
conv4_block1_0_bn (BatchNormalizatio...)	(None, None, None, 256)	1,024	pool3_pool[0] [0]
conv4_block1_0_relu (Activation)	(None, None, None, 256)	0	conv4_block1_0_b...
conv4_block1_1_conv (Conv2D)	(None, None, None, 128)	32,768	conv4_block1_0_r...
conv4_block1_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block1_1_c...
conv4_block1_1_relu (Activation)	(None, None, None, 128)	0	conv4_block1_1_b...
conv4_block1_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv4_block1_1_r...
conv4_block1_concat (Concatenate)	(None, None, None, 288)	0	pool3_pool[0] [0], conv4_block1_2_c...
conv4_block2_0_bn	(None, None,	1,152	conv4_block1_con...

(BatchNormalizatio...	None, 288)		
conv4_block2_0_relu (Activation)	(None, None, None, 288)	0	conv4_block2_0_b...
conv4_block2_1_conv (Conv2D)	(None, None, None, 128)	36,864	conv4_block2_0_r...
conv4_block2_1_bn (BatchNormalizatio...	(None, None, None, 128)	512	conv4_block2_1_c...
conv4_block2_1_relu (Activation)	(None, None, None, 128)	0	conv4_block2_1_b...
conv4_block2_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv4_block2_1_r...
conv4_block2_concat (Concatenate)	(None, None, None, 320)	0	conv4_block1_con... conv4_block2_c...
conv4_block3_0_bn (BatchNormalizatio...	(None, None, None, 320)	1,280	conv4_block2_con...
conv4_block3_0_relu (Activation)	(None, None, None, 320)	0	conv4_block3_0_b...
conv4_block3_1_conv (Conv2D)	(None, None, None, 128)	40,960	conv4_block3_0_r...
conv4_block3_1_bn (BatchNormalizatio...	(None, None, None, 128)	512	conv4_block3_1_c...
conv4_block3_1_relu (Activation)	(None, None, None, 128)	0	conv4_block3_1_b...
conv4_block3_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv4_block3_1_r...
conv4_block3_concat (Concatenate)	(None, None, None, 352)	0	conv4_block2_con... conv4_block3_2_c...
conv4_block4_0_bn (BatchNormalizatio...	(None, None, None, 352)	1,408	conv4_block3_con...
conv4_block4_0_relu (Activation)	(None, None, None, 352)	0	conv4_block4_0_b...
conv4_block4_1_conv (Conv2D)	(None, None, None, 128)	45,056	conv4_block4_0_r...
conv4_block4_1_bn (BatchNormalizatio...	(None, None, None, 128)	512	conv4_block4_1_c...
conv4_block4_1_relu (Activation)	(None, None, None, 128)	0	conv4_block4_1_b...
conv4_block4_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv4_block4_1_r...
conv4_block4_concat (Concatenate)	(None, None, None, 384)	0	conv4_block3_con... conv4_block4_2_c...
conv4_block5_0_bn (BatchNormalizatio...	(None, None, None, 384)	1,536	conv4_block4_con...

conv4_block5_0_relu (Activation)	(None, None, None, 384)	0	conv4_block5_0_b...
conv4_block5_1_conv (Conv2D)	(None, None, None, 128)	49,152	conv4_block5_0_r...
conv4_block5_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block5_1_c...
conv4_block5_1_relu (Activation)	(None, None, None, 128)	0	conv4_block5_1_b...
conv4_block5_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv4_block5_1_r...
conv4_block5_concat (Concatenate)	(None, None, None, 416)	0	conv4_block4_con... conv4_block5_2_c...
conv4_block6_0_bn (BatchNormalizatio...)	(None, None, None, 416)	1,664	conv4_block5_con...
conv4_block6_0_relu (Activation)	(None, None, None, 416)	0	conv4_block6_0_b...
conv4_block6_1_conv (Conv2D)	(None, None, None, 128)	53,248	conv4_block6_0_r...
conv4_block6_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block6_1_c...
conv4_block6_1_relu (Activation)	(None, None, None, 128)	0	conv4_block6_1_b...
conv4_block6_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv4_block6_1_r...
conv4_block6_concat (Concatenate)	(None, None, None, 448)	0	conv4_block5_con... conv4_block6_2_c...
conv4_block7_0_bn (BatchNormalizatio...)	(None, None, None, 448)	1,792	conv4_block6_con...
conv4_block7_0_relu (Activation)	(None, None, None, 448)	0	conv4_block7_0_b...
conv4_block7_1_conv (Conv2D)	(None, None, None, 128)	57,344	conv4_block7_0_r...
conv4_block7_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block7_1_c...
conv4_block7_1_relu (Activation)	(None, None, None, 128)	0	conv4_block7_1_b...
conv4_block7_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv4_block7_1_r...
conv4_block7_concat (Concatenate)	(None, None, None, 480)	0	conv4_block6_con... conv4_block7_2_c...
conv4_block8_0_bn (BatchNormalizatio...)	(None, None, None, 480)	1,920	conv4_block7_con...

conv4_block8_0_relu (Activation)	(None, None, None, 480)	0	conv4_block8_0_b...
conv4_block8_1_conv (Conv2D)	(None, None, None, 128)	61,440	conv4_block8_0_r...
conv4_block8_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block8_1_c...
conv4_block8_1_relu (Activation)	(None, None, None, 128)	0	conv4_block8_1_b...
conv4_block8_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv4_block8_1_r...
conv4_block8_concat (Concatenate)	(None, None, None, 512)	0	conv4_block7_con... conv4_block8_2_c...
conv4_block9_0_bn (BatchNormalizatio...)	(None, None, None, 512)	2,048	conv4_block8_con...
conv4_block9_0_relu (Activation)	(None, None, None, 512)	0	conv4_block9_0_b...
conv4_block9_1_conv (Conv2D)	(None, None, None, 128)	65,536	conv4_block9_0_r...
conv4_block9_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block9_1_c...
conv4_block9_1_relu (Activation)	(None, None, None, 128)	0	conv4_block9_1_b...
conv4_block9_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv4_block9_1_r...
conv4_block9_concat (Concatenate)	(None, None, None, 544)	0	conv4_block8_con... conv4_block9_2_c...
conv4_block10_0_bn (BatchNormalizatio...)	(None, None, None, 544)	2,176	conv4_block9_con...
conv4_block10_0_re... (Activation)	(None, None, None, 544)	0	conv4_block10_0_...
conv4_block10_1_co... (Conv2D)	(None, None, None, 128)	69,632	conv4_block10_0 ...
conv4_block10_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block10_1_...
conv4_block10_1_re... (Activation)	(None, None, None, 128)	0	conv4_block10_1_...
conv4_block10_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block10_1_...
conv4_block10_concat (Concatenate)	(None, None, None, 576)	0	conv4_block9_con... conv4_block10_2_...
conv4_block11_0_bn (BatchNormalizatio...)	(None, None, None, 576)	2,304	conv4_block10_co...
conv4_block11_0_re... (Activation)	(None, None,	0	conv4_block11_0_...

