

```
In [ ]:  
import argparse  
import os  
import random  
import torch  
from tqdm import tqdm  
import torch.nn as nn  
import torch.nn.parallel  
import torch.backends.cudnn as cudnn  
import torch.optim as optim  
import torch.utils.data  
import torchvision.datasets as dset  
import torchvision.transforms as transforms  
import torchvision.utils as vutils  
import numpy as np  
import matplotlib.pyplot as plt  
import matplotlib.animation as animation  
from IPython.display import HTML  
  
# Set random seed for reproducibility  
manualSeed = 999  
# manualSeed = random.randint(1, 10000) # use if you want new results  
print("Random Seed: ", manualSeed)  
random.seed(manualSeed)  
torch.manual_seed(manualSeed)  
  
# Root directory for dataset  
dataroot = "./GAN_dataset"  
  
# Number of workers for dataloader  
workers = 2  
  
# Batch size during training  
batch_size = 128  
  
# 圖片要resize的大小 · 作為Discriminator的輸入跟Generator的輸出size  
image_size = 64  
  
# 圖片之channel數(RGB)  
channel = 3  
  
# latent space z 的vector size  
z_latent = 100  
  
# Generator 的feature map size  
fm_size_G = 64  
  
# Discriminator 的feature map size  
fm_size_D = 64  
  
# Number of training epochs  
num_epochs = 500  
  
# Learning rate for optimizers  
lr = 0.0002  
  
# Beta1 hyperparam for Adam optimizers  
beta1 = 0.5  
  
# Number of GPUs available. Use 0 for CPU mode.  
ngpu = 1
```

```
/home/yagami0zero/.local/lib/python3.8/site-packages/torchvision/io/image.py:13: UserWarning: Failed to load image Python extension: /home/yagami0zero/.local/lib/python3.8/site-packages/torchvision/image.so: undefined symbol: _ZN3c105ErrorC2ENS_14SourceLocationESs
  warn(f"Failed to load image Python extension: {e}")
Random Seed: 999
```

```
In [ ]: # We can use an image folder dataset the way we have it setup.
# Create the dataset
transform = transforms.Compose([
    transforms.Resize(image_size), # resize
    transforms.RandomHorizontalFlip(p=0.5), # 隨機水平翻轉
    transforms.RandomVerticalFlip(p=0.5), # 隨機垂直翻轉
    transforms.RandomRotation(10), # 隨機旋轉-10~10度
    transforms.ToTensor(),
    transforms.Normalize(mean=(0.5,0.5,0.5), std=(0.5,0.5,0.5)), # 對圖片做normalize · 以便讓model更快收斂
])

dataset = dset.ImageFolder(root=dataroot, transform=transform)

# Create the dataloader
dataloader = torch.utils.data.DataLoader(dataset, batch_size=batch_size,
                                         shuffle=True, num_workers=workers)

# Decide which device we want to run on
device = torch.device("cuda:0" if (torch.cuda.is_available() and ngpu > 0) else "cpu")

# Plot some training images 看一下data augmentation的結果
"real_batch = next(iter(dataloader))
plt.figure(figsize=(8,8))
plt.axis("off")
plt.title("Training Images")
plt.imshow(np.transpose(vutils.make_grid(real_batch[0].to(device)[:64], padding=2, normalize=True).cpu(),(1,2,
""
```

```
Out[ ]: 'real_batch = next(iter(dataloader))\nplt.figure(figsize=(8,8))\nplt.axis("off")\nplt.title("Training Images")\nplt.imshow(np.transpose(vutils.make_grid(real_batch[0].to(device)[:64], padding=2, normalize=True).cpu(),(1,2,0)))\n'
```

```
In [ ]: # custom weights initialization called on netG and netD

# 照原paper之作法 · 作者認為Conv層應由mean=0, std=0.02的normal distribution開始隨機初始化
# BatchNorm層則是由mean=1, std=0.02的normal distribution開始隨機初始化
def weights_init(m):
    classname = m.__class__.__name__
    if classname.find('Conv') != -1:
        nn.init.normal_(m.weight.data, 0.0, 0.02)
    elif classname.find('BatchNorm') != -1:
        nn.init.normal_(m.weight.data, 1.0, 0.02)
        nn.init.constant_(m.bias.data, 0)

# Generator Code
# DCGAN之Generator的架構
class Generator(nn.Module):
    def __init__(self, ngpu):
        super(Generator, self).__init__()
        self.ngpu = ngpu
        self.main = nn.Sequential(
            # input is Z, going into a convolution
            nn.ConvTranspose2d(z_latent, fm_size_G * 8, 4, 1, 0, bias=False),
            nn.BatchNorm2d(fm_size_G * 8),
            nn.ReLU(True),
            # state size. (ngf*8) x 4 x 4
            nn.ConvTranspose2d(fm_size_G * 8, fm_size_G * 4, 4, 2, 1, bias=False),
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nn.BatchNorm2d(fm_size_G * 4),
nn.ReLU(True),
# state size. (ngf*4) x 8 x 8
nn.ConvTranspose2d( fm_size_G * 4, fm_size_G * 2, 4, 2, 1, bias=False),
nn.BatchNorm2d(fm_size_G * 2),
nn.ReLU(True),
# state size. (ngf*2) x 16 x 16
nn.ConvTranspose2d( fm_size_G * 2, fm_size_G, 4, 2, 1, bias=False),
nn.BatchNorm2d(fm_size_G),
nn.ReLU(True),
# state size. (ngf) x 32 x 32
nn.ConvTranspose2d( fm_size_G, channel, 4, 2, 1, bias=False),
nn.Tanh()
# state size. (nc) x 64 x 64
)

def forward(self, input):
    return self.main(input)

# Create the generator
# instance
netG = Generator(ngpu).to(device)

# Handle multi-gpu if desired
if (device.type == 'cuda') and (ngpu > 1):
    netG = nn.DataParallel(netG, list(range(ngpu)))

# Apply the weights_init function to randomly initialize all weights
# to mean=0, std=0.02.
# 將Generator初始化參數
netG.apply(weights_init)

# Print the model
print(netG)

```

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Generator(
(main): 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()
)
)
```

```

In [ ]: # DCGAN之Discriminator的架構
class Discriminator(nn.Module):
    def __init__(self, ngpu):
        super(Discriminator, self).__init__()
        self.ngpu = ngpu
        self.main = nn.Sequential(
            # input is (nc) x 64 x 64
            nn.Conv2d(channel, fm_size_D, 4, 2, 1, bias=False),
            nn.LeakyReLU(0.2, inplace=True),

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# state size. (ndf) x 32 x 32
nn.Conv2d(fm_size_D, fm_size_D * 2, 4, 2, 1, bias=False),
nn.BatchNorm2d(fm_size_D * 2),
nn.LeakyReLU(0.2, inplace=True),
# state size. (ndf*2) x 16 x 16
nn.Conv2d(fm_size_D * 2, fm_size_D * 4, 4, 2, 1, bias=False),
nn.BatchNorm2d(fm_size_D * 4),
nn.LeakyReLU(0.2, inplace=True),
# state size. (ndf*4) x 8 x 8
nn.Conv2d(fm_size_D * 4, fm_size_D * 8, 4, 2, 1, bias=False),
nn.BatchNorm2d(fm_size_D * 8),
nn.LeakyReLU(0.2, inplace=True),
# state size. (ndf*8) x 4 x 4
nn.Conv2d(fm_size_D * 8, 1, 4, 1, 0, bias=False),
nn.Sigmoid()
)

def forward(self, input):
    return self.main(input)

# Create the Discriminator
netD = Discriminator(ngpu).to(device)

# Handle multi-gpu if desired
if (device.type == 'cuda') and (ngpu > 1):
    netD = nn.DataParallel(netD, list(range(ngpu)))

# Apply the weights_init function to randomly initialize all weights
# to mean=0, std=0.2.
# 將Discriminator初始化參數
netD.apply(weights_init)

# Print the model
print(netD)

```

```

Discriminator(
    (main): 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()
    )
)

```

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In [ ]: # Initialize BCELoss function
criterion = nn.BCELoss()

# Create batch of latent vectors that we will use to visualize
# the progression of the generator
# 一組固定的noise
fixed_noise = torch.randn(64, z_latent, 1, 1, device=device)

# Establish convention for real and fake labels during training
real_label = 1.

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fake_label = 0.

# Setup Adam optimizers for both G and D
optimizerD = optim.Adam(netD.parameters(), lr=lr, betas=(beta1, 0.999))
optimizerG = optim.Adam(netG.parameters(), lr=lr, betas=(beta1, 0.999))
```

In []: # Training Loop

```
img_list = []
G_losses = []
D_losses = []
iters = 0

print("Starting Training Loop...")

for epoch in range(num_epochs):

    # 用個tqdm progress bar方便看一下batch內的進度
    loop = tqdm(enumerate(dataloader), total = len(dataloader))
    for i, data in loop:

        ##### 先train Discriminator，盡可能最大化D對真假圖的辨識成功score，maximize log(D(x)) + log(1 - D(G(z)))
        # 用真的圖片給Discriminator先學習何謂真圖
        netD.zero_grad()
        real_img = data[0].to(device)
        b_size_of_real = real_img.size(0)

        # 把代表真圖的label=1 assign到這個batch內的所有真圖上
        label = torch.full((b_size_of_real,), real_label, dtype=torch.float, device=device)

        # 計算discriminator對真圖的訓練結果
        output = netD(real_img).view(-1)
        D_loss_real = criterion(output, label)
        D_loss_real.backward()
        # 大概看一下真圖的平均分布為何
        D_x = output.mean().item()

        #### 再用G產出的假圖片給D訓練
        noise = torch.randn(b_size_of_real, z_latent, 1, 1, device=device)
        # 用每次都random的noise給G生成假圖片
        fake = netG(noise)
        label.fill_(fake_label) # 將label填成0代表假圖

        # 計算generator的訓練結果
        output = netD(fake.detach()).view(-1)
        D_loss_fake = criterion(output, label)
        D_loss_fake.backward()
        # 大概看一下假圖的平均分布為何
        D_G_z1 = output.mean().item()
        # Discriminator的總loss是將對real還有fake的loss加總
        D_loss = D_loss_real + D_loss_fake
        optimizerD.step()

        ##### 再train Generator，盡可能最大化D覺得G產出的假圖為真圖的score，maximize log(D(G(z)))
        netG.zero_grad()
        label.fill_(real_label) # 讓假圖對G來說是真的，以讓其越來越真
        output = netD(fake).view(-1)

        # 把G生成的假圖丟到D，計算G的loss
```

```
G_loss = criterion(output, label)
G_loss.backward()
# 大概看一下train過的G產出假圖的平均分布為何
D_G_z2 = output.mean().item()
optimizerG.step()

# 在progress bar內加入一些training stat的參數顯示以便觀察
loop.set_description(f'Epoch [{epoch}/{num_epochs}]')
loop.set_postfix({'Loss_D':D_loss.item(), 'Loss_G':G_loss.item(), 'D(x)':D_x, 'D(G(z))':{:4f} / {:4f}'.format(D_G_z2, D_G_z2)})

# 把loss存起來畫learning curve
G_losses.append(G_loss.item())
D_losses.append(D_loss.item())

# 將G用先前assign的一組固定noise產出圖片，存起來看結果的變化
# 每一個epoch存一次
if (iters % 78 == 0) or ((epoch == num_epochs-1) and (i == len(dataloader)-1)):
    with torch.no_grad():
        fake = netG(fixed_noise).detach().cpu() # 丟回到cpu
        img_list.append(vutils.make_grid(fake, padding=2, normalize=True))

iters += 1
```

Starting Training Loop...

Epoch [0/500]: 100% [██████████] 79/79 [00:04<00:00, 13.31it/s, Loss_D=0.885, Loss_G=11.7, D(x)=0.863, D(G(z))=0.3449 / 0.0000]

Epoch [1/500]: 100% [██████████] 79/79 [00:04<00:00, 17.86it/s, Loss_D=0.22, Loss_G=6.8, D(x)=0.837, D(G(z))=0.0191 / 0.0019]

Epoch [2/500]: 100% [██████████] 79/79 [00:04<00:00, 17.75it/s, Loss_D=1.82, Loss_G=16.6, D(x)=0.98, D(G(z))=0.7623 / 0.0000]

Epoch [3/500]: 100% [██████████] 79/79 [00:04<00:00, 17.49it/s, Loss_D=0.34, Loss_G=6.22, D(x)=0.933, D(G(z))=0.2131 / 0.0037]

Epoch [4/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.264, Loss_G=6.07, D(x)=0.944, D(G(z))=0.1692 / 0.0029]

Epoch [5/500]: 100% [██████████] 79/79 [00:04<00:00, 17.79it/s, Loss_D=0.119, Loss_G=4.18, D(x)=0.949, D(G(z))=0.0607 / 0.0207]

Epoch [6/500]: 100% [██████████] 79/79 [00:04<00:00, 17.37it/s, Loss_D=0.498, Loss_G=8.98, D(x)=0.947, D(G(z))=0.3065 / 0.0005]

Epoch [7/500]: 100% [██████████] 79/79 [00:04<00:00, 17.66it/s, Loss_D=0.306, Loss_G=3.16, D(x)=0.796, D(G(z))=0.0246 / 0.0700]

Epoch [8/500]: 100% [██████████] 79/79 [00:04<00:00, 17.60it/s, Loss_D=0.283, Loss_G=5.11, D(x)=0.852, D(G(z))=0.0768 / 0.0087]

Epoch [9/500]: 100% [██████████] 79/79 [00:04<00:00, 17.60it/s, Loss_D=0.35, Loss_G=5.77, D(x)=0.861, D(G(z))=0.1563 / 0.0059]

Epoch [10/500]: 100% [██████████] 79/79 [00:04<00:00, 17.64it/s, Loss_D=0.509, Loss_G=6.59, D(x)=0.979, D(G(z))=0.2888 / 0.0025]

Epoch [11/500]: 100% [██████████] 79/79 [00:04<00:00, 17.35it/s, Loss_D=0.53, Loss_G=8.1, D(x)=0.893, D(G(z))=0.3009 / 0.0007]

Epoch [12/500]: 100% [██████████] 79/79 [00:04<00:00, 18.14it/s, Loss_D=0.657, Loss_G=6.7, D(x)=0.819, D(G(z))=0.2921 / 0.0062]

Epoch [13/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.458, Loss_G=5.61, D(x)=0.871, D(G(z))=0.1986 / 0.0065]

Epoch [14/500]: 100% [██████████] 79/79 [00:04<00:00, 17.99it/s, Loss_D=0.821, Loss_G=8.16, D(x)=0.909, D(G(z))=0.4756 / 0.0011]

Epoch [15/500]: 100% [██████████] 79/79 [00:04<00:00, 17.46it/s, Loss_D=0.743, Loss_G=5.89, D(x)=0.925, D(G(z))=0.4042 / 0.0033]

Epoch [16/500]: 100% [██████████] 79/79 [00:04<00:00, 17.58it/s, Loss_D=0.59, Loss_G=8.02, D(x)=0.983, D(G(z))=0.3671 / 0.0008]

Epoch [17/500]: 100% [██████████] 79/79 [00:04<00:00, 17.45it/s, Loss_D=0.277, Loss_G=4.19, D(x)=0.876, D(G(z))=0.1120 / 0.0211]

Epoch [18/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.446, Loss_G=5.95, D(x)=0.898, D(G(z))=0.2543 / 0.0042]

Epoch [19/500]: 100% [██████████] 79/79 [00:04<00:00, 17.36it/s, Loss_D=1.33, Loss_G=0.483, D(x)=0.364, D(G(z))=0.0456 / 0.6733]

Epoch [20/500]: 100% [██████████] 79/79 [00:04<00:00, 17.75it/s, Loss_D=1.5, Loss_G=11.8, D(x)=0.952, D(G(z))=0.7016 / 0.0000]

Epoch [21/500]: 100% [██████████] 79/79 [00:04<00:00, 17.72it/s, Loss_D=1.02, Loss_G=1.14, D(x)=0.454, D(G(z))=0.0694 / 0.3525]

Epoch [22/500]: 100% [██████████] 79/79 [00:04<00:00, 17.94it/s, Loss_D=1.04, Loss_G=1.5, D(x)=0.452, D(G(z))=0.0156 / 0.3051]

Epoch [23/500]: 100% [██████████] 79/79 [00:04<00:00, 17.44it/s, Loss_D=1, Loss_G=7.61, D(x)=0.884, D(G(z))=0.5042 / 0.0025]

Epoch [24/500]: 100% [██████████] 79/79 [00:04<00:00, 17.71it/s, Loss_D=0.801, Loss_G=6.83, D(x)=0.964, D(G(z))=0.4428 / 0.0022]

Epoch [25/500]: 100% [██████████] 79/79 [00:04<00:00, 17.68it/s, Loss_D=1.17, Loss_G=1.81, D(x)=0.375, D(G(z))=0.0082 / 0.3051]

Epoch [26/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=1.46, Loss_G=6.07, D(x)=0.959, D(G(z))=0.6248 / 0.0046]

