



Welcome to Python Boot Camp!

Fall
2013!

Objectives

- Introduce you to the Python language
- Get you writing Python code. Build Python hacking muscle memory
- Convince you of its utility in your research life
- Instill good coding and curation practices
- We try not to proselytize, but sometimes it's too hard to resist

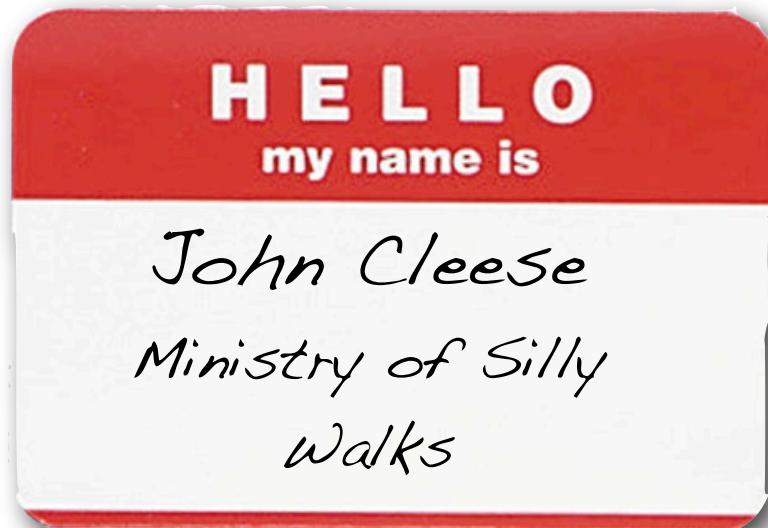
Organization

- 3 days of modules (1-1.5 hr) lectures + demos
<http://www.pythonbootcamp.info/lectures/>
- Breakout coding sessions (supervised) after each module
- Caffeine provided, Quick lunch on your own
- Homework (small code projects)
- Blood, sweat, tears → a more productive you

Connecting



#pyboot



Atlassian HipChat

Help prior to and during the August 2013 Berkeley Python Bootcamp

Welcome!	You're a guest in the Cal Bootcamp: Python for Science room. A list of people in the room is on the right.	<ul style="list-style-type: none">ChDaFeJosPai
----------	--	--

<http://tinyurl.com/pybootchat>

Cal Bootcamp: P...



Something you should know about us...

@profjsb

Introduction

- What is Python?
- Why Python?
- Getting Started...

What is Python?

Python is an interpreted, object-oriented, high-level programming language with dynamic semantics. Its high-level built in data structures, combined with dynamic typing and dynamic binding, make it very attractive for Rapid Application Development, as well as for use as a scripting or glue language to connect existing components together. Python's simple, easy to learn syntax emphasizes readability and therefore reduces the cost of program maintenance. Python supports modules and packages, which encourages program modularity and code reuse. The Python interpreter and the extensive standard library are available in source or binary form without charge for all major platforms, and can be freely distributed.

<http://www.python.org/doc/essays/blurb/>

What is Python?

<i>interpreted</i>	no need for a compiling stage
<i>object-oriented</i>	programming paradigm that uses objects (complex data structures with methods)
<i>high level</i>	abstraction from the way machine interprets & executes
<i>dynamic semantics</i>	can change meaning on-the-fly
<i>built in</i>	core language (not external)
<i>data structures</i>	ways of storing/manipulating data
<i>script/glue</i>	programs that control other programs
<i>typing</i>	the sort of variable (int, string)
<i>syntax</i>	grammar which defines the language
<i>library</i>	reusable collection of code
<i>binary</i>	a file that you can run/execute

Development History

- started over the Christmas break 1989, by Guido van Rossum (now at Google)
- developed in the early 1990s
- name comes from **Monty Python's Flying Circus**
- Guido is the Benevolent Dictator for Life (BDFL), meaning that he continues to oversee Python's development.



Development History

- Open-sourced development from the start (BSD licensed now)
<http://www.opensource.org/licenses/bsd-license.php>
- Relies on large community input (bugs, patches) and 3rd party add-on software
- Version 2.0 (2000), 2.6 (2008), 2.7 (2010). We're using **2.7.5** in this class
- Version 3.X (2008) is not backward compatible with 1.X & 2.X. But 2.7 code is “easily” migrated to 3.X

Why Python?

Some of the Alternatives

C, C++, FORTRAN

Pros: great performance, backbone of legacy scientific computing codes

Cons: syntax not optimized for causal programming, no interactive facilities, difficult visualization, text processing, etc.

Mathematics, Maple, Matlab, IDL

Pros: interactive, great visuals, extensive libraries

Cons: costly, proprietary, unpleasant for large-scale programs and non-mathematical tasks.

Perl: <http://www.strombergers.com/python/>

Why Python?

- ▶ Free (BSD license), highly portable (Linux, OSX, Windows, lots...)
- ▶ Interactive interpreter provided.
- ▶ Extremely readable syntax (“executable pseudo-code”).
- ▶ Simple: non-professional programmers can use it effectively
 - great documentation
 - total abstraction of memory management
- ▶ Clean object-oriented model, but not mandatory.
- ▶ Rich built-in types: lists, sets, dictionaries (hash tables), strings, ...
- ▶ Very comprehensive standard library (batteries included)
- ▶ Standard libraries for IDL/Matlab-like arrays (NumPy)
- ▶ Easy to wrap existing C, C++ and FORTRAN codes.

Why Python?

Amazingly Scalable

Interactive experimentation
build small, self-contained scripts or million-lines projects.
From occasional/novice to full-time use (try that with C++).

The Kitchen Sink (in a good way)

really can do anything you want, with impressive simplicity

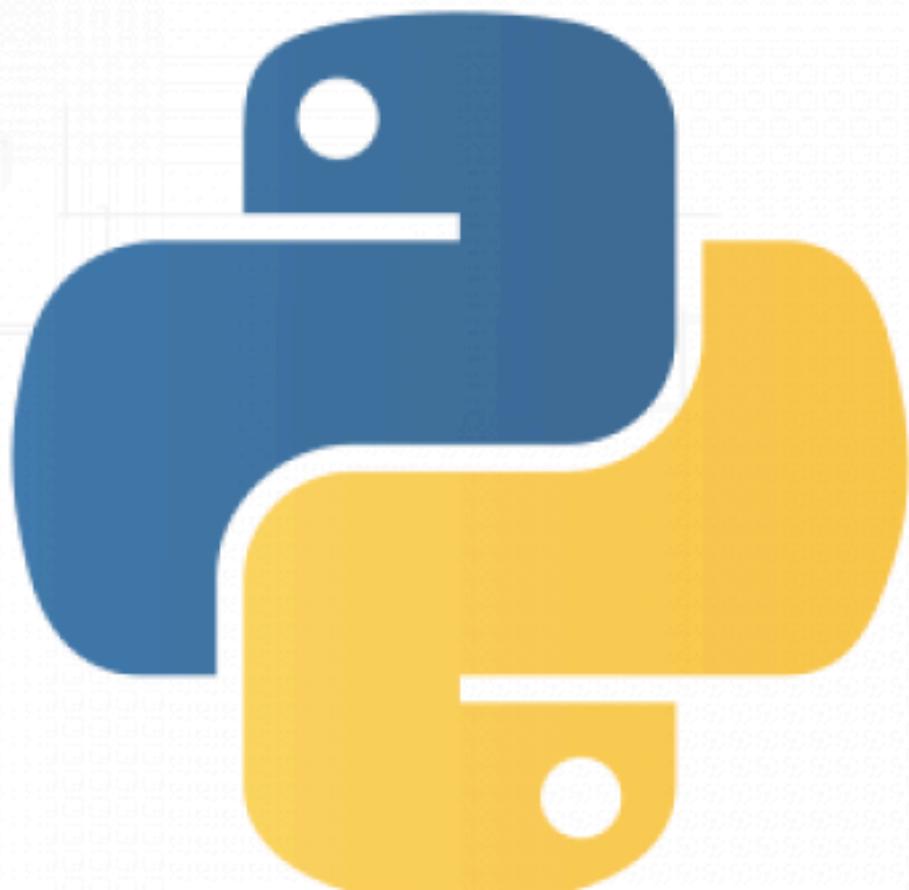
Performance, if you need it

As an interpreted language, Python is slow.
But...if you need speed you can do the heavy lifting in C or FORTRAN
or you can use a Python compiler (e.g. Cython)

