

# Modules and scoping rules

## ***This lab covers:***

- [Defining a module]
- [Writing a first module]
- [Using the [import] statement]
- [Modifying the module search path]
- [Making names private in modules]
- [Importing standard library and third-party modules]
- [Understanding Python scoping rules and namespaces]

Modules are used to organize larger Python projects. The Python standard library is split into modules to make it more manageable. You don't need to organize your own code into modules, but if you're writing any programs that are more than a few pages long or any code that you want to reuse, you should probably do so.

## **What is a module?**

A *module* is a file containing code. It defines a group of Python functions or other objects, and the name of the module is derived from the name of the file.

Modules most often contain Python source code, but they can also be compiled C or C++ object files. Compiled modules and Python source modules are used the same way.

As well as grouping related Python objects, modules help avert name-clash problems. You might write a module for your program called [mymodule], which defines a function called [reverse]. In the same program, you might also want to use somebody else's module called [othermodule], which also defines a function called [reverse] but does something different from your [reverse] function. In a language without modules, it would be impossible to use two different functions named [reverse]. In Python, the process is trivial; you refer to the functions in your main program as [mymodule.reverse] and [othermodule.reverse].

Using the module names keeps the two [reverse] functions straight because Python uses namespaces. A *namespace* is essentially a dictionary of the identifiers available to a block, function, class, module, and so on. I discuss namespaces a bit more at the end of this chapter, but be aware that each module has its own namespace, which helps prevent naming conflicts.

Modules are also used to make Python itself more manageable. Most standard Python functions aren't built into the core of the language but are provided via specific modules, which you can load as needed.

## **A first module**

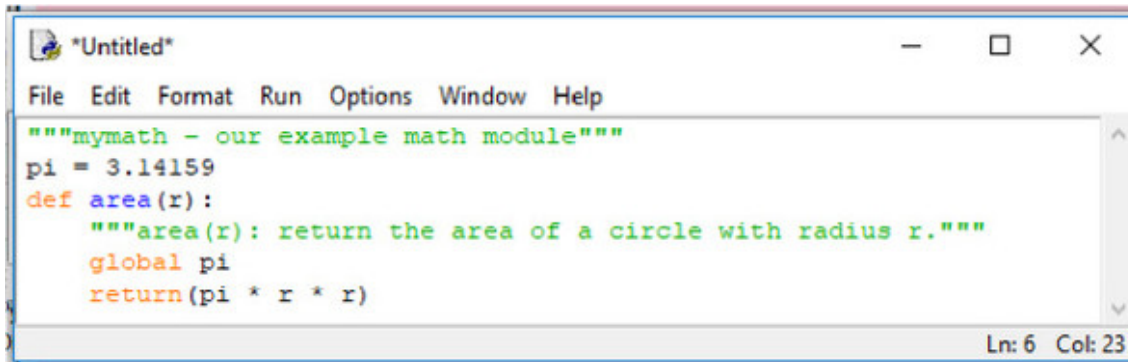
The best way to learn about modules is probably to make one, so you get started in this section.

Create a text file called mymath.py, and in that text file, enter the Python code in [listing 10.1]. (If you're using IDLE, choose File > New Window and start typing, as shown in [figure 10.1])

### **Listing: File mymath.py**

```
"""mymath - our example math module"""
pi = 3.14159
def area(r):
    """area(r): return the area of a circle with radius r."""
    global pi
    return(pi * r * r)
```

**Figure 10.1.** An IDLE edit window provides the same editing functionality as the shell window, including automatic indentation and colorization.



Save this code for now in the directory where your Python executable is. This code merely assigns [pi] a value and defines a function. The .py filename suffix is strongly suggested for all Python code files; it identifies that file to the Python interpreter as consisting of Python source code. As with functions, you have the option of putting in a document string as the first line of your module.

Now start up the Python shell and type the following:

```
>>> pi
Traceback (innermost last):
  File "<stdin>", line 1, in ?
NameError: name 'pi' is not defined
>>> area(2)
Traceback (innermost last):
  File "<stdin>", line 1, in ?
NameError: name 'area' is not defined
```

In other words, Python doesn't have the constant [pi] or the function [area] built in.

