Homework #3

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Problem1

1.

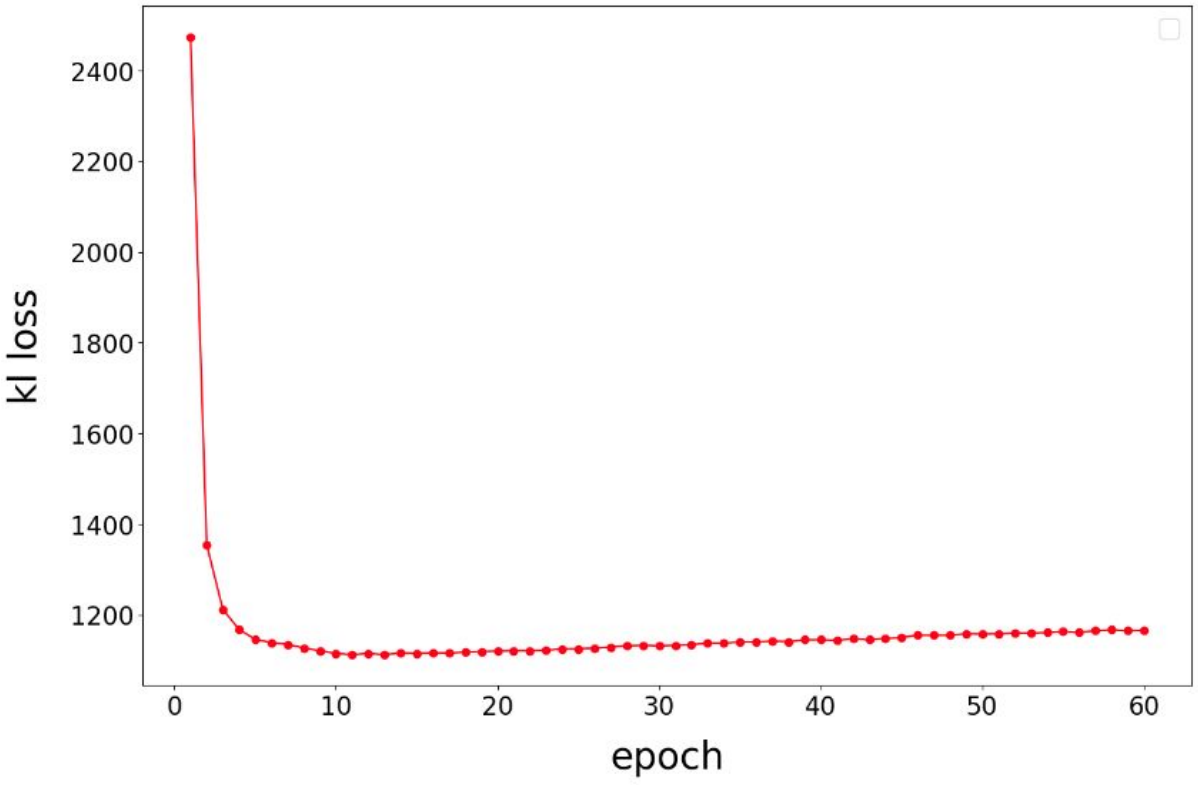
model architecture:

```
VAE(
  (encoder): Sequential(
    (0): encode_block(
      (module): Sequential(
        (0): Conv2d(3, 128, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1))
        (1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (2): LeakyReLU(negative_slope=0.2)
      )
    )
    (1): encode_block(
      (module): Sequential(
        (0): Conv2d(128, 256, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1))
        (1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (2): LeakyReLU(negative_slope=0.2)
      )
    )
    (2): encode_block(
      (module): Sequential(
        (0): Conv2d(256, 512, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1))
        (1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (2): LeakyReLU(negative_slope=0.2)
      )
    )
    (3): encode_block(
      (module): Sequential(
        (0): Conv2d(512, 1024, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1))
        (1): BatchNorm2d(1024, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (2): LeakyReLU(negative_slope=0.2)
      )
    )
    (4): encode_block(
      (module): Sequential(
        (0): Conv2d(1024, 2048, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1))
        (1): BatchNorm2d(2048, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (2): LeakyReLU(negative_slope=0.2)
      )
    )
  )
  (mean_fc): Linear(in_features=8192, out_features=1024, bias=True)
  (logvar_fc): Linear(in_features=8192, out_features=1024, bias=True)
  (decode_fc): Linear(in_features=1024, out_features=8192, bias=True)
  (relu): ReLU()
  (decoder): Sequential(
    (0): decode_block(
      (module): Sequential(
        (0): UpsamplingNearest2d(scale_factor=2.0, mode=nearest)
        (1): ReplicationPad2d((1, 1, 1, 1))
        (2): Conv2d(2048, 1024, kernel_size=(3, 3), stride=(1, 1))
        (3): BatchNorm2d(1024, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (4): LeakyReLU(negative_slope=0.2)
      )
    )
    (1): decode_block(
      (module): Sequential(
        (0): UpsamplingNearest2d(scale_factor=2.0, mode=nearest)
        (1): ReplicationPad2d((1, 1, 1, 1))
        (2): Conv2d(1024, 512, kernel_size=(3, 3), stride=(1, 1))
        (3): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (4): LeakyReLU(negative_slope=0.2)
      )
    )
    (2): decode_block(
      (module): Sequential(
        (0): UpsamplingNearest2d(scale_factor=2.0, mode=nearest)
        (1): ReplicationPad2d((1, 1, 1, 1))
        (2): Conv2d(512, 256, kernel_size=(3, 3), stride=(1, 1))
        (3): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (4): LeakyReLU(negative_slope=0.2)
      )
    )
    (3): decode_block(
      (module): Sequential(
        (0): UpsamplingNearest2d(scale_factor=2.0, mode=nearest)
        (1): ReplicationPad2d((1, 1, 1, 1))
        (2): Conv2d(256, 128, kernel_size=(3, 3), stride=(1, 1))
        (3): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (4): LeakyReLU(negative_slope=0.2)
      )
    )
    (4): decode_block(
      (module): Sequential(
        (0): UpsamplingNearest2d(scale_factor=2.0, mode=nearest)
        (1): ReplicationPad2d((1, 1, 1, 1))
        (2): Conv2d(128, 3, kernel_size=(3, 3), stride=(1, 1))
        (3): Tanh()
      )
    )
  )
)
```

