# 深入淺出 Python

2023.02.21 廖唯辰

@Deep Learning

## Outline

- Environment
- Built- in Functions
- Packing and Unpacking
- Class

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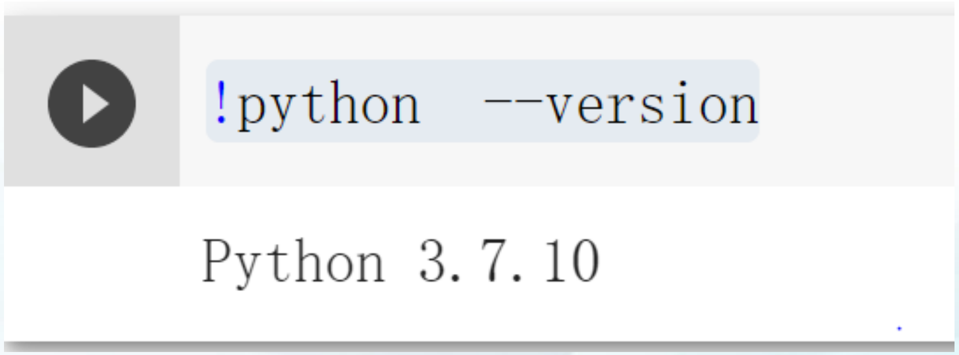
## Environments

- (NYCU) We’ll provide workstation
- (Local) Install Python3
- (Local / Remote) Jupyter Notebook
- (Cloud) Google Colab

## Python version

- python >= 3.6
- Command:  python –V
- Colab: !python --version



```
!python  --version
```

```
Python 3.7.10
```

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## Built- in Functions

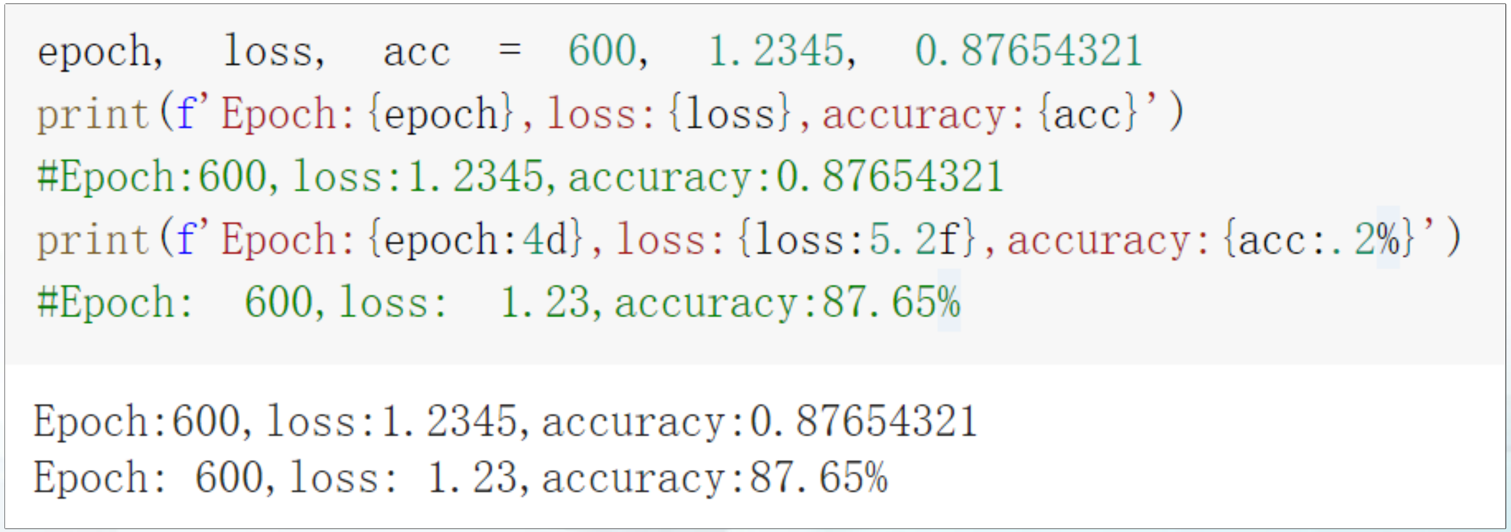
- Reference: Built-in Functions — Python 3.9.2 documentation

## Example

```python
data = [1, 3, 2]
print(max(data)) # 3
print(min(data)) # 1
print(sum(data)) # 6
print(len(data)) # 3

# Example: loss less than threshold
dones = [True, False, True, True]
all_done = all(dones) # False
any_done = any(dones) # True
```

