Modules in Python

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Our focus will be on modules that are written in Python.
All you need to do is create a `.py` file that contains Python code.

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Modules should have short, all-lowercase names. Underscores can be used in the module name if it improves readability.

Python packages should also have short, all-lowercase names, although the use of underscores is discouraged.

You can find more details here:
https://www.python.org/dev/peps/pep-0008/#package-and-module-names

Example:

A module can contain trigonometric functions

The module defines several functions and variables

```
# variables
pi
_maximum_number_of_iterations

# functions
sin()
cos()
tan()
_service_function()
```

Interface of a module

Interface

```
pi
sin()
cos()
tan()
```

Secrets of the module

```
_maximum_number_of_iterations
_service_function()
```

The underscore prefix [**_**] means that a variable or function is intended for **internal use** only.
It is merely a **hint to another programmer** that should avoid using `_maximum_number_of_iterations` and `_service_function()` .
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The programmer could completely **change the implementation of the module**, while leaving the interface unchanged.

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If we rely on an implementation detail of the server module, **if the implementation changes**, the client code may no longer work.

Assuming `mymodule.py` is in an *appropriate location*, the *client module* can access its objects by importing the module as follows:

```
# mainprogram.py

import mymodule

print(mymodule.pi)
print(mymodule.sin(x))
```

Modules help avoid collisions between names:

You can define a function `f()` both in the `mainprogram.py` and in a module, and you can use them with no conflict.

```
# mainprogram.py

import mymodule

def f():
  ...

a = mymodule.f()  # from mymodule.py
b = f()  # from mainprogram.py
```

Executing a Module as a Script

Any `.py` file that contains a module is essentially a Python script, so we can run it as a script. **But** we get the same output when we just *import the module*.
The action of importing the module entails the execution of the code.

```
# mymodule.py

def f(x):
  return x + 1

print("I am a module!")
print(f(1))
```

```
import mymodule
```

```
Output
--------------------

I am a module!
2
```

The special variable `__name__`

You can control what code to execute when you run the module as a script.

When a .py file is **imported as a module**, Python sets the special **dunder**[1] variable `__name__` to the name of the module.

When a file is run as a standalone script, `__name__` is set to the string `__main__`.

---

(1) Dunder here means "Double Underscores"

```python
# my_module.py

print(__name__)
```

```python
# import only
import my_module
```

```
Output
------------------

my_module
```

```
# run as a script
python my_module.py
```

```
Output
------------------

__main__
```

Using this fact, you can discern 'run' actions from 'import' actions.

```python
# my_module.py

"""your code here"""

if (__name__ == "__main__"):
  print("Executing as standalone script")
  print("example of use")
  ...
```

Modules are often designed with the capability to run as a standalone script for **purposes of explain how to use it** or **testing its functionality.**

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Write the module and a program that imports and uses the module.

Python Packages

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- In a very large application with many modules (`.py` files) it becomes difficult to keep track of all of them.
  A single module can contain several 'public' elements (functions, variables, and so on), and several non-public elements.
- Packages are essentially **directories** and provide an effective solution.
- They facilitate the organization and grouping of modules, allowing for a hierarchical structuring of the module namespace through dot notation (e.g., `pkg.mod1`). To create a package, simply create a **directory** and insert the modules (`.py` *files*) in it.

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- Old documentation states that an `__init__.py` file **must be present** in the package directory. Since Python 3.3 it is now possible to create a package without `__init__.py` file.

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- This can be used for the execution of **package initialization code**, such as the initialization of package-level data. In this way, a package provides not only functions but also data.
- `__init__.py` can be also used to **automatic import modules from a package.**

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   Each function must print its name.
   Import and use the functions.

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   Import and use the functions.
2. Open a new instance of the python interpreter.
   Try to **import the package** `mypkg`. What happens?
   After that you import **only** the package `mypkg`, can you use the functions or the modules?

