Mayavi: Bringing Data to Life

Prabhu Ramachandran

Department of Aerospace Engineering
IIT Bombay

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Outline

Introduction

Mayavi and its features

Design and Architecture

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Design and Architecture

What is visualization?

Visual representation of data

Visualization is about data!

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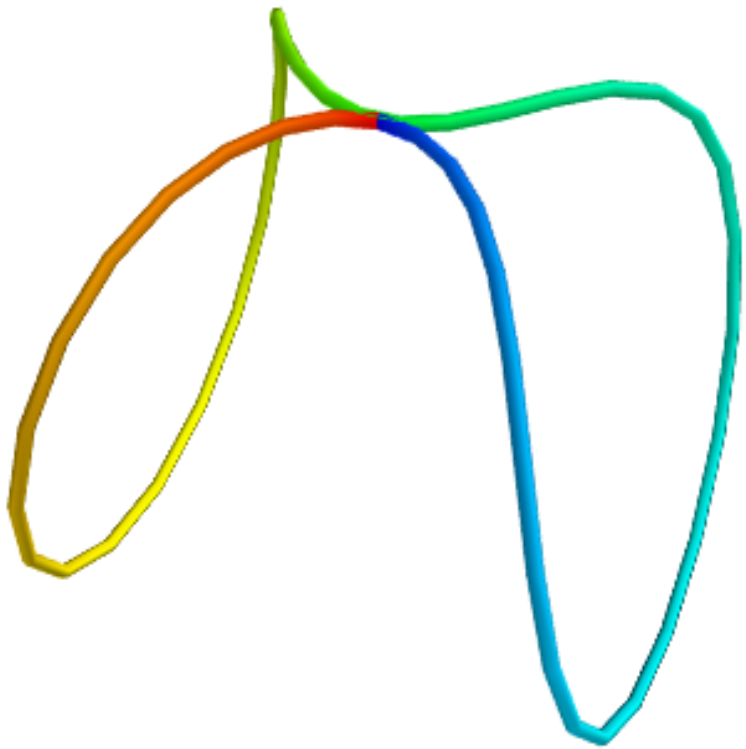
Visual representation of data

Visualization is about data!

Example



Motivation

Scientists want to look at their data ...

QUICKLY
and EASILY!

Scientists want to look at their data

. . .

QUICKLY

and EASILY!

Scientists want to look at their data

. . .

QUICKLY
and EASILY!

Needs are diverse

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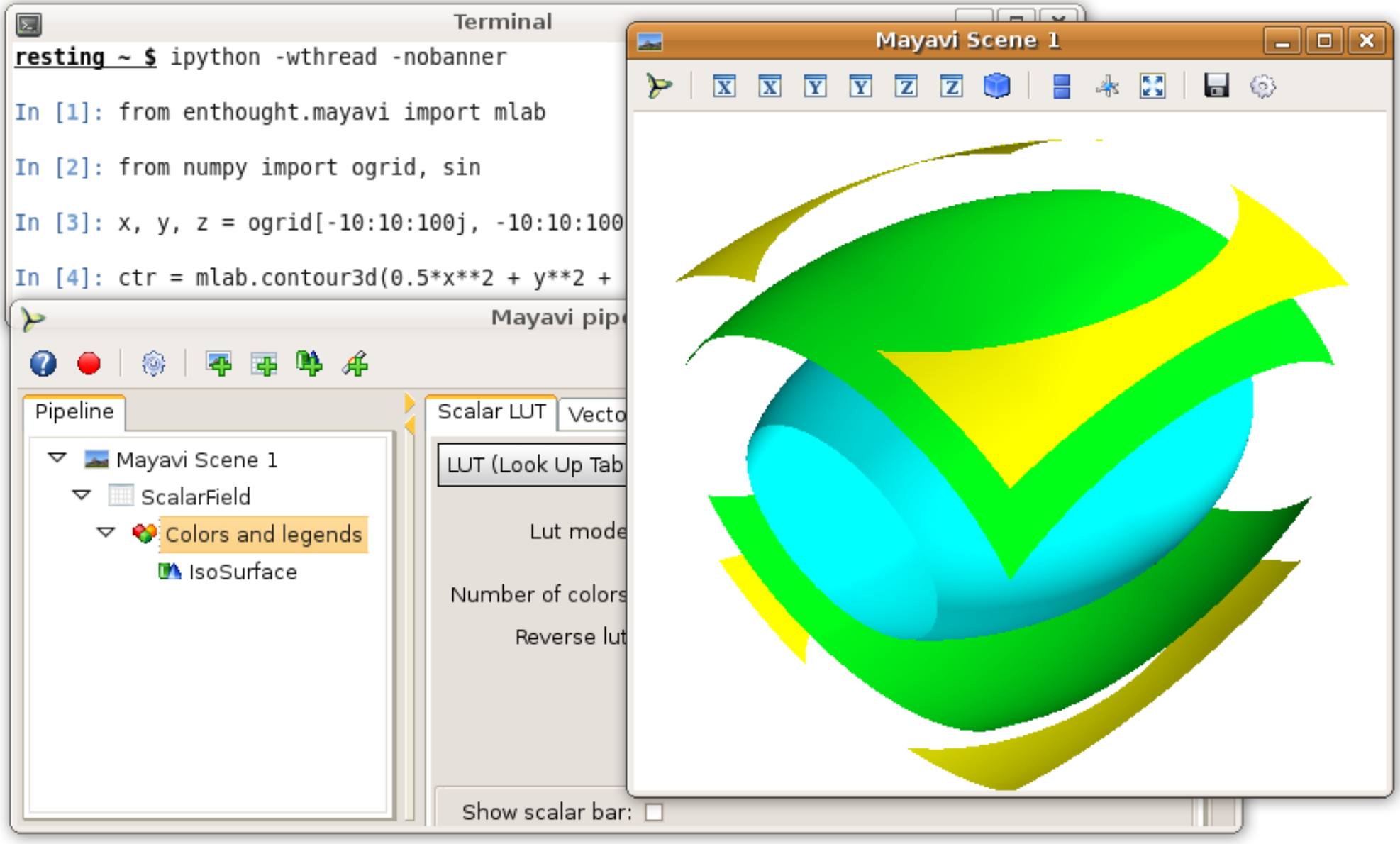
Interactive visualization of data (think Matlab)


