



Hello Spam!

PYTHON BASICS

Jui Pann

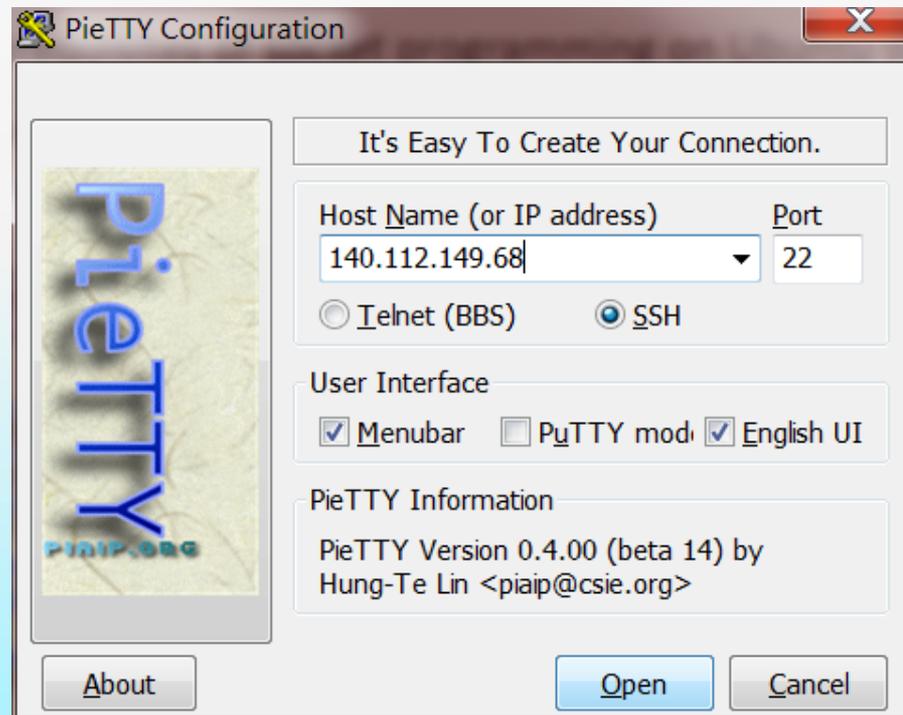


Eggs

- Prerequisites
- Hello Spam!
- Data Types
- Variables, Operators, and Value Assignment
- Dynamic Typing
- String, List, Dictionary, Tuple
- Statements
- Odds-and-Ends
- Python Scoping and Function
- Python Module
- OOP, Class, Object

Prerequisites

- Download pietty for establishing ssh connections.
- <http://ntu.csie.org/~piaip/pietty/>





UNIX commands

- Basic instructions
 - **passwd**: change password
 - **exit**: logout
 - **ps**: show processes
 - `ps aux | grep xxx`: show processes with keyword



UNIX commands

- Useful commands
 - **man**: manual page
 - **ls**: list the contents of current folder
 - **ls -a**: list all (including the hidden files)
 - **ls -aux** : list all files with detailed information
 - **cp** : copy files from one folder/directory to another
 - **cp -r** : copy the whole folder to another
 - **mkdir** : create a folder
 - **rmdir**: delete a folder
 - **pwd** : display your current path

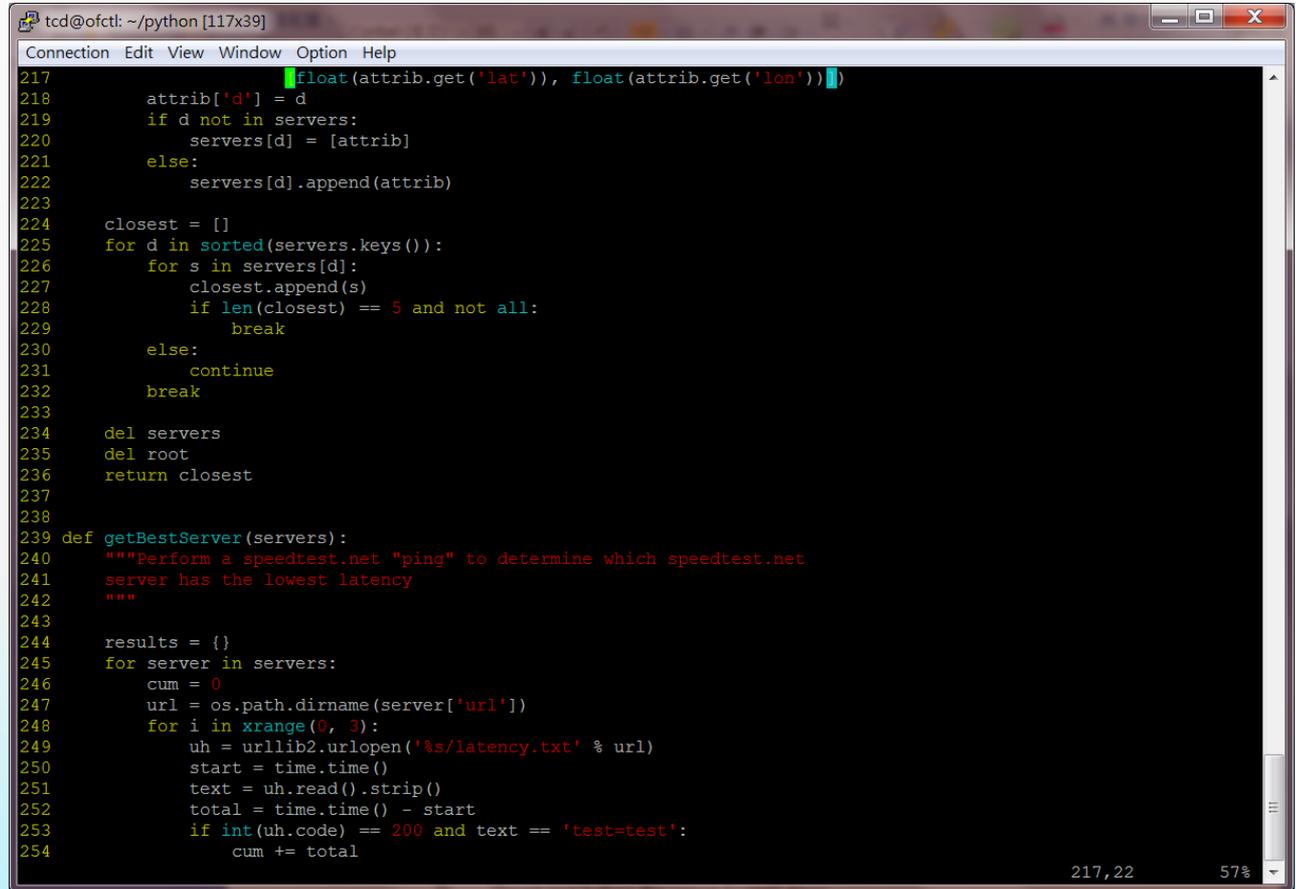


UNIX commands

- More useful commands
 - **cd** : change folder
 - **rm** : delete files
 - **rm -r** : remove the whole folder
 - **tar** : pack and/or compress files
 - **mv** : move or rename file
 - **exit** : logout
 - **cat**: read a file
 - **more**: read a file with scrolling by enter or space key
 - **less**: read a file with scrolling by PgUp or PgDn

UNIX Editors

- nano
- vi
- vim
- gedit
- joe
- emacs



The screenshot shows a terminal window titled "tcd@ofctl: ~/python [117x39]". The window contains a Python script with the following code:

```
217         float(attrib.get('lat')), float(attrib.get('lon'))]]
218     attrib['d'] = d
219     if d not in servers:
220         servers[d] = [attrib]
221     else:
222         servers[d].append(attrib)
223
224     closest = []
225     for d in sorted(servers.keys()):
226         for s in servers[d]:
227             closest.append(s)
228             if len(closest) == 5 and not all:
229                 break
230         else:
231             continue
232         break
233
234     del servers
235     del root
236     return closest
237
238
239 def getBestServer(servers):
240     """Perform a speedtest.net "ping" to determine which speedtest.net
241     server has the lowest latency
242     """
243
244     results = {}
245     for server in servers:
246         cum = 0
247         url = os.path.dirname(server['url'])
248         for i in xrange(0, 3):
249             uh = urllib2.urlopen('%s/latency.txt' % url)
250             start = time.time()
251             text = uh.read().strip()
252             total = time.time() - start
253             if int(uh.code) == 200 and text == 'test=test':
254                 cum += total
```

The terminal window also shows a menu bar with "Connection", "Edit", "View", "Window", "Option", and "Help". The status bar at the bottom right indicates "217,22" and "57%".

vim commands

- To open or edit a file:

```
tcd@ofctl:~/python$ vim test.py
```

- Insert text: i
- Move the cursor: h (←), j (↓), k (↑), l (→), PgUp, PgDn, Home (o), End(\$).
- Move n letters: n[space]
- Move n lines: n[enter]



vim commands

- Move to the head of the file: gg
- Move to the tail of the file: G
- Move to the nth line of the file: nG
- Delete a letter: x
- Delete n letters: nx
- Delete a line: dd
- Delete n lines: ndd



vim commands

- Delete lines to the tail: dG
- Delete lines to the head: dgg
- Delete letters to the head of line: do
- Delete letters to the tail of line: d\$
- Copy the line: yy
- Copy n lines: nyy
- Copy lines to the tail: yG
- Copy lines to the head: ygg



vim commands

- Copy letters to the head of line: `yo`
- Copy letters to the tail of line: `y$`
- Paste on the next/last line: `p/P`
- Merge two lines: `J`
- Undo: `u`
- Redo: `[ctrl]+r`
- Repeat the last action: `.`



vim commands

- i: enter INSERT mode at the cursor position
- a: enter INSERT mode at the next position of the cursor
- o: enter INSERT mode at the next newline of cursor position
- O: enter INSERT mode at the last newline of cursor position
- Esc: enter VIEW mode



vim commands

- `:w` write the file
- `:q` simply quit vim
- `:q!` quit vim without saving
- `:wq` save and quit vim
- `:n1,n2s/word1/word2/g`
 - Replace word1 with word2 from line n1 to line n2
- `:1,$s/word1/word2/g`
 - Replace word1 with word2 from head to tail of file



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Python

- Proposed by Guido van Rossum at 1989.
- Python originally means:





Python Philosophy

- Beautiful is better than ugly.
- Explicit is better than implicit.
- Simple is better than complex.
- Complex is better than complicated.
- Readability counts!



Why Python?

- Not hard to read, write and maintain
- No compiling or linking: short development cycle
- No type declarations: simpler, shorter, flexible
- Automatic memory management: 3R
- OOP: code structuring and reusability
- Interactive shell interface: in-time execution results
- Classes, modules: programming-in-the-large support
- Famous: Google, YouTube, NASA, NSA, Pixar, etc

Hello Spam!

- Enter Python Shell

```
tcd@ofctl:~/python$ python
Python 2.7.6 (default, Mar 22 2014, 22:59:56)
[GCC 4.8.2] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> █
```

- Hello Spam!

```
>>> print 'Hello Spam!'
Hello Spam!
```

.py script(file)

- Create a .py file

```
tcd@ofctl:~/python$ vim hello.py
```

- Edit the file

```
1
2 x = 'Hi Eggs, My name is Spam.'
3 print 'Spam:',x
4 print 'Eggs:', 'Hello Spam!'
5
6 print 1+2
7 print 2 ** 20
8
```