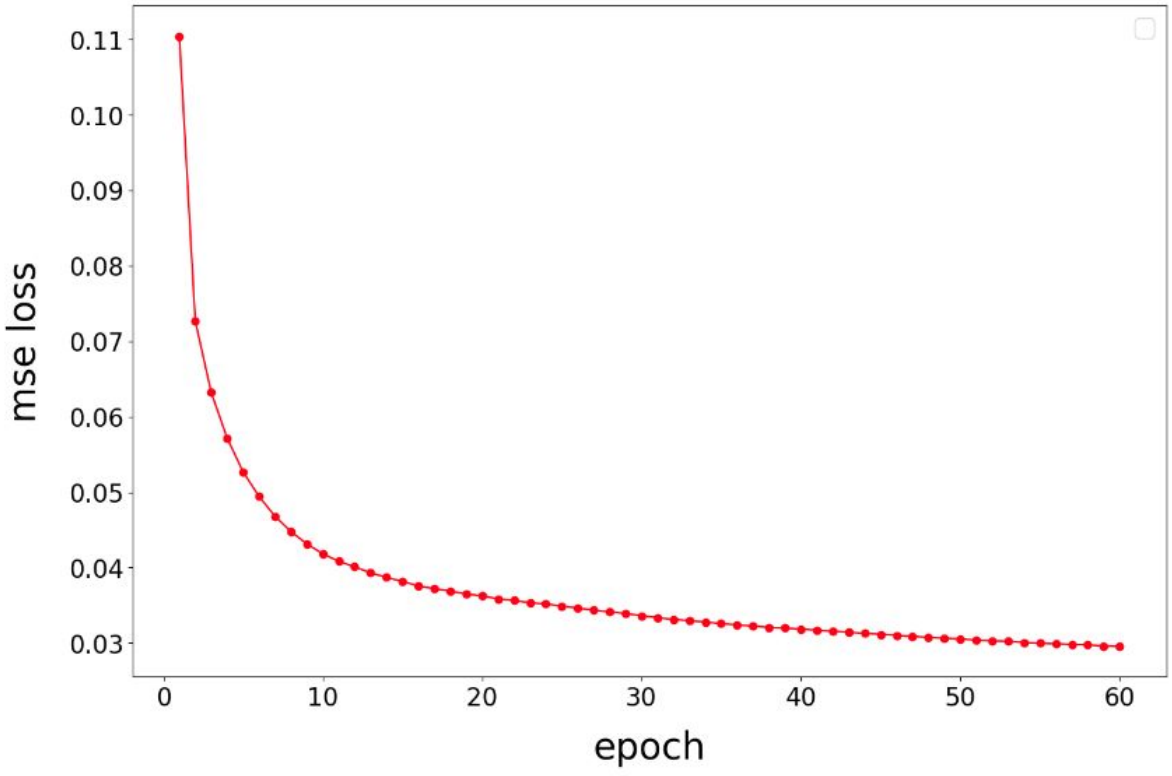
Training Epoch	60
Learning Rate	0.001
Data augmentation	transforms.RandomAffine(translate=(0.1,0.1)) transforms.RandomHorizontalFlip(p=0.5),
Optimizer	Adam
Batchsize	15
KL_lambda	1e-5

