```
import warnings
warnings.filterwarnings('ignore')
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import os
import torch
import torch.nn as nn
from torch.utils.data import DataLoader
from PIL import Image
import torchvision
import torchvision.transforms as transforms
from torchvision.datasets import ImageFolder
import torch.optim as optim
import torch.nn.functional as F
import colorama
from colorama import Fore, Style


import opendatasets as od

od.download("https://www.kaggle.com/datasets/vipoooool/new-plant-
diseases-dataset") #json file for kaggle token uploaded
```

```
Skipping, found downloaded files in "./new-plant-diseases-dataset"
(use force=True to force download)
```

```
import os

data_dir = './new-plant-diseases-dataset'

os.listdir(data_dir)
```

```
['New Plant Diseases Dataset(Augmented)',
 'test',
 'new plant diseases dataset(augmented)']
```

```
Root_dir = "new-plant-diseases-dataset/New Plant Diseases
Dataset(Augmented)/New Plant Diseases Dataset(Augmented)"
train_dir = Root_dir + "/train"
valid_dir = Root_dir + "/valid"
test_dir = "new-plant-diseases-dataset/test"
Diseases_classes = os.listdir(train_dir)

Diseases_classes
```

```
['Corn_(maize)___Cercospora_leaf_spot Gray_leaf_spot',
 'Tomato___Tomato_mosaic_virus',
 'Apple___Cedar_apple_rust',
 'Corn_(maize)___healthy',
 'Potato___Late_blight',
```

```
 'Strawberry___healthy',
 'Tomato___Spider_mites Two-spotted_spider_mite',
 'Grape___Black_rot',
 'Cherry_(including_sour)___healthy',
 'Peach___Bacterial_spot',
 'Tomato___healthy',
 'Tomato___Late_blight',
 'Orange___Haunglongbing_(Citrus_greening)',
 'Soybean___healthy',
 'Grape___Leaf_blight_(Isariopsis_Leaf_Spot)',
 'Potato___Early_blight',
 'Strawberry___Leaf_scorch',
 'Grape___Esca_(Black_Measles)',
 'Grape___healthy',
 'Apple___Black_rot',
 'Pepper,_bell___healthy',
 'Peach___healthy',
 'Tomato___Tomato_Yellow_Leaf_Curl_Virus',
 'Tomato___Septoria_leaf_spot',
 'Squash___Powdery_mildew',
 'Tomato___Leaf_Mold',
 'Blueberry___healthy',
 'Corn_(maize)___Northern_Leaf_Blight',
 'Apple___Apple_scab',
 'Tomato___Target_Spot',
 'Raspberry___healthy',
 'Pepper,_bell___Bacterial_spot',
 'Corn_(maize)___Common_rust_',
 'Potato___healthy',
 'Tomato___Early_blight',
 'Apple___healthy',
 'Tomato___Bacterial_spot',
 'Cherry_(including_sour)___Powdery_mildew']

print(Fore.GREEN +str(Diseases_classes))
print("\nTotal number of classes are: ", len(Diseases_classes))
```

```
['Corn_(maize)___Cercospora_leaf_spot Gray_leaf_spot',
'Tomato___Tomato_mosaic_virus', 'Apple___Cedar_apple_rust',
'Corn_(maize)___healthy', 'Potato___Late_blight',
'Strawberry___healthy', 'Tomato___Spider_mites Two-
spotted_spider_mite', 'Grape___Black_rot',
'Cherry_(including_sour)___healthy', 'Peach___Bacterial_spot',
'Tomato___healthy', 'Tomato___Late_blight',
'Orange___Haunglongbing_(Citrus_greening)', 'Soybean___healthy',
'Grape___Leaf_blight_(Isariopsis_Leaf_Spot)', 'Potato___Early_blight',
'Strawberry___Leaf_scorch', 'Grape___Esca_(Black_Measles)',
'Grape___healthy', 'Apple___Black_rot', 'Pepper,_bell___healthy',
'Peach___healthy', 'Tomato___Tomato_Yellow_Leaf_Curl_Virus',
'Tomato___Septoria_leaf_spot', 'Squash___Powdery_mildew',
```

```
'Tomato___Leaf_Mold', 'Blueberry___healthy',
'Corn_(maize)___Northern_Leaf_Blight', 'Apple___Apple_scab',
'Tomato___Target_Spot', 'Raspberry___healthy',
'Pepper,_bell___Bacterial_spot', 'Corn_(maize)___Common_rust_',
'Potato___healthy', 'Tomato___Early_blight', 'Apple___healthy',
