Lecture Series for Computer Vision

Chapter 6

GAN for 3D Reconstruction

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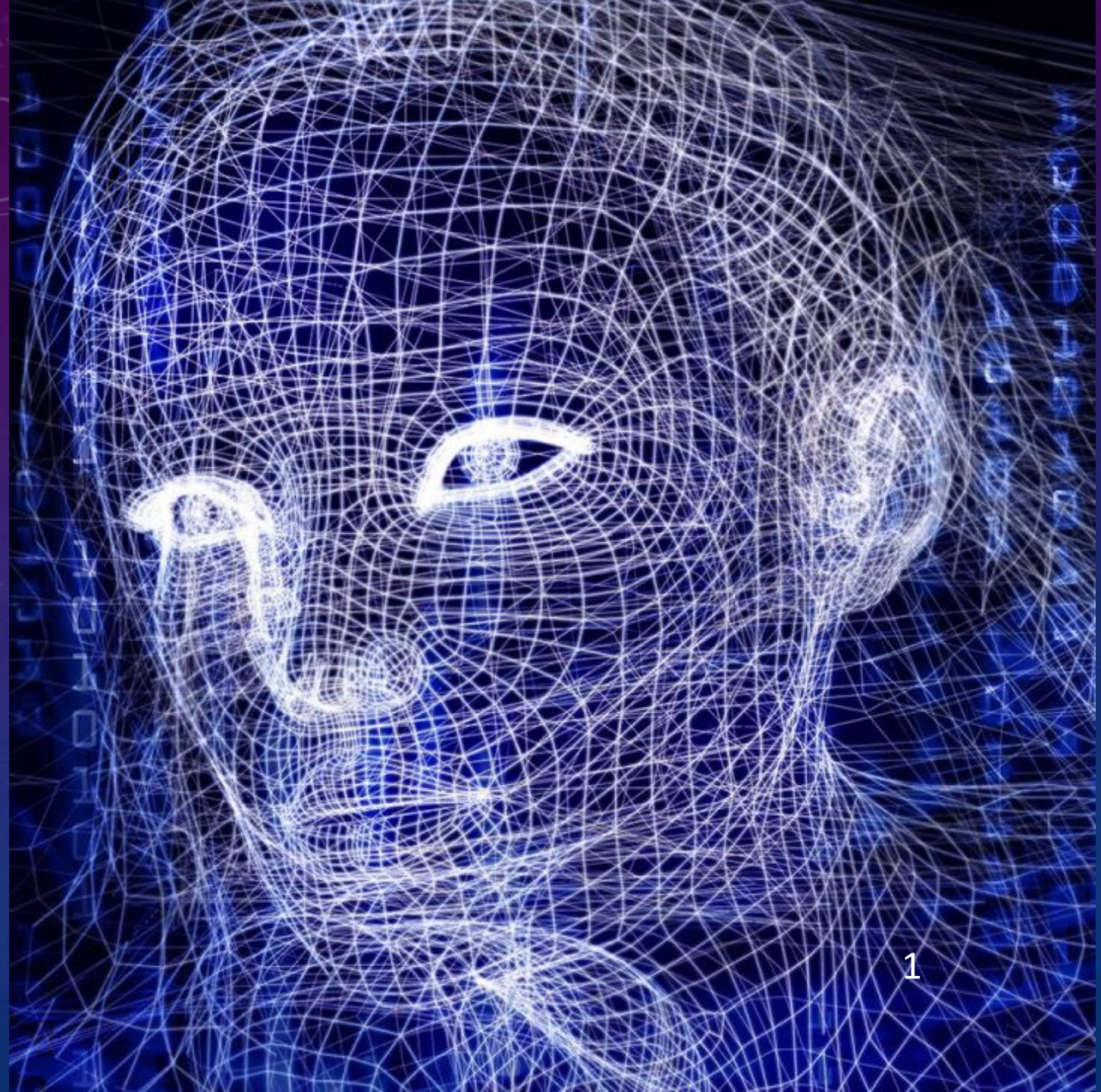


GAN-based 3D Reconstruction

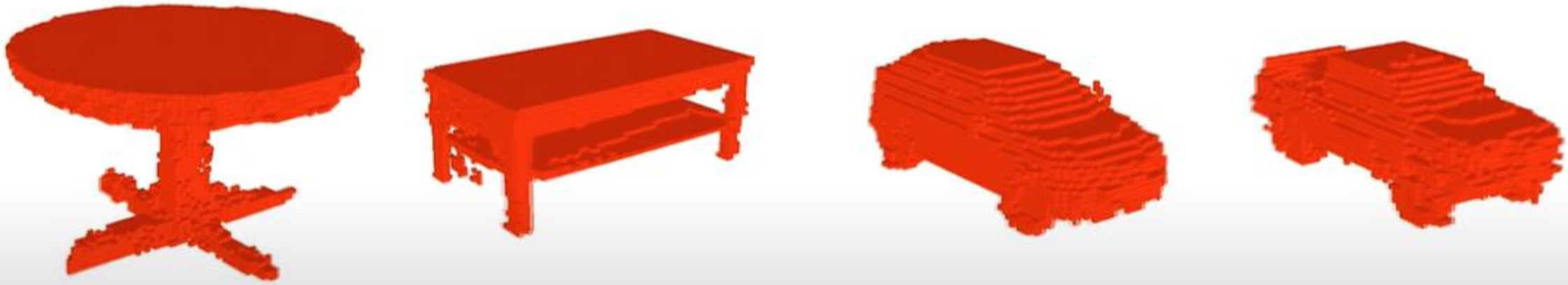
AI Makes 3D Models From Photos (3D-GAN)

Source: [Wu and Zhang et al. 2017]

Randomly Sampled Shapes

Tables

Cars

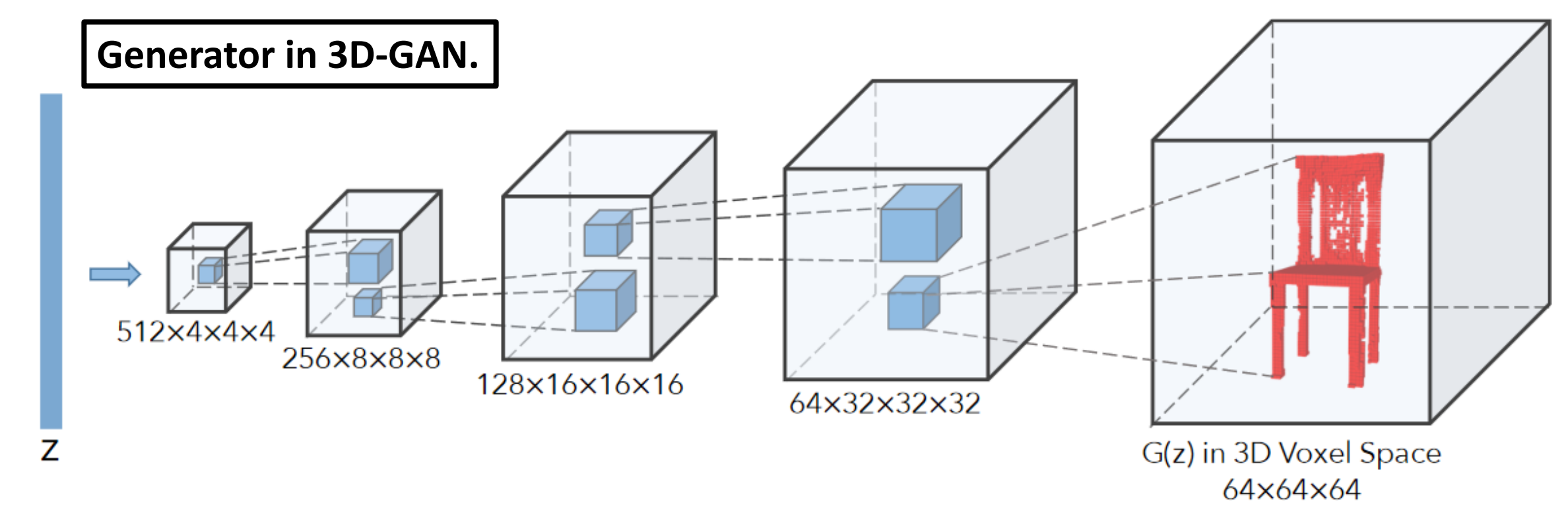


https://www.youtube.com/watch?v=HO1LYJb818Q&ab_channel=TwoMinutePapers [00:00 - 3:00]

This Neural Network Creates 3D Objects From Your Photos

https://youtu.be/548sCh0mMRc [00:00 - 04:48]

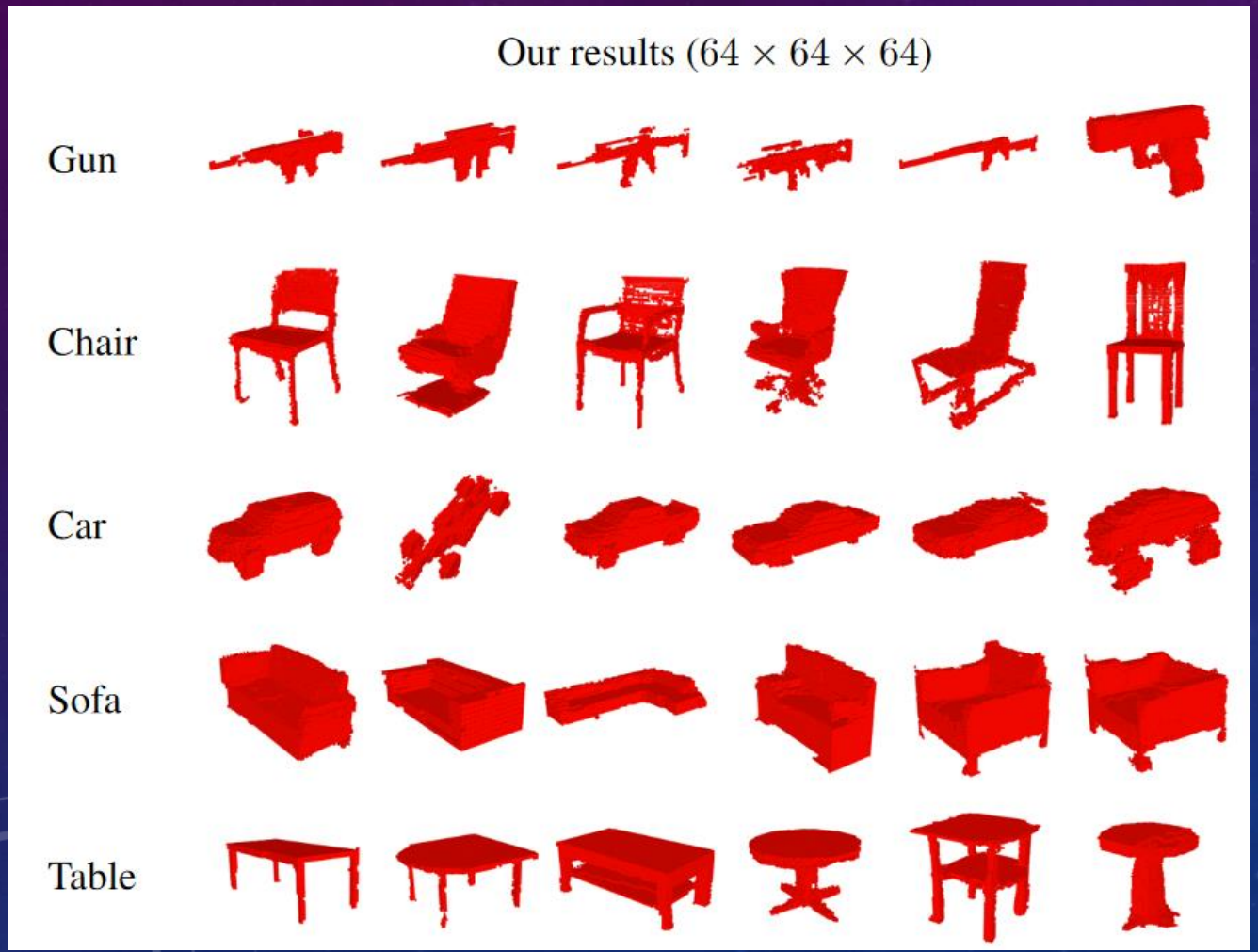
Example 6.1 – 3D Chair Generation by 3D-GAN
(Wu and Zhang et al., 2017)



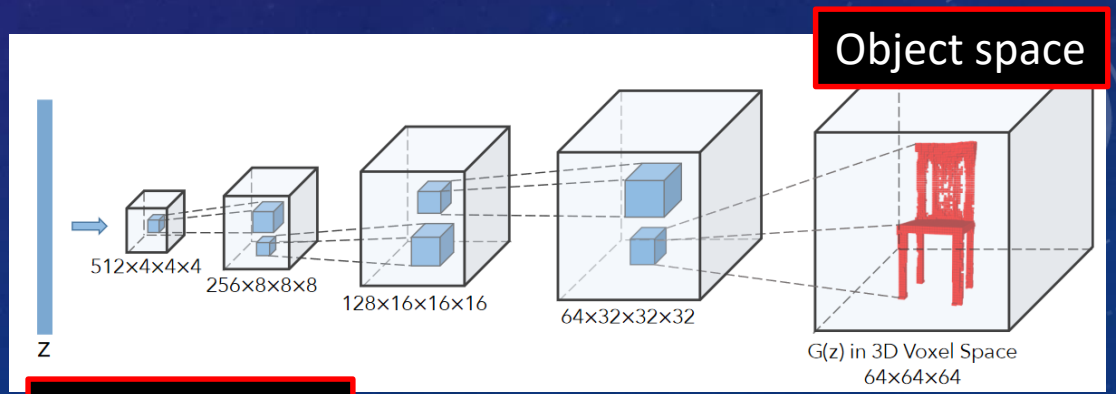
The generator in 3D-GAN. The discriminator mostly mirrors the generator.

Paper Link： https://arxiv.org/pdf/1610.07584.pdf

Example 6.1 – 3D Chair Generation by 3D-GAN
(Wu and Zhang et al., 2017)



The generator in 3D-GAN aims to generate the novel objects by sampling a latent vector z and mapping it to the object space.

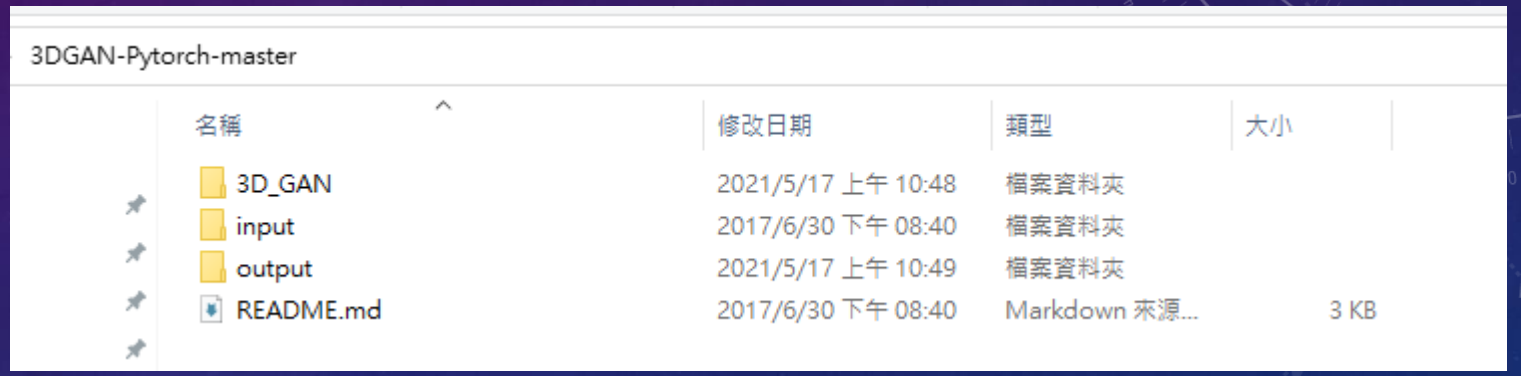


Example 6.1 – Structure of the Codes

Please download the 3D-GAN codes from the Moodle “Exercise6-1_3D-GAN.zip”

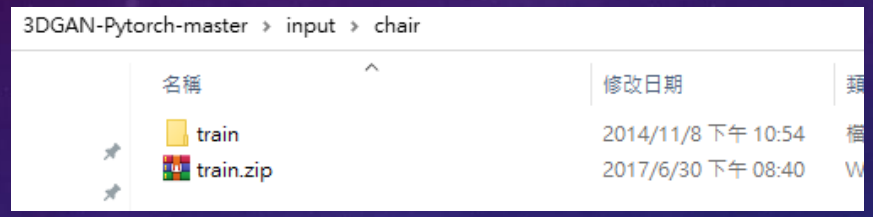
The code structure can be visualized as follows:

```
|-- 3D_GAN
      |-- main.py
      |-- train.py
      |-- utils.py
      |-- … etc.
|-- input
      |-- chair
            |-- train.zip (Please unzip it!)
```



Example 6.1 – How to train 3D-GAN

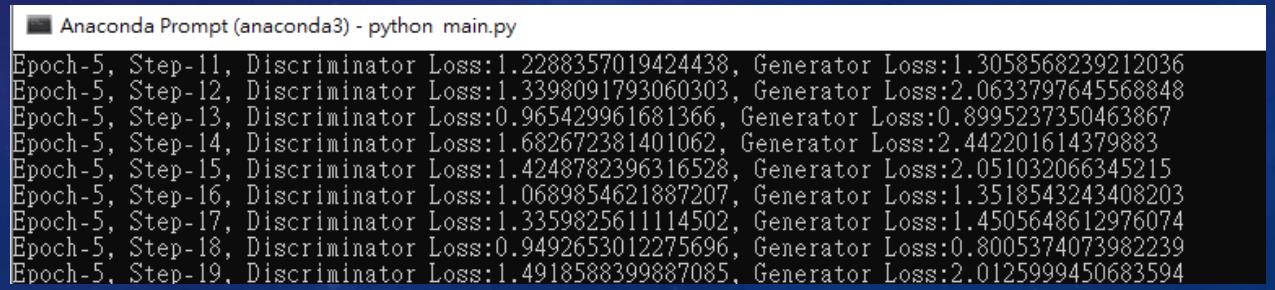
- Build the Pytorch environment on Anaconda, which is the same as described in "CV_Ch4_Example 4.6 CycleGAN"
- Prepare the data by unzipping the train.zip file in "/input/chair/train.zip"



- Train the model with **train.py** in "/3D_GAN/train.py" :

```
C:\WINDOWS\system32> cd 3DGAN-Pytorch-master/3D_GAN
C:\WINDOWS\system32\ 3DGAN-Pytorch-master/3D_GAN > python train.py
```

- If you see the following statements, the model is successfully being trained!



Example 6.1 – (model.py) Generator

```
class _G(torch.nn.Module):
    def __init__(self, args):
        super(_G, self).__init__()
        self.args = args
        self.cube_len = args.cube_len

        padd = (0, 0, 0)
        if self.cube_len == 32:
            padd = (1,1,1)

        self.layer1 = torch.nn.Sequential(
            torch.nn.ConvTranspose3d(self.args.z_size, self.cube_len*8, kernel_size=4, stride=2, bias=args.bias, padding=padd),
            torch.nn.BatchNorm3d(self.cube_len*8),
            torch.nn.ReLU()
        )
        self.layer2 = torch.nn.Sequential(
            torch.nn.ConvTranspose3d(self.cube_len*8, self.cube_len*4, kernel_size=4, stride=2, bias=args.bias, padding=(1, 1, 1)),
            torch.nn.BatchNorm3d(self.cube_len*4),
            torch.nn.ReLU()
        )
        self.layer3 = torch.nn.Sequential(
            torch.nn.ConvTranspose3d(self.cube_len*4, self.cube_len*2, kernel_size=4, stride=2, bias=args.bias, padding=(1, 1, 1)),
            torch.nn.BatchNorm3d(self.cube_len*2),
            torch.nn.ReLU()
        )
        self.layer4 = torch.nn.Sequential(
            torch.nn.ConvTranspose3d(self.cube_len*2, self.cube_len, kernel_size=4, stride=2, bias=args.bias, padding=(1, 1, 1)),
            torch.nn.BatchNorm3d(self.cube_len),
            torch.nn.ReLU()
        )
```

Employ “ConvTranspose3d” to perform 3D transposed convolution

Example 6.1 – (model.py) Discriminator

```
class _D(torch.nn.Module):
    def __init__(self, args):
        super(_D, self).__init__()
        self.args = args
        self.cube_len = args.cube_len

        padd = (0,0,0)
        if self.cube_len == 32:
            padd = (1,1,1)

        self.layer1 = torch.nn.Sequential(
            torch.nn.Conv3d(1, self.cube_len, kernel_size=4, stride=2, bias=args.bias, padding=(1, 1, 1)),
            torch.nn.BatchNorm3d(self.cube_len),
            torch.nn.LeakyReLU(self.args.leak_value)
        )
        self.layer2 = torch.nn.Sequential(
            torch.nn.Conv3d(self.cube_len, self.cube_len*2, kernel_size=4, stride=2, bias=args.bias, padding=(1, 1, 1)),
            torch.nn.BatchNorm3d(self.cube_len*2),
            torch.nn.LeakyReLU(self.args.leak_value)
        )
        self.layer3 = torch.nn.Sequential(
            torch.nn.Conv3d(self.cube_len*2, self.cube_len*4, kernel_size=4, stride=2, bias=args.bias, padding=(1, 1, 1)),
            torch.nn.BatchNorm3d(self.cube_len*4),
            torch.nn.LeakyReLU(self.args.leak_value)
        )
        self.layer4 = torch.nn.Sequential(
            torch.nn.Conv3d(self.cube_len*4, self.cube_len*8, kernel_size=4, stride=2, bias=args.bias, padding=(1, 1, 1)),
            torch.nn.BatchNorm3d(self.cube_len*8),
            torch.nn.LeakyReLU(self.args.leak_value)
        )
```

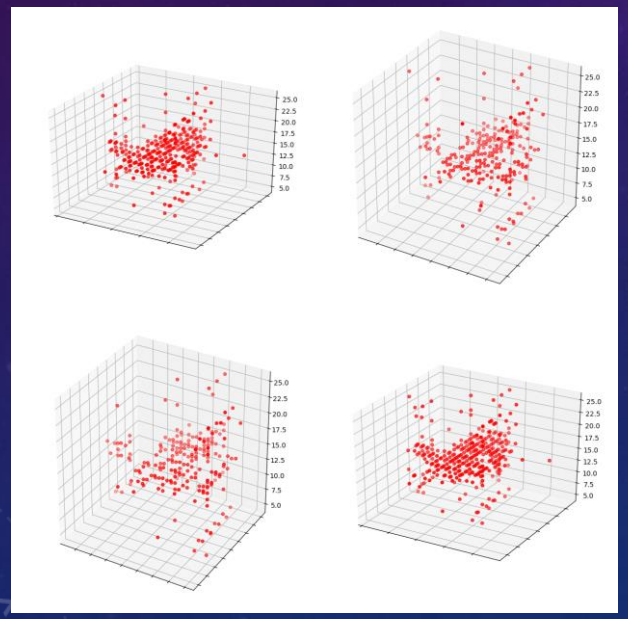
The network structure of the discriminator mostly mirrors the generator

Use “Conv3d” and “BatchNorm3d” since the input data are 3-dimentional data

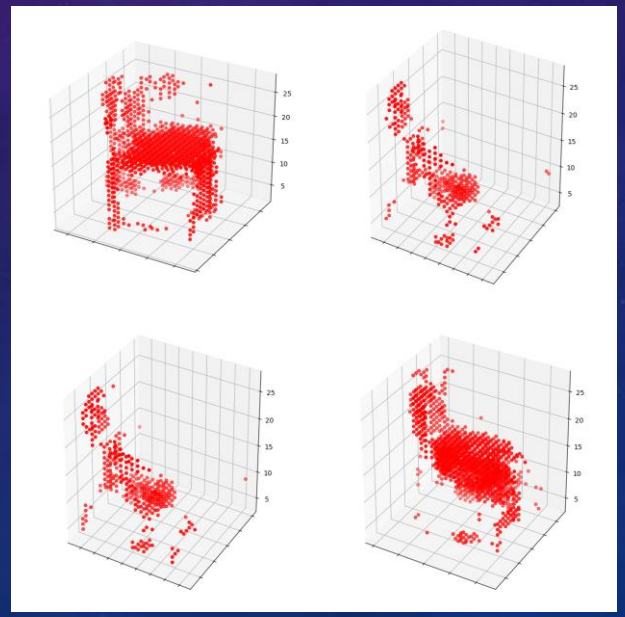
Example 6.1 – Result

- The generated 3D objects and the model will be saved in “/output/image”
- The tensorboard log file will be saved in “/output/log”, and you can use tensorboard --logdir=./” to visualize the outputs during training.

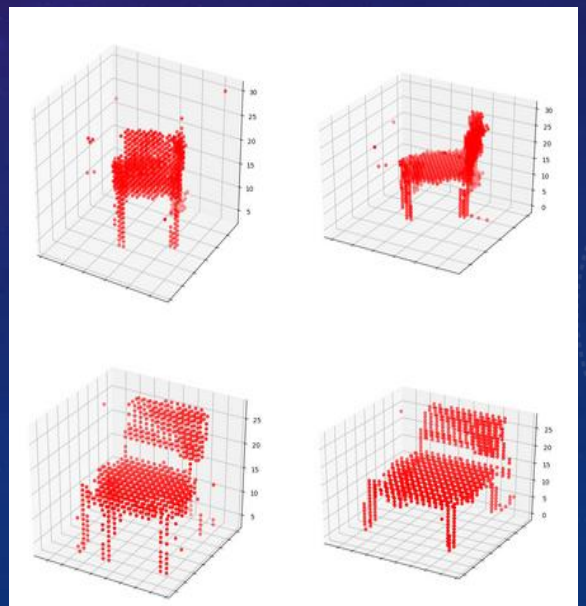
Epoch-0



Epoch-200



Epoch-1000



Exercise 6.1 – 3D-GAN

As the training process takes too long (around 1,000 epochs), please download the pre-trained model on the Moodle, and use it as your pre-trained weights to answer the following question.

1. Use the pre-trained model to generate 10 different 3D-object data by the random noise.
2. Re-trained the model with WGAN-GP, the WGAN-GP's code can be found in "CV_Ch4_Example 4.5 DC-GAN". You only need to train 500 steps, and show what can be observed in the generated data.