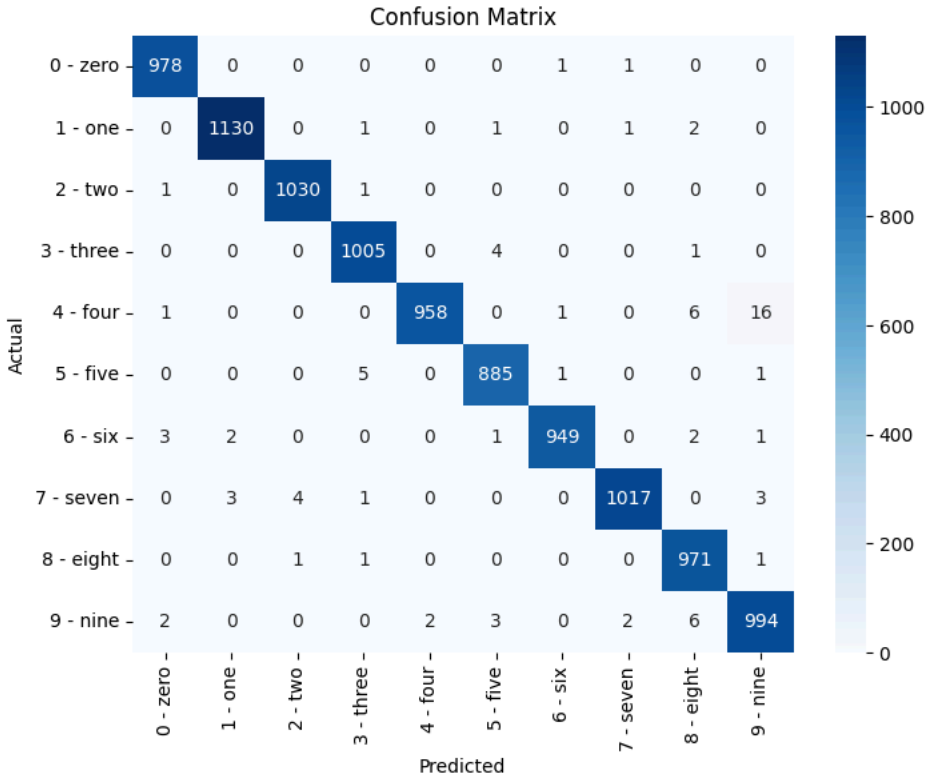
```
import torch as t
import torch.nn as nn
import torch.optim as optim
import torchvision
import torchvision.transforms as transforms
from torch.utils.data import DataLoader
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns
from sklearn.metrics import confusion_matrix, classification_report

transform=transforms.Compose([transforms.ToTensor(),transforms.Normalize((0.5,),(0.5,))])
train_dataset=torchvision.datasets.MNIST(root='./data',train=True,download=True,transform=transform)
test_dataset=torchvision.datasets.MNIST(root='./data',train=False,download=True,transform=transform)

image,label=train_dataset[0]
print("Image shape:",image.shape)
print("Number of training samples:",len(train_dataset))

image,label=test_dataset[0]
print("Image shape:",image.shape)
print("Number of testing samples:",len(test_dataset))
train_loader=DataLoader(train_dataset,batch_size=32,shuffle=True)
test_loader=DataLoader(test_dataset,batch_size=32,shuffle=False)

class CNNClassifier(nn.Module):
  def __init__(self):
    super(CNNClassifier,self).__init__()
    self.conv1=nn.Conv2d(in_channels=1,out_channels=32,kernel_size=3,padding=1)
    self.conv2=nn.Conv2d(in_channels=32,out_channels=64,kernel_size=3,padding=1)
    self.conv3=nn.Conv2d(in_channels=64,out_channels=128,kernel_size=3,padding=1)
    self.pool=nn.MaxPool2d(kernel_size=2,stride=2)
    self.fc1=nn.Linear(128*3*3,128)
    self.fc2=nn.Linear(128,64)
    self.fc3=nn.Linear(64,10)

  def forward(self,x):
    x=self.pool(t.relu(self.conv1(x)))
    x=self.pool(t.relu(self.conv2(x)))
    x=self.pool(t.relu(self.conv3(x)))
    x=x.view(x.size(0),-1)
    x=nn.functional.relu(self.fc1(x))
    x=nn.functional.relu(self.fc2(x))
    x=self.fc3(x)
    return x

from torchsummary import summary
model=CNNClassifier()
if t.cuda.is_available():
  device=t.device("cuda")
  model.to(device)
print("Name: Yashwini M")
print("Reg.no: 212223230249")
summary(model,input_size=(1,28,28))
criterion=nn.CrossEntropyLoss()
optimizer=optim.Adam(model.parameters(),lr=0.001)
def train_model(model,train_loader,num_epochs):
  for epoch in range(num_epochs):
    model.train()
    running_loss=0.0
    for images,labels in train_loader:
      if t.cuda.is_available():
        images,labels=images.to(device),labels.to(device)
      optimizer.zero_grad()
      outputs=model(images)
      loss=criterion(outputs,labels)
      loss.backward()
      optimizer.step()
      running_loss+=loss.item()
    print(f"Epoch [{epoch+1}/{num_epochs}], Loss: {running_loss/len(train_loader):.4f}")
print("Name: Yashwini M")
print("Reg.no: 212223230249")

train_model(model,train_loader,num_epochs=10)

def test_model(model, test_loader):
  model.eval()
  correct = 0
  total = 0
  all_preds = []
  all_labels = []
```

```
  with t.no_grad():
    for images, labels in test_loader:
      if t.cuda.is_available():
        images, labels = images.to(device), labels.to(device)

      outputs = model(images)
      _, predicted = t.max(outputs, 1)
      total += labels.size(0)
      correct += (predicted == labels).sum().item()
      all_preds.extend(predicted.cpu().numpy())
      all_labels.extend(labels.cpu().numpy())

  accuracy = correct/total
  print("Name: Yashwini M")
  print("Register No: 212223230249")
  print(f"Test Accuracy: {accuracy:.4f}")

  cm = confusion_matrix(all_labels, all_preds)
