Scientific Visualization
An Introduction

Featuring

Vetria L. Byrd, PhD
Assistant Professor

International High Performance Computing Summer School
Ljubljana, Slovenia
Wednesday, June 29, 2016

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About Me

Vetria L. Byrd, PhD

Academic Preparation

- Computer Science (PhD, MS)
- Biomedical Engineering (MSMBE)

THE UNIVERSITY OF ALABAMA AT BIRMINGHAM
Knowledge that will change your world

Where I Am Now

Assistant Professor
Purdue University
Computer Graphics Technology
Research Focus: Data Visualization

What I've Done

CLEMSON UNIVERSITY

Visualization Initiatives

- Research Experience for Undergraduates in Collaborative Data Visualization Applications (2014/2015)
- BPViz: Broaden Participation in Visualization (2014/2016)
  - August 3 – 4, 2016
  - Purdue/NCSA

Agent for "Insight"

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AGENDA

INTRODUCTION TO SCIENTIFIC VISUALIZATION

- High Level Overview
- Purpose Of visualization
- Visualization Applications
- Data Visualization Process
- Scientific Visualization Process
- Introduction to Scientific Visualization Using ParaView
  - Hands-on Workshop
- Additional Resources

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Slides Available on the XSEDE WIKI

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What is the purpose of Visualization?

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"The purpose of visualization is "insight", not pictures."
~Ben Shneiderman

What does Insight lead to?

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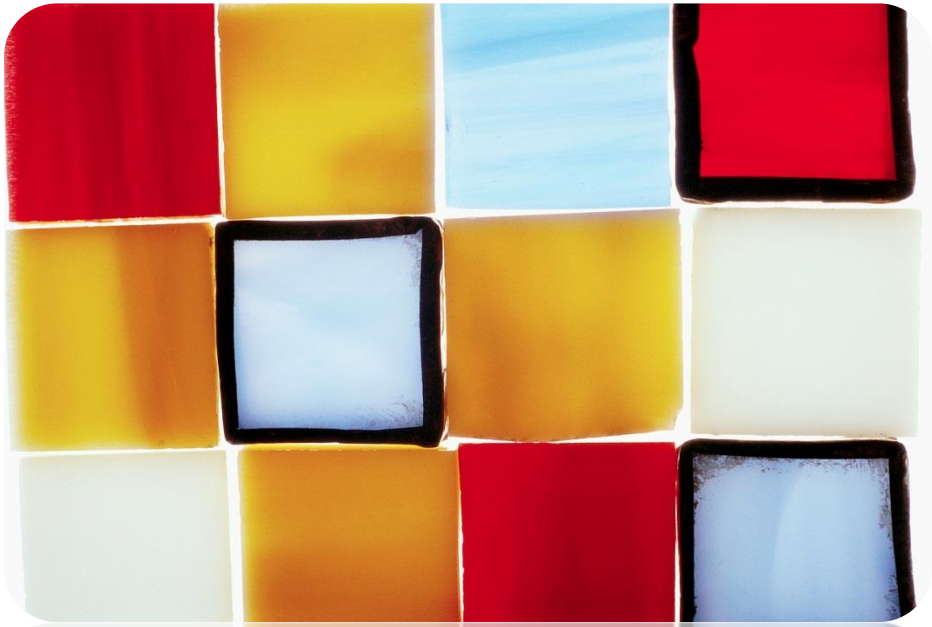
“Insight” Leads to . .

Discovery

Source: greenbookblog.org



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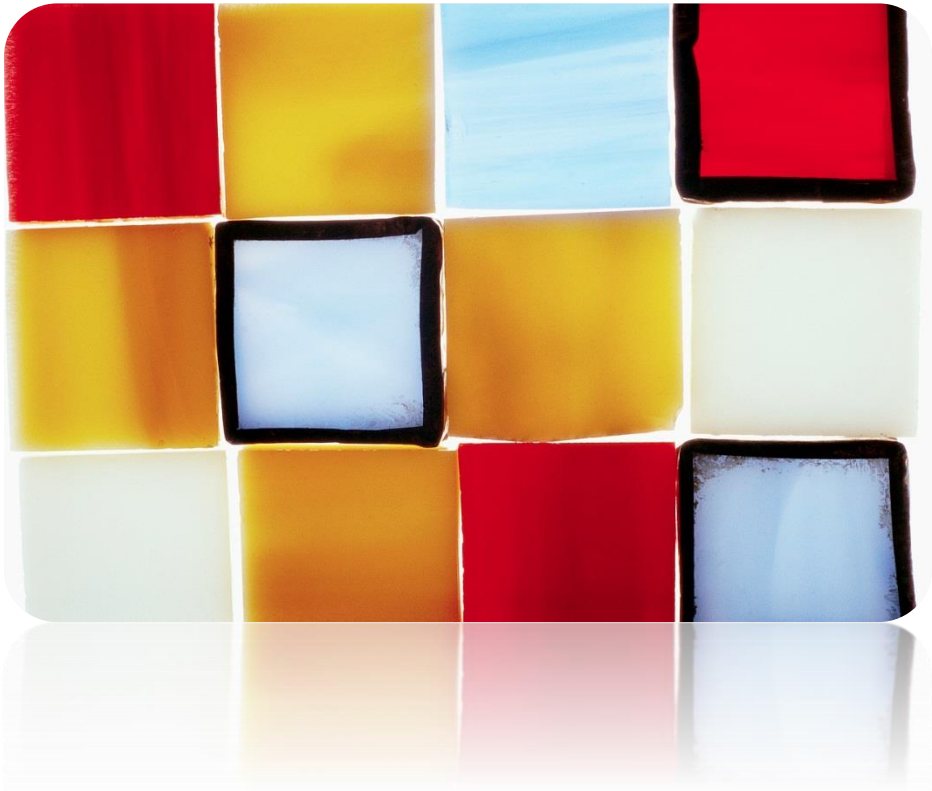
"Insight" Leads to . .

Discovery

Visualizing Patterns over Time

Source: greenbookblog.org



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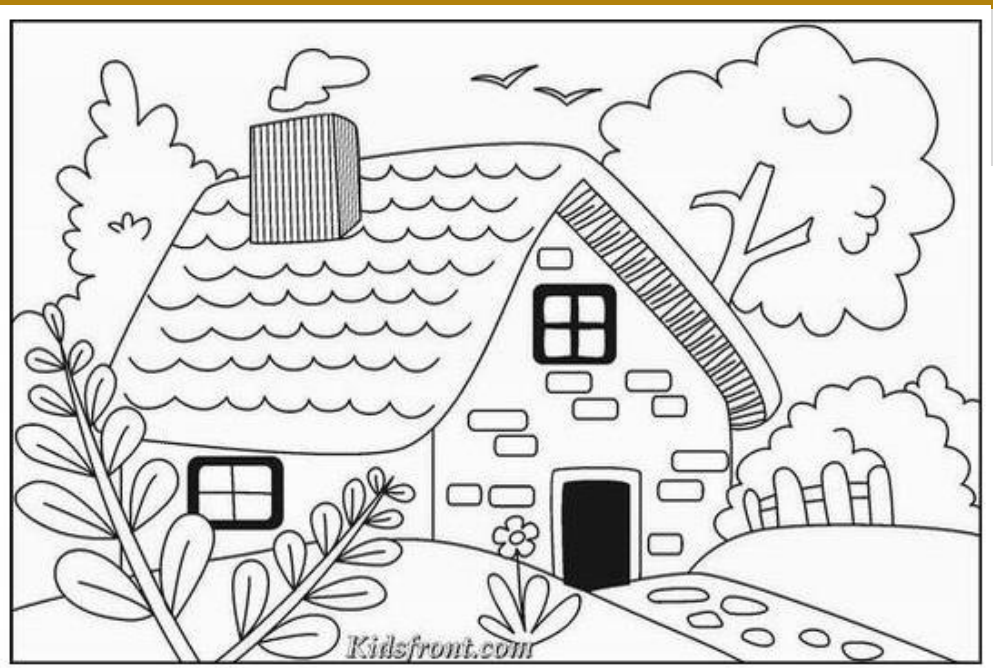
“Insight” Leads to . .

Discovery

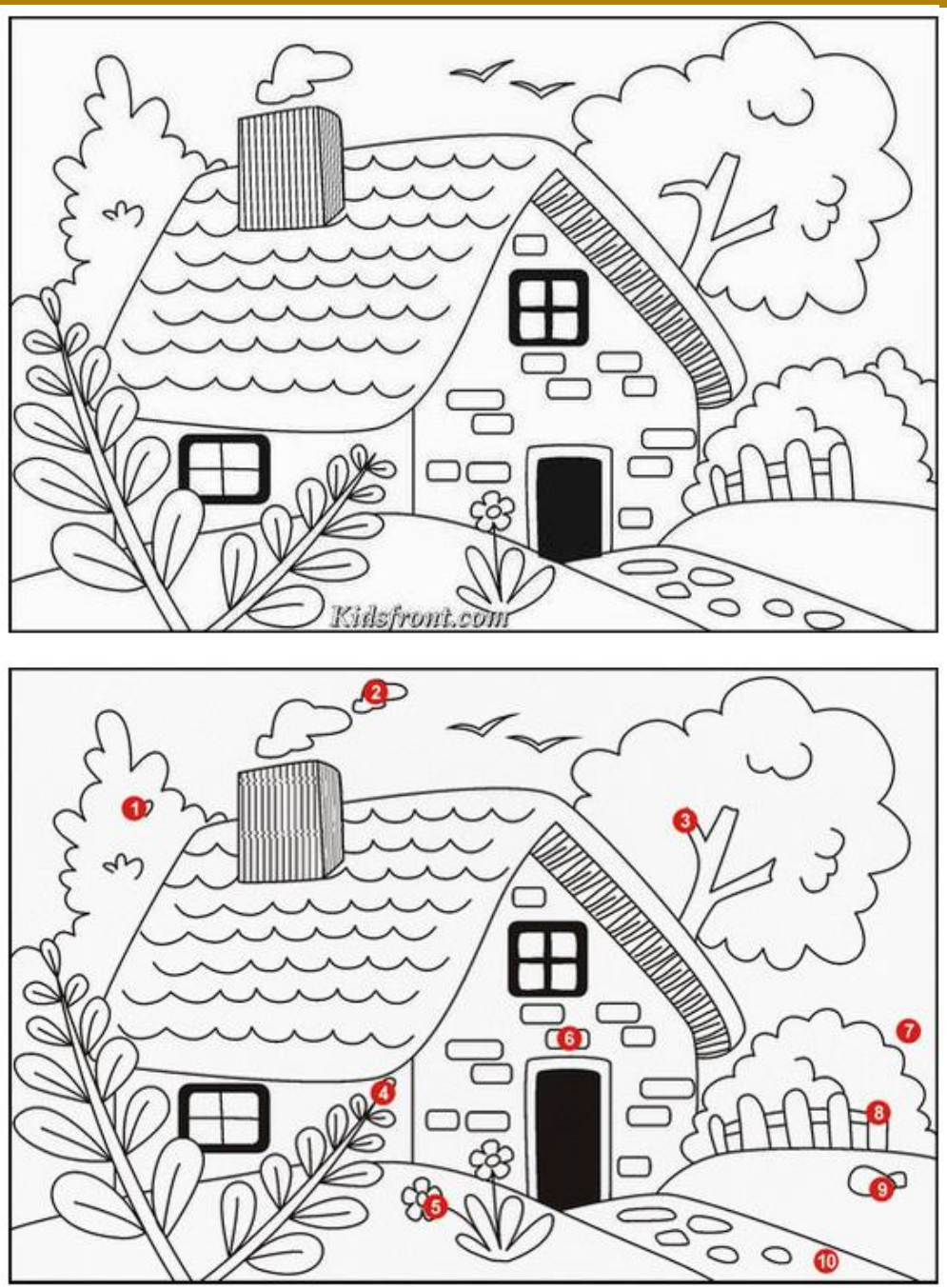
Spotting Differences



"Insight" Leads to . .

Discovery

Spotting Differences



http://www.kidsfront.com/spot-differences/9.html

"Insight" Leads to . .

Discovery

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01010701010101010100107001011001l0
01100110011001100111001100110010101
01010107010101010111000101110001O1
11100010100110101010101010111000
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Spotting Differences

How many 7's do you see?

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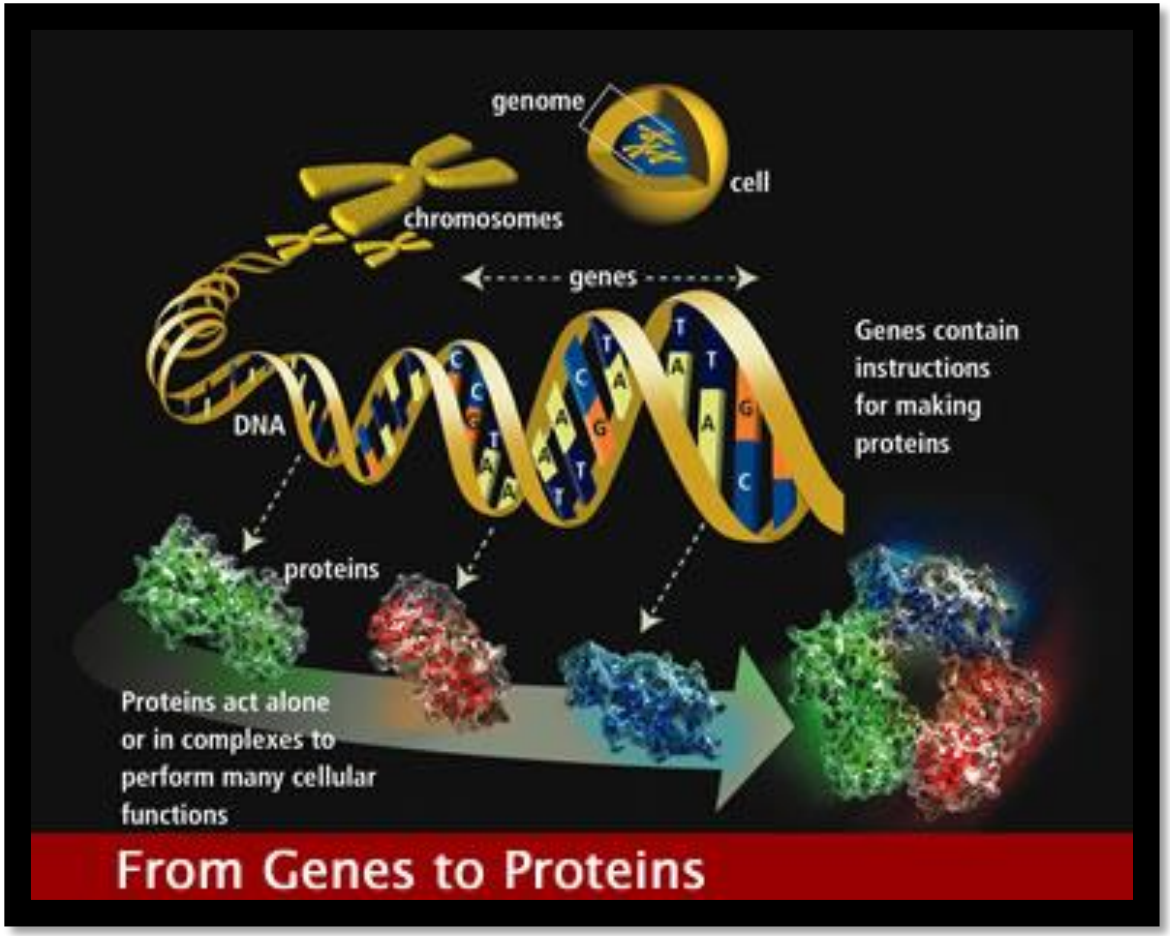
"Insight" Leads to . .

Decision Making

Allows users to answer questions they didn't know they had



Human Genome Project
https://pradipjntu.files.wordpress.com/2011/05/molecularmachine.jpg

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"Insight" Leads to . .

Analysis Of Data

The Challenger Disaster

http://en.wikipedia.org/wiki/33
File: Challenger_explosion.jpg

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"Insight" Leads to . .

Explanation

Visualizing Spatial Relationships

http://datafl.ws/197

http://datafl.ws/198

Muehlenhaus, I. (2012). **Chapter 8, Visualizing Spatial Relationships,** Visualize This: The Flowing Data Guide to Design, Visualization, and Statistics, pp 271-326.

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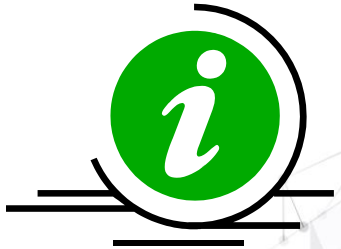
Can anyone think of another reason why “insight” is important?



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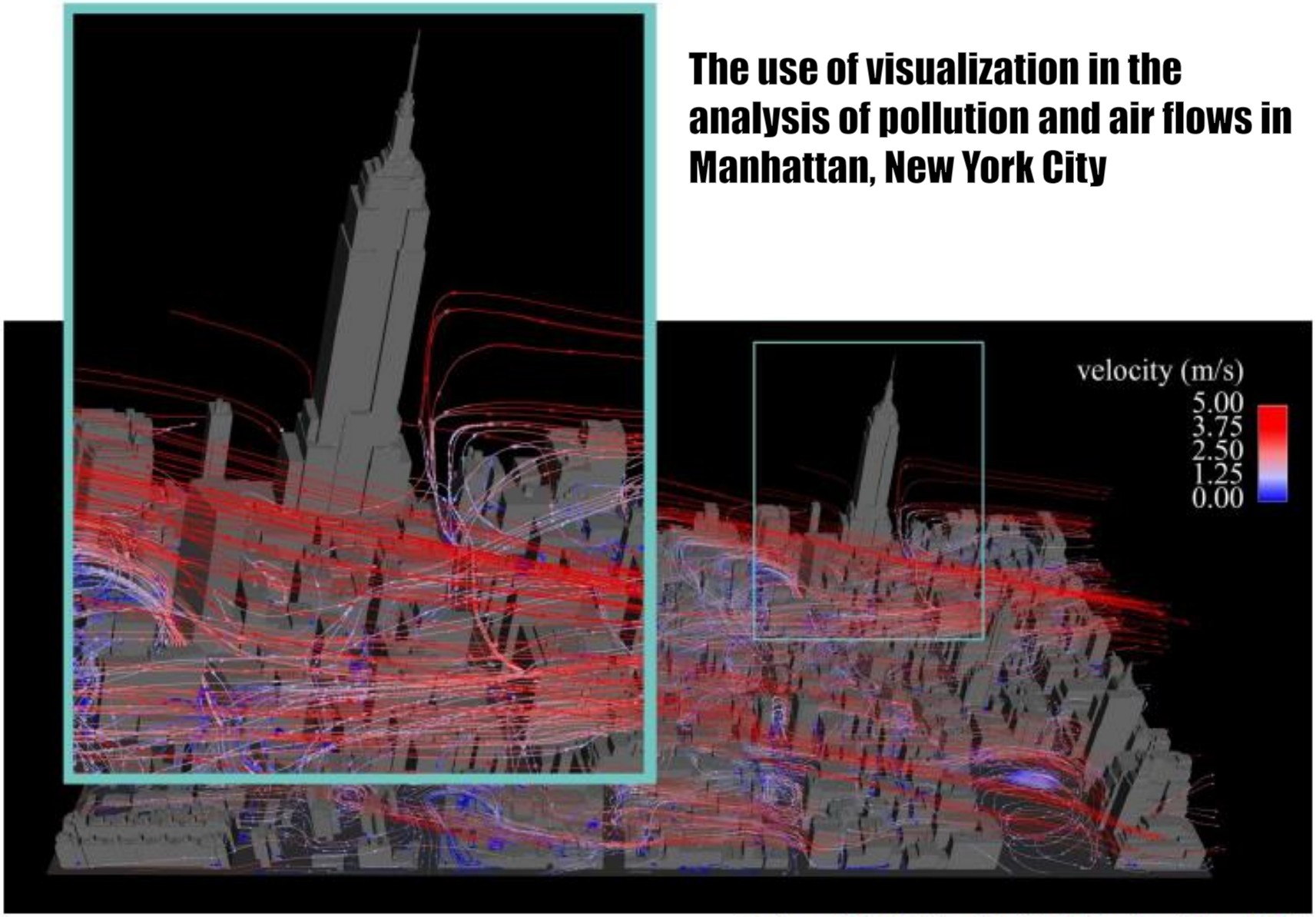
“Insight” Tells a Story.

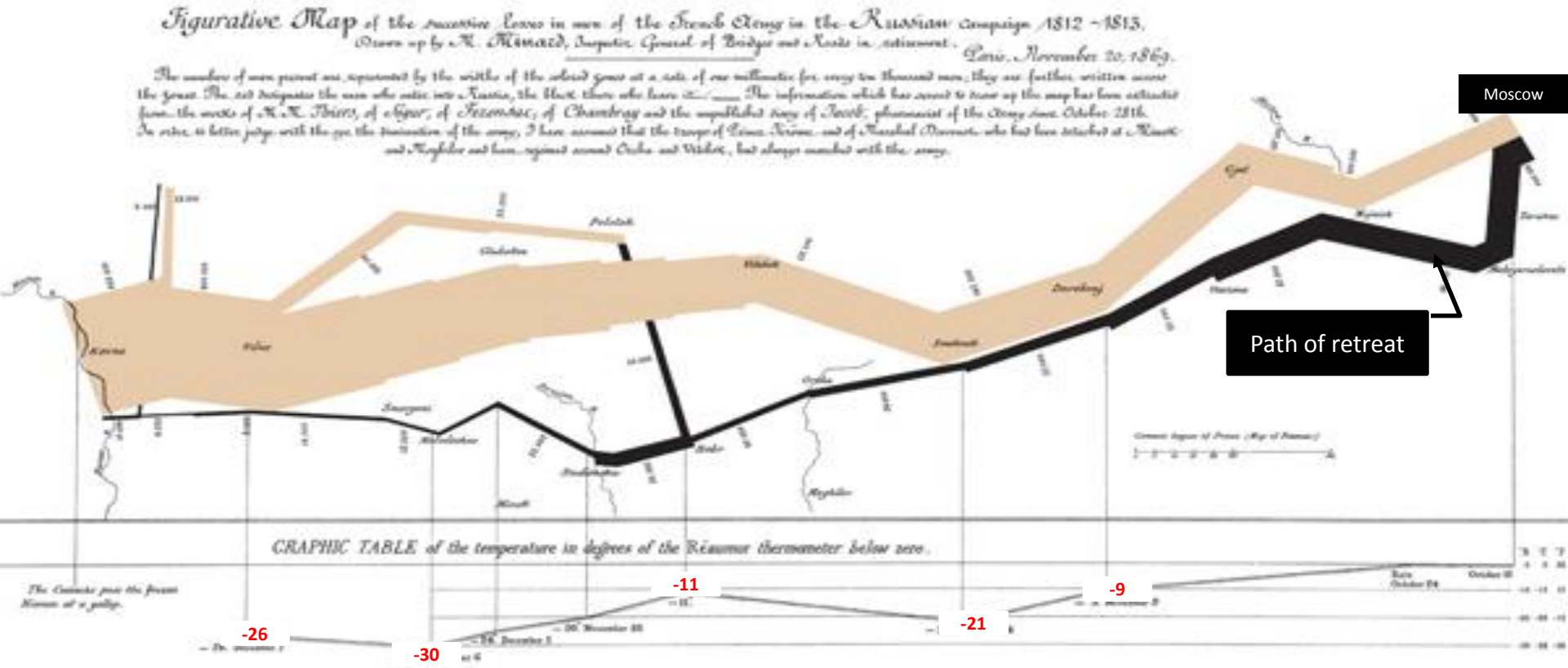
The use of visualization in the analysis of pollution and air flows in Manhattan, New York City



Courtesy of RENCI, University of North Carolina at Chapel Hill.

“Insight” Tells a Story

Napoleon’s Invasion of Russia in 1812 By Jacque Minard



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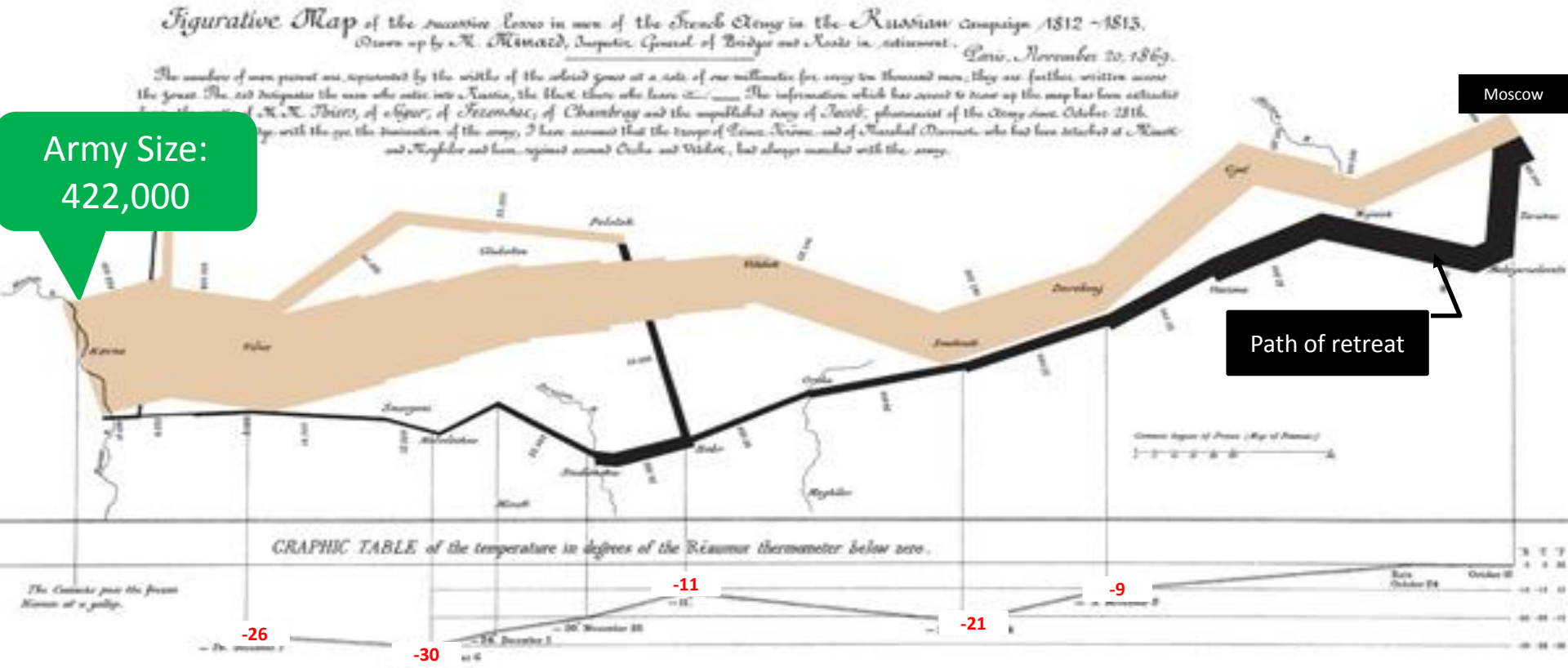

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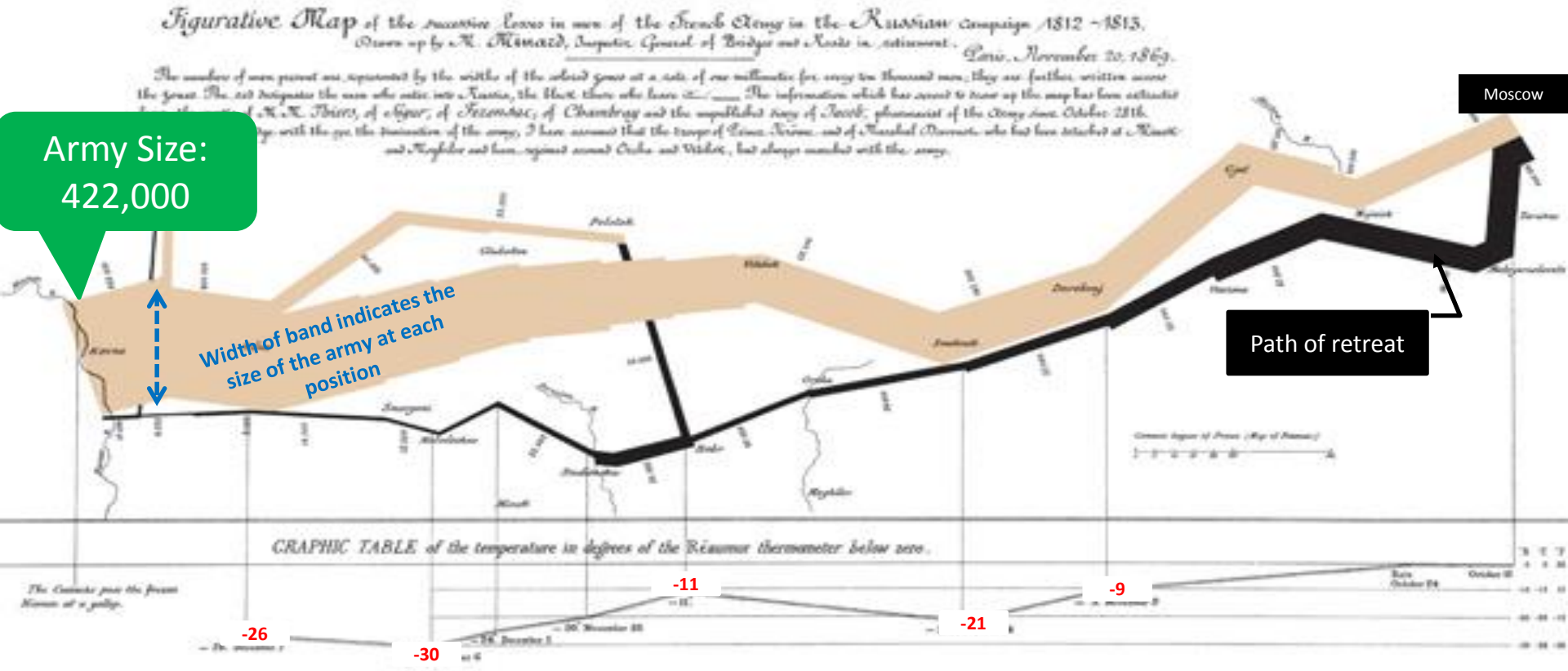

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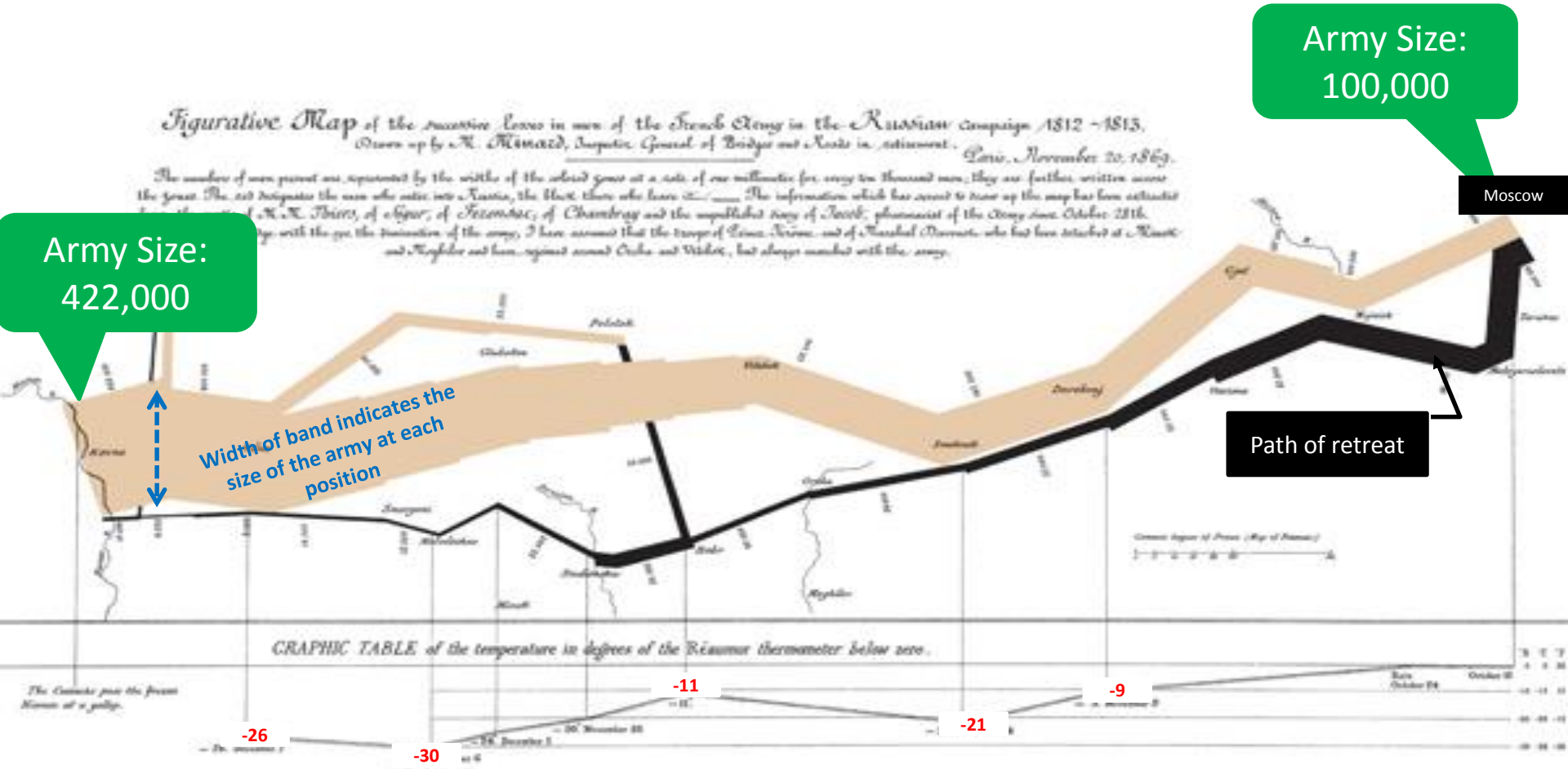

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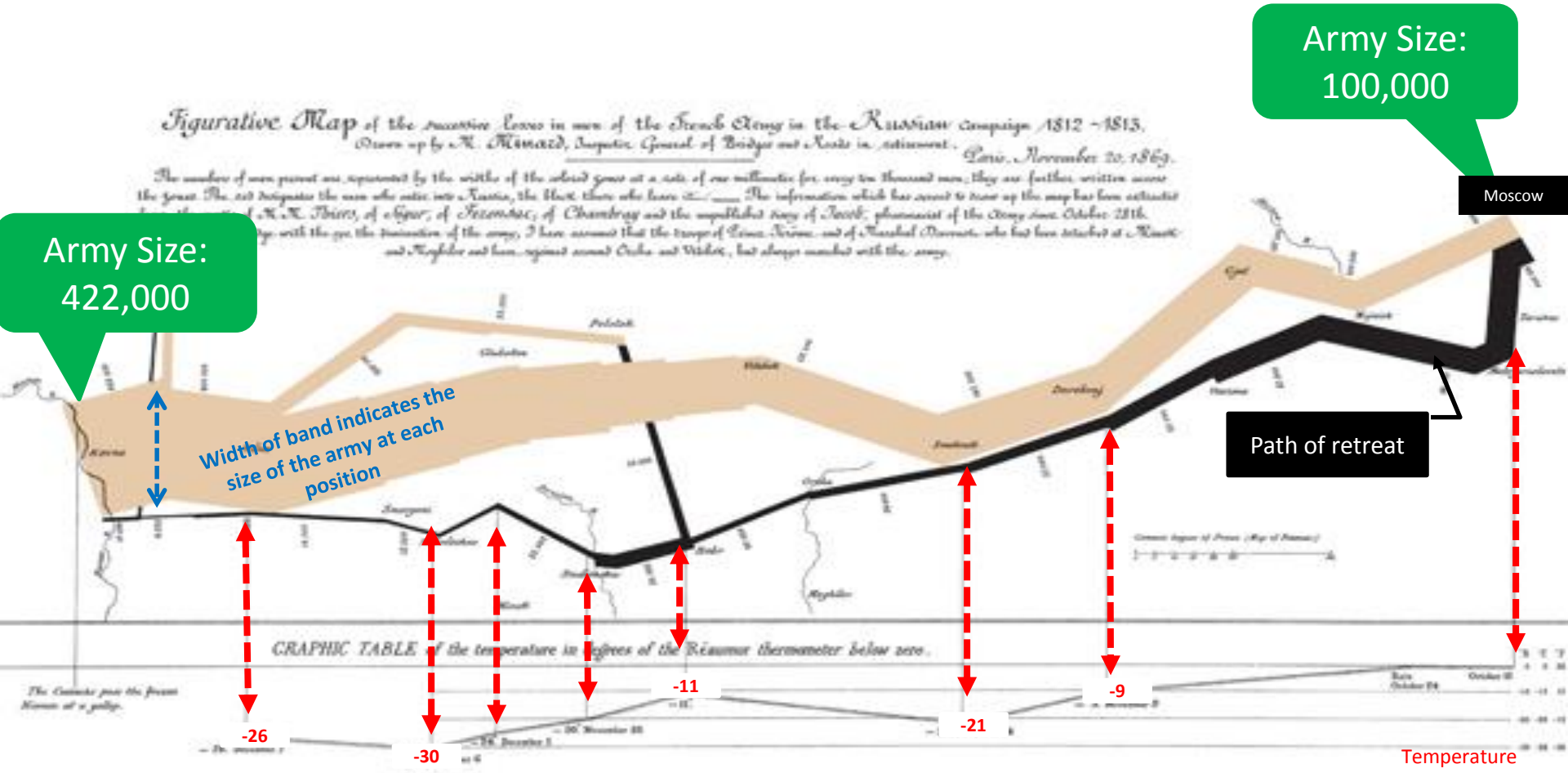

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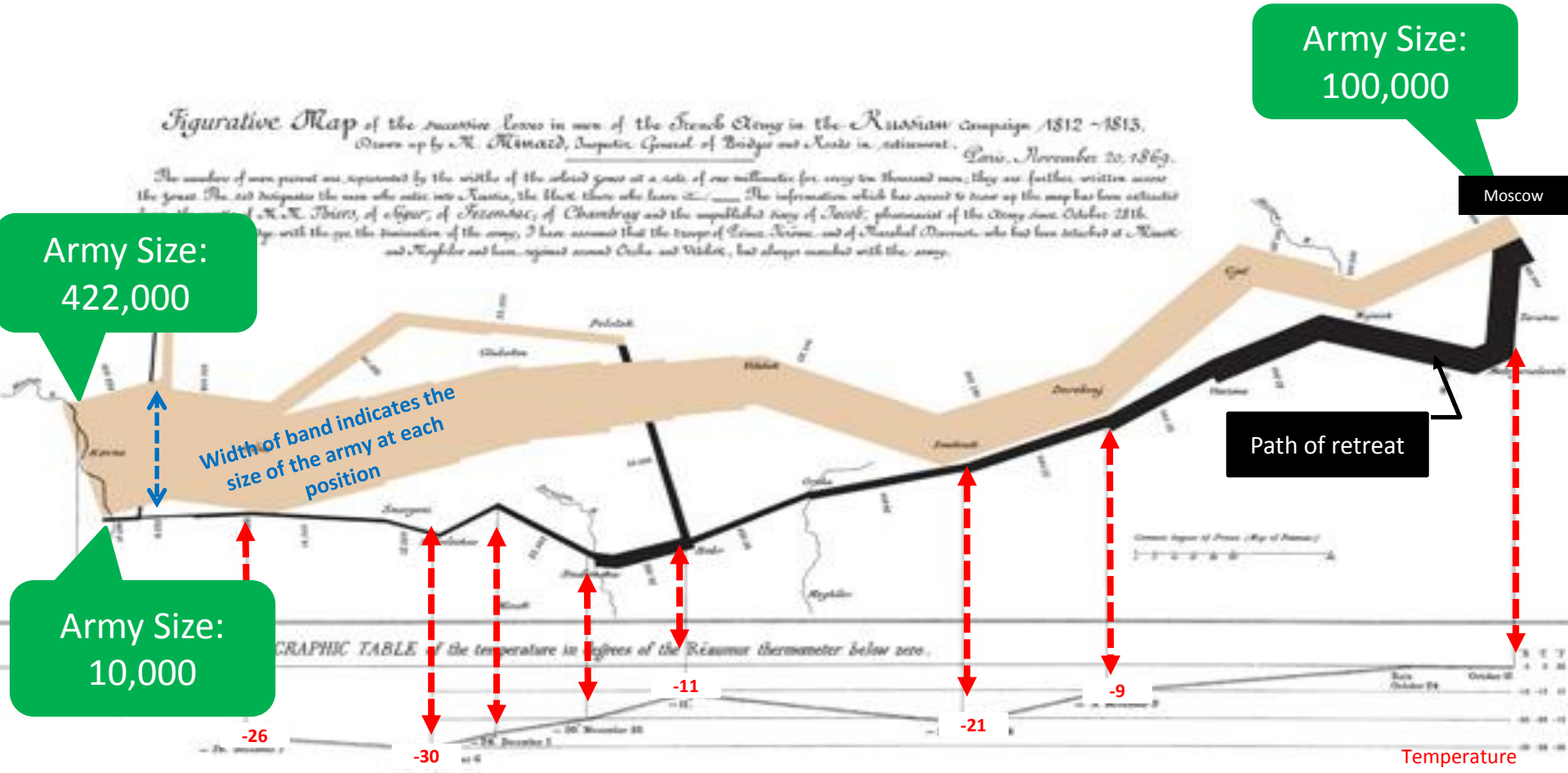
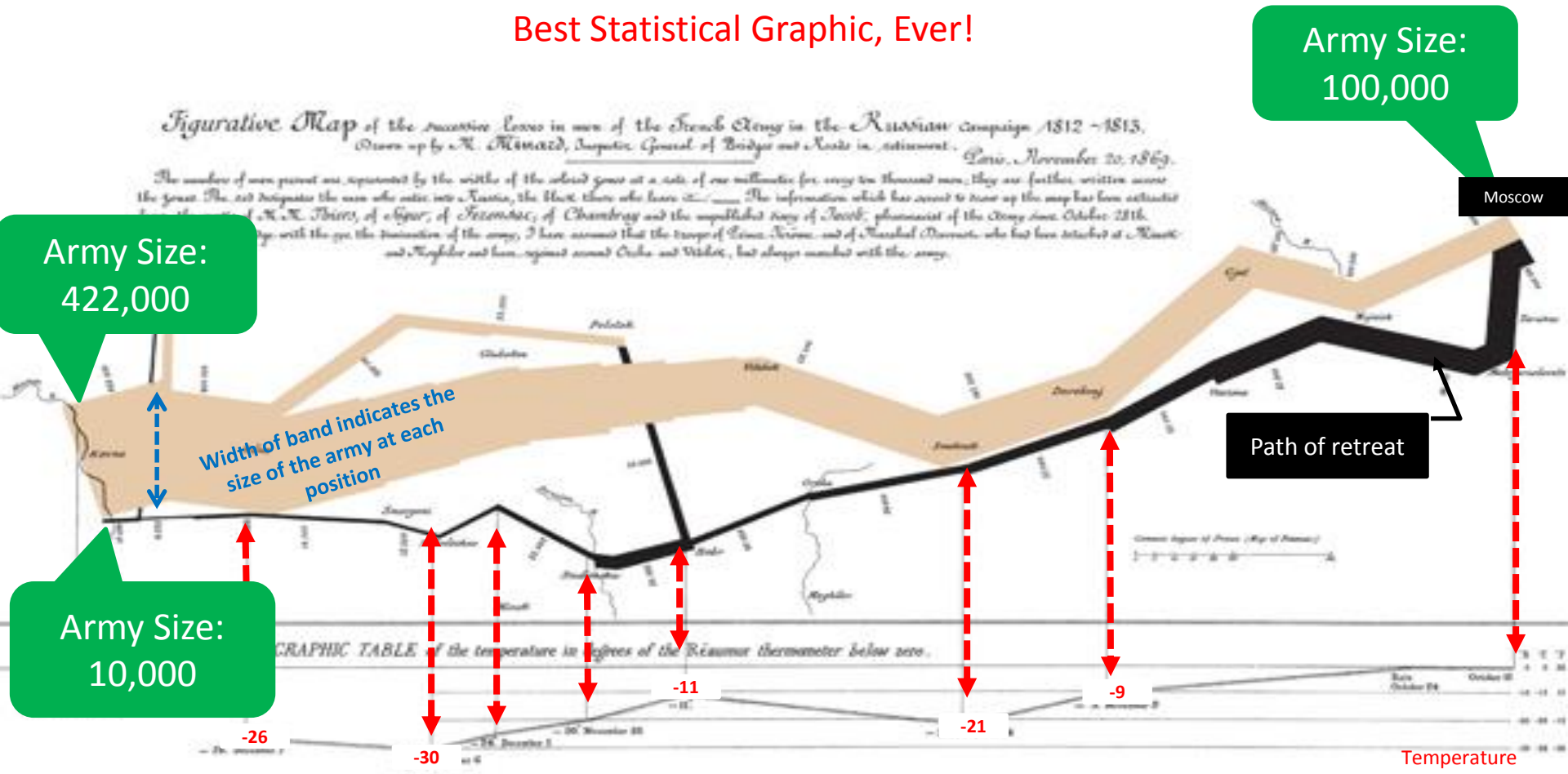
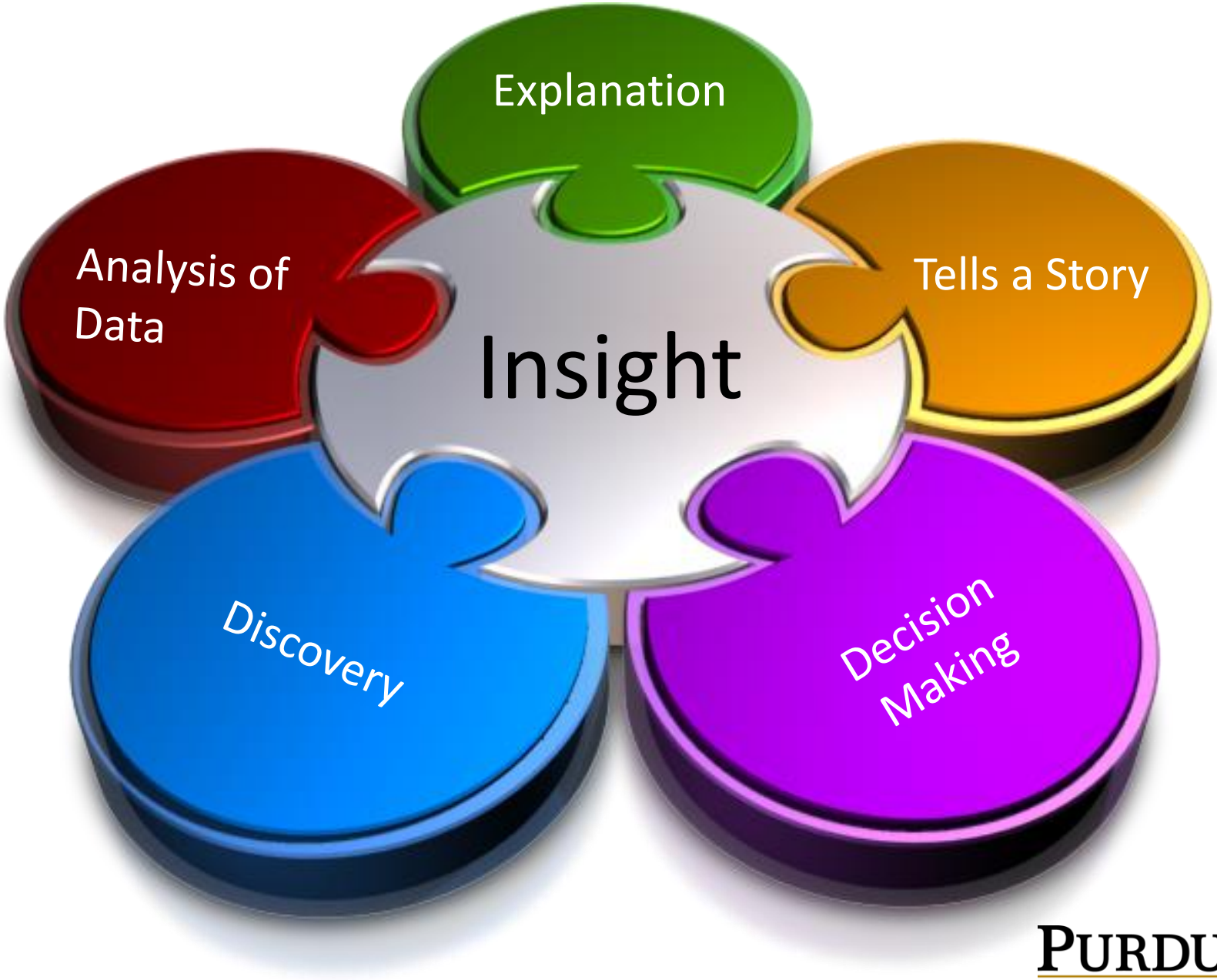


"Insight" Tells a Story

Napoleon's Invasion of Russia in 1812 By Jacque Minard

Best Statistical Graphic, Ever!





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Visualization Applications

Why is visualization important?

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Visualization Applications

Biovisualization (BioVis)

The visualization of biological data;

Often grouped with computer animation

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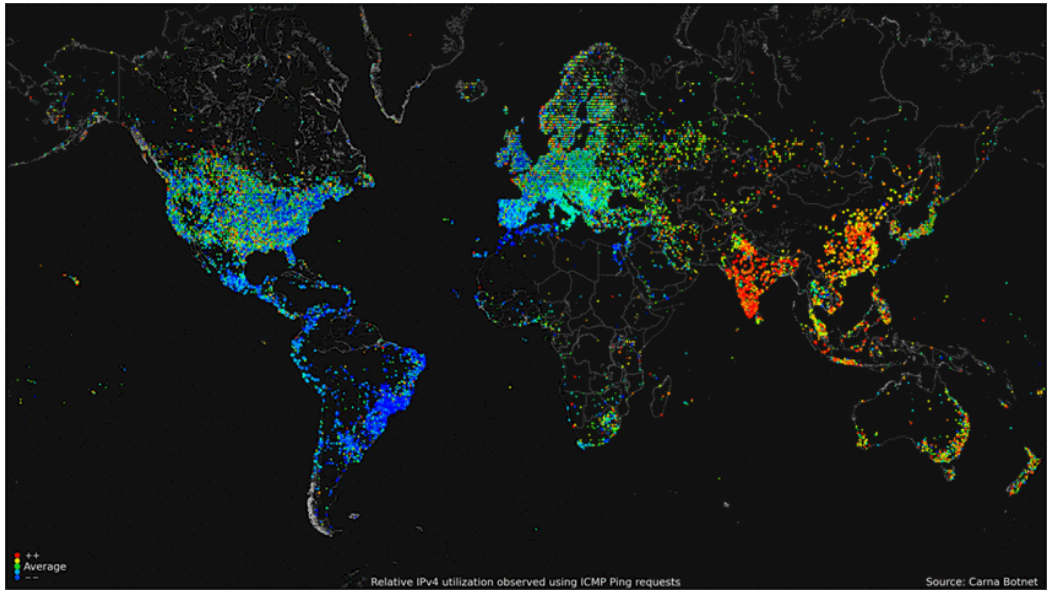
Visualization Applications

Information Visualization (InfoVis)

Interdisciplinary

Study of the “visual representation of large-scale collections of non-numerical information

InfoVis



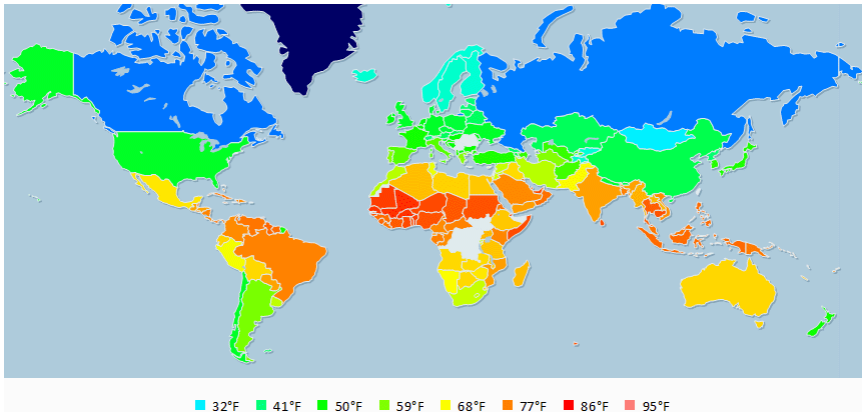
Internet Usage
Source: http://www.cernea.net/wp-content/uploads/2013/03/internet.gif

Visualization Applications

Geographic Visualization

GeoVis

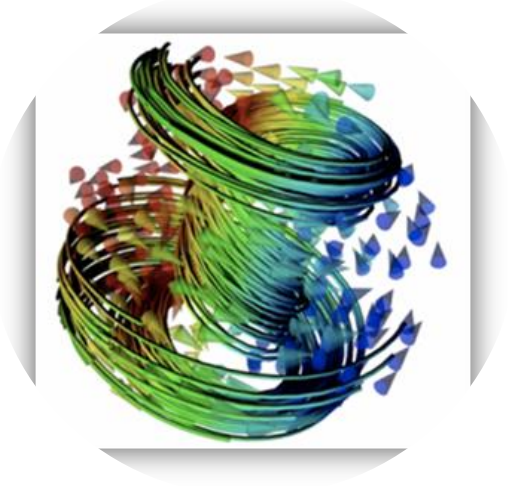
Communicates geospatial information in ways that, when combined with human understanding, allow for data exploration and decision-making processes.



