

```
In [6]: import tensorflow as tf
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.applications import ResNet50
from tensorflow.keras.layers import Dense, Flatten, Dropout, GlobalAveragePooling2D
from tensorflow.keras.models import Sequential, Model
from tensorflow.keras.optimizers import Adam
from sklearn.metrics import classification_report, confusion_matrix
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns
import os
```

```
In [7]: # ✎ MODIFY THIS PATH TO YOUR LOCAL DATASET SPLIT FOLDER
train_dir = r"C:\Users\ASUS\Desktop\AI Learning\archive"
val_dir = r"C:\Users\ASUS\Desktop\AI Learning\archive"
test_dir = r"C:\Users\ASUS\Desktop\AI Learning\archive"

img_size = (224, 224)
batch_size = 32
```

```
In [8]: train_gen = ImageDataGenerator(
    rescale=1./255,
    rotation_range=20,
    width_shift_range=0.2,
    height_shift_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True
)

val_gen = ImageDataGenerator(rescale=1./255)
test_gen = ImageDataGenerator(rescale=1./255)

train_data = train_gen.flow_from_directory(
    train_dir, target_size=img_size, batch_size=batch_size, class_mode='categorical')

val_data = val_gen.flow_from_directory(
    val_dir, target_size=img_size, batch_size=batch_size, class_mode='categorical')
```

```
test_data = test_gen.flow_from_directory(
    test_dir, target_size=img_size, batch_size=batch_size, class_mode='categorical', shuffle=False)

num_classes = train_data.num_classes
```

Found 13711 images belonging to 23 classes.

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Found 13711 images belonging to 23 classes.

```
In [9]: # CNN Model
cnn_model = Sequential([
    tf.keras.layers.Conv2D(32, (3,3), activation='relu', input_shape=(img_size,3)),
    tf.keras.layers.MaxPooling2D(2,2),
    tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2,2),
