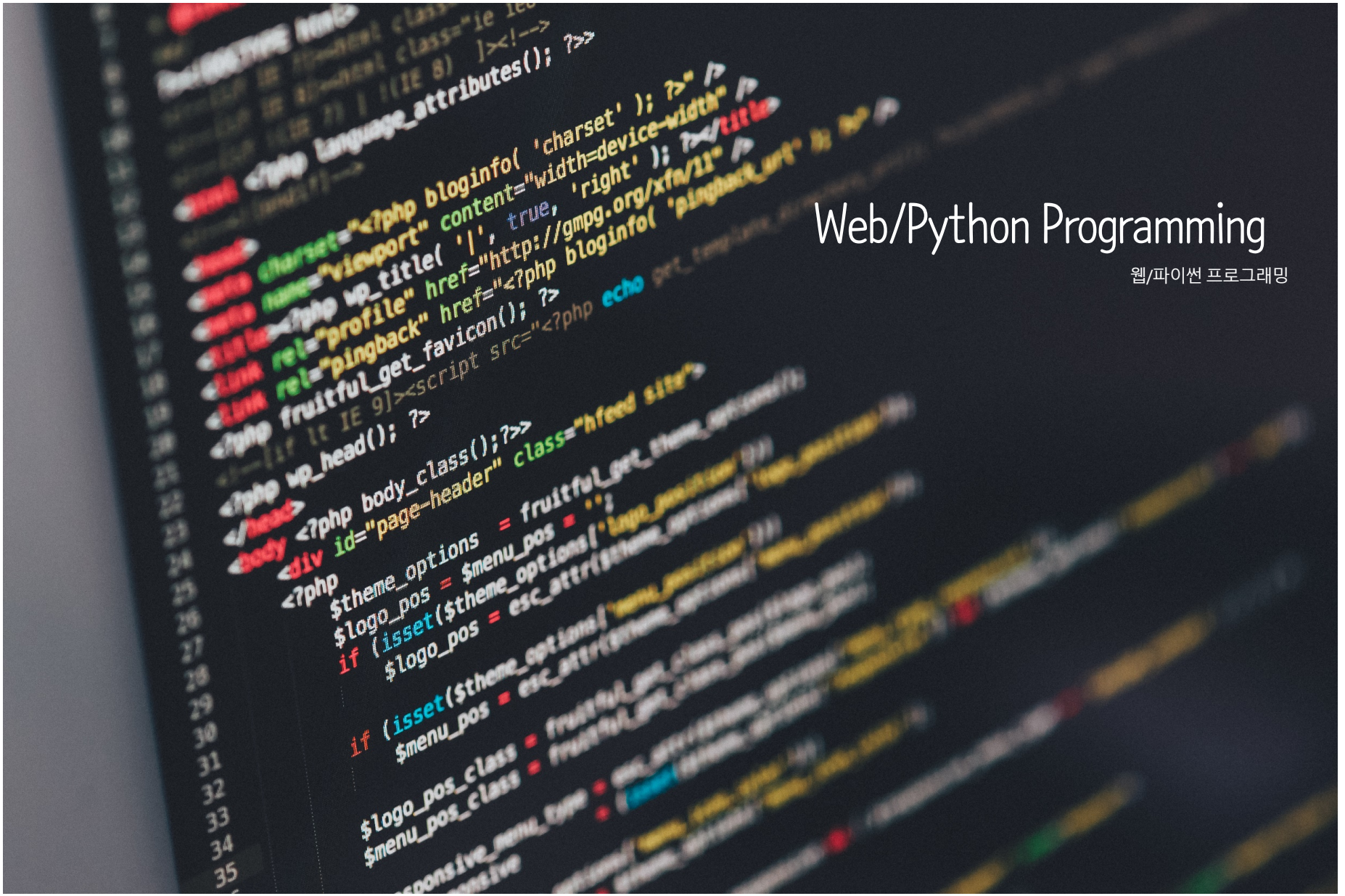


Web/Python Programming

웹/파이썬 프로그래밍

Today

- Modules
- Classes
- Methods
- Calling methods the object-oriented way

Today

MODULE & FUNCTION

Modules

- Mathematicians don’t prove every theorem from scratch.
- They build their proofs on the truths their predecessors have already established.

