Blosc and Friends – PyGrunn

Valentin Haenel

Freelance Consultant and Software Developer
http://haenel.co

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whoami

- Valentin Haenel
- Freelance developer and consultant
- Free-software enthusiast
- Check my homepage: http://haenel.co
- Follow me on Twitter: esc___

Outline

Disclaimer

- All examples with Py3
- No comparisons to other technologies

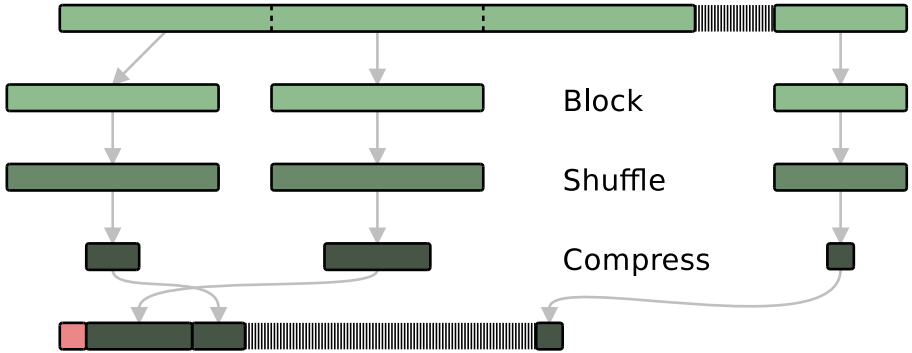
Outline

Blosc

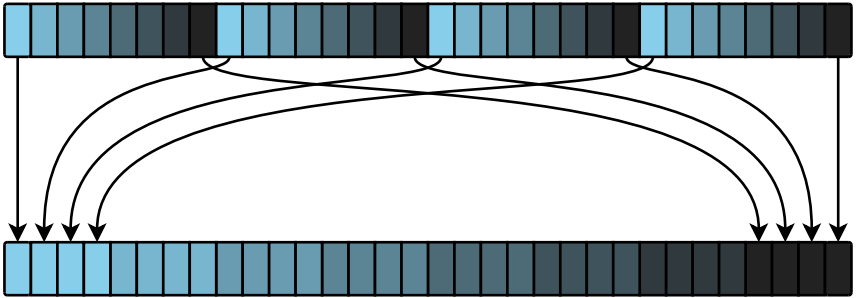
- **Blocking** by operating on data in blocks
- **Shuffling** by doing a byte shuffle
- **Fast** by multithreading across **blocks**
- **Metacodec** because it can drive **[lz4|snappy|zlib]**
- (But also comes with it's very own **blosclz**)

- **Blosc** was created by Francesc Alted of PyTables fame

Schematic



Shuffle



- Reorder **bytes** within a **block** by significance
- Requires the **typesize**
- Can leverage **SSE2** or **AVX** if available
- Great for **time-series** data

Blosc... Why?

- Accelerate computation by compression
- Keep data compressed in memory
- Mitigate the **starving CPU problem**
- Transmit data faster from memory $\rightarrow$ CPU

Outline

Python-Blosc

- **Python-Blosc** ← Python bindings
- Python C-API
- Blosc (and codecs) are vendored
- Can be dynamically linked

```
$ pip install blosc
```

Code, Yo!

```
>>> import blosc
>>> b = b"b"*888
>>> c = blosc.compress(b, typesize=8)
>>> len(b)/len(c)
15.857142857142858
>>> c = blosc.compress(b, typesize=1, shuffle=False,
... clevel=9, cname='lz4')
>>> len(b)/len(c)
23.36842105263158
```

C'mmon man, your pulling my leg?!

```
>>> d = blosc.decompress(c)
>>> assert b == d
```

What Up?

- Long sequence of the same character
- Not hard to beat
- Feel free to try with some input of your own choosing
- Feel free to compare to `zlib`

Help

- Doesn't yet support compressing via buffer-interface

Outline

And now some «stuff» layered on top!

- **Bloscpack**
- Command-line interface
- File-format
- **Numpy** array serialization
- Pure Python based on Python-Blosc

```
$ pip install bloscpack
```

More Code, Yo!

```
>>> import bloscpack, numpy
>>> b = numpy.arange(5e6)
>>> c = bloscpack.pack_ndarray_str(b)
>>> b.nbytes/len(c)
122.8799370854722

>>> c = bloscpack.pack_ndarray_str(b,
... blosc_args=bloscpack.BloscArgs(clevel=9, cname='lz4'))
>>> b.nbytes/len(c)
141.55183274235443
```

And Back Again

```
>>> d = bloscpack.unpack_ndarray_str(c)
>>> assert (b == d).all()
```

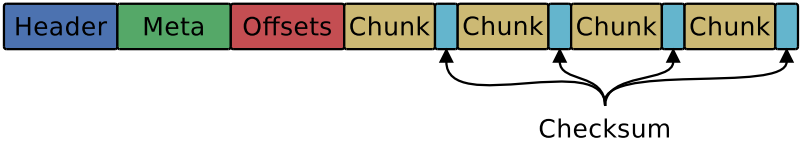
Command-line Usability

```
>>> np.save('b.npy', b)

$ ./blpk compress b.npy
$ ./blpk compress -l 9 -c lz4 b.npy b.npy.lv9lz4.blp
$ ls -lh b.*
-rw------- 1 esc esc  39M May 13 21:50 b.npy
-rw------- 1 esc esc 319K May 13 21:52 b.npy.blp
-rw------- 1 esc esc 277K May 17 20:39 b.npy.lv9lz4.blp
```

Format

- A **simple** file format
- Optional
  - **Checksum**
  - **Metadata**
  - **Offsets**



Numpy Support

- Python-Blosc can also pack an array:

```
>>> b = numpy.arange(5e6)
>>> %timeit c = blosc.pack_array(b)
10 loops, best of 3: 40.2 ms per loop

>>> %timeit c = bloscpack.pack_ndarray_str(b)
100 loops, best of 3: 9.81 ms per loop
```

- Internal copy vs. pointer operation
- Numpy metadata is stored in metadata section

```
>>> from io import BytesIO
>>> %timeit bio=BytesIO(); np.save(bio, b)
...
```

Help

- `pack_ndarray_str` ← **str**, really?!
- Py3 support not merged :(

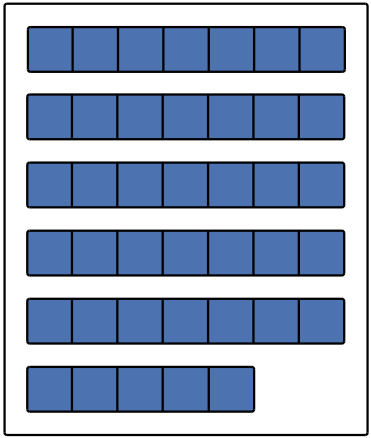
Outline

Bcolz

- Chunked container(s)
- `carray` and `ctable`
- In-memory and out-of-core
- Good for **medium data**
- Support basic analytics
- Uses Blosc and Bloscpack under the hood
- Python/Cython

```
$ pip install bcolz
$ conda install bcolz
```

Layout of the carray



- Discontigous
- Blosc-compressed
- Homogeneously typed
- **Chunks**
- Great for appending
- Not so good for random indexing

Creating a carray

```
>>> b = bcolz.arange(5e6)
>>> b
carray((5000000,), float64)
  nbytes: 38.15 MB; cbytes: 1.45 MB; ratio: 26.33
  cparams := cparams(clevel=5, shuffle=True, cname='blosclz')
[  0.00000000e+00   1.00000000e+00   2.00000000e+00 ...,   4.99999700e+06
   4.99999800e+06   4.99999900e+06]
```

- (The worse compression ratio compared to Bloscpack is a result of the so-called **leftovers** which remain uncompressed)

The chunks

```
>>> b.chunks[0]
chunk(float64)  nbytes: 524288; cbytes: 18698; ratio: 28.04
'[  0.00000000e+00   1.00000000e+00   2.00000000e+00 ...,   6.55330000e+04
    6.55340000e+04   6.55350000e+04]'
>>> b.chunks[0][:]  # slice returns a Numpy array
array([  0.00000000e+00,   1.00000000e+00,   2.00000000e+00, ...,
         6.55330000e+04,   6.55340000e+04,   6.55350000e+04])
>>> type b.chunks
list
```

Variation

```
>>> b = bcolz.arange(5e6, cparams=bcolz.cparams(clevel=9, cname='lz4'))

>>> b
carray((5000000,), float64)
  nbytes: 38.15 MB; cbytes: 849.54 KB; ratio: 45.98
  cparams := cparams(clevel=9, shuffle=True, cname='lz4')
[  0.00000000e+00   1.00000000e+00   2.00000000e+00 ...,   4.99999700e+06
   4.99999800e+06   4.99999900e+06]
```

On-Disk

```
>>> b = bcolz.arange(5e6, rootdir='bexample', chunklen=1000**2)
>>> ls -lh bexample/*
-rw------- 1 esc esc    3 May 17 22:19 bexample/__attrs__

bexample/data:
total 992K
-rw------- 1 esc esc 168K May 17 22:19 __0.blp
-rw------- 1 esc esc 138K May 17 22:19 __1.blp
-rw------- 1 esc esc 190K May 20 19:29 __2.blp
-rw------- 1 esc esc 195K May 20 19:29 __3.blp
-rw------- 1 esc esc 286K May 20 19:29 __4.blp

bexample/meta:
total 16K
-rw------- 1 esc esc   60 May 17 22:19 sizes
-rw------- 1 esc esc  122 May 17 22:19 storage
```

- `*.blp` ← Bloscpack files

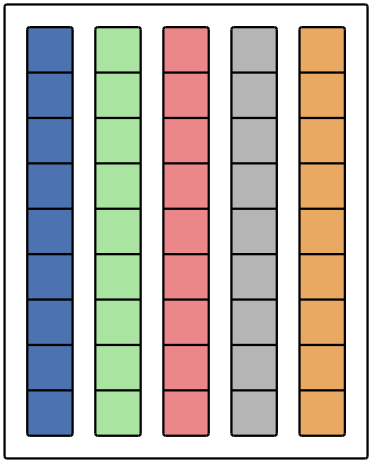
Compute: Witness the power of numexpr

- Uses numexpr under the hood for computation
- ... because numexpr can do **blocking** on **chunks**

```
>>> a = bcolz.arange(2e8, rootdir='a')
>>> b = bcolz.arange(2e8, rootdir='b')
>>> c = bcolz.eval('a**2 + 2 * b', rootdir='c')
>>> c
carray((200000000,), float64)
  nbytes: 1.49 GB; cbytes: 386.22 MB; ratio: 3.95
  cparams := cparams(clevel=5, shuffle=True, cname='blosclz')
  rootdir := 'c'
  mode    := 'a'
[  0.00000000e+00   3.00000000e+00   8.00000000e+00 ...,   3.99999992e+16
   3.99999996e+16   4.00000000e+16]
```

- Both a and b are about 1.5GB uncompressed

Layout of the `ctable`



- Columnar
- Heterogeneously typed
- **Columns**
- Every column $\rightarrow$ `carray`

Philosophy of `Bcolz`

- Keep it simple
- Expose a Cython interface to `carray`
- Layer everything else on-top

- **bquery** ← out of core groupby
- **dask** ← out-of-core abstraction
- **odo** ← convert from one format to another

Whats coming (maybe)

- Networked storage, e.g. S3
- Bcolz based server / database
- Better Cython interface
- True n-dimensionality (really?)

Summary (I)

- Everyone always asks me about the relationship of our toolstack

Summary (II)

- **Blosc**
  - The codec
- **Python-Blosc**
  - The Python bindings
- **Bloscpack**
  - Serialization format
  - Command-line interface
  - Fast Numpy serializer
- **Bcolz**
  - Compressed container(s)
  - In-memory and out-of-core
  - Analytics engine

Summary (III)

- **Bcolz** uses a vendored, older version of Bloscpack
- **Bcolz** interfaces with Blosc using it's own Cython bindings (not Python-Blosc)

Famous last words

- Links:
  - http://blosc.org
  - https://github.com/blosc
  - https://github.com/esc/blosc-and-friends
- Open source tools used to make this presentation:
  - Wiki2beamer
  - LaTeXbeamer
  - Dia
  - Pygments
  - Minted
  - Solarized theme for pygments