'Tomato___Bacterial_spot', 'Cherry_(including_sour)___Powdery_mildew']

Total number of classes are:  38
```

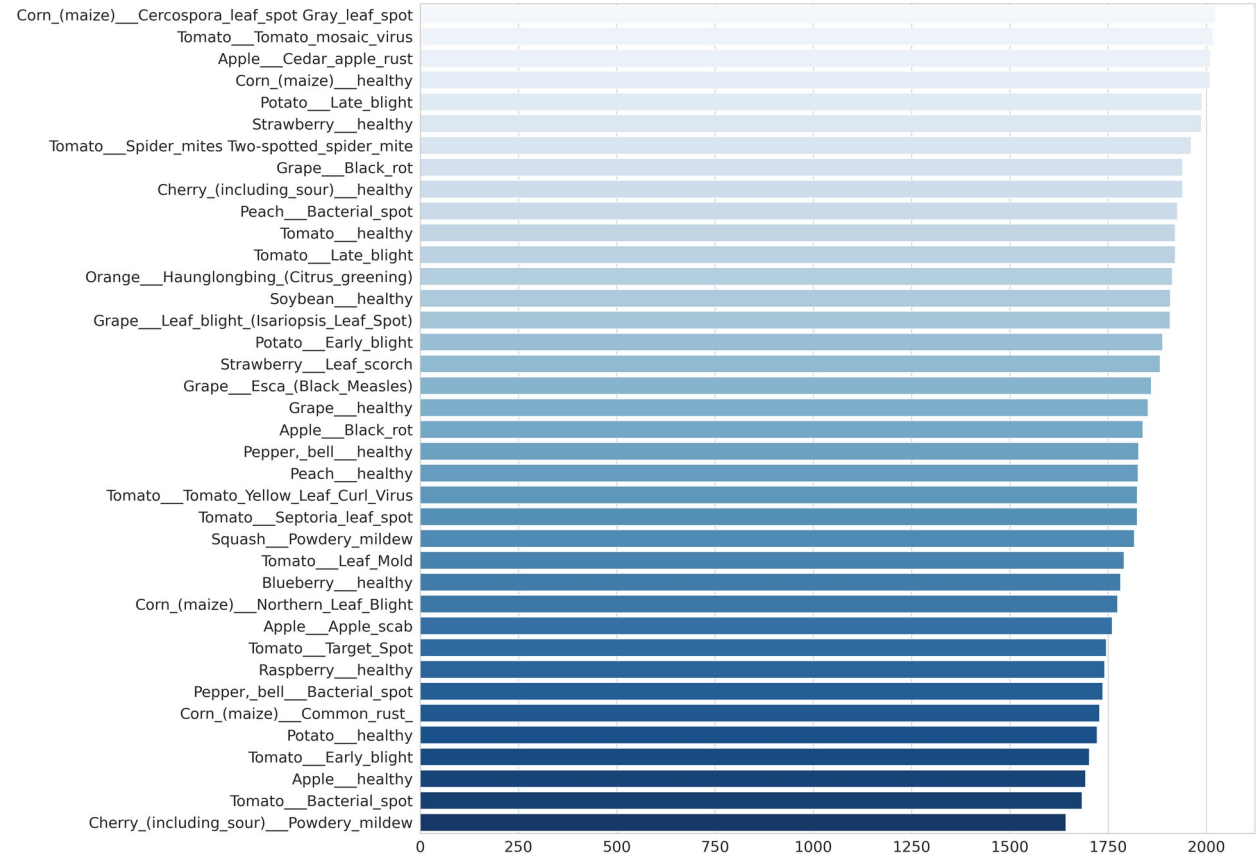
```
plt.figure(figsize=(60,60), dpi=200)
cnt = 0
plant_names = []
tot_images = 0

for i in Diseases_classes:
    cnt += 1
    plant_names.append(i)
    plt.subplot(7,7,cnt)

    image_path = os.listdir(train_dir + "/" + i)
    print(Fore.GREEN)
    print("The Number of Images in " +i+ ":", len(image_path), end= "
")
    tot_images += len(image_path)

    img_show = plt.imread(train_dir + "/" + i + "/" + image_path[0])

    plt.imshow(img_show)
    plt.xlabel(i,fontsize=30)
    plt.xticks([])
    plt.yticks([])


print("\nTotal Number of Images in Directory: ", tot_images)
```

```
The Number of Images in Corn_(maize)___Cercospora_leaf_spot
Gray_leaf_spot: 1642
The Number of Images in Tomato___Tomato_mosaic_virus: 1790
The Number of Images in Apple___Cedar_apple_rust: 1760
The Number of Images in Corn_(maize)___healthy: 1859
The Number of Images in Potato___Late_blight: 1939
The Number of Images in Strawberry___healthy: 1824
The Number of Images in Tomato___Spider_mites Two-spotted_spider_mite:
1741
The Number of Images in Grape___Black_rot: 1888
The Number of Images in Cherry_(including_sour)___healthy: 1826
The Number of Images in Peach___Bacterial_spot: 1838
The Number of Images in Tomato___healthy: 1926
The Number of Images in Tomato___Late_blight: 1851
```

```
The Number of Images in Orange___Haunglongbing_(Citrus_greening): 2010

The Number of Images in Soybean___healthy: 2022
The Number of Images in Grape___Leaf_blight_(Isariopsis_Leaf_Spot):
1722
The Number of Images in Potato___Early_blight: 1939
The Number of Images in Strawberry___Leaf_scorch: 1774
The Number of Images in Grape___Esca_(Black_Measles): 1920
The Number of Images in Grape___healthy: 1692
The Number of Images in Apple___Black_rot: 1987
The Number of Images in Pepper,_bell___healthy: 1988
The Number of Images in Peach___healthy: 1728
The Number of Images in Tomato___Tomato_Yellow_Leaf_Curl_Virus: 1961
The Number of Images in Tomato___Septoria_leaf_spot: 1745
The Number of Images in Squash___Powdery_mildew: 1736
The Number of Images in Tomato___Leaf_Mold: 1882
The Number of Images in Blueberry___healthy: 1816
The Number of Images in Corn_(maize)___Northern_Leaf_Blight: 1908
The Number of Images in Apple___Apple_scab: 2016
The Number of Images in Tomato___Target_Spot: 1827
The Number of Images in Raspberry___healthy: 1781
The Number of Images in Pepper,_bell___Bacterial_spot: 1913
The Number of Images in Corn_(maize)___Common_rust_: 1907
The Number of Images in Potato___healthy: 1824
The Number of Images in Tomato___Early_blight: 1920
The Number of Images in Apple___healthy: 2008
The Number of Images in Tomato___Bacterial_spot: 1702
The Number of Images in Cherry_(including_sour)___Powdery_mildew: 1683

Total Number of Images in Directory:  70295
```


```
plant_names = []
Len = []
```

```
for i in Diseases_classes:
    plant_names.append(i)
    imgs_path = os.listdir(train_dir + "/" + i)
    Len.append(len(imgs_path))

Len.sort(reverse=True)

sns.set(style="whitegrid", color_codes=True)
plt.figure(figsize=(20,20),dpi=200)
ax = sns.barplot(x= Len, y= plant_names, palette="Blues")
plt.xticks(fontsize=20)
plt.yticks(fontsize=20)
plt.show()
```




```
train = ImageFolder(train_dir, transform=transforms.ToTensor())
valid = ImageFolder(valid_dir, transform=transforms.ToTensor())

train
```

```
Dataset ImageFolder
    Number of datapoints: 70295
