```
!pip install tensorflow-gpu==2.0.0
```

```
Collecting tensorflow-gpu==2.0.0
  Downloading https://files.pythonhosted.org/packages/25/44/47f0722aea081697143fbcf5d2aa
     |████████████████████████████████| 380.8MB 43kB/s
Requirement already satisfied: wheel>=0.26 in /usr/local/lib/python3.6/dist-packages (fr
Requirement already satisfied: grpcio>=1.8.6 in /usr/local/lib/python3.6/dist-packages (
Requirement already satisfied: protobuf>=3.6.1 in /usr/local/lib/python3.6/dist-packages
Requirement already satisfied: astor>=0.6.0 in /usr/local/lib/python3.6/dist-packages (f
Requirement already satisfied: numpy<2.0,>=1.16.0 in /usr/local/lib/python3.6/dist-packa
Collecting tensorflow-estimator<2.1.0,>=2.0.0
  Downloading https://files.pythonhosted.org/packages/fc/08/8b927337b7019c374719145d1dce
     |████████████████████████████████| 450kB 54.2MB/s
Requirement already satisfied: wrapt>=1.11.1 in /usr/local/lib/python3.6/dist-packages (
Requirement already satisfied: opt-einsum>=2.3.2 in /usr/local/lib/python3.6/dist-packag
Requirement already satisfied: six>=1.10.0 in /usr/local/lib/python3.6/dist-packages (fr
Requirement already satisfied: keras-preprocessing>=1.0.5 in /usr/local/lib/python3.6/di
Collecting tensorboard<2.1.0,>=2.0.0
  Downloading https://files.pythonhosted.org/packages/76/54/99b9d5d52d5cb732f099baaaf774
     |████████████████████████████████| 3.8MB 71.6MB/s
Requirement already satisfied: keras-applications>=1.0.8 in /usr/local/lib/python3.6/dis
Requirement already satisfied: absl-py>=0.7.0 in /usr/local/lib/python3.6/dist-packages
Requirement already satisfied: gast==0.2.2 in /usr/local/lib/python3.6/dist-packages (fr
Requirement already satisfied: termcolor>=1.1.0 in /usr/local/lib/python3.6/dist-package
Requirement already satisfied: google-pasta>=0.1.6 in /usr/local/lib/python3.6/dist-pack
Requirement already satisfied: setuptools in /usr/local/lib/python3.6/dist-packages (fro
Requirement already satisfied: werkzeug>=0.11.15 in /usr/local/lib/python3.6/dist-packag
Requirement already satisfied: google-auth<2,>=1.6.3 in /usr/local/lib/python3.6/dist-pa
Requirement already satisfied: markdown>=2.6.8 in /usr/local/lib/python3.6/dist-packages
Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in /usr/local/lib/python
Requirement already satisfied: requests<3,>=2.21.0 in /usr/local/lib/python3.6/dist-pack
Requirement already satisfied: h5py in /usr/local/lib/python3.6/dist-packages (from kera
Requirement already satisfied: pyasn1-modules>=0.2.1 in /usr/local/lib/python3.6/dist-pa
Requirement already satisfied: cachetools<3.2,>=2.0.0 in /usr/local/lib/python3.6/dist-p
Requirement already satisfied: rsa<4.1,>=3.1.4 in /usr/local/lib/python3.6/dist-packages
Requirement already satisfied: requests-oauthlib>=0.7.0 in /usr/local/lib/python3.6/dist
Requirement already satisfied: idna<2.9,>=2.5 in /usr/local/lib/python3.6/dist-packages
Requirement already satisfied: certifi>=2017.4.17 in /usr/local/lib/python3.6/dist-packa
Requirement already satisfied: urllib3<1.25,>=1.21.1 in /usr/local/lib/python3.6/dist-pa
Requirement already satisfied: chardet<3.1.0,>=3.0.2 in /usr/local/lib/python3.6/dist-pa
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in /usr/local/lib/python3.6/dist-pac
Requirement already satisfied: oauthlib>=3.0.0 in /usr/local/lib/python3.6/dist-packages
ERROR: tensorflow 1.15.0 has requirement tensorboard<1.16.0,>=1.15.0, but you'll have te
ERROR: tensorflow 1.15.0 has requirement tensorflow-estimator==1.15.1, but you'll have t
ERROR: tensorflow-federated 0.12.0 has requirement tensorflow~=2.1.0, but you'll have te
ERROR: tensorflow-federated 0.12.0 has requirement tensorflow-addons~=0.7.0, but you'll
Installing collected packages: tensorflow-estimator, tensorboard, tensorflow-gpu
  Found existing installation: tensorflow-estimator 1.15.1
    Uninstalling tensorflow-estimator-1.15.1:
      Successfully uninstalled tensorflow-estimator-1.15.1
  Found existing installation: tensorboard 1.15.0
    Uninstalling tensorboard-1.15.0:
      Successfully uninstalled tensorboard-1.15.0
Successfully installed tensorboard-2.1.1 tensorflow-estimator-2.1.0 tensorflow-gpu-2.0.0
```

```
!pip install tensorflow-hub
```

```
Requirement already satisfied: tensorflow-hub in /usr/local/lib/python3.6/dist-packages
Requirement already satisfied: protobuf>=3.4.0 in /usr/local/lib/python3.6/dist-packages
Requirement already satisfied: numpy>=1.12.0 in /usr/local/lib/python3.6/dist-packages (
Requirement already satisfied: six>=1.10.0 in /usr/local/lib/python3.6/dist-packages (fr
Requirement already satisfied: setuptools in /usr/local/lib/python3.6/dist-packages (fro
```

```
from __future__ import absolute_import, division, print_function, unicode_literals
import tensorflow as tf
import tensorflow_hub as hub
import os

from tensorflow.keras.layers import Dense, Flatten, Conv2D
from tensorflow.keras import Model
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.optimizers import Adam
from tensorflow.keras import layers
```