Home ›

Readers' Choice Awards 2011

Dec 01, 2011 By Shawn Powers



Best Programming Language

Python

Runner-up: C++

A three-time winner in our best programming category, Python continues to dominate. Close on its heels this year, however, is C++. In fact, a scant 6% separated the two. It's quite obvious, however, that our readers don't suffer from ophidiophobia in the least —hiss.

My group uses it for....

Running a robotic telescope

- interfacing with legacy hardware device drivers
- talking over serial & parallel lines to telescope control hardware
- oversee functioning of all sub-systems (themselves written in Python)
- sending email and pager alerts when distressed
- writing real-time web pages (for data display, weather)
- moving image data over the network
- interacting with databases

<http://pairitel.org>

My group uses it for....

Data reduction & Analysis

- processing FITS images quickly
- wrapping around 3rd party software

A Handy & Quick Calculator

Prototyping new algorithms/ideas

Making plots for papers

Making fast, parallel, and efficient webservices

My group uses it for....

Writing Google-hosted (cloud-based) websites
that we use for research (& collaboration)

The screenshot shows a dark-themed web application interface for PTFInfoBot. At the top, there's a navigation bar with links for Home, Preferences, PTF Sources, Keywords, Contact, and Links. Below the navigation, there's a timeline of events:

- 2010-08-02 05:28:37.701861: Welcome to PTFInfoBot. Source [10pvh](#) added. 1 email(s) regarding this source.
- 2010-08-02 05:28:36.022048: What PTFInfoBot Does. Source [10oet](#) added. 1 email(s) regarding this source.
- 2010-08-02 05:28:35.270651: Source [10qfo](#) added. 2 email(s) regarding this source.
- 2010-08-02 05:28:35.032813: Some examples of what you can do with PTFInfoBot. Source [10mbw](#) added. 1 email(s) regarding this source.

The main content area contains two sections: "Welcome to PTFInfoBot" and "What PTFInfoBot Does". The "Welcome" section includes a brief description of the app's purpose. The "What PTFInfoBot Does" section provides instructions on how to use the service, mentioning email processing and keyword tracking.

Many Others Use it Too



Google



Honeywell



LSST

devis

You Tube
Broadcast Yourself

EVE
ONLINE

USA
United Space Alliance

INDUSTRIAL
LIGHT & MAGI

AstraZeneca

Pollenation Internet.

PHILIPS

Quora

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Eventbrite

Verity

GravityZoo



Dropbox

your
grandmother



IP[y]: Notebook

bootcamp fun (unsaved changes)