    Root location: new-plant-diseases-dataset/New Plant Diseases
Dataset(Augmented)/New Plant Diseases Dataset(Augmented)/train
```

```
    StandardTransform
Transform: ToTensor()
```

```
train[1]
```

```
(tensor([[[0.5294, 0.5098, 0.4941,  ..., 0.4745, 0.4745, 0.4784],
          [0.5137, 0.5098, 0.5098,  ..., 0.4745, 0.4745, 0.4784],
          [0.5020, 0.5137, 0.5255,  ..., 0.4745, 0.4784, 0.4824],
          ...,
          [0.1961, 0.1961, 0.1922,  ..., 0.3412, 0.3490, 0.3529],
          [0.1804, 0.1804, 0.1804,  ..., 0.3412, 0.3451, 0.3490],
          [0.1686, 0.1686, 0.1647,  ..., 0.3412, 0.3451, 0.3451]],

         [[0.5020, 0.4824, 0.4667,  ..., 0.4549, 0.4549, 0.4588],
          [0.4863, 0.4824, 0.4824,  ..., 0.4549, 0.4549, 0.4588],
          [0.4745, 0.4863, 0.4980,  ..., 0.4549, 0.4588, 0.4627],
          ...,
          [0.1333, 0.1333, 0.1294,  ..., 0.3098, 0.3176, 0.3216],
          [0.1216, 0.1216, 0.1216,  ..., 0.3137, 0.3176, 0.3216],
          [0.1098, 0.1098, 0.1059,  ..., 0.3137, 0.3176, 0.3176]],

         [[0.7020, 0.6824, 0.6667,  ..., 0.6745, 0.6745, 0.6784],
          [0.6863, 0.6824, 0.6824,  ..., 0.6745, 0.6745, 0.6784],
          [0.6745, 0.6863, 0.6980,  ..., 0.6745, 0.6784, 0.6824],
          ...,
          [0.2353, 0.2353, 0.2314,  ..., 0.4549, 0.4627, 0.4667],
          [0.2118, 0.2118, 0.2118,  ..., 0.4471, 0.4510, 0.4549],
          [0.2000, 0.2000, 0.1961,  ..., 0.4471, 0.4510, 0.4510]]]),
 0)
```

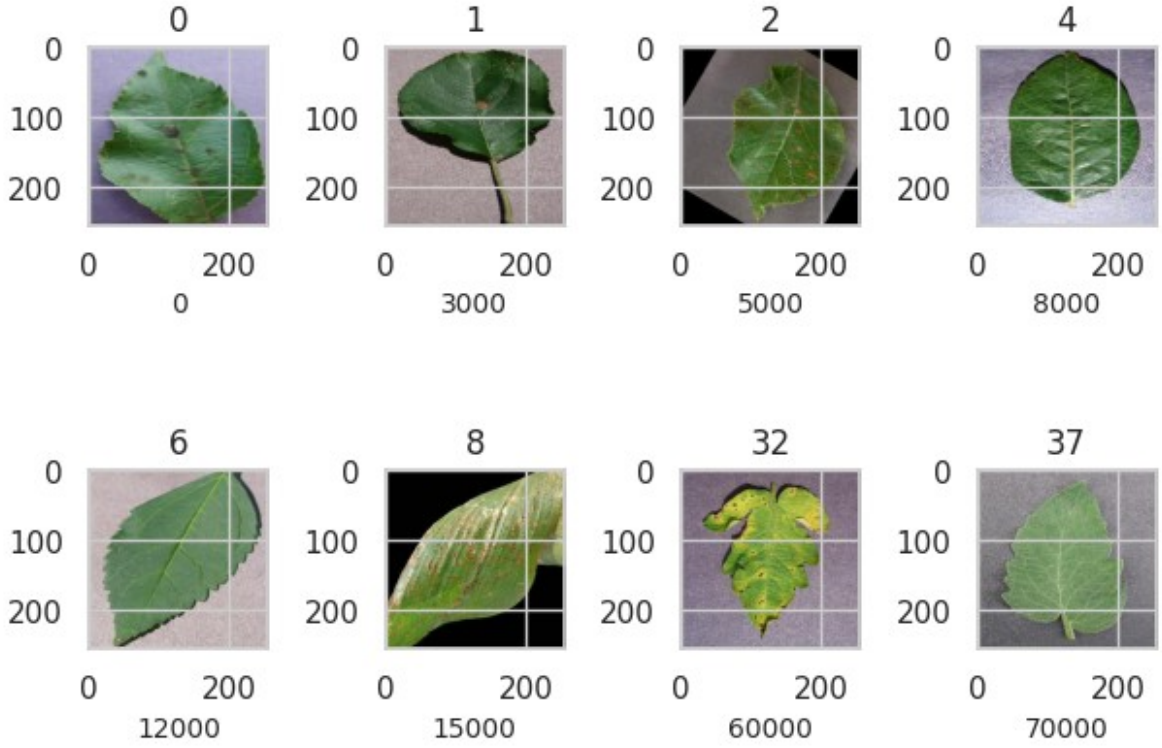
```
img, label = train[0]
print(img.shape, label)
```

```
torch.Size([3, 256, 256]) 0
```

```
def show_image(image, label):
    print("Label :" + train.classes[label] + "(" + str(label) + ")")
    plt.imshow(image.permute(1, 2, 0))


image_list = [0, 3000, 5000, 8000, 12000, 15000, 60000, 70000]

chs = 0
for img in image_list:
    chs += 1
    plt.subplot(2,4,chs)
    print(Fore.GREEN)
    plt.tight_layout()
    plt.xlabel(img,fontsize=10)
```

```
    plt.title(train[img][1])
    show_image(*train[img])
```

```
Label :Apple___Apple_scab(0)

Label :Apple___Black_rot(1)

Label :Apple___Cedar_apple_rust(2)

Label :Blueberry___healthy(4)

Label :Cherry_(including_sour)___healthy(6)

Label :Corn_(maize)___Common_rust_(8)

Label :Tomato___Septoria_leaf_spot(32)

Label :Tomato___healthy(37)
```




```
batch_size = 8 #Since I have have small space allocated on my GPU, this is the maximum size

# DataLoaders for training and validation
train_dataloader = DataLoader(train, batch_size=batch_size, shuffle=True, num_workers=2, pin_memory=True)
```

```
valid_dataloader = DataLoader(valid, batch_size=batch_size,
num_workers=2, pin_memory=True)

# for moving data into GPU (if available)
def get_default_device():
    """Pick GPU if available, else CPU"""
    if torch.cuda.is_available:
        return torch.device("cuda")
    else:
        return torch.device("cpu")

device = get_default_device() #very important for faster processing
speed
#get_default_device()

# for moving data to device (CPU or GPU)
def to_device(data, device):
    """Move tensor(s) to chosen device"""
    if isinstance(data, (list,tuple)):
        return [to_device(x, device) for x in data]
    return data.to(device, non_blocking=True)

#to_device() - pushing certain model on GPU in this case

# for loading in the device (GPU if available else CPU)
class DeviceDataLoader():
    """Wrap a dataloader to move data to a device"""
    def __init__(self, dataloader, device):
        self.dataloader = dataloader
        self.device = device