Terminal
resting ~ $ ipython -wthread -nobanner
In [1]: from enthought.mayavi import mlab
In [2]: from numpy import ogrid, sin
In [3]: x, y, z = ogrid[-10:10:100j, -10:10:100
In [4]: ctr = mlab.contour3d(0.5*x**2 + y**2 +
Mayavi pip
Pipeline
Mayavi Scene 1
ScalarField
Colors and legends
IsoSurface
Scalar LUT
Vecto
LUT (Look Up Tab
Lut mode
Number of colors
Reverse lut
Show scalar bar:
Mayavi Scene 1

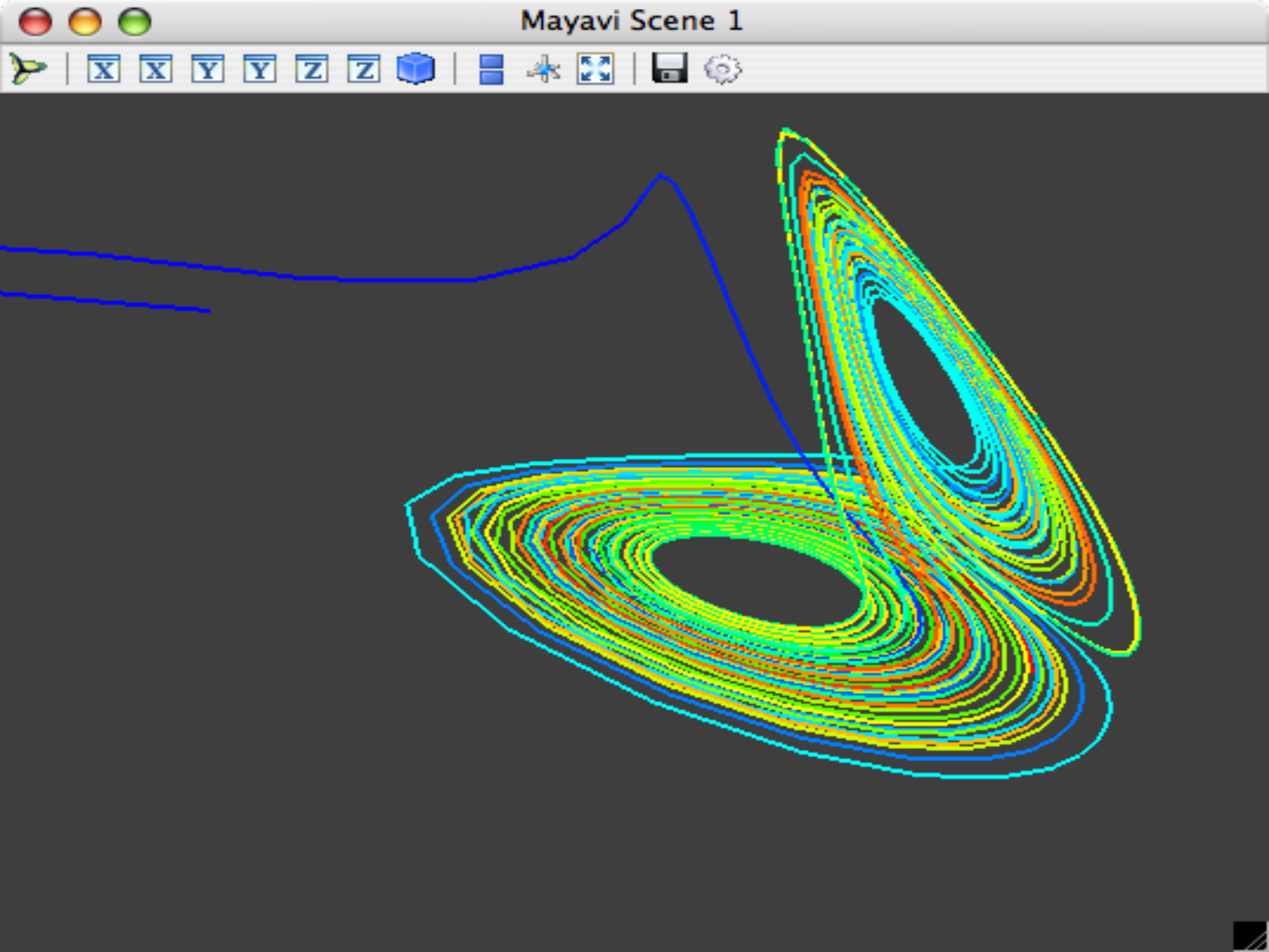
Demos

- mlab.plot3d, mlab.surf
- Interaction
- UI configuration
- Updating data
- @mlab.animate
- Other functions

