



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

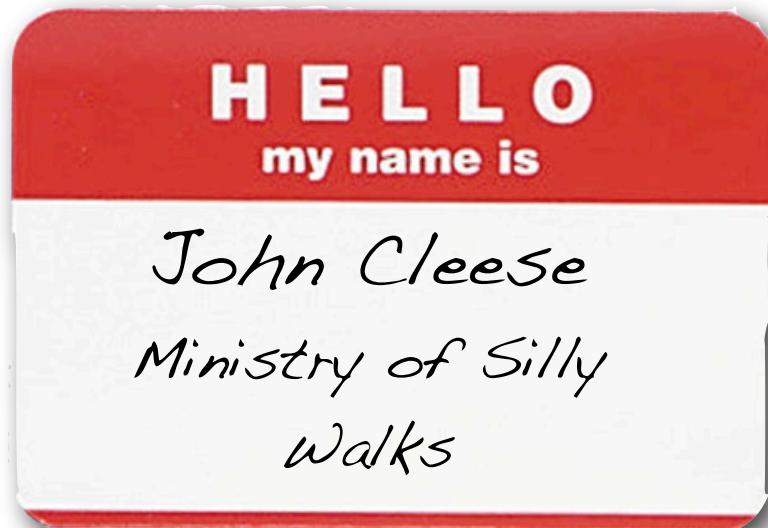
# Organization

- 3 days of modules (~1 hour) lectures + demos  
<http://www.pythonbootcamp.info/schedule>
- 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"><li>Ch</li><li>Da</li><li>Fe</li><li>Jos</li><li>Pai</li></ul>
----------	------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------

<http://tinyurl.com/pybootchat>

Cal Bootcamp: P...

# Shout out



**Vice Chancellor for Research**

*Kassie Darling, Kaja Sehert*



**BIGDATA Grant**



**github**  
SOCIAL CODING



**Something you should know about us...**

@profjsb, @fperez\_org

# 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 Dropbox)
- 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.

### **Mathematica, Maple, Matlab, IDL**

Pros: interactive, great visuals, extensive libraries

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

**Perl:** <http://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

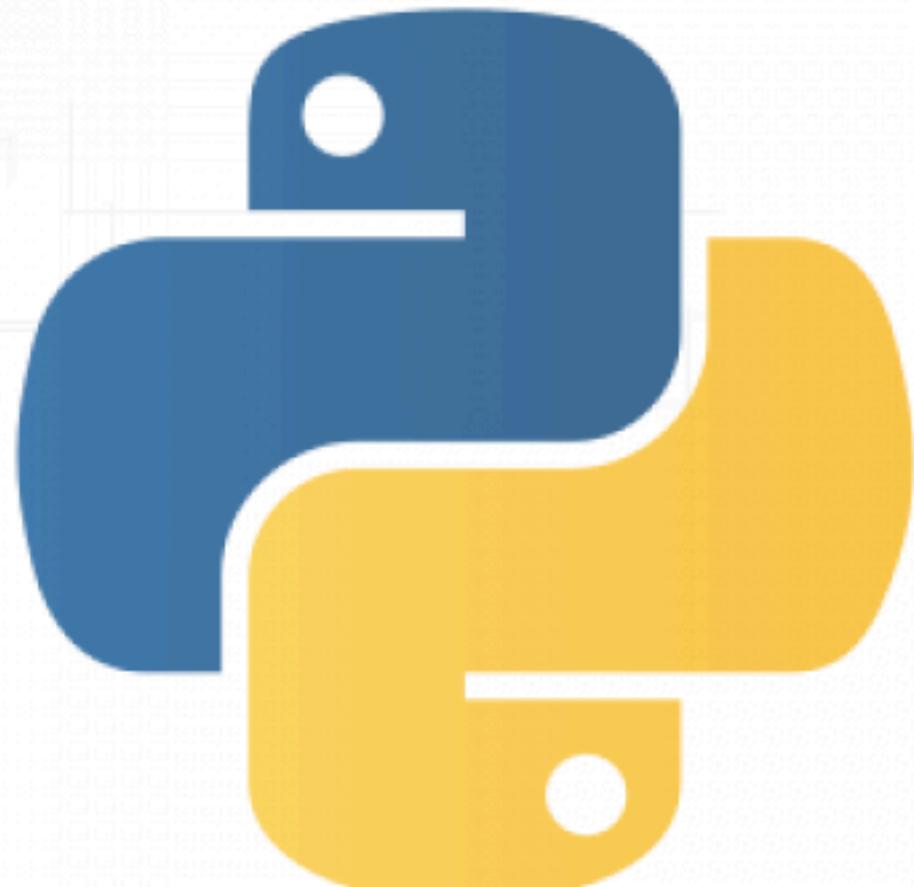
As an interpreted language, Python is slow.

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**

# Many Others Use it Too



Google



reddit



Honeywell



LSST



You Tube  
Broadcast Yourself



USA  
*United Space Alliance*



Quora  
Pollenation Internet.

PHILIPS

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Eventbrite

Verity

GravityZoo



Dropbox

your  
grandmother



# IP[y]: Notebook

bootcamp fun (unsaved changes)