2.

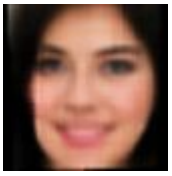
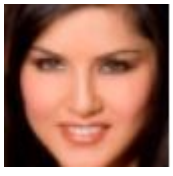
KLD Loss:



MSE Loss:



3.

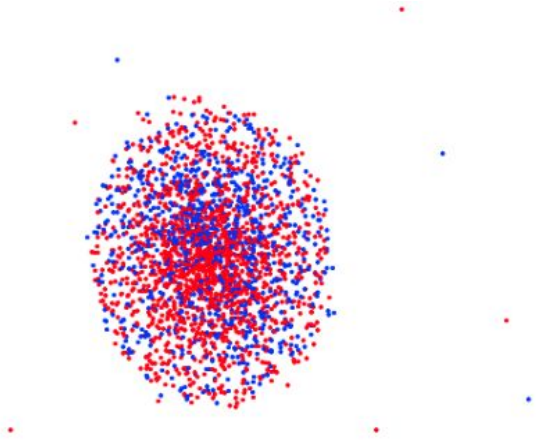
Testing Image	Recon Image	MSE
		0.0662
		0.1646
		0.0992
		0.0582
		0.0565
		0.0545
		0.0876
		0.0533

		0.1142
		0.0629

4.

5.

Red: female; Blue: male



6.
作data augmentation能夠增進隨機生成人臉的品質，然而也會留下一些痕跡，如下圖所示，有明顯平移的痕跡：

Problem2

1.

Generator:

```
Generator(
  (layer): Sequential(
    (0): ConvTranspose2d(100, 512, kernel_size=(4, 4), stride=(1, 1), bias=False)
    (1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (2): ReLU(inplace=True)
    (3): ConvTranspose2d(512, 256, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (4): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (5): ReLU(inplace=True)
    (6): ConvTranspose2d(256, 128, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (7): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (8): ReLU(inplace=True)
    (9): ConvTranspose2d(128, 64, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (10): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (11): ReLU(inplace=True)
    (12): ConvTranspose2d(64, 3, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (13): Tanh()
  )
)
```

Discriminator:

```
Discriminator(
  (layer): Sequential(
    (0): Conv2d(3, 64, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (1): LeakyReLU(negative_slope=0.2, inplace=True)
    (2): Conv2d(64, 128, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (3): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (4): LeakyReLU(negative_slope=0.2, inplace=True)
    (5): Conv2d(128, 256, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (6): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (7): LeakyReLU(negative_slope=0.2, inplace=True)
    (8): Conv2d(256, 512, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (9): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (10): LeakyReLU(negative_slope=0.2, inplace=True)
    (11): Conv2d(512, 1, kernel_size=(4, 4), stride=(1, 1), bias=False)
    (12): Sigmoid()
  )
)
```

Training Epoch	200
Learning Rate	0.0002
Data augmentation	transforms.RandomHorizontalFlip(p=0.5)
Optimizer	Adam
Batchsize	64

2.

