Python Programming

NCTU Network Administration 2015

Created by darkgerm.

http://www.python.org/

Hello World

```
#!/usr/bin/env python3
print('Hello World')
```

Outline

1. Introduction

Python Introduction

- General-purpose, high-level programming language.
- Dynamic typing, strong typing.
- Object-oriented, imperative and functional programming styles.
- Automatic memory management.
- Large and comprehensive standard library.
- 3rd package repository: PyPI (the Python Package Index)
  - 55938 packages now. (2015/3/5)
- `Readability` is important.

Who use Python

- Python is widely used in many domains, including:
  - Scientific and Math. (numpy, scipy)
  - Web programming. (Django, Pyramid, Flask)
  - Cloud computing. (Openstack)
  - Multimedia, animation, and graphics. (SimpleCV)
  - Game programming. (PyGame)
  - GUI programming. (PyQt, wxPython)
  - Hardware/Embedded system design. (raspberryPi)
  - Network Programming. (Twisted)
  - System tools. (yum, many gentoo tools)
  - ...
- Heavy usage of Python at Google, Dropbox, ...

The Zen of Python

There should be one obvious way to do it.

```
>>> import this
The Zen of Python, by Tim Peters

Beautiful is better than ugly.
Explicit is better than implicit.
Simple is better than complex.
Complex is better than complicated.
Flat is better than nested.
Sparse is better than dense.
Readability counts.
Special cases aren't special enough to break the rules.
Although practicality beats purity.
Errors should never pass silently.
Unless explicitly silenced.
In the face of ambiguity, refuse the temptation to guess.
There should be one-- and preferably only one --obvious wa
Although that way may not be obvious at first unless you'r
Now is better than never.
Although never is often better than *right* now.
If the implementation is hard to explain, it's a bad idea.
If the implementation is easy to explain, it may be a good
Namespaces are one honking great idea -- let's do more of
```

Python Versions

- Python 2.7.9 (2014-12-10 Release)
- Python 3.4.3 (2015-02-25 Release)
- 2 and 3 are **not** compatible.
  - Python 2.x is legacy, Python 3.x is the present and future of the language.
  - `2to3` can help you convert code from 2 to 3.
- Check your python version:
  - `python --version`
  - `python3 --version`

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https://wiki.python.org/moin/Python2orPython3

Python Installation

- FreeBSD
  - with ports system:
    - `cd /usr/ports/lang/python3 && make install clean`
  - with pkgng:
    - `pkg install python3`
- Linux
  - Arch Linux: `pacman -S python3`
  - Debian(Ubuntu, Mint, ...): `apt-get install python3`
  - Fedora: `yum install python3`
- Build from source: **https://hg.python.org/cpython/**
  - `hg clone https://hg.python.org/cpython`
  - `cd cpython && ./configure && make`

Use Python Interpreter

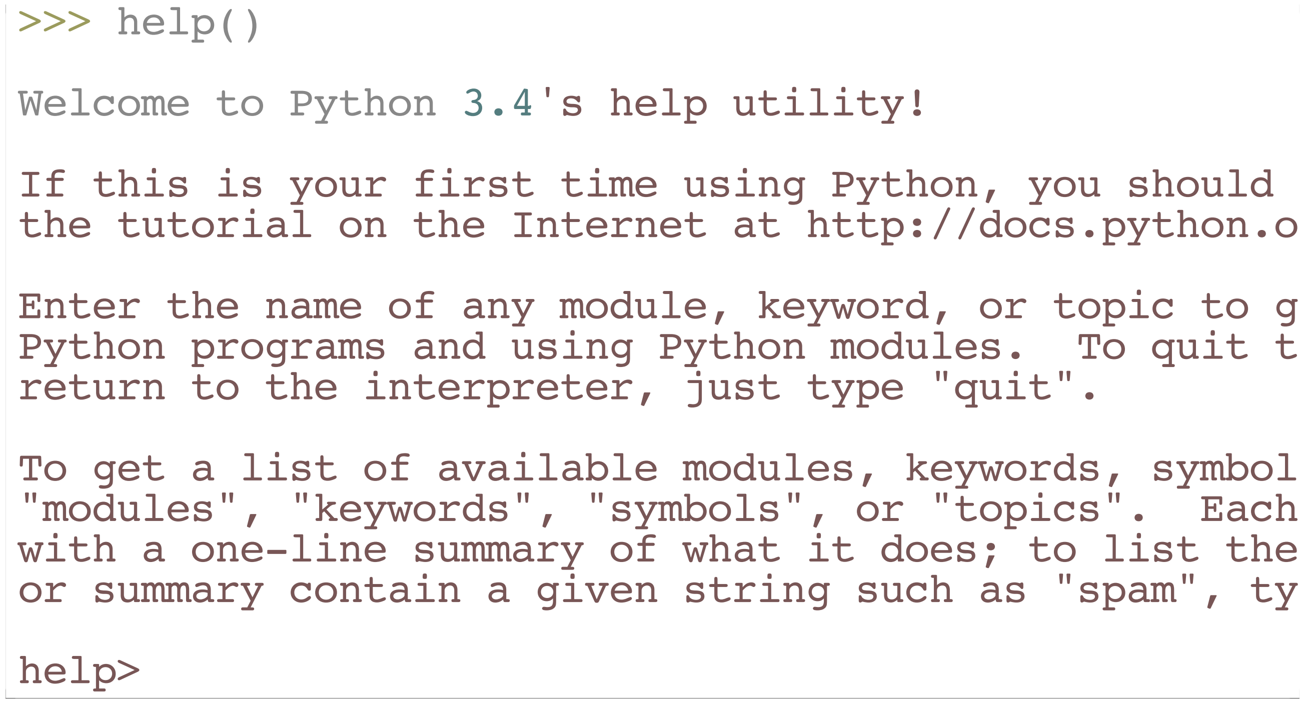
```
$ python3
Python 3.4.2 (default, Feb  8 2015, 20:11:44)
[GCC 4.2.1 Compatible FreeBSD Clang 3.4.1 (tags/RELEASE_34
Type "help", "copyright", "credits" or "license" for more
>>>
```

Execute the Python Script

```
$ cat demo.py
#!/usr/bin/env python3
print('Hello World!')

$ python3 demo.py
Hello World!

$
```

Python document and help functions.

