Lab3

December 6, 2020

[1]:
```
import torch
import torch.nn as nn
import torch.optim as optim
import torch.utils.data
import torch.nn.functional as F
import torchvision
from torchvision import transforms
from PIL import Image
import matplotlib.pyplot as plt
import numpy as np
%matplotlib inline
```

1

[2]:
```
LEARNING_RATE = 0.01
EPOCHS = 50
TRAIN_DATA_SIZE = 10000
```

[3]:
```
def check_image(path):
    try:
        im = Image.open(path)
        return True
    except:
        return False
```

[4]:
```
img_transforms = transforms.Compose([
    transforms.Resize((64,64)),
    transforms.Grayscale(),
    transforms.ToTensor()
    ])
```

[5]:
```
train_data_path = "./train/"
train_data = torchvision.datasets.
 ↪ImageFolder(root=train_data_path,transform=img_transforms,␣
 ↪is_valid_file=check_image)
len(train_data)
```

[5]: 60000

[6]:
```
val_data_path = "./val/"
val_data = torchvision.datasets.
 ↪ImageFolder(root=val_data_path,transform=img_transforms,␣
 ↪is_valid_file=check_image)
```

[7]:
```
test_data_path = "./test/"
test_data = torchvision.datasets.
 ↪ImageFolder(root=test_data_path,transform=img_transforms,␣
 ↪is_valid_file=check_image)
```

[8]:
```
batch_size=TRAIN_DATA_SIZE
```

[9]:
```
train_data_loader = torch.utils.data.DataLoader(train_data,␣
 ↪batch_size=batch_size)
val_data_loader  = torch.utils.data.DataLoader(val_data, batch_size=batch_size)
test_data_loader  = torch.utils.data.DataLoader(test_data,␣
 ↪batch_size=batch_size)
```

[10]:
```
class SimpleNet(nn.Module):

    def __init__(self):
        super(SimpleNet, self).__init__()
        self.fc1 = nn.Linear(4096, 250)
        self.fc2 = nn.Linear(250, 50)
        self.fc3 = nn.Linear(50,10)

    def forward(self, x):
        x = x.view(-1, 64*64)
        x = F.relu(self.fc1(x))
        x = F.relu(self.fc2(x))
        x = self.fc3(x)
        return x
```

[11]:
```
simplenet = SimpleNet()
```

[12]:
```
optimizer = optim.Adam(simplenet.parameters(), lr=LEARNING_RATE)
```

[13]:
```
if torch.cuda.is_available():
    device = torch.device("cuda")
else:
    device = torch.device("cpu")

simplenet.to(device)
```

```
/home/blestrong/anaconda3/lib/python3.8/site-packages/torch/cuda/__init__.py:52:
```

```
UserWarning: CUDA initialization: The NVIDIA driver on your system is too old
(found version 6050). Please update your GPU driver by downloading and
installing a new version from the URL: http://www.nvidia.com/Download/index.aspx
Alternatively, go to: https://pytorch.org to install a PyTorch version that has
been compiled with your version of the CUDA driver. (Triggered internally at
/opt/conda/conda-bld/pytorch_1603729096996/work/c10/cuda/CUDAFunctions.cpp:100.)
  return torch._C._cuda_getDeviceCount() > 0
```

[13]:
```
SimpleNet(
  (fc1): Linear(in_features=4096, out_features=250, bias=True)
  (fc2): Linear(in_features=250, out_features=50, bias=True)
  (fc3): Linear(in_features=50, out_features=10, bias=True)
)
```

[14]:
```
def train(model, optimizer, loss_fn, train_loader, val_loader, epochs=20,␣
↪device="cpu"):
    for epoch in range(epochs):
        training_loss = 0.0
        valid_loss = 0.0
        model.train()
        for batch in train_loader:
            optimizer.zero_grad()
            inputs, targets = batch
            inputs = inputs.to(device)
            targets = targets.to(device)
            output = model(inputs)
            loss = loss_fn(output, targets)
            loss.backward()
            optimizer.step()
            training_loss += loss.data.item() * inputs.size(0)
        training_loss /= len(train_loader.dataset)

        model.eval()
        num_correct = 0
        num_examples = 0
        for batch in val_loader:
            inputs, targets = batch
            inputs = inputs.to(device)
            output = model(inputs)
            targets = targets.to(device)
            loss = loss_fn(output,targets)
            valid_loss += loss.data.item() * inputs.size(0)
            correct = torch.eq(torch.max(F.softmax(output), dim=1)[1], targets).
↪view(-1)
            num_correct += torch.sum(correct).item()
            num_examples += correct.shape[0]
        valid_loss /= len(val_loader.dataset)
```

```
        print('Epoch: {}, Training Loss: {:.2f}, Validation Loss: {:.2f},␣
↪accuracy = {:.2f}'.format(epoch, training_loss,
        valid_loss, num_correct / num_examples))
```