- Execute it

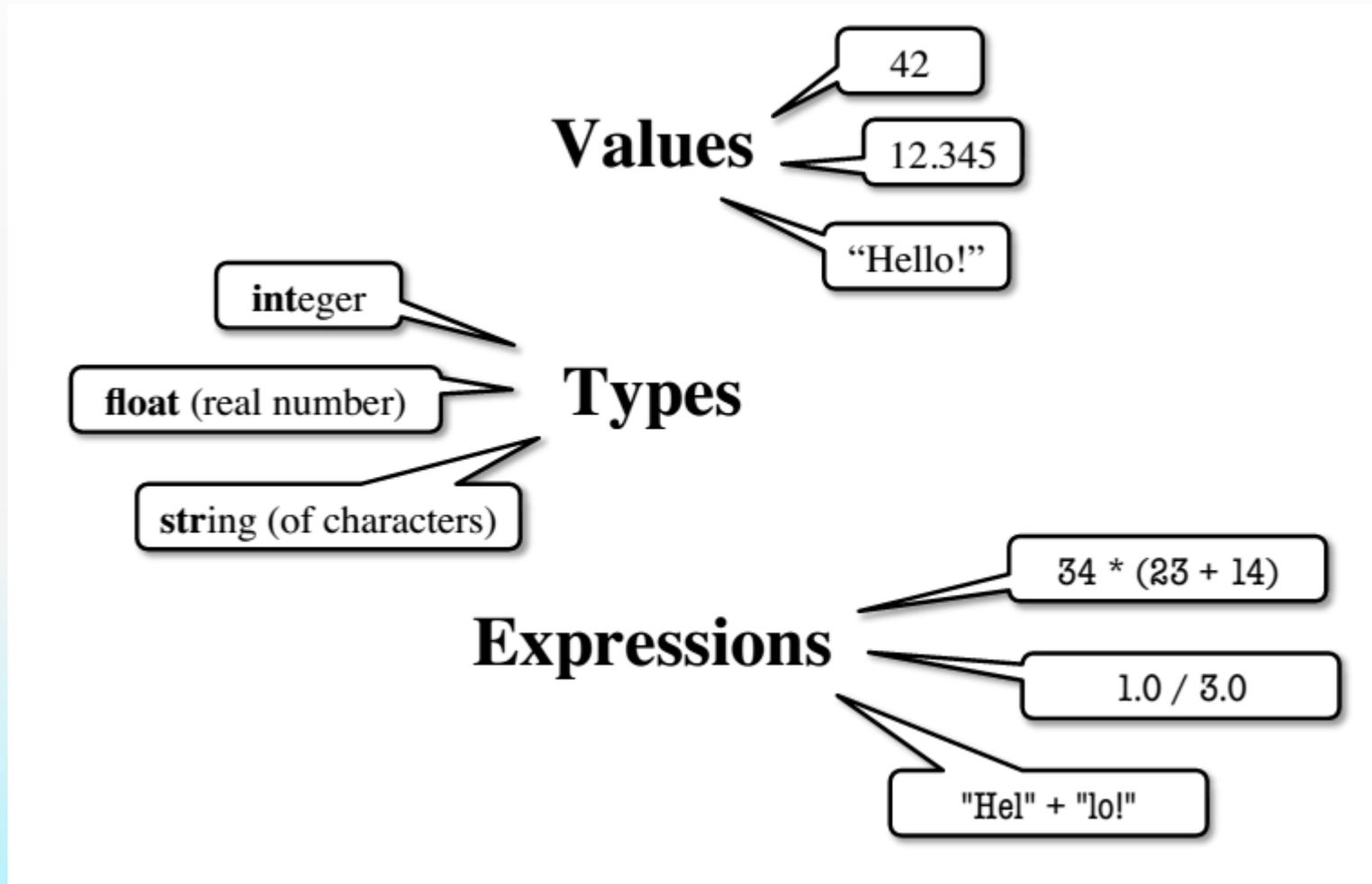
```
tcd@ofctl:~/python$ python hello.py
Spam: Hi Eggs, My name is Spam.
Eggs: Hello Spam!
3
1048576
```



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Components



Type: `int`

- Values: -100, 0, 123, 1048576, etc.
- Operations: +, -, *, /, **(power), %(modulo)
- Operations on **int** values yield an **int**
 - $1 / 2 = 0$
 - $3 / 2 = 1$
- To obtain 1.5 for $3 / 2$?!
 - `float(3) / 2`
 - $3.0 / 2$
 - $3. / 2$

Type: float

- Values: -10.23, 0.0, 123.456, etc.
- Operations: +, -, *, /, **, %
- Exponent notation:
 - A day has $8.64e4$ (86400) seconds
 - Boltzmann constant: $1.38e-23$ joule/K

Type: str

- Values: sequence of characters
 - 'Hello Spam!'
 - 'a # b & abc \$ abcdefg'
- Operation: + for catenation
 - 'He' + 'llo' = 'Hello'
 - 'join' + 4 + 'free' results in an error message
 - 'join' + '4' + 'free' = 'join4free'
- Operation: * for repeating
 - 'TANET' * 3 = 'TANETTANETTANET'

Type: bool

- Values: True, False
- Operations: and, or, not, ^ (xor; exclusive or)
- Often come from comparisons:
 - Order comparison: <, <=, >, >=
 - Equality: ==, !=

Type Query and Conversion

- `>>> type(2.5)`
 - `<type 'float'>`
- `>>> type(True)`
 - `<type 'bool'>`
- `>>> int(3.14)`
 - `3`
- `>>> float(2)`
 - `2.0`



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Precedence of Operators

- Exponentiation: `**`
- Unary operators: `+`, `-`
- Binary arithmetic: `*`, `/`, `%`
- Binary arithmetic: `+`, `-`
- Comparisons: `>`, `>=`, `<`, `<=`
- Equality: `==`, `!=`
- Logical not
- Logical and
- Logical or

Enhanced & Bitwise Operators

- Enhanced operators: +=, -=, *=, /=, %=, **=
 - $x += y$ means $x = x + y$
 - $x **= y$ means $x = x ** y$
 - No $x++$ expression in Python!
- Bitwise operators: &(and), |(or), ^(xor), ~(not), <<(left shift), >>(right shift)
 - $>>> x = 4$
 - $>>> x << 1$
 - $>>> x | 1$
 - $>>> x \& 1$

Variables & Value Assignment

- `>>> x = 3`
- `>>> x`
 - 3
- `>>> x = x + 2`
- `>>> x`
 - 5
- `>>> x = x * 2 + 2`
- `>>> x`
 - 12



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Dynamic Typing

- Python is a dynamically typed language
 - Variables can hold values of any type
 - Variables can hold different types at different times
 - Use `type(x)` to find out the type of the value in `x`
 - Use names of types for conversion, comparison
- `>>> x = 5`
- `>>> type(x)`
 - `<type 'int'>`
- `>>> x = x / 2.`
- `>>> type(x)`
 - `<type 'float'>`

Type Confirmation

- `>>> x = 5`
- `>>> type(x)`
 - `<type 'int'>`
- `>>> type(x) == float`
 - `False`
- `>>> type('abcd') == str`
 - `True`



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String: Text-Valued Variable

- Use `"` (preferred) or `'''` to quote characters.
- When quotation marks are needed in the string, use another one.
 - `'Happy "B"irthday'`
 - `"Alles 'G'ute zum Geburtstag"`
- Escape characters:

Char	Meaning
<code>\'</code>	single quote
<code>\"</code>	double quote
<code>\n</code>	new line
<code>\t</code>	tab
<code>\\</code>	backslash

Indices of a String

- `>>> x = 'Robin van Persie'`
- `>>> x[0]`
 - `R`
- `>>> len(x)`
 - `16`
- `>>> x[6:9]`
 - `'van'`
- `>>> x[6:]`
 - `'van Persie'`

Other String Methods

- `>>> 'x' in x`
 - False
- `>>> 'Per' in x`
 - True
- `>>> x.index('v')`
 - 6
- `>>> x.count('i')`
 - 2

Even More String Methods?