- **http://docs.python.org/3/**
- In Python Interpreter !!



```
>>> help()

Welcome to Python 3.4's help utility!

If this is your first time using Python, you should
the tutorial on the Internet at http://docs.python.o

Enter the name of any module, keyword, or topic to g
Python programs and using Python modules.  To quit t
return to the interpreter, just type "quit".

To get a list of available modules, keywords, symbol
"modules", "keywords", "symbols", or "topics".  Each
with a one-line summary of what it does; to list the
or summary contain a given string such as "spam", ty

help>
```

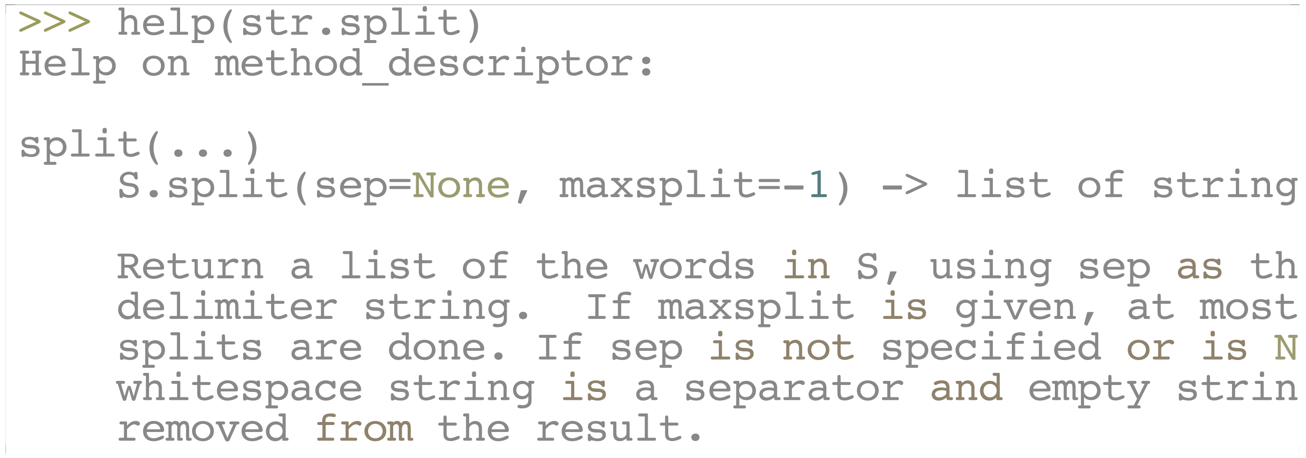
Python document and help functions.

Example 1/3: `help()` functions.

```
>>> help('if')
The "if" statement
******************

The "if" statement is used for conditional execution

   if_stmt ::= "if" expression ":" suite
               ( "elif" expression ":" suite )*
               ["else" ":" suite]

It selects exactly one of the suites by evaluating t
by one until one is found to be true (see section *B
for the definition of true and false); then that sui
(and no other part of the "if" statement is executed
If all expressions are false, the suite of the "else
present, is executed.

Related help topics: TRUTHVALUE
```

Python document and help functions.

Example 2/3: `help()` functions.



```
>>> help(str.split)
Help on method_descriptor:

split(...)
    S.split(sep=None, maxsplit=-1) -> list of string

    Return a list of the words in S, using sep as th
    delimiter string.  If maxsplit is given, at most
    splits are done. If sep is not specified or is N
    whitespace string is a separator and empty strin
    removed from the result.
```

Python document and help funcions.

Example 3/3: `dir()` functions.

```
>>> dir([])
['__add__', '__class__', '__contains__', '__delattr_
'__dir__', '__doc__', '__eq__', '__format__', '__ge_
'__getitem__', '__gt__', '__hash__', '__iadd__', '__
'__iter__', '__le__', '__len__', '__lt__', '__mul__'
'__reduce__', '__reduce_ex__', '__repr__', '__revers
'__setattr__', '__setitem__', '__sizeof__', '__str__
'append', 'clear', 'copy', 'count', 'extend', 'index
'remove', 'reverse', 'sort']
```

2. Python Data Type

Built-in Data Types

- Boolean Type - `bool`
- Numeric Types - `int` , `float` , `complex`
- Sequence Types - `list` , `tuple`
- Text Sequence Type - `str`
- Binary Sequence Type - `bytes`
- Mapping Type - `dict`
- Null Object - `None`
- Functions - `function`
- More Types - `bytearray` , `set` , ...

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http://docs.python.org/3/library/stdtypes.html

Boolean Type - bool

- `True` , `False`
- `and` , `or` , `not`

Null Object

- `None`

Numeric Types - int, float, complex

- `1` , `2.17` , `3+4j` , `1e4` , `0xFF` , `0b1010`
- Operations:
  - `+` , `-` , `*` , `/` , `//`
  - bitwise: `|` , `^` , `&` , `<<` , `>>`
  - power: `**`
  - absolute: `abs()`
  - comparisons: `<` , `>` , `<=` , `>=` , `==` , `!=`
  - `round()` , `math.floor()` , `math.ceil()`
- All numbers are big number.

---

http://docs.python.org/3/library/stdtypes.html#numeric-types-int-float-complex

Numeric Types - int, float, complex

Examples 1/3

```
>>> type(1)         # <class 'int'>
>>> type(2.3)       # <class 'float'>
>>> type(4 + 5j)    # <class 'complex'>

>>> 1 + 2 * 3       # 7
>>> 5 / 2           # 2.5
>>> 5 // 2          # 2
>>> 2 ** 31         # 2147483648
>>> 2 ** 100        # 126765060022822940149670320537
>>> 2 ** 0.5        # 1.4142135623730951
>>> abs(3 + 4j)     # 5.0

>>> import math
>>> math.e ** (math.pi * 1j)    # (-1+1.224646799147
```

Numeric Types - int, float, complex

Examples 2/3

```
# More about float
>>> round (3.14159, 2)       # 3.14
>>> import math
>>> math.floor(1.5)          # 1
>>> math.ceil(1.5)           # 2

# More about bitwise
>>> 0b101 | 0b10         # 0b111 = 7
>>> 1 << 10              # 1024

# More about complex
>>> x = 1 + 2j
>>> x.imag           # 2.0
>>> x.real           # 1.0
>>> x.conjugate()    # 1 - 2j
```

Numeric Types - int, float, complex

Examples 3/3

```
# More about comparison
>>> 3 > 2 > 1       # True

>>> a = 0.1 + 0.2
>>> b = 0.3
>>> a == b                # False  (It's computer)

>>> allowed_error = 1e-6
>>> abs(a - b) < allowed_error   # True

# More about convert
# int(x, base=10), hex(x), oct(x), bin(x)
>>> int('3')           # 3
>>> int('0xF', 16)     # 15
>>> int('F', 16)       # 15
>>> int('10', 2)       # 2
>>> hex(254)           # '0xfe'
>>> bin(224)           # '0b11100000'
```

http://docs.python.org/3/library/functions.html#int

Sequence Types - list, tuple

- list: Mutable, `[1, 2.3, 'abc', [4, 5]]`
- tuple: Immutable, `(255, 255, 128)`
- Operations:
  - `in` , `not in`
  - extend: `+`
  - repeat: `*`
  - length: `len()`
  - index: `[start:end:step]`
  - `.append()` , `.extend()` , `.insert()` , `.sort()`
- List Comprehension.