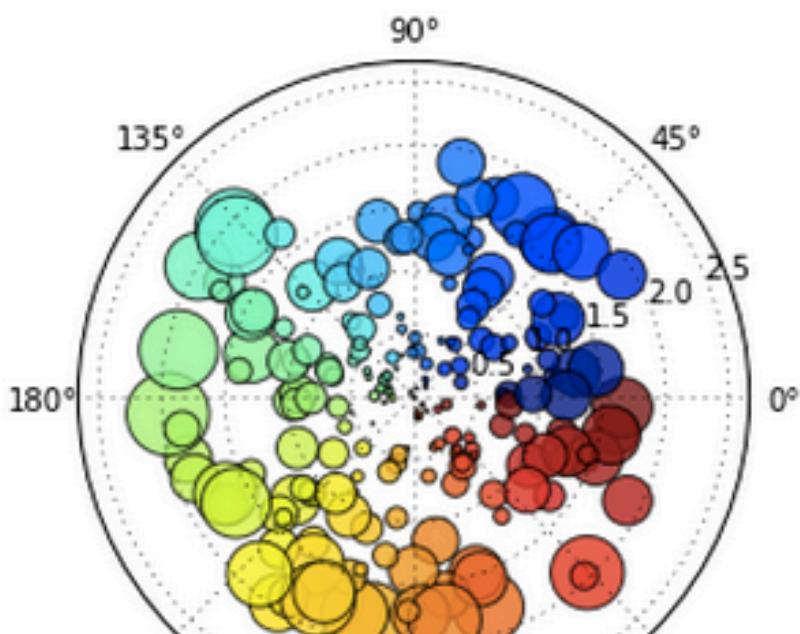
File Edit View Insert Cell Kernel Help



In [6]: `%pylab inline`

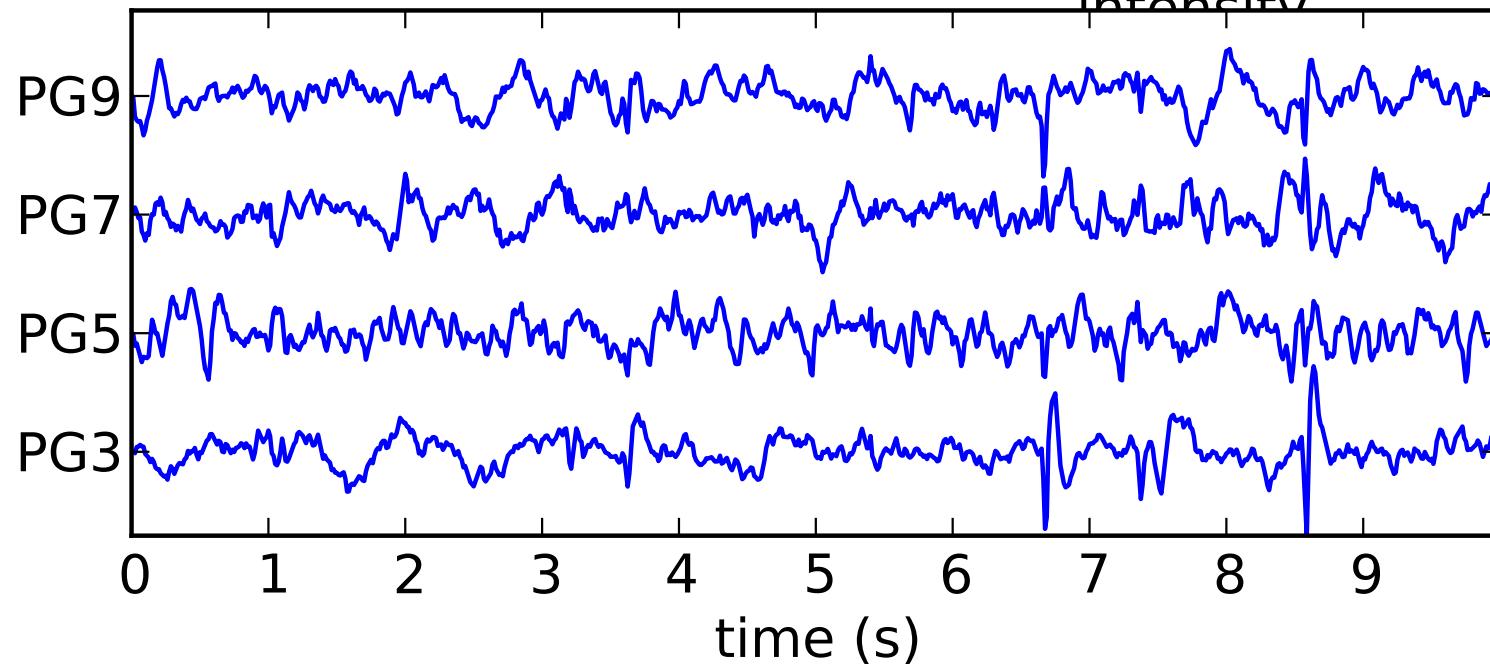
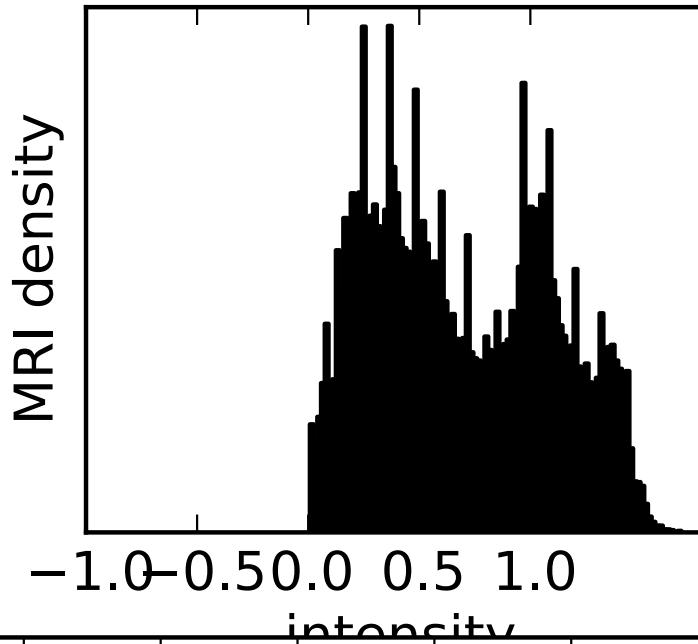
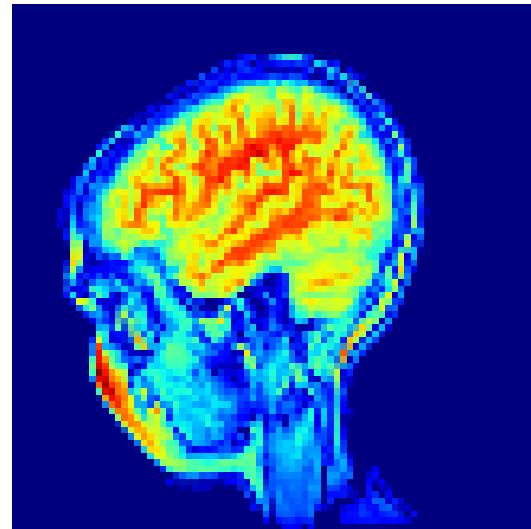
Populating the interactive namespace from numpy and matplotlib

In [7]: `num_bootcampers = 212
r = 2*rand(num_bootcampers)
theta = 2*pi*rand(num_bootcampers)
area = 200*r**2*rand(num_bootcampers)
ax = subplot(111,polar=True)
c = scatter(theta,r,c=theta,s=area,alpha=0.75)`



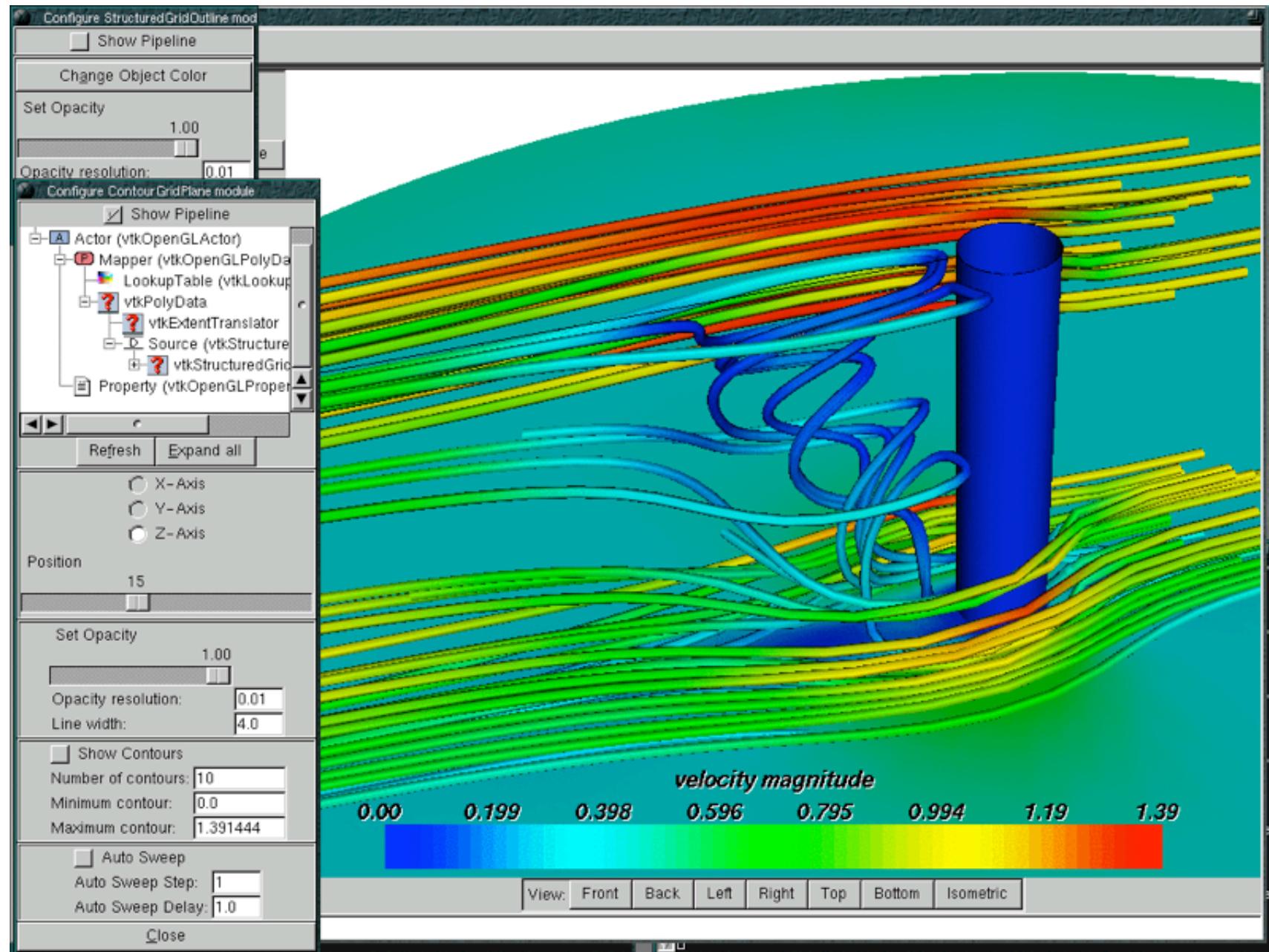
IPython notebook:
- interactive
- versionable
- reproducible