3.

平衡Generator及Discriminator是訓練的關鍵，如果一方收斂過快，會導致另一方的Loss值無法下降，甚至回升

4.

GAN所畫出的人臉變化較多也較為清晰，尤其是在髮色的部份，相較之下VAE所畫出的人臉相對單調且幾乎都是黑髮。然而VAE所畫出的臉部輪廓較為圓滑，GAN則較為不規則

Problem3

1.

	USPS → MNIST-M	MNIST-M → SVHN	SVHN → USPS
accuracy	0.2967	0.4413	0.6652

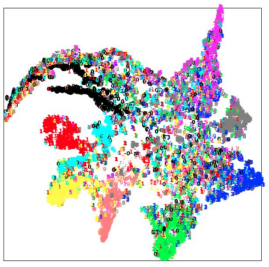
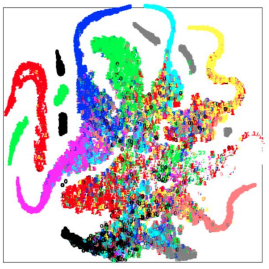
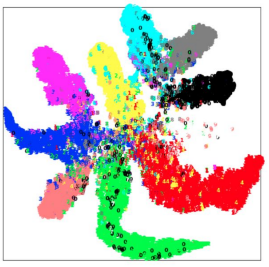
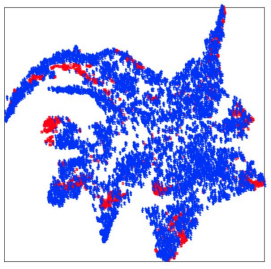
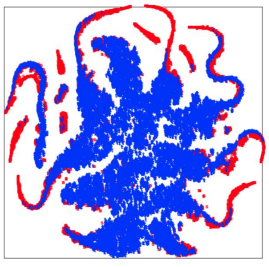
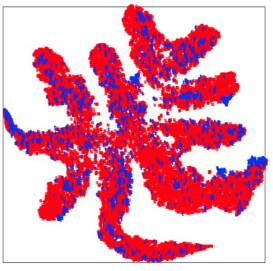
2.

	USPS → MNIST-M	MNIST-M → SVHN	SVHN → USPS
accuracy	0.4213	0.5132	0.7095

3.

	MNIST-M	SVHN	USPS
accuracy	0.9672	0.9158	0.9571

4.

	USPS → MNIST-M	MNIST-M → SVHN	SVHN → USPS
digit classes			
domains			

5.

CNN:

```
MNISTM2SVHN(
  (feature): Sequential(
    (0): Conv2d(3, 64, kernel_size=(7, 7), stride=(2, 2), padding=(3, 3), bias=False)
    (1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (2): ReLU(inplace=True)
    (3): MaxPool2d(kernel_size=3, stride=2, padding=1, dilation=1, ceil_mode=False)
    (4): Sequential(
      (0): BasicBlock(
        (conv1): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
        (bn1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (relu): ReLU(inplace=True)
        (conv2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
        (bn2): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      )
      (1): BasicBlock(
        (conv1): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
        (bn1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (relu): ReLU(inplace=True)
        (conv2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
        (bn2): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      )
    )
    (5): Sequential(
      (0): BasicBlock(
        (conv1): Conv2d(64, 128, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1), bias=False)
        (bn1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (relu): ReLU(inplace=True)
        (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
        (bn2): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (downsample): Sequential(
          (0): Conv2d(64, 128, kernel_size=(1, 1), stride=(2, 2), bias=False)
          (1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        )
      )
      (1): BasicBlock(
        (conv1): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
        (bn1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (relu): ReLU(inplace=True)
        (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
        (bn2): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      )
    )
```

```
  (6): Sequential(
    (0): BasicBlock(
      (conv1): Conv2d(128, 256, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1), bias=False)
      (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      (relu): ReLU(inplace=True)
      (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
      (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      (downsample): Sequential(
        (0): Conv2d(128, 256, kernel_size=(1, 1), stride=(2, 2), bias=False)
        (1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      )
    )
    (1): BasicBlock(
      (conv1): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
      (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      (relu): ReLU(inplace=True)
      (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
      (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    )
  )
  (7): Sequential(
    (0): BasicBlock(
      (conv1): Conv2d(256, 512, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1), bias=False)
      (bn1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      (relu): ReLU(inplace=True)
      (conv2): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
      (bn2): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      (downsample): Sequential(
        (0): Conv2d(256, 512, kernel_size=(1, 1), stride=(2, 2), bias=False)
        (1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      )
    )
    (1): BasicBlock(
      (conv1): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
      (bn1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      (relu): ReLU(inplace=True)
      (conv2): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
      (bn2): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    )
  )
  (8): AdaptiveAvgPool2d(output_size=(1, 1))
)
```