(Activation)	None, 576)		
conv4_block11_1_co... (Conv2D)	(None, None, None, 128)	73,728	conv4_block11_0_...
conv4_block11_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block11_1_...
conv4_block11_1_re... (Activation)	(None, None, None, 128)	0	conv4_block11_1_...
conv4_block11_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block11_1_...
conv4_block11_conc... (Concatenate)	(None, None, None, 608)	0	conv4_block10_co... conv4_block11_2_...
conv4_block12_0_bn (BatchNormalizatio...)	(None, None, None, 608)	2,432	conv4_block11_co...
conv4_block12_0_re... (Activation)	(None, None, None, 608)	0	conv4_block12_0_...
conv4_block12_1_co... (Conv2D)	(None, None, None, 128)	77,824	conv4_block12_0_...
conv4_block12_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block12_1_...
conv4_block12_1_re... (Activation)	(None, None, None, 128)	0	conv4_block12_1_...
conv4_block12_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block12_1_...
conv4_block12_conc... (Concatenate)	(None, None, None, 640)	0	conv4_block11_co... conv4_block12_2_...
conv4_block13_0_bn (BatchNormalizatio...)	(None, None, None, 640)	2,560	conv4_block12_co...
conv4_block13_0_re... (Activation)	(None, None, None, 640)	0	conv4_block13_0_...
conv4_block13_1_co... (Conv2D)	(None, None, None, 128)	81,920	conv4_block13_0_...
conv4_block13_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block13_1_...
conv4_block13_1_re... (Activation)	(None, None, None, 128)	0	conv4_block13_1_...
conv4_block13_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block13_1_...
conv4_block13_conc... (Concatenate)	(None, None, None, 672)	0	conv4_block12_co... conv4_block13_2_...
conv4_block14_0_bn (BatchNormalizatio...)	(None, None, None, 672)	2,688	conv4_block13_co...
conv4_block14_0_re... (Activation)	(None, None, None, 672)	0	conv4_block14_0_...

conv4_block14_1_co... (Conv2D)	(None, None, None, 128)	86,016	conv4_block14_0_...
conv4_block14_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block14_1_...
conv4_block14_1_re... (Activation)	(None, None, None, 128)	0	conv4_block14_1_...
conv4_block14_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block14_1_...
conv4_block14_conc... (Concatenate)	(None, None, None, 704)	0	conv4_block13_co... conv4_block14_2_...
conv4_block15_0_bn (BatchNormalizatio...)	(None, None, None, 704)	2,816	conv4_block14_co...
conv4_block15_0_re... (Activation)	(None, None, None, 704)	0	conv4_block15_0 ...
conv4_block15_1_co... (Conv2D)	(None, None, None, 128)	90,112	conv4_block15_0_...
conv4_block15_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block15_1_...
conv4_block15_1_re... (Activation)	(None, None, None, 128)	0	conv4_block15_1_...
conv4_block15_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block15_1_...
conv4_block15_conc... (Concatenate)	(None, None, None, 736)	0	conv4_block14_co... conv4_block15_2_...
conv4_block16_0_bn (BatchNormalizatio...)	(None, None, None, 736)	2,944	conv4_block15_co...
conv4_block16_0_re... (Activation)	(None, None, None, 736)	0	conv4_block16_0 ...
conv4_block16_1_co... (Conv2D)	(None, None, None, 128)	94,208	conv4_block16_0_...
conv4_block16_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block16_1_...
conv4_block16_1_re... (Activation)	(None, None, None, 128)	0	conv4_block16_1_...
conv4_block16_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block16_1_...
conv4_block16_conc... (Concatenate)	(None, None, None, 768)	0	conv4_block15_co... conv4_block16_2_...
conv4_block17_0_bn (BatchNormalizatio...)	(None, None, None, 768)	3,072	conv4_block16_co...
conv4_block17_0_re... (Activation)	(None, None, None, 768)	0	conv4_block17_0 ...

conv4_block17_1_co... (Conv2D)	(None, None, None, 128)	98,304	conv4_block17_0_...
conv4_block17_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block17_1_...
conv4_block17_1_re... (Activation)	(None, None, None, 128)	0	conv4_block17_1_...
conv4_block17_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block17_1_...
conv4_block17_concat... (Concatenate)	(None, None, None, 800)	0	conv4_block16_co... conv4_block17_2_...
conv4_block18_0_bn (BatchNormalizatio...)	(None, None, None, 800)	3,200	conv4_block17_co...
conv4_block18_0_re... (Activation)	(None, None, None, 800)	0	conv4_block18_0_...
conv4_block18_1_co... (Conv2D)	(None, None, None, 128)	102,400	conv4_block18_0_...
conv4_block18_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block18_1_...
conv4_block18_1_re... (Activation)	(None, None, None, 128)	0	conv4_block18_1_...
conv4_block18_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block18_1_...
conv4_block18_concat... (Concatenate)	(None, None, None, 832)	0	conv4_block17_co... conv4_block18_2_...
conv4_block19_0_bn (BatchNormalizatio...)	(None, None, None, 832)	3,328	conv4_block18_co...
conv4_block19_0_re... (Activation)	(None, None, None, 832)	0	conv4_block19_0_...
conv4_block19_1_co... (Conv2D)	(None, None, None, 128)	106,496	conv4_block19_0_...
conv4_block19_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block19_1_...
conv4_block19_1_re... (Activation)	(None, None, None, 128)	0	conv4_block19_1_...
conv4_block19_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block19_1_...
conv4_block19_concat... (Concatenate)	(None, None, None, 864)	0	conv4_block18_co... conv4_block19_2_...
conv4_block20_0_bn (BatchNormalizatio...)	(None, None, None, 864)	3,456	conv4_block19_co...
conv4_block20_0_re... (Activation)	(None, None, None, 864)	0	conv4_block20_0_...
conv4_block20_1_co...	(None, None,	110,592	conv4_block20_0_...

(Conv2D)	None, 128)		
conv4_block20_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block20_1...
conv4_block20_1_re... (Activation)	(None, None, None, 128)	0	conv4_block20_1...
conv4_block20_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block20_1...
conv4_block20_conc... (Concatenate)	(None, None, None, 896)	0	conv4_block19_co... conv4_block20_2...
conv4_block21_0_bn (BatchNormalizatio...)	(None, None, None, 896)	3,584	conv4_block20_co...
conv4_block21_0_re... (Activation)	(None, None, None, 896)	0	conv4_block21_0...
conv4_block21_1_co... (Conv2D)	(None, None, None, 128)	114,688	conv4_block21_0...
conv4_block21_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block21_1...
conv4_block21_1_re... (Activation)	(None, None, None, 128)	0	conv4_block21_1...
conv4_block21_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block21_1...
conv4_block21_conc... (Concatenate)	(None, None, None, 928)	0	conv4_block20_co... conv4_block21_2...
conv4_block22_0_bn (BatchNormalizatio...)	(None, None, None, 928)	3,712	conv4_block21_co...
conv4_block22_0_re... (Activation)	(None, None, None, 928)	0	conv4_block22_0...
conv4_block22_1_co... (Conv2D)	(None, None, None, 128)	118,784	conv4_block22_0...
conv4_block22_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block22_1...
conv4_block22_1_re... (Activation)	(None, None, None, 128)	0	conv4_block22_1...
conv4_block22_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block22_1...
conv4_block22_conc... (Concatenate)	(None, None, None, 960)	0	conv4_block21_co... conv4_block22_2...
conv4_block23_0_bn (BatchNormalizatio...)	(None, None, None, 960)	3,840	conv4_block22_co...
conv4_block23_0_re... (Activation)	(None, None, None, 960)	0	conv4_block23_0...
conv4_block23_1_co... (Conv2D)	(None, None, None, 128)	122,880	conv4_block23_0...