    def __iter__(self):
        """Yield a batch of data after moving it to device"""
        for b in self.dataloader:
            yield to_device(b, self.device)

    def __len__(self):
        """Number of batches"""
        return len(self.dataloader)

# Moving data into GPU, WrappedDataLoader
train_dataloader = DeviceDataLoader(train_dataloader, device)
valid_dataloader = DeviceDataLoader(valid_dataloader, device)

# for calculating the accuracy
def accuracy(outputs, labels):
    _, preds = torch.max(outputs, dim=1)
    return torch.tensor(torch.sum(preds == labels).item() /
len(preds))
```

```
class ImageClassificationBase(nn.Module):

    def training_step(self, batch):
        images, labels = batch
        out = self(images)                  # Generate predictions
        loss = F.cross_entropy(out, labels) # Calculate loss
        return loss

    def validation_step(self, batch):
        images, labels = batch
        out = self(images)                    # Generate predictions
        loss = F.cross_entropy(out, labels)   # Calculate loss
        acc = accuracy(out, labels)           # Calculate accuracy
        return {'val_loss': loss.detach(), 'val_acc': acc}

    def validation_epoch_end(self, outputs):
        batch_losses = [x['val_loss'] for x in outputs]
        epoch_loss = torch.stack(batch_losses).mean()   # Combine
losses
        batch_accs = [x['val_acc'] for x in outputs]
        epoch_acc = torch.stack(batch_accs).mean()      # Combine
accuracies
        return {'val_loss': epoch_loss.item(), 'val_acc':
epoch_acc.item()}

    def epoch_end(self, epoch, result):
        print("Epoch [{}], train_loss: {:.4f}, val_loss: {:.4f},
val_acc: {:.4f}".format(
            epoch, result['train_loss'], result['val_loss'],
result['val_acc']))

# convolution block with BatchNormalization
def ConvBlock(in_channels, out_channels, pool=False):
    layers = [nn.Conv2d(in_channels, out_channels, kernel_size=3,
padding=1),
              nn.BatchNorm2d(out_channels),
              nn.ReLU(inplace=True)]
    if pool:
        layers.append(nn.MaxPool2d(4))
    return nn.Sequential(*layers)

# resnet architecture
class CNN_NeuralNet(ImageClassificationBase):
    def __init__(self, in_channels, num_diseases):
        super().__init__()

        self.conv1 = ConvBlock(in_channels, 64)
        self.conv2 = ConvBlock(64, 128, pool=True)
        self.res1 = nn.Sequential(ConvBlock(128, 128), ConvBlock(128,
128))
```

```
        self.conv3 = ConvBlock(128, 256, pool=True)
        self.conv4 = ConvBlock(256, 512, pool=True)
        #self.conv5 = ConvBlock(256, 256, pool=True)
        #self.conv6 = ConvBlock(256, 512, pool=True)
        #self.conv7 = ConvBlock(512, 512, pool=True)

        self.res2 = nn.Sequential(ConvBlock(512, 512), ConvBlock(512,
512))
        self.classifier = nn.Sequential(nn.MaxPool2d(4),
                                        nn.Flatten(),
                                        nn.Linear(512, num_diseases))

    def forward(self, x): # x is the loaded batch
        out = self.conv1(x)
        out = self.conv2(out)
        out = self.res1(out) + out
        out = self.conv3(out)
        out = self.conv4(out)
        #out = self.conv5(out)
        #out = self.conv6(out)
        #out = self.conv7(out)
        out = self.res2(out) + out
        out = self.classifier(out)
        return out

# defining the model and moving it to the GPU
# 3 is number of channels RGB, len(train.classes()) is number of
diseases.