Visualization

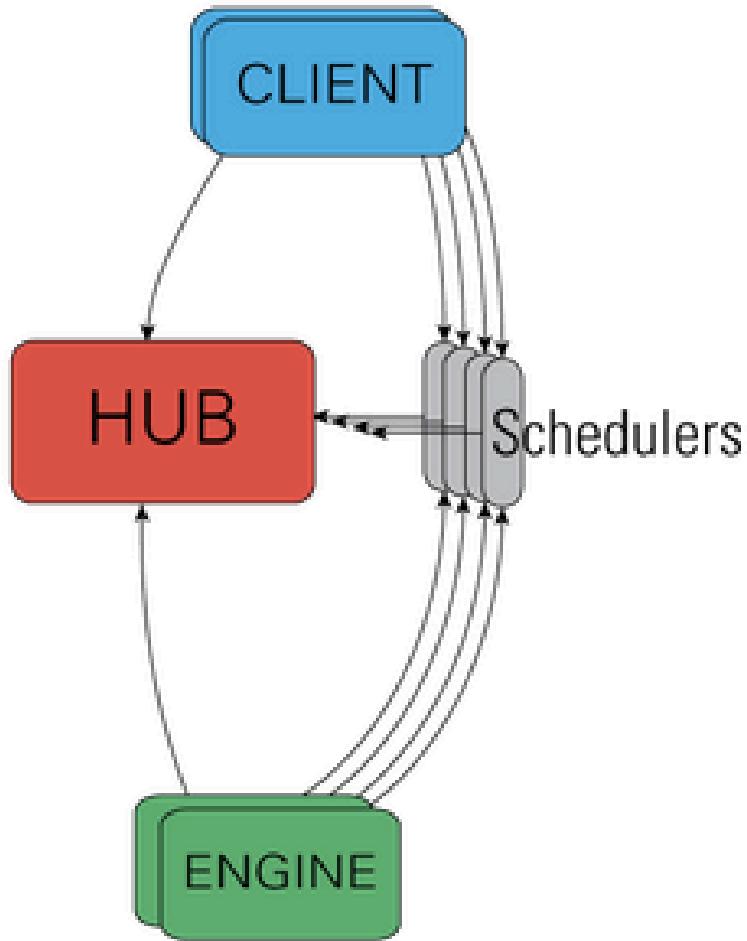


matplotlib

Visualization

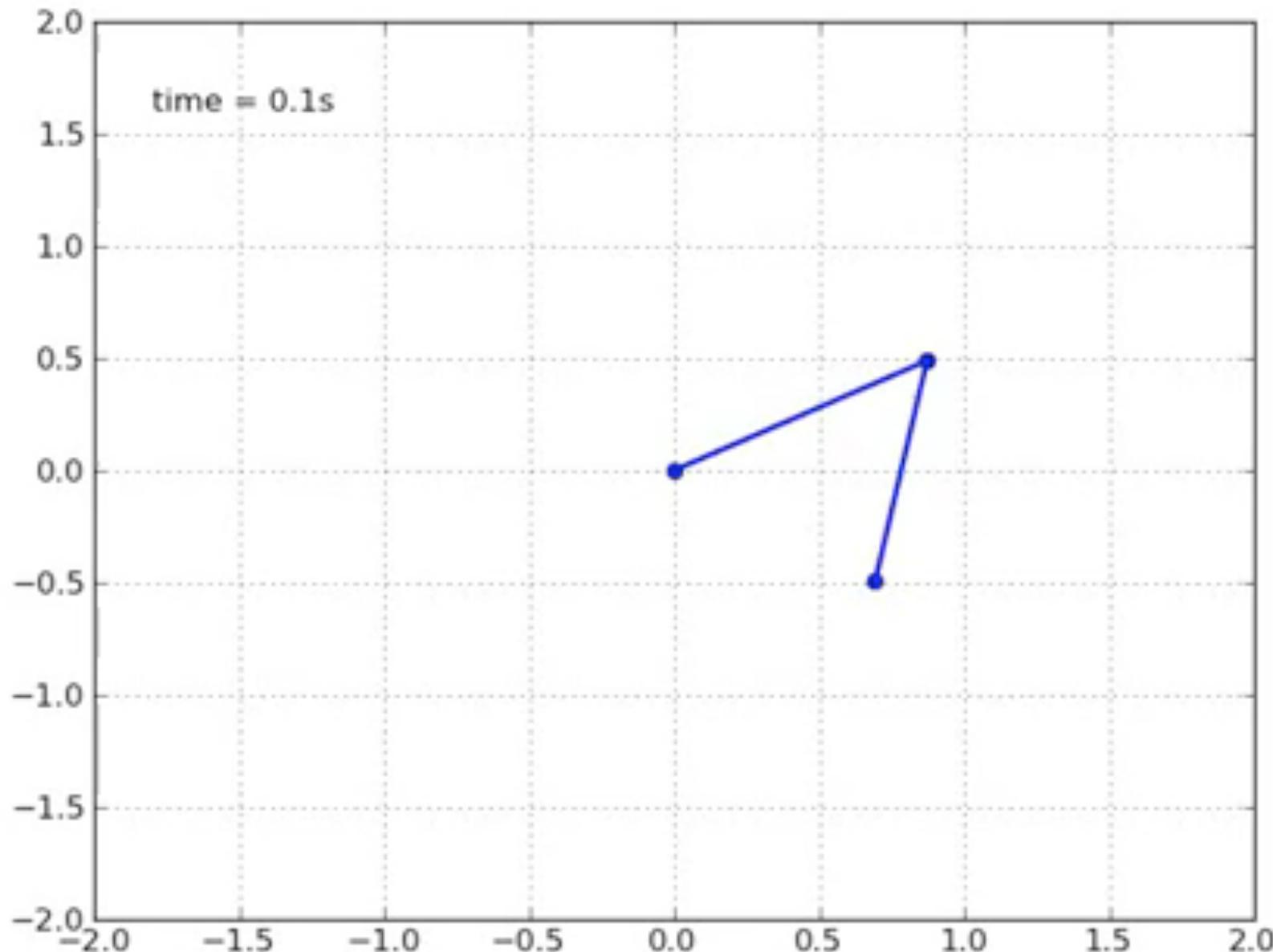


Mayavi



Parallelization is now
very accessible
(via the IPython notebook)

Animation



http://matplotlib.sourceforge.net/examples/animation/double_pendulum_animated.html

