

```

1 #import libraries
2
3 import os
4 import torch
5 import torch.nn as nn
6 import numpy as np
7 #import libraries
8
9 import os
10 import torch
11 import torch.nn as nn
12 import numpy as np
13 import matplotlib.pyplot as plt
14 import torchvision
15 import torch.nn.functional as F
16 from torchvision.transforms import ToTensor
17 from torch.utils.data import DataLoader
18 from torchvision.datasets import ImageFolder
19 import torchvision.transforms as T
20 %matplotlib inline
21 from torchvision.datasets import ImageFolder
22 import torchvision.transforms as T
23 %matplotlib inline

```

```

1 from google.colab import drive
2 drive.mount('/content/drive')

```

Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=True).

```

1 import os
2 directory_path = "/content/drive/MyDrive/Cotton Disease"
3 print(os.listdir(directory_path))
4

```

['test', 'train', 'val']

```

1 print(os.listdir(directory_path))
2 classes = os.listdir(directory_path + "/train")
3 print(classes)

```

['test', 'train', 'val']
['fresh cotton leaf', 'fresh cotton plant', 'diseased cotton plant', 'diseased cotton leaf']

```

1 diseased_cotton_leaf = os.listdir(directory_path + "/train/diseased cotton leaf")
2 print(diseased_cotton_leaf[:10])

```

['dis_leaf (111)_iaip.jpg', 'dis_leaf (120)_iaip.jpg', 'dis_leaf (110)_iaip.jpg', 'dis_leaf (121)_iaip.jpg', 'dis_leaf (126)_iaip.jpg',

```

1 for i in classes:
2     result = os.listdir(directory_path + "/train/" + i)
3     print(f"Number of Images in {i} = {len(result)}")

```

Number of Images in fresh cotton leaf = 427
Number of Images in fresh cotton plant = 421
Number of Images in diseased cotton plant = 815
Number of Images in diseased cotton leaf = 288

```

1 image_size = 32
2 batch_size = 200
3 stats = ((0.4914, 0.4822, 0.4465), (0.2023, 0.1994, 0.2010))

```

```

1 train_ds = ImageFolder(directory_path + "/train", transform=T.Compose ([
2     T.Resize((image_size, image_size)),
3     T.CenterCrop((image_size, image_size)),
4     T.ToTensor(), T.Normalize(*stats)
5 ]))
6
7 val_ds = ImageFolder(directory_path + "/val", transform=T.Compose([
8     T.Resize((image_size, image_size)),

```

```

9     T.CenterCrop((image_size, image_size)),
10     T.ToTensor(), T.Normalize(*stats)
11 ]))

```

```

1 train_dl = DataLoader(train_ds, batch_size, shuffle=True, num_workers=3, pin_memory=True)
2 val_dl = DataLoader(val_ds, batch_size*2, num_workers=4, pin_memory=True)

```

```

/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py:617: UserWarning: This DataLoader will create 3 worker processes
warnings.warn(
/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py:617: UserWarning: This DataLoader will create 4 worker processes
warnings.warn(

```

```

1 def denorm(img_tensors):
2     return img_tensors * stats[1][10] + stats[0][0]

