ProjectFinal

December 2, 2021

</html>

0.1 1. Importing Library

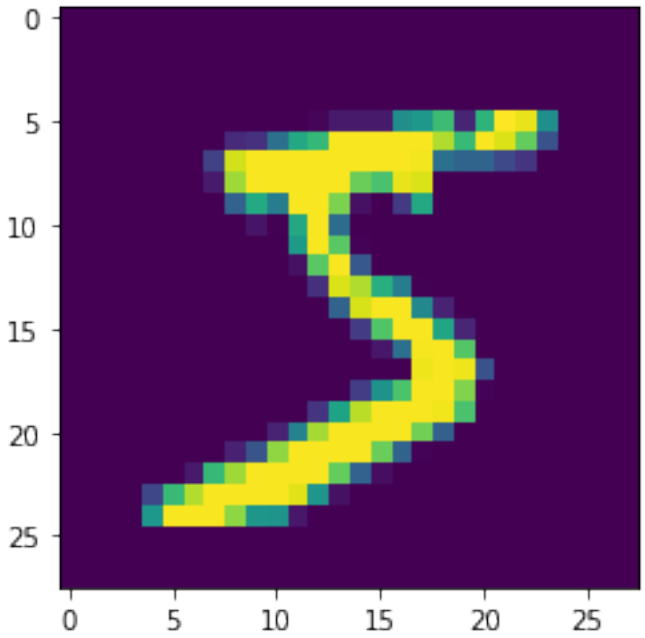
```
In [1]: import torch
        import torchvision
        from torchvision.datasets import MNIST
        import torchvision.transforms as transforms
        from torch.utils.data import random_split
        from torch.utils.data import DataLoader
        import torch.nn.functional as F
        import torch.nn as nn
        import numpy as np
        import matplotlib.pyplot as plt
        import matplotlib.image as im
        %matplotlib inline
```

0.2 2.Loading Data and Preprocessing

```
In [2]: d=MNIST(root='data/',download=True)

In [3]: img,label=d[0]

In [4]: d[0]

Out[4]: (<PIL.Image.Image image mode=L size=28x28 at 0x1F17D9E8400>, 5)

In [5]: img

   Out[5]:
```

In [6]:
```
plt.imshow(img)
```

Out[6]:
```
<matplotlib.image.AxesImage at 0x1f17dab1780>
```



In [7]:
```
dataset=MNIST(root='data/',train=True,transform=transforms.ToTensor())
```

In [8]:
```
test_dataset=MNIST(root='data/',train=False,transform=transforms.ToTensor())
```

In [9]:
```
train_ds,val_ds=random_split(dataset,[50000,10000])
len(train_ds),len(val_ds)
```

Out[9]:
```
(50000, 10000)
```

In [101]:
```
len(test_dataset)
```

Out[101]:
```
10000
```

In [10]:
```
batch_size=128
train_loader=DataLoader(train_ds,batch_size,shuffle=True)
val_loader=DataLoader(val_ds,batch_size)
```

In [11]:
```
input_size=28*28
num_classes=10
```

0.3 Traning

```
In [12]: def accuracy(outputs,labels):
             _,preds=torch.max(outputs,dim=1)
             return torch.tensor(torch.sum(preds==labels).item()/len(preds))

In [13]: class MnistModel(nn.Module):
             def __init__(self):
                 super().__init__()
                 self.linear=nn.Linear(input_size,num_classes)

             def forward(self,xb):
                 xb=xb.reshape(-1,784)
                 out=self.linear(xb)
                 return out

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

             def validation_step(self,batch):
                 images,labels=batch
                 out=self(images)
                 loss=F.cross_entropy(out,labels)
                 acc=accuracy(out,labels)
                 return {'val_loss':loss,'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()
                 batch_accs=[x['val_acc'] for x in outputs]
                 epoch_acc=torch.stack(batch_accs).mean()
                 return {'val_loss':epoch_loss.item(),'val_acc':epoch_acc.item()}

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

         model=MnistModel()

In [14]: def fit(epochs,lr,model,train_loader,val_loader,opt_func=torch.optim.SGD):
             optimizer=opt_func(model.parameters(),lr)
             history=[]
             for epoch in range(epochs):
                 for batch in train_loader:
                     loss=model.training_step(batch)
                     loss.backward()
                     optimizer.step()
```

```
                optimizer.zero_grad()

            result=evaluate(model,val_loader)
            model.epoch_end(epoch,result)
            history.append(result)
        return history
```

```
In [15]: def evaluate(model,val_loader):
            outputs=[model.validation_step(batch) for batch in val_loader]
            return model.validation_epoch_end(outputs)
```

```
In [16]: result0=evaluate(model,val_loader)
         result0
```

```
Out[16]: {'val_loss': 2.333756923675537, 'val_acc': 0.08405854552984238}
```

```
In [17]: history1=fit(5,0.001,model,train_loader,val_loader)
```

```
Epoch [0], val_loss: 1.9608, val_acc: 0.6368
Epoch [1], val_loss: 1.6868, val_acc: 0.7392
Epoch [2], val_loss: 1.4829, val_acc: 0.7697
Epoch [3], val_loss: 1.3295, val_acc: 0.7866
Epoch [4], val_loss: 1.2116, val_acc: 0.8001
```

```
In [18]: history2=fit(5,0.001,model,train_loader,val_loader)
```

```
Epoch [0], val_loss: 1.1191, val_acc: 0.8084
Epoch [1], val_loss: 1.0451, val_acc: 0.8164
Epoch [2], val_loss: 0.9844, val_acc: 0.8223
Epoch [3], val_loss: 0.9339, val_acc: 0.8277
Epoch [4], val_loss: 0.8913, val_acc: 0.8314
```

```
In [19]: history3=fit(5,0.001,model,train_loader,val_loader)
```