    tf.keras.layers.Conv2D(128, (3,3), activation='relu'),
    tf.keras.layers.MaxPooling2D(2,2),
    Flatten(),
    Dense(256, activation='relu'),
    Dropout(0.3),
    Dense(num_classes, activation='softmax')
])

cnn_model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])
cnn_model.summary()
```

C:\Users\ASUS\anaconda3\envs\tf\lib\site-packages\keras\src\layers\convolutional\base_conv.py:113: UserWarning: Do not pass an `input\_shape`/`input\_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.

```
super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 222, 222, 32)	896
max_pooling2d (MaxPooling2D)	(None, 111, 111, 32)	0
conv2d_1 (Conv2D)	(None, 109, 109, 64)	18,496
max_pooling2d_1 (MaxPooling2D)	(None, 54, 54, 64)	0
conv2d_2 (Conv2D)	(None, 52, 52, 128)	73,856
max_pooling2d_2 (MaxPooling2D)	(None, 26, 26, 128)	0
flatten (Flatten)	(None, 86528)	0
dense (Dense)	(None, 256)	22,151,424
dropout (Dropout)	(None, 256)	0
dense_1 (Dense)	(None, 23)	5,911

Total params: 22,250,583 (84.88 MB)

Trainable params: 22,250,583 (84.88 MB)

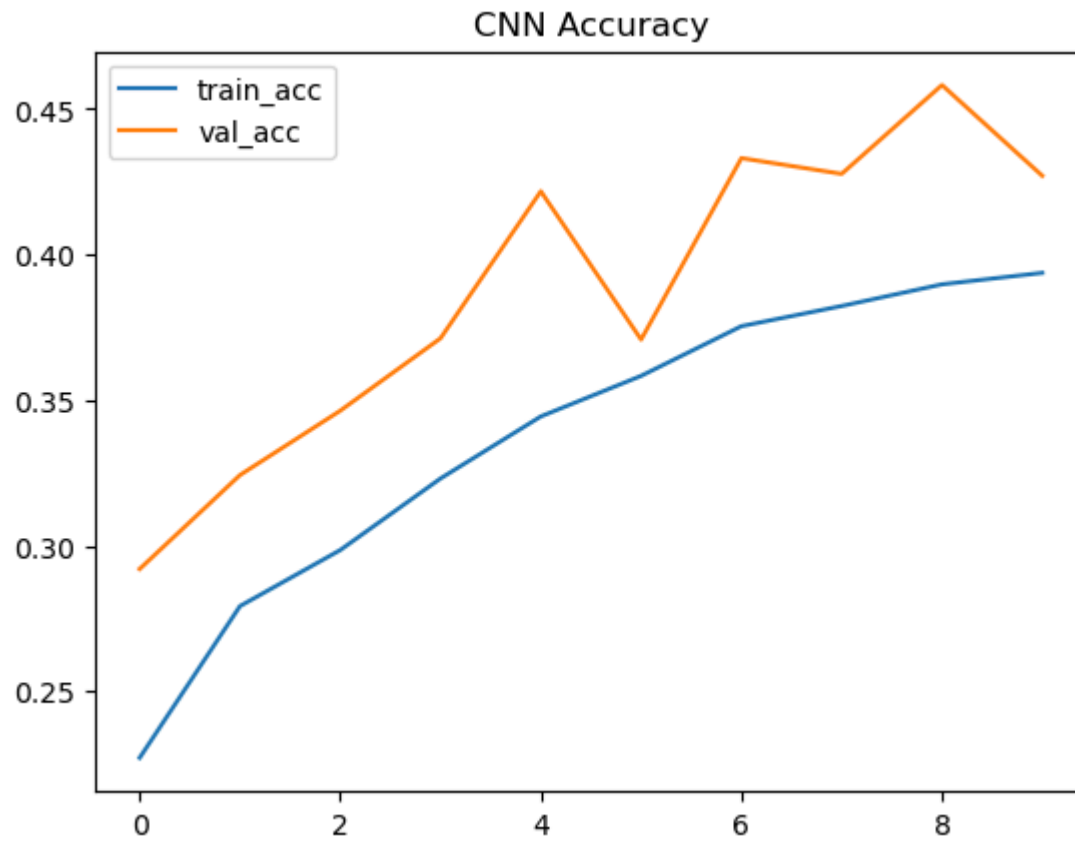
Non-trainable params: 0 (0.00 B)

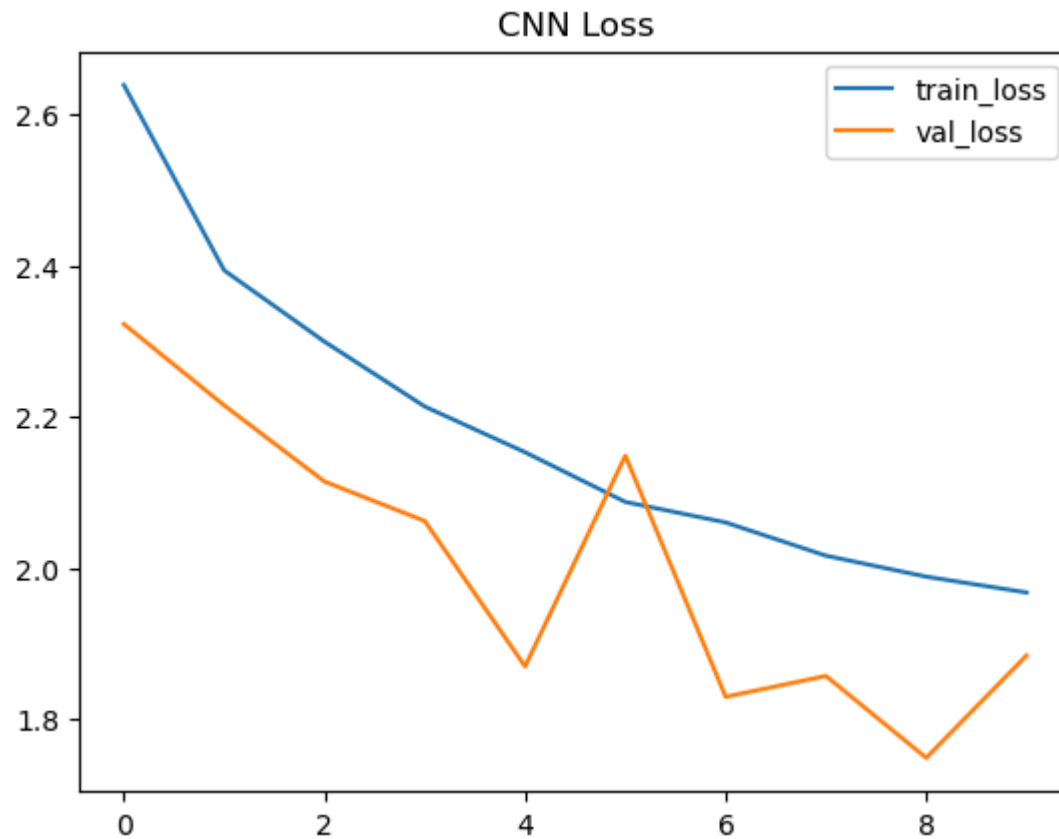
```
In [11]: history_cnn = cnn_model.fit(train_data, validation_data=val_data, epochs=10)
```

Epoch 1/10
429/429 ————— **672s** 2s/step - accuracy: 0.2272 - loss: 2.6389 - val_accuracy: 0.2920 - val_loss: 2.3225
 Epoch 2/10
429/429 ————— **730s** 2s/step - accuracy: 0.2793 - loss: 2.3936 - val_accuracy: 0.3243 - val_loss: 2.2149
 Epoch 3/10
429/429 ————— **1100s** 3s/step - accuracy: 0.2985 - loss: 2.2992 - val_accuracy: 0.3464 - val_loss: 2.1140
 Epoch 4/10
429/429 ————— **1080s** 3s/step - accuracy: 0.3231 - loss: 2.2133 - val_accuracy: 0.3712 - val_loss: 2.0618
 Epoch 5/10
429/429 ————— **5444s** 13s/step - accuracy: 0.3444 - loss: 2.1528 - val_accuracy: 0.4217 - val_loss: 1.8694