conv4_block23_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block23_1...
conv4_block23_1_re... (Activation)	(None, None, None, 128)	0	conv4_block23_1...
conv4_block23_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block23_1...
conv4_block23_conc... (Concatenate)	(None, None, None, 992)	0	conv4_block22_co... conv4_block23_2...
conv4_block24_0_bn (BatchNormalizatio...)	(None, None, None, 992)	3,968	conv4_block23_co...
conv4_block24_0_re... (Activation)	(None, None, None, 992)	0	conv4_block24_0...
conv4_block24_1_co... (Conv2D)	(None, None, None, 128)	126,976	conv4_block24_0 ...
conv4_block24_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block24_1...
conv4_block24_1_re... (Activation)	(None, None, None, 128)	0	conv4_block24_1...
conv4_block24_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block24_1...
conv4_block24_conc... (Concatenate)	(None, None, None, 1024)	0	conv4_block23_co... conv4_block24_2...
conv4_block25_0_bn (BatchNormalizatio...)	(None, None, None, 1024)	4,096	conv4_block24_co...
conv4_block25_0_re... (Activation)	(None, None, None, 1024)	0	conv4_block25_0...
conv4_block25_1_co... (Conv2D)	(None, None, None, 128)	131,072	conv4_block25_0...
conv4_block25_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block25_1...
conv4_block25_1_re... (Activation)	(None, None, None, 128)	0	conv4_block25_1...
conv4_block25_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block25_1...
conv4_block25_conc... (Concatenate)	(None, None, None, 1056)	0	conv4_block24_co... conv4_block25_2...
conv4_block26_0_bn (BatchNormalizatio...)	(None, None, None, 1056)	4,224	conv4_block25_co...
conv4_block26_0_re... (Activation)	(None, None, None, 1056)	0	conv4_block26_0...
conv4_block26_1_co... (Conv2D)	(None, None, None, 128)	135,168	conv4_block26_0...

conv4_block26_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block26_1...
conv4_block26_1_re... (Activation)	(None, None, None, 128)	0	conv4_block26_1...
conv4_block26_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block26_1...
conv4_block26_conc... (Concatenate)	(None, None, None, 1088)	0	conv4_block25_co... conv4_block26_2...
conv4_block27_0_bn (BatchNormalizatio...)	(None, None, None, 1088)	4,352	conv4_block26_co...
conv4_block27_0_re... (Activation)	(None, None, None, 1088)	0	conv4_block27_0...
conv4_block27_1_co... (Conv2D)	(None, None, None, 128)	139,264	conv4_block27_0...
conv4_block27_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block27_1...
conv4_block27_1_re... (Activation)	(None, None, None, 128)	0	conv4_block27_1...
conv4_block27_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block27_1...
conv4_block27_conc... (Concatenate)	(None, None, None, 1120)	0	conv4_block26_co... conv4_block27_2...
conv4_block28_0_bn (BatchNormalizatio...)	(None, None, None, 1120)	4,480	conv4_block27_co...
conv4_block28_0_re... (Activation)	(None, None, None, 1120)	0	conv4_block28_0...
conv4_block28_1_co... (Conv2D)	(None, None, None, 128)	143,360	conv4_block28_0...
conv4_block28_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv4_block28_1...
conv4_block28_1_re... (Activation)	(None, None, None, 128)	0	conv4_block28_1 ...
conv4_block28_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block28_1...
conv4_block28_conc... (Concatenate)	(None, None, None, 1152)	0	conv4_block27_co... conv4_block28_2...
conv4_block29_0_bn (BatchNormalizatio...)	(None, None, None, 1152)	4,608	conv4_block28_co...
conv4_block29_0_re... (Activation)	(None, None, None, 1152)	0	conv4_block29_0...
conv4_block29_1_co... (Conv2D)	(None, None, None, 128)	147,456	conv4_block29_0 ...
conv4_block29_1_bn	(None, None,	512	conv4_block29_1...

(BatchNormalizatio...	None, 128)		
conv4_block29_1_re... (Activation)	(None, None, None, 128)	0	conv4_block29_1...
conv4_block29_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block29_1...
conv4_block29_conc... (Concatenate)	(None, None, None, 1184)	0	conv4_block28_co... conv4_block29_2...
conv4_block30_0_bn (BatchNormalizatio...	(None, None, None, 1184)	4,736	conv4_block29_co...
conv4_block30_0_re... (Activation)	(None, None, None, 1184)	0	conv4_block30_0...
conv4_block30_1_co... (Conv2D)	(None, None, None, 128)	151,552	conv4_block30_0...
conv4_block30_1_bn (BatchNormalizatio...	(None, None, None, 128)	512	conv4_block30_1...
conv4_block30_1_re... (Activation)	(None, None, None, 128)	0	conv4_block30_1...
conv4_block30_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block30_1...
conv4_block30_conc... (Concatenate)	(None, None, None, 1216)	0	conv4_block29_co... conv4_block30_2...
conv4_block31_0_bn (BatchNormalizatio...	(None, None, None, 1216)	4,864	conv4_block30_co...
conv4_block31_0_re... (Activation)	(None, None, None, 1216)	0	conv4_block31_0...
conv4_block31_1_co... (Conv2D)	(None, None, None, 128)	155,648	conv4_block31_0...
conv4_block31_1_bn (BatchNormalizatio...	(None, None, None, 128)	512	conv4_block31_1...
conv4_block31_1_re... (Activation)	(None, None, None, 128)	0	conv4_block31_1...
conv4_block31_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block31_1...
conv4_block31_conc... (Concatenate)	(None, None, None, 1248)	0	conv4_block30_co... conv4_block31_2...
conv4_block32_0_bn (BatchNormalizatio...	(None, None, None, 1248)	4,992	conv4_block31_co...
conv4_block32_0_re... (Activation)	(None, None, None, 1248)	0	conv4_block32_0...
conv4_block32_1_co... (Conv2D)	(None, None, None, 128)	159,744	conv4_block32_0...
conv4_block32_1_bn (BatchNormalizatio...	(None, None, None, 128)	512	conv4_block32_1...

conv4_block32_1_re... (Activation)	(None, None, None, 128)	0	conv4_block32_1...
conv4_block32_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv4_block32_1...
conv4_block32_concat... (Concatenate)	(None, None, None, 1280)	0	conv4_block31_co... conv4_block32_2...
pool4_bn (BatchNormalizatio...)	(None, None, None, 1280)	5,120	conv4_block32_co...
pool4_relu (Activation)	(None, None, None, 1280)	0	pool4_bn[0][0]
pool4_conv (Conv2D)	(None, None, None, 640)	819,200	pool4_relu[0][0]
pool4_pool (AveragePooling2D)	(None, None, None, 640)	0	pool4_conv[0][0]
conv5_block1_0_bn (BatchNormalizatio...)	(None, None, None, 640)	2,560	pool4_pool[0][0]
conv5_block1_0_relu (Activation)	(None, None, None, 640)	0	conv5_block1_0_b...
conv5_block1_1_conv (Conv2D)	(None, None, None, 128)	81,920	conv5_block1_0_r...
conv5_block1_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block1_1_c...
conv5_block1_1_relu (Activation)	(None, None, None, 128)	0	conv5_block1_1_b...
conv5_block1_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv5_block1_1_r...
conv5_block1_concat (Concatenate)	(None, None, None, 672)	0	pool4_pool[0][0], conv5_block1_2_c...
conv5_block2_0_bn (BatchNormalizatio...)	(None, None, None, 672)	2,688	conv5_block1_con...
conv5_block2_0_relu (Activation)	(None, None, None, 672)	0	conv5_block2_0_b...
conv5_block2_1_conv (Conv2D)	(None, None, None, 128)	86,016	conv5_block2_0_r...
conv5_block2_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block2_1_c...
conv5_block2_1_relu (Activation)	(None, None, None, 128)	0	conv5_block2_1_b...
conv5_block2_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv5_block2_1_r...
conv5_block2_concat (Concatenate)	(None, None, None, 704)	0	conv5_block1_con... conv5_block2_2_c...

