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Python

Libraries

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Hierarchical organization

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A *library* does the same thing for related functions

Hierarchical organization

library

function

statement

Every Python file can be used as a library

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Use `import` to load it

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```
# halman.py
def threshold(signal):
    return 1.0 / sum(signal)
```

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# halman.py
def threshold(signal):
   return 1.0 / sum(signal)
```

```
# program.py
import halman
readings = [0.1, 0.4, 0.2]
print('signal threshold is', halman.threshold(readings))
```

Every Python file can be used as a library

Use `import` to load it

```
# halman.py
def threshold(signal):
   return 1.0 / sum(signal)
```

```
# program.py
import halman
readings = [0.1, 0.4, 0.2]
print('signal threshold is', halman.threshold(readings))
```

```
$ python program.py
signal threshold is 1.4285714285714286
```

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NOISE_LEVEL = 1./3.
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NOISE_LEVEL = 1./3.
```

```
>>> import noisy
is this module being loaded?
```

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1. Executes the statements it contains
2. Creates an object that stores references to the top-level items in that module

```
# noisy.py
print('is this module being loaded?')
NOISE_LEVEL = 1./3.
```

```
>>> import noisy
is this module being loaded?
>>> print(noisy.NOISE_LEVEL)
0.3333333333333333
```

Each module is a *namespace*

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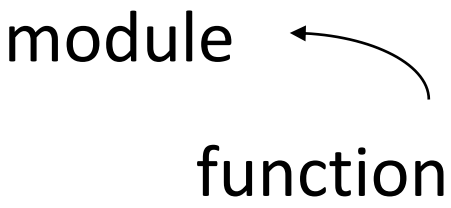
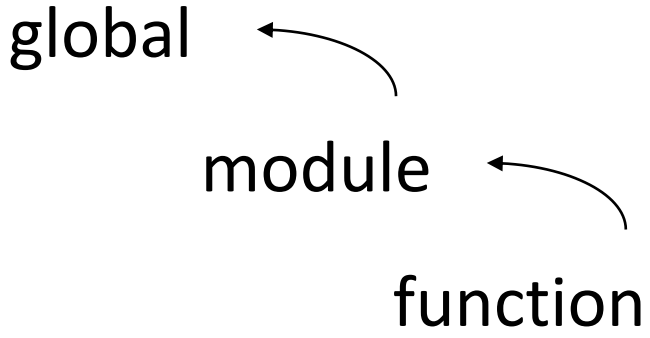
function

Each module is a *namespace*



Each module is a *namespace*



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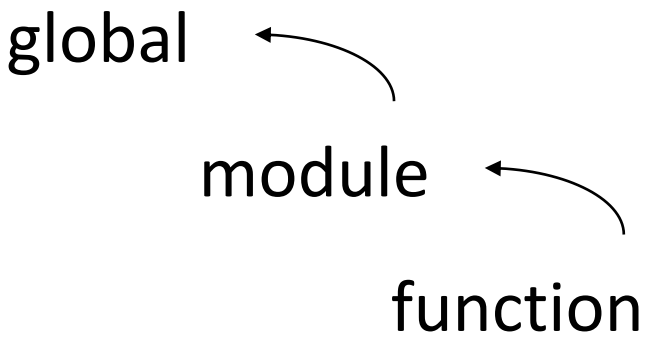
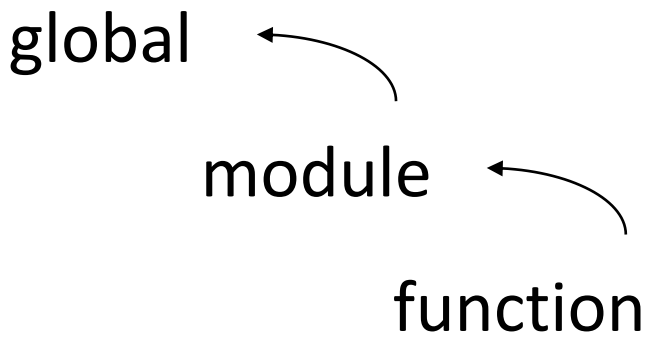