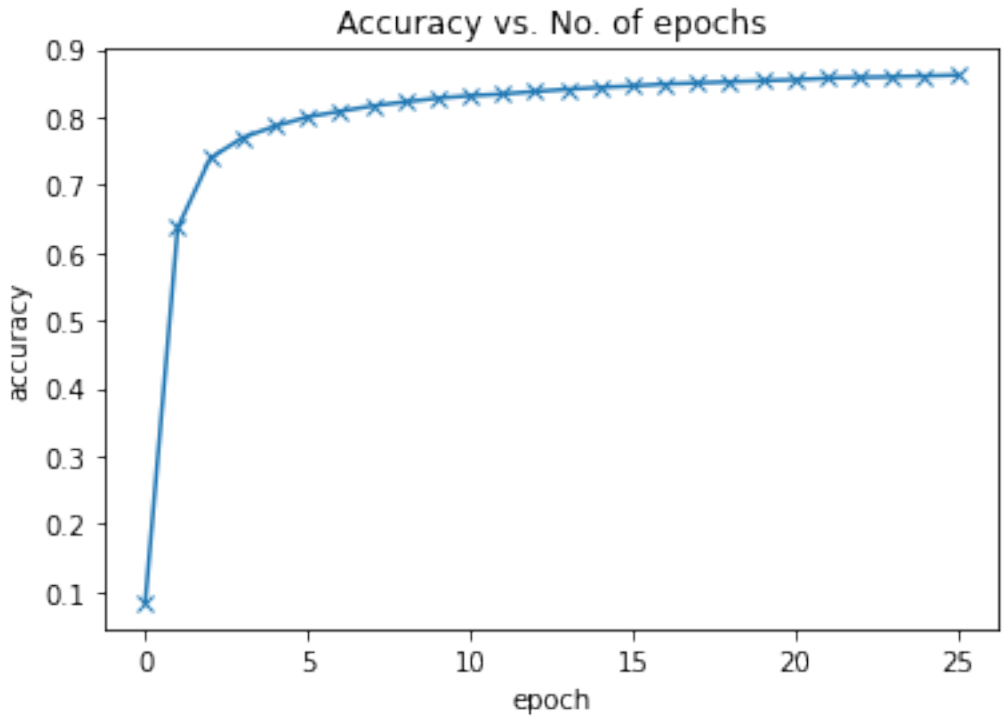
```
Epoch [0], val_loss: 0.8547, val_acc: 0.8340
Epoch [1], val_loss: 0.8231, val_acc: 0.8376
Epoch [2], val_loss: 0.7953, val_acc: 0.8409
Epoch [3], val_loss: 0.7709, val_acc: 0.8436
Epoch [4], val_loss: 0.7491, val_acc: 0.8459
```

```
In [20]: history4=fit(5,0.001,model,train_loader,val_loader)
```

```
Epoch [0], val_loss: 0.7296, val_acc: 0.8486
Epoch [1], val_loss: 0.7119, val_acc: 0.8503
Epoch [2], val_loss: 0.6959, val_acc: 0.8520
Epoch [3], val_loss: 0.6814, val_acc: 0.8535
Epoch [4], val_loss: 0.6680, val_acc: 0.8549
```

```
In [21]: history5=fit(5,0.001,model,train_loader,val_loader)

Epoch [0], val_loss: 0.6557, val_acc: 0.8573
Epoch [1], val_loss: 0.6443, val_acc: 0.8585
Epoch [2], val_loss: 0.6337, val_acc: 0.8593
Epoch [3], val_loss: 0.6240, val_acc: 0.8605
Epoch [4], val_loss: 0.6149, val_acc: 0.8618
```

```
In [22]: history=[result0]+history1+history2+history3+history4+history5
         accuricies=[result['val_acc'] for result in history]
         plt.plot(accuricies,'-x')
         plt.xlabel('epoch')
         plt.ylabel('accuracy')
         plt.title('Accuracy vs. No. of epochs')

Out[22]: Text(0.5, 1.0, 'Accuracy vs. No. of epochs')
```