conv5_block3_0_bn (BatchNormalizatio...)	(None, None, None, 704)	2,816	conv5_block2_con...
conv5_block3_0_relu (Activation)	(None, None, None, 704)	0	conv5_block3_0_b...
conv5_block3_1_conv (Conv2D)	(None, None, None, 128)	90,112	conv5_block3_0_r...
conv5_block3_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block3_1_c...
conv5_block3_1_relu (Activation)	(None, None, None, 128)	0	conv5_block3_1_b...
conv5_block3_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv5_block3_1_r...
conv5_block3_concat (Concatenate)	(None, None, None, 736)	0	conv5_block2_con... conv5_block3_2_c...
conv5_block4_0_bn (BatchNormalizatio...)	(None, None, None, 736)	2,944	conv5_block3_con...
conv5_block4_0_relu (Activation)	(None, None, None, 736)	0	conv5_block4_0_b...
conv5_block4_1_conv (Conv2D)	(None, None, None, 128)	94,208	conv5_block4_0_r...
conv5_block4_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block4_1_c...
conv5_block4_1_relu (Activation)	(None, None, None, 128)	0	conv5_block4_1_b...
conv5_block4_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv5_block4_1_r...
conv5_block4_concat (Concatenate)	(None, None, None, 768)	0	conv5_block3_con... conv5_block4_2_c...
conv5_block5_0_bn (BatchNormalizatio...)	(None, None, None, 768)	3,072	conv5_block4_con...
conv5_block5_0_relu (Activation)	(None, None, None, 768)	0	conv5_block5_0_b...
conv5_block5_1_conv (Conv2D)	(None, None, None, 128)	98,304	conv5_block5_0_r...
conv5_block5_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block5_1_c...
conv5_block5_1_relu (Activation)	(None, None, None, 128)	0	conv5_block5_1_b...
conv5_block5_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv5_block5_1_r...
conv5_block5_concat (Concatenate)	(None, None, None, 800)	0	conv5_block4_con... conv5_block5_2_c...
conv5_block6_0_bn	(None, None,	3,200	conv5_block5_con...

(BatchNormalizatio...	None, 800)		
conv5_block6_0_relu (Activation)	(None, None, None, 800)	0	conv5_block6_0_b...
conv5_block6_1_conv (Conv2D)	(None, None, None, 128)	102,400	conv5_block6_0_r...
conv5_block6_1_bn (BatchNormalizatio...	(None, None, None, 128)	512	conv5_block6_1_c...
conv5_block6_1_relu (Activation)	(None, None, None, 128)	0	conv5_block6_1_b...
conv5_block6_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv5_block6_1_r...
conv5_block6_concat (Concatenate)	(None, None, None, 832)	0	conv5_block5_con... conv5_block6_2_c...
conv5_block7_0_bn (BatchNormalizatio...	(None, None, None, 832)	3,328	conv5_block6_con...
conv5_block7_0_relu (Activation)	(None, None, None, 832)	0	conv5_block7_0_b...
conv5_block7_1_conv (Conv2D)	(None, None, None, 128)	106,496	conv5_block7_0_r...
conv5_block7_1_bn (BatchNormalizatio...	(None, None, None, 128)	512	conv5_block7_1_c...
conv5_block7_1_relu (Activation)	(None, None, None, 128)	0	conv5_block7_1_b...
conv5_block7_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv5_block7_1_r...
conv5_block7_concat (Concatenate)	(None, None, None, 864)	0	conv5_block6_con... conv5_block7_2_c...
conv5_block8_0_bn (BatchNormalizatio...	(None, None, None, 864)	3,456	conv5_block7_con...
conv5_block8_0_relu (Activation)	(None, None, None, 864)	0	conv5_block8_0_b...
conv5_block8_1_conv (Conv2D)	(None, None, None, 128)	110,592	conv5_block8_0_r...
conv5_block8_1_bn (BatchNormalizatio...	(None, None, None, 128)	512	conv5_block8_1_c...
conv5_block8_1_relu (Activation)	(None, None, None, 128)	0	conv5_block8_1_b...
conv5_block8_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv5_block8_1_r...
conv5_block8_concat (Concatenate)	(None, None, None, 896)	0	conv5_block7_con... conv5_block8_2_c...
conv5_block9_0_bn (BatchNormalizatio...	(None, None, None, 896)	3,584	conv5_block8_con...

conv5_block9_0_relu (Activation)	(None, None, None, 896)	0	conv5_block9_0_b...
conv5_block9_1_conv (Conv2D)	(None, None, None, 128)	114,688	conv5_block9_0_r...
conv5_block9_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block9_1_c...
conv5_block9_1_relu (Activation)	(None, None, None, 128)	0	conv5_block9_1_b...
conv5_block9_2_conv (Conv2D)	(None, None, None, 32)	36,864	conv5_block9_1_r...
conv5_block9_concat (Concatenate)	(None, None, None, 928)	0	conv5_block8_con... conv5_block9_2_c...
conv5_block10_0_bn (BatchNormalizatio...)	(None, None, None, 928)	3,712	conv5_block9_con...
conv5_block10_0_re... (Activation)	(None, None, None, 928)	0	conv5_block10_0_...
conv5_block10_1_co... (Conv2D)	(None, None, None, 128)	118,784	conv5_block10_0_...
conv5_block10_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block10_1_...
conv5_block10_1_re... (Activation)	(None, None, None, 128)	0	conv5_block10_1_...
conv5_block10_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block10_1_...
conv5_block10_concat (Concatenate)	(None, None, None, 960)	0	conv5_block9_con... conv5_block10_2_...
conv5_block11_0_bn (BatchNormalizatio...)	(None, None, None, 960)	3,840	conv5_block10_co...
conv5_block11_0_re... (Activation)	(None, None, None, 960)	0	conv5_block11_0_...
conv5_block11_1_co... (Conv2D)	(None, None, None, 128)	122,880	conv5_block11_0_...
conv5_block11_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block11_1_...
conv5_block11_1_re... (Activation)	(None, None, None, 128)	0	conv5_block11_1_...
conv5_block11_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block11_1_...
conv5_block11_concat (Concatenate)	(None, None, None, 992)	0	conv5_block10_co... conv5_block11_2_...
conv5_block12_0_bn (BatchNormalizatio...)	(None, None, None, 992)	3,968	conv5_block11_co...

conv5_block12_0_re... (Activation)	(None, None, None, 992)	0	conv5_block12_0...
conv5_block12_1_co... (Conv2D)	(None, None, None, 128)	126,976	conv5_block12_0...
conv5_block12_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block12_1...
conv5_block12_1_re... (Activation)	(None, None, None, 128)	0	conv5_block12_1...
conv5_block12_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block12_1...
conv5_block12_concat... (Concatenate)	(None, None, None, 1024)	0	conv5_block11_co... conv5_block12_2...
conv5_block13_0_bn (BatchNormalizatio...)	(None, None, None, 1024)	4,096	conv5_block12_co...
conv5_block13_0_re... (Activation)	(None, None, None, 1024)	0	conv5_block13_0...
conv5_block13_1_co... (Conv2D)	(None, None, None, 128)	131,072	conv5_block13_0...
conv5_block13_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block13_1...
conv5_block13_1_re... (Activation)	(None, None, None, 128)	0	conv5_block13_1...
conv5_block13_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block13_1...
conv5_block13_concat... (Concatenate)	(None, None, None, 1056)	0	conv5_block12_co... conv5_block13_2...
conv5_block14_0_bn (BatchNormalizatio...)	(None, None, None, 1056)	4,224	conv5_block13_co...
conv5_block14_0_re... (Activation)	(None, None, None, 1056)	0	conv5_block14_0...
conv5_block14_1_co... (Conv2D)	(None, None, None, 128)	135,168	conv5_block14_0 ...
conv5_block14_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block14_1...
conv5_block14_1_re... (Activation)	(None, None, None, 128)	0	conv5_block14_1...
conv5_block14_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block14_1...
conv5_block14_concat... (Concatenate)	(None, None, None, 1088)	0	conv5_block13_co... conv5_block14_2...
conv5_block15_0_bn (BatchNormalizatio...)	(None, None, None, 1088)	4,352	conv5_block14_co...
conv5_block15_0_re... (Activation)	(None, None,	0	conv5_block15_0...

