學號：B06902042　系級：資工三　姓名：劉愷為

1. (2.5%) 訓練一個 model。

   a. Generator: 與 colab 相同

```
----------------------------------------------------------------
        Layer (type)               Output Shape         Param #
================================================================
            Linear-1                 [-1, 8192]         819,200
       BatchNorm1d-2                 [-1, 8192]          16,384
              ReLU-3                 [-1, 8192]               0
   ConvTranspose2d-4            [-1, 256, 8, 8]       3,276,800
       BatchNorm2d-5            [-1, 256, 8, 8]             512
              ReLU-6            [-1, 256, 8, 8]               0
   ConvTranspose2d-7          [-1, 128, 16, 16]         819,200
       BatchNorm2d-8          [-1, 128, 16, 16]             256
              ReLU-9          [-1, 128, 16, 16]               0
  ConvTranspose2d-10           [-1, 64, 32, 32]         204,800
      BatchNorm2d-11           [-1, 64, 32, 32]             128
             ReLU-12           [-1, 64, 32, 32]               0
  ConvTranspose2d-13            [-1, 3, 64, 64]           4,803
             Tanh-14            [-1, 3, 64, 64]               0
================================================================
Total params: 5,142,083
Trainable params: 5,142,083
Non-trainable params: 0
----------------------------------------------------------------
Input size (MB): 0.00
Forward/backward pass size (MB): 3.00
Params size (MB): 19.62
Estimated Total Size (MB): 22.62
----------------------------------------------------------------
```

   Discriminator: 與 colab 相同

```
----------------------------------------------------------------
        Layer (type)               Output Shape         Param #
================================================================
            Conv2d-1           [-1, 64, 32, 32]           4,864
         LeakyReLU-2           [-1, 64, 32, 32]               0
            Conv2d-3          [-1, 128, 16, 16]         204,928
       BatchNorm2d-4          [-1, 128, 16, 16]             256
         LeakyReLU-5          [-1, 128, 16, 16]               0
            Conv2d-6            [-1, 256, 8, 8]         819,456
       BatchNorm2d-7            [-1, 256, 8, 8]             512
         LeakyReLU-8            [-1, 256, 8, 8]               0
            Conv2d-9            [-1, 512, 4, 4]       3,277,312
      BatchNorm2d-10            [-1, 512, 4, 4]           1,024
        LeakyReLU-11            [-1, 512, 4, 4]               0
           Conv2d-12              [-1, 1, 1, 1]           8,193
          Sigmoid-13              [-1, 1, 1, 1]               0
================================================================
Total params: 4,316,545
Trainable params: 4,316,545
Non-trainable params: 0
----------------------------------------------------------------
Input size (MB): 0.05
Forward/backward pass size (MB): 2.31
Params size (MB): 16.47
Estimated Total Size (MB): 18.83
----------------------------------------------------------------
```

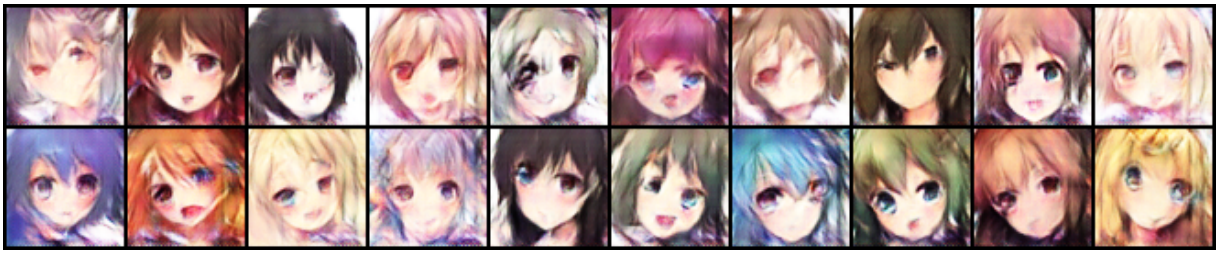
Loss Function: BCELoss 與 colab 相同

Dataset: 助教提供

Optimizer: Adam, lr = 1e-4, betas = (0.5,0.999)

