```
import tensorflow as tf
from tensorflow import keras

img_height =224
img_width =224
batch_size = 32
validation_split = 0.2
```

```
rescale = tf.keras.layers.Rescaling(1./255)
```

```
import zipfile
zip_ref = zipfile.ZipFile('/content/drive/MyDrive/Level 6/Artificial_Intelligence/Week5/FruitinAmazon.zip', 'r')
zip_ref.extractall('/content')
zip_ref.close()
```

```
# data.data.districts
import tensorflow as tf
from tensorflow import keras
from keras import Sequential
from keras.layers import Dense, Conv2D, MaxPooling2D, Flatten, BatchNormalization, Dropout
```

```
train_dir = '/content/drive/MyDrive/Level 6/Artificial_Intelligence/Week5/FruitinAmazon/train'
```

```
train_ds = tf.keras.preprocessing.image_dataset_from_directory(
train_dir,
labels='inferred',
label_mode='int',
image_size=(img_height, img_width),
interpolation='nearest',
batch_size=batch_size,
shuffle=True,
validation_split=validation_split,
subset='training',
seed=123
)
train_ds = train_ds.map(lambda x, y: (rescale(x), y))
```

```
Found 90 files belonging to 6 classes.
Using 72 files for training.
```

```
# Create validation dataset with normalization
val_ds = tf.keras.preprocessing.image_dataset_from_directory(
train_dir,
labels='inferred',
label_mode='int',
image_size=(img_height, img_width),
interpolation='nearest',
batch_size=batch_size,
shuffle=False,
validation_split=validation_split,
subset='validation',
seed=123
)
val_ds = val_ds.map(lambda x, y: (rescale(x), y))
```

```
Found 90 files belonging to 6 classes.
Using 18 files for validation.
```

```
from tensorflow.keras.applications import VGG16
base_model = VGG16(weights='imagenet', include_top=False, input_shape=(224, 224, 3))
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/vgg16/vgg16_weights_tf_dim_ordering_t
58889256/58889256 ━━━━━━━━━━━━━━━━━━━━ 0s 0us/step
```

```
base_model.summary()
```

```
Model: "vgg16"
┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━┓
┃ Layer (type)                         ┃ Output Shape                ┃         Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━┩
│ input_layer (InputLayer)             │ (None, 224, 224, 3)         │               0 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block1_conv1 (Conv2D)                │ (None, 224, 224, 64)        │           1,792 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block1_conv2 (Conv2D)                │ (None, 224, 224, 64)        │          36,928 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block1_pool (MaxPooling2D)           │ (None, 112, 112, 64)        │               0 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block2_conv1 (Conv2D)                │ (None, 112, 112, 128)       │          73,856 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block2_conv2 (Conv2D)                │ (None, 112, 112, 128)       │         147,584 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block2_pool (MaxPooling2D)           │ (None, 56, 56, 128)         │               0 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block3_conv1 (Conv2D)                │ (None, 56, 56, 256)         │         295,168 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block3_conv2 (Conv2D)                │ (None, 56, 56, 256)         │         590,080 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block3_conv3 (Conv2D)                │ (None, 56, 56, 256)         │         590,080 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block3_pool (MaxPooling2D)           │ (None, 28, 28, 256)         │               0 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block4_conv1 (Conv2D)                │ (None, 28, 28, 512)         │       1,180,160 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block4_conv2 (Conv2D)                │ (None, 28, 28, 512)         │       2,359,808 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block4_conv3 (Conv2D)                │ (None, 28, 28, 512)         │       2,359,808 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block4_pool (MaxPooling2D)           │ (None, 14, 14, 512)         │               0 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block5_conv1 (Conv2D)                │ (None, 14, 14, 512)         │       2,359,808 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block5_conv2 (Conv2D)                │ (None, 14, 14, 512)         │       2,359,808 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block5_conv3 (Conv2D)                │ (None, 14, 14, 512)         │       2,359,808 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ block5_pool (MaxPooling2D)           │ (None, 7, 7, 512)           │               0 │
└──────────────────────────────────────┴─────────────────────────────┴─────────────────┘
 Total params: 14,714,688 (56.13 MB)
 Trainable params: 14,714,688 (56.13 MB)
 Non-trainable params: 0 (0.00 B)
```

```
for layer in base_model.layers:
  layer.trainable = False
```

```
model = Sequential()
model.add(base_model)
model.add(Flatten())
model.add(Dense(1024, activation='relu'))
model.add(Dense(6, activation='softmax'))
```

```
model.summary()
```

```
Model: "sequential"
┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━┓
┃ Layer (type)                         ┃ Output Shape                ┃         Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━┩
│ vgg16 (Functional)                   │ (None, 7, 7, 512)           │      14,714,688 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ flatten (Flatten)                    │ (None, 25088)               │               0 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ dense (Dense)                        │ (None, 1024)                │      25,691,136 │
├──────────────────────────────────────┼─────────────────────────────┼─────────────────┤
│ dense_1 (Dense)                      │ (None, 6)                   │           6,150 │
└──────────────────────────────────────┴─────────────────────────────┴─────────────────┘
 Total params: 40,411,974 (154.16 MB)
 Trainable params: 25,697,286 (98.03 MB)
 Non-trainable params: 14,714,688 (56.13 MB)
```

```
model.compile(optimizer='adam', loss='sparse_categorical_crossentropy', metrics=['accuracy'])
```

```
history = model.fit(train_ds, validation_data=val_ds, epochs=10)
```

```
Epoch 1/10
3/3 ━━━━━━━━━━━━━━━━━━━━ 73s 19s/step - accuracy: 0.1997 - loss: 7.5966 - val_accuracy: 0.1111 - val_loss: 10.7234
Epoch 2/10
3/3 ━━━━━━━━━━━━━━━━━━━━ 73s 20s/step - accuracy: 0.4913 - loss: 8.9173 - val_accuracy: 0.8333 - val_loss: 2.3984
Epoch 3/10
3/3 ━━━━━━━━━━━━━━━━━━━━ 50s 16s/step - accuracy: 0.6289 - loss: 8.3381 - val_accuracy: 0.8333 - val_loss: 0.9623
Epoch 4/10
3/3 ━━━━━━━━━━━━━━━━━━━━ 82s 16s/step - accuracy: 0.7700 - loss: 5.0412 - val_accuracy: 0.6111 - val_loss: 3.2832
Epoch 5/10
3/3 ━━━━━━━━━━━━━━━━━━━━ 61s 21s/step - accuracy: 0.7639 - loss: 2.5738 - val_accuracy: 0.6111 - val_loss: 3.5414
Epoch 6/10
3/3 ━━━━━━━━━━━━━━━━━━━━ 82s 22s/step - accuracy: 0.9449 - loss: 0.3297 - val_accuracy: 0.4444 - val_loss: 3.0220
Epoch 7/10