MacEachren, A.M. and Kraak, M.J. 1997 Exploratory cartographic visualization: advancing the agenda. Computers & Geosciences, 23(4), pp. 335-343.
Jiang, B., and Li, Z. 2005. Editorial: Geovisualization: Design, Enhanced Visual Tools and Applications. The Cartographic Journal, 42(1), pp. 3-4
MacEachren, A.M. 2004. Geovisualization for knowledge construction and decision support. IEEE computer graphics and applications, 24(1), pp.13-17

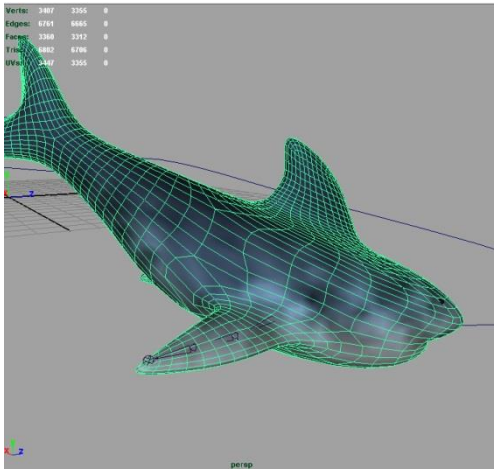
Visualization Applications

Scientific Visualization (SciVis)



Primarily concerned with the visualization of three-dimensional phenomena

Emphases on realistic renderings of volumes, surfaces, illumination sources, etc.



http://www.tinkering.net/sciviz/

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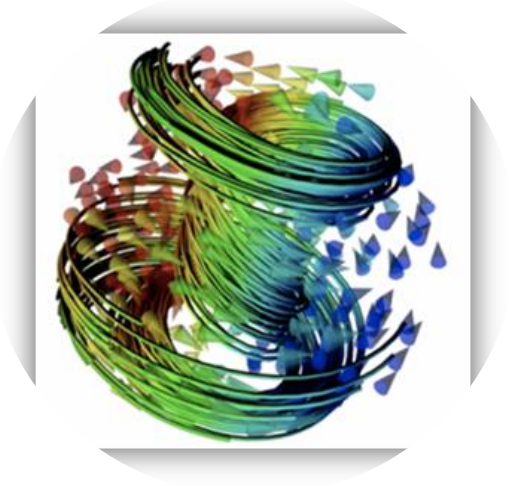
Visualization Applications

Scientific Visualization (SciVis)

The focus of this workshop



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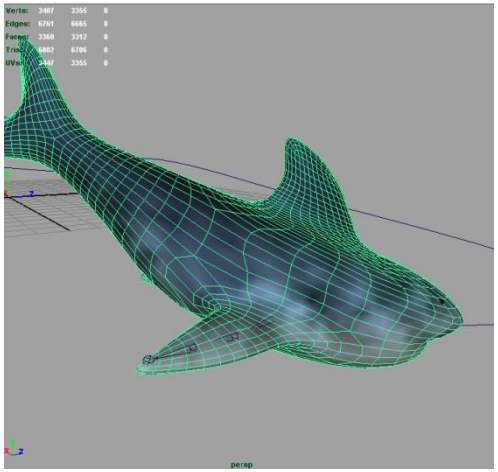

http://www.tinkering.net/sciviz/

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Data Visualization Process

High Level Overview

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When do you think about visualizing your data?

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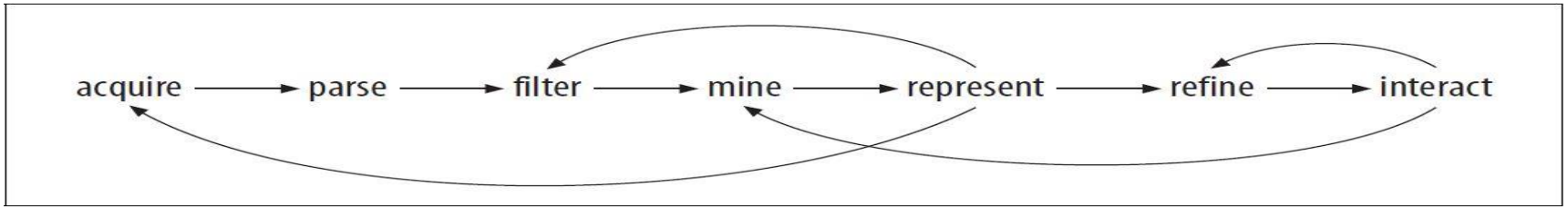
Data Visualization Process



Adopted from Visualizing Data: Exploring and Explaining Data with the Processing Environment by Ben Fry, O'Reilly (p 15)

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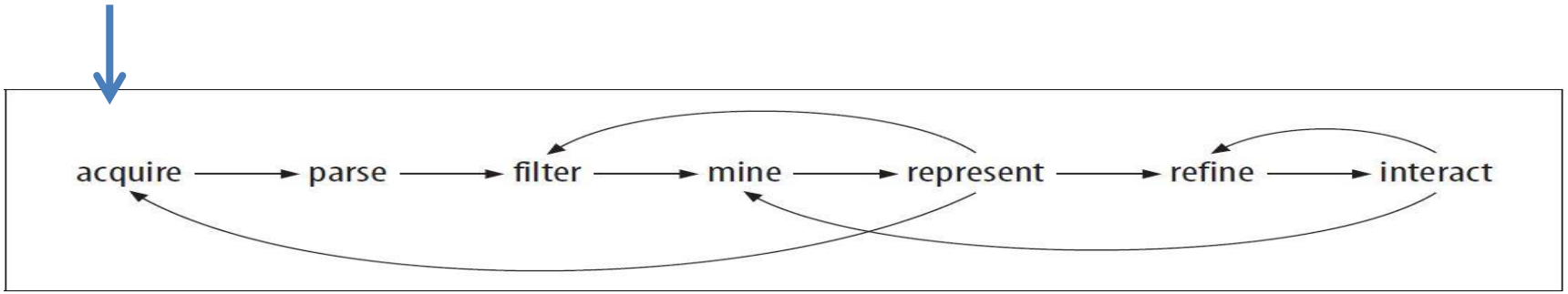
Data Visualization Process

obtain the data



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Data Visualization Process

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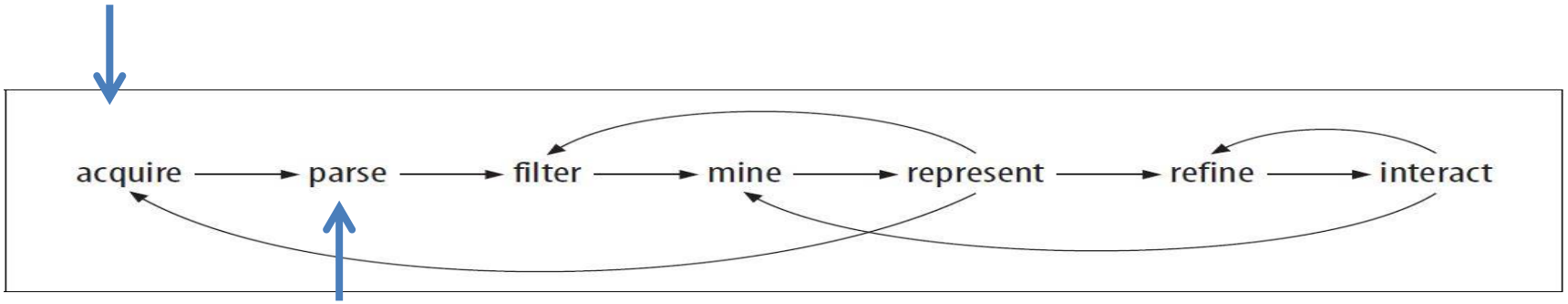

provide
structure

Adopted from Visualizing Data: Exploring and Explaining Data with the Processing Environment by Ben Fry, O'Reilly (p 15)

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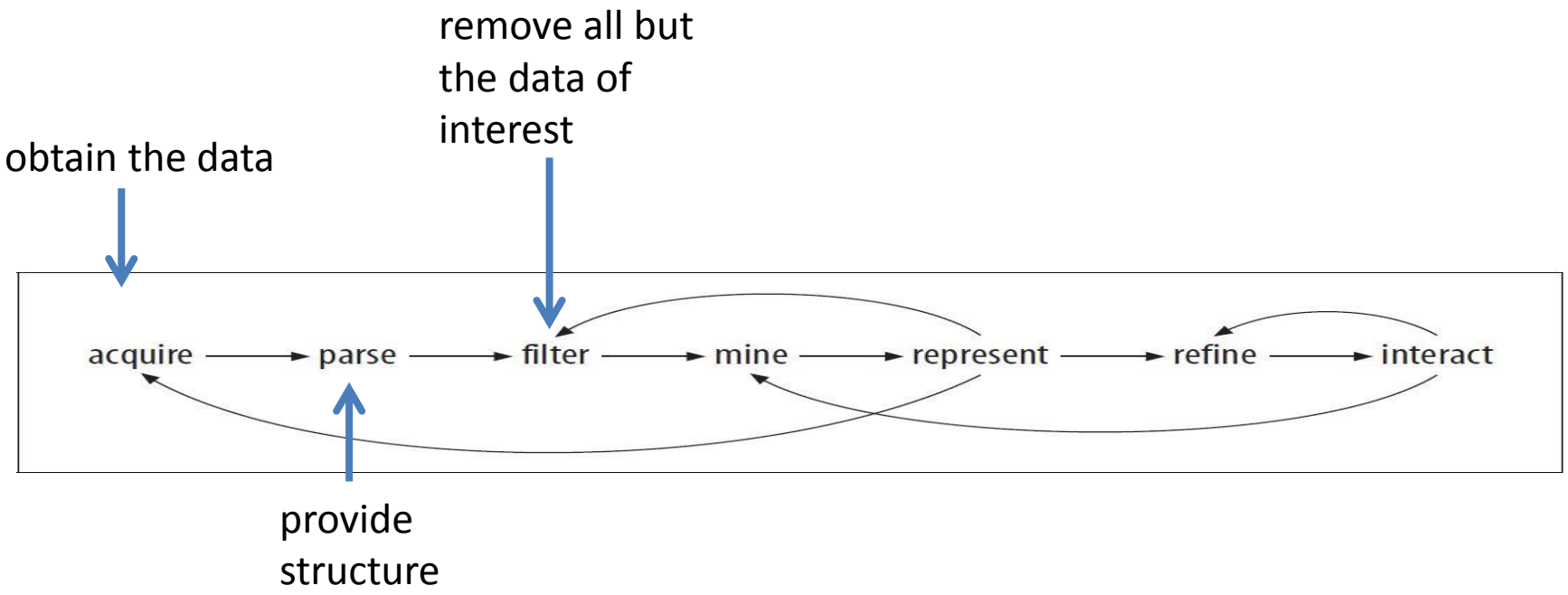
Data Visualization Process



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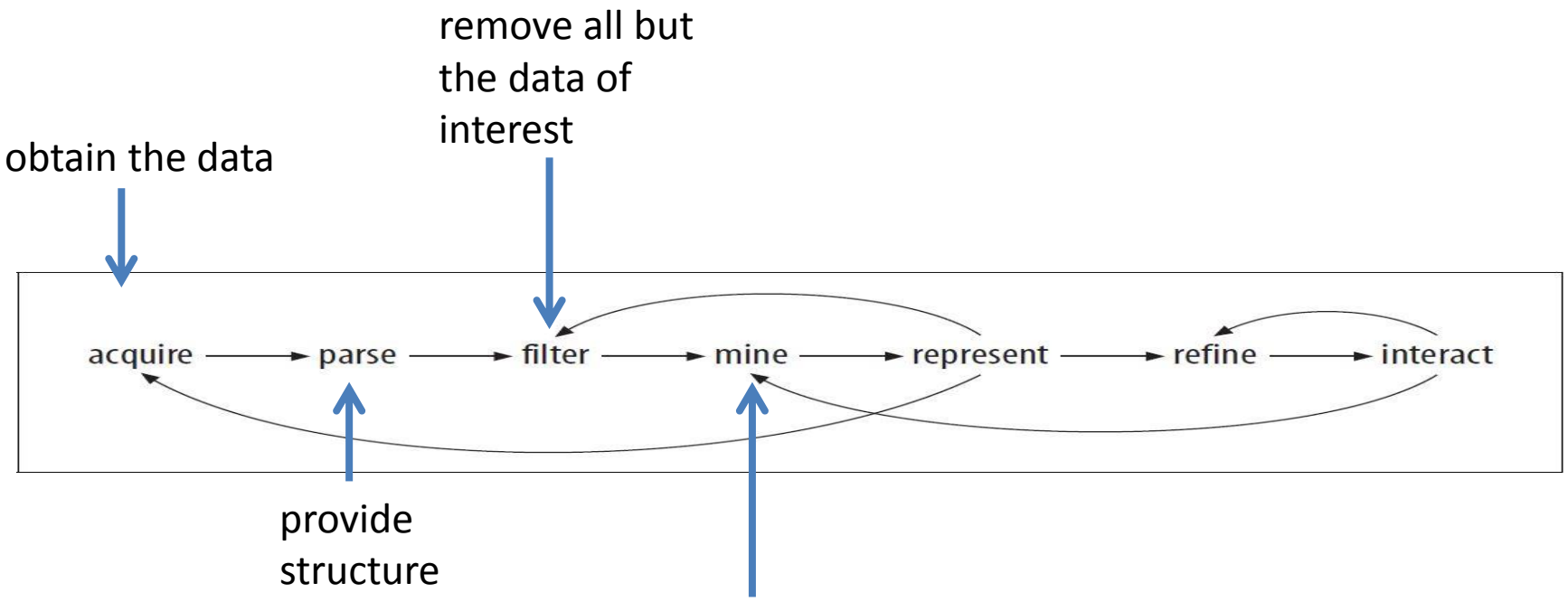

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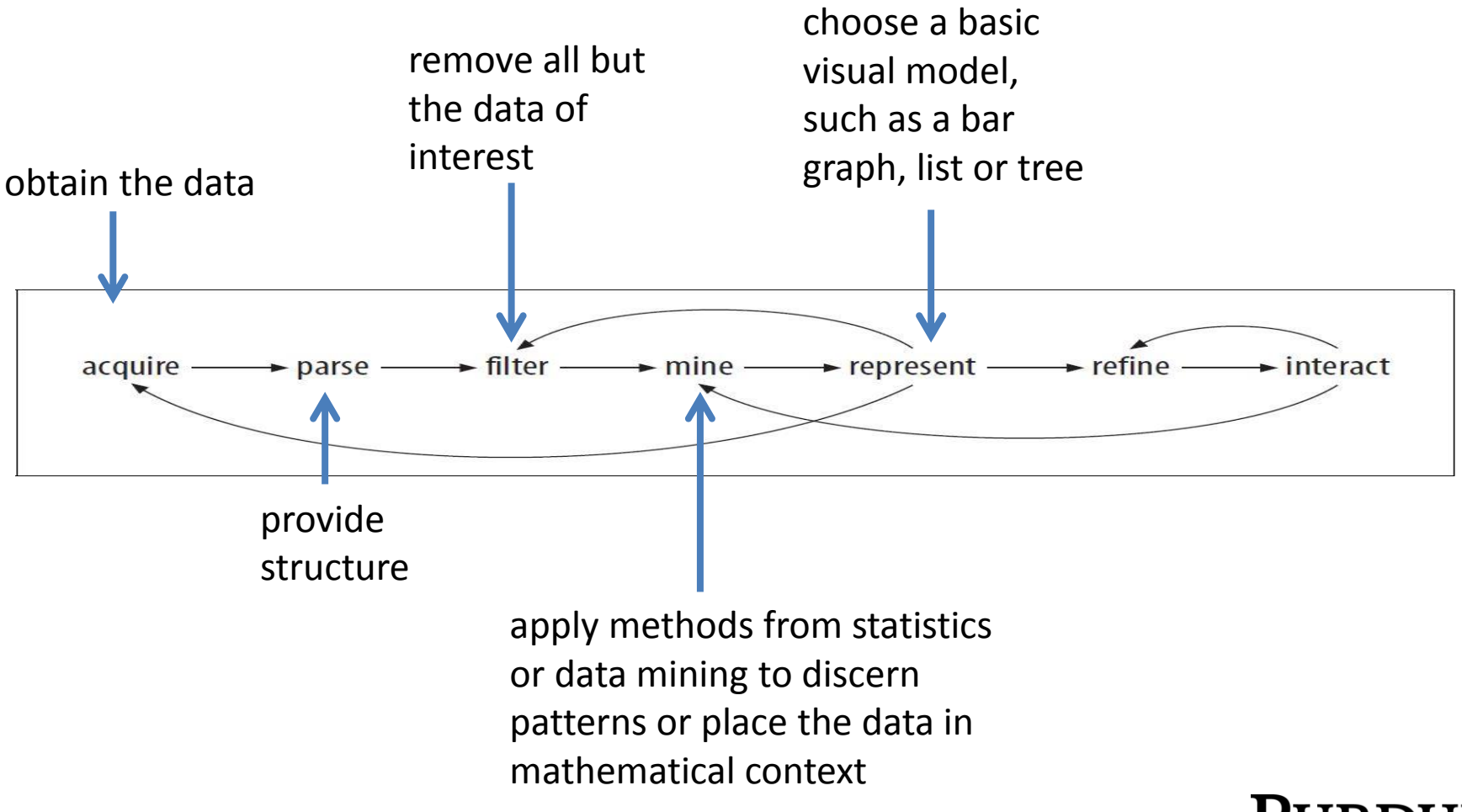

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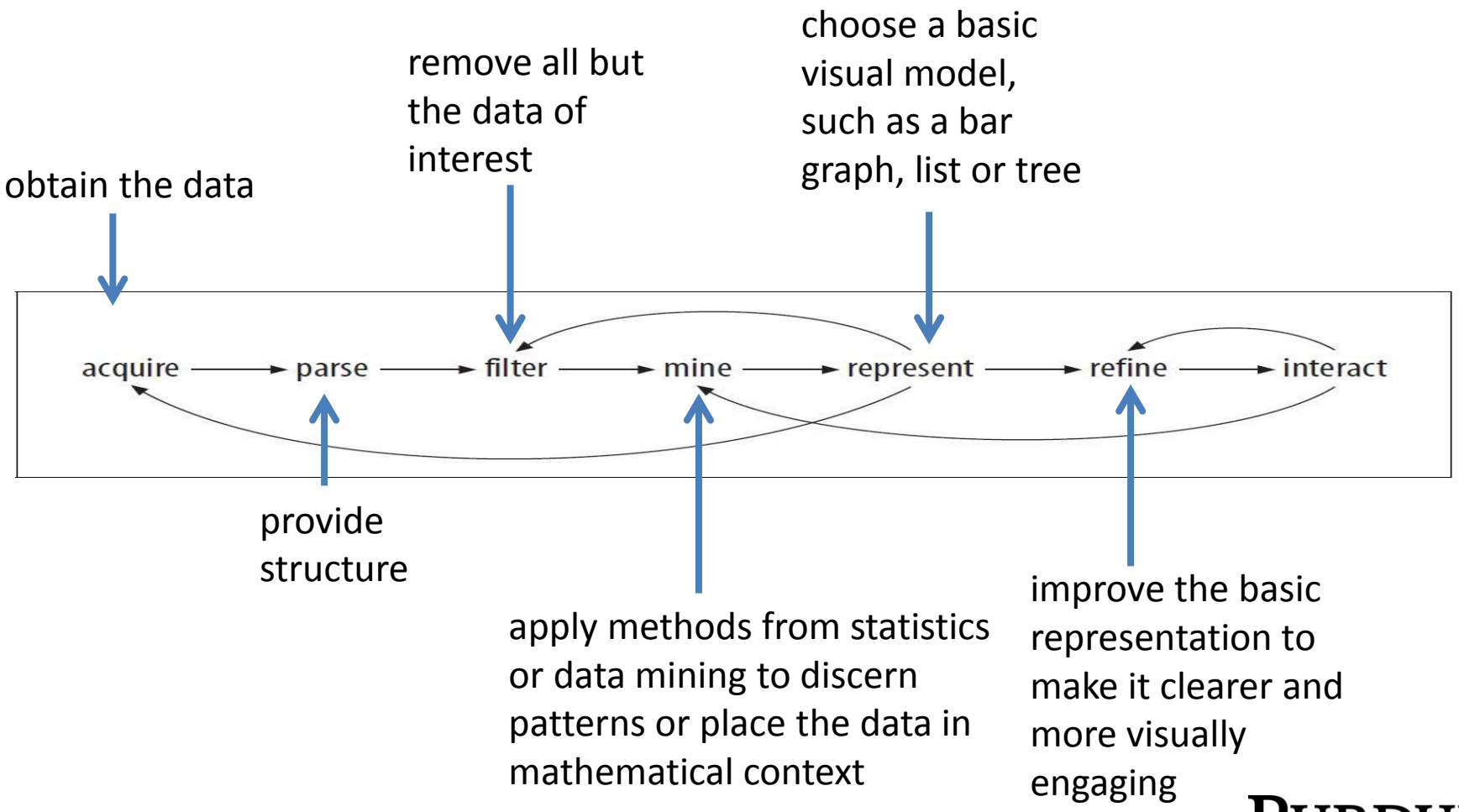
Data Visualization Process



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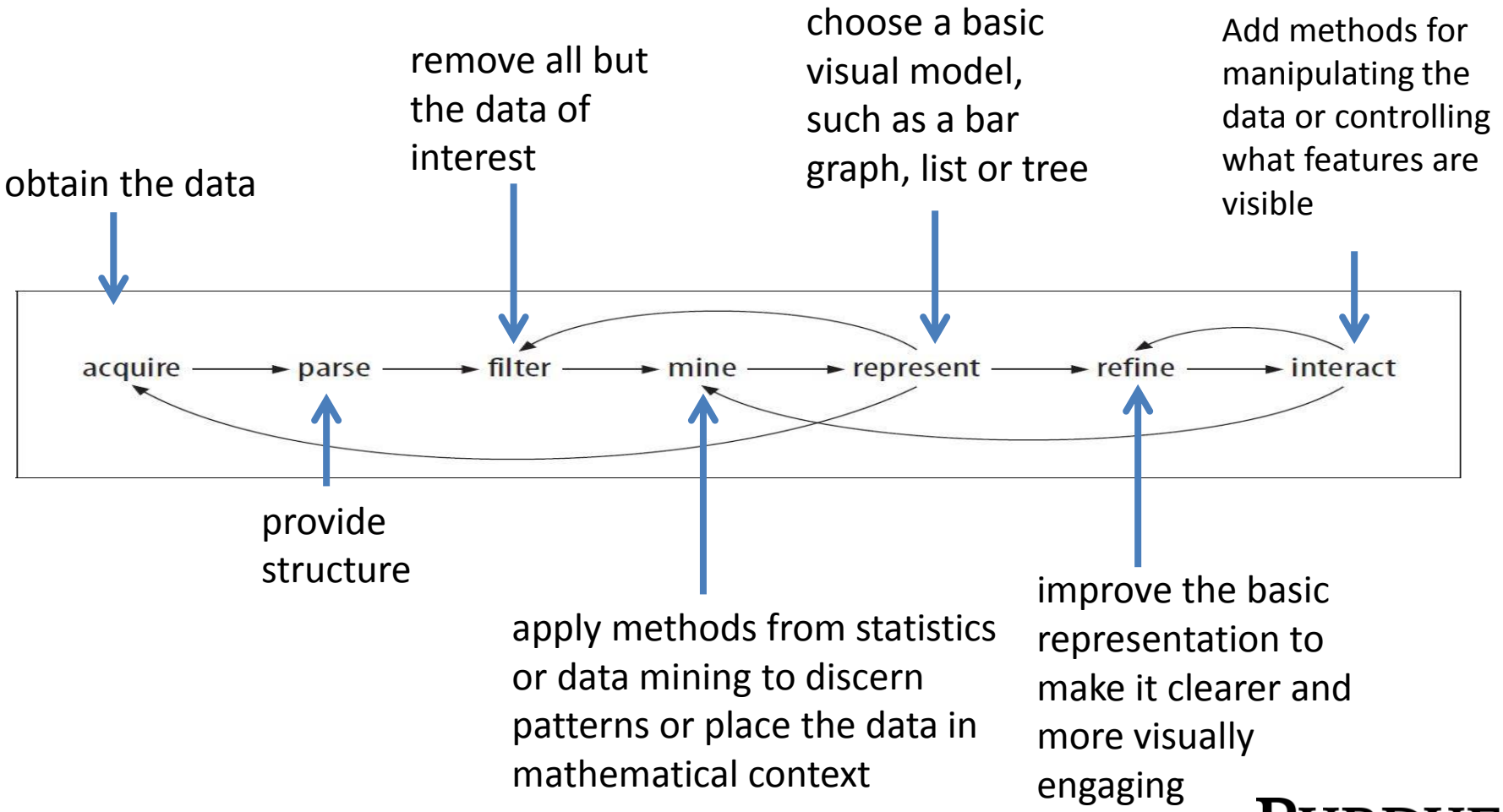
Data Visualization Process



Adopted from Visualizing Data: Exploring and Explaining Data with the Processing Environment by Ben Fry, O'Reilly (p 15)

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Data Visualization Process

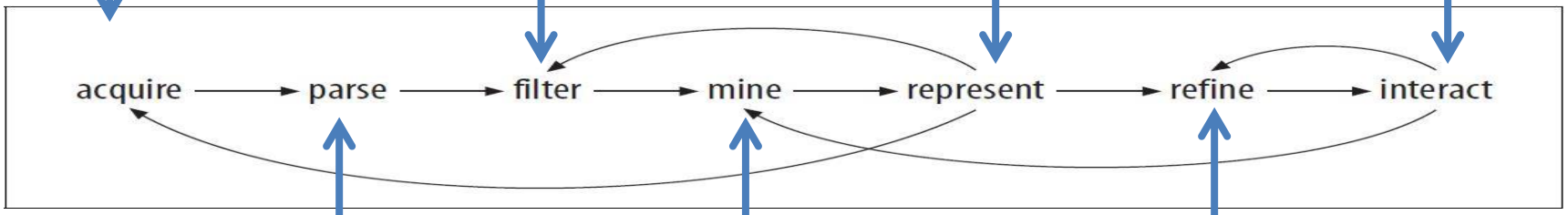
An iterative process

obtain the data

remove all but the data of interest

choose a basic visual model, such as a bar graph, list or tree

Add methods for manipulating the data or controlling what features are visible



provide structure

apply methods from statistics or data mining to discern patterns or place the data in mathematical context

improve the basic representation to make it clearer and more visually engaging

Adopted from Visualizing Data: Exploring and Explaining Data with the Processing Environment by Ben Fry, O'Reilly (p 15)

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Visualization Process

Taking raw data and converting it to a form that is viewable and understandable to humans.

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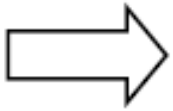
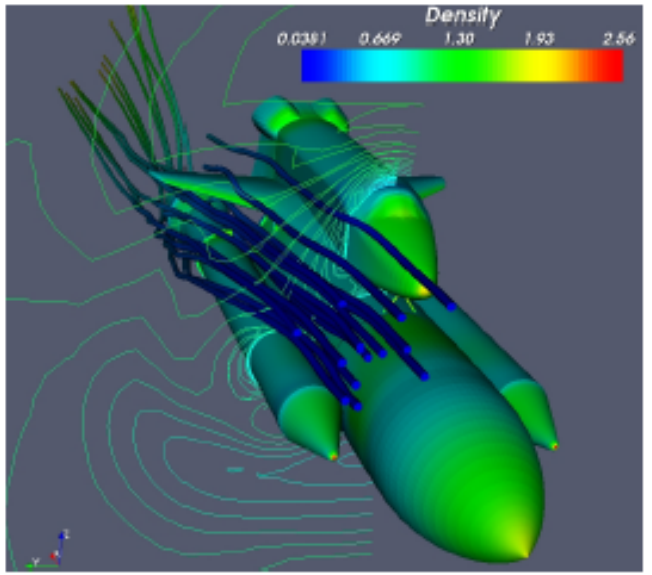
Visualization Process

There are several steps between raw data and a finished visualization





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Adopted from The ParaView Tutorial, The Basics of Visualization, version 3.98

Why do we care?

Why should you care?

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Why do you/we care?

- Data visualization is becoming an increasingly important component of analytics in the age of big data *(SAS: Five big data challenges and how to overcome them with visual analytics)*

  http://www.sas.com/resources/asset/five-big-data-challenges-article.pdf

- Between now and 2020, the information in the Digital Universe will grow by a factor of 44; the number of "files" in it to be managed will grow by a factor of 67

Gantz, J., and Reinsel, D. (2012). The Digital Universe in 2020: Big Data, Bigger Digital Shadows, and Biggest Growth in the Far East. IDC IVIEW, Sponsored by EMC Corporation

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When should you think about visualizing your data?

As early as possible

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https://polytechnic.purdue.edu/vis/reu

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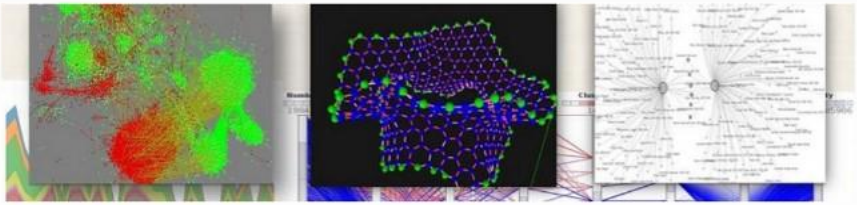
Home / Research Experience for Undergraduates in Collaborative Data Visualization Applications

Research Experience for Undergraduates in Collaborative Data Visualization Applications

Purdue Polytechnic Institute Computer Graphics Technology Department invites undergraduates with an interest in visualization to participate in cutting-edge undergraduate research at Purdue University.

The VisREU Experience: 8-Weeks, Paid Research, Professional Development, Network Building, Developing Lifetime Transferrable Skills



What is Visualization

Visualization is the process of transforming raw data into a visual representation of relationships that exist within the data. Visualization leads to insight, better understanding of relationships between variables that exist in the data. Regardless of your academic major, at some point during your academic life you will have a need to visualize something. The VisREU Site is the perfect opportunity to learn about the visualization pipeline, applications and tools to help you create impactful visualizations.

About the Program

The program identifies research collaborators with visualization needs and assigns each student to a

Sponsored By

NSF

VisREU Cohorts

2014 | 2015

VisREU Newsletter

Volume 1 Issue 1

Volume 1 Issue 2

Volume 2 Issue 1 (2 MB)

Volume 2 Issue 2 (13 MB)

Book of Abstracts

2014 | 2015

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Visualization

Visualization is the tool that will take us forward from the traditional output of high performance computing (HPC) that we are used to into a visual medium that allows researchers to *collaborate* and *elaborate* on the finding's they've got.

Tim Carroll
Director and Global Lead,
Dell Research Computing Solutions
HPC Source (Spring 2011)

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Scientific Visualization

- Primarily concerned with the visualization of three-dimensional phenomena (architectural, meteorological, medical, biological, etc.),

Wikipedia.com

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Scientific Visualization

- Primarily concerned with the visualization of three-dimensional phenomena (architectural, meteorological, medical, biological, etc.),
- Where the emphasis is on realistic renderings of volumes, surfaces, illumination sources, and so forth, perhaps with a dynamic (time) component.

Wikipedia.com

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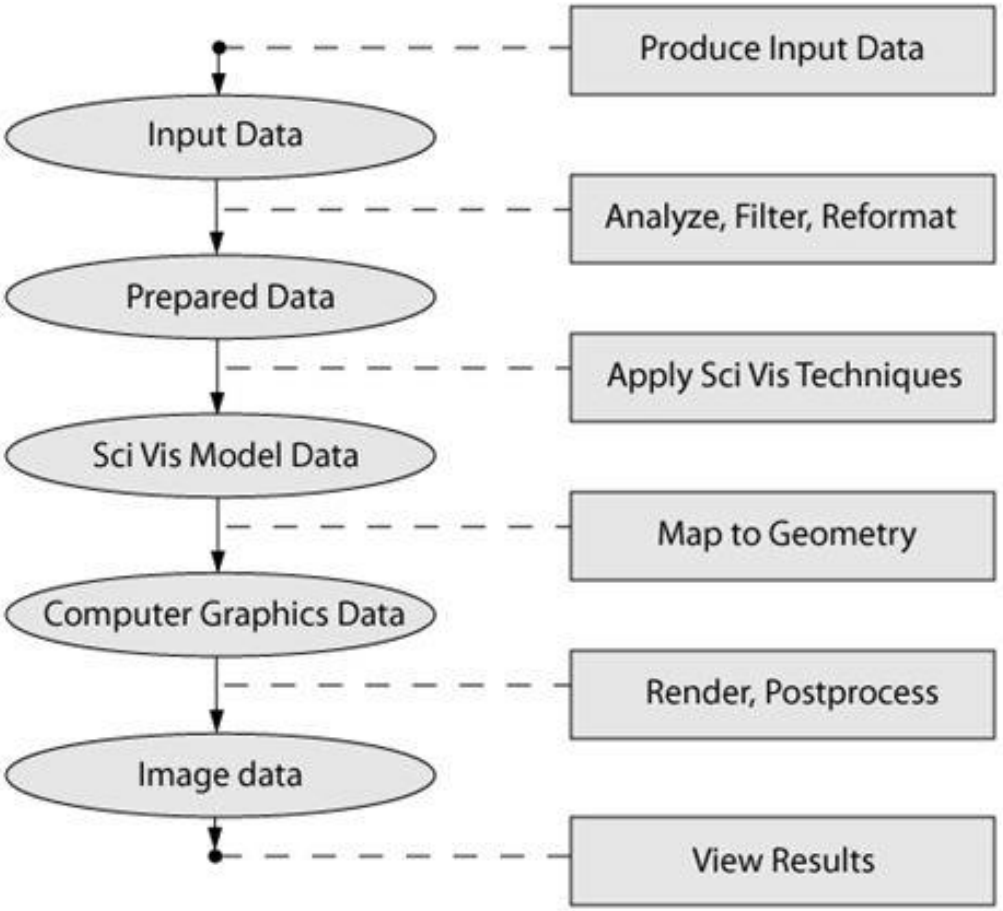
Scientific Visualization Pipeline

What's Missing?



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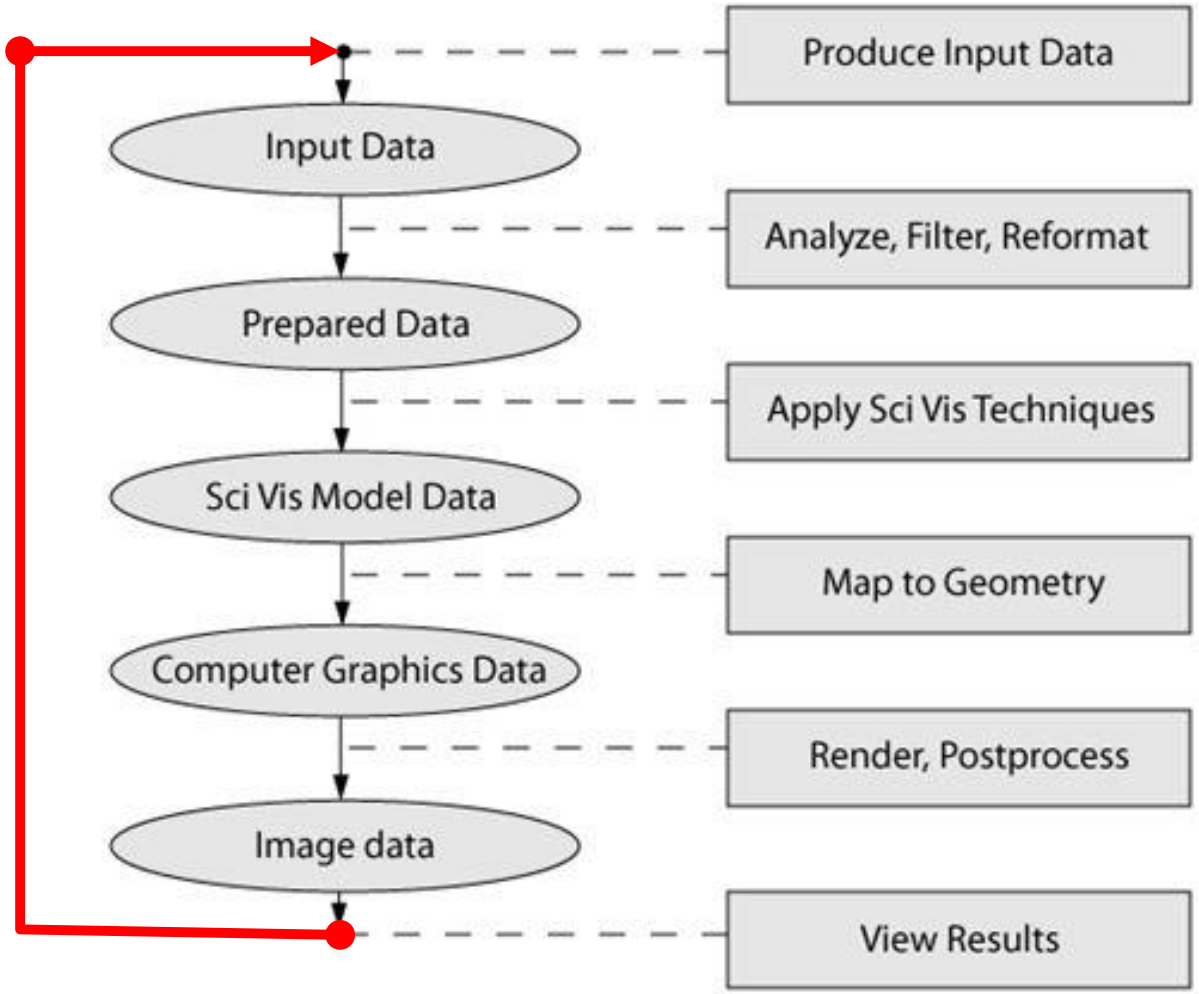
http://www.bu.edu/tech/research/training/tutorials/introduction-to-scientific-visualization-tutorial/the-scientific-visualization-pipeline/

Scientific Visualization Pipeline



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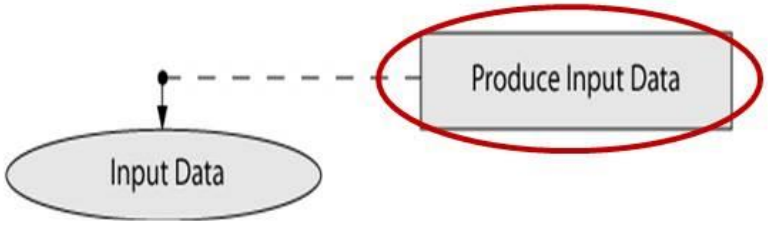
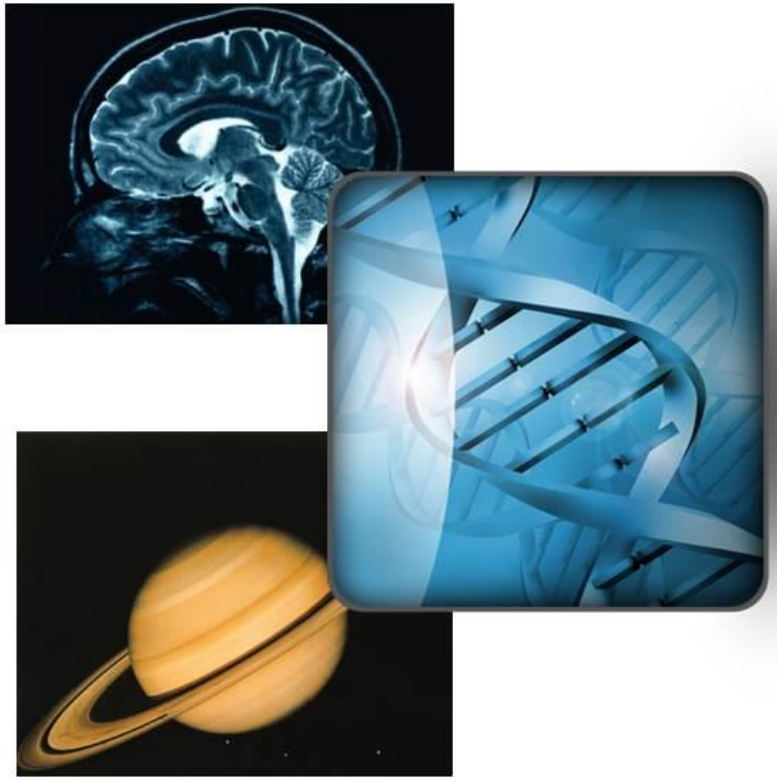
http://www.bu.edu/tech/research/training/tutorials/introduction-to-scientific-visualization-tutorial/the-scientific-visualization-pipeline/

Scientific Visualization Pipeline: Step 1 . . .

Produce Data



- Simulated Data
- Images
- Numerical
- Some measured value
- Observed Phenomena



Adopted from
http://www.bu.edu/tech/research/training/tutorials/introduction-to-scientific-visualization-tutorial/the-scientific-visualization-pipeline/

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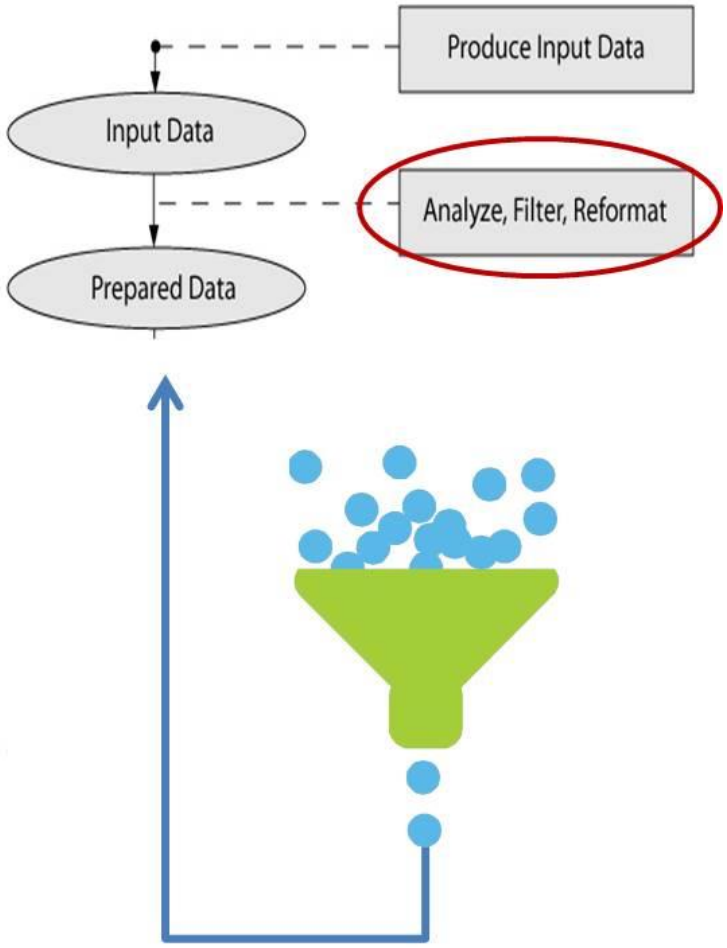
Scientific Visualization Pipeline: Step 2 . . .

Analyze, Filter, Reformat

- Cleaning up the data
  - Removing noise
  - Replacing missing values
  - Clamping values to be within a specific range of interest
- Performing operations to yield more useful data



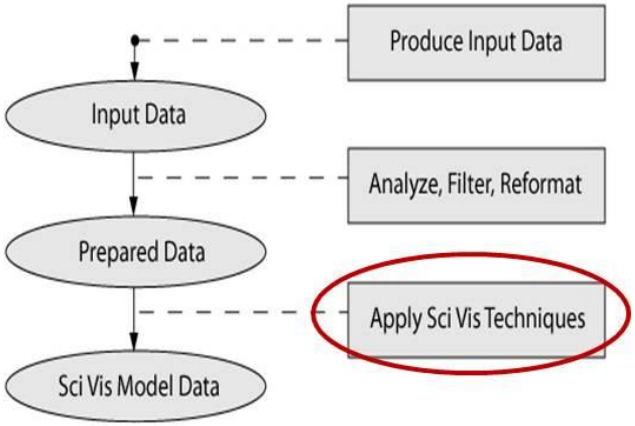
Adopted from
http://www.bu.edu/tech/research/training/tutorials/introduction-to-scientific-visualization-tutorial/the-scientific-visualization-pipeline/

Scientific Visualization Pipeline: Step 3

Apply SciVis Techniques

- Converts raw information into something more understandable

- Visually extracting meaning from a scientific data set using various techniques



Adopted from
http://www.bu.edu/tech/research/training/tutorials/introduction-to-scientific-visualization-tutorial/the-scientific-visualization-pipeline/

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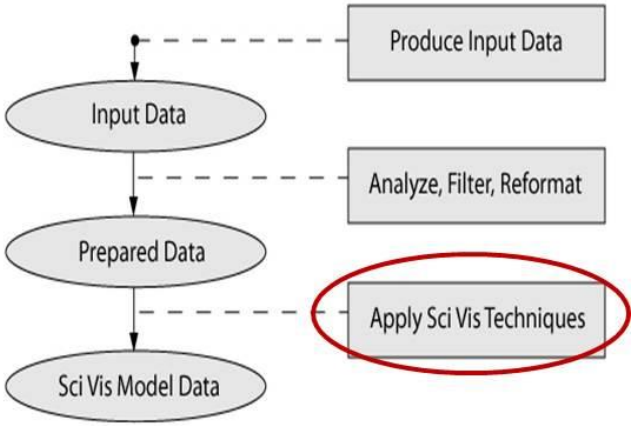
Scientific Visualization Pipeline: Step 3

Apply SciVis Techniques

- Converts raw information into something more understandable

- Visually extracting meaning from a scientific data set using various techniques



Contour

Clip

Threshold

Glyphs

Streamlines

Adopted from
http://www.bu.edu/tech/research/training/tutorials/introduction-to-scientific-visualization-tutorial/the-scientific-visualization-pipeline/

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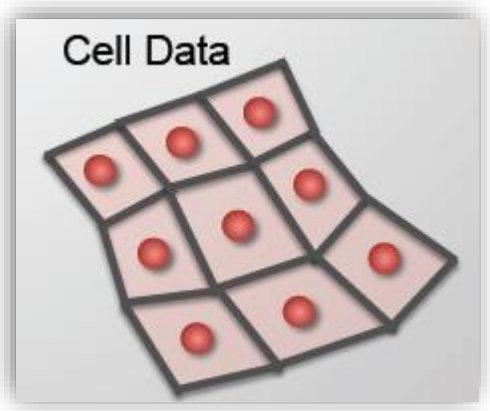
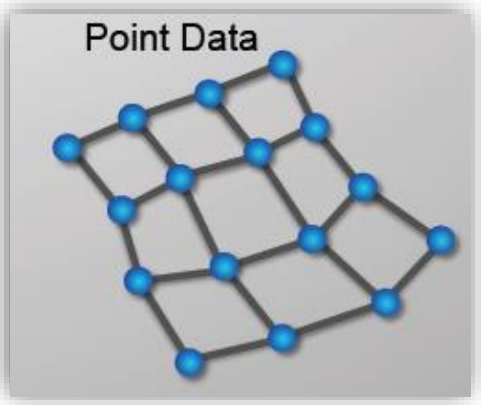
Scientific Visualization Pipeline

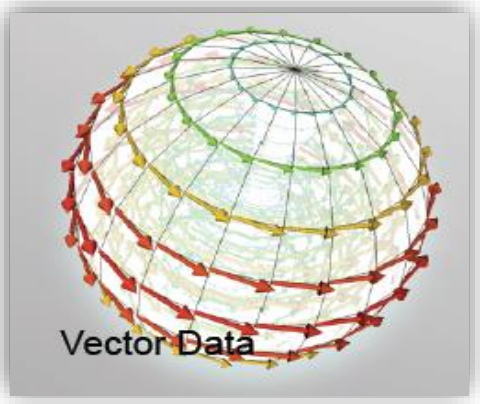
Step 4 . . .

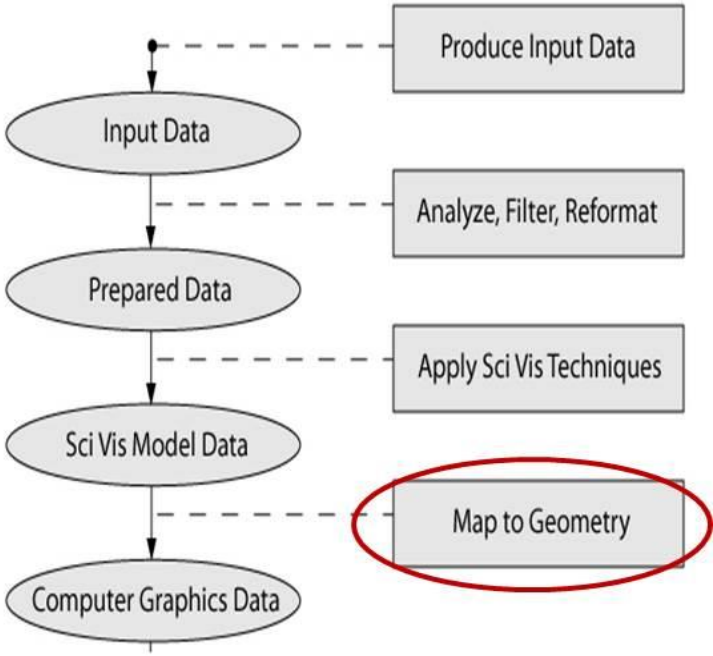
Map to Geometry



- Scalars, vectors, tensors
- 1D, 2D, 3D
- Mesh



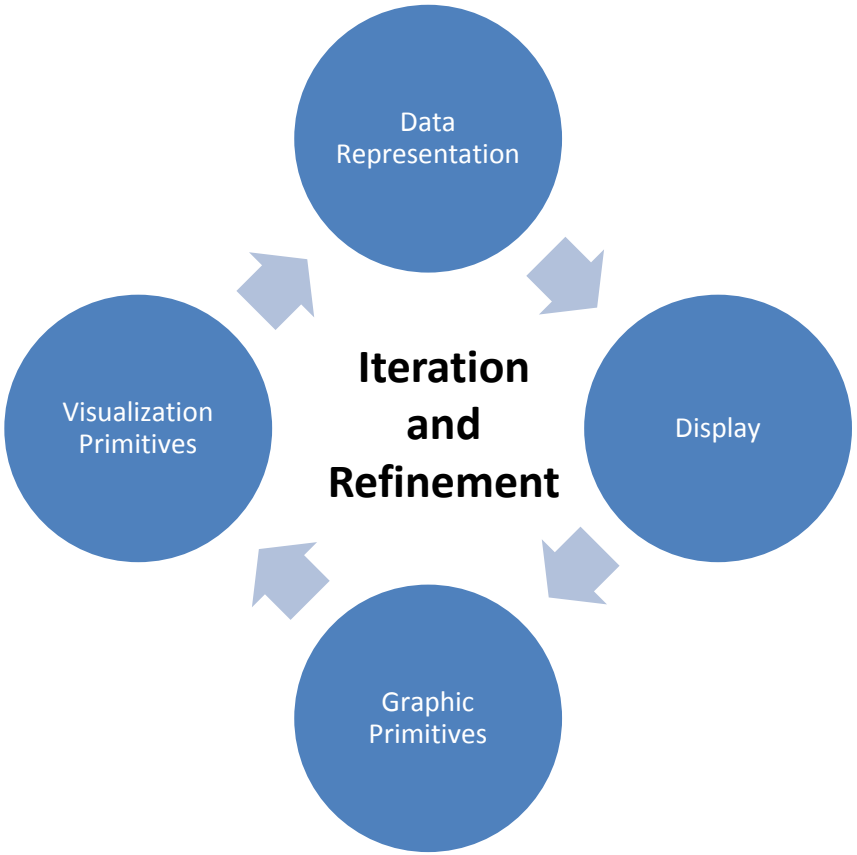


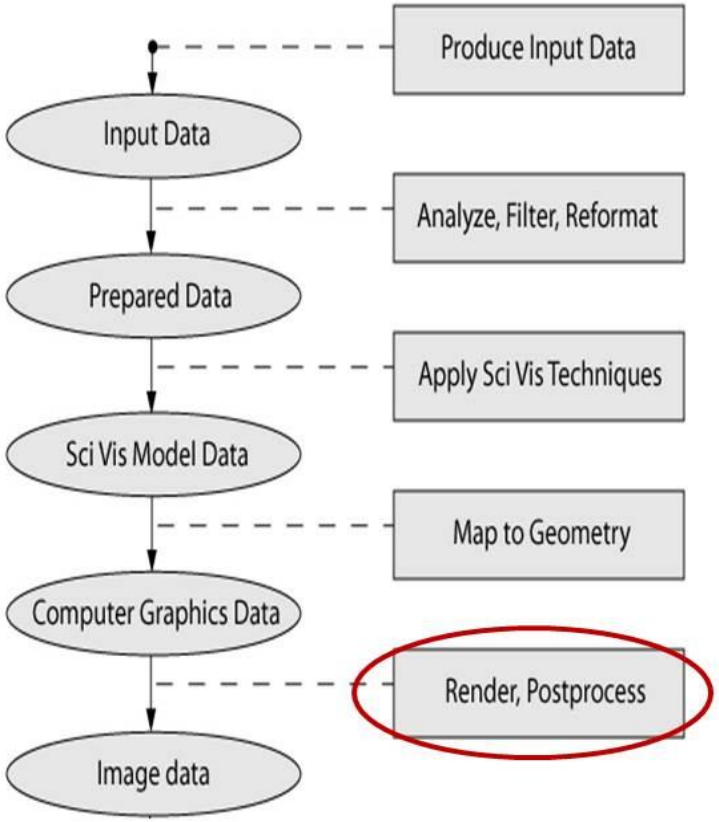


Adopted from
http://www.bu.edu/tech/research/training/tutorials/introduction-to-scientific-visualization-tutorial/the-scientific-visualization-pipeline/

Scientific Visualization Pipeline: Step 5 . . .

Render, Post Process



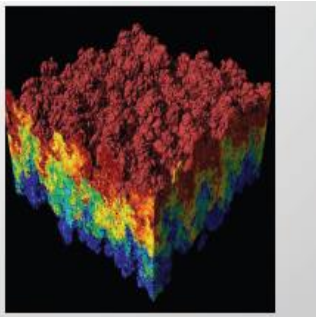


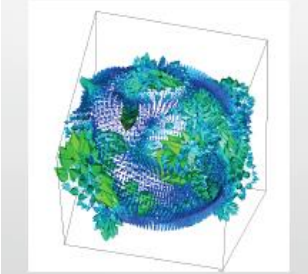
Adopted from
http://www.bu.edu/tech/research/training/tutorials/introduction-to-scientific-visualization-tutorial/the-scientific-visualization-pipeline/

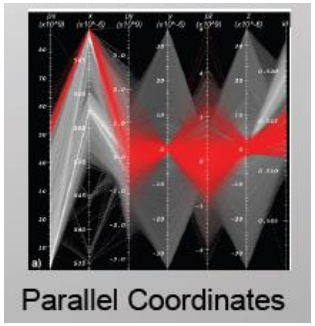
Scientific Visualization Pipeline: Step 6 . . .

