Touch to PyTorch

: From basic to vanilla GAN

ISL Lab Seminar

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PyTorch
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What is PyTorch?

- PyTorch

an open source **machine learning library for Python**.
It is primarily developed by **Facebook's artificial-intelligence research group**.

Vs.

What is PyTorch?

- Deep Learning Framework

Nov. 2010

Written in : Python
Interface : Python

Dec. 2013

Written in : C++
Interface : Python, MATLAB, C++

Jul. 2014

Written in : C, Lua
Interface : C, Lua

Mar. 2015

Written in : Python
Interface : Python, R

Nov. 2015

Written in : C++, Python, CUDA
Interface : Python, C/C++, Java, Go, R, Julia

Oct. 2016

Written in : Python, C, CUDA
Interface : Python

Recommend to choose these framework

Apr. 2017

Written in :
Interface : Python, C++

DL4J(Java)
Chainer(Python)
MXNet(C++, Python, Julia, MATLAB, JavaScript, Go, R, Scala, Perl)
CNTK(Python, C++),
TF Learn(Python)
TF-Slim(Python)
Etc.

Cf.

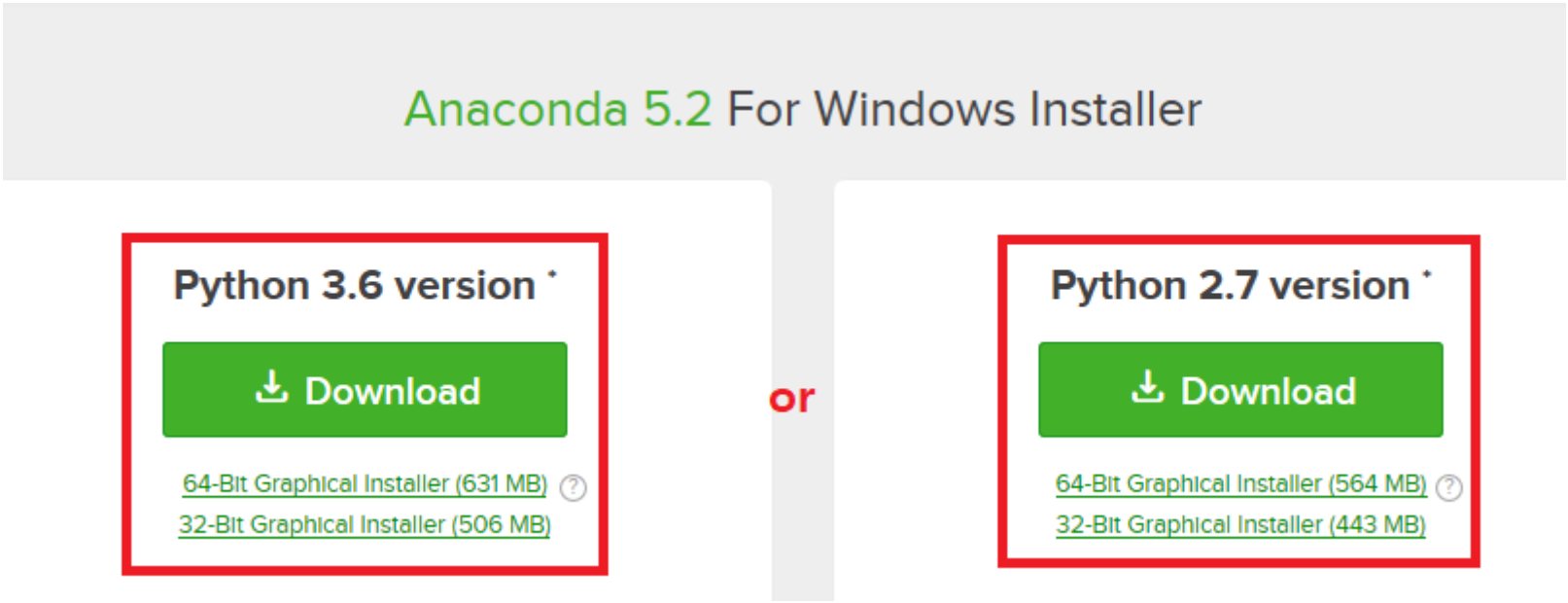
“What is this? Gum? It's GAN.”, pp. 21-22

Image System Laboratory

Setup

- Install

  https://www.anaconda.com/download/



Setup

- Install

  https://pytorch.org/

C++ : Preview, Linux only

Setup

- Install

```
conda create -n PyTorch python=3.6
activate PyTorch
conda install pytorch cuda90 -c pytorch
pip install torchvision
```

- **conda create**는 환경 생성하는 명령어. PyTorch 뿐만 아니라 Tensorflow 같은 다른 딥러닝 프레임워크를 사용한다거나 하위 파이썬 버전도 사용해야하는 경우 환경마다 설정해주면, 디펜던시가 꼬이지 않음.
- **-n 환경명, python=파이썬버전** 입력. 환경설정 리스트는 **conda env list**를 입력하면 확인 가능.
- **activate**는 해당 환경을 활성화 시키는 명령어. 반대로 환경을 빠져나오는 명령어는 **deactivate**.
- PyTorch를 설치하는 명령어는 **conda install pytorch cuda90 -c pytorch**..
- **torchvision**은 딥러닝 학습에 많이 사용되는 데이터셋, 네트워크 구조, 이미지 변환과 같은 기능을 제공하므로 설치하는 것을 권장.

Setup

- Development Tools

: Intellisense

: Cell based execution

: Startup file

: Intellisense
: Management of python env.
: GitHub
~~: AI tool package~~

: Extension program

: Intellisense
: Cell based execution
: Management of python env.

: Intellisense
: Environment setting

: Insane extension program

Image System Laboratory

Setup

- Development Tools

Personal opinion :  > Visual Studio

Setup

- Development Tools – Visual Studio

File-New-Project

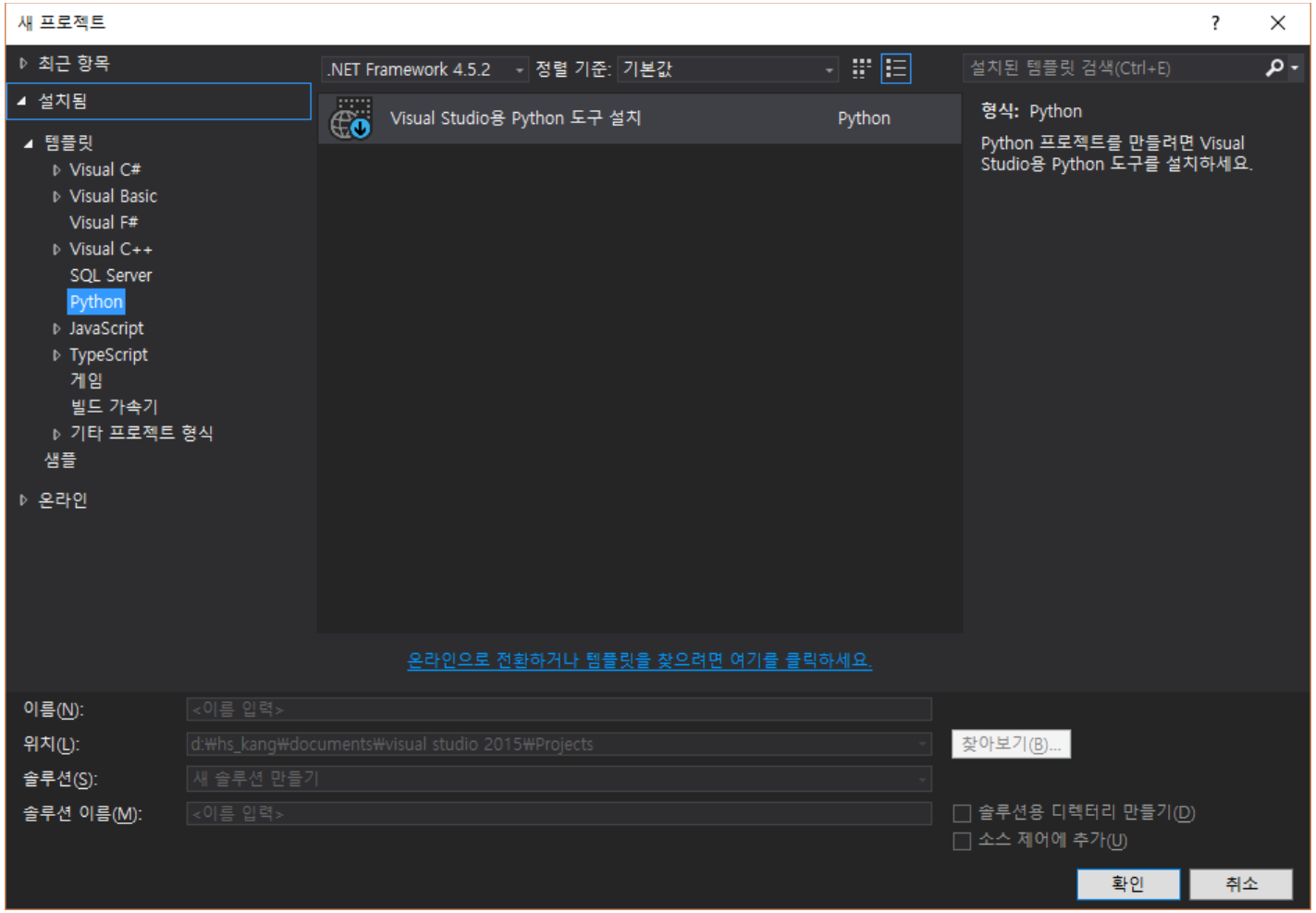


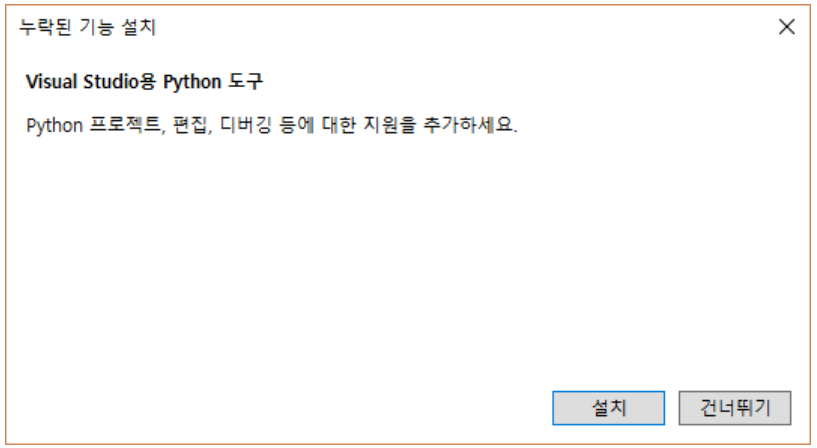
Image System Laboratory

Setup

- Development Tools – Visual Studio

File-New-Project

Python 도구 설치



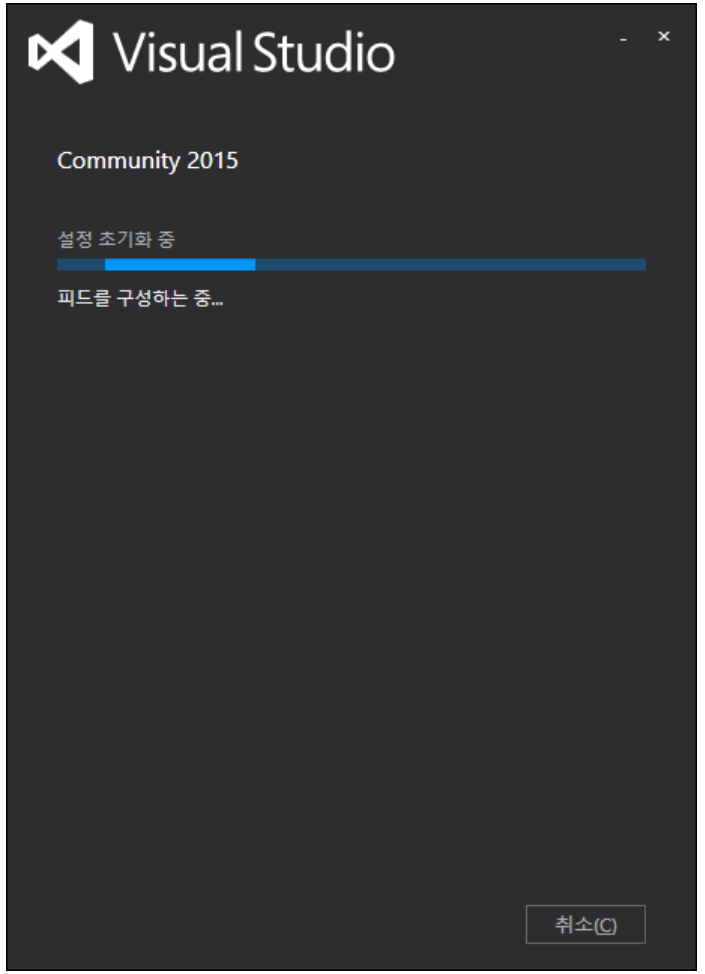


Image System Laboratory

Setup

- Development Tools – Visual Studio

File-New-Project

Python 도구 설치

Python Application

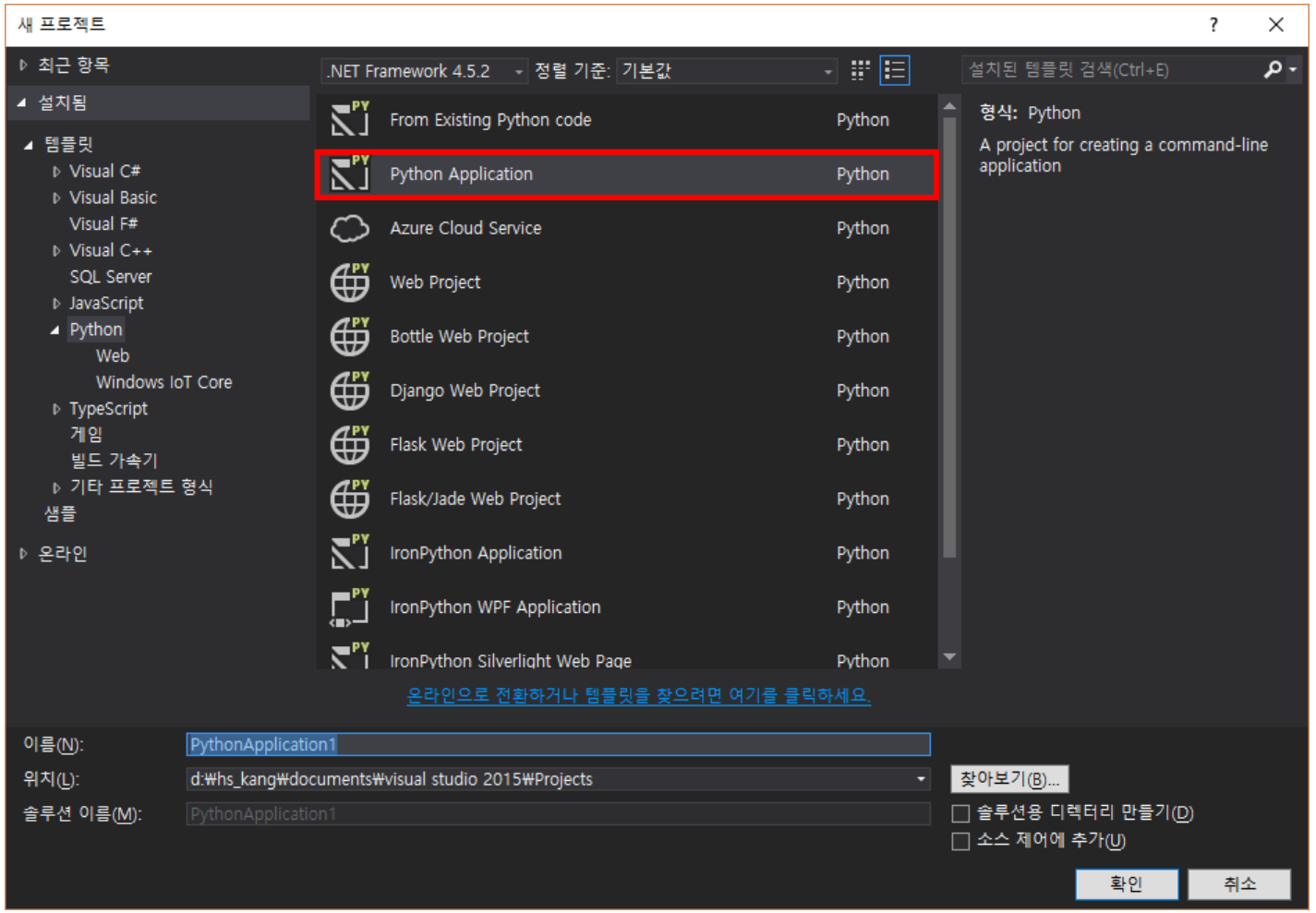
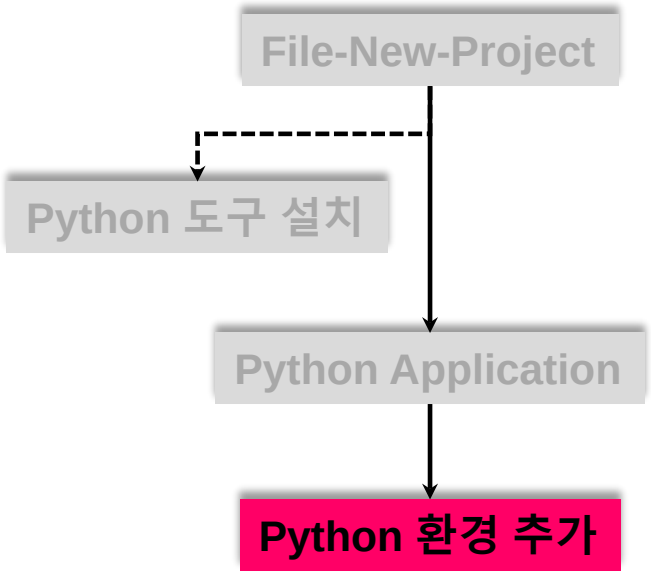
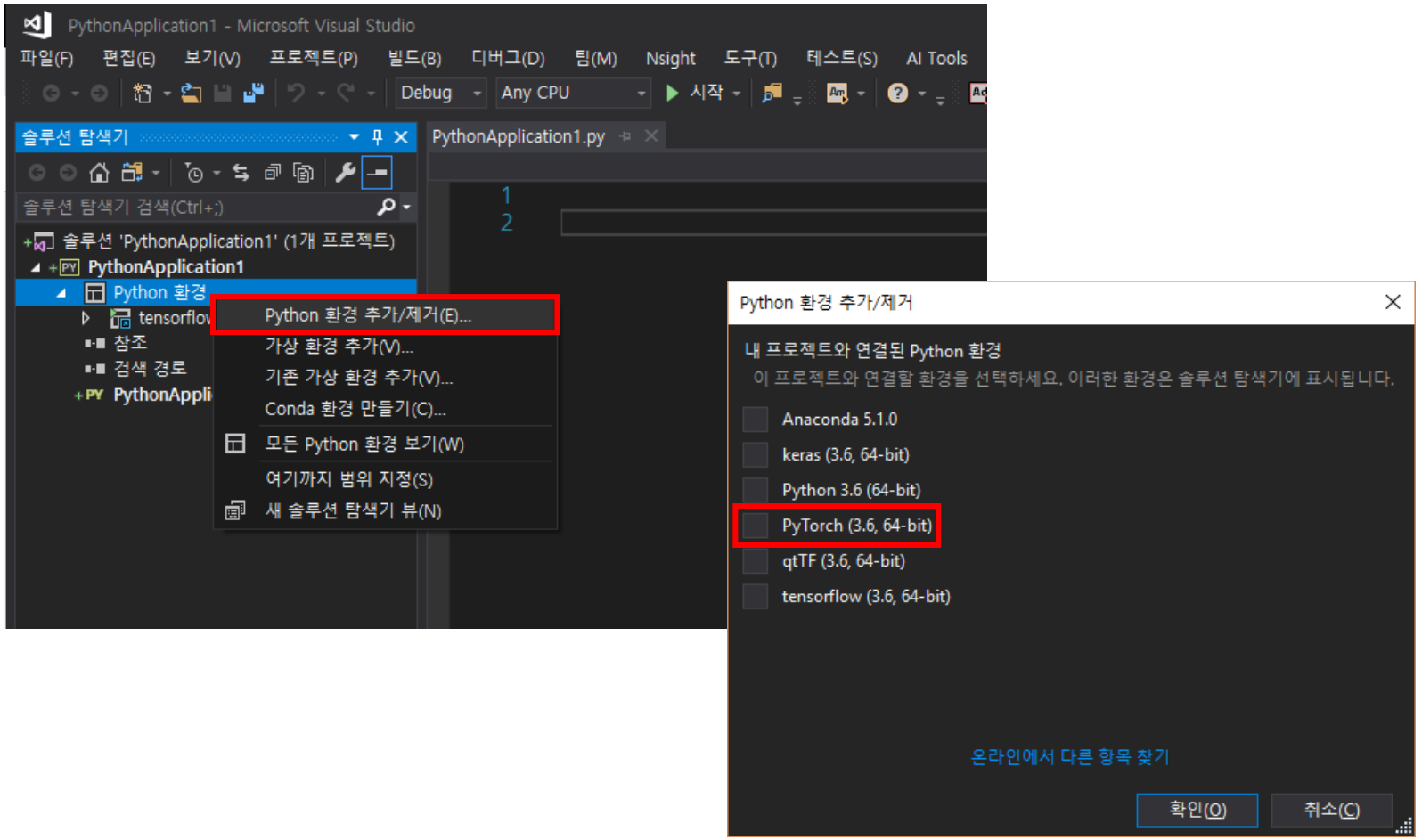


Image System Laboratory

Setup

- Development Tools – Visual Studio





Setup

- Development Tools – Visual Studio

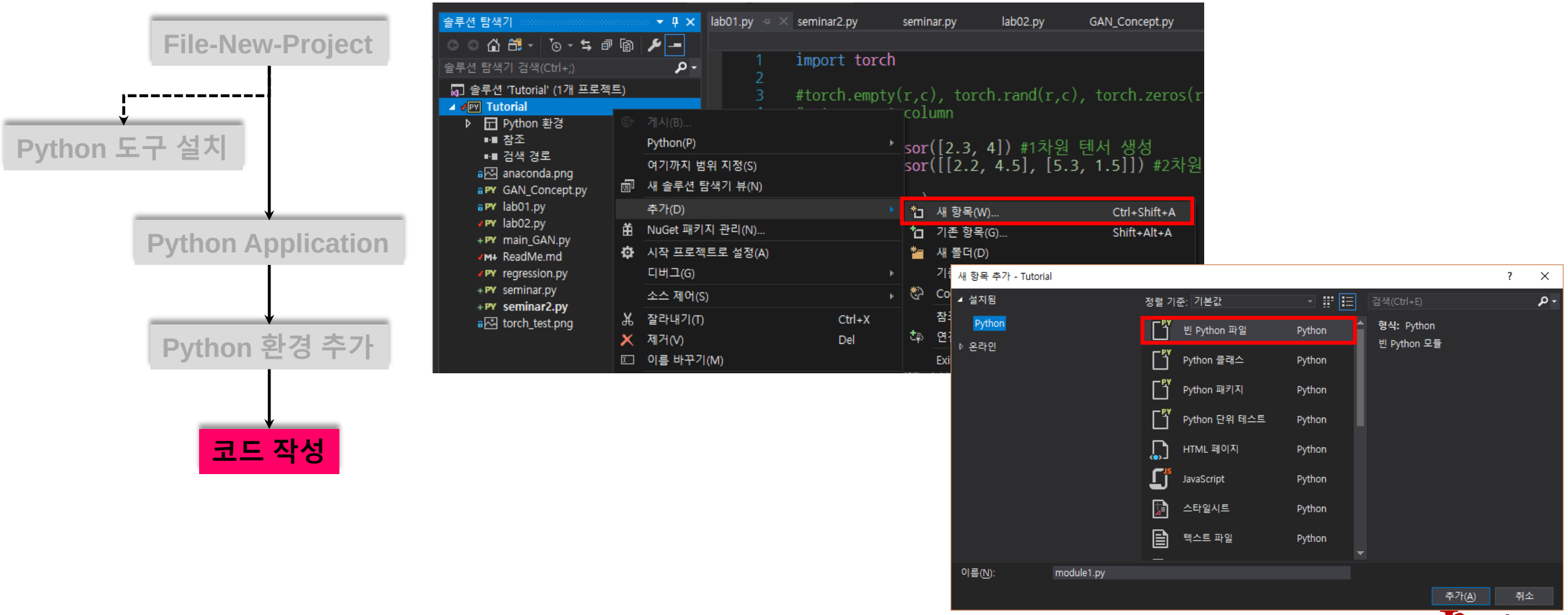
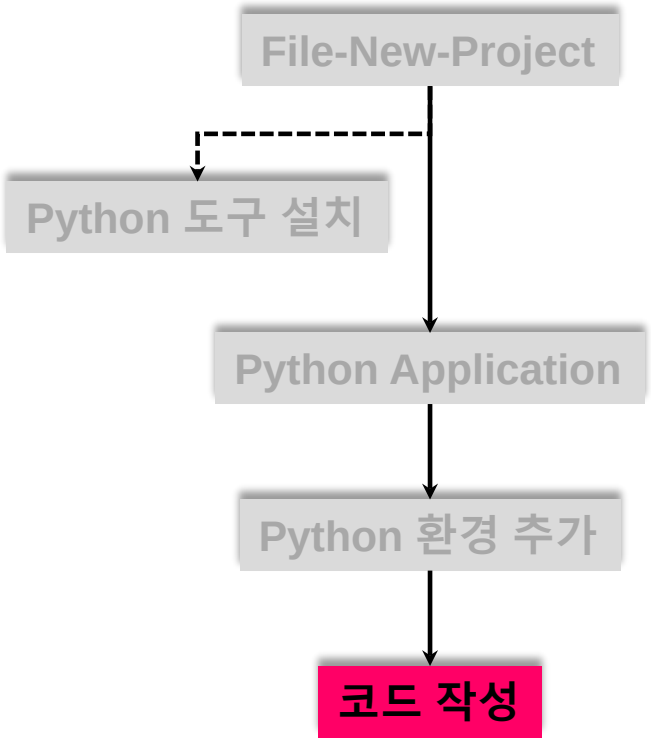


Image System Laboratory

Setup

- Development Tools – Visual Studio

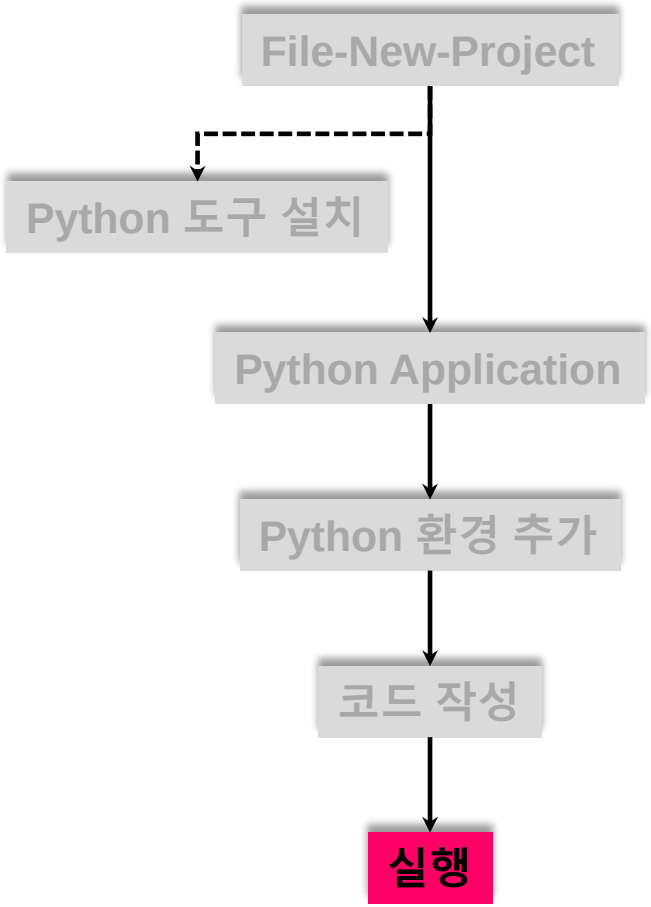


lab01.py | seminar2.py | seminar.py | lab02.py | GAN_Concept.py | regression.py

```python
import torch

#torch.empty(r,c), torch.rand(r,c), torch.zeros(r,c,dtype)
#r : row, c: column

a = torch.tensor([2.3, 4]) #1차원 텐서 생성
b = torch.tensor([[2.2, 4.5], [5.3, 1.5]]) #2차원 텐서 생성

print("a : ", a)
print("size of a : ", a.size(), "\n")

print("b : ", b)
print("size of b : ", b.size(), "\n")

x = a.new_ones(5,3,dtype=torch.double) #텐서 재사용
print("x : ", x)

#텐서를 넘겨 받음. dtype override
x = torch.randn_like(x, dtype=torch.float)
print("print : ", x)

#y.add_(x), 언더바 붙이면 in-place 자기 자신
c = torch.rand(2,2)
c.add_(b)
print(c)
```

Setup

- Development Tools – Visual Studio

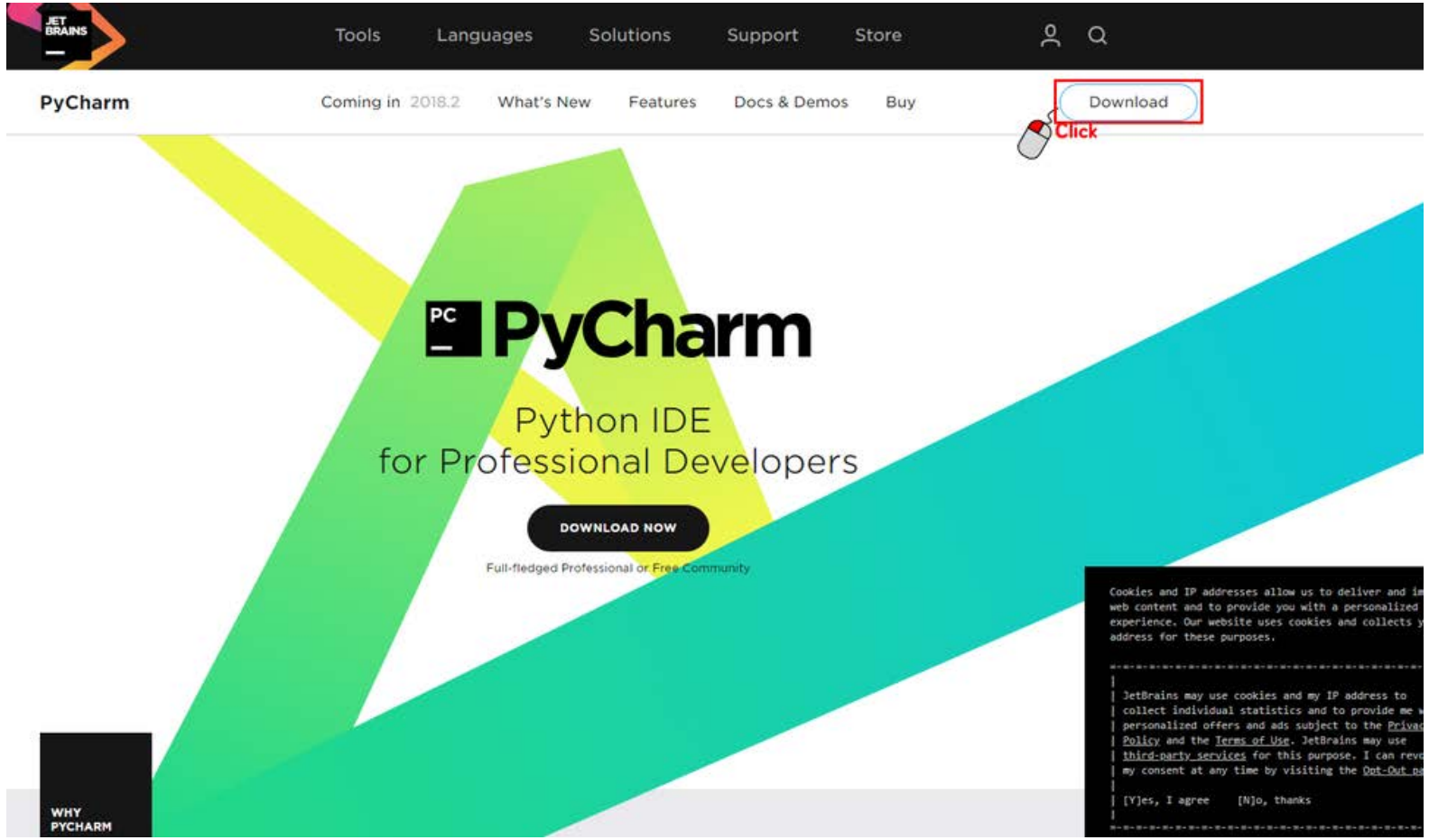



```
C:₩WINDOWS₩system32₩cmd.exe
a :  tensor([ 2.3000,  4.0000])
size of a :  torch.Size([2])

b :  tensor([[ 2.2000,  4.5000],
        [ 5.3000,  1.5000]])
size of b :  torch.Size([2, 2])

x :  tensor([[ 1.,  1.,  1.],
        [ 1.,  1.,  1.],
        [ 1.,  1.,  1.],
        [ 1.,  1.,  1.],
        [ 1.,  1.,  1.]], dtype=torch.float64)
print :  tensor([[-0.8485,  0.1334, -0.9038],
        [ 0.9339,  0.1457, -0.6499],
        [-0.9843,  0.2999,  2.0542],
        [ 0.0576,  0.6289,  1.3946],
        [-1.3774, -0.0733,  1.0720]])
tensor([[ 2.6828,  5.2298],
        [ 5.7302,  2.3466]])
torch.Size([4, 4]) torch.Size([16]) torch.Size([2, 8])
x:  tensor([[ 0.2956,  0.9266, -0.0140,  0.1061],
        [-0.6696, -0.8309,  0.2865, -0.2927],
        [ 0.3135, -0.5125, -0.4398, -1.3477],
        [-0.7555, -0.8231, -0.8202,  1.1952]])
```

: 시작 파일로 설정-> Ctrl+F5

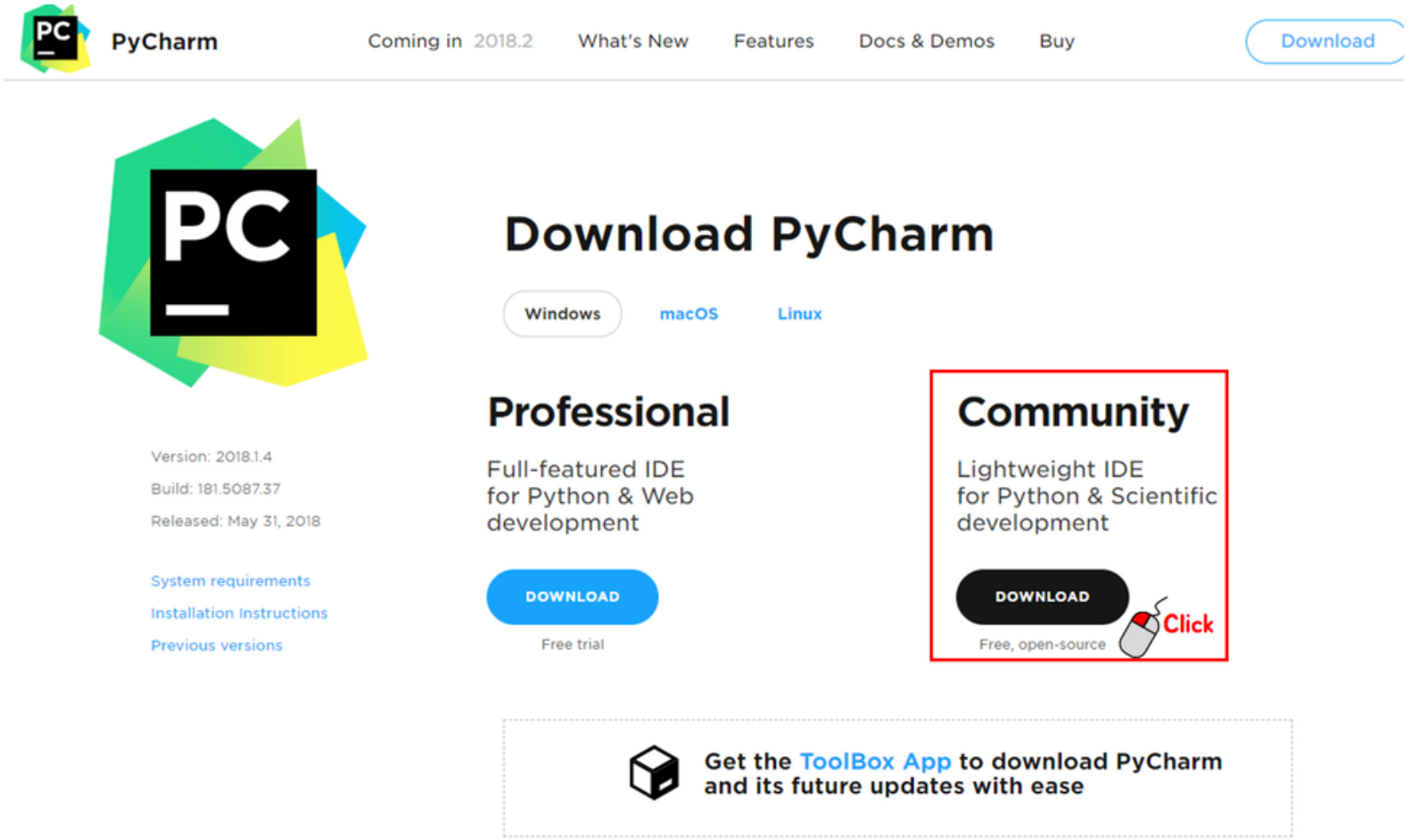
Setup

- Development Tools – PyCharm



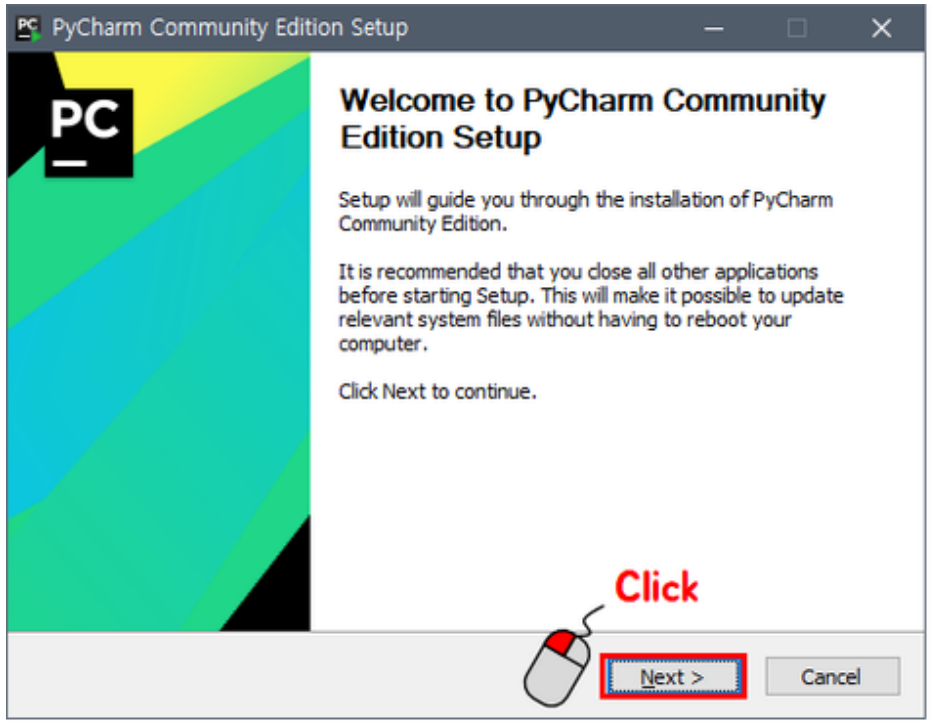
Setup

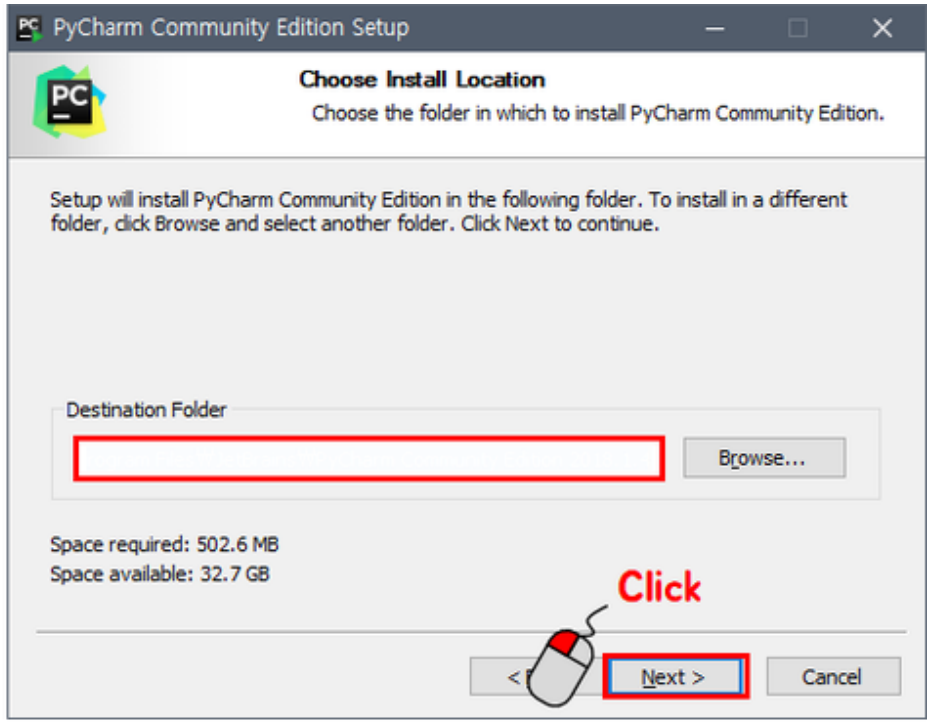
- Development Tools – PyCharm



Setup

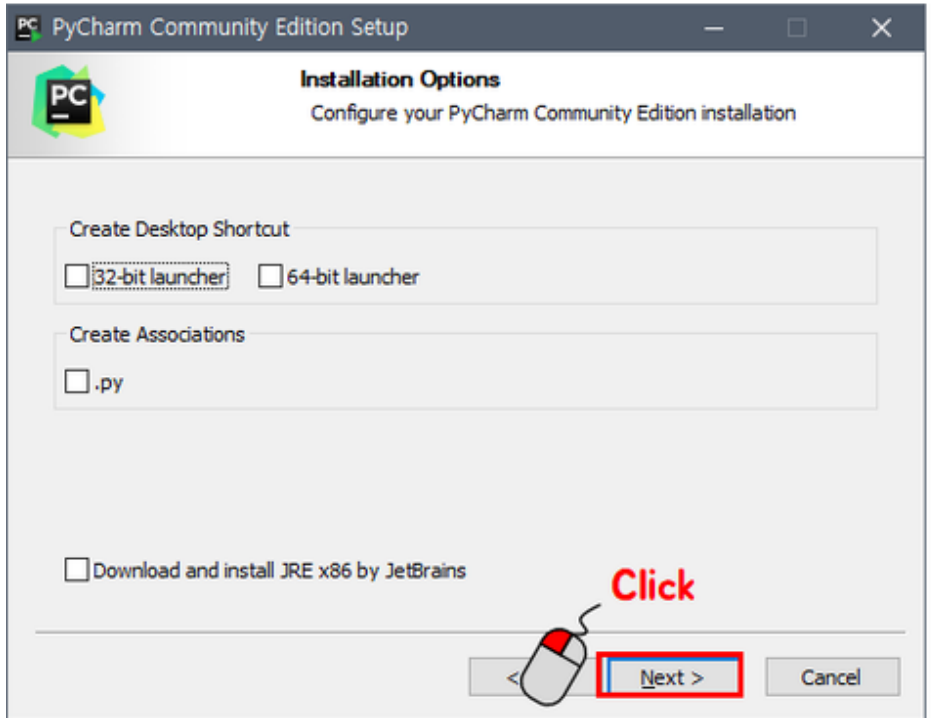
- Development Tools – PyCharm

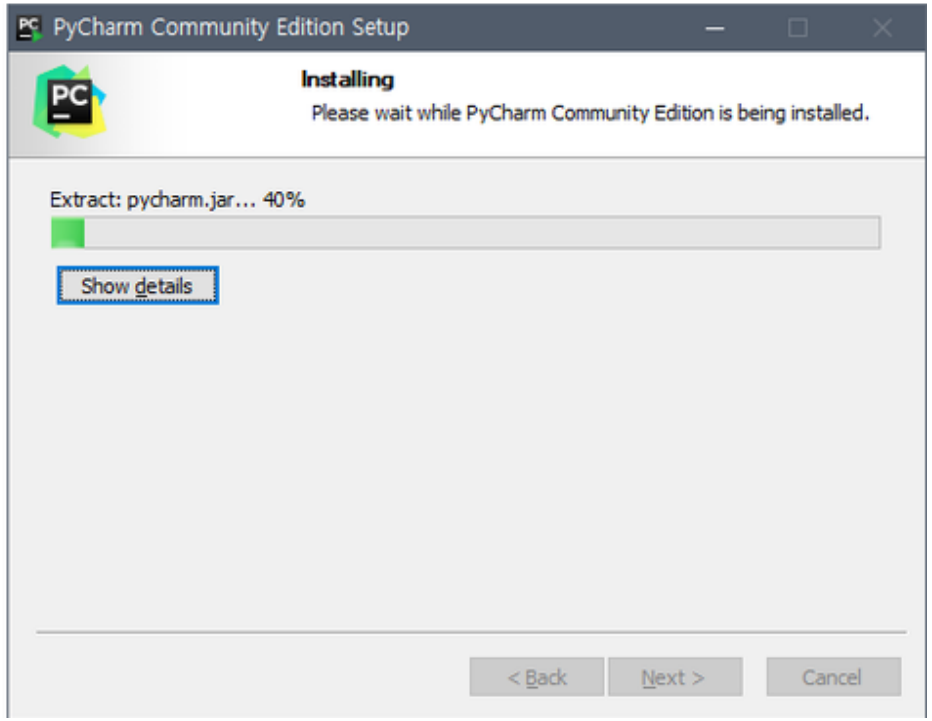




Setup

- Development Tools – PyCharm





Setup

- Development Tools – PyCharm

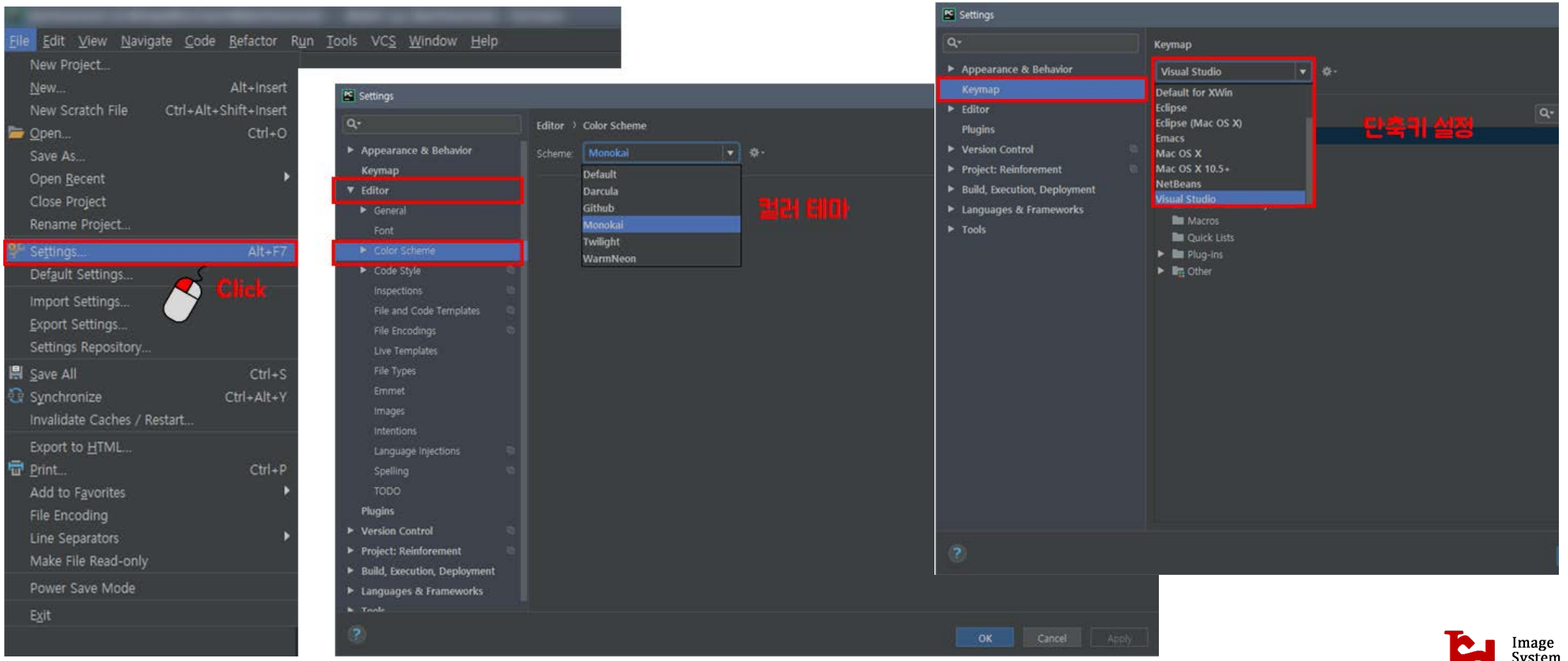
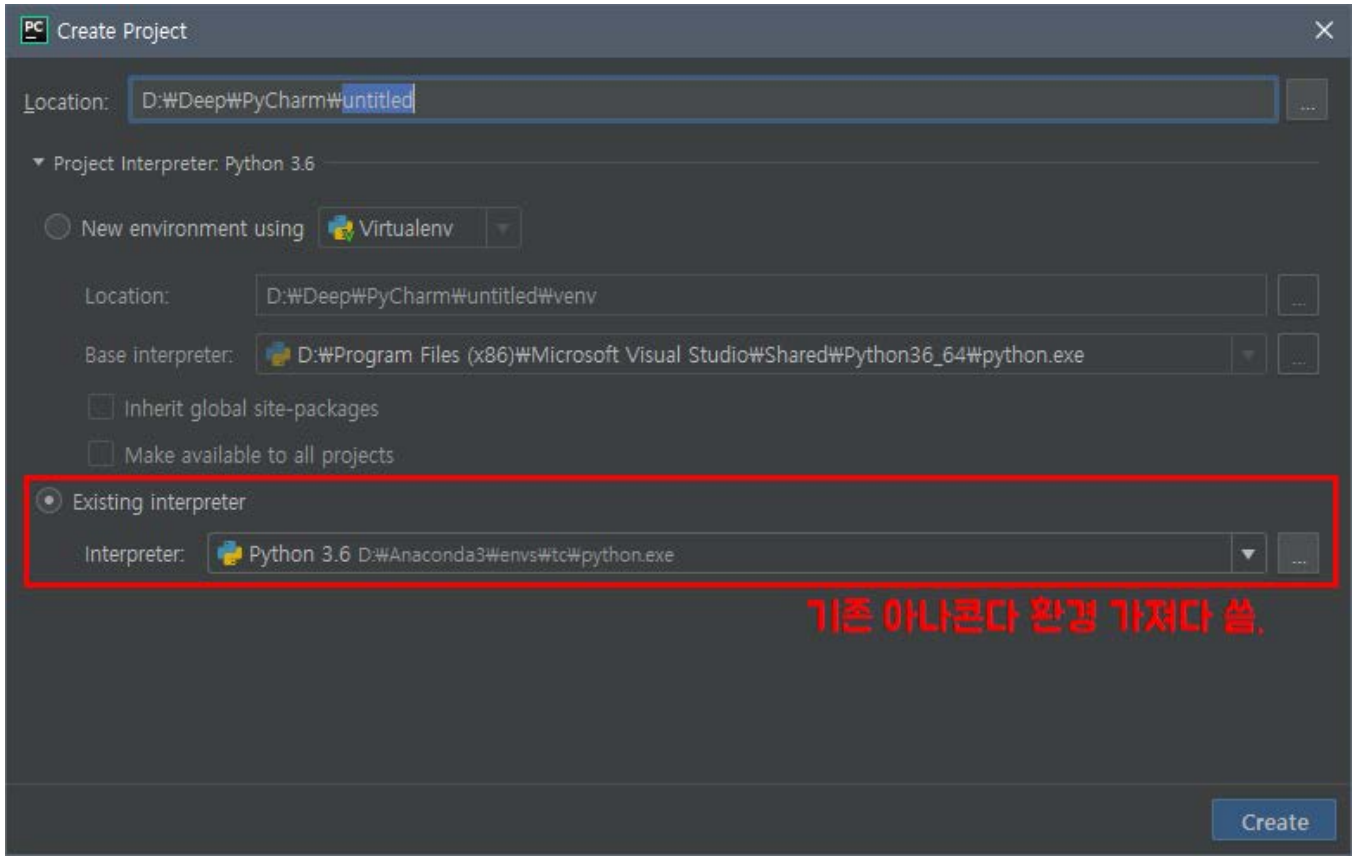


Image System Laboratory

Setup

- Development Tools – PyCharm

File-New Project



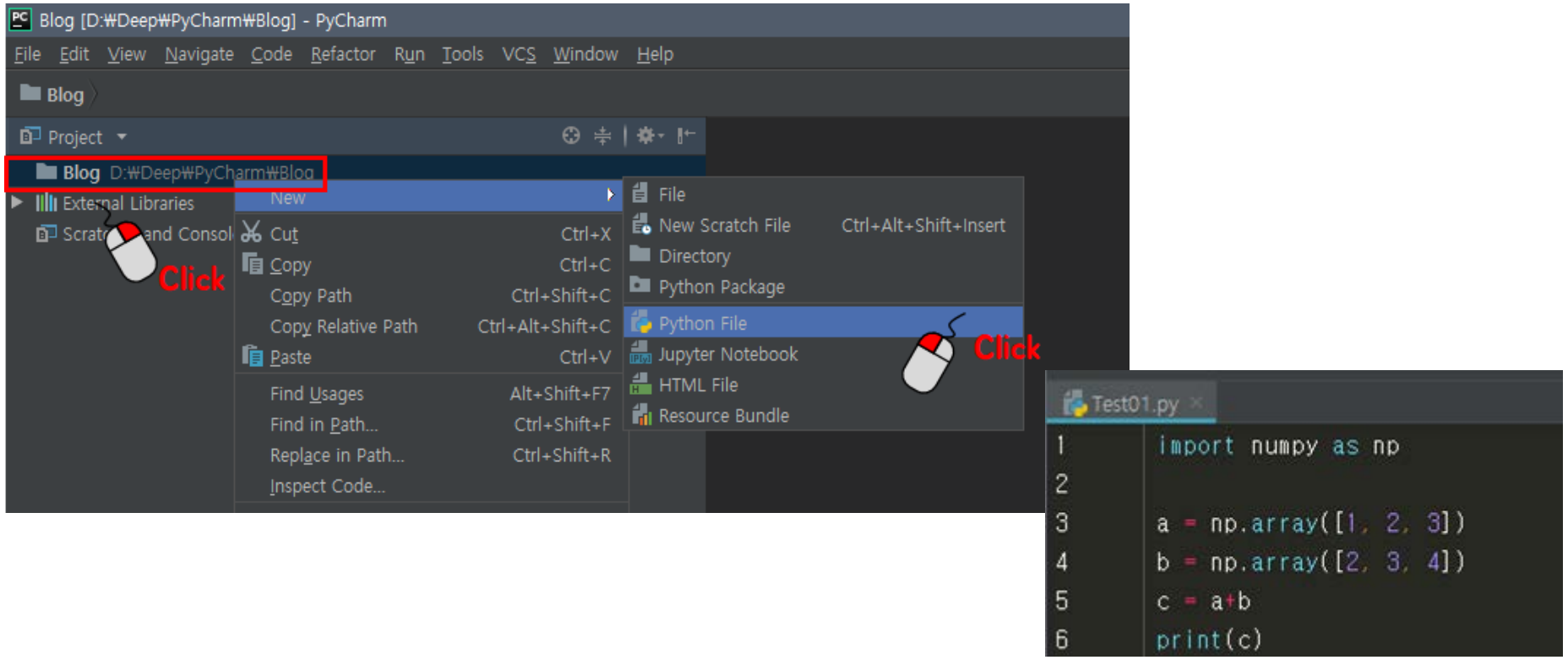
Setup

- Development Tools – PyCharm

File-New Project

↓

코드 작성



Setup

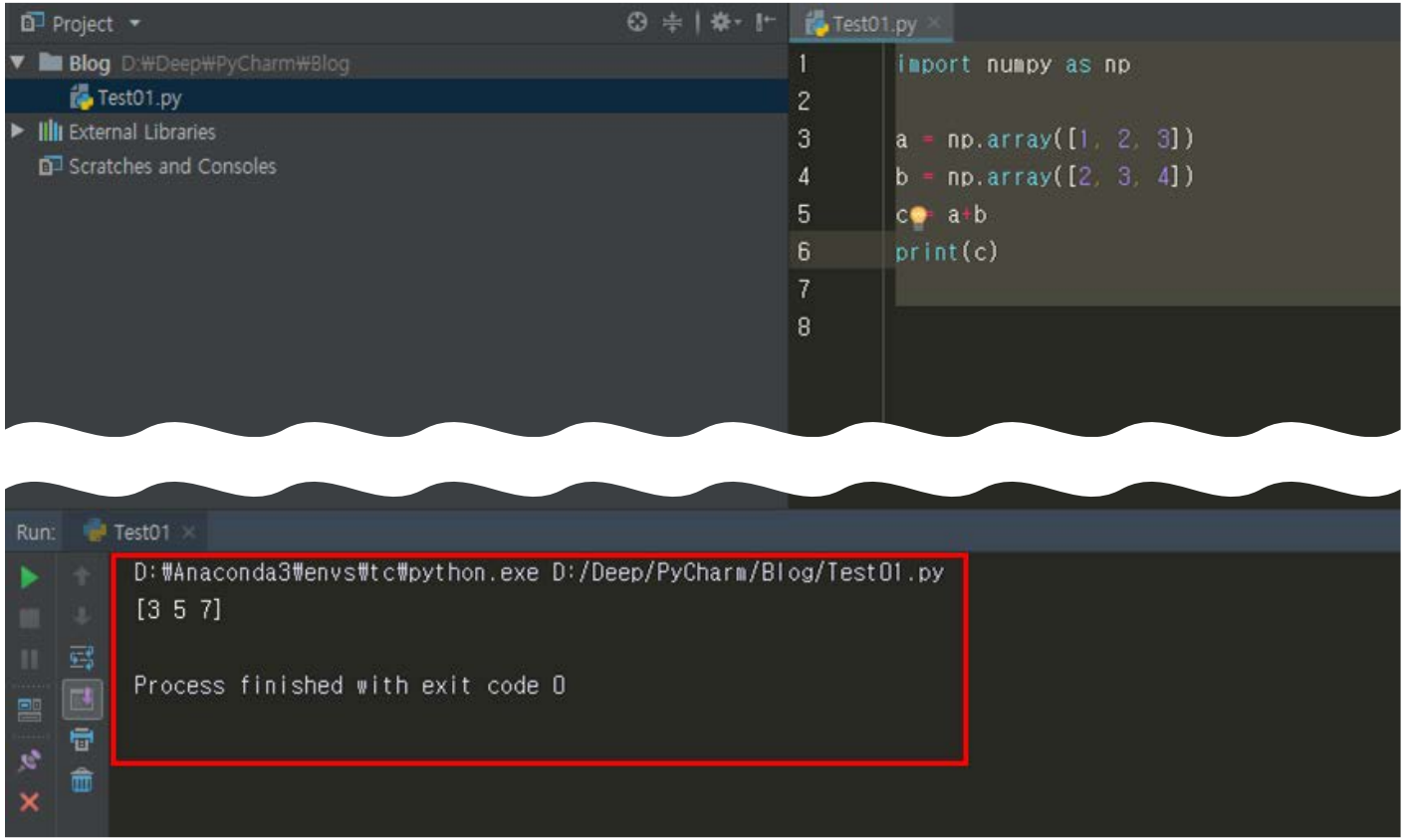
- Development Tools – PyCharm

File-New Project

코드 작성

실행

: Ctrl+F5



Cf. TODO

"Too easy, but important things", pp. 42-43

Example

- Tensor

PYTORCH

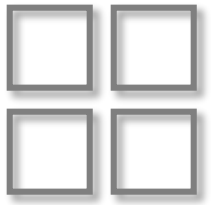
array		Tensor
reshape		view(reshape)
linspace	from_numpy → / ← numpy	linspace
ones, zeros		ones, zeros
random.randn, random.rand		randn, rand
		to, cuda

Example

- Tensor

```
import torch as tc

#Tensor
a = tc.Tensor([2.5, 4])
b = tc.Tensor([[1, 2.5], [2.5, 6]])
```

```
Tensor a :
 tensor([ 2.5000,  4.0000])
Size of a :  torch.Size([2])
Tensor b :
 tensor([[ 1.0000,  2.5000],
         [ 2.5000,  6.0000]])
Size of b :  torch.Size([2, 2])
```



```
#reshape
c = b.reshape(1, 4)
d = b.reshape(1, -1)
```

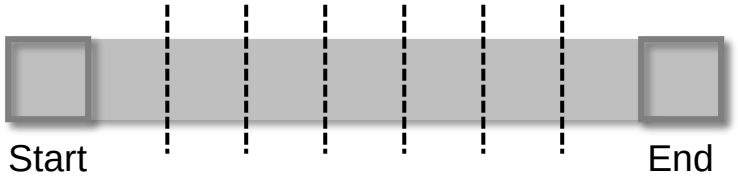
```
Tensor c :
 tensor([[ 1.0000,  2.5000,  2.5000,  6.0000]])
Size of c :  torch.Size([1, 4])
Tensor d :
 tensor([[ 1.0000,  2.5000,  2.5000,  6.0000]])
Size of d :  torch.Size([1, 4])
```

Example

- Tensor

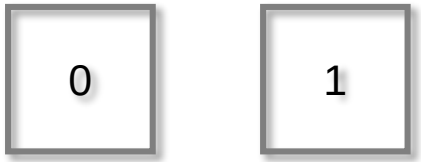
```
#linspace
x = tc.linspace(-1, 1, 9)
```

```
Tensor x :
 tensor([-1.0000, -0.7500, -0.5000,
-0.2500,  0.0000,  0.2500,  0.5000,
         0.7500,  1.0000])
Size of x :  torch.Size([9])
```




```
#ones, zeros
real = tc.ones(2, 2)
fake = tc.zeros(2, 2)
```

```
Tensor real :
 tensor([[ 1.,  1.],
         [ 1.,  1.]])
Size of real :  torch.Size([2, 2])
Tensor fake :
 tensor([[ 0.,  0.],
         [ 0.,  0.]])
Size of fake :  torch.Size([2, 2])
```

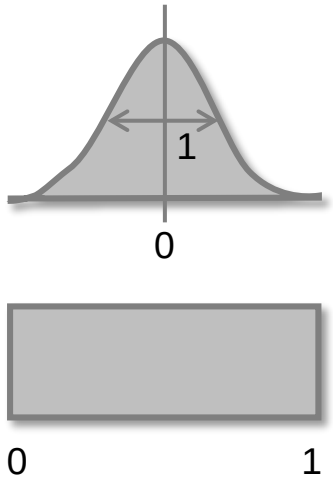


Example

- Tensor

```
#randn, rand
z1 = tc.randn(2, 3)
z2 = tc.rand(2, 3)
```

```
Tensor z1 :
 tensor([[-0.0750, -1.0555, -0.0706],
         [-0.1946, -0.8593, -0.2238]])
Size of z1 :  torch.Size([2, 3])
Tensor z2 :
 tensor([[ 0.8204,  0.3505,  0.1034],
         [ 0.5318,  0.9543,  0.8781]])
Size of z2 :  torch.Size([2, 3])
```




```
#to, cuda
z_cuda = z1.cuda()
device = tc.device('cuda' if tc.cuda.is_available() else 'cpu')
z_device = z1.to(device)
```

```
Tensor z_cuda :
 tensor([[-0.0750, -1.0555, -0.0706],
         [-0.1946, -0.8593, -0.2238]], device='cuda:0')
Tensor z_device :
 tensor([[-0.0750, -1.0555, -0.0706],
         [-0.1946, -0.8593, -0.2238]], device='cuda:0')
```

Example

- Tensor

```
#from_numpy, numpy
import numpy as np

a = np.array([3.5, 4])
b = tc.from_numpy(a)
c = b.numpy()
```

```
array a :
 [3.5 4. ]
Tensor b :
 tensor([ 3.5000,  4.0000], dtype=torch.float64)
array c :
 [3.5 4. ]
```

Example

- Datasets

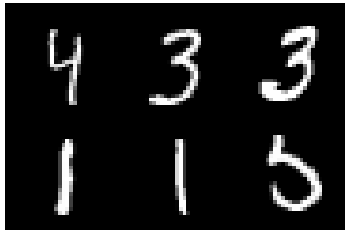
The following datasets are available:

- ✓ MNIST
- ✓ Fashion-MNIST
- EMNIST
- COCO
- ✓ LSUN
- ✓ ImageFolder
- DatasetFolder
- Imagenet-12
- ✓ CIFAR
- STL10
- SVHN
- PhotoTour

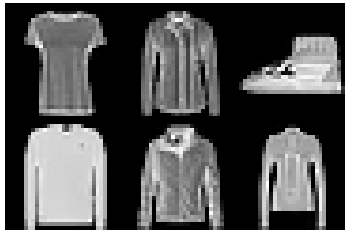
✓ : 바로 사용 가능.

✓ : 추가적인 과정 필요.

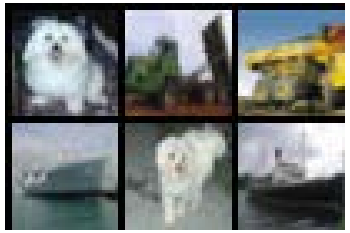
✓ : Custom dataset에 활용.



MNIST



Fashion-MNIST



CIFAR

LSUN

CelebA

K-pop(Custom)

Example

- Datasets – MNIST

```
import torch as tc
import torchvision as tv
import torchvision.transforms as transforms
```

```
trans = transforms.Compose([transforms.ToTensor(), transforms.Normalize((0.5, 0.5, 0.5), (0.5, 0.5, 0.5))])
datasets = tv.datasets.MNIST(root='./MNIST', train=True, download=True, transform=trans)
dataloader = tc.utils.data.DataLoader(datasets=datasets, batch_size=100, shuffle=True)
```

trans

- Compose()is used when there are multiple transform options. Here, ToTensor() and Normalize(mean, std) are used.
- ToTensor () changes the PIL Image to a tensor. torchvision dataset The default type is PIL Image.
- Normalize (mean, std) transforms the range of the image. Here, the value of [0, 1] is adjusted to [-1, 1]. ((value-mean) / std)

Example

- Datasets – MNIST

```
import torch as tc
import torchvision as tv
import torchvision.transforms as transforms
```

```
trans = transforms.Compose([transforms.ToTensor(), transforms.Normalize((0.5, 0.5, 0.5), (0.5, 0.5, 0.5))])
datasets = tv.datasets.MNIST(root='./MNIST', train=True, download=True, transform=trans)
dataloader = tc.utils.data.DataLoader(datasets=datasets, batch_size=100, shuffle=True)
```

dataset

- root : This is the path to store (MNIST data). Folders are automatically created with the specified name.
- train : Set the data to be used for the train.
- transform : Transform the data according to the transform option set previously.
- download : Download (MINST data). (If you downloaded it once, it will not do it again.)

Example

- Datasets – MNIST

```
import torch as tc
import torchvision as tv
import torchvision.transforms as transforms
```

```
trans = transforms.Compose([transforms.ToTensor(), transforms.Normalize((0.5, 0.5, 0.5), (0.5, 0.5, 0.5))])
datasets = tv.datasets.MNIST(root='./MNIST', train=True, download=True, transform=trans)
dataloader = tc.utils.data.DataLoader(datasets=datasets, batch_size=100, shuffle=True)
```

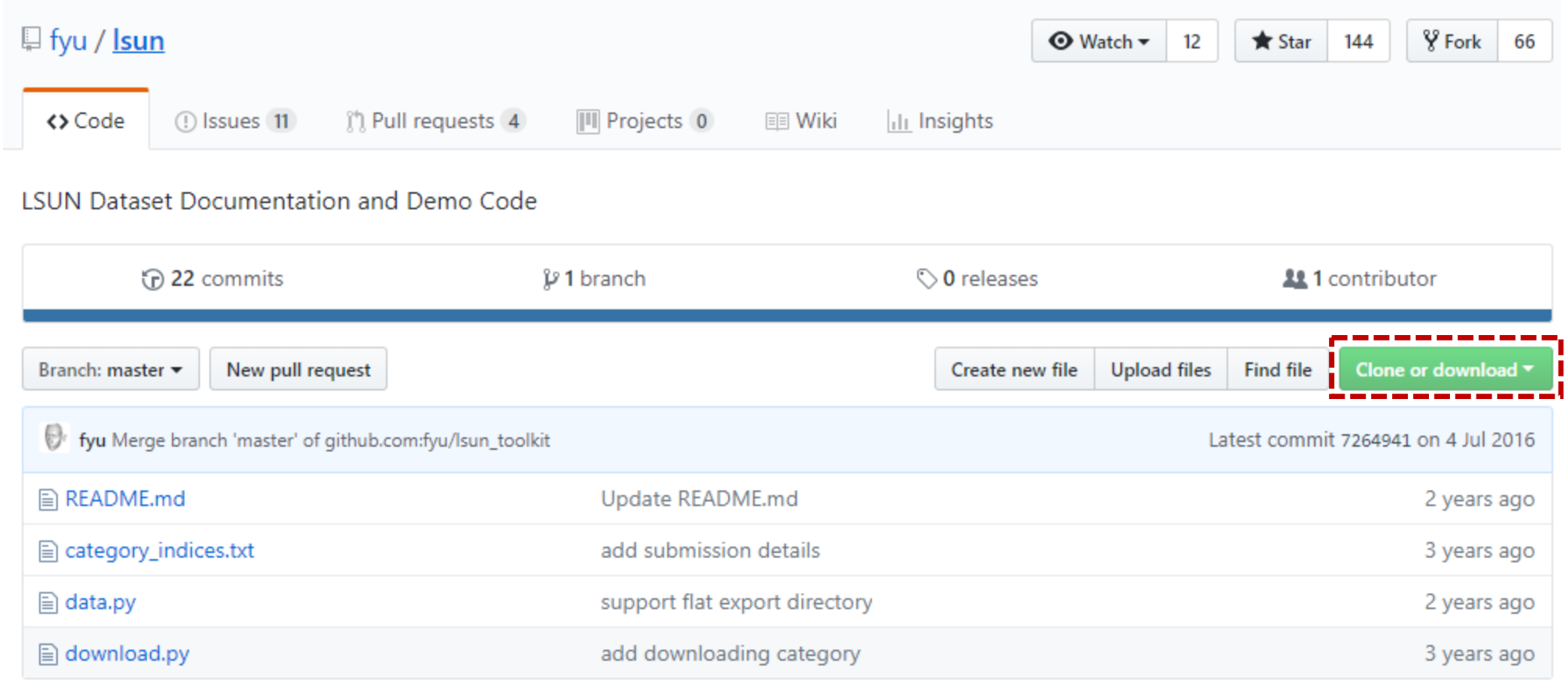
dataloader

- dataset : Set the dataset to load.
- batch_size : Set the batch size.
- shuffle : Shuffle the data and load it.

Example

- Datasets – LSUN

  https://github.com/fyu/lsun



Example

- Datasets – LSUN

Run download.py **download.py -c bedroom**

bedroom 0
bridge 1
church_outdoor 2
classroom 3
conference_room 4
dining_room 5
kitchen 6
living_room 7
restaurant 8
tower 9

If you are using Python 3.0 or later, modify the code from urllib2.urlopen (url) to urlopen (url).

```
def list_categories(tag):
    url = 'http://lsun.cs.princeton.edu/htbin/list.cgi?tag=' + tag
    f = urlopen(url)
    return json.loads(f.read())
```

Example

- Datasets – LSUN

```
trans = transforms.Compose([transforms.Resize((64,64)) ,transforms.ToTensor(), transforms.Normalize((0.5, 0.5, 0.5), (0.5, 0.5, 0.5))])
datasets = tv.datasets.LSUN('.', classes=['bedroom_train'], transform=trans)
dataloader = tc.utils.data.DataLoader(datasets=datasets, batch_size=100, shuffle=True)
```

trans

- Resize() is used to resize the image.

datasets

- root : Root directory for the database files.
- classes : One of {‘train’, ‘val’, ‘test’} or a list of categories to load. e,g. [‘bedroom_train’, ‘church_train’].

Example

- Datasets – ImageFolder(CelebA)

  http://mmlab.ie.cuhk.edu.hk/projects/CelebA.html

News

2016-07-29 If DropBox are not accessable, please download the dataset using Google Drive or Baidu Drive.

Details

CelebFaces Attributes Dataset (CelebA) is a large-scale face attributes dataset with more than **200K** celebrity images, each with **40** attribute annotations. The images in this dataset cover large pose variations and background clutter. CelebA has large diversities, large quantities, and rich annotations, including

- **10,177** number of **identities**,
- **202,599** number of **face images**, and
- **5 landmark locations**, **40 binary attributes** annotations per image.

The dataset can be employed as the training and test sets for the following computer vision tasks: face attribute recognition, face detection, and landmark (or facial part) localization.

Sample Images

Example

- Datasets – ImageFolder(CelebA)

  http://mmlab.ie.cuhk.edu.hk/projects/CelebA.html

압축을 풀면 jpg 형태로 파일들이 저장된 것을 확인할 수 있음.

Example

- Datasets – ImageFolder(CelebA)

```
trans = transforms.Compose([transforms.Resize((64,64)) ,transforms.ToTensor(), transforms.Normalize((0.5, 0.5, 0.5), (0.5, 0.5, 0.5))])
datasets = tv.datasets.ImageFolder('./img_align_celeba', trans)
dataloader = tc.utils.data.DataLoader(datasets=datasets, batch_size=100, shuffle=True)
```

datasets

- root : Root directory for the database files.
- transform : Transform the data according to the transform option set previously.

Example

- Neural Nets

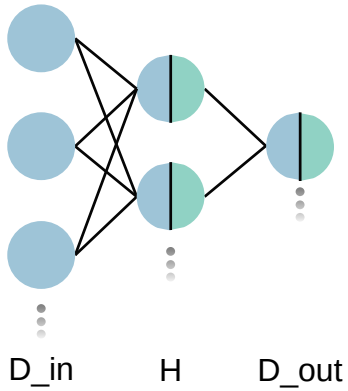
Class base

```
class Model(tc.nn.Module):
    def __init__(self):
        super(Model, self).__init__()
        self.linear1 = tc.nn.Linear(D_in, H),
        self.linear2 = tc.nn.Linear(H, D_out)

    def forward(self, input):
        x = tc.nn.functional.relu(self.linear1(input))
        x = tc.nn.functional.sigmoid(self.linear2(x))

        return x
```

Data manipulation

Sequence base

```
model = tc.nn.Sequential(
    tc.nn.Linear(D_in, H),
    tc.nn.ReLU(),
    tc.nn.Linear(H, D_out),
    tc.nn.Sigmoid()
    )
```

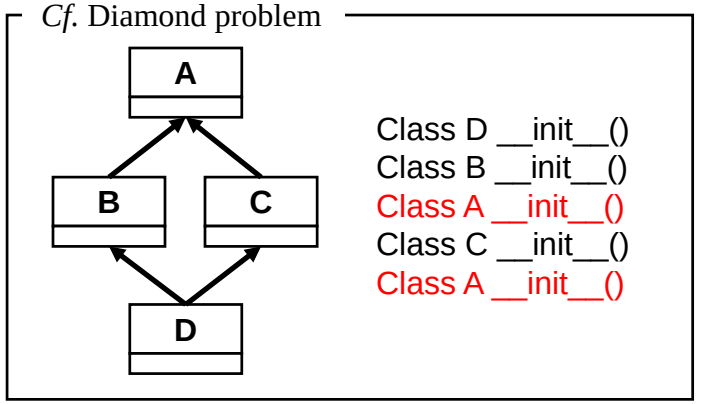


Example

- Neural Nets

Class base

Cf. Diamond problem

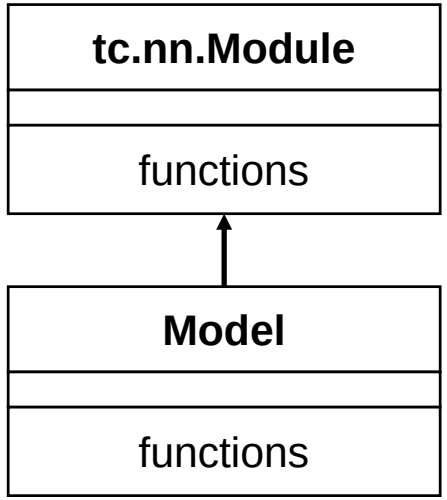



```
class Model(tc.nn.Module):
    def __init__(self):
        super(Model, self).__init__()
        self.linear1 = tc.nn.Linear(D_in, H),
        self.linear2 = tc.nn.Linear(H, D_out)

    def forward(self, input):
        x = tc.nn.functional.relu(self.linear1(input))
        x = tc.nn.functional.sigmoid(self.linear2(x))

        return x
```

생성자

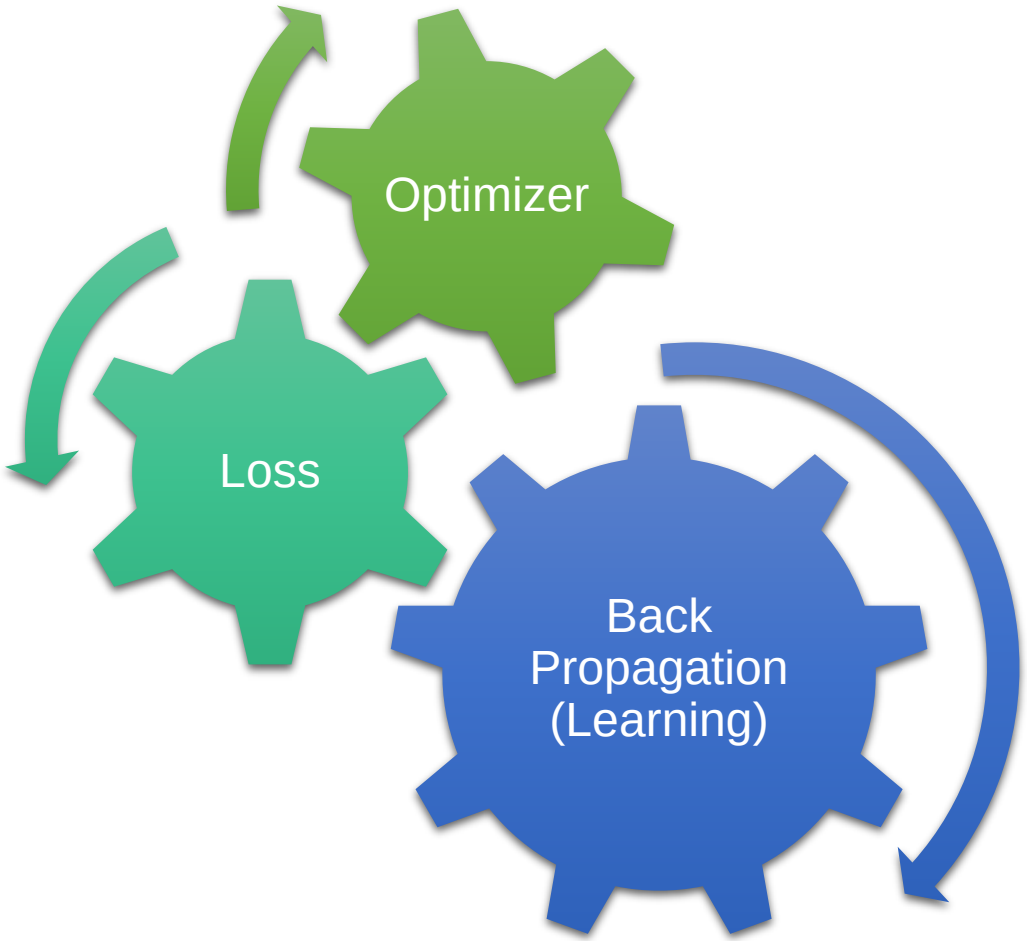
부모 클래스 초기화

Propagation



Example

- Learning




```
loss_func = tc.nn.MSELoss()
opt = tc.optim.Adam(model.parameters(), lr=0.01 )

for ep in range(epoch_sz):
    for step, (images, labels) in enumerate(dataloader):
        opt.zero_grad()
        images = images.to(device)
        labels = labels.to(device)

        output = model(images)

        loss = loss_func(output)
        loss.backward()
        opt.step()
```

Example

- Learning

Cf.

```
trans = transforms.Compose([transforms.ToTensor(), transforms.Normalize((0.5, 0.5, 0.5), (0.5, 0.5, 0.5))])
datasets = tv.datasets.MNIST(root='./MNIST', train=True, download=True, transform=trans)
dataloader = tc.utils.data.DataLoader(datasets=datasets, batch_size=100, shuffle=True)
```

```
loss_func = tc.nn.MSELoss()
opt = tc.optim.Adam(model.parameters(), lr=0.01 )

for ep in range(epoch_sz):
    for step, (images, labels) in enumerate(dataloader):
        opt.zero_grad()
        images = images.to(device)
        labels = labels.to(device)

        output = model(images)

        loss = loss_func(output)
        loss.backward()
        opt.step()
```

Loss 선언

Optimizer 선언 (업데이트 하려는 parameter)

정해진 epoch 만큼 수행

앞서 설정한 dataloader에 따라 image(data)와 label(_) 불러옴

Gradient 초기화.

Loss 구함

Back propagation(Gradient 구함)

정해진 optimizer에 따라 parameter 업데이트

Example

- Learning

Loss

- L1Loss
- **MSELoss**
- **CrossEntropyLoss**
- NLLLoss
- PoissonNLLLoss
- KLDivLoss
- **BCELoss**
- BCEWithLogitsLoss
- MarginRankingLoss
- HingeEmbeddingLoss
- SmoothL1Loss
- SoftMarginLoss
- MultiLabelSoftMarginLoss
- CosineEmbeddingLoss
- MultiMarginLoss
- TripleMarginLoss

Optimizer

- Adadelta
- Adagrad
- **Adam**
- SparseAdam
- Adamax
- ASGD
- LBFGS
- RMSprop
- Rprop
- **SGD**

* Bold체는 주로 사용하는 함수들.

Example

- Applications –Vanilla GAN

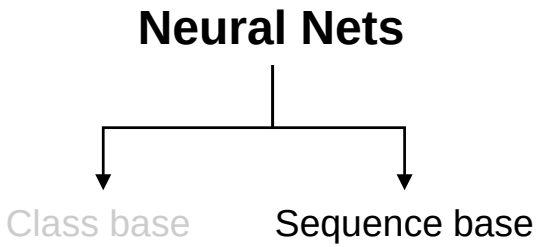
Cf.

“What is this? Gum? It's GAN.”

https://github.com/messy-snail/GAN_PyTorch

Example

- Applications –Vanilla GAN



Example

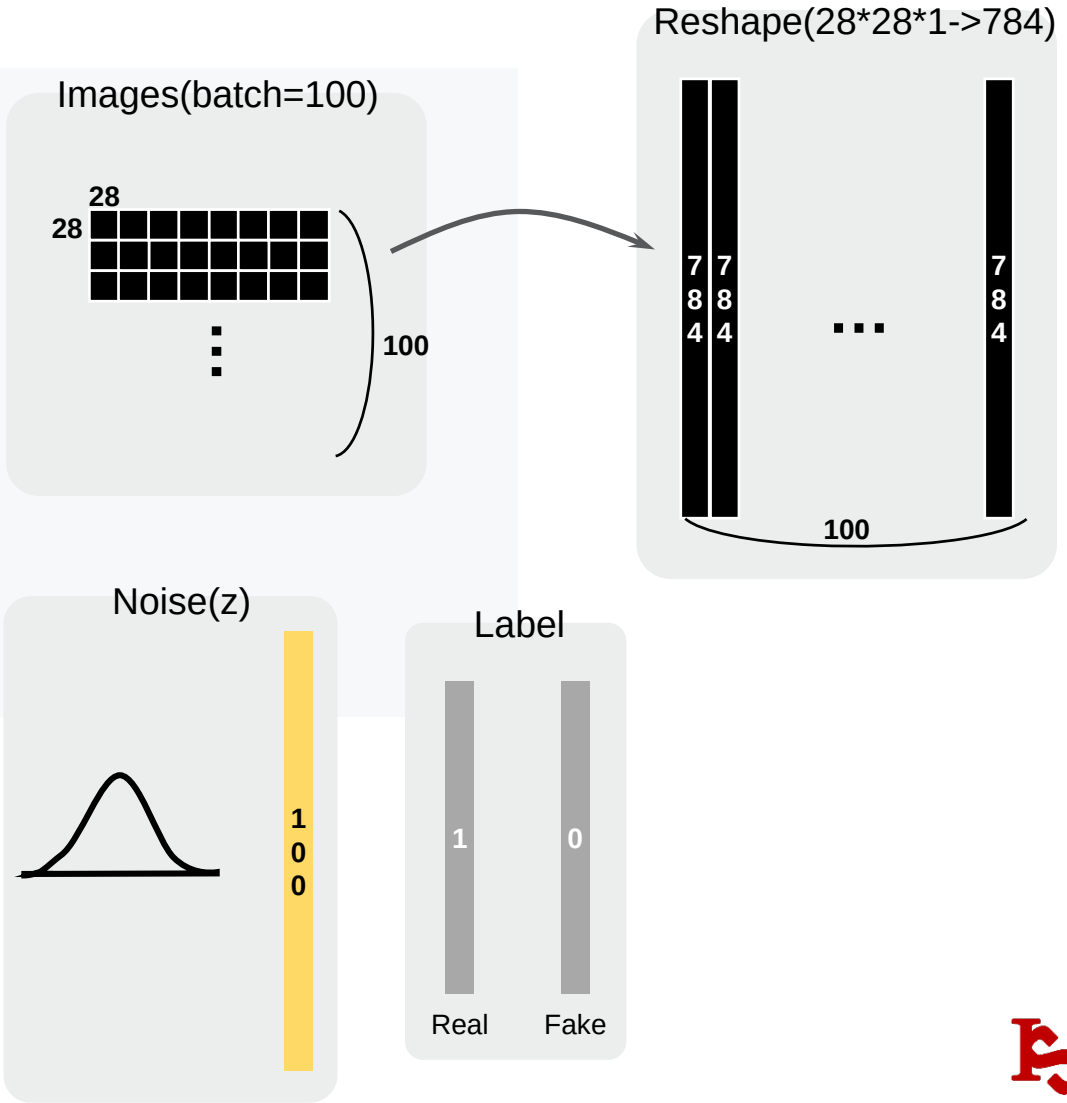
- Applications –Vanilla GAN

```
loss_func = tc.nn.BCELoss()
d_opt = tc.optim.Adam(D.parameters(), lr=lr)
g_opt = tc.optim.Adam(G.parameters(), lr=lr)
```

Example

- Applications –Vanilla GAN

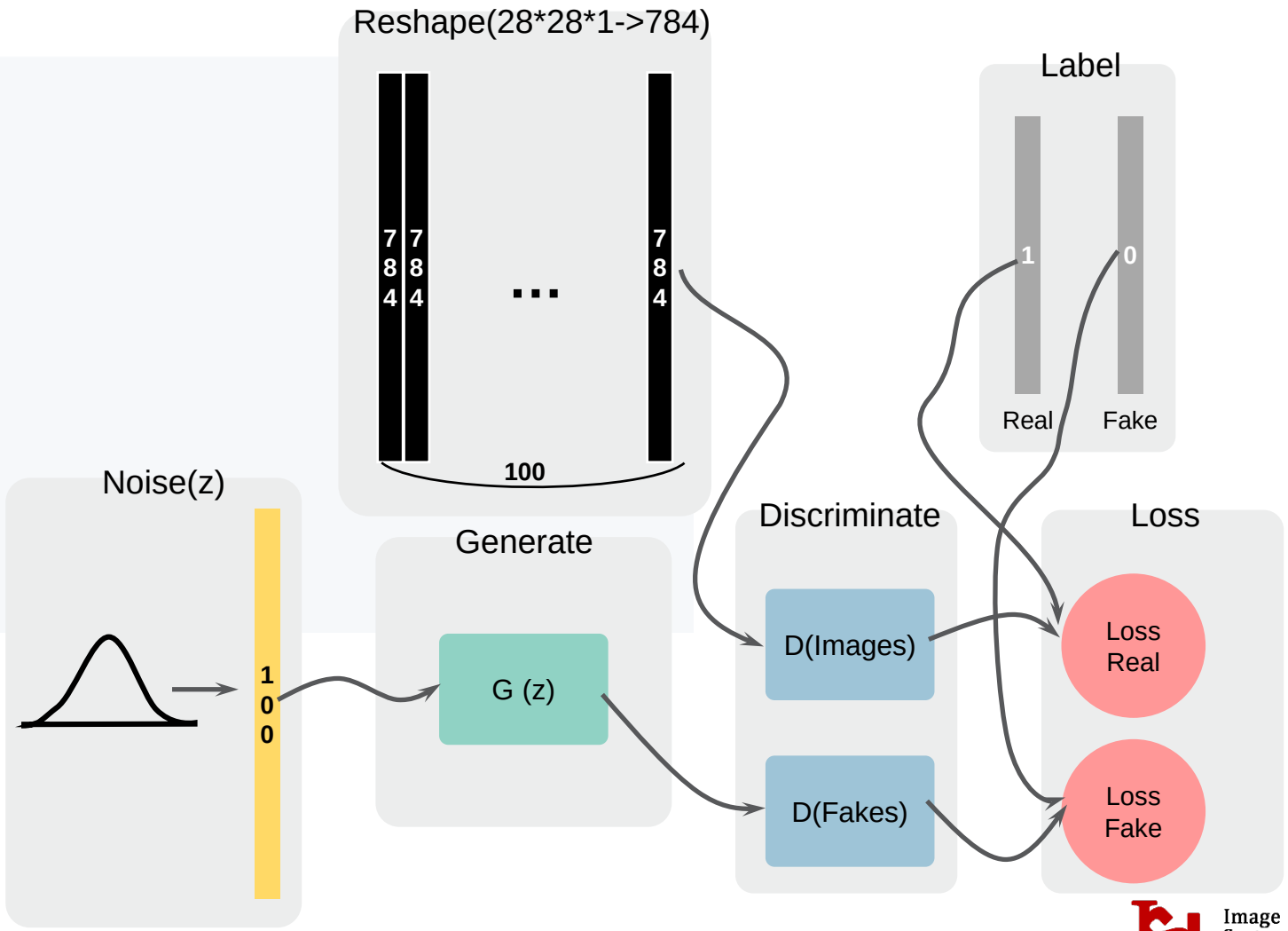
```
for ep in range(nEpoch):
    for step, (images,  ) in enumerate(dataloader):
        images = images.reshape(batch_sz, -1).to(device)
        z = tc.randn(batch_sz, noise_sz).to(device)

        real_label = tc.ones(batch_sz, 1).to(device)
        fake_label = tc.zeros(batch_sz, 1).to(device)

        loss_real = loss_func(D(images), real_label)
        loss_fake = loss_func(D(G(z)), fake_label)

        d_loss = loss_real + loss_fake

        d_opt.zero_grad()
        d_loss.backward()
        d_opt.step()
```



Example

- Applications –Vanilla GAN

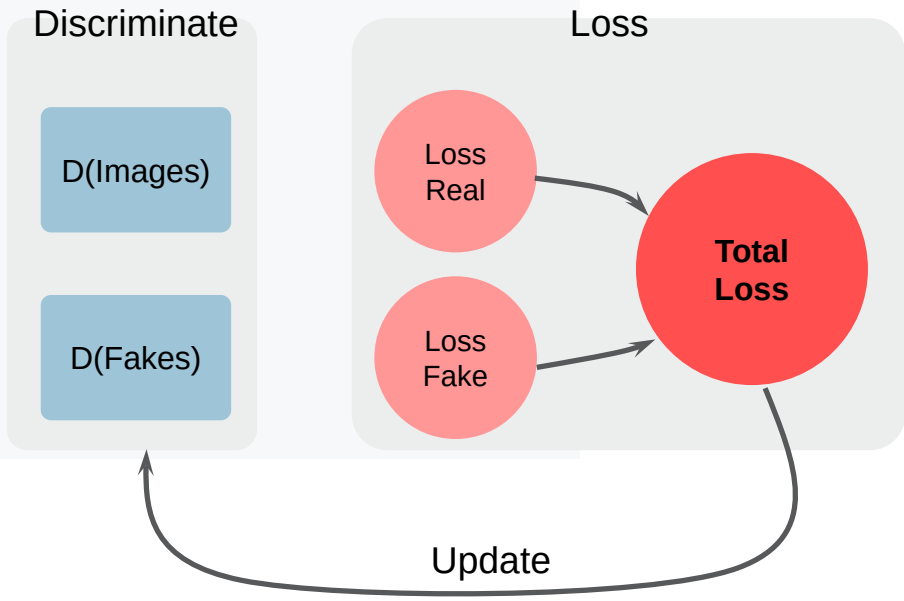
```
for ep in range(nEpoch):
    for step, (images, _) in enumerate(dataloader):
        images = images.reshape(batch_sz, -1).to(device)
        z = tc.randn(batch_sz, noise_sz).to(device)

        real_label = tc.ones(batch_sz, 1).to(device)
        fake_label = tc.zeros(batch_sz, 1).to(device)

        loss_real = loss_func(D(images), real_label)
        loss_fake = loss_func(D(G(z)), fake_label)

        d_loss = loss_real + loss_fake

        d_opt.zero_grad()
        d_loss.backward()
        d_opt.step()
```



Example

- Applications –Vanilla GAN

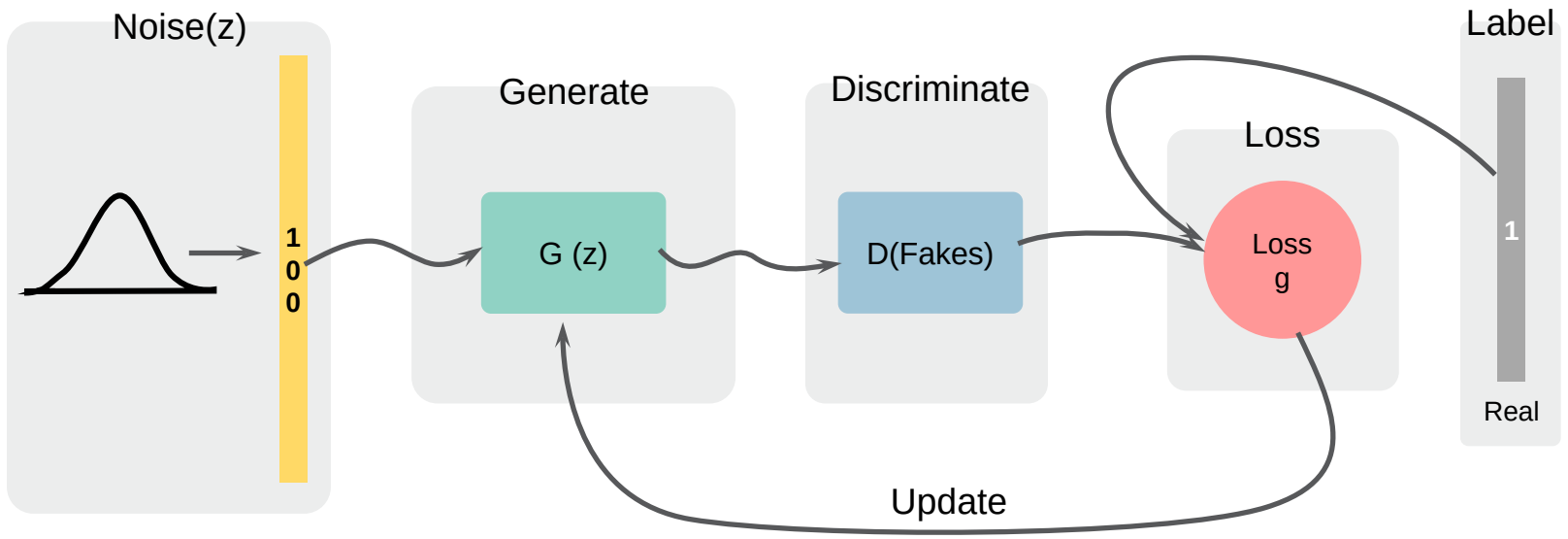
```
for ep in range(nEpoch):
    for step, (images, _) in enumerate(dataloader):
        images = images.reshape(batch_sz, -1).to(device)
        z = tc.randn(batch_sz, noise_sz).to(device)

        real_label = tc.ones(batch_sz, 1).to(device)
        fake_label = tc.zeros(batch_sz, 1).to(device)

        loss_real = loss_func(D(images), real_label)
        loss_fake = loss_func(D(G(z)), fake_label)

        d_loss = loss_real + loss_fake

        d_opt.zero_grad()
        d_loss.backward()
        d_opt.step()
```



Example

- Applications –Vanilla GAN

```
fake_images = G(z)
g_loss = loss_func(D(fake_images), real_label)

g_opt.zero_grad()
g_loss.backward()
g_opt.step()
```



Future Work

Paper Review

- [x] ~~Vanilla GAN~~
- [x] ~~DCGAN~~
- [ ] InfoGAN
- [ ] Unrolled GAN
- [ ] Wasserstein GAN
- [ ] LS GAN
- [ ] BEGAN
- [ ] ~~Pix2Pix~~
- [ ] Cycle GAN

Maybe next seminar?

Proposed Model

- [ ] ~~SpyGAN~~

Tools

- [x] ~~Document~~
- [x] ~~Programming~~
- [x] ~~PyTorch~~
- [ ] Python executable & UI

Mathematical Study

- [ ] Linear algebra
- [ ] Probability and statistics
- [ ] Information theory

Others

- [x] ~~Level Processor~~
- [ ] Ice Propagation

Q & A

Thank you for your attention