ADL HW4 Report

Explain the structure of your networks and loss terms in detail (1.5%)

Basically I used the structure similar in DCGAN for both the generator and discriminator. I have added a conv layer to both the generator and discriminator to resize the output of the image to 128x128. I have also taken off the sigmoid function in the discriminator layer and batch normalization layers in the discriminator for WGAN-GP training and add 4 classifiers(Hair classifier, eye classifier, face classifier, glass classifier) to classify the conditions.

Generator:

```
Generator(
  (gen): Sequential(
    (0): ConvTranspose2d(115, 1024, kernel_size=(4, 4), stride=(1, 1), bias=False)
    (1): BatchNorm2d(1024, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (2): ReLU(inplace)
    (3): ConvTranspose2d(1024, 512, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (4): BatchNorm2d(512, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (5): ReLU(inplace)
    (6): ConvTranspose2d(512, 256, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (7): BatchNorm2d(256, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (8): ReLU(inplace)
    (9): ConvTranspose2d(256, 128, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (10): BatchNorm2d(128, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (11): ReLU(inplace)
    (12): ConvTranspose2d(128, 64, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (13): BatchNorm2d(64, eps=1e-05, momentum=0.1, affine=True, track_running_stats=True)
    (14): ReLU(inplace)
    (15): ConvTranspose2d(64, 3, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1))
    (16): Tanh()
  )
)
```

Discriminator:

```
Discriminator(
  (conv_layers): Sequential(
    (0): Conv2d(3, 64, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (1): LeakyReLU(negative_slope=0.2, inplace)
    (2): Conv2d(64, 128, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (3): LeakyReLU(negative_slope=0.2, inplace)
    (4): Conv2d(128, 256, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (5): LeakyReLU(negative_slope=0.2, inplace)
    (6): Conv2d(256, 512, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (7): LeakyReLU(negative_slope=0.2, inplace)
    (8): Conv2d(512, 1024, kernel_size=(4, 4), stride=(2, 2), padding=(1, 1), bias=False)
    (9): LeakyReLU(negative_slope=0.2, inplace)
  )
  (discriminator_layer): Sequential(
    (0): Conv2d(1024, 1, kernel_size=(4, 4), stride=(1, 1))
  )
  (bottleneck): Sequential(
    (0): Conv2d(1024, 1024, kernel_size=(4, 4), stride=(1, 1))
    (1): LeakyReLU(negative_slope=0.2)
  )
  (hair_classifier_layer): Sequential(
    (0): Linear(in_features=1024, out_features=128, bias=True)
    (1): LeakyReLU(negative_slope=0.2)
    (2): Linear(in_features=128, out_features=6, bias=True)
    (3): LogSoftmax()
  )
  (eye_classifier_layer): Sequential(
    (0): Linear(in_features=1024, out_features=128, bias=True)
    (1): LeakyReLU(negative_slope=0.2)
    (2): Linear(in_features=128, out_features=4, bias=True)
    (3): LogSoftmax()
  )
  (face_classifier_layer): Sequential(
    (0): Linear(in_features=1024, out_features=128, bias=True)
    (1): LeakyReLU(negative_slope=0.2)
    (2): Linear(in_features=128, out_features=3, bias=True)
    (3): LogSoftmax()
  )
  (glass_classifier_layer): Sequential(
    (0): Linear(in_features=1024, out_features=128, bias=True)
    (1): LeakyReLU(negative_slope=0.2)
    (2): Linear(in_features=128, out_features=2, bias=True)
    (3): LogSoftmax()
  )
)
```

Loss terms:

Adversarial loss:

GAN	Discriminator Loss	Generator Loss
WGAN GP	$\mathcal{L}_{\mathrm{D}}^{\mathrm{WGANGP}} = \mathcal{L}_{\mathrm{D}}^{\mathrm{WGAN}} + \lambda \mathbb{E}_{\hat{x}\sim p_g}[(\|\nabla D(\alpha x + (1-\alpha\hat{x})\|_2 - 1)^2]$	$\mathcal{L}_{\mathrm{G}}^{\mathrm{WGANGP}} = -\mathbb{E}_{\hat{x}\sim p_g}[D(\hat{x})]$

$$\lambda = 10$$

Classifier loss:

Generator classifier loss
$CrossEntropyLoss\big(P\big(class = hair\big\vert X_{fake}\big), fake\_tag_{hair}\big)$ $+ CrossEntropyLoss\big(P\big(class = eye\big\vert X_{fake}\big), fake\_tag_{eye}\big)$ $+ CrossEntropyLoss\big(P\big(class = face\big\vert X_{fake}\big), fake\_tag_{face}\big)$ $+ CrossEntropyLoss\big(P\big(class = glasses\big\vert X_{fake}\big), fake\_tag_{glasses}\big)$

Discriminator classifier loss
$CrossEntropyLoss(P(class = hair\|X_{real}), real\_tag_{hair})$ $+ CrossEntropyLoss\big(P(class = eye\|X_{real}), real\_tag_{eye}\big)$ $+ CrossEntropyLoss\big(P(class = face\|X_{real}), real\_tag_{face}\big)$ $+ CrossEntropyLoss\big(P(class = glasses\|X_{real}), real\_tag_{glasses}\big)$

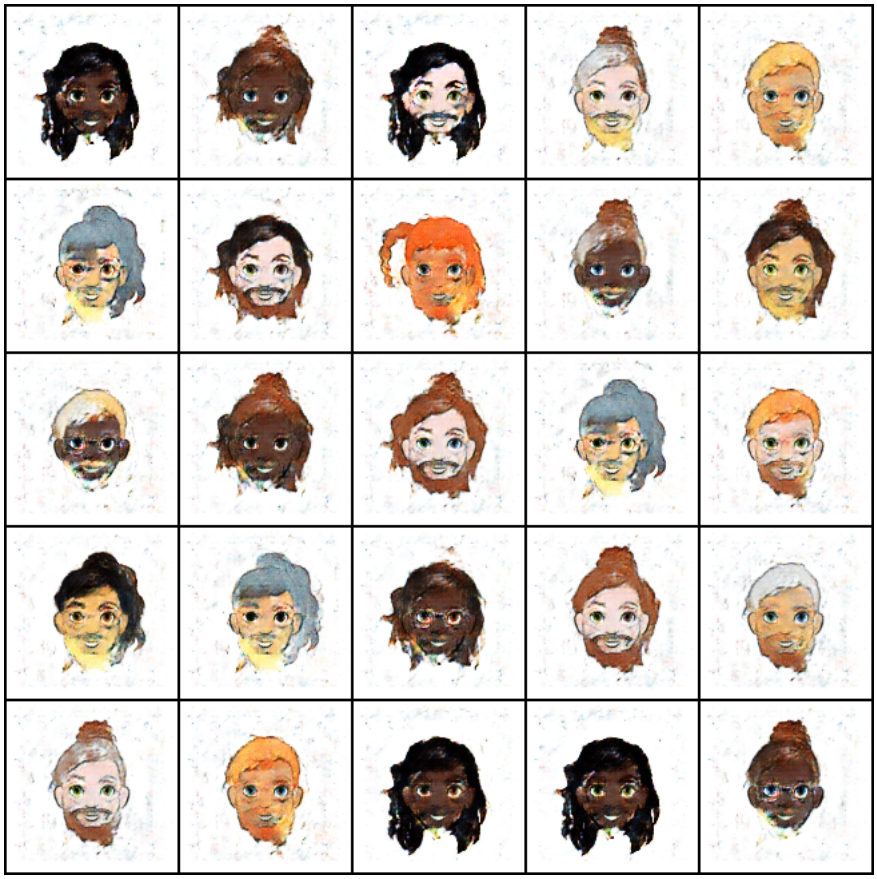
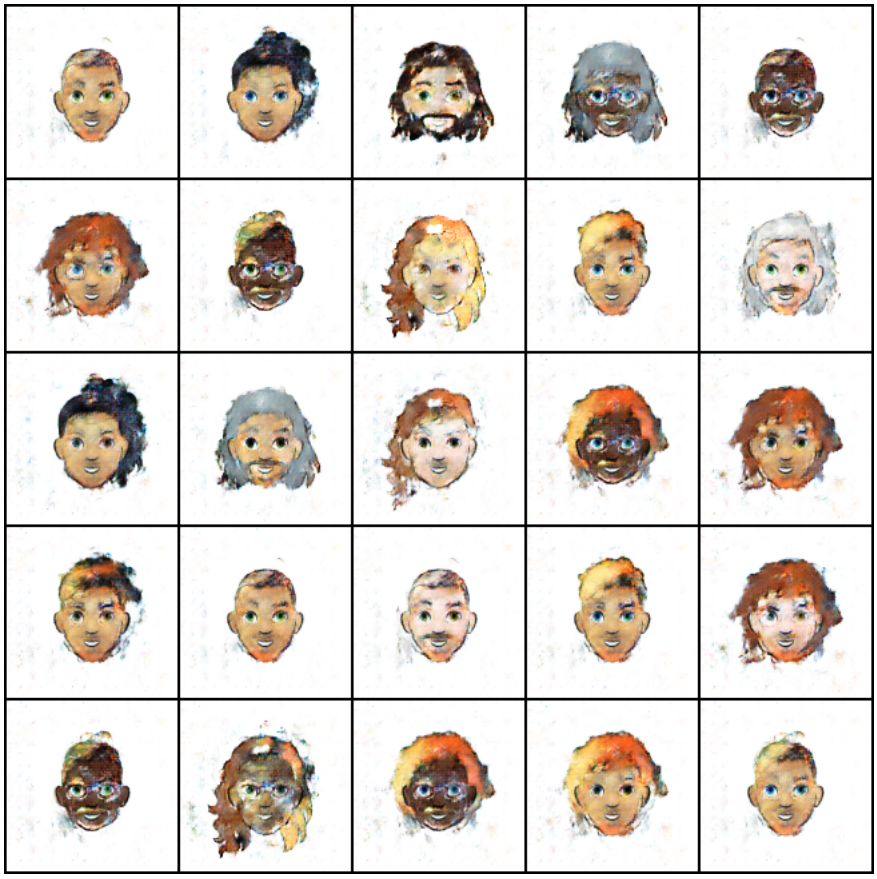
Experiment settings and results

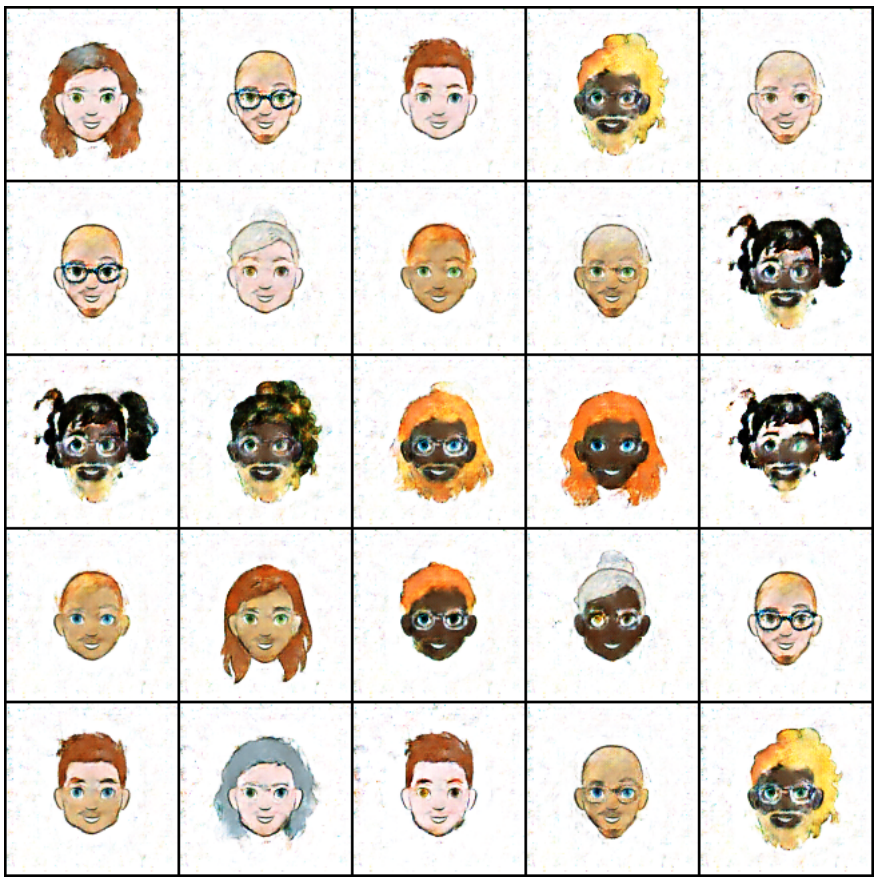
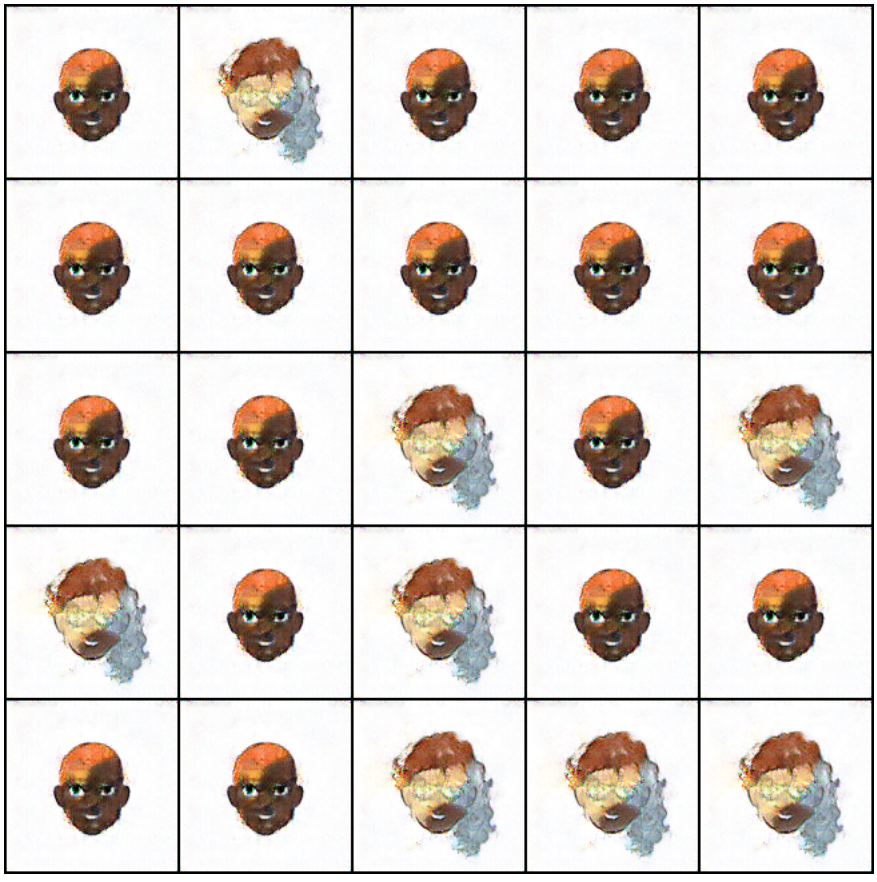
Iter	50000
Discriminator_iter: Generator_iter when training	5:1
Batch size	64
Learning Rate	0.0001
Optimizer	Adam
Latent dim	100
FID score	17.277

Plot your training progress (10 pics) (0.5%)

Step 500	

R07922118 資工碩一 翁子騰

Step 5000	
Step 10000	

Step 15000	
Step 20000	

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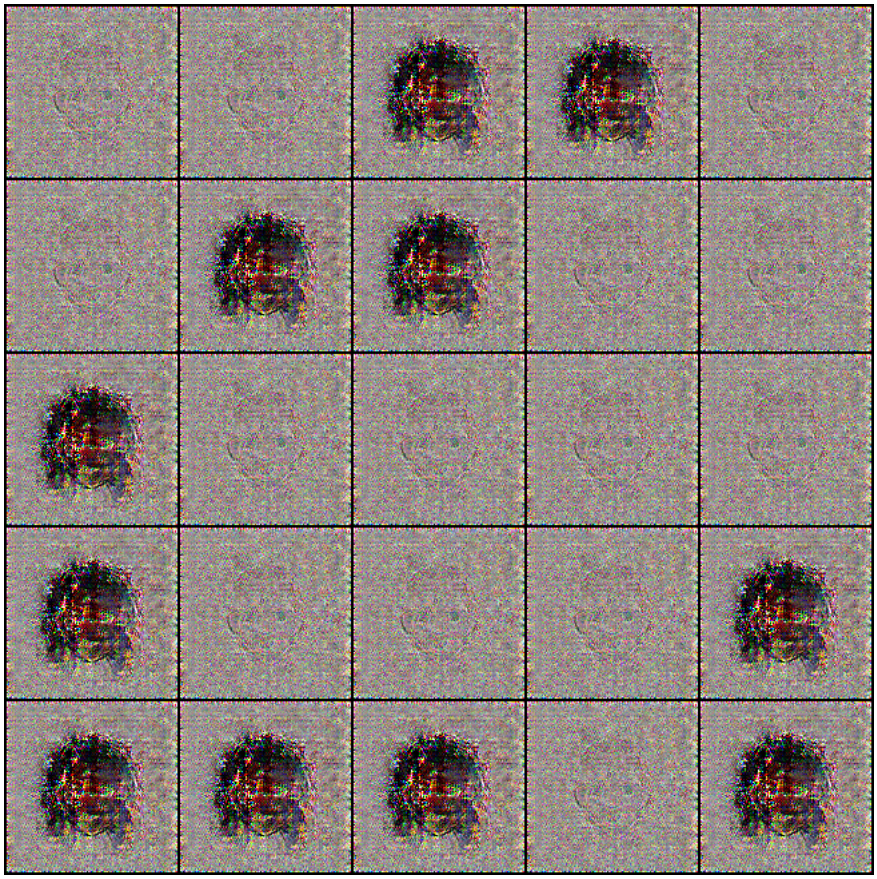
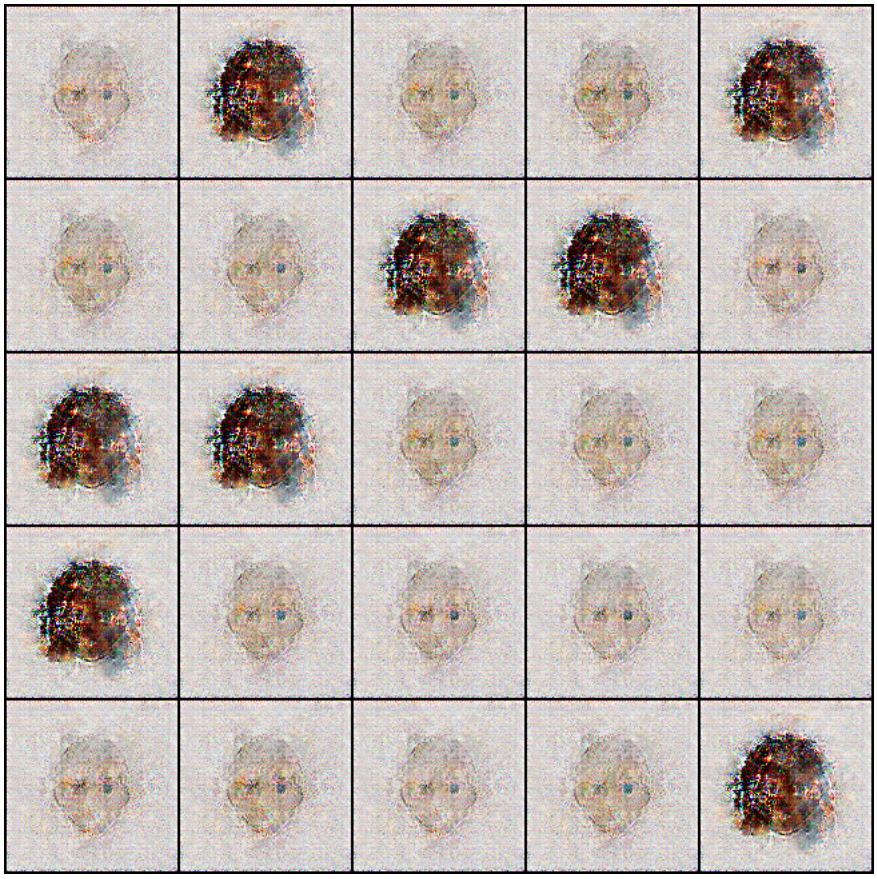
Step 25000	
Step 30000	

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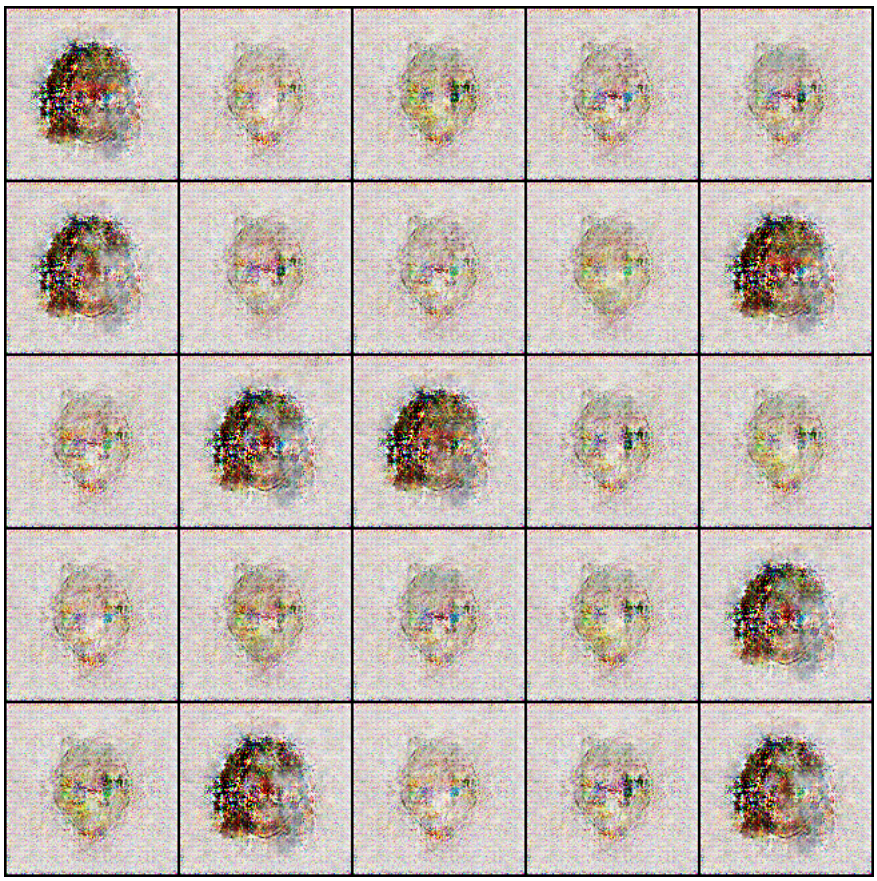
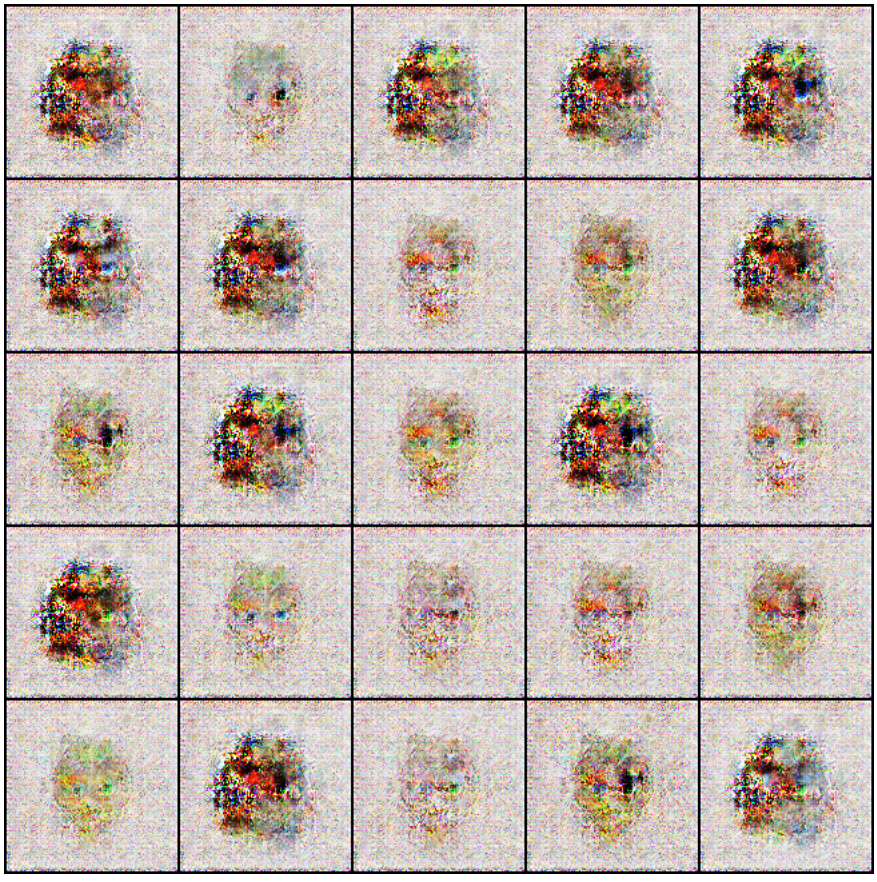
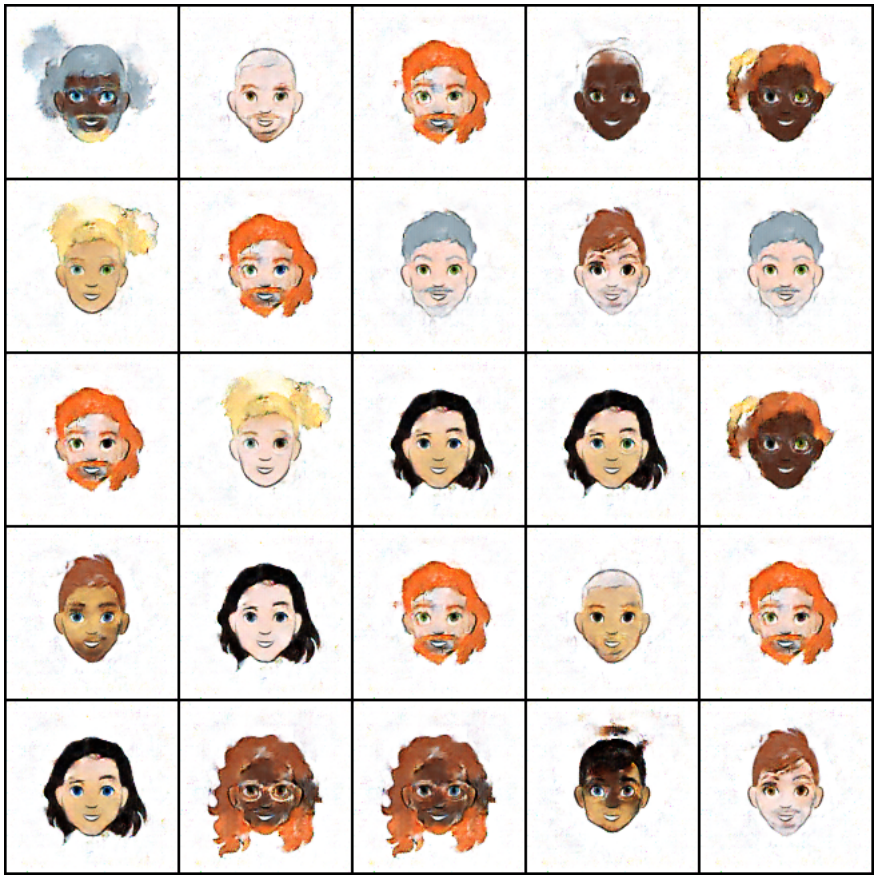
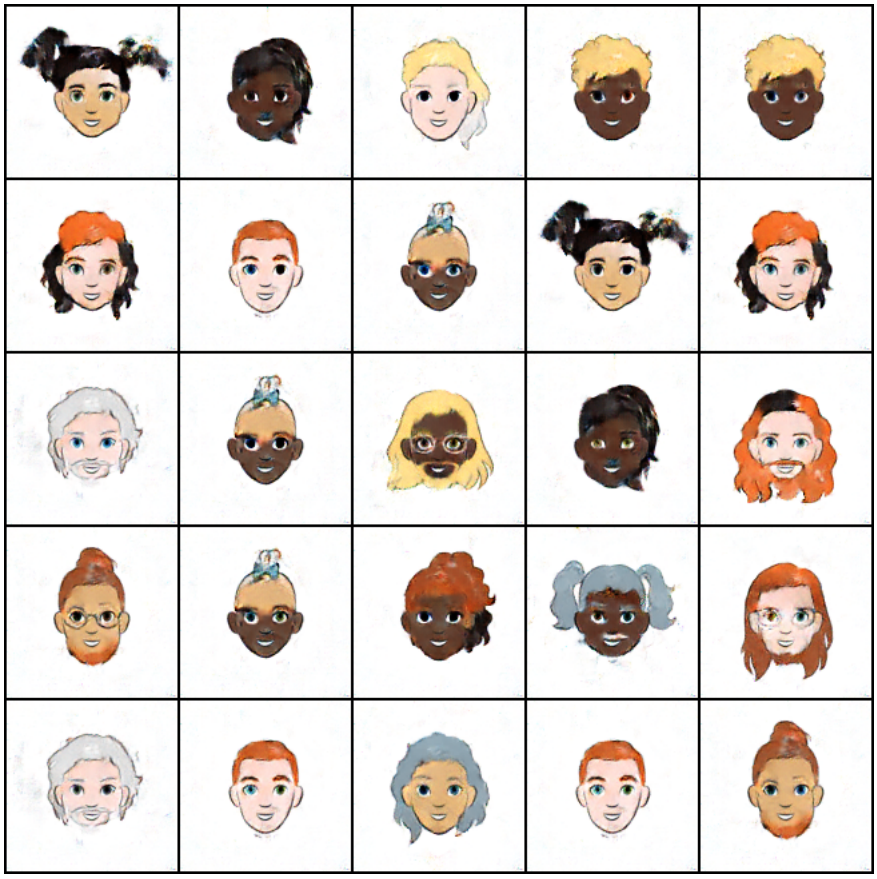
Step 35000	
Step 40000	

R07922118 資工碩一 翁子騰

Step 45000	
Step 50000	

可以觀察到訓練到一半時，generator 一度有崩潰的情形。但是後來有比較好一點。

Design at least 3 different experiments. Describe your settings, making comparisons and report your observations. (4% + 0.5% bonus)

$$X_{fake} = G(z, tag)\ is\ the\ fake\ image(or\ generated\ image),$$
$$and\ \ X_{real}\ is\ the\ real\ image$$

1.

Discriminator Loss function
$-\left(logP(S = real\|X_{real}) + \log\left(1 - P\left(S = fake\|X_{fake}\right)\right)\right) * \frac{1}{2}$ $-(logP(class = c\|X_{real}))$
Generator Loss function
$-\log \mathrm{P}\left(S = fake\middle\|X_{fake}\right) - logP(class = c\|X_{fake})$

The classification loss for fake images are omitted, since we believe that fake images will confuse the discriminator. I divide the adversarial loss for discriminator by 2 to balance the gradient descent schedule of G/D.

Iter	Batch size	FID score
50000	128	187.534

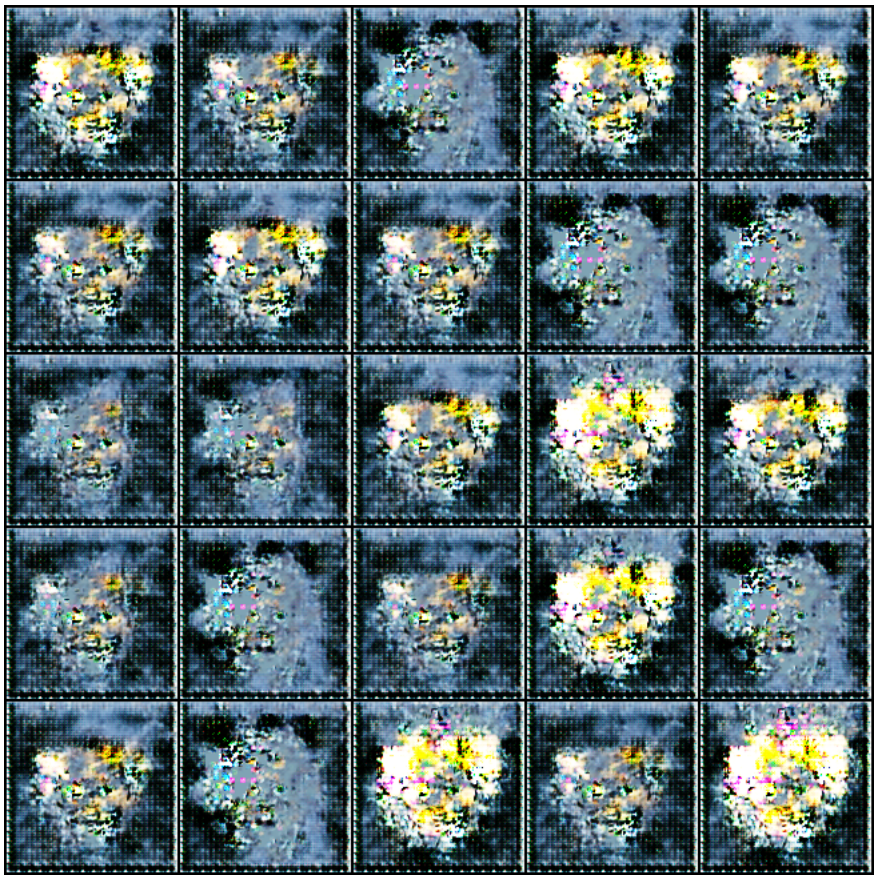
2.

Discriminator Loss function
$-\left(logP(S = real\|X_{real}) + \log\left(1 - P\left(S = fake\|X_{fake}\right)\right)\right) * \frac{1}{2}$ $-(logP(class = c\|X_{real}) + logP(class = c\|X_{fake}))$
Generator Loss function
$-\log \mathrm{P}\left(S = fake\middle\|X_{fake}\right) - logP(class = c\|X_{fake})$

Add classification loss for fake images in the discriminator loss function.

Iter	Batch size	FID score
300000	32	Generator crashed

訓練到約 25 萬 iters 時 generator 崩潰(見下圖)。所以終止訓練。



3.

Discriminator Loss function
$$-\left(logP(S=real\|X_{real})+\log\left(1-P\left(S=fake\|X_{fake}\right)\right)\right)$$ $$-(logP(class=hair\ \|X_{real})+logP(class=eye\ \|X_{real}) + logP(class=face\ \|X_{real})+logP(class=glass\|X_{real}))$$
Generator Loss function
$$-\log P\left(S=fake\middle\|X_{fake}\right)-logP\left(class=hair\middle\|X_{fake}\right) - logP\left(class=eye\middle\|X_{fake}\right)-logP\left(class=face\middle\|X_{fake}\right) - logP(class=glass\|X_{fake})$$

Split the classifier in discriminator into 4 different parts to classify hair colors, eye colors, face colors and with and without glasses.

Iter	Batch size	FID score
50000	128	133.792