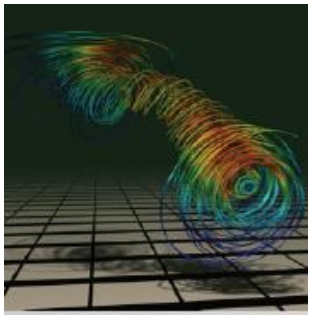
View Results

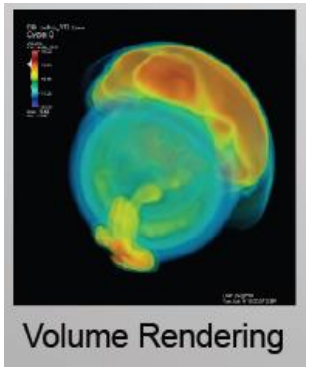
Output from ParaView

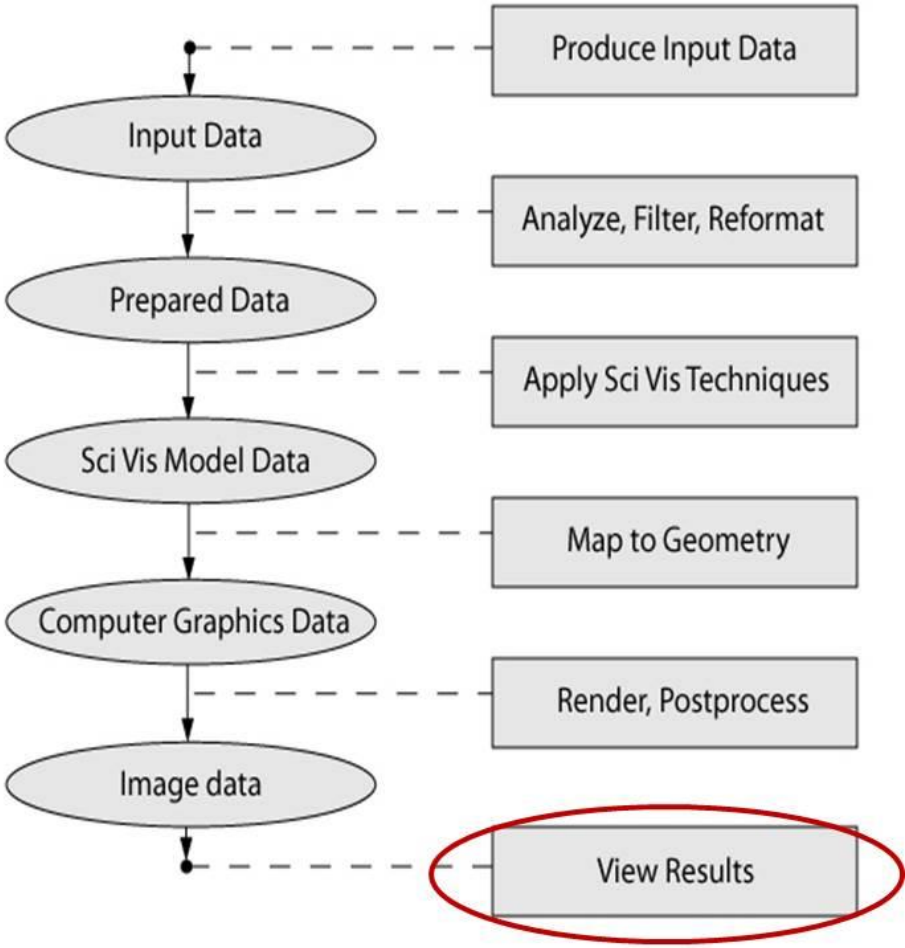

Pseudocolor Rendering


Vector / Tensor Glyphs


Parallel Coordinates


Streamlines

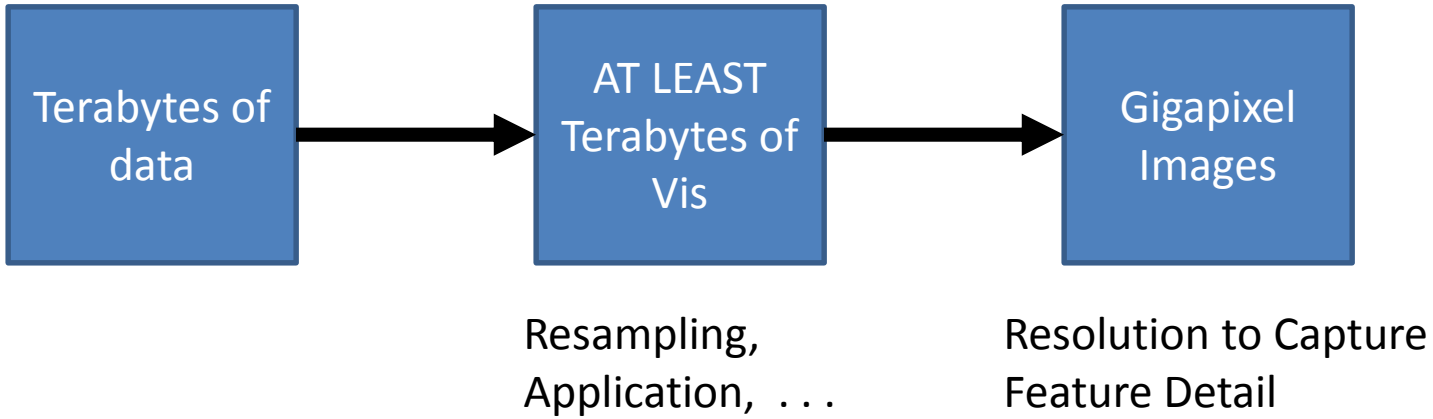

Volume Rendering



Adopted from
http://www.bu.edu/tech/research/training/tutorials/introduction-to-scientific-visualization-tutorial/the-scientific-visualization-pipeline/

Visualization Scales with HPC

Large data produced by large simulations produce large visualization results and require large visualization resources



Visualization Toolkit (VTK)

- Open source, multiplatform
- Supports distributed computation models
- Extensible modular architecture
- Available for 3D computer graphics, image processing and visualization

- Collection of C++ libraries
- Leveraged by many applications
- Divided into logical areas
  - Filtering
  - Information Visualization
  - Volume Rendering
- Cross platform, using OpenGL
- Wrapped in Python, Tool Command Language (Tcl) and Java

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Visualization Toolkit (VTK)

ParaView is an end-user application with support for

- Parallel Data Archiving
- Parallel Reading
- Parallel Processing
- Parallel Rendering
- Single node, Client-Server, MPI Cluster Rendering

ParaView

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Introduction to Scientific Visualization Using

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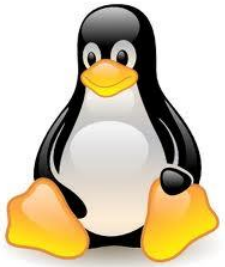
ParaView

- Multi-platform parallel data analysis and visualization application
- Mature, feature-rich interface
- Good for general purpose, rapid visualization


Mac


Windows


Linux

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ParaView

- Open Source . . . It's Free!
- http://www.paraview.org/
- Built upon the Visualization Toolkit (VTK) library
- Primary contributors:
  - Kitware, Inc.
  - Sandia National Laboratory
  - Los Alamos National Laboratory
  - Army Research Laboratory

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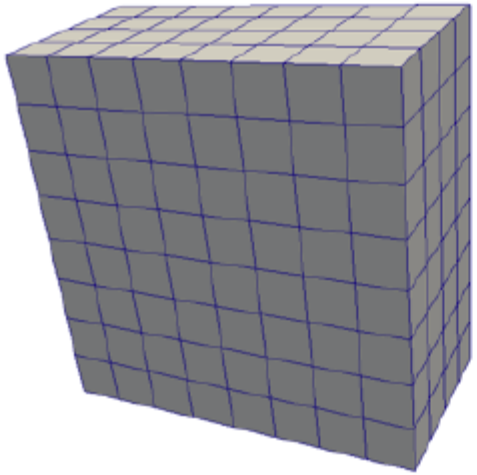
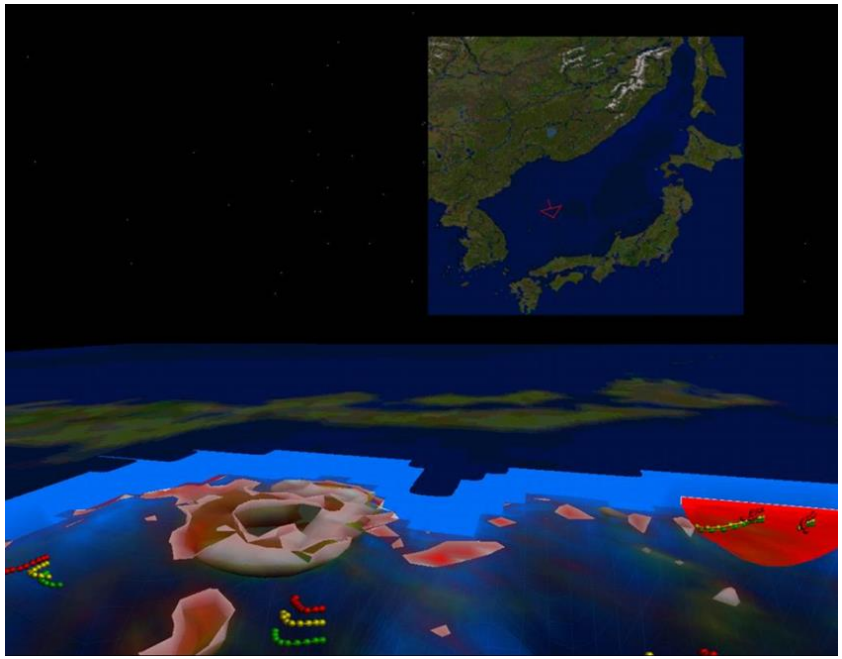
Supported Data Types



Uniform Rectilinear (Image Data)
A uniform rectilinear grid is a one- two- or three- dimensional array of data. The points are orthonormal to each other and are spaced regularly along each direction.

Grid – regular structure, all voxels (cells) are the same size and shape



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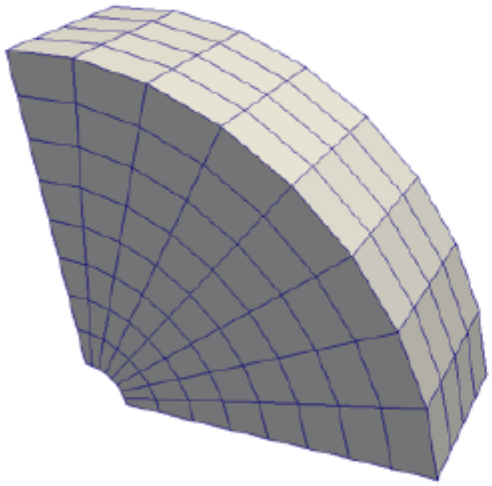
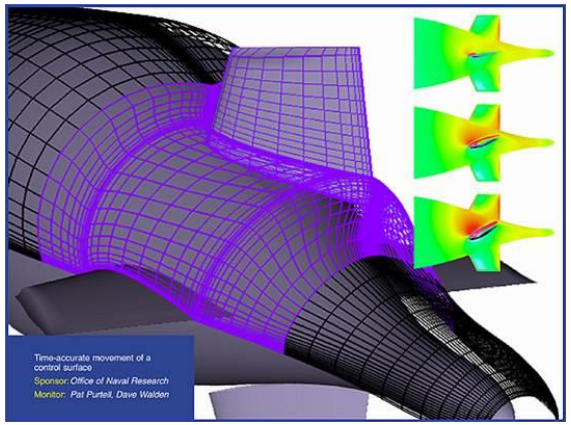
Supported Data Types



Curvilinear (Structured Grid)
Curvilinear grids have the same topology as rectilinear grids. However, each point in a curvilinear grid can be placed at an arbitrary coordinate (provided that it does not result in cells that overlap or self intersect). Curvilinear grids provide the more compact memory footprint and implicit topology of the rectilinear grids, but also allow for much more variation in the shape of the mesh.

Curvilinear – regularly gridded mesh shaping function applied



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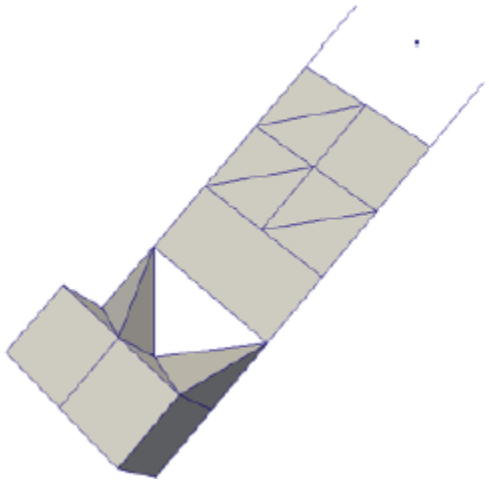
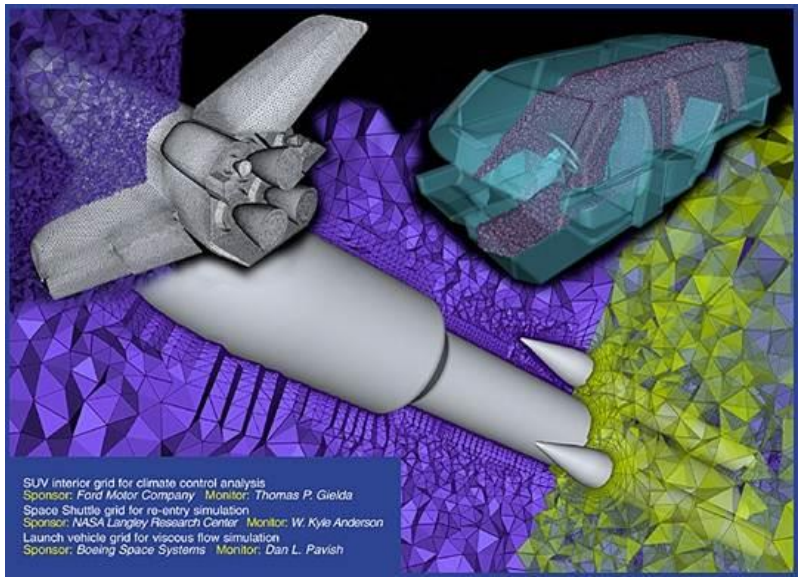
Supported Data Types



Unstructured Grid

Unstructured data sets are composed of points, lines, 2D polygons, 3D tetrahedra, and nonlinear cells. They are similar to polygonal data except that they can also represent 3D tetrahedra and nonlinear cells, which cannot be directly rendered.

Unstructured grid – irregular mesh typically composed of tetrahedra, prisms, pyramids, or hexahedra



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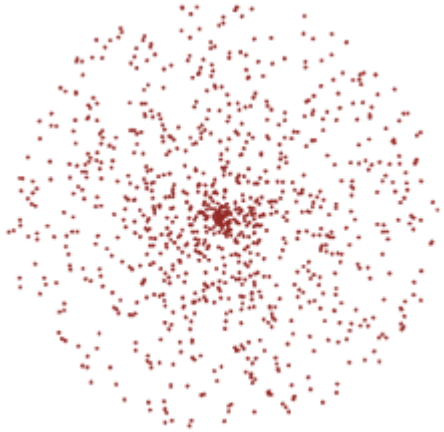
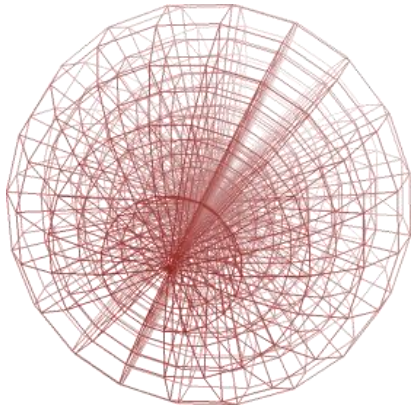
Supported Data Types

- Point data
- Polygonal data
- Images
- Multi-block
- Adaptive Mesh Refinement (AMR)
- Time series support





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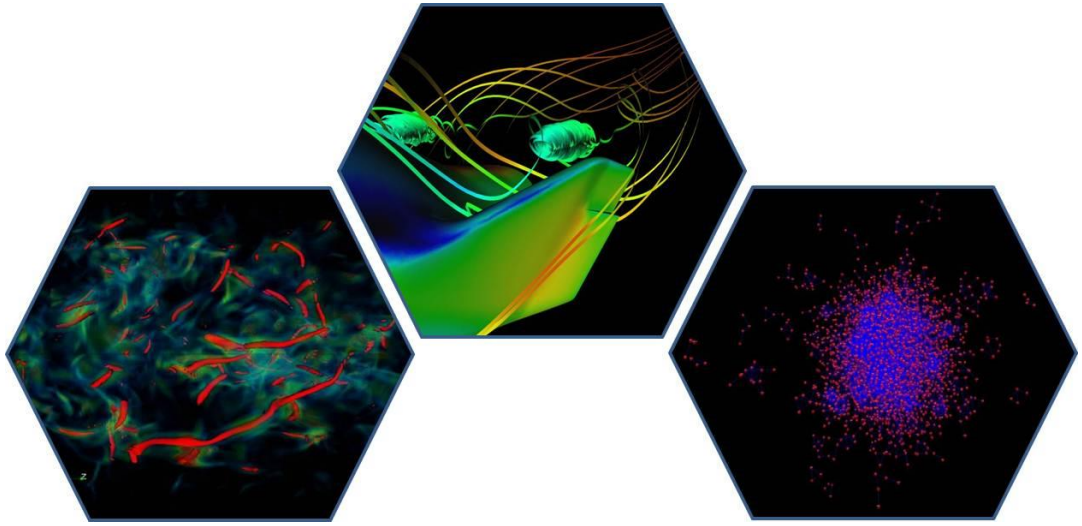
SUPPORTED VISUALIZATION ALGORITHMS

- Isosurfaces
- Cutting planes
- Streamlines
- Glyphs
- Volume rendering
- Clipping
- Height maps
- & more

ParaView



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SPECIAL FEATURES

- Supports derived variables
- Scriptable via Python
- Saves animations
- Can run in parallel / distributed mode for large data visualization

ParaView SUPPORTED FILE FORMATS

- ParaView Data (.pvd)
- VTK (.vtp, .vtu, .vti, .vts, .vtr)
- VTK Legacy (.vtk)
- VTK Multi Block (.vtm, .vtmb, .vtmg, .vthd, .vthb)
- Partitioned VTK (.pvtu, .pvti, .pvts, .pvtr)
- ADAPT (.nc, .cdf, .elev, .ncd)
- ANALYZE (.img, .hdr)
- ANSYS (.inp)
- AVS UCD (.inp)
- BOV (.bov)
- BYU (.g)
- CCSM MTSD (.nc, .cdf, .elev, .ncd)
- CCSM STSD (.nc, .cdf, .elev, .ncd)
- CEAucd (.ucd, .inp)
- CMAT (.cmat)
- CTRL (.ctrl)
- Chombo (.hdf5, .h5)
- Claw (.claw)
- Comma Separated Values (.csv)
- Cosmology Files (.cosmo, .gadget2)
- Curve2D (.curve, .ultra, .ult, .u)
- DDCMD (.ddcmd)
- Digital Elevation Map (.dem)
- Dyna3D(.dyn)
- EnSight (.case, .sos)
- Enzo boundary and hierarchy
- ExodusII (.g, .e, .exe, .ex2, .ex2v.., etc)
- ExtrudedVol (.exvol)
- FVCOM (MTMD, MTSD, Particle, STSD)
- Facet Polygonal Data
- ProSTAR (.cel, .vrt)
- Protein Data Bank (.pdb, .ent, .pdb)
- Raw Image Files
- Raw NRRD image files (.nrrd)
- SAMRAI (.samrai)
- SAR (.SAR, .sar)
- SAS (.sasgeom, .sas, .sasdata)
- SESAME Tables
- SLAC netCDF mesh and mode data
- SLAC netCDF particle data
- Silo (.silo, .pdb)
- Spheral (.spheral, .sv)
- SpyPlot CTH
- Spy Plot (.case)
- Stereo Lithography (.stl)
- TFT Files
- TIFF Image Files
- TSurf Files

Many more . . .

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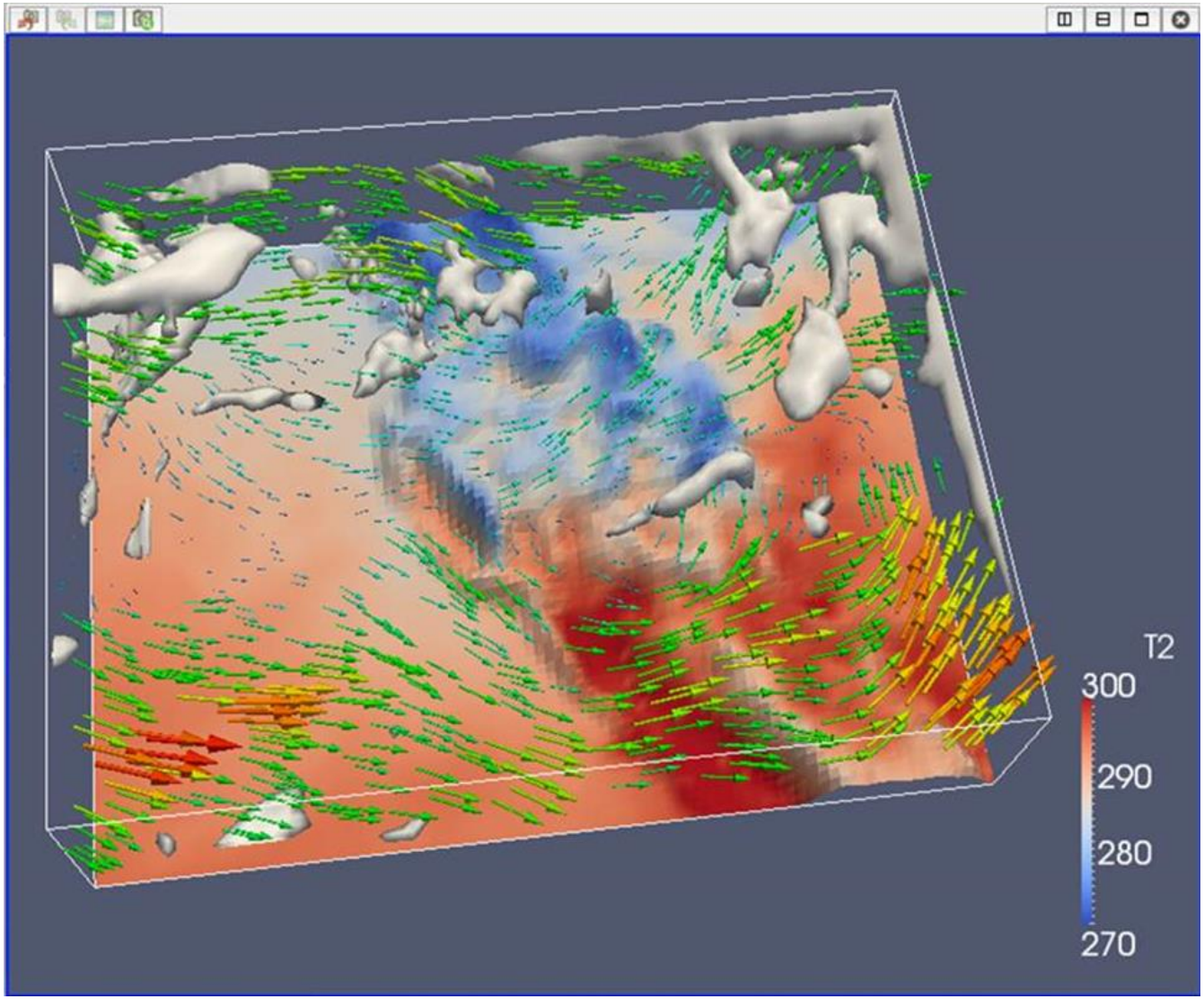
VISUALIZATION PIPELINE

- All processing operations (filters) produce data sets
- Can further process the result of every operation to build complex visualizations
  - Extract a cutting plane,
  - Apply glyphs (i.e. vector arrows) to the result
    - Gives a plane of glyphs through your 3D volume

DEMONSTRATION

- WRF weather forecast data set
  - Rectilinear grid
  - Multiple scalar and vector variables
  - Time series
- Can show:
  - Clouds
  - Wind
  - Temperature



VISUALIZING DATA USING PARAVIEW

Three Basic Steps:

- First your data must be **read** into ParaView
- Next, you may apply any number of **filter**s that process the data to generate, extract, or derive features from the data
- Finally, a viewable image is **render**ed from the data

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ParaView 5.0.0

Let's get started . . . .

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Sanity Check

- ✓ Software Installed?
- ✓ Data Sets downloaded?
- ✓ Can you locate the datasets?

http://web.ics.purdue.edu/~vbyrd/trainingData.html

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Tutorial Datasets

- RectGrid2.vtk
- headsq.vti

Sample data file

- header.txt
- xCoordinates.txt
- yCoordinates.txt
- zCoordinates.txt
- lookUpTable.txt

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What are we going to do?

- Load Data File
- Extract Isosurfaces from the data
- Create contours, clip contours, slice contours
- Volume Rendering
- Saving your Data
- Getting your data into Paraview
- Introduction to ParaView and Python Scripting
- Additional Resources

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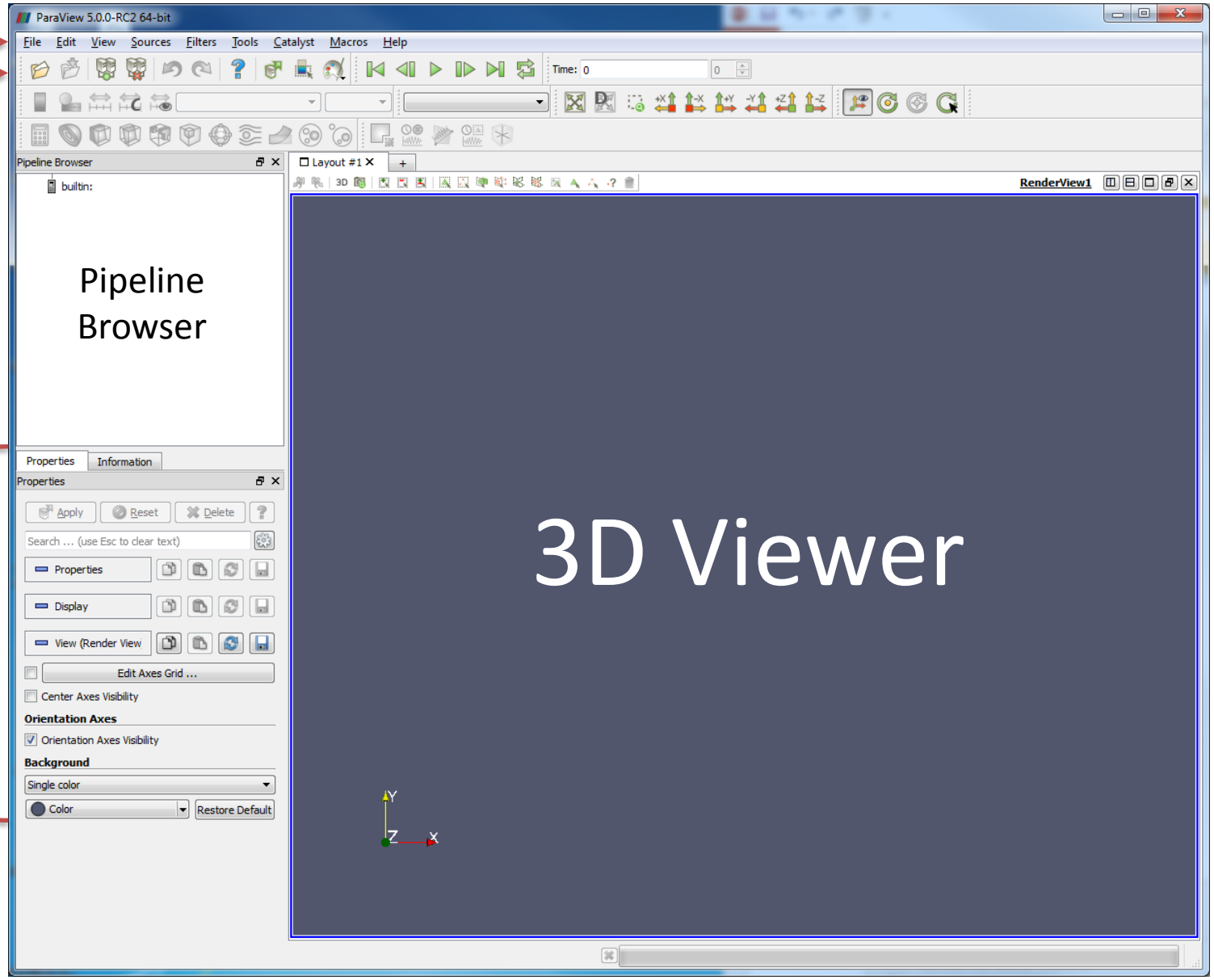
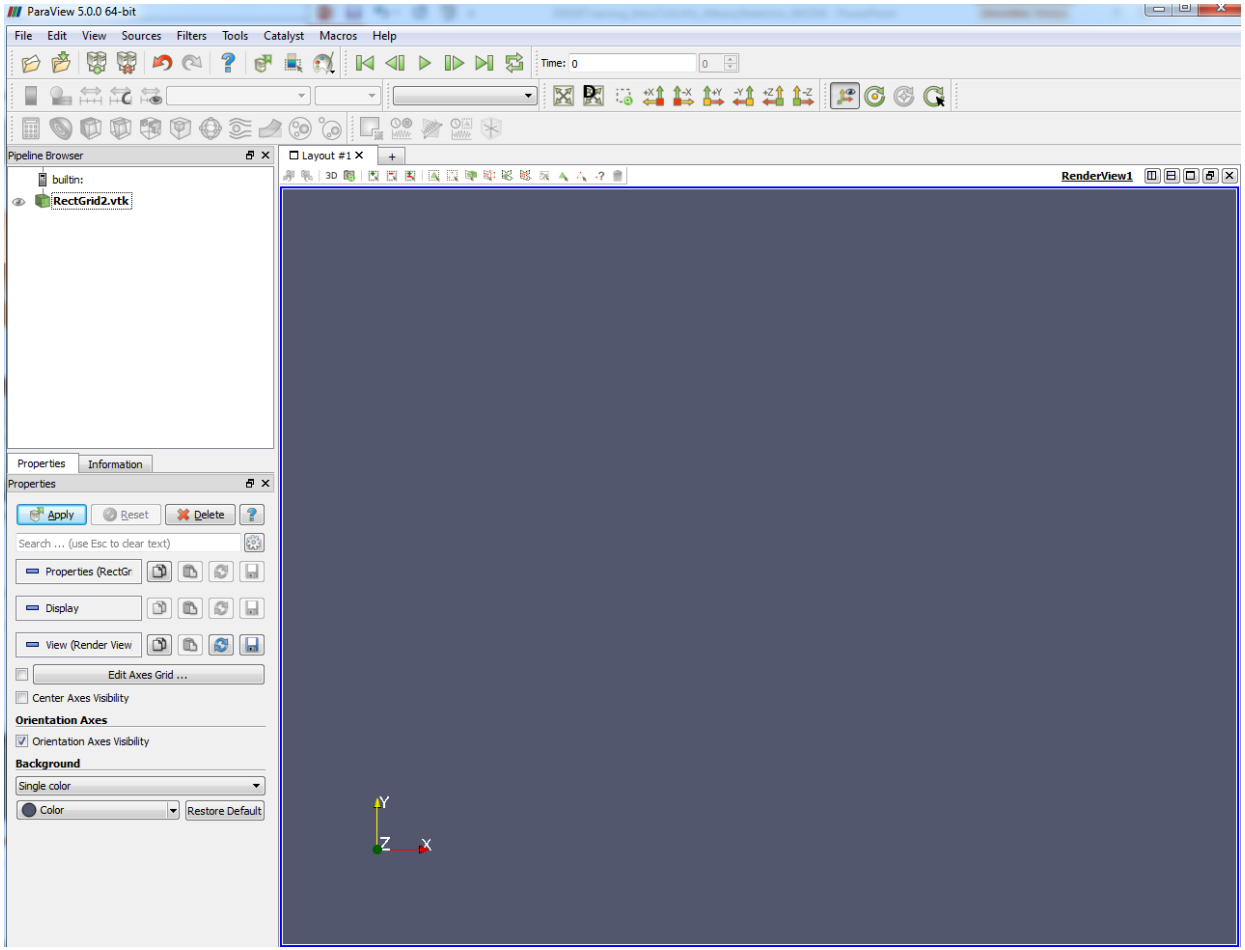
User Interface



Open Data File: RectGrid2.vtk

- Locate **RecGtrid2.vtk**
- Click **File** → **Open**
- Select **RectGrid2.vtk**
- Click **OK**



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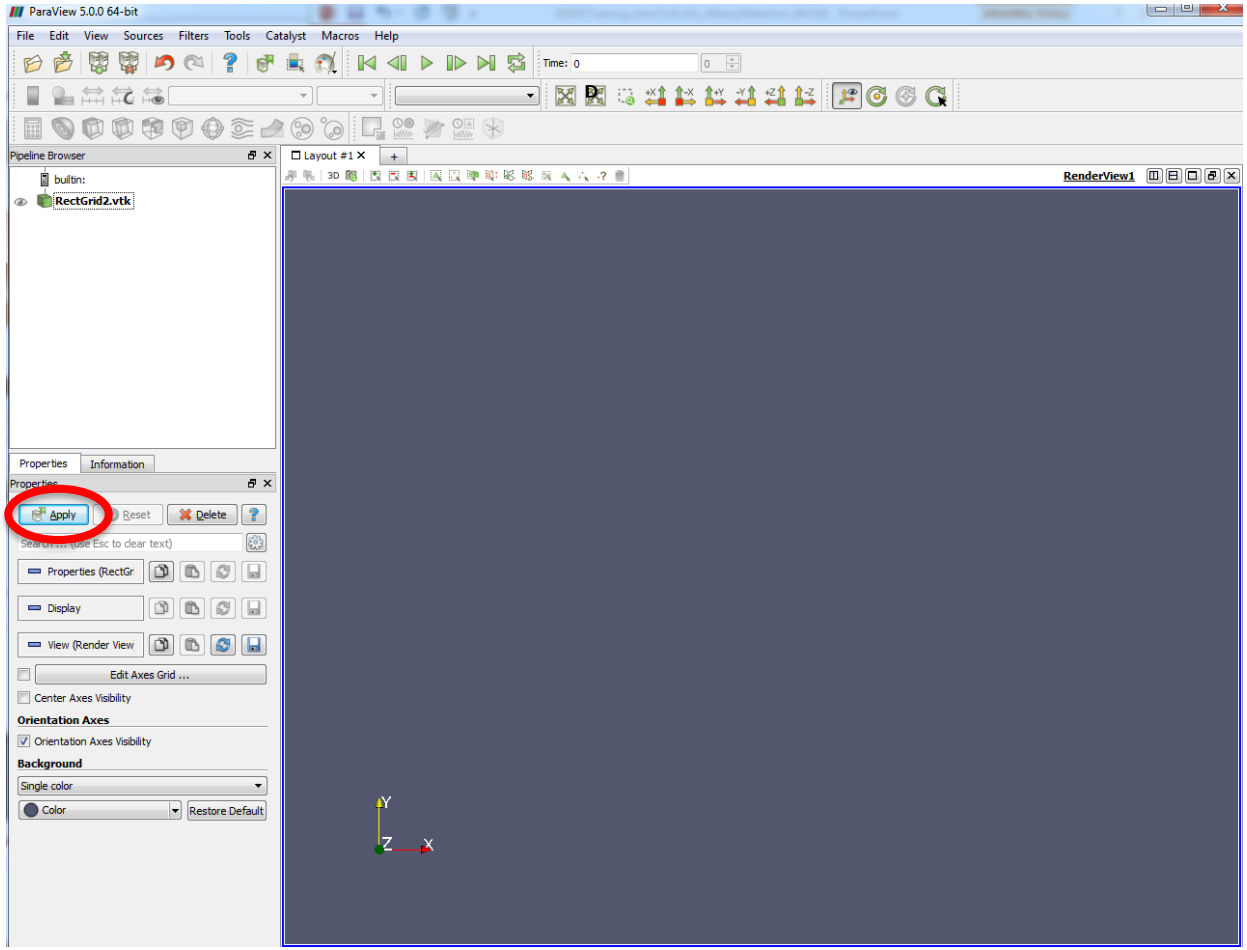
Open Data File: RectGrid2.vtk

- Locate **RecGtrid2.vtk**
- Click **File** → **Open**
- Select **RectGrid2.vtk**
- Click **OK**

- Click **Apply**



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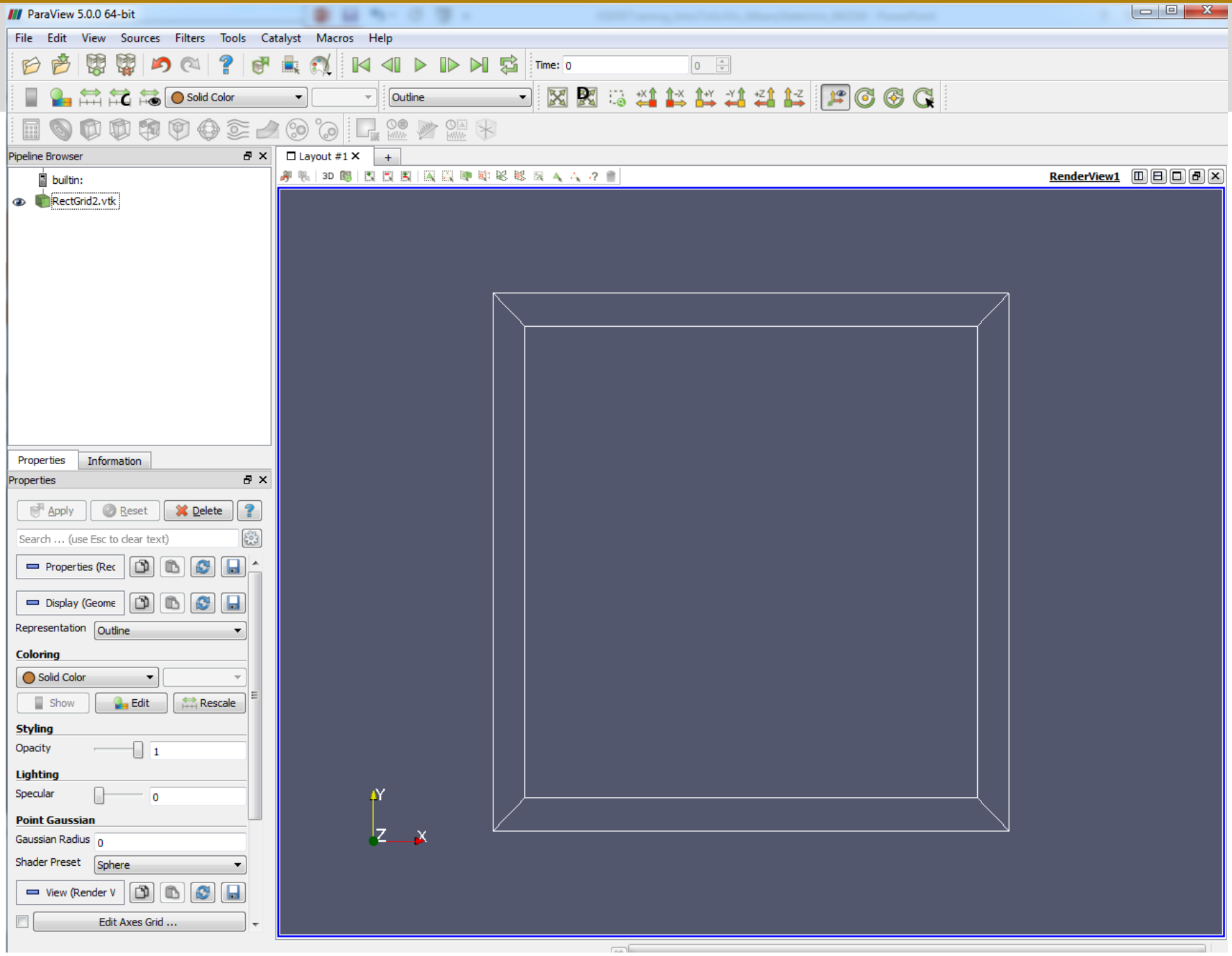
ParaView 5.0.0 64-bit
File Edit View Sources Filters Tools Catalyst Macros Help
Time: 0
Solid Color
Outline
Pipeline Browser
builtin:
RectGrid2.vtk
Layout #1
RenderView1
Properties
Information
Apply
Reset
Delete
Search ... (use Esc to clear text)
Properties (Rec
Display (Geome
Representation
Outline
Coloring
Solid Color
Show
Edit
Rescale
Styling
Opacity
1
Lighting
Specular
0
Point Gaussian
Gaussian Radius
0
Shader Preset
Sphere
View (Render V
Edit Axes Grid ...
Y
Z
X

Sample rectilinear grid

```
# vtk DataFile Version 2.0
Sample rectilinear grid
ASCIIDATASET RECTILINEAR_GRID
DIMENSIONS 47 33 11
X_COORDINATES 47 float
-1.22396 -1.17188 -1.11979 -1.06771 -1.01562 -0.963542
-0.911458 -0.859375 -0.807292 -0.755208 -0.703125 -0.651042
-0.598958 -0.546875 -0.494792 -0.442708 -0.390625 -0.338542
-0.286458 -0.234375 -0.182292 -0.130209 -0.078125 -0.026042
0.0260415 0.078125 0.130208 0.182291 0.234375 0.286458
0.338542 0.390625 0.442708 0.494792 0.546875 0.598958
0.651042 0.703125 0.755208 0.807292 0.859375 0.911458
0.963542 1.01562 1.06771 1.11979 1.17188
Y_COORDINATES 33 float
-1.25 -1.17188 -1.09375 -1.01562 -0.9375 -0.859375
-0.78125 -0.703125 -0.625 -0.546875 -0.46875 -0.390625
-0.3125 -0.234375 -0.15625 -0.078125 0 0.078125
0.15625 0.234375 0.3125 0.390625 0.46875 0.546875
0.625 0.703125 0.78125 0.859375 0.9375 1.01562
1.09375 1.17188 1.25
Z_COORDINATES 11 float
0 0.1 0.2 0.3 0.4 0.5
0.6 0.7 0.75 0.8 0.9
POINT_DATA 17061
SCALARS scalars float
LOOKUP_TABLE default
0 0 0 0 0 0
0 0 0 0 0 0
0 0 0 0 0 0
0 0 0 0 0 0
0 0 0 0 0 0
:
```

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Create Isosurfaces

Contour – extracts the points, curves, or surfaces where a scalar field is equal to a user-defined value.

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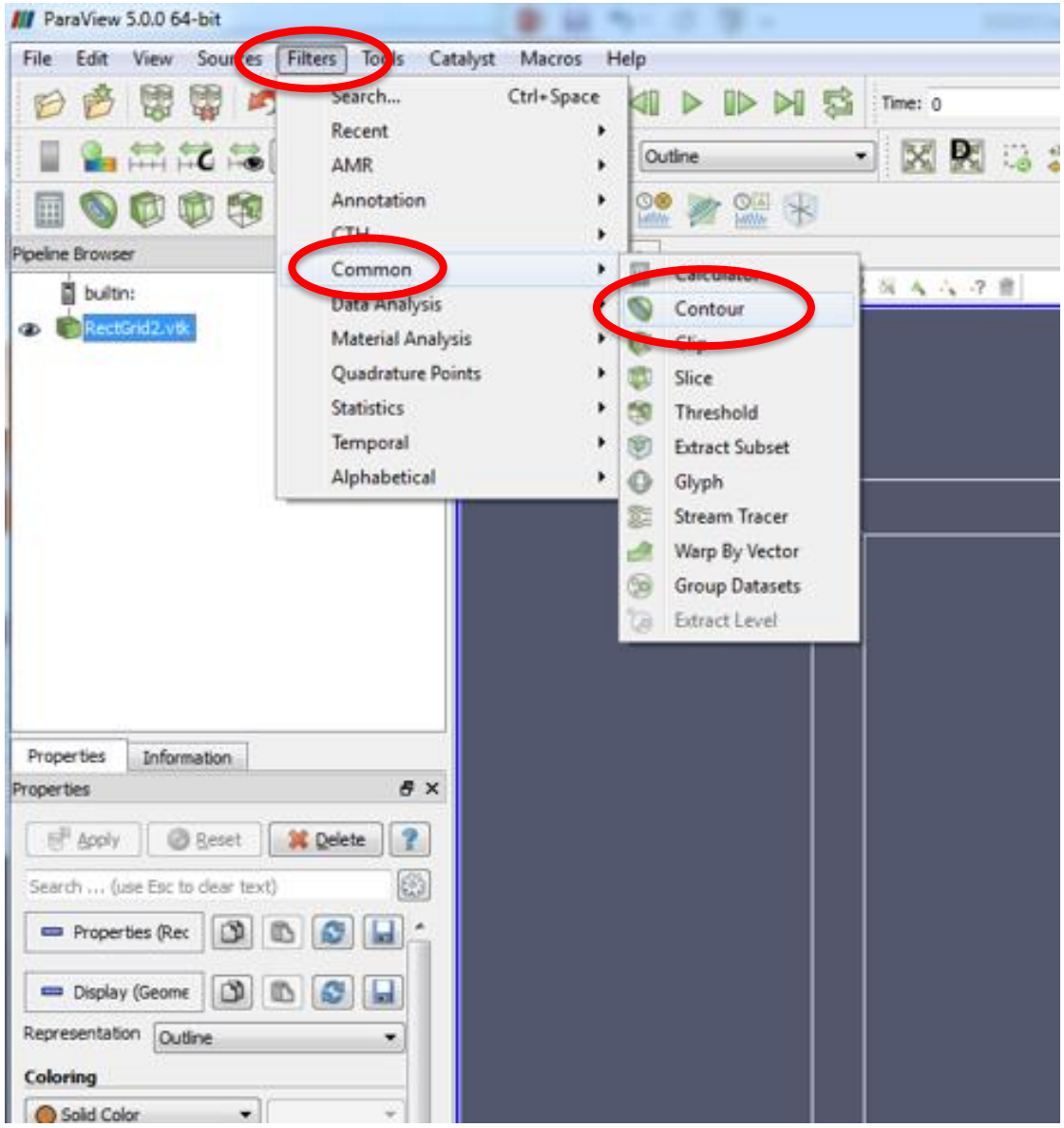
Create Isosurface

Click on RectGrid2.vtk

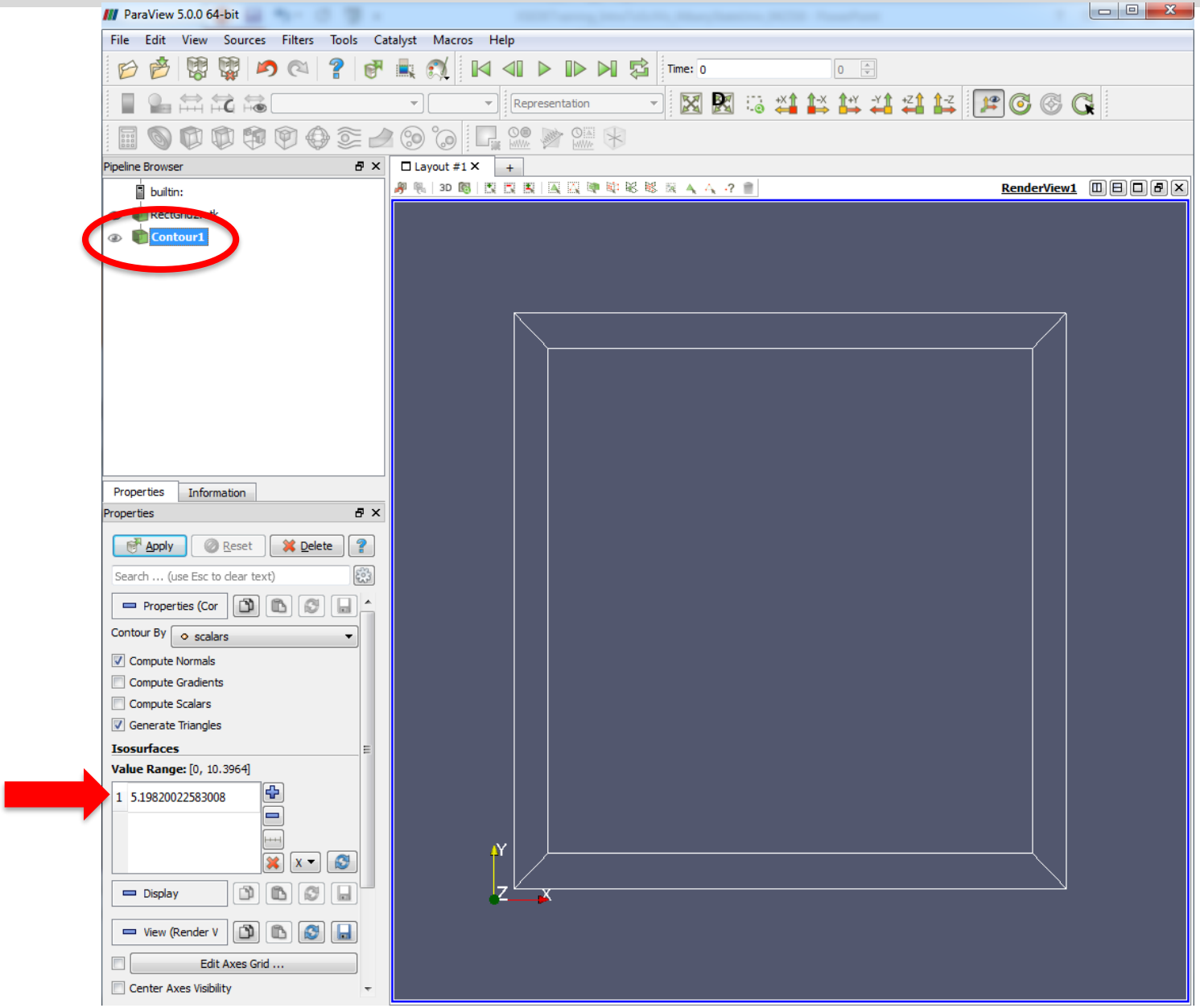
Select

- Filters
- Common
- Contour

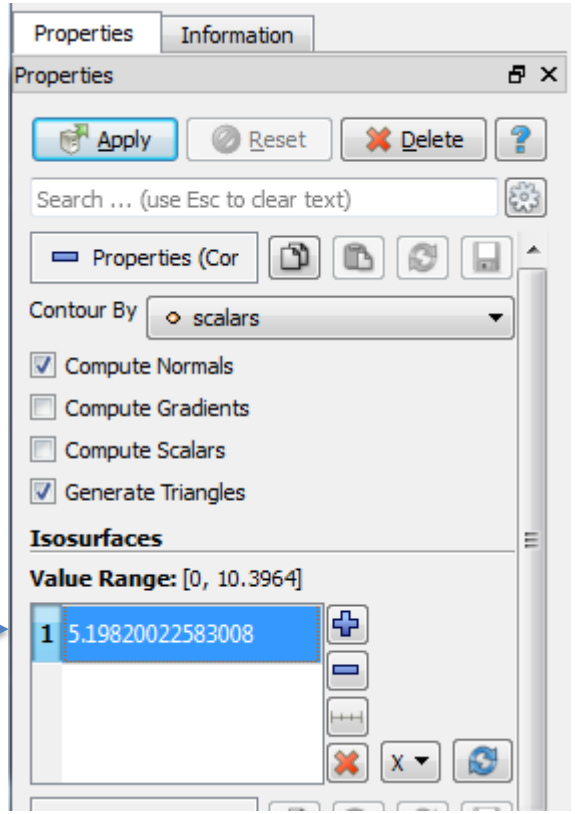


Should see

- New object in Pipeline Browser
- One (1) value in the value range box

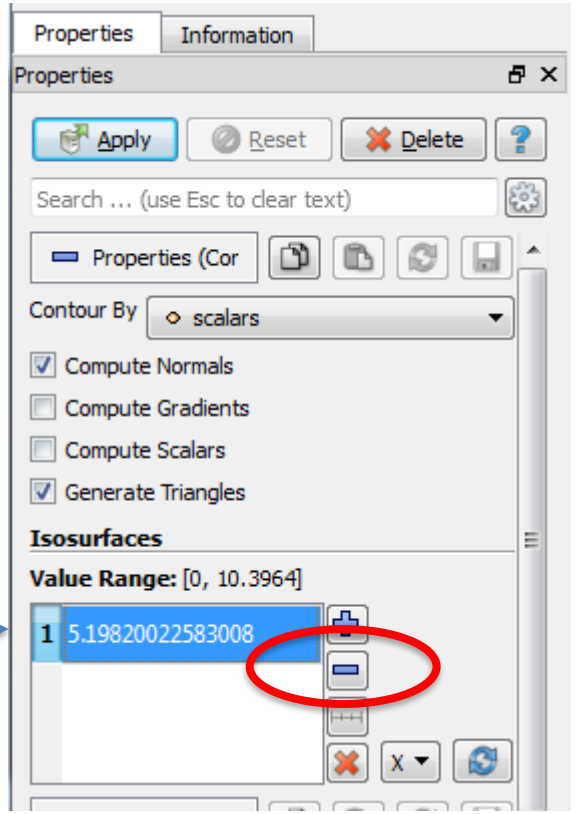


- Select the value in the Value Range window



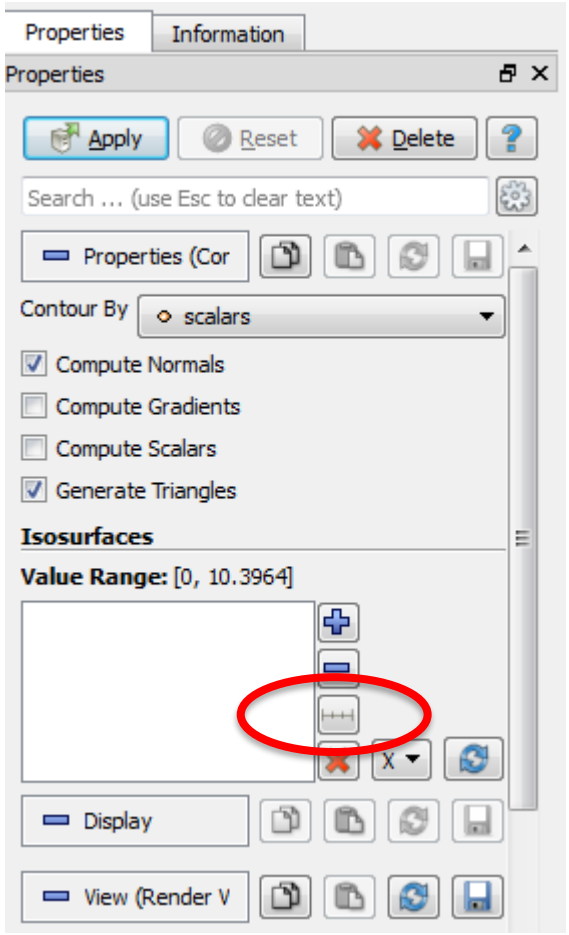
PURDUE POLYTECHNIC

- Select the value in the Value Range window
- Click the minus sign in the value range box to Delete the value



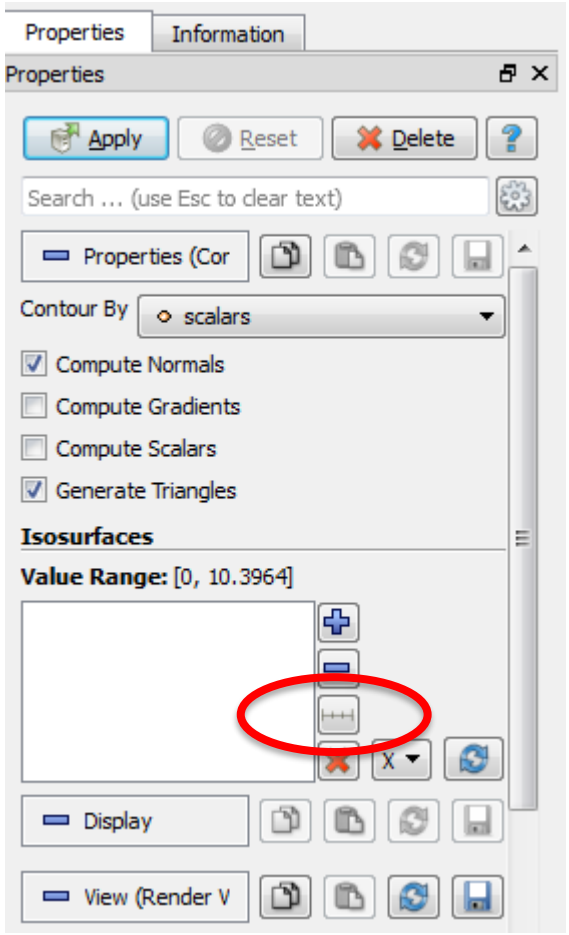
PURDUE POLYTECHNIC

Click the Add a range of values button

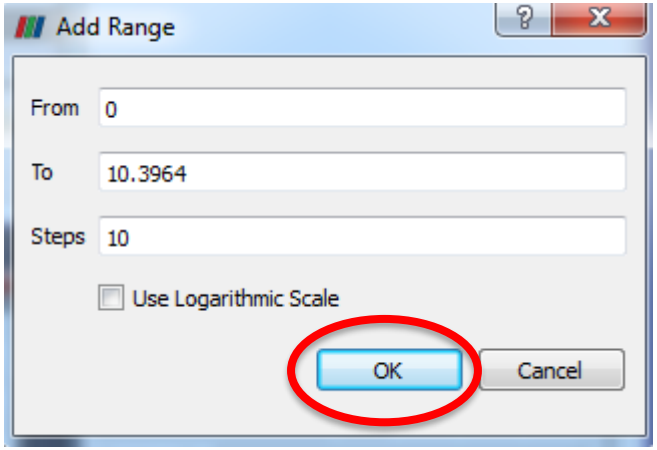


PURDUE
POLYTECHNIC

Click the Add a range of values button

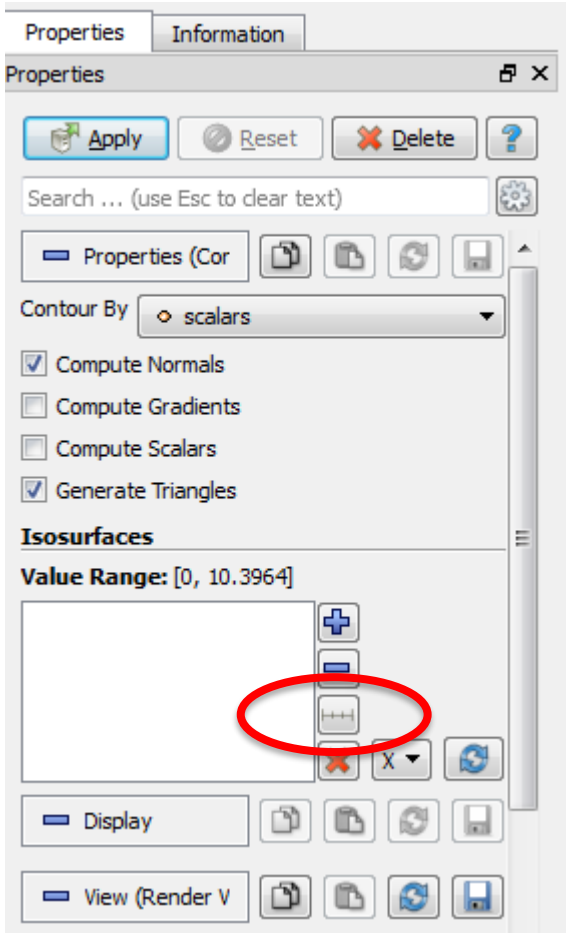


Click **OK**



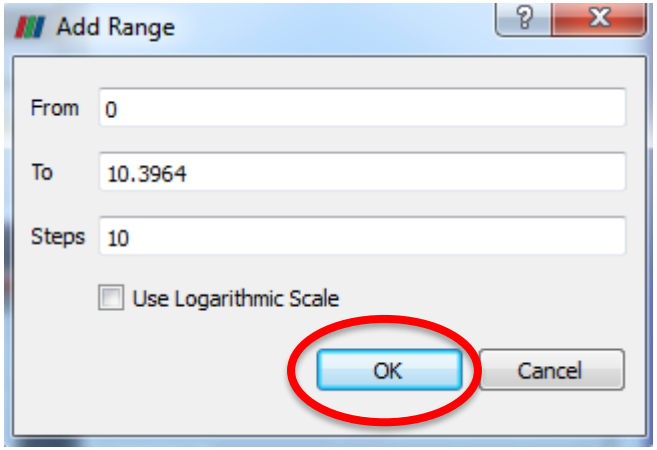
PURDUE POLYTECHNIC

Click the Add a range of values button



Click **OK**

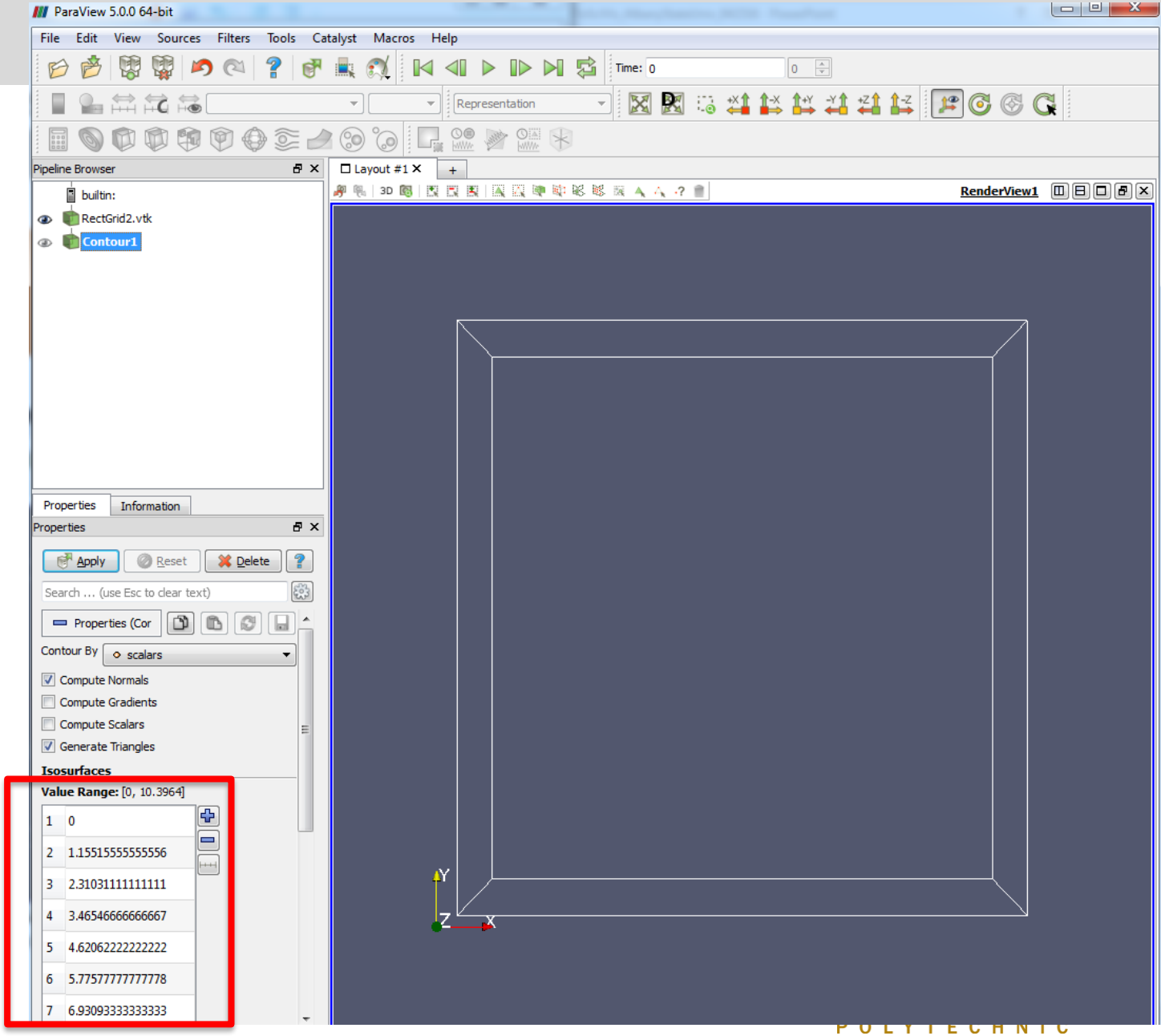
Click **Apply**



PURDUE POLYTECHNIC

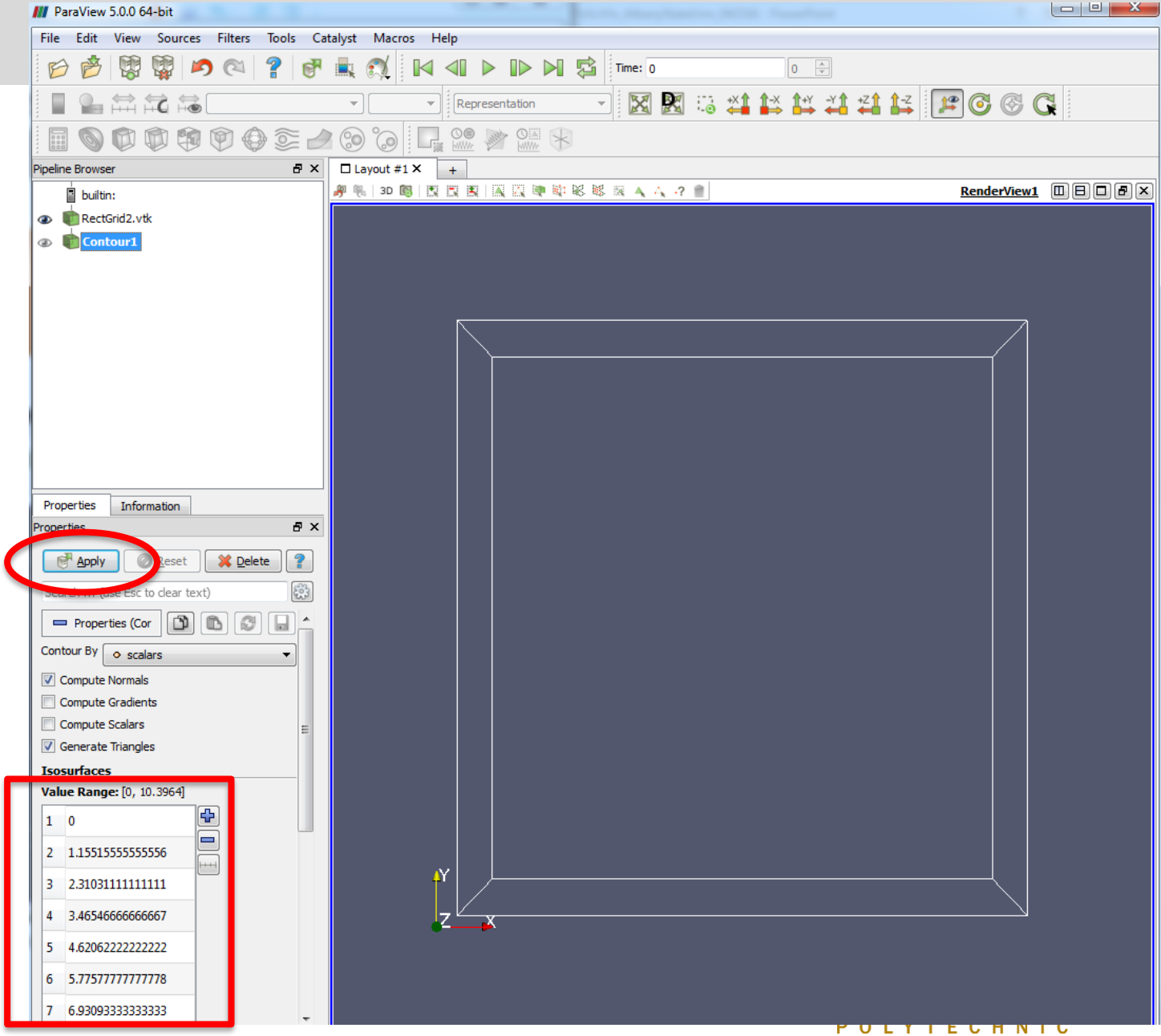
Should see

- A range of values in the Value Range box
- Values range from the min and max values entered in the previous dialog box



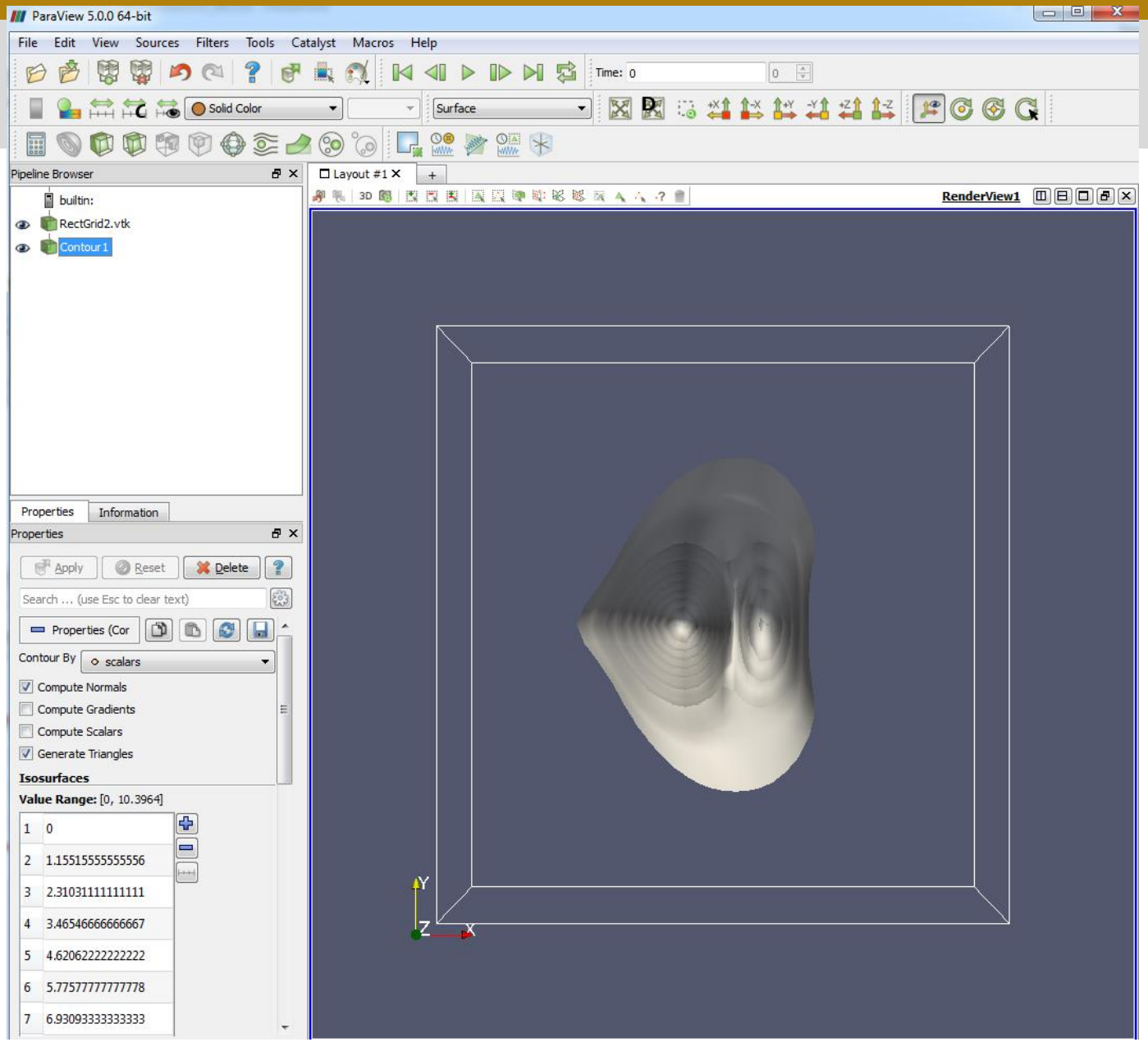
Should see

- A range of values in the Value Range box
- Values range from the min and max values entered in the previous dialog box



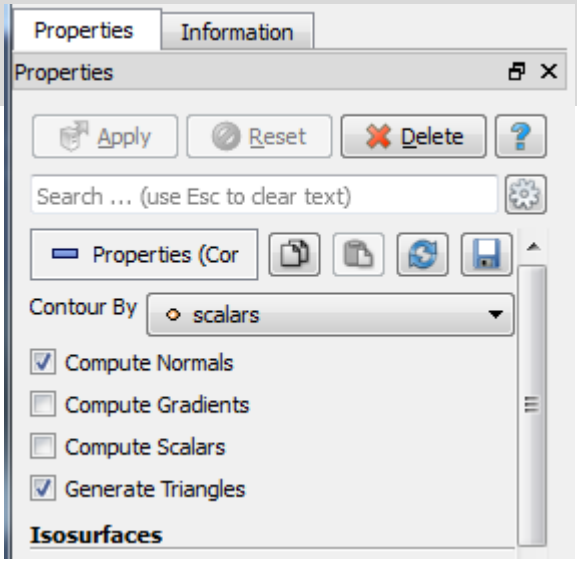
Should see

- Rendering in the 3D viewer
- Use your mouse to explore (rotate) the output



PURDUE POLYTECHNIC

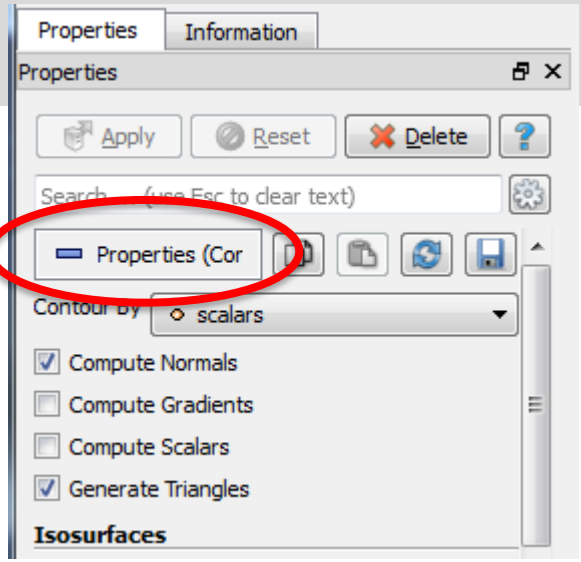
Step 1



Step 2

PURDUE
POLYTECHNIC

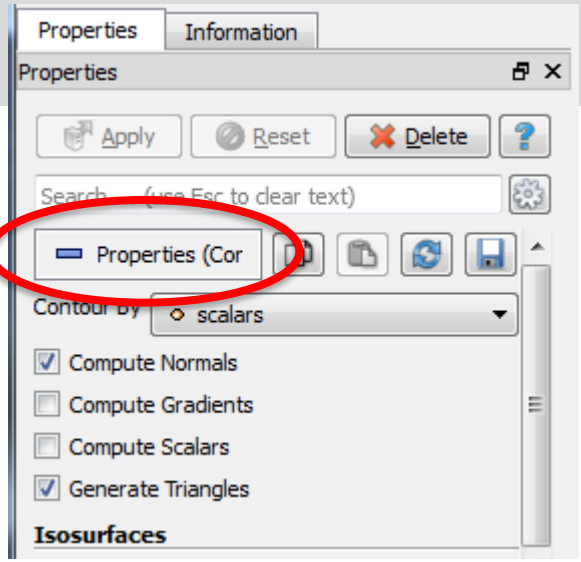
Step 1



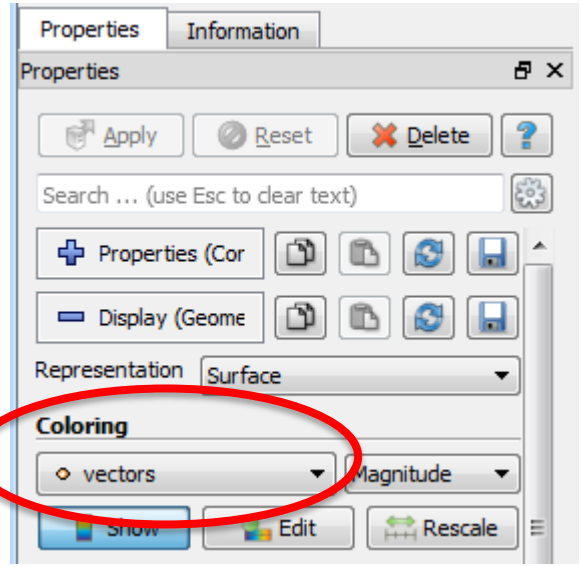
Step 2

PURDUE
POLYTECHNIC

Step 1

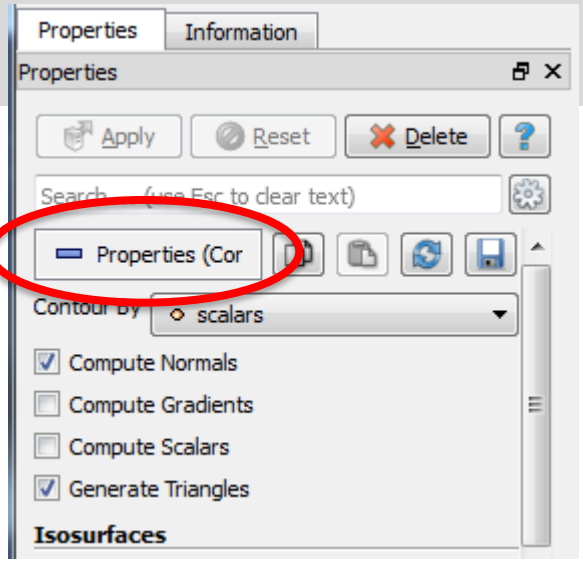


Step 2

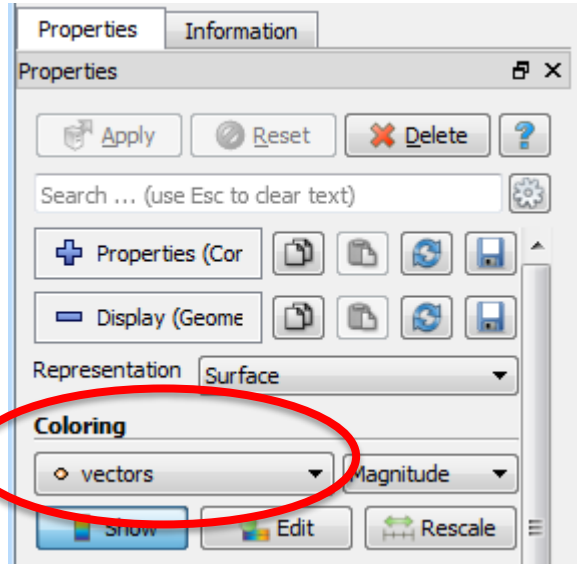


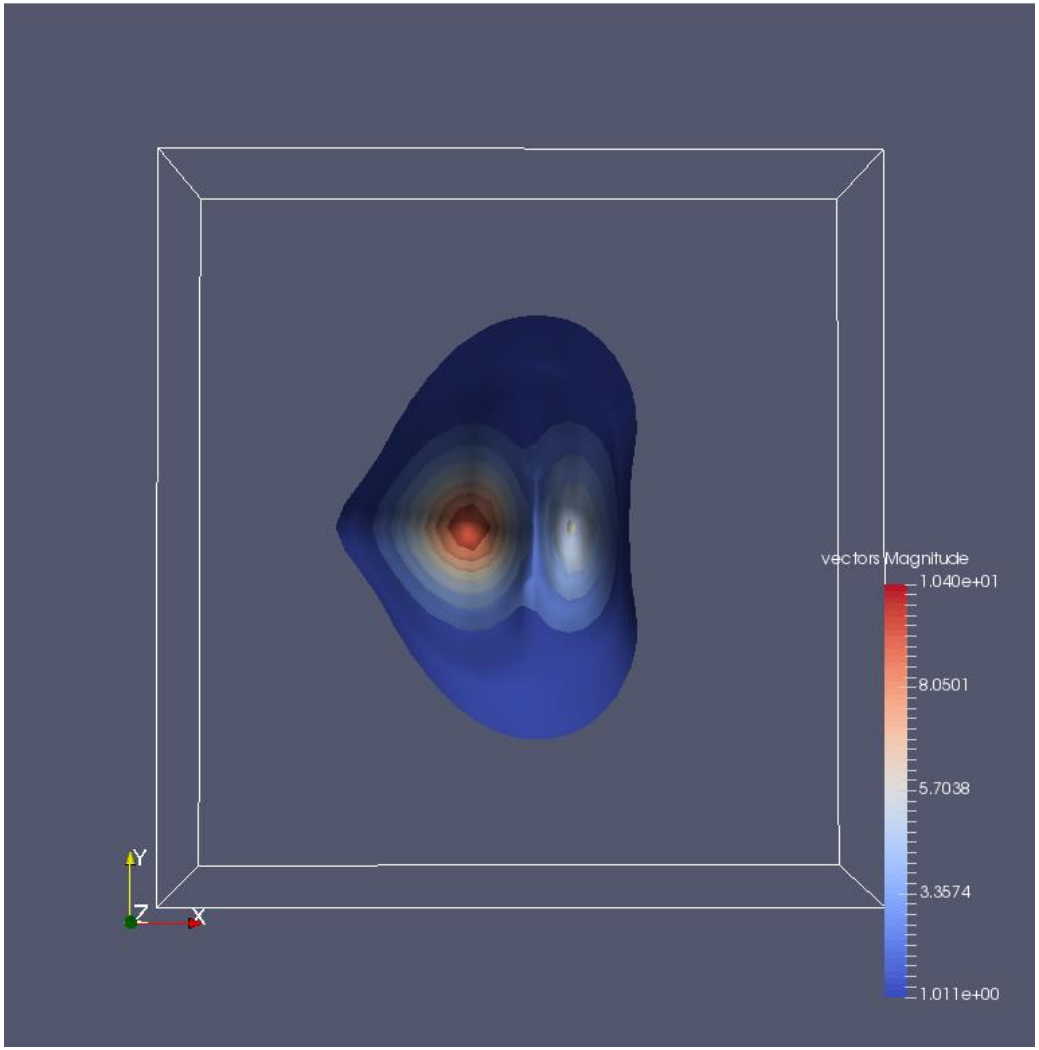
PURDUE
POLYTECHNIC

Step 1


Properties
Information
Properties
Apply
Reset
Delete
Search ... (use Esc to clear text)
Properties (Cor
Contour By
scalars
Compute Normals
Compute Gradients
Compute Scalars
Generate Triangles
Isosurfaces

Step 2

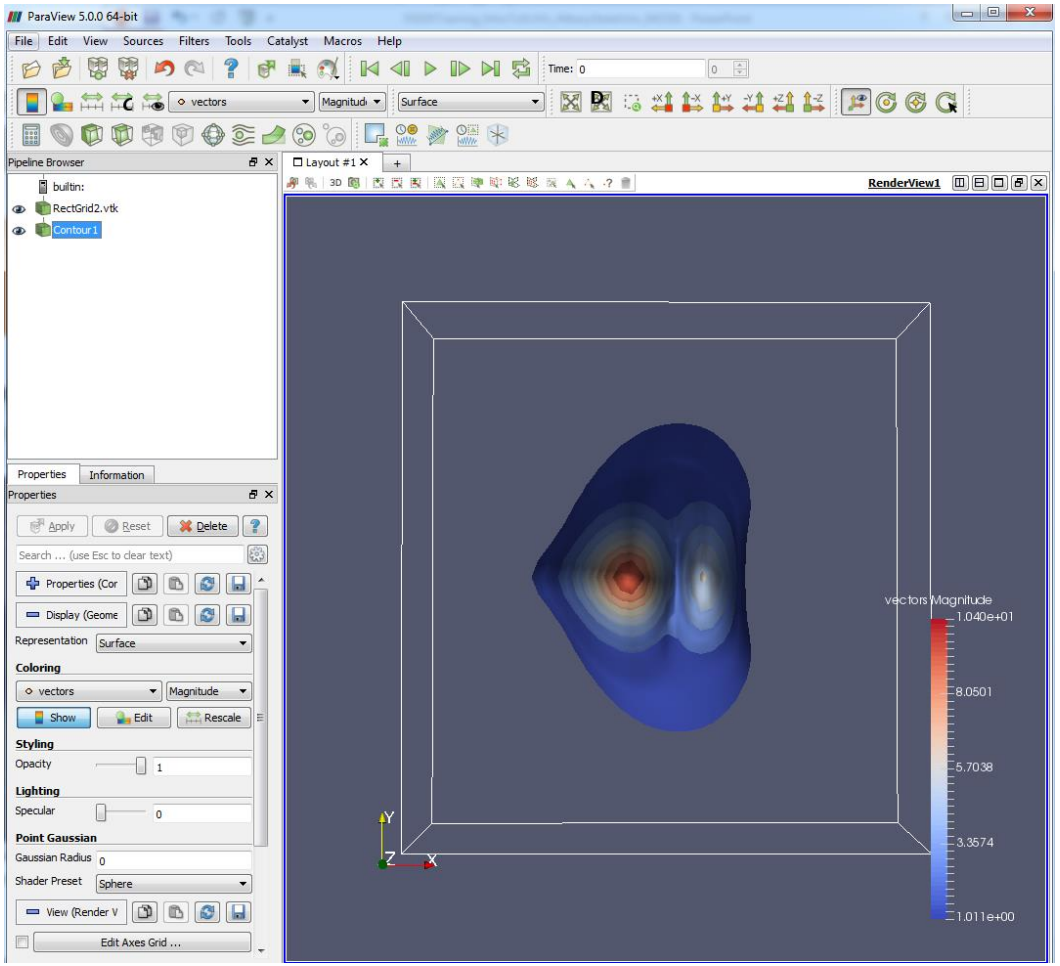

Properties
Information
Properties
Apply
Reset
Delete
Search ... (use Esc to clear text)
Properties (Cor
Display (Geome
Representation
Surface
Coloring
vectors
Magnitude
Show
Edit
Rescale


vectors Magnitude
1.040e+01
8.0501
5.7038
3.3574
1.011e+00
Y
Z
X

CREATE ISOSURFACES

SUMMARY OF STEPS

- Click Filters → Common → Contour
- Remove all values in Value Range Box
- Click Add a range of values
- Set values (Or accept default)
- Click Apply
- Set Color By property: vectors



PURDUE POLYTECHNIC

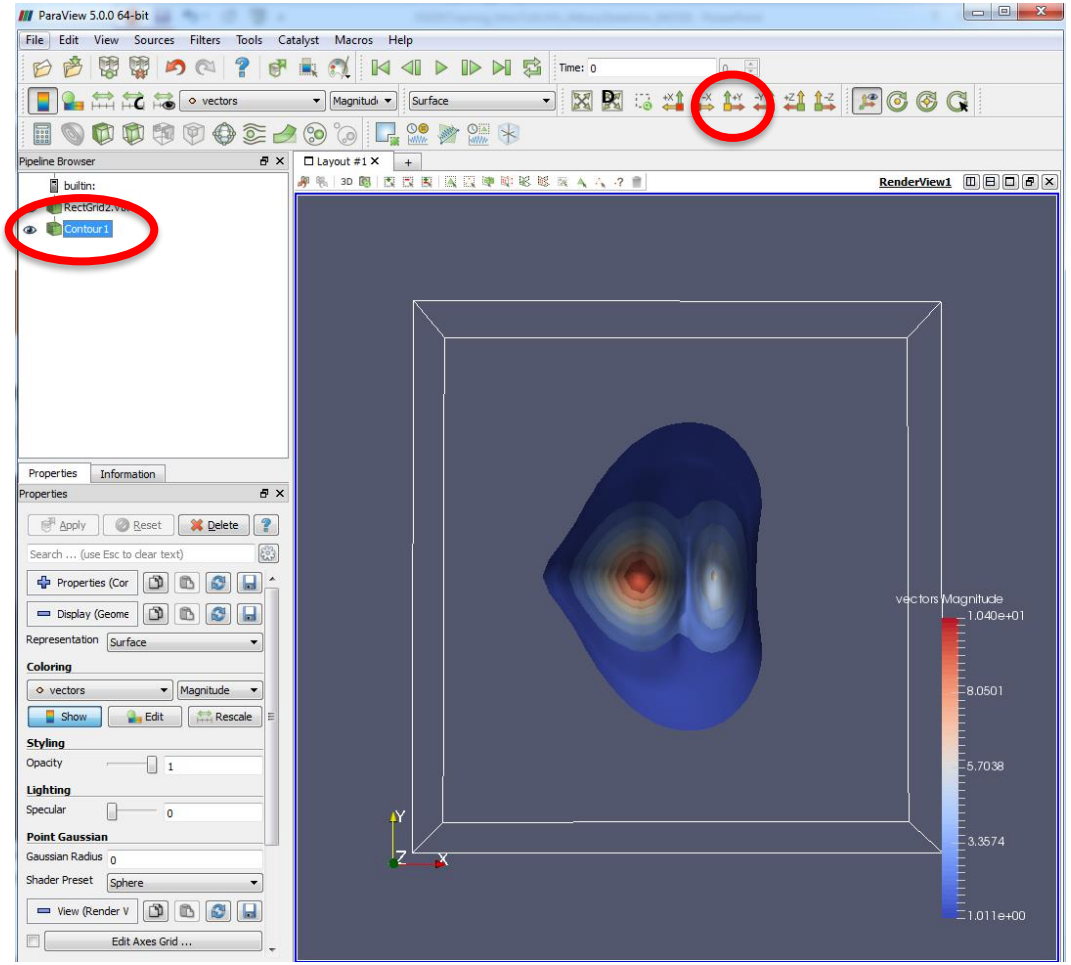
Clip Isosurfaces

Clip – Intersects the geometry with a half space. The effect is to remove all the geometry on one side of a user-defined plane.

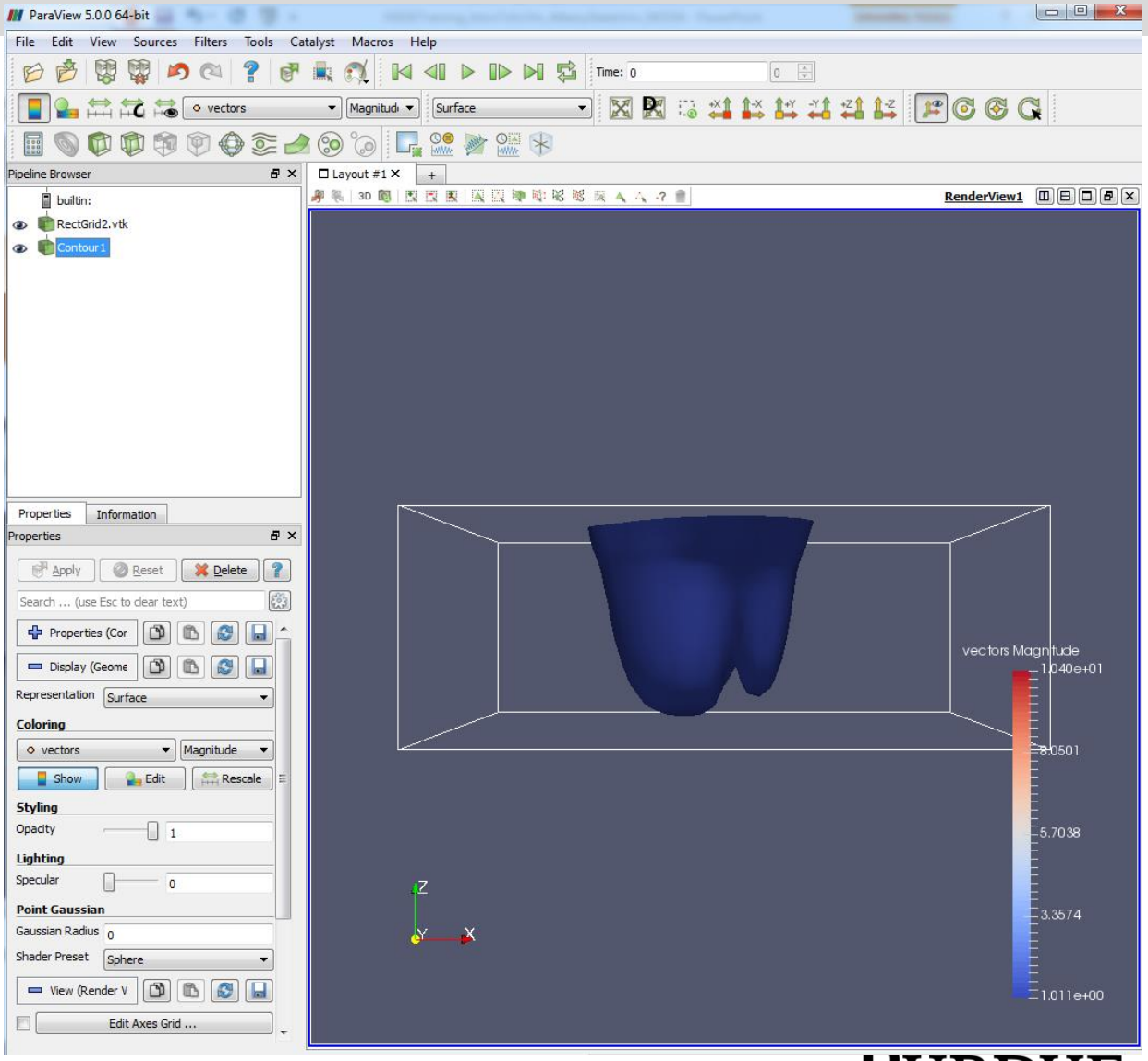
PURDUE
POLYTECHNIC

CLIP ISOSURFACES

- Make sure Contour 1 is selected (highlighted in blue)
- Set View Direction to +Y

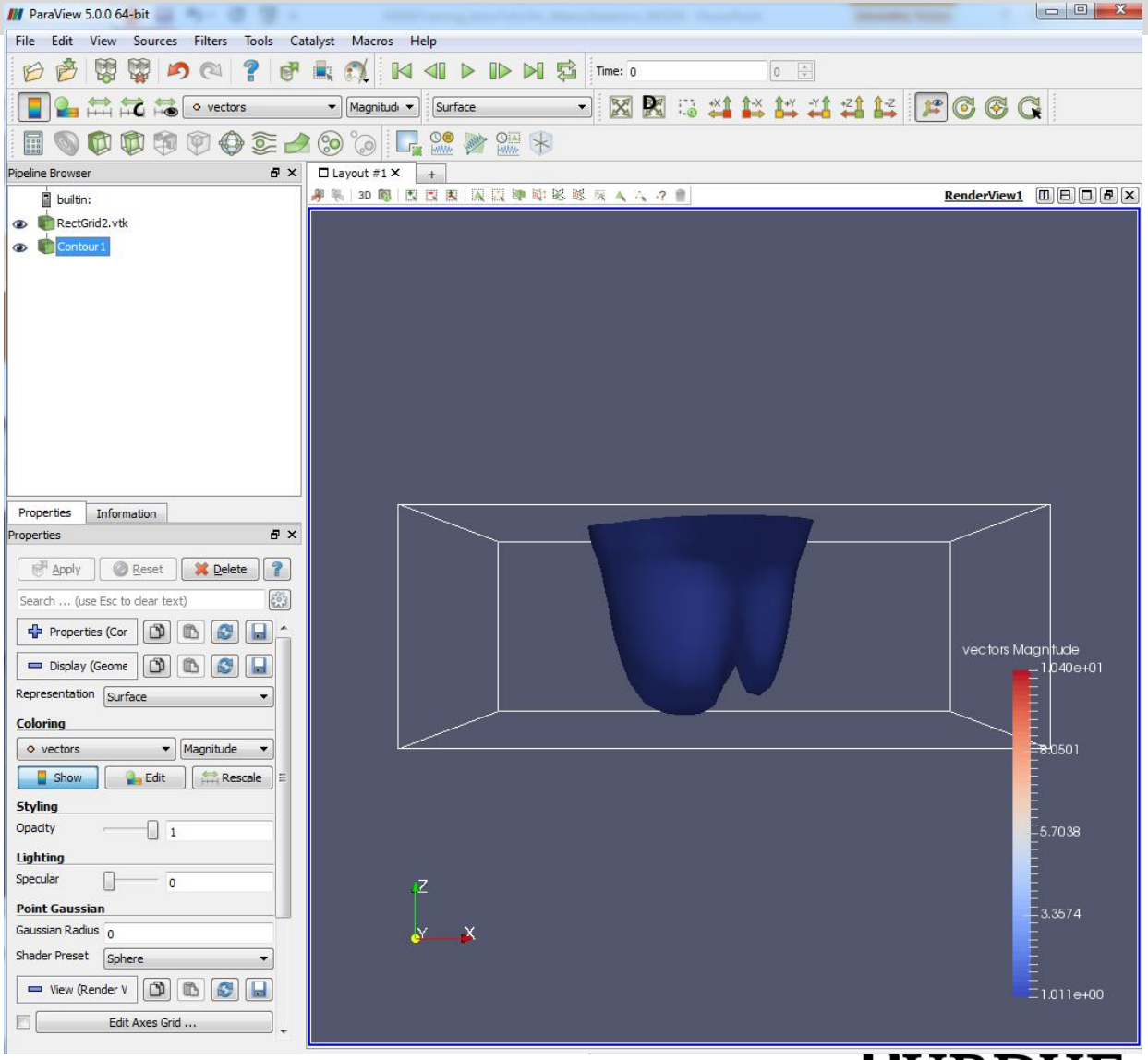


PURDUE POLYTECHNIC



PURDUE
POLYTECHNIC

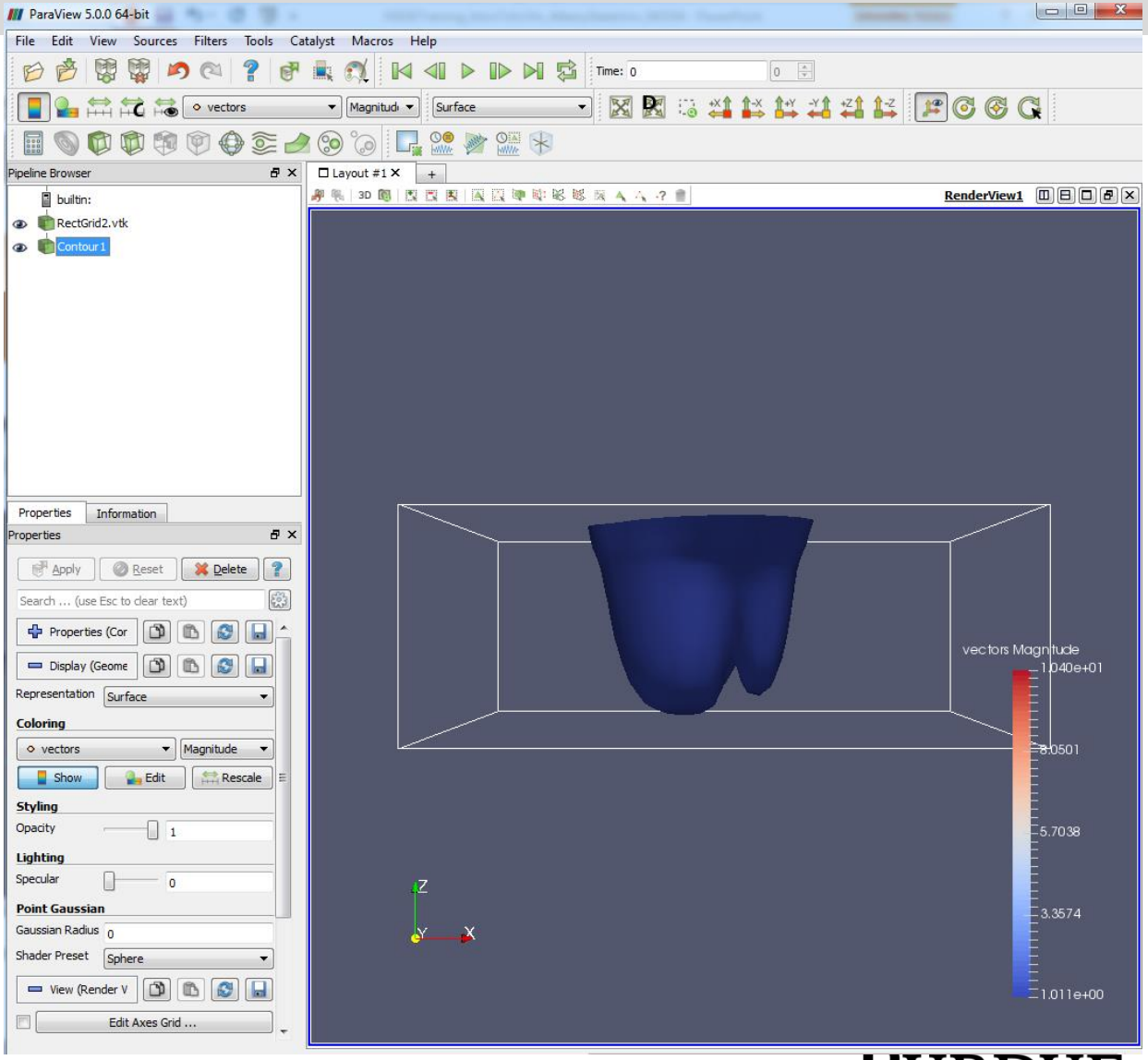
Create a new Clip filter:



PURDUE POLYTECHNIC

Create a new Clip filter:

Select:

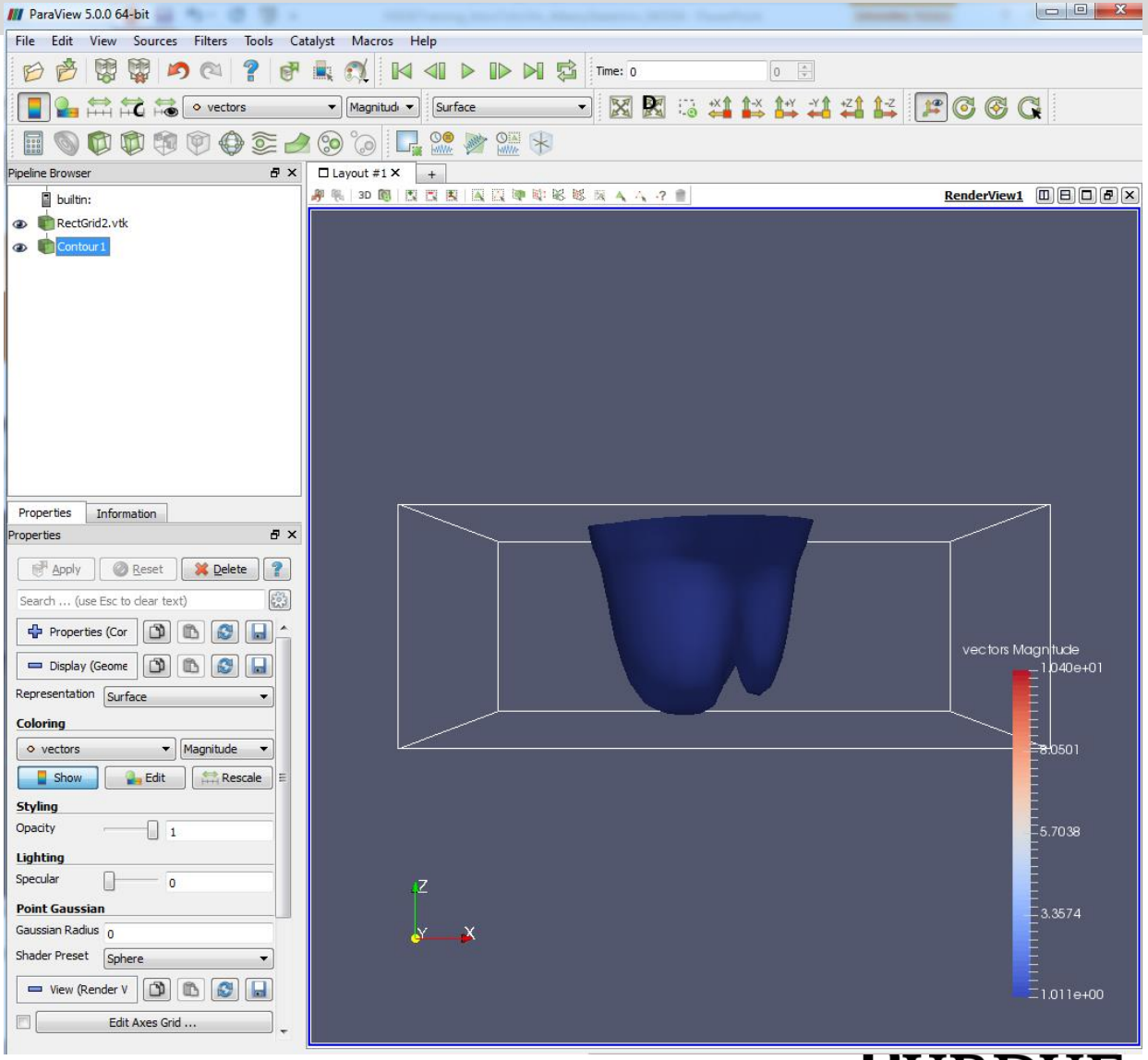


PURDUE POLYTECHNIC

Create a new Clip filter:

Select:

- Filters

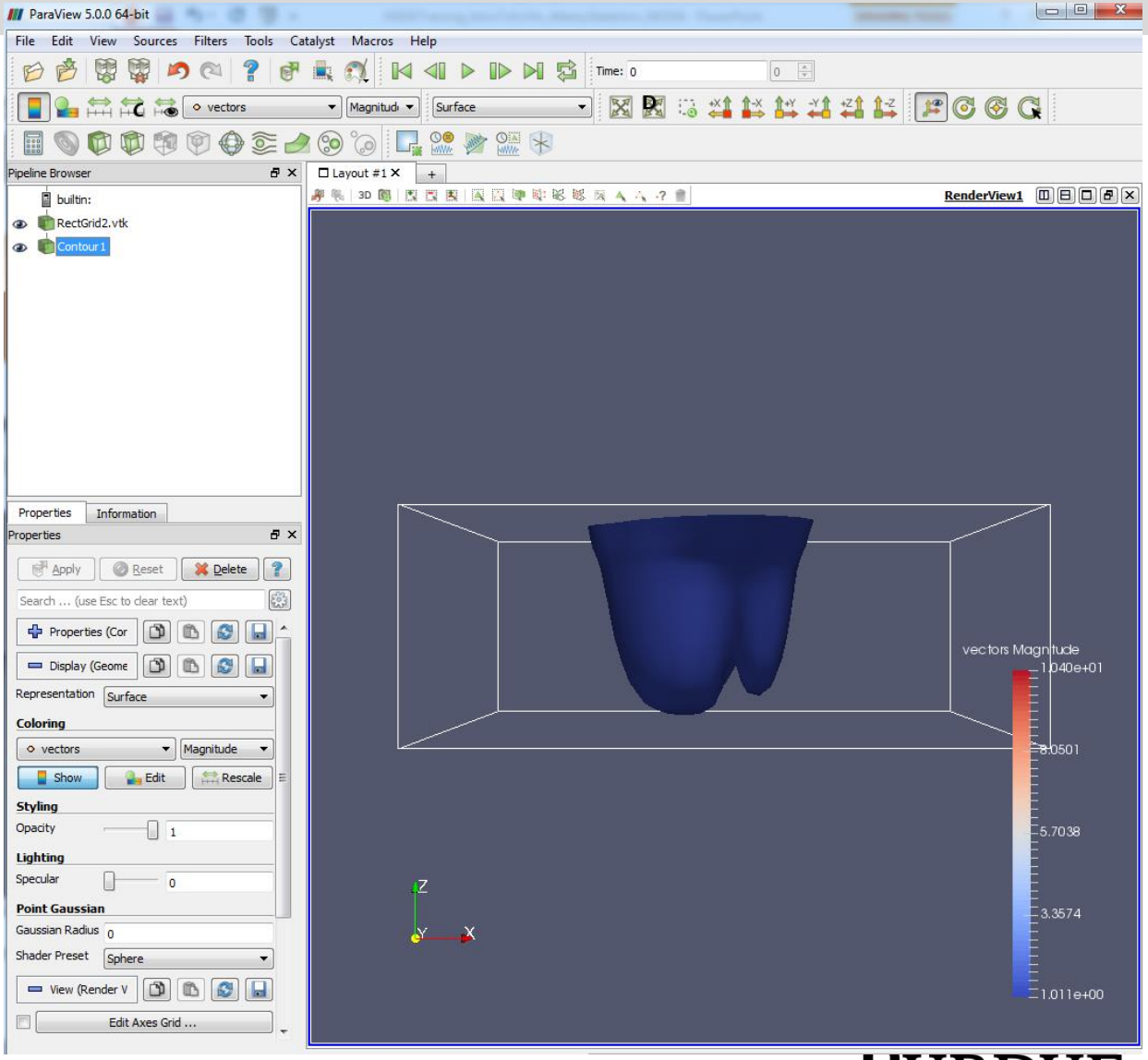


PURDUE POLYTECHNIC

Create a new Clip filter:

Select:

- Filters
- Common

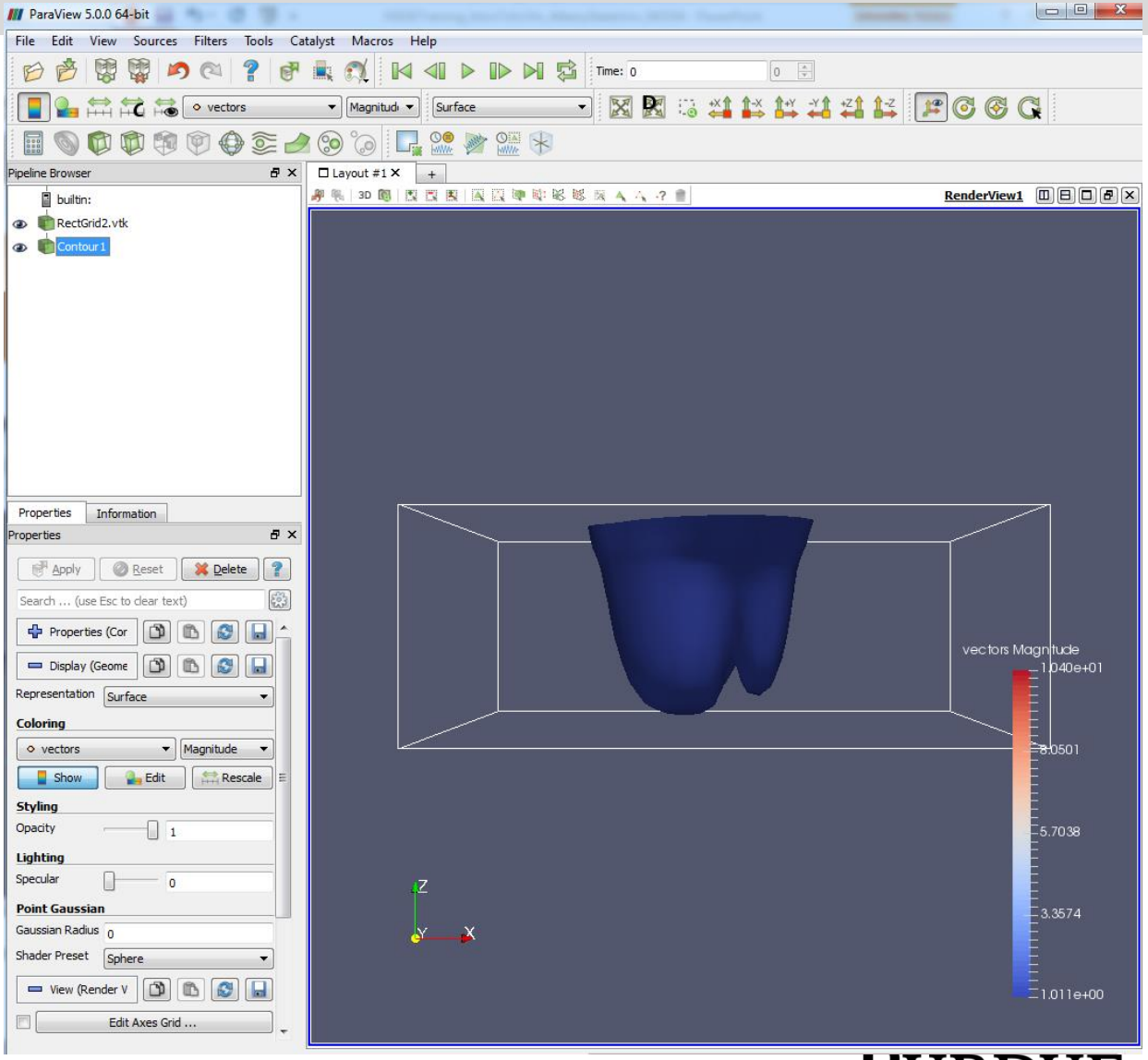


PURDUE POLYTECHNIC

Create a new Clip filter:

Select:

- Filters
- Common
- Clip

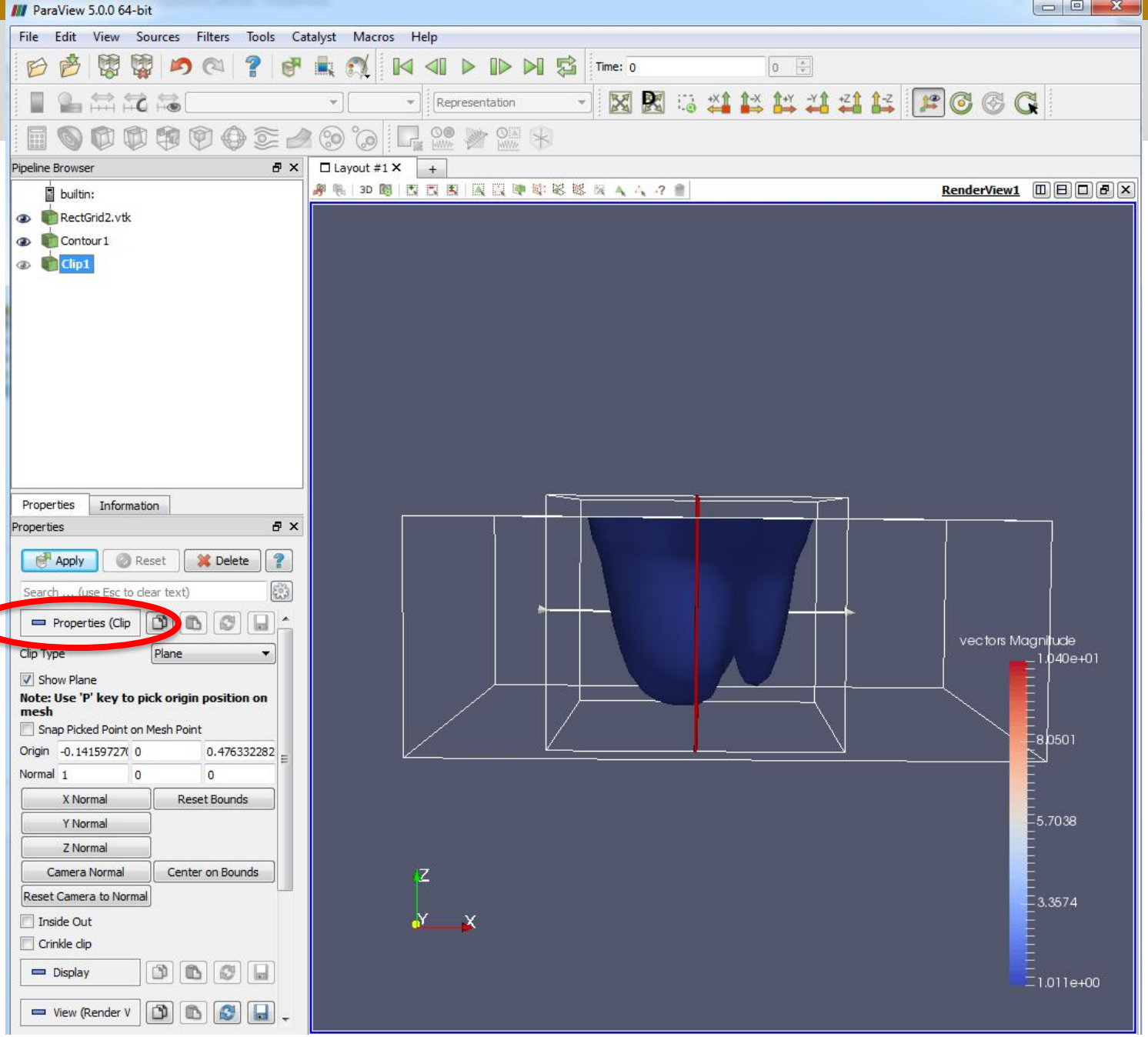


PURDUE POLYTECHNIC

Should see

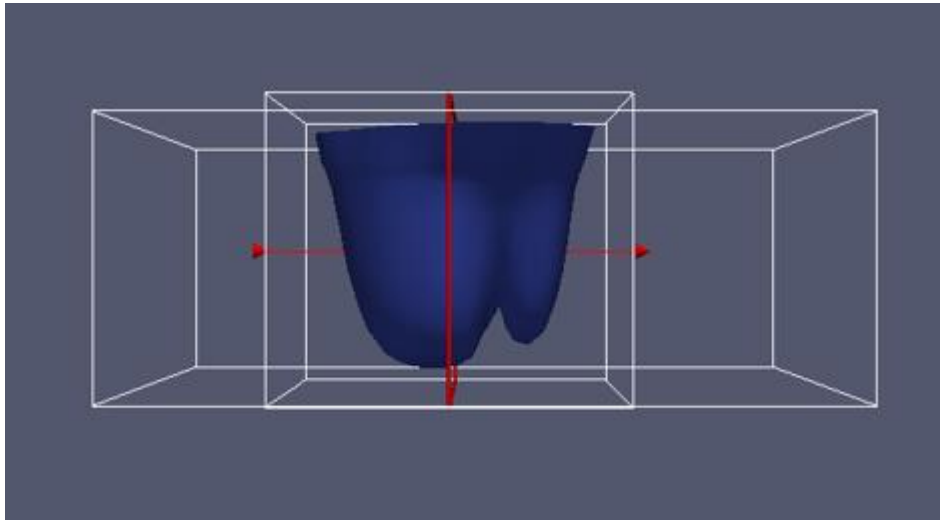
- Clip object in Pipeline Browser
- Clipping Plane

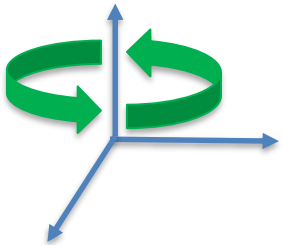
If you do not see the clipping plane click the properties button



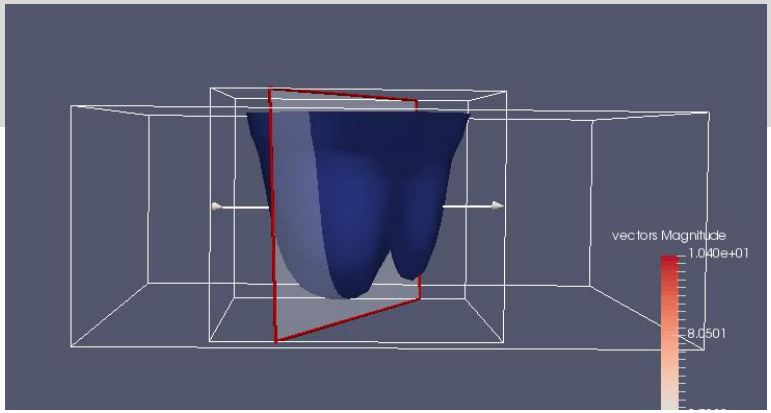
POSITION THE CLIPPING PLANE

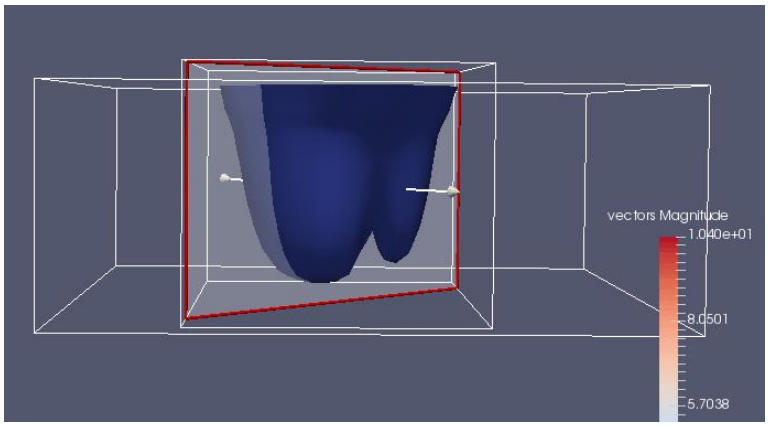
- Using the mouse, hover over the arrow head (will change color – red)
- Press the mouse button, keep it pressed and rotate the clipping plane; arrow points out of the screen towards you

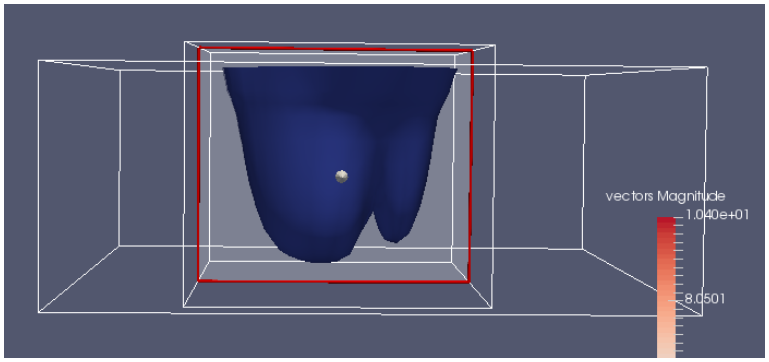


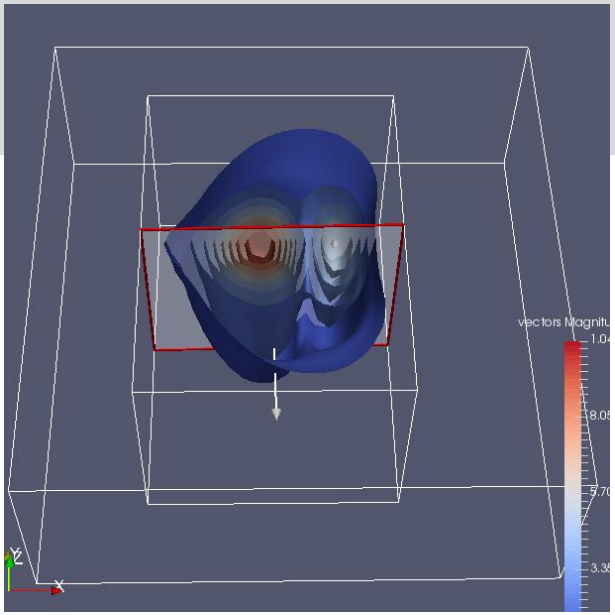


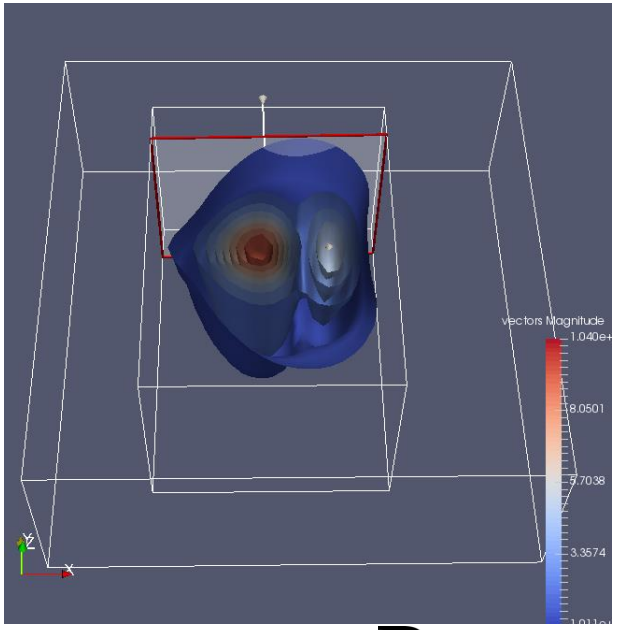
PURDUE
POLYTECHNIC



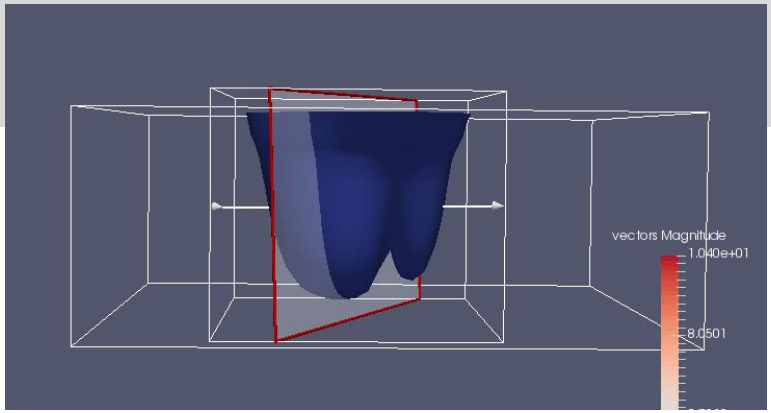


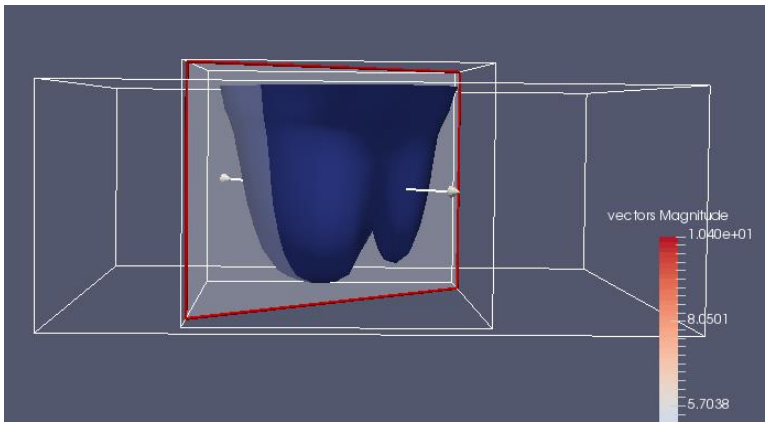


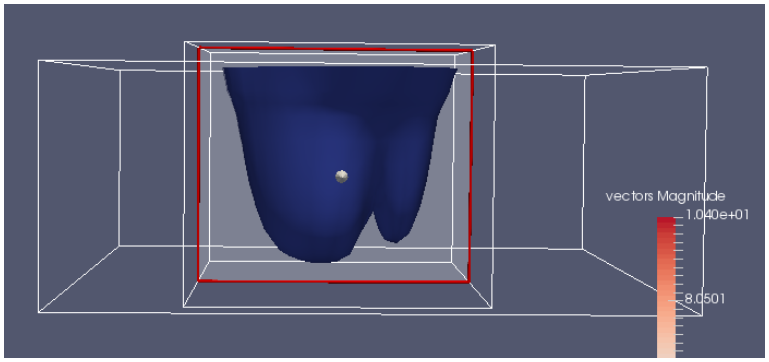


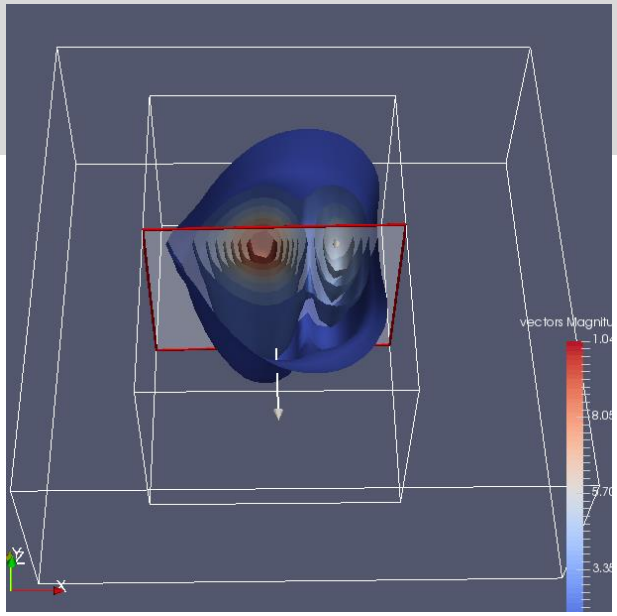


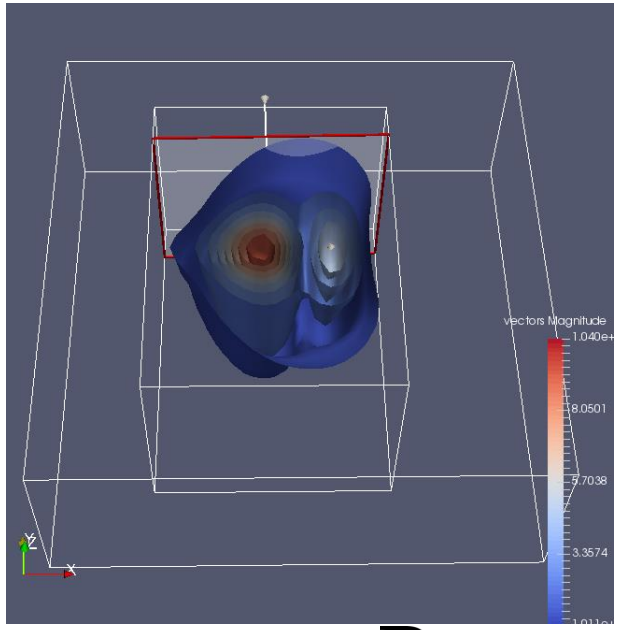
PURDUE
POLYTECHNIC







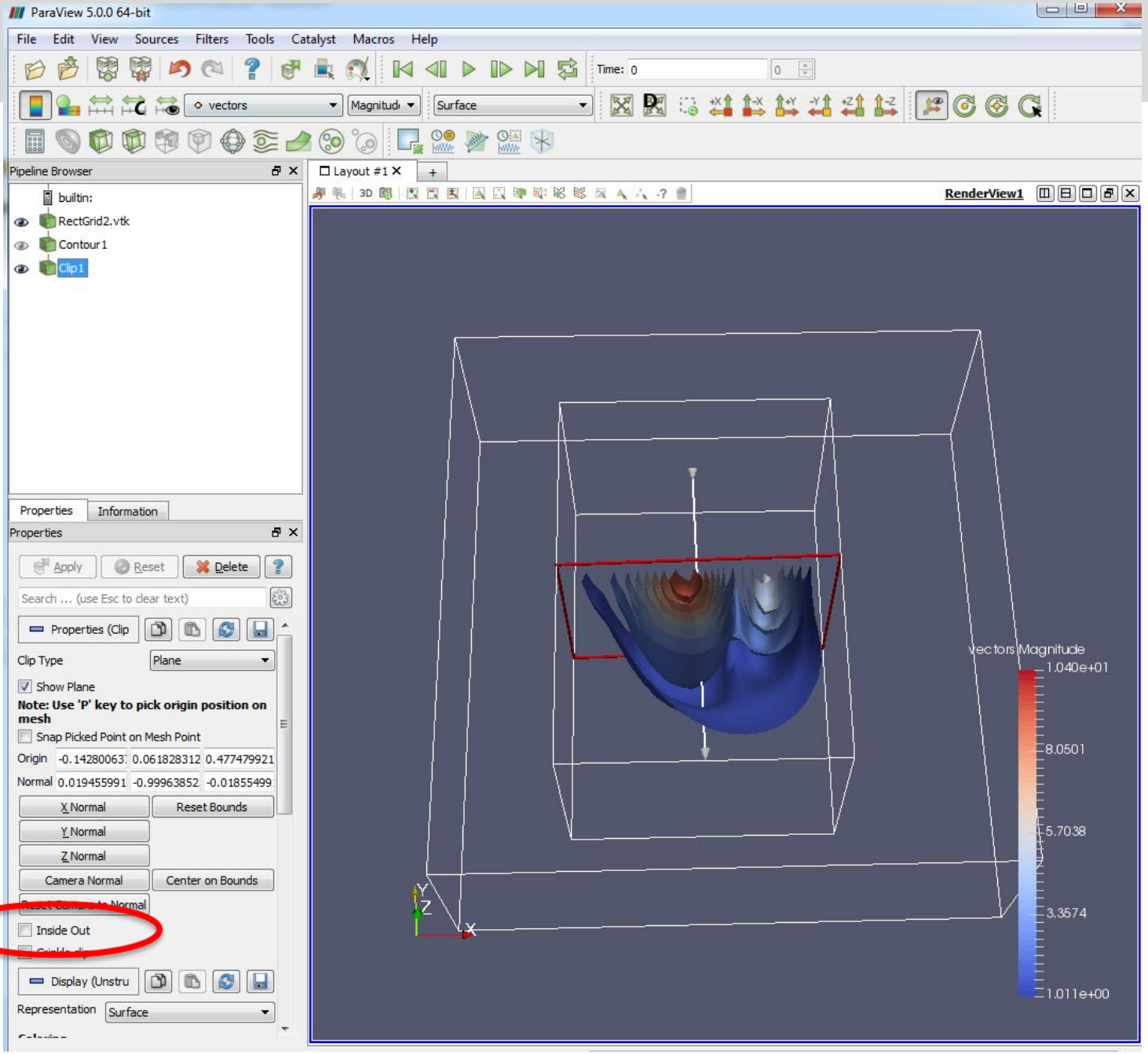




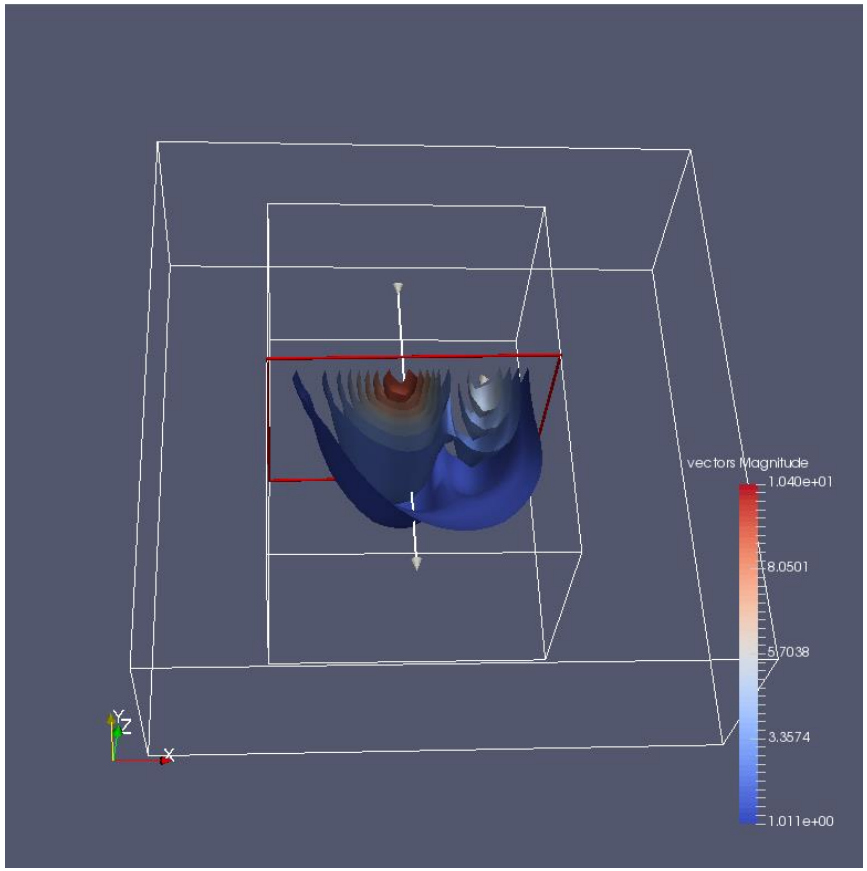
PURDUE
POLYTECHNIC

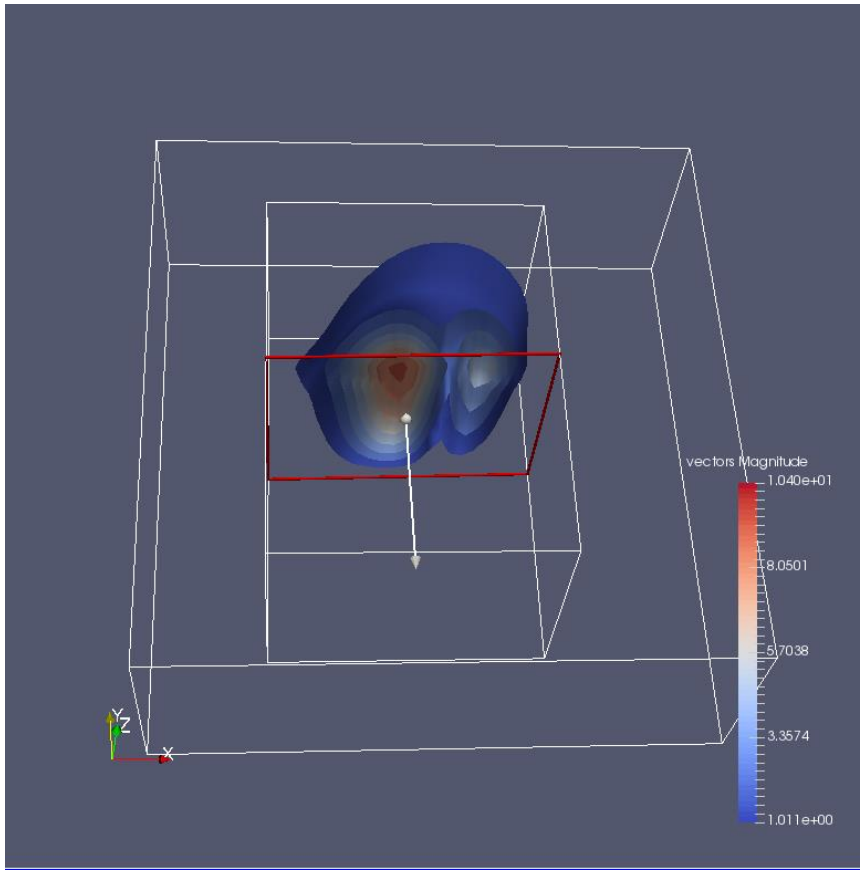
When done: Click **Apply**

- Click the Inside Out box to switch the clipping plane
- Click Apply



INSIDE OUT FEATURE



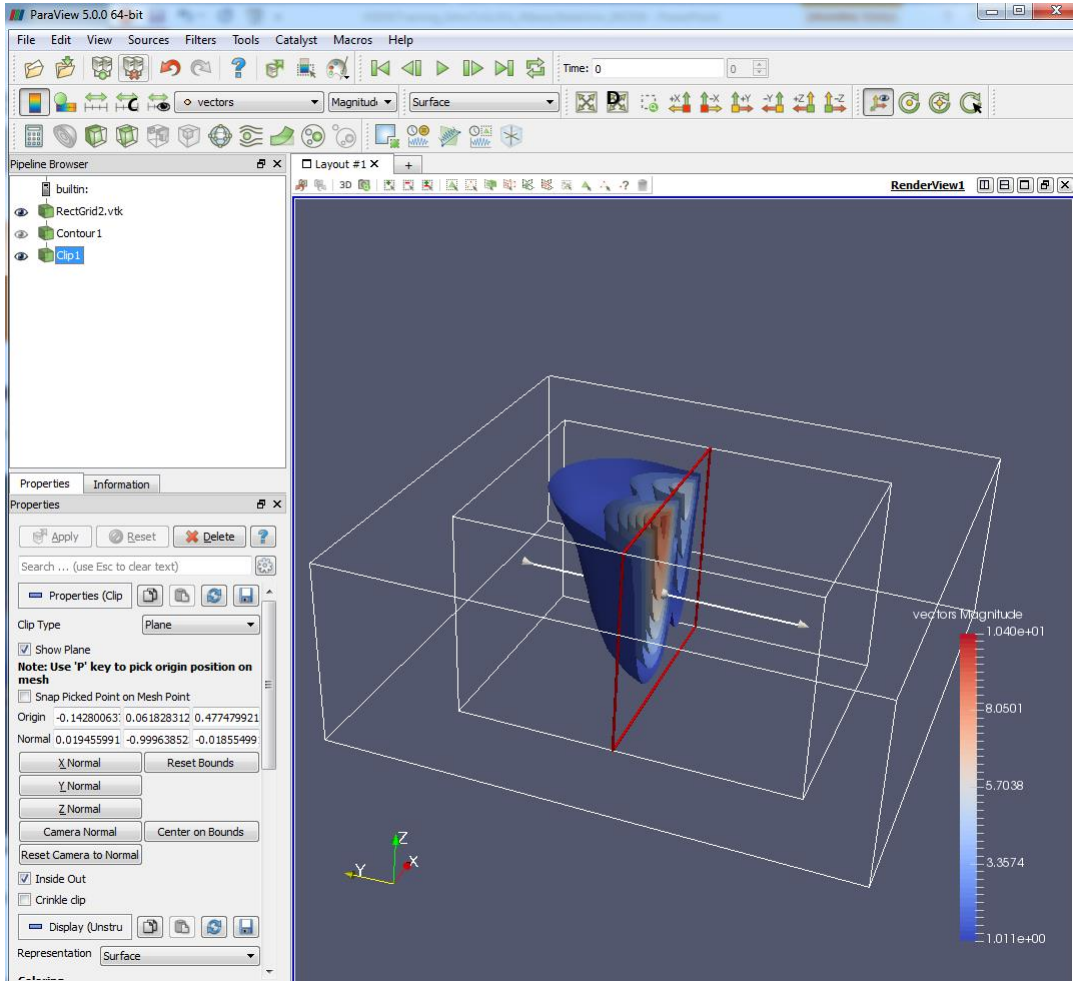


PURDUE
POLYTECHNIC

CLIP ISOSURFACES

SUMMARY OF STEPS

- Click +Y view button
- Click Filters→ Common → Clip
- Position the clipping plane (move arrow point to desired position)
- Click Apply
- Check Inside Out check box to switch the clipping plane view



PURDUE POLYTECHNIC

Slice Isosurfaces

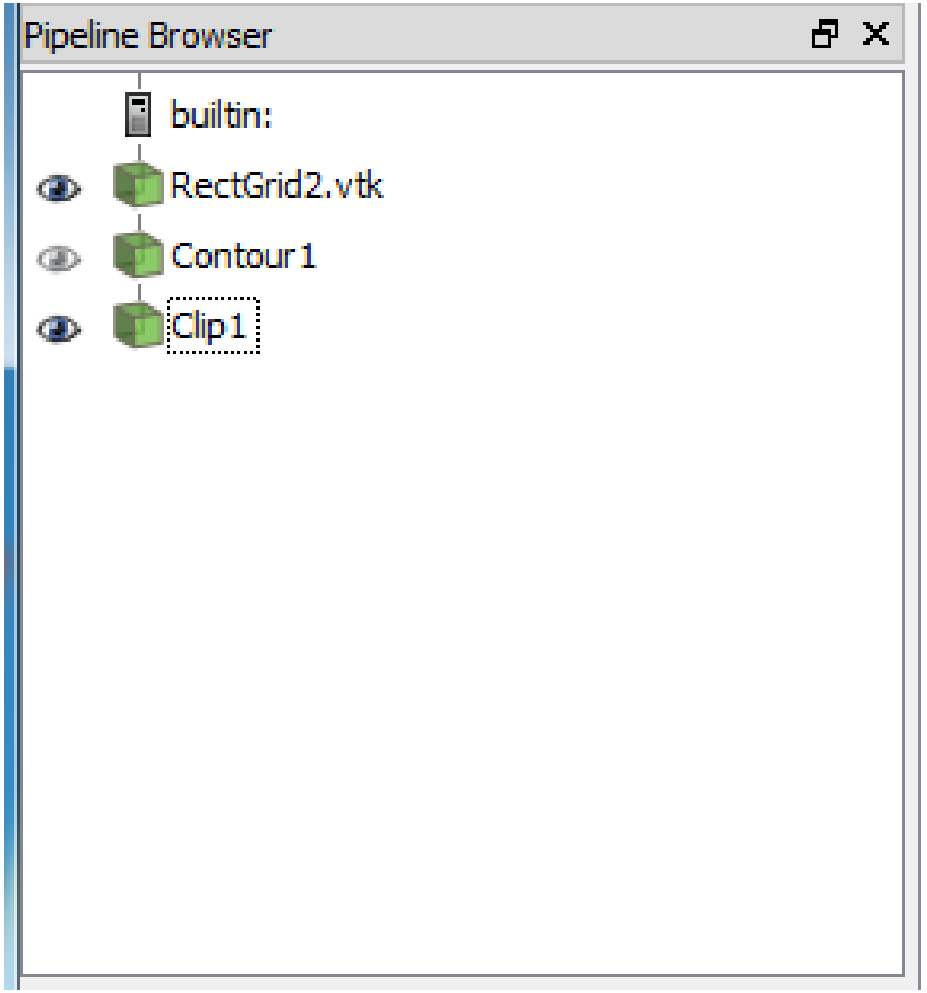
Slice – Intersects the geometry with a plane. The effect is similar to clipping except that all that remains is the geometry where the plane is located.

PURDUE
POLYTECHNIC

- Make visible
  - RectGrid2.vtk
  - Clip1

- To make an object visible click the eye icon to the left of the object

- Contour 1 should **NOT** be visible for the next task

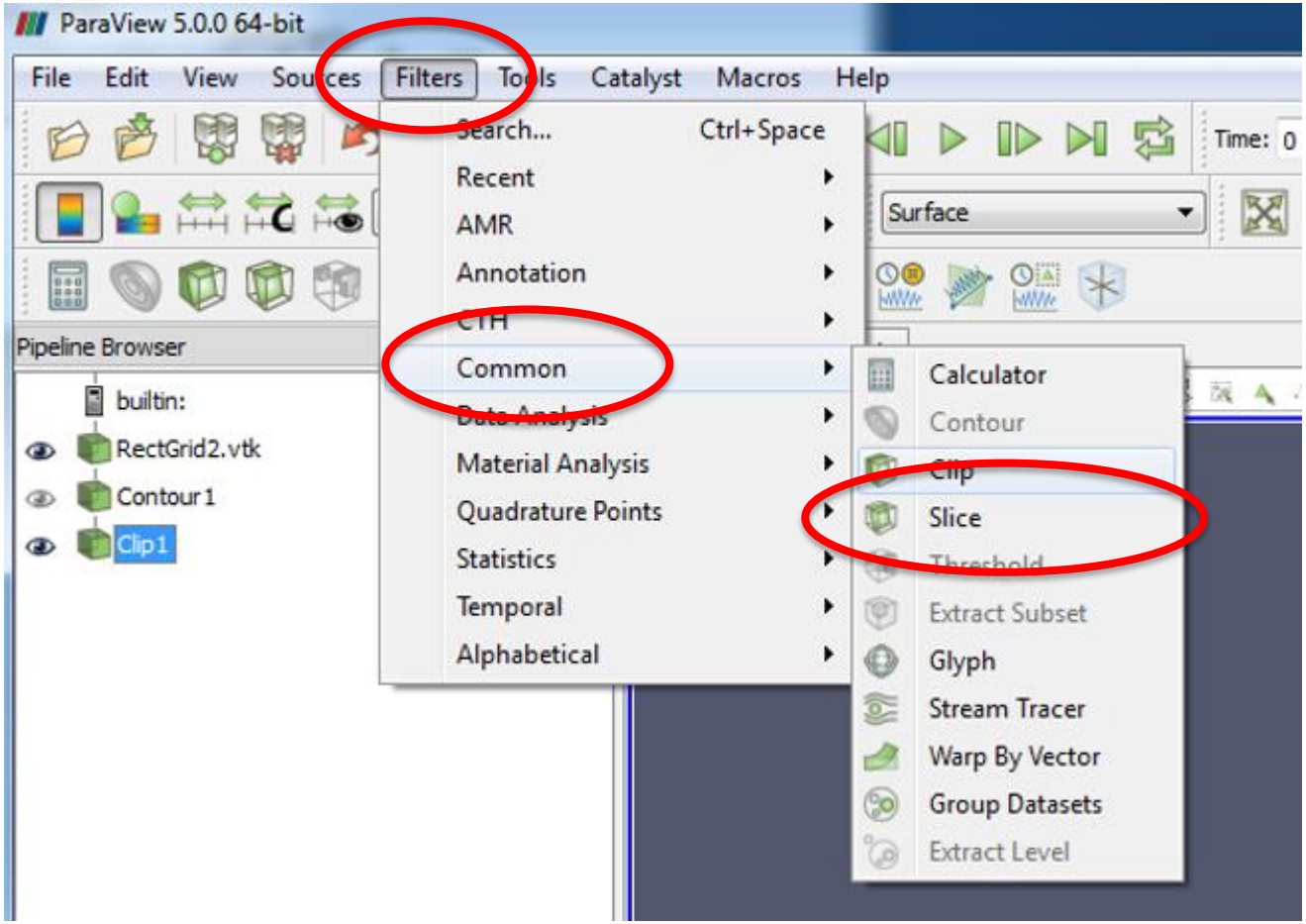


PURDUE
POLYTECHNIC

SLICE ISOSURFACE

Select Clip 1

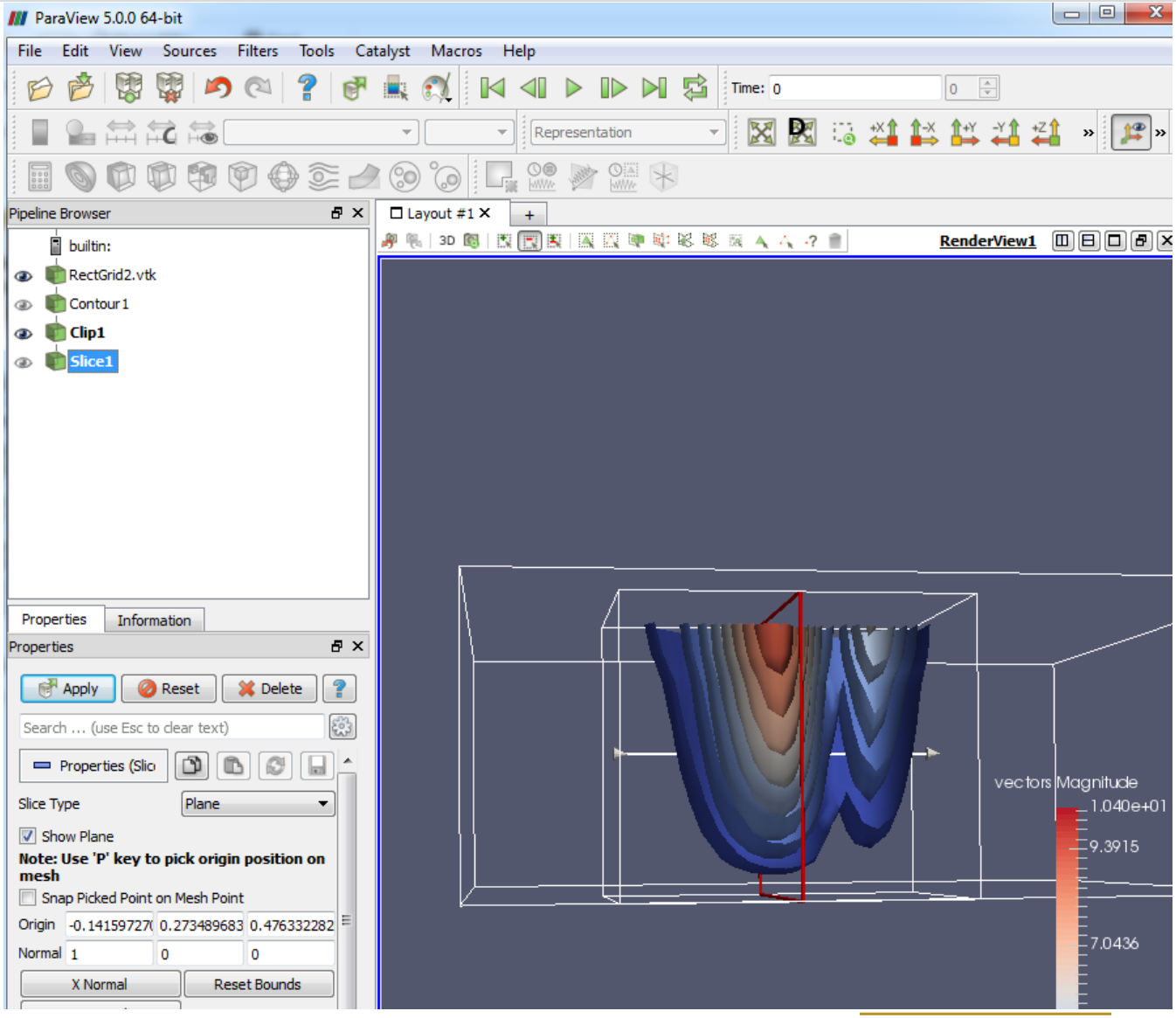
- Filters
- Common
- Slice



PURDUE POLYTECHNIC

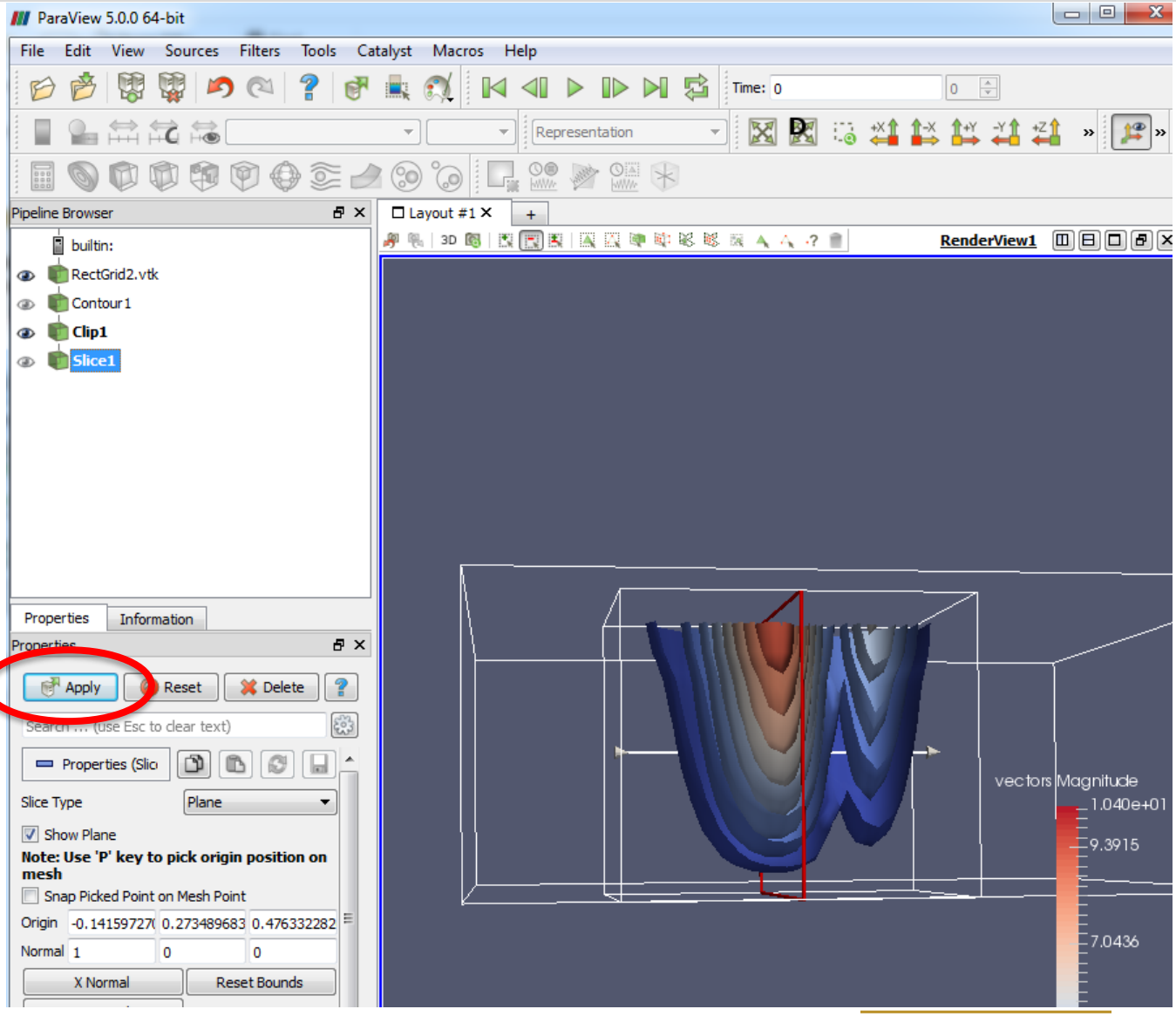
Should see

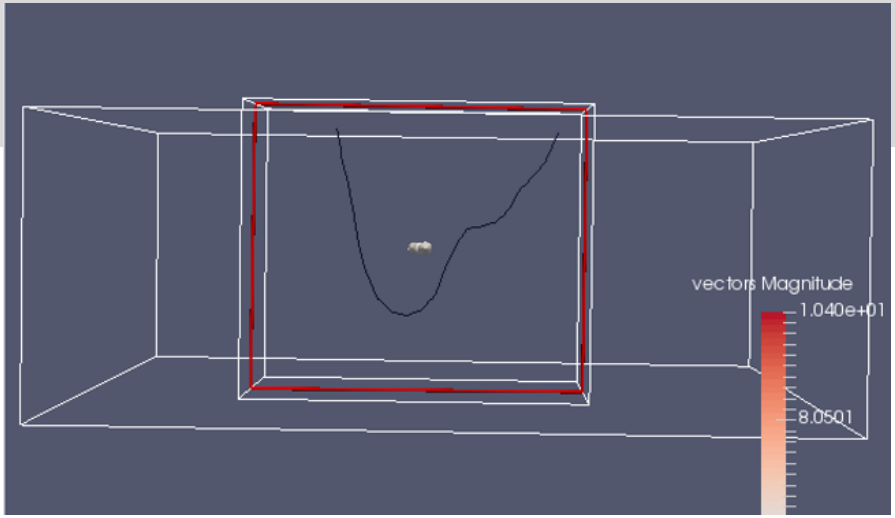
- Slice1 object in Pipeline Browser
- Slicing Plane with arrow in 3D window

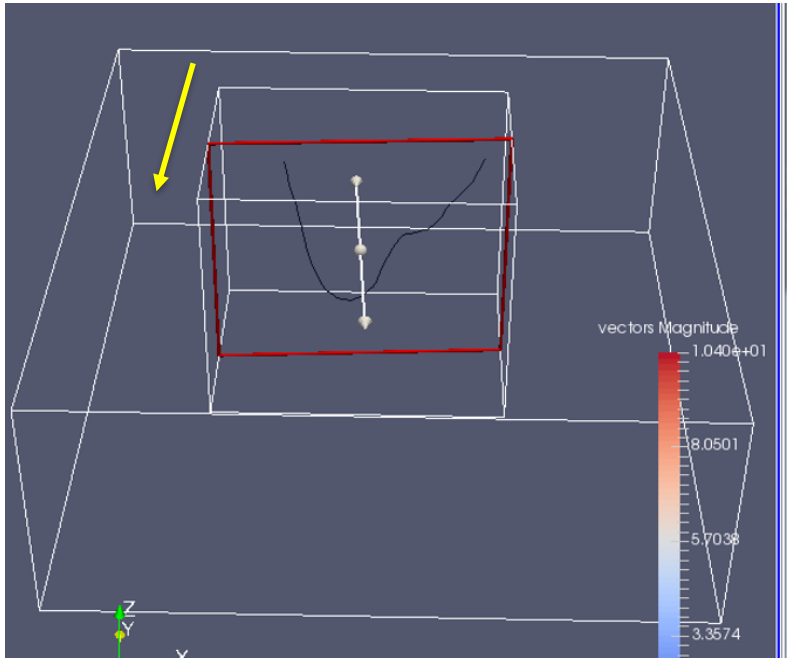


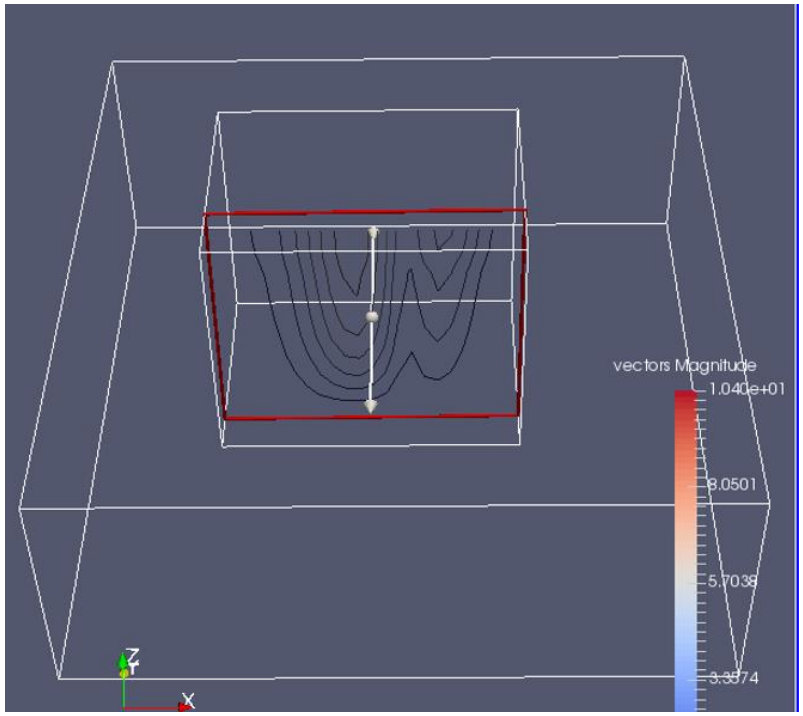
Position the slicing plane (move arrow point to desired position)

Click **Apply**









You can move the slicing plane along the axis to see a different slice

Click **Apply** to see changes

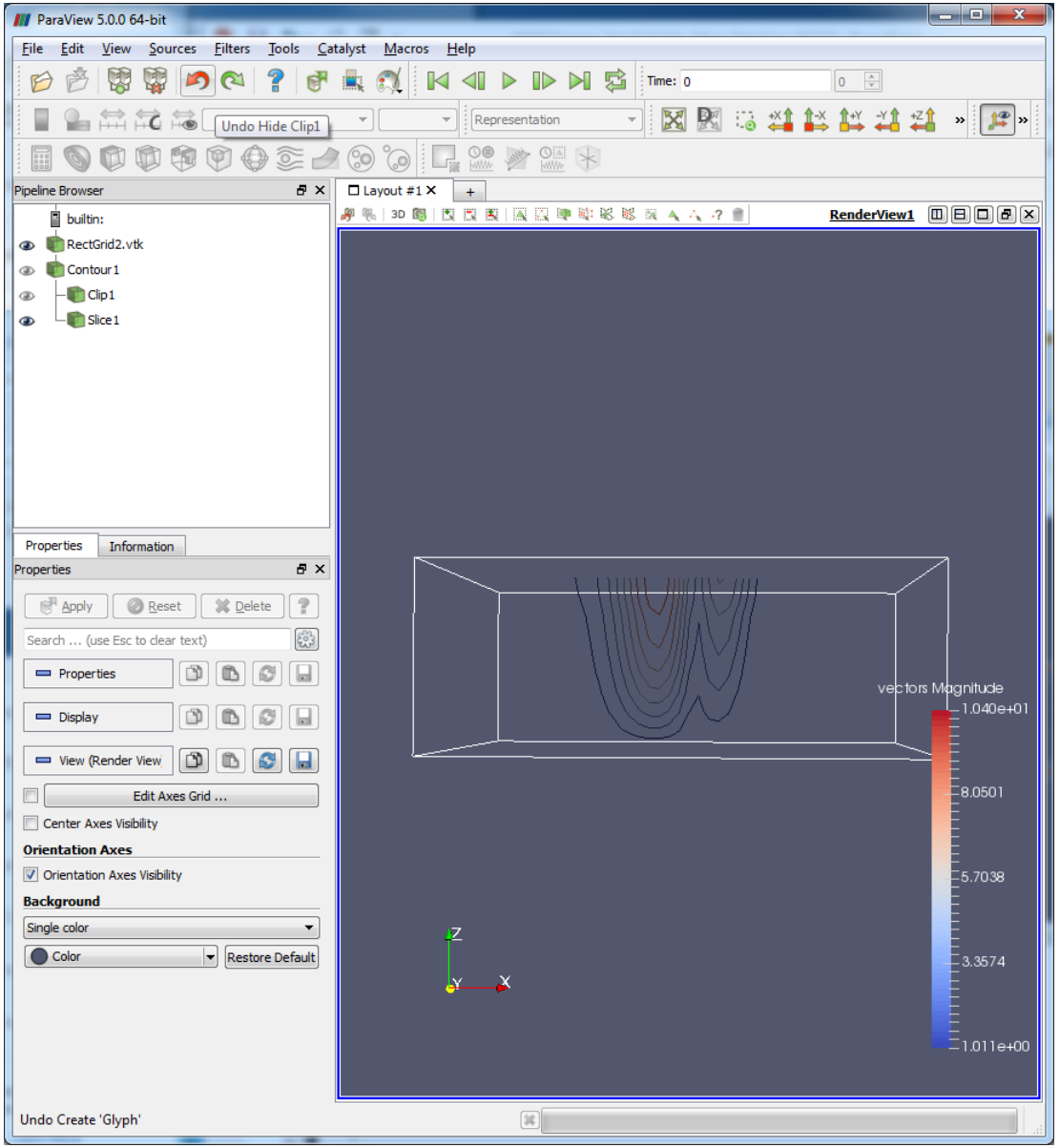
PURDUE
POLYTECHNIC

SLICE ISOSURFACE

SUMMARY OF STEPS

- Select **Clip1** Object
- Select **Filter**
- Select **Common**
- Select **Slice**
- Position Slicing Plane
- Click **Apply**

Slice - Intersects the geometry with a plane. The effect is similar to clipping except that all that remains is the geometry where the plane is located



What have we done?

Recall Three Basic Steps:

- First your data must be **read** into ParaView
- Next, you may apply any number of **filter**s that process the data to generate, extract, or derive features from the data
- Finally, a viewable image is **render**ed from the data

Opened simple data file **RectGrid2.vtk**

Applied filters:

Contour, Slice, Clip

PURDUE POLYTECHNIC

Let's try a more complex data set

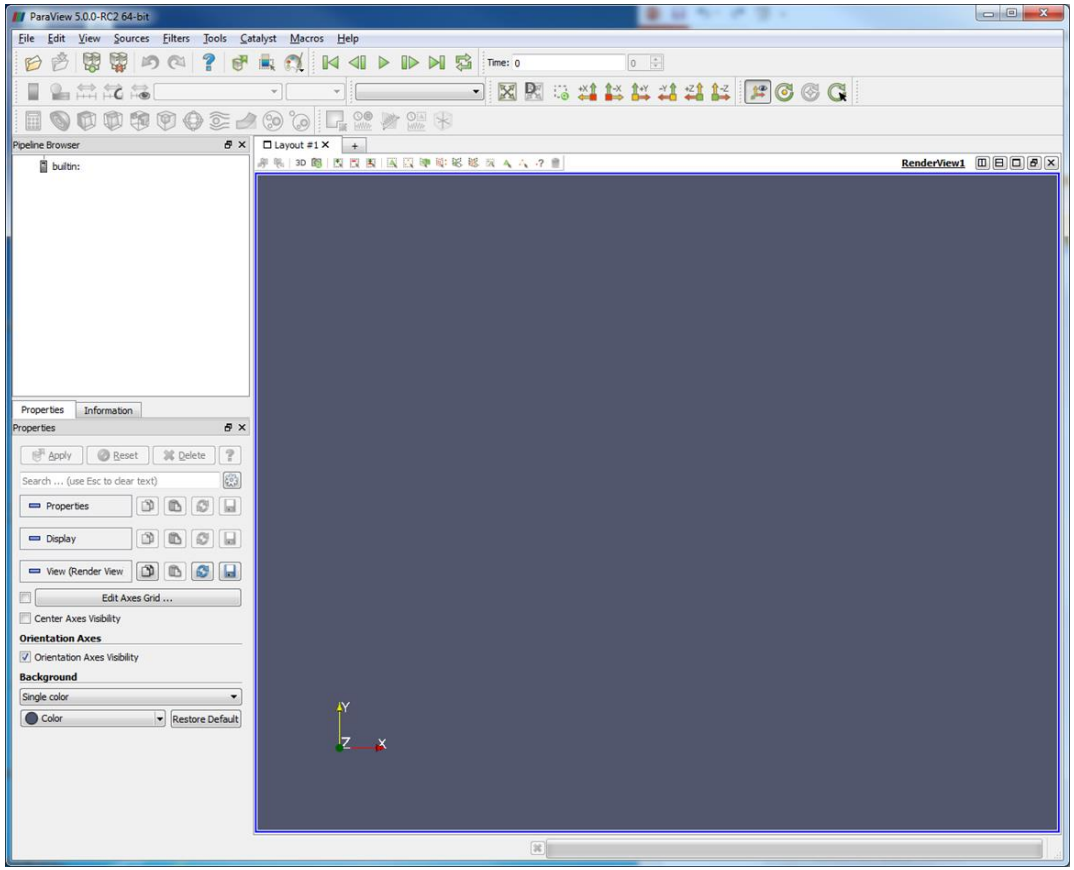
headsq.vti

PURDUE
POLYTECHNIC

In preparation for the next section

- Delete all objects in the Pipeline Browser
- Select an object in the Pipeline Browser
- Click the Delete button (or right click, then Delete)
- To select multiple objects press and hold the CTRL key while selecting objects

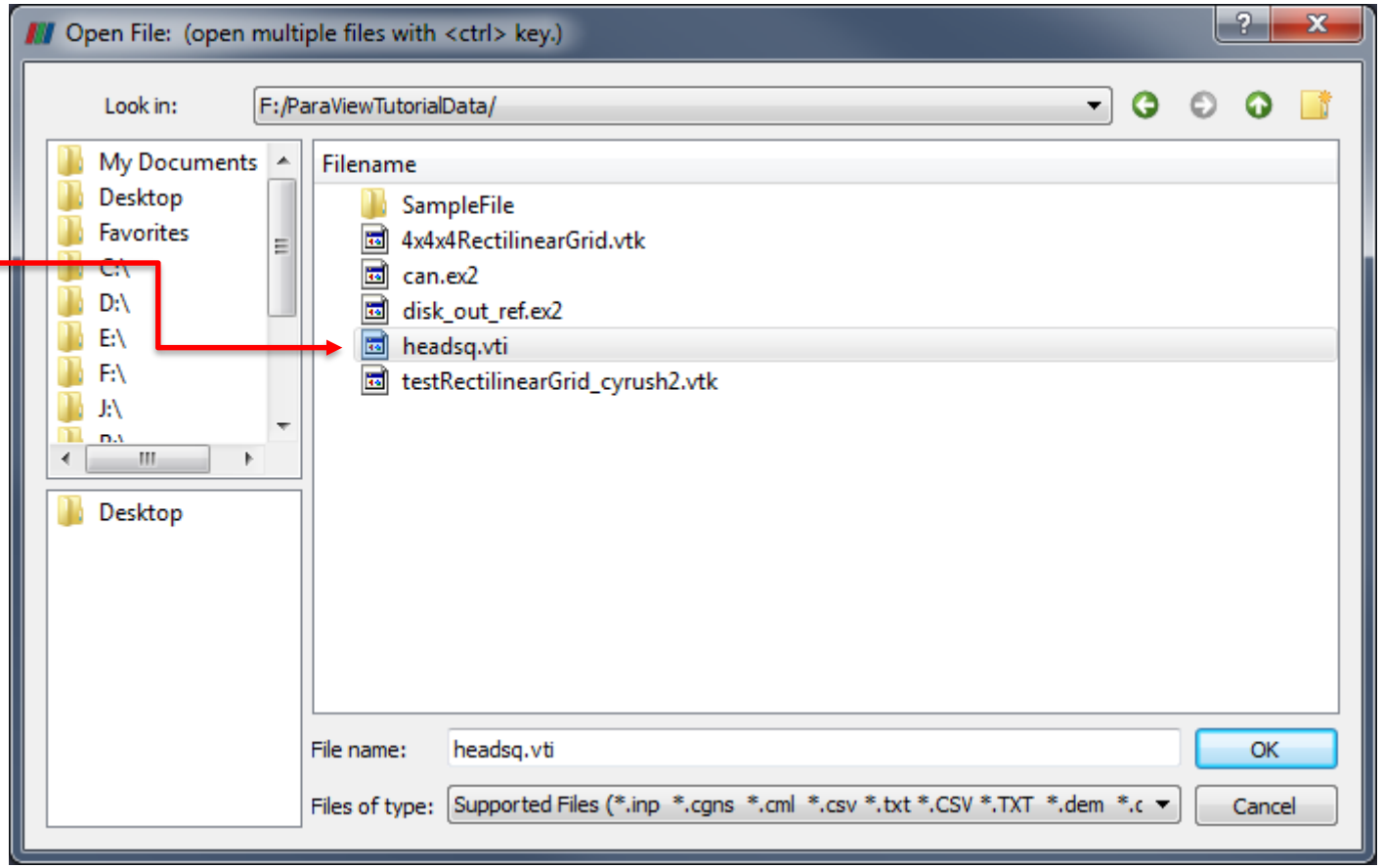
You should be here



PURDUE POLYTECHNIC

Locate File: headsq.vti

File
Open
headsq.vti

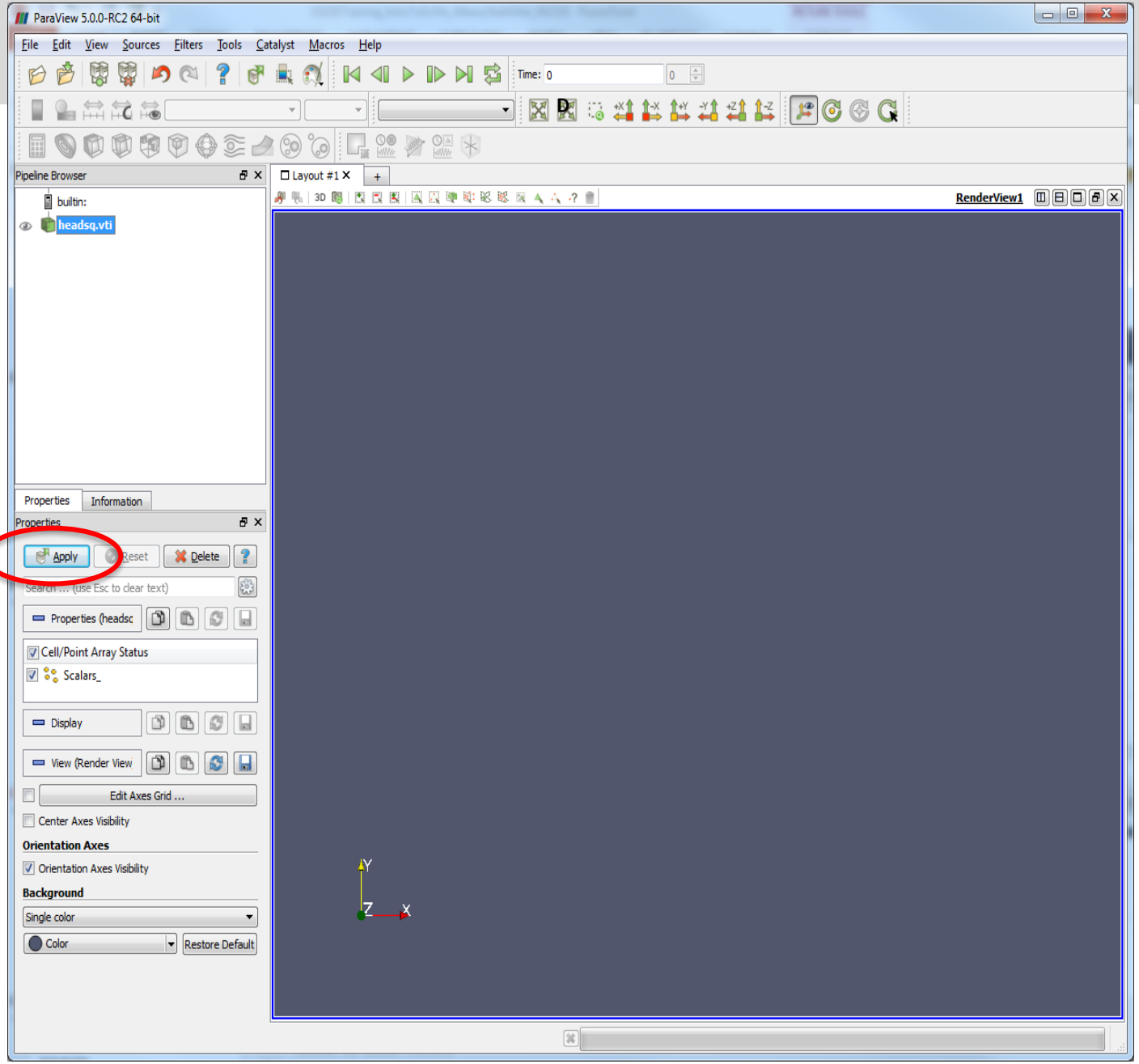


PURDUE POLYTECHNIC

ParaView

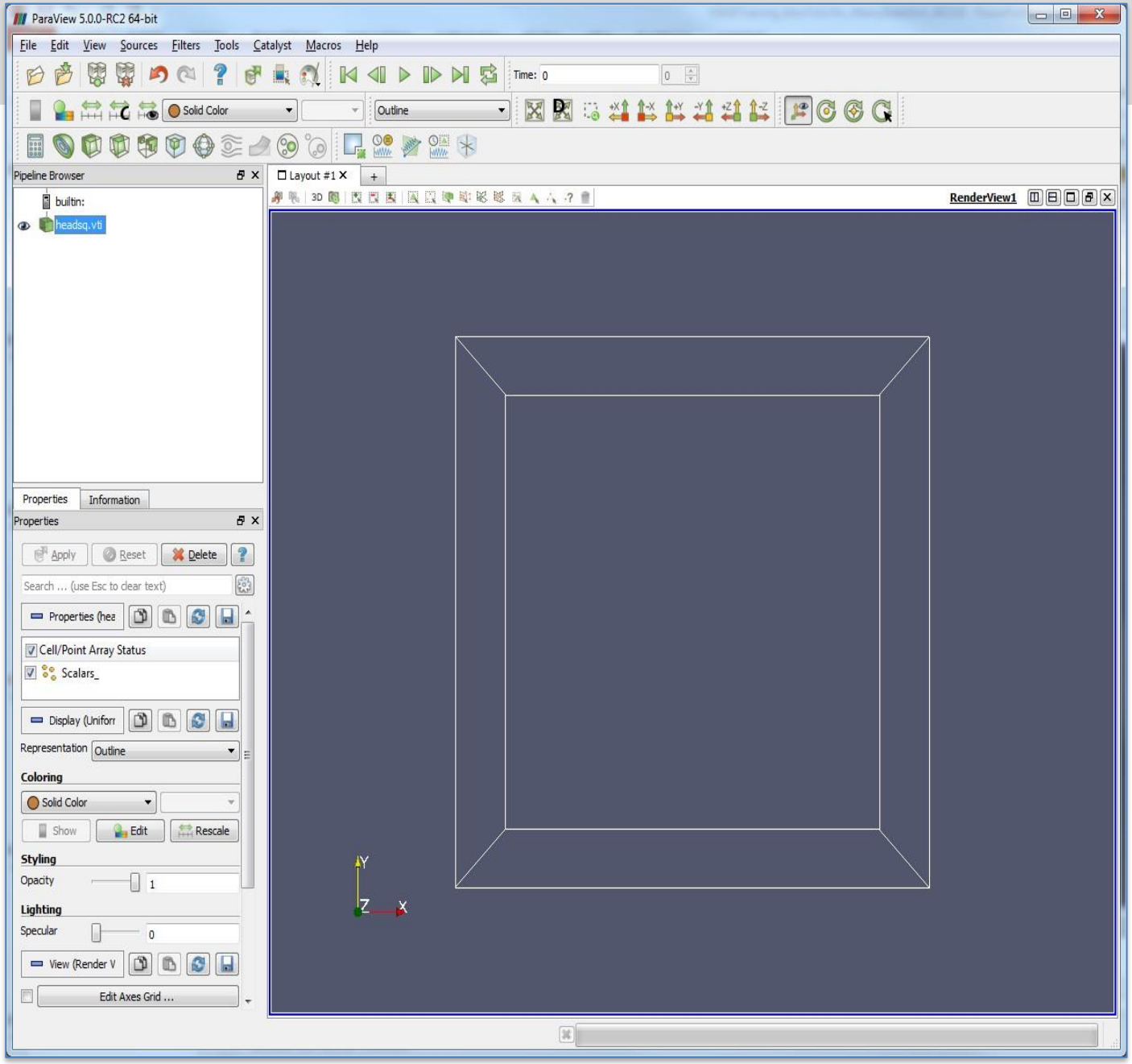
- New Object in Pipeline Browser

- Click **Apply**



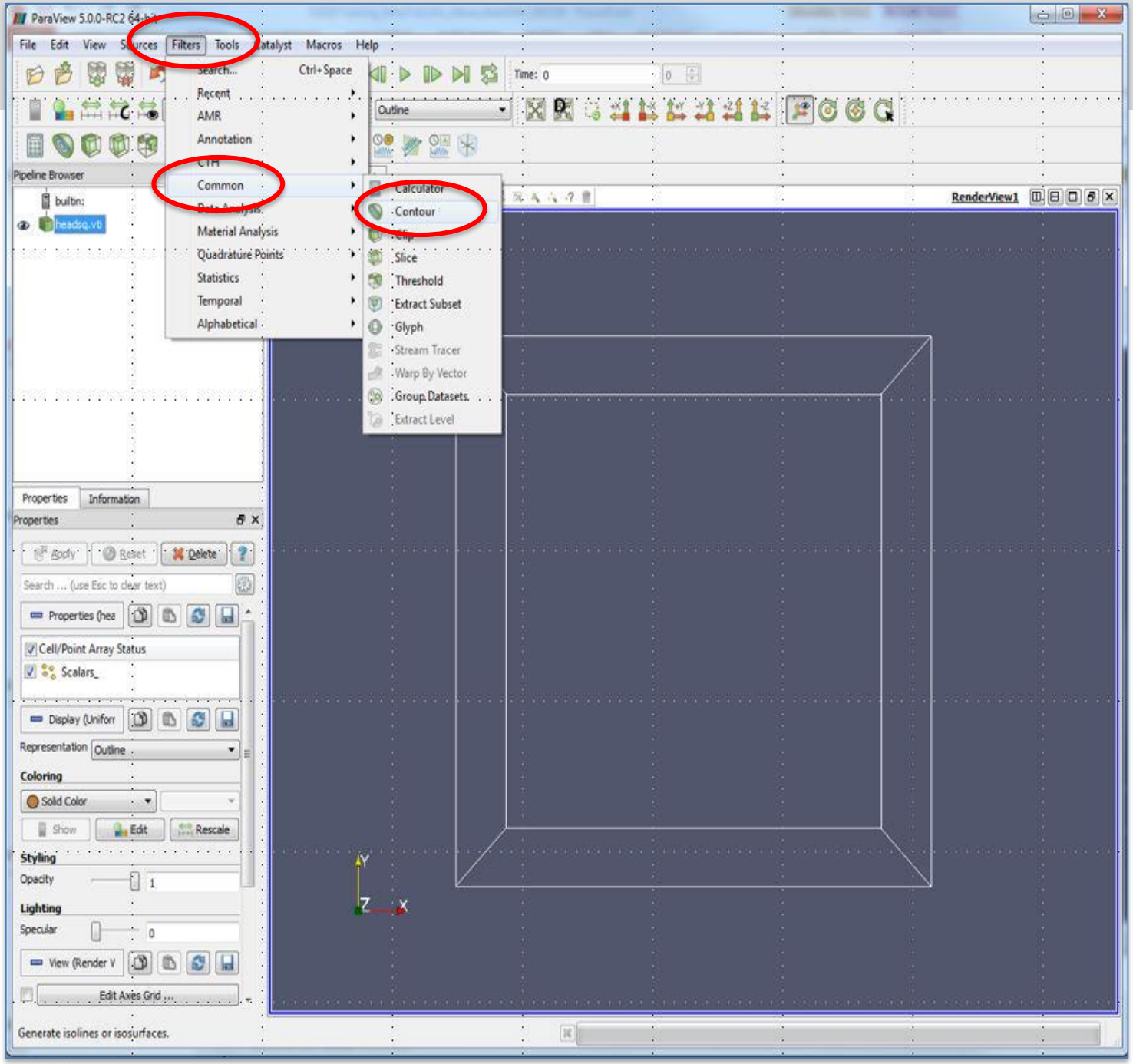
ParaView

- **Should see** a bounding box in the 3D viewer window



Create an Isosurface

Select:
→ Filters
→ Common
→ Contour

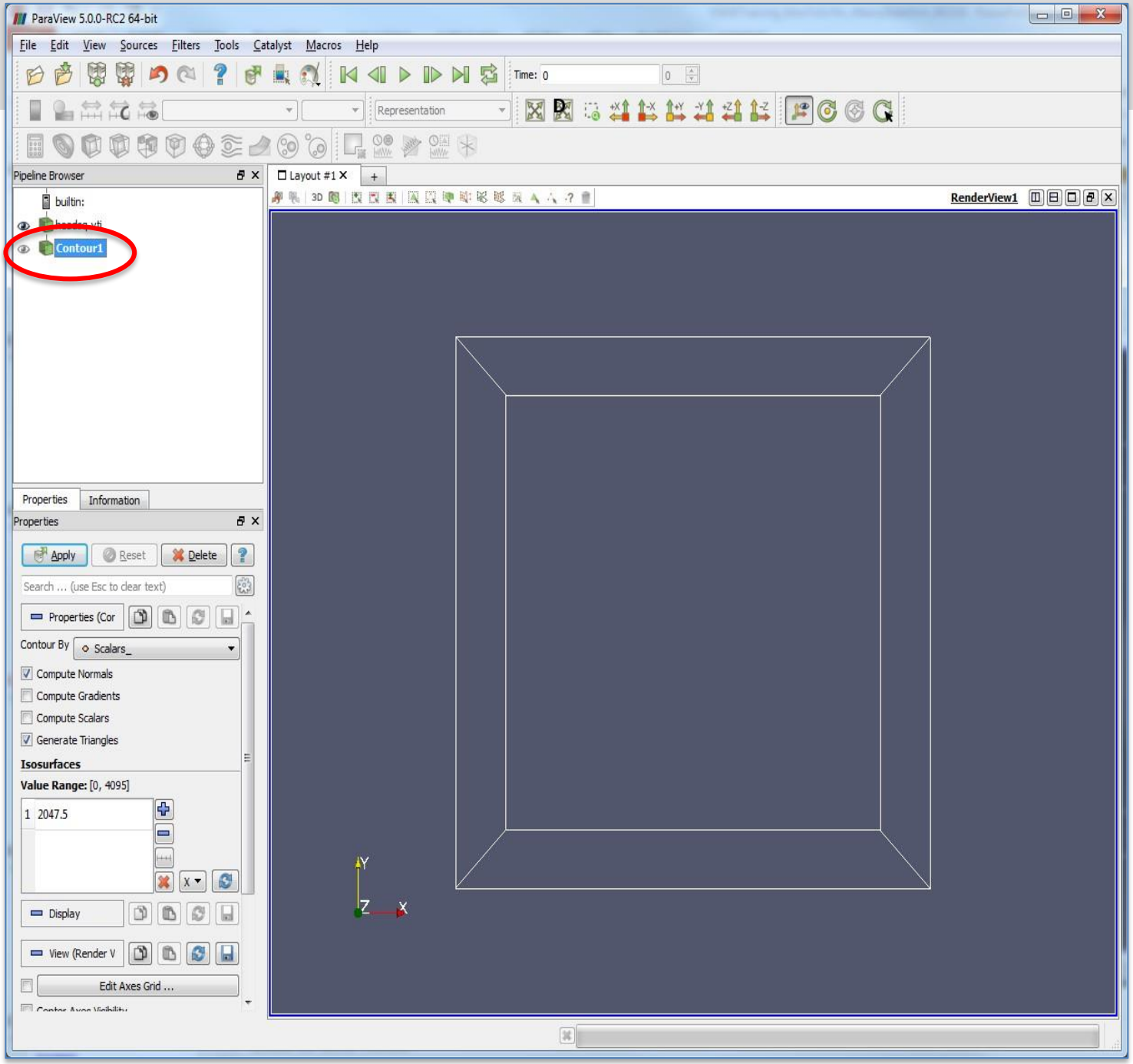


ParaView

- A new object appeared in the pipeline browser (Contour 1)

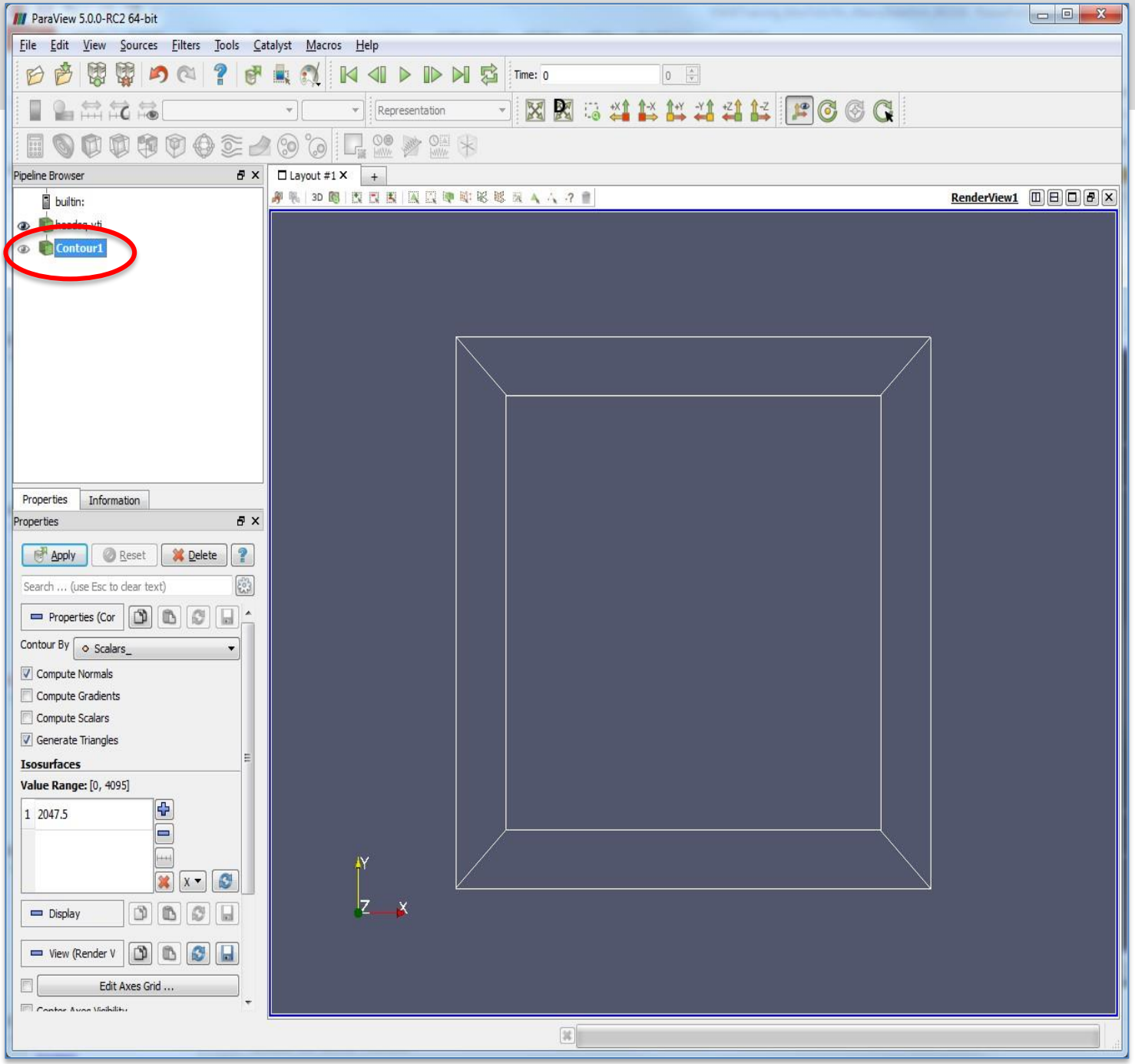
Contour – Extracts the points, curves, or surfaces where a scalar field is equal to a user-defined value.

The surface is often also called an ***isosurface***.



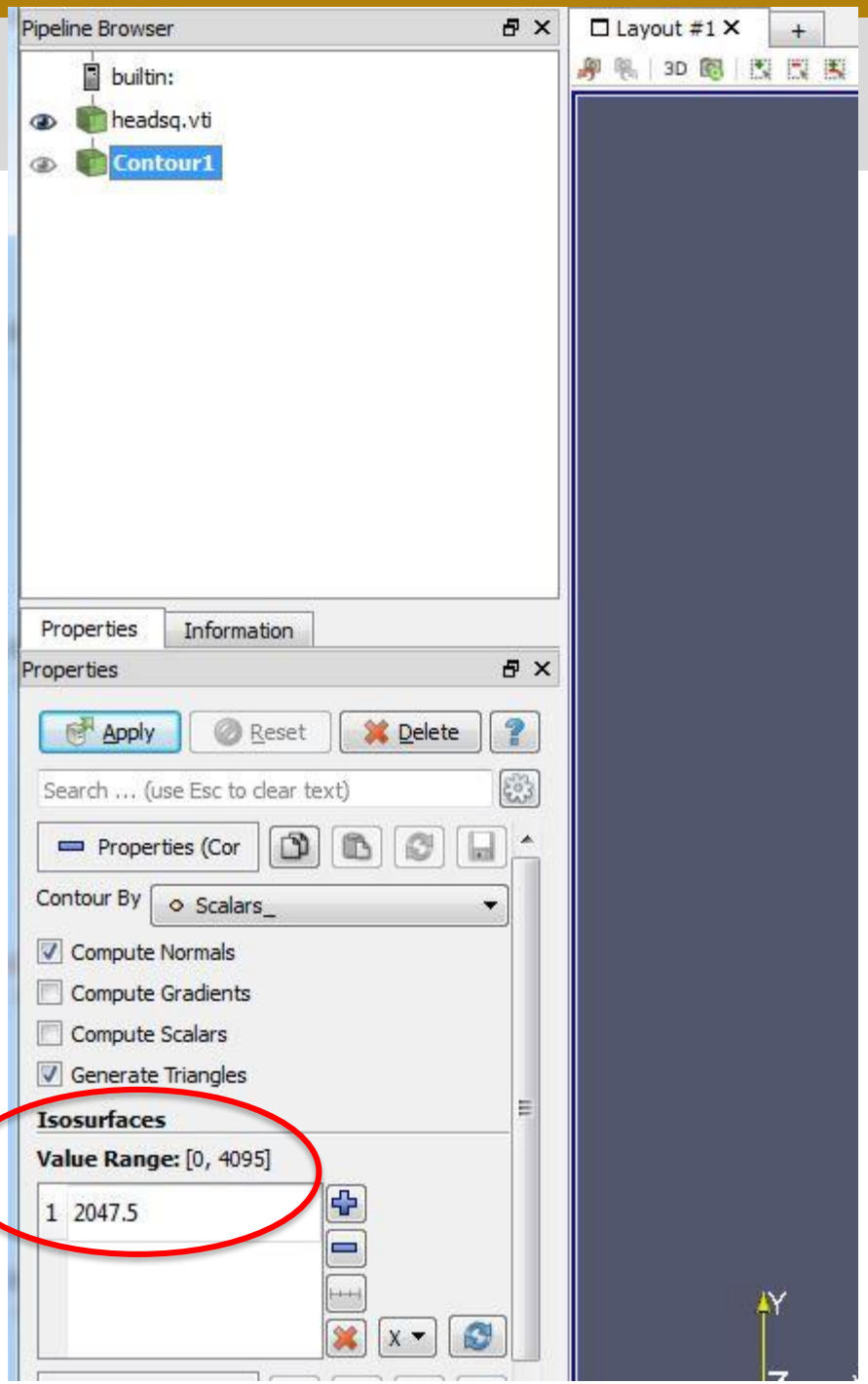
ParaView

- Value Range for the data set is now visible



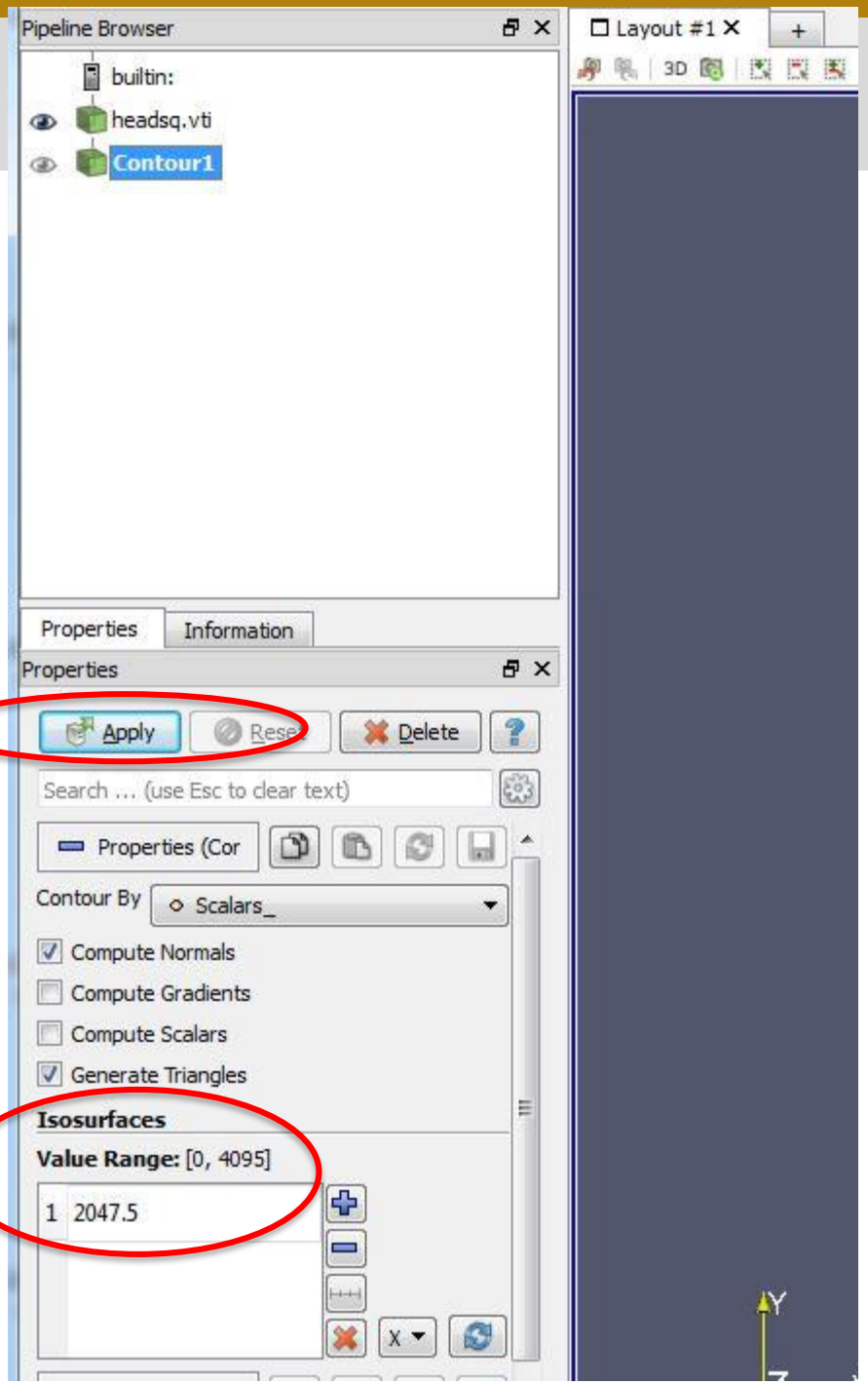
ParaView

- Value Range for the data set is [0, 4095]
- Only one value is showing: 2047.5



ParaView

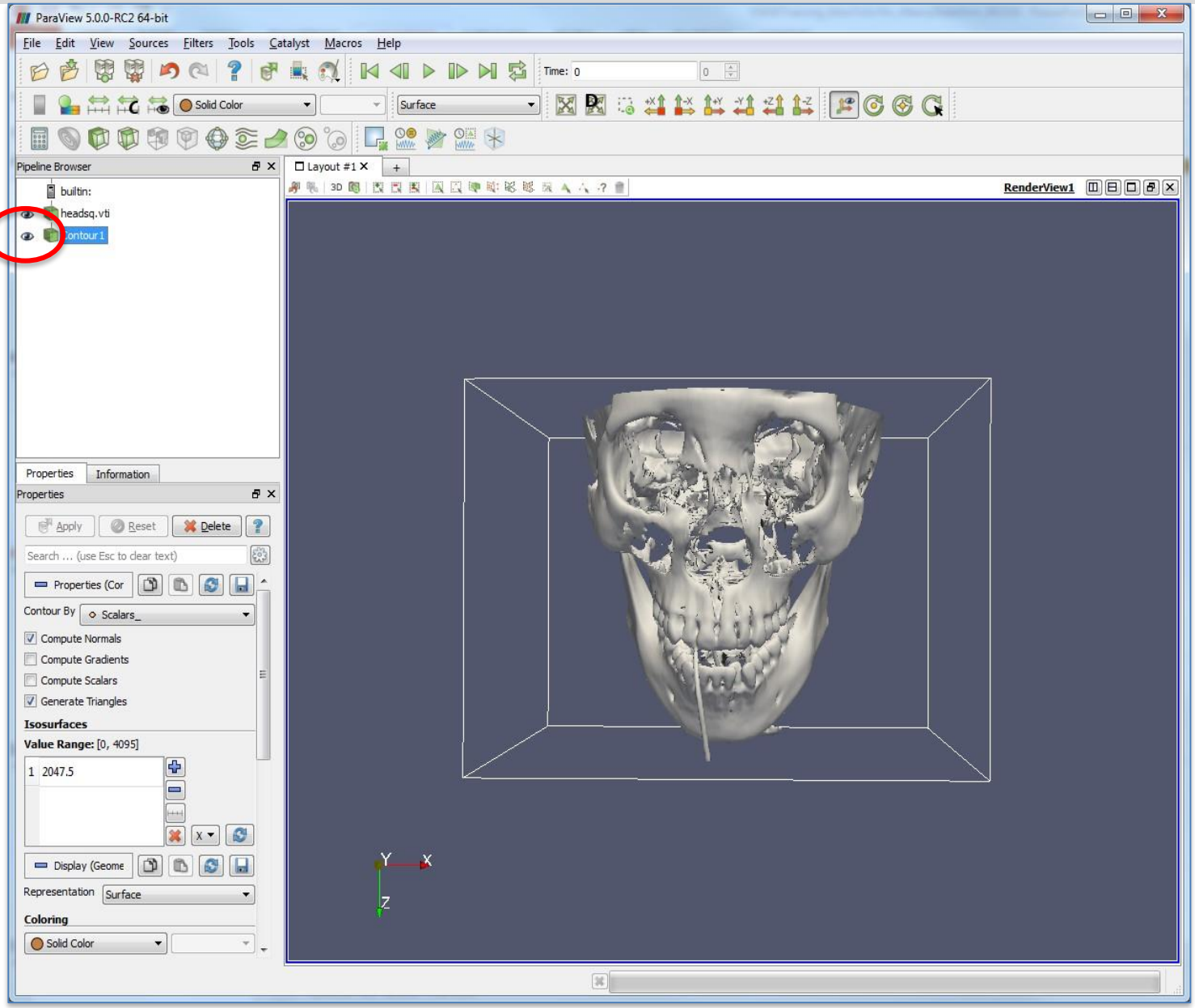
- Value Range for the data set is [0, 4095]
- Only one value is showing: 2047.5
- Click **Apply** to see what points, curves, or surfaces in the dataset have a value of 2047.5



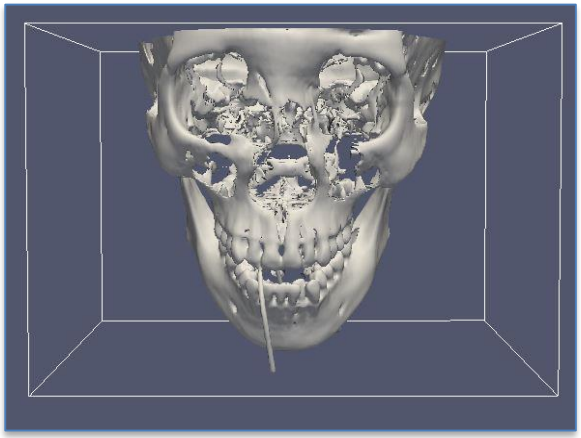
ParaView

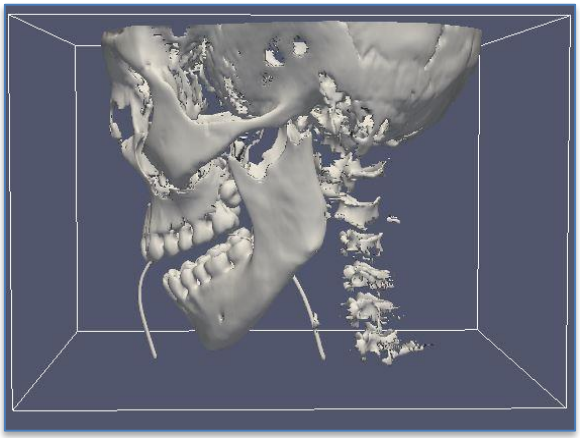
- If you do not see anything in the 3D window click the eye icon next to Contour1 in the Pipeline Browser

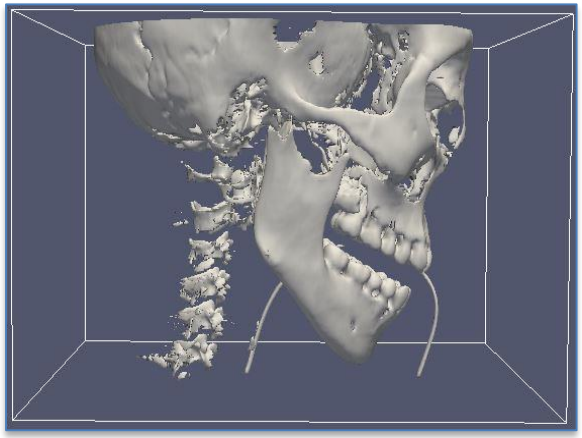
- This allows you to toggle between views in the 3D Viewer

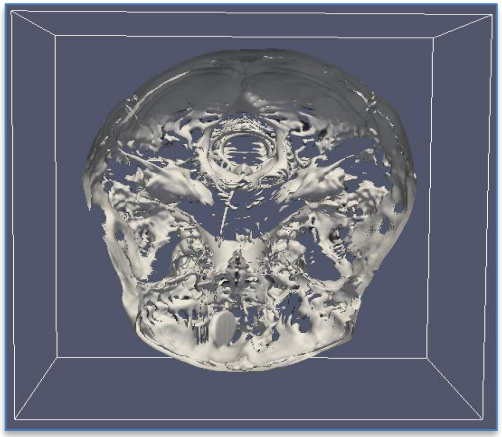


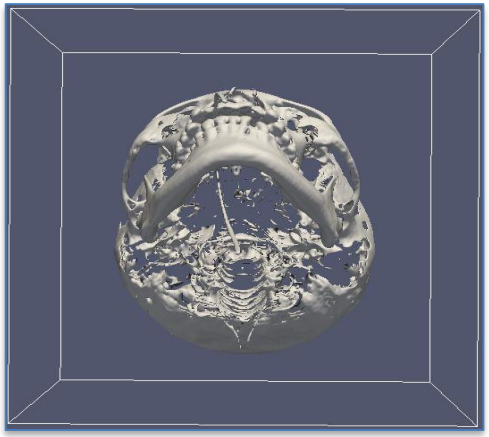
Visually Explore Dataset





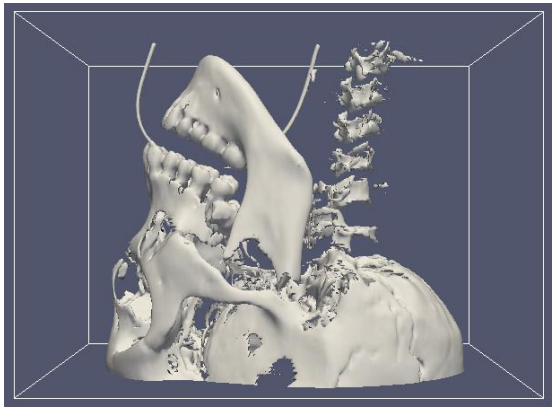






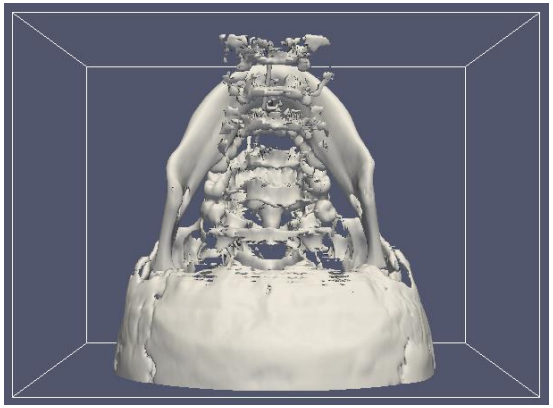
PURDUE
POLYTECHNIC

Visually Explore Dataset



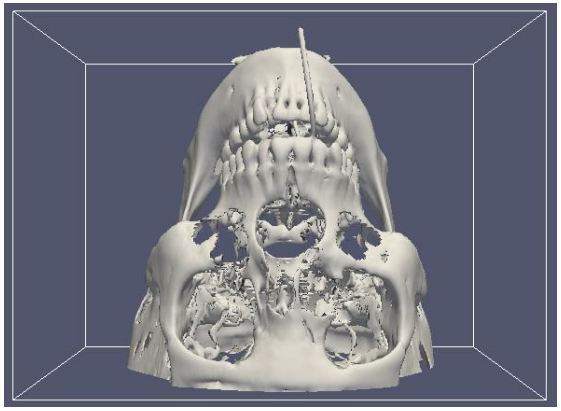
+X

-X

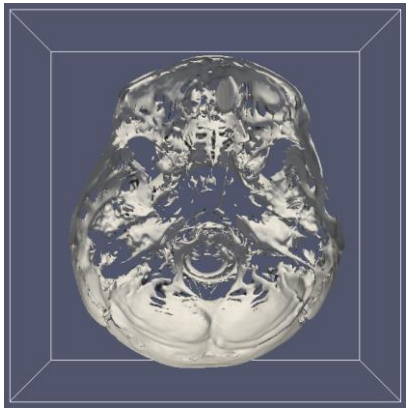


+Y

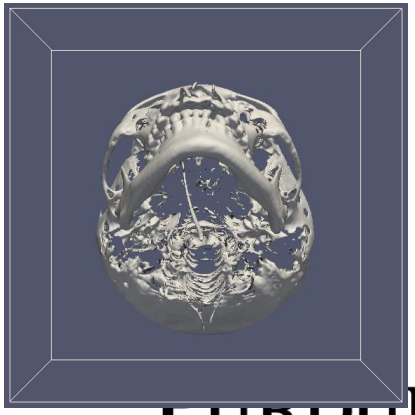
-Y



+Z



- Z

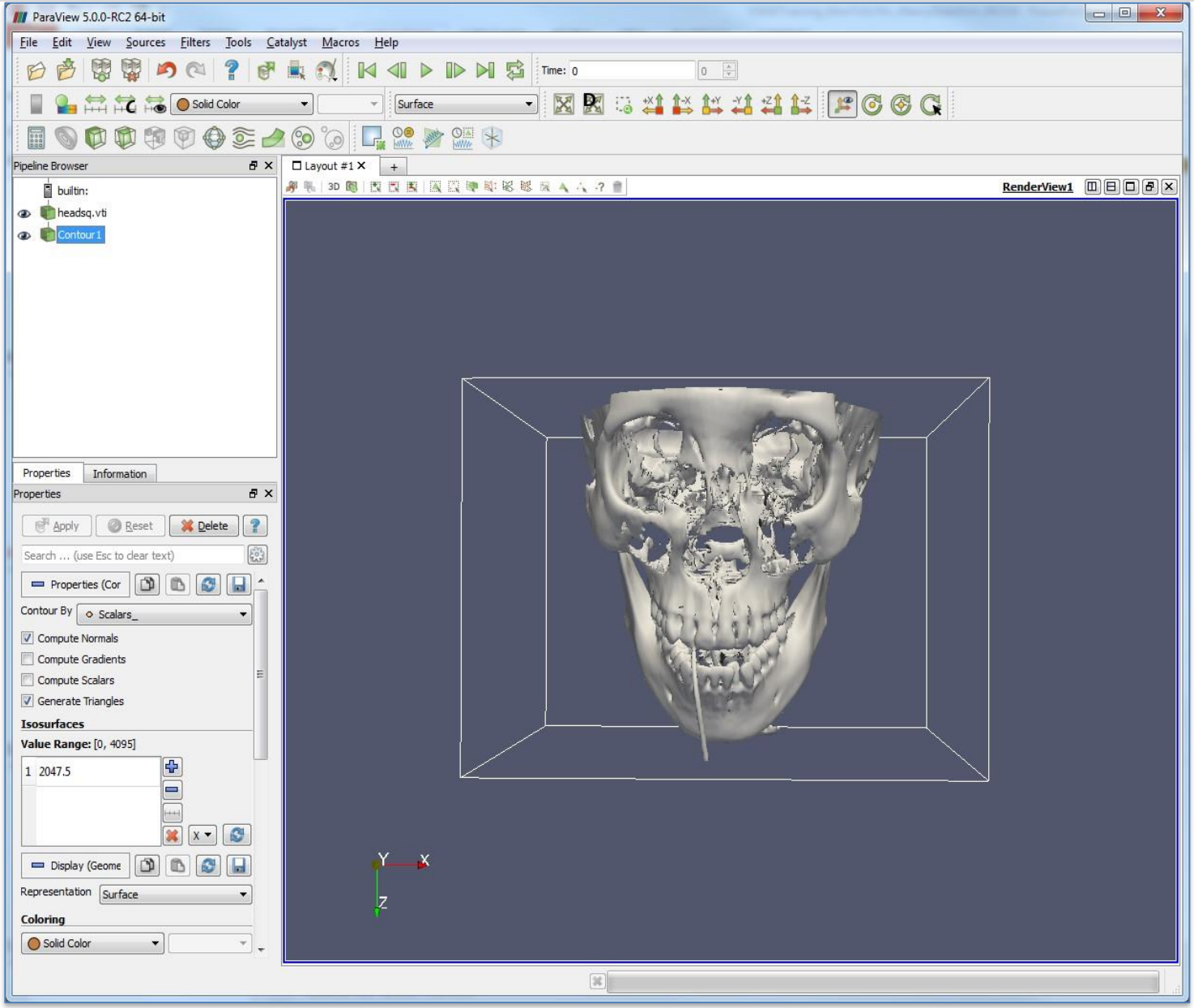


PURDUE
POLYTECHNIC

ParaView

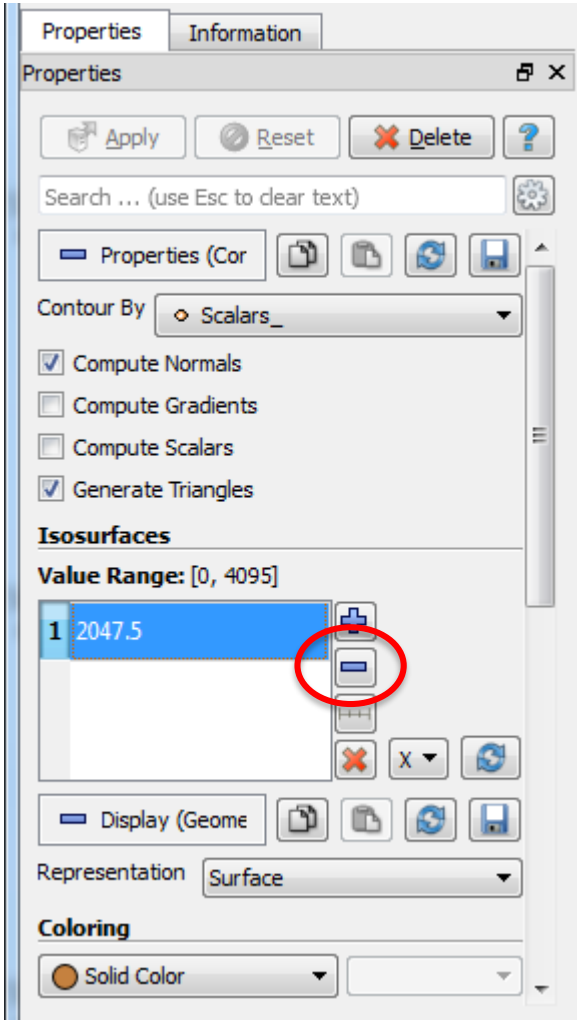
You should be here

Pipeline Browser
→ Two objects
→ Value Range
[0, 4095]



Isosurfaces

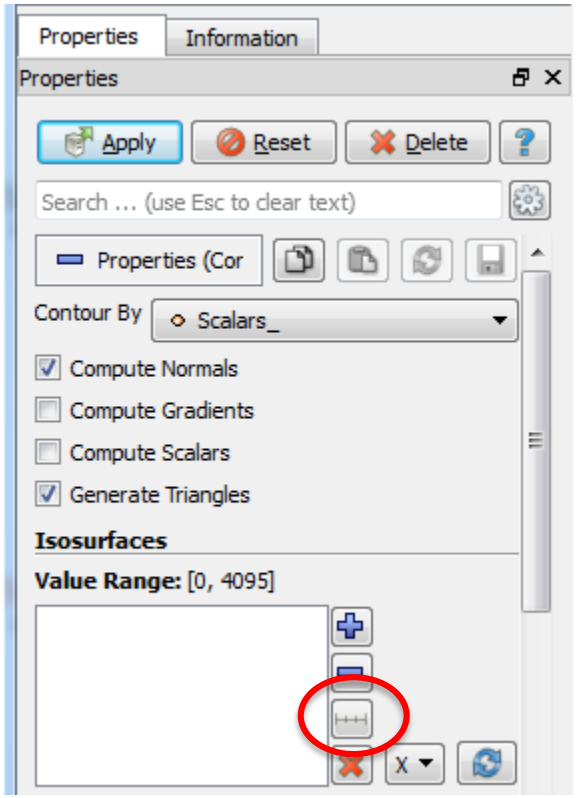
- Select 2047.5 showing in Value Range
- Delete that value (click the minus button to remove all values)



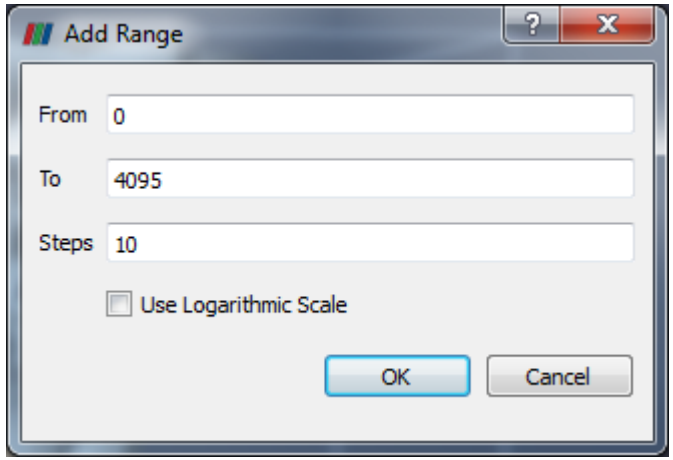
PURDUE POLYTECHNIC

Isosurfaces

- Click the button below the minus button to: **Add a Range Of Values**

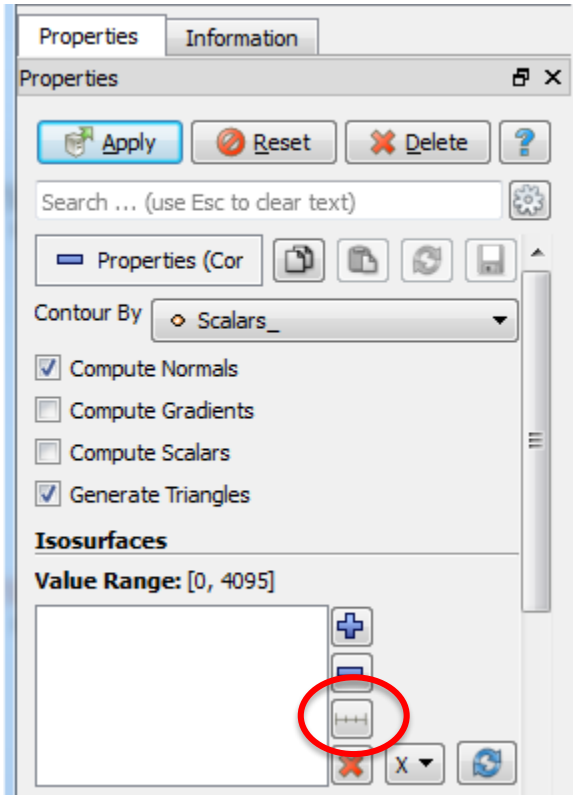


- Should see the Add Range Window
  - Use this window to set the range of values
  - For this tutorial
    - Min: 0
    - Max: 4095
  - Feel free to pay around with the range (between 0 and 4905)

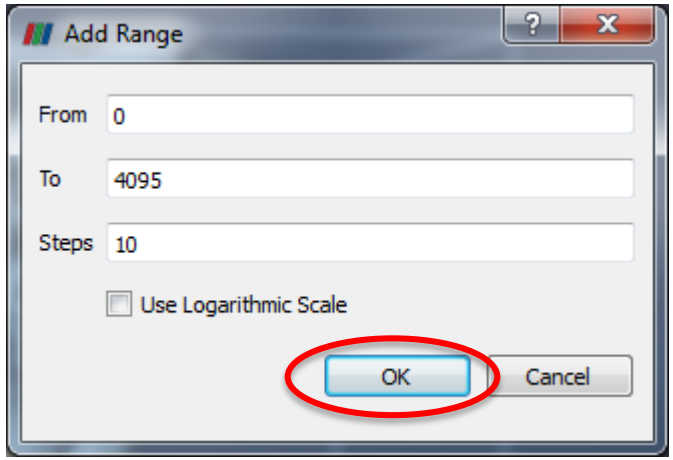


Isosurfaces

- Click the button below the minus button to: **Add a Range Of Values**

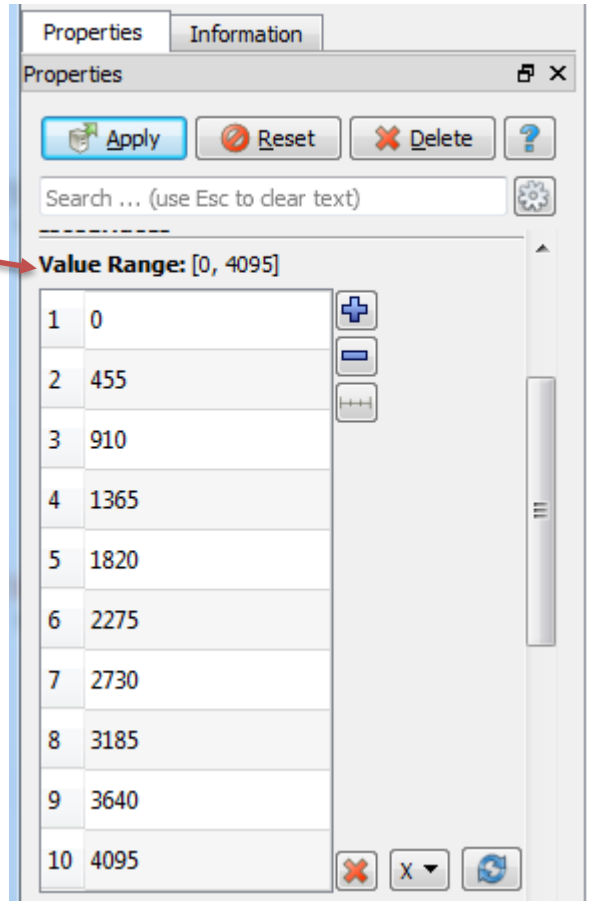


- Should see the Add Range Window
  - Use this window to set the range of values
  - For this tutorial
    - Min: 0
    - Max: 4095
  - Feel free to pay around with the range (between 0 and 4905)
  - Click **OK**

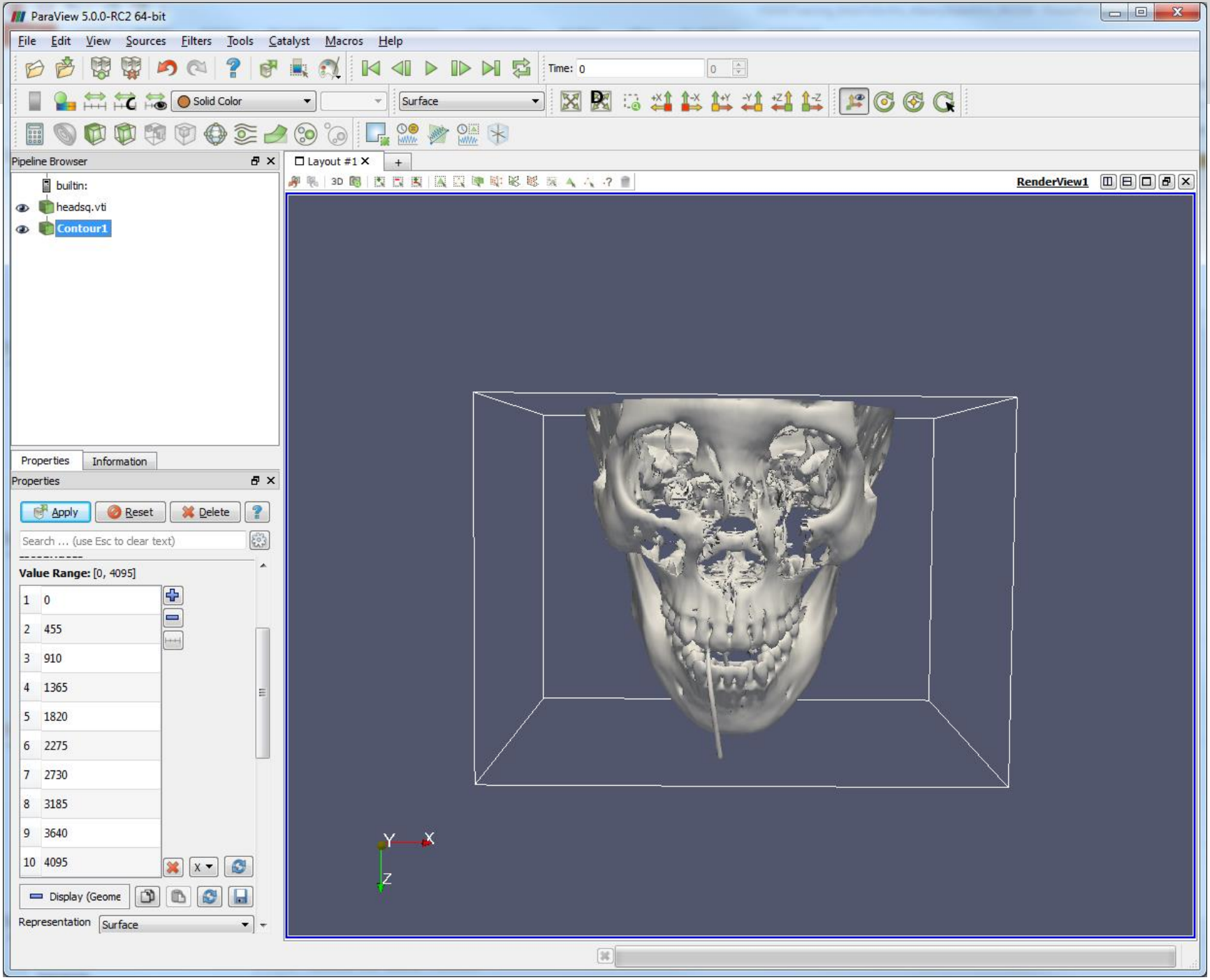


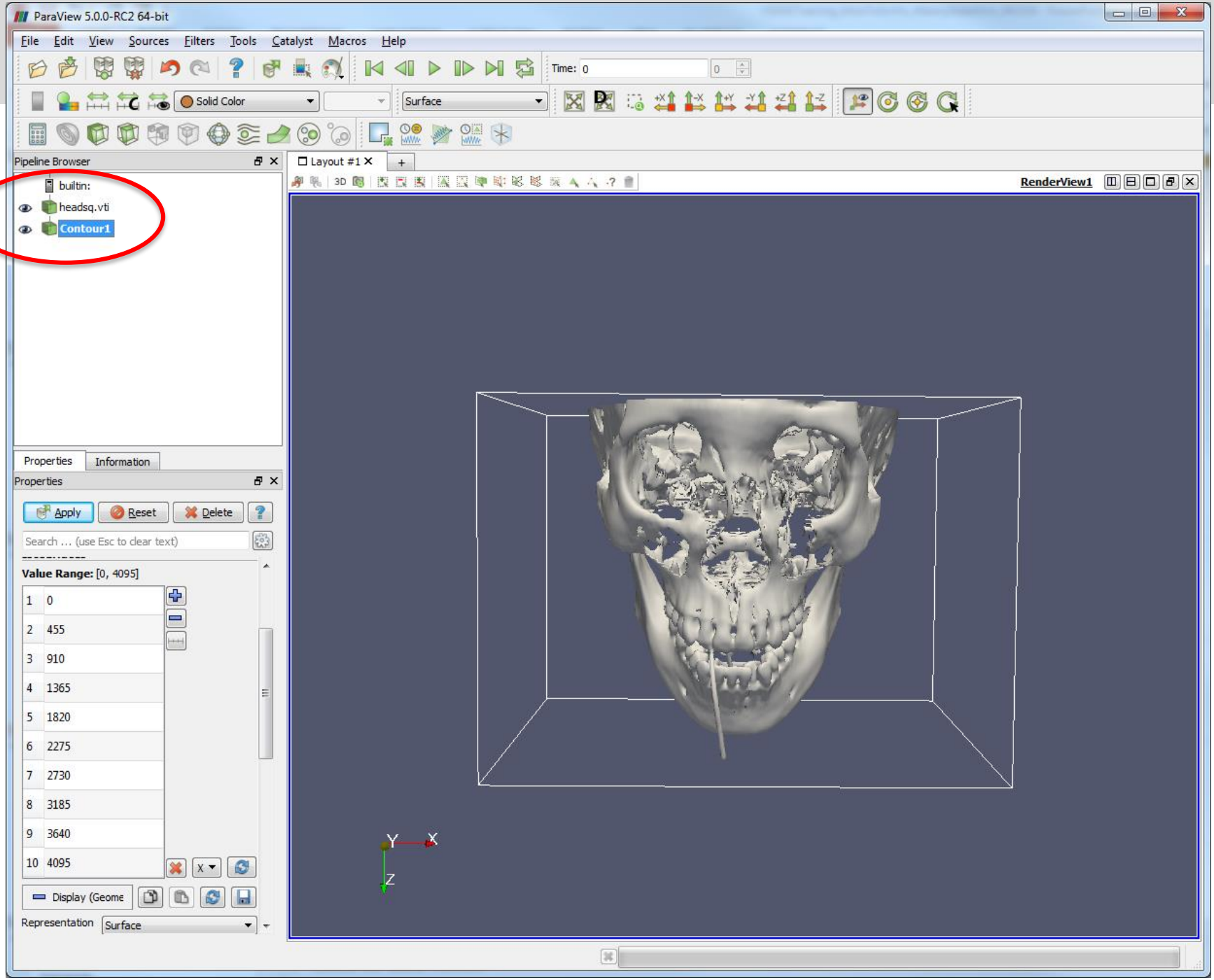
Isosurfaces

- Notice the Value Range: [0, 4095]
- There are 10 values (steps) showing values between 0 and 4095



PURDUE POLYTECHNIC


ParaView 5.0.0-RC2 64-bit
File Edit View Sources Filters Tools Catalyst Macros Help
Time: 0
Solid Color
Surface
Pipeline Browser
builtin:
headsq.vti
Contour1
Properties Information
Properties
Apply Reset Delete
Search ... (use Esc to clear text)
Value Range: [0, 4095]
1 0
2 455
3 910
4 1365
5 1820
6 2275
7 2730
8 3185
9 3640
10 4095
Display (Geome
Representation Surface
Layout #1
RenderView1
Y X Z


ParaView 5.0.0-RC2 64-bit
File Edit View Sources Filters Tools Catalyst Macros Help
Time: 0
Solid Color
Surface
Pipeline Browser
builtin:
headsq.vti
Contour1
Layout #1
RenderView1
Properties
Information
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Apply
Reset
Delete
Search ... (use Esc to clear text)
Value Range: [0, 4095]
1 0
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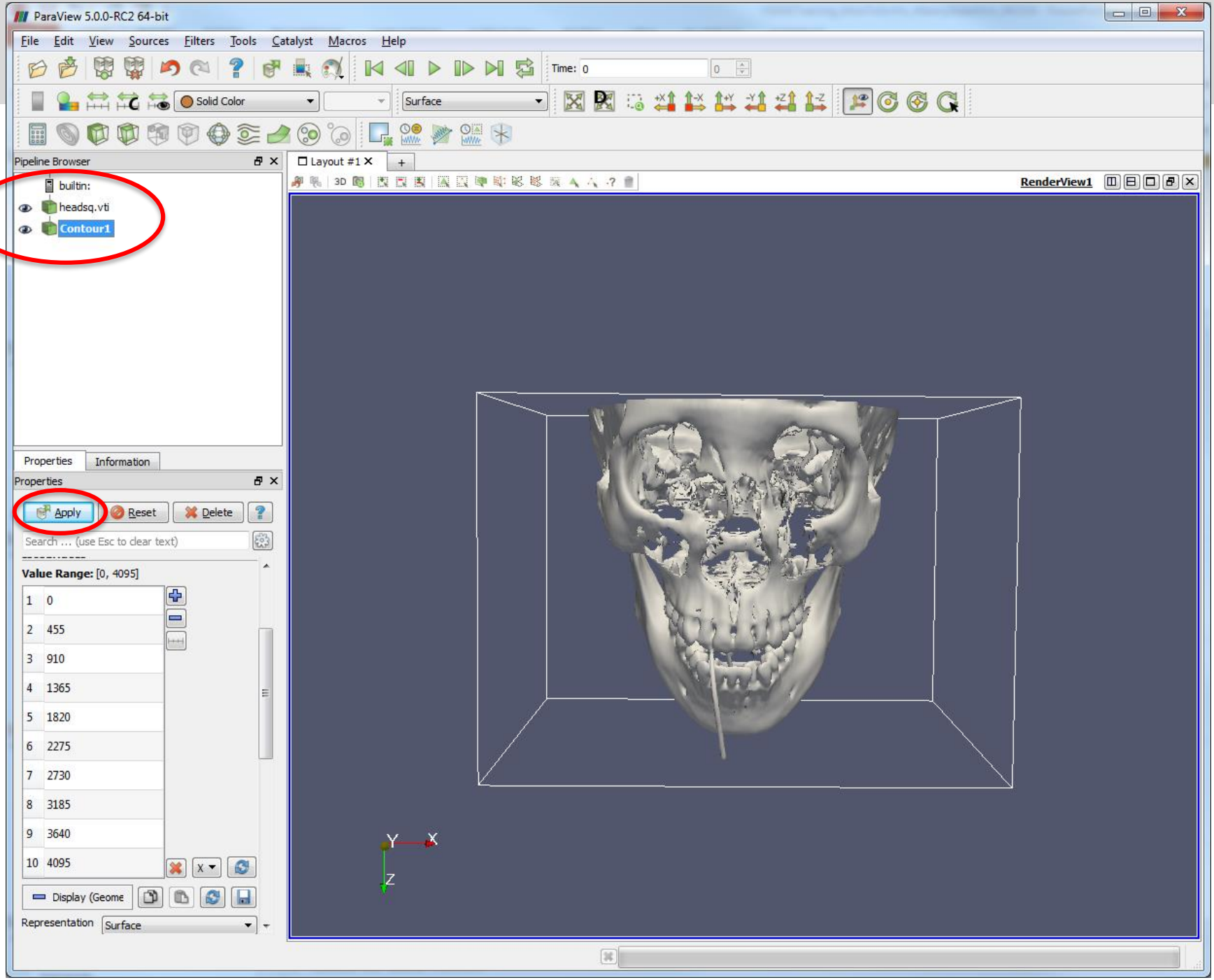
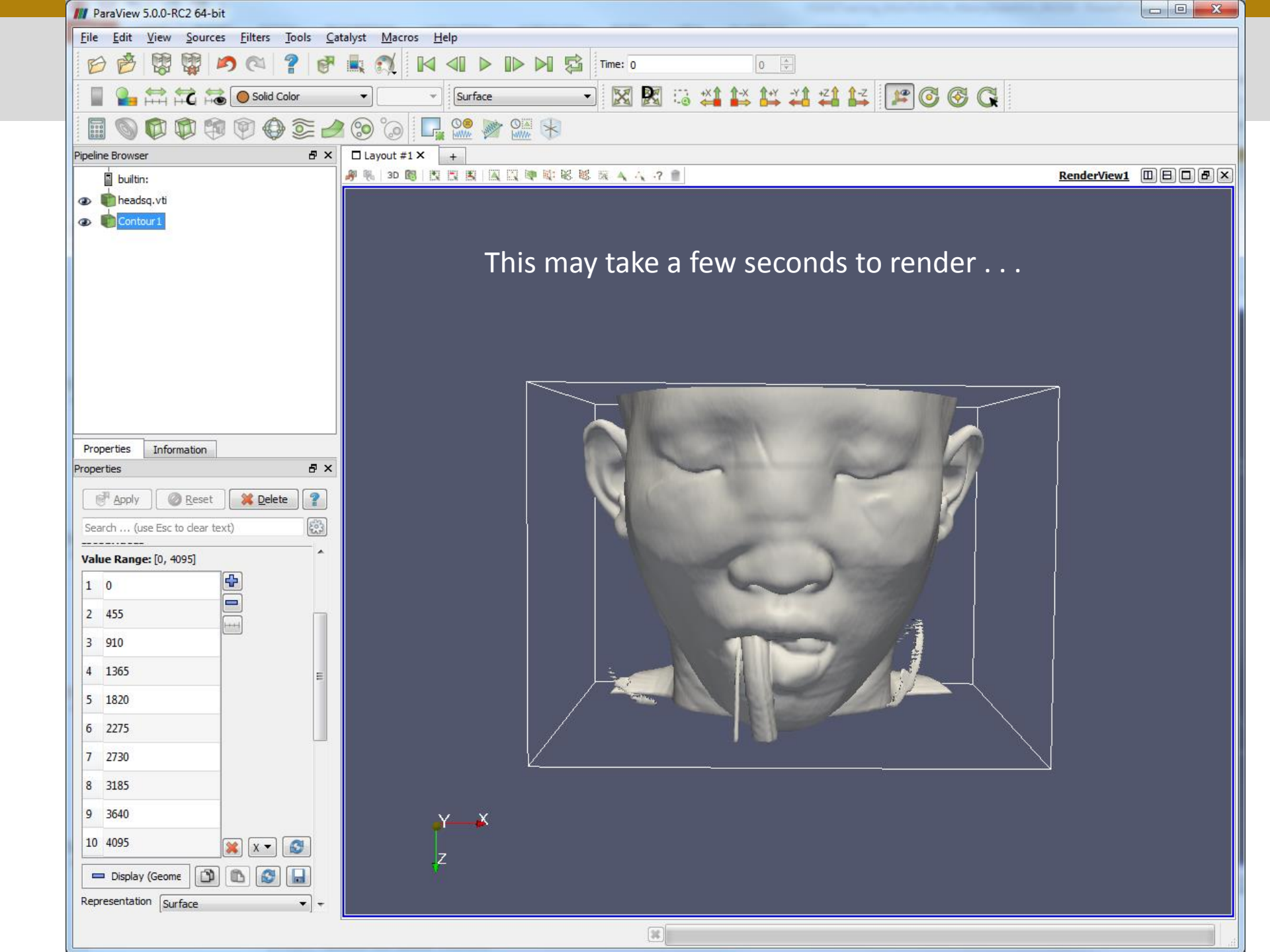
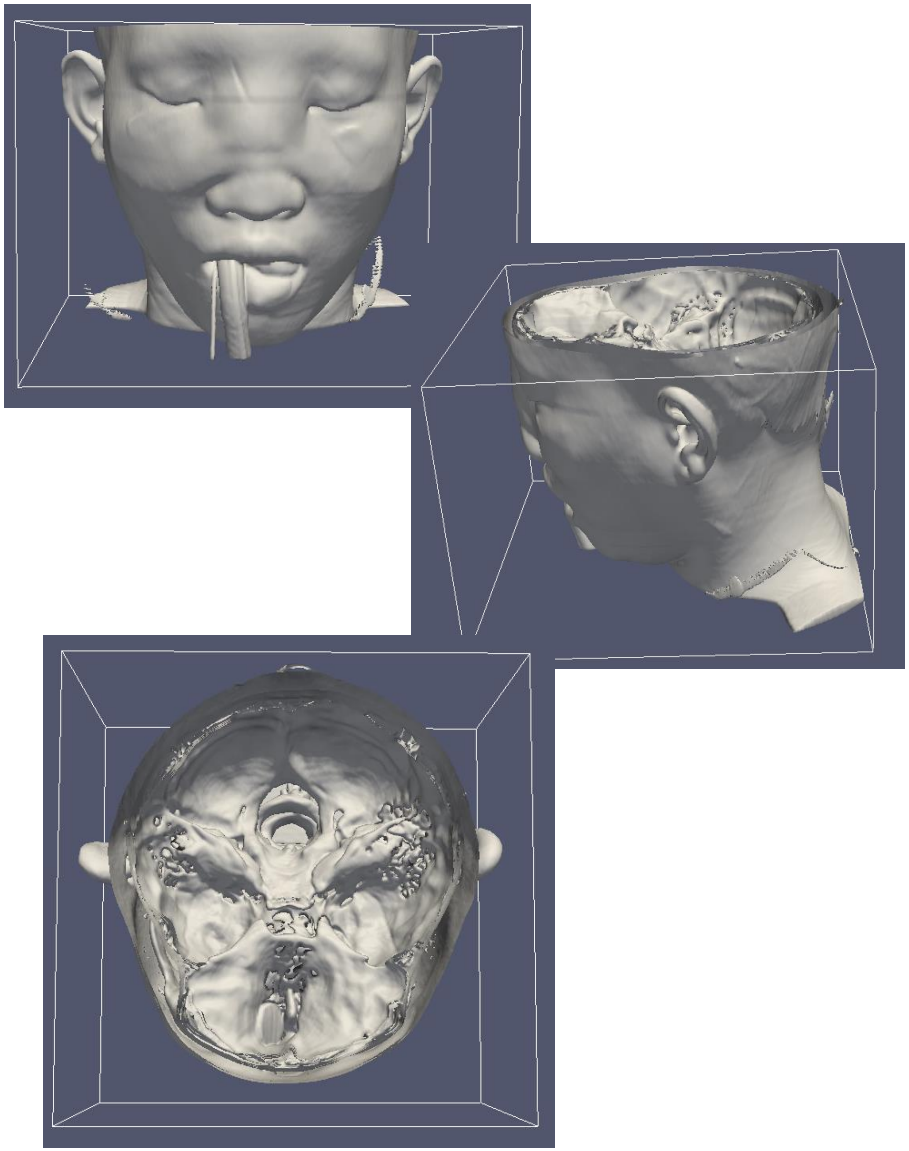
8 3185
9 3640
10 4095
Display (Geome
Representation
Surface
Y
X
Z


ParaView 5.0.0-RC2 64-bit
File Edit View Sources Filters Tools Catalyst Macros Help
Time: 0
Solid Color
Surface
Pipeline Browser
builtin:
headsq.vti
Contour1
Layout #1
RenderView1
Properties
Information
Properties
Apply
Reset
Delete
Search ... (use Esc to clear text)
Value Range: [0, 4095]
1 0
2 455
3 910
4 1365
5 1820
6 2275
7 2730
8 3185
9 3640
10 4095
Display (Geome
Representation
Surface
Y
X
Z


ParaView 5.0.0-RC2 64-bit
File Edit View Sources Filters Tools Catalyst Macros Help
Time: 0
Solid Color
Surface
Pipeline Browser
builtin:
headsq.vti
Contour1
Properties
Information
Properties
Apply
Reset
Delete
Search ... (use Esc to clear text)
Value Range: [0, 4095]
1 0
2 455
3 910
4 1365
5 1820
6 2275
7 2730
8 3185
9 3640
10 4095
Display (Geome
Representation
Surface
Layout #1
RenderView1
This may take a few seconds to render . . .
Y
X
Z

Explore the rendering . . .



Properties | Information

Information

Statistics

Type:	Polygonal Mesh
Number of Cells:	2292169
Number of Points:	1151862
Memory:	99 MB

Data Arrays

Name	Data Type	Data Ranges
Normals	float	[-1, 0.999998], [-0...

Bounds

X range: 7.44 to 243 (delta: 236)

Y range: 0 to 234 (delta: 234)

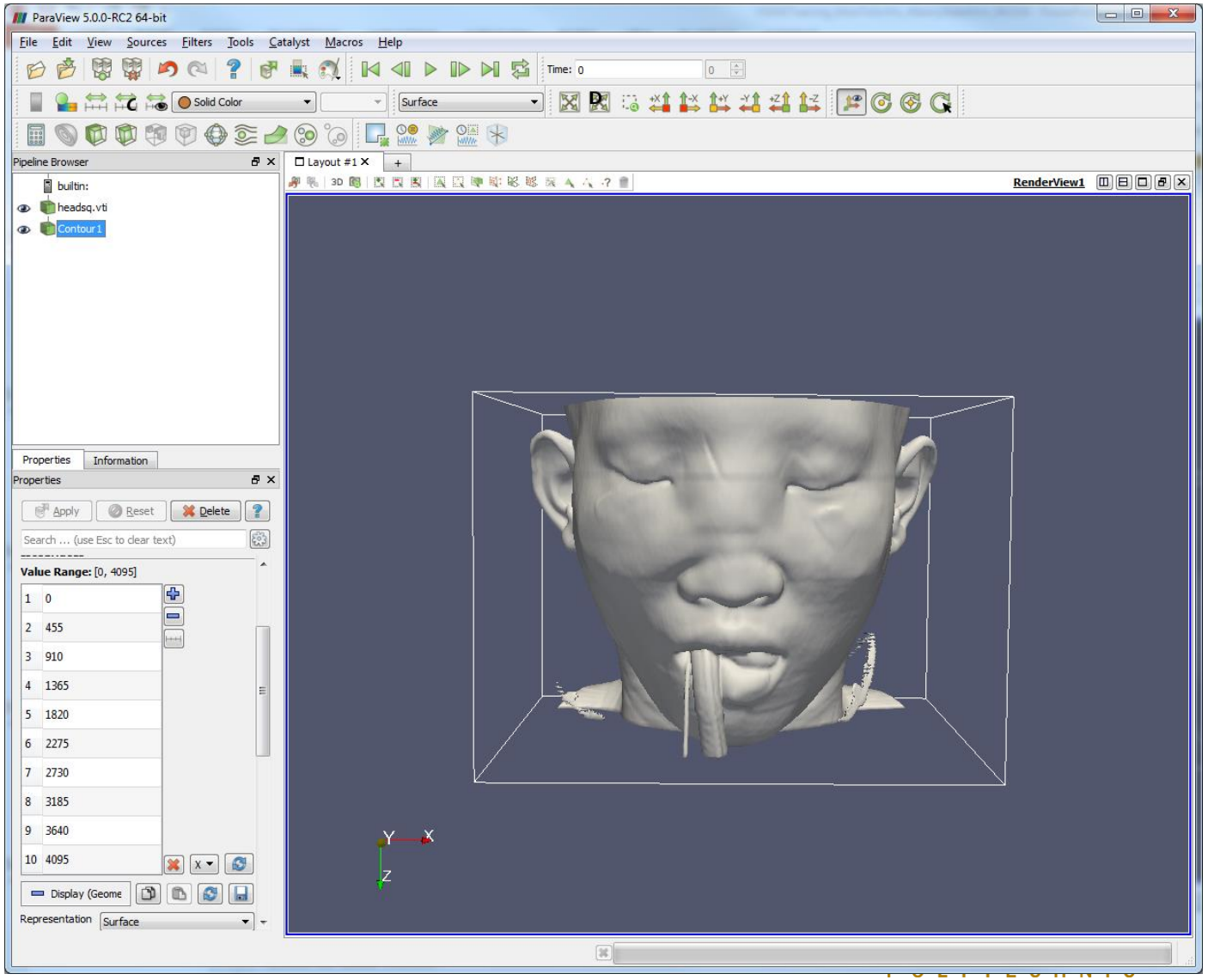
Z range: 0 to 186 (delta: 186)

PURDUE POLYTECHNIC

You should be here . . .

Contour – Extracts the points, curves, or surfaces where a scalar field is equal to a user-defined value.

The surface is often also called an ***isosurface***.



Explore the data set

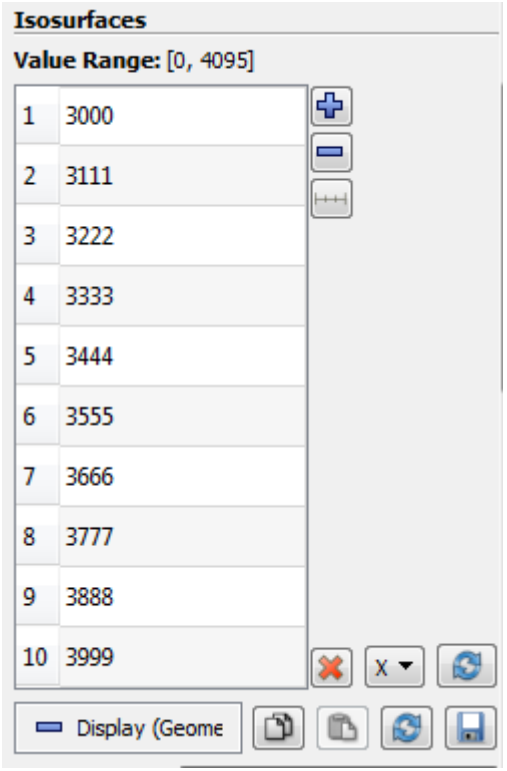
Set Value Range

From	To	Step	What do you get?
1500	2500	10	
2500	3500	10	
2999	3500	20	
3500	4000	20	
2000	2999	10	
3000	3999	10	

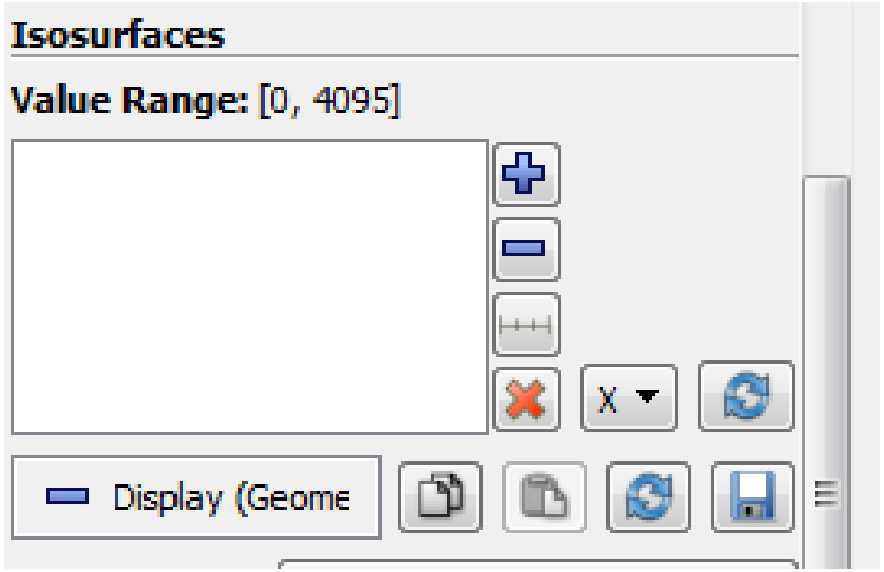
PURDUE POLYTECHNIC

Reset Values

Click red X – Remove all entries



Click Add a range of values button



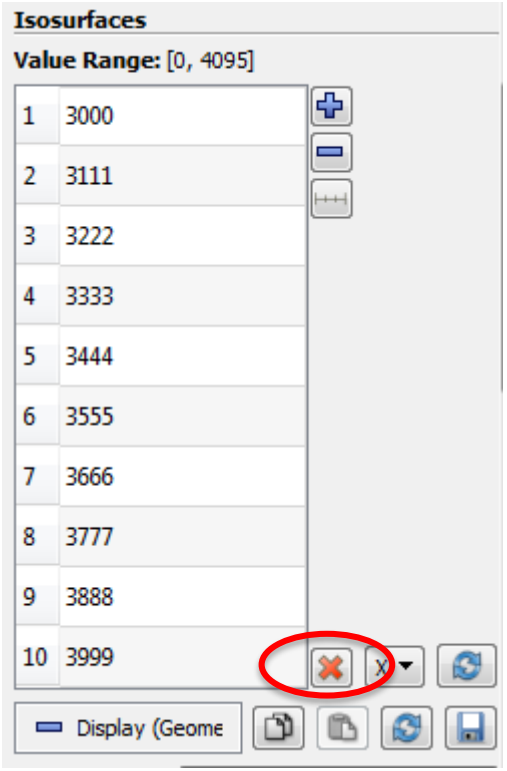
Click OK

Click Apply

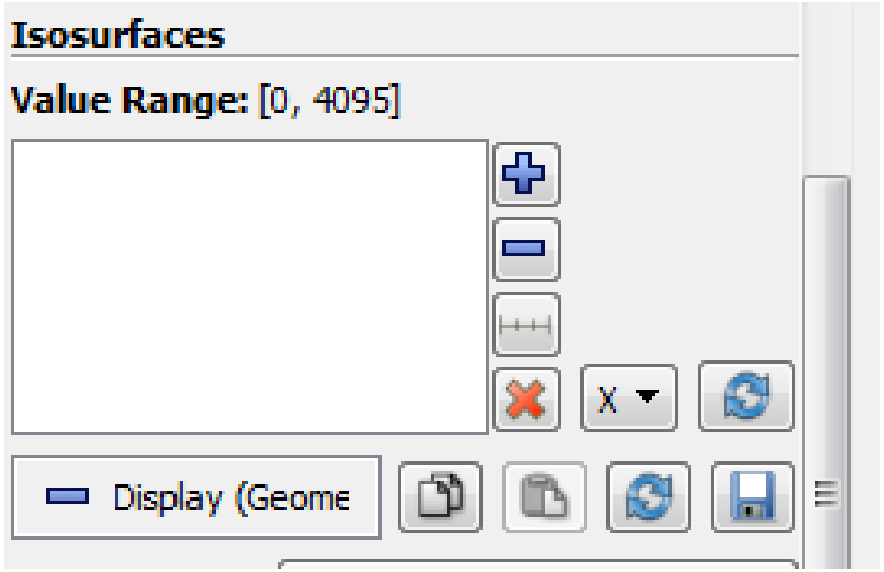
PURDUE POLYTECHNIC

Reset Values

Click red X – Remove all entries



Click Add a range of values button



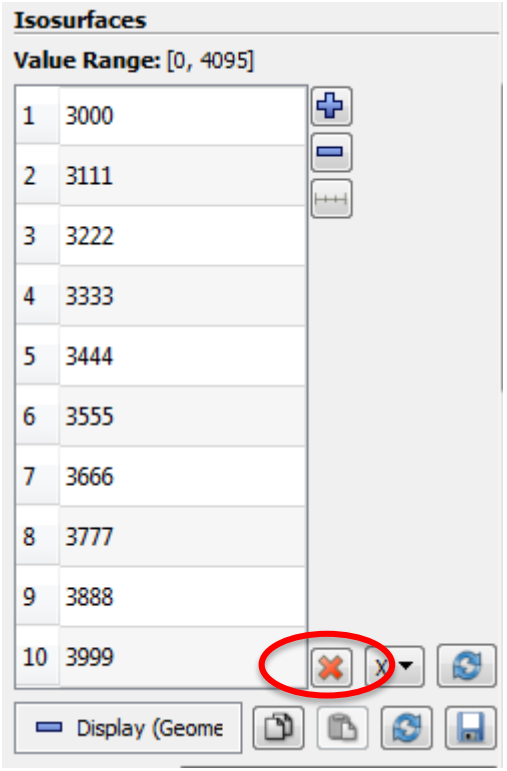
Click OK

Click Apply

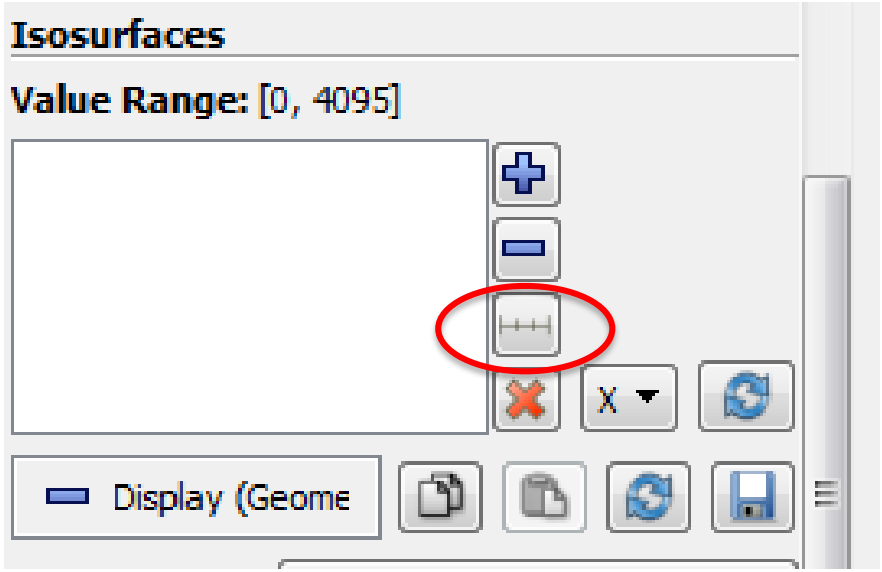
PURDUE POLYTECHNIC

Reset Values

Click red X – Remove all entries



Click Add a range of values button

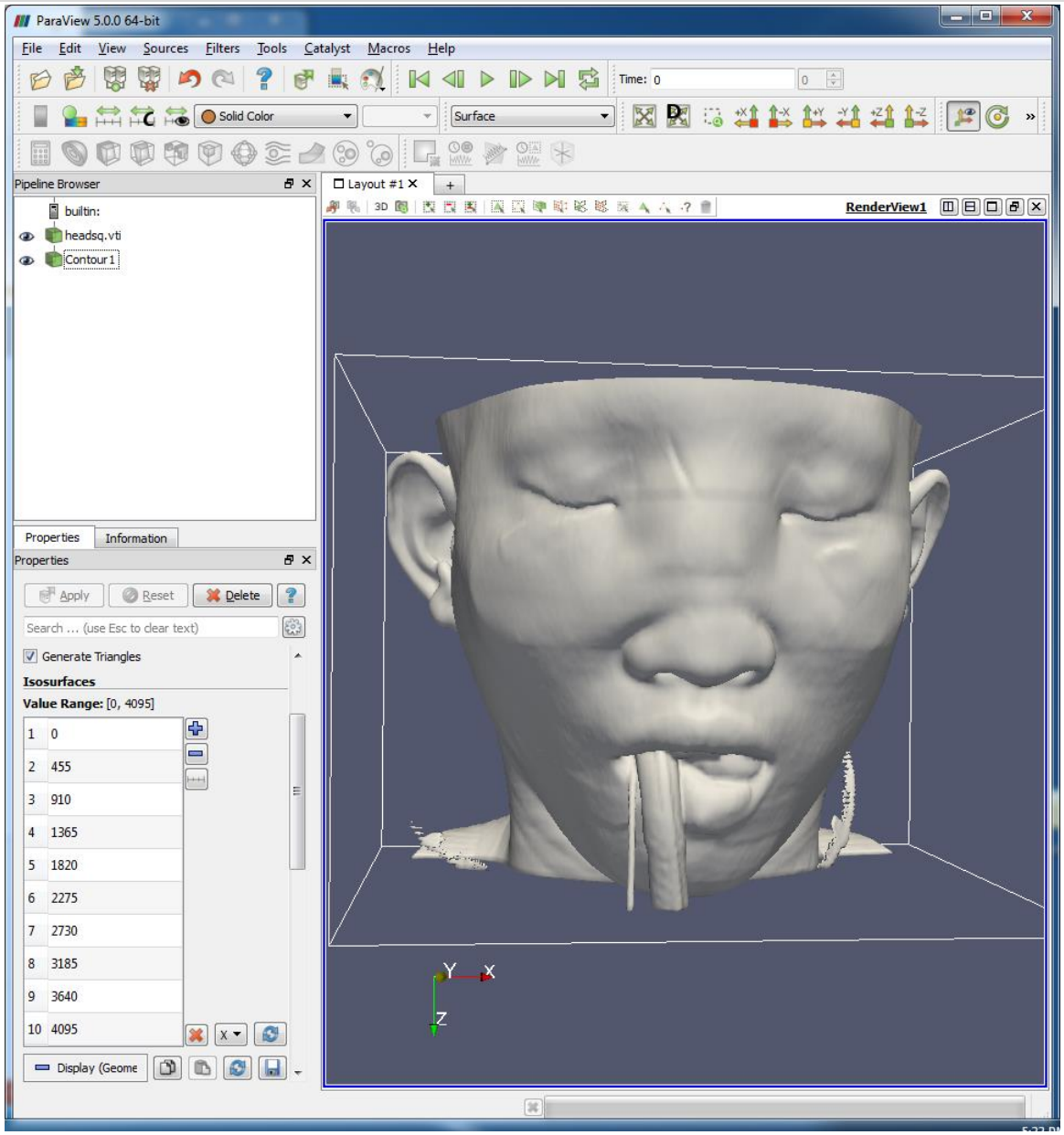


Click OK

Click Apply

PURDUE POLYTECHNIC

You should be here



PURDUE POLYTECHNIC

Clip Isosurface

- CLIP - Intersects the geometry with a half space.
- The effect is to remove all the geometry on one side of a user-defined plane.

PURDUE
POLYTECHNIC

Clip Isosurface

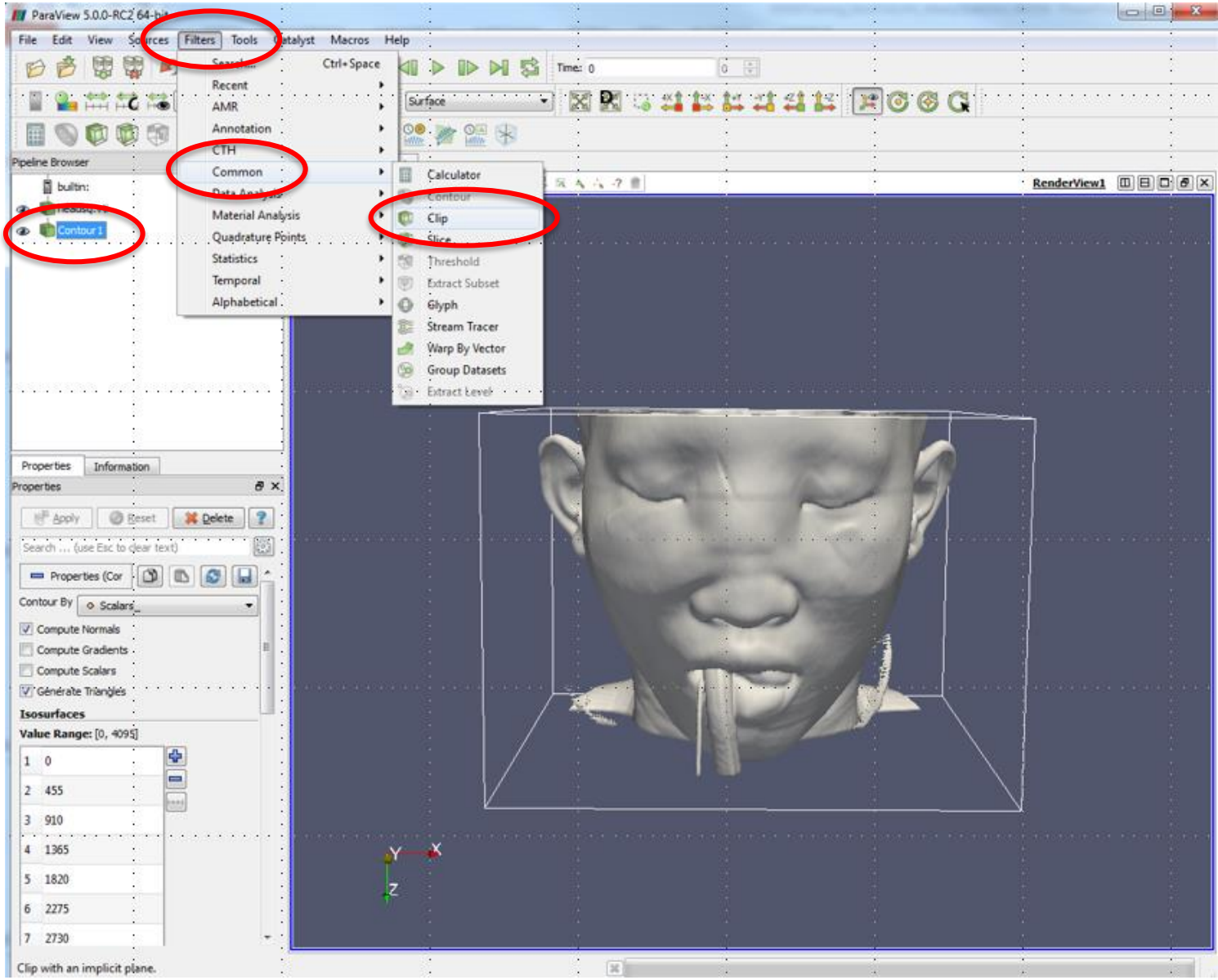
Select:

→ Contour 1 *(in pipeline Browser)*

→ Filters

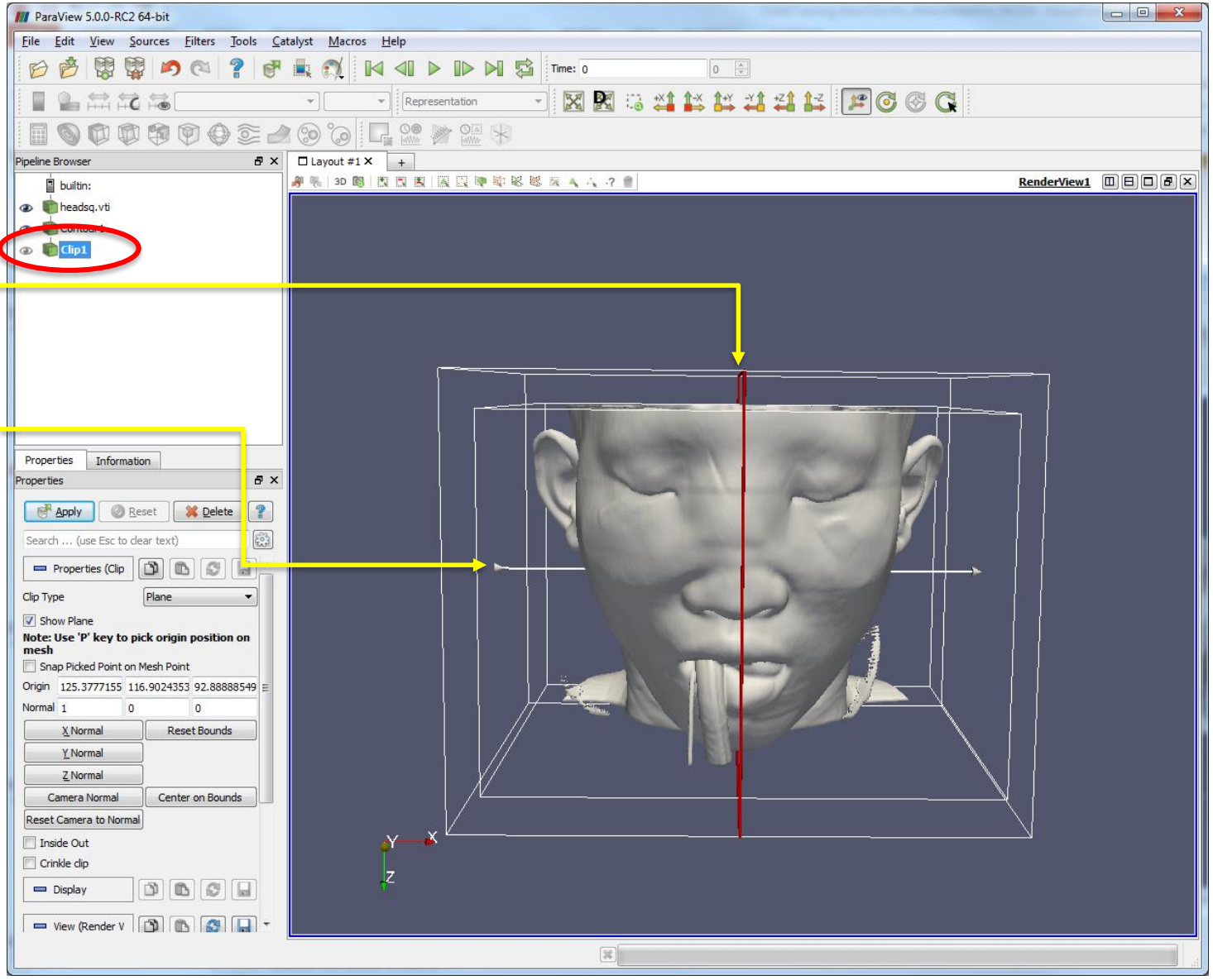
→ Common

→ Clip



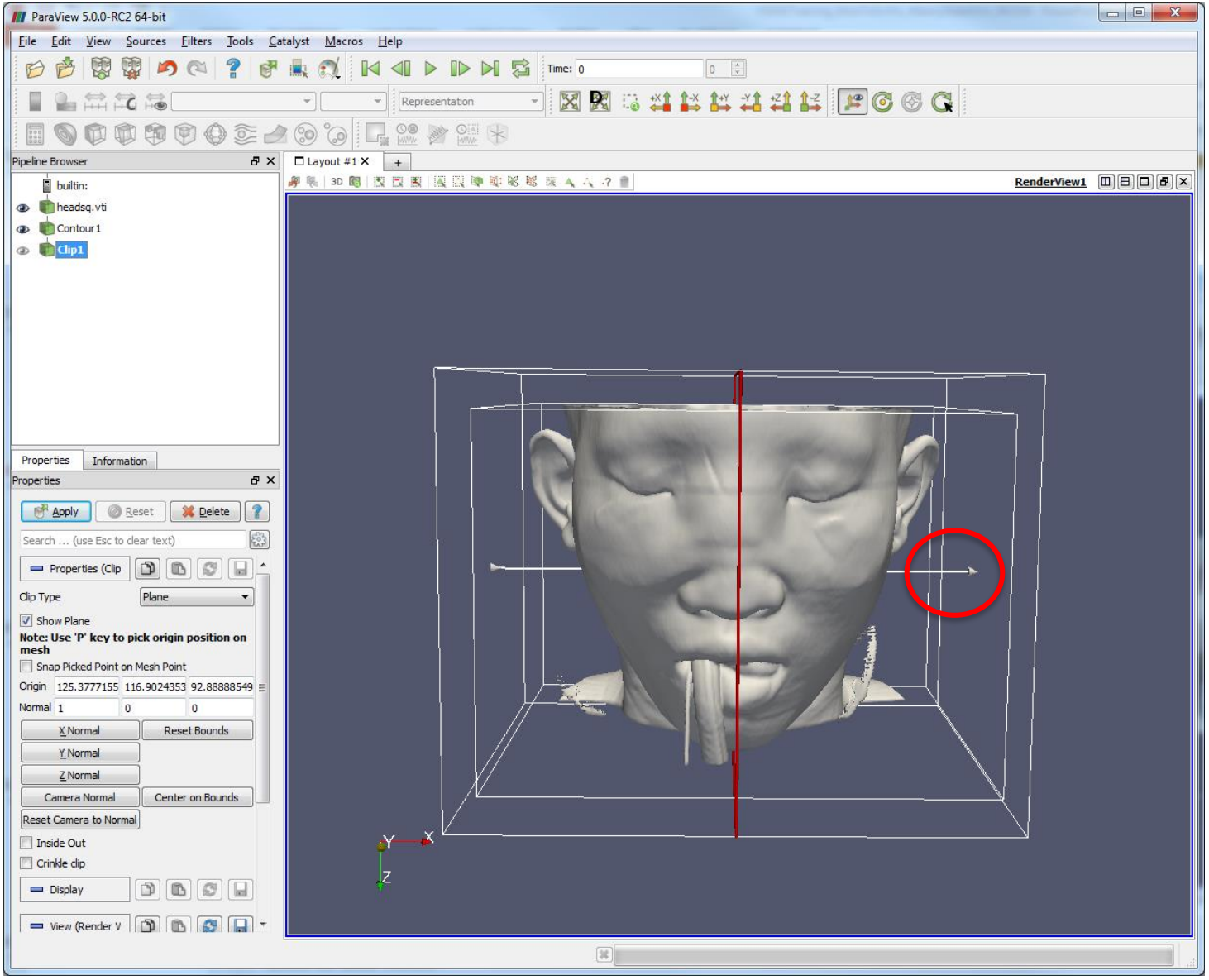
Clip Isosurface

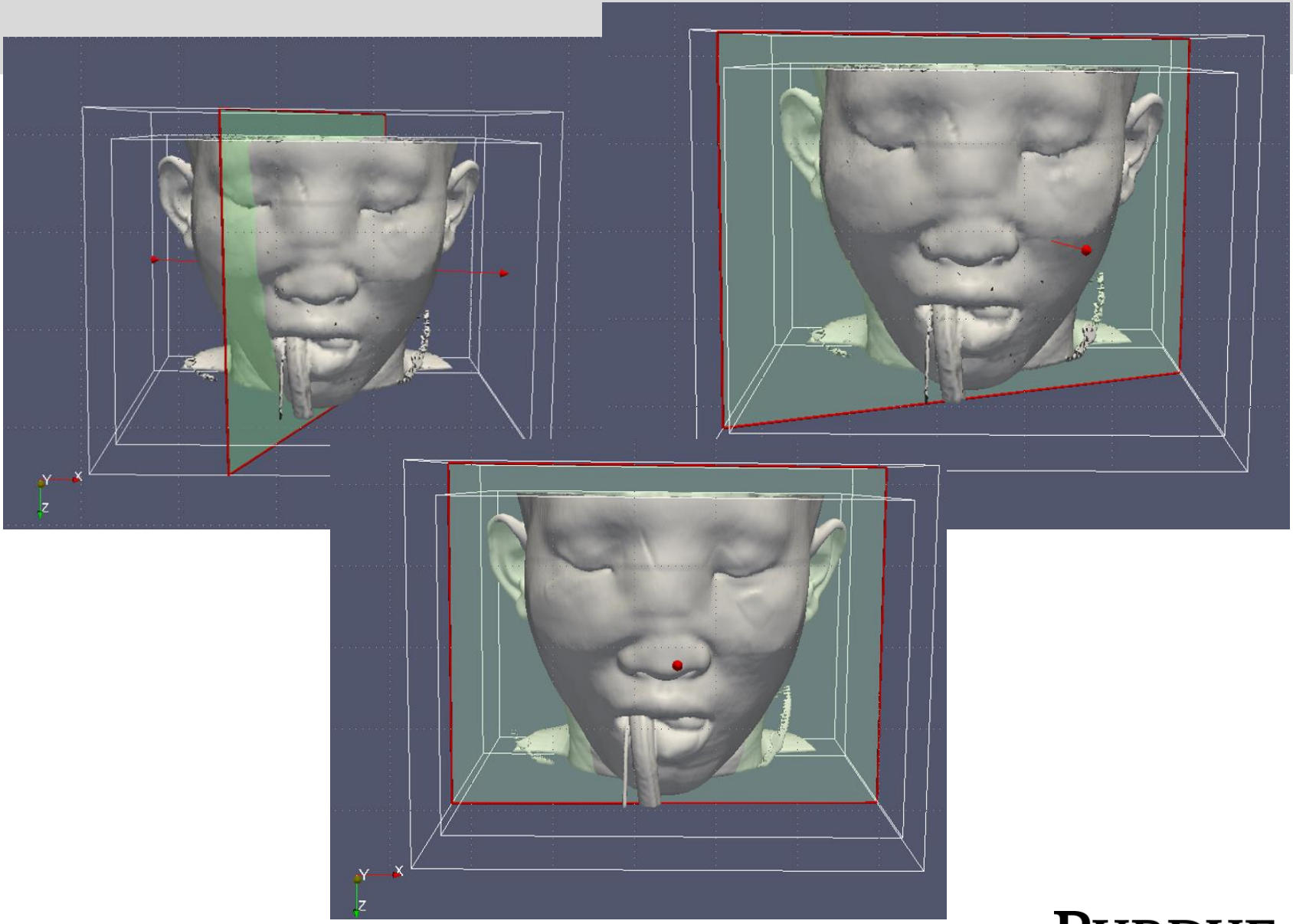
- A new object appeared in the pipeline browser (Clip 1)
- Clipping plane (see red vertical line and horizontal arrow)



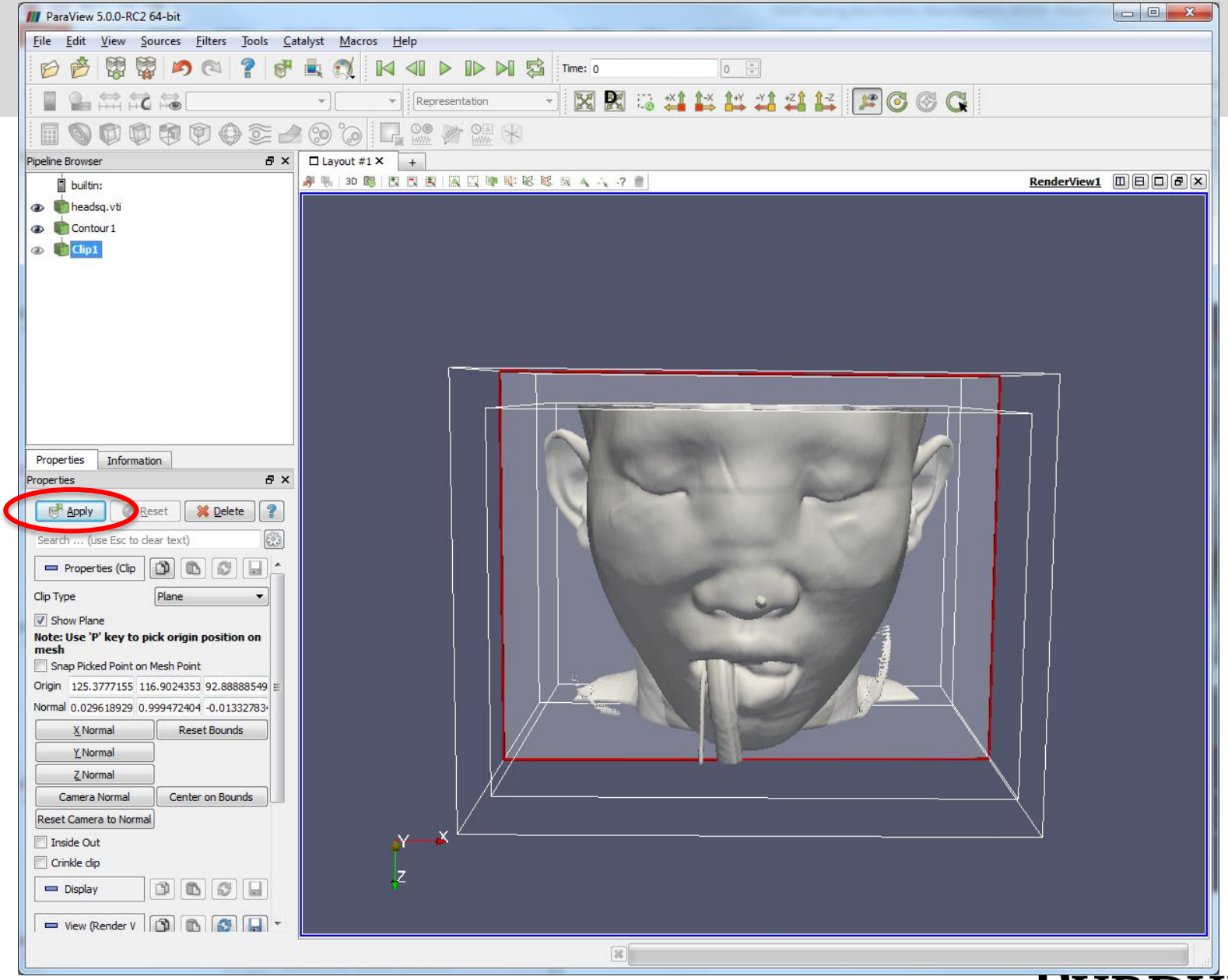
Clip Isosurface

- Select the arrow point (arrow turns red)
- Rotate (drag) the arrow point until the arrow is pointing out of the screen toward you)





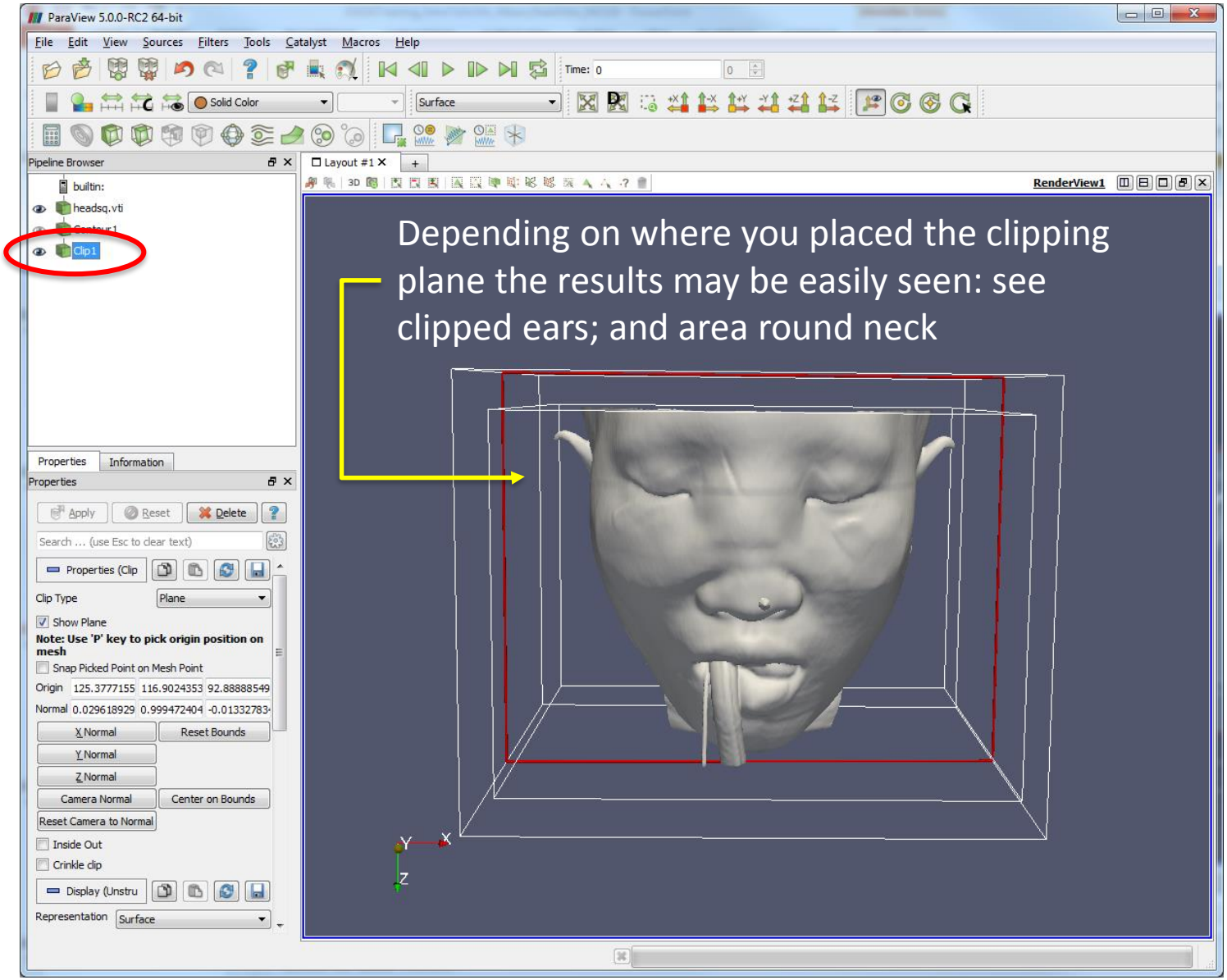
PURDUE
POLYTECHNIC



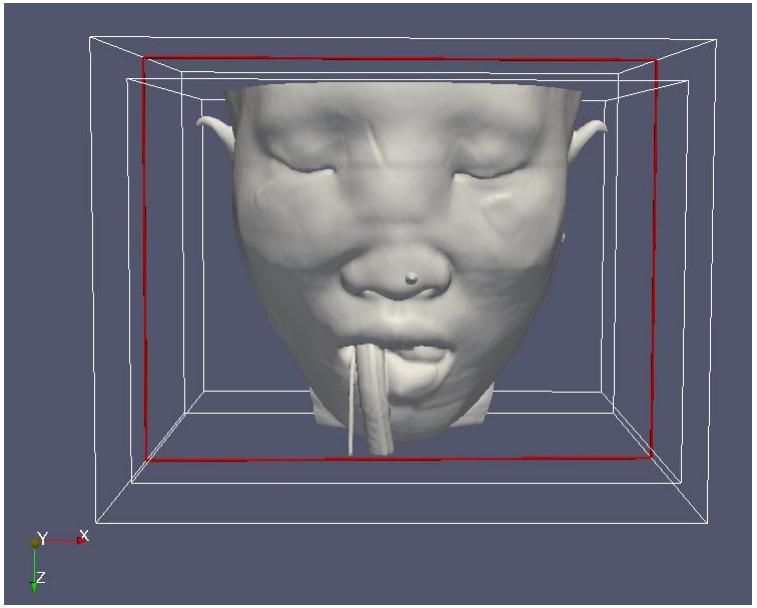
PURDUE
POLYTECHNIC

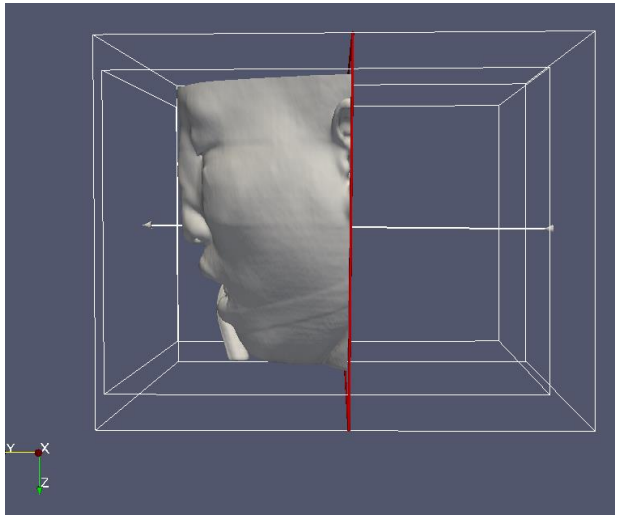
Clip Isosurface

- Make sure the eye icon is not greyed out on the Clip1 object in the Pipeline Browser

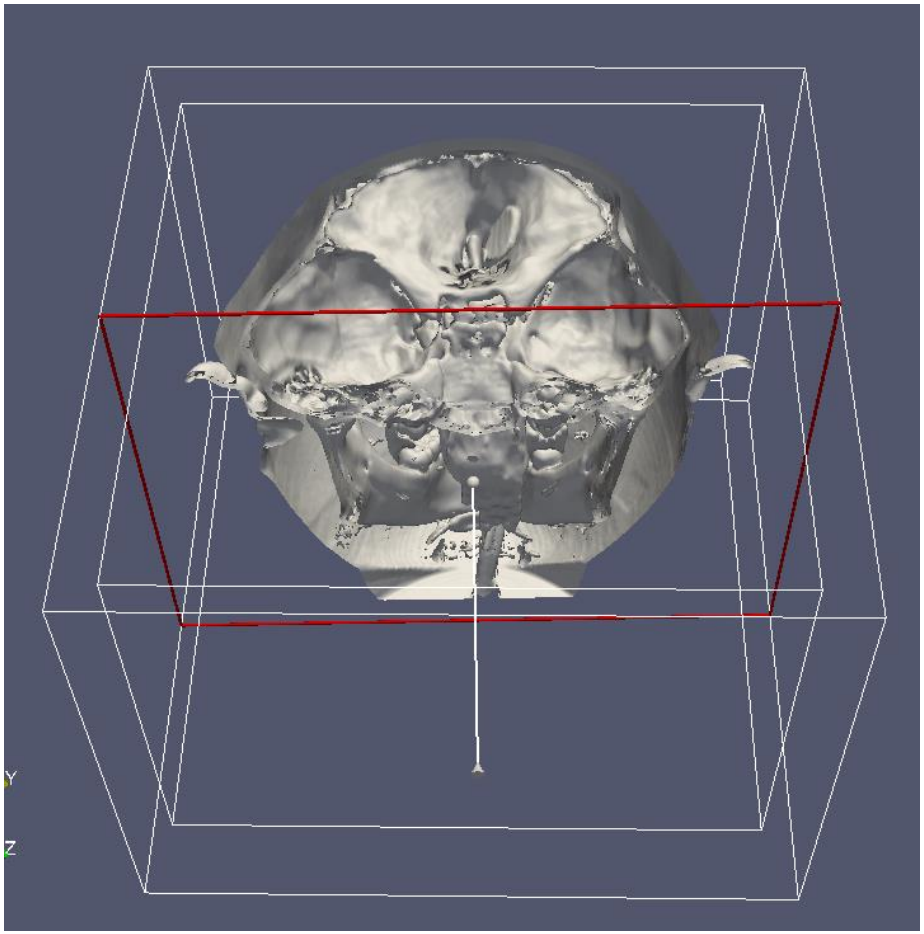


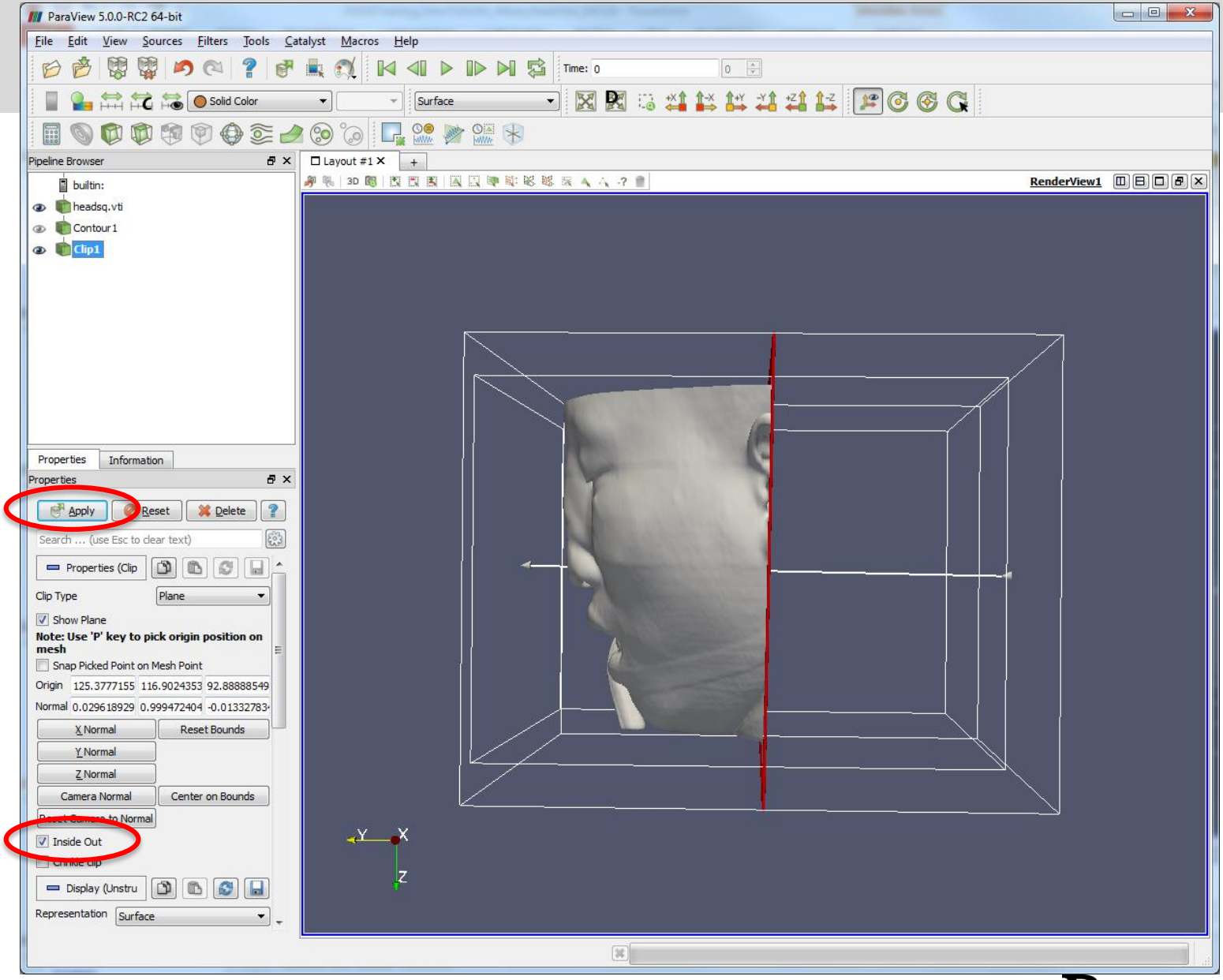
Clip Isosurface





Rotating the view reveals the clipped isosurface

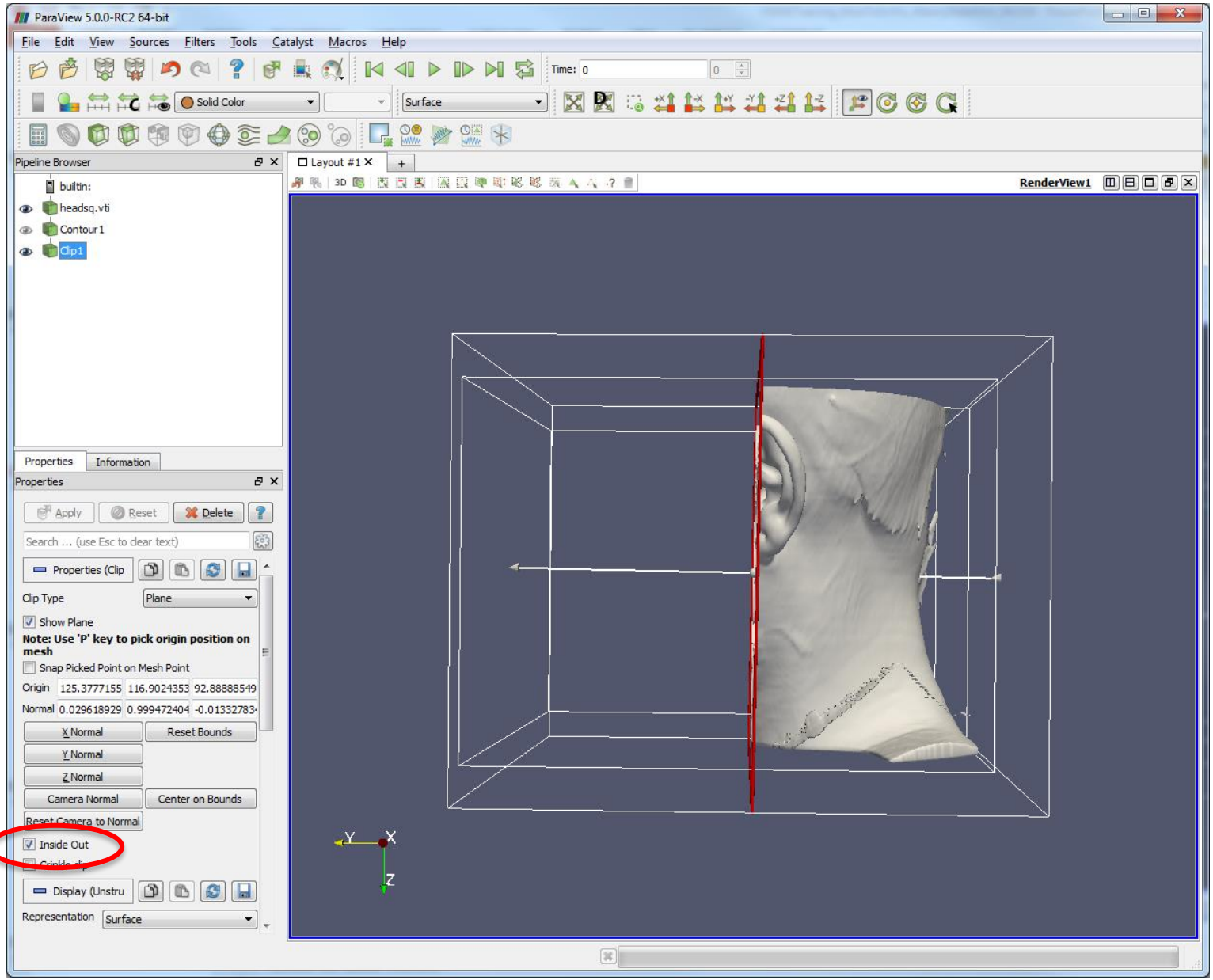




PURDUE
POLYTECHNIC

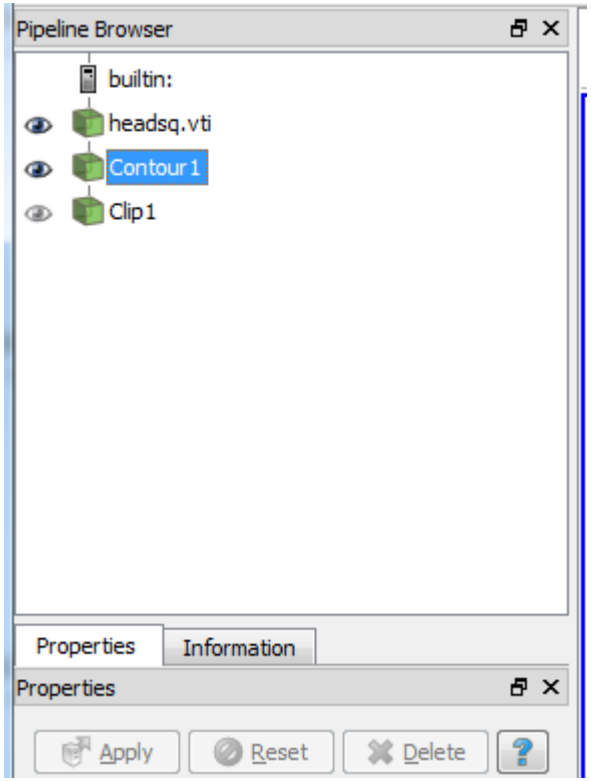
Inside Out Property

- If this property is set to 0, then clip filter will return that portion of the dataset that lies within the clip function.
- If set to 1, the portions of the dataset that lie outside the clip function will be returned instead



Slice Isosurface

- Click the eye icon next to Clip1 in the pipeline browser *(hide the clip plot)*
- Select **Contour 1**

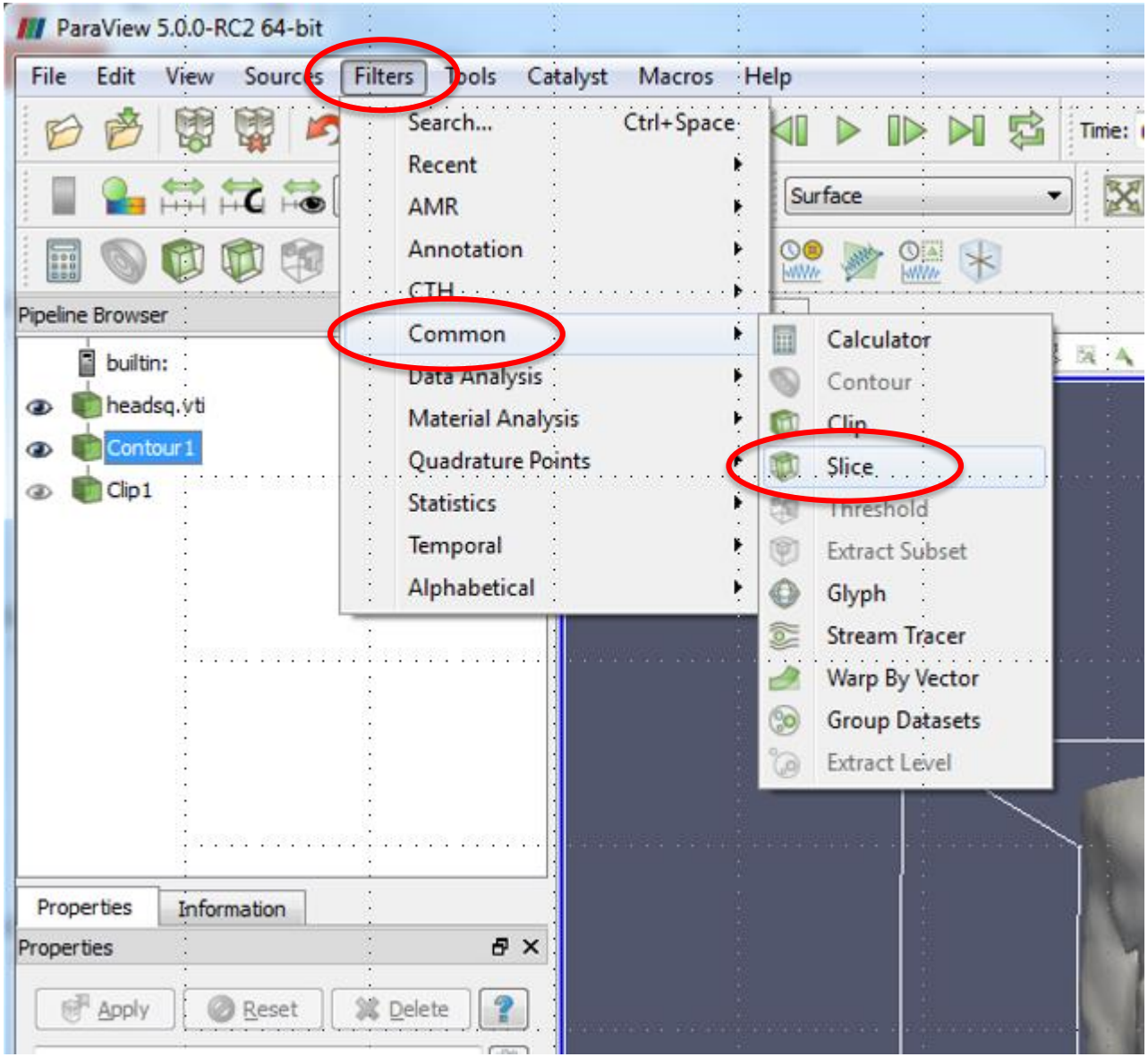


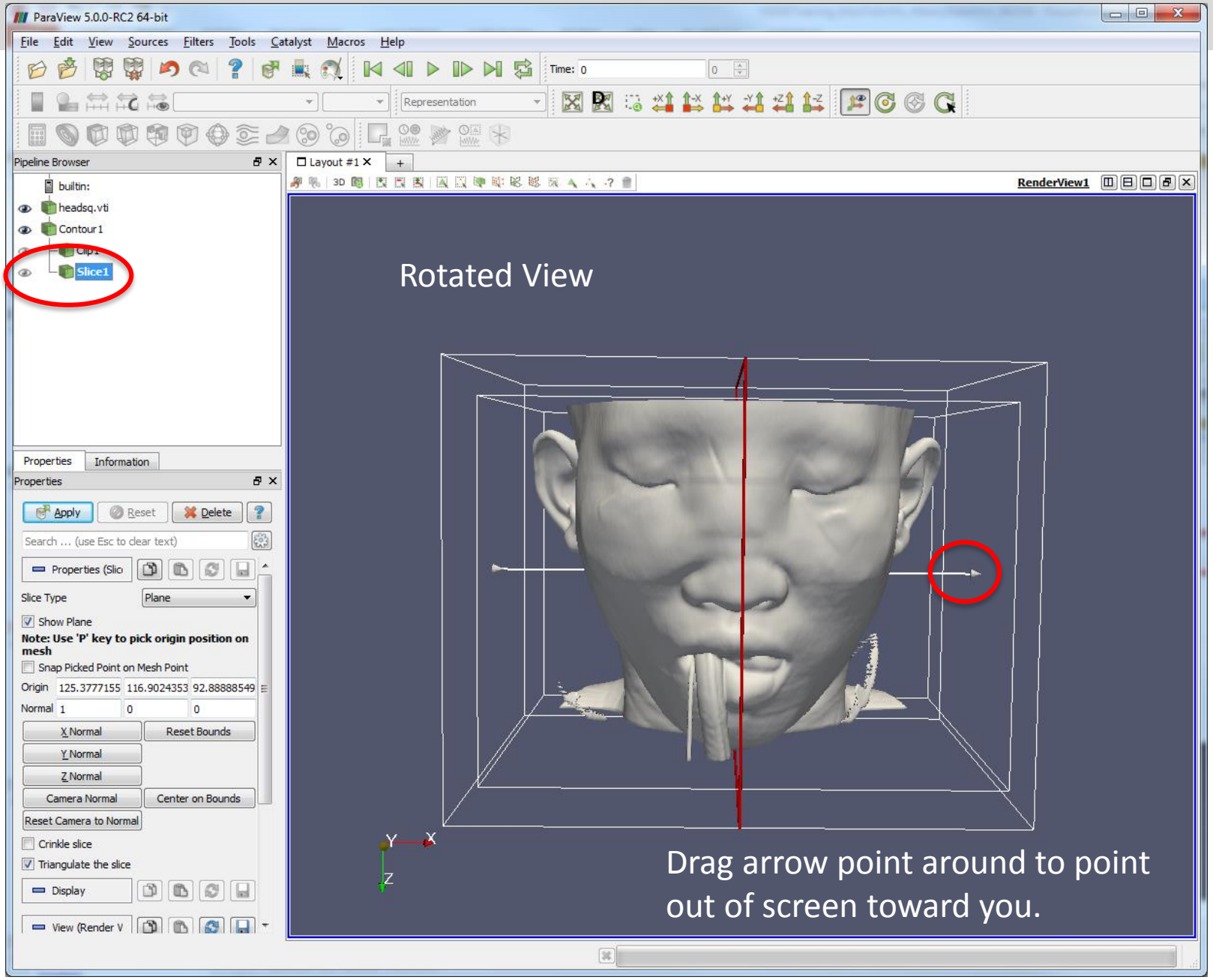
PURDUE POLYTECHNIC

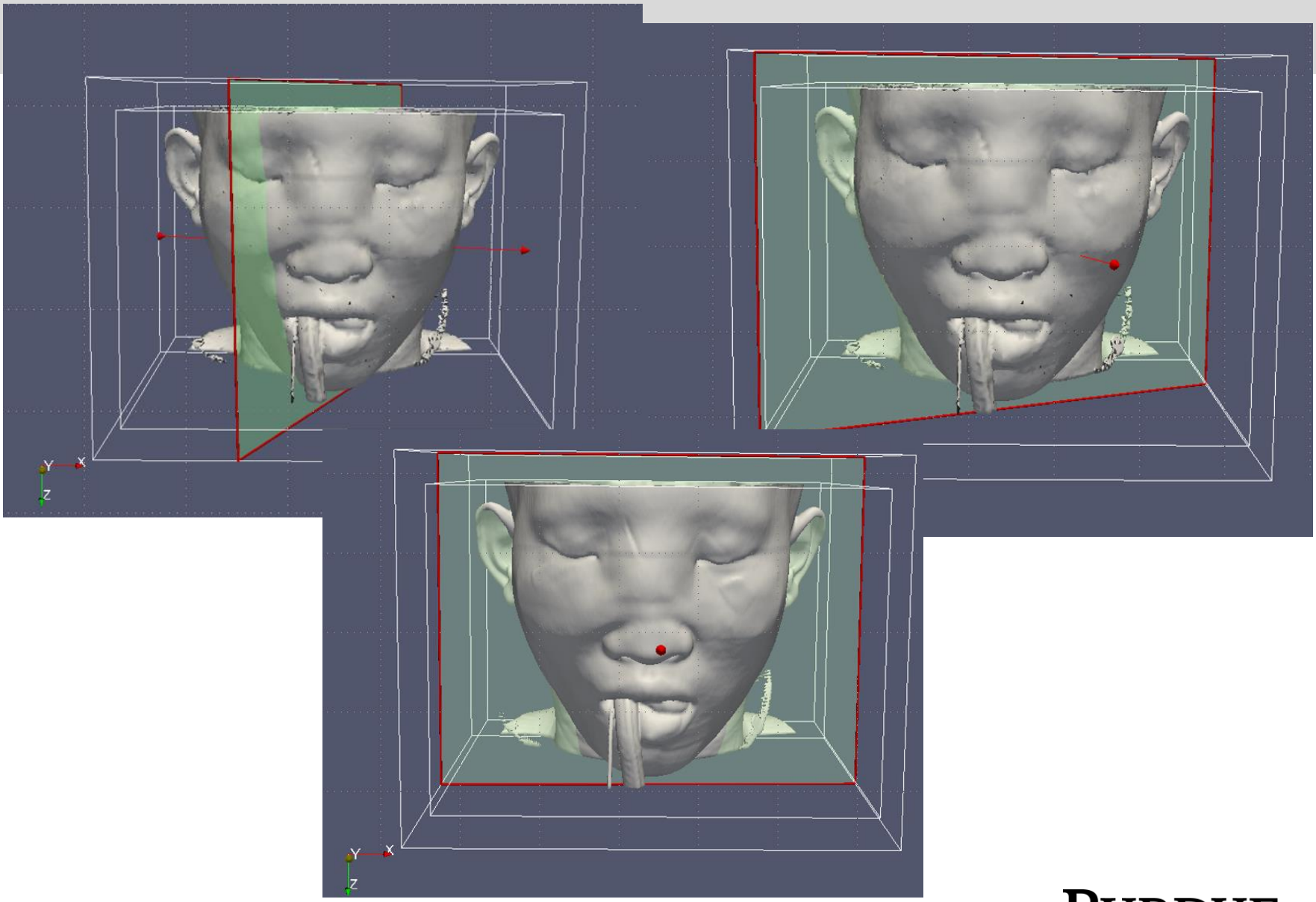
Slice Isosurface

Select

- Filters
- Common
- Slice




ParaView 5.0.0-RC2 64-bit
File Edit View Sources Filters Tools Catalyst Macros Help
Time: 0
Representation
Pipeline Browser
builtin:
headsq.vti
Contour1
Clip1
Slice1
Layout #1
RenderView1
Rotated View
Properties
Information
Properties
Apply
Reset
Delete
Search ... (use Esc to clear text)
Properties (Slic
Slice Type
Plane
Show Plane
Note: Use 'P' key to pick origin position on mesh
Snap Picked Point on Mesh Point
Origin 125.3777155 116.9024353 92.88888549
Normal 1 0 0
X Normal
Reset Bounds
Y Normal
Z Normal
Camera Normal
Center on Bounds
Reset Camera to Normal
Crinkle slice
Triangulate the slice
Display
View (Render V
Y
X
Z
Drag arrow point around to point out of screen toward you.



PURDUE
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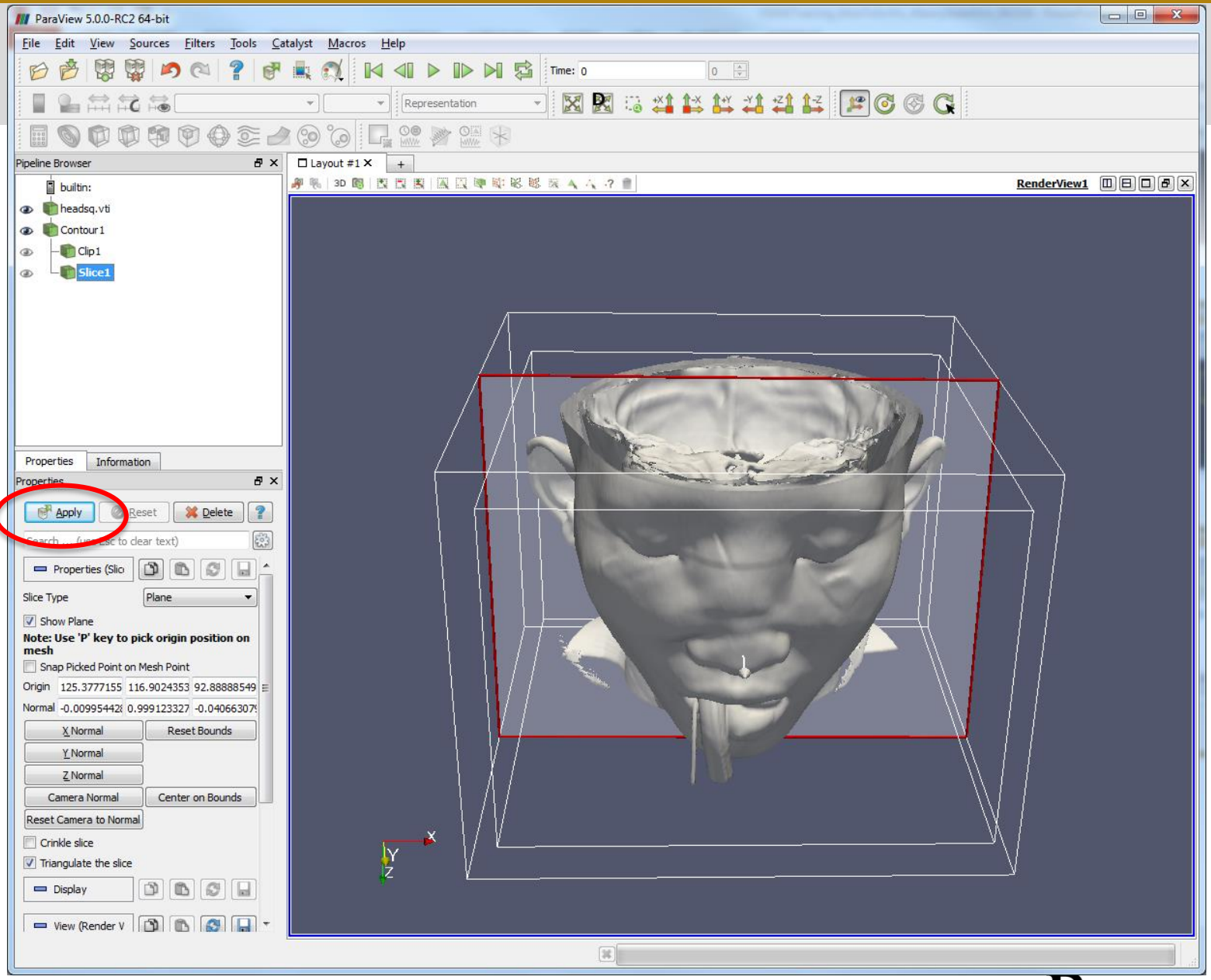
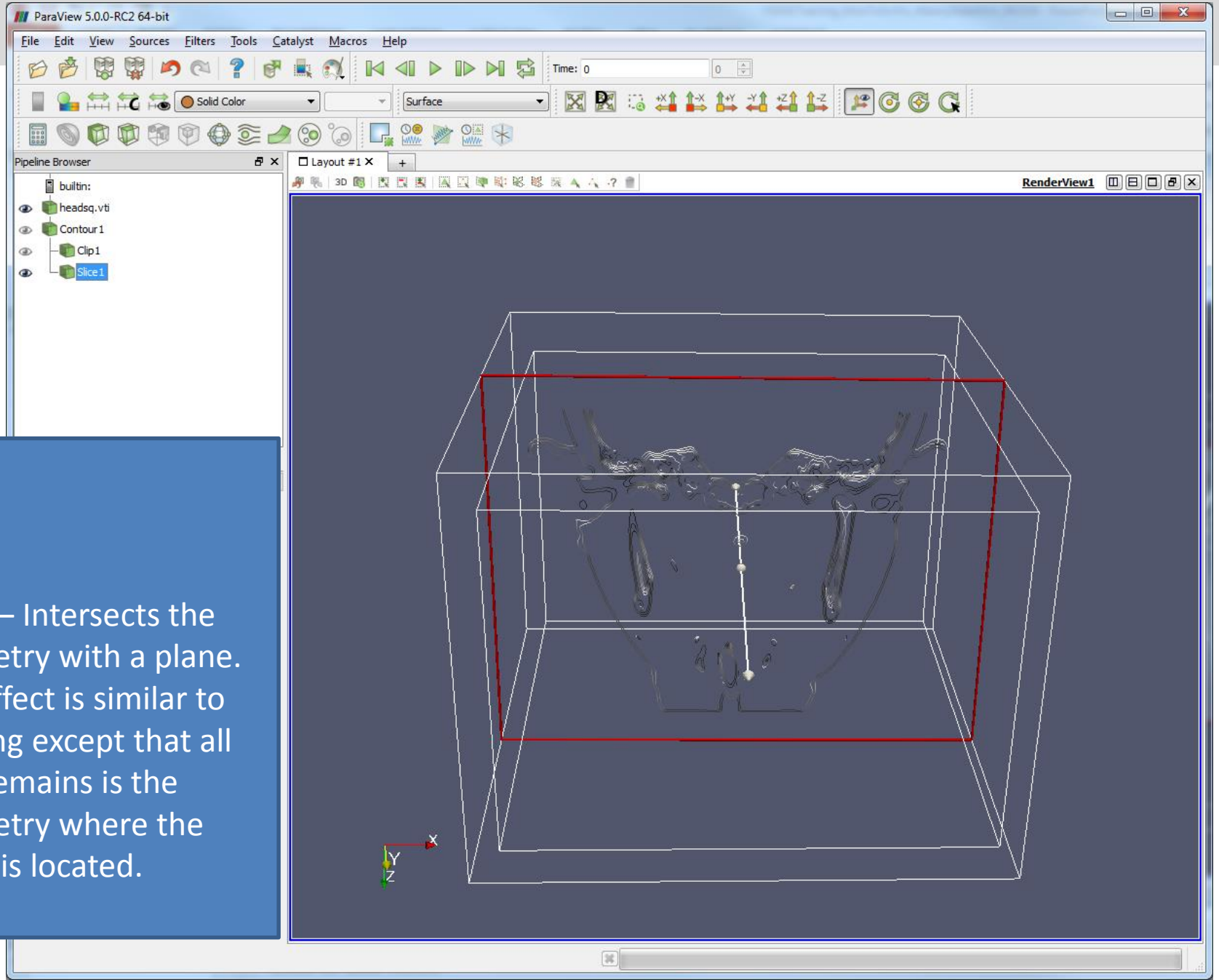
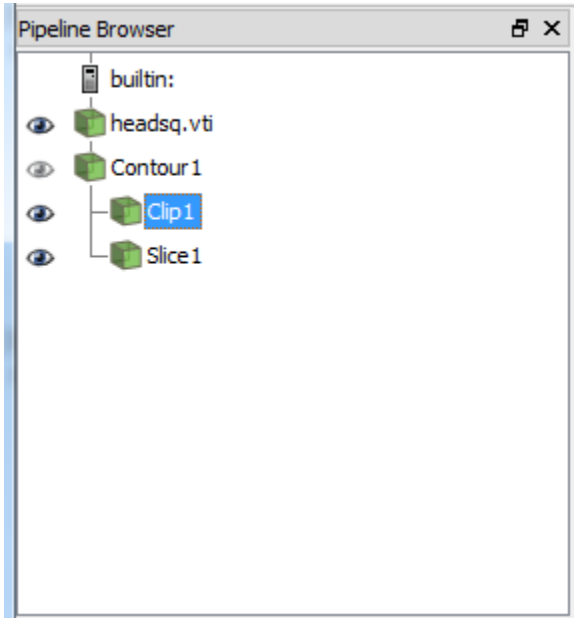


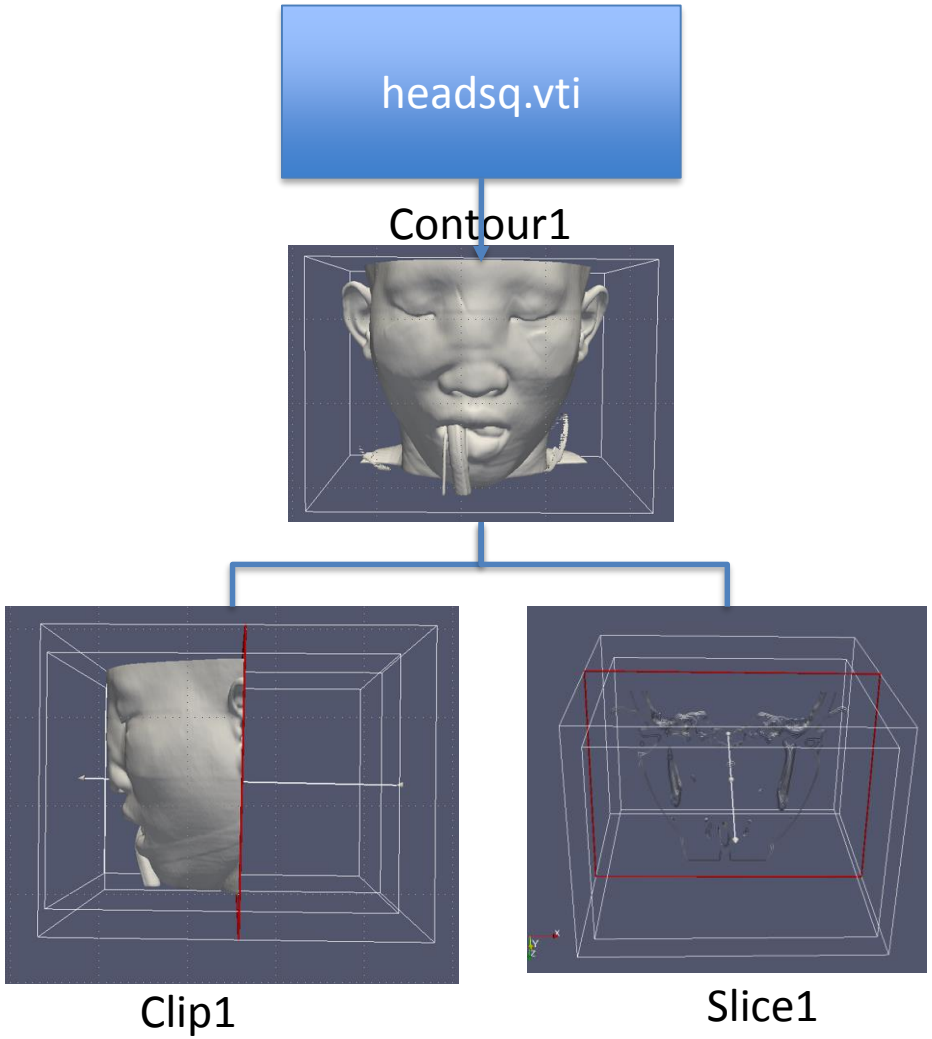
PURDUE
POLYTECHNIC



SLICE – Intersects the geometry with a plane. The effect is similar to clipping except that all that remains is the geometry where the plane is located.

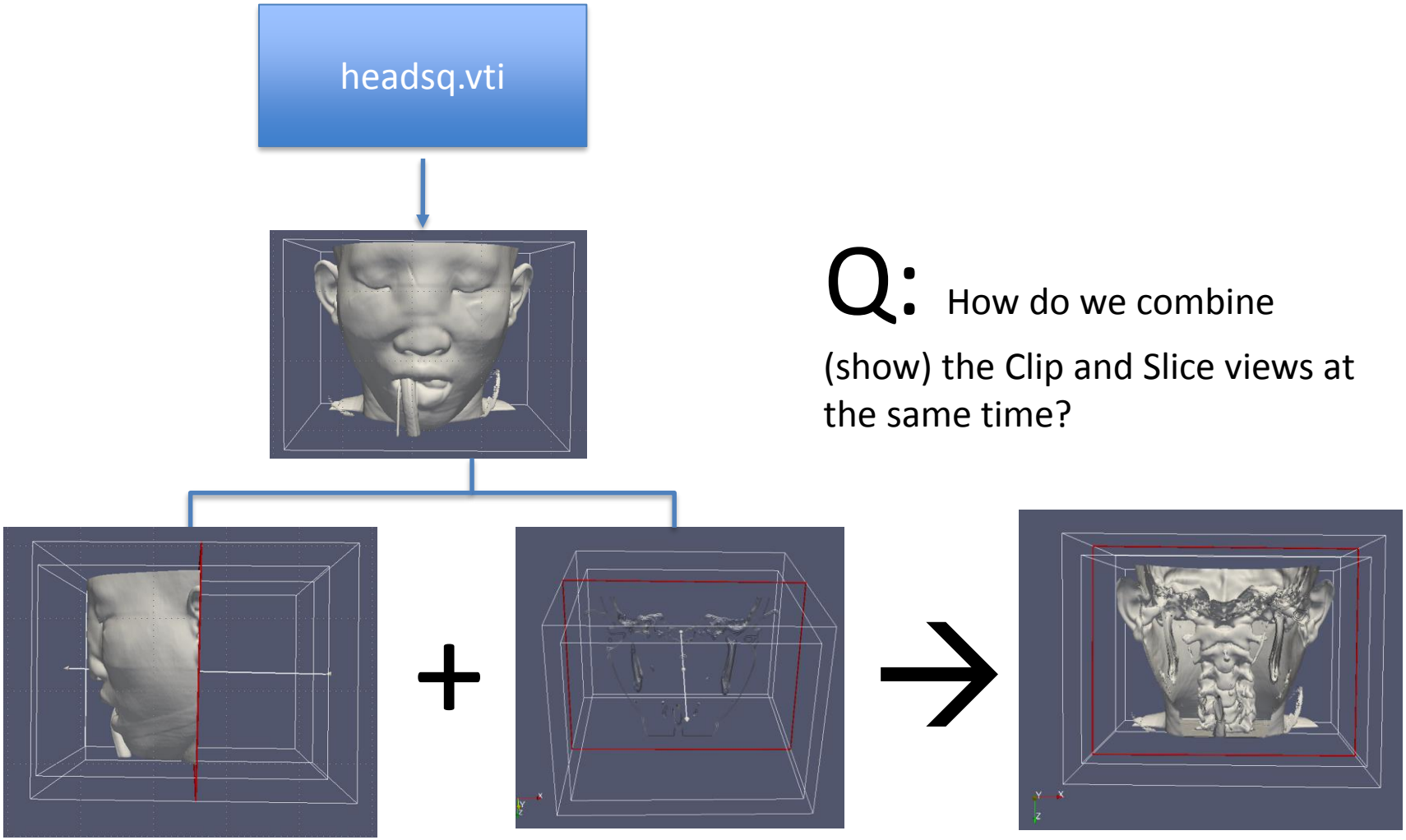
PIPELINE BROWSER