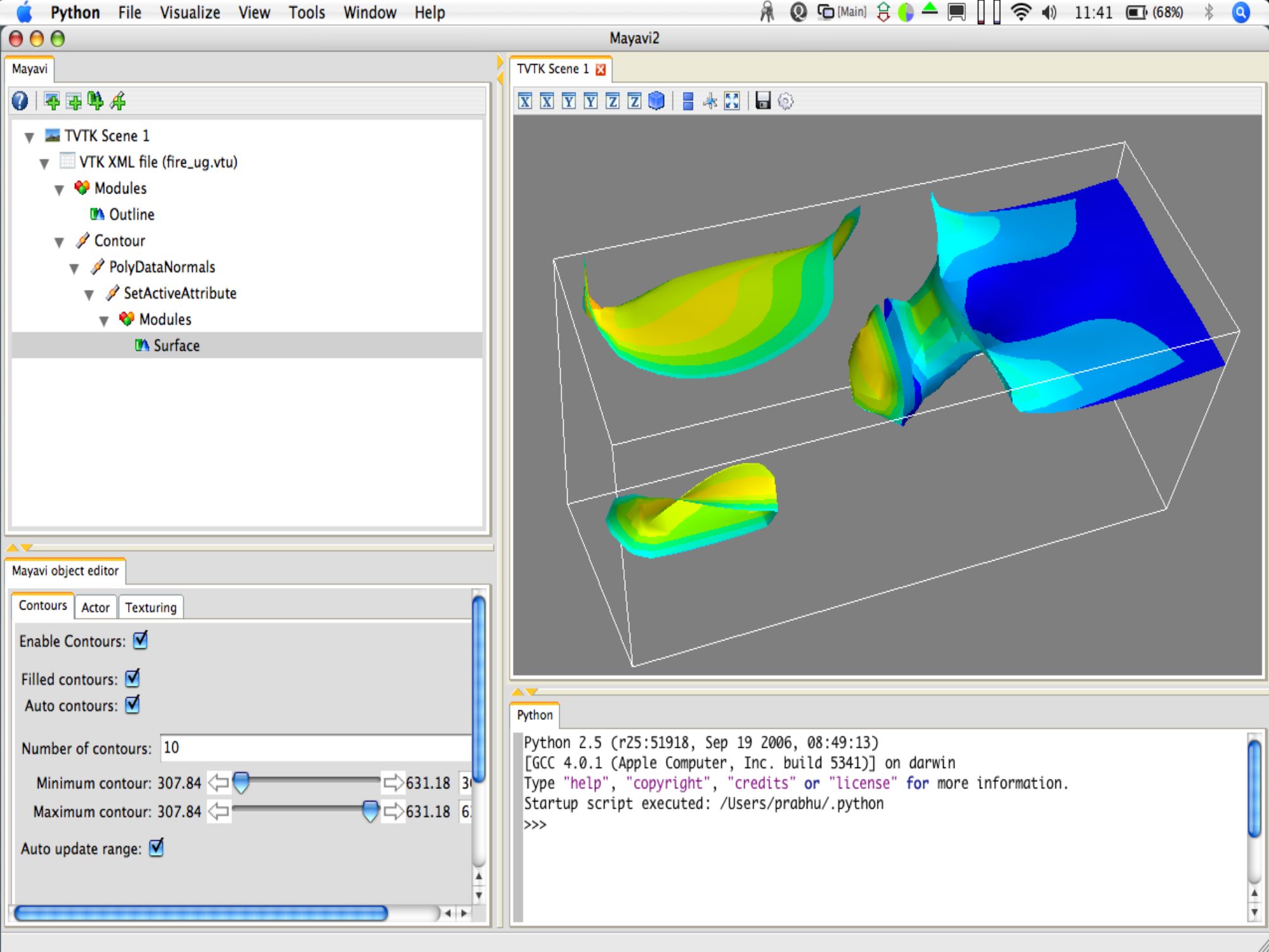
Lorenz equation example

$$\begin{aligned}
\frac{dx}{dt} &= s(y - x) \\
\frac{dy}{dt} &= rx - y - xz \\
\frac{dz}{dt} &= xy - bz
\end{aligned}$$

- Specifies the evolution of the system
- Think: Velocity of a particle in 3D
- Lets trace its path


Mayavi Scene 1
X
X
Y
Y
Z
Z

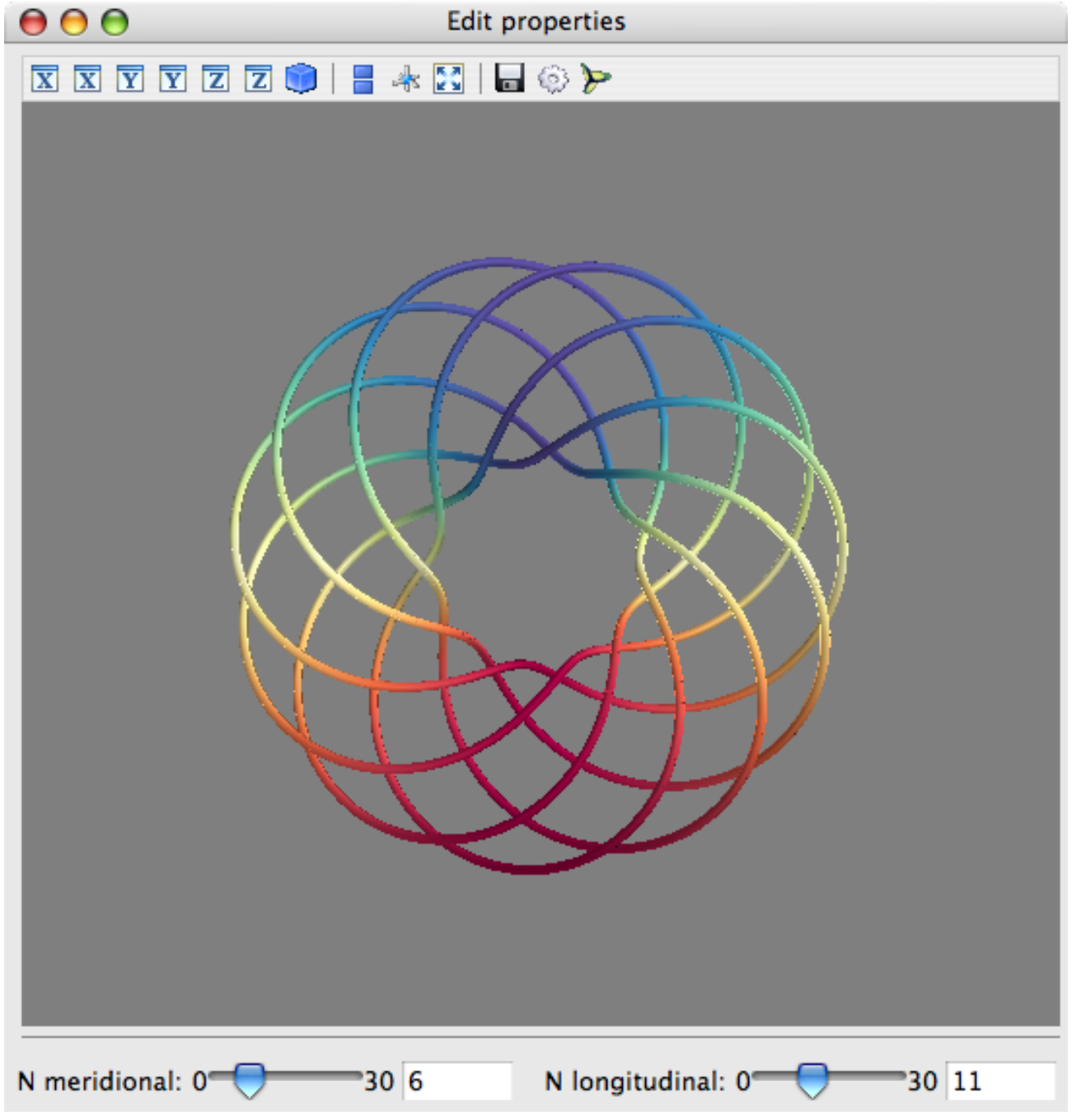
Visualization of data files with a nice UI