Now type

```
>>> import mymath
>>> pi
Traceback (innermost last):
  File "<stdin>", line 1, in ?
NameError: name 'pi' is not defined
>>> mymath.pi
3.14159
>>> mymath.area(2)
12.56636
>>> mymath.__doc__
'mymath - our example math module'
>>> mymath.area.__doc__
'area(r): return the area of a circle with radius r.'
```

You've brought in the definitions for [pi] and [area] from the mymath.py file, using the [import] statement (which automatically adds the .py suffix when it searches for the file defining the module named [mymath]). But the new definitions aren't directly accessible; typing [pi] by itself gave an error, and typing [area(2)] by itself would give an error. Instead, you access [pi] and [area] by *prepending* them with the name of the module that contains them, which

guarantees name safety. Another module out there may also define `[pi]` (maybe the author of that module thinks that `pi` is 3.14 or 3.14159265), but that module is of no concern. Even if that other module is imported, its version of `[pi]` will be accessed by `[othermodulename.pi]`, which is different from `[mymath.pi]`. This form of access is often referred to as *qualification* (that is, the variable `[pi]` is being qualified by the module `[mymath]`). You may also refer to `[pi]` as an *attribute* of `[mymath]`.

Definitions within a module can access other definitions within that module without prepending the module name. The `[mymath.area]` function accesses the `[mymath.pi]` constant as just `[pi]`.

If you want to, you can also specifically ask for names from a module to be imported in such a manner that you don't have to prepend them with the module name. Type

```
>>> from mymath import pi
>>> pi
3.14159
>>> area(2)
Traceback (innermost last):
  File "<stdin>", line 1, in ?
NameError: name 'area' is not defined
```

The name `[pi]` is now directly accessible because you specifically requested it by using `[from mymath import pi]`. The function `[area]` still needs to be called as `[mymath.area]`, though, because it wasn't explicitly imported.

You may want to use the basic interactive mode or IDLE's Python shell to incrementally test a module as you're creating it. But if you change your module on disk, retyping the `[import]` command won't cause it to load again. You need to use the `[reload]` function from the `[importlib]` module for this purpose. The `[importlib]` module provides an interface to the mechanisms behind importing modules:

```
>>> import mymath, importlib
>>> importlib.reload(mymath)
<module 'mymath' from '/home/doc/quickpythonbook/code/mymath.py'>
```

When a module is reloaded (or imported for the first time), all of its code is parsed. A syntax exception is raised if an error is found. On the other hand, if everything is okay, a `.pyc` file (for example, `mymath.pyc`) containing Python byte code is created.

Reloading a module doesn't put you back into exactly the same situation as when you start a new session and import it for the first time. But the differences won't normally cause you any problems. If you're interested, you can look up `[reload]` in the section on the `[importlib]` module in the *Python Language Reference*, found at <https://docs.python.org/3/reference/import.html> in this page's `importlib` section, to find the details.

Modules don't need to be used only from the interactive Python shell, of course. You can also import them into scripts (or other modules, for that matter); enter suitable `[import]` statements at the beginning of your program file. Internally to Python, the interactive session and a script are considered to be modules as well.

To summarize:

- [A module is a file defining Python objects.]
- [If the name of the module file is `modulename.py`, the Python name of the module is `[modulename]`.]
- [You can bring a module named `[modulename]` into use with the `[import modulename]` statement. After this statement is executed, objects defined in the module can be accessed as `[modulename.objectname]`.]
- [Specific names from a module can be brought directly into your program by using the `[from modulename import objectname]` statement. This statement makes `[objectname]` accessible to your program without your needing to prepend it with `[modulename]`, and it's useful for bringing in names that are often used.]

