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ParaView's Comparative Viewing, XY Plot, Spreadsheet View, Matrix View

Dublin, March 2013

Jean M. Favre, CSCS

Motivational movie
Supercomputing 2011 Movie Gallery

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Agenda

- **9:30 – 11:00**

  Start ParaView and show some demos. Do some exercises

- **11:30 – 13:00**

  Parallel and python usage. More exercises

http://www.paraview.org/files/v3.98/ParaViewData-3.98.1.zip
http://www.paraview.org/files/v3.98/ParaViewData-3.98.1.tar.gz

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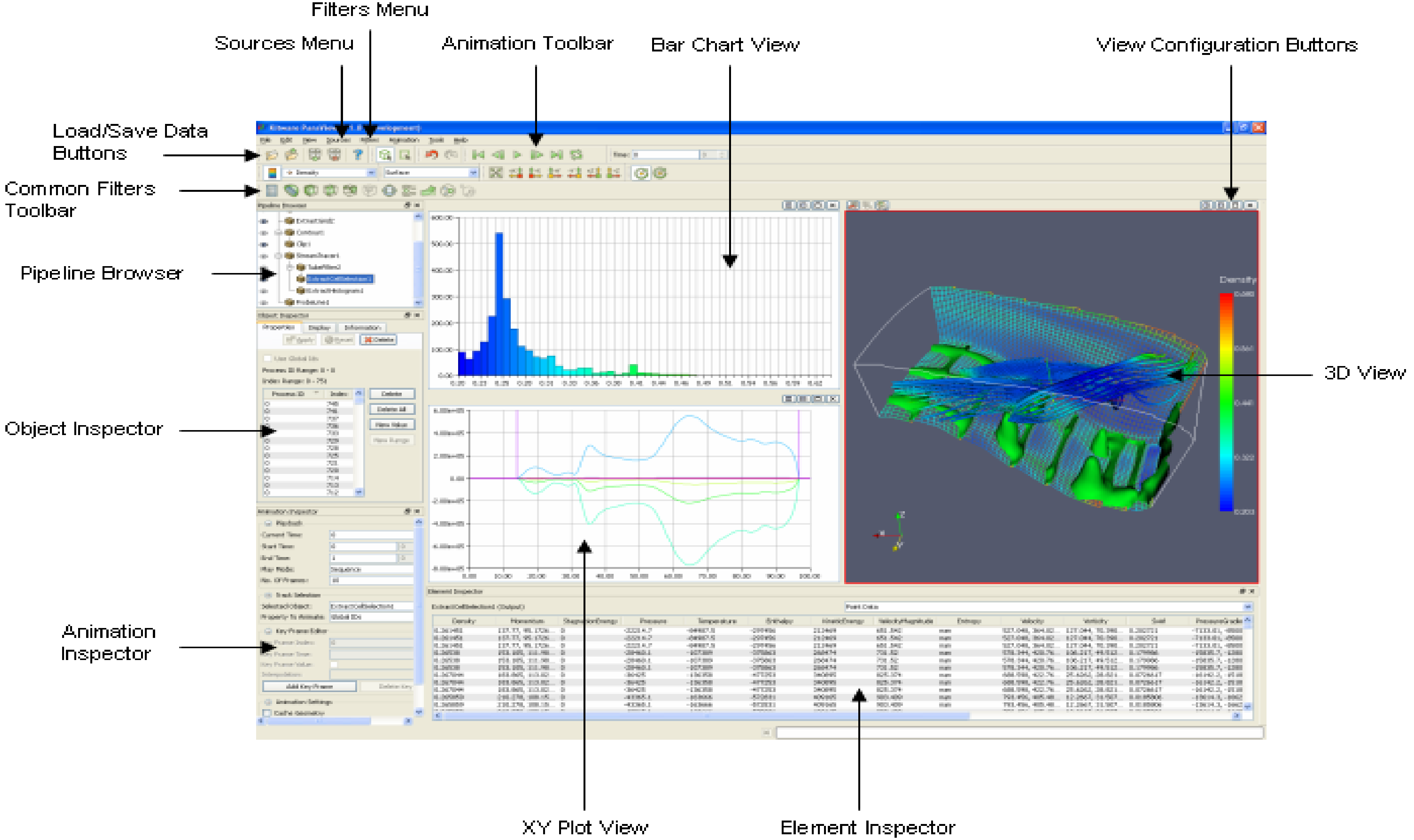
Quantitative and qualitative data



Plot Over a Line

- Position the line end-points on the extremities of the dataset
- User can move them back with the “p” stroke (two times)
- Plot will open a “Line Chart View”
- Use panning, zooming and reset camera buttons
- ValidPointMask array set to 0 if data is missing
- Can be done interactively, in “real-time” with the Auto-Accept button (View->Settings)
- Browse with the mouse over the line
- Select which fields to make visibile/invisible

- Exercise with “naca.bin.case”

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Bart Chart

- Histogram (a vtkTable) will open a “Bar Chart View”
- Use panning, zooming and reset camera buttons
- Can be saved as vtkTable, or as CSV file
- Use SpreadSheet View to look at “RowData”

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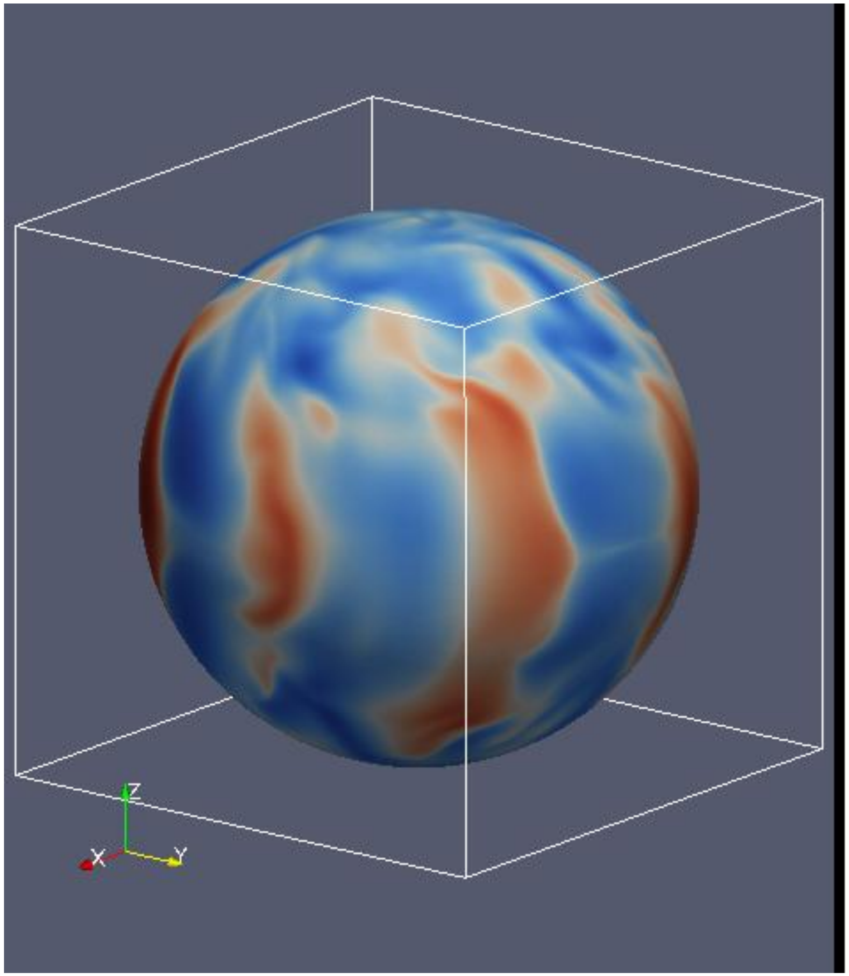
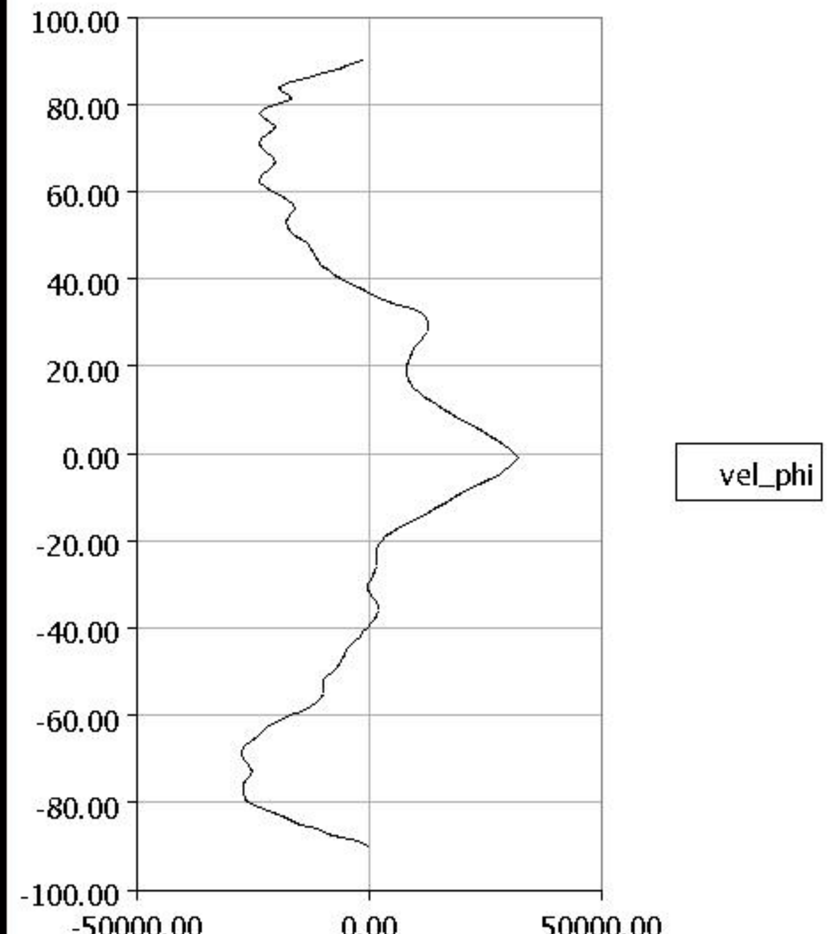
GeoPhysics example: Longitudinal average





Spreadsheet View

- Any dataset can be viewed in a “Spreadsheet View”
- Allows display of node-, cell-, field- and row-data
- Allows linked-selection
- Can be exported as CSV file
- Display can be reduced to “Show only selected elements”
- Allows sorting by column

Exercise 1: Source->Wavelet
Filters->PointData to CellData

Select all cells above 230

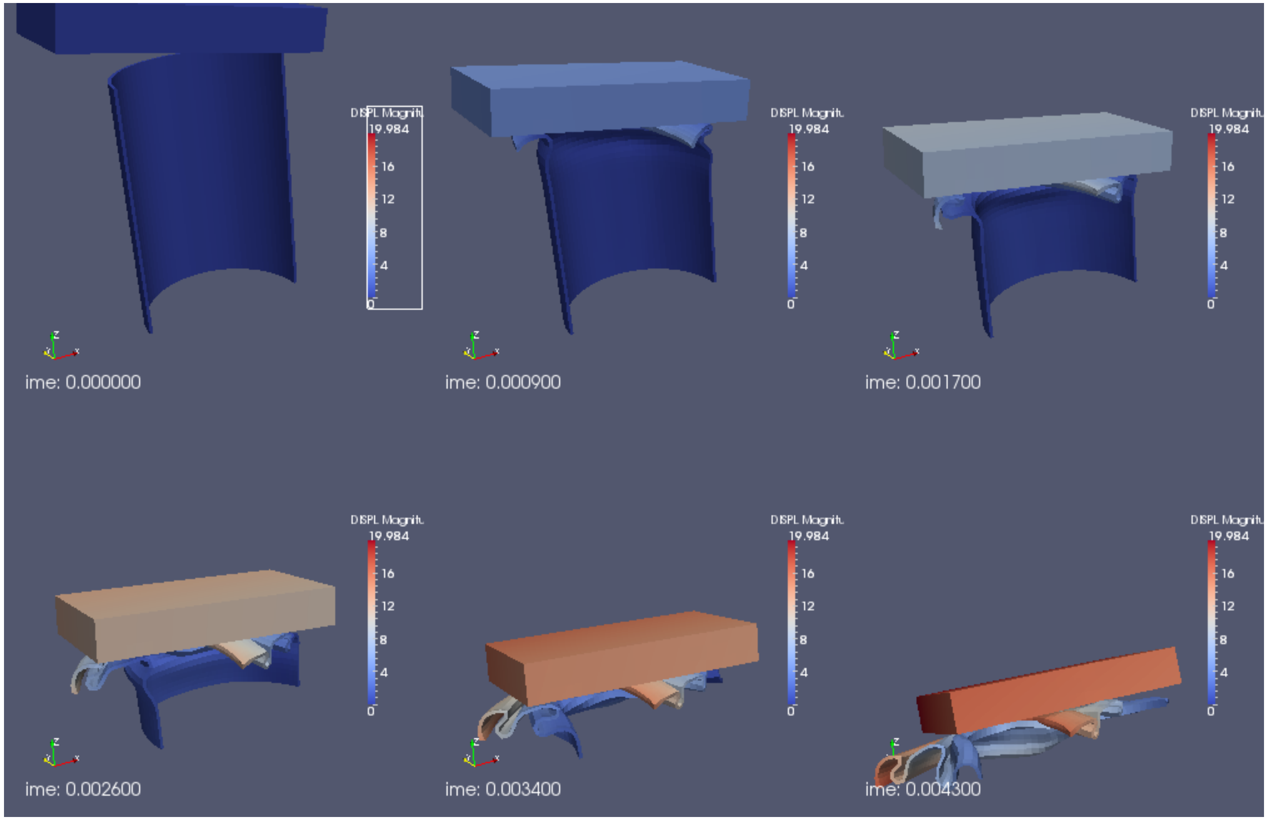
Exercise 2: Use Edit->Find Data to do the same search (Manual page 108)

Comparative Viewing

Compare, side-by-side, multiple visualization pipelines

- Open the 3D View (Comparative) Inspector

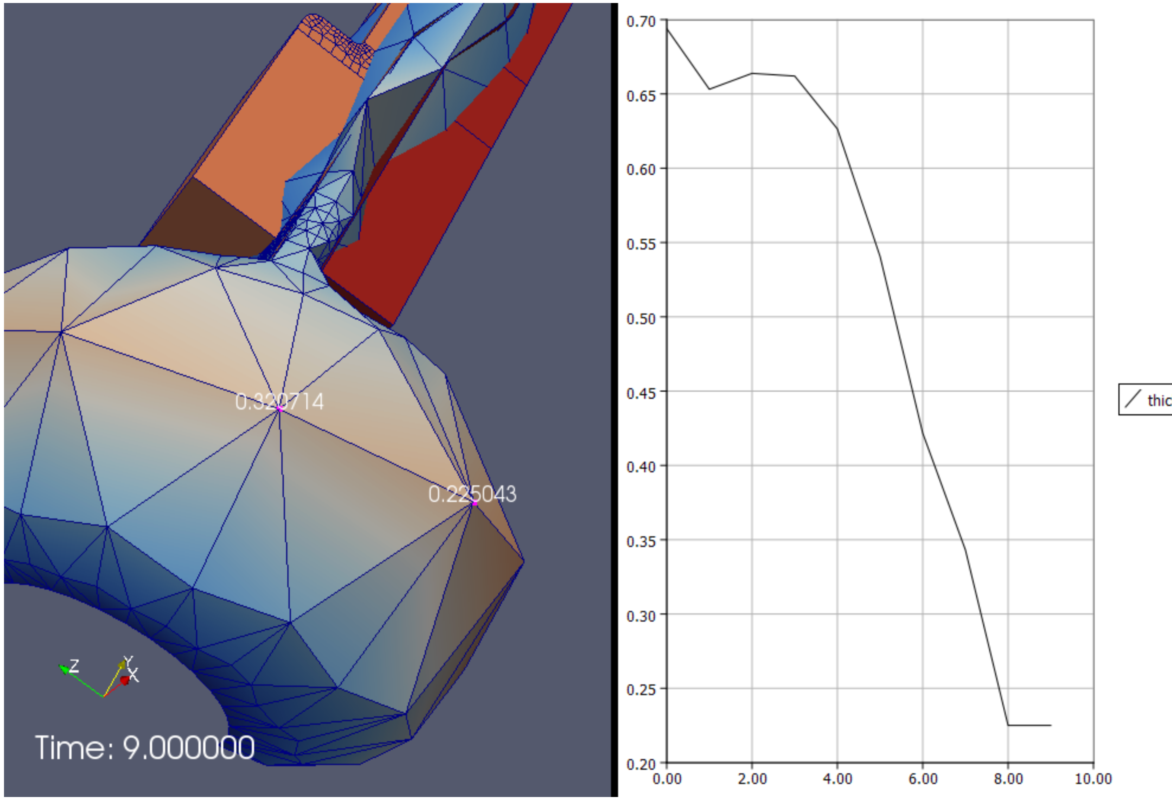
- Load file can.ex2



Plot Over Time

- Multiple points can be tracked over time (based on their ID)
  - Make a selection
  - Copy the Active Selection
  - Apply
  - Plotting is allowed for multiple points

- Produces a multi-block dataset

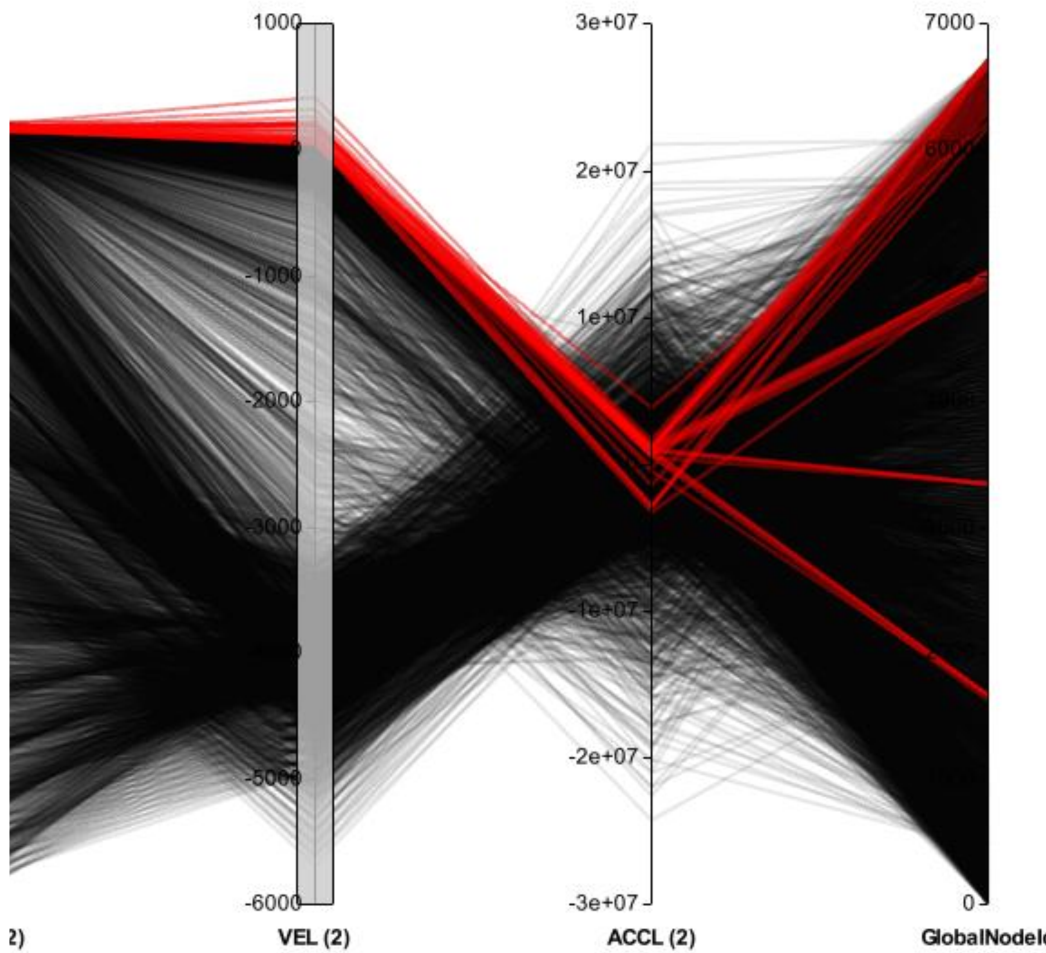


Parallel Coordinates View

- Points are shown in n-dimensional space
- Each vertical column allows subset selection

http://en.wikipedia.org/wiki/Parallel_coordinates

Load "vehicle_data.csv"



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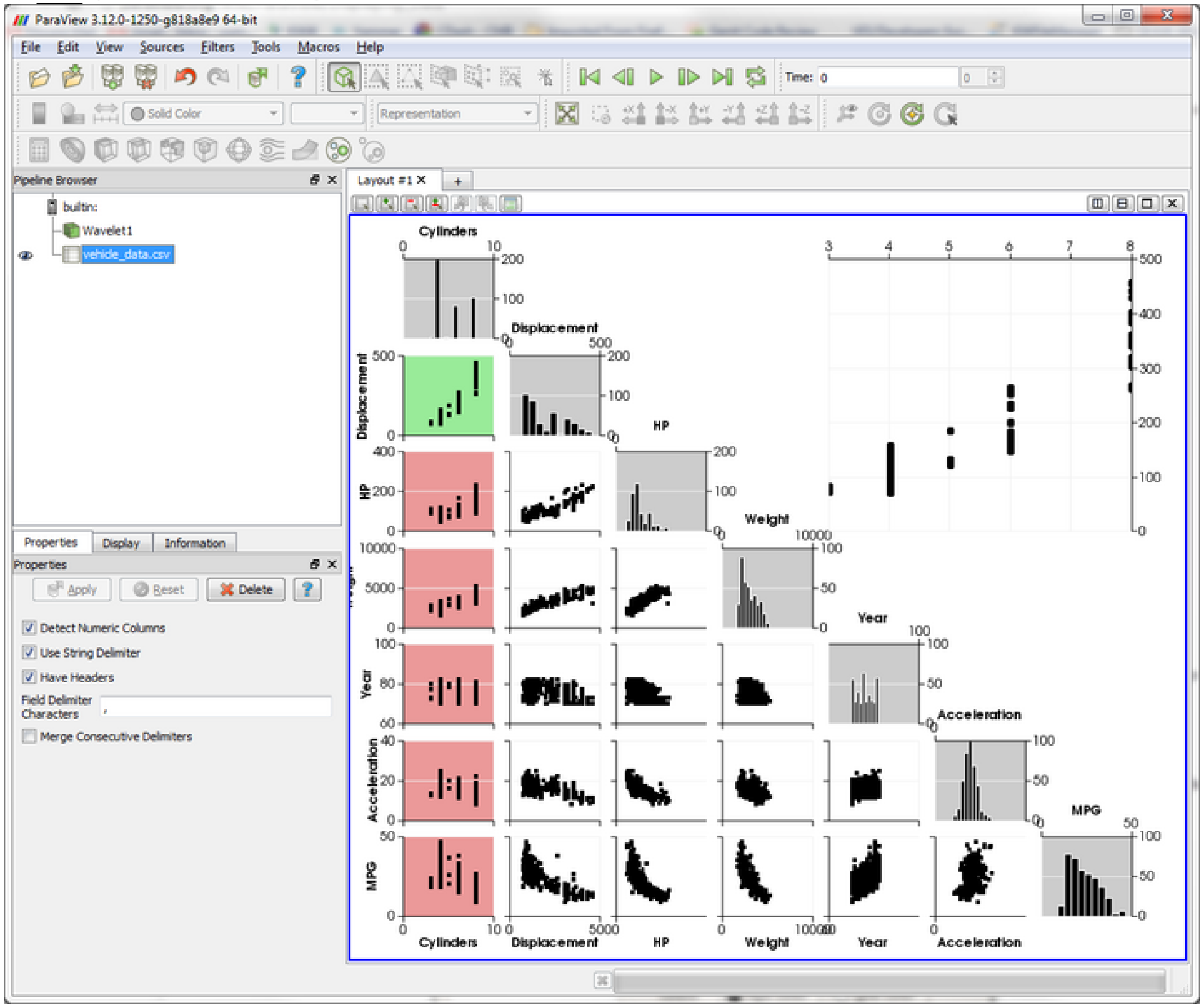
Plot-Matrix View

- Open vehicle_data.csv

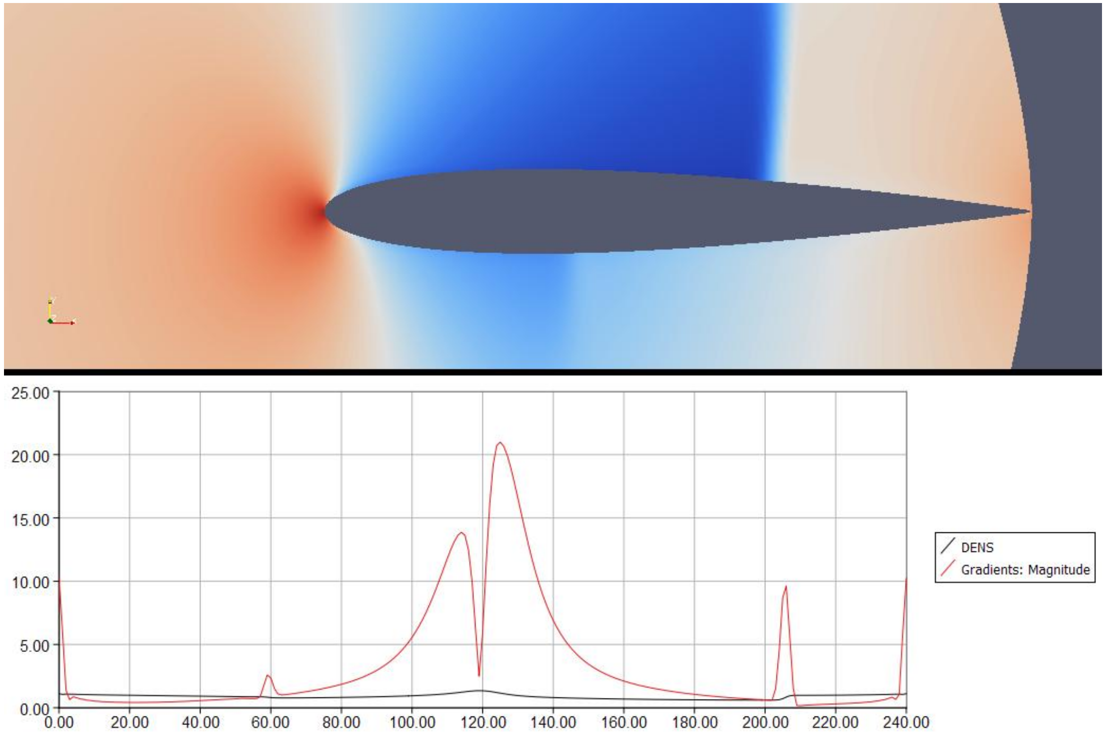


Summary

- http://paraview.org/Wiki/ParaView/Displaying_Data
- Plotting and Charting will use vtkTables
- Comparative viewing is to be done with caution (or low-resolution data)
- Idem for "plot over time"
- Both are ideal candidates for batch-mode processing

Exercise: Naca dataset

- **Load ${PARAVIEW_DATA_ROOT}/Data/naca.bin.case**
- **Plot density and gradient along the curvilinear contour of the airfoil**
- **Export plot as PDF**



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ParaView Python Tools

Dublin, March 2013

Jean M. Favre, CSCS

Outline

1. Tools, application scripting, python traces
   - pvpython, pvserver
   - parallel execution

2. Quantitative Analysis
   - programmable filters, python calculator

ParaView tools

- paraview, pvbatch can run in a single or multi-cpu session
- pvpython can connect to a parallel server

The “standard” version called paraview, will run interactively, i.e. with a graphics OpenGL window. This is intended to do exploratory visualization, and to prepare a visualization script.

To keep interaction live, you might want to use lower-resolution data

Important:

http://paraview.org/Wiki/ParaView/EnvironmentSetup

pvbatch

The “batch-oriented” tool called pvbatch, will run without user’s interaction.

pvbatch will be used to repeat the same visualization for:

- many time-steps in a transient simulation
- different input datasets
- to customize an animation

pvbatch can execute a hand-written python script, or reload a script generated with paraview, and save images to disk.

Reloading a state file

paraview can reload a state file with the option –state=filename.pvsm

paraview can reload a state with the command File->Load State

pvbatch can reload the same state file with the commands:

```
from paraview.simple import *
Connect()
servermanager.LoadState('/users/jfavre/state.pvsm')
```

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Reloading a python script

paraview can reload a python script with the option --script=filename.py

paraview can reload a python script with the command Tools->Python Shell->Run Script

Try reloading lib/paraview-3.98/site-packages/paraview/demos/demo1.py

```
sph = Sphere()
shr = Shrink()
rep = Show()
Render()
```

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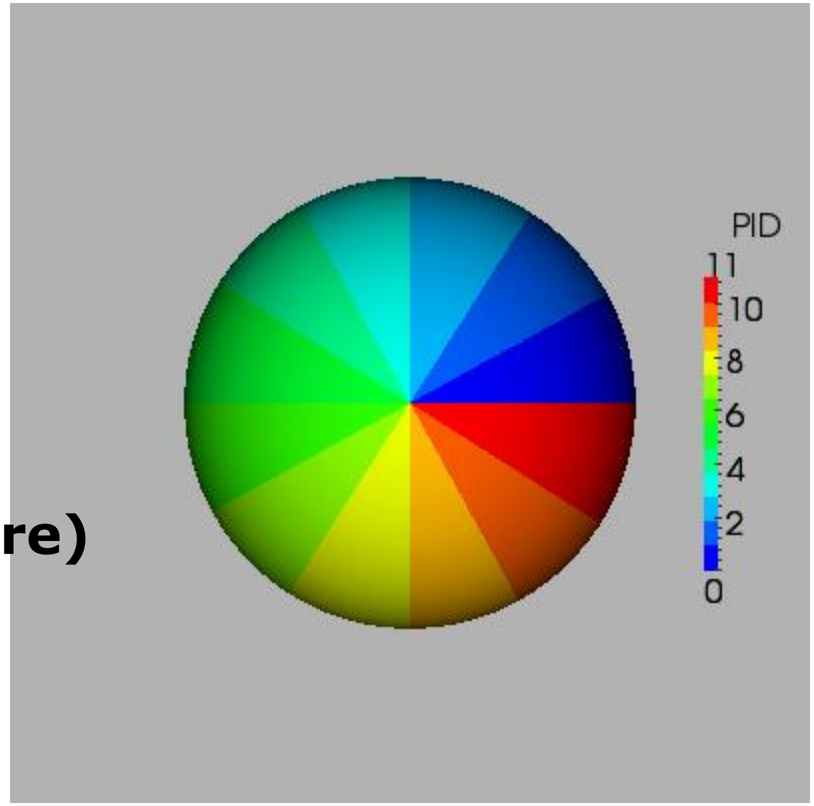
ColoredSphere (parallel) example

```
from paraview.simple import *

view = GetRenderView()

sphere = Sphere()
sphere.PhiResolution = 100

pidscal = ProcessIdScalars(sphere)

rep = Show(pidscal)

nbprocs =
  servermanager.ActiveConnection.GetNumberOfDataParti
  tions()
drange = [0, nbprocs-1]
```

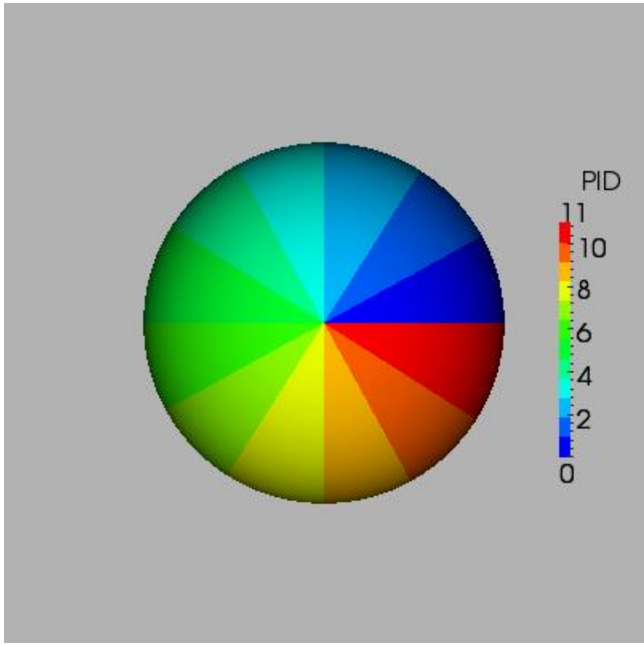


ColoredSphere (parallel) example

```
lt = MakeBlueToRedLT(drange[0], drange[1])
lt.NumberOfTableValues = nbprocs

rep.LookupTable = lt
rep.ColorAttributeType = 'POINT_DATA'
rep.ColorArrayName = "ProcessId"

bar = CreateScalarBar(LookupTable=lt, Title="PID")
bar.TitleColor = [0,0,0]
bar.LabelColor = [0,0,0]
bar.NumberOfLabels = 6

view.Representations.append(bar)
```

running the example with pvbatch

```
view.ResetCamera()
view.Background = [.7, .7, .7]
view.CameraViewUp = [0, 1, 0]
view.StillRender()
WriteImage("coloredSphere.png", view=view,
  Writer="vtkPNGWriter")


# Execute with MPI

mpirun –n12 `which pvbatch` \
         --use-offscreen-rendering \
         coloredSphere.py
```



How to get started with Python commands?

- http://paraview.org/Wiki/ParaView/Python_Scripting

- Utilities/VTKPythonWrapping/servermanager.py
- Utilities/VTKPythonWrapping/simple.py

- Use Python Shell -> Trace

- Start trace, trace state, show/edit/save trace

- The traces are very verbose. Editing is recommended.

Look at data fields stored in the grid

```
r = OpenDataFile("/ParaViewData/Data/bluntfin.vts")
r.UpdatePipeline()

pd = r.PointData

for n in range(pd.GetNumberOfArrays()):
  print pd.GetArray(n).GetName(), ' ',
  pd.GetArray(n).GetRange()

for n in range(pd.NumberOfArrays):
  print pd[n].Name, ' ', pd[n].GetRange()

for k, v in pd.iteritems():     # pd is a python dictionary
  print k, v.GetRange()
```

Execute a script for multiple timesteps

AnimateReader() (from simple.py) is a macro that takes a time-aware data source, a view, and a filename

AnimateReader(reader, GetRenderView(), "/tmp/foo.png")

It will step through all timesteps. The execution is run on-demand by the view

Execute for some timesteps

AnimateReader() starts at the beginning and runs to the end with a fixed increment. You can change that and do your own start, end, and time increment.

```
tsteps = reader.TimestepValues
start = 2
incr = 3
end = 7
for i in tsteps[start:end:incr]:
    view.ViewTime = tsteps[i]
    view.StillRender()
    imgfile = “image.%03d.png” % (start+i*incr)
    view.WriteImage(imgfile, “vtkPNGWriter”, 1)
```

Exercise with a file can.ex2

reader = FindSource("can.ex2")

view = GetRenderView()

tsteps = reader.TimestepValues
start = 0
incr = 1
end = len(tsteps) -1
for i in tsteps[start:end:incr]:
   view.ViewTime = tsteps[i]
   view.StillRender()

AnimateReader(reader, view,
"c:/Users/jfavre/foo.png")

Execute a script for multiple files

While running paraview, get the python interface. Find all files

Tools-> Python Shell

```
import glob, string

files = glob.glob("/scratch/user/file*.dat")
files.sort()
```

Execute a script for multiple files

How do we update the pipeline objects?

must find the names of the objects to be modified

```
view = GetRenderView()
#you created a pipeline and read a file “file.000.dat”
#using the GUI Open menu
# the object called 'file.000.dat' shows in the pipeline viewer

reader  = FindSource('file.000.dat')
# reader can now be updated
reader.Filename = files[i]
view.StillRender()
```

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Quantitative Analysis

- Calculator (page 90)
- Python Calculator (page 96)
- Programmable Source/Filter (page 87)

Ref. ParaView 3.98 User Manual

Calculator filter

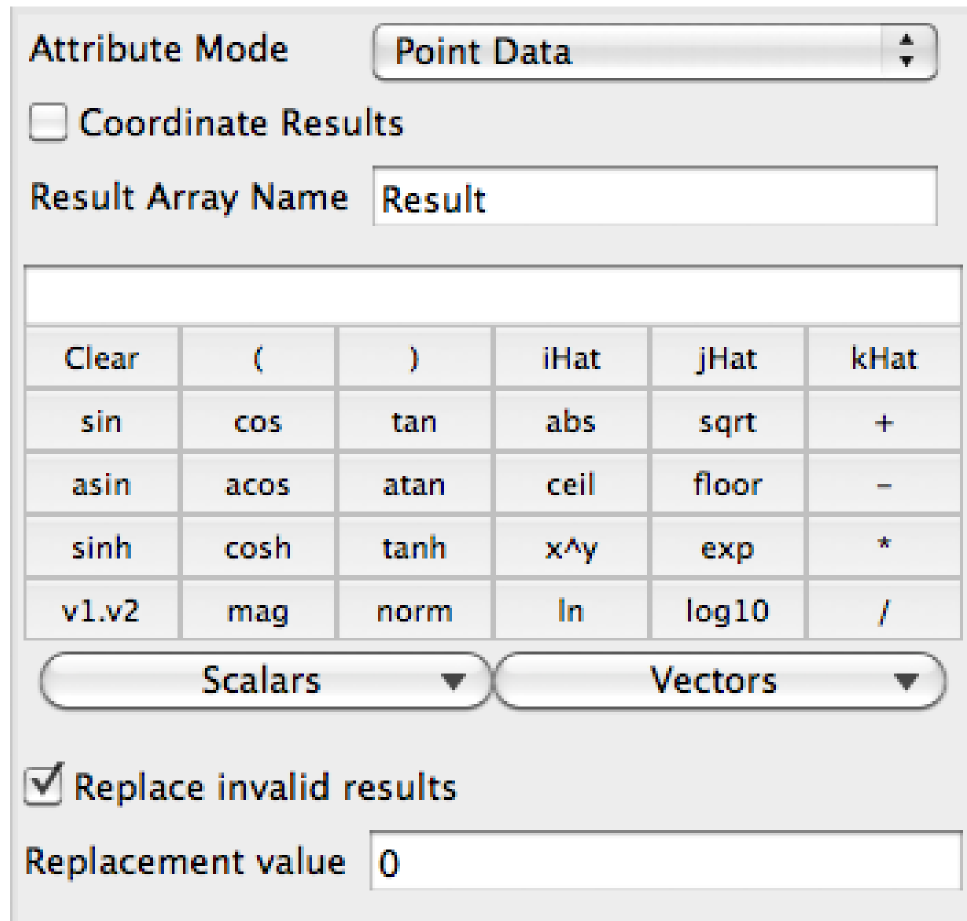
Calculate derived quantities from existing attributes

Use a free-form text expression

Example:

5 * RTData

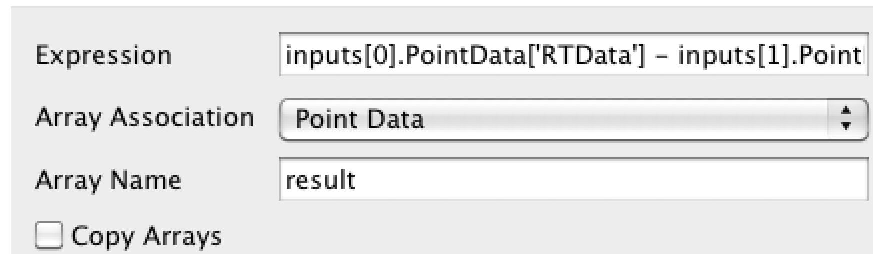
if(condition,true_expression,false_expression)



Python Calculator filter

Uses python and numpy

- Accepts multiple inputs. inputs[0], inputs[1], …
- Can access the point or cell data using the .PointData or .CellData qualifiers.
- Can access the coordinates array using the .Points qualifier:




```
inputs[0].PointData[‘Normals']
inputs[0].Points[:,0]
```

Python Calculator filter

Examples:

```
Normals + 5
Normals + [1,2,3]
velocity[:, 0]
hstack([velocity_x, velocity_y, velocity_z])
```

- When the calculation is more involved and trying to do it in one expression may be difficult…. When you need access to a program flow construct such as if or for…
- When you need to change the type of the mesh…
- => use the programmable filter

Python Programmable Source/Filters

Creates and transforms VTK grids

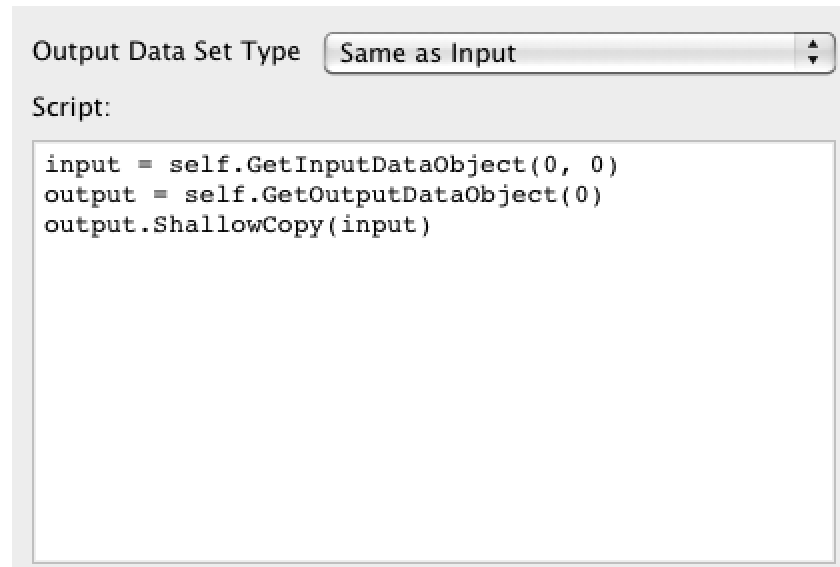
Examples:

Have a Python code to read data, and you may re-use it instead of writing a C++ reader.

Prototype a filter, without a GUI

Import one of many python packages…

Extract the data arrays of a ‘Grid’ and show them as a ‘Table’

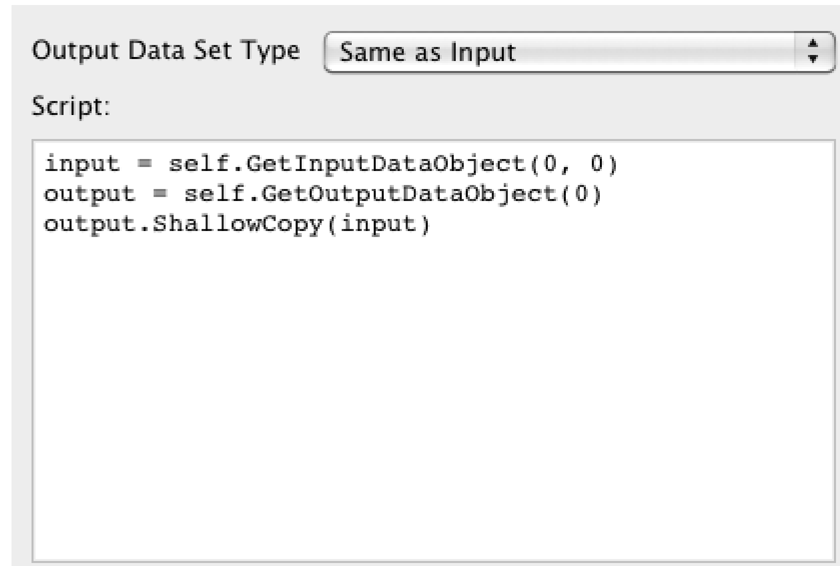


Python Programmable Source/Filters

In it simplest form, the input is copied to the output.

It is a pass-thru filter

With the "Copy Arrays" option, the output will have all of the input arrays



Example:

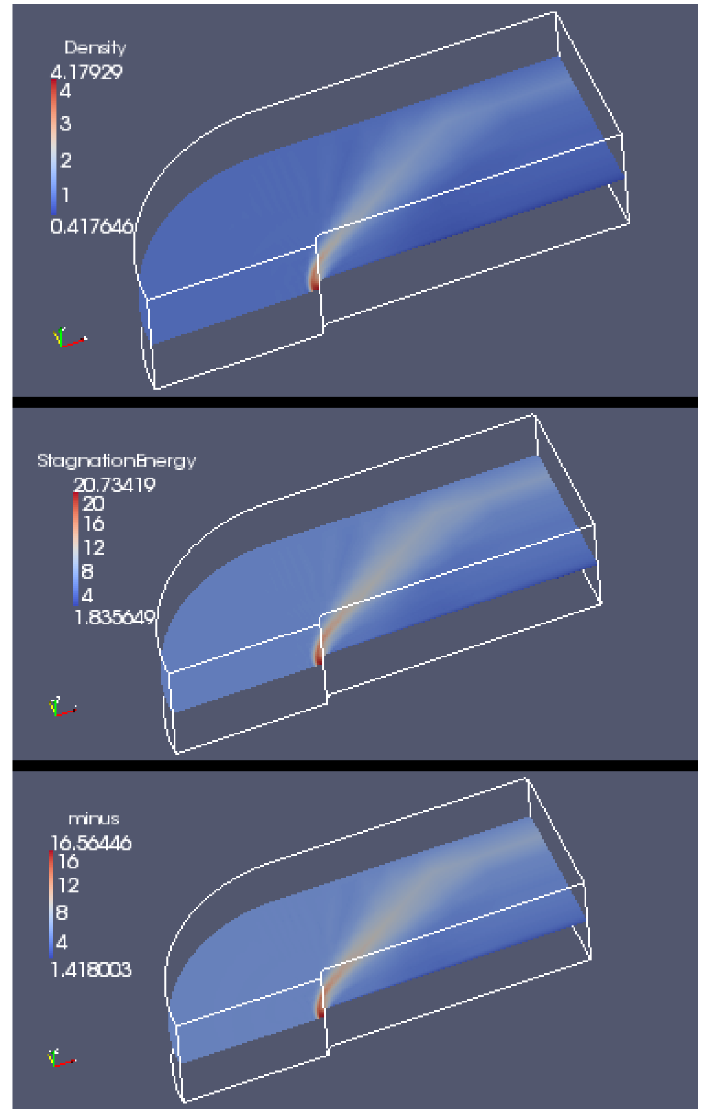
create a Sphere Source and add

```
normals = inputs[0].PointData['Normals']
output.PointData.append(normals[:,0], "Normals_x")
```

Example of the use of numpy

```
#get VTK objects
pdi = self.GetInputDataObject(0,0)
pdo = self.GetOutputDataObject(0)
pdo.ShallowCopy(pdi)

#manipulate Python objects
data0 = inputs[0].PointData['Density']
data1 = inputs[0].PointData['Energy']
output.PointData.append(data1-data0,
   'minus')
```



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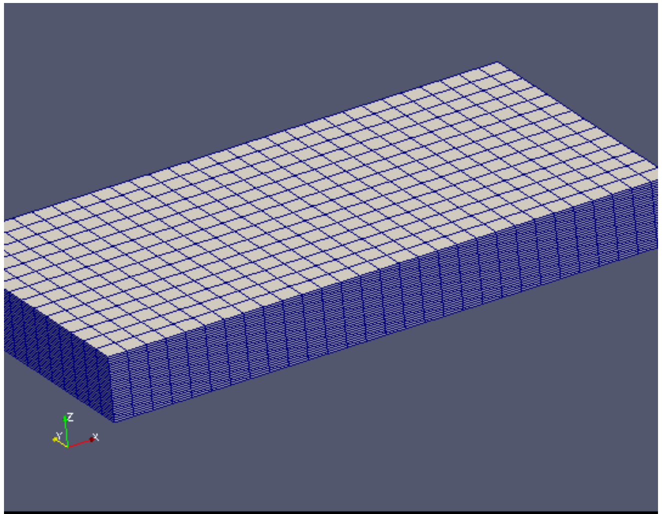
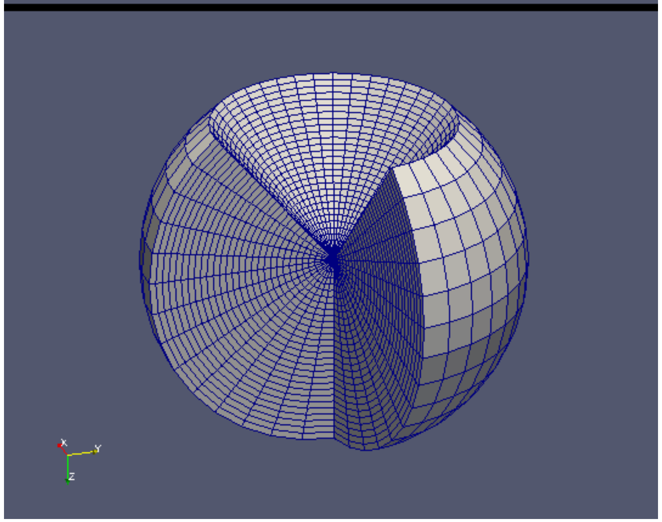
Example : create a grid and remap it to spherical space





Python Prog. Source

Python Prog. Filter

Source code here

http://www.paraview.org/pipermail/paraview/2010-August/018495.html

```
from paraview.util import SetOutputWholeExtent
SetOutputWholeExtent(self, [0, 29, 0, 19, 0, 19])
```

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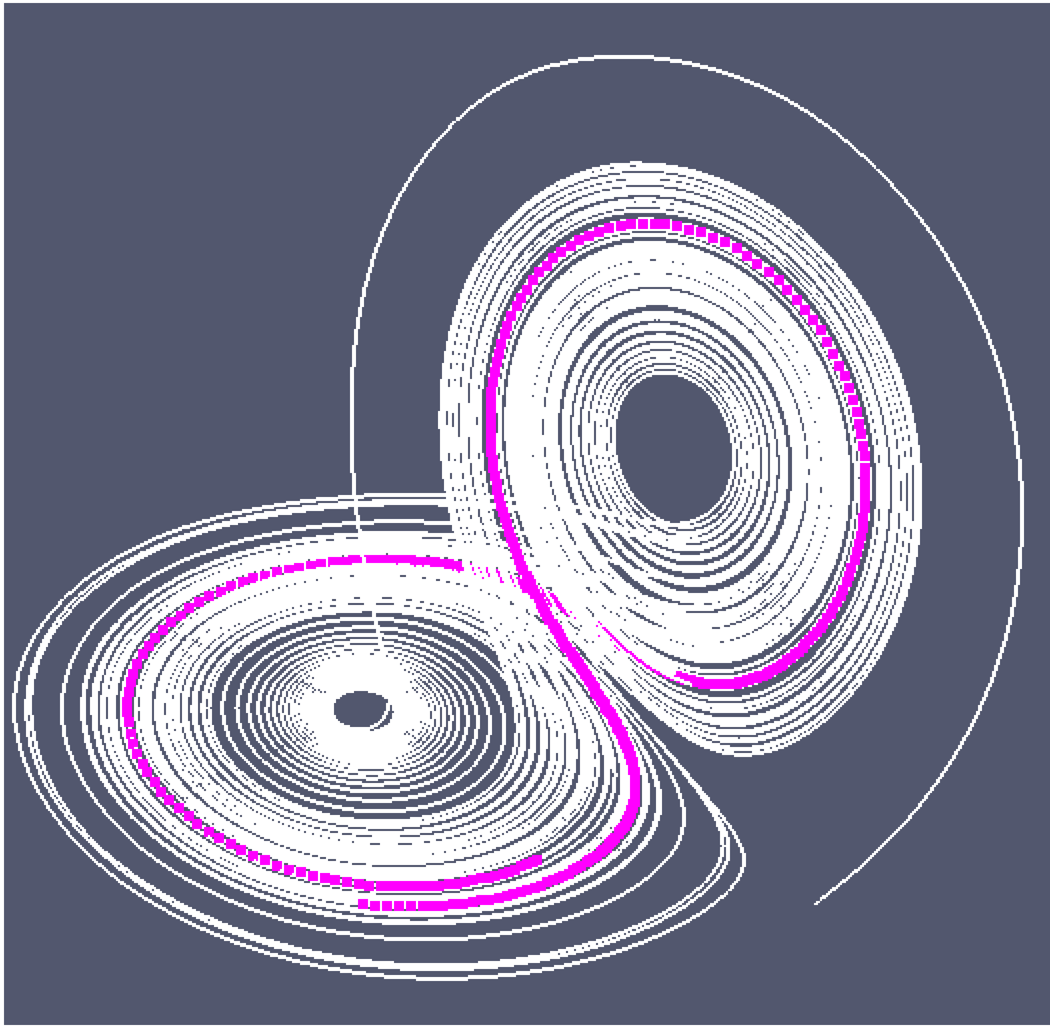
Example of the use of a python package

import scipy
from scipy import integrate

And create a vtkPolyData object to view



- Google for source code with
- “lorenz python laprise”

Grid to Table translation

```
# Get a Programmable filter
# set the output type to "vtkTable"

table = self.GetTableOutput()
pd = self.GetInput().GetPointData()

for i in range(pd.GetNumberOfArrays()):
  table.AddColumn(pd.GetArray(i))
```

Summary

- Python scripts are a much better representation of the pipeline than the older state files (*.pvsm)

- I recommend you learn at least the basics, to reload a given configuration, in a more portable manner

- Python is the only interface to run ParaView in batch mode