- Programmers don’t write all of a program alone.
- They make use of the many lines of code that other programmers have written before.
- It’s very common and more productive.

Modules

- A module is a kind of object, which can contain functions and other variables.
- A module is a group of functions and variables defined within a single file.

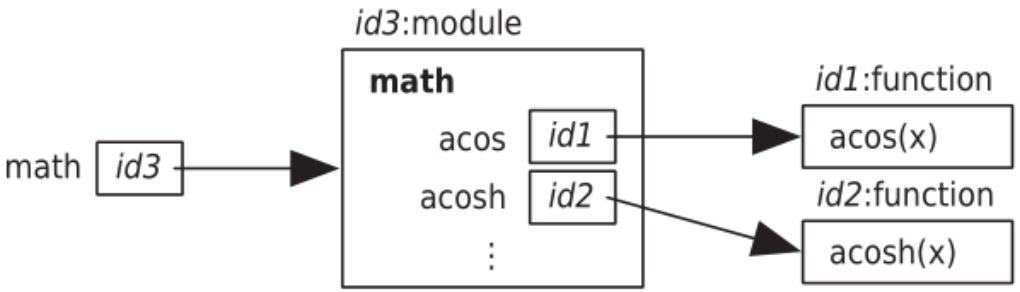
temperature.py

```
def convert_to_celsius(fahrenheit):
    """ (number) -> float

    Return the number of celsius degree
    equivalent to fahrenheit degrees

    >>> convert_to_celsius(212)
    100.0
    """

    return (fahrenheit - 32)*5/9

def convert_to_fahrenheit(celsius):
    """ (number) -> float

    Return the number of fahrenheit degree
    equivalent to celsius degrees

    >>> convert_to_celsius(100)
    212.0
    """

    return celsius*1.8 + 32
```

Import modules

```
>>> type(math)
Traceback (most recent call last):
  File "<pyshell#0>", line 1, in <module
>
    type(math)
NameError: name 'math' is not defined
```

```
>>> import math
>>> type(math)
<class 'module'>
```




```
>>> help(math)
Help on built-in module math:

NAME
    math

DESCRIPTION
    This module is always available.  It
provides access to the
    mathematical functions defined by th
e C standard.

FUNCTIONS
    acos(...)
        acos(x)

        Return the arc cosine (measured
in radians) of x.

    acosh(...)
        acosh(x)

        Return the inverse hyperbolic co
sine of x.
```

How to use those functions?

```
>>> sqrt(9)
Traceback (most recent call last):
  File "<pyshell#5>", line 1, in <module
>
    sqrt(9)
NameError: name 'sqrt' is not defined
>>> math.sqrt(9)
3.0
```

The dot(.) is an operator, just like + and **

1) Look up the object that the variable to the left of the dot refers to.

2) In that object, find the name that occurs to the right of the dot.

Variables imported from modules

```
>>> import math
>>> math.pi
3.141592653589793
>>> radius = 5
>>> area = math.pi * radius **2
>>> area
78.53981633974483
>>> math.pi = 3
>>> area = math.pi * radius **2
>>> area
75
```

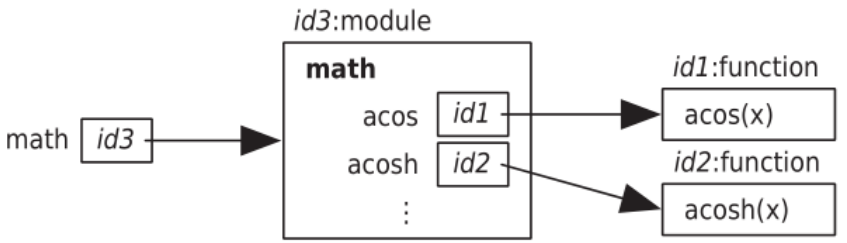
Don't do this!!

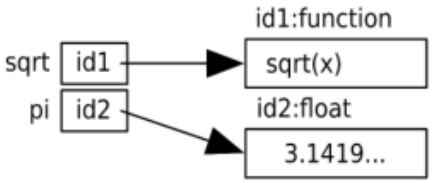
- It is a bad idea to change the value of a variable defined within the module (usually meant to be a constant value)
- However, it is possible in Python.