[15]:
```
train(simplenet, optimizer,torch.nn.CrossEntropyLoss(),␣
↪train_data_loader,val_data_loader, epochs=EPOCHS, device=device)
```

```
<ipython-input-14-f38d79bc5988>:28: UserWarning: Implicit dimension choice for
softmax has been deprecated. Change the call to include dim=X as an argument.
  correct = torch.eq(torch.max(F.softmax(output), dim=1)[1], targets).view(-1)

Epoch: 0, Training Loss: 5.08, Validation Loss: 2.19, accuracy = 0.16
Epoch: 1, Training Loss: 2.25, Validation Loss: 2.11, accuracy = 0.14
Epoch: 2, Training Loss: 2.07, Validation Loss: 2.06, accuracy = 0.18
Epoch: 3, Training Loss: 2.05, Validation Loss: 1.96, accuracy = 0.31
Epoch: 4, Training Loss: 1.93, Validation Loss: 1.82, accuracy = 0.34
Epoch: 5, Training Loss: 1.75, Validation Loss: 1.65, accuracy = 0.39
Epoch: 6, Training Loss: 1.58, Validation Loss: 1.50, accuracy = 0.41
Epoch: 7, Training Loss: 1.42, Validation Loss: 1.36, accuracy = 0.48
Epoch: 8, Training Loss: 1.27, Validation Loss: 1.24, accuracy = 0.55
Epoch: 9, Training Loss: 1.19, Validation Loss: 1.17, accuracy = 0.57
Epoch: 10, Training Loss: 1.11, Validation Loss: 1.08, accuracy = 0.60
Epoch: 11, Training Loss: 1.01, Validation Loss: 1.02, accuracy = 0.61
Epoch: 12, Training Loss: 0.98, Validation Loss: 0.95, accuracy = 0.65
Epoch: 13, Training Loss: 0.87, Validation Loss: 0.87, accuracy = 0.68
Epoch: 14, Training Loss: 0.84, Validation Loss: 0.79, accuracy = 0.73
Epoch: 15, Training Loss: 0.81, Validation Loss: 0.83, accuracy = 0.71
Epoch: 16, Training Loss: 0.77, Validation Loss: 0.69, accuracy = 0.76
Epoch: 17, Training Loss: 0.71, Validation Loss: 0.72, accuracy = 0.76
Epoch: 18, Training Loss: 0.79, Validation Loss: 0.72, accuracy = 0.75
Epoch: 19, Training Loss: 0.73, Validation Loss: 0.60, accuracy = 0.79
Epoch: 20, Training Loss: 0.66, Validation Loss: 0.59, accuracy = 0.81
Epoch: 21, Training Loss: 0.55, Validation Loss: 0.54, accuracy = 0.84
Epoch: 22, Training Loss: 0.54, Validation Loss: 0.49, accuracy = 0.86
Epoch: 23, Training Loss: 0.47, Validation Loss: 0.44, accuracy = 0.87
Epoch: 24, Training Loss: 0.45, Validation Loss: 0.42, accuracy = 0.87
Epoch: 25, Training Loss: 0.43, Validation Loss: 0.40, accuracy = 0.87
Epoch: 26, Training Loss: 0.43, Validation Loss: 0.41, accuracy = 0.88
Epoch: 27, Training Loss: 0.40, Validation Loss: 0.39, accuracy = 0.88
Epoch: 28, Training Loss: 0.37, Validation Loss: 0.39, accuracy = 0.88
Epoch: 29, Training Loss: 0.36, Validation Loss: 0.35, accuracy = 0.89
Epoch: 30, Training Loss: 0.33, Validation Loss: 0.34, accuracy = 0.90
Epoch: 31, Training Loss: 0.32, Validation Loss: 0.33, accuracy = 0.90
Epoch: 32, Training Loss: 0.30, Validation Loss: 0.32, accuracy = 0.90
Epoch: 33, Training Loss: 0.30, Validation Loss: 0.31, accuracy = 0.91
Epoch: 34, Training Loss: 0.28, Validation Loss: 0.30, accuracy = 0.91
Epoch: 35, Training Loss: 0.28, Validation Loss: 0.29, accuracy = 0.91
```