  plt.figure(figsize=(8, 6))
  print("Name: Yashwini M")
  print("Register No: 212223230249")
  sns.heatmap(cm, annot=True, fmt="d", cmap="Blues", xticklabels=test_dataset.classes, yticklabels=test_dataset.classes)
  plt.xlabel("Predicted")
  plt.ylabel("Actual")
  plt.title("Confusion Matrix")
  plt.show()

  print("Name: Yashwini M")
  print("Register No: 212223230249")
  print("Classification Report:")
  print(classification_report(all_labels, all_preds, target_names=[str(i) for i in range(10)]))
test_model(model, test_loader)

def predict_image(model,image_index,dataset):
  model.eval()
  image,label=dataset[image_index]
  if t.cuda.is_available():
    image=image.to(device)

  with t.no_grad():
    output=model(image.unsqueeze(0))
    _,predicted=t.max(output,1)
  class_names=[str(i) for i in range(10)]
  print("Name: Yashwini M")
  print("Reg no: 212223230249")
  plt.imshow(image.cpu().squeeze(0),cmap='gray')
  plt.title(f"Actual: {class_names[label]}\nPredicted: {class_names[predicted.item()]}")
  plt.axis("off")
  plt.show()
  print(f"Actual: {class_names[label]}\nPredicted: {class_names[predicted.item()]}")
predict_image(model,image_index=80,dataset=test_dataset)
```

```
Image shape: torch.Size([1, 28, 28])
Number of training samples: 60000
Image shape: torch.Size([1, 28, 28])
Number of testing samples: 10000
Name: Yashwini M
Reg.no: 212223230249
----------------------------------------------------------------
        Layer (type)               Output Shape         Param #
================================================================
            Conv2d-1           [-1, 32, 28, 28]             320
         MaxPool2d-2           [-1, 32, 14, 14]               0
            Conv2d-3           [-1, 64, 14, 14]          18,496
         MaxPool2d-4             [-1, 64, 7, 7]               0
            Conv2d-5            [-1, 128, 7, 7]          73,856
         MaxPool2d-6            [-1, 128, 3, 3]               0
            Linear-7                  [-1, 128]         147,584
            Linear-8                   [-1, 64]           8,256
            Linear-9                   [-1, 10]             650
================================================================
Total params: 249,162
Trainable params: 249,162
Non-trainable params: 0
----------------------------------------------------------------
Input size (MB): 0.00
Forward/backward pass size (MB): 0.42
Params size (MB): 0.95
Estimated Total Size (MB): 1.37
----------------------------------------------------------------
Name: Yashwini M
Reg.no: 212223230249
Epoch [1/10], Loss: 0.1547
Epoch [2/10], Loss: 0.0464
Epoch [3/10], Loss: 0.0338
Epoch [4/10], Loss: 0.0262
Epoch [5/10], Loss: 0.0217
Epoch [6/10], Loss: 0.0190
Epoch [7/10], Loss: 0.0137
Epoch [8/10], Loss: 0.0141
Epoch [9/10], Loss: 0.0120
Epoch [10/10], Loss: 0.0122
Name: Yashwini M
Register No: 212223230249
Test Accuracy: 0.9917
Name: Yashwini M
Register No: 212223230249
```




```
Name: Yashwini M
Register No: 212223230249
Classification Report:
              precision    recall  f1-score   support

           0       0.99      1.00      1.00       980
           1       1.00      1.00      1.00      1135
           2       1.00      1.00      1.00      1032
           3       0.99      1.00      0.99      1010
           4       1.00      0.98      0.99       982
           5       0.99      0.99      0.99       892
```