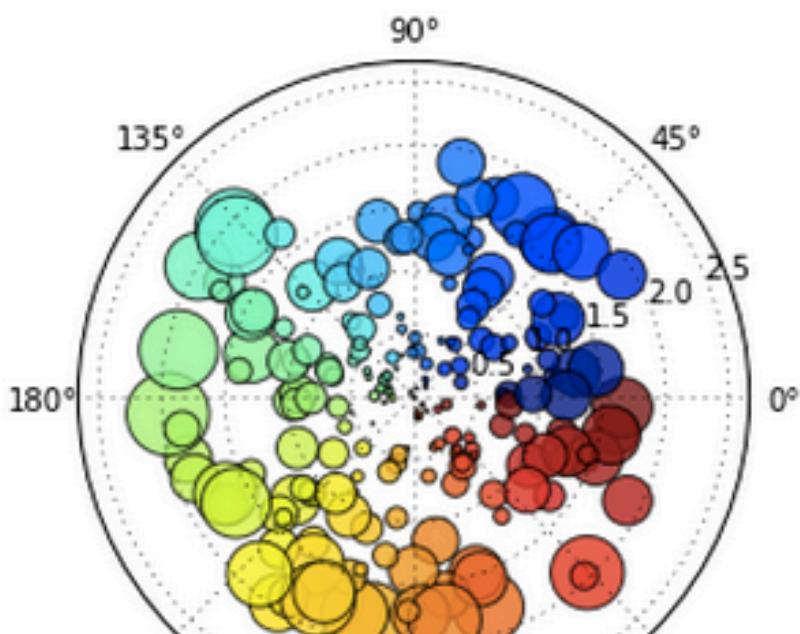
File Edit View Insert Cell Kernel Help



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

# IPython Notebook is Gaining Major Acceptance

Analyzing IBM Watson Experiments  
With IPython Notebook

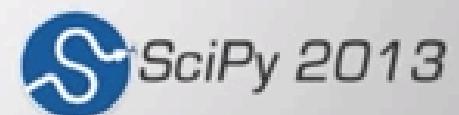


Torsten Bittner  
IBM Emerging Technologies  
[@torstenbittner](https://twitter.com/torstenbittner)



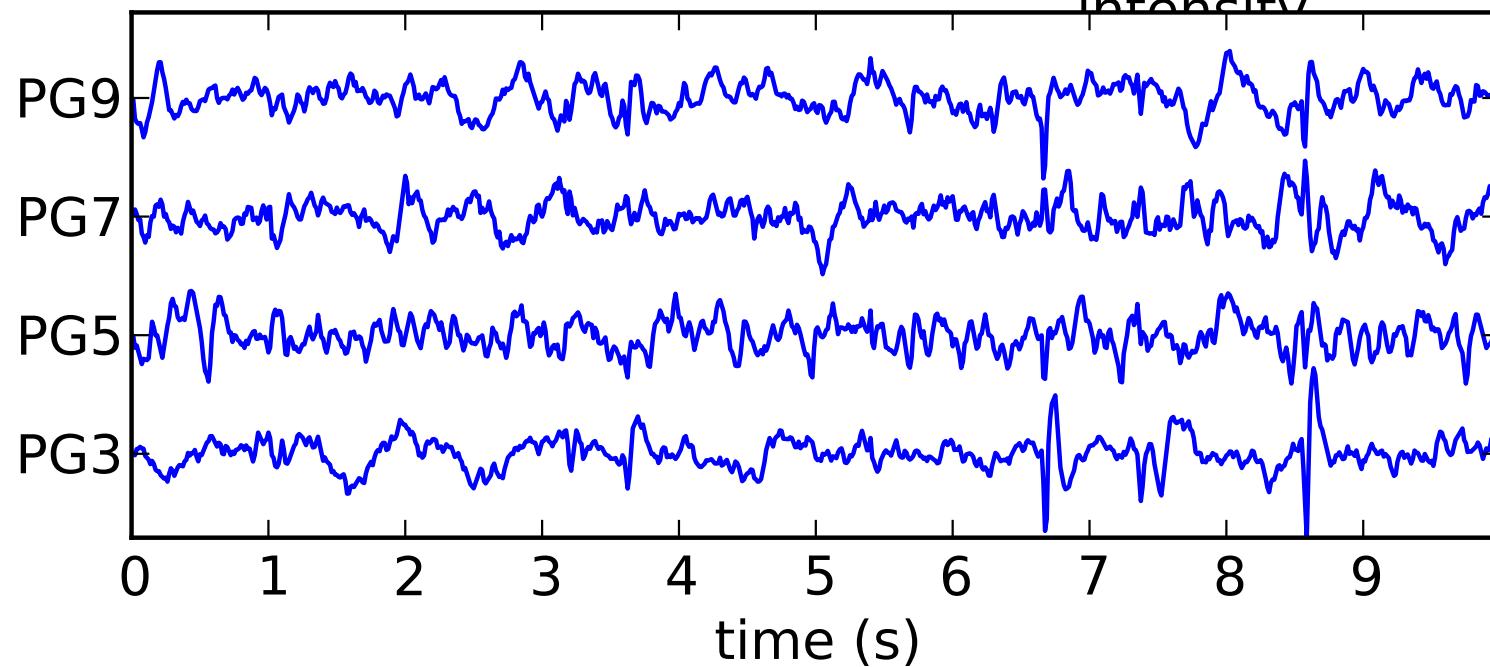
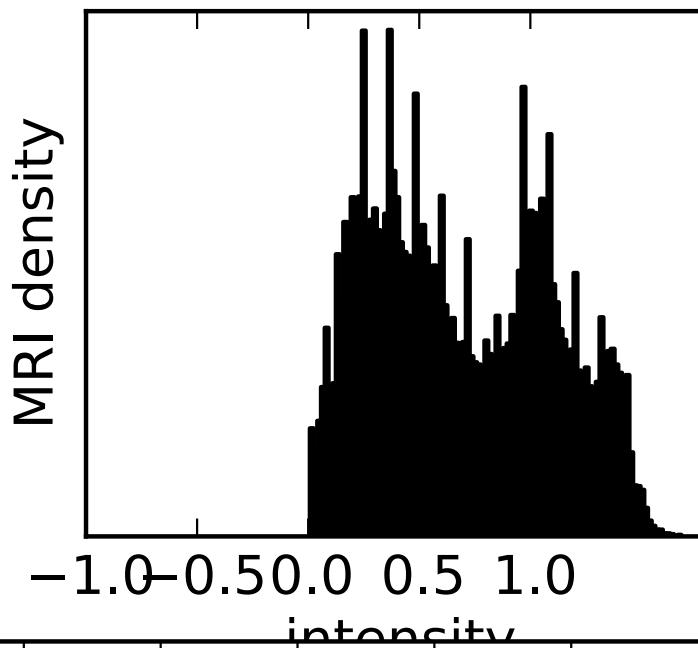
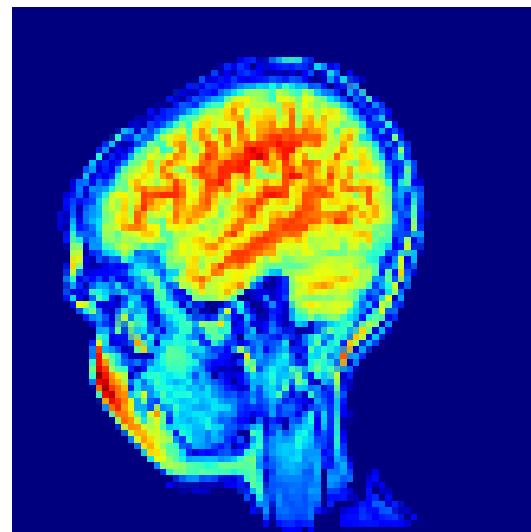
SciPy 2013, Austin TX, USA