(Activation)	None, 1088		
conv5_block15_1_co... (Conv2D)	(None, None, None, 128)	139,264	conv5_block15_0_...
conv5_block15_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block15_1_...
conv5_block15_1_re... (Activation)	(None, None, None, 128)	0	conv5_block15_1_...
conv5_block15_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block15_1_...
conv5_block15_conc... (Concatenate)	(None, None, None, 1120)	0	conv5_block14_co... conv5_block15_2_...
conv5_block16_0_bn (BatchNormalizatio...)	(None, None, None, 1120)	4,480	conv5_block15_co...
conv5_block16_0_re... (Activation)	(None, None, None, 1120)	0	conv5_block16_0_...
conv5_block16_1_co... (Conv2D)	(None, None, None, 128)	143,360	conv5_block16_0_...
conv5_block16_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block16_1_...
conv5_block16_1_re... (Activation)	(None, None, None, 128)	0	conv5_block16_1_...
conv5_block16_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block16_1_...
conv5_block16_conc... (Concatenate)	(None, None, None, 1152)	0	conv5_block15_co... conv5_block16_2_...
conv5_block17_0_bn (BatchNormalizatio...)	(None, None, None, 1152)	4,608	conv5_block16_co...
conv5_block17_0_re... (Activation)	(None, None, None, 1152)	0	conv5_block17_0_...
conv5_block17_1_co... (Conv2D)	(None, None, None, 128)	147,456	conv5_block17_0_...
conv5_block17_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block17_1_...
conv5_block17_1_re... (Activation)	(None, None, None, 128)	0	conv5_block17_1_...
conv5_block17_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block17_1_...
conv5_block17_conc... (Concatenate)	(None, None, None, 1184)	0	conv5_block16_co... conv5_block17_2_...
conv5_block18_0_bn (BatchNormalizatio...)	(None, None, None, 1184)	4,736	conv5_block17_co...
conv5_block18_0_re... (Activation)	(None, None, None, 1184)	0	conv5_block18_0_...

conv5_block18_1_co... (Conv2D)	(None, None, None, 128)	151,552	conv5_block18_0_...
conv5_block18_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block18_1_...
conv5_block18_1_re... (Activation)	(None, None, None, 128)	0	conv5_block18_1_...
conv5_block18_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block18_1_...
conv5_block18_concat... (Concatenate)	(None, None, None, 1216)	0	conv5_block17_co... conv5_block18_2_...
conv5_block19_0_bn (BatchNormalizatio...)	(None, None, None, 1216)	4,864	conv5_block18_co...
conv5_block19_0_re... (Activation)	(None, None, None, 1216)	0	conv5_block19_0 ...
conv5_block19_1_co... (Conv2D)	(None, None, None, 128)	155,648	conv5_block19_0_...
conv5_block19_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block19_1_...
conv5_block19_1_re... (Activation)	(None, None, None, 128)	0	conv5_block19_1_...
conv5_block19_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block19_1_...
conv5_block19_concat... (Concatenate)	(None, None, None, 1248)	0	conv5_block18_co... conv5_block19_2_...
conv5_block20_0_bn (BatchNormalizatio...)	(None, None, None, 1248)	4,992	conv5_block19_co...
conv5_block20_0_re... (Activation)	(None, None, None, 1248)	0	conv5_block20_0 ...
conv5_block20_1_co... (Conv2D)	(None, None, None, 128)	159,744	conv5_block20_0_...
conv5_block20_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block20_1_...
conv5_block20_1_re... (Activation)	(None, None, None, 128)	0	conv5_block20_1...
conv5_block20_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block20_1_...
conv5_block20_concat... (Concatenate)	(None, None, None, 1280)	0	conv5_block19_co... conv5_block20_2_...
conv5_block21_0_bn (BatchNormalizatio...)	(None, None, None, 1280)	5,120	conv5_block20_co...
conv5_block21_0_re... (Activation)	(None, None, None, 1280)	0	conv5_block21_0 ...

conv5_block21_1_co... (Conv2D)	(None, None, None, 128)	163,840	conv5_block21_0_...
conv5_block21_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block21_1_...
conv5_block21_1_re... (Activation)	(None, None, None, 128)	0	conv5_block21_1_...
conv5_block21_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block21_1_...
conv5_block21_conc... (Concatenate)	(None, None, None, 1312)	0	conv5_block20_co... conv5_block21_2_...
conv5_block22_0_bn (BatchNormalizatio...)	(None, None, None, 1312)	5,248	conv5_block21_co...
conv5_block22_0_re... (Activation)	(None, None, None, 1312)	0	conv5_block22_0_...
conv5_block22_1_co... (Conv2D)	(None, None, None, 128)	167,936	conv5_block22_0_...
conv5_block22_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block22_1_...
conv5_block22_1_re... (Activation)	(None, None, None, 128)	0	conv5_block22_1_...
conv5_block22_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block22_1_...
conv5_block22_conc... (Concatenate)	(None, None, None, 1344)	0	conv5_block21_co... conv5_block22_2_...
conv5_block23_0_bn (BatchNormalizatio...)	(None, None, None, 1344)	5,376	conv5_block22_co...
conv5_block23_0_re... (Activation)	(None, None, None, 1344)	0	conv5_block23_0_...
conv5_block23_1_co... (Conv2D)	(None, None, None, 128)	172,032	conv5_block23_0_...
conv5_block23_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block23_1_...
conv5_block23_1_re... (Activation)	(None, None, None, 128)	0	conv5_block23_1_...
conv5_block23_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block23_1_...
conv5_block23_conc... (Concatenate)	(None, None, None, 1376)	0	conv5_block22_co... conv5_block23_2_...
conv5_block24_0_bn (BatchNormalizatio...)	(None, None, None, 1376)	5,504	conv5_block23_co...
conv5_block24_0_re... (Activation)	(None, None, None, 1376)	0	conv5_block24_0_...
conv5_block24_1_co...	(None, None,	176,128	conv5_block24_0_...

(Conv2D)	None, 128)		
conv5_block24_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block24_1...
conv5_block24_1_re... (Activation)	(None, None, None, 128)	0	conv5_block24_1...
conv5_block24_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block24_1...
conv5_block24_conc... (Concatenate)	(None, None, None, 1408)	0	conv5_block23_co... conv5_block24_2...
conv5_block25_0_bn (BatchNormalizatio...)	(None, None, None, 1408)	5,632	conv5_block24_co...
conv5_block25_0_re... (Activation)	(None, None, None, 1408)	0	conv5_block25_0...
conv5_block25_1_co... (Conv2D)	(None, None, None, 128)	180,224	conv5_block25_0...
conv5_block25_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block25_1...
conv5_block25_1_re... (Activation)	(None, None, None, 128)	0	conv5_block25_1...
conv5_block25_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block25_1...
conv5_block25_conc... (Concatenate)	(None, None, None, 1440)	0	conv5_block24_co... conv5_block25_2...
conv5_block26_0_bn (BatchNormalizatio...)	(None, None, None, 1440)	5,760	conv5_block25_co...
conv5_block26_0_re... (Activation)	(None, None, None, 1440)	0	conv5_block26_0...
conv5_block26_1_co... (Conv2D)	(None, None, None, 128)	184,320	conv5_block26_0...
conv5_block26_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block26_1...
conv5_block26_1_re... (Activation)	(None, None, None, 128)	0	conv5_block26_1...
conv5_block26_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block26_1...
conv5_block26_conc... (Concatenate)	(None, None, None, 1472)	0	conv5_block25_co... conv5_block26_2...
conv5_block27_0_bn (BatchNormalizatio...)	(None, None, None, 1472)	5,888	conv5_block26_co...
conv5_block27_0_re... (Activation)	(None, None, None, 1472)	0	conv5_block27_0...
conv5_block27_1_co... (Conv2D)	(None, None, None, 128)	188,416	conv5_block27_0...

conv5_block27_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block27_1...
conv5_block27_1_re... (Activation)	(None, None, None, 128)	0	conv5_block27_1...
conv5_block27_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block27_1...
conv5_block27_conc... (Concatenate)	(None, None, None, 1504)	0	conv5_block26_co... conv5_block27_2...
conv5_block28_0_bn (BatchNormalizatio...)	(None, None, None, 1504)	6,016	conv5_block27_co...
conv5_block28_0_re... (Activation)	(None, None, None, 1504)	0	conv5_block28_0...
conv5_block28_1_co... (Conv2D)	(None, None, None, 128)	192,512	conv5_block28_0 ...
conv5_block28_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block28_1...
conv5_block28_1_re... (Activation)	(None, None, None, 128)	0	conv5_block28_1...
conv5_block28_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block28_1...
conv5_block28_conc... (Concatenate)	(None, None, None, 1536)	0	conv5_block27_co... conv5_block28_2...
conv5_block29_0_bn (BatchNormalizatio...)	(None, None, None, 1536)	6,144	conv5_block28_co...
conv5_block29_0_re... (Activation)	(None, None, None, 1536)	0	conv5_block29_0...
conv5_block29_1_co... (Conv2D)	(None, None, None, 128)	196,608	conv5_block29_0...
conv5_block29_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block29_1...
conv5_block29_1_re... (Activation)	(None, None, None, 128)	0	conv5_block29_1...
conv5_block29_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block29_1...
conv5_block29_conc... (Concatenate)	(None, None, None, 1568)	0	conv5_block28_co... conv5_block29_2...
conv5_block30_0_bn (BatchNormalizatio...)	(None, None, None, 1568)	6,272	conv5_block29_co...
conv5_block30_0_re... (Activation)	(None, None, None, 1568)	0	conv5_block30_0...
conv5_block30_1_co... (Conv2D)	(None, None, None, 128)	200,704	conv5_block30_0...

conv5_block30_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block30_1...
conv5_block30_1_re... (Activation)	(None, None, None, 128)	0	conv5_block30_1...
conv5_block30_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block30_1...
conv5_block30_conc... (Concatenate)	(None, None, None, 1600)	0	conv5_block29_co... conv5_block30_2...
conv5_block31_0_bn (BatchNormalizatio...)	(None, None, None, 1600)	6,400	conv5_block30_co...
conv5_block31_0_re... (Activation)	(None, None, None, 1600)	0	conv5_block31_0...
conv5_block31_1_co... (Conv2D)	(None, None, None, 128)	204,800	conv5_block31_0...
conv5_block31_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block31_1...
conv5_block31_1_re... (Activation)	(None, None, None, 128)	0	conv5_block31_1...
conv5_block31_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block31_1...
conv5_block31_conc... (Concatenate)	(None, None, None, 1632)	0	conv5_block30_co... conv5_block31_2...
conv5_block32_0_bn (BatchNormalizatio...)	(None, None, None, 1632)	6,528	conv5_block31_co...
conv5_block32_0_re... (Activation)	(None, None, None, 1632)	0	conv5_block32_0...
conv5_block32_1_co... (Conv2D)	(None, None, None, 128)	208,896	conv5_block32_0...
conv5_block32_1_bn (BatchNormalizatio...)	(None, None, None, 128)	512	conv5_block32_1...
conv5_block32_1_re... (Activation)	(None, None, None, 128)	0	conv5_block32_1 ...
conv5_block32_2_co... (Conv2D)	(None, None, None, 32)	36,864	conv5_block32_1...
conv5_block32_conc... (Concatenate)	(None, None, None, 1664)	0	conv5_block31_co... conv5_block32_2...
bn (BatchNormalizatio...)	(None, None, None, 1664)	6,656	conv5_block32_co...
relu (Activation)	(None, None, None, 1664)	0	bn[0][0]
global_average_poo... (GlobalAveragePool...)	(None, 1664)	0	relu[0][0]
dense_13 (Dense)	(None, 512)	852,480	global_average_p...

dropout_7 (Dropout)	(None, 512)	0	dense_13[0][0]
dense_14 (Dense)	(None, 10)	5,130	dropout_7[0][0]

Total params: 13,500,490 (51.50 MB)

Trainable params: 857,610 (3.27 MB)

Non-trainable params: 12,642,880 (48.23 MB)