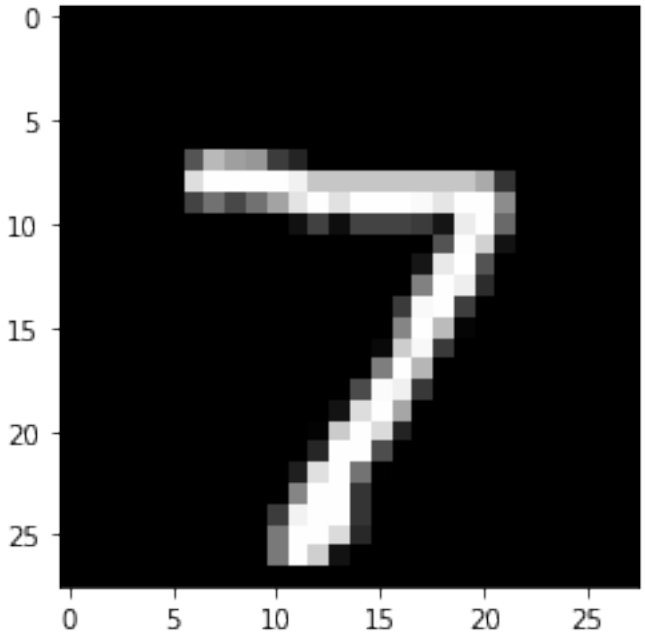


0.4 Testing

```
In [23]: def predicted_image(img,model):
             xb=img.unsqueeze(0)
             yb=model(xb)
             _,preds=torch.max(yb,dim=1)
             return preds[0].item()
```

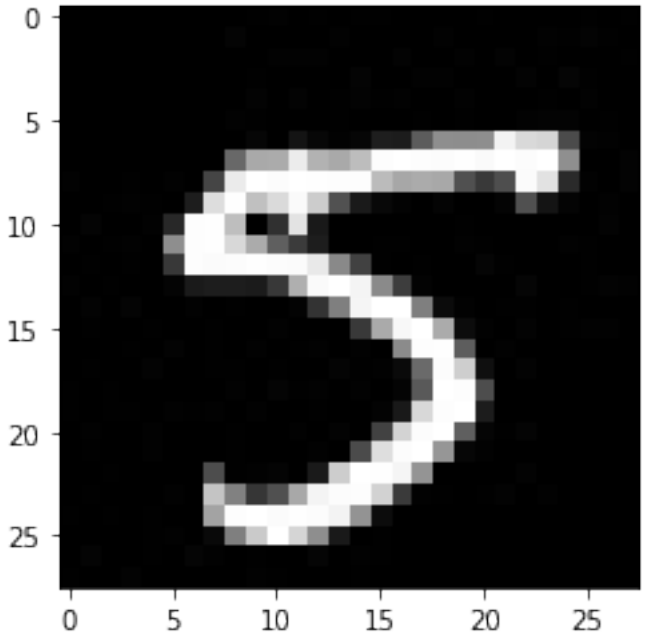
```
In [24]: img,label=test_dataset[0]
         plt.imshow(img[0],cmap='gray')
         print('Label: ',label,'\nPredicted: ',predicted_image(img,model))
```

```
Label:  7
Predicted:  7
```




```
In [60]: img=plt.imread('C:\\Users\\hp\\Downloads\\Picture\\t102.jpg')
         plt.imshow(img)
         img=np.array(img,dtype='float32')
         t=torch.from_numpy(img)
         print(predicted_image(t,model))
```

```
5
```




```
In [26]: test_loader=DataLoader(test_dataset,batch_size=256)
         result=evaluate(model,test_loader)
         result

Out[26]: {'val_loss': 0.5886543989181519, 'val_acc': 0.8677734136581421}

In [102]: import tkinter as tk
          from tkinter import PhotoImage
          from tkinter import filedialog
          from tkinter.filedialog import askopenfile
          root=tk.Tk()
          root.geometry("700x500")
          root.title("Recognition of Digit")
          font=('times',18,'bold')
          l1=tk.Label(root,text='WELCOME TO ARTIFICIAL NEURAL NETWORK MODEL',font=font)
          l1.grid(row=1,column=1)
          b1=tk.Button(root,text='Upload Image',width=20,command=lambda:upload_file(),fg='red'
          b1.grid(row=2,column=1)

          def f(img):
              temp=np.array(img,dtype='float32')/255
              plt.imshow(img)
              temp=torch.from_numpy(temp)
              prediction=predicted_image(temp,model)
              print('Predicted Value: ',prediction)
              tk.Label(root,text=' ').grid(row=6,column=1)
```

```
            l2=tk.Label(root,text="Predicted Value: "+str(prediction),bg='#feac78',fg='#2388
            #plt.imshow(img,cmap='gray')

        def upload_file():
            f_types=[('Jpg Files','*.jpg')]
            filename=filedialog.askopenfilename(filetypes=f_types)
            img=im.imread(filename)
            tk.Label(root,text=" ").grid(row=4,column=1)
            b2=tk.Button(root,text="Predict Value",command=lambda:f(img),fg='pink',bg='brown
            b2.grid(row=5,column=1)


        root.mainloop()
```

```
Predicted Value:  7
```