- `>>> from string import *`
- `>>> dir()`
 - `['Formatter', 'Template', '__builtins__', '__doc__', '__name__', '__package__', 'ascii_letters', 'ascii_lowercase', 'ascii_uppercase', 'atof', 'atof_error', 'atoi', 'atoi_error', 'atol', 'atol_error', 'capitalize', 'capwords', 'center', 'count', 'digits', 'expandtabs', 'find', 'hexdigits', 'index', 'index_error', 'join', 'joinfields', 'letters', 'ljust', 'lower', 'lowercase', 'lstrip', 'maketrans', 'octdigits', 'printable', 'punctuation', 'replace', 'rfind', 'rindex', 'rjust', 'rsplit', 'rstrip', 'split', 'splitfields', 'strip', 'swapcase', 'translate', 'upper', 'uppercase', 'whitespace', 'zfill']`
- Refer to <https://docs.python.org/2/library/>

Python Modules

The image shows a screenshot of the Python documentation for the `math` module. The page is divided into a left sidebar and a main content area. The sidebar contains a table of contents with sections like "9.2.1. Number-theoretic and representation functions", "9.2.2. Power and logarithmic functions", "9.2.3. Trigonometric functions", "9.2.4. Angular conversion", "9.2.5. Hyperbolic functions", "9.2.6. Gamma functions", and "9.2.7. Miscellaneous functions". The main content area shows the documentation for the `math.ceil(x)` function. The function signature is `math.ceil(x)`, and the description is "Return the ceiling of `x` as a float, the smallest integer value greater than or equal to `x`".

Callouts from the image:

- Function name**: Points to `ceil` in `math.ceil(x)`.
- Argument list**: Points to `(x)` in `math.ceil(x)`.
- Module**: Points to `math` in `math.ceil(x)`.
- What the function evaluates to**: Points to the description "Return the ceiling of `x` as a float, the smallest integer value greater than or equal to `x`".

Other visible text in the screenshot includes:

- standard.
- These functions cannot be used with complex numbers; use the functions of the same name from the `cmath` module if you require support for complex numbers. The distinction between functions which support complex numbers and those which don't is made since most users do not want to learn quite as much mathematics as required to understand complex numbers. Receiving an exception instead of a complex result allows earlier detection of the unexpected complex number used as a parameter, so that the programmer can determine how and why it was generated in the first place.
- Following functions are provided by this module. Except when explicitly noted otherwise, all return values are floats.
- `math.copysign(x, y)` from that supports signed zeros, `copysign(1.0, -0.0)` returns
- New in version 2.6.*
- `math.fabs(x)` Return the absolute value of `x`.
- `math.factorial(x)`

Python Modules

- Frequently used modules:
 - io: Read/write from files
 - math: Mathematical functions
 - random: Generate random numbers
 - Distribution selectable
 - string: Useful string functions
 - sys: Information about your OS
- Refer to:
 - <https://docs.python.org/2/library/>
 - <https://docs.python.org/2/py-modindex.html>

Import a Python Module

- `>>> import math`
- `>>> import random`
- `>>> math.pi`
 - `3.141592653589793`
- `>>> print math.sin(math.pi/6)`
- `>>> random.random()`
- `>>> int(random.random()*10)+1`
- `>>> random.randint(1,10)`

List

- A list is a series of data inside [](brackets).
 - Items are separated by “,”(comma).
 - Items are not necessarily of the same type.
 - Items are editable.
 - A list can contain another list
-
- `>>> x = [2,5,'abc',10.1,'!!!',True]`
 - `>>> type(x[2])`
 - `<type 'str'>`

List

- `>>> type(x)`
 - `<type 'list'>`
- `>>> x[2:5]`
 - `['abc', 10.1, '!!!']`
- `>>> x[1] = 'hello'`
- `>>> x`
 - `[2, 'hello', 'abc', 10.1, '!!!', True]`
- `>>> x[2]=[4,5]`
 - `[2, 'hello', [4, 5], 10.1, '!!!', True]`

List

- `>>> x.append(55)`
- `>>> x`
 - `[2, 'hello', [4, 5], 10.1, '!!!', True, 55]`
- `>>> y = [2, 8, 5, 7, 1, 4]`
- `>>> y.sort()`
 - `[1, 2, 4, 5, 7, 8]`
- `>>> y.pop()`
- `>>> y`
 - `[2, 4, 5, 7, 8]`

List

- `>>> y.reverse()`
- `>>> y`
 - `[8, 7, 5, 4, 2]`
- `>>> y.insert(2, 'hi')`
- `>>> y`
 - `[8, 7, 'hi', 5, 4, 2]`
- `>>> del y[3]`
- `>>> y`
 - `[8, 7, 'hi', 4, 2]`

List

- `>>> y+[6,5,4]`
 - `[8, 7, 'hi', 4, 2, 6, 5, 4]`
- `>>> y`
 - `[8, 7, 'hi', 4, 2]`
- `>>> y += [6,5,4]`
- `>>> y`
 - `[8, 7, 'hi', 4, 2, 6, 5, 4]`
- `>> matrix = [[1,2,3],[4,5,6],[7,8,9]]`
- `>> matrix[2][1]`

List

- `>>> z = [6, 5, 0, 1, 2]`
- `>>> sum(z)`
- `>>> [min(z), max(z)]`
- `>>> range(5)`
 - `[0, 1, 2, 3, 4]`
- `>>> range(2,7)`
 - `[2, 3, 4, 5, 6]`
- `>>> range(2,7,2)`
 - `[2, 4, 6]`

Dictionary

- `>>> dic = {'Robben':11, 'Sneijder':10, 'Kuyt':15}`
- `>>> dic['Sneijder']`
 - 10
- `>>> 'Robben' in dic`
 - True
- `>>> dic.keys()`
 - ['Robben', 'Sneijder', 'Kuyt']
- `>>> dic['Kuyt'] = ['goal','miss']`

Dictionary

- `>>> dic`
 - `{'Robben': 11, 'Sneijder': 10, 'Kuyt': ['goal', 'miss']}`
- `>>> dic['Kuyt'][0]`
 - `'goal'`
- `>>> dic.pop('Sneijder')`
 - `10`
- `>>> dic`
 - `{'Robben': 11, 'Kuyt': ['goal', 'miss']}`