---

http://docs.python.org/3/library/stdtypes.html#sequence-types-list-tuple-range

Sequence Types - list, tuple

Examples 1/5

```
>>> type([])            # <class 'list'>
>>> type(())            # <class 'tuple'>

# Common Sequence Operations  (list, tuple)
>>> a = [1, 2, 3]
>>> b = [4, 5, 6]
>>> len(a)              # 3
>>> a + b               # [1, 2, 3, 4, 5, 6]
>>> [1] * 5             # [1, 1, 1, 1, 1]
>>> 2 in a              # True
>>> 4 in a              # False

>>> c = [5, 6, 6, 7, 8]
>>> c.count(6)          # 2
```

Sequence Types - list, tuple

Examples 2/5

```
# More about index  (list, tuple)
>>> a = [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
# index: 0  1  2  3  4  5  6  7  8  9
#      -10 -9 -8 -7 -6 -5 -4 -3 -2 -1
>>> a[3]              # 3
>>> a[-1]             # 9
>>> a[100]            # IndexError: list index out of
>>> a[2:4]            # [2, 3]

>>> i = 3
>>> a[i:i+5]          # [3, 4, 5, 6, 7]
>>> len(a[i:i+5])     # 5

>>> a[:5]             # [0, 1, 2, 3, 4]
>>> a[6:]             # [6, 7, 8, 9]
>>> a[::2]            # [0, 2, 4, 6, 8]
>>> a[::-1]           # [9, 8, 7, 6, 5, 4, 3, 2, 1, 0]
```

Sequence Types - list, tuple

Examples 3/5

```
# More about Mutable Sequence Type (list)
>>> a = [1, 2, 3]
>>> a.append(4)
>>> a                    # [1, 2, 3, 4]
>>> a.append([5])
>>> a                    # [1, 2, 3, 4, [5]]
>>> a.extend([6, 7])
>>> a                    # [1, 2, 3, 4, [5], 6, 7]
>>> a.pop()
>>> a                    # [1, 2, 3, 4, [5], 6]
>>> a.insert(0, 5566)
>>> a                    # [5566, 1, 2, 3, 4, [5], 6]
```

Sequence Types - list, tuple

Examples 4/5

```
# More about Immutable Sequence Type (tuple)
>>> hash([])            # TypeError: unhashable type: 'l
>>> hash(())            # 3527539

# More about tuple
>>> (x, y) = (4, 5)         # x = 4 and y = 5
>>> x, y = 4, 5             # same as above
>>> x, y = y, x             # swap

# Conversion
>>> list((1, 2, 3))         # [1, 2, 3]

# Sort
>>> a = [2, 0, 9, 3, 6, 1, 8, 4, 5, 7]
>>> a.sort()
>>> a
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
```

Sequence Types - list, tuple

Examples 5/5

- list comprehension.

```
>>> a = [i for i in range(10)]
>>> a
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]

>>> b = [i*i for i in a]
>>> b
[0, 1, 4, 9, 16, 25, 36, 49, 64, 81]

>>> c = [i for i in a if i % 2 == 0]
>>> c
[0, 2, 4, 6, 8]
```

Text Sequence Type - str

- Single quotes: `'"one" obvious way to do it.'`
- Double quotes: `"It's true."`
- Triple quoted: `'''multi-line string'''`, `"""same effect"""`
- Operations:
  - str is type of Immutable Sequence Type. Operations are the same :)
  - `str.split()`, `str.strip()`, `str.replace()`
  - `str.join()`
  - `str.format()`
  - `re` module. (Mention it later) **5. Built-in Modules**
  - `str.encode()` (Mention it later) **Binary Sequence Type - bytes**

---

http://docs.python.org/3/library/stdtypes.html#text-sequence-type-str

Text Sequence Type - str

Examples 1/2

```
>>> type('')                # <class 'str'>

>>> s = 'NA is very interesting.'
>>> 'NA' in s                       # True
>>> s[6:10]                         # 'very'
>>> s[::-1][1:7:2].upper()  # 'GIS'
>>> s.replace('NA', 'Network Administration')
'Network Administration is very interesting.'

>>> s.split()
['NA', 'is', 'very', 'interesting.']

>>> '  darkgerm  \n\n  '.strip()
'darkgerm'

>>> ', '.join('abc')
'a, b, c'

>>> ''.join(['a', 'b', 'c'])
'abc'
```

Text Sequence Type - str

Examples 2/2

```
>>> '{0} {1} {2}'.format('a', 'b', 'c')     # 'a b c
>>> '{} {} {}'.format('a', 'b', 'c')        # 'a b c
>>> '{2} {1} {0}'.format('a', 'b', 'c')     # 'c b a

>>> 'draw a circle at ({x}, {y}) r={radius}'.format(
...     x=3, y=4, radius=5
... )
'draw a circle at (3, 4) r=5'

>>> 'align right "{:>10}"'.format(345)
'align right "       345"'

>>> 'align center "{:-^20}"'.format('我是分隔線')
'align center "-------我是分隔線--------"'

>>> "int: {0:d};  hex: {0:x};  oct: {0:o};  bin: {0:
'int: 42;  hex: 2a;  oct: 52;  bin: 101010'
```

http://docs.python.org/3/library/string.html#format-string-syntax

http://docs.python.org/3/library/string.html#format-examples

Binary Sequence Type - bytes

- Single quotes: `b'"one" obvious way to do it.'`
- Double quotes: `b"It's true."`
- Triple quoted: `b'''multi-line bytes'''` , `b"""same effect"""`
- `bytes` is immutable (same as `str`)
- The differences between `bytes` and `str` are:
    - `str` is unicode, while `bytes` is raw character array.
    - We can encode `str` to `bytes` .
    - We can decode `bytes` to `str` .
    - `str` to C++ `string` , as `bytes` to C++ `char[]` .

---

http://docs.python.org/3/library/stdtypes.html#binary-sequence-types-bytes-bytearray-memoryview

Binary Sequence Type - bytes

Examples 1/2

```
>>> type(b'')               # <class 'bytes'>

>>> b'安安你好'      # SyntaxError: bytes can only con
>>> '安安你好'       # '安安你好'

>>> len('大中天')            # 3
>>> len('大中天'.encode())   # 9

# encode default is UTF-8
>>> '大中天'.encode()        # b'\xe5\xa4\xa7\xe4\xb8\
>>> '大中天'.encode('big5') # b'\xa4j\xa4\xa4\xa4\xd1
>>> '大中天'.encode('sjis') # b'\x91\xe5\x92\x86\x93V
```

Binary Sequence Type - bytes

Examples 2/2

```
# More about encode, decode

# You will receive bytes() from socket, system call,
# You should tell the program how to translate it.
>>> received = b'\x83n\x83\x8b\x83q'
>>> print(received)
b'\x83n\x83\x8b\x83q'

>>> print(received.decode())
UnicodeDecodeError: 'utf-8' codec cannot decode byte

>>> print(received.decode('sjis'))
ハルヒ
```

Mapping Type - dict

- `key: value` pairs
- `{ 'name': 'Yotsuba', 'age': 5, 'hair-color': 'green'}`
- Operations:
    - length: `len()`
    - get value: `d[key]` , `d.get(key[, default])`
    - delete key: `del d[key]`
    - find: `key in d` , `key not in d`
    - `d.keys()` , `d.values()` , `d.items()`