model = to_device(CNN_NeuralNet(3, len(train.classes)), device)
model
```

```
CNN_NeuralNet(
  (conv1): Sequential(
    (0): Conv2d(3, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1,
1))
    (1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
    (2): ReLU(inplace=True)
  )
  (conv2): Sequential(
    (0): Conv2d(64, 128, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1))
    (1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
    (2): ReLU(inplace=True)
    (3): MaxPool2d(kernel_size=4, stride=4, padding=0, dilation=1,
ceil_mode=False)
  )
  (res1): Sequential(
```

```
    (0): Sequential(
      (0): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1))
      (1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
      (2): ReLU(inplace=True)
    )
    (1): Sequential(
      (0): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1))
      (1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
      (2): ReLU(inplace=True)
    )
  )
  (conv3): Sequential(
    (0): Conv2d(128, 256, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1))
    (1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
    (2): ReLU(inplace=True)
    (3): MaxPool2d(kernel_size=4, stride=4, padding=0, dilation=1,
ceil_mode=False)
  )
  (conv4): Sequential(
    (0): Conv2d(256, 512, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1))
    (1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
    (2): ReLU(inplace=True)
    (3): MaxPool2d(kernel_size=4, stride=4, padding=0, dilation=1,
ceil_mode=False)
  )
  (res2): Sequential(
    (0): Sequential(
      (0): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1))
      (1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
      (2): ReLU(inplace=True)
    )
    (1): Sequential(
      (0): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1),
padding=(1, 1))
      (1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True,
track_running_stats=True)
      (2): ReLU(inplace=True)
    )
  )
```

```
  (classifier): Sequential(
    (0): MaxPool2d(kernel_size=4, stride=4, padding=0, dilation=1,
ceil_mode=False)
    (1): Flatten(start_dim=1, end_dim=-1)
    (2): Linear(in_features=512, out_features=38, bias=True)
  )
)
```

```
#if having problem with diagnostic CUDA, check this first
import torch
print(torch.cuda.is_available())  # Should return True if CUDA is
available
print(torch.cuda.device_count())  # Should show the number of GPUs
available
print(torch.cuda.get_device_name(0))  # Should return the name of the
GPU (if any)
```

```
True
1
NVIDIA GeForce MX330
```

```
if torch.cuda.is_available():
    device = torch.device('cuda')
    x = torch.rand(5, 5, device=device)
    print(x)
else:
    print("CUDA is not available")
```

```
tensor([[0.0198, 0.3497, 0.1135, 0.7351, 0.8201],
        [0.4885, 0.1438, 0.0613, 0.2614, 0.2029],
        [0.4305, 0.8346, 0.2058, 0.3147, 0.5754],
        [0.9144, 0.3378, 0.4837, 0.5922, 0.0786],
        [0.7038, 0.1116, 0.2227, 0.7549, 0.7824]], device='cuda:0')
```

```
print(torch.version.cuda)
```

```