Epoch [27/500]: 100% [██████████] 79/79 [00:04<00:00, 17.57it/s, Loss_D=0.595, Loss_G=4.67, D(x)=0.889, D(G(z))=0.3281 / 0.0129]

Epoch [28/500]: 100% [██████████] 79/79 [00:04<00:00, 18.10it/s, Loss_D=1.01, Loss_G=8.6, D(x)=0.907, D(G(z))=0.5337 / 0.0004]

Epoch [29/500]: 100% [██████████] 79/79 [00:04<00:00, 17.66it/s, Loss_D=0.917, Loss_G=8.3, D(x)=0.986, D(G(z))=0.4496 / 0.0012]

Epoch [30/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=0.464, Loss_G=2.65, D(x)=0.737, D(G(z))=0.0854 / 0.0880]

Epoch [31/500]: 100% [██████████] 79/79 [00:04<00:00, 17.34it/s, Loss_D=0.323, Loss_G=4.05, D(x)=0.906, D(G(z))=0.1805 / 0.0201]

Epoch [32/500]: 100% [██████████] 79/79 [00:04<00:00, 18.14it/s, Loss_D=0.328, Loss_G=5.18, D(x)=0.889, D(G(z))=0.1684 / 0.0077]

Epoch [33/500]: 100% [██████████] 79/79 [00:04<00:00, 17.65it/s, Loss_D=1.05, Loss_G=0.979, D(x)=0.472, D(G(z))=0.0399 / 0.4417]

Epoch [34/500]: 100% [██████████] 79/79 [00:04<00:00, 17.60it/s, Loss_D=0.494, Loss_G=6.87, D(x)=0.953, D(G(z))=0.3221 / 0.0051]

Epoch [35/500]: 100% [██████████] 79/79 [00:04<00:00, 17.39it/s, Loss_D=0.407, Loss_G=5.55, D(x)=0.959, D(G(z))=0.2723 / 0.0060]

Epoch [36/500]: 100% [██████████] 79/79 [00:04<00:00, 17.66it/s, Loss_D=0.605, Loss_G=4.37, D(x)=0.799, D(G(z))=0.2822 / 0.0153]

Epoch [37/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=0.451, Loss_G=2.72, D(x)=0.724, D(G(z))=0.0811 / 0.0843]

Epoch [38/500]: 100% [██████████] 79/79 [00:04<00:00, 17.37it/s, Loss_D=0.242, Loss_G=3.9, D(x)=0.828, D(G(z))=0.0364 / 0.0295]

Epoch [39/500]: 100% [██████████] 79/79 [00:04<00:00, 17.39it/s, Loss_D=1.08, Loss_G=1.16, D(x)=0.422, D(G(z))=0.0373 / 0.4203]

Epoch [40/500]: 100% [██████████] 79/79 [00:04<00:00, 18.02it/s, Loss_D=1.24, Loss_G=0.934, D(x)=0.355, D(G(z))=0.0103 / 0.5403]

Epoch [41/500]: 100% [██████████] 79/79 [00:04<00:00, 17.47it/s, Loss_D=0.425, Loss_G=2.77, D(x)=0.774, D(G(z))=0.1036 / 0.0835]

Epoch [42/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.606, Loss_G=3.3, D(x)=0.745, D(G(z))=0.2022 / 0.0532]

Epoch [43/500]: 100% [██████████] 79/79 [00:04<00:00, 17.47it/s, Loss_D=0.678, Loss_G=6.38, D(x)=0.819, D(G(z))=0.3349 / 0.0058]

Epoch [44/500]: 100% [██████████] 79/79 [00:04<00:00, 17.63it/s, Loss_D=0.749, Loss_G=4.95, D(x)=0.781, D(G(z))=0.3226 / 0.0142]

Epoch [45/500]: 100% [██████████] 79/79 [00:04<00:00, 17.68it/s, Loss_D=2.06, Loss_G=1.12, D(x)=0.17, D(G(z))=0.0107 / 0.3848]

Epoch [46/500]: 100% [██████████] 79/79 [00:04<00:00, 17.28it/s, Loss_D=1.87, Loss_G=10.2, D(x)=0.985, D(G(z))=0.7731 / 0.0001]

Epoch [47/500]: 100% [██████████] 79/79 [00:04<00:00, 17.48it/s, Loss_D=0.587, Loss_G=6.27, D(x)=0.914, D(G(z))=0.3507 / 0.0025]

Epoch [48/500]: 100% [██████████] 79/79 [00:04<00:00, 17.44it/s, Loss_D=0.357, Loss_G=3.28, D(x)=0.755, D(G(z))=0.0516 / 0.0493]

Epoch [49/500]: 100% [██████████] 79/79 [00:04<00:00, 17.51it/s, Loss_D=0.6, Loss_G=7.5, D(x)=0.94, D(G(z))=0.3919 / 0.0055]

Epoch [50/500]: 100% [██████████] 79/79 [00:04<00:00, 17.53it/s, Loss_D=0.343, Loss_G=3.9, D(x)=0.861, D(G(z))=0.1547 / 0.0283]

Epoch [51/500]: 100% [██████████] 79/79 [00:04<00:00, 17.82it/s, Loss_D=0.617, Loss_G=2.95, D(x)=0.663, D(G(z))=0.1428 / 0.0741]

Epoch [52/500]: 100% [██████████] 79/79 [00:04<00:00, 17.68it/s, Loss_D=1.94, Loss_G=10.3, D(x)=0.966, D(G(z))=0.7860 / 0.0003]

Epoch [53/500]: 100% [██████████] 79/79 [00:04<00:00, 17.49it/s, Loss_D=0.488, Loss_G=6.33, D(x)=0.964, D(G(z))=0.3290 / 0.0049]

Epoch [54/500]: 100% [██████████] 79/79 [00:04<00:00, 17.61it/s, Loss_D=0.523, Loss_G=2.83, D(x)=0.735, D(G(z))=0.1060 / 0.0782]

Epoch [55/500]: 100% [██████████] 79/79 [00:04<00:00, 17.79it/s, Loss_D=0.329, Loss_G=3.33, D(x)=0.849, D(G(z))=0.1395 / 0.0483]

Epoch [56/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.407, Loss_G=4.26, D(x)=0.857, D(G(z))=0.2034 / 0.0179]

Epoch [57/500]: 100% [██████████] 79/79 [00:04<00:00, 16.94it/s, Loss_D=0.47, Loss_G=2.4, D(x)=0.782, D(G(z))=0.1757 / 0.1148]

Epoch [58/500]: 100% [██████████] 79/79 [00:04<00:00, 17.29it/s, Loss_D=0.621, Loss_G=7.04, D(x)=0.945, D(G(z))=0.4060 / 0.0017]

Epoch [59/500]: 100% [██████████] 79/79 [00:04<00:00, 17.74it/s, Loss_D=0.346, Loss_G=3.02, D(x)=0.778, D(G(z))=0.0594 / 0.0721]

Epoch [60/500]: 100% [██████████] 79/79 [00:04<00:00, 17.54it/s, Loss_D=0.855, Loss_G=8.32, D(x)=0.959, D(G(z))=0.5101 / 0.0006]

Epoch [61/500]: 100% [██████████] 79/79 [00:04<00:00, 17.27it/s, Loss_D=0.69, Loss_G=4.3, D(x)=0.758, D(G(z))=0.2858 / 0.0274]

Epoch [62/500]: 100% [██████████] 79/79 [00:04<00:00, 17.52it/s, Loss_D=0.263, Loss_G=3.22, D(x)=0.805, D(G(z))=0.0272 / 0.0663]

Epoch [63/500]: 100% [██████████] 79/79 [00:04<00:00, 17.25it/s, Loss_D=0.906, Loss_G=8.53, D(x)=0.834, D(G(z))=0.4447 / 0.0038]

Epoch [64/500]: 100% [██████████] 79/79 [00:04<00:00, 17.70it/s, Loss_D=0.208, Loss_G=4.46, D(x)=0.911, D(G(z))=0.1030 / 0.0161]

Epoch [65/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=1.67, Loss_G=0.158, D(x)=0.26, D(G(z))=0.0112 / 0.8651]

Epoch [66/500]: 100% [██████████] 79/79 [00:04<00:00, 17.52it/s, Loss_D=0.596, Loss_G=7.7, D(x)=0.934, D(G(z))=0.3705 / 0.0012]

Epoch [67/500]: 100% [██████████] 79/79 [00:04<00:00, 17.68it/s, Loss_D=0.335, Loss_G=2.59, D(x)=0.795, D(G(z))=0.0668 / 0.0987]

Epoch [68/500]: 100% [██████████] 79/79 [00:04<00:00, 17.49it/s, Loss_D=0.406, Loss_G=6.1, D(x)=0.962, D(G(z))=0.2871 / 0.0029]

Epoch [69/500]: 100% [██████████] 79/79 [00:04<00:00, 17.50it/s, Loss_D=0.717, Loss_G=8.14, D(x)=0.978, D(G(z))=0.4362 / 0.0012]

Epoch [70/500]: 100% [██████████] 79/79 [00:04<00:00, 17.29it/s, Loss_D=0.47, Loss_G=3.81, D(x)=0.81, D(G(z))=0.1847 / 0.0381]

Epoch [71/500]: 100% [██████████] 79/79 [00:04<00:00, 17.68it/s, Loss_D=0.577, Loss_G=6.85, D(x)=0.916, D(G(z))=0.3549 / 0.0027]

Epoch [72/500]: 100% [██████████] 79/79 [00:04<00:00, 17.78it/s, Loss_D=0.621, Loss_G=1.88, D(x)=0.632, D(G(z))=0.0776 / 0.1920]

Epoch [73/500]: 100% [██████████] 79/79 [00:04<00:00, 17.84it/s, Loss_D=0.486, Loss_G=3.4, D(x)=0.797, D(G(z))=0.2020 / 0.0448]

Epoch [74/500]: 100% [██████████] 79/79 [00:04<00:00, 17.57it/s, Loss_D=0.314, Loss_G=3.94, D(x)=0.843, D(G(z))=0.1175 / 0.0252]

Epoch [75/500]: 100% [██████████] 79/79 [00:04<00:00, 17.64it/s, Loss_D=0.241, Loss_G=3.24, D(x)=0.887, D(G(z))=0.0982 / 0.0529]

Epoch [76/500]: 100% [██████████] 79/79 [00:04<00:00, 17.49it/s, Loss_D=0.429, Loss_G=6.88, D(x)=0.965, D(G(z))=0.2974 / 0.0017]

Epoch [77/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.629, Loss_G=3.23, D(x)=0.707, D(G(z))=0.1357 / 0.0660]

Epoch [78/500]: 100% [██████████] 79/79 [00:04<00:00, 17.23it/s, Loss_D=0.678, Loss_G=5.25, D(x)=0.806, D(G(z))=0.3132 / 0.0111]

Epoch [79/500]: 100% [██████████] 79/79 [00:04<00:00, 17.69it/s, Loss_D=0.466, Loss_G=7.2, D(x)=0.99, D(G(z))=0.3428 / 0.0014]

Epoch [80/500]: 100% [██████████] 79/79 [00:04<00:00, 17.44it/s, Loss_D=0.934, Loss_G=1.81, D(x)=0.572, D(G(z))=0.1341 / 0.2437]

Epoch [81/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.416, Loss_G=5.31, D(x)=0.889, D(G(z))=0.2367 / 0.0131]

Epoch [82/500]: 100% [██████████] 79/79 [00:04<00:00, 17.53it/s, Loss_D=0.42, Loss_G=5.77, D(x)=0.894, D(G(z))=0.1864 / 0.0055]

Epoch [83/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=0.234, Loss_G=5.45, D(x)=0.965, D(G(z))=0.1629 / 0.0058]

Epoch [84/500]: 100% [██████████] 79/79 [00:04<00:00, 17.65it/s, Loss_D=1.58, Loss_G=0.615, D(x)=0.336, D(G(z))=0.0463 / 0.5746]

Epoch [85/500]: 100% [██████████] 79/79 [00:04<00:00, 17.48it/s, Loss_D=0.365, Loss_G=5.62, D(x)=0.954, D(G(z))=0.2384 / 0.0058]

Epoch [86/500]: 100% [██████████] 79/79 [00:04<00:00, 17.80it/s, Loss_D=0.548, Loss_G=7.49, D(x)=0.968, D(G(z))=0.3526 / 0.0018]

Epoch [87/500]: 100% [██████████] 79/79 [00:04<00:00, 17.19it/s, Loss_D=0.429, Loss_G=2.24, D(x)=0.76, D(G(z))=0.1171 / 0.1324]

Epoch [88/500]: 100% [██████████] 79/79 [00:04<00:00, 17.47it/s, Loss_D=0.536, Loss_G=6.76, D(x)=0.885, D(G(z))=0.3134 / 0.0015]

Epoch [89/500]: 100% [██████████] 79/79 [00:04<00:00, 17.52it/s, Loss_D=0.513, Loss_G=2.48, D(x)=0.717, D(G(z))=0.1261 / 0.1231]

Epoch [90/500]: 100% [██████████] 79/79 [00:04<00:00, 17.52it/s, Loss_D=0.955, Loss_G=2.11, D(x)=0.451, D(G(z))=0.0215 / 0.1691]

Epoch [91/500]: 100% [██████████] 79/79 [00:04<00:00, 17.51it/s, Loss_D=0.438, Loss_G=4.55, D(x)=0.833, D(G(z))=0.1552 / 0.0135]

Epoch [92/500]: 100% [██████████] 79/79 [00:04<00:00, 17.73it/s, Loss_D=0.154, Loss_G=4.72, D(x)=0.943, D(G(z))=0.0810 / 0.0097]

Epoch [93/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.662, Loss_G=6.31, D(x)=0.856, D(G(z))=0.3217 / 0.0036]

Epoch [94/500]: 100% [██████████] 79/79 [00:04<00:00, 17.73it/s, Loss_D=0.212, Loss_G=4.31, D(x)=0.902, D(G(z))=0.0900 / 0.0174]

Epoch [95/500]: 100% [██████████] 79/79 [00:04<00:00, 17.73it/s, Loss_D=0.332, Loss_G=3.56, D(x)=0.775, D(G(z))=0.0503 / 0.0379]

Epoch [96/500]: 100% [██████████] 79/79 [00:04<00:00, 17.19it/s, Loss_D=0.512, Loss_G=3.08, D(x)=0.762, D(G(z))=0.1348 / 0.0652]

Epoch [97/500]: 100% [██████████] 79/79 [00:04<00:00, 17.27it/s, Loss_D=0.197, Loss_G=4.12, D(x)=0.912, D(G(z))=0.0944 / 0.0191]

Epoch [98/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=0.576, Loss_G=1.03, D(x)=0.634, D(G(z))=0.0234 / 0.4330]

Epoch [99/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=0.311, Loss_G=5.26, D(x)=0.948, D(G(z))=0.2035 / 0.0082]

Epoch [100/500]: 100% [██████████] 79/79 [00:04<00:00, 17.32it/s, Loss_D=0.359, Loss_G=3.35, D(x)=0.799, D(G(z))=0.0927 / 0.0483]

Epoch [101/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=1.1, Loss_G=10.6, D(x)=0.987, D(G(z))=0.5528 / 0.0001]

Epoch [102/500]: 100% [██████████] 79/79 [00:04<00:00, 17.63it/s, Loss_D=0.268, Loss_G=5.11, D(x)=0.967, D(G(z))=0.1840 / 0.0111]

Epoch [103/500]: 100% [██████████] 79/79 [00:04<00:00, 17.28it/s, Loss_D=0.311, Loss_G=6.47, D(x)=0.933, D(G(z))=0.1731 / 0.0040]

Epoch [104/500]: 100% [██████████] 79/79 [00:04<00:00, 17.57it/s, Loss_D=0.263, Loss_G=5.21, D(x)=0.922, D(G(z))=0.1487 / 0.0099]

Epoch [105/500]: 100% [██████████] 79/79 [00:04<00:00, 17.37it/s, Loss_D=0.331, Loss_G=3.12, D(x)=0.843, D(G(z))=0.1180 / 0.0601]

Epoch [106/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.416, Loss_G=5.34, D(x)=0.846, D(G(z))=0.1753 / 0.0098]

Epoch [107/500]: 100% [██████████] 79/79 [00:04<00:00, 17.46it/s, Loss_D=0.947, Loss_G=2.59, D(x)=0.497, D(G(z))=0.0105 / 0.0986]

Epoch [108/500]: 100% [██████████] 79/79 [00:04<00:00, 17.34it/s, Loss_D=4.33, Loss_G=14.8, D(x)=0.998, D(G(z))=0.9740 / 0.0000]

Epoch [109/500]: 100% [██████████] 79/79 [00:04<00:00, 17.65it/s, Loss_D=0.124, Loss_G=3.79, D(x)=0.93, D(G(z))=0.0464 / 0.0324]

Epoch [110/500]: 100% [██████████] 79/79 [00:04<00:00, 17.27it/s, Loss_D=1.99, Loss_G=0.483, D(x)=0.18, D(G(z))=0.0430 / 0.6773]