 Epoch 6/10
429/429 ————— **3622s** 8s/step - accuracy: 0.3583 - loss: 2.0870 - val_accuracy: 0.3708 - val_loss: 2.1482
 Epoch 7/10
429/429 ————— **738s** 2s/step - accuracy: 0.3754 - loss: 2.0599 - val_accuracy: 0.4331 - val_loss: 1.8291
 Epoch 8/10
429/429 ————— **700s** 2s/step - accuracy: 0.3823 - loss: 2.0159 - val_accuracy: 0.4277 - val_loss: 1.8567
 Epoch 9/10
429/429 ————— **688s** 2s/step - accuracy: 0.3898 - loss: 1.9881 - val_accuracy: 0.4582 - val_loss: 1.7483
 Epoch 10/10
429/429 ————— **656s** 2s/step - accuracy: 0.3937 - loss: 1.9672 - val_accuracy: 0.4270 - val_loss: 1.8838

```
In [12]: plt.plot(history_cnn.history['accuracy'], label='train_acc')
plt.plot(history_cnn.history['val_accuracy'], label='val_acc')
plt.legend()
plt.title('CNN Accuracy')
plt.show()

plt.plot(history_cnn.history['loss'], label='train_loss')
plt.plot(history_cnn.history['val_loss'], label='val_loss')
plt.legend()
plt.title('CNN Loss')
plt.show()
```





```
In [13]: # 🧠 ResNet50 Transfer Learning
base = ResNet50(weights='imagenet', include_top=False, input_shape=(img_size,3))
base.trainable = False

x = GlobalAveragePooling2D()(base.output)
x = Dense(256, activation='relu')(x)
x = Dropout(0.3)(x)
output = Dense(num_classes, activation='softmax')(x)

resnet_model = Model(inputs=base.input, outputs=output)
resnet_model.compile(optimizer=Adam(1e-4), loss='categorical_crossentropy', metrics=['accuracy'])
resnet_model.summary()
```

Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/resnet/resnet50_weights_tf_dim_ordering_tf_kernels_notop.h5
94765736/94765736  5s 0us/step
Model: "functional_1"

Layer (type)	Output Shape	Param #	Connected to
input_layer_1 (InputLayer)	(None, 224, 224, 3)	0	-
conv1_pad (ZeroPadding2D)	(None, 230, 230, 3)	0	input_layer_1[0]...