Loading the data

```
zip_file=tf.keras.utils.get_file(origin='https://storage.googleapis.com/plantdata/PlantVillag
 fname='PlantVillage.zip', extract=True)
# Create the training and validation directories
data_dir = os.path.join(os.path.dirname(zip_file), 'PlantVillage')
train_dir = os.path.join(data_dir, 'train')
validation_dir = os.path.join(data_dir, 'validation')
```

```
Downloading data from https://storage.googleapis.com/plantdata/PlantVillage.zip
856842240/856839084 [==============================] - 19s 0us/step
```

Label Mapping

```
!wget https://github.com/obeshor/Plant-Diseases-Detector/archive/master.zip
!unzip master.zip;
import json
with open('Plant-Diseases-Detector-master/categories.json', 'r') as f:
    cat_to_name = json.load(f)
    classes = list(cat_to_name.values())

print (classes)
```

```
--2020-03-22 17:38:36--  https://github.com/obeshor/Plant-Diseases-Detector/archive/mast
Resolving github.com (github.com)... 140.82.112.4
Connecting to github.com (github.com)|140.82.112.4|:443... connected.
HTTP request sent, awaiting response... 302 Found
Location: https://codeload.github.com/obeshor/Plant-Diseases-Detector/zip/master [follow
--2020-03-22 17:38:37--  https://codeload.github.com/obeshor/Plant-Diseases-Detector/zip
Resolving codeload.github.com (codeload.github.com)... 140.82.113.9
Connecting to codeload.github.com (codeload.github.com)|140.82.113.9|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: unspecified [application/zip]
Saving to: ‘master.zip’

master.zip              [  <=>                ]   2.25M  11.0MB/s    in 0.2s

2020-03-22 17:38:37 (11.0 MB/s) - ‘master.zip’ saved [2358172]

Archive:  master.zip
59c418921242879a6aa5378175076bf7f39a84fe
   creating: Plant-Diseases-Detector-master/
   creating: Plant-Diseases-Detector-master/GreenDoctor/
  inflating: Plant-Diseases-Detector-master/GreenDoctor/.gitignore
   creating: Plant-Diseases-Detector-master/GreenDoctor/.idea/
   creating: Plant-Diseases-Detector-master/GreenDoctor/.idea/codeStyles/
  inflating: Plant-Diseases-Detector-master/GreenDoctor/.idea/codeStyles/Project.xml
  inflating: Plant-Diseases-Detector-master/GreenDoctor/.idea/codeStyles/codeStyleConfig
  inflating: Plant-Diseases-Detector-master/GreenDoctor/.idea/encodings.xml
  inflating: Plant-Diseases-Detector-master/GreenDoctor/.idea/gradle.xml
  inflating: Plant-Diseases-Detector-master/GreenDoctor/.idea/misc.xml
  inflating: Plant-Diseases-Detector-master/GreenDoctor/.idea/runConfigurations.xml
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/
 extracting: Plant-Diseases-Detector-master/GreenDoctor/app/.gitignore
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/build.gradle
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/proguard-rules.pro
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/androidTest/
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/androidTest/java/
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/androidTest/java/isomora
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/androidTest/java/isomora
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   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/AndroidManifest.xml
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/assets/
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/assets/plant_labels
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/assets/soybean.JPG
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/ic_launcher-web.png
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/java/
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/java/isomora/
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/java/isomora/com/
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   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/
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  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/drawable/ic_lau