To avoid using the dot

```
>>> pi
Traceback (most recent call last):
  File "<pyshell#0>", line 1, in <module>
    pi
NameError: name 'pi' is not defined
>>> import math
>>> pi
Traceback (most recent call last):
  File "<pyshell#2>", line 1, in <module>
    pi
NameError: name 'pi' is not defined
>>> math.pi
3.141592653589793
>>> from math import pi, sqrt
>>> pi
3.141592653589793
>>> sqrt(9)
3.0
>>> from math import *
>>>
```

Usually not a good idea





Python modules

- https://docs.python.org/3/py-modindex.html

Python Module Index

_ | a | b | c | d | e | f | g | h | i | j | k | l | m | n | o | p | q | r | s | t | u | v | w | x | z

_	
__future__	*Future statement definitions*
__main__	*The environment where the top-level script is run.*
_dummy_thread	*Drop-in replacement for the _thread module.*
_thread	*Low-level threading API.*
a	
abc	*Abstract base classes according to PEP 3119.*
aifc	*Read and write audio files in AIFF or AIFC format.*
argparse	*Command-line option and argument parsing library.*
array	*Space efficient arrays of uniformly typed numeric values.*
ast	*Abstract Syntax Tree classes and manipulation.*
asynchat	*Support for asynchronous command/response protocols.*
asyncore	*A base class for developing asynchronous socket handling services.*
atexit	*Register and execute cleanup functions.*
audioop	*Manipulate raw audio data.*
b	
base64	*RFC 3548: Base16, Base32, Base64 Data Encodings*
bdb	*Debugger framework.*
binascii	*Tools for converting between binary and various ASCII-encoded binary representations.*
binhex	*Encode and decode files in binhex4 format.*

Defining your own modules

Be careful with the saving directory (location)

temperature.py

```
def convert_to_celsius(fahrenheit):
    """ (number) -> float

    Return the number of celsius degree
    equivalent to fahrenheit degrees

    >>> convert_to_celsius(212)
    100.0
    """

    return (fahrenheit - 32)*5/9

def convert_to_fahrenheit(celsius):
    """ (number) -> float

    Return the number of fahrenheit degree
    equivalent to celsius degrees

    >>> convert_to_celsius(100)
    212.0
    """

    return celsius*1.8 + 32
```

Save .py file

```
>>> import temperature
Traceback (most recent call last):
  File "<pyshell#0>", line 1, in <module>
    import temperature
ImportError: No module named 'temperature'

>>> import temperature
>>> convert_to_celsius(212)
Traceback (most recent call last):
  File "<pyshell#2>", line 1, in <module>
    convert_to_celsius(212)
NameError: name 'convert_to_celsius' is not defined
>>> temperature.convert_to_celsius(212)
100.0
>>> temperature.convert_to_fahrenheit(100)
212.0
```

What happens during import

exp.py

```
print("this is experiment")
```

- Python executes modules as it imports them
- Python loads modules only the first time they're imported

```
>>> import exp
this is experiment
>>> import exp
>>>
>>> import imp
>>> imp.reload(exp)
this is experiment
<module 'exp' from 'C:\\Users\\jiyoung\\AppData
\\Local\\Programs\\Python\\Python35\\exp.py'>
>>>
```

__name__

```
>>> __name__
'__main__'

>>> exp.__name__
'exp'
>>>

>>> import exp
this is experiment
Name is exp
>>>
```

exp.py

```
print("this is experiment")
print("Name is", __name__)
```

Import math

```
>>> import math
>>> a = 0
>>> b = 30
>>> c = 45
>>> d = 60
>>> e = 90
>>> math.sin(b)
>>> math.sin(math.radians(b))
>>> math.degrees(math.asin(0.5))
```

```
>>> math.pi
>>> math.inf
>>> math.e
>>> math.exp(1)
>>> math.log(math.e)
>>> math.log(math.exp(2))
>>> math.log10(10.0)
>>> math.log10(100.0)
```

Import random

```
>>> import random
>>> x1 = random.random()
    # generates a random floating-point number in range [0,1)
>>> x2 = random.uniform(a,b)
    # generates a random floating-point number in range [a,b)
>>> x3 = random.randrange(stop)
    # chooses an integer in the range [0,stop)
>>> x4 = random.randrange(start,stop)
    # chooses an integer in the range [start,stop)
>>> x5 = random.randrange(start,stop,step)
    # chooses an integer in the range [start,start+step, start+2*step,…,stop)
>>> x5 = random.randint(start,stop)
    # chooses an integer in the range [start, stop] including both end points
```

