```
# Set seeds for reproducibility
import random
random.seed(0)

import numpy as np
np.random.seed(0)

import tensorflow as tf
tf.random.set_seed(0)
```

```
import os
import json
from zipfile import ZipFile
from PIL import Image

import numpy as np
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras import layers, models
```

```
kaggle_credentails = json.load(open("kaggle.json"))
```

```
# setup Kaggle API key as environment variables
os.environ['KAGGLE_USERNAME'] = kaggle_credentails["username"]
os.environ['KAGGLE_KEY'] = kaggle_credentails["key"]
```

```
!kaggle datasets download -d abdallahalidev/plantvillage-dataset
```

```
Dataset URL: https://www.kaggle.com/datasets/abdallahalidev/plantvillage-dataset
License(s): CC-BY-NC-SA-4.0
Downloading plantvillage-dataset.zip to /content
 98% 1.99G/2.04G [00:13<00:00, 130MB/s]
100% 2.04G/2.04G [00:13<00:00, 158MB/s]
```

```
!ls
```

```
kaggle.json  plantvillage-dataset.zip  sample_data
```

```
# Unzip the downloaded dataset
with ZipFile("plantvillage-dataset.zip", 'r') as zip_ref:
    zip_ref.extractall()
```

```
print(os.listdir("plantvillage dataset"))
```

```
print(len(os.listdir("plantvillage dataset/segmented")))
print(os.listdir("plantvillage dataset/segmented")[:5])

print(len(os.listdir("plantvillage dataset/color")))
print(os.listdir("plantvillage dataset/color")[:5])

print(len(os.listdir("plantvillage dataset/grayscale")))
print(os.listdir("plantvillage dataset/grayscale")[:5])
```

```
['color', 'segmented', 'grayscale']
38
['Peach___Bacterial_spot', 'Potato___Early_blight', 'Squash___Powdery_mildew', 'Corn_(maize)___Northern_Leaf_Blight',
38
['Peach___Bacterial_spot', 'Potato___Early_blight', 'Squash___Powdery_mildew', 'Corn_(maize)___Northern_Leaf_Blight',
38
['Peach___Bacterial_spot', 'Potato___Early_blight', 'Squash___Powdery_mildew', 'Corn_(maize)___Northern_Leaf_Blight',
```

```
print(len(os.listdir("plantvillage dataset/color/Grape___healthy")))
print(os.listdir("plantvillage dataset/color/Grape___healthy")[:5])
```

```
423
['abe2906e-bb00-466f-bf7c-72ef59a5ea82___Mt.N.V_HL 9062.JPG', '5385fa4e-cf2a-431e-8f30-459d7e05bd7a___Mt.N.V_HL 9005.J
```

```
# Dataset Path
base_dir = 'plantvillage dataset/color'
```

```
image_path = '/content/plantvillage dataset/color/Apple___Cedar_apple_rust/025b2b9a-0ec4-4132-96ac-7f2832d0db4a___FREC_C.R

# Read the image
img = mpimg.imread(image_path)

print(img.shape)
# Display the image
plt.imshow(img)
plt.axis('off')  # Turn off axis numbers
plt.show()
```

```
(256, 256, 3)
```

```
# Image Parameters
img_size = 224
batch_size = 32
```

```
image_path = '/content/plantvillage dataset/color/Apple___Cedar_apple_rust/025b2b9a-0ec4-4132-96ac-7f2832d0db4a___FREC_C.R
```

```
img = mpimg.imread(image_path)
```

```
print(img)
```

```
[[[179 175 176]
  [181 177 178]
  [184 180 181]
  ...
  [115 112 105]
  [108 105  98]
  [101  98  91]]

 [[176 172 173]
  [177 173 174]
  [178 174 175]
  ...
  [113 110 103]
  [111 108 101]
  [109 106  99]]

 [[180 176 177]
  [180 176 177]
  [180 176 177]
  ...
