

Python

Libraries

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A *library* does the same thing for related functions

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Hierarchical organization

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- Avoid duplication
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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)
```

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))
```

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
```

When a module is imported, Python:

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


When a module is imported, Python:

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?
```

When a module is imported, Python:

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*

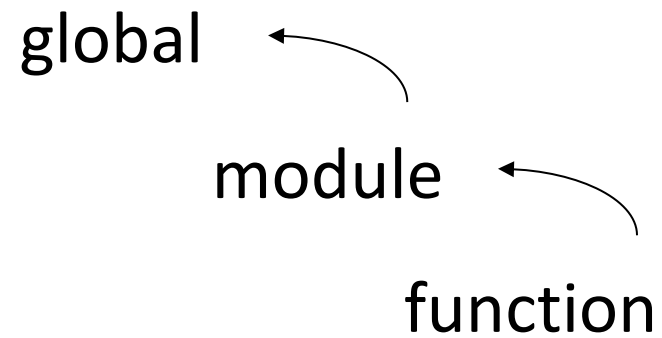
Each module is a *namespace*

function

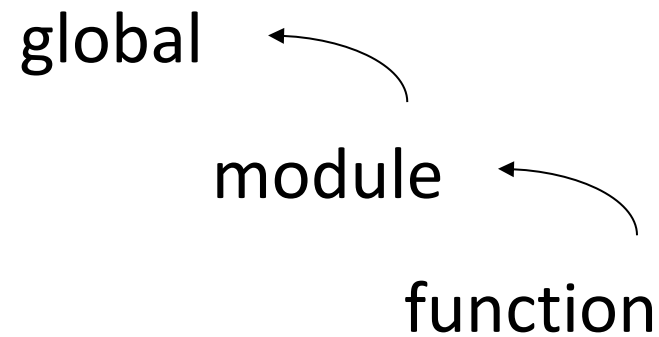
Each module is a *namespace*

module ←
function

Each module is a *namespace*



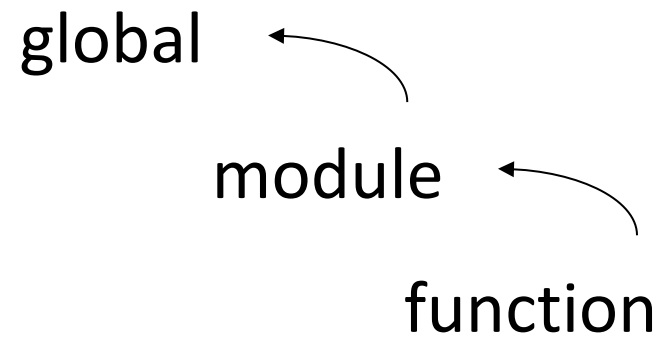
Each module is a *namespace*



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

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

Each module is a *namespace*

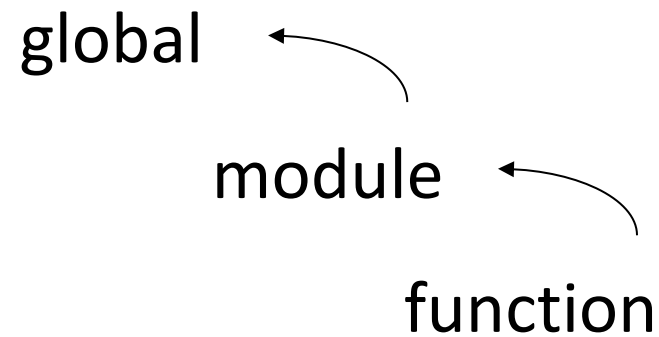


```
# module.py
NAME = 'Transylvania'

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

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


Each module is a *namespace*

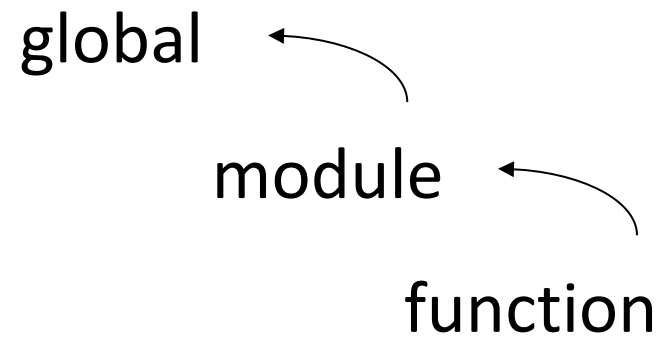


```
# module.py
NAME = 'Transylvania'

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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```
>>> import math
>>> print(math.sqrt(2))
1.4142135623730951
```

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```
>>> import math
>>> print(math.sqrt(2))
1.4142135623730951
>>> print(math.hypot(2, 3))    # sqrt(x**2 + y**2)
3.6055512754639891
```

Python comes with many standard libraries

```
>>> 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 the  
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

And some nicer ways to do imports

```
>>> from math import sqrt  
>>> sqrt(3)  
1.7320508075688772
```

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```
>>> from math import sqrt
>>> sqrt(3)
1.7320508075688772
>>> from math import hypot as euclid
>>> euclid(3, 4)
5.0
```

And some nicer ways to do imports

```
>>> from math import sqrt
>>> sqrt(3)
1.7320508075688772
>>> from math import hypot as euclid
>>> euclid(3, 4)
5.0
>>> from math import *
>>> sin(pi)
1.2246467991473532e-16
>>>
```

And some nicer ways to do imports

```
>>> from math import sqrt
>>> sqrt(3)
1.7320508075688772
>>> from math import hypot as euclid
>>> euclid(3, 4)
5.0
>>> from math import * ← Generally a bad idea
>>> sin(pi)
1.2246467991473532e-16
>>>
```

And some nicer ways to do imports

```
>>> from math import sqrt
```

```
>>> sqrt(3)
```

```
1.7320508075688772
```

```
>>> from math import hypot as euclid
```

```
>>> euclid(3, 4)
```

```
5.0
```

```
>>> from math import * ← Generally a bad idea
```

```
>>> sin(pi)
```

```
1.2246467991473532e-16
```

```
>>>
```

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]
```

Almost every program uses the `sys` library

```
>>> import sys
>>> print(sys.version)
3.7.0 (default, Jun 28 2018, 13:15:42)
[GCC 7.2.0]
>>> print(sys.platform)
linux
```

Almost every program uses the `sys` library

```
>>> import sys
>>> print(sys.version)
3.7.0 (default, Jun 28 2018, 13:15:42)
[GCC 7.2.0]
>>> print(sys.platform)
linux
>>> print(sys.maxsize)
9223372036854775807
```

Almost every program uses the `sys` library

```
>>> import sys
>>> print(sys.version)
3.7.0 (default, Jun 28 2018, 13:15:42)
[GCC 7.2.0]
>>> 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

`sys.argv` holds command-line arguments

Script name is `sys.argv[0]`

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Script name is `sys.argv[0]`

```
# echo.py
import sys
for i, a in enumerate(sys.argv):
    print(i, a)
```


`sys.argv` holds command-line arguments

Script name is `sys.argv[0]`

```
# echo.py
import sys
for i,a in enumerate(sys.argv):
    print(i,a)
```

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

`sys.argv` holds command-line arguments

Script name is `sys.argv[0]`

```
# echo.py
import sys
for i,a in enumerate(sys.argv):
    print(i,a)
```

```
$ 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
```

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

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.

```
>>> import importlib
```

```
>>> importlib.reload(mylib)
```

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

hello



It worked!

Free stuff - the Python Standard Library

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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/>

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']
```

Would recommend using “requests” for url interactions

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

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

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

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

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

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

```
48
```

```
$
```

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

```
$ 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...
```

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

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



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

If the first statement in a module or function is a string, it is saved as a *docstring*

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a string, it is saved as a *docstring*
Used for online (and offline) help

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Used for online (and offline) help

```
# 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.

>>>
```

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

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main program

`'__main__'`

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

main program	loaded as library
<code>'__main__'</code>	module name

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

main program	loaded as library
<code>'__main__'</code>	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
<code>'__main__'</code>	module name

```
...module definitions...
```

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

← Always executed

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

main program	loaded as library
<code>'__main__'</code>	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}))
```

```
# 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
$
```

```
# 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
$
```


Python

Combining scripts and modules

Thanks to all contributors:

Alison Pamment, Sam Pepler, Ag Stephens, Stephen Pascoe, Kevin Marsh, Anabelle Guillory, Graham Parton, Esther Conway, Eduardo Damasio Da Costa, Wendy Garland, Alan Iwi, Matt Pritchard and Tommy Godfrey.

A simple python module/script

In Python you will often want to write a module where most of your code is held and then use a separate script to interact with it.

In this contrived example we have:



`greetings.py`
(module)



`greeter.py`
(script)

How will it work?

When written, the script will be called like this:

```
$ python greeter.py
```

```
Nobody to greet!
```

```
$ python greeter.py Greta
```

```
Hello Greta
```

```
$ python greeter.py Harpo Chico Zeppo
```

```
Hello Harpo
```

```
Hello Chico
```

```
Hello Zeppo
```

The "greetings.py" module



`greetings.py`
(module)

Holds the function that actual does something:

```
def greet(someone) :  
    print("Hello {0}".format(someone))
```

The "greeter.py" script



greeter.py
(script)

- defines the interaction between the "greetings.py" module and user input (from the command-line).