```
# module.py
NAME = 'Transylvania'

def func(arg):
   return NAME + ' ' + arg
```

Each module is a *namespace*

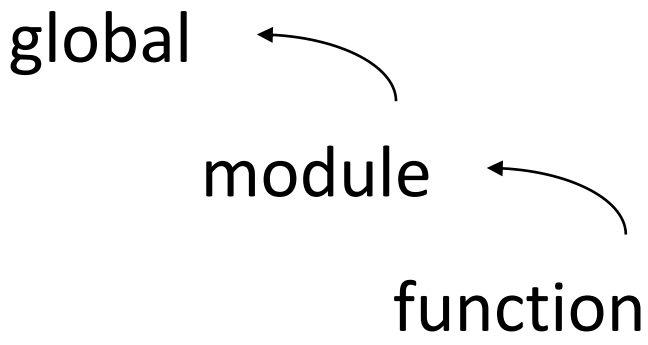



```
# module.py
NAME = 'Transylvania'

def func(arg):
  return NAME + ' ' + arg
```

```
>>> NAME = 'Hamunaptra'
```

Each module is a *namespace*

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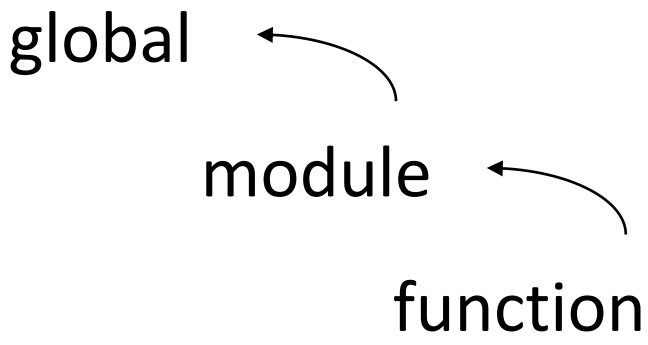
# module.py
NAME = 'Transylvania'

def func(arg):
  return NAME + ' ' + arg
```

```
>>> NAME = 'Hamunaptra'
>>> import module
```

Each module is a *namespace*




```
# module.py
NAME = 'Transylvania'

def func(arg):
  return NAME + ' ' + arg
```

```
>>> NAME = 'Hamunaptra'
>>> import module
>>> print(module.func('!!!'))
Transylvania !!!
```

Python comes with many standard libraries

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>>> import math
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>>> print(math.sqrt(2))
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>>> print(math.hypot(2, 3))   # sqrt(x**2 + y**2)
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```

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>>> import math
>>> print(math.sqrt(2))
1.4142135623730951
>>> print(math.hypot(2, 3))   # sqrt(x**2 + y**2)
3.605551275463989
>>> print(math.e, math.pi)    # as accurate as possible
2.718281828459045 3.141592653589793
```

Python also provides a `help` function

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```
>>> import math
>>> help(math)
Help on module math:
NAME
    math
MODULE REFERENCE
    https://docs.python.org/3.7/library/math
DESCRIPTION
    This module is always available.  It provides access to th
    mathematical functions defined by the C standard.
FUNCTIONS
    acos(x, /)
    Return the arc cosine (measured in radians) of x.
:
```

And some nicer ways to do imports

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```
>>> from math import sqrt
>>> sqrt(3)
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```

And some nicer ways to do imports

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>>> from math import sqrt
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>>> from math import hypot as euclid
>>> euclid(3, 4)
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>>> from math import *
>>> sin(pi)
1.2246467991473532e-16
>>>
```

And some nicer ways to do imports

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>>> from math import sqrt
>>> sqrt(3)
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>>> from math import hypot as euclid
>>> euclid(3, 4)
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>>> from math import *
>>> sin(pi)
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>>>
```

← Generally a bad idea

And some nicer ways to do imports

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```

← Generally a bad idea

Someone could add to the library after you start using it

Almost every program uses the `sys` library

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>>> import sys
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```
>>> import sys
>>> print(sys.version)
3.7.0 (default, Jun 28 2018, 13:15:42)
[GCC 7.2.0]
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>>> print(sys.maxsize)
9223372036854775807
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Almost every program uses the `sys` library