Epoch: 10

b. (1.5%) 請畫出至少 16 張 model 生成的圖片。



2. (3.5%) 請選擇下列其中一種 model： WGAN, WGAN-GP, LSGAN, SNGAN

（不要和 1. 使用的 model 一樣，至少 architecture 或是 loss function 要不同）

a. Generator: 將 ReLU 改成 LeakyReLU

```
----------------------------------------------------------------
        Layer (type)               Output Shape         Param #
================================================================
            Linear-1                 [-1, 8192]         819,200
       BatchNorm1d-2                 [-1, 8192]          16,384
         LeakyReLU-3                 [-1, 8192]               0
   ConvTranspose2d-4            [-1, 256, 8, 8]       3,276,800
      BatchNorm2d-5            [-1, 256, 8, 8]             512
         LeakyReLU-6            [-1, 256, 8, 8]               0
   ConvTranspose2d-7          [-1, 128, 16, 16]         819,200
      BatchNorm2d-8          [-1, 128, 16, 16]             256
         LeakyReLU-9          [-1, 128, 16, 16]               0
  ConvTranspose2d-10           [-1, 64, 32, 32]         204,800
     BatchNorm2d-11           [-1, 64, 32, 32]             128
        LeakyReLU-12           [-1, 64, 32, 32]               0
  ConvTranspose2d-13            [-1, 3, 64, 64]           4,803
             Tanh-14            [-1, 3, 64, 64]               0
================================================================
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----------------------------------------------------------------
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----------------------------------------------------------------
```

Discriminator: 與 colab 相同

```
----------------------------------------------------------------
        Layer (type)               Output Shape         Param #
================================================================
            Conv2d-1          [-1, 64, 32, 32]           4,864
         LeakyReLU-2          [-1, 64, 32, 32]               0
            Conv2d-3         [-1, 128, 16, 16]         204,928
       BatchNorm2d-4         [-1, 128, 16, 16]             256
         LeakyReLU-5         [-1, 128, 16, 16]               0
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       BatchNorm2d-7           [-1, 256, 8, 8]             512
         LeakyReLU-8           [-1, 256, 8, 8]               0
            Conv2d-9           [-1, 512, 4, 4]       3,277,312
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```

Loss Function: BCELoss + 0.1 倍的 compute_gradient_penalty

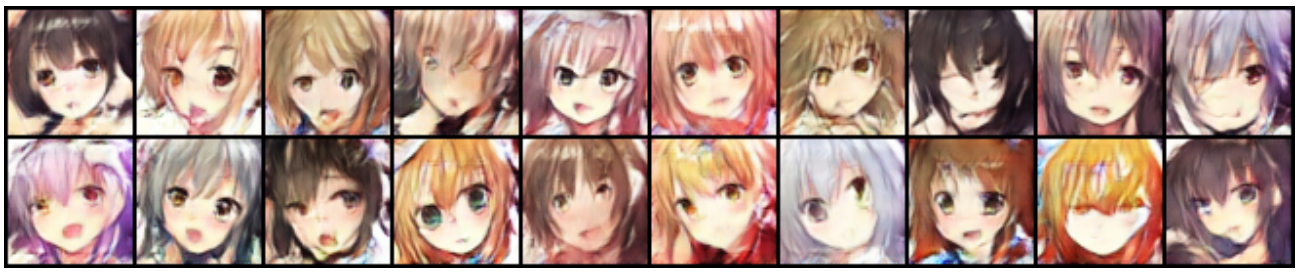
```python
def compute_gradient_penalty(D, real_samples, fake_samples):
    """Calculates the gradient penalty loss for WGAN GP"""
    # Random weight term for interpolation between real and fake samples
    alpha = Tensor(np.random.random((real_samples.size(0), 1, 1, 1)))
    # Get random interpolation between real and fake samples
    interpolates = (alpha * real_samples + ((1 - alpha) * fake_samples)).requires_grad_(True)
    d_interpolates = D(interpolates)

