8.3. `collections` — High-performance container datatypes

New in version 2.4.

Source code: Lib/collections.py and Lib/_abcoll.py

This module implements specialized container datatypes providing alternatives to Python's general purpose built-in containers, `dict`, `list`, `set`, and `tuple`.

`namedtuple()`	factory function for creating tuple subclasses with named fields	*New in version 2.6.*
`deque`	list-like container with fast appends and pops on either end	*New in version 2.4.*
`Counter`	dict subclass for counting hashable objects	*New in version 2.7.*
`OrderedDict`	dict subclass that remembers the order entries were added	*New in version 2.7.*
`defaultdict`	dict subclass that calls a factory function to supply missing values	*New in version 2.5.*

In addition to the concrete container classes, the collections module provides abstract base classes that can be used to test whether a class provides a particular interface, for example, whether it is hashable or a mapping.

8.3.1. `Counter` objects

A counter tool is provided to support convenient and rapid tallies. For example:

```
>>> # Tally occurrences of words in a list
>>> cnt = Counter()
>>> for word in ['red', 'blue', 'red', 'green', 'blue', 'blue']:
```

```
...     cnt[word] += 1
>>> cnt
Counter({'blue': 3, 'red': 2, 'green': 1})

>>> # Find the ten most common words in Hamlet
>>> import re
>>> words = re.findall(r'\w+', open('hamlet.txt').read().lower())
>>> Counter(words).most_common(10)
[('the', 1143), ('and', 966), ('to', 762), ('of', 669), ('i', 631),
 ('you', 554),  ('a', 546), ('my', 514), ('hamlet', 471), ('in', 451)]
```

class `collections.`**`Counter`**([*iterable-or-mapping*])

A `Counter` is a `dict` subclass for counting hashable objects. It is an unordered collection where elements are stored as dictionary keys and their counts are stored as dictionary values. Counts are allowed to be any integer value including zero or negative counts. The `Counter` class is similar to bags or multisets in other languages.

Elements are counted from an *iterable* or initialized from another *mapping* (or counter):

```
>>> c = Counter()                           # a new, empty counter
>>> c = Counter('gallahad')                 # a new counter from an iterable
>>> c = Counter({'red': 4, 'blue': 2})      # a new counter from a mapping
>>> c = Counter(cats=4, dogs=8)             # a new counter from keyword args
```

Counter objects have a dictionary interface except that they return a zero count for missing items instead of raising a `KeyError`:

```
>>> c = Counter(['eggs', 'ham'])
>>> c['bacon']                              # count of a missing element is zero
0
```

Setting a count to zero does not remove an element from a counter. Use `del` to remove it entirely:

```
>>> c['sausage'] = 0                        # counter entry with a zero count
>>> del c['sausage']                        # del actually removes the entry
```

New in version 2.7.

Counter objects support three methods beyond those available for all dictionaries:

`elements`()

Return an iterator over elements repeating each as many times as its count. Elements are returned in arbitrary order. If an element's count is less than one, `elements()` will ignore it.

```
>>> c = Counter(a=4, b=2, c=0, d=-2)
>>> list(c.elements())
['a', 'a', 'a', 'a', 'b', 'b']
```

most_common([*n*])

Return a list of the *n* most common elements and their counts from the most common to the least. If *n* is omitted or `None`, `most_common()` returns *all* elements in the counter. Elements with equal counts are ordered arbitrarily:

```
>>> Counter('abracadabra').most_common(3)
[('a', 5), ('r', 2), ('b', 2)]
```

subtract([*iterable-or-mapping*])

Elements are subtracted from an *iterable* or from another *mapping* (or counter). Like `dict.update()` but subtracts counts instead of replacing them. Both inputs and outputs may be zero or negative.

```
>>> c = Counter(a=4, b=2, c=0, d=-2)
>>> d = Counter(a=1, b=2, c=3, d=4)
>>> c.subtract(d)
>>> c
Counter({'a': 3, 'b': 0, 'c': -3, 'd': -6})
```

The usual dictionary methods are available for `Counter` objects except for two which work differently for counters.

fromkeys(*iterable*)

This class method is not implemented for `Counter` objects.

update([*iterable-or-mapping*])

Elements are counted from an *iterable* or added-in from another *mapping* (or counter). Like `dict.update()` but adds counts instead of replacing them. Also, the *iterable* is expected to be a sequence of elements, not a sequence of `(key, value)` pairs.