Tackling Python: Let's Get Started



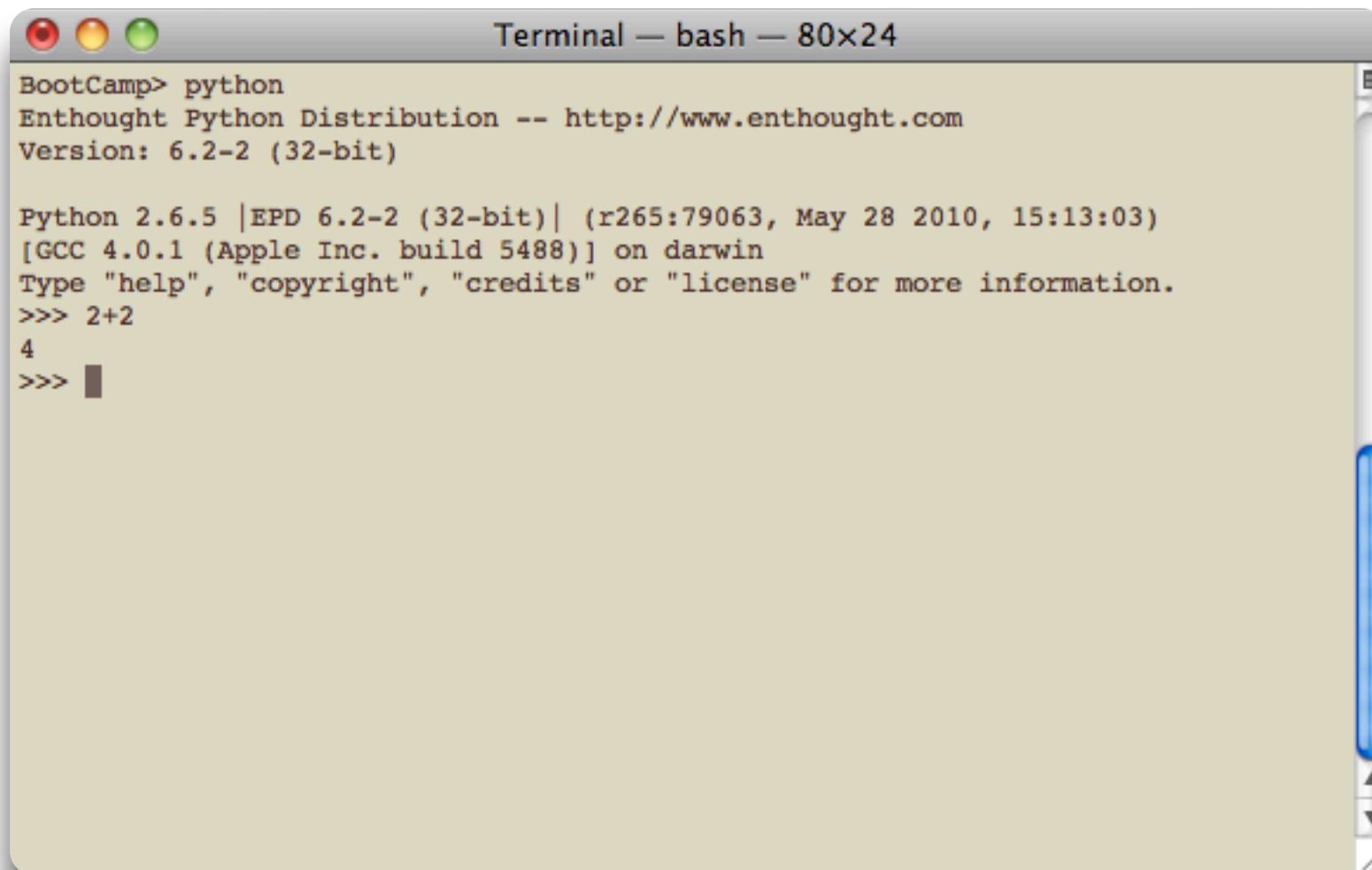
Asking Questions during Module presentations

- Speak up - Raise your hand
- Post questions to the chat (<http://tinyurl.com/pybootchat>)

Getting Help at Any Time

- Raise your hand and make eye contact with a counselor
- Join the chat (<http://tinyurl.com/pybootchat>)
- Send email ucbpythonclass+bootcamp@gmail.com
 - Twitter Hashtag: #pyboot

Firing up the Interpreter



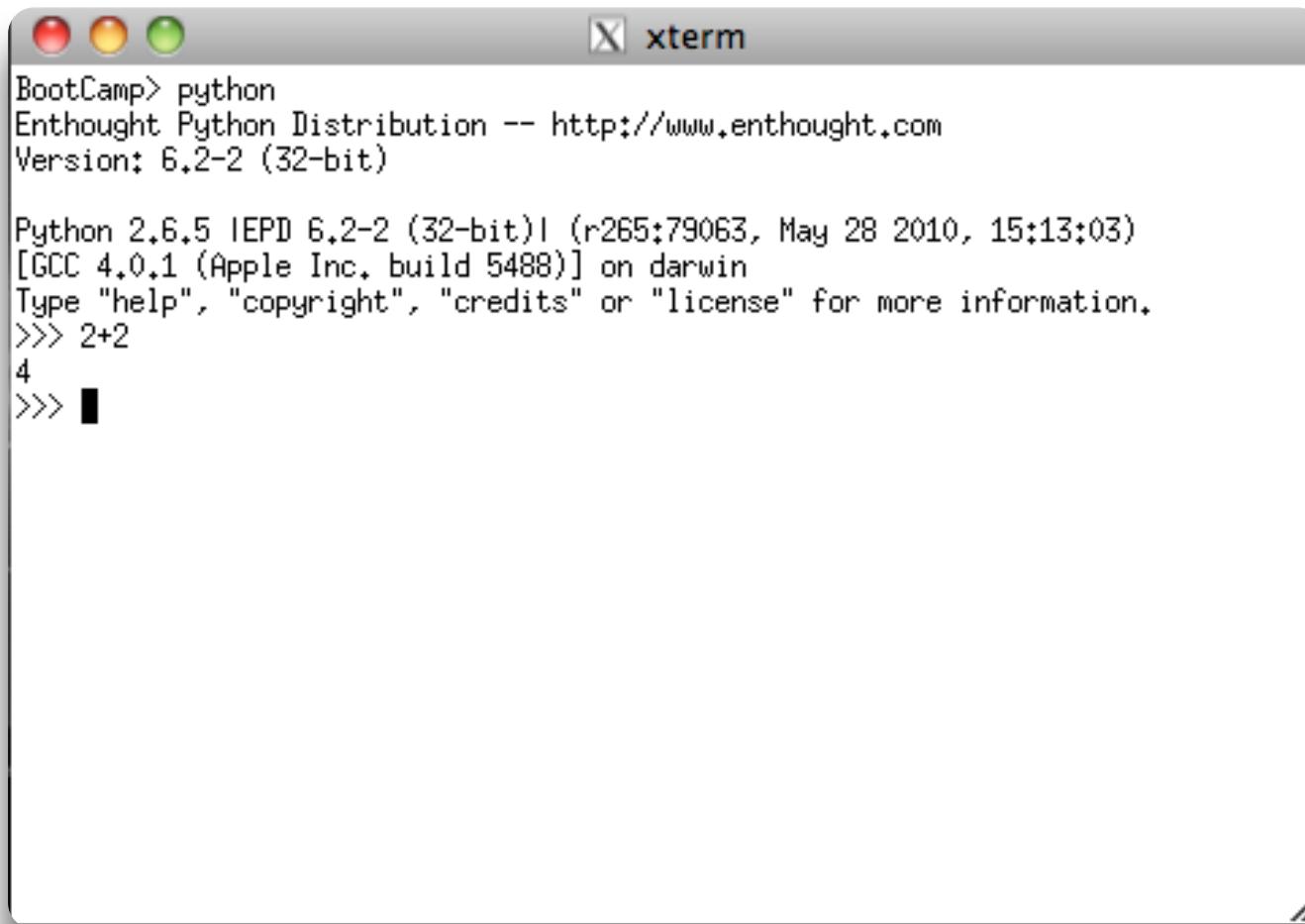
The image shows a Mac OS X Terminal window titled "Terminal — bash — 80x24". The window contains the following text:

```
BootCamp> python
Enthought Python Distribution -- http://www.enthought.com
Version: 6.2-2 (32-bit)

Python 2.6.5 |EPD 6.2-2 (32-bit)| (r265:79063, May 28 2010, 15:13:03)
[GCC 4.0.1 (Apple Inc. build 5488)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> 2+2
4
>>> █
```