```

```
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/layout/
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/layout/activity
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-anydpi-v
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-anydpi-v
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-anydpi-v
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-hdpi/
 extracting: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-hdpi/ic_
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-hdpi/ic_
 extracting: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-hdpi/ic_
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-mdpi/
 extracting: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-mdpi/ic_
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-mdpi/ic_
 extracting: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-mdpi/ic_
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-xhdpi/
 extracting: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-xhdpi/ic
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-xhdpi/ic
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   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-xxhdpi/
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-xxhdpi/i
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-xxhdpi/i
 extracting: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-xxhdpi/i
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-xxxhdpi/
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-xxxhdpi/
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-xxxhdpi/
 extracting: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/mipmap-xxxhdpi/
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/values/
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/values/colors.x
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/values/ic_launc
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/values/strings.
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/main/res/values/styles.x
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/test/
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/test/java/
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/test/java/isomora/
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/test/java/isomora/com/
   creating: Plant-Diseases-Detector-master/GreenDoctor/app/src/test/java/isomora/com/gr
  inflating: Plant-Diseases-Detector-master/GreenDoctor/app/src/test/java/isomora/com/gr
  inflating: Plant-Diseases-Detector-master/GreenDoctor/build.gradle
  inflating: Plant-Diseases-Detector-master/GreenDoctor/gradle.properties
   creating: Plant-Diseases-Detector-master/GreenDoctor/gradle/
   creating: Plant-Diseases-Detector-master/GreenDoctor/gradle/wrapper/
  inflating: Plant-Diseases-Detector-master/GreenDoctor/gradle/wrapper/gradle-wrapper.ja
  inflating: Plant-Diseases-Detector-master/GreenDoctor/gradle/wrapper/gradle-wrapper.pr
  inflating: Plant-Diseases-Detector-master/GreenDoctor/gradlew
  inflating: Plant-Diseases-Detector-master/GreenDoctor/gradlew.bat
 extracting: Plant-Diseases-Detector-master/GreenDoctor/settings.gradle
  inflating: Plant-Diseases-Detector-master/Plant_Diseases_Detection_with_TF2_V2.ipynb
  inflating: Plant-Diseases-Detector-master/Plant_Diseases_Detection_with_TF2_V4.ipynb
  inflating: Plant-Diseases-Detector-master/README.md
  inflating: Plant-Diseases-Detector-master/_config.yml
   creating: Plant-Diseases-Detector-master/assets/
  inflating: Plant-Diseases-Detector-master/assets/PlantVillagefarmer.jpg
  inflating: Plant-Diseases-Detector-master/assets/detect_crop_disease_in_africa.jpg
  inflating: Plant-Diseases-Detector-master/assets/greendoctor.png
  inflating: Plant-Diseases-Detector-master/assets/over.png
  inflating: Plant-Diseases-Detector-master/categories.json
['Apple___Apple_scab', 'Apple___Black_rot', 'Apple___Cedar_apple_rust', 'Apple___healthy
```