3/3 ━━━━━━━━━━━━━━━━━━━━ 50s 16s/step - accuracy: 0.8806 - loss: 0.4283 - val_accuracy: 0.7778 - val_loss: 1.0958
Epoch 8/10
3/3 ━━━━━━━━━━━━━━━━━━━━ 51s 17s/step - accuracy: 0.9627 - loss: 0.0748 - val_accuracy: 0.8889 - val_loss: 0.4856
Epoch 9/10
3/3 ━━━━━━━━━━━━━━━━━━━━ 61s 21s/step - accuracy: 1.0000 - loss: 0.0049 - val_accuracy: 0.9444 - val_loss: 0.2508
Epoch 10/10
3/3 ━━━━━━━━━━━━━━━━━━━━ 55s 17s/step - accuracy: 1.0000 - loss: 0.0177 - val_accuracy: 0.9444 - val_loss: 0.2098
```

```
test_loss, test_acc = model.evaluate(val_ds)
print(f"Validation Accuracy: {test_acc:.2f}")
```

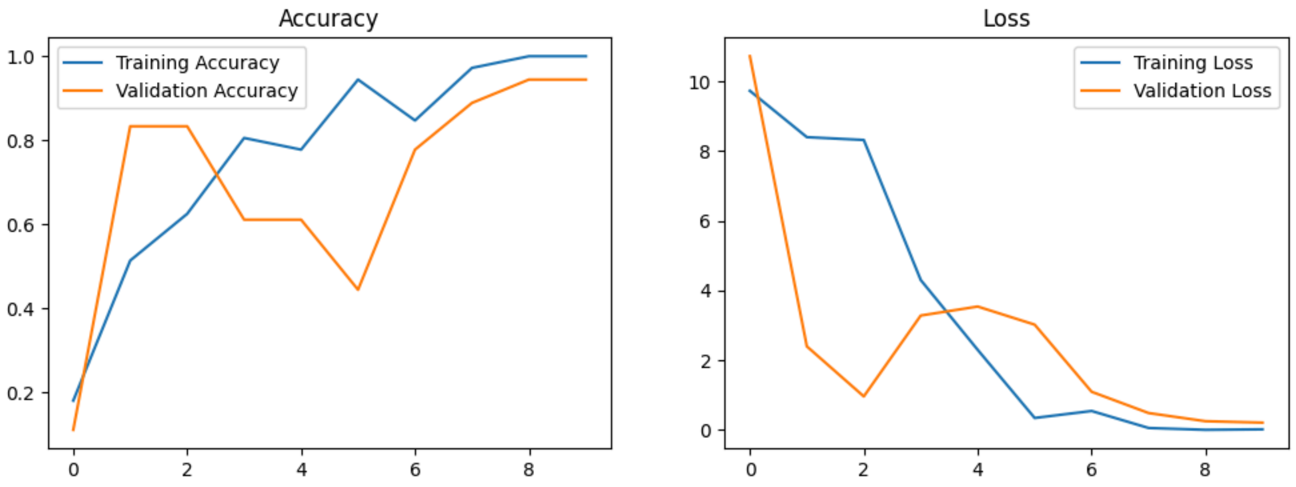
```
1/1 ━━━━━━━━━━━━━━━━━━━━ 10s 10s/step - accuracy: 0.9444 - loss: 0.2098
Validation Accuracy: 0.94
```

```
#plot for test data
# Plot training history
import matplotlib.pyplot as plt
plt.figure(figsize=(12, 4))

plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'], label='Training Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.title('Accuracy')
plt.legend()

plt.subplot(1, 2, 2)
plt.plot(history.history['loss'], label='Training Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.title('Loss')
plt.legend()

plt.show()
```



```
test_dir = "/content/drive/MyDrive/Level 6/Artificial_Intelligence/Week5/FruitinAmazon/test"
test_ds = tf.keras.preprocessing.image_dataset_from_directory(
    test_dir,
    labels='inferred',
    label_mode='int',
    image_size=(img_height, img_width),
    batch_size=batch_size,
    shuffle=False,
    interpolation='nearest',
    seed=123
)


test_ds = test_ds.map(lambda x, y: (rescale(x), y))
```

```
Found 30 files belonging to 6 classes.
```

```
test_loss, test_accuracy = model.evaluate(test_ds)
print(f"Test Accuracy: {test_accuracy:.4f}")
print(f"Test Loss: {test_loss:.4f}")
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 20s 20s/step - accuracy: 0.2667 - loss: 6.7009
Test Accuracy: 0.2667
Test Loss: 6.7009
```

```
import tensorflow
from tensorflow import keras
from keras import Sequential
from keras.layers import Dense,Flatten
from keras.applications.vgg16 import VGG16
from tensorflow.keras.optimizers import RMSprop
```

```
base_model = VGG16(
    weights='imagenet',
    include_top = False,
    input_shape=(224,224,3)
)
```

```
base_model.trainable = True

set_trainable = False

for layer in base_model.layers:
  if layer.name == 'block5_conv1':
    set_trainable = True
  if set_trainable:
    layer.trainable = True
  else:
    layer.trainable = False

for layer in base_model.layers:
  print(layer.name,layer.trainable)
```

```
input_layer_2 False
block1_conv1 False
block1_conv2 False
block1_pool False
block2_conv1 False
block2_conv2 False
block2_pool False
block3_conv1 False
block3_conv2 False
block3_conv3 False
block3_pool False
block4_conv1 False
block4_conv2 False
block4_conv3 False
block4_pool False
block5_conv1 True
block5_conv2 True
block5_conv3 True
block5_pool True
```

```
base_model.summary()
```

```
Model: "vgg16"
┏━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━━━━━━━━━━┳━━━━━━━━━━━━━━━┓
┃ Layer (type)                    ┃ Output Shape           ┃       Param # ┃
┡━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━━━━━━━━━━╇━━━━━━━━━━━━━━━┩