Mac OS X (Terminal)

Firing up the Interpreter



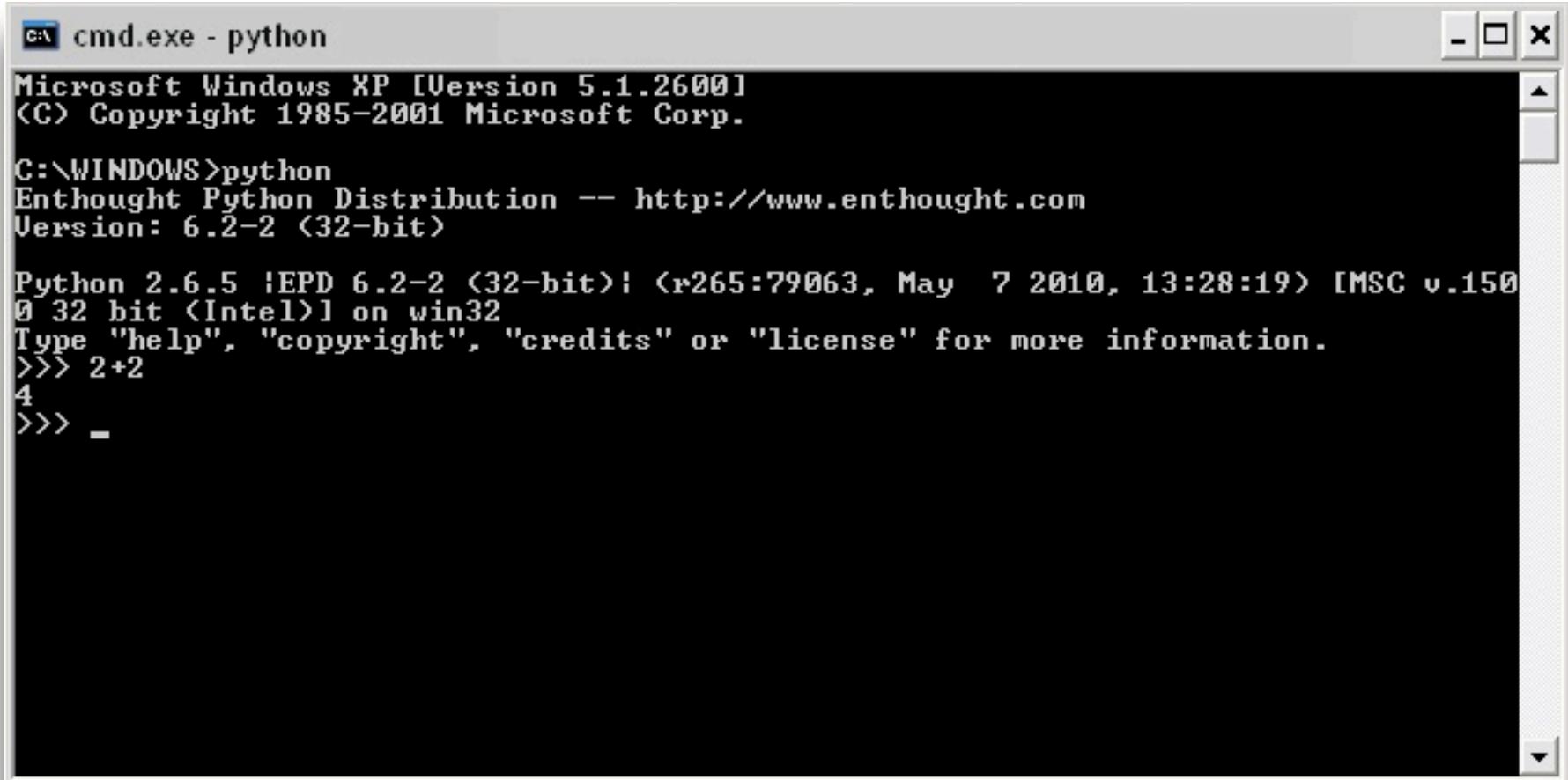
The image shows a screenshot of an xterm window on a Mac OS X desktop. The window title is "xterm". Inside the terminal, the following text is displayed:

```
BootCamp> python
Enthought Python Distribution -- http://www.enthought.com
Version: 6.2-2 (32-bit)

Python 2.6.5 |EPD 6.2-2 (32-bit)| (r265:79063, May 28 2010, 15:13:03)
[GCC 4.0.1 (Apple Inc. build 5488)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> 2+2
4
>>> █
```

Linux/UNIX/Mac OS X (X11/Xterm)

Firing up the Interpreter



The screenshot shows a Microsoft Windows XP command prompt window titled "cmd.exe - python". The window displays the following text:

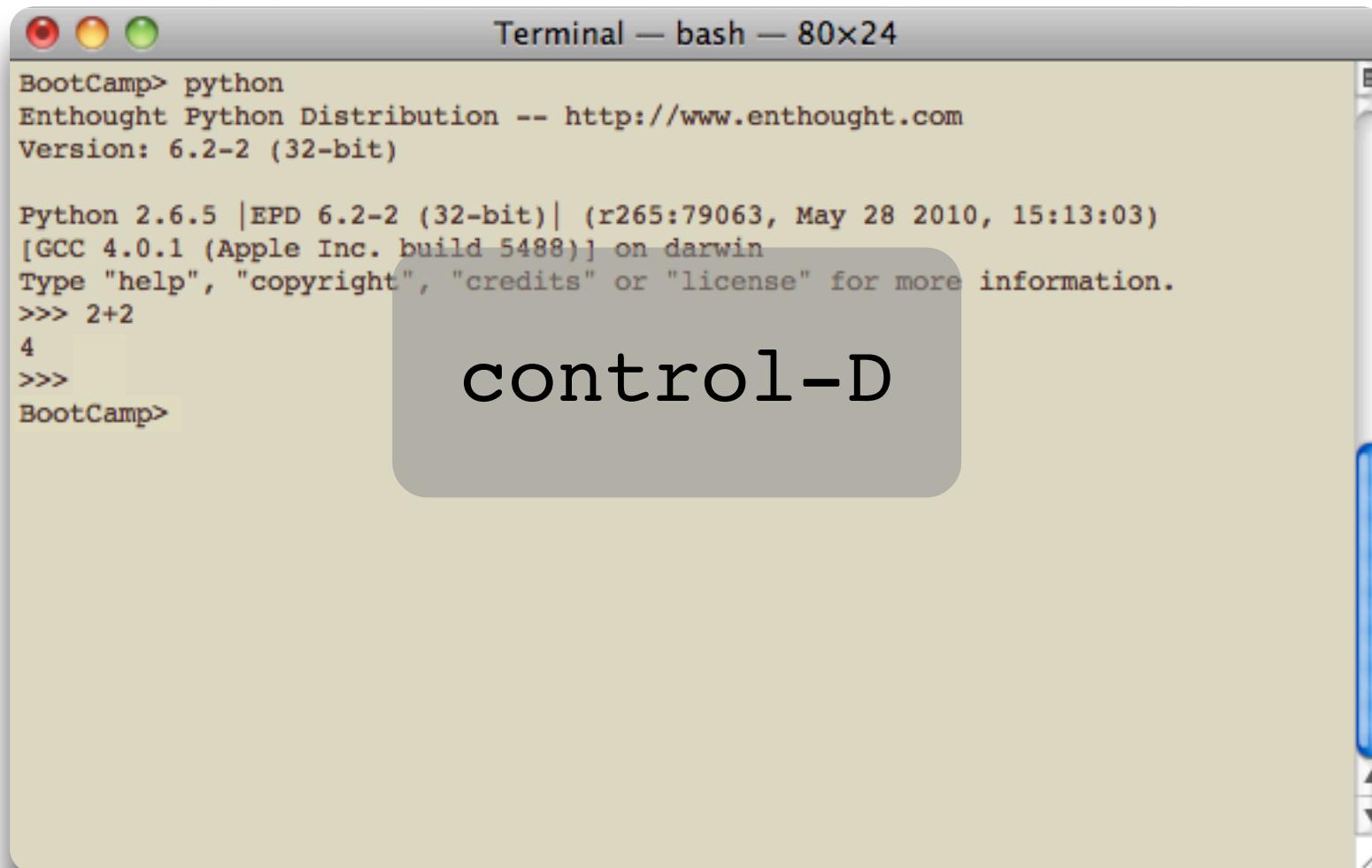
```
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\WINDOWS>python
Enthought Python Distribution -- http://www.enthought.com
Version: 6.2-2 (32-bit)

Python 2.6.5 |EPD 6.2-2 (32-bit)| (r265:79063, May  7 2010, 13:28:19) [MSC v.150
0 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> 2+2
4
>>> _
```

Windows

Firing up the Interpreter



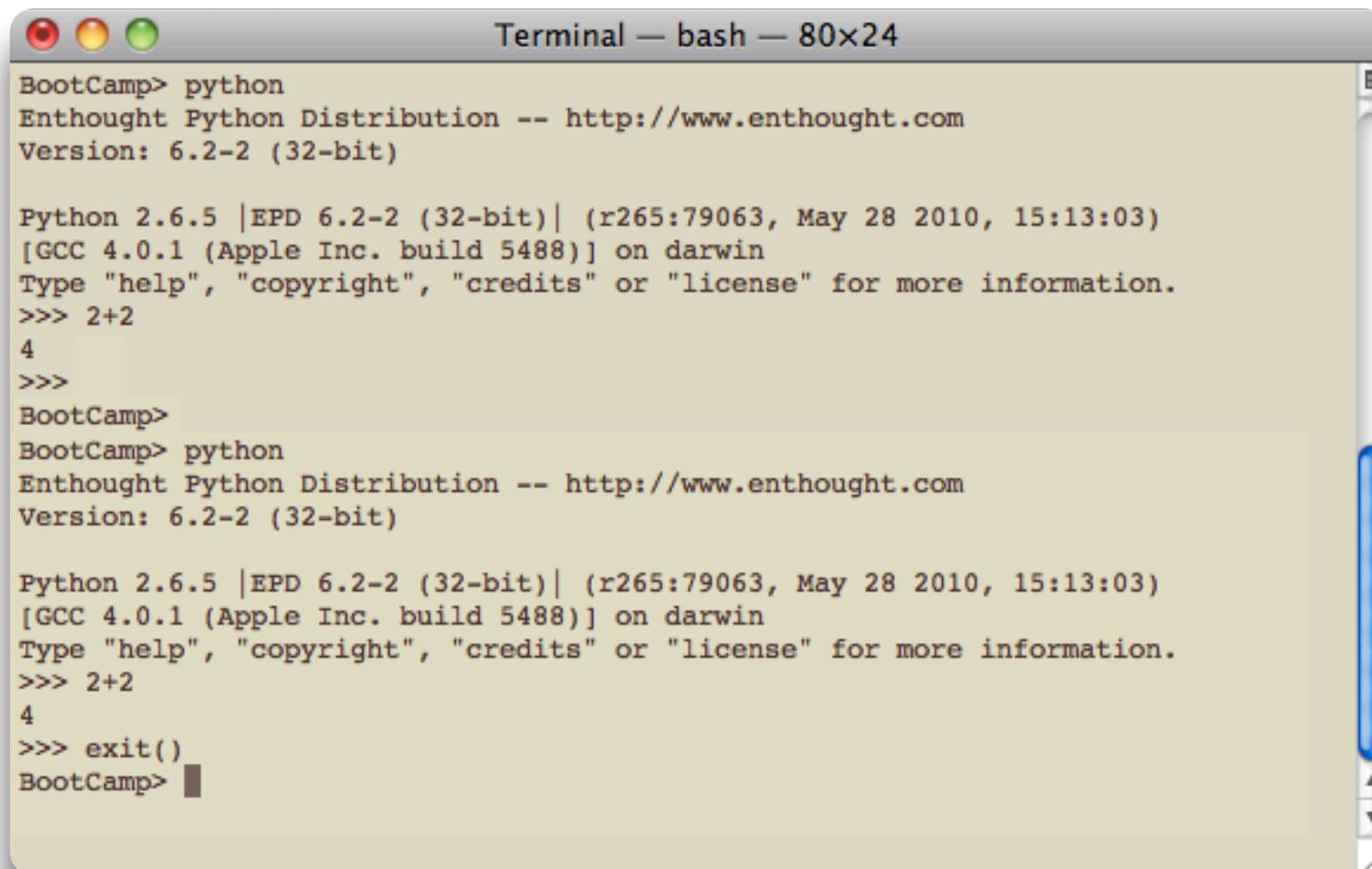
```
BootCamp> python
Enthought Python Distribution -- http://www.enthought.com
Version: 6.2-2 (32-bit)

Python 2.6.5 |EPD 6.2-2 (32-bit)| (r265:79063, May 28 2010, 15:13:03)
[GCC 4.0.1 (Apple Inc. build 5488)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> 2+2
4
>>>
BootCamp>
```

