9.7. `sets` — Unordered collections of unique elements¶

New in version 2.3.

Deprecated since version 2.6: The built-in `set/frozenset` types replace this module.

The `sets` module provides classes for constructing and manipulating unordered collections of unique elements. Common uses include membership testing, removing duplicates from a sequence, and computing standard math operations on sets such as intersection, union, difference, and symmetric difference.

Like other collections, sets support `x in set`, `len(set)`, and `for x in set`. Being an unordered collection, sets do not record element position or order of insertion. Accordingly, sets do not support indexing, slicing, or other sequence-like behavior.

Most set applications use the [Set](#) class which provides every set method except for [`__hash__()`](#). For advanced applications requiring a hash method, the [ImmutableSet](#) class adds a [`__hash__()`](#) method but omits methods which alter the contents of the set. Both [Set](#) and [ImmutableSet](#) derive from `BaseSet`, an abstract class useful for determining whether something is a set: `isinstance(obj, BaseSet)`.

The set classes are implemented using dictionaries. Accordingly, the requirements for set elements are the same as those for dictionary keys; namely, that the element defines both [`__eq__()`](#) and [`__hash__()`](#). As a result, sets cannot contain mutable elements such as lists or dictionaries. However, they can contain immutable collections such as tuples or instances of [ImmutableSet](#). For convenience in implementing sets of sets, inner sets are automatically converted to immutable form, for example, `Set([Set(['dog'])])` is transformed to `Set([ImmutableSet(['dog'])])`.

class `sets.Set`([*iterable*])¶
Constructs a new empty [Set](#) object. If the optional *iterable* parameter is supplied, updates the set with elements obtained from iteration. All of the elements in *iterable* should be immutable or be transformable to an immutable using the protocol described in section *[Protocol for automatic conversion to immutable](#)*.

class `sets.ImmutableSet`([*iterable*])¶

Constructs a new empty [ImmutableSet](#) object. If the optional *iterable* parameter is supplied, updates the set with elements obtained from iteration. All of the elements in *iterable* should be immutable or be transformable to an immutable using the protocol described in section *[Protocol for automatic conversion to immutable](#)*.

Because [ImmutableSet](#) objects provide a [`__hash__()`](#) method, they can be used as set elements or as dictionary keys. [ImmutableSet](#) objects do not have methods for adding or removing elements, so all of the elements must be known when the constructor is called.

9.7.1. Set Objects¶

Instances of [Set](#) and [ImmutableSet](#) both provide the following operations:

Operation	Equivalent	Result
`len(s)`		cardinality of set *s*
`x in s`		test *x* for membership in *s*
`x not in s`		test *x* for non-membership in *s*
`s.issubset(t)`	`s <= t`	test whether every element in *s* is in *t*
`s.issuperset(t)`	`s >= t`	test whether every element in *t* is in *s*
`s.union(t)`	`s	t`	new set with elements from both *s* and *t*
`s.intersection(t)`	`s & t`	new set with elements common to *s* and *t*
`s.difference(t)`	`s - t`	new set with elements in *s* but not in *t*
`s.symmetric_difference(t)`	`s ^ t`	new set with elements in either *s* or *t* but not both
`s.copy()`		new set with a shallow copy of *s*

Note, the non-operator versions of `union()`, `intersection()`, `difference()`, and `symmetric_difference()` will accept any iterable as an argument. In contrast, their operator based counterparts require their arguments to be sets. This precludes error-prone constructions like `Set('abc') & 'cbs'` in favor of the more readable `Set('abc').intersection('cbs')`.

Changed in version 2.3.1: Formerly all arguments were required to be sets.

In addition, both [Set](#) and [ImmutableSet](#) support set to set comparisons. Two sets are equal if and only if every element of each set is contained in the other (each is a subset of the other). A set is less than another set if and only if the first set is a proper subset of the second set (is a subset, but is not equal). A set is greater than another set if and only if the first set is a proper superset of the second set (is a superset, but is not equal).

The subset and equality comparisons do not generalize to a complete ordering function. For example, any two disjoint sets are not equal and are not subsets of each other, so *all* of the following return False: a<b, a==b, or a>b. Accordingly, sets do not implement the `__cmp__()` method.

Since sets only define partial ordering (subset relationships), the output of the `list.sort()` method is undefined for lists of sets.