Transfer Learning with TensorFlow Hub

```
pixels = 299
FV_SIZE = 2048
MODULE_HANDLE = "https://tfhub.dev/google/tf2-preview/inception_v3/feature_vector/4"
IMAGE_SIZE = (pixels, pixels)
BATCH_SIZE = 64
```

Data Processing

```
# Inputs are suitably resized for the selected module
validation_datagen = tf.keras.preprocessing.image.ImageDataGenerator(rescale = 1./255)
validation_generator = validation_datagen.flow_from_directory(
    validation_dir,
    shuffle = False,
    color_mode = "rgb",
    class_mode = "categorical",
    target_size = IMAGE_SIZE,
    batch_size = BATCH_SIZE)

do_data_augmentation = True
if do_data_augmentation:
  train_datagen = tf.keras.preprocessing.image.ImageDataGenerator(
      rescale = 1./255,
      rotation_range = 40,
      horizontal_flip = True,
      width_shift_range = 0.2,
      height_shift_range = 0.2,
      shear_range = 0.2,
      zoom_range = 0.2,
      fill_mode = 'nearest')
else:
  train_datagen = validation_datagen

train_generator = train_datagen.flow_from_directory(
    train_dir,
    subset = "training",
    shuffle = True,
    seed = 42,
    color_mode = "rgb",
    class_mode = "categorical",
    target_size=IMAGE_SIZE,
    batch_size=BATCH_SIZE)
```

```
Found 10861 images belonging to 38 classes.
Found 43444 images belonging to 38 classes.
```

Build the Model

```
feature_extractor = hub.KerasLayer(MODULE_HANDLE,
                                   input_shape=IMAGE_SIZE+(3,),
                                   output_shape=[FV_SIZE])
do_fine_tuning = False
if do_fine_tuning:
  feature_extractor.trainable = True
  # unfreeze some layers of base network for fine-tuning
  for layer in feature_extractor.layers[-30:]:
    layer.trainable =True

else:
  feature_extractor.trainable = False

model = tf.keras.Sequential([
    feature_extractor,
    tf.keras.layers.Flatten(),
    tf.keras.layers.Dense(512, activation='relu'),
    tf.keras.layers.Dropout(rate=0.2),
    tf.keras.layers.Dense(train_generator.num_classes, activation='softmax',
                          kernel_regularizer=tf.keras.regularizers.l2(0.0001))
])
```

Specifying Loss Function and Optimizer

```
#Compile model specifying the optimizer learning rate                                    LEARNING_
LEARNING_RATE = 0.001 #@param {type:"number"}
model.compile(
   optimizer=tf.keras.optimizers.Adam(lr=LEARNING_RATE),
   loss='categorical_crossentropy',
   metrics=['accuracy'])
```

Double-click (or enter) to edit

Training the Model

```
EPOCHS=10
STEPS_EPOCHS = train_generator.samples//train_generator.batch_size
VALID_STEPS=validation_generator.samples//validation_generator.batch_size
history = model.fit_generator(
          train_generator,
          steps_per_epoch=STEPS_EPOCHS,
          epochs=EPOCHS,
          validation_data=validation_generator,
```

```
validation_steps=VALID_STEPS)
```

```
Epoch 1/10
678/678 [==============================] - 962s 1s/step - loss: 0.7876 - accuracy: 0.773
Epoch 2/10
678/678 [==============================] - 948s 1s/step - loss: 0.4053 - accuracy: 0.869
Epoch 3/10
396/678 [================>.............] - ETA: 6:10 - loss: 0.3563 - accuracy: 0.8833
```