12.4
```

```
# for training
@torch.no_grad()
def evaluate(model, val_loader):
    model.eval()
    outputs = [model.validation_step(batch) for batch in val_loader]
    return model.validation_epoch_end(outputs)

def get_lr(optimizer):
    for param_group in optimizer.param_groups:
        return param_group['lr']

def fit_OneCycle(epochs, max_lr, model, train_loader, val_loader,
weight_decay=0,
```

```
                grad_clip=None, opt_func=torch.optim.SGD):
    torch.cuda.empty_cache()
    history = []  #For collecting the results

    optimizer = opt_func(model.parameters(), max_lr,
weight_decay=weight_decay)
    # scheduler for one cycle learniing rate
    #Sets the learning rate of each parameter group according to the
1cycle learning rate policy.
    #The 1cycle policy anneals the learning rate from an initial
learning rate to some
    #maximum learning rate and then from that maximum learning rate to
some minimum learning rate
    #much lower than the initial learning rate.
    sched = torch.optim.lr_scheduler.OneCycleLR(optimizer, max_lr,
                                                epochs=epochs,
steps_per_epoch=len(train_loader))


    for epoch in range(epochs):
        # Training
        model.train()
        train_losses = []
        lrs = []
        for batch in train_loader:
            loss = model.training_step(batch)
            train_losses.append(loss)
            loss.backward()

            # gradient clipping
            #Clip the gradients of an iterable of parameters at
specified value.
            #All from pytorch documantation.
            if grad_clip:
                nn.utils.clip_grad_value_(model.parameters(),
grad_clip)

            optimizer.step()
            optimizer.zero_grad()

            # recording and updating learning rates
            lrs.append(get_lr(optimizer))
            sched.step()
             # validation

        result = evaluate(model, val_loader)
        result['train_loss'] = torch.stack(train_losses).mean().item()
        result['lrs'] = lrs
        model.epoch_end(epoch, result)
```

```
        history.append(result)

    return history
```

```
%%time
history = [evaluate(model, valid_dataloader)]
history
```

```
CPU times: user 6min 46s, sys: 25.6 s, total: 7min 12s
Wall time: 6min 24s
```

```
[{'val_loss': 3.63800048828125, 'val_acc': 0.026741011068224907}]
```

```
num_epoch = 1
lr_rate = 0.01
grad_clip = 0.15
weight_decay = 1e-4
optims = torch.optim.Adam
```

```
%%time
history += fit_OneCycle(num_epoch, lr_rate, model, train_dataloader,
valid_dataloader,
                            grad_clip=grad_clip,
                            weight_decay=weight_decay,
                            opt_func=optims)
```

```
Epoch [0], train_loss: 0.9851, val_loss: 0.0909, val_acc: 0.9705
CPU times: user 1h 7min 6s, sys: 35min 25s, total: 1h 42min 32s
Wall time: 1h 30min 3s
```

```
val_acc = []
val_loss = []
train_loss = []

for i in history:
    val_acc.append(i['val_acc'])
    val_loss.append(i['val_loss'])
    train_loss.append(i.get('train_loss'))

