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# Python

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First Created: Feb 26, 2023  
Last Modified: February 27, 2023

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# Chapter 1

## Module

Functions encapsulate pieces of code so that they can be reused throughout a program. Modules collect sets of functions together so that they can be used by any number of programs. Packages group sets of modules because their modules provide related functionality or because they depend on each other.

It is important to be aware of what the library can offer, since using predefined functionality makes programming much faster than creating everything from scratch.

Syntax for importing:

```
1 import importable
2 import importable1, importable2, ..., importableN
3 import importable as preferred_name
4
5 from importable import object as preferred_name
6 from importable import object1, object2, ..., objectN
7 from importable import *
```

In the last syntax, the `*` means “import everything that is not private”, which in practical terms means either every object in the module is imported except for those whose names begin with a leading underscore, or, if the module has a global `__all__` variable that holds a list of names, that all the objects named in the `__all__` variable are imported.

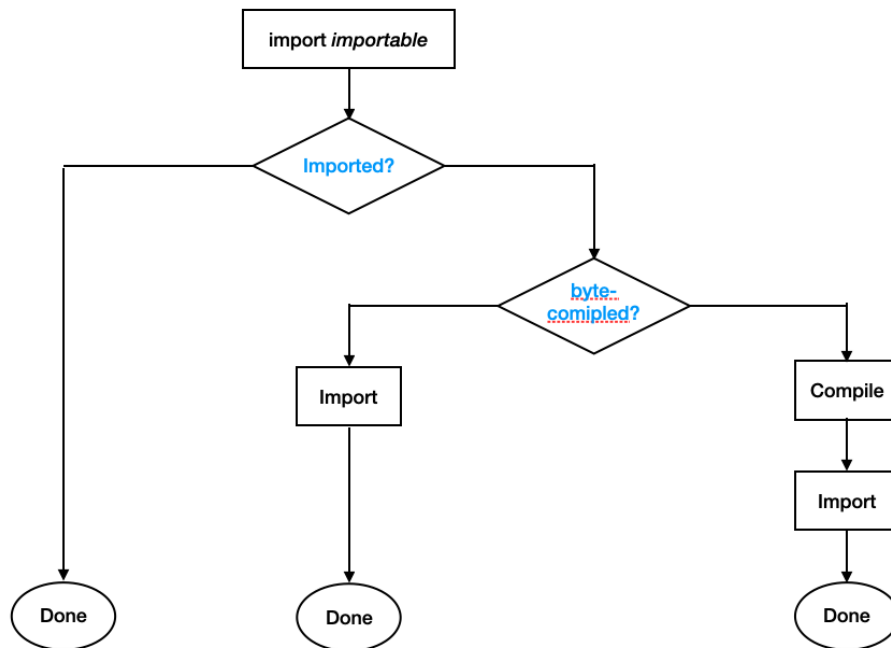
How does Python know where to look for the modules and packages that are imported?

The built-in `sys` module has a list called `sys.path` that holds a list of the directories that constitutes the **Python path**. The first directory is the directory that contains the program itself, even if the program was invoked from another directory. If the `PYTHONPATH` environment variable is set, the paths specified in it are the next ones in the list. The final paths are those needed to access Python’s standard library — these are set when Python is installed.

When we first import a module, if it isn’t built-in, Python looks for the module in each path listed in `sys.path` in turn.

Using byte-code compiled files leads to faster start-up times since the interpreter only has to load and

run the code, rather than load, compile, (save if possible), and run the code; runtimes are not affected, though. When Python is installed, the standard library modules are usually byte-code compiled as part of the installation process.



**Figures 1.1:** Import process

## 1.1 Package

A package is simply a directory that contains a set of modules and a file called `__init__.py`.

In some situations it is convenient to load in all of a **package**'s modules using a single statement. To do this we must edit the **package**'s `__init__.py` file to contain a statement which specifies which modules we want loaded. This statement must assign a list of module names to the special variable `__all__`.

This syntax can also be applied to a module in which case all the functions, variables, and other object defined in the module (apart from those whose names begin with a leading underscore) will be imported. If we want to control exactly what is imported, we can define an `__all__` list in the module itself.

## 1.2 Custom module

You can define your own module. If you want your module to be available to all your program, there are 3 approaches:

- 1 Put the module in the Python distribution's `site-packages` subdirectory.
- 2 Create a directory for the custom modules and set the `PYTHONPATH` environment variable to this directory
- 3 Put the module in the local site-packages subdirectory (`./local/lib/python3.9/site-packages`)

The second and third approaches have the advantage of keeping our own code separate from the official installation.

Doctesting is usually done by the following code:

```
1 if __name__ == '__main__':  
2     import doctest  
3  
4     doctest.testmod()
```

Whenever a module is imported Python creates a variable for the module called `__name__` and store the modules name in this variable. A modules name is simply the name of its `.py` file but without the extension.

Whenever a `.py` file is run Python creates a variable for the program called `__name__` and sets it to the string `__main__`.



# Chapter 2

## Programming techniques

### 2.1 Generator

Generators provide a means of performing lazy evaluation, which means that they compute only the values that are actually needed. This can be more efficient than computing a very large list in one go.

There are two ways to create a generator:

- ♥ generator expression
- ♥ the keyword `yield`

```
1 (expression for item in iterable)
2 (expression for item in iterable if condition)
```

If we need all the items in one go we can pass the generator returned to `list()` or `tuple()`. We can use `next()` to retrieve the next item from the generator.

### 2.2 Dynamic code execution

Dynamic code execution means treating a string as code to evaluate. There are two built-in functions for dynamic code execution:

- ♥ `eval()` for expression
- ♥ `exec()` for code

```
1 x = eval('2 ** 10')
2 print(x) # 1024
```

```
1 import math
2
3 code = '''
4 def area_of_sphere(r):
5     return 4 * math.pi * r ** 2
6 '''
7
8 context = {}
```

```
9 context['math'] = math
10 exec(code, context) # define the function area_of_sphere
```

After the `exec()` call the context dictionary contains a key called `area_of_sphere` whose value is the `area_of_sphere()` function.

```
1 area_of_sphere = context['area_of_sphere']
2 area = area_of_sphere(5)
3 print(area) # 314.1592653589793
```

## 2.3 Decorator

A **decorator** is a function that takes a function or method as its sole argument and returns a new function or method that incorporates the decorated function or method with some additional functionality added.

```
1 @positive_result
2 def discriminant(a, b, c):
3     return b ** 2 - 4 * a * c
4
5
6 def positive_result(function):
7     def wrapper(*args, **kwargs):
8         result = function(*args, **kwargs)
9         assert result >= 0, function.__name__ + "() result isn't >= 0"
10        return result
11
12    wrapper.__name__ = function.__name__
13    wrapper.__doc__ = function.__doc__
14    return wrapper
```

Here `positive_result` is a decorator. It defines a new local function (here `wrapper()`) that calls the original function. The wrapper finishes by returning the result computed by the wrapped function. After creating the wrapper, we set its name and docstring to those of the original function. This helps with introspection, since we want error messages to mention the name of the original function, not the wrapper. Finally, we return the wrapper function.

We can also use the `functools` module's `@functools.wraps` decorator to set the function name and docstring to its original ones. Here's the code:

```
1 import functools
2
3
4 def positive_result(function):
5     @functools.wraps(function)
6     def wrapper(*args, **kwargs):
7         result = function(*args, **kwargs)
8         assert result >= 0, function.__name__ + "() result isn't >=0"
9         return result
10
11    return wrapper
```

Here's an example code to create a decorator with parameters.

```

1 @bounded(0, 100)
2 def percent(amount, total):
3     return (amount / total) * 100
4
5 def bounded(minimum, maximum):
6     def decorator(function):
7         @functools.wraps(function)
8         def wrapper(*args, **kwargs):
9             result = function(*args, **kwargs)
10            if result < minimum:
11                return minimum
12            elif result > maximum:
13                return maximum
14            return result
15
16        return wrapper
17
18    return decorator

```

Decorators can also be used for logging. This is a very neat and efficient way for logging.

## 2.4 Function annotation

```

1 def function_name(par1: exp1, par2: exp2, ..., parN: expN) -> rexp:
2     suite

```

Every colon expression part (: expN) and the return expression part (-> rexp) are optional annotations.

If annotations are present they are added to the function's `__annotations__` dictionary. If they are not present this dictionary is empty. The dictionary's keys are the parameter names, and the value are the corresponding expressions. Annotations have no special significance to Python. What we can do depends on how we use the `__annotations__` dictionary. For example to do type checking.





# Chapter 3

## Object oriented programming

### 3.1 Attribute controlling

The `__slot__` attribute in a class controls whether we can add or remove attributes to and from a class instance.

When a class is created without the use of `__slot__`, behind the scenes Python creates a private dictionary called `__dict__` for each `instance`, and this dictionary holds the instances's data attributes. This is why we can add or remove attributes from object.

If we only need objects where we access the original attributes and don't need to add or remove attributes, we can create classes that don't have a `__dict__`. This is achieved simply by defining a class attribute called `__slot__` whose value is a tuple of `attribute` names. (Here attributes is different from method.) Each object of such a class will have attributes of the specified names and no `__dict__`; no attributes can be added or removed from such classes.

### 3.2 Special methods

Special methods are methods start and end with two underscores. We can use different but convenient usage syntax to access those special methods.

Special Method	Usage	Description
<code>__delattr__(self, name)</code>	<code>del x.n</code>	Deletes object x's n attribute
<code>__dir__(self)</code>	<code>dir(x)</code>	Returns a list of x's attribute names
<code>__getattr__(self, name)</code>	<code>x.n</code>	Returns the value of object x's n attribute if it isn't found directly
<code>__setattr__(self, name, value)</code>	<code>x.n = v</code>	Sets object x's n attribute's value to v

Tables 3.1

### 3.3 Functors

A `functor` is an object that can be called. Any class that has a `__call__()` special method is a functor.

The key benefit that functors offer is that they can maintain some state information.

```
1 class Strip:
2     def __init__(self, characters):
3         self.characters = characters
4
5     def __call__(self, string):
6         return string.strip(self.characters)
7
8 strip_punctuation = Strip(',:.!?')
9 print(strip_punctuation('Mingming Li!'))
```

The **Strip** class maintain a state of **characters** and when the class instance is called it can use this state.

This can also be implemented using a functor (also a closure<sup>1</sup>) but without using a class.

```
1 def make_strip_function(characters):
2     def strip_function(string):
3         return string.strip(characters)
4
5     return strip_function
6
7 strip_punctuation = make_strip_function(',:.!?')
8 print(strip_punctuation('Mingming Li!'))
```

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<sup>1</sup>A closure is a function or method that captures some external state.

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