## The import statement

The `[import]` statement takes three different forms. The most basic is

```
import modulename
```

which searches for a Python module of the given name, parses its contents, and makes it available. The importing code can use the contents of the module, but any references by that code to names within the module must still be prepended with the module name. If the named module isn't found, an error is generated. I discuss exactly where Python looks for modules in [section 10.4].

The second form permits specific names from a module to be explicitly imported into the code:

```
from modulename import name1, name2, name3, . . .
```

Each of `[name1]`, `[name2]`, and so forth from within `[modulename]` is made available to the importing code; code after the `[import]` statement can use any of `[name1]`, `[name2]`, `[name3]`, and so on without your prepending the module name.

Finally, there's a general form of the `[from ... import ...]` statement:

```
from modulename import *
```

The `[*]` stands for all the exported names in `[modulename]`. `[from modulename import *]` imports all public names from `[modulename]`---that is, those that don't begin with an underscore---and makes them available to the importing code without the necessity of prepending the module name. But if a list of names called `[_all_]` exists in the module (or the package's `__init__.py`), the names are the ones imported, whether or not they begin with an underscore.

You should take care when using this particular form of importing. If two modules both define a name, and you import both modules using this form of importing, you'll end up with a name clash, and the name from the second module will replace the name from the first. This technique also makes it more difficult for readers of your code to determine where the names you're using originate. When you use either of the two previous forms of the import statement, you give your reader explicit information about where they're from.

But some modules (such as `[tkinter]`) name their functions to make it obvious where they originate and to make it unlikely that name clashes will occur. It's also common to use the general import to save keystrokes when using an interactive shell.

## The module search path

Exactly where Python looks for modules is defined in a variable called `[path]`, which you can access through a module called `[sys]`. Enter the following:

```
>>> import sys
>>> sys.path
_list of directories in the search path_
```

The value shown in place of `[_list of directories in the search path_]` depends on the configuration of your system. Regardless of the details, the string indicates a list of directories that Python searches (in order) when attempting to execute an `[import]` statement. The first module found that satisfies the `[import]` request is used. If there's no satisfactory module in the module search path, an `[ImportError]` exception is raised.

If you're using IDLE, you can graphically look at the search path and the modules on it by using the Path Browser window, which you can start from the File menu of the Python shell window.

The `[sys.path]` variable is initialized from the value of the environment (operating system) variable `[PYTHONPATH]`, if it exists, or from a default value that's dependent on your installation. In addition, whenever you run a Python script, the `[sys.path]` variable for that script has the directory containing the script inserted as its first element, which provides a convenient way of determining where the executing Python program is located. In an interactive session such as the previous one, the first element of `[sys.path]` is set to the empty string, which Python takes as meaning that it should first look for modules in the current directory.

### Where to place your own modules

In the example that starts this lab, the `[mymath]` module is accessible to Python because (1) when you execute Python interactively, the first element of `[sys.path]` is `[""]`, telling Python to look for modules in the current directory; and (2) you executed Python in the directory that contained the `mymath.py` file. In a production environment, neither of these conditions typically is true. You won't be running Python interactively, and Python code files won't be located in your current directory. To ensure that your programs can use the modules you coded, you need to:

- [Place your modules in one of the directories that Python normally searches for modules.]
- [Place all the modules used by a Python program in the same directory as the program.]
- [Create a directory (or directories) to hold your modules, and modify the `[sys.path]` variable so that it includes this new directory (or directories).]

Of these three options, the first is apparently the easiest and is also an option that you should *never* choose unless your version of Python includes local code directories in its default module search path. Such directories are specifically intended for site-specific code (that is, code specific to your machine) and aren't in danger of being overwritten by a new Python install because they're not part of the Python installation. If your `[sys.path]` refers to such directories, you can put your modules there.

The second option is a good choice for modules that are associated with a particular program. Just keep them with the program.

The third option is the right choice for site-specific modules that will be used in more than one program at that site. You can modify `[sys.path]` in various ways. You can assign to it in your code, which is easy, but doing so hardcodes directory locations into your program code. You can set the `[PYTHONPATH]` environment variable, which is relatively easy, but it may not apply to all users at your site; or you can add it to the default search path by using a `.pth` file.

Examples of how to set `[PYTHONPATH]` are in the Python documentation in the Python Setup and Usage section (under Command line and environment). The directory or directories you set it to are prepended to the `[sys.path]` variable. If you use `[PYTHONPATH]`, be careful that you don't define a module with the same name as one of the existing library modules that you're using. If you do that your module will be found before the library module. In some cases, this may be what you want, but probably not often.

You can avoid this issue by using a `.pth` file. In this case, the directory or directories you added will be appended to `[sys.path]`. The last of these mechanisms is best illustrated by an example. On Windows, you can place a `.pth` file in the directory pointed to by `[sys.prefix]`. Assume your `[sys.prefix]` is `[c:\program files \python]`, and place the file in this listing in that directory.

#### Listing: File `myModules.pth`

```
mymodules
c:\Users\naomi\My Documents\python\modules
```

The next time a Python interpreter is started, `[sys.path]` will have `[c:\program files \python\mymodules]` and `[c:\Users\naomi\My Documents\python\modules]` added to it, if they exist. Now you can place your modules in these directories. Note that the `mymodules` directory still runs the danger of being overwritten with a new installation. The `modules` directory is safer. You also may have to move or create a `mymodules.pth` file when you upgrade Python. See the description of the `[site]` module in the *Python Library Reference* if you want more details on using `.pth` files.

## Private names in modules

I mentioned earlier in the chapter that you can enter `[from module import *]` to import *almost* all names from a module. The exception is that identifiers in the module beginning with an underscore can't be imported with `[from module import *]`. People can write modules that are intended for importation with `[from module import *]` but still keep certain function or variables from being imported. By starting all internal names (that is, names that shouldn't be accessed outside the module) with an underscore, you can ensure that `[from module import *]` brings in only those names that the user will want to access.

To see this technique in action, assume that you have a file called `modtest.py` containing this code.

### Listing: File `modtest.py`

```
"""modtest: our test module"""
def f(x):
    return x
def _g(x):
    return x
a = 4
_b = 2
```

Now start up an interactive session and enter the following:

```
>>> from modtest import *
>>> f(3)
3
>>> _g(3)
Traceback (innermost last):
  File "<stdin>", line 1, in ?
NameError: name '_g' is not defined
>>> a
4
>>> _b
Traceback (innermost last):
  File "<stdin>", line 1, in ?
NameError: name '_b' is not defined
```

As you can see, the names `[f]` and `[a]` are imported, but the names `[_g]` and `[_b]` remain hidden outside `[modtest]`. Note that this behavior occurs only with `[from ... import *]`. You can do the following to access `[_g]` or `[_b]`:

```
>>> import modtest
>>> modtest._b
2
>>> from modtest import _g
>>> _g(5)
5
```

The convention of leading underscores to indicate private names is used throughout Python, not just in modules.

## Library and third-party modules

At the beginning of this lab, I mentioned that the standard Python distribution is split into modules to make it more manageable. After you've installed Python, all the functionality in these library modules is available to you. All that's needed is to import the appropriate modules, functions, classes, and so forth explicitly, before you use them.

Many of the most common and useful standard modules are discussed throughout this course. But the standard Python distribution includes far more than what this course describes. At the very least, you should browse the table of contents of the *Python Library Reference*.

In IDLE, you can easily browse to and look at those modules written in Python by using the Path Browser window. You can also search for example code that uses modules with the Find in Files dialog box, which you can open from the Edit menu of the Python shell window. You can search your own modules as well in this way.

Available third-party modules and links to them are identified in the Python Package Index (pyPI), which I discuss in [chapter 19]. You need to download these modules and install them in a directory in your module search path to make them available for import into your programs.

### Quick Check: Modules

Suppose that you have a module called `[new_math]` that contains a function called `[new_divide]`. What are the ways that you might import and then use that function? What are the pros and cons of each method?

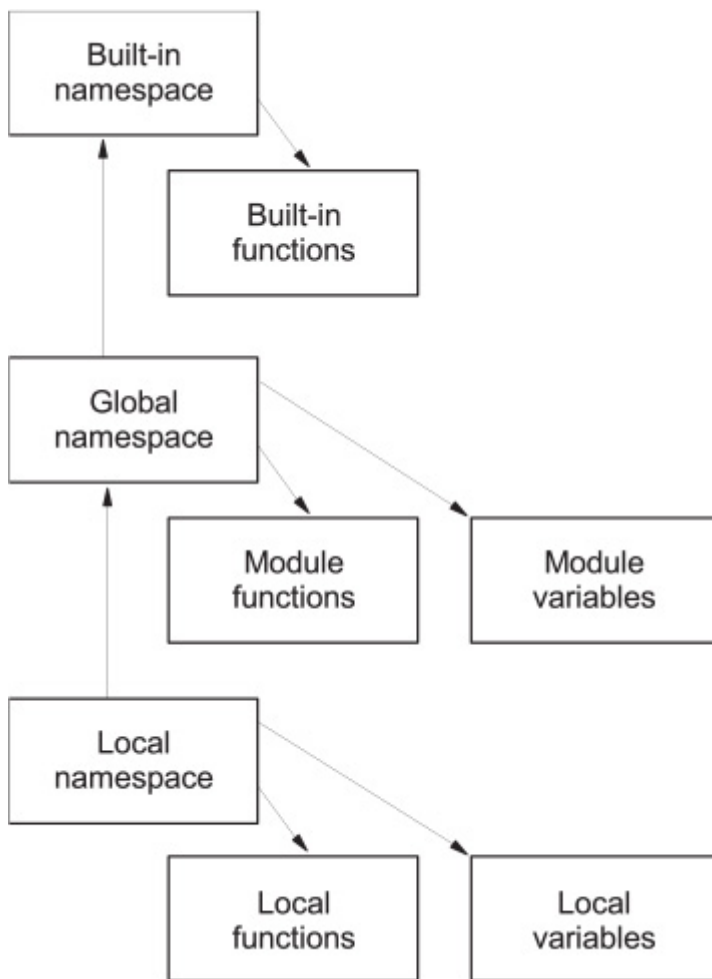
Suppose that the `[new_math]` module contains a function call `[_helper_math()]`. How will the underscore character affect the way that `[_helper_math()]` is imported?

### Python scoping rules and namespaces

Python's scoping rules and namespaces will become more interesting as your experience as a Python programmer grows. If you're new to Python, you probably don't need to do anything more than quickly read through the text to get the basic ideas. For more details, look up *namespaces* in the *Python Language Reference*.

The core concept here is that of a namespace. A *namespace* in Python is a mapping from identifiers to objects---that is, how Python keeps track of what variables and identifiers are active and what they point to. So a statement like `[x = 1]` adds `[x]` to a namespace (assuming that it isn't already there) and associates it with the value `[1]`. When a block of code is executed in Python, it has three namespaces: *local*, *global*, and *built-in* (see [figure 10.2]).

**Figure 10.2. The order in which namespaces are checked to locate identifiers**



When an identifier is encountered during execution, Python first looks in the *local namespace* for it. If the identifier isn't found, the *global namespace* is looked in next. If the identifier still hasn't been found, the *built-in namespace* is checked. If it doesn't exist there, this situation is considered to be an error, and a `[NameError]` exception occurs.

For a module, a command executed in an interactive session, or a script running from a file, the global and local namespaces are the same. Creating any variable or function or importing anything from another module results in a new entry, or *binding*, being made in this namespace.

But when a function call is made, a local namespace is created, and a binding is entered in it for each parameter of the call. Then a new binding is entered into this local namespace whenever a variable is created within the function. The global namespace of a function is the global namespace of the containing block of the function (that of the module, script file, or interactive session). It's independent of the dynamic context from which it's called.