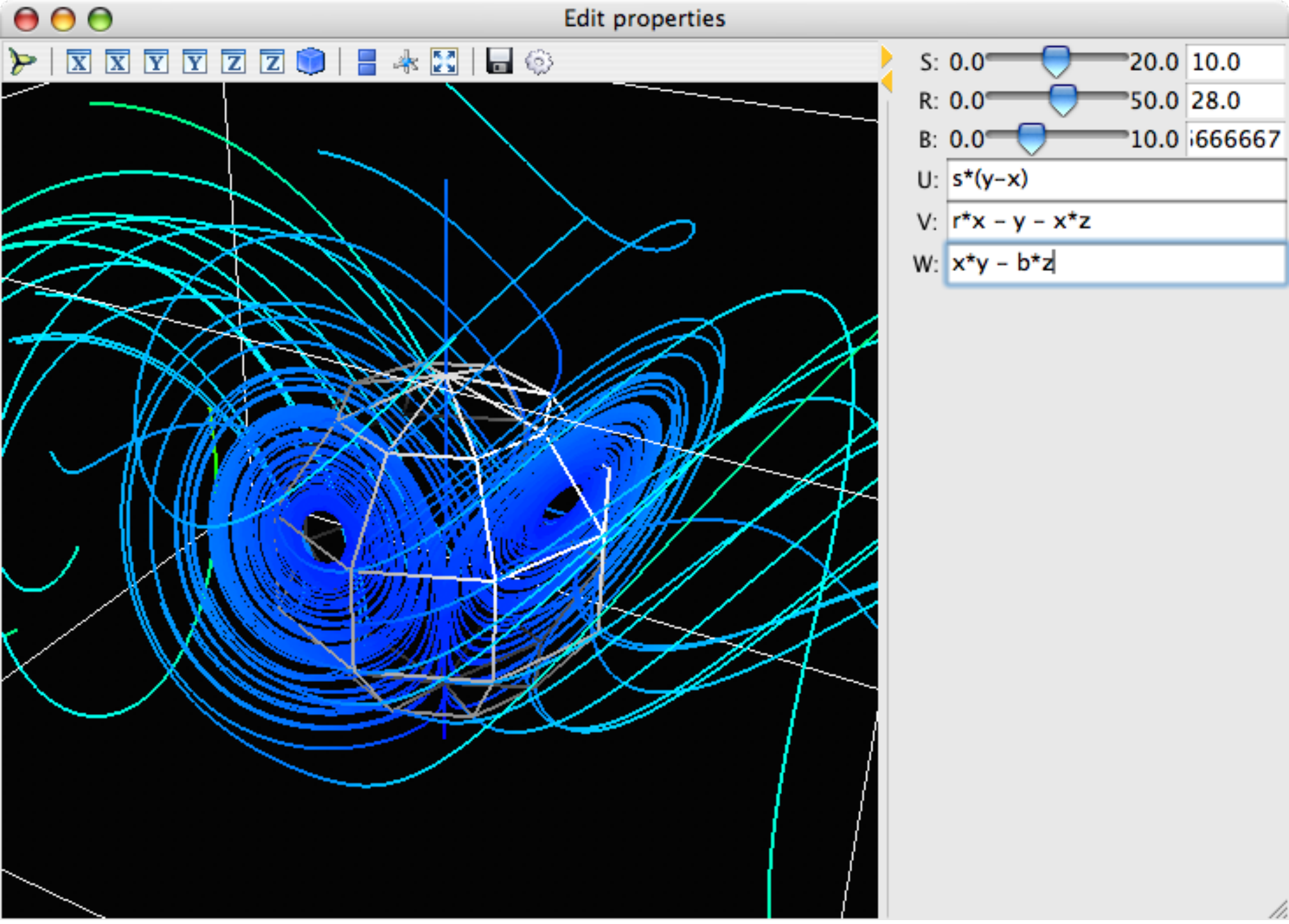

Python File Visualize View Tools Window Help
11:41
(68%)
Mayavi2
Mayavi
TVTK Scene 1
VTK XML file (fire_ug.vtu)
Modules
Outline
Contour
PolyDataNormals
SetActiveAttribute
Modules
Surface
TVTK Scene 1
Mayavi object editor
Contours
Actor
Texturing
Enable Contours:
Filled contours:
Auto contours:
Number of contours: 10
Minimum contour: 307.84
631.18
Maximum contour: 307.84
631.18
Auto update range:
Python
Python 2.5 (r25:51918, Sep 19 2006, 08:49:13)
[GCC 4.0.1 (Apple Computer, Inc. build 5341)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
Startup script executed: /Users/prabhu/.python
>>>