June 27, 2013



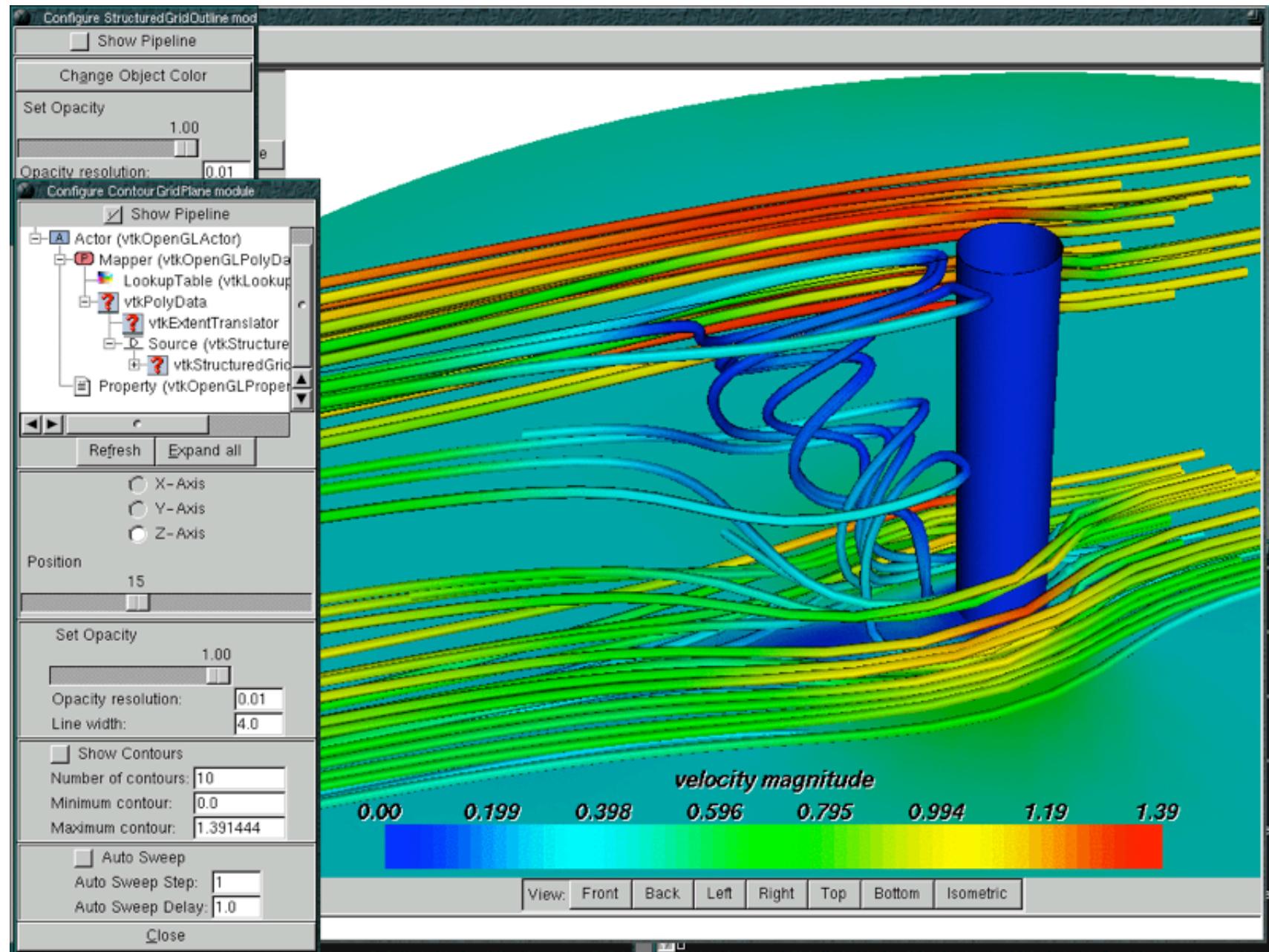
<http://www.youtube.com/watch?v=tlontoyWX70>