In all of these situations, the built-in namespace is that of the `[__builtins__]` module. This module contains, among other things, all the built-in functions you've encountered (such as `[len]`, `[min]`, `[max]`, `[int]`, `[float]`, `[list]`, `[tuple]`, `[range]`, `[str]`, and `[repr]`) and the other built-in classes in Python, such as the exceptions (like `[NameError]`).

One thing that sometimes trips up new Python programmers is the fact that you can override items in the built-in module. If, for example, you create a list in your program and put it in a variable called `[list]`, you can't subsequently use the built-in `[list]` function. The entry for your list is found first. There's no differentiation between names for functions and modules and other objects. The most recent occurrence of a binding for a given identifier is used.



Enough talk---it's time to explore some examples. The examples use two built-in functions: `[locals]` and `[globals]`. These functions return dictionaries containing the bindings in the local and global namespaces, respectively.

Start a new interactive session:

```
>>> locals()
{'__builtins__': <module 'builtins' (built-in)>, '__name__': '__main__',
 '__doc__': None, '__package__': None}
>>> globals()
{'__builtins__': <module 'builtins' (built-in)>, '__name__': '__main__',
 '__doc__': None, '__package__': None}>>>
```

The local and global namespaces for this new interactive session are the same. They have three initial key-value pairs that are for internal use: (1) an empty documentation string `[_doc_]`, (2) the main module name `[_name_]` (which for interactive sessions and scripts run from files is always `[_main_]`), and (3) the module used for the built-in namespace `[_builtins_]` (the module `[_builtins_]`).

Now if you continue by creating a variable and importing from modules, you see several bindings created:

```
>>> z = 2
>>> import math
>>> from cmath import cos
>>> globals()
{'cos': <built-in function cos>, '__builtins__': <module 'builtins'
 (built-in)>, '__package__': None, '__name__': '__main__', 'z': 2,
 '__doc__': None, 'math': <module 'math' from
 '/usr/local/lib/python3.0/libdynload/math.so'>}}
>>> locals()
{'cos': <built-in function cos>, '__builtins__':
 <module 'builtins' (built-in)>, '__package__': None, '__name__':
 '__main__', 'z': 2, '__doc__': None, 'math': <module 'math' from
 '/usr/local/lib/python3.0/libdynload/math.so'>}}
>>> math.ceil(3.4)
4
```

As expected, the local and global namespaces continue to be equivalent. Entries have been added for `[z]` as a number, `[math]` as a module, and `[cos]` from the `[cmath]` module as a function.

You can use the `[del]` statement to remove these new bindings from the namespace (including the module bindings created with the `[import]` statements):

```
>>> del z, math, cos
>>> locals()
{'__builtins__': <module 'builtins' (built-in)>, '__package__': None,
 '__name__': '__main__', '__doc__': None}
>>> math.ceil(3.4)
Traceback (innermost last):
  File "<stdin>", line 1, in <module>
NameError: math is not defined
>>> import math
>>> math.ceil(3.4)
4
```

The result isn't drastic, because you're able to import the `[math]` module and use it again. Using `[del]` in this manner can be handy when you're in the interactive mode.<sup>^[[1]]^</sup>

Using `[del]` and then `[import]` again won't pick up changes made to a module on disk. It isn't removed from memory and then loaded from disk again. The binding is taken out of and then put back into your namespace. You still need to use `[importlib.reload]` if you want to pick up changes made to a file.

For the trigger-happy, yes, it's also possible to use `[del]` to remove the `[__doc__]`, `[__main__]`, and `[__builtins__]` entries. But resist doing this, because it wouldn't be good for the health of your session!