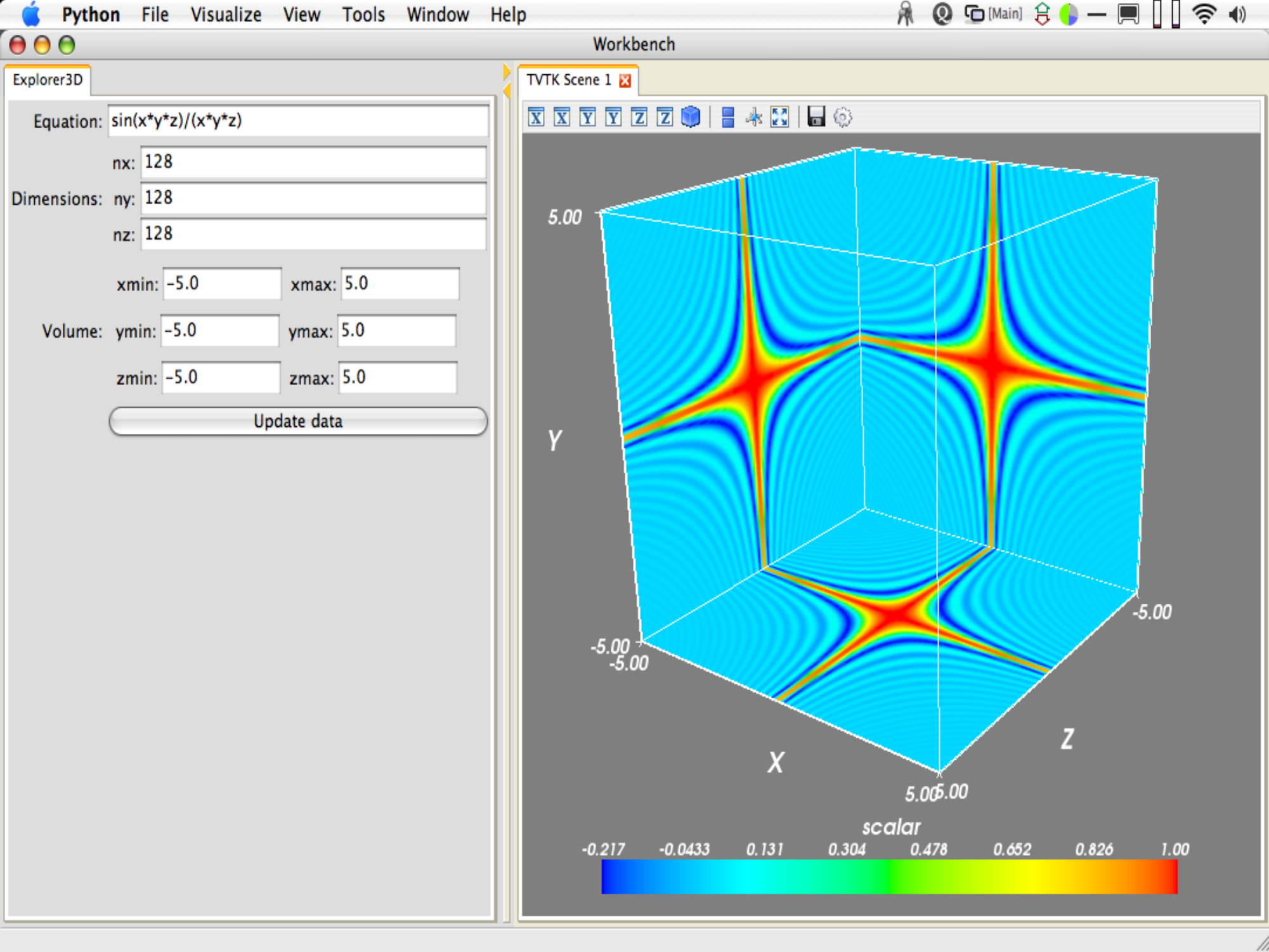
Demos

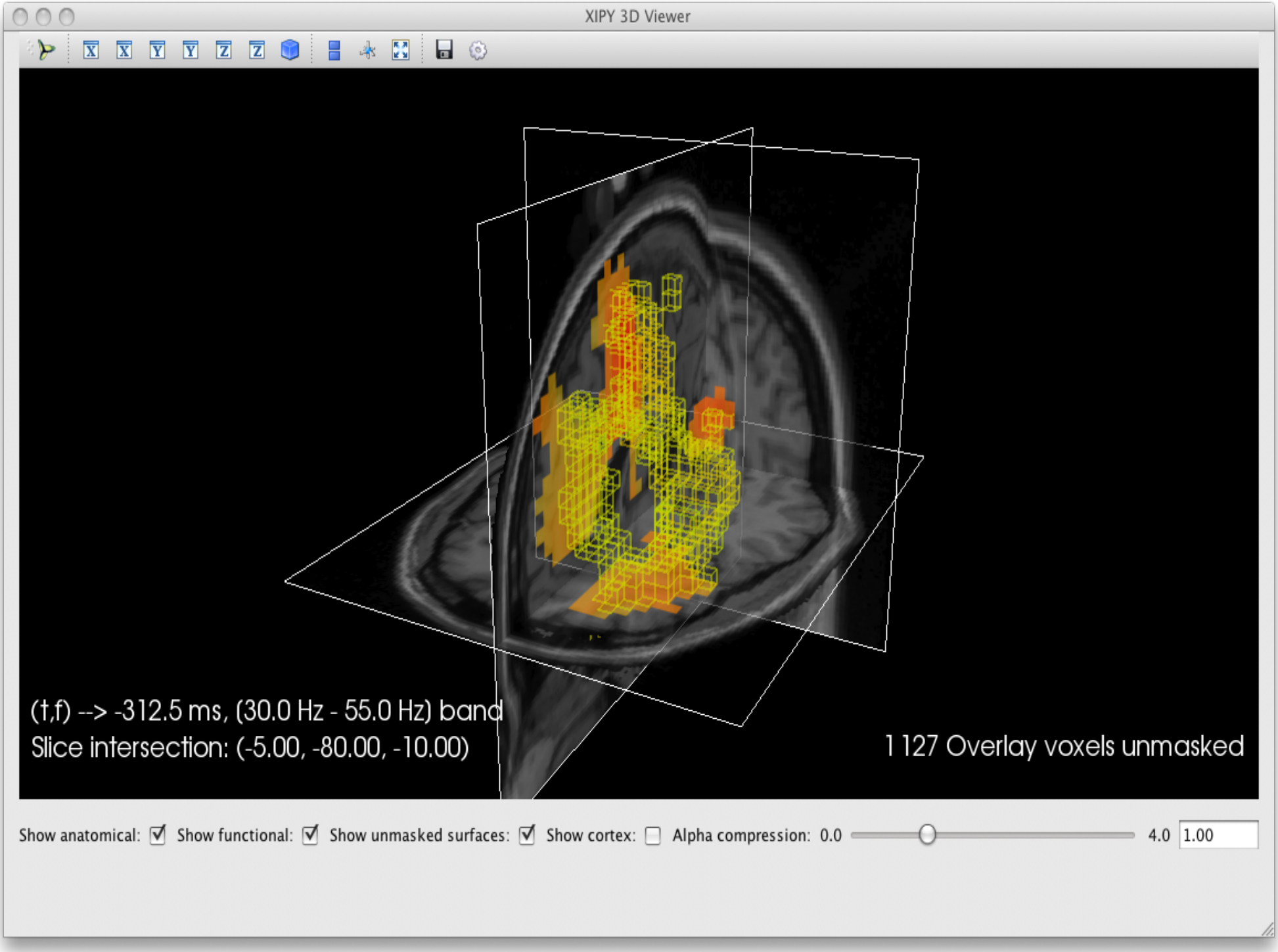
- Using data files
- Command line options
- Drag and drop
- Record
- Qt/Wx