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>>> print(sys.platform)
linux
>>> print(sys.maxsize)
9223372036854775807
>>> print(sys.path)
['',
'/home/vagrant/miniconda3/envs/isc/lib/python37.zip',
'/home/vagrant/miniconda3/envs/isc/lib/python3.7',
'/home/vagrant/miniconda3/envs/isc/lib/python3.7/lib-dynload',
'/home/vagrant/miniconda3/envs/isc/lib/python3.7/site-packages']
```

`sys.argv` holds command-line arguments

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Script name is `sys.argv[0]`

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```
# echo.py
import sys
for i in range(len(sys.argv)):
    print(i, " " + sys.argv[i] + " ")
```

`sys.argv` holds command-line arguments

Script name is `sys.argv[0]`

```
# echo.py
import sys
for i in range(len(sys.argv)):
    print(i, " " + sys.argv[i] + " ")
```

```
$ python echo.py
0 echo.py
$
```

`sys.argv` holds command-line arguments

Script name is `sys.argv[0]`

```
# echo.py
import sys
for i in range(len(sys.argv)):
    print(i, " " + sys.argv[i] + " ")
```

```
$ python echo.py
0 echo.py
$ python echo.py first second
0 echo.py
1 first
2 second
$
```

`sys.stdin` is *standard input* (e.g., the keyboard)

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See the Unix shell lecture for more information

Picking up changes in external libraries ("reload")

In some scenarios you will want to keep a python session running whilst modifying an external module.

Picking up changes in external libraries ("reload")

In some scenarios you will want to keep a python session running whilst modifying an external module.

E.g…

```
>>> import mylib
>>> print(mylib.x)
33.8
>>> # change "mylib.py" now and get new x
```

Let's look in detail

```
>>> import mylib
>>> print(mylib.x)
33.8
```

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```
>>> import mylib
>>> print(mylib.x)
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```

Change "mylib.py" so that x is set to "hello" - and save the module.

```
>>> import mylib
>>> print(mylib.x)
33.8
```

Let's look in detail

```
>>> import mylib
>>> print(mylib.x)
33.8
```

Change "mylib.py" so that x is set to "hello" - and save the module.

```
>>> import mylib
>>> print(mylib.x)
33.8
```

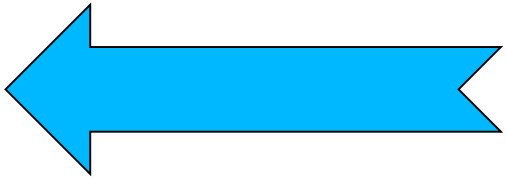
Oh No! Python has ignored my changes.

We need to "reload"!!!

```
>>> import mylib
>>> print(mylib.x)
33.8
```

Change "mylib.py" so that x is set to "hello" - and save the module.

```
>>> reload(mylib)
>>> print(mylib.x)
hello
```



It worked!

Free stuff - the Python Standard Library

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10. Full Grammar specification

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The Python Standard Library

While The Python Language Reference describes the exact syntax and semantics of the Python language, this library reference manual describes the standard library that is distributed with Python. It also describes some of the optional components that are commonly included in Python distributions.

Python's standard library is very extensive, offering a wide range of facilities as indicated by the long table of contents listed below. The library contains built-in modules (written in C) that provide access to system functionality such as file I/O that would otherwise be inaccessible to Python programmers, as well as modules written in Python that provide standardized solutions for many problems that occur in everyday programming. Some of these modules are explicitly designed to encourage and enhance the portability of Python programs by abstracting away platform-specifics into platform-neutral APIs.

The Python installers for the Windows platform usually include the entire standard library and often also include many additional components. For Unix-like operating systems Python is normally provided as a collection of packages, so it may be necessary to use the packaging tools provided with the operating system to obtain some or all of the optional components.

In addition to the standard library, there is a growing collection of several thousand components (from individual programs and modules to packages and entire application development frameworks), available from the Python Package Index.

