# 物聯網與微處理機系統設計
# Internet of Things and Microprocessor System Design

# Lecture 01 – Python Programming

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Partial slides are modified the slide from Chen Lin (clin@brandeis.edu)

# Outline

- Python Basics
- Data Types
- Control Flow
- String
- Files I/O
- Modules
- Function & Class

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- Data Types
- Control Flow
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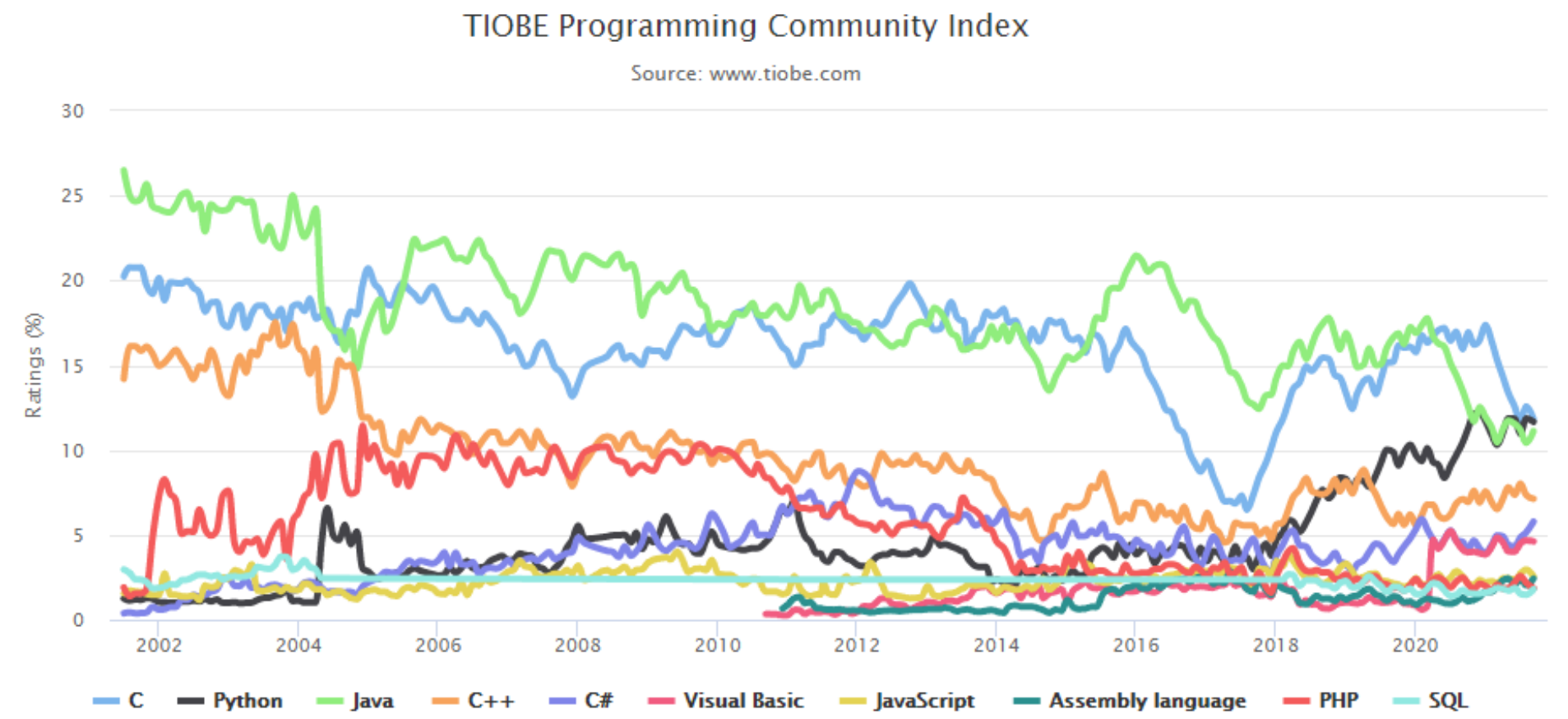
# PL Popularity (1/2)