## Format String

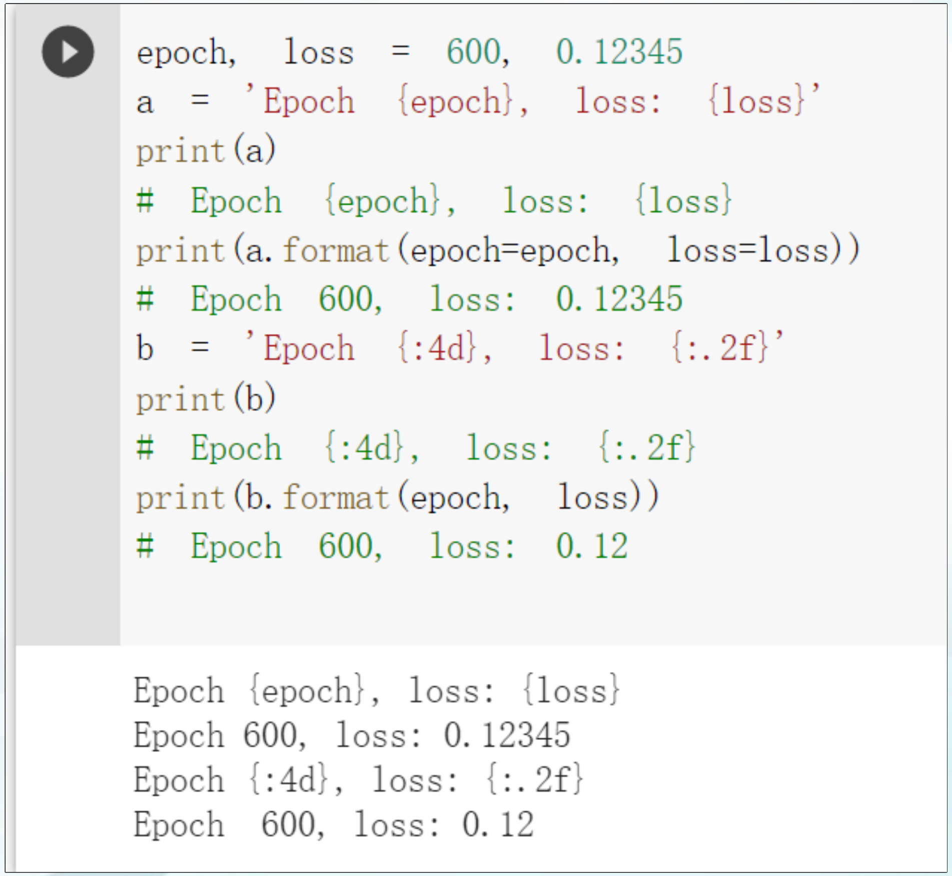
- 子串開頭有 f
- 字串內大括號包住變數



```
epoch,   loss,   acc  =  600,   1.2345,   0.87654321
print(f'Epoch:{epoch},loss:{loss},accuracy:{acc}')
#Epoch:600,loss:1.2345,accuracy:0.87654321
print(f'Epoch:{epoch:4d},loss:{loss:5.2f},accuracy:{acc:.2%}')
#Epoch:  600,loss:   1.23,accuracy:87.65%
```

```
Epoch:600,loss:1.2345,accuracy:0.87654321
Epoch: 600,loss: 1.23,accuracy:87.65%
```

## Format 方法



```
epoch, loss = 600, 0.12345
a = 'Epoch {epoch}, loss: {loss}'
print(a)
# Epoch {epoch}, loss: {loss}
print(a.format(epoch=epoch, loss=loss))
# Epoch 600, loss: 0.12345
b = 'Epoch {:4d}, loss: {:.2f}'
print(b)
# Epoch {:4d}, loss: {:.2f}
print(b.format(epoch, loss))
# Epoch 600, loss: 0.12
```

```
Epoch {epoch}, loss: {loss}
Epoch 600, loss: 0.12345
Epoch {:4d}, loss: {:.2f}
Epoch  600, loss: 0.12
```

## Enumerate

iterable: list, tuple, dict, …

- enumerate(iterable, start=0)

```
>>> print(list(enumerate(['A', 'B', 'C'])))
[(0, 'A'), (1, 'B'), (2, 'C')]
```

Img1 Img2 Img3

```
data = [Img(), Img(), Img()]
for i, x in enumerate(data):
    print(i, x)
```

```
0   Img1
1   Img2
2   Img3
```

## Open

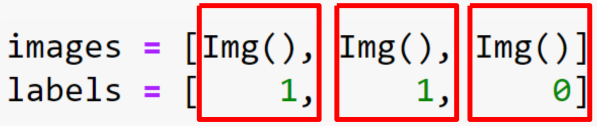
```python
# mode 'r': read (default)
# mode 'w': write
# mode 'a': append
f = open('test.txt', 'w')
f.write('zzz')
f.close()
```

Open 簡寫:

```python
with open('test.txt', 'w') as f:
    print('zzz', file=f)
    f.write('zzz')
```

## zip

```python
images = [Img(), Img(), Img()]
labels = [1, 1, 0]

for img, label in zip(images, labels):
    do_something(image, label)
```



```python
images = [Img(), Img(), Img()]
labels = [     1,      1,     0]
```

與 enumerate 混用:

```python
for i, (img, label) in enumerate(zip(images, labels), start=1):
    do_something(image, label)
```

## map

map(function, iterable, ...) ，通常與 list 混用輸出 list。(tuple也可以)

```
raw_data = ['1', '2', '3']
data = list(map(int, raw_data))
# [1, 2, 3]
```

## Practice 1

How to generate io_channel ?

```
channels = [32, 64, 128, 256, 512]

io_channel = [(32, 64), (64, 128), (128, 256), (256, 512)]

for in_channel, out_channel in io_channel:
    do_something(in_channel, out_channel)
```

## Practice 1

Given

```
channels = [32, 64, 128, 256, 512]
```

How to generate io_channel without hardcoding the values?

```
io_channel = [(32, 64), (64, 128), (128, 256), (256, 512)]
```

- Hint: zip, slice

## Practice 1 : Answer

```
channels = [32, 64, 128, 256, 512]

print(list(zip(channels[:-1], channels[1:])))

io_channel = [(32, 64), (64, 128), (128, 256), (256, 512)]
```

## Practice 1 : Review

```
          channels[:-1]          channels[1:]
```

```
r = zip([32, 64, 128, 256], [64, 128, 256, 512])
print(list(r))
# [(32, 64), (64, 128), (128, 256), (256, 512)]
```

$$\Downarrow$$

```
channels = [32, 64, 128, 256, 512]
r = zip(channels[:-1], channels[1:])
print(list(r))
# [(32, 64), (64, 128), (128, 256), (256, 512)]
```

## Practice 1 : Example

```python
channels = [32, 64, 128, 256, 512]

for in_channel, out_channel in zip(channels[:-1], channels[1:])
    do_something(in_channel, out_channel)
```

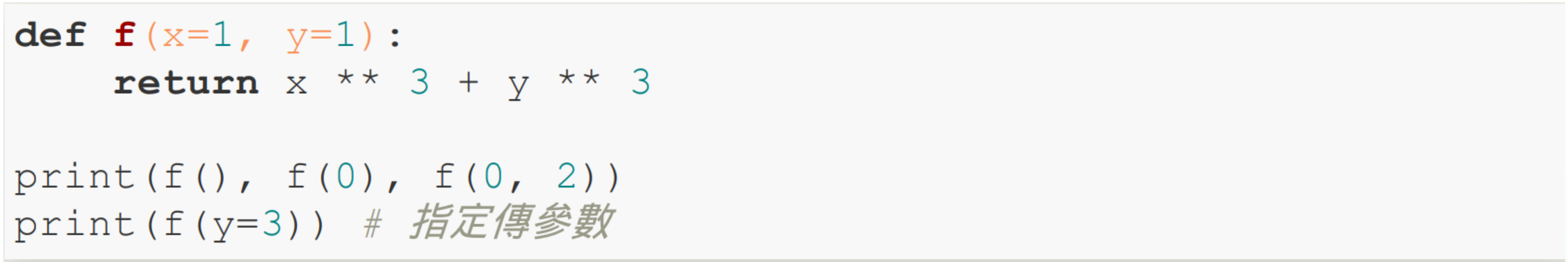
## Lambda Function

```
def f(x):
    return x ** 3 + 3 * (x ** 2) + 1

# Lambda function
f2 = lambda x : x ** 3 + 3 * (x ** 2) + 1

print(f(-1), f2(-1))
```

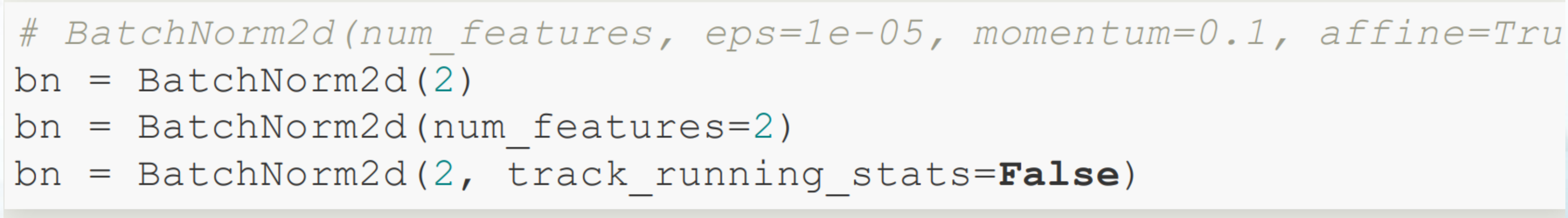
Lambda Function 搭配 map

```
raw_data = ['1', '2', '3']
data = list(map(lambda n : n + 'x', raw_data))
# ['1x', '2x', '3x']
```

## Default Argument and Positional Argument



```python
def f(x=1, y=1):
    return x ** 3 + y ** 3

print(f(), f(0), f(0, 2))
print(f(y=3)) # 指定傳參數
```

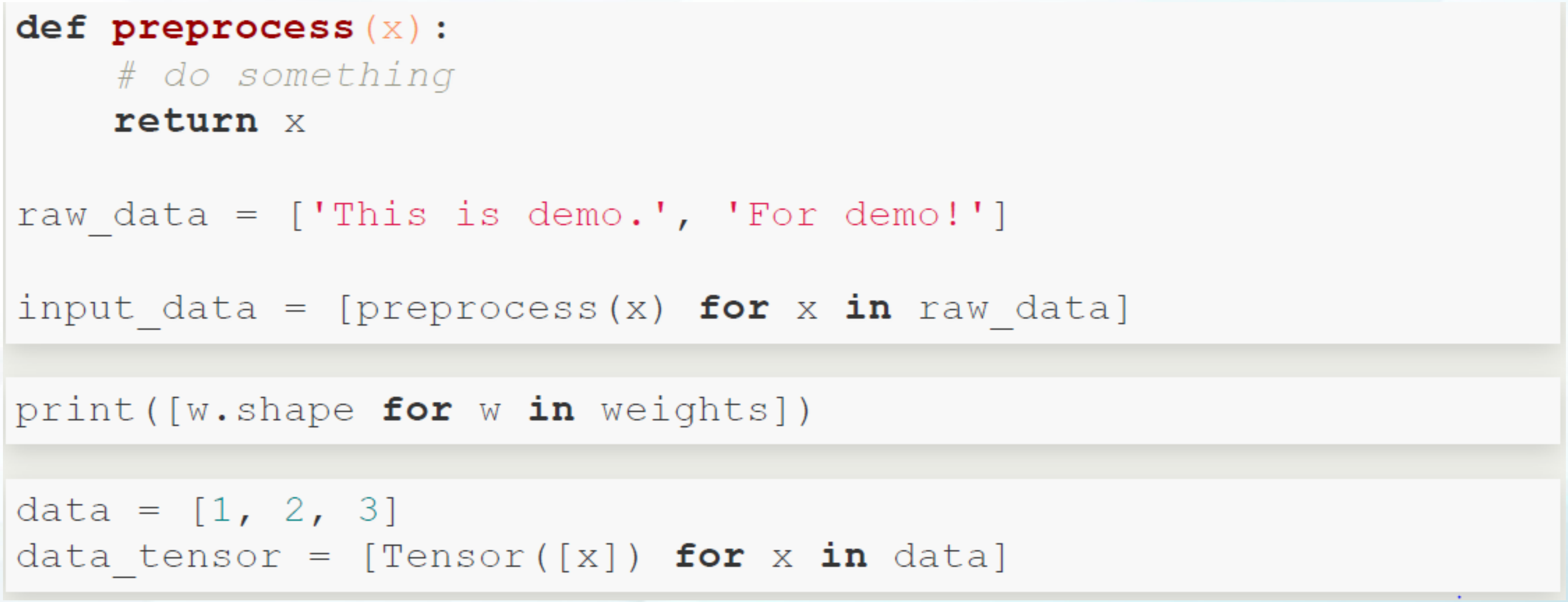


```python
# BatchNorm2d(num_features, eps=1e-05, momentum=0.1, affine=Tru
bn = BatchNorm2d(2)
bn = BatchNorm2d(num_features=2)
bn = BatchNorm2d(2, track_running_stats=False)
```

## List Comprehensions

```
# Original:
squares = []
for x in range(10):
    squares.append(x ** 2)


# List comprehension:
squares = [x ** 2 for x in range(10)]
```

## List Comprehensions: Example

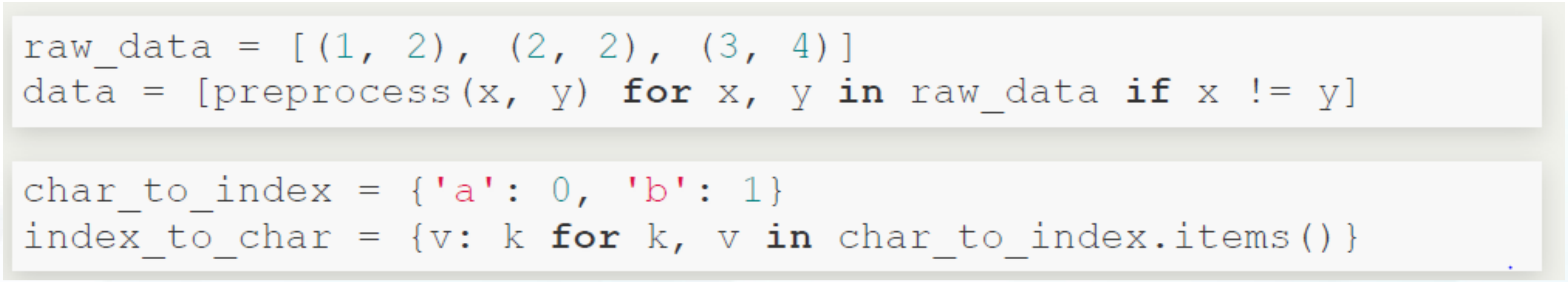


```python
def preprocess(x):
    # do something
    return x

raw_data = ['This is demo.', 'For demo!']

input_data = [preprocess(x) for x in raw_data]
```

```python
print([w.shape for w in weights])
```

```python
data = [1, 2, 3]
data_tensor = [Tensor([x]) for x in data]
```

## List Comprehensions: Example



```python
raw_data = [(1, 2), (2, 2), (3, 4)]
data = [preprocess(x, y) for x, y in raw_data if x != y]
```

```python
char_to_index = {'a': 0, 'b': 1}
index_to_char = {v: k for k, v in char_to_index.items()}
```

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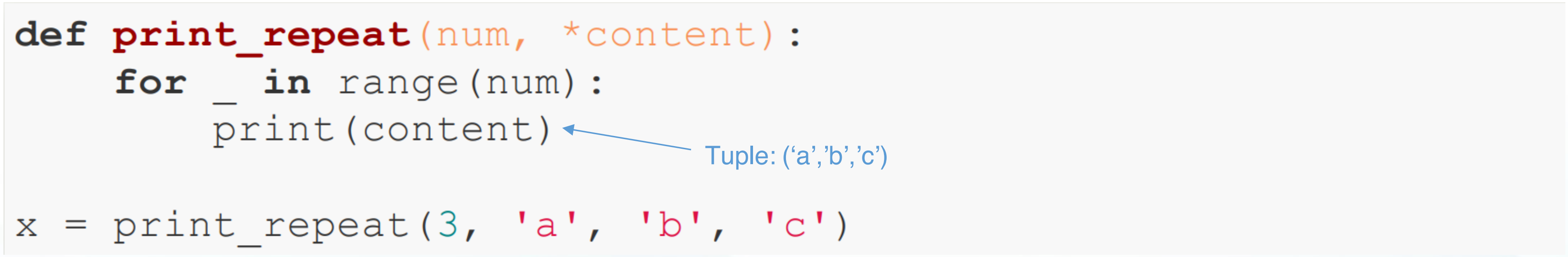
## * args

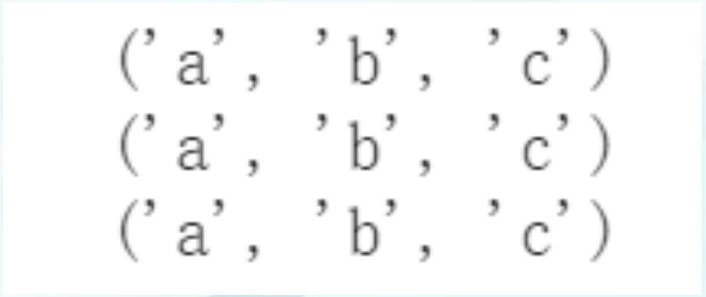
* 可做為 Packing 或 Unpacking 使用，看資料流方向。

* 作為 Packing 使用



```python
def print_repeat(num, *content):
    for _ in range(num):
        print(content)

x = print_repeat(3, 'a', 'b', 'c')
```

Tuple: (‘a’,’b’,’c’)



```
('a', 'b', 'c')
('a', 'b', 'c')
('a', 'b', 'c')
```

## * args : example

* 作為 Packing 使用

```
def p_norm(*v, p):
    ret = 0
    for k in v:
        ret += k ** p
    return ret ** (1 / p)

print(p_norm(1, 2, 3, p=2))
```

keyword-only argument

v: (1,2,3)
p: 2

```
3.7416573867739413
```

## Iterable Unpacking

- tuple, list, str
- 底線 _ 忽略該變數

```python
_, value = net(input)

dim = (4096, 3, 80, 80) # [N, C, H, W]
batch_size, _, height, width = dim
```

- 搭配使用 * (* 作為 Packing 使用)

```python
_, _, *size = dim
# size == [80, 80]

batch_size, *_ = dim
# batch_size == 4096
```

## Iterable Unpacking: example

- Example 1

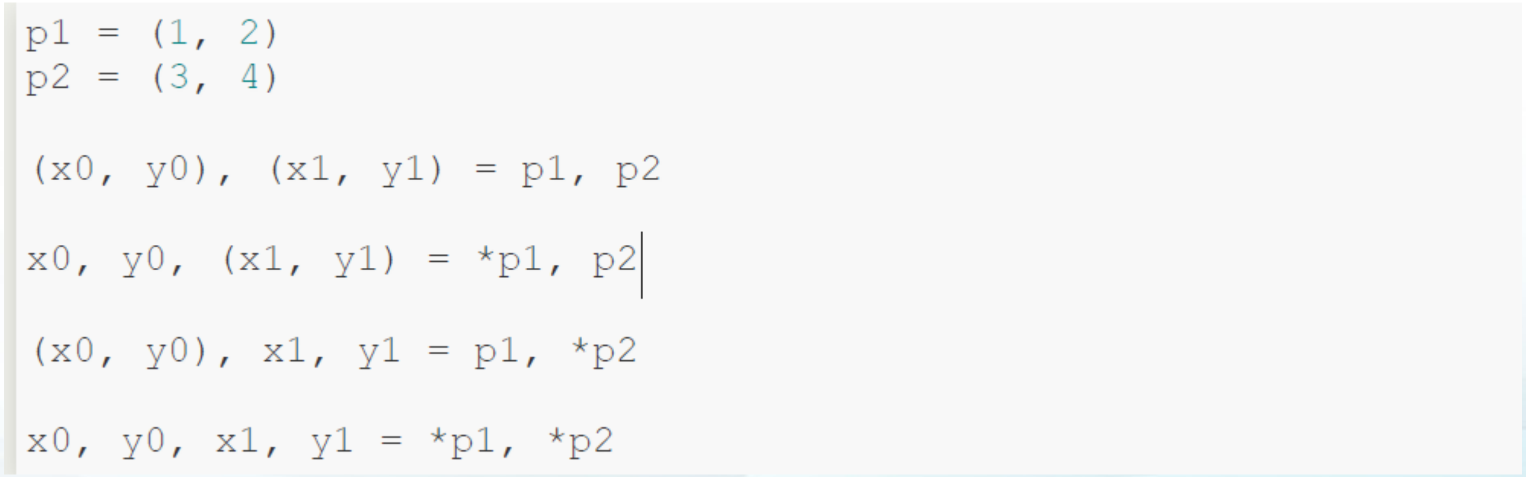
```python
def distance_square(p1, p2):
    (x1, y1), (x2, y2) = p1, p2
    dis = (x1 - x2) ** 2 + (y1 - y2) ** 2
    print(dis)

distance_square((1, 2), (3, 4))
```

- Example 2

```python
points = [(1, 2), (2, 2), (3, 4)]
for p in points:
    # p 是 tuple
    print(p[0], p[1])

# 結合 Unpacking
for x, y in points:
    # x 和 y 都是 int
    print(x, y)
```

## Iterable Unpacking: * args

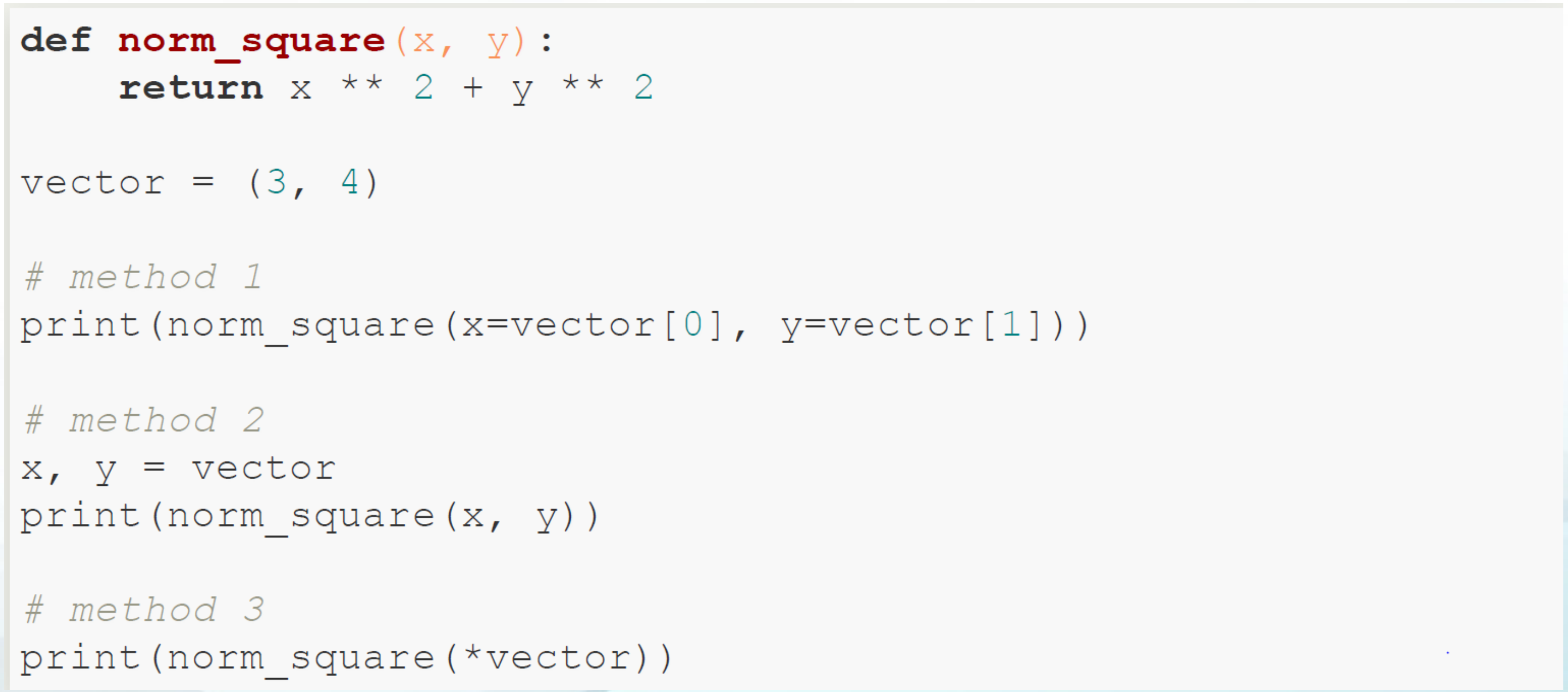
- * 可用於 Iterable 物件(tuple, list …)做 unpacking



```
p1 = (1, 2)
p2 = (3, 4)

(x0, y0), (x1, y1) = p1, p2

x0, y0, (x1, y1) = *p1, p2

(x0, y0), x1, y1 = p1, *p2

x0, y0, x1, y1 = *p1, *p2
```

## Iterable Unpacking: example

- Example 3



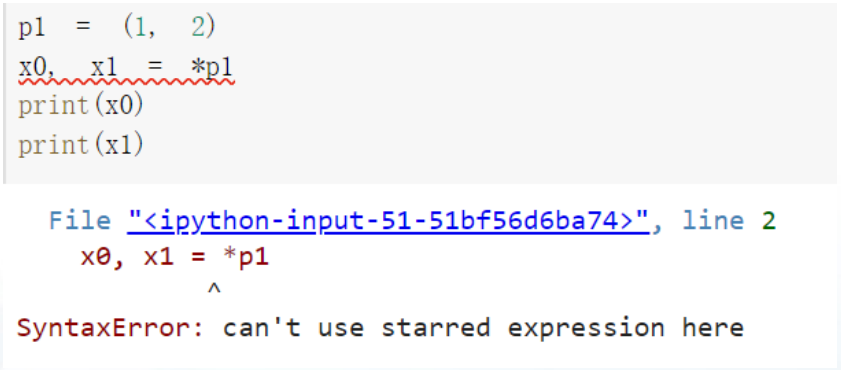
```python
def norm_square(x, y):
    return x ** 2 + y ** 2

vector = (3, 4)

# method 1
print(norm_square(x=vector[0], y=vector[1]))

# method 2
x, y = vector
print(norm_square(x, y))

# method 3
print(norm_square(*vector))
```

- * 作為 Unpacking 使用

# Iterable Unpacking: example

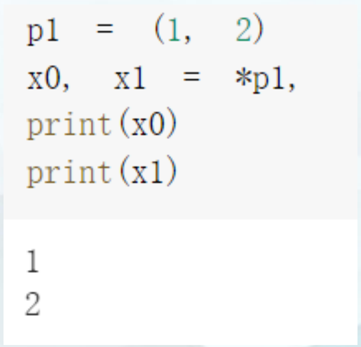
- 注意!: * 不能單獨使用，需要搭配 “, “或是當作函數的參數，不論是 packing or unpacking。

  - * 作為 Unpacking 使用



```
p1  =  (1,  2)
x0,  x1  =  *p1
print(x0)
print(x1)
```

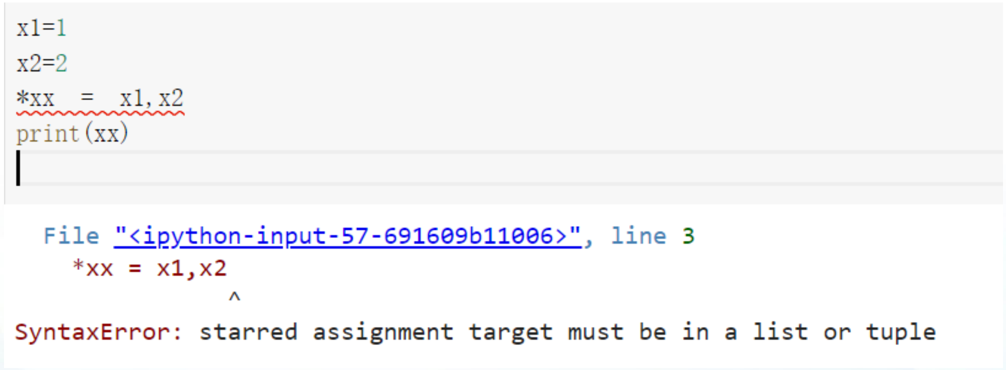
```
  File "<ipython-input-51-51bf56d6ba74>", line 2
    x0, x1 = *p1
            ^
SyntaxError: can't use starred expression here
```



```
p1  =  (1,  2)
x0,  x1  =  *p1,
print(x0)
print(x1)
```

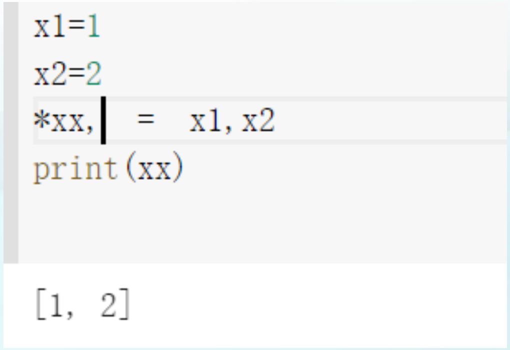
```
1
2
```

  - * 作為 Packing 使用



```
x1=1
x2=2
*xx  =  x1, x2
print(xx)
```

```
  File "<ipython-input-57-691609b11006>", line 3
    *xx = x1,x2
          ^
SyntaxError: starred assignment target must be in a list or tuple
```



```
x1=1
x2=2
*xx,  =  x1, x2
print(xx)
```

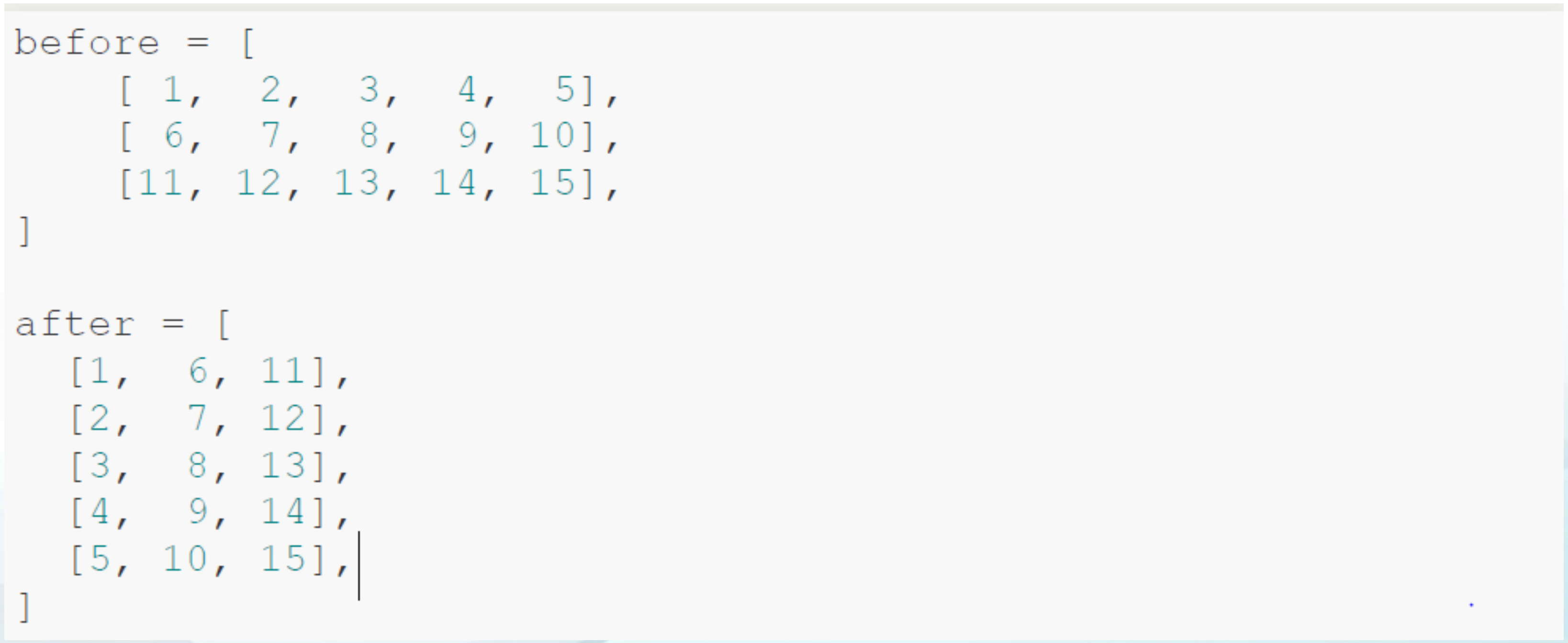
```
[1,  2]
```

## Dictionary Unpacking

```
# BatchNorm2d(num_features, eps=1e-05, momentum=0.1, affine=True
bn_args = {
    'momentum': None,
    'track_running_stats': False,
}
bn1 = BatchNorm2d(2, **bn_args)
bn2 = BatchNorm2d(25, **bn_args)
```

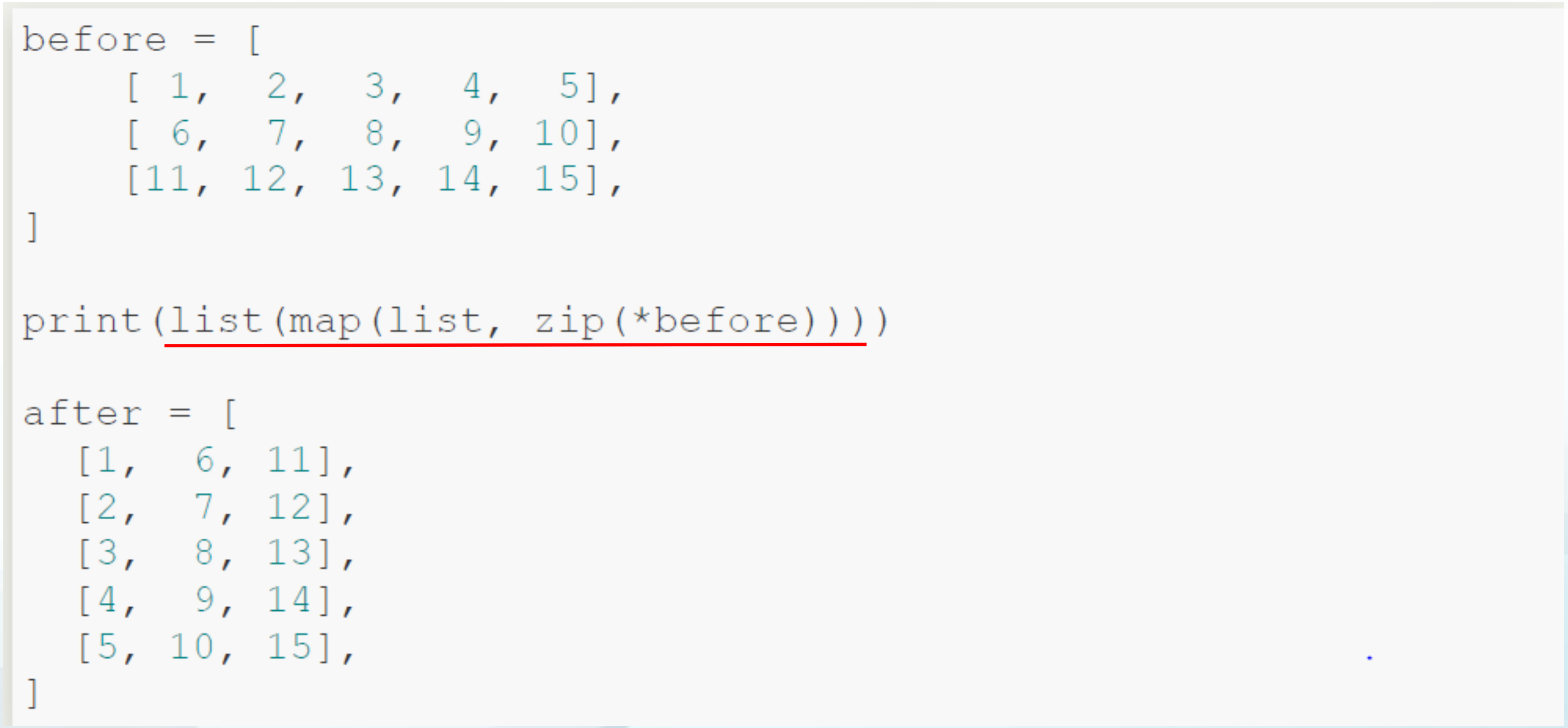
## Practice 2: Transpose List of List

- 如何只使用一行進行轉置矩陣?
- One-liner Hint: zip, list, map



```
before = [
    [ 1,  2,  3,  4,  5],
    [ 6,  7,  8,  9, 10],
    [11, 12, 13, 14, 15],
]

after = [
  [1,  6, 11],
  [2,  7, 12],
  [3,  8, 13],
  [4,  9, 14],
  [5, 10, 15],
]
```

## Practice 2: Answer



```
before = [
     [ 1,  2,  3,  4,  5],
     [ 6,  7,  8,  9, 10],
     [11, 12, 13, 14, 15],
]

print(list(map(list, zip(*before))))

after = [
  [1,  6, 11],
  [2,  7, 12],
  [3,  8, 13],
  [4,  9, 14],
  [5, 10, 15],
]
```

## Practice 2: Review

```
r1 = zip([1, 2, 3, 4, 5], [6, 7, 8, 9, 10], [11, 12, 13, 14, 15]
print(list(r1))
# [(1, 6, 11), (2, 7, 12), (3, 8, 13), (4, 9, 14), (5, 10, 15)]

r2 = list(map(list, r1))
# [[1, 6, 11], [2, 7, 12], [3, 8, 13], [4, 9, 14], [5, 10, 15]]
```

```
r1 = zip(*before)
r2 = list(map(list, r1))

# in one line
result = list(map(list, zip(*before)))
```

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# Class

- **inheritance from nn.Module**

```python
class MyNN(nn.Module):
  def __init__(self, input_size, hidden_size):
    super().__init__()
    self.layer = nn.Linear(input_size, hidden_size)

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

# Class: example

```python
class ReplayMemory:
  def __init__(self, capacity):
    self._buffer = deque(maxlen=capacity)

  def __len__(self):
    return len(self._buffer)

  def append(self, *transition):
    # (state, action, reward, next_state, done)
    self._buffer.append(tuple(map(tuple, transition)))

  def sample(self, batch_size=1):
    return random.sample(self._buffer, batch_size)
```

__len__ ← len(buffer)

__getitem__ ← buffer[i]

```python
buffer = ReplayMemory(5000)
buffer.append(state, action, reward, next_state, done)
transitions = memory.sample(20)
```