Digital Surveillance Systems and Application

AUTOENCODERS

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Example 8.1 : Autoencoder

Define the hyper-parameter and load the training data

```
num_epochs = 10
batch_size = 32
learning_rate = 1e-3

img_transform = transforms.Compose([transforms.ToTensor()])

dataset = torchvision.datasets.MNIST(root='./data', train=True, download=True, transform=img_transform)
dataloader = torch.utils.data.DataLoader(dataset, batch_size=batch_size, shuffle=False)
```

Define the hyperparameter

Download the Mnist dataset to the folder ‘./data’

Example 8.1 : Autoencoder

Define the model architecture

```
class autoencoder(nn.Module):
    def __init__(self):
        super(autoencoder, self).__init__()
        self.encoder = nn.Sequential(
            nn.Linear(28 * 28, 128),
            nn.ReLU(True),
            nn.Linear(128, 64),
            nn.ReLU(True),
            nn.Linear(64, 12),
            nn.ReLU(True),
            nn.Linear(12, 3))
        self.decoder = nn.Sequential(
            nn.Linear(3, 12),
            nn.ReLU(True),
            nn.Linear(12, 64),
            nn.ReLU(True),
            nn.Linear(64, 128),
            nn.ReLU(True), nn.Linear(128, 28 * 28), nn.Tanh())
```

Define the encoder

Define the decoder

```
def forward(self, x):
        x = self.encoder(x)
        x = self.decoder(x)
        return x
```

```
autoencoder(
  (encoder): Sequential(
    (0): Linear(in_features=784, out_features=128, bias=True)
    (1): ReLU(inplace=True)
    (2): Linear(in_features=128, out_features=64, bias=True)
    (3): ReLU(inplace=True)
    (4): Linear(in_features=64, out_features=12, bias=True)
    (5): ReLU(inplace=True)
    (6): Linear(in_features=12, out_features=3, bias=True)
  )
  (decoder): Sequential(
    (0): Linear(in_features=3, out_features=12, bias=True)
    (1): ReLU(inplace=True)
    (2): Linear(in_features=12, out_features=64, bias=True)
    (3): ReLU(inplace=True)
    (4): Linear(in_features=64, out_features=128, bias=True)
    (5): ReLU(inplace=True)
    (6): Linear(in_features=128, out_features=784, bias=True)
    (7): Tanh()
  )
)
```

Example 8.1 : Autoencoder

Use the Mean Square Error as the loss function

```
criterion = nn.MSELoss()
optimizer = torch.optim.Adam(model.parameters(), lr=learning_rate, weight_decay=1e-5)
```

```
for epoch in range(num_epochs):
    for data in dataloader:
        img, _ = data
        img = img.view(img.size(0), -1)
        img = Variable(img).cuda()
        output = model(img)
        loss = criterion(output, img)
        optimizer.zero_grad()
        loss.backward()
        optimizer.step()
    print('epoch [{}/{}], loss:{:.4f}'.format(epoch + 1, num_epochs, loss.item()))
```

Flatten the input images

Compute the loss

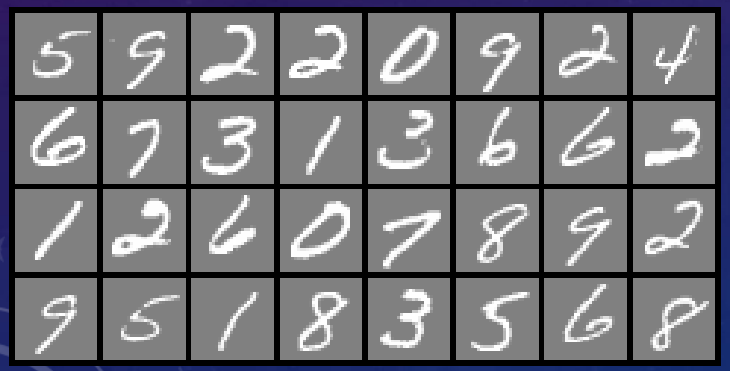
Example 8.1 : Autoencoder

```
if epoch % 1 == 0:
    img = to_img(img.cpu().data)
    save_image(img, ‘./AE_img/input_{}.png'.format(epoch))
    pic = to_img(output.cpu().data)
    save_image(pic, './ AE _img/output_{}.png'.format(epoch))
```

→ Save the input images

→ Save the reconstruction images

Input images



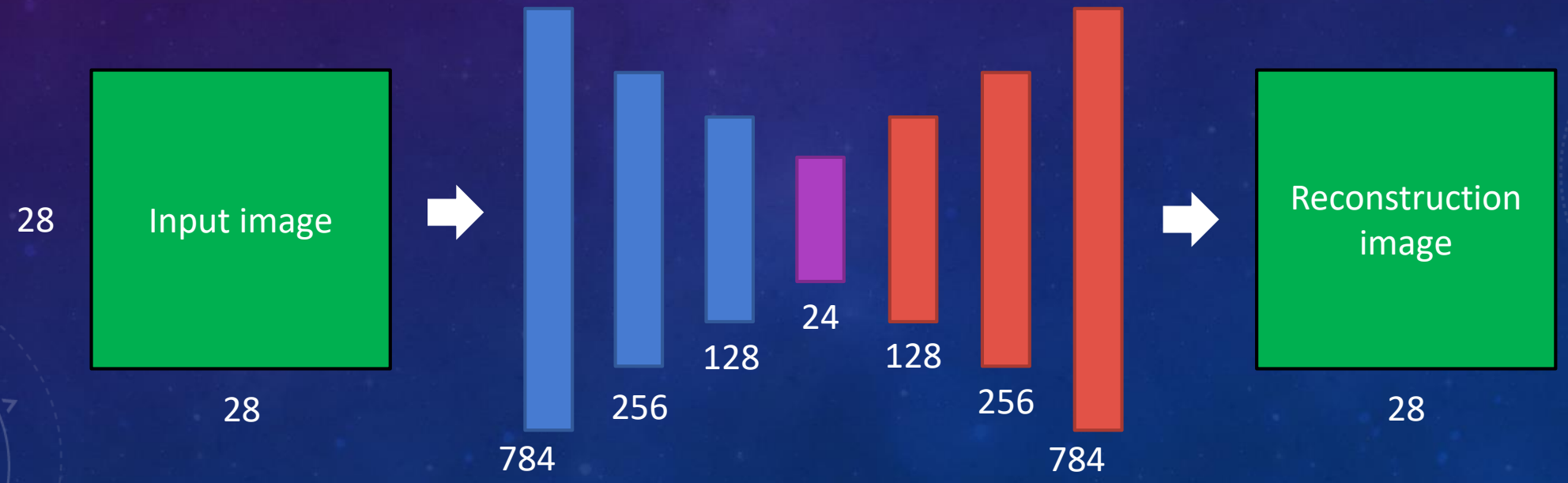
Epoch 1 : reconstruction images

Epoch 10 : reconstruction images

Exercise 8.1 : Autoencoder

- Please download the “exercise8.1_Autoencoder.ipynb” on Moodle.
  - Train the autoencoder and compare the images that reconstruct from the different epoch.
  - Change the encoder and decoder to the below architecture and compare the difference.

Please copy your results and code and paste to a MS Word, then upload to Moodle.



Example 8.2 : VAE

Define the model architecture

Define the latent vector dimension

```
class VAE(nn.Module):
    def __init__(self, image_channels=1, h_dim=1600, z_dim=20):
        super(VAE, self).__init__()

        self.conv1 = nn.Conv2d(image_channels, 32, kernel_size=4, stride=2)
        self.conv2 = nn.Conv2d(32, 64, kernel_size=4, stride=2)

        self.fc1 = nn.Linear(h_dim, z_dim)
        self.fc2 = nn.Linear(h_dim, z_dim)
        self.fc3 = nn.Linear(z_dim, h_dim)

        self.deconv2 = nn.ConvTranspose2d(64, 32, kernel_size=5, stride=2)
        self.deconv1 = nn.ConvTranspose2d(32, image_channels, kernel_size=4, stride=2)
```

Example 8.2 : VAE

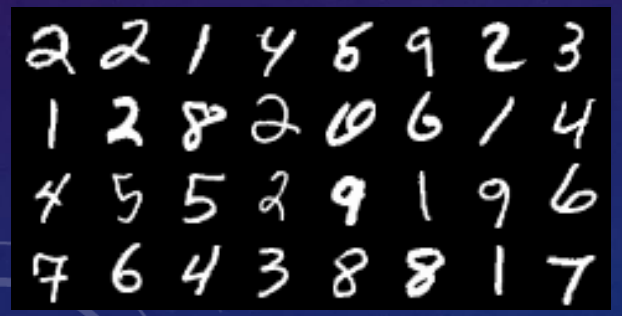
```
if epoch % 1 == 0:
    save = img.cpu().data
    save_image(img, './vae_img/input_{}.png'.format(epoch))
    save = recon_batch.cpu().data
    save_image(save, './vae_img/output_{}.png'.format(epoch))
```

→ Save the input images

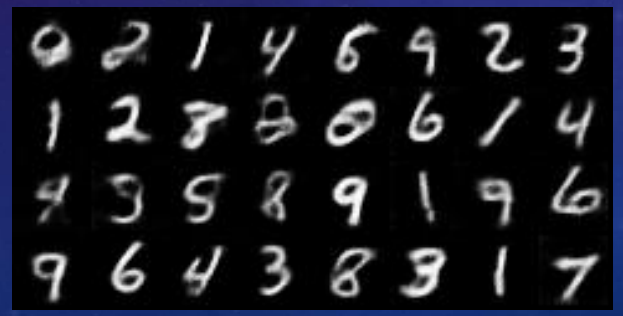
→ Save the reconstruction images

Epoch: 0

Input

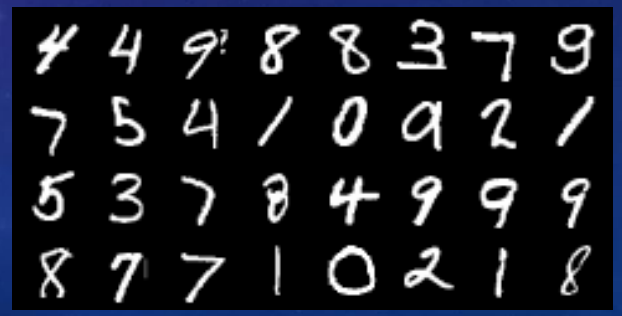


Reconstruct

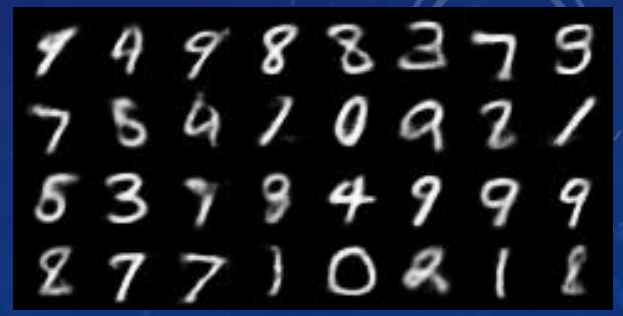


Epoch: 4

Input



Reconstruct



Exercise 8.2 - VAE

- Please download the “exercise8.2_VAE.ipynb” on Moodle.
- Please use different latent vector dimension
  1. 1 dimension
  2. 10 dimension
  3. 100 dimension

Please copy your results and code and paste to a MS Word, then upload to Moodle.