array — Sequence of Fixed-type Data

> **Purpose:** Manage sequences of fixed-type numerical data efficiently.

The array module defines a sequence data structure that looks very much like a list, except that all of the members have to be of the same primitive type. The types supported are all numeric or other fixed-size primitive types such as bytes.

Refer to the table below for some of the supported types. The standard library documentation for array includes a complete list of type codes.

Type Codes for array Members

Code	Type	Minimum size (bytes)
b	int	1
B	int	1
h	signed short	2
H	unsigned short	2
i	signed int	2
I	unsigned int	2
l	signed long	4
L	unsigned long	4
q	signed long long	8
Q	unsigned long long	8
f	float	4
d	double float	8

Initialization

An array is instantiated with an argument describing the type of data to be allowed, and possibly an initial sequence of data to store in the array.

```
# array_string.py

import array
import binascii

s = b'This is the array.'
a = array.array('b', s)

print('As byte string:', s)
print('As array      :', a)
print('As hex        :', binascii.hexlify(a))
```

In this example, the array is configured to hold a sequence of bytes and is initialized with a simple byte string.

```
$ python3 array_string.py

As byte string: b'This is the array.'
As array      : array('b', [84, 104, 105, 115, 32, 105, 115, 32,
 116, 104, 101, 32, 97, 114, 114, 97, 121, 46])
As hex        : b'54686973206973207468652061727261792e'
```

Manipulating Arrays

An array can be extended and otherwise manipulated in the same ways as other Python sequences.

```
# array_sequence.py

import array
import pprint

a = array.array('i', range(3))
print('Initial :', a)

a.extend(range(3))
print('Extended:', a)

print('Slice   :', a[2:5])

print('Iterator:')
print(list(enumerate(a)))
```

The supported operations include slicing, iterating, and adding elements to the end.

```
$ python3 array_sequence.py

Initial : array('i', [0, 1, 2])
Extended: array('i', [0, 1, 2, 0, 1, 2])
Slice   : array('i', [2, 0, 1])
Iterator:
[(0, 0), (1, 1), (2, 2), (3, 0), (4, 1), (5, 2)]
```

Arrays and Files

The contents of an array can be written to and read from files using built-in methods coded efficiently for that purpose.

```
# array_file.py

import array
import binascii
import tempfile

a = array.array('i', range(5))
print('A1:', a)

# Write the array of numbers to a temporary file
output = tempfile.NamedTemporaryFile()
a.tofile(output.file)  # must pass an *actual* file
output.flush()

# Read the raw data
with open(output.name, 'rb') as input:
    raw_data = input.read()
    print('Raw Contents:', binascii.hexlify(raw_data))

    # Read the data into an array
    input.seek(0)
    a2 = array.array('i')
    a2.fromfile(input, len(a))
    print('A2:', a2)
```

This example illustrates reading the data “raw,” meaning directly from the binary file, versus reading it into a new array and converting the bytes to the appropriate types.

```
$ python3 array_file.py

A1: array('i', [0, 1, 2, 3, 4])
Raw Contents: b'0000000001000000020000000300000004000000'
A2: array('i', [0, 1, 2, 3, 4])
```

`tofile()` uses `tobytes()` to format the data, and `fromfile()` uses `frombytes()` to convert it back to an array instance.

```
# array_tobytes.py
```

```
import array
import binascii

a = array.array('i', range(5))
print('A1:', a)

as_bytes = a.tobytes()
print('Bytes:', binascii.hexlify(as_bytes))

a2 = array.array('i')
a2.frombytes(as_bytes)
print('A2:', a2)
```

Both tobytes() and frombytes() work on byte strings, not Unicode strings.

```
$ python3 array_tobytes.py

A1: array('i', [0, 1, 2, 3, 4])
Bytes: b'0000000001000000020000000300000004000000'
A2: array('i', [0, 1, 2, 3, 4])
```

Alternative Byte Ordering

If the data in the array is not in the native byte order, or if the data needs to be swapped before being sent to a system with a different byte order (or over the network), it is possible to convert the entire array without iterating over the elements from Python.

```
# array_byteswap.py

import array
import binascii


def to_hex(a):
    chars_per_item = a.itemsize * 2  # 2 hex digits
    hex_version = binascii.hexlify(a)
    num_chunks = len(hex_version) // chars_per_item
    for i in range(num_chunks):
        start = i * chars_per_item
        end = start + chars_per_item
        yield hex_version[start:end]


start = int('0x12345678', 16)
end = start + 5
a1 = array.array('i', range(start, end))
a2 = array.array('i', range(start, end))
a2.byteswap()

fmt = '{:>12} {:>12} {:>12} {:>12}'
print(fmt.format('A1 hex', 'A1', 'A2 hex', 'A2'))
print(fmt.format('-' * 12, '-' * 12, '-' * 12, '-' * 12))
fmt = '{!r:>12} {:12} {!r:>12} {:12}'
for values in zip(to_hex(a1), a1, to_hex(a2), a2):
    print(fmt.format(*values))
```

The byteswap() method switches the byte order of the items in the array from within C, so it is much more efficient than looping over the data in Python.

```
$ python3 array_byteswap.py

      A1 hex           A1       A2 hex           A2
------------ ------------ ------------ ------------
 b'78563412'    305419896  b'12345678'   2018915346
 b'79563412'    305419897  b'12345679'   2035692562
 b'7a563412'    305419898  b'1234567a'   2052469778
 b'7b563412'    305419899  b'1234567b'   2069246994
 b'7c563412'    305419900  b'1234567c'   2086024210
```

See also

- Standard library documentation for array
- `struct` – The `struct` module.
- Numerical Python – NumPy is a Python library for working with large data sets efficiently.
- Python 2 to 3 porting notes for array

collections.abc — Abstract Base Classes for Containers

heapq – Heap Sort Algorithm

Quick Links

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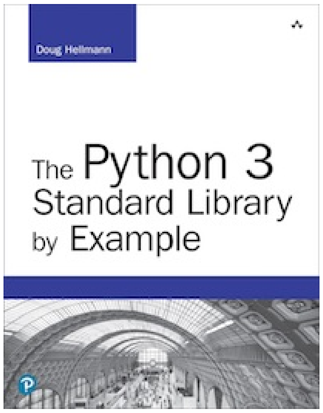

The output from all the example programs from PyMOTW-3 has been generated with Python 3.7.1, unless otherwise noted. Some of the features described here may not be available in earlier versions of Python.

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