```

```

1 from torchvision.utils import make_grid

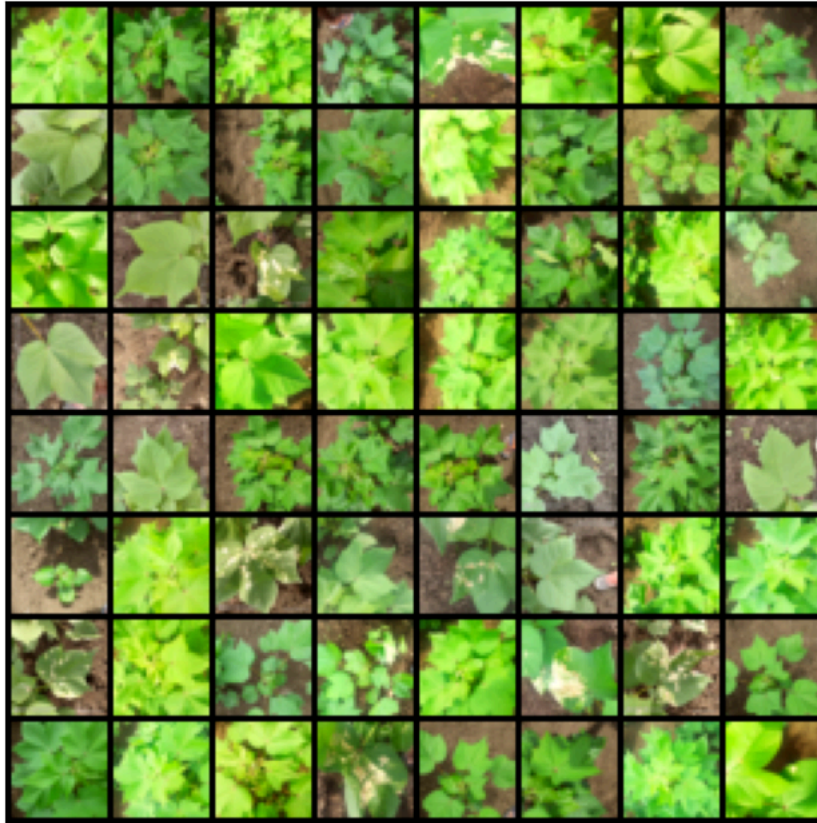
```

```

1 # Define the normalization parameters
2 means = [0.485, 0.456, 0.406]
3 stds = [0.229, 0.224, 0.225]
4
5 # Function to denormalize images
6 def denormalize(images, means, stds):
7     means = torch.tensor(means).view(1, 3, 1, 1)
8     stds = torch.tensor(stds).view(1, 3, 1, 1)
9     return images * stds + means
10
11 # Function to show images
12 def show_images(images, means, stds, nmax=64):
13     images = denormalize(images, means, stds)
14     fig, ax = plt.subplots(figsize=(8, 8))
15     ax.set_xticks([]); ax.set_yticks([])
16     ax.imshow(make_grid(images[:nmax], nrow=8).permute(1, 2, 0))
17
18 # Function to show a batch
19 def show_batches(dl, means, stds, nmax=64):
20     for images, _ in dl:
21         show_images(images, means, stds, nmax)
22         break
23
24 # Call the function
25 show_batches(train_dl, means, stds, nmax=64)
26

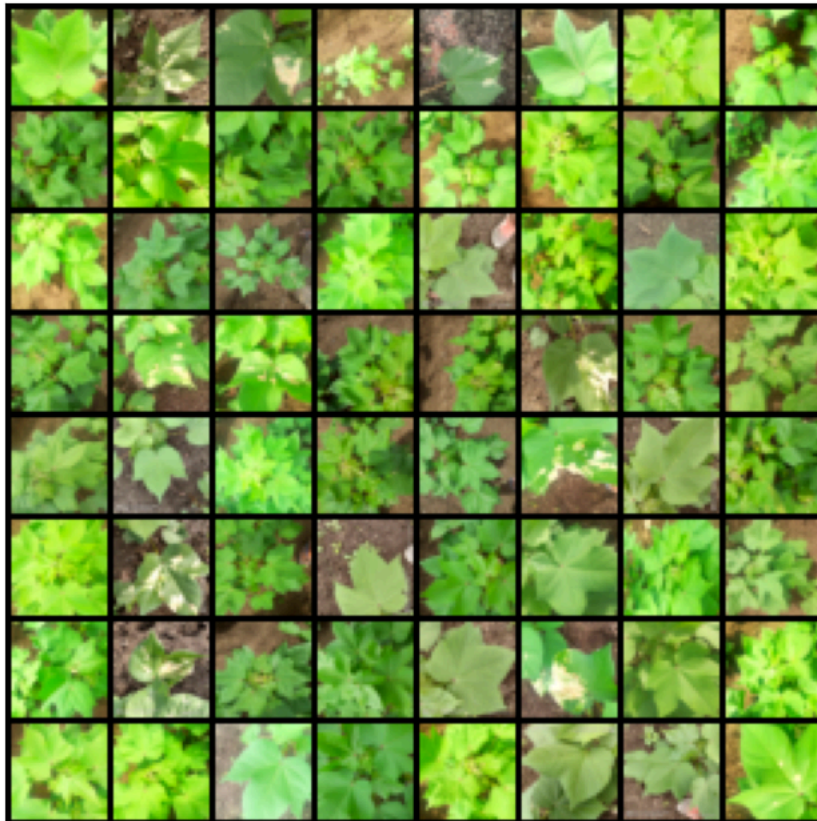
```

WARNING:matplotlib.image:Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers). 6



