8.11. `weakref` — Weak references

New in version 2.1.

Source code: Lib/weakref.py

The `weakref` module allows the Python programmer to create *weak references* to objects.

In the following, the term *referent* means the object which is referred to by a weak reference.

A weak reference to an object is not enough to keep the object alive: when the only remaining references to a referent are weak references, garbage collection is free to destroy the referent and reuse its memory for something else. A primary use for weak references is to implement caches or mappings holding large objects, where it's desired that a large object not be kept alive solely because it appears in a cache or mapping.

For example, if you have a number of large binary image objects, you may wish to associate a name with each. If you used a Python dictionary to map names to images, or images to names, the image objects would remain alive just because they appeared as values or keys in the dictionaries. The `WeakKeyDictionary` and `WeakValueDictionary` classes supplied by the `weakref` module are an alternative, using weak references to construct mappings that don't keep objects alive solely because they appear in the mapping objects. If, for example, an image object is a value in a `WeakValueDictionary`, then when the last remaining references to that image object are the weak references held by weak mappings, garbage collection can reclaim the object, and its corresponding entries in weak mappings are simply deleted.

`WeakKeyDictionary` and `WeakValueDictionary` use weak references in their implementation, setting up callback functions on the weak references that notify the weak dictionaries when a key or value has been reclaimed by garbage collection. Most programs should find that using one of these weak dictionary types is all they need – it's not usually necessary to create your own weak references directly. The low-level machinery used by the weak dictionary implementations is exposed by the `weakref` module for the benefit of advanced uses.

Not all objects can be weakly referenced; those objects which can include class instances, functions written in Python (but not in C), methods (both bound and unbound), sets, frozensets, file objects, generators, type objects, `DBcursor` objects from the `bsddb` module, sockets, arrays, deques, regular expression pattern objects, and code objects.

Changed in version 2.4: Added support for files, sockets, arrays, and patterns.

Changed in version 2.7: Added support for thread.lock, threading.Lock, and code objects.

Several built-in types such as `list` and `dict` do not directly support weak references but can add support through subclassing:

```
class Dict(dict):
    pass

obj = Dict(red=1, green=2, blue=3)   # this object is weak referenceable
```

CPython implementation detail: Other built-in types such as `tuple` and `long` do not support weak references even when subclassed.

Extension types can easily be made to support weak references; see Weak Reference Support.

class `weakref.`**`ref`**(*object*[, *callback*])

Return a weak reference to *object*. The original object can be retrieved by calling the reference object if the referent is still alive; if the referent is no longer alive, calling the reference object will cause `None` to be returned. If *callback* is provided and not `None`, and the returned weakref object is still alive, the callback will be called when the object is about to be finalized; the weak reference object will be passed as the only parameter to the callback; the referent will no longer be available.

It is allowable for many weak references to be constructed for the same object. Callbacks registered for each weak reference will be called from the most recently registered callback to the oldest registered callback.

Exceptions raised by the callback will be noted on the standard error output, but cannot be propagated; they are handled in exactly the same way as exceptions raised from an object's `__del__()` method.

Weak references are hashable if the *object* is hashable. They will maintain their hash value even after the *object* was deleted. If `hash()` is called the first time only after the *object* was deleted, the call will raise `TypeError`.

Weak references support tests for equality, but not ordering. If the referents are still alive, two references have the same equality relationship as their referents (regardless of the *callback*). If either referent has been deleted, the references are equal only if the reference objects are the same object.

Changed in version 2.4: This is now a subclassable type rather than a factory function; it derives from `object`.

`weakref.`**`proxy`**(*object*[, *callback*])

Return a proxy to *object* which uses a weak reference. This supports use of the proxy in most contexts instead of requiring the explicit dereferencing used with weak reference objects. The returned object will have a type of either `ProxyType` or `CallableProxyType`, depending on whether *object* is callable. Proxy objects are not hashable regardless of the referent; this avoids a number of problems related to their fundamentally mutable nature, and prevent their use as dictionary keys. *callback* is the same as the parameter of the same name to the `ref()` function.

`weakref.`**`getweakrefcount`**(*object*)

Return the number of weak references and proxies which refer to *object*.

`weakref.`**`getweakrefs`**(*object*)

Return a list of all weak reference and proxy objects which refer to *object*.

class weakref.**WeakKeyDictionary**([*dict*])

Mapping class that references keys weakly. Entries in the dictionary will be discarded when there is no longer a strong reference to the key. This can be used to associate additional data with an object owned by other parts of an application without adding attributes to those objects. This can be especially useful with objects that override attribute accesses.

> **Note:** Caution: Because a `WeakKeyDictionary` is built on top of a Python dictionary, it must not change size when iterating over it. This can be difficult to ensure for a `WeakKeyDictionary` because actions performed by the program during iteration may cause items in the dictionary to vanish "by magic" (as a side effect of garbage collection).

`WeakKeyDictionary` objects have the following additional methods. These expose the internal references directly. The references are not guaranteed to be "live" at the time they are used, so the result of calling the references needs to be checked before being used. This can be used to avoid creating references that will cause the garbage collector to keep the keys around longer than needed.

WeakKeyDictionary.**iterkeyrefs**()

Return an iterable of the weak references to the keys.

New in version 2.5.

WeakKeyDictionary.**keyrefs**()

Return a list of weak references to the keys.

New in version 2.5.

class weakref.**WeakValueDictionary**([*dict*])

Mapping class that references values weakly. Entries in the dictionary will be discarded when no strong reference to the value exists any more.

> **Note:** Caution: Because a `WeakValueDictionary` is built on top of a Python dictionary, it must not change size when iterating over it. This can be difficult to ensure for a `WeakValueDictionary` because actions performed by the program during iteration may cause items in the dictionary to vanish "by magic" (as a side effect of garbage collection).

`WeakValueDictionary` objects have the following additional methods. These method have the same issues as the `iterkeyrefs()` and `keyrefs()` methods of `WeakKeyDictionary` objects.

WeakValueDictionary.**itervaluerefs**()

Return an iterable of the weak references to the values.

New in version 2.5.

WeakValueDictionary.**valuerefs**()

Return a list of weak references to the values.

New in version 2.5.

class weakref.**WeakSet**([*elements*])

Set class that keeps weak references to its elements. An element will be discarded when no strong reference to it exists any more.

New in version 2.7.

weakref.**ReferenceType**

The type object for weak references objects.

weakref.**ProxyType**

The type object for proxies of objects which are not callable.

weakref.**CallableProxyType**

The type object for proxies of callable objects.

weakref.**ProxyTypes**

Sequence containing all the type objects for proxies. This can make it simpler to test if an object is a proxy without being dependent on naming both proxy types.

exception weakref.**ReferenceError**

Exception raised when a proxy object is used but the underlying object has been collected. This is the same as the standard `ReferenceError` exception.

See also:

PEP 205 - Weak References

The proposal and rationale for this feature, including links to earlier implementations and information about similar features in other languages.

8.11.1. Weak Reference Objects

Weak reference objects have no attributes or methods, but do allow the referent to be obtained, if it still exists, by calling it:

```
>>> import weakref
>>> class Object:
...     pass
...
>>> o = Object()
>>> r = weakref.ref(o)
>>> o2 = r()
>>> o is o2
True
```

If the referent no longer exists, calling the reference object returns `None`:

```
>>> del o, o2
>>> print r()
None
```

Testing that a weak reference object is still live should be done using the expression `ref() is not None`. Normally, application code that needs to use a reference object should follow this pattern:

```
# r is a weak reference object
o = r()
if o is None:
    # referent has been garbage collected
    print "Object has been deallocated; can't frobnicate."
else:
    print "Object is still live!"
    o.do_something_useful()
```

Using a separate test for “liveness” creates race conditions in threaded applications; another thread can cause a weak reference to become invalidated before the weak reference is called; the idiom shown above is safe in threaded applications as well as single-threaded applications.

Specialized versions of `ref` objects can be created through subclassing. This is used in the implementation of the `WeakValueDictionary` to reduce the memory overhead for each entry in the mapping. This may be most useful to associate additional information with a reference, but could also be used to insert additional processing on calls to retrieve the referent.

This example shows how a subclass of `ref` can be used to store additional information about an object and affect the value that’s returned when the referent is accessed:

```
import weakref

class ExtendedRef(weakref.ref):
    def __init__(self, ob, callback=None, **annotations):
        super(ExtendedRef, self).__init__(ob, callback)
        self.__counter = 0
        for k, v in annotations.iteritems():
            setattr(self, k, v)

    def __call__(self):
        """Return a pair containing the referent and the number of
        times the reference has been called.
        """
        ob = super(ExtendedRef, self).__call__()
        if ob is not None:
            self.__counter += 1
            ob = (ob, self.__counter)
        return ob
```

8.11.2. Example

This simple example shows how an application can use objects IDs to retrieve objects that it has seen before. The IDs of the objects can then be used in other data structures without forcing the objects to remain alive, but the objects can still be retrieved by ID if they do.

```
import weakref

_id2obj_dict = weakref.WeakValueDictionary()

def remember(obj):
    oid = id(obj)
```

```
    _id2obj_dict[oid] = obj
    return oid

def id2obj(oid):
    return _id2obj_dict[oid]
```