Workshop5 Output:

```
[1]  import os
     import random
     import numpy as np
     import tensorflow as tf
     import matplotlib.pyplot as plt
     from tensorflow.keras.models import Sequential
     from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense, Rescaling
     from tensorflow.keras.preprocessing.image import load_img, img_to_array
     from tensorflow.keras.preprocessing.image import ImageDataGenerator
     from tensorflow.keras.callbacks import ModelCheckpoint, EarlyStopping
     from sklearn.metrics import classification_report
```

```
[4]  from google.colab import drive
     drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

```
[2]  train_dir = "/content/drive/MyDrive/Workshop5_AI/FruitinAmazon/train"
     test_dir = "/content/drive/MyDrive/Workshop5_AI/FruitinAmazon/test"
```

```
[5]  class_names = os.listdir(train_dir)
     print(f"Classes: {class_names}")
```

```
Classes: ['guarana', 'graviola', 'acai', 'cupuacu', 'tucuma', 'pupunha']
```

```
def visualize_images(train_dir, class_names):
    fig, axes = plt.subplots(2, len(class_names) // 2, figsize=(12, 6))
    axes = axes.flatten()
    for i, class_name in enumerate(class_names):
        class_path = os.path.join(train_dir, class_name)
        img_name = random.choice(os.listdir(class_path))
        img_path = os.path.join(class_path, img_name)
        img = load_img(img_path)
        axes[i].imshow(img)
        axes[i].set_title(class_name)
        axes[i].axis("off")
    plt.show()

visualize_images(train_dir, class_names)
```

guarana

graviola

acai

cupuacu

tucuma

pupunha

```
[7]  damagedImages = []
     for class_name in class_names:
         class_path = os.path.join(train_dir, class_name)
         for img_name in os.listdir(class_path):
             img_path = os.path.join(class_path, img_name)
             try:
                 img = load_img(img_path)  # Try opening the image
             except (IOError, SyntaxError):
                 damagedImages.append(img_path)
                 os.remove(img_path)
                 print(f"Damaged image removed: {img_path}")

     if not damagedImages:
         print("No Damaged Images Found.")
```

```
No Damaged Images Found.
```

```
[8] img_height, img_width = 128, 128
    batch_size = 32
    validation_split = 0.2
```

```
[9] train_ds = tf.keras.preprocessing.image_dataset_from_directory(
        train_dir,
        labels='inferred',
        label_mode='int',
        image_size=(img_height, img_width),
        batch_size=batch_size,
        shuffle=True,
        validation_split=validation_split,
        subset='training',
        seed=123
    )
```

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

```
[ ] val_ds = tf.keras.preprocessing.image_dataset_from_directory(
        train_dir,
        labels='inferred',
        label_mode='int',
        image_size=(img_height, img_width),
        batch_size=batch_size,
        shuffle=False,
        validation_split=validation_split,
        subset='validation',
        seed=123
    )
```

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

```
[11] rescale = Rescaling(1./255)
     train_ds = train_ds.map(lambda x, y: (rescale(x), y))
     val_ds = val_ds.map(lambda x, y: (rescale(x), y))
```

```
[12] num_classes = len(class_names)

    model = Sequential([
        Conv2D(32, (3,3), activation='relu', padding='same', input_shape=(img_height, img_width, 3)),
        MaxPooling2D((2,2), strides=2),

        Conv2D(32, (3,3), activation='relu', padding='same'),
        MaxPooling2D((2,2), strides=2),

        Flatten(),
        Dense(64, activation='relu'),
        Dense(128, activation='relu'),
        Dense(num_classes, activation='softmax')
    ])

    model.summary()
```

```
/usr/local/lib/python3.11/dist-packages/keras/src/layers/convolutional/base_conv.py:107: UserWarning: Do not pass an `input_shape`/`input_dim`
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
Model: "sequential"
```

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 128, 128, 32)	896
max_pooling2d (MaxPooling2D)	(None, 64, 64, 32)	0
conv2d_1 (Conv2D)	(None, 64, 64, 32)	9,248
max_pooling2d_1 (MaxPooling2D)	(None, 32, 32, 32)	0
flatten (Flatten)	(None, 32768)	0
dense (Dense)	(None, 64)	2,097,216
dense_1 (Dense)	(None, 128)	8,320
dense_2 (Dense)	(None, 6)	774

```
Total params: 2,116,454 (8.07 MB)
Trainable params: 2,116,454 (8.07 MB)
Non-trainable params: 0 (0.00 B)
```

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

```
[14] callbacks = [
        ModelCheckpoint("best_model.h5", save_best_only=True, monitor="val_accuracy", mode="max"),
        EarlyStopping(monitor="val_loss", patience=10, restore_best_weights=True)
     ]

     history = model.fit(
         train_ds,
         validation_data=val_ds,
         epochs=250,
         batch_size=16,
         callbacks=callbacks
     )
```

```
Epoch 1/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 0s 375ms/step - accuracy: 0.1904 - loss: 2.2249WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(
3/3 ━━━━━━━━━━━━━━━━━━━━ 4s 694ms/step - accuracy: 0.1879 - loss: 2.2723 - val_accuracy: 0.8333 - val_loss: 1.1333
Epoch 2/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 3s 813ms/step - accuracy: 0.1853 - loss: 1.8386 - val_accuracy: 0.0000e+00 - val_loss: 1.7819
Epoch 3/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 4s 536ms/step - accuracy: 0.3338 - loss: 1.6873 - val_accuracy: 0.0000e+00 - val_loss: 1.8785
Epoch 4/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 475ms/step - accuracy: 0.1793 - loss: 1.6343 - val_accuracy: 0.0000e+00 - val_loss: 1.9184
Epoch 5/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 3s 467ms/step - accuracy: 0.3702 - loss: 1.5101 - val_accuracy: 0.3333 - val_loss: 1.7069
Epoch 6/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 552ms/step - accuracy: 0.5425 - loss: 1.4167 - val_accuracy: 0.1667 - val_loss: 1.7707
Epoch 7/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 3s 709ms/step - accuracy: 0.5000 - loss: 1.2407 - val_accuracy: 0.4444 - val_loss: 1.5451
Epoch 8/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 4s 530ms/step - accuracy: 0.6302 - loss: 1.0921 - val_accuracy: 0.5000 - val_loss: 1.2680
Epoch 9/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 462ms/step - accuracy: 0.6819 - loss: 0.8641 - val_accuracy: 0.8333 - val_loss: 0.8749
Epoch 10/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 521ms/step - accuracy: 0.7934 - loss: 0.6959 - val_accuracy: 0.2222 - val_loss: 1.5155
Epoch 11/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 3s 566ms/step - accuracy: 0.7756 - loss: 0.6744 - val_accuracy: 0.5000 - val_loss: 1.3197
Epoch 12/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 0s 604ms/step - accuracy: 0.8443 - loss: 0.6197WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(
3/3 ━━━━━━━━━━━━━━━━━━━━ 4s 842ms/step - accuracy: 0.8485 - loss: 0.6031 - val_accuracy: 0.8889 - val_loss: 0.8000
Epoch 13/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 545ms/step - accuracy: 0.9301 - loss: 0.4003 - val_accuracy: 0.8333 - val_loss: 0.9476
Epoch 14/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 546ms/step - accuracy: 0.9332 - loss: 0.3115 - val_accuracy: 0.7778 - val_loss: 0.7349
Epoch 15/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 475ms/step - accuracy: 0.9813 - loss: 0.1743 - val_accuracy: 0.8333 - val_loss: 0.6318
Epoch 17/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 690ms/step - accuracy: 1.0000 - loss: 0.1146 - val_accuracy: 0.8333 - val_loss: 0.5765
Epoch 18/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 3s 778ms/step - accuracy: 0.9891 - loss: 0.0582 - val_accuracy: 0.7778 - val_loss: 0.8537
Epoch 19/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 536ms/step - accuracy: 1.0000 - loss: 0.0506 - val_accuracy: 0.8889 - val_loss: 0.5510
Epoch 20/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 0s 358ms/step - accuracy: 1.0000 - loss: 0.0226WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 575ms/step - accuracy: 1.0000 - loss: 0.0232 - val_accuracy: 0.9444 - val_loss: 0.4446
Epoch 21/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 547ms/step - accuracy: 1.0000 - loss: 0.0240 - val_accuracy: 0.8889 - val_loss: 0.3478
Epoch 22/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 474ms/step - accuracy: 1.0000 - loss: 0.0142 - val_accuracy: 0.9444 - val_loss: 0.4080
Epoch 23/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 514ms/step - accuracy: 1.0000 - loss: 0.0101 - val_accuracy: 0.8889 - val_loss: 0.7530
Epoch 24/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 4s 789ms/step - accuracy: 0.9627 - loss: 0.0584 - val_accuracy: 0.8889 - val_loss: 0.4801
Epoch 25/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 538ms/step - accuracy: 1.0000 - loss: 0.0071 - val_accuracy: 0.7778 - val_loss: 0.5452
Epoch 26/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 3s 533ms/step - accuracy: 1.0000 - loss: 0.0118 - val_accuracy: 0.8333 - val_loss: 0.5479
Epoch 27/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 476ms/step - accuracy: 1.0000 - loss: 0.0079 - val_accuracy: 0.8889 - val_loss: 0.5369
Epoch 28/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 537ms/step - accuracy: 1.0000 - loss: 0.0032 - val_accuracy: 0.8889 - val_loss: 0.5783
Epoch 29/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 537ms/step - accuracy: 1.0000 - loss: 0.0037 - val_accuracy: 0.8889 - val_loss: 0.6067
Epoch 30/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 4s 766ms/step - accuracy: 1.0000 - loss: 0.0034 - val_accuracy: 0.9444 - val_loss: 0.6134
Epoch 31/250
3/3 ━━━━━━━━━━━━━━━━━━━━ 2s 477ms/step - accuracy: 1.0000 - loss: 0.0026 - val_accuracy: 0.9444 - val_loss: 0.6048
```

```
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
)

test_ds = test_ds.map(lambda x, y: (rescale(x), y))
test_loss, test_accuracy = model.evaluate(test_ds)
print(f"Test Accuracy: {test_accuracy * 100:.2f}%")
```

```
Found 30 files belonging to 6 classes.
1/1 ━━━━━━━━━━━━━━━━━━━━ 10s 10s/step - accuracy: 0.5667 - loss: 1.3295
Test Accuracy: 56.67%
```

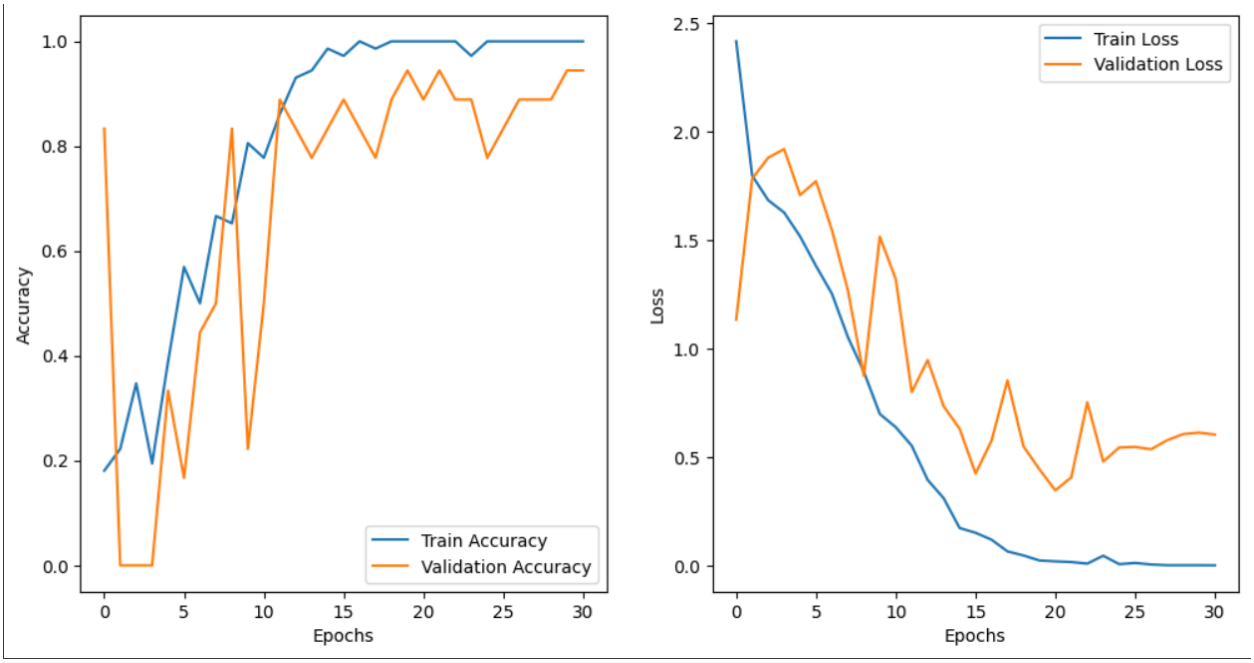
```
[16] model.save("final_model.h5")
     loaded_model = tf.keras.models.load_model("final_model.h5")
```

```
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(model)`. This file format is considered legacy. We recommend using instead
WARNING:absl:Compiled the loaded model, but the compiled metrics have yet to be built. `model.compile_metrics` will be empty until you train or evaluate the model.
```

```
y_true = []
y_pred = []

for images, labels in test_ds:
    preds = loaded_model.predict(images)
    y_pred.extend(np.argmax(preds, axis=1))
    y_true.extend(labels.numpy())

print(classification_report(y_true, y_pred, target_names=class_names))
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 343ms/step
              precision    recall  f1-score   support

      guarana       0.75      0.60      0.67         5
    graviola        0.33      0.40      0.36         5
        acai        0.67      0.80      0.73         5
     cupuacu        0.75      0.60      0.67         5
      tucuma        0.71      1.00      0.83         5
     pupunha        0.00      0.00      0.00         5

    accuracy                           0.57        30
   macro avg       0.54      0.57      0.54        30
weighted avg       0.54      0.57      0.54        30
```

```
plt.figure(figsize=(12, 6))
plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'], label='Train Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.xlabel('Epochs')
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.xlabel('Epochs')
plt.ylabel('Loss')
plt.legend()

plt.show()
```


Accuracy
Epochs
Train Accuracy
Validation Accuracy
Loss
Epochs
Train Loss
Validation Loss