  [108 105  98]
  [111 108 101]
  [114 111 104]]

 ...

 [[137 128 119]
  [131 122 113]
  [125 116 107]
  ...
  [ 74  65  48]
  [ 74  65  48]
  [ 73  64  47]]

 [[136 127 118]
  [132 123 114]
  [128 119 110]
  ...
  [ 77  69  50]
  [ 75  67  48]
  [ 75  67  48]]

 [[133 124 115]
  [133 124 115]
  [132 123 114]
  ...
  [ 81  73  54]
  [ 80  72  53]
  [ 79  71  52]]]
```

```
# Image Data Generators
data_gen = ImageDataGenerator(
    rescale=1./255,
    validation_split=0.2  # Use 20% of data for validation
)
```

```
# Train Generator
train_generator = data_gen.flow_from_directory(
    base_dir,
    target_size=(img_size, img_size),
    batch_size=batch_size,
    subset='training',
    class_mode='categorical'
)
```

```
Found 43456 images belonging to 38 classes.
```

```
# Validation Generator
validation_generator = data_gen.flow_from_directory(
    base_dir,
    target_size=(img_size, img_size),
    batch_size=batch_size,
    subset='validation',
    class_mode='categorical'
)
```

```
Found 10849 images belonging to 38 classes.
```

CNN

```
model = models.Sequential()

model.add(layers.Conv2D(32, (3, 3), activation='relu', input_shape=(img_size, img_size, 3)))
model.add(layers.MaxPooling2D(2, 2))

model.add(layers.Conv2D(64, (3, 3), activation='relu'))
model.add(layers.MaxPooling2D(2, 2))


model.add(layers.Flatten())
model.add(layers.Dense(256, activation='relu'))
model.add(layers.Dense(train_generator.num_classes, activation='softmax'))
```

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

```
model.summary()
```

```
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 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ flatten (Flatten)               │ (None, 186624)         │             0 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ dense (Dense)                   │ (None, 256)            │    47,776,000 │
