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# Python Setup and Usage

發 3.13.0rc2

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9 月 25, 2024

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這部分的說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 [-bBdEhiIOPqRsSuvVWx?] [-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. For more on interactive mode, see `tut-interac`.
- 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.

#### 備 F

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.

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

#### 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 版被加入。

`--help-xoptions`

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

在 3.11 版被加入。

**--help-all**

印出完整使用資訊離開。

在 3.11 版被加入。

**-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 版被加入: `-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). See also the `PYTHONDEBUG` environment variable.

This option requires a *debug build of Python*, otherwise it's ignored.

**-E**

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

另請參閱 `-P` 和 `-I` (isolated) 選項。

**-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 版被加入。

**-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: 根據 [PEP 488](#) 修改 `.pyc` 檔案名稱。

**-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: 根據 [PEP 488](#) 修改 `.pyc` 檔案名稱。

**-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 版被加入。

**-q**

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

在 3.2 版被加入。

**-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 版被加入。

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`.

另請參閱 [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 `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 `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
-Wall      # Same as -Walways
-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`.

完整的引數形式:

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

Empty fields match all values; trailing empty fields may be omitted. For example `-Wignore::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](#).  
在 3.3 版被加入.
- `-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*.  
在 3.4 版被加入.
- `-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.  
在 3.4 版被加入.
- `-X int_max_str_digits` configures the integer string conversion length limitation. See also [PYTHONINTMAXSTRDIGITS](#).  
在 3.11 版被加入.
- `-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](#).  
在 3.7 版被加入.
- `-X dev`: enable Python Development Mode, introducing additional runtime checks that are too expensive to be enabled by default. See also [PYTHONDEVMODE](#).  
在 3.7 版被加入.
- `-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](#).  
在 3.7 版被加入.
- `-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](#).  
在 3.8 版被加入.
- `-X warn_default_encoding` issues a `EncodingWarning` when the locale-specific default encoding is used for opening files. See also [PYTHONWARNDEFAULTENCODING](#).  
在 3.10 版被加入.
- `-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](#).  
在 3.11 版被加入.
- `-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`. See also [PYTHON\\_FROZEN\\_MODULES](#).  
在 3.11 版被加入.
- `-X perf` enables support for the Linux `perf` profiler. When this option is provided, the `perf` profiler will be able to report Python calls. This option is only available on some platforms and will do nothing

if is not supported on the current system. The default value is "off". See also `PYTHONPERFSUPPORT` and `perf_profiling`.

在 3.12 版被加入。

- `-X perf_jit` enables support for the Linux `perf` profiler with DWARF support. When this option is provided, the `perf` profiler will be able to report Python calls using DWARF information. This option is only available on some platforms and will do nothing if is not supported on the current system. The default value is "off". See also `PYTHON_PERF_JIT_SUPPORT` and `perf_profiling`.

在 3.13 版被加入。

- `-X cpu_count=n` overrides `os.cpu_count()`, `os.process_cpu_count()`, and `multiprocessing.cpu_count()`. `n` must be greater than or equal to 1. This option may be useful for users who need to limit CPU resources of a container system. See also `PYTHON_CPU_COUNT`. If `n` is default, nothing is overridden.

在 3.13 版被加入。

- `-X presite=package.module` specifies a module that should be imported before the `site` module is executed and before the `__main__` module exists. Therefore, the imported module isn't `__main__`. This can be used to execute code early during Python initialization. Python needs to be *built in debug mode* for this option to exist. See also `PYTHON_PRESITE`.

在 3.13 版被加入。

- `-X gil=0,1` forces the GIL to be disabled or enabled, respectively. Setting to 0 is only available in builds configured with `--disable-gil`. See also `PYTHON_GIL` and `whatsnew313-free-threaded-cpython`.

在 3.13 版被加入。

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

在 3.2 版被加入。

在 3.9 版的變更: 移除 `-X showalloccount` 選項。

在 3.10 版的變更: 移除 `-X oldparser` 選項。

## 1.1.4 Controlling color

The Python interpreter is configured by default to use colors to highlight output in certain situations such as when displaying tracebacks. This behavior can be controlled by setting different environment variables.

Setting the environment variable `TERM` to `dumb` will disable color.

If the `FORCE_COLOR` environment variable is set, then color will be enabled regardless of the value of `TERM`. This is useful on CI systems which aren't terminals but can still display ANSI escape sequences.

If the `NO_COLOR` environment variable is set, Python will disable all color in the output. This takes precedence over `FORCE_COLOR`.

All these environment variables are used also by other tools to control color output. To control the color output only in the Python interpreter, the `PYTHON_COLORS` environment variable can be used. This variable takes precedence over `NO_COLOR`, which in turn takes precedence over `FORCE_COLOR`.



### 1.1.5 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 版被加入。

### PYTHONPLATLIBDIR

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

在 3.9 版被加入。

### 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.

引發一個附帶呼叫 啟動時的檔案名稱 引數的稽核事件 *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 版被加入。

#### **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.

This environment variable requires a *debug build of Python*, otherwise it's ignored.

#### **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.

引發一個不附帶引數的稽核事件 `cpython.run_stdin`。

在 3.12.5 版的變更: (also 3.11.10, 3.10.15, 3.9.20, and 3.8.20) Emits audit events.

在 3.13 版的變更: Uses PyREPL if possible, in which case `PYTHONSTARTUP` is also executed. Emits audit events.

#### **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 `-Xpycache_prefix=PATH` option.

在 3.8 版被加入。

#### **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 版被加入。

#### **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 版被加入。

#### **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=all     # Same as PYTHONWARNINGS=always
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 版被加入。

#### **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 版被加入。

#### **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 版被加入。

#### **PYTHONASYNCIODEBUG**

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

在 3.4 版被加入。

#### **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.
- `mimalloc`: use the `mimalloc` 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.
- `mimalloc_debug`: same as `mimalloc` but also install debug hooks.

在 3.6 版被加入。

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 版被加入: 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 版被加入。

**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 版被加入：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 版被加入。

**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 版被加入。

**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 版被加入。

**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 版被加入.

#### **PYTHONPERFSUPPORT**

If this variable is set to a nonzero value, it enables support for the Linux `perf` profiler so Python calls can be detected by it.

If set to 0, disable Linux `perf` profiler support.

See also the `-X perf` command-line option and `perf_profiling`.

在 3.12 版被加入.

#### **PYTHON\_PERF\_JIT\_SUPPORT**

If this variable is set to a nonzero value, it enables support for the Linux `perf` profiler so Python calls can be detected by it using DWARF information.

If set to 0, disable Linux `perf` profiler support.

See also the `-X perf_jit` command-line option and `perf_profiling`.

在 3.13 版被加入.

#### **PYTHON\_CPU\_COUNT**

If this variable is set to a positive integer, it overrides the return values of `os.cpu_count()` and `os.process_cpu_count()`.

See also the `-X cpu_count` command-line option.

在 3.13 版被加入.

#### **PYTHON\_FROZEN\_MODULES**

If this variable is set to `on` or `off`, it 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` for non-debug builds (the normal case) and `off` for debug builds. Note that the `importlib_bootstrap` and `importlib_bootstrap_external` frozen modules are always used, even if this flag is set to `off`.

See also the `-X frozen_modules` command-line option.

在 3.13 版被加入.

#### **PYTHON\_COLORS**

If this variable is set to 1, the interpreter will colorize various kinds of output. Setting it to 0 deactivates this behavior. See also [Controlling color](#).

在 3.13 版被加入.

#### **PYTHON\_BASIC\_REPL**

If this variable is set to 1, the interpreter will not attempt to load the Python-based [REPL](#) that requires `curses` and `readline`, and will instead use the traditional parser-based [REPL](#).

在 3.13 版被加入.

#### **PYTHON\_HISTORY**

This environment variable can be used to set the location of a `.python_history` file (by default, it is `.python_history` in the user's home directory).

在 3.13 版被加入.

#### **PYTHON\_GIL**

If this variable is set to 1, the global interpreter lock (GIL) will be forced on. Setting it to 0 forces the GIL off (needs Python configured with the `--disable-gil` build option).

See also the `-X gil` command-line option, which takes precedence over this variable, and `whatsnew313-free-threaded-cpython`.

在 3.13 版被加入.

### 1.2.1 除錯模式變數

#### **PYTHONDUMPREFS**

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

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

#### **PYTHONDUMPREFSFILE**

If set, Python will dump objects and reference counts still alive after shutting down the interpreter into a file under the path given as the value to this environment variable.

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

在 3.11 版被加入.

#### **PYTHON\_PRESITE**

If this variable is set to a module, that module will be imported early in the interpreter lifecycle, before the `site` module is executed, and before the `__main__` module is created. Therefore, the imported module is not treated as `__main__`.

This can be used to execute code early during Python initialization.

To import a submodule, use `package.module` as the value, like in an import statement.

See also the `-X presite` command-line option, which takes precedence over this variable.

Needs Python configured with the `--with-pydebug` build option.

在 3.13 版被加入.





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## 在 Unix 平臺上使用 Python

---

### 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。參閱以下連結：

#### 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
```

## 2.2 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` 二進制檔案。因此，建議使用 `make altinstall` 而不是 `make install`，因為它只安裝 `exec_prefix/bin/pythonversion`。

## 2.3 與 Python 相關的路徑和檔案

這取決於本地安裝慣例；`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 系統可能沒有 `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 \
  --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制化 OpenSSL 安裝版就可以了。



### 3.1 建置需求

Features and minimum versions required to build CPython:

- A C11 compiler. Optional C11 features are not required.
- 在 Windows 上需要 Microsoft Visual Studio 2017 或更新版本。
- Support for IEEE 754 floating-point numbers and floating-point Not-a-Number (NaN).
- thread 的支援。
- OpenSSL 1.1.1 is the minimum version and OpenSSL 3.0.9 is the recommended minimum version for the `ssl` and `hashlib` extension modules.
- SQLite 3.15.2 for the `sqlite3` extension module.
- Tcl/Tk 8.5.12 for the `tkinter` module.
- Autoconf 2.71 and aclocal 1.16.4 are required to regenerate the `configure` script.

在 3.1 版的變更: Tcl/Tk version 8.3.1 is now required.

在 3.5 版的變更: On Windows, Visual Studio 2015 or later is now required. Tcl/Tk version 8.4 is now required.

在 3.6 版的變更: Selected C99 features are now required, like `<stdint.h>` and `static inline` functions.

在 3.7 版的變更: 對執行緒與 OpenSSL 1.0.2 的支援現在是必要的。

在 3.10 版的變更: OpenSSL 1.1.1 is now required. Require SQLite 3.7.15.

在 3.11 版的變更: C11 compiler, IEEE 754 and NaN support are now required. On Windows, Visual Studio 2017 or later is required. Tcl/Tk version 8.5.12 is now required for the `tkinter` module.

在 3.13 版的變更: Autoconf 2.71, aclocal 1.16.4 and SQLite 3.15.2 are now required.

See also **PEP 7** "Style Guide for C Code" and **PEP 11** "CPython platform support".

## 3.2 生成的檔案

To reduce build dependencies, Python source code contains multiple generated files. Commands to regenerate all generated files:

```
make regen-all
make regen-stdlib-module-names
make regen-limited-abi
make regen-configure
```

The `Makefile.pre.in` file documents generated files, their inputs, and tools used to regenerate them. Search for `regen-*` make targets.

### 3.2.1 設定本

The `make regen-configure` command regenerates the `aclocal.m4` file and the `configure` script using the `Tools/build/regen-configure.sh` shell script which uses an Ubuntu container to get the same tools versions and have a reproducible output.

The container is optional, the following command can be run locally:

```
autoreconf -ivf -Werror
```

The generated files can change depending on the exact `autoconf-archive`, `aclocal` and `pkg-config` versions.

## 3.3 設定選項

List all `configure` script options using:

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

請見 Python 原始碼發行版中的 `Misc/SpecialBuilds.txt`。

### 3.3.1 一般選項

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

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

請見 `sqlite3` 模組的 `sqlite3.Connection.enable_load_extension()` 方法。

在 3.6 版被加入。

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

停用 IPv6 支援（如果支援的話預設是用的），請見 `socket` 模組。

#### **--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 15 或 30。

參見 `sys.int_info.bits_per_digit`。

**--with-suffix=SUFFIX**

將 Python 執行檔的後綴設定為 `SUFFIX`。

在 Windows 和 macOS 上預設的後綴是 `.exe` (`python.exe` 執行檔)、在 Emscripten node 上 `.js`、在 Emscripten 瀏覽器 `.html`、在 WASI 上 `.wasm`，以及在其他平台 `.空字串` (`python` 執行檔)。

在 3.11 版的變更: 在 WASM 平台上預設的後綴是 `.js`、`.html` 或 `.wasm` 中的一個。

**--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.

預設值: `/usr/share/zoneinfo:/usr/lib/zoneinfo:/usr/share/lib/zoneinfo:/etc/zoneinfo`。

請見 `os.pathsep` 路徑分隔符號。

在 3.9 版被加入。

**--without-decimal-contextvar**

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

請見 `decimal.HAVE_CONTEXTVAR` 與 `contextvars` 模組。

在 3.9 版被加入。

**--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).

不要定義 `PY_COERCE_C_LOCALE` 巨集。

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

**--without-freelists**

Disable all freelists except the empty tuple singleton.

在 3.11 版被加入。

**--with-platlibdir=DIRNAME**

Python 函式庫目錄名稱 (預設 `lib`)。

Fedora 和 SuSE 在 64 位元平台上使用 `lib64`。

參見 `sys.platlibdir`。

在 3.9 版被加入。

**--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 版被加入。

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

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

- check (預設): **pkg-config** 是可選的
- yes: **pkg-config** 是必要的
- no: 即使存在也不使用 **pkg-config** 來配置

在 3.11 版被加入。

**--enable-pystats**

Turn on internal Python performance statistics gathering.

By default, statistics gathering is off. Use `python3 -X pystats` command or set `PYTHONSTATS=1` environment variable to turn on statistics gathering at Python startup.

At Python exit, dump statistics if statistics gathering was on and not cleared.

效果：

- Add `-X pystats` command line option.
- Add `PYTHONSTATS` environment variable.
- Define the `Py_STATS` macro.
- Add functions to the `sys` module:
  - `sys._stats_on()`: Turns on statistics gathering.
  - `sys._stats_off()`: Turns off statistics gathering.
  - `sys._stats_clear()`: Clears the statistics.
  - `sys._stats_dump()`: Dump statistics to file, and clears the statistics.

The statistics will be dumped to a arbitrary (probably unique) file in `/tmp/py_stats/` (Unix) or `C:\temp\py_stats\` (Windows). If that directory does not exist, results will be printed on `stderr`.

使用 `Tools/scripts/summarize_stats.py` 來讀取統計資料。

Statistics:

- Opcode:
  - Specialization: success, failure, hit, deferred, miss, deopt, failures;
  - Execution count;
  - Pair count.
- Call:
  - Inlined Python calls;
  - PyEval calls;
  - Frames pushed;
  - Frame object created;
  - Eval calls: vector, generator, legacy, function `VECTORCALL`, build class, slot, function "ex", API, method.
- Object:
  - incref and decref;
  - interpreter incref and decref;
  - allocations: all, 512 bytes, 4 kiB, big;
  - free;



- to/from free lists;
- dictionary materialized/dematerialized;
- type cache;
- optimization attempts;
- optimization traces created/executed;
- uops executed.
- Garbage collector:
  - Garbage collections;
  - Objects visited;
  - Objects collected.

在 3.11 版被加入。

#### **--disable-gil**

Enables **experimental** support for running Python without the *global interpreter lock* (GIL): free threading build.

Defines the `PY_GIL_DISABLED` macro and adds "t" to `sys.abiflags`.

See [whatsnew313-free-threaded-cpython](#) for more detail.

在 3.13 版被加入。

#### **PKG\_CONFIG**

Path to `pkg-config` utility.

#### **PKG\_CONFIG\_LIBDIR**

#### **PKG\_CONFIG\_PATH**

`pkg-config` options.

### 3.3.2 C compiler options

#### **CC**

C 編譯器指令。

#### **CFLAGS**

C 編譯器旗標。

#### **CPP**

C preprocessor command.

#### **CPPFLAGS**

C preprocessor flags, e.g. `-Iinclude_dir`.

### 3.3.3 Linker options

#### **LDFLAGS**

Linker flags, e.g. `-Llibrary_directory`.

#### **LIBS**

Libraries to pass to the linker, e.g. `-llibrary`.

#### **MACHDEP**

Name for machine-dependent library files.

### 3.3.4 Options for third-party dependencies

在 3.11 版被加入.

**BZIP2\_CFLAGS****BZIP2\_LIBS**

C compiler and linker flags to link Python to libbz2, used by bz2 module, overriding pkg-config.

**CURSES\_CFLAGS****CURSES\_LIBS**

C compiler and linker flags for libncurses or libncursesw, used by curses module, overriding pkg-config.

**GDBM\_CFLAGS****GDBM\_LIBS**

C compiler and linker flags for gdbm.

**LIBB2\_CFLAGS****LIBB2\_LIBS**

C compiler and linker flags for libb2 (BLAKE2), used by hashlib module, overriding pkg-config.

**LIBEDIT\_CFLAGS****LIBEDIT\_LIBS**

C compiler and linker flags for libedit, used by readline module, overriding pkg-config.

**LIBFFI\_CFLAGS****LIBFFI\_LIBS**

C compiler and linker flags for libffi, used by ctypes module, overriding pkg-config.

**LIBMPDEC\_CFLAGS****LIBMPDEC\_LIBS**

C compiler and linker flags for libmpdec, used by decimal module, overriding pkg-config.

備

These environment variables have no effect unless `--with-system-libmpdec` is specified.

**LIBLZMA\_CFLAGS****LIBLZMA\_LIBS**

C compiler and linker flags for liblzma, used by lzma module, overriding pkg-config.

**LIBREADLINE\_CFLAGS****LIBREADLINE\_LIBS**

C compiler and linker flags for libreadline, used by readline module, overriding pkg-config.

**LIBSQLITE3\_CFLAGS****LIBSQLITE3\_LIBS**

C compiler and linker flags for libsqlite3, used by sqlite3 module, overriding pkg-config.

**LIBUUID\_CFLAGS**

**LIBUUID\_LIBS**

C compiler and linker flags for libuuid, used by uuid module, overriding pkg-config.

**PANEL\_CFLAGS****PANEL\_LIBS**

C compiler and linker flags for PANEL, overriding pkg-config.

C compiler and linker flags for libpanel or libpanelw, used by curses.panel module, overriding pkg-config.

**TCLTK\_CFLAGS****TCLTK\_LIBS**

C compiler and linker flags for TCLTK, overriding pkg-config.

**ZLIB\_CFLAGS****ZLIB\_LIBS**

C compiler and linker flags for libzlib, used by gzip module, overriding pkg-config.

### 3.3.5 WebAssembly 選項

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

Set build flavor for wasm32-emscripten.

- browser (default): preload minimal stdlib, default MEMFS.
- node: 對 NODERAWFS 和 pthread 支援。

在 3.11 版被加入。

**--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 版被加入。

**--enable-wasm-pthreads**

Turn on pthreads support for WASM.

在 3.11 版被加入。

### 3.3.6 安裝選項

**--prefix**=PREFIX

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

這個值可以在 runtime 使用 `sys.prefix` 取得。

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`.

這個值可以在 runtime 使用 `sys.exec_prefix` 取得

**--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 版被加入。

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

選擇在 Python 安裝時執行的 `ensurepip` 命令：

- `upgrade` (預設): 執行 `python -m ensurepip --altinstall --upgrade` 命令。
- `install`: 執行 `python -m ensurepip --altinstall` 命令；
- `no`: 不要執行 `ensurepip`；

在 3.6 版被加入。

### 3.3.7 Performance options

Configuring Python using `--enable-optimizations --with-lto` (PGO + LTO) is recommended for best performance. The experimental `--enable-bolt` flag can also be used to improve 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.

**備 註**

During the build, you may encounter compiler warnings about profile data not being available for some source files. These warnings are harmless, as only a subset of the code is exercised during profile data acquisition. To disable these warnings on Clang, manually suppress them by adding `-Wno-profile-instr-unprofiled` to `CFLAGS`.

在 3.6 版被加入。

在 3.10 版的變更: 在 GCC 上使用 `-fno-semantic-interposition`。

**PROFILE\_TASK**

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

預設值: `-m test --pgo --timeout=$(TESTTIMEOUT)`。

在 3.8 版被加入。

在 3.13 版的變更: Task failure is no longer ignored silently.

**--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 版被加入。

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

在 3.12 版的變更: Use ThinLTO as the default optimization policy on Clang if the compiler accepts the flag.

**--enable-bolt**

Enable usage of the [BOLT post-link binary optimizer](#) (disabled by default).

BOLT is part of the LLVM project but is not always included in their binary distributions. This flag requires that `llvm-bolt` and `merge-fdata` are available.

BOLT is still a fairly new project so this flag should be considered experimental for now. Because this tool operates on machine code its success is dependent on a combination of the build environment + the other optimization configure args + the CPU architecture, and not all combinations are supported. BOLT versions before LLVM 16 are known to crash BOLT under some scenarios. Use of LLVM 16 or newer for BOLT optimization is strongly encouraged.

The `BOLT_INSTRUMENT_FLAGS` and `BOLT_APPLY_FLAGS` **configure** variables can be defined to override the default set of arguments for `llvm-bolt` to instrument and apply BOLT data to binaries, respectively.

在 3.12 版被加入。

**BOLT\_APPLY\_FLAGS**

Arguments to `llvm-bolt` when creating a [BOLT optimized binary](#).

在 3.12 版被加入。

**BOLT\_INSTRUMENT\_FLAGS**

Arguments to `llvm-bolt` when instrumenting binaries.

在 3.12 版被加入。

**--with-computed-gotos**

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

**--without-mimalloc**

Disable the fast mimalloc allocator (enabled by default).

另請參閱 [PYTHONMALLOC](#) 環境變數。

**--without-pymalloc**

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

另請參閱 [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.

不要定義 `WITH_DOC_STRINGS` 巨集。

請見 `PyDoc_STRVAR()` 巨集。

**--enable-profiling**

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

**--with-strict-overflow**

Add `-fstrict-overflow` to the C compiler flags (by default we add `-fno-strict-overflow` instead).

### 3.3.8 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.
- 新增 `d` 到 `sys.abiflags`.
- 新增 `sys.gettotalrefcount()` 函式。
- 新增 `-X showrefcount` 命令列選項。
- Add `-d` command line option and `PYTHONDEBUG` environment variable to debug the parser.
- 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.
- 定義 `Py_DEBUG` 和 `Py_REF_DEBUG` 巨集。
- 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).

### 3.3.9 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).

效果:

- 定義 `Py_TRACE_REFS` 巨集。
- 新增 `sys.getobjects()` 函式。
- 新增 `PYTHONDUMPREFS` 環境變數。

The `PYTHONDUMPREFS` environment variable can be used to dump objects and reference counts still alive at Python exit.

Statically allocated objects are not traced.

在 3.8 版被加入。

在 3.13 版的變更: This build is now ABI compatible with release build and *debug build*.

#### **--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 版被加入。

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

啟用 Valgrind 支援 (預設不啟用)。

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

啟用 DTrace 支援 (預設不啟用)。

See Instrumenting CPython with DTrace and SystemTap.

在 3.6 版被加入。

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

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

在 3.6 版被加入。

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

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

在 3.6 版被加入。

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

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

在 3.6 版被加入。

#### **--with-thread-sanitizer**

Enable ThreadSanitizer data race detector, `tsan` (default is no).

在 3.13 版被加入。

### 3.3.10 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 版被加入。

### 3.3.11 函式庫選項

#### **--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-libmpdec**

Build the `_decimal` extension module using an installed `mpdecimal` library, see the `decimal` module (default is yes).

在 3.3 版被加入。

在 3.13 版的變更: Default to using the installed `mpdecimal` library.

Deprecated since version 3.13, will be removed in version 3.15: A copy of the `mpdecimal` library sources will no longer be distributed with Python 3.15.

**也參考**

`LIBMPDEC_CFLAGS` and `LIBMPDEC_LIBS`.

**--with-readline=readline|editline**

Designate a backend library for the `readline` module.

- `readline`: Use `readline` as the backend.
- `editline`: Use `editline` as the backend.

在 3.10 版被加入。

**--without-readline**

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

不要定義 `HAVE_LIBREADLINE` 巨集。

在 3.10 版被加入。

**--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 版被加入。

**--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 版被加入。

## 3.3.12 Security Options

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

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

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



在 3.4 版被加入。

在 3.11 版被加入: `siphash13` is added and it is the new default.

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

建雜模組:

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

在 3.9 版被加入。

**--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

請見 `ssl` 模組。

在 3.7 版被加入。

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

### 3.3.13 macOS 選項

See [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.

選項:

- 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).

**--with-app-store-compliance**

**--with-app-store-compliance=PATCH-FILE**

The Python standard library contains strings that are known to trigger automated inspection tool errors when submitted for distribution by the macOS and iOS App Stores. If enabled, this option will apply the list of patches that are known to correct app store compliance. A custom patch file can also be specified. This option is disabled by default.

在 3.13 版被加入。

### 3.3.14 iOS Options

See `iOS/README.rst`.

**--enable-framework=INSTALLDIR**

Create a Python.framework. Unlike macOS, the `INSTALLDIR` argument specifying the installation path is mandatory.

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

Specify the name for the framework (default: Python).

### 3.3.15 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 版被加入。

**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
```

**HOSTRUNNER**

Program to run CPython for the host platform for cross-compilation.

在 3.11 版被加入。

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
```

## 3.4 Python Build System

### 3.4.1 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;

### 3.4.2 主要建置步驟

- 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`).

### 3.4.3 主要 Makefile 目標

#### make

For the most part, when rebuilding after editing some code or refreshing your checkout from upstream, all you need to do is execute `make`, which (per Make's semantics) builds the default target, the first one defined in the `Makefile`. By tradition (including in the CPython project) this is usually the `all` target. The `configure` script expands an `autoconf` variable, `@DEF_MAKE_ALL_RULE@` to describe precisely which targets `make all` will build. The three choices are:

- `profile-opt` (configured with `--enable-optimizations`)
- `build_wasm` (configured with `--with-emscripten-target`)
- `build_all` (configured without explicitly using either of the others)

Depending on the most recent source file changes, `Make` will rebuild any targets (object files and executables) deemed out-of-date, including running `configure` again if necessary. Source/target dependencies are many and maintained manually however, so `Make` sometimes doesn't have all the information necessary to correctly detect all targets which need to be rebuilt. Depending on which targets aren't rebuilt, you might experience a number of problems. If you have build or test problems which you can't otherwise explain, `make clean && make` should work around most dependency problems, at the expense of longer build times.

### make platform

Build the `python` program, but don't build the standard library extension modules. This generates a file named `platform` which contains a single line describing the details of the build platform, e.g., `macosx-14.3-arm64-3.12` or `linux-x86_64-3.13`.

### 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 clean

Remove built files.

### make distclean

In addition to the work done by `make clean`, remove files created by the configure script. `configure` will have to be run before building again.<sup>1</sup>

### make install

Build the `all` target and install Python.

### make test

Build the `all` target and run the Python test suite with the `--fast-ci` option. Variables:

- `TESTOPTS`: additional `regtest` command-line options.
- `TESTPYTHONOPTS`: additional Python command-line options.
- `TESTTIMEOUT`: timeout in seconds (default: 10 minutes).

### make buildbottest

This is similar to `make test`, but uses the `--slow-ci` option and default timeout of 20 minutes, instead of `--fast-ci` option.

### make regen-all

Regenerate (almost) all generated files. These include (but are not limited to) bytecode cases, and parser generator file. `make regen-stdlib-module-names` and `autoconf` must be run separately for the remaining *generated files*.

---

<sup>1</sup> `git clean -fdx` is an even more extreme way to "clean" your checkout. It removes all files not known to Git. When bug hunting using `git bisect`, this is recommended between probes to guarantee a completely clean build. **Use with care**, as it will delete all files not checked into Git, including your new, uncommitted work.

### 3.4.4 C 擴充模組

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

- 如果定義了 `Py_BUILD_CORE_MODULE`, 則使用 `Py_EXPORTED_SYMBOL`
- 否則使用 `Py_IMPORTED_SYMBOL`。

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.

## 3.5 Compiler and linker flags

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

### 3.5.1 Preprocessor flags

#### CONFIGURE\_CPPFLAGS

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

在 3.6 版被加入。

#### 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 to be able to build extension modules using the directories specified in the environment variables.

#### BASECPPFLAGS

在 3.4 版被加入。

**PY\_CPPFLAGS**

Extra preprocessor flags added for building the interpreter object files.

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

在 3.2 版被加入。

### 3.5.2 編譯器旗標

**CC**

C 編譯器指令。

Example: `gcc -pthread`.

**CXX**

C++ 編譯器指令。

範例: `g++ -pthread`。

**CFLAGS**

C 編譯器旗標。

**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 `CFLAGS` once Python is installed ([gh-65320](#)).

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 版被加入。

**COMPILEALL\_OPTS**

Options passed to the `compileall` command line when building PYC files in `make install`. Default: `-j0`.

在 3.12 版被加入。

**EXTRA\_CFLAGS**

額外的 C 編譯器旗標。

**CONFIGURE\_CFLAGS**

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

在 3.2 版被加入。

**CONFIGURE\_CFLAGS\_NODIST**

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

在 3.5 版被加入。

**BASECFLAGS**

基本編譯器旗標。

**OPT**

最佳化旗標。

**CFLAGS\_ALIASING**

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

在 3.7 版被加入。

**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 版被加入。

**PY\_STDMODULE\_CFLAGS**

C flags used for building the interpreter object files.

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

在 3.7 版被加入。

**PY\_CORE\_CFLAGS**

Default: `$(PY_STDMODULE_CFLAGS) -DPy_BUILD_CORE`.

在 3.2 版被加入。

**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 版被加入。

**PURIFY**

Purify command. Purify is a memory debugger program.

Default: empty string (not used).

### 3.5.3 Linker flags

**LINKCC**

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

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

**CONFIGURE\_LDFLAGS**

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

Avoid assigning `CFLAGS`, `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 版被加入。

**LDFLAGS\_NODIST**

`LDFLAGS_NODIST` is used in the same manner as `CFLAGS_NODIST`. Use it when a linker flag should *not* be part of `LDFLAGS` once Python is installed (gh-65320).

In particular, `LDFLAGS` 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 `LDFLAGS` would take precedence over user- and package-supplied `-L` flags.

**CONFIGURE\_LDFLAGS\_NODIST**

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

在 3.8 版被加入。

**LDFLAGS**

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

Both `CPPFLAGS` and `LDFLAGS` need to contain the shell's value 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.

範例: `-lrt`。

**LDSHARED**

Command to build a shared library.

預設值: `@LDSHARED@ $(PY_LDFLAGS)`。

**BLDSHARED**

Command to build `libpython` shared library.

預設值: `@BLDSHARED@ $(PY_CORE_LDFLAGS)`。

**PY\_LDFLAGS**

預設值: `$(CONFIGURE_LDFLAGS) $(LDFLAGS)`。

**PY\_LDFLAGS\_NODIST**

預設值: `$(CONFIGURE_LDFLAGS_NODIST) $(LDFLAGS_NODIST)`。

在 3.8 版被加入。

**PY\_CORE\_LDFLAGS**

Linker flags used for building the interpreter object files.

在 3.8 版被加入。



---

# 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 3.13 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.

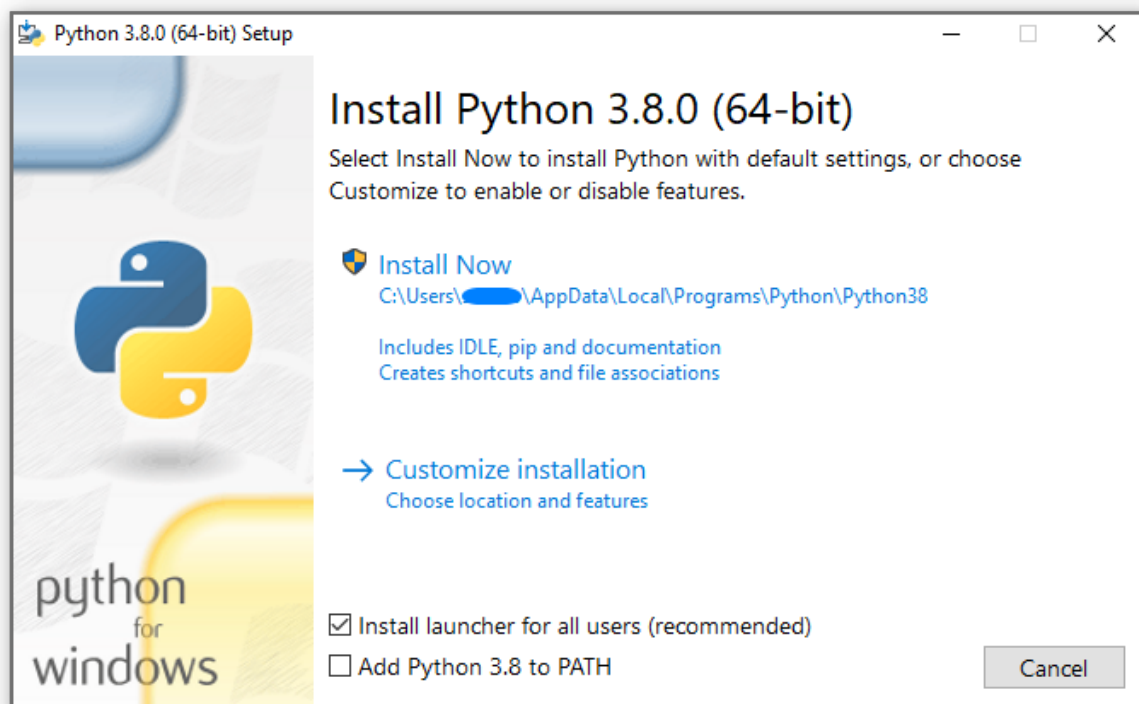
*The embeddable package* is a minimal package of Python suitable for embedding into a larger application.

## 4.1 The full installer

### 4.1.1 安裝步驟

Four Python 3.13 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.

The following options (found by executing the installer with `/?`) can be passed into the installer:

名 稱	描 述
<code>/passive</code>	to display progress without requiring user interaction
<code>/quiet</code>	to install/uninstall without displaying any UI
<code>/simple</code>	to prevent user customization
<code>/uninstall</code>	to remove Python (without confirmation)
<code>/layout [directory]</code>	to pre-download all components
<code>/log [filename]</code>	to specify log files location

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.

名徵	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 或 %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 或 %LocalAppData%\Programs\Python\PythonXY-32 或 %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
IncludeDoc	安裝 Python 文件	1
IncludeDebug	Install debug binaries	0
IncludeDev	Install developer headers and libraries. Omitting this may lead to an unusable installation.	1
IncludeExe	Install python.exe and related files. Omitting this may lead to an unusable installation.	1
IncludeLauncher	安裝 <i>Python Launcher for Windows</i> 。	1
InstallLauncherAllUsers	Installs the launcher for all users. Also requires Include_launcher to be set to 1	1
IncludeLib	Install standard library and extension modules. Omitting this may lead to an unusable installation.	1
IncludePip	Install bundled pip and setup tools	1
IncludeSym	Install debugging symbols (*.pdb)	0
IncludeTclTk	Install Tcl/Tk support and IDLE	1
IncludeTest	Install standard library test suite	1
IncludeTools	Install utility scripts	1
LauncherC	Only installs the launcher. This will override most other options.	0

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.

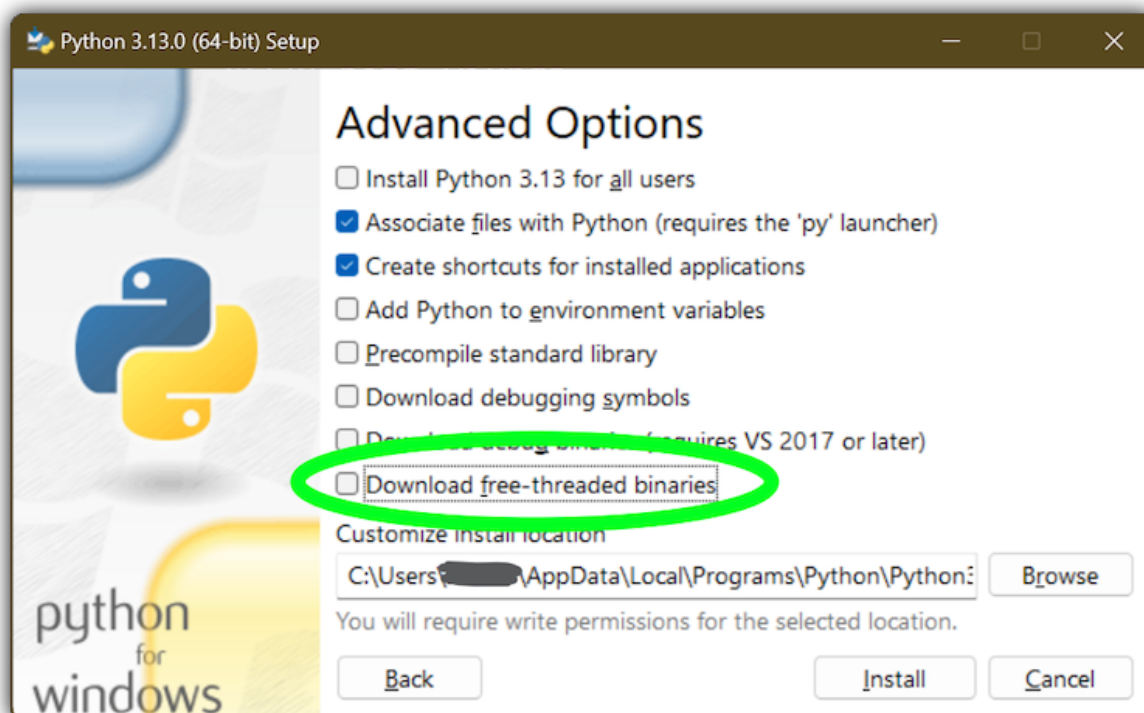
## 4.1.6 Installing Free-threaded Binaries

在 3.13 版被加入: (Experimental)

備 F

Everything described in this section is considered experimental, and should be expected to change in future releases.

To install pre-built binaries with free-threading enabled (see [PEP 703](#)), you should select "Customize installation". The second page of options includes the "Download free-threaded binaries" checkbox.



Selecting this option will download and install additional binaries to the same location as the main Python install. The main executable is called `python3.13t.exe`, and other binaries either receive a `t` suffix or a full ABI suffix. Python source files and bundled third-party dependencies are shared with the main install.

The free-threaded version is registered as a regular Python install with the tag `3.13t` (with a `-32` or `-arm64` suffix as normal for those platforms). This allows tools to discover it, and for the *Python Launcher for Windows* to support `py.exe -3.13t`. Note that the launcher will interpret `py.exe -3` (or a `python3` shebang) as "the latest 3.x install", which will prefer the free-threaded binaries over the regular ones, while `py.exe -3.13` will not. If you use the short style of option, you may prefer to not install the free-threaded binaries at this time.

To specify the install option at the command line, use `Include_freethreaded=1`. See [當安裝時不下載](#) for instructions on pre-emptively downloading the additional binaries for offline install. The options to include debug symbols and binaries also apply to the free-threaded builds.

Free-threaded binaries are also available [on nuget.org](https://nuget.org).

## 4.2 The Microsoft Store package

在 3.7.2 版被加入。

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 3.13". 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 `3.13`). 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\VS\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)
'C:\\Users\\example\\AppData\\Local\\Packages\\PythonSoftwareFoundation.Python.3.8_
↪qbz5n2kfra8p0\\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 版被加入.

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, [www.nuget.org/packages/pythonx86](https://www.nuget.org/packages/pythonx86) for the 32-bit version, and [www.nuget.org/packages/pythonarm64](https://www.nuget.org/packages/pythonarm64) for the ARM64 version



### 4.3.1 Free-threaded packages

在 3.13 版被加入: (Experimental)

#### 備

Everything described in this section is considered experimental, and should be expected to change in future releases.

Packages containing free-threaded binaries are named `python-freethreaded` for the 64-bit version, `pythonx86-freethreaded` for the 32-bit version, and `pythonarm64-freethreaded` for the ARM64 version. These packages contain both the `python3.13t.exe` and `python.exe` entry points, both of which run free threaded.

## 4.4 The embeddable package

在 3.5 版被加入.

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

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

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 版被加入。

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 F

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 版被加入。

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 3.13) you will have noticed that Python 3.13 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 版被加入。

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 or an active virtual environment 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. If a virtual environment is active, the version will be ignored and the environment will be used.

在 3.7 版被加入: 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.

在 3.13 版的變更: Virtual commands referencing `python` now prefer an active virtual environment rather than searching `PATH`. This handles cases where the shebang specifies `/usr/bin/env python3` but `python3.exe` is not present in the active environment.

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.

舉例來：



- 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.

名徵	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 找尋模組

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.

最終這所有的結果圖：

- 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 set `PyConfig.module_search_paths` before `Py_InitializeFromConfig()`.
- 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 額外的模組

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 檔 (Registry)
- 事件日 (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 在 Mac 的 macOS 上執行和在其他 Unix 平台上執行的原理非常相似，但值得一提的是在 macOS 上有其他額外的功能，例如整合開發環境 (IDE) 與套件管理。

## 5.1 取得和安裝 Python

macOS 自 10.8 版本開始至 12.3 版本之間預設安裝 Python 2.7。你也可以到 [Python 網站](#) 安裝最新的 Python 3 版本。你可以找到建立在“通用二進位 (universal2 binary)”上的 Python 建置版本，它能原生地運行在 Mac 新的 Apple Silicon CPU 與過去的 Intel CPU 上。

在安裝後你必須要做幾件事：

- 會有一個 Python 3.13 資料夾在你的 Applications 資料夾中。在這你可以找到 IDLE，它是作官方 Python 發行版標準組成的開發環境；以及 **Python Launcher**，它負責處理在 Finder 中雙擊 Python 腳本的操作。
- `/Library/Frameworks/Python.framework` 框架，包括 Python 可執行檔案 (executable) 和函式庫 (library)。安裝程式將此位置新增到 shell 路徑。要解除安裝 Python，你可以移除這三個專案。Python 可執行檔案的符號連結 (symlink) 則放在 `/usr/local/bin/` 中。

### 備註

在 macOS 10.8-12.3，Apple 提供的 Python 建置版本分安裝在 `/System/Library/Frameworks/Python.framework` 和 `/usr/bin/python` 中。你不應該去修改或刪除這些內容，因為它們由 Apple 控制且被 Apple 或第三方軟體使用。請記住，如果你選擇從 [python.org](#) 安裝較新的 Python 版本，那麼你的計算機上將安裝兩個不同但都可運作的 Python，因此你的路徑和用法與你想要執行的操作一致非常重要。

IDLE 包含一個幫助 (Help) 選單，讓你可以參閱 Python 文件。如果你是 Python 的新手，你應該開始閱讀該文件中的教學介紹。

如果你熟悉其他 Unix 平臺上的 Python，那麼你應該閱讀有關從 Unix shell 執行 Python 腳本的部分。

### 5.1.1 如何執行 Python 本

在 macOS 上開始使用 Python 的最佳方法是透過 IDLE 整合開發環境；參見整合化開發工具 (IDE) 部分，在 IDE 執行時使用幫助選單。

如果要從終端機視窗命令列或 Finder 執行 Python 本，首先需要一個編輯器來建立本。macOS 附帶了許多標準的 Unix 命令列編輯器，如 **vim** 和 **nano**。如果你想要一個更 Mac 化的編輯器，那來自 Bare Bones Software 的 **BBEdit**（參見 <http://www.barebones.com/products/bbedit/index.html>）是不錯的選擇，**TextMate**（參見 <https://macromates.com/>）也是個選擇。其他編輯器包括 **MacVim** (<https://macvim.org>) 和 **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：

- 把它拖曳到 **Python Launcher**
- 透過 finder Info 視窗選擇 **Python Launcher** 作開本（或任何 `.py` 本）的預設應用程式，然後雙擊本。**Python Launcher** 有各種用來控制本動方式的選項。拖曳選項可以讓你一次更改多個選項，或使用其偏好設定選單以全域性地更改容。

### 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

macOS 上的 Python 遵循所有標準的 Unix 環境變數，例如 `PYTHONPATH`，但是 Finder 動的程式設定這些變數非是標準做法，因 Finder 在動時不會讀取你的 `.profile` 或 `.cshrc`。你需要建立一個檔案 `~/MacOSX/environment.plist`。相關資訊請參 Apple 的技術問答集 QA1067。

更多關於安裝 Python 套件的資訊，參安裝額外的 Python 套件 部分。

## 5.2 整合化開發工具 (IDE)

Python 附帶標準的 IDLE 開發環境。有關使用 IDLE 的詳細介紹，請見 [https://www.hashcollision.org/hkn/python/ide\\_intro/index.html](https://www.hashcollision.org/hkn/python/ide_intro/index.html)。

## 5.3 安裝額外的 Python 套件

這個章節已經被移動到 [Python Packaging User Guide](#)。

## 5.4 開發 GUI 程式

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 結 (binding)，這是大多數現代 Mac 開發的基礎。有關 *PyObjC* 的資訊，請見 [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 macOS 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。

有許多替代 macOS GUI 工具套件可用：

- **PySide**：Qt GUI 工具包的官方 Python 結。
- **PyQt**：Qt 的替代 Python 結。
- **Kivy**：一個支援桌面和行動平臺的跨平臺 GUI 工具包。
- **Toga**：BeeWare 專案的一部分；支援桌面、行動、網頁和控制台應用程式。
- **wxPython**：一個支援桌面作業系統的跨平臺工具包。

## 5.5 發行 Python 應用程式

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

- **py2app**：支援從 Python 專案打包成 macOS .app。
- **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**：一個跨平臺打包工具，可以將單一檔案或資料夾打包成可分發的檔案。

### 5.5.1 App Store Compliance

Apps submitted for distribution through the macOS App Store must pass Apple's app review process. This process includes a set of automated validation rules that inspect the submitted application bundle for problematic code.

The Python standard library contains some code that is known to violate these automated rules. While these violations appear to be false positives, Apple's review rules cannot be challenged. Therefore, it is necessary to modify the Python standard library for an app to pass App Store review.

The Python source tree contains a [patch file](#) that will remove all code that is known to cause issues with the App Store review process. This patch is applied automatically when CPython is configured with the `--with-app-store-compliance` option.

This patch is not normally required to use CPython on a Mac; nor is it required if you are distributing an app *outside* the macOS App Store. It is *only* required if you are using the macOS App Store as a distribution channel.

## 5.6 其他資源

Pythonmac-SIG 郵件清單對於 Mac 上的 Python 使用者和開發者是一個極佳的支援資源：

<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>





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## Using Python on Android

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Python on Android is unlike Python on desktop platforms. On a desktop platform, Python is generally installed as a system resource that can be used by any user of that computer. Users then interact with Python by running a **python** executable and entering commands at an interactive prompt, or by running a Python script.

On Android, there is no concept of installing as a system resource. The only unit of software distribution is an "app". There is also no console where you could run a **python** executable, or interact with a Python REPL.

As a result, the only way you can use Python on Android is in embedded mode—that is, by writing a native Android application, embedding a Python interpreter using `libpython`, and invoking Python code using the Python embedding API. The full Python interpreter, the standard library, and all your Python code is then packaged into your app for its own private use.

The Python standard library has some notable omissions and restrictions on Android. See the API availability guide for details.

### 6.1 Adding Python to an Android app

These instructions are only needed if you're planning to compile Python for Android yourself. Most users should *not* need to do this. Instead, use one of the following tools, which will provide a much easier experience:

- [Briefcase](#), from the BeeWare project
- [Buildozer](#), from the Kivy project
- [Chaquopy](#)
- [pyqtdeploy](#)
- [Termux](#)

If you're sure you want to do all of this manually, read on. You can use the [testbed app](#) as a guide; each step below contains a link to the relevant file.

- Build Python by following the instructions in [Android/README.md](#).
- Add code to your [build.gradle](#) file to copy the following items into your project. All except your own Python code can be copied from `cross-build/HOST/prefix/lib`:
  - In your JNI libraries:

```
* libpython*.*.so
```

- \* `lib*_python.so` (external libraries such as OpenSSL)
  - In your assets:
    - \* `python*.*` (the Python standard library)
    - \* `python*/site-packages` (your own Python code)
- Add code to your app to [extract the assets to the filesystem](#).
- Add code to your app to [start Python in embedded mode](#). This will need to be C code called via JNI.

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## Using Python on iOS

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### Authors

Russell Keith-Magee (2024-03)

Python on iOS is unlike Python on desktop platforms. On a desktop platform, Python is generally installed as a system resource that can be used by any user of that computer. Users then interact with Python by running a **python** executable and entering commands at an interactive prompt, or by running a Python script.

On iOS, there is no concept of installing as a system resource. The only unit of software distribution is an "app". There is also no console where you could run a **python** executable, or interact with a Python REPL.

As a result, the only way you can use Python on iOS is in embedded mode - that is, by writing a native iOS application, and embedding a Python interpreter using `libPython`, and invoking Python code using the Python embedding API. The full Python interpreter, the standard library, and all your Python code is then packaged as a standalone bundle that can be distributed via the iOS App Store.

If you're looking to experiment for the first time with writing an iOS app in Python, projects such as [BeeWare](#) and [Kivy](#) will provide a much more approachable user experience. These projects manage the complexities associated with getting an iOS project running, so you only need to deal with the Python code itself.

## 7.1 Python at runtime on iOS

### 7.1.1 iOS version compatibility

The minimum supported iOS version is specified at compile time, using the `--host` option to `configure`. By default, when compiled for iOS, Python will be compiled with a minimum supported iOS version of 13.0. To use a different minimum iOS version, provide the version number as part of the `--host` argument - for example, `--host=arm64-apple-ios15.4-simulator` would compile an ARM64 simulator build with a deployment target of 15.4.

### 7.1.2 Platform identification

When executing on iOS, `sys.platform` will report as `ios`. This value will be returned on an iPhone or iPad, regardless of whether the app is running on the simulator or a physical device.

Information about the specific runtime environment, including the iOS version, device model, and whether the device is a simulator, can be obtained using `platform.ios_ver()`. `platform.system()` will report `ios` or `iPadOS`, depending on the device.

`os.uname()` reports kernel-level details; it will report a name of Darwin.

### 7.1.3 Standard library availability

The Python standard library has some notable omissions and restrictions on iOS. See the API availability guide for iOS for details.

### 7.1.4 Binary extension modules

One notable difference about iOS as a platform is that App Store distribution imposes hard requirements on the packaging of an application. One of these requirements governs how binary extension modules are distributed.

The iOS App Store requires that *all* binary modules in an iOS app must be dynamic libraries, contained in a framework with appropriate metadata, stored in the `Frameworks` folder of the packaged app. There can be only a single binary per framework, and there can be no executable binary material outside the `Frameworks` folder.

This conflicts with the usual Python approach for distributing binaries, which allows a binary extension module to be loaded from any location on `sys.path`. To ensure compliance with App Store policies, an iOS project must post-process any Python packages, converting `.so` binary modules into individual standalone frameworks with appropriate metadata and signing. For details on how to perform this post-processing, see the guide for [adding Python to your project](#).

To help Python discover binaries in their new location, the original `.so` file on `sys.path` is replaced with a `.framework` file. This file is a text file containing the location of the framework binary, relative to the app bundle. To allow the framework to resolve back to the original location, the framework must contain a `.origin` file that contains the location of the `.framework` file, relative to the app bundle.

For example, consider the case of an import from `foo.bar` import `_whiz`, where `_whiz` is implemented with the binary module `sources/foo/bar/_whiz.abi3.so`, with `sources` being the location registered on `sys.path`, relative to the application bundle. This module *must* be distributed as `Frameworks/foo.bar._whiz.framework/foo.bar._whiz` (creating the framework name from the full import path of the module), with an `Info.plist` file in the `.framework` directory identifying the binary as a framework. The `foo.bar._whiz` module would be represented in the original location with a `sources/foo/bar/_whiz.abi3.framework` marker file, containing the path `Frameworks/foo.bar._whiz/framework/foo.bar._whiz`. The framework would also contain `Frameworks/foo.bar._whiz.framework/foo.bar._whiz.origin`, containing the path to the `.framework` file.

When running on iOS, the Python interpreter will install an `AppleFrameworkLoader` that is able to read and import `.framework` files. Once imported, the `__file__` attribute of the binary module will report as the location of the `.framework` file. However, the `ModuleSpec` for the loaded module will report the `origin` as the location of the binary in the framework folder.

## 7.1.5 Compiler stub binaries

Xcode doesn't expose explicit compilers for iOS; instead, it uses an `xcrun` script that resolves to a full compiler path (e.g., `xcrun --sdk iphoneos clang` to get the `clang` for an iPhone device). However, using this script poses two problems:

- The output of `xcrun` includes paths that are machine specific, resulting in a `sysconfig` module that cannot be shared between users; and
- It results in `CC/CPP/LD/AR` definitions that include spaces. There is a lot of C ecosystem tooling that assumes that you can split a command line at the first space to get the path to the compiler executable; this isn't the case when using `xcrun`.

To avoid these problems, Python provided stubs for these tools. These stubs are shell script wrappers around the underlying `xcrun` tools, distributed in a `bin` folder distributed alongside the compiled iOS framework. These scripts are relocatable, and will always resolve to the appropriate local system paths. By including these scripts in the `bin` folder that accompanies a framework, the contents of the `sysconfig` module becomes useful for end-users to compile their own modules. When compiling third-party Python modules for iOS, you should ensure these stub binaries are on your path.

## 7.2 Installing Python on iOS

### 7.2.1 Tools for building iOS apps

Building for iOS requires the use of Apple's Xcode tooling. It is strongly recommended that you use the most recent stable release of Xcode. This will require the use of the most (or second-most) recently released macOS version, as Apple does not maintain Xcode for older macOS versions. The Xcode Command Line Tools are not sufficient for iOS development; you need a *full* Xcode install.

If you want to run your code on the iOS simulator, you'll also need to install an iOS Simulator Platform. You should be prompted to select an iOS Simulator Platform when you first run Xcode. Alternatively, you can add an iOS Simulator Platform by selecting from the Platforms tab of the Xcode Settings panel.

### 7.2.2 Adding Python to an iOS project

Python can be added to any iOS project, using either Swift or Objective C. The following examples will use Objective C; if you are using Swift, you may find a library like [PythonKit](#) to be helpful.

To add Python to an iOS Xcode project:

1. Build or obtain a Python `XCframework`. See the instructions in [iOS/README.rst](#) (in the CPython source distribution) for details on how to build a Python `XCframework`. At a minimum, you will need a build that supports `arm64-apple-ios`, plus one of either `arm64-apple-ios-simulator` or `x86_64-apple-ios-simulator`.
2. Drag the `XCframework` into your iOS project. In the following instructions, we'll assume you've dropped the `XCframework` into the root of your project; however, you can use any other location that you want by adjusting paths as needed.
3. Drag the `iOS/Resources/dylib-Info-template.plist` file into your project, and ensure it is associated with the app target.
4. Add your application code as a folder in your Xcode project. In the following instructions, we'll assume that your user code is in a folder named `app` in the root of your project; you can use any other location by adjusting paths as needed. Ensure that this folder is associated with your app target.
5. Select the app target by selecting the root node of your Xcode project, then the target name in the sidebar that appears.
6. In the "General" settings, under "Frameworks, Libraries and Embedded Content", add `Python.xcframework`, with "Embed & Sign" selected.

7. In the "Build Settings" tab, modify the following:

- Build Options
  - User Script Sandboxing: No
  - Enable Testability: Yes
- Search Paths
  - Framework Search Paths: \$(PROJECT\_DIR)
  - Header Search Paths: "\$(BUILT\_PRODUCTS\_DIR)/Python.framework/Headers"
- Apple Clang - Warnings - All languages
  - Quoted Include In Framework Header: No

8. Add a build step that copies the Python standard library into your app. In the "Build Phases" tab, add a new "Run Script" build step *before* the "Embed Frameworks" step, but *after* the "Copy Bundle Resources" step. Name the step "Install Target Specific Python Standard Library", disable the "Based on dependency analysis" checkbox, and set the script content to:

```
set -e

mkdir -p "$CODESIGNING_FOLDER_PATH/python/lib"
if [ "$EFFECTIVE_PLATFORM_NAME" = "-iphonesimulator" ]; then
    echo "Installing Python modules for iOS Simulator"
    rsync -au --delete "$PROJECT_DIR/Python.xcframework/ios-arm64_x86_64-
    ↪imulator/lib/" "$CODESIGNING_FOLDER_PATH/python/lib/"
else
    echo "Installing Python modules for iOS Device"
    rsync -au --delete "$PROJECT_DIR/Python.xcframework/ios-arm64/lib/" "
    ↪$CODESIGNING_FOLDER_PATH/python/lib/"
fi
```

Note that the name of the simulator "slice" in the XCframework may be different, depending the CPU architectures your XCFramework supports.

9. Add a second build step that processes the binary extension modules in the standard library into "Framework" format. Add a "Run Script" build step *directly after* the one you added in step 8, named "Prepare Python Binary Modules". It should also have "Based on dependency analysis" unchecked, with the following script content:

```
set -e

install_dylib () {
    INSTALL_BASE=$1
    FULL_EXT=$2

    # The name of the extension file
    EXT=$(basename "$FULL_EXT")
    # The location of the extension file, relative to the bundle
    RELATIVE_EXT=${FULL_EXT#$CODESIGNING_FOLDER_PATH/}
    # The path to the extension file, relative to the install base
    PYTHON_EXT=${RELATIVE_EXT/$INSTALL_BASE/}
    # The full dotted name of the extension module, constructed from the file
    ↪path.
    FULL_MODULE_NAME=$(echo $PYTHON_EXT | cut -d "." -f 1 | tr "/" ".");
    # A bundle identifier; not actually used, but required by Xcode framework
    ↪packaging
    FRAMEWORK_BUNDLE_ID=$(echo $PRODUCT_BUNDLE_IDENTIFIER.$FULL_MODULE_NAME |
    ↪tr "_" "-")
    # The name of the framework folder.
    FRAMEWORK_FOLDER="Frameworks/$FULL_MODULE_NAME.framework"

    # If the framework folder doesn't exist, create it.
```

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(繼續上一頁)

```

if [ ! -d "$CODESIGNING_FOLDER_PATH/$FRAMEWORK_FOLDER" ]; then
    echo "Creating framework for $RELATIVE_EXT"
    mkdir -p "$CODESIGNING_FOLDER_PATH/$FRAMEWORK_FOLDER"
    cp "$CODESIGNING_FOLDER_PATH/dylib-Info-template.plist" "$CODESIGNING_
→FOLDER_PATH/$FRAMEWORK_FOLDER/Info.plist"
    plutil -replace CFBundleExecutable -string "$FULL_MODULE_NAME" "
→$CODESIGNING_FOLDER_PATH/$FRAMEWORK_FOLDER/Info.plist"
    plutil -replace CFBundleIdentifier -string "$FRAMEWORK_BUNDLE_ID" "
→$CODESIGNING_FOLDER_PATH/$FRAMEWORK_FOLDER/Info.plist"
fi

echo "Installing binary for $FRAMEWORK_FOLDER/$FULL_MODULE_NAME"
mv "$FULL_EXT" "$CODESIGNING_FOLDER_PATH/$FRAMEWORK_FOLDER/$FULL_MODULE_
→NAME"
# Create a placeholder .fwork file where the .so was
echo "$FRAMEWORK_FOLDER/$FULL_MODULE_NAME" > ${FULL_EXT%.so}.fwork
# Create a back reference to the .so file location in the framework
echo "${RELATIVE_EXT%.so}.fwork" > "$CODESIGNING_FOLDER_PATH/$FRAMEWORK_
→FOLDER_PATH/$FULL_MODULE_NAME.origin"
}

PYTHON_VER=$(ls -l "$CODESIGNING_FOLDER_PATH/python/lib")
echo "Install Python $PYTHON_VER standard library extension modules..."
find "$CODESIGNING_FOLDER_PATH/python/lib/$PYTHON_VER/lib-dynload" -name "*.so
→" | while read FULL_EXT; do
    install_dylib python/lib/$PYTHON_VER/lib-dynload/ "$FULL_EXT"
done

# Clean up dylib template
rm -f "$CODESIGNING_FOLDER_PATH/dylib-Info-template.plist"

echo "Signing frameworks as $EXPANDED_CODE_SIGN_IDENTITY_NAME ($EXPANDED_CODE_
→SIGN_IDENTITY)..."
find "$CODESIGNING_FOLDER_PATH/Frameworks" -name "*.framework" -exec /usr/bin/
→codesign --force --sign "$EXPANDED_CODE_SIGN_IDENTITY" ${OTHER_CODE_SIGN_
→FLAGS:-} -o runtime --timestamp=none --preserve-metadata=identifier,
→entitlements,flags --generate-entitlement-der "{}" \;

```

10. Add Objective C code to initialize and use a Python interpreter in embedded mode. You should ensure that:

- UTF-8 mode is *enabled*;
- Buffered stdio is *disabled*;
- Writing bytecode is *disabled*;
- Signal handlers are *enabled*;
- PYTHONHOME for the interpreter is configured to point at the python subfolder of your app's bundle; and
- The PYTHONPATH for the interpreter includes:
  - the python/lib/python3.X subfolder of your app's bundle,
  - the python/lib/python3.X/lib-dynload subfolder of your app's bundle, and
  - the app subfolder of your app's bundle

Your app's bundle location can be determined using `[[NSBundle mainBundle] resourcePath]`.

Steps 8, 9 and 10 of these instructions assume that you have a single folder of pure Python application code, named app. If you have third-party binary modules in your app, some additional steps will be required:

- You need to ensure that any folders containing third-party binaries are either associated with the app target, or copied in as part of step 8. Step 8 should also purge any binaries that are not appropriate for the platform a specific build is targeting (i.e., delete any device binaries if you're building an app targeting the simulator).
- Any folders that contain third-party binaries must be processed into framework form by step 9. The invocation of `install_dylib` that processes the `lib-dynload` folder can be copied and adapted for this purpose.
- If you're using a separate folder for third-party packages, ensure that folder is included as part of the `PYTHONPATH` configuration in step 10.

## 7.3 App Store Compliance

The only mechanism for distributing apps to third-party iOS devices is to submit the app to the iOS App Store; apps submitted for distribution must pass Apple's app review process. This process includes a set of automated validation rules that inspect the submitted application bundle for problematic code.

The Python standard library contains some code that is known to violate these automated rules. While these violations appear to be false positives, Apple's review rules cannot be challenged; so, it is necessary to modify the Python standard library for an app to pass App Store review.

The Python source tree contains a [patch file](#) that will remove all code that is known to cause issues with the App Store review process. This patch is applied automatically when building for iOS.



## CHAPTER 8

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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) 內部, 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。
- 創建常數 Ellipsis。

**abstract base class (抽象基底類)**

抽象基底類 (又稱 ABC) 提供了一種定義介面的方法, 作 *duck-typing* (鴨子型) 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 用擬的 subclass (子類), 它們不繼承自另一個 class (類), 但仍可被 `isinstance()` 及 `issubclass()` 辨識; 請參 `abc` 模組的說明文件。Python 有許多建立的 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 (釋)**

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

在執行環境 (runtime), 區域變數的釋無法被存取, 但全域變數、class 屬性和函式的解, 會分被儲存在模組、class 和函式的 `__annotations__` 特殊屬性中。

請參 *variable annotation*、*function annotation*、**PEP 484** 和 **PEP 526**, 這些章節皆有此功能的說明。關於釋的最佳實踐方法也請參 `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` 所定義之識別符 (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 (二進位檔案)

一個能讀取和寫入 *bytes-like objects* (類位元組串物件) 的 *file object* (檔案物件)。二進位檔案的例子有: 以二進位模式 ('rb'、'wb' 或 'rb+') 開的檔案、`sys.stdin.buffer`、`sys.stdout.buffer`, 以及 `io.BytesIO` 和 `gzip.GzipFile` 實例。

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)

在 Python 的 C API 中，借用參照是一個對物件的參照，其中使用該物件的程式碼不擁有這個參照。如果該物件被銷毀，它會成一個迷途指標 (dangling pointer)。例如，一次垃圾回收 (garbage collection) 可以移除對物件的最後一個 *strong reference* (參照)，而將該物件銷毀。

對 *borrowed reference* 呼叫 `Py_INCREF()` 以將它原地 (in-place) 轉成 *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位資料的各種運算；這些運算包括壓縮、儲存至二進位檔案和透過 `socket` (插座) 發送。

有些運算需要二進位資料是可變的。明文文件通常會將這些物件稱「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位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* (擬機器) 上，該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 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` 模組的明文文件中找到。

### 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。複數就是複數單位 ( $-1$  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  $3+1j$ 。若要將 `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，那你幾乎能確定你可以安全地忽略它們。

### context manager (情境管理器)

一個可以控制 `with` 陳述式中所見環境的物件，而它是透過定義 `__enter__()` 和 `__exit__()` `method` 來控制的。請參 [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 `contextvars`。

**contiguous (連續的)**

如果一個緩衝區是 *C-contiguous* 或是 *Fortran contiguous*，則它會確切地被視爲是連續的。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 [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，可能包含 `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](http://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，被應用一種函式的變 (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，請參函式定義和 class 定義的說明文件。

**descriptor (描述器)**

任何定義了 `__get__()`、`__set__()` 或 `__delete__()` method 的物件。當一個 class 屬性是一個描述器時，它的特殊連結行會在屬性查找時被觸發。通常，使用 `a.b` 來取得、設定或除某個屬性時，會在 `a` 的 class 字典中查找名稱 `b` 的物件，但如果 `b` 是一個描述器，則相對應的描述器 method 會被呼叫。對描述器的理解是深入理解 Python 的關鍵，因它們是許多功能的基礎，這些功能包括函式、method、屬性 (property)、class method、態 method，以及對 super class (父類) 的參照。

關於描述器 method 的更多資訊，請參 [descriptors](#) 或描述器使用指南。

**dictionary (字典)**

一個關聯陣列 (associative array)，其中任意的鍵會被映射到值。鍵可以是任何帶有 `__hash__()` 和 `__eq__()` method 的物件。在 Perl 中被稱爲雜 (hash)。

**dictionary comprehension (字典綜合運算)**

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，將處理結果以一個字典回傳。`results = {n: n ** 2 for n in range(10)}` 會生一個字典，它包含了鍵 `n` 映射到值 `n ** 2`。請參 [comprehensions](#)。

**dictionary view (字典檢視)**

從 `dict.keys()`、`dict.values()` 及 `dict.items()` 回傳的物件被稱爲字典檢視。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。若要制將字典檢視轉完整的 list (串列)，須使用 `list(dictview)`。請參 [dict-views](#)。

**docstring (說明字串)**

一個在 class、函式或模組中，作第一個運算式出現的字串文本。雖然它在套件執行時會被忽略，



但它會被編譯器辨識，被放入所屬 class、函式或模組的 `__doc__` 屬性中。由於明字串可以透過省 (introspection) 來覽，因此它是物件的明文件存放的標準位置。

### 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。（「如果它看起來像一鴨子而且叫起來像一鴨子，那它一定是一鴨子。」）因調介面而非特定型，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，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。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「f 字串」，它是格式化的字串文本的縮寫。另請參 PEP 498。

### file object (檔案物件)

一個讓使用者透過檔案導向 (file-oriented) API（如 `read()` 或 `write()` 等 method）來操作底層資源的物件。根據檔案物件被建立的方式，它能協調對真實磁碟檔案或是其他類型的儲存器或通訊裝置（例如標準輸入 / 輸出、記憶體緩衝區、socket（插座）、管 (pipe) 等）的存取。檔案物件也被稱類檔案物件 (file-like object) 或串流 (stream)。

實際上，有三種檔案物件：原始的二進位檔案、緩衝的二進位檔案和文字檔案。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 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）。

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 `importsystem` 和 `importlib` 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` 的計算結果是 `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`，因為是 `-2.75` 被向下無條件舍去。請參 [PEP 238](#)。

**free threading**

A threading model where multiple threads can run Python bytecode simultaneously within the same interpreter. This is in contrast to the *global interpreter lock* which allows only one thread to execute Python bytecode at a time. See [PEP 703](#).

**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 [type hint](#)：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，能生一系列的 `yield` 值，這些值可用於 `for` 圈，或是以 `next()` 函式，每次檢索其中的一個值。

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。該組合運算式會外層函式生多個值：

```
>>> 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 (包括關鍵的建型，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。

As of Python 3.13, the GIL can be disabled using the `--disable-gil` build configuration. After building Python with this option, code must be run with `-X gil 0` or after setting the `PYTHON_GIL=0` environment variable. This feature enables improved performance for multi-threaded applications and makes it easier to use multi-core CPUs efficiently. For more details, see [PEP 703](#).

**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)**

如果一個物件有一個雜值，該值在其生命期中永不改變 (它需要一個 `__hash__()` method)，且可與其他物件互相比較 (它需要一個 `__eq__()` method)，那它就是一個可雜物件。比較結果相等的多個可雜物件，它們必須擁有相同的雜值。

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 不可變建物件都是可雜的；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。

**immortal**

*Immortal objects* are a CPython implementation detail introduced in [PEP 683](#).

If an object is immortal, its *reference count* is never modified, and therefore it is never deallocated while the interpreter is running. For example, `True` and `None` are immortal in CPython.

**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)`）。更多互動式模式相關資訊請見 `tut-interac`。

**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，因為有位元組碼 (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，因為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)**

一種能一次回傳一個其中成員的物件。可代物件的例子包括所有的序列型（像是 `list`、`str` 和 `tuple`）和某些非序列型，像是 `dict`、*檔案物件*，以及你所定義的任何 `class` 物件，只要那些 `class` 有 `__iter__()` method 或是實作 *sequence* (序列) 語意的 `__getitem__()` method，該物件就是可代物件。

可代物件可用於 `for` 圈和許多其他需要一個序列的地方 (`zip()`、`map()`...)。當一個可代物件作引數被傳遞給 `iter()` 時，它會該物件回傳一個代器。此代器適用於針對一組值進行一遍 (*one pass*) 運算。使用代器時，通常不一定要呼叫 `iter()` 或自行處理代器物件。`for` 陳述式會自動地你處理這些事，它會建立一個暫時性的未命名變數，用於在圈期間保有該代器。另請參 *iterator* (代器)、*sequence* (序列) 和 *generator* (生成器)。

**iterator (代器)**

一個表示資料流的物件。重地呼叫代器的 `__next__()` method (或是將它傳遞給 `iter()` 會依序回傳資料流中的各項目。當不再有資料時，則會引發 `StopIteration` 例外。此時，該代器物件已被用盡，而任何對其 `__next__()` method 的進一步呼叫，都只會再次引發 `StopIteration`。代器必須有一個 `__iter__()` method，它會回傳代器物件本身，所以每個代器也都是可代物件，且可以用於大多數適用其他可代物件的場合。一個明顯的例外，是嘗試多遍代 (*multiple iteration passes*) 的程式碼。一個容器物件（像是 `list`）在每次你將它傳遞給 `iter()` 函式或在 `for` 圈中使用它時，都會生一個全新的代器。使用代器嘗試此事（多遍代）時，只會回傳在前一遍代中被用過的、同一個已被用盡的代器物件，使其看起來就像一個空的容器。

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__()`. And also please note that the free-threading CPython does not guarantee the thread-safety of iterator operations.

**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，請參如何排序。

### keyword argument (關鍵字引數)

請參 [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)

一個 Python 建的 *sequence* (序列)。管它的名字是 `list`，它其實更類似其他語言中的一個陣列 (array) 而較不像一個鏈結串列 (linked list)，因存取元素的時間複雜度是  $O(1)$ 。

### 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]` 會生一個字串 `list`，其中包含 0 到 255 範圍，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 [PEP 302](#)，關於 *abstract base class* (抽象基底類)，請參 `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()` 可以用來取得區域編碼。

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 Python 自 2.3 版直譯器所使用的演算法細節，請參 `python_2.3_mro`。

### 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。

有些建型是 `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
```

有些 `named tuple` 是建型 (如上例)。或者，一個 `named tuple` 也可以從一個正規的 `class` 定義來建立，只要該 `class` 是繼承自 `tuple`，且定義了附名欄位 (named field) 即可。這類的 `class` 可以手工編寫、可以繼承自 `typing.NamedTuple` 來建立，也可以使用工廠函式 (factory function) `collections.namedtuple()` 來建立。後者技術也增加了一些額外的 `method`，這些 `method` 可能是在手寫或建的 `named tuple` 中，無法找到的。

### 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。命名空間套件可能有實體的表示法，而且具體來它們不像是一個 *regular package* (正規套件)，因它們有 `__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，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)

一個舊名，它是指現在所有的 `class` 物件所使用的 `class` 風格。在早期的 Python 版本中，只有新式 `class` 才能使用 Python 較新的、多樣的功能，像是 `__slots__`、描述器 (descriptor)、屬性 (property)、`__getattr__()`、`class method` (類方法) 和 `static method` (態方法)。

### 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)。

### optimized scope (最佳化作用域)

A scope where target local variable names are reliably known to the compiler when the code is compiled, allowing optimization of read and write access to these names. The local namespaces for functions, generators, coroutines, comprehensions, and generator expressions are optimized in this fashion. Note: most interpreter optimizations are applied to all scopes, only those relying on a known set of local and nonlocal variable names are restricted to optimized scopes.

### 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)：指明一個可以按照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 `importlib.abc.PathEntryFinder`。

**path entry hook (路徑項目)**

在 `sys.path_hooks` 列表中的一個可呼叫物件 (callable)，若它知道如何在一個特定的 *path entry* 中尋找模組，則會回傳一個 *path entry finder* (路徑項目尋檢器)。

**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為 `str` 或 `bytes` 檔案系統路徑；而 `os.fsdecode()` 及 `os.fsencode()` 則分可用於確保 `str` 及 `bytes` 的結果。由 **PEP 519** 引入。

**PEP**

Python Enhancement Proposal (Python 增提案)。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 **PEP 1**。

**portion (部分)**

在單一中的一組檔案 (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 *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「最後的解方案」——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 **PEP 411** 了解更多細節。

**provisional package (暫行套件)**

請參 *provisional API* (暫行 API)。

**Python 3000**

Python 3.x 系列版本的稱 (很久以前創造的，當時第 3 版的發布是在遠的未來。) 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，對一個可代物件的所有元素進行圈。許多其他語言有這種類型的架構，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 (*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)

The number of references to an object. When the reference count of an object drops to zero, it is deallocated. Some objects are *immortal* and have reference counts that are never modified, and therefore the objects are never deallocated. Reference counting is generally not visible to Python code, but it is a key element of the *CPython* implementation. Programmers can call the `sys.getrefcount()` function to return the reference count for a particular object.

### 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)。

### REPL

An acronym for the “read–eval–print loop”, another name for the *interactive* interpreter shell.

### \_\_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)

一個 *iterable* (可代物件)，它透過 `__getitem__()` special method (特殊方法)，使用整數索引來支援高效率的元素存取，`__len__()` method 來回傳該序列的長度。一些建序列型包括 `list`、`str`、`tuple` 和 `bytes`。請注意，雖然 `dict` 也支援 `__getitem__()` 和 `__len__()`，但它被視為對映 (mapping) 而不是序列，因其查找方式是使用任意的 *hashable* 鍵，而不是整數。

抽象基底類 (abstract base class) `collections.abc.Sequence` 定義了一個更加豐富的介面，不僅止於 `__getitem__()` 和 `__len__()`，還增加了 `count()`、`index()`、`__contains__()` 和 `__reversed__()`。實作此擴充介面的型，可以使用 `register()` 被明確地。更多關於序列方法的文件，請見常見序列操作。

### 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。

**soft deprecated**

A soft deprecation can be used when using an API which should no longer be used to write new code, but it remains safe to continue using it in existing code. The API remains documented and tested, but will not be developed further (no enhancement).

The main difference between a "soft" and a (regular) "hard" deprecation is that the soft deprecation does not imply scheduling the removal of the deprecated API.

Another difference is that a soft deprecation does not issue a warning.

See [PEP 387: Soft Deprecation](#).

**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 (態型檢查器)**

會讀取 Python 程式碼分析的外部工具，能找出錯誤，像是使用了不正確的型。另請參 *提示 (type hints)* 以及 `typing` 模組。

**strong reference (參照)**

在 Python 的 C API 中，參照是對物件的參照，該物件持有該參照的程式碼所擁有。建立參照時透過呼叫 `Py_INCREF()` 來獲得參照、除參照時透過 `Py_DECREF()` 釋放參照。

`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* (二進位檔案)，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有用。

**type (型)**

一個 Python 物件的型定了它是什類型的物件；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。

型提示是選擇性的，而不是被 Python 制的，但它們對態型檢查器 (static type checkers) 很有用，能協助 IDE 完成程式碼的補全 (completion) 和重構 (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。



---

### 關於這些📄明文件

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這些📄明文件是透過 [Sphinx](#)（一個專📄 Python 📄明文件所撰寫的文件處理器）將使用 [reStructuredText](#) 撰寫的原始檔轉📄而成。

如同 Python 自身，透過自願者的努力下📄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，📄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📄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📄 Python 這門語言、Python 標準函式庫和 Python 📄明文件貢獻過。Python 所發📄的原始碼中含有部份貢獻者的清單，請見 [Misc/ACKS](#)。

正因📄 Python 社群的撰寫與貢獻才有這份這📄棒的📄明文件 -- 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。

所有的 Python 版本都是開源的（有關開源的定義，參見 <https://opensource.org/>）。歷史上，大多數但非全部的 Python 版本，也是 GPL 相容的；以下表格總結各個版本的差異。

發行版本	源自	年份	擁有者	GPL 相容性？
0.9.0 至 1.2	不適用	1991-1995	CWI	是
1.3 至 1.5.2	1.2	1995-1999	CNRI	是
1.6	1.5.2	2000	CNRI	否
2.0	1.6	2000	BeOpen.com	否
1.6.1	1.6	2001	CNRI	否
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

## 備註

GPL 相容並不表示我們是在 GPL 下發行 Python。不像 GPL，所有的 Python 授權都可以讓你發行修改後的版本，但不一定要使你的變更成開源。GPL 相容的授權使得 Python 可以結合其他在 GPL 下發

的軟體一起使用；但其它的授權則不行。

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。

## C.2 關於存取或以其他方式使用 Python 的合約條款

Python 軟體和明文件的授權是基於 *PSF* 授權合約。

從 Python 3.8.6 開始，明文件中的範例、程式庫和其他程式碼，是被雙重授權 (dual licensed) 於 PSF 授權合約以及 *Zero-Clause BSD* 授權。

有些被納入 Python 中的軟體是基於不同的授權。這些授權將會與其授權之程式碼一起被列出。關於這些授權的不完整清單，請參被收軟體的授權與致謝。

### C.2.1 用於 PYTHON 3.13.0rc2 的 PSF 授權合約

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### C.3.1 Mersenne Twister

random 模組底下的 `_random` C 擴充程式包含了以 <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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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

socket 模組使用 `getaddrinfo()` 和 `getnameinfo()` 函式，它們在 WIDE 專案 (<https://www.wide.ad.jp/>) 中，於不同的原始檔案中被編碼：

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```

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```
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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.3.10 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。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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除非在建置 pyexpat 擴充時設定 `--with-system-expat`，否則該擴充會用一個含 expat 原始碼的副本來建置：

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### C.3.14 libffi

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### C.3.15 zlib

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### 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.3.19 mimalloc

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