│ input_layer_2 (InputLayer)      │ (None, 224, 224, 3)    │             0 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block1_conv1 (Conv2D)           │ (None, 224, 224, 64)   │         1,792 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block1_conv2 (Conv2D)           │ (None, 224, 224, 64)   │        36,928 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block1_pool (MaxPooling2D)      │ (None, 112, 112, 64)   │             0 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block2_conv1 (Conv2D)           │ (None, 112, 112, 128)  │        73,856 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block2_conv2 (Conv2D)           │ (None, 112, 112, 128)  │       147,584 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block2_pool (MaxPooling2D)      │ (None, 56, 56, 128)    │             0 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block3_conv1 (Conv2D)           │ (None, 56, 56, 256)    │       295,168 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block3_conv2 (Conv2D)           │ (None, 56, 56, 256)    │       590,080 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block3_conv3 (Conv2D)           │ (None, 56, 56, 256)    │       590,080 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block3_pool (MaxPooling2D)      │ (None, 28, 28, 256)    │             0 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block4_conv1 (Conv2D)           │ (None, 28, 28, 512)    │     1,180,160 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block4_conv2 (Conv2D)           │ (None, 28, 28, 512)    │     2,359,808 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block4_conv3 (Conv2D)           │ (None, 28, 28, 512)    │     2,359,808 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block4_pool (MaxPooling2D)      │ (None, 14, 14, 512)    │             0 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block5_conv1 (Conv2D)           │ (None, 14, 14, 512)    │     2,359,808 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block5_conv2 (Conv2D)           │ (None, 14, 14, 512)    │     2,359,808 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block5_conv3 (Conv2D)           │ (None, 14, 14, 512)    │     2,359,808 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ block5_pool (MaxPooling2D)      │ (None, 7, 7, 512)      │             0 │
└─────────────────────────────────┴────────────────────────┴───────────────┘
 Total params: 14,714,688 (56.13 MB)
 Trainable params: 7,079,424 (27.01 MB)
 Non-trainable params: 7,635,264 (29.13 MB)
```

```
model = Sequential()

model.add(base_model)
model.add(Flatten())
model.add(Dense(256,activation='relu'))
model.add(Dense(6,activation='softmax'))
```

```
model.compile(optimizer=keras.optimizers.RMSprop(learning_rate=1e-5), loss='sparse_categorical_crossentropy', metrics=['accu
```

```
test_loss, test_acc = model.evaluate(val_ds)
print(f"Validation Accuracy: {test_acc:.2f}")
```

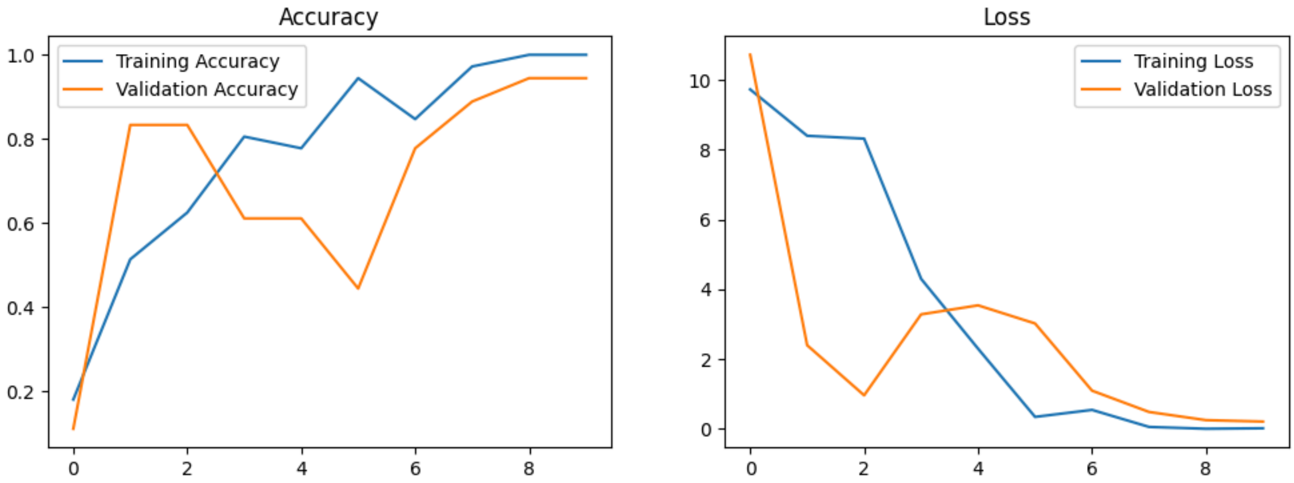
```
1/1 ━━━━━━━━━━━━━━━━━━━━ 11s 11s/step - accuracy: 0.0000e+00 - loss: 2.3541
Validation Accuracy: 0.00
```

```
#plot for test data
# Plot training history
import matplotlib.pyplot as plt
plt.figure(figsize=(12, 4))

plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'], label='Training Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.title('Accuracy')
plt.legend()

plt.subplot(1, 2, 2)
plt.plot(history.history['loss'], label='Training Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.title('Loss')
plt.legend()

plt.show()
```



```
test_dir = "/content/drive/MyDrive/Level 6/Artificial_Intelligence/Week5/FruitinAmazon/test"

test_ds = tf.keras.preprocessing.image_dataset_from_directory(
    test_dir,
    labels='inferred',
    label_mode='int',
    image_size=(img_height, img_width),
    batch_size=batch_size,
    shuffle=False,
    interpolation='nearest',
    seed=123
)
```