---

http://docs.python.org/3/library/stdtypes.html#mapping-types-dict

Mapping Type - dict

Examples 1/2

```
>>> type({})                    # <class 'dict'>

>>> d = { 'name': 'Yotsuba', 'age': 5, 'hair-color':
>>> len(d)                      # 3, means 3 items.
>>> d['name']                   # 'Yotsuba'
>>> d['height']                 # KeyError: 'height'
>>> d['height'] = 107
>>> d
{'hair-color': 'green', 'name': 'Yotsuba', 'age': 5,

>>> 'age' in d          # True
>>> del d['age']
>>> d
{'hair-color': 'green', 'name': 'Yotsuba', 'height':
```

Mapping Type - dict

Examples 2/2

```
>>> d = { 'name': 'Yotsuba', 'age': 5, 'hair-color':
>>> d.keys()
dict_keys(['hair-color', 'name', 'height'])

>>> d.values()
dict_values(['green', 'Yotsuba', 107])

>>> d.items()
dict_items([('hair-color', 'green'), ('name', 'Yotsu

>>> for key, value in d:
...     print('key = {:<10}, value = {:<10}'.format(
...
key = hair-color, value = green
key = name      , value = Yotsuba
key = height    , value = 107
```

Functions

- Mention it later!
    - **4. Syntax and Control Flows**

3. Input and Output

Input and Output

- Standard I/O - `print()` , `input()`
- File I/O - `open()`

---

http://docs.python.org/3/tutorial/inputoutput.html

Standard I/O - print(), input()

Example: `print()`

```
>>>> print('hello', 'world')
hello world

>>> print('hello', 'world', sep=', ')
hello, world

>>> print('hello', 'world', sep=', ', end='$$$\n')
hello, world$$$

>>> print([1, 2, 3])        # convert to string usin
[1, 2, 3]

>>> import sys
>>> print('This line will be printed to stderr.', fi
This line will be printed to stderr.
```

http://docs.python.org/3/library/functions.html#print

Standard I/O - print(), input()

Example: `input()`

```
>>> name = input('What is your name: ')
What is your name: darkgerm

>>> print('your name is', name)
your name is darkgerm
```

---

http://docs.python.org/3/library/functions.html#input

File I/O - open()

Example: open a file for read.

```
>>> f = open('/etc/resolv.conf')
>>> print(f.read())
search cs.nctu.edu.tw
nameserver 140.113.235.1
nameserver 8.8.8.8
nameserver 140.113.1.1

>>> open('/etc/resolv.conf', 'r').readlines()
['search cs.nctu.edu.tw\n', 'nameserver 140.113.235.
'nameserver 8.8.8.8\n', 'nameserver 140.113.1.1\n']

>>> f = open('/etc/resolv.conf', 'rb')
>>> f.read(6)
b'search'

>>> f.close()
```

http://docs.python.org/3/library/functions.html#open

File I/O - open()

Example: open a file for write.

```
>>> f = open('/etc/hosts.allow', 'w')
>>> f.write('ALL : ALL : deny')
>>> f.close()

>>> open('/etc/hosts.allow').read()
ALL : ALL : deny
```

4. Syntax and Control Flows

Python Syntax 1/2

- Use `#` for inline comments.
- Use multi-line string for block comments.
  - `'''This is a comment'''`
  - `"""Me too"""`

```
# I am a comment.
def add(a, b):
    """
        :description: Add two number.
        :args:        a, b.
        :return:      sum of a and b.
    """
    return a + b
```

http://legacy.python.org/dev/peps/pep-0008/#comments

Python Syntax 2/2

- Use `indentation` to delimit program blocks.
  - `tab`, `any number of spaces` are OK, but **only use one** in a file.
  - Suggestion: `4 spaces` (PEP8)

```
def fibonacci(n):
    if n <= 2:
        return 1
    else:
        return fibonacci(n-1) + fibonacci(n-2)
```

---

http://en.wikipedia.org/wiki/Python_syntax_and_semantics#Indentation

PEP8: http://legacy.python.org/dev/peps/pep-0008/

Control Flows

- `if` statement
- `for` statement
- `while` statement
- `def` statement (functions)
- `try`, `except` statements
- More control flows:
    - `raise` statement
    - `with` statement
    - `lambda` expression
    - ...

---

http://docs.python.org/3/tutorial/controlflow.html

http://docs.python.org/3/reference/compound_stmts.html

`if` statement

`if`, `elif`, `else`

```
>>> x = int(input("Please enter an integer: "))
Please enter an integer: 42
>>> if x < 0:
...     x = 0
...     print('Negative changed to zero')
... elif x == 0:
...     print('Zero')
... elif x == 1:
...     print('Single')
... else:
...     print('More')
...
More
```

http://docs.python.org/3/reference/compound_stmts.html#the-if-statement

`for` statement 1/3

`for` var `in` iterable_object `:` statement

```
for animal in ['cat', 'dog', 'fish', 'bird']:
    print(animal)

'''output:
cat
dog
fish
bird
'''

for char in 'NyanCat':
    print(char, end=' ')
print()

'''output:
N y a n C a t
'''
```

http://docs.python.org/3/reference/compound_stmts.html#for

`for` statement 2/3

Useful function for iteration: `range()`

```
'''
range(stop)
range(start, stop[, step])
'''
square_numbers = []
for i in range(10):
    square_numbers.append(i*i)

print(square_numbers)   # [0, 1, 4, 9, 16, 25, 36, 49, 64,


odd_numbers = []
for i in range(1, 12, 2):
    odd_numbers += [i]

print(odd_numbers)      # [1, 3, 5, 7, 9, 11]
```

http://docs.python.org/3/library/functions.html#func-range

`for` statement 3/3

Nested for loop.

```
for i in range(1, 10):
    for j in range(1, 10):
        print('{}*{} = {:<2}'.format(i, j, i * j), end='
    print()

'''output:
1*1 = 1   1*2 = 2   1*3 = 3   1*4 = 4   1*5 = 5   1*6 = 6
2*1 = 2   2*2 = 4   2*3 = 6   2*4 = 8   2*5 = 10  2*6 = 12
3*1 = 3   3*2 = 6   3*3 = 9   3*4 = 12  3*5 = 15  3*6 = 18
4*1 = 4   4*2 = 8   4*3 = 12  4*4 = 16  4*5 = 20  4*6 = 24
5*1 = 5   5*2 = 10  5*3 = 15  5*4 = 20  5*5 = 25  5*6 = 30
6*1 = 6   6*2 = 12  6*3 = 18  6*4 = 24  6*5 = 30  6*6 = 36
7*1 = 7   7*2 = 14  7*3 = 21  7*4 = 28  7*5 = 35  7*6 = 42
8*1 = 8   8*2 = 16  8*3 = 24  8*4 = 32  8*5 = 40  8*6 = 48
9*1 = 9   9*2 = 18  9*3 = 27  9*4 = 36  9*5 = 45  9*6 = 54
'''
```