- Introduction

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

More examples from the **Python Standard Library**

datetime:

```
>>> from datetime import date,
timedelta
>>> today = date.today()
>>> print(today)
2018-09-28
>>> print(today - timedelta(days=365))
2017-09-28
```

random:

```
>>> import random
>>> random.random() # Random float x, 0 <= x < 1
0.5227860581946859
>>> random.uniform(1, 10) # Random float x, 1 <= x < 10
1.2573473116956713
>>> random.randint(1, 10) # Integer from 1 to 10,
4                           endpoints included
```

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

urllib:

```
>>> import urllib.request
>>> response =
urllib.request.urlopen('http://python.org/')
>>> print(response.readlines()[:3])
[b'<!doctype html>\n', b'<!--[if lt IE 7]>   <html
class="no-js ie6 lt-ie7 lt-ie8 lt-ie9">   <![endif]-
->\n', b'<!--[if IE 7]>      <html class="no-js ie7
lt-ie8 lt-ie9">
<![endif]-->\n']
```

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

```
# count.py
import sys
if len(sys.argv) == 1:
  count_lines(sys.stdin)
else:
  rd = open(sys.argv[1], 'r')
  count_lines(rd)
  rd.close()
```

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if len(sys.argv) == 1:
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# count.py
import sys
if len(sys.argv) == 1:
   count_lines(sys.stdin)
else:
   rd = open(sys.argv[1], 'r')
   count_lines(rd)
   rd.close()
```

```
$ python count.py < a.txt
48
$
```

```
# count.py
import sys
if len(sys.argv) == 1:
   count_lines(sys.stdin)
else:
   rd = open(sys.argv[1], 'r')
   count_lines(rd)
   rd.close()
```

```
$ python count.py < a.txt
48
$ python count.py b.txt
227
$
```

The more polite way

```
'''Count lines in files.  If no filename arguments given,
read from standard input.'''

import sys

def count_lines(reader):
  '''Return number of lines in text read from reader.'''
  return len(reader.readlines())

if __name__ == '__main__':
  ...as before...
```

The more polite way

```
'''Count lines in files.  If no filename arguments given,
read from standard input.'''

import sys

def count_lines(reader):
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```

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Used for online (and offline) help

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```
# adder.py
'''Addition utilities.'''

def add(a, b):
   '''Add arguments.'''
   return a+b
```

If the first statement in a module or function is

a string, it is saved as a *docstring*

Used for online (and offline) help

```
# adder.py
'''Addition utilities.'''

def add(a, b):
   '''Add arguments.'''
   return a+b
```

```
>>> import adder
>>> help(adder)
Help on module adder:

NAME
    adder - Addition utilities.

FUNCTIONS
    add(a, b)
        Add arguments.

FILE
    /home/vagrant/adder.py
```

If the first statement in a module or function is

a string, it is saved as a *docstring*

Used for online (and offline) help

```
# adder.py
'''Addition utilities.'''

def add(a, b):
   '''Add arguments.'''
   return a+b
```

```
>>> import adder
>>> help(adder.add)
Help on function add in
module adder:

add(a, b)
    Add arguments.
>>>
```

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main program

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`'__main__'`	module name

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main program	loaded as library
`'__main__'`	module name

```
...module definitions...

if __name__ == '__main__':
   ...run as main program...
```

When Python loads a module, it assigns a value to the module-level variable `__name__`

main program	loaded as library
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...module definitions...

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← Always executed

When Python loads a module, it assigns a value to the module-level variable `__name__`

main program	loaded as library
`'__main__'`	module name

```
...module definitions...

if __name__ == '__main__':
   ...run as main program...
```

← Always executed

← Only executed when file run directly

```
# stats.py
'''Useful statistical tools.'''

def average(values):
  '''Return average of values or None if no data.'''
  if values:
    return sum(values) / len(values)
  else:
    return None

if __name__ == '__main__':
  print('test 1 should be None:', average([]))
  print('test 2 should be 1:', average([1]))
  print('test 3 should be 2:', average([1, 2, 3]))
```

```
# test-stats.py
from stats import average
print('test 4 should be None:', average(set()))
print('test 5 should be -1:', average({0, -1, -2}))
```

```
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from stats import average
print('test 4 should be None:', average(set()))
print('test 5 should be -1:', average({0, -1, -2}))
```

```
$ python stats.py
test 1 should be None: None
test 2 should be 1: 1.0
test 3 should be 2: 2.0
$
```

```
# test-stats.py
from stats import average
print('test 4 should be None:', average(set()))
print('test 5 should be -1:', average({0, -1, -2}))
```

```
$ python stats.py
test 1 should be None: None
test 2 should be 1: 1.0
test 3 should be 2: 2.0
$ python test-stats.py
test 4 should be None: None
test 5 should be -1: -1.0
$
```

created by

Greg Wilson

October 2010