Python

Libraries

A function is a way to turn a bunch of related statements into a single "chunk"

A function is a way to turn a bunch of related statements into a single "chunk"

– Avoid duplication

A function is a way to turn a bunch of related statements into a single "chunk"

- Avoid duplication
- Make code easier to read

A function is a way to turn a bunch of related statements into a single "chunk"

- Avoid duplication
- Make code easier to read

A *library* does the same thing for related functions

A function is a way to turn a bunch of related statements into a single "chunk"

- Avoid duplication
- Make code easier to read

A *library* does the same thing for related functions

Hierarchical organization

A function is a way to turn a bunch of related statements into a single "chunk"

– Avoid duplication
– Make code easier to read

A *library* does the same thing for related functions

Hierarchical organization

library

function

statement

Every Python file can be used as a library

Every Python file can be used as a library

Use `import` to load it

Every Python file can be used as a library

Use `import` to load it

```
# 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:

When a module is imported, Python:

1. Executes the statements it contains

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

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.
```

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)
0.333333333333333
```

Each module is a *namespace*

Each module is a *namespace*

function

Each module is a *namespace*

$$\begin{tikzcd}\text{module} & \\ & \text{function} \arrow[ul, bend right]\end{tikzcd}$$

Each module is a *namespace*

$$\begin{tikzcd}
\text{global} & & \\
& \text{module} \arrow[ul, bend right] & \\
& & \text{function} \arrow[ul, bend right]
\end{tikzcd}$$

Each module is a *namespace*

$$\begin{tikzcd}
\text{global} & & \\
& \text{module} \arrow[ul, bend right] & \\
& & \text{function} \arrow[ul, bend right]
\end{tikzcd}$$

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

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

Each module is a *namespace*

$$\begin{tikzcd}
\text{global} & & \\
& \text{module} \arrow[ul, bend right] & \\
& & \text{function} \arrow[ul, bend right]
\end{tikzcd}$$

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

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

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

Each module is a *namespace*

$$\begin{tikzcd}
\text{global} & & \\
& \text{module} \arrow[ul, bend right] & \\
& & \text{function} \arrow[ul, bend right]
\end{tikzcd}$$

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

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

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

Each module is a *namespace*

$$\begin{tikzcd}
\text{global} & & \\
& \text{module} \arrow[ul, bend right] & \\
& & \text{function} \arrow[ul, bend right]
\end{tikzcd}$$

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

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

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

Python comes with many standard libraries

Python comes with many standard libraries

```
>>> import math
```

Python comes with many standard libraries

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

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
```

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

Python also provides a `help` function

```
>>> 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

And some nicer ways to do imports

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

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
```

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 * ←
>>> sin(pi)
1.2246467991473532e-16
>>>
```

Generally a bad idea

Someone could add to the library after you start using it

Almost every program uses the `sys` library

Almost every program uses the `sys` library

```
>>> import sys
```

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]
```

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]`

`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] + " ")
```

`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)

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

`sys.stdout` is *standard output* (e.g., the screen)

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

`sys.stdout` is *standard output* (e.g., the screen)

`sys.stderr` is *standard error* (usually also the screen)

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

`sys.stdout` is *standard output* (e.g., the screen)

`sys.stderr` is *standard error* (usually also the screen)

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`"!!!

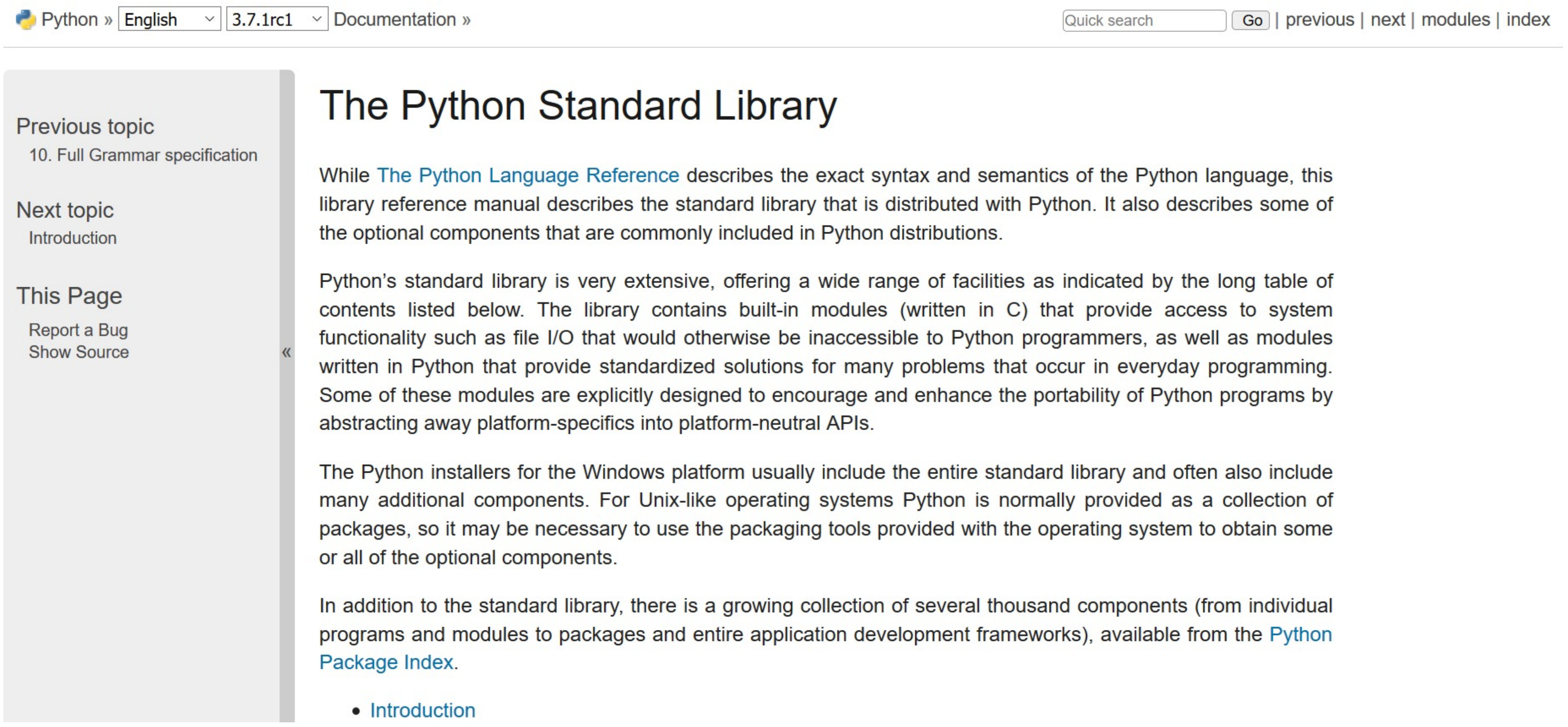
```
>>> import mylib
>>> print(mylib.x)
33.8
```

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


Python » English 3.7.1rc1 Documentation »

Quick search Go | previous | next | modules | index

Previous topic

10. Full Grammar specification

Next topic

Introduction

This Page

Report a Bug

Show Source

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()
```

```
# 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()
```

```
# 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
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
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):
  '''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):
  '''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*

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

Used for online (and offline) help

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
```

