Turning the image processing wheel *faster* with *Cython* and *Numba*.

Nathan Faggian, PhD.

PyConAU, Hobart, 2013.

Contents

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IP[y]: IPython
Interactive Computing

Python emphasizes programmer time over machine time

http://stackoverflow.com/questions/3033329/why-are-python-programs-often-slower-than-the-equivalent-program-written-in-c-or

Other interpreted languages such as Java bytecode and .NET bytecode run faster than Python because the standard distributions include a JIT compiler that compiles bytecode to native code at runtime.

Cython

- **www.cython.org** : “Combined power of Python and C”
- Superset of the python language that allows calls to C functions and declarations of C types, leading to efficient C code from cython code.

Numba

- **numba.pydata.org:** “Just-In-Time specializing compiler”
- A compiler for python code with minimal markup that leverages off the low level virtual machine toolchain (LLVM).

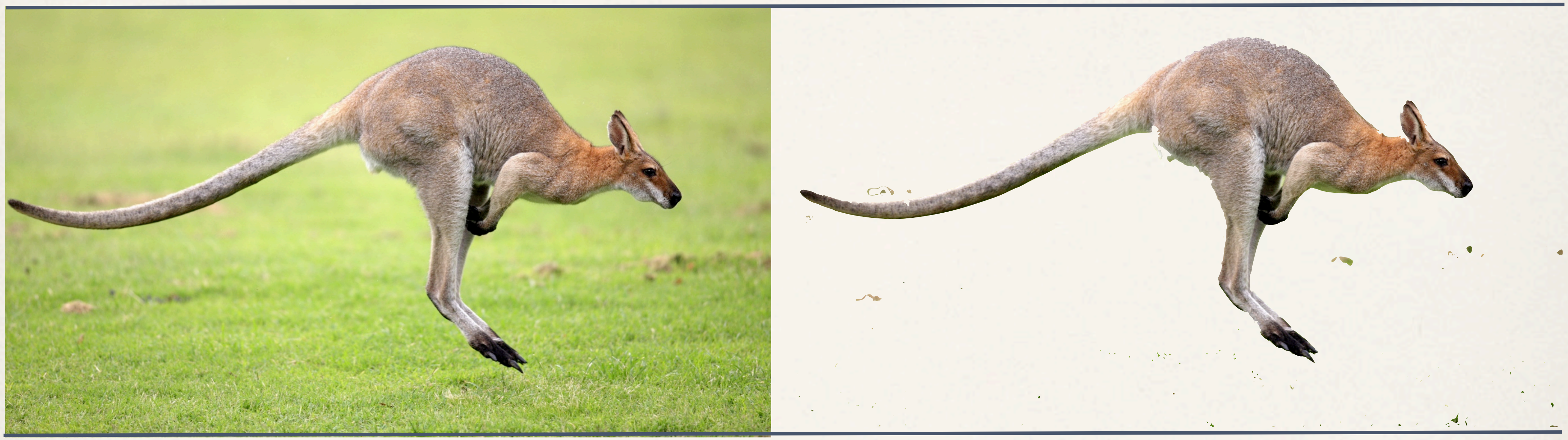


Image Segmentation

Partitioning of an image into regions of interest.

IP[y]: IPython
Interactive Computing

Basic Speed Comparison (timeit)

Python + Numpy	Cython	Numba
4.83 s per loop	**12.9 ms per loop**	**13.1 ms per loop**

http://stackoverflow.com/questions/8097408/why-python-is-so-slow-for-a-simple-loop

"CPython interpreter is doing some extra work that wastes time: specifically, it is binding the name x with the next object from the iterator, then when it evaluates the assignment it has to look up the name x again."

Cython

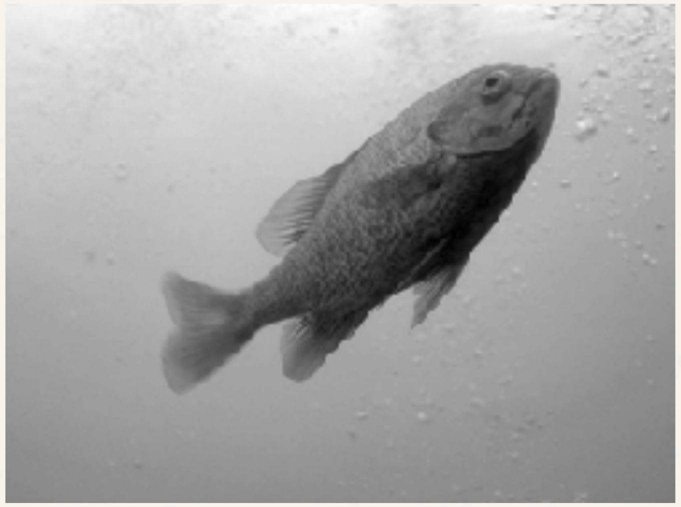
- Transform your python code into something more like C.
- Little understanding is required to obtain huge speed gains simply by statically typing.
- Nice integration with Numpy.

Numba

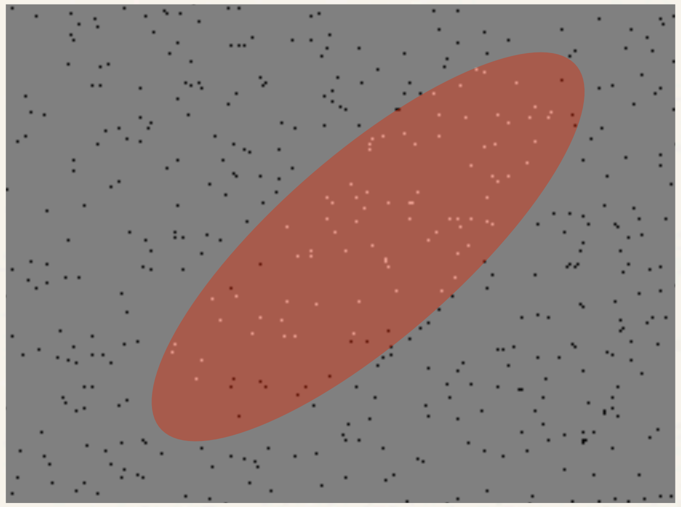
- Similar level of unfolding as Cython with less understanding required.
- Extreme simplicity, requires the LLVM toolchain to be installed.
- Get a copy of Anaconda: *http://www.continuum.io/*

GrowCut

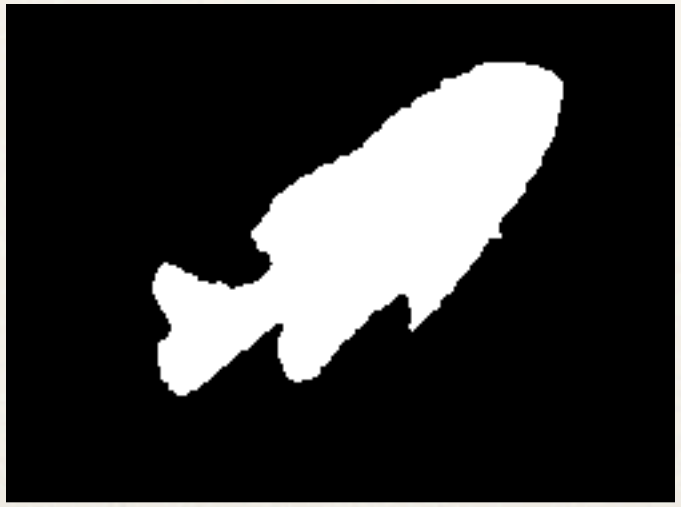
V. Vezhnevets, V. Konouchine. ***"Grow-Cut" - Interactive Multi-Label N-D Image Segmentation".*** *In Proceedings of the 2005 Conference, Graphicon. Pages 150 – 156.*



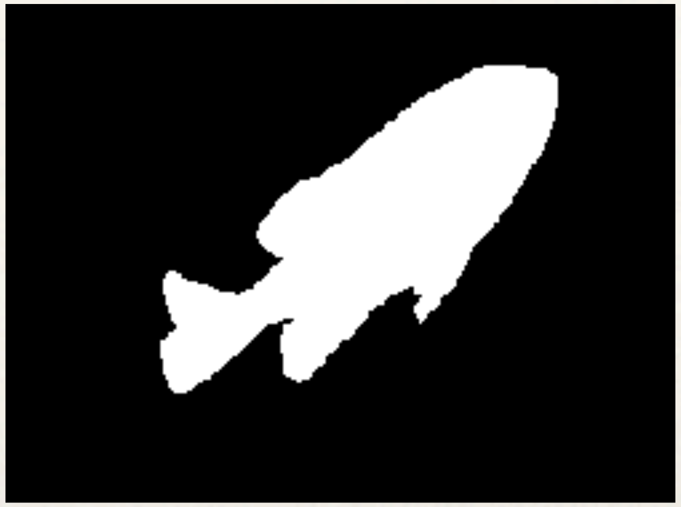
Bacteria



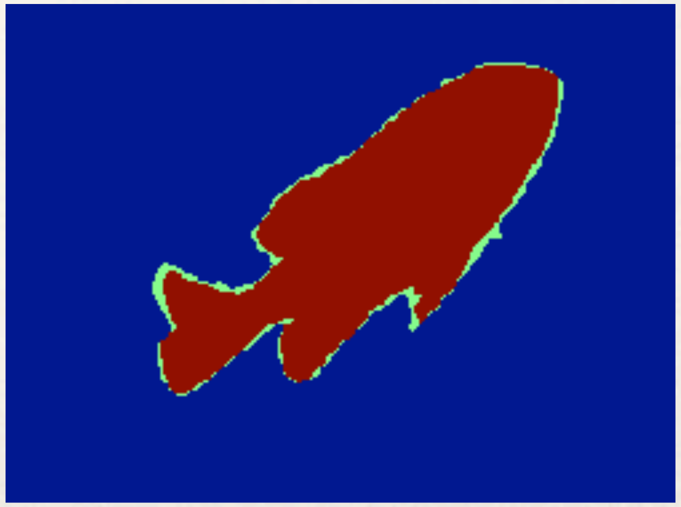
Human Segmentation



GrowCut



Overlap

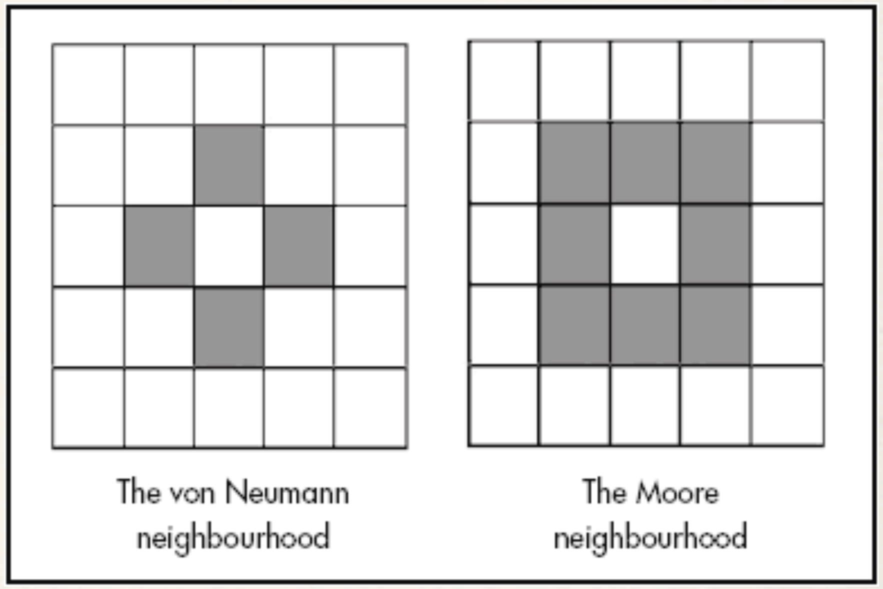


Algorithm

Code 1 Automata evolution rule

```
// For each cell...
for $\forall p \in P$
    // Copy previous state
    $l_p^{t+1} = l_p^t$;
    $\theta_p^{t+1} = \theta_p^t$;
    // neighbors try to attack current cell
    for $\forall q \in N(p)$
        if $g(\|\vec{C}_p - \vec{C}_q\|_2) \cdot \theta_q^t > \theta_p^t$
            $l_p^{t+1} = l_q^t$
            $\theta_p^{t+1} = g(\|\vec{C}_p - \vec{C}_q\|_2) \cdot \theta_q^t$
        end if
    end for
end for
```

kernel



$$g(x) = 1 - \frac{x}{\max \|\vec{C}\|_2};$$

IP[y]: IPython

Interactive Computing

Conclusions

- Easier than ever before to make use of tools to speed-up slow python code.
- IPython notebook is a great platform for tinkering with cython.
- Speed gap between Cython and Numba is almost negligible:

  Jake Vanderplas: *http://jakevdp.github.io*

- Numba is **fantastic** but is still less mature than Cython - different technology.
  - Exponential growth in the last couple of months.
  - Success of Continuum Analytics.
  - GPU/CPU targets.

Thanks

- **Stefan Van Der Walt**
  - Scikit-image : *http://scikit-image.org*
- **Aron Ahmadia**
  - Numba development team : *http://continuum.io/blog/numba_growcut*
- **Ed Schofield**
  - Melbourne python users group: *http://wiki.python.org/moin/MelbournePUG*

Questions?

https://github.com/nfaggian

https://github.com/stefanv

https://github.com/ahmadia