# Visualization



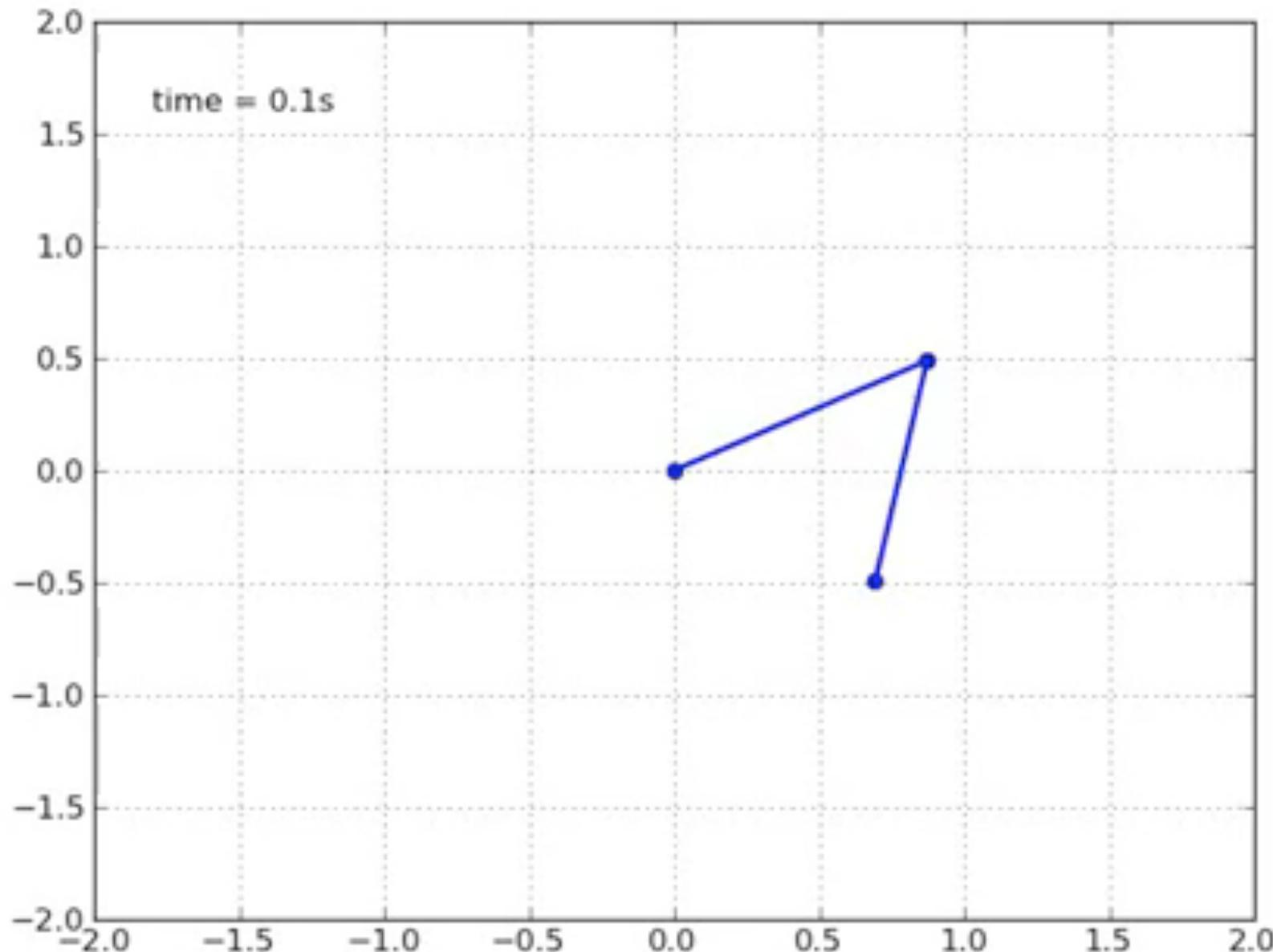
matplotlib

# Visualization

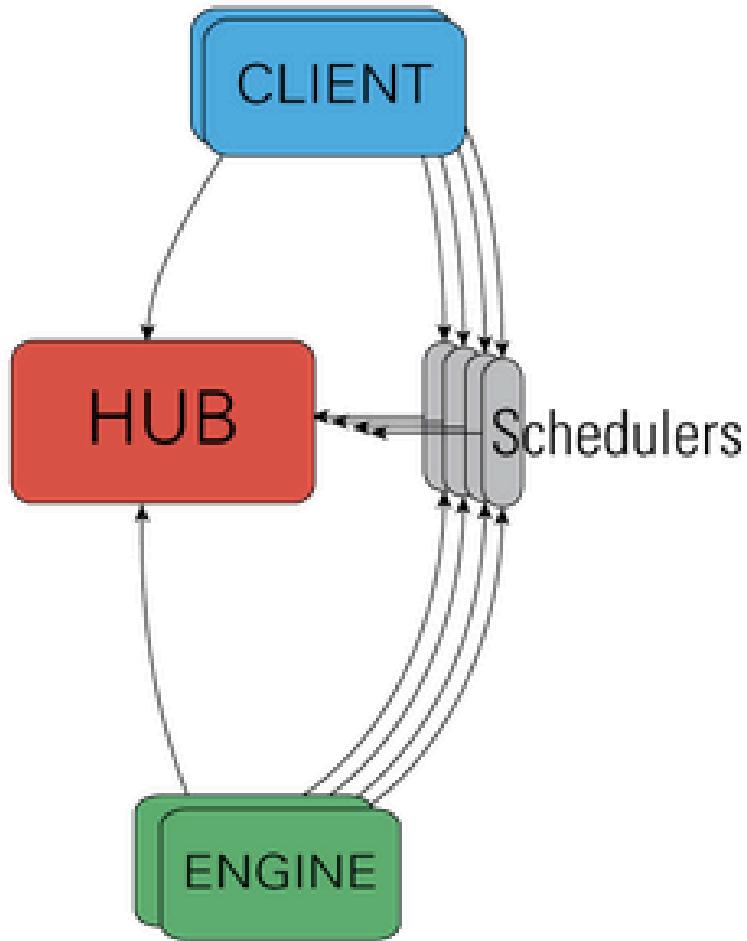


Mayavi

# Animation



[http://matplotlib.sourceforge.net/examples/animation/double\\_pendulum\\_animated.html](http://matplotlib.sourceforge.net/examples/animation/double_pendulum_animated.html)



**Parallelization** is now  
very accessible  
(via the IPython notebook)

# Tackling Python: Let's Get Started



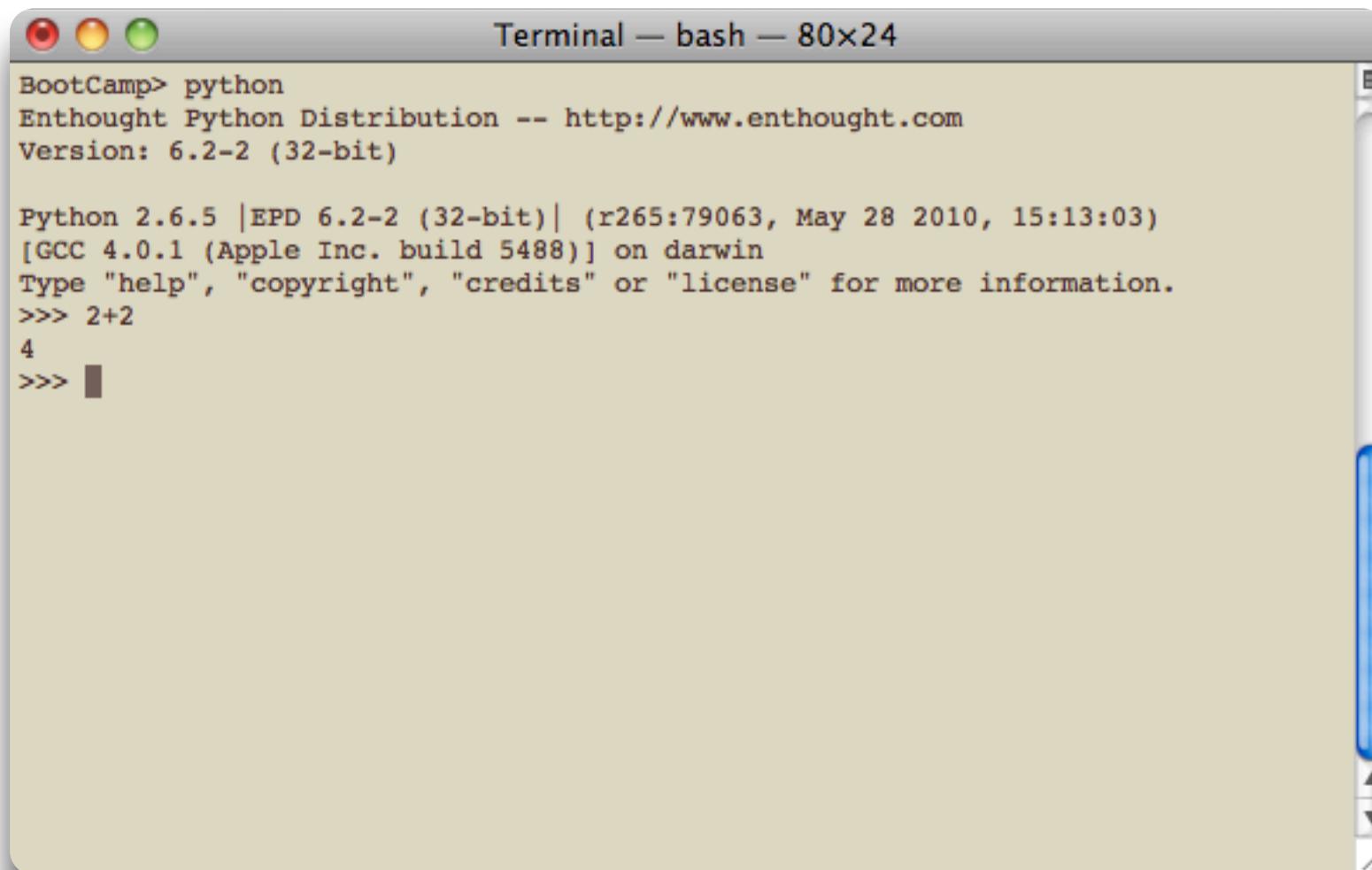
# **Asking Questions during Module presentations**

- 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](mailto: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



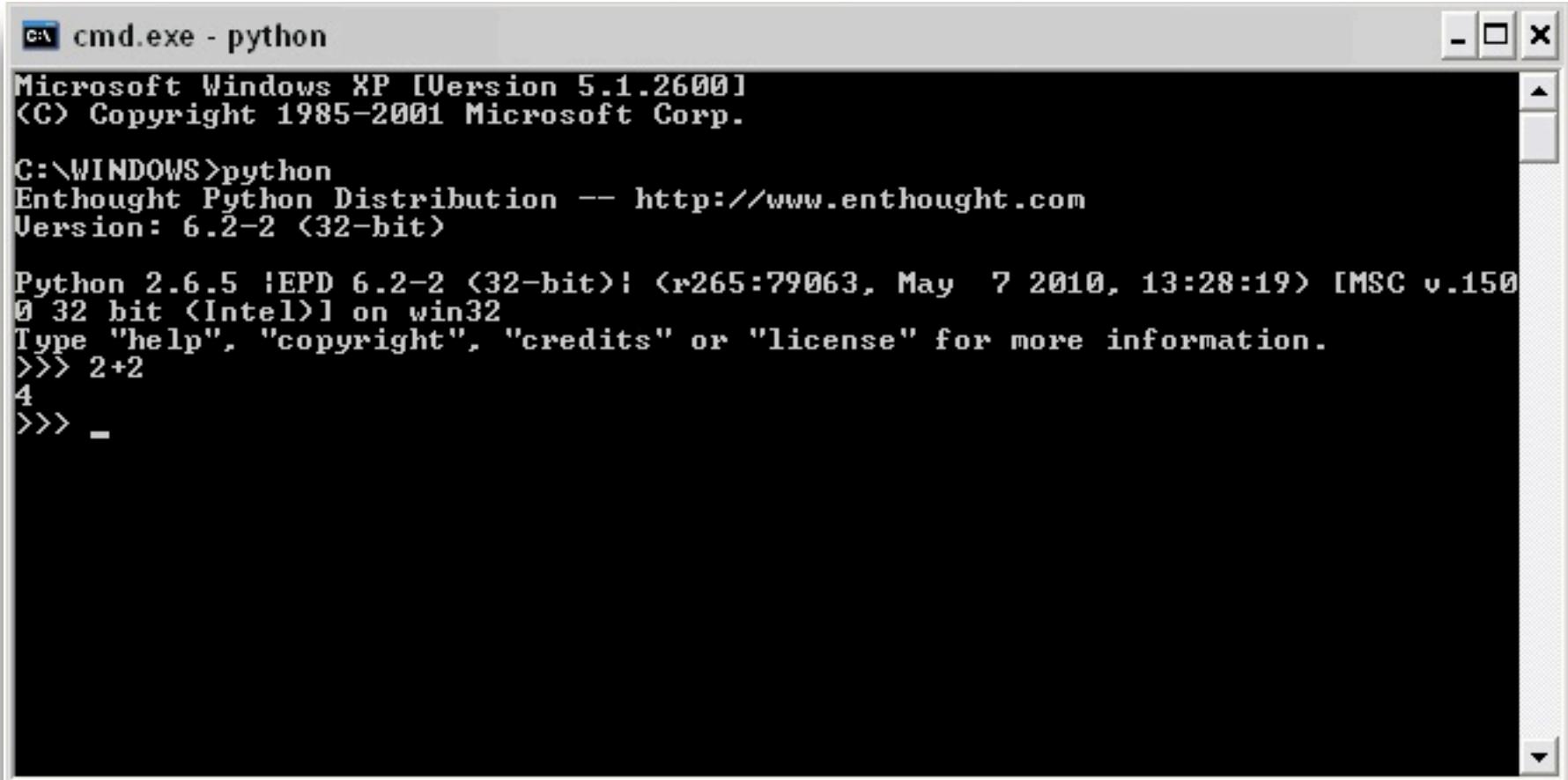
The image shows a screenshot of an xterm window on a Mac OS X desktop. The window title is "xterm". Inside the terminal, the following text is displayed:

```
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:

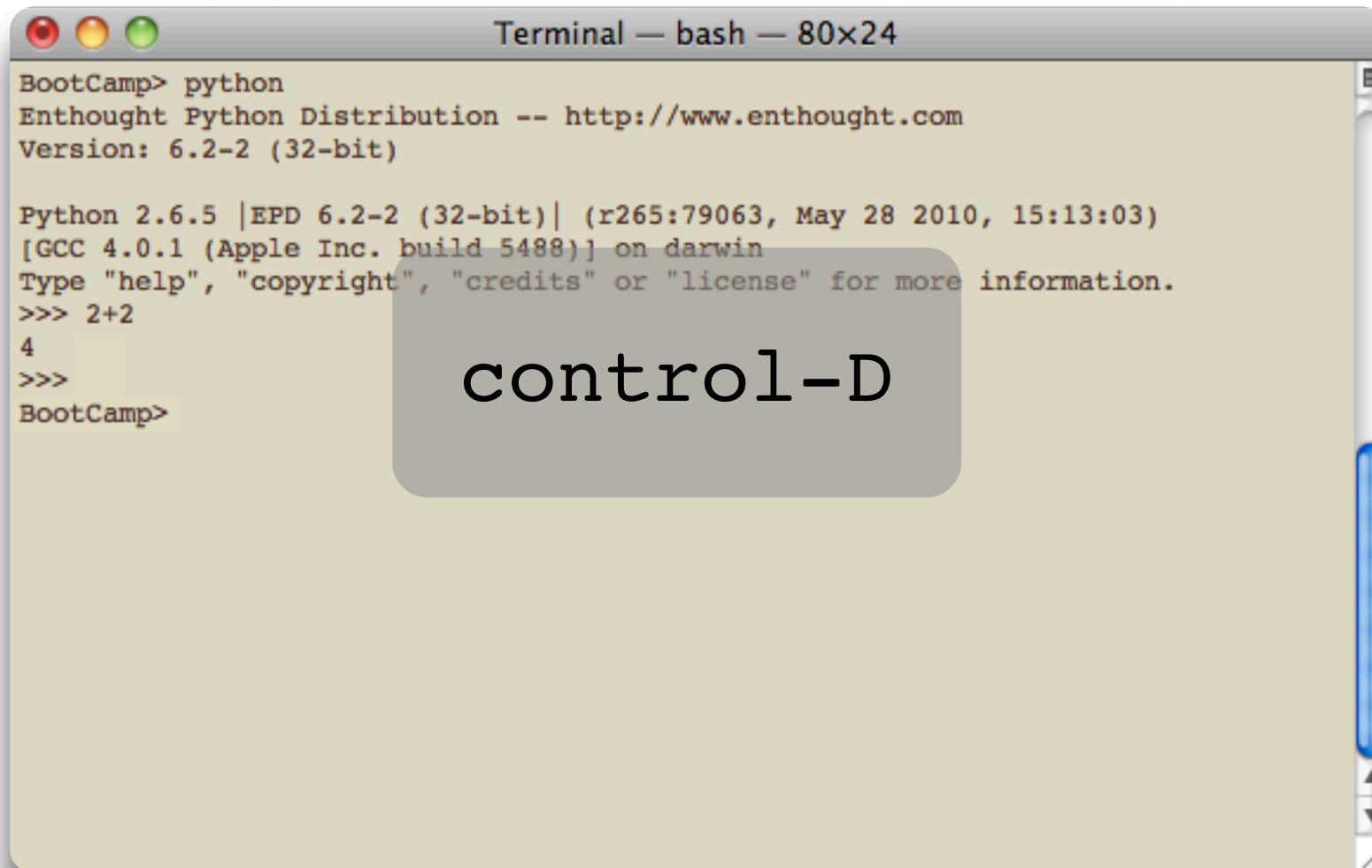
```
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

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



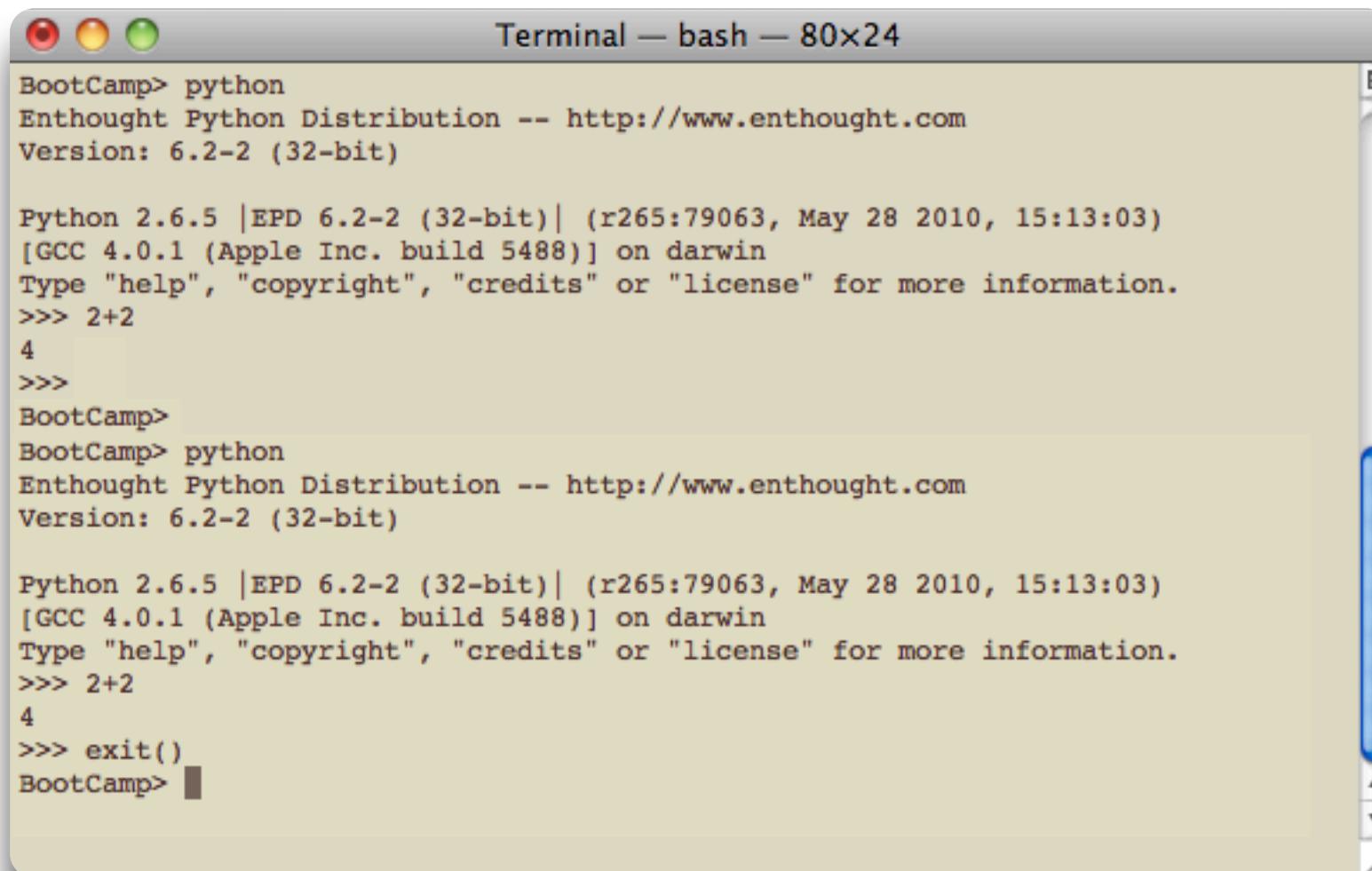
```
BootCamp> python
Enthought Python Distribution -- http://www.enthought.com
Version: 6.2-2 (32-bit)

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



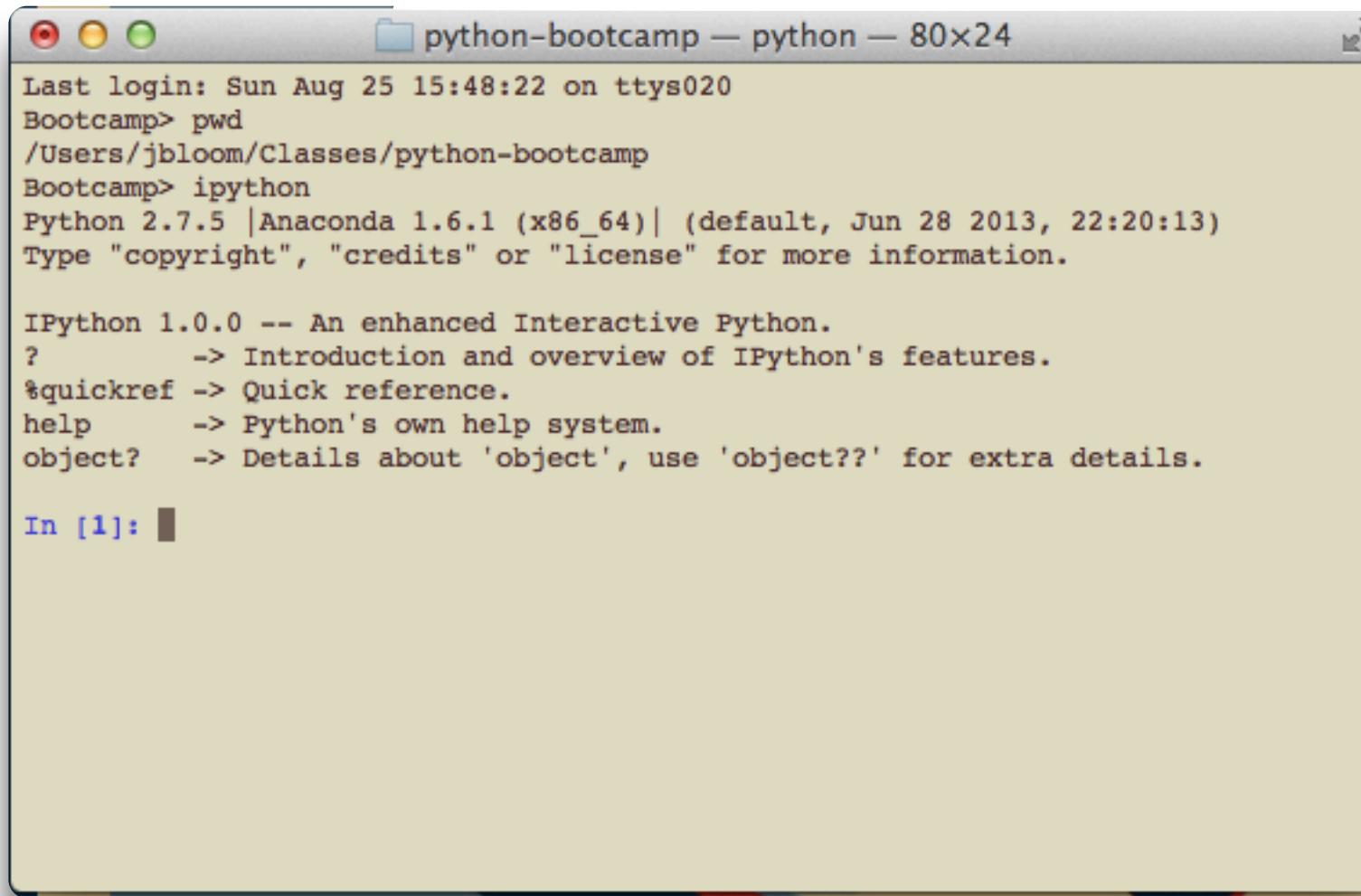
```
BootCamp> python
Enthought Python Distribution -- http://www.enthought.com
Version: 6.2-2 (32-bit)