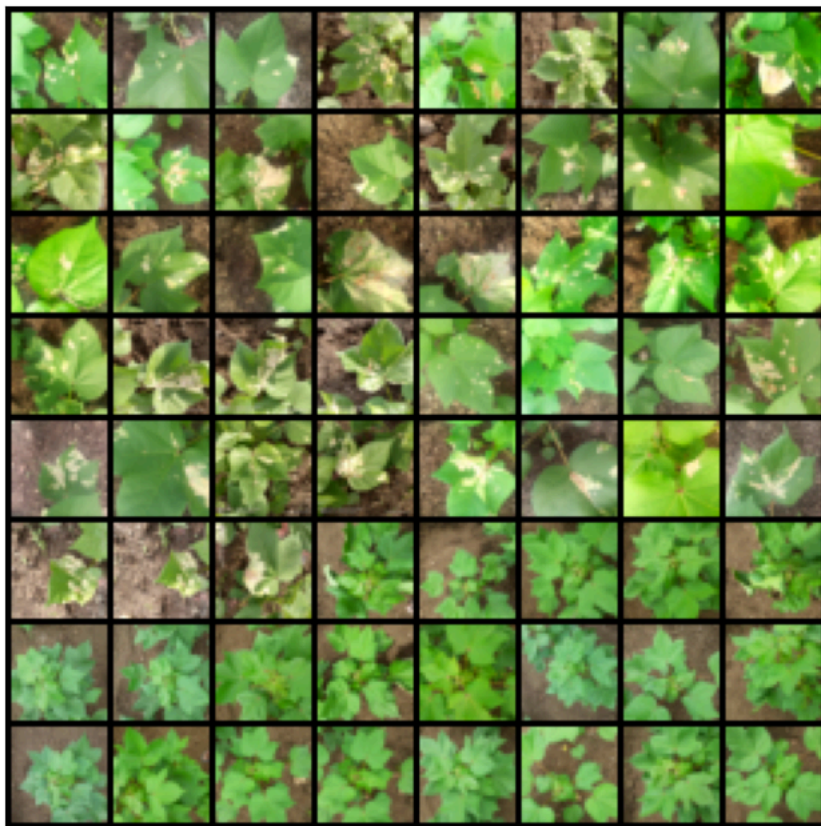
```
1 show_batches(train_dl, means, stds)
2 torch.cuda.empty_cache()
```

WARNING:matplotlib.image:Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers). 6



```
1 show_batches(val_dl, means, stds)
```

WARNING:matplotlib.image:Clipping input data to the valid range for imshow with RGB data ([0..1] for floats or [0..255] for integers). C



```
1 class ImageClassificationBase(nn.Module):
2     def training_step(self, batch):
3         images, labels = batch
4         out = self(images)
5         loss = F.cross_entropy(out, labels)
6         return loss
7
8     def validation_step(self, batch):
9         images, labels = batch
10        out = self(images)
11        loss = F.cross_entropy(out, labels)
12        acc = self.accuracy(out, labels)
13        return {'val_loss': loss.detach(), 'val_acc': acc}
14
15    def validation_epoch_end(self, outputs):
16        batch_losses = [x['val_loss'] for x in outputs]
17        epoch_loss = torch.stack(batch_losses).mean()
18        batch_accs = [x['val_acc'] for x in outputs]
19        epoch_acc = torch.stack(batch_accs).mean()
20        return {'val_loss': epoch_loss.item(), 'val_acc': epoch_acc.item()}
21
22    def epoch_end(self, epoch, result):
23        print("Epoch [{}],train_loss: {:.4f},val_loss: {:.4f}, val_acc: {:.4f}".format(
24            epoch, result['train_loss'], result['val_loss'], result['val_acc']
25        ))
26
27    def accuracy(self, outputs, labels):
28        _, preds = torch.max(outputs, dim=1)
29        return torch.tensor(torch.sum(preds == labels).item() / len(preds))
```

```
1 class CnnModel(ImageClassificationBase):
2     def __init__(self):
3         super().__init__()
4         self.network = nn.Sequential(
5             nn.Conv2d(3, 32, kernel_size=3, padding=1),
6             nn.ReLU(),
```

```

7         nn.Conv2d(32, 64, kernel_size=3, stride=1, padding=1),
8         nn.ReLU(),
9         nn.MaxPool2d(2,2),
10
11        nn.Conv2d(64, 128, kernel_size=3, stride=1, padding=1),
12        nn.ReLU(),
13        nn.Conv2d(128, 128, kernel_size=3, stride=1, padding=1),
14        nn.ReLU(),
15        nn.MaxPool2d(2,2),
16
17        nn.Conv2d(128, 256, kernel_size=3, stride=1, padding=1),
18        nn.ReLU(),
19        nn.Conv2d(256, 256, kernel_size=3, stride=1, padding=1),
20        nn.ReLU(),
21        nn.MaxPool2d(2,2),
22
23        nn.Flatten(),
24        nn.Linear(256*4*4, 512),
25        nn.ReLU(),
26        nn.Linear(512, 512),
27        nn.ReLU(),
28        nn.Linear(512,4)
29    )
30
31    def forward(self, xb):
32        return self.network(xb)
33
34    def accuracy(self, outputs, labels):
35        _, preds = torch.max(outputs, dim=1)
36        return torch.tensor(torch.sum(preds == labels).item() / len(preds))
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```