# epoch_count = 1
# plt.figure(figsize=(10,5), dpi=200)
# plt.plot(epoch_count, train_loss, 'r--', color= 'orangered')
# plt.plot(epoch_count, val_loss, '--bo',color= 'green', linewidth =
'2.5', label='line with marker')
# plt.legend(['Training Loss', 'Val Loss'])
# plt.title('Number of epochs & Loss')
# plt.xlabel('Epoch')
# plt.ylabel('Loss')
# plt.xticks(np.arange(1,7,1))
# plt.show();
```

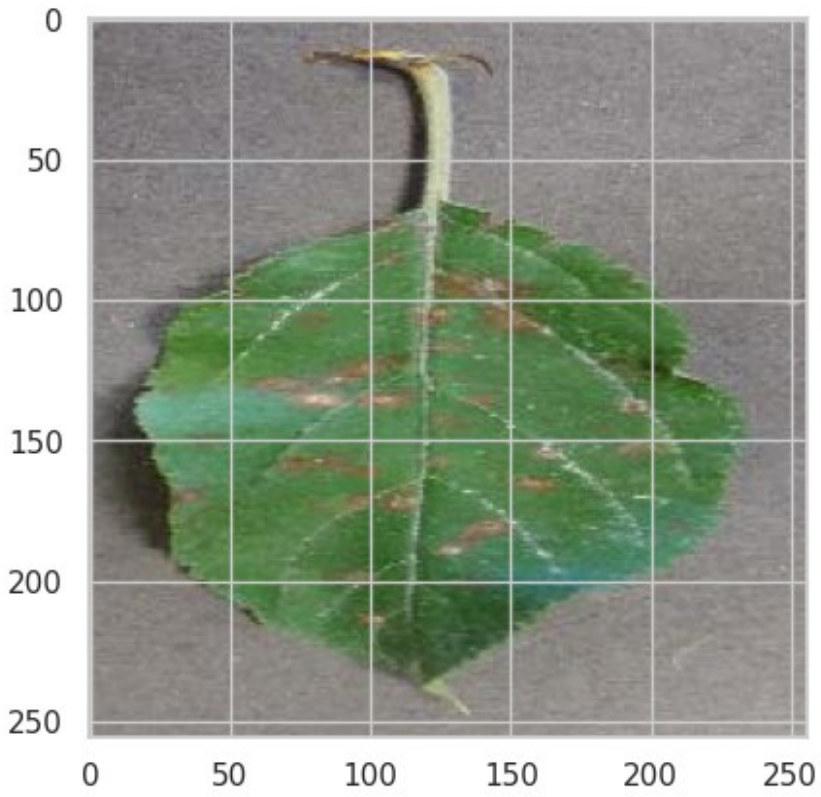
```
# epoch_count = range(1,7)
# plt.figure(figsize=(10,5), dpi=200)
# plt.plot(epoch_count, val_acc, '--bo',color= 'green', linewidth =
'2.5', label='line with marker')
# plt.legend(['Val Acc'])
# plt.title('Number of epochs & Acc')
# plt.xlabel('Epoch')
# plt.ylabel('Acc')
# plt.xticks(np.arange(1,7,1))
# plt.show();

test = ImageFolder(test_dir, transform=transforms.ToTensor())
test_images = sorted(os.listdir(test_dir + '/test'))
print(Fore.GREEN)
print(test_images)
print(len(test_images))
```

```
['AppleCedarRust1.JPG', 'AppleCedarRust2.JPG', 'AppleCedarRust3.JPG',
'AppleCedarRust4.JPG', 'AppleScab1.JPG', 'AppleScab2.JPG',
'AppleScab3.JPG', 'CornCommonRust1.JPG', 'CornCommonRust2.JPG',
'CornCommonRust3.JPG', 'PotatoEarlyBlight1.JPG',
'PotatoEarlyBlight2.JPG', 'PotatoEarlyBlight3.JPG',
'PotatoEarlyBlight4.JPG', 'PotatoEarlyBlight5.JPG',
'PotatoHealthy1.JPG', 'PotatoHealthy2.JPG', 'TomatoEarlyBlight1.JPG',
'TomatoEarlyBlight2.JPG', 'TomatoEarlyBlight3.JPG',
'TomatoEarlyBlight4.JPG', 'TomatoEarlyBlight5.JPG',
'TomatoEarlyBlight6.JPG', 'TomatoHealthy1.JPG', 'TomatoHealthy2.JPG',
'TomatoHealthy3.JPG', 'TomatoHealthy4.JPG',
'TomatoYellowCurlVirus1.JPG', 'TomatoYellowCurlVirus2.JPG',
'TomatoYellowCurlVirus3.JPG', 'TomatoYellowCurlVirus4.JPG',
'TomatoYellowCurlVirus5.JPG', 'TomatoYellowCurlVirus6.JPG']
33
```

```
def predict_image(img, model):
    """Converts image to array and return the predicted class
        with highest probability"""
    # Convert to a batch of 1
    xb = to_device(img.unsqueeze(0), device)
    # Get predictions from model
    yb = model(xb)
    # Pick index with highest probability
    _, preds  = torch.max(yb, dim=1)
    # Retrieve the class label

    return train.classes[preds[0].item()]

# predicting first image
img, label = test[1]
plt.imshow(img.permute(1, 2, 0))
```

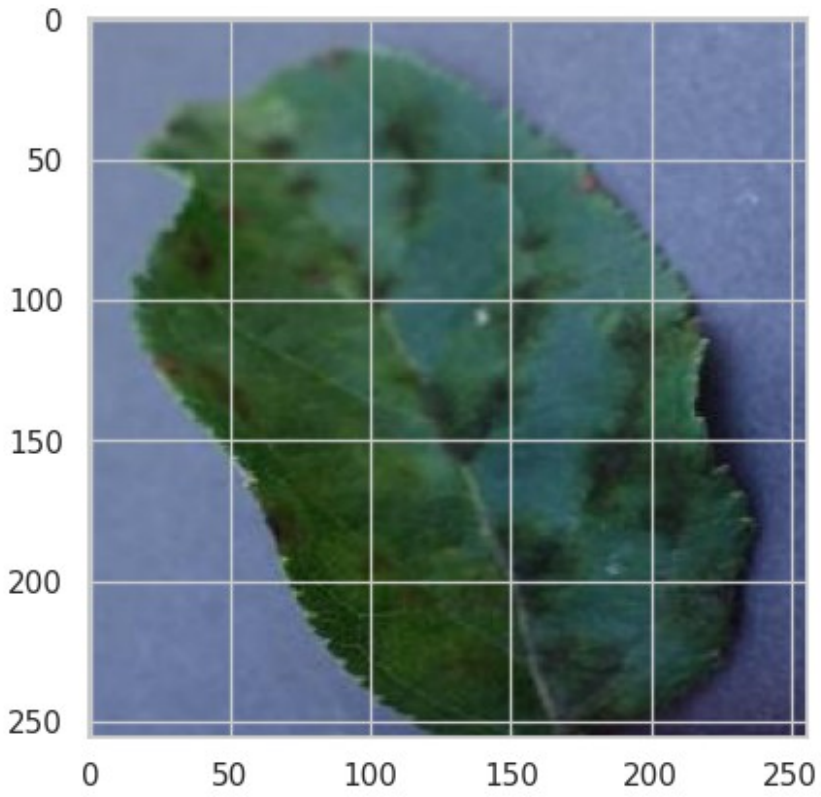
```
print(Fore.GREEN)
print('Label:', test_images[1], ', Predicted:', predict_image(img,
model))
```

```
Label: AppleCedarRust2.JPG , Predicted: Apple___Cedar_apple_rust
```



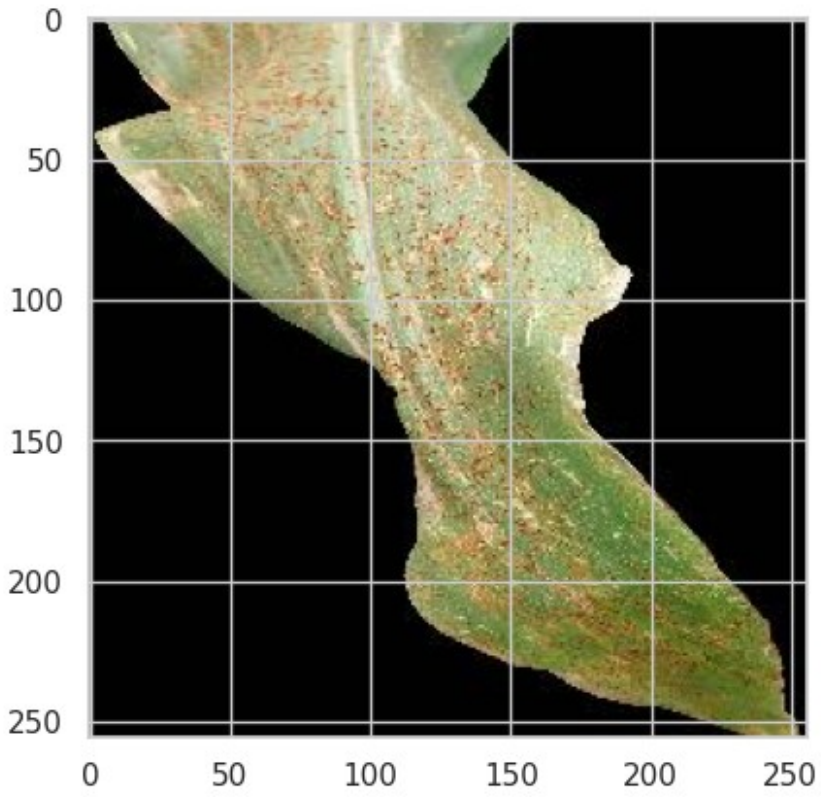

```
# predicting first image
img, label = test[5]
plt.imshow(img.permute(1, 2, 0))
print(Fore.GREEN)
print('Label:', test_images[5], ', Predicted:', predict_image(img,
model))
```

```
Label: AppleScab2.JPG , Predicted: Apple___Apple_scab
```



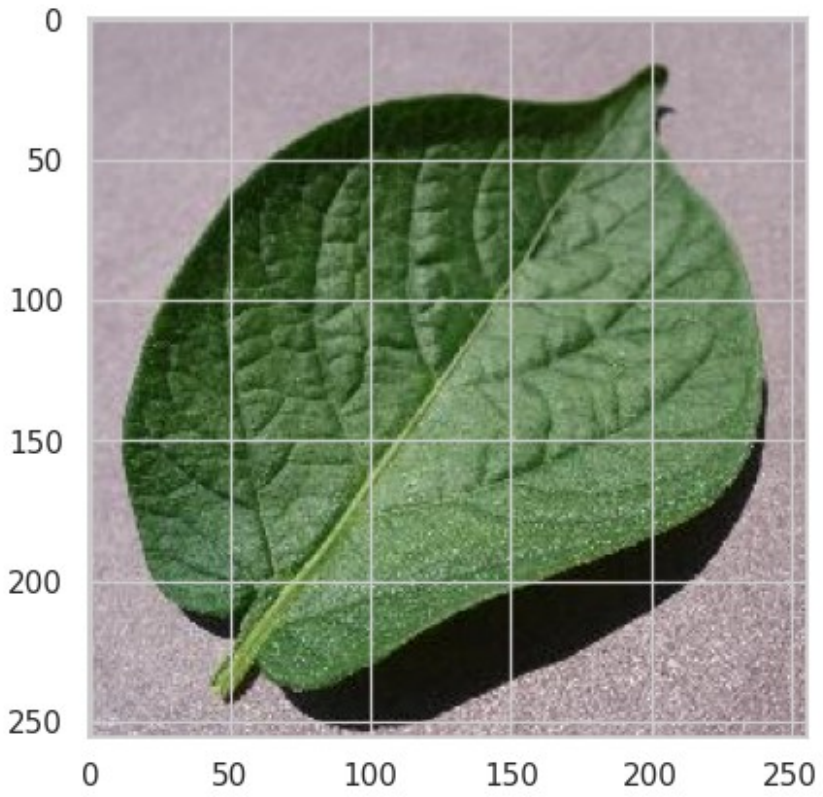

```
# predicting first image
img, label = test[9]
plt.imshow(img.permute(1, 2, 0))
print(Fore.GREEN)
print('Label:', test_images[9], ', Predicted:', predict_image(img,
model))
```

```
Label: CornCommonRust3.JPG , Predicted: Corn_(maize)___Common_rust_