Tuple

- A tuple is a series of data inside ()(parentheses).
 - Items are separated by “,”(comma).
 - Items are not necessarily of the same type.
 - Items are NOT editable.
 - A tuple can contain another list or tuple.
-
- `>>> t1 = (6,5,4)`
 - `>>> t2 = 9,8,7`

Tuple

- `>>> t1 + t2`
 - `(6, 5, 4, 9, 8, 7)`
- `>>> t2[1]`
- `>>> t3 = 'hello','hola','boujour'`
- `>>> t3 * 2`
 - `('hello', 'hola', 'boujour', 'hello', 'hola', 'boujour')`
- `>>> t4 = t1[0],t2[1:3]`
- `>>> t4`
 - `(6, (8, 7))`

Tuple

- `>>> r = [x*5 for x in t1]`
- `>>> r`
- `>>> t1[0] = 1`
 - `TypeError: 'tuple' object does not support item assignment`
- `>>> t1 = list(t1)`
- `>>> t1[0] = 1`
- `>>> t1 = tuple(t1)`
- `>>> t1`



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if/elif/else Statement

- Usage: if <test1>:

<statements1>

elif <test2>:

<statements2>

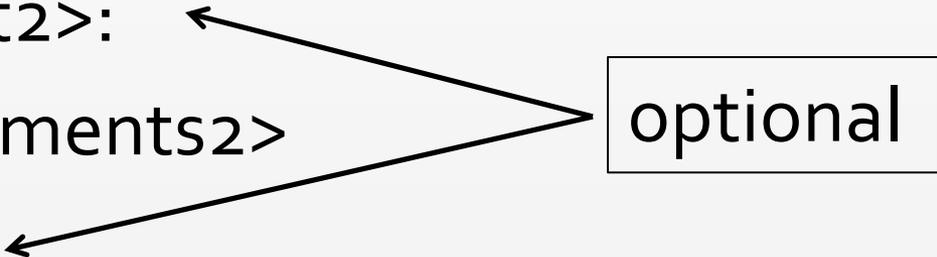
.

.

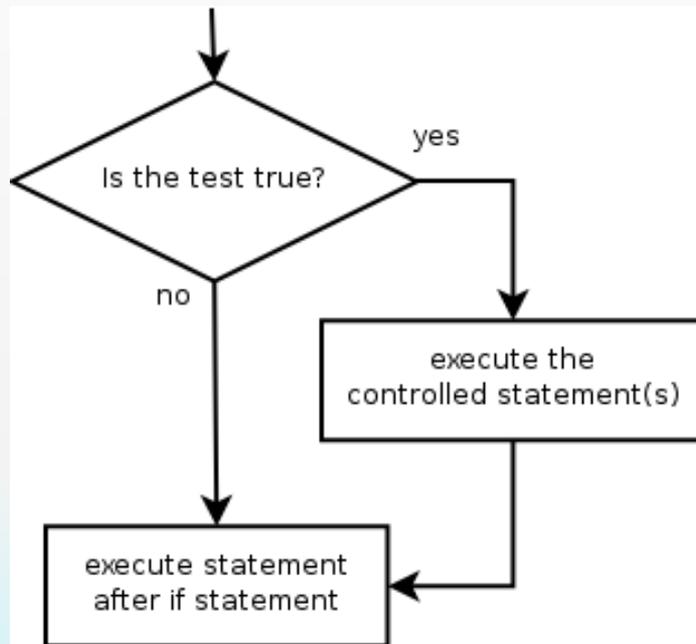
else:

<statements3>

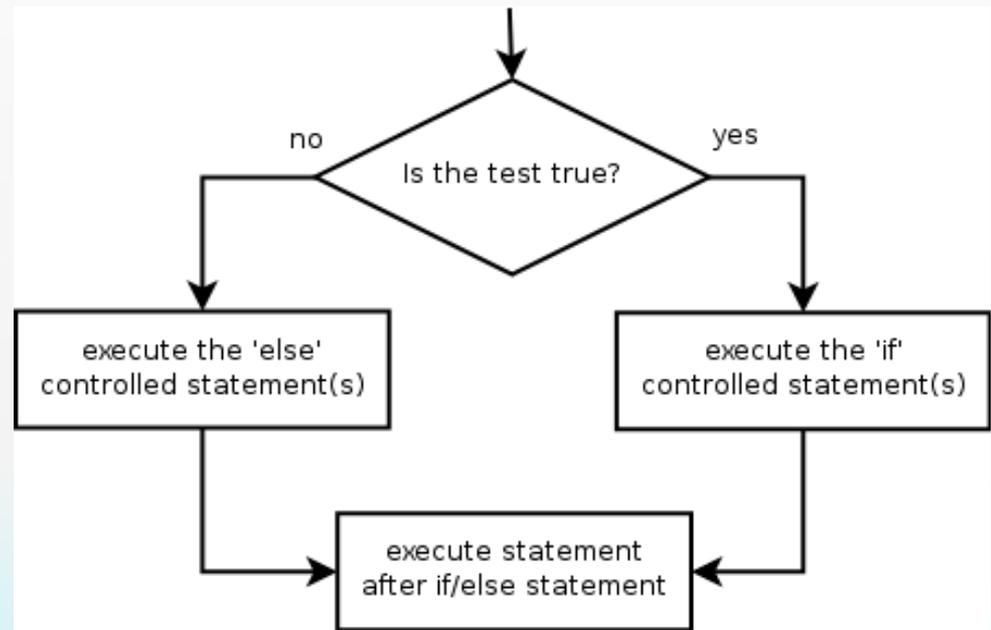
optional



if/elif/else Statement

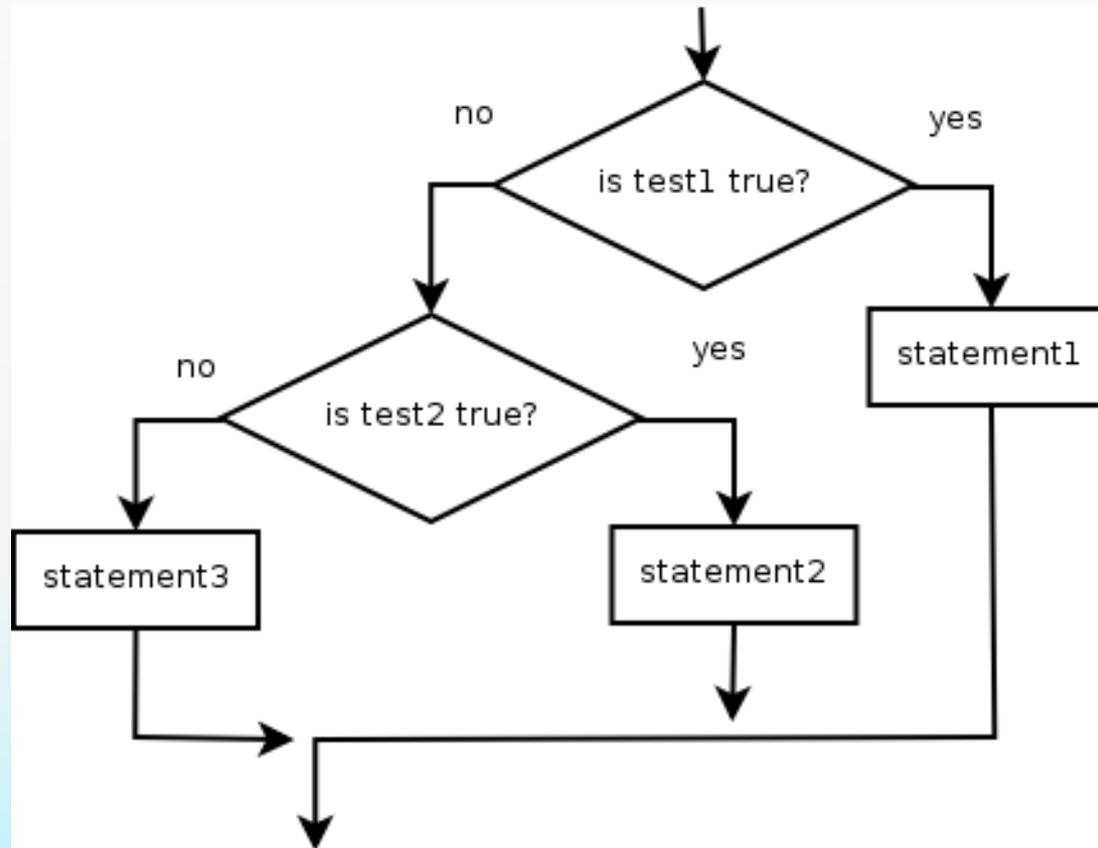


if



if/else

if/elif/else Statement



if/elif/else

if/elif/else Statement

- Example:

```
1
2 x = raw_input('enter a positive integer: ')
3
4 if not x.isdigit():
5     print x, 'is not a positive integer'
6 elif int(x) < 10:
7     print 'the integer is less than 10'
8 else:
9     print 'the integer is larger than 10'
10
```

map Function

- Usage: `map(<function>, <sequence>)`
- Example 1:
 - `>>> x = [1.2, 3.4, 5.6, 7.8]`
 - `>>> y = map(round, x)`
- Example 2:
 - `>>> x = ['55', '66', 'derdi', 'y']`
 - `>>> y = map(len, x)`
- Example 3:
 - `>>> x = ['Abian', 'MyAngel', 'DongYingBaZhu']`
 - `>>> y = (str.lower, x)`

for Statement

- Usage: **for** *<variable>* **in** *<sequence>*:
 <statements>
- Example 1:
 - `>>> for i in range(5):`
 - `print i+1`
- Example 2:
 - `>>> for i in [2,4,6,8,10]:`
 - `print '*' * i`

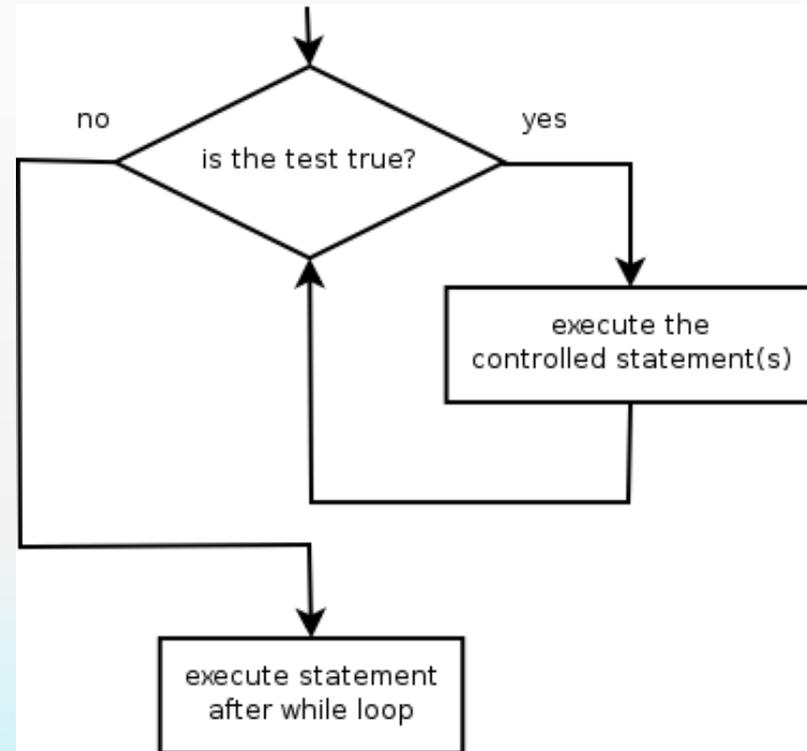
for Statement

- Example 3:
 - `>>> t = [(1,2),(3,4),(5,6)]`
 - `>>> for (a, b) in t:`
 - `... print a*b`
- Example 4:
 - `>>> s = 'OnsOranje'`
 - `>>> for i in range(len(s)):`
 - `... print ' ' * i, s[i]`

while Statement

- Usage: while <test>:
 <statements1>
else:
 <statements2>

optional



while Statement

- Example 1:
 - `>>> x = 'Spam'`
 - `>>> while x:`
 - `... print x,`
 - `... x = x[1:]`
- Example 2:
 - `>>> a, b = 0, 10`
 - `>>> while a < b:`
 - `... print a,`
 - `... a += 1`

break/continue/pass

- Appears only in loops.
- **break**: exit the loop right away, neglecting all the statements in loop.
- **continue**: go to the beginning of the loop, neglecting the rest statements.
- **pass**: do nothing, ~~used to show off your specialty~~, used to occupy a position for further revision.

