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# Python Setup and Usage

發  3.11.8

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這部分的圖明文件是關於在不同平台上設定 Python 環境的綜合資訊、直譯器的呼叫，以及讓 Python 更容易使用的一些方法。





The CPython interpreter scans the command line and the environment for various settings.

**CPython 實作細節：** Other implementations' command line schemes may differ. See implementations for further resources.

## 1.1 命令列

When invoking Python, you may specify any of these options:

```
python [-bBdEhiIOqsSuvVWx?] [-c command | -m module-name | script | - ] [args]
```

The most common use case is, of course, a simple invocation of a script:

```
python myscript.py
```

### 1.1.1 介面選項

The interpreter interface resembles that of the UNIX shell, but provides some additional methods of invocation:

- When called with standard input connected to a tty device, it prompts for commands and executes them until an EOF (an end-of-file character, you can produce that with `Ctrl-D` on UNIX or `Ctrl-Z`, `Enter` on Windows) is read.
- When called with a file name argument or with a file as standard input, it reads and executes a script from that file.
- When called with a directory name argument, it reads and executes an appropriately named script from that directory.
- When called with `-c command`, it executes the Python statement(s) given as *command*. Here *command* may contain multiple statements separated by newlines. Leading whitespace is significant in Python statements!
- When called with `-m module-name`, the given module is located on the Python module path and executed as a script.

In non-interactive mode, the entire input is parsed before it is executed.

An interface option terminates the list of options consumed by the interpreter, all consecutive arguments will end up in `sys.argv` -- note that the first element, subscript zero (`sys.argv[0]`), is a string reflecting the program's source.

**-c** <command>

Execute the Python code in *command*. *command* can be one or more statements separated by newlines, with significant leading whitespace as in normal module code.

If this option is given, the first element of `sys.argv` will be `"-c"` and the current directory will be added to the start of `sys.path` (allowing modules in that directory to be imported as top level modules).

引發一個附帶引數 `command` 的稽核事件 `cpython.run_command`。

**-m** <module-name>

Search `sys.path` for the named module and execute its contents as the `__main__` module.

Since the argument is a *module* name, you must not give a file extension (`.py`). The module name should be a valid absolute Python module name, but the implementation may not always enforce this (e.g. it may allow you to use a name that includes a hyphen).

Package names (including namespace packages) are also permitted. When a package name is supplied instead of a normal module, the interpreter will execute `<pkg>.__main__` as the main module. This behaviour is deliberately similar to the handling of directories and zipfiles that are passed to the interpreter as the script argument.

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**備註：** This option cannot be used with built-in modules and extension modules written in C, since they do not have Python module files. However, it can still be used for precompiled modules, even if the original source file is not available.

---

If this option is given, the first element of `sys.argv` will be the full path to the module file (while the module file is being located, the first element will be set to `"-m"`). As with the `-c` option, the current directory will be added to the start of `sys.path`.

`-I` option can be used to run the script in isolated mode where `sys.path` contains neither the current directory nor the user's site-packages directory. All `PYTHON*` environment variables are ignored, too.

Many standard library modules contain code that is invoked on their execution as a script. An example is the `timeit` module:

```
python -m timeit -s 'setup here' 'benchmarked code here'
python -m timeit -h # for details
```

引發一個附帶引數 `module-name` 的稽核事件 `cpython.run_module`。

**也參考：**

**`runpy.run_module()`**

Equivalent functionality directly available to Python code

**PEP 338** -- Executing modules as scripts

在 3.1 版的變更: Supply the package name to run a `__main__` submodule.

在 3.4 版的變更: namespace packages are also supported

—

Read commands from standard input (`sys.stdin`). If standard input is a terminal, `-i` is implied.

If this option is given, the first element of `sys.argv` will be `"-"` and the current directory will be added to the start of `sys.path`.

引發一個不附帶引數的稽核事件 `cpython.run_stdin`。

#### <script>

Execute the Python code contained in *script*, which must be a filesystem path (absolute or relative) referring to either a Python file, a directory containing a `__main__.py` file, or a zipfile containing a `__main__.py` file.

If this option is given, the first element of `sys.argv` will be the script name as given on the command line.

If the script name refers directly to a Python file, the directory containing that file is added to the start of `sys.path`, and the file is executed as the `__main__` module.

If the script name refers to a directory or zipfile, the script name is added to the start of `sys.path` and the `__main__.py` file in that location is executed as the `__main__` module.

`-I` option can be used to run the script in isolated mode where `sys.path` contains neither the script's directory nor the user's site-packages directory. All `PYTHON*` environment variables are ignored, too.

Raises an auditing event `cpython.run_file` with argument `filename`.

也參考:

#### `runpy.run_path()`

Equivalent functionality directly available to Python code

If no interface option is given, `-i` is implied, `sys.argv[0]` is an empty string ("") and the current directory will be added to the start of `sys.path`. Also, tab-completion and history editing is automatically enabled, if available on your platform (see `rlcompleter-config`).

也參考:

tut-invoking

在 3.4 版的變更: Automatic enabling of tab-completion and history editing.

## 1.1.2 Generic options

`-?`

`-h`

`--help`

Print a short description of all command line options and corresponding environment variables and exit.

`--help-env`

Print a short description of Python-specific environment variables and exit.

在 3.11 版新加入。

`--help-xoptions`

Print a description of implementation-specific `-X` options and exit.

在 3.11 版新加入。

`--help-all`

印出完整使用資訊離開。

在 3.11 版新加入。

`-v`

**--version**

Print the Python version number and exit. Example output could be:

```
Python 3.8.0b2+
```

When given twice, print more information about the build, like:

```
Python 3.8.0b2+ (3.8:0c076caaa8, Apr 20 2019, 21:55:00)
[GCC 6.2.0 20161005]
```

在 3.6 版新加入: `-vv` 選項

### 1.1.3 Miscellaneous options

**-b**

Issue a warning when converting `bytes` or `bytearray` to `str` without specifying encoding or comparing `bytes` or `bytearray` with `str` or `bytes` with `int`. Issue an error when the option is given twice (`-bb`).

在 3.5 版的變更: Affects also comparisons of `bytes` with `int`.

**-B**

If given, Python won't try to write `.pyc` files on the import of source modules. See also `PYTHONDONTWRITEBYTECODE`.

**--check-hash-based-pycs** `default|always|never`

Control the validation behavior of hash-based `.pyc` files. See `pyc-invalidation`. When set to `default`, checked and unchecked hash-based bytecode cache files are validated according to their default semantics. When set to `always`, all hash-based `.pyc` files, whether checked or unchecked, are validated against their corresponding source file. When set to `never`, hash-based `.pyc` files are not validated against their corresponding source files.

The semantics of timestamp-based `.pyc` files are unaffected by this option.

**-d**

Turn on parser debugging output (for expert only, depending on compilation options). See also `PYTHONDEBUG`.

**-E**

Ignore all `PYTHON*` environment variables, e.g. `PYTHONPATH` and `PYTHONHOME`, that might be set.

See also the `-P` and `-I` (isolated) options.

**-i**

When a script is passed as first argument or the `-c` option is used, enter interactive mode after executing the script or the command, even when `sys.stdin` does not appear to be a terminal. The `PYTHONSTARTUP` file is not read.

This can be useful to inspect global variables or a stack trace when a script raises an exception. See also `PYTHONINSPECT`.

**-I**

Run Python in isolated mode. This also implies `-E`, `-P` and `-s` options.

In isolated mode `sys.path` contains neither the script's directory nor the user's site-packages directory. All `PYTHON*` environment variables are ignored, too. Further restrictions may be imposed to prevent the user from injecting malicious code.

在 3.4 版新加入.

**-O**

Remove assert statements and any code conditional on the value of `__debug__`. Augment the filename for compiled (*bytecode*) files by adding `.opt-1` before the `.pyc` extension (see [PEP 488](#)). See also [PYTHONOPTIMIZE](#).

在 3.5 版的變更: Modify `.pyc` filenames according to [PEP 488](#).

**-OO**

Do **-O** and also discard docstrings. Augment the filename for compiled (*bytecode*) files by adding `.opt-2` before the `.pyc` extension (see [PEP 488](#)).

在 3.5 版的變更: Modify `.pyc` filenames according to [PEP 488](#).

**-P**

Don't prepend a potentially unsafe path to `sys.path`:

- `python -m module` command line: Don't prepend the current working directory.
- `python script.py` command line: Don't prepend the script's directory. If it's a symbolic link, resolve symbolic links.
- `python -c code` and `python (REPL)` command lines: Don't prepend an empty string, which means the current working directory.

See also the [PYTHONSAFEPATH](#) environment variable, and **-E** and **-I** (isolated) options.

在 3.11 版新加入.

**-q**

Don't display the copyright and version messages even in interactive mode.

在 3.2 版新加入.

**-R**

Turn on hash randomization. This option only has an effect if the [PYTHONHASHSEED](#) environment variable is set to 0, since hash randomization is enabled by default.

On previous versions of Python, this option turns on hash randomization, so that the `__hash__()` values of `str` and `bytes` objects are "salted" with an unpredictable random value. Although they remain constant within an individual Python process, they are not predictable between repeated invocations of Python.

Hash randomization is intended to provide protection against a denial-of-service caused by carefully chosen inputs that exploit the worst case performance of a dict construction,  $O(n^2)$  complexity. See <http://ocert.org/advisories/ocert-2011-003.html> for details.

[PYTHONHASHSEED](#) allows you to set a fixed value for the hash seed secret.

在 3.2.3 版新加入.

在 3.7 版的變更: The option is no longer ignored.

**-s**

Don't add the user `site-packages` directory to `sys.path`.

See also [PYTHONNOUSERSITE](#).

也參考:

[PEP 370](#) -- Per user site-packages directory

**-S**

Disable the import of the module `site` and the site-dependent manipulations of `sys.path` that it entails. Also disable these manipulations if `site` is explicitly imported later (call `site.main()` if you want them to be triggered).

**-u**

Force the stdout and stderr streams to be unbuffered. This option has no effect on the stdin stream.

另請參 [F](#) `PYTHONUNBUFFERED`。

在 3.7 版的變更: The text layer of the stdout and stderr streams now is unbuffered.

**-v**

Print a message each time a module is initialized, showing the place (filename or built-in module) from which it is loaded. When given twice (`-vv`), print a message for each file that is checked for when searching for a module. Also provides information on module cleanup at exit.

在 3.10 版的變更: The `site` module reports the site-specific paths and `.pth` files being processed.

另請參 [F](#) `PYTHONVERBOSE`。

**-W arg**

Warning control. Python's warning machinery by default prints warning messages to `sys.stderr`.

The simplest settings apply a particular action unconditionally to all warnings emitted by a process (even those that are otherwise ignored by default):

```
-Wdefault  # Warn once per call location
-Werror    # Convert to exceptions
-Walways   # Warn every time
-Wmodule   # Warn once per calling module
-Wonce     # Warn once per Python process
-Wignore   # Never warn
```

The action names can be abbreviated as desired and the interpreter will resolve them to the appropriate action name. For example, `-Wi` is the same as `-Wignore`.

The full form of argument is:

```
action:message:category:module:lineno
```

Empty fields match all values; trailing empty fields may be omitted. For example `-W ignore::DeprecationWarning` ignores all `DeprecationWarning` warnings.

The *action* field is as explained above but only applies to warnings that match the remaining fields.

The *message* field must match the whole warning message; this match is case-insensitive.

The *category* field matches the warning category (ex: `DeprecationWarning`). This must be a class name; the match test whether the actual warning category of the message is a subclass of the specified warning category.

The *module* field matches the (fully qualified) module name; this match is case-sensitive.

The *lineno* field matches the line number, where zero matches all line numbers and is thus equivalent to an omitted line number.

Multiple `-W` options can be given; when a warning matches more than one option, the action for the last matching option is performed. Invalid `-W` options are ignored (though, a warning message is printed about invalid options when the first warning is issued).

Warnings can also be controlled using the `PYTHONWARNINGS` environment variable and from within a Python program using the `warnings` module. For example, the `warnings.filterwarnings()` function can be used to use a regular expression on the warning message.

See `warning-filter` and `describing-warning-filters` for more details.

**-x**

Skip the first line of the source, allowing use of non-Unix forms of `#!cmd`. This is intended for a DOS specific hack only.

**-X**

Reserved for various implementation-specific options. CPython currently defines the following possible values:

- `-X faulthandler` to enable `faulthandler`. See also [PYTHONFAULTHANDLER](#).
- `-X showrefcount` to output the total reference count and number of used memory blocks when the program finishes or after each statement in the interactive interpreter. This only works on *debug builds*.
- `-X tracemalloc` to start tracing Python memory allocations using the `tracemalloc` module. By default, only the most recent frame is stored in a traceback of a trace. Use `-X tracemalloc=NFRAME` to start tracing with a traceback limit of `NFRAME` frames. See `tracemalloc.start()` and [PYTHONTRACEMALLOC](#) for more information.
- `-X int_max_str_digits` configures the integer string conversion length limitation. See also [PYTHONINTMAXSTRDIGITS](#).
- `-X importtime` to show how long each import takes. It shows module name, cumulative time (including nested imports) and self time (excluding nested imports). Note that its output may be broken in multi-threaded application. Typical usage is `python3 -X importtime -c 'import asyncio'`. See also [PYTHONPROFILEIMPORTTIME](#).
- `-X dev`: enable Python Development Mode, introducing additional runtime checks that are too expensive to be enabled by default. See also [PYTHONDEVMODE](#).
- `-X utf8` enables the Python UTF-8 Mode. `-X utf8=0` explicitly disables Python UTF-8 Mode (even when it would otherwise activate automatically). See also [PYTHONUTF8](#).
- `-X pycache_prefix=PATH` enables writing `.pyc` files to a parallel tree rooted at the given directory instead of to the code tree. See also [PYTHONPYCACHEPREFIX](#).
- `-X warn_default_encoding` issues a `EncodingWarning` when the locale-specific default encoding is used for opening files. See also [PYTHONWARNDEFAULTENCODING](#).
- `-X no_debug_ranges` disables the inclusion of the tables mapping extra location information (end line, start column offset and end column offset) to every instruction in code objects. This is useful when smaller code objects and `pyc` files are desired as well as suppressing the extra visual location indicators when the interpreter displays tracebacks. See also [PYTHONNODEBUGRANGES](#).
- `-X frozen_modules` determines whether or not frozen modules are ignored by the import machinery. A value of "on" means they get imported and "off" means they are ignored. The default is "on" if this is an installed Python (the normal case). If it's under development (running from the source tree) then the default is "off". Note that the "importlib\_bootstrap" and "importlib\_bootstrap\_external" frozen modules are always used, even if this flag is set to "off".

It also allows passing arbitrary values and retrieving them through the `sys._xoptions` dictionary.

在 3.2 版新加入.

在 3.3 版的變更: Added the `-X faulthandler` option.

在 3.4 版的變更: Added the `-X showrefcount` and `-X tracemalloc` options.

在 3.6 版的變更: Added the `-X showalloccount` option.

在 3.7 版的變更: Added the `-X importtime`, `-X dev` and `-X utf8` options.

在 3.8 版的變更: Added the `-X pycache_prefix` option. The `-X dev` option now logs `close()` exceptions in `io.IOBase` destructor.

在 3.9 版的變更: Using `-X dev` option, check *encoding* and *errors* arguments on string encoding and decoding operations.

`-X showalloccount` 選項已被移除。

在 3.10 版的變更: Added the `-X warn_default_encoding` option. Removed the `-X oldparser` option.

在 3.11 版的變更: Added the `-X no_debug_ranges`, `-X frozen_modules` and `-X int_max_str_digits` options.

### 1.1.4 你不該使用的選項

`-J`

Reserved for use by Jython.

## 1.2 環境變數

These environment variables influence Python's behavior, they are processed before the command-line switches other than `-E` or `-I`. It is customary that command-line switches override environmental variables where there is a conflict.

### **PYTHONHOME**

Change the location of the standard Python libraries. By default, the libraries are searched in *prefix/lib/pythonversion* and *exec\_prefix/lib/pythonversion*, where *prefix* and *exec\_prefix* are installation-dependent directories, both defaulting to `/usr/local`.

When *PYTHONHOME* is set to a single directory, its value replaces both *prefix* and *exec\_prefix*. To specify different values for these, set *PYTHONHOME* to *prefix:exec\_prefix*.

### **PYTHONPATH**

Augment the default search path for module files. The format is the same as the shell's `PATH`: one or more directory pathnames separated by `os.pathsep` (e.g. colons on Unix or semicolons on Windows). Non-existent directories are silently ignored.

In addition to normal directories, individual *PYTHONPATH* entries may refer to zipfiles containing pure Python modules (in either source or compiled form). Extension modules cannot be imported from zipfiles.

The default search path is installation dependent, but generally begins with *prefix/lib/pythonversion* (see *PYTHONHOME* above). It is *always* appended to *PYTHONPATH*.

An additional directory will be inserted in the search path in front of *PYTHONPATH* as described above under 介面選項. The search path can be manipulated from within a Python program as the variable `sys.path`.

### **PYTHONSAFEPATH**

If this is set to a non-empty string, don't prepend a potentially unsafe path to `sys.path`: see the `-P` option for details.

在 3.11 版新加入.

### **PYTHONPLATLIBDIR**

If this is set to a non-empty string, it overrides the `sys.platlibdir` value.

在 3.9 版新加入.



**PYTHONSTARTUP**

If this is the name of a readable file, the Python commands in that file are executed before the first prompt is displayed in interactive mode. The file is executed in the same namespace where interactive commands are executed so that objects defined or imported in it can be used without qualification in the interactive session. You can also change the prompts `sys.ps1` and `sys.ps2` and the hook `sys.__interactivehook__` in this file.

引發一個附帶引數 `filename` 的稽核事件 `cpython.run_startup`。

**PYTHONOPTIMIZE**

If this is set to a non-empty string it is equivalent to specifying the `-O` option. If set to an integer, it is equivalent to specifying `-O` multiple times.

**PYTHONBREAKPOINT**

If this is set, it names a callable using dotted-path notation. The module containing the callable will be imported and then the callable will be run by the default implementation of `sys.breakpointhook()` which itself is called by built-in `breakpoint()`. If not set, or set to the empty string, it is equivalent to the value `"pdb.set_trace"`. Setting this to the string `"0"` causes the default implementation of `sys.breakpointhook()` to do nothing but return immediately.

在 3.7 版新加入。

**PYTHONDEBUG**

If this is set to a non-empty string it is equivalent to specifying the `-d` option. If set to an integer, it is equivalent to specifying `-d` multiple times.

**PYTHONINSPECT**

If this is set to a non-empty string it is equivalent to specifying the `-i` option.

This variable can also be modified by Python code using `os.environ` to force inspect mode on program termination.

**PYTHONUNBUFFERED**

If this is set to a non-empty string it is equivalent to specifying the `-u` option.

**PYTHONVERBOSE**

If this is set to a non-empty string it is equivalent to specifying the `-v` option. If set to an integer, it is equivalent to specifying `-v` multiple times.

**PYTHONCASEOK**

If this is set, Python ignores case in `import` statements. This only works on Windows and macOS.

**PYTHONDONTWRITEBYTECODE**

If this is set to a non-empty string, Python won't try to write `.pyc` files on the import of source modules. This is equivalent to specifying the `-B` option.

**PYTHONPYCACHEPREFIX**

If this is set, Python will write `.pyc` files in a mirror directory tree at this path, instead of in `__pycache__` directories within the source tree. This is equivalent to specifying the `-X pycache_prefix=PATH` option.

在 3.8 版新加入。

**PYTHONHASHSEED**

If this variable is not set or set to `random`, a random value is used to seed the hashes of `str` and `bytes` objects.

If `PYTHONHASHSEED` is set to an integer value, it is used as a fixed seed for generating the `hash()` of the types covered by the hash randomization.

Its purpose is to allow repeatable hashing, such as for selftests for the interpreter itself, or to allow a cluster of python processes to share hash values.

The integer must be a decimal number in the range [0,4294967295]. Specifying the value 0 will disable hash randomization.

在 3.2.3 版新加入。

#### PYTHONINTMAXSTRDIGITS

If this variable is set to an integer, it is used to configure the interpreter's global integer string conversion length limitation.

在 3.11 版新加入。

#### PYTHONIOENCODING

If this is set before running the interpreter, it overrides the encoding used for stdin/stdout/stderr, in the syntax `encodingname:errorhandler`. Both the `encodingname` and the `:errorhandler` parts are optional and have the same meaning as in `str.encode()`.

For stderr, the `:errorhandler` part is ignored; the handler will always be `'backslashreplace'`.

在 3.4 版的變更: The `encodingname` part is now optional.

在 3.6 版的變更: On Windows, the encoding specified by this variable is ignored for interactive console buffers unless `PYTHONLEGACYWINDOWSSTDIO` is also specified. Files and pipes redirected through the standard streams are not affected.

#### PYTHONNOUSERSITE

If this is set, Python won't add the user `site-packages` directory to `sys.path`.

也參考:

**PEP 370** -- Per user site-packages directory

#### PYTHONUSERBASE

Defines the user base directory, which is used to compute the path of the user `site-packages` directory and installation paths for `python -m pip install --user`.

也參考:

**PEP 370** -- Per user site-packages directory

#### PYTHONEXECUTABLE

If this environment variable is set, `sys.argv[0]` will be set to its value instead of the value got through the C runtime. Only works on macOS.

#### PYTHONWARNINGS

This is equivalent to the `-W` option. If set to a comma separated string, it is equivalent to specifying `-W` multiple times, with filters later in the list taking precedence over those earlier in the list.

The simplest settings apply a particular action unconditionally to all warnings emitted by a process (even those that are otherwise ignored by default):

```
PYTHONWARNINGS=default # Warn once per call location
PYTHONWARNINGS=error   # Convert to exceptions
PYTHONWARNINGS=always  # Warn every time
PYTHONWARNINGS=module  # Warn once per calling module
PYTHONWARNINGS=once    # Warn once per Python process
PYTHONWARNINGS=ignore  # Never warn
```

See `warning-filter` and `describing-warning-filters` for more details.

**PYTHONFAULTHANDLER**

If this environment variable is set to a non-empty string, `faulthandler.enable()` is called at startup: install a handler for SIGSEGV, SIGFPE, SIGABRT, SIGBUS and SIGILL signals to dump the Python traceback. This is equivalent to `-X faulthandler` option.

在 3.3 版新加入。

**PYTHONTRACEMALLOC**

If this environment variable is set to a non-empty string, start tracing Python memory allocations using the `tracemalloc` module. The value of the variable is the maximum number of frames stored in a traceback of a trace. For example, `PYTHONTRACEMALLOC=1` stores only the most recent frame. See the `tracemalloc.start()` function for more information. This is equivalent to setting the `-X tracemalloc` option.

在 3.4 版新加入。

**PYTHONPROFILEIMPORTTIME**

If this environment variable is set to a non-empty string, Python will show how long each import takes. This is equivalent to setting the `-X importtime` option.

在 3.7 版新加入。

**PYTHONASYNCIODEBUG**

If this environment variable is set to a non-empty string, enable the debug mode of the `asyncio` module.

在 3.4 版新加入。

**PYTHONMALLOC**

Set the Python memory allocators and/or install debug hooks.

Set the family of memory allocators used by Python:

- `default`: use the default memory allocators.
- `malloc`: use the `malloc()` function of the C library for all domains (`PYMEM_DOMAIN_RAW`, `PYMEM_DOMAIN_MEM`, `PYMEM_DOMAIN_OBJ`).
- `pymalloc`: use the `pymalloc` allocator for `PYMEM_DOMAIN_MEM` and `PYMEM_DOMAIN_OBJ` domains and use the `malloc()` function for the `PYMEM_DOMAIN_RAW` domain.

Install debug hooks:

- `debug`: install debug hooks on top of the default memory allocators.
- `malloc_debug`: same as `malloc` but also install debug hooks.
- `pymalloc_debug`: same as `pymalloc` but also install debug hooks.

在 3.6 版新加入。

在 3.7 版的變更: Added the "default" allocator.

**PYTHONMALLOCSTATS**

If set to a non-empty string, Python will print statistics of the `pymalloc` memory allocator every time a new `pymalloc` object arena is created, and on shutdown.

This variable is ignored if the `PYTHONMALLOC` environment variable is used to force the `malloc()` allocator of the C library, or if Python is configured without `pymalloc` support.

在 3.6 版的變更: This variable can now also be used on Python compiled in release mode. It now has no effect if set to an empty string.

**PYTHONLEGACYWINDOWSFSENCODING**

If set to a non-empty string, the default *filesystem encoding and error handler* mode will revert to their pre-3.6 values of 'mbcs' and 'replace', respectively. Otherwise, the new defaults 'utf-8' and 'surrogatepass' are used.

This may also be enabled at runtime with `sys._enablelegacywindowsfsencoding()`.

適用：Windows。

在 3.6 版新加入：更多細節請見 [PEP 529](#)。

**PYTHONLEGACYWINDOWSSTDIO**

If set to a non-empty string, does not use the new console reader and writer. This means that Unicode characters will be encoded according to the active console code page, rather than using utf-8.

This variable is ignored if the standard streams are redirected (to files or pipes) rather than referring to console buffers.

適用：Windows。

在 3.6 版新加入。

**PYTHONCOERCECLOCALE**

If set to the value 0, causes the main Python command line application to skip coercing the legacy ASCII-based C and POSIX locales to a more capable UTF-8 based alternative.

If this variable is *not* set (or is set to a value other than 0), the `LC_ALL` locale override environment variable is also not set, and the current locale reported for the `LC_CTYPE` category is either the default C locale, or else the explicitly ASCII-based `POSIX` locale, then the Python CLI will attempt to configure the following locales for the `LC_CTYPE` category in the order listed before loading the interpreter runtime:

- C.UTF-8
- C.utf8
- UTF-8

If setting one of these locale categories succeeds, then the `LC_CTYPE` environment variable will also be set accordingly in the current process environment before the Python runtime is initialized. This ensures that in addition to being seen by both the interpreter itself and other locale-aware components running in the same process (such as the GNU `readline` library), the updated setting is also seen in subprocesses (regardless of whether or not those processes are running a Python interpreter), as well as in operations that query the environment rather than the current C locale (such as Python's own `locale.getdefaultlocale()`).

Configuring one of these locales (either explicitly or via the above implicit locale coercion) automatically enables the `surrogateescape` error handler for `sys.stdin` and `sys.stdout` (`sys.stderr` continues to use `backslashreplace` as it does in any other locale). This stream handling behavior can be overridden using [PYTHONIOENCODING](#) as usual.

For debugging purposes, setting `PYTHONCOERCECLOCALE=warn` will cause Python to emit warning messages on `stderr` if either the locale coercion activates, or else if a locale that *would* have triggered coercion is still active when the Python runtime is initialized.

Also note that even when locale coercion is disabled, or when it fails to find a suitable target locale, [PYTHONUTF8](#) will still activate by default in legacy ASCII-based locales. Both features must be disabled in order to force the interpreter to use ASCII instead of UTF-8 for system interfaces.

適用：Unix。

在 3.7 版新加入：更多細節請見 [PEP 538](#)。

**PYTHONDEVMODE**

If this environment variable is set to a non-empty string, enable Python Development Mode, introducing additional runtime checks that are too expensive to be enabled by default. This is equivalent to setting the `-X dev` option.

在 3.7 版新加入。

**PYTHONUTF8**

如果設 1，則用 Python UTF-8 Mode。

如果設 0，則停用 Python UTF-8 Mode。

Setting any other non-empty string causes an error during interpreter initialisation.

在 3.7 版新加入。

**PYTHONWARNDEFAULTENCODING**

If this environment variable is set to a non-empty string, issue a `EncodingWarning` when the locale-specific default encoding is used.

細節請見 `io-encoding-warning`。

在 3.10 版新加入。

**PYTHONNODEBUGRANGES**

If this variable is set, it disables the inclusion of the tables mapping extra location information (end line, start column offset and end column offset) to every instruction in code objects. This is useful when smaller code objects and pyc files are desired as well as suppressing the extra visual location indicators when the interpreter displays tracebacks.

在 3.11 版新加入。

## 1.2.1 除錯模式變數

**PYTHONTHREADDEBUG**

If set, Python will print threading debug info into stdout.

Need a *debug build of Python*.

自從版本 3.10 後不推薦使用，將會自版本 3.12 中移除。

**PYTHONDUMPPREFS**

If set, Python will dump objects and reference counts still alive after shutting down the interpreter.

Need Python configured with the `--with-trace-refs` build option.

**PYTHONDUMPPREFSFILE=FILENAME**

If set, Python will dump objects and reference counts still alive after shutting down the interpreter into a file called *FILENAME*.

Need Python configured with the `--with-trace-refs` build option.

在 3.11 版新加入。



### 2.1 獲得與安裝 Python 的最新版本

#### 2.1.1 在 Linux 上

在大多數 Linux 發行版上會預先安裝 Python，作為一個套件提供給所有其他使用者。但是發行版提供的套件可能沒有你想要使用的某些功能，這時你可以選擇從原始碼編譯最新版本的 Python，做法相當容易。

如果 Python 有預先安裝，且不在發行版提供的儲存庫 (repository) 中，你可以輕鬆地自己使用的發行版建立套件。參見以下連結：

也參考：

<https://www.debian.org/doc/manuals/maint-guide/first.en.html>

對於 Debian 用

<https://en.opensuse.org/Portal:Packaging>

對於 OpenSuse 用

[https://docs.fedoraproject.org/en-US/package-maintainers/Packaging\\_Tutorial\\_GNU\\_Hello/](https://docs.fedoraproject.org/en-US/package-maintainers/Packaging_Tutorial_GNU_Hello/)

對於 Fedora 用

<https://slackbook.org/html/package-management-making-packages.html>

對於 Slackware 用

## 2.1.2 在 FreeBSD 和 OpenBSD 上

- FreeBSD 用 `pkg` 應使用以下命令增加套件：

```
pkg install python3
```

- OpenBSD 用 `pkg_add` 應使用以下命令增加套件：

```
pkg_add -r python
pkg_add ftp://ftp.openbsd.org/pub/OpenBSD/4.2/packages/<insert your architecture_
↪ here>/python-<version>.tgz
```

例如 i386 使用者要獲取 Python 2.5.1 的可用版本：

```
pkg_add ftp://ftp.openbsd.org/pub/OpenBSD/4.2/packages/i386/python-2.5.1p2.tgz
```

## 2.1.3 在 OpenSolaris 系統上

你可以從 [OpenCSW](#) 獲取、安裝及使用各種版本的 Python。比如 `pkgutil -i python27`。

## 2.2 建置 Python

如果你想自己編譯 CPython，首先要做的是獲取原始碼。你可以下載最新版本的原始碼，也可以直接提取最新的 [clone](#)（克隆）。（如果你想要貢獻修補程式碼，也會需要一份 clone。）

建置過程由幾個常用命令組成：

```
./configure
make
make install
```

特定 Unix 平臺的[配置選項](#)和注意事項通常會詳細地記在 Python 原始碼樹 (source tree) 根目下的 [README.rst](#) 檔案中。

**警告：** `make install` 可以覆蓋或安裝 `python3` 二進位制檔案。因此，建議使用 `make altinstall` 而不是 `make install`，因它只安裝 `exec_prefix/bin/pythonversion`。

## 2.3 與 Python 相關的路徑和檔案

這取於本地安裝慣例；`prefix` 和 `exec_prefix` 相依於安裝方式，應被直譯來讓 GNU 軟體使用；它們也可能相同。

例如，在大多數 Linux 系統上，兩者的預設值皆是 `/usr`。



檔案/目錄	含意
<code>exec_prefix/bin/python3</code>	直譯器的推薦位置。
<code>prefix/lib/pythonversion</code> 、 <code>exec_prefix/lib/pythonversion</code>	包含標準模組目錄的推薦位置。
<code>prefix/include/pythonversion</code> 、 <code>exec_prefix/include/pythonversion</code>	包含開發 Python 擴充套件和嵌入直譯器所需 <code>include</code> 檔案之目錄的推薦位置。

## 2.4 雜項

要在 Unix 上使用 Python 腳本，你需要讓他們是可執行的 (executable)，例如用

```
$ chmod +x script
```

在腳本的頂部放一個合適的 Shebang。以下通常是個好選擇：

```
#!/usr/bin/env python3
```

將在整個 PATH 中搜索 Python 直譯器。然而某些 Unix 系統可能有 `env` 命令，因此你可能需要將 `/usr/bin/python3` 寫死 (hardcode) 成直譯器路徑。

要在 Python 腳本中使用 shell 命令，請見 `subprocess` 模組。

## 2.5 客制化 OpenSSL

1. 要使用你所選擇發行商 (vendor) 的 OpenSSL 配置和系統信任儲存區 (system trust store)，請找到包含 `openssl.cnf` 檔案的目錄或位於 `/etc` 的符號連結 (symlink)。在大多數發行版上，該檔案會是在 `/etc/ssl` 或者 `/etc/pki/tls` 中。該目錄亦應包含一個 `cert.pem` 檔案和/或一個 `certs` 目錄。

```
$ find /etc/ -name openssl.cnf -printf "%h\n"
/etc/ssl
```

2. 下載、建置並安裝 OpenSSL。請確保你使用 `install_sw` 而不是 `install`。`install_sw` 的目標不會覆蓋 `openssl.cnf`。

```
$ curl -O https://www.openssl.org/source/openssl-VERSION.tar.gz
$ tar xzf openssl-VERSION
$ pushd openssl-VERSION
$ ./config \
  --prefix=/usr/local/custom-openssl \
  --libdir=lib \
  --openssldir=/etc/ssl
$ make -j1 depend
$ make -j8
$ make install_sw
$ popd
```

3. 使用客制化 OpenSSL 建置 Python (參見配置 `--with-openssl` 和 `--with-openssl-rpath` 選項)

```
$ pushd python-3.x.x
$ ./configure -C \
```

(繼續下一頁)

(繼續上一頁)

```
--with-openssl=/usr/local/custom-openssl \
--with-openssl-rpath=auto \
--prefix=/usr/local/python-3.x.x
$ make -j8
$ make altinstall
```

---

**備註：** OpenSSL 的修補釋出版 (patch releases) 具有向後相容的 ABI。你不需要重新編譯 Python 來更新 OpenSSL。使用一個新的版本來替代客體化 OpenSSL 安裝版就可以了。

---

## 3.1 Configure Options

List all `./configure` script options using:

```
./configure --help
```

See also the `Misc/SpecialBuilds.txt` in the Python source distribution.

### 3.1.1 General Options

#### **--enable-loadable-sqlite-extensions**

Support loadable extensions in the `_sqlite` extension module (default is no) of the `sqlite3` module.

See the `sqlite3.Connection.enable_load_extension()` method of the `sqlite3` module.

在 3.6 版新加入。

#### **--disable-ipv6**

Disable IPv6 support (enabled by default if supported), see the `socket` module.

#### **--enable-big-digits=[15|30]**

Define the size in bits of Python `int` digits: 15 or 30 bits.

By default, the digit size is 30.

將 `PYLONG_BITS_IN_DIGIT` 定義為 15 或 30。

參見 `sys.int_info.bits_per_digit`。

#### **--with-cxx-main**

**--with-cxx-main=COMPILER**

Compile the Python `main()` function and link Python executable with C++ compiler: `$CXX`, or *COMPILER* if specified.

**--with-suffix=SUFFIX**

Set the Python executable suffix to *SUFFIX*.

The default suffix is `.exe` on Windows and macOS (`python.exe` executable), `.js` on Emscripten node, `.html` on Emscripten browser, `.wasm` on WASI, and an empty string on other platforms (`python` executable).

在 3.11 版的變更: The default suffix on WASM platform is one of `.js`, `.html` or `.wasm`.

**--with-tzpath=<list of absolute paths separated by pathsep>**

Select the default time zone search path for `zoneinfo.TZPATH`. See the Compile-time configuration of the `zoneinfo` module.

Default: `/usr/share/zoneinfo:/usr/lib/zoneinfo:/usr/share/lib/zoneinfo:/etc/zoneinfo`.

See `os.pathsep` path separator.

在 3.9 版新加入.

**--without-decimal-contextvar**

Build the `_decimal` extension module using a thread-local context rather than a coroutine-local context (default), see the `decimal` module.

See `decimal.HAVE_CONTEXTVAR` and the `contextvars` module.

在 3.9 版新加入.

**--with-dbmliborder=<list of backend names>**

Override order to check db backends for the `dbm` module

A valid value is a colon (`:`) separated string with the backend names:

- `ndbm`;
- `gdbm`;
- `bdb`.

**--without-c-locale-coercion**

Disable C locale coercion to a UTF-8 based locale (enabled by default).

Don't define the `PY_COERCE_C_LOCALE` macro.

請見 `PYTHONCOERCECLOCALE` 與 [PEP 538](#).

**--with-platlibdir=DIRNAME**

Python library directory name (default is `lib`).

Fedora and SuSE use `lib64` on 64-bit platforms.

參見 `sys.platlibdir`.

在 3.9 版新加入.

**--with-wheel-pkg-dir=PATH**

Directory of wheel packages used by the `ensurepip` module (none by default).

Some Linux distribution packaging policies recommend against bundling dependencies. For example, Fedora installs wheel packages in the `/usr/share/python-wheels/` directory and don't install the `ensurepip._bundled` package.

在 3.10 版新加入.

**--with-pkg-config**=[check|yes|no]

Whether configure should use **pkg-config** to detect build dependencies.

- check (default): **pkg-config** is optional
- yes: **pkg-config** is mandatory
- no: configure does not use **pkg-config** even when present

在 3.11 版新加入.

**--enable-pystats**

Turn on internal statistics gathering.

The statistics will be dumped to a arbitrary (probably unique) file in /tmp/py\_stats/, or C:\temp\py\_stats\ on Windows.

Use Tools/scripts/summarize\_stats.py to read the stats.

在 3.11 版新加入.

## 3.1.2 WebAssembly Options

**--with-emscripten-target**=[browser|node]

Set build flavor for wasm32-emscripten.

- browser (default): preload minimal stdlib, default MEMFS.
- node: NODERAWFS and pthread support.

在 3.11 版新加入.

**--enable-wasm-dynamic-linking**

Turn on dynamic linking support for WASM.

Dynamic linking enables dlopen. File size of the executable increases due to limited dead code elimination and additional features.

在 3.11 版新加入.

**--enable-wasm-pthreads**

Turn on pthreads support for WASM.

在 3.11 版新加入.

## 3.1.3 Install Options

**--prefix**=PREFIX

Install architecture-independent files in PREFIX. On Unix, it defaults to /usr/local.

This value can be retrieved at runtime using `sys.prefix`.

As an example, one can use `--prefix="$HOME/.local/"` to install a Python in its home directory.

**--exec-prefix**=EPREFIX

Install architecture-dependent files in EPREFIX, defaults to `--prefix`.

This value can be retrieved at runtime using `sys.exec_prefix`.

**--disable-test-modules**

Don't build nor install test modules, like the `test` package or the `_testcapi` extension module (built and installed by default).

在 3.10 版新加入。

**--with-ensurepip**=[upgrade|install|no]

Select the `ensurepip` command run on Python installation:

- `upgrade` (default): `run python -m ensurepip --altinstall --upgrade command`.
- `install`: `run python -m ensurepip --altinstall command`;
- `no`: don't run `ensurepip`;

在 3.6 版新加入。

### 3.1.4 Performance options

Configuring Python using `--enable-optimizations --with-lto` (PGO + LTO) is recommended for best performance.

**--enable-optimizations**

Enable Profile Guided Optimization (PGO) using `PROFILE_TASK` (disabled by default).

The C compiler Clang requires `llvm-profdata` program for PGO. On macOS, GCC also requires it: GCC is just an alias to Clang on macOS.

Disable also semantic interposition in `libpython` if `--enable-shared` and GCC is used: add `-fno-semantic-interposition` to the compiler and linker flags.

在 3.6 版新加入。

在 3.10 版的變更: Use `-fno-semantic-interposition` on GCC.

**PROFILE\_TASK**

Environment variable used in the Makefile: Python command line arguments for the PGO generation task.

Default: `-m test --pgo --timeout=$(TESTTIMEOUT)`.

在 3.8 版新加入。

**--with-lto**=[full|thin|no|yes]

Enable Link Time Optimization (LTO) in any build (disabled by default).

The C compiler Clang requires `llvm-ar` for LTO (`ar` on macOS), as well as an LTO-aware linker (`ld.gold` or `lld`).

在 3.6 版新加入。

在 3.11 版新加入: To use ThinLTO feature, use `--with-lto=thin` on Clang.

**--with-computed-gotos**

Enable computed gotos in evaluation loop (enabled by default on supported compilers).

**--without-pymalloc**

Disable the specialized Python memory allocator `pymalloc` (enabled by default).

另請參 [F](#) `PYTHONMALLOC` 環境變數。

**--without-doc-strings**

Disable static documentation strings to reduce the memory footprint (enabled by default). Documentation strings defined in Python are not affected.

Don't define the `WITH_DOC_STRINGS` macro.

See the `PyDoc_STRVAR()` macro.

**--enable-profiling**

Enable C-level code profiling with `gprof` (disabled by default).

### 3.1.5 Python Debug Build

A debug build is Python built with the `--with-pydebug` configure option.

Effects of a debug build:

- Display all warnings by default: the list of default warning filters is empty in the `warnings` module.
- Add `d` to `sys.abiflags`.
- Add `sys.gettotalrefcount()` function.
- Add `-X showrefcount` command line option.
- Add `PYTHONTHREADDEBUG` environment variable.
- Add support for the `__lltrace__` variable: enable low-level tracing in the bytecode evaluation loop if the variable is defined.
- Install debug hooks on memory allocators to detect buffer overflow and other memory errors.
- Define `Py_DEBUG` and `Py_REF_DEBUG` macros.
- Add runtime checks: code surrounded by `#ifdef Py_DEBUG` and `#endif`. Enable `assert(...)` and `_PyObject_ASSERT(...)` assertions: don't set the `NDEBUG` macro (see also the `--with-assertions` configure option). Main runtime checks:
  - Add sanity checks on the function arguments.
  - Unicode and int objects are created with their memory filled with a pattern to detect usage of uninitialized objects.
  - Ensure that functions which can clear or replace the current exception are not called with an exception raised.
  - Check that deallocator functions don't change the current exception.
  - The garbage collector (`gc.collect()` function) runs some basic checks on objects consistency.
  - The `Py_SAFE_DOWNCAST()` macro checks for integer underflow and overflow when downcasting from wide types to narrow types.

See also the Python Development Mode and the `--with-trace-refs` configure option.

在 3.8 版的變更: Release builds and debug builds are now ABI compatible: defining the `Py_DEBUG` macro no longer implies the `Py_TRACE_REFS` macro (see the `--with-trace-refs` option), which introduces the only ABI incompatibility.

### 3.1.6 Debug options

#### **--with-pydebug**

*Build Python in debug mode:* define the `Py_DEBUG` macro (disabled by default).

#### **--with-trace-refs**

Enable tracing references for debugging purpose (disabled by default).

Effects:

- Define the `Py_TRACE_REFS` macro.
- Add `sys.getobjects()` function.
- Add `PYTHONDUMPREFS` environment variable.

This build is not ABI compatible with release build (default build) or debug build (`Py_DEBUG` and `Py_REF_DEBUG` macros).

在 3.8 版新加入.

#### **--with-assertions**

Build with C assertions enabled (default is no): `assert(...);` and `_PyObject_ASSERT(...);`.

If set, the `NDEBUG` macro is not defined in the `OPT` compiler variable.

See also the *--with-pydebug* option (*debug build*) which also enables assertions.

在 3.6 版新加入.

#### **--with-valgrind**

Enable Valgrind support (default is no).

#### **--with-dtrace**

Enable DTrace support (default is no).

See Instrumenting CPython with DTrace and SystemTap.

在 3.6 版新加入.

#### **--with-address-sanitizer**

Enable AddressSanitizer memory error detector, `asan` (default is no).

在 3.6 版新加入.

#### **--with-memory-sanitizer**

Enable MemorySanitizer allocation error detector, `msan` (default is no).

在 3.6 版新加入.

#### **--with-undefined-behavior-sanitizer**

Enable UndefinedBehaviorSanitizer undefined behaviour detector, `ubsan` (default is no).

在 3.6 版新加入.



### 3.1.7 Linker options

#### **--enable-shared**

Enable building a shared Python library: `libpython` (default is no).

#### **--without-static-libpython**

Do not build `libpythonMAJOR.MINOR.a` and do not install `python.o` (built and enabled by default).

在 3.10 版新加入。

### 3.1.8 Libraries options

#### **--with-libs='lib1 ...'**

Link against additional libraries (default is no).

#### **--with-system-expat**

Build the `pyexpat` module using an installed `expat` library (default is no).

#### **--with-system-ffi**

Build the `_ctypes` extension module using an installed `ffi` library, see the `ctypes` module (default is system-dependent).

#### **--with-system-libmpdec**

Build the `_decimal` extension module using an installed `mpdec` library, see the `decimal` module (default is no).

在 3.3 版新加入。

#### **--with-readline=editline**

Use `editline` library for backend of the `readline` module.

Define the `WITH_EDITLINE` macro.

在 3.10 版新加入。

#### **--without-readline**

Don't build the `readline` module (built by default).

Don't define the `HAVE_LIBREADLINE` macro.

在 3.10 版新加入。

#### **--with-libm=STRING**

Override `libm` math library to *STRING* (default is system-dependent).

#### **--with-libc=STRING**

Override `libc` C library to *STRING* (default is system-dependent).

#### **--with-openssl=DIR**

Root of the OpenSSL directory.

在 3.7 版新加入。

#### **--with-openssl-rpath=[no|auto|DIR]**

Set runtime library directory (rpath) for OpenSSL libraries:

- `no` (default): don't set rpath;
- `auto`: auto-detect rpath from `--with-openssl` and `pkg-config`;

- *DIR*: set an explicit rpath.

在 3.10 版新加入.

### 3.1.9 Security Options

**--with-hash-algorithm**=[fnv|siphhash13|siphhash24]

Select hash algorithm for use in Python/pyhash.c:

- siphhash13 (default);
- siphhash24;
- fnv.

在 3.4 版新加入.

在 3.11 版新加入: siphhash13 is added and it is the new default.

**--with-builtin-hashlib-hashes**=md5,sha1,sha256,sha512,sha3,blake2

Built-in hash modules:

- md5;
- sha1;
- sha256;
- sha512;
- sha3 (with shake);
- blake2.

在 3.9 版新加入.

**--with-ssl-default-suites**=[python|openssl|STRING]

Override the OpenSSL default cipher suites string:

- python (default): use Python's preferred selection;
- openssl: leave OpenSSL's defaults untouched;
- *STRING*: use a custom string

See the `ssl` module.

在 3.7 版新加入.

在 3.10 版的變更: The settings `python` and *STRING* also set TLS 1.2 as minimum protocol version.

### 3.1.10 macOS Options

參 發 Mac/README.rst。

**--enable-universalsdk**

**--enable-universalsdk**=SDKDIR

Create a universal binary build. *SDKDIR* specifies which macOS SDK should be used to perform the build (default is no).

**--enable-framework**

**--enable-framework=INSTALLDIR**

Create a Python.framework rather than a traditional Unix install. Optional *INSTALLDIR* specifies the installation path (default is no).

**--with-universal-archs=ARCH**

Specify the kind of universal binary that should be created. This option is only valid when *--enable-universalsdk* is set.

Options:

- universal2;
- 32-bit;
- 64-bit;
- 3-way;
- intel;
- intel-32;
- intel-64;
- all.

**--with-framework-name=FRAMEWORK**

Specify the name for the python framework on macOS only valid when *--enable-framework* is set (default: Python).

### 3.1.11 Cross Compiling Options

Cross compiling, also known as cross building, can be used to build Python for another CPU architecture or platform. Cross compiling requires a Python interpreter for the build platform. The version of the build Python must match the version of the cross compiled host Python.

**--build=BUILD**

configure for building on BUILD, usually guessed by **config.guess**.

**--host=HOST**

cross-compile to build programs to run on HOST (target platform)

**--with-build-python=path/to/python**

path to build python binary for cross compiling

在 3.11 版新加入.

**CONFIG\_SITE=file**

An environment variable that points to a file with configure overrides.

Example *config.site* file:

```
# config.site-aarch64
ac_cv_buggy_getaddrinfo=no
ac_cv_file__dev_ptmx=yes
ac_cv_file__dev_ptc=no
```

Cross compiling example:

```
CONFIG_SITE=config.site-aarch64 ../configure \
--build=x86_64-pc-linux-gnu \
--host=aarch64-unknown-linux-gnu \
--with-build-python=../x86_64/python
```

## 3.2 Python Build System

### 3.2.1 Main files of the build system

- `configure.ac` => `configure`;
- `Makefile.pre.in` => `Makefile` (created by `configure`);
- `pyconfig.h` (created by `configure`);
- `Modules/Setup`: C extensions built by the `Makefile` using `Module/makesetup` shell script;
- `setup.py`: C extensions built using the `distutils` module.

### 3.2.2 Main build steps

- C files (`.c`) are built as object files (`.o`).
- A static `libpython` library (`.a`) is created from objects files.
- `python.o` and the static `libpython` library are linked into the final `python` program.
- C extensions are built by the `Makefile` (see `Modules/Setup`) and `python setup.py build`.

### 3.2.3 Main Makefile targets

- `make`: Build Python with the standard library.
- `make platform::` build the `python` program, but don't build the standard library extension modules.
- `make profile-opt`: build Python using Profile Guided Optimization (PGO). You can use the `configure --enable-optimizations` option to make this the default target of the `make` command (`make all` or `just make`).
- `make buildbottest`: Build Python and run the Python test suite, the same way than `buildbots` test Python. Set `TESTTIMEOUT` variable (in seconds) to change the test timeout (1200 by default: 20 minutes).
- `make install`: Build and install Python.
- `make regen-all`: Regenerate (almost) all generated files; `make regen-stdlib-module-names` and `autoconf` must be run separately for the remaining generated files.
- `make clean`: Remove built files.
- `make distclean`: Same than `make clean`, but remove also files created by the `configure` script.

### 3.2.4 C extensions

Some C extensions are built as built-in modules, like the `sys` module. They are built with the `Py_BUILD_CORE_BUILTIN` macro defined. Built-in modules have no `__file__` attribute:

```
>>> import sys
>>> sys
<module 'sys' (built-in)>
>>> sys.__file__
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
AttributeError: module 'sys' has no attribute '__file__'
```

Other C extensions are built as dynamic libraries, like the `_asyncio` module. They are built with the `Py_BUILD_CORE_MODULE` macro defined. Example on Linux x86-64:

```
>>> import _asyncio
>>> _asyncio
<module '_asyncio' from '/usr/lib64/python3.9/lib-dynload/_asyncio.cpython-39-x86_64-
↳ linux-gnu.so'>
>>> _asyncio.__file__
'/usr/lib64/python3.9/lib-dynload/_asyncio.cpython-39-x86_64-linux-gnu.so'
```

`Modules/Setup` is used to generate Makefile targets to build C extensions. At the beginning of the files, C extensions are built as built-in modules. Extensions defined after the `*shared*` marker are built as dynamic libraries.

The `setup.py` script only builds C extensions as shared libraries using the `distutils` module.

The `PyAPI_FUNC()`, `PyAPI_DATA()` and `PyMODINIT_FUNC` macros of `Include/pyport.h` are defined differently depending if the `Py_BUILD_CORE_MODULE` macro is defined:

- Use `Py_EXPORTED_SYMBOL` if the `Py_BUILD_CORE_MODULE` is defined
- Use `Py_IMPORTED_SYMBOL` otherwise.

If the `Py_BUILD_CORE_BUILTIN` macro is used by mistake on a C extension built as a shared library, its `PyInit_xxx()` function is not exported, causing an `ImportError` on import.

## 3.3 Compiler and linker flags

Options set by the `./configure` script and environment variables and used by Makefile.

### 3.3.1 Preprocessor flags

#### CONFIGURE\_CPPFLAGS

Value of `CPPFLAGS` variable passed to the `./configure` script.

在 3.6 版新加入.

#### CPPFLAGS

(Objective) C/C++ preprocessor flags, e.g. `-Iinclude_dir` if you have headers in a nonstandard directory `include_dir`.

Both `CPPFLAGS` and `LDFLAGS` need to contain the shell's value for `setup.py` to be able to build extension modules using the directories specified in the environment variables.

**BASECPPFLAGS**

在 3.4 版新加入.

**PY\_CPPFLAGS**

Extra preprocessor flags added for building the interpreter object files.

Default: `$(BASECPPFLAGS) -I. -I$(srcdir)/Include $(CONFIGURE_CPPFLAGS) $(CPPFLAGS)`.

在 3.2 版新加入.

## 3.3.2 Compiler flags

**CC**

C compiler command.

Example: `gcc -pthread`.

**MAINCC**

C compiler command used to build the `main()` function of programs like `python`.

Variable set by the `--with-cxx-main` option of the configure script.

Default: `$(CC)`.

**CXX**

C++ compiler command.

Used if the `--with-cxx-main` option is used.

Example: `g++ -pthread`.

**CFLAGS**

C compiler flags.

**CFLAGS\_NODIST**

`CFLAGS_NODIST` is used for building the interpreter and stdlib C extensions. Use it when a compiler flag should *not* be part of the distutils `CFLAGS` once Python is installed ([bpo-21121](#)).

In particular, `CFLAGS` should not contain:

- the compiler flag `-I` (for setting the search path for include files). The `-I` flags are processed from left to right, and any flags in `CFLAGS` would take precedence over user- and package-supplied `-I` flags.
- hardening flags such as `-Werror` because distributions cannot control whether packages installed by users conform to such heightened standards.

在 3.5 版新加入.

**EXTRA\_CFLAGS**

Extra C compiler flags.

**CONFIGURE\_CFLAGS**

Value of `CFLAGS` variable passed to the `./configure` script.

在 3.2 版新加入.

**CONFIGURE\_CFLAGS\_NODIST**

Value of `CFLAGS_NODIST` variable passed to the `./configure` script.

在 3.5 版新加入.

**BASECFLAGS**

Base compiler flags.

**OPT**

Optimization flags.

**CFLAGS\_ALIASING**

Strict or non-strict aliasing flags used to compile `Python/dtoa.c`.

在 3.7 版新加入。

**CCSHARED**

Compiler flags used to build a shared library.

例如 `-fPIC` 被使用於 Linux 與 BSD 上。

**CFLAGSFORSHARED**

Extra C flags added for building the interpreter object files.

Default: `$(CCSHARED)` when `--enable-shared` is used, or an empty string otherwise.

**PY\_CFLAGS**

Default: `$(BASECFLAGS) $(OPT) $(CONFIGURE_CFLAGS) $(CFLAGS) $(EXTRA_CFLAGS)`.

**PY\_CFLAGS\_NODIST**

Default: `$(CONFIGURE_CFLAGS_NODIST) $(CFLAGS_NODIST) -I$(srcdir)/Include/internal`.

在 3.5 版新加入。

**PY\_STDMODULE\_CFLAGS**

C flags used for building the interpreter object files.

Default: `$(PY_CFLAGS) $(PY_CFLAGS_NODIST) $(PY_CPPFLAGS) $(CFLAGSFORSHARED)`.

在 3.7 版新加入。

**PY\_CORE\_CFLAGS**

Default: `$(PY_STDMODULE_CFLAGS) -DPy_BUILD_CORE`.

在 3.2 版新加入。

**PY\_BUILTIN\_MODULE\_CFLAGS**

Compiler flags to build a standard library extension module as a built-in module, like the `posix` module.

Default: `$(PY_STDMODULE_CFLAGS) -DPy_BUILD_CORE_BUILTIN`.

在 3.8 版新加入。

**PURIFY**

Purify command. Purify is a memory debugger program.

Default: empty string (not used).

### 3.3.3 Linker flags

#### LINKCC

Linker command used to build programs like `python` and `_testembed`.

Default: `$(PURIFY) $(MAINCC)`.

#### CONFIGURE\_LDFLAGS

Value of `LD_FLAGS` variable passed to the `./configure` script.

Avoid assigning `C_FLAGS`, `LD_FLAGS`, etc. so users can use them on the command line to append to these values without stomping the pre-set values.

在 3.2 版新加入.

#### LD\_FLAGS\_NODIST

`LD_FLAGS_NODIST` is used in the same manner as `C_FLAGS_NODIST`. Use it when a linker flag should *not* be part of the distutils `LD_FLAGS` once Python is installed ([bpo-35257](#)).

In particular, `LD_FLAGS` should not contain:

- the compiler flag `-L` (for setting the search path for libraries). The `-L` flags are processed from left to right, and any flags in `LD_FLAGS` would take precedence over user- and package-supplied `-L` flags.

#### CONFIGURE\_LD\_FLAGS\_NODIST

Value of `LD_FLAGS_NODIST` variable passed to the `./configure` script.

在 3.8 版新加入.

#### LD\_FLAGS

Linker flags, e.g. `-Llib_dir` if you have libraries in a nonstandard directory `lib_dir`.

Both `CPP_FLAGS` and `LD_FLAGS` need to contain the shell's value for `setup.py` to be able to build extension modules using the directories specified in the environment variables.

#### LIBS

Linker flags to pass libraries to the linker when linking the Python executable.

Example: `-lrt`.

#### LD\_SHARED

Command to build a shared library.

Default: `@LD_SHARED@ $(PY_LD_FLAGS)`.

#### BLD\_SHARED

Command to build `libpython` shared library.

Default: `@BLD_SHARED@ $(PY_CORE_LD_FLAGS)`.

#### PY\_LD\_FLAGS

Default: `$(CONFIGURE_LD_FLAGS) $(LD_FLAGS)`.

#### PY\_LD\_FLAGS\_NODIST

Default: `$(CONFIGURE_LD_FLAGS_NODIST) $(LD_FLAGS_NODIST)`.

在 3.8 版新加入.

#### PY\_CORE\_LD\_FLAGS

Linker flags used for building the interpreter object files.

在 3.8 版新加入.



---

### 在 Windows 上使用 Python

---

This document aims to give an overview of Windows-specific behaviour you should know about when using Python on Microsoft Windows.

Unlike most Unix systems and services, Windows does not include a system supported installation of Python. To make Python available, the CPython team has compiled Windows installers with every [release](#) for many years. These installers are primarily intended to add a per-user installation of Python, with the core interpreter and library being used by a single user. The installer is also able to install for all users of a single machine, and a separate ZIP file is available for application-local distributions.

As specified in [PEP 11](#), a Python release only supports a Windows platform while Microsoft considers the platform under extended support. This means that Python 3.11 supports Windows 8.1 and newer. If you require Windows 7 support, please install Python 3.8.

There are a number of different installers available for Windows, each with certain benefits and downsides.

*The full installer* contains all components and is the best option for developers using Python for any kind of project.

*The Microsoft Store package* is a simple installation of Python that is suitable for running scripts and packages, and using IDLE or other development environments. It requires Windows 10 and above, but can be safely installed without corrupting other programs. It also provides many convenient commands for launching Python and its tools.

*nuget.org 套件* are lightweight installations intended for continuous integration systems. It can be used to build Python packages or run scripts, but is not updateable and has no user interface tools.

*The embeddable package* is a minimal package of Python suitable for embedding into a larger application.

## 4.1 The full installer

### 4.1.1 安裝步驟

Four Python 3.11 installers are available for download - two each for the 32-bit and 64-bit versions of the interpreter. The *web installer* is a small initial download, and it will automatically download the required components as necessary. The *offline installer* includes the components necessary for a default installation and only requires an internet connection for optional features. See 當安裝時不下載 for other ways to avoid downloading during installation.

After starting the installer, one of two options may be selected:



如果你選擇「馬上安裝」：

- You will *not* need to be an administrator (unless a system update for the C Runtime Library is required or you install the *Python Launcher for Windows* for all users)
- Python will be installed into your user directory
- The *Python Launcher for Windows* will be installed according to the option at the bottom of the first page
- The standard library, test suite, launcher and pip will be installed
- 如果選擇，安裝目錄將被加入到你的 PATH
- 安裝捷徑將只能被目前使用者所看見

選擇「客制化安裝」將允許你選擇所需的項目進行安裝，安裝位置與其他選擇或安裝後的所需進行的動作。你將需要使用此選項「除錯特徵」或「二進位方式」進行安裝。

To perform an all-users installation, you should select "Customize installation". In this case:

- You may be required to provide administrative credentials or approval

- Python will be installed into the Program Files directory
- The *Python Launcher for Windows* will be installed into the Windows directory
- Optional features may be selected during installation
- The standard library can be pre-compiled to bytecode
- If selected, the install directory will be added to the system PATH
- 捷徑將被所有使用者所見

### 4.1.2 Removing the MAX\_PATH Limitation

Windows historically has limited path lengths to 260 characters. This meant that paths longer than this would not resolve and errors would result.

In the latest versions of Windows, this limitation can be expanded to approximately 32,000 characters. Your administrator will need to activate the "Enable Win32 long paths" group policy, or set `LongPathsEnabled` to 1 in the registry key `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\FileSystem`.

This allows the `open()` function, the `os` module and most other path functionality to accept and return paths longer than 260 characters.

After changing the above option, no further configuration is required.

在 3.6 版的變更: Support for long paths was enabled in Python.

### 4.1.3 安裝排除使用者介面

All of the options available in the installer UI can also be specified from the command line, allowing scripted installers to replicate an installation on many machines without user interaction. These options may also be set without suppressing the UI in order to change some of the defaults.

To completely hide the installer UI and install Python silently, pass the `/quiet` option. To skip past the user interaction but still display progress and errors, pass the `/passive` option. The `/uninstall` option may be passed to immediately begin removing Python - no confirmation prompt will be displayed.

All other options are passed as `name=value`, where the value is usually 0 to disable a feature, 1 to enable a feature, or a path. The full list of available options is shown below.

Name	描述	預設
InstallAllUsers	Perform a system-wide installation.	0
TargetDir	安裝目錄	Selected based on InstallAllUsers
DefaultAllUsersTargetDir	The default installation directory for all-user installs	%ProgramFiles%\Python X.Y or %ProgramFiles(x86)%\Python X.Y
DefaultJustForMeTargetDir	預設安裝目錄給只有給我安裝方式	%LocalAppData%\Programs\Python\PythonXY or %LocalAppData%\Programs\Python\PythonXY-32 or %LocalAppData%\Programs\Python\PythonXY-64
DefaultCustomTargetDir	The default custom install directory displayed in the UI	(empty)
AssociateFiles	當執行程序也被安裝時創造檔案關聯	1
CompileAll	編譯所有 .py 檔案為 .pyc。	0
PrependPath	Prepend install and Scripts directories to PATH and add .PY to PATHEXT	0
AppendPath	Append install and Scripts directories to PATH and add .PY to PATHEXT	0
Shortcuts	Create shortcuts for the interpreter, documentation and IDLE if installed.	1
Include_doc	安裝 Python 文件	1
Include_debug	Install debug binaries	0
Include_dev	Install developer headers and libraries. Omitting this may lead to an unusable installation.	1
Include_exe	Install python.exe and related files. Omitting this may lead to an unusable installation.	1
Include_launcher	安裝 <i>Python Launcher for Windows</i> 。	1
Install-Launcher-AllUsers	Installs the launcher for all users. Also requires Include_launcher to be set to 1	1
Include_lib	Install standard library and extension modules. Omitting this may lead to an unusable installation.	1
Include_pip	Install bundled pip and setuptools	1
Include_symbols	Install debugging symbols (*.pdb)	0
Include_tcltk	Install Tcl/Tk support and IDLE	1
Include_test	Install standard library test suite	1
Include_tools	Install utility scripts	1

For example, to silently install a default, system-wide Python installation, you could use the following command (from an elevated command prompt):

```
python-3.9.0.exe /quiet InstallAllUsers=1 PrependPath=1 Include_test=0
```

To allow users to easily install a personal copy of Python without the test suite, you could provide a shortcut with the following command. This will display a simplified initial page and disallow customization:

```
python-3.9.0.exe InstallAllUsers=0 Include_launcher=0 Include_test=0
SimpleInstall=1 SimpleInstallDescription="Just for me, no test suite."
```

(Note that omitting the launcher also omits file associations, and is only recommended for per-user installs when there is also a system-wide installation that included the launcher.)

The options listed above can also be provided in a file named `unattend.xml` alongside the executable. This file specifies a list of options and values. When a value is provided as an attribute, it will be converted to a number if possible. Values provided as element text are always left as strings. This example file sets the same options as the previous example:

```
<Options>
  <Option Name="InstallAllUsers" Value="no" />
  <Option Name="Include_launcher" Value="0" />
  <Option Name="Include_test" Value="no" />
  <Option Name="SimpleInstall" Value="yes" />
  <Option Name="SimpleInstallDescription">Just for me, no test suite</Option>
</Options>
```

#### 4.1.4 當安裝時不下載

As some features of Python are not included in the initial installer download, selecting those features may require an internet connection. To avoid this need, all possible components may be downloaded on-demand to create a complete *layout* that will no longer require an internet connection regardless of the selected features. Note that this download may be bigger than required, but where a large number of installations are going to be performed it is very useful to have a locally cached copy.

Execute the following command from Command Prompt to download all possible required files. Remember to substitute `python-3.9.0.exe` for the actual name of your installer, and to create layouts in their own directories to avoid collisions between files with the same name.

```
python-3.9.0.exe /layout [optional target directory]
```

You may also specify the `/quiet` option to hide the progress display.

#### 4.1.5 Modifying an install

Once Python has been installed, you can add or remove features through the Programs and Features tool that is part of Windows. Select the Python entry and choose "Uninstall/Change" to open the installer in maintenance mode.

"Modify" allows you to add or remove features by modifying the checkboxes - unchanged checkboxes will not install or remove anything. Some options cannot be changed in this mode, such as the install directory; to modify these, you will need to remove and then reinstall Python completely.

"Repair" will verify all the files that should be installed using the current settings and replace any that have been removed or modified.

"Uninstall" will remove Python entirely, with the exception of the *Python Launcher for Windows*, which has its own entry in Programs and Features.

## 4.2 The Microsoft Store package

在 3.7.2 版新加入。

The Microsoft Store package is an easily installable Python interpreter that is intended mainly for interactive use, for example, by students.

To install the package, ensure you have the latest Windows 10 updates and search the Microsoft Store app for "Python 3.11". Ensure that the app you select is published by the Python Software Foundation, and install it.

**警告：** Python will always be available for free on the Microsoft Store. If you are asked to pay for it, you have not selected the correct package.

After installation, Python may be launched by finding it in Start. Alternatively, it will be available from any Command Prompt or PowerShell session by typing `python`. Further, `pip` and `IDLE` may be used by typing `pip` or `idle`. `IDLE` can also be found in Start.

All three commands are also available with version number suffixes, for example, as `python3.exe` and `python3.x.exe` as well as `python.exe` (where `3.x` is the specific version you want to launch, such as 3.11). Open "Manage App Execution Aliases" through Start to select which version of Python is associated with each command. It is recommended to make sure that `pip` and `idle` are consistent with whichever version of `python` is selected.

Virtual environments can be created with `python -m venv` and activated and used as normal.

If you have installed another version of Python and added it to your `PATH` variable, it will be available as `python.exe` rather than the one from the Microsoft Store. To access the new installation, use `python3.exe` or `python3.x.exe`.

The `py.exe` launcher will detect this Python installation, but will prefer installations from the traditional installer.

To remove Python, open Settings and use Apps and Features, or else find Python in Start and right-click to select Uninstall. Uninstalling will remove all packages you installed directly into this Python installation, but will not remove any virtual environments

### 4.2.1 Known issues

#### Redirection of local data, registry, and temporary paths

Because of restrictions on Microsoft Store apps, Python scripts may not have full write access to shared locations such as `TEMP` and the registry. Instead, it will write to a private copy. If your scripts must modify the shared locations, you will need to install the full installer.

At runtime, Python will use a private copy of well-known Windows folders and the registry. For example, if the environment variable `%APPDATA%` is `c:\Users\<user>\AppData\`, then when writing to `C:\Users\<user>\AppData\Local` will write to `C:\Users\<user>\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.8_qbz5n2kfra8p0\LocalCache\Local\`.

When reading files, Windows will return the file from the private folder, or if that does not exist, the real Windows directory. For example reading `C:\Windows\System32` returns the contents of `C:\Windows\System32` plus the contents of `C:\Program Files\WindowsApps\package_name\VFS\SystemX86`.

You can find the real path of any existing file using `os.path.realpath()`:

```
>>> import os
>>> test_file = 'C:\\Users\\example\\AppData\\Local\\test.txt'
>>> os.path.realpath(test_file)
```

(繼續下一頁)

(繼續上一頁)

```
'C:\\Users\\example\\AppData\\Local\\Packages\\PythonSoftwareFoundation.Python.3.8_
↪qbz5n2kf8p0\\LocalCache\\Local\\test.txt'
```

When writing to the Windows Registry, the following behaviors exist:

- Reading from HKLM\\Software is allowed and results are merged with the `registry.dat` file in the package.
- Writing to HKLM\\Software is not allowed if the corresponding key/value exists, i.e. modifying existing keys.
- Writing to HKLM\\Software is allowed as long as a corresponding key/value does not exist in the package and the user has the correct access permissions.

For more detail on the technical basis for these limitations, please consult Microsoft's documentation on packaged full-trust apps, currently available at [docs.microsoft.com/en-us/windows/msix/desktop/desktop-to-uwp-behind-the-scenes](https://docs.microsoft.com/en-us/windows/msix/desktop/desktop-to-uwp-behind-the-scenes)

## 4.3 nuget.org 套件

在 3.5.2 版新加入。

The nuget.org package is a reduced size Python environment intended for use on continuous integration and build systems that do not have a system-wide install of Python. While nuget is "the package manager for .NET", it also works perfectly fine for packages containing build-time tools.

Visit [nuget.org](https://nuget.org) for the most up-to-date information on using nuget. What follows is a summary that is sufficient for Python developers.

The `nuget.exe` command line tool may be downloaded directly from <https://aka.ms/nugetclidl>, for example, using curl or PowerShell. With the tool, the latest version of Python for 64-bit or 32-bit machines is installed using:

```
nuget.exe install python -ExcludeVersion -OutputDirectory .
nuget.exe install pythonx86 -ExcludeVersion -OutputDirectory .
```

To select a particular version, add a `-Version 3.x.y`. The output directory may be changed from `.`, and the package will be installed into a subdirectory. By default, the subdirectory is named the same as the package, and without the `-ExcludeVersion` option this name will include the specific version installed. Inside the subdirectory is a `tools` directory that contains the Python installation:

```
# Without -ExcludeVersion
> .\python.3.5.2\tools\python.exe -V
Python 3.5.2

# With -ExcludeVersion
> .\python\tools\python.exe -V
Python 3.5.2
```

In general, nuget packages are not upgradeable, and newer versions should be installed side-by-side and referenced using the full path. Alternatively, delete the package directory manually and install it again. Many CI systems will do this automatically if they do not preserve files between builds.

Alongside the `tools` directory is a `build\native` directory. This contains a MSBuild properties file `python.props` that can be used in a C++ project to reference the Python install. Including the settings will automatically use the headers and import libraries in your build.

The package information pages on nuget.org are [www.nuget.org/packages/python](https://www.nuget.org/packages/python) for the 64-bit version and [www.nuget.org/packages/pythonx86](https://www.nuget.org/packages/pythonx86) for the 32-bit version.

## 4.4 The embeddable package

在 3.5 版新加入。

The embedded distribution is a ZIP file containing a minimal Python environment. It is intended for acting as part of another application, rather than being directly accessed by end-users.

When extracted, the embedded distribution is (almost) fully isolated from the user's system, including environment variables, system registry settings, and installed packages. The standard library is included as pre-compiled and optimized .pyc files in a ZIP, and `python3.dll`, `python37.dll`, `python.exe` and `pythonw.exe` are all provided. Tcl/tk (including all dependents, such as Idle), pip and the Python documentation are not included.

---

**備註：** The embedded distribution does not include the [Microsoft C Runtime](#) and it is the responsibility of the application installer to provide this. The runtime may have already been installed on a user's system previously or automatically via Windows Update, and can be detected by finding `ucrtbase.dll` in the system directory.

---

Third-party packages should be installed by the application installer alongside the embedded distribution. Using pip to manage dependencies as for a regular Python installation is not supported with this distribution, though with some care it may be possible to include and use pip for automatic updates. In general, third-party packages should be treated as part of the application ("vendoring") so that the developer can ensure compatibility with newer versions before providing updates to users.

The two recommended use cases for this distribution are described below.

### 4.4.1 Python Application

An application written in Python does not necessarily require users to be aware of that fact. The embedded distribution may be used in this case to include a private version of Python in an install package. Depending on how transparent it should be (or conversely, how professional it should appear), there are two options.

Using a specialized executable as a launcher requires some coding, but provides the most transparent experience for users. With a customized launcher, there are no obvious indications that the program is running on Python: icons can be customized, company and version information can be specified, and file associations behave properly. In most cases, a custom launcher should simply be able to call `Py_Main` with a hard-coded command line.

The simpler approach is to provide a batch file or generated shortcut that directly calls the `python.exe` or `pythonw.exe` with the required command-line arguments. In this case, the application will appear to be Python and not its actual name, and users may have trouble distinguishing it from other running Python processes or file associations.

With the latter approach, packages should be installed as directories alongside the Python executable to ensure they are available on the path. With the specialized launcher, packages can be located in other locations as there is an opportunity to specify the search path before launching the application.

### 4.4.2 嵌入 Python

Applications written in native code often require some form of scripting language, and the embedded Python distribution can be used for this purpose. In general, the majority of the application is in native code, and some part will either invoke `python.exe` or directly use `python3.dll`. For either case, extracting the embedded distribution to a subdirectory of the application installation is sufficient to provide a loadable Python interpreter.

As with the application use, packages can be installed to any location as there is an opportunity to specify search paths before initializing the interpreter. Otherwise, there is no fundamental differences between using the embedded distribution and a regular installation.



## 4.5 Alternative bundles

Besides the standard CPython distribution, there are modified packages including additional functionality. The following is a list of popular versions and their key features:

### ActivePython

Installer with multi-platform compatibility, documentation, PyWin32

### Anaconda

Popular scientific modules (such as numpy, scipy and pandas) and the conda package manager.

### Enthought Deployment Manager

”The Next Generation Python Environment and Package Manager”.

Previously Enthought provided Canopy, but it [reached end of life in 2016](#).

### WinPython

Windows-specific distribution with prebuilt scientific packages and tools for building packages.

Note that these packages may not include the latest versions of Python or other libraries, and are not maintained or supported by the core Python team.

## 4.6 設定 Python

To run Python conveniently from a command prompt, you might consider changing some default environment variables in Windows. While the installer provides an option to configure the PATH and PATHEXT variables for you, this is only reliable for a single, system-wide installation. If you regularly use multiple versions of Python, consider using the [Python Launcher for Windows](#).

### 4.6.1 Excursus: Setting environment variables

Windows allows environment variables to be configured permanently at both the User level and the System level, or temporarily in a command prompt.

To temporarily set environment variables, open Command Prompt and use the **set** command:

```
C:\>set PATH=C:\Program Files\Python 3.9;%PATH%
C:\>set PYTHONPATH=%PYTHONPATH%;C:\My_python_lib
C:\>python
```

These changes will apply to any further commands executed in that console, and will be inherited by any applications started from the console.

Including the variable name within percent signs will expand to the existing value, allowing you to add your new value at either the start or the end. Modifying PATH by adding the directory containing **python.exe** to the start is a common way to ensure the correct version of Python is launched.

To permanently modify the default environment variables, click Start and search for 'edit environment variables', or open System properties, *Advanced system settings* and click the *Environment Variables* button. In this dialog, you can add or modify User and System variables. To change System variables, you need non-restricted access to your machine (i.e. Administrator rights).

備 註: Windows will concatenate User variables *after* System variables, which may cause unexpected results when modifying PATH.

The `PYTHONPATH` variable is used by all versions of Python, so you should not permanently configure it unless the listed paths only include code that is compatible with all of your installed Python versions.

---

也參考:

<https://docs.microsoft.com/en-us/windows/win32/procthread/environment-variables>

Windows 上的環境變數概要

[https://docs.microsoft.com/en-us/windows-server/administration/windows-commands/set\\_1](https://docs.microsoft.com/en-us/windows-server/administration/windows-commands/set_1)

The `set` command, for temporarily modifying environment variables

<https://docs.microsoft.com/en-us/windows-server/administration/windows-commands/setx>

The `setx` command, for permanently modifying environment variables

### 4.6.2 Finding the Python executable

在 3.5 版的變更。

Besides using the automatically created start menu entry for the Python interpreter, you might want to start Python in the command prompt. The installer has an option to set that up for you.

On the first page of the installer, an option labelled "Add Python to PATH" may be selected to have the installer add the install location into the `PATH`. The location of the `Scripts\` folder is also added. This allows you to type `python` to run the interpreter, and `pip` for the package installer. Thus, you can also execute your scripts with command line options, see 命令列 documentation.

If you don't enable this option at install time, you can always re-run the installer, select Modify, and enable it. Alternatively, you can manually modify the `PATH` using the directions in *Excursus: Setting environment variables*. You need to set your `PATH` environment variable to include the directory of your Python installation, delimited by a semicolon from other entries. An example variable could look like this (assuming the first two entries already existed):

```
C:\WINDOWS\system32;C:\WINDOWS;C:\Program Files\Python 3.9
```

## 4.7 UTF-8 模式

在 3.7 版新加入。

Windows still uses legacy encodings for the system encoding (the ANSI Code Page). Python uses it for the default encoding of text files (e.g. `locale.getencoding()`).

This may cause issues because UTF-8 is widely used on the internet and most Unix systems, including WSL (Windows Subsystem for Linux).

You can use the Python UTF-8 Mode to change the default text encoding to UTF-8. You can enable the Python UTF-8 Mode via the `-X utf8` command line option, or the `PYTHONUTF8=1` environment variable. See *PYTHONUTF8* for enabling UTF-8 mode, and *Excursus: Setting environment variables* for how to modify environment variables.

When the Python UTF-8 Mode is enabled, you can still use the system encoding (the ANSI Code Page) via the "mbcs" codec.

Note that adding `PYTHONUTF8=1` to the default environment variables will affect all Python 3.7+ applications on your system. If you have any Python 3.7+ applications which rely on the legacy system encoding, it is recommended to set the environment variable temporarily or use the `-X utf8` command line option.

---

備註: Even when UTF-8 mode is disabled, Python uses UTF-8 by default on Windows for:

- Console I/O including standard I/O (see [PEP 528](#) for details).
- The *filesystem encoding* (see [PEP 529](#) for details).

## 4.8 Python Launcher for Windows

在 3.3 版新加入。

The Python launcher for Windows is a utility which aids in locating and executing of different Python versions. It allows scripts (or the command-line) to indicate a preference for a specific Python version, and will locate and execute that version.

Unlike the `PATH` variable, the launcher will correctly select the most appropriate version of Python. It will prefer per-user installations over system-wide ones, and orders by language version rather than using the most recently installed version.

The launcher was originally specified in [PEP 397](#).

### 4.8.1 開始

#### From the command-line

在 3.6 版的變更。

System-wide installations of Python 3.3 and later will put the launcher on your `PATH`. The launcher is compatible with all available versions of Python, so it does not matter which version is installed. To check that the launcher is available, execute the following command in Command Prompt:

```
py
```

You should find that the latest version of Python you have installed is started - it can be exited as normal, and any additional command-line arguments specified will be sent directly to Python.

If you have multiple versions of Python installed (e.g., 3.7 and 3.11) you will have noticed that Python 3.11 was started - to launch Python 3.7, try the command:

```
py -3.7
```

If you want the latest version of Python 2 you have installed, try the command:

```
py -2
```

If you see the following error, you do not have the launcher installed:

```
'py' is not recognized as an internal or external command,
operable program or batch file.
```

指令:

```
py --list
```

displays the currently installed version(s) of Python.

The `-x.y` argument is the short form of the `-V:Company/Tag` argument, which allows selecting a specific Python runtime, including those that may have come from somewhere other than python.org. Any runtime registered by following [PEP 514](#) will be discoverable. The `--list` command lists all available runtimes using the `-V:` format.

When using the `-V:` argument, specifying the Company will limit selection to runtimes from that provider, while specifying only the Tag will select from all providers. Note that omitting the slash implies a tag:

```
# Select any '3.*' tagged runtime
py -V:3

# Select any 'PythonCore' released runtime
py -V:PythonCore/

# Select PythonCore's latest Python 3 runtime
py -V:PythonCore/3
```

The short form of the argument (`-3`) only ever selects from core Python releases, and not other distributions. However, the longer form (`-V:3`) will select from any.

The Company is matched on the full string, case-insensitive. The Tag is matched on either the full string, or a prefix, provided the next character is a dot or a hyphen. This allows `-V:3.1` to match `3.1-32`, but not `3.10`. Tags are sorted using numerical ordering (`3.10` is newer than `3.1`), but are compared using text (`-V:3.01` does not match `3.1`).

### 擬環境 (Virtual environment)

在 3.5 版新加入。

If the launcher is run with no explicit Python version specification, and a virtual environment (created with the standard library `venv` module or the external `virtualenv` tool) active, the launcher will run the virtual environment's interpreter rather than the global one. To run the global interpreter, either deactivate the virtual environment, or explicitly specify the global Python version.

### From a script

Let's create a test Python script - create a file called `hello.py` with the following contents

```
#!/python
import sys
sys.stdout.write("hello from Python %s\n" % (sys.version,))
```

From the directory in which `hello.py` lives, execute the command:

```
py hello.py
```

You should notice the version number of your latest Python 2.x installation is printed. Now try changing the first line to be:

```
#!/python3
```

Re-executing the command should now print the latest Python 3.x information. As with the above command-line examples, you can specify a more explicit version qualifier. Assuming you have Python 3.7 installed, try changing the first line to `#!/python3.7` and you should find the 3.7 version information printed.

Note that unlike interactive use, a bare "python" will use the latest version of Python 2.x that you have installed. This is for backward compatibility and for compatibility with Unix, where the command `python` typically refers to Python 2.

## 從檔案關聯

The launcher should have been associated with Python files (i.e. `.py`, `.pyw`, `.pyc` files) when it was installed. This means that when you double-click on one of these files from Windows explorer the launcher will be used, and therefore you can use the same facilities described above to have the script specify the version which should be used.

The key benefit of this is that a single launcher can support multiple Python versions at the same time depending on the contents of the first line.

## 4.8.2 Shebang Lines

If the first line of a script file starts with `#!`, it is known as a "shebang" line. Linux and other Unix like operating systems have native support for such lines and they are commonly used on such systems to indicate how a script should be executed. This launcher allows the same facilities to be used with Python scripts on Windows and the examples above demonstrate their use.

To allow shebang lines in Python scripts to be portable between Unix and Windows, this launcher supports a number of 'virtual' commands to specify which interpreter to use. The supported virtual commands are:

- `/usr/bin/env`
- `/usr/bin/python`
- `/usr/local/bin/python`
- `python`

For example, if the first line of your script starts with

```
#!/usr/bin/python
```

The default Python will be located and used. As many Python scripts written to work on Unix will already have this line, you should find these scripts can be used by the launcher without modification. If you are writing a new script on Windows which you hope will be useful on Unix, you should use one of the shebang lines starting with `/usr`.

Any of the above virtual commands can be suffixed with an explicit version (either just the major version, or the major and minor version). Furthermore the 32-bit version can be requested by adding `"-32"` after the minor version. I.e. `/usr/bin/python3.7-32` will request usage of the 32-bit python 3.7.

在 3.7 版新加入: Beginning with python launcher 3.7 it is possible to request 64-bit version by the `"-64"` suffix. Furthermore it is possible to specify a major and architecture without minor (i.e. `/usr/bin/python3-64`).

在 3.11 版的變更: The `"-64"` suffix is deprecated, and now implies "any architecture that is not provably i386/32-bit". To request a specific environment, use the new `-V: TAG` argument with the complete tag.

The `/usr/bin/env` form of shebang line has one further special property. Before looking for installed Python interpreters, this form will search the executable `PATH` for a Python executable matching the name provided as the first argument. This corresponds to the behaviour of the Unix `env` program, which performs a `PATH` search. If an executable matching the first argument after the `env` command cannot be found, but the argument starts with `python`, it will be handled as described for the other virtual commands. The environment variable `PYLAUNCHER_NO_SEARCH_PATH` may be set (to any value) to skip this search of `PATH`.

Shebang lines that do not match any of these patterns are looked up in the `[commands]` section of the launcher's *.INI file*. This may be used to handle certain commands in a way that makes sense for your system. The name of the command must be a single argument (no spaces in the shebang executable), and the value substituted is the full path to the executable (additional arguments specified in the *.INI* will be quoted as part of the filename).

```
[commands]
/bin/xpython=C:\Program Files\XPython\python.exe
```

Any commands not found in the .INI file are treated as **Windows** executable paths that are absolute or relative to the directory containing the script file. This is a convenience for Windows-only scripts, such as those generated by an installer, since the behavior is not compatible with Unix-style shells. These paths may be quoted, and may include multiple arguments, after which the path to the script and any additional arguments will be appended.

### 4.8.3 Arguments in shebang lines

The shebang lines can also specify additional options to be passed to the Python interpreter. For example, if you have a shebang line:

```
#!/usr/bin/python -v
```

Then Python will be started with the `-v` option

### 4.8.4 Customization

#### Customization via INI files

Two .ini files will be searched by the launcher - `py.ini` in the current user's application data directory (`%LOCALAPPDATA%` or `$env:LocalAppData`) and `py.ini` in the same directory as the launcher. The same .ini files are used for both the 'console' version of the launcher (i.e. `py.exe`) and for the 'windows' version (i.e. `pyw.exe`).

Customization specified in the "application directory" will have precedence over the one next to the executable, so a user, who may not have write access to the .ini file next to the launcher, can override commands in that global .ini file.

#### Customizing default Python versions

In some cases, a version qualifier can be included in a command to dictate which version of Python will be used by the command. A version qualifier starts with a major version number and can optionally be followed by a period ('.') and a minor version specifier. Furthermore it is possible to specify if a 32 or 64 bit implementation shall be requested by adding "-32" or "-64".

For example, a shebang line of `#!/python` has no version qualifier, while `#!/python3` has a version qualifier which specifies only a major version.

If no version qualifiers are found in a command, the environment variable `PY_PYTHON` can be set to specify the default version qualifier. If it is not set, the default is "3". The variable can specify any value that may be passed on the command line, such as "3", "3.7", "3.7-32" or "3.7-64". (Note that the "-64" option is only available with the launcher included with Python 3.7 or newer.)

If no minor version qualifiers are found, the environment variable `PY_PYTHON{major}` (where {major} is the current major version qualifier as determined above) can be set to specify the full version. If no such option is found, the launcher will enumerate the installed Python versions and use the latest minor release found for the major version, which is likely, although not guaranteed, to be the most recently installed version in that family.

On 64-bit Windows with both 32-bit and 64-bit implementations of the same (major.minor) Python version installed, the 64-bit version will always be preferred. This will be true for both 32-bit and 64-bit implementations of the launcher - a 32-bit launcher will prefer to execute a 64-bit Python installation of the specified version if available. This is so the behavior of the launcher can be predicted knowing only what versions are installed on the PC and without regard to the order in which they were installed (i.e., without knowing whether a 32 or 64-bit version of Python and corresponding launcher was installed last). As noted above, an optional "-32" or "-64" suffix can be used on a version specifier to change this behaviour.

範例：

- If no relevant options are set, the commands `python` and `python2` will use the latest Python 2.x version installed and the command `python3` will use the latest Python 3.x installed.
- The command `python3.7` will not consult any options at all as the versions are fully specified.
- If `PY_PYTHON=3`, the commands `python` and `python3` will both use the latest installed Python 3 version.
- If `PY_PYTHON=3.7-32`, the command `python` will use the 32-bit implementation of 3.7 whereas the command `python3` will use the latest installed Python (`PY_PYTHON` was not considered at all as a major version was specified.)
- If `PY_PYTHON=3` and `PY_PYTHON3=3.7`, the commands `python` and `python3` will both use specifically 3.7

In addition to environment variables, the same settings can be configured in the .INI file used by the launcher. The section in the INI file is called `[defaults]` and the key name will be the same as the environment variables without the leading `PY_` prefix (and note that the key names in the INI file are case insensitive.) The contents of an environment variable will override things specified in the INI file.

For example:

- Setting `PY_PYTHON=3.7` is equivalent to the INI file containing:

```
[defaults]
python=3.7
```

- Setting `PY_PYTHON=3` and `PY_PYTHON3=3.7` is equivalent to the INI file containing:

```
[defaults]
python=3
python3=3.7
```

## 4.8.5 Diagnostics

If an environment variable `PYLAUNCHER_DEBUG` is set (to any value), the launcher will print diagnostic information to `stderr` (i.e. to the console). While this information manages to be simultaneously verbose *and* terse, it should allow you to see what versions of Python were located, why a particular version was chosen and the exact command-line used to execute the target Python. It is primarily intended for testing and debugging.

## 4.8.6 Dry Run

If an environment variable `PYLAUNCHER_DRYRUN` is set (to any value), the launcher will output the command it would have run, but will not actually launch Python. This may be useful for tools that want to use the launcher to detect and then launch Python directly. Note that the command written to standard output is always encoded using UTF-8, and may not render correctly in the console.

### 4.8.7 安裝隨選

If an environment variable `PYLAUNCHER_ALLOW_INSTALL` is set (to any value), and the requested Python version is not installed but is available on the Microsoft Store, the launcher will attempt to install it. This may require user interaction to complete, and you may need to run the command again.

An additional `PYLAUNCHER_ALWAYS_INSTALL` variable causes the launcher to always try to install Python, even if it is detected. This is mainly intended for testing (and should be used with `PYLAUNCHER_DRYRUN`).

### 4.8.8 Return codes

The following exit codes may be returned by the Python launcher. Unfortunately, there is no way to distinguish these from the exit code of Python itself.

The names of codes are as used in the sources, and are only for reference. There is no way to access or resolve them apart from reading this page. Entries are listed in alphabetical order of names.

Name	Value	描述
<code>RC_BAD_VENV_CFG</code>	107	A <code>pyvenv.cfg</code> was found but is corrupt.
<code>RC_CREATE_PROCESS</code>	101	Failed to launch Python.
<code>RC_INSTALLING</code>	111	An install was started, but the command will need to be re-run after it completes.
<code>RC_INTERNAL_ERROR</code>	109	Unexpected error. Please report a bug.
<code>RC_NO_COMMANDLINE</code>	108	Unable to obtain command line from the operating system.
<code>RC_NO_PYTHON</code>	103	Unable to locate the requested version.
<code>RC_NO_VENV_CFG</code>	106	A <code>pyvenv.cfg</code> was required but not found.

## 4.9 Finding modules

These notes supplement the description at `sys-path-init` with detailed Windows notes.

When no `._pth` file is found, this is how `sys.path` is populated on Windows:

- An empty entry is added at the start, which corresponds to the current directory.
- If the environment variable `PYTHONPATH` exists, as described in 環境變數, its entries are added next. Note that on Windows, paths in this variable must be separated by semicolons, to distinguish them from the colon used in drive identifiers (`C:\` etc.).
- Additional "application paths" can be added in the registry as subkeys of `\SOFTWARE\Python\PythonCore{version}\PythonPath` under both the `HKEY_CURRENT_USER` and `HKEY_LOCAL_MACHINE` hives. Subkeys which have semicolon-delimited path strings as their default value will cause each path to be added to `sys.path`. (Note that all known installers only use `HKLM`, so `HKCU` is typically empty.)
- If the environment variable `PYTHONHOME` is set, it is assumed as "Python Home". Otherwise, the path of the main Python executable is used to locate a "landmark file" (either `Lib\os.py` or `pythonXY.zip`) to deduce the "Python Home". If a Python home is found, the relevant sub-directories added to `sys.path` (`Lib`, `plat-win`, etc) are based on that folder. Otherwise, the core Python path is constructed from the `PythonPath` stored in the registry.
- If the Python Home cannot be located, no `PYTHONPATH` is specified in the environment, and no registry entries can be found, a default path with relative entries is used (e.g. `.\Lib`; `.\plat-win`, etc).



If a `pyvenv.cfg` file is found alongside the main executable or in the directory one level above the executable, the following variations apply:

- If `home` is an absolute path and `PYTHONHOME` is not set, this path is used instead of the path to the main executable when deducing the home location.

最終這所有的結果：

- When running `python.exe`, or any other `.exe` in the main Python directory (either an installed version, or directly from the PCbuild directory), the core path is deduced, and the core paths in the registry are ignored. Other "application paths" in the registry are always read.
- When Python is hosted in another `.exe` (different directory, embedded via COM, etc), the "Python Home" will not be deduced, so the core path from the registry is used. Other "application paths" in the registry are always read.
- If Python can't find its home and there are no registry value (frozen `.exe`, some very strange installation setup) you get a path with some default, but relative, paths.

For those who want to bundle Python into their application or distribution, the following advice will prevent conflicts with other installations:

- Include a `._pth` file alongside your executable containing the directories to include. This will ignore paths listed in the registry and environment variables, and also ignore `site` unless `import site` is listed.
- If you are loading `python3.dll` or `python37.dll` in your own executable, explicitly call `Py_SetPath()` or (at least) `Py_SetProgramName()` before `Py_Initialize()`.
- Clear and/or overwrite `PYTHONPATH` and set `PYTHONHOME` before launching `python.exe` from your application.
- If you cannot use the previous suggestions (for example, you are a distribution that allows people to run `python.exe` directly), ensure that the landmark file (`Lib\os.py`) exists in your install directory. (Note that it will not be detected inside a ZIP file, but a correctly named ZIP file will be detected instead.)

These will ensure that the files in a system-wide installation will not take precedence over the copy of the standard library bundled with your application. Otherwise, your users may experience problems using your application. Note that the first suggestion is the best, as the others may still be susceptible to non-standard paths in the registry and user `site-packages`.

在 3.6 版的變更: Add `._pth` file support and removes `applocal` option from `pyvenv.cfg`.

在 3.6 版的變更: Add `pythonXX.zip` as a potential landmark when directly adjacent to the executable.

在 3.6 版之後被用: Modules specified in the registry under `Modules` (not `PythonPath`) may be imported by `importlib.machinery.WindowsRegistryFinder`. This finder is enabled on Windows in 3.6.0 and earlier, but may need to be explicitly added to `sys.meta_path` in the future.

## 4.10 Additional modules

Even though Python aims to be portable among all platforms, there are features that are unique to Windows. A couple of modules, both in the standard library and external, and snippets exist to use these features.

The Windows-specific standard modules are documented in `mswin-specific-services`.

### 4.10.1 PyWin32

The `PyWin32` module by Mark Hammond is a collection of modules for advanced Windows-specific support. This includes utilities for:

- [Component Object Model \(COM\)](#)
- Win32 API 呼叫
- 登錄檔 (Registry)
- 事件日誌 (Event log)
- [Microsoft Foundation Classes \(MFC\)](#) user interfaces

`PythonWin` is a sample MFC application shipped with `PyWin32`. It is an embeddable IDE with a built-in debugger.

也參考:

#### `Win32 How Do I...?`

由 Tim Golden 所著

#### `Python and COM`

由 David 與 Paul Boddie 所著

### 4.10.2 `cx_Freeze`

`cx_Freeze` wraps Python scripts into executable Windows programs (`*.exe` files). When you have done this, you can distribute your application without requiring your users to install Python.

## 4.11 編譯 Python 在 Windows

If you want to compile CPython yourself, first thing you should do is get the [source](#). You can download either the latest release's source or just grab a fresh [checkout](#).

The source tree contains a build solution and project files for Microsoft Visual Studio, which is the compiler used to build the official Python releases. These files are in the `PCbuild` directory.

Check `PCbuild/readme.txt` for general information on the build process.

For extension modules, consult `building-on-windows`.

## 4.12 其他平台

With ongoing development of Python, some platforms that used to be supported earlier are no longer supported (due to the lack of users or developers). Check [PEP 11](#) for details on all unsupported platforms.

- [Windows CE](#) is [no longer supported](#) since Python 3 (if it ever was).
- The [Cygwin](#) installer offers to install the [Python interpreter](#) as well

See [Python for Windows](#) for detailed information about platforms with pre-compiled installers.

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## 在 Mac 系統使用 Python

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Python on a Mac running macOS is in principle very similar to Python on any other Unix platform, but there are a number of additional features such as the integrated development environment (IDE) and the Package Manager that are worth pointing out.

### 5.1 Getting and Installing Python

macOS used to come with Python 2.7 pre-installed between versions 10.8 and 12.3. You are invited to install the most recent version of Python 3 from the [Python website](https://www.python.org). A current "universal2 binary" build of Python, which runs natively on the Mac's new Apple Silicon and legacy Intel processors, is available there.

在安裝後你必須要做幾件事：

- A `Python 3.11` folder in your `Applications` folder. In here you find `IDLE`, the development environment that is a standard part of official Python distributions; and **Python Launcher**, which handles double-clicking Python scripts from the Finder.
- A framework `/Library/Frameworks/Python.framework`, which includes the Python executable and libraries. The installer adds this location to your shell path. To uninstall Python, you can remove these three things. A symlink to the Python executable is placed in `/usr/local/bin/`.

---

**備註：** On macOS 10.8-12.3, the Apple-provided build of Python is installed in `/System/Library/Frameworks/Python.framework` and `/usr/bin/python`, respectively. You should never modify or delete these, as they are Apple-controlled and are used by Apple- or third-party software. Remember that if you choose to install a newer Python version from `python.org`, you will have two different but functional Python installations on your computer, so it will be important that your paths and usages are consistent with what you want to do.

---

IDLE includes a Help menu that allows you to access Python documentation. If you are completely new to Python you should start reading the tutorial introduction in that document.

如果你熟悉其他 Unix 平臺上的 Python，那你應該讀有關從 Unix shell 執行 Python 本的部分。

### 5.1.1 如何執行 Python 本

Your best way to get started with Python on macOS is through the IDLE integrated development environment; see section 整合化開發工具 (IDE) and use the Help menu when the IDE is running.

If you want to run Python scripts from the Terminal window command line or from the Finder you first need an editor to create your script. macOS comes with a number of standard Unix command line editors, **vim nano** among them. If you want a more Mac-like editor, **BEdit** from Bare Bones Software (see <https://www.barebones.com/products/bbedit/index.html>) are good choices, as is **TextMate** (see <https://macromates.com>). Other editors include **MacVim** (<https://macvim.org>) and **Aquamacs** (<https://aquamacs.org>).

要從終端機視窗執行本，你必須確保 `/usr/local/bin` 位於 shell 搜尋路徑中。

從 Finder 執行你的本時，你有兩個選項：

- Drag it to **Python Launcher**.
- Select **Python Launcher** as the default application to open your script (or any `.py` script) through the finder Info window and double-click it. **Python Launcher** has various preferences to control how your script is launched. Option-dragging allows you to change these for one invocation, or use its Preferences menu to change things globally.

### 5.1.2 透過 GUI 執行本

對於舊版本的 Python，你需要注意一個 macOS 的怪之處：與 Aqua 視窗管理器溝通的程式（而言之，任何具有 GUI（圖形化使用者介面）的程式）需要以特殊方式執行。使用 **pythonw** 而不是 **python** 來動這樣的本。

Python 3.9 上，你可以使用 **python** 或者 **pythonw**。

### 5.1.3 設定

Python on macOS honors all standard Unix environment variables such as `PYTHONPATH`, but setting these variables for programs started from the Finder is non-standard as the Finder does not read your `.profile` or `.cshrc` at startup. You need to create a file `~/MacOSX/environment.plist`. See Apple's [Technical Q&A QA1067](#) for details.

For more information on installation Python packages, see section 安裝額外的 Python 套件。

## 5.2 整合化開發工具 (IDE)

Python ships with the standard IDLE development environment. A good introduction to using IDLE can be found at [https://www.hashcollision.org/hkn/python/idle\\_intro/index.html](https://www.hashcollision.org/hkn/python/idle_intro/index.html).

## 5.3 安裝額外的 Python 套件

This section has moved to the [Python Packaging User Guide](#).

## 5.4 GUI Programming

於 Mac 上使用 Python 來建立 GUI 應用程式有許多選項。

*PyObjC* 是一個 Apple Objective-C/Cocoa 框架的 Python 綁定 (binding)，這是大多數現代 Mac 開發的基礎。有關 *PyObjC* 的資訊，請見 <https://pypi.org/project/pyobjc/>。

標準的 Python GUI 工具套件是 *tkinter*，基於跨平臺的 Tk 工具套件 (<https://www.tcl.tk>)。Apple 的 OS X 包含了 Aqua 原生版本的 Tk，最新版本可以從 <https://www.activestate.com> 下載和安裝；它也可以從原始碼開始建置。

A number of alternative macOS GUI toolkits are available:

- *PySide*: Official Python bindings to the Qt GUI toolkit.
- *PyQt*: Alternative Python bindings to Qt.
- *Kivy*: A cross-platform GUI toolkit that supports desktop and mobile platforms.
- *Toga*: Part of the [BeeWare Project](#); supports desktop, mobile, web and console apps.
- *wxPython*: A cross-platform toolkit that supports desktop operating systems.

## 5.5 Distributing Python Applications

A range of tools exist for converting your Python code into a standalone distributable application:

- *py2app*: Supports creating macOS .app bundles from a Python project.
- *Briefcase*: Part of the [BeeWare Project](#); a cross-platform packaging tool that supports creation of .app bundles on macOS, as well as managing signing and notarization.
- *PyInstaller*: A cross-platform packaging tool that creates a single file or folder as a distributable artifact.

## 5.6 其他資源

The Pythonmac-SIG mailing list is an excellent support resource for Python users and developers on the Mac:

<https://www.python.org/community/sigs/current/pythonmac-sig/>

另一個好用資源是 MacPython wiki：

<https://wiki.python.org/moin/MacPython>



## CHAPTER 6

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### 編輯器與 IDE

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There are a number of IDEs that support Python programming language. Many editors and IDEs provide syntax highlighting, debugging tools, and **PEP 8** checks.

Please go to [Python Editors](#) and [Integrated Development Environments](#) for a comprehensive list.





## 術語表

&gt;&gt;&gt;

互動式 shell 的預設 Python 提示字元。常見於能在直譯器中以互動方式被執行的程式碼範例。

...

可以表示：

- 在一個被縮排的程式碼區塊、在一對匹配的左右定界符（delimiter，例如括號、方括號、花括號或三引號）[\[F\]](#)部，或是在指定一個裝飾器（decorator）之後，要輸入程式碼時，互動式 shell 顯示的預設 Python 提示字元。
- [\[F\]](#)建常數 Ellipsis。

**2to3**

一個試著將 Python 2.x 程式碼轉[\[F\]](#)[\[F\]](#) Python 3.x 程式碼的工具，它是透過處理大部分的不相容性來達成此目的，而這些不相容性能[\[F\]](#)透過剖析原始碼和遍歷剖析樹而被檢測出來。

2to3 在標準函式庫中以 lib2to3 被使用；它提供了一個獨立的入口點，在 Tools/scripts/2to3。請參[\[F\]](#) 2to3-reference。

**abstract base class（抽象基底類[\[F\]](#)）**

抽象基底類[\[F\]](#)（又稱[\[F\]](#) ABC）提供了一種定義介面的方法，作[\[F\]](#)[\[F\]](#)duck-typing（鴨子型[\[F\]](#)）的補充。其他類似的技術，像是 hasattr()，則顯得笨拙或是帶有細微的錯誤（例如使用魔術方法（magic method））。ABC [\[F\]](#)用[\[F\]](#)擬的 subclass（子類[\[F\]](#)），它們[\[F\]](#)不繼承自另一個 class（類[\[F\]](#)），但仍可被 isinstance() 及 issubclass() 辨識；請參[\[F\]](#) abc 模組的[\[F\]](#)明文件。Python 有許多[\[F\]](#)建的 ABC，用於資料結構（在 collections.abc 模組）、數字（在 numbers 模組）、串流（在 io 模組）及 import 尋檢器和載入器（在 importlib.abc 模組）。你可以使用 abc 模組建立自己的 ABC。

**annotation（[\[F\]](#)釋）**

一個與變數、class 屬性、函式的參數或回傳值相關聯的標[\[F\]](#)。照慣例，它被用來作[\[F\]](#)type hint（型[\[F\]](#)提示）。

在執行環境（runtime），區域變數的[\[F\]](#)釋無法被存取，但全域變數、class 屬性和函式的[\[F\]](#)解，會分[\[F\]](#)被儲存在模組、class 和函式的 \_\_annotations\_\_ 特殊屬性中。

請參[\[F\]](#)variable annotation、function annotation、[\[F\]](#)PEP 484 和 [\[F\]](#)PEP 526，這些章節皆有此功能的[\[F\]](#)明。關於[\[F\]](#)釋的最佳實踐方法也請參[\[F\]](#) annotations-howto。

**argument (引數)**

呼叫函式時被傳遞給 *function* (或 *method*) 的值。引數有兩種：

- **關鍵字引數 (keyword argument)**: 在函式呼叫中, 以識字 (identifier, 例如 `name=`) 開頭的引數, 或是以 `**` 後面 *dictionary* (字典) 的值被傳遞的引數。例如, 3 和 5 都是以下 `complex()` 呼叫中的關鍵字引數:

```
complex(real=3, imag=5)
complex(**{'real': 3, 'imag': 5})
```

- **位置引數 (positional argument)**: 不是關鍵字引數的引數。位置引數可在一個引數列表的起始處出現, 和 (或) 作 `*` 之後的 *iterable* (可代物件) 中的元素被傳遞。例如, 3 和 5 都是以下呼叫中的位置引數:

```
complex(3, 5)
complex(*(3, 5))
```

引數會被指定給函式主體中的附名區域變數。關於支配這個指定過程的規則, 請參 [calls](#) 章節。在語法上, 任何運算式都可以被用來表示一個引數; 其評估值會被指定給區域變數。

另請參 [術語表](#) 的 *parameter* (參數) 條目、常見問題中的引數和參數之間的差別, 以及 [PEP 362](#)。

**asynchronous context manager (非同步情境管理器)**

一個可以控制 `async with` 陳述式中所見環境的物件, 而它是透過定義 `__aenter__()` 和 `__aexit__()` *method* (方法) 來控制的。由 [PEP 492](#) 引入。

**asynchronous generator (非同步生成器)**

一個會回傳 *asynchronous generator iterator* (非同步生成器代器) 的函式。它看起來像一個以 `async def` 定義的協程函式 (coroutine function), 但不同的是它包含了 `yield` 運算式, 能生成一系列可用於 `async for` 圈的值。

這個術語通常用來表示一個非同步生成器函式, 但在某些情境中, 也可能是表示非同步生成器代器 (*asynchronous generator iterator*)。萬一想表達的意思不清楚, 那就使用完整的術語, 以避免歧義。

一個非同步生成器函式可能包含 `await` 運算式, 以及 `async for` 和 `async with` 陳述式。

**asynchronous generator iterator (非同步生成器代器)**

一個由 *asynchronous generator* (非同步生成器) 函式所建立的物件。

這是一個 *asynchronous iterator* (非同步代器), 當它以 `__anext__()` *method* 被呼叫時, 會回傳一個可等待物件 (awaitable object), 該物件將執行非同步生成器的函式主體, 直到遇到下一個 `yield` 運算式。

每個 `yield` 會暫停處理程序, 記住位置執行狀態 (包括區域變數及擱置中的 `try` 陳述式)。當非同步生成器代器以另一個被 `__anext__()` 回傳的可等待物件有效地回復時, 它會從停止的地方繼續執行。請參 [PEP 492](#) 和 [PEP 525](#)。

**asynchronous iterable (非同步可代物件)**

一個物件, 它可以在 `async for` 陳述式中被使用。必須從它的 `__aiter__()` *method* 回傳一個 *asynchronous iterator* (非同步代器)。由 [PEP 492](#) 引入。

**asynchronous iterator (非同步代器)**

一個實作 `__aiter__()` 和 `__anext__()` *method* 的物件。`__anext__()` 必須回傳一個 *awaitable* (可等待物件)。`async for` 會解析非同步代器的 `__anext__()` *method* 所回傳的可等待物件, 直到它引發 `StopAsyncIteration` 例外。由 [PEP 492](#) 引入。

**attribute (屬性)**

一個與某物件相關聯的值, 該值大多能透過使用點分隔運算式 (dotted expression) 的名稱被參照。例如, 如果物件 `o` 有一個屬性 `a`, 則該屬性能以 `o.a` 被參照。

如果一個物件允許，給予該物件一個名稱不是由 `identifiers` 所定義之識符 (identifier) 的屬性是有可能的，例如使用 `setattr()`。像這樣的屬性將無法使用點分隔運算式來存取，而是需要使用 `getattr()` 來取得它。

### awaitable (可等待物件)

一個可以在 `await` 運算式中被使用的物件。它可以是一個 *coroutine* (協程)，或是一個有 `__await__()` method 的物件。另請參 [PEP 492](#)。

### BDFL

Benevolent Dictator For Life (終身仁慈獨裁者)，又名 [Guido van Rossum](#)，Python 的創造者。

### binary file (二進制檔案)

A *file object* able to read and write *bytes-like objects*. Examples of binary files are files opened in binary mode ('rb', 'wb' or 'rb+'), `sys.stdin.buffer`, `sys.stdout.buffer`, and instances of `io.BytesIO` and `gzip.GzipFile`.

另請參 [text file](#) (文字檔案)，它是一個能讀取和寫入 `str` 物件的檔案物件。

### borrowed reference (借用參照)

In Python's C API, a borrowed reference is a reference to an object, where the code using the object does not own the reference. It becomes a dangling pointer if the object is destroyed. For example, a garbage collection can remove the last *strong reference* to the object and so destroy it.

對 *borrowed reference* 呼叫 `Py_INCREF()` 以將它原地 (in-place) 轉為 *strong reference* 是被建議的做法，除非該物件不能在最後一次使用借用參照之前被銷毀。`Py_NewRef()` 函式可用於建立一個新的 *strong reference*。

### bytes-like object (類位元組串物件)

一個支援 `bufferobjects` 且能匯出 *C-contiguous* 緩衝區的物件。這包括所有的 `bytes`、`bytearray` 和 `array.array` 物件，以及許多常見的 `memoryview` 物件。類位元組串物件可用於處理二進制資料的各種運算；這些運算包括壓縮、儲存至二進制檔案和透過 `socket` (插座) 發送。

有些運算需要二進制資料是可變的。[C](#) 明文件通常會將這些物件稱作「可讀寫的類位元組串物件」。可變緩衝區的物件包括 `bytearray`，以及 `bytearray` 的 `memoryview`。其他的運算需要讓二進制資料被儲存在不可變物件 (「唯讀的類位元組串物件」) 中；這些物件包括 `bytes`，以及 `bytes` 物件的 `memoryview`。

### bytecode (位元組碼)

Python 的原始碼會被編譯成位元組碼，它是 Python 程式在 CPython 直譯器中的內部表示法。該位元組碼也會被暫存在 `.pyc` 檔案中，以便第二次執行同一個檔案時能更快 (可以不用從原始碼重新編譯位元組碼)。這種「中間語言 (intermediate language)」據說是運行在一個 *virtual machine* (虛擬機器) 上，該虛擬機器會執行與每個位元組碼對應的機器碼 (machine code)。要注意的是，位元組碼理論上是無法在不同的 Python 虛擬機器之間運作的，也不能在不同版本的 Python 之間保持穩定。

位元組碼的指令列表可以在 `dis` 模組的 [C](#) 明文件中找到。

### callable (可呼叫物件)

一個 callable 是可以被呼叫的物件，呼叫時可能以下列形式帶有一組引數 (請見 [argument](#)):

```
callable(argument1, argument2, argumentN)
```

一個 *function* 與其延伸的 *method* 都是 callable。一個有實作 `__call__()` 方法的 `class` 之實例也是個 callable。

### callback (回呼)

作引數被傳遞的一個副程式 (subroutine) 函式，會在未來的某個時間點被執行。

### class (類)

一個用於建立使用者定義物件的模板。Class 的定義通常會包含 `method` 的定義，這些 `method` 可以在 `class` 的實例上進行操作。

**class variable (類變數)**

一個在 class 中被定義，且應該只能在 class 層次（意即不是在 class 的實例中）被修改的變數。

**complex number (複數)**

一個我們熟悉的實數系統的擴充，在此所有數字都會被表示成一個實部和一個虛部之和。複數就是實數單位（-1 的平方根）的實數倍，此單位通常在數學中被寫成  $i$ ，在工程學中被寫成  $j$ 。Python 建立了對複數的支援，它是用後者的記法來表示複數；虛部會帶著一個後綴的  $j$  被編寫，例如  $3+1j$ 。若要将 `math` 模組的工具等效地用於複數，請使用 `cmath` 模組。複數的使用是一個相當進階的數學功能。如果你有察覺到對它們的需求，那幾乎能確定你可以安全地忽略它們。

**context manager (情境管理器)**

An object which controls the environment seen in a `with` statement by defining `__enter__()` and `__exit__()` methods. See [PEP 343](#).

**context variable (情境變數)**

一個變數，其值可以根據上下文的情境而有所不同。這類似執行緒區域儲存區 (Thread-Local Storage)，在其中，一個變數在每個執行緒可能具有不同的值。然而，關於情境變數，在一個執行緒中可能會有多个情境，而情境變數的主要用途，是在行的非同步任務 (concurrent asynchronous task) 中，對於變數狀態的追蹤。請參閱 `contextvars`。

**contiguous (連續的)**

如果一個緩衝區是 *C-contiguous* 或是 *Fortran contiguous*，則它會確切地被視作是連續的。零維 (zero-dimensional) 的緩衝區都是 C 及 Fortran contiguous。在一維 (one-dimensional) 陣列中，各項目必須在記憶體中彼此相鄰地排列，而其索引順序是從零開始遞增。在多維的 (multidimensional) C-contiguous 陣列中，按記憶體位址的順序訪問各個項目時，最後一個索引的變化最快。然而，在 Fortran contiguous 陣列中，第一個索引的變化最快。

**coroutine (協程)**

協程是副程式 (subroutine) 的一種更廣義的形式。副程式是在某個時間點被進入並在另一個時間點被退出。協程可以在許多不同的時間點被進入、退出和回復。它們能以 `async def` 陳述式被實作。另請參閱 [PEP 492](#)。

**coroutine function (協程函式)**

一個回傳 *coroutine* (協程) 物件的函式。一個協程函式能以 `async def` 陳述式被定義，它可能會包含 `await`、`async for` 和 `async with` 關鍵字。這些關鍵字由 [PEP 492](#) 引入。

**CPython**

Python 程式語言的標準實作 (canonical implementation)，被發布在 [python.org](#) 上。「CPython」這個術語在必要時被使用，以區分此實作與其它語言的實作，例如 Jython 或 IronPython。

**decorator (裝飾器)**

一個函式，它會回傳另一個函式，通常它會使用 `@wrapper` 語法，被應用於一種函式的變換 (function transformation)。裝飾器的常見範例是 `classmethod()` 和 `staticmethod()`。

裝飾器語法只是語法糖。以下兩個函式定義在語義上是等效的：

```
def f(arg):
    ...
f = staticmethod(f)

@staticmethod
def f(arg):
    ...
```

Class 也存在相同的概念，但在那比較不常用。關於裝飾器的更多內容，請參閱函式定義和 class 定義的說明文件。

**descriptor (描述器)**

Any object which defines the methods `__get__()`, `__set__()`, or `__delete__()`. When a class attribute is a descriptor, its special binding behavior is triggered upon attribute lookup. Normally, using `a.b` to get, set or

delete an attribute looks up the object named *b* in the class dictionary for *a*, but if *b* is a descriptor, the respective descriptor method gets called. Understanding descriptors is a key to a deep understanding of Python because they are the basis for many features including functions, methods, properties, class methods, static methods, and reference to super classes.

關於描述器 method 的更多資訊，請參閱 descriptors 或描述器使用指南。

### dictionary (字典)

An associative array, where arbitrary keys are mapped to values. The keys can be any object with `__hash__()` and `__eq__()` methods. Called a hash in Perl.

### dictionary comprehension (字典綜合運算)

一種緊密的方法，用來處理一個可迭代物件中的全部或部分元素，`dict` 將處理結果以一個字典回傳。`results = {n: n ** 2 for n in range(10)}` 會生成一個字典，它包含了鍵 *n* 映射到值 *n* \*\* 2。請參閱 comprehensions。

### dictionary view (字典檢視)

從 `dict.keys()`、`dict.values()` 及 `dict.items()` 回傳的物件被稱作字典檢視。它們提供了字典中項目的動態檢視，這表示當字典有變動時，該檢視會反映這些變動。若要限制將字典檢視轉為完整的 list (串列)，須使用 `list(dictview)`。請參閱 dict-views。

### docstring (說明字串)

A string literal which appears as the first expression in a class, function or module. While ignored when the suite is executed, it is recognized by the compiler and put into the `__doc__` attribute of the enclosing class, function or module. Since it is available via introspection, it is the canonical place for documentation of the object.

### duck-typing (鴨子型)

一種程式設計風格，它不是藉由檢查一個物件的型別來確定它是否具有正確的介面；取而代之的是，method 或屬性會單純地被呼叫或使用。（「如果它看起來像一隻鴨子而且叫起來像一隻鴨子，那它一定是一隻鴨子。」）因調用介面而非特定型別，精心設計的程式碼能讓多形替代 (polymorphic substitution) 來增進它的靈活性。鴨子型要避免使用 `type()` 或 `isinstance()` 進行測試。（但是請注意，鴨子型可以用抽象基底類 (abstract base class) 來補充。）然而，它通常會用 `hasattr()` 測試，或是 EAFP 程式設計風格。

### EAFP

Easier to ask for forgiveness than permission. (請求寬恕比請求許可更容易。) 這種常見的 Python 編碼風格會先假設有效的鍵或屬性的存在，`try` 在該假設被推翻時再捕獲例外。這種乾且快速的風格，其特色是存在許多的 `try` 和 `except` 陳述式。該技術與許多其他語言 (例如 C) 常見的 LBYL 風格形成了對比。

### expression (運算式)

一段可以被評估求值的語法。一句話，一個運算式就是文字、名稱、屬性存取、運算子或函式呼叫等運算式元件的累積，而這些元件都能回傳一個值。與許多其他語言不同的是，非所有的 Python 語言構造都是運算式。另外有一些 statement (陳述式) 不能被用作運算式，例如 `while`。賦值 (assignment) 也是陳述式，而不是運算式。

### extension module (擴充模組)

一個以 C 或 C++ 編寫的模組，它使用 Python 的 C API 來與核心及使用者程式碼進行互動。

### f-string (f 字串)

以 'f' 或 'F' 前綴的字串文本通常被稱作「f 字串」，它是格式化的字串文本的縮寫。另請參閱 PEP 498。

### file object (檔案物件)

An object exposing a file-oriented API (with methods such as `read()` or `write()`) to an underlying resource. Depending on the way it was created, a file object can mediate access to a real on-disk file or to another type of storage or communication device (for example standard input/output, in-memory buffers, sockets, pipes, etc.). File objects are also called *file-like objects* or *streams*.

實際上，有三種檔案物件：原始的二進制檔案、緩衝的二進制檔案和文字檔案。它們的介面在 `io` 模組中被定義。建立檔案物件的標準方法是使用 `open()` 函式。



**file-like object (類檔案物件)**

*file object* (檔案物件) 的同義字。

**filesystem encoding and error handler (檔案系統編碼和錯誤處理函式)**

Python 所使用的一種編碼和錯誤處理函式，用來解碼來自作業系統的位元組，以及將 Unicode 編碼到作業系統。

檔案系統編碼必須保證能成功解碼所有小於 128 的位元組。如果檔案系統編碼無法提供此保證，則 API 函式會引發 `UnicodeError`。

`sys.getfilesystemencoding()` 和 `sys.getfilesystemencodeerrors()` 函式可用於取得檔案系統編碼和錯誤處理函式。

*filesystem encoding and error handler* (檔案系統編碼和錯誤處理函式) 會在 Python 啟動時由 `PyConfig_Read()` 函式來配置：請參 [filesystem\\_encoding](#)，以及 `PyConfig` 的成員 `filesystem_errors`。

另請參 [locale encoding](#) (區域編碼)。

**finder (尋檢器)**

一個物件，它會嘗試正在被 `import` 的模組尋找 *loader* (載入器)。

從 Python 3.3 開始，有兩種類型的尋檢器：*元路徑尋檢器 (meta path finder)* 會使用 `sys.meta_path`，而*路徑項目尋檢器 (path entry finder)* 會使用 `sys.path_hooks`。

請參 [PEP 302](#)、[PEP 420](#) 和 [PEP 451](#) 以了解更多細節。

**floor division (向下取整除法)**

向下無條件舍去到最接近整數的數學除法。向下取整除法的運算子是 `//`。例如，運算式 `11 // 4` 的計算結果 [2](#)，與 `float` (浮點數) 真除法所回傳的 `2.75` 不同。請注意，`(-11) // 4` 的結果是 `-3`，因 [2](#) 是 `-2.75` 被向下無條件舍去。請參 [PEP 238](#)。

**function (函式)**

一連串的陳述式，它能向呼叫者回傳一些值。它也可以被傳遞零個或多個 [引數](#)，這些引數可被使用於函式本體的執行。另請參 [parameter](#) (參數)、*method* (方法)，以及 [function](#) 章節。

**function annotation (函式釋)**

函式參數或回傳值的一個 *annotation* (釋)。

函式釋通常被使用於 [型提示](#)：例如，這個函式預期會得到兩個 `int` 引數，會有一個 `int` 回傳值：

```
def sum_two_numbers(a: int, b: int) -> int:
    return a + b
```

函式釋的語法在 [function](#) 章節有詳細解釋。

請參 [variable annotation](#) 和 [PEP 484](#)，皆有此功能的描述。關於釋的最佳實踐方法，另請參 [annotations-howto](#)。

**`__future__`**

`future` 陳述式：`from __future__ import <feature>`，會指示編譯器使用那些在 Python 未來的發布版本中將成標準的語法或語義，來編譯當前的模組。而 `__future__` 模組則記了 *feature* (功能) 可能的值。透過 `import` 此模組對其變數求值，你可以看見一個新的功能是何時首次被新增到此語言中，以及它何時將會 (或已經) 成預設的功能：

```
>>> import __future__
>>> __future__.division
_Feature((2, 2, 0, 'alpha', 2), (3, 0, 0, 'alpha', 0), 8192)
```

**garbage collection (垃圾回收)**

當記憶體不再被使用時，將其釋放的過程。Python 執行垃圾回收，是透過參照計數 (reference counting)，

以及一個能檢測和中斷參照循環 (reference cycle) 的循環垃圾回收器 (cyclic garbage collector) 來完成。垃圾回收器可以使用 `gc` 模組對其進行控制。

### generator (生成器)

一個會回傳 *generator iterator* (生成器迭代器) 的函式。它看起來像一個正常的函式，但不同的是它包含了 `yield` 運算式，能生成一系列的値，這些値可用於 `for` 圈，或是以 `next()` 函式，每次檢索其中的一個値。

這個術語通常用來表示一個生成器函式，但在某些情境中，也可能是表示生成器迭代器。萬一想表達的意思不清楚，那就使用完整的術語，以避免歧義。

### generator iterator (生成器迭代器)

一個由 *generator* (生成器) 函式所建立的物件。

每個 `yield` 會暫停處理程序，記住位置執行狀態 (包括區域變數及擱置中的 `try` 陳述式)。當生成器迭代器回復時，它會從停止的地方繼續執行 (與那些每次調用時都要重新開始的函式有所不同)。

### generator expression (生成器運算式)

一個會回傳迭代器的運算式。它看起來像一個正常的運算式，後面接著一個 `for` 子句，該子句定義了圈變數、範圍以及一個選擇性的 `if` 子句。該組合運算式會在外層函式生成多個値：

```
>>> sum(i*i for i in range(10))           # sum of squares 0, 1, 4, ... 81
285
```

### generic function (泛型函式)

一個由多個函式組成的函式，該函式會對不同的型實作相同的運算。呼叫期間應該使用哪種實作，是由調度演算法 (dispatch algorithm) 來決定。

另請參 *single dispatch* (單一調度) 術語表條目、`functools.singledispatch()` 裝飾器和 **PEP 443**。

### generic type (泛型型)

一個能被參數化 (parameterized) 的 *type* (型)；通常是一個容器型，像是 `list` 和 `dict`。它被用於型提示和解釋。

詳情請參泛型名、**PEP 483**、**PEP 484**、**PEP 585** 和 `typing` 模組。

## GIL

請參 *global interpreter lock* (全域直譯器鎖)。

### global interpreter lock (全域直譯器鎖)

*CPython* 直譯器所使用的機制，用以確保每次都只有一個執行緒能執行 Python 的 *bytecode* (位元組碼)。透過使物件模型 (包括關鍵的型，如 `dict`) 自動地避免行存取 (concurrent access) 的危險，此機制可以簡化 *CPython* 的實作。鎖定整個直譯器，會使直譯器更容易成多執行緒 (multi-threaded)，但代價是會犧牲掉多處理器的機器能提供的一大部分平行性 (parallelism)。

然而，有些擴充模組，無論是標準的或是第三方的，它們被設計成在執行壓縮或雜等計算密集 (computationally intensive) 的任務時，可以解除 GIL。另外，在執行 I/O 時，GIL 總是會被解除。

過去對於建立「無限制執行緒」直譯器 (以更高的精細度鎖定共享資料的直譯器) 的努力未成功，因在一般的單一處理器情況下，效能會有所損失。一般認為，若要克服這個效能問題，會使實作變得雜許多，進而付出更高的維護成本。

### hash-based pyc (雜架構的 pyc)

一個位元組碼 (bytecode) 暫存檔，它使用雜值而不是對應原始檔案的最後修改時間，來確定其有效性。請參 `pyc-invalidation`。

### hashable (可雜的)

An object is *hashable* if it has a hash value which never changes during its lifetime (it needs a `__hash__()` method), and can be compared to other objects (it needs an `__eq__()` method). Hashable objects which compare equal must have the same hash value.

可雜性 (hashability) 使一個物件可用作 dictionary (字典) 的鍵和 set (集合) 的成員，因這些資料結構都在其部使用了雜值。

大多數的 Python 不可變物件都是可雜的；可變的容器 (例如 list 或 dictionary) 不是；而不可變的容器 (例如 tuple (元組) 和 frozenset)，只有當它們的元素是可雜的，它們本身才是可雜的。若物件是使用者自定 class 的實例，則這些物件會被預設可雜的。它們在互相比較時都是不相等的 (除非它們與自己比較)，而它們的雜值則是衍生自它們的 `id()`。

## IDLE

Python 的 Integrated Development and Learning Environment (整合開發與學習環境)。idle 是一個基本的編輯器和直譯器環境，它和 Python 的標準發行版本一起被提供。

## immutable (不可變物件)

一個具有固定值的物件。不可變物件包括數字、字串和 tuple (元組)。這類物件是不能被改變的。如果一個不同的值必須被儲存，則必須建立一個新的物件。它們在需要定雜值的地方，扮演重要的角色，例如 dictionary (字典) 中的一個鍵。

## import path (引入路徑)

一個位置 (或路徑項目) 的列表，而那些位置就是在 import 模組時，會被 *path based finder* (基於路徑的尋檢器) 搜尋模組的位置。在 import 期間，此位置列表通常是來自 `sys.path`，但對於子套件 (subpackage) 而言，它也可能是來自父套件的 `__path__` 屬性。

## importing (引入)

一個過程。一個模組中的 Python 程式碼可以透過此過程，被另一個模組中的 Python 程式碼使用。

## importer (引入器)

一個能尋找及載入模組的物件；它既是 *finder* (尋檢器) 也是 *loader* (載入器) 物件。

## interactive (互動的)

Python 有一個互動式直譯器，這表示你可以在直譯器的提示字元輸入陳述式和運算式，立即執行它們且看到它們的結果。只要啟動 python，不需要任何引數 (可能藉由從你的電腦的主選單選擇它)。這是測試新想法或檢查模塊和包的非常大的方法 (請記住 `help(x)`)。

## interpreted (直譯的)

Python 是一種直譯語言，而不是編譯語言，不過這個區分可能有些模糊，因有位元組碼 (bytecode) 編譯器的存在。這表示原始檔案可以直接被運行，而不需明確地建立另一個執行檔，然後再執行它。直譯語言通常比編譯語言有更短的開發 / 除錯期，不過它們的程式通常也運行得較慢。另請參 *interactive* (互動的)。

## interpreter shutdown (直譯器關閉)

當 Python 直譯器被要求關閉時，它會進入一個特殊階段，在此它逐漸釋放所有被配置的資源，例如模組和各種關鍵部結構。它也會多次呼叫 *垃圾回收器* (*garbage collector*)。這能觸發使用者自定的解構函式 (destructor) 或弱引用的回呼 (weakref callback)，執行其中的程式碼。在關閉階段被執行的程式碼會遇到各種例外，因它所依賴的資源可能不再有作用了 (常見的例子是函式庫模組或是警告機制)。

直譯器關閉的主要原因，是 `__main__` 模組或正被運行的本已經執行完成。

## iterable (可代物件)

An object capable of returning its members one at a time. Examples of iterables include all sequence types (such as list, str, and tuple) and some non-sequence types like dict, *file objects*, and objects of any classes you define with an `__iter__()` method or with a `__getitem__()` method that implements *sequence* semantics.

Iterables can be used in a for loop and in many other places where a sequence is needed (`zip()`, `map()`, ...). When an iterable object is passed as an argument to the built-in function `iter()`, it returns an iterator for the object. This iterator is good for one pass over the set of values. When using iterables, it is usually not necessary to call `iter()` or deal with iterator objects yourself. The for statement does that automatically for you, creating a temporary unnamed variable to hold the iterator for the duration of the loop. See also *iterator*, *sequence*, and *generator*.



**iterator (迭代器)**

An object representing a stream of data. Repeated calls to the iterator's `__next__()` method (or passing it to the built-in function `next()`) return successive items in the stream. When no more data are available a `StopIteration` exception is raised instead. At this point, the iterator object is exhausted and any further calls to its `__next__()` method just raise `StopIteration` again. Iterators are required to have an `__iter__()` method that returns the iterator object itself so every iterator is also iterable and may be used in most places where other iterables are accepted. One notable exception is code which attempts multiple iteration passes. A container object (such as a `list`) produces a fresh new iterator each time you pass it to the `iter()` function or use it in a `for` loop. Attempting this with an iterator will just return the same exhausted iterator object used in the previous iteration pass, making it appear like an empty container.

在 `typeiter` 文中可以找到更多資訊。

**CPython 實作細節：** CPython does not consistently apply the requirement that an iterator define `__iter__()`.

**key function (鍵函式)**

鍵函式或理序函式 (collation function) 是一個可呼叫 (callable) 函式，它會回傳一個用於排序 (sorting) 或定序 (ordering) 的值。例如，`locale.strxfrm()` 被用來產生一個了解區域特定排序慣例的排序鍵。

Python 中的許多工具，都接受以鍵函式來控制元素被定序或分組的方式。它們包括 `min()`、`max()`、`sorted()`、`list.sort()`、`heapq.merge()`、`heapq.nsmallest()`、`heapq.nlargest()` 和 `itertools.groupby()`。

有幾種方法可以建立一個鍵函式。例如，`str.lower()` method 可以作不分大小寫排序的鍵函式。或者，一個鍵函式也可以從 `lambda` 運算式被建造，例如 `lambda r: (r[0], r[2])`。另外，`operator.attrgetter()`、`operator.itemgetter()` 和 `operator.methodcaller()` 三個鍵函式的建構函式 (constructor)。關於如何建立和使用鍵函式的範例，請參閱如何排序。

**keyword argument (關鍵字引數)**

請參閱 [argument](#) (引數)。

**lambda**

由單一 *expression* (運算式) 所組成的一個匿名行函式 (inline function)，於該函式被呼叫時求值。建立 `lambda` 函式的語法是 `lambda [parameters]: expression`

**LBYL**

Look before you leap. (三思而後行。) 這種編碼風格會在進行呼叫或查找之前，明確地測試先條件。這種風格與 *EAFP* 方式形成對比，且它的特色是會有許多 `if` 陳述式的存在。

在一個多執行緒環境中，LBYL 方式有在「三思」和「後行」之間引入了競態條件 (race condition) 的風險。例如以下程式碼 `if key in mapping: return mapping[key]`，如果另一個執行緒在測試之後但在查找之前，從 `mapping` 中移除了 `key`，則該程式碼就會失效。這個問題可以用鎖 (lock) 或使用 *EAFP* 編碼方式來解。

**list (串列)**

A built-in Python *sequence*. Despite its name it is more akin to an array in other languages than to a linked list since access to elements is  $O(1)$ .

**list comprehension (串列綜合運算)**

一種用來處理一個序列中的全部或部分元素，將處理結果以一個 `list` 回傳的簡要方法。`result = ['{:04x}'.format(x) for x in range(256) if x % 2 == 0]` 會產生一個字串 `list`，其中包含 0 到 255 範圍內，所有偶數的十六進位數 (0x..)。 `if` 子句是選擇性的。如果省略它，則 `range(256)` 中的所有元素都會被處理。

**loader (載入器)**

一個能載入模組的物件。它必須定義一個名 `load_module()` 的 `method` (方法)。載入器通常是被 *finder* (尋檢器) 回傳。更多細節請參閱 [PEP 302](#)，關於 *abstract base class* (抽象基底類)，請參閱 `importlib.abc.Loader`。

**locale encoding (區域編碼)**

在 Unix 上, 它是 LC\_CTYPE 區域設定的編碼。它可以用 `locale.setlocale(locale.LC_CTYPE, new_locale)` 來設定。

在 Windows 上, 它是 ANSI 代碼頁 (code page, 例如 "cp1252")。

在 Android 和 VxWorks 上, Python 使用 "utf-8" 作區域編碼。

`locale.getencoding()` can be used to get the locale encoding.

也請參考 *filesystem encoding and error handler*。

**magic method (魔術方法)**

*special method* (特殊方法) 的一個非正式同義詞。

**mapping (對映)**

一個容器物件, 它支援任意鍵的查找, 且能實作 abstract base classes (抽象基底類) 中, `collections.abc.Mapping` 或 `collections.abc.MutableMapping` 所指定的 method。範例包括 `dict`、`collections.defaultdict`、`collections.OrderedDict` 和 `collections.Counter`。

**meta path finder (元路徑尋檢器)**

一種經由搜尋 `sys.meta_path` 而回傳的 *finder* (尋檢器)。元路徑尋檢器與路徑項目尋檢器 (*path entry finder*) 相關但是不同。

關於元路徑尋檢器實作的 method, 請參 `importlib.abc.MetaPathFinder`。

**metaclass (元類)**

一種 class 的 class。Class 定義過程會建立一個 class 名稱、一個 class dictionary (字典), 以及一個 base class (基底類) 的列表。Metaclass 負責接受這三個引數, 建立該 class。大多數的物件導向程式語言會提供一個預設的實作。Python 的特之處在於它能建立自訂的 metaclass。大部分的使用者從未需要此工具, 但是當需要時, metaclass 可以提供大且優雅的解決方案。它們已被用於記屬性存取、增加執行緒安全性、追物件建立、實作單例模式 (singleton), 以及許多其他的任務。

更多資訊可以在 metaclasses 章節中找到。

**method (方法)**

一個在 class 本體被定義的函式。如果 method 作其 class 實例的一個屬性被呼叫, 則它將會得到該實例物件成它的第一個 *argument* (引數) (此引數通常被稱 `self`)。請參 *function* (函式) 和 *nested scope* (巢狀作用域)。

**method resolution order (方法解析順序)**

方法解析順序是在查找某個成員的過程中, base class (基底類) 被搜尋的順序。關於第 2.3 版至今, Python 直譯器所使用的演算法細節, 請參 *Python 2.3 版方法解析順序*。

**module (模組)**

一個擔任 Python 程式碼的組織單位 (organizational unit) 的物件。模組有一個命名空間, 它包含任意的 Python 物件。模組是藉由 *importing* 的過程, 被載入至 Python。

另請參 *package* (套件)。

**module spec (模組規格)**

一個命名空間, 它包含用於載入模組的 import 相關資訊。它是 `importlib.machinery.ModuleSpec` 的一個實例。

**MRO**

請參 *method resolution order* (方法解析順序)。

**mutable (可變物件)**

可變物件可以改變它們的值, 但維持它們的 `id()`。另請參 *immutable* (不可變物件)。

**named tuple (附名元組)**

術語「named tuple (附名元組)」是指從 tuple 繼承的任何型或 class, 且它的可索引 (indexable) 元素也可以用附名屬性來存取。這些型或 class 也可以具有其他的特性。

有些型別是 **named tuple**，包括由 `time.localtime()` 和 `os.stat()` 回傳的值。另一個例子是 `sys.float_info`：

```
>>> sys.float_info[1]           # indexed access
1024
>>> sys.float_info.max_exp      # named field access
1024
>>> isinstance(sys.float_info, tuple) # kind of tuple
True
```

Some named tuples are built-in types (such as the above examples). Alternatively, a named tuple can be created from a regular class definition that inherits from `tuple` and that defines named fields. Such a class can be written by hand, or it can be created by inheriting `typing.NamedTuple`, or with the factory function `collections.namedtuple()`. The latter techniques also add some extra methods that may not be found in hand-written or built-in named tuples.

### namespace (命名空間)

變數被儲存的地方。命名空間是以 **dictionary** (字典) 被實作。有區域的、全域的及建立的命名空間，而在物件中 (在 **method** 中) 也有巢狀的命名空間。命名空間藉由防止命名衝突，來支援模組化。例如，函式 `builtins.open` 和 `os.open()` 是透過它們的命名空間來區分彼此。命名空間也藉由明確地區分是哪個模組在實作一個函式，來增進可讀性及可維護性。例如，寫出 `random.seed()` 或 `itertools.islice()` 明確地表示，這些函式分別是由 `random` 和 `itertools` 模組在實作。

### namespace package (命名空間套件)

一個 **PEP 420 package** (套件)，它只能作子套件 (subpackage) 的一個容器。命名空間套件可能沒有實體的表示法，而且具體來說它們不像是一個 **regular package** (正規套件)，因為它們有 `__init__.py` 這個檔案。

另請參 **module** (模組)。

### nested scope (巢狀作用域)

能參照外層定義 (enclosing definition) 中的變數的能力。舉例來說，一個函式如果是在另一個函式中被定義，則它便能參照外層函式中的變數。請注意，在預設情況下，巢狀作用域僅適用於參照，而無法用於賦值。區域變數能在最層作用域中讀取及寫入。同樣地，全域變數是在全域命名空間中讀取及寫入。`nonlocal` 容許對外層作用域進行寫入。

### new-style class (新式類)

Old name for the flavor of classes now used for all class objects. In earlier Python versions, only new-style classes could use Python's newer, versatile features like `__slots__`, descriptors, properties, `__getattr__()`, class methods, and static methods.

### object (物件)

具有狀態 (屬性或值) 及被定義的行 (method) 的任何資料。它也是任何 **new-style class** (新式類) 的最終 **base class** (基底類)。

### package (套件)

一個 Python 的 **module** (模組)，它可以包含子模組 (submodule) 或是遞的子套件 (subpackage)。技術上而言，套件就是具有 `__path__` 屬性的一個 Python 模組。

另請參 **regular package** (正規套件) 和 **namespace package** (命名空間套件)。

### parameter (參數)

在 **function** (函式) 或 **method** 定義中的一個命名實體 (named entity)，它指明該函式能接受的一個 **argument** (引數)，或在某些情況下指示多個引數。共有五種不同的參數類型：

- **positional-or-keyword** (位置或關鍵字)：指明一個可以按位置或是作關鍵字引數被傳遞的引數。這是參數的預設類型，例如以下的 `foo` 和 `bar`：

```
def func(foo, bar=None): ...
```

- *positional-only* (僅限位置): 指明一個只能按照位置被提供的引數。在函式定義的參數列表中包含一個 / 字元, 就可以在該字元前面定義僅限位置參數, 例如以下的 *posonly1* 和 *posonly2*:

```
def func(posonly1, posonly2, /, positional_or_keyword): ...
```

- *keyword-only* (僅限關鍵字): 指明一個只能以關鍵字被提供的引數。在函式定義的參數列表中, 包含一個任意數量位置參數 (var-positional parameter) 或是單純的 \* 字元, 就可以在其後方定義僅限關鍵字參數, 例如以下的 *kw\_only1* 和 *kw\_only2*:

```
def func(arg, *, kw_only1, kw_only2): ...
```

- *var-positional* (任意數量位置): 指明一串能以任意序列被提供的位置引數 (在已被其他參數接受的任何位置引數之外)。這類參數是透過在其參數名稱字首加上 \* 來定義的, 例如以下的 *args*:

```
def func(*args, **kwargs): ...
```

- *var-keyword* (任意數量關鍵字): 指明可被提供的任意數量關鍵字引數 (在已被其他參數接受的任何關鍵字引數之外)。這類參數是透過在其參數名稱字首加上 \*\* 來定義的, 例如上面範例中的 *kwargs*。

參數可以指明引數是選擇性的或必需的, 也可以一些選擇性的引數指定預設值。

另請參閱術語表的 *argument* (引數) 條目、常見問題中的引數和參數之間的差別、`inspect.Parameter` class、function 章節, 以及 [PEP 362](#)。

### path entry (路徑項目)

在 `import path` (引入路徑) 中的一個位置, 而 *path based finder* (基於路徑的尋檢器) 會參考該位置來尋找要 import 的模組。

### path entry finder (路徑項目尋檢器)

被 `sys.path_hooks` 中的一個可呼叫物件 (callable) (意即一個 *path entry hook*) 所回傳的一種 *finder*, 它知道如何以一個 *path entry* 定位模組。

關於路徑項目尋檢器實作的 method, 請參閱 `importlib.abc.PathEntryFinder`。

### path entry hook (路徑項目)

A callable on the `sys.path_hooks` list which returns a *path entry finder* if it knows how to find modules on a specific *path entry*.

### path based finder (基於路徑的尋檢器)

預設的元路徑尋檢器 (*meta path finder*) 之一, 它會在一個 `import path` 中搜尋模組。

### path-like object (類路徑物件)

一個表示檔案系統路徑的物件。類路徑物件可以是一個表示路徑的 `str` 或 `bytes` 物件, 或是一個實作 `os.PathLike` 協定的物件。透過呼叫 `os.fspath()` 函式, 一個支援 `os.PathLike` 協定的物件可以被轉成 `str` 或 `bytes` 檔案系統路徑; 而 `os.fsdecode()` 及 `os.fsencode()` 則分別可用於確保 `str` 及 `bytes` 的結果。由 [PEP 519](#) 引入。

## PEP

Python Enhancement Proposal (Python 增進提案)。PEP 是一份設計明文件, 它能 Python 社群提供資訊, 或是描述 Python 的一個新功能或該功能的程序和環境。PEP 應該要提供簡潔的技術規範以及被提案功能的運作原理。

PEP 的存在目的, 是要成重大新功能的提案、社群中關於某個問題的意見收集, 以及已納入 Python 的設計策的記, 這些過程的主要機制。PEP 的作者要負責在社群建立共識記反對意見。

請參閱 [PEP 1](#)。

### portion (部分)

在單一目標中的一組檔案 (也可能儲存在一個 zip 檔中), 這些檔案能對一個命名空間套件 (namespace package) 有所貢獻, 如同 [PEP 420](#) 中的定義。

**positional argument (位置引數)**

請參閱 [argument](#) (引數)。

**provisional API (暫行 API)**

暫行 API 是指，從標準函式庫的向後相容性 (backwards compatibility) 保證中，故意被排除的 API。雖然此類介面，只要它們被標示為暫行的，理論上不會有重大的變更，但如果核心開發人員認為有必要，也可能會出現向後不相容的變更（甚至包括移除該介面）。這種變更不會無端地發生——只有 API 被納入之前未察覺的嚴重基本缺陷被揭露時，它們才會發生。

即使對於暫行 API，向後不相容的變更也會被視為「最後的解決方案」——對於任何被發現的問題，仍然會盡可能找出一個向後相容的解決方案。

這個過程使得標準函式庫能隨著時間不斷進化，而避免耗費過長的時間去鎖定有問題的設計錯誤。請參閱 [PEP 411](#) 了解更多細節。

**provisional package (暫行套件)**

請參閱 [provisional API](#) (暫行 API)。

**Python 3000**

Python 3.x 系列版本的暱稱（很久以前創造的，當時第 3 版的發布是在很遠的未來。）也可以縮寫為「Py3k」。

**Pythonic (Python 風格的)**

一個想法或一段程式碼，它應用了 Python 語言最常見的慣用語，而不是使用其他語言常見的概念來實作程式碼。例如，Python 中常見的一種習慣用法，是使用一個 `for` 陳述式，對一個可迭代物件的所有元素進行遍歷。許多其他語言也有這種類型的架構，所以不熟悉 Python 的人有時會使用一個數值計數器來代替：

```
for i in range(len(food)):
    print(food[i])
```

相較之下，以下方法更簡潔、更具有 Python 風格：

```
for piece in food:
    print(piece)
```

**qualified name (限定名稱)**

一個「點分隔名稱」，它顯示從一個模組的全域作用域到該模組中定義的 `class`、函式或 `method` 的「路徑」，如 [PEP 3155](#) 中的定義。對於頂層的函式和 `class` 而言，限定名稱與其物件名稱相同：

```
>>> class C:
...     class D:
...         def meth(self):
...             pass
...
>>> C.__qualname__
'C'
>>> C.D.__qualname__
'C.D'
>>> C.D.meth.__qualname__
'C.D.meth'
```

當用於引用模組時，完全限定名稱 (*fully qualified name*) 是表示該模組的完整點分隔路徑，包括任何的父套件，例如 `email.mime.text`：

```
>>> import email.mime.text
>>> email.mime.text.__name__
'email.mime.text'
```



**reference count (參照計數)**

對於一個物件的參照次數。當一個物件的參照計數下降到零時，它會被解除配置 (deallocated)。參照計數通常在 Python 程式碼中看不到，但它 [是 CPython 實作的一個關鍵元素](#)。程式設計師可以呼叫 `getrefcount()` 函式來回傳一個特定物件的參照計數。

**regular package (正規套件)**

一個傳統的 *package* (套件)，例如一個包含 `__init__.py` 檔案的目錄。

另請參 [namespace package](#) (命名空間套件)。

**`__slots__`**

在 class 部的一個宣告，它藉由預先宣告實例屬性的空間，以及消除實例 dictionary (字典)，來節省記憶體。雖然該技術很普遍，但它有點難以正確地使用，最好保留給那種在一個記憶體關鍵 (memory-critical) 的應用程式中存在大量實例的罕見情況。

**sequence (序列)**

An *iterable* which supports efficient element access using integer indices via the `__getitem__()` special method and defines a `__len__()` method that returns the length of the sequence. Some built-in sequence types are `list`, `str`, `tuple`, and `bytes`. Note that `dict` also supports `__getitem__()` and `__len__()`, but is considered a mapping rather than a sequence because the lookups use arbitrary *immutable* keys rather than integers.

The `collections.abc.Sequence` abstract base class defines a much richer interface that goes beyond just `__getitem__()` and `__len__()`, adding `count()`, `index()`, `__contains__()`, and `__reversed__()`. Types that implement this expanded interface can be registered explicitly using `register()`. For more documentation on sequence methods generally, see [Common Sequence Operations](#).

**set comprehension (集合綜合運算)**

一種緊密的方法，用來處理一個可代物件中的全部或部分元素，將處理結果以一個 `set` 回傳。  
`results = {c for c in 'abracadabra' if c not in 'abc'}` 會生一個字串 `set: {'r', 'd'}`。請參 [comprehensions](#)。

**single dispatch (單一調度)**

*generic function* (泛型函式) 調度的一種形式，在此，實作的選擇是基於單一引數的型。

**slice (切片)**

一個物件，它通常包含一段 *sequence* (序列) 的某一部分。建立一段切片的方法是使用下標符號 (subscript notation) `[]`，若要給出多個數字，則在數字之間使用冒號，例如 `variable_name[1:3:5]`。在括號 (下標) 符號的部，會使用 `slice` 物件。

**special method (特殊方法)**

一種會被 Python 自動呼叫的 `method`，用於對某種型執行某種運算，例如加法。這種 `method` 的名稱會在開頭和結尾有兩個下底。Special method 在 `specialnames` 中有詳細明。

**statement (陳述式)**

陳述式是一個套組 (suite，一個程式碼「區塊」) 中的一部分。陳述式可以是一個 *expression* (運算式)，或是含有關鍵字 (例如 `if`、`while` 或 `for`) 的多種結構之一。

**static type checker**

An external tool that reads Python code and analyzes it, looking for issues such as incorrect types. See also *type hints* and the `typing` module.

**strong reference (參照)**

In Python's C API, a strong reference is a reference to an object which is owned by the code holding the reference. The strong reference is taken by calling `Py_INCREF()` when the reference is created and released with `Py_DECREF()` when the reference is deleted.

`Py_NewRef()` 函式可用於建立一個對物件的參照。通常，在退出參照的作用域之前，必須在該參照上呼叫 `Py_DECREF()` 函式，以避免漏一個參照。

另請參 [borrowed reference](#) (借用參照)。

**text encoding (文字編碼)**

Python 中的字串是一個 Unicode 碼點 (code point) 的序列 (範圍在 U+0000 -- U+10FFFF 之間)。若要儲存或傳送一個字串，它必須被序列化一個位元組序列。

將一個字串序列化位元組序列，稱「編碼」，而從位元組序列重新建立該字串則稱「解碼 (decoding)」。

有多種不同的文字序列化編解碼器 (codecs)，它們被統稱「文字編碼」。

**text file (文字檔案)**

一個能讀取和寫入 `str` 物件的一個 *file object* (檔案物件)。通常，文字檔案實際上是存取位元組導向的資料流 (byte-oriented datastream) 會自動處理 *text encoding* (文字編碼)。文字檔案的例子有：以文字模式 ('r' 或 'w') 開的檔案、`sys.stdin`、`sys.stdout` 以及 `io.StringIO` 的實例。

另請參 *binary file* (二進制檔案)，它是一個能讀取和寫入類位元組串物件 (*bytes-like object*) 的檔案物件。

**triple-quoted string (三引號字串)**

由三個雙引號 (") 或單引號 (') 的作邊界的一個字串。雖然它們有提供於單引號字串的任何額外功能，但基於許多原因，它們仍是很有用的。它們讓你可以字串中包含未跳 (unescaped) 的單引號和雙引號，而且它們不需使用連續字元 (continuation character) 就可以跨越多行，這使得它們在編寫明字串時特別有用。

**type (型)**

一個 Python 物件的型定了它是什麼類型的物件；每個物件都有一個型。一個物件的型可以用它的 `__class__` 屬性來存取，或以 `type(obj)` 來檢索。

**type alias (型名)**

一個型的同義詞，透過將型指定給一個識符 (identifier) 來建立。

型名對於簡化型提示 (*type hint*) 很有用。例如：

```
def remove_gray_shades(
    colors: list[tuple[int, int, int]]) -> list[tuple[int, int, int]]:
    pass
```

可以寫成這樣，更具有可讀性：

```
Color = tuple[int, int, int]

def remove_gray_shades(colors: list[Color]) -> list[Color]:
    pass
```

請參 `typing` 和 **PEP 484**，有此功能的描述。

**type hint (型提示)**

一種 *annotation* (釋)，它指定一個變數、一個 class 屬性或一個函式的參數或回傳值的預期型。

Type hints are optional and are not enforced by Python but they are useful to *static type checkers*. They can also aid IDEs with code completion and refactoring.

全域變數、class 屬性和函式 (不含區域變數) 的型提示，都可以使用 `typing.get_type_hints()` 來存取。

請參 `typing` 和 **PEP 484**，有此功能的描述。

**universal newlines (通用行字元)**

一種解譯文字流 (text stream) 的方式，會將以下所有的情識一行的結束：Unix 行尾慣例 '\n'、Windows 慣例 '\r\n' 和舊的 Macintosh 慣例 '\r'。請參 **PEP 278** 和 **PEP 3116**，以及用於 `bytes.splitlines()` 的附加用途。

**variable annotation (變數釋)**

一個變數或 class 屬性的 *annotation* (釋)。

釋變數或 class 屬性時，賦值是選擇性的：

```
class C:
    field: 'annotation'
```

變數釋通常用於型提示 (*type hint*)：例如，這個變數預期會取得 `int` (整數) 值：

```
count: int = 0
```

變數釋的語法在 `annassign` 章節有詳細的解釋。

請參 *function annotation* (函式釋)、**PEP 484** 和 **PEP 526**，皆有此功能的描述。關於釋的最佳實踐方法，另請參 `annotations-howto`。

**virtual environment (擬環境)**

一個協作隔離 (*cooperatively isolated*) 的執行環境，能讓 Python 的使用者和應用程式得以安裝和升級 Python 發套件，而不會對同一個系統上運行的其他 Python 應用程式的行生干擾。

另請參 `venv`。

**virtual machine (擬機器)**

一部完全由軟體所定義的電腦 (*computer*)。Python 的擬機器會執行由 *bytecode* (位元組碼) 編譯器所發出的位元組碼。

**Zen of Python (Python 之)**

Python 設計原則與哲學的列表，其容有助於理解和使用此語言。此列表可以透過在互動式提示字元後輸入 `import this` 來找到它。



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## 關於這些文檔文件

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這些文檔文件是透過 [Sphinx](#)（一個專為 Python 文檔文件所撰寫的文件處理器）將使用 [reStructuredText](#) 撰寫的原始檔轉換而成。

如同 Python 自身，透過自願者的努力下輸出文件與封裝後自動化執行工具。若想要回報臭蟲，請見 [reporting-bugs](#) 頁面，包含相關資訊。我們永遠歡迎新的自願者加入！

致謝：

- Fred L. Drake, Jr., 原始 Python 文件工具集的創造者以及一大部份內容的作者；
- 創造 [reStructuredText](#) 和 [Docutils](#) 工具組的 [Docutils](#) 專案；
- Fredrik Lundh 先生，Sphinx 從他的 [Alternative Python Reference](#) 計劃中獲得許多的好主意。

### B.1 Python 文件的貢獻者們

許多人都曾為 Python 這門語言、Python 標準函式庫和 Python 文檔文件貢獻過。Python 所發出的原始碼中含有一部分貢獻者的清單，請見 [Misc/ACKS](#)。

正因為 Python 社群的撰寫與貢獻才有這份這麼棒的文檔文件 -- 感謝所有貢獻過的人們！



## 沿革與授權

## C.1 軟體沿革

Python 是由荷蘭數學和計算機科學研究學會（CWI，見 <https://www.cwi.nl/>）的 Guido van Rossum 於 1990 年代早期所創造，目的是作一種稱作 ABC 語言的後繼者。儘管 Python 包含了許多來自其他人的貢獻，Guido 仍是其主要作者。

1995 年，Guido 在維吉尼亞州雷斯頓的國家創新研究公司（CNRI，見 <https://www.cnri.reston.va.us/>）繼續他在 Python 的工作，在那發行了該軟體的多個版本。

2000 年五月，Guido 和 Python 核心開發團隊轉移到 BeOpen.com 成立了 BeOpen PythonLabs 團隊。同年十月，PythonLabs 團隊轉移到 Digital Creations（現 Zope Corporation；見 <https://www.zope.org/>）。2001 年，Python 軟體基金會（PSF，見 <https://www.python.org/psf/>）成立，這是一個專擁有 Python 相關的智慧財產權而創立的非營利組織。Zope Corporation 是 PSF 的一個贊助會員。

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發行版本	源自	年份	擁有者	GPL 相容性？
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1.3 至 1.5.2	1.2	1995-1999	CNRI	是
1.6	1.5.2	2000	CNRI	否
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2.1	2.0+1.6.1	2001	PSF	否
2.0.1	2.0+1.6.1	2001	PSF	是
2.1.1	2.1+2.0.1	2001	PSF	是
2.1.2	2.1.1	2002	PSF	是
2.1.3	2.1.2	2002	PSF	是
2.2 以上	2.1.1	2001 至今	PSF	是

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感謝許多的外部志工，在 Guido 指導下的付出，使得這些版本的發成可能。

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### C.3.1 Mersenne Twister

`_random` 模組包含了以 <http://www.math.sci.hiroshima-u.ac.jp/~m-mat/MT/MT2002/emt19937ar.html> 的下載 容 基礎的程式碼。以下是原始程式碼的完整聲明：

```
A C-program for MT19937, with initialization improved 2002/1/26.
Coded by Takuji Nishimura and Makoto Matsumoto.

Before using, initialize the state by using init_genrand(seed)
or init_by_array(init_key, key_length).

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Any feedback is very welcome.
http://www.math.sci.hiroshima-u.ac.jp/~m-mat/MT/emt.html
email: m-mat @ math.sci.hiroshima-u.ac.jp (remove space)
```



### C.3.2 Sockets

The `socket` module uses the functions, `getaddrinfo()`, and `getnameinfo()`, which are coded in separate source files from the WIDE Project, <https://www.wide.ad.jp/>.

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```
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```
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mailto:zooko@zooko.com

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### C.3.6 UUencode 與 UUdecode 函式

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```
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Modified by Jack Jansen, CWI, July 1995:
- Use binascii module to do the actual line-by-line conversion
  between ascii and binary. This results in a 1000-fold speedup. The C
  version is still 5 times faster, though.
- Arguments more compliant with Python standard
```

### C.3.7 XML 遠端程序呼叫

xmlrpc.client 模組包含以下聲明：

```
The XML-RPC client interface is

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```

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### C.3.8 test\_epoll

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### C.3.9 Select queue

`select` 模組對於 `kqueue` 介面包含以下聲明:

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### C.3.10 SipHash24

Python/pyhash.c 檔案包含 Marek Majkowski 基於 Dan Bernstein 的 SipHash24 演算法的實作。它包含以下聲明：

```
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Original location:
    https://github.com/majek/csiphash/

Solution inspired by code from:
    Samuel Neves (supercop/crypto_auth/siphash24/little)
    djb (supercop/crypto_auth/siphash24/little2)
    Jean-Philippe Aumasson (https://131002.net/siphash/siphash24.c)
```

### C.3.11 strtod 與 dtoa

Python/dtoa.c 檔案提供了 C 的 dtoa 和 strtod 函式，用於將 C 的雙精度浮點數和字串互相轉換。該檔案是衍生自 David M. Gay 建立的同名檔案，後者現在可以從 <https://web.archive.org/web/20220517033456/http://www.netlib.org/fp/dtoa.c> 下載。於 2009 年 3 月 16 日所檢索的原始檔案包含以下版權與授權聲明：

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 */
```

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```
*
*****/
```

### C.3.12 OpenSSL

The modules `hashlib`, `posix`, `ssl`, `crypt` use the OpenSSL library for added performance if made available by the operating system. Additionally, the Windows and macOS installers for Python may include a copy of the OpenSSL libraries, so we include a copy of the OpenSSL license here. For the OpenSSL 3.0 release, and later releases derived from that, the Apache License v2 applies:

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The pyexpat extension is built using an included copy of the expat sources unless the build is configured `--with-system-expat`:

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### C.3.14 libffi

除非在建置 `_ctypes` 擴充時設定 `--with-system-libffi`，否則該擴充會用一個含 `libffi` 原始碼的副本來建置：

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### C.3.15 zlib

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```
Jean-loup Gailly
jloup@gzip.org
```

```
Mark Adler
madler@alumni.caltech.edu
```

### C.3.16 cfuhash

tracemalloc 使用的雜表 (hash table) 實作，是以 cfuhash 專案基礎：

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### C.3.17 libmpdec

除非在建置 `_decimal` 模組時設定 `--with-system-libmpdec`，否則該模組會用一個含 `libmpdec` 函式庫的副本來建置：

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### C.3.19 Audioop

The audioop module uses the code base in g771.c file of the SoX project. <https://sourceforge.net/projects/sox/files/sox/12.17.7/sox-12.17.7.tar.gz>

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