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# What's New in Python

リリース 3.12.11

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## 編集者

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この記事では Python 3.11 と比較した Python 3.12 の新機能を解説します。Python 3.12 は 2023 年 10 月 2 日にリリースされました。全詳細については [変更履歴](#) をご覧ください。

## 1 概要 -- リリースハイライト

Python 3.12 is a stable release of the Python programming language, with a mix of changes to the language and the standard library. The library changes focus on cleaning up deprecated APIs, usability, and correctness. Of note, the `distutils` package has been removed from the standard library. Filesystem support in `os` and `pathlib` has seen a number of improvements, and several modules have better performance.

f-strings は多くの制限が取り除かれ、'Did you mean ...' サジェストも改善され続けています。新しい [型パラメータの構文](#) と `type` 文は、ジェネリック と 型エイリアス を静的型チェッカーで使用する際の人間工学を改善します。

この記事は全ての新機能の完全な仕様を提供しようとするものではなく、便利な概要について説明をするものです。全詳細については、[ライブラリリファレンス](#) や [言語リファレンス](#) などのドキュメントを参照してください。変更の実装や設計原理について完全に理解したい場合は、特定の新機能の PEP を参照してください。しかし、一旦機能が完全に実装されると、普通 PEP は最新の状態に保たれないことに注意してください。

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新たな文法機能:

- [PEP 695](#), 型パラメータの構文と `type` 文

新たな文法機能:

- [PEP 701](#), 文法の中の f-strings

インタプリタの改善:

- [PEP 684](#), インタープリタごとのユニークな GIL
- [PEP 669](#), 低影響なモニタリング
- `NameError`, `ImportError`, `SyntaxError` 例外に対する 'Did you mean ...' サジェストを改善 しました

Python のデータモデルの改善:

- [PEP 688](#), Python の バッファプロトコル を使用します

標準ライブラリーの顕著な改善

- `pathlib.Path` クラスがサブクラス化をサポートするようになりました
- `os` モジュールは Windows サポートのためにいくつかの改良が加えられました
- `sqlite3` モジュールに コマンドライン・インターフェース が追加されました

- `runtime-checkable` プロトコル に対する `isinstance()` のチェックは、2 倍～20 倍のスピードアップを実現します
- `asyncio` パッケージは多くのパフォーマンスを向上させ、いくつかのベンチマークでは 75% のスピードアップを示しました。
- `uuid` モジュールに コマンドライン・インターフェース が追加されました
- [PEP 701](#) の変更により、`tokenize` モジュールによるトークンの生成は最大で 64% 速くなりました。

セキュリティの改善:

- 組み込みの `hashlib` による SHA1, SHA3, SHA2-384, SHA2-512, MD5 の実装を、[HACL\\*](#) プロジェクトから正式に検証されたコードに置き換えます。これらの組み込み実装は、OpenSSL がそれらを提供しない場合にのみ使用されるフォールバックとして残ります。

C API の改善:

- [PEP 697](#), 不安定な C API 層
- [PEP 683](#), 不変オブジェクト

CPython の実装の改善:

- [PEP 709](#), 内包表記のインライン化
- Linux `perf` プロファイラの CPython サポート
- サポートされているプラットフォームでスタック・オーバーフロー保護を実装します

新しい型ヒントの機能:

- [PEP 692](#), `TypedDict` を使用して `**kwargs` をアノテートします
- [PEP 698](#), `typing.override()` デコレータ

重要な非推奨化、削除または制限:

- [PEP 623](#): Python の C API の Unicode オブジェクトから `wstr` を削除し、全ての `str` オブジェクトのサイズを少なくとも 8 バイト減らします
- [PEP 632](#): Remove the `distutils` package. See [the migration guide](#) for advice replacing the APIs it provided. The third-party `Setuptools` package continues to provide `distutils`, if you still require it in Python 3.12 and beyond.
- [gh-95299](#): `venv` で作成された仮想環境には `setuptools` をプリインストールしません。これは `distutils`, `setuptools`, `pkg_resources`, `easy_install` がデフォルトでは利用できないことを意味します。これらを利用するには、有効化された 仮想環境で `pip install setuptools` を実行してください。
- `asynchat`, `asyncore`, `imp` モジュールが、いくつかの `unittest.TestCase` [メソッドのエイリアス](#) と共に削除されました。

## 2 新しい機能

### 2.1 PEP 695: 型パラメータの構文

PEP 484 のジェネリッククラスと関数は、型パラメータの範囲が不明確なまま冗長な構文を使用して宣言されており、差異の明示的な宣言が必要でした。

PEP 695 は ジェネリッククラス と 関数 を作成するための、よりコンパクトで明示的な新しい方法を紹介します:

```
def max[T](args: Iterable[T]) -> T:
    ...

class list[T]:
    def __getitem__(self, index: int, /) -> T:
        ...

    def append(self, element: T) -> None:
        ...
```

さらに、PEP では 型エイリアス を宣言する新しい方法が導入されました。type 文を使用し、TypeAliasType のインスタンスを作成します:

```
type Point = tuple[float, float]
```

型エイリアスは ジェネリック とすることもできます:

```
type Point[T] = tuple[T, T]
```

新しい構文では、TypeVarTuple と ParamSpec パラメータ、および TypeVar パラメータに境界や制約を宣言することができます:

```
type IntFunc[**P] = Callable[P, int] # ParamSpec
type LabeledTuple[*Ts] = tuple[str, *Ts] # TypeVarTuple
type HashableSequence[T: Hashable] = Sequence[T] # TypeVar with bound
type IntOrStrSequence[T: (int, str)] = Sequence[T] # TypeVar with constraints
```

この構文で作成された型エイリアスの値や型変数の境界や制約はオンデマンドで評価されます (遅延評価 を参照してください)。つまり、型エイリアスはファイルの後半で定義された他の型を参照することができます。

型パラメータリストを通して宣言された型パラメータは、宣言の範囲と入れ子になった範囲内では表示されますが、外側の範囲では表示されません。例えば、ジェネリッククラスのメソッドの型アノテーションやクラス本体で使うことができます。しかし、クラス定義後にモジュール範囲内で使うことはできません。型パラメータの実行時の解釈の問題に関する詳細な説明は type-params を参照してください。

このような範囲の解釈の問題をサポートするために、アノテーション範囲 という新しい範囲が

導入されました。アノテーションスコープはほとんどの場合関数スコープと同じように動作しますが、外側のクラススコープとは異なる方法で対話します。Python 3.13 では、アノテーション もアノテーションスコープで評価されます。

より詳しくは [PEP 695](#) を参照してください。

(PEP は Eric Traut によって作成されました。実装は Jelle Zijlstra, Eric Traut らによって [gh-103764](#) で行われました。)

## 2.2 PEP 701: f-strings の構文的な形式化

**PEP 701** は f-strings の使い方の制限をいくつか解除しました。f-string 内の式コンポーネントは有効な Python 式であれば何でも使用できるようになりました。これには、f-string を含む文字列と同じ引用符を再利用する文字列、複数行の式、コメント、バックスラッシュ、Unicode エスケープシーケンスなどが含まれます。これらについて詳しく説明します:

- クォートの再利用: Python 3.11 では、f-string を囲むクォートと同じクォートを再利用すると `SyntaxError` が発生し、ユーザーは他の利用可能なクォート ( f-string がシングルクォートを使用している場合に、ダブルクォートまたはトリプルクォートを使用するなど) を使用する必要があります。Python 3.12 では次のようなことができるようになりました:

```
>>> songs = ['Take me back to Eden', 'Alkaline', 'Ascensionism']
>>> f"This is the playlist: {", ".join(songs)}"
'This is the playlist: Take me back to Eden, Alkaline, Ascensionism'
```

この変更以前は、f-string のネスト方法に明示的な制限はありませんでしたが、f-string の式コンポーネント内で文字列引用符を再利用できないという事実により、f-string を任意にネストすることが不可能になったことに注意してください。実際、これは記述できる中で最もネストされた f-string です。

```
>>> f"""{f' '{f' {f" {1+1}" }' }' }' }' """
'2'
```

f-string には式コンポーネント内に任意の有効な Python 式を含めることができるため、f-string を任意にネストできるようになりました。

```
>>> f"{f" {f" {f" {f" {f" {f" {1+1}" }" }" }" }" }" }" }"
'2'
```

- 複数行の式とコメント: Python 3.11 では、f-string 式は 1 行で定義されなければいけませんでしたが。たとえ f-string 式が複数行にまたがっていても (リテラルリストが複数行にわたって定義されている場合など)、読みにくくなります。Python 3.12 では、複数行にまたがる f-string を定義し、インラインコメントを追加できるようになりました:

```
>>> f"This is the playlist: {", ".join([
...     'Take me back to Eden', # My, my, those eyes like fire
...     'Alkaline',           # Not acid nor alkaline
```

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```
...     'Ascensionism'           # Take to the broken skies at last
... ]})"
'This is the playlist: Take me back to Eden, Alkaline, Ascensionism'
```

- バックスラッシュと unicode 文字: Python 3.12 以前では f-string 式に \ 文字を含めることはできませんでした。これは、unicode エスケープシーケンス ( \N{snowman} など) にも影響しました。これは、unicode のエスケープシーケンスにも影響し、これらは \N の部分を含んでいたため、以前は f-string の式コンポーネントの一部とすることができませんでした。このように式を定義することができます:

```
>>> print(f"This is the playlist: {\n".join(songs)}")
This is the playlist: Take me back to Eden
Alkaline
Ascensionism
>>> print(f"This is the playlist: {\N{BLACK HEART SUIT}}".join(songs)}")
This is the playlist: Take me back to Eden ♥ Alkaline ♥ Ascensionism
```

より詳しくは [PEP 701](#) を参照してください。

この機能が実装されたことによる良い副作用として ( [PEG パーサ](#) で f-string を解析することにより)、f-string のエラーメッセージがより正確になり、エラーの正確な位置が含まれるようになりました。例えば、Python 3.11 では、以下の f-string は `SyntaxError` を送出させます:

```
>>> my_string = f"{x z y}" + f"{1 + 1}"
File "<stdin>", line 1
    (x z y)
    ~~~
SyntaxError: f-string: invalid syntax. Perhaps you forgot a comma?
```

しかし、エラーメッセージは行内の正確なエラーの位置を含まず、また式が人為的に括弧で囲まれています。Python 3.12 では、f-string は PEG パーサで解析されるため、エラーメッセージはより正確になり、行全体が表示されます:

```
>>> my_string = f"{x z y}" + f"{1 + 1}"
File "<stdin>", line 1
    my_string = f"{x z y}" + f"{1 + 1}"
                ~~~
SyntaxError: invalid syntax. Perhaps you forgot a comma?
```

(Pablo Galindo, Batuhan Taskaya, Lysandros Nikolaou, Christian Maureira-Fredes, および Marta Gomez によって、[gh-102856](#) で寄稿されました。PEP は Pablo Galindo, Batuhan Taskaya, Lysandros Nikolaou, および Marta Gomez によって作成されました)。



## 2.3 PEP 684: インタープリタごとの GIL

**PEP 684** ではインタープリタごとの GIL が導入され、インタープリタごとの固有の GIL を使用してサブインタープリタを作成できるようになりました。これにより、Python プログラムは複数の CPU コアを最大限に活用できるようになります。これは現在 C-API を通じてのみ利用できますが、Python API は **3.13** で利用可能になる予定です。

独自の GIL を持つインタープリタを作成するには、新しい `Py_NewInterpreterFromConfig()` 関数を使います:

```
PyInterpreterConfig config = {
    .check_multi_interp_extensions = 1,
    .gil = PyInterpreterConfig_OWN_GIL,
};
PyThreadState *tstate = NULL;
PyStatus status = Py_NewInterpreterFromConfig(&tstate, &config);
if (PyStatus_Exception(status)) {
    return -1;
}
/* The new interpreter is now active in the current thread. */
```

For further examples how to use the C-API for sub-interpreters with a per-interpreter GIL, see [Modules/\\_xxsubinterpretersmodule.c](#).

(寄稿: Eric Snow, [gh-104210](#) ほか)

## 2.4 PEP 669: CPython の低影響モニタリング

**PEP 669** は、CPython でイベントを監視するためのプロファイラ、デバッガー、およびその他のツール用の新しい API を定義します。呼び出し、戻り値、行、例外、ジャンプなどを含む幅広いイベントをカバーします。つまり、使用した分だけ料金を支払い、オーバーヘッドがほぼゼロのデバッガーとカバレッジツールのサポートを提供します。詳細については `sys.monitoring` を参照してください。

(Mark Shannon による [gh-103082](#) での貢献)

## 2.5 PEP 688: バッファプロトコルを Python で利用可能にする

**PEP 688** は Python のコードから バッファプロトコル を利用する方法を導入します。`__buffer__()` メソッドを実装するクラスは今やバッファ型として利用可能です。

新規追加された `collections.abc.Buffer` ABC は、例えば型注釈で、バッファオブジェクトを表現する標準的な方法を提供します。新規追加された `inspect.BufferFlags` enum はバッファ生成を調整するフラグを表現します。(Jelle Zijlstra による [gh-102500](#) での貢献。)

## 2.6 PEP 709: 内包表記のインライン化

辞書、リスト、そして集合の内包表記は今やインライン化され、内包表記の毎回の実行の度に一度しか使われない関数オブジェクトが新規作成されることはなくなります。これにより内包表記の実行は最大2倍速くなります。詳しくは [PEP 709](#) を参照してください。

Comprehension iteration variables remain isolated and don't overwrite a variable of the same name in the outer scope, nor are they visible after the comprehension. Inlining does result in a few visible behavior changes:

- There is no longer a separate frame for the comprehension in tracebacks, and tracing/profiling no longer shows the comprehension as a function call.
- The `symtable` module will no longer produce child symbol tables for each comprehension; instead, the comprehension's locals will be included in the parent function's symbol table.
- Calling `locals()` inside a comprehension now includes variables from outside the comprehension, and no longer includes the synthetic `.0` variable for the comprehension "argument".
- A comprehension iterating directly over `locals()` (e.g. `[k for k in locals()]`) may see "RuntimeError: dictionary changed size during iteration" when run under tracing (e.g. code coverage measurement). This is the same behavior already seen in e.g. `for k in locals():`. To avoid the error, first create a list of keys to iterate over: `keys = list(locals()); [k for k in keys]`.

(Contributed by Carl Meyer and Vladimir Matveev in [PEP 709](#).)

## 2.7 エラーメッセージの改善

- Modules from the standard library are now potentially suggested as part of the error messages displayed by the interpreter when a `NameError` is raised to the top level. (Contributed by Pablo Galindo in [gh-98254](#).)

```
>>> sys.version_info
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'sys' is not defined. Did you forget to import 'sys'?
```

- Improve the error suggestion for `NameError` exceptions for instances. Now if a `NameError` is raised in a method and the instance has an attribute that's exactly equal to the name in the exception, the suggestion will include `self.<NAME>` instead of the closest match in the method scope. (Contributed by Pablo Galindo in [gh-99139](#).)

```
>>> class A:
...     def __init__(self):
...         self.blech = 1
...
...     def foo(self):
```

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```
...         somethin = blech
...
>>> A().foo()
Traceback (most recent call last):
  File "<stdin>", line 1
    somethin = blech
           ~~~~~
NameError: name 'blech' is not defined. Did you mean: 'self.blech'?
```

- Improve the `SyntaxError` error message when the user types `import x from y` instead of `from y import x`. (Contributed by Pablo Galindo in [gh-98931](#).)

```
>>> import a.y.z from b.y.z
Traceback (most recent call last):
  File "<stdin>", line 1
    import a.y.z from b.y.z
    ~~~~~
SyntaxError: Did you mean to use 'from ... import ...' instead?
```

- `ImportError` exceptions raised from failed `from <module> import <name>` statements now include suggestions for the value of `<name>` based on the available names in `<module>`. (Contributed by Pablo Galindo in [gh-91058](#).)

```
>>> from collections import chainmap
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
ImportError: cannot import name 'chainmap' from 'collections'. Did you mean:
↳ 'ChainMap'?
```

### 3 型ヒントに関連する新しい機能

This section covers major changes affecting [type hints](#) and the `typing` module.

#### 3.1 PEP 692: Using TypedDict for more precise \*\*kwargs typing

Typing `**kwargs` in a function signature as introduced by [PEP 484](#) allowed for valid annotations only in cases where all of the `**kwargs` were of the same type.

[PEP 692](#) specifies a more precise way of typing `**kwargs` by relying on typed dictionaries:

```
from typing import TypedDict, Unpack

class Movie(TypedDict):
```

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```

name: str
year: int

def foo(**kwargs: Unpack[Movie]): ...

```

より詳しくは [PEP 692](#) を参照してください。

(Contributed by Franek Magiera in [gh-103629](#).)

## 3.2 PEP 698: Override Decorator for Static Typing

A new decorator `typing.override()` has been added to the `typing` module. It indicates to type checkers that the method is intended to override a method in a superclass. This allows type checkers to catch mistakes where a method that is intended to override something in a base class does not in fact do so.

以下はプログラム例です:

```

from typing import override

class Base:
    def get_color(self) -> str:
        return "blue"

class GoodChild(Base):
    @override # ok: overrides Base.get_color
    def get_color(self) -> str:
        return "yellow"

class BadChild(Base):
    @override # type checker error: does not override Base.get_color
    def get_colour(self) -> str:
        return "red"

```

See [PEP 698](#) for more details.

(Contributed by Steven Troxler in [gh-101561](#).)

## 4 その他の言語変更

- The parser now raises `SyntaxError` when parsing source code containing null bytes. (Contributed by Pablo Galindo in [gh-96670](#).)
- A backslash-character pair that is not a valid escape sequence now generates a `SyntaxWarning`, instead of `DeprecationWarning`. For example, `re.compile("\d+\\.\\d+")` now emits a `SyntaxWarning` ("`\d`" is an invalid escape sequence, use raw strings for regular expression: `re`).

`compile(r"\d+\.\d+")`). In a future Python version, `SyntaxError` will eventually be raised, instead of `SyntaxWarning`. (Contributed by Victor Stinner in [gh-98401](#).)

- Octal escapes with value larger than `0o377` (ex: `"\477"`), deprecated in Python 3.11, now produce a `SyntaxWarning`, instead of `DeprecationWarning`. In a future Python version they will be eventually a `SyntaxError`. (Contributed by Victor Stinner in [gh-98401](#).)
- Variables used in the target part of comprehensions that are not stored to can now be used in assignment expressions (`:=`). For example, in `[(b := 1) for a, b.prop in some_iter]`, the assignment to `b` is now allowed. Note that assigning to variables stored to in the target part of comprehensions (like `a`) is still disallowed, as per [PEP 572](#). (Contributed by Nikita Sobolev in [gh-100581](#).)
- Exceptions raised in a class or type's `__set_name__` method are no longer wrapped by a `RuntimeError`. Context information is added to the exception as a [PEP 678](#) note. (Contributed by Irit Katriel in [gh-77757](#).)
- When a `try-except*` construct handles the entire `ExceptionGroup` and raises one other exception, that exception is no longer wrapped in an `ExceptionGroup`. Also changed in version 3.11.4. (Contributed by Irit Katriel in [gh-103590](#).)
- The Garbage Collector now runs only on the eval breaker mechanism of the Python bytecode evaluation loop instead of object allocations. The GC can also run when `PyErr_CheckSignals()` is called so C extensions that need to run for a long time without executing any Python code also have a chance to execute the GC periodically. (Contributed by Pablo Galindo in [gh-97922](#).)
- All builtin and extension callables expecting boolean parameters now accept arguments of any type instead of just `bool` and `int`. (Contributed by Serhiy Storchaka in [gh-60203](#).)
- `memoryview` now supports the half-float type (the `"e"` format code). (Contributed by Donghee Na and Antoine Pitrou in [gh-90751](#).)
- `slice` objects are now hashable, allowing them to be used as dict keys and set items. (Contributed by Will Bradshaw, Furkan Onder, and Raymond Hettinger in [gh-101264](#).)
- `sum()` now uses Neumaier summation to improve accuracy and commutativity when summing floats or mixed ints and floats. (Contributed by Raymond Hettinger in [gh-100425](#).)
- `ast.parse()` now raises `SyntaxError` instead of `ValueError` when parsing source code containing null bytes. (Contributed by Pablo Galindo in [gh-96670](#).)
- The extraction methods in `tarfile`, and `shutil.unpack_archive()`, have a new `filter` argument that allows limiting tar features than may be surprising or dangerous, such as creating files outside the destination directory. See tarfile extraction filters for details. In Python 3.14, the default will switch to `'data'`. (Contributed by Petr Viktorin in [PEP 706](#).)
- `types.MappingProxyType` instances are now hashable if the underlying mapping is hashable. (Contributed by Serhiy Storchaka in [gh-87995](#).)
- Add support for the perf profiler through the new environment variable `PYTHONPERFSUPPORT` and

command-line option `-X perf`, as well as the new `sys.activate_stack_trampoline()`, `sys.deactivate_stack_trampoline()`, and `sys.is_stack_trampoline_active()` functions. (Design by Pablo Galindo. Contributed by Pablo Galindo and Christian Heimes with contributions from Gregory P. Smith [Google] and Mark Shannon in [gh-96123](#).)

## 5 新たなモジュール

- None.

## 6 改良されたモジュール

### 6.1 array

- The `array.array` class now supports subscripting, making it a generic type. (Contributed by Jelle Zijlstra in [gh-98658](#).)

### 6.2 asyncio

- The performance of writing to sockets in `asyncio` has been significantly improved. `asyncio` now avoids unnecessary copying when writing to sockets and uses `sendmsg()` if the platform supports it. (Contributed by Kumar Aditya in [gh-91166](#).)
- Add `asyncio.eager_task_factory()` and `asyncio.create_eager_task_factory()` functions to allow opting an event loop in to eager task execution, making some use-cases 2x to 5x faster. (Contributed by Jacob Bower & Itamar Oren in [gh-102853](#), [gh-104140](#), and [gh-104138](#).)
- On Linux, `asyncio` uses `asyncio.PidfdChildWatcher` by default if `os.pidfd_open()` is available and functional instead of `asyncio.ThreadedChildWatcher`. (Contributed by Kumar Aditya in [gh-98024](#).)
- The event loop now uses the best available child watcher for each platform (`asyncio.PidfdChildWatcher` if supported and `asyncio.ThreadedChildWatcher` otherwise), so manually configuring a child watcher is not recommended. (Contributed by Kumar Aditya in [gh-94597](#).)
- Add `loop_factory` parameter to `asyncio.run()` to allow specifying a custom event loop factory. (Contributed by Kumar Aditya in [gh-99388](#).)
- Add C implementation of `asyncio.current_task()` for 4x-6x speedup. (Contributed by Itamar Oren and Pranav Thulasiram Bhat in [gh-100344](#).)
- `asyncio.iscoroutine()` now returns `False` for generators as `asyncio` does not support legacy generator-based coroutines. (Contributed by Kumar Aditya in [gh-102748](#).)
- `asyncio.wait()` and `asyncio.as_completed()` now accepts generators yielding tasks. (Contributed by Kumar Aditya in [gh-78530](#).)

## 6.3 calendar

- Add enums `calendar.Month` and `calendar.Day` defining months of the year and days of the week. (Contributed by Prince Roshan in [gh-103636](#).)

## 6.4 csv

- Add `csv.QUOTE_NOTNULL` and `csv.QUOTE_STRINGS` flags to provide finer grained control of `None` and empty strings by `csv.writer` objects.

## 6.5 dis

- Pseudo instruction opcodes (which are used by the compiler but do not appear in executable bytecode) are now exposed in the `dis` module. `HAVE_ARGUMENT` is still relevant to real opcodes, but it is not useful for pseudo instructions. Use the new `dis.hasarg` collection instead. (Contributed by Irit Katriel in [gh-94216](#).)
- Add the `dis.hasexc` collection to signify instructions that set an exception handler. (Contributed by Irit Katriel in [gh-94216](#).)

## 6.6 fractions

- Objects of type `fractions.Fraction` now support float-style formatting. (Contributed by Mark Dickinson in [gh-100161](#).)

## 6.7 importlib.resources

- `importlib.resources.as_file()` now supports resource directories. (Contributed by Jason R. Coombs in [gh-97930](#).)
- Rename first parameter of `importlib.resources.files()` to *anchor*. (Contributed by Jason R. Coombs in [gh-100598](#).)

## 6.8 inspect

- Add `inspect.markcoroutinefunction()` to mark sync functions that return a coroutine for use with `inspect.iscoroutinefunction()`. (Contributed by Carlton Gibson in [gh-99247](#).)
- Add `inspect.getasynccgenstate()` and `inspect.getasynccgenlocals()` for determining the current state of asynchronous generators. (Contributed by Thomas Krennwallner in [gh-79940](#).)
- The performance of `inspect.getattr_static()` has been considerably improved. Most calls to the function should be at least 2x faster than they were in Python 3.11. (Contributed by Alex Waygood in [gh-103193](#).)

## 6.9 itertools

- Add `itertools.batched()` for collecting into even-sized tuples where the last batch may be shorter than the rest. (Contributed by Raymond Hettinger in [gh-98363](#).)

## 6.10 math

- Add `math.sumprod()` for computing a sum of products. (Contributed by Raymond Hettinger in [gh-100485](#).)
- Extend `math.nextafter()` to include a *steps* argument for moving up or down multiple steps at a time. (Contributed by Matthias Goergens, Mark Dickinson, and Raymond Hettinger in [gh-94906](#).)

## 6.11 os

- Add `os.PIDFD_NONBLOCK` to open a file descriptor for a process with `os.pidfd_open()` in non-blocking mode. (Contributed by Kumar Aditya in [gh-93312](#).)
- `os.DirEntry` now includes an `os.DirEntry.is_junction()` method to check if the entry is a junction. (Contributed by Charles Machalow in [gh-99547](#).)
- Add `os.listdirives()`, `os.listvolumes()` and `os.listmounts()` functions on Windows for enumerating drives, volumes and mount points. (Contributed by Steve Dower in [gh-102519](#).)
- `os.stat()` and `os.lstat()` are now more accurate on Windows. The `st_birthtime` field will now be filled with the creation time of the file, and `st_ctime` is deprecated but still contains the creation time (but in the future will return the last metadata change, for consistency with other platforms). `st_dev` may be up to 64 bits and `st_ino` up to 128 bits depending on your file system, and `st_rdev` is always set to zero rather than incorrect values. Both functions may be significantly faster on newer releases of Windows. (Contributed by Steve Dower in [gh-99726](#).)
- As of 3.12.4, `os.mkdir()` and `os.makedirs()` on Windows now support passing a *mode* value of `0o700` to apply access control to the new directory. This implicitly affects `tempfile.mkdtemp()` and is a mitigation for [CVE 2024-4030](#). Other values for *mode* continue to be ignored. (Contributed by Steve Dower in [gh-118486](#).)

## 6.12 os.path

- Add `os.path.isjunction()` to check if a given path is a junction. (Contributed by Charles Machalow in [gh-99547](#).)
- Add `os.path.splitroot()` to split a path into a triad (*drive*, *root*, *tail*). (Contributed by Barney Gale in [gh-101000](#).)



## 6.13 pathlib

- Add support for subclassing `pathlib.PurePath` and `pathlib.Path`, plus their Posix- and Windows-specific variants. Subclasses may override the `pathlib.PurePath.with_segments()` method to pass information between path instances.
- Add `pathlib.Path.walk()` for walking the directory trees and generating all file or directory names within them, similar to `os.walk()`. (Contributed by Stanislav Zmiev in [gh-90385](#).)
- Add `walk_up` optional parameter to `pathlib.PurePath.relative_to()` to allow the insertion of `..` entries in the result; this behavior is more consistent with `os.path.relpath()`. (Contributed by Domenico Ragusa in [gh-84538](#).)
- Add `pathlib.Path.is_junction()` as a proxy to `os.path.isjunction()`. (Contributed by Charles Machalow in [gh-99547](#).)
- Add `case_sensitive` optional parameter to `pathlib.Path.glob()`, `pathlib.Path.rglob()` and `pathlib.PurePath.match()` for matching the path's case sensitivity, allowing for more precise control over the matching process.

## 6.14 プラットフォーム

- Add support for detecting Windows 11 and Windows Server releases past 2012. Previously, lookups on Windows Server platforms newer than Windows Server 2012 and on Windows 11 would return `Windows-10`. (Contributed by Steve Dower in [gh-89545](#).)

## 6.15 pdb

- Add convenience variables to hold values temporarily for debug session and provide quick access to values like the current frame or the return value. (Contributed by Tian Gao in [gh-103693](#).)

## 6.16 random

- Add `random.binomialvariate()`. (Contributed by Raymond Hettinger in [gh-81620](#).)
- Add a default of `lamdb=1.0` to `random.expovariate()`. (Contributed by Raymond Hettinger in [gh-100234](#).)

## 6.17 shutil

- `shutil.make_archive()` now passes the `root_dir` argument to custom archivers which support it. In this case it no longer temporarily changes the current working directory of the process to `root_dir` to perform archiving. (Contributed by Serhiy Storchaka in [gh-74696](#).)
- `shutil.rmtree()` now accepts a new argument `onexc` which is an error handler like `onerror` but which expects an exception instance rather than a *(typ, val, tb)* triplet. `onerror` is deprecated. (Contributed by Irit Katriel in [gh-102828](#).)
- `shutil.which()` now consults the `PATHEXT` environment variable to find matches within `PATH`

on Windows even when the given *cmd* includes a directory component. (Contributed by Charles Machalow in [gh-103179](#).)

`shutil.which()` will call `NeedCurrentDirectoryForExePathW` when querying for executables on Windows to determine if the current working directory should be prepended to the search path. (Contributed by Charles Machalow in [gh-103179](#).)

`shutil.which()` will return a path matching the *cmd* with a component from `PATHEXT` prior to a direct match elsewhere in the search path on Windows. (Contributed by Charles Machalow in [gh-103179](#).)

## 6.18 sqlite3

- Add a command-line interface. (Contributed by Erlend E. Aasland in [gh-77617](#).)
- Add the `sqlite3.Connection.autocommit` attribute to `sqlite3.Connection` and the *autocommit* parameter to `sqlite3.connect()` to control [PEP 249](#)-compliant transaction handling. (Contributed by Erlend E. Aasland in [gh-83638](#).)
- Add *entrypoint* keyword-only parameter to `sqlite3.Connection.load_extension()`, for overriding the SQLite extension entry point. (Contributed by Erlend E. Aasland in [gh-103015](#).)
- Add `sqlite3.Connection.getconfig()` and `sqlite3.Connection.setconfig()` to `sqlite3.Connection` to make configuration changes to a database connection. (Contributed by Erlend E. Aasland in [gh-103489](#).)

## 6.19 statistics

- Extend `statistics.correlation()` to include as a *ranked* method for computing the Spearman correlation of ranked data. (Contributed by Raymond Hettinger in [gh-95861](#).)

## 6.20 sys

- Add the `sys.monitoring` namespace to expose the new [PEP 669](#) monitoring API. (Contributed by Mark Shannon in [gh-103082](#).)
- Add `sys.activate_stack_trampoline()` and `sys.deactivate_stack_trampoline()` for activating and deactivating stack profiler trampolines, and `sys.is_stack_trampoline_active()` for querying if stack profiler trampolines are active. (Contributed by Pablo Galindo and Christian Heimes with contributions from Gregory P. Smith [Google] and Mark Shannon in [gh-96123](#).)
- Add `sys.last_exc` which holds the last unhandled exception that was raised (for post-mortem debugging use cases). Deprecate the three fields that have the same information in its legacy form: `sys.last_type`, `sys.last_value` and `sys.last_traceback`. (Contributed by Irit Katriel in [gh-102778](#).)
- `sys._current_exceptions()` now returns a mapping from thread-id to an exception instance, rather than to a `(typ, exc, tb)` tuple. (Contributed by Irit Katriel in [gh-103176](#).)

- `sys.setrecursionlimit()` and `sys.getrecursionlimit()`. The recursion limit now applies only to Python code. Builtin functions do not use the recursion limit, but are protected by a different mechanism that prevents recursion from causing a virtual machine crash.

## 6.21 tempfile

- The `tempfile.NamedTemporaryFile` function has a new optional parameter `delete_on_close` (Contributed by Evgeny Zorin in [gh-58451](#).)
- `tempfile.mkdtemp()` now always returns an absolute path, even if the argument provided to the `dir` parameter is a relative path.
- As of 3.12.4 on Windows, the default mode `0o700` used by `tempfile.mkdtemp()` now limits access to the new directory due to changes to `os.mkdir()`. This is a mitigation for [CVE 2024-4030](#). (Contributed by Steve Dower in [gh-118486](#).)

## 6.22 threading

- Add `threading.settrace_all_threads()` and `threading.setprofile_all_threads()` that allow to set tracing and profiling functions in all running threads in addition to the calling one. (Contributed by Pablo Galindo in [gh-93503](#).)

## 6.23 tkinter

- `tkinter.Canvas.coords()` now flattens its arguments. It now accepts not only coordinates as separate arguments (`x1, y1, x2, y2, ...`) and a sequence of coordinates (`[x1, y1, x2, y2, ...]`), but also coordinates grouped in pairs (`(x1, y1), (x2, y2), ...` and `[(x1, y1), (x2, y2), ...]`), like `create_*()` methods. (Contributed by Serhiy Storchaka in [gh-94473](#).)

## 6.24 tokenize

- The `tokenize` module includes the changes introduced in [PEP 701](#). (Contributed by Marta Gómez Macías and Pablo Galindo in [gh-102856](#).) See [Python 3.12 への移植](#) for more information on the changes to the `tokenize` module.

## 6.25 types

- Add `types.get_original_bases()` to allow for further introspection of user-defined-generics when subclassed. (Contributed by James Hilton-Balfe and Alex Waygood in [gh-101827](#).)

## 6.26 typing

- `isinstance()` checks against runtime-checkable protocols now use `inspect.getattr_static()` rather than `hasattr()` to lookup whether attributes exist. This means that descriptors and `__getattr__()` methods are no longer unexpectedly evaluated during `isinstance()` checks against runtime-checkable protocols. However, it may also mean that some objects which used to be considered instances of a runtime-checkable protocol may no longer be

considered instances of that protocol on Python 3.12+, and vice versa. Most users are unlikely to be affected by this change. (Contributed by Alex Waygood in [gh-102433](#).)

- The members of a runtime-checkable protocol are now considered "frozen" at runtime as soon as the class has been created. Monkey-patching attributes onto a runtime-checkable protocol will still work, but will have no impact on `isinstance()` checks comparing objects to the protocol. For example:

```
>>> from typing import Protocol, runtime_checkable
>>> @runtime_checkable
... class HasX(Protocol):
...     x = 1
...
>>> class Foo: ...
...
>>> f = Foo()
>>> isinstance(f, HasX)
False
>>> f.x = 1
>>> isinstance(f, HasX)
True
>>> HasX.y = 2
>>> isinstance(f, HasX)  # unchanged, even though HasX now also has a "y"
↳ attribute
True
```

This change was made in order to speed up `isinstance()` checks against runtime-checkable protocols.

- The performance profile of `isinstance()` checks against `runtime-checkable` protocols has changed significantly. Most `isinstance()` checks against protocols with only a few members should be at least 2x faster than in 3.11, and some may be 20x faster or more. However, `isinstance()` checks against protocols with many members may be slower than in Python 3.11. (Contributed by Alex Waygood in [gh-74690](#) and [gh-103193](#).)
- All `typing.TypedDict` and `typing.NamedTuple` classes now have the `__orig_bases__` attribute. (Contributed by Adrian Garcia Badaracco in [gh-103699](#).)
- Add `frozen_default` parameter to `typing.dataclass_transform()`. (Contributed by Erik De Bonte in [gh-99957](#).)

## 6.27 unicodedata

- The Unicode database has been updated to version 15.0.0. (Contributed by Benjamin Peterson in [gh-96734](#)).

## 6.28 unittest

Add a `--durations` command line option, showing the N slowest test cases:

```
python3 -m unittest --durations=3 lib.tests.test_threading
.....
Slowest test durations
-----
1.210s      test_timeout (Lib.test.test_threading.BarrierTests)
1.003s      test_default_timeout (Lib.test.test_threading.BarrierTests)
0.518s      test_timeout (Lib.test.test_threading.EventTests)

(0.000 durations hidden.  Use -v to show these durations.)
-----
Ran 158 tests in 9.869s

OK (skipped=3)
```

(Contributed by Giampaolo Rodola in [gh-48330](#))

## 6.29 uuid

- Add a command-line interface. (Contributed by Adam Chhina in [gh-88597](#).)

## 7 最適化

- Remove `wstr` and `wstr_length` members from Unicode objects. It reduces object size by 8 or 16 bytes on 64bit platform. (**PEP 623**) (Contributed by Inada Naoki in [gh-92536](#).)
- Add experimental support for using the BOLT binary optimizer in the build process, which improves performance by 1-5%. (Contributed by Kevin Modzelewski in [gh-90536](#) and tuned by Donghee Na in [gh-101525](#))
- Speed up the regular expression substitution (functions `re.sub()` and `re.subn()` and corresponding `re.Pattern` methods) for replacement strings containing group references by 2--3 times. (Contributed by Serhiy Storchaka in [gh-91524](#).)
- Speed up `asyncio.Task` creation by deferring expensive string formatting. (Contributed by Itamar Oren in [gh-103793](#).)
- The `tokenize.tokenize()` and `tokenize.generate_tokens()` functions are up to 64% faster as a side effect of the changes required to cover **PEP 701** in the `tokenize` module. (Contributed by

Marta Gómez Macías and Pablo Galindo in [gh-102856](#).)

- Speed up `super()` method calls and attribute loads via the new `LOAD_SUPER_ATTR` instruction. (Contributed by Carl Meyer and Vladimir Matveev in [gh-103497](#).)

## 8 CPython バイトコードの変更

- Remove the `LOAD_METHOD` instruction. It has been merged into `LOAD_ATTR`. `LOAD_ATTR` will now behave like the old `LOAD_METHOD` instruction if the low bit of its oparg is set. (Contributed by Ken Jin in [gh-93429](#).)
- Remove the `JUMP_IF_FALSE_OR_POP` and `JUMP_IF_TRUE_OR_POP` instructions. (Contributed by Irit Katriel in [gh-102859](#).)
- Remove the `PRECALL` instruction. (Contributed by Mark Shannon in [gh-92925](#).)
- Add the `BINARY_SLICE` and `STORE_SLICE` instructions. (Contributed by Mark Shannon in [gh-94163](#).)
- Add the `CALL_INTRINSIC_1` instructions. (Contributed by Mark Shannon in [gh-99005](#).)
- Add the `CALL_INTRINSIC_2` instruction. (Contributed by Irit Katriel in [gh-101799](#).)
- Add the `CLEANUP_THROW` instruction. (Contributed by Brandt Bucher in [gh-90997](#).)
- Add the `END_SEND` instruction. (Contributed by Mark Shannon in [gh-103082](#).)
- Add the `LOAD_FAST_AND_CLEAR` instruction as part of the implementation of **PEP 709**. (Contributed by Carl Meyer in [gh-101441](#).)
- Add the `LOAD_FAST_CHECK` instruction. (Contributed by Dennis Sweeney in [gh-93143](#).)
- Add the `LOAD_FROM_DICT_OR_DEREF`, `LOAD_FROM_DICT_OR_GLOBALS`, and `LOAD_LOCALS` opcodes as part of the implementation of **PEP 695**. Remove the `LOAD_CLASSDEREF` opcode, which can be replaced with `LOAD_LOCALS` plus `LOAD_FROM_DICT_OR_DEREF`. (Contributed by Jelle Zijlstra in [gh-103764](#).)
- Add the `LOAD_SUPER_ATTR` instruction. (Contributed by Carl Meyer and Vladimir Matveev in [gh-103497](#).)
- Add the `RETURN_CONST` instruction. (Contributed by Wenyang Wang in [gh-101632](#).)

## 9 Demos and Tools

- Remove the `Tools/demo/` directory which contained old demo scripts. A copy can be found in the `old-demos` project. (Contributed by Victor Stinner in [gh-97681](#).)
- Remove outdated example scripts of the `Tools/scripts/` directory. A copy can be found in the `old-demos` project. (Contributed by Victor Stinner in [gh-97669](#).)

## 10 非推奨

- **argparse**: The *type*, *choices*, and *metavar* parameters of `argparse.BooleanOptionalAction` are deprecated and will be removed in 3.14. (Contributed by Nikita Sobolev in [gh-92248](#).)
- **ast**: The following `ast` features have been deprecated in documentation since Python 3.8, now cause a `DeprecationWarning` to be emitted at runtime when they are accessed or used, and will be removed in Python 3.14:

- `ast.Num`
- `ast.Str`
- `ast.Bytes`
- `ast.NameConstant`
- `ast.Ellipsis`

Use `ast.Constant` instead. (Contributed by Serhiy Storchaka in [gh-90953](#).)

- **asyncio**:
  - The child watcher classes `asyncio.MultiLoopChildWatcher`, `asyncio.FastChildWatcher`, `asyncio.AbstractChildWatcher` and `asyncio.SafeChildWatcher` are deprecated and will be removed in Python 3.14. (Contributed by Kumar Aditya in [gh-94597](#).)
  - `asyncio.set_child_watcher()`, `asyncio.get_child_watcher()`, `asyncio.AbstractEventLoopPolicy.set_child_watcher()` and `asyncio.AbstractEventLoopPolicy.get_child_watcher()` are deprecated and will be removed in Python 3.14. (Contributed by Kumar Aditya in [gh-94597](#).)
  - The `get_event_loop()` method of the default event loop policy now emits a `DeprecationWarning` if there is no current event loop set and it decides to create one. (Contributed by Serhiy Storchaka and Guido van Rossum in [gh-100160](#).)
- **calendar**: `calendar.January` and `calendar.February` constants are deprecated and replaced by `calendar.JANUARY` and `calendar.FEBRUARY`. (Contributed by Prince Roshan in [gh-103636](#).)
- **collections.abc**: Deprecated `collections.abc.ByteString`. Prefer `Sequence` or `collections.abc.Buffer`. For use in typing, prefer a union, like `bytes | bytearray`, or `collections.abc.Buffer`. (Contributed by Shantanu Jain in [gh-91896](#).)
- **datetime**: `datetime.datetime`'s `utcnow()` and `utcfromtimestamp()` are deprecated and will be removed in a future version. Instead, use timezone-aware objects to represent datetimes in UTC: respectively, call `now()` and `fromtimestamp()` with the `tz` parameter set to `datetime.UTC`. (Contributed by Paul Ganssle in [gh-103857](#).)
- **email**: Deprecate the `isdst` parameter in `email.utils.localtime()`. (Contributed by Alan Williams in [gh-72346](#).)
- **importlib.abc**: Deprecated the following classes, scheduled for removal in Python 3.14:

- `importlib.abc.ResourceReader`
- `importlib.abc.Traversable`
- `importlib.abc.TraversableResources`

Use `importlib.resources.abc` classes instead:

- `importlib.resources.abc.Traversable`
- `importlib.resources.abc.TraversableResources`

(Contributed by Jason R. Coombs and Hugo van Kemenade in [gh-93963](#).)

- **itertools:** Deprecate the support for `copy`, `deepcopy`, and `pickle` operations, which is undocumented, inefficient, historically buggy, and inconsistent. This will be removed in 3.14 for a significant reduction in code volume and maintenance burden. (Contributed by Raymond Hettinger in [gh-101588](#).)
- **multiprocessing:** In Python 3.14, the default `multiprocessing` start method will change to a safer one on Linux, BSDs, and other non-macOS POSIX platforms where `'fork'` is currently the default ([gh-84559](#)). Adding a runtime warning about this was deemed too disruptive as the majority of code is not expected to care. Use the `get_context()` or `set_start_method()` APIs to explicitly specify when your code *requires* `'fork'`. See contexts and start methods.
- **pkgutil:** `pkgutil.find_loader()` and `pkgutil.get_loader()` are deprecated and will be removed in Python 3.14; use `importlib.util.find_spec()` instead. (Contributed by Nikita Sobolev in [gh-97850](#).)
- **pty:** The module has two undocumented `master_open()` and `slave_open()` functions that have been deprecated since Python 2 but only gained a proper `DeprecationWarning` in 3.12. Remove them in 3.14. (Contributed by Soumendra Ganguly and Gregory P. Smith in [gh-85984](#).)
- **os:**
  - The `st_ctime` fields return by `os.stat()` and `os.lstat()` on Windows are deprecated. In a future release, they will contain the last metadata change time, consistent with other platforms. For now, they still contain the creation time, which is also available in the new `st_birthtime` field. (Contributed by Steve Dower in [gh-99726](#).)
  - On POSIX platforms, `os.fork()` can now raise a `DeprecationWarning` when it can detect being called from a multithreaded process. There has always been a fundamental incompatibility with the POSIX platform when doing so. Even if such code *appeared* to work. We added the warning to raise awareness as issues encountered by code doing this are becoming more frequent. See the `os.fork()` documentation for more details along with [this discussion on fork being incompatible with threads](#) for *why* we're now surfacing this longstanding platform compatibility problem to developers.

When this warning appears due to usage of `multiprocessing` or `concurrent.futures` the fix is to use a different `multiprocessing` start method such as `"spawn"` or `"forkserver"`.



- **shutil:** The *onerror* argument of `shutil.rmtree()` is deprecated; use *onexc* instead. (Contributed by Irit Katriel in [gh-102828](#).)
- **sqlite3:**
  - default adapters and converters are now deprecated. Instead, use the `sqlite3-adapters-converter-recipes` and tailor them to your needs. (Contributed by Erlend E. Aasland in [gh-90016](#).)
  - In `execute()`, `DeprecationWarning` is now emitted when named placeholders are used together with parameters supplied as a sequence instead of as a `dict`. Starting from Python 3.14, using named placeholders with parameters supplied as a sequence will raise a `ProgrammingError`. (Contributed by Erlend E. Aasland in [gh-101698](#).)
- **sys:** The `sys.last_type`, `sys.last_value` and `sys.last_traceback` fields are deprecated. Use `sys.last_exc` instead. (Contributed by Irit Katriel in [gh-102778](#).)
- **tarfile:** Extracting tar archives without specifying *filter* is deprecated until Python 3.14, when 'data' filter will become the default. See `tarfile-extraction-filter` for details.
- **typing:**
  - `typing.Hashable` and `typing.Sized`, aliases for `collections.abc.Hashable` and `collections.abc.Sized` respectively, are deprecated. ([gh-94309](#).)
  - `typing.ByteString`, deprecated since Python 3.9, now causes a `DeprecationWarning` to be emitted when it is used. (Contributed by Alex Waygood in [gh-91896](#).)
- **xml.etree.ElementTree:** The module now emits `DeprecationWarning` when testing the truth value of an `xml.etree.ElementTree.Element`. Before, the Python implementation emitted `FutureWarning`, and the C implementation emitted nothing. (Contributed by Jacob Walls in [gh-83122](#).)
- The 3-arg signatures (type, value, traceback) of `coroutine throw()`, `generator throw()` and `async generator throw()` are deprecated and may be removed in a future version of Python. Use the single-arg versions of these functions instead. (Contributed by Ofey Chan in [gh-89874](#).)
- `DeprecationWarning` is now raised when `__package__` on a module differs from `__spec__.parent` (previously it was `ImportWarning`). (Contributed by Brett Cannon in [gh-65961](#).)
- Setting `__package__` or `__cached__` on a module is deprecated, and will cease to be set or taken into consideration by the import system in Python 3.14. (Contributed by Brett Cannon in [gh-65961](#).)
- The bitwise inversion operator (`~`) on `bool` is deprecated. It will throw an error in Python 3.16. Use `not` for logical negation of booleans instead. In the rare case that you really need the bitwise inversion of the underlying `int`, convert to `int` explicitly: `~int(x)`. (Contributed by Tim Hoffmann in [gh-103487](#).)
- Accessing `co_lnotab` on code objects was deprecated in Python 3.10 via [PEP 626](#), but it only got

a proper `DeprecationWarning` in 3.12. May be removed in 3.15. (Contributed by Nikita Sobolev in [gh-101866](#).)

## 10.1 Pending Removal in Python 3.13

モジュール ([PEP 594](#) を参照):

- `aifc`
- `audioop`
- `cgi`
- `cgitb`
- `chunk`
- `crypt`
- `imghdr`
- `mailcap`
- `msilib`
- `nis`
- `nntplib`
- `ossaudiodev`
- `pipes`
- `sndhdr`
- `spwd`
- `sunau`
- `telnetlib`
- `uu`
- `xdrlib`

その他のモジュール:

- `lib2to3`, and the `2to3` program ([gh-84540](#))

API

- `configparser.LegacyInterpolation` ([gh-90765](#))
- `locale.resetlocale()` ([gh-90817](#))
- `turtle.RawTurtle.settiltangle()` ([gh-50096](#))

- `unittest.findTestCases()` ([gh-50096](#))
- `unittest.getTestCaseNames()` ([gh-50096](#))
- `unittest.makeSuite()` ([gh-50096](#))
- `unittest.TestProgram.usageExit()` ([gh-67048](#))
- `webbrowser.MacOSX` ([gh-86421](#))
- classmethod descriptor chaining ([gh-89519](#))
- `importlib.resources` deprecated methods:
  - `contents()`
  - `is_resource()`
  - `open_binary()`
  - `open_text()`
  - `path()`
  - `read_binary()`
  - `read_text()`

Use `importlib.resources.files()` instead. Refer to [importlib-resources: Migrating from Legacy](#) ([gh-106531](#))

## 10.2 Pending Removal in Python 3.14

- **argparse**: The *type*, *choices*, and *metavar* parameters of `argparse.BooleanOptionalAction` are deprecated and will be removed in 3.14. (Contributed by Nikita Sobolev in [gh-92248](#).)
- **ast**: The following features have been deprecated in documentation since Python 3.8, now cause a `DeprecationWarning` to be emitted at runtime when they are accessed or used, and will be removed in Python 3.14:
  - `ast.Num`
  - `ast.Str`
  - `ast.Bytes`
  - `ast.NameConstant`
  - `ast.Ellipsis`

Use `ast.Constant` instead. (Contributed by Serhiy Storchaka in [gh-90953](#).)

- **asyncio**:

- The child watcher classes `MultiLoopChildWatcher`, `FastChildWatcher`, `AbstractChildWatcher` and `SafeChildWatcher` are deprecated and will be removed in Python 3.14. (Contributed by Kumar Aditya in [gh-94597](#).)
  - `asyncio.set_child_watcher()`, `asyncio.get_child_watcher()`, `asyncio.AbstractEventLoopPolicy.set_child_watcher()` and `asyncio.AbstractEventLoopPolicy.get_child_watcher()` are deprecated and will be removed in Python 3.14. (Contributed by Kumar Aditya in [gh-94597](#).)
  - The `get_event_loop()` method of the default event loop policy now emits a `DeprecationWarning` if there is no current event loop set and it decides to create one. (Contributed by Serhiy Storchaka and Guido van Rossum in [gh-100160](#).)
  - `collections.abc`: Deprecated `ByteString`. Prefer `Sequence` or `Buffer`. For use in typing, prefer a union, like `bytes | bytearray`, or `collections.abc.Buffer`. (Contributed by Shantanu Jain in [gh-91896](#).)
  - `email`: Deprecated the `isdst` parameter in `email.utils.localtime()`. (Contributed by Alan Williams in [gh-72346](#).)
  - `importlib`: `__package__` and `__cached__` will cease to be set or taken into consideration by the import system ([gh-97879](#)).
  - `importlib.abc` deprecated classes:
    - `importlib.abc.ResourceReader`
    - `importlib.abc.Traversable`
    - `importlib.abc.TraversableResources`
- Use `importlib.resources.abc` classes instead:
- `importlib.resources.abc.Traversable`
  - `importlib.resources.abc.TraversableResources`
- (Contributed by Jason R. Coombs and Hugo van Kemenade in [gh-93963](#).)
- `itertools` had undocumented, inefficient, historically buggy, and inconsistent support for copy, deepcopy, and pickle operations. This will be removed in 3.14 for a significant reduction in code volume and maintenance burden. (Contributed by Raymond Hettinger in [gh-101588](#).)
  - `multiprocessing`: The default start method will change to a safer one on Linux, BSDs, and other non-macOS POSIX platforms where 'fork' is currently the default ([gh-84559](#)). Adding a runtime warning about this was deemed too disruptive as the majority of code is not expected to care. Use the `get_context()` or `set_start_method()` APIs to explicitly specify when your code *requires* 'fork'. See `multiprocessing-start-methods`.
  - `pathlib`: `is_relative_to()` and `relative_to()`: passing additional arguments is deprecated.

- `pkgutil`: `find_loader()` and `get_loader()` now raise `DeprecationWarning`; use `importlib.util.find_spec()` instead. (Contributed by Nikita Sobolev in [gh-97850](#).)
- `pty`:
  - `master_open()`: use `pty.openpty()`.
  - `slave_open()`: use `pty.openpty()`.
- `sqlite3`:
  - `version` and `version_info`.
  - `execute()` and `executemany()` if named placeholders are used and *parameters* is a sequence instead of a dict.
- `typing`: `ByteString`, deprecated since Python 3.9, now causes a `DeprecationWarning` to be emitted when it is used.
- `urllib`: `urllib.parse.Quoter` is deprecated: it was not intended to be a public API. (Contributed by Gregory P. Smith in [gh-88168](#).)

### 10.3 Pending Removal in Python 3.15

- `http.server.CGIHTTPRequestHandler` will be removed along with its related `--cgi` flag to `python -m http.server`. It was obsolete and rarely used. No direct replacement exists. *Anything* is better than CGI to interface a web server with a request handler.
- `importlib`:
  - `load_module()` method: use `exec_module()` instead.
- `locale`: `locale.getdefaultlocale()` was deprecated in Python 3.11 and originally planned for removal in Python 3.13 ([gh-90817](#)), but removal has been postponed to Python 3.15. Use `locale.setlocale()`, `locale.getencoding()` and `locale.getlocale()` instead. (Contributed by Hugo van Kemenade in [gh-111187](#).)
- `pathlib`: `pathlib.PurePath.is_reserved()` is deprecated and scheduled for removal in Python 3.15. From Python 3.13 onwards, use `os.path.isreserved` to detect reserved paths on Windows.
- `platform`: `java_ver()` is deprecated and will be removed in 3.15. It was largely untested, had a confusing API, and was only useful for Jython support. (Contributed by Nikita Sobolev in [gh-116349](#).)
- `sysconfig`:
  - The *check\_home* argument of `sysconfig.is_python_build()` has been deprecated since Python 3.12.
- `threading`: Passing any arguments to `threading.RLock()` is now deprecated. C version allows any numbers of args and kwargs, but they are just ignored. Python version does not allow any

arguments. All arguments will be removed from `threading.RLock()` in Python 3.15. (Contributed by Nikita Sobolev in [gh-102029](#).)

- `typing.NamedTuple`:
  - The undocumented keyword argument syntax for creating `NamedTuple` classes (`NT = NamedTuple("NT", x=int)`) is deprecated, and will be disallowed in 3.15. Use the class-based syntax or the functional syntax instead.
- `types`:
  - `types.CodeType`: Accessing `co_notab` was deprecated in [PEP 626](#) since 3.10 and was planned to be removed in 3.12, but it only got a proper `DeprecationWarning` in 3.12. May be removed in 3.15. (Contributed by Nikita Sobolev in [gh-101866](#).)
- `typing`:
  - When using the functional syntax to create a `NamedTuple` class, failing to pass a value to the *fields* parameter (`NT = NamedTuple("NT")`) is deprecated. Passing `None` to the *fields* parameter (`NT = NamedTuple("NT", None)`) is also deprecated. Both will be disallowed in Python 3.15. To create a `NamedTuple` class with 0 fields, use `class NT(NamedTuple): pass` or `NT = NamedTuple("NT", [])`.
- `typing.TypedDict`: When using the functional syntax to create a `TypedDict` class, failing to pass a value to the *fields* parameter (`TD = TypedDict("TD")`) is deprecated. Passing `None` to the *fields* parameter (`TD = TypedDict("TD", None)`) is also deprecated. Both will be disallowed in Python 3.15. To create a `TypedDict` class with 0 fields, use `class TD(TypedDict): pass` or `TD = TypedDict("TD", {})`.
- `wave`: Deprecate the `getmark()`, `setmark()` and `getmarkers()` methods of the `wave.Wave_read` and `wave.Wave_write` classes. They will be removed in Python 3.15. (Contributed by Victor Stinner in [gh-105096](#).)

## 10.4 Pending Removal in Python 3.16

- The import system:
  - Setting `__loader__` on a module while failing to set `__spec__.loader` is deprecated. In Python 3.16, `__loader__` will cease to be set or taken into consideration by the import system or the standard library.
- `array`: `array.array 'u' type (wchar_t)`: use the `'w'` type instead (`Py_UCS4`).
- `builtins`: `~bool`, bitwise inversion on `bool`.
- `symtable`: Deprecate `symtable.Class.get_methods()` due to the lack of interest. (Contributed by B  n  dikt Tran in [gh-119698](#).)

## 10.5 Pending Removal in Future Versions

The following APIs will be removed in the future, although there is currently no date scheduled for their removal.

- **argparse**: Nesting argument groups and nesting mutually exclusive groups are deprecated.
- **array**'s 'u' format code ([gh-57281](#))
- **builtins**:
  - `bool(NotImplemented)`.
  - Generators: `throw(type, exc, tb)` and `athrow(type, exc, tb)` signature is deprecated: use `throw(exc)` and `athrow(exc)` instead, the single argument signature.
  - Currently Python accepts numeric literals immediately followed by keywords, for example `0in x, 1or x, 0if 1else 2`. It allows confusing and ambiguous expressions like `[0x1for x in y]` (which can be interpreted as `[0x1 for x in y]` or `[0x1f or x in y]`). A syntax warning is raised if the numeric literal is immediately followed by one of keywords `and`, `else`, `for`, `if`, `in`, `is` and `or`. In a future release it will be changed to a syntax error. ([gh-87999](#))
  - Support for `__index__()` and `__int__()` method returning non-int type: these methods will be required to return an instance of a strict subclass of `int`.
  - Support for `__float__()` method returning a strict subclass of `float`: these methods will be required to return an instance of `float`.
  - Support for `__complex__()` method returning a strict subclass of `complex`: these methods will be required to return an instance of `complex`.
  - Delegation of `int()` to `__trunc__()` method.
  - Passing a complex number as the *real* or *imag* argument in the `complex()` constructor is now deprecated; it should only be passed as a single positional argument. (Contributed by Serhiy Storchaka in [gh-109218](#).)
- **calendar**: `calendar.January` and `calendar.February` constants are deprecated and replaced by `calendar.JANUARY` and `calendar.FEBRUARY`. (Contributed by Prince Roshan in [gh-103636](#).)
- **codeobject.co\_lnotab**: use the `codeobject.co_lines()` method instead.
- **datetime**:
  - `utcnow()`: use `datetime.datetime.now(tz=datetime.UTC)`.
  - `utcfromtimestamp()`: use `datetime.datetime.fromtimestamp(timestamp, tz=datetime.UTC)`.
- **gettext**: Plural value must be an integer.
- **importlib**:

- `cache_from_source()` *debug\_override* parameter is deprecated: use the *optimization* parameter instead.
- `importlib.metadata`:
  - `EntryPoint` tuple interface.
  - Implicit `None` on return values.
- `mailbox`: Use of `StringIO` input and text mode is deprecated, use `BytesIO` and binary mode instead.
- `os`: Calling `os.register_at_fork()` in multi-threaded process.
- `pydoc.ErrorDuringImport`: A tuple value for *exc\_info* parameter is deprecated, use an exception instance.
- `re`: More strict rules are now applied for numerical group references and group names in regular expressions. Only sequence of ASCII digits is now accepted as a numerical reference. The group name in bytes patterns and replacement strings can now only contain ASCII letters and digits and underscore. (Contributed by Serhiy Storchaka in [gh-91760](#).)
- `sre_compile`, `sre_constants` and `sre_parse` modules.
- `shutil`: `rmtree()`'s *onerror* parameter is deprecated in Python 3.12; use the *onexc* parameter instead.
- `ssl` options and protocols:
  - `ssl.SSLContext` without protocol argument is deprecated.
  - `ssl.SSLContext`: `set_npn_protocols()` and `selected_npn_protocol()` are deprecated: use ALPN instead.
  - `ssl.OP_NO_SSL*` options
  - `ssl.OP_NO_TLS*` options
  - `ssl.PROTOCOL_SSLv3`
  - `ssl.PROTOCOL_TLS`
  - `ssl.PROTOCOL_TLSv1`
  - `ssl.PROTOCOL_TLSv1_1`
  - `ssl.PROTOCOL_TLSv1_2`
  - `ssl.TLSVersion.SSLv3`
  - `ssl.TLSVersion.TLSv1`
  - `ssl.TLSVersion.TLSv1_1`
- `threading` methods:



- `threading.Condition.notifyAll()`: use `notify_all()`.
- `threading.Event.isSet()`: use `is_set()`.
- `threading.Thread.isDaemon()`, `threading.Thread.setDaemon()`: use `threading.Thread.daemon` attribute.
- `threading.Thread.getName()`, `threading.Thread.setName()`: use `threading.Thread.name` attribute.
- `threading.currentThread()`: use `threading.current_thread()`.
- `threading.activeCount()`: use `threading.active_count()`.
- `typing.Text` ([gh-92332](#)).
- `unittest.IsolatedAsyncioTestCase`: it is deprecated to return a value that is not `None` from a test case.
- `urllib.parse` deprecated functions: `urlparse()` instead
  - `splitattr()`
  - `splithost()`
  - `splitnport()`
  - `splitpasswd()`
  - `splitport()`
  - `splitquery()`
  - `splittag()`
  - `splitttype()`
  - `splituser()`
  - `splitvalue()`
  - `to_bytes()`
- `urllib.request`: `URLopener` and `FancyURLopener` style of invoking requests is deprecated. Use newer `urlopen()` functions and methods.
- `wsgiref`: `SimpleHandler.stdout.write()` should not do partial writes.
- `xml.etree.ElementTree`: Testing the truth value of an `Element` is deprecated. In a future release it will always return `True`. Prefer explicit `len(elem)` or `elem is not None` tests instead.
- `zipimport.zipimporter.load_module()` is deprecated: use `exec_module()` instead.

## 11 削除

### 11.1 asynchat and asyncore

- These two modules have been removed according to the schedule in [PEP 594](#), having been deprecated in Python 3.6. Use `asyncio` instead. (Contributed by Nikita Sobolev in [gh-96580](#).)

### 11.2 configparser

- Several names deprecated in the `configparser` way back in 3.2 have been removed per [gh-89336](#):
  - `configparser.ParsingError` no longer has a `filename` attribute or argument. Use the `source` attribute and argument instead.
  - `configparser` no longer has a `SafeConfigParser` class. Use the shorter `ConfigParser` name instead.
  - `configparser.ConfigParser` no longer has a `readfp` method. Use `read_file()` instead.

### 11.3 distutils

- Remove the `distutils` package. It was deprecated in Python 3.10 by [PEP 632](#) "Deprecate `distutils` module". For projects still using `distutils` and cannot be updated to something else, the `setuptools` project can be installed: it still provides `distutils`. (Contributed by Victor Stinner in [gh-92584](#).)

### 11.4 ensurepip

- Remove the bundled `setuptools` wheel from `ensurepip`, and stop installing `setuptools` in environments created by `venv`.

`pip (>= 22.1)` does not require `setuptools` to be installed in the environment. `setuptools`-based (and `distutils`-based) packages can still be used with `pip install`, since `pip` will provide `setuptools` in the build environment it uses for building a package.

`easy_install`, `pkg_resources`, `setuptools` and `distutils` are no longer provided by default in environments created with `venv` or bootstrapped with `ensurepip`, since they are part of the `setuptools` package. For projects relying on these at runtime, the `setuptools` project should be declared as a dependency and installed separately (typically, using `pip`).

(Contributed by Pradyun Gedam in [gh-95299](#).)

### 11.5 enum

- Remove `enum`'s `EnumMeta.__getattr__`, which is no longer needed for `enum` attribute access. (Contributed by Ethan Furman in [gh-95083](#).)

## 11.6 ftplib

- Remove `ftplib`'s `FTP_TLS.ssl_version` class attribute: use the *context* parameter instead. (Contributed by Victor Stinner in [gh-94172](#).)

## 11.7 gzip

- Remove the `filename` attribute of `gzip`'s `gzip.GzipFile`, deprecated since Python 2.6, use the `name` attribute instead. In write mode, the `filename` attribute added `'.gz'` file extension if it was not present. (Contributed by Victor Stinner in [gh-94196](#).)

## 11.8 hashlib

- Remove the pure Python implementation of `hashlib`'s `hashlib.pbkdf2_hmac()`, deprecated in Python 3.10. Python 3.10 and newer requires OpenSSL 1.1.1 ([PEP 644](#)): this OpenSSL version provides a C implementation of `pbkdf2_hmac()` which is faster. (Contributed by Victor Stinner in [gh-94199](#).)

## 11.9 importlib

- Many previously deprecated cleanups in `importlib` have now been completed:
  - References to, and support for `module_repr()` has been removed. (Contributed by Barry Warsaw in [gh-97850](#).)
  - `importlib.util.set_package`, `importlib.util.set_loader` and `importlib.util.module_for_loader` have all been removed. (Contributed by Brett Cannon and Nikita Sobolev in [gh-65961](#) and [gh-97850](#).)
  - Support for `find_loader()` and `find_module()` APIs have been removed. (Contributed by Barry Warsaw in [gh-98040](#).)
  - `importlib.abc.Finder`, `pkgutil.ImpImporter`, and `pkgutil.ImpLoader` have been removed. (Contributed by Barry Warsaw in [gh-98040](#).)

## 11.10 imp

- The `imp` module has been removed. (Contributed by Barry Warsaw in [gh-98040](#).)

To migrate, consult the following correspondence table:

imp	importlib
imp. NullImporter	sys.path_importer_cache に None を挿入する
imp. cache_from_source()	importlib.util.cache_from_source()
imp. find_module()	importlib.util.find_spec()
imp. get_magic()	importlib.util.MAGIC_NUMBER
imp. get_suffixes()	importlib.machinery.SOURCE_SUFFIXES, importlib.machinery.EXTENSION_SUFFIXES, and importlib.machinery.BYTECODE_SUFFIXES
imp. get_tag()	sys.implementation.cache_tag
imp. load_module()	importlib.import_module()
imp. new_module(name)	types.ModuleType(name)
imp.reload()	importlib.reload()
imp. source_from_cache()	importlib.util.source_from_cache()
imp. load_source()	See below

Replace `imp.load_source()` with:

```
import importlib.util
import importlib.machinery

def load_source(modname, filename):
    loader = importlib.machinery.SourceFileLoader(modname, filename)
    spec = importlib.util.spec_from_file_location(modname, filename,
    ↪ loader=loader)
    module = importlib.util.module_from_spec(spec)
    # The module is always executed and not cached in sys.modules.
    # Uncomment the following line to cache the module.
    # sys.modules[module.__name__] = module
    loader.exec_module(module)
    return module
```

- Remove `imp` functions and attributes with no replacements:

- ドキュメント化されていない関数:

- \* `imp.init_builtin()`
- \* `imp.load_compiled()`
- \* `imp.load_dynamic()`
- \* `imp.load_package()`
- `imp.lock_held()`, `imp.acquire_lock()`, `imp.release_lock()`: the locking scheme has changed in Python 3.3 to per-module locks.
- `imp.find_module()` constants: `SEARCH_ERROR`, `PY_SOURCE`, `PY_COMPILED`, `C_EXTENSION`, `PY_RESOURCE`, `PKG_DIRECTORY`, `C_BUILTIN`, `PY_FROZEN`, `PY_CODERESOURCE`, `IMP_HOOK`.

### 11.11 io

- Remove `io`'s `io.OpenWrapper` and `_pyio.OpenWrapper`, deprecated in Python 3.10: just use `open()` instead. The `open()` (`io.open()`) function is a built-in function. Since Python 3.10, `_pyio.open()` is also a static method. (Contributed by Victor Stinner in [gh-94169](#).)

### 11.12 locale

- Remove `locale`'s `locale.format()` function, deprecated in Python 3.7: use `locale.format_string()` instead. (Contributed by Victor Stinner in [gh-94226](#).)

### 11.13 smtpd

- The `smtpd` module has been removed according to the schedule in [PEP 594](#), having been deprecated in Python 3.4.7 and 3.5.4. Use the `aiosmtpd` PyPI module or any other `asyncio`-based server instead. (Contributed by Oleg Iarygin in [gh-93243](#).)

### 11.14 sqlite3

- The following undocumented `sqlite3` features, deprecated in Python 3.10, are now removed:

- `sqlite3.enable_shared_cache()`
- `sqlite3.OptimizedUnicode`

If a shared cache must be used, open the database in URI mode using the `cache=shared` query parameter.

The `sqlite3.OptimizedUnicode` text factory has been an alias for `str` since Python 3.3. Code that previously set the text factory to `OptimizedUnicode` can either use `str` explicitly, or rely on the default value which is also `str`.

(Contributed by Erlend E. Aasland in [gh-92548](#).)

## 11.15 ssl

- Remove `ssl`'s `ssl.RAND_pseudo_bytes()` function, deprecated in Python 3.6: use `os.urandom()` or `ssl.RAND_bytes()` instead. (Contributed by Victor Stinner in [gh-94199](#).)
- Remove the `ssl.match_hostname()` function. It was deprecated in Python 3.7. OpenSSL performs hostname matching since Python 3.7, Python no longer uses the `ssl.match_hostname()` function. (Contributed by Victor Stinner in [gh-94199](#).)
- Remove the `ssl.wrap_socket()` function, deprecated in Python 3.7: instead, create a `ssl.SSLContext` object and call its `ssl.SSLContext.wrap_socket` method. Any package that still uses `ssl.wrap_socket()` is broken and insecure. The function neither sends a SNI TLS extension nor validates the server hostname. Code is subject to **CWE 295** (Improper Certificate Validation). (Contributed by Victor Stinner in [gh-94199](#).)

## 11.16 unittest

- Remove many long-deprecated `unittest` features:
  - A number of `TestCase` method aliases:

非推奨のエイリアス	メソッド名	非推奨となるバージョン
<code>failUnless</code>	<code>assertTrue()</code>	3.1
<code>failIf</code>	<code>assertFalse()</code>	3.1
<code>failUnlessEqual</code>	<code>assertEqual()</code>	3.1
<code>failIfEqual</code>	<code>assertNotEqual()</code>	3.1
<code>failUnlessAlmostEqual</code>	<code>assertAlmostEqual()</code>	3.1
<code>failIfAlmostEqual</code>	<code>assertNotAlmostEqual()</code>	3.1
<code>failUnlessRaises</code>	<code>assertRaises()</code>	3.1
<code>assert_</code>	<code>assertTrue()</code>	3.2
<code>assertEquals</code>	<code>assertEqual()</code>	3.2
<code>assertNotEquals</code>	<code>assertNotEqual()</code>	3.2
<code>assertAlmostEquals</code>	<code>assertAlmostEqual()</code>	3.2
<code>assertNotAlmostEquals</code>	<code>assertNotAlmostEqual()</code>	3.2
<code>assertRegexpMatches</code>	<code>assertRegex()</code>	3.2
<code>assertRaisesRegexp</code>	<code>assertRaisesRegex()</code>	3.2
<code>assertNotRegexpMatches</code>	<code>assertNotRegex()</code>	3.5

You can use <https://github.com/isidentical/teyit> to automatically modernise your unit tests.

- Undocumented and broken `TestCase` method `assertDictContainsSubset` (deprecated in Python 3.2).
- Undocumented `TestLoader.loadTestsFromModule` parameter `use_load_tests` (deprecated and ignored since Python 3.5).

- An alias of the `TextTestResult` class: `_TextTestResult` (deprecated in Python 3.2).

(Contributed by Serhiy Storchaka in [gh-89325](#).)

### 11.17 webbrowser

- Remove support for obsolete browsers from `webbrowser`. The removed browsers include: Grail, Mosaic, Netscape, Galeon, Skipstone, Iceape, Firebird, and Firefox versions 35 and below ([gh-102871](#)).

### 11.18 xml.etree.ElementTree

- Remove the `ElementTree.Element.copy()` method of the pure Python implementation, deprecated in Python 3.10, use the `copy.copy()` function instead. The C implementation of `xml.etree.ElementTree` has no `copy()` method, only a `__copy__()` method. (Contributed by Victor Stinner in [gh-94383](#).)

### 11.19 zipimport

- Remove `zipimport`'s `find_loader()` and `find_module()` methods, deprecated in Python 3.10: use the `find_spec()` method instead. See [PEP 451](#) for the rationale. (Contributed by Victor Stinner in [gh-94379](#).)

### 11.20 その他

- Remove the `suspicious` rule from the documentation `Makefile` and `Doc/tools/rstlint.py`, both in favor of `sphinx-lint`. (Contributed by Julien Palard in [gh-98179](#).)
- Remove the `keyfile` and `certfile` parameters from the `ftplib`, `imaplib`, `poplib` and `smtplib` modules, and the `key_file`, `cert_file` and `check_hostname` parameters from the `http.client` module, all deprecated since Python 3.6. Use the `context` parameter (`ssl_context` in `imaplib`) instead. (Contributed by Victor Stinner in [gh-94172](#).)
- Remove `Jython` compatibility hacks from several `stdlib` modules and tests. (Contributed by Nikita Sobolev in [gh-99482](#).)
- Remove `_use_broken_old_ctypes_structure_semantics_` flag from `ctypes` module. (Contributed by Nikita Sobolev in [gh-99285](#).)

## 12 Python 3.12 への移植

このセクションでは前述の変更とバグフィックスにより必要となるかもしれないコードの変更を列挙します:

## 12.1 Python API の変更

- More strict rules are now applied for numerical group references and group names in regular expressions. Only sequence of ASCII digits is now accepted as a numerical reference. The group name in bytes patterns and replacement strings can now only contain ASCII letters and digits and underscore. (Contributed by Serhiy Storchaka in [gh-91760](#).)
- Remove `randrange()` functionality deprecated since Python 3.10. Formerly, `randrange(10.0)` losslessly converted to `randrange(10)`. Now, it raises a `TypeError`. Also, the exception raised for non-integer values such as `randrange(10.5)` or `randrange('10')` has been changed from `ValueError` to `TypeError`. This also prevents bugs where `randrange(1e25)` would silently select from a larger range than `randrange(10**25)`. (Originally suggested by Serhiy Storchaka [gh-86388](#).)
- `argparse.ArgumentParser` changed encoding and error handler for reading arguments from file (e.g. `fromfile_prefix_chars` option) from default text encoding (e.g. `locale.getpreferredencoding(False)`) to filesystem encoding and error handler. Argument files should be encoded in UTF-8 instead of ANSI Codepage on Windows.
- Remove the `asyncore`-based `smtpd` module deprecated in Python 3.4.7 and 3.5.4. A recommended replacement is the `asyncio`-based `aiosmtpd` PyPI module.
- `shlex.split()`: Passing `None` for `s` argument now raises an exception, rather than reading `sys.stdin`. The feature was deprecated in Python 3.9. (Contributed by Victor Stinner in [gh-94352](#).)
- The `os` module no longer accepts bytes-like paths, like `bytearray` and `memoryview` types: only the exact `bytes` type is accepted for bytes strings. (Contributed by Victor Stinner in [gh-98393](#).)
- `syslog.openlog()` and `syslog.closelog()` now fail if used in subinterpreters. `syslog.syslog()` may still be used in subinterpreters, but now only if `syslog.openlog()` has already been called in the main interpreter. These new restrictions do not apply to the main interpreter, so only a very small set of users might be affected. This change helps with interpreter isolation. Furthermore, `syslog` is a wrapper around process-global resources, which are best managed from the main interpreter. (Contributed by Donghee Na in [gh-99127](#).)
- The undocumented locking behavior of `cached_property()` is removed, because it locked across all instances of the class, leading to high lock contention. This means that a cached property getter function could now run more than once for a single instance, if two threads race. For most simple cached properties (e.g. those that are idempotent and simply calculate a value based on other attributes of the instance) this will be fine. If synchronization is needed, implement locking within the cached property getter function or around multi-threaded access points.
- `sys._current_exceptions()` now returns a mapping from thread-id to an exception instance, rather than to a `(typ, exc, tb)` tuple. (Contributed by Irit Katriel in [gh-103176](#).)
- When extracting tar files using `tarfile` or `shutil.unpack_archive()`, pass the `filter` argument to limit features that may be surprising or dangerous. See `tarfile-extraction-filter` for details.
- The output of the `tokenize.tokenize()` and `tokenize.generate_tokens()` functions is now



changed due to the changes introduced in [PEP 701](#). This means that `STRING` tokens are not emitted any more for f-strings and the tokens described in [PEP 701](#) are now produced instead: `FSTRING_START`, `FSTRING_MIDDLE` and `FSTRING_END` are now emitted for f-string "string" parts in addition to the appropriate tokens for the tokenization in the expression components. For example for the f-string `f"start {1+1} end"` the old version of the tokenizer emitted:

<code>1,0-1,18:</code>	<code>STRING</code>	<code>'f"start {1+1} end"'</code>
------------------------	---------------------	-----------------------------------

while the new version emits:

<code>1,0-1,2:</code>	<code>FSTRING_START</code>	<code>'f''</code>
<code>1,2-1,8:</code>	<code>FSTRING_MIDDLE</code>	<code>'start '</code>
<code>1,8-1,9:</code>	<code>OP</code>	<code>'{'</code>
<code>1,9-1,10:</code>	<code>NUMBER</code>	<code>'1'</code>
<code>1,10-1,11:</code>	<code>OP</code>	<code>'+'</code>
<code>1,11-1,12:</code>	<code>NUMBER</code>	<code>'1'</code>
<code>1,12-1,13:</code>	<code>OP</code>	<code>'}'</code>
<code>1,13-1,17:</code>	<code>FSTRING_MIDDLE</code>	<code>' end'</code>
<code>1,17-1,18:</code>	<code>FSTRING_END</code>	<code>'''</code>

Additionally, there may be some minor behavioral changes as a consequence of the changes required to support [PEP 701](#). Some of these changes include:

- The `type` attribute of the tokens emitted when tokenizing some invalid Python characters such as `!` has changed from `ERRORTOKEN` to `OP`.
- Incomplete single-line strings now also raise `tokenize.TokenError` as incomplete multiline strings do.
- Some incomplete or invalid Python code now raises `tokenize.TokenError` instead of returning arbitrary `ERRORTOKEN` tokens when tokenizing it.
- Mixing tabs and spaces as indentation in the same file is not supported anymore and will raise a `TabError`.
- The `threading` module now expects the `_thread` module to have an `_is_main_interpreter` attribute. It is a function with no arguments that returns `True` if the current interpreter is the main interpreter.

Any library or application that provides a custom `_thread` module should provide `_is_main_interpreter()`. (See [gh-112826](#).)

## 13 Build Changes

- Python no longer uses `setup.py` to build shared C extension modules. Build parameters like headers and libraries are detected in `configure` script. Extensions are built by `Makefile`. Most extensions use `pkg-config` and fall back to manual detection. (Contributed by Christian Heimes in [gh-93939](#).)
- `va_start()` with two parameters, like `va_start(args, format)`, is now required to build Python. `va_start()` is no longer called with a single parameter. (Contributed by Kumar Aditya in [gh-93207](#).)
- CPython now uses the ThinLTO option as the default link time optimization policy if the Clang compiler accepts the flag. (Contributed by Donghee Na in [gh-89536](#).)
- Add `COMPILEALL_OPTS` variable in `Makefile` to override `compileall` options (default: `-j0`) in `make install`. Also merged the 3 `compileall` commands into a single command to build `.pyc` files for all optimization levels (0, 1, 2) at once. (Contributed by Victor Stinner in [gh-99289](#).)
- Add platform triplets for 64-bit LoongArch:
  - `loongarch64-linux-gnustf`
  - `loongarch64-linux-gnuf32`
  - `loongarch64-linux-gnu`(Contributed by Zhang Na in [gh-90656](#).)
- `PYTHON_FOR_REGEN` now require Python 3.10 or newer.
- Autoconf 2.71 and `aclocal` 1.16.4 is now required to regenerate `!configure`. (Contributed by Christian Heimes in [gh-89886](#).)
- Windows builds and macOS installers from python.org now use OpenSSL 3.0.

## 14 C API の変更

### 14.1 新しい機能

- **PEP 697**: Introduce the Unstable C API tier, intended for low-level tools like debuggers and JIT compilers. This API may change in each minor release of CPython without deprecation warnings. Its contents are marked by the `PyUnstable_` prefix in names.

Code object constructors:

- `PyUnstable_Code_New()` (renamed from `PyCode_New`)
- `PyUnstable_Code_NewWithPosOnlyArgs()` (renamed from `PyCode_NewWithPosOnlyArgs`)

Extra storage for code objects (**PEP 523**):

- `PyUnstable_Eval_RequestCodeExtraIndex()` (renamed from `_PyEval_RequestCodeExtraIndex()`)
- `PyUnstable_Code_GetExtra()` (renamed from `_PyCode_GetExtra()`)
- `PyUnstable_Code_SetExtra()` (renamed from `_PyCode_SetExtra()`)

The original names will continue to be available until the respective API changes.

(Contributed by Petr Viktorin in [gh-101101](#).)

- **PEP 697**: Add an API for extending types whose instance memory layout is opaque:
  - `PyType_Spec.basicsize` can be zero or negative to specify inheriting or extending the base class size.
  - `PyObject_GetTypeData()` and `PyType_GetTypeDataSize()` added to allow access to subclass-specific instance data.
  - `Py_TPFLAGS_ITEMS_AT_END` and `PyObject_GetItemData()` added to allow safely extending certain variable-sized types, including `PyType_Type`.
  - `Py_RELATIVE_OFFSET` added to allow defining `members` in terms of a subclass-specific struct.

(Contributed by Petr Viktorin in [gh-103509](#).)

- Add the new limited C API function `PyType_FromMetaclass()`, which generalizes the existing `PyType_FromModuleAndSpec()` using an additional metaclass argument. (Contributed by Wenzel Jakob in [gh-93012](#).)
- API for creating objects that can be called using the vectorcall protocol was added to the Limited API:

- `Py_TPFLAGS_HAVE_VECTORCALL`
- `PyVectorcall_NARGS()`
- `PyVectorcall_Call()`
- `vectorcallfunc`

The `Py_TPFLAGS_HAVE_VECTORCALL` flag is now removed from a class when the class's `__call__()` method is reassigned. This makes vectorcall safe to use with mutable types (i.e. heap types without the immutable flag, `Py_TPFLAGS_IMMUTABLETYPE`). Mutable types that do not override `tp_call` now inherit the `Py_TPFLAGS_HAVE_VECTORCALL` flag. (Contributed by Petr Viktorin in [gh-93274](#).)

The `Py_TPFLAGS_MANAGED_DICT` and `Py_TPFLAGS_MANAGED_WEAKREF` flags have been added. This allows extension classes to support object `__dict__` and weakrefs with less bookkeeping, using less memory and with faster access.

- API for performing calls using the vectorcall protocol was added to the Limited API:

- `PyObject_Vectorcall()`
- `PyObject_VectorcallMethod()`
- `PY_VECTORCALL_ARGUMENTS_OFFSET`

This means that both the incoming and outgoing ends of the vector call protocol are now available in the Limited API. (Contributed by Wenzel Jakob in [gh-98586](#).)

- Add two new public functions, `PyEval_SetProfileAllThreads()` and `PyEval_SetTraceAllThreads()`, that allow to set tracing and profiling functions in all running threads in addition to the calling one. (Contributed by Pablo Galindo in [gh-93503](#).)
- Add new function `PyFunction_SetVectorcall()` to the C API which sets the vectorcall field of a given `PyFunctionObject`. (Contributed by Andrew Frost in [gh-92257](#).)
- The C API now permits registering callbacks via `PyDict_AddWatcher()`, `PyDict_Watch()` and related APIs to be called whenever a dictionary is modified. This is intended for use by optimizing interpreters, JIT compilers, or debuggers. (Contributed by Carl Meyer in [gh-91052](#).)
- Add `PyType_AddWatcher()` and `PyType_Watch()` API to register callbacks to receive notification on changes to a type. (Contributed by Carl Meyer in [gh-91051](#).)
- Add `PyCode_AddWatcher()` and `PyCode_ClearWatcher()` APIs to register callbacks to receive notification on creation and destruction of code objects. (Contributed by Itamar Oren in [gh-91054](#).)
- Add `PyFrame_GetVar()` and `PyFrame_GetVarString()` functions to get a frame variable by its name. (Contributed by Victor Stinner in [gh-91248](#).)
- Add `PyErr_GetRaisedException()` and `PyErr_SetRaisedException()` for saving and restoring the current exception. These functions return and accept a single exception object, rather than the triple arguments of the now-deprecated `PyErr_Fetch()` and `PyErr_Restore()`. This is less error prone and a bit more efficient. (Contributed by Mark Shannon in [gh-101578](#).)
- Add `_PyErr_ChainExceptions1`, which takes an exception instance, to replace the legacy-API `_PyErr_ChainExceptions`, which is now deprecated. (Contributed by Mark Shannon in [gh-101578](#).)
- Add `PyException_GetArgs()` and `PyException_SetArgs()` as convenience functions for retrieving and modifying the `args` passed to the exception’s constructor. (Contributed by Mark Shannon in [gh-101578](#).)
- Add `PyErr_DisplayException()`, which takes an exception instance, to replace the legacy-api `PyErr_Display()`. (Contributed by Irit Katriel in [gh-102755](#).)
- **PEP 683**: Introduce *Immortal Objects*, which allows objects to bypass reference counts, and related changes to the C-API:

`_Py_IMMORTAL_REFCNT`: The reference count that defines an object as immortal.

– `_Py_IsImmortal` Checks if an object has the immortal reference count.

`PyObject_HEAD_INIT` This will now initialize reference count to

`_Py_IMMORTAL_REFCNT` when used with `Py_BUILD_CORE`.

`SSSTATE_INTERNED_IMMORTAL` An identifier for interned unicode objects that are immortal.

`SSSTATE_INTERNED_IMMORTAL_STATIC` An identifier for interned unicode objects that are immortal and static

`sys.getunicodeinternedsize` This returns the total number of unicode objects that have been interned. This is now needed for `refleak.py` to correctly track reference counts and allocated blocks

(Contributed by Eddie Elizondo in [gh-84436](#).)

- **PEP 684**: Add the new `Py_NewInterpreterFromConfig()` function and `PyInterpreterConfig`, which may be used to create sub-interpreters with their own GILs. (See [PEP 684](#): [インタプリタごとの GIL](#) for more info.) (Contributed by Eric Snow in [gh-104110](#).)
- In the limited C API version 3.12, `Py_INCREF()` and `Py_DECREF()` functions are now implemented as opaque function calls to hide implementation details. (Contributed by Victor Stinner in [gh-105387](#).)

## 14.2 Python 3.12 への移植

- Legacy Unicode APIs based on `Py_UNICODE*` representation has been removed. Please migrate to APIs based on UTF-8 or `wchar_t*`.
- Argument parsing functions like `PyArg_ParseTuple()` doesn't support `Py_UNICODE*` based format (e.g. `u`, `Z`) anymore. Please migrate to other formats for Unicode like `s`, `z`, `es`, and `U`.
- `tp_weaklist` for all static builtin types is always `NULL`. This is an internal-only field on `PyTypeObject` but we're pointing out the change in case someone happens to be accessing the field directly anyway. To avoid breakage, consider using the existing public C-API instead, or, if necessary, the (internal-only) `_PyObject_GET_WEAKREFS_LISTPTR()` macro.
- This internal-only `PyTypeObject.tp_subclasses` may now not be a valid object pointer. Its type was changed to `void*` to reflect this. We mention this in case someone happens to be accessing the internal-only field directly.

To get a list of subclasses, call the Python method `__subclasses__()` (using `PyObject_CallMethod()`, for example).

- Add support of more formatting options (left aligning, octals, uppercase hexadecimals, `intmax_t`, `ptrdiff_t`, `wchar_t` C strings, variable width and precision) in `PyUnicode_FromFormat()` and `PyUnicode_FromFormatV()`. (Contributed by Serhiy Storchaka in [gh-98836](#).)
- An unrecognized format character in `PyUnicode_FromFormat()` and `PyUnicode_FromFormatV()`

now sets a `SystemError`. In previous versions it caused all the rest of the format string to be copied as-is to the result string, and any extra arguments discarded. (Contributed by Serhiy Storchaka in [gh-95781](#).)

- Fix wrong sign placement in `PyUnicode_FromFormat()` and `PyUnicode_FromFormatV()`. (Contributed by Philip Georgi in [gh-95504](#).)
- Extension classes wanting to add a `__dict__` or weak reference slot should use `Py_TPFLAGS_MANAGED_DICT` and `Py_TPFLAGS_MANAGED_WEAKREF` instead of `tp_dictoffset` and `tp_weaklistoffset`, respectively. The use of `tp_dictoffset` and `tp_weaklistoffset` is still supported, but does not fully support multiple inheritance ([gh-95589](#)), and performance may be worse. Classes declaring `Py_TPFLAGS_MANAGED_DICT` should call `_PyObject_VisitManagedDict()` and `_PyObject_ClearManagedDict()` to traverse and clear their instance's dictionaries. To clear weakrefs, call `PyObject_ClearWeakRefs()`, as before.
- The `PyUnicode_FSDecoder()` function no longer accepts bytes-like paths, like `bytearray` and `memoryview` types: only the exact `bytes` type is accepted for bytes strings. (Contributed by Victor Stinner in [gh-98393](#).)
- The `Py_CLEAR`, `Py_SETREF` and `Py_XSETREF` macros now only evaluate their arguments once. If an argument has side effects, these side effects are no longer duplicated. (Contributed by Victor Stinner in [gh-98724](#).)
- The interpreter's error indicator is now always normalized. This means that `PyErr_SetObject()`, `PyErr_SetString()` and the other functions that set the error indicator now normalize the exception before storing it. (Contributed by Mark Shannon in [gh-101578](#).)
- `_Py_RefTotal` is no longer authoritative and only kept around for ABI compatibility. Note that it is an internal global and only available on debug builds. If you happen to be using it then you'll need to start using `_Py_GetGlobalRefTotal()`.
- The following functions now select an appropriate metaclass for the newly created type:
  - `PyType_FromSpec()`
  - `PyType_FromSpecWithBases()`
  - `PyType_FromModuleAndSpec()`

Creating classes whose metaclass overrides `tp_new` is deprecated, and in Python 3.14+ it will be disallowed. Note that these functions ignore `tp_new` of the metaclass, possibly allowing incomplete initialization.

Note that `PyType_FromMetaclass()` (added in Python 3.12) already disallows creating classes whose metaclass overrides `tp_new` (`__new__()` in Python).

Since `tp_new` overrides almost everything `PyType_From*` functions do, the two are incompatible with each other. The existing behavior -- ignoring the metaclass for several steps of type creation -- is unsafe in general, since (meta)classes assume that `tp_new` was called. There is no simple general workaround. One of the following may work for you:

- If you control the metaclass, avoid using `tp_new` in it:
    - \* If initialization can be skipped, it can be done in `tp_init` instead.
    - \* If the metaclass doesn't need to be instantiated from Python, set its `tp_new` to `NULL` using the `Py_TPFLAGS_DISALLOW_INSTANTIATION` flag. This makes it acceptable for `PyType_From*` functions.
  - Avoid `PyType_From*` functions: if you don't need C-specific features (slots or setting the instance size), create types by calling the metaclass.
  - If you *know* the `tp_new` can be skipped safely, filter the deprecation warning out using `warnings.catch_warnings()` from Python.
  - `PyOS_InputHook` and `PyOS_ReadlineFunctionPointer` are no longer called in subinterpreters. This is because clients generally rely on process-wide global state (since these callbacks have no way of recovering extension module state).
- This also avoids situations where extensions may find themselves running in a subinterpreter that they don't support (or haven't yet been loaded in). See [gh-104668](#) for more info.
- `PyLongObject` has had its internals changed for better performance. Although the internals of `PyLongObject` are private, they are used by some extension modules. The internal fields should no longer be accessed directly, instead the API functions beginning `PyLong_...` should be used instead. Two new *unstable* API functions are provided for efficient access to the value of `PyLongObjects` which fit into a single machine word:
    - `PyUnstable_Long_IsCompact()`
    - `PyUnstable_Long_CompactValue()`
  - Custom allocators, set via `PyMem_SetAllocator()`, are now required to be thread-safe, regardless of memory domain. Allocators that don't have their own state, including "hooks", are not affected. If your custom allocator is not already thread-safe and you need guidance then please create a new GitHub issue and CC [@eric snow currently](#).

### 14.3 非推奨

- In accordance with [PEP 699](#), the `ma_version_tag` field in `PyDictObject` is deprecated for extension modules. Accessing this field will generate a compiler warning at compile time. This field will be removed in Python 3.14. (Contributed by Ramvikrams and Kumar Aditya in [gh-101193](#). PEP by Ken Jin.)
- Deprecate global configuration variable:
  - `Py_DebugFlag`: use `PyConfig.parser_debug`
  - `Py_VerboseFlag`: use `PyConfig.verbose`
  - `Py_QuietFlag`: use `PyConfig.quiet`

- `Py_InteractiveFlag`: use `PyConfig.interactive`
- `Py_InspectFlag`: use `PyConfig.inspect`
- `Py_OptimizeFlag`: use `PyConfig.optimization_level`
- `Py_NoSiteFlag`: use `PyConfig.site_import`
- `Py_BytesWarningFlag`: use `PyConfig.bytes_warning`
- `Py_FrozenFlag`: use `PyConfig.pathconfig_warnings`
- `Py_IgnoreEnvironmentFlag`: use `PyConfig.use_environment`
- `Py_DontWriteBytecodeFlag`: use `PyConfig.write_bytecode`
- `Py_NoUserSiteDirectory`: use `PyConfig.user_site_directory`
- `Py_UnbufferedStdioFlag`: use `PyConfig.buffered_stdio`
- `Py_HashRandomizationFlag`: use `PyConfig.use_hash_seed` and `PyConfig.hash_seed`
- `Py_IsolatedFlag`: use `PyConfig.isolated`
- `Py_LegacyWindowsFSEncodingFlag`: use `PyPreConfig.legacy_windows_fs_encoding`
- `Py_LegacyWindowsStdioFlag`: use `PyConfig.legacy_windows_stdio`
- `Py_FileSystemDefaultEncoding`: use `PyConfig.filesystem_encoding`
- `Py_HasFileSystemDefaultEncoding`: use `PyConfig.filesystem_encoding`
- `Py_FileSystemDefaultEncodeErrors`: use `PyConfig.filesystem_errors`
- `Py_UTF8Mode`: use `PyPreConfig.utf8_mode` (see `Py_PreInitialize()`)

The `Py_InitializeFromConfig()` API should be used with `PyConfig` instead. (Contributed by Victor Stinner in [gh-77782](#).)

- Creating `immutable` types with mutable bases is deprecated and will be disabled in Python 3.14. ([gh-95388](#))
- The `structmember.h` header is deprecated, though it continues to be available and there are no plans to remove it.

Its contents are now available just by including `Python.h`, with a `Py` prefix added if it was missing:

- `PyMemberDef`, `PyMember_GetOne()` and `PyMember_SetOne()`
- Type macros like `Py_T_INT`, `Py_T_DOUBLE`, etc. (previously `T_INT`, `T_DOUBLE`, etc.)
- The flags `Py_READONLY` (previously `READONLY`) and `Py_AUDIT_READ` (previously all uppercase)

Several items are not exposed from `Python.h`:

- `T_OBJECT` (use `Py_T_OBJECT_EX`)



- `T_NONE` (previously undocumented, and pretty quirky)
- The macro `WRITE_RESTRICTED` which does nothing.
- The macros `RESTRICTED` and `READ_RESTRICTED`, equivalents of `Py_AUDIT_READ`.
- In some configurations, `<stddef.h>` is not included from `Python.h`. It should be included manually when using `offsetof()`.

The deprecated header continues to provide its original contents under the original names. Your old code can stay unchanged, unless the extra include and non-namespaced macros bother you greatly.

(Contributed in [gh-47146](#) by Petr Viktorin, based on earlier work by Alexander Belopolsky and Matthias Braun.)

- `PyErr_Fetch()` and `PyErr_Restore()` are deprecated. Use `PyErr_GetRaisedException()` and `PyErr_SetRaisedException()` instead. (Contributed by Mark Shannon in [gh-101578](#).)
- `PyErr_Display()` is deprecated. Use `PyErr_DisplayException()` instead. (Contributed by Irit Katriel in [gh-102755](#)).
- `_PyErr_ChainExceptions` is deprecated. Use `_PyErr_ChainExceptions1` instead. (Contributed by Irit Katriel in [gh-102192](#).)
- Using `PyType_FromSpec()`, `PyType_FromSpecWithBases()` or `PyType_FromModuleAndSpec()` to create a class whose metaclass overrides `tp_new` is deprecated. Call the metaclass instead.

### Pending Removal in Python 3.14

- The `ma_version_tag` field in `PyDictObject` for extension modules ([PEP 699](#); [gh-101193](#)).
- Creating immutable types with mutable bases ([gh-95388](#)).
- Functions to configure Python’s initialization, deprecated in Python 3.11:
  - `PySys_SetArgvEx()`: Set `PyConfig.argv` instead.
  - `PySys_SetArgv()`: Set `PyConfig.argv` instead.
  - `Py_SetProgramName()`: Set `PyConfig.program_name` instead.
  - `Py_SetPythonHome()`: Set `PyConfig.home` instead.

The `Py_InitializeFromConfig()` API should be used with `PyConfig` instead.

- Global configuration variables:
  - `Py_DebugFlag`: Use `PyConfig.parser_debug` instead.
  - `Py_VerboseFlag`: Use `PyConfig.verbose` instead.
  - `Py_QuietFlag`: Use `PyConfig.quiet` instead.
  - `Py_InteractiveFlag`: Use `PyConfig.interactive` instead.

- `Py_InspectFlag`: Use `PyConfig.inspect` instead.
- `Py_OptimizeFlag`: Use `PyConfig.optimization_level` instead.
- `Py_NoSiteFlag`: Use `PyConfig.site_import` instead.
- `Py_BytesWarningFlag`: Use `PyConfig.bytes_warning` instead.
- `Py_FrozenFlag`: Use `PyConfig.pathconfig_warnings` instead.
- `Py_IgnoreEnvironmentFlag`: Use `PyConfig.use_environment` instead.
- `Py_DontWriteBytecodeFlag`: Use `PyConfig.write_bytecode` instead.
- `Py_NoUserSiteDirectory`: Use `PyConfig.user_site_directory` instead.
- `Py_UnbufferedStdioFlag`: Use `PyConfig.buffered_stdio` instead.
- `Py_HashRandomizationFlag`: Use `PyConfig.use_hash_seed` and `PyConfig.hash_seed` instead.
- `Py_IsolatedFlag`: Use `PyConfig.isolated` instead.
- `Py_LegacyWindowsFSEncodingFlag`: Use `PyPreConfig.legacy_windows_fs_encoding` instead.
- `Py_LegacyWindowsStdioFlag`: Use `PyConfig.legacy_windows_stdio` instead.
- `Py_FileSystemDefaultEncoding`: Use `PyConfig.filesystem_encoding` instead.
- `Py_HasFileSystemDefaultEncoding`: Use `PyConfig.filesystem_encoding` instead.
- `Py_FileSystemDefaultEncodeErrors`: Use `PyConfig.filesystem_errors` instead.
- `Py_UTF8Mode`: Use `PyPreConfig.utf8_mode` instead. (see `Py_PreInitialize()`)

The `Py_InitializeFromConfig()` API should be used with `PyConfig` instead.

### Pending Removal in Python 3.15

- The bundled copy of `libmpdecimal`.
- The `PyImport_ImportModuleNoBlock()`: Use `PyImport_ImportModule()` instead.
- `PyWeakref_GetObject()` and `PyWeakref_GET_OBJECT()`: Use `PyWeakref_GetRef()` instead.
- `Py_UNICODE` type and the `Py_UNICODE_WIDE` macro: Use `wchar_t` instead.
- Python initialization functions:
  - `PySys_ResetWarnOptions()`: Clear `sys.warnoptions` and `warnings.filters` instead.
  - `Py_GetExecPrefix()`: Get `sys.exec_prefix` instead.
  - `Py_GetPath()`: Get `sys.path` instead.
  - `Py_GetPrefix()`: Get `sys.prefix` instead.

- `Py_GetProgramFullPath()`: Get `sys.executable` instead.
- `Py_GetProgramName()`: Get `sys.executable` instead.
- `Py_GetPythonHome()`: Get `PyConfig.home` or the `PYTHONHOME` environment variable instead.

### Pending Removal in Future Versions

The following APIs are deprecated and will be removed, although there is currently no date scheduled for their removal.

- `Py_TPFLAGS_HAVE_FINALIZE`: Unneeded since Python 3.8.
- `PyErr_Fetch()`: Use `PyErr_GetRaisedException()` instead.
- `PyErr_NormalizeException()`: Use `PyErr_GetRaisedException()` instead.
- `PyErr_Restore()`: Use `PyErr_SetRaisedException()` instead.
- `PyModule_GetFilename()`: Use `PyModule_GetFilenameObject()` instead.
- `PyOS_AfterFork()`: Use `PyOS_AfterFork_Child()` instead.
- `PySlice_GetIndicesEx()`: Use `PySlice_Unpack()` and `PySlice_AdjustIndices()` instead.
- `PyUnicode_AsDecodedObject()`: Use `PyCodec_Decode()` instead.
- `PyUnicode_AsDecodedUnicode()`: Use `PyCodec_Decode()` instead.
- `PyUnicode_AsEncodedObject()`: Use `PyCodec_Encode()` instead.
- `PyUnicode_AsEncodedUnicode()`: Use `PyCodec_Encode()` instead.
- `PyUnicode_READY()`: Unneeded since Python 3.12
- `PyErr_Display()`: Use `PyErr_DisplayException()` instead.
- `_PyErr_ChainExceptions()`: Use `_PyErr_ChainExceptions1()` instead.
- `PyBytesObject.ob_shash` member: call `PyObject_Hash()` instead.
- `PyDictObject.ma_version_tag` member.
- Thread Local Storage (TLS) API:
  - `PyThread_create_key()`: Use `PyThread_tss_alloc()` instead.
  - `PyThread_delete_key()`: Use `PyThread_tss_free()` instead.
  - `PyThread_set_key_value()`: Use `PyThread_tss_set()` instead.
  - `PyThread_get_key_value()`: Use `PyThread_tss_get()` instead.
  - `PyThread_delete_key_value()`: Use `PyThread_tss_delete()` instead.
  - `PyThread_ReInitTLS()`: Unneeded since Python 3.7.

## 14.4 删除

- Remove the `token.h` header file. There was never any public tokenizer C API. The `token.h` header file was only designed to be used by Python internals. (Contributed by Victor Stinner in [gh-92651](#).)
- Legacy Unicode APIs have been removed. See [PEP 623](#) for detail.
  - `PyUnicode_WCHAR_KIND`
  - `PyUnicode_AS_UNICODE()`
  - `PyUnicode_AsUnicode()`
  - `PyUnicode_AsUnicodeAndSize()`
  - `PyUnicode_AS_DATA()`
  - `PyUnicode_FromUnicode()`
  - `PyUnicode_GET_SIZE()`
  - `PyUnicode_GetSize()`
  - `PyUnicode_GET_DATA_SIZE()`
- Remove the `PyUnicode_InternImmortal()` function macro. (Contributed by Victor Stinner in [gh-85858](#).)

## 15 Notable changes in 3.12.4

### 15.1 ipaddress

- Fixed `is_global` and `is_private` behavior in `IPv4Address`, `IPv6Address`, `IPv4Network` and `IPv6Network`.

## 16 Notable changes in 3.12.5

### 16.1 email

- Headers with embedded newlines are now quoted on output.

The `generator` will now refuse to serialize (write) headers that are improperly folded or delimited, such that they would be parsed as multiple headers or joined with adjacent data. If you need to turn this safety feature off, set `verify_generated_headers`. (Contributed by Bas Bloemsaat and Petr Viktorin in [gh-121650](#).)

## 17 Notable changes in 3.12.6

### 17.1 email

- `email.utils.getaddresses()` and `email.utils.parseaddr()` now return `(' ', '')` 2-tuples in more situations where invalid email addresses are encountered, instead of potentially inaccurate values. An optional *strict* parameter was added to these two functions: use `strict=False` to get the old behavior, accepting malformed inputs. `getattr(email.utils, 'supports_strict_parsing', False)` can be used to check if the *strict* parameter is available. (Contributed by Thomas Dwyer and Victor Stinner for [gh-102988](#) to improve the CVE-2023-27043 fix.)

## 18 Notable changes in 3.12.8

### 18.1 sys

- The previously undocumented special function `sys.getobjects()`, which only exists in specialized builds of Python, may now return objects from other interpreters than the one it's called in.

## 19 Notable changes in 3.12.10

### 19.1 os.path

- The *strict* parameter to `os.path.realpath()` accepts a new value, `os.path.ALLOW_MISSING`. If used, errors other than `FileNotFoundError` will be re-raised; the resulting path can be missing but it will be free of symlinks. (Contributed by Petr Viktorin for [CVE 2025-4517](#).)

### 19.2 tarfile

- `data_filter()` now normalizes symbolic link targets in order to avoid path traversal attacks. (Contributed by Petr Viktorin in [gh-127987](#) and [CVE 2025-4138](#).)
- `extractall()` now skips fixing up directory attributes when a directory was removed or replaced by another kind of file. (Contributed by Petr Viktorin in [gh-127987](#) and [CVE 2024-12718](#).)
- `extract()` and `extractall()` now (re-)apply the extraction filter when substituting a link (hard or symbolic) with a copy of another archive member, and when fixing up directory attributes. The former raises a new exception, `LinkFallbackError`. (Contributed by Petr Viktorin for [CVE 2025-4330](#) and [CVE 2024-12718](#).)
- `extract()` and `extractall()` no longer extract rejected members when `errorlevel()` is zero. (Contributed by Matt Prodan and Petr Viktorin in [gh-112887](#) and [CVE 2025-4435](#).)

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