Embedding visualizations in applications

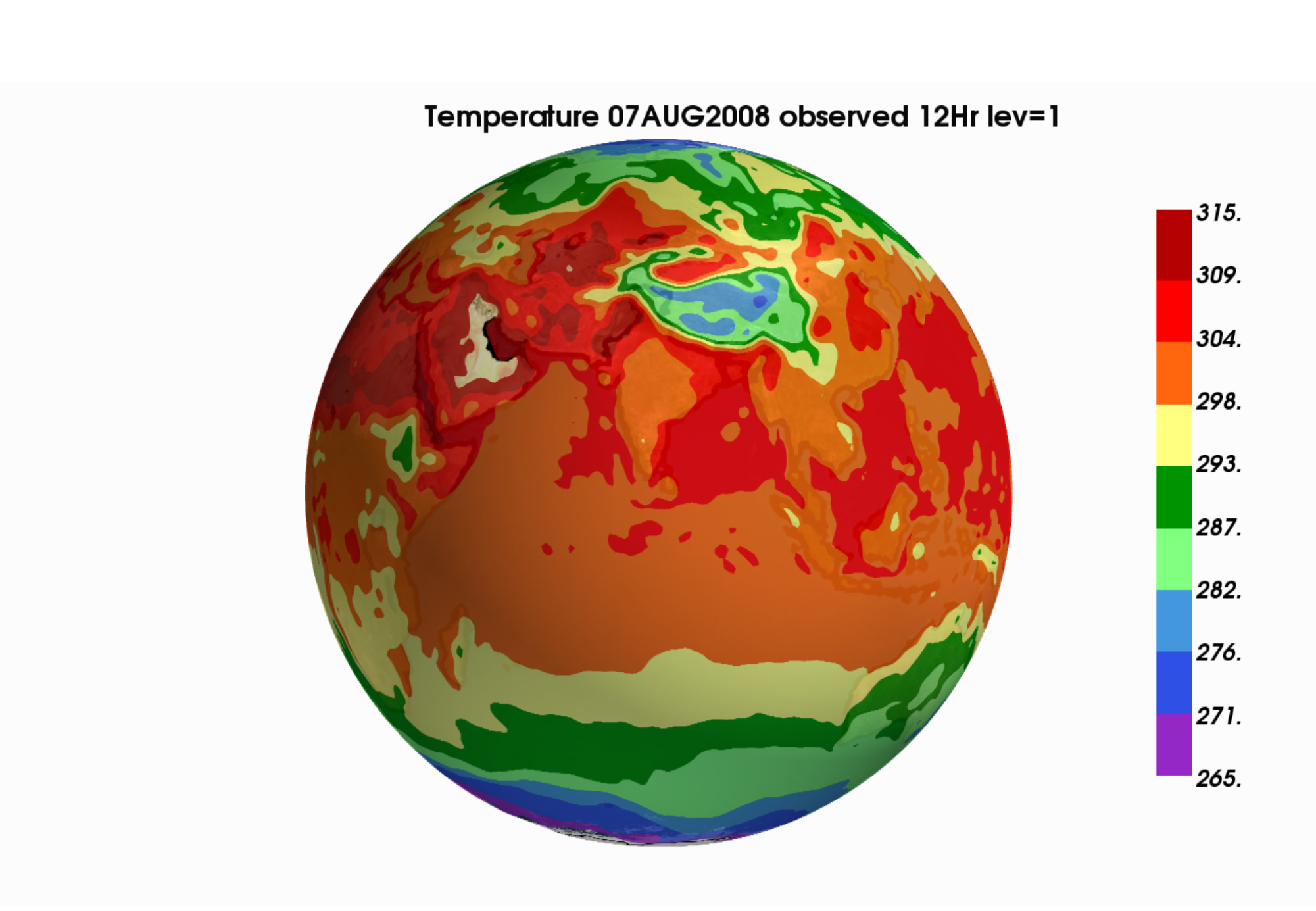

Edit properties
N meridional: 0
30
6
N longitudinal: 0
30
11


Edit properties
S: 0.0 20.0 10.0
R: 0.0 50.0 28.0
B: 0.0 10.0 666667
U: s*(y-x)
V: r*x - y - x*z
W: x*y - b*z


Python File Visualize View Tools Window Help
Workbench
Explorer3D
Equation: sin(x*y*z)/(x*y*z)
nx: 128
Dimensions: ny: 128
nz: 128
xmin: -5.0 xmax: 5.0
Volume: ymin: -5.0 ymax: 5.0
zmin: -5.0 zmax: 5.0
Update data
TVTK Scene 1
5.00
Y
-5.00
-5.00
X
5.00
5.00
Z
-5.00
scalar
-0.217 -0.0433 0.131 0.304 0.478 0.652 0.826 1.00

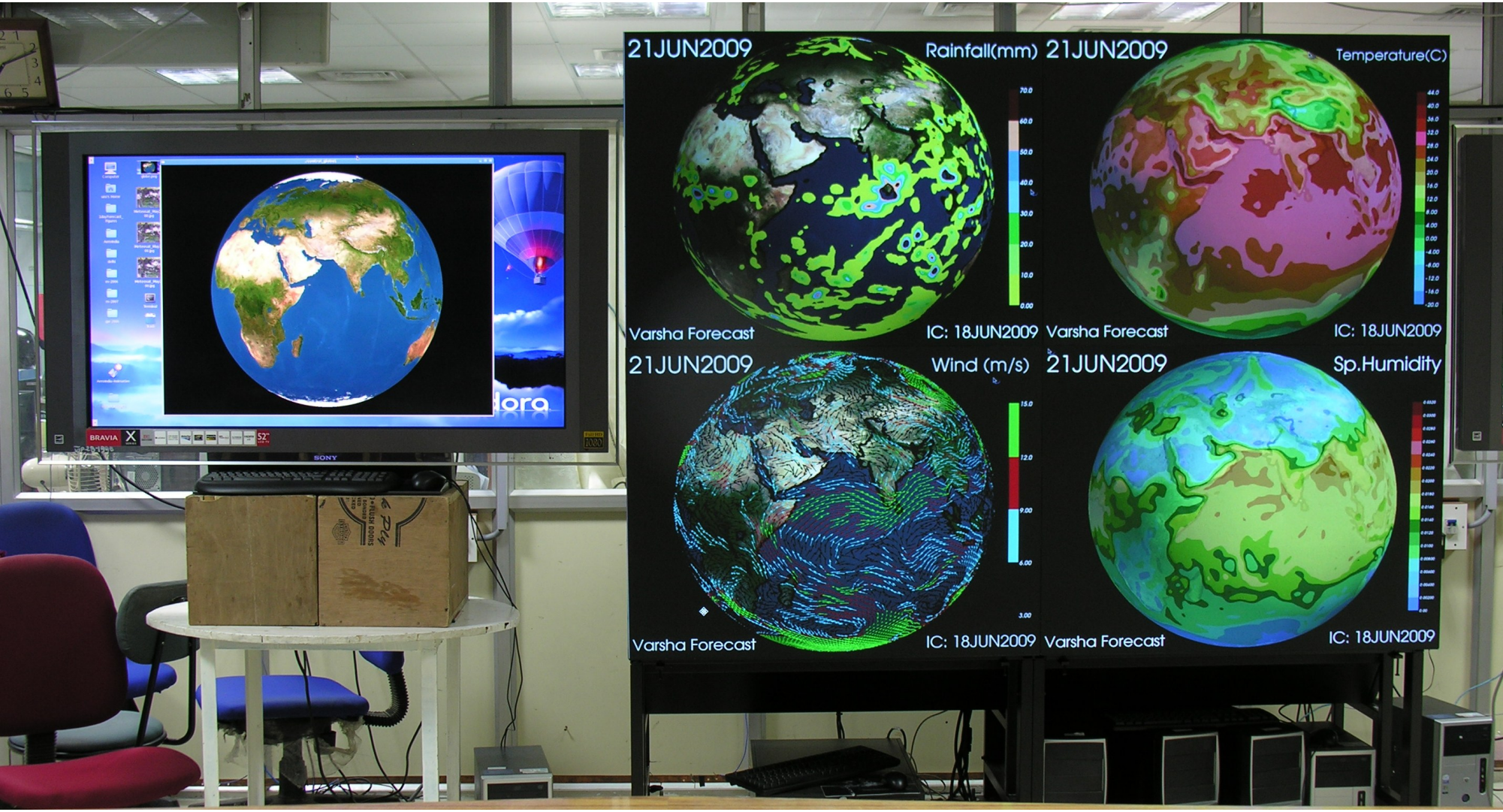

XIPY 3D Viewer
(t,f) --> -312.5 ms, (30.0 Hz - 55.0 Hz) band
Slice intersection: (-5.00, -80.00, -10.00)
1 127 Overlay voxels unmasked
Show anatomical:
Show functional:
Show unmasked surfaces:
Show cortex:
Alpha compression:
0.0
4.0
1.00

Customization


Temperature 07AUG2008 observed 12Hr lev=1
315.
309.
304.
298.
293.
287.
282.
276.
271.
265.

Demos

- Adding custom sources/modules etc.


21JUN2009
Rainfall(mm)
Varsha Forecast
IC: 18JUN2009
21JUN2009
Temperature(C)
Varsha Forecast
IC: 18JUN2009
21JUN2009
Wind (m/s)
Varsha Forecast
IC: 18JUN2009
21JUN2009
Sp.Humidity
Varsha Forecast
IC: 18JUN2009
BRAVIA
SONY