    fake = Variable(Tensor(real_samples.shape[0]).fill_(1.0), requires_grad=False)
    # Get gradient w.r.t. interpolates
    gradients = torch.autograd.grad(
        outputs=d_interpolates,
        inputs=interpolates,
        grad_outputs=fake,
        create_graph=True,
        retain_graph=True,
        only_inputs=True,
    )[0]
    gradients = gradients.view(gradients.size(0), -1)
    gradient_penalty = ((gradients.norm(2, dim=1) - 1) ** 2).mean()
    return gradient_penalty
```

Dataset: 助教提供

Optimizer: Adam, lr = 1e-4, betas = (0.5,0.999)

Epoch: 20

b. (1.5%) 和 1.b 一樣，就你選擇的 model，畫出至少 16 張 model 生成的圖片。



c. (1%) 請簡單探討你在 1. 使用的 model 和 2. 使用的 model，他們分別有何性質，描述你觀察到的異同。

第一題的 model 所畫出的圖片比較模糊，人的輪廓也有點奇怪，比方說眼睛的形狀和位置都會有點畸形。第二題的圖片就比較清晰，人的輪廓也較第一題正常且清晰許多。推測可能為計算 loss 的差異(gradient penalty)

3. (4%) 請訓練一個會導致 mode collapse 的 model。

a. Generator: 與 colab 相同

```
----------------------------------------------------------------
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      BatchNorm2d-11           [-1, 64, 32, 32]             128
             ReLU-12           [-1, 64, 32, 32]               0
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Discriminator: 與 colab 相同

```
----------------------------------------------------------------
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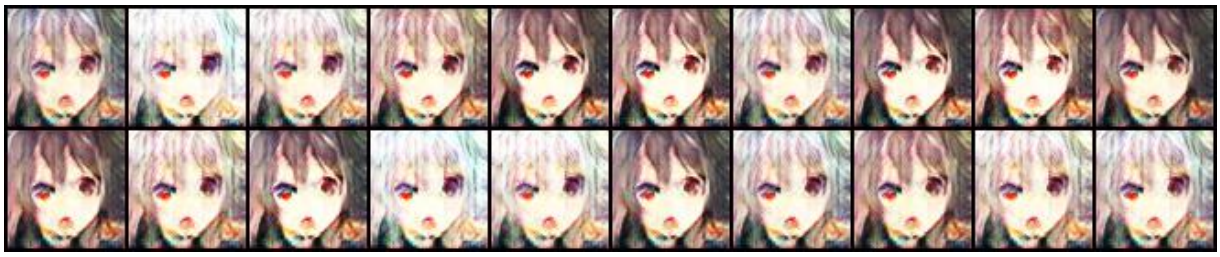
Loss Function: BCELoss 與 colab 相同

Dataset: 助教提供

Optimizer: Adam, lr = 1e-4, betas = (0.5,0.999)

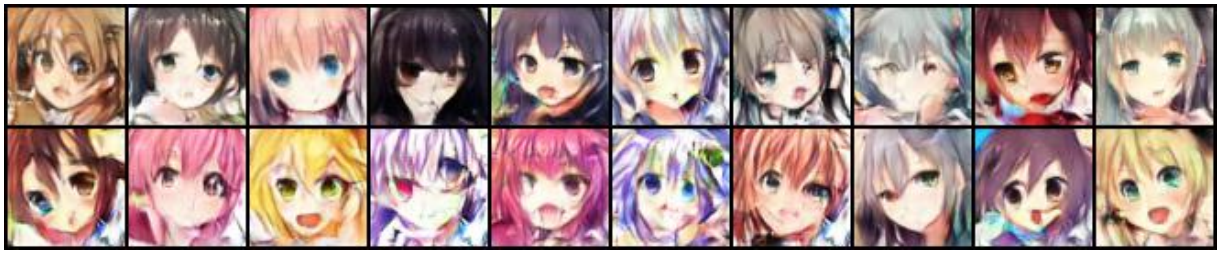
Epoch: 29

b. (1.5%) 請畫出至少 16 張 model 生成且具有 mode collapse 現象的圖片。



c. (1.5%) 在不改變 optimizer 和訓練 step 數的情況下，請嘗試使用一些方法來減緩 mode collapse。說明你嘗試了哪些方法，請至少舉出一種成功改善的方法，若有其它失敗的方法也可以記錄下來。

使用 WGAN_GP 的方法，在基礎條件不更動的情況下，生成的圖片 依然具有多樣性。效果如下：



除了將 Loss Function 改成 BCELoss + 0.1 倍的 compute_gradient_penalty，其餘都和 3-a 相同