Epoch [111/500]: 100% [██████████] 79/79 [00:04<00:00, 17.34it/s, Loss_D=0.724, Loss_G=1.03, D(x)=0.552, D(G(z))=0.0223 / 0.4293]

Epoch [112/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=0.283, Loss_G=2.23, D(x)=0.806, D(G(z))=0.0469 / 0.1445]

Epoch [113/500]: 100% [██████████] 79/79 [00:04<00:00, 18.12it/s, Loss_D=0.84, Loss_G=1.74, D(x)=0.535, D(G(z))=0.0296 / 0.2345]

Epoch [114/500]: 100% [██████████] 79/79 [00:04<00:00, 17.65it/s, Loss_D=0.256, Loss_G=6.27, D(x)=0.959, D(G(z))=0.1755 / 0.0052]

Epoch [115/500]: 100% [██████████] 79/79 [00:04<00:00, 17.54it/s, Loss_D=0.599, Loss_G=11.4, D(x)=0.96, D(G(z))=0.3846 / 0.0001]

Epoch [116/500]: 100% [██████████] 79/79 [00:04<00:00, 17.53it/s, Loss_D=0.739, Loss_G=8.66, D(x)=0.878, D(G(z))=0.3808 / 0.0022]

Epoch [117/500]: 100% [██████████] 79/79 [00:04<00:00, 17.30it/s, Loss_D=0.339, Loss_G=2.87, D(x)=0.788, D(G(z))=0.0737 / 0.0637]

Epoch [118/500]: 100% [██████████] 79/79 [00:04<00:00, 17.28it/s, Loss_D=0.214, Loss_G=3.53, D(x)=0.878, D(G(z))=0.0707 / 0.0375]

Epoch [119/500]: 100% [██████████] 79/79 [00:04<00:00, 17.63it/s, Loss_D=0.319, Loss_G=2.87, D(x)=0.795, D(G(z))=0.0590 / 0.0785]

Epoch [120/500]: 100% [██████████] 79/79 [00:04<00:00, 17.48it/s, Loss_D=0.523, Loss_G=5.57, D(x)=0.821, D(G(z))=0.2482 / 0.0081]

Epoch [121/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=0.415, Loss_G=1.84, D(x)=0.727, D(G(z))=0.0533 / 0.2151]

Epoch [122/500]: 100% [██████████] 79/79 [00:04<00:00, 17.21it/s, Loss_D=0.286, Loss_G=3.03, D(x)=0.841, D(G(z))=0.0742 / 0.0624]

Epoch [123/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=0.966, Loss_G=0.492, D(x)=0.45, D(G(z))=0.0155 / 0.7160]

Epoch [124/500]: 100% [██████████] 79/79 [00:04<00:00, 17.41it/s, Loss_D=0.389, Loss_G=4.74, D(x)=0.875, D(G(z))=0.1955 / 0.0123]

Epoch [125/500]: 100% [██████████] 79/79 [00:04<00:00, 17.21it/s, Loss_D=0.186, Loss_G=3.93, D(x)=0.925, D(G(z))=0.0936 / 0.0273]

Epoch [126/500]: 100% [██████████] 79/79 [00:04<00:00, 17.33it/s, Loss_D=0.102, Loss_G=4.64, D(x)=0.961, D(G(z))=0.0582 / 0.0110]

Epoch [127/500]: 100% [██████████] 79/79 [00:04<00:00, 17.13it/s, Loss_D=0.37, Loss_G=7.09, D(x)=0.913, D(G(z))=0.1950 / 0.0028]

Epoch [128/500]: 100% [██████████] 79/79 [00:04<00:00, 17.51it/s, Loss_D=0.0669, Loss_G=3.95, D(x)=0.966, D(G(z))=0.0302 / 0.0226]
Epoch [129/500]: 100% [██████████] 79/79 [00:04<00:00, 17.24it/s, Loss_D=0.461, Loss_G=10.9, D(x)=0.986, D(G(z))=0.3306 / 0.0001]
Epoch [130/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=1.15, Loss_G=1.37, D(x)=0.407, D(G(z))=0.0022 / 0.2913]
Epoch [131/500]: 100% [██████████] 79/79 [00:04<00:00, 17.67it/s, Loss_D=0.235, Loss_G=6.81, D(x)=0.939, D(G(z))=0.1487 / 0.0013]
Epoch [132/500]: 100% [██████████] 79/79 [00:04<00:00, 17.45it/s, Loss_D=0.185, Loss_G=4.67, D(x)=0.906, D(G(z))=0.0672 / 0.0114]
Epoch [133/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.334, Loss_G=4.65, D(x)=0.834, D(G(z))=0.1283 / 0.0180]
Epoch [134/500]: 100% [██████████] 79/79 [00:04<00:00, 17.63it/s, Loss_D=0.127, Loss_G=3.98, D(x)=0.926, D(G(z))=0.0447 / 0.0250]
Epoch [135/500]: 100% [██████████] 79/79 [00:04<00:00, 17.65it/s, Loss_D=0.103, Loss_G=3.98, D(x)=0.943, D(G(z))=0.0408 / 0.0230]
Epoch [136/500]: 100% [██████████] 79/79 [00:04<00:00, 17.53it/s, Loss_D=0.459, Loss_G=3.06, D(x)=0.739, D(G(z))=0.0979 / 0.0555]
Epoch [137/500]: 100% [██████████] 79/79 [00:04<00:00, 17.34it/s, Loss_D=0.3, Loss_G=6.18, D(x)=0.902, D(G(z))=0.1662 / 0.0028]
Epoch [138/500]: 100% [██████████] 79/79 [00:04<00:00, 17.31it/s, Loss_D=0.216, Loss_G=6.34, D(x)=0.96, D(G(z))=0.1472 / 0.0023]
Epoch [139/500]: 100% [██████████] 79/79 [00:04<00:00, 17.87it/s, Loss_D=0.512, Loss_G=9.29, D(x)=0.931, D(G(z))=0.3157 / 0.0004]
Epoch [140/500]: 100% [██████████] 79/79 [00:04<00:00, 17.70it/s, Loss_D=0.467, Loss_G=10.4, D(x)=0.989, D(G(z))=0.3287 / 0.0001]
Epoch [141/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.269, Loss_G=2.46, D(x)=0.825, D(G(z))=0.0386 / 0.1138]
Epoch [142/500]: 100% [██████████] 79/79 [00:04<00:00, 17.28it/s, Loss_D=0.199, Loss_G=3.06, D(x)=0.86, D(G(z))=0.0255 / 0.0585]
Epoch [143/500]: 100% [██████████] 79/79 [00:04<00:00, 17.51it/s, Loss_D=0.277, Loss_G=2.59, D(x)=0.821, D(G(z))=0.0609 / 0.0913]
Epoch [144/500]: 100% [██████████] 79/79 [00:04<00:00, 17.58it/s, Loss_D=3.34, Loss_G=0.0888, D(x)=0.0561, D(G(z))=0.0001 / 0.9202]
Epoch [145/500]: 100% [██████████] 79/79 [00:04<00:00, 17.65it/s, Loss_D=0.3, Loss_G=7.45, D(x)=0.919, D(G(z))=0.1673 / 0.0016]
Epoch [146/500]: 100% [██████████] 79/79 [00:04<00:00, 17.80it/s, Loss_D=0.0601, Loss_G=4.16, D(x)=0.976, D(G(z))=0.0349 / 0.0178]
Epoch [147/500]: 100% [██████████] 79/79 [00:04<00:00, 17.68it/s, Loss_D=0.169, Loss_G=4.13, D(x)=0.927, D(G(z))=0.0731 / 0.0217]
Epoch [148/500]: 100% [██████████] 79/79 [00:04<00:00, 17.29it/s, Loss_D=0.448, Loss_G=8.15, D(x)=0.946, D(G(z))=0.2828 / 0.0011]
Epoch [149/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=0.31, Loss_G=3.75, D(x)=0.845, D(G(z))=0.1104 / 0.0328]
Epoch [150/500]: 100% [██████████] 79/79 [00:04<00:00, 17.69it/s, Loss_D=4.7, Loss_G=0.392, D(x)=0.018, D(G(z))=0.0001 / 0.7229]
Epoch [151/500]: 100% [██████████] 79/79 [00:04<00:00, 17.01it/s, Loss_D=0.41, Loss_G=2.78, D(x)=0.75, D(G(z))=0.0941 / 0.0822]
Epoch [152/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=0.121, Loss_G=2.98, D(x)=0.914, D(G(z))=0.0275 / 0.0587]
Epoch [153/500]: 100% [██████████] 79/79 [00:04<00:00, 17.52it/s, Loss_D=0.0659, Loss_G=4.8, D(x)=0.952, D(G(z))=0.0147 / 0.0101]
Epoch [154/500]: 100% [██████████] 79/79 [00:04<00:00, 17.33it/s, Loss_D=0.608, Loss_G=0.865, D(x)=0.647, D(G(z))=0.0459 / 0.4987]
Epoch [155/500]: 100% [██████████] 79/79 [00:04<00:00, 17.30it/s, Loss_D=0.147, Loss_G=4.58, D(x)=0.928, D(G(z))=0.0654 / 0.0128]
Epoch [156/500]: 100% [██████████] 79/79 [00:04<00:00, 17.45it/s, Loss_D=0.139, Loss_G=5.21, D(x)=0.963, D(G(z))=0.0910 / 0.0068]
Epoch [157/500]: 100% [██████████] 79/79 [00:04<00:00, 17.66it/s, Loss_D=0.126, Loss_G=5.17, D(x)=0.934, D(G(z))=0.0522 / 0.0073]
Epoch [158/500]: 100% [██████████] 79/79 [00:04<00:00, 17.54it/s, Loss_D=0.216, Loss_G=3.03, D(x)=0.858, D(G(z))=0.0456 / 0.0669]
Epoch [159/500]: 100% [██████████] 79/79 [00:04<00:00, 17.21it/s, Loss_D=0.406, Loss_G=6.51, D(x)=0.909, D(G(z))=0.2116 / 0.0050]

Epoch [160/500]: 100% [██████████] 79/79 [00:04<00:00, 17.70it/s, Loss_D=0.226, Loss_G=4.6, D(x)=0.886, D(G(z))=0.0838 / 0.0281]

Epoch [161/500]: 100% [██████████] 79/79 [00:04<00:00, 17.80it/s, Loss_D=0.267, Loss_G=3.21, D(x)=0.847, D(G(z))=0.0677 / 0.0553]

Epoch [162/500]: 100% [██████████] 79/79 [00:04<00:00, 17.96it/s, Loss_D=0.147, Loss_G=4.51, D(x)=0.886, D(G(z))=0.0195 / 0.0208]

Epoch [163/500]: 100% [██████████] 79/79 [00:04<00:00, 17.27it/s, Loss_D=0.777, Loss_G=1.97, D(x)=0.543, D(G(z))=0.0399 / 0.2141]

Epoch [164/500]: 100% [██████████] 79/79 [00:04<00:00, 17.83it/s, Loss_D=0.126, Loss_G=4.35, D(x)=0.924, D(G(z))=0.0435 / 0.0155]

Epoch [165/500]: 100% [██████████] 79/79 [00:04<00:00, 17.49it/s, Loss_D=0.139, Loss_G=5.9, D(x)=0.973, D(G(z))=0.0851 / 0.0054]

Epoch [166/500]: 100% [██████████] 79/79 [00:04<00:00, 17.40it/s, Loss_D=0.285, Loss_G=2.53, D(x)=0.807, D(G(z))=0.0404 / 0.1073]

Epoch [167/500]: 100% [██████████] 79/79 [00:04<00:00, 17.36it/s, Loss_D=0.131, Loss_G=4.61, D(x)=0.903, D(G(z))=0.0223 / 0.0141]

Epoch [168/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.0661, Loss_G=4.79, D(x)=0.971, D(G(z))=0.0345 / 0.0111]

Epoch [169/500]: 100% [██████████] 79/79 [00:04<00:00, 17.28it/s, Loss_D=0.129, Loss_G=4.37, D(x)=0.899, D(G(z))=0.0110 / 0.0262]

Epoch [170/500]: 100% [██████████] 79/79 [00:04<00:00, 17.41it/s, Loss_D=0.136, Loss_G=5.91, D(x)=0.957, D(G(z))=0.0815 / 0.0039]

Epoch [171/500]: 100% [██████████] 79/79 [00:04<00:00, 17.61it/s, Loss_D=0.0714, Loss_G=5.48, D(x)=0.946, D(G(z))=0.0119 / 0.0064]

Epoch [172/500]: 100% [██████████] 79/79 [00:04<00:00, 17.46it/s, Loss_D=1.76, Loss_G=2.68, D(x)=0.371, D(G(z))=0.3323 / 0.2994]

Epoch [173/500]: 100% [██████████] 79/79 [00:04<00:00, 17.63it/s, Loss_D=1.46, Loss_G=0.629, D(x)=0.302, D(G(z))=0.0031 / 0.6002]

Epoch [174/500]: 100% [██████████] 79/79 [00:04<00:00, 17.58it/s, Loss_D=0.0933, Loss_G=5.11, D(x)=0.963, D(G(z))=0.0516 / 0.0075]

Epoch [175/500]: 100% [██████████] 79/79 [00:04<00:00, 17.58it/s, Loss_D=0.141, Loss_G=4.64, D(x)=0.935, D(G(z))=0.0634 / 0.0150]

Epoch [176/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=0.376, Loss_G=8.01, D(x)=0.931, D(G(z))=0.2248 / 0.0011]

Epoch [177/500]: 100% [██████████] 79/79 [00:04<00:00, 17.60it/s, Loss_D=0.124, Loss_G=6.04, D(x)=0.969, D(G(z))=0.0865 / 0.0026]

Epoch [178/500]: 100% [██████████] 79/79 [00:04<00:00, 17.40it/s, Loss_D=0.114, Loss_G=5.84, D(x)=0.981, D(G(z))=0.0858 / 0.0037]

Epoch [179/500]: 100% [██████████] 79/79 [00:04<00:00, 17.39it/s, Loss_D=0.112, Loss_G=3.94, D(x)=0.929, D(G(z))=0.0262 / 0.0263]

Epoch [180/500]: 100% [██████████] 79/79 [00:04<00:00, 17.40it/s, Loss_D=0.252, Loss_G=2.43, D(x)=0.816, D(G(z))=0.0343 / 0.1116]

Epoch [181/500]: 100% [██████████] 79/79 [00:04<00:00, 17.42it/s, Loss_D=0.0593, Loss_G=5.05, D(x)=0.956, D(G(z))=0.0135 / 0.0077]

Epoch [182/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.0712, Loss_G=4.49, D(x)=0.955, D(G(z))=0.0225 / 0.0137]

Epoch [183/500]: 100% [██████████] 79/79 [00:04<00:00, 17.72it/s, Loss_D=0.179, Loss_G=5.42, D(x)=0.886, D(G(z))=0.0369 / 0.0078]

Epoch [184/500]: 100% [██████████] 79/79 [00:04<00:00, 17.52it/s, Loss_D=0.0894, Loss_G=5.16, D(x)=0.98, D(G(z))=0.0575 / 0.0084]

Epoch [185/500]: 100% [██████████] 79/79 [00:04<00:00, 17.38it/s, Loss_D=1.18, Loss_G=3.27, D(x)=0.491, D(G(z))=0.1916 / 0.0801]

Epoch [186/500]: 100% [██████████] 79/79 [00:04<00:00, 17.39it/s, Loss_D=0.0941, Loss_G=4.66, D(x)=0.927, D(G(z))=0.0145 / 0.0117]

Epoch [187/500]: 100% [██████████] 79/79 [00:04<00:00, 17.67it/s, Loss_D=0.22, Loss_G=5.29, D(x)=0.901, D(G(z))=0.0983 / 0.0070]

Epoch [188/500]: 100% [██████████] 79/79 [00:04<00:00, 17.45it/s, Loss_D=0.072, Loss_G=6.06, D(x)=0.994, D(G(z))=0.0598 / 0.0038]

Epoch [189/500]: 100% [██████████] 79/79 [00:04<00:00, 17.63it/s, Loss_D=0.184, Loss_G=4.2, D(x)=0.905, D(G(z))=0.0705 / 0.0218]

Epoch [190/500]: 100% [██████████] 79/79 [00:04<00:00, 17.41it/s, Loss_D=0.209, Loss_G=3.25, D(x)=0.857, D(G(z))=0.0408 / 0.0535]

Epoch [191/500]: 100% [██████████] 79/79 [00:04<00:00, 17.61it/s, Loss_D=0.791, Loss_G=5.11, D(x)=0.811, D(G(z))=0.3121 / 0.0193]

Epoch [192/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.0643, Loss_G=5.22, D(x)=0.951, D(G(z))=0.0110 / 0.0087]

Epoch [193/500]: 100% [██████████] 79/79 [00:04<00:00, 17.57it/s, Loss_D=0.606, Loss_G=2.13, D(x)=0.659, D(G(z))=0.1231 / 0.1986]

