CHAPTER

SIXTEEN

GENERIC OPERATING SYSTEM SERVICES

The modules described in this chapter provide interfaces to operating system features that are available on (almost) all operating systems, such as files and a clock. The interfaces are generally modeled after the Unix or C interfaces, but they are available on most other systems as well. Here's an overview:

16.1 `os` — Miscellaneous operating system interfaces

Source code: Lib/os.py

This module provides a portable way of using operating system dependent functionality. If you just want to read or write a file see *open()*, if you want to manipulate paths, see the *os.path* module, and if you want to read all the lines in all the files on the command line see the *fileinput* module. For creating temporary files and directories see the *tempfile* module, and for high-level file and directory handling see the *shutil* module.

Notes on the availability of these functions:

- The design of all built-in operating system dependent modules of Python is such that as long as the same functionality is available, it uses the same interface; for example, the function `os.stat(path)` returns stat information about *path* in the same format (which happens to have originated with the POSIX interface).
- Extensions peculiar to a particular operating system are also available through the *os* module, but using them is of course a threat to portability.
- All functions accepting path or file names accept both bytes and string objects, and result in an object of the same type, if a path or file name is returned.

Note: All functions in this module raise *OSError* in the case of invalid or inaccessible file names and paths, or other arguments that have the correct type, but are not accepted by the operating system.

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exception os.error
An alias for the built-in *OSError* exception.

os.name
The name of the operating system dependent module imported. The following names have currently been registered: `'posix'`, `'nt'`, `'java'`.

See also:

sys.platform has a finer granularity. *os.uname()* gives system-dependent version information.

The *platform* module provides detailed checks for the system's identity.

16.1.1 File Names, Command Line Arguments, and Environment Variables

In Python, file names, command line arguments, and environment variables are represented using the string type. On some systems, decoding these strings to and from bytes is necessary before passing them to the operating system. Python uses the file system encoding to perform this conversion (see *sys.getfilesystemencoding()*).

Changed in version 3.1: On some systems, conversion using the file system encoding may fail. In this case, Python uses the *surrogateescape encoding error handler*, which means that undecodable bytes are replaced by a Unicode character U+DCxx on decoding, and these are again translated to the original byte on encoding.

The file system encoding must guarantee to successfully decode all bytes below 128. If the file system encoding fails to provide this guarantee, API functions may raise UnicodeErrors.

16.1.2 Process Parameters

These functions and data items provide information and operate on the current process and user.

`os.ctermid()`

Return the filename corresponding to the controlling terminal of the process.

Availability: Unix.

`os.environ`

A *mapping* object representing the string environment. For example, `environ['HOME']` is the pathname of your home directory (on some platforms), and is equivalent to `getenv("HOME")` in C.

This mapping is captured the first time the *os* module is imported, typically during Python startup as part of processing `site.py`. Changes to the environment made after this time are not reflected in `os.environ`, except for changes made by modifying `os.environ` directly.

If the platform supports the *putenv()* function, this mapping may be used to modify the environment as well as query the environment. *putenv()* will be called automatically when the mapping is modified.

On Unix, keys and values use *sys.getfilesystemencoding()* and `'surrogateescape'` error handler. Use *environb* if you would like to use a different encoding.

Note: Calling *putenv()* directly does not change `os.environ`, so it's better to modify `os.environ`.

Note: On some platforms, including FreeBSD and Mac OS X, setting `environ` may cause memory leaks. Refer to the system documentation for `putenv()`.

If *putenv()* is not provided, a modified copy of this mapping may be passed to the appropriate process-creation functions to cause child processes to use a modified environment.

If the platform supports the *unsetenv()* function, you can delete items in this mapping to unset environment variables. *unsetenv()* will be called automatically when an item is deleted from `os.environ`, and when one of the `pop()` or `clear()` methods is called.

`os.environb`

Bytes version of *environ*: a *mapping* object representing the environment as byte strings. *environ* and *environb* are synchronized (modify *environb* updates *environ*, and vice versa).

environb is only available if *supports_bytes_environ* is True.

New in version 3.2.

`os.chdir(path)`
`os.fchdir(fd)`

os.getcwd()

These functions are described in *Files and Directories*.

os.fsencode(*filename*)

Encode *path-like* *filename* to the filesystem encoding with `'surrogateescape'` error handler, or `'strict'` on Windows; return `bytes` unchanged.

`fsdecode()` is the reverse function.

New in version 3.2.

Changed in version 3.6: Support added to accept objects implementing the `os.PathLike` interface.

os.fsdecode(*filename*)

Decode the *path-like* *filename* from the filesystem encoding with `'surrogateescape'` error handler, or `'strict'` on Windows; return `str` unchanged.

`fsencode()` is the reverse function.

New in version 3.2.

Changed in version 3.6: Support added to accept objects implementing the `os.PathLike` interface.

os.fspath(*path*)

Return the file system representation of the path.

If `str` or `bytes` is passed in, it is returned unchanged. Otherwise `__fspath__()` is called and its value is returned as long as it is a `str` or `bytes` object. In all other cases, `TypeError` is raised.

New in version 3.6.

class os.PathLike

An *abstract base class* for objects representing a file system path, e.g. `pathlib.PurePath`.

New in version 3.6.

abstractmethod __fspath__()

Return the file system path representation of the object.

The method should only return a `str` or `bytes` object, with the preference being for `str`.

os.getenv(*key*, *default=None*)

Return the value of the environment variable *key* if it exists, or *default* if it doesn't. *key*, *default* and the result are str.

On Unix, keys and values are decoded with `sys.getfilesystemencoding()` and `'surrogateescape'` error handler. Use `os.getenvb()` if you would like to use a different encoding.

Availability: most flavors of Unix, Windows.

os.getenvb(*key*, *default=None*)

Return the value of the environment variable *key* if it exists, or *default* if it doesn't. *key*, *default* and the result are bytes.

`getenvb()` is only available if `supports_bytes_environ` is True.

Availability: most flavors of Unix.

New in version 3.2.

os.get_exec_path(*env=None*)

Returns the list of directories that will be searched for a named executable, similar to a shell, when launching a process. *env*, when specified, should be an environment variable dictionary to lookup the PATH in. By default, when *env* is `None`, `environ` is used.

New in version 3.2.

os.getegid()

Return the effective group id of the current process. This corresponds to the "set id" bit on the file being executed in the current process.

Availability: Unix.

os.geteuid()

Return the current process's effective user id.

Availability: Unix.

os.getgid()

Return the real group id of the current process.

Availability: Unix.

os.getgrouplist(*user*, *group*)

Return list of group ids that *user* belongs to. If *group* is not in the list, it is included; typically, *group* is specified as the group ID field from the password record for *user*.

Availability: Unix.

New in version 3.3.

os.getgroups()

Return list of supplemental group ids associated with the current process.

Availability: Unix.

Note: On Mac OS X, *getgroups()* behavior differs somewhat from other Unix platforms. If the Python interpreter was built with a deployment target of `10.5` or earlier, *getgroups()* returns the list of effective group ids associated with the current user process; this list is limited to a system-defined number of entries, typically 16, and may be modified by calls to *setgroups()* if suitably privileged. If built with a deployment target greater than `10.5`, *getgroups()* returns the current group access list for the user associated with the effective user id of the process; the group access list may change over the lifetime of the process, it is not affected by calls to *setgroups()*, and its length is not limited to 16. The deployment target value, `MACOSX_DEPLOYMENT_TARGET`, can be obtained with *sysconfig.get_config_var()*.

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os.getlogin()

Return the name of the user logged in on the controlling terminal of the process. For most purposes, it is more useful to use *getpass.getuser()* since the latter checks the environment variables `LOGNAME` or `USERNAME` to find out who the user is, and falls back to `pwd.getpwuid(os.getuid())[0]` to get the login name of the current real user id.

Availability: Unix, Windows.

os.getpgid(*pid*)

Return the process group id of the process with process id *pid*. If *pid* is 0, the process group id of the current process is returned.

Availability: Unix.

os.getpgrp()

Return the id of the current process group.

Availability: Unix.

os.getpid()

Return the current process id.

os.getppid()

Return the parent's process id. When the parent process has exited, on Unix the id returned is the one of the init process (1), on Windows it is still the same id, which may be already reused by another process.

Availability: Unix, Windows.

Changed in version 3.2: Added support for Windows.

os.getpriority(*which*, *who*)

Get program scheduling priority. The value *which* is one of *PRIO_PROCESS*, *PRIO_PGRP*, or *PRIO_USER*, and *who* is interpreted relative to *which* (a process identifier for *PRIO_PROCESS*, process group identifier for *PRIO_PGRP*, and a user ID for *PRIO_USER*). A zero value for *who* denotes (respectively) the calling process, the process group of the calling process, or the real user ID of the calling process.

Availability: Unix.

New in version 3.3.

os.PRIO_PROCESS
os.PRIO_PGRP
os.PRIO_USER

Parameters for the *getpriority()* and *setpriority()* functions.

Availability: Unix.

New in version 3.3.

os.getresuid()

Return a tuple (ruid, euid, suid) denoting the current process's real, effective, and saved user ids.

Availability: Unix.

New in version 3.2.

os.getresgid()

Return a tuple (rgid, egid, sgid) denoting the current process's real, effective, and saved group ids.

Availability: Unix.

New in version 3.2.

os.getuid()

Return the current process's real user id.

Availability: Unix.

os.initgroups(*username*, *gid*)

Call the system initgroups() to initialize the group access list with all of the groups of which the specified username is a member, plus the specified group id.

Availability: Unix.

New in version 3.2.

os.putenv(*key*, *value*)

Set the environment variable named *key* to the string *value*. Such changes to the environment affect subprocesses started with *os.system()*, *popen()* or *fork()* and *execv()*.

Availability: most flavors of Unix, Windows.

Note: On some platforms, including FreeBSD and Mac OS X, setting `environ` may cause memory leaks. Refer to the system documentation for putenv.

When *putenv()* is supported, assignments to items in `os.environ` are automatically translated into corresponding calls to *putenv()*; however, calls to *putenv()* don't update `os.environ`, so it is actually preferable to assign to items of `os.environ`.

`os.setegid(egid)`
Set the current process's effective group id.

Availability: Unix.

`os.seteuid(euid)`
Set the current process's effective user id.

Availability: Unix.

`os.setgid(gid)`
Set the current process' group id.

Availability: Unix.

`os.setgroups(groups)`
Set the list of supplemental group ids associated with the current process to *groups*. *groups* must be a sequence, and each element must be an integer identifying a group. This operation is typically available only to the superuser.

Availability: Unix.

Note: On Mac OS X, the length of *groups* may not exceed the system-defined maximum number of effective group ids, typically 16. See the documentation for `getgroups()` for cases where it may not return the same group list set by calling setgroups().

`os.setpgrp()`
Call the system call `setpgrp()` or `setpgrp(0, 0)` depending on which version is implemented (if any). See the Unix manual for the semantics.

Availability: Unix.

`os.setpgid(pid, pgrp)`
Call the system call `setpgid()` to set the process group id of the process with id *pid* to the process group with id *pgrp*. See the Unix manual for the semantics.

Availability: Unix.

`os.setpriority(which, who, priority)`
Set program scheduling priority. The value *which* is one of `PRIO_PROCESS`, `PRIO_PGRP`, or `PRIO_USER`, and *who* is interpreted relative to *which* (a process identifier for `PRIO_PROCESS`, process group identifier for `PRIO_PGRP`, and a user ID for `PRIO_USER`). A zero value for *who* denotes (respectively) the calling process, the process group of the calling process, or the real user ID of the calling process. *priority* is a value in the range -20 to 19. The default priority is 0; lower priorities cause more favorable scheduling.

Availability: Unix.

New in version 3.3.

`os.setregid(rgid, egid)`
Set the current process's real and effective group ids.

Availability: Unix.

`os.setresgid(rgid, egid, sgid)`
Set the current process's real, effective, and saved group ids.

Availability: Unix.

New in version 3.2.

`os.setresuid(ruid, euid, suid)`
Set the current process's real, effective, and saved user ids.

Availability: Unix.

New in version 3.2.

`os.setreuid(ruid, euid)`
Set the current process's real and effective user ids.

Availability: Unix.

`os.getsid(pid)`
Call the system call `getsid()`. See the Unix manual for the semantics.

Availability: Unix.

`os.setsid()`
Call the system call `setsid()`. See the Unix manual for the semantics.

Availability: Unix.

`os.setuid(uid)`
Set the current process's user id.

Availability: Unix.

`os.strerror(code)`
Return the error message corresponding to the error code in *code*. On platforms where `strerror()` returns `NULL` when given an unknown error number, `ValueError` is raised.

`os.supports_bytes_environ`
`True` if the native OS type of the environment is bytes (eg. `False` on Windows).

New in version 3.2.

`os.umask(mask)`
Set the current numeric umask and return the previous umask.

`os.uname()`
Returns information identifying the current operating system. The return value is an object with five attributes:

- `sysname` - operating system name
- `nodename` - name of machine on network (implementation-defined)
- `release` - operating system release
- `version` - operating system version
- `machine` - hardware identifier

For backwards compatibility, this object is also iterable, behaving like a five-tuple containing `sysname`, `nodename`, `release`, `version`, and `machine` in that order.

Some systems truncate `nodename` to 8 characters or to the leading component; a better way to get the hostname is `socket.gethostname()` or even `socket.gethostbyaddr(socket.gethostname())`.

Availability: recent flavors of Unix.

Changed in version 3.3: Return type changed from a tuple to a tuple-like object with named attributes.

`os.unsetenv(key)`
Unset (delete) the environment variable named *key*. Such changes to the environment affect subprocesses started with `os.system()`, `popen()` or `fork()` and `execv()`.

When `unsetenv()` is supported, deletion of items in `os.environ` is automatically translated into a corresponding call to `unsetenv()`; however, calls to `unsetenv()` don't update `os.environ`, so it is actually preferable to delete items of `os.environ`.

Availability: most flavors of Unix, Windows.

16.1.3 File Object Creation

This function creates new *file objects*. (See also `open()` for opening file descriptors.)

`os.fdopen(fd, *args, **kwargs)`

Return an open file object connected to the file descriptor *fd*. This is an alias of the `open()` built-in function and accepts the same arguments. The only difference is that the first argument of `fdopen()` must always be an integer.

16.1.4 File Descriptor Operations

These functions operate on I/O streams referenced using file descriptors.

File descriptors are small integers corresponding to a file that has been opened by the current process. For example, standard input is usually file descriptor 0, standard output is 1, and standard error is 2. Further files opened by a process will then be assigned 3, 4, 5, and so forth. The name "file descriptor" is slightly deceptive; on Unix platforms, sockets and pipes are also referenced by file descriptors.

The `fileno()` method can be used to obtain the file descriptor associated with a *file object* when required. Note that using the file descriptor directly will bypass the file object methods, ignoring aspects such as internal buffering of data.

`os.close(fd)`

Close file descriptor *fd*.

Note: This function is intended for low-level I/O and must be applied to a file descriptor as returned by `os.open()` or `pipe()`. To close a "file object" returned by the built-in function `open()` or by `popen()` or `fdopen()`, use its `close()` method.

`os.closerange(fd_low, fd_high)`

Close all file descriptors from *fd_low* (inclusive) to *fd_high* (exclusive), ignoring errors. Equivalent to (but much faster than):

```
for fd in range(fd_low, fd_high):
    try:
        os.close(fd)
    except OSError:
        pass
```

`os.device_encoding(fd)`

Return a string describing the encoding of the device associated with *fd* if it is connected to a terminal; else return `None`.

`os.dup(fd)`

Return a duplicate of file descriptor *fd*. The new file descriptor is *non-inheritable*.

On Windows, when duplicating a standard stream (0: stdin, 1: stdout, 2: stderr), the new file descriptor is *inheritable*.

Changed in version 3.4: The new file descriptor is now non-inheritable.

`os.dup2(fd, fd2, inheritable=True)`

Duplicate file descriptor *fd* to *fd2*, closing the latter first if necessary. Return *fd2*. The new file descriptor is *inheritable* by default or non-inheritable if *inheritable* is `False`.

Changed in version 3.4: Add the optional *inheritable* parameter.

Changed in version 3.7: Return *fd2* on success. Previously, `None` was always returned.

`os.fchmod(fd, mode)`
Change the mode of the file given by *fd* to the numeric *mode*. See the docs for *chmod()* for possible values of *mode*. As of Python 3.3, this is equivalent to `os.chmod(fd, mode)`.

Availability: Unix.

`os.fchown(fd, uid, gid)`
Change the owner and group id of the file given by *fd* to the numeric *uid* and *gid*. To leave one of the ids unchanged, set it to -1. See *chown()*. As of Python 3.3, this is equivalent to `os.chown(fd, uid, gid)`.

Availability: Unix.

`os.fdatasync(fd)`
Force write of file with filedescriptor *fd* to disk. Does not force update of metadata.

Availability: Unix.

Note: This function is not available on MacOS.

`os.fpathconf(fd, name)`
Return system configuration information relevant to an open file. *name* specifies the configuration value to retrieve; it may be a string which is the name of a defined system value; these names are specified in a number of standards (POSIX.1, Unix 95, Unix 98, and others). Some platforms define additional names as well. The names known to the host operating system are given in the `pathconf_names` dictionary. For configuration variables not included in that mapping, passing an integer for *name* is also accepted.

If *name* is a string and is not known, *ValueError* is raised. If a specific value for *name* is not supported by the host system, even if it is included in `pathconf_names`, an *OSError* is raised with *errno.EINVAL* for the error number.

As of Python 3.3, this is equivalent to `os.pathconf(fd, name)`.

Availability: Unix.

`os.fstat(fd)`
Get the status of the file descriptor *fd*. Return a *stat_result* object.

As of Python 3.3, this is equivalent to `os.stat(fd)`.

See also:

The *stat()* function.

`os.fstatvfs(fd)`
Return information about the filesystem containing the file associated with file descriptor *fd*, like *statvfs()*. As of Python 3.3, this is equivalent to `os.statvfs(fd)`.

Availability: Unix.

`os.fsync(fd)`
Force write of file with filedescriptor *fd* to disk. On Unix, this calls the native `fsync()` function; on Windows, the MS `_commit()` function.

If you're starting with a buffered Python *file object f*, first do `f.flush()`, and then do `os.fsync(f.fileno())`, to ensure that all internal buffers associated with *f* are written to disk.

Availability: Unix, Windows.

`os.ftruncate(fd, length)`
Truncate the file corresponding to file descriptor *fd*, so that it is at most *length* bytes in size. As of Python 3.3, this is equivalent to `os.truncate(fd, length)`.

Availability: Unix, Windows.

Changed in version 3.5: Added support for Windows

`os.get_blocking(fd)`

Get the blocking mode of the file descriptor: `False` if the `O_NONBLOCK` flag is set, `True` if the flag is cleared.

See also `set_blocking()` and `socket.socket.setblocking()`.

Availability: Unix.

New in version 3.5.

`os.isatty(fd)`

Return `True` if the file descriptor *fd* is open and connected to a tty(-like) device, else `False`.

`os.lockf(fd, cmd, len)`

Apply, test or remove a POSIX lock on an open file descriptor. *fd* is an open file descriptor. *cmd* specifies the command to use - one of `F_LOCK`, `F_TLOCK`, `F_ULOCK` or `F_TEST`. *len* specifies the section of the file to lock.

Availability: Unix.

New in version 3.3.

`os.F_LOCK`
`os.F_TLOCK`
`os.F_ULOCK`
`os.F_TEST`

Flags that specify what action `lockf()` will take.

Availability: Unix.

New in version 3.3.

`os.lseek(fd, pos, how)`

Set the current position of file descriptor *fd* to position *pos*, modified by *how*: `SEEK_SET` or `0` to set the position relative to the beginning of the file; `SEEK_CUR` or `1` to set it relative to the current position; `SEEK_END` or `2` to set it relative to the end of the file. Return the new cursor position in bytes, starting from the beginning.

`os.SEEK_SET`
`os.SEEK_CUR`
`os.SEEK_END`

Parameters to the `lseek()` function. Their values are 0, 1, and 2, respectively.

New in version 3.3: Some operating systems could support additional values, like `os.SEEK_HOLE` or `os.SEEK_DATA`.

`os.open(path, flags, mode=0o777, *, dir_fd=None)`

Open the file *path* and set various flags according to *flags* and possibly its mode according to *mode*. When computing *mode*, the current umask value is first masked out. Return the file descriptor for the newly opened file. The new file descriptor is *non-inheritable*.

For a description of the flag and mode values, see the C run-time documentation; flag constants (like `O_RDONLY` and `O_WRONLY`) are defined in the `os` module. In particular, on Windows adding `O_BINARY` is needed to open files in binary mode.

This function can support *paths relative to directory descriptors* with the *dir_fd* parameter.

Changed in version 3.4: The new file descriptor is now non-inheritable.

Note: This function is intended for low-level I/O. For normal usage, use the built-in function *open()*, which returns a *file object* with `read()` and `write()` methods (and many more). To wrap a file descriptor in a file object, use *fdopen()*.

New in version 3.3: The *dir_fd* argument.

Changed in version 3.5: If the system call is interrupted and the signal handler does not raise an exception, the function now retries the system call instead of raising an *InterruptedError* exception (see **PEP 475** for the rationale).

Changed in version 3.6: Accepts a *path-like object*.

The following constants are options for the *flags* parameter to the *open()* function. They can be combined using the bitwise OR operator `|`. Some of them are not available on all platforms. For descriptions of their availability and use, consult the *open(2)* manual page on Unix or the MSDN on Windows.

`os.O_RDONLY`
`os.O_WRONLY`
`os.O_RDWR`
`os.O_APPEND`
`os.O_CREAT`
`os.O_EXCL`
`os.O_TRUNC`

The above constants are available on Unix and Windows.

`os.O_DSYNC`
`os.O_RSYNC`
`os.O_SYNC`
`os.O_NDELAY`
`os.O_NONBLOCK`
`os.O_NOCTTY`
`os.O_CLOEXEC`

The above constants are only available on Unix.

Changed in version 3.3: Add *O_CLOEXEC* constant.

`os.O_BINARY`
`os.O_NOINHERIT`
`os.O_SHORT_LIVED`
`os.O_TEMPORARY`
`os.O_RANDOM`
`os.O_SEQUENTIAL`
`os.O_TEXT`

The above constants are only available on Windows.

`os.O_ASYNC`
`os.O_DIRECT`
`os.O_DIRECTORY`
`os.O_NOFOLLOW`
`os.O_NOATIME`
`os.O_PATH`
`os.O_TMPFILE`
`os.O_SHLOCK`
`os.O_EXLOCK`

The above constants are extensions and not present if they are not defined by the C library.

Changed in version 3.4: Add *O_PATH* on systems that support it. Add *O_TMPFILE*, only available on Linux Kernel 3.11 or newer.

os.openpty()

Open a new pseudo-terminal pair. Return a pair of file descriptors `(master, slave)` for the pty and the tty, respectively. The new file descriptors are *non-inheritable*. For a (slightly) more portable approach, use the `pty` module.

Availability: some flavors of Unix.

Changed in version 3.4: The new file descriptors are now non-inheritable.

os.pipe()

Create a pipe. Return a pair of file descriptors `(r, w)` usable for reading and writing, respectively. The new file descriptor is *non-inheritable*.

Availability: Unix, Windows.

Changed in version 3.4: The new file descriptors are now non-inheritable.

os.pipe2(*flags*)

Create a pipe with *flags* set atomically. *flags* can be constructed by ORing together one or more of these values: `O_NONBLOCK`, `O_CLOEXEC`. Return a pair of file descriptors `(r, w)` usable for reading and writing, respectively.

Availability: some flavors of Unix.

New in version 3.3.

os.posix_fallocate(*fd*, *offset*, *len*)

Ensures that enough disk space is allocated for the file specified by *fd* starting from *offset* and continuing for *len* bytes.

Availability: Unix.

New in version 3.3.

os.posix_fadvise(*fd*, *offset*, *len*, *advice*)

Announces an intention to access data in a specific pattern thus allowing the kernel to make optimizations. The advice applies to the region of the file specified by *fd* starting at *offset* and continuing for *len* bytes. *advice* is one of `POSIX_FADV_NORMAL`, `POSIX_FADV_SEQUENTIAL`, `POSIX_FADV_RANDOM`, `POSIX_FADV_NOREUSE`, `POSIX_FADV_WILLNEED` or `POSIX_FADV_DONTNEED`.

Availability: Unix.

New in version 3.3.

os.POSIX_FADV_NORMAL
os.POSIX_FADV_SEQUENTIAL
os.POSIX_FADV_RANDOM
os.POSIX_FADV_NOREUSE
os.POSIX_FADV_WILLNEED
os.POSIX_FADV_DONTNEED

Flags that can be used in *advice* in `posix_fadvise()` that specify the access pattern that is likely to be used.

Availability: Unix.

New in version 3.3.

os.pread(*fd*, *n*, *offset*)

Read at most *n* bytes from file descriptor *fd* at a position of *offset*, leaving the file offset unchanged.

Return a bytestring containing the bytes read. If the end of the file referred to by *fd* has been reached, an empty bytes object is returned.

Availability: Unix.

New in version 3.3.

`os.preadv(fd, buffers, offset, flags=0)`

Read from a file descriptor *fd* at a position of *offset* into mutable *bytes-like objects* *buffers*, leaving the file offset unchanged. Transfer data into each buffer until it is full and then move on to the next buffer in the sequence to hold the rest of the data.

The flags argument contains a bitwise OR of zero or more of the following flags:

- `RWF_HIPRI`
- `RWF_NOWAIT`

Return the total number of bytes actually read which can be less than the total capacity of all the objects.

The operating system may set a limit (`sysconf()` value `'SC_IOV_MAX'`) on the number of buffers that can be used.

Combine the functionality of `os.readv()` and `os.pread()`.

Availability: Linux 2.6.30 and newer, FreeBSD 6.0 and newer, OpenBSD 2.7 and newer. Using flags requires Linux 4.6 or newer.

New in version 3.7.

`os.RWF_NOWAIT`

Do not wait for data which is not immediately available. If this flag is specified, the system call will return instantly if it would have to read data from the backing storage or wait for a lock.

If some data was successfully read, it will return the number of bytes read. If no bytes were read, it will return `-1` and set errno to `errno.EAGAIN`.

Availability: Linux 4.14 and newer.

New in version 3.7.

`os.RWF_HIPRI`

High priority read/write. Allows block-based filesystems to use polling of the device, which provides lower latency, but may use additional resources.

Currently, on Linux, this feature is usable only on a file descriptor opened using the `O_DIRECT` flag.

Availability: Linux 4.6 and newer.

New in version 3.7.

`os.pwrite(fd, str, offset)`

Write the bytestring in *str* to file descriptor *fd* at position of *offset*, leaving the file offset unchanged.

Return the number of bytes actually written.

Availability: Unix.

New in version 3.3.

`os.pwritev(fd, buffers, offset, flags=0)`

Write the *buffers* contents to file descriptor *fd* at a offset *offset*, leaving the file offset unchanged. *buffers* must be a sequence of *bytes-like objects*. Buffers are processed in array order. Entire contents of the first buffer is written before proceeding to the second, and so on.

The flags argument contains a bitwise OR of zero or more of the following flags:

- `RWF_DSYNC`
- `RWF_SYNC`

Return the total number of bytes actually written.

The operating system may set a limit (`sysconf()` value `'SC_IOV_MAX'`) on the number of buffers that can be used.

Combine the functionality of `os.writev()` and `os.pwrite()`.

Availability: Linux 2.6.30 and newer, FreeBSD 6.0 and newer, OpenBSD 2.7 and newer. Using flags requires Linux 4.7 or newer.

New in version 3.7.

os.RWF_DSYNC
Provide a per-write equivalent of the `O_DSYNC` `open(2)` flag. This flag effect applies only to the data range written by the system call.

Availability: Linux 4.7 and newer.

New in version 3.7.

os.RWF_SYNC
Provide a per-write equivalent of the `O_SYNC` `open(2)` flag. This flag effect applies only to the data range written by the system call.

Availability: Linux 4.7 and newer.

New in version 3.7.

os.read(*fd*, *n*)
Read at most *n* bytes from file descriptor *fd*.

Return a bytestring containing the bytes read. If the end of the file referred to by *fd* has been reached, an empty bytes object is returned.

Note: This function is intended for low-level I/O and must be applied to a file descriptor as returned by `os.open()` or `pipe()`. To read a "file object" returned by the built-in function `open()` or by `popen()` or `fdopen()`, or `sys.stdin`, use its `read()` or `readline()` methods.

Changed in version 3.5: If the system call is interrupted and the signal handler does not raise an exception, the function now retries the system call instead of raising an `InterruptedError` exception (see **PEP 475** for the rationale).

os.sendfile(*out*, *in*, *offset*, *count*)
os.sendfile(*out*, *in*, *offset*, *count*[, *headers*][, *trailers*], *flags=0*)
Copy *count* bytes from file descriptor *in* to file descriptor *out* starting at *offset*. Return the number of bytes sent. When EOF is reached return 0.

The first function notation is supported by all platforms that define `sendfile()`.

On Linux, if *offset* is given as `None`, the bytes are read from the current position of *in* and the position of *in* is updated.

The second case may be used on Mac OS X and FreeBSD where *headers* and *trailers* are arbitrary sequences of buffers that are written before and after the data from *in* is written. It returns the same as the first case.

On Mac OS X and FreeBSD, a value of 0 for *count* specifies to send until the end of *in* is reached.

All platforms support sockets as *out* file descriptor, and some platforms allow other types (e.g. regular file, pipe) as well.

Cross-platform applications should not use *headers*, *trailers* and *flags* arguments.

Availability: Unix.

Note: For a higher-level wrapper of `sendfile()`, see `socket.socket.sendfile()`.

New in version 3.3.

`os.set_blocking(fd, blocking)`

Set the blocking mode of the specified file descriptor. Set the *O_NONBLOCK* flag if blocking is `False`, clear the flag otherwise.

See also *get_blocking()* and *socket.socket.setblocking()*.

Availability: Unix.

New in version 3.5.

`os.SF_NODISKIO`
`os.SF_MNOWAIT`
`os.SF_SYNC`

Parameters to the *sendfile()* function, if the implementation supports them.

Availability: Unix.

New in version 3.3.

`os.readv(fd, buffers)`

Read from a file descriptor *fd* into a number of mutable *bytes-like objects* *buffers*. Transfer data into each buffer until it is full and then move on to the next buffer in the sequence to hold the rest of the data.

Return the total number of bytes actually read which can be less than the total capacity of all the objects.

The operating system may set a limit (*sysconf()* value `'SC_IOV_MAX'`) on the number of buffers that can be used.

Availability: Unix.

New in version 3.3.

`os.tcgetpgrp(fd)`

Return the process group associated with the terminal given by *fd* (an open file descriptor as returned by *os.open()*).

Availability: Unix.

`os.tcsetpgrp(fd, pg)`

Set the process group associated with the terminal given by *fd* (an open file descriptor as returned by *os.open()*) to *pg*.

Availability: Unix.

`os.ttyname(fd)`

Return a string which specifies the terminal device associated with file descriptor *fd*. If *fd* is not associated with a terminal device, an exception is raised.

Availability: Unix.

`os.write(fd, str)`

Write the bytestring in *str* to file descriptor *fd*.

Return the number of bytes actually written.

Note: This function is intended for low-level I/O and must be applied to a file descriptor as returned by *os.open()* or *pipe()*. To write a "file object" returned by the built-in function *open()* or by *popen()* or *fdopen()*, or *sys.stdout* or *sys.stderr*, use its `write()` method.

Changed in version 3.5: If the system call is interrupted and the signal handler does not raise an exception, the function now retries the system call instead of raising an *InterruptedError* exception (see **PEP 475** for the rationale).

os.**writev**(*fd*, *buffers*)

Write the contents of *buffers* to file descriptor *fd*. *buffers* must be a sequence of *bytes-like objects*. Buffers are processed in array order. Entire contents of the first buffer is written before proceeding to the second, and so on.

Returns the total number of bytes actually written.

The operating system may set a limit (`sysconf()` value `'SC_IOV_MAX'`) on the number of buffers that can be used.

Availability: Unix.

New in version 3.3.

Querying the size of a terminal

New in version 3.3.

os.**get_terminal_size**(*fd=STDOUT_FILENO*)

Return the size of the terminal window as `(columns, lines)`, tuple of type `terminal_size`.

The optional argument `fd` (default `STDOUT_FILENO`, or standard output) specifies which file descriptor should be queried.

If the file descriptor is not connected to a terminal, an `OSError` is raised.

`shutil.get_terminal_size()` is the high-level function which should normally be used, `os.get_terminal_size` is the low-level implementation.

Availability: Unix, Windows.

class os.**terminal_size**

A subclass of tuple, holding `(columns, lines)` of the terminal window size.

columns

Width of the terminal window in characters.

lines

Height of the terminal window in characters.

Inheritance of File Descriptors

New in version 3.4.

A file descriptor has an "inheritable" flag which indicates if the file descriptor can be inherited by child processes. Since Python 3.4, file descriptors created by Python are non-inheritable by default.

On UNIX, non-inheritable file descriptors are closed in child processes at the execution of a new program, other file descriptors are inherited.

On Windows, non-inheritable handles and file descriptors are closed in child processes, except for standard streams (file descriptors 0, 1 and 2: stdin, stdout and stderr), which are always inherited. Using `spawn*` functions, all inheritable handles and all inheritable file descriptors are inherited. Using the `subprocess` module, all file descriptors except standard streams are closed, and inheritable handles are only inherited if the *close_fds* parameter is `False`.

os.**get_inheritable**(*fd*)

Get the "inheritable" flag of the specified file descriptor (a boolean).

os.**set_inheritable**(*fd*, *inheritable*)

Set the "inheritable" flag of the specified file descriptor.

os.get_handle_inheritable(*handle*)
Get the "inheritable" flag of the specified handle (a boolean).

Availability: Windows.

os.set_handle_inheritable(*handle*, *inheritable*)
Set the "inheritable" flag of the specified handle.

Availability: Windows.

16.1.5 Files and Directories

On some Unix platforms, many of these functions support one or more of these features:

- **specifying a file descriptor:** For some functions, the *path* argument can be not only a string giving a path name, but also a file descriptor. The function will then operate on the file referred to by the descriptor. (For POSIX systems, Python will call the `f...` version of the function.)

  You can check whether or not *path* can be specified as a file descriptor on your platform using *os.supports_fd*. If it is unavailable, using it will raise a *NotImplementedError*.

  If the function also supports *dir_fd* or *follow_symlinks* arguments, it is an error to specify one of those when supplying *path* as a file descriptor.

- **paths relative to directory descriptors:** If *dir_fd* is not `None`, it should be a file descriptor referring to a directory, and the path to operate on should be relative; path will then be relative to that directory. If the path is absolute, *dir_fd* is ignored. (For POSIX systems, Python will call the `...at` or `f...at` version of the function.)

  You can check whether or not *dir_fd* is supported on your platform using *os.supports_dir_fd*. If it is unavailable, using it will raise a *NotImplementedError*.

- **not following symlinks:** If *follow_symlinks* is `False`, and the last element of the path to operate on is a symbolic link, the function will operate on the symbolic link itself instead of the file the link points to. (For POSIX systems, Python will call the `l...` version of the function.)

  You can check whether or not *follow_symlinks* is supported on your platform using *os.supports_follow_symlinks*. If it is unavailable, using it will raise a *NotImplementedError*.

os.access(*path*, *mode*, *, *dir_fd=None*, *effective_ids=False*, *follow_symlinks=True*)
Use the real uid/gid to test for access to *path*. Note that most operations will use the effective uid/gid, therefore this routine can be used in a suid/sgid environment to test if the invoking user has the specified access to *path*. *mode* should be *F_OK* to test the existence of *path*, or it can be the inclusive OR of one or more of *R_OK*, *W_OK*, and *X_OK* to test permissions. Return *True* if access is allowed, *False* if not. See the Unix man page *access(2)* for more information.

This function can support specifying *paths relative to directory descriptors* and *not following symlinks*.

If *effective_ids* is `True`, *access()* will perform its access checks using the effective uid/gid instead of the real uid/gid. *effective_ids* may not be supported on your platform; you can check whether or not it is available using *os.supports_effective_ids*. If it is unavailable, using it will raise a *NotImplementedError*.

Note: Using *access()* to check if a user is authorized to e.g. open a file before actually doing so using *open()* creates a security hole, because the user might exploit the short time interval between checking and opening the file to manipulate it. It's preferable to use *EAFP* techniques. For example:

```
if os.access("myfile", os.R_OK):
    with open("myfile") as fp:
```

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```
        return fp.read()
return "some default data"
```

is better written as:

```
try:
    fp = open("myfile")
except PermissionError:
    return "some default data"
else:
    with fp:
        return fp.read()
```

Note: I/O operations may fail even when *access()* indicates that they would succeed, particularly for operations on network filesystems which may have permissions semantics beyond the usual POSIX permission-bit model.

Changed in version 3.3: Added the *dir_fd*, *effective_ids*, and *follow_symlinks* parameters.

Changed in version 3.6: Accepts a *path-like object*.

`os.F_OK`
`os.R_OK`
`os.W_OK`
`os.X_OK`

Values to pass as the *mode* parameter of *access()* to test the existence, readability, writability and executability of *path*, respectively.

`os.chdir(path)`

Change the current working directory to *path*.

This function can support *specifying a file descriptor*. The descriptor must refer to an opened directory, not an open file.

New in version 3.3: Added support for specifying *path* as a file descriptor on some platforms.

Changed in version 3.6: Accepts a *path-like object*.

`os.chflags(path, flags, *, follow_symlinks=True)`

Set the flags of *path* to the numeric *flags*. *flags* may take a combination (bitwise OR) of the following values (as defined in the *stat* module):

- *stat.UF_NODUMP*
- *stat.UF_IMMUTABLE*
- *stat.UF_APPEND*
- *stat.UF_OPAQUE*
- *stat.UF_NOUNLINK*
- *stat.UF_COMPRESSED*
- *stat.UF_HIDDEN*
- *stat.SF_ARCHIVED*
- *stat.SF_IMMUTABLE*

- *stat.SF_APPEND*
- *stat.SF_NOUNLINK*
- *stat.SF_SNAPSHOT*

This function can support *not following symlinks*.

Availability: Unix.

New in version 3.3: The *follow_symlinks* argument.

Changed in version 3.6: Accepts a *path-like object*.

`os.chmod(path, mode, *, dir_fd=None, follow_symlinks=True)`

Change the mode of *path* to the numeric *mode*. *mode* may take one of the following values (as defined in the *stat* module) or bitwise ORed combinations of them:

- *stat.S_ISUID*
- *stat.S_ISGID*
- *stat.S_ENFMT*
- *stat.S_ISVTX*
- *stat.S_IREAD*
- *stat.S_IWRITE*
- *stat.S_IEXEC*
- *stat.S_IRWXU*
- *stat.S_IRUSR*
- *stat.S_IWUSR*
- *stat.S_IXUSR*
- *stat.S_IRWXG*
- *stat.S_IRGRP*
- *stat.S_IWGRP*
- *stat.S_IXGRP*
- *stat.S_IRWXO*
- *stat.S_IROTH*
- *stat.S_IWOTH*
- *stat.S_IXOTH*

This function can support *specifying a file descriptor*, *paths relative to directory descriptors* and *not following symlinks*.

Note: Although Windows supports *chmod()*, you can only set the file's read-only flag with it (via the `stat.S_IWRITE` and `stat.S_IREAD` constants or a corresponding integer value). All other bits are ignored.

New in version 3.3: Added support for specifying *path* as an open file descriptor, and the *dir_fd* and *follow_symlinks* arguments.

Changed in version 3.6: Accepts a *path-like object*.

os.chown(*path*, *uid*, *gid*, ***, *dir_fd=None*, *follow_symlinks=True*)
Change the owner and group id of *path* to the numeric *uid* and *gid*. To leave one of the ids unchanged, set it to -1.

This function can support *specifying a file descriptor*, *paths relative to directory descriptors* and *not following symlinks*.

See `shutil.chown()` for a higher-level function that accepts names in addition to numeric ids.

Availability: Unix.

New in version 3.3: Added support for specifying an open file descriptor for *path*, and the *dir_fd* and *follow_symlinks* arguments.

Changed in version 3.6: Supports a *path-like object*.

os.chroot(*path*)
Change the root directory of the current process to *path*.

Availability: Unix.

Changed in version 3.6: Accepts a *path-like object*.

os.fchdir(*fd*)
Change the current working directory to the directory represented by the file descriptor *fd*. The descriptor must refer to an opened directory, not an open file. As of Python 3.3, this is equivalent to `os.chdir(fd)`.

Availability: Unix.

os.getcwd()
Return a string representing the current working directory.

os.getcwdb()
Return a bytestring representing the current working directory.

os.lchflags(*path*, *flags*)
Set the flags of *path* to the numeric *flags*, like `chflags()`, but do not follow symbolic links. As of Python 3.3, this is equivalent to `os.chflags(path, flags, follow_symlinks=False)`.

Availability: Unix.

Changed in version 3.6: Accepts a *path-like object*.

os.lchmod(*path*, *mode*)
Change the mode of *path* to the numeric *mode*. If path is a symlink, this affects the symlink rather than the target. See the docs for `chmod()` for possible values of *mode*. As of Python 3.3, this is equivalent to `os.chmod(path, mode, follow_symlinks=False)`.

Availability: Unix.

Changed in version 3.6: Accepts a *path-like object*.

os.lchown(*path*, *uid*, *gid*)
Change the owner and group id of *path* to the numeric *uid* and *gid*. This function will not follow symbolic links. As of Python 3.3, this is equivalent to `os.chown(path, uid, gid, follow_symlinks=False)`.

Availability: Unix.

Changed in version 3.6: Accepts a *path-like object*.

os.link(*src*, *dst*, ***, *src_dir_fd=None*, *dst_dir_fd=None*, *follow_symlinks=True*)
Create a hard link pointing to *src* named *dst*.

This function can support specifying *src_dir_fd* and/or *dst_dir_fd* to supply *paths relative to directory descriptors*, and *not following symlinks*.

Availability: Unix, Windows.

Changed in version 3.2: Added Windows support.

New in version 3.3: Added the *src_dir_fd*, *dst_dir_fd*, and *follow_symlinks* arguments.

Changed in version 3.6: Accepts a *path-like object* for *src* and *dst*.

`os.listdir(path='.')`

Return a list containing the names of the entries in the directory given by *path*. The list is in arbitrary order, and does not include the special entries `'.'` and `'..'` even if they are present in the directory.

path may be a *path-like object*. If *path* is of type `bytes` (directly or indirectly through the `PathLike` interface), the filenames returned will also be of type `bytes`; in all other circumstances, they will be of type `str`.

This function can also support *specifying a file descriptor*; the file descriptor must refer to a directory.

Note: To encode `str` filenames to `bytes`, use `fsencode()`.

See also:

The `scandir()` function returns directory entries along with file attribute information, giving better performance for many common use cases.

Changed in version 3.2: The *path* parameter became optional.

New in version 3.3: Added support for specifying an open file descriptor for *path*.

Changed in version 3.6: Accepts a *path-like object*.

`os.lstat(path, *, dir_fd=None)`

Perform the equivalent of an `lstat()` system call on the given path. Similar to `stat()`, but does not follow symbolic links. Return a `stat_result` object.

On platforms that do not support symbolic links, this is an alias for `stat()`.

As of Python 3.3, this is equivalent to `os.stat(path, dir_fd=dir_fd, follow_symlinks=False)`.

This function can also support *paths relative to directory descriptors*.

See also:

The `stat()` function.

Changed in version 3.2: Added support for Windows 6.0 (Vista) symbolic links.

Changed in version 3.3: Added the *dir_fd* parameter.

Changed in version 3.6: Accepts a *path-like object* for *src* and *dst*.

`os.mkdir(path, mode=0o777, *, dir_fd=None)`

Create a directory named *path* with numeric mode *mode*.

If the directory already exists, `FileExistsError` is raised.

On some systems, *mode* is ignored. Where it is used, the current umask value is first masked out. If bits other than the last 9 (i.e. the last 3 digits of the octal representation of the *mode*) are set, their meaning is platform-dependent. On some platforms, they are ignored and you should call `chmod()` explicitly to set them.

This function can also support *paths relative to directory descriptors*.

It is also possible to create temporary directories; see the `tempfile` module's `tempfile.mkdtemp()` function.

New in version 3.3: The *dir_fd* argument.

Changed in version 3.6: Accepts a *path-like object*.

`os.makedirs(name, mode=0o777, exist_ok=False)`

Recursive directory creation function. Like `mkdir()`, but makes all intermediate-level directories needed to contain the leaf directory.

The *mode* parameter is passed to `mkdir()` for creating the leaf directory; see *the mkdir() description* for how it is interpreted. To set the file permission bits of any newly-created parent directories you can set the umask before invoking `makedirs()`. The file permission bits of existing parent directories are not changed.

If *exist_ok* is `False` (the default), an `OSError` is raised if the target directory already exists.

Note: `makedirs()` will become confused if the path elements to create include `pardir` (eg. ".." on UNIX systems).

This function handles UNC paths correctly.

New in version 3.2: The *exist_ok* parameter.

Changed in version 3.4.1: Before Python 3.4.1, if *exist_ok* was `True` and the directory existed, `makedirs()` would still raise an error if *mode* did not match the mode of the existing directory. Since this behavior was impossible to implement safely, it was removed in Python 3.4.1. See bpo-21082.

Changed in version 3.6: Accepts a *path-like object*.

Changed in version 3.7: The *mode* argument no longer affects the file permission bits of newly-created intermediate-level directories.

`os.mkfifo(path, mode=0o666, *, dir_fd=None)`

Create a FIFO (a named pipe) named *path* with numeric mode *mode*. The current umask value is first masked out from the mode.

This function can also support *paths relative to directory descriptors*.

FIFOs are pipes that can be accessed like regular files. FIFOs exist until they are deleted (for example with `os.unlink()`). Generally, FIFOs are used as rendezvous between "client" and "server" type processes: the server opens the FIFO for reading, and the client opens it for writing. Note that `mkfifo()` doesn't open the FIFO — it just creates the rendezvous point.

Availability: Unix.

New in version 3.3: The *dir_fd* argument.

Changed in version 3.6: Accepts a *path-like object*.

`os.mknod(path, mode=0o600, device=0, *, dir_fd=None)`

Create a filesystem node (file, device special file or named pipe) named *path*. *mode* specifies both the permissions to use and the type of node to be created, being combined (bitwise OR) with one of `stat.S_IFREG`, `stat.S_IFCHR`, `stat.S_IFBLK`, and `stat.S_IFIFO` (those constants are available in `stat`). For `stat.S_IFCHR` and `stat.S_IFBLK`, *device* defines the newly created device special file (probably using `os.makedev()`), otherwise it is ignored.

This function can also support *paths relative to directory descriptors*.

Availability: Unix.

New in version 3.3: The *dir_fd* argument.

Changed in version 3.6: Accepts a *path-like object*.

`os.major(device)`

Extract the device major number from a raw device number (usually the `st_dev` or `st_rdev` field from `stat`).

`os.minor`(*device*)
Extract the device minor number from a raw device number (usually the `st_dev` or `st_rdev` field from `stat`).

`os.makedev`(*major*, *minor*)
Compose a raw device number from the major and minor device numbers.

`os.pathconf`(*path*, *name*)
Return system configuration information relevant to a named file. *name* specifies the configuration value to retrieve; it may be a string which is the name of a defined system value; these names are specified in a number of standards (POSIX.1, Unix 95, Unix 98, and others). Some platforms define additional names as well. The names known to the host operating system are given in the `pathconf_names` dictionary. For configuration variables not included in that mapping, passing an integer for *name* is also accepted.

If *name* is a string and is not known, `ValueError` is raised. If a specific value for *name* is not supported by the host system, even if it is included in `pathconf_names`, an `OSError` is raised with `errno.EINVAL` for the error number.

This function can support *specifying a file descriptor*.

Availability: Unix.

Changed in version 3.6: Accepts a *path-like object*.

`os.pathconf_names`
Dictionary mapping names accepted by `pathconf()` and `fpathconf()` to the integer values defined for those names by the host operating system. This can be used to determine the set of names known to the system.

Availability: Unix.

`os.readlink`(*path*, ***, *dir_fd=None*)
Return a string representing the path to which the symbolic link points. The result may be either an absolute or relative pathname; if it is relative, it may be converted to an absolute pathname using `os.path.join(os.path.dirname(path), result)`.

If the *path* is a string object (directly or indirectly through a `PathLike` interface), the result will also be a string object, and the call may raise a UnicodeDecodeError. If the *path* is a bytes object (direct or indirectly), the result will be a bytes object.

This function can also support *paths relative to directory descriptors*.

Availability: Unix, Windows.

Changed in version 3.2: Added support for Windows 6.0 (Vista) symbolic links.

New in version 3.3: The *dir_fd* argument.

Changed in version 3.6: Accepts a *path-like object*.

`os.remove`(*path*, ***, *dir_fd=None*)
Remove (delete) the file *path*. If *path* is a directory, `OSError` is raised. Use `rmdir()` to remove directories.

This function can support *paths relative to directory descriptors*.

On Windows, attempting to remove a file that is in use causes an exception to be raised; on Unix, the directory entry is removed but the storage allocated to the file is not made available until the original file is no longer in use.

This function is semantically identical to `unlink()`.

New in version 3.3: The *dir_fd* argument.

Changed in version 3.6: Accepts a *path-like object*.

`os.removedirs(name)`
Remove directories recursively. Works like `rmdir()` except that, if the leaf directory is successfully removed, `removedirs()` tries to successively remove every parent directory mentioned in *path* until an error is raised (which is ignored, because it generally means that a parent directory is not empty). For example, `os.removedirs('foo/bar/baz')` will first remove the directory `'foo/bar/baz'`, and then remove `'foo/bar'` and `'foo'` if they are empty. Raises `OSError` if the leaf directory could not be successfully removed.

Changed in version 3.6: Accepts a *path-like object*.

`os.rename(src, dst, *, src_dir_fd=None, dst_dir_fd=None)`
Rename the file or directory *src* to *dst*. If *dst* is a directory, `OSError` will be raised. On Unix, if *dst* exists and is a file, it will be replaced silently if the user has permission. The operation may fail on some Unix flavors if *src* and *dst* are on different filesystems. If successful, the renaming will be an atomic operation (this is a POSIX requirement). On Windows, if *dst* already exists, `OSError` will be raised even if it is a file.

This function can support specifying *src_dir_fd* and/or *dst_dir_fd* to supply *paths relative to directory descriptors*.

If you want cross-platform overwriting of the destination, use `replace()`.

New in version 3.3: The *src_dir_fd* and *dst_dir_fd* arguments.

Changed in version 3.6: Accepts a *path-like object* for *src* and *dst*.

`os.renames(old, new)`
Recursive directory or file renaming function. Works like `rename()`, except creation of any intermediate directories needed to make the new pathname good is attempted first. After the rename, directories corresponding to rightmost path segments of the old name will be pruned away using `removedirs()`.

Note: This function can fail with the new directory structure made if you lack permissions needed to remove the leaf directory or file.

Changed in version 3.6: Accepts a *path-like object* for *old* and *new*.

`os.replace(src, dst, *, src_dir_fd=None, dst_dir_fd=None)`
Rename the file or directory *src* to *dst*. If *dst* is a directory, `OSError` will be raised. If *dst* exists and is a file, it will be replaced silently if the user has permission. The operation may fail if *src* and *dst* are on different filesystems. If successful, the renaming will be an atomic operation (this is a POSIX requirement).

This function can support specifying *src_dir_fd* and/or *dst_dir_fd* to supply *paths relative to directory descriptors*.

New in version 3.3.

Changed in version 3.6: Accepts a *path-like object* for *src* and *dst*.

`os.rmdir(path, *, dir_fd=None)`
Remove (delete) the directory *path*. Only works when the directory is empty, otherwise, `OSError` is raised. In order to remove whole directory trees, `shutil.rmtree()` can be used.

This function can support *paths relative to directory descriptors*.

New in version 3.3: The *dir_fd* parameter.

Changed in version 3.6: Accepts a *path-like object*.

`os.scandir(path='.')`
Return an iterator of `os.DirEntry` objects corresponding to the entries in the directory given by *path*. The entries are yielded in arbitrary order, and the special entries `'.'` and `'..'` are not included.

Using *scandir()* instead of *listdir()* can significantly increase the performance of code that also needs file type or file attribute information, because *os.DirEntry* objects expose this information if the operating system provides it when scanning a directory. All *os.DirEntry* methods may perform a system call, but *is_dir()* and *is_file()* usually only require a system call for symbolic links; *os.DirEntry.stat()* always requires a system call on Unix but only requires one for symbolic links on Windows.

path may be a *path-like object*. If *path* is of type `bytes` (directly or indirectly through the *PathLike* interface), the type of the *name* and *path* attributes of each *os.DirEntry* will be `bytes`; in all other circumstances, they will be of type `str`.

This function can also support *specifying a file descriptor*; the file descriptor must refer to a directory.

The *scandir()* iterator supports the *context manager* protocol and has the following method:

`scandir.close()`

Close the iterator and free acquired resources.

This is called automatically when the iterator is exhausted or garbage collected, or when an error happens during iterating. However it is advisable to call it explicitly or use the `with` statement.

New in version 3.6.

The following example shows a simple use of *scandir()* to display all the files (excluding directories) in the given *path* that don't start with `'.'`. The `entry.is_file()` call will generally not make an additional system call:

```
with os.scandir(path) as it:
    for entry in it:
        if not entry.name.startswith('.') and entry.is_file():
            print(entry.name)
```

Note: On Unix-based systems, *scandir()* uses the system's opendir() and readdir() functions. On Windows, it uses the Win32 FindFirstFileW and FindNextFileW functions.

New in version 3.5.

New in version 3.6: Added support for the *context manager* protocol and the *close()* method. If a *scandir()* iterator is neither exhausted nor explicitly closed a *ResourceWarning* will be emitted in its destructor.

The function accepts a *path-like object*.

Changed in version 3.7: Added support for *file descriptors* on Unix.

`class os.DirEntry`

Object yielded by *scandir()* to expose the file path and other file attributes of a directory entry.

scandir() will provide as much of this information as possible without making additional system calls. When a `stat()` or `lstat()` system call is made, the `os.DirEntry` object will cache the result.

`os.DirEntry` instances are not intended to be stored in long-lived data structures; if you know the file metadata has changed or if a long time has elapsed since calling *scandir()*, call `os.stat(entry.path)` to fetch up-to-date information.

Because the `os.DirEntry` methods can make operating system calls, they may also raise *OSError*. If you need very fine-grained control over errors, you can catch *OSError* when calling one of the `os.DirEntry` methods and handle as appropriate.

To be directly usable as a *path-like object*, `os.DirEntry` implements the *PathLike* interface.

Attributes and methods on a `os.DirEntry` instance are as follows:

name

The entry's base filename, relative to the *scandir()* *path* argument.

The *name* attribute will be `bytes` if the *scandir()* *path* argument is of type `bytes` and `str` otherwise. Use *fsdecode()* to decode byte filenames.

path

The entry's full path name: equivalent to `os.path.join(scandir_path, entry.name)` where *scandir_path* is the *scandir()* *path* argument. The path is only absolute if the *scandir()* *path* argument was absolute. If the *scandir()* *path* argument was a *file descriptor*, the *path* attribute is the same as the *name* attribute.

The *path* attribute will be `bytes` if the *scandir()* *path* argument is of type `bytes` and `str` otherwise. Use *fsdecode()* to decode byte filenames.

inode()

Return the inode number of the entry.

The result is cached on the `os.DirEntry` object. Use `os.stat(entry.path, follow_symlinks=False).st_ino` to fetch up-to-date information.

On the first, uncached call, a system call is required on Windows but not on Unix.

is_dir(**, follow_symlinks=True*)

Return `True` if this entry is a directory or a symbolic link pointing to a directory; return `False` if the entry is or points to any other kind of file, or if it doesn't exist anymore.

If *follow_symlinks* is `False`, return `True` only if this entry is a directory (without following symlinks); return `False` if the entry is any other kind of file or if it doesn't exist anymore.

The result is cached on the `os.DirEntry` object, with a separate cache for *follow_symlinks* `True` and `False`. Call *os.stat()* along with *stat.S_ISDIR()* to fetch up-to-date information.

On the first, uncached call, no system call is required in most cases. Specifically, for non-symlinks, neither Windows or Unix require a system call, except on certain Unix file systems, such as network file systems, that return `dirent.d_type == DT_UNKNOWN`. If the entry is a symlink, a system call will be required to follow the symlink unless *follow_symlinks* is `False`.

This method can raise *OSError*, such as *PermissionError*, but *FileNotFoundError* is caught and not raised.

is_file(**, follow_symlinks=True*)

Return `True` if this entry is a file or a symbolic link pointing to a file; return `False` if the entry is or points to a directory or other non-file entry, or if it doesn't exist anymore.

If *follow_symlinks* is `False`, return `True` only if this entry is a file (without following symlinks); return `False` if the entry is a directory or other non-file entry, or if it doesn't exist anymore.

The result is cached on the `os.DirEntry` object. Caching, system calls made, and exceptions raised are as per *is_dir()*.

is_symlink()

Return `True` if this entry is a symbolic link (even if broken); return `False` if the entry points to a directory or any kind of file, or if it doesn't exist anymore.

The result is cached on the `os.DirEntry` object. Call *os.path.islink()* to fetch up-to-date information.

On the first, uncached call, no system call is required in most cases. Specifically, neither Windows or Unix require a system call, except on certain Unix file systems, such as network file systems, that return `dirent.d_type == DT_UNKNOWN`.

This method can raise *OSError*, such as *PermissionError*, but *FileNotFoundError* is caught and not raised.

stat(**, follow_symlinks=True*)

Return a *stat_result* object for this entry. This method follows symbolic links by default; to stat a symbolic link add the `follow_symlinks=False` argument.

On Unix, this method always requires a system call. On Windows, it only requires a system call if *follow_symlinks* is `True` and the entry is a symbolic link.

On Windows, the `st_ino`, `st_dev` and `st_nlink` attributes of the *stat_result* are always set to zero. Call *os.stat()* to get these attributes.

The result is cached on the `os.DirEntry` object, with a separate cache for *follow_symlinks* `True` and `False`. Call *os.stat()* to fetch up-to-date information.

Note that there is a nice correspondence between several attributes and methods of `os.DirEntry` and of *pathlib.Path*. In particular, the `name` attribute has the same meaning, as do the `is_dir()`, `is_file()`, `is_symlink()` and `stat()` methods.

New in version 3.5.

Changed in version 3.6: Added support for the *PathLike* interface. Added support for *bytes* paths on Windows.

`os.`**stat**(*path, *, dir_fd=None, follow_symlinks=True*)

Get the status of a file or a file descriptor. Perform the equivalent of a `stat()` system call on the given path. *path* may be specified as either a string or bytes – directly or indirectly through the *PathLike* interface – or as an open file descriptor. Return a *stat_result* object.

This function normally follows symlinks; to stat a symlink add the argument `follow_symlinks=False`, or use *lstat()*.

This function can support *specifying a file descriptor* and *not following symlinks*.

Example:

```
>>> import os
>>> statinfo = os.stat('somefile.txt')
>>> statinfo
os.stat_result(st_mode=33188, st_ino=7876932, st_dev=234881026,
st_nlink=1, st_uid=501, st_gid=501, st_size=264, st_atime=1297230295,
st_mtime=1297230027, st_ctime=1297230027)
>>> statinfo.st_size
264
```

See also:

fstat() and *lstat()* functions.

New in version 3.3: Added the *dir_fd* and *follow_symlinks* arguments, specifying a file descriptor instead of a path.

Changed in version 3.6: Accepts a *path-like object*.

class `os.`**stat_result**

Object whose attributes correspond roughly to the members of the `stat` structure. It is used for the result of *os.stat()*, *os.fstat()* and *os.lstat()*.

Attributes:

st_mode

File mode: file type and file mode bits (permissions).

st_ino

Platform dependent, but if non-zero, uniquely identifies the file for a given value of `st_dev`. Typically:

- the inode number on Unix,
- the file index on Windows

st_dev
Identifier of the device on which this file resides.

st_nlink
Number of hard links.

st_uid
User identifier of the file owner.

st_gid
Group identifier of the file owner.

st_size
Size of the file in bytes, if it is a regular file or a symbolic link. The size of a symbolic link is the length of the pathname it contains, without a terminating null byte.

Timestamps:

st_atime
Time of most recent access expressed in seconds.

st_mtime
Time of most recent content modification expressed in seconds.

st_ctime
Platform dependent:

- the time of most recent metadata change on Unix,
- the time of creation on Windows, expressed in seconds.

st_atime_ns
Time of most recent access expressed in nanoseconds as an integer.

st_mtime_ns
Time of most recent content modification expressed in nanoseconds as an integer.

st_ctime_ns
Platform dependent:

- the time of most recent metadata change on Unix,
- the time of creation on Windows, expressed in nanoseconds as an integer.

Note: The exact meaning and resolution of the *st_atime*, *st_mtime*, and *st_ctime* attributes depend on the operating system and the file system. For example, on Windows systems using the FAT or FAT32 file systems, *st_mtime* has 2-second resolution, and *st_atime* has only 1-day resolution. See your operating system documentation for details.

Similarly, although *st_atime_ns*, *st_mtime_ns*, and *st_ctime_ns* are always expressed in nanoseconds, many systems do not provide nanosecond precision. On systems that do provide nanosecond precision, the floating-point object used to store *st_atime*, *st_mtime*, and *st_ctime* cannot preserve all of it, and as such will be slightly inexact. If you need the exact timestamps you should always use *st_atime_ns*, *st_mtime_ns*, and *st_ctime_ns*.

On some Unix systems (such as Linux), the following attributes may also be available:

st_blocks
Number of 512-byte blocks allocated for file. This may be smaller than *st_size*/512 when the file has holes.

st_blksize
"Preferred" blocksize for efficient file system I/O. Writing to a file in smaller chunks may cause an inefficient read-modify-rewrite.

st_rdev
Type of device if an inode device.

st_flags
User defined flags for file.

On other Unix systems (such as FreeBSD), the following attributes may be available (but may be only filled out if root tries to use them):

st_gen
File generation number.

st_birthtime
Time of file creation.

On Solaris and derivatives, the following attributes may also be available:

st_fstype
String that uniquely identifies the type of the filesystem that contains the file.

On Mac OS systems, the following attributes may also be available:

st_rsize
Real size of the file.

st_creator
Creator of the file.

st_type
File type.

On Windows systems, the following attribute is also available:

st_file_attributes
Windows file attributes: `dwFileAttributes` member of the `BY_HANDLE_FILE_INFORMATION` structure returned by `GetFileInformationByHandle()`. See the `FILE_ATTRIBUTE_*` constants in the *stat* module.

The standard module *stat* defines functions and constants that are useful for extracting information from a `stat` structure. (On Windows, some items are filled with dummy values.)

For backward compatibility, a *stat_result* instance is also accessible as a tuple of at least 10 integers giving the most important (and portable) members of the `stat` structure, in the order *st_mode*, *st_ino*, *st_dev*, *st_nlink*, *st_uid*, *st_gid*, *st_size*, *st_atime*, *st_mtime*, *st_ctime*. More items may be added at the end by some implementations. For compatibility with older Python versions, accessing *stat_result* as a tuple always returns integers.

New in version 3.3: Added the *st_atime_ns*, *st_mtime_ns*, and *st_ctime_ns* members.

New in version 3.5: Added the *st_file_attributes* member on Windows.

Changed in version 3.5: Windows now returns the file index as *st_ino* when available.

New in version 3.7: Added the *st_fstype* member to Solaris/derivatives.

os.**statvfs**(*path*)
Perform a `statvfs()` system call on the given path. The return value is an object whose attributes describe the filesystem on the given path, and correspond to the members of the `statvfs` structure, namely: `f_bsize`, `f_frsize`, `f_blocks`, `f_bfree`, `f_bavail`, `f_files`, `f_ffree`, `f_favail`, `f_flag`, `f_namemax`, `f_fsid`.

Two module-level constants are defined for the `f_flag` attribute's bit-flags: if `ST_RDONLY` is set, the filesystem is mounted read-only, and if `ST_NOSUID` is set, the semantics of setuid/setgid bits are disabled or not supported.

Additional module-level constants are defined for GNU/glibc based systems. These are `ST_NODEV` (disallow access to device special files), `ST_NOEXEC` (disallow program execution), `ST_SYNCHRONOUS` (writes are synced at once), `ST_MANDLOCK` (allow mandatory locks on an FS), `ST_WRITE` (write on file/directory/symlink), `ST_APPEND` (append-only file), `ST_IMMUTABLE` (immutable file), `ST_NOATIME` (do not update access times), `ST_NODIRATIME` (do not update directory access times), `ST_RELATIME` (update atime relative to mtime/ctime).

This function can support *specifying a file descriptor*.

Availability: Unix.

Changed in version 3.2: The `ST_RDONLY` and `ST_NOSUID` constants were added.

New in version 3.3: Added support for specifying an open file descriptor for *path*.

Changed in version 3.4: The `ST_NODEV`, `ST_NOEXEC`, `ST_SYNCHRONOUS`, `ST_MANDLOCK`, `ST_WRITE`, `ST_APPEND`, `ST_IMMUTABLE`, `ST_NOATIME`, `ST_NODIRATIME`, and `ST_RELATIME` constants were added.

Changed in version 3.6: Accepts a *path-like object*.

New in version 3.7: Added `f_fsid`.

os.supports_dir_fd

A *Set* object indicating which functions in the *os* module permit use of their *dir_fd* parameter. Different platforms provide different functionality, and an option that might work on one might be unsupported on another. For consistency's sakes, functions that support *dir_fd* always allow specifying the parameter, but will raise an exception if the functionality is not actually available.

To check whether a particular function permits use of its *dir_fd* parameter, use the `in` operator on `supports_dir_fd`. As an example, this expression determines whether the *dir_fd* parameter of *os.stat()* is locally available:

```
os.stat in os.supports_dir_fd
```

Currently *dir_fd* parameters only work on Unix platforms; none of them work on Windows.

New in version 3.3.

os.supports_effective_ids

A *Set* object indicating which functions in the *os* module permit use of the *effective_ids* parameter for *os.access()*. If the local platform supports it, the collection will contain *os.access()*, otherwise it will be empty.

To check whether you can use the *effective_ids* parameter for *os.access()*, use the `in` operator on `supports_effective_ids`, like so:

```
os.access in os.supports_effective_ids
```

Currently *effective_ids* only works on Unix platforms; it does not work on Windows.

New in version 3.3.

os.supports_fd

A *Set* object indicating which functions in the *os* module permit specifying their *path* parameter as an open file descriptor. Different platforms provide different functionality, and an option that might work on one might be unsupported on another. For consistency's sakes, functions that support *fd* always allow specifying the parameter, but will raise an exception if the functionality is not actually available.

To check whether a particular function permits specifying an open file descriptor for its *path* parameter, use the `in` operator on `supports_fd`. As an example, this expression determines whether *os.chdir()* accepts open file descriptors when called on your local platform:

```
os.chdir in os.supports_fd
```

New in version 3.3.

os.supports_follow_symlinks

A *Set* object indicating which functions in the *os* module permit use of their *follow_symlinks* parameter. Different platforms provide different functionality, and an option that might work on one might be unsupported on another. For consistency's sakes, functions that support *follow_symlinks* always allow specifying the parameter, but will raise an exception if the functionality is not actually available.

To check whether a particular function permits use of its *follow_symlinks* parameter, use the `in` operator on `supports_follow_symlinks`. As an example, this expression determines whether the *follow_symlinks* parameter of *os.stat()* is locally available:

```
os.stat in os.supports_follow_symlinks
```

New in version 3.3.

os.symlink(*src*, *dst*, *target_is_directory=False*, ***, *dir_fd=None*)

Create a symbolic link pointing to *src* named *dst*.

On Windows, a symlink represents either a file or a directory, and does not morph to the target dynamically. If the target is present, the type of the symlink will be created to match. Otherwise, the symlink will be created as a directory if *target_is_directory* is `True` or a file symlink (the default) otherwise. On non-Windows platforms, *target_is_directory* is ignored.

Symbolic link support was introduced in Windows 6.0 (Vista). *symlink()* will raise a *NotImplementedError* on Windows versions earlier than 6.0.

This function can support *paths relative to directory descriptors*.

Note: On Windows, the *SeCreateSymbolicLinkPrivilege* is required in order to successfully create symlinks. This privilege is not typically granted to regular users but is available to accounts which can escalate privileges to the administrator level. Either obtaining the privilege or running your application as an administrator are ways to successfully create symlinks.

OSError is raised when the function is called by an unprivileged user.

Availability: Unix, Windows.

Changed in version 3.2: Added support for Windows 6.0 (Vista) symbolic links.

New in version 3.3: Added the *dir_fd* argument, and now allow *target_is_directory* on non-Windows platforms.

Changed in version 3.6: Accepts a *path-like object* for *src* and *dst*.

os.sync()

Force write of everything to disk.

Availability: Unix.

New in version 3.3.

os.truncate(*path*, *length*)

Truncate the file corresponding to *path*, so that it is at most *length* bytes in size.

This function can support *specifying a file descriptor*.

Availability: Unix, Windows.

New in version 3.3.

Changed in version 3.5: Added support for Windows

Changed in version 3.6: Accepts a *path-like object*.

`os.unlink(path, *, dir_fd=None)`

Remove (delete) the file *path*. This function is semantically identical to `remove()`; the `unlink` name is its traditional Unix name. Please see the documentation for `remove()` for further information.

New in version 3.3: The *dir_fd* parameter.

Changed in version 3.6: Accepts a *path-like object*.

`os.utime(path, times=None, *[, ns], dir_fd=None, follow_symlinks=True)`

Set the access and modified times of the file specified by *path*.

`utime()` takes two optional parameters, *times* and *ns*. These specify the times set on *path* and are used as follows:

- If *ns* is specified, it must be a 2-tuple of the form `(atime_ns, mtime_ns)` where each member is an int expressing nanoseconds.
- If *times* is not `None`, it must be a 2-tuple of the form `(atime, mtime)` where each member is an int or float expressing seconds.
- If *times* is `None` and *ns* is unspecified, this is equivalent to specifying `ns=(atime_ns, mtime_ns)` where both times are the current time.

It is an error to specify tuples for both *times* and *ns*.

Whether a directory can be given for *path* depends on whether the operating system implements directories as files (for example, Windows does not). Note that the exact times you set here may not be returned by a subsequent `stat()` call, depending on the resolution with which your operating system records access and modification times; see `stat()`. The best way to preserve exact times is to use the *st_atime_ns* and *st_mtime_ns* fields from the `os.stat()` result object with the *ns* parameter to *utime*.

This function can support *specifying a file descriptor*, *paths relative to directory descriptors* and *not following symlinks*.

New in version 3.3: Added support for specifying an open file descriptor for *path*, and the *dir_fd*, *follow_symlinks*, and *ns* parameters.

Changed in version 3.6: Accepts a *path-like object*.

`os.walk(top, topdown=True, onerror=None, followlinks=False)`

Generate the file names in a directory tree by walking the tree either top-down or bottom-up. For each directory in the tree rooted at directory *top* (including *top* itself), it yields a 3-tuple `(dirpath, dirnames, filenames)`.

dirpath is a string, the path to the directory. *dirnames* is a list of the names of the subdirectories in *dirpath* (excluding `'.'` and `'..'`). *filenames* is a list of the names of the non-directory files in *dirpath*. Note that the names in the lists contain no path components. To get a full path (which begins with *top*) to a file or directory in *dirpath*, do `os.path.join(dirpath, name)`.

If optional argument *topdown* is `True` or not specified, the triple for a directory is generated before the triples for any of its subdirectories (directories are generated top-down). If *topdown* is `False`, the triple for a directory is generated after the triples for all of its subdirectories (directories are generated bottom-up). No matter the value of *topdown*, the list of subdirectories is retrieved before the tuples for the directory and its subdirectories are generated.

When *topdown* is `True`, the caller can modify the *dirnames* list in-place (perhaps using `del` or slice assignment), and *walk()* will only recurse into the subdirectories whose names remain in *dirnames*; this can be used to prune the search, impose a specific order of visiting, or even to inform *walk()* about directories the caller creates or renames before it resumes *walk()* again. Modifying *dirnames* when *topdown* is `False` has no effect on the behavior of the walk, because in bottom-up mode the directories in *dirnames* are generated before *dirpath* itself is generated.

By default, errors from the *scandir()* call are ignored. If optional argument *onerror* is specified, it should be a function; it will be called with one argument, an *OSError* instance. It can report the error to continue with the walk, or raise the exception to abort the walk. Note that the filename is available as the `filename` attribute of the exception object.

By default, *walk()* will not walk down into symbolic links that resolve to directories. Set *followlinks* to `True` to visit directories pointed to by symlinks, on systems that support them.

Note: Be aware that setting *followlinks* to `True` can lead to infinite recursion if a link points to a parent directory of itself. *walk()* does not keep track of the directories it visited already.

Note: If you pass a relative pathname, don't change the current working directory between resumptions of *walk()*. *walk()* never changes the current directory, and assumes that its caller doesn't either.

This example displays the number of bytes taken by non-directory files in each directory under the starting directory, except that it doesn't look under any CVS subdirectory:

```
import os
from os.path import join, getsize
for root, dirs, files in os.walk('python/Lib/email'):
    print(root, "consumes", end=" ")
    print(sum(getsize(join(root, name)) for name in files), end=" ")
    print("bytes in", len(files), "non-directory files")
    if 'CVS' in dirs:
        dirs.remove('CVS')  # don't visit CVS directories
```

In the next example (simple implementation of *shutil.rmtree()*), walking the tree bottom-up is essential, *rmdir()* doesn't allow deleting a directory before the directory is empty:

```
# Delete everything reachable from the directory named in "top",
# assuming there are no symbolic links.
# CAUTION:  This is dangerous!  For example, if top == '/', it
# could delete all your disk files.
import os
for root, dirs, files in os.walk(top, topdown=False):
    for name in files:
        os.remove(os.path.join(root, name))
    for name in dirs:
        os.rmdir(os.path.join(root, name))
```

Changed in version 3.5: This function now calls *os.scandir()* instead of *os.listdir()*, making it faster by reducing the number of calls to *os.stat()*.

Changed in version 3.6: Accepts a *path-like object*.

`os.fwalk`(*top='.'*, *topdown=True*, *onerror=None*, ***, *follow_symlinks=False*, *dir_fd=None*)

This behaves exactly like *walk()*, except that it yields a 4-tuple `(dirpath, dirnames, filenames,` dirfd), and it supports dir_fd.

dirpath, *dirnames* and *filenames* are identical to *walk()* output, and *dirfd* is a file descriptor referring to the directory *dirpath*.

This function always supports *paths relative to directory descriptors* and *not following symlinks*. Note however that, unlike other functions, the *fwalk()* default value for *follow_symlinks* is False.

Note: Since *fwalk()* yields file descriptors, those are only valid until the next iteration step, so you should duplicate them (e.g. with *dup()*) if you want to keep them longer.

This example displays the number of bytes taken by non-directory files in each directory under the starting directory, except that it doesn't look under any CVS subdirectory:

```
import os
for root, dirs, files, rootfd in os.fwalk('python/Lib/email'):
    print(root, "consumes", end="")
    print(sum([os.stat(name, dir_fd=rootfd).st_size for name in files]),
          end="")
    print("bytes in", len(files), "non-directory files")
    if 'CVS' in dirs:
        dirs.remove('CVS')  # don't visit CVS directories
```

In the next example, walking the tree bottom-up is essential: *rmdir()* doesn't allow deleting a directory before the directory is empty:

```
# Delete everything reachable from the directory named in "top",
# assuming there are no symbolic links.
# CAUTION:  This is dangerous!  For example, if top == '/', it
# could delete all your disk files.
import os
for root, dirs, files, rootfd in os.fwalk(top, topdown=False):
    for name in files:
        os.unlink(name, dir_fd=rootfd)
    for name in dirs:
        os.rmdir(name, dir_fd=rootfd)
```

Availability: Unix.

New in version 3.3.

Changed in version 3.6: Accepts a *path-like object*.

Changed in version 3.7: Added support for *bytes* paths.

Linux extended attributes

New in version 3.3.

These functions are all available on Linux only.

os.**getxattr**(*path*, *attribute*, *, *follow_symlinks=True*)

Return the value of the extended filesystem attribute *attribute* for *path*. *attribute* can be bytes or str (directly or indirectly through the *PathLike* interface). If it is str, it is encoded with the filesystem encoding.

This function can support *specifying a file descriptor* and *not following symlinks*.

Changed in version 3.6: Accepts a *path-like object* for *path* and *attribute*.

`os.listxattr(path=None, *, follow_symlinks=True)`

Return a list of the extended filesystem attributes on *path*. The attributes in the list are represented as strings decoded with the filesystem encoding. If *path* is `None`, `listxattr()` will examine the current directory.

This function can support *specifying a file descriptor* and *not following symlinks*.

Changed in version 3.6: Accepts a *path-like object*.

`os.removexattr(path, attribute, *, follow_symlinks=True)`

Removes the extended filesystem attribute *attribute* from *path*. *attribute* should be bytes or str (directly or indirectly through the `PathLike` interface). If it is a string, it is encoded with the filesystem encoding.

This function can support *specifying a file descriptor* and *not following symlinks*.

Changed in version 3.6: Accepts a *path-like object* for *path* and *attribute*.

`os.setxattr(path, attribute, value, flags=0, *, follow_symlinks=True)`

Set the extended filesystem attribute *attribute* on *path* to *value*. *attribute* must be a bytes or str with no embedded NULs (directly or indirectly through the `PathLike` interface). If it is a str, it is encoded with the filesystem encoding. *flags* may be `XATTR_REPLACE` or `XATTR_CREATE`. If `XATTR_REPLACE` is given and the attribute does not exist, `EEXISTS` will be raised. If `XATTR_CREATE` is given and the attribute already exists, the attribute will not be created and `ENODATA` will be raised.

This function can support *specifying a file descriptor* and *not following symlinks*.

Note: A bug in Linux kernel versions less than 2.6.39 caused the flags argument to be ignored on some filesystems.

Changed in version 3.6: Accepts a *path-like object* for *path* and *attribute*.

`os.XATTR_SIZE_MAX`

The maximum size the value of an extended attribute can be. Currently, this is 64 KiB on Linux.

`os.XATTR_CREATE`

This is a possible value for the flags argument in `setxattr()`. It indicates the operation must create an attribute.

`os.XATTR_REPLACE`

This is a possible value for the flags argument in `setxattr()`. It indicates the operation must replace an existing attribute.

16.1.6 Process Management

These functions may be used to create and manage processes.

The various `exec*` functions take a list of arguments for the new program loaded into the process. In each case, the first of these arguments is passed to the new program as its own name rather than as an argument a user may have typed on a command line. For the C programmer, this is the `argv[0]` passed to a program's `main()`. For example, `os.execv('/bin/echo', ['foo', 'bar'])` will only print `bar` on standard output; `foo` will seem to be ignored.

`os.abort()`

Generate a `SIGABRT` signal to the current process. On Unix, the default behavior is to produce a core dump; on Windows, the process immediately returns an exit code of `3`. Be aware that calling this function will not call the Python signal handler registered for `SIGABRT` with `signal.signal()`.

`os.execl(path, arg0, arg1, ...)`
`os.execle(path, arg0, arg1, ..., env)`

os.**execlp**(*file*, *arg0*, *arg1*, *...*)
os.**execlpe**(*file*, *arg0*, *arg1*, *...*, *env*)
os.**execv**(*path*, *args*)
os.**execve**(*path*, *args*, *env*)
os.**execvp**(*file*, *args*)
os.**execvpe**(*file*, *args*, *env*)

These functions all execute a new program, replacing the current process; they do not return. On Unix, the new executable is loaded into the current process, and will have the same process id as the caller. Errors will be reported as *OSError* exceptions.

The current process is replaced immediately. Open file objects and descriptors are not flushed, so if there may be data buffered on these open files, you should flush them using `sys.stdout.flush()` or *os.fsync()* before calling an *exec** function.

The "l" and "v" variants of the *exec** functions differ in how command-line arguments are passed. The "l" variants are perhaps the easiest to work with if the number of parameters is fixed when the code is written; the individual parameters simply become additional parameters to the `execl*()` functions. The "v" variants are good when the number of parameters is variable, with the arguments being passed in a list or tuple as the *args* parameter. In either case, the arguments to the child process should start with the name of the command being run, but this is not enforced.

The variants which include a "p" near the end (*execlp()*, *execlpe()*, *execvp()*, and *execvpe()*) will use the `PATH` environment variable to locate the program *file*. When the environment is being replaced (using one of the *exec*e* variants, discussed in the next paragraph), the new environment is used as the source of the `PATH` variable. The other variants, *execl()*, *execle()*, *execv()*, and *execve()*, will not use the `PATH` variable to locate the executable; *path* must contain an appropriate absolute or relative path.

For *execle()*, *execlpe()*, *execve()*, and *execvpe()* (note that these all end in "e"), the *env* parameter must be a mapping which is used to define the environment variables for the new process (these are used instead of the current process' environment); the functions *execl()*, *execlp()*, *execv()*, and *execvp()* all cause the new process to inherit the environment of the current process.

For *execve()* on some platforms, *path* may also be specified as an open file descriptor. This functionality may not be supported on your platform; you can check whether or not it is available using *os.supports_fd*. If it is unavailable, using it will raise a *NotImplementedError*.

Availability: Unix, Windows.

New in version 3.3: Added support for specifying an open file descriptor for *path* for *execve()*.

Changed in version 3.6: Accepts a *path-like object*.

os.**_exit**(*n*)

Exit the process with status *n*, without calling cleanup handlers, flushing stdio buffers, etc.

Note: The standard way to exit is `sys.exit(n)`. *_exit()* should normally only be used in the child process after a *fork()*.

The following exit codes are defined and can be used with *_exit()*, although they are not required. These are typically used for system programs written in Python, such as a mail server's external command delivery program.

Note: Some of these may not be available on all Unix platforms, since there is some variation. These constants are defined where they are defined by the underlying platform.

`os.EX_OK`
Exit code that means no error occurred.

Availability: Unix.

`os.EX_USAGE`
Exit code that means the command was used incorrectly, such as when the wrong number of arguments are given.

Availability: Unix.

`os.EX_DATAERR`
Exit code that means the input data was incorrect.

Availability: Unix.

`os.EX_NOINPUT`
Exit code that means an input file did not exist or was not readable.

Availability: Unix.

`os.EX_NOUSER`
Exit code that means a specified user did not exist.

Availability: Unix.

`os.EX_NOHOST`
Exit code that means a specified host did not exist.

Availability: Unix.

`os.EX_UNAVAILABLE`
Exit code that means that a required service is unavailable.

Availability: Unix.

`os.EX_SOFTWARE`
Exit code that means an internal software error was detected.

Availability: Unix.

`os.EX_OSERR`
Exit code that means an operating system error was detected, such as the inability to fork or create a pipe.

Availability: Unix.

`os.EX_OSFILE`
Exit code that means some system file did not exist, could not be opened, or had some other kind of error.

Availability: Unix.

`os.EX_CANTCREAT`
Exit code that means a user specified output file could not be created.

Availability: Unix.

`os.EX_IOERR`
Exit code that means that an error occurred while doing I/O on some file.

Availability: Unix.

`os.EX_TEMPFAIL`
Exit code that means a temporary failure occurred. This indicates something that may not really be an error, such as a network connection that couldn't be made during a retryable operation.

Availability: Unix.

`os.EX_PROTOCOL`
Exit code that means that a protocol exchange was illegal, invalid, or not understood.

Availability: Unix.

`os.EX_NOPERM`
Exit code that means that there were insufficient permissions to perform the operation (but not intended for file system problems).

Availability: Unix.

`os.EX_CONFIG`
Exit code that means that some kind of configuration error occurred.

Availability: Unix.

`os.EX_NOTFOUND`
Exit code that means something like "an entry was not found".

Availability: Unix.

`os.fork()`
Fork a child process. Return `0` in the child and the child's process id in the parent. If an error occurs *OSError* is raised.

Note that some platforms including FreeBSD <= 6.3 and Cygwin have known issues when using fork() from a thread.

> **Warning:** See *ssl* for applications that use the SSL module with fork().

Availability: Unix.

`os.forkpty()`
Fork a child process, using a new pseudo-terminal as the child's controlling terminal. Return a pair of `(pid, fd)`, where *pid* is `0` in the child, the new child's process id in the parent, and *fd* is the file descriptor of the master end of the pseudo-terminal. For a more portable approach, use the *pty* module. If an error occurs *OSError* is raised.

Availability: some flavors of Unix.

`os.kill(pid, sig)`
Send signal *sig* to the process *pid*. Constants for the specific signals available on the host platform are defined in the *signal* module.

Windows: The *signal.CTRL_C_EVENT* and *signal.CTRL_BREAK_EVENT* signals are special signals which can only be sent to console processes which share a common console window, e.g., some subprocesses. Any other value for *sig* will cause the process to be unconditionally killed by the TerminateProcess API, and the exit code will be set to *sig*. The Windows version of *kill()* additionally takes process handles to be killed.

See also *signal.pthread_kill()*.

New in version 3.2: Windows support.

`os.killpg(pgid, sig)`
Send the signal *sig* to the process group *pgid*.

Availability: Unix.

`os.nice(increment)`
Add *increment* to the process's "niceness". Return the new niceness.

Availability: Unix.

`os.plock(op)`

Lock program segments into memory. The value of *op* (defined in `<sys/lock.h>`) determines which segments are locked.

Availability: Unix.

`os.popen(cmd, mode='r', buffering=-1)`

Open a pipe to or from command *cmd*. The return value is an open file object connected to the pipe, which can be read or written depending on whether *mode* is `'r'` (default) or `'w'`. The *buffering* argument has the same meaning as the corresponding argument to the built-in `open()` function. The returned file object reads or writes text strings rather than bytes.

The `close` method returns `None` if the subprocess exited successfully, or the subprocess's return code if there was an error. On POSIX systems, if the return code is positive it represents the return value of the process left-shifted by one byte. If the return code is negative, the process was terminated by the signal given by the negated value of the return code. (For example, the return value might be `-signal.SIGKILL` if the subprocess was killed.) On Windows systems, the return value contains the signed integer return code from the child process.

This is implemented using `subprocess.Popen`; see that class's documentation for more powerful ways to manage and communicate with subprocesses.

`os.register_at_fork(*, before=None, after_in_parent=None, after_in_child=None)`

Register callables to be executed when a new child process is forked using `os.fork()` or similar process cloning APIs. The parameters are optional and keyword-only. Each specifies a different call point.

- *before* is a function called before forking a child process.
- *after_in_parent* is a function called from the parent process after forking a child process.
- *after_in_child* is a function called from the child process.

These calls are only made if control is expected to return to the Python interpreter. A typical `subprocess` launch will not trigger them as the child is not going to re-enter the interpreter.

Functions registered for execution before forking are called in reverse registration order. Functions registered for execution after forking (either in the parent or in the child) are called in registration order.

Note that `fork()` calls made by third-party C code may not call those functions, unless it explicitly calls `PyOS_BeforeFork()`, `PyOS_AfterFork_Parent()` and `PyOS_AfterFork_Child()`.

There is no way to unregister a function.

Availability: Unix.

New in version 3.7.

`os.spawnl(mode, path, ...)`
`os.spawnle(mode, path, ..., env)`
`os.spawnlp(mode, file, ...)`
`os.spawnlpe(mode, file, ..., env)`
`os.spawnv(mode, path, args)`
`os.spawnve(mode, path, args, env)`
`os.spawnvp(mode, file, args)`
`os.spawnvpe(mode, file, args, env)`

Execute the program *path* in a new process.

(Note that the `subprocess` module provides more powerful facilities for spawning new processes and retrieving their results; using that module is preferable to using these functions. Check especially the *Replacing Older Functions with the subprocess Module* section.)

If *mode* is `P_NOWAIT`, this function returns the process id of the new process; if *mode* is `P_WAIT`, returns the process's exit code if it exits normally, or `-signal`, where *signal* is the signal that killed the process.

On Windows, the process id will actually be the process handle, so can be used with the *waitpid()* function.

The "l" and "v" variants of the *spawn** functions differ in how command-line arguments are passed. The "l" variants are perhaps the easiest to work with if the number of parameters is fixed when the code is written; the individual parameters simply become additional parameters to the `spawnl*()` functions. The "v" variants are good when the number of parameters is variable, with the arguments being passed in a list or tuple as the *args* parameter. In either case, the arguments to the child process must start with the name of the command being run.

The variants which include a second "p" near the end (*spawnlp()*, *spawnlpe()*, *spawnvp()*, and *spawnvpe()*) will use the `PATH` environment variable to locate the program *file*. When the environment is being replaced (using one of the *spawn*e* variants, discussed in the next paragraph), the new environment is used as the source of the `PATH` variable. The other variants, *spawnl()*, *spawnle()*, *spawnv()*, and *spawnve()*, will not use the `PATH` variable to locate the executable; *path* must contain an appropriate absolute or relative path.

For *spawnle()*, *spawnlpe()*, *spawnve()*, and *spawnvpe()* (note that these all end in "e"), the *env* parameter must be a mapping which is used to define the environment variables for the new process (they are used instead of the current process' environment); the functions *spawnl()*, *spawnlp()*, *spawnv()*, and *spawnvp()* all cause the new process to inherit the environment of the current process. Note that keys and values in the *env* dictionary must be strings; invalid keys or values will cause the function to fail, with a return value of `127`.

As an example, the following calls to *spawnlp()* and *spawnvpe()* are equivalent:

```
import os
os.spawnlp(os.P_WAIT, 'cp', 'cp', 'index.html', '/dev/null')

L = ['cp', 'index.html', '/dev/null']
os.spawnvpe(os.P_WAIT, 'cp', L, os.environ)
```

Availability: Unix, Windows. *spawnlp()*, *spawnlpe()*, *spawnvp()* and *spawnvpe()* are not available on Windows. *spawnle()* and *spawnve()* are not thread-safe on Windows; we advise you to use the *subprocess* module instead.

Changed in version 3.6: Accepts a *path-like object*.

`os.P_NOWAIT`
`os.P_NOWAITO`

Possible values for the *mode* parameter to the *spawn** family of functions. If either of these values is given, the `spawn*()` functions will return as soon as the new process has been created, with the process id as the return value.

Availability: Unix, Windows.

`os.P_WAIT`

Possible value for the *mode* parameter to the *spawn** family of functions. If this is given as *mode*, the `spawn*()` functions will not return until the new process has run to completion and will return the exit code of the process the run is successful, or `-signal` if a signal kills the process.

Availability: Unix, Windows.

`os.P_DETACH`
`os.P_OVERLAY`

Possible values for the *mode* parameter to the *spawn** family of functions. These are less portable than those listed above. *P_DETACH* is similar to *P_NOWAIT*, but the new process is detached from the console of the calling process. If *P_OVERLAY* is used, the current process will be replaced; the *spawn** function will not return.

Availability: Windows.

`os.startfile(path[, operation])`

Start a file with its associated application.

When *operation* is not specified or `'open'`, this acts like double-clicking the file in Windows Explorer, or giving the file name as an argument to the **start** command from the interactive command shell: the file is opened with whatever application (if any) its extension is associated.

When another *operation* is given, it must be a "command verb" that specifies what should be done with the file. Common verbs documented by Microsoft are `'print'` and `'edit'` (to be used on files) as well as `'explore'` and `'find'` (to be used on directories).

startfile() returns as soon as the associated application is launched. There is no option to wait for the application to close, and no way to retrieve the application's exit status. The *path* parameter is relative to the current directory. If you want to use an absolute path, make sure the first character is not a slash (`'/'`); the underlying Win32 `ShellExecute()` function doesn't work if it is. Use the *os.path.normpath()* function to ensure that the path is properly encoded for Win32.

To reduce interpreter startup overhead, the Win32 `ShellExecute()` function is not resolved until this function is first called. If the function cannot be resolved, *NotImplementedError* will be raised.

Availability: Windows.

`os.system(command)`

Execute the command (a string) in a subshell. This is implemented by calling the Standard C function `system()`, and has the same limitations. Changes to *sys.stdin*, etc. are not reflected in the environment of the executed command. If *command* generates any output, it will be sent to the interpreter standard output stream.

On Unix, the return value is the exit status of the process encoded in the format specified for *wait()*. Note that POSIX does not specify the meaning of the return value of the C `system()` function, so the return value of the Python function is system-dependent.

On Windows, the return value is that returned by the system shell after running *command*. The shell is given by the Windows environment variable `COMSPEC`: it is usually **cmd.exe**, which returns the exit status of the command run; on systems using a non-native shell, consult your shell documentation.

The *subprocess* module provides more powerful facilities for spawning new processes and retrieving their results; using that module is preferable to using this function. See the *Replacing Older Functions with the subprocess Module* section in the *subprocess* documentation for some helpful recipes.

Availability: Unix, Windows.

`os.times()`

Returns the current global process times. The return value is an object with five attributes:

- `user` - user time
- *system* - system time
- `children_user` - user time of all child processes
- `children_system` - system time of all child processes
- `elapsed` - elapsed real time since a fixed point in the past

For backwards compatibility, this object also behaves like a five-tuple containing `user`, *system*, `children_user`, `children_system`, and `elapsed` in that order.

See the Unix manual page *times(2)* or the corresponding Windows Platform API documentation. On Windows, only `user` and *system* are known; the other attributes are zero.

Availability: Unix, Windows.

Changed in version 3.3: Return type changed from a tuple to a tuple-like object with named attributes.

os.wait()

Wait for completion of a child process, and return a tuple containing its pid and exit status indication: a 16-bit number, whose low byte is the signal number that killed the process, and whose high byte is the exit status (if the signal number is zero); the high bit of the low byte is set if a core file was produced.

Availability: Unix.

os.waitid(*idtype*, *id*, *options*)

Wait for the completion of one or more child processes. *idtype* can be *P_PID*, *P_PGID* or *P_ALL*. *id* specifies the pid to wait on. *options* is constructed from the ORing of one or more of *WEXITED*, *WSTOPPED* or *WCONTINUED* and additionally may be ORed with *WNOHANG* or *WNOWAIT*. The return value is an object representing the data contained in the `siginfo_t` structure, namely: `si_pid`, `si_uid`, `si_signo`, `si_status`, `si_code` or `None` if *WNOHANG* is specified and there are no children in a waitable state.

Availability: Unix.

New in version 3.3.

os.P_PID

os.P_PGID

os.P_ALL

These are the possible values for *idtype* in *waitid()*. They affect how *id* is interpreted.

Availability: Unix.

New in version 3.3.

os.WEXITED

os.WSTOPPED

os.WNOWAIT

Flags that can be used in *options* in *waitid()* that specify what child signal to wait for.

Availability: Unix.

New in version 3.3.

os.CLD_EXITED

os.CLD_DUMPED

os.CLD_TRAPPED

os.CLD_CONTINUED

These are the possible values for `si_code` in the result returned by *waitid()*.

Availability: Unix.

New in version 3.3.

os.waitpid(*pid*, *options*)

The details of this function differ on Unix and Windows.

On Unix: Wait for completion of a child process given by process id *pid*, and return a tuple containing its process id and exit status indication (encoded as for *wait()*). The semantics of the call are affected by the value of the integer *options*, which should be `0` for normal operation.

If *pid* is greater than `0`, *waitpid()* requests status information for that specific process. If *pid* is `0`, the request is for the status of any child in the process group of the current process. If *pid* is `-1`, the request pertains to any child of the current process. If *pid* is less than `-1`, status is requested for any process in the process group `-pid` (the absolute value of *pid*).

An *OSError* is raised with the value of errno when the syscall returns -1.

On Windows: Wait for completion of a process given by process handle *pid*, and return a tuple containing *pid*, and its exit status shifted left by 8 bits (shifting makes cross-platform use of the function easier). A *pid* less than or equal to `0` has no special meaning on Windows, and raises an exception. The value of integer *options* has no effect. *pid* can refer to any process whose id is known, not necessarily a child process. The *spawn** functions called with *P_NOWAIT* return suitable process handles.

Changed in version 3.5: If the system call is interrupted and the signal handler does not raise an exception, the function now retries the system call instead of raising an *InterruptedError* exception (see **PEP 475** for the rationale).

`os.wait3(options)`
Similar to *waitpid()*, except no process id argument is given and a 3-element tuple containing the child's process id, exit status indication, and resource usage information is returned. Refer to *resource.getrusage()* for details on resource usage information. The option argument is the same as that provided to *waitpid()* and *wait4()*.

Availability: Unix.

`os.wait4(pid, options)`
Similar to *waitpid()*, except a 3-element tuple, containing the child's process id, exit status indication, and resource usage information is returned. Refer to *resource.getrusage()* for details on resource usage information. The arguments to *wait4()* are the same as those provided to *waitpid()*.

Availability: Unix.

`os.WNOHANG`
The option for *waitpid()* to return immediately if no child process status is available immediately. The function returns `(0, 0)` in this case.

Availability: Unix.

`os.WCONTINUED`
This option causes child processes to be reported if they have been continued from a job control stop since their status was last reported.

Availability: some Unix systems.

`os.WUNTRACED`
This option causes child processes to be reported if they have been stopped but their current state has not been reported since they were stopped.

Availability: Unix.

The following functions take a process status code as returned by *system()*, *wait()*, or *waitpid()* as a parameter. They may be used to determine the disposition of a process.

`os.WCOREDUMP(status)`
Return `True` if a core dump was generated for the process, otherwise return `False`.

Availability: Unix.

`os.WIFCONTINUED(status)`
Return `True` if the process has been continued from a job control stop, otherwise return `False`.

Availability: Unix.

`os.WIFSTOPPED(status)`
Return `True` if the process has been stopped, otherwise return `False`.

Availability: Unix.

`os.WIFSIGNALED(status)`
Return `True` if the process exited due to a signal, otherwise return `False`.

Availability: Unix.

`os.WIFEXITED(status)`
Return `True` if the process exited using the *exit(2)* system call, otherwise return `False`.

Availability: Unix.

`os.WEXITSTATUS(status)`
If `WIFEXITED(status)` is true, return the integer parameter to the *exit(2)* system call. Otherwise, the return value is meaningless.

Availability: Unix.

`os.WSTOPSIG(status)`
Return the signal which caused the process to stop.

Availability: Unix.

`os.WTERMSIG(status)`
Return the signal which caused the process to exit.

Availability: Unix.

16.1.7 Interface to the scheduler

These functions control how a process is allocated CPU time by the operating system. They are only available on some Unix platforms. For more detailed information, consult your Unix manpages.

New in version 3.3.

The following scheduling policies are exposed if they are supported by the operating system.

`os.SCHED_OTHER`
The default scheduling policy.

`os.SCHED_BATCH`
Scheduling policy for CPU-intensive processes that tries to preserve interactivity on the rest of the computer.

`os.SCHED_IDLE`
Scheduling policy for extremely low priority background tasks.

`os.SCHED_SPORADIC`
Scheduling policy for sporadic server programs.

`os.SCHED_FIFO`
A First In First Out scheduling policy.

`os.SCHED_RR`
A round-robin scheduling policy.

`os.SCHED_RESET_ON_FORK`
This flag can be OR'ed with any other scheduling policy. When a process with this flag set forks, its child's scheduling policy and priority are reset to the default.

`class os.sched_param(sched_priority)`
This class represents tunable scheduling parameters used in `sched_setparam()`, `sched_setscheduler()`, and `sched_getparam()`. It is immutable.

At the moment, there is only one possible parameter:

`sched_priority`
The scheduling priority for a scheduling policy.

`os.sched_get_priority_min(policy)`
Get the minimum priority value for *policy*. *policy* is one of the scheduling policy constants above.

os.sched_get_priority_max(*policy*)
Get the maximum priority value for *policy*. *policy* is one of the scheduling policy constants above.

os.sched_setscheduler(*pid*, *policy*, *param*)
Set the scheduling policy for the process with PID *pid*. A *pid* of 0 means the calling process. *policy* is one of the scheduling policy constants above. *param* is a *sched_param* instance.

os.sched_getscheduler(*pid*)
Return the scheduling policy for the process with PID *pid*. A *pid* of 0 means the calling process. The result is one of the scheduling policy constants above.

os.sched_setparam(*pid*, *param*)
Set a scheduling parameters for the process with PID *pid*. A *pid* of 0 means the calling process. *param* is a *sched_param* instance.

os.sched_getparam(*pid*)
Return the scheduling parameters as a *sched_param* instance for the process with PID *pid*. A *pid* of 0 means the calling process.

os.sched_rr_get_interval(*pid*)
Return the round-robin quantum in seconds for the process with PID *pid*. A *pid* of 0 means the calling process.

os.sched_yield()
Voluntarily relinquish the CPU.

os.sched_setaffinity(*pid*, *mask*)
Restrict the process with PID *pid* (or the current process if zero) to a set of CPUs. *mask* is an iterable of integers representing the set of CPUs to which the process should be restricted.

os.sched_getaffinity(*pid*)
Return the set of CPUs the process with PID *pid* (or the current process if zero) is restricted to.

16.1.8 Miscellaneous System Information

os.confstr(*name*)
Return string-valued system configuration values. *name* specifies the configuration value to retrieve; it may be a string which is the name of a defined system value; these names are specified in a number of standards (POSIX, Unix 95, Unix 98, and others). Some platforms define additional names as well. The names known to the host operating system are given as the keys of the `confstr_names` dictionary. For configuration variables not included in that mapping, passing an integer for *name* is also accepted.

If the configuration value specified by *name* isn't defined, `None` is returned.

If *name* is a string and is not known, *ValueError* is raised. If a specific value for *name* is not supported by the host system, even if it is included in `confstr_names`, an *OSError* is raised with *errno.EINVAL* for the error number.

Availability: Unix.

os.confstr_names
Dictionary mapping names accepted by *confstr()* to the integer values defined for those names by the host operating system. This can be used to determine the set of names known to the system.

Availability: Unix.

os.cpu_count()
Return the number of CPUs in the system. Returns `None` if undetermined.

This number is not equivalent to the number of CPUs the current process can use. The number of usable CPUs can be obtained with `len(os.sched_getaffinity(0))`

New in version 3.4.

os.getloadavg()
Return the number of processes in the system run queue averaged over the last 1, 5, and 15 minutes or raises *OSError* if the load average was unobtainable.

Availability: Unix.

os.sysconf(*name*)
Return integer-valued system configuration values. If the configuration value specified by *name* isn't defined, `-1` is returned. The comments regarding the *name* parameter for *confstr()* apply here as well; the dictionary that provides information on the known names is given by `sysconf_names`.

Availability: Unix.

os.sysconf_names
Dictionary mapping names accepted by *sysconf()* to the integer values defined for those names by the host operating system. This can be used to determine the set of names known to the system.

Availability: Unix.

The following data values are used to support path manipulation operations. These are defined for all platforms.

Higher-level operations on pathnames are defined in the *os.path* module.

os.curdir
The constant string used by the operating system to refer to the current directory. This is `'.'` for Windows and POSIX. Also available via *os.path*.

os.pardir
The constant string used by the operating system to refer to the parent directory. This is `'..'` for Windows and POSIX. Also available via *os.path*.

os.sep
The character used by the operating system to separate pathname components. This is `'/'` for POSIX and `'\\'` for Windows. Note that knowing this is not sufficient to be able to parse or concatenate pathnames — use *os.path.split()* and *os.path.join()* — but it is occasionally useful. Also available via *os.path*.

os.altsep
An alternative character used by the operating system to separate pathname components, or `None` if only one separator character exists. This is set to `'/'` on Windows systems where `sep` is a backslash. Also available via *os.path*.

os.extsep
The character which separates the base filename from the extension; for example, the `'.'` in `os.py`. Also available via *os.path*.

os.pathsep
The character conventionally used by the operating system to separate search path components (as in `PATH`), such as `':'` for POSIX or `';'` for Windows. Also available via *os.path*.

os.defpath
The default search path used by *exec*p** and *spawn*p** if the environment doesn't have a `'PATH'` key. Also available via *os.path*.

os.linesep
The string used to separate (or, rather, terminate) lines on the current platform. This may be a single character, such as `'\n'` for POSIX, or multiple characters, for example, `'\r\n'` for Windows. Do not use *os.linesep* as a line terminator when writing files opened in text mode (the default); use a single `'\n'` instead, on all platforms.

`os.devnull`
The file path of the null device. For example: `'/dev/null'` for POSIX, `'nul'` for Windows. Also available via *os.path*.

`os.RTLD_LAZY`
`os.RTLD_NOW`
`os.RTLD_GLOBAL`
`os.RTLD_LOCAL`
`os.RTLD_NODELETE`
`os.RTLD_NOLOAD`
`os.RTLD_DEEPBIND`
Flags for use with the *setdlopenflags()* and *getdlopenflags()* functions. See the Unix manual page **dlopen(3)** for what the different flags mean.

New in version 3.3.

16.1.9 Random numbers

`os.getrandom(size, flags=0)`
Get up to *size* random bytes. The function can return less bytes than requested.

These bytes can be used to seed user-space random number generators or for cryptographic purposes.

`getrandom()` relies on entropy gathered from device drivers and other sources of environmental noise. Unnecessarily reading large quantities of data will have a negative impact on other users of the `/dev/random` and `/dev/urandom` devices.

The flags argument is a bit mask that can contain zero or more of the following values ORed together: *os.GRND_RANDOM* and *GRND_NONBLOCK*.

See also the Linux getrandom() manual page.

Availability: Linux 3.17 and newer.

New in version 3.6.

`os.urandom(size)`
Return a string of *size* random bytes suitable for cryptographic use.

This function returns random bytes from an OS-specific randomness source. The returned data should be unpredictable enough for cryptographic applications, though its exact quality depends on the OS implementation.

On Linux, if the `getrandom()` syscall is available, it is used in blocking mode: block until the system urandom entropy pool is initialized (128 bits of entropy are collected by the kernel). See the **PEP 524** for the rationale. On Linux, the *getrandom()* function can be used to get random bytes in non-blocking mode (using the *GRND_NONBLOCK* flag) or to poll until the system urandom entropy pool is initialized.

On a Unix-like system, random bytes are read from the `/dev/urandom` device. If the `/dev/urandom` device is not available or not readable, the *NotImplementedError* exception is raised.

On Windows, it will use `CryptGenRandom()`.

See also:

The *secrets* module provides higher level functions. For an easy-to-use interface to the random number generator provided by your platform, please see *random.SystemRandom*.

Changed in version 3.6.0: On Linux, `getrandom()` is now used in blocking mode to increase the security.

Changed in version 3.5.2: On Linux, if the `getrandom()` syscall blocks (the urandom entropy pool is not initialized yet), fall back on reading `/dev/urandom`.

Changed in version 3.5: On Linux 3.17 and newer, the `getrandom()` syscall is now used when available. On OpenBSD 5.6 and newer, the C `getentropy()` function is now used. These functions avoid the usage of an internal file descriptor.

`os.GRND_NONBLOCK`

By default, when reading from `/dev/random`, *getrandom()* blocks if no random bytes are available, and when reading from `/dev/urandom`, it blocks if the entropy pool has not yet been initialized.

If the *GRND_NONBLOCK* flag is set, then *getrandom()* does not block in these cases, but instead immediately raises *BlockingIOError*.

New in version 3.6.

`os.GRND_RANDOM`

If this bit is set, then random bytes are drawn from the `/dev/random` pool instead of the `/dev/urandom` pool.

New in version 3.6.

16.2 io — Core tools for working with streams

Source code: Lib/io.py

16.2.1 Overview

The *io* module provides Python's main facilities for dealing with various types of I/O. There are three main types of I/O: *text I/O*, *binary I/O* and *raw I/O*. These are generic categories, and various backing stores can be used for each of them. A concrete object belonging to any of these categories is called a *file object*. Other common terms are *stream* and *file-like object*.

Independent of its category, each concrete stream object will also have various capabilities: it can be read-only, write-only, or read-write. It can also allow arbitrary random access (seeking forwards or backwards to any location), or only sequential access (for example in the case of a socket or pipe).

All streams are careful about the type of data you give to them. For example giving a *str* object to the `write()` method of a binary stream will raise a *TypeError*. So will giving a *bytes* object to the `write()` method of a text stream.

Changed in version 3.3: Operations that used to raise *IOError* now raise *OSError*, since *IOError* is now an alias of *OSError*.

Text I/O

Text I/O expects and produces *str* objects. This means that whenever the backing store is natively made of bytes (such as in the case of a file), encoding and decoding of data is made transparently as well as optional translation of platform-specific newline characters.

The easiest way to create a text stream is with *open()*, optionally specifying an encoding:

```
f = open("myfile.txt", "r", encoding="utf-8")
```

In-memory text streams are also available as *StringIO* objects:

```
f = io.StringIO("some initial text data")
```

The text stream API is described in detail in the documentation of *TextIOBase*.

Binary I/O

Binary I/O (also called *buffered I/O*) expects *bytes-like objects* and produces `bytes` objects. No encoding, decoding, or newline translation is performed. This category of streams can be used for all kinds of non-text data, and also when manual control over the handling of text data is desired.

The easiest way to create a binary stream is with `open()` with `'b'` in the mode string:

```
f = open("myfile.jpg", "rb")
```

In-memory binary streams are also available as `BytesIO` objects:

```
f = io.BytesIO(b"some initial binary data: \x00\x01")
```

The binary stream API is described in detail in the docs of `BufferedIOBase`.

Other library modules may provide additional ways to create text or binary streams. See `socket.socket.makefile()` for example.

Raw I/O

Raw I/O (also called *unbuffered I/O*) is generally used as a low-level building-block for binary and text streams; it is rarely useful to directly manipulate a raw stream from user code. Nevertheless, you can create a raw stream by opening a file in binary mode with buffering disabled:

```
f = open("myfile.jpg", "rb", buffering=0)
```

The raw stream API is described in detail in the docs of `RawIOBase`.

16.2.2 High-level Module Interface

io.DEFAULT_BUFFER_SIZE
An int containing the default buffer size used by the module's buffered I/O classes. `open()` uses the file's blksize (as obtained by `os.stat()`) if possible.

io.open(*file*, *mode='r'*, *buffering=-1*, *encoding=None*, *errors=None*, *newline=None*, *closefd=True*, *opener=None*)
This is an alias for the builtin `open()` function.

exception io.BlockingIOError
This is a compatibility alias for the builtin `BlockingIOError` exception.

exception io.UnsupportedOperation
An exception inheriting `OSError` and `ValueError` that is raised when an unsupported operation is called on a stream.

In-memory streams

It is also possible to use a `str` or *bytes-like object* as a file for both reading and writing. For strings `StringIO` can be used like a file opened in text mode. `BytesIO` can be used like a file opened in binary mode. Both provide full read-write capabilities with random access.

See also:

`sys` contains the standard IO streams: `sys.stdin`, `sys.stdout`, and `sys.stderr`.

16.2.3 Class hierarchy

The implementation of I/O streams is organized as a hierarchy of classes. First *abstract base classes* (ABCs), which are used to specify the various categories of streams, then concrete classes providing the standard stream implementations.

> **Note:** The abstract base classes also provide default implementations of some methods in order to help implementation of concrete stream classes. For example, *BufferedIOBase* provides unoptimized implementations of `readinto()` and *readline()*.

At the top of the I/O hierarchy is the abstract base class *IOBase*. It defines the basic interface to a stream. Note, however, that there is no separation between reading and writing to streams; implementations are allowed to raise *UnsupportedOperation* if they do not support a given operation.

The *RawIOBase* ABC extends *IOBase*. It deals with the reading and writing of bytes to a stream. *FileIO* subclasses *RawIOBase* to provide an interface to files in the machine's file system.

The *BufferedIOBase* ABC deals with buffering on a raw byte stream (*RawIOBase*). Its subclasses, *BufferedWriter*, *BufferedReader*, and *BufferedRWPair* buffer streams that are readable, writable, and both readable and writable. *BufferedRandom* provides a buffered interface to random access streams. Another *BufferedIOBase* subclass, *BytesIO*, is a stream of in-memory bytes.

The *TextIOBase* ABC, another subclass of *IOBase*, deals with streams whose bytes represent text, and handles encoding and decoding to and from strings. *TextIOWrapper*, which extends it, is a buffered text interface to a buffered raw stream (*BufferedIOBase*). Finally, *StringIO* is an in-memory stream for text.

Argument names are not part of the specification, and only the arguments of *open()* are intended to be used as keyword arguments.

The following table summarizes the ABCs provided by the *io* module:

ABC	Inherits	Stub Methods	Mixin Methods and Properties
IOBase		`fileno`, `seek`, and `truncate`	`close`, `closed`, `__enter__`, `__exit__`, `flush`, `isatty`, `__iter__`, `__next__`, `readable`, `readline`, `readlines`, `seekable`, `tell`, `writable`, and `writelines`
RawIOBase	*IOBase*	`readinto` and `write`	Inherited *IOBase* methods, `read`, and `readall`
BufferedIOBase	*IOBase*	`detach`, `read`, `read1`, and `write`	Inherited *IOBase* methods, `readinto`, and `readinto1`
TextIOBase	*IOBase*	`detach`, `read`, `readline`, and `write`	Inherited *IOBase* methods, `encoding`, `errors`, and `newlines`

I/O Base Classes

class io.IOBase

The abstract base class for all I/O classes, acting on streams of bytes. There is no public constructor.

This class provides empty abstract implementations for many methods that derived classes can override selectively; the default implementations represent a file that cannot be read, written or seeked.

Even though *IOBase* does not declare `read()`, `readinto()`, or `write()` because their signatures will vary, implementations and clients should consider those methods part of the interface. Also, implementations may raise a *ValueError* (or *UnsupportedOperation*) when operations they do not support are called.

The basic type used for binary data read from or written to a file is *bytes*. Other *bytes-like objects* are accepted as method arguments too. In some cases, such as *readinto()*, a writable object such as *bytearray* is required. Text I/O classes work with *str* data.

Note that calling any method (even inquiries) on a closed stream is undefined. Implementations may raise *ValueError* in this case.

IOBase (and its subclasses) supports the iterator protocol, meaning that an *IOBase* object can be iterated over yielding the lines in a stream. Lines are defined slightly differently depending on whether the stream is a binary stream (yielding bytes), or a text stream (yielding character strings). See *readline()* below.

IOBase is also a context manager and therefore supports the `with` statement. In this example, *file* is closed after the `with` statement's suite is finished—even if an exception occurs:

```
with open('spam.txt', 'w') as file:
    file.write('Spam and eggs!')
```

IOBase provides these data attributes and methods:

close()
Flush and close this stream. This method has no effect if the file is already closed. Once the file is closed, any operation on the file (e.g. reading or writing) will raise a *ValueError*.

As a convenience, it is allowed to call this method more than once; only the first call, however, will have an effect.

closed
`True` if the stream is closed.

fileno()
Return the underlying file descriptor (an integer) of the stream if it exists. An *OSError* is raised if the IO object does not use a file descriptor.

flush()
Flush the write buffers of the stream if applicable. This does nothing for read-only and non-blocking streams.

isatty()
Return `True` if the stream is interactive (i.e., connected to a terminal/tty device).

readable()
Return `True` if the stream can be read from. If `False`, `read()` will raise *OSError*.

readline(*size=-1*)
Read and return one line from the stream. If *size* is specified, at most *size* bytes will be read.

The line terminator is always `b'\n'` for binary files; for text files, the *newline* argument to *open()* can be used to select the line terminator(s) recognized.

readlines(*hint=-1*)
Read and return a list of lines from the stream. *hint* can be specified to control the number of lines read: no more lines will be read if the total size (in bytes/characters) of all lines so far exceeds *hint*.

Note that it's already possible to iterate on file objects using `for line in file: ...` without calling `file.readlines()`.

seek(*offset*[, *whence*])
Change the stream position to the given byte *offset*. *offset* is interpreted relative to the position indicated by *whence*. The default value for *whence* is `SEEK_SET`. Values for *whence* are:

- `SEEK_SET` or `0` – start of the stream (the default); *offset* should be zero or positive
- `SEEK_CUR` or `1` – current stream position; *offset* may be negative
- `SEEK_END` or `2` – end of the stream; *offset* is usually negative

Return the new absolute position.

New in version 3.1: The `SEEK_*` constants.

New in version 3.3: Some operating systems could support additional values, like `os.SEEK_HOLE` or `os.SEEK_DATA`. The valid values for a file could depend on it being open in text or binary mode.

seekable()
Return `True` if the stream supports random access. If `False`, *`seek()`*, *`tell()`* and *`truncate()`* will raise *`OSError`*.

tell()
Return the current stream position.

truncate(*size=None*)
Resize the stream to the given *size* in bytes (or the current position if *size* is not specified). The current stream position isn't changed. This resizing can extend or reduce the current file size. In case of extension, the contents of the new file area depend on the platform (on most systems, additional bytes are zero-filled). The new file size is returned.

Changed in version 3.5: Windows will now zero-fill files when extending.

writable()
Return `True` if the stream supports writing. If `False`, `write()` and *`truncate()`* will raise *`OSError`*.

writelines(*lines*)
Write a list of lines to the stream. Line separators are not added, so it is usual for each of the lines provided to have a line separator at the end.

__del__()
Prepare for object destruction. *`IOBase`* provides a default implementation of this method that calls the instance's *`close()`* method.

class io.**RawIOBase**
Base class for raw binary I/O. It inherits *`IOBase`*. There is no public constructor.

Raw binary I/O typically provides low-level access to an underlying OS device or API, and does not try to encapsulate it in high-level primitives (this is left to Buffered I/O and Text I/O, described later in this page).

In addition to the attributes and methods from *`IOBase`*, *`RawIOBase`* provides the following methods:

read(*size=-1*)
Read up to *size* bytes from the object and return them. As a convenience, if *size* is unspecified or -1, all bytes until EOF are returned. Otherwise, only one system call is ever made. Fewer than *size* bytes may be returned if the operating system call returns fewer than *size* bytes.

If 0 bytes are returned, and *size* was not 0, this indicates end of file. If the object is in non-blocking mode and no bytes are available, `None` is returned.

The default implementation defers to *`readall()`* and *`readinto()`*.

readall()

Read and return all the bytes from the stream until EOF, using multiple calls to the stream if necessary.

readinto(*b*)

Read bytes into a pre-allocated, writable *bytes-like object* *b*, and return the number of bytes read. If the object is in non-blocking mode and no bytes are available, `None` is returned.

write(*b*)

Write the given *bytes-like object*, *b*, to the underlying raw stream, and return the number of bytes written. This can be less than the length of *b* in bytes, depending on specifics of the underlying raw stream, and especially if it is in non-blocking mode. `None` is returned if the raw stream is set not to block and no single byte could be readily written to it. The caller may release or mutate *b* after this method returns, so the implementation should only access *b* during the method call.

class io.BufferedIOBase

Base class for binary streams that support some kind of buffering. It inherits *IOBase*. There is no public constructor.

The main difference with *RawIOBase* is that methods *read()*, *readinto()* and *write()* will try (respectively) to read as much input as requested or to consume all given output, at the expense of making perhaps more than one system call.

In addition, those methods can raise *BlockingIOError* if the underlying raw stream is in non-blocking mode and cannot take or give enough data; unlike their *RawIOBase* counterparts, they will never return `None`.

Besides, the *read()* method does not have a default implementation that defers to *readinto()*.

A typical *BufferedIOBase* implementation should not inherit from a *RawIOBase* implementation, but wrap one, like *BufferedWriter* and *BufferedReader* do.

BufferedIOBase provides or overrides these methods and attribute in addition to those from *IOBase*:

raw

The underlying raw stream (a *RawIOBase* instance) that *BufferedIOBase* deals with. This is not part of the *BufferedIOBase* API and may not exist on some implementations.

detach()

Separate the underlying raw stream from the buffer and return it.

After the raw stream has been detached, the buffer is in an unusable state.

Some buffers, like *BytesIO*, do not have the concept of a single raw stream to return from this method. They raise *UnsupportedOperation*.

New in version 3.1.

read(*size=-1*)

Read and return up to *size* bytes. If the argument is omitted, `None`, or negative, data is read and returned until EOF is reached. An empty *bytes* object is returned if the stream is already at EOF.

If the argument is positive, and the underlying raw stream is not interactive, multiple raw reads may be issued to satisfy the byte count (unless EOF is reached first). But for interactive raw streams, at most one raw read will be issued, and a short result does not imply that EOF is imminent.

A *BlockingIOError* is raised if the underlying raw stream is in non blocking-mode, and has no data available at the moment.

read1([*size*])

Read and return up to *size* bytes, with at most one call to the underlying raw stream's *read()*

(or *readinto()*) method. This can be useful if you are implementing your own buffering on top of a *BufferedIOBase* object.

If *size* is `-1` (the default), an arbitrary number of bytes are returned (more than zero unless EOF is reached).

readinto(*b*)
Read bytes into a pre-allocated, writable *bytes-like object* *b* and return the number of bytes read.

Like *read()*, multiple reads may be issued to the underlying raw stream, unless the latter is interactive.

A *BlockingIOError* is raised if the underlying raw stream is in non blocking-mode, and has no data available at the moment.

readinto1(*b*)
Read bytes into a pre-allocated, writable *bytes-like object* *b*, using at most one call to the underlying raw stream's *read()* (or *readinto()*) method. Return the number of bytes read.

A *BlockingIOError* is raised if the underlying raw stream is in non blocking-mode, and has no data available at the moment.

New in version 3.5.

write(*b*)
Write the given *bytes-like object*, *b*, and return the number of bytes written (always equal to the length of *b* in bytes, since if the write fails an *OSError* will be raised). Depending on the actual implementation, these bytes may be readily written to the underlying stream, or held in a buffer for performance and latency reasons.

When in non-blocking mode, a *BlockingIOError* is raised if the data needed to be written to the raw stream but it couldn't accept all the data without blocking.

The caller may release or mutate *b* after this method returns, so the implementation should only access *b* during the method call.

Raw File I/O

class io.**FileIO**(*name*, *mode='r'*, *closefd=True*, *opener=None*)
FileIO represents an OS-level file containing bytes data. It implements the *RawIOBase* interface (and therefore the *IOBase* interface, too).

The *name* can be one of two things:

- a character string or *bytes* object representing the path to the file which will be opened. In this case closefd must be `True` (the default) otherwise an error will be raised.
- an integer representing the number of an existing OS-level file descriptor to which the resulting *FileIO* object will give access. When the FileIO object is closed this fd will be closed as well, unless *closefd* is set to `False`.

The *mode* can be `'r'`, `'w'`, `'x'` or `'a'` for reading (default), writing, exclusive creation or appending. The file will be created if it doesn't exist when opened for writing or appending; it will be truncated when opened for writing. *FileExistsError* will be raised if it already exists when opened for creating. Opening a file for creating implies writing, so this mode behaves in a similar way to `'w'`. Add a `'+'` to the mode to allow simultaneous reading and writing.

The `read()` (when called with a positive argument), `readinto()` and `write()` methods on this class will only make one system call.

A custom opener can be used by passing a callable as *opener*. The underlying file descriptor for the file object is then obtained by calling *opener* with (*name*, *flags*). *opener* must return an open file descriptor (passing *os.open* as *opener* results in functionality similar to passing `None`).

The newly created file is *non-inheritable*.

See the *open()* built-in function for examples on using the *opener* parameter.

Changed in version 3.3: The *opener* parameter was added. The 'x' mode was added.

Changed in version 3.4: The file is now non-inheritable.

In addition to the attributes and methods from *IOBase* and *RawIOBase*, *FileIO* provides the following data attributes:

mode
The mode as given in the constructor.

name
The file name. This is the file descriptor of the file when no name is given in the constructor.

Buffered Streams

Buffered I/O streams provide a higher-level interface to an I/O device than raw I/O does.

class io.**BytesIO**([*initial_bytes*])
A stream implementation using an in-memory bytes buffer. It inherits *BufferedIOBase*. The buffer is discarded when the *close()* method is called.

The optional argument *initial_bytes* is a *bytes-like object* that contains initial data.

BytesIO provides or overrides these methods in addition to those from *BufferedIOBase* and *IOBase*:

getbuffer()
Return a readable and writable view over the contents of the buffer without copying them. Also, mutating the view will transparently update the contents of the buffer:

```
>>> b = io.BytesIO(b"abcdef")
>>> view = b.getbuffer()
>>> view[2:4] = b"56"
>>> b.getvalue()
b'ab56ef'
```

Note: As long as the view exists, the *BytesIO* object cannot be resized or closed.

New in version 3.2.

getvalue()
Return *bytes* containing the entire contents of the buffer.

read1([*size*])
In *BytesIO*, this is the same as *read()*.

Changed in version 3.7: The *size* argument is now optional.

readinto1(*b*)
In *BytesIO*, this is the same as *readinto()*.

New in version 3.5.

class io.**BufferedReader**(*raw*, *buffer_size=DEFAULT_BUFFER_SIZE*)
A buffer providing higher-level access to a readable, sequential *RawIOBase* object. It inherits *BufferedIOBase*. When reading data from this object, a larger amount of data may be requested from the underlying raw stream, and kept in an internal buffer. The buffered data can then be returned directly on subsequent reads.

The constructor creates a *BufferedReader* for the given readable *raw* stream and *buffer_size*. If *buffer_size* is omitted, *DEFAULT_BUFFER_SIZE* is used.

BufferedReader provides or overrides these methods in addition to those from *BufferedIOBase* and *IOBase*:

peek([*size*])
Return bytes from the stream without advancing the position. At most one single read on the raw stream is done to satisfy the call. The number of bytes returned may be less or more than requested.

read([*size*])
Read and return *size* bytes, or if *size* is not given or negative, until EOF or if the read call would block in non-blocking mode.

read1([*size*])
Read and return up to *size* bytes with only one call on the raw stream. If at least one byte is buffered, only buffered bytes are returned. Otherwise, one raw stream read call is made.

Changed in version 3.7: The *size* argument is now optional.

class io.**BufferedWriter**(*raw*, *buffer_size=DEFAULT_BUFFER_SIZE*)
A buffer providing higher-level access to a writeable, sequential *RawIOBase* object. It inherits *BufferedIOBase*. When writing to this object, data is normally placed into an internal buffer. The buffer will be written out to the underlying *RawIOBase* object under various conditions, including:

- when the buffer gets too small for all pending data;
- when *flush()* is called;
- when a `seek()` is requested (for *BufferedRandom* objects);
- when the *BufferedWriter* object is closed or destroyed.

The constructor creates a *BufferedWriter* for the given writeable *raw* stream. If the *buffer_size* is not given, it defaults to *DEFAULT_BUFFER_SIZE*.

BufferedWriter provides or overrides these methods in addition to those from *BufferedIOBase* and *IOBase*:

flush()
Force bytes held in the buffer into the raw stream. A *BlockingIOError* should be raised if the raw stream blocks.

write(*b*)
Write the *bytes-like object*, *b*, and return the number of bytes written. When in non-blocking mode, a *BlockingIOError* is raised if the buffer needs to be written out but the raw stream blocks.

class io.**BufferedRandom**(*raw*, *buffer_size=DEFAULT_BUFFER_SIZE*)
A buffered interface to random access streams. It inherits *BufferedReader* and *BufferedWriter*, and further supports `seek()` and `tell()` functionality.

The constructor creates a reader and writer for a seekable raw stream, given in the first argument. If the *buffer_size* is omitted it defaults to *DEFAULT_BUFFER_SIZE*.

BufferedRandom is capable of anything *BufferedReader* or *BufferedWriter* can do.

class io.**BufferedRWPair**(*reader*, *writer*, *buffer_size=DEFAULT_BUFFER_SIZE*)
A buffered I/O object combining two unidirectional *RawIOBase* objects – one readable, the other writeable – into a single bidirectional endpoint. It inherits *BufferedIOBase*.

reader and *writer* are *RawIOBase* objects that are readable and writeable respectively. If the *buffer_size* is omitted it defaults to *DEFAULT_BUFFER_SIZE*.

BufferedRWPair implements all of *BufferedIOBase*'s methods except for *detach()*, which raises *UnsupportedOperation*.

> **Warning:** *BufferedRWPair* does not attempt to synchronize accesses to its underlying raw streams. You should not pass it the same object as reader and writer; use *BufferedRandom* instead.

Text I/O

class io.TextIOBase

Base class for text streams. This class provides a character and line based interface to stream I/O. There is no `readinto()` method because Python's character strings are immutable. It inherits *IOBase*. There is no public constructor.

TextIOBase provides or overrides these data attributes and methods in addition to those from *IOBase*:

encoding

The name of the encoding used to decode the stream's bytes into strings, and to encode strings into bytes.

errors

The error setting of the decoder or encoder.

newlines

A string, a tuple of strings, or `None`, indicating the newlines translated so far. Depending on the implementation and the initial constructor flags, this may not be available.

buffer

The underlying binary buffer (a *BufferedIOBase* instance) that *TextIOBase* deals with. This is not part of the *TextIOBase* API and may not exist in some implementations.

detach()

Separate the underlying binary buffer from the *TextIOBase* and return it.

After the underlying buffer has been detached, the *TextIOBase* is in an unusable state.

Some *TextIOBase* implementations, like *StringIO*, may not have the concept of an underlying buffer and calling this method will raise *UnsupportedOperation*.

New in version 3.1.

read(*size=-1*)

Read and return at most *size* characters from the stream as a single *str*. If *size* is negative or `None`, reads until EOF.

readline(*size=-1*)

Read until newline or EOF and return a single `str`. If the stream is already at EOF, an empty string is returned.

If *size* is specified, at most *size* characters will be read.

seek(*offset*[, *whence*])

Change the stream position to the given *offset*. Behaviour depends on the *whence* parameter. The default value for *whence* is `SEEK_SET`.

- `SEEK_SET` or `0`: seek from the start of the stream (the default); *offset* must either be a number returned by *TextIOBase.tell()*, or zero. Any other *offset* value produces undefined behaviour.
- `SEEK_CUR` or `1`: "seek" to the current position; *offset* must be zero, which is a no-operation (all other values are unsupported).

- `SEEK_END` or `2`: seek to the end of the stream; *offset* must be zero (all other values are unsupported).

Return the new absolute position as an opaque number.

New in version 3.1: The `SEEK_*` constants.

tell()
Return the current stream position as an opaque number. The number does not usually represent a number of bytes in the underlying binary storage.

write(*s*)
Write the string *s* to the stream and return the number of characters written.

class io.TextIOWrapper(*buffer*, *encoding=None*, *errors=None*, *newline=None*, *line_buffering=False*, *write_through=False*)
A buffered text stream over a *BufferedIOBase* binary stream. It inherits *TextIOBase*.

encoding gives the name of the encoding that the stream will be decoded or encoded with. It defaults to *locale.getpreferredencoding(False)*.

errors is an optional string that specifies how encoding and decoding errors are to be handled. Pass `'strict'` to raise a *ValueError* exception if there is an encoding error (the default of `None` has the same effect), or pass `'ignore'` to ignore errors. (Note that ignoring encoding errors can lead to data loss.) `'replace'` causes a replacement marker (such as `'?'`) to be inserted where there is malformed data. `'backslashreplace'` causes malformed data to be replaced by a backslashed escape sequence. When writing, `'xmlcharrefreplace'` (replace with the appropriate XML character reference) or `'namereplace'` (replace with `\N{...}` escape sequences) can be used. Any other error handling name that has been registered with *codecs.register_error()* is also valid.

newline controls how line endings are handled. It can be `None`, `''`, `'\n'`, `'\r'`, and `'\r\n'`. It works as follows:

- When reading input from the stream, if *newline* is `None`, *universal newlines* mode is enabled. Lines in the input can end in `'\n'`, `'\r'`, or `'\r\n'`, and these are translated into `'\n'` before being returned to the caller. If it is `''`, universal newlines mode is enabled, but line endings are returned to the caller untranslated. If it has any of the other legal values, input lines are only terminated by the given string, and the line ending is returned to the caller untranslated.
- When writing output to the stream, if *newline* is `None`, any `'\n'` characters written are translated to the system default line separator, *os.linesep*. If *newline* is `''` or `'\n'`, no translation takes place. If *newline* is any of the other legal values, any `'\n'` characters written are translated to the given string.

If *line_buffering* is `True`, `flush()` is implied when a call to write contains a newline character or a carriage return.

If *write_through* is `True`, calls to `write()` are guaranteed not to be buffered: any data written on the *TextIOWrapper* object is immediately handled to its underlying binary *buffer*.

Changed in version 3.3: The *write_through* argument has been added.

Changed in version 3.3: The default *encoding* is now `locale.getpreferredencoding(False)` instead of `locale.getpreferredencoding()`. Don't change temporary the locale encoding using *locale.setlocale()*, use the current locale encoding instead of the user preferred encoding.

TextIOWrapper provides these members in addition to those of *TextIOBase* and its parents:

line_buffering
Whether line buffering is enabled.

write_through
Whether writes are passed immediately to the underlying binary buffer.

New in version 3.7.

reconfigure(**[, encoding][, errors][, newline][, line_buffering][, write_through]*)

Reconfigure this text stream using new settings for *encoding*, *errors*, *newline*, *line_buffering* and *write_through*.

Parameters not specified keep current settings, except `errors='strict` is used when *encoding* is specified but *errors* is not specified.

It is not possible to change the encoding or newline if some data has already been read from the stream. On the other hand, changing encoding after write is possible.

This method does an implicit stream flush before setting the new parameters.

New in version 3.7.

class io.**StringIO**(*initial_value=", newline='\n'*)

An in-memory stream for text I/O. The text buffer is discarded when the `close()` method is called.

The initial value of the buffer can be set by providing *initial_value*. If newline translation is enabled, newlines will be encoded as if by `write()`. The stream is positioned at the start of the buffer.

The *newline* argument works like that of `TextIOWrapper`. The default is to consider only `\n` characters as ends of lines and to do no newline translation. If *newline* is set to `None`, newlines are written as `\n` on all platforms, but universal newline decoding is still performed when reading.

`StringIO` provides this method in addition to those from `TextIOBase` and its parents:

getvalue()

Return a `str` containing the entire contents of the buffer. Newlines are decoded as if by `read()`, although the stream position is not changed.

Example usage:

```
import io

output = io.StringIO()
output.write('First line.\n')
print('Second line.', file=output)

# Retrieve file contents -- this will be
# 'First line.\nSecond line.\n'
contents = output.getvalue()

# Close object and discard memory buffer --
# .getvalue() will now raise an exception.
output.close()
```

class io.**IncrementalNewlineDecoder**

A helper codec that decodes newlines for *universal newlines* mode. It inherits `codecs.IncrementalDecoder`.

16.2.4 Performance

This section discusses the performance of the provided concrete I/O implementations.

Binary I/O

By reading and writing only large chunks of data even when the user asks for a single byte, buffered I/O hides any inefficiency in calling and executing the operating system's unbuffered I/O routines. The gain depends on the OS and the kind of I/O which is performed. For example, on some modern OSes such as

Linux, unbuffered disk I/O can be as fast as buffered I/O. The bottom line, however, is that buffered I/O offers predictable performance regardless of the platform and the backing device. Therefore, it is almost always preferable to use buffered I/O rather than unbuffered I/O for binary data.

Text I/O

Text I/O over a binary storage (such as a file) is significantly slower than binary I/O over the same storage, because it requires conversions between unicode and binary data using a character codec. This can become noticeable handling huge amounts of text data like large log files. Also, `TextIOWrapper.tell()` and `TextIOWrapper.seek()` are both quite slow due to the reconstruction algorithm used.

StringIO, however, is a native in-memory unicode container and will exhibit similar speed to *BytesIO*.

Multi-threading

FileIO objects are thread-safe to the extent that the operating system calls (such as `read(2)` under Unix) they wrap are thread-safe too.

Binary buffered objects (instances of *BufferedReader*, *BufferedWriter*, *BufferedRandom* and *BufferedRWPair*) protect their internal structures using a lock; it is therefore safe to call them from multiple threads at once.

TextIOWrapper objects are not thread-safe.

Reentrancy

Binary buffered objects (instances of *BufferedReader*, *BufferedWriter*, *BufferedRandom* and *BufferedRWPair*) are not reentrant. While reentrant calls will not happen in normal situations, they can arise from doing I/O in a *signal* handler. If a thread tries to re-enter a buffered object which it is already accessing, a *RuntimeError* is raised. Note this doesn't prohibit a different thread from entering the buffered object.

The above implicitly extends to text files, since the *open()* function will wrap a buffered object inside a *TextIOWrapper*. This includes standard streams and therefore affects the built-in function *print()* as well.

16.3 `time` — Time access and conversions

This module provides various time-related functions. For related functionality, see also the *datetime* and *calendar* modules.

Although this module is always available, not all functions are available on all platforms. Most of the functions defined in this module call platform C library functions with the same name. It may sometimes be helpful to consult the platform documentation, because the semantics of these functions varies among platforms.

An explanation of some terminology and conventions is in order.

- The *epoch* is the point where the time starts, and is platform dependent. For Unix, the epoch is January 1, 1970, 00:00:00 (UTC). To find out what the epoch is on a given platform, look at `time.gmtime(0)`.
- The term *seconds since the epoch* refers to the total number of elapsed seconds since the epoch, typically excluding leap seconds. Leap seconds are excluded from this total on all POSIX-compliant platforms.

- The functions in this module may not handle dates and times before the epoch or far in the future. The cut-off point in the future is determined by the C library; for 32-bit systems, it is typically in 2038.
- **Year 2000 (Y2K) issues**: Python depends on the platform's C library, which generally doesn't have year 2000 issues, since all dates and times are represented internally as seconds since the epoch. Function *strptime()* can parse 2-digit years when given `%y` format code. When 2-digit years are parsed, they are converted according to the POSIX and ISO C standards: values 69–99 are mapped to 1969–1999, and values 0–68 are mapped to 2000–2068.
- UTC is Coordinated Universal Time (formerly known as Greenwich Mean Time, or GMT). The acronym UTC is not a mistake but a compromise between English and French.
- DST is Daylight Saving Time, an adjustment of the timezone by (usually) one hour during part of the year. DST rules are magic (determined by local law) and can change from year to year. The C library has a table containing the local rules (often it is read from a system file for flexibility) and is the only source of True Wisdom in this respect.
- The precision of the various real-time functions may be less than suggested by the units in which their value or argument is expressed. E.g. on most Unix systems, the clock "ticks" only 50 or 100 times a second.
- On the other hand, the precision of *time()* and *sleep()* is better than their Unix equivalents: times are expressed as floating point numbers, *time()* returns the most accurate time available (using Unix `gettimeofday()` where available), and *sleep()* will accept a time with a nonzero fraction (Unix `select()` is used to implement this, where available).
- The time value as returned by *gmtime()*, *localtime()*, and *strptime()*, and accepted by *asctime()*, *mktime()* and *strftime()*, is a sequence of 9 integers. The return values of *gmtime()*, *localtime()*, and *strptime()* also offer attribute names for individual fields.

  See *struct_time* for a description of these objects.

  Changed in version 3.3: The *struct_time* type was extended to provide the `tm_gmtoff` and `tm_zone` attributes when platform supports corresponding `struct tm` members.

  Changed in version 3.6: The *struct_time* attributes `tm_gmtoff` and `tm_zone` are now available on all platforms.
- Use the following functions to convert between time representations:

From	To	Use
seconds since the epoch	*struct_time* in UTC	*gmtime()*
seconds since the epoch	*struct_time* in local time	*localtime()*
struct_time in UTC	seconds since the epoch	*calendar.timegm()*
struct_time in local time	seconds since the epoch	*mktime()*

16.3.1 Functions

time.asctime([*t*])

Convert a tuple or *struct_time* representing a time as returned by *gmtime()* or *localtime()* to a string of the following form: `'Sun Jun 20 23:21:05 1993'`. If *t* is not provided, the current time as returned by *localtime()* is used. Locale information is not used by *asctime()*.

Note: Unlike the C function of the same name, *asctime()* does not add a trailing newline.

time.clock()

On Unix, return the current processor time as a floating point number expressed in seconds. The precision, and in fact the very definition of the meaning of "processor time", depends on that of the C function of the same name.

On Windows, this function returns wall-clock seconds elapsed since the first call to this function, as a floating point number, based on the Win32 function `QueryPerformanceCounter()`. The resolution is typically better than one microsecond.

Deprecated since version 3.3: The behaviour of this function depends on the platform: use *perf_counter()* or *process_time()* instead, depending on your requirements, to have a well defined behaviour.

time.pthread_getcpuclockid(*thread_id*)

Return the *clk_id* of the thread-specific CPU-time clock for the specified *thread_id*.

Use *threading.get_ident()* or the *ident* attribute of *threading.Thread* objects to get a suitable value for *thread_id*.

> **Warning:** Passing an invalid or expired *thread_id* may result in undefined behavior, such as segmentation fault.

Availability: Unix (see the man page for *pthread_getcpuclockid(3)* for further information).

New in version 3.7.

time.clock_getres(*clk_id*)

Return the resolution (precision) of the specified clock *clk_id*. Refer to *Clock ID Constants* for a list of accepted values for *clk_id*.

Availability: Unix.

New in version 3.3.

time.clock_gettime(*clk_id*) → float

Return the time of the specified clock *clk_id*. Refer to *Clock ID Constants* for a list of accepted values for *clk_id*.

Availability: Unix.

New in version 3.3.

time.clock_gettime_ns(*clk_id*) → int

Similar to *clock_gettime()* but return time as nanoseconds.

Availability: Unix.

New in version 3.7.

time.clock_settime(*clk_id*, *time: float*)

Set the time of the specified clock *clk_id*. Currently, *CLOCK_REALTIME* is the only accepted value for *clk_id*.

Availability: Unix.

New in version 3.3.

time.clock_settime_ns(*clk_id*, *time: int*)

Similar to *clock_settime()* but set time with nanoseconds.

Availability: Unix.

New in version 3.7.

time.ctime([*secs*])

Convert a time expressed in seconds since the epoch to a string representing local time. If *secs* is not provided or *None*, the current time as returned by *time()* is used. `ctime(secs)` is equivalent to `asctime(localtime(secs))`. Locale information is not used by *ctime()*.

`time.get_clock_info(name)`

Get information on the specified clock as a namespace object. Supported clock names and the corresponding functions to read their value are:

- `'clock'`: *time.clock()*
- `'monotonic'`: *time.monotonic()*
- `'perf_counter'`: *time.perf_counter()*
- `'process_time'`: *time.process_time()*
- `'thread_time'`: *time.thread_time()*
- `'time'`: *time.time()*

The result has the following attributes:

- *adjustable*: `True` if the clock can be changed automatically (e.g. by a NTP daemon) or manually by the system administrator, `False` otherwise
- *implementation*: The name of the underlying C function used to get the clock value. Refer to *Clock ID Constants* for possible values.
- *monotonic*: `True` if the clock cannot go backward, `False` otherwise
- *resolution*: The resolution of the clock in seconds (*float*)

New in version 3.3.

`time.gmtime([secs])`

Convert a time expressed in seconds since the epoch to a *struct_time* in UTC in which the dst flag is always zero. If *secs* is not provided or *None*, the current time as returned by *time()* is used. Fractions of a second are ignored. See above for a description of the *struct_time* object. See *calendar.timegm()* for the inverse of this function.

`time.localtime([secs])`

Like *gmtime()* but converts to local time. If *secs* is not provided or *None*, the current time as returned by *time()* is used. The dst flag is set to `1` when DST applies to the given time.

`time.mktime(t)`

This is the inverse function of *localtime()*. Its argument is the *struct_time* or full 9-tuple (since the dst flag is needed; use `-1` as the dst flag if it is unknown) which expresses the time in *local* time, not UTC. It returns a floating point number, for compatibility with *time()*. If the input value cannot be represented as a valid time, either *OverflowError* or *ValueError* will be raised (which depends on whether the invalid value is caught by Python or the underlying C libraries). The earliest date for which it can generate a time is platform-dependent.

`time.monotonic()` → float

Return the value (in fractional seconds) of a monotonic clock, i.e. a clock that cannot go backwards. The clock is not affected by system clock updates. The reference point of the returned value is undefined, so that only the difference between the results of consecutive calls is valid.

New in version 3.3.

Changed in version 3.5: The function is now always available and always system-wide.

`time.monotonic_ns()` → int

Similar to *monotonic()*, but return time as nanoseconds.

New in version 3.7.

`time.perf_counter()` → float

Return the value (in fractional seconds) of a performance counter, i.e. a clock with the highest available resolution to measure a short duration. It does include time elapsed during sleep and is system-wide. The reference point of the returned value is undefined, so that only the difference between the results of consecutive calls is valid.

New in version 3.3.

`time.perf_counter_ns()` → int

Similar to *perf_counter()*, but return time as nanoseconds.

New in version 3.7.

`time.process_time()` → float

Return the value (in fractional seconds) of the sum of the system and user CPU time of the current process. It does not include time elapsed during sleep. It is process-wide by definition. The reference point of the returned value is undefined, so that only the difference between the results of consecutive calls is valid.

New in version 3.3.

`time.process_time_ns()` → int

Similar to *process_time()* but return time as nanoseconds.

New in version 3.7.

`time.sleep(`*secs*`)`

Suspend execution of the calling thread for the given number of seconds. The argument may be a floating point number to indicate a more precise sleep time. The actual suspension time may be less than that requested because any caught signal will terminate the *sleep()* following execution of that signal's catching routine. Also, the suspension time may be longer than requested by an arbitrary amount because of the scheduling of other activity in the system.

Changed in version 3.5: The function now sleeps at least *secs* even if the sleep is interrupted by a signal, except if the signal handler raises an exception (see **PEP 475** for the rationale).

`time.strftime(`*format*[, *t*]`)`

Convert a tuple or *struct_time* representing a time as returned by *gmtime()* or *localtime()* to a string as specified by the *format* argument. If *t* is not provided, the current time as returned by *localtime()* is used. *format* must be a string. *ValueError* is raised if any field in *t* is outside of the allowed range.

0 is a legal argument for any position in the time tuple; if it is normally illegal the value is forced to a correct one.

The following directives can be embedded in the *format* string. They are shown without the optional field width and precision specification, and are replaced by the indicated characters in the *strftime()* result:

Directive	Meaning	Notes
`%a`	Locale's abbreviated weekday name.	
`%A`	Locale's full weekday name.	
`%b`	Locale's abbreviated month name.	
`%B`	Locale's full month name.	
`%c`	Locale's appropriate date and time representation.	
`%d`	Day of the month as a decimal number [01,31].	
`%H`	Hour (24-hour clock) as a decimal number [00,23].	
`%I`	Hour (12-hour clock) as a decimal number [01,12].	
`%j`	Day of the year as a decimal number [001,366].	
`%m`	Month as a decimal number [01,12].	
`%M`	Minute as a decimal number [00,59].	
`%p`	Locale's equivalent of either AM or PM.	(1)
`%S`	Second as a decimal number [00,61].	(2)
`%U`	Week number of the year (Sunday as the first day of the week) as a decimal number [00,53]. All days in a new year preceding the first Sunday are considered to be in week 0.	(3)
`%w`	Weekday as a decimal number [0(Sunday),6].	
`%W`	Week number of the year (Monday as the first day of the week) as a decimal number [00,53]. All days in a new year preceding the first Monday are considered to be in week 0.	(3)
`%x`	Locale's appropriate date representation.	
`%X`	Locale's appropriate time representation.	
`%y`	Year without century as a decimal number [00,99].	
`%Y`	Year with century as a decimal number.	
`%z`	Time zone offset indicating a positive or negative time difference from UTC/GMT of the form +HHMM or -HHMM, where H represents decimal hour digits and M represents decimal minute digits [-23:59, +23:59].	
`%Z`	Time zone name (no characters if no time zone exists).	
`%%`	A literal `'%'` character.	

Notes:

(1) When used with the *strptime()* function, the `%p` directive only affects the output hour field if the `%I` directive is used to parse the hour.

(2) The range really is `0` to `61`; value `60` is valid in timestamps representing leap seconds and value `61` is supported for historical reasons.

(3) When used with the *strptime()* function, `%U` and `%W` are only used in calculations when the day of the week and the year are specified.

Here is an example, a format for dates compatible with that specified in the **RFC 2822** Internet email standard.[1]

```
>>> from time import gmtime, strftime
>>> strftime("%a, %d %b %Y %H:%M:%S +0000", gmtime())
'Thu, 28 Jun 2001 14:17:15 +0000'
```

[1] The use of `%Z` is now deprecated, but the `%z` escape that expands to the preferred hour/minute offset is not supported by all ANSI C libraries. Also, a strict reading of the original 1982 **RFC 822** standard calls for a two-digit year (%y rather than %Y), but practice moved to 4-digit years long before the year 2000. After that, **RFC 822** became obsolete and the 4-digit year has been first recommended by **RFC 1123** and then mandated by **RFC 2822**.

Additional directives may be supported on certain platforms, but only the ones listed here have a meaning standardized by ANSI C. To see the full set of format codes supported on your platform, consult the *strftime(3)* documentation.

On some platforms, an optional field width and precision specification can immediately follow the initial `'%'` of a directive in the following order; this is also not portable. The field width is normally 2 except for `%j` where it is 3.

`time.strptime(string[, format])`

Parse a string representing a time according to a format. The return value is a *struct_time* as returned by *gmtime()* or *localtime()*.

The *format* parameter uses the same directives as those used by *strftime()*; it defaults to `"%a %b %d %H:%M:%S %Y"` which matches the formatting returned by *ctime()*. If *string* cannot be parsed according to *format*, or if it has excess data after parsing, *ValueError* is raised. The default values used to fill in any missing data when more accurate values cannot be inferred are `(1900, 1, 1, 0, 0, 0, 0, 1, -1)`. Both *string* and *format* must be strings.

For example:

```
>>> import time
>>> time.strptime("30 Nov 00", "%d %b %y")   # doctest: +NORMALIZE_WHITESPACE
time.struct_time(tm_year=2000, tm_mon=11, tm_mday=30, tm_hour=0, tm_min=0,
                 tm_sec=0, tm_wday=3, tm_yday=335, tm_isdst=-1)
```

Support for the `%Z` directive is based on the values contained in `tzname` and whether `daylight` is true. Because of this, it is platform-specific except for recognizing UTC and GMT which are always known (and are considered to be non-daylight savings timezones).

Only the directives specified in the documentation are supported. Because `strftime()` is implemented per platform it can sometimes offer more directives than those listed. But `strptime()` is independent of any platform and thus does not necessarily support all directives available that are not documented as supported.

`class time.struct_time`

The type of the time value sequence returned by *gmtime()*, *localtime()*, and *strptime()*. It is an object with a *named tuple* interface: values can be accessed by index and by attribute name. The following values are present:

Index	Attribute	Values
0	`tm_year`	(for example, 1993)
1	`tm_mon`	range [1, 12]
2	`tm_mday`	range [1, 31]
3	`tm_hour`	range [0, 23]
4	`tm_min`	range [0, 59]
5	`tm_sec`	range [0, 61]; see **(2)** in *strftime()* description
6	`tm_wday`	range [0, 6], Monday is 0
7	`tm_yday`	range [1, 366]
8	`tm_isdst`	0, 1 or -1; see below
N/A	`tm_zone`	abbreviation of timezone name
N/A	`tm_gmtoff`	offset east of UTC in seconds

Note that unlike the C structure, the month value is a range of [1, 12], not [0, 11].

In calls to *mktime()*, `tm_isdst` may be set to 1 when daylight savings time is in effect, and 0 when it is not. A value of -1 indicates that this is not known, and will usually result in the correct state being filled in.

When a tuple with an incorrect length is passed to a function expecting a *struct_time*, or having elements of the wrong type, a *TypeError* is raised.

time.time() → float
Return the time in seconds since the *epoch* as a floating point number. The specific date of the epoch and the handling of leap seconds is platform dependent. On Windows and most Unix systems, the epoch is January 1, 1970, 00:00:00 (UTC) and leap seconds are not counted towards the time in seconds since the epoch. This is commonly referred to as Unix time. To find out what the epoch is on a given platform, look at `gmtime(0)`.

Note that even though the time is always returned as a floating point number, not all systems provide time with a better precision than 1 second. While this function normally returns non-decreasing values, it can return a lower value than a previous call if the system clock has been set back between the two calls.

The number returned by *time()* may be converted into a more common time format (i.e. year, month, day, hour, etc…) in UTC by passing it to *gmtime()* function or in local time by passing it to the *localtime()* function. In both cases a *struct_time* object is returned, from which the components of the calendar date may be accessed as attributes.

time.thread_time() → float
Return the value (in fractional seconds) of the sum of the system and user CPU time of the current thread. It does not include time elapsed during sleep. It is thread-specific by definition. The reference point of the returned value is undefined, so that only the difference between the results of consecutive calls in the same thread is valid.

Availability: Windows, Linux, Unix systems supporting `CLOCK_THREAD_CPUTIME_ID`.

New in version 3.7.

time.thread_time_ns() → int
Similar to *thread_time()* but return time as nanoseconds.

New in version 3.7.

time.time_ns() → int
Similar to *time()* but returns time as an integer number of nanoseconds since the *epoch*.

New in version 3.7.

time.tzset()
Reset the time conversion rules used by the library routines. The environment variable `TZ` specifies how this is done. It will also set the variables `tzname` (from the `TZ` environment variable), `timezone` (non-DST seconds West of UTC), `altzone` (DST seconds west of UTC) and `daylight` (to 0 if this timezone does not have any daylight saving time rules, or to nonzero if there is a time, past, present or future when daylight saving time applies).

Availability: Unix.

Note: Although in many cases, changing the `TZ` environment variable may affect the output of functions like *localtime()* without calling *tzset()*, this behavior should not be relied on.

The `TZ` environment variable should contain no whitespace.

The standard format of the `TZ` environment variable is (whitespace added for clarity):

```
std offset [dst [offset [,start[/time], end[/time]]]]
```

Where the components are:

std and dst Three or more alphanumerics giving the timezone abbreviations. These will be propagated into time.tzname

offset The offset has the form: ± `hh[:mm[:ss]]`. This indicates the value added the local time to arrive at UTC. If preceded by a '-', the timezone is east of the Prime Meridian; otherwise, it is west. If no offset follows dst, summer time is assumed to be one hour ahead of standard time.

start[/time], end[/time] Indicates when to change to and back from DST. The format of the start and end dates are one of the following:

Jn The Julian day *n* (1 <= *n* <= 365). Leap days are not counted, so in all years February 28 is day 59 and March 1 is day 60.

n The zero-based Julian day (0 <= *n* <= 365). Leap days are counted, and it is possible to refer to February 29.

M*m*.*n*.*d* The *d*'th day (0 <= *d* <= 6) of week *n* of month *m* of the year (1 <= *n* <= 5, 1 <= *m* <= 12, where week 5 means "the last *d* day in month *m*" which may occur in either the fourth or the fifth week). Week 1 is the first week in which the *d*'th day occurs. Day zero is a Sunday.

`time` has the same format as `offset` except that no leading sign ('-' or '+') is allowed. The default, if time is not given, is 02:00:00.

```
>>> os.environ['TZ'] = 'EST+05EDT,M4.1.0,M10.5.0'
>>> time.tzset()
>>> time.strftime('%X %x %Z')
'02:07:36 05/08/03 EDT'
>>> os.environ['TZ'] = 'AEST-10AEDT-11,M10.5.0,M3.5.0'
>>> time.tzset()
>>> time.strftime('%X %x %Z')
'16:08:12 05/08/03 AEST'
```

On many Unix systems (including *BSD, Linux, Solaris, and Darwin), it is more convenient to use the system's zoneinfo (*tzfile(5)*) database to specify the timezone rules. To do this, set the `TZ` environment variable to the path of the required timezone datafile, relative to the root of the systems 'zoneinfo' timezone database, usually located at `/usr/share/zoneinfo`. For example, `'US/Eastern'`, `'Australia/Melbourne'`, `'Egypt'` or `'Europe/Amsterdam'`.

```
>>> os.environ['TZ'] = 'US/Eastern'
>>> time.tzset()
>>> time.tzname
('EST', 'EDT')
>>> os.environ['TZ'] = 'Egypt'
>>> time.tzset()
>>> time.tzname
('EET', 'EEST')
```

16.3.2 Clock ID Constants

These constants are used as parameters for *clock_getres()* and *clock_gettime()*.

`time.CLOCK_BOOTTIME`

Identical to *CLOCK_MONOTONIC*, except it also includes any time that the system is suspended.

This allows applications to get a suspend-aware monotonic clock without having to deal with the complications of *CLOCK_REALTIME*, which may have discontinuities if the time is changed using `settimeofday()` or similar.

Availability: Linux 2.6.39 or later.

New in version 3.7.

time.CLOCK_HIGHRES
The Solaris OS has a `CLOCK_HIGHRES` timer that attempts to use an optimal hardware source, and may give close to nanosecond resolution. `CLOCK_HIGHRES` is the nonadjustable, high-resolution clock.

Availability: Solaris.

New in version 3.3.

time.CLOCK_MONOTONIC
Clock that cannot be set and represents monotonic time since some unspecified starting point.

Availability: Unix.

New in version 3.3.

time.CLOCK_MONOTONIC_RAW
Similar to *CLOCK_MONOTONIC*, but provides access to a raw hardware-based time that is not subject to NTP adjustments.

Availability: Linux 2.6.28 and newer, macOS 10.12 and newer.

New in version 3.3.

time.CLOCK_PROCESS_CPUTIME_ID
High-resolution per-process timer from the CPU.

Availability: Unix.

New in version 3.3.

time.CLOCK_PROF
High-resolution per-process timer from the CPU.

Availability: FreeBSD, NetBSD 7 or later, OpenBSD.

New in version 3.7.

time.CLOCK_THREAD_CPUTIME_ID
Thread-specific CPU-time clock.

Availability: Unix.

New in version 3.3.

time.CLOCK_UPTIME
Time whose absolute value is the time the system has been running and not suspended, providing accurate uptime measurement, both absolute and interval.

Availability: FreeBSD, OpenBSD 5.5 or later.

New in version 3.7.

The following constant is the only parameter that can be sent to *clock_settime()*.

time.CLOCK_REALTIME
System-wide real-time clock. Setting this clock requires appropriate privileges.

Availability: Unix.

New in version 3.3.

16.3.3 Timezone Constants

time.altzone
The offset of the local DST timezone, in seconds west of UTC, if one is defined. This is negative if the local DST timezone is east of UTC (as in Western Europe, including the UK). Only use this if `daylight` is nonzero. See note below.

time.daylight
Nonzero if a DST timezone is defined. See note below.

time.timezone
The offset of the local (non-DST) timezone, in seconds west of UTC (negative in most of Western Europe, positive in the US, zero in the UK). See note below.

time.tzname
A tuple of two strings: the first is the name of the local non-DST timezone, the second is the name of the local DST timezone. If no DST timezone is defined, the second string should not be used. See note below.

Note: For the above Timezone constants (*altzone*, *daylight*, *timezone*, and *tzname*), the value is determined by the timezone rules in effect at module load time or the last time *tzset()* is called and may be incorrect for times in the past. It is recommended to use the `tm_gmtoff` and `tm_zone` results from *localtime()* to obtain timezone information.

See also:

Module *datetime* More object-oriented interface to dates and times.

Module *locale* Internationalization services. The locale setting affects the interpretation of many format specifiers in *strftime()* and *strptime()*.

Module *calendar* General calendar-related functions. *timegm()* is the inverse of *gmtime()* from this module.

16.4 argparse — Parser for command-line options, arguments and sub-commands

New in version 3.2.

Source code: Lib/argparse.py

Tutorial

This page contains the API reference information. For a more gentle introduction to Python command-line parsing, have a look at the argparse tutorial.

The *argparse* module makes it easy to write user-friendly command-line interfaces. The program defines what arguments it requires, and *argparse* will figure out how to parse those out of *sys.argv*. The *argparse* module also automatically generates help and usage messages and issues errors when users give the program invalid arguments.

16.4.1 Example

The following code is a Python program that takes a list of integers and produces either the sum or the max:

```
import argparse

parser = argparse.ArgumentParser(description='Process some integers.')
```

(continues on next page)

(continued from previous page)

```
parser.add_argument('integers', metavar='N', type=int, nargs='+',
                    help='an integer for the accumulator')
parser.add_argument('--sum', dest='accumulate', action='store_const',
                    const=sum, default=max,
                    help='sum the integers (default: find the max)')

args = parser.parse_args()
print(args.accumulate(args.integers))
```

Assuming the Python code above is saved into a file called `prog.py`, it can be run at the command line and provides useful help messages:

```
$ python prog.py -h
usage: prog.py [-h] [--sum] N [N ...]

Process some integers.

positional arguments:
 N           an integer for the accumulator

optional arguments:
 -h, --help  show this help message and exit
 --sum       sum the integers (default: find the max)
```

When run with the appropriate arguments, it prints either the sum or the max of the command-line integers:

```
$ python prog.py 1 2 3 4
4

$ python prog.py 1 2 3 4 --sum
10
```

If invalid arguments are passed in, it will issue an error:

```
$ python prog.py a b c
usage: prog.py [-h] [--sum] N [N ...]
prog.py: error: argument N: invalid int value: 'a'
```

The following sections walk you through this example.

Creating a parser

The first step in using the *argparse* is creating an *ArgumentParser* object:

```
>>> parser = argparse.ArgumentParser(description='Process some integers.')
```

The *ArgumentParser* object will hold all the information necessary to parse the command line into Python data types.

Adding arguments

Filling an *ArgumentParser* with information about program arguments is done by making calls to the *add_argument()* method. Generally, these calls tell the *ArgumentParser* how to take the strings on the command line and turn them into objects. This information is stored and used when *parse_args()* is called. For example:

```
>>> parser.add_argument('integers', metavar='N', type=int, nargs='+',
...                     help='an integer for the accumulator')
>>> parser.add_argument('--sum', dest='accumulate', action='store_const',
...                     const=sum, default=max,
...                     help='sum the integers (default: find the max)')
```

Later, calling *parse_args()* will return an object with two attributes, `integers` and `accumulate`. The `integers` attribute will be a list of one or more ints, and the `accumulate` attribute will be either the *sum()* function, if `--sum` was specified at the command line, or the *max()* function if it was not.

Parsing arguments

ArgumentParser parses arguments through the *parse_args()* method. This will inspect the command line, convert each argument to the appropriate type and then invoke the appropriate action. In most cases, this means a simple *Namespace* object will be built up from attributes parsed out of the command line:

```
>>> parser.parse_args(['--sum', '7', '-1', '42'])
Namespace(accumulate=<built-in function sum>, integers=[7, -1, 42])
```

In a script, *parse_args()* will typically be called with no arguments, and the *ArgumentParser* will automatically determine the command-line arguments from *sys.argv*.

16.4.2 ArgumentParser objects

class `argparse.ArgumentParser`(*prog=None*, *usage=None*, *description=None*, *epilog=None*, *parents=[]*, *formatter_class=argparse.HelpFormatter*, *prefix_chars='-'*, *fromfile_prefix_chars=None*, *argument_default=None*, *conflict_handler='error'*, *add_help=True*, *allow_abbrev=True*)

Create a new *ArgumentParser* object. All parameters should be passed as keyword arguments. Each parameter has its own more detailed description below, but in short they are:

- *prog* - The name of the program (default: `sys.argv[0]`)
- *usage* - The string describing the program usage (default: generated from arguments added to parser)
- *description* - Text to display before the argument help (default: none)
- *epilog* - Text to display after the argument help (default: none)
- *parents* - A list of *ArgumentParser* objects whose arguments should also be included
- *formatter_class* - A class for customizing the help output
- *prefix_chars* - The set of characters that prefix optional arguments (default: '-')
- *fromfile_prefix_chars* - The set of characters that prefix files from which additional arguments should be read (default: `None`)
- *argument_default* - The global default value for arguments (default: `None`)
- *conflict_handler* - The strategy for resolving conflicting optionals (usually unnecessary)
- *add_help* - Add a `-h/--help` option to the parser (default: `True`)
- *allow_abbrev* - Allows long options to be abbreviated if the abbreviation is unambiguous. (default: `True`)

Changed in version 3.5: *allow_abbrev* parameter was added.

The following sections describe how each of these are used.

prog

By default, *ArgumentParser* objects use `sys.argv[0]` to determine how to display the name of the program in help messages. This default is almost always desirable because it will make the help messages match how the program was invoked on the command line. For example, consider a file named `myprogram.py` with the following code:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument('--foo', help='foo help')
args = parser.parse_args()
```

The help for this program will display `myprogram.py` as the program name (regardless of where the program was invoked from):

```
$ python myprogram.py --help
usage: myprogram.py [-h] [--foo FOO]

optional arguments:
 -h, --help  show this help message and exit
 --foo FOO   foo help
$ cd ..
$ python subdir/myprogram.py --help
usage: myprogram.py [-h] [--foo FOO]

optional arguments:
 -h, --help  show this help message and exit
 --foo FOO   foo help
```

To change this default behavior, another value can be supplied using the `prog=` argument to *ArgumentParser*:

```
>>> parser = argparse.ArgumentParser(prog='myprogram')
>>> parser.print_help()
usage: myprogram [-h]

optional arguments:
 -h, --help  show this help message and exit
```

Note that the program name, whether determined from `sys.argv[0]` or from the `prog=` argument, is available to help messages using the `%(prog)s` format specifier.

```
>>> parser = argparse.ArgumentParser(prog='myprogram')
>>> parser.add_argument('--foo', help='foo of the %(prog)s program')
>>> parser.print_help()
usage: myprogram [-h] [--foo FOO]

optional arguments:
 -h, --help  show this help message and exit
 --foo FOO   foo of the myprogram program
```

usage

By default, *ArgumentParser* calculates the usage message from the arguments it contains:

```
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('--foo', nargs='?', help='foo help')
>>> parser.add_argument('bar', nargs='+', help='bar help')
>>> parser.print_help()
usage: PROG [-h] [--foo [FOO]] bar [bar ...]

positional arguments:
 bar          bar help

optional arguments:
 -h, --help   show this help message and exit
 --foo [FOO]  foo help
```

The default message can be overridden with the `usage=` keyword argument:

```
>>> parser = argparse.ArgumentParser(prog='PROG', usage='%(prog)s [options]')
>>> parser.add_argument('--foo', nargs='?', help='foo help')
>>> parser.add_argument('bar', nargs='+', help='bar help')
>>> parser.print_help()
usage: PROG [options]

positional arguments:
 bar          bar help

optional arguments:
 -h, --help   show this help message and exit
 --foo [FOO]  foo help
```

The `%(prog)s` format specifier is available to fill in the program name in your usage messages.

description

Most calls to the *ArgumentParser* constructor will use the `description=` keyword argument. This argument gives a brief description of what the program does and how it works. In help messages, the description is displayed between the command-line usage string and the help messages for the various arguments:

```
>>> parser = argparse.ArgumentParser(description='A foo that bars')
>>> parser.print_help()
usage: argparse.py [-h]

A foo that bars

optional arguments:
 -h, --help  show this help message and exit
```

By default, the description will be line-wrapped so that it fits within the given space. To change this behavior, see the *formatter_class* argument.

epilog

Some programs like to display additional description of the program after the description of the arguments. Such text can be specified using the `epilog=` argument to *ArgumentParser*:

```
>>> parser = argparse.ArgumentParser(
...     description='A foo that bars',
...     epilog="And that's how you'd foo a bar")
>>> parser.print_help()
usage: argparse.py [-h]

A foo that bars

optional arguments:
 -h, --help  show this help message and exit

And that's how you'd foo a bar
```

As with the *description* argument, the `epilog=` text is by default line-wrapped, but this behavior can be adjusted with the *formatter_class* argument to *ArgumentParser*.

parents

Sometimes, several parsers share a common set of arguments. Rather than repeating the definitions of these arguments, a single parser with all the shared arguments and passed to `parents=` argument to *ArgumentParser* can be used. The `parents=` argument takes a list of *ArgumentParser* objects, collects all the positional and optional actions from them, and adds these actions to the *ArgumentParser* object being constructed:

```
>>> parent_parser = argparse.ArgumentParser(add_help=False)
>>> parent_parser.add_argument('--parent', type=int)

>>> foo_parser = argparse.ArgumentParser(parents=[parent_parser])
>>> foo_parser.add_argument('foo')
>>> foo_parser.parse_args(['--parent', '2', 'XXX'])
Namespace(foo='XXX', parent=2)

>>> bar_parser = argparse.ArgumentParser(parents=[parent_parser])
>>> bar_parser.add_argument('--bar')
>>> bar_parser.parse_args(['--bar', 'YYY'])
Namespace(bar='YYY', parent=None)
```

Note that most parent parsers will specify `add_help=False`. Otherwise, the *ArgumentParser* will see two `-h/--help` options (one in the parent and one in the child) and raise an error.

Note: You must fully initialize the parsers before passing them via `parents=`. If you change the parent parsers after the child parser, those changes will not be reflected in the child.

formatter_class

ArgumentParser objects allow the help formatting to be customized by specifying an alternate formatting class. Currently, there are four such classes:

class argparse.**RawDescriptionHelpFormatter**
class argparse.**RawTextHelpFormatter**
class argparse.**ArgumentDefaultsHelpFormatter**
class argparse.**MetavarTypeHelpFormatter**

RawDescriptionHelpFormatter and *RawTextHelpFormatter* give more control over how textual descriptions are displayed. By default, *ArgumentParser* objects line-wrap the *description* and *epilog* texts in command-line help messages:

```
>>> parser = argparse.ArgumentParser(
...     prog='PROG',
...     description='''this description
...         was indented weird
...             but that is okay''',
...     epilog='''
...             likewise for this epilog whose whitespace will
...         be cleaned up and whose words will be wrapped
...         across a couple lines''')
>>> parser.print_help()
usage: PROG [-h]

this description was indented weird but that is okay

optional arguments:
 -h, --help  show this help message and exit

likewise for this epilog whose whitespace will be cleaned up and whose words
will be wrapped across a couple lines
```

Passing *RawDescriptionHelpFormatter* as `formatter_class=` indicates that *description* and *epilog* are already correctly formatted and should not be line-wrapped:

```
>>> parser = argparse.ArgumentParser(
...     prog='PROG',
...     formatter_class=argparse.RawDescriptionHelpFormatter,
...     description=textwrap.dedent('''\
...         Please do not mess up this text!
...         --------------------------------
...             I have indented it
...             exactly the way
...             I want it
...         '''))
>>> parser.print_help()
usage: PROG [-h]

Please do not mess up this text!
--------------------------------
   I have indented it
   exactly the way
   I want it

optional arguments:
 -h, --help  show this help message and exit
```

RawTextHelpFormatter maintains whitespace for all sorts of help text, including argument descriptions. However, multiple new lines are replaced with one. If you wish to preserve multiple blank lines, add spaces between the newlines.

ArgumentDefaultsHelpFormatter automatically adds information about default values to each of the argument help messages:

```
>>> parser = argparse.ArgumentParser(
...     prog='PROG',
...     formatter_class=argparse.ArgumentDefaultsHelpFormatter)
>>> parser.add_argument('--foo', type=int, default=42, help='FOO!')
>>> parser.add_argument('bar', nargs='*', default=[1, 2, 3], help='BAR!')
>>> parser.print_help()
usage: PROG [-h] [--foo FOO] [bar [bar ...]]

positional arguments:
 bar         BAR! (default: [1, 2, 3])

optional arguments:
 -h, --help  show this help message and exit
 --foo FOO   FOO! (default: 42)
```

MetavarTypeHelpFormatter uses the name of the *type* argument for each argument as the display name for its values (rather than using the *dest* as the regular formatter does):

```
>>> parser = argparse.ArgumentParser(
...     prog='PROG',
...     formatter_class=argparse.MetavarTypeHelpFormatter)
>>> parser.add_argument('--foo', type=int)
>>> parser.add_argument('bar', type=float)
>>> parser.print_help()
usage: PROG [-h] [--foo int] float

positional arguments:
  float

optional arguments:
  -h, --help  show this help message and exit
  --foo int
```

prefix_chars

Most command-line options will use `-` as the prefix, e.g. `-f/--foo`. Parsers that need to support different or additional prefix characters, e.g. for options like `+f` or `/foo`, may specify them using the `prefix_chars=` argument to the ArgumentParser constructor:

```
>>> parser = argparse.ArgumentParser(prog='PROG', prefix_chars='-+')
>>> parser.add_argument('+f')
>>> parser.add_argument('++bar')
>>> parser.parse_args('+f X ++bar Y'.split())
Namespace(bar='Y', f='X')
```

The `prefix_chars=` argument defaults to `'-'`. Supplying a set of characters that does not include `-` will cause `-f/--foo` options to be disallowed.

fromfile_prefix_chars

Sometimes, for example when dealing with a particularly long argument lists, it may make sense to keep the list of arguments in a file rather than typing it out at the command line. If the `fromfile_prefix_chars=` argument is given to the *ArgumentParser* constructor, then arguments that start with any of the specified characters will be treated as files, and will be replaced by the arguments they contain. For example:

```
>>> with open('args.txt', 'w') as fp:
...     fp.write('-f\nbar')
>>> parser = argparse.ArgumentParser(fromfile_prefix_chars='@')
>>> parser.add_argument('-f')
>>> parser.parse_args(['-f', 'foo', '@args.txt'])
Namespace(f='bar')
```

Arguments read from a file must by default be one per line (but see also *convert_arg_line_to_args()*) and are treated as if they were in the same place as the original file referencing argument on the command line. So in the example above, the expression `['-f', 'foo', '@args.txt']` is considered equivalent to the expression `['-f', 'foo', '-f', 'bar']`.

The `fromfile_prefix_chars=` argument defaults to `None`, meaning that arguments will never be treated as file references.

argument_default

Generally, argument defaults are specified either by passing a default to *add_argument()* or by calling the *set_defaults()* methods with a specific set of name-value pairs. Sometimes however, it may be useful to specify a single parser-wide default for arguments. This can be accomplished by passing the `argument_default=` keyword argument to *ArgumentParser*. For example, to globally suppress attribute creation on *parse_args()* calls, we supply `argument_default=SUPPRESS`:

```
>>> parser = argparse.ArgumentParser(argument_default=argparse.SUPPRESS)
>>> parser.add_argument('--foo')
>>> parser.add_argument('bar', nargs='?')
>>> parser.parse_args(['--foo', '1', 'BAR'])
Namespace(bar='BAR', foo='1')
>>> parser.parse_args([])
Namespace()
```

allow_abbrev

Normally, when you pass an argument list to the *parse_args()* method of an *ArgumentParser*, it *recognizes abbreviations* of long options.

This feature can be disabled by setting `allow_abbrev` to `False`:

```
>>> parser = argparse.ArgumentParser(prog='PROG', allow_abbrev=False)
>>> parser.add_argument('--foobar', action='store_true')
>>> parser.add_argument('--foonley', action='store_false')
>>> parser.parse_args(['--foon'])
usage: PROG [-h] [--foobar] [--foonley]
PROG: error: unrecognized arguments: --foon
```

New in version 3.5.

conflict_handler

ArgumentParser objects do not allow two actions with the same option string. By default, *ArgumentParser* objects raise an exception if an attempt is made to create an argument with an option string that is already in use:

```
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('-f', '--foo', help='old foo help')
>>> parser.add_argument('--foo', help='new foo help')
Traceback (most recent call last):
 ..
ArgumentError: argument --foo: conflicting option string(s): --foo
```

Sometimes (e.g. when using *parents*) it may be useful to simply override any older arguments with the same option string. To get this behavior, the value `'resolve'` can be supplied to the `conflict_handler=` argument of *ArgumentParser*:

```
>>> parser = argparse.ArgumentParser(prog='PROG', conflict_handler='resolve')
>>> parser.add_argument('-f', '--foo', help='old foo help')
>>> parser.add_argument('--foo', help='new foo help')
>>> parser.print_help()
usage: PROG [-h] [-f FOO] [--foo FOO]

optional arguments:
 -h, --help  show this help message and exit
 -f FOO      old foo help
 --foo FOO   new foo help
```

Note that *ArgumentParser* objects only remove an action if all of its option strings are overridden. So, in the example above, the old `-f/--foo` action is retained as the `-f` action, because only the `--foo` option string was overridden.

add_help

By default, ArgumentParser objects add an option which simply displays the parser's help message. For example, consider a file named `myprogram.py` containing the following code:

```
import argparse
parser = argparse.ArgumentParser()
parser.add_argument('--foo', help='foo help')
args = parser.parse_args()
```

If `-h` or `--help` is supplied at the command line, the ArgumentParser help will be printed:

```
$ python myprogram.py --help
usage: myprogram.py [-h] [--foo FOO]

optional arguments:
 -h, --help  show this help message and exit
 --foo FOO   foo help
```

Occasionally, it may be useful to disable the addition of this help option. This can be achieved by passing `False` as the `add_help=` argument to *ArgumentParser*:

```
>>> parser = argparse.ArgumentParser(prog='PROG', add_help=False)
>>> parser.add_argument('--foo', help='foo help')
>>> parser.print_help()
usage: PROG [--foo FOO]

optional arguments:
 --foo FOO  foo help
```

The help option is typically `-h/--help`. The exception to this is if the `prefix_chars=` is specified and does not include `-`, in which case `-h` and `--help` are not valid options. In this case, the first character in `prefix_chars` is used to prefix the help options:

```
>>> parser = argparse.ArgumentParser(prog='PROG', prefix_chars='+/')
>>> parser.print_help()
usage: PROG [+h]

optional arguments:
  +h, ++help  show this help message and exit
```

16.4.3 The add_argument() method

`ArgumentParser.add_argument`(*name or flags...*[, *action*][, *nargs*][, *const*][, *default*][, *type*][, *choices*][, *required*][, *help*][, *metavar*][, *dest*])

Define how a single command-line argument should be parsed. Each parameter has its own more detailed description below, but in short they are:

- *name or flags* - Either a name or a list of option strings, e.g. `foo` or `-f, --foo`.
- *action* - The basic type of action to be taken when this argument is encountered at the command line.
- *nargs* - The number of command-line arguments that should be consumed.
- *const* - A constant value required by some *action* and *nargs* selections.
- *default* - The value produced if the argument is absent from the command line.
- *type* - The type to which the command-line argument should be converted.
- *choices* - A container of the allowable values for the argument.
- *required* - Whether or not the command-line option may be omitted (optionals only).
- *help* - A brief description of what the argument does.
- *metavar* - A name for the argument in usage messages.
- *dest* - The name of the attribute to be added to the object returned by `parse_args()`.

The following sections describe how each of these are used.

name or flags

The `add_argument()` method must know whether an optional argument, like `-f` or `--foo`, or a positional argument, like a list of filenames, is expected. The first arguments passed to `add_argument()` must therefore be either a series of flags, or a simple argument name. For example, an optional argument could be created like:

```
>>> parser.add_argument('-f', '--foo')
```

while a positional argument could be created like:

```
>>> parser.add_argument('bar')
```

When *parse_args()* is called, optional arguments will be identified by the `-` prefix, and the remaining arguments will be assumed to be positional:

```
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('-f', '--foo')
>>> parser.add_argument('bar')
>>> parser.parse_args(['BAR'])
Namespace(bar='BAR', foo=None)
>>> parser.parse_args(['BAR', '--foo', 'FOO'])
Namespace(bar='BAR', foo='FOO')
>>> parser.parse_args(['--foo', 'FOO'])
usage: PROG [-h] [-f FOO] bar
PROG: error: the following arguments are required: bar
```

action

ArgumentParser objects associate command-line arguments with actions. These actions can do just about anything with the command-line arguments associated with them, though most actions simply add an attribute to the object returned by *parse_args()*. The `action` keyword argument specifies how the command-line arguments should be handled. The supplied actions are:

- `'store'` - This just stores the argument's value. This is the default action. For example:

  ```
  >>> parser = argparse.ArgumentParser()
  >>> parser.add_argument('--foo')
  >>> parser.parse_args('--foo 1'.split())
  Namespace(foo='1')
  ```

- `'store_const'` - This stores the value specified by the *const* keyword argument. The `'store_const'` action is most commonly used with optional arguments that specify some sort of flag. For example:

  ```
  >>> parser = argparse.ArgumentParser()
  >>> parser.add_argument('--foo', action='store_const', const=42)
  >>> parser.parse_args(['--foo'])
  Namespace(foo=42)
  ```

- `'store_true'` and `'store_false'` - These are special cases of `'store_const'` used for storing the values `True` and `False` respectively. In addition, they create default values of `False` and `True` respectively. For example:

  ```
  >>> parser = argparse.ArgumentParser()
  >>> parser.add_argument('--foo', action='store_true')
  >>> parser.add_argument('--bar', action='store_false')
  >>> parser.add_argument('--baz', action='store_false')
  >>> parser.parse_args('--foo --bar'.split())
  Namespace(foo=True, bar=False, baz=True)
  ```

- `'append'` - This stores a list, and appends each argument value to the list. This is useful to allow an option to be specified multiple times. Example usage:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--foo', action='append')
>>> parser.parse_args('--foo 1 --foo 2'.split())
Namespace(foo=['1', '2'])
```

- `'append_const'` - This stores a list, and appends the value specified by the *const* keyword argument to the list. (Note that the *const* keyword argument defaults to `None`.) The `'append_const'` action is typically useful when multiple arguments need to store constants to the same list. For example:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--str', dest='types', action='append_const', const=str)
>>> parser.add_argument('--int', dest='types', action='append_const', const=int)
>>> parser.parse_args('--str --int'.split())
Namespace(types=[<class 'str'>, <class 'int'>])
```

- `'count'` - This counts the number of times a keyword argument occurs. For example, this is useful for increasing verbosity levels:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--verbose', '-v', action='count')
>>> parser.parse_args(['-vvv'])
Namespace(verbose=3)
```

- `'help'` - This prints a complete help message for all the options in the current parser and then exits. By default a help action is automatically added to the parser. See *ArgumentParser* for details of how the output is created.
- `'version'` - This expects a `version=` keyword argument in the *add_argument()* call, and prints version information and exits when invoked:

```
>>> import argparse
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('--version', action='version', version='%(prog)s 2.0')
>>> parser.parse_args(['--version'])
PROG 2.0
```

You may also specify an arbitrary action by passing an Action subclass or other object that implements the same interface. The recommended way to do this is to extend *Action*, overriding the `__call__` method and optionally the `__init__` method.

An example of a custom action:

```
>>> class FooAction(argparse.Action):
...     def __init__(self, option_strings, dest, nargs=None, **kwargs):
...         if nargs is not None:
...             raise ValueError("nargs not allowed")
...         super(FooAction, self).__init__(option_strings, dest, **kwargs)
...     def __call__(self, parser, namespace, values, option_string=None):
...         print('%r %r %r' % (namespace, values, option_string))
...         setattr(namespace, self.dest, values)
...
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--foo', action=FooAction)
>>> parser.add_argument('bar', action=FooAction)
>>> args = parser.parse_args('1 --foo 2'.split())
```

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```
Namespace(bar=None, foo=None) '1' None
Namespace(bar='1', foo=None) '2' '--foo'
>>> args
Namespace(bar='1', foo='2')
```

For more details, see *Action*.

nargs

ArgumentParser objects usually associate a single command-line argument with a single action to be taken. The **nargs** keyword argument associates a different number of command-line arguments with a single action. The supported values are:

- `N` (an integer). `N` arguments from the command line will be gathered together into a list. For example:

  ```
  >>> parser = argparse.ArgumentParser()
  >>> parser.add_argument('--foo', nargs=2)
  >>> parser.add_argument('bar', nargs=1)
  >>> parser.parse_args('c --foo a b'.split())
  Namespace(bar=['c'], foo=['a', 'b'])
  ```

  Note that **nargs=1** produces a list of one item. This is different from the default, in which the item is produced by itself.

- `'?'`. One argument will be consumed from the command line if possible, and produced as a single item. If no command-line argument is present, the value from *default* will be produced. Note that for optional arguments, there is an additional case - the option string is present but not followed by a command-line argument. In this case the value from *const* will be produced. Some examples to illustrate this:

  ```
  >>> parser = argparse.ArgumentParser()
  >>> parser.add_argument('--foo', nargs='?', const='c', default='d')
  >>> parser.add_argument('bar', nargs='?', default='d')
  >>> parser.parse_args(['XX', '--foo', 'YY'])
  Namespace(bar='XX', foo='YY')
  >>> parser.parse_args(['XX', '--foo'])
  Namespace(bar='XX', foo='c')
  >>> parser.parse_args([])
  Namespace(bar='d', foo='d')
  ```

  One of the more common uses of **nargs='?'** is to allow optional input and output files:

  ```
  >>> parser = argparse.ArgumentParser()
  >>> parser.add_argument('infile', nargs='?', type=argparse.FileType('r'),
  ...                     default=sys.stdin)
  >>> parser.add_argument('outfile', nargs='?', type=argparse.FileType('w'),
  ...                     default=sys.stdout)
  >>> parser.parse_args(['input.txt', 'output.txt'])
  Namespace(infile=<_io.TextIOWrapper name='input.txt' encoding='UTF-8'>,
            outfile=<_io.TextIOWrapper name='output.txt' encoding='UTF-8'>)
  >>> parser.parse_args([])
  Namespace(infile=<_io.TextIOWrapper name='<stdin>' encoding='UTF-8'>,
            outfile=<_io.TextIOWrapper name='<stdout>' encoding='UTF-8'>)
  ```

- `'*'`. All command-line arguments present are gathered into a list. Note that it generally doesn't make much sense to have more than one positional argument with `nargs='*'`, but multiple optional arguments with `nargs='*'` is possible. For example:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--foo', nargs='*')
>>> parser.add_argument('--bar', nargs='*')
>>> parser.add_argument('baz', nargs='*')
>>> parser.parse_args('a b --foo x y --bar 1 2'.split())
Namespace(bar=['1', '2'], baz=['a', 'b'], foo=['x', 'y'])
```

- `'+'`. Just like `'*'`, all command-line args present are gathered into a list. Additionally, an error message will be generated if there wasn't at least one command-line argument present. For example:

```
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('foo', nargs='+')
>>> parser.parse_args(['a', 'b'])
Namespace(foo=['a', 'b'])
>>> parser.parse_args([])
usage: PROG [-h] foo [foo ...]
PROG: error: the following arguments are required: foo
```

- `argparse.REMAINDER`. All the remaining command-line arguments are gathered into a list. This is commonly useful for command line utilities that dispatch to other command line utilities:

```
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('--foo')
>>> parser.add_argument('command')
>>> parser.add_argument('args', nargs=argparse.REMAINDER)
>>> print(parser.parse_args('--foo B cmd --arg1 XX ZZ'.split()))
Namespace(args=['--arg1', 'XX', 'ZZ'], command='cmd', foo='B')
```

If the `nargs` keyword argument is not provided, the number of arguments consumed is determined by the *action*. Generally this means a single command-line argument will be consumed and a single item (not a list) will be produced.

const

The `const` argument of *add_argument()* is used to hold constant values that are not read from the command line but are required for the various *ArgumentParser* actions. The two most common uses of it are:

- When *add_argument()* is called with `action='store_const'` or `action='append_const'`. These actions add the `const` value to one of the attributes of the object returned by *parse_args()*. See the *action* description for examples.
- When *add_argument()* is called with option strings (like `-f` or `--foo`) and `nargs='?'`. This creates an optional argument that can be followed by zero or one command-line arguments. When parsing the command line, if the option string is encountered with no command-line argument following it, the value of `const` will be assumed instead. See the *nargs* description for examples.

With the `'store_const'` and `'append_const'` actions, the `const` keyword argument must be given. For other actions, it defaults to `None`.

default

All optional arguments and some positional arguments may be omitted at the command line. The `default` keyword argument of *add_argument()*, whose value defaults to `None`, specifies what value should be used if the command-line argument is not present. For optional arguments, the `default` value is used when the option string was not present at the command line:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--foo', default=42)
>>> parser.parse_args(['--foo', '2'])
Namespace(foo='2')
>>> parser.parse_args([])
Namespace(foo=42)
```

If the `default` value is a string, the parser parses the value as if it were a command-line argument. In particular, the parser applies any *type* conversion argument, if provided, before setting the attribute on the *Namespace* return value. Otherwise, the parser uses the value as is:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--length', default='10', type=int)
>>> parser.add_argument('--width', default=10.5, type=int)
>>> parser.parse_args()
Namespace(length=10, width=10.5)
```

For positional arguments with *nargs* equal to `?` or `*`, the `default` value is used when no command-line argument was present:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('foo', nargs='?', default=42)
>>> parser.parse_args(['a'])
Namespace(foo='a')
>>> parser.parse_args([])
Namespace(foo=42)
```

Providing `default=argparse.SUPPRESS` causes no attribute to be added if the command-line argument was not present:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--foo', default=argparse.SUPPRESS)
>>> parser.parse_args([])
Namespace()
>>> parser.parse_args(['--foo', '1'])
Namespace(foo='1')
```

type

By default, *ArgumentParser* objects read command-line arguments in as simple strings. However, quite often the command-line string should instead be interpreted as another type, like a *float* or *int*. The `type` keyword argument of *add_argument()* allows any necessary type-checking and type conversions to be performed. Common built-in types and functions can be used directly as the value of the `type` argument:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('foo', type=int)
```

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```
>>> parser.add_argument('bar', type=open)
>>> parser.parse_args('2 temp.txt'.split())
Namespace(bar=<_io.TextIOWrapper name='temp.txt' encoding='UTF-8'>, foo=2)
```

See the section on the *default* keyword argument for information on when the `type` argument is applied to default arguments.

To ease the use of various types of files, the argparse module provides the factory FileType which takes the `mode=`, `bufsize=`, `encoding=` and `errors=` arguments of the `open()` function. For example, `FileType('w')` can be used to create a writable file:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('bar', type=argparse.FileType('w'))
>>> parser.parse_args(['out.txt'])
Namespace(bar=<_io.TextIOWrapper name='out.txt' encoding='UTF-8'>)
```

`type=` can take any callable that takes a single string argument and returns the converted value:

```
>>> def perfect_square(string):
...     value = int(string)
...     sqrt = math.sqrt(value)
...     if sqrt != int(sqrt):
...         msg = "%r is not a perfect square" % string
...         raise argparse.ArgumentTypeError(msg)
...     return value
...
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('foo', type=perfect_square)
>>> parser.parse_args(['9'])
Namespace(foo=9)
>>> parser.parse_args(['7'])
usage: PROG [-h] foo
PROG: error: argument foo: '7' is not a perfect square
```

The *choices* keyword argument may be more convenient for type checkers that simply check against a range of values:

```
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('foo', type=int, choices=range(5, 10))
>>> parser.parse_args(['7'])
Namespace(foo=7)
>>> parser.parse_args(['11'])
usage: PROG [-h] {5,6,7,8,9}
PROG: error: argument foo: invalid choice: 11 (choose from 5, 6, 7, 8, 9)
```

See the *choices* section for more details.

choices

Some command-line arguments should be selected from a restricted set of values. These can be handled by passing a container object as the *choices* keyword argument to `add_argument()`. When the command line is parsed, argument values will be checked, and an error message will be displayed if the argument was not one of the acceptable values:

```
>>> parser = argparse.ArgumentParser(prog='game.py')
>>> parser.add_argument('move', choices=['rock', 'paper', 'scissors'])
>>> parser.parse_args(['rock'])
Namespace(move='rock')
>>> parser.parse_args(['fire'])
usage: game.py [-h] {rock,paper,scissors}
game.py: error: argument move: invalid choice: 'fire' (choose from 'rock',
'paper', 'scissors')
```

Note that inclusion in the *choices* container is checked after any *type* conversions have been performed, so the type of the objects in the *choices* container should match the *type* specified:

```
>>> parser = argparse.ArgumentParser(prog='doors.py')
>>> parser.add_argument('door', type=int, choices=range(1, 4))
>>> print(parser.parse_args(['3']))
Namespace(door=3)
>>> parser.parse_args(['4'])
usage: doors.py [-h] {1,2,3}
doors.py: error: argument door: invalid choice: 4 (choose from 1, 2, 3)
```

Any object that supports the `in` operator can be passed as the *choices* value, so `dict` objects, `set` objects, custom containers, etc. are all supported.

required

In general, the `argparse` module assumes that flags like `-f` and `--bar` indicate *optional* arguments, which can always be omitted at the command line. To make an option *required*, `True` can be specified for the `required=` keyword argument to `add_argument()`:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--foo', required=True)
>>> parser.parse_args(['--foo', 'BAR'])
Namespace(foo='BAR')
>>> parser.parse_args([])
usage: argparse.py [-h] [--foo FOO]
argparse.py: error: option --foo is required
```

As the example shows, if an option is marked as `required`, `parse_args()` will report an error if that option is not present at the command line.

Note: Required options are generally considered bad form because users expect *options* to be *optional*, and thus they should be avoided when possible.

help

The `help` value is a string containing a brief description of the argument. When a user requests help (usually by using `-h` or `--help` at the command line), these `help` descriptions will be displayed with each argument:

```
>>> parser = argparse.ArgumentParser(prog='frobble')
>>> parser.add_argument('--foo', action='store_true',
...                     help='foo the bars before frobbling')
```

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```
>>> parser.add_argument('bar', nargs='+',
...                     help='one of the bars to be frobbled')
>>> parser.parse_args(['-h'])
usage: frobble [-h] [--foo] bar [bar ...]

positional arguments:
 bar     one of the bars to be frobbled

optional arguments:
 -h, --help  show this help message and exit
 --foo   foo the bars before frobbling
```

The `help` strings can include various format specifiers to avoid repetition of things like the program name or the argument *default*. The available specifiers include the program name, `%(prog)s` and most keyword arguments to `add_argument()`, e.g. `%(default)s`, `%(type)s`, etc.:

```
>>> parser = argparse.ArgumentParser(prog='frobble')
>>> parser.add_argument('bar', nargs='?', type=int, default=42,
...                     help='the bar to %(prog)s (default: %(default)s)')
>>> parser.print_help()
usage: frobble [-h] [bar]

positional arguments:
 bar     the bar to frobble (default: 42)

optional arguments:
 -h, --help  show this help message and exit
```

As the help string supports %-formatting, if you want a literal `%` to appear in the help string, you must escape it as `%%`.

`argparse` supports silencing the help entry for certain options, by setting the `help` value to `argparse.SUPPRESS`:

```
>>> parser = argparse.ArgumentParser(prog='frobble')
>>> parser.add_argument('--foo', help=argparse.SUPPRESS)
>>> parser.print_help()
usage: frobble [-h]

optional arguments:
  -h, --help  show this help message and exit
```

metavar

When `ArgumentParser` generates help messages, it needs some way to refer to each expected argument. By default, ArgumentParser objects use the *dest* value as the "name" of each object. By default, for positional argument actions, the *dest* value is used directly, and for optional argument actions, the *dest* value is uppercased. So, a single positional argument with `dest='bar'` will be referred to as `bar`. A single optional argument `--foo` that should be followed by a single command-line argument will be referred to as `FOO`. An example:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--foo')
>>> parser.add_argument('bar')
>>> parser.parse_args('X --foo Y'.split())
Namespace(bar='X', foo='Y')
>>> parser.print_help()
usage:  [-h] [--foo FOO] bar

positional arguments:
 bar

optional arguments:
 -h, --help  show this help message and exit
 --foo FOO
```

An alternative name can be specified with `metavar`:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--foo', metavar='YYY')
>>> parser.add_argument('bar', metavar='XXX')
>>> parser.parse_args('X --foo Y'.split())
Namespace(bar='X', foo='Y')
>>> parser.print_help()
usage:  [-h] [--foo YYY] XXX

positional arguments:
 XXX

optional arguments:
 -h, --help  show this help message and exit
 --foo YYY
```

Note that `metavar` only changes the *displayed* name - the name of the attribute on the *parse_args()* object is still determined by the *dest* value.

Different values of `nargs` may cause the metavar to be used multiple times. Providing a tuple to `metavar` specifies a different display for each of the arguments:

```
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('-x', nargs=2)
>>> parser.add_argument('--foo', nargs=2, metavar=('bar', 'baz'))
>>> parser.print_help()
usage: PROG [-h] [-x X X] [--foo bar baz]

optional arguments:
 -h, --help     show this help message and exit
 -x X X
 --foo bar baz
```

dest

Most *ArgumentParser* actions add some value as an attribute of the object returned by *parse_args()*. The name of this attribute is determined by the `dest` keyword argument of *add_argument()*. For positional argument actions, `dest` is normally supplied as the first argument to *add_argument()*:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('bar')
>>> parser.parse_args(['XXX'])
Namespace(bar='XXX')
```

For optional argument actions, the value of `dest` is normally inferred from the option strings. *ArgumentParser* generates the value of `dest` by taking the first long option string and stripping away the initial `--` string. If no long option strings were supplied, `dest` will be derived from the first short option string by stripping the initial `-` character. Any internal `-` characters will be converted to `_` characters to make sure the string is a valid attribute name. The examples below illustrate this behavior:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('-f', '--foo-bar', '--foo')
>>> parser.add_argument('-x', '-y')
>>> parser.parse_args('-f 1 -x 2'.split())
Namespace(foo_bar='1', x='2')
>>> parser.parse_args('--foo 1 -y 2'.split())
Namespace(foo_bar='1', x='2')
```

`dest` allows a custom attribute name to be provided:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--foo', dest='bar')
>>> parser.parse_args('--foo XXX'.split())
Namespace(bar='XXX')
```

Action classes

Action classes implement the Action API, a callable which returns a callable which processes arguments from the command-line. Any object which follows this API may be passed as the `action` parameter to `add_argument()`.

class argparse.Action(*option_strings*, *dest*, *nargs=None*, *const=None*, *default=None*, *type=None*, *choices=None*, *required=False*, *help=None*, *metavar=None*)

Action objects are used by an ArgumentParser to represent the information needed to parse a single argument from one or more strings from the command line. The Action class must accept the two positional arguments plus any keyword arguments passed to *ArgumentParser.add_argument()* except for the `action` itself.

Instances of Action (or return value of any callable to the `action` parameter) should have attributes "dest", "option_strings", "default", "type", "required", "help", etc. defined. The easiest way to ensure these attributes are defined is to call `Action.__init__`.

Action instances should be callable, so subclasses must override the `__call__` method, which should accept four parameters:

- `parser` - The ArgumentParser object which contains this action.
- `namespace` - The *Namespace* object that will be returned by *parse_args()*. Most actions add an attribute to this object using *setattr()*.
- `values` - The associated command-line arguments, with any type conversions applied. Type conversions are specified with the *type* keyword argument to *add_argument()*.
- `option_string` - The option string that was used to invoke this action. The `option_string` argument is optional, and will be absent if the action is associated with a positional argument.

The `__call__` method may perform arbitrary actions, but will typically set attributes on the `namespace` based on `dest` and `values`.

16.4.4 The parse_args() method

`ArgumentParser.parse_args`(*args=None*, *namespace=None*)

Convert argument strings to objects and assign them as attributes of the namespace. Return the populated namespace.

Previous calls to *add_argument()* determine exactly what objects are created and how they are assigned. See the documentation for *add_argument()* for details.

- *args* - List of strings to parse. The default is taken from *sys.argv*.
- *namespace* - An object to take the attributes. The default is a new empty *Namespace* object.

Option value syntax

The *parse_args()* method supports several ways of specifying the value of an option (if it takes one). In the simplest case, the option and its value are passed as two separate arguments:

```
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('-x')
>>> parser.add_argument('--foo')
>>> parser.parse_args(['-x', 'X'])
Namespace(foo=None, x='X')
>>> parser.parse_args(['--foo', 'FOO'])
Namespace(foo='FOO', x=None)
```

For long options (options with names longer than a single character), the option and value can also be passed as a single command-line argument, using `=` to separate them:

```
>>> parser.parse_args(['--foo=FOO'])
Namespace(foo='FOO', x=None)
```

For short options (options only one character long), the option and its value can be concatenated:

```
>>> parser.parse_args(['-xX'])
Namespace(foo=None, x='X')
```

Several short options can be joined together, using only a single `-` prefix, as long as only the last option (or none of them) requires a value:

```
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('-x', action='store_true')
>>> parser.add_argument('-y', action='store_true')
>>> parser.add_argument('-z')
>>> parser.parse_args(['-xyzZ'])
Namespace(x=True, y=True, z='Z')
```

Invalid arguments

While parsing the command line, *parse_args()* checks for a variety of errors, including ambiguous options, invalid types, invalid options, wrong number of positional arguments, etc. When it encounters such an error, it exits and prints the error along with a usage message:

```
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('--foo', type=int)
>>> parser.add_argument('bar', nargs='?')

>>> # invalid type
>>> parser.parse_args(['--foo', 'spam'])
usage: PROG [-h] [--foo FOO] [bar]
PROG: error: argument --foo: invalid int value: 'spam'

>>> # invalid option
>>> parser.parse_args(['--bar'])
usage: PROG [-h] [--foo FOO] [bar]
PROG: error: no such option: --bar

>>> # wrong number of arguments
>>> parser.parse_args(['spam', 'badger'])
usage: PROG [-h] [--foo FOO] [bar]
PROG: error: extra arguments found: badger
```

Arguments containing -

The *parse_args()* method attempts to give errors whenever the user has clearly made a mistake, but some situations are inherently ambiguous. For example, the command-line argument `-1` could either be an attempt to specify an option or an attempt to provide a positional argument. The *parse_args()* method is cautious here: positional arguments may only begin with `-` if they look like negative numbers and there are no options in the parser that look like negative numbers:

```
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('-x')
>>> parser.add_argument('foo', nargs='?')

>>> # no negative number options, so -1 is a positional argument
>>> parser.parse_args(['-x', '-1'])
Namespace(foo=None, x='-1')

>>> # no negative number options, so -1 and -5 are positional arguments
>>> parser.parse_args(['-x', '-1', '-5'])
Namespace(foo='-5', x='-1')

>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('-1', dest='one')
>>> parser.add_argument('foo', nargs='?')

>>> # negative number options present, so -1 is an option
>>> parser.parse_args(['-1', 'X'])
Namespace(foo=None, one='X')

>>> # negative number options present, so -2 is an option
>>> parser.parse_args(['-2'])
usage: PROG [-h] [-1 ONE] [foo]
PROG: error: no such option: -2
```

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```
>>> # negative number options present, so both -1s are options
>>> parser.parse_args(['-1', '-1'])
usage: PROG [-h] [-1 ONE] [foo]
PROG: error: argument -1: expected one argument
```

If you have positional arguments that must begin with - and don't look like negative numbers, you can insert the pseudo-argument `'--'` which tells *parse_args()* that everything after that is a positional argument:

```
>>> parser.parse_args(['--', '-f'])
Namespace(foo='-f', one=None)
```

Argument abbreviations (prefix matching)

The *parse_args()* method *by default* allows long options to be abbreviated to a prefix, if the abbreviation is unambiguous (the prefix matches a unique option):

```
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('-bacon')
>>> parser.add_argument('-badger')
>>> parser.parse_args('-bac MMM'.split())
Namespace(bacon='MMM', badger=None)
>>> parser.parse_args('-bad WOOD'.split())
Namespace(bacon=None, badger='WOOD')
>>> parser.parse_args('-ba BA'.split())
usage: PROG [-h] [-bacon BACON] [-badger BADGER]
PROG: error: ambiguous option: -ba could match -badger, -bacon
```

An error is produced for arguments that could produce more than one options. This feature can be disabled by setting *allow_abbrev* to `False`.

Beyond `sys.argv`

Sometimes it may be useful to have an ArgumentParser parse arguments other than those of *sys.argv*. This can be accomplished by passing a list of strings to *parse_args()*. This is useful for testing at the interactive prompt:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument(
...     'integers', metavar='int', type=int, choices=range(10),
...     nargs='+', help='an integer in the range 0..9')
>>> parser.add_argument(
...     '--sum', dest='accumulate', action='store_const', const=sum,
...     default=max, help='sum the integers (default: find the max)')
>>> parser.parse_args(['1', '2', '3', '4'])
Namespace(accumulate=<built-in function max>, integers=[1, 2, 3, 4])
>>> parser.parse_args(['1', '2', '3', '4', '--sum'])
Namespace(accumulate=<built-in function sum>, integers=[1, 2, 3, 4])
```

The Namespace object

class argparse.Namespace

Simple class used by default by *parse_args()* to create an object holding attributes and return it.

This class is deliberately simple, just an *object* subclass with a readable string representation. If you prefer to have dict-like view of the attributes, you can use the standard Python idiom, *vars()*:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--foo')
>>> args = parser.parse_args(['--foo', 'BAR'])
>>> vars(args)
{'foo': 'BAR'}
```

It may also be useful to have an *ArgumentParser* assign attributes to an already existing object, rather than a new *Namespace* object. This can be achieved by specifying the `namespace=` keyword argument:

```
>>> class C:
...     pass
...
>>> c = C()
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--foo')
>>> parser.parse_args(args=['--foo', 'BAR'], namespace=c)
>>> c.foo
'BAR'
```

16.4.5 Other utilities

Sub-commands

ArgumentParser.**add_subparsers**([*title*][, *description*][, *prog*][, *parser_class*][, *action*][, *option_string*][, *dest*][, *required*][, *help*][, *metavar*])

Many programs split up their functionality into a number of sub-commands, for example, the `svn` program can invoke sub-commands like `svn checkout`, `svn update`, and `svn commit`. Splitting up functionality this way can be a particularly good idea when a program performs several different functions which require different kinds of command-line arguments. *ArgumentParser* supports the creation of such sub-commands with the *add_subparsers()* method. The *add_subparsers()* method is normally called with no arguments and returns a special action object. This object has a single method, `add_parser()`, which takes a command name and any *ArgumentParser* constructor arguments, and returns an *ArgumentParser* object that can be modified as usual.

Description of parameters:

- title - title for the sub-parser group in help output; by default "subcommands" if description is provided, otherwise uses title for positional arguments
- description - description for the sub-parser group in help output, by default `None`
- prog - usage information that will be displayed with sub-command help, by default the name of the program and any positional arguments before the subparser argument
- parser_class - class which will be used to create sub-parser instances, by default the class of the current parser (e.g. ArgumentParser)
- *action* - the basic type of action to be taken when this argument is encountered at the command line

- *dest* - name of the attribute under which sub-command name will be stored; by default `None` and no value is stored
- *required* - Whether or not a subcommand must be provided, by default `False`.
- *help* - help for sub-parser group in help output, by default `None`
- *metavar* - string presenting available sub-commands in help; by default it is `None` and presents sub-commands in form {cmd1, cmd2, ..}

Some example usage:

```
>>> # create the top-level parser
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> parser.add_argument('--foo', action='store_true', help='foo help')
>>> subparsers = parser.add_subparsers(help='sub-command help')
>>>
>>> # create the parser for the "a" command
>>> parser_a = subparsers.add_parser('a', help='a help')
>>> parser_a.add_argument('bar', type=int, help='bar help')
>>>
>>> # create the parser for the "b" command
>>> parser_b = subparsers.add_parser('b', help='b help')
>>> parser_b.add_argument('--baz', choices='XYZ', help='baz help')
>>>
>>> # parse some argument lists
>>> parser.parse_args(['a', '12'])
Namespace(bar=12, foo=False)
>>> parser.parse_args(['--foo', 'b', '--baz', 'Z'])
Namespace(baz='Z', foo=True)
```

Note that the object returned by `parse_args()` will only contain attributes for the main parser and the subparser that was selected by the command line (and not any other subparsers). So in the example above, when the `a` command is specified, only the `foo` and `bar` attributes are present, and when the `b` command is specified, only the `foo` and `baz` attributes are present.

Similarly, when a help message is requested from a subparser, only the help for that particular parser will be printed. The help message will not include parent parser or sibling parser messages. (A help message for each subparser command, however, can be given by supplying the `help=` argument to `add_parser()` as above.)

```
>>> parser.parse_args(['--help'])
usage: PROG [-h] [--foo] {a,b} ...

positional arguments:
  {a,b}   sub-command help
    a     a help
    b     b help

optional arguments:
  -h, --help  show this help message and exit
  --foo   foo help

>>> parser.parse_args(['a', '--help'])
usage: PROG a [-h] bar

```

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```
positional arguments:
  bar     bar help

optional arguments:
  -h, --help  show this help message and exit

>>> parser.parse_args(['b', '--help'])
usage: PROG b [-h] [--baz {X,Y,Z}]

optional arguments:
  -h, --help     show this help message and exit
  --baz {X,Y,Z}  baz help
```

The *add_subparsers()* method also supports `title` and `description` keyword arguments. When either is present, the subparser's commands will appear in their own group in the help output. For example:

```
>>> parser = argparse.ArgumentParser()
>>> subparsers = parser.add_subparsers(title='subcommands',
...                                    description='valid subcommands',
...                                    help='additional help')
>>> subparsers.add_parser('foo')
>>> subparsers.add_parser('bar')
>>> parser.parse_args(['-h'])
usage:  [-h] {foo,bar} ...

optional arguments:
  -h, --help  show this help message and exit

subcommands:
  valid subcommands

  {foo,bar}   additional help
```

Furthermore, `add_parser` supports an additional `aliases` argument, which allows multiple strings to refer to the same subparser. This example, like `svn`, aliases `co` as a shorthand for `checkout`:

```
>>> parser = argparse.ArgumentParser()
>>> subparsers = parser.add_subparsers()
>>> checkout = subparsers.add_parser('checkout', aliases=['co'])
>>> checkout.add_argument('foo')
>>> parser.parse_args(['co', 'bar'])
Namespace(foo='bar')
```

One particularly effective way of handling sub-commands is to combine the use of the *add_subparsers()* method with calls to *set_defaults()* so that each subparser knows which Python function it should execute. For example:

```
>>> # sub-command functions
>>> def foo(args):
...     print(args.x * args.y)
...
>>> def bar(args):
```

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```
...     print('((%s))' % args.z)
...
>>> # create the top-level parser
>>> parser = argparse.ArgumentParser()
>>> subparsers = parser.add_subparsers()
>>>
>>> # create the parser for the "foo" command
>>> parser_foo = subparsers.add_parser('foo')
>>> parser_foo.add_argument('-x', type=int, default=1)
>>> parser_foo.add_argument('y', type=float)
>>> parser_foo.set_defaults(func=foo)
>>>
>>> # create the parser for the "bar" command
>>> parser_bar = subparsers.add_parser('bar')
>>> parser_bar.add_argument('z')
>>> parser_bar.set_defaults(func=bar)
>>>
>>> # parse the args and call whatever function was selected
>>> args = parser.parse_args('foo 1 -x 2'.split())
>>> args.func(args)
2.0
>>>
>>> # parse the args and call whatever function was selected
>>> args = parser.parse_args('bar XYZYX'.split())
>>> args.func(args)
((XYZYX))
```

This way, you can let *parse_args()* do the job of calling the appropriate function after argument parsing is complete. Associating functions with actions like this is typically the easiest way to handle the different actions for each of your subparsers. However, if it is necessary to check the name of the subparser that was invoked, the `dest` keyword argument to the *add_subparsers()* call will work:

```
>>> parser = argparse.ArgumentParser()
>>> subparsers = parser.add_subparsers(dest='subparser_name')
>>> subparser1 = subparsers.add_parser('1')
>>> subparser1.add_argument('-x')
>>> subparser2 = subparsers.add_parser('2')
>>> subparser2.add_argument('y')
>>> parser.parse_args(['2', 'frobble'])
Namespace(subparser_name='2', y='frobble')
```

FileType objects

class argparse.**FileType**(*mode='r', bufsize=-1, encoding=None, errors=None*)

The *FileType* factory creates objects that can be passed to the type argument of *ArgumentParser.add_argument()*. Arguments that have *FileType* objects as their type will open command-line arguments as files with the requested modes, buffer sizes, encodings and error handling (see the *open()* function for more details):

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--raw', type=argparse.FileType('wb', 0))
```

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```
>>> parser.add_argument('out', type=argparse.FileType('w', encoding='UTF-8'))
>>> parser.parse_args(['--raw', 'raw.dat', 'file.txt'])
Namespace(out=<_io.TextIOWrapper name='file.txt' mode='w' encoding='UTF-8'>, raw=<_
↪io.FileIO name='raw.dat' mode='wb'>)
```

FileType objects understand the pseudo-argument `'-'` and automatically convert this into `sys.stdin` for readable *FileType* objects and `sys.stdout` for writable *FileType* objects:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('infile', type=argparse.FileType('r'))
>>> parser.parse_args(['-'])
Namespace(infile=<_io.TextIOWrapper name='<stdin>' encoding='UTF-8'>)
```

New in version 3.4: The *encodings* and *errors* keyword arguments.

Argument groups

`ArgumentParser.add_argument_group`(*title=None*, *description=None*)

By default, *ArgumentParser* groups command-line arguments into "positional arguments" and "optional arguments" when displaying help messages. When there is a better conceptual grouping of arguments than this default one, appropriate groups can be created using the *add_argument_group()* method:

```
>>> parser = argparse.ArgumentParser(prog='PROG', add_help=False)
>>> group = parser.add_argument_group('group')
>>> group.add_argument('--foo', help='foo help')
>>> group.add_argument('bar', help='bar help')
>>> parser.print_help()
usage: PROG [--foo FOO] bar

group:
  bar        bar help
  --foo FOO  foo help
```

The *add_argument_group()* method returns an argument group object which has an *add_argument()* method just like a regular *ArgumentParser*. When an argument is added to the group, the parser treats it just like a normal argument, but displays the argument in a separate group for help messages. The *add_argument_group()* method accepts *title* and *description* arguments which can be used to customize this display:

```
>>> parser = argparse.ArgumentParser(prog='PROG', add_help=False)
>>> group1 = parser.add_argument_group('group1', 'group1 description')
>>> group1.add_argument('foo', help='foo help')
>>> group2 = parser.add_argument_group('group2', 'group2 description')
>>> group2.add_argument('--bar', help='bar help')
>>> parser.print_help()
usage: PROG [--bar BAR] foo

group1:
  group1 description

  foo    foo help
```

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```
group2:
  group2 description

  --bar BAR  bar help
```

Note that any arguments not in your user-defined groups will end up back in the usual "positional arguments" and "optional arguments" sections.

Mutual exclusion

ArgumentParser.**add_mutually_exclusive_group**(*required=False*)

Create a mutually exclusive group. *argparse* will make sure that only one of the arguments in the mutually exclusive group was present on the command line:

```
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> group = parser.add_mutually_exclusive_group()
>>> group.add_argument('--foo', action='store_true')
>>> group.add_argument('--bar', action='store_false')
>>> parser.parse_args(['--foo'])
Namespace(bar=True, foo=True)
>>> parser.parse_args(['--bar'])
Namespace(bar=False, foo=False)
>>> parser.parse_args(['--foo', '--bar'])
usage: PROG [-h] [--foo | --bar]
PROG: error: argument --bar: not allowed with argument --foo
```

The *add_mutually_exclusive_group()* method also accepts a *required* argument, to indicate that at least one of the mutually exclusive arguments is required:

```
>>> parser = argparse.ArgumentParser(prog='PROG')
>>> group = parser.add_mutually_exclusive_group(required=True)
>>> group.add_argument('--foo', action='store_true')
>>> group.add_argument('--bar', action='store_false')
>>> parser.parse_args([])
usage: PROG [-h] (--foo | --bar)
PROG: error: one of the arguments --foo --bar is required
```

Note that currently mutually exclusive argument groups do not support the *title* and *description* arguments of *add_argument_group()*.

Parser defaults

ArgumentParser.**set_defaults**(***kwargs*)

Most of the time, the attributes of the object returned by *parse_args()* will be fully determined by inspecting the command-line arguments and the argument actions. *set_defaults()* allows some additional attributes that are determined without any inspection of the command line to be added:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('foo', type=int)
>>> parser.set_defaults(bar=42, baz='badger')
```

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```
>>> parser.parse_args(['736'])
Namespace(bar=42, baz='badger', foo=736)
```

Note that parser-level defaults always override argument-level defaults:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--foo', default='bar')
>>> parser.set_defaults(foo='spam')
>>> parser.parse_args([])
Namespace(foo='spam')
```

Parser-level defaults can be particularly useful when working with multiple parsers. See the *add_subparsers()* method for an example of this type.

`ArgumentParser.get_default`(*dest*)
Get the default value for a namespace attribute, as set by either *add_argument()* or by *set_defaults()*:

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--foo', default='badger')
>>> parser.get_default('foo')
'badger'
```

Printing help

In most typical applications, *parse_args()* will take care of formatting and printing any usage or error messages. However, several formatting methods are available:

`ArgumentParser.print_usage`(*file=None*)
Print a brief description of how the *ArgumentParser* should be invoked on the command line. If *file* is `None`, *sys.stdout* is assumed.

`ArgumentParser.print_help`(*file=None*)
Print a help message, including the program usage and information about the arguments registered with the *ArgumentParser*. If *file* is `None`, *sys.stdout* is assumed.

There are also variants of these methods that simply return a string instead of printing it:

`ArgumentParser.format_usage()`
Return a string containing a brief description of how the *ArgumentParser* should be invoked on the command line.

`ArgumentParser.format_help()`
Return a string containing a help message, including the program usage and information about the arguments registered with the *ArgumentParser*.

Partial parsing

`ArgumentParser.parse_known_args`(*args=None*, *namespace=None*)

Sometimes a script may only parse a few of the command-line arguments, passing the remaining arguments on to another script or program. In these cases, the *parse_known_args()* method can be useful. It works much like *parse_args()* except that it does not produce an error when extra arguments are present. Instead, it returns a two item tuple containing the populated namespace and the list of remaining argument strings.

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--foo', action='store_true')
>>> parser.add_argument('bar')
>>> parser.parse_known_args(['--foo', '--badger', 'BAR', 'spam'])
(Namespace(bar='BAR', foo=True), ['--badger', 'spam'])
```

Warning: *Prefix matching* rules apply to `parse_known_args()`. The parser may consume an option even if it's just a prefix of one of its known options, instead of leaving it in the remaining arguments list.

Customizing file parsing

`ArgumentParser.convert_arg_line_to_args(`*arg_line*`)`

Arguments that are read from a file (see the *fromfile_prefix_chars* keyword argument to the *`ArgumentParser`* constructor) are read one argument per line. *`convert_arg_line_to_args()`* can be overridden for fancier reading.

This method takes a single argument *arg_line* which is a string read from the argument file. It returns a list of arguments parsed from this string. The method is called once per line read from the argument file, in order.

A useful override of this method is one that treats each space-separated word as an argument. The following example demonstrates how to do this:

```
class MyArgumentParser(argparse.ArgumentParser):
    def convert_arg_line_to_args(self, arg_line):
        return arg_line.split()
```

Exiting methods

`ArgumentParser.exit(`*status=0*, *message=None*`)`

This method terminates the program, exiting with the specified *status* and, if given, it prints a *message* before that.

`ArgumentParser.error(`*message*`)`

This method prints a usage message including the *message* to the standard error and terminates the program with a status code of 2.

Intermixed parsing

`ArgumentParser.parse_intermixed_args(`*args=None*, *namespace=None*`)`

`ArgumentParser.parse_known_intermixed_args(`*args=None*, *namespace=None*`)`

A number of Unix commands allow the user to intermix optional arguments with positional arguments. The *`parse_intermixed_args()`* and *`parse_known_intermixed_args()`* methods support this parsing style.

These parsers do not support all the argparse features, and will raise exceptions if unsupported features are used. In particular, subparsers, `argparse.REMAINDER`, and mutually exclusive groups that include both optionals and positionals are not supported.

The following example shows the difference between *`parse_known_args()`* and *`parse_intermixed_args()`*: the former returns `['2', '3']` as unparsed arguments, while the latter collects all the positionals into `rest`.

```
>>> parser = argparse.ArgumentParser()
>>> parser.add_argument('--foo')
>>> parser.add_argument('cmd')
>>> parser.add_argument('rest', nargs='*', type=int)
>>> parser.parse_known_args('doit 1 --foo bar 2 3'.split())
(Namespace(cmd='doit', foo='bar', rest=[1]), ['2', '3'])
>>> parser.parse_intermixed_args('doit 1 --foo bar 2 3'.split())
Namespace(cmd='doit', foo='bar', rest=[1, 2, 3])
```

parse_known_intermixed_args() returns a two item tuple containing the populated namespace and the list of remaining argument strings. *parse_intermixed_args()* raises an error if there are any remaining unparsed argument strings.

New in version 3.7.

16.4.6 Upgrading optparse code

Originally, the *argparse* module had attempted to maintain compatibility with *optparse*. However, *optparse* was difficult to extend transparently, particularly with the changes required to support the new `nargs=` specifiers and better usage messages. When most everything in *optparse* had either been copy-pasted over or monkey-patched, it no longer seemed practical to try to maintain the backwards compatibility.

The *argparse* module improves on the standard library *optparse* module in a number of ways including:

- Handling positional arguments.
- Supporting sub-commands.
- Allowing alternative option prefixes like `+` and `/`.
- Handling zero-or-more and one-or-more style arguments.
- Producing more informative usage messages.
- Providing a much simpler interface for custom `type` and `action`.

A partial upgrade path from *optparse* to *argparse*:

- Replace all *optparse.OptionParser.add_option()* calls with *ArgumentParser.add_argument()* calls.
- Replace `(options, args) = parser.parse_args()` with `args = parser.parse_args()` and add additional *ArgumentParser.add_argument()* calls for the positional arguments. Keep in mind that what was previously called `options`, now in the *argparse* context is called `args`.
- Replace *optparse.OptionParser.disable_interspersed_args()* by using *parse_intermixed_args()* instead of *parse_args()*.
- Replace callback actions and the `callback_*` keyword arguments with `type` or `action` arguments.
- Replace string names for `type` keyword arguments with the corresponding type objects (e.g. int, float, complex, etc).
- Replace `optparse.Values` with *Namespace* and `optparse.OptionError` and `optparse.OptionValueError` with `ArgumentError`.
- Replace strings with implicit arguments such as `%default` or `%prog` with the standard Python syntax to use dictionaries to format strings, that is, `%(default)s` and `%(prog)s`.
- Replace the OptionParser constructor `version` argument with a call to `parser.add_argument('--version', action='version', version='<the version>')`.

16.5 `getopt` — C-style parser for command line options

Source code: Lib/getopt.py

Note: The *getopt* module is a parser for command line options whose API is designed to be familiar to users of the C `getopt()` function. Users who are unfamiliar with the C `getopt()` function or who would like to write less code and get better help and error messages should consider using the *argparse* module instead.

This module helps scripts to parse the command line arguments in `sys.argv`. It supports the same conventions as the Unix `getopt()` function (including the special meanings of arguments of the form '`-`' and '`--`'). Long options similar to those supported by GNU software may be used as well via an optional third argument.

This module provides two functions and an exception:

`getopt.getopt`(*args*, *shortopts*, *longopts=[]*)

Parses command line options and parameter list. *args* is the argument list to be parsed, without the leading reference to the running program. Typically, this means `sys.argv[1:]`. *shortopts* is the string of option letters that the script wants to recognize, with options that require an argument followed by a colon (`':'`; i.e., the same format that Unix `getopt()` uses).

Note: Unlike GNU `getopt()`, after a non-option argument, all further arguments are considered also non-options. This is similar to the way non-GNU Unix systems work.

longopts, if specified, must be a list of strings with the names of the long options which should be supported. The leading `'--'` characters should not be included in the option name. Long options which require an argument should be followed by an equal sign (`'='`). Optional arguments are not supported. To accept only long options, *shortopts* should be an empty string. Long options on the command line can be recognized so long as they provide a prefix of the option name that matches exactly one of the accepted options. For example, if *longopts* is `['foo', 'frob']`, the option `--fo` will match as `--foo`, but `--f` will not match uniquely, so *GetoptError* will be raised.

The return value consists of two elements: the first is a list of `(option, value)` pairs; the second is the list of program arguments left after the option list was stripped (this is a trailing slice of *args*). Each option-and-value pair returned has the option as its first element, prefixed with a hyphen for short options (e.g., `'-x'`) or two hyphens for long options (e.g., `'--long-option'`), and the option argument as its second element, or an empty string if the option has no argument. The options occur in the list in the same order in which they were found, thus allowing multiple occurrences. Long and short options may be mixed.

`getopt.gnu_getopt`(*args*, *shortopts*, *longopts=[]*)

This function works like *getopt()*, except that GNU style scanning mode is used by default. This means that option and non-option arguments may be intermixed. The *getopt()* function stops processing options as soon as a non-option argument is encountered.

If the first character of the option string is `'+'`, or if the environment variable `POSIXLY_CORRECT` is set, then option processing stops as soon as a non-option argument is encountered.

exception `getopt.GetoptError`

This is raised when an unrecognized option is found in the argument list or when an option requiring an argument is given none. The argument to the exception is a string indicating the cause of the error. For long options, an argument given to an option which does not require one will also cause this exception to be raised. The attributes `msg` and `opt` give the error message and related option; if there is no specific option to which the exception relates, `opt` is an empty string.

exception getopt.error
Alias for *GetoptError*; for backward compatibility.

An example using only Unix style options:

```
>>> import getopt
>>> args = '-a -b -cfoo -d bar a1 a2'.split()
>>> args
['-a', '-b', '-cfoo', '-d', 'bar', 'a1', 'a2']
>>> optlist, args = getopt.getopt(args, 'abc:d:')
>>> optlist
[('-a', ''), ('-b', ''), ('-c', 'foo'), ('-d', 'bar')]
>>> args
['a1', 'a2']
```

Using long option names is equally easy:

```
>>> s = '--condition=foo --testing --output-file abc.def -x a1 a2'
>>> args = s.split()
>>> args
['--condition=foo', '--testing', '--output-file', 'abc.def', '-x', 'a1', 'a2']
>>> optlist, args = getopt.getopt(args, 'x', [
...     'condition=', 'output-file=', 'testing'])
>>> optlist
[('--condition', 'foo'), ('--testing', ''), ('--output-file', 'abc.def'), ('-x', '')]
>>> args
['a1', 'a2']
```

In a script, typical usage is something like this:

```
import getopt, sys

def main():
    try:
        opts, args = getopt.getopt(sys.argv[1:], "ho:v", ["help", "output="])
    except getopt.GetoptError as err:
        # print help information and exit:
        print(err)  # will print something like "option -a not recognized"
        usage()
        sys.exit(2)
    output = None
    verbose = False
    for o, a in opts:
        if o == "-v":
            verbose = True
        elif o in ("-h", "--help"):
            usage()
            sys.exit()
        elif o in ("-o", "--output"):
            output = a
        else:
            assert False, "unhandled option"
```

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```
    # ...

if __name__ == "__main__":
    main()
```

Note that an equivalent command line interface could be produced with less code and more informative help and error messages by using the *argparse* module:

```
import argparse

if __name__ == '__main__':
    parser = argparse.ArgumentParser()
    parser.add_argument('-o', '--output')
    parser.add_argument('-v', dest='verbose', action='store_true')
    args = parser.parse_args()
    # ... do something with args.output ...
    # ... do something with args.verbose ..
```

See also:

Module *argparse* Alternative command line option and argument parsing library.

16.6 `logging` — Logging facility for Python

Source code: Lib/logging/__init__.py

Important

This page contains the API reference information. For tutorial information and discussion of more advanced topics, see

- Basic Tutorial
- Advanced Tutorial
- Logging Cookbook

This module defines functions and classes which implement a flexible event logging system for applications and libraries.

The key benefit of having the logging API provided by a standard library module is that all Python modules can participate in logging, so your application log can include your own messages integrated with messages from third-party modules.

The module provides a lot of functionality and flexibility. If you are unfamiliar with logging, the best way to get to grips with it is to see the tutorials (see the links on the right).

The basic classes defined by the module, together with their functions, are listed below.

- Loggers expose the interface that application code directly uses.
- Handlers send the log records (created by loggers) to the appropriate destination.
- Filters provide a finer grained facility for determining which log records to output.
- Formatters specify the layout of log records in the final output.

16.6.1 Logger Objects

Loggers have the following attributes and methods. Note that Loggers are never instantiated directly, but always through the module-level function `logging.getLogger(name)`. Multiple calls to *getLogger()* with the same name will always return a reference to the same Logger object.

The `name` is potentially a period-separated hierarchical value, like `foo.bar.baz` (though it could also be just plain `foo`, for example). Loggers that are further down in the hierarchical list are children of loggers higher up in the list. For example, given a logger with a name of `foo`, loggers with names of `foo.bar`, `foo.bar.baz`, and `foo.bam` are all descendants of `foo`. The logger name hierarchy is analogous to the Python package hierarchy, and identical to it if you organise your loggers on a per-module basis using the recommended construction `logging.getLogger(__name__)`. That's because in a module, `__name__` is the module's name in the Python package namespace.

class logging.Logger

propagate

If this attribute evaluates to true, events logged to this logger will be passed to the handlers of higher level (ancestor) loggers, in addition to any handlers attached to this logger. Messages are passed directly to the ancestor loggers' handlers - neither the level nor filters of the ancestor loggers in question are considered.

If this evaluates to false, logging messages are not passed to the handlers of ancestor loggers.

The constructor sets this attribute to `True`.

Note: If you attach a handler to a logger *and* one or more of its ancestors, it may emit the same record multiple times. In general, you should not need to attach a handler to more than one logger - if you just attach it to the appropriate logger which is highest in the logger hierarchy, then it will see all events logged by all descendant loggers, provided that their propagate setting is left set to `True`. A common scenario is to attach handlers only to the root logger, and to let propagation take care of the rest.

setLevel(*level*)

Sets the threshold for this logger to *level*. Logging messages which are less severe than *level* will be ignored; logging messages which have severity *level* or higher will be emitted by whichever handler or handlers service this logger, unless a handler's level has been set to a higher severity level than *level*.

When a logger is created, the level is set to `NOTSET` (which causes all messages to be processed when the logger is the root logger, or delegation to the parent when the logger is a non-root logger). Note that the root logger is created with level `WARNING`.

The term 'delegation to the parent' means that if a logger has a level of NOTSET, its chain of ancestor loggers is traversed until either an ancestor with a level other than NOTSET is found, or the root is reached.

If an ancestor is found with a level other than NOTSET, then that ancestor's level is treated as the effective level of the logger where the ancestor search began, and is used to determine how a logging event is handled.

If the root is reached, and it has a level of NOTSET, then all messages will be processed. Otherwise, the root's level will be used as the effective level.

See *Logging Levels* for a list of levels.

Changed in version 3.2: The *level* parameter now accepts a string representation of the level such as 'INFO' as an alternative to the integer constants such as `INFO`. Note, however, that levels are internally stored as integers, and methods such as e.g. *getEffectiveLevel()* and *isEnabledFor()* will return/expect to be passed integers.

isEnabledFor(*lvl*)
Indicates if a message of severity *lvl* would be processed by this logger. This method checks first the module-level level set by `logging.disable(lvl)` and then the logger's effective level as determined by *getEffectiveLevel()*.

getEffectiveLevel()
Indicates the effective level for this logger. If a value other than `NOTSET` has been set using *setLevel()*, it is returned. Otherwise, the hierarchy is traversed towards the root until a value other than `NOTSET` is found, and that value is returned. The value returned is an integer, typically one of `logging.DEBUG`, `logging.INFO` etc.

getChild(*suffix*)
Returns a logger which is a descendant to this logger, as determined by the suffix. Thus, `logging.getLogger('abc').getChild('def.ghi')` would return the same logger as would be returned by `logging.getLogger('abc.def.ghi')`. This is a convenience method, useful when the parent logger is named using e.g. `__name__` rather than a literal string.

New in version 3.2.

debug(*msg*, **args*, ***kwargs*)
Logs a message with level `DEBUG` on this logger. The *msg* is the message format string, and the *args* are the arguments which are merged into *msg* using the string formatting operator. (Note that this means that you can use keywords in the format string, together with a single dictionary argument.)

There are three keyword arguments in *kwargs* which are inspected: *exc_info*, *stack_info*, and *extra*.

If *exc_info* does not evaluate as false, it causes exception information to be added to the logging message. If an exception tuple (in the format returned by *sys.exc_info()*) or an exception instance is provided, it is used; otherwise, *sys.exc_info()* is called to get the exception information.

The second optional keyword argument is *stack_info*, which defaults to `False`. If true, stack information is added to the logging message, including the actual logging call. Note that this is not the same stack information as that displayed through specifying *exc_info*: The former is stack frames from the bottom of the stack up to the logging call in the current thread, whereas the latter is information about stack frames which have been unwound, following an exception, while searching for exception handlers.

You can specify *stack_info* independently of *exc_info*, e.g. to just show how you got to a certain point in your code, even when no exceptions were raised. The stack frames are printed following a header line which says:

```
Stack (most recent call last):
```

This mimics the `Traceback (most recent call last):` which is used when displaying exception frames.

The third keyword argument is *extra* which can be used to pass a dictionary which is used to populate the __dict__ of the LogRecord created for the logging event with user-defined attributes. These custom attributes can then be used as you like. For example, they could be incorporated into logged messages. For example:

```
FORMAT = '%(asctime)-15s %(clientip)s %(user)-8s %(message)s'
logging.basicConfig(format=FORMAT)
```

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```
d = {'clientip': '192.168.0.1', 'user': 'fbloggs'}
logger = logging.getLogger('tcpserver')
logger.warning('Protocol problem: %s', 'connection reset', extra=d)
```

would print something like

```
2006-02-08 22:20:02,165 192.168.0.1 fbloggs  Protocol problem: connection reset
```

The keys in the dictionary passed in *extra* should not clash with the keys used by the logging system. (See the *Formatter* documentation for more information on which keys are used by the logging system.)

If you choose to use these attributes in logged messages, you need to exercise some care. In the above example, for instance, the *Formatter* has been set up with a format string which expects 'clientip' and 'user' in the attribute dictionary of the LogRecord. If these are missing, the message will not be logged because a string formatting exception will occur. So in this case, you always need to pass the *extra* dictionary with these keys.

While this might be annoying, this feature is intended for use in specialized circumstances, such as multi-threaded servers where the same code executes in many contexts, and interesting conditions which arise are dependent on this context (such as remote client IP address and authenticated user name, in the above example). In such circumstances, it is likely that specialized *Formatter*s would be used with particular *Handler*s.

New in version 3.2: The *stack_info* parameter was added.

Changed in version 3.5: The *exc_info* parameter can now accept exception instances.

info(*msg*, **args*, ***kwargs*)
Logs a message with level `INFO` on this logger. The arguments are interpreted as for *debug()*.

warning(*msg*, **args*, ***kwargs*)
Logs a message with level `WARNING` on this logger. The arguments are interpreted as for *debug()*.

Note: There is an obsolete method `warn` which is functionally identical to `warning`. As `warn` is deprecated, please do not use it - use `warning` instead.

error(*msg*, **args*, ***kwargs*)
Logs a message with level `ERROR` on this logger. The arguments are interpreted as for *debug()*.

critical(*msg*, **args*, ***kwargs*)
Logs a message with level `CRITICAL` on this logger. The arguments are interpreted as for *debug()*.

log(*lvl*, *msg*, **args*, ***kwargs*)
Logs a message with integer level *lvl* on this logger. The other arguments are interpreted as for *debug()*.

exception(*msg*, **args*, ***kwargs*)
Logs a message with level `ERROR` on this logger. The arguments are interpreted as for *debug()*. Exception info is added to the logging message. This method should only be called from an exception handler.

addFilter(*filter*)
Adds the specified filter *filter* to this logger.

removeFilter(*filter*)
Removes the specified filter *filter* from this logger.

filter(*record*)
Applies this logger's filters to the record and returns a true value if the record is to be processed. The filters are consulted in turn, until one of them returns a false value. If none of them return a false value, the record will be processed (passed to handlers). If one returns a false value, no further processing of the record occurs.

addHandler(*hdlr*)
Adds the specified handler *hdlr* to this logger.

removeHandler(*hdlr*)
Removes the specified handler *hdlr* from this logger.

findCaller(*stack_info=False*)
Finds the caller's source filename and line number. Returns the filename, line number, function name and stack information as a 4-element tuple. The stack information is returned as `None` unless *stack_info* is `True`.

handle(*record*)
Handles a record by passing it to all handlers associated with this logger and its ancestors (until a false value of *propagate* is found). This method is used for unpickled records received from a socket, as well as those created locally. Logger-level filtering is applied using `filter()`.

makeRecord(*name*, *lvl*, *fn*, *lno*, *msg*, *args*, *exc_info*, *func=None*, *extra=None*, *sinfo=None*)
This is a factory method which can be overridden in subclasses to create specialized `LogRecord` instances.

hasHandlers()
Checks to see if this logger has any handlers configured. This is done by looking for handlers in this logger and its parents in the logger hierarchy. Returns `True` if a handler was found, else `False`. The method stops searching up the hierarchy whenever a logger with the 'propagate' attribute set to false is found - that will be the last logger which is checked for the existence of handlers.

New in version 3.2.

Changed in version 3.7: Loggers can now be pickled and unpickled.

16.6.2 Logging Levels

The numeric values of logging levels are given in the following table. These are primarily of interest if you want to define your own levels, and need them to have specific values relative to the predefined levels. If you define a level with the same numeric value, it overwrites the predefined value; the predefined name is lost.

Level	Numeric value
`CRITICAL`	50
`ERROR`	40
`WARNING`	30
`INFO`	20
`DEBUG`	10
`NOTSET`	0

16.6.3 Handler Objects

Handlers have the following attributes and methods. Note that `Handler` is never instantiated directly; this class acts as a base for more useful subclasses. However, the `__init__()` method in subclasses needs to call `Handler.__init__()`.

class logging.Handler

`__init__`(*level=NOTSET*)
Initializes the *Handler* instance by setting its level, setting the list of filters to the empty list and creating a lock (using *createLock()*) for serializing access to an I/O mechanism.

createLock()
Initializes a thread lock which can be used to serialize access to underlying I/O functionality which may not be threadsafe.

acquire()
Acquires the thread lock created with *createLock()*.

release()
Releases the thread lock acquired with *acquire()*.

setLevel(*level*)
Sets the threshold for this handler to *level*. Logging messages which are less severe than *level* will be ignored. When a handler is created, the level is set to `NOTSET` (which causes all messages to be processed).

See *Logging Levels* for a list of levels.

Changed in version 3.2: The *level* parameter now accepts a string representation of the level such as 'INFO' as an alternative to the integer constants such as `INFO`.

setFormatter(*fmt*)
Sets the *Formatter* for this handler to *fmt*.

addFilter(*filter*)
Adds the specified filter *filter* to this handler.

removeFilter(*filter*)
Removes the specified filter *filter* from this handler.

filter(*record*)
Applies this handler's filters to the record and returns a true value if the record is to be processed. The filters are consulted in turn, until one of them returns a false value. If none of them return a false value, the record will be emitted. If one returns a false value, the handler will not emit the record.

flush()
Ensure all logging output has been flushed. This version does nothing and is intended to be implemented by subclasses.

close()
Tidy up any resources used by the handler. This version does no output but removes the handler from an internal list of handlers which is closed when *shutdown()* is called. Subclasses should ensure that this gets called from overridden *close()* methods.

handle(*record*)
Conditionally emits the specified logging record, depending on filters which may have been added to the handler. Wraps the actual emission of the record with acquisition/release of the I/O thread lock.

handleError(*record*)
This method should be called from handlers when an exception is encountered during an *emit()* call. If the module-level attribute `raiseExceptions` is `False`, exceptions get silently ignored. This is what is mostly wanted for a logging system - most users will not care about errors in the logging system, they are more interested in application errors. You could, however, replace this with a custom handler if you wish. The specified record is the one which was being processed

when the exception occurred. (The default value of `raiseExceptions` is `True`, as that is more useful during development).

format(*record*)
Do formatting for a record - if a formatter is set, use it. Otherwise, use the default formatter for the module.

emit(*record*)
Do whatever it takes to actually log the specified logging record. This version is intended to be implemented by subclasses and so raises a *NotImplementedError*.

For a list of handlers included as standard, see *logging.handlers*.

16.6.4 Formatter Objects

Formatter objects have the following attributes and methods. They are responsible for converting a *LogRecord* to (usually) a string which can be interpreted by either a human or an external system. The base *Formatter* allows a formatting string to be specified. If none is supplied, the default value of `'%(message)s'` is used, which just includes the message in the logging call. To have additional items of information in the formatted output (such as a timestamp), keep reading.

A Formatter can be initialized with a format string which makes use of knowledge of the *LogRecord* attributes - such as the default value mentioned above making use of the fact that the user's message and arguments are pre-formatted into a *LogRecord*'s *message* attribute. This format string contains standard Python %-style mapping keys. See section *printf-style String Formatting* for more information on string formatting.

The useful mapping keys in a *LogRecord* are given in the section on *LogRecord attributes*.

class `logging.`**Formatter**(*fmt=None*, *datefmt=None*, *style='%'*)
Returns a new instance of the *Formatter* class. The instance is initialized with a format string for the message as a whole, as well as a format string for the date/time portion of a message. If no *fmt* is specified, `'%(message)s'` is used. If no *datefmt* is specified, a format is used which is described in the *formatTime()* documentation.

The *style* parameter can be one of '%', '{' or '$' and determines how the format string will be merged with its data: using one of %-formatting, *str.format()* or *string.Template*. See formatting-styles for more information on using {- and $-formatting for log messages.

Changed in version 3.2: The *style* parameter was added.

format(*record*)
The record's attribute dictionary is used as the operand to a string formatting operation. Returns the resulting string. Before formatting the dictionary, a couple of preparatory steps are carried out. The *message* attribute of the record is computed using *msg* % *args*. If the formatting string contains `'(asctime)'`, *formatTime()* is called to format the event time. If there is exception information, it is formatted using *formatException()* and appended to the message. Note that the formatted exception information is cached in attribute *exc_text*. This is useful because the exception information can be pickled and sent across the wire, but you should be careful if you have more than one *Formatter* subclass which customizes the formatting of exception information. In this case, you will have to clear the cached value after a formatter has done its formatting, so that the next formatter to handle the event doesn't use the cached value but recalculates it afresh.

If stack information is available, it's appended after the exception information, using *formatStack()* to transform it if necessary.

formatTime(*record*, *datefmt=None*)
This method should be called from *format()* by a formatter which wants to make use of a formatted time. This method can be overridden in formatters to provide for any specific requirement, but the basic behavior is as follows: if *datefmt* (a string) is specified, it is used with *time.strftime()* to format the creation time of the record. Otherwise, the format '%Y-%m-%d %H:%M:%S,uuu'

is used, where the uuu part is a millisecond value and the other letters are as per the *time.strftime()* documentation. An example time in this format is `2003-01-23 00:29:50,411`. The resulting string is returned.

This function uses a user-configurable function to convert the creation time to a tuple. By default, *time.localtime()* is used; to change this for a particular formatter instance, set the `converter` attribute to a function with the same signature as *time.localtime()* or *time.gmtime()*. To change it for all formatters, for example if you want all logging times to be shown in GMT, set the `converter` attribute in the `Formatter` class.

Changed in version 3.3: Previously, the default format was hard-coded as in this example: `2010-09-06 22:38:15,292` where the part before the comma is handled by a strptime format string (`'%Y-%m-%d %H:%M:%S'`), and the part after the comma is a millisecond value. Because strptime does not have a format placeholder for milliseconds, the millisecond value is appended using another format string, `'%s,%03d'` — and both of these format strings have been hardcoded into this method. With the change, these strings are defined as class-level attributes which can be overridden at the instance level when desired. The names of the attributes are `default_time_format` (for the strptime format string) and `default_msec_format` (for appending the millisecond value).

formatException(*exc_info*)

Formats the specified exception information (a standard exception tuple as returned by *sys.exc_info()*) as a string. This default implementation just uses *traceback.print_exception()*. The resulting string is returned.

formatStack(*stack_info*)

Formats the specified stack information (a string as returned by *traceback.print_stack()*, but with the last newline removed) as a string. This default implementation just returns the input value.

16.6.5 Filter Objects

`Filters` can be used by `Handlers` and `Loggers` for more sophisticated filtering than is provided by levels. The base filter class only allows events which are below a certain point in the logger hierarchy. For example, a filter initialized with 'A.B' will allow events logged by loggers 'A.B', 'A.B.C', 'A.B.C.D', 'A.B.D' etc. but not 'A.BB', 'B.A.B' etc. If initialized with the empty string, all events are passed.

class logging.Filter(*name=''*)

Returns an instance of the *Filter* class. If *name* is specified, it names a logger which, together with its children, will have its events allowed through the filter. If *name* is the empty string, allows every event.

filter(*record*)

Is the specified record to be logged? Returns zero for no, nonzero for yes. If deemed appropriate, the record may be modified in-place by this method.

Note that filters attached to handlers are consulted before an event is emitted by the handler, whereas filters attached to loggers are consulted whenever an event is logged (using *debug()*, *info()*, etc.), before sending an event to handlers. This means that events which have been generated by descendant loggers will not be filtered by a logger's filter setting, unless the filter has also been applied to those descendant loggers.

You don't actually need to subclass `Filter`: you can pass any instance which has a `filter` method with the same semantics.

Changed in version 3.2: You don't need to create specialized `Filter` classes, or use other classes with a `filter` method: you can use a function (or other callable) as a filter. The filtering logic will check to see if the filter object has a `filter` attribute: if it does, it's assumed to be a `Filter` and its *filter()* method is called. Otherwise, it's assumed to be a callable and called with the record as the single parameter. The returned value should conform to that returned by *filter()*.

Although filters are used primarily to filter records based on more sophisticated criteria than levels, they get to see every record which is processed by the handler or logger they're attached to: this can be useful if you want to do things like counting how many records were processed by a particular logger or handler, or adding, changing or removing attributes in the LogRecord being processed. Obviously changing the LogRecord needs to be done with some care, but it does allow the injection of contextual information into logs (see filters-contextual).

16.6.6 LogRecord Objects

LogRecord instances are created automatically by the *Logger* every time something is logged, and can be created manually via *makeLogRecord()* (for example, from a pickled event received over the wire).

class `logging.LogRecord`(*name*, *level*, *pathname*, *lineno*, *msg*, *args*, *exc_info*, *func=None*, *sinfo=None*)

Contains all the information pertinent to the event being logged.

The primary information is passed in `msg` and `args`, which are combined using `msg % args` to create the `message` field of the record.

Parameters

- **name** – The name of the logger used to log the event represented by this LogRecord. Note that this name will always have this value, even though it may be emitted by a handler attached to a different (ancestor) logger.
- **level** – The numeric level of the logging event (one of DEBUG, INFO etc.) Note that this is converted to *two* attributes of the LogRecord: `levelno` for the numeric value and `levelname` for the corresponding level name.
- **pathname** – The full pathname of the source file where the logging call was made.
- **lineno** – The line number in the source file where the logging call was made.
- **msg** – The event description message, possibly a format string with placeholders for variable data.
- **args** – Variable data to merge into the *msg* argument to obtain the event description.
- **exc_info** – An exception tuple with the current exception information, or `None` if no exception information is available.
- **func** – The name of the function or method from which the logging call was invoked.
- **sinfo** – A text string representing stack information from the base of the stack in the current thread, up to the logging call.

`getMessage()`

Returns the message for this *LogRecord* instance after merging any user-supplied arguments with the message. If the user-supplied message argument to the logging call is not a string, *str()* is called on it to convert it to a string. This allows use of user-defined classes as messages, whose `__str__` method can return the actual format string to be used.

Changed in version 3.2: The creation of a `LogRecord` has been made more configurable by providing a factory which is used to create the record. The factory can be set using *getLogRecordFactory()* and *setLogRecordFactory()* (see this for the factory's signature).

This functionality can be used to inject your own values into a LogRecord at creation time. You can use the following pattern:

```
old_factory = logging.getLogRecordFactory()
```

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```
def record_factory(*args, **kwargs):
    record = old_factory(*args, **kwargs)
    record.custom_attribute = 0xdecafbad
    return record

logging.setLogRecordFactory(record_factory)
```

With this pattern, multiple factories could be chained, and as long as they don't overwrite each other's attributes or unintentionally overwrite the standard attributes listed above, there should be no surprises.

16.6.7 LogRecord attributes

The LogRecord has a number of attributes, most of which are derived from the parameters to the constructor. (Note that the names do not always correspond exactly between the LogRecord constructor parameters and the LogRecord attributes.) These attributes can be used to merge data from the record into the format string. The following table lists (in alphabetical order) the attribute names, their meanings and the corresponding placeholder in a %-style format string.

If you are using {}-formatting (*str.format()*), you can use `{attrname}` as the placeholder in the format string. If you are using $-formatting (*string.Template*), use the form `${attrname}`. In both cases, of course, replace `attrname` with the actual attribute name you want to use.

In the case of {}-formatting, you can specify formatting flags by placing them after the attribute name, separated from it with a colon. For example: a placeholder of `{msecs:03d}` would format a millisecond value of `4` as `004`. Refer to the *str.format()* documentation for full details on the options available to you.

Attribute name	Format	Description
args	You shouldn't need to format this yourself.	The tuple of arguments merged into `msg` to produce `message`, or a dict whose values are used for the merge (when there is only one argument, and it is a dictionary).
asctime	`%(asctime)s`	Human-readable time when the *LogRecord* was created. By default this is of the form '2003-07-08 16:49:45,896' (the numbers after the comma are millisecond portion of the time).
created	`%(created)f`	Time when the *LogRecord* was created (as returned by *time.time()*).
exc_info	You shouldn't need to format this yourself.	Exception tuple (à la `sys.exc_info`) or, if no exception has occurred, `None`.
filename	`%(filename)s`	Filename portion of `pathname`.
funcName	`%(funcName)s`	Name of function containing the logging call.
levelname	`%(levelname)s`	Text logging level for the message (`'DEBUG'`, `'INFO'`, `'WARNING'`, `'ERROR'`, `'CRITICAL'`).
levelno	`%(levelno)s`	Numeric logging level for the message (`DEBUG`, `INFO`, `WARNING`, `ERROR`, `CRITICAL`).
lineno	`%(lineno)d`	Source line number where the logging call was issued (if available).
message	`%(message)s`	The logged message, computed as `msg % args`. This is set when *Formatter.format()* is invoked.
module	`%(module)s`	Module (name portion of `filename`).
msecs	`%(msecs)d`	Millisecond portion of the time when the *LogRecord* was created.
msg	You shouldn't need to format this yourself.	The format string passed in the original logging call. Merged with `args` to produce `message`, or an arbitrary object (see arbitrary-object-messages).
name	`%(name)s`	Name of the logger used to log the call.
pathname	`%(pathname)s`	Full pathname of the source file where the logging call was issued (if available).
process	`%(process)d`	Process ID (if available).
processName	`%(processName)s`	Process name (if available).
relativeCreated	`%(relativeCreated)d`	Time in milliseconds when the LogRecord was created, relative to the time the logging module was loaded.
stack_info	You shouldn't need to format this yourself.	Stack frame information (where available) from the bottom of the stack in the current thread, up to and including the stack frame of the logging call which resulted in the creation of this record.
thread	`%(thread)d`	Thread ID (if available).
threadName	`%(threadName)s`	Thread name (if available).

Changed in version 3.1: *processName* was added.

16.6.8 LoggerAdapter Objects

LoggerAdapter instances are used to conveniently pass contextual information into logging calls. For a usage example, see the section on adding contextual information to your logging output.

class logging.LoggerAdapter(*logger*, *extra*)

Returns an instance of *LoggerAdapter* initialized with an underlying *Logger* instance and a dict-like object.

process(*msg*, *kwargs*)

Modifies the message and/or keyword arguments passed to a logging call in order to insert contextual information. This implementation takes the object passed as *extra* to the constructor and adds it to *kwargs* using key 'extra'. The return value is a (*msg*, *kwargs*) tuple which has the (possibly modified) versions of the arguments passed in.

In addition to the above, *LoggerAdapter* supports the following methods of *Logger*: *debug()*, *info()*, *warning()*, *error()*, *exception()*, *critical()*, *log()*, *isEnabledFor()*, *getEffectiveLevel()*, *setLevel()* and *hasHandlers()*. These methods have the same signatures as their counterparts in *Logger*, so you can use the two types of instances interchangeably.

Changed in version 3.2: The *isEnabledFor()*, *getEffectiveLevel()*, *setLevel()* and *hasHandlers()* methods were added to *LoggerAdapter*. These methods delegate to the underlying logger.

16.6.9 Thread Safety

The logging module is intended to be thread-safe without any special work needing to be done by its clients. It achieves this though using threading locks; there is one lock to serialize access to the module's shared data, and each handler also creates a lock to serialize access to its underlying I/O.

If you are implementing asynchronous signal handlers using the *signal* module, you may not be able to use logging from within such handlers. This is because lock implementations in the *threading* module are not always re-entrant, and so cannot be invoked from such signal handlers.

16.6.10 Module-Level Functions

In addition to the classes described above, there are a number of module-level functions.

logging.getLogger(*name=None*)

Return a logger with the specified name or, if name is `None`, return a logger which is the root logger of the hierarchy. If specified, the name is typically a dot-separated hierarchical name like *'a'*, *'a.b'* or *'a.b.c.d'*. Choice of these names is entirely up to the developer who is using logging.

All calls to this function with a given name return the same logger instance. This means that logger instances never need to be passed between different parts of an application.

logging.getLoggerClass()

Return either the standard *Logger* class, or the last class passed to *setLoggerClass()*. This function may be called from within a new class definition, to ensure that installing a customized *Logger* class will not undo customizations already applied by other code. For example:

```
class MyLogger(logging.getLoggerClass()):
    # ... override behaviour here
```

logging.getLogRecordFactory()

Return a callable which is used to create a *LogRecord*.

New in version 3.2: This function has been provided, along with *setLogRecordFactory()*, to allow developers more control over how the *LogRecord* representing a logging event is constructed.

See *setLogRecordFactory()* for more information about the how the factory is called.

`logging.debug`(*msg*, **args*, ***kwargs*)

Logs a message with level `DEBUG` on the root logger. The *msg* is the message format string, and the *args* are the arguments which are merged into *msg* using the string formatting operator. (Note that this means that you can use keywords in the format string, together with a single dictionary argument.)

There are three keyword arguments in *kwargs* which are inspected: *exc_info* which, if it does not evaluate as false, causes exception information to be added to the logging message. If an exception tuple (in the format returned by *sys.exc_info()*) or an exception instance is provided, it is used; otherwise, *sys.exc_info()* is called to get the exception information.

The second optional keyword argument is *stack_info*, which defaults to `False`. If true, stack information is added to the logging message, including the actual logging call. Note that this is not the same stack information as that displayed through specifying *exc_info*: The former is stack frames from the bottom of the stack up to the logging call in the current thread, whereas the latter is information about stack frames which have been unwound, following an exception, while searching for exception handlers.

You can specify *stack_info* independently of *exc_info*, e.g. to just show how you got to a certain point in your code, even when no exceptions were raised. The stack frames are printed following a header line which says:

```
Stack (most recent call last):
```

This mimics the `Traceback (most recent call last):` which is used when displaying exception frames.

The third optional keyword argument is *extra* which can be used to pass a dictionary which is used to populate the __dict__ of the LogRecord created for the logging event with user-defined attributes. These custom attributes can then be used as you like. For example, they could be incorporated into logged messages. For example:

```
FORMAT = '%(asctime)-15s %(clientip)s %(user)-8s %(message)s'
logging.basicConfig(format=FORMAT)
d = {'clientip': '192.168.0.1', 'user': 'fbloggs'}
logging.warning('Protocol problem: %s', 'connection reset', extra=d)
```

would print something like:

```
2006-02-08 22:20:02,165 192.168.0.1 fbloggs  Protocol problem: connection reset
```

The keys in the dictionary passed in *extra* should not clash with the keys used by the logging system. (See the *Formatter* documentation for more information on which keys are used by the logging system.)

If you choose to use these attributes in logged messages, you need to exercise some care. In the above example, for instance, the *Formatter* has been set up with a format string which expects 'clientip' and 'user' in the attribute dictionary of the LogRecord. If these are missing, the message will not be logged because a string formatting exception will occur. So in this case, you always need to pass the *extra* dictionary with these keys.

While this might be annoying, this feature is intended for use in specialized circumstances, such as multi-threaded servers where the same code executes in many contexts, and interesting conditions which arise are dependent on this context (such as remote client IP address and authenticated user name, in the above example). In such circumstances, it is likely that specialized *Formatter*s would be used with particular *Handler*s.

New in version 3.2: The *stack_info* parameter was added.

`logging.info(msg, *args, **kwargs)`
Logs a message with level `INFO` on the root logger. The arguments are interpreted as for *debug()*.

`logging.warning(msg, *args, **kwargs)`
Logs a message with level `WARNING` on the root logger. The arguments are interpreted as for *debug()*.

Note: There is an obsolete function `warn` which is functionally identical to `warning`. As `warn` is deprecated, please do not use it - use `warning` instead.

`logging.error(msg, *args, **kwargs)`
Logs a message with level `ERROR` on the root logger. The arguments are interpreted as for *debug()*.

`logging.critical(msg, *args, **kwargs)`
Logs a message with level `CRITICAL` on the root logger. The arguments are interpreted as for *debug()*.

`logging.exception(msg, *args, **kwargs)`
Logs a message with level `ERROR` on the root logger. The arguments are interpreted as for *debug()*. Exception info is added to the logging message. This function should only be called from an exception handler.

`logging.log(level, msg, *args, **kwargs)`
Logs a message with level *level* on the root logger. The other arguments are interpreted as for *debug()*.

Note: The above module-level convenience functions, which delegate to the root logger, call *basicConfig()* to ensure that at least one handler is available. Because of this, they should *not* be used in threads, in versions of Python earlier than 2.7.1 and 3.2, unless at least one handler has been added to the root logger *before* the threads are started. In earlier versions of Python, due to a thread safety shortcoming in *basicConfig()*, this can (under rare circumstances) lead to handlers being added multiple times to the root logger, which can in turn lead to multiple messages for the same event.

`logging.disable(lvl=CRITICAL)`
Provides an overriding level *lvl* for all loggers which takes precedence over the logger's own level. When the need arises to temporarily throttle logging output down across the whole application, this function can be useful. Its effect is to disable all logging calls of severity *lvl* and below, so that if you call it with a value of INFO, then all INFO and DEBUG events would be discarded, whereas those of severity WARNING and above would be processed according to the logger's effective level. If `logging.disable(logging.NOTSET)` is called, it effectively removes this overriding level, so that logging output again depends on the effective levels of individual loggers.

Note that if you have defined any custom logging level higher than `CRITICAL` (this is not recommended), you won't be able to rely on the default value for the *lvl* parameter, but will have to explicitly supply a suitable value.

Changed in version 3.7: The *lvl* parameter was defaulted to level `CRITICAL`. See Issue #28524 for more information about this change.

`logging.addLevelName(lvl, levelName)`
Associates level *lvl* with text *levelName* in an internal dictionary, which is used to map numeric levels to a textual representation, for example when a *Formatter* formats a message. This function can also be used to define your own levels. The only constraints are that all levels used must be registered using this function, levels should be positive integers and they should increase in increasing order of severity.

Note: If you are thinking of defining your own levels, please see the section on custom-levels.

`logging.getLevelName(lvl)`

Returns the textual representation of logging level *lvl*. If the level is one of the predefined levels `CRITICAL`, `ERROR`, `WARNING`, `INFO` or `DEBUG` then you get the corresponding string. If you have associated levels with names using `addLevelName()` then the name you have associated with *lvl* is returned. If a numeric value corresponding to one of the defined levels is passed in, the corresponding string representation is returned. Otherwise, the string 'Level %s' % lvl is returned.

Note: Levels are internally integers (as they need to be compared in the logging logic). This function is used to convert between an integer level and the level name displayed in the formatted log output by means of the `%(levelname)s` format specifier (see *LogRecord attributes*).

Changed in version 3.4: In Python versions earlier than 3.4, this function could also be passed a text level, and would return the corresponding numeric value of the level. This undocumented behaviour was considered a mistake, and was removed in Python 3.4, but reinstated in 3.4.2 due to retain backward compatibility.

`logging.makeLogRecord(attrdict)`

Creates and returns a new `LogRecord` instance whose attributes are defined by *attrdict*. This function is useful for taking a pickled `LogRecord` attribute dictionary, sent over a socket, and reconstituting it as a `LogRecord` instance at the receiving end.

`logging.basicConfig(**kwargs)`

Does basic configuration for the logging system by creating a `StreamHandler` with a default `Formatter` and adding it to the root logger. The functions `debug()`, `info()`, `warning()`, `error()` and `critical()` will call `basicConfig()` automatically if no handlers are defined for the root logger.

This function does nothing if the root logger already has handlers configured for it.

Note: This function should be called from the main thread before other threads are started. In versions of Python prior to 2.7.1 and 3.2, if this function is called from multiple threads, it is possible (in rare circumstances) that a handler will be added to the root logger more than once, leading to unexpected results such as messages being duplicated in the log.

The following keyword arguments are supported.

Format	Description
filename	Specifies that a FileHandler be created, using the specified filename, rather than a StreamHandler.
filemode	If *filename* is specified, open the file in this *mode*. Defaults to `'a'`.
format	Use the specified format string for the handler.
datefmt	Use the specified date/time format, as accepted by `time.strftime()`.
style	If *format* is specified, use this style for the format string. One of `'%'`, `'{'` or `'$'` for *printf-style*, `str.format()` or `string.Template` respectively. Defaults to `'%'`.
level	Set the root logger level to the specified *level*.
stream	Use the specified stream to initialize the StreamHandler. Note that this argument is incompatible with *filename* - if both are present, a `ValueError` is raised.
handlers	If specified, this should be an iterable of already created handlers to add to the root logger. Any handlers which don't already have a formatter set will be assigned the default formatter created in this function. Note that this argument is incompatible with *filename* or *stream* - if both are present, a `ValueError` is raised.

Changed in version 3.2: The *style* argument was added.

Changed in version 3.3: The *handlers* argument was added. Additional checks were added to catch situations where incompatible arguments are specified (e.g. *handlers* together with *stream* or *filename*, or *stream* together with *filename*).

`logging.shutdown()`

Informs the logging system to perform an orderly shutdown by flushing and closing all handlers. This should be called at application exit and no further use of the logging system should be made after this call.

`logging.setLoggerClass(klass)`

Tells the logging system to use the class *klass* when instantiating a logger. The class should define `__init__()` such that only a name argument is required, and the `__init__()` should call `Logger.__init__()`. This function is typically called before any loggers are instantiated by applications which need to use custom logger behavior.

`logging.setLogRecordFactory(factory)`

Set a callable which is used to create a *LogRecord*.

Parameters **factory** – The factory callable to be used to instantiate a log record.

New in version 3.2: This function has been provided, along with *getLogRecordFactory()*, to allow developers more control over how the *LogRecord* representing a logging event is constructed.

The factory has the following signature:

`factory(name, level, fn, lno, msg, args, exc_info, func=None, sinfo=None, **kwargs)`

name The logger name.

level The logging level (numeric).

fn The full pathname of the file where the logging call was made.

lno The line number in the file where the logging call was made.

msg The logging message.

args The arguments for the logging message.

exc_info An exception tuple, or `None`.

func The name of the function or method which invoked the logging call.

sinfo A stack traceback such as is provided by *traceback.print_stack()*, showing the call hierarchy.

kwargs Additional keyword arguments.

16.6.11 Module-Level Attributes

`logging.lastResort`

A "handler of last resort" is available through this attribute. This is a *StreamHandler* writing to `sys.stderr` with a level of `WARNING`, and is used to handle logging events in the absence of any logging configuration. The end result is to just print the message to `sys.stderr`. This replaces the earlier error message saying that "no handlers could be found for logger XYZ". If you need the earlier behaviour for some reason, `lastResort` can be set to `None`.

New in version 3.2.

16.6.12 Integration with the warnings module

The *captureWarnings()* function can be used to integrate *logging* with the *warnings* module.

`logging.captureWarnings(capture)`

This function is used to turn the capture of warnings by logging on and off.

If *capture* is `True`, warnings issued by the *warnings* module will be redirected to the logging system. Specifically, a warning will be formatted using *warnings.formatwarning()* and the resulting string logged to a logger named `'py.warnings'` with a severity of `WARNING`.

If *capture* is `False`, the redirection of warnings to the logging system will stop, and warnings will be redirected to their original destinations (i.e. those in effect before `captureWarnings(True)` was called).

See also:

Module *logging.config* Configuration API for the logging module.

Module *logging.handlers* Useful handlers included with the logging module.

PEP 282 - A Logging System The proposal which described this feature for inclusion in the Python standard library.

Original Python logging package This is the original source for the *logging* package. The version of the package available from this site is suitable for use with Python 1.5.2, 2.1.x and 2.2.x, which do not include the *logging* package in the standard library.

16.7 `logging.config` — Logging configuration

Source code: Lib/logging/config.py

Important

This page contains only reference information. For tutorials, please see

- Basic Tutorial
- Advanced Tutorial
- Logging Cookbook

This section describes the API for configuring the logging module.

16.7.1 Configuration functions

The following functions configure the logging module. They are located in the *logging.config* module. Their use is optional — you can configure the logging module using these functions or by making calls to the main API (defined in *logging* itself) and defining handlers which are declared either in *logging* or *logging.handlers*.

`logging.config.dictConfig(config)`

Takes the logging configuration from a dictionary. The contents of this dictionary are described in *Configuration dictionary schema* below.

If an error is encountered during configuration, this function will raise a *ValueError*, *TypeError*, *AttributeError* or *ImportError* with a suitably descriptive message. The following is a (possibly incomplete) list of conditions which will raise an error:

- A `level` which is not a string or which is a string not corresponding to an actual logging level.

- A `propagate` value which is not a boolean.
- An id which does not have a corresponding destination.
- A non-existent handler id found during an incremental call.
- An invalid logger name.
- Inability to resolve to an internal or external object.

Parsing is performed by the `DictConfigurator` class, whose constructor is passed the dictionary used for configuration, and has a `configure()` method. The *`logging.config`* module has a callable attribute `dictConfigClass` which is initially set to `DictConfigurator`. You can replace the value of `dictConfigClass` with a suitable implementation of your own.

`dictConfig()` calls `dictConfigClass` passing the specified dictionary, and then calls the `configure()` method on the returned object to put the configuration into effect:

```
def dictConfig(config):
    dictConfigClass(config).configure()
```

For example, a subclass of `DictConfigurator` could call `DictConfigurator.__init__()` in its own `__init__()`, then set up custom prefixes which would be usable in the subsequent `configure()` call. `dictConfigClass` would be bound to this new subclass, and then *`dictConfig()`* could be called exactly as in the default, uncustomized state.

New in version 3.2.

`logging.config.`**`fileConfig`**(*fname*, *defaults=None*, *disable_existing_loggers=True*)

Reads the logging configuration from a *`configparser`*-format file. The format of the file should be as described in *Configuration file format*. This function can be called several times from an application, allowing an end user to select from various pre-canned configurations (if the developer provides a mechanism to present the choices and load the chosen configuration).

Parameters

- **`fname`** – A filename, or a file-like object, or an instance derived from *`RawConfigParser`*. If a `RawConfigParser`-derived instance is passed, it is used as is. Otherwise, a `Configparser` is instantiated, and the configuration read by it from the object passed in `fname`. If that has a *`readline()`* method, it is assumed to be a file-like object and read using *`read_file()`*; otherwise, it is assumed to be a filename and passed to *`read()`*.
- **`defaults`** – Defaults to be passed to the ConfigParser can be specified in this argument.
- **`disable_existing_loggers`** – If specified as `False`, loggers which exist when this call is made are left enabled. The default is `True` because this enables old behaviour in a backward-compatible way. This behaviour is to disable any existing loggers unless they or their ancestors are explicitly named in the logging configuration.

Changed in version 3.4: An instance of a subclass of *`RawConfigParser`* is now accepted as a value for `fname`. This facilitates:

- Use of a configuration file where logging configuration is just part of the overall application configuration.
- Use of a configuration read from a file, and then modified by the using application (e.g. based on command-line parameters or other aspects of the runtime environment) before being passed to `fileConfig`.

`logging.config.`**`listen`**(*port=DEFAULT_LOGGING_CONFIG_PORT*, *verify=None*)

Starts up a socket server on the specified port, and listens for new configurations. If no port is specified, the module's default `DEFAULT_LOGGING_CONFIG_PORT` is used. Logging configurations will be sent as a file suitable for processing by *dictConfig()* or *fileConfig()*. Returns a *Thread* instance on which you can call *start()* to start the server, and which you can *join()* when appropriate. To stop the server, call *stopListening()*.

The `verify` argument, if specified, should be a callable which should verify whether bytes received across the socket are valid and should be processed. This could be done by encrypting and/or signing what is sent across the socket, such that the `verify` callable can perform signature verification and/or decryption. The `verify` callable is called with a single argument - the bytes received across the socket - and should return the bytes to be processed, or `None` to indicate that the bytes should be discarded. The returned bytes could be the same as the passed in bytes (e.g. when only verification is done), or they could be completely different (perhaps if decryption were performed).

To send a configuration to the socket, read in the configuration file and send it to the socket as a sequence of bytes preceded by a four-byte length string packed in binary using `struct.pack('>L', n)`.

Note: Because portions of the configuration are passed through *eval()*, use of this function may open its users to a security risk. While the function only binds to a socket on `localhost`, and so does not accept connections from remote machines, there are scenarios where untrusted code could be run under the account of the process which calls *listen()*. Specifically, if the process calling *listen()* runs on a multi-user machine where users cannot trust each other, then a malicious user could arrange to run essentially arbitrary code in a victim user's process, simply by connecting to the victim's *listen()* socket and sending a configuration which runs whatever code the attacker wants to have executed in the victim's process. This is especially easy to do if the default port is used, but not hard even if a different port is used). To avoid the risk of this happening, use the `verify` argument to *listen()* to prevent unrecognised configurations from being applied.

Changed in version 3.4: The `verify` argument was added.

Note: If you want to send configurations to the listener which don't disable existing loggers, you will need to use a JSON format for the configuration, which will use *dictConfig()* for configuration. This method allows you to specify `disable_existing_loggers` as `False` in the configuration you send.

`logging.config.stopListening()`

Stops the listening server which was created with a call to *listen()*. This is typically called before calling `join()` on the return value from *listen()*.

16.7.2 Configuration dictionary schema

Describing a logging configuration requires listing the various objects to create and the connections between them; for example, you may create a handler named 'console' and then say that the logger named 'startup' will send its messages to the 'console' handler. These objects aren't limited to those provided by the *logging* module because you might write your own formatter or handler class. The parameters to these classes may also need to include external objects such as `sys.stderr`. The syntax for describing these objects and connections is defined in *Object connections* below.

Dictionary Schema Details

The dictionary passed to *dictConfig()* must contain the following keys:

- *version* - to be set to an integer value representing the schema version. The only valid value at present is 1, but having this key allows the schema to evolve while still preserving backwards compatibility.

All other keys are optional, but if present they will be interpreted as described below. In all cases below where a 'configuring dict' is mentioned, it will be checked for the special `'()'` key to see if a custom instantiation is required. If so, the mechanism described in *User-defined objects* below is used to create an instance; otherwise, the context is used to determine what to instantiate.

- *formatters* - the corresponding value will be a dict in which each key is a formatter id and each value is a dict describing how to configure the corresponding `Formatter` instance.

  The configuring dict is searched for keys `format` and `datefmt` (with defaults of `None`) and these are used to construct a `Formatter` instance.

- *filters* - the corresponding value will be a dict in which each key is a filter id and each value is a dict describing how to configure the corresponding Filter instance.

  The configuring dict is searched for the key `name` (defaulting to the empty string) and this is used to construct a `logging.Filter` instance.

- *handlers* - the corresponding value will be a dict in which each key is a handler id and each value is a dict describing how to configure the corresponding Handler instance.

  The configuring dict is searched for the following keys:

  – `class` (mandatory). This is the fully qualified name of the handler class.

  – `level` (optional). The level of the handler.

  – `formatter` (optional). The id of the formatter for this handler.

  – `filters` (optional). A list of ids of the filters for this handler.

  All *other* keys are passed through as keyword arguments to the handler's constructor. For example, given the snippet:

```
handlers:
  console:
    class : logging.StreamHandler
    formatter: brief
    level   : INFO
    filters: [allow_foo]
    stream  : ext://sys.stdout
  file:
    class : logging.handlers.RotatingFileHandler
    formatter: precise
    filename: logconfig.log
    maxBytes: 1024
    backupCount: 3
```

  the handler with id `console` is instantiated as a `logging.StreamHandler`, using `sys.stdout` as the underlying stream. The handler with id `file` is instantiated as a `logging.handlers.RotatingFileHandler` with the keyword arguments `filename='logconfig.log', maxBytes=1024, backupCount=3`.

- *loggers* - the corresponding value will be a dict in which each key is a logger name and each value is a dict describing how to configure the corresponding Logger instance.

  The configuring dict is searched for the following keys:

  – `level` (optional). The level of the logger.

  – `propagate` (optional). The propagation setting of the logger.

  – `filters` (optional). A list of ids of the filters for this logger.

  – `handlers` (optional). A list of ids of the handlers for this logger.

The specified loggers will be configured according to the level, propagation, filters and handlers specified.

- *root* - this will be the configuration for the root logger. Processing of the configuration will be as for any logger, except that the `propagate` setting will not be applicable.
- *incremental* - whether the configuration is to be interpreted as incremental to the existing configuration. This value defaults to `False`, which means that the specified configuration replaces the existing configuration with the same semantics as used by the existing `fileConfig()` API.

  If the specified value is `True`, the configuration is processed as described in the section on *Incremental Configuration*.
- *disable_existing_loggers* - whether any existing loggers are to be disabled. This setting mirrors the parameter of the same name in `fileConfig()`. If absent, this parameter defaults to `True`. This value is ignored if *incremental* is `True`.

Incremental Configuration

It is difficult to provide complete flexibility for incremental configuration. For example, because objects such as filters and formatters are anonymous, once a configuration is set up, it is not possible to refer to such anonymous objects when augmenting a configuration.

Furthermore, there is not a compelling case for arbitrarily altering the object graph of loggers, handlers, filters, formatters at run-time, once a configuration is set up; the verbosity of loggers and handlers can be controlled just by setting levels (and, in the case of loggers, propagation flags). Changing the object graph arbitrarily in a safe way is problematic in a multi-threaded environment; while not impossible, the benefits are not worth the complexity it adds to the implementation.

Thus, when the `incremental` key of a configuration dict is present and is `True`, the system will completely ignore any `formatters` and `filters` entries, and process only the `level` settings in the `handlers` entries, and the `level` and `propagate` settings in the `loggers` and `root` entries.

Using a value in the configuration dict lets configurations to be sent over the wire as pickled dicts to a socket listener. Thus, the logging verbosity of a long-running application can be altered over time with no need to stop and restart the application.

Object connections

The schema describes a set of logging objects - loggers, handlers, formatters, filters - which are connected to each other in an object graph. Thus, the schema needs to represent connections between the objects. For example, say that, once configured, a particular logger has attached to it a particular handler. For the purposes of this discussion, we can say that the logger represents the source, and the handler the destination, of a connection between the two. Of course in the configured objects this is represented by the logger holding a reference to the handler. In the configuration dict, this is done by giving each destination object an id which identifies it unambiguously, and then using the id in the source object's configuration to indicate that a connection exists between the source and the destination object with that id.

So, for example, consider the following YAML snippet:

```
formatters:
  brief:
    # configuration for formatter with id 'brief' goes here
  precise:
    # configuration for formatter with id 'precise' goes here
handlers:
  h1: #This is an id
```

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```
    # configuration of handler with id 'h1' goes here
    formatter: brief
  h2: #This is another id
    # configuration of handler with id 'h2' goes here
    formatter: precise
loggers:
  foo.bar.baz:
    # other configuration for logger 'foo.bar.baz'
    handlers: [h1, h2]
```

(Note: YAML used here because it's a little more readable than the equivalent Python source form for the dictionary.)

The ids for loggers are the logger names which would be used programmatically to obtain a reference to those loggers, e.g. `foo.bar.baz`. The ids for Formatters and Filters can be any string value (such as `brief`, `precise` above) and they are transient, in that they are only meaningful for processing the configuration dictionary and used to determine connections between objects, and are not persisted anywhere when the configuration call is complete.

The above snippet indicates that logger named `foo.bar.baz` should have two handlers attached to it, which are described by the handler ids `h1` and `h2`. The formatter for `h1` is that described by id `brief`, and the formatter for `h2` is that described by id `precise`.

User-defined objects

The schema supports user-defined objects for handlers, filters and formatters. (Loggers do not need to have different types for different instances, so there is no support in this configuration schema for user-defined logger classes.)

Objects to be configured are described by dictionaries which detail their configuration. In some places, the logging system will be able to infer from the context how an object is to be instantiated, but when a user-defined object is to be instantiated, the system will not know how to do this. In order to provide complete flexibility for user-defined object instantiation, the user needs to provide a 'factory' - a callable which is called with a configuration dictionary and which returns the instantiated object. This is signalled by an absolute import path to the factory being made available under the special key `'()'`. Here's a concrete example:

```
formatters:
  brief:
    format: '%(message)s'
  default:
    format: '%(asctime)s %(levelname)-8s %(name)-15s %(message)s'
    datefmt: '%Y-%m-%d %H:%M:%S'
  custom:
      (): my.package.customFormatterFactory
      bar: baz
      spam: 99.9
      answer: 42
```

The above YAML snippet defines three formatters. The first, with id `brief`, is a standard *logging.Formatter* instance with the specified format string. The second, with id `default`, has a longer format and also defines the time format explicitly, and will result in a *logging.Formatter* initialized with those two format strings. Shown in Python source form, the `brief` and `default` formatters have configuration sub-dictionaries:

```
{
  'format' : '%(message)s'
}
```

and:

```
{
  'format' : '%(asctime)s %(levelname)-8s %(name)-15s %(message)s',
  'datefmt' : '%Y-%m-%d %H:%M:%S'
}
```

respectively, and as these dictionaries do not contain the special key `'()'`, the instantiation is inferred from the context: as a result, standard *logging.Formatter* instances are created. The configuration sub-dictionary for the third formatter, with id `custom`, is:

```
{
  '()' : 'my.package.customFormatterFactory',
  'bar' : 'baz',
  'spam' : 99.9,
  'answer' : 42
}
```

and this contains the special key `'()'`, which means that user-defined instantiation is wanted. In this case, the specified factory callable will be used. If it is an actual callable it will be used directly - otherwise, if you specify a string (as in the example) the actual callable will be located using normal import mechanisms. The callable will be called with the **remaining** items in the configuration sub-dictionary as keyword arguments. In the above example, the formatter with id `custom` will be assumed to be returned by the call:

```
my.package.customFormatterFactory(bar='baz', spam=99.9, answer=42)
```

The key `'()'` has been used as the special key because it is not a valid keyword parameter name, and so will not clash with the names of the keyword arguments used in the call. The `'()'` also serves as a mnemonic that the corresponding value is a callable.

Access to external objects

There are times where a configuration needs to refer to objects external to the configuration, for example `sys.stderr`. If the configuration dict is constructed using Python code, this is straightforward, but a problem arises when the configuration is provided via a text file (e.g. JSON, YAML). In a text file, there is no standard way to distinguish `sys.stderr` from the literal string `'sys.stderr'`. To facilitate this distinction, the configuration system looks for certain special prefixes in string values and treat them specially. For example, if the literal string `'ext://sys.stderr'` is provided as a value in the configuration, then the `ext://` will be stripped off and the remainder of the value processed using normal import mechanisms.

The handling of such prefixes is done in a way analogous to protocol handling: there is a generic mechanism to look for prefixes which match the regular expression `^(?P<prefix>[a-z]+)://(?P<suffix>.*)$` whereby, if the `prefix` is recognised, the `suffix` is processed in a prefix-dependent manner and the result of the processing replaces the string value. If the prefix is not recognised, then the string value will be left as-is.

Access to internal objects

As well as external objects, there is sometimes also a need to refer to objects in the configuration. This will be done implicitly by the configuration system for things that it knows about. For example, the string value `'DEBUG'` for a `level` in a logger or handler will automatically be converted to the value `logging.DEBUG`, and the `handlers`, `filters` and `formatter` entries will take an object id and resolve to the appropriate destination object.

However, a more generic mechanism is needed for user-defined objects which are not known to the *logging* module. For example, consider *logging.handlers.MemoryHandler*, which takes a `target` argument which is another handler to delegate to. Since the system already knows about this class, then in the configuration, the given `target` just needs to be the object id of the relevant target handler, and the system will resolve to the handler from the id. If, however, a user defines a `my.package.MyHandler` which has an `alternate` handler, the configuration system would not know that the `alternate` referred to a handler. To cater for this, a generic resolution system allows the user to specify:

```
handlers:
  file:
    # configuration of file handler goes here

  custom:
    (): my.package.MyHandler
    alternate: cfg://handlers.file
```

The literal string `'cfg://handlers.file'` will be resolved in an analogous way to strings with the `ext://` prefix, but looking in the configuration itself rather than the import namespace. The mechanism allows access by dot or by index, in a similar way to that provided by `str.format`. Thus, given the following snippet:

```
handlers:
  email:
    class: logging.handlers.SMTPHandler
    mailhost: localhost
    fromaddr: my_app@domain.tld
    toaddrs:
      - support_team@domain.tld
      - dev_team@domain.tld
    subject: Houston, we have a problem.
```

in the configuration, the string `'cfg://handlers'` would resolve to the dict with key `handlers`, the string `'cfg://handlers.email` would resolve to the dict with key `email` in the `handlers` dict, and so on. The string `'cfg://handlers.email.toaddrs[1]` would resolve to `'dev_team.domain.tld'` and the string `'cfg://handlers.email.toaddrs[0]'` would resolve to the value `'support_team@domain.tld'`. The `subject` value could be accessed using either `'cfg://handlers.email.subject'` or, equivalently, `'cfg://handlers.email[subject]'`. The latter form only needs to be used if the key contains spaces or non-alphanumeric characters. If an index value consists only of decimal digits, access will be attempted using the corresponding integer value, falling back to the string value if needed.

Given a string `cfg://handlers.myhandler.mykey.123`, this will resolve to `config_dict['handlers']['myhandler']['mykey']['123']`. If the string is specified as `cfg://handlers.myhandler.mykey[123]`, the system will attempt to retrieve the value from `config_dict['handlers']['myhandler']['mykey'][123]`, and fall back to `config_dict['handlers']['myhandler']['mykey']['123']` if that fails.

Import resolution and custom importers

Import resolution, by default, uses the builtin *__import__()* function to do its importing. You may want to replace this with your own importing mechanism: if so, you can replace the `importer` attribute of the `DictConfigurator` or its superclass, the `BaseConfigurator` class. However, you need to be careful because of the way functions are accessed from classes via descriptors. If you are using a Python callable to do your imports, and you want to define it at class level rather than instance level, you need to wrap it with *staticmethod()*. For example:

```
from importlib import import_module
from logging.config import BaseConfigurator

BaseConfigurator.importer = staticmethod(import_module)
```

You don't need to wrap with *staticmethod()* if you're setting the import callable on a configurator *instance*.

16.7.3 Configuration file format

The configuration file format understood by *fileConfig()* is based on *configparser* functionality. The file must contain sections called `[loggers]`, `[handlers]` and `[formatters]` which identify by name the entities of each type which are defined in the file. For each such entity, there is a separate section which identifies how that entity is configured. Thus, for a logger named `log01` in the `[loggers]` section, the relevant configuration details are held in a section `[logger_log01]`. Similarly, a handler called `hand01` in the `[handlers]` section will have its configuration held in a section called `[handler_hand01]`, while a formatter called `form01` in the `[formatters]` section will have its configuration specified in a section called `[formatter_form01]`. The root logger configuration must be specified in a section called `[logger_root]`.

Note: The *fileConfig()* API is older than the *dictConfig()* API and does not provide functionality to cover certain aspects of logging. For example, you cannot configure *Filter* objects, which provide for filtering of messages beyond simple integer levels, using *fileConfig()*. If you need to have instances of *Filter* in your logging configuration, you will need to use *dictConfig()*. Note that future enhancements to configuration functionality will be added to *dictConfig()*, so it's worth considering transitioning to this newer API when it's convenient to do so.

Examples of these sections in the file are given below.

```
[loggers]
keys=root,log02,log03,log04,log05,log06,log07

[handlers]
keys=hand01,hand02,hand03,hand04,hand05,hand06,hand07,hand08,hand09

[formatters]
keys=form01,form02,form03,form04,form05,form06,form07,form08,form09
```

The root logger must specify a level and a list of handlers. An example of a root logger section is given below.

```
[logger_root]
level=NOTSET
handlers=hand01
```

The `level` entry can be one of `DEBUG, INFO, WARNING, ERROR, CRITICAL` or `NOTSET`. For the root logger only, `NOTSET` means that all messages will be logged. Level values are *eval()*uated in the context of the `logging` package's namespace.

The `handlers` entry is a comma-separated list of handler names, which must appear in the `[handlers]` section. These names must appear in the `[handlers]` section and have corresponding sections in the configuration file.

For loggers other than the root logger, some additional information is required. This is illustrated by the following example.

```
[logger_parser]
level=DEBUG
handlers=hand01
propagate=1
qualname=compiler.parser
```

The `level` and `handlers` entries are interpreted as for the root logger, except that if a non-root logger's level is specified as `NOTSET`, the system consults loggers higher up the hierarchy to determine the effective level of the logger. The `propagate` entry is set to 1 to indicate that messages must propagate to handlers higher up the logger hierarchy from this logger, or 0 to indicate that messages are **not** propagated to handlers up the hierarchy. The `qualname` entry is the hierarchical channel name of the logger, that is to say the name used by the application to get the logger.

Sections which specify handler configuration are exemplified by the following.

```
[handler_hand01]
class=StreamHandler
level=NOTSET
formatter=form01
args=(sys.stdout,)
```

The `class` entry indicates the handler's class (as determined by *eval()* in the `logging` package's namespace). The `level` is interpreted as for loggers, and `NOTSET` is taken to mean 'log everything'.

The `formatter` entry indicates the key name of the formatter for this handler. If blank, a default formatter (`logging._defaultFormatter`) is used. If a name is specified, it must appear in the `[formatters]` section and have a corresponding section in the configuration file.

The `args` entry, when *eval()*uated in the context of the `logging` package's namespace, is the list of arguments to the constructor for the handler class. Refer to the constructors for the relevant handlers, or to the examples below, to see how typical entries are constructed. If not provided, it defaults to `()`.

The optional `kwargs` entry, when *eval()*uated in the context of the `logging` package's namespace, is the keyword argument dict to the constructor for the handler class. If not provided, it defaults to `{}`.

```
[handler_hand02]
class=FileHandler
level=DEBUG
formatter=form02
args=('python.log', 'w')

[handler_hand03]
class=handlers.SocketHandler
level=INFO
formatter=form03
args=('localhost', handlers.DEFAULT_TCP_LOGGING_PORT)

[handler_hand04]
class=handlers.DatagramHandler
level=WARN
formatter=form04
args=('localhost', handlers.DEFAULT_UDP_LOGGING_PORT)
```

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```
[handler_hand05]
class=handlers.SysLogHandler
level=ERROR
formatter=form05
args=(('localhost', handlers.SYSLOG_UDP_PORT), handlers.SysLogHandler.LOG_USER)

[handler_hand06]
class=handlers.NTEventLogHandler
level=CRITICAL
formatter=form06
args=('Python Application', '', 'Application')

[handler_hand07]
class=handlers.SMTPHandler
level=WARN
formatter=form07
args=('localhost', 'from@abc', ['user1@abc', 'user2@xyz'], 'Logger Subject')
kwargs={'timeout': 10.0}

[handler_hand08]
class=handlers.MemoryHandler
level=NOTSET
formatter=form08
target=
args=(10, ERROR)

[handler_hand09]
class=handlers.HTTPHandler
level=NOTSET
formatter=form09
args=('localhost:9022', '/log', 'GET')
kwargs={'secure': True}
```

Sections which specify formatter configuration are typified by the following.

```
[formatter_form01]
format=F1 %(asctime)s %(levelname)s %(message)s
datefmt=
class=logging.Formatter
```

The `format` entry is the overall format string, and the `datefmt` entry is the `strftime()`-compatible date/time format string. If empty, the package substitutes something which is almost equivalent to specifying the date format string `'%Y-%m-%d %H:%M:%S'`. This format also specifies milliseconds, which are appended to the result of using the above format string, with a comma separator. An example time in this format is `2003-01-23 00:29:50,411`.

The `class` entry is optional. It indicates the name of the formatter's class (as a dotted module and class name.) This option is useful for instantiating a *`Formatter`* subclass. Subclasses of *`Formatter`* can present exception tracebacks in an expanded or condensed format.

Note: Due to the use of *`eval()`* as described above, there are potential security risks which result from using the *`listen()`* to send and receive configurations via sockets. The risks are limited to where multiple users with no mutual trust run code on the same machine; see the *listen()* documentation for more information.

See also:

Module *logging* API reference for the logging module.

Module *logging.handlers* Useful handlers included with the logging module.

16.8 `logging.handlers` — Logging handlers

Source code: Lib/logging/handlers.py

Important

This page contains only reference information. For tutorials, please see

- Basic Tutorial
- Advanced Tutorial
- Logging Cookbook

The following useful handlers are provided in the package. Note that three of the handlers (*StreamHandler*, *FileHandler* and *NullHandler*) are actually defined in the *logging* module itself, but have been documented here along with the other handlers.

16.8.1 StreamHandler

The *StreamHandler* class, located in the core *logging* package, sends logging output to streams such as *sys.stdout*, *sys.stderr* or any file-like object (or, more precisely, any object which supports `write()` and `flush()` methods).

class logging.StreamHandler(*stream=None*)

Returns a new instance of the *StreamHandler* class. If *stream* is specified, the instance will use it for logging output; otherwise, *sys.stderr* will be used.

emit(*record*)

If a formatter is specified, it is used to format the record. The record is then written to the stream with a terminator. If exception information is present, it is formatted using *traceback.print_exception()* and appended to the stream.

flush()

Flushes the stream by calling its *flush()* method. Note that the `close()` method is inherited from *Handler* and so does no output, so an explicit *flush()* call may be needed at times.

setStream(*stream*)

Sets the instance's stream to the specified value, if it is different. The old stream is flushed before the new stream is set.

Parameters **stream** – The stream that the handler should use.

Returns the old stream, if the stream was changed, or *None* if it wasn't.

New in version 3.7.

Changed in version 3.2: The `StreamHandler` class now has a `terminator` attribute, default value `'\n'`, which is used as the terminator when writing a formatted record to a stream. If you don't want this newline termination, you can set the handler instance's `terminator` attribute to the empty string. In earlier versions, the terminator was hardcoded as `'\n'`.

16.8.2 FileHandler

The *FileHandler* class, located in the core *logging* package, sends logging output to a disk file. It inherits the output functionality from *StreamHandler*.

class logging.FileHandler(*filename*, *mode='a'*, *encoding=None*, *delay=False*)

Returns a new instance of the *FileHandler* class. The specified file is opened and used as the stream for logging. If *mode* is not specified, `'a'` is used. If *encoding* is not `None`, it is used to open the file with that encoding. If *delay* is true, then file opening is deferred until the first call to *emit()*. By default, the file grows indefinitely.

Changed in version 3.6: As well as string values, *Path* objects are also accepted for the *filename* argument.

close()

Closes the file.

emit(*record*)

Outputs the record to the file.

16.8.3 NullHandler

New in version 3.1.

The *NullHandler* class, located in the core *logging* package, does not do any formatting or output. It is essentially a 'no-op' handler for use by library developers.

class logging.NullHandler

Returns a new instance of the *NullHandler* class.

emit(*record*)

This method does nothing.

handle(*record*)

This method does nothing.

createLock()

This method returns `None` for the lock, since there is no underlying I/O to which access needs to be serialized.

See library-config for more information on how to use *NullHandler*.

16.8.4 WatchedFileHandler

The *WatchedFileHandler* class, located in the *logging.handlers* module, is a `FileHandler` which watches the file it is logging to. If the file changes, it is closed and reopened using the file name.

A file change can happen because of usage of programs such as *newsyslog* and *logrotate* which perform log file rotation. This handler, intended for use under Unix/Linux, watches the file to see if it has changed since the last emit. (A file is deemed to have changed if its device or inode have changed.) If the file has changed, the old file stream is closed, and the file opened to get a new stream.

This handler is not appropriate for use under Windows, because under Windows open log files cannot be moved or renamed - logging opens the files with exclusive locks - and so there is no need for such a handler. Furthermore, *ST_INO* is not supported under Windows; `stat()` always returns zero for this value.

class `logging.handlers.WatchedFileHandler`(*filename*, *mode='a'*, *encoding=None*, *delay=False*)

Returns a new instance of the `WatchedFileHandler` class. The specified file is opened and used as the stream for logging. If *mode* is not specified, `'a'` is used. If *encoding* is not `None`, it is used to open the file with that encoding. If *delay* is true, then file opening is deferred until the first call to `emit()`. By default, the file grows indefinitely.

Changed in version 3.6: As well as string values, `Path` objects are also accepted for the *filename* argument.

`reopenIfNeeded()`

Checks to see if the file has changed. If it has, the existing stream is flushed and closed and the file opened again, typically as a precursor to outputting the record to the file.

New in version 3.6.

`emit`(*record*)

Outputs the record to the file, but first calls `reopenIfNeeded()` to reopen the file if it has changed.

16.8.5 BaseRotatingHandler

The `BaseRotatingHandler` class, located in the `logging.handlers` module, is the base class for the rotating file handlers, `RotatingFileHandler` and `TimedRotatingFileHandler`. You should not need to instantiate this class, but it has attributes and methods you may need to override.

class `logging.handlers.BaseRotatingHandler`(*filename*, *mode*, *encoding=None*, *delay=False*)

The parameters are as for `FileHandler`. The attributes are:

`namer`

If this attribute is set to a callable, the `rotation_filename()` method delegates to this callable. The parameters passed to the callable are those passed to `rotation_filename()`.

Note: The namer function is called quite a few times during rollover, so it should be as simple and as fast as possible. It should also return the same output every time for a given input, otherwise the rollover behaviour may not work as expected.

New in version 3.3.

`rotator`

If this attribute is set to a callable, the `rotate()` method delegates to this callable. The parameters passed to the callable are those passed to `rotate()`.

New in version 3.3.

`rotation_filename`(*default_name*)

Modify the filename of a log file when rotating.

This is provided so that a custom filename can be provided.

The default implementation calls the 'namer' attribute of the handler, if it's callable, passing the default name to it. If the attribute isn't callable (the default is `None`), the name is returned unchanged.

Parameters `default_name` – The default name for the log file.

New in version 3.3.

rotate(*source*, *dest*)

When rotating, rotate the current log.

The default implementation calls the 'rotator' attribute of the handler, if it's callable, passing the source and dest arguments to it. If the attribute isn't callable (the default is `None`), the source is simply renamed to the destination.

Parameters

- **source** – The source filename. This is normally the base filename, e.g. 'test.log'.
- **dest** – The destination filename. This is normally what the source is rotated to, e.g. 'test.log.1'.

New in version 3.3.

The reason the attributes exist is to save you having to subclass - you can use the same callables for instances of *RotatingFileHandler* and *TimedRotatingFileHandler*. If either the namer or rotator callable raises an exception, this will be handled in the same way as any other exception during an `emit()` call, i.e. via the `handleError()` method of the handler.

If you need to make more significant changes to rotation processing, you can override the methods.

For an example, see cookbook-rotator-namer.

16.8.6 RotatingFileHandler

The *RotatingFileHandler* class, located in the *logging.handlers* module, supports rotation of disk log files.

class logging.handlers.RotatingFileHandler(*filename*, *mode='a'*, *maxBytes=0*, *backupCount=0*, *encoding=None*, *delay=False*)

Returns a new instance of the *RotatingFileHandler* class. The specified file is opened and used as the stream for logging. If *mode* is not specified, `'a'` is used. If *encoding* is not `None`, it is used to open the file with that encoding. If *delay* is true, then file opening is deferred until the first call to *emit()*. By default, the file grows indefinitely.

You can use the *maxBytes* and *backupCount* values to allow the file to *rollover* at a predetermined size. When the size is about to be exceeded, the file is closed and a new file is silently opened for output. Rollover occurs whenever the current log file is nearly *maxBytes* in length; but if either of *maxBytes* or *backupCount* is zero, rollover never occurs, so you generally want to set *backupCount* to at least 1, and have a non-zero *maxBytes*. When *backupCount* is non-zero, the system will save old log files by appending the extensions '.1', '.2' etc., to the filename. For example, with a *backupCount* of 5 and a base file name of `app.log`, you would get `app.log`, `app.log.1`, `app.log.2`, up to `app.log.5`. The file being written to is always `app.log`. When this file is filled, it is closed and renamed to `app.log.1`, and if files `app.log.1`, `app.log.2`, etc. exist, then they are renamed to `app.log.2`, `app.log.3` etc. respectively.

Changed in version 3.6: As well as string values, *Path* objects are also accepted for the *filename* argument.

doRollover()

Does a rollover, as described above.

emit(*record*)

Outputs the record to the file, catering for rollover as described previously.

16.8.7 TimedRotatingFileHandler

The *TimedRotatingFileHandler* class, located in the *logging.handlers* module, supports rotation of disk log files at certain timed intervals.

class logging.handlers.TimedRotatingFileHandler(*filename*, *when='h'*, *interval=1*, *backupCount=0*, *encoding=None*, *delay=False*, *utc=False*, *atTime=None*)

Returns a new instance of the *TimedRotatingFileHandler* class. The specified file is opened and used as the stream for logging. On rotating it also sets the filename suffix. Rotating happens based on the product of *when* and *interval*.

You can use the *when* to specify the type of *interval*. The list of possible values is below. Note that they are not case sensitive.

Value	Type of interval	If/how *atTime* is used
`'S'`	Seconds	Ignored
`'M'`	Minutes	Ignored
`'H'`	Hours	Ignored
`'D'`	Days	Ignored
`'W0'-'W6'`	Weekday (0=Monday)	Used to compute initial rollover time
`'midnight'`	Roll over at midnight, if *atTime* not specified, else at time *atTime*	Used to compute initial rollover time

When using weekday-based rotation, specify 'W0' for Monday, 'W1' for Tuesday, and so on up to 'W6' for Sunday. In this case, the value passed for *interval* isn't used.

The system will save old log files by appending extensions to the filename. The extensions are date-and-time based, using the strftime format `%Y-%m-%d_%H-%M-%S` or a leading portion thereof, depending on the rollover interval.

When computing the next rollover time for the first time (when the handler is created), the last modification time of an existing log file, or else the current time, is used to compute when the next rotation will occur.

If the *utc* argument is true, times in UTC will be used; otherwise local time is used.

If *backupCount* is nonzero, at most *backupCount* files will be kept, and if more would be created when rollover occurs, the oldest one is deleted. The deletion logic uses the interval to determine which files to delete, so changing the interval may leave old files lying around.

If *delay* is true, then file opening is deferred until the first call to *emit()*.

If *atTime* is not `None`, it must be a `datetime.time` instance which specifies the time of day when rollover occurs, for the cases where rollover is set to happen "at midnight" or "on a particular weekday". Note that in these cases, the *atTime* value is effectively used to compute the *initial* rollover, and subsequent rollovers would be calculated via the normal interval calculation.

Note: Calculation of the initial rollover time is done when the handler is initialised. Calculation of subsequent rollover times is done only when rollover occurs, and rollover occurs only when emitting output. If this is not kept in mind, it might lead to some confusion. For example, if an interval of "every minute" is set, that does not mean you will always see log files with times (in the filename) separated by a minute; if, during application execution, logging output is generated more frequently than once a minute, *then* you can expect to see log files with times separated by a minute. If, on the other hand, logging messages are only output once every five minutes (say), then there will be gaps in the file times corresponding to the minutes where no output (and hence no rollover) occurred.

Changed in version 3.4: *atTime* parameter was added.

Changed in version 3.6: As well as string values, *Path* objects are also accepted for the *filename* argument.

doRollover()
Does a rollover, as described above.

emit(*record*)
Outputs the record to the file, catering for rollover as described above.

16.8.8 SocketHandler

The *SocketHandler* class, located in the *logging.handlers* module, sends logging output to a network socket. The base class uses a TCP socket.

class logging.handlers.SocketHandler(*host*, *port*)
Returns a new instance of the *SocketHandler* class intended to communicate with a remote machine whose address is given by *host* and *port*.

Changed in version 3.4: If `port` is specified as `None`, a Unix domain socket is created using the value in `host` - otherwise, a TCP socket is created.

close()
Closes the socket.

emit()
Pickles the record's attribute dictionary and writes it to the socket in binary format. If there is an error with the socket, silently drops the packet. If the connection was previously lost, re-establishes the connection. To unpickle the record at the receiving end into a *LogRecord*, use the *makeLogRecord()* function.

handleError()
Handles an error which has occurred during *emit()*. The most likely cause is a lost connection. Closes the socket so that we can retry on the next event.

makeSocket()
This is a factory method which allows subclasses to define the precise type of socket they want. The default implementation creates a TCP socket (*socket.SOCK_STREAM*).

makePickle(*record*)
Pickles the record's attribute dictionary in binary format with a length prefix, and returns it ready for transmission across the socket.

Note that pickles aren't completely secure. If you are concerned about security, you may want to override this method to implement a more secure mechanism. For example, you can sign pickles using HMAC and then verify them on the receiving end, or alternatively you can disable unpickling of global objects on the receiving end.

send(*packet*)
Send a pickled string *packet* to the socket. This function allows for partial sends which can happen when the network is busy.

createSocket()
Tries to create a socket; on failure, uses an exponential back-off algorithm. On initial failure, the handler will drop the message it was trying to send. When subsequent messages are handled by the same instance, it will not try connecting until some time has passed. The default parameters are such that the initial delay is one second, and if after that delay the connection still can't be made, the handler will double the delay each time up to a maximum of 30 seconds.

This behaviour is controlled by the following handler attributes:

- `retryStart` (initial delay, defaulting to 1.0 seconds).
- `retryFactor` (multiplier, defaulting to 2.0).
- `retryMax` (maximum delay, defaulting to 30.0 seconds).

This means that if the remote listener starts up *after* the handler has been used, you could lose messages (since the handler won't even attempt a connection until the delay has elapsed, but just silently drop messages during the delay period).

16.8.9 DatagramHandler

The *DatagramHandler* class, located in the *logging.handlers* module, inherits from *SocketHandler* to support sending logging messages over UDP sockets.

class logging.handlers.DatagramHandler(*host*, *port*)

Returns a new instance of the *DatagramHandler* class intended to communicate with a remote machine whose address is given by *host* and *port*.

Changed in version 3.4: If `port` is specified as `None`, a Unix domain socket is created using the value in `host` - otherwise, a UDP socket is created.

emit()

Pickles the record's attribute dictionary and writes it to the socket in binary format. If there is an error with the socket, silently drops the packet. To unpickle the record at the receiving end into a *LogRecord*, use the *makeLogRecord()* function.

makeSocket()

The factory method of *SocketHandler* is here overridden to create a UDP socket (*socket.SOCK_DGRAM*).

send(*s*)

Send a pickled string to a socket.

16.8.10 SysLogHandler

The *SysLogHandler* class, located in the *logging.handlers* module, supports sending logging messages to a remote or local Unix syslog.

class logging.handlers.SysLogHandler(*address=('localhost', SYSLOG_UDP_PORT)*, *facility=LOG_USER*, *socktype=socket.SOCK_DGRAM*)

Returns a new instance of the *SysLogHandler* class intended to communicate with a remote Unix machine whose address is given by *address* in the form of a `(host, port)` tuple. If *address* is not specified, `('localhost', 514)` is used. The address is used to open a socket. An alternative to providing a `(host, port)` tuple is providing an address as a string, for example '/dev/log'. In this case, a Unix domain socket is used to send the message to the syslog. If *facility* is not specified, `LOG_USER` is used. The type of socket opened depends on the *socktype* argument, which defaults to *socket.SOCK_DGRAM* and thus opens a UDP socket. To open a TCP socket (for use with the newer syslog daemons such as rsyslog), specify a value of *socket.SOCK_STREAM*.

Note that if your server is not listening on UDP port 514, *SysLogHandler* may appear not to work. In that case, check what address you should be using for a domain socket - it's system dependent. For example, on Linux it's usually '/dev/log' but on OS/X it's '/var/run/syslog'. You'll need to check your platform and use the appropriate address (you may need to do this check at runtime if your application needs to run on several platforms). On Windows, you pretty much have to use the UDP option.

Changed in version 3.2: *socktype* was added.

close()

Closes the socket to the remote host.

emit(*record*)

The record is formatted, and then sent to the syslog server. If exception information is present, it is *not* sent to the server.

Changed in version 3.2.1: (See: bpo-12168.) In earlier versions, the message sent to the syslog daemons was always terminated with a NUL byte, because early versions of these daemons expected a NUL terminated message - even though it's not in the relevant specification (**RFC 5424**). More recent versions of these daemons don't expect the NUL byte but strip it off if it's there, and even more recent daemons (which adhere more closely to RFC 5424) pass the NUL byte on as part of the message.

To enable easier handling of syslog messages in the face of all these differing daemon behaviours, the appending of the NUL byte has been made configurable, through the use of a class-level attribute, `append_nul`. This defaults to `True` (preserving the existing behaviour) but can be set to `False` on a `SysLogHandler` instance in order for that instance to *not* append the NUL terminator.

Changed in version 3.3: (See: bpo-12419.) In earlier versions, there was no facility for an "ident" or "tag" prefix to identify the source of the message. This can now be specified using a class-level attribute, defaulting to `""` to preserve existing behaviour, but which can be overridden on a `SysLogHandler` instance in order for that instance to prepend the ident to every message handled. Note that the provided ident must be text, not bytes, and is prepended to the message exactly as is.

encodePriority(*facility*, *priority*)

Encodes the facility and priority into an integer. You can pass in strings or integers - if strings are passed, internal mapping dictionaries are used to convert them to integers.

The symbolic `LOG_` values are defined in *SysLogHandler* and mirror the values defined in the `sys/syslog.h` header file.

Priorities

Name (string)	Symbolic value
`alert`	LOG_ALERT
`crit` or `critical`	LOG_CRIT
`debug`	LOG_DEBUG
`emerg` or `panic`	LOG_EMERG
`err` or `error`	LOG_ERR
`info`	LOG_INFO
`notice`	LOG_NOTICE
`warn` or `warning`	LOG_WARNING

Facilities

Name (string)	Symbolic value
auth	LOG_AUTH
authpriv	LOG_AUTHPRIV
cron	LOG_CRON
daemon	LOG_DAEMON
ftp	LOG_FTP
kern	LOG_KERN
lpr	LOG_LPR
mail	LOG_MAIL
news	LOG_NEWS
syslog	LOG_SYSLOG
user	LOG_USER
uucp	LOG_UUCP
local0	LOG_LOCAL0
local1	LOG_LOCAL1
local2	LOG_LOCAL2
local3	LOG_LOCAL3
local4	LOG_LOCAL4
local5	LOG_LOCAL5
local6	LOG_LOCAL6
local7	LOG_LOCAL7

mapPriority(*levelname*)

Maps a logging level name to a syslog priority name. You may need to override this if you are using custom levels, or if the default algorithm is not suitable for your needs. The default algorithm maps `DEBUG`, `INFO`, `WARNING`, `ERROR` and `CRITICAL` to the equivalent syslog names, and all other level names to 'warning'.

16.8.11 NTEventLogHandler

The *NTEventLogHandler* class, located in the *logging.handlers* module, supports sending logging messages to a local Windows NT, Windows 2000 or Windows XP event log. Before you can use it, you need Mark Hammond's Win32 extensions for Python installed.

class logging.handlers.**NTEventLogHandler**(*appname*, *dllname=None*, *logtype='Application'*)

Returns a new instance of the *NTEventLogHandler* class. The *appname* is used to define the application name as it appears in the event log. An appropriate registry entry is created using this name. The *dllname* should give the fully qualified pathname of a .dll or .exe which contains message definitions to hold in the log (if not specified, `'win32service.pyd'` is used - this is installed with the Win32 extensions and contains some basic placeholder message definitions. Note that use of these placeholders will make your event logs big, as the entire message source is held in the log. If you want slimmer logs, you have to pass in the name of your own .dll or .exe which contains the message definitions you want to use in the event log). The *logtype* is one of `'Application'`, `'System'` or `'Security'`, and defaults to `'Application'`.

close()

At this point, you can remove the application name from the registry as a source of event log entries. However, if you do this, you will not be able to see the events as you intended in the Event Log Viewer - it needs to be able to access the registry to get the .dll name. The current version does not do this.

emit(*record*)

Determines the message ID, event category and event type, and then logs the message in the NT event log.

getEventCategory(*record*)
Returns the event category for the record. Override this if you want to specify your own categories. This version returns 0.

getEventType(*record*)
Returns the event type for the record. Override this if you want to specify your own types. This version does a mapping using the handler's typemap attribute, which is set up in `__init__()` to a dictionary which contains mappings for `DEBUG`, `INFO`, `WARNING`, `ERROR` and `CRITICAL`. If you are using your own levels, you will either need to override this method or place a suitable dictionary in the handler's *typemap* attribute.

getMessageID(*record*)
Returns the message ID for the record. If you are using your own messages, you could do this by having the *msg* passed to the logger being an ID rather than a format string. Then, in here, you could use a dictionary lookup to get the message ID. This version returns 1, which is the base message ID in `win32service.pyd`.

16.8.12 SMTPHandler

The *SMTPHandler* class, located in the *logging.handlers* module, supports sending logging messages to an email address via SMTP.

class logging.handlers.**SMTPHandler**(*mailhost*, *fromaddr*, *toaddrs*, *subject*, *credentials=None*, *secure=None*, *timeout=1.0*)
Returns a new instance of the *SMTPHandler* class. The instance is initialized with the from and to addresses and subject line of the email. The *toaddrs* should be a list of strings. To specify a non-standard SMTP port, use the (host, port) tuple format for the *mailhost* argument. If you use a string, the standard SMTP port is used. If your SMTP server requires authentication, you can specify a (username, password) tuple for the *credentials* argument.

To specify the use of a secure protocol (TLS), pass in a tuple to the *secure* argument. This will only be used when authentication credentials are supplied. The tuple should be either an empty tuple, or a single-value tuple with the name of a keyfile, or a 2-value tuple with the names of the keyfile and certificate file. (This tuple is passed to the *smtplib.SMTP.starttls()* method.)

A timeout can be specified for communication with the SMTP server using the *timeout* argument.

New in version 3.3: The *timeout* argument was added.

emit(*record*)
Formats the record and sends it to the specified addressees.

getSubject(*record*)
If you want to specify a subject line which is record-dependent, override this method.

16.8.13 MemoryHandler

The *MemoryHandler* class, located in the *logging.handlers* module, supports buffering of logging records in memory, periodically flushing them to a *target* handler. Flushing occurs whenever the buffer is full, or when an event of a certain severity or greater is seen.

MemoryHandler is a subclass of the more general *BufferingHandler*, which is an abstract class. This buffers logging records in memory. Whenever each record is added to the buffer, a check is made by calling `shouldFlush()` to see if the buffer should be flushed. If it should, then `flush()` is expected to do the flushing.

class logging.handlers.**BufferingHandler**(*capacity*)
Initializes the handler with a buffer of the specified capacity.

emit(*record*)
Appends the record to the buffer. If *shouldFlush()* returns true, calls *flush()* to process the buffer.

flush()
You can override this to implement custom flushing behavior. This version just zaps the buffer to empty.

shouldFlush(*record*)
Returns true if the buffer is up to capacity. This method can be overridden to implement custom flushing strategies.

class logging.handlers.**MemoryHandler**(*capacity*, *flushLevel=ERROR*, *target=None*, *flushOnClose=True*)
Returns a new instance of the *MemoryHandler* class. The instance is initialized with a buffer size of *capacity*. If *flushLevel* is not specified, `ERROR` is used. If no *target* is specified, the target will need to be set using *setTarget()* before this handler does anything useful. If *flushOnClose* is specified as `False`, then the buffer is *not* flushed when the handler is closed. If not specified or specified as `True`, the previous behaviour of flushing the buffer will occur when the handler is closed.

Changed in version 3.6: The *flushOnClose* parameter was added.

close()
Calls *flush()*, sets the target to `None` and clears the buffer.

flush()
For a *MemoryHandler*, flushing means just sending the buffered records to the target, if there is one. The buffer is also cleared when this happens. Override if you want different behavior.

setTarget(*target*)
Sets the target handler for this handler.

shouldFlush(*record*)
Checks for buffer full or a record at the *flushLevel* or higher.

16.8.14 HTTPHandler

The *HTTPHandler* class, located in the *logging.handlers* module, supports sending logging messages to a Web server, using either `GET` or `POST` semantics.

class logging.handlers.**HTTPHandler**(*host*, *url*, *method='GET'*, *secure=False*, *credentials=None*, *context=None*)
Returns a new instance of the *HTTPHandler* class. The *host* can be of the form `host:port`, should you need to use a specific port number. If no *method* is specified, `GET` is used. If *secure* is true, a HTTPS connection will be used. The *context* parameter may be set to a *ssl.SSLContext* instance to configure the SSL settings used for the HTTPS connection. If *credentials* is specified, it should be a 2-tuple consisting of userid and password, which will be placed in a HTTP 'Authorization' header using Basic authentication. If you specify credentials, you should also specify secure=True so that your userid and password are not passed in cleartext across the wire.

Changed in version 3.5: The *context* parameter was added.

mapLogRecord(*record*)
Provides a dictionary, based on `record`, which is to be URL-encoded and sent to the web server. The default implementation just returns `record.__dict__`. This method can be overridden if e.g. only a subset of *LogRecord* is to be sent to the web server, or if more specific customization of what's sent to the server is required.

emit(*record*)
Sends the record to the Web server as a URL-encoded dictionary. The *mapLogRecord()* method is used to convert the record to the dictionary to be sent.

Note: Since preparing a record for sending it to a Web server is not the same as a generic formatting operation, using `setFormatter()` to specify a `Formatter` for a `HTTPHandler` has no effect. Instead of calling `format()`, this handler calls `mapLogRecord()` and then `urllib.parse.urlencode()` to encode the dictionary in a form suitable for sending to a Web server.

16.8.15 QueueHandler

New in version 3.2.

The `QueueHandler` class, located in the `logging.handlers` module, supports sending logging messages to a queue, such as those implemented in the `queue` or `multiprocessing` modules.

Along with the `QueueListener` class, `QueueHandler` can be used to let handlers do their work on a separate thread from the one which does the logging. This is important in Web applications and also other service applications where threads servicing clients need to respond as quickly as possible, while any potentially slow operations (such as sending an email via `SMTPHandler`) are done on a separate thread.

class logging.handlers.**QueueHandler**(*queue*)

Returns a new instance of the `QueueHandler` class. The instance is initialized with the queue to send messages to. The queue can be any queue-like object; it's used as-is by the `enqueue()` method, which needs to know how to send messages to it.

emit(*record*)

Enqueues the result of preparing the LogRecord.

prepare(*record*)

Prepares a record for queuing. The object returned by this method is enqueued.

The base implementation formats the record to merge the message, arguments, and exception information, if present. It also removes unpickleable items from the record in-place.

You might want to override this method if you want to convert the record to a dict or JSON string, or send a modified copy of the record while leaving the original intact.

enqueue(*record*)

Enqueues the record on the queue using `put_nowait()`; you may want to override this if you want to use blocking behaviour, or a timeout, or a customized queue implementation.

16.8.16 QueueListener

New in version 3.2.

The `QueueListener` class, located in the `logging.handlers` module, supports receiving logging messages from a queue, such as those implemented in the `queue` or `multiprocessing` modules. The messages are received from a queue in an internal thread and passed, on the same thread, to one or more handlers for processing. While `QueueListener` is not itself a handler, it is documented here because it works hand-in-hand with `QueueHandler`.

Along with the `QueueHandler` class, `QueueListener` can be used to let handlers do their work on a separate thread from the one which does the logging. This is important in Web applications and also other service applications where threads servicing clients need to respond as quickly as possible, while any potentially slow operations (such as sending an email via `SMTPHandler`) are done on a separate thread.

class logging.handlers.**QueueListener**(*queue*, **handlers*, *respect_handler_level=False*)

Returns a new instance of the `QueueListener` class. The instance is initialized with the queue to send messages to and a list of handlers which will handle entries placed on the queue. The queue can be any queue-like object; it's passed as-is to the `dequeue()` method, which needs to know how to get messages from it. If `respect_handler_level` is `True`, a handler's level is respected (compared with the level for the message) when deciding whether to pass messages to that handler; otherwise, the behaviour is as in previous Python versions - to always pass each message to each handler.

Changed in version 3.5: The `respect_handler_levels` argument was added.

`dequeue`(*block*)
Dequeues a record and return it, optionally blocking.

The base implementation uses `get()`. You may want to override this method if you want to use timeouts or work with custom queue implementations.

`prepare`(*record*)
Prepare a record for handling.

This implementation just returns the passed-in record. You may want to override this method if you need to do any custom marshalling or manipulation of the record before passing it to the handlers.

`handle`(*record*)
Handle a record.

This just loops through the handlers offering them the record to handle. The actual object passed to the handlers is that which is returned from *`prepare()`*.

`start`()
Starts the listener.

This starts up a background thread to monitor the queue for LogRecords to process.

`stop`()
Stops the listener.

This asks the thread to terminate, and then waits for it to do so. Note that if you don't call this before your application exits, there may be some records still left on the queue, which won't be processed.

`enqueue_sentinel`()
Writes a sentinel to the queue to tell the listener to quit. This implementation uses `put_nowait()`. You may want to override this method if you want to use timeouts or work with custom queue implementations.

New in version 3.3.

See also:

Module *`logging`* API reference for the logging module.

Module *`logging.config`* Configuration API for the logging module.

16.9 `getpass` — Portable password input

Source code: Lib/getpass.py

The *`getpass`* module provides two functions:

`getpass.`**`getpass`**(*prompt='Password: ', stream=None*)
Prompt the user for a password without echoing. The user is prompted using the string *prompt*, which defaults to `'Password: '`. On Unix, the prompt is written to the file-like object *stream* using the replace error handler if needed. *stream* defaults to the controlling terminal (`/dev/tty`) or if that is unavailable to `sys.stderr` (this argument is ignored on Windows).

If echo free input is unavailable getpass() falls back to printing a warning message to *stream* and reading from `sys.stdin` and issuing a *GetPassWarning*.

Note: If you call getpass from within IDLE, the input may be done in the terminal you launched IDLE from rather than the idle window itself.

exception getpass.GetPassWarning
A *UserWarning* subclass issued when password input may be echoed.

getpass.getuser()
Return the "login name" of the user.

This function checks the environment variables `LOGNAME`, `USER`, `LNAME` and `USERNAME`, in order, and returns the value of the first one which is set to a non-empty string. If none are set, the login name from the password database is returned on systems which support the *pwd* module, otherwise, an exception is raised.

In general, this function should be preferred over *os.getlogin()*.

16.10 curses — Terminal handling for character-cell displays

The *curses* module provides an interface to the curses library, the de-facto standard for portable advanced terminal handling.

While curses is most widely used in the Unix environment, versions are available for Windows, DOS, and possibly other systems as well. This extension module is designed to match the API of ncurses, an open-source curses library hosted on Linux and the BSD variants of Unix.

Note: Whenever the documentation mentions a *character* it can be specified as an integer, a one-character Unicode string or a one-byte byte string.

Whenever the documentation mentions a *character string* it can be specified as a Unicode string or a byte string.

Note: Since version 5.4, the ncurses library decides how to interpret non-ASCII data using the `nl_langinfo` function. That means that you have to call *locale.setlocale()* in the application and encode Unicode strings using one of the system's available encodings. This example uses the system's default encoding:

```
import locale
locale.setlocale(locale.LC_ALL, '')
code = locale.getpreferredencoding()
```

Then use *code* as the encoding for *str.encode()* calls.

See also:

Module *curses.ascii* Utilities for working with ASCII characters, regardless of your locale settings.

Module *curses.panel* A panel stack extension that adds depth to curses windows.

Module *curses.textpad* Editable text widget for curses supporting **Emacs**-like bindings.

curses-howto Tutorial material on using curses with Python, by Andrew Kuchling and Eric Raymond.

The Tools/demo/ directory in the Python source distribution contains some example programs using the curses bindings provided by this module.

16.10.1 Functions

The module *curses* defines the following exception:

exception curses.error
Exception raised when a curses library function returns an error.

Note: Whenever *x* or *y* arguments to a function or a method are optional, they default to the current cursor location. Whenever *attr* is optional, it defaults to `A_NORMAL`.

The module *curses* defines the following functions:

`curses.baudrate()`
Return the output speed of the terminal in bits per second. On software terminal emulators it will have a fixed high value. Included for historical reasons; in former times, it was used to write output loops for time delays and occasionally to change interfaces depending on the line speed.

`curses.beep()`
Emit a short attention sound.

`curses.can_change_color()`
Return `True` or `False`, depending on whether the programmer can change the colors displayed by the terminal.

`curses.cbreak()`
Enter cbreak mode. In cbreak mode (sometimes called "rare" mode) normal tty line buffering is turned off and characters are available to be read one by one. However, unlike raw mode, special characters (interrupt, quit, suspend, and flow control) retain their effects on the tty driver and calling program. Calling first *raw()* then *cbreak()* leaves the terminal in cbreak mode.

`curses.color_content(`*color_number*`)`
Return the intensity of the red, green, and blue (RGB) components in the color *color_number*, which must be between `0` and `COLORS`. Return a 3-tuple, containing the R,G,B values for the given color, which will be between `0` (no component) and `1000` (maximum amount of component).

`curses.color_pair(`*color_number*`)`
Return the attribute value for displaying text in the specified color. This attribute value can be combined with `A_STANDOUT`, `A_REVERSE`, and the other `A_*` attributes. *pair_number()* is the counterpart to this function.

`curses.curs_set(`*visibility*`)`
Set the cursor state. *visibility* can be set to `0`, `1`, or `2`, for invisible, normal, or very visible. If the terminal supports the visibility requested, return the previous cursor state; otherwise raise an exception. On many terminals, the "visible" mode is an underline cursor and the "very visible" mode is a block cursor.

`curses.def_prog_mode()`
Save the current terminal mode as the "program" mode, the mode when the running program is using curses. (Its counterpart is the "shell" mode, for when the program is not in curses.) Subsequent calls to *reset_prog_mode()* will restore this mode.

`curses.def_shell_mode()`
Save the current terminal mode as the "shell" mode, the mode when the running program is not using curses. (Its counterpart is the "program" mode, when the program is using curses capabilities.) Subsequent calls to *reset_shell_mode()* will restore this mode.

`curses.delay_output(ms)`
Insert an *ms* millisecond pause in output.

`curses.doupdate()`
Update the physical screen. The curses library keeps two data structures, one representing the current physical screen contents and a virtual screen representing the desired next state. The *doupdate()* ground updates the physical screen to match the virtual screen.

The virtual screen may be updated by a *noutrefresh()* call after write operations such as *addstr()* have been performed on a window. The normal *refresh()* call is simply `noutrefresh()` followed by `doupdate()`; if you have to update multiple windows, you can speed performance and perhaps reduce screen flicker by issuing `noutrefresh()` calls on all windows, followed by a single `doupdate()`.

`curses.echo()`
Enter echo mode. In echo mode, each character input is echoed to the screen as it is entered.

`curses.endwin()`
De-initialize the library, and return terminal to normal status.

`curses.erasechar()`
Return the user's current erase character as a one-byte bytes object. Under Unix operating systems this is a property of the controlling tty of the curses program, and is not set by the curses library itself.

`curses.filter()`
The *filter()* routine, if used, must be called before *initscr()* is called. The effect is that, during those calls, `LINES` is set to `1`; the capabilities `clear`, `cup`, `cud`, `cud1`, `cuu1`, `cuu`, `vpa` are disabled; and the `home` string is set to the value of `cr`. The effect is that the cursor is confined to the current line, and so are screen updates. This may be used for enabling character-at-a-time line editing without touching the rest of the screen.

`curses.flash()`
Flash the screen. That is, change it to reverse-video and then change it back in a short interval. Some people prefer such as 'visible bell' to the audible attention signal produced by *beep()*.

`curses.flushinp()`
Flush all input buffers. This throws away any typeahead that has been typed by the user and has not yet been processed by the program.

`curses.getmouse()`
After *getch()* returns `KEY_MOUSE` to signal a mouse event, this method should be call to retrieve the queued mouse event, represented as a 5-tuple `(id, x, y, z, bstate)`. *id* is an ID value used to distinguish multiple devices, and *x*, *y*, *z* are the event's coordinates. (*z* is currently unused.) *bstate* is an integer value whose bits will be set to indicate the type of event, and will be the bitwise OR of one or more of the following constants, where *n* is the button number from 1 to 4: `BUTTONn_PRESSED`, `BUTTONn_RELEASED`, `BUTTONn_CLICKED`, `BUTTONn_DOUBLE_CLICKED`, `BUTTONn_TRIPLE_CLICKED`, `BUTTON_SHIFT`, `BUTTON_CTRL`, `BUTTON_ALT`.

`curses.getsyx()`
Return the current coordinates of the virtual screen cursor as a tuple `(y, x)`. If *leaveok* is currently `True`, then return `(-1, -1)`.

`curses.getwin(file)`
Read window related data stored in the file by an earlier `putwin()` call. The routine then creates and initializes a new window using that data, returning the new window object.

`curses.has_colors()`
Return `True` if the terminal can display colors; otherwise, return `False`.

`curses.has_ic()`
Return `True` if the terminal has insert- and delete-character capabilities. This function is included for historical reasons only, as all modern software terminal emulators have such capabilities.

`curses.has_il()`
Return `True` if the terminal has insert- and delete-line capabilities, or can simulate them using scrolling regions. This function is included for historical reasons only, as all modern software terminal emulators have such capabilities.

`curses.has_key(ch)`
Take a key value *ch*, and return `True` if the current terminal type recognizes a key with that value.

`curses.halfdelay(tenths)`
Used for half-delay mode, which is similar to cbreak mode in that characters typed by the user are immediately available to the program. However, after blocking for *tenths* tenths of seconds, raise an exception if nothing has been typed. The value of *tenths* must be a number between `1` and `255`. Use `nocbreak()` to leave half-delay mode.

`curses.init_color(color_number, r, g, b)`
Change the definition of a color, taking the number of the color to be changed followed by three RGB values (for the amounts of red, green, and blue components). The value of *color_number* must be between `0` and `COLORS`. Each of *r*, *g*, *b*, must be a value between `0` and `1000`. When `init_color()` is used, all occurrences of that color on the screen immediately change to the new definition. This function is a no-op on most terminals; it is active only if `can_change_color()` returns `True`.

`curses.init_pair(pair_number, fg, bg)`
Change the definition of a color-pair. It takes three arguments: the number of the color-pair to be changed, the foreground color number, and the background color number. The value of *pair_number* must be between `1` and `COLOR_PAIRS - 1` (the `0` color pair is wired to white on black and cannot be changed). The value of *fg* and *bg* arguments must be between `0` and `COLORS`. If the color-pair was previously initialized, the screen is refreshed and all occurrences of that color-pair are changed to the new definition.

`curses.initscr()`
Initialize the library. Return a *window* object which represents the whole screen.

Note: If there is an error opening the terminal, the underlying curses library may cause the interpreter to exit.

`curses.is_term_resized(nlines, ncols)`
Return `True` if `resize_term()` would modify the window structure, `False` otherwise.

`curses.isendwin()`
Return `True` if `endwin()` has been called (that is, the curses library has been deinitialized).

`curses.keyname(k)`
Return the name of the key numbered *k* as a bytes object. The name of a key generating printable ASCII character is the key's character. The name of a control-key combination is a two-byte bytes object consisting of a caret (`b'^'`) followed by the corresponding printable ASCII character. The name of an alt-key combination (128–255) is a bytes object consisting of the prefix `b'M-'` followed by the name of the corresponding ASCII character.

`curses.killchar()`
Return the user's current line kill character as a one-byte bytes object. Under Unix operating systems this is a property of the controlling tty of the curses program, and is not set by the curses library itself.

`curses.longname()`
Return a bytes object containing the terminfo long name field describing the current terminal. The maximum length of a verbose description is 128 characters. It is defined only after the call to `initscr()`.

`curses.meta(flag)`
If *flag* is `True`, allow 8-bit characters to be input. If *flag* is `False`, allow only 7-bit chars.

`curses.mouseinterval(`*interval*`)`
Set the maximum time in milliseconds that can elapse between press and release events in order for them to be recognized as a click, and return the previous interval value. The default value is 200 msec, or one fifth of a second.

`curses.mousemask(`*mousemask*`)`
Set the mouse events to be reported, and return a tuple `(availmask, oldmask)`. *availmask* indicates which of the specified mouse events can be reported; on complete failure it returns `0`. *oldmask* is the previous value of the given window's mouse event mask. If this function is never called, no mouse events are ever reported.

`curses.napms(`*ms*`)`
Sleep for *ms* milliseconds.

`curses.newpad(`*nlines*, *ncols*`)`
Create and return a pointer to a new pad data structure with the given number of lines and columns. Return a pad as a window object.

A pad is like a window, except that it is not restricted by the screen size, and is not necessarily associated with a particular part of the screen. Pads can be used when a large window is needed, and only a part of the window will be on the screen at one time. Automatic refreshes of pads (such as from scrolling or echoing of input) do not occur. The `refresh()` and `noutrefresh()` methods of a pad require 6 arguments to specify the part of the pad to be displayed and the location on the screen to be used for the display. The arguments are *pminrow*, *pmincol*, *sminrow*, *smincol*, *smaxrow*, *smaxcol*; the *p* arguments refer to the upper left corner of the pad region to be displayed and the *s* arguments define a clipping box on the screen within which the pad region is to be displayed.

`curses.newwin(`*nlines*, *ncols*`)`
`curses.newwin(`*nlines*, *ncols*, *begin_y*, *begin_x*`)`
Return a new *window*, whose left-upper corner is at `(begin_y, begin_x)`, and whose height/width is *nlines*/*ncols*.

By default, the window will extend from the specified position to the lower right corner of the screen.

`curses.nl()`
Enter newline mode. This mode translates the return key into newline on input, and translates newline into return and line-feed on output. Newline mode is initially on.

`curses.nocbreak()`
Leave cbreak mode. Return to normal "cooked" mode with line buffering.

`curses.noecho()`
Leave echo mode. Echoing of input characters is turned off.

`curses.nonl()`
Leave newline mode. Disable translation of return into newline on input, and disable low-level translation of newline into newline/return on output (but this does not change the behavior of `addch('\n')`, which always does the equivalent of return and line feed on the virtual screen). With translation off, curses can sometimes speed up vertical motion a little; also, it will be able to detect the return key on input.

`curses.noqiflush()`
When the `noqiflush()` routine is used, normal flush of input and output queues associated with the `INTR`, `QUIT` and `SUSP` characters will not be done. You may want to call `noqiflush()` in a signal handler if you want output to continue as though the interrupt had not occurred, after the handler exits.

`curses.noraw()`
Leave raw mode. Return to normal "cooked" mode with line buffering.

curses.pair_content(*pair_number*)
Return a tuple `(fg, bg)` containing the colors for the requested color pair. The value of *pair_number* must be between `1` and `COLOR_PAIRS - 1`.

curses.pair_number(*attr*)
Return the number of the color-pair set by the attribute value *attr*. *color_pair()* is the counterpart to this function.

curses.putp(*str*)
Equivalent to `tputs(str, 1, putchar)`; emit the value of a specified terminfo capability for the current terminal. Note that the output of *putp()* always goes to standard output.

curses.qiflush([*flag*])
If *flag* is `False`, the effect is the same as calling *noqiflush()*. If *flag* is `True`, or no argument is provided, the queues will be flushed when these control characters are read.

curses.raw()
Enter raw mode. In raw mode, normal line buffering and processing of interrupt, quit, suspend, and flow control keys are turned off; characters are presented to curses input functions one by one.

curses.reset_prog_mode()
Restore the terminal to "program" mode, as previously saved by *def_prog_mode()*.

curses.reset_shell_mode()
Restore the terminal to "shell" mode, as previously saved by *def_shell_mode()*.

curses.resetty()
Restore the state of the terminal modes to what it was at the last call to *savetty()*.

curses.resize_term(*nlines*, *ncols*)
Backend function used by *resizeterm()*, performing most of the work; when resizing the windows, *resize_term()* blank-fills the areas that are extended. The calling application should fill in these areas with appropriate data. The `resize_term()` function attempts to resize all windows. However, due to the calling convention of pads, it is not possible to resize these without additional interaction with the application.

curses.resizeterm(*nlines*, *ncols*)
Resize the standard and current windows to the specified dimensions, and adjusts other bookkeeping data used by the curses library that record the window dimensions (in particular the SIGWINCH handler).

curses.savetty()
Save the current state of the terminal modes in a buffer, usable by *resetty()*.

curses.setsyx(*y*, *x*)
Set the virtual screen cursor to *y*, *x*. If *y* and *x* are both `-1`, then *leaveok* is set `True`.

curses.setupterm(*term=None*, *fd=-1*)
Initialize the terminal. *term* is a string giving the terminal name, or `None`; if omitted or `None`, the value of the `TERM` environment variable will be used. *fd* is the file descriptor to which any initialization sequences will be sent; if not supplied or `-1`, the file descriptor for `sys.stdout` will be used.

curses.start_color()
Must be called if the programmer wants to use colors, and before any other color manipulation routine is called. It is good practice to call this routine right after *initscr()*.

start_color() initializes eight basic colors (black, red, green, yellow, blue, magenta, cyan, and white), and two global variables in the *curses* module, `COLORS` and `COLOR_PAIRS`, containing the maximum number of colors and color-pairs the terminal can support. It also restores the colors on the terminal to the values they had when the terminal was just turned on.

`curses.termattrs()`
Return a logical OR of all video attributes supported by the terminal. This information is useful when a curses program needs complete control over the appearance of the screen.

`curses.termname()`
Return the value of the environment variable `TERM`, as a bytes object, truncated to 14 characters.

`curses.tigetflag(`*capname*`)`
Return the value of the Boolean capability corresponding to the terminfo capability name *capname* as an integer. Return the value `-1` if *capname* is not a Boolean capability, or `0` if it is canceled or absent from the terminal description.

`curses.tigetnum(`*capname*`)`
Return the value of the numeric capability corresponding to the terminfo capability name *capname* as an integer. Return the value `-2` if *capname* is not a numeric capability, or `-1` if it is canceled or absent from the terminal description.

`curses.tigetstr(`*capname*`)`
Return the value of the string capability corresponding to the terminfo capability name *capname* as a bytes object. Return `None` if *capname* is not a terminfo "string capability", or is canceled or absent from the terminal description.

`curses.tparm(`*str*[, *...*]`)`
Instantiate the bytes object *str* with the supplied parameters, where *str* should be a parameterized string obtained from the terminfo database. E.g. `tparm(tigetstr("cup"), 5, 3)` could result in `b'\033[6;4H'`, the exact result depending on terminal type.

`curses.typeahead(`*fd*`)`
Specify that the file descriptor *fd* be used for typeahead checking. If *fd* is `-1`, then no typeahead checking is done.

The curses library does "line-breakout optimization" by looking for typeahead periodically while updating the screen. If input is found, and it is coming from a tty, the current update is postponed until refresh or doupdate is called again, allowing faster response to commands typed in advance. This function allows specifying a different file descriptor for typeahead checking.

`curses.unctrl(`*ch*`)`
Return a bytes object which is a printable representation of the character *ch*. Control characters are represented as a caret followed by the character, for example as `b'^C'`. Printing characters are left as they are.

`curses.ungetch(`*ch*`)`
Push *ch* so the next *`getch()`* will return it.

Note: Only one *ch* can be pushed before `getch()` is called.

`curses.update_lines_cols()`
Update `LINES` and `COLS`. Useful for detecting manual screen resize.

New in version 3.5.

`curses.unget_wch(`*ch*`)`
Push *ch* so the next *`get_wch()`* will return it.

Note: Only one *ch* can be pushed before `get_wch()` is called.

New in version 3.3.

`curses.ungetmouse(`*id*, *x*, *y*, *z*, *bstate*`)`
Push a `KEY_MOUSE` event onto the input queue, associating the given state data with it.

`curses.use_env(`*flag*`)`
If used, this function should be called before *`initscr()`* or newterm are called. When *flag* is `False`, the values of lines and columns specified in the terminfo database will be used, even if environment variables `LINES` and `COLUMNS` (used by default) are set, or if curses is running in a window (in which case default behavior would be to use the window size if `LINES` and `COLUMNS` are not set).

`curses.use_default_colors()`
Allow use of default values for colors on terminals supporting this feature. Use this to support transparency in your application. The default color is assigned to the color number `-1`. After calling this function, `init_pair(x, curses.COLOR_RED, -1)` initializes, for instance, color pair *x* to a red foreground color on the default background.

`curses.wrapper(`*func*, *...*`)`
Initialize curses and call another callable object, *func*, which should be the rest of your curses-using application. If the application raises an exception, this function will restore the terminal to a sane state before re-raising the exception and generating a traceback. The callable object *func* is then passed the main window 'stdscr' as its first argument, followed by any other arguments passed to `wrapper()`. Before calling *func*, `wrapper()` turns on cbreak mode, turns off echo, enables the terminal keypad, and initializes colors if the terminal has color support. On exit (whether normally or by exception) it restores cooked mode, turns on echo, and disables the terminal keypad.

16.10.2 Window Objects

Window objects, as returned by *`initscr()`* and *`newwin()`* above, have the following methods and attributes:

`window.addch(`*ch*[, *attr*]`)`
`window.addch(`*y*, *x*, *ch*[, *attr*]`)`
Paint character *ch* at `(y, x)` with attributes *attr*, overwriting any character previously painter at that location. By default, the character position and attributes are the current settings for the window object.

Note: Writing outside the window, subwindow, or pad raises a *`curses.error`*. Attempting to write to the lower right corner of a window, subwindow, or pad will cause an exception to be raised after the character is printed.

`window.addnstr(`*str*, *n*[, *attr*]`)`
`window.addnstr(`*y*, *x*, *str*, *n*[, *attr*]`)`
Paint at most *n* characters of the character string *str* at `(y, x)` with attributes *attr*, overwriting anything previously on the display.

`window.addstr(`*str*[, *attr*]`)`
`window.addstr(`*y*, *x*, *str*[, *attr*]`)`
Paint the character string *str* at `(y, x)` with attributes *attr*, overwriting anything previously on the display.

Note: Writing outside the window, subwindow, or pad raises *`curses.error`*. Attempting to write to the lower right corner of a window, subwindow, or pad will cause an exception to be raised after the string is printed.

`window.attroff(attr)`
: Remove attribute *attr* from the "background" set applied to all writes to the current window.

`window.attron(attr)`
: Add attribute *attr* from the "background" set applied to all writes to the current window.

`window.attrset(attr)`
: Set the "background" set of attributes to *attr*. This set is initially `0` (no attributes).

`window.bkgd(ch[, attr])`
: Set the background property of the window to the character *ch*, with attributes *attr*. The change is then applied to every character position in that window:

- The attribute of every character in the window is changed to the new background attribute.
- Wherever the former background character appears, it is changed to the new background character.

`window.bkgdset(ch[, attr])`
: Set the window's background. A window's background consists of a character and any combination of attributes. The attribute part of the background is combined (OR'ed) with all non-blank characters that are written into the window. Both the character and attribute parts of the background are combined with the blank characters. The background becomes a property of the character and moves with the character through any scrolling and insert/delete line/character operations.

`window.border([ls[, rs[, ts[, bs[, tl[, tr[, bl[, br]]]]]]]])`
: Draw a border around the edges of the window. Each parameter specifies the character to use for a specific part of the border; see the table below for more details.

Note: A `0` value for any parameter will cause the default character to be used for that parameter. Keyword parameters can *not* be used. The defaults are listed in this table:

Parameter	Description	Default value
ls	Left side	`ACS_VLINE`
rs	Right side	`ACS_VLINE`
ts	Top	`ACS_HLINE`
bs	Bottom	`ACS_HLINE`
tl	Upper-left corner	`ACS_ULCORNER`
tr	Upper-right corner	`ACS_URCORNER`
bl	Bottom-left corner	`ACS_LLCORNER`
br	Bottom-right corner	`ACS_LRCORNER`

`window.box([vertch, horch])`
: Similar to `border()`, but both *ls* and *rs* are *vertch* and both *ts* and *bs* are *horch*. The default corner characters are always used by this function.

`window.chgat(attr)`
`window.chgat(num, attr)`
`window.chgat(y, x, attr)`
`window.chgat(y, x, num, attr)`
: Set the attributes of *num* characters at the current cursor position, or at position `(y, x)` if supplied. If *num* is not given or is `-1`, the attribute will be set on all the characters to the end of the line. This function moves cursor to position `(y, x)` if supplied. The changed line will be touched using the `touchline()` method so that the contents will be redisplayed by the next window refresh.

`window.clear()`
: Like `erase()`, but also cause the whole window to be repainted upon next call to `refresh()`.

window.clearok(*flag*)
If *flag* is `True`, the next call to `refresh()` will clear the window completely.

window.clrtobot()
Erase from cursor to the end of the window: all lines below the cursor are deleted, and then the equivalent of `clrtoeol()` is performed.

window.clrtoeol()
Erase from cursor to the end of the line.

window.cursyncup()
Update the current cursor position of all the ancestors of the window to reflect the current cursor position of the window.

window.delch([*y*, *x*])
Delete any character at `(y, x)`.

window.deleteln()
Delete the line under the cursor. All following lines are moved up by one line.

window.derwin(*begin_y*, *begin_x*)
window.derwin(*nlines*, *ncols*, *begin_y*, *begin_x*)
An abbreviation for "derive window", `derwin()` is the same as calling `subwin()`, except that *begin_y* and *begin_x* are relative to the origin of the window, rather than relative to the entire screen. Return a window object for the derived window.

window.echochar(*ch*[, *attr*])
Add character *ch* with attribute *attr*, and immediately call `refresh()` on the window.

window.enclose(*y*, *x*)
Test whether the given pair of screen-relative character-cell coordinates are enclosed by the given window, returning `True` or `False`. It is useful for determining what subset of the screen windows enclose the location of a mouse event.

window.encoding
Encoding used to encode method arguments (Unicode strings and characters). The encoding attribute is inherited from the parent window when a subwindow is created, for example with `window.subwin()`. By default, the locale encoding is used (see `locale.getpreferredencoding()`).

New in version 3.3.

window.erase()
Clear the window.

window.getbegyx()
Return a tuple `(y, x)` of co-ordinates of upper-left corner.

window.getbkgd()
Return the given window's current background character/attribute pair.

window.getch([*y*, *x*])
Get a character. Note that the integer returned does *not* have to be in ASCII range: function keys, keypad keys and so on are represented by numbers higher than 255. In no-delay mode, return `-1` if there is no input, otherwise wait until a key is pressed.

window.get_wch([*y*, *x*])
Get a wide character. Return a character for most keys, or an integer for function keys, keypad keys, and other special keys. In no-delay mode, raise an exception if there is no input.

New in version 3.3.

window.getkey([*y*, *x*])
Get a character, returning a string instead of an integer, as `getch()` does. Function keys, keypad keys

and other special keys return a multibyte string containing the key name. In no-delay mode, raise an exception if there is no input.

`window.getmaxyx()`
: Return a tuple `(y, x)` of the height and width of the window.

`window.getparyx()`
: Return the beginning coordinates of this window relative to its parent window as a tuple `(y, x)`. Return `(-1, -1)` if this window has no parent.

`window.getstr()`
`window.getstr(`*n*`)`
`window.getstr(`*y*, *x*`)`
`window.getstr(`*y*, *x*, *n*`)`
: Read a bytes object from the user, with primitive line editing capacity.

`window.getyx()`
: Return a tuple `(y, x)` of current cursor position relative to the window's upper-left corner.

`window.hline(`*ch*, *n*`)`
`window.hline(`*y*, *x*, *ch*, *n*`)`
: Display a horizontal line starting at `(y, x)` with length *n* consisting of the character *ch*.

`window.idcok(`*flag*`)`
: If *flag* is `False`, curses no longer considers using the hardware insert/delete character feature of the terminal; if *flag* is `True`, use of character insertion and deletion is enabled. When curses is first initialized, use of character insert/delete is enabled by default.

`window.idlok(`*flag*`)`
: If *flag* is `True`, `curses` will try and use hardware line editing facilities. Otherwise, line insertion/deletion are disabled.

`window.immedok(`*flag*`)`
: If *flag* is `True`, any change in the window image automatically causes the window to be refreshed; you no longer have to call `refresh()` yourself. However, it may degrade performance considerably, due to repeated calls to wrefresh. This option is disabled by default.

`window.inch(`[*y*, *x*]`)`
: Return the character at the given position in the window. The bottom 8 bits are the character proper, and upper bits are the attributes.

`window.insch(`*ch*[, *attr*]`)`
`window.insch(`*y*, *x*, *ch*[, *attr*]`)`
: Paint character *ch* at `(y, x)` with attributes *attr*, moving the line from position *x* right by one character.

`window.insdelln(`*nlines*`)`
: Insert *nlines* lines into the specified window above the current line. The *nlines* bottom lines are lost. For negative *nlines*, delete *nlines* lines starting with the one under the cursor, and move the remaining lines up. The bottom *nlines* lines are cleared. The current cursor position remains the same.

`window.insertln()`
: Insert a blank line under the cursor. All following lines are moved down by one line.

`window.insnstr(`*str*, *n*[, *attr*]`)`
`window.insnstr(`*y*, *x*, *str*, *n*[, *attr*]`)`
: Insert a character string (as many characters as will fit on the line) before the character under the cursor, up to *n* characters. If *n* is zero or negative, the entire string is inserted. All characters to the right of the cursor are shifted right, with the rightmost characters on the line being lost. The cursor position does not change (after moving to *y*, *x*, if specified).

`window.insstr(`*str*[, *attr*]`)`

`window.insstr(y, x, str[, attr])`
: Insert a character string (as many characters as will fit on the line) before the character under the cursor. All characters to the right of the cursor are shifted right, with the rightmost characters on the line being lost. The cursor position does not change (after moving to *y*, *x*, if specified).

`window.instr([n])`
`window.instr(y, x[, n])`
: Return a bytes object of characters, extracted from the window starting at the current cursor position, or at *y*, *x* if specified. Attributes are stripped from the characters. If *n* is specified, `instr()` returns a string at most *n* characters long (exclusive of the trailing NUL).

`window.is_linetouched(line)`
: Return `True` if the specified line was modified since the last call to `refresh()`; otherwise return `False`. Raise a `curses.error` exception if *line* is not valid for the given window.

`window.is_wintouched()`
: Return `True` if the specified window was modified since the last call to `refresh()`; otherwise return `False`.

`window.keypad(flag)`
: If *flag* is `True`, escape sequences generated by some keys (keypad, function keys) will be interpreted by `curses`. If *flag* is `False`, escape sequences will be left as is in the input stream.

`window.leaveok(flag)`
: If *flag* is `True`, cursor is left where it is on update, instead of being at "cursor position." This reduces cursor movement where possible. If possible the cursor will be made invisible.

  If *flag* is `False`, cursor will always be at "cursor position" after an update.

`window.move(new_y, new_x)`
: Move cursor to `(new_y, new_x)`.

`window.mvderwin(y, x)`
: Move the window inside its parent window. The screen-relative parameters of the window are not changed. This routine is used to display different parts of the parent window at the same physical position on the screen.

`window.mvwin(new_y, new_x)`
: Move the window so its upper-left corner is at `(new_y, new_x)`.

`window.nodelay(flag)`
: If *flag* is `True`, `getch()` will be non-blocking.

`window.notimeout(flag)`
: If *flag* is `True`, escape sequences will not be timed out.

  If *flag* is `False`, after a few milliseconds, an escape sequence will not be interpreted, and will be left in the input stream as is.

`window.noutrefresh()`
: Mark for refresh but wait. This function updates the data structure representing the desired state of the window, but does not force an update of the physical screen. To accomplish that, call `doupdate()`.

`window.overlay(destwin[, sminrow, smincol, dminrow, dmincol, dmaxrow, dmaxcol])`
: Overlay the window on top of *destwin*. The windows need not be the same size, only the overlapping region is copied. This copy is non-destructive, which means that the current background character does not overwrite the old contents of *destwin*.

  To get fine-grained control over the copied region, the second form of `overlay()` can be used. *sminrow* and *smincol* are the upper-left coordinates of the source window, and the other variables mark a rectangle in the destination window.

window.overwrite(*destwin* [, *sminrow*, *smincol*, *dminrow*, *dmincol*, *dmaxrow*, *dmaxcol*])

Overwrite the window on top of *destwin*. The windows need not be the same size, in which case only the overlapping region is copied. This copy is destructive, which means that the current background character overwrites the old contents of *destwin*.

To get fine-grained control over the copied region, the second form of `overwrite()` can be used. *sminrow* and *smincol* are the upper-left coordinates of the source window, the other variables mark a rectangle in the destination window.

window.putwin(*file*)

Write all data associated with the window into the provided file object. This information can be later retrieved using the `getwin()` function.

window.redrawln(*beg*, *num*)

Indicate that the *num* screen lines, starting at line *beg*, are corrupted and should be completely redrawn on the next `refresh()` call.

window.redrawwin()

Touch the entire window, causing it to be completely redrawn on the next `refresh()` call.

window.refresh([*pminrow*, *pmincol*, *sminrow*, *smincol*, *smaxrow*, *smaxcol*])

Update the display immediately (sync actual screen with previous drawing/deleting methods).

The 6 optional arguments can only be specified when the window is a pad created with `newpad()`. The additional parameters are needed to indicate what part of the pad and screen are involved. *pminrow* and *pmincol* specify the upper left-hand corner of the rectangle to be displayed in the pad. *sminrow*, *smincol*, *smaxrow*, and *smaxcol* specify the edges of the rectangle to be displayed on the screen. The lower right-hand corner of the rectangle to be displayed in the pad is calculated from the screen coordinates, since the rectangles must be the same size. Both rectangles must be entirely contained within their respective structures. Negative values of *pminrow*, *pmincol*, *sminrow*, or *smincol* are treated as if they were zero.

window.resize(*nlines*, *ncols*)

Reallocate storage for a curses window to adjust its dimensions to the specified values. If either dimension is larger than the current values, the window's data is filled with blanks that have the current background rendition (as set by `bkgdset()`) merged into them.

window.scroll([*lines=1*])

Scroll the screen or scrolling region upward by *lines* lines.

window.scrollok(*flag*)

Control what happens when the cursor of a window is moved off the edge of the window or scrolling region, either as a result of a newline action on the bottom line, or typing the last character of the last line. If *flag* is `False`, the cursor is left on the bottom line. If *flag* is `True`, the window is scrolled up one line. Note that in order to get the physical scrolling effect on the terminal, it is also necessary to call `idlok()`.

window.setscrreg(*top*, *bottom*)

Set the scrolling region from line *top* to line *bottom*. All scrolling actions will take place in this region.

window.standend()

Turn off the standout attribute. On some terminals this has the side effect of turning off all attributes.

window.standout()

Turn on attribute *A_STANDOUT*.

window.subpad(*begin_y*, *begin_x*)
window.subpad(*nlines*, *ncols*, *begin_y*, *begin_x*)

Return a sub-window, whose upper-left corner is at `(begin_y, begin_x)`, and whose width/height is *ncols*/*nlines*.

window.subwin(*begin_y*, *begin_x*)

`window.subwin(`*nlines*, *ncols*, *begin_y*, *begin_x*`)`
Return a sub-window, whose upper-left corner is at `(begin_y, begin_x)`, and whose width/height is *ncols*/*nlines*.

By default, the sub-window will extend from the specified position to the lower right corner of the window.

`window.syncdown()`
Touch each location in the window that has been touched in any of its ancestor windows. This routine is called by *refresh()*, so it should almost never be necessary to call it manually.

`window.syncok(`*flag*`)`
If *flag* is `True`, then *syncup()* is called automatically whenever there is a change in the window.

`window.syncup()`
Touch all locations in ancestors of the window that have been changed in the window.

`window.timeout(`*delay*`)`
Set blocking or non-blocking read behavior for the window. If *delay* is negative, blocking read is used (which will wait indefinitely for input). If *delay* is zero, then non-blocking read is used, and *getch()* will return `-1` if no input is waiting. If *delay* is positive, then *getch()* will block for *delay* milliseconds, and return `-1` if there is still no input at the end of that time.

`window.touchline(`*start*, *count*[, *changed*]`)`
Pretend *count* lines have been changed, starting with line *start*. If *changed* is supplied, it specifies whether the affected lines are marked as having been changed (*changed*`=True`) or unchanged (*changed*`=False`).

`window.touchwin()`
Pretend the whole window has been changed, for purposes of drawing optimizations.

`window.untouchwin()`
Mark all lines in the window as unchanged since the last call to *refresh()*.

`window.vline(`*ch*, *n*`)`
`window.vline(`*y*, *x*, *ch*, *n*`)`
Display a vertical line starting at `(y, x)` with length *n* consisting of the character *ch*.

16.10.3 Constants

The *curses* module defines the following data members:

`curses.ERR`
Some curses routines that return an integer, such as `getch()`, return *ERR* upon failure.

`curses.OK`
Some curses routines that return an integer, such as *napms()*, return *OK* upon success.

`curses.version`
A bytes object representing the current version of the module. Also available as `__version__`.

Some constants are available to specify character cell attributes. The exact constants available are system dependent.

Attribute	Meaning
A_ALTCHARSET	Alternate character set mode
A_BLINK	Blink mode
A_BOLD	Bold mode
A_DIM	Dim mode
A_INVIS	Invisible or blank mode
A_ITALIC	Italic mode
A_NORMAL	Normal attribute
A_PROTECT	Protected mode
A_REVERSE	Reverse background and foreground colors
A_STANDOUT	Standout mode
A_UNDERLINE	Underline mode
A_HORIZONTAL	Horizontal highlight
A_LEFT	Left highlight
A_LOW	Low highlight
A_RIGHT	Right highlight
A_TOP	Top highlight
A_VERTICAL	Vertical highlight
A_CHARTEXT	Bit-mask to extract a character

New in version 3.7: `A_ITALIC` was added.

Several constants are available to extract corresponding attributes returned by some methods.

Bit-mask	Meaning
A_ATTRIBUTES	Bit-mask to extract attributes
A_CHARTEXT	Bit-mask to extract a character
A_COLOR	Bit-mask to extract color-pair field information

Keys are referred to by integer constants with names starting with `KEY_`. The exact keycaps available are system dependent.

Key constant	Key
KEY_MIN	Minimum key value
KEY_BREAK	Break key (unreliable)
KEY_DOWN	Down-arrow
KEY_UP	Up-arrow
KEY_LEFT	Left-arrow
KEY_RIGHT	Right-arrow
KEY_HOME	Home key (upward+left arrow)
KEY_BACKSPACE	Backspace (unreliable)
KEY_F0	Function keys. Up to 64 function keys are supported.
KEY_Fn	Value of function key *n*
KEY_DL	Delete line
KEY_IL	Insert line
KEY_DC	Delete character
KEY_IC	Insert char or enter insert mode
KEY_EIC	Exit insert char mode
KEY_CLEAR	Clear screen
KEY_EOS	Clear to end of screen
KEY_EOL	Clear to end of line

Continued on next page

Table 1 – continued from previous page

Key constant	Key
KEY_SF	Scroll 1 line forward
KEY_SR	Scroll 1 line backward (reverse)
KEY_NPAGE	Next page
KEY_PPAGE	Previous page
KEY_STAB	Set tab
KEY_CTAB	Clear tab
KEY_CATAB	Clear all tabs
KEY_ENTER	Enter or send (unreliable)
KEY_SRESET	Soft (partial) reset (unreliable)
KEY_RESET	Reset or hard reset (unreliable)
KEY_PRINT	Print
KEY_LL	Home down or bottom (lower left)
KEY_A1	Upper left of keypad
KEY_A3	Upper right of keypad
KEY_B2	Center of keypad
KEY_C1	Lower left of keypad
KEY_C3	Lower right of keypad
KEY_BTAB	Back tab
KEY_BEG	Beg (beginning)
KEY_CANCEL	Cancel
KEY_CLOSE	Close
KEY_COMMAND	Cmd (command)
KEY_COPY	Copy
KEY_CREATE	Create
KEY_END	End
KEY_EXIT	Exit
KEY_FIND	Find
KEY_HELP	Help
KEY_MARK	Mark
KEY_MESSAGE	Message
KEY_MOVE	Move
KEY_NEXT	Next
KEY_OPEN	Open
KEY_OPTIONS	Options
KEY_PREVIOUS	Prev (previous)
KEY_REDO	Redo
KEY_REFERENCE	Ref (reference)
KEY_REFRESH	Refresh
KEY_REPLACE	Replace
KEY_RESTART	Restart
KEY_RESUME	Resume
KEY_SAVE	Save
KEY_SBEG	Shifted Beg (beginning)
KEY_SCANCEL	Shifted Cancel
KEY_SCOMMAND	Shifted Command
KEY_SCOPY	Shifted Copy
KEY_SCREATE	Shifted Create
KEY_SDC	Shifted Delete char
KEY_SDL	Shifted Delete line

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Key constant	Key
KEY_SELECT	Select
KEY_SEND	Shifted End
KEY_SEOL	Shifted Clear line
KEY_SEXIT	Shifted Exit
KEY_SFIND	Shifted Find
KEY_SHELP	Shifted Help
KEY_SHOME	Shifted Home
KEY_SIC	Shifted Input
KEY_SLEFT	Shifted Left arrow
KEY_SMESSAGE	Shifted Message
KEY_SMOVE	Shifted Move
KEY_SNEXT	Shifted Next
KEY_SOPTIONS	Shifted Options
KEY_SPREVIOUS	Shifted Prev
KEY_SPRINT	Shifted Print
KEY_SREDO	Shifted Redo
KEY_SREPLACE	Shifted Replace
KEY_SRIGHT	Shifted Right arrow
KEY_SRSUME	Shifted Resume
KEY_SSAVE	Shifted Save
KEY_SSUSPEND	Shifted Suspend
KEY_SUNDO	Shifted Undo
KEY_SUSPEND	Suspend
KEY_UNDO	Undo
KEY_MOUSE	Mouse event has occurred
KEY_RESIZE	Terminal resize event
KEY_MAX	Maximum key value

On VT100s and their software emulations, such as X terminal emulators, there are normally at least four function keys (`KEY_F1`, `KEY_F2`, `KEY_F3`, `KEY_F4`) available, and the arrow keys mapped to `KEY_UP`, `KEY_DOWN`, `KEY_LEFT` and `KEY_RIGHT` in the obvious way. If your machine has a PC keyboard, it is safe to expect arrow keys and twelve function keys (older PC keyboards may have only ten function keys); also, the following keypad mappings are standard:

Keycap	Constant
Insert	KEY_IC
Delete	KEY_DC
Home	KEY_HOME
End	KEY_END
Page Up	KEY_PPAGE
Page Down	KEY_NPAGE

The following table lists characters from the alternate character set. These are inherited from the VT100 terminal, and will generally be available on software emulations such as X terminals. When there is no graphic available, curses falls back on a crude printable ASCII approximation.

Note: These are available only after *initscr()* has been called.

ACS code	Meaning
ACS_BBSS	alternate name for upper right corner
ACS_BLOCK	solid square block
ACS_BOARD	board of squares
ACS_BSBS	alternate name for horizontal line
ACS_BSSB	alternate name for upper left corner
ACS_BSSS	alternate name for top tee
ACS_BTEE	bottom tee
ACS_BULLET	bullet
ACS_CKBOARD	checker board (stipple)
ACS_DARROW	arrow pointing down
ACS_DEGREE	degree symbol
ACS_DIAMOND	diamond
ACS_GEQUAL	greater-than-or-equal-to
ACS_HLINE	horizontal line
ACS_LANTERN	lantern symbol
ACS_LARROW	left arrow
ACS_LEQUAL	less-than-or-equal-to
ACS_LLCORNER	lower left-hand corner
ACS_LRCORNER	lower right-hand corner
ACS_LTEE	left tee
ACS_NEQUAL	not-equal sign
ACS_PI	letter pi
ACS_PLMINUS	plus-or-minus sign
ACS_PLUS	big plus sign
ACS_RARROW	right arrow
ACS_RTEE	right tee
ACS_S1	scan line 1
ACS_S3	scan line 3
ACS_S7	scan line 7
ACS_S9	scan line 9
ACS_SBBS	alternate name for lower right corner
ACS_SBSB	alternate name for vertical line
ACS_SBSS	alternate name for right tee
ACS_SSBB	alternate name for lower left corner
ACS_SSBS	alternate name for bottom tee
ACS_SSSB	alternate name for left tee
ACS_SSSS	alternate name for crossover or big plus
ACS_STERLING	pound sterling
ACS_TTEE	top tee
ACS_UARROW	up arrow
ACS_ULCORNER	upper left corner
ACS_URCORNER	upper right corner
ACS_VLINE	vertical line

The following table lists the predefined colors:

Constant	Color
COLOR_BLACK	Black
COLOR_BLUE	Blue
COLOR_CYAN	Cyan (light greenish blue)
COLOR_GREEN	Green
COLOR_MAGENTA	Magenta (purplish red)
COLOR_RED	Red
COLOR_WHITE	White
COLOR_YELLOW	Yellow

16.11 `curses.textpad` — Text input widget for curses programs

The *curses.textpad* module provides a *Textbox* class that handles elementary text editing in a curses window, supporting a set of keybindings resembling those of Emacs (thus, also of Netscape Navigator, BBedit 6.x, FrameMaker, and many other programs). The module also provides a rectangle-drawing function useful for framing text boxes or for other purposes.

The module *curses.textpad* defines the following function:

`curses.textpad.`**`rectangle`**`(`*win*, *uly*, *ulx*, *lry*, *lrx*`)`

Draw a rectangle. The first argument must be a window object; the remaining arguments are coordinates relative to that window. The second and third arguments are the y and x coordinates of the upper left hand corner of the rectangle to be drawn; the fourth and fifth arguments are the y and x coordinates of the lower right hand corner. The rectangle will be drawn using VT100/IBM PC forms characters on terminals that make this possible (including xterm and most other software terminal emulators). Otherwise it will be drawn with ASCII dashes, vertical bars, and plus signs.

16.11.1 Textbox objects

You can instantiate a *Textbox* object as follows:

`class` `curses.textpad.`**`Textbox`**`(`*win*`)`

Return a textbox widget object. The *win* argument should be a curses *window* object in which the textbox is to be contained. The edit cursor of the textbox is initially located at the upper left hand corner of the containing window, with coordinates `(0, 0)`. The instance's *stripspaces* flag is initially on.

Textbox objects have the following methods:

`edit``(`[*validator*]`)`

This is the entry point you will normally use. It accepts editing keystrokes until one of the termination keystrokes is entered. If *validator* is supplied, it must be a function. It will be called for each keystroke entered with the keystroke as a parameter; command dispatch is done on the result. This method returns the window contents as a string; whether blanks in the window are included is affected by the *stripspaces* attribute.

`do_command``(`*ch*`)`

Process a single command keystroke. Here are the supported special keystrokes:

Keystroke	Action
`Control-A`	Go to left edge of window.
`Control-B`	Cursor left, wrapping to previous line if appropriate.
`Control-D`	Delete character under cursor.
`Control-E`	Go to right edge (stripspaces off) or end of line (stripspaces on).
`Control-F`	Cursor right, wrapping to next line when appropriate.
`Control-G`	Terminate, returning the window contents.
`Control-H`	Delete character backward.
`Control-J`	Terminate if the window is 1 line, otherwise insert newline.
`Control-K`	If line is blank, delete it, otherwise clear to end of line.
`Control-L`	Refresh screen.
`Control-N`	Cursor down; move down one line.
`Control-O`	Insert a blank line at cursor location.
`Control-P`	Cursor up; move up one line.

Move operations do nothing if the cursor is at an edge where the movement is not possible. The following synonyms are supported where possible:

Constant	Keystroke
`KEY_LEFT`	`Control-B`
`KEY_RIGHT`	`Control-F`
`KEY_UP`	`Control-P`
`KEY_DOWN`	`Control-N`
`KEY_BACKSPACE`	`Control-h`

All other keystrokes are treated as a command to insert the given character and move right (with line wrapping).

gather()
Return the window contents as a string; whether blanks in the window are included is affected by the *stripspaces* member.

stripspaces
This attribute is a flag which controls the interpretation of blanks in the window. When it is on, trailing blanks on each line are ignored; any cursor motion that would land the cursor on a trailing blank goes to the end of that line instead, and trailing blanks are stripped when the window contents are gathered.

16.12 `curses.ascii` — Utilities for ASCII characters

The *curses.ascii* module supplies name constants for ASCII characters and functions to test membership in various ASCII character classes. The constants supplied are names for control characters as follows:

Name	Meaning
`NUL`	
`SOH`	Start of heading, console interrupt
`STX`	Start of text
`ETX`	End of text
`EOT`	End of transmission

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Name	Meaning
`ENQ`	Enquiry, goes with `ACK` flow control
`ACK`	Acknowledgement
`BEL`	Bell
`BS`	Backspace
`TAB`	Tab
`HT`	Alias for `TAB`: "Horizontal tab"
`LF`	Line feed
`NL`	Alias for `LF`: "New line"
`VT`	Vertical tab
`FF`	Form feed
`CR`	Carriage return
`SO`	Shift-out, begin alternate character set
`SI`	Shift-in, resume default character set
`DLE`	Data-link escape
`DC1`	XON, for flow control
`DC2`	Device control 2, block-mode flow control
`DC3`	XOFF, for flow control
`DC4`	Device control 4
`NAK`	Negative acknowledgement
`SYN`	Synchronous idle
`ETB`	End transmission block
`CAN`	Cancel
`EM`	End of medium
`SUB`	Substitute
`ESC`	Escape
`FS`	File separator
`GS`	Group separator
`RS`	Record separator, block-mode terminator
`US`	Unit separator
`SP`	Space
`DEL`	Delete

Note that many of these have little practical significance in modern usage. The mnemonics derive from teleprinter conventions that predate digital computers.

The module supplies the following functions, patterned on those in the standard C library:

`curses.ascii.isalnum(c)`
: Checks for an ASCII alphanumeric character; it is equivalent to `isalpha(c) or isdigit(c)`.

`curses.ascii.isalpha(c)`
: Checks for an ASCII alphabetic character; it is equivalent to `isupper(c) or islower(c)`.

`curses.ascii.isascii(c)`
: Checks for a character value that fits in the 7-bit ASCII set.

`curses.ascii.isblank(c)`
: Checks for an ASCII whitespace character; space or horizontal tab.

`curses.ascii.iscntrl(c)`
: Checks for an ASCII control character (in the range 0x00 to 0x1f or 0x7f).

`curses.ascii.isdigit(c)`
: Checks for an ASCII decimal digit, `'0'` through `'9'`. This is equivalent to `c in string.digits`.

`curses.ascii.isgraph(c)`
: Checks for ASCII any printable character except space.

`curses.ascii.islower(c)`
: Checks for an ASCII lower-case character.

`curses.ascii.isprint(c)`
: Checks for any ASCII printable character including space.

`curses.ascii.ispunct(c)`
: Checks for any printable ASCII character which is not a space or an alphanumeric character.

`curses.ascii.isspace(c)`
: Checks for ASCII white-space characters; space, line feed, carriage return, form feed, horizontal tab, vertical tab.

`curses.ascii.isupper(c)`
: Checks for an ASCII uppercase letter.

`curses.ascii.isxdigit(c)`
: Checks for an ASCII hexadecimal digit. This is equivalent to `c in string.hexdigits`.

`curses.ascii.isctrl(c)`
: Checks for an ASCII control character (ordinal values 0 to 31).

`curses.ascii.ismeta(c)`
: Checks for a non-ASCII character (ordinal values 0x80 and above).

These functions accept either integers or single-character strings; when the argument is a string, it is first converted using the built-in function *ord()*.

Note that all these functions check ordinal bit values derived from the character of the string you pass in; they do not actually know anything about the host machine's character encoding.

The following two functions take either a single-character string or integer byte value; they return a value of the same type.

`curses.ascii.ascii(c)`
: Return the ASCII value corresponding to the low 7 bits of *c*.

`curses.ascii.ctrl(c)`
: Return the control character corresponding to the given character (the character bit value is bitwise-anded with 0x1f).

`curses.ascii.alt(c)`
: Return the 8-bit character corresponding to the given ASCII character (the character bit value is bitwise-ored with 0x80).

The following function takes either a single-character string or integer value; it returns a string.

`curses.ascii.unctrl(c)`
: Return a string representation of the ASCII character *c*. If *c* is printable, this string is the character itself. If the character is a control character (0x00–0x1f) the string consists of a caret (`'^'`) followed by the corresponding uppercase letter. If the character is an ASCII delete (0x7f) the string is `'^?'`. If the character has its meta bit (0x80) set, the meta bit is stripped, the preceding rules applied, and `'!'` prepended to the result.

`curses.ascii.controlnames`
: A 33-element string array that contains the ASCII mnemonics for the thirty-two ASCII control characters from 0 (NUL) to 0x1f (US), in order, plus the mnemonic `SP` for the space character.

16.13 `curses.panel` — A panel stack extension for curses

Panels are windows with the added feature of depth, so they can be stacked on top of each other, and only the visible portions of each window will be displayed. Panels can be added, moved up or down in the stack, and removed.

16.13.1 Functions

The module *curses.panel* defines the following functions:

`curses.panel.bottom_panel()`
: Returns the bottom panel in the panel stack.

`curses.panel.new_panel(`*win*`)`
: Returns a panel object, associating it with the given window *win*. Be aware that you need to keep the returned panel object referenced explicitly. If you don't, the panel object is garbage collected and removed from the panel stack.

`curses.panel.top_panel()`
: Returns the top panel in the panel stack.

`curses.panel.update_panels()`
: Updates the virtual screen after changes in the panel stack. This does not call *curses.doupdate()*, so you'll have to do this yourself.

16.13.2 Panel Objects

Panel objects, as returned by *new_panel()* above, are windows with a stacking order. There's always a window associated with a panel which determines the content, while the panel methods are responsible for the window's depth in the panel stack.

Panel objects have the following methods:

`Panel.above()`
: Returns the panel above the current panel.

`Panel.below()`
: Returns the panel below the current panel.

`Panel.bottom()`
: Push the panel to the bottom of the stack.

`Panel.hidden()`
: Returns `True` if the panel is hidden (not visible), `False` otherwise.

`Panel.hide()`
: Hide the panel. This does not delete the object, it just makes the window on screen invisible.

`Panel.move(`*y*, *x*`)`
: Move the panel to the screen coordinates `(y, x)`.

`Panel.replace(`*win*`)`
: Change the window associated with the panel to the window *win*.

`Panel.set_userptr(`*obj*`)`
: Set the panel's user pointer to *obj*. This is used to associate an arbitrary piece of data with the panel, and can be any Python object.

`Panel.show()`
Display the panel (which might have been hidden).

`Panel.top()`
Push panel to the top of the stack.

`Panel.userptr()`
Returns the user pointer for the panel. This might be any Python object.

`Panel.window()`
Returns the window object associated with the panel.

16.14 `platform` — Access to underlying platform's identifying data

Source code: Lib/platform.py

Note: Specific platforms listed alphabetically, with Linux included in the Unix section.

16.14.1 Cross Platform

`platform.architecture(`*executable=sys.executable, bits=", linkage="*`)`
Queries the given executable (defaults to the Python interpreter binary) for various architecture information.

Returns a tuple `(bits, linkage)` which contain information about the bit architecture and the linkage format used for the executable. Both values are returned as strings.

Values that cannot be determined are returned as given by the parameter presets. If bits is given as `''`, the `sizeof(pointer)` (or `sizeof(long)` on Python version < 1.5.2) is used as indicator for the supported pointer size.

The function relies on the system's `file` command to do the actual work. This is available on most if not all Unix platforms and some non-Unix platforms and then only if the executable points to the Python interpreter. Reasonable defaults are used when the above needs are not met.

Note: On Mac OS X (and perhaps other platforms), executable files may be universal files containing multiple architectures.

To get at the "64-bitness" of the current interpreter, it is more reliable to query the *`sys.maxsize`* attribute:

```
is_64bits = sys.maxsize > 2**32
```

`platform.machine()`
Returns the machine type, e.g. `'i386'`. An empty string is returned if the value cannot be determined.

`platform.node()`
Returns the computer's network name (may not be fully qualified!). An empty string is returned if the value cannot be determined.

`platform.platform(`*aliased=0, terse=0*`)`
Returns a single string identifying the underlying platform with as much useful information as possible.

The output is intended to be *human readable* rather than machine parseable. It may look different on different platforms and this is intended.

If *aliased* is true, the function will use aliases for various platforms that report system names which differ from their common names, for example SunOS will be reported as Solaris. The *system_alias()* function is used to implement this.

Setting *terse* to true causes the function to return only the absolute minimum information needed to identify the platform.

`platform.processor()`
Returns the (real) processor name, e.g. `'amdk6'`.

An empty string is returned if the value cannot be determined. Note that many platforms do not provide this information or simply return the same value as for *machine()*. NetBSD does this.

`platform.python_build()`
Returns a tuple `(buildno, builddate)` stating the Python build number and date as strings.

`platform.python_compiler()`
Returns a string identifying the compiler used for compiling Python.

`platform.python_branch()`
Returns a string identifying the Python implementation SCM branch.

`platform.python_implementation()`
Returns a string identifying the Python implementation. Possible return values are: 'CPython', 'IronPython', 'Jython', 'PyPy'.

`platform.python_revision()`
Returns a string identifying the Python implementation SCM revision.

`platform.python_version()`
Returns the Python version as string `'major.minor.patchlevel'`.

Note that unlike the Python `sys.version`, the returned value will always include the patchlevel (it defaults to 0).

`platform.python_version_tuple()`
Returns the Python version as tuple `(major, minor, patchlevel)` of strings.

Note that unlike the Python `sys.version`, the returned value will always include the patchlevel (it defaults to `'0'`).

`platform.release()`
Returns the system's release, e.g. `'2.2.0'` or `'NT'` An empty string is returned if the value cannot be determined.

`platform.system()`
Returns the system/OS name, e.g. `'Linux'`, `'Windows'`, or `'Java'`. An empty string is returned if the value cannot be determined.

`platform.system_alias(`*system*, *release*, *version*`)`
Returns `(system, release, version)` aliased to common marketing names used for some systems. It also does some reordering of the information in some cases where it would otherwise cause confusion.

`platform.version()`
Returns the system's release version, e.g. `'#3 on degas'`. An empty string is returned if the value cannot be determined.

`platform.uname()`
Fairly portable uname interface. Returns a *namedtuple()* containing six attributes: *system*, *node*, *release*, *version*, *machine*, and *processor*.

Note that this adds a sixth attribute (*processor*) not present in the *os.uname()* result. Also, the attribute names are different for the first two attributes; *os.uname()* names them `sysname` and `nodename`.

Entries which cannot be determined are set to `''`.

Changed in version 3.3: Result changed from a tuple to a namedtuple.

16.14.2 Java Platform

`platform.java_ver`(*release=", vendor=", vminfo=(", ", "), osinfo=(", ", ")*)

Version interface for Jython.

Returns a tuple `(release, vendor, vminfo, osinfo)` with *vminfo* being a tuple `(vm_name, vm_release, vm_vendor)` and *osinfo* being a tuple `(os_name, os_version, os_arch)`. Values which cannot be determined are set to the defaults given as parameters (which all default to `''`).

16.14.3 Windows Platform

`platform.win32_ver`(*release=", version=", csd=", ptype="*)

Get additional version information from the Windows Registry and return a tuple `(release, version, csd, ptype)` referring to OS release, version number, CSD level (service pack) and OS type (multi/single processor).

As a hint: *ptype* is `'Uniprocessor Free'` on single processor NT machines and `'Multiprocessor Free'` on multi processor machines. The *'Free'* refers to the OS version being free of debugging code. It could also state *'Checked'* which means the OS version uses debugging code, i.e. code that checks arguments, ranges, etc.

Note: This function works best with Mark Hammond's `win32all` package installed, but also on Python 2.3 and later (support for this was added in Python 2.6). It obviously only runs on Win32 compatible platforms.

Win95/98 specific

`platform.popen`(*cmd, mode='r', bufsize=-1*)

Portable *popen()* interface. Find a working popen implementation preferring `win32pipe.popen()`. On Windows NT, `win32pipe.popen()` should work; on Windows 9x it hangs due to bugs in the MS C library.

Deprecated since version 3.3: This function is obsolete. Use the *subprocess* module. Check especially the *Replacing Older Functions with the subprocess Module* section.

16.14.4 Mac OS Platform

`platform.mac_ver`(*release=", versioninfo=(", ", "), machine="*)

Get Mac OS version information and return it as tuple `(release, versioninfo, machine)` with *versioninfo* being a tuple `(version, dev_stage, non_release_version)`.

Entries which cannot be determined are set to `''`. All tuple entries are strings.

16.14.5 Unix Platforms

platform.dist(*distname=", version=", id=", supported_dists=('SuSE', 'debian', 'redhat', 'mandrake', ...)*)

This is another name for *linux_distribution()*.

Deprecated since version 3.5, will be removed in version 3.8: See alternative like the distro package.

platform.linux_distribution(*distname=", version=", id=", supported_dists=('SuSE', 'debian', 'redhat', 'mandrake', ...), full_distribution_name=1*)

Tries to determine the name of the Linux OS distribution name.

`supported_dists` may be given to define the set of Linux distributions to look for. It defaults to a list of currently supported Linux distributions identified by their release file name.

If `full_distribution_name` is true (default), the full distribution read from the OS is returned. Otherwise the short name taken from `supported_dists` is used.

Returns a tuple `(distname,version,id)` which defaults to the args given as parameters. `id` is the item in parentheses after the version number. It is usually the version codename.

Deprecated since version 3.5, will be removed in version 3.8: See alternative like the distro package.

platform.libc_ver(*executable=sys.executable, lib=", version=", chunksize=16384*)

Tries to determine the libc version against which the file executable (defaults to the Python interpreter) is linked. Returns a tuple of strings `(lib, version)` which default to the given parameters in case the lookup fails.

Note that this function has intimate knowledge of how different libc versions add symbols to the executable is probably only usable for executables compiled using `gcc`.

The file is read and scanned in chunks of *chunksize* bytes.

16.15 `errno` — Standard errno system symbols

This module makes available standard `errno` system symbols. The value of each symbol is the corresponding integer value. The names and descriptions are borrowed from `linux/include/errno.h`, which should be pretty all-inclusive.

errno.errorcode

Dictionary providing a mapping from the errno value to the string name in the underlying system. For instance, `errno.errorcode[errno.EPERM]` maps to `'EPERM'`.

To translate a numeric error code to an error message, use *os.strerror()*.

Of the following list, symbols that are not used on the current platform are not defined by the module. The specific list of defined symbols is available as `errno.errorcode.keys()`. Symbols available can include:

errno.EPERM

Operation not permitted

errno.ENOENT

No such file or directory

errno.ESRCH

No such process

errno.EINTR

Interrupted system call.

See also:

This error is mapped to the exception *InterruptedError*.

`errno.EIO`
I/O error

`errno.ENXIO`
No such device or address

`errno.E2BIG`
Arg list too long

`errno.ENOEXEC`
Exec format error

`errno.EBADF`
Bad file number

`errno.ECHILD`
No child processes

`errno.EAGAIN`
Try again

`errno.ENOMEM`
Out of memory

`errno.EACCES`
Permission denied

`errno.EFAULT`
Bad address

`errno.ENOTBLK`
Block device required

`errno.EBUSY`
Device or resource busy

`errno.EEXIST`
File exists

`errno.EXDEV`
Cross-device link

`errno.ENODEV`
No such device

`errno.ENOTDIR`
Not a directory

`errno.EISDIR`
Is a directory

`errno.EINVAL`
Invalid argument

`errno.ENFILE`
File table overflow

`errno.EMFILE`
Too many open files

`errno.ENOTTY`
Not a typewriter

`errno.ETXTBSY`
Text file busy

`errno.EFBIG`
: File too large

`errno.ENOSPC`
: No space left on device

`errno.ESPIPE`
: Illegal seek

`errno.EROFS`
: Read-only file system

`errno.EMLINK`
: Too many links

`errno.EPIPE`
: Broken pipe

`errno.EDOM`
: Math argument out of domain of func

`errno.ERANGE`
: Math result not representable

`errno.EDEADLK`
: Resource deadlock would occur

`errno.ENAMETOOLONG`
: File name too long

`errno.ENOLCK`
: No record locks available

`errno.ENOSYS`
: Function not implemented

`errno.ENOTEMPTY`
: Directory not empty

`errno.ELOOP`
: Too many symbolic links encountered

`errno.EWOULDBLOCK`
: Operation would block

`errno.ENOMSG`
: No message of desired type

`errno.EIDRM`
: Identifier removed

`errno.ECHRNG`
: Channel number out of range

`errno.EL2NSYNC`
: Level 2 not synchronized

`errno.EL3HLT`
: Level 3 halted

`errno.EL3RST`
: Level 3 reset

`errno.ELNRNG`
: Link number out of range

errno.EUNATCH
: Protocol driver not attached

errno.ENOCSI
: No CSI structure available

errno.EL2HLT
: Level 2 halted

errno.EBADE
: Invalid exchange

errno.EBADR
: Invalid request descriptor

errno.EXFULL
: Exchange full

errno.ENOANO
: No anode

errno.EBADRQC
: Invalid request code

errno.EBADSLT
: Invalid slot

errno.EDEADLOCK
: File locking deadlock error

errno.EBFONT
: Bad font file format

errno.ENOSTR
: Device not a stream

errno.ENODATA
: No data available

errno.ETIME
: Timer expired

errno.ENOSR
: Out of streams resources

errno.ENONET
: Machine is not on the network

errno.ENOPKG
: Package not installed

errno.EREMOTE
: Object is remote

errno.ENOLINK
: Link has been severed

errno.EADV
: Advertise error

errno.ESRMNT
: Srmount error

errno.ECOMM
: Communication error on send

`errno.EPROTO`
Protocol error

`errno.EMULTIHOP`
Multihop attempted

`errno.EDOTDOT`
RFS specific error

`errno.EBADMSG`
Not a data message

`errno.EOVERFLOW`
Value too large for defined data type

`errno.ENOTUNIQ`
Name not unique on network

`errno.EBADFD`
File descriptor in bad state

`errno.EREMCHG`
Remote address changed

`errno.ELIBACC`
Can not access a needed shared library

`errno.ELIBBAD`
Accessing a corrupted shared library

`errno.ELIBSCN`
.lib section in a.out corrupted

`errno.ELIBMAX`
Attempting to link in too many shared libraries

`errno.ELIBEXEC`
Cannot exec a shared library directly

`errno.EILSEQ`
Illegal byte sequence

`errno.ERESTART`
Interrupted system call should be restarted

`errno.ESTRPIPE`
Streams pipe error

`errno.EUSERS`
Too many users

`errno.ENOTSOCK`
Socket operation on non-socket

`errno.EDESTADDRREQ`
Destination address required

`errno.EMSGSIZE`
Message too long

`errno.EPROTOTYPE`
Protocol wrong type for socket

`errno.ENOPROTOOPT`
Protocol not available

errno.**EPROTONOSUPPORT**
Protocol not supported

errno.**ESOCKTNOSUPPORT**
Socket type not supported

errno.**EOPNOTSUPP**
Operation not supported on transport endpoint

errno.**EPFNOSUPPORT**
Protocol family not supported

errno.**EAFNOSUPPORT**
Address family not supported by protocol

errno.**EADDRINUSE**
Address already in use

errno.**EADDRNOTAVAIL**
Cannot assign requested address

errno.**ENETDOWN**
Network is down

errno.**ENETUNREACH**
Network is unreachable

errno.**ENETRESET**
Network dropped connection because of reset

errno.**ECONNABORTED**
Software caused connection abort

errno.**ECONNRESET**
Connection reset by peer

errno.**ENOBUFS**
No buffer space available

errno.**EISCONN**
Transport endpoint is already connected

errno.**ENOTCONN**
Transport endpoint is not connected

errno.**ESHUTDOWN**
Cannot send after transport endpoint shutdown

errno.**ETOOMANYREFS**
Too many references: cannot splice

errno.**ETIMEDOUT**
Connection timed out

errno.**ECONNREFUSED**
Connection refused

errno.**EHOSTDOWN**
Host is down

errno.**EHOSTUNREACH**
No route to host

errno.**EALREADY**
Operation already in progress

errno.EINPROGRESS
Operation now in progress

errno.ESTALE
Stale NFS file handle

errno.EUCLEAN
Structure needs cleaning

errno.ENOTNAM
Not a XENIX named type file

errno.ENAVAIL
No XENIX semaphores available

errno.EISNAM
Is a named type file

errno.EREMOTEIO
Remote I/O error

errno.EDQUOT
Quota exceeded

16.16 `ctypes` — A foreign function library for Python

ctypes is a foreign function library for Python. It provides C compatible data types, and allows calling functions in DLLs or shared libraries. It can be used to wrap these libraries in pure Python.

16.16.1 ctypes tutorial

Note: The code samples in this tutorial use *doctest* to make sure that they actually work. Since some code samples behave differently under Linux, Windows, or Mac OS X, they contain doctest directives in comments.

Note: Some code samples reference the ctypes *c_int* type. On platforms where `sizeof(long) == sizeof(int)` it is an alias to *c_long*. So, you should not be confused if *c_long* is printed if you would expect *c_int* — they are actually the same type.

Loading dynamic link libraries

ctypes exports the *cdll*, and on Windows *windll* and *oledll* objects, for loading dynamic link libraries.

You load libraries by accessing them as attributes of these objects. *cdll* loads libraries which export functions using the standard `cdecl` calling convention, while *windll* libraries call functions using the `stdcall` calling convention. *oledll* also uses the `stdcall` calling convention, and assumes the functions return a Windows `HRESULT` error code. The error code is used to automatically raise an *OSError* exception when the function call fails.

Changed in version 3.3: Windows errors used to raise *WindowsError*, which is now an alias of *OSError*.

Here are some examples for Windows. Note that `msvcrt` is the MS standard C library containing most standard C functions, and uses the cdecl calling convention:

```
>>> from ctypes import *
>>> print(windll.kernel32)
<WinDLL 'kernel32', handle ... at ...>
>>> print(cdll.msvcrt)
<CDLL 'msvcrt', handle ... at ...>
>>> libc = cdll.msvcrt
>>>
```

Windows appends the usual `.dll` file suffix automatically.

Note: Accessing the standard C library through `cdll.msvcrt` will use an outdated version of the library that may be incompatible with the one being used by Python. Where possible, use native Python functionality, or else import and use the `msvcrt` module.

On Linux, it is required to specify the filename *including* the extension to load a library, so attribute access can not be used to load libraries. Either the `LoadLibrary()` method of the dll loaders should be used, or you should load the library by creating an instance of CDLL by calling the constructor:

```
>>> cdll.LoadLibrary("libc.so.6")
<CDLL 'libc.so.6', handle ... at ...>
>>> libc = CDLL("libc.so.6")
>>> libc
<CDLL 'libc.so.6', handle ... at ...>
>>>
```

Accessing functions from loaded dlls

Functions are accessed as attributes of dll objects:

```
>>> from ctypes import *
>>> libc.printf
<_FuncPtr object at 0x...>
>>> print(windll.kernel32.GetModuleHandleA)
<_FuncPtr object at 0x...>
>>> print(windll.kernel32.MyOwnFunction)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
  File "ctypes.py", line 239, in __getattr__
    func = _StdcallFuncPtr(name, self)
AttributeError: function 'MyOwnFunction' not found
>>>
```

Note that win32 system dlls like `kernel32` and `user32` often export ANSI as well as UNICODE versions of a function. The UNICODE version is exported with an `W` appended to the name, while the ANSI version is exported with an `A` appended to the name. The win32 `GetModuleHandle` function, which returns a *module handle* for a given module name, has the following C prototype, and a macro is used to expose one of them as `GetModuleHandle` depending on whether UNICODE is defined or not:

```
/* ANSI version */
HMODULE GetModuleHandleA(LPCSTR lpModuleName);
/* UNICODE version */
HMODULE GetModuleHandleW(LPCWSTR lpModuleName);
```

windll does not try to select one of them by magic, you must access the version you need by specifying `GetModuleHandleA` or `GetModuleHandleW` explicitly, and then call it with bytes or string objects respectively.

Sometimes, dlls export functions with names which aren't valid Python identifiers, like `"??2@YAPAXI@Z"`. In this case you have to use *getattr()* to retrieve the function:

```
>>> getattr(cdll.msvcrt, "??2@YAPAXI@Z")
<_FuncPtr object at 0x...>
>>>
```

On Windows, some dlls export functions not by name but by ordinal. These functions can be accessed by indexing the dll object with the ordinal number:

```
>>> cdll.kernel32[1]
<_FuncPtr object at 0x...>
>>> cdll.kernel32[0]
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
  File "ctypes.py", line 310, in __getitem__
    func = _StdcallFuncPtr(name, self)
AttributeError: function ordinal 0 not found
>>>
```

Calling functions

You can call these functions like any other Python callable. This example uses the `time()` function, which returns system time in seconds since the Unix epoch, and the `GetModuleHandleA()` function, which returns a win32 module handle.

This example calls both functions with a NULL pointer (`None` should be used as the NULL pointer):

```
>>> print(libc.time(None))
1150640792
>>> print(hex(windll.kernel32.GetModuleHandleA(None)))
0x1d000000
>>>
```

Note: *ctypes* may raise a *ValueError* after calling the function, if it detects that an invalid number of arguments were passed. This behavior should not be relied upon. It is deprecated in 3.6.2, and will be removed in 3.7.

ValueError is raised when you call an `stdcall` function with the `cdecl` calling convention, or vice versa:

```
>>> cdll.kernel32.GetModuleHandleA(None)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: Procedure probably called with not enough arguments (4 bytes missing)
>>>

>>> windll.msvcrt.printf(b"spam")
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
```

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```
ValueError: Procedure probably called with too many arguments (4 bytes in excess)
>>>
```

To find out the correct calling convention you have to look into the C header file or the documentation for the function you want to call.

On Windows, *ctypes* uses win32 structured exception handling to prevent crashes from general protection faults when functions are called with invalid argument values:

```
>>> windll.kernel32.GetModuleHandleA(32)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
OSError: exception: access violation reading 0x00000020
>>>
```

There are, however, enough ways to crash Python with *ctypes*, so you should be careful anyway. The *faulthandler* module can be helpful in debugging crashes (e.g. from segmentation faults produced by erroneous C library calls).

`None`, integers, bytes objects and (unicode) strings are the only native Python objects that can directly be used as parameters in these function calls. `None` is passed as a C `NULL` pointer, bytes objects and strings are passed as pointer to the memory block that contains their data (`char *` or `wchar_t *`). Python integers are passed as the platforms default C `int` type, their value is masked to fit into the C type.

Before we move on calling functions with other parameter types, we have to learn more about *ctypes* data types.

Fundamental data types

ctypes defines a number of primitive C compatible data types:

ctypes type	C type	Python type
c_bool	`_Bool`	bool (1)
c_char	`char`	1-character bytes object
c_wchar	`wchar_t`	1-character string
c_byte	`char`	int
c_ubyte	`unsigned char`	int
c_short	`short`	int
c_ushort	`unsigned short`	int
c_int	`int`	int
c_uint	`unsigned int`	int
c_long	`long`	int
c_ulong	`unsigned long`	int
c_longlong	`__int64` or `long long`	int
c_ulonglong	`unsigned __int64` or `unsigned long long`	int
c_size_t	`size_t`	int
c_ssize_t	`ssize_t` or `Py_ssize_t`	int
c_float	`float`	float
c_double	`double`	float
c_longdouble	`long double`	float
c_char_p	`char *` (NUL terminated)	bytes object or `None`
c_wchar_p	`wchar_t *` (NUL terminated)	string or `None`
c_void_p	`void *`	int or `None`

(1) The constructor accepts any object with a truth value.

All these types can be created by calling them with an optional initializer of the correct type and value:

```
>>> c_int()
c_long(0)
>>> c_wchar_p("Hello, World")
c_wchar_p(140018365411392)
>>> c_ushort(-3)
c_ushort(65533)
>>>
```

Since these types are mutable, their value can also be changed afterwards:

```
>>> i = c_int(42)
>>> print(i)
c_long(42)
>>> print(i.value)
42
>>> i.value = -99
>>> print(i.value)
-99
>>>
```

Assigning a new value to instances of the pointer types *c_char_p*, *c_wchar_p*, and *c_void_p* changes the *memory location* they point to, *not the contents* of the memory block (of course not, because Python bytes objects are immutable):

```
>>> s = "Hello, World"
>>> c_s = c_wchar_p(s)
>>> print(c_s)
c_wchar_p(139966785747344)
>>> print(c_s.value)
Hello World
>>> c_s.value = "Hi, there"
>>> print(c_s)              # the memory location has changed
c_wchar_p(139966783348904)
>>> print(c_s.value)
Hi, there
>>> print(s)                # first object is unchanged
Hello, World
>>>
```

You should be careful, however, not to pass them to functions expecting pointers to mutable memory. If you need mutable memory blocks, ctypes has a *create_string_buffer()* function which creates these in various ways. The current memory block contents can be accessed (or changed) with the `raw` property; if you want to access it as NUL terminated string, use the `value` property:

```
>>> from ctypes import *
>>> p = create_string_buffer(3)            # create a 3 byte buffer, initialized to NUL␣
↪bytes
>>> print(sizeof(p), repr(p.raw))
3 b'\x00\x00\x00'
>>> p = create_string_buffer(b"Hello")      # create a buffer containing a NUL terminated␣
↪string
```

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```
>>> print(sizeof(p), repr(p.raw))
6 b'Hello\x00'
>>> print(repr(p.value))
b'Hello'
>>> p = create_string_buffer(b"Hello", 10) # create a 10 byte buffer
>>> print(sizeof(p), repr(p.raw))
10 b'Hello\x00\x00\x00\x00\x00'
>>> p.value = b"Hi"
>>> print(sizeof(p), repr(p.raw))
10 b'Hi\x00lo\x00\x00\x00\x00\x00'
>>>
```

The *create_string_buffer()* function replaces the `c_buffer()` function (which is still available as an alias), as well as the `c_string()` function from earlier ctypes releases. To create a mutable memory block containing unicode characters of the C type `wchar_t` use the *create_unicode_buffer()* function.

Calling functions, continued

Note that printf prints to the real standard output channel, *not* to *sys.stdout*, so these examples will only work at the console prompt, not from within *IDLE* or *PythonWin*:

```
>>> printf = libc.printf
>>> printf(b"Hello, %s\n", b"World!")
Hello, World!
14
>>> printf(b"Hello, %S\n", "World!")
Hello, World!
14
>>> printf(b"%d bottles of beer\n", 42)
42 bottles of beer
19
>>> printf(b"%f bottles of beer\n", 42.5)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ArgumentError: argument 2: exceptions.TypeError: Don't know how to convert parameter 2
>>>
```

As has been mentioned before, all Python types except integers, strings, and bytes objects have to be wrapped in their corresponding *ctypes* type, so that they can be converted to the required C data type:

```
>>> printf(b"An int %d, a double %f\n", 1234, c_double(3.14))
An int 1234, a double 3.140000
31
>>>
```

Calling functions with your own custom data types

You can also customize *ctypes* argument conversion to allow instances of your own classes be used as function arguments. *ctypes* looks for an `_as_parameter_` attribute and uses this as the function argument. Of course, it must be one of integer, string, or bytes:

```
>>> class Bottles:
...     def __init__(self, number):
...         self._as_parameter_ = number
...
>>> bottles = Bottles(42)
>>> printf(b"%d bottles of beer\n", bottles)
42 bottles of beer
19
>>>
```

If you don't want to store the instance's data in the `_as_parameter_` instance variable, you could define a *property* which makes the attribute available on request.

Specifying the required argument types (function prototypes)

It is possible to specify the required argument types of functions exported from DLLs by setting the `argtypes` attribute.

`argtypes` must be a sequence of C data types (the `printf` function is probably not a good example here, because it takes a variable number and different types of parameters depending on the format string, on the other hand this is quite handy to experiment with this feature):

```
>>> printf.argtypes = [c_char_p, c_char_p, c_int, c_double]
>>> printf(b"String '%s', Int %d, Double %f\n", b"Hi", 10, 2.2)
String 'Hi', Int 10, Double 2.200000
37
>>>
```

Specifying a format protects against incompatible argument types (just as a prototype for a C function), and tries to convert the arguments to valid types:

```
>>> printf(b"%d %d %d", 1, 2, 3)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ArgumentError: argument 2: exceptions.TypeError: wrong type
>>> printf(b"%s %d %f\n", b"X", 2, 3)
X 2 3.000000
13
>>>
```

If you have defined your own classes which you pass to function calls, you have to implement a `from_param()` class method for them to be able to use them in the `argtypes` sequence. The `from_param()` class method receives the Python object passed to the function call, it should do a typecheck or whatever is needed to make sure this object is acceptable, and then return the object itself, its `_as_parameter_` attribute, or whatever you want to pass as the C function argument in this case. Again, the result should be an integer, string, bytes, a *ctypes* instance, or an object with an `_as_parameter_` attribute.

Return types

By default functions are assumed to return the C `int` type. Other return types can be specified by setting the `restype` attribute of the function object.

Here is a more advanced example, it uses the `strchr` function, which expects a string pointer and a char, and returns a pointer to a string:

```
>>> strchr = libc.strchr
>>> strchr(b"abcdef", ord("d"))
8059983
>>> strchr.restype = c_char_p    # c_char_p is a pointer to a string
>>> strchr(b"abcdef", ord("d"))
b'def'
>>> print(strchr(b"abcdef", ord("x")))
None
>>>
```

If you want to avoid the `ord("x")` calls above, you can set the `argtypes` attribute, and the second argument will be converted from a single character Python bytes object into a C char:

```
>>> strchr.restype = c_char_p
>>> strchr.argtypes = [c_char_p, c_char]
>>> strchr(b"abcdef", b"d")
'def'
>>> strchr(b"abcdef", b"def")
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ArgumentError: argument 2: exceptions.TypeError: one character string expected
>>> print(strchr(b"abcdef", b"x"))
None
>>> strchr(b"abcdef", b"d")
'def'
>>>
```

You can also use a callable Python object (a function or a class for example) as the `restype` attribute, if the foreign function returns an integer. The callable will be called with the *integer* the C function returns, and the result of this call will be used as the result of your function call. This is useful to check for error return values and automatically raise an exception:

```
>>> GetModuleHandle = windll.kernel32.GetModuleHandleA
>>> def ValidHandle(value):
...     if value == 0:
...         raise WinError()
...     return value
...
>>>
>>> GetModuleHandle.restype = ValidHandle
>>> GetModuleHandle(None)
486539264
>>> GetModuleHandle("something silly")
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
  File "<stdin>", line 3, in ValidHandle
OSError: [Errno 126] The specified module could not be found.
>>>
```

`WinError` is a function which will call Windows `FormatMessage()` api to get the string representation of an error code, and *returns* an exception. `WinError` takes an optional error code parameter, if no one is used, it calls *GetLastError()* to retrieve it.

Please note that a much more powerful error checking mechanism is available through the `errcheck` attribute; see the reference manual for details.

Passing pointers (or: passing parameters by reference)

Sometimes a C api function expects a *pointer* to a data type as parameter, probably to write into the corresponding location, or if the data is too large to be passed by value. This is also known as *passing parameters by reference*.

`ctypes` exports the `byref()` function which is used to pass parameters by reference. The same effect can be achieved with the `pointer()` function, although `pointer()` does a lot more work since it constructs a real pointer object, so it is faster to use `byref()` if you don't need the pointer object in Python itself:

```
>>> i = c_int()
>>> f = c_float()
>>> s = create_string_buffer(b'\000' * 32)
>>> print(i.value, f.value, repr(s.value))
0 0.0 b''
>>> libc.sscanf(b"1 3.14 Hello", b"%d %f %s",
...             byref(i), byref(f), s)
3
>>> print(i.value, f.value, repr(s.value))
1 3.1400001049 b'Hello'
>>>
```

Structures and unions

Structures and unions must derive from the `Structure` and `Union` base classes which are defined in the `ctypes` module. Each subclass must define a `_fields_` attribute. `_fields_` must be a list of *2-tuples*, containing a *field name* and a *field type*.

The field type must be a `ctypes` type like `c_int`, or any other derived `ctypes` type: structure, union, array, pointer.

Here is a simple example of a POINT structure, which contains two integers named *x* and *y*, and also shows how to initialize a structure in the constructor:

```
>>> from ctypes import *
>>> class POINT(Structure):
...     _fields_ = [("x", c_int),
...                 ("y", c_int)]
...
>>> point = POINT(10, 20)
>>> print(point.x, point.y)
10 20
>>> point = POINT(y=5)
>>> print(point.x, point.y)
0 5
>>> POINT(1, 2, 3)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ValueError: too many initializers
>>>
```

You can, however, build much more complicated structures. A structure can itself contain other structures by using a structure as a field type.

Here is a RECT structure which contains two POINTs named *upperleft* and *lowerright*:

```
>>> class RECT(Structure):
...     _fields_ = [("upperleft", POINT),
...                 ("lowerright", POINT)]
...
>>> rc = RECT(point)
>>> print(rc.upperleft.x, rc.upperleft.y)
0 5
>>> print(rc.lowerright.x, rc.lowerright.y)
0 0
>>>
```

Nested structures can also be initialized in the constructor in several ways:

```
>>> r = RECT(POINT(1, 2), POINT(3, 4))
>>> r = RECT((1, 2), (3, 4))
```

Field *descriptor*s can be retrieved from the *class*, they are useful for debugging because they can provide useful information:

```
>>> print(POINT.x)
<Field type=c_long, ofs=0, size=4>
>>> print(POINT.y)
<Field type=c_long, ofs=4, size=4>
>>>
```

Warning: *ctypes* does not support passing unions or structures with bit-fields to functions by value. While this may work on 32-bit x86, it's not guaranteed by the library to work in the general case. Unions and structures with bit-fields should always be passed to functions by pointer.

Structure/union alignment and byte order

By default, Structure and Union fields are aligned in the same way the C compiler does it. It is possible to override this behavior be specifying a `_pack_` class attribute in the subclass definition. This must be set to a positive integer and specifies the maximum alignment for the fields. This is what `#pragma pack(n)` also does in MSVC.

ctypes uses the native byte order for Structures and Unions. To build structures with non-native byte order, you can use one of the *BigEndianStructure*, *LittleEndianStructure*, `BigEndianUnion`, and `LittleEndianUnion` base classes. These classes cannot contain pointer fields.

Bit fields in structures and unions

It is possible to create structures and unions containing bit fields. Bit fields are only possible for integer fields, the bit width is specified as the third item in the `_fields_` tuples:

```
>>> class Int(Structure):
...     _fields_ = [("first_16", c_int, 16),
...                 ("second_16", c_int, 16)]
...
>>> print(Int.first_16)
<Field type=c_long, ofs=0:0, bits=16>
```

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```
>>> print(Int.second_16)
<Field type=c_long, ofs=0:16, bits=16>
>>>
```

Arrays

Arrays are sequences, containing a fixed number of instances of the same type.

The recommended way to create array types is by multiplying a data type with a positive integer:

```
TenPointsArrayType = POINT * 10
```

Here is an example of a somewhat artificial data type, a structure containing 4 POINTs among other stuff:

```
>>> from ctypes import *
>>> class POINT(Structure):
...     _fields_ = ("x", c_int), ("y", c_int)
...
>>> class MyStruct(Structure):
...     _fields_ = [("a", c_int),
...                 ("b", c_float),
...                 ("point_array", POINT * 4)]
>>>
>>> print(len(MyStruct().point_array))
4
>>>
```

Instances are created in the usual way, by calling the class:

```
arr = TenPointsArrayType()
for pt in arr:
    print(pt.x, pt.y)
```

The above code print a series of `0 0` lines, because the array contents is initialized to zeros.

Initializers of the correct type can also be specified:

```
>>> from ctypes import *
>>> TenIntegers = c_int * 10
>>> ii = TenIntegers(1, 2, 3, 4, 5, 6, 7, 8, 9, 10)
>>> print(ii)
<c_long_Array_10 object at 0x...>
>>> for i in ii: print(i, end=" ")
...
1 2 3 4 5 6 7 8 9 10
>>>
```

Pointers

Pointer instances are created by calling the *pointer()* function on a *ctypes* type:

```
>>> from ctypes import *
>>> i = c_int(42)
>>> pi = pointer(i)
>>>
```

Pointer instances have a *contents* attribute which returns the object to which the pointer points, the `i` object above:

```
>>> pi.contents
c_long(42)
>>>
```

Note that *ctypes* does not have OOR (original object return), it constructs a new, equivalent object each time you retrieve an attribute:

```
>>> pi.contents is i
False
>>> pi.contents is pi.contents
False
>>>
```

Assigning another *c_int* instance to the pointer's contents attribute would cause the pointer to point to the memory location where this is stored:

```
>>> i = c_int(99)
>>> pi.contents = i
>>> pi.contents
c_long(99)
>>>
```

Pointer instances can also be indexed with integers:

```
>>> pi[0]
99
>>>
```

Assigning to an integer index changes the pointed to value:

```
>>> print(i)
c_long(99)
>>> pi[0] = 22
>>> print(i)
c_long(22)
>>>
```

It is also possible to use indexes different from 0, but you must know what you're doing, just as in C: You can access or change arbitrary memory locations. Generally you only use this feature if you receive a pointer from a C function, and you *know* that the pointer actually points to an array instead of a single item.

Behind the scenes, the *pointer()* function does more than simply create pointer instances, it has to create pointer *types* first. This is done with the *POINTER()* function, which accepts any *ctypes* type, and returns a new type:

```
>>> PI = POINTER(c_int)
>>> PI
```

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```
<class 'ctypes.LP_c_long'>
>>> PI(42)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: expected c_long instead of int
>>> PI(c_int(42))
<ctypes.LP_c_long object at 0x...>
>>>
```

Calling the pointer type without an argument creates a `NULL` pointer. `NULL` pointers have a `False` boolean value:

```
>>> null_ptr = POINTER(c_int)()
>>> print(bool(null_ptr))
False
>>>
```

ctypes checks for `NULL` when dereferencing pointers (but dereferencing invalid non-`NULL` pointers would crash Python):

```
>>> null_ptr[0]
Traceback (most recent call last):
    ....
ValueError: NULL pointer access
>>>

>>> null_ptr[0] = 1234
Traceback (most recent call last):
    ....
ValueError: NULL pointer access
>>>
```

Type conversions

Usually, ctypes does strict type checking. This means, if you have `POINTER(c_int)` in the `argtypes` list of a function or as the type of a member field in a structure definition, only instances of exactly the same type are accepted. There are some exceptions to this rule, where ctypes accepts other objects. For example, you can pass compatible array instances instead of pointer types. So, for `POINTER(c_int)`, ctypes accepts an array of c_int:

```
>>> class Bar(Structure):
...     _fields_ = [("count", c_int), ("values", POINTER(c_int))]
...
>>> bar = Bar()
>>> bar.values = (c_int * 3)(1, 2, 3)
>>> bar.count = 3
>>> for i in range(bar.count):
...     print(bar.values[i])
...
1
2
```

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```
3
>>>
```

In addition, if a function argument is explicitly declared to be a pointer type (such as `POINTER(c_int)`) in `argtypes`, an object of the pointed type (`c_int` in this case) can be passed to the function. ctypes will apply the required *byref()* conversion in this case automatically.

To set a POINTER type field to `NULL`, you can assign `None`:

```
>>> bar.values = None
>>>
```

Sometimes you have instances of incompatible types. In C, you can cast one type into another type. *ctypes* provides a *cast()* function which can be used in the same way. The `Bar` structure defined above accepts `POINTER(c_int)` pointers or *c_int* arrays for its `values` field, but not instances of other types:

```
>>> bar.values = (c_byte * 4)()
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: incompatible types, c_byte_Array_4 instance instead of LP_c_long instance
>>>
```

For these cases, the *cast()* function is handy.

The *cast()* function can be used to cast a ctypes instance into a pointer to a different ctypes data type. *cast()* takes two parameters, a ctypes object that is or can be converted to a pointer of some kind, and a ctypes pointer type. It returns an instance of the second argument, which references the same memory block as the first argument:

```
>>> a = (c_byte * 4)()
>>> cast(a, POINTER(c_int))
<ctypes.LP_c_long object at ...>
>>>
```

So, *cast()* can be used to assign to the `values` field of `Bar` the structure:

```
>>> bar = Bar()
>>> bar.values = cast((c_byte * 4)(), POINTER(c_int))
>>> print(bar.values[0])
0
>>>
```

Incomplete Types

Incomplete Types are structures, unions or arrays whose members are not yet specified. In C, they are specified by forward declarations, which are defined later:

```
struct cell; /* forward declaration */

struct cell {
    char *name;
    struct cell *next;
};
```

The straightforward translation into ctypes code would be this, but it does not work:

```
>>> class cell(Structure):
...     _fields_ = [("name", c_char_p),
...                 ("next", POINTER(cell))]
...
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
  File "<stdin>", line 2, in cell
NameError: name 'cell' is not defined
>>>
```

because the new `class cell` is not available in the class statement itself. In *ctypes*, we can define the `cell` class and set the `_fields_` attribute later, after the class statement:

```
>>> from ctypes import *
>>> class cell(Structure):
...     pass
...
>>> cell._fields_ = [("name", c_char_p),
...                  ("next", POINTER(cell))]
>>>
```

Lets try it. We create two instances of `cell`, and let them point to each other, and finally follow the pointer chain a few times:

```
>>> c1 = cell()
>>> c1.name = "foo"
>>> c2 = cell()
>>> c2.name = "bar"
>>> c1.next = pointer(c2)
>>> c2.next = pointer(c1)
>>> p = c1
>>> for i in range(8):
...     print(p.name, end=" ")
...     p = p.next[0]
...
foo bar foo bar foo bar foo bar
>>>
```

Callback functions

ctypes allows creating C callable function pointers from Python callables. These are sometimes called *callback functions*.

First, you must create a class for the callback function. The class knows the calling convention, the return type, and the number and types of arguments this function will receive.

The *CFUNCTYPE()* factory function creates types for callback functions using the `cdecl` calling convention. On Windows, the *WINFUNCTYPE()* factory function creates types for callback functions using the `stdcall` calling convention.

Both of these factory functions are called with the result type as first argument, and the callback functions expected argument types as the remaining arguments.

I will present an example here which uses the standard C library's `qsort()` function, that is used to sort items with the help of a callback function. `qsort()` will be used to sort an array of integers:

```
>>> IntArray5 = c_int * 5
>>> ia = IntArray5(5, 1, 7, 33, 99)
>>> qsort = libc.qsort
>>> qsort.restype = None
>>>
```

`qsort()` must be called with a pointer to the data to sort, the number of items in the data array, the size of one item, and a pointer to the comparison function, the callback. The callback will then be called with two pointers to items, and it must return a negative integer if the first item is smaller than the second, a zero if they are equal, and a positive integer otherwise.

So our callback function receives pointers to integers, and must return an integer. First we create the `type` for the callback function:

```
>>> CMPFUNC = CFUNCTYPE(c_int, POINTER(c_int), POINTER(c_int))
>>>
```

To get started, here is a simple callback that shows the values it gets passed:

```
>>> def py_cmp_func(a, b):
...     print("py_cmp_func", a[0], b[0])
...     return 0
...
>>> cmp_func = CMPFUNC(py_cmp_func)
>>>
```

The result:

```
>>> qsort(ia, len(ia), sizeof(c_int), cmp_func)
py_cmp_func 5 1
py_cmp_func 33 99
py_cmp_func 7 33
py_cmp_func 5 7
py_cmp_func 1 7
>>>
```

Now we can actually compare the two items and return a useful result:

```
>>> def py_cmp_func(a, b):
...     print("py_cmp_func", a[0], b[0])
...     return a[0] - b[0]
...
>>>
>>> qsort(ia, len(ia), sizeof(c_int), CMPFUNC(py_cmp_func))
py_cmp_func 5 1
py_cmp_func 33 99
py_cmp_func 7 33
py_cmp_func 1 7
py_cmp_func 5 7
>>>
```

As we can easily check, our array is sorted now:

```
>>> for i in ia: print(i, end=" ")
...
1 5 7 33 99
>>>
```

The function factories can be used as decorator factories, so we may as well write:

```
>>> @CFUNCTYPE(c_int, POINTER(c_int), POINTER(c_int))
... def py_cmp_func(a, b):
...     print("py_cmp_func", a[0], b[0])
...     return a[0] - b[0]
...
>>> qsort(ia, len(ia), sizeof(c_int), py_cmp_func)
py_cmp_func 5 1
py_cmp_func 33 99
py_cmp_func 7 33
py_cmp_func 1 7
py_cmp_func 5 7
>>>
```

Note: Make sure you keep references to *CFUNCTYPE()* objects as long as they are used from C code. *ctypes* doesn't, and if you don't, they may be garbage collected, crashing your program when a callback is made.

Also, note that if the callback function is called in a thread created outside of Python's control (e.g. by the foreign code that calls the callback), ctypes creates a new dummy Python thread on every invocation. This behavior is correct for most purposes, but it means that values stored with *threading.local* will *not* survive across different callbacks, even when those calls are made from the same C thread.

Accessing values exported from dlls

Some shared libraries not only export functions, they also export variables. An example in the Python library itself is the `Py_OptimizeFlag`, an integer set to 0, 1, or 2, depending on the `-O` or `-OO` flag given on startup.

ctypes can access values like this with the `in_dll()` class methods of the type. *pythonapi* is a predefined symbol giving access to the Python C api:

```
>>> opt_flag = c_int.in_dll(pythonapi, "Py_OptimizeFlag")
>>> print(opt_flag)
c_long(0)
>>>
```

If the interpreter would have been started with `-O`, the sample would have printed `c_long(1)`, or `c_long(2)` if `-OO` would have been specified.

An extended example which also demonstrates the use of pointers accesses the `PyImport_FrozenModules` pointer exported by Python.

Quoting the docs for that value:

> This pointer is initialized to point to an array of `struct _frozen` records, terminated by one whose members are all *NULL* or zero. When a frozen module is imported, it is searched in this table. Third-party code could play tricks with this to provide a dynamically created collection of frozen modules.

So manipulating this pointer could even prove useful. To restrict the example size, we show only how this table can be read with *ctypes*:

```
>>> from ctypes import *
>>>
>>> class struct_frozen(Structure):
...     _fields_ = [("name", c_char_p),
...                 ("code", POINTER(c_ubyte)),
...                 ("size", c_int)]
...
>>>
```

We have defined the `struct _frozen` data type, so we can get the pointer to the table:

```
>>> FrozenTable = POINTER(struct_frozen)
>>> table = FrozenTable.in_dll(pythonapi, "PyImport_FrozenModules")
>>>
```

Since `table` is a `pointer` to the array of `struct_frozen` records, we can iterate over it, but we just have to make sure that our loop terminates, because pointers have no size. Sooner or later it would probably crash with an access violation or whatever, so it's better to break out of the loop when we hit the NULL entry:

```
>>> for item in table:
...     if item.name is None:
...         break
...     print(item.name.decode("ascii"), item.size)
...
_frozen_importlib 31764
_frozen_importlib_external 41499
__hello__ 161
__phello__ -161
__phello__.spam 161
>>>
```

The fact that standard Python has a frozen module and a frozen package (indicated by the negative size member) is not well known, it is only used for testing. Try it out with `import __hello__` for example.

Surprises

There are some edges in *ctypes* where you might expect something other than what actually happens.

Consider the following example:

```
>>> from ctypes import *
>>> class POINT(Structure):
...     _fields_ = ("x", c_int), ("y", c_int)
...
>>> class RECT(Structure):
...     _fields_ = ("a", POINT), ("b", POINT)
...
>>> p1 = POINT(1, 2)
>>> p2 = POINT(3, 4)
>>> rc = RECT(p1, p2)
>>> print(rc.a.x, rc.a.y, rc.b.x, rc.b.y)
```

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```
1 2 3 4
>>> # now swap the two points
>>> rc.a, rc.b = rc.b, rc.a
>>> print(rc.a.x, rc.a.y, rc.b.x, rc.b.y)
3 4 3 4
>>>
```

Hm. We certainly expected the last statement to print `3 4 1 2`. What happened? Here are the steps of the `rc.a, rc.b = rc.b, rc.a` line above:

```
>>> temp0, temp1 = rc.b, rc.a
>>> rc.a = temp0
>>> rc.b = temp1
>>>
```

Note that `temp0` and `temp1` are objects still using the internal buffer of the `rc` object above. So executing `rc.a = temp0` copies the buffer contents of `temp0` into `rc` 's buffer. This, in turn, changes the contents of `temp1`. So, the last assignment `rc.b = temp1`, doesn't have the expected effect.

Keep in mind that retrieving sub-objects from Structure, Unions, and Arrays doesn't *copy* the sub-object, instead it retrieves a wrapper object accessing the root-object's underlying buffer.

Another example that may behave different from what one would expect is this:

```
>>> s = c_char_p()
>>> s.value = "abc def ghi"
>>> s.value
'abc def ghi'
>>> s.value is s.value
False
>>>
```

Why is it printing `False`? ctypes instances are objects containing a memory block plus some *descriptor*s accessing the contents of the memory. Storing a Python object in the memory block does not store the object itself, instead the `contents` of the object is stored. Accessing the contents again constructs a new Python object each time!

Variable-sized data types

`ctypes` provides some support for variable-sized arrays and structures.

The *`resize()`* function can be used to resize the memory buffer of an existing ctypes object. The function takes the object as first argument, and the requested size in bytes as the second argument. The memory block cannot be made smaller than the natural memory block specified by the objects type, a *`ValueError`* is raised if this is tried:

```
>>> short_array = (c_short * 4)()
>>> print(sizeof(short_array))
8
>>> resize(short_array, 4)
Traceback (most recent call last):
    ...
ValueError: minimum size is 8
>>> resize(short_array, 32)
```

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```
>>> sizeof(short_array)
32
>>> sizeof(type(short_array))
8
>>>
```

This is nice and fine, but how would one access the additional elements contained in this array? Since the type still only knows about 4 elements, we get errors accessing other elements:

```
>>> short_array[:]
[0, 0, 0, 0]
>>> short_array[7]
Traceback (most recent call last):
    ...
IndexError: invalid index
>>>
```

Another way to use variable-sized data types with *ctypes* is to use the dynamic nature of Python, and (re-)define the data type after the required size is already known, on a case by case basis.

16.16.2 ctypes reference

Finding shared libraries

When programming in a compiled language, shared libraries are accessed when compiling/linking a program, and when the program is run.

The purpose of the `find_library()` function is to locate a library in a way similar to what the compiler or runtime loader does (on platforms with several versions of a shared library the most recent should be loaded), while the ctypes library loaders act like when a program is run, and call the runtime loader directly.

The `ctypes.util` module provides a function which can help to determine the library to load.

`ctypes.util.find_library(`*name*`)`

    Try to find a library and return a pathname. *name* is the library name without any prefix like *lib*, suffix like `.so`, `.dylib` or version number (this is the form used for the posix linker option `-l`). If no library can be found, returns `None`.

The exact functionality is system dependent.

On Linux, `find_library()` tries to run external programs (`/sbin/ldconfig`, `gcc`, `objdump` and `ld`) to find the library file. It returns the filename of the library file.

Changed in version 3.6: On Linux, the value of the environment variable `LD_LIBRARY_PATH` is used when searching for libraries, if a library cannot be found by any other means.

Here are some examples:

```
>>> from ctypes.util import find_library
>>> find_library("m")
'libm.so.6'
>>> find_library("c")
'libc.so.6'
>>> find_library("bz2")
'libbz2.so.1.0'
>>>
```

On OS X, `find_library()` tries several predefined naming schemes and paths to locate the library, and returns a full pathname if successful:

```
>>> from ctypes.util import find_library
>>> find_library("c")
'/usr/lib/libc.dylib'
>>> find_library("m")
'/usr/lib/libm.dylib'
>>> find_library("bz2")
'/usr/lib/libbz2.dylib'
>>> find_library("AGL")
'/System/Library/Frameworks/AGL.framework/AGL'
>>>
```

On Windows, `find_library()` searches along the system search path, and returns the full pathname, but since there is no predefined naming scheme a call like `find_library("c")` will fail and return `None`.

If wrapping a shared library with *ctypes*, it *may* be better to determine the shared library name at development time, and hardcode that into the wrapper module instead of using `find_library()` to locate the library at runtime.

Loading shared libraries

There are several ways to load shared libraries into the Python process. One way is to instantiate one of the following classes:

class ctypes.CDLL(*name*, *mode=DEFAULT_MODE*, *handle=None*, *use_errno=False*, *use_last_error=False*)

Instances of this class represent loaded shared libraries. Functions in these libraries use the standard C calling convention, and are assumed to return `int`.

class ctypes.OleDLL(*name*, *mode=DEFAULT_MODE*, *handle=None*, *use_errno=False*, *use_last_error=False*)

Windows only: Instances of this class represent loaded shared libraries, functions in these libraries use the `stdcall` calling convention, and are assumed to return the windows specific *HRESULT* code. *HRESULT* values contain information specifying whether the function call failed or succeeded, together with additional error code. If the return value signals a failure, an *OSError* is automatically raised.

Changed in version 3.3: *WindowsError* used to be raised.

class ctypes.WinDLL(*name*, *mode=DEFAULT_MODE*, *handle=None*, *use_errno=False*, *use_last_error=False*)

Windows only: Instances of this class represent loaded shared libraries, functions in these libraries use the `stdcall` calling convention, and are assumed to return `int` by default.

On Windows CE only the standard calling convention is used, for convenience the *WinDLL* and *OleDLL* use the standard calling convention on this platform.

The Python *global interpreter lock* is released before calling any function exported by these libraries, and reacquired afterwards.

class ctypes.PyDLL(*name*, *mode=DEFAULT_MODE*, *handle=None*)

Instances of this class behave like *CDLL* instances, except that the Python GIL is *not* released during the function call, and after the function execution the Python error flag is checked. If the error flag is set, a Python exception is raised.

Thus, this is only useful to call Python C api functions directly.

All these classes can be instantiated by calling them with at least one argument, the pathname of the shared library. If you have an existing handle to an already loaded shared library, it can be passed as the `handle` named parameter, otherwise the underlying platforms **dlopen** or **LoadLibrary** function is used to load the library into the process, and to get a handle to it.

The *mode* parameter can be used to specify how the library is loaded. For details, consult the *dlopen(3)* manpage. On Windows, *mode* is ignored. On posix systems, RTLD_NOW is always added, and is not configurable.

The *use_errno* parameter, when set to true, enables a ctypes mechanism that allows accessing the system *errno* error number in a safe way. *ctypes* maintains a thread-local copy of the systems *errno* variable; if you call foreign functions created with `use_errno=True` then the *errno* value before the function call is swapped with the ctypes private copy, the same happens immediately after the function call.

The function *ctypes.get_errno()* returns the value of the ctypes private copy, and the function *ctypes.set_errno()* changes the ctypes private copy to a new value and returns the former value.

The *use_last_error* parameter, when set to true, enables the same mechanism for the Windows error code which is managed by the *GetLastError()* and `SetLastError()` Windows API functions; *ctypes.get_last_error()* and *ctypes.set_last_error()* are used to request and change the ctypes private copy of the windows error code.

`ctypes.`**`RTLD_GLOBAL`**

Flag to use as *mode* parameter. On platforms where this flag is not available, it is defined as the integer zero.

`ctypes.`**`RTLD_LOCAL`**

Flag to use as *mode* parameter. On platforms where this is not available, it is the same as *RTLD_GLOBAL*.

`ctypes.`**`DEFAULT_MODE`**

The default mode which is used to load shared libraries. On OSX 10.3, this is *RTLD_GLOBAL*, otherwise it is the same as *RTLD_LOCAL*.

Instances of these classes have no public methods. Functions exported by the shared library can be accessed as attributes or by index. Please note that accessing the function through an attribute caches the result and therefore accessing it repeatedly returns the same object each time. On the other hand, accessing it through an index returns a new object each time:

```
>>> from ctypes import CDLL
>>> libc = CDLL("libc.so.6")  # On Linux
>>> libc.time == libc.time
True
>>> libc['time'] == libc['time']
False
```

The following public attributes are available, their name starts with an underscore to not clash with exported function names:

`PyDLL.`**`_handle`**

The system handle used to access the library.

`PyDLL.`**`_name`**

The name of the library passed in the constructor.

Shared libraries can also be loaded by using one of the prefabricated objects, which are instances of the *LibraryLoader* class, either by calling the `LoadLibrary()` method, or by retrieving the library as attribute of the loader instance.

class `ctypes.`**`LibraryLoader`**(*dlltype*)

Class which loads shared libraries. *dlltype* should be one of the *CDLL*, *PyDLL*, *WinDLL*, or *OleDLL* types.

`__getattr__()` has special behavior: It allows loading a shared library by accessing it as attribute of a library loader instance. The result is cached, so repeated attribute accesses return the same library each time.

LoadLibrary(*name*)
Load a shared library into the process and return it. This method always returns a new instance of the library.

These prefabricated library loaders are available:

ctypes.cdll
Creates *CDLL* instances.

ctypes.windll
Windows only: Creates *WinDLL* instances.

ctypes.oledll
Windows only: Creates *OleDLL* instances.

ctypes.pydll
Creates *PyDLL* instances.

For accessing the C Python api directly, a ready-to-use Python shared library object is available:

ctypes.pythonapi
An instance of *PyDLL* that exposes Python C API functions as attributes. Note that all these functions are assumed to return C `int`, which is of course not always the truth, so you have to assign the correct `restype` attribute to use these functions.

Foreign functions

As explained in the previous section, foreign functions can be accessed as attributes of loaded shared libraries. The function objects created in this way by default accept any number of arguments, accept any ctypes data instances as arguments, and return the default result type specified by the library loader. They are instances of a private class:

class ctypes._FuncPtr
Base class for C callable foreign functions.

Instances of foreign functions are also C compatible data types; they represent C function pointers.

This behavior can be customized by assigning to special attributes of the foreign function object.

restype
Assign a ctypes type to specify the result type of the foreign function. Use `None` for `void`, a function not returning anything.

It is possible to assign a callable Python object that is not a ctypes type, in this case the function is assumed to return a C `int`, and the callable will be called with this integer, allowing further processing or error checking. Using this is deprecated, for more flexible post processing or error checking use a ctypes data type as *restype* and assign a callable to the *errcheck* attribute.

argtypes
Assign a tuple of ctypes types to specify the argument types that the function accepts. Functions using the `stdcall` calling convention can only be called with the same number of arguments as the length of this tuple; functions using the C calling convention accept additional, unspecified arguments as well.

When a foreign function is called, each actual argument is passed to the `from_param()` class method of the items in the *argtypes* tuple, this method allows adapting the actual argument to an object that the foreign function accepts. For example, a *c_char_p* item in the *argtypes* tuple will convert a string passed as argument into a bytes object using ctypes conversion rules.

New: It is now possible to put items in argtypes which are not ctypes types, but each item must have a `from_param()` method which returns a value usable as argument (integer, string, ctypes instance). This allows defining adapters that can adapt custom objects as function parameters.

errcheck
Assign a Python function or another callable to this attribute. The callable will be called with three or more arguments:

callable(*result*, *func*, *arguments*)
result is what the foreign function returns, as specified by the `restype` attribute.

func is the foreign function object itself, this allows reusing the same callable object to check or post process the results of several functions.

arguments is a tuple containing the parameters originally passed to the function call, this allows specializing the behavior on the arguments used.

The object that this function returns will be returned from the foreign function call, but it can also check the result value and raise an exception if the foreign function call failed.

exception ctypes.**ArgumentError**
This exception is raised when a foreign function call cannot convert one of the passed arguments.

Function prototypes

Foreign functions can also be created by instantiating function prototypes. Function prototypes are similar to function prototypes in C; they describe a function (return type, argument types, calling convention) without defining an implementation. The factory functions must be called with the desired result type and the argument types of the function, and can be used as decorator factories, and as such, be applied to functions through the `@wrapper` syntax. See *Callback functions* for examples.

ctypes.**CFUNCTYPE**(*restype*, **argtypes*, *use_errno=False*, *use_last_error=False*)
The returned function prototype creates functions that use the standard C calling convention. The function will release the GIL during the call. If *use_errno* is set to true, the ctypes private copy of the system *errno* variable is exchanged with the real *errno* value before and after the call; *use_last_error* does the same for the Windows error code.

ctypes.**WINFUNCTYPE**(*restype*, **argtypes*, *use_errno=False*, *use_last_error=False*)
Windows only: The returned function prototype creates functions that use the `stdcall` calling convention, except on Windows CE where *WINFUNCTYPE()* is the same as *CFUNCTYPE()*. The function will release the GIL during the call. *use_errno* and *use_last_error* have the same meaning as above.

ctypes.**PYFUNCTYPE**(*restype*, **argtypes*)
The returned function prototype creates functions that use the Python calling convention. The function will *not* release the GIL during the call.

Function prototypes created by these factory functions can be instantiated in different ways, depending on the type and number of the parameters in the call:

prototype(*address*)
Returns a foreign function at the specified address which must be an integer.

prototype(*callable*)
Create a C callable function (a callback function) from a Python *callable*.

prototype(*func_spec*[, *paramflags*])
Returns a foreign function exported by a shared library. *func_spec* must be a 2-tuple `(name_or_ordinal, library)`. The first item is the name of the exported function as string, or the ordinal of the exported function as small integer. The second item is the shared library instance.

prototype(*vtbl_index*, *name*[, *paramflags*[, *iid*]])
Returns a foreign function that will call a COM method. *vtbl_index* is the index into the virtual function table, a small non-negative integer. *name* is name of the COM method. *iid* is an optional pointer to the interface identifier which is used in extended error reporting.

COM methods use a special calling convention: They require a pointer to the COM interface as first argument, in addition to those parameters that are specified in the `argtypes` tuple.

The optional *paramflags* parameter creates foreign function wrappers with much more functionality than the features described above.

paramflags must be a tuple of the same length as `argtypes`.

Each item in this tuple contains further information about a parameter, it must be a tuple containing one, two, or three items.

The first item is an integer containing a combination of direction flags for the parameter:

1 Specifies an input parameter to the function.

2 Output parameter. The foreign function fills in a value.

4 Input parameter which defaults to the integer zero.

The optional second item is the parameter name as string. If this is specified, the foreign function can be called with named parameters.

The optional third item is the default value for this parameter.

This example demonstrates how to wrap the Windows `MessageBoxW` function so that it supports default parameters and named arguments. The C declaration from the windows header file is this:

```
WINUSERAPI int WINAPI
MessageBoxW(
    HWND hWnd,
    LPCWSTR lpText,
    LPCWSTR lpCaption,
    UINT uType);
```

Here is the wrapping with *ctypes*:

```
>>> from ctypes import c_int, WINFUNCTYPE, windll
>>> from ctypes.wintypes import HWND, LPCWSTR, UINT
>>> prototype = WINFUNCTYPE(c_int, HWND, LPCWSTR, LPCWSTR, UINT)
>>> paramflags = (1, "hwnd", 0), (1, "text", "Hi"), (1, "caption", "Hello from ctypes"),
↪(1, "flags", 0)
>>> MessageBox = prototype(("MessageBoxW", windll.user32), paramflags)
```

The `MessageBox` foreign function can now be called in these ways:

```
>>> MessageBox()
>>> MessageBox(text="Spam, spam, spam")
>>> MessageBox(flags=2, text="foo bar")
```

A second example demonstrates output parameters. The win32 `GetWindowRect` function retrieves the dimensions of a specified window by copying them into `RECT` structure that the caller has to supply. Here is the C declaration:

```
WINUSERAPI BOOL WINAPI
GetWindowRect(
```

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```
    HWND hWnd,
    LPRECT lpRect);
```

Here is the wrapping with *ctypes*:

```
>>> from ctypes import POINTER, WINFUNCTYPE, windll, WinError
>>> from ctypes.wintypes import BOOL, HWND, RECT
>>> prototype = WINFUNCTYPE(BOOL, HWND, POINTER(RECT))
>>> paramflags = (1, "hwnd"), (2, "lprect")
>>> GetWindowRect = prototype(("GetWindowRect", windll.user32), paramflags)
>>>
```

Functions with output parameters will automatically return the output parameter value if there is a single one, or a tuple containing the output parameter values when there are more than one, so the GetWindowRect function now returns a RECT instance, when called.

Output parameters can be combined with the `errcheck` protocol to do further output processing and error checking. The win32 `GetWindowRect` api function returns a `BOOL` to signal success or failure, so this function could do the error checking, and raises an exception when the api call failed:

```
>>> def errcheck(result, func, args):
...     if not result:
...         raise WinError()
...     return args
...
>>> GetWindowRect.errcheck = errcheck
>>>
```

If the `errcheck` function returns the argument tuple it receives unchanged, *ctypes* continues the normal processing it does on the output parameters. If you want to return a tuple of window coordinates instead of a `RECT` instance, you can retrieve the fields in the function and return them instead, the normal processing will no longer take place:

```
>>> def errcheck(result, func, args):
...     if not result:
...         raise WinError()
...     rc = args[1]
...     return rc.left, rc.top, rc.bottom, rc.right
...
>>> GetWindowRect.errcheck = errcheck
>>>
```

Utility functions

`ctypes.addressof(obj)`
: Returns the address of the memory buffer as integer. *obj* must be an instance of a ctypes type.

`ctypes.alignment(obj_or_type)`
: Returns the alignment requirements of a ctypes type. *obj_or_type* must be a ctypes type or instance.

`ctypes.byref(obj[, offset])`
: Returns a light-weight pointer to *obj*, which must be an instance of a ctypes type. *offset* defaults to zero, and must be an integer that will be added to the internal pointer value.

  `byref(obj, offset)` corresponds to this C code:

```
(((char *)&obj) + offset)
```

The returned object can only be used as a foreign function call parameter. It behaves similar to `pointer(obj)`, but the construction is a lot faster.

`ctypes.cast(`*obj*, *type*`)`
This function is similar to the cast operator in C. It returns a new instance of *type* which points to the same memory block as *obj*. *type* must be a pointer type, and *obj* must be an object that can be interpreted as a pointer.

`ctypes.create_string_buffer(`*init_or_size*, *size=None*`)`
This function creates a mutable character buffer. The returned object is a ctypes array of *c_char*.

init_or_size must be an integer which specifies the size of the array, or a bytes object which will be used to initialize the array items.

If a bytes object is specified as first argument, the buffer is made one item larger than its length so that the last element in the array is a NUL termination character. An integer can be passed as second argument which allows specifying the size of the array if the length of the bytes should not be used.

`ctypes.create_unicode_buffer(`*init_or_size*, *size=None*`)`
This function creates a mutable unicode character buffer. The returned object is a ctypes array of *c_wchar*.

init_or_size must be an integer which specifies the size of the array, or a string which will be used to initialize the array items.

If a string is specified as first argument, the buffer is made one item larger than the length of the string so that the last element in the array is a NUL termination character. An integer can be passed as second argument which allows specifying the size of the array if the length of the string should not be used.

`ctypes.DllCanUnloadNow()`
Windows only: This function is a hook which allows implementing in-process COM servers with ctypes. It is called from the DllCanUnloadNow function that the _ctypes extension dll exports.

`ctypes.DllGetClassObject()`
Windows only: This function is a hook which allows implementing in-process COM servers with ctypes. It is called from the DllGetClassObject function that the `_ctypes` extension dll exports.

`ctypes.util.find_library(`*name*`)`
Try to find a library and return a pathname. *name* is the library name without any prefix like `lib`, suffix like `.so`, `.dylib` or version number (this is the form used for the posix linker option `-l`). If no library can be found, returns `None`.

The exact functionality is system dependent.

`ctypes.util.find_msvcrt()`
Windows only: return the filename of the VC runtime library used by Python, and by the extension modules. If the name of the library cannot be determined, `None` is returned.

If you need to free memory, for example, allocated by an extension module with a call to the `free(void *)`, it is important that you use the function in the same library that allocated the memory.

`ctypes.FormatError(`[*code*]`)`
Windows only: Returns a textual description of the error code *code*. If no error code is specified, the last error code is used by calling the Windows api function GetLastError.

`ctypes.GetLastError()`
Windows only: Returns the last error code set by Windows in the calling thread. This function calls the Windows *GetLastError()* function directly, it does not return the ctypes-private copy of the error code.

`ctypes.get_errno()`
Returns the current value of the ctypes-private copy of the system *errno* variable in the calling thread.

`ctypes.get_last_error()`
Windows only: returns the current value of the ctypes-private copy of the system `LastError` variable in the calling thread.

`ctypes.memmove(`*dst*, *src*, *count*`)`
Same as the standard C memmove library function: copies *count* bytes from *src* to *dst*. *dst* and *src* must be integers or ctypes instances that can be converted to pointers.

`ctypes.memset(`*dst*, *c*, *count*`)`
Same as the standard C memset library function: fills the memory block at address *dst* with *count* bytes of value *c*. *dst* must be an integer specifying an address, or a ctypes instance.

`ctypes.POINTER(`*type*`)`
This factory function creates and returns a new ctypes pointer type. Pointer types are cached and reused internally, so calling this function repeatedly is cheap. *type* must be a ctypes type.

`ctypes.pointer(`*obj*`)`
This function creates a new pointer instance, pointing to *obj*. The returned object is of the type `POINTER(type(obj))`.

Note: If you just want to pass a pointer to an object to a foreign function call, you should use `byref(obj)` which is much faster.

`ctypes.resize(`*obj*, *size*`)`
This function resizes the internal memory buffer of *obj*, which must be an instance of a ctypes type. It is not possible to make the buffer smaller than the native size of the objects type, as given by `sizeof(type(obj))`, but it is possible to enlarge the buffer.

`ctypes.set_errno(`*value*`)`
Set the current value of the ctypes-private copy of the system *errno* variable in the calling thread to *value* and return the previous value.

`ctypes.set_last_error(`*value*`)`
Windows only: set the current value of the ctypes-private copy of the system `LastError` variable in the calling thread to *value* and return the previous value.

`ctypes.sizeof(`*obj_or_type*`)`
Returns the size in bytes of a ctypes type or instance memory buffer. Does the same as the C `sizeof` operator.

`ctypes.string_at(`*address*, *size=-1*`)`
This function returns the C string starting at memory address *address* as a bytes object. If size is specified, it is used as size, otherwise the string is assumed to be zero-terminated.

`ctypes.WinError(`*code=None*, *descr=None*`)`
Windows only: this function is probably the worst-named thing in ctypes. It creates an instance of OSError. If *code* is not specified, `GetLastError` is called to determine the error code. If *descr* is not specified, *FormatError()* is called to get a textual description of the error.

Changed in version 3.3: An instance of *WindowsError* used to be created.

`ctypes.wstring_at(`*address*, *size=-1*`)`
This function returns the wide character string starting at memory address *address* as a string. If *size* is specified, it is used as the number of characters of the string, otherwise the string is assumed to be zero-terminated.

Data types

class `ctypes._CData`

This non-public class is the common base class of all ctypes data types. Among other things, all ctypes type instances contain a memory block that hold C compatible data; the address of the memory block is returned by the *addressof()* helper function. Another instance variable is exposed as *_objects*; this contains other Python objects that need to be kept alive in case the memory block contains pointers.

Common methods of ctypes data types, these are all class methods (to be exact, they are methods of the *metaclass*):

from_buffer(*source*[, *offset*])

This method returns a ctypes instance that shares the buffer of the *source* object. The *source* object must support the writeable buffer interface. The optional *offset* parameter specifies an offset into the source buffer in bytes; the default is zero. If the source buffer is not large enough a *ValueError* is raised.

from_buffer_copy(*source*[, *offset*])

This method creates a ctypes instance, copying the buffer from the *source* object buffer which must be readable. The optional *offset* parameter specifies an offset into the source buffer in bytes; the default is zero. If the source buffer is not large enough a *ValueError* is raised.

from_address(*address*)

This method returns a ctypes type instance using the memory specified by *address* which must be an integer.

from_param(*obj*)

This method adapts *obj* to a ctypes type. It is called with the actual object used in a foreign function call when the type is present in the foreign function's `argtypes` tuple; it must return an object that can be used as a function call parameter.

All ctypes data types have a default implementation of this classmethod that normally returns *obj* if that is an instance of the type. Some types accept other objects as well.

in_dll(*library*, *name*)

This method returns a ctypes type instance exported by a shared library. *name* is the name of the symbol that exports the data, *library* is the loaded shared library.

Common instance variables of ctypes data types:

_b_base_

Sometimes ctypes data instances do not own the memory block they contain, instead they share part of the memory block of a base object. The *_b_base_* read-only member is the root ctypes object that owns the memory block.

_b_needsfree_

This read-only variable is true when the ctypes data instance has allocated the memory block itself, false otherwise.

_objects

This member is either `None` or a dictionary containing Python objects that need to be kept alive so that the memory block contents is kept valid. This object is only exposed for debugging; never modify the contents of this dictionary.

Fundamental data types

class `ctypes._SimpleCData`

This non-public class is the base class of all fundamental ctypes data types. It is mentioned here because it contains the common attributes of the fundamental ctypes data types. *_SimpleCData* is a subclass of *_CData*, so it inherits their methods and attributes. ctypes data types that are not and do not contain pointers can now be pickled.

Instances have a single attribute:

value
This attribute contains the actual value of the instance. For integer and pointer types, it is an integer, for character types, it is a single character bytes object or string, for character pointer types it is a Python bytes object or string.

When the `value` attribute is retrieved from a ctypes instance, usually a new object is returned each time. *ctypes* does *not* implement original object return, always a new object is constructed. The same is true for all other ctypes object instances.

Fundamental data types, when returned as foreign function call results, or, for example, by retrieving structure field members or array items, are transparently converted to native Python types. In other words, if a foreign function has a `restype` of *c_char_p*, you will always receive a Python bytes object, *not* a *c_char_p* instance.

Subclasses of fundamental data types do *not* inherit this behavior. So, if a foreign functions `restype` is a subclass of *c_void_p*, you will receive an instance of this subclass from the function call. Of course, you can get the value of the pointer by accessing the `value` attribute.

These are the fundamental ctypes data types:

class ctypes.c_byte
Represents the C `signed char` datatype, and interprets the value as small integer. The constructor accepts an optional integer initializer; no overflow checking is done.

class ctypes.c_char
Represents the C `char` datatype, and interprets the value as a single character. The constructor accepts an optional string initializer, the length of the string must be exactly one character.

class ctypes.c_char_p
Represents the C `char *` datatype when it points to a zero-terminated string. For a general character pointer that may also point to binary data, `POINTER(c_char)` must be used. The constructor accepts an integer address, or a bytes object.

class ctypes.c_double
Represents the C `double` datatype. The constructor accepts an optional float initializer.

class ctypes.c_longdouble
Represents the C `long double` datatype. The constructor accepts an optional float initializer. On platforms where `sizeof(long double) == sizeof(double)` it is an alias to *c_double*.

class ctypes.c_float
Represents the C `float` datatype. The constructor accepts an optional float initializer.

class ctypes.c_int
Represents the C `signed int` datatype. The constructor accepts an optional integer initializer; no overflow checking is done. On platforms where `sizeof(int) == sizeof(long)` it is an alias to *c_long*.

class ctypes.c_int8
Represents the C 8-bit `signed int` datatype. Usually an alias for *c_byte*.

class ctypes.c_int16
Represents the C 16-bit `signed int` datatype. Usually an alias for *c_short*.

class ctypes.c_int32
Represents the C 32-bit `signed int` datatype. Usually an alias for *c_int*.

class ctypes.c_int64
Represents the C 64-bit `signed int` datatype. Usually an alias for *c_longlong*.

class ctypes.c_long
Represents the C `signed long` datatype. The constructor accepts an optional integer initializer; no overflow checking is done.

class ctypes.c_longlong
Represents the C `signed long long` datatype. The constructor accepts an optional integer initializer; no overflow checking is done.

class ctypes.c_short
Represents the C `signed short` datatype. The constructor accepts an optional integer initializer; no overflow checking is done.

class ctypes.c_size_t
Represents the C `size_t` datatype.

class ctypes.c_ssize_t
Represents the C `ssize_t` datatype.

New in version 3.2.

class ctypes.c_ubyte
Represents the C `unsigned char` datatype, it interprets the value as small integer. The constructor accepts an optional integer initializer; no overflow checking is done.

class ctypes.c_uint
Represents the C `unsigned int` datatype. The constructor accepts an optional integer initializer; no overflow checking is done. On platforms where `sizeof(int) == sizeof(long)` it is an alias for *c_ulong*.

class ctypes.c_uint8
Represents the C 8-bit `unsigned int` datatype. Usually an alias for *c_ubyte*.

class ctypes.c_uint16
Represents the C 16-bit `unsigned int` datatype. Usually an alias for *c_ushort*.

class ctypes.c_uint32
Represents the C 32-bit `unsigned int` datatype. Usually an alias for *c_uint*.

class ctypes.c_uint64
Represents the C 64-bit `unsigned int` datatype. Usually an alias for *c_ulonglong*.

class ctypes.c_ulong
Represents the C `unsigned long` datatype. The constructor accepts an optional integer initializer; no overflow checking is done.

class ctypes.c_ulonglong
Represents the C `unsigned long long` datatype. The constructor accepts an optional integer initializer; no overflow checking is done.

class ctypes.c_ushort
Represents the C `unsigned short` datatype. The constructor accepts an optional integer initializer; no overflow checking is done.

class ctypes.c_void_p
Represents the C `void *` type. The value is represented as integer. The constructor accepts an optional integer initializer.

class ctypes.c_wchar
Represents the C `wchar_t` datatype, and interprets the value as a single character unicode string. The constructor accepts an optional string initializer, the length of the string must be exactly one character.

class ctypes.c_wchar_p
Represents the C `wchar_t *` datatype, which must be a pointer to a zero-terminated wide character string. The constructor accepts an integer address, or a string.

class ctypes.c_bool
Represent the C `bool` datatype (more accurately, `_Bool` from C99). Its value can be `True` or `False`, and the constructor accepts any object that has a truth value.

class ctypes.HRESULT
Windows only: Represents a `HRESULT` value, which contains success or error information for a function or method call.

class ctypes.py_object
Represents the C `PyObject *` datatype. Calling this without an argument creates a `NULL PyObject *` pointer.

The `ctypes.wintypes` module provides quite some other Windows specific data types, for example `HWND`, `WPARAM`, or `DWORD`. Some useful structures like `MSG` or `RECT` are also defined.

Structured data types

class ctypes.Union(**args*, ***kw*)
Abstract base class for unions in native byte order.

class ctypes.BigEndianStructure(**args*, ***kw*)
Abstract base class for structures in *big endian* byte order.

class ctypes.LittleEndianStructure(**args*, ***kw*)
Abstract base class for structures in *little endian* byte order.

Structures with non-native byte order cannot contain pointer type fields, or any other data types containing pointer type fields.

class ctypes.Structure(**args*, ***kw*)
Abstract base class for structures in *native* byte order.

Concrete structure and union types must be created by subclassing one of these types, and at least define a `_fields_` class variable. `ctypes` will create *descriptor*s which allow reading and writing the fields by direct attribute accesses. These are the

fields
A sequence defining the structure fields. The items must be 2-tuples or 3-tuples. The first item is the name of the field, the second item specifies the type of the field; it can be any ctypes data type.

For integer type fields like `c_int`, a third optional item can be given. It must be a small positive integer defining the bit width of the field.

Field names must be unique within one structure or union. This is not checked, only one field can be accessed when names are repeated.

It is possible to define the `_fields_` class variable *after* the class statement that defines the Structure subclass, this allows creating data types that directly or indirectly reference themselves:

```
class List(Structure):
    pass
List._fields_ = [("pnext", POINTER(List)),
                  ...
                 ]
```

The `_fields_` class variable must, however, be defined before the type is first used (an instance is created, `sizeof()` is called on it, and so on). Later assignments to the `_fields_` class variable will raise an AttributeError.

It is possible to defined sub-subclasses of structure types, they inherit the fields of the base class plus the *_fields_* defined in the sub-subclass, if any.

pack

An optional small integer that allows overriding the alignment of structure fields in the instance. *_pack_* must already be defined when *_fields_* is assigned, otherwise it will have no effect.

anonymous

An optional sequence that lists the names of unnamed (anonymous) fields. *_anonymous_* must be already defined when *_fields_* is assigned, otherwise it will have no effect.

The fields listed in this variable must be structure or union type fields. *ctypes* will create descriptors in the structure type that allows accessing the nested fields directly, without the need to create the structure or union field.

Here is an example type (Windows):

```
class _U(Union):
    _fields_ = [("lptdesc", POINTER(TYPEDESC)),
                ("lpadesc", POINTER(ARRAYDESC)),
                ("hreftype", HREFTYPE)]

class TYPEDESC(Structure):
    _anonymous_ = ("u",)
    _fields_ = [("u", _U),
                ("vt", VARTYPE)]
```

The `TYPEDESC` structure describes a COM data type, the `vt` field specifies which one of the union fields is valid. Since the `u` field is defined as anonymous field, it is now possible to access the members directly off the TYPEDESC instance. `td.lptdesc` and `td.u.lptdesc` are equivalent, but the former is faster since it does not need to create a temporary union instance:

```
td = TYPEDESC()
td.vt = VT_PTR
td.lptdesc = POINTER(some_type)
td.u.lptdesc = POINTER(some_type)
```

It is possible to defined sub-subclasses of structures, they inherit the fields of the base class. If the subclass definition has a separate *_fields_* variable, the fields specified in this are appended to the fields of the base class.

Structure and union constructors accept both positional and keyword arguments. Positional arguments are used to initialize member fields in the same order as they are appear in *_fields_*. Keyword arguments in the constructor are interpreted as attribute assignments, so they will initialize *_fields_* with the same name, or create new attributes for names not present in *_fields_*.

Arrays and pointers

class `ctypes.Array`(**args*)

Abstract base class for arrays.

The recommended way to create concrete array types is by multiplying any *ctypes* data type with a positive integer. Alternatively, you can subclass this type and define *_length_* and *_type_* class variables. Array elements can be read and written using standard subscript and slice accesses; for slice reads, the resulting object is *not* itself an *Array*.

length
A positive integer specifying the number of elements in the array. Out-of-range subscripts result in an *IndexError*. Will be returned by *len()*.

type
Specifies the type of each element in the array.

Array subclass constructors accept positional arguments, used to initialize the elements in order.

class ctypes._Pointer
Private, abstract base class for pointers.

Concrete pointer types are created by calling *POINTER()* with the type that will be pointed to; this is done automatically by *pointer()*.

If a pointer points to an array, its elements can be read and written using standard subscript and slice accesses. Pointer objects have no size, so *len()* will raise *TypeError*. Negative subscripts will read from the memory *before* the pointer (as in C), and out-of-range subscripts will probably crash with an access violation (if you're lucky).

type
Specifies the type pointed to.

contents
Returns the object to which to pointer points. Assigning to this attribute changes the pointer to point to the assigned object.