`while` statement

`while` condition **:** statement

```
#!/usr/bin/env python3
''' 3n+1 Problem '''
step = 0
n = int(input('give me a number: '))

while n != 1:
    if n % 2 == 0:
        n //= 2
    else:
        n = 3 * n + 1
    step += 1

print('{} step(s) to 1.'.format(step))

'''sample run
$ python3 3n+1.py
give me a number: 10
6 steps to 1.
'''
```

http://docs.python.org/3/reference/compound_stmts.html#while

`def` statement (functions) 1/3

`def` function_name `(` argument_list `)` `:`

```
#!/usr/bin/env python3
""" fibonacci """
def fib(n):
    a, b = 1, 1
    for i in range(n-2):
        a, b = b, a+b
    return b

while True:
    print(fib(int(input('n = '))))

"""sample run
n = 10
55
"""
```

http://docs.python.org/3/tutorial/controlflow.html#defining-functions

http://docs.python.org/3/reference/compound_stmts.html#def

`def` statement (functions) 2/3

functions are objects.

```
#!/usr/bin/env python3
rng = range                    # alias of built-in function range

def print_pow_of_2(n):
    for i in rng(n):
        print(2**i, end=' ')
    print()

ppo2 = print_pow_of_2
# ppo2 and print_pow_of_2 are the same function

ppo2(10)                       # 1 2 4 8 16 32 64 128 256 512
print_pow_of_2(10)             # 1 2 4 8 16 32 64 128 256 512

print(type(ppo2))              # <class 'function'>

print(ppo2 == print_pow_of_2)    # True
```

`def` statement (functions) 3/3

More about function arguments.

- Default Argument Values
- Keyword Arguments
- Arbitrary Argument Lists (Next page)

```
def pass_or_not(exams, bonus=0, special_case=None):
    if special_case is not None: return special_case
    return sum(exams)/len(exams) + bonus >= 60

pass_or_not([50, 60, 70])                           # True
pass_or_not([50, 60])                               # False

pass_or_not([50, 60], bonus=5)                      # True
pass_or_not([50, 60], 5)                            # True,
pass_or_not(bonus=5, exams=[50, 60])                # True,

pass_or_not([50, 60], special_case=True)
pass_or_not([90, 90], bonus=10, special_case=False)
```

---

https://docs.python.org/3/tutorial/controlflow.html#more-on-defining-functions

`def` statement (functions) 3/3

More about function arguments: Arbitrary Argument Lists.

```
def summation(*args):
    '''An implementation of sum()'''
    print(type(args))                # <class 'tuple'>
    print(args)
    ret = 0
    for i in args:
        ret += i
    return ret

print(summation(1, 2, 3))            # (1, 2, 3)  6
print(summation(36, 45))             # (36, 45)  81
```

```
def foo(a, b, *args, **kwargs):
    print('a={} b={} args={} kwargs={}'.format(a, b,

foo(1, 2)             # a=1 b=2 args=() kwargs={}
foo(1, 2, 3)          # a=1 b=2 args=(3,) kwargs={}
foo(1, 2, 3, x=9)     # a=1 b=2 args=(3,) kwargs={'x':
foo(1, 2, x=9, y=8)   # a=1 b=2 args=() kwargs={'x': 9
foo(1, 2, 8, 9)       # a=1 b=2 args=(8, 9) kwargs={}

foo(1)  # TypeError: foo() missing 1 required positi
```

`try`, `except` statement

Handling Exceptions.

```
try:
    # do something may be dangerous.
except Some_Errors_or_Exceptions:
    # do things if Some_Errors_or_Exceptions happend
except:
    # catch ALL exceptions.
```

---

https://docs.python.org/3/tutorial/errors.html

`try` , `except` , `raise` statement

Example 1/3

```
#!/usr/bin/env python3
print('Welcome to Square Root Calculator(SRC)')
while True:
    try:
        n = int(input('Please give me a number: '))
        print('Square Root of {} = {}'.format(n, n**
    except KeyboardInterrupt:
        print('Goodbye! See you next time~')
        break
```

```
# sample run
$ python3 SRC.py
Welcome to Square Root Calculator(SRC)
Please give me a number: 2
Square Root of 2 = 1.4142135623730951
Please give me a number: 3
Square Root of 3 = 1.7320508075688772
Please give me a number: 100
Square Root of 100 = 10.0
Please give me a number: ^C
Goodbye! See you next time~
$
```

`try` , `except` , `raise` statement

Example 2/3

What if a BAD user input some string?

```
$ python3 SRC.py
Welcome to Square Root Calculator(SRC)
Please give me a number: abc
Traceback (most recent call last):
  File "test.py", line 6, in <module>
    n = int(input('Please give me a number: '))
ValueError: invalid literal for int() with base 10:
```

Use `except` to catch the `ValueError` exception.

`try`, `except`, `raise` statement

Example 3/3

```
#!/usr/bin/env python3
print('Welcome to Square Root Calculator(SRC)')
while True:
    try:
        n = int(input('Please give me a number: '))
        print('Square Root of {} = {}'.format(n, n**
    except KeyboardInterrupt:
        print('Goodbye! See you next time~')
        break
    except ValueError:
        print("YOU ARE A BAD USER! I don't want to p
        break
```

```
# sample run
$ python3 SRC.py
Welcome to Square Root Calculator(SRC)
Please give me a number: abc
YOU ARE A BAD USER! I don't want to play with you!
$
```

5. Built-in Modules

The Python Standard Library

- Python’s standard library is very extensive.
  - Regular Expression. (`re`)
  - Date and Time. (`datetime`)
  - Data Structure. (`heapq`)
  - Filesystem. (`os.path` , `stat` , `glob`)
  - Database. (`sqlite3`)
  - Compression and Archiving. (`zlib` , `gzip` , `zipfile`)
  - Concurrent Execution. (`threading` , `subprocess`)
  - Networking. (`socket` , `ssl`)
  - Internet Protocols. (`http` , `urllib` , `telnetlib` , `smtpd`)
  - Multimedia. (`audioop` , `wave`)
  - ...

The Python Standard Library

- It's impossible to introduce them all.
- Here I will introduce the following common modules.
    - Regular Expression. (`re`)
    - System call. (`subprocess`)
    - HTTP. (`urllib`)
    - Socket Programming. (`socket`)
    - Other modules. (`os` , `sys`)

---

http://docs.python.org/3/library/index.html

How to use modules?