Epoch [194/500]: 100% [██████████] 79/79 [00:04<00:00, 17.77it/s, Loss_D=0.117, Loss_G=4, D(x)=0.931, D(G(z))=0.0416 / 0.0203]

Epoch [195/500]: 100% [██████████] 79/79 [00:04<00:00, 17.71it/s, Loss_D=0.11, Loss_G=5.67, D(x)=0.984, D(G(z))=0.0864 / 0.0043]

Epoch [196/500]: 100% [██████████] 79/79 [00:04<00:00, 17.66it/s, Loss_D=0.0851, Loss_G=4.24, D(x)=0.945, D(G(z))=0.0273 / 0.0213]

Epoch [197/500]: 100% [██████████] 79/79 [00:04<00:00, 17.53it/s, Loss_D=0.124, Loss_G=5.46, D(x)=0.953, D(G(z))=0.0664 / 0.0056]

Epoch [198/500]: 100% [██████████] 79/79 [00:04<00:00, 17.47it/s, Loss_D=0.199, Loss_G=5.07, D(x)=0.885, D(G(z))=0.0571 / 0.0136]

Epoch [199/500]: 100% [██████████] 79/79 [00:04<00:00, 17.78it/s, Loss_D=0.0449, Loss_G=4.67, D(x)=0.975, D(G(z))=0.0182 / 0.0117]

Epoch [200/500]: 100% [██████████] 79/79 [00:04<00:00, 17.84it/s, Loss_D=0.376, Loss_G=10.9, D(x)=0.94, D(G(z))=0.2290 / 0.0002]

Epoch [201/500]: 100% [██████████] 79/79 [00:04<00:00, 17.23it/s, Loss_D=0.218, Loss_G=0.82, D(x)=0.829, D(G(z))=0.0152 / 0.4972]

Epoch [202/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.228, Loss_G=2.31, D(x)=0.833, D(G(z))=0.0313 / 0.1315]

Epoch [203/500]: 100% [██████████] 79/79 [00:04<00:00, 17.66it/s, Loss_D=0.277, Loss_G=2.84, D(x)=0.841, D(G(z))=0.0691 / 0.0872]

Epoch [204/500]: 100% [██████████] 79/79 [00:04<00:00, 17.29it/s, Loss_D=0.13, Loss_G=2.77, D(x)=0.909, D(G(z))=0.0277 / 0.0784]

Epoch [205/500]: 100% [██████████] 79/79 [00:04<00:00, 17.40it/s, Loss_D=0.113, Loss_G=4, D(x)=0.907, D(G(z))=0.0110 / 0.0387]

Epoch [206/500]: 100% [██████████] 79/79 [00:04<00:00, 17.24it/s, Loss_D=0.189, Loss_G=2.2, D(x)=0.861, D(G(z))=0.0120 / 0.1585]

Epoch [207/500]: 100% [██████████] 79/79 [00:04<00:00, 17.37it/s, Loss_D=0.278, Loss_G=4.23, D(x)=0.822, D(G(z))=0.0613 / 0.0181]

Epoch [208/500]: 100% [██████████] 79/79 [00:04<00:00, 17.48it/s, Loss_D=0.117, Loss_G=5.96, D(x)=0.968, D(G(z))=0.0750 / 0.0037]

Epoch [209/500]: 100% [██████████] 79/79 [00:04<00:00, 17.94it/s, Loss_D=0.288, Loss_G=6.73, D(x)=0.884, D(G(z))=0.1345 / 0.0065]

Epoch [210/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=2.68, Loss_G=0.224, D(x)=0.125, D(G(z))=0.0004 / 0.8393]

Epoch [211/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=0.173, Loss_G=3.87, D(x)=0.907, D(G(z))=0.0675 / 0.0254]

Epoch [212/500]: 100% [██████████] 79/79 [00:04<00:00, 17.15it/s, Loss_D=0.968, Loss_G=15.9, D(x)=0.997, D(G(z))=0.5189 / 0.0000]

Epoch [213/500]: 100% [██████████] 79/79 [00:04<00:00, 17.33it/s, Loss_D=0.0769, Loss_G=4.06, D(x)=0.952, D(G(z))=0.0266 / 0.0228]

Epoch [214/500]: 100% [██████████] 79/79 [00:04<00:00, 17.50it/s, Loss_D=0.262, Loss_G=9.1, D(x)=0.975, D(G(z))=0.1820 / 0.0005]

Epoch [215/500]: 100% [██████████] 79/79 [00:04<00:00, 17.75it/s, Loss_D=0.138, Loss_G=6.17, D(x)=0.962, D(G(z))=0.0860 / 0.0029]

Epoch [216/500]: 100% [██████████] 79/79 [00:04<00:00, 17.38it/s, Loss_D=0.192, Loss_G=4.91, D(x)=0.904, D(G(z))=0.0533 / 0.0100]

Epoch [217/500]: 100% [██████████] 79/79 [00:04<00:00, 17.80it/s, Loss_D=0.673, Loss_G=10.5, D(x)=0.995, D(G(z))=0.3138 / 0.0002]

Epoch [218/500]: 100% [██████████] 79/79 [00:04<00:00, 17.30it/s, Loss_D=0.0956, Loss_G=4.84, D(x)=0.94, D(G(z))=0.0295 / 0.0162]

Epoch [219/500]: 100% [██████████] 79/79 [00:04<00:00, 17.77it/s, Loss_D=0.141, Loss_G=3.81, D(x)=0.91, D(G(z))=0.0316 / 0.0262]

Epoch [220/500]: 100% [██████████] 79/79 [00:04<00:00, 17.63it/s, Loss_D=0.215, Loss_G=3.37, D(x)=0.857, D(G(z))=0.0494 / 0.0466]

Epoch [221/500]: 100% [██████████] 79/79 [00:04<00:00, 17.68it/s, Loss_D=0.0641, Loss_G=4.24, D(x)=0.955, D(G(z))=0.0158 / 0.0199]

Epoch [222/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=0.147, Loss_G=6.54, D(x)=0.944, D(G(z))=0.0779 / 0.0024]

Epoch [223/500]: 100% [██████████] 79/79 [00:04<00:00, 17.57it/s, Loss_D=0.148, Loss_G=3.71, D(x)=0.915, D(G(z))=0.0535 / 0.0319]

Epoch [224/500]: 100% [██████████] 79/79 [00:04<00:00, 17.39it/s, Loss_D=0.0841, Loss_G=6.36, D(x)=0.976, D(G(z))=0.0535 / 0.0030]

Epoch [225/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=0.138, Loss_G=6.01, D(x)=0.947, D(G(z))=0.0711 / 0.0034]

Epoch [226/500]: 100% [██████████] 79/79 [00:04<00:00, 17.52it/s, Loss_D=0.164, Loss_G=3.19, D(x)=0.884, D(G(z))=0.0233 / 0.0705]

Epoch [227/500]: 100% [██████████] 79/79 [00:04<00:00, 17.04it/s, Loss_D=0.285, Loss_G=3.61, D(x)=0.834, D(G(z))=0.0565 / 0.0379]

Epoch [228/500]: 100% [██████████] 79/79 [00:04<00:00, 17.73it/s, Loss_D=0.208, Loss_G=8.75, D(x)=0.975, D(G(z))=0.1429 / 0.0005]

Epoch [229/500]: 100% [██████████] 79/79 [00:04<00:00, 17.50it/s, Loss_D=0.0687, Loss_G=3.98, D(x)=0.953, D(G(z))=0.0187 / 0.0268]

Epoch [230/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=0.111, Loss_G=4.34, D(x)=0.921, D(G(z))=0.0177 / 0.0196]

Epoch [231/500]: 100% [██████████] 79/79 [00:04<00:00, 17.89it/s, Loss_D=0.18, Loss_G=5.42, D(x)=0.882, D(G(z))=0.0400 / 0.0086]

Epoch [232/500]: 100% [██████████] 79/79 [00:04<00:00, 17.60it/s, Loss_D=0.126, Loss_G=8.77, D(x)=0.993, D(G(z))=0.1030 / 0.0006]

Epoch [233/500]: 100% [██████████] 79/79 [00:04<00:00, 17.15it/s, Loss_D=0.159, Loss_G=2.98, D(x)=0.889, D(G(z))=0.0124 / 0.0659]

Epoch [234/500]: 100% [██████████] 79/79 [00:04<00:00, 17.07it/s, Loss_D=0.0563, Loss_G=5.82, D(x)=0.996, D(G(z))=0.0481 / 0.0042]

Epoch [235/500]: 100% [██████████] 79/79 [00:04<00:00, 17.31it/s, Loss_D=0.103, Loss_G=4.01, D(x)=0.923, D(G(z))=0.0188 / 0.0264]

Epoch [236/500]: 100% [██████████] 79/79 [00:04<00:00, 17.66it/s, Loss_D=0.137, Loss_G=8.35, D(x)=0.991, D(G(z))=0.1105 / 0.0011]

Epoch [237/500]: 100% [██████████] 79/79 [00:04<00:00, 17.40it/s, Loss_D=0.0777, Loss_G=4.1, D(x)=0.946, D(G(z))=0.0186 / 0.0253]

Epoch [238/500]: 100% [██████████] 79/79 [00:04<00:00, 17.83it/s, Loss_D=4.6, Loss_G=16.2, D(x)=1, D(G(z))=0.9704 / 0.0000]

Epoch [239/500]: 100% [██████████] 79/79 [00:04<00:00, 17.29it/s, Loss_D=0.243, Loss_G=8.01, D(x)=0.931, D(G(z))=0.1339 / 0.0013]

Epoch [240/500]: 100% [██████████] 79/79 [00:04<00:00, 17.42it/s, Loss_D=0.603, Loss_G=3.45, D(x)=0.747, D(G(z))=0.1461 / 0.0719]

Epoch [241/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=0.0957, Loss_G=4.23, D(x)=0.934, D(G(z))=0.0240 / 0.0206]

Epoch [242/500]: 100% [██████████] 79/79 [00:04<00:00, 17.22it/s, Loss_D=0.124, Loss_G=5.45, D(x)=0.948, D(G(z))=0.0617 / 0.0050]

Epoch [243/500]: 100% [██████████] 79/79 [00:04<00:00, 17.34it/s, Loss_D=0.129, Loss_G=4.82, D(x)=0.896, D(G(z))=0.0085 / 0.0151]

Epoch [244/500]: 100% [██████████] 79/79 [00:04<00:00, 17.57it/s, Loss_D=0.447, Loss_G=3.39, D(x)=0.788, D(G(z))=0.0794 / 0.0483]

Epoch [245/500]: 100% [██████████] 79/79 [00:04<00:00, 17.46it/s, Loss_D=0.0747, Loss_G=5.64, D(x)=0.983, D(G(z))=0.0536 / 0.0043]

Epoch [246/500]: 100% [██████████] 79/79 [00:04<00:00, 17.75it/s, Loss_D=0.277, Loss_G=3.34, D(x)=0.83, D(G(z))=0.0580 / 0.0421]

Epoch [247/500]: 100% [██████████] 79/79 [00:04<00:00, 17.48it/s, Loss_D=0.121, Loss_G=4.16, D(x)=0.937, D(G(z))=0.0439 / 0.0225]

Epoch [248/500]: 100% [██████████] 79/79 [00:04<00:00, 17.63it/s, Loss_D=0.0662, Loss_G=4.92, D(x)=0.96, D(G(z))=0.0242 / 0.0091]

Epoch [249/500]: 100% [██████████] 79/79 [00:04<00:00, 17.23it/s, Loss_D=0.0907, Loss_G=4.45, D(x)=0.919, D(G(z))=0.0040 / 0.0164]

Epoch [250/500]: 100% [██████████] 79/79 [00:04<00:00, 17.07it/s, Loss_D=0.104, Loss_G=8.62, D(x)=0.997, D(G(z))=0.0912 / 0.0004]

Epoch [251/500]: 100% [██████████] 79/79 [00:04<00:00, 17.50it/s, Loss_D=0.0887, Loss_G=6.16, D(x)=0.971, D(G(z))=0.0547 / 0.0026]

Epoch [252/500]: 100% [██████████] 79/79 [00:04<00:00, 17.54it/s, Loss_D=0.0924, Loss_G=5.23, D(x)=0.948, D(G(z))=0.0320 / 0.0077]

Epoch [253/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.0888, Loss_G=4.49, D(x)=0.965, D(G(z))=0.0491 / 0.0149]

Epoch [254/500]: 100% [██████████] 79/79 [00:04<00:00, 17.79it/s, Loss_D=0.0982, Loss_G=4.27, D(x)=0.931, D(G(z))=0.0215 / 0.0225]

Epoch [255/500]: 100% [██████████] 79/79 [00:04<00:00, 17.51it/s, Loss_D=0.179, Loss_G=4.83, D(x)=0.891, D(G(z))=0.0509 / 0.0093]

Epoch [256/500]: 100% [██████████] 79/79 [00:04<00:00, 17.48it/s, Loss_D=0.0118, Loss_G=6.56, D(x)=0.991, D(G(z))=0.0026 / 0.0022]

Epoch [257/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=0.123, Loss_G=7.92, D(x)=0.99, D(G(z))=0.0919 / 0.0010]

Epoch [258/500]: 100% [██████████] 79/79 [00:04<00:00, 17.91it/s, Loss_D=0.0323, Loss_G=6.03, D(x)=0.974, D(G(z))=0.0051 / 0.0041]

Epoch [259/500]: 100% [██████████] 79/79 [00:04<00:00, 17.37it/s, Loss_D=0.0765, Loss_G=5, D(x)=0.94, D(G(z))=0.0089 / 0.0116]

Epoch [260/500]: 100% [██████████] 79/79 [00:04<00:00, 17.32it/s, Loss_D=1.07, Loss_G=6.25, D(x)=0.787, D(G(z))=0.4205 / 0.0139]

Epoch [261/500]: 100% [██████████] 79/79 [00:04<00:00, 17.73it/s, Loss_D=0.123, Loss_G=3.58, D(x)=0.906, D(G(z))=0.0085 / 0.0425]

Epoch [262/500]: 100% [██████████] 79/79 [00:04<00:00, 17.49it/s, Loss_D=0.111, Loss_G=5.94, D(x)=0.923, D(G(z))=0.0272 / 0.0053]

Epoch [263/500]: 100% [██████████] 79/79 [00:04<00:00, 17.47it/s, Loss_D=0.124, Loss_G=4.99, D(x)=0.907, D(G(z))=0.0161 / 0.0194]

Epoch [264/500]: 100% [██████████] 79/79 [00:04<00:00, 17.18it/s, Loss_D=0.0431, Loss_G=5.22, D(x)=0.972, D(G(z))=0.0136 / 0.0081]

Epoch [265/500]: 100% [██████████] 79/79 [00:04<00:00, 17.68it/s, Loss_D=0.49, Loss_G=3.45, D(x)=0.791, D(G(z))=0.1383 / 0.0648]

Epoch [266/500]: 100% [██████████] 79/79 [00:04<00:00, 17.43it/s, Loss_D=0.0529, Loss_G=3.69, D(x)=0.971, D(G(z))=0.0218 / 0.0317]

Epoch [267/500]: 100% [██████████] 79/79 [00:04<00:00, 17.24it/s, Loss_D=0.0488, Loss_G=6.23, D(x)=0.99, D(G(z))=0.0354 / 0.0034]

Epoch [268/500]: 100% [██████████] 79/79 [00:04<00:00, 17.44it/s, Loss_D=0.0788, Loss_G=6.32, D(x)=0.97, D(G(z))=0.0442 / 0.0031]

Epoch [269/500]: 100% [██████████] 79/79 [00:04<00:00, 17.50it/s, Loss_D=0.714, Loss_G=10.3, D(x)=0.953, D(G(z))=0.3957 / 0.0003]

Epoch [270/500]: 100% [██████████] 79/79 [00:04<00:00, 17.46it/s, Loss_D=0.16, Loss_G=6.84, D(x)=0.947, D(G(z))=0.0919 / 0.0030]

Epoch [271/500]: 100% [██████████] 79/79 [00:04<00:00, 17.70it/s, Loss_D=0.086, Loss_G=6.05, D(x)=0.958, D(G(z))=0.0393 / 0.0042]

Epoch [272/500]: 100% [██████████] 79/79 [00:04<00:00, 17.68it/s, Loss_D=0.0606, Loss_G=6.58, D(x)=0.996, D(G(z))=0.0536 / 0.0021]

Epoch [273/500]: 100% [██████████] 79/79 [00:04<00:00, 17.44it/s, Loss_D=0.279, Loss_G=3.49, D(x)=0.845, D(G(z))=0.0779 / 0.0449]

Epoch [274/500]: 100% [██████████] 79/79 [00:04<00:00, 17.47it/s, Loss_D=0.162, Loss_G=3.42, D(x)=0.865, D(G(z))=0.0057 / 0.0639]

Epoch [275/500]: 100% [██████████] 79/79 [00:04<00:00, 17.40it/s, Loss_D=0.0863, Loss_G=4.18, D(x)=0.931, D(G(z))=0.0109 / 0.0282]

Epoch [276/500]: 100% [██████████] 79/79 [00:04<00:00, 17.08it/s, Loss_D=0.142, Loss_G=4.87, D(x)=0.912, D(G(z))=0.0211 / 0.0105]

Epoch [277/500]: 100% [██████████] 79/79 [00:04<00:00, 17.51it/s, Loss_D=6.17, Loss_G=2.42, D(x)=0.00502, D(G(z))=0.0003 / 0.2571]

Epoch [278/500]: 100% [██████████] 79/79 [00:04<00:00, 17.40it/s, Loss_D=0.271, Loss_G=11.7, D(x)=0.99, D(G(z))=0.1928 / 0.0000]

Epoch [279/500]: 100% [██████████] 79/79 [00:04<00:00, 17.29it/s, Loss_D=0.0447, Loss_G=5.38, D(x)=0.983, D(G(z))=0.0261 / 0.0069]

Epoch [280/500]: 100% [██████████] 79/79 [00:04<00:00, 17.35it/s, Loss_D=0.0788, Loss_G=7.92, D(x)=0.997, D(G(z))=0.0686 / 0.0010]

Epoch [281/500]: 100% [██████████] 79/79 [00:04<00:00, 17.36it/s, Loss_D=0.0348, Loss_G=6.11, D(x)=0.982, D(G(z))=0.0158 / 0.0037]

Epoch [282/500]: 100% [██████████] 79/79 [00:04<00:00, 17.09it/s, Loss_D=0.571, Loss_G=2.66, D(x)=0.713, D(G(z))=0.1133 / 0.1184]

Epoch [283/500]: 100% [██████████] 79/79 [00:04<00:00, 17.53it/s, Loss_D=0.0708, Loss_G=4.21, D(x)=0.949, D(G(z))=0.0148 / 0.0263]

Epoch [284/500]: 100% [██████████] 79/79 [00:04<00:00, 17.63it/s, Loss_D=0.765, Loss_G=3.35, D(x)=0.667, D(G(z))=0.0795 / 0.0657]

Epoch [285/500]: 100% [██████████] 79/79 [00:04<00:00, 17.64it/s, Loss_D=0.337, Loss_G=2.47, D(x)=0.767, D(G(z))=0.0178 / 0.1848]

Epoch [286/500]: 100% [██████████] 79/79 [00:04<00:00, 17.14it/s, Loss_D=0.212, Loss_G=9.6, D(x)=0.997, D(G(z))=0.1341 / 0.0002]

Epoch [287/500]: 100% [██████████] 79/79 [00:04<00:00, 17.66it/s, Loss_D=0.356, Loss_G=0.441, D(x)=0.762, D(G(z))=0.0076 / 0.6887]

Epoch [288/500]: 100% [██████████] 79/79 [00:04<00:00, 17.70it/s, Loss_D=0.0977, Loss_G=6.69, D(x)=0.992, D(G(z))=0.0749 / 0.0035]

Epoch [289/500]: 100% [██████████] 79/79 [00:04<00:00, 17.17it/s, Loss_D=0.0342, Loss_G=5.68, D(x)=0.985, D(G(z))=0.0188 / 0.0063]

Epoch [290/500]: 100% [██████████] 79/79 [00:04<00:00, 17.35it/s, Loss_D=0.0496, Loss_G=4.27, D(x)=0.961, D(G(z))=0.0075 / 0.0215]

Epoch [291/500]: 100% [██████████] 79/79 [00:04<00:00, 17.46it/s, Loss_D=0.0686, Loss_G=6.98, D(x)=0.989, D(G(z))=0.0532 / 0.0012]

Epoch [292/500]: 100% [██████████] 79/79 [00:04<00:00, 17.53it/s, Loss_D=0.23, Loss_G=9.85, D(x)=0.969, D(G(z))=0.1588 / 0.0002]

Epoch [293/500]: 100% [██████████] 79/79 [00:04<00:00, 17.44it/s, Loss_D=0.177, Loss_G=2.29, D(x)=0.902, D(G(z))=0.0155 / 0.2060]

Epoch [294/500]: 100% [██████████] 79/79 [00:04<00:00, 17.57it/s, Loss_D=0.0814, Loss_G=6.77, D(x)=0.973, D(G(z))=0.0493 / 0.0022]

Epoch [295/500]: 100% [██████████] 79/79 [00:04<00:00, 17.66it/s, Loss_D=0.0364, Loss_G=5.63, D(x)=0.969, D(G(z))=0.0043 / 0.0065]

Epoch [296/500]: 100% [██████████] 79/79 [00:04<00:00, 17.65it/s, Loss_D=0.107, Loss_G=4.36, D(x)=0.932, D(G(z))=0.0317 / 0.0182]

Epoch [297/500]: 100% [██████████] 79/79 [00:04<00:00, 17.28it/s, Loss_D=0.172, Loss_G=3.54, D(x)=0.905, D(G(z))=0.0565 / 0.0589]

Epoch [298/500]: 100% [██████████] 79/79 [00:04<00:00, 17.34it/s, Loss_D=0.159, Loss_G=3.04, D(x)=0.884, D(G(z))=0.0092 / 0.0743]

Epoch [299/500]: 100% [██████████] 79/79 [00:04<00:00, 17.66it/s, Loss_D=0.0634, Loss_G=5.77, D(x)=0.981, D(G(z))=0.0420 / 0.0044]

Epoch [300/500]: 100% [██████████] 79/79 [00:04<00:00, 17.61it/s, Loss_D=0.0276, Loss_G=6.07, D(x)=0.984, D(G(z))=0.0112 / 0.0045]

Epoch [301/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=0.11, Loss_G=2.87, D(x)=0.914, D(G(z))=0.0014 / 0.1080]

Epoch [302/500]: 100% [██████████] 79/79 [00:04<00:00, 17.45it/s, Loss_D=0.0399, Loss_G=6.14, D(x)=0.979, D(G(z))=0.0175 / 0.0063]

Epoch [303/500]: 100% [██████████] 79/79 [00:04<00:00, 17.47it/s, Loss_D=0.0113, Loss_G=6.66, D(x)=0.992, D(G(z))=0.0030 / 0.0023]

Epoch [304/500]: 100% [██████████] 79/79 [00:04<00:00, 17.11it/s, Loss_D=0.818, Loss_G=4.03, D(x)=0.765, D(G(z))=0.2921 / 0.1028]

Epoch [305/500]: 100% [██████████] 79/79 [00:04<00:00, 17.43it/s, Loss_D=0.0556, Loss_G=5.83, D(x)=0.998, D(G(z))=0.0504 / 0.0033]

Epoch [306/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.0601, Loss_G=5.83, D(x)=0.958, D(G(z))=0.0133 / 0.0049]

Epoch [307/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.0383, Loss_G=5.68, D(x)=0.979, D(G(z))=0.0168 / 0.0051]

Epoch [308/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.154, Loss_G=4.55, D(x)=0.918, D(G(z))=0.0579 / 0.0133]

Epoch [309/500]: 100% [██████████] 79/79 [00:04<00:00, 17.61it/s, Loss_D=0.0491, Loss_G=4.71, D(x)=0.972, D(G(z))=0.0199 / 0.0125]

Epoch [310/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.0286, Loss_G=5.63, D(x)=0.995, D(G(z))=0.0229 / 0.0043]

Epoch [311/500]: 100% [██████████] 79/79 [00:04<00:00, 17.64it/s, Loss_D=0.0642, Loss_G=7.12, D(x)=0.985, D(G(z))=0.0438 / 0.0010]

Epoch [312/500]: 100% [██████████] 79/79 [00:04<00:00, 17.68it/s, Loss_D=0.226, Loss_G=0.805, D(x)=0.826, D(G(z))=0.0105 / 0.6258]

Epoch [313/500]: 100% [██████████] 79/79 [00:04<00:00, 17.64it/s, Loss_D=0.0957, Loss_G=8.78, D(x)=0.994, D(G(z))=0.0797 / 0.0003]

Epoch [314/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.0105, Loss_G=5.68, D(x)=0.997, D(G(z))=0.0071 / 0.0057]

Epoch [315/500]: 100% [██████████] 79/79 [00:04<00:00, 17.57it/s, Loss_D=0.256, Loss_G=2.7, D(x)=0.801, D(G(z))=0.0153 / 0.1372]

Epoch [316/500]: 100% [██████████] 79/79 [00:04<00:00, 17.65it/s, Loss_D=0.127, Loss_G=7.48, D(x)=0.958, D(G(z))=0.0682 / 0.0011]

Epoch [317/500]: 100% [██████████] 79/79 [00:04<00:00, 17.73it/s, Loss_D=0.139, Loss_G=5.1, D(x)=0.922, D(G(z))=0.0420 / 0.0143]

Epoch [318/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.0562, Loss_G=5.8, D(x)=0.979, D(G(z))=0.0333 / 0.0040]

Epoch [319/500]: 100% [██████████] 79/79 [00:04<00:00, 17.66it/s, Loss_D=0.333, Loss_G=2.81, D(x)=0.776, D(G(z))=0.0531 / 0.1066]

Epoch [320/500]: 100% [██████████] 79/79 [00:04<00:00, 17.27it/s, Loss_D=0.262, Loss_G=12.2, D(x)=0.966, D(G(z))=0.1680 / 0.0001]

Epoch [321/500]: 100% [██████████] 79/79 [00:04<00:00, 17.52it/s, Loss_D=0.0893, Loss_G=4.68, D(x)=0.931, D(G(z))=0.0125 / 0.0165]

Epoch [322/500]: 100% [██████████] 79/79 [00:04<00:00, 17.54it/s, Loss_D=0.0628, Loss_G=5.43, D(x)=0.996, D(G(z))=0.0554 / 0.0053]

Epoch [323/500]: 100% [██████████] 79/79 [00:04<00:00, 17.14it/s, Loss_D=0.167, Loss_G=4.53, D(x)=0.919, D(G(z))=0.0405 / 0.0138]

Epoch [324/500]: 100% [██████████] 79/79 [00:04<00:00, 17.58it/s, Loss_D=0.0928, Loss_G=7.69, D(x)=0.972, D(G(z))=0.0583 / 0.0008]

Epoch [325/500]: 100% [██████████] 79/79 [00:04<00:00, 17.46it/s, Loss_D=0.162, Loss_G=2.61, D(x)=0.891, D(G(z))=0.0189 / 0.1223]

Epoch [326/500]: 100% [██████████] 79/79 [00:04<00:00, 17.54it/s, Loss_D=0.167, Loss_G=6.82, D(x)=0.946, D(G(z))=0.0791 / 0.0037]

Epoch [327/500]: 100% [██████████] 79/79 [00:04<00:00, 17.47it/s, Loss_D=0.061, Loss_G=6.15, D(x)=0.983, D(G(z))=0.0415 / 0.0027]

Epoch [328/500]: 100% [██████████] 79/79 [00:04<00:00, 17.54it/s, Loss_D=0.0278, Loss_G=6.42, D(x)=0.976, D(G(z))=0.0028 / 0.0031]

Epoch [329/500]: 100% [██████████] 79/79 [00:04<00:00, 17.29it/s, Loss_D=0.306, Loss_G=4.34, D(x)=0.873, D(G(z))=0.1360 / 0.0184]

Epoch [330/500]: 100% [██████████] 79/79 [00:04<00:00, 17.99it/s, Loss_D=0.0351, Loss_G=6.14, D(x)=0.984, D(G(z))=0.0185 / 0.0041]

Epoch [331/500]: 100% [██████████] 79/79 [00:04<00:00, 17.24it/s, Loss_D=0.66, Loss_G=0.0029, D(x)=0.57, D(G(z))=0.0185 / 0.9971]

Epoch [332/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=0.12, Loss_G=4.19, D(x)=0.917, D(G(z))=0.0232 / 0.0337]

Epoch [333/500]: 100% [██████████] 79/79 [00:04<00:00, 17.65it/s, Loss_D=0.118, Loss_G=5.84, D(x)=0.993, D(G(z))=0.0972 / 0.0057]

Epoch [334/500]: 100% [██████████] 79/79 [00:04<00:00, 17.70it/s, Loss_D=0.0954, Loss_G=3.65, D(x)=0.933, D(G(z))=0.0199 / 0.0437]

Epoch [335/500]: 100% [██████████] 79/79 [00:04<00:00, 17.31it/s, Loss_D=0.0283, Loss_G=5.6, D(x)=0.977, D(G(z))=0.0033 / 0.0058]

Epoch [336/500]: 100% [██████████] 79/79 [00:04<00:00, 17.47it/s, Loss_D=0.522, Loss_G=1.56, D(x)=0.667, D(G(z))=0.0038 / 0.3960]

Epoch [337/500]: 100% [██████████] 79/79 [00:04<00:00, 17.24it/s, Loss_D=0.03, Loss_G=5.8, D(x)=0.977, D(G(z))=0.0059 / 0.0072]

Epoch [338/500]: 100% [██████████] 79/79 [00:04<00:00, 17.15it/s, Loss_D=0.0253, Loss_G=5.71, D(x)=0.986, D(G(z))=0.0113 / 0.0050]

Epoch [339/500]: 100% [██████████] 79/79 [00:04<00:00, 17.63it/s, Loss_D=0.0137, Loss_G=7.89, D(x)=0.993, D(G(z))=0.0060 / 0.0008]

Epoch [340/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.0439, Loss_G=5.18, D(x)=0.982, D(G(z))=0.0245 / 0.0075]

Epoch [341/500]: 100% [██████████] 79/79 [00:04<00:00, 17.48it/s, Loss_D=0.061, Loss_G=6, D(x)=0.956, D(G(z))=0.0105 / 0.0042]

Epoch [342/500]: 100% [██████████] 79/79 [00:04<00:00, 17.34it/s, Loss_D=0.0654, Loss_G=6.71, D(x)=0.97, D(G(z))=0.0302 / 0.0023]

Epoch [343/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.192, Loss_G=0.786, D(x)=0.847, D(G(z))=0.0028 / 0.5318]

Epoch [344/500]: 100% [██████████] 79/79 [00:04<00:00, 17.60it/s, Loss_D=0.0545, Loss_G=5.77, D(x)=0.967, D(G(z))=0.0180 / 0.0050]

Epoch [345/500]: 100% [██████████] 79/79 [00:04<00:00, 17.22it/s, Loss_D=0.108, Loss_G=3.3, D(x)=0.919, D(G(z))=0.0072 / 0.0994]

Epoch [346/500]: 100% [██████████] 79/79 [00:04<00:00, 17.34it/s, Loss_D=0.54, Loss_G=6.65, D(x)=0.883, D(G(z))=0.2833 / 0.0066]

Epoch [347/500]: 100% [██████████] 79/79 [00:04<00:00, 17.51it/s, Loss_D=0.0786, Loss_G=6.05, D(x)=0.932, D(G(z))=0.0037 / 0.0045]

Epoch [348/500]: 100% [██████████] 79/79 [00:04<00:00, 17.47it/s, Loss_D=0.0695, Loss_G=5.35, D(x)=0.964, D(G(z))=0.0310 / 0.0091]

Epoch [349/500]: 100% [██████████] 79/79 [00:04<00:00, 17.15it/s, Loss_D=0.113, Loss_G=4.6, D(x)=0.931, D(G(z))=0.0343 / 0.0180]

Epoch [350/500]: 100% [██████████] 79/79 [00:04<00:00, 17.03it/s, Loss_D=0.373, Loss_G=1.95, D(x)=0.783, D(G(z))=0.0532 / 0.2371]

Epoch [351/500]: 100% [██████████] 79/79 [00:04<00:00, 17.71it/s, Loss_D=0.021, Loss_G=6.41, D(x)=0.988, D(G(z))=0.0083 / 0.0032]

Epoch [352/500]: 100% [██████████] 79/79 [00:04<00:00, 17.48it/s, Loss_D=0.0378, Loss_G=5.5, D(x)=0.98, D(G(z))=0.0167 / 0.0051]

Epoch [353/500]: 100% [██████████] 79/79 [00:04<00:00, 17.37it/s, Loss_D=0.261, Loss_G=14.8, D(x)=0.996, D(G(z))=0.2039 / 0.0000]

Epoch [354/500]: 100% [██████████] 79/79 [00:04<00:00, 17.30it/s, Loss_D=0.222, Loss_G=11.7, D(x)=0.997, D(G(z))=0.1640 / 0.0000]

Epoch [355/500]: 100% [██████████] 79/79 [00:04<00:00, 17.58it/s, Loss_D=0.102, Loss_G=4.13, D(x)=0.929, D(G(z))=0.0165 / 0.0360]

Epoch [356/500]: 100% [██████████] 79/79 [00:04<00:00, 17.58it/s, Loss_D=0.0672, Loss_G=5.14, D(x)=0.961, D(G(z))=0.0255 / 0.0085]

Epoch [357/500]: 100% [██████████] 79/79 [00:04<00:00, 17.75it/s, Loss_D=0.345, Loss_G=0.146, D(x)=0.767, D(G(z))=0.0339 / 0.8777]

Epoch [358/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=0.416, Loss_G=6.75, D(x)=0.939, D(G(z))=0.2106 / 0.0148]

Epoch [359/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=0.0389, Loss_G=5.51, D(x)=0.988, D(G(z))=0.0261 / 0.0055]

Epoch [360/500]: 100% [██████████] 79/79 [00:04<00:00, 17.18it/s, Loss_D=0.404, Loss_G=7.9, D(x)=0.956, D(G(z))=0.1998 / 0.0066]

Epoch [361/500]: 100% [██████████] 79/79 [00:04<00:00, 17.35it/s, Loss_D=0.0727, Loss_G=5.03, D(x)=0.954, D(G(z))=0.0207 / 0.0154]

Epoch [362/500]: 100% [██████████] 79/79 [00:04<00:00, 17.60it/s, Loss_D=0.0493, Loss_G=5.29, D(x)=0.973, D(G(z))=0.0207 / 0.0057]

Epoch [363/500]: 100% [██████████] 79/79 [00:04<00:00, 17.06it/s, Loss_D=0.011, Loss_G=5.33, D(x)=0.994, D(G(z))=0.0044 / 0.0074]

Epoch [364/500]: 100% [██████████] 79/79 [00:04<00:00, 17.64it/s, Loss_D=0.204, Loss_G=5.7, D(x)=0.905, D(G(z))=0.0804 / 0.0077]

Epoch [365/500]: 100% [██████████] 79/79 [00:04<00:00, 17.44it/s, Loss_D=0.131, Loss_G=7.59, D(x)=0.974, D(G(z))=0.0649 / 0.0015]

Epoch [366/500]: 100% [██████████] 79/79 [00:04<00:00, 17.77it/s, Loss_D=0.0504, Loss_G=6.69, D(x)=0.986, D(G(z))=0.0341 / 0.0024]

Epoch [367/500]: 100% [██████████] 79/79 [00:04<00:00, 17.16it/s, Loss_D=0.0343, Loss_G=5.83, D(x)=0.989, D(G(z))=0.0223 / 0.0047]

Epoch [368/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.717, Loss_G=13.2, D(x)=0.917, D(G(z))=0.4076 / 0.0000]

Epoch [369/500]: 100% [██████████] 79/79 [00:04<00:00, 17.48it/s, Loss_D=0.266, Loss_G=6.58, D(x)=0.916, D(G(z))=0.1411 / 0.0031]

Epoch [370/500]: 100% [██████████] 79/79 [00:04<00:00, 17.50it/s, Loss_D=0.0735, Loss_G=7.62, D(x)=0.97, D(G(z))=0.0395 / 0.0014]

Epoch [371/500]: 100% [██████████] 79/79 [00:04<00:00, 17.70it/s, Loss_D=0.056, Loss_G=4.74, D(x)=0.954, D(G(z))=0.0062 / 0.0130]

Epoch [372/500]: 100% [██████████] 79/79 [00:04<00:00, 17.30it/s, Loss_D=0.0252, Loss_G=5.63, D(x)=0.986, D(G(z))=0.0106 / 0.0059]

Epoch [373/500]: 100% [██████████] 79/79 [00:04<00:00, 17.61it/s, Loss_D=0.0474, Loss_G=5.41, D(x)=0.979, D(G(z))=0.0251 / 0.0063]

Epoch [374/500]: 100% [██████████] 79/79 [00:04<00:00, 17.37it/s, Loss_D=0.0193, Loss_G=6.5, D(x)=0.983, D(G(z))=0.0016 / 0.0027]

Epoch [375/500]: 100% [██████████] 79/79 [00:04<00:00, 17.28it/s, Loss_D=0.0332, Loss_G=5.73, D(x)=0.977, D(G(z))=0.0094 / 0.0055]

Epoch [376/500]: 100% [██████████] 79/79 [00:04<00:00, 17.67it/s, Loss_D=0.0152, Loss_G=7.2, D(x)=0.988, D(G(z))=0.0025 / 0.0012]

Epoch [377/500]: 100% [██████████] 79/79 [00:04<00:00, 17.46it/s, Loss_D=0.0542, Loss_G=4.77, D(x)=0.953, D(G(z))=0.0047 / 0.0160]

Epoch [378/500]: 100% [██████████] 79/79 [00:04<00:00, 17.37it/s, Loss_D=0.0129, Loss_G=6.15, D(x)=0.993, D(G(z))=0.0054 / 0.0033]

Epoch [379/500]: 100% [██████████] 79/79 [00:04<00:00, 16.89it/s, Loss_D=0.0657, Loss_G=5.09, D(x)=0.95, D(G(z))=0.0120 / 0.0083]

Epoch [380/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.218, Loss_G=5.17, D(x)=0.825, D(G(z))=0.0006 / 0.0135]

Epoch [381/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=0.0109, Loss_G=9.02, D(x)=0.99, D(G(z))=0.0006 / 0.0004]

Epoch [382/500]: 100% [██████████] 79/79 [00:04<00:00, 17.37it/s, Loss_D=0.0573, Loss_G=5.93, D(x)=0.967, D(G(z))=0.0204 / 0.0042]

Epoch [383/500]: 100% [██████████] 79/79 [00:04<00:00, 17.46it/s, Loss_D=0.0594, Loss_G=4.08, D(x)=0.968, D(G(z))=0.0256 / 0.0286]

Epoch [384/500]: 100% [██████████] 79/79 [00:04<00:00, 17.75it/s, Loss_D=0.427, Loss_G=3.9, D(x)=0.793, D(G(z))=0.1019 / 0.0858]

Epoch [385/500]: 100% [██████████] 79/79 [00:04<00:00, 17.61it/s, Loss_D=2.44, Loss_G=16.9, D(x)=0.992, D(G(z))=0.8496 / 0.0000]

Epoch [386/500]: 100% [██████████] 79/79 [00:04<00:00, 17.66it/s, Loss_D=0.145, Loss_G=5.11, D(x)=0.879, D(G(z))=0.0054 / 0.0207]

Epoch [387/500]: 100% [██████████] 79/79 [00:04<00:00, 17.23it/s, Loss_D=0.537, Loss_G=5.38, D(x)=0.853, D(G(z))=0.2368 / 0.0128]

Epoch [388/500]: 100% [██████████] 79/79 [00:04<00:00, 17.45it/s, Loss_D=0.0663, Loss_G=5.78, D(x)=0.961, D(G(z))=0.0219 / 0.0060]

Epoch [389/500]: 100% [██████████] 79/79 [00:04<00:00, 17.68it/s, Loss_D=0.0551, Loss_G=5.77, D(x)=0.959, D(G(z))=0.0113 / 0.0065]

Epoch [390/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.02, Loss_G=6.26, D(x)=0.99, D(G(z))=0.0099 / 0.0031]

Epoch [391/500]: 100% [██████████] 79/79 [00:04<00:00, 17.06it/s, Loss_D=0.123, Loss_G=3.18, D(x)=0.91, D(G(z))=0.0173 / 0.0652]

Epoch [392/500]: 100% [██████████] 79/79 [00:04<00:00, 17.58it/s, Loss_D=0.058, Loss_G=4.71, D(x)=0.967, D(G(z))=0.0213 / 0.0151]

Epoch [393/500]: 100% [██████████] 79/79 [00:04<00:00, 17.61it/s, Loss_D=0.0269, Loss_G=5.9, D(x)=0.984, D(G(z))=0.0105 / 0.0048]

Epoch [394/500]: 100% [██████████] 79/79 [00:04<00:00, 17.37it/s, Loss_D=0.0364, Loss_G=6.11, D(x)=0.98, D(G(z))=0.0158 / 0.0038]

Epoch [395/500]: 100% [██████████] 79/79 [00:04<00:00, 17.54it/s, Loss_D=0.00907, Loss_G=6.36, D(x)=0.998, D(G(z))=0.0071 / 0.0028]

Epoch [396/500]: 100% [██████████] 79/79 [00:04<00:00, 17.54it/s, Loss_D=0.0592, Loss_G=4.55, D(x)=0.953, D(G(z))=0.0082 / 0.0227]

Epoch [397/500]: 100% [██████████] 79/79 [00:04<00:00, 17.50it/s, Loss_D=0.169, Loss_G=5.07, D(x)=0.896, D(G(z))=0.0152 / 0.0689]

Epoch [398/500]: 100% [██████████] 79/79 [00:04<00:00, 17.29it/s, Loss_D=0.0469, Loss_G=7.2, D(x)=0.992, D(G(z))=0.0370 / 0.0010]

Epoch [399/500]: 100% [██████████] 79/79 [00:04<00:00, 17.52it/s, Loss_D=0.0879, Loss_G=4.91, D(x)=0.94, D(G(z))=0.0211 / 0.0101]

Epoch [400/500]: 100% [██████████] 79/79 [00:04<00:00, 17.40it/s, Loss_D=0.191, Loss_G=1.35, D(x)=0.864, D(G(z))=0.0113 / 0.3787]

Epoch [401/500]: 100% [██████████] 79/79 [00:04<00:00, 17.54it/s, Loss_D=0.093, Loss_G=5.36, D(x)=0.932, D(G(z))=0.0176 / 0.0094]

Epoch [402/500]: 100% [██████████] 79/79 [00:04<00:00, 17.45it/s, Loss_D=0.207, Loss_G=4.64, D(x)=0.895, D(G(z))=0.0699 / 0.0167]

Epoch [403/500]: 100% [██████████] 79/79 [00:04<00:00, 17.24it/s, Loss_D=0.0473, Loss_G=6.84, D(x)=0.956, D(G(z))=0.0007 / 0.0032]

Epoch [404/500]: 100% [██████████] 79/79 [00:04<00:00, 17.46it/s, Loss_D=0.0169, Loss_G=8.04, D(x)=0.996, D(G(z))=0.0123 / 0.0009]

Epoch [405/500]: 100% [██████████] 79/79 [00:04<00:00, 17.53it/s, Loss_D=1.43, Loss_G=2.1, D(x)=0.407, D(G(z))=0.0047 / 0.2837]

Epoch [406/500]: 100% [██████████] 79/79 [00:04<00:00, 17.09it/s, Loss_D=0.0194, Loss_G=7.09, D(x)=0.988, D(G(z))=0.0071 / 0.0019]

Epoch [407/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.0732, Loss_G=8.81, D(x)=0.992, D(G(z))=0.0584 / 0.0003]

Epoch [408/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=0.02, Loss_G=6.04, D(x)=0.987, D(G(z))=0.0066 / 0.0036]

Epoch [409/500]: 100% [██████████] 79/79 [00:04<00:00, 17.63it/s, Loss_D=3.92, Loss_G=1.84, D(x)=0.0634, D(G(z))=0.0000 / 0.3556]

Epoch [410/500]: 100% [██████████] 79/79 [00:04<00:00, 17.50it/s, Loss_D=0.0341, Loss_G=5.81, D(x)=0.994, D(G(z))=0.0267 / 0.0036]

Epoch [411/500]: 100% [██████████] 79/79 [00:04<00:00, 17.37it/s, Loss_D=0.016, Loss_G=6.19, D(x)=0.987, D(G(z))=0.0024 / 0.0046]

Epoch [412/500]: 100% [██████████] 79/79 [00:04<00:00, 17.85it/s, Loss_D=0.0254, Loss_G=5.26, D(x)=1, D(G(z))=0.0242 / 0.0066]

Epoch [413/500]: 100% [██████████] 79/79 [00:04<00:00, 17.52it/s, Loss_D=0.127, Loss_G=3.52, D(x)=0.911, D(G(z))=0.0171 / 0.0571]

Epoch [414/500]: 100% [██████████] 79/79 [00:04<00:00, 17.45it/s, Loss_D=0.0359, Loss_G=4.91, D(x)=0.971, D(G(z))=0.0062 / 0.0115]

Epoch [415/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.0713, Loss_G=5.82, D(x)=0.956, D(G(z))=0.0187 / 0.0054]

Epoch [416/500]: 100% [██████████] 79/79 [00:04<00:00, 17.34it/s, Loss_D=0.78, Loss_G=0.00307, D(x)=0.65, D(G(z))=0.0183 / 0.9970]

Epoch [417/500]: 100% [██████████] 79/79 [00:04<00:00, 17.71it/s, Loss_D=0.257, Loss_G=3.8, D(x)=0.859, D(G(z))=0.0661 / 0.0475]

Epoch [418/500]: 100% [██████████] 79/79 [00:04<00:00, 17.65it/s, Loss_D=0.0201, Loss_G=5.21, D(x)=0.992, D(G(z))=0.0123 / 0.0093]

Epoch [419/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=0.216, Loss_G=4.36, D(x)=0.855, D(G(z))=0.0442 / 0.0192]

Epoch [420/500]: 100% [██████████] 79/79 [00:04<00:00, 17.17it/s, Loss_D=0.0265, Loss_G=5.86, D(x)=0.99, D(G(z))=0.0158 / 0.0055]

Epoch [421/500]: 100% [██████████] 79/79 [00:04<00:00, 17.53it/s, Loss_D=0.0902, Loss_G=3.5, D(x)=0.924, D(G(z))=0.0058 / 0.0598]

Epoch [422/500]: 100% [██████████] 79/79 [00:04<00:00, 17.12it/s, Loss_D=0.121, Loss_G=2.8, D(x)=0.899, D(G(z))=0.0071 / 0.0979]

Epoch [423/500]: 100% [██████████] 79/79 [00:04<00:00, 17.62it/s, Loss_D=0.0331, Loss_G=5.73, D(x)=0.978, D(G(z))=0.0098 / 0.0062]

Epoch [424/500]: 100% [██████████] 79/79 [00:04<00:00, 17.43it/s, Loss_D=0.0282, Loss_G=7.27, D(x)=0.987, D(G(z))=0.0141 / 0.0011]

Epoch [425/500]: 100% [██████████] 79/79 [00:04<00:00, 17.36it/s, Loss_D=0.0473, Loss_G=5.41, D(x)=0.976, D(G(z))=0.0224 / 0.0061]

Epoch [426/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=0.00532, Loss_G=6.28, D(x)=0.999, D(G(z))=0.0045 / 0.0028]

Epoch [427/500]: 100% [██████████] 79/79 [00:04<00:00, 17.46it/s, Loss_D=0.105, Loss_G=4.97, D(x)=0.94, D(G(z))=0.0363 / 0.0096]

Epoch [428/500]: 100% [██████████] 79/79 [00:04<00:00, 17.26it/s, Loss_D=0.0365, Loss_G=6.35, D(x)=0.986, D(G(z))=0.0219 / 0.0030]

Epoch [429/500]: 100% [██████████] 79/79 [00:04<00:00, 17.39it/s, Loss_D=0.609, Loss_G=4.65, D(x)=0.762, D(G(z))=0.1530 / 0.1082]

Epoch [430/500]: 100% [██████████] 79/79 [00:04<00:00, 17.60it/s, Loss_D=0.0373, Loss_G=6.74, D(x)=0.975, D(G(z))=0.0114 / 0.0039]

Epoch [431/500]: 100% [██████████] 79/79 [00:04<00:00, 17.23it/s, Loss_D=0.0187, Loss_G=5.78, D(x)=0.995, D(G(z))=0.0134 / 0.0047]

Epoch [432/500]: 100% [██████████] 79/79 [00:04<00:00, 17.58it/s, Loss_D=0.241, Loss_G=4.83, D(x)=0.87, D(G(z))=0.0739 / 0.0143]

Epoch [433/500]: 100% [██████████] 79/79 [00:04<00:00, 17.33it/s, Loss_D=0.0629, Loss_G=4.94, D(x)=0.944, D(G(z))=0.0035 / 0.0270]

Epoch [434/500]: 100% [██████████] 79/79 [00:04<00:00, 17.76it/s, Loss_D=0.0725, Loss_G=5.06, D(x)=0.941, D(G(z))=0.0034 / 0.0158]

Epoch [435/500]: 100% [██████████] 79/79 [00:04<00:00, 17.36it/s, Loss_D=0.0305, Loss_G=6.22, D(x)=0.975, D(G(z))=0.0042 / 0.0060]

Epoch [436/500]: 100% [██████████] 79/79 [00:04<00:00, 17.60it/s, Loss_D=0.00838, Loss_G=6.47, D(x)=0.995, D(G(z))=0.0038 / 0.0027]

Epoch [437/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=0.112, Loss_G=4.47, D(x)=0.92, D(G(z))=0.0059 / 0.0206]

Epoch [438/500]: 100% [██████████] 79/79 [00:04<00:00, 17.41it/s, Loss_D=0.0487, Loss_G=4.53, D(x)=0.966, D(G(z))=0.0123 / 0.0146]

Epoch [439/500]: 100% [██████████] 79/79 [00:04<00:00, 17.52it/s, Loss_D=0.0338, Loss_G=6.39, D(x)=0.971, D(G(z))=0.0024 / 0.0038]

