Python Setup and Usage

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Guido van Rossum and the Python development team

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Python Software Foundation Email: docs@python.org

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This part of the documentation is devoted to general information on the setup of the Python environment on different platforms, the invocation of the interpreter and things that make working with Python easier.

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COMMAND LINE AND ENVIRONMENT

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

CPython implementation detail: Other implementations' command line schemes may differ. See implementations for further resources.

1.1 Command line

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

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

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

python myscript.py

1.1.1 Interface options

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

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

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

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

-c <command>

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

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

-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.

Note: 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.

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

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

See also:

runpy.run_module() Equivalent functionality directly available to Python code

PEP 338 - Executing modules as scripts

Changed in version 3.1: Supply the package name to run a __main__ submodule.

Changed in version 3.4: 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.

<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.

See also:

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).

See also:

tut-invoking

Changed in version 3.4: Automatic enabling of tab-completion and history editing.

1.1.2 Generic options

```
-?
```

-h

--help

Print a short description of all command line options.

-V

--version

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

```
Python 3.6.0b2+
```

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

```
Python 3.6.0b2+ (3.6:84a3c5003510+, Oct 26 2016, 02:33:55)
[GCC 6.2.0 20161005]
```

New in version 3.6: The -VV option.

1.1.3 Miscellaneous options

-b

Issue a warning when comparing bytes or bytearray with str or bytes with int. Issue an error when the option is given twice (-bb).

Changed in version 3.5: Affects 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*.

-d

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

-E

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

-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.

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

New in version 3.4.

-0

Turn on basic optimizations. See also PYTHONOPTIMIZE.

-00

Discard docstrings in addition to the -0 optimizations.

-q

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

New in version 3.2.

-R

Kept for compatibility. On Python 3.3 and greater, hash randomization is turned on by default.

On previous versions of Python, this option turns on hash randomization, so that the <code>__hash__()</code> values of str, bytes and datetime 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://www.ocert.org/advisories/ocert-2011-003.html for details.

PYTHONHASHSEED allows you to set a fixed value for the hash seed secret.

New in version 3.2.3.

-s

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

See also:

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 binary layer of the stdout and stderr streams (which is available as their buffer attribute) to be unbuffered. The text I/O layer will still be line-buffered if writing to the console, or block-buffered if redirected to a non-interactive file.

See also PYTHONUNBUFFERED.

-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. See also *PYTHONVERBOSE*.

-W arg

Warning control. Python's warning machinery by default prints warning messages to sys.stderr. A typical warning message has the following form:

file:line: category: message

By default, each warning is printed once for each source line where it occurs. This option controls how often warnings are printed.

Multiple -W options may 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 from within a Python program using the warnings module.

The simplest form of argument is one of the following action strings (or a unique abbreviation):

ignore Ignore all warnings.

default Explicitly request the default behavior (printing each warning once per source line).

all Print a warning each time it occurs (this may generate many messages if a warning is triggered repeatedly for the same source line, such as inside a loop).

module Print each warning only the first time it occurs in each module.

once Print each warning only the first time it occurs in the program.

error Raise an exception instead of printing a warning message.

The full form of argument is:

action:message:category:module:line

Here, action is as explained above but only applies to messages that match the remaining fields. Empty fields match all values; trailing empty fields may be omitted. The message field matches the start of the warning message printed; this match is case-insensitive. The category field matches the warning category. This must be a class name; the match tests whether the actual warning category of the message is a subclass of the specified warning category. The full class name must be given. The module field matches the (fully-qualified) module name; this match is case-sensitive. The line field matches the line number, where zero matches all line numbers and is thus equivalent to an omitted line number.

See also:

warnings - the warnings module

PEP 230 – Warning framework

PYTHONWARNINGS

-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;
- -X showrefcount to output the total reference count and number of used memory blocks when the program finishes or after each statement in the interactive interpreter. This only works on debug builds.
- -X tracemalloc to start tracing Python memory allocations using the tracemalloc module. By default, only the most recent frame is stored in a traceback of a trace. Use -X tracemalloc=NFRAME to start tracing with a traceback limit of NFRAME frames. See the tracemalloc.start() for more information.

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• -X showalloccount to output the total count of allocated objects for each type when the program finishes. This only works when Python was built with COUNT_ALLOCS defined.

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

Changed in version 3.2: The -X option was added.

New in version 3.3: The -X faulthandler option.

New in version 3.4: The -X showrefcount and -X tracemalloc options.

New in version 3.6: The -X showalloccount option.

1.1.4 Options you shouldn't use

-J

Reserved for use by Jython.

1.2 Environment variables

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/python*version* (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 *Interface options*. The search path can be manipulated from within a Python program as the variable sys.path.

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.

PYTHONOPTIMIZE

If this is set to a non-empty string it is equivalent to specifying the -0 option. If set to an integer, it is equivalent to specifying -0 multiple times.

PYTHONDEBUG

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

PYTHONINSPECT

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

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

PYTHONUNBUFFERED

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

PYTHONVERBOSE

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

PYTHONCASEOK

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

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.

PYTHONHASHSEED

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

New in version 3.2.3.

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'.

Changed in version 3.4: The encodingname part is now optional.

Changed in version 3.6: On Windows, the encoding specified by this variable is ignored for interactive console buffers unless <code>PYTHONLEGACYWINDOWSSTDIO</code> 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.

See also:

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 Distutils installation paths for python setup.py install --user.

See also:

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 Mac OS X.

PYTHONWARNINGS

This is equivalent to the -W option. If set to a comma separated string, it is equivalent to specifying -W multiple times.

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.

New in version 3.3.

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() for more information.

New in version 3.4.

PYTHONASYNCIODEBUG

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

New in version 3.4.

PYTHONMALLOC

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

Set the family of memory allocators used by Python:

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

Install debug hooks:

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

When Python is compiled in release mode, the default is pymalloc. When compiled in debug mode, the default is pymalloc_debug and the debug hooks are used automatically.

If Python is configured without pymalloc support, pymalloc and pymalloc_debug are not available, the default is malloc in release mode and malloc debug in debug mode.

See the PyMem_SetupDebugHooks() function for debug hooks on Python memory allocators.

New in version 3.6.

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.

Changed in version 3.6: 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 errors 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().

Availability: Windows

New in version 3.6: See PEP 529 for more details.

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.

Availability: Windows New in version 3.6.

1.2.1 Debug-mode variables

Setting these variables only has an effect in a debug build of Python, that is, if Python was configured with the --with-pydebug build option.

PYTHONTHREADDEBUG

If set, Python will print threading debug info.

PYTHONDUMPREFS

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

CHAPTER

TWO

USING PYTHON ON UNIX PLATFORMS

2.1 Getting and installing the latest version of Python

2.1.1 On Linux

Python comes preinstalled on most Linux distributions, and is available as a package on all others. However there are certain features you might want to use that are not available on your distro's package. You can easily compile the latest version of Python from source.

In the event that Python doesn't come preinstalled and isn't in the repositories as well, you can easily make packages for your own distro. Have a look at the following links:

See also:

https://www.debian.org/doc/manuals/maint-guide/first.en.html for Debian users

https://en.opensuse.org/Portal:Packaging for OpenSuse users

 $https://docs.fedoraproject.org/en-US/Fedora_Draft_Documentation/0.1/html/RPM_Guide/ch-creating-particle for Fedora users$

http://www.slackbook.org/html/package-management-making-packages.html for users

2.1.2 On FreeBSD and OpenBSD

• FreeBSD users, to add the package use:

```
pkg_add -r python
```

• OpenBSD users use:

pkg_add ftp://ftp.openbsd.org/pub/OpenBSD/4.2/packages/<insert your architecture here>/python-

For example i386 users get the 2.5.1 version of Python using:

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

2.1.3 On OpenSolaris

You can get Python from OpenCSW. Various versions of Python are available and can be installed with e.g. pkgutil -i python27.

2.2 Building Python

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 clone. (If you want to contribute patches, you will need a clone.)

The build process consists in the usual

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

invocations. Configuration options and caveats for specific Unix platforms are extensively documented in the README.rst file in the root of the Python source tree.

Warning: make install can overwrite or masquerade the python3 binary. make altinstall is therefore recommended instead of make install since it only installs <code>exec_prefix/bin/pythonversion</code>.

2.3 Python-related paths and files

These are subject to difference depending on local installation conventions; prefix (\${prefix}) and exec_prefix (\${exec_prefix}) are installation-dependent and should be interpreted as for GNU software; they may be the same.

For example, on most Linux systems, the default for both is /usr.

File/directory	Meaning	
exec_prefix/bin/python3	Recommended location of the interpreter.	
<pre>prefix/lib/pythonversion,</pre>	Recommended locations of the directories containing the standard	
<pre>exec_prefix/lib/pythonversion</pre>	modules.	
<pre>prefix/include/pythonversion,</pre>	Recommended locations of the directories containing the include	
<pre>exec_prefix/include/</pre>	files needed for developing Python extensions and embedding the	
pythonversion	interpreter.	

2.4 Miscellaneous

To easily use Python scripts on Unix, you need to make them executable, e.g. with

```
$ chmod +x script
```

and put an appropriate Shebang line at the top of the script. A good choice is usually

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

which searches for the Python interpreter in the whole PATH. However, some Unices may not have the env command, so you may need to hardcode /usr/bin/python3 as the interpreter path.

To use shell commands in your Python scripts, look at the subprocess module.

2.5 Editors and IDEs

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.

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USING PYTHON ON WINDOWS

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

3.1 Installing Python

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 (MSI packages) 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.

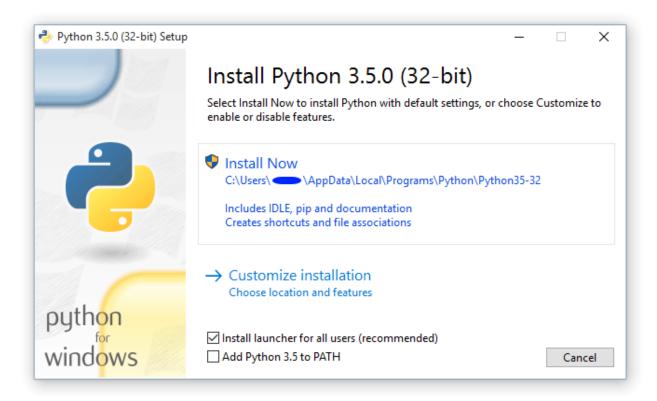
3.1.1 Supported Versions

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 3.6 supports Windows Vista and newer. If you require Windows XP support then please install Python 3.4.

3.1.2 Installation Steps

Four Python 3.6 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 Installing Without Downloading for other ways to avoid downloading during installation.

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



If you select "Install Now":

- 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
- If selected, the install directory will be added to your PATH
- Shortcuts will only be visible for the current user

Selecting "Customize installation" will allow you to select the features to install, the installation location and other options or post-install actions. To install debugging symbols or binaries, you will need to use this option.

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
- Shortcuts are available for all users

3.1.3 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 the registry value HKEY LOCAL MACHINE\SYSTEM\CurrentControlSet\Control\FileSystem@LongPathsEnabled to 1.

This allows the open() function, the os module and most other path functionality to accept and return paths longer than 260 characters when using strings. (Use of bytes as paths is deprecated on Windows, and this feature is not available when using bytes.)

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

Changed in version 3.6: Support for long paths was enabled in Python.

3.1.4 Installing Without UI

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

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

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

Name	Description	Default	
InstallAllUsers	Perform a system-wide installation.	0	
TargetDir	The installation directory	Selected based on InstallAllUsers	
DefaultAl-	The default installation directory for	%ProgramFiles%\Python X.Y or	
lUsersTarget-	all-user installs	%ProgramFiles(x86)%\Python X.Y	
Dir		g a a a a ş	
DefaultJust-	The default install directory for just-for-	%LocalAppData%\Programs\PythonXY or	
ForMeTarget-	me installs	%LocalAppData%\Programs\PythonXY-32	
Dir			
DefaultCus-	The default custom install directory dis-	(empty)	
tomTargetDir	played in the UI		
AssociateFiles	Create file associations if the launcher is	1	
	also installed.		
CompileAll	Compile all .py files to .pyc.	0	
PrependPath	Add install and Scripts directories tho	0	
•	PATH and .PY to PATHEXT		
Shortcuts	Create shortcuts for the interpreter,	1	
	documentation and IDLE if installed.		
Include_doc	Install Python manual	1	
In-	Install debug binaries	0	
clude_debug			
Include dev	Install developer headers and libraries	1	
Include exe	Install python.exe and related files	1	
In-	Install Python Launcher for Windows.	1	
clude_launcher	, and the second		
Install-	Installs Python Launcher for Windows	1	
Launcher-	for all users.		
AllUsers			
Include_lib	Install standard library and extension	1	
	modules		
Include_pip	Install bundled pip and setuptools	1	
In-	Install debugging symbols (*.pdb)	0	
clude_symbols			
Include_tcltk	Install Tcl/Tk support and IDLE	1	
Include_test	Install standard library test suite	1	
Include_tools	Install utility scripts	1	
LauncherOnly Only installs the launcher. This will		0	
	override most other options.		
SimpleInstall	Disable most install UI	0	
SimpleIn-	A custom message to display when the	(empty)	
stallDescrip- simplified install UI is used.			
tion			

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

```
python-3.6.0.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-3.6.0.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 and 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>
```

3.1.5 Installing Without Downloading

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-3.6.0.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-3.6.0.exe /layout [optional target directory]
```

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

3.1.6 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.

3.1.7 Other Platforms

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 still supported.
- The Cygwin installer offers to install the Python interpreter as well (cf. Cygwin package source, Maintainer releases)

See Python for Windows for detailed information about platforms with pre-compiled installers.

See also:

Python on XP "7 Minutes to "Hello World!"" by Richard Dooling, 2006

Installing on Windows in "Dive into Python: Python from novice to pro" by Mark Pilgrim, 2004, ISBN 1-59059-356-1

For Windows users in "Installing Python" in "A Byte of Python" by Swaroop C H, 2003

3.2 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.

Canopy A "comprehensive Python analysis environment" with editors and other development tools.

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.

3.3 Configuring 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*.

3.3.1 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 3.6;%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).

Note: 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 2 and Python 3, so you should not permanently configure this variable unless it only includes code that is compatible with all of your installed Python versions.

See also:

https://support.microsoft.com/kb/100843 Environment variables in Windows NT

https://technet.microsoft.com/en-us/library/cc754250.aspx The SET command, for temporarily modifying environment variables

https://technet.microsoft.com/en-us/library/cc755104.aspx The SETX command, for permanently modifying environment variables

https://support.microsoft.com/kb/310519 How To Manage Environment Variables in Windows XP

 ${\bf https://www.chem.gla.ac.uk/\sim louis/software/faq/q1.html\ \ Setting\ Environment\ variables,\ Louis\ J.\ Farrugia$

3.3.2 Finding the Python executable

Changed in version 3.5.

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 *Command line* 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 3.6

3.4 Python Launcher for Windows

New in version 3.3.

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.

3.4.1 Getting started

From the command-line

Changed in version 3.6.

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:

ру

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., 2.7 and 3.6) you will have noticed that Python 3.6 was started - to launch Python 2.7, try the command:

py -2.7

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

ру -2

You should find the latest version of Python 2.x starts.

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.

Per-user installations of Python do not add the launcher to PATH unless the option was selected on installation.

Virtual environments

New in version 3.5.

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 2.6 installed, try changing the first line to #! python2.6 and you should find the 2.6 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.

From file associations

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.

3.4.2 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 python
- /usr/bin/python
- /usr/local/bin/python
- python

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

#! /usr/bin/python

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

Any of the above virtual commands can be suffixed with an explicit version (either just the major version, or the major and minor version) - for example /usr/bin/python2.7 - which will cause that specific version to be located and used.

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. This corresponds to the behaviour of the Unix env program, which performs a PATH search.

3.4.3 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

3.4.4 Customization

Customization via INI files

Two .ini files will be searched by the launcher - py.ini in the current user's "application data" directory (i.e. the directory returned by calling the Windows function SHGetFolderPath with CSIDL_LOCAL_APPDATA) 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. If the minor qualifier is specified, it may optionally be followed by "-32" to indicate the 32-bit implementation of that version be used.

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 - the default value is "2". Note this value could specify just a major version (e.g. "2") or a major.minor qualifier (e.g. "2.6"), or even major.minor-32.

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" suffix can be used on a version specifier to change this behaviour.

Examples:

- 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 commands python3.1 and python2.7 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=3.1-32, the command python will use the 32-bit implementation of 3.1 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=3.1, the commands python and python3 will both use specifically 3.1

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

For example:

• Setting PY_PYTHON=3.1 is equivalent to the INI file containing:

```
[defaults]
python=3.1
```

• Setting PY_PYTHON=3 and PY_PYTHON3=3.1 is equivalent to the INI file containing:

```
[defaults]
python=3
python3=3.1
```

3.4.5 Diagnostics

If an environment variable PYLAUNCH_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.

3.5 Finding modules

Python usually stores its library (and thereby your site-packages folder) in the installation directory. So, if you had installed Python to C:\Python\, the default library would reside in C:\Python\Lib\ and third-party modules should be stored in C:\Python\Lib\site-packages\.

To completely override <code>sys.path</code>, create a <code>._pth</code> file with the same name as the DLL (<code>python36._pth</code>) or the executable (<code>python._pth</code>) and specify one line for each path to add to <code>sys.path</code>. The file based on the DLL name overrides the one based on the executable, which allows paths to be restricted for any program loading the runtime if desired.

When the file exists, all registry and environment variables are ignored, isolated mode is enabled, and site is not imported unless one line in the file specifies import site. Blank paths and lines starting with # are ignored. Each path may be absolute or relative to the location of the file. Import statements other than to site are not permitted, and arbitrary code cannot be specified.

Note that .pth files (without leading underscore) will be processed normally by the site module.

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 *Environment variables*, 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 <code>PYTHONHOME</code> is set, it is assumed as "Python Home". Otherwise, the path of the main Python executable is used to locate a "landmark file" (either <code>Lib\os.py</code> or <code>pythonXY.zip</code>) to deduce the "Python Home". If a Python home is found, the relevant sub-directories added to <code>sys.path</code> (Lib, <code>plat-win</code>, 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.

The end result of all this is:

- 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 python36.dll in your own executable, explicitly call Py_SetPath() or (at least) Py_SetProgramName() before Py_Initialize().
- Clear and/or overwrite *PYTHONPATH* and set *PYTHONHOME* before launching python.exe from your application.
- If you cannot use the previous suggestions (for example, you are a distribution that allows people to run python.exe directly), ensure that the landmark file (Lib\os.py) exists in your install directory. (Note that it will not be detected inside a ZIP file, but a correctly named ZIP file will be detected instead.)

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

Changed in version 3.6:

- Adds ._pth file support and removes applocal option from pyvenv.cfg.
- Adds pythonXX.zip as a potential landmark when directly adjacent to the executable.

Deprecated since version 3.6: 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.

3.6 Additional modules

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

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

3.6.1 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 calls
- Registry
- 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.

See also:

Win32 How Do I...? by Tim Golden

Python and COM by David and Paul Boddie

3.6.2 cx_Freeze

cx_Freeze is a distutils extension (see extending-distutils) which 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.

3.6.3 WConio

Since Python's advanced terminal handling layer, curses, is restricted to Unix-like systems, there is a library exclusive to Windows as well: Windows Console I/O for Python.

WConio is a wrapper for Turbo-C's CONIO.H, used to create text user interfaces.

3.7 Compiling Python on 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 2015, which is the compiler used to build the official Python releases. These files are in the PCbuild directory.

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

For extension modules, consult building-on-windows.

See also:

Python + Windows + distutils + SWIG + gcc MinGW or "Creating Python extensions in C/C++ with SWIG and compiling them with MinGW gcc under Windows" or "Installing Python extension with distutils and without Microsoft Visual C++" by Sébastien Sauvage, 2003

MingW - Python extensions by Trent Apted et al, 2007

3.8 Embedded Distribution

New in version 3.5.

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, python36.dll, python.exe and pythonw. exe are all provided. Tcl/tk (including all dependants, such as Idle), pip and the Python documentation are not included.

Note: 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.

3.8.1 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.

3.8.2 Embedding 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.

3.9 Other resources

See also:

Python Programming On Win32 "Help for Windows Programmers" by Mark Hammond and Andy Robinson, O'Reilly Media, 2000, ISBN 1-56592-621-8

A Python for Windows Tutorial by Amanda Birmingham, 2004

PEP 397 - Python launcher for Windows The proposal for the launcher to be included in the Python distribution.

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USING PYTHON ON A MACINTOSH

Author Bob Savage

 bobsavage@mac.com>

Python on a Macintosh running Mac OS X is in principle very similar to Python on any other Unix platform, but there are a number of additional features such as the IDE and the Package Manager that are worth pointing out.

4.1 Getting and Installing MacPython

Mac OS X 10.8 comes with Python 2.7 pre-installed by Apple. If you wish, you are invited to install the most recent version of Python 3 from the Python website (https://www.python.org). A current "universal binary" build of Python, which runs natively on the Mac's new Intel and legacy PPC CPU's, is available there.

What you get after installing is a number of things:

- A MacPython 3.6 folder in your Applications folder. In here you find IDLE, the development environment that is a standard part of official Python distributions; PythonLauncher, which handles double-clicking Python scripts from the Finder; and the "Build Applet" tool, which allows you to package Python scripts as standalone applications on your system.
- A framework /Library/Frameworks/Python.framework, which includes the Python executable and libraries. The installer adds this location to your shell path. To uninstall MacPython, you can simply remove these three things. A symlink to the Python executable is placed in /usr/local/bin/.

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

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

If you are familiar with Python on other Unix platforms you should read the section on running Python scripts from the Unix shell.

4.1.1 How to run a Python script

Your best way to get started with Python on Mac OS X is through the IDLE integrated development environment, see section $The\ IDE$ and use the Help menu when the IDE is running.

If you want to run Python scripts from the Terminal window command line or from the Finder you first need an editor to create your script. Mac OS X comes with a number of standard Unix command line editors, vim and emacs among them. If you want a more Mac-like editor, BBEdit or TextWrangler from

Bare Bones Software (see http://www.barebones.com/products/bbedit/index.html) are good choices, as is TextMate (see https://macromates.com/). Other editors include Gvim (http://macvim.org) and Aquamacs (http://aquamacs.org/).

To run your script from the Terminal window you must make sure that /usr/local/bin is in your shell search path.

To run your script from the Finder you have two options:

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

4.1.2 Running scripts with a GUI

With older versions of Python, there is one Mac OS X quirk that you need to be aware of: programs that talk to the Aqua window manager (in other words, anything that has a GUI) need to be run in a special way. Use pythonw instead of python to start such scripts.

With Python 3.6, you can use either python or pythonw.

4.1.3 Configuration

Python on OS X honors all standard Unix environment variables such as *PYTHONPATH*, but setting these variables for programs started from the Finder is non-standard as the Finder does not read your .profile or .cshrc at startup. You need to create a file ~/.MacOSX/environment.plist. See Apple's Technical Document QA1067 for details.

For more information on installation Python packages in MacPython, see section *Installing Additional Python Packages*.

4.2 The IDE

MacPython ships with the standard IDLE development environment. A good introduction to using IDLE can be found at https://hkn.eecs.berkeley.edu/~dyoo/python/idle intro/index.html.

4.3 Installing Additional Python Packages

There are several methods to install additional Python packages:

- Packages can be installed via the standard Python distutils mode (python setup.py install).
- Many packages can also be installed via the setuptools extension or pip wrapper, see https://pip. pypa.io/.

4.4 GUI Programming on the Mac

There are several options for building GUI applications on the Mac with Python.

PyObjC is a Python binding to Apple's Objective-C/Cocoa framework, which is the foundation of most modern Mac development. Information on PyObjC is available from https://pythonhosted.org/pyobjc/.

The standard Python GUI toolkit is tkinter, based on the cross-platform Tk toolkit (https://www.tcl.tk). An Aqua-native version of Tk is bundled with OS X by Apple, and the latest version can be downloaded and installed from https://www.activestate.com; it can also be built from source.

wxPython is another popular cross-platform GUI toolkit that runs natively on Mac OS X. Packages and documentation are available from http://www.wxpython.org.

PyQt is another popular cross-platform GUI toolkit that runs natively on Mac OS X. More information can be found at https://riverbankcomputing.com/software/pyqt/intro.

4.5 Distributing Python Applications on the Mac

The "Build Applet" tool that is placed in the MacPython 3.6 folder is fine for packaging small Python scripts on your own machine to run as a standard Mac application. This tool, however, is not robust enough to distribute Python applications to other users.

The standard tool for deploying standalone Python applications on the Mac is **py2app**. More information on installing and using py2app can be found at http://undefined.org/python/#py2app.

4.6 Other Resources

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

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

Another useful resource is the MacPython wiki:

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

GLOSSARY

- >>> The default Python prompt of the interactive shell. Often seen for code examples which can be executed interactively in the interpreter.
- ... The default Python prompt of the interactive shell when entering code for an indented code block or within a pair of matching left and right delimiters (parentheses, square brackets or curly braces).
- **2to3** A tool that tries to convert Python 2.x code to Python 3.x code by handling most of the incompatibilities which can be detected by parsing the source and traversing the parse tree.
 - 2to3 is available in the standard library as lib2to3; a standalone entry point is provided as Tools/scripts/2to3. See 2to3-reference.
- abstract base class Abstract base classes complement duck-typing by providing a way to define interfaces when other techniques like hasattr() would be clumsy or subtly wrong (for example with magic methods). ABCs introduce virtual subclasses, which are classes that don't inherit from a class but are still recognized by isinstance() and issubclass(); see the abc module documentation. Python comes with many built-in ABCs for data structures (in the collections.abc module), numbers (in the numbers module), streams (in the io module), import finders and loaders (in the importlib.abc module). You can create your own ABCs with the abc module.
- **argument** A value passed to a *function* (or *method*) when calling the function. There are two kinds of argument:
 - keyword argument: an argument preceded by an identifier (e.g. name=) in a function call or passed as a value in a dictionary preceded by **. For example, 3 and 5 are both keyword arguments in the following calls to complex():

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

• positional argument: an argument that is not a keyword argument. Positional arguments can appear at the beginning of an argument list and/or be passed as elements of an *iterable* preceded by *. For example, 3 and 5 are both positional arguments in the following calls:

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

Arguments are assigned to the named local variables in a function body. See the calls section for the rules governing this assignment. Syntactically, any expression can be used to represent an argument; the evaluated value is assigned to the local variable.

See also the *parameter* glossary entry, the FAQ question on the difference between arguments and parameters, and **PEP 362**.

asynchronous context manager An object which controls the environment seen in an async with statement by defining _aenter_() and _aexit_() methods. Introduced by PEP 492.

asynchronous generator A function which returns an *asynchronous generator iterator*. It looks like a coroutine function defined with async def except that it contains yield expressions for producing a series of values usable in an async for loop.

Usually refers to a asynchronous generator function, but may refer to an asynchronous generator iterator in some contexts. In cases where the intended meaning isn't clear, using the full terms avoids ambiguity.

An asynchronous generator function may contain await expressions as well as async for, and async with statements.

asynchronous generator An object created by a asynchronous generator function.

This is an *asynchronous iterator* which when called using the <code>__anext__()</code> method returns an awaitable object which will execute that the body of the asynchronous generator function until the next <code>yield</code> expression.

Each yield temporarily suspends processing, remembering the location execution state (including local variables and pending try-statements). When the *asynchronous generator iterator* effectively resumes with another awaitable returned by __anext__(), it picks-up where it left-off. See PEP 492 and PEP 525.

- asynchronous iterable An object, that can be used in an async for statement. Must return an asynchronous iterator from its __aiter__() method. Introduced by PEP 492.
- asynchronous iterator An object that implements __aiter__() and __anext__() methods. __anext__
 must return an *awaitable* object. async for resolves awaitable returned from asynchronous iterator's
 __anext__() method until it raises StopAsyncIteration exception. Introduced by PEP 492.
- **attribute** A value associated with an object which is referenced by name using dotted expressions. For example, if an object o has an attribute a it would be referenced as o.a.
- awaitable An object that can be used in an await expression. Can be a *coroutine* or an object with an __await__() method. See also PEP 492.
- BDFL Benevolent Dictator For Life, a.k.a. Guido van Rossum, Python's creator.
- binary file A file object able to read and write bytes-like objects. Examples of binary files are files opened in binary mode ('rb', 'wb' or 'rb+'), sys.stdin.buffer, sys.stdout.buffer, and instances of io.BytesIO and gzip.GzipFile.

See also:

A text file reads and writes str objects.

bytes-like object An object that supports the bufferobjects and can export a C-contiguous buffer. This includes all bytes, bytearray, and array array objects, as well as many common memoryview objects. Bytes-like objects can be used for various operations that work with binary data; these include compression, saving to a binary file, and sending over a socket.

Some operations need the binary data to be mutable. The documentation often refers to these as "read-write bytes-like objects". Example mutable buffer objects include bytearray and a memoryview of a bytearray. Other operations require the binary data to be stored in immutable objects ("read-only bytes-like objects"); examples of these include bytes and a memoryview of a bytes object.

bytecode Python source code is compiled into bytecode, the internal representation of a Python program in the CPython interpreter. The bytecode is also cached in .pyc files so that executing the same file is faster the second time (recompilation from source to bytecode can be avoided). This "intermediate language" is said to run on a *virtual machine* that executes the machine code corresponding to each bytecode. Do note that bytecodes are not expected to work between different Python virtual machines, nor to be stable between Python releases.

A list of bytecode instructions can be found in the documentation for the dis module.

- **class** A template for creating user-defined objects. Class definitions normally contain method definitions which operate on instances of the class.
- coercion The implicit conversion of an instance of one type to another during an operation which involves two arguments of the same type. For example, int(3.15) converts the floating point number to the integer 3, but in 3+4.5, each argument is of a different type (one int, one float), and both must be converted to the same type before they can be added or it will raise a TypeError. Without coercion, all arguments of even compatible types would have to be normalized to the same value by the programmer, e.g., float(3)+4.5 rather than just 3+4.5.
- complex number An extension of the familiar real number system in which all numbers are expressed as a sum of a real part and an imaginary part. Imaginary numbers are real multiples of the imaginary unit (the square root of -1), often written i in mathematics or j in engineering. Python has built-in support for complex numbers, which are written with this latter notation; the imaginary part is written with a j suffix, e.g., 3+1j. To get access to complex equivalents of the math module, use cmath. Use of complex numbers is a fairly advanced mathematical feature. If you're not aware of a need for them, it's almost certain you can safely ignore them.
- context manager An object which controls the environment seen in a with statement by defining __enter__() and __exit__() methods. See PEP 343.
- contiguous A buffer is considered contiguous exactly if it is either *C-contiguous* or *Fortran contiguous*. Zero-dimensional buffers are C and Fortran contiguous. In one-dimensional arrays, the items must be laid out in memory next to each other, in order of increasing indexes starting from zero. In multidimensional C-contiguous arrays, the last index varies the fastest when visiting items in order of memory address. However, in Fortran contiguous arrays, the first index varies the fastest.
- coroutine Coroutines is a more generalized form of subroutines. Subroutines are entered at one point and exited at another point. Coroutines can be entered, exited, and resumed at many different points. They can be implemented with the async def statement. See also PEP 492.
- coroutine function A function which returns a *coroutine* object. A coroutine function may be defined with the async def statement, and may contain await, async for, and async with keywords. These were introduced by PEP 492.
- **CPython** The canonical implementation of the Python programming language, as distributed on python.org. The term "CPython" is used when necessary to distinguish this implementation from others such as Jython or IronPython.
- **decorator** A function returning another function, usually applied as a function transformation using the @wrapper syntax. Common examples for decorators are classmethod() and staticmethod().

The decorator syntax is merely syntactic sugar, the following two function definitions are semantically equivalent:

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

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

The same concept exists for classes, but is less commonly used there. See the documentation for function definitions and class definitions for more about decorators.

descriptor Any object which defines the methods $__get__()$, $__set__()$, or $__delete__()$. When a class attribute is a descriptor, its special binding behavior is triggered upon attribute lookup. Normally, using a.b to get, set or delete an attribute looks up the object named b in the class dictionary for a, but if b is a descriptor, the respective descriptor method gets called. Understanding descriptors is a key

to a deep understanding of Python because they are the basis for many features including functions, methods, properties, class methods, static methods, and reference to super classes.

For more information about descriptors' methods, see descriptors.

- dictionary An associative array, where arbitrary keys are mapped to values. The keys can be any object with __hash__() and __eq__() methods. Called a hash in Perl.
- dictionary view The objects returned from dict.keys(), dict.values(), and dict.items() are called dictionary views. They provide a dynamic view on the dictionary's entries, which means that when the dictionary changes, the view reflects these changes. To force the dictionary view to become a full list use list(dictview). See dict-views.
- docstring A string literal which appears as the first expression in a class, function or module. While ignored when the suite is executed, it is recognized by the compiler and put into the <code>__doc__</code> attribute of the enclosing class, function or module. Since it is available via introspection, it is the canonical place for documentation of the object.
- duck-typing A programming style which does not look at an object's type to determine if it has the right interface; instead, the method or attribute is simply called or used ("If it looks like a duck and quacks like a duck, it must be a duck.") By emphasizing interfaces rather than specific types, well-designed code improves its flexibility by allowing polymorphic substitution. Duck-typing avoids tests using type() or isinstance(). (Note, however, that duck-typing can be complemented with abstract base classes.) Instead, it typically employs hasattr() tests or EAFP programming.
- **EAFP** Easier to ask for forgiveness than permission. This common Python coding style assumes the existence of valid keys or attributes and catches exceptions if the assumption proves false. This clean and fast style is characterized by the presence of many try and except statements. The technique contrasts with the *LBYL* style common to many other languages such as C.
- **expression** A piece of syntax which can be evaluated to some value. In other words, an expression is an accumulation of expression elements like literals, names, attribute access, operators or function calls which all return a value. In contrast to many other languages, not all language constructs are expressions. There are also *statements* which cannot be used as expressions, such as if. Assignments are also statements, not expressions.
- **extension module** A module written in C or C++, using Python's C API to interact with the core and with user code.
- **f-string** String literals prefixed with 'f' or 'F' are commonly called "f-strings" which is short for formatted string literals. See also **PEP 498**.
- file object An object exposing a file-oriented API (with methods such as read() or write()) to an underlying resource. Depending on the way it was created, a file object can mediate access to a real on-disk file or to another type of storage or communication device (for example standard input/output, in-memory buffers, sockets, pipes, etc.). File objects are also called *file-like objects* or *streams*.

There are actually three categories of file objects: raw binary files, buffered binary files and text files. Their interfaces are defined in the io module. The canonical way to create a file object is by using the open() function.

- file-like object A synonym for file object.
- finder An object that tries to find the *loader* for a module that is being imported.

Since Python 3.3, there are two types of finder: *meta path finders* for use with sys.meta_path, and *path entry finders* for use with sys.path_hooks.

See PEP 302, PEP 420 and PEP 451 for much more detail.

floor division Mathematical division that rounds down to nearest integer. The floor division operator is //. For example, the expression 11 // 4 evaluates to 2 in contrast to the 2.75 returned by float true division. Note that (-11) // 4 is -3 because that is -2.75 rounded downward. See PEP 238.

- function A series of statements which returns some value to a caller. It can also be passed zero or more arguments which may be used in the execution of the body. See also parameter, method, and the function section.
- function annotation An arbitrary metadata value associated with a function parameter or return value. Its syntax is explained in section function. Annotations may be accessed via the __annotations__ special attribute of a function object.

Python itself does not assign any particular meaning to function annotations. They are intended to be interpreted by third-party libraries or tools. See PEP 3107, which describes some of their potential uses.

___future___ A pseudo-module which programmers can use to enable new language features which are not compatible with the current interpreter.

By importing the **__future__** module and evaluating its variables, you can see when a new feature was first added to the language and when it becomes the default:

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

- garbage collection The process of freeing memory when it is not used anymore. Python performs garbage collection via reference counting and a cyclic garbage collector that is able to detect and break reference cycles. The garbage collector can be controlled using the gc module.
- **generator** A function which returns a *generator iterator*. It looks like a normal function except that it contains yield expressions for producing a series of values usable in a for-loop or that can be retrieved one at a time with the next() function.

Usually refers to a generator function, but may refer to a *generator iterator* in some contexts. In cases where the intended meaning isn't clear, using the full terms avoids ambiguity.

generator iterator An object created by a *generator* function.

Each yield temporarily suspends processing, remembering the location execution state (including local variables and pending try-statements). When the *generator iterator* resumes, it picks-up where it left-off (in contrast to functions which start fresh on every invocation).

generator expression An expression that returns an iterator. It looks like a normal expression followed by a for expression defining a loop variable, range, and an optional if expression. The combined expression generates values for an enclosing function:

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

generic function A function composed of multiple functions implementing the same operation for different types. Which implementation should be used during a call is determined by the dispatch algorithm.

See also the *single dispatch* glossary entry, the functools.singledispatch() decorator, and PEP 443.

GIL See global interpreter lock.

global interpreter lock The mechanism used by the *CPython* interpreter to assure that only one thread executes Python bytecode at a time. This simplifies the CPython implementation by making the object model (including critical built-in types such as dict) implicitly safe against concurrent access. Locking the entire interpreter makes it easier for the interpreter to be multi-threaded, at the expense of much of the parallelism afforded by multi-processor machines.

However, some extension modules, either standard or third-party, are designed so as to release the GIL when doing computationally-intensive tasks such as compression or hashing. Also, the GIL is always released when doing I/O.

Past efforts to create a "free-threaded" interpreter (one which locks shared data at a much finer granularity) have not been successful because performance suffered in the common single-processor case. It is believed that overcoming this performance issue would make the implementation much more complicated and therefore costlier to maintain.

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

Hashability makes an object usable as a dictionary key and a set member, because these data structures use the hash value internally.

All of Python's immutable built-in objects are hashable; mutable containers (such as lists or dictionaries) are not. Objects which are instances of user-defined classes are hashable by default. They all compare unequal (except with themselves), and their hash value is derived from their id().

- **IDLE** An Integrated Development Environment for Python. IDLE is a basic editor and interpreter environment which ships with the standard distribution of Python.
- **immutable** An object with a fixed value. Immutable objects include numbers, strings and tuples. Such an object cannot be altered. A new object has to be created if a different value has to be stored. They play an important role in places where a constant hash value is needed, for example as a key in a dictionary.
- import path A list of locations (or *path entries*) that are searched by the *path based finder* for modules to import. During import, this list of locations usually comes from sys.path, but for subpackages it may also come from the parent package's __path__ attribute.
- **importing** The process by which Python code in one module is made available to Python code in another module.
- importer An object that both finds and loads a module; both a finder and loader object.
- interactive Python has an interactive interpreter which means you can enter statements and expressions at the interpreter prompt, immediately execute them and see their results. Just launch python with no arguments (possibly by selecting it from your computer's main menu). It is a very powerful way to test out new ideas or inspect modules and packages (remember help(x)).
- interpreted Python is an interpreted language, as opposed to a compiled one, though the distinction can be blurry because of the presence of the bytecode compiler. This means that source files can be run directly without explicitly creating an executable which is then run. Interpreted languages typically have a shorter development/debug cycle than compiled ones, though their programs generally also run more slowly. See also *interactive*.
- interpreter shutdown When asked to shut down, the Python interpreter enters a special phase where it gradually releases all allocated resources, such as modules and various critical internal structures. It also makes several calls to the *garbage collector*. This can trigger the execution of code in user-defined destructors or weakref callbacks. Code executed during the shutdown phase can encounter various exceptions as the resources it relies on may not function anymore (common examples are library modules or the warnings machinery).

The main reason for interpreter shutdown is that the __main__ module or the script being run has finished executing.

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

Iterables can be used in a for loop and in many other places where a sequence is needed (zip(), map(), ...). When an iterable object is passed as an argument to the built-in function iter(), it returns an iterator for the object. This iterator is good for one pass over the set of values. When using iterables,

it is usually not necessary to call iter() or deal with iterator objects yourself. The for statement does that automatically for you, creating a temporary unnamed variable to hold the iterator for the duration of the loop. See also *iterator*, *sequence*, and *generator*.

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

More information can be found in typeiter.

key function A key function or collation function is a callable that returns a value used for sorting or ordering. For example, locale.strxfrm() is used to produce a sort key that is aware of locale specific sort conventions.

A number of tools in Python accept key functions to control how elements are ordered or grouped. They include min(), max(), sorted(), list.sort(), heapq.merge(), heapq.nsmallest(), heapq.nlargest(), and itertools.groupby().

There are several ways to create a key function. For example, the str.lower() method can serve as a key function for case insensitive sorts. Alternatively, a key function can be built from a lambda expression such as lambda r: (r[0], r[2]). Also, the operator module provides three key function constructors: attrgetter(), itemgetter(), and methodcaller(). See the Sorting HOW TO for examples of how to create and use key functions.

keyword argument See argument.

- lambda An anonymous inline function consisting of a single *expression* which is evaluated when the function is called. The syntax to create a lambda function is lambda [arguments]: expression
- **LBYL** Look before you leap. This coding style explicitly tests for pre-conditions before making calls or lookups. This style contrasts with the EAFP approach and is characterized by the presence of many if statements.

In a multi-threaded environment, the LBYL approach can risk introducing a race condition between "the looking" and "the leaping". For example, the code, if key in mapping: return mapping [key] can fail if another thread removes *key* from *mapping* after the test, but before the lookup. This issue can be solved with locks or by using the EAFP approach.

- list A built-in Python sequence. Despite its name it is more akin to an array in other languages than to a linked list since access to elements are O(1).
- list comprehension A compact way to process all or part of the elements in a sequence and return a list with the results. result = ['{:#04x}'.format(x) for x in range(256) if x % 2 == 0] generates a list of strings containing even hex numbers (0x..) in the range from 0 to 255. The if clause is optional. If omitted, all elements in range(256) are processed.
- loader An object that loads a module. It must define a method named load_module(). A loader is typically returned by a *finder*. See PEP 302 for details and importlib.abc.Loader for an abstract base class.
- mapping A container object that supports arbitrary key lookups and implements the methods specified in the Mapping or MutableMapping abstract base classes. Examples include dict, collections. defaultdict, collections.OrderedDict and collections.Counter.

meta path finder A finder returned by a search of sys.meta_path. Meta path finders are related to, but different from path entry finders.

See importlib.abc.MetaPathFinder for the methods that meta path finders implement.

metaclass The class of a class. Class definitions create a class name, a class dictionary, and a list of base classes. The metaclass is responsible for taking those three arguments and creating the class. Most object oriented programming languages provide a default implementation. What makes Python special is that it is possible to create custom metaclasses. Most users never need this tool, but when the need arises, metaclasses can provide powerful, elegant solutions. They have been used for logging attribute access, adding thread-safety, tracking object creation, implementing singletons, and many other tasks.

More information can be found in metaclasses.

- method A function which is defined inside a class body. If called as an attribute of an instance of that class, the method will get the instance object as its first *argument* (which is usually called self). See *function* and *nested scope*.
- method resolution order Method Resolution Order is the order in which base classes are searched for a member during lookup. See The Python 2.3 Method Resolution Order for details of the algorithm used by the Python interpreter since the 2.3 release.
- **module** An object that serves as an organizational unit of Python code. Modules have a namespace containing arbitrary Python objects. Modules are loaded into Python by the process of *importing*.

See also package.

module spec A namespace containing the import-related information used to load a module. An instance of importlib.machinery.ModuleSpec.

MRO See method resolution order.

mutable Mutable objects can change their value but keep their id(). See also immutable.

named tuple Any tuple-like class whose indexable elements are also accessible using named attributes (for example, time.localtime() returns a tuple-like object where the *year* is accessible either with an index such as t[0] or with a named attribute like t.tm_year).

A named tuple can be a built-in type such as time.struct_time, or it can be created with a regular class definition. A full featured named tuple can also be created with the factory function collections. namedtuple(). The latter approach automatically provides extra features such as a self-documenting representation like Employee(name='jones', title='programmer').

- namespace The place where a variable is stored. Namespaces are implemented as dictionaries. There are the local, global and built-in namespaces as well as nested namespaces in objects (in methods). Namespaces support modularity by preventing naming conflicts. For instance, the functions builtins. open and os.open() are distinguished by their namespaces. Namespaces also aid readability and maintainability by making it clear which module implements a function. For instance, writing random. seed() or itertools.islice() makes it clear that those functions are implemented by the random and itertools modules, respectively.
- namespace package A PEP 420 package which serves only as a container for subpackages. Namespace packages may have no physical representation, and specifically are not like a regular package because they have no <code>__init__.py</code> file.

See also module.

nested scope The ability to refer to a variable in an enclosing definition. For instance, a function defined inside another function can refer to variables in the outer function. Note that nested scopes by default work only for reference and not for assignment. Local variables both read and write in the innermost scope. Likewise, global variables read and write to the global namespace. The **nonlocal** allows writing to outer scopes.

- new-style class Old name for the flavor of classes now used for all class objects. In earlier Python versions, only new-style classes could use Python's newer, versatile features like __slots__, descriptors, properties, __getattribute__(), class methods, and static methods.
- **object** Any data with state (attributes or value) and defined behavior (methods). Also the ultimate base class of any new-style class.
- **package** A Python *module* which can contain submodules or recursively, subpackages. Technically, a package is a Python module with an __path__ attribute.

See also regular package and namespace package.

- **parameter** A named entity in a *function* (or method) definition that specifies an *argument* (or in some cases, arguments) that the function can accept. There are five kinds of parameter:
 - positional-or-keyword: specifies an argument that can be passed either positionally or as a keyword argument. This is the default kind of parameter, for example foo and bar in the following:

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

- positional-only: specifies an argument that can be supplied only by position. Python has no syntax for defining positional-only parameters. However, some built-in functions have positional-only parameters (e.g. abs()).
- keyword-only: specifies an argument that can be supplied only by keyword. Keyword-only parameters can be defined by including a single var-positional parameter or bare * in the parameter list of the function definition before them, for example kw_only1 and kw_only2 in the following:

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

• var-positional: specifies that an arbitrary sequence of positional arguments can be provided (in addition to any positional arguments already accepted by other parameters). Such a parameter can be defined by prepending the parameter name with *, for example args in the following:

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

• var-keyword: specifies that arbitrarily many keyword arguments can be provided (in addition to any keyword arguments already accepted by other parameters). Such a parameter can be defined by prepending the parameter name with **, for example kwargs in the example above.

Parameters can specify both optional and required arguments, as well as default values for some optional arguments.

See also the *argument* glossary entry, the FAQ question on the difference between arguments and parameters, the inspect.Parameter class, the function section, and PEP 362.

- **path entry** A single location on the *import path* which the *path based finder* consults to find modules for importing.
- path entry finder A finder returned by a callable on sys.path_hooks (i.e. a path entry hook) which knows how to locate modules given a path entry.
 - See importlib.abc.PathEntryFinder for the methods that path entry finders implement.
- path entry hook A callable on the sys.path_hook list which returns a path entry finder if it knows how to find modules on a specific path entry.
- path based finder One of the default meta path finders which searches an import path for modules.
- path-like object An object representing a file system path. A path-like object is either a str or bytes object representing a path, or an object implementing the os.PathLike protocol. An object that supports the os.PathLike protocol can be converted to a str or bytes file system path by calling the

os.fspath() function; os.fsdecode() and os.fsencode() can be used to guarantee a str or bytes result instead, respectively. Introduced by PEP 519.

portion A set of files in a single directory (possibly stored in a zip file) that contribute to a namespace package, as defined in PEP 420.

positional argument See argument.

provisional API A provisional API is one which has been deliberately excluded from the standard library's backwards compatibility guarantees. While major changes to such interfaces are not expected, as long as they are marked provisional, backwards incompatible changes (up to and including removal of the interface) may occur if deemed necessary by core developers. Such changes will not be made gratuitously – they will occur only if serious fundamental flaws are uncovered that were missed prior to the inclusion of the API.

Even for provisional APIs, backwards incompatible changes are seen as a "solution of last resort" - every attempt will still be made to find a backwards compatible resolution to any identified problems.

This process allows the standard library to continue to evolve over time, without locking in problematic design errors for extended periods of time. See PEP 411 for more details.

provisional package See provisional API.

Python 3000 Nickname for the Python 3.x release line (coined long ago when the release of version 3 was something in the distant future.) This is also abbreviated "Py3k".

Pythonic An idea or piece of code which closely follows the most common idioms of the Python language, rather than implementing code using concepts common to other languages. For example, a common idiom in Python is to loop over all elements of an iterable using a for statement. Many other languages don't have this type of construct, so people unfamiliar with Python sometimes use a numerical counter instead:

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

As opposed to the cleaner, Pythonic method:

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

qualified name A dotted name showing the "path" from a module's global scope to a class, function or method defined in that module, as defined in PEP 3155. For top-level functions and classes, the qualified name is the same as the object's name:

When used to refer to modules, the *fully qualified name* means the entire dotted path to the module, including any parent packages, e.g. email.mime.text:

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

- reference count The number of references to an object. When the reference count of an object drops to zero, it is deallocated. Reference counting is generally not visible to Python code, but it is a key element of the *CPython* implementation. The sys module defines a getrefcount() function that programmers can call to return the reference count for a particular object.
- regular package A traditional package, such as a directory containing an __init__.py file.

See also namespace package.

- ___slots___ A declaration inside a class that saves memory by pre-declaring space for instance attributes and eliminating instance dictionaries. Though popular, the technique is somewhat tricky to get right and is best reserved for rare cases where there are large numbers of instances in a memory-critical application.
- sequence An *iterable* which supports efficient element access using integer indices via the __getitem__() special method and defines a __len__() method that returns the length of the sequence. Some built-in sequence types are list, str, tuple, and bytes. Note that dict also supports __getitem__() and __len__(), but is considered a mapping rather than a sequence because the lookups use arbitrary *immutable* keys rather than integers.
 - The collections.abc.Sequence abstract base class defines a much richer interface that goes beyond just __getitem__() and __len__(), adding count(), index(), __contains__(), and __reversed__(). Types that implement this expanded interface can be registered explicitly using register().
- **single dispatch** A form of *generic function* dispatch where the implementation is chosen based on the type of a single argument.
- slice An object usually containing a portion of a *sequence*. A slice is created using the subscript notation, [] with colons between numbers when several are given, such as in variable_name[1:3:5]. The bracket (subscript) notation uses slice objects internally.
- **special method** A method that is called implicitly by Python to execute a certain operation on a type, such as addition. Such methods have names starting and ending with double underscores. Special methods are documented in specialnames.
- **statement** A statement is part of a suite (a "block" of code). A statement is either an *expression* or one of several constructs with a keyword, such as if, while or for.
- struct sequence A tuple with named elements. Struct sequences expose an interface similar to named tuple in that elements can either be accessed either by index or as an attribute. However, they do not have any of the named tuple methods like _make() or _asdict(). Examples of struct sequences include sys.float_info and the return value of os.stat().
- text encoding A codec which encodes Unicode strings to bytes.
- text file A file object able to read and write str objects. Often, a text file actually accesses a byte-oriented datastream and handles the text encoding automatically. Examples of text files are files opened in text mode ('r' or 'w'), sys.stdin, sys.stdout, and instances of io.StringIO.

See also:

A binary file reads and write bytes objects.

triple-quoted string A string which is bound by three instances of either a quotation mark (") or an apostrophe ('). While they don't provide any functionality not available with single-quoted strings, they are useful for a number of reasons. They allow you to include unescaped single and double quotes

- within a string and they can span multiple lines without the use of the continuation character, making them especially useful when writing docstrings.
- type The type of a Python object determines what kind of object it is; every object has a type. An object's type is accessible as its __class__ attribute or can be retrieved with type(obj).
- universal newlines A manner of interpreting text streams in which all of the following are recognized as ending a line: the Unix end-of-line convention '\n', the Windows convention '\r', and the old Macintosh convention '\r'. See PEP 278 and PEP 3116, as well as bytes.splitlines() for an additional use.
- variable annotation A type metadata value associated with a module global variable or a class attribute. Its syntax is explained in section annassign. Annotations are stored in the __annotations__ special attribute of a class or module object and can be accessed using typing.get_type_hints().
 - Python itself does not assign any particular meaning to variable annotations. They are intended to be interpreted by third-party libraries or type checking tools. See **PEP 526**, **PEP 484** which describe some of their potential uses.
- virtual environment A cooperatively isolated runtime environment that allows Python users and applications to install and upgrade Python distribution packages without interfering with the behaviour of other Python applications running on the same system.

See also venv.

- **virtual machine** A computer defined entirely in software. Python's virtual machine executes the *bytecode* emitted by the bytecode compiler.
- **Zen of Python** Listing of Python design principles and philosophies that are helpful in understanding and using the language. The listing can be found by typing "import this" at the interactive prompt.

В

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Development of the documentation and its toolchain is an entirely volunteer effort, just like Python itself. If you want to contribute, please take a look at the reporting-bugs page for information on how to do so. New volunteers are always welcome!

Many thanks go to:

- Fred L. Drake, Jr., the creator of the original Python documentation toolset and writer of much of the content:
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- Fredrik Lundh for his Alternative Python Reference project from which Sphinx got many good ideas.

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It is only with the input and contributions of the Python community that Python has such wonderful documentation – Thank You!

C

HISTORY AND LICENSE

C.1 History of the software

Python was created in the early 1990s by Guido van Rossum at Stichting Mathematisch Centrum (CWI, see https://www.cwi.nl/) in the Netherlands as a successor of a language called ABC. Guido remains Python's principal author, although it includes many contributions from others.

In 1995, Guido continued his work on Python at the Corporation for National Research Initiatives (CNRI, see https://www.cnri.reston.va.us/) in Reston, Virginia where he released several versions of the software.

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1.6.1	1.6	2001	CNRI	no
2.1	2.0+1.6.1	2001	PSF	no
2.0.1	2.0+1.6.1	2001	PSF	yes
2.1.1	2.1+2.0.1	2001	PSF	yes
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C.3.1 Mersenne Twister

The _random module includes code based on a download from http://www.math.sci.hiroshima-u.ac.jp/~m-mat/MT/MT2002/emt19937ar.html. The following are the verbatim comments from the original code:

A C-program for MT19937, with initialization improved 2002/1/26. Coded by Takuji Nishimura and Makoto Matsumoto.

Before using, initialize the state by using init_genrand(seed) or init_by_array(init_key, key_length).

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Any feedback is very welcome.

```
http://www.math.sci.hiroshima-u.ac.jp/~m-mat/MT/emt.html
email: m-mat @ math.sci.hiroshima-u.ac.jp (remove space)
```

C.3.2 Sockets

The socket module uses the functions, getaddrinfo(), and getnameinfo(), which are coded in separate source files from the WIDE Project, http://www.wide.ad.jp/.

```
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```
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The trace module contains the following notice:

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Author: Zooko O'Whielacronx

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C.3.7 UUencode and UUdecode functions

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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.3.8 XML Remote Procedure Calls

The xmlrpc.client module contains the following notice:

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C.3.10 Select kqueue

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C.3.11 SipHash24

The file Python/pyhash.c contains Marek Majkowski' implementation of Dan Bernstein's SipHash24 algorithm. The contains the following note:

```
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   Jean-Philippe Aumasson (https://131002.net/siphash/siphash24.c)
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C.3.12 strtod and dtoa

The file Python/dtoa.c, which supplies C functions dtoa and strtod for conversion of C doubles to and from strings, is derived from the file of the same name by David M. Gay, currently available from http://www.netlib.org/fp/. The original file, as retrieved on March 16, 2009, contains the following copyright and licensing notice:

C.3.13 OpenSSL

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C.3.16 zlib

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C.3.17 cfuhash

The implementation of the hash table used by the tracemalloc is based on the cfuhash project:

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