control-D

to exit: either **control-D** or **exit()**

Firing up the Interpreter



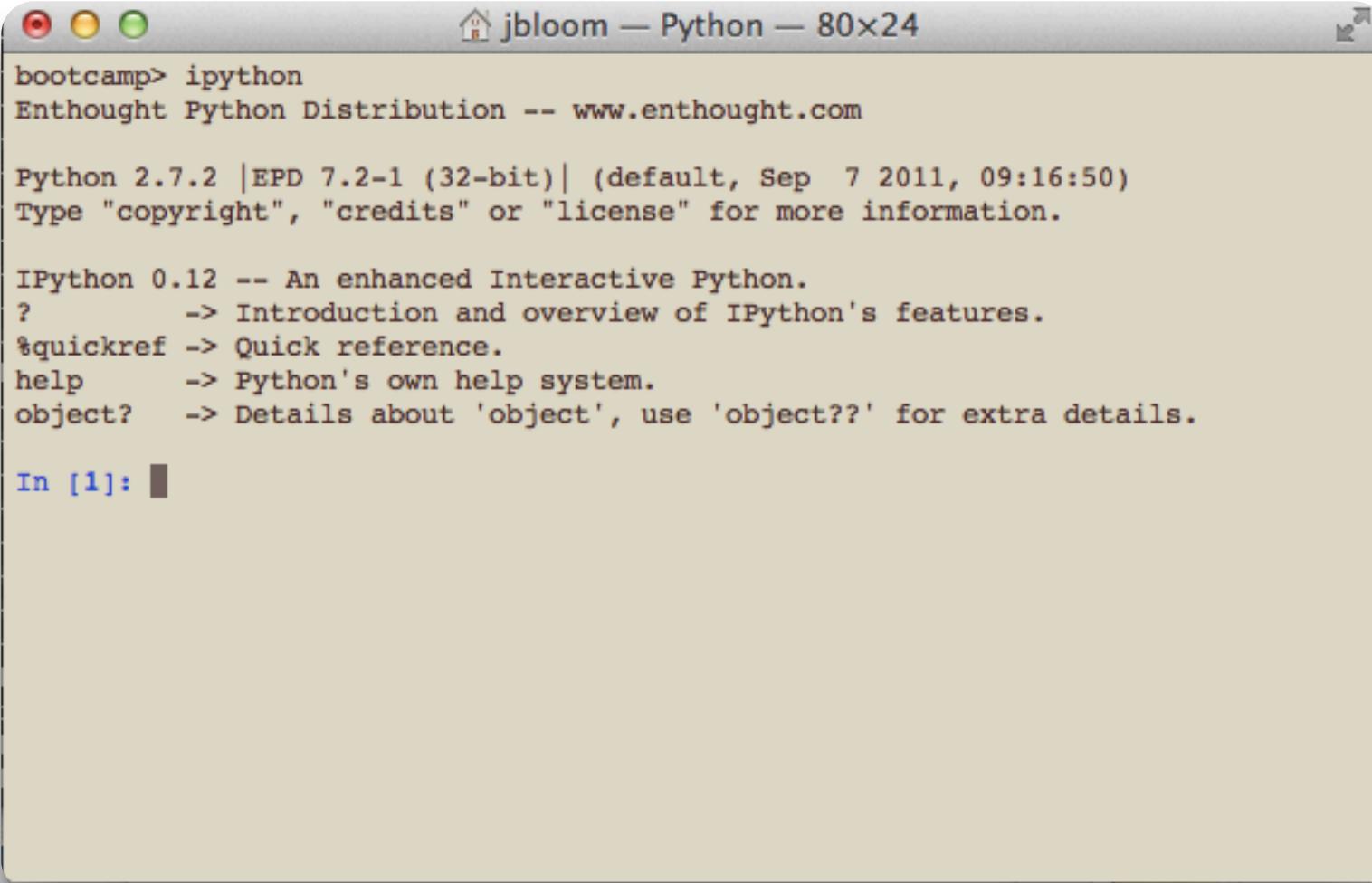
```
BootCamp> python
Enthought Python Distribution -- http://www.enthought.com
Version: 6.2-2 (32-bit)

Python 2.6.5 |EPD 6.2-2 (32-bit)| (r265:79063, May 28 2010, 15:13:03)
[GCC 4.0.1 (Apple Inc. build 5488)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> 2+2
4
>>>
BootCamp>
BootCamp> python
Enthought Python Distribution -- http://www.enthought.com
Version: 6.2-2 (32-bit)

Python 2.6.5 |EPD 6.2-2 (32-bit)| (r265:79063, May 28 2010, 15:13:03)
[GCC 4.0.1 (Apple Inc. build 5488)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>> 2+2
4
>>> exit()
BootCamp>
```

to exit: either **control-D** or **exit()**

Firing up the Interpreter



```
bootcamp> ipython
Enthought Python Distribution -- www.enthought.com

Python 2.7.2 |EPD 7.2-1 (32-bit)| (default, Sep  7 2011, 09:16:50)
Type "copyright", "credits" or "license" for more information.

IPython 0.12 -- An enhanced Interactive Python.
?          -> Introduction and overview of IPython's features.
%quickref -> Quick reference.
help       -> Python's own help system.
object?    -> Details about 'object', use 'object??' for extra details.

In [1]:
```

ipython

Editing Python Files



```
geohash2.py — Code
* jsbcmd.py * lc.py * lockfile.py * makeps.py * models.py * marshal.py * nat.py * newcm.py * oa

def union (self,other):-
    other = str(other)
    hash = self.hash
    for i in range(min(len(self.hash),len(other))):-
        if self.hash[i] != other[i]:-
            hash = self.hash[:i] + ("1" * (self.depth*2))
            break
    return type(self)(hash,self.bound,self.depth)

__add__ = union

class Geohash (Geostring):-
    BASE_32 = "0123456789bcdefghjklmnpqrstuvwxyz"->

    def bitstring (cls,coord,bound=defbound,depth=defdepth):-
        bits = Geostring.bitstring(coord,bound,depth)
        hash = ""
        for i in range(0,len(bits),5):-
            m = sum([int(n)<<(4-j) for j,n in enumerate(bits[i:i+5])])
            hash += cls.BASE_32[m]
        return hash
    bitstring = classmethod(bitstring)

    def bbox (self,prefix=None):-
        if not prefix: prefix=len(self.hash)
        bits = [[n>>(4-i)&1 for i in range(5)]->
                for n in map(self.BASE_32.find, self.hash)]
        bits = reduce(lambda x,y:x+y, bits, [])
        return self._to_bbox(bits)

Line: 188 Column: 44 Python Soft Tabs: 4 def bitstring (cls,coord,bound=defbound,depth=defdepth):-
```



usually we name
python files with
a .py suffix

- snazzy GUI-based editors:

Sublime Text, TextWrangler (Mac);
NotePad++, SublimeText (Windows);
KWrite, Scribes, eggy (linux)

- old/powerful editors:

vim, emacs, nano, ...

<http://www.sublimetext.com/2>

<http://wiki.python.org/moin/PythonEditors>

```
Py4Science> ipython notebook
[NotebookApp] Using existing profile dir: u'/Users/jbloom/.ipython/profile_default'
[NotebookApp] Serving notebooks from local directory: /Users/jbloom/Dev/ipython
[NotebookApp] The IPython Notebook is running at: http://127.0.0.1:8888/
[NotebookApp] Use Control-C to stop this server and shut down all kernels.
```

The screenshot shows a web browser window displaying an IPython Notebook. The title bar indicates the page is 'ipython — Python BootCamp 2012 — 114x41'. The main content area is titled 'IP[y]: Notebook' and shows a notebook titled 'My First Notebook!' last saved on Aug 13 11:40 AM. A toolbar above the notebook includes standard browser controls (back, forward, search) and specific notebook actions like 'Code'. Below the toolbar, a code cell labeled 'In [3]' contains the Python code 'a = 1' followed by 'print(a)'. The output of this cell is '1'. A new cell labeled 'In []:' is visible at the bottom, ready for input.

127.0.0.1:8888/9d1601a2-cafb-4749-977e-4934bbe50fd6

ABP

IP[y]: Notebook

My First Notebook!

Last saved: Aug 13 11:40 AM

File Edit View Insert Cell Kernel Help

In [3]:

```
a = 1
print(a)
```

1

In []: