Experiment no: 5

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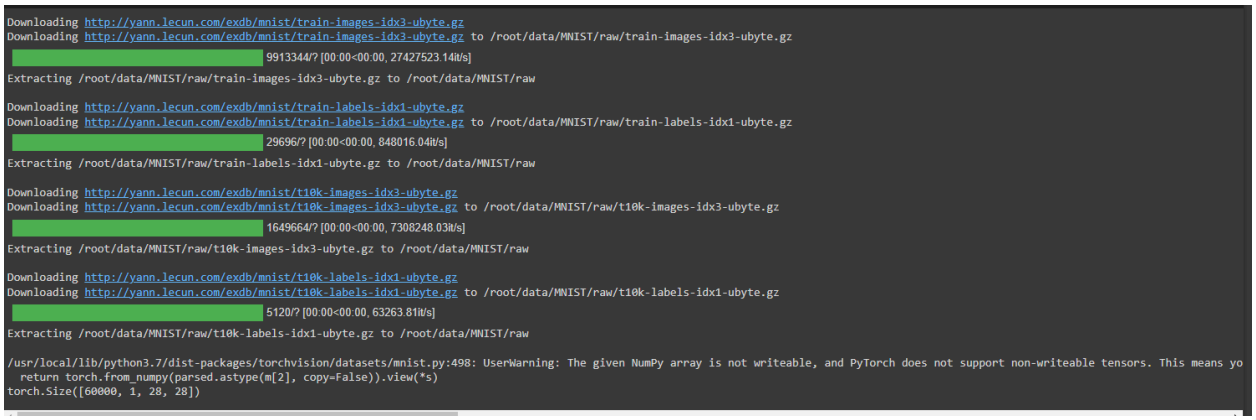
Code:

```
import torch
import torchvision
from torch import nn
import torch.nn.functional as F
import matplotlib.pyplot as plt
import numpy as np
rng = np.random.default_rng(123456)

ata = torchvision.datasets.MNIST(root='~/data', download=True)
data = data.data
data = data.float() / 255.
data = data.view(-1, 1, 28, 28)
print(data.shape)d
```

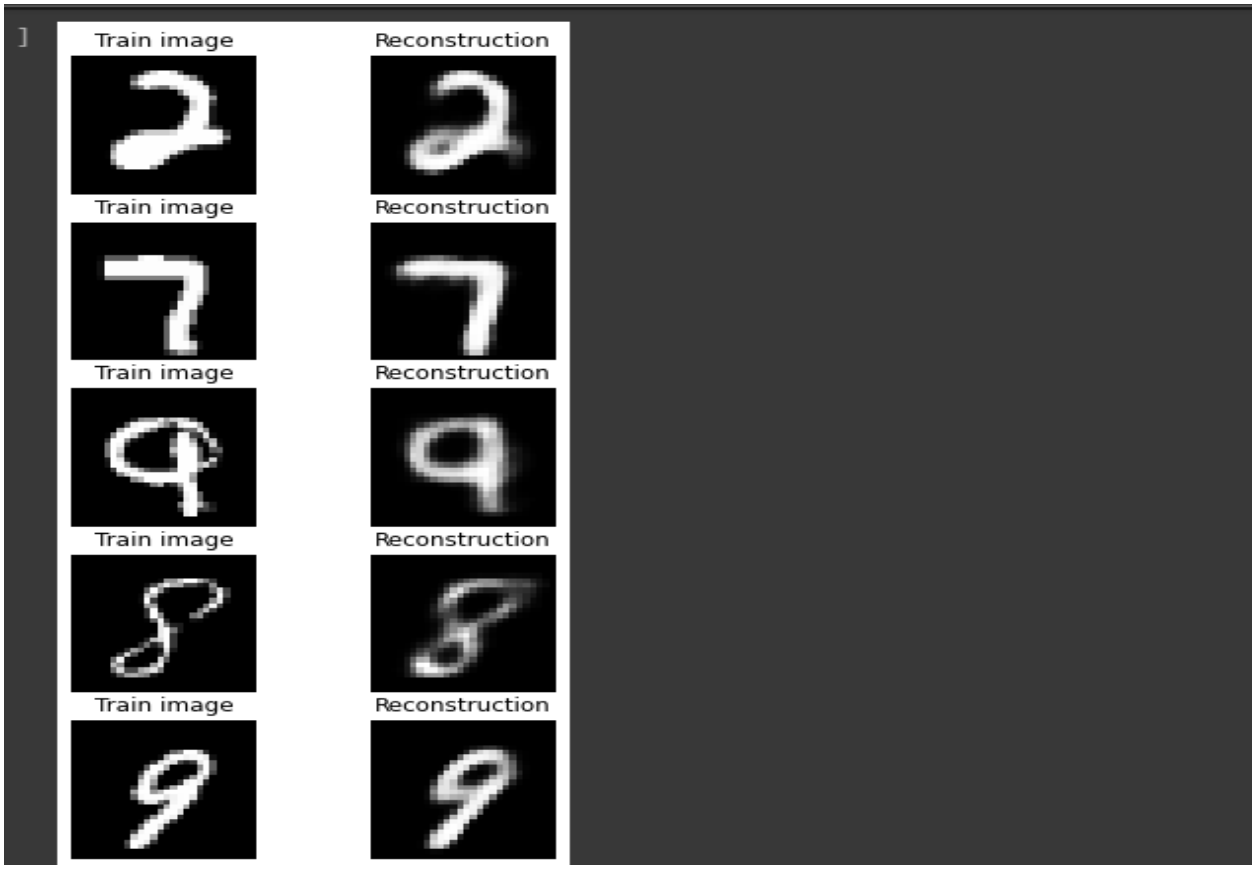



```
class AutoEncoder(nn.Module):
    def __init__(self):
        super().__init__()
        self.encoder = nn.Sequential(
            nn.Flatten(),
            nn.Linear(28*28, 100),
            nn.ReLU(),
            nn.Linear(100, 10),
            nn.ReLU(),
        )
        self.decoder = nn.Sequential(
            nn.Linear(10, 100),
            nn.ReLU(),
            nn.Linear(100, 28*28),
```

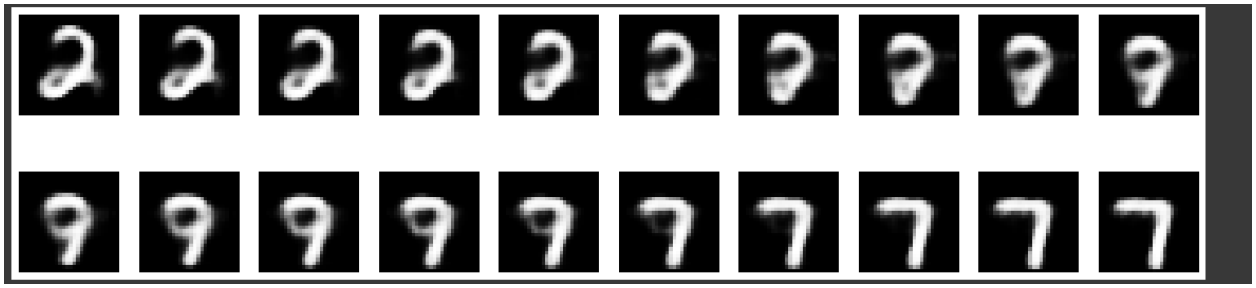
```
            nn.Sigmoid()
        )

    def encode(self, x):
        return self.encoder(x)

    def decode(self, x):
        x = self.decoder(x)
        return x.view(-1,1,28,28)

    def forward(self, x):
        return self.decode(self.encode(x))

model = AutoEncoder().cuda()
opt = torch.optim.Adam(model.parameters())

for epoch in range(25):
    print(f'Epoch {epoch+1}/25')
    for i in range(0, data.shape[0], 32):
        x = data[i:i+32].cuda()
        x_rec = model(x)
        loss = F.binary_cross_entropy(x_rec, x)

        opt.zero_grad()
        loss.backward()
        opt.step()

    data = data[rng.permutation(len(data))]
    print(f'\tloss: {loss.item():.4f}')
```

```
Epoch 1/25
        loss: 0.1552
Epoch 2/25
        loss: 0.1270
Epoch 3/25
        loss: 0.1206
Epoch 4/25
        loss: 0.1324
Epoch 5/25
        loss: 0.1237
Epoch 6/25
        loss: 0.1256
Epoch 7/25
        loss: 0.1357
Epoch 8/25
        loss: 0.1197
Epoch 9/25
        loss: 0.1368
Epoch 10/25
        loss: 0.1163
Epoch 11/25
        loss: 0.1418
Epoch 12/25
        loss: 0.1164
Epoch 13/25
        loss: 0.1288
Epoch 14/25
        loss: 0.1217
Epoch 15/25
        loss: 0.1252
Epoch 16/25
        loss: 0.1132
Epoch 17/25
```

```
plt.figure(figsize=(5,10))

for i in range(5):
    plt.subplot(5, 2, i*2+1, title=f'Train image')
    plt.imshow(np.squeeze(x[i].cpu()), cmap='gray')
    plt.axis('off')

    plt.subplot(5, 2, i*2+2, title='Reconstruction')
    with torch.no_grad(): plt.imshow(np.squeeze(x_rec[i].cpu()), cmap='gray')
    plt.axis('off')
```




```
# Sample two random images and encode
f = model.encode(x[0:2])
f1,f2 = f[0].unsqueeze(0),f[1].unsqueeze(0)

# Show reconstructions of interpolated codes
plt.figure(figsize=(20,5))
reconstructions = []
for i in range(20):
    v = i/19.
    f_interp = f1*(1-v) + f2*v
    with torch.no_grad():
        x_rec_interp = np.squeeze(model.decode(f_interp).cpu())
        reconstructions.append(x_rec_interp)

    plt.subplot(2,10,i+1)
    plt.imshow(x_rec_interp, cmap='gray')
    plt.axis('off')
```



```
from IPython.display import HTML
from matplotlib import animation

fig = plt.figure()
plt.axis('off')
artists = [[plt.imshow(img, animated=False, cmap='gray')] for img in reconstructions]
ani = animation.ArtistAnimation(fig, artists, interval=200, blit=False, repeat_delay=1000)

print('Latent interpolation')
HTML(ani.to_html5_video())
```


```
img1,img2 = x[0],x[2]
images = []
for i in range(20):
    v = i/19.
```

```
    img_interp = img1*(1-v) + img2*v
    images.append(np.squeeze(img_interp.cpu()))

fig = plt.figure()
plt.axis('off')
artists = [[plt.imshow(img, animated=False, cmap='gray')] for img in images]
ani = animation.ArtistAnimation(fig, artists, interval=200, blit=False, repeat_delay=1000)

print('Pixel interpolation')
HTML(ani.to_html5_video())
```