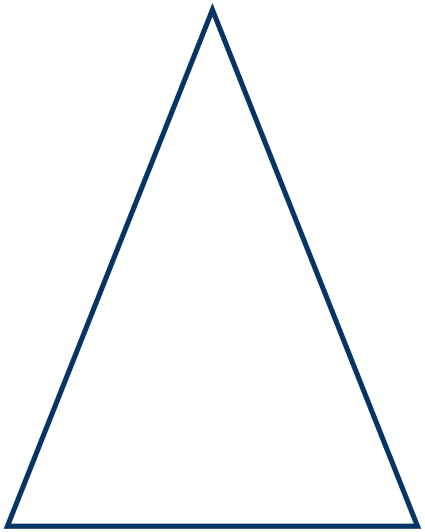
Graphic exercise

```
>>> import turtle
>>> t = turtle.Pen()
>>> t.forward(50)
>>> t.left(90)
>>> t.forward(50)
>>> t.left(90)
>>> t.forward(50)
>>> t.left(90)
>>> t.forward(50)
>>> t.left(90)
```

```
>>> t.reset()
>>> t.backward(100)
>>> t.up()
>>> t.right(90)
>>> t.forward(20)
>>> t.left(90)
>>> t.down()
>>> t.forward(100)

>>> t.clear()
```

Graphic exercise

- Draw a isosceles triangle (이등변삼각형)



- Draw a box with open corners (size is not important)

Modules - summary

- A module is a kind of object, which can contain functions and other variables.
- A module is a collection of functions and variables defined within a single file.
- Math module and random module are useful
- You can make your own module

temperature.py

```
def convert_to_celsius(fahrenheit):
    """ (number) -> float

    Return the number of celsius degree
    equivalent to fahrenheit degrees

    >>> convert_to_celsius(212)
    100.0
    """

    return (fahrenheit - 32)*5/9

def convert_to_fahrenheit(celsius):
    """ (number) -> float

    Return the number of fahrenheit degree
    equivalent to celsius degrees

    >>> convert_to_celsius(100)
    212.0
    """

    return celsius*1.8 + 32
```

Today

CLASS & METHOD

Methods

- Functions
  - Built-in functions
  - Functions inside modules
  - Functions that we've defined

- A method is a kind of function that is attached to a particular type
  - `str` methods
  - `int` methods
  - `bool` methods
  - Every type has its own set of methods

Classes

- A class is another kind of object that is similar to a module.
- A class is how Python represents a type.
- A class has methods

```
>>> type(17)
<class 'int'>
>>> type(17.0)
<class 'float'>
>>> type('hello')
<class 'str'>
```

```
>>> help(str)
Help on class str in module builtins:

class str(object)
 |  str(object='') -> str
 |  str(bytes_or_buffer[, encoding[, errors]]) -> str
 |
 |  Create a new string object from the given object. If encoding or
 |  errors is specified, then the object must expose a data buffer
 |  that will be decoded using the given encoding and error handler.
 |  Otherwise, returns the result of object.__str__() (if defined)
 |  or repr(object).
 |  encoding defaults to sys.getdefaultencoding().
 |  errors defaults to 'strict'.
 |
 |  Methods defined here:
 |
 |  __add__(self, value, /)
 |      Return self+value.
 |
 |  __contains__(self, key, /)
 |      Return key in self.
 |
 |  __eq__(self, value, /)
 |      Return self==value.
```

Module vs. Class

- Functions in Module math
- Functions in Module random

```
>>> import math
>>> math.sqrt(9.0)
3.0
>>> math.pi
3.141592653589793
>>>
```

```
>>> import random
>>> random.randrange(0,10)
6
```

- Methods in Class string

Every method in class `str` requires a string as its first argument

```
>>> str.capitalize('trump')
'Trump'
>>> str.upper('trump')
'TRUMP'
>>> str.center('Center',26)
'          Center          '
>>>
>>> str.center('Sonnet 43',26)
'         Sonnet 43        '
>>> str.count('The biggest snow of the season','s')
4
```