```
14 break
```

```
15
```

```
→ images.shape: torch.Size([200, 3, 32, 32])
   out.shape: torch.Size([200, 4])
   out[0]: tensor([ 0.0419, -0.0421, -0.0315, -0.0203], grad_fn=<SelectBackward0>)
```

```
1 def get_default_device():
2     if torch.cuda.is_available():
3         return torch.device('cuda')
4     else:
5         return torch.device('cpu')
6
7 def to_device(data, device):
8     if isinstance(data, (list, tuple)):
9         return [to_device(x, device) for x in data]
10    return data.to(device, non_blocking=True)
11
12 class DeviceDataLoader():
13     def __init__(self, dl, device):
14         self.dl = dl
15         self.device = device
16
17     def __iter__(self):
18         for b in self.dl:
19             yield to_device(b, self.device)
20
21     def __len__(self):
22         return len(self.dl)
```

```
1 device = get_default_device()
2 device
```

```
→ device(type='cpu')
```

```
1 train_dl = DeviceDataLoader(train_dl, device)
2 val_dl = DeviceDataLoader(val_dl, device)
3 to_device(model, device);
```

```
1 @torch.no_grad()
2 def evaluate(model, val_loader):
3     model.eval()
4     outputs = [model.validation_step(batch) for batch in val_loader]
5     return model.validation_epoch_end(outputs)
6
7 def fit(epochs, lr, model, train_loader, val_loader, opt_func=torch.optim.SGD):
8     history = []
9     optimizer = opt_func(model.parameters(), lr)
10    for epoch in range(epochs):
11        model.train()
12        train_losses = []
13        for batch in train_loader:
14            loss = model.training_step(batch)
15            train_losses.append(loss)
16            loss.backward()
17            optimizer.step()
18            optimizer.zero_grad()
19        result = evaluate(model, val_loader)
20        result['train_loss'] = torch.stack(train_losses).mean().item()
21        model.epoch_end(epoch, result)
22        history.append(result)
23    return history
24
25
```

```
1 model = to_device(CnnModel(), device)
2
```

```
1 evaluate(model, val_dl)
```

```
{'val_loss': 1.3903604745864868, 'val_acc': 0.16996046900749207}
```

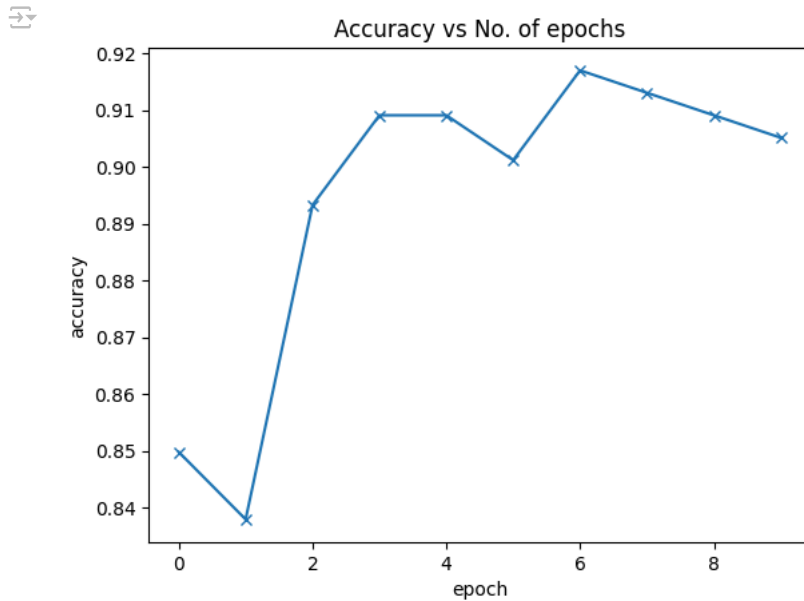
```
1 num_epochs = 10
2 opt_func = torch.optim.Adam
3 lr = 0.001
```

```
1 %%time
2 history = fit(num_epochs, lr, model, train_dl, val_dl, opt_func)
```

```
Epoch [0],train_loss: 0.7017,val_loss: 0.5209, val_acc: 0.8498
Epoch [1],train_loss: 0.3877,val_loss: 0.4412, val_acc: 0.8379
Epoch [2],train_loss: 0.2776,val_loss: 0.2858, val_acc: 0.8933
Epoch [3],train_loss: 0.2045,val_loss: 0.2652, val_acc: 0.9091
Epoch [4],train_loss: 0.1536,val_loss: 0.3391, val_acc: 0.9091
Epoch [5],train_loss: 0.1384,val_loss: 0.2437, val_acc: 0.9012
Epoch [6],train_loss: 0.1204,val_loss: 0.2134, val_acc: 0.9170
Epoch [7],train_loss: 0.1102,val_loss: 0.2615, val_acc: 0.9130
Epoch [8],train_loss: 0.0823,val_loss: 0.3252, val_acc: 0.9091
Epoch [9],train_loss: 0.0561,val_loss: 0.2519, val_acc: 0.9051
CPU times: user 5min 57s, sys: 20.9 s, total: 6min 18s
Wall time: 8min 35s
```

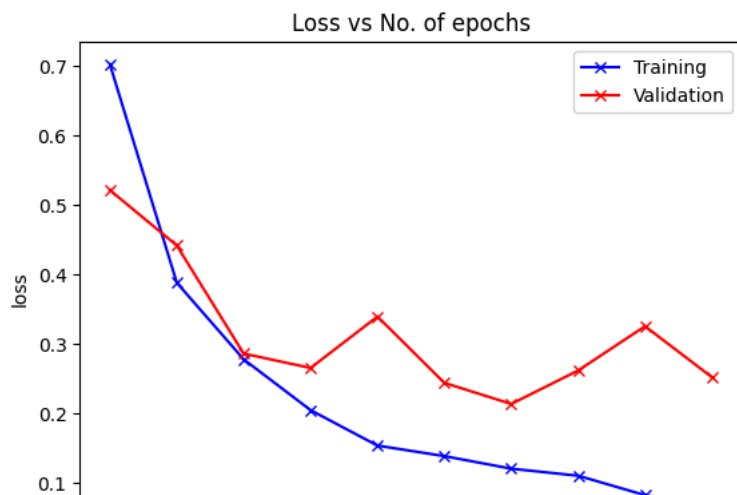
```
1 def plot_accuracies(history):
2     accuracies = [x['val_acc'] for x in history]
3     plt.plot(accuracies, '-x')
4     plt.xlabel('epoch')
5     plt.ylabel('accuracy')
6     plt.title('Accuracy vs No. of epochs')
```

```
1 plot_accuracies(history)
```



```
1 def plot_losses(history):
2     train_losses = [x.get('train_loss') for x in history]
3     val_losses = [x['val_loss'] for x in history]
4     plt.plot(train_losses, '-bx')
5     plt.plot(val_losses, '-rx')
6     plt.xlabel('epoch')
7     plt.ylabel('loss')
8     plt.legend(['Training', 'Validation'])
9     plt.title('Loss vs No. of epochs')
```

```
1 plot_losses(history)
```



```
1 test_dataset = ImageFolder(directory_path + "/test", transform=T.Compose([
2     T.Resize((image_size, image_size)),
3     T.CenterCrop((image_size, image_size)),
4     T.ToTensor(), T.Normalize(*stats)
5 ]))
```

```
1 def predict_image(img, model):
2     xb = to_device(img.unsqueeze(0), device)
3     yb = model(xb)
4     _, preds = torch.max(yb, dim=1)
5     return train_ds.classes[preds[0].item()]
```

```
1 dataset = ImageFolder(directory_path + "/train", transform=ToTensor())
```

```
1 torch.save(model.state_dict(), 'cotton_disease_model.pth')
```

```
1 def denorm(img_tensors):
2     # Unnormalize the image tensor using mean and std for each channel
3     mean = torch.tensor(stats[0]) # mean = [mean_r, mean_g, mean_b]
4     std = torch.tensor(stats[1]) # std = [std_r, std_g, std_b]
5     return img_tensors * std + mean
6
```

```
1 test_dataset1 = ImageFolder(directory_path + "/test", transform=ToTensor())
2 img, label = test_dataset[0]
3 plt.imshow(denorm(img.permute(1,2,0)))
4 print('label:', dataset.classes[label], ',Predicted:', predict_image(img, model))
```

label: diseased cotton leaf ,Predicted: diseased cotton leaf