Common patterns for working with `Counter` objects:

```
sum(c.values())                 # total of all counts
c.clear()                       # reset all counts
```

```
list(c)                         # list unique elements
set(c)                          # convert to a set
dict(c)                         # convert to a regular dictionary
c.items()                       # convert to a list of (elem, cnt) pairs
Counter(dict(list_of_pairs))    # convert from a list of (elem, cnt) pairs
c.most_common()[:-n-1:-1]       # n least common elements
c += Counter()                  # remove zero and negative counts
```

Several mathematical operations are provided for combining `Counter` objects to produce multisets (counters that have counts greater than zero). Addition and subtraction combine counters by adding or subtracting the counts of corresponding elements. Intersection and union return the minimum and maximum of corresponding counts. Each operation can accept inputs with signed counts, but the output will exclude results with counts of zero or less.

```
>>> c = Counter(a=3, b=1)
>>> d = Counter(a=1, b=2)
>>> c + d                       # add two counters together:  c[x] + d[x]
Counter({'a': 4, 'b': 3})
>>> c - d                       # subtract (keeping only positive counts)
Counter({'a': 2})
>>> c & d                       # intersection:  min(c[x], d[x])
Counter({'a': 1, 'b': 1})
>>> c | d                       # union:  max(c[x], d[x])
Counter({'a': 3, 'b': 2})
```

Note: Counters were primarily designed to work with positive integers to represent running counts; however, care was taken to not unnecessarily preclude use cases needing other types or negative values. To help with those use cases, this section documents the minimum range and type restrictions.

- The `Counter` class itself is a dictionary subclass with no restrictions on its keys and values. The values are intended to be numbers representing counts, but you *could* store anything in the value field.
- The `most_common()` method requires only that the values be orderable.
- For in-place operations such as `c[key] += 1`, the value type need only support addition and subtraction. So fractions, floats, and decimals would work and negative values are supported. The same is also true for `update()` and `subtract()` which allow negative and zero values for both inputs and outputs.
- The multiset methods are designed only for use cases with positive values. The inputs may be negative or zero, but only outputs with positive values are created. There are no type restrictions, but the value type needs to support addition, subtraction, and comparison.
- The `elements()` method requires integer counts. It ignores zero and negative counts.

See also:

- Counter class adapted for Python 2.5 and an early Bag recipe for Python 2.4.

  in Smalltalk.
- Wikipedia entry for Multisets.
- C++ multisets tutorial with examples.
- For mathematical operations on multisets and their use cases, see *Knuth, Donald. The Art of Computer Programming Volume II, Section 4.6.3, Exercise 19*.
- To enumerate all distinct multisets of a given size over a given set of elements, see `itertools.combinations_with_replacement()`.

    map(Counter, combinations_with_replacement('ABC', 2)) –> AA AB AC BB BC CC

8.3.2. `deque` objects

class `collections.`**deque**([*iterable*[, *maxlen*]])

Returns a new deque object initialized left-to-right (using `append()`) with data from *iterable*. If *iterable* is not specified, the new deque is empty.

Deques are a generalization of stacks and queues (the name is pronounced "deck" and is short for "double-ended queue"). Deques support thread-safe, memory efficient appends and pops from either side of the deque with approximately the same O(1) performance in either direction.

Though `list` objects support similar operations, they are optimized for fast fixed-length operations and incur O(n) memory movement costs for `pop(0)` and `insert(0, v)` operations which change both the size and position of the underlying data representation.

New in version 2.4.

If *maxlen* is not specified or is `None`, deques may grow to an arbitrary length. Otherwise, the deque is bounded to the specified maximum length. Once a bounded length deque is full, when new items are added, a corresponding number of items are discarded from the opposite end. Bounded length deques provide functionality similar to the `tail` filter in Unix. They are also useful for tracking transactions and other pools of data where only the most recent activity is of interest.

