

What's New In Python 3.1

Author: Raymond Hettinger

This article explains the new features in Python 3.1, compared to 3.0.

PEP 372: Ordered Dictionaries

Regular Python dictionaries iterate over key/value pairs in arbitrary order. Over the years, a number of authors have written alternative implementations that remember the order that the keys were originally inserted. Based on the experiences from those implementations, a new `class: collections.OrderedDict` class has been introduced.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 55); [backlink](#)

Unknown interpreted text role "class".

The OrderedDict API is substantially the same as regular dictionaries but will iterate over keys and values in a guaranteed order depending on when a key was first inserted. If a new entry overwrites an existing entry, the original insertion position is left unchanged. Deleting an entry and reinserting it will move it to the end.

The standard library now supports use of ordered dictionaries in several modules. The `mod: configparser` module uses them by default. This lets configuration files be read, modified, and then written back in their original order. The `asdict()` method for `func: collections.namedtuple` now returns an ordered dictionary with the values appearing in the same order as the underlying tuple indices. The `mod: json` module is being built-out with an `object_pairs_hook` to allow OrderedDicts to be built by the decoder. Support was also added for third-party tools like [PyYAML](#).

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 67); [backlink](#)

Unknown interpreted text role "mod".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 67); [backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 67); [backlink](#)

Unknown interpreted text role "mod".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 76)

Unknown directive type "seealso".

.. seealso::

:pep: `372` - Ordered Dictionaries
PEP written by Armin Ronacher and Raymond Hettinger. Implementation
written by Raymond Hettinger.

PEP 378: Format Specifier for Thousands Separator

The built-in `func: format` function and the `meth: str.format` method use a mini-language that now includes a simple, non-locale aware way to format a number with a thousands separator. That provides a way to humanize a program's output, improving its professional appearance and readability:

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 86); [backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 86); [backlink](#)

Unknown interpreted text role "meth".

```
>>> format(1234567, ',d')
'1,234,567'
>>> format(1234567.89, ',.2f')
'1,234,567.89'
>>> format(12345.6 + 8901234.12j, ',f')
'12,345.600000+8,901,234.120000j'
>>> format(Decimal('1234567.89'), ',f')
'1,234,567.89'
```

The supported types are :class:`int`, :class:`float`, :class:`complex` and :class:`decimal.Decimal`.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 100); [backlink](#)

Unknown interpreted text role "class".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 100); [backlink](#)

Unknown interpreted text role "class".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 100); [backlink](#)

Unknown interpreted text role "class".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 100); [backlink](#)

Unknown interpreted text role "class".

Discussions are underway about how to specify alternative separators like dots, spaces, apostrophes, or underscores. Locale-aware applications should use the existing *n* format specifier which already has some support for thousands separators.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 108)

Unknown directive type "seealso".

```
.. seealso::

   :pep:`378` - Format Specifier for Thousands Separator
   PEP written by Raymond Hettinger and implemented by Eric Smith and
   Mark Dickinson.
```

Other Language Changes

Some smaller changes made to the core Python language are:

- Directories and zip archives containing a `:file:`__main__.py`` file can now be executed directly by passing their name to the interpreter. The directory/zipfile is automatically inserted as the first entry in `sys.path`. (Suggestion and initial patch by Andy Chur; revised patch by Phillip J. Eby and Nick Coghlan; [issue:`1739468`](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 120); [backlink](#)

Unknown interpreted text role "file".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 120); [backlink](#)

Unknown interpreted text role "issue".

- The `:func:`int`` type gained a `bit_length` method that returns the number of bits necessary to represent its argument in binary:

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 126);
[backlink](#)

Unknown interpreted text role "func".

```
>>> n = 37
>>> bin(37)
'0b100101'
>>> n.bit_length()
6
>>> n = 2**123-1
>>> n.bit_length()
123
>>> (n+1).bit_length()
124
```

(Contributed by Fredrik Johansson, Victor Stinner, Raymond Hettinger, and Mark Dickinson; [issue:3439](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 140);
[backlink](#)

Unknown interpreted text role "issue".

- The fields in `:func:`format`` strings can now be automatically numbered:

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 143);
[backlink](#)

Unknown interpreted text role "func".

```
>>> 'Sir {} of {}'.format('Gallahad', 'Camelot')
'Sir Gallahad of Camelot'
```

Formerly, the string would have required numbered fields such as: `'Sir {0} of {1}'`.

(Contributed by Eric Smith; [issue:5237](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 152);
[backlink](#)

Unknown interpreted text role "issue".

- The `:func:`string.maketrans`` function is deprecated and is replaced by new static methods, `:meth:`bytes.maketrans`` and `:meth:`bytearray.maketrans``. This change solves the confusion around which types were supported by the `:mod:`string`` module. Now, `:class:`str``, `:class:`bytes``, and `:class:`bytearray`` each have their own `maketrans` and `translate` methods with intermediate translation tables of the appropriate type.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 154);
[backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 154);
[backlink](#)

Unknown interpreted text role "meth".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-

resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 154);
[backlink](#)

Unknown interpreted text role "meth".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 154);
[backlink](#)

Unknown interpreted text role "mod".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 154);
[backlink](#)

Unknown interpreted text role "class".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 154);
[backlink](#)

Unknown interpreted text role "class".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 154);
[backlink](#)

Unknown interpreted text role "class".

(Contributed by Georg Brandl; [issue: 5675](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 161);
[backlink](#)

Unknown interpreted text role "issue".

- The syntax of the `:keyword:with` statement now allows multiple context managers in a single statement:

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 163);
[backlink](#)

Unknown interpreted text role "keyword".

```
>>> with open('mylog.txt') as infile, open('a.out', 'w') as outfile:
...     for line in infile:
...         if '<critical>' in line:
...             outfile.write(line)
```

With the new syntax, the `:func:contextlib.nested` function is no longer needed and is now deprecated.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 171);
[backlink](#)

Unknown interpreted text role "func".

(Contributed by Georg Brandl and Mattias Brändström; [appspot issue 53094](#).)

- `round(x, n)` now returns an integer if `x` is an integer. Previously it returned a float:

```
>>> round(1123, -2)
1100
```

(Contributed by Mark Dickinson; [issue: 4707](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-

resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 183);
[backlink](#)

Unknown interpreted text role "issue".

- Python now uses David Gay's algorithm for finding the shortest floating point representation that doesn't change its value. This should help mitigate some of the confusion surrounding binary floating point numbers.

The significance is easily seen with a number like 1.1 which does not have an exact equivalent in binary floating point. Since there is no exact equivalent, an expression like `float('1.1')` evaluates to the nearest representable value which is `0x1.199999999999ap+0` in hex or `1.100000000000000088817841970012523233890533447265625` in decimal. That nearest value was and still is used in subsequent floating point calculations.

What is new is how the number gets displayed. Formerly, Python used a simple approach. The value of `repr(1.1)` was computed as `format(1.1, '.17g')` which evaluated to `'1.1000000000000001'`. The advantage of using 17 digits was that it relied on IEEE-754 guarantees to assure that `eval(repr(1.1))` would round-trip exactly to its original value. The disadvantage is that many people found the output to be confusing (mistaking intrinsic limitations of binary floating point representation as being a problem with Python itself).

The new algorithm for `repr(1.1)` is smarter and returns `'1.1'`. Effectively, it searches all equivalent string representations (ones that get stored with the same underlying float value) and returns the shortest representation.

The new algorithm tends to emit cleaner representations when possible, but it does not change the underlying values. So, it is still the case that `1.1 + 2.2 != 3.3` even though the representations may suggest otherwise.

The new algorithm depends on certain features in the underlying floating point implementation. If the required features are not found, the old algorithm will continue to be used. Also, the text pickle protocols assure cross-platform portability by using the old algorithm.

(Contributed by Eric Smith and Mark Dickinson; :issue:`1580`)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 221);
[backlink](#)

Unknown interpreted text role "issue".

New, Improved, and Deprecated Modules

- Added a `:class:`collections.Counter`` class to support convenient counting of unique items in a sequence or iterable:

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 226);
[backlink](#)

Unknown interpreted text role "class".

```
>>> Counter(['red', 'blue', 'red', 'green', 'blue', 'blue'])
Counter({'blue': 3, 'red': 2, 'green': 1})
```

(Contributed by Raymond Hettinger; :issue:`1696199`.)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 232);
[backlink](#)

Unknown interpreted text role "issue".

- Added a new module, `:mod:`tkinter.ttk`` for access to the Tk themed widget set. The basic idea of `ttk` is to separate, to the extent possible, the code implementing a widget's behavior from the code implementing its appearance.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 234);
[backlink](#)

Unknown interpreted text role "mod".

(Contributed by Guilherme Polo; :issue:`2983`.)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-

resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 238);
[backlink](#)

Unknown interpreted text role "issue".

- The `:class:`gzip.GzipFile`` and `:class:`bz2.BZ2File`` classes now support the context management protocol:

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 240);
[backlink](#)

Unknown interpreted text role "class".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 240);
[backlink](#)

Unknown interpreted text role "class".

```
>>> # Automatically close file after writing
>>> with gzip.GzipFile(filename, "wb") as f:
...     f.write(b"xxx")
```

(Contributed by Antoine Pitrou.)

- The `:mod:`decimal`` module now supports methods for creating a decimal object from a binary `:class:`float``. The conversion is exact but can sometimes be surprising:

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 249);
[backlink](#)

Unknown interpreted text role "mod".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 249);
[backlink](#)

Unknown interpreted text role "class".

```
>>> Decimal.from_float(1.1)
Decimal('1.1000000000000000088817841970012523233890533447265625')
```

The long decimal result shows the actual binary fraction being stored for *1.1*. The fraction has many digits because *1.1* cannot be exactly represented in binary.

(Contributed by Raymond Hettinger and Mark Dickinson.)

- The `:mod:`itertools`` module grew two new functions. The `:func:`itertools.combinations_with_replacement`` function is one of four for generating combinatorics including permutations and Cartesian products. The `:func:`itertools.compress`` function mimics its namesake from APL. Also, the existing `:func:`itertools.count`` function now has an optional *step* argument and can accept any type of counting sequence including `:class:`fractions.Fraction`` and `:class:`decimal.Decimal``:

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 262);
[backlink](#)

Unknown interpreted text role "mod".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 262);
[backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 262);
[backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 262);
[backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 262);
[backlink](#)

Unknown interpreted text role "class".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 262);
[backlink](#)

Unknown interpreted text role "class".

```
>>> [p+q for p,q in combinations_with_replacement('LOVE', 2)]
['LL', 'LO', 'LV', 'LE', 'OO', 'OV', 'OE', 'VV', 'VE', 'EE']

>>> list(compress(data=range(10), selectors=[0,0,1,1,0,1,0,1,0,0]))
[2, 3, 5, 7]

>>> c = count(start=Fraction(1,2), step=Fraction(1,6))
>>> [next(c), next(c), next(c)]
[Fraction(1, 2), Fraction(2, 3), Fraction(5, 6), Fraction(1, 1)]
```

(Contributed by Raymond Hettinger.)

- `:func:`collections.namedtuple`` now supports a keyword argument *rename* which lets invalid fieldnames be automatically converted to positional names in the form `_0`, `_1`, etc. This is useful when the field names are being created by an external source such as a CSV header, SQL field list, or user input:

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 283);
[backlink](#)

Unknown interpreted text role "func".

```
>>> query = input()
SELECT region, dept, count(*) FROM main GROUPBY region, dept

>>> cursor.execute(query)
>>> query_fields = [desc[0] for desc in cursor.description]
>>> UserQuery = namedtuple('UserQuery', query_fields, rename=True)
>>> pprint.pprint([UserQuery(*row) for row in cursor])
[UserQuery(region='South', dept='Shipping', _2=185),
 UserQuery(region='North', dept='Accounting', _2=37),
 UserQuery(region='West', dept='Sales', _2=419)]
```

(Contributed by Raymond Hettinger; [issue`1818`](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 300);
[backlink](#)

Unknown interpreted text role "issue".

- The `:func:`re.sub``, `:func:`re.subn`` and `:func:`re.split`` functions now accept a `flags` parameter.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 302);
[backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 302); [backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 302); [backlink](#)

Unknown interpreted text role "func".

(Contributed by Gregory Smith.)

- The `mod:logging` module now implements a simple `class:logging.NullHandler` class for applications that are not using logging but are calling library code that does. Setting-up a null handler will suppress spurious warnings such as "No handlers could be found for logger foo".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 307); [backlink](#)

Unknown interpreted text role "mod".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 307); [backlink](#)

Unknown interpreted text role "class".

```
>>> h = logging.NullHandler()
>>> logging.getLogger("foo").addHandler(h)
```

(Contributed by Vinay Sajip; `issue:4384`).

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 315); [backlink](#)

Unknown interpreted text role "issue".

- The `mod:rumpy` module which supports the `-m` command line switch now supports the execution of packages by looking for and executing a `__main__` submodule when a package name is supplied.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 317); [backlink](#)

Unknown interpreted text role "mod".

(Contributed by Andi Vajda; `issue:4195`).

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 321); [backlink](#)

Unknown interpreted text role "issue".

- The `mod:pdb` module can now access and display source code loaded via `mod:zipimport` (or any other conformant [PEP 302](#) loader).

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 323); [backlink](#)

Unknown interpreted text role "mod".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\[cpython-main] [Doc] [whatsnew] 3.1.rst, line 323); [backlink](#)

Unknown interpreted text role "mod".

(Contributed by Alexander Belopolsky; [:issue:`4201`](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\[cpython-main] [Doc] [whatsnew] 3.1.rst, line 326); [backlink](#)

Unknown interpreted text role "issue".

- [:class:`functools.partial`](#) objects can now be pickled.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\[cpython-main] [Doc] [whatsnew] 3.1.rst, line 328); [backlink](#)

Unknown interpreted text role "class".

(Suggested by Antoine Pitrou and Jesse Noller. Implemented by Jack Diederich; [:issue:`5228`](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\[cpython-main] [Doc] [whatsnew] 3.1.rst, line 330); [backlink](#)

Unknown interpreted text role "issue".

- Add [:mod:`pydoc`](#) help topics for symbols so that `help('')` works as expected in the interactive environment.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\[cpython-main] [Doc] [whatsnew] 3.1.rst, line 333); [backlink](#)

Unknown interpreted text role "mod".

(Contributed by David Laban; [:issue:`4739`](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\[cpython-main] [Doc] [whatsnew] 3.1.rst, line 336); [backlink](#)

Unknown interpreted text role "issue".

- The [:mod:`unittest`](#) module now supports skipping individual tests or classes of tests. And it supports marking a test as an expected failure, a test that is known to be broken, but shouldn't be counted as a failure on a `TestResult`:

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\[cpython-main] [Doc] [whatsnew] 3.1.rst, line 338); [backlink](#)

Unknown interpreted text role "mod".

```
class TestGizmo(unittest.TestCase):

    @unittest.skipUnless(sys.platform.startswith("win"), "requires Windows")
    def test_gizmo_on_windows(self):
        ...

    @unittest.expectedFailure
    def test_gizmo_without_required_library(self):
        ...
```

Also, tests for exceptions have been builtout to work with context managers using the [:keyword:`with`](#) statement:

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 353); [backlink](#)

Unknown interpreted text role "keyword".

```
def test_division_by_zero(self):
    with self.assertRaises(ZeroDivisionError):
        x / 0
```

In addition, several new assertion methods were added including `:func:`assertSetEqual``, `:func:`assertDictEqual``, `:func:`assertDictContainsSubset``, `:func:`assertListEqual``, `:func:`assertTupleEqual``, `:func:`assertSequenceEqual``, `:func:`assertRaisesRegexp``, `:func:`assertIsNone``, and `:func:`assertIsNotNone``.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 360); [backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 360); [backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 360); [backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 360); [backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 360); [backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 360); [backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 360); [backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 360); [backlink](#)

Unknown interpreted text role "func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 360); [backlink](#)

Unknown interpreted text role "func".

(Contributed by Benjamin Peterson and Antoine Pitrou.)

- The `mod:io` module has three new constants for the `meth:seek` method `data:SEEK_SET`, `data:SEEK_CUR`, and `data:SEEK_END`.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\cpython-main [Doc] [whatsnew] 3.1.rst, line 369); [backlink](#)

Unknown interpreted text role "mod".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\cpython-main [Doc] [whatsnew] 3.1.rst, line 369); [backlink](#)

Unknown interpreted text role "meth".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\cpython-main [Doc] [whatsnew] 3.1.rst, line 369); [backlink](#)

Unknown interpreted text role "data".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\cpython-main [Doc] [whatsnew] 3.1.rst, line 369); [backlink](#)

Unknown interpreted text role "data".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\cpython-main [Doc] [whatsnew] 3.1.rst, line 369); [backlink](#)

Unknown interpreted text role "data".

- The `attr:sys.version_info` tuple is now a named tuple:

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\cpython-main [Doc] [whatsnew] 3.1.rst, line 372); [backlink](#)

Unknown interpreted text role "attr".

```
>>> sys.version_info
sys.version_info(major=3, minor=1, micro=0, releaselevel='alpha', serial=2)
```

(Contributed by Ross Light; [issue:4285](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\cpython-main [Doc] [whatsnew] 3.1.rst, line 377); [backlink](#)

Unknown interpreted text role "issue".

- The `mod:ntplib` and `mod:imaplib` modules now support IPv6.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\cpython-main [Doc] [whatsnew] 3.1.rst, line 379); [backlink](#)

Unknown interpreted text role "mod".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\cpython-main [Doc] [whatsnew] 3.1.rst, line 379);

[backlink](#)

Unknown interpreted text role "mod".

(Contributed by Derek Morr; [:issue:`1655`](#) and [:issue:`1664`](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 381);
[backlink](#)

Unknown interpreted text role "issue".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 381);
[backlink](#)

Unknown interpreted text role "issue".

- The `mod:`pickle`` module has been adapted for better interoperability with Python 2.x when used with protocol 2 or lower. The reorganization of the standard library changed the formal reference for many objects. For example, `__builtin__.set` in Python 2 is called `builtins.set` in Python 3. This change confounded efforts to share data between different versions of Python. But now when protocol 2 or lower is selected, the pickler will automatically use the old Python 2 names for both loading and dumping. This remapping is turned-on by default but can be disabled with the `fix_imports` option:

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 383);
[backlink](#)

Unknown interpreted text role "mod".

```
>>> s = {1, 2, 3}
>>> pickle.dumps(s, protocol=0)
b'c__builtin__\nset\np0\n((lp1\nL1L\naL2L\naL3L\natp2\nRp3\n.'
>>> pickle.dumps(s, protocol=0, fix_imports=False)
b'cbuiltins\nset\np0\n((lp1\nL1L\naL2L\naL3L\natp2\nRp3\n.'
```

An unfortunate but unavoidable side-effect of this change is that protocol 2 pickles produced by Python 3.1 won't be readable with Python 3.0. The latest pickle protocol, protocol 3, should be used when migrating data between Python 3.x implementations, as it doesn't attempt to remain compatible with Python 2.x.

(Contributed by Alexandre Vassalotti and Antoine Pitrou, [:issue:`6137`](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 405);
[backlink](#)

Unknown interpreted text role "issue".

- A new module, `mod:`importlib`` was added. It provides a complete, portable, pure Python reference implementation of the `keyword:`import`` statement and its counterpart, the `func:`__import__`` function. It represents a substantial step forward in documenting and defining the actions that take place during imports.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 407);
[backlink](#)

Unknown interpreted text role "mod".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 407);
[backlink](#)

Unknown interpreted text role "keyword".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 407);
[backlink](#)

Unknown interpreted text role "func".

(Contributed by Brett Cannon.)

Optimizations

Major performance enhancements have been added:

- The new I/O library (as defined in [PEP 3116](#)) was mostly written in Python and quickly proved to be a problematic bottleneck in Python 3.0. In Python 3.1, the I/O library has been entirely rewritten in C and is 2 to 20 times faster depending on the task at hand. The pure Python version is still available for experimentation purposes through the `_pyio` module.

(Contributed by Amaury Forgeot d'Arc and Antoine Pitrou.)

- Added a heuristic so that tuples and dicts containing only untrackable objects are not tracked by the garbage collector. This can reduce the size of collections and therefore the garbage collection overhead on long-running programs, depending on their particular use of datatypes.

(Contributed by Antoine Pitrou, [:issue:`4688`](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 434); [backlink](#)

Unknown interpreted text role "issue".

- Enabling a configure option named `--with-computed-gotos` on compilers that support it (notably: gcc, SunPro, icc), the bytecode evaluation loop is compiled with a new dispatch mechanism which gives speedups of up to 20%, depending on the system, the compiler, and the benchmark.

(Contributed by Antoine Pitrou along with a number of other participants, [:issue:`4753`](#)).

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 442); [backlink](#)

Unknown interpreted text role "issue".

- The decoding of UTF-8, UTF-16 and LATIN-1 is now two to four times faster.

(Contributed by Antoine Pitrou and Amaury Forgeot d'Arc, [:issue:`4868`](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 448); [backlink](#)

Unknown interpreted text role "issue".

- The `mod:json` module now has a C extension to substantially improve its performance. In addition, the API was modified so that json works only with `:class:`str``, not with `:class:`bytes``. That change makes the module closely match the [JSON specification](#) which is defined in terms of Unicode.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 450); [backlink](#)

Unknown interpreted text role "mod".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 450); [backlink](#)

Unknown interpreted text role "class".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 450); [backlink](#)

Unknown interpreted text role "class".

(Contributed by Bob Ippolito and converted to Py3.1 by Antoine Pitrou and Benjamin Peterson; [issue: 4136](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 456); [backlink](#)

Unknown interpreted text role "issue".

- Unpickling now interns the attribute names of pickled objects. This saves memory and allows pickles to be smaller.

(Contributed by Jake McGuire and Antoine Pitrou; [issue: 5084](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 462); [backlink](#)

Unknown interpreted text role "issue".

IDLE

- IDLE's format menu now provides an option to strip trailing whitespace from a source file.

(Contributed by Roger D. Serwy; [issue: 5150](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 470); [backlink](#)

Unknown interpreted text role "issue".

Build and C API Changes

Changes to Python's build process and to the C API include:

- Integers are now stored internally either in base 2^{15} or in base 2^{30} , the base being determined at build time. Previously, they were always stored in base 2^{15} . Using base 2^{30} gives significant performance improvements on 64-bit machines, but benchmark results on 32-bit machines have been mixed. Therefore, the default is to use base 2^{30} on 64-bit machines and base 2^{15} on 32-bit machines; on Unix, there's a new configure option `--enable-big-digits` that can be used to override this default.

Apart from the performance improvements this change should be invisible to end users, with one exception: for testing and debugging purposes there's a new `attr:sys.int_info` that provides information about the internal format, giving the number of bits per digit and the size in bytes of the C type used to store each digit:

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 486); [backlink](#)

Unknown interpreted text role "attr".

```
>>> import sys
>>> sys.int_info
sys.int_info(bits_per_digit=30, sizeof_digit=4)
```

(Contributed by Mark Dickinson; [issue: 4258](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 496); [backlink](#)

Unknown interpreted text role "issue".

- The `func:PyLong_AsUnsignedLongLong()` function now handles a negative *pylong* by raising `exc:OverflowError` instead of `exc:TypeError`.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 498);

[backlink](#)

Unknown interpreted text role "c:func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 498);
[backlink](#)

Unknown interpreted text role "exc".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 498);
[backlink](#)

Unknown interpreted text role "exc".

(Contributed by Mark Dickinson and Lisandro Dalcin; [issue:5175](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 501);
[backlink](#)

Unknown interpreted text role "issue".

- Deprecated `c:func:PyNumber_Int`. Use `c:func:PyNumber_Long` instead.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 503);
[backlink](#)

Unknown interpreted text role "c:func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 503);
[backlink](#)

Unknown interpreted text role "c:func".

(Contributed by Mark Dickinson; [issue:4910](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 505);
[backlink](#)

Unknown interpreted text role "issue".

- Added a new `c:func:PyOS_string_to_double` function to replace the deprecated functions `c:func:PyOS_ascii_strtod` and `c:func:PyOS_ascii_atof`.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 507);
[backlink](#)

Unknown interpreted text role "c:func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 507);
[backlink](#)

Unknown interpreted text role "c:func".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\ [cpython-main] [Doc] [whatsnew] 3.1.rst, line 507);
[backlink](#)

Unknown interpreted text role "c:func".

(Contributed by Mark Dickinson; [:issue:'5914'](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\[cpython-main] [Doc] [whatsnew] 3.1.rst, line 510); [backlink](#)

Unknown interpreted text role "issue".

- Added `:xtype:'PyCapsule'` as a replacement for the `:xtype:'PyCObject'` API. The principal difference is that the new type has a well defined interface for passing typing safety information and a less complicated signature for calling a destructor. The old type had a problematic API and is now deprecated.

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\[cpython-main] [Doc] [whatsnew] 3.1.rst, line 512); [backlink](#)

Unknown interpreted text role "c:type".

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\[cpython-main] [Doc] [whatsnew] 3.1.rst, line 512); [backlink](#)

Unknown interpreted text role "c:type".

(Contributed by Larry Hastings; [:issue:'5630'](#).)

System Message: ERROR/3 (D:\onboarding-resources\sample-onboarding-resources\cpython-main\Doc\whatsnew\[cpython-main] [Doc] [whatsnew] 3.1.rst, line 518); [backlink](#)

Unknown interpreted text role "issue".

Porting to Python 3.1

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

- The new floating point string representations can break existing doctests. For example:

```
def e():
    '''Compute the base of natural logarithms.

    >>> e()
    2.7182818284590451

    '''
    return sum(1/math.factorial(x) for x in reversed(range(30)))

doctest.testmod()

*****
Failed example:
  e()
Expected:
  2.7182818284590451
Got:
  2.718281828459045
*****
```

- The automatic name remapping in the pickle module for protocol 2 or lower can make Python 3.1 pickles unreadable in Python 3.0. One solution is to use protocol 3. Another solution is to set the `fix_imports` option to `False`. See the discussion above for more details.