- TIOBE Index in September 2021
  - https://www.tiobe.com/tiobe-index/

| Sep 2021 | Sep 2020 | Change | Programming Language | Ratings | Change |
|---|---|---|---|---|---|
| 1 | 1 | | C | 11.83% | -4.12% |
| 2 | 3 | ↑ | Python | 11.67% | +1.20% |
| 3 | 2 | ↓ | Java | 11.12% | -2.37% |
| 4 | 4 | | C++ | 7.13% | +0.01% |
| 5 | 5 | | C# | 5.78% | +1.20% |
| 6 | 6 | | Visual Basic | 4.62% | +0.50% |
| 7 | 7 | | JavaScript | 2.55% | +0.01% |
| 8 | 14 | ⇈ | Assembly language | 2.42% | +1.12% |
| 9 | 8 | ↓ | PHP | 1.85% | -0.64% |
| 10 | 10 | | SQL | 1.80% | +0.04% |
| 11 | 22 | ⇈ | Classic Visual Basic | 1.52% | +0.77% |
| 12 | 17 | ⇈ | Groovy | 1.46% | +0.48% |
| 13 | 15 | ↑ | Ruby | 1.27% | +0.03% |
| 14 | 11 | ↓ | Go | 1.13% | -0.33% |
| 15 | 12 | ↓ | Swift | 1.07% | -0.31% |
| 16 | 16 | | MATLAB | 1.02% | -0.07% |
| 17 | 37 | ⇈ | Fortran | 1.01% | +0.65% |
| 18 | 9 | ⇊ | R | 0.98% | -1.40% |
| 19 | 13 | ⇊ | Perl | 0.78% | -0.53% |
| 20 | 29 | ⇈ | Delphi/Object Pascal | 0.77% | +0.24% |