Use `import` statement.

```
# import a module
import math
print('pi =', math.pi)                              # 3.14159265358979
print('log10(2) =', math.log10(2))                  # 0.30102999566398

# only import a function/class/variable
from itertools import combinations
print(list(combinations('ABC', 2)))
# [('A', 'B'), ('A', 'C'), ('B', 'C')]

# import a module and make an alias
import random as rnd
rnd.randint(0, 10)                  # 8  (or a random number in [0

# import a function/class/variable and make an alias
from datetime import date as dt
print(dt.today())                   # 2014-03-02
```

Regular Expression (`re`)

- Provide regular expression matching operations similar to those found in Perl.
- Match the string at any location: `re.search()`
- Split the string by pattern: `re.split()`
- Find all the matched pattern: `re.findall()`

---

http://docs.python.org/3/library/re.html

http://docs.python.org/3/howto/regex.html#regex-howto

Regular Expression (`re`)

`re.search()` Example

```
import re
''' re.search(pattern, string) '''

string = 'Sun Mar  2 21:33:29 CST 2014'

r = re.search('\d+:\d+:\d+', string)
print('{}-{} matched: {}'.format(r.start(), r.end(),
# 11-19 matched: 21:33:29

r = re.search('(\d+):(\d+):(\d+)', string)
print('hour = {}  minute = {}  second = {}'.format(
    r.group(1), r.group(2), r.group(3)
))
# hour = 21  minute = 33  second = 29
```

Regular Expression (`re`)

`re.split()` , `re.findall()` Example

```
>>> import re

>>> re.split('[: ]', 'Sun Mar  2 21:23:09 CST 2014')
['Sun', 'Mar', '', '2', '21', '23', '09', 'CST', '20

>>> re.findall('\w+', 'regexp is very important')
['regexp', 'is', 'very', 'important']

>>> re.findall('\w+s', 'raining cats and dogs')
['cats', 'dogs']
```

System call. (`subprocess`)

- `subprocess` allows you to spawn new processes, connect to their input/output/error pipes, and obtain their return codes.
- `subprocess.call()`
- `subprocess.check_output()`
- `subprocess.Popen`

---

http://docs.python.org/3/library/subprocess.html

System call. (`subprocess`)

`subprocess.call()` Example

```
#!/usr/bin/env python3
from subprocess import call

# call() is just like system() in C.
return_code = call('ls')        # 0

# The output will display on screen, but you can't g
# To get the output,
# you should use the more powerful one: check_output
```

---

http://docs.python.org/3/library/subprocess.html#subprocess.call

System call. (`subprocess`)

`subprocess.check_output()` Example

```
#!/usr/bin/env python3
from subprocess import check_output

# check_output() is just like backquote in Perl
stdout = check_output(['ls', '-al'])

# or convenient way (but not safe)
stdout = check_output('ls -al', shell=True)

# You can't get stderr and can't give the stdin.
# If you want to get control of stderr and stdin,
# you should use the more powerful one: Popen()
```

http://docs.python.org/3/library/subprocess.html#subprocess.check_output

System call. (`subprocess`)

`subprocess.Popen` Example 1/2

```
#!/usr/bin/env python3
import subprocess as sp

# Popen is the most powerful one.

# Example 1: execute `base64 -d` with stdin 'cHl0aG9

process = sp.Popen(
    ['base64', '-d'],
    stdin=sp.PIPE,
    stdout=sp.PIPE
)
stdout = process.communicate(input=b'cHl0aG9uCg==')[
# stdout = b'python\n'
```

http://docs.python.org/3/library/subprocess.html#popen-constructor

System call. (`subprocess`)

`subprocess.Popen` Example 2/2

```
#!/usr/bin/env python3
import subprocess as sp
import shlex

# Example 2: execute `/sbin/pfctl -t ssh_bruteforce

cmd = shlex.split('/sbin/pfctl -t ssh_bruteforce -T
# shlex.split() help you to split in shell way.
# cmd = ['/sbin/pfctl', '-t', 'ssh_bruteforce', '-T'

process = sp.Popen(cmd, stdout=sp.PIPE, stderr=sp.PI

stdout, stderr = process.communicate()
# stdout = (many ips)
# stderr = b'No ALTQ support in kernel\nALTQ related
```

HTTP. (`urllib`)

- `urllib` is a package, collects 4 modules.
  - `urllib.request` , `urllib.error` , `urllib.parse` , `urllib.robotparser`
- `urllib.request` defines functions and classes which help in opening URLs.
  - `urllib.request.urlopen()`
- `urllib.parse` defines a standard interface to manipulate URL (Uniform Resource Locator)
  - Parsing URL: `urllib.parse.urlparse()`
  - Parsing query string: `urllib.parse.parse_qs()`
  - String conversion: `urllib.parse.quote()`

---

http://docs.python.org/3/library/urllib.request.html#module-urllib.request

http://docs.python.org/3/library/urllib.parse.html#module-urllib.parse

HTTP. (`urllib`)

`urllib.request.urlopen()` Example

```
#!/usr/bin/env python3
""" get the google homepage. """
from urllib.request import urlopen

response = urlopen('http://www.google.com')

print(response.code)          # 200
print(response.msg)           # OK
print(response.headers)       # (the HTTP headers)
print(response.read())        # (the HTTP content)
```

---

http://docs.python.org/3/library/urllib.request.html#urllib.request.urlopen

HTTP. (`urllib`)

`urllib.parse.quote()` Example

```
#!/usr/bin/env python3
""" 取得 wiki "銀河系" 頁面 """
from urllib.reqeust import urlopen
from urllib.parse import quote

url = 'http://zh.wikipedia.org/wiki/'
keyword = '銀河系'

# urlopen(url + keyword)
# This will raise UnicodeEncodeError.
# Because '銀河系' is not valid ascii codes.

keyword_quote = quote(keyword)              # %E9%8A
response = urlopen(url + keyword_quote)     # succes

open('result.html', 'w').write(response.read())
```

---

http://docs.python.org/3/library/urllib.parse.html#urllib.parse.quote

Socket Programming. (`socket`)

- `socket` module provides access to the BSD socket interface.
- It is available on all modern Unix systems, Windows, MacOS, ...
- Common use:
  - Open a socket: `socket.socket()`
  - Connect the socket to (host, port): `socket.connect()`
  - Bind the socket to (host, port): `socket.bind()`
  - Listen the socket: `socket.listen()`
  - Accept a connection: `socket.accept()`
  - Receive/Send data from the socket: `socket.recv()` , `socket.sendall()`