Classifier:

```
(cclassifier): Sequential(
  (0): Linear(in_features=512, out_features=512, bias=True)
  (1): ReLU()
  (2): Linear(in_features=512, out_features=512, bias=True)
  (3): ReLU()
  (4): Linear(in_features=512, out_features=10, bias=True)
  (5): LogSoftmax()
)
```

Discriminator:

```
(dclassifier): Sequential(
  (0): Linear(in_features=512, out_features=512, bias=True)
  (1): BatchNorm1d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
  (2): ReLU()
  (3): Linear(in_features=512, out_features=512, bias=True)
  (4): BatchNorm1d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
  (5): ReLU()
  (6): Linear(in_features=512, out_features=512, bias=True)
  (7): BatchNorm1d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
  (8): ReLU()
  (9): Linear(in_features=512, out_features=512, bias=True)
  (10): BatchNorm1d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
  (11): ReLU()
  (12): Linear(in_features=512, out_features=2, bias=True)
  (13): LogSoftmax()
)
```

Training Epoch	100
Learning Rate	0.001
Data augmentation	無
Optimizer	Adam
Batchsize	128

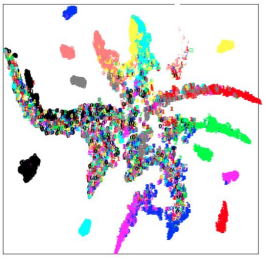
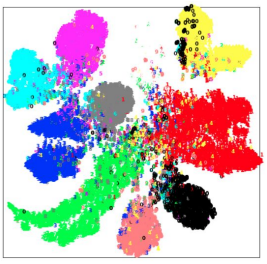
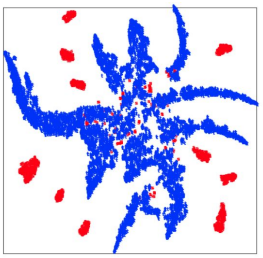
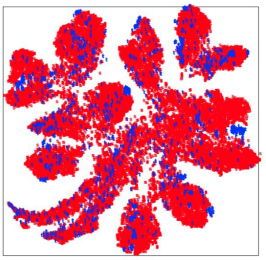
6.
我認為discriminator的深度是訓練的關鍵，在一開始我只用了一層全連接層，提昇的準確度始終有限，在加深模型後才漸漸有了改善。

Problem4

1.

	USPS → MNIST-M	MNIST-M → SVHN	SVHN → USPS
accuracy	0.4324	0.5415	0.7414

2.

	USPS → MNIST-M	MNIST-M → SVHN	SVHN → USPS
digit classes			
domains			

3.