# PL Popularity (2/2)

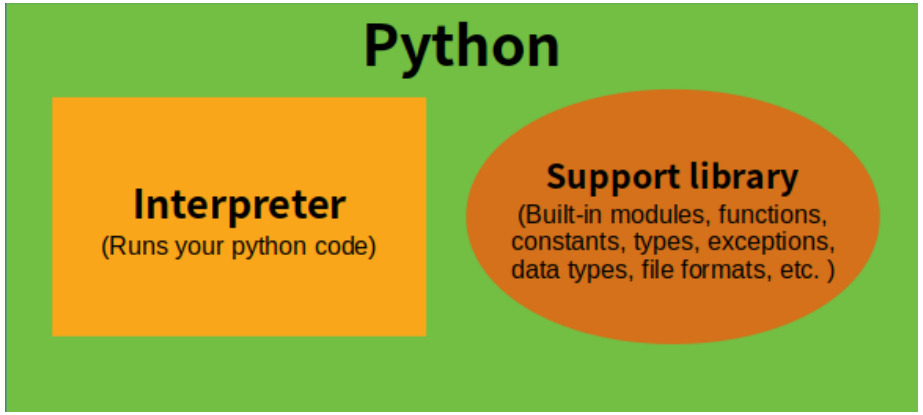


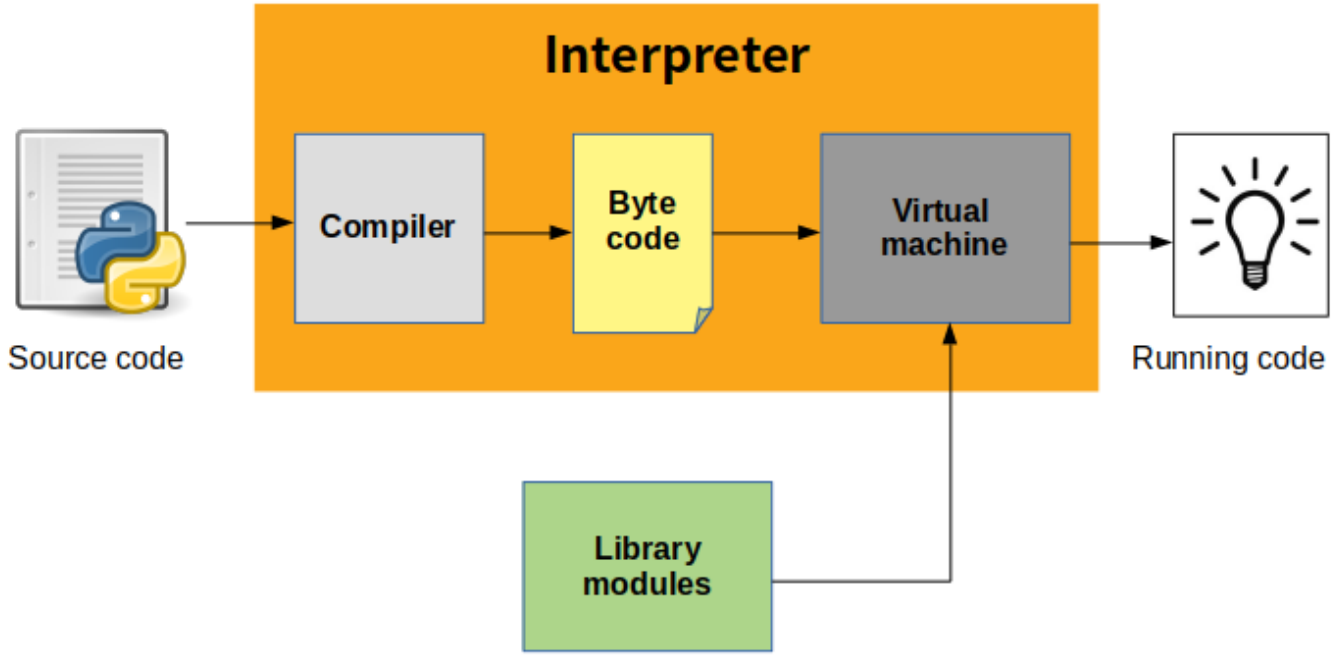
# Introduction

- Python is a clear and powerful object-oriented programming language
  - Uses an elegant syntax, making the programs you write easier to read.
  - Is an easy-to-use language that makes it simple to get your program working.
  - Comes with a large standard library that supports many common programming tasks.
  - Python's interactive mode makes it easy to test short snippets of code.
  - Is easily extended by adding new modules implemented in a compiled language such as C or C++.
  - Can also be embedded into an application to provide a programmable interface.
  - Runs anywhere, including Mac OS X, Windows, Linux, and Unix.
  - Is free software in two senses. It doesn't cost anything to download or use Python, or to include it in your application.

# Interpreter

Installed on your machine:




Ref: https://www.quora.com/How-does-a-Python-program-get-executed-Is-there-any-concept-of-compile-time-and-run-time-in-Python

# Execution Types (1/3)

- Python Interactive Shell

```
Python 3.8.3 (default, Jul  2 2020, 17:30:36) [MSC v.1916 64 bit (AMD64)] :: Anaconda, Inc. on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> _
```

- You can type things directly into a running Python session.

```
>>> A = 1
>>> B = 2
>>> C = A + B
>>> C
3
>>> c
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'c' is not defined
```

Python is case-sensitive.

```
>>> name = "yzu"
>>> name
'yzu'
>>> print("hello", name)
hello yzu
>>> print("hello %s" % name)
hello yzu
```

# Execution Types (2/3)

- Run with a saved file.

hello.py

```
1  A = 1
2  B = 2
3  C = A + B
4  print(C)
5  name = "yzu"
6  print("hello", name)
```

- Run module
  - You have to change the directory to the one where the hello.py is in.

```
(base) D:\>python
Python 3.7.3 (default, Apr 24 2019, 15:29:51) [MSC v.1915 64 bit (AMD64)] :: Anaconda, Inc. on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> import hello
3
hello yzu
```

# Execution Types (3/3)

- Run with a saved file.