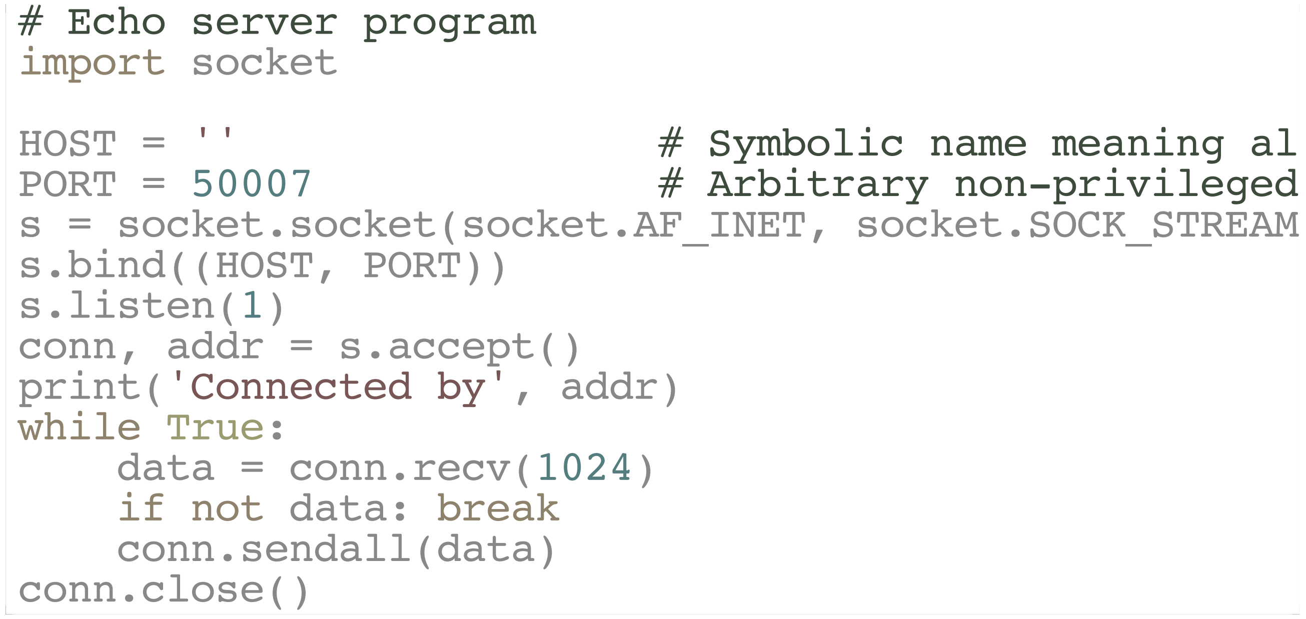
---

http://docs.python.org/3/library/socket.html

http://docs.python.org/3/howto/sockets.html#socket-howto

Socket Programming. (`socket`)

Example (Echo server program)



```
# Echo server program
import socket

HOST = ''                         # Symbolic name meaning al
PORT = 50007                      # Arbitrary non-privileged
s = socket.socket(socket.AF_INET, socket.SOCK_STREAM
s.bind((HOST, PORT))
s.listen(1)
conn, addr = s.accept()
print('Connected by', addr)
while True:
    data = conn.recv(1024)
    if not data: break
    conn.sendall(data)
conn.close()
```

---

http://docs.python.org/3/library/socket.html#example

Socket Programming. (`socket`)

Example (Echo client program)

```
# Echo client program
import socket

HOST = 'daring.cwi.nl'    # The remote host
PORT = 50007              # The same port as used by
s = socket.socket(socket.AF_INET, socket.SOCK_STREAM
s.connect((HOST, PORT))
s.sendall(b'Hello, world')
data = s.recv(1024)
s.close()
print('Received', repr(data))
```

---

http://docs.python.org/3/library/socket.html#example

Other modules. (`os` , `sys`)

- `os` module provides a portable way of using operation system dependent functionality.
  - You can find lots of unix system calls here.
  - `os.getuid()` , `os.getpid()` , `os.kill()` , ...
- `sys` module provides access to some variables used or maintained by the interpreter.
  - You can get the command line arguments passed to the script.
  - You can get the File object of stdin, stdout, stderr.
  - `sys.argv` , `sys.path` , ...

---

http://docs.python.org/3/library/os.html

http://docs.python.org/3/library/sys.html

Other modules. (`os` , `sys`)

Example

```
#!/usr/bin/env python3
# run this script by 'python3 demo.py arg1 asdf'
import os, sys

print(os.name)        # 'posix'
print(os.getuid())    # 14822
print(os.getpid())    # 10215
print(os.uname())
'''posix.uname_result(sysname='FreeBSD', nodename='b
release='10.1-RELEASE-p5', version='FreeBSD 10.1-REL
08:55:07 UTC 2015
root@amd64-builder.daemonology.net:/usr/obj/usr/src/
machine='amd64')
'''
print(sys.argv)       # ['demo.py', 'arg1', 'adsf']
print(sys.path)
'''['', '/usr/local/lib/python34.zip', '/usr/local/l
'/usr/local/lib/python3.4/plat-freebsd10',
'/usr/local/lib/python3.4/lib-dynload',
'/usr/local/lib/python3.4/site-packages']
'''
```

6. 3rd Packages

PyPI - the Python Package Index

- **https://pypi.python.org/pypi**
- The Python Package Index is a repository of software for the Python programming language. There are currently 55938 packages here. (2015/3/5)
- Use `pip` to install packages.
    - `pip install <package-name>`
- Import it and use!

PyPI - the Python Package Index

- Instead of install the package system-wide, I suggest you to install them locally.
- Use `venv` module (since 3.3) to create your own virtual environments.

```
$ VENV=venv

# create virtual env.
$ python3 -m venv $VENV

# activate the environment.
$ source $VENV/bin/activate

# install pip.
(venv)$ curl https://raw.githubusercontent.com/pypa/pip/ma

# re-activate the environment to apply settings.
(venv)$ deactivate
$ source $VENV/bin/activate
```

---

https://docs.python.org/3/library/venv.html

Other packages

- Download from it's website and follow its install instructions.
- Example: `BeautifulSoup`

```
# Download it from its website.
$ wget http://www.crummy.com/software/BeautifulSoup/bs4/do

# untar it
$ tar zxvf beautifulsoup4-4.3.2.tar.gz

# Run `2to3` to make it compatible with Python3.
$ cd beautifulsoup4-4.3.2
$ 2to3 -w bs4
```

---

http://www.crummy.com/software/BeautifulSoup/

7. Examples

Examples

- `id.py`
  - control flows, functions, string, array, type conversion
- `latency.py`
  - system command, re
- `myip.py`
  - http request, re
- `parser.py`
  - file, re, dict
- `split.py`
  - file, string
- `youtube.py`
  - http request, re, argument parse, 3rd package

id.py

Code 1/3

```python
#!/usr/bin/env python3
"""Check the input is a valid id or not."""
import re

table = dict(
    A=10, J=18, S=26,
    B=11, K=19, T=27,
    C=12, L=20, U=28,
    D=13, M=21, V=29,
    E=14, N=22, W=32,
    F=15, O=35, X=30,
    G=16, P=23, Y=31,
    H=17, Q=24, Z=33,
    I=34, R=25,
)
```

id.py

Code 2/3

```
def check(id_):
    digit = table[id_[0]]
    cks = digit // 10 + digit % 10 * 9
    cks += sum(int(id_[i]) * (9-i) for i in range(1,
    cks += int(id_[9])
    return cks % 10 == 0

# Alternative check.
def check2(id_):
    cks = int('10987654932210898765431320'[ord(id_[0
    cks += sum(int(id_[i]) * (9-i) for i in range(1,
    cks += int(id_[9])
    return cks % 10 == 0
```

id.py

Code 3/3

```
if __name__ == '__main__':
    while True:
        id_ = input('please input id: ')

        if not re.search('^[A-Z]\d{9}$', id_):
            print('wrong format!')

        elif check(id_):
            print('valid')

        else:
            print('invalid')
```

