



Python: From Beginner to **Intermediate**



Sunglok Choi, Assistant Professor, Ph.D.
Computer Science and Engineering Department, SEOULTECH
sunglok@seoultech.ac.kr | <https://mint-lab.github.io/>

Python: Basic

- Why Python? What is Python? How to Use Python

- Data Types

- Dynamically-typed → Type specifiers are *optional*.
- Built-in compound data types: `str`, `tuple`*, `list`*, `set`*, `dict`* (*support heterogenous data types)

- Operators

- More natural (e.g. `&&` → `and`, condition `? A : B` → `A if condition else B`)

- Flow Control

- Easier access to elements in compound data with `for` statement (similar to *iterators*)

- Function Definition

- Multiple return values (as a `tuple`)

- Object-oriented Programming

- Explicit: `self` is explicit. (`this` is implicit in C++ and Java)
- Dynamically-typed → You can make member variables whenever you want.

Note) Recommendation: Please make member variables in constructors (`__init__` function).

My Comments for Better Python Programming



1. Take advantage of Python itself. (a.k.a. *Pythonic*)

- e.g. Swap using unpacking

```
temp = a
a = b    VS.    (a, b) = (b, a)
b = temp
```

- References
 - [Code Style](#), The Hitchhiker's Guide to Python
 - [Write More Pythonic Code](#), Real Python
 - [PEP 8 – Style Guide for Python Code](#), Python

2. Utilize the existing libraries (a.k.a. *Don't reinvent the wheel*) and master them if they are useful.

- Problem #1) Too many libraries
 - ~~Search your keywords in **Google**, Github (with *python*), ...~~
 - ~~Select *related* and *popular* libraries (if possible) and read their tutorials and documents. → Ask **ChatGPT** for help.~~
- Problem #2) A few documents and examples
 - Search your problem in **Google** (or read and analyze their source codes).

Data Types

▪ Numbers

- **int**: Integers with an unlimited range

```
a = 329
```

- **float**: Double-precision (64-bit) floating-point numbers

```
a = 3. # Same with 'a = 3.0'
```

```
b = 3.29
```

- **bool**: Boolean values (False or True)

```
a = False
```

```
b = (3 == 3.) # Check this result
```

Note) Dynamically-typed → no type specifier



▪ Numbers

- **int**: Integers with an unlimited range

a = 329 # Decimal number

b = 0b101001001 # Binary number

c = 0o511 # Octal number

d = 0x149 # Hexadecimal number

- **float**: Double-precision (64-bit) floating-point numbers

Note) Python does not support single-precision (32-bit) floating-point numbers by itself.

- **complex**: Complex numbers with imaginary and real float numbers

a = 3.29 + 8.2j

- **Built-in constants**: False, True, None, ...

- None: Not available ([N/A](#)), not determined, ... (e.g. when your function does not return a value)

- Note) **None == False** # False

type(None) # NoneType

Data Types

- **String**

- **str**: A text encoded in Unicode

`name = 'Choi'` or `name = "Choi"`

For multi-line text

`name = 'Sunglok\nChoi'` or `name = """Sunglok
Choi"""` # Also used for a block comment (~ /* ... */ in C++)

Note) String is a **built-in** type, not in a library (~ `std::string` in C++).



▪ String

– String formatting [\[Real Python\]](#) [\[Format Specifiers\]](#)

```
prof_dict = {'name': 'Choi', 'room_no': 327, 2021: True}
```

- % operator (~ printf in C): Mandatory type/format specifiers

```
'My name is %s and my room is %d' % ('Choi', 327)
```

```
'My name is %s and my room is %d' % ['Choi', 327] # Error!
```

```
'My name is %(name)s and my room is %(room_no)04d' % prof_dict # 327 -> 0327
```

- str.format function (~ std::cout in C++): Optional type/format specifiers

```
'My name is {} and my room is {}'.format('Choi', 327)
```

```
'My name is {1} and my room is {0}'.format(327, 'Choi')
```

```
'My name is {name} and my room is {room_no}'.format(name='Choi', room_no=327)
```

```
'My name is {name} and my room is {room_no}'.format('Choi', 327) # Error!
```

```
'My name is {name} and my room is {room_no:04d}'.format(**prof_dict) # 327 -> 0327
```



▪ String

– String formatting [\[Real Python\]](#) [\[Format Specifiers\]](#)

```
name = 'Choi'
```

```
room_no = 327 # Need to print the next room as 0328
```

- % operator (~ printf in C): Mandatory type/format specifiers

```
'My name is %s and my next room is %04d' % (name, room_no + 1)
```

- str.format function (~ std::cout in C++): Optional type/format specifiers

```
'My name is {} and my next room is {:04d}'.format(name, room_no + 1)
```

- + operator: Unnecessary to match argument position

```
'My name is ' + name + ' and my next room is ' + str(room_no + 1)
```

- f-string (Python 3.6+): Concise (without + operators) and no type conversion (to str)

```
f'My name is {name} and my next room is {room_no + 1}'
```

```
f'My name is {name} and my next room is {room_no + 1:04d}'
```


Data Types



- **String**

- **String trimming**

```
full_name = '\t Sunglok Choi \n'
```

```
full_name.strip()      # 'Sunglok Choi'
```

```
full_name.strip('\t\n') # ' Sunglok Choi '
```

```
full_name.lstrip()     # 'Sunglok Choi \n'
```

```
full_name.rstrip()     # '\t Sunglok Choi'
```



- **String**

- **String splitting**

```
prof = 'Choi, 327, 1'
```

```
prof.split(',')      # ['Choi', ' 327', ' 1']
```

```
prof.split(' ', ' ') # ['Choi', '327', '1']
```

```
prof.split('|')      # ['Choi, 327, 1']
```

```
prof.partition(' ', ' ') # ('Choi', ' ', ' ', '327, 1') / (~ std::strtok in C)
```

```
profs = 'Choi, 327, 1\nKang, 328, 1'
```

```
profs.split(' ', ' ') # ['Choi', '327', '1\nKang', '328', '1']
```

```
profs.splitlines()    # ['Choi, 327, 1', 'Kang, 328, 1']
```

Data Types



▪ String

- **String matching:** Whether both are **same** or not
- **String searching:** Whether the given text **contains** the query text or not
 - Also known as *substring matching*

```
profs = [  
    'My name is Choi and my E-mail is sunglok@seoultech.ac.kr.',  
    'My name is Kim and my e-mail address is jindae.kim@seoultech.ac.kr.'  
]  
for line in profs:  
    print('e-mail' == line)           # False False  Note) Matching  
    print('e-mail' in line)           # False True   Note) Searching  
    print('e-mail' in line.lower())   # True  True    Note) upper()  
    print(line.find('e-mail'))        # -1    22      Note) Starting index  
    print(line.endswith('.'))         # True  True    Note) startswith()
```

Data Types

▪ Compound data

- **tuple**: Comma-separated arbitrary Python objects

```
prof_tuple = ('Choi', 327, True) or prof_tuple = 'Choi', 327, True
```

- **list**: A list of arbitrary Python objects (~ std::array in C++)

```
prof_list = ['Choi', 327, True]
```

- **set**: An unordered set of unique arbitrary objects (~ std::set in C++)

```
prof_set = {'Choi', 327, True}
```

```
prof_set == {'Choi', True, 327}          # True (unordered)
```

```
prof_set == {'Choi', 327, True, True}    # True (unique)
```

- **dict**: A hash table of arbitrary values indexed by arbitrary keys (~ std::map in C++)

```
prof_dict = {'name': 'Choi', 'room_no': 327, 2021: True}
```

Note) The *compound* data can contain **heterogeneous** data types (not same with *arrays* with a homogeneous data type).

Data Types

- **Compound data**

```
Given) prof_str    = 'Choi'
      prof_tuple   = ('Choi', 327, True)
      prof_list    = ['Choi', 327, True]
      prof_set     = {'Choi', 327, True}
      prof_dict    = {'name': 'Choi', 'room_no': 327, 2021: True}
```

- **Indexing**

```
prof_tuple[0] == 'Choi'
prof_list[-1] == True # Reverse indexing
prof_set[0]      # Error!
prof_dict['name'] == 'Choi'
prof_dict[2021] == True
```

- **Slicing**

```
prof_str[1:3] == 'ho'
prof_str[1:] == 'hoi'
prof_str[1::2] == 'hi'
prof_list[::-1] == [True, 327, 'Choi']
```

Data Types



Note) in-place methods [\[More\]](#)

▪ Compound data

```
Given) prof_str    = 'Choi'
      prof_tuple   = ('Choi', 327, True)
      prof_list    = ['Choi', 327, True]
      prof_set     = {'Choi', 327, True}
      prof_dict    = {'name': 'Choi', 'room_no': 327, 2021: True}
```

– Concatenation: Merging two compounds

```
new_str   = prof_str + ' Sunglok'
new_list  = prof_list + ['Mirae Hall', 'SEOULTECH']
prof_set.union({327, 'Mirae Hall', 'SEOULTECH'}) # prof_set = {'Choi', ..., 'SEOULTECH'}
prof_dict.update({'room_no': 109, 'building': 'Mirae Hall', 'school': 'SEOULTECH'}) # ...
```

– Appending: Adding an item to a compound

```
prof_list.append('Mirae Hall')           # prof_list = ['Choi', ..., 'MiraeHall']
prof_set.add('Mirae Hall')                # prof_set  = {'Choi', ..., 'MiraeHall'}
prof_dict['building'] = 'Mirae Hall'      # prof_dict = {'name': ..., 'building': 'MiraeHall'}
```

Check) How about concatenation and appending for a **tuple**?

Data Types



Compound data

– tuple vs. list

```
prof_tuple[0] = 'Sunglok' # Error!
```

```
prof_list[0] = 'Sunglok'
```

– Why tuple? Packing and unpacking (instantly)

- e.g. Swap

```
(a, b) = (b, a) # a, b = b, a
```

- e.g. Multiple return values

- Note) Extended unpacking

```
name, *others = prof_tuple
# name = 'Choi'
# others = (327, True)
```

– Why list? + Processing and modifying data

Indexing
Slicing

Type	Sequential	Editable
	Ordered	Mutable
str	O	X
tuple	O	X
list	O	O
set	X	O
dict	X	O

```
def mean_var(data):
```

```
    n = len(data)
```

```
    if n > 0:
```

```
        mean = sum(data) / n
```

```
        sum2 = 0
```

```
        for datum in data:
```

```
            sum2 += datum**2
```

```
        var = sum2 / n - mean**2
```

```
        return mean, var
```

```
    return None, None
```

```
data = [3, 2, 9, 1, 0, 8, 7, 5]
```

```
pair = mean_var(data) # pair = (4.375, 9.984)
```

```
mean, var = mean_var(data) # mean = 4.375, var = 9.984
```

Data Types

- Useful built-in functions

- Type check

- ```
type(prof_str) == str
```

- Type casting

- ```
int(3.29) == 3
```

- ```
str(3) == '3'
```

- ```
int('29') == 29
```

- Note) The above two conversions are easier to use than C/C++/Java.

- Length of compound data

- ```
len(prof_name) == 4 # The number of items
```



# Operators

## ▪ Operator precedence



| Operator Types                        | Operators                                                                      | Description                                                                   |
|---------------------------------------|--------------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| <b>Compound data (Parentheses)</b>    | (expressions...),<br>[expressions...],<br>{key: value...},<br>{expressions...} | Binding (tuple) / parenthesized expression,<br>list,<br>dictionary,<br>set    |
| <b>Subscription</b>                   | x[index],<br>x[index:index],<br>x(arguments...),<br>x.attribute                | Indexing,<br>slicing,<br>call,<br>attribute reference                         |
| <b>Arithmetic (Bitwise)</b>           | **                                                                             | Exponentiation                                                                |
|                                       | +x, -x, ~x                                                                     | Positive, negative, bitwise NOT                                               |
|                                       | *, @,<br>/, //, %                                                              | Multiplication, matrix multiplication,<br>division, floor division, remainder |
|                                       | +, -                                                                           | Addition and subtraction                                                      |
| <b>Bitwise</b>                        | <<, >>                                                                         | Bitwise shifts                                                                |
|                                       | &                                                                              | Bitwise AND                                                                   |
|                                       | ^                                                                              | Bitwise XOR                                                                   |
|                                       |                                                                                | Bitwise OR                                                                    |
| <b>Membership Identity Comparison</b> | in, not in,<br>is, is not,<br><, <=, >, >=, !=, ==                             | Membership tests,<br>Identity tests,<br>Comparisons                           |
| <b>Logical</b>                        | not                                                                            | Boolean NOT                                                                   |
|                                       | and                                                                            | Boolean AND                                                                   |
|                                       | or                                                                             | Boolean OR                                                                    |
| <b>Ternary</b>                        | if - else                                                                      | Conditional expression                                                        |
| <b>Lambda</b>                         | lambda                                                                         | Lambda expression                                                             |
| <b>Assignment</b>                     | =, +=, -=, *=, /=                                                              | Assignment expression                                                         |

# Operators

- **Arithmetic** operators

```
type(4 / 2) == float # Always 'float' type (not 'int' type)
(7.5 // 2) == 3 # Floor division (integer division; 'int' type)
(-7.5 // 2) == -4
(7.5 % 2) == 1.5 # Modulo (remainder)
(2 ** 4) == 16 # Exponentiation
```

Note) Please distinguish **division** (/; float type) and **floor division** (//; int type).

- **Logical** operators

```
not 3.29 > 3 and 10.18 < 10 or 5.12 > 5 # Note) They are not '!', '&&', and '||'.
(not 3.29 > 3) and (10.18 < 10 or 5.12 > 5) # Check two results
```

- **Ternary** operators

```
x = 3
is_odd = True if x % 2 == 1 else False # In Python
is_odd = (x % 2) == 1 ? 1 : 0; // In C/C++
```

# Operators



- Lambda expression: A short function (as a variable)

```
is_odd = lambda x: True if x % 2 == 1 else False
is_odd(3) # True
```

- **Note) Sorting**

```
data = [3, 2, 9]

list.sort(): An in-place function
data.sort() # data = [2, 3, 9]
data.sort(reverse=True) # data = [9, 3, 2]
data.sort(key=lambda x: abs(x - 4)) # data = [3, 2, 9]

sorted(): Returning a new list
sorted(data) # [2, 3, 9]
sorted(data, reverse=True) # [9, 3, 2]
sorted(data, key=lambda x: abs(x - 4)) # [3, 2, 9]
```

Example) Sorting points according to their distance from the origin (0, 0)

```
pts = [(3, 29), (10, 18), (10, 27), (5, 12)]
nearest_pts = sorted(pts, key=lambda pt: pt[0]**2 + pt[1]**2)
```

# Operators



- Lambda expression: A short function (as a variable)

```
is_odd = lambda x: True if x % 2 == 1 else False
is_odd(3) # True
```

- **Note) List comprehensions**

Example) Generate a list with  $[0^2, 1^2, \dots, 8^2, 9^2]$

- **C-style codes**

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

- **map function** (Note: filter, reduce)

```
squares = list(map(lambda x: x**2, range(10)))
```

- **List comprehension**

```
squares = [x**2 for x in range(10)]
```

# Operators



- **Identity** operator

**Equality** (value) vs. **identity** (~ address)

```
x = 2021
y = 2020 + 1
x == y # True Note) print(x, y)
x is y # False Note) print(id(x), id(y))
```

- **Membership** operator (similar to string search)

```
1 in [0, 1, 2, 3, 4] # True
5 not in range(5) # True
1 not in range(0, 5, 2) # True
'name' in {'name': 'Choi', 'room_no': 327, 2021: True} # True
```

# Flow Control

- **Condition:** `if` statement, ~~`switch-case-break` statement~~ `match-case` statement (Python 3.10+)
- **Loop:** `for` statement, `while` statement
  - Loop control: `break`, `continue`, and `else` statements
- **No action:** `pass` statement (similar to `;` and `{ }` in C/C++)
- Example) Factorial (of a positive integer  $n$ )
  - The product of all positive integers less than or equal to  $n$
  - $n! = n \cdot (n - 1)! = n \cdot (n - 1) \cdot (n - 2) \cdot \dots \cdot 3 \cdot 2 \cdot 1$

```
n = 7 # The given integer
f = 1 # The result of factorial
if n < 0: # Note) No curly-bracket for a block
 pass
elif n == 0:
 pass
else:
 while n > 0:
 f = f * n
 n = n - 1
```

# Flow Control

- **Condition:** `if` statement, ~~`switch-case-break` statement~~ `match-case` statement (Python 3.10+)
- **Loop:** `for` statement, `while` statement
  - Loop control: `break`, `continue`, and `else` statements
- **No action:** `pass` statement (similar to `;` and `{ }` in C/C++)
- Example) Prime number
  - A natural number ( $n > 1$ ) that is not a product of two smaller natural numbers

```
n = 7 # The given integer
for x in range(2, n):
 if n % x == 0:
 print(n, 'equals', x, '*', n//x)
 break
 else:
 print(n, 'is a prime number')
```

# Flow Control



- **Loop:** `for` statements

- `for` statements with **sequential data** (string, list, tuple, ...)
  - You can loop with **each index** or **each item** (~ `std::iterator` in C++) or **both**.

```
year_list = [1982, 1984, 2014, 2016]
for idx in range(len(year_list)): # Loop with indices
 print(idx)
for item in year_list: # Loop with items
 print(item)
for idx, item in enumerate(year_list): # Loop with indices and items
 print(idx, item)
```

- You can merge sequential compound data using `zip`.

```
year_list = [1982, 1984, 2014, 2016]
month_list = ['March', 'October', 'October', 'May']
for idx in range(len(year_list)): # Loop with indices
 print(year_list[idx], month_list[idx])
for idx, year in enumerate(year_list): # Loop with indices and items
 print(year, month_list[idx])
for year, month in zip(year_list, month_list): # Loop with items
 print(year, month)
```



# Flow Control



- **Loop:** `for` statements
  - `for` statements with **set-type data**

```
year_set = {1982, 1984, 2014, 2016}
for item in year_set:
 print(item)
for num, item in enumerate(year_set):
 print(num, item) # 'num' is not a index.
```

- `for` statements with **dictionary-type data**

```
year_dict = {'S': 1982, 'K': 1984, 'J': 2014, 'Y': 2016}
for key in year_dict:
 print(key)
for key in year_dict.keys():
 print(key)
for value in year_dict.values():
 print(value)
for pair in year_dict.items():
 print(pair)
for key, value in year_dict.items():
 print(key, value)
```

# Flow Control



- **Condition:** `if` statements
  - Note) [Falsy and truthy values](#)

```
values = [False, 0, 0., None, '', (), [], {}, range(0), (None), (None,), [None], {None}]

for val in values:
 if val:
 print(f'{val} is True.')
 else:
 print(f'{val} is False.')
```

# Function Definition

## ▪ Function definition

- Example) Factorial (of a positive integer  $n$ )
  - The product of all positive integers less than or equal to  $n$
  - $n! = n \cdot (n - 1)! = n \cdot (n - 1) \cdot (n - 2) \cdot \dots \cdot 3 \cdot 2 \cdot 1$

```
def factorial_for(n):
 f = 1
 for m in range(1, n + 1):
 f *= m
 return f

def factorial_rec(n=1): # Default argument values
 if n <= 1:
 return 1
 else:
 return n * factorial_rec(n - 1)

factorial_for(10) # 3628800
factorial_rec(10) # 3628800
factorial_for() # Error!
factorial_rec() # 1
```

# Function Definition



- **Multiple return values (as a tuple)**

- Example) Mean and variance of data

- Mean (a.k.a. average):  $\mu = E(X) = \frac{1}{n}(x_1 + x_2 + \dots + x_n)$
    - Variance:  $\text{Var}(X) = E((X - \mu)^2) = E(X^2) - \mu^2$

```
def mean_var(data):
 n = len(data)
 if n > 0:
 mean = sum(data) / n
 sum2 = 0
 for datum in data:
 sum2 += datum**2
 var = sum2 / n - mean**2
 return mean, var
return None, None

data = [3, 2, 9, 1, 0, 8, 7, 5]
pair = mean_var(data) # pair = (4.375, 9.984)
mean, var = mean_var(data) # mean = 4.375, var = 9.984
mean, _ = mean_var(data) # Get only the first one
mean = mean_var(data)[0] # Get only the first one
```

# Function Definition



- **Function overloading is not supported.** [\[Stack Overflow\]](#)

– Example) My range function #1

```
def range1(end): # Ignored
 return list(range(end))

def range1(start, end): # Ignored
 return list(range(start, end))

def range1(start, end, step):
 return list(range(start, end, step))

range1(10) # Error!
```

# Function Definition



## ▪ Various argument passing

- Positional arguments, **keyword arguments**, and [more](#)
- Example) My range function #2

```
def range2(end, start=0, step=1):
 if start > end:
 (start, end) = (end, start)
 return list(range(start, end, step))

print(range2(10)) # [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
print(range2(1, 10)) # [1, 2, 3, 4, 5, 6, 7, 8, 9]
print(range2(1, 10, 2)) # [1, 3, 5, 7, 9]
print(range2(10, step=2)) # [0, 2, 4, 6, 8]
print(range2(step=2, 10)) # Error!
print(range2(step=2, end=10)) # Check the result
print(range2(10, step=2, start=1)) # [1, 3, 5, 7, 9]
print(range2(10, 2, start=1)) # Check the result
arg_tuple = (1, 10, 2)
print(range2(*arg_tuple)) # [1, 3, 5, 7, 9]
arg_dict = {'end': 10, 'step': 2, 'start': 1}
print(range2(**arg_dict)) # [1, 3, 5, 7, 9]
```

# Object-oriented Programming

- Class definition and object instantiation

- Example) Dice and coin



```
from random import randint

class Dice:
 def throw(self):
 return randint(1, 6)

dice = Dice()
print(dice.throw()) # [1, 6]
```

```
from random import randint

class Dice:
 def __init__(self, boundary=(1, 6)): # A constructor
 self.start = min(boundary)
 self.end = max(boundary)

 def throw(self):
 return randint(self.start, self.end)

dice = Dice()
print(dice.throw()) # [1, 6]

coin = Dice((0, 1))
print(coin.throw()) # 0 or 1
```

# Object-oriented Programming



- Class definition and object instantiation

- Example) Dice and coin

```
from random import randint

class Dice:
 def throw(self):
 return randint(1, 6)

dice = Dice()
print(dice.throw()) # [1, 6]
```

```
class Coin(Dice):
 def throw(self):
 return super().throw() % 2

coin = Coin()
print(coin.throw()) # 0 or 1
```

```
from random import randint

class Dice:
 def __init__(self, boundary=(1, 6)): # A constructor
 self.start = min(boundary)
 self.end = max(boundary)

 def throw(self):
 return randint(self.start, self.end)

dice = Dice()
print(dice.throw()) # [1, 6]

coin = Dice((0, 1))
print(coin.throw()) # 0 or 1
```

What is better programming (in the view of OOP or users)?



# Object-oriented Programming



## ▪ Private member definition

- Example) Dice and coin

```
from random import randint

class Dice:
 def throw(self):
 return randint(1, 6)

dice = Dice()
print(dice.throw()) # [1, 6]
```

```
class Coin(Dice):
 def throw(self):
 return super().throw() % 2

coin = Coin()
print(coin.throw()) # 0 or 1
```

```
from random import randint

class Dice:
 def __init__(self, boundary=(1, 6)): # A constructor
 self.__start = min(boundary)
 self.__end = max(boundary)

 def throw(self):
 return randint(self.__start, self.__end)

dice = Dice()
print(dice.__start, dice.__end) # Error!
print(dice._Dice__start, dice._Dice__end) # 1 6
```

What is better programming (in the view of OOP or users)?



# File Input and Output

- Example) Read a text file using `read()`

```
f = open('data/class_score_kr.csv', 'r')
lines = f.read() # Read all lines together
print(lines)
f.close()
```
- Example) Read a text file using `readline()`

```
f = open('data/class_score_kr.csv', 'r')
while True:
 line = f.readline() # Read a line sequentially
 if not line:
 break
 print(line)
f.close()
```
- Example) Read a text file using `readlines()`

```
with open('data/class_score_kr.csv', 'r') as f:
 for line in f.readlines(): # Read all lines as a list
 print(line.strip())
```

```
123, 94
112, 92
97, 98
87, 90
89, 87
...
```

```
123, 94

112, 92

97, 98
...
```

```
123, 94
112, 92
97, 98
87, 90
89, 87
...
```

# File Input and Output



- Example) Write a text file using write()

```
with open('data/class_score_kr.csv', 'r') as fi, open('class_score_mean.csv', 'w') as fo:
 for line in fi.readlines():
 values = [int(word) for word in line.split(',')]
 mean = sum(values) / len(values)
 for val in values:
 fo.write(f'{val}, ')
 fo.write(f'{mean}\n')
```

- Check) I provide you two files, 'data/class\_score\_kr.csv' and 'data/class\_score.csv'.

Please try the above example with following files.

- 'data/class\_score.csv' (which does not exist) → **FileNotFoundError**: [Errno 2] No such file or directory: ...
- 'data/class\_score\_en.csv' (which contains the header) → **ValueError**: invalid literal for int() with based 10: ...

```
midterm (max 125), final (max 100)
113, 86
104, 83
110, 78
...
```

# Exception Handling



- [Exception](#) (~ runtime error)
  - Anomalous or exceptional conditions requiring special processing (during the execution of a program)
  - [Built-in exceptions in Python](#)
- Example) Calculate averaged scores from a text file with the header

```
with open('data/class_score_en.csv', 'r') as fi, \
 open('class_score_mean.csv', 'w') as fo:
 for line in fi.readlines():
 try:
 values = [int(word) for word in line.split(',')]
 mean = sum(values) / len(values)
 for val in values:
 fo.write(f'{val}, ')
 fo.write(f'{mean}\n')
 except ValueError as ex:
 print(f'A line is ignored. (message: {ex})')
```

# Exception Handling



- **Exception** (~ runtime error)
  - Anomalous or exceptional conditions requiring special processing (during the execution of a program)
  - Built-in exceptions in Python
- Example) Calculate averaged scores from a not-exist text file

```
try:
 with open('data/class_score.csv', 'r') as fi, \
 open('class_score_mean.csv', 'w') as fo:
 for line in fi.readlines():
 try:
 values = [int(word) for word in line.split(',')]
 mean = sum(values) / len(values)
 for val in values:
 fo.write(f'{val}, ')
 fo.write(f'{mean}\n')
 except ValueError as ex: # Try 'data/class_score_en.csv' without this try/except
 print(f'A line is ignored. (message: {ex})')
except Exception as ex:
 print(f'Cannot run the program. (message: {ex})')
```

# Package Import



- Example) Calculate mean and variance of scores using the previous example

mean\_var.py

```
def mean_var(data):
 n = len(data)
 if n > 0:
 mean = sum(data) / n
 sum2 = sum([datum**2 for datum in data])
 var = sum2 / n - mean**2
 return mean, var
 return None, None

data = [3, 2, 9, 1, 0, 8, 7, 5]
mean, var = mean_var(data)
print(f'mean = {mean:.3f}, var = {var:.3f}')
```

Result)

```
mean = 4.375, var = 9.984
```

class\_score\_mean.py

```
from mean_var import mean_var

try:
 with open('data/class_score_kr.csv', 'r') as fi, \
 open('class_score_mean.csv', 'w') as fo:
 for line in fi.readlines():
 try:
 values = [int(word) for word in line.split(',')]
 mean, var = mean_var(values)
 for val in values:
 fo.write(f'{val}, ')
 fo.write(f'{mean}, {var}\n')

 except ValueError as ex:
 print(f'A line is ignored. (message: {ex})')
 print('The program was terminated successfully.')
except Exception as ex:
 print(f'Cannot run the program. (message: {ex})')
```

Result)

```
mean = 4.375, var = 9.984
The program was terminated successfully.
```

# Package Import



- Example) Calculate mean and variance of scores using the previous example

mean\_var.py

```
def mean_var(data):
 n = len(data)
 if n > 0:
 mean = sum(data) / n
 sum2 = sum([datum**2 for datum in data])
 var = sum2 / n - mean**2
 return mean, var
 return None, None

if __name__ == '__main__':
 data = [3, 2, 9, 1, 0, 8, 7, 5]
 mean, var = mean_var(data)
 print(f'mean = {mean:.3f}, var = {var:.3f}')
```

Result)

```
mean = 4.375, var = 9.984
```

mean\_var.py: \_\_name\_\_ == '\_\_main\_\_' (entry point)

class\_score\_mean.py

```
from mean_var import mean_var

try:
 with open('data/class_score_kr.csv', 'r') as fi, \
 open('class_score_mean.csv', 'w') as fo:
 for line in fi.readlines():
 try:
 values = [int(word) for word in line.split(',')]
 mean, var = mean_var(values)
 for val in values:
 fo.write(f'{val}, ')
 fo.write(f'{mean}, {var}\n')

 except ValueError as ex:
 print(f'A line is ignored. (message: {ex})')
 print('The program was terminated successfully.')
except Exception as ex:
 print(f'Cannot run the program. (message: {ex})')
```

Result)

```
The program was terminated successfully.
```

class\_score\_mean.py: \_\_name\_\_ == '\_\_main\_\_' (entry point)  
mean\_var.py : \_\_name\_\_ == 'mean\_var'

# Summary



- **My Comments for Better Python Programming**
  - 1) Take advantage of Python itself. / 2) Utilize the exiting libraries and master them if they are useful.
- **Data Types**
  - **String**: Formatting, trimming, splitting (tokenization), matching, and searching
  - Compound data: In-place methods, **tuple (immutable; packing/unpacking)** vs. **list (mutable)**
- **Operators**
  - Lambda operator: A way to define a function shortly
    - **key** in **sorting**
    - **map(/filter/reduce)** function → **list comprehensions**
  - Identity (**id** ~ address) and membership (**in**) operators
- **Flow Control**
  - Easier access to elements in compound data with **for** statement
  - Falsy and truthy values
- **Function Definition: Keyword argument association**, passing compound data as a series of arguments
- **Object-oriented Programming**: Inheritance, private member definition
- **File Input and Output**: **open** function
- **Exception Handling**: **try** - **except** statement
- **Package Import**: Why `__name__ == '__main__'` is necessary?