Memory Management and Limits

sys includes several functions for understanding and controlling memory usage.

Reference Counts

The primary implementation of Python (CPython) uses *reference counting* and *garbage collection* for automatic memory management. An object is automatically marked to be collected when its reference count drops to zero. To examine the reference count of an existing object, use `getrefcount()`.

```
# sys_getrefcount.py

import sys

one = []
print('At start         :', sys.getrefcount(one))

two = one

print('Second reference :', sys.getrefcount(one))

del two

print('After del        :', sys.getrefcount(one))
```

The value reported is actually one higher than expected because there is a temporary reference to the object held by `getrefcount()` itself.

```
$ python3 sys_getrefcount.py

At start         : 2
Second reference : 3
After del        : 2
```

See also

- gc – Control the garbage collector via the functions exposed in gc.

Object Size

Knowing how many references an object has may help find cycles or a memory leak, but it is not enough to determine what objects are consuming the *most* memory. That requires knowledge about how big objects are.

```
# sys_getsizeof.py

import sys


class MyClass:
    pass


objects = [
    [], (), {}, 'c', 'string', b'bytes', 1, 2.3,
    MyClass, MyClass(),
]

for obj in objects:
    print('{:>10} : {}'.format(type(obj).__name
```

```
    print('{:>10} : {}'.format(type(obj).__name__,
                               sys.getsizeof(obj)))
```

`getsizeof()` reports the size of an object in bytes.

```
$ python3 sys_getsizeof.py

      list : 64
     tuple : 48
      dict : 240
       str : 50
       str : 55
     bytes : 38
       int : 28
     float : 24
      type : 1056
   MyClass : 56
```

The reported size for a custom class does not include the size of the attribute values.

```
# sys_getsizeof_object.py

import sys


class WithoutAttributes:
    pass


class WithAttributes:
    def __init__(self):
        self.a = 'a'
        self.b = 'b'
        return


without_attrs = WithoutAttributes()
print('WithoutAttributes:', sys.getsizeof(without_attrs))

with_attrs = WithAttributes()
print('WithAttributes:', sys.getsizeof(with_attrs))
```

This can give a false impression of the amount of memory being consumed.

```
$ python3 sys_getsizeof_object.py

WithoutAttributes: 56
WithAttributes: 56
```

For a more complete estimate of the space used by a class, provide a `__sizeof__()` method to compute the value by aggregating the sizes of attributes of an object.

```
# sys_getsizeof_custom.py

import sys


class WithAttributes:
    def __init__(self):
        self.a = 'a'
        self.b = 'b'
        return

    def __sizeof__(self):
        return object.__sizeof__(self) + \
            sum(sys.getsizeof(v) for v in self.__dict__.values())


my_inst = WithAttributes()
print(sys.getsizeof(my_inst))
```

```
print(sys.getsizeof(my_inst))
```

This version adds the base size of the object to the sizes of all of the attributes stored in the internal `__dict__`.

```
$ python3 sys_getsizeof_custom.py

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```

Recursion

Allowing infinite recursion in a Python application may introduce a stack overflow in the interpreter itself, leading to a crash. To eliminate this situation, the interpreter provides a way to control the maximum recursion depth using `setrecursionlimit()` and `getrecursionlimit()`.

```
# sys_recursionlimit.py

import sys

print('Initial limit:', sys.getrecursionlimit())

sys.setrecursionlimit(10)

print('Modified limit:', sys.getrecursionlimit())


def generate_recursion_error(i):
    print('generate_recursion_error({})'.format(i))
    generate_recursion_error(i + 1)


try:
    generate_recursion_error(1)
except RuntimeError as err:
    print('Caught exception:', err)
```

Once the stack size reaches the recursion limit, the interpreter raises a `RuntimeError` exception so the program has an opportunity to handle the situation.

```
$ python3 sys_recursionlimit.py

Initial limit: 1000
Modified limit: 10
generate_recursion_error(1)
generate_recursion_error(2)
generate_recursion_error(3)
generate_recursion_error(4)
generate_recursion_error(5)
generate_recursion_error(6)
generate_recursion_error(7)
generate_recursion_error(8)
Caught exception: maximum recursion depth exceeded while calling
a Python object
```

Maximum Values

Along with the runtime configurable values, `sys` includes variables defining the maximum values for types that vary from system to system.

```
# sys_maximums.py

import sys

print('maxsize   :', sys.maxsize)
print('maxunicode:', sys.maxunicode)
```

`maxsize` is the maximum size of a list, dictionary, string, or other data structure dictated by the C interpreter's size type. `maxunicode` is the largest integer Unicode point supported by the interpreter as currently configured.

```
$ python3 sys_maximums.py

maxsize   : 9223372036854775807
maxunicode: 1114111
```

Floating Point Values

The structure `float_info` contains information about the floating-point type representation used by the interpreter, based on the underlying system's `float` implementation.

```
# sys_float_info.py

import sys

print('Smallest difference (epsilon):', sys.float_info.epsilon)
print()
print('Digits (dig)              :', sys.float_info.dig)
print('Mantissa digits (mant_dig):', sys.float_info.mant_dig)
print()
print('Maximum (max):', sys.float_info.max)
print('Minimum (min):', sys.float_info.min)
print()
print('Radix of exponents (radix):', sys.float_info.radix)
print()
print('Maximum exponent for radix (max_exp):',
      sys.float_info.max_exp)
print('Minimum exponent for radix (min_exp):',
      sys.float_info.min_exp)
print()
print('Max. exponent power of 10 (max_10_exp):',
      sys.float_info.max_10_exp)
print('Min. exponent power of 10 (min_10_exp):',
      sys.float_info.min_10_exp)
print()
print('Rounding for addition (rounds):', sys.float_info.rounds)
```

These values depend on the compiler and underlying system. These examples were produced on OS X 10.9.5 on an Intel Core i7.

```
$ python3 sys_float_info.py

Smallest difference (epsilon): 2.220446049250313e-16

Digits (dig)              : 15
Mantissa digits (mant_dig): 53

Maximum (max): 1.7976931348623157e+308
Minimum (min): 2.2250738585072014e-308

Radix of exponents (radix): 2

Maximum exponent for radix (max_exp): 1024
Minimum exponent for radix (min_exp): -1021

Max. exponent power of 10 (max_10_exp): 308
Min. exponent power of 10 (min_10_exp): -307

Rounding for addition (rounds): 1
```

See also

- The `float.h` C header file for the local compiler contains more details about these settings.

Integer Values

The structure `int_info` holds information about the internal representation of integers used by the interpreter.

```
# sys_int_info.py

import sys

print('Number of bits used to hold each digit:',
      sys.int_info.bits_per_digit)
print('Size in bytes of C type used to hold each digit:',
      sys.int_info.sizeof_digit)
```

These examples were produced on OS X 10.9.5 on an Intel Core i7.

```
$ python3 sys_int_info.py

Number of bits used to hold each digit: 30
Size in bytes of C type used to hold each digit: 4
```

The C type used to store integers internally is determined when the interpreter is built. 64-bit architectures automatically use 30-bit integers by default, and they can be enabled for 32-bit architectures with the configuration flag `--enable-big-digits`.

See also

- Build and C API Changes from *What's New in Python 3.1*

Byte Ordering

`byteorder` is set to the native byte order.

```
# sys_byteorder.py

import sys

print(sys.byteorder)
```

The value is either `big` for big-endian or `little` for little-endian.

```
$ python3 sys_byteorder.py

little
```

See also

- Wikipedia: Endianness – Description of big and little endian memory systems.
- `array` and `struct` – Other modules that depend on the byte order of data.
- **`float.h` – The C header file for the local compiler contains** more details about these settings.

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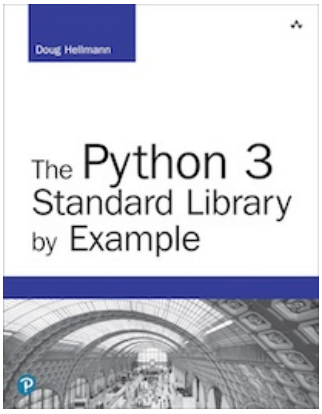

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The output from all the example programs from PyMOTW-3 has been generated with Python 3.7.1, unless otherwise noted. Some of the features described here may not be available in earlier versions of Python.

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