A Toy

```
1
2 import string
3 nums = string.digits
4
5 while True:
6     reply = raw_input('enter: ')
7     if reply == 'stop':
8         break
9     else:
10        k = 0
11        for i in reply:
12            if i not in nums:
13                k = 1
14                break
15        if k == 0:
16            print int(reply) ** 2
17        else:
18            print reply.upper()
19 print 'au revoir!'
20
```

A “Larger” Toy - Craps

```
1
2 from random import randint
3
4 W = [7, 11]
5 L = [2, 3, 12]
6
7 def dice():
8     return randint(1,6) + randint(1,6)
9
10 P = dice()
11 print 'rolled',P,'\t'
12 if P in W:
13     S = 'win'
14 elif P in L:
15     S = 'los'
16 else:
17     S = 'con'
18     pt = P
19     print 'roll',pt,'again to win'
```

```
20
21 while S == 'con':
22     P = dice()
23     print 'rolled',P,'\t'
24     if P == pt:
25         S = 'win'
26         break
27     elif P == 7:
28         S = 'los'
29         break
30
31 if S == 'win':
32     print 'win!'
33 elif S == 'los':
34     print 'lose!'
```



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Read and write file

- `>>> myfile = open('filename','r')`
- `>>> x = myfile.readline()`
- `>>> y = myfile.read()`
- `>>> myfile.close()`
- `>>> newfile = open('towrite','w')`
- `>>> newfile.write('911 was a \n')`
- `>>> newfile.write('god-damned hoax!\n')`
- `>>> newfile.close()`

Exception handling

- `>>> x = dir(__builtins__)`
- `>>> y = []`
- `>>> for i in range(len(x)):`
- `... if 'Error' in x[i]:`
- `... y.append(x[i])`
- `>>> y`
 - `['ArithmeticError', 'AssertionError', 'AttributeError', 'BufferError', 'EOFError', 'EnvironmentError', 'FloatingPointError', 'IOError', 'ImportError', 'IndentationError', 'IndexError', 'KeyError', 'LookupError', 'MemoryError', 'NameError', 'NotImplementedError', 'OSError', 'OverflowError', 'ReferenceError', 'RuntimeError', 'StandardError', 'SyntaxError', 'SystemError', 'TabError', 'TypeError', 'UnboundLocalError', 'UnicodeDecodeError', 'UnicodeEncodeError', 'UnicodeError', 'UnicodeTranslateError', 'ValueError', 'ZeroDivisionError']`

try... except ...

- Usage: try:

<statement1>

except (<error1>):

<statement2>

.....

(else:)

- When an exception is encountered in statement1, jump to the corresponding block.
- **else** block will only be executed when no exception.

An Example

```
1
2 def fetcher(x, index):
3     return x[index]
4
5 x = 'Schweinsteiger'
6 y = 'Klose'
7 a = 5
8
9 print x
10 print y
11
12 try:
13     print fetcher(x,a)
14 except IndexError:
15     print 'x[,a,'] does not exist'
16
17 try:
18     print fetcher(y,a)
19 except IndexError:
20     print 'y[,a,'] does not exist'
21
```



Eggs

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Python Scoping

Built-in (Python)

Names preassigned in the built-in names module: `open`, `range`, `SyntaxError`....

Global (module)

Names assigned at the top-level of a module file, or declared `global` in a `def` within the file.

Enclosing function locals

Names in the local scope of any and all enclosing functions (`def` or `lambda`), from inner to outer.

Local (function)

Names assigned in any way within a function (`def` or `lambda`), and not declared `global` in that function.

Functions

- `tcd@ofctl:~/python$ vim simplearith.py`

```
1
2 def add(a,b):
3     print a, '+', b, '=', a+b
4     return a+b
5
6 def minus(a,b):
7     print a, '-', b, '=', a-b
8     return a-b
9 □
```

- `>>> import simplearith`
- `>>> x = simplearith.add(4,1)`
 - `4 + 1 = 5`
- `>>> y = simplearith.minus(4,1)`
 - `4 - 1 = 3`

Functions

- Keywords: **def**, **return**
- Another example: Fibonacci sequence

```
1
2 def fibonacci(x):
3     a,b = 1,1
4     for i in range(x-1):
5         a,b = b, a+b
6     return a
7
8 fib = []
9
10 for i in range(1,21):
11     fib.append(fibonacci(i))
12
13 print fib
14
```

Functions

- Execution time function definition is allowed.
- Function overloading is allowed.

```
1
2 x = input('enter an integer: ')
3 y = raw_input('enter a string: ')
4
5 if x % 2 == 0:
6     def func(z):
7         return z[1::2]
8 else:
9     def func(z):
10        return z[0::2]
11
12 print func(y)
13
```

Functions

- Roll a die many times to see if it is fair.

```
1 from random import randint
2
3 t = raw_input('times to roll: ')
4 x = [0,0,0,0,0,0]
5
6 if not t.isdigit():
7     print 'Antler is the hair in the ear of deer?!'
8
9 else:
10    for i in range(int(t)):
11        r = randint(1,6)
12        x[r-1] += 1
13
14    ctr = 0
15    while ctr < 6:
16        print ctr+1, 'point: ', x[ctr], 'times'
17        ctr += 1
18
```

- Of course you have to enter an integer!

More about Functions

- Default value setting:
 - `>>> def fun1(a, b, c):` `print a,b,c`
 - `>>> def fun2(a,b,c=1):` `print a,b,c`
- `*pargs` & `**kargs` are used to pass a variable number of arguments to a function.
 - `*pargs` is used to pass a non-keyworded, variable-length argument list.
 - `**kargs` is used to pass a keyworded, variable-length argument list.

More about Functions

```
1
2 def test_var_pargs(farg, *pargs):
3     print 'formal arg:', farg
4     for arg in pargs:
5         print 'another arg:', arg
6
7 def test_var_kargs(farg, **kargs):
8     print 'formal arg:', farg
9     for key in kargs:
10        print 'another keyword arg: %s: %s' % (key, kargs[key])
11
12 def test_var_args_call(arg1, arg2, arg3):
13     print "arg1:", arg1
14     print "arg2:", arg2
15     print "arg3:", arg3
```

```
16
17
18 test_var_pargs(1, 'two', 3)
19 test_var_kargs(farg=1, myarg2='two', myarg3=3)
20
21 pargs = ('two', 3)
22 test_var_args_call(1, *pargs)
23 kargs = {'arg3': 3, 'arg2': 'two'}
24 test_var_args_call(1, **kargs)
25
```



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Haunted by Module

- A module is intrinsically a file containing Python definitions and statements.
- A module can contain executable statements as well as function definitions.
- The statements in a module are intended to initialize the module. They are executed only the first time the module name is encountered in an **import** statement.