本次實作採用**ADDA**

Source CNN and Target CNN(兩者使用相同架構):

```
MNISTM2SVHN(
  (SEncoder): Encoder(
    (layer): Sequential(
      (0): Conv2d(3, 64, kernel_size=(7, 7), stride=(2, 2), padding=(3, 3), bias=False)
      (1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      (2): ReLU(inplace=True)
      (3): MaxPool2d(kernel_size=3, stride=2, padding=1, dilation=1, ceil_mode=False)
      (4): Sequential(
        (0): BasicBlock(
          (conv1): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
          (bn1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
          (relu): ReLU(inplace=True)
          (conv2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
          (bn2): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        )
        (1): BasicBlock(
          (conv1): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
          (bn1): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
          (relu): ReLU(inplace=True)
          (conv2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
          (bn2): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        )
      )
      (5): Sequential(
        (0): BasicBlock(
          (conv1): Conv2d(64, 128, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1), bias=False)
          (bn1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
          (relu): ReLU(inplace=True)
          (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
          (bn2): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
          (downsample): Sequential(
            (0): Conv2d(64, 128, kernel_size=(1, 1), stride=(2, 2), bias=False)
            (1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
          )
        )
        (1): BasicBlock(
          (conv1): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
          (bn1): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
          (relu): ReLU(inplace=True)
          (conv2): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
          (bn2): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        )
      )
```

```
    (6): Sequential(
      (0): BasicBlock(
        (conv1): Conv2d(128, 256, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1), bias=False)
        (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (relu): ReLU(inplace=True)
        (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
        (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (downsample): Sequential(
          (0): Conv2d(128, 256, kernel_size=(1, 1), stride=(2, 2), bias=False)
          (1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        )
      )
      (1): BasicBlock(
        (conv1): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
        (bn1): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (relu): ReLU(inplace=True)
        (conv2): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
        (bn2): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      )
    )
    (7): Sequential(
      (0): BasicBlock(
        (conv1): Conv2d(256, 512, kernel_size=(3, 3), stride=(2, 2), padding=(1, 1), bias=False)
        (bn1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (relu): ReLU(inplace=True)
        (conv2): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
        (bn2): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (downsample): Sequential(
          (0): Conv2d(256, 512, kernel_size=(1, 1), stride=(2, 2), bias=False)
          (1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        )
      )
      (1): BasicBlock(
        (conv1): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
        (bn1): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
        (relu): ReLU(inplace=True)
        (conv2): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1), bias=False)
        (bn2): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
      )
    )
    (8): AdaptiveAvgPool2d(output_size=(1, 1))
  )
  (fc): Linear(in_features=512, out_features=512, bias=True)
)
```

Classifier:

```
(cls): Classifier(
  (layer): Sequential(
    (0): Linear(in_features=512, out_features=10, bias=True)
  )
```

Discirminator:

```
 (dsc): Discriminator(
   (layer): Sequential(
     (0): Linear(in_features=512, out_features=128, bias=True)
     (1): ReLU()
     (2): Linear(in_features=128, out_features=32, bias=True)
     (3): ReLU()
     (4): Linear(in_features=32, out_features=8, bias=True)
     (5): ReLU()
     (6): Linear(in_features=8, out_features=2, bias=True)
     (7): LogSoftmax()
   )
 )
```

Training Epoch	100
Learning Rate	0.0001
Data augmentation	X
Optimizer	Adam
Batchsize	512

4.
雖然sourse CNN及target CNN是採用相同的架構，但權重(weight)並不相同，故經由t-SNE視覺畫後的latent space，即使屬於相同digit classes，來自不同domain的sample可能分別形成兩個群落，如下如所示，每個digit classes基本都對應兩個群落。

Reference:

Problem1:

1. https://github.com/pytorch/examples/tree/master/vae
2. https://github.com/bhpfelix/Variational-Autoencoder-PyTorch

Problem2:

1.https://pytorch.org/tutorials/beginner/dcgan_faces_tutorial.html?fbclid=IwAR0QqIaeqn8wajh5yigrqZ9UXRak0j_tN-ag0gx6_U5sH8xXgL8vAZmmJ5k

Problem3:

1. https://github.com/fungtion/DANN
2. https://github.com/CuthbertCai/pytorch_DANN

Problem4:

1.https://github.com/corenel/pytorch-adda?fbclid=IwAR0Z4oHvw5P_QvjurK0kmv10GAPNksSAM6W0U5y-mghEQ0tEqtOiyMsNfUI