Changed in version 2.6: Added *maxlen* parameter.

Deque objects support the following methods:

append(*x*)

Add *x* to the right side of the deque.

appendleft(*x*)

Add *x* to the left side of the deque.

clear()

Remove all elements from the deque leaving it with length 0.

count(*x*)

Count the number of deque elements equal to *x*.

New in version 2.7.

extend(*iterable*)

Extend the right side of the deque by appending elements from the iterable argument.

extendleft(*iterable*)

Extend the left side of the deque by appending elements from *iterable*. Note, the series of left appends results in reversing the order of elements in the iterable argument.

pop()

Remove and return an element from the right side of the deque. If no elements are present, raises an `IndexError`.

popleft()

Remove and return an element from the left side of the deque. If no elements are present, raises an `IndexError`.

remove(*value*)

Removed the first occurrence of *value*. If not found, raises a `ValueError`.

New in version 2.5.

reverse()

Reverse the elements of the deque in-place and then return `None`.

New in version 2.7.

rotate(*n*)

Rotate the deque *n* steps to the right. If *n* is negative, rotate to the left. Rotating one step to the right is equivalent to: `d.appendleft(d.pop())`.

Deque objects also provide one read-only attribute:

maxlen

Maximum size of a deque or `None` if unbounded.

New in version 2.7.

In addition to the above, deques support iteration, pickling, `len(d)`, `reversed(d)`, `copy.copy(d)`, `copy.deepcopy(d)`, membership testing with the `in` operator, and subscript references such as `d[-1]`. Indexed access is O(1) at both ends but slows to O(n) in the middle. For fast random access, use lists instead.

Example:

```
>>> from collections import deque
>>> d = deque('ghi')                 # make a new deque with three items
>>> for elem in d:                   # iterate over the deque's elements
...     print elem.upper()
G
H
I

>>> d.append('j')                    # add a new entry to the right side
>>> d.appendleft('f')                # add a new entry to the left side
>>> d                                # show the representation of the deque
deque(['f', 'g', 'h', 'i', 'j'])

>>> d.pop()                          # return and remove the rightmost item
'j'
>>> d.popleft()                      # return and remove the leftmost item
'f'
>>> list(d)                          # list the contents of the deque
['g', 'h', 'i']
```

```
>>> d[0]                             # peek at leftmost item
'g'
>>> d[-1]                            # peek at rightmost item
'i'

>>> list(reversed(d))                # list the contents of a deque in reverse
['i', 'h', 'g']
>>> 'h' in d                         # search the deque
True
>>> d.extend('jkl')                  # add multiple elements at once
>>> d
deque(['g', 'h', 'i', 'j', 'k', 'l'])
>>> d.rotate(1)                      # right rotation
>>> d
deque(['l', 'g', 'h', 'i', 'j', 'k'])
>>> d.rotate(-1)                     # left rotation
>>> d
deque(['g', 'h', 'i', 'j', 'k', 'l'])

>>> deque(reversed(d))               # make a new deque in reverse order
deque(['l', 'k', 'j', 'i', 'h', 'g'])
>>> d.clear()                        # empty the deque
>>> d.pop()                          # cannot pop from an empty deque
Traceback (most recent call last):
  File "<pyshell#6>", line 1, in -toplevel-
    d.pop()
IndexError: pop from an empty deque

>>> d.extendleft('abc')              # extendleft() reverses the input order
>>> d
deque(['c', 'b', 'a'])
```

8.3.2.1. `deque` Recipes

This section shows various approaches to working with deques.

Bounded length deques provide functionality similar to the `tail` filter in Unix:

```
def tail(filename, n=10):
    'Return the last n lines of a file'
    return deque(open(filename), n)
```

Another approach to using deques is to maintain a sequence of recently added elements by appending to the right and popping to the left:

```
def moving_average(iterable, n=3):
    # moving_average([40, 30, 50, 46, 39, 44]) --> 40.0 42.0 45.0 43.0
    # http://en.wikipedia.org/wiki/Moving_average
    it = iter(iterable)
    d = deque(itertools.islice(it, n-1))
    d.appendleft(0)
    s = sum(d)
    for elem in it:
        s += elem - d.popleft()
        d.append(elem)
        yield s / float(n)
```

The `rotate()` method provides a way to implement `deque` slicing and deletion. For example, a pure Python implementation of `del d[n]` relies on the `rotate()` method to position elements to be popped:

```
def delete_nth(d, n):
    d.rotate(-n)
    d.popleft()
    d.rotate(n)
```

To implement `deque` slicing, use a similar approach applying `rotate()` to bring a target element to the left side of the deque. Remove old entries with `popleft()`, add new entries with `extend()`, and then reverse the rotation. With minor variations on that approach, it is easy to implement Forth style stack manipulations such as `dup`, `drop`, `swap`, `over`, `pick`, `rot`, and `roll`.

8.3.3. `defaultdict` objects

class `collections.`**`defaultdict`**([*default_factory*[, ...]])

Returns a new dictionary-like object. `defaultdict` is a subclass of the built-in `dict` class. It overrides one method and adds one writable instance variable. The remaining functionality is the same as for the `dict` class and is not documented here.

The first argument provides the initial value for the `default_factory` attribute; it defaults to `None`. All remaining arguments are treated the same as if they were passed to the `dict` constructor, including keyword arguments.

New in version 2.5.

`defaultdict` objects support the following method in addition to the standard `dict` operations:

`__missing__`(*key*)

If the `default_factory` attribute is `None`, this raises a `KeyError` exception with the *key* as argument.

If `default_factory` is not `None`, it is called without arguments to provide a default value for the given *key*, this value is inserted in the dictionary for the *key*, and returned.

If calling `default_factory` raises an exception this exception is propagated unchanged.

This method is called by the `__getitem__()` method of the `dict` class when the requested key is not found; whatever it returns or raises is then returned or raised by `__getitem__()`.

Note that `__missing__()` is *not* called for any operations besides `__getitem__()`. This means that `get()` will, like normal dictionaries, return `None` as a default rather than using `default_factory`.

`defaultdict` objects support the following instance variable:

`default_factory`

This attribute is used by the `__missing__()` method; it is initialized from the first argument to the constructor, if present, or to `None`, if absent.

8.3.3.1. `defaultdict` Examples

Using `list` as the `default_factory`, it is easy to group a sequence of key-value pairs into a dictionary of lists:

```
>>> s = [('yellow', 1), ('blue', 2), ('yellow', 3), ('blue', 4), ('red', 1)]
>>> d = defaultdict(list)
>>> for k, v in s:
...     d[k].append(v)
...
>>> d.items()
[('blue', [2, 4]), ('red', [1]), ('yellow', [1, 3])]
```

When each key is encountered for the first time, it is not already in the mapping; so an entry is automatically created using the `default_factory` function which returns an empty `list`. The `list.append()` operation then attaches the value to the new list. When keys are encountered again, the look-up proceeds normally (returning the list for that key) and the `list.append()` operation adds another value to the list. This technique is simpler and faster than an equivalent technique using `dict.setdefault()`:

```
>>> d = {}
>>> for k, v in s:
...     d.setdefault(k, []).append(v)
...
>>> d.items()
[('blue', [2, 4]), ('red', [1]), ('yellow', [1, 3])]
```

Setting the `default_factory` to `int` makes the `defaultdict` useful for counting (like a bag or multiset in other languages):

```
>>> s = 'mississippi'
>>> d = defaultdict(int)
>>> for k in s:
...     d[k] += 1
...
>>> d.items()
[('i', 4), ('p', 2), ('s', 4), ('m', 1)]
```

When a letter is first encountered, it is missing from the mapping, so the `default_factory` function calls `int()` to supply a default count of zero. The increment operation then builds up the count for each letter.