Demos

- Network support

Mayavi + Sage

File Edit View History Bookmarks ScrapBook Tools Help

http://nb.hpfem.org/home/pub/16/

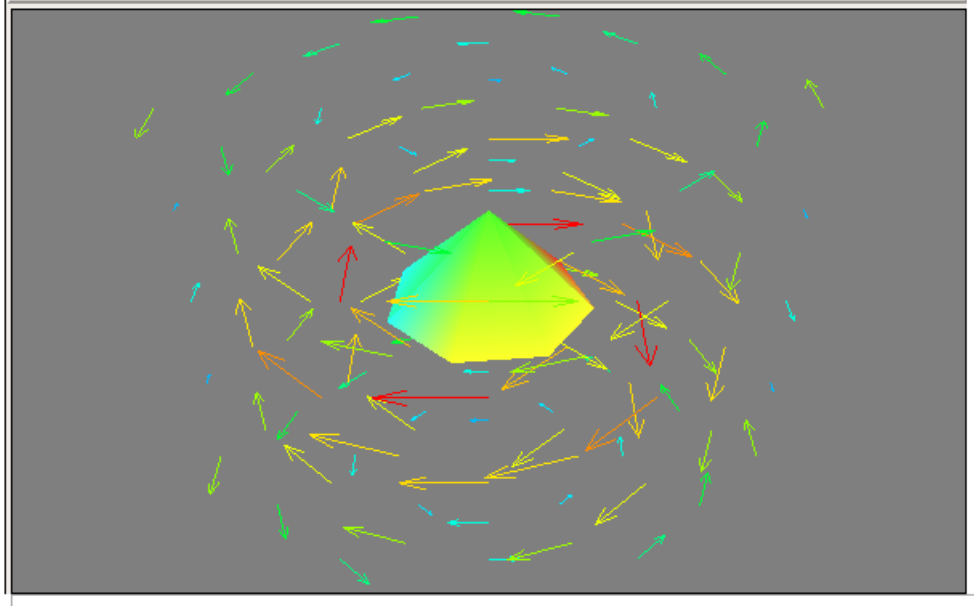
Google

Mayavi2 in Sage! (Sage)

```
# Test embedding x3d files.
from enthought.mayavi import mlab
mlab.options.offscreen = True
mlab.clf()
import numpy
# A simple triangular mesh
mlab.test_triangular_mesh()
# Some nice vectors.
x, y, z = numpy.mgrid[-2:3, -2:3, -2:3]
r = numpy.sqrt(x**2 + y**2 + z**4)
u = y*numpy.sin(r)/(r+0.001)
v = -x*numpy.sin(r)/(r+0.001)
w = numpy.zeros_like(z)
mlab.quiver3d(x, y, z, u, v, w, scale_factor=1)
# Export a x3d file for online 3D viewing.
# FreeWRL (http://freewrl.sourceforge.net) works great!
mlab.savefig("a.x3d")
```

a.x3d

Navigate Preferences Help



jsMath

Summary

- Interactive
- Pythonic
- UI + Application
- Embeddable/reusable
- Customizable
- Many cool features
- Offscreen capabilities

Flexible library/app for every one of these needs!

Developers and support

Prabhu Ramachandran	Creator and lead, 2001 –
Gaël Varoquaux	Mlab, documentation, usability, 2007 –
Enthought Inc.	ETS, Hosting, support, sprints, initial funding, distribution
IITB	Freedom and support for PR

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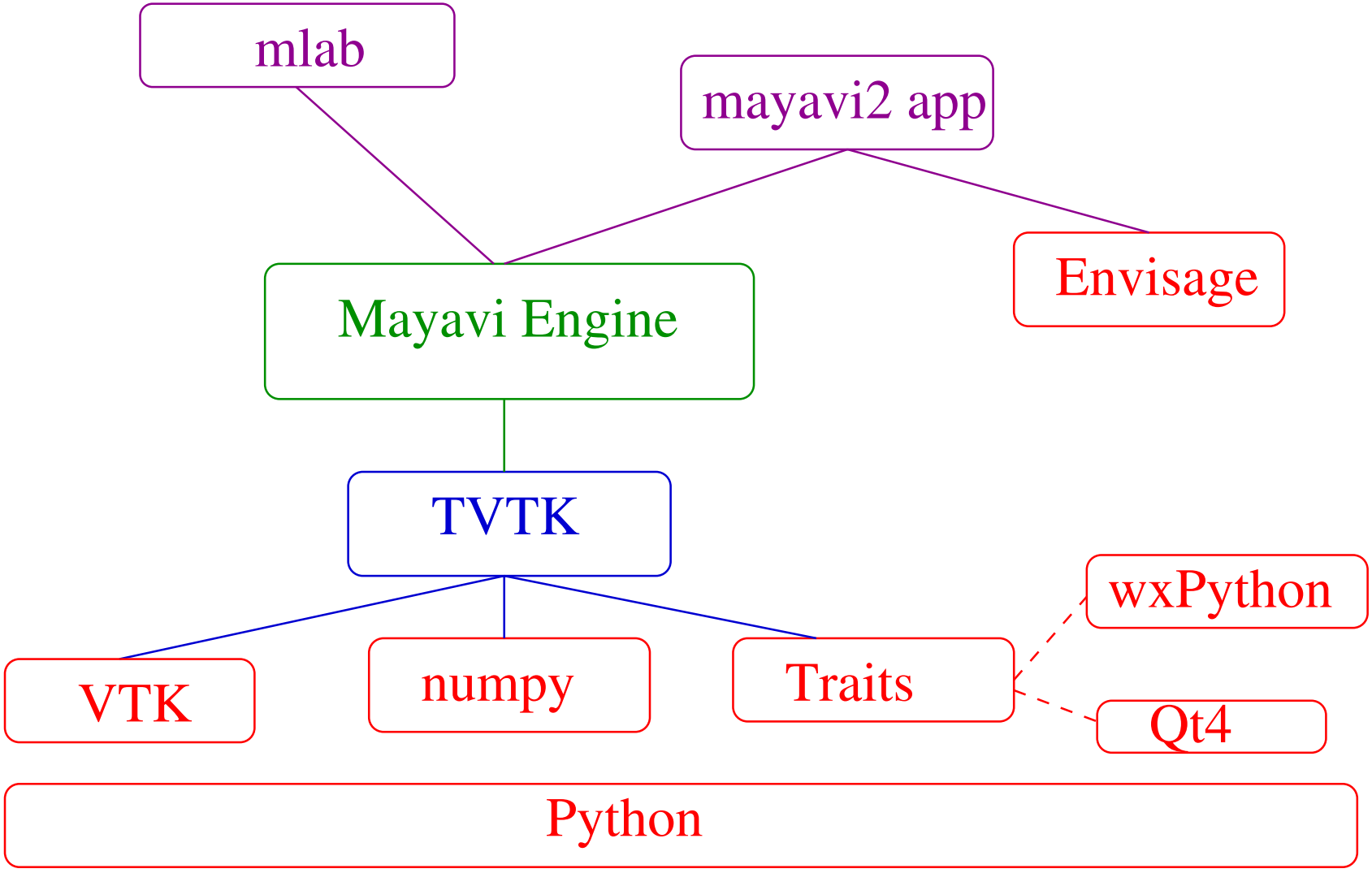
Overview of architecture



Secrets: Traits

- Allows for a powerful object model
- Inversion of control
- Notifications
- Easy UIs (works both ways)
- UIs and scripting are well connected
- wx and Qt backends available
- Forces a separation of UI/view from object model

Lessons . . .

- Abstraction layer of mayavi helps
- `mlab` was actually an afterthought
- `mlab` is extremely important!
- Automatic function/code generation is a big deal
- Abstraction of menu generation based on simple metadata allows for great simplification and reuse

Issues

- Testing: not easy but immensely useful, needs more work
- Documentation: Sphinx rocks

Thank you!

?

enthought-dev@mail.enthought.com

mayavi-users@lists.sf.net