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__`

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

main program

`'__main__'`

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

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

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...
```

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

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}))
```

```
# 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:

FILE `greetings.py` `(module)`

FILE `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).

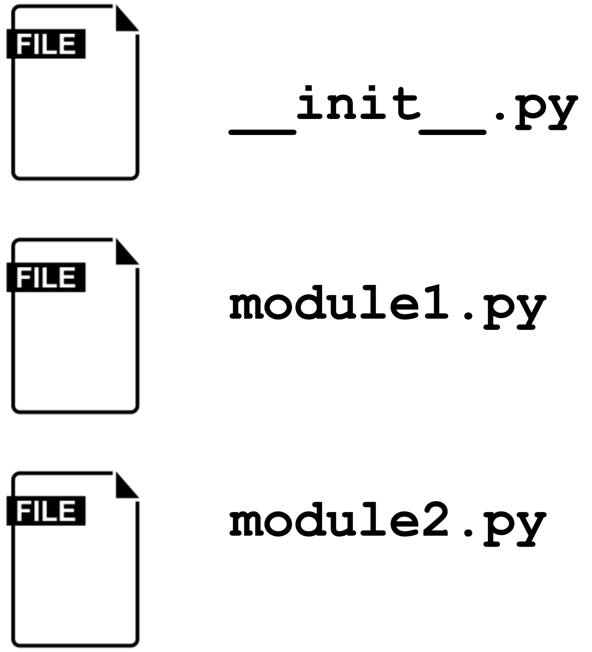
```
import greetings
import sys

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?

`mylib/`   FILE   `__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*.

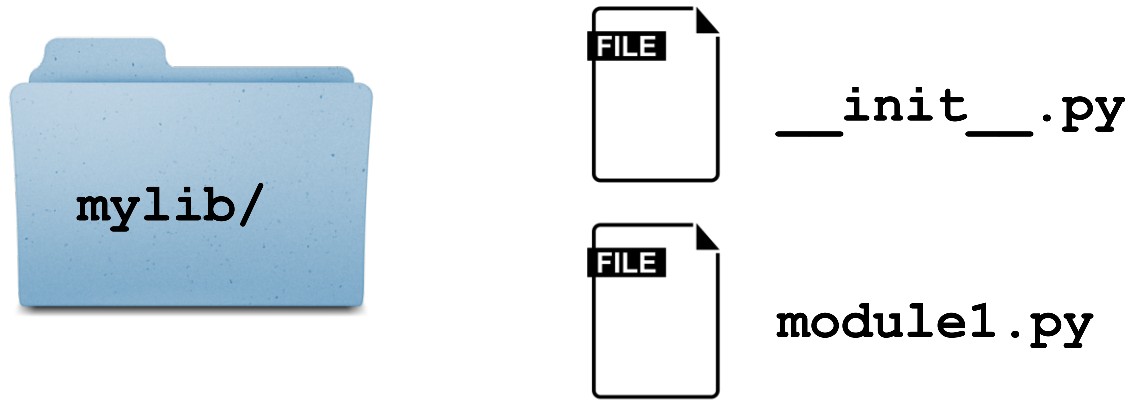
In this case it is called "mylib" so you would type:

```
>>> 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