Sample Run

```
$ python3 id.py
please input id: A123456789
valid
please input id: XDD
wrong format!
```

latency.py

Code 1/1

```python
#!/usr/bin/env python3
import re
import subprocess as sp

cmd = 'ping -c 5 linux1.cs.nctu.edu.tw | tail -n +2

ping_rst_bytes = sp.check_output(cmd, shell=True)
ping_rst = ping_rst_bytes.decode()

times = []
for line in ping_rst.split('\n'):
    reobj = re.search('time=(\d*\.\d*) ms', line)
    if reobj:
        times.append(float(reobj.group(1)))

print('sum = {:.3f} ms'.format(sum(times)))
print('max = {:.3f} ms'.format(max(times)))
print('min = {:.3f} ms'.format(min(times)))
```

latency.py

Sample Run

```
$ python3 latency.py
sum = 1.008 ms
max = 0.258 ms
min = 0.177 ms
```

myip.py

Code 1/1

```
#!/usr/bin/env python3
import re
from urllib.request import urlopen

url = 'https://www.esolutions.se/whatsmyinfo'
pattern = '<div class="col-md-8">(\d+\.\d+\.\d+\.\d+)</div

content = urlopen(url).read().decode()
reobj = re.search(pattern, content)
if reobj:
    print('my ip: {}'.format(reobj.group(1)))
else:
    print('cannot find your ip QQ.')
```

Sample Run

```
$ python3 myip.py
my ip: 140.113.235.135
```

parser.py

Code 1/1

```
#!/usr/bin/env python3
import re

table = {}

#Dec 21 17:07:08 nat235 pure-ftpd: (?@192.168.0.15)
for line in open('xferlog', errors='ignore'):
    if 'logged' not in line: continue

    cols = line.split(' ')
    ip, user = cols[5][3:-1], cols[7]

    if ip not in table:            table[ip] = [user]
    elif user not in table[ip]: table[ip] += [user]
    else:                          pass         # do not

for key, value in sorted(table.items()):
    print('{:20s} {}'.format(key, value))
```

parser.py

Sample Run

```
$ python3 parser.py
192.168.1.103           ['ioi23']
192.168.1.193           ['ioi16']
192.168.1.210           ['ioi28']
```

split.py

Code 1/1

```
#!/usr/bin/env python3

pass_f = open('/etc/passwd')

for line in pass_f:
    if line.strip()[0] == '#': continue
    arr = line.split(':')
    if len(arr) < 2: continue
    print('username = {:<10} uid = {}'.format(arr[0]

pass_f.close()
```

split.py

Sample Run

```
$ python3 split.py
username = root         uid = 0
username = toor         uid = 0
username = daemon       uid = 1
username = operator     uid = 2
username = bin          uid = 3
username = tty          uid = 4
username = kmem         uid = 5
username = games        uid = 7
username = news         uid = 8
username = man          uid = 9
username = sshd         uid = 22
username = smmsp        uid = 25
username = mailnull     uid = 26
username = bind         uid = 53
username = proxy        uid = 62
username = _pflogd      uid = 64
username = _dhcp        uid = 65
username = uucp         uid = 66
username = pop          uid = 68
username = www          uid = 80
username = hast         uid = 845
username = nobody       uid = 65534
```

youtube.py

Code 1/4

```python
#!/usr/bin/env python3
import os
import re
import sys
from urllib.request import urlopen
from urllib.parse import quote

sys.path.append(os.path.abspath('./beautifulsoup4-4.
from bs4 import BeautifulSoup
```

youtube.py

Code 2/4

```python
def youtube_search(keyword, n=6):
    url_fmt = (
        'http://www.youtube.com/results'
        '?hl=en&search_query={}'
    )
    url = url_fmt.format(quote(keyword))

    content = urlopen(url).read().decode()
    html = BeautifulSoup(content)

    base = 'http://www.youtube.com'
    all_links = html.find_all(
        class_='yt-uix-tile-link',
        href=re.compile("watch\?v="),
    )
    for link in all_links:
        if 'Watch Later' not in str(link):
            print(base + link.get('href'))
            print(link.text.strip())
            print()
            n -= 1
            if n == 0: break
```

youtube.py

Code 3/4

```
def main1():
    import getopt

    def usage():
        print('Usage: %s [-n N] keyword.' % sys.argv
        exit(1)

    try:
        opts, args = getopt.getopt(sys.argv[1:], 'n:

    except getopt.GetoptError as err:
        usage()

    if len(args) != 1: usage()

    n = 6
    for opt, arg in opts:
        if opt == '-n': n = int(arg)

    youtube_search(args[0], n=n)
```

youtube.py

Code 4/4

```
def main2():
    import argparse
    parser = argparse.ArgumentParser(
            description='Youtube search engine.'
    )
    parser.add_argument('-n', type=int, default=6,
            help='number of search result. default i
    parser.add_argument(
            'keyword', nargs=1,
            help='keyword to search.'
    )
    args = parser.parse_args()

    youtube_search(args.keyword[0], n=args.n)


if __name__ == '__main__':
    main2()
```

youtube.py

Sample Run 1/2

```
$ python3 youtube.py -h
usage: youtube.py [-h] [-n N] keyword

Youtube search engine.

positional arguments:
  keyword      keyword to search.

optional arguments:
  -h, --help   show this help message and exit
  -n N         number of search result. default is 6.
```

youtube.py

Sample Run 2/2

```
$ python3 youtube.py 五五六六
http://www.youtube.com/watch?v=2Ii0kpKi8kI
5566【MVP情人】我難過 MV

http://www.youtube.com/watch?v=2NqXSYfL3as
56不能亡！5566金曲2小時終極串燒！

http://www.youtube.com/watch?v=E974uH3cs9I
台灣啟示錄5566

http://www.youtube.com/watch?v=60HMLlYIXQA
2015 02 19【超级巨星红白體能大讚】- 5566領軍陪你過新年

http://www.youtube.com/watch?v=J4hvUELE-AU
5566【2006 One World 同一個世界演唱會】

http://www.youtube.com/watch?v=jjQ4lYKBC2U
好久不见 5566
```

The course is going to end here.

However, things in this course are only 10% of Python.

Oops, maybe 5% or less.

What's more you can learn first

- `class`
- `lambda`
- Generators, `yield` statement.
- `set` type.
- `json` module.
- Write your own module.
- Docstring.
- Syntax suggestion: PEP8
- Binding with C: `ctypes` module, `<Python.h>`

What's more and more you can learn

- For GUI: `PySide` , `wxPython`
- For 3D Graph: `VPython`
- For Image Manipulate: `SimpleCV`
- For Website Design: `Django` , `jinja2` , `Flask` , `web2py`
- For Scientific Calculation: `SciPy` , `NumPy` , `metaplot2`
- For Network Programming: `Twisted`
- For Documentation: `sphinx`

Welcome to Python World !

Learning Materials and References

- **The Python Tutorial**
- **Python Standard Library**
- 良葛格學習筆記