Classical Artwork Generation using Generative Adversarial Networks

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[1]:
```
!pip install kaggle
!pip install torchsummary
!pip install imageio
```

```
Requirement already satisfied: kaggle in /usr/local/lib/python3.10/dist-packages
(1.6.12)
Requirement already satisfied: six>=1.10 in /usr/local/lib/python3.10/dist-
packages (from kaggle) (1.16.0)
Requirement already satisfied: certifi>=2023.7.22 in
/usr/local/lib/python3.10/dist-packages (from kaggle) (2024.2.2)
Requirement already satisfied: python-dateutil in
/usr/local/lib/python3.10/dist-packages (from kaggle) (2.8.2)
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-
packages (from kaggle) (2.31.0)
Requirement already satisfied: tqdm in /usr/local/lib/python3.10/dist-packages
(from kaggle) (4.66.4)
Requirement already satisfied: python-slugify in /usr/local/lib/python3.10/dist-
packages (from kaggle) (8.0.4)
Requirement already satisfied: urllib3 in /usr/local/lib/python3.10/dist-
packages (from kaggle) (2.0.7)
Requirement already satisfied: bleach in /usr/local/lib/python3.10/dist-packages
(from kaggle) (6.1.0)
Requirement already satisfied: webencodings in /usr/local/lib/python3.10/dist-
packages (from bleach->kaggle) (0.5.1)
Requirement already satisfied: text-unidecode>=1.3 in
/usr/local/lib/python3.10/dist-packages (from python-slugify->kaggle) (1.3)
Requirement already satisfied: charset-normalizer<4,>=2 in
/usr/local/lib/python3.10/dist-packages (from requests->kaggle) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-
packages (from requests->kaggle) (3.7)
Requirement already satisfied: torchsummary in /usr/local/lib/python3.10/dist-
packages (1.5.1)
Requirement already satisfied: imageio in /usr/local/lib/python3.10/dist-
packages (2.31.6)
Requirement already satisfied: numpy in /usr/local/lib/python3.10/dist-packages
(from imageio) (1.25.2)
Requirement already satisfied: pillow<10.1.0,>=8.3.2 in
/usr/local/lib/python3.10/dist-packages (from imageio) (9.4.0)
```

[2]:
```
import os
import torch
import torch.nn as nn
import torch.nn.functional as F
import torchvision.transforms as tt
from torch.utils.data import DataLoader
from torchvision.datasets import ImageFolder
from torchvision.utils import save_image, make_grid
import matplotlib.pyplot as plt
from tqdm.auto import tqdm
from torch.nn.utils import spectral_norm
from torch.utils.tensorboard import SummaryWriter
import torchvision.utils as vutils
import sys
import subprocess
from torchsummary import summary
import imageio
from IPython.display import Video
from IPython.display import Image
```

[3]:
```
os.environ['KAGGLE_CONFIG_DIR'] = "/content"
!chmod 600 /content/kaggle.json
```

```
chmod: cannot access '/content/kaggle.json': No such file or directory
```

[4]:
```
dataset_path = '/content/dataset'
if not os.path.exists(dataset_path):
    # If the dataset folder doesn't exist, download and unzip the dataset
    !kaggle datasets download -d ikarus777/best-artworks-of-all-time -p␣
 ↪{dataset_path} --unzip
else:
    print("Dataset already downloaded.")
```

```
Dataset already downloaded.
```

[5]:
```
data_dir = '/content/dataset/resized'
image_save_path = '/content/generated_images/'
os.makedirs(image_save_path, exist_ok=True)
```

[6]:
```
def get_mean_std(loader):
    # Vectors to hold image mean and std
    mean = 0.
    std = 0.
    total_images_count = 0
    for images, _ in tqdm(loader, desc="Calculating mean and std"):
        images = images.view(images.size(0), images.size(1), -1)
        mean += images.mean(2).sum(0)
```

```
        std += images.std(2).sum(0)
        total_images_count += images.size(0)

    # Final mean and std
    mean /= total_images_count
    std /= total_images_count
    return mean, std
```

[7]:
```
pre_transforms = tt.Compose([
    tt.Resize((128, 128)),
    tt.ToTensor(),
])
pre_dataset = ImageFolder(data_dir, transform=pre_transforms)
pre_loader = DataLoader(pre_dataset, batch_size=64, shuffle=False,␣
 ↪num_workers=2)

# Calculate mean and std
dataset_mean, dataset_std = get_mean_std(pre_loader)
```

```
/usr/lib/python3.10/multiprocessing/popen_fork.py:66: RuntimeWarning: os.fork()
was called. os.fork() is incompatible with multithreaded code, and JAX is
multithreaded, so this will likely lead to a deadlock.
  self.pid = os.fork()
```

```
Calculating mean and std:   0%|          | 0/136 [00:00<?, ?it/s]
```

[8]:
```
transformations = tt.Compose([

    tt.Resize((128, 128)),
    tt.RandomHorizontalFlip(),
    tt.RandomRotation(5),
    tt.ToTensor(),
    tt.Normalize(dataset_mean.tolist(), dataset_std.tolist())
])

dataset = ImageFolder(data_dir, transform=transformations)
train_dl = DataLoader(dataset, batch_size=64, shuffle=True, num_workers=2,␣
 ↪pin_memory=True)
```

[9]:
```
print(f"Total number of images in dataset: {len(dataset)}")
```

```
Total number of images in dataset: 8683
```

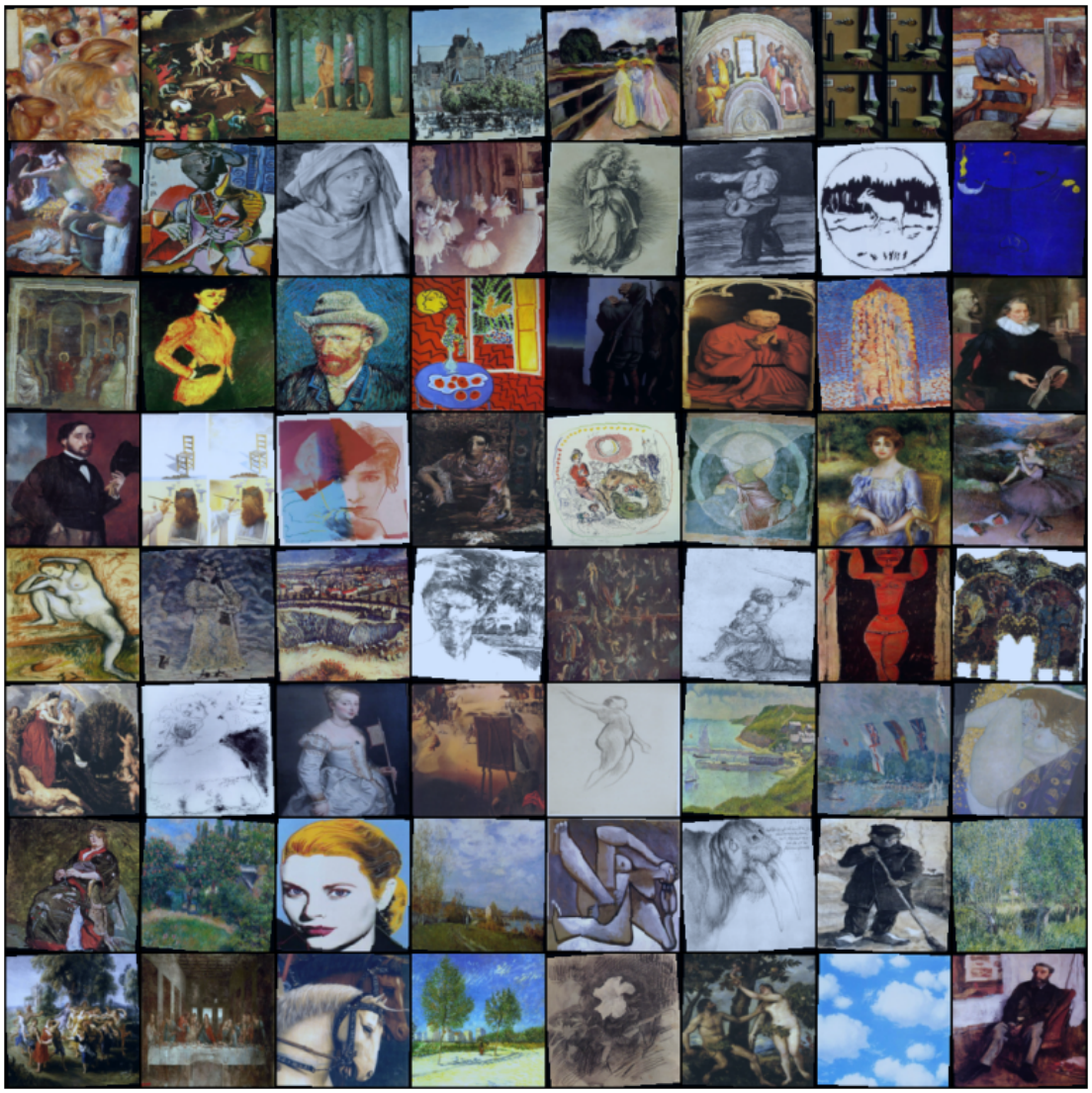
[10]:
```
num_batches = len(train_dl)
print(f"Number of batches per epoch (batch size = 64): {num_batches}")
```

```
Number of batches per epoch (batch size = 64): 136
```

[11]:
```
dataiter = iter(train_dl)
images, labels = next(dataiter)

# Create a grid of images
img_grid = vutils.make_grid(images, nrow=8, normalize=True)

# Display these images
plt.figure(figsize=(10, 10))
plt.imshow(img_grid.permute(1, 2, 0))
plt.axis('off')
plt.show()
```



[12]:
```
class Generator(nn.Module):
    def __init__(self, latent_size=128):
        super(Generator, self).__init__()

        # Initial layers focus on broader features
        self.initial_layers = nn.Sequential(
            nn.ConvTranspose2d(latent_size, 1024, kernel_size=4, stride=1,␣
↪padding=0, bias=False),
            nn.ReLU(True),
            nn.BatchNorm2d(1024),

            nn.ConvTranspose2d(1024, 512, kernel_size=4, stride=2, padding=1,␣
↪bias=False),
            nn.ReLU(True),
            nn.BatchNorm2d(512),
        )

        # Detail layers focus on finer details
        self.detail_layers = nn.Sequential(
            nn.ConvTranspose2d(512, 256, kernel_size=4, stride=2, padding=1,␣
↪bias=False),
            nn.ReLU(True),
            nn.BatchNorm2d(256),

            nn.ConvTranspose2d(256, 128, kernel_size=4, stride=2, padding=1,␣
↪bias=False),
            nn.ReLU(True),
            nn.BatchNorm2d(128),

            nn.ConvTranspose2d(128, 64, kernel_size=4, stride=2, padding=1,␣
↪bias=False),
            nn.ReLU(True),
            nn.BatchNorm2d(64),

            nn.ConvTranspose2d(64, 3, kernel_size=4, stride=2, padding=1,␣
↪bias=False),
            nn.Tanh(),
        )

    def forward(self, x):
        x = self.initial_layers(x)
        x = self.detail_layers(x)
        return x
```

[13]:
```
class Discriminator(nn.Module):
    def __init__(self, dropout_rate=0.3):
        super(Discriminator, self).__init__()
```

```
        self.disc = nn.Sequential(
            spectral_norm(nn.Conv2d(3, 64, kernel_size=4, stride=2, padding=1,␣
↪bias=False)),
            nn.LeakyReLU(0.2, inplace=True),
            nn.Dropout(dropout_rate),

            spectral_norm(nn.Conv2d(64, 128, kernel_size=4, stride=2,␣
↪padding=1, bias=False)),
            nn.LeakyReLU(0.2, inplace=True),
            nn.Dropout(dropout_rate),

            spectral_norm(nn.Conv2d(128, 256, kernel_size=4, stride=2,␣
↪padding=1, bias=False)),
            nn.LeakyReLU(0.2, inplace=True),
            nn.Dropout(dropout_rate),

            spectral_norm(nn.Conv2d(256, 512, kernel_size=4, stride=2,␣
↪padding=1, bias=False)),
            nn.LeakyReLU(0.2, inplace=True),
            nn.Dropout(dropout_rate),

            spectral_norm(nn.Conv2d(512, 1, kernel_size=4, stride=1, padding=0,␣
↪bias=False)),
            nn.AdaptiveAvgPool2d((1, 1)),
            nn.Flatten(),
            nn.Sigmoid()
        )

    def forward(self, x):
        return self.disc(x)
```

[14]:
```
device = torch.device("cuda" if torch.cuda.is_available() else "cpu")
generator = Generator().to(device)
discriminator = Discriminator().to(device)

opt_d = torch.optim.Adam(discriminator.parameters(), lr=0.0001, betas=(0.5, 0.
↪999))
```

[15]:
```
def adjust_learning_rates(optimizer_initial, optimizer_detail, feedback_signal):

    lr_adjustment_factor = 0.95

    # discriminator is too good
    if feedback_signal > 0.8:
        for param_group in optimizer_initial.param_groups:
```

```
            param_group['lr'] *= lr_adjustment_factor
        for param_group in optimizer_detail.param_groups:
            param_group['lr'] *= lr_adjustment_factor

    # discriminator is too poor
    elif feedback_signal < 0.3:
        for param_group in optimizer_initial.param_groups:
            param_group['lr'] /= lr_adjustment_factor
        for param_group in optimizer_detail.param_groups:
            param_group['lr'] /= lr_adjustment_factor
```

[16]:
```
opt_initial = torch.optim.Adam(generator.initial_layers.parameters(), lr=0.
↪0002, betas=(0.5, 0.999))
opt_detail = torch.optim.Adam(generator.detail_layers.parameters(), lr=0.00005,␣
↪betas=(0.5, 0.999))
```

[17]:
```
def train_discriminator(real_images):

    # Adding Gaussian noise
    noise = torch.randn_like(real_images) * 0.05
    real_images = real_images + noise

    opt_d.zero_grad()
    real_preds = discriminator(real_images)
    real_targets = torch.full_like(real_preds, 0.9)
    real_loss = F.binary_cross_entropy(real_preds, real_targets)
    real_score = torch.mean(real_preds).item()

    latent = torch.randn(real_images.size(0), 128, 1, 1, device=device)
    fake_images = generator(latent)
    fake_preds = discriminator(fake_images.detach())
    fake_targets = torch.full_like(fake_preds, 0.1)
    fake_loss = F.binary_cross_entropy(fake_preds, fake_targets)
    fake_score = torch.mean(fake_preds).item()

    loss = real_loss + fake_loss
    loss.backward()
    opt_d.step()
    return loss.item(), real_score, fake_score
```

[18]:
```
def train_generator():

    # Zero the gradients for both optimizers
    opt_initial.zero_grad()
    opt_detail.zero_grad()

    latent = torch.randn(64, 128, 1, 1, device=device)
```

```
    fake_images = generator(latent)
    preds = discriminator(fake_images)
    targets = torch.ones_like(preds)
    loss = F.binary_cross_entropy(preds, targets)

    # Perform backpropagation
    loss.backward()

    # Update both parts of the generator
    opt_initial.step()
    opt_detail.step()

    return loss.item()
```

[19]:
```
def save_models(generator, discriminator, epoch, save_directory="/content/
↪saved_models"):
    os.makedirs(save_directory, exist_ok=True)
    torch.save(generator.state_dict(), os.path.join(save_directory,␣
↪f"generator_epoch_{epoch}.pth"))
    torch.save(discriminator.state_dict(), os.path.join(save_directory,␣
↪f"discriminator_epoch_{epoch}.pth"))
    print(f"Saved models to {save_directory} at epoch {epoch}")
```

[20]:
```
num_epochs = 500
save_interval = 100
fixed_latent = torch.randn(64, 128, 1, 1, device=device)
writer = SummaryWriter('runs/gan_experiment')
```

[21]:
```
generator_losses = []
discriminator_losses = []
hyperparams = {
    'g_lr': [], 'd_lr': []
}
```

[22]:
```
for epoch in range(num_epochs):
    epoch_d_loss, epoch_g_loss = 0, 0
    num_batches = len(train_dl)
    discriminator_effectiveness = []

    with tqdm(total=num_batches, desc=f"Epoch {epoch + 1}/{num_epochs}",␣
↪unit='batch') as pbar:
        for real_images, _ in train_dl:
            real_images = real_images.to(device)
            generator.train()
            discriminator.train()

            # n_critic iterations
```

```
            for _ in range(4):
                d_loss, real_score, fake_score =␣
↪train_discriminator(real_images)
                discriminator_effectiveness.append((real_score + (1 -␣
↪fake_score)) / 2)
                discriminator_losses.append(d_loss)


            # Generator update
            g_loss = train_generator()
            generator_losses.append(g_loss)

            # Logging
            batch_num = epoch * num_batches + pbar.n
            writer.add_scalar('Loss/Generator', g_loss, batch_num)
            writer.add_scalar('Loss/Discriminator', d_loss, batch_num)

            # Progress update
            pbar.set_postfix_str(f"D Loss: {d_loss:.4f}, G Loss: {g_loss:.4f}")
            pbar.update()

            # Cumulative loss calculation
            epoch_d_loss += d_loss
            epoch_g_loss += g_loss

            # Log current learning rates
            hyperparams['d_lr'].append(opt_d.param_groups[0]['lr'])
            hyperparams['g_lr'].append(opt_initial.param_groups[0]['lr'] +␣
↪opt_detail.param_groups[0]['lr'])


        # Feedback-based learning rate adjustment
        avg_discriminator_effectiveness = sum(discriminator_effectiveness) /␣
↪len(discriminator_effectiveness)
        adjust_learning_rates(opt_initial, opt_detail,␣
↪avg_discriminator_effectiveness)


        # Generate images at the end of each epoch
        with torch.no_grad():
            generated_images = generator(fixed_latent).cpu()
            save_image(generated_images, os.path.join(image_save_path,␣
↪f'generated_images_epoch_{epoch}.png'), normalize=True, nrow=8)

        # Epoch summary
```

```
        print(f"Epoch {epoch + 1}/{num_epochs}: Average D Loss: {epoch_d_loss /␣
↪num_batches:.4f}, Average G Loss: {epoch_g_loss / num_batches:.4f}")

        # Save models at specified interval
        if (epoch + 1) % save_interval == 0 or epoch == num_epochs - 1:
            save_models(generator, discriminator, epoch)

# Cleanup
writer.close()
```

```
Epoch 1/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 1/500: Average D Loss: 0.7533, Average G Loss: 1.9294
Epoch 2/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 2/500: Average D Loss: 0.7841, Average G Loss: 1.7830
Epoch 3/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 3/500: Average D Loss: 0.8142, Average G Loss: 1.6581
Epoch 4/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 4/500: Average D Loss: 0.7937, Average G Loss: 1.6543
Epoch 5/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 5/500: Average D Loss: 0.7825, Average G Loss: 1.6485
Epoch 6/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 6/500: Average D Loss: 0.7953, Average G Loss: 1.5864
Epoch 7/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 7/500: Average D Loss: 0.8143, Average G Loss: 1.4850
Epoch 8/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 8/500: Average D Loss: 0.8592, Average G Loss: 1.2103
Epoch 9/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 9/500: Average D Loss: 0.9089, Average G Loss: 1.0399
Epoch 10/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 10/500: Average D Loss: 0.9422, Average G Loss: 0.9485
Epoch 11/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 11/500: Average D Loss: 0.9498, Average G Loss: 0.9214
Epoch 12/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 12/500: Average D Loss: 0.9640, Average G Loss: 0.8861
Epoch 13/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 13/500: Average D Loss: 0.9702, Average G Loss: 0.8665
Epoch 14/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 14/500: Average D Loss: 0.9799, Average G Loss: 0.8470
Epoch 15/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 15/500: Average D Loss: 0.9840, Average G Loss: 0.8395
Epoch 16/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 16/500: Average D Loss: 0.9910, Average G Loss: 0.8289
Epoch 17/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 17/500: Average D Loss: 0.9984, Average G Loss: 0.8032
Epoch 18/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 18/500: Average D Loss: 1.0089, Average G Loss: 0.7900
Epoch 19/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 19/500: Average D Loss: 1.0109, Average G Loss: 0.7797
Epoch 20/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at
0x7b125e54d630>
Traceback (most recent call last):
  File "/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py",
line 1479, in __del__
    self._shutdown_workers()
  File "/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py",
line 1462, in _shutdown_workers
    if w.is_alive():
  File "/usr/lib/python3.10/multiprocessing/process.py", line 160, in is_alive
    assert self._parent_pid == os.getpid(), 'can only test a child process'
AssertionError: can only test a child process
Epoch 20/500: Average D Loss: 1.0179, Average G Loss: 0.7607
Epoch 21/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at
0x7b125e54d630>
Traceback (most recent call last):
  File "/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py",
line 1479, in __del__
    self._shutdown_workers()
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    assert self._parent_pid == os.getpid(), 'can only test a child process'
AssertionError: can only test a child process
```

```
Epoch 21/500: Average D Loss: 1.0182, Average G Loss: 0.7625
```

```
Epoch 22/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at
0x7b125e54d630>
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  File "/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py",
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    self._shutdown_workers()
  File "/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py",
line 1462, in _shutdown_workers
    if w.is_alive():
  File "/usr/lib/python3.10/multiprocessing/process.py", line 160, in is_alive
    assert self._parent_pid == os.getpid(), 'can only test a child process'
AssertionError: can only test a child process
Exception ignored in: <function _MultiProcessingDataLoaderIter.__del__ at
0x7b125e54d630>
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line 1462, in _shutdown_workers
    if w.is_alive():
  File "/usr/lib/python3.10/multiprocessing/process.py", line 160, in is_alive
    assert self._parent_pid == os.getpid(), 'can only test a child process'
AssertionError: can only test a child process
```

```
Epoch 22/500: Average D Loss: 1.0232, Average G Loss: 0.7476
```

```
Epoch 23/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Exception ignored in: Exception ignored in: <function
_MultiProcessingDataLoaderIter.__del__ at 0x7b125e54d630>
<function _MultiProcessingDataLoaderIter.__del__ at 0x7b125e54d630>Traceback
(most recent call last):
```

```
  File "/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py",
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line 1462, in _shutdown_workers
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        assert self._parent_pid == os.getpid(), 'can only test a child
process'assert self._parent_pid == os.getpid(), 'can only test a child process'

AssertionErrorAssertionError: : can only test a child process
can only test a child process

Epoch 23/500: Average D Loss: 1.0262, Average G Loss: 0.7454

Epoch 24/500:   0%|          | 0/136 [00:00<?, ?batch/s]

Exception ignored in: Exception ignored in: <function
_MultiProcessingDataLoaderIter.__del__ at 0x7b125e54d630>
<function _MultiProcessingDataLoaderIter.__del__ at 0x7b125e54d630>Traceback
(most recent call last):

  File "/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py",
line 1479, in __del__
Traceback (most recent call last):
      File "/usr/local/lib/python3.10/dist-
packages/torch/utils/data/dataloader.py", line 1479, in __del__
self._shutdown_workers()
self._shutdown_workers()  File "/usr/local/lib/python3.10/dist-
packages/torch/utils/data/dataloader.py", line 1462, in _shutdown_workers

  File "/usr/local/lib/python3.10/dist-packages/torch/utils/data/dataloader.py",
line 1462, in _shutdown_workers
        if w.is_alive():if w.is_alive():

  File "/usr/lib/python3.10/multiprocessing/process.py", line 160, in is_alive
  File "/usr/lib/python3.10/multiprocessing/process.py", line 160, in is_alive
        assert self._parent_pid == os.getpid(), 'can only test a child
process'assert self._parent_pid == os.getpid(), 'can only test a child process'
```

```
AssertionErrorAssertionError:
: can only test a child processcan only test a child process
Epoch 24/500: Average D Loss: 1.0249, Average G Loss: 0.7461
Epoch 25/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 25/500: Average D Loss: 1.0273, Average G Loss: 0.7487
Epoch 26/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 26/500: Average D Loss: 1.0370, Average G Loss: 0.7330
Epoch 27/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 27/500: Average D Loss: 1.0256, Average G Loss: 0.7477
Epoch 28/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 28/500: Average D Loss: 1.0294, Average G Loss: 0.7294
Epoch 29/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 29/500: Average D Loss: 1.0366, Average G Loss: 0.7270
Epoch 30/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 30/500: Average D Loss: 1.0333, Average G Loss: 0.7257
Epoch 31/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 31/500: Average D Loss: 1.0553, Average G Loss: 0.7092
Epoch 32/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 32/500: Average D Loss: 1.0357, Average G Loss: 0.7304
Epoch 33/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 33/500: Average D Loss: 1.0387, Average G Loss: 0.7200
Epoch 34/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 34/500: Average D Loss: 1.0371, Average G Loss: 0.7238
Epoch 35/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 35/500: Average D Loss: 1.0304, Average G Loss: 0.7388
Epoch 36/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 36/500: Average D Loss: 1.0453, Average G Loss: 0.7073
Epoch 37/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 37/500: Average D Loss: 1.0483, Average G Loss: 0.7118
Epoch 38/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 38/500: Average D Loss: 1.0444, Average G Loss: 0.7151
Epoch 39/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 39/500: Average D Loss: 1.0640, Average G Loss: 0.7031
Epoch 40/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 40/500: Average D Loss: 1.0455, Average G Loss: 0.7129
Epoch 41/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 41/500: Average D Loss: 1.0526, Average G Loss: 0.7096
Epoch 42/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 42/500: Average D Loss: 1.0563, Average G Loss: 0.7034
Epoch 43/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 43/500: Average D Loss: 1.0492, Average G Loss: 0.7126
Epoch 44/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 44/500: Average D Loss: 1.0516, Average G Loss: 0.7100
Epoch 45/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 45/500: Average D Loss: 1.0520, Average G Loss: 0.7085
Epoch 46/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 46/500: Average D Loss: 1.0491, Average G Loss: 0.7432
Epoch 47/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 47/500: Average D Loss: 1.0363, Average G Loss: 0.7405
Epoch 48/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 48/500: Average D Loss: 1.0403, Average G Loss: 0.7275
Epoch 49/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 49/500: Average D Loss: 1.0522, Average G Loss: 0.7054
Epoch 50/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 50/500: Average D Loss: 1.0474, Average G Loss: 0.7179
Epoch 51/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 51/500: Average D Loss: 1.0452, Average G Loss: 0.7133
Epoch 52/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 52/500: Average D Loss: 1.0476, Average G Loss: 0.7145
Epoch 53/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 53/500: Average D Loss: 1.0503, Average G Loss: 0.7102
Epoch 54/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 54/500: Average D Loss: 1.0549, Average G Loss: 0.7019
Epoch 55/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 55/500: Average D Loss: 1.0505, Average G Loss: 0.7105
Epoch 56/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 56/500: Average D Loss: 1.0546, Average G Loss: 0.7083
Epoch 57/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 57/500: Average D Loss: 1.0563, Average G Loss: 0.7056
Epoch 58/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 58/500: Average D Loss: 1.0467, Average G Loss: 0.7173
Epoch 59/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 59/500: Average D Loss: 1.0545, Average G Loss: 0.7077
Epoch 60/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 60/500: Average D Loss: 1.0634, Average G Loss: 0.6996
Epoch 61/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 61/500: Average D Loss: 1.0573, Average G Loss: 0.7121
Epoch 62/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 62/500: Average D Loss: 1.0545, Average G Loss: 0.7124
Epoch 63/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 63/500: Average D Loss: 1.0545, Average G Loss: 0.7076
Epoch 64/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 64/500: Average D Loss: 1.0661, Average G Loss: 0.6937
Epoch 65/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 65/500: Average D Loss: 1.0590, Average G Loss: 0.7051
Epoch 66/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 66/500: Average D Loss: 1.0580, Average G Loss: 0.7052
Epoch 67/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 67/500: Average D Loss: 1.0583, Average G Loss: 0.7030
Epoch 68/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 68/500: Average D Loss: 1.0607, Average G Loss: 0.7007
Epoch 69/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 69/500: Average D Loss: 1.0621, Average G Loss: 0.7018
Epoch 70/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 70/500: Average D Loss: 1.0609, Average G Loss: 0.7058
Epoch 71/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 71/500: Average D Loss: 1.0537, Average G Loss: 0.7105
Epoch 72/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 72/500: Average D Loss: 1.0662, Average G Loss: 0.7019
Epoch 73/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 73/500: Average D Loss: 1.0658, Average G Loss: 0.7049
Epoch 74/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 74/500: Average D Loss: 1.0589, Average G Loss: 0.7085
Epoch 75/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 75/500: Average D Loss: 1.0627, Average G Loss: 0.7040
Epoch 76/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 76/500: Average D Loss: 1.0654, Average G Loss: 0.6998
Epoch 77/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 77/500: Average D Loss: 1.0616, Average G Loss: 0.7051
Epoch 78/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 78/500: Average D Loss: 1.0809, Average G Loss: 0.6933
Epoch 79/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 79/500: Average D Loss: 1.0598, Average G Loss: 0.7174
Epoch 80/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 80/500: Average D Loss: 1.0631, Average G Loss: 0.7062
Epoch 81/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 81/500: Average D Loss: 1.0733, Average G Loss: 0.7038
Epoch 82/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 82/500: Average D Loss: 1.0724, Average G Loss: 0.7029
Epoch 83/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 83/500: Average D Loss: 1.0702, Average G Loss: 0.7090
Epoch 84/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 84/500: Average D Loss: 1.0777, Average G Loss: 0.7035
Epoch 85/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 85/500: Average D Loss: 1.0691, Average G Loss: 0.7083
Epoch 86/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 86/500: Average D Loss: 1.0841, Average G Loss: 0.6994
Epoch 87/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 87/500: Average D Loss: 1.0730, Average G Loss: 0.7088
Epoch 88/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 88/500: Average D Loss: 1.0669, Average G Loss: 0.7155
Epoch 89/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 89/500: Average D Loss: 1.0769, Average G Loss: 0.7055
Epoch 90/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 90/500: Average D Loss: 1.0741, Average G Loss: 0.7063
Epoch 91/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 91/500: Average D Loss: 1.0821, Average G Loss: 0.7068
Epoch 92/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 92/500: Average D Loss: 1.0784, Average G Loss: 0.7167
Epoch 93/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 93/500: Average D Loss: 1.0806, Average G Loss: 0.7081
Epoch 94/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 94/500: Average D Loss: 1.0802, Average G Loss: 0.7126
Epoch 95/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 95/500: Average D Loss: 1.0728, Average G Loss: 0.7152
Epoch 96/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 96/500: Average D Loss: 1.0673, Average G Loss: 0.7184
Epoch 97/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 97/500: Average D Loss: 1.0837, Average G Loss: 0.7069
Epoch 98/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 98/500: Average D Loss: 1.0778, Average G Loss: 0.7094
Epoch 99/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 99/500: Average D Loss: 1.0815, Average G Loss: 0.7055
Epoch 100/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 100/500: Average D Loss: 1.0846, Average G Loss: 0.7094
Saved models to /content/saved_models at epoch 99
Epoch 101/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 101/500: Average D Loss: 1.0892, Average G Loss: 0.7100
Epoch 102/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 102/500: Average D Loss: 1.0813, Average G Loss: 0.7048
```

```
Epoch 103/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 103/500: Average D Loss: 1.0820, Average G Loss: 0.7050
Epoch 104/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 104/500: Average D Loss: 1.0769, Average G Loss: 0.7167
Epoch 105/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 105/500: Average D Loss: 1.0833, Average G Loss: 0.7112
Epoch 106/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 106/500: Average D Loss: 1.0814, Average G Loss: 0.7134
Epoch 107/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 107/500: Average D Loss: 1.0884, Average G Loss: 0.7115
Epoch 108/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 108/500: Average D Loss: 1.0783, Average G Loss: 0.7144
Epoch 109/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 109/500: Average D Loss: 1.0849, Average G Loss: 0.7055
Epoch 110/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 110/500: Average D Loss: 1.0793, Average G Loss: 0.7148
Epoch 111/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 111/500: Average D Loss: 1.0824, Average G Loss: 0.7144
Epoch 112/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 112/500: Average D Loss: 1.0847, Average G Loss: 0.7087
Epoch 113/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 113/500: Average D Loss: 1.0865, Average G Loss: 0.7093
Epoch 114/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 114/500: Average D Loss: 1.0876, Average G Loss: 0.7054
Epoch 115/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 115/500: Average D Loss: 1.0836, Average G Loss: 0.7083
Epoch 116/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 116/500: Average D Loss: 1.0818, Average G Loss: 0.7172
Epoch 117/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 117/500: Average D Loss: 1.0897, Average G Loss: 0.7068
Epoch 118/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 118/500: Average D Loss: 1.0872, Average G Loss: 0.7131
```

```
Epoch 119/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 119/500: Average D Loss: 1.0903, Average G Loss: 0.7083
Epoch 120/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 120/500: Average D Loss: 1.0868, Average G Loss: 0.7226
Epoch 121/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 121/500: Average D Loss: 1.0882, Average G Loss: 0.7057
Epoch 122/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 122/500: Average D Loss: 1.0846, Average G Loss: 0.7178
Epoch 123/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 123/500: Average D Loss: 1.0902, Average G Loss: 0.7068
Epoch 124/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 124/500: Average D Loss: 1.0921, Average G Loss: 0.7020
Epoch 125/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 125/500: Average D Loss: 1.0939, Average G Loss: 0.7087
Epoch 126/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 126/500: Average D Loss: 1.0910, Average G Loss: 0.7067
Epoch 127/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 127/500: Average D Loss: 1.0911, Average G Loss: 0.7139
Epoch 128/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 128/500: Average D Loss: 1.0910, Average G Loss: 0.7087
Epoch 129/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 129/500: Average D Loss: 1.0826, Average G Loss: 0.7220
Epoch 130/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 130/500: Average D Loss: 1.0914, Average G Loss: 0.7082
Epoch 131/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 131/500: Average D Loss: 1.0918, Average G Loss: 0.7096
Epoch 132/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 132/500: Average D Loss: 1.0969, Average G Loss: 0.7049
Epoch 133/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 133/500: Average D Loss: 1.0880, Average G Loss: 0.7149
Epoch 134/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 134/500: Average D Loss: 1.0883, Average G Loss: 0.7084
```

```
Epoch 135/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 135/500: Average D Loss: 1.0957, Average G Loss: 0.7042
Epoch 136/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 136/500: Average D Loss: 1.0920, Average G Loss: 0.7119
Epoch 137/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 137/500: Average D Loss: 1.0941, Average G Loss: 0.7076
Epoch 138/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 138/500: Average D Loss: 1.0981, Average G Loss: 0.7020
Epoch 139/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 139/500: Average D Loss: 1.0941, Average G Loss: 0.7165
Epoch 140/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 140/500: Average D Loss: 1.0940, Average G Loss: 0.7134
Epoch 141/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 141/500: Average D Loss: 1.0914, Average G Loss: 0.7135
Epoch 142/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 142/500: Average D Loss: 1.0993, Average G Loss: 0.7026
Epoch 143/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 143/500: Average D Loss: 1.0905, Average G Loss: 0.7166
Epoch 144/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 144/500: Average D Loss: 1.0951, Average G Loss: 0.7112
Epoch 145/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 145/500: Average D Loss: 1.0975, Average G Loss: 0.7129
Epoch 146/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 146/500: Average D Loss: 1.0948, Average G Loss: 0.7150
Epoch 147/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 147/500: Average D Loss: 1.0943, Average G Loss: 0.7074
Epoch 148/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 148/500: Average D Loss: 1.0964, Average G Loss: 0.7117
Epoch 149/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 149/500: Average D Loss: 1.0938, Average G Loss: 0.7101
Epoch 150/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 150/500: Average D Loss: 1.0972, Average G Loss: 0.7147
```

```
Epoch 151/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 151/500: Average D Loss: 1.0970, Average G Loss: 0.7111
Epoch 152/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 152/500: Average D Loss: 1.0966, Average G Loss: 0.7146
Epoch 153/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 153/500: Average D Loss: 1.1010, Average G Loss: 0.7057
Epoch 154/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 154/500: Average D Loss: 1.0961, Average G Loss: 0.7102
Epoch 155/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 155/500: Average D Loss: 1.0954, Average G Loss: 0.7126
Epoch 156/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 156/500: Average D Loss: 1.0980, Average G Loss: 0.7096
Epoch 157/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 157/500: Average D Loss: 1.1016, Average G Loss: 0.6991
Epoch 158/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 158/500: Average D Loss: 1.1016, Average G Loss: 0.7052
Epoch 159/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 159/500: Average D Loss: 1.1012, Average G Loss: 0.7100
Epoch 160/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 160/500: Average D Loss: 1.1035, Average G Loss: 0.7014
Epoch 161/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 161/500: Average D Loss: 1.1053, Average G Loss: 0.7049
Epoch 162/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 162/500: Average D Loss: 1.0978, Average G Loss: 0.7126
Epoch 163/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 163/500: Average D Loss: 1.1043, Average G Loss: 0.7060
Epoch 164/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 164/500: Average D Loss: 1.1035, Average G Loss: 0.7039
Epoch 165/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 165/500: Average D Loss: 1.1061, Average G Loss: 0.7071
Epoch 166/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 166/500: Average D Loss: 1.1097, Average G Loss: 0.7001
```

```
Epoch 167/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 167/500: Average D Loss: 1.1008, Average G Loss: 0.7099
Epoch 168/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 168/500: Average D Loss: 1.1070, Average G Loss: 0.7078
Epoch 169/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 169/500: Average D Loss: 1.1039, Average G Loss: 0.7138
Epoch 170/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 170/500: Average D Loss: 1.1060, Average G Loss: 0.7104
Epoch 171/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 171/500: Average D Loss: 1.1034, Average G Loss: 0.7064
Epoch 172/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 172/500: Average D Loss: 1.1054, Average G Loss: 0.7056
Epoch 173/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 173/500: Average D Loss: 1.1101, Average G Loss: 0.6990
Epoch 174/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 174/500: Average D Loss: 1.1070, Average G Loss: 0.7040
Epoch 175/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 175/500: Average D Loss: 1.1082, Average G Loss: 0.7005
Epoch 176/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 176/500: Average D Loss: 1.1117, Average G Loss: 0.7003
Epoch 177/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 177/500: Average D Loss: 1.1067, Average G Loss: 0.7000
Epoch 178/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 178/500: Average D Loss: 1.1079, Average G Loss: 0.7085
Epoch 179/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 179/500: Average D Loss: 1.1068, Average G Loss: 0.7093
Epoch 180/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 180/500: Average D Loss: 1.1073, Average G Loss: 0.7058
Epoch 181/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 181/500: Average D Loss: 1.1133, Average G Loss: 0.7000
Epoch 182/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 182/500: Average D Loss: 1.1107, Average G Loss: 0.7020
```

```
Epoch 183/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 183/500: Average D Loss: 1.1046, Average G Loss: 0.7194
Epoch 184/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 184/500: Average D Loss: 1.1145, Average G Loss: 0.6956
Epoch 185/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 185/500: Average D Loss: 1.1114, Average G Loss: 0.7069
Epoch 186/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 186/500: Average D Loss: 1.1072, Average G Loss: 0.7114
Epoch 187/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 187/500: Average D Loss: 1.1094, Average G Loss: 0.7064
Epoch 188/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 188/500: Average D Loss: 1.1154, Average G Loss: 0.6939
Epoch 189/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 189/500: Average D Loss: 1.1145, Average G Loss: 0.7025
Epoch 190/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 190/500: Average D Loss: 1.1143, Average G Loss: 0.7018
Epoch 191/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 191/500: Average D Loss: 1.1091, Average G Loss: 0.7131
Epoch 192/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 192/500: Average D Loss: 1.1122, Average G Loss: 0.6981
Epoch 193/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 193/500: Average D Loss: 1.1127, Average G Loss: 0.7063
Epoch 194/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 194/500: Average D Loss: 1.1137, Average G Loss: 0.7015
Epoch 195/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 195/500: Average D Loss: 1.1141, Average G Loss: 0.7026
Epoch 196/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 196/500: Average D Loss: 1.1135, Average G Loss: 0.7068
Epoch 197/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 197/500: Average D Loss: 1.1129, Average G Loss: 0.7074
Epoch 198/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 198/500: Average D Loss: 1.1138, Average G Loss: 0.6998
```

```
Epoch 199/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 199/500: Average D Loss: 1.1157, Average G Loss: 0.7023
Epoch 200/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 200/500: Average D Loss: 1.1157, Average G Loss: 0.7028
Saved models to /content/saved_models at epoch 199
Epoch 201/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 201/500: Average D Loss: 1.1178, Average G Loss: 0.6947
Epoch 202/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 202/500: Average D Loss: 1.1137, Average G Loss: 0.6989
Epoch 203/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 203/500: Average D Loss: 1.1136, Average G Loss: 0.7032
Epoch 204/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 204/500: Average D Loss: 1.1124, Average G Loss: 0.7033
Epoch 205/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 205/500: Average D Loss: 1.1114, Average G Loss: 0.7101
Epoch 206/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 206/500: Average D Loss: 1.1126, Average G Loss: 0.7059
Epoch 207/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 207/500: Average D Loss: 1.1110, Average G Loss: 0.7010
Epoch 208/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 208/500: Average D Loss: 1.1159, Average G Loss: 0.6973
Epoch 209/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 209/500: Average D Loss: 1.1139, Average G Loss: 0.7044
Epoch 210/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 210/500: Average D Loss: 1.1193, Average G Loss: 0.7016
Epoch 211/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 211/500: Average D Loss: 1.1133, Average G Loss: 0.7085
Epoch 212/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 212/500: Average D Loss: 1.1190, Average G Loss: 0.7001
Epoch 213/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 213/500: Average D Loss: 1.1221, Average G Loss: 0.6937
Epoch 214/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 214/500: Average D Loss: 1.1234, Average G Loss: 0.6999
Epoch 215/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 215/500: Average D Loss: 1.1175, Average G Loss: 0.6993
Epoch 216/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 216/500: Average D Loss: 1.1216, Average G Loss: 0.6923
Epoch 217/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 217/500: Average D Loss: 1.1171, Average G Loss: 0.6973
Epoch 218/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 218/500: Average D Loss: 1.1199, Average G Loss: 0.7012
Epoch 219/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 219/500: Average D Loss: 1.1207, Average G Loss: 0.6914
Epoch 220/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 220/500: Average D Loss: 1.1227, Average G Loss: 0.7020
Epoch 221/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 221/500: Average D Loss: 1.1186, Average G Loss: 0.6996
Epoch 222/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 222/500: Average D Loss: 1.1183, Average G Loss: 0.7012
Epoch 223/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 223/500: Average D Loss: 1.1210, Average G Loss: 0.6965
Epoch 224/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 224/500: Average D Loss: 1.1213, Average G Loss: 0.6973
Epoch 225/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 225/500: Average D Loss: 1.1196, Average G Loss: 0.7020
Epoch 226/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 226/500: Average D Loss: 1.1182, Average G Loss: 0.6981
Epoch 227/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 227/500: Average D Loss: 1.1169, Average G Loss: 0.6969
Epoch 228/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 228/500: Average D Loss: 1.1179, Average G Loss: 0.6962
Epoch 229/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 229/500: Average D Loss: 1.1188, Average G Loss: 0.6996
Epoch 230/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 230/500: Average D Loss: 1.1231, Average G Loss: 0.6943
Epoch 231/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 231/500: Average D Loss: 1.1214, Average G Loss: 0.6940
Epoch 232/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 232/500: Average D Loss: 1.1205, Average G Loss: 0.6988
Epoch 233/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 233/500: Average D Loss: 1.1219, Average G Loss: 0.6987
Epoch 234/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 234/500: Average D Loss: 1.1208, Average G Loss: 0.6977
Epoch 235/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 235/500: Average D Loss: 1.1195, Average G Loss: 0.7027
Epoch 236/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 236/500: Average D Loss: 1.1340, Average G Loss: 0.6879
Epoch 237/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 237/500: Average D Loss: 1.1256, Average G Loss: 0.6933
Epoch 238/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 238/500: Average D Loss: 1.1231, Average G Loss: 0.7017
Epoch 239/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 239/500: Average D Loss: 1.1193, Average G Loss: 0.7000
Epoch 240/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 240/500: Average D Loss: 1.1273, Average G Loss: 0.6942
Epoch 241/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 241/500: Average D Loss: 1.1257, Average G Loss: 0.6887
Epoch 242/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 242/500: Average D Loss: 1.1236, Average G Loss: 0.6985
Epoch 243/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 243/500: Average D Loss: 1.1283, Average G Loss: 0.6930
Epoch 244/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 244/500: Average D Loss: 1.1323, Average G Loss: 0.6835
Epoch 245/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 245/500: Average D Loss: 1.1245, Average G Loss: 0.6964
Epoch 246/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 246/500: Average D Loss: 1.1227, Average G Loss: 0.6960
Epoch 247/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 247/500: Average D Loss: 1.1272, Average G Loss: 0.6968
Epoch 248/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 248/500: Average D Loss: 1.1237, Average G Loss: 0.6969
Epoch 249/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 249/500: Average D Loss: 1.1258, Average G Loss: 0.6944
Epoch 250/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 250/500: Average D Loss: 1.1317, Average G Loss: 0.6859
Epoch 251/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 251/500: Average D Loss: 1.1270, Average G Loss: 0.6917
Epoch 252/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 252/500: Average D Loss: 1.1214, Average G Loss: 0.7007
Epoch 253/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 253/500: Average D Loss: 1.1270, Average G Loss: 0.6937
Epoch 254/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 254/500: Average D Loss: 1.1283, Average G Loss: 0.6910
Epoch 255/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 255/500: Average D Loss: 1.1307, Average G Loss: 0.6922
Epoch 256/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 256/500: Average D Loss: 1.1263, Average G Loss: 0.6925
Epoch 257/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 257/500: Average D Loss: 1.1328, Average G Loss: 0.6859
Epoch 258/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 258/500: Average D Loss: 1.1266, Average G Loss: 0.7007
Epoch 259/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 259/500: Average D Loss: 1.1305, Average G Loss: 0.6870
Epoch 260/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 260/500: Average D Loss: 1.1330, Average G Loss: 0.6925
Epoch 261/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 261/500: Average D Loss: 1.1298, Average G Loss: 0.6946
Epoch 262/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 262/500: Average D Loss: 1.1298, Average G Loss: 0.6928
Epoch 263/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 263/500: Average D Loss: 1.1301, Average G Loss: 0.6897
Epoch 264/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 264/500: Average D Loss: 1.1280, Average G Loss: 0.6965
Epoch 265/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 265/500: Average D Loss: 1.1300, Average G Loss: 0.6904
Epoch 266/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 266/500: Average D Loss: 1.1307, Average G Loss: 0.6865
Epoch 267/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 267/500: Average D Loss: 1.1323, Average G Loss: 0.6898
Epoch 268/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 268/500: Average D Loss: 1.1320, Average G Loss: 0.6895
Epoch 269/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 269/500: Average D Loss: 1.1346, Average G Loss: 0.6808
Epoch 270/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 270/500: Average D Loss: 1.1287, Average G Loss: 0.7023
Epoch 271/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 271/500: Average D Loss: 1.1252, Average G Loss: 0.6964
Epoch 272/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 272/500: Average D Loss: 1.1317, Average G Loss: 0.6897
Epoch 273/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 273/500: Average D Loss: 1.1288, Average G Loss: 0.6977
Epoch 274/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 274/500: Average D Loss: 1.1306, Average G Loss: 0.6910
Epoch 275/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 275/500: Average D Loss: 1.1283, Average G Loss: 0.6882
Epoch 276/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 276/500: Average D Loss: 1.1322, Average G Loss: 0.6943
Epoch 277/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 277/500: Average D Loss: 1.1313, Average G Loss: 0.6908
Epoch 278/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 278/500: Average D Loss: 1.1247, Average G Loss: 0.6931
Epoch 279/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 279/500: Average D Loss: 1.1298, Average G Loss: 0.6963
Epoch 280/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 280/500: Average D Loss: 1.1327, Average G Loss: 0.6881
Epoch 281/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 281/500: Average D Loss: 1.1360, Average G Loss: 0.6897
Epoch 282/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 282/500: Average D Loss: 1.1333, Average G Loss: 0.6936
Epoch 283/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 283/500: Average D Loss: 1.1310, Average G Loss: 0.6879
Epoch 284/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 284/500: Average D Loss: 1.1333, Average G Loss: 0.6910
Epoch 285/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 285/500: Average D Loss: 1.1363, Average G Loss: 0.6869
Epoch 286/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 286/500: Average D Loss: 1.1339, Average G Loss: 0.6948
Epoch 287/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 287/500: Average D Loss: 1.1323, Average G Loss: 0.6922
Epoch 288/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 288/500: Average D Loss: 1.1335, Average G Loss: 0.6930
Epoch 289/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 289/500: Average D Loss: 1.1330, Average G Loss: 0.6933
Epoch 290/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 290/500: Average D Loss: 1.1334, Average G Loss: 0.6965
Epoch 291/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 291/500: Average D Loss: 1.1344, Average G Loss: 0.6952
Epoch 292/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 292/500: Average D Loss: 1.1372, Average G Loss: 0.6907
Epoch 293/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 293/500: Average D Loss: 1.1386, Average G Loss: 0.6886
Epoch 294/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 294/500: Average D Loss: 1.1347, Average G Loss: 0.6899
Epoch 295/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 295/500: Average D Loss: 1.1388, Average G Loss: 0.6868
Epoch 296/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 296/500: Average D Loss: 1.1369, Average G Loss: 0.6976
Epoch 297/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 297/500: Average D Loss: 1.1405, Average G Loss: 0.6925
Epoch 298/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 298/500: Average D Loss: 1.1404, Average G Loss: 0.6940
Epoch 299/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 299/500: Average D Loss: 1.1387, Average G Loss: 0.6964
Epoch 300/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 300/500: Average D Loss: 1.1380, Average G Loss: 0.6892
Saved models to /content/saved_models at epoch 299
Epoch 301/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 301/500: Average D Loss: 1.1397, Average G Loss: 0.6897
Epoch 302/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 302/500: Average D Loss: 1.1393, Average G Loss: 0.6833
Epoch 303/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 303/500: Average D Loss: 1.1380, Average G Loss: 0.6936
Epoch 304/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 304/500: Average D Loss: 1.1370, Average G Loss: 0.6936
Epoch 305/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 305/500: Average D Loss: 1.1396, Average G Loss: 0.6882
Epoch 306/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 306/500: Average D Loss: 1.1388, Average G Loss: 0.6897
Epoch 307/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 307/500: Average D Loss: 1.1376, Average G Loss: 0.6921
Epoch 308/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 308/500: Average D Loss: 1.1373, Average G Loss: 0.6882
Epoch 309/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 309/500: Average D Loss: 1.1417, Average G Loss: 0.6852
```

```
Epoch 310/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 310/500: Average D Loss: 1.1393, Average G Loss: 0.6906
Epoch 311/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 311/500: Average D Loss: 1.1378, Average G Loss: 0.6866
Epoch 312/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 312/500: Average D Loss: 1.1361, Average G Loss: 0.6880
Epoch 313/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 313/500: Average D Loss: 1.1415, Average G Loss: 0.6832
Epoch 314/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 314/500: Average D Loss: 1.1416, Average G Loss: 0.6869
Epoch 315/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 315/500: Average D Loss: 1.1415, Average G Loss: 0.6830
Epoch 316/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 316/500: Average D Loss: 1.1431, Average G Loss: 0.6866
Epoch 317/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 317/500: Average D Loss: 1.1398, Average G Loss: 0.6891
Epoch 318/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 318/500: Average D Loss: 1.1422, Average G Loss: 0.6838
Epoch 319/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 319/500: Average D Loss: 1.1405, Average G Loss: 0.6876
Epoch 320/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 320/500: Average D Loss: 1.1367, Average G Loss: 0.6919
Epoch 321/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 321/500: Average D Loss: 1.1407, Average G Loss: 0.6863
Epoch 322/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 322/500: Average D Loss: 1.1387, Average G Loss: 0.6909
Epoch 323/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 323/500: Average D Loss: 1.1424, Average G Loss: 0.6881
Epoch 324/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 324/500: Average D Loss: 1.1412, Average G Loss: 0.6879
Epoch 325/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 325/500: Average D Loss: 1.1422, Average G Loss: 0.6821
```

```
Epoch 326/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 326/500: Average D Loss: 1.1421, Average G Loss: 0.6851
Epoch 327/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 327/500: Average D Loss: 1.1455, Average G Loss: 0.6862
Epoch 328/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 328/500: Average D Loss: 1.1374, Average G Loss: 0.6933
Epoch 329/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 329/500: Average D Loss: 1.1397, Average G Loss: 0.6871
Epoch 330/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 330/500: Average D Loss: 1.1443, Average G Loss: 0.6792
Epoch 331/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 331/500: Average D Loss: 1.1488, Average G Loss: 0.6766
Epoch 332/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 332/500: Average D Loss: 1.1428, Average G Loss: 0.6813
Epoch 333/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 333/500: Average D Loss: 1.1435, Average G Loss: 0.6836
Epoch 334/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 334/500: Average D Loss: 1.1437, Average G Loss: 0.6849
Epoch 335/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 335/500: Average D Loss: 1.1452, Average G Loss: 0.6745
Epoch 336/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 336/500: Average D Loss: 1.1468, Average G Loss: 0.6864
Epoch 337/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 337/500: Average D Loss: 1.1428, Average G Loss: 0.6834
Epoch 338/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 338/500: Average D Loss: 1.1434, Average G Loss: 0.6845
Epoch 339/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 339/500: Average D Loss: 1.1427, Average G Loss: 0.6800
Epoch 340/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 340/500: Average D Loss: 1.1481, Average G Loss: 0.6806
Epoch 341/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 341/500: Average D Loss: 1.1455, Average G Loss: 0.6914
```

```
Epoch 342/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 342/500: Average D Loss: 1.1436, Average G Loss: 0.6812
Epoch 343/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 343/500: Average D Loss: 1.1444, Average G Loss: 0.6919
Epoch 344/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 344/500: Average D Loss: 1.1501, Average G Loss: 0.6772
Epoch 345/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 345/500: Average D Loss: 1.1470, Average G Loss: 0.6790
Epoch 346/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 346/500: Average D Loss: 1.1472, Average G Loss: 0.6838
Epoch 347/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 347/500: Average D Loss: 1.1407, Average G Loss: 0.6923
Epoch 348/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 348/500: Average D Loss: 1.1437, Average G Loss: 0.6956
Epoch 349/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 349/500: Average D Loss: 1.1413, Average G Loss: 0.6886
Epoch 350/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 350/500: Average D Loss: 1.1460, Average G Loss: 0.6857
Epoch 351/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 351/500: Average D Loss: 1.1474, Average G Loss: 0.6744
Epoch 352/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 352/500: Average D Loss: 1.1447, Average G Loss: 0.6815
Epoch 353/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 353/500: Average D Loss: 1.1451, Average G Loss: 0.6837
Epoch 354/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 354/500: Average D Loss: 1.1491, Average G Loss: 0.6772
Epoch 355/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 355/500: Average D Loss: 1.1466, Average G Loss: 0.6791
Epoch 356/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 356/500: Average D Loss: 1.1423, Average G Loss: 0.6937
Epoch 357/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 357/500: Average D Loss: 1.1430, Average G Loss: 0.6806
```

```
Epoch 358/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 358/500: Average D Loss: 1.1473, Average G Loss: 0.6857
Epoch 359/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 359/500: Average D Loss: 1.1464, Average G Loss: 0.6827
Epoch 360/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 360/500: Average D Loss: 1.1467, Average G Loss: 0.6800
Epoch 361/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 361/500: Average D Loss: 1.1498, Average G Loss: 0.6796
Epoch 362/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 362/500: Average D Loss: 1.1452, Average G Loss: 0.6892
Epoch 363/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 363/500: Average D Loss: 1.1477, Average G Loss: 0.6837
Epoch 364/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 364/500: Average D Loss: 1.1490, Average G Loss: 0.6776
Epoch 365/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 365/500: Average D Loss: 1.1502, Average G Loss: 0.6807
Epoch 366/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 366/500: Average D Loss: 1.1458, Average G Loss: 0.6852
Epoch 367/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 367/500: Average D Loss: 1.1474, Average G Loss: 0.6810
Epoch 368/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 368/500: Average D Loss: 1.1456, Average G Loss: 0.6762
Epoch 369/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 369/500: Average D Loss: 1.1491, Average G Loss: 0.6849
Epoch 370/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 370/500: Average D Loss: 1.1480, Average G Loss: 0.6830
Epoch 371/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 371/500: Average D Loss: 1.1459, Average G Loss: 0.6892
Epoch 372/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 372/500: Average D Loss: 1.1476, Average G Loss: 0.6785
Epoch 373/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 373/500: Average D Loss: 1.1432, Average G Loss: 0.6931
```

```
Epoch 374/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 374/500: Average D Loss: 1.1466, Average G Loss: 0.6829
Epoch 375/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 375/500: Average D Loss: 1.1479, Average G Loss: 0.6819
Epoch 376/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 376/500: Average D Loss: 1.1505, Average G Loss: 0.6818
Epoch 377/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 377/500: Average D Loss: 1.1506, Average G Loss: 0.6826
Epoch 378/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 378/500: Average D Loss: 1.1520, Average G Loss: 0.6829
Epoch 379/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 379/500: Average D Loss: 1.1527, Average G Loss: 0.6823
Epoch 380/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 380/500: Average D Loss: 1.1505, Average G Loss: 0.6808
Epoch 381/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 381/500: Average D Loss: 1.1465, Average G Loss: 0.6766
Epoch 382/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 382/500: Average D Loss: 1.1463, Average G Loss: 0.6816
Epoch 383/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 383/500: Average D Loss: 1.1469, Average G Loss: 0.6820
Epoch 384/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 384/500: Average D Loss: 1.1483, Average G Loss: 0.6853
Epoch 385/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 385/500: Average D Loss: 1.1521, Average G Loss: 0.6810
Epoch 386/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 386/500: Average D Loss: 1.1486, Average G Loss: 0.6846
Epoch 387/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 387/500: Average D Loss: 1.1449, Average G Loss: 0.6855
Epoch 388/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 388/500: Average D Loss: 1.1509, Average G Loss: 0.6806
Epoch 389/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 389/500: Average D Loss: 1.1477, Average G Loss: 0.6877
```

```
Epoch 390/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 390/500: Average D Loss: 1.1435, Average G Loss: 0.6867
Epoch 391/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 391/500: Average D Loss: 1.1493, Average G Loss: 0.6822
Epoch 392/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 392/500: Average D Loss: 1.1457, Average G Loss: 0.6821
Epoch 393/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 393/500: Average D Loss: 1.1456, Average G Loss: 0.6844
Epoch 394/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 394/500: Average D Loss: 1.1496, Average G Loss: 0.6737
Epoch 395/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 395/500: Average D Loss: 1.1497, Average G Loss: 0.6752
Epoch 396/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 396/500: Average D Loss: 1.1516, Average G Loss: 0.6783
Epoch 397/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 397/500: Average D Loss: 1.1516, Average G Loss: 0.6727
Epoch 398/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 398/500: Average D Loss: 1.1528, Average G Loss: 0.6766
Epoch 399/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 399/500: Average D Loss: 1.1476, Average G Loss: 0.6829
Epoch 400/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 400/500: Average D Loss: 1.1502, Average G Loss: 0.6836
Saved models to /content/saved_models at epoch 399
Epoch 401/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 401/500: Average D Loss: 1.1538, Average G Loss: 0.6715
Epoch 402/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 402/500: Average D Loss: 1.1557, Average G Loss: 0.6795
Epoch 403/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 403/500: Average D Loss: 1.1531, Average G Loss: 0.6742
Epoch 404/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 404/500: Average D Loss: 1.1562, Average G Loss: 0.6802
Epoch 405/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 405/500: Average D Loss: 1.1516, Average G Loss: 0.6695
Epoch 406/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 406/500: Average D Loss: 1.1545, Average G Loss: 0.6766
Epoch 407/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 407/500: Average D Loss: 1.1466, Average G Loss: 0.6803
Epoch 408/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 408/500: Average D Loss: 1.1535, Average G Loss: 0.6765
Epoch 409/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 409/500: Average D Loss: 1.1529, Average G Loss: 0.6810
Epoch 410/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 410/500: Average D Loss: 1.1513, Average G Loss: 0.6735
Epoch 411/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 411/500: Average D Loss: 1.1522, Average G Loss: 0.6780
Epoch 412/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 412/500: Average D Loss: 1.1516, Average G Loss: 0.6778
Epoch 413/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 413/500: Average D Loss: 1.1548, Average G Loss: 0.6792
Epoch 414/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 414/500: Average D Loss: 1.1534, Average G Loss: 0.6784
Epoch 415/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 415/500: Average D Loss: 1.1549, Average G Loss: 0.6749
Epoch 416/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 416/500: Average D Loss: 1.1553, Average G Loss: 0.6711
Epoch 417/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 417/500: Average D Loss: 1.1538, Average G Loss: 0.6824
Epoch 418/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 418/500: Average D Loss: 1.1540, Average G Loss: 0.6768
Epoch 419/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 419/500: Average D Loss: 1.1520, Average G Loss: 0.6758
Epoch 420/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 420/500: Average D Loss: 1.1545, Average G Loss: 0.6783
Epoch 421/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 421/500: Average D Loss: 1.1525, Average G Loss: 0.6760
Epoch 422/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 422/500: Average D Loss: 1.1505, Average G Loss: 0.6738
Epoch 423/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 423/500: Average D Loss: 1.1501, Average G Loss: 0.6777
Epoch 424/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 424/500: Average D Loss: 1.1534, Average G Loss: 0.6762
Epoch 425/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 425/500: Average D Loss: 1.1497, Average G Loss: 0.6802
Epoch 426/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 426/500: Average D Loss: 1.1514, Average G Loss: 0.6705
Epoch 427/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 427/500: Average D Loss: 1.1527, Average G Loss: 0.6800
Epoch 428/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 428/500: Average D Loss: 1.1566, Average G Loss: 0.6742
Epoch 429/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 429/500: Average D Loss: 1.1553, Average G Loss: 0.6743
Epoch 430/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 430/500: Average D Loss: 1.1514, Average G Loss: 0.6795
Epoch 431/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 431/500: Average D Loss: 1.1513, Average G Loss: 0.6725
Epoch 432/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 432/500: Average D Loss: 1.1525, Average G Loss: 0.6827
Epoch 433/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 433/500: Average D Loss: 1.1541, Average G Loss: 0.6772
Epoch 434/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 434/500: Average D Loss: 1.1583, Average G Loss: 0.6709
Epoch 435/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 435/500: Average D Loss: 1.1543, Average G Loss: 0.6691
Epoch 436/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 436/500: Average D Loss: 1.1550, Average G Loss: 0.6721
Epoch 437/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 437/500: Average D Loss: 1.1509, Average G Loss: 0.6785
Epoch 438/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 438/500: Average D Loss: 1.1547, Average G Loss: 0.6774
Epoch 439/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 439/500: Average D Loss: 1.1532, Average G Loss: 0.6747
Epoch 440/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 440/500: Average D Loss: 1.1559, Average G Loss: 0.6710
Epoch 441/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 441/500: Average D Loss: 1.1566, Average G Loss: 0.6719
Epoch 442/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 442/500: Average D Loss: 1.1525, Average G Loss: 0.6702
Epoch 443/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 443/500: Average D Loss: 1.1526, Average G Loss: 0.6758
Epoch 444/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 444/500: Average D Loss: 1.1546, Average G Loss: 0.6742
Epoch 445/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 445/500: Average D Loss: 1.1550, Average G Loss: 0.6718
Epoch 446/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 446/500: Average D Loss: 1.1521, Average G Loss: 0.6773
Epoch 447/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 447/500: Average D Loss: 1.1523, Average G Loss: 0.6754
Epoch 448/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 448/500: Average D Loss: 1.1551, Average G Loss: 0.6776
Epoch 449/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 449/500: Average D Loss: 1.1591, Average G Loss: 0.6743
Epoch 450/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 450/500: Average D Loss: 1.1578, Average G Loss: 0.6722
Epoch 451/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 451/500: Average D Loss: 1.1565, Average G Loss: 0.6688
Epoch 452/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 452/500: Average D Loss: 1.1534, Average G Loss: 0.6747
Epoch 453/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

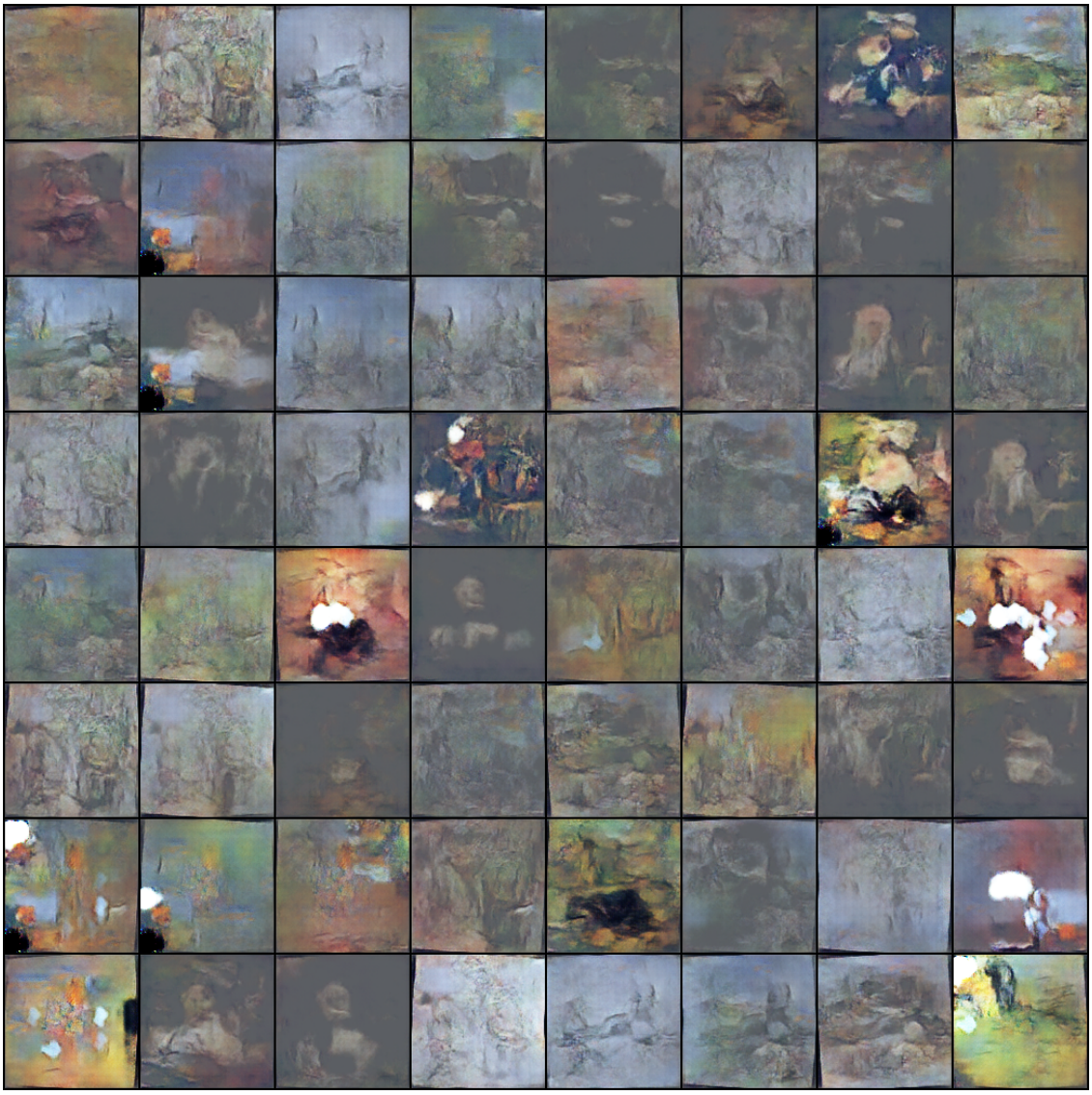
```
Epoch 453/500: Average D Loss: 1.1533, Average G Loss: 0.6740
Epoch 454/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 454/500: Average D Loss: 1.1570, Average G Loss: 0.6727
Epoch 455/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 455/500: Average D Loss: 1.1564, Average G Loss: 0.6686
Epoch 456/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 456/500: Average D Loss: 1.1591, Average G Loss: 0.6724
Epoch 457/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 457/500: Average D Loss: 1.1561, Average G Loss: 0.6751
Epoch 458/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 458/500: Average D Loss: 1.1535, Average G Loss: 0.6769
Epoch 459/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 459/500: Average D Loss: 1.1545, Average G Loss: 0.6781
Epoch 460/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 460/500: Average D Loss: 1.1571, Average G Loss: 0.6733
Epoch 461/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 461/500: Average D Loss: 1.1582, Average G Loss: 0.6662
Epoch 462/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 462/500: Average D Loss: 1.1556, Average G Loss: 0.6726
Epoch 463/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 463/500: Average D Loss: 1.1573, Average G Loss: 0.6667
Epoch 464/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 464/500: Average D Loss: 1.1579, Average G Loss: 0.6655
Epoch 465/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 465/500: Average D Loss: 1.1612, Average G Loss: 0.6743
Epoch 466/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 466/500: Average D Loss: 1.1520, Average G Loss: 0.6755
Epoch 467/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 467/500: Average D Loss: 1.1546, Average G Loss: 0.6835
Epoch 468/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 468/500: Average D Loss: 1.1579, Average G Loss: 0.6740
Epoch 469/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 469/500: Average D Loss: 1.1555, Average G Loss: 0.6746
Epoch 470/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 470/500: Average D Loss: 1.1560, Average G Loss: 0.6743
Epoch 471/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 471/500: Average D Loss: 1.1547, Average G Loss: 0.6719
Epoch 472/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 472/500: Average D Loss: 1.1588, Average G Loss: 0.6669
Epoch 473/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 473/500: Average D Loss: 1.1551, Average G Loss: 0.6744
Epoch 474/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 474/500: Average D Loss: 1.1572, Average G Loss: 0.6699
Epoch 475/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 475/500: Average D Loss: 1.1550, Average G Loss: 0.6731
Epoch 476/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 476/500: Average D Loss: 1.1565, Average G Loss: 0.6719
Epoch 477/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 477/500: Average D Loss: 1.1570, Average G Loss: 0.6709
Epoch 478/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 478/500: Average D Loss: 1.1553, Average G Loss: 0.6724
Epoch 479/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 479/500: Average D Loss: 1.1595, Average G Loss: 0.6719
Epoch 480/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 480/500: Average D Loss: 1.1573, Average G Loss: 0.6712
Epoch 481/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 481/500: Average D Loss: 1.1582, Average G Loss: 0.6668
Epoch 482/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 482/500: Average D Loss: 1.1553, Average G Loss: 0.6714
Epoch 483/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 483/500: Average D Loss: 1.1593, Average G Loss: 0.6718
Epoch 484/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 484/500: Average D Loss: 1.1541, Average G Loss: 0.6770
Epoch 485/500:   0%|          | 0/136 [00:00<?, ?batch/s]
```

```
Epoch 485/500: Average D Loss: 1.1626, Average G Loss: 0.6640
Epoch 486/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 486/500: Average D Loss: 1.1566, Average G Loss: 0.6684
Epoch 487/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 487/500: Average D Loss: 1.1548, Average G Loss: 0.6674
Epoch 488/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 488/500: Average D Loss: 1.1610, Average G Loss: 0.6744
Epoch 489/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 489/500: Average D Loss: 1.1550, Average G Loss: 0.6765
Epoch 490/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 490/500: Average D Loss: 1.1604, Average G Loss: 0.6716
Epoch 491/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 491/500: Average D Loss: 1.1563, Average G Loss: 0.6701
Epoch 492/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 492/500: Average D Loss: 1.1587, Average G Loss: 0.6671
Epoch 493/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 493/500: Average D Loss: 1.1576, Average G Loss: 0.6737
Epoch 494/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 494/500: Average D Loss: 1.1590, Average G Loss: 0.6691
Epoch 495/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 495/500: Average D Loss: 1.1559, Average G Loss: 0.6722
Epoch 496/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 496/500: Average D Loss: 1.1559, Average G Loss: 0.6721
Epoch 497/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 497/500: Average D Loss: 1.1601, Average G Loss: 0.6689
Epoch 498/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 498/500: Average D Loss: 1.1574, Average G Loss: 0.6676
Epoch 499/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 499/500: Average D Loss: 1.1594, Average G Loss: 0.6719
Epoch 500/500:   0%|          | 0/136 [00:00<?, ?batch/s]
Epoch 500/500: Average D Loss: 1.1574, Average G Loss: 0.6784
Saved models to /content/saved_models at epoch 499
```

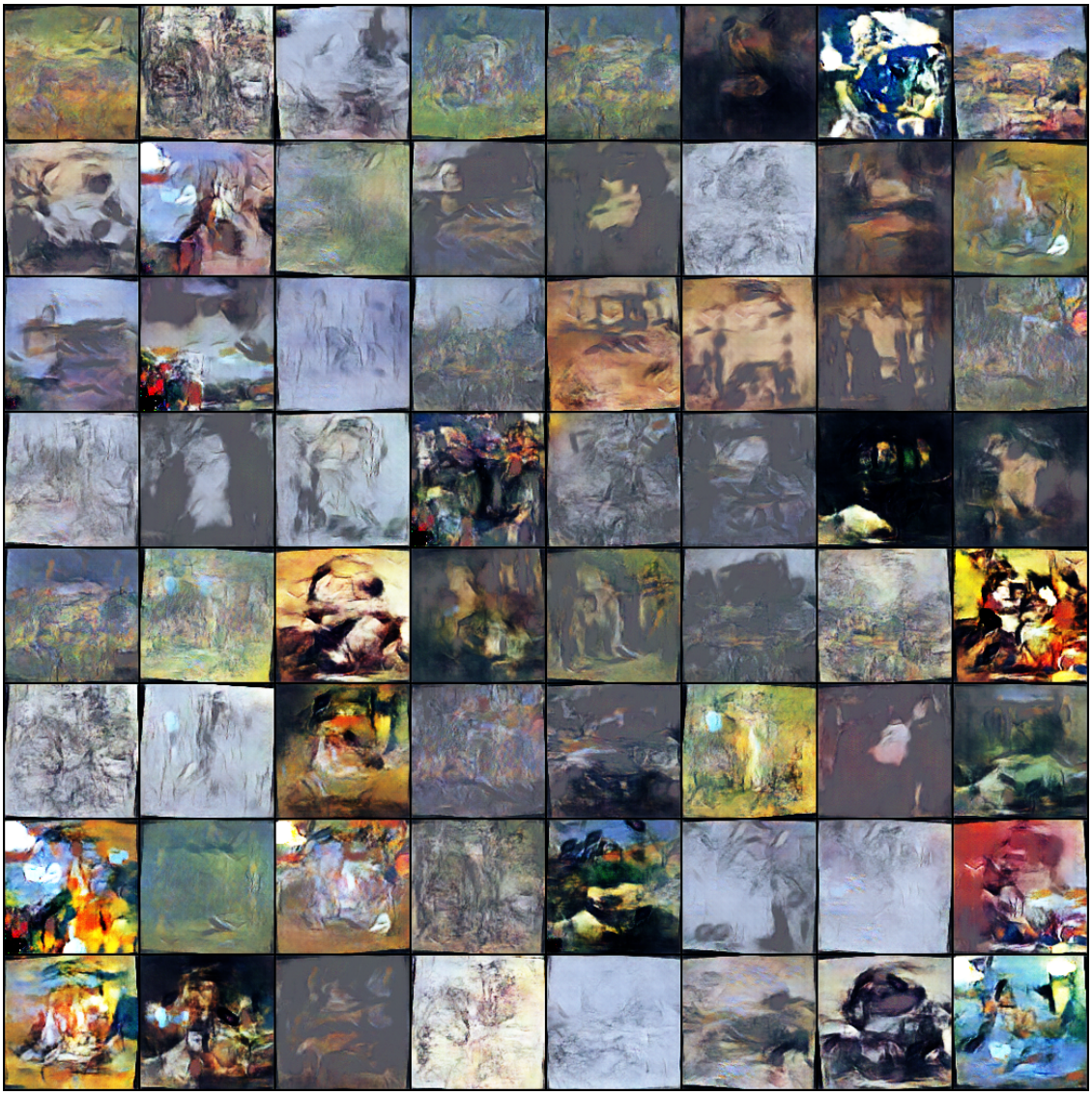
[23]:
```
Image('./generated_images/generated_images_epoch_100.png')
```

[23]:



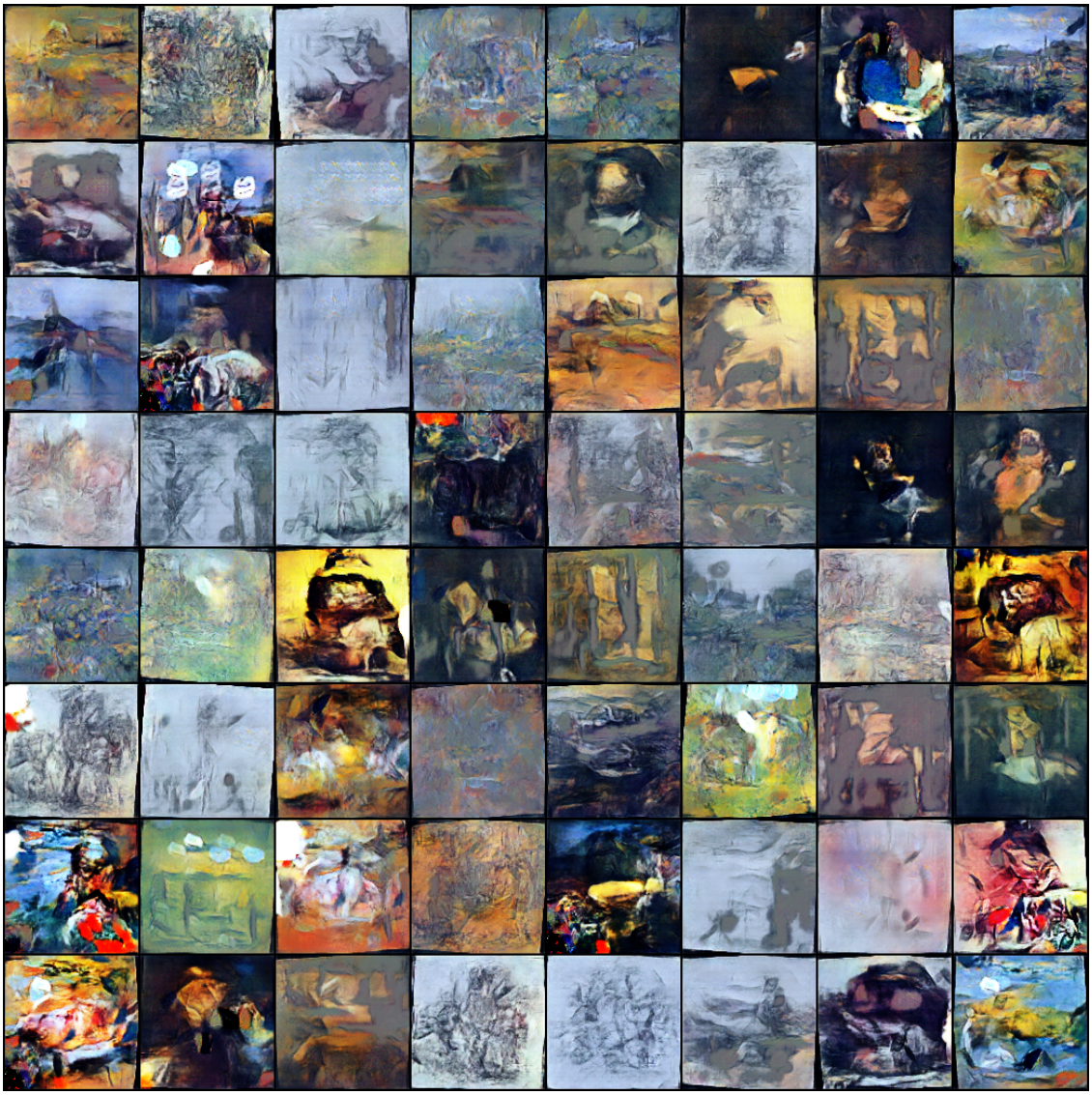
[24]:
```
Image('./generated_images/generated_images_epoch_200.png')
```

[24]:



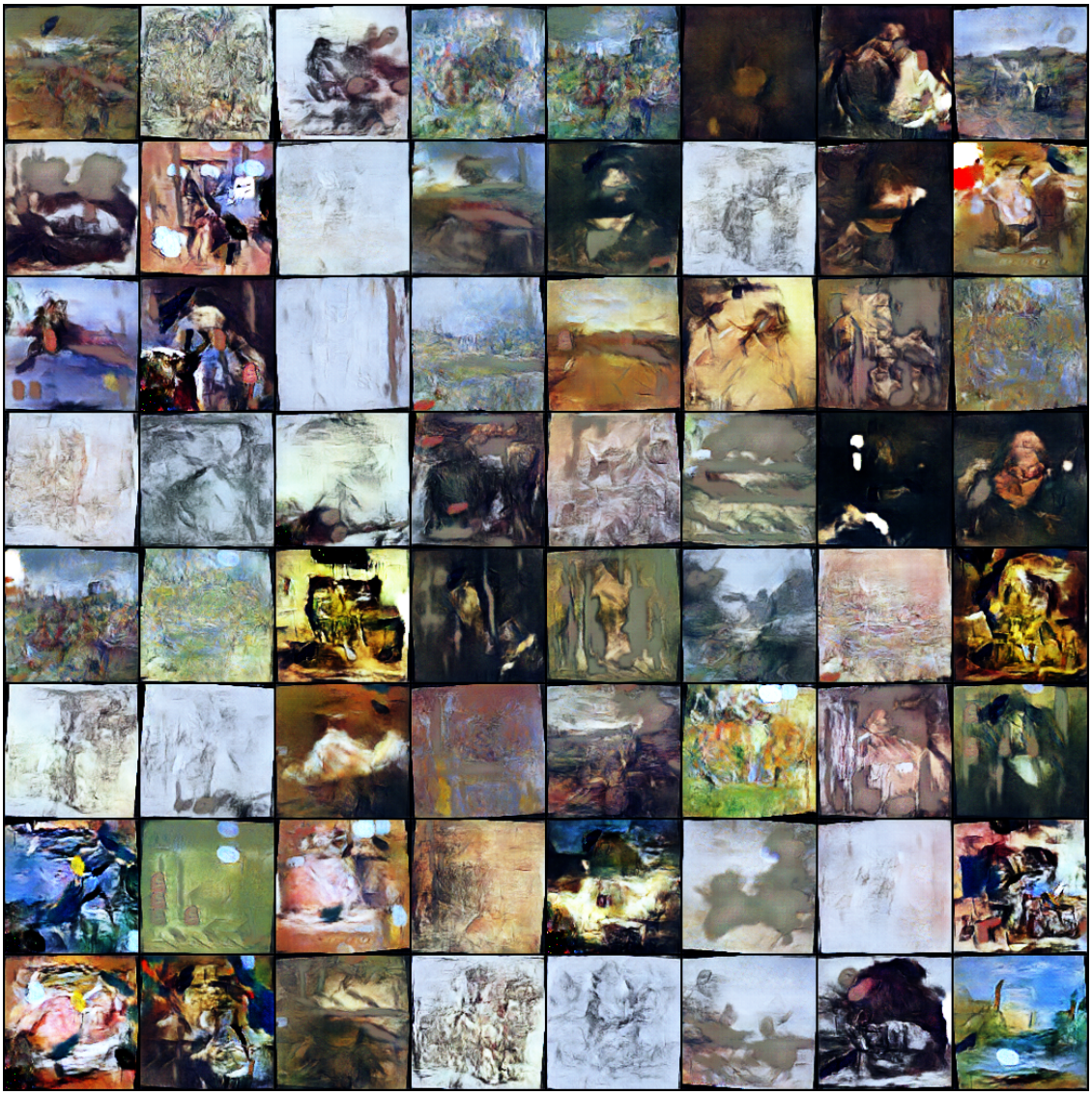
[25]:
```
Image('./generated_images/generated_images_epoch_300.png')
```

[25]:



[26]:
```
Image('./generated_images/generated_images_epoch_400.png')
```

[26]:



[27]:
```
Image('./generated_images/generated_images_epoch_499.png')
```

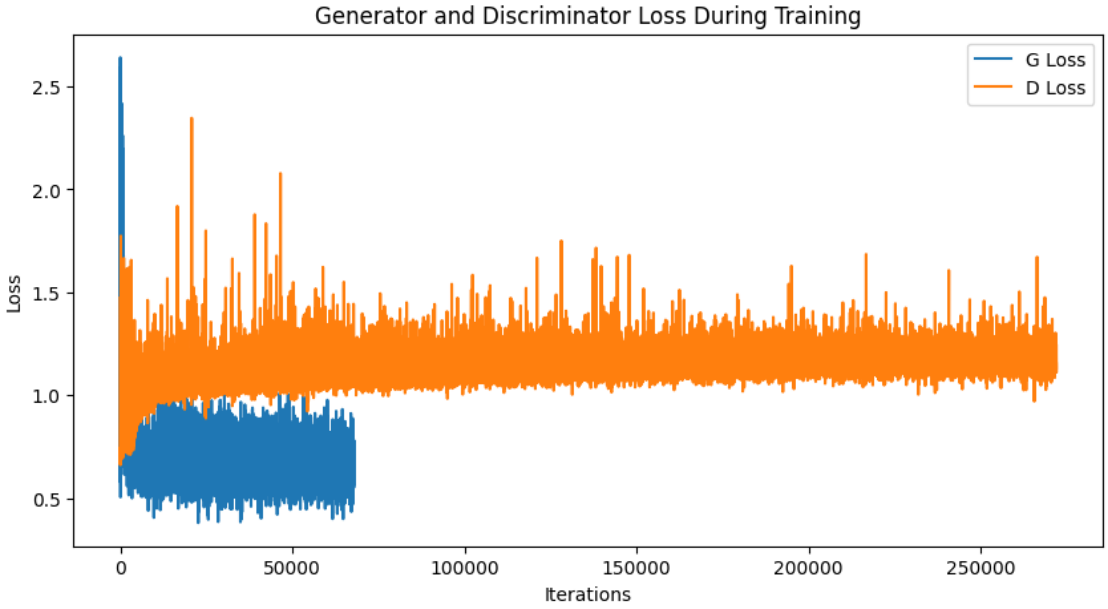
[27]:

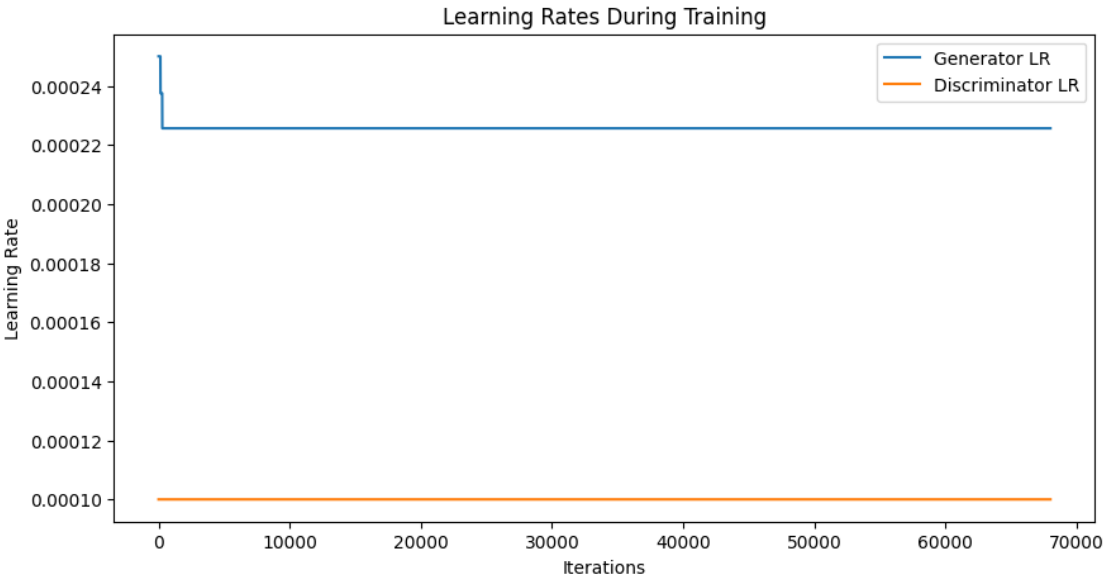
[28]:
```
# Specify the directory where images are saved
image_folder = '/content/generated_images/'
video_path = '/content/generation_animation.mp4'

# Gather sorted list of images by epoch number
image_files = [f for f in os.listdir(image_folder) if f.
 ↪startswith('generated_images_epoch_')]
image_files.sort(key=lambda x: int(x.split('_')[-1].split('.')[0]))

# Load images and append to the list
images = []
for filename in image_files:
    img_path = os.path.join(image_folder, filename)
```

```
    images.append(imageio.imread(img_path))

# Create a video from images
imageio.mimsave(video_path, images, fps=5)
print(f"Video saved at {video_path}")
```

```
<ipython-input-28-75320fa08ed8>:13: DeprecationWarning: Starting with ImageIO v3
the behavior of this function will switch to that of iio.v3.imread. To keep the
current behavior (and make this warning disappear) use `import imageio.v2 as
imageio` or call `imageio.v2.imread` directly.
  images.append(imageio.imread(img_path))
WARNING:imageio_ffmpeg:IMAGEIO FFMPEG_WRITER WARNING: input image is not
divisible by macro_block_size=16, resizing from (1042, 1042) to (1056, 1056) to
ensure video compatibility with most codecs and players. To prevent resizing,
make your input image divisible by the macro_block_size or set the
macro_block_size to 1 (risking incompatibility).
/usr/lib/python3.10/subprocess.py:1796: RuntimeWarning: os.fork() was called.
os.fork() is incompatible with multithreaded code, and JAX is multithreaded, so
this will likely lead to a deadlock.
  self.pid = _posixsubprocess.fork_exec(

Video saved at /content/generation_animation.mp4
```

[29]:
```
# Plotting Losses
plt.figure(figsize=(10, 5))
plt.title("Generator and Discriminator Loss During Training")
plt.plot(generator_losses, label="G Loss")
plt.plot(discriminator_losses, label="D Loss")
plt.xlabel("Iterations")
plt.ylabel("Loss")
plt.legend()
plt.show()

# Plotting Learning Rates
plt.figure(figsize=(10, 5))
plt.title("Learning Rates During Training")
plt.plot(hyperparams['g_lr'], label="Generator LR")
plt.plot(hyperparams['d_lr'], label="Discriminator LR")
plt.xlabel("Iterations")
plt.ylabel("Learning Rate")
plt.legend()
plt.show()
```





[30]:
```
# Assuming generator and discriminator are already instantiated
print("Generator Summary:")
print(summary(generator, (128, 1, 1)))  # Latent vector size as input

print("Discriminator Summary:")
print(summary(discriminator, (3, 128, 128)))  # Image size as input
```

```
Generator Summary:
```

```
----------------------------------------------------------------
        Layer (type)               Output Shape         Param #
================================================================
   ConvTranspose2d-1           [-1, 1024, 4, 4]       2,097,152
              ReLU-2           [-1, 1024, 4, 4]               0
       BatchNorm2d-3           [-1, 1024, 4, 4]           2,048
   ConvTranspose2d-4            [-1, 512, 8, 8]       8,388,608
              ReLU-5            [-1, 512, 8, 8]               0
       BatchNorm2d-6            [-1, 512, 8, 8]           1,024
   ConvTranspose2d-7          [-1, 256, 16, 16]       2,097,152
              ReLU-8          [-1, 256, 16, 16]               0
       BatchNorm2d-9          [-1, 256, 16, 16]             512
  ConvTranspose2d-10          [-1, 128, 32, 32]         524,288
             ReLU-11          [-1, 128, 32, 32]               0
      BatchNorm2d-12          [-1, 128, 32, 32]             256
  ConvTranspose2d-13           [-1, 64, 64, 64]         131,072
             ReLU-14           [-1, 64, 64, 64]               0
      BatchNorm2d-15           [-1, 64, 64, 64]             128
  ConvTranspose2d-16          [-1, 3, 128, 128]           3,072
             Tanh-17          [-1, 3, 128, 128]               0
================================================================
Total params: 13,245,312
Trainable params: 13,245,312
Non-trainable params: 0
----------------------------------------------------------------
Input size (MB): 0.00
Forward/backward pass size (MB): 12.38
Params size (MB): 50.53
Estimated Total Size (MB): 62.90
----------------------------------------------------------------
None
Discriminator Summary:
----------------------------------------------------------------
        Layer (type)               Output Shape         Param #
================================================================
            Conv2d-1          [-1, 64, 64, 64]           3,072
         LeakyReLU-2          [-1, 64, 64, 64]               0
           Dropout-3          [-1, 64, 64, 64]               0
            Conv2d-4         [-1, 128, 32, 32]         131,072
         LeakyReLU-5         [-1, 128, 32, 32]               0
           Dropout-6         [-1, 128, 32, 32]               0
            Conv2d-7         [-1, 256, 16, 16]         524,288
         LeakyReLU-8         [-1, 256, 16, 16]               0
           Dropout-9         [-1, 256, 16, 16]               0
           Conv2d-10           [-1, 512, 8, 8]       2,097,152
        LeakyReLU-11           [-1, 512, 8, 8]               0
          Dropout-12           [-1, 512, 8, 8]               0
           Conv2d-13             [-1, 1, 5, 5]           8,192
```

```
AdaptiveAvgPool2d-14              [-1, 1, 1, 1]               0
          Flatten-15                    [-1, 1]               0
          Sigmoid-16                    [-1, 1]               0
================================================================
Total params: 2,763,776
Trainable params: 2,763,776
Non-trainable params: 0
----------------------------------------------------------------
Input size (MB): 0.19
Forward/backward pass size (MB): 11.25
Params size (MB): 10.54
Estimated Total Size (MB): 21.98
----------------------------------------------------------------
None
```

[31]:
```python
# Function to execute shell commands
def shell_cmd(command):
    try:
        return subprocess.check_output(command, shell=True, text=True)
    except subprocess.CalledProcessError:
        return "Unavailable"

# Print CPU Information
print("CPU:", shell_cmd("cat /proc/cpuinfo | grep 'model name' | uniq | awk -F: '{print $2}'"))

# Print GPU Information
gpu_info = shell_cmd("nvidia-smi --query-gpu=gpu_name --format=csv,noheader")
print("GPU:", gpu_info.strip() if gpu_info else "No GPU detected")

# Print System Memory Information
mem_info = shell_cmd("cat /proc/meminfo | grep 'MemTotal' | awk '{print $2/1024 \" MB\"}'")
print("System Memory:", mem_info.strip() if mem_info else "Memory info unavailable")

# Python and PyTorch details
print("Python Version:", sys.version)
print("CUDA Version:", torch.version.cuda if torch.cuda.is_available() else "CUDA not available")
print("Torch Version:", torch.__version__)
```

```
CPU:  Intel(R) Xeon(R) CPU @ 2.00GHz

GPU: Tesla V100-SXM2-16GB
System Memory: 52217.5 MB
Python Version: 3.10.12 (main, Nov 20 2023, 15:14:05) [GCC 11.4.0]
```

```
CUDA Version: 12.1
Torch Version: 2.2.1+cu121
```