```



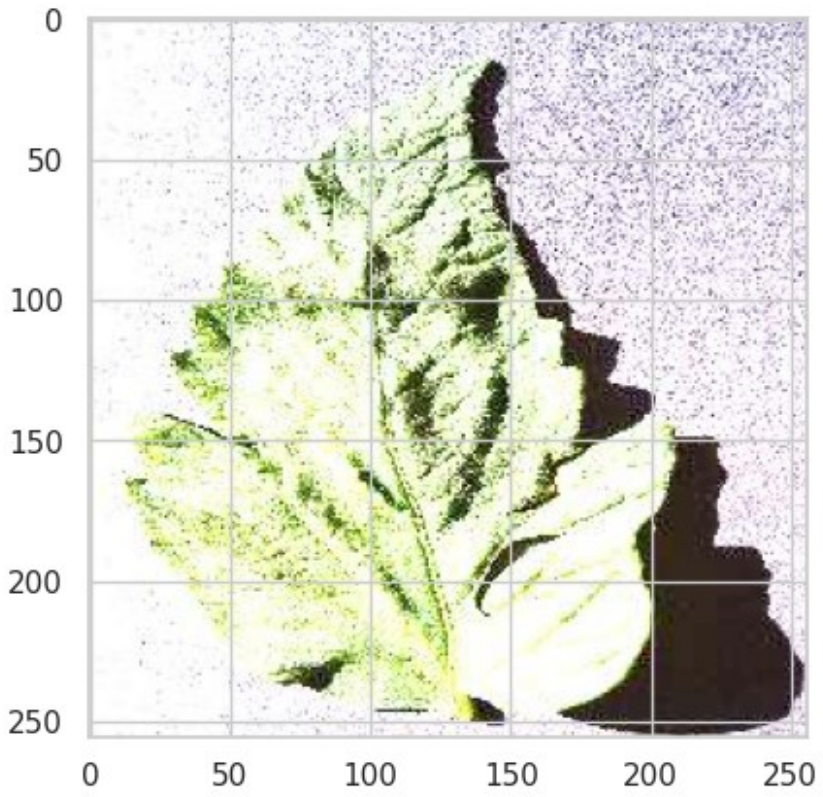

```
# predicting first image
img, label = test[16]
plt.imshow(img.permute(1, 2, 0))
print(Fore.GREEN)
print('Label:', test_images[16], ', Predicted:', predict_image(img,
model))
```

```
Label: PotatoHealthy2.JPG , Predicted: Potato___healthy
```




```
# predicting first image
img, label = test[26]
plt.imshow(img.permute(1, 2, 0))
print(Fore.GREEN)
print('Label:', test_images[26], ', Predicted:', predict_image(img,
model))
```

```
Label: TomatoHealthy4.JPG , Predicted: Tomato___healthy
```




```
# getting all predictions (actual label vs predicted)
for i, (img, label) in enumerate(test):
    print(Fore.GREEN)
    print('Label:', test_images[i], ', Predicted:', predict_image(img,
model))
```

```
Label: AppleCedarRust1.JPG , Predicted: Apple___Cedar_apple_rust

Label: AppleCedarRust2.JPG , Predicted: Apple___Cedar_apple_rust

Label: AppleCedarRust3.JPG , Predicted: Apple___Cedar_apple_rust

Label: AppleCedarRust4.JPG , Predicted: Apple___Cedar_apple_rust

Label: AppleScab1.JPG , Predicted:
Orange___Haunglongbing_(Citrus_greening)

Label: AppleScab2.JPG , Predicted: Apple___Apple_scab

Label: AppleScab3.JPG , Predicted: Apple___Apple_scab

Label: CornCommonRust1.JPG , Predicted: Corn_(maize)___Common_rust_

Label: CornCommonRust2.JPG , Predicted: Corn_(maize)___Common_rust_
```

```
Label: CornCommonRust3.JPG , Predicted: Corn_(maize)___Common_rust_

Label: PotatoEarlyBlight1.JPG , Predicted: Potato___Early_blight

Label: PotatoEarlyBlight2.JPG , Predicted: Potato___Early_blight

Label: PotatoEarlyBlight3.JPG , Predicted: Potato___Early_blight

Label: PotatoEarlyBlight4.JPG , Predicted: Potato___Early_blight

Label: PotatoEarlyBlight5.JPG , Predicted: Potato___Early_blight

Label: PotatoHealthy1.JPG , Predicted: Potato___healthy

Label: PotatoHealthy2.JPG , Predicted: Potato___healthy

Label: TomatoEarlyBlight1.JPG , Predicted: Tomato___Late_blight

Label: TomatoEarlyBlight2.JPG , Predicted: Tomato___Late_blight

Label: TomatoEarlyBlight3.JPG , Predicted: Tomato___Early_blight

Label: TomatoEarlyBlight4.JPG , Predicted: Tomato___Early_blight

Label: TomatoEarlyBlight5.JPG , Predicted: Tomato___Early_blight

Label: TomatoEarlyBlight6.JPG , Predicted: Tomato___Bacterial_spot

Label: TomatoHealthy1.JPG , Predicted: Tomato___healthy

Label: TomatoHealthy2.JPG , Predicted: Tomato___healthy

Label: TomatoHealthy3.JPG , Predicted: Tomato___healthy

Label: TomatoHealthy4.JPG , Predicted: Tomato___healthy

Label: TomatoYellowCurlVirus1.JPG , Predicted:
Tomato___Tomato_Yellow_Leaf_Curl_Virus

Label: TomatoYellowCurlVirus2.JPG , Predicted:
Tomato___Tomato_Yellow_Leaf_Curl_Virus

Label: TomatoYellowCurlVirus3.JPG , Predicted:
Tomato___Tomato_Yellow_Leaf_Curl_Virus

Label: TomatoYellowCurlVirus4.JPG , Predicted:
Tomato___Tomato_Yellow_Leaf_Curl_Virus

Label: TomatoYellowCurlVirus5.JPG , Predicted:
Tomato___Tomato_Yellow_Leaf_Curl_Virus
```

```
Label: TomatoYellowCurlVirus6.JPG , Predicted:
Tomato___Tomato_Yellow_Leaf_Curl_Virus
```