Now look at a function created in an interactive session:

```
>>> def f(x):
...     print("global: ", globals())
...     print("Entry local: ", locals())
...     y = x
...     print("Exit local: ", locals())
...
>>> z = 2
>>> globals()
{'f': <function f at 0xb7cbfeac>, '__builtins__': <module 'builtins'
(built-in)>, '__package__': None, '__name__': '__main__', 'z': 2,
 '__doc__': None}
>>> f(z)
global:  {'f': <function f at 0xb7cbfeac>, '__builtins__': <module
'builtins' (built-in)>, '__package__': None, '__name__': '__main__',
'z': 2, '__doc__': None}
Entry local:  {'x': 2}
Exit local:  {'y': 2, 'x': 2}
>>>
```

If you dissect this apparent mess, you see that as expected, upon entry the parameter `[x]` is the original entry in `[f]`'s local namespace, but `[y]` is added later. The global namespace is the same as that of your interactive session, which is where `[f]` was defined. Note that it contains `[z]`, which was defined after `[f]`.

In a production environment, you normally call functions that are defined in modules. Their global namespace is that of the module in which the functions are defined. Assume that you've created the file in this listing.

#### Listing: File `scopetest.py`

```
"""scopetest: our scope test module"""
v = 6
def f(x):
    """f: scope test function"""
    print("global: ", list(globals().keys()))
    print("entry local:", locals())
    y = x
    w = v
    print("exit local:", locals().keys())
```

Note that you'll be printing only the keys (identifiers) of the dictionary returned by `[globals]` to reduce clutter in the results. You print only the keys because modules are optimized to store the whole `[__builtins__]` dictionary as the value field for the `[__builtins__]` key:

```
>>> import scopetest
>>> z = 2
>>> scopetest.f(z)
global:  ['__name__', '__doc__', '__package__', '__loader__', '__spec__',
         '__file__', '__cached__', '__builtins__', 'v', 'f']
entry local: {'x': 2}
exit local: dict_keys(['x', 'w', 'y'])
```

Now the global namespace is that of the [scopetest] module and includes the function [f] and integer [v] (but not [z] from your interactive session). Thus, when creating a module, you have complete control over the namespaces of its functions.

I've covered local and global namespaces. Next, I move on to the built-in namespace. This example introduces another built-in function, [dir], which, given a module, returns a list of the names defined in it:

```
>>> dir(__builtins__)
['ArithmeticError', 'AssertionError', 'AttributeError', 'BaseException',
 'BlockingIOError', 'BrokenPipeError', 'BufferError', 'BytesWarning',
 'ChildProcessError', 'ConnectionAbortedError', 'ConnectionError',
 'ConnectionRefusedError', 'ConnectionResetError', 'DeprecationWarning',
 'EOFError', 'Ellipsis', 'EnvironmentError', 'Exception', 'False',
 'FileExistsError', 'FileNotFoundError', 'FloatingPointError',
 'FutureWarning', 'GeneratorExit', 'IOError', 'ImportError',
 'ImportWarning', 'IndentationError', 'IndexError', 'InterruptedError',
 'IsADirectoryError', 'KeyError', 'KeyboardInterrupt', 'LookupError',
 'MemoryError', 'ModuleNotFoundError', 'NameError', 'None',
 'NotADirectoryError', 'NotImplemented', 'NotImplementedError',
 'OSError', 'OverflowError', 'PendingDeprecationWarning',
 'PermissionError', 'ProcessLookupError', 'RecursionError',
 'ReferenceError', 'ResourceWarning', 'RuntimeError', 'RuntimeWarning',
 'StopAsyncIteration', 'StopIteration', 'SyntaxError', 'SyntaxWarning',
 'SystemError', 'SystemExit', 'TabError', 'TimeoutError', 'True',
 'TypeError', 'UnboundLocalError', 'UnicodeDecodeError',
 'UnicodeEncodeError', 'UnicodeError', 'UnicodeTranslateError',
 'UnicodeWarning', 'UserWarning', 'ValueError', 'Warning',
 'ZeroDivisionError', '__build_class__', '__debug__', '__doc__',
 '__import__', '__loader__', '__name__', '__package__', '__spec__',
 'abs', 'all', 'any', 'ascii', 'bin', 'bool', 'bytearray', 'bytes',
 'callable', 'chr', 'classmethod', 'compile', 'complex', 'copyright',
 'credits', 'delattr', 'dict', 'dir', 'divmod', 'enumerate', 'eval',
 'exec', 'exit', 'filter', 'float', 'format', 'frozenset', 'getattr',
 'globals', 'hasattr', 'hash', 'help', 'hex', 'id', 'input', 'int',
 'isinstance', 'issubclass', 'iter', 'len', 'license', 'list', 'locals',
 'map', 'max', 'memoryview', 'min', 'next', 'object', 'oct', 'open',
 'ord', 'pow', 'print', 'property', 'quit', 'range', 'repr', 'reversed',
 'round', 'set', 'setattr', 'slice', 'sorted', 'staticmethod', 'str',
 'sum', 'super', 'tuple', 'type', 'vars', 'zip']
```

