
What's New in Python

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A. M. Kuchling

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Python Software Foundation

Email: docs@python.org

Sumário

1	Resumo - Destaques da versão	4
2	Novas Funcionalidades	5
2.1	PEP 563: Avaliação Postergada de Anotações	5
2.2	PEP 538: Coerção de localidade C legada	6
2.3	PEP 540: Modo de tempo de execução UTF-8 forçado	6
2.4	PEP 553: <code>breakpoint()</code> embutida	7
2.5	PEP 539: Nova API C para armazenamento local de thread	7
2.6	PEP 562: Personalização de acesso aos atributos do módulo	7
2.7	PEP 564: Novas funções de tempo com resolução de nanossegundos	8
2.8	PEP 565: Mostra <code>DeprecationWarning</code> em <code>__main__</code>	8
2.9	PEP 560: Suporte básico para módulo <code>typing</code> e tipos genéricos	9
2.10	PEP 552: Arquivos <code>.pyc</code> baseados em hash	9
2.11	PEP 545: Python Documentation Translations	9
2.12	Development Runtime Mode: <code>-X dev</code>	10
3	Outras mudanças na Linguagem	10
4	Novos Módulos	10
4.1	<code>contextvars</code>	10
4.2	<code>dataclasses</code>	11
4.3	<code>importlib.resources</code>	11
5	Módulos melhorados	11
5.1	<code>argparse</code>	11
5.2	<code>asyncio</code>	11
5.3	<code>binascii</code>	13
5.4	<code>calendar</code>	13
5.5	<code>collections</code>	13
5.6	<code>compileall</code>	13
5.7	<code>concurrent.futures</code>	13
5.8	<code>contextlib</code>	14
5.9	<code>cProfile</code>	14
5.10	<code>crypt</code>	14

5.11	datetime	14
5.12	dbm	14
5.13	decimal	14
5.14	dis	14
5.15	distutils	15
5.16	enum	15
5.17	functools	15
5.18	gc	15
5.19	hmac	15
5.20	http.client	15
5.21	http.server	15
5.22	idlelib and IDLE	16
5.23	importlib	16
5.24	io	17
5.25	ipaddress	17
5.26	itertools	17
5.27	locale	17
5.28	logging	17
5.29	math	17
5.30	mimetypes	17
5.31	msilib	18
5.32	multiprocessing	18
5.33	os	18
5.34	pathlib	18
5.35	pdb	18
5.36	py_compile	19
5.37	pydoc	19
5.38	queue	19
5.39	re	19
5.40	signal	19
5.41	socket	19
5.42	socketserver	20
5.43	sqlite3	20
5.44	ssl	20
5.45	string	21
5.46	subprocess	21
5.47	sys	21
5.48	time	21
5.49	tkinter	22
5.50	tracemalloc	22
5.51	types	22
5.52	unicodedata	22
5.53	unittest	22
5.54	unittest.mock	23
5.55	urllib.parse	23
5.56	uu	23
5.57	uuid	23
5.58	avisos	23
5.59	xml	24
5.60	xml.etree	24
5.61	xmlrpc.server	24
5.62	zipapp	24
5.63	zipfile	24

6	Alterações na API C	24
7	Alterações de compilação	26
8	Otimizações	26
9	Outras mudanças na implementação do CPython	27
10	Comportamento do Python descontinuado	28
11	Deprecated Python modules, functions and methods	28
11.1	aifc	28
11.2	asyncio	28
11.3	collections	28
11.4	dbm	28
11.5	enum	29
11.6	gettext	29
11.7	importlib	29
11.8	locale	29
11.9	macpath	29
11.10	threading	29
11.11	socket	29
11.12	ssl	30
11.13	sunau	30
11.14	sys	30
11.15	wave	30
12	Deprecated functions and types of the C API	30
13	Platform Support Removals	30
14	API and Feature Removals	31
15	Module Removals	31
16	Windows-only Changes	32
17	Porting to Python 3.7	32
17.1	Changes in Python Behavior	32
17.2	Changes in the Python API	33
17.3	Changes in the C API	35
17.4	Alterações de bytecode do CPython	35
17.5	Windows-only Changes	35
17.6	Other CPython implementation changes	35
18	Notable changes in Python 3.7.1	36
19	Notable changes in Python 3.7.2	36
20	Notable changes in Python 3.7.6	36
21	Notable changes in Python 3.7.10	36
22	Notable changes in Python 3.7.11	36
23	Notable security feature in 3.7.14	37

Editor Elvis Pranskevichus <elvis@magic.io>

Este artigo explica os novos recursos no Python 3.7, em comparação com 3.6. Python 3.7 foi lançado em 27 de Junho de 2018. Veja :ref:`changelog` para uma lista completa de mudanças.

1 Resumo - Destaques da versão

Novos recursos de sintaxe:

- [PEP 563](#),

Alterações de sintaxe incompatíveis com versões anteriores:

- `async` e `await` são agora palavras chave reservadas.

Novo módulo de biblioteca:

- `contextvars`: [PEP 567](#) – *Variáveis de Contexto*
- `dataclasses`: [PEP 557](#) – *Classes de Data*
- `importlib.resources`

Novos recursos internos:

- [PEP 553](#), a nova função `breakpoint()`.

Melhorias no modelo de dados Python:

- [PEP 562](#), customização de acesso aos atributos do módulo.
- [PEP 560](#), suporte principal para o módulo de digitação e tipos genéricos.
- a natureza de preservação da ordem de inserção de dict objects **foi declarada** como uma parte oficial da especificação da linguagem Python.

Melhorias significativas na biblioteca padrão:

- O módulo `asyncio` recebeu novos recursos, significativos à :ref:`melhorias de usabilidade e desempenho <whats-new37_asyncio>`.
- O módulo `time` ganhou suporte para *funções com resolução de nanossegundos*.

Melhorias na implementação do CPython:

- Evitando o uso de ASCII como a codificação de texto padrão:
 - [PEP 538](#), herdada de C coerção de localidade.
 - [PEP 540](#), modo de tempo de execução UTF-8 forçado.
- [PEP 552](#), determinísticos `.pycs`
- *o novo modo de tempo de execução de desenvolvimento*
- [PEP 565](#), aprimorado `DeprecationWarning` manipulação

Melhorias na API C:

- [PEP 539](#), nova API C para armazenamento local de threads

Melhorias na documentação:

- [PEP 545](#), Traduções da documentação do Python
- Novas traduções da documentação: [japonês](#), [francês](#) e [coreano](#).

Esta versão apresenta melhorias de desempenho notáveis em muitas áreas. A seção [Otimizações](#) os lista em detalhes.

Para uma lista de mudanças que podem afetar a compatibilidade com versões anteriores do Python, consulte a seção [Porting to Python 3.7](#).

2 Novas Funcionalidades

2.1 PEP 563: Avaliação Postergada de Anotações

O advento das dicas de tipo no Python revelou dois problemas de usabilidade gritantes com a funcionalidade das anotações adicionadas em [PEP 3107](#) e refinadas ainda mais em [PEP 526](#):

- as anotações só podiam usar nomes que já estavam disponíveis no escopo atual, ou seja, não suportavam referências de encaminhamento de nenhum tipo; e
- anotar o código-fonte teve efeitos adversos no tempo de inicialização dos programas Python.

Ambos os problemas são corrigidos com o adiamento da avaliação das anotações. Em vez de compilar o código que executa expressões em anotações em seu tempo de definição, o compilador armazena a anotação em um formato de string equivalente ao AST da expressão em questão. Se necessário, as anotações podem ser resolvidas em tempo de execução usando `digitando.get_type_hints()`. No caso comum em que isso não é necessário, as anotações são mais baratas de armazenar (uma vez que strings curtas são internadas pelo interpretador) e tornam o tempo de inicialização mais rápido.

Em termos de usabilidade, as anotações agora suportam referências futuras, tornando a seguinte sintaxe válida:

```
class C:
    @classmethod
    def from_string(cls, source: str) -> C:
        ...

    def validate_b(self, obj: B) -> bool:
        ...

class B:
    ...
```

Como essa mudança quebra a compatibilidade, o novo comportamento precisa ser habilitado por módulo no Python 3.7 usando uma importação de `__future__`

```
from __future__ import annotations
```

It will become the default in Python 3.10.

Ver também:

PEP 563 – avaliação postergada de anotações de tipos PEP written and implemented by Łukasz Langa.

2.2 PEP 538: Coerção de localidade C legada

Um desafio contínuo dentro da série Python 3 tem sido determinar uma estratégia padrão sensata para lidar com a suposição de codificação de texto “ASCII de 7 bits” atualmente implícita pelo uso da localidade C ou POSIX padrão em plataformas não Windows.

O **PEP 538** atualiza a interface de linha de comando do interpretador padrão para forçar automaticamente essa localidade para uma localidade baseada em UTF-8 disponível conforme descrito na documentação da nova variável de ambiente `PYTHONCOERCECLOCALE`. Configurar automaticamente `LC_CTYPE` desta forma significa que tanto o interpretador central quanto as extensões C com reconhecimento da localidade (como `readline`) irão presumir o uso de UTF-8 como a codificação de texto padrão, ao invés de ASCII.

A definição de suporte de plataforma na **PEP 11** também foi atualizada para limitar o suporte de manipulação de texto completo para localidades não baseadas em ASCII adequadamente configuradas.

Como parte dessa mudança, o tratador de erros padrão para `stdin` e `stdout` agora é `surrogateescape` (em vez de `strict`) ao usar qualquer uma das localidades de destino de coerção definidas (atualmente `C.UTF-8`, `C.utf8` e `UTF-8`). O tratador de erros padrão para `stderr` continua a ser `backslashreplace`, independente da localidade.

A coerção de localidade é silenciosa por padrão, mas para ajudar na depuração de problemas de integração potencialmente relacionados à localidade, avisos explícitos (emitidos diretamente em `stderr`) podem ser solicitados configurando `PYTHONCOERCECLOCALE=warn`. Essa configuração também fará com que o tempo de execução do Python emita um aviso se a localidade C legada permanecer ativa quando o interpretador principal for inicializado.

Embora a coerção de localidade **PEP 538** tenha o benefício de também afetar os módulos de extensão (como `GNU readline`), bem como processos filhos (incluindo aqueles que executam aplicativos não Python e versões mais antigas do Python), tem a desvantagem de exigir que uma localidade de destino adequado esteja presente no sistema em execução. Para tratador melhor o caso em que nenhuma localidade de destino adequado está disponível (como ocorre no RHEL/CentOS 7, por exemplo), o Python 3.7 também implementa *PEP 540: Modo de tempo de execução UTF-8 forçado*.

Ver também:

PEP 538 – Forçando a localidade C legada para uma localidade baseada em UTF-8 PEP escrita e implementada por Nick Coghlan.

2.3 PEP 540: Modo de tempo de execução UTF-8 forçado

A nova opção de linha de comando `-X utf8` e a variável de ambiente `PYTHONUTF8` podem ser usadas para habilitar o modo CPython *UTF-8*.

Quando no modo UTF-8, o CPython ignora as configurações de localidade e usa a codificação UTF-8 por padrão. Os tratador de erros para fluxos `sys.stdin` e `sys.stdout` são configurados para `surrogateescape`.

O modo UTF-8 forçado pode ser usado para alterar o comportamento de manipulação de texto em um interpretador Python embutido sem alterar as configurações de localidade de uma aplicação embutida.

Embora o modo UTF-8 do **PEP 540** tenha a vantagem de funcionar independentemente de quais localidades estão disponíveis no sistema em execução, ele tem a desvantagem de não ter efeito sobre os módulos de extensão (como `GNU readline`), processos filho executando aplicativos não-Python e processos filho executando versões anteriores do Python. Para reduzir o risco de corromper dados de texto ao se comunicar com tais componentes, o Python 3.7 também implementa *PEP 540: Modo de tempo de execução UTF-8 forçado*.

O modo UTF-8 é habilitado por padrão quando a localidade é `C` ou `POSIX`, e o recurso de coerção de localidade **PEP 538** falha em mudá-la para uma alternativa baseada em UTF-8 (seja falha é devido a `PYTHONCOERCECLOCALE=0` sendo definido, `LC_ALL` sendo definido, ou a falta de uma localidade de destino adequada).

Ver também:

PEP 540 – Adiciona um novo modo UTF-8 PEP written and implemented by Victor Stinner

2.4 PEP 553: breakpoint() embutida

Python 3.7 inclui a nova função embutida `breakpoint()` como uma maneira fácil e consistente de entrar no depurador Python.

`breakpoint()` embutida chama `sys.breakpointhook()`. Por padrão, o último importa `pdb` e então chama `pdb.set_trace()`, mas ao ligar `sys.breakpointhook()` à função de sua escolha, `breakpoint()` pode entrar em qualquer depurador. Além disso, a variável de ambiente `PYTHONBREAKPOINT` pode ser configurada para o chamável de seu depurador de escolha. Defina `PYTHONBREAKPOINT=0` para desabilitar completamente o `breakpoint()` embutida.

Ver também:

PEP 553 – `breakpoint()` embutida PEP escrita e implementada por Barry Warsaw

2.5 PEP 539: Nova API C para armazenamento local de thread

Enquanto Python fornece uma API C para suporte de armazenamento local de thread; a existente API de armazenamento local de thread (TLS) usou `int` para representar as chaves TLS em todas as plataformas. Isso geralmente não tem sido um problema para plataformas oficialmente suportadas, mas isso não é compatível com POSIX, nem portátil em qualquer sentido prático.

A **PEP 539** muda isso fornecendo uma nova API de armazenamento específico de thread (TSS) para CPython que substitui o uso da API de TLS existente dentro do interpretador CPython, enquanto descontinua a API existente. A API de TSS usa um novo tipo `Py_tss_t` em vez de `int` para representar as chaves de TSS – um tipo não visível cuja definição pode depender da implementação TLS subjacente. Portanto, isso permitirá construir CPython em plataformas onde a chave nativa de TLS é definida de uma forma que não pode ser convertida com segurança para `int`.

Observe que em plataformas onde a chave nativa de TLS é definida de uma forma que não pode ser convertida com segurança para `int`, todas as funções da API de TLS existente serão autônomas e retornarão imediatamente falha. Isso indica claramente que a API antiga não é suportada em plataformas onde não pode ser usada de forma confiável e que nenhum esforço será feito para adicionar esse suporte.

Ver também:

PEP 539 – Uma nova API C para armazenamento local de thread no CPython PEP escrita por Erik M. Bray; implementação por Masayuki Yamamoto.

2.6 PEP 562: Personalização de acesso aos atributos do módulo

Python 3.7 permite definir `__getattr__()` em módulos e irá chamá-lo sempre que um atributo de módulo não for encontrado. Definir `__dir__()` em módulos agora também é permitido.

Um exemplo típico de onde isso pode ser útil é a depreciação do atributo do módulo e o carregamento lento.

Ver também:

PEP 562 – Module `__getattr__` and `__dir__` PEP escrita e implementada por Ivan Levkivskiy

2.7 PEP 564: Novas funções de tempo com resolução de nanossegundos

A resolução dos relógios em sistemas modernos pode exceder a precisão limitada de um número de ponto flutuante retornado pela função `time.time()` e suas variantes. Para evitar perda de precisão, **PEP 564** adiciona seis novas variantes em “nanossegundos” das funções de temporizador existentes ao módulo `time`:

- `time.clock_gettime_ns()`
- `time.clock_settime_ns()`
- `time.monotonic_ns()`
- `time.perf_counter_ns()`
- `time.process_time_ns()`
- `time.time_ns()`

As novas funções retornam o número de nanossegundos como um valor inteiro.

Medições mostram que no Linux e no Windows a resolução de `time.time_ns()` é aproximadamente 3 vezes melhor do que `time.time()`.

Ver também:

PEP 564 – Adiciona novas funções de tempo com resolução de nanossegundos PEP written and implemented by Victor Stinner

2.8 PEP 565: Mostra DeprecationWarning em `__main__`

O tratamento padrão de `:exc: DeprecationWarning` foi alterado de forma que esses avisos sejam mais uma vez mostrados por padrão, mas apenas quando o código que os aciona está sendo executado diretamente no módulo `__main__`. Como resultado, os desenvolvedores de scripts de arquivo único e aqueles que usam Python interativamente devem mais uma vez começar a ver avisos de descontinuação para as APIs que usam, mas os avisos de descontinuação acionados por aplicações importadas, biblioteca e módulos de estrutura continuarão ocultos por padrão.

Como resultado dessa mudança, a biblioteca padrão agora permite que os desenvolvedores escolham entre três comportamentos diferentes de aviso de descontinuação:

- `FutureWarning`: sempre exibida por padrão, recomendado para avisos que devem ser vistos pelos usuários finais da aplicação (por exemplo, para definições de configuração de aplicações descontinuadas).
- `DeprecationWarning`: exibida por padrão apenas em `__main__` e ao executar testes, recomendado para avisos que devem ser vistos por outros desenvolvedores Python onde uma atualização de versão pode resultar em mudança de comportamento ou um erro.
- `PendingDeprecationWarning`: exibida por padrão apenas ao executar testes, destinados a casos em que uma atualização de versão futura mudará a categoria de aviso para `DeprecationWarning` ou `FutureWarning`.

Anteriormente, ambas `DeprecationWarning` e `PendingDeprecationWarning` eram visíveis apenas durante a execução de testes, o que significava que os desenvolvedores principalmente escrevendo scripts de arquivo único ou usando Python interativamente poderiam ser surpreendidos por alterações nas APIs que usavam.

Ver também:

PEP 565 – Show DeprecationWarning in `__main__` PEP escrita e implementada por Nick Coghlan

2.9 PEP 560: Suporte básico para módulo `typing` e tipos genéricos

Inicialmente a **PEP 484** foi projetado de tal forma que não introduziria *nenhuma* mudança no interpretador CPython central. Agora que type hints e o módulo `typing` são amplamente usados pela comunidade, então esta restrição foi removida. A PEP introduz dois métodos especiais `__class_getitem__()` e `__mro_entries__`, esses métodos agora são usados pela maioria das classes e construções especiais em `typing`. Como resultado, a velocidade de várias operações com tipos aumentou em até 7 vezes, os tipos genéricos podem ser usados sem conflitos de metaclasses e vários bugs de longa data no módulo `typing` foram corrigidos.

Ver também:

PEP 560 – Suporte básico para módulo `typing` e tipos genéricos PEP escrita e implementada por Ivan Levkivskiy

2.10 PEP 552: Arquivos `.pyc` baseados em hash

O Python tradicionalmente verifica a atualização dos arquivos de cache em bytecode (ou seja, arquivos `.pyc`) comparando os metadados da fonte (registro de data e hora e tamanho da última modificação) com os metadados da fonte salvos no cabeçalho do arquivo de cache quando foi gerado. Embora eficaz, esse método de invalidação tem suas desvantagens. Quando os registros de data e hora do sistema de arquivos são muito grosseiros, o Python pode perder as atualizações de origem, levando à confusão do usuário. Além disso, ter um registro de data e hora no arquivo de cache é problemático para **reprodutibilidade de compilação** e sistemas de compilação baseados em conteúdo.

PEP 552 estende o formato `pyc` para permitir que o hash do arquivo de origem seja usado para invalidação em vez do registro de data e hora da fonte. Esses arquivos `.pyc` são chamados de “baseados em hash”. Por padrão, Python ainda usa invalidação baseada em registro de data e hora e não gera arquivos `.pyc` baseados em hash em tempo de execução. Arquivos `.pyc` baseados em hash podem ser gerados com `py_compile` ou `compileall`.

Hash-based `.pyc` files come in two variants: checked and unchecked. Python validates checked hash-based `.pyc` files against the corresponding source files at runtime but doesn't do so for unchecked hash-based pycs. Unchecked hash-based `.pyc` files are a useful performance optimization for environments where a system external to Python (e.g., the build system) is responsible for keeping `.pyc` files up-to-date.

See `pyc`-invalidation for more information.

Ver também:

PEP 552 – Deterministic pycs PEP written and implemented by Benjamin Peterson

2.11 PEP 545: Python Documentation Translations

PEP 545 describes the process of creating and maintaining Python documentation translations.

Three new translations have been added:

- Japanese: <https://docs.python.org/ja/>
- French: <https://docs.python.org/fr/>
- Korean: <https://docs.python.org/ko/>

Ver também:

PEP 545 – Python Documentation Translations PEP written and implemented by Julien Palard, Inada Naoki, and Victor Stinner.

2.12 Development Runtime Mode: -X dev

The new `-X dev` command line option or the new `PYTHONDEVMODE` environment variable can be used to enable CPython's *development mode*. When in development mode, CPython performs additional runtime checks that are too expensive to be enabled by default. See `-X dev` documentation for the full description of the effects of this mode.

3 Outras mudanças na Linguagem

- An `await` expression and comprehensions containing an `async for` clause were illegal in the expressions in formatted string literals due to a problem with the implementation. In Python 3.7 this restriction was lifted.
- More than 255 arguments can now be passed to a function, and a function can now have more than 255 parameters. (Contributed by Serhiy Storchaka in [bpo-12844](#) and [bpo-18896](#).)
- `bytes.fromhex()` and `bytearray.fromhex()` now ignore all ASCII whitespace, not only spaces. (Contributed by Robert Xiao in [bpo-28927](#).)
- `str`, `bytes`, and `bytearray` gained support for the new `isascii()` method, which can be used to test if a string or bytes contain only the ASCII characters. (Contributed by INADA Naoki in [bpo-32677](#).)
- `ImportError` now displays module name and module `__file__` path when `from ... import ...` fails. (Contributed by Matthias Bussonnier in [bpo-29546](#).)
- Circular imports involving absolute imports with binding a submodule to a name are now supported. (Contributed by Serhiy Storchaka in [bpo-30024](#).)
- `object.__format__(x, '')` is now equivalent to `str(x)` rather than `format(str(self), '')`. (Contributed by Serhiy Storchaka in [bpo-28974](#).)
- In order to better support dynamic creation of stack traces, `types.TracebackType` can now be instantiated from Python code, and the `tb_next` attribute on tracebacks is now writable. (Contributed by Nathaniel J. Smith in [bpo-30579](#).)
- When using the `-m` switch, `sys.path[0]` is now eagerly expanded to the full starting directory path, rather than being left as the empty directory (which allows imports from the *current* working directory at the time when an import occurs) (Contributed by Nick Coghlan in [bpo-33053](#).)
- The new `-X importtime` option or the `PYTHONPROFILEIMPORTTIME` environment variable can be used to show the timing of each module import. (Contributed by Victor Stinner in [bpo-31415](#).)

4 Novos Módulos

4.1 contextvars

The new `contextvars` module and a set of new C APIs introduce support for *context variables*. Context variables are conceptually similar to thread-local variables. Unlike TLS, context variables support asynchronous code correctly.

The `asyncio` and `decimal` modules have been updated to use and support context variables out of the box. Particularly the active decimal context is now stored in a context variable, which allows decimal operations to work with the correct context in asynchronous code.

Ver também:

PEP 567 – Context Variables PEP written and implemented by Yury Selivanov

4.2 dataclasses

The new `dataclass()` decorator provides a way to declare *data classes*. A data class describes its attributes using class variable annotations. Its constructor and other magic methods, such as `__repr__()`, `__eq__()`, and `__hash__()` are generated automatically.

Exemplo:

```
@dataclass
class Point:
    x: float
    y: float
    z: float = 0.0

p = Point(1.5, 2.5)
print(p)    # produces "Point(x=1.5, y=2.5, z=0.0)"
```

Ver também:

PEP 557 – Data Classes PEP written and implemented by Eric V. Smith

4.3 importlib.resources

The new `importlib.resources` module provides several new APIs and one new ABC for access to, opening, and reading *resources* inside packages. Resources are roughly similar to files inside packages, but they needn't be actual files on the physical file system. Module loaders can provide a `get_resource_reader()` function which returns a `importlib.abc.ResourceReader` instance to support this new API. Built-in file path loaders and zip file loaders both support this.

Contributed by Barry Warsaw and Brett Cannon in [bpo-32248](#).

Ver também:

`importlib_resources` – a PyPI backport for earlier Python versions.

5 Módulos melhorados

5.1 argparse

The new `ArgumentParser.parse_intermixed_args()` method allows intermixing options and positional arguments. (Contributed by paul.j3 in [bpo-14191](#).)

5.2 asyncio

The `asyncio` module has received many new features, usability and *performance improvements*. Notable changes include:

- The new provisional `asyncio.run()` function can be used to run a coroutine from synchronous code by automatically creating and destroying the event loop. (Contributed by Yury Selivanov in [bpo-32314](#).)
- `asyncio` gained support for contextvars. `loop.call_soon()`, `loop.call_soon_threadsafe()`, `loop.call_later()`, `loop.call_at()`, and `Future.add_done_callback()` have a new optional keyword-only *context* parameter. Tasks now track their context automatically. See **PEP 567** for more details. (Contributed by Yury Selivanov in [bpo-32436](#).)

- The new `asyncio.create_task()` function has been added as a shortcut to `asyncio.get_event_loop().create_task()`. (Contributed by Andrew Svetlov in [bpo-32311](#).)
- The new `loop.start_tls()` method can be used to upgrade an existing connection to TLS. (Contributed by Yury Selivanov in [bpo-23749](#).)
- The new `loop.sock_recv_into()` method allows reading data from a socket directly into a provided buffer making it possible to reduce data copies. (Contributed by Antoine Pitrou in [bpo-31819](#).)
- The new `asyncio.current_task()` function returns the currently running Task instance, and the new `asyncio.all_tasks()` function returns a set of all existing Task instances in a given loop. The `Task.current_task()` and `Task.all_tasks()` methods have been deprecated. (Contributed by Andrew Svetlov in [bpo-32250](#).)
- The new *provisional* `BufferedProtocol` class allows implementing streaming protocols with manual control over the receive buffer. (Contributed by Yury Selivanov in [bpo-32251](#).)
- The new `asyncio.get_running_loop()` function returns the currently running loop, and raises a `RuntimeError` if no loop is running. This is in contrast with `asyncio.get_event_loop()`, which will *create* a new event loop if none is running. (Contributed by Yury Selivanov in [bpo-32269](#).)
- The new `StreamWriter.wait_closed()` coroutine method allows waiting until the stream writer is closed. The new `StreamWriter.is_closing()` method can be used to determine if the writer is closing. (Contributed by Andrew Svetlov in [bpo-32391](#).)
- The new `loop.sock_sendfile()` coroutine method allows sending files using `os.sendfile` when possible. (Contributed by Andrew Svetlov in [bpo-32410](#).)
- The new `Future.get_loop()` and `Task.get_loop()` methods return the instance of the loop on which a task or a future were created. `Server.get_loop()` allows doing the same for `asyncio.Server` objects. (Contributed by Yury Selivanov in [bpo-32415](#) and Srinivas Reddy Thatiparthi in [bpo-32418](#).)
- It is now possible to control how instances of `asyncio.Server` begin serving. Previously, the server would start serving immediately when created. The new *start_serving* keyword argument to `loop.create_server()` and `loop.create_unix_server()`, as well as `Server.start_serving()`, and `Server.serve_forever()` can be used to decouple server instantiation and serving. The new `Server.is_serving()` method returns `True` if the server is serving. Server objects are now asynchronous context managers:

```

srv = await loop.create_server(...)

async with srv:
    # some code

# At this point, srv is closed and no longer accepts new connections.

```

(Contributed by Yury Selivanov in [bpo-32662](#).)

- Callback objects returned by `loop.call_later()` gained the new `when()` method which returns an absolute scheduled callback timestamp. (Contributed by Andrew Svetlov in [bpo-32741](#).)
- The `loop.create_datagram_endpoint()` method gained support for Unix sockets. (Contributed by Quentin Dawans in [bpo-31245](#).)
- The `asyncio.open_connection()`, `asyncio.start_server()` functions, `loop.create_connection()`, `loop.create_server()`, `loop.create_accepted_socket()` methods and their corresponding UNIX socket variants now accept the *ssl_handshake_timeout* keyword argument. (Contributed by Neil Aspinall in [bpo-29970](#).)
- The new `Handle.cancelled()` method returns `True` if the callback was cancelled. (Contributed by Marat Sharafutdinov in [bpo-31943](#).)

- The `asyncio` source has been converted to use the `async/await` syntax. (Contributed by Andrew Svetlov in [bpo-32193](#).)
- The new `ReadTransport.is_reading()` method can be used to determine the reading state of the transport. Additionally, calls to `ReadTransport.resume_reading()` and `ReadTransport.pause_reading()` are now idempotent. (Contributed by Yury Selivanov in [bpo-32356](#).)
- Loop methods which accept socket paths now support passing path-like objects. (Contributed by Yury Selivanov in [bpo-32066](#).)
- In `asyncio` TCP sockets on Linux are now created with `TCP_NODELAY` flag set by default. (Contributed by Yury Selivanov and Victor Stinner in [bpo-27456](#).)
- Exceptions occurring in cancelled tasks are no longer logged. (Contributed by Yury Selivanov in [bpo-30508](#).)
- New `WindowsSelectorEventLoopPolicy` and `WindowsProactorEventLoopPolicy` classes. (Contributed by Yury Selivanov in [bpo-33792](#).)

Several `asyncio` APIs have been *deprecated*.

5.3 binascii

The `b2a_uu()` function now accepts an optional *backtick* keyword argument. When it's true, zeros are represented by `'`'` instead of spaces. (Contributed by Xiang Zhang in [bpo-30103](#).)

5.4 calendar

The `HTMLCalendar` class has new class attributes which ease the customization of CSS classes in the produced HTML calendar. (Contributed by Oz Tiram in [bpo-30095](#).)

5.5 collections

`collections.namedtuple()` now supports default values. (Contributed by Raymond Hettinger in [bpo-32320](#).)

5.6 compileall

`compileall.compile_dir()` learned the new *invalidation_mode* parameter, which can be used to enable *hash-based .pyc invalidation*. The invalidation mode can also be specified on the command line using the new `--invalidation-mode` argument. (Contributed by Benjamin Peterson in [bpo-31650](#).)

5.7 concurrent.futures

`ProcessPoolExecutor` and `ThreadPoolExecutor` now support the new *initializer* and *initargs* constructor arguments. (Contributed by Antoine Pitrou in [bpo-21423](#).)

The `ProcessPoolExecutor` can now take the multiprocessing context via the new *mp_context* argument. (Contributed by Thomas Moreau in [bpo-31540](#).)

5.8 contextlib

The new `nullcontext()` is a simpler and faster no-op context manager than `ExitStack`. (Contributed by Jesse Bakker in [bpo-10049](#).)

The new `asynccontextmanager()`, `AbstractAsyncContextManager`, and `AsyncExitStack` have been added to complement their synchronous counterparts. (Contributed by Jelle Zijlstra in [bpo-29679](#) and [bpo-30241](#), and by Alexander Mohr and Ilya Kulakov in [bpo-29302](#).)

5.9 cProfile

The `cProfile` command line now accepts `-m module_name` as an alternative to script path. (Contributed by Sanyam Khurana in [bpo-21862](#).)

5.10 crypt

The `crypt` module now supports the Blowfish hashing method. (Contributed by Serhiy Storchaka in [bpo-31664](#).)

The `mksalt()` function now allows specifying the number of rounds for hashing. (Contributed by Serhiy Storchaka in [bpo-31702](#).)

5.11 datetime

The new `datetime.fromisoformat()` method constructs a `datetime` object from a string in one of the formats output by `datetime.isoformat()`. (Contributed by Paul Ganssle in [bpo-15873](#).)

The `tzinfo` class now supports sub-minute offsets. (Contributed by Alexander Belopolsky in [bpo-5288](#).)

5.12 dbm

`dbm.dumb` now supports reading read-only files and no longer writes the index file when it is not changed.

5.13 decimal

The `decimal` module now uses *context variables* to store the decimal context. (Contributed by Yury Selivanov in [bpo-32630](#).)

5.14 dis

The `dis()` function is now able to disassemble nested code objects (the code of comprehensions, generator expressions and nested functions, and the code used for building nested classes). The maximum depth of disassembly recursion is controlled by the new *depth* parameter. (Contributed by Serhiy Storchaka in [bpo-11822](#).)

5.15 distutils

`README.rst` is now included in the list of distutils standard READMEs and therefore included in source distributions. (Contributed by Ryan Gonzalez in [bpo-11913](#).)

5.16 enum

The `Enum` learned the new `__ignore__` class property, which allows listing the names of properties which should not become enum members. (Contributed by Ethan Furman in [bpo-31801](#).)

In Python 3.8, attempting to check for non-Enum objects in `Enum` classes will raise a `TypeError` (e.g. `1 in Color`); similarly, attempting to check for non-Flag objects in a `Flag` member will raise `TypeError` (e.g. `1 in Perm.RW`); currently, both operations return `False` instead and are deprecated. (Contributed by Ethan Furman in [bpo-33217](#).)

5.17 functools

`functools.singledispatch()` now supports registering implementations using type annotations. (Contributed by Łukasz Langa in [bpo-32227](#).)

5.18 gc

The new `gc.freeze()` function allows freezing all objects tracked by the garbage collector and excluding them from future collections. This can be used before a POSIX `fork()` call to make the GC copy-on-write friendly or to speed up collection. The new `gc.unfreeze()` functions reverses this operation. Additionally, `gc.get_freeze_count()` can be used to obtain the number of frozen objects. (Contributed by Li Zekun in [bpo-31558](#).)

5.19 hmac

The `hmac` module now has an optimized one-shot `digest()` function, which is up to three times faster than `HMAC()`. (Contributed by Christian Heimes in [bpo-32433](#).)

5.20 http.client

`HTTPConnection` and `HTTPSConnection` now support the new `blocksize` argument for improved upload throughput. (Contributed by Nir Soffer in [bpo-31945](#).)

5.21 http.server

`SimpleHTTPRequestHandler` now supports the `HTTP If-Modified-Since` header. The server returns the 304 response status if the target file was not modified after the time specified in the header. (Contributed by Pierre Quentel in [bpo-29654](#).)

`SimpleHTTPRequestHandler` accepts the new `directory` argument, in addition to the new `--directory` command line argument. With this parameter, the server serves the specified directory, by default it uses the current working directory. (Contributed by Stéphane Wirtel and Julien Palard in [bpo-28707](#).)

The new `ThreadingHTTPServer` class uses threads to handle requests using `ThreadingMixin`. It is used when `http.server` is run with `-m`. (Contributed by Julien Palard in [bpo-31639](#).)

5.22 idlelib and IDLE

Multiple fixes for autocompletion. (Contributed by Louie Lu in [bpo-15786](#).)

Module Browser (on the File menu, formerly called Class Browser), now displays nested functions and classes in addition to top-level functions and classes. (Contributed by Guilherme Polo, Cheryl Sabella, and Terry Jan Reedy in [bpo-1612262](#).)

The Settings dialog (Options, Configure IDLE) has been partly rewritten to improve both appearance and function. (Contributed by Cheryl Sabella and Terry Jan Reedy in multiple issues.)

The font sample now includes a selection of non-Latin characters so that users can better see the effect of selecting a particular font. (Contributed by Terry Jan Reedy in [bpo-13802](#).) The sample can be edited to include other characters. (Contributed by Serhiy Storchaka in [bpo-31860](#).)

The IDLE features formerly implemented as extensions have been reimplemented as normal features. Their settings have been moved from the Extensions tab to other dialog tabs. (Contributed by Charles Wohlganger and Terry Jan Reedy in [bpo-27099](#).)

Editor code context option revised. Box displays all context lines up to maxlines. Clicking on a context line jumps the editor to that line. Context colors for custom themes is added to Highlights tab of Settings dialog. (Contributed by Cheryl Sabella and Terry Jan Reedy in [bpo-33642](#), [bpo-33768](#), and [bpo-33679](#).)

On Windows, a new API call tells Windows that tk scales for DPI. On Windows 8.1+ or 10, with DPI compatibility properties of the Python binary unchanged, and a monitor resolution greater than 96 DPI, this should make text and lines sharper. It should otherwise have no effect. (Contributed by Terry Jan Reedy in [bpo-33656](#).)

New in 3.7.1:

A saída em N linhas (50 por padrão) é compactada até um limite inferior. N pode ser alterado na seção PyShell da página General da caixa de diálogo Settings. Menos linhas, mas possivelmente extra longas, podem ser espremidas clicando com o botão direito do mouse na saída. A saída compactada pode ser expandida no local clicando duas vezes no botão ou na área de transferência ou em uma janela separada clicando com o botão direito do mouse. (Contribuição de Tal Einat em [bpo-1529353](#).)

The changes above have been backported to 3.6 maintenance releases.

NEW in 3.7.4:

Add “Run Customized” to the Run menu to run a module with customized settings. Any command line arguments entered are added to sys.argv. They re-appear in the box for the next customized run. One can also suppress the normal Shell main module restart. (Contributed by Cheryl Sabella, Terry Jan Reedy, and others in [bpo-5680](#) and [bpo-37627](#).)

New in 3.7.5:

Add optional line numbers for IDLE editor windows. Windows open without line numbers unless set otherwise in the General tab of the configuration dialog. Line numbers for an existing window are shown and hidden in the Options menu. (Contributed by Tal Einat and Saimadhav Heblikar in [bpo-17535](#).)

5.23 importlib

The `importlib.abc.ResourceReader ABC` was introduced to support the loading of resources from packages. See also [importlib.resources](#). (Contributed by Barry Warsaw, Brett Cannon in [bpo-32248](#).)

`importlib.reload()` now raises `ModuleNotFoundError` if the module lacks a spec. (Contributed by Garvit Khatri in [bpo-29851](#).)

`importlib.find_spec()` now raises `ModuleNotFoundError` instead of `AttributeError` if the specified parent module is not a package (i.e. lacks a `__path__` attribute). (Contributed by Milan Oberkirch in [bpo-30436](#).)

The new `importlib.source_hash()` can be used to compute the hash of the passed source. A *hash-based .pyc file* embeds the value returned by this function.

5.24 io

The new `TextIOWrapper.reconfigure()` method can be used to reconfigure the text stream with the new settings. (Contributed by Antoine Pitrou in [bpo-30526](#) and INADA Naoki in [bpo-15216](#).)

5.25 ipaddress

The new `subnet_of()` and `supernet_of()` methods of `ipaddress.IPv6Network` and `ipaddress.IPv4Network` can be used for network containment tests. (Contributed by Michel Albert and Cheryl Sabella in [bpo-20825](#).)

5.26 itertools

`itertools.islice()` now accepts integer-like objects as start, stop, and slice arguments. (Contributed by Will Roberts in [bpo-30537](#).)

5.27 locale

The new *monetary* argument to `locale.format_string()` can be used to make the conversion use monetary thousands separators and grouping strings. (Contributed by Garvit in [bpo-10379](#).)

The `locale.getpreferredencoding()` function now always returns `'UTF-8'` on Android or when in the *forced UTF-8 mode*.

5.28 logging

`Logger` instances can now be pickled. (Contributed by Vinay Sajip in [bpo-30520](#).)

The new `StreamHandler.setStream()` method can be used to replace the logger stream after handler creation. (Contributed by Vinay Sajip in [bpo-30522](#).)

It is now possible to specify keyword arguments to handler constructors in configuration passed to `logging.config.fileConfig()`. (Contributed by Preston Landers in [bpo-31080](#).)

5.29 math

The new `math.remainder()` function implements the IEEE 754-style remainder operation. (Contributed by Mark Dickinson in [bpo-29962](#).)

5.30 mimetypes

The MIME type of `.bmp` has been changed from `'image/x-ms-bmp'` to `'image/bmp'`. (Contributed by Nitish Chandra in [bpo-22589](#).)

5.31 msilib

The new `Database.Close()` method can be used to close the MSI (last-in, first-out) database. (Contributed by Berker Peksag in [bpo-20486](#).)

5.32 multiprocessing

The new `Process.close()` method explicitly closes the process object and releases all resources associated with it. `ValueError` is raised if the underlying process is still running. (Contributed by Antoine Pitrou in [bpo-30596](#).)

The new `Process.kill()` method can be used to terminate the process using the `SIGKILL` signal on Unix. (Contributed by Vitor Pereira in [bpo-30794](#).)

Non-daemonic threads created by `Process` are now joined on process exit. (Contributed by Antoine Pitrou in [bpo-18966](#).)

5.33 os

`os.fwalk()` now accepts the *path* argument as `bytes`. (Contributed by Serhiy Storchaka in [bpo-28682](#).)

`os.scandir()` gained support for file descriptors. (Contributed by Serhiy Storchaka in [bpo-25996](#).)

The new `register_at_fork()` function allows registering Python callbacks to be executed at process fork. (Contributed by Antoine Pitrou in [bpo-16500](#).)

Added `os.preadv()` (combine the functionality of `os.readv()` and `os.pread()`) and `os.pwritev()` functions (combine the functionality of `os.writev()` and `os.pwrite()`). (Contributed by Pablo Galindo in [bpo-31368](#).)

The mode argument of `os.makedirs()` no longer affects the file permission bits of newly-created intermediate-level directories. (Contributed by Serhiy Storchaka in [bpo-19930](#).)

`os.dup2()` now returns the new file descriptor. Previously, `None` was always returned. (Contributed by Benjamin Peterson in [bpo-32441](#).)

The structure returned by `os.stat()` now contains the `st_fstype` attribute on Solaris and its derivatives. (Contributed by Jesús Cea Avi3n in [bpo-32659](#).)

5.34 pathlib

The new `Path.is_mount()` method is now available on POSIX systems and can be used to determine whether a path is a mount point. (Contributed by Cooper Ry Lees in [bpo-30897](#).)

5.35 pdb

`pdb.set_trace()` now takes an optional *header* keyword-only argument. If given, it is printed to the console just before debugging begins. (Contributed by Barry Warsaw in [bpo-31389](#).)

`pdb` command line now accepts `-m module_name` as an alternative to script file. (Contributed by Mario Corchero in [bpo-32206](#).)

5.36 py_compile

`py_compile.compile()` – and by extension, `compileall` – now respects the `SOURCE_DATE_EPOCH` environment variable by unconditionally creating `.pyc` files for hash-based validation. This allows for guaranteeing [reproducible builds](#) of `.pyc` files when they are created eagerly. (Contributed by Bernhard M. Wiedemann in [bpo-29708](#).)

5.37 pydoc

The `pydoc` server can now bind to an arbitrary hostname specified by the new `-n` command-line argument. (Contributed by Feanil Patel in [bpo-31128](#).)

5.38 queue

The new `SimpleQueue` class is an unbounded FIFO (last-in, first-out) queue. (Contributed by Antoine Pitrou in [bpo-14976](#).)

5.39 re

The flags `re.ASCII`, `re.LOCALE` and `re.UNICODE` can be set within the scope of a group. (Contributed by Serhiy Storchaka in [bpo-31690](#).)

`re.split()` now supports splitting on a pattern like `r'\b', '^$'` or `(?=)` that matches an empty string. (Contributed by Serhiy Storchaka in [bpo-25054](#).)

Regular expressions compiled with the `re.LOCALE` flag no longer depend on the locale at compile time. Locale settings are applied only when the compiled regular expression is used. (Contributed by Serhiy Storchaka in [bpo-30215](#).)

`FutureWarning` is now emitted if a regular expression contains character set constructs that will change semantically in the future, such as nested sets and set operations. (Contributed by Serhiy Storchaka in [bpo-30349](#).)

Compiled regular expression and match objects can now be copied using `copy.copy()` and `copy.deepcopy()`. (Contributed by Serhiy Storchaka in [bpo-10076](#).)

5.40 signal

The new `warn_on_full_buffer` argument to the `signal.set_wakeup_fd()` function makes it possible to specify whether Python prints a warning on `stderr` when the wakeup buffer overflows. (Contributed by Nathaniel J. Smith in [bpo-30050](#).)

5.41 socket

The new `socket.getblocking()` method returns `True` if the socket is in blocking mode and `False` otherwise. (Contributed by Yury Selivanov in [bpo-32373](#).)

The new `socket.close()` function closes the passed socket file descriptor. This function should be used instead of `os.close()` for better compatibility across platforms. (Contributed by Christian Heimes in [bpo-32454](#).)

The `socket` module now exposes the `socket.TCP_CONGESTION` (Linux 2.6.13), `socket.TCP_USER_TIMEOUT` (Linux 2.6.37), and `socket.TCP_NOTSENT_LOWAT` (Linux 3.12) constants. (Contributed by Omar Sandoval in [bpo-26273](#) and Nathaniel J. Smith in [bpo-29728](#).)

Support for `socket.AF_VSOCK` sockets has been added to allow communication between virtual machines and their hosts. (Contributed by Cathy Avery in [bpo-27584](#).)

Sockets now auto-detect family, type and protocol from file descriptor by default. (Contributed by Christian Heimes in [bpo-28134](#).)

5.42 socketserver

`socketserver.ThreadingMixIn.server_close()` now waits until all non-daemon threads complete.
`socketserver.ForkingMixIn.server_close()` now waits until all child processes complete.

Add a new `socketserver.ForkingMixIn.block_on_close` class attribute to `socketserver.ForkingMixIn` and `socketserver.ThreadingMixIn` classes. Set the class attribute to `False` to get the pre-3.7 behaviour.

5.43 sqlite3

`sqlite3.Connection` now exposes the `backup()` method when the underlying SQLite library is at version 3.6.11 or higher. (Contributed by Lele Gaifax in [bpo-27645](#).)

The `database` argument of `sqlite3.connect()` now accepts any path-like object, instead of just a string. (Contributed by Anders Lorentsen in [bpo-31843](#).)

5.44 ssl

The `ssl` module now uses OpenSSL's builtin API instead of `match_hostname()` to check a host name or an IP address. Values are validated during TLS handshake. Any certificate validation error including failing the host name check now raises `SSLCertVerificationError` and aborts the handshake with a proper TLS Alert message. The new exception contains additional information. Host name validation can be customized with `SSLContext.hostname_checks_common_name`. (Contributed by Christian Heimes in [bpo-31399](#).)

Nota: The improved host name check requires a *libssl* implementation compatible with OpenSSL 1.0.2 or 1.1. Consequently, OpenSSL 0.9.8 and 1.0.1 are no longer supported (see [Platform Support Removals](#) for more details). The `ssl` module is mostly compatible with LibreSSL 2.7.2 and newer.

The `ssl` module no longer sends IP addresses in SNI TLS extension. (Contributed by Christian Heimes in [bpo-32185](#).)

`match_hostname()` no longer supports partial wildcards like `www*.example.org`. (Contributed by Mandeep Singh in [bpo-23033](#) and Christian Heimes in [bpo-31399](#).)

The default cipher suite selection of the `ssl` module now uses a blacklist approach rather than a hard-coded whitelist. Python no longer re-enables ciphers that have been blocked by OpenSSL security updates. Default cipher suite selection can be configured at compile time. (Contributed by Christian Heimes in [bpo-31429](#).)

Validation of server certificates containing internationalized domain names (IDNs) is now supported. As part of this change, the `SSLContext.server_hostname` attribute now stores the expected hostname in A-label form ("`xn--pythn-mua.org`"), rather than the U-label form ("`python.org`"). (Contributed by Nathaniel J. Smith and Christian Heimes in [bpo-28414](#).)

The `ssl` module has preliminary and experimental support for TLS 1.3 and OpenSSL 1.1.1. At the time of Python 3.7.0 release, OpenSSL 1.1.1 is still under development and TLS 1.3 hasn't been finalized yet. The TLS 1.3 handshake and protocol behaves slightly differently than TLS 1.2 and earlier, see `ssl-tls1_3`. (Contributed by Christian Heimes in [bpo-32947](#), [bpo-20995](#), [bpo-29136](#), [bpo-30622](#) and [bpo-33618](#))

`SSLContext` and `SSLObject` no longer have a public constructor. Direct instantiation was never a documented and supported feature. Instances must be created with `SSLContext` methods `wrap_socket()` and `wrap_bio()`. (Contributed by Christian Heimes in [bpo-32951](#))

OpenSSL 1.1 APIs for setting the minimum and maximum TLS protocol version are available as `SSLContext.minimum_version` and `SSLContext.maximum_version`. Supported protocols are indicated by several new flags, such as `HAS_TLSv1_1`. (Contributed by Christian Heimes in [bpo-32609](#).)

Added `SSLContext.post_handshake_auth` to `enable` and `ssl.SSLSocket.verify_client_post_handshake()` to initiate TLS 1.3 post-handshake authentication. (Contributed by Christian Heimes in [bpo-34670](#).)

5.45 string

`string.Template` now lets you to optionally modify the regular expression pattern for braced placeholders and non-braced placeholders separately. (Contributed by Barry Warsaw in [bpo-1198569](#).)

5.46 subprocess

The `subprocess.run()` function accepts the new `capture_output` keyword argument. When true, `stdout` and `stderr` will be captured. This is equivalent to passing `subprocess.PIPE` as `stdout` and `stderr` arguments. (Contributed by Bo Bayles in [bpo-32102](#).)

The `subprocess.run` function and the `subprocess.Popen` constructor now accept the `text` keyword argument as an alias to `universal_newlines`. (Contributed by Andrew Clegg in [bpo-31756](#).)

On Windows the default for `close_fds` was changed from `False` to `True` when redirecting the standard handles. It's now possible to set `close_fds` to `true` when redirecting the standard handles. See `subprocess.Popen`. This means that `close_fds` now defaults to `True` on all supported platforms. (Contributed by Segev Finer in [bpo-19764](#).)

The `subprocess` module is now more graceful when handling `KeyboardInterrupt` during `subprocess.call()`, `subprocess.run()`, or in a `Popen` context manager. It now waits a short amount of time for the child to exit, before continuing the handling of the `KeyboardInterrupt` exception. (Contributed by Gregory P. Smith in [bpo-25942](#).)

5.47 sys

The new `sys.breakpointhook()` hook function is called by the built-in `breakpoint()`. (Contributed by Barry Warsaw in [bpo-31353](#).)

On Android, the new `sys.getandroidapilevel()` returns the build-time Android API version. (Contributed by Victor Stinner in [bpo-28740](#).)

The new `sys.get_coroutine_origin_tracking_depth()` function returns the current coroutine origin tracking depth, as set by the new `sys.set_coroutine_origin_tracking_depth()`. `asyncio` has been converted to use this new API instead of the deprecated `sys.set_coroutine_wrapper()`. (Contributed by Nathaniel J. Smith in [bpo-32591](#).)

5.48 time

PEP 564 adds six new functions with nanosecond resolution to the `time` module:

- `time.clock_gettime_ns()`
- `time.clock_settime_ns()`
- `time.monotonic_ns()`
- `time.perf_counter_ns()`
- `time.process_time_ns()`

- `time.time_ns()`

New clock identifiers have been added:

- `time.CLOCK_BOOTTIME` (Linux): Identical to `time.CLOCK_MONOTONIC`, except it also includes any time that the system is suspended.
- `time.CLOCK_PROF` (FreeBSD, NetBSD and OpenBSD): High-resolution per-process CPU timer.
- `time.CLOCK_UPTIME` (FreeBSD, OpenBSD): Time whose absolute value is the time the system has been running and not suspended, providing accurate uptime measurement.

The new `time.thread_time()` and `time.thread_time_ns()` functions can be used to get per-thread CPU time measurements. (Contributed by Antoine Pitrou in [bpo-32025](#).)

The new `time.pthread_getcpuclockid()` function returns the clock ID of the thread-specific CPU-time clock.

5.49 tkinter

The new `tkinter.ttk.Spinbox` class is now available. (Contributed by Alan Moore in [bpo-32585](#).)

5.50 tracemalloc

`tracemalloc.Traceback` behaves more like regular tracebacks, sorting the frames from oldest to most recent. `Traceback.format()` now accepts negative *limit*, truncating the result to the `abs(limit)` oldest frames. To get the old behaviour, use the new *most_recent_first* argument to `Traceback.format()`. (Contributed by Jesse Bakker in [bpo-32121](#).)

5.51 types

The new `WrapperDescriptorType`, `MethodWrapperType`, `MethodDescriptorType`, and `ClassMethodDescriptorType` classes are now available. (Contributed by Manuel Krebber and Guido van Rossum in [bpo-29377](#), and Serhiy Storchaka in [bpo-32265](#).)

The new `types.resolve_bases()` function resolves MRO entries dynamically as specified by [PEP 560](#). (Contributed by Ivan Levkivskyi in [bpo-32717](#).)

5.52 unicodedata

The internal `unicodedata` database has been upgraded to use [Unicode 11](#). (Contributed by Benjamin Peterson.)

5.53 unittest

The new `-k` command-line option allows filtering tests by a name substring or a Unix shell-like pattern. For example, `python -m unittest -k foo` runs `foo_tests.SomeTest.test_something`, `bar_tests.SomeTest.test_foo`, but not `bar_tests.FooTest.test_something`. (Contributed by Jonas Haag in [bpo-32071](#).)

5.54 unittest.mock

The `sentinel` attributes now preserve their identity when they are copied or pickled. (Contributed by Serhiy Storchaka in [bpo-20804](#).)

The new `seal()` function allows sealing `Mock` instances, which will disallow further creation of attribute mocks. The seal is applied recursively to all attributes that are themselves mocks. (Contributed by Mario Corchero in [bpo-30541](#).)

5.55 urllib.parse

`urllib.parse.quote()` has been updated from [RFC 2396](#) to [RFC 3986](#), adding `~` to the set of characters that are never quoted by default. (Contributed by Christian Theune and Ratnadeep Debnath in [bpo-16285](#).)

5.56 uu

The `uu.encode()` function now accepts an optional `backtick` keyword argument. When it's true, zeros are represented by `` `` instead of spaces. (Contributed by Xiang Zhang in [bpo-30103](#).)

5.57 uuid

The new `UUID.is_safe` attribute relays information from the platform about whether generated UUIDs are generated with a multiprocessing-safe method. (Contributed by Barry Warsaw in [bpo-22807](#).)

`uuid.getnode()` now prefers universally administered MAC addresses over locally administered MAC addresses. This makes a better guarantee for global uniqueness of UUIDs returned from `uuid.uuid1()`. If only locally administered MAC addresses are available, the first such one found is returned. (Contributed by Barry Warsaw in [bpo-32107](#).)

5.58 avisos

The initialization of the default warnings filters has changed as follows:

- warnings enabled via command line options (including those for `-b` and the new CPython-specific `-X dev` option) are always passed to the warnings machinery via the `sys.warnoptions` attribute.
- warnings filters enabled via the command line or the environment now have the following order of precedence:
 - the `BytesWarning` filter for `-b` (or `-bb`)
 - any filters specified with the `-W` option
 - any filters specified with the `PYTHONWARNINGS` environment variable
 - any other CPython specific filters (e.g. the default filter added for the new `-X dev` mode)
 - any implicit filters defined directly by the warnings machinery
- in CPython debug builds, all warnings are now displayed by default (the implicit filter list is empty)

(Contributed by Nick Coghlan and Victor Stinner in [bpo-20361](#), [bpo-32043](#), and [bpo-32230](#).)

Deprecation warnings are once again shown by default in single-file scripts and at the interactive prompt. See [PEP 565: *Mostra Deprecation Warning em __main__*](#) for details. (Contributed by Nick Coghlan in [bpo-31975](#).)

5.59 xml

Como atenuação a DTD e recuperação de entidade externa, os módulos `xml.dom.minidom` e `xml.sax` não processam mais entidades externas por padrão. (Contribuição de Christian Heimes em [bpo-17239](#).)

5.60 xml.etree

`ElementPath` predicates in the `find()` methods can now compare text of the current node with `[. = "text"]`, not only text in children. Predicates also allow adding spaces for better readability. (Contributed by Stefan Behnel in [bpo-31648](#).)

5.61 xmlrpc.server

`SimpleXMLRPCDispatcher.register_function` can now be used as a decorator. (Contributed by Xiang Zhang in [bpo-7769](#).)

5.62 zipapp

Function `create_archive()` now accepts an optional *filter* argument to allow the user to select which files should be included in the archive. (Contributed by Irmien de Jong in [bpo-31072](#).)

Function `create_archive()` now accepts an optional *compressed* argument to generate a compressed archive. A command line option `--compress` has also been added to support compression. (Contributed by Zhiming Wang in [bpo-31638](#).)

5.63 zipfile

`ZipFile` now accepts the new *compresslevel* parameter to control the compression level. (Contributed by Bo Bayles in [bpo-21417](#).)

Subdirectories in archives created by `ZipFile` are now stored in alphabetical order. (Contributed by Bernhard M. Wiedemann in [bpo-30693](#).)

6 Alterações na API C

A new API for thread-local storage has been implemented. See [PEP 539: Nova API C para armazenamento local de thread](#) for an overview and [thread-specific-storage-api](#) for a complete reference. (Contributed by Masayuki Yamamoto in [bpo-25658](#).)

The new *context variables* functionality exposes a number of new C APIs.

The new `PyImport_GetModule()` function returns the previously imported module with the given name. (Contributed by Eric Snow in [bpo-28411](#).)

The new `Py_RETURN_RICHCOMPARE` macro eases writing rich comparison functions. (Contributed by Petr Victorin in [bpo-23699](#).)

The new `Py_UNREACHABLE` macro can be used to mark unreachable code paths. (Contributed by Barry Warsaw in [bpo-31338](#).)

The `tracemalloc` now exposes a C API through the new `PyTraceMalloc_Track()` and `PyTraceMalloc_Untrack()` functions. (Contributed by Victor Stinner in [bpo-30054](#).)

The new `import__find__load__start()` and `import__find__load__done()` static markers can be used to trace module imports. (Contributed by Christian Heimes in [bpo-31574](#).)

The fields `name` and `doc` of structures `PyMemberDef`, `PyGetSetDef`, `PyStructSequence_Field`, `PyStructSequence_Desc`, and `wrapperbase` are now of type `const char *` rather of `char *`. (Contributed by Serhiy Storchaka in [bpo-28761](#).)

The result of `PyUnicode_AsUTF8AndSize()` and `PyUnicode_AsUTF8()` is now of type `const char *` rather of `char *`. (Contributed by Serhiy Storchaka in [bpo-28769](#).)

The result of `PyMapping_Keys()`, `PyMapping_Values()` and `PyMapping_Items()` is now always a list, rather than a list or a tuple. (Contributed by Oren Milman in [bpo-28280](#).)

Added functions `PySlice_Unpack()` and `PySlice_AdjustIndices()`. (Contributed by Serhiy Storchaka in [bpo-27867](#).)

`PyOS_AfterFork()` is deprecated in favour of the new functions `PyOS_BeforeFork()`, `PyOS_AfterFork_Parent()` and `PyOS_AfterFork_Child()`. (Contributed by Antoine Pitrou in [bpo-16500](#).)

The `PyExc_RecursionErrorInst` singleton that was part of the public API has been removed as its members being never cleared may cause a segfault during finalization of the interpreter. Contributed by Xavier de Gaye in [bpo-22898](#) and [bpo-30697](#).

Added C API support for timezones with timezone constructors `PyTimeZone_FromOffset()` and `PyTimeZone_FromOffsetAndName()`, and access to the UTC singleton with `PyDateTime_TimeZone_UTC`. Contributed by Paul Ganssle in [bpo-10381](#).

The type of results of `PyThread_start_new_thread()` and `PyThread_get_thread_ident()`, and the `id` parameter of `PyThreadState_SetAsynExc()` changed from `long` to `unsigned long`. (Contributed by Serhiy Storchaka in [bpo-6532](#).)

`PyUnicode_AsWideCharString()` now raises a `ValueError` if the second argument is `NULL` and the `wchar_t*` string contains null characters. (Contributed by Serhiy Storchaka in [bpo-30708](#).)

Changes to the startup sequence and the management of dynamic memory allocators mean that the long documented requirement to call `Py_Initialize()` before calling most C API functions is now relied on more heavily, and failing to abide by it may lead to segfaults in embedding applications. See the [Porting to Python 3.7](#) section in this document and the pre-init-safe section in the C API documentation for more details.

The new `PyInterpreterState_GetID()` returns the unique ID for a given interpreter. (Contributed by Eric Snow in [bpo-29102](#).)

`Py_DecodeLocale()`, `Py_EncodeLocale()` now use the UTF-8 encoding when the *UTF-8 mode* is enabled. (Contributed by Victor Stinner in [bpo-29240](#).)

`PyUnicode_DecodeLocaleAndSize()` and `PyUnicode_EncodeLocale()` now use the current locale encoding for surrogateescape error handler. (Contributed by Victor Stinner in [bpo-29240](#).)

The `start` and `end` parameters of `PyUnicode_FindChar()` are now adjusted to behave like string slices. (Contributed by Xiang Zhang in [bpo-28822](#).)

7 Alterações de compilação

Support for building `--without-threads` has been removed. The `threading` module is now always available. (Contributed by Antoine Pitrou in [bpo-31370](#).)

A full copy of `libffi` is no longer bundled for use when building the `_ctypes` module on non-OSX UNIX platforms. An installed copy of `libffi` is now required when building `_ctypes` on such platforms. (Contributed by Zachary Ware in [bpo-27979](#).)

The Windows build process no longer depends on Subversion to pull in external sources, a Python script is used to download zipfiles from GitHub instead. If Python 3.6 is not found on the system (via `py -3.6`), NuGet is used to download a copy of 32-bit Python for this purpose. (Contributed by Zachary Ware in [bpo-30450](#).)

The `ssl` module requires OpenSSL 1.0.2 or 1.1 compatible `libssl`. OpenSSL 1.0.1 has reached end of lifetime on 2016-12-31 and is no longer supported. LibreSSL is temporarily not supported as well. LibreSSL releases up to version 2.6.4 are missing required OpenSSL 1.0.2 APIs.

8 Otimizações

The overhead of calling many methods of various standard library classes implemented in C has been significantly reduced by porting more code to use the `METH_FASTCALL` convention. (Contributed by Victor Stinner in [bpo-29300](#), [bpo-29507](#), [bpo-29452](#), and [bpo-29286](#).)

Various optimizations have reduced Python startup time by 10% on Linux and up to 30% on macOS. (Contributed by Victor Stinner, INADA Naoki in [bpo-29585](#), and Ivan Levkivskyi in [bpo-31333](#).)

Method calls are now up to 20% faster due to the bytecode changes which avoid creating bound method instances. (Contributed by Yury Selivanov and INADA Naoki in [bpo-26110](#).)

The `asyncio` module received a number of notable optimizations for commonly used functions:

- The `asyncio.get_event_loop()` function has been reimplemented in C to make it up to 15 times faster. (Contributed by Yury Selivanov in [bpo-32296](#).)
- `asyncio.Future` callback management has been optimized. (Contributed by Yury Selivanov in [bpo-32348](#).)
- `asyncio.gather()` is now up to 15% faster. (Contributed by Yury Selivanov in [bpo-32355](#).)
- `asyncio.sleep()` is now up to 2 times faster when the `delay` argument is zero or negative. (Contributed by Andrew Svetlov in [bpo-32351](#).)
- The performance overhead of `asyncio` debug mode has been reduced. (Contributed by Antoine Pitrou in [bpo-31970](#).)

As a result of [PEP 560 work](#), the import time of `typing` has been reduced by a factor of 7, and many typing operations are now faster. (Contributed by Ivan Levkivskyi in [bpo-32226](#).)

`sorted()` and `list.sort()` have been optimized for common cases to be up to 40-75% faster. (Contributed by Elliot Gorokhovskiy in [bpo-28685](#).)

`dict.copy()` is now up to 5.5 times faster. (Contributed by Yury Selivanov in [bpo-31179](#).)

`hasattr()` and `getattr()` are now about 4 times faster when `name` is not found and `obj` does not override `object.__getattr__()` or `object.__getattribute__()`. (Contributed by INADA Naoki in [bpo-32544](#).)

Searching for certain Unicode characters (like Ukrainian capital “Є”) in a string was up to 25 times slower than searching for other characters. It is now only 3 times slower in the worst case. (Contributed by Serhiy Storchaka in [bpo-24821](#).)

The `collections.namedtuple()` factory has been reimplemented to make the creation of named tuples 4 to 6 times faster. (Contributed by Jelle Zijlstra with further improvements by INADA Naoki, Serhiy Storchaka, and Raymond Hettinger in [bpo-28638](#).)

`date.fromordinal()` and `date.fromtimestamp()` are now up to 30% faster in the common case. (Contributed by Paul Ganssle in [bpo-32403](#).)

The `os.fwalk()` function is now up to 2 times faster thanks to the use of `os.scandir()`. (Contributed by Serhiy Storchaka in [bpo-25996](#).)

The speed of the `shutil.rmtree()` function has been improved by 20–40% thanks to the use of the `os.scandir()` function. (Contributed by Serhiy Storchaka in [bpo-28564](#).)

Optimized case-insensitive matching and searching of regular expressions. Searching some patterns can now be up to 20 times faster. (Contributed by Serhiy Storchaka in [bpo-30285](#).)

`re.compile()` now converts `flags` parameter to `int` object if it is `RegexFlag`. It is now as fast as Python 3.5, and faster than Python 3.6 by about 10% depending on the pattern. (Contributed by INADA Naoki in [bpo-31671](#).)

The `modify()` methods of classes `selectors.EpollSelector`, `selectors.PollSelector` and `selectors.DevpollSelector` may be around 10% faster under heavy loads. (Contributed by Giampaolo Rodola' in [bpo-30014](#).)

Constant folding has been moved from the peephole optimizer to the new AST optimizer, which is able perform optimizations more consistently. (Contributed by Eugene Toder and INADA Naoki in [bpo-29469](#) and [bpo-11549](#).)

Most functions and methods in `abc` have been rewritten in C. This makes creation of abstract base classes, and calling `isinstance()` and `issubclass()` on them 1.5x faster. This also reduces Python start-up time by up to 10%. (Contributed by Ivan Levkivskyi and INADA Naoki in [bpo-31333](#).)

Significant speed improvements to alternate constructors for `datetime.date` and `datetime.datetime` by using fast-path constructors when not constructing subclasses. (Contributed by Paul Ganssle in [bpo-32403](#).)

The speed of comparison of `array.array` instances has been improved considerably in certain cases. It is now from 10x to 70x faster when comparing arrays holding values of the same integer type. (Contributed by Adrian Wielgosik in [bpo-24700](#).)

The `math.erf()` and `math.erfc()` functions now use the (faster) C library implementation on most platforms. (Contributed by Serhiy Storchaka in [bpo-26121](#).)

9 Outras mudanças na implementação do CPython

- Trace hooks may now opt out of receiving the `line` and opt into receiving the `opcode` events from the interpreter by setting the corresponding new `f_trace_lines` and `f_trace_opcodes` attributes on the frame being traced. (Contributed by Nick Coghlan in [bpo-31344](#).)
- Fixed some consistency problems with namespace package module attributes. Namespace module objects now have an `__file__` that is set to `None` (previously unset), and their `__spec__.origin` is also set to `None` (previously the string `"namespace"`). See [bpo-32305](#). Also, the namespace module object's `__spec__.loader` is set to the same value as `__loader__` (previously, the former was set to `None`). See [bpo-32303](#).
- The `locals()` dictionary now displays in the lexical order that variables were defined. Previously, the order was undefined. (Contributed by Raymond Hettinger in [bpo-32690](#).)
- The `distutils.upload` command no longer tries to change CR end-of-line characters to CRLF. This fixes a corruption issue with sdists that ended with a byte equivalent to CR. (Contributed by Bo Bayles in [bpo-32304](#).)

10 Comportamento do Python descontinuado

Yield expressions (both `yield` and `yield from` clauses) are now deprecated in comprehensions and generator expressions (aside from the iterable expression in the leftmost `for` clause). This ensures that comprehensions always immediately return a container of the appropriate type (rather than potentially returning a generator iterator object), while generator expressions won't attempt to interleave their implicit output with the output from any explicit `yield` expressions. In Python 3.7, such expressions emit `DeprecationWarning` when compiled, in Python 3.8 this will be a `SyntaxError`. (Contributed by Serhiy Storchaka in [bpo-10544](#).)

Returning a subclass of `complex` from `object.__complex__()` is deprecated and will be an error in future Python versions. This makes `__complex__()` consistent with `object.__int__()` and `object.__float__()`. (Contributed by Serhiy Storchaka in [bpo-28894](#).)

11 Deprecated Python modules, functions and methods

11.1 aifc

`aifc.openfp()` has been deprecated and will be removed in Python 3.9. Use `aifc.open()` instead. (Contributed by Brian Curtin in [bpo-31985](#).)

11.2 asyncio

Support for directly `await`-ing instances of `asyncio.Lock` and other `asyncio` synchronization primitives has been deprecated. An asynchronous context manager must be used in order to acquire and release the synchronization resource. (Contributed by Andrew Svetlov in [bpo-32253](#).)

The `asyncio.Task.current_task()` and `asyncio.Task.all_tasks()` methods have been deprecated. (Contributed by Andrew Svetlov in [bpo-32250](#).)

11.3 collections

In Python 3.8, the abstract base classes in `collections.abc` will no longer be exposed in the regular `collections` module. This will help create a clearer distinction between the concrete classes and the abstract base classes. (Contributed by Serhiy Storchaka in [bpo-25988](#).)

11.4 dbm

`dbm.dumb` now supports reading read-only files and no longer writes the index file when it is not changed. A deprecation warning is now emitted if the index file is missing and recreated in the `'r'` and `'w'` modes (this will be an error in future Python releases). (Contributed by Serhiy Storchaka in [bpo-28847](#).)

11.5 enum

In Python 3.8, attempting to check for non-Enum objects in Enum classes will raise a `TypeError` (e.g. `1 in Color`); similarly, attempting to check for non-Flag objects in a Flag member will raise `TypeError` (e.g. `1 in Perm.RW`); currently, both operations return `False` instead. (Contributed by Ethan Furman in [bpo-33217](#).)

11.6 gettext

Using non-integer value for selecting a plural form in `gettext` is now deprecated. It never correctly worked. (Contributed by Serhiy Storchaka in [bpo-28692](#).)

11.7 importlib

Methods `MetaPathFinder.find_module()` (replaced by `MetaPathFinder.find_spec()`) and `PathEntryFinder.find_loader()` (replaced by `PathEntryFinder.find_spec()`) both deprecated in Python 3.4 now emit `DeprecationWarning`. (Contributed by Matthias Bussonnier in [bpo-29576](#))

The `importlib.abc.ResourceLoader ABC` has been deprecated in favour of `importlib.abc.ResourceReader`.

11.8 locale

`locale.format()` has been deprecated, use `locale.format_string()` instead. (Contributed by Garvit in [bpo-10379](#).)

11.9 macpath

The `macpath` is now deprecated and will be removed in Python 3.8. (Contributed by Chi Hsuan Yen in [bpo-9850](#).)

11.10 threading

`dummy_threading` and `_dummy_thread` have been deprecated. It is no longer possible to build Python with threading disabled. Use `threading` instead. (Contributed by Antoine Pitrou in [bpo-31370](#).)

11.11 socket

The silent argument value truncation in `socket.htons()` and `socket.ntohs()` has been deprecated. In future versions of Python, if the passed argument is larger than 16 bits, an exception will be raised. (Contributed by Oren Milman in [bpo-28332](#).)

11.12 ssl

`ssl.wrap_socket()` is deprecated. Use `ssl.SSLContext.wrap_socket()` instead. (Contributed by Christian Heimes in [bpo-28124](#).)

11.13 sunau

`sunau.openfp()` has been deprecated and will be removed in Python 3.9. Use `sunau.open()` instead. (Contributed by Brian Curtin in [bpo-31985](#).)

11.14 sys

Deprecated `sys.set_coroutine_wrapper()` and `sys.get_coroutine_wrapper()`.

The undocumented `sys.callstats()` function has been deprecated and will be removed in a future Python version. (Contributed by Victor Stinner in [bpo-28799](#).)

11.15 wave

`wave.openfp()` has been deprecated and will be removed in Python 3.9. Use `wave.open()` instead. (Contributed by Brian Curtin in [bpo-31985](#).)

12 Deprecated functions and types of the C API

Function `PySlice_GetIndicesEx()` is deprecated and replaced with a macro if `Py_LIMITED_API` is not set or set to a value in the range between `0x03050400` and `0x03060000` (not inclusive), or is `0x03060100` or higher. (Contributed by Serhiy Storchaka in [bpo-27867](#).)

`PyOS_AfterFork()` has been deprecated. Use `PyOS_BeforeFork()`, `PyOS_AfterFork_Parent()` or `PyOS_AfterFork_Child()` instead. (Contributed by Antoine Pitrou in [bpo-16500](#).)

13 Platform Support Removals

- FreeBSD 9 and older are no longer officially supported.
- For full Unicode support, including within extension modules, *nix platforms are now expected to provide at least one of `C.UTF-8` (full locale), `C.utf8` (full locale) or `UTF-8 (LC_CTYPE-only locale)` as an alternative to the legacy ASCII-based C locale.
- OpenSSL 0.9.8 and 1.0.1 are no longer supported, which means building CPython 3.7 with SSL/TLS support on older platforms still using these versions requires custom build options that link to a more recent version of OpenSSL.

Notably, this issue affects the Debian 8 (aka “jessie”) and Ubuntu 14.04 (aka “Trusty”) LTS Linux distributions, as they still use OpenSSL 1.0.1 by default.

Debian 9 (“stretch”) and Ubuntu 16.04 (“xenial”), as well as recent releases of other LTS Linux releases (e.g. RHEL/CentOS 7.5, SLES 12-SP3), use OpenSSL 1.0.2 or later, and remain supported in the default build configuration.

CPython's own [CI configuration file](#) provides an example of using the [SSL compatibility testing infrastructure](#) in CPython's test suite to build and link against OpenSSL 1.1.0 rather than an outdated system provided OpenSSL.

14 API and Feature Removals

The following features and APIs have been removed from Python 3.7:

- The `os.stat_float_times()` function has been removed. It was introduced in Python 2.3 for backward compatibility with Python 2.2, and was deprecated since Python 3.1.
- Unknown escapes consisting of `'\'` and an ASCII letter in replacement templates for `re.sub()` were deprecated in Python 3.5, and will now cause an error.
- Removed support of the *exclude* argument in `tarfile.TarFile.add()`. It was deprecated in Python 2.7 and 3.2. Use the *filter* argument instead.
- The `splitunc()` function in the `ntpath` module was deprecated in Python 3.1, and has now been removed. Use the `splitdrive()` function instead.
- `collections.namedtuple()` no longer supports the *verbose* parameter or `_source` attribute which showed the generated source code for the named tuple class. This was part of an optimization designed to speed-up class creation. (Contributed by Jelle Zijlstra with further improvements by INADA Naoki, Serhiy Storchaka, and Raymond Hettinger in [bpo-28638](#).)
- Functions `bool()`, `float()`, `list()` and `tuple()` no longer take keyword arguments. The first argument of `int()` can now be passed only as positional argument.
- Removed previously deprecated in Python 2.4 classes `Plist`, `Dict` and `_InternalDict` in the `plistlib` module. Dict values in the result of functions `readPlist()` and `readPlistFromBytes()` are now normal dicts. You no longer can use attribute access to access items of these dictionaries.
- The `asyncio.windows_utils.socketpair()` function has been removed. Use the `socket.socketpair()` function instead, it is available on all platforms since Python 3.5. `asyncio.windows_utils.socketpair` was just an alias to `socket.socketpair` on Python 3.5 and newer.
- `asyncio` no longer exports the `selectors` and `_overlapped` modules as `asyncio.selectors` and `asyncio._overlapped`. Replace `from asyncio import selectors` with `import selectors`.
- Direct instantiation of `ssl.SSLSocket` and `ssl.SSLObject` objects is now prohibited. The constructors were never documented, tested, or designed as public constructors. Users were supposed to use `ssl.wrap_socket()` or `ssl.SSLContext`. (Contributed by Christian Heimes in [bpo-32951](#).)
- The unused `distutils.install_misc` command has been removed. (Contributed by Eric N. Vander Weele in [bpo-29218](#).)

15 Module Removals

The `fpectl` module has been removed. It was never enabled by default, never worked correctly on x86-64, and it changed the Python ABI in ways that caused unexpected breakage of C extensions. (Contributed by Nathaniel J. Smith in [bpo-29137](#).)

16 Windows-only Changes

The python launcher, (py.exe), can accept 32 & 64 bit specifiers **without** having to specify a minor version as well. So `py -3-32` and `py -3-64` become valid as well as `py -3.7-32`, also the `-m-64` and `-m.n-64` forms are now accepted to force 64 bit python even if 32 bit would have otherwise been used. If the specified version is not available py.exe will error exit. (Contributed by Steve Barnes in [bpo-30291](#).)

The launcher can be run as `py -0` to produce a list of the installed pythons, *with default marked with an asterisk*. Running `py -0p` will include the paths. If py is run with a version specifier that cannot be matched it will also print the *short form* list of available specifiers. (Contributed by Steve Barnes in [bpo-30362](#).)

17 Porting to Python 3.7

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

17.1 Changes in Python Behavior

- `async` and `await` names are now reserved keywords. Code using these names as identifiers will now raise a `SyntaxError`. (Contributed by Jelle Zijlstra in [bpo-30406](#).)
- **PEP 479** is enabled for all code in Python 3.7, meaning that `StopIteration` exceptions raised directly or indirectly in coroutines and generators are transformed into `RuntimeError` exceptions. (Contributed by Yury Selivanov in [bpo-32670](#).)
- `object.__aiter__()` methods can no longer be declared as asynchronous. (Contributed by Yury Selivanov in [bpo-31709](#).)
- Due to an oversight, earlier Python versions erroneously accepted the following syntax:

```
f(1 for x in [1],)

class C(1 for x in [1]):
    pass
```

Python 3.7 now correctly raises a `SyntaxError`, as a generator expression always needs to be directly inside a set of parentheses and cannot have a comma on either side, and the duplication of the parentheses can be omitted only on calls. (Contributed by Serhiy Storchaka in [bpo-32012](#) and [bpo-32023](#).)

- When using the `-m` switch, the initial working directory is now added to `sys.path`, rather than an empty string (which dynamically denoted the current working directory at the time of each import). Any programs that are checking for the empty string, or otherwise relying on the previous behaviour, will need to be updated accordingly (e.g. by also checking for `os.getcwd()` or `os.path.dirname(__main__.__file__)`, depending on why the code was checking for the empty string in the first place).

17.2 Changes in the Python API

- `socketserver.ThreadingMixIn.server_close()` now waits until all non-daemon threads complete. Set the new `socketserver.ThreadingMixIn.block_on_close` class attribute to `False` to get the pre-3.7 behaviour. (Contributed by Victor Stinner in [bpo-31233](#) and [bpo-33540](#).)
- `socketserver.ForkingMixIn.server_close()` now waits until all child processes complete. Set the new `socketserver.ForkingMixIn.block_on_close` class attribute to `False` to get the pre-3.7 behaviour. (Contributed by Victor Stinner in [bpo-31151](#) and [bpo-33540](#).)
- The `locale.localeconv()` function now temporarily sets the `LC_CTYPE` locale to the value of `LC_NUMERIC` in some cases. (Contributed by Victor Stinner in [bpo-31900](#).)
- `pkgutil.walk_packages()` now raises a `ValueError` if *path* is a string. Previously an empty list was returned. (Contributed by Sanyam Khurana in [bpo-24744](#).)
- A format string argument for `string.Formatter.format()` is now positional-only. Passing it as a keyword argument was deprecated in Python 3.5. (Contributed by Serhiy Storchaka in [bpo-29193](#).)
- Attributes `key`, `value` and `coded_value` of class `http.cookies.Morsel` are now read-only. Assigning to them was deprecated in Python 3.5. Use the `set()` method for setting them. (Contributed by Serhiy Storchaka in [bpo-29192](#).)
- The *mode* argument of `os.makedirs()` no longer affects the file permission bits of newly-created intermediate-level directories. To set their file permission bits you can set the `umask` before invoking `makedirs()`. (Contributed by Serhiy Storchaka in [bpo-19930](#).)
- The `struct.Struct.format` type is now `str` instead of `bytes`. (Contributed by Victor Stinner in [bpo-21071](#).)
- `parse_multipart()` now accepts the *encoding* and *errors* arguments and returns the same results as `FieldStorage`: for non-file fields, the value associated to a key is a list of strings, not bytes. (Contributed by Pierre Quentel in [bpo-29979](#).)
- Due to internal changes in `socket`, calling `socket.fromshare()` on a socket created by `socket.share` in older Python versions is not supported.
- `repr` for `BaseException` has changed to not include the trailing comma. Most exceptions are affected by this change. (Contributed by Serhiy Storchaka in [bpo-30399](#).)
- `repr` for `datetime.timedelta` has changed to include the keyword arguments in the output. (Contributed by Utkarsh Upadhyay in [bpo-30302](#).)
- Because `shutil.rmtree()` is now implemented using the `os.scandir()` function, the user specified handler *onerror* is now called with the first argument `os.scandir` instead of `os.listdir` when listing the directory is failed.
- Support for nested sets and set operations in regular expressions as in [Unicode Technical Standard #18](#) might be added in the future. This would change the syntax. To facilitate this future change a `FutureWarning` will be raised in ambiguous cases for the time being. That include sets starting with a literal '[' or containing literal character sequences '--', '&&', '~', and '|'. To avoid a warning, escape them with a backslash. (Contributed by Serhiy Storchaka in [bpo-30349](#).)
- The result of splitting a string on a regular expression that could match an empty string has been changed. For example splitting on `r'\s+'` will now split not only on whitespaces as it did previously, but also on empty strings before all non-whitespace characters and just before the end of the string. The previous behavior can be restored by changing the pattern to `r'\s+'`. A `FutureWarning` was emitted for such patterns since Python 3.5.

For patterns that match both empty and non-empty strings, the result of searching for all matches may also be changed in other cases. For example in the string `'a\n\n'`, the pattern `r'(?m)^\s*?$'` will not only match

empty strings at positions 2 and 3, but also the string `'\n'` at positions 2–3. To match only blank lines, the pattern should be rewritten as `r'(?m)^[^\S\n]*$'`.

`re.sub()` now replaces empty matches adjacent to a previous non-empty match. For example `re.sub('x*', '-', 'abxd')` returns now `'-a-b--d-'` instead of `'-a-b-d-'` (the first minus between `'b'` and `'d'` replaces `'x'`, and the second minus replaces an empty string between `'x'` and `'d'`).

(Contributed by Serhiy Storchaka in [bpo-25054](#) and [bpo-32308](#).)

- Change `re.escape()` to only escape regex special characters instead of escaping all characters other than ASCII letters, numbers, and `'_'`. (Contributed by Serhiy Storchaka in [bpo-29995](#).)
- `traceback.Traceback` frames are now sorted from oldest to most recent to be more consistent with `traceback`. (Contributed by Jesse Bakker in [bpo-32121](#).)
- On OSes that support `socket.SOCK_NONBLOCK` or `socket.SOCK_CLOEXEC` bit flags, the `socket.type` no longer has them applied. Therefore, checks like `if sock.type == socket.SOCK_STREAM` work as expected on all platforms. (Contributed by Yury Selivanov in [bpo-32331](#).)
- On Windows the default for the `close_fds` argument of `subprocess.Popen` was changed from `False` to `True` when redirecting the standard handles. If you previously depended on handles being inherited when using `subprocess.Popen` with standard io redirection, you will have to pass `close_fds=False` to preserve the previous behaviour, or use `STARTUPINFO.lpAttributeList`.
- `importlib.machinery.PathFinder.invalidate_caches()` – which implicitly affects `importlib.invalidate_caches()` – now deletes entries in `sys.path_importer_cache` which are set to `None`. (Contributed by Brett Cannon in [bpo-33169](#).)
- In `asyncio`, `loop.sock_recv()`, `loop.sock_sendall()`, `loop.sock_accept()`, `loop.getaddrinfo()`, `loop.getnameinfo()` have been changed to be proper coroutine methods to match their documentation. Previously, these methods returned `asyncio.Future` instances. (Contributed by Yury Selivanov in [bpo-32327](#).)
- `asyncio.Server.sockets` now returns a copy of the internal list of server sockets, instead of returning it directly. (Contributed by Yury Selivanov in [bpo-32662](#).)
- `Struct.format` is now a `str` instance instead of a `bytes` instance. (Contributed by Victor Stinner in [bpo-21071](#).)
- `argparse` subparsers can now be made mandatory by passing `required=True` to `ArgumentParser.add_subparsers()`. (Contributed by Anthony Sottile in [bpo-26510](#).)
- `ast.literal_eval()` is now stricter. Addition and subtraction of arbitrary numbers are no longer allowed. (Contributed by Serhiy Storchaka in [bpo-31778](#).)
- `Calendar.itermonthdates` will now consistently raise an exception when a date falls outside of the 0001-01-01 through 9999-12-31 range. To support applications that cannot tolerate such exceptions, the new `Calendar.itermonthdays3` and `Calendar.itermonthdays4` can be used. The new methods return tuples and are not restricted by the range supported by `datetime.date`. (Contributed by Alexander Belopolsky in [bpo-28292](#).)
- `collections.ChainMap` now preserves the order of the underlying mappings. (Contributed by Raymond Hettinger in [bpo-32792](#).)
- The `submit()` method of `concurrent.futures.ThreadPoolExecutor` and `concurrent.futures.ProcessPoolExecutor` now raises a `RuntimeError` if called during interpreter shutdown. (Contributed by Mark Nemec in [bpo-33097](#).)
- The `configparser.ConfigParser` constructor now uses `read_dict()` to process the default values, making its behavior consistent with the rest of the parser. Non-string keys and values in the defaults dictionary are now being implicitly converted to strings. (Contributed by James Tocknell in [bpo-23835](#).)

- Several undocumented internal imports were removed. One example is that `os.errno` is no longer available; use `import errno` directly instead. Note that such undocumented internal imports may be removed any time without notice, even in micro version releases.

17.3 Changes in the C API

The function `PySlice_GetIndicesEx()` is considered unsafe for resizable sequences. If the slice indices are not instances of `int`, but objects that implement the `__index__()` method, the sequence can be resized after passing its length to `PySlice_GetIndicesEx()`. This can lead to returning indices out of the length of the sequence. For avoiding possible problems use new functions `PySlice_Unpack()` and `PySlice_AdjustIndices()`. (Contributed by Serhiy Storchaka in [bpo-27867](#).)

17.4 Alterações de bytecode do CPython

There are two new opcodes: `LOAD_METHOD` and `CALL_METHOD`. (Contributed by Yury Selivanov and INADA Naoki in [bpo-26110](#).)

The `STORE_ANNOTATION` opcode has been removed. (Contributed by Mark Shannon in [bpo-32550](#).)

17.5 Windows-only Changes

The file used to override `sys.path` is now called `<python-executable>._pth` instead of `'sys.path'`. See [finding_modules](#) for more information. (Contributed by Steve Dower in [bpo-28137](#).)

17.6 Other CPython implementation changes

In preparation for potential future changes to the public CPython runtime initialization API (see [PEP 432](#) for an initial, but somewhat outdated, draft), CPython's internal startup and configuration management logic has been significantly refactored. While these updates are intended to be entirely transparent to both embedding applications and users of the regular CPython CLI, they're being mentioned here as the refactoring changes the internal order of various operations during interpreter startup, and hence may uncover previously latent defects, either in embedding applications, or in CPython itself. (Initially contributed by Nick Coghlan and Eric Snow as part of [bpo-22257](#), and further updated by Nick, Eric, and Victor Stinner in a number of other issues). Some known details affected:

- `PySys_AddWarnOptionUnicode()` is not currently usable by embedding applications due to the requirement to create a Unicode object prior to calling `Py_Initialize`. Use `PySys_AddWarnOption()` instead.
- warnings filters added by an embedding application with `PySys_AddWarnOption()` should now more consistently take precedence over the default filters set by the interpreter

Due to changes in the way the default warnings filters are configured, setting `Py_BytesWarningFlag` to a value greater than one is no longer sufficient to both emit `BytesWarning` messages and have them converted to exceptions. Instead, the flag must be set (to cause the warnings to be emitted in the first place), and an explicit `error::BytesWarning` warnings filter added to convert them to exceptions.

Due to a change in the way docstrings are handled by the compiler, the implicit `return None` in a function body consisting solely of a docstring is now marked as occurring on the same line as the docstring, not on the function's header line.

The current exception state has been moved from the frame object to the co-routine. This simplified the interpreter and fixed a couple of obscure bugs caused by having swap exception state when entering or exiting a generator. (Contributed by Mark Shannon in [bpo-25612](#).)

18 Notable changes in Python 3.7.1

Starting in 3.7.1, `Py_Initialize()` now consistently reads and respects all of the same environment settings as `Py_Main()` (in earlier Python versions, it respected an ill-defined subset of those environment variables, while in Python 3.7.0 it didn't read any of them due to [bpo-34247](#)). If this behavior is unwanted, set `Py_IgnoreEnvironmentFlag` to 1 before calling `Py_Initialize()`.

In 3.7.1 the C API for Context Variables was updated to use `PyObject` pointers. See also [bpo-34762](#).

`xml.dom.minidom` and `xml.sax` modules no longer process external entities by default. See also [bpo-17239](#).

In 3.7.1 the `tokenize` module now implicitly emits a `NEWLINE` token when provided with input that does not have a trailing new line. This behavior now matches what the C tokenizer does internally. (Contributed by Ammar Askar in [bpo-33899](#).)

19 Notable changes in Python 3.7.2

In 3.7.2, `venv` on Windows no longer copies the original binaries, but creates redirector scripts named `python.exe` and `pythonw.exe` instead. This resolves a long standing issue where all virtual environments would have to be upgraded or recreated with each Python update. However, note that this release will still require recreation of virtual environments in order to get the new scripts.

20 Notable changes in Python 3.7.6

Devido a significativas preocupações de segurança, o parâmetro `reuse_address` de `asyncio.loop.create_datagram_endpoint()` não é mais suportado. Isso ocorre devido ao comportamento da opção de soquete `SO_REUSEADDR` no UDP. Para mais detalhes, consulte a documentação de `loop.create_datagram_endpoint()`. (Contribuição de Kyle Stanley, Antoine Pitrou e Yuri Selivanov em [bpo-37228](#).)

21 Notable changes in Python 3.7.10

Earlier Python versions allowed using both `;` and `&` as query parameter separators in `urllib.parse.parse_qs()` and `urllib.parse.parse_qsl()`. Due to security concerns, and to conform with newer W3C recommendations, this has been changed to allow only a single separator key, with `&` as the default. This change also affects `cgi.parse()` and `cgi.parse_multipart()` as they use the affected functions internally. For more details, please see their respective documentation. (Contributed by Adam Goldschmidt, Senthil Kumaran and Ken Jin in [bpo-42967](#).)

22 Notable changes in Python 3.7.11

A security fix alters the `ftplib.FTP` behavior to not trust the IPv4 address sent from the remote server when setting up a passive data channel. We reuse the ftp server IP address instead. For unusual code requiring the old behavior, set a `trust_server_pasv_ipv4_address` attribute on your FTP instance to `True`. (See [bpo-43285](#))

The presence of newline or tab characters in parts of a URL allows for some forms of attacks. Following the WHATWG specification that updates RFC 3986, ASCII newline `\n`, `\r` and tab `\t` characters are stripped from the URL by the parser `urllib.parse()` preventing such attacks. The removal characters are controlled by a new module level variable `urllib.parse._UNSAFE_URL_BYTES_TO_REMOVE`. (See [bpo-43882](#))

23 Notable security feature in 3.7.14

Converting between `int` and `str` in bases other than 2 (binary), 4, 8 (octal), 16 (hexadecimal), or 32 such as base 10 (decimal) now raises a `ValueError` if the number of digits in string form is above a limit to avoid potential denial of service attacks due to the algorithmic complexity. This is a mitigation for [CVE-2020-10735](#). This limit can be configured or disabled by environment variable, command line flag, or `sys` APIs. See the integer string conversion length limitation documentation. The default limit is 4300 digits in string form.

Índice

P

Propostas Estendidas Python

- PEP 11, [6](#)
- PEP 432, [35](#)
- PEP 479, [32](#)
- PEP 484, [9](#)
- PEP 526, [5](#)
- PEP 538, [6](#)
- PEP 539, [7](#)
- PEP 540, [6](#), [7](#)
- PEP 545, [9](#)
- PEP 552, [9](#)
- PEP 553, [7](#)
- PEP 557, [11](#)
- PEP 560, [9](#), [22](#)
- PEP 562, [7](#)
- PEP 563, [5](#)
- PEP 564, [8](#), [21](#)
- PEP 565, [8](#)
- PEP 567, [10](#), [11](#)
- PEP 3107, [5](#)

- PYTHONBREAKPOINT, [7](#)
- PYTHONCOERCECLOCALE, [6](#)
- PYTHONDEVMODE, [10](#)
- PYTHONPROFILEIMPORTTIME, [10](#)
- PYTHONUTF8, [6](#)
- PYTHONWARNINGS, [23](#)

R

RFC

- RFC 2396, [23](#)
- RFC 3986, [23](#)

S

- SOURCE_DATE_EPOCH, [19](#)

V

variável de ambiente

- PYTHONBREAKPOINT, [7](#)
- PYTHONCOERCECLOCALE, [6](#)
- PYTHONDEVMODE, [10](#)
- PYTHONPROFILEIMPORTTIME, [10](#)
- PYTHONUTF8, [6](#)
- PYTHONWARNINGS, [23](#)
- SOURCE_DATE_EPOCH, [19](#)