hello.py

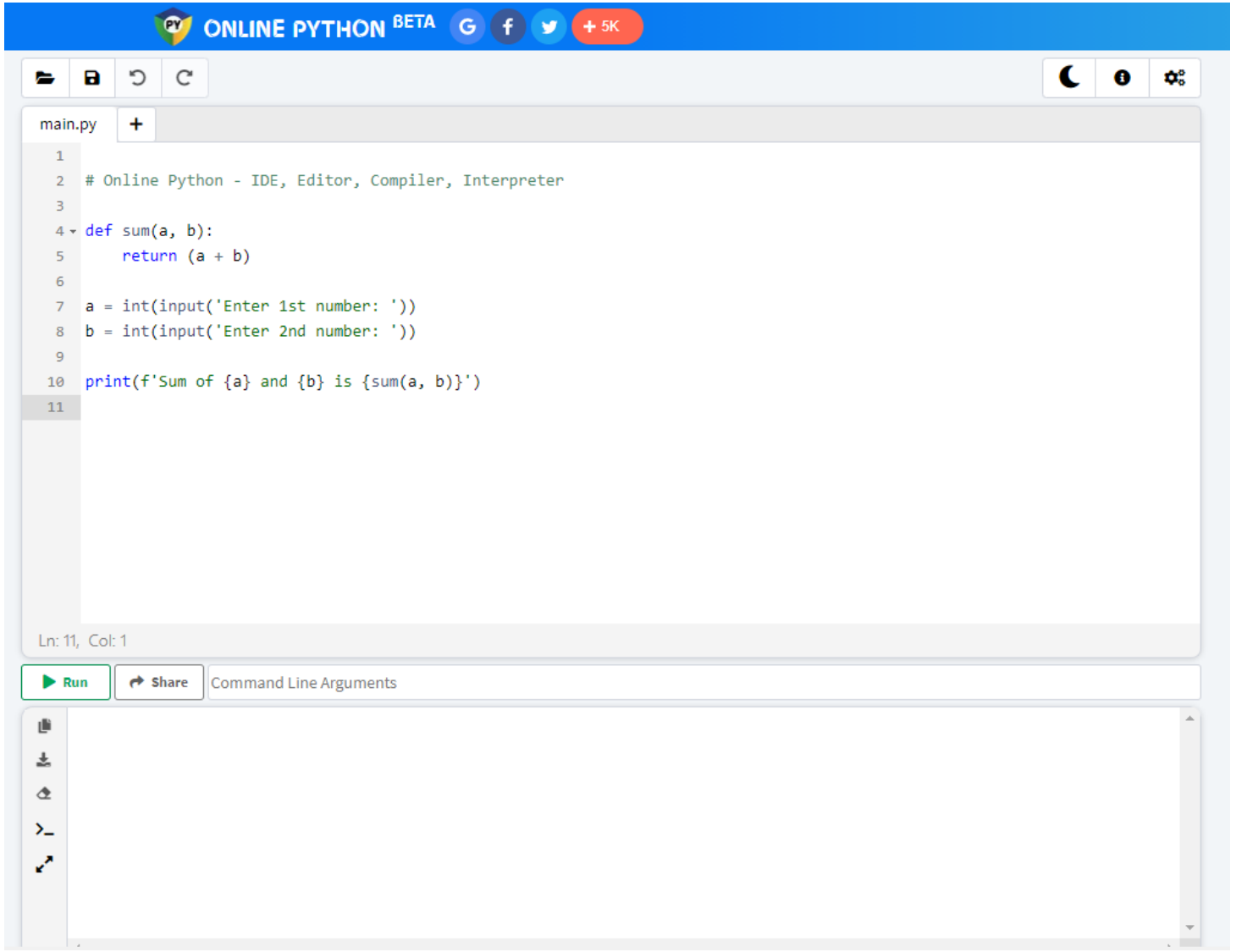
```
1  A = 1
2  B = 2
3  C = A + B
4  print(C)
5  name = "yzu"
6  print("hello", name)
```

- Run with command
  - python “filename”

```
(base) D:\>python hello.py
3
hello yzu
```

# Online Tool

- You can utilize online compiler.
- https://www.online-python.com/



# Offline Installation

- Python official website
  - https://www.python.org/downloads/
- Anaconda
  - https://www.anaconda.com/products/individual

# Indentation

- Determine the grouping of statements.
- In C++, we use { } to form a block of statements.
- Leading whitespace (spaces and tabs) at the beginning of a logical line is used to compute the indentation level of the line.

# Built-in Types

- https://docs.python.org/3/library/stdtypes.html
- The principal built-in types are numerics, sequences, mappings, classes, instances and exceptions.

# Boolean Operations

| Operation | Result | Notes |
|---|---|---|
| `x or y` | if *x* is false, then *y*, else *x* | (1) |
| `x and y` | if *x* is false, then *x*, else *y* | (2) |
| `not x` | if *x* is false, then `True`, else `False` | (3) |

Notes:

1. This is a short-circuit operator, so it only evaluates the second argument if the first one is false.
2. This is a short-circuit operator, so it only evaluates the second argument if the first one is true.
3. `not` has a lower priority than non-Boolean operators, so `not a == b` is interpreted as `not (a == b)`, and `a == not b` is a syntax error.

# Comparisons

| Operation | Meaning |
|---|---|
| `<` | strictly less than |
| `<=` | less than or equal |
| `>` | strictly greater than |
| `>=` | greater than or equal |
| `==` | equal |
| `!=` | not equal |
| `is` | object identity |
| `is not` | negated object identity |

```
>>> x = 1
>>> x
1
>>> x is 1
True
>>> type(x) is int
True
>>> type(x) is float
False
```

# Numeric Types

- int, float, complex
- All numeric types (except complex) support the following operations.

| Operation | Result |
|---|---|
| `x + y` | sum of *x* and *y* |
| `x - y` | difference of *x* and *y* |
| `x * y` | product of *x* and *y* |
| `x / y` | quotient of *x* and *y* |
| `x // y` | floored quotient of *x* and *y* |
| `x % y` | remainder of `x / y` |
| `-x` | *x* negated |
| `+x` | *x* unchanged |
| `abs(x)` | absolute value or magnitude of *x* |
| `int(x)` | *x* converted to integer |
| `float(x)` | *x* converted to floating point |
| `complex(re, im)` | a complex number with real part *re*, imaginary part *im*. *im* defaults to zero. |
| `c.conjugate()` | conjugate of the complex number *c* |
| `divmod(x, y)` | the pair `(x // y, x % y)` |
| `pow(x, y)` | *x* to the power *y* |
| `x ** y` | *x* to the power *y* |