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   - the package must print a welcome message and it must initialize the list `mypkg.myList=['a','b', 'c']`
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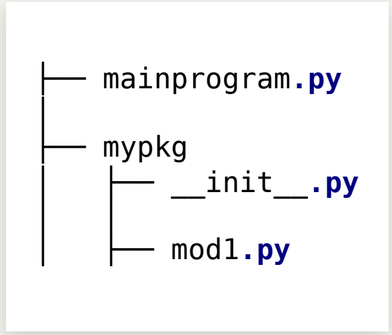
   - the package must print a welcome message and it must initialize the list `mypkg.myList=['a','b', 'c']`
   - modules `module1` and `module2` are imported automatically.
3. Write a client (`main.py`) that uses the `bar()` and `_secret()`.

Different ways to import a module

Consider the following situation:



`mod1.py` contains `bar1()` and `foo1()` functions.

IMPORT

Instruction	Effect
`import mypkg`	imports the symbol `mypkg`
`import mypkg.mod1`	`mypkg.mod1.bar1()` `mypkg.mod1.foo1()`
`from mypkg import mod1`	`mod1.foo1()` `mod1.bar1()`
`from mypkg.mod1 import foo1`	`foo1()` *(in the namespace of the client module)*

AS

Instruction	Effect
`import mypkg.mod1 as mymodule`	`mymodule.foo1()` `mymodule.bar1()`
`from mypkg import mod1 as mymodule`	`mymodule.foo1()` `mymodule.bar1()`
`from mypkg.mod1 import foo1 as myfunction`	`myfunction()` *(in the namespace of the client module)*

ERROR

Instruction	Error
`import mypkg.mod1.foo1`	ERROR: No module named '`mypkg.mod1.foo1`' *foo1 is a function, not a module*
`from mypkg.mod1 import foo1` `bar1()`	ERROR - we imported `foo1()` only
`from mypkg.mod1 import foo1 as myfunction` `foo1()`	ERROR: `foo1` is not defined we imported `foo1` with the name `myfunction`

It is even possible to indiscriminately import *everything* from a module:

```
from mypkg.mod1 import *

foo1()
bar1()
```

This will place the names of all objects from `mypkg.mod1` into the local symbol table, **except names that begin with the underscore** `(_)` character.

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```
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This will place the names of all objects from `mypkg.mod1` into the local symbol table, **except names that begin with the underscore** `(_)` character.

This form is not recommended, because it adds names into the local symbol table, potentially causing unintentionally overwriting of existing names.

The analogous statement for a package is this:

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from mypkg import *
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Despite what we could expect, this instruction **does not import the modules of the package**.

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If the `__init__.py` file in the package directory contains a list named `__all__`, this `import` statement imports all modules in the list.

For example, the file `sound/effects/__init__.py` could contain the following code:

```
__all__ = ["echo", "surround", "reverse"]
```

This would mean that `from sound.effects import *` would import the three named submodules of the sound package.

For example, the file `sound/effects/__init__.py` could contain the following code:

```
__all__ = ["echo", "surround", "reverse"]
```

This would mean that `from sound.effects import *` would import the three named submodules of the sound package.

If `__all__` is not defined, the statement `from sound.effects import *` does not import all submodules; it only ensures that the package `sound.effects` has been imported (possibly running any initialization code in `__init__.py`) and then imports the names defined in the package.

The Module Search Path

When the interpreter executes

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import mod
```

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- the current directory (the directory from which the input script was run)
- the directories contained in the `PYTHONPATH` environment variable
- an installation-dependent list of directories

The search path is accessible in the Python variable `sys.path`

```
import sys
sys.path
```

```
Output
--------------------

['', /Users/username/anaconda3/lib/python37.zip, /Users/username/anaconda3/lib/python3.7]
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Note: The exact contents of sys.path are installation-dependent

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Note: The exact contents of sys.path are installation-dependent

It is possible to modify `sys.path` at run-time so that it contains your module directory.

```
sys.path.append('my_module_dir')
```

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- `dir()` can be useful for identifying what exactly has been added to the namespace by an import statement.
- When given an argument that is the name of a module, `dir()` lists the names defined in the module.

The `help()` function

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We can define `help()` function output for our custom classes and functions by defining docstring (documentation string). By default, the first comment string in the body of a method is used as its docstring. It’s surrounded by three double quotes.

See also:

https://docs.python.org/3/reference/import.html https://docs.python.org/3/tutorial/modules.html