The function `int()` which always returns zero is just a special case of constant functions. A faster and more flexible way to create constant functions is to use `itertools.repeat()` which can supply any constant value (not just zero):

```
>>> def constant_factory(value):
...     return itertools.repeat(value).next
>>> d = defaultdict(constant_factory('<missing>'))
>>> d.update(name='John', action='ran')
>>> '%(name)s %(action)s to %(object)s' % d
'John ran to <missing>'
```

Setting the `default_factory` to `set` makes the `defaultdict` useful for building a dictionary of sets:

```
>>> s = [('red', 1), ('blue', 2), ('red', 3), ('blue', 4), ('red', 1), ('blue', 4)]
>>> d = defaultdict(set)
>>> for k, v in s:
...     d[k].add(v)
...
>>> d.items()
[('blue', set([2, 4])), ('red', set([1, 3]))]
```

8.3.4. `namedtuple()` Factory Function for Tuples with Named Fields

Named tuples assign meaning to each position in a tuple and allow for more readable, self-documenting code. They can be used wherever regular tuples are used, and they add the ability to access fields by name instead of position index.

`collections.`**`namedtuple`**(*typename*, *field_names*[, *verbose=False*][, *rename=False*])

Returns a new tuple subclass named *typename*. The new subclass is used to create tuple-like objects that have fields accessible by attribute lookup as well as being indexable and iterable. Instances of the subclass also have a helpful docstring (with typename and field_names) and a helpful `__repr__()` method which lists the tuple contents in a `name=value` format.

The *field_names* are a sequence of strings such as `['x', 'y']`. Alternatively, *field_names* can be a single string with each fieldname separated by whitespace and/or commas, for example `'x y'` or `'x, y'`.

Any valid Python identifier may be used for a fieldname except for names starting with an underscore. Valid identifiers consist of letters, digits, and underscores but do not start with a digit or underscore and cannot be a `keyword` such as *class*, *for*, *return*, *global*, *pass*, *print*, or *raise*.

If *rename* is true, invalid fieldnames are automatically replaced with positional names. For example, `['abc', 'def', 'ghi', 'abc']` is converted to `['abc', '_1', 'ghi', '_3']`, eliminating the keyword `def` and the duplicate fieldname `abc`.

If *verbose* is true, the class definition is printed just before being built.

Named tuple instances do not have per-instance dictionaries, so they are lightweight and require no more memory than regular tuples.

New in version 2.6.

Changed in version 2.7: added support for *rename*.

Example:

```
>>> Point = namedtuple('Point', ['x', 'y'], verbose=True)
class Point(tuple):
    'Point(x, y)'

    __slots__ = ()

    _fields = ('x', 'y')
```

```
    def __new__(_cls, x, y):
        'Create new instance of Point(x, y)'
        return _tuple.__new__(_cls, (x, y))

    @classmethod
    def _make(cls, iterable, new=tuple.__new__, len=len):
        'Make a new Point object from a sequence or iterable'
        result = new(cls, iterable)
        if len(result) != 2:
            raise TypeError('Expected 2 arguments, got %d' % len(result))
        return result

    def __repr__(self):
        'Return a nicely formatted representation string'
        return 'Point(x=%r, y=%r)' % self

    def _asdict(self):
        'Return a new OrderedDict which maps field names to their values'
        return OrderedDict(zip(self._fields, self))

    def _replace(_self, **kwds):
        'Return a new Point object replacing specified fields with new values'
        result = _self._make(map(kwds.pop, ('x', 'y'), _self))
        if kwds:
            raise ValueError('Got unexpected field names: %r' % kwds.keys())
        return result

    def __getnewargs__(self):
        'Return self as a plain tuple.  Used by copy and pickle.'
        return tuple(self)

    __dict__ = _property(_asdict)

    def __getstate__(self):
        'Exclude the OrderedDict from pickling'
        pass

    x = _property(_itemgetter(0), doc='Alias for field number 0')

    y = _property(_itemgetter(1), doc='Alias for field number 1')
```

```
>>> p = Point(11, y=22)     # instantiate with positional or keyword arguments
>>> p[0] + p[1]             # indexable like the plain tuple (11, 22)
33
>>> x, y = p                # unpack like a regular tuple
```

```
>>> x, y
(11, 22)
>>> p.x + p.y               # fields also accessible by name
33
>>> p                       # readable __repr__ with a name=value style
Point(x=11, y=22)
```

Named tuples are especially useful for assigning field names to result tuples returned by the `csv` or `sqlite3` modules:

```
EmployeeRecord = namedtuple('EmployeeRecord', 'name, age, title, department, paygrade')

import csv
for emp in map(EmployeeRecord._make, csv.reader(open("employees.csv", "rb"))):
    print emp.name, emp.title

import sqlite3
conn = sqlite3.connect('/companydata')
cursor = conn.cursor()
cursor.execute('SELECT name, age, title, department, paygrade FROM employees')
for emp in map(EmployeeRecord._make, cursor.fetchall()):
    print emp.name, emp.title
```

In addition to the methods inherited from tuples, named tuples support three additional methods and one attribute. To prevent conflicts with field names, the method and attribute names start with an underscore.

classmethod `somenamedtuple.`**`_make`**(*iterable*)

Class method that makes a new instance from an existing sequence or iterable.

```
>>> t = [11, 22]
>>> Point._make(t)
Point(x=11, y=22)
```

`somenamedtuple.`**`_asdict`**()

Return a new `OrderedDict` which maps field names to their corresponding values:

```
>>> p = Point(x=11, y=22)
>>> p._asdict()
OrderedDict([('x', 11), ('y', 22)])
```

Changed in version 2.7: Returns an `OrderedDict` instead of a regular `dict`.

somenamedtuple.**_replace**(*kwargs*)

Return a new instance of the named tuple replacing specified fields with new values:

```
>>> p = Point(x=11, y=22)
>>> p._replace(x=33)
Point(x=33, y=22)

>>> for partnum, record in inventory.items():
...     inventory[partnum] = record._replace(price=newprices[partnum], timestamp=time.now())
```

somenamedtuple.**_fields**

Tuple of strings listing the field names. Useful for introspection and for creating new named tuple types from existing named tuples.

```
>>> p._fields            # view the field names
('x', 'y')

>>> Color = namedtuple('Color', 'red green blue')
>>> Pixel = namedtuple('Pixel', Point._fields + Color._fields)
>>> Pixel(11, 22, 128, 255, 0)
Pixel(x=11, y=22, red=128, green=255, blue=0)
```

To retrieve a field whose name is stored in a string, use the `getattr()` function:

```
>>> getattr(p, 'x')
11
```

To convert a dictionary to a named tuple, use the double-star-operator (as described in Unpacking Argument Lists):

```
>>> d = {'x': 11, 'y': 22}
>>> Point(**d)
Point(x=11, y=22)
```

Since a named tuple is a regular Python class, it is easy to add or change functionality with a subclass. Here is how to add a calculated field and a fixed-width print format:

```
>>> class Point(namedtuple('Point', 'x y')):
...     __slots__ = ()
...     @property
...     def hypot(self):
...         return (self.x ** 2 + self.y ** 2) ** 0.5
```

```
...     def __str__(self):
...         return 'Point: x=%6.3f  y=%6.3f  hypot=%6.3f' % (self.x, self.y, self.hypot)
...
>>> for p in Point(3, 4), Point(14, 5/7.):
...     print p
Point: x= 3.000  y= 4.000  hypot= 5.000
Point: x=14.000  y= 0.714  hypot=14.018
```

The subclass shown above sets `__slots__` to an empty tuple. This helps keep memory requirements low by preventing the creation of instance dictionaries.

Subclassing is not useful for adding new, stored fields. Instead, simply create a new named tuple type from the `_fields` attribute:

```
>>> Point3D = namedtuple('Point3D', Point._fields + ('z',))
```

Default values can be implemented by using `_replace()` to customize a prototype instance:

```
>>> Account = namedtuple('Account', 'owner balance transaction_count')
>>> default_account = Account('<owner name>', 0.0, 0)
>>> johns_account = default_account._replace(owner='John')
```

Enumerated constants can be implemented with named tuples, but it is simpler and more efficient to use a simple class declaration:

```
>>> Status = namedtuple('Status', 'open pending closed')._make(range(3))
>>> Status.open, Status.pending, Status.closed
(0, 1, 2)
>>> class Status:
...     open, pending, closed = range(3)
```

See also: Named tuple recipe adapted for Python 2.4.

8.3.5. `OrderedDict` objects

Ordered dictionaries are just like regular dictionaries but they remember the order that items were inserted. When iterating over an ordered dictionary, the items are returned in the order their keys were first added.

class `collections.`**`OrderedDict`**([*items*])

Return an instance of a dict subclass, supporting the usual `dict` methods. An *OrderedDict* is a dict that remembers the order that keys were 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.

New in version 2.7.

`OrderedDict.`**`popitem`**(*last=True*)

The `popitem()` method for ordered dictionaries returns and removes a (key, value) pair. The pairs are returned in LIFO order if *last* is true or FIFO order if false.

In addition to the usual mapping methods, ordered dictionaries also support reverse iteration using `reversed()`.

Equality tests between `OrderedDict` objects are order-sensitive and are implemented as `list(od1.items())==list(od2.items())`. Equality tests between `OrderedDict` objects and other `Mapping` objects are order-insensitive like regular dictionaries. This allows `OrderedDict` objects to be substituted anywhere a regular dictionary is used.

The `OrderedDict` constructor and **`update()`** method both accept keyword arguments, but their order is lost because Python’s function call semantics pass-in keyword arguments using a regular unordered dictionary.

See also: Equivalent OrderedDict recipe that runs on Python 2.4 or later.

8.3.5.1. `OrderedDict` Examples and Recipes

Since an ordered dictionary remembers its insertion order, it can be used in conjunction with sorting to make a sorted dictionary:

```
>>> # regular unsorted dictionary
>>> d = {'banana': 3, 'apple': 4, 'pear': 1, 'orange': 2}

>>> # dictionary sorted by key
>>> OrderedDict(sorted(d.items(), key=lambda t: t[0]))
OrderedDict([('apple', 4), ('banana', 3), ('orange', 2), ('pear', 1)])

>>> # dictionary sorted by value
>>> OrderedDict(sorted(d.items(), key=lambda t: t[1]))
OrderedDict([('pear', 1), ('orange', 2), ('banana', 3), ('apple', 4)])

>>> # dictionary sorted by length of the key string
```

```
>>> OrderedDict(sorted(d.items(), key=lambda t: len(t[0])))
OrderedDict([('pear', 1), ('apple', 4), ('orange', 2), ('banana', 3)])
```

The new sorted dictionaries maintain their sort order when entries are deleted. But when new keys are added, the keys are appended to the end and the sort is not maintained.

It is also straight-forward to create an ordered dictionary variant that remembers the order the keys were *last* inserted. If a new entry overwrites an existing entry, the original insertion position is changed and moved to the end:

```
class LastUpdatedOrderedDict(OrderedDict):
    'Store items in the order the keys were last added'

    def __setitem__(self, key, value):
        if key in self:
            del self[key]
        OrderedDict.__setitem__(self, key, value)
```

An ordered dictionary can be combined with the `Counter` class so that the counter remembers the order elements are first encountered:

```
class OrderedCounter(Counter, OrderedDict):
     'Counter that remembers the order elements are first encountered'

     def __repr__(self):
         return '%s(%r)' % (self.__class__.__name__, OrderedDict(self))

     def __reduce__(self):
         return self.__class__, (OrderedDict(self),)
```

8.3.6. Collections Abstract Base Classes

The collections module offers the following ABCs:

ABC	Inherits from	Abstract Methods	Mixin Methods
`Container`		`__contains__`	
`Hashable`		`__hash__`	
`Iterable`		`__iter__`	
`Iterator`	`Iterable`	`next`	`__iter__`
`Sized`		`__len__`	

ABC	Inherits from	Abstract Methods	Mixin Methods
`Callable`		`__call__`	
`Sequence`	`Sized`, `Iterable`, `Container`	`__getitem__`, `__len__`	`__contains__`, `__iter__`, `__reversed__`, `index`, and `count`
`MutableSequence`	`Sequence`	`__getitem__`, `__setitem__`, `__delitem__`, `__len__`, `insert`	Inherited `Sequence` methods and `append`, `reverse`, `extend`, `pop`, `remove`, and `__iadd__`
`Set`	`Sized`, `Iterable`, `Container`	`__contains__`, `__iter__`, `__len__`	`__le__`, `__lt__`, `__eq__`, `__ne__`, `__gt__`, `__ge__`, `__and__`, `__or__`, `__sub__`, `__xor__`, and `isdisjoint`
`MutableSet`	`Set`	`__contains__`, `__iter__`, `__len__`, `add`, `discard`	Inherited `Set` methods and `clear`, `pop`, `remove`, `__ior__`, `__iand__`, `__ixor__`, and `__isub__`
`Mapping`	`Sized`, `Iterable`, `Container`	`__getitem__`, `__iter__`, `__len__`	`__contains__`, `keys`, `items`, `values`, `get`, `__eq__`, and `__ne__`
`MutableMapping`	`Mapping`	`__getitem__`, `__setitem__`, `__delitem__`, `__iter__`, `__len__`	Inherited `Mapping` methods and `pop`, `popitem`, `clear`, `update`, and `setdefault`
`MappingView`	`Sized`		`__len__`
`ItemsView`	`MappingView`, `Set`		`__contains__`, `__iter__`
`KeysView`	`MappingView`, `Set`		`__contains__`, `__iter__`
`ValuesView`	`MappingView`		`__contains__`, `__iter__`

class `collections.`**`Container`**
class `collections.`**`Hashable`**
class `collections.`**`Sized`**
class `collections.`**`Callable`**

ABCs for classes that provide respectively the methods `__contains__()`, `__hash__()`, `__len__()`, and `__call__()`.

class `collections.`**`Iterable`**

ABC for classes that provide the `__iter__()` method. See also the definition of iterable.

class `collections.`**`Iterator`**

ABC for classes that provide the `__iter__()` and `next()` methods. See also the definition of iterator.

class `collections.`**`Sequence`**
class `collections.`**`MutableSequence`**

ABCs for read-only and mutable sequences.

class collections.**Set**
class collections.**MutableSet**

ABCs for read-only and mutable sets.

class collections.**Mapping**
class collections.**MutableMapping**

ABCs for read-only and mutable mappings.

class collections.**MappingView**
class collections.**ItemsView**
class collections.**KeysView**
class collections.**ValuesView**

ABCs for mapping, items, keys, and values views.

These ABCs allow us to ask classes or instances if they provide particular functionality, for example:

```
size = None
if isinstance(myvar, collections.Sized):
    size = len(myvar)
```

Several of the ABCs are also useful as mixins that make it easier to develop classes supporting container APIs. For example, to write a class supporting the full `Set` API, it only necessary to supply the three underlying abstract methods: `__contains__()`, `__iter__()`, and `__len__()`. The ABC supplies the remaining methods such as `__and__()` and `isdisjoint()`

```
class ListBasedSet(collections.Set):
     ''' Alternate set implementation favoring space over speed
         and not requiring the set elements to be hashable. '''
     def __init__(self, iterable):
         self.elements = lst = []
         for value in iterable:
             if value not in lst:
                 lst.append(value)

     def __iter__(self):
         return iter(self.elements)

     def __contains__(self, value):
         return value in self.elements

     def __len__(self):
         return len(self.elements)
```

```
s1 = ListBasedSet('abcdef')
s2 = ListBasedSet('defghi')
overlap = s1 & s2            # The __and__() method is supported automatically
```

Notes on using `Set` and `MutableSet` as a mixin:

1. Since some set operations create new sets, the default mixin methods need a way to create new instances from an iterable. The class constructor is assumed to have a signature in the form `ClassName(iterable)`. That assumption is factored-out to an internal classmethod called `_from_iterable()` which calls `cls(iterable)` to produce a new set. If the `Set` mixin is being used in a class with a different constructor signature, you will need to override `_from_iterable()` with a classmethod that can construct new instances from an iterable argument.
2. To override the comparisons (presumably for speed, as the semantics are fixed), redefine `__le__()` and `__ge__()`, then the other operations will automatically follow suit.
3. The `Set` mixin provides a `_hash()` method to compute a hash value for the set; however, `__hash__()` is not defined because not all sets are hashable or immutable. To add set hashability using mixins, inherit from both `Set()` and `Hashable()`, then define `__hash__ = Set._hash`.

See also:

- OrderedSet recipe for an example built on `MutableSet`.
- For more about ABCs, see the `abc` module and **PEP 3119**.