Calling methods the object-oriented way

```
>>> 'trump'.capitalize()
'Trump'
>>> 'trump'.upper()
'TRUMP'
>>> 'Center'.center(26)
'          Center          '
>>> 'Sonnet 43'.center(26)
'         Sonnet 43        '
>>> 'The biggest snow of the season'.count('s')
4
>>>
```

Module vs. Class

```
>>> help(math.sqrt)
Help on built-in function sqrt in module math:

sqrt(...)
    sqrt(x)

    Return the square root of x.

>>> help(str.upper)
Help on method_descriptor:

upper(...)
    S.upper() -> str

    Return a copy of S converted to uppercase.
```

```
>>> math.sqrt(9.0)
3.0
>>> str.upper('trump')
'TRUMP'
>>> 'trump'.upper()
'TRUMP'
```

Methods

<<expression>>.<<method_name>>(<<arguments>>)

```
>>> ('TTA' + 'G' * 3).count('T')
2
```

1) ('TTAGGG').count('T')
2) str.count('TTAGGG', 'T')
3) 2

String methods

```
>>> 'trump'.capitalize()
'Trump'
>>> 'ATTGGG'.count('T')
2
>>> 'strange'.endswith('ge')
True
>>> 'strange'.endswith('gE')
False
>>> 'strange'.find('an')
3
>>> 'strange'.find('ei')
-1
>>> 'strange'.find('an',4)
-1
>>> 'strange'.find('an',2,5)
3
```

Method	Description
str.capitalize()	Returns a copy of the string with the first letter capitalized and the rest lowercase
str.count(s)	Returns the number of nonoverlapping occurrences of s in the string
str.endswith(end)	Returns True iff the string ends with the characters in the end string—this is case sensitive.
str.find(s)	Returns the index of the first occurrence of s in the string, or -1 if s doesn't occur in the string—the first character is at index 0. This is case sensitive.
str.find(s, beg)	Returns the index of the first occurrence of s at or after index beg in the string, or -1 if s doesn't occur in the string at or after index beg—the first character is at index 0. This is case sensitive.
str.find(s, beg, end)	Returns the index of the first occurrence of s between indices beg (inclusive) and end (exclusive) in the string, or -1 if s does not occur in the string between indices beg and end—the first character is at index 0. This is case sensitive.
str.format(«expressions»)	Returns a string made by substituting for placeholder fields in the string—each field is a pair of braces ('{' and '}') with an integer in between; the expression arguments are numbered from left to right starting at 0. Each field is replaced by the value produced by evaluating the expression whose index corresponds with the integer in between the braces of the field. If an expression produces a value that isn't a string, that value is converted into a string.

String methods

```
>>> 'trump'.islower()
True
>>> 'Trump'.islower()
False
>>> 'TRUMP'.lower()
'trump'
>>> str.lstrip('     hello  world      ')
'hello  world      '
>>> str.rstrip('     hello  world      ')
'     hello  world'
>>> str.strip('     hello  world      ')
'hello  world'
>>> str.swapcase('Computer Science')
'cOMPUTER sCIENCE'
>>>
```

str.islower()	Returns True iff all characters in the string are lowercase
str.isupper()	Returns True iff all characters in the string are uppercase
str.lower()	Returns a copy of the string with all letters converted to lowercase
str.lstrip()	Returns a copy of the string with leading whitespace removed
str.lstrip(s)	Returns a copy of the string with leading occurrences of the characters in s removed
str.replace(old, new)	Returns a copy of the string with all occurrences of substring old replaced with string new
str.rstrip()	Returns a copy of the string with trailing whitespace removed
str.rstrip(s)	Returns a copy of the string with trailing occurrences of the characters in s removed
str.split()	Returns the whitespace-separated words in the string as a list (We'll introduce the list type in Section 8.1, *Storing and Accessing Data in Lists*, on page 129.)
str.startswith(beginning)	Returns True iff the string starts with the letters in the string beginning—this is case sensitive.
str.strip()	Returns a copy of the string with leading and trailing whitespace removed
str.strip(s)	Returns a copy of the string with leading and trailing occurrences of the characters in s removed
str.swapcase()	Returns a copy of the string with all lowercase letters capitalized and all uppercase letters made lowercase
str.upper()	Returns a copy of the string with all letters converted to uppercase