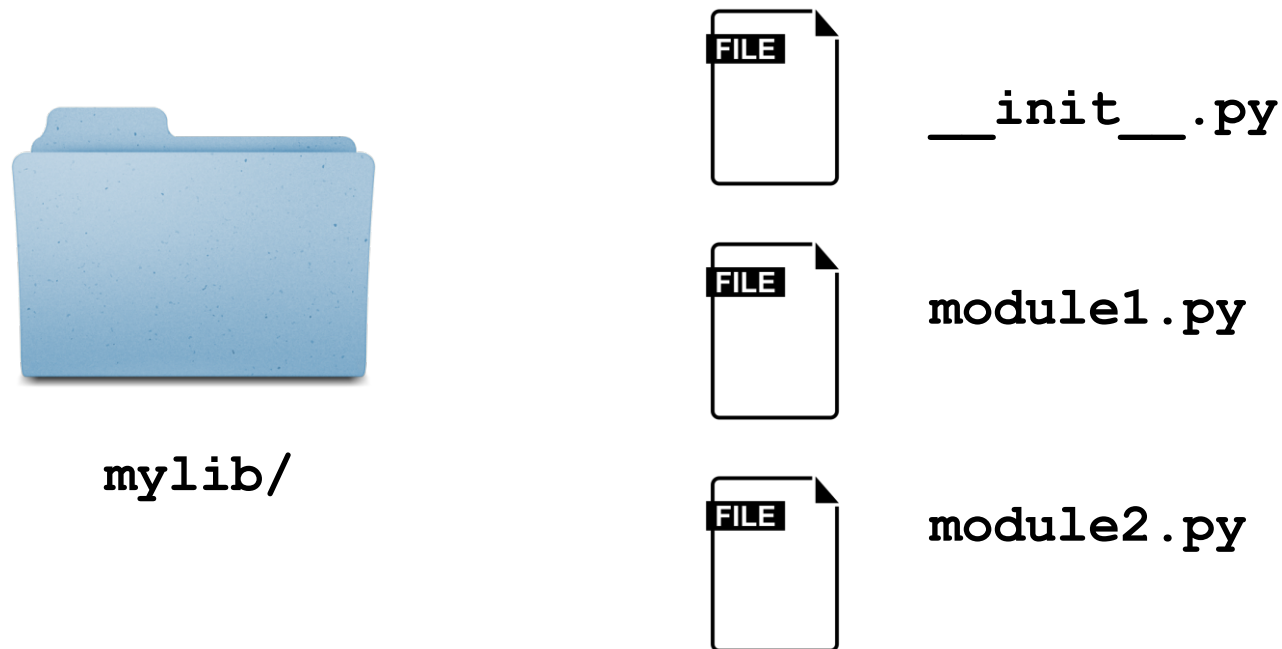
```
import greetings
import sys

if len(sys.argv) == 1:
    print("Nobody to greet!")
else:
    for person in sys.argv[1:]:
        greetings.greet(person)
```

A python "package"

In Python you will often want to group a set of modules into a **package** or **library**.

On the file system a library might look like this:



What does `__init__.py` do?



`__init__.py`

The "`__init__.py`" module is run when you import the name of the directory. It tells python that this directory is a Python *package*.

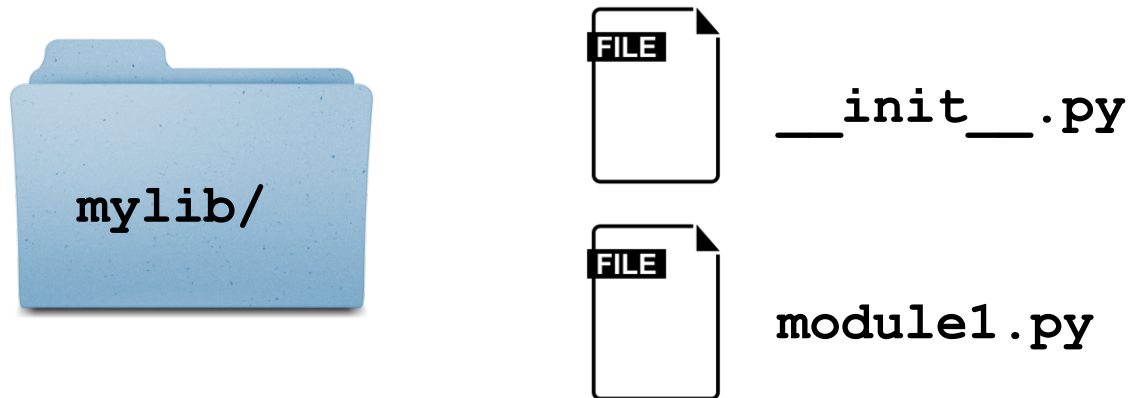
In this case it is called "mylib" so you would type:

```
>>> import mylib      # runs content of mylib/__init__.py
```

If "`__init__.py`" contained the line "`print (10)`" you would see:

```
>>> import mylib
10
```

Importing a package module



The existence of the "`___init___ .py`" module allows you to import modules within the package with:

```
>>> import mylib.module1  
>>> mylib.module1.runSomething(1, 2, 3)
```




created by

Greg Wilson

October 2010



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