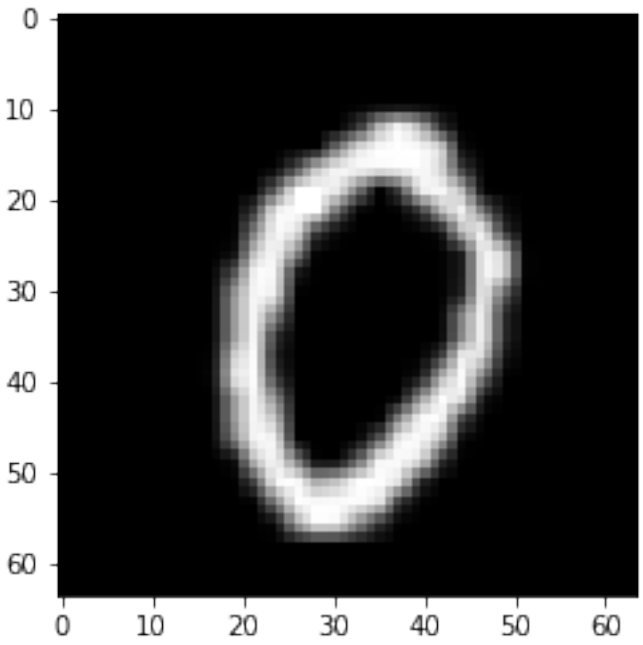
```
Epoch: 36, Training Loss: 0.27, Validation Loss: 0.29, accuracy = 0.91
Epoch: 37, Training Loss: 0.26, Validation Loss: 0.28, accuracy = 0.91
Epoch: 38, Training Loss: 0.25, Validation Loss: 0.27, accuracy = 0.92
Epoch: 39, Training Loss: 0.25, Validation Loss: 0.27, accuracy = 0.92
Epoch: 40, Training Loss: 0.24, Validation Loss: 0.26, accuracy = 0.92
Epoch: 41, Training Loss: 0.24, Validation Loss: 0.26, accuracy = 0.92
Epoch: 42, Training Loss: 0.23, Validation Loss: 0.25, accuracy = 0.92
Epoch: 43, Training Loss: 0.23, Validation Loss: 0.25, accuracy = 0.92
Epoch: 44, Training Loss: 0.23, Validation Loss: 0.25, accuracy = 0.93
Epoch: 45, Training Loss: 0.24, Validation Loss: 0.26, accuracy = 0.92
Epoch: 46, Training Loss: 0.25, Validation Loss: 0.25, accuracy = 0.92
Epoch: 47, Training Loss: 0.26, Validation Loss: 0.26, accuracy = 0.92
Epoch: 48, Training Loss: 0.26, Validation Loss: 0.26, accuracy = 0.92
Epoch: 49, Training Loss: 0.24, Validation Loss: 0.26, accuracy = 0.92
```

#

[16]:
```
labels = ['0','1', '2', '3', '4', '5', '6', '7', '8', '9']

img = Image.open("./test/0/4675.png")
img = img_transforms(img).to(device)

plt.imshow(  img.permute(1, 2, 0), cmap ='gray'  )

prediction = F.softmax(simplenet(img))
prediction = prediction.argmax()
print(labels[prediction])
```

```
0
```

```
<ipython-input-16-d51a979042ec>:8: UserWarning: Implicit dimension choice for
softmax has been deprecated. Change the call to include dim=X as an argument.
  prediction = F.softmax(simplenet(img))
```



[17]:
```
num_examples = len(test_data)
num_correct = 0
for data in test_data:
    prediction = F.softmax(simplenet(data[0]))
    prediction = prediction.argmax()
    if data[1] == prediction:
        num_correct += 1
print("Accuracy = {}".format(num_correct/num_examples))
```

```
<ipython-input-17-033a5615afd5>:4: UserWarning: Implicit dimension choice for
softmax has been deprecated. Change the call to include dim=X as an argument.
  prediction = F.softmax(simplenet(data[0]))
```

```
Accuracy = 0.950018443378827
```

2

[18]:
```
torch.save(simplenet.state_dict(), "tmp/simplenet_2")
```

3

[19]:
```
simplenet = SimpleNet()
simplenet_state_dict = torch.load("tmp/simplenet_2")
simplenet.load_state_dict(simplenet_state_dict)
```

[19]: <All keys matched successfully>

[ ]: