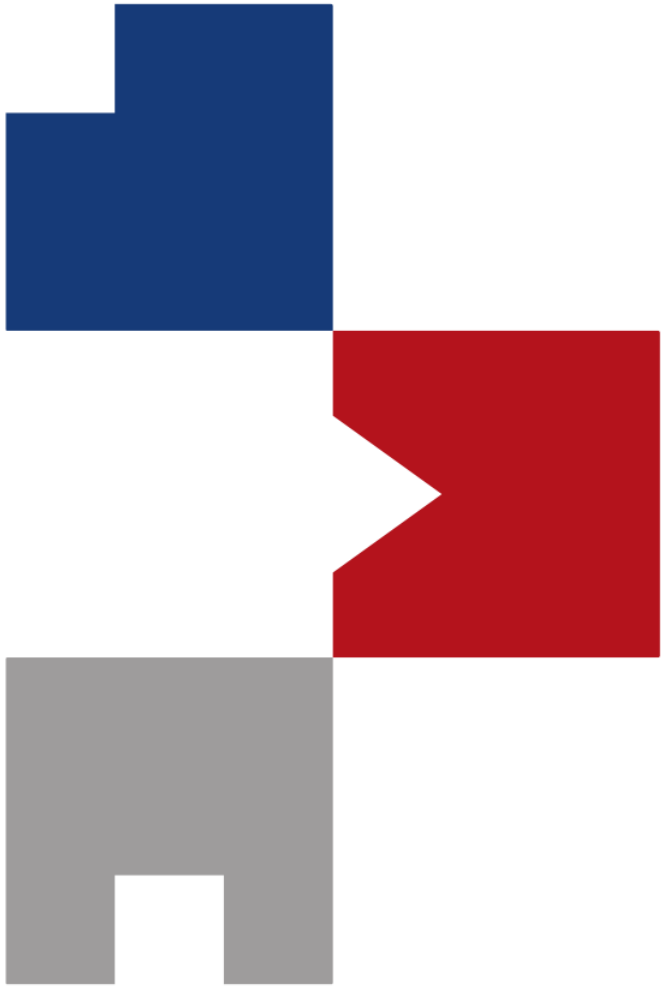
Note) Slides and example codes are available:
https://github.com/mint-lab/prog_meets_math



Python:
From Beginner to Intermediate

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Python: Basic

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

- **Data Types**
  - Dynamically-typed → no type specifier
  - 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
- **Function Definition**
  - Multiple return values (as a `tuple`)
- **Object-oriented Programming**
  - Dynamically-typed → no definition for member variables

My Comments for Better Python Programming

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

- e.g. Swap using unpacking

```
temp = a
a = b
b = temp
```

vs.

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

- 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 exiting 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*), PyPI, and …
- Problem #2) A few documents and examples
  - Select a popular one (if possible)
  - Search your problem in **Google** (or analyze the 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

Data Types

- **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++).

Data Types

- **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
```

Data Types

- **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'
```

Data Types

- **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’)



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**: A 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 heterogenous 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'
```

Sequential **Editable**

Indexing, Slicing

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

  - **Why tuple?** ~~Collecting and modifying data~~
    - **Packing** and **unpacking**
    - 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)
```

```
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 more easy-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
Compound data (Parentheses)	`(expressions...)`, `[expressions...]`, `{key: value...}`, `{expressions...}`	Binding (tuple) / parenthesized expression, list, dictionary, set
Subscription	`x[index]`, `x[index:index]`, `x(arguments...)`, `x.attribute`	Indexing, slicing, call, attribute reference
Arithmetic (Bitwise)	`**`	Exponentiation
	`+x, -x, ~x`	Positive, negative, bitwise NOT
	`*, @,` `/, //, %`	Multiplication, matrix multiplication, division, floor division, remainder
	`+, -`	Addition and subtraction
Bitwise	`<<, >>`	Bitwise shifts
	`&`	Bitwise AND
	`^`	Bitwise XOR
	`|`	Bitwise OR

Membership Identity Comparison	`in, not in,`
	`is, is not,`
	`<, <=, >, >=, !=, ==`
		Membership tests,
		Identity tests,
		Comparisons

Logical	`not`	Boolean NOT
	`and`	Boolean AND
	`or`	Boolean OR
Ternary	`if - else`	Conditional expression
Lambda	`lambda`	Lambda expression
Assignment	`=, +=, -=, *=, /=`	Assignment expression

Operators

- **Arithmetic** operators

```
type(4 / 2) == float # Always 'float' type (not 'int' type)
(7.5 % 2) == 1.5     # Modulo (remainder)
(7.5 // 2) == 3      # Floor division (integer division; 'int' type)
(-7.5 // 2) == -4
(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 $[0^2, 1^2, \ldots, 8^2, 9^2]$

  - **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 (~ 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` 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
  - $n! = n \cdot (n-1)! = n \cdot (n-1) \cdot (n-2) \cdot \cdots \cdot 3 \cdot 2 \cdot 1$

```
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` 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 trusy 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
    - $n! = n \cdot (n-1)! = n \cdot (n-1) \cdot (n-2) \cdot \cdots \cdot 3 \cdot 2 \cdot 1$

```
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 <= 0:
        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): $\mu = \mathrm{E}(X) = \frac{1}{n}(x_1 + x_2 + \cdots + x_n)$
    - Variance: $\mathrm{Var}(X) = \mathrm{E}\left((X - \mu)^2\right) = \mathrm{E}(X^2) - \mu^2$

```
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
```

```
sum2 = sum([datum**2 for datum in data])
```

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()
```

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

- 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()
```

```
123, 94

112, 92

97, 98
...
```

- 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
...
```

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) → FileNotFoundErrror: [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 advantages 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 trusy 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?