What's New in Python

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Contents

Release 3.10.0a5

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This article explains the new features in Python 3.10, compared to 3.9.

For full details, see the changelog.

注解： Prerelease users should be aware that this document is currently in draft form. It will be updated substantially as Python 3.10 moves towards release, so it's worth checking back even after reading earlier versions.

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1 Summary -- Release highlights

2 New Features

2.1 Parenthesized context managers

Using enclosing parentheses for continuation across multiple lines in context managers is now supported. This allows formatting a long collection of context managers in multiple lines in a similar way as it was previously possible with import statements. For instance, all these examples are now valid:

```
with (CtxManager() as example):
    ...

with (
    CtxManager1(),
    CtxManager2()
```

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```
):
    ...

with (CtxManager1() as example,
      CtxManager2()):
    ...

with (CtxManager1(),
      CtxManager2() as example):
    ...

with (
    CtxManager1() as example1,
    CtxManager2() as example2
):
    ...
```

it is also possible to use a trailing comma at the end of the enclosed group:

```
with (
    CtxManager1() as example1,
    CtxManager2() as example2,
    CtxManager3() as example3,
):
    ...
```

This new syntax uses the non LL(1) capacities of the new parser. Check **PEP 617** for more details.

(Contributed by Guido van Rossum, Pablo Galindo and Lysandros Nikolaou in bpo-12782 and bpo-40334.)

2.2 PEP 563: Postponed Evaluation of Annotations Becomes Default

In Python 3.7, postponed evaluation of annotations was added, to be enabled with a `from __future__ import annotations` directive. In 3.10 this became the default behavior, even without that future directive. With this being default, all annotations stored in `__annotations__` will be strings. If needed, annotations can be resolved at runtime using `typing.get_type_hints()`. See **PEP 563** for a full description. Also, the `inspect.signature()` will try to resolve types from now on, and when it fails it will fall back to showing the string annotations. (Contributed by Batuhan Taskaya in bpo-38605.)

- The `int` type has a new method `int.bit_count()`, returning the number of ones in the binary expansion of a given integer, also known as the population count. (Contributed by Niklas Fiekas in bpo-29882.)
- The views returned by `dict.keys()`, `dict.values()` and `dict.items()` now all have a `mapping` attribute that gives a `types.MappingProxyType` object wrapping the original dictionary. (Contributed by Dennis Sweeney in bpo-40890.)
- **PEP 618**: The `zip()` function now has an optional `strict` flag, used to require that all the iterables have an equal length.

2.3 PEP 613: TypeAlias Annotation

PEP 484 introduced the concept of type aliases, only requiring them to be top-level unannotated assignments. This simplicity sometimes made it difficult for type checkers to distinguish between type aliases and ordinary assignments, especially when forward references or invalid types were involved. Compare:

```
StrCache = 'Cache[str]'  # a type alias
LOG_PREFIX = 'LOG[DEBUG]'  # a module constant
```

Now the `typing` module has a special annotation `TypeAlias` to declare type aliases more explicitly:

```
StrCache: TypeAlias = 'Cache[str]'  # a type alias
LOG_PREFIX = 'LOG[DEBUG]'  # a module constant
```

See **PEP 613** for more details.

(Contributed by Mikhail Golubev in bpo-41923.)

2.4 PEP 604: New Type Union Operator

A new type union operator was introduced which enables the syntax `X | Y`. This provides a cleaner way of expressing 'either type X or type Y' instead of using `typing.Union`, especially in type hints (annotations).

In previous versions of Python, to apply a type hint for functions accepting arguments of multiple types, `typing.Union` was used:

```
def square(number: Union[int, float]) -> Union[int, float]:
    return number ** 2
```

Type hints can now be written in a more succinct manner:

```
def square(number: int | float) -> int | float:
    return number ** 2
```

See **PEP 604** for more details.

(Contributed by Maggie Moss and Philippe Prados in bpo-41428.)

2.5 PEP 612: Parameter Specification Variables

Two new options to improve the information provided to static type checkers for **PEP 484**'s `Callable` have been added to the `typing` module.

The first is the parameter specification variable. They are used to forward the parameter types of one callable to another callable -- a pattern commonly found in higher order functions and decorators. Examples of usage can be found in `typing.ParamSpec`. Previously, there was no easy way to type annotate dependency of parameter types in such a precise manner.

The second option is the new `Concatenate` operator. It's used in conjunction with parameter specification variables to type annotate a higher order callable which adds or removes parameters of another callable. Examples of usage can be found in `typing.Concatenate`.

See `typing.Callable`, `typing.ParamSpec`, `typing.Concatenate` and **PEP 612** for more details.

(Contributed by Ken Jin in bpo-41559.)

2.6 Better error messages in the parser

When parsing code that contains unclosed parentheses or brackets the interpreter now includes the location of the unclosed bracket of parentheses instead of displaying *SyntaxError: unexpected EOF while parsing* or pointing to some incorrect location. For instance, consider the following code (notice the unclosed '{'):

```
expected = {9: 1, 18: 2, 19: 2, 27: 3, 28: 3, 29: 3, 36: 4, 37: 4,
            38: 4, 39: 4, 45: 5, 46: 5, 47: 5, 48: 5, 49: 5, 54: 6,
some_other_code = foo()
```

previous versions of the interpreter reported confusing places as the location of the syntax error:

```
File "example.py", line 3
    some_other_code = foo()
                    ^
SyntaxError: invalid syntax
```

but in Python3.10 a more informative error is emitted:

```
File "example.py", line 1
    expected = {9: 1, 18: 2, 19: 2, 27: 3, 28: 3, 29: 3, 36: 4, 37: 4,
               ^
SyntaxError: '{' was never closed
```

In a similar way, errors involving unclosed string literals (single and triple quoted) now point to the start of the string instead of reporting EOF/EOL.

These improvements are inspired by previous work in the PyPy interpreter.

(Contributed by Pablo Galindo in bpo-42864 and Batuhan Taskaya in bpo-40176.)

3 Other Language Changes

- Builtin and extension functions that take integer arguments no longer accept `Decimals`, `Fractions` and other objects that can be converted to integers only with a loss (e.g. that have the `__int__()` method but do not have the `__index__()` method). (Contributed by Serhiy Storchaka in bpo-37999.)
- Assignment expressions can now be used unparenthesized within set literals and set comprehensions, as well as in sequence indexes (but not slices).

4 New Modules

- None yet.

5 Improved Modules

5.1 argparse

Misleading phrase "optional arguments" was replaced with "options" in argparse help. Some tests might require adaptation if they rely on exact output match. (Contributed by Raymond Hettinger in bpo-9694.)

5.2 base64

Add `base64.b32hexencode()` and `base64.b32hexdecode()` to support the Base32 Encoding with Extended Hex Alphabet.

5.3 codecs

Add a `codecs.unregister()` function to unregister a codec search function. (Contributed by Hai Shi in bpo-41842.)

5.4 collections.abc

The `__args__` of the parameterized generic for `collections.abc.Callable` are now consistent with `typing.Callable`. `collections.abc.Callable` generic now flattens type parameters, similar to what `typing.Callable` currently does. This means that `collections.abc.Callable[[int, str], str]` will have `__args__` of `(int, str, str)`; previously this was `([int, str], str)`. To allow this change, `types.GenericAlias` can now be subclassed, and a subclass will be returned when subscripting the `collections.abc.Callable` type. Note that a `TypeError` may be raised for invalid forms of parameterizing `collections.abc.Callable` which may have passed silently in Python 3.9. (Contributed by Ken Jin in bpo-42195.)

5.5 contextlib

Add a `contextlib.aclosing()` context manager to safely close async generators and objects representing asynchronously released resources. (Contributed by Joongi Kim and John Belmonte in bpo-41229.)

Add asynchronous context manager support to `contextlib.nullcontext()`. (Contributed by Tom Gringauz in bpo-41543.)

5.6 curses

The extended color functions added in ncurses 6.1 will be used transparently by `curses.color_content()`, `curses.init_color()`, `curses.init_pair()`, and `curses.pair_content()`. A new function, `curses.has_extended_color_support()`, indicates whether extended color support is provided by the underlying ncurses library. (Contributed by Jeffrey Kintscher and Hans Petter Jansson in bpo-36982.)

The `BUTTON5_*` constants are now exposed in the `curses` module if they are provided by the underlying curses library. (Contributed by Zackery Spytz in bpo-39273.)

5.7 distutils

The entire `distutils` package is deprecated, to be removed in Python 3.12. Its functionality for specifying package builds has already been completely replaced by third-party packages `setuptools` and `packaging`, and most other commonly used APIs are available elsewhere in the standard library (such as `platform`, `shutil`, `subprocess` or `sysconfig`). There are no plans to migrate any other functionality from `distutils`, and applications that are using other functions should plan to make private copies of the code. Refer to **PEP 632** for discussion.

The `bdist_wininst` command deprecated in Python 3.8 has been removed. The `bdist_wheel` command is now recommended to distribute binary packages on Windows. (Contributed by Victor Stinner in bpo-42802.)

5.8 doctest

When a module does not define `__loader__`, fall back to `__spec__.loader`. (Contributed by Brett Cannon in bpo-42133.)

5.9 encodings

`encodings.normalize_encoding()` now ignores non-ASCII characters. (Contributed by Hai Shi in bpo-39337.)

5.10 glob

Added the *root_dir* and *dir_fd* parameters in `glob()` and `iglob()` which allow to specify the root directory for searching. (Contributed by Serhiy Storchaka in bpo-38144.)

5.11 inspect

When a module does not define `__loader__`, fall back to `__spec__.loader`. (Contributed by Brett Cannon in bpo-42133.)

Added *globalns* and *localns* parameters in `signature()` and `inspect.Signature.from_callable()` to retrieve the annotations in given local and global namespaces. (Contributed by Batuhan Taskaya in bpo-41960.)

5.12 linecache

When a module does not define `__loader__`, fall back to `__spec__.loader`. (Contributed by Brett Cannon in bpo-42133.)

5.13 os

Added `os.cpu_count()` support for VxWorks RTOS. (Contributed by Peixing Xin in bpo-41440.)

Added a new function `os.eventfd()` and related helpers to wrap the `eventfd2` syscall on Linux. (Contributed by Christian Heimes in bpo-41001.)

Added `os.splice()` that allows to move data between two file descriptors without copying between kernel address space and user address space, where one of the file descriptors must refer to a pipe. (Contributed by Pablo Galindo in bpo-41625.)

5.14 pathlib

Added slice support to `PurePath.parents`. (Contributed by Joshua Cannon in bpo-35498)

Added negative indexing support to `PurePath.parents`. (Contributed by Yaroslav Pankovych in bpo-21041)

5.15 platform

Added `platform.freedesktop_os_release()` to retrieve operation system identification from freedesktop.org os-release standard file. (Contributed by Christian Heimes in bpo-28468)

5.16 py_compile

Added `--quiet` option to command-line interface of `py_compile`. (Contributed by Gregory Schevchenko in bpo-38731.)

5.17 pyclbr

Added an `end_lineno` attribute to the `Function` and `Class` objects in the tree returned by `pyclbr.readline()` and `pyclbr.readline_ex()`. It matches the existing (start) `lineno`. (Contributed by Aviral Srivastava in bpo-38307.)

5.18 shelve

The `shelve` module now uses `pickle.DEFAULT_PROTOCOL` by default instead of `pickle` protocol `3` when creating shelves. (Contributed by Zackery Spytz in bpo-34204.)

5.19 site

When a module does not define `__loader__`, fall back to `__spec__.loader`. (Contributed by Brett Cannon in bpo-42133.)

5.20 socket

The exception `socket.timeout` is now an alias of `TimeoutError`. (Contributed by Christian Heimes in bpo-42413.)

5.21 sys

Add `sys.orig_argv` attribute: the list of the original command line arguments passed to the Python executable. (Contributed by Victor Stinner in bpo-23427.)

Add `sys.stdlib_module_names`, containing the list of the standard library module names. (Contributed by Victor Stinner in bpo-42955.)

5.22 threading

Added `threading.gettrace()` and `threading.getprofile()` to retrieve the functions set by `threading.settrace()` and `threading.setprofile()` respectively. (Contributed by Mario Corchero in bpo-42251.)

Add `threading.__excepthook__` to allow retrieving the original value of `threading.excepthook()` in case it is set to a broken or a different value. (Contributed by Mario Corchero in bpo-42308.)

5.23 traceback

The `format_exception()`, `format_exception_only()`, and `print_exception()` functions can now take an exception object as a positional-only argument. (Contributed by Zackery Spytz and Matthias Bussonnier in bpo-26389.)

5.24 types

Reintroduced the `types.EllipsisType`, `types.NoneType` and `types.NotImplementedType` classes, providing a new set of types readily interpretable by type checkers. (Contributed by Bas van Beek in bpo-41810.)

5.25 typing

The behavior of `typing.Literal` was changed to conform with **PEP 586** and to match the behavior of static type checkers specified in the PEP.

1. `Literal` now de-duplicates parameters.
2. Equality comparisons between `Literal` objects are now order independent.
3. `Literal` comparisons now respects types. For example, `Literal[0] == Literal[False]` previously evaluated to `True`. It is now `False`. To support this change, the internally used type cache now supports differentiating types.
4. `Literal` objects will now raise a `TypeError` exception during equality comparisons if one of their parameters are not immutable. Note that declaring `Literal` with mutable parameters will not throw an error:

```
>>> from typing import Literal
>>> Literal[{0}]
>>> Literal[{0}] == Literal[{False}]
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: unhashable type: 'set'
```

(Contributed by Yurii Karabas in bpo-42345.)

5.26 unittest

Add new method `assertNoLogs()` to complement the existing `assertLogs()`. (Contributed by Kit Yan Choi in bpo-39385.)

5.27 xml

Add a `LexicalHandler` class to the `xml.sax.handler` module. (Contributed by Jonathan Gossage and Zackery Spytz in bpo-35018.)

5.28 zipimport

Add methods related to **PEP 451**: `find_spec()`, `zipimport.zipimporter.create_module()`, and `zipimport.zipimporter.exec_module()`. (Contributed by Brett Cannon in bpo-42131.

6 Optimizations

- Constructors `str()`, `bytes()` and `bytearray()` are now faster (around 30--40% for small objects). (Contributed by Serhiy Storchaka in bpo-41334.)
- The `runpy` module now imports fewer modules. The `python3 -m module-name` command startup time is 1.3x faster in average. (Contributed by Victor Stinner in bpo-41006.)
- The `LOAD_ATTR` instruction now uses new "per opcode cache" mechanism. It is about 36% faster now for regular attributes and 44% faster for slots. (Contributed by Pablo Galindo and Yury Selivanov in bpo-42093 and Guido van Rossum in bpo-42927, based on ideas implemented originally in PyPy and MicroPython.)
- When building Python with `--enable-optimizations` now `-fno-semantic-interposition` is added to both the compile and link line. This speeds builds of the Python interpreter created with `--enable-shared` with `gcc` by up to 30%. See this article for more details. (Contributed by Victor Stinner and Pablo Galindo in bpo-38980.)
- Function parameters and their annotations are no longer computed at runtime, but rather at compilation time. They are stored as a tuple of strings at the bytecode level. It is now around 100% faster to create a function with parameter annotations. (Contributed by Yurii Karabas and Inada Naoki in bpo-42202)

7 Deprecated

- Starting in this release, there will be a concerted effort to begin cleaning up old import semantics that were kept for Python 2.7 compatibility. Specifically, `find_loader()`/`find_module()` (superseded by `find_spec()`), `load_module()` (superseded by `exec_module()`), `module_repr()` (which the import system takes care of for you), the `__package__` attribute (superseded by `__spec__.parent`), the `__loader__` attribute (superseded by `__spec__.loader`), and the `__cached__` attribute (superseded by `__spec__.cached`) will slowly be removed (as well as other classes and methods in `importlib`). `ImportWarning` and/or `DeprecationWarning` will be raised as appropriate to help identify code which needs updating during this transition.
- The entire `distutils` namespace is deprecated, to be removed in Python 3.12. Refer to the *module changes* section for more information.
- Non-integer arguments to `random.randrange()` are deprecated. The `ValueError` is deprecated in favor of a `TypeError`. (Contributed by Serhiy Storchaka and Raymond Hettinger in bpo-37319.)
- The various `load_module()` methods of `importlib` have been documented as deprecated since Python 3.6, but will now also trigger a `DeprecationWarning`. Use `exec_module()` instead. (Contributed by Brett Cannon in bpo-26131.)
- `zimport.zipimporter.load_module()` has been deprecated in preference for `exec_module()`. (Contributed by Brett Cannon in bpo-26131.)
- The use of `load_module()` by the import system now triggers an `ImportWarning` as `exec_module()` is preferred. (Contributed by Brett Cannon in bpo-26131.)
- `sqlite3.OptimizedUnicode` has been undocumented and obsolete since Python 3.3, when it was made an alias to `str`. It is now deprecated, scheduled for removal in Python 3.12. (Contributed by Erlend E. Aasland in bpo-42264.)
- The undocumented built-in function `sqlite3.enable_shared_cache` is now deprecated, scheduled for removal in Python 3.12. Its use is strongly discouraged by the SQLite3 documentation. See the

SQLite3 docs for more details. If shared cache must be used, open the database in URI mode using the `cache=shared` query parameter. (Contributed by Erlend E. Aasland in bpo-24464.)

8 Removed

- Removed special methods `__int__`, `__float__`, `__floordiv__`, `__mod__`, `__divmod__`, `__rfloordiv__`, `__rmod__` and `__rdivmod__` of the `complex` class. They always raised a `TypeError`. (Contributed by Serhiy Storchaka in bpo-41974.)
- The `ParserBase.error()` method from the private and undocumented `_markupbase` module has been removed. `html.parser.HTMLParser` is the only subclass of `ParserBase` and its `error()` implementation has already been removed in Python 3.5. (Contributed by Berker Peksag in bpo-31844.)
- Removed the `unicodedata.ucnhash_CAPI` attribute which was an internal PyCapsule object. The related private `_PyUnicode_Name_CAPI` structure was moved to the internal C API. (Contributed by Victor Stinner in bpo-42157.)
- Removed the `parser` module, which was deprecated in 3.9 due to the switch to the new PEG parser, as well as all the C source and header files that were only being used by the old parser, including `node.h`, `parser.h`, `graminit.h` and `grammar.h`.
- Removed the Public C API functions `PyParser_SimpleParseStringFlags()`, `PyParser_SimpleParseStringFlagsFilename()`, `PyParser_SimpleParseFileFlags()` and `PyNode_Compile()` that were deprecated in 3.9 due to the switch to the new PEG parser.
- Removed the `formatter` module, which was deprecated in Python 3.4. It is somewhat obsolete, little used, and not tested. It was originally scheduled to be removed in Python 3.6, but such removals were delayed until after Python 2.7 EOL. Existing users should copy whatever classes they use into their code. (Contributed by Dong-hee Na and Terry J. Reedy in bpo-42299.)
- Removed the `PyModule_GetWarningsModule()` function that was useless now due to the _warnings module was converted to a builtin module in 2.6. (Contributed by Hai Shi in bpo-42599.)
- Remove deprecated aliases to collections-abstract-base-classes from the `collections` module. (Contributed by Victor Stinner in bpo-37324.)
- The `loop` parameter has been removed from most of `asyncio`'s high-level API following deprecation in Python 3.8. The motivation behind this change is multifold:

  1. This simplifies the high-level API.
  2. The functions in the high-level API have been implicitly getting the current thread's running event loop since Python 3.7. There isn't a need to pass the event loop to the API in most normal use cases.
  3. Event loop passing is error-prone especially when dealing with loops running in different threads.

  Note that the low-level API will still accept `loop`. See *Changes in the Python API* for examples of how to replace existing code.

  (Contributed by Yurii Karabas, Andrew Svetlov, Yury Selivanov and Kyle Stanley in bpo-42392.)

9 Porting to Python 3.10

This section lists previously described changes and other bugfixes that may require changes to your code.

9.1 Changes in the Python API

- The *etype* parameters of the `format_exception()`, `format_exception_only()`, and `print_exception()` functions in the `traceback` module have been renamed to *exc*. (Contributed by Zackery Spytz and Matthias Bussonnier in bpo-26389.)
- `atexit`: At Python exit, if a callback registered with `atexit.register()` fails, its exception is now logged. Previously, only some exceptions were logged, and the last exception was always silently ignored. (Contributed by Victor Stinner in bpo-42639.)
- `collections.abc.Callable` generic now flattens type parameters, similar to what `typing.Callable` currently does. This means that `collections.abc.Callable[[int, str], str]` will have `__args__` of `(int, str, str)`; previously this was `([int, str], str)`. Code which accesses the arguments via `typing.get_args()` or `__args__` need to account for this change. Furthermore, `TypeError` may be raised for invalid forms of parameterizing `collections.abc.Callable` which may have passed silently in Python 3.9. (Contributed by Ken Jin in bpo-42195.)
- `socket.htons()` and `socket.ntohs()` now raise `OverflowError` instead of `DeprecationWarning` if the given parameter will not fit in a 16-bit unsigned integer. (Contributed by Erlend E. Aasland in bpo-42393.)
- The `loop` parameter has been removed from most of `asyncio`'s high-level API following deprecation in Python 3.8.

  A coroutine that currently look like this:

```
async def foo(loop):
    await asyncio.sleep(1, loop=loop)
```

  Should be replaced with this:

```
async def foo():
    await asyncio.sleep(1)
```

  If `foo()` was specifically designed *not* to run in the current thread's running event loop (e.g. running in another thread's event loop), consider using `asyncio.run_coroutine_threadsafe()` instead.

  (Contributed by Yurii Karabas, Andrew Svetlov, Yury Selivanov and Kyle Stanley in bpo-42392.)

10 CPython bytecode changes

- The `MAKE_FUNCTION` instruction accepts tuple of strings as annotations instead of dictionary. (Contributed by Yurii Karabas and Inada Naoki in bpo-42202)

11 Build Changes

- The C99 functions `snprintf()` and `vsnprintf()` are now required to build Python. (Contributed by Victor Stinner in bpo-36020.)
- `sqlite3` requires SQLite 3.7.15 or higher. (Contributed by Sergey Fedoseev and Erlend E. Aasland bpo-40744 and bpo-40810.)
- The `atexit` module must now always be built as a built-in module. (Contributed by Victor Stinner in bpo-42639.)
- Added `--disable-test-modules` option to the `configure` script: don't build nor install test modules. (Contributed by Xavier de Gaye, Thomas Petazzoni and Peixing Xin in bpo-27640.)

- Add `--with-wheel-pkg-dir=PATH` option to the `./configure` script. If specified, the `ensurepip` module looks for `setuptools` and `pip` wheel packages in this directory: if both are present, these wheel packages are used instead of ensurepip bundled wheel packages.

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

  (Contributed by Victor Stinner in bpo-42856.)

12 C API Changes

12.1 New Features

- The result of `PyNumber_Index()` now always has exact type `int`. Previously, the result could have been an instance of a subclass of `int`. (Contributed by Serhiy Storchaka in bpo-40792.)
- Add a new `orig_argv` member to the `PyConfig` structure: the list of the original command line arguments passed to the Python executable. (Contributed by Victor Stinner in bpo-23427.)
- The `PyDateTime_DATE_GET_TZINFO()` and `PyDateTime_TIME_GET_TZINFO()` macros have been added for accessing the `tzinfo` attributes of `datetime.datetime` and `datetime.time` objects. (Contributed by Zackery Spytz in bpo-30155.)
- Add a `PyCodec_Unregister()` function to unregister a codec search function. (Contributed by Hai Shi in bpo-41842.)
- The `PyIter_Send()` function was added to allow sending value into iterator without raising `StopIteration` exception. (Contributed by Vladimir Matveev in bpo-41756.)
- Added `PyUnicode_AsUTF8AndSize()` to the limited C API. (Contributed by Alex Gaynor in bpo-41784.)
- Added `PyModule_AddObjectRef()` function: similar to `PyModule_AddObject()` but don't steal a reference to the value on success. (Contributed by Victor Stinner in bpo-1635741.)
- Added `Py_NewRef()` and `Py_XNewRef()` functions to increment the reference count of an object and return the object. (Contributed by Victor Stinner in bpo-42262.)
- The `PyType_FromSpecWithBases()` and `PyType_FromModuleAndSpec()` functions now accept a single class as the *bases* argument. (Contributed by Serhiy Storchaka in bpo-42423.)
- The `PyType_FromModuleAndSpec()` function now accepts NULL `tp_doc` slot. (Contributed by Hai Shi in bpo-41832.)
- The `PyType_GetSlot()` function can accept static types. (Contributed by Hai Shi and Petr Viktorin in bpo-41073.)

12.2 Porting to Python 3.10

- The `PY_SSIZE_T_CLEAN` macro must now be defined to use `PyArg_ParseTuple()` and `Py_BuildValue()` formats which use `#`: `es#`, `et#`, `s#`, `u#`, `y#`, `z#`, `U#` and `Z#`. See Parsing arguments and building values and the **PEP 353**. (Contributed by Victor Stinner in bpo-40943.)
- Since `Py_REFCNT()` is changed to the inline static function, `Py_REFCNT(obj) = new_refcnt` must be replaced with `Py_SET_REFCNT(obj, new_refcnt)`: see `Py_SET_REFCNT()` (available since Python 3.9). For backward compatibility, this macro can be used:

```
#if PY_VERSION_HEX < 0x030900A4
#  define Py_SET_REFCNT(obj, refcnt) ((Py_REFCNT(obj) = (refcnt)), (void)0)
#endif
```

(Contributed by Victor Stinner in bpo-39573.)

- Calling `PyDict_GetItem()` without GIL held had been allowed for historical reason. It is no longer allowed. (Contributed by Victor Stinner in bpo-40839.)
- `PyUnicode_FromUnicode(NULL, size)` and `PyUnicode_FromStringAndSize(NULL, size)` raise `DeprecationWarning` now. Use `PyUnicode_New()` to allocate Unicode object without initial data. (Contributed by Inada Naoki in bpo-36346.)
- The private `_PyUnicode_Name_CAPI` structure of the PyCapsule API `unicodedata.ucnhash_CAPI` has been moved to the internal C API. (Contributed by Victor Stinner in bpo-42157.)
- `Py_GetPath()`, `Py_GetPrefix()`, `Py_GetExecPrefix()`, `Py_GetProgramFullPath()`, `Py_GetPythonHome()` and `Py_GetProgramName()` functions now return `NULL` if called before `Py_Initialize()` (before Python is initialized). Use the new Python Initialization Configuration API to get the Python Path Configuration.. (Contributed by Victor Stinner in bpo-42260.)
- `PyList_SET_ITEM()`, `PyTuple_SET_ITEM()` and `PyCell_SET()` macros can no longer be used as l-value or r-value. For example, `x = PyList_SET_ITEM(a, b, c)` and `PyList_SET_ITEM(a, b, c) = x` now fail with a compiler error. It prevents bugs like `if (PyList_SET_ITEM (a, b, c) < 0) ...` test. (Contributed by Zackery Spytz and Victor Stinner in bpo-30459.)

12.3 Deprecated

- The `PyUnicode_InternImmortal()` function is now deprecated and will be removed in Python 3.12: use `PyUnicode_InternInPlace()` instead. (Contributed by Victor Stinner in bpo-41692.)

12.4 Removed

- `PyObject_AsCharBuffer()`, `PyObject_AsReadBuffer()`, `PyObject_CheckReadBuffer()`, and `PyObject_AsWriteBuffer()` are removed. Please migrate to new buffer protocol; `PyObject_GetBuffer()` and `PyBuffer_Release()`. (Contributed by Inada Naoki in bpo-41103.)
- Removed `Py_UNICODE_str*` functions manipulating `Py_UNICODE*` strings. (Contributed by Inada Naoki in bpo-41123.)
  - `Py_UNICODE_strlen`: use `PyUnicode_GetLength()` or `PyUnicode_GET_LENGTH`
  - `Py_UNICODE_strcat`: use `PyUnicode_CopyCharacters()` or `PyUnicode_FromFormat()`
  - `Py_UNICODE_strcpy`, `Py_UNICODE_strncpy`: use `PyUnicode_CopyCharacters()` or `PyUnicode_Substring()`
  - `Py_UNICODE_strcmp`: use `PyUnicode_Compare()`
  - `Py_UNICODE_strncmp`: use `PyUnicode_Tailmatch()`
  - `Py_UNICODE_strchr`, `Py_UNICODE_strrchr`: use `PyUnicode_FindChar()`
- Removed `PyUnicode_GetMax()`. Please migrate to new (**PEP 393**) APIs. (Contributed by Inada Naoki in bpo-41103.)
- Removed `PyLong_FromUnicode()`. Please migrate to `PyLong_FromUnicodeObject()`. (Contributed by Inada Naoki in bpo-41103.)
- Removed `PyUnicode_AsUnicodeCopy()`. Please use `PyUnicode_AsUCS4Copy()` or `PyUnicode_AsWideCharString()` (Contributed by Inada Naoki in bpo-41103.)
- Removed `_Py_CheckRecursionLimit` variable: it has been replaced by `ceval.recursion_limit` of the `PyInterpreterState` structure. (Contributed by Victor Stinner in bpo-41834.)

- Removed undocumented macros `Py_ALLOW_RECURSION` and `Py_END_ALLOW_RECURSION` and the `recursion_critical` field of the `PyInterpreterState` structure. (Contributed by Serhiy Storchaka in bpo-41936.)
- Removed the undocumented `PyOS_InitInterrupts()` function. Initializing Python already implicitly installs signal handlers: see `PyConfig.install_signal_handlers`. (Contributed by Victor Stinner in bpo-41713.)

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