Checking Performance

```
import matplotlib.pylab as plt
import numpy as np
acc = history.history['accuracy']
val_acc = history.history['val_accuracy']
loss = history.history['loss']
val_loss = history.history['val_loss']
epochs_range = range(EPOCHS)
plt.figure(figsize=(8, 8))
plt.subplot(1, 2, 1)
plt.plot(epochs_range, acc, label='Training Accuracy')
plt.plot(epochs_range, val_acc, label='Validation Accuracy')
plt.legend(loc='lower right')
plt.title('Training and Validation Accuracy')
plt.ylabel("Accuracy (training and validation)")
plt.xlabel("Training Steps")
plt.subplot(1, 2, 2)
plt.plot(epochs_range, loss, label='Training Loss')
plt.plot(epochs_range, val_loss, label='Validation Loss')
plt.legend(loc='upper right')
plt.title('Training and Validation Loss')
plt.ylabel("Loss (training and validation)")
plt.xlabel("Training Steps")
plt.show()
```

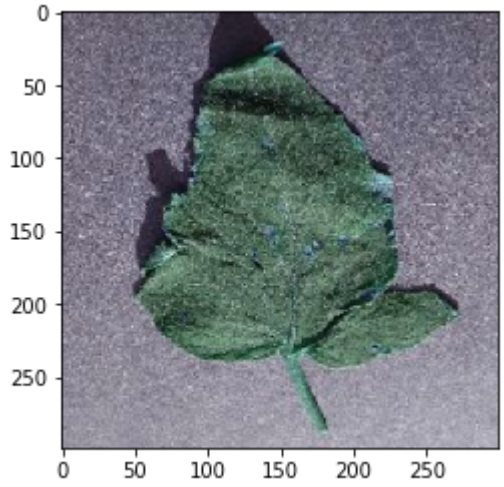
```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-1-91320fedef2f> in <module>()
      2 import matplotlib.pylab as plt
      3 import numpy as np
----> 4 acc = history.history['accuracy']
      5 val_acc = history.history['val_accuracy']
      6 loss = history.history['loss']

NameError: name 'history' is not defined
```

SEARCH STACK OVERFLOW

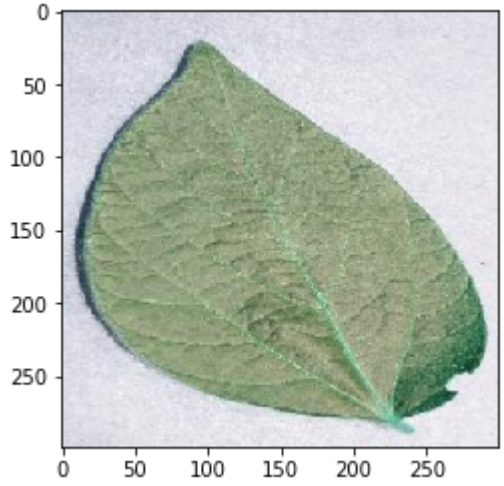
Random Test

```
# Import OpenCV
import cv2
# Utility
import itertools
import random
from collections import Counter
from glob import iglob
def load_image(filename):
    img = cv2.imread(os.path.join(data_dir, validation_dir, filename))
    img = cv2.resize(img, (IMAGE_SIZE[0], IMAGE_SIZE[1]) )
    img = img /255

    return img
def predict(image):
    probabilities = model.predict(np.asarray([img]))[0]
    class_idx = np.argmax(probabilities)

    return {classes[class_idx]: probabilities[class_idx]}

for idx, filename in enumerate(random.sample(validation_generator.filenames, 5)):
    print("SOURCE: class: %s, file: %s" % (os.path.split(filename)[0], filename))

    img = load_image(filename)
    prediction = predict(img)
    print("PREDICTED: class: %s, confidence: %f" % (list(prediction.keys())[0], list(predicti
    plt.imshow(img)
    plt.figure(idx)
    plt.show()
```