The following table lists operations available in `ImmutableSet` but not found in `Set`:

Operation	Result
hash(s)	returns a hash value for *s*

The following table lists operations available in `Set` but not found in `ImmutableSet`:

Operation	Equivalent	Result
s.update(t)	s |= t	return set *s* with elements added from *t*
s.intersection_update(t)	s &= t	return set *s* keeping only elements also found in *t*
s.difference_update(t)	s -= t	return set *s* after removing elements found in *t*
s.symmetric_difference_update(t)	s ^= t	return set *s* with elements from *s* or *t* but not both
s.add(x)		add element *x* to set *s*
s.remove(x)		remove *x* from set *s*; raises `KeyError` if not present
s.discard(x)		removes *x* from set *s* if present
s.pop()		remove and return an arbitrary element from *s*; raises `KeyError` if empty
s.clear()		remove all elements from set *s*

Note, the non-operator versions of `update()`, `intersection_update()`, `difference_update()`, and `symmetric_difference_update()` will accept any iterable as an argument.

Changed in version 2.3.1: Formerly all arguments were required to be sets.

Also note, the module also includes a `union_update()` method which is an alias for `update()`. The method is included for backwards compatibility. Programmers should prefer the `update()` method because it is supported by the built-in `set()` and `frozenset()` types.

9.7.2. Example¶

```
>>> from sets import Set
>>> engineers = Set(['John', 'Jane', 'Jack', 'Janice'])
>>> programmers = Set(['Jack', 'Sam', 'Susan', 'Janice'])
>>> managers = Set(['Jane', 'Jack', 'Susan', 'Zack'])
>>> employees = engineers | programmers | managers          # union
>>> engineering_management = engineers & managers           # intersection
>>> fulltime_management = managers - engineers - programmers # difference
>>> engineers.add('Marvin')                                 # add element
>>> print engineers # doctest: +SKIP
Set(['Jane', 'Marvin', 'Janice', 'John', 'Jack'])
>>> employees.issuperset(engineers)     # superset test
False
>>> employees.update(engineers)         # update from another set
>>> employees.issuperset(engineers)
True
>>> for group in [engineers, programmers, managers, employees]: # doctest: +SKIP
...     group.discard('Susan')          # unconditionally remove element
...     print group
...
Set(['Jane', 'Marvin', 'Janice', 'John', 'Jack'])
Set(['Janice', 'Jack', 'Sam'])
Set(['Jane', 'Zack', 'Jack'])
Set(['Jack', 'Sam', 'Jane', 'Marvin', 'Janice', 'John', 'Zack'])
```

9.7.3. Protocol for automatic conversion to immutable¶

Sets can only contain immutable elements. For convenience, mutable `Set` objects are automatically copied to an `ImmutableSet` before being added as a set element.

The mechanism is to always add a *hashable* element, or if it is not hashable, the element is checked to see if it has an `__as_immutable__()` method which returns an immutable equivalent.

Since `Set` objects have a `__as_immutable__()` method returning an instance of `ImmutableSet`, it is possible to construct sets of sets.

A similar mechanism is needed by the `__contains__()` and `remove()` methods which need to hash an element to check for membership in a set. Those methods check an element for hashability and, if not, check for a `__as_temporarily_immutable__()` method which returns the element wrapped by a class that provides temporary methods for `__hash__()`, `__eq__()`, and `__ne__()`.

The alternate mechanism spares the need to build a separate copy of the original mutable object.

`Set` objects implement the `__as_temporarily_immutable__()` method which returns the `Set` object wrapped by a new class `_TemporarilyImmutableSet`.

The two mechanisms for adding hashability are normally invisible to the user; however, a conflict can arise in a multi-threaded environment where one thread is updating a set while another has temporarily wrapped it in `_TemporarilyImmutableSet`. In other words, sets of mutable sets are not thread-safe.

9.7.4. Comparison to the built-in `set` types¶

The built-in `set` and `frozenset` types were designed based on lessons learned from the `sets` module. The key differences are:

- `Set` and `ImmutableSet` were renamed to `set` and `frozenset`.
- There is no equivalent to `BaseSet`. Instead, use `isinstance(x, (set, frozenset))`.
- The hash algorithm for the built-ins performs significantly better (fewer collisions) for most datasets.
- The built-in versions have more space efficient pickles.
- The built-in versions do not have a `union_update()` method. Instead, use the `update()` method which is equivalent.
- The built-in versions do not have a `_repr(sorted=True)` method. Instead, use the built-in `repr()` and `sorted()` functions: `repr(sorted(s))`.
- The built-in version does not have a protocol for automatic conversion to immutable. Many found this feature to be confusing and no one in the community reported having found real uses for it.

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