Lab 10 AutoEncoders and Latent Space

Answer to Questions:

- A. For this AutoEncoder, I implemented a CNN version AE. The encoder encodes the input image tensor to a 1x576 (3*3*64)-length code vector after a few CONV and Maxpool layers, Flatten, and a few FC layers. The decoder decodes the vector and reconstructs it to the original-sized 28x28 image tensor. The architecture outline is as follows:

Encoder:

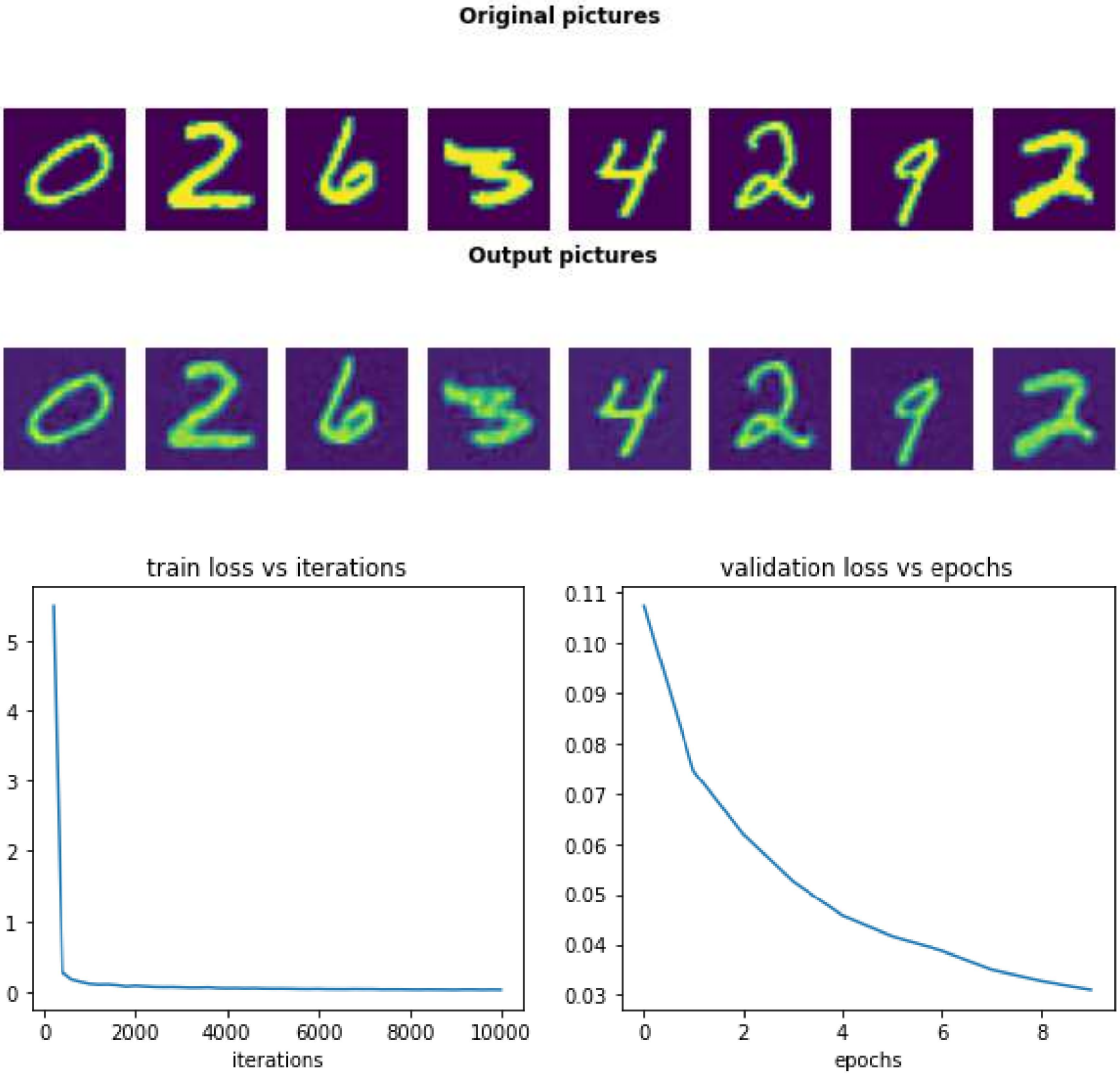
> | Layer | Dimension | Filter | Stride | Padding |
> |---|---|---|---|---|
> | Input | 1x28x28 | NA | NA | NA |
> | Conv | 32x28x28 | 5x5 | 1 | 2 |
> | MaxP | 32x14x14 | 2x2 | 2 | NA |
> | Conv | 64x14x14 | 5x5 | 1 | 2 |
> | Maxp | 64x7x7 | 2x2 | 2 | NA |
> | Flatten | 64*7*7 | NA | NA | NA |
> | FC | 64*5*5 | NA | NA | NA |
> | FC | 64*3*3 | NA | NA | NA |
> | Latent | 64*3*3 | NA | NA | NA |

Decoder:

> | Layer | Dimension | Filter | Stride | Padding |
> |---|---|---|---|---|
> | Latent | 64*3*3 | NA | NA | NA |
> | FC | 64*5* | NA | NA | NA |
> | FC | 64*7*7 | NA | NA | NA |
> | Unflatten | 64x7x7 | NA | NA | NA |
> | ConvTrans | 64x14x14 | 4x4 | 2 | 1 |
> | ConvTrans | 1x28x28 | 4x4 | 2 | 1 |
> | Output | 1x28x28 | NA | NA | NA |

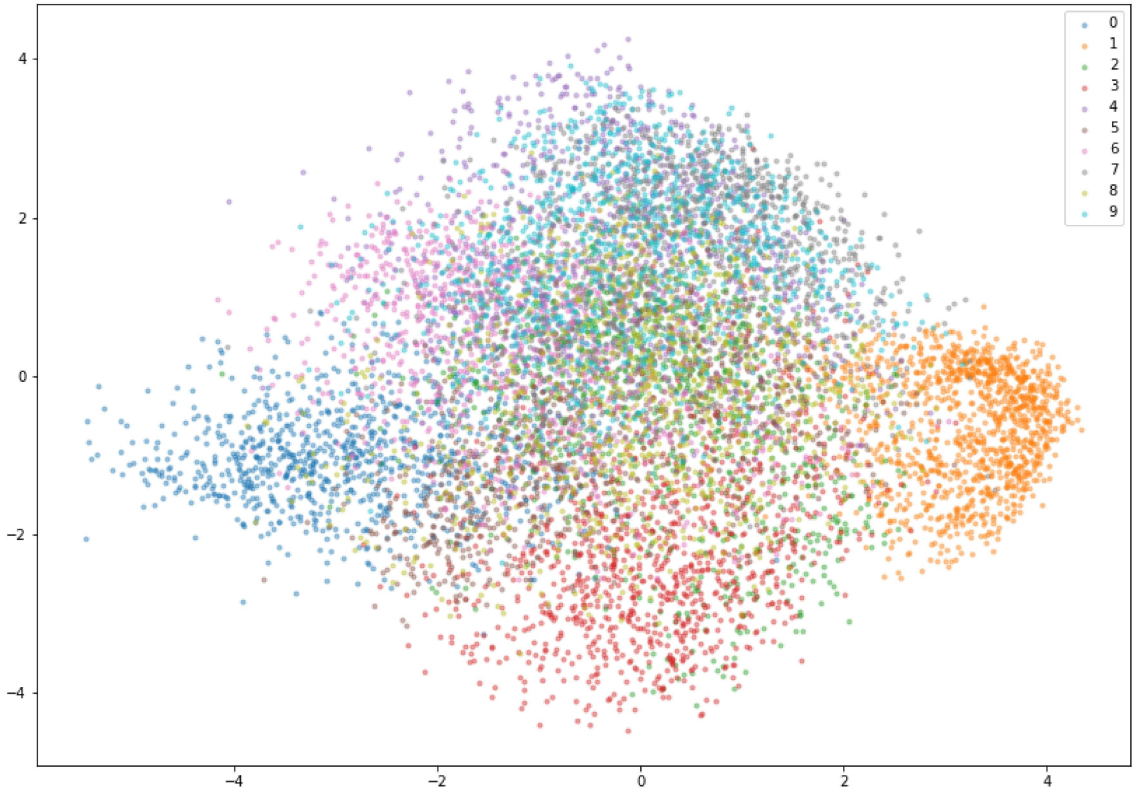
- optimizer = Adam
- lr = 1e-4
- decay_weight= 1e-6
- epoch num = 10
- batch_train_size = 64

B.



The generated images are quite the same as input images. The MSE loss is also low. And the background seems clear.

C. For latent space visualization, 10000 test images are put into the model. The latent vector is returned with dimension 10000x576. Using low rank PCA on this matrix and plotting the first two eigenvectors, I obtain this plot. It seems that the blue, orange, and red are well clustered. It is clear to see these 3's pattern. But it remains hard to distinguish the other clusters.



The direct PCA on input images (flattened), with first two eigenvectors, is plotted as following:

Although the orange cluster is clear to see, the blue and red ones are hard to distinguish, which was accomplished in AE.