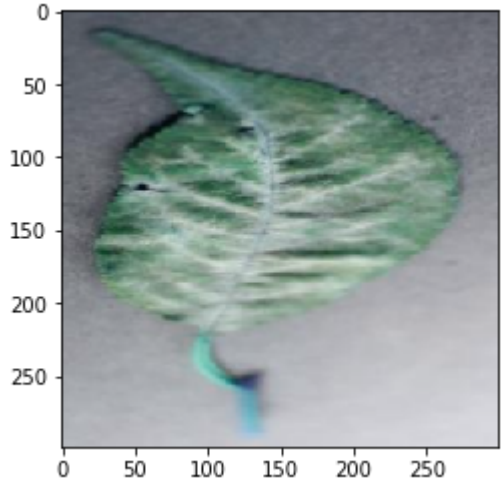
```
SOURCE: class: Tomato___Target_Spot, file: Tomato___Target_Spot/b1daf6e8-612f-469c-9a22-
PREDICTED: class: Tomato___Spider_mites Two-spotted_spider_mite, confidence: 0.531647
```



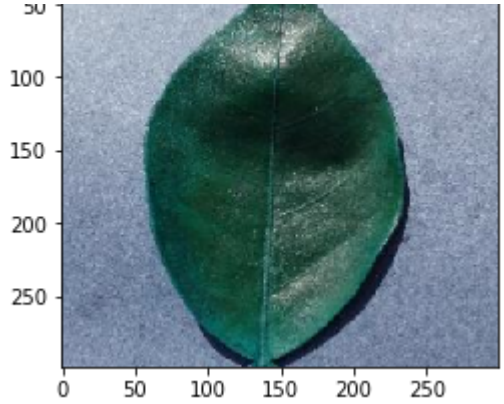

```
<Figure size 432x288 with 0 Axes>
SOURCE: class: Soybean___healthy, file: Soybean___healthy/8851e67a-5530-4c9e-868c-9efa4d
PREDICTED: class: Soybean___healthy, confidence: 0.999971
```



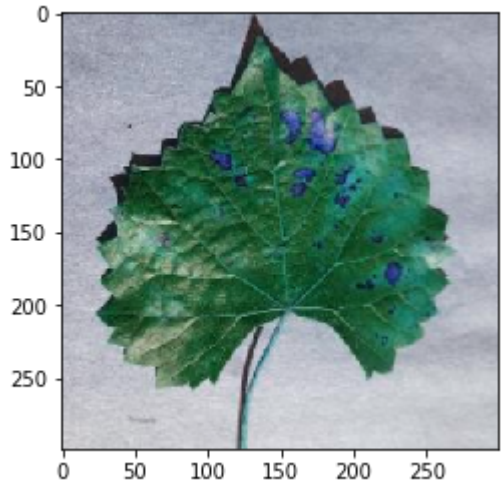

```
SOURCE: class: Cherry_(including_sour)___Powdery_mildew, file: Cherry_(including_sour)__
PREDICTED: class: Cherry_(including_sour)___Powdery_mildew, confidence: 0.999121
```




```
<Figure size 432x288 with 0 Axes>
SOURCE: class: Orange___Haunglongbing_(Citrus_greening), file: Orange___Haunglongbing_(C
PREDICTED: class: Orange___Haunglongbing_(Citrus_greening), confidence: 0.999979
```




```
<Figure size 432x288 with 0 Axes>
SOURCE: class: Grape___Esca_(Black_Measles), file: Grape___Esca_(Black_Measles)/c6701b18
PREDICTED: class: Grape___Esca_(Black_Measles), confidence: 0.968418
```




```
<Figure size 432x288 with 0 Axes>
```