conv1_conv (Conv2D)	(None, 112, 112, 64)	9,472	conv1_pad[0][0]
conv1_bn (BatchNormalizatio...	(None, 112, 112, 64)	256	conv1_conv[0][0]
conv1_relu (Activation)	(None, 112, 112, 64)	0	conv1_bn[0][0]
pool1_pad (ZeroPadding2D)	(None, 114, 114, 64)	0	conv1_relu[0][0]
pool1_pool (MaxPooling2D)	(None, 56, 56, 64)	0	pool1_pad[0][0]
conv2_block1_1_conv (Conv2D)	(None, 56, 56, 64)	4,160	pool1_pool[0][0]
conv2_block1_1_bn (BatchNormalizatio...	(None, 56, 56, 64)	256	conv2_block1_1_c...
conv2_block1_1_relu (Activation)	(None, 56, 56, 64)	0	conv2_block1_1_b...
conv2_block1_2_conv (Conv2D)	(None, 56, 56, 64)	36,928	conv2_block1_1_r...
conv2_block1_2_bn (BatchNormalizatio...	(None, 56, 56, 64)	256	conv2_block1_2_c...
conv2_block1_2_relu (Activation)	(None, 56, 56, 64)	0	conv2_block1_2_b...

conv2_block1_0_conv (Conv2D)	(None, 56, 56, 256)	16,640	pool1_pool[0][0]
conv2_block1_3_conv (Conv2D)	(None, 56, 56, 256)	16,640	conv2_block1_2_r...
conv2_block1_0_bn (BatchNormalizatio...	(None, 56, 56, 256)	1,024	conv2_block1_0_c...
conv2_block1_3_bn (BatchNormalizatio...	(None, 56, 56, 256)	1,024	conv2_block1_3_c...
conv2_block1_add (Add)	(None, 56, 56, 256)	0	conv2_block1_0_b... conv2_block1_3_b...
conv2_block1_out (Activation)	(None, 56, 56, 256)	0	conv2_block1_add...
conv2_block2_1_conv (Conv2D)	(None, 56, 56, 64)	16,448	conv2_block1_out...
conv2_block2_1_bn (BatchNormalizatio...	(None, 56, 56, 64)	256	conv2_block2_1_c...
conv2_block2_1_relu (Activation)	(None, 56, 56, 64)	0	conv2_block2_1_b...
conv2_block2_2_conv (Conv2D)	(None, 56, 56, 64)	36,928	conv2_block2_1_r...
conv2_block2_2_bn (BatchNormalizatio...	(None, 56, 56, 64)	256	conv2_block2_2_c...
conv2_block2_2_relu (Activation)	(None, 56, 56, 64)	0	conv2_block2_2_b...
conv2_block2_3_conv (Conv2D)	(None, 56, 56, 256)	16,640	conv2_block2_2_r...
conv2_block2_3_bn	(None, 56, 56,	1,024	conv2_block2_3_c...

(BatchNormalizatio...	256)		
conv2_block2_add (Add)	(None, 56, 56, 256)	0	conv2_block1_out... conv2_block2_3_b...
conv2_block2_out (Activation)	(None, 56, 56, 256)	0	conv2_block2_add...
conv2_block3_1_conv (Conv2D)	(None, 56, 56, 64)	16,448	conv2_block2_out...
conv2_block3_1_bn (BatchNormalizatio...	(None, 56, 56, 64)	256	conv2_block3_1_c...
conv2_block3_1_relu (Activation)	(None, 56, 56, 64)	0	conv2_block3_1_b...
conv2_block3_2_conv (Conv2D)	(None, 56, 56, 64)	36,928	conv2_block3_1_r...
conv2_block3_2_bn (BatchNormalizatio...	(None, 56, 56, 64)	256	conv2_block3_2_c...
conv2_block3_2_relu (Activation)	(None, 56, 56, 64)	0	conv2_block3_2_b...
conv2_block3_3_conv (Conv2D)	(None, 56, 56, 256)	16,640	conv2_block3_2_r...
conv2_block3_3_bn (BatchNormalizatio...	(None, 56, 56, 256)	1,024	conv2_block3_3_c...
conv2_block3_add (Add)	(None, 56, 56, 256)	0	conv2_block2_out... conv2_block3_3_b...
conv2_block3_out (Activation)	(None, 56, 56, 256)	0	conv2_block3_add...
conv3_block1_1_conv (Conv2D)	(None, 28, 28, 128)	32,896	conv2_block3_out...

conv3_block1_1_bn (BatchNormalizatio...	(None, 28, 28, 128)	512	conv3_block1_1_c...
conv3_block1_1_relu (Activation)	(None, 28, 28, 128)	0	conv3_block1_1_b...
conv3_block1_2_conv (Conv2D)	(None, 28, 28, 128)	147,584	conv3_block1_1_r...
conv3_block1_2_bn (BatchNormalizatio...	(None, 28, 28, 128)	512	conv3_block1_2_c...
conv3_block1_2_relu (Activation)	(None, 28, 28, 128)	0	conv3_block1_2_b...
conv3_block1_0_conv (Conv2D)	(None, 28, 28, 512)	131,584	conv2_block3_out...
conv3_block1_3_conv (Conv2D)	(None, 28, 28, 512)	66,048	conv3_block1_2_r...
conv3_block1_0_bn (BatchNormalizatio...	(None, 28, 28, 512)	2,048	conv3_block1_0_c...
conv3_block1_3_bn (BatchNormalizatio...	(None, 28, 28, 512)	2,048	conv3_block1_3_c...
conv3_block1_add (Add)	(None, 28, 28, 512)	0	conv3_block1_0_b... conv3_block1_3_b...
conv3_block1_out (Activation)	(None, 28, 28, 512)	0	conv3_block1_add...
conv3_block2_1_conv (Conv2D)	(None, 28, 28, 128)	65,664	conv3_block1_out...
conv3_block2_1_bn (BatchNormalizatio...	(None, 28, 28, 128)	512	conv3_block2_1_c...
conv3_block2_1_relu (Activation)	(None, 28, 28, 128)	0	conv3_block2_1_b...

conv3_block2_2_conv (Conv2D)	(None, 28, 28, 128)	147,584	conv3_block2_1_r...
conv3_block2_2_bn (BatchNormalizatio...	(None, 28, 28, 128)	512	conv3_block2_2_c...
conv3_block2_2_relu (Activation)	(None, 28, 28, 128)	0	conv3_block2_2_b...
conv3_block2_3_conv (Conv2D)	(None, 28, 28, 512)	66,048	conv3_block2_2_r...
conv3_block2_3_bn (BatchNormalizatio...	(None, 28, 28, 512)	2,048	conv3_block2_3_c...
conv3_block2_add (Add)	(None, 28, 28, 512)	0	conv3_block1_out... conv3_block2_3_b...
conv3_block2_out (Activation)	(None, 28, 28, 512)	0	conv3_block2_add...
conv3_block3_1_conv (Conv2D)	(None, 28, 28, 128)	65,664	conv3_block2_out...
conv3_block3_1_bn (BatchNormalizatio...	(None, 28, 28, 128)	512	conv3_block3_1_c...
conv3_block3_1_relu (Activation)	(None, 28, 28, 128)	0	conv3_block3_1_b...
conv3_block3_2_conv (Conv2D)	(None, 28, 28, 128)	147,584	conv3_block3_1_r...
conv3_block3_2_bn (BatchNormalizatio...	(None, 28, 28, 128)	512	conv3_block3_2_c...
conv3_block3_2_relu (Activation)	(None, 28, 28, 128)	0	conv3_block3_2_b...
conv3_block3_3_conv	(None, 28, 28,	66,048	conv3_block3_2_r...

(Conv2D)	512)		
conv3_block3_3_bn (BatchNormalizatio...	(None, 28, 28, 512)	2,048	conv3_block3_3_c...
conv3_block3_add (Add)	(None, 28, 28, 512)	0	conv3_block2_out... conv3_block3_3_b...
conv3_block3_out (Activation)	(None, 28, 28, 512)	0	conv3_block3_add...
conv3_block4_1_conv (Conv2D)	(None, 28, 28, 128)	65,664	conv3_block3_out...
conv3_block4_1_bn (BatchNormalizatio...	(None, 28, 28, 128)	512	conv3_block4_1_c...
conv3_block4_1_relu (Activation)	(None, 28, 28, 128)	0	conv3_block4_1_b...
conv3_block4_2_conv (Conv2D)	(None, 28, 28, 128)	147,584	conv3_block4_1_r...
conv3_block4_2_bn (BatchNormalizatio...	(None, 28, 28, 128)	512	conv3_block4_2_c...
conv3_block4_2_relu (Activation)	(None, 28, 28, 128)	0	conv3_block4_2_b...
conv3_block4_3_conv (Conv2D)	(None, 28, 28, 512)	66,048	conv3_block4_2_r...
conv3_block4_3_bn (BatchNormalizatio...	(None, 28, 28, 512)	2,048	conv3_block4_3_c...
conv3_block4_add (Add)	(None, 28, 28, 512)	0	conv3_block3_out... conv3_block4_3_b...
conv3_block4_out (Activation)	(None, 28, 28, 512)	0	conv3_block4_add...

conv4_block1_1_conv (Conv2D)	(None, 14, 14, 256)	131,328	conv3_block4_out...
conv4_block1_1_bn (BatchNormalizatio...	(None, 14, 14, 256)	1,024	conv4_block1_1_c...
conv4_block1_1_relu (Activation)	(None, 14, 14, 256)	0	conv4_block1_1_b...
conv4_block1_2_conv (Conv2D)	(None, 14, 14, 256)	590,080	conv4_block1_1_r...
conv4_block1_2_bn (BatchNormalizatio...	(None, 14, 14, 256)	1,024	conv4_block1_2_c...
conv4_block1_2_relu (Activation)	(None, 14, 14, 256)	0	conv4_block1_2_b...
conv4_block1_0_conv (Conv2D)	(None, 14, 14, 1024)	525,312	conv3_block4_out...
conv4_block1_3_conv (Conv2D)	(None, 14, 14, 1024)	263,168	conv4_block1_2_r...
conv4_block1_0_bn (BatchNormalizatio...	(None, 14, 14, 1024)	4,096	conv4_block1_0_c...
conv4_block1_3_bn (BatchNormalizatio...	(None, 14, 14, 1024)	4,096	conv4_block1_3_c...
conv4_block1_add (Add)	(None, 14, 14, 1024)	0	conv4_block1_0_b... conv4_block1_3_b...
conv4_block1_out (Activation)	(None, 14, 14, 1024)	0	conv4_block1_add...
conv4_block2_1_conv (Conv2D)	(None, 14, 14, 256)	262,400	conv4_block1_out...
conv4_block2_1_bn (BatchNormalizatio...	(None, 14, 14, 256)	1,024	conv4_block2_1_c...

conv4_block2_1_relu (Activation)	(None, 14, 14, 256)	0	conv4_block2_1_b...
conv4_block2_2_conv (Conv2D)	(None, 14, 14, 256)	590,080	conv4_block2_1_r...
conv4_block2_2_bn (BatchNormalizatio...	(None, 14, 14, 256)	1,024	conv4_block2_2_c...
conv4_block2_2_relu (Activation)	(None, 14, 14, 256)	0	conv4_block2_2_b...
conv4_block2_3_conv (Conv2D)	(None, 14, 14, 1024)	263,168	conv4_block2_2_r...
conv4_block2_3_bn (BatchNormalizatio...	(None, 14, 14, 1024)	4,096	conv4_block2_3_c...
conv4_block2_add (Add)	(None, 14, 14, 1024)	0	conv4_block1_out... conv4_block2_3_b...
conv4_block2_out (Activation)	(None, 14, 14, 1024)	0	conv4_block2_add...
conv4_block3_1_conv (Conv2D)	(None, 14, 14, 256)	262,400	conv4_block2_out...
conv4_block3_1_bn (BatchNormalizatio...	(None, 14, 14, 256)	1,024	conv4_block3_1_c...
conv4_block3_1_relu (Activation)	(None, 14, 14, 256)	0	conv4_block3_1_b...
conv4_block3_2_conv (Conv2D)	(None, 14, 14, 256)	590,080	conv4_block3_1_r...
conv4_block3_2_bn (BatchNormalizatio...	(None, 14, 14, 256)	1,024	conv4_block3_2_c...
conv4_block3_2_relu	(None, 14, 14,	0	conv4_block3_2_b...

(Activation)	256)		
conv4_block3_3_conv (Conv2D)	(None, 14, 14, 1024)	263,168	conv4_block3_2_r...
conv4_block3_3_bn (BatchNormalizatio...	(None, 14, 14, 1024)	4,096	conv4_block3_3_c...
conv4_block3_add (Add)	(None, 14, 14, 1024)	0	conv4_block2_out... conv4_block3_3_b...
conv4_block3_out (Activation)	(None, 14, 14, 1024)	0	conv4_block3_add...
conv4_block4_1_conv (Conv2D)	(None, 14, 14, 256)	262,400	conv4_block3_out...
conv4_block4_1_bn (BatchNormalizatio...	(None, 14, 14, 256)	1,024	conv4_block4_1_c...
conv4_block4_1_relu (Activation)	(None, 14, 14, 256)	0	conv4_block4_1_b...
conv4_block4_2_conv (Conv2D)	(None, 14, 14, 256)	590,080	conv4_block4_1_r...
conv4_block4_2_bn (BatchNormalizatio...	(None, 14, 14, 256)	1,024	conv4_block4_2_c...
conv4_block4_2_relu (Activation)	(None, 14, 14, 256)	0	conv4_block4_2_b...
conv4_block4_3_conv (Conv2D)	(None, 14, 14, 1024)	263,168	conv4_block4_2_r...
conv4_block4_3_bn (BatchNormalizatio...	(None, 14, 14, 1024)	4,096	conv4_block4_3_c...
conv4_block4_add (Add)	(None, 14, 14, 1024)	0	conv4_block3_out... conv4_block4_3_b...

conv4_block4_out (Activation)	(None, 14, 14, 1024)	0	conv4_block4_add...
conv4_block5_1_conv (Conv2D)	(None, 14, 14, 256)	262,400	conv4_block4_out...
conv4_block5_1_bn (BatchNormalizatio...	(None, 14, 14, 256)	1,024	conv4_block5_1_c...
conv4_block5_1_relu (Activation)	(None, 14, 14, 256)	0	conv4_block5_1_b...
conv4_block5_2_conv (Conv2D)	(None, 14, 14, 256)	590,080	conv4_block5_1_r...
conv4_block5_2_bn (BatchNormalizatio...	(None, 14, 14, 256)	1,024	conv4_block5_2_c...
conv4_block5_2_relu (Activation)	(None, 14, 14, 256)	0	conv4_block5_2_b...
conv4_block5_3_conv (Conv2D)	(None, 14, 14, 1024)	263,168	conv4_block5_2_r...
conv4_block5_3_bn (BatchNormalizatio...	(None, 14, 14, 1024)	4,096	conv4_block5_3_c...
conv4_block5_add (Add)	(None, 14, 14, 1024)	0	conv4_block4_out... conv4_block5_3_b...
conv4_block5_out (Activation)	(None, 14, 14, 1024)	0	conv4_block5_add...
conv4_block6_1_conv (Conv2D)	(None, 14, 14, 256)	262,400	conv4_block5_out...
conv4_block6_1_bn (BatchNormalizatio...	(None, 14, 14, 256)	1,024	conv4_block6_1_c...
conv4_block6_1_relu (Activation)	(None, 14, 14, 256)	0	conv4_block6_1_b...

conv4_block6_2_conv (Conv2D)	(None, 14, 14, 256)	590,080	conv4_block6_1_r...
conv4_block6_2_bn (BatchNormalizatio...	(None, 14, 14, 256)	1,024	conv4_block6_2_c...
conv4_block6_2_relu (Activation)	(None, 14, 14, 256)	0	conv4_block6_2_b...
conv4_block6_3_conv (Conv2D)	(None, 14, 14, 1024)	263,168	conv4_block6_2_r...
conv4_block6_3_bn (BatchNormalizatio...	(None, 14, 14, 1024)	4,096	conv4_block6_3_c...
conv4_block6_add (Add)	(None, 14, 14, 1024)	0	conv4_block5_out... conv4_block6_3_b...
conv4_block6_out (Activation)	(None, 14, 14, 1024)	0	conv4_block6_add...
conv5_block1_1_conv (Conv2D)	(None, 7, 7, 512)	524,800	conv4_block6_out...
conv5_block1_1_bn (BatchNormalizatio...	(None, 7, 7, 512)	2,048	conv5_block1_1_c...
conv5_block1_1_relu (Activation)	(None, 7, 7, 512)	0	conv5_block1_1_b...
conv5_block1_2_conv (Conv2D)	(None, 7, 7, 512)	2,359,808	conv5_block1_1_r...
conv5_block1_2_bn (BatchNormalizatio...	(None, 7, 7, 512)	2,048	conv5_block1_2_c...
conv5_block1_2_relu (Activation)	(None, 7, 7, 512)	0	conv5_block1_2_b...
conv5_block1_0_conv	(None, 7, 7,	2,099,200	conv4_block6_out...

(Conv2D)	2048)		
conv5_block1_3_conv (Conv2D)	(None, 7, 7, 2048)	1,050,624	conv5_block1_2_r...
conv5_block1_0_bn (BatchNormalizatio...	(None, 7, 7, 2048)	8,192	conv5_block1_0_c...
conv5_block1_3_bn (BatchNormalizatio...	(None, 7, 7, 2048)	8,192	conv5_block1_3_c...
conv5_block1_add (Add)	(None, 7, 7, 2048)	0	conv5_block1_0_b... conv5_block1_3_b...
conv5_block1_out (Activation)	(None, 7, 7, 2048)	0	conv5_block1_add...
conv5_block2_1_conv (Conv2D)	(None, 7, 7, 512)	1,049,088	conv5_block1_out...
conv5_block2_1_bn (BatchNormalizatio...	(None, 7, 7, 512)	2,048	conv5_block2_1_c...
conv5_block2_1_relu (Activation)	(None, 7, 7, 512)	0	conv5_block2_1_b...
conv5_block2_2_conv (Conv2D)	(None, 7, 7, 512)	2,359,808	conv5_block2_1_r...
conv5_block2_2_bn (BatchNormalizatio...	(None, 7, 7, 512)	2,048	conv5_block2_2_c...
conv5_block2_2_relu (Activation)	(None, 7, 7, 512)	0	conv5_block2_2_b...
conv5_block2_3_conv (Conv2D)	(None, 7, 7, 2048)	1,050,624	conv5_block2_2_r...
conv5_block2_3_bn (BatchNormalizatio...	(None, 7, 7, 2048)	8,192	conv5_block2_3_c...

conv5_block2_add (Add)	(None, 7, 7, 2048)	0	conv5_block1_out... conv5_block2_3_b...
conv5_block2_out (Activation)	(None, 7, 7, 2048)	0	conv5_block2_add...
conv5_block3_1_conv (Conv2D)	(None, 7, 7, 512)	1,049,088	conv5_block2_out...
conv5_block3_1_bn (BatchNormalizatio...	(None, 7, 7, 512)	2,048	conv5_block3_1_c...
conv5_block3_1_relu (Activation)	(None, 7, 7, 512)	0	conv5_block3_1_b...
conv5_block3_2_conv (Conv2D)	(None, 7, 7, 512)	2,359,808	conv5_block3_1_r...
conv5_block3_2_bn (BatchNormalizatio...	(None, 7, 7, 512)	2,048	conv5_block3_2_c...
conv5_block3_2_relu (Activation)	(None, 7, 7, 512)	0	conv5_block3_2_b...
conv5_block3_3_conv (Conv2D)	(None, 7, 7, 2048)	1,050,624	conv5_block3_2_r...
conv5_block3_3_bn (BatchNormalizatio...	(None, 7, 7, 2048)	8,192	conv5_block3_3_c...
conv5_block3_add (Add)	(None, 7, 7, 2048)	0	conv5_block2_out... conv5_block3_3_b...
conv5_block3_out (Activation)	(None, 7, 7, 2048)	0	conv5_block3_add...
global_average_poo... (GlobalAveragePool...	(None, 2048)	0	conv5_block3_out...
dense_2 (Dense)	(None, 256)	524,544	global_average_p...

dropout_1 (Dropout)	(None, 256)	0	dense_2[0][0]
dense_3 (Dense)	(None, 23)	5,911	dropout_1[0][0]

Total params: 24,118,167 (92.00 MB)

Trainable params: 530,455 (2.02 MB)

Non-trainable params: 23,587,712 (89.98 MB)

```
In [ ]: !jupyter nbconvert --to pdf Assignment.ipynb
```

```
In [ ]: preds = resnet_model.predict(test_data)
y_pred = np.argmax(preds, axis=1)
y_true = test_data.classes

print(classification_report(y_true, y_pred, target_names=test_data.class_indices.keys()))

cm = confusion_matrix(y_true, y_pred)
plt.figure(figsize=(12,10))
sns.heatmap(cm, annot=False, cmap='Blues')
plt.title('Confusion Matrix')
plt.show()
```

```
In [ ]: history_resnet = resnet_model.fit(train_data, validation_data=val_data, epochs=3)
```

```
In [ ]:
```