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



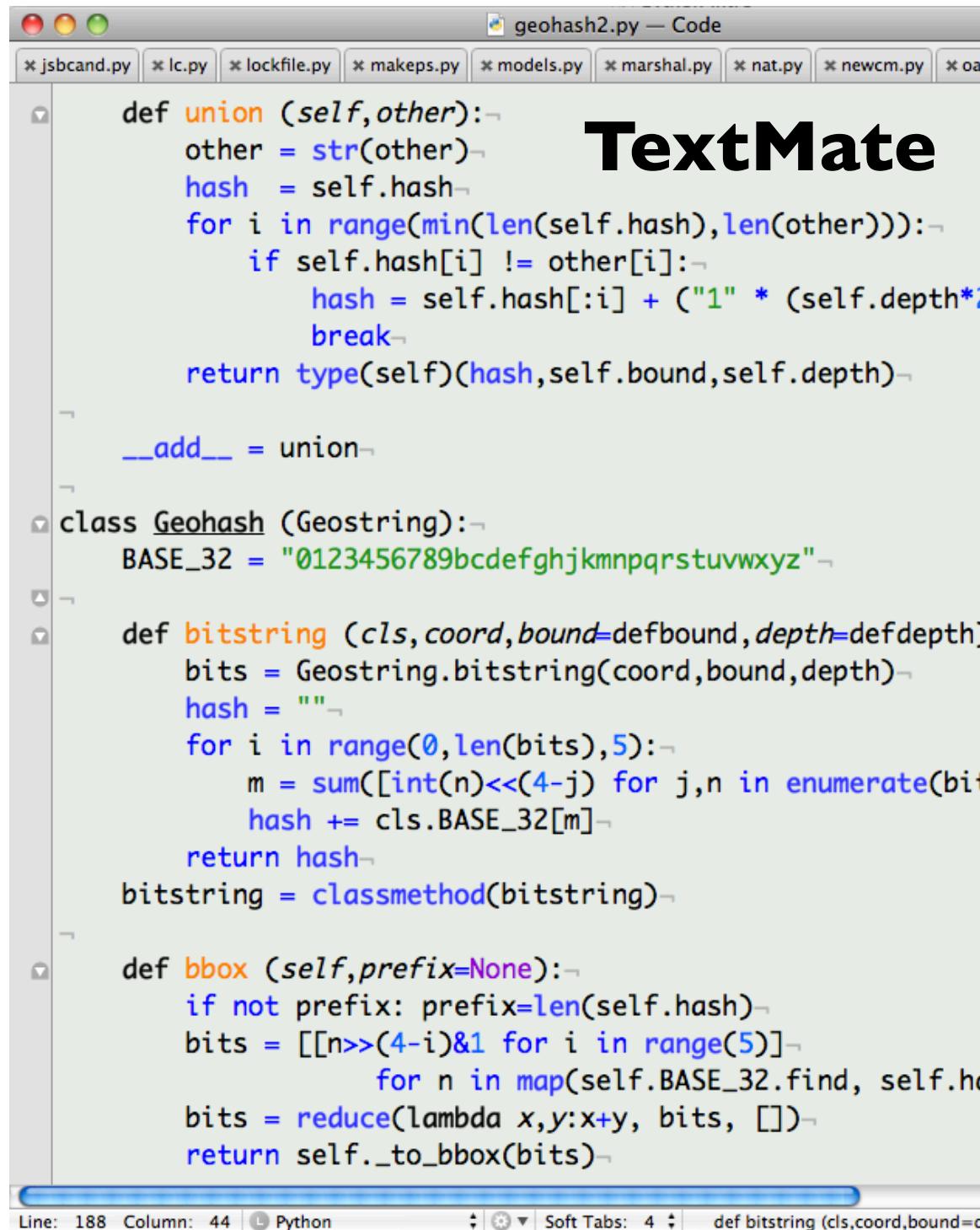
```
Last login: Sun Aug 25 15:48:22 on ttys020
Bootcamp> pwd
/Users/jbloom/Classes/python-bootcamp
Bootcamp> ipython
Python 2.7.5 |Anaconda 1.6.1 (x86_64)| (default, Jun 28 2013, 22:20:13)
Type "copyright", "credits" or "license" for more information.

IPython 1.0.0 -- 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



The screenshot shows a Mac OS X window titled "geohash2.py — Code". The window contains Python code for a Geohash class. The code includes methods for union, \_\_add\_\_, bitstring, and bbox. The TextMate logo is visible in the top right corner of the editor area.

```
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>

```
Bootcamp> ipython notebook  
2013-08-25 21:50:29.598 [NotebookApp] Using existing profile dir: u'/Users/jbloom/.ipython/pr  
2013-08-25 21:50:29.604 [NotebookApp] Using MathJax from CDN: http://cdn.mathjax.org/mathjax/  
2013-08-25 21:50:29.629 [NotebookApp] The port 8888 is already in use, trying another random  
2013-08-25 21:50:29.629 [NotebookApp] The port 8889 is already in use, trying another random  
2013-08-25 21:50:29.629 [NotebookApp] The port 8890 is already in use, trying another random  
2013-08-25 21:50:29.629 [NotebookApp] The port 8891 is already in use, trying another random  
2013-08-25 21:50:29.630 [NotebookApp] The port 8892 is already in use, trying another random  
2013-08-25 21:50:29.630 [NotebookApp] Serving notebooks from local directory: /Users/jbloom/C  
2013-08-25 21:50:29.630 [NotebookApp] The IPython Notebook is running at: http://127.0.0.1:89  
2013-08-25 21:50:29.630 [NotebookApp] Use Control-C to stop this server and shut down all ker  
irmation).
```



# IP[y]: Notebook

[Notebooks](#)[Clusters](#)

To import a notebook, drag the file onto the listing below or [click here](#).

[Refresh](#)[New Notebook](#)

/ Users / jbloom / Classes / python-bootcamp /

Notebook list empty.