Epoch [440/500]: 100% [██████████] 79/79 [00:04<00:00, 17.40it/s, Loss_D=0.0286, Loss_G=6.42, D(x)=0.99, D(G(z))=0.0178 / 0.0025]

Epoch [441/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=0.125, Loss_G=4.01, D(x)=0.893, D(G(z))=0.0037 / 0.0475]

Epoch [442/500]: 100% [██████████] 79/79 [00:04<00:00, 17.52it/s, Loss_D=0.0458, Loss_G=6.61, D(x)=0.978, D(G(z))=0.0218 / 0.0016]

Epoch [443/500]: 100% [██████████] 79/79 [00:04<00:00, 17.43it/s, Loss_D=0.0335, Loss_G=4.59, D(x)=0.974, D(G(z))=0.0067 / 0.0143]

Epoch [444/500]: 100% [██████████] 79/79 [00:04<00:00, 17.50it/s, Loss_D=0.0688, Loss_G=5.86, D(x)=0.939, D(G(z))=0.0023 / 0.0152]

Epoch [445/500]: 100% [██████████] 79/79 [00:04<00:00, 17.54it/s, Loss_D=0.0497, Loss_G=7.67, D(x)=0.992, D(G(z))=0.0400 / 0.0008]

Epoch [446/500]: 100% [██████████] 79/79 [00:04<00:00, 17.47it/s, Loss_D=0.336, Loss_G=6.81, D(x)=0.917, D(G(z))=0.1722 / 0.0095]

Epoch [447/500]: 100% [██████████] 79/79 [00:04<00:00, 17.50it/s, Loss_D=0.0397, Loss_G=4.84, D(x)=0.973, D(G(z))=0.0094 / 0.0138]

Epoch [448/500]: 100% [██████████] 79/79 [00:04<00:00, 17.38it/s, Loss_D=2.56, Loss_G=0.373, D(x)=0.226, D(G(z))=0.0929 / 0.8678]
Epoch [449/500]: 100% [██████████] 79/79 [00:04<00:00, 17.37it/s, Loss_D=0.446, Loss_G=0.775, D(x)=0.709, D(G(z))=0.0143 / 0.5566]
Epoch [450/500]: 100% [██████████] 79/79 [00:04<00:00, 17.50it/s, Loss_D=0.0208, Loss_G=5.47, D(x)=0.995, D(G(z))=0.0152 / 0.0059]
Epoch [451/500]: 100% [██████████] 79/79 [00:04<00:00, 17.45it/s, Loss_D=0.0415, Loss_G=5.61, D(x)=0.965, D(G(z))=0.0028 / 0.0098]
Epoch [452/500]: 100% [██████████] 79/79 [00:04<00:00, 17.47it/s, Loss_D=0.0207, Loss_G=6.05, D(x)=0.986, D(G(z))=0.0069 / 0.0055]
Epoch [453/500]: 100% [██████████] 79/79 [00:04<00:00, 17.37it/s, Loss_D=0.232, Loss_G=0.0728, D(x)=0.838, D(G(z))=0.0139 / 0.9452]
Epoch [454/500]: 100% [██████████] 79/79 [00:04<00:00, 16.90it/s, Loss_D=0.185, Loss_G=3.54, D(x)=0.867, D(G(z))=0.0168 / 0.0693]
Epoch [455/500]: 100% [██████████] 79/79 [00:04<00:00, 17.54it/s, Loss_D=0.0943, Loss_G=4.55, D(x)=0.951, D(G(z))=0.0397 / 0.0165]
Epoch [456/500]: 100% [██████████] 79/79 [00:04<00:00, 17.59it/s, Loss_D=0.101, Loss_G=8.62, D(x)=0.986, D(G(z))=0.0764 / 0.0005]
Epoch [457/500]: 100% [██████████] 79/79 [00:04<00:00, 17.36it/s, Loss_D=0.169, Loss_G=7.37, D(x)=0.988, D(G(z))=0.1278 / 0.0012]
Epoch [458/500]: 100% [██████████] 79/79 [00:04<00:00, 17.44it/s, Loss_D=0.051, Loss_G=4.58, D(x)=0.982, D(G(z))=0.0314 / 0.0136]
Epoch [459/500]: 100% [██████████] 79/79 [00:04<00:00, 17.34it/s, Loss_D=0.129, Loss_G=6.82, D(x)=0.895, D(G(z))=0.0049 / 0.0037]
Epoch [460/500]: 100% [██████████] 79/79 [00:04<00:00, 17.53it/s, Loss_D=0.032, Loss_G=6.62, D(x)=0.974, D(G(z))=0.0044 / 0.0040]
Epoch [461/500]: 100% [██████████] 79/79 [00:04<00:00, 17.29it/s, Loss_D=0.256, Loss_G=2.91, D(x)=0.832, D(G(z))=0.0184 / 0.1018]
Epoch [462/500]: 100% [██████████] 79/79 [00:04<00:00, 17.23it/s, Loss_D=0.00509, Loss_G=7.76, D(x)=0.997, D(G(z))=0.0021 / 0.0015]
Epoch [463/500]: 100% [██████████] 79/79 [00:04<00:00, 17.58it/s, Loss_D=0.0858, Loss_G=4.37, D(x)=0.936, D(G(z))=0.0156 / 0.0225]
Epoch [464/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.066, Loss_G=5.39, D(x)=0.949, D(G(z))=0.0090 / 0.0093]
Epoch [465/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.0299, Loss_G=6.3, D(x)=0.983, D(G(z))=0.0124 / 0.0031]
Epoch [466/500]: 100% [██████████] 79/79 [00:04<00:00, 17.52it/s, Loss_D=0.05, Loss_G=3.99, D(x)=0.961, D(G(z))=0.0079 / 0.0289]
Epoch [467/500]: 100% [██████████] 79/79 [00:04<00:00, 17.17it/s, Loss_D=0.0266, Loss_G=6.08, D(x)=0.987, D(G(z))=0.0127 / 0.0034]
Epoch [468/500]: 100% [██████████] 79/79 [00:04<00:00, 17.19it/s, Loss_D=0.105, Loss_G=5.69, D(x)=0.937, D(G(z))=0.0285 / 0.0080]
Epoch [469/500]: 100% [██████████] 79/79 [00:04<00:00, 17.44it/s, Loss_D=0.0392, Loss_G=5.93, D(x)=0.979, D(G(z))=0.0171 / 0.0050]
Epoch [470/500]: 100% [██████████] 79/79 [00:04<00:00, 17.39it/s, Loss_D=0.0361, Loss_G=6.99, D(x)=0.998, D(G(z))=0.0316 / 0.0014]
Epoch [471/500]: 100% [██████████] 79/79 [00:04<00:00, 17.45it/s, Loss_D=0.00975, Loss_G=7.78, D(x)=0.992, D(G(z))=0.0015 / 0.0009]
Epoch [472/500]: 100% [██████████] 79/79 [00:04<00:00, 17.73it/s, Loss_D=0.0332, Loss_G=5.43, D(x)=0.983, D(G(z))=0.0138 / 0.0091]
Epoch [473/500]: 100% [██████████] 79/79 [00:04<00:00, 17.57it/s, Loss_D=0.0659, Loss_G=5.83, D(x)=0.951, D(G(z))=0.0119 / 0.0080]
Epoch [474/500]: 100% [██████████] 79/79 [00:04<00:00, 17.46it/s, Loss_D=0.0695, Loss_G=7.92, D(x)=0.99, D(G(z))=0.0543 / 0.0010]
Epoch [475/500]: 100% [██████████] 79/79 [00:04<00:00, 17.36it/s, Loss_D=2.77, Loss_G=0.229, D(x)=0.147, D(G(z))=0.0223 / 0.8668]
Epoch [476/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=0.164, Loss_G=5.27, D(x)=0.94, D(G(z))=0.0806 / 0.0129]
Epoch [477/500]: 100% [██████████] 79/79 [00:04<00:00, 17.19it/s, Loss_D=0.0293, Loss_G=7.08, D(x)=0.989, D(G(z))=0.0179 / 0.0019]
Epoch [478/500]: 100% [██████████] 79/79 [00:04<00:00, 17.48it/s, Loss_D=0.0309, Loss_G=6.46, D(x)=0.989, D(G(z))=0.0186 / 0.0032]
Epoch [479/500]: 100% [██████████] 79/79 [00:04<00:00, 17.43it/s, Loss_D=0.84, Loss_G=3.83, D(x)=0.67, D(G(z))=0.0921 / 0.0799]

Epoch [480/500]: 100% [██████████] 79/79 [00:04<00:00, 17.56it/s, Loss_D=0.113, Loss_G=11.4, D(x)=0.987, D(G(z))=0.0866 / 0.0001]

Epoch [481/500]: 100% [██████████] 79/79 [00:04<00:00, 17.17it/s, Loss_D=0.158, Loss_G=2.37, D(x)=0.881, D(G(z))=0.0088 / 0.1921]

Epoch [482/500]: 100% [██████████] 79/79 [00:04<00:00, 17.26it/s, Loss_D=0.0557, Loss_G=6.2, D(x)=0.965, D(G(z))=0.0186 / 0.0055]

Epoch [483/500]: 100% [██████████] 79/79 [00:04<00:00, 17.55it/s, Loss_D=0.0164, Loss_G=5.47, D(x)=0.997, D(G(z))=0.0131 / 0.0072]

Epoch [484/500]: 100% [██████████] 79/79 [00:04<00:00, 17.27it/s, Loss_D=0.113, Loss_G=8.37, D(x)=0.991, D(G(z))=0.0928 / 0.0004]

Epoch [485/500]: 100% [██████████] 79/79 [00:04<00:00, 17.16it/s, Loss_D=0.0601, Loss_G=7.78, D(x)=0.991, D(G(z))=0.0462 / 0.0008]

Epoch [486/500]: 100% [██████████] 79/79 [00:04<00:00, 17.36it/s, Loss_D=0.00912, Loss_G=6.87, D(x)=0.995, D(G(z))=0.0044 / 0.0025]

Epoch [487/500]: 100% [██████████] 79/79 [00:04<00:00, 17.42it/s, Loss_D=0.203, Loss_G=3.46, D(x)=0.857, D(G(z))=0.0007 / 0.0626]

Epoch [488/500]: 100% [██████████] 79/79 [00:04<00:00, 17.03it/s, Loss_D=0.0994, Loss_G=5.41, D(x)=0.951, D(G(z))=0.0316 / 0.0108]

Epoch [489/500]: 100% [██████████] 79/79 [00:04<00:00, 17.36it/s, Loss_D=0.207, Loss_G=3.54, D(x)=0.868, D(G(z))=0.0469 / 0.0445]

Epoch [490/500]: 100% [██████████] 79/79 [00:04<00:00, 17.50it/s, Loss_D=0.1, Loss_G=6.76, D(x)=0.969, D(G(z))=0.0625 / 0.0024]

Epoch [491/500]: 100% [██████████] 79/79 [00:04<00:00, 17.27it/s, Loss_D=0.0538, Loss_G=5.58, D(x)=0.975, D(G(z))=0.0261 / 0.0054]

Epoch [492/500]: 100% [██████████] 79/79 [00:04<00:00, 17.50it/s, Loss_D=0.333, Loss_G=1.12, D(x)=0.809, D(G(z))=0.0248 / 0.5276]

Epoch [493/500]: 100% [██████████] 79/79 [00:04<00:00, 17.32it/s, Loss_D=0.0159, Loss_G=6.29, D(x)=0.998, D(G(z))=0.0139 / 0.0034]

Epoch [494/500]: 100% [██████████] 79/79 [00:04<00:00, 17.38it/s, Loss_D=0.0168, Loss_G=5.62, D(x)=0.997, D(G(z))=0.0131 / 0.0054]

Epoch [495/500]: 100% [██████████] 79/79 [00:04<00:00, 17.34it/s, Loss_D=0.188, Loss_G=3.72, D(x)=0.864, D(G(z))=0.0198 / 0.0518]

Epoch [496/500]: 100% [██████████] 79/79 [00:04<00:00, 17.29it/s, Loss_D=0.15, Loss_G=5.63, D(x)=0.917, D(G(z))=0.0427 / 0.0181]

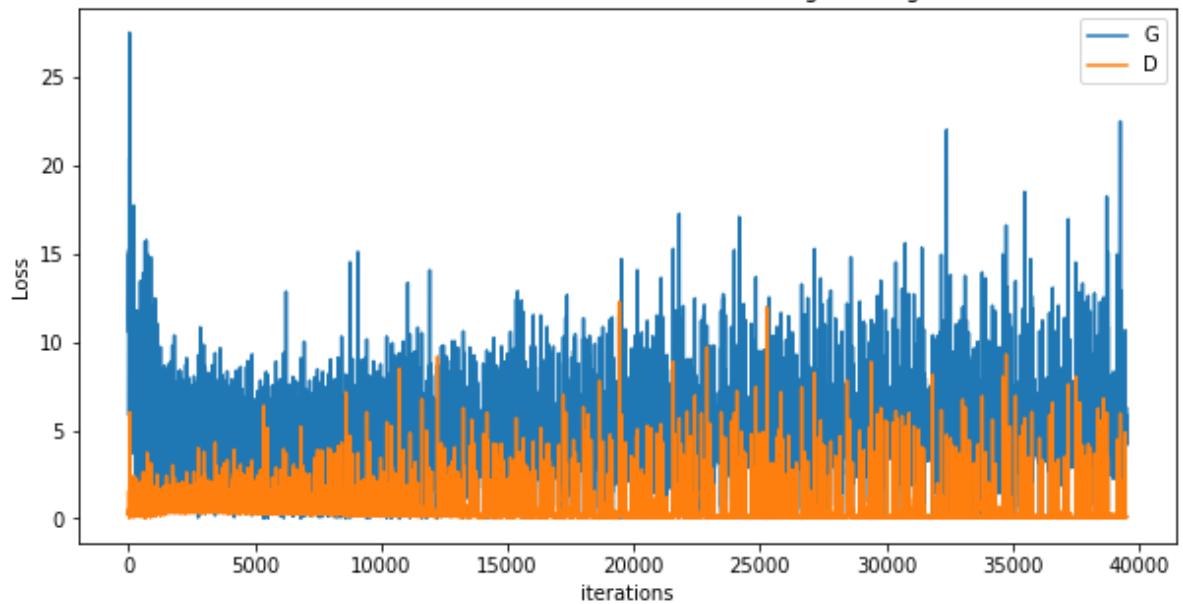
Epoch [497/500]: 100% [██████████] 79/79 [00:04<00:00, 17.39it/s, Loss_D=0.00641, Loss_G=7.61, D(x)=0.995, D(G(z))=0.0016 / 0.0015]

Epoch [498/500]: 100% [██████████] 79/79 [00:04<00:00, 17.50it/s, Loss_D=0.0251, Loss_G=6.93, D(x)=0.979, D(G(z))=0.0035 / 0.0034]

Epoch [499/500]: 100% [██████████] 79/79 [00:04<00:00, 17.23it/s, Loss_D=0.013, Loss_G=7.01, D(x)=0.989, D(G(z))=0.0015 / 0.0017]

```
In [ ]: plt.figure(figsize=(10,5))
plt.title("Generator and Discriminator Loss During Training")
plt.plot(G_losses,label="G")
plt.plot(D_losses,label="D")
plt.xlabel("iterations")
plt.ylabel("Loss")
plt.legend()
plt.show()
print(len(G_losses))
```

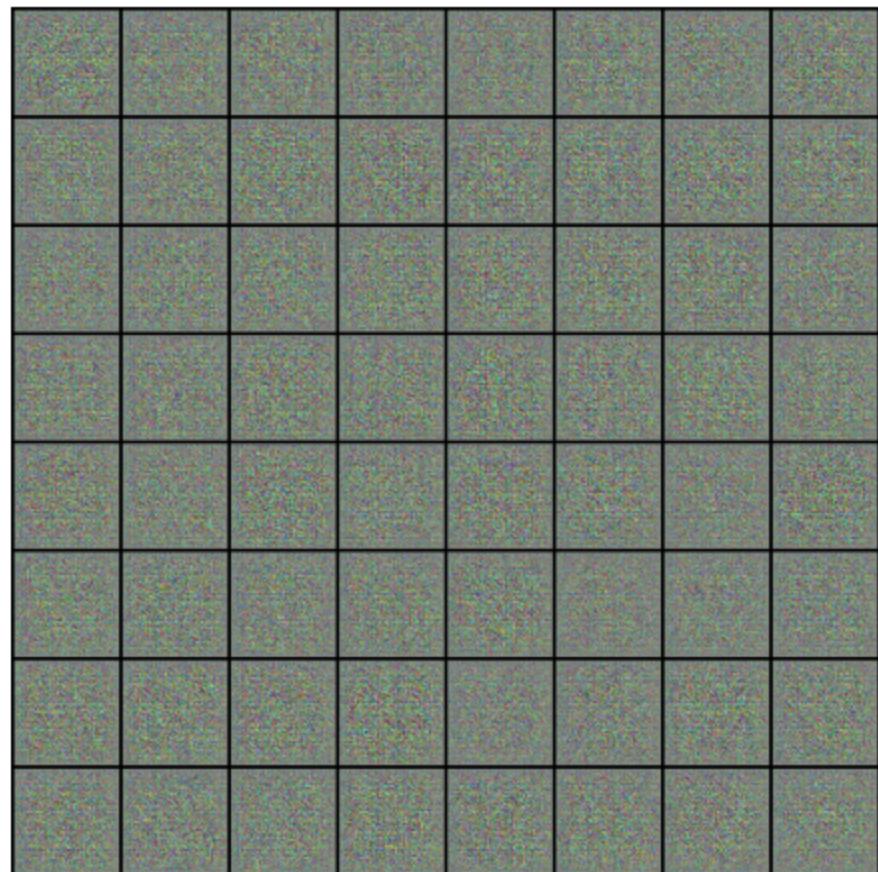
Generator and Discriminator Loss During Training



39500

```
In [ ]: %%capture  
plt.rcParams['animation.embed_limit'] = 2**128  
fig = plt.figure(figsize=(8,8))  
plt.axis("off")  
ims = [[plt.imshow(np.transpose(i,(1,2,0)), animated=True)] for i in img_list]  
ani = animation.ArtistAnimation(fig, ims, interval=1000, repeat_delay=1000, blit=True)  
HTML(ani.to_jshtml())
```

Out[]:

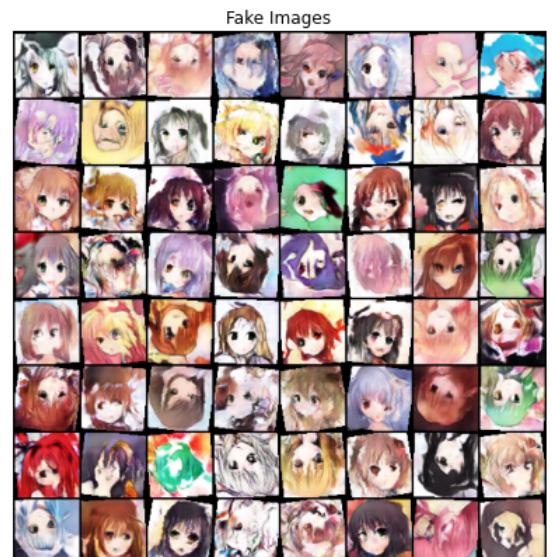
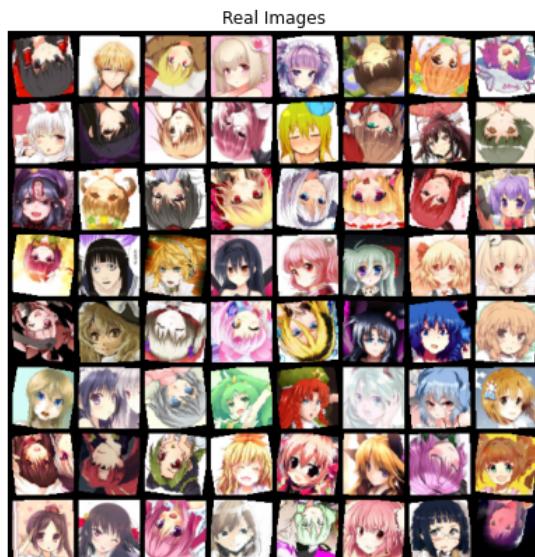




```
In [ ]: # Grab a batch of real images from the dataloader
real_batch = next(iter(dataloader))

# Plot the real images
plt.figure(figsize=(15,15))
plt.subplot(1,2,1)
plt.axis("off")
plt.title("Real Images")
plt.imshow(np.transpose(vutils.make_grid(real_batch[0].to(device)[:64], padding=5, normalize=True).cpu(),(1,2,0)))

# Plot the fake images from the last epoch
plt.subplot(1,2,2)
plt.axis("off")
plt.title("Fake Images")
plt.imshow(np.transpose(img_list[-1],(1,2,0)))
plt.show()
```



Reports for each exercise

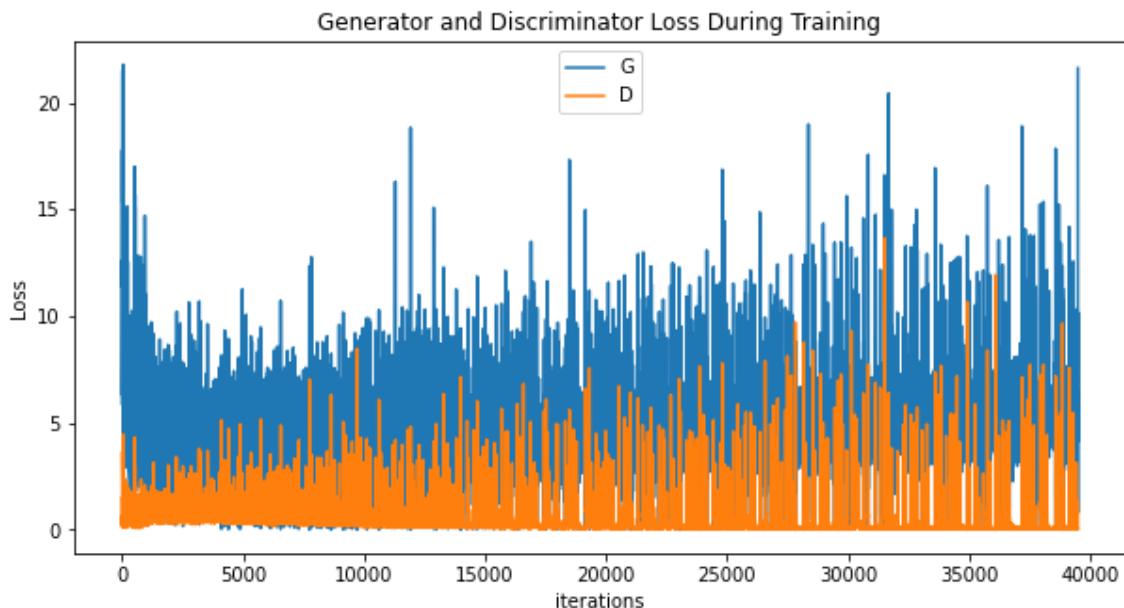
1. (a) Describe how you preprocess the dataset (such as resize, crop, rotate and flip) and explain why. (5%)

Ans:

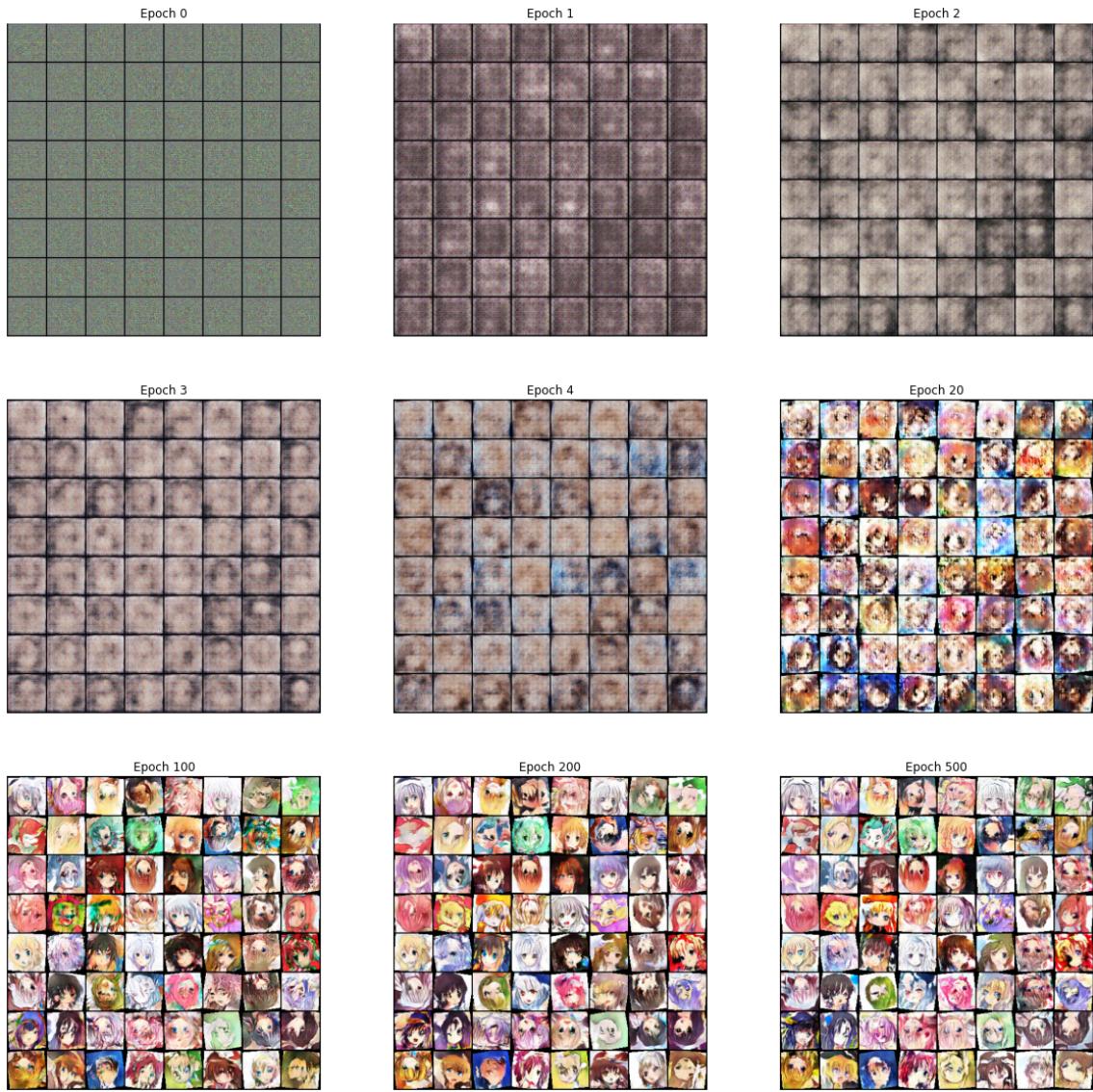
在這邊我使用了Resize(為了fit模型的input) · 以及隨機水平、垂直翻轉、旋轉-10~10度的 preprocess · 想說為了增加dataset之中臉方向的多樣性 · 希望能藉此讓模型學習到更多更像臉特徵的生成方法。

```
transform = transforms.Compose([
    transforms.Resize(image_size), # resize
    transforms.RandomHorizontalFlip(p=0.5), # 隨機水平翻轉
    transforms.RandomVerticalFlip(p=0.5), # 隨機垂直翻轉
    transforms.RandomRotation(10), # 隨機旋轉-10~10度
    transforms.ToTensor(),
    transforms.Normalize(mean=(0.5, 0.5, 0.5), std=(0.5, 0.5, 0.5)), #
    對圖片做normalize · 以便讓model更快收斂
])
```

1. (b) Plot the learning curves for both generator and discriminator. (15%)



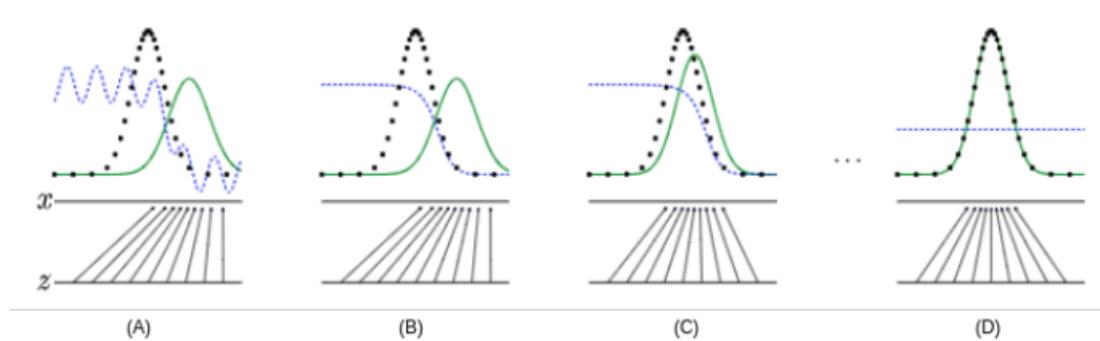
1. (c) Draw some samples generated from your generator at different training stages. For example, you may show the results when running at 5th and final epoch. (10%)



Ans:

可以看到從Epoch 0開始原本只是生成一堆雜訊，到Epoch 3開始逐漸形成臉的輪廓，到了Epoch 20則可以開始看出眼睛、頭髮等重要特徵形成，在Epoch 100時圖片已經變得滿清楚的只是人臉某些特徵可能有點扭曲不自然，在最後Epoch 500時人臉模樣已經大致建構完整。

2. (a) Please describe the meaning of the following four pictures during training of GAN, where blue dashed line indicates the *discriminator*, green solid line indicates the *generator*. The answer should include the following: (Note: Each step should be discussed.)(10%)



- what is the meaning of black dashed line, x and z

Ans:

黑色虛線為真實圖片之分布、 z 為從normal distribution之中sample出來的noise、 x 為將 z 輸入至Generator中所產生的圖片之分布，也就是 $x=G(z)$ 。

- which step is to train the generator or discriminator and show the corresponding objective function

Ans:

(A)為最初始的階段，discriminator(藍色虛線)判別圖像真假的情況很不穩定，generator(綠色實線)所生成的假圖也與真圖的分布不太相近。

在(A)~(B)的階段為用真實圖片訓練discriminator的step，到達(B)階段時可以看到discriminator判別的情況逐漸穩定，可以將真圖與假圖劃分清楚。此時的objective function為**maximize $\log(D(x)) + \log(1 - D(G(z)))$** 。

在(B)~(C)的階段為訓練generator更加貼近真實圖片的step，到達(C)階段時可以看到generator(綠色實線)的分布更加貼近真實圖片的分布。此時的objective function為**maximize $\log(D(G(z)))$** ，越讓discriminator覺得generator產生的圖片為真實圖片越好。

在(C)~(D)的階段為不斷重複以上階段後的最終理想結果，到達(D)階段時可以看到generator(綠色實線)的分布已經與真實圖片的分布重合，代表其已經能夠找出產生真實圖片之方法。至於discriminator(藍色虛線)則是在0.5的數值上，代表其已經無法分辨真實圖片以及generator所產生的圖片何為真、何為假。

- why $D(x)$ equals to 1/2 in ideal case when the training is finished

Ans:

如同前一題所述，若最終 $D(x)=1/2$ ，則代表discriminator無法確切分辨真實圖片以及generator所產生的假圖何為真假，而generator也已經可以產生出非常貼近真實圖片的假圖片。

2. (b) The Helvetica Scenario often happens during training procedure of GAN. Please explain why this problem occurs and how to avoid it. (5%)

Ans:

The Helvetica Scenario這個現象指的是，當generator發現生成某些特定的圖像或特徵即可騙過discriminator，即便用不同的noise輸入到generator中，generator就也只會產出相同類型的圖片，從而停止學習且沒有學習到真實圖片的distribution。而發生此現象的generator也失去了產生多樣性圖片的能力。

避免Helvetica Scenario的作法為要盡可能的讓discriminator與generator的訓練次數相等，避免在更新一次discriminator前更新過多次generator。此外Batch Normalization的做法也可以防止generator一直產生相同樣本。

2. (c) Both VAE and GAN are generative models. The following figures are random generated results by using VAE (left) and GAN (right). Please compare two results and describe the pros and cons of two models. (5%) (Hint: You can compare the loss function and training method using these two models.)



Ans:

VAE以及GAN所產生之圖片最大不同之處在於，VAE產生的圖片看起來較為模糊粗略，但人已經可以辨識出這些圖片像是臉。

至於GAN所產生的圖片，雖然在細部(例如頭髮、眼睛、鼻子等輪廓)上表現較好較細微，但是可以看到在尚未訓練完成的情況之下，某些圖片會產生扭曲的部位，這在人的眼中反而是較為怪異不自然的。

VAE

1. Pros : 模型簡單、較容易訓練
2. Cons : 產生的圖片較模糊不夠細緻真實

GAN

1. Pros : 產生的圖片較細緻真實
2. Cons : 模型較為複雜訓練不易，容易發生The Helvetica Scenario現象導致生成的多樣性不夠

可以從Loss function以及training method之中來推測可能性：

$$L_{\theta,\phi}^{VAE} = -\mathbb{E}_{q_\phi(z|x_i)}[\log(p(x_i|g_\theta(z)))] + KL(q_\phi(z|x_i) \parallel p(z))$$

在VAE的loss function之中，是由reconstruction loss跟KL-divergence組成從而貼近真實圖片的分布與呈現。reconstruction loss的目的是要讓產生的圖片與真實圖片中以pixel-level的程度越接近越好，因此整體來說圖片產生的較為模糊。

而GAN的loss function中主要目的是讓discriminator與generator互相競爭，在沒有reconstruction loss的情況之下，generator會傾向生成更細緻更貼近真實圖片的假圖片，以騙過discriminator。