There are a lot of entries here. Those entries ending in [Error] and [Exit] are the names of the exceptions built into Python, which I discuss in [chapter 14].

The last group (from [abs] to [zip]) is built-in functions of Python. You've already seen many of these functions in this course and will see more, but I don't cover all of them here. If you're interested, you can find details on the rest in the

*Python Library Reference*. You can also easily obtain the documentation string for any of them by using the `[help()]` function or by printing the docstring directly:

```
>>> print(max.__doc__)
max(iterable[, key=func]) -> value
max(a, b, c, ...[, key=func]) -> value

With a single iterable argument, return its largest item.
With two or more arguments, return the largest argument.
```

As I mentioned earlier, it's not unheard-of for a new Python programmer to inadvertently override a built-in function:

```
>>> list("Peyto Lake")
['P', 'e', 'y', 't', 'o', ' ', 'L', 'a', 'k', 'e']
>>> list = [1, 3, 5, 7]
>>> list("Peyto Lake")
Traceback (innermost last):
  File "<stdin>", line 1, in ?
TypeError: 'list' object is not callable
```

The Python interpreter won't look beyond the new binding for `[list]` as a `[list]`, even though you're using the built-in `[list]` function syntax.

The same thing happens, of course, if you try to use the same identifier twice in a single namespace. The previous value is overwritten, regardless of its type:

```
>>> import mymath
>>> mymath = mymath.area
>>> mymath.pi
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
AttributeError: 'function' object has no attribute 'pi'
```

When you're aware of this situation, it isn't a significant issue. Reusing identifiers, even for different types of objects, wouldn't make for the most readable code anyway. If you do inadvertently make one of these mistakes when in interactive mode, it's easy to recover. You can use `[del]` to remove your binding, to regain access to an overridden built-in, or to import your module again to regain access:

```
>>> del list
>>> list("Peyto Lake")
['P', 'e', 'y', 't', 'o', ' ', 'L', 'a', 'k', 'e']
>>> import mymath
>>> mymath.pi
3.14159
```

The `[locals]` and `[globals]` functions can be useful as simple debugging tools. The `[dir]` function doesn't give the current settings, but if you call it without parameters, it returns a sorted list of the identifiers in the local namespace. This practice helps you catch the mistyped variable error that compilers usually catch for you in languages that require declarations:

```
>>> x1 = 6
>>> x1 = x1 - 2
>>> x1
```

```
6
>>> dir()
['__annotations__', '__builtins__', '__doc__', '__loader__', '__name__',
  '__package__', '__spec__', 'x1', 'x1']
```

The debugger that's bundled with IDLE has settings that allow you to view the local and global variable settings as you step through your code; it displays the output of the [locals] and [globals] functions.

### Quick Check: Namespaces and scope

Consider a variable [width] that's in the module [make\_window.py]. In which of the following contexts is [width] in scope?:

- (A) within the module itself
- (B) inside the [resize()] function in the module
- (C) within the script that imported the [make\_window.py] module

### Lab 10: Create a module

Package the functions created at the end of [chapter 9] as a standalone module. Although you can include code to run the module as the main program, the goal should be for the functions to be completely usable from another script.

### Summary

- [Python modules allow you to put related code and objects into a file.]
- [Using modules also helps prevent conflicting variable names, because imported objects are normally named in association with their module.]