├─────────────────────────────────┼────────────────────────┼───────────────┤
│ dense_1 (Dense)                 │ (None, 38)             │         9,766 │
└─────────────────────────────────┴────────────────────────┴───────────────┘
 Total params: 47,805,158 (182.36 MB)
```

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

Model Training

```
history = model.fit(
    train_generator,
    steps_per_epoch=train_generator.samples // batch_size,  # Number of steps per epoch
    epochs=5,
    validation_data=validation_generator,
    validation_steps=validation_generator.samples // batch_size
)
```

```
Epoch 1/5
/usr/local/lib/python3.11/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:121: UserWarning: Your
  self._warn_if_super_not_called()
1358/1358 ━━━━━━━━━━━━━━━━━━━━ 108s 74ms/step - accuracy: 0.6040 - loss: 1.6212 - val_accuracy: 0.8674 - val_loss: 0.4
Epoch 2/5
1358/1358 ━━━━━━━━━━━━━━━━━━━━ 98s 72ms/step - accuracy: 0.9242 - loss: 0.2438 - val_accuracy: 0.8509 - val_loss: 0.49
Epoch 3/5
1358/1358 ━━━━━━━━━━━━━━━━━━━━ 140s 71ms/step - accuracy: 0.9663 - loss: 0.1061 - val_accuracy: 0.8532 - val_loss: 0.5
Epoch 4/5
1358/1358 ━━━━━━━━━━━━━━━━━━━━ 142s 71ms/step - accuracy: 0.9769 - loss: 0.0752 - val_accuracy: 0.8756 - val_loss: 0.4
Epoch 5/5
1358/1358 ━━━━━━━━━━━━━━━━━━━━ 97s 71ms/step - accuracy: 0.9854 - loss: 0.0498 - val_accuracy: 0.8708 - val_loss: 0.62
```

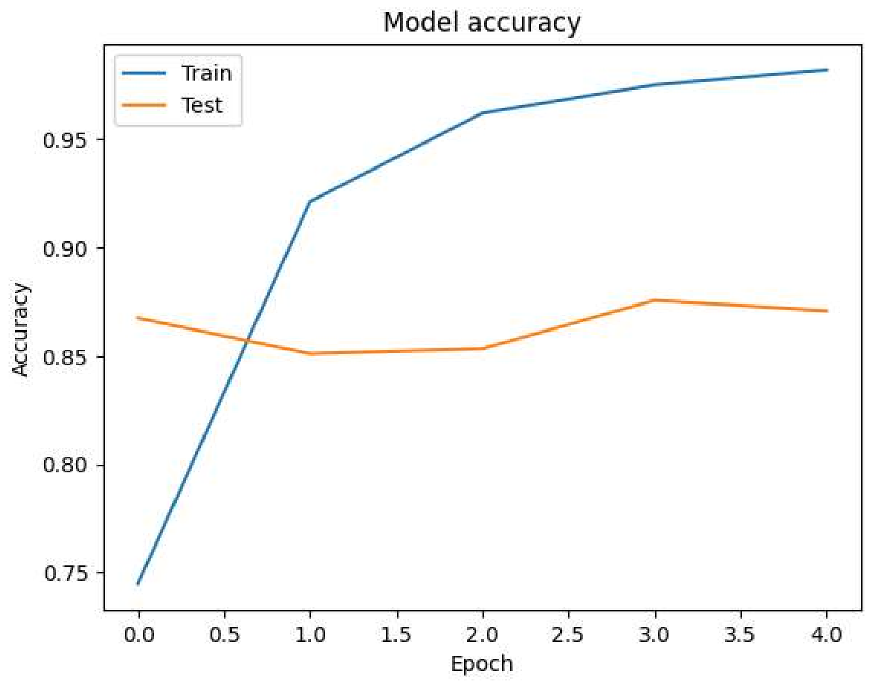
Model evaluation

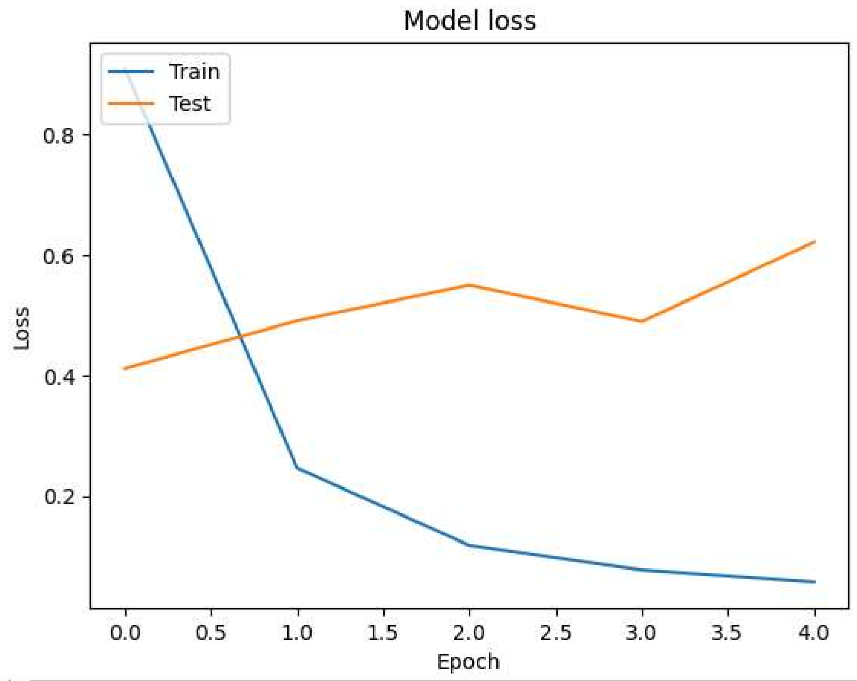
```
print("Evaluating model...")
val_loss, val_accuracy = model.evaluate(validation_generator, steps=validation_generator.samples // batch_size)
print(f"Validation Accuracy: {val_accuracy * 100:.2f}%")
```

```
Evaluating model...
339/339 ━━━━━━━━━━━━━━━━━━━━ 19s 55ms/step - accuracy: 0.8663 - loss: 0.6543
Validation Accuracy: 87.09%
```

```
# Plot training & validation accuracy values
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['Train', 'Test'], loc='upper left')
plt.show()

# Plot training & validation loss values
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('Model loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['Train', 'Test'], loc='upper left')
plt.show()
```





```
def load_and_preprocess_image(image_path, target_size=(224, 224))
    # Load the image
    img = Image.open(image_path)
    # Resize the image
    img = img.resize(target_size)
    # Convert the image to a numpy array
    img_array = np.array(img)
    # Add batch dimension
    img_array = np.expand_dims(img_array, axis=0)
    # Scale the image values to [0, 1]
    img_array = img_array.astype('float32') / 255.
    return img_array

# Function to Predict the Class of an Image
def predict_image_class(model, image_path, class_indices):
    preprocessed_img = load_and_preprocess_image(image_path)
    predictions = model.predict(preprocessed_img)
    predicted_class_index = np.argmax(predictions, axis=1)[0]
    predicted_class_name = class_indices[predicted_class_index]
```

```
#creating mapping for classindices to class names

class_indices = {v: k for k, v in train_generator.class_indices.items()}
```

```
class_indices
```

```
{0: 'Apple___Apple_scab',
 1: 'Apple___Black_rot',
 2: 'Apple___Cedar_apple_rust',
 3: 'Apple___healthy',
 4: 'Blueberry___healthy',
 5: 'Cherry_(including_sour)___Powdery_mildew',
 6: 'Cherry_(including_sour)___healthy',
 7: 'Corn_(maize)___Cercospora_leaf_spot Gray_leaf_spot',
 8: 'Corn_(maize)___Common_rust_',
 9: 'Corn_(maize)___Northern_Leaf_Blight',
 10: 'Corn_(maize)___healthy',
 11: 'Grape___Black_rot',
 12: 'Grape___Esca_(Black_Measles)',
 13: 'Grape___Leaf_blight_(Isariopsis_Leaf_Spot)',
 14: 'Grape___healthy',
 15: 'Orange___Haunglongbing_(Citrus_greening)',
 16: 'Peach___Bacterial_spot',
 17: 'Peach___healthy',
 18: 'Pepper,_bell___Bacterial_spot',
 19: 'Pepper,_bell___healthy',
 20: 'Potato___Early_blight',
 21: 'Potato___Late_blight',
 22: 'Potato___healthy',
 23: 'Raspberry___healthy',
 24: 'Soybean___healthy',
 25: 'Squash___Powdery_mildew',
 26: 'Strawberry___Leaf_scorch',
 27: 'Strawberry___healthy',
 28: 'Tomato___Bacterial_spot',
 29: 'Tomato___Early_blight',
 30: 'Tomato___Late_blight',
 31: 'Tomato___Leaf_Mold',
 32: 'Tomato___Septoria_leaf_spot',
 33: 'Tomato___Spider_mites Two-spotted_spider_mite',
 34: 'Tomato___Target_Spot',
 35: 'Tomato___Tomato_Yellow_Leaf_Curl_Virus',
 36: 'Tomato___Tomato_mosaic_virus',
 37: 'Tomato___healthy'}
```

```
# saving the class names as json file
json.dump(class_indices, open('class_indices.json', 'w'))
```

```
image_path = '/content/test_apple_black_rot.JPG'
#image_path = '/content/test_blueberry_healthy.jpg'
#image_path = '/content/test_potato_early_blight.jpg'

predicted_class_name = predict_image_class(model, image_path, class_indices)

print("Predicted Class Name:", predicted_class_name)
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 0s 34ms/step
Predicted Class Name: Apple___Black_rot
```