Haunted by Module

- The built-in function **dir()** is used to find out which names a module defines. It returns a sorted list of strings.
- ```
>>> dir()
```
- ```
>>> dir(__builtins__)
```
- ```
>>> import math
```
- ```
>>> dir(math)
```

reload

- Re-import an imported module after revision.
- Often used when restarting the entire application is costly.

- `>>> import reload`
- `>>> reload.printer()`
- `>>> reload(reload)`
- `>>> reload.printer()`

```
1
2 message = 'first version'
3
4 def printer():
5     print message
6
```

```
1
2 message = 'second version'
3
4 def printer():
5     print message
6
```

Import Nested Modules

- To figure out your current search path:
 - `>>> import sys`
 - `>>> sys.path`
 - `[..... '/usr/local/lib/python2.7/dist-packages',.....]`
- To import the module in `dir1/dir2/`, simply type:
 - `import dir1.dir2.<module name>`
- Remember to add a `__init__.py` in a user-defined module dir.

```
tcd@ofctl1:~$ ls /usr/local/lib/python2.7/dist-packages/ryu
app      cfg.pyc  controller  flags.py  hooks.pyc  lib      ofproto  topology
base     cmd      exception.py flags.pyc  __init__.py log.py   services  utils.py
cfg.py   contrib  exception.pyc hooks.py  __init__.pyc log.pyc  tests    utils.pyc
```

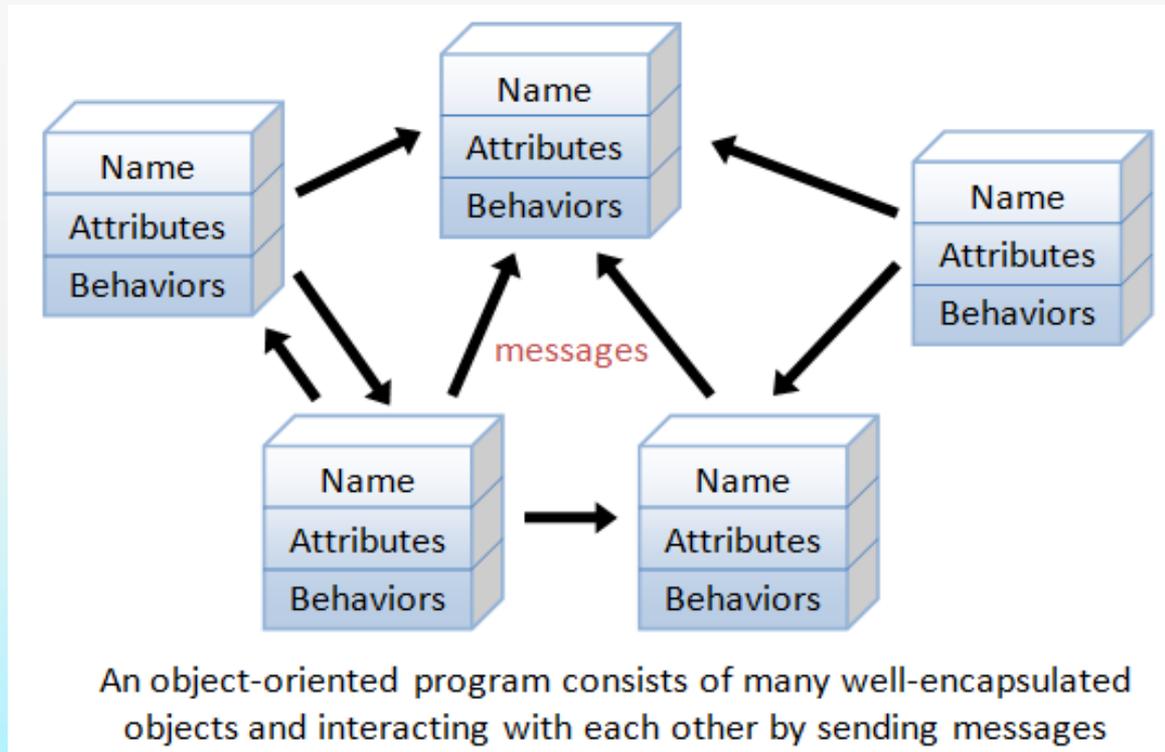


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Viva OOP!

- Object-oriented programming is an approach to design modular, reusable systems.





Viva OOP!

- The goals of OOP are:
 - Increased understanding
 - Ease of maintenance
 - Ease of evolution
- Object is an instance of class.
- Class is the definition of object, defining the components and functionality.

An Example of Class

```
1
2 class firstcla:
3
4     def setData(self, value):
5         self.data = value
6     def display(self):
7         print self.data
8
9     a = 1
10    b = 2
11
12
13 class secondcla(firstcla):
14
15     def display(self):
16         print 'current value = \'%s\'' % self.data
17     def dispsh(z):
18         print '*' * z
19
20    b = 3
21    c = 4
22
```

An Example of Class

- Object creation:
 - `>>> x = firstcla()`
 - `>>> y = secondcla()`
- Definition (methods & variables) visualization:
 - `>>> dir(y)`
 - `['__doc__', '__module__', 'a', 'b', 'c', 'data', 'display', 'dispsb', 'setData']`
 - `>>> dir(x)`
 - `['__doc__', '__module__', 'a', 'b', 'data', 'display', 'setData']`

Inheritance

- Inheritance is when an object or class is based on another object or class, using the same implementation or specifying implementation to maintain the same behavior.
- Usage: `class derivedClass(baseClass1,...):`
 <statements>
 - Depth-first
 - Left to right
 - Self -> Father -> Grandfather

An Example of Class

- Method (function) call:

- `>>> x.setData('Nigel de Jong')`
- `>>> x.display()`
- `>>> y.dispsh(5)`

- Attribute reference:

- `>>> y.c` ← Quite straightforward
- `>>> y.b` ← 2 or 3 ??
- `>>> y.a` ← Inherited attribute

Class Example Enhanced

- Initiation operation `__init__`: things to do when right after the object is created.
- If you are familiar with C++, recall “constructor.”

```
1
2 class firstcla:
3
4     def __init__(self):
5         self.data = 'data unset!'
6         self.x = 2048
7     def setData(self, value):
8         self.data = value
9     def display(self):
10        print self.data
11
12    a = 1
13    b = 2
14
```

Set Values when Hatching

```
1
2 class firstcla:
3
4     def __init__(self, value='data unset!'):
5         self.data = value
6         self.x = 2048
7     def setData(self, value):
8         self.data = value
9     def display(self):
10        print self.data
11
```

- >>> x = firstcla()
- >>> y = firstcla('BRT?BUS?')
- >>> x.display()
- >>> y.display()