# Bitwise Operations

- Bitwise Operations on Integer Types

| Operation | Result |
|---|---|
| `x \| y` | bitwise *or* of *x* and *y* |
| `x ^ y` | bitwise *exclusive or* of *x* and *y* |
| `x & y` | bitwise *and* of *x* and *y* |
| `x << n` | *x* shifted left by *n* bits |
| `x >> n` | *x* shifted right by *n* bits |
| `~x` | the bits of *x* inverted |

# Arithmetic

```
>>> 3 + 3
6
>>> 60 - 4 * 5
40
>>> (60 - 5*4) / 4
10.0
>>> 9/5
1.8
>>>
```

The division result is a floating number.

Complex number

```
>>> x = (4 + 5j)
>>> x
(4+5j)
>>> type(x)
<class 'complex'>
```

```
>>> 20 / 3
6.666666666666667
>>> 20 // 3
6
>>> 20 % 3
2
```

```
>>> 2 ** 2
4
>>> 2 ** 10
1024
```

Powers of Numbers

```
>>> PI = 3.14
>>> r = 6
>>> Area = r * r * PI
>>> Area
113.04
```

# Sequence Types

- There are three basic sequence types: lists, tuples, and range objects.
- Common Sequence Operations

| Operation | Result |
|---|---|
| `x in s` | `True` if an item of *s* is equal to *x*, else `False` |
| `x not in s` | `False` if an item of *s* is equal to *x*, else `True` |
| `s + t` | the concatenation of *s* and *t* |
| `s * n` or `n * s` | equivalent to adding *s* to itself *n* times |
| `s[i]` | *i*th item of *s*, origin 0 |
| `s[i:j]` | slice of *s* from *i* to *j* |
| `s[i:j:k]` | slice of *s* from *i* to *j* with step *k* |
| `len(s)` | length of *s* |
| `min(s)` | smallest item of *s* |
| `max(s)` | largest item of *s* |
| `s.index(x[, i[, j]])` | index of the first occurrence of *x* in *s* (at or after index *i* and before index *j*) |
| `s.count(x)` | total number of occurrences of *x* in *s* |

# List (1/2)

- Lists are mutable sequences, typically used to store collections of homogeneous items
- A compound data type:

[0]

[2.3, 4.5]

[5, "Hello", "there", 9.8]

[]

- Use [ ] to index items in the list.
- Use len() to get the length of a list.

```
>>> c = []
>>> c
[]
>>> c.append(2.3)
>>> c.append(4.5)
>>> c
[2.3, 4.5]
>>> c.clear()
>>> c
[]
>>> c.extend([5, "Hello", "there", 9.8])
>>> c
[5, 'Hello', 'there', 9.8]
>>> c[3]
9.8
>>> c = []
>>> c
[]
>>>
```

# List (2/2)

- Lists may be constructed in several ways:
  - Using a pair of square brackets to denote the empty list: []
  - Using square brackets, separating items with commas: [a], [a, b, c]
  - Using a list comprehension: [x for x in iterable]
  - Using the type constructor: list() or list(iterable)

# Lists are mutable - Some useful methods

```
>>> ids = ["9pti", "2plv", "1crn"]
>>> ids.append("1alm")                    # append an element
>>> ids
['9pti', '2plv', '1crn', '1alm']
>>>ids.extend(L)
   Extend the list by appending all the items in the given list; equivalent to a[len(a):] = L.
>>> del ids[0]                            # remove an element
>>> ids
['2plv', '1crn', '1alm']
>>> ids.sort()                            # sort by default order
>>> ids
['1alm', '1crn', '2plv']
>>> ids.reverse()                         # reverse the elements in a list
>>> ids
['2plv', '1crn', '1alm']
>>> ids.insert(0, "9pti")                 # insert an element at some
>>> ids                                   # specified position.
['9pti', '2plv', '1crn', '1alm']          # (slower than .append())
```

# Tuples

- Tuples are immutable sequences, typically used to store collections of heterogeneous data
- Tuples may be constructed in a number of ways:
  - Using a pair of parentheses to denote the empty tuple: ()
  - Using a trailing comma for a singleton tuple: a, or (a,)
  - Separating items with commas: a, b, c or (a, b, c)
  - Using the tuple() built-in: tuple() or tuple(iterable)

# Tuples: sort of an immutable list

```
>>> yellow = (255, 255, 0) # r, g, b
>>> one    = (1,)
>>> yellow[0]
255
>>> yellow[1:]
(255, 0)
>>> yellow[0] = 0
Traceback (most recent call last):
File "<stdin>", line 1, in <module>
TypeError: 'tuple' object does not support item assignment
```