String methods: Practice

```
>>> 'hello'.upper()
>>> 'Happy Birthday!'.lower()
>>> 'WeeeEEEeeeEEee'.swapcase()
>>> 'ABC123'.isupper()
>>> 'aeiusAEIOU'.count('a')
>>> 'hello'.endswith('o')
>>> 'hello'.startswith('H')
>>> 'Hello {0}'.format('Python')
>>> 'Hello {}! Hello {}!'.format('Python','World')
```

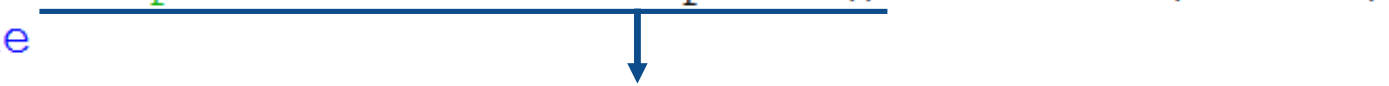
str.format()

```
>>> '{0} ate {1} apples {2}'.format('I','3','yesterday')
'I ate 3 apples yesterday'
>>> '{0} ate {1} apples {2}'.format('You','five','at 2 pm')
'You ate five apples at 2 pm'
>>> '{1} ate {0} apples {2}'.format('two','He','on Monday')
'He ate two apples on Monday'
>>> '{} ate {} apples {}'.format('He','two','on Monday')
'He ate two apples on Monday'
```

```
>>> my_pi = 3.141592
>>> 'Pi rounded to {0} decimal places is {1:.2f}.'.format(2, my_pi)
'Pi rounded to 2 decimal places is 3.14.'
>>> 'Pi rounded to {0} decimal places is {1:.3f}.'.format(3, my_pi)
'Pi rounded to 3 decimal places is 3.142.'
>>> sentence = 'Pi rounded to {0} decimal places is {1:.3f}.'
>>> sentence.format(3, my_pi)
'Pi rounded to 3 decimal places is 3.142.'
>>> 'Pi rounded to {} decimal places is {:.2f}.'.format(2, my_pi)
'Pi rounded to 2 decimal places is 3.14.'
```

Nesting

```
>>> 'Computer Science'.swapcase().endswith('ENCE')
True
```



‘cOMPUTER sCIENCE’

Class and object

```
>>> help(int)
Help on class int in module builtins:

class int(object)
 |  int(x=0) -> integer
 |  int(x, base=10) -> integer
 |
 |  Convert a number or string to an integer, or ret
urn 0 if no arguments
 |  are given.  If x is a number, return x.__int__()
.  For floating point
 |  numbers, this truncates towards zero.
 |
 |  If x is not a number or if base is given, then x
must be a string,
 |  bytes, or bytearray instance representing an int
eger literal in the
 |  given base.  The literal can be preceded by '+'
or '-' and be surrounded
 |  by whitespace.  The base defaults to 10.  Valid
bases are 0 and 2-36.
 |  Base 0 means to interpret the base from the stri
ng as an integer literal.
 |  >>> int('0b100', base=0)
 |  4
```

```
>>> help(17)
Help on int object:

class int(object)
 |  int(x=0) -> integer
 |  int(x, base=10) -> integer
 |
 |  Convert a number or string to an integer, or ret
urn 0 if no arguments
 |  are given.  If x is a number, return x.__int__()
.  For floating point
 |  numbers, this truncates towards zero.
 |
 |  If x is not a number or if base is given, then x
must be a string,
 |  bytes, or bytearray instance representing an int
eger literal in the
 |  given base.  The literal can be preceded by '+'
or '-' and be surrounded
 |  by whitespace.  The base defaults to 10.  Valid
bases are 0 and 2-36.
 |  Base 0 means to interpret the base from the stri
ng as an integer literal.
 |  >>> int('0b100', base=0)
 |  4
```

Object-oriented programming

- Python is an object-oriented programming language
- “Object-oriented” is a style of programming
- The objects are the main focus

- Imperative programming set the primary focus on functions, and pass the objects to the functions.
- Python allows a mixture of both styles.

- Later we will learn how to create new kinds of objects

Today

OBJECT ORIENTED

Summary

- Classes are like modules, except that class contain methods and modules contain functions
- Methods are like functions, except that the first argument must be an object of the class in which the method is defined.
- Method calls

```
>>> str.capitalize('trump')
'Trump'
>>> 'trump'.capitalize()
'Trump'
```