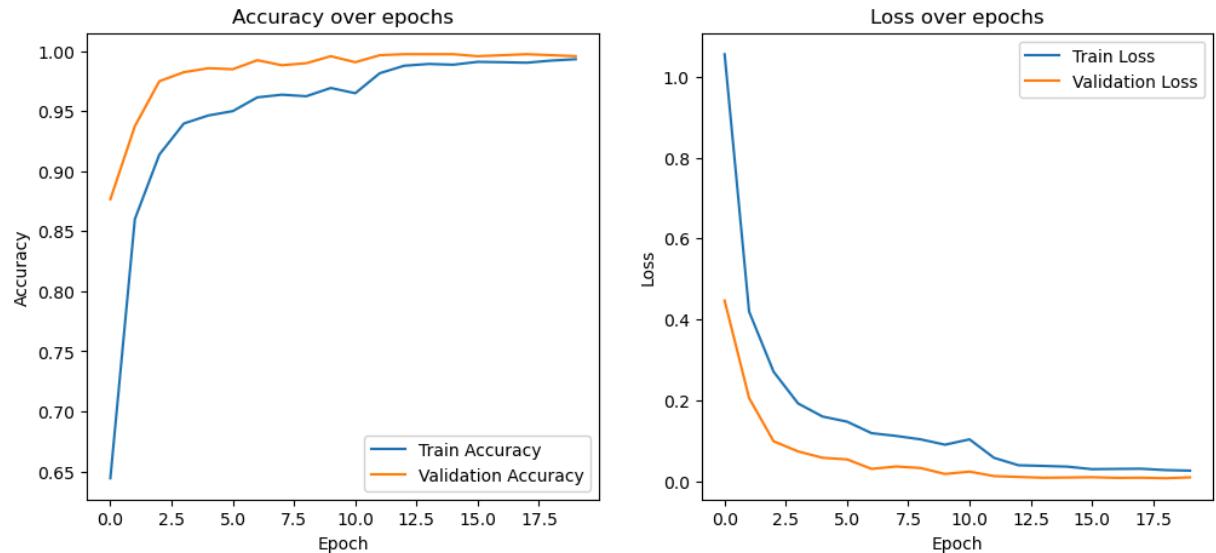
```
In [65]: # Train the model with data augmentation and learning rate scheduling  
history = model.fit(train_generator, validation_data=val_generator, epochs=20)
```

```
Epoch 1/20
300/300 340s 1s/step - accuracy: 0.4825 - loss: 1.5623
- val_accuracy: 0.8767 - val_loss: 0.4467 - learning_rate: 0.0010
Epoch 2/20
300/300 368s 1s/step - accuracy: 0.8402 - loss: 0.4807
- val_accuracy: 0.9375 - val_loss: 0.2055 - learning_rate: 0.0010
Epoch 3/20
300/300 373s 1s/step - accuracy: 0.9082 - loss: 0.2831
- val_accuracy: 0.9750 - val_loss: 0.0987 - learning_rate: 0.0010
Epoch 4/20
300/300 914s 3s/step - accuracy: 0.9408 - loss: 0.1986
- val_accuracy: 0.9825 - val_loss: 0.0736 - learning_rate: 0.0010
Epoch 5/20
300/300 354s 1s/step - accuracy: 0.9472 - loss: 0.1590
- val_accuracy: 0.9858 - val_loss: 0.0578 - learning_rate: 0.0010
Epoch 6/20
300/300 834s 3s/step - accuracy: 0.9481 - loss: 0.1519
- val_accuracy: 0.9850 - val_loss: 0.0539 - learning_rate: 0.0010
Epoch 7/20
300/300 780s 3s/step - accuracy: 0.9606 - loss: 0.1218
- val_accuracy: 0.9925 - val_loss: 0.0304 - learning_rate: 0.0010
Epoch 8/20
300/300 2864s 10s/step - accuracy: 0.9639 - loss: 0.113
- val_accuracy: 0.9883 - val_loss: 0.0362 - learning_rate: 0.0010
Epoch 9/20
300/300 348s 1s/step - accuracy: 0.9597 - loss: 0.1069
- val_accuracy: 0.9900 - val_loss: 0.0325 - learning_rate: 0.0010
Epoch 10/20
300/300 380s 1s/step - accuracy: 0.9699 - loss: 0.0887
- val_accuracy: 0.9958 - val_loss: 0.0178 - learning_rate: 0.0010
Epoch 11/20
300/300 565s 2s/step - accuracy: 0.9672 - loss: 0.0989
- val_accuracy: 0.9908 - val_loss: 0.0236 - learning_rate: 0.0010
Epoch 12/20
300/300 522s 2s/step - accuracy: 0.9774 - loss: 0.0728
- val_accuracy: 0.9967 - val_loss: 0.0126 - learning_rate: 1.0000e-04
Epoch 13/20
300/300 519s 2s/step - accuracy: 0.9888 - loss: 0.0391
- val_accuracy: 0.9975 - val_loss: 0.0105 - learning_rate: 1.0000e-04
Epoch 14/20
300/300 402s 1s/step - accuracy: 0.9873 - loss: 0.0441
- val_accuracy: 0.9975 - val_loss: 0.0085 - learning_rate: 1.0000e-04
Epoch 15/20
300/300 407s 1s/step - accuracy: 0.9896 - loss: 0.0338
- val_accuracy: 0.9975 - val_loss: 0.0090 - learning_rate: 1.0000e-04
Epoch 16/20
300/300 402s 1s/step - accuracy: 0.9916 - loss: 0.0284
- val_accuracy: 0.9958 - val_loss: 0.0098 - learning_rate: 1.0000e-04
Epoch 17/20
300/300 420s 1s/step - accuracy: 0.9903 - loss: 0.0315
- val_accuracy: 0.9967 - val_loss: 0.0081 - learning_rate: 1.0000e-04
Epoch 18/20
300/300 431s 1s/step - accuracy: 0.9917 - loss: 0.0284
- val_accuracy: 0.9975 - val_loss: 0.0086 - learning_rate: 1.0000e-04
Epoch 19/20
300/300 434s 1s/step - accuracy: 0.9909 - loss: 0.0285
- val_accuracy: 0.9967 - val_loss: 0.0072 - learning_rate: 1.0000e-04
Epoch 20/20
300/300 436s 1s/step - accuracy: 0.9932 - loss: 0.0260
- val_accuracy: 0.9958 - val_loss: 0.0094 - learning_rate: 1.0000e-04
```

```
In [66]: # Plot the training history
plt.figure(figsize=(12, 5))
plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'], label='Train Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.title('Accuracy over epochs')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()

plt.subplot(1, 2, 2)
plt.plot(history.history['loss'], label='Train Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.title('Loss over epochs')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()
```

Out[66]: <matplotlib.legend.Legend at 0x2d0b0c250>



```
In [67]: # Evaluate the model
test_loss, test_accuracy = model.evaluate(test_generator)
print('Test accuracy:', test_accuracy)

# Predict labels for the test set
y_pred = model.predict(test_generator)
y_pred_classes = np.argmax(y_pred, axis=1)

# Get true labels from the test generator
y_true = test_generator.classes

# Generate classification report
class_report = classification_report(y_true, y_pred_classes, target_names=class_names)
print(class_report)
```

38/38 ━━━━━━━━ 47s 1s/step - accuracy: 0.9989 - loss: 0.0033

Test accuracy: 0.996666669845581

38/38 ━━━━━━━━ 49s 1s/step

	precision	recall	f1-score	support
Alopecia Areata	0.99	1.00	1.00	120
Contact Dermatitis	1.00	1.00	1.00	120
Folliculitis	1.00	1.00	1.00	120
Head Lice	1.00	1.00	1.00	120
Lichen Planus	0.99	1.00	1.00	120
Male Pattern Baldness	1.00	1.00	1.00	120
Psoriasis	0.98	1.00	0.99	120
Seborrheic Dermatitis	1.00	0.97	0.98	120
Telogen Effluvium	1.00	1.00	1.00	120
Tinea Capitis	1.00	1.00	1.00	120
accuracy			1.00	1200
macro avg	1.00	1.00	1.00	1200
weighted avg	1.00	1.00	1.00	1200

```
In [68]: # Obtain true labels from the test generator
y_true = test_generator.classes
```

```
In [69]: # Calculate the confusion matrix
conf_matrix = confusion_matrix(y_true, y_pred_classes)
```

```
In [70]: # Function to plot the confusion matrix
def plot_confusion_matrix(cm, target_names, title='Confusion Matrix', cmap=None):
    import itertools
    if cmap is None:
        cmap = plt.get_cmap('Greens')
    plt.figure(figsize=(10, 8))
    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(target_names))
    plt.xticks(tick_marks, target_names, rotation=45)
    plt.yticks(tick_marks, target_names)
    if normalize:
        cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]
    thresh = cm.max() / 1.5 if normalize else cm.max() / 2
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, "{:.2f}".format(cm[i, j]) if normalize else "{:,}").format(
            horizontalalignment="center",
            color="white" if cm[i, j] > thresh else "black")
    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')
    plt.show()
```

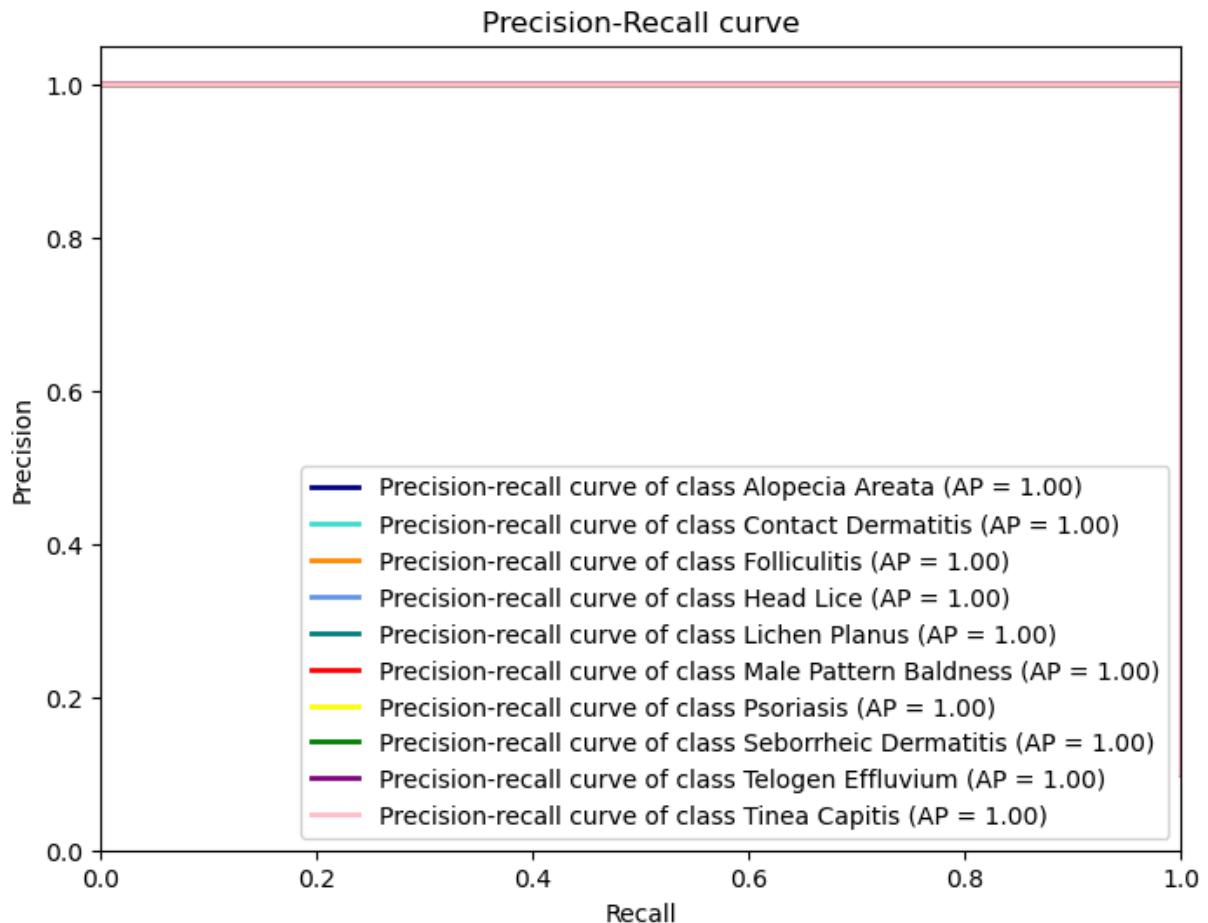
```
In [71]: from sklearn.metrics import precision_recall_curve, average_precision_score

def plot_precision_recall_curve(y_true, y_pred, classes):
    # Compute precision and recall for each class
    precision = dict()
    recall = dict()
    average_precision = dict()
    for i in range(len(classes)):
        precision[i], recall[i], _ = precision_recall_curve(y_true == i, y_pred)
        average_precision[i] = average_precision_score(y_true == i, y_pred[:, i])

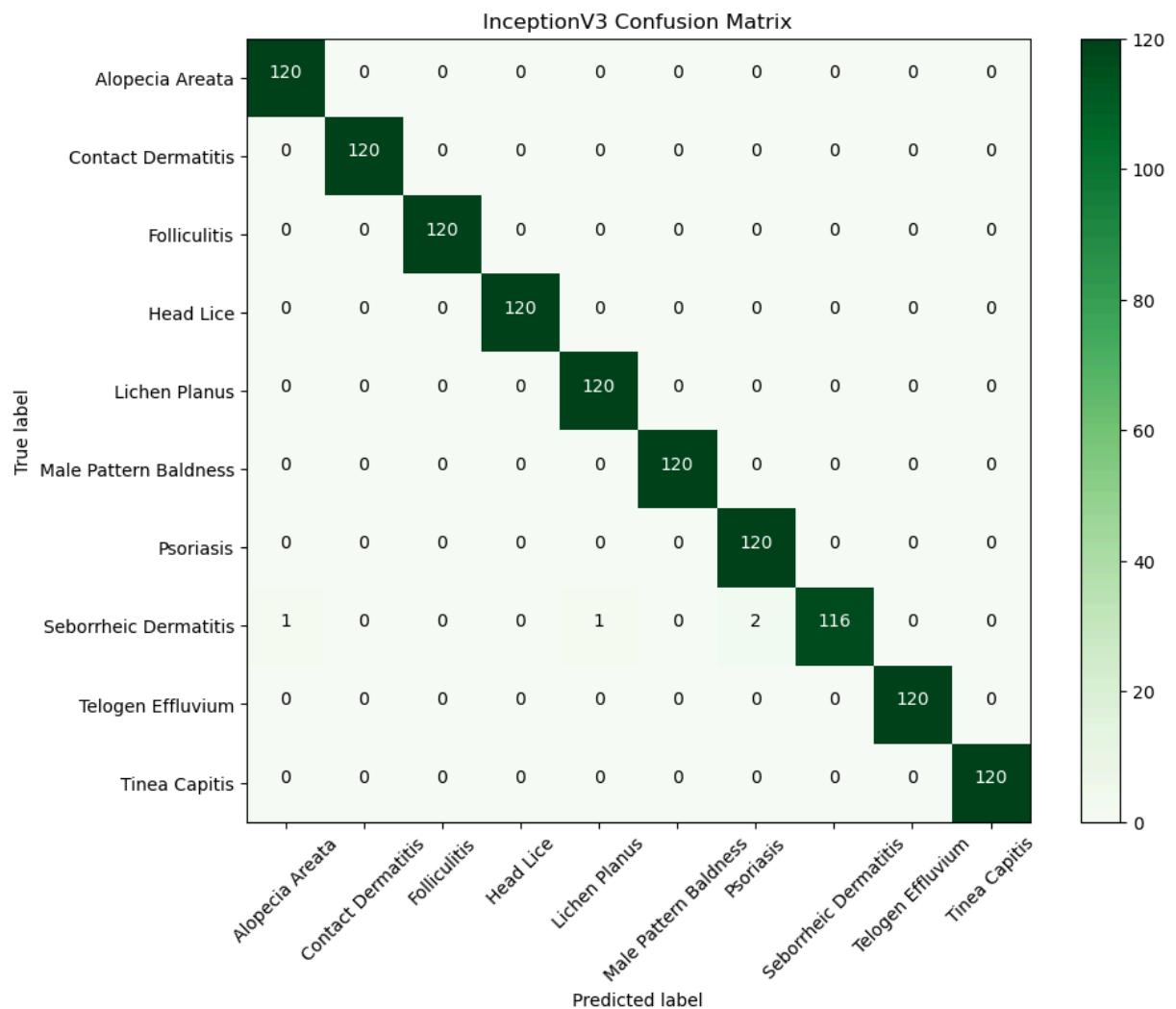
    # Plot precision-recall curve for each class
    plt.figure(figsize=(8, 6))
    colors = ['navy', 'turquoise', 'darkorange', 'cornflowerblue', 'teal', 'red',
              'purple', 'brown', 'pink', 'lightgreen']
    for i, color in zip(range(len(classes)), colors):
        plt.plot(recall[i], precision[i], color=color, lw=2,
                 label=f'Precision-recall curve of class {classes[i]} (AP = {average_precision[i]:.2f})')

    plt.xlabel('Recall')
    plt.ylabel('Precision')
    plt.xlim([0.0, 1.0])
    plt.ylim([0.0, 1.05])
    plt.title('Precision-Recall curve')
    plt.legend(loc="lower right")
    plt.show()

# Plot precision-recall curve
plot_precision_recall_curve(y_true, y_pred, classes)
```



```
In [72]: # Plot the confusion matrix  
plot_confusion_matrix(cm=conf_matrix, target_names=classes, title='DenseNet16')
```



```
In [ ]:
```