## Very common in string interpolation:

```
>>> "%s lives in %s at latitude %.1f" % ("Andrew", "Sweden", 57.7056)
'Andrew lives in Sweden at latitude 57.7'
```

# Ranges

- The range type represents an immutable sequence of numbers and is commonly used for looping a specific number of times in for loops.
  - “range” creates a list of numbers in a specified range
  - range([start,] stop[, step]) -> list of integers
  - When step is given, it specifies the increment (or decrement).

```
>>> range(5)
[0, 1, 2, 3, 4]
>>> range(5, 10)
[5, 6, 7, 8, 9]
>>> range(0, 10, 2)
[0, 2, 4, 6, 8]
```

## How to get every second element in a list?

```
for i in range(0, len(data), 2):
    print data[i]
```

# Mapping Types

- A mapping object maps hashable values to arbitrary objects. Mappings are mutable objects.
- Dictionary is a lookup table.
- It maps from a ‘key’ to a ‘value’.

```
>>> studentList = {'s001': "Alice", 's002': "Bob"}
>>> studentList
{'s001': 'Alice', 's002': 'Bob'}
>>> studentList['s001']
'Alice'
>>> studentList['s002']
'Bob'
>>> studentList['s003']
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
KeyError: 's003'
```

- Duplicate keys are not allowed.
- Duplicate values are all right.

**Keys can be any immutable value**
**numbers, strings, tuples, frozenset,**
**not list, dictionary, set, ...**

```
atomic_number_to_name = {
1: "hydrogen"
6: "carbon",
7: "nitrogen"
8: "oxygen",
}
nobel_prize_winners = {
(1979, "physics"): ["Glashow", "Salam", "Weinberg"],
(1962, "chemistry"): ["Hodgkin"],
(1984, "biology"): ["McClintock"],
}
```

```
# A set is an unordered collection
# with no duplicate elements.
```

# Dictionary

```
symbol_to_name = {
        "H": "hydrogen",
        "He": "helium",
        "Li": "lithium",
        "C": "carbon",
        "O": "oxygen",
        "N": "nitrogen"
}
```

```
>>> symbol_to_name["C"]
'carbon'
>>> "O" in symbol_to_name, "U" in symbol_to_name
(True, False)
>>> "oxygen" in symbol_to_name
False
>>> symbol_to_name["P"]
Traceback (most recent call last):
File "<stdin>", line 1, in <module>
KeyError: 'P'
>>> symbol_to_name.get("P", "unknown")
'unknown'
>>> symbol_to_name.get("C", "unknown")
'carbon'
```

```
# Get the value for a given key

# Test if the key exists
("in" only checks the keys,
not the values.)

# [] lookup failures raise an exception.
#Use ".get()" if you want
# to return a default value.
```

# Some useful dictionary methods

```
>>> symbol_to_name.keys()
['C', 'H', 'O', 'N', 'Li', 'He']

>>> symbol_to_name.values()
['carbon', 'hydrogen', 'oxygen', 'nitrogen', 'lithium', 'helium']

>>> symbol_to_name.update( {"P": "phosphorous", "S": "sulfur"} )
>>> symbol_to_name.items()
[('C', 'carbon'), ('H', 'hydrogen'), ('O', 'oxygen'), ('N', 'nitrogen'), ('P', 'phosphorous'), ('S',
    'sulfur'), ('Li', 'lithium'), ('He', 'helium')]

>>> del symbol_to_name['C']
>>> symbol_to_name
{'H': 'hydrogen', 'O': 'oxygen', 'N': 'nitrogen', 'Li': 'lithium', 'He': 'helium'}
```

# Outline

- Python Basics
- Data Types
- Control Flow
- String
- Files I/O
- Modules
- Function & Class

# If

- Condition tests

```
>>> if True:
...     print("True")
...
True
>>> if 1 == 2:
...     print("True")
... else:
...     print("False")
...
False
```

- Multiple condition tests

```
>>> if x == 1:
...     print("1")
... elif x == 2:
...     print("2")
... else:
...     print(">2")
...
>2
```

- Nested conditions

# Use “elif” to chain subsequent tests

```
>>> mode = "absolute"
>>> if mode == "canonical":
...                     smiles = "canonical"
...     elif mode == "isomeric":
...                     smiles = "isomeric”
...             elif mode == "absolute":
...                     smiles = "absolute"
...     else:
...                     raise TypeError("unknown mode")
...
>>> smiles
' absolute '
>>>
# “raise” is the Python way to raise exceptions
```

# Boolean Logic

- Python expressions can have “and”s and “or”s:

```
if (ben <= 5 and chen >= 10 or chen == 500 and ben != 5):
    print “Ben and Chen“
```

# Range Test

- Test if the number is in the range.

```
>>> range(10)
range(0, 10)
>>> if 3 in range(10):
...   print("In")
...
In
>>> if 11 in range(10):
...   print("In")
...
>>>
```

# For

```
>>> symbols = ["alpha", "beta", "carlie", "delta", "echo", "foxtrot"]
>>> for s in symbols:
...     print(s)
...
alpha
beta
carlie
delta
echo
foxtrot
>>> for i in range(len(symbols)):
...     print(symbols[i])
...
alpha
beta
carlie
delta
echo
foxtrot
```

# Tuple assignment in for loops

```
>>> data = [ ("C20H20O3", 308.371),
   ("C22H20O2", 316.393),
   ("C24H40N4O2", 416.6),
   ("C14H25N5O3", 311.38),
   ("C15H20O2", 232.3181)]

>>> for (formula, mw) in data:
...       print "The molecular weight of %s is %s" % (formula, mw)
```

```
The molecular weight of C20H20O3 is 308.371
The molecular weight of C22H20O2 is 316.393
The molecular weight of C24H40N4O2 is 416.6
The molecular weight of C14H25N5O3 is 311.38
The molecular weight of C15H20O2 is 232.3181
```

# Break, Continue

```
>>> for value in [3, 1, 4, 1, 5, 9, 2]:
...         print ("Checking", value)
...         if value > 8:
...                 print ("Exiting for loop")
...                 break
...         elif value < 3:
...                 print ("Ignoring")
...                 continue
...         print ("The square is", value**2)
...
```

# Use “break” to stop the for loop

# Use “continue” to stop processing the current item

```
Checking 3
The square is 9
Checking 1
Ignoring
Checking 4
The square is 16
Checking 1
Ignoring
Checking 5
The square is 25
Checking 9
Exiting for loop
>>>
```

# While

```
>>> counter = 1
>>> while counter < 10:
...     print(counter)
...     counter = counter + 1
...
1
2
3
4
5
6
7
8
9
```

- Indefinite loop

```
>>> while True:
...     cmd = input("input: ")
...     if cmd == "q":
...         break
...
input: c
input: d
input: f
input: q
```

- "pass" statement does nothing

```
>>> while True:
...     pass
...
Traceback (most recent call last):
  File "<stdin>", line 2, in <module>
KeyboardInterrupt
>>>
```

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# Strings share many features with lists

```
>>> smiles = "C(=N)(N)N.C(=O)(O)O"
>>> smiles[0]
'C'
>>> smiles[1]
'('
>>> smiles[-1]
'O'
>>> smiles[1:5]
'(=N)'
>>> smiles[10:-4]
'C(=O)'
```

Use “slice” notation to get a substring

# String Methods: find, split

```
smiles = "C(=N)(N)N.C(=O)(O)O"
>>> smiles.find("(O)")
15
>>> smiles.find(".")
9
>>> smiles.find(".", 10)
-1
>>> smiles.split(".")
['C(=N)(N)N', 'C(=O)(O)O']
>>>
```

Use “find” to find the start of a substring.

Start looking at position 10.

Find returns -1 if it couldn’t find a match.

Split the string into parts with “.” as the delimiter

# String operators: in, not in

```
if "Br" in “Brother”:
  print "contains brother“


email_address = “clin”
if "@" not in email_address:
  email_address += "@brandeis.edu“
```

# String Method: “strip”, “rstrip”, “lstrip” are ways to remove whitespace or selected characters

```
>>> line = " # This is a comment line \n"
>>> line.strip()
'# This is a comment line'
>>> line.rstrip()
' # This is a comment line'
>>> line.rstrip("\n")
' # This is a comment line '
>>>
```

# More String methods

email.startswith("c")  endswith("u”)

True/False

>>> "%s@brandeis.edu" % "clin"

'clin@brandeis.edu'

>>> names = [“Ben", “Chen", “Yaqin"]

>>> ", ".join(names)

'Ben, Chen, Yaqin'

>>> "chen".upper()

'CHEN'

# Unexpected things about strings

```
>>> s = "andrew"
>>> s[0] = "A"                                    # strings are read only
Traceback (most recent call last):
File "<stdin>", line 1, in <module>
TypeError: 'str' object does not support item assignment
>>> s = "A" + s[1:]
>>> s
'Andrew‘
```

# “\” is for special characters

\n -> newline

\t -> tab

\\ -> backslash

…

But Windows uses backslash for directories!

filename = "M:\nickel_project\reactive.smi" # DANGER!

filename = "M:\\nickel_project\\reactive.smi" # Better!

filename = "M:/nickel_project/reactive.smi" # Usually works

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# Reading files

```
>>> f = open("names.txt")
>>> f.readline()
'Yan-Ann Chen\n'
```

# Quick Way

```
>>> lst= [ x for x in open("text.txt","r").readlines() ]

>>> lst

['Yan-Ann Chen\n', 'chenya@saturn.yzu.edu.tw\n', 'CS348A\n', 'Office Hour: Tues. 7-8, Fri. 8-9\n', 'Yan-Ann Chen\n', 'chenya@saturn.yzu.edu.tw\n', 'CS348B\n', 'Office Hour: Tues. 7-8, Fri. 8-9\n', 'Yan-Ann Chen\n', 'chenya@saturn.yzu.edu.tw\n', 'IN303A\n', 'Office Hour: Tues. 7-8, Fri. 8-9\n']
```

Ignore the header?

```
for (i,line) in enumerate(open('text.txt',"r").readlines()):
    if i == 0: continue
    print(line)
```

# Using dictionaries to count occurrences

```
>>> name_count = {}
>>> for line in open('names.txt'):
...         name = line.strip()
...         name_count[name] = name_count.get(name,0)+ 1
...
>>> for (name, count) in name_count.items():
...         print(name, count)
...
```

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# File Output

```
input_file = open(“in.txt")
output_file = open(“out.txt", "w")
for line in input_file:
        output_file.write(line)
```

“w” = “write mode”
“a” = “append mode”
“wb” = “write in binary”
“r” = “read mode” (default)
“rb” = “read in binary”
“U” = “read files with Unix or Windows line endings”

# Outline

- Python Basics
- Data Types
- Control Flow
- String
- Files I/O
- Modules
- Function & Class

# Modules

- When a Python program starts it only has access to a basic functions and classes.

  (“int”, “dict”, “len”, “sum”, “range”, ...)

- “Modules” contain additional functionality.
- Use “import” to tell Python to load a module.

```
>>> import math
>>> import nltk
```

# import the math module

```
>>> import math
>>> math.pi
3.14159265358979 31
>>> math.cos(0)
1.0
>>> math.cos(math.pi)
-1.0
>>> dir(math)
['__doc__', '__file__', '__name__', '__package__', 'acos', 'acosh',
'asin', 'asinh', 'atan', 'atan2', 'atanh', 'ceil', 'copysign', 'cos',
'cosh', 'degrees', 'e', 'exp', 'fabs', 'factorial', 'floor', 'fmod',
'frexp', 'fsum', 'hypot', 'isinf', 'isnan', 'ldexp', 'log', 'log10',
'log1p', 'modf', 'pi', 'pow', 'radians', 'sin', 'sinh', 'sqrt', 'tan',
'tanh', 'trunc']
>>> help(math)
>>> help(math.cos)
```

# “import” and “from … import …”

```
>>> import math
math.cos
>>> from math import cos, pi
cos
>>> from math import *
```

# Outline

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# Function

```
def function_name():
    process

def function_name(param_name):
    process

def function_name(param_name = 3):
    process
```

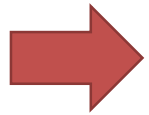
# Classes

```
class ClassName(object):
        <statement-1>
        . . .
        <statement-N>

class MyClass(object):
        """A simple example class"""
        i = 12345
        def f(self):
            return self.i

class DerivedClassName(BaseClassName):
        <statement-1>
        . . .
        <statement-N>
```

# Lab

- Create a file called “symbols.txt”
  - Each line has a symbol as shown in the figure.
- Input the mapping
  ex: *:1,#:2,@:3,$:4

```
*
##
@@@
$$$$
*****
######
@@@@@@@
$$$$$$$$
*********
##########
@@@@@@@@@@
$$$$$$$$$$$
***********
############
@@@@@@@@@@@@
$$$$$$$$$$$$$
*************
##############
@@@@@@@@@@@@@@@
$$$$$$$$$$$$$$$
***************
################
@@@@@@@@@@@@@@@@
$$$$$$$$$$$$$$$$$
```



```
mapping: *:1,#:2,@:3,$:4
1
22
333
4444
11111
222222
3333333
44444444
111111111
2222222222
33333333333
444444444444
1111111111111
22222222222222
333333333333333
4444444444444444
11111111111111111
222222222222222222
3333333333333333333
44444444444444444444
```

- Read these symbols into program.
- Map each symbol to its corresponding number and output.
  (You cannot directly output the result.)
- print(xxx, end=“”): print without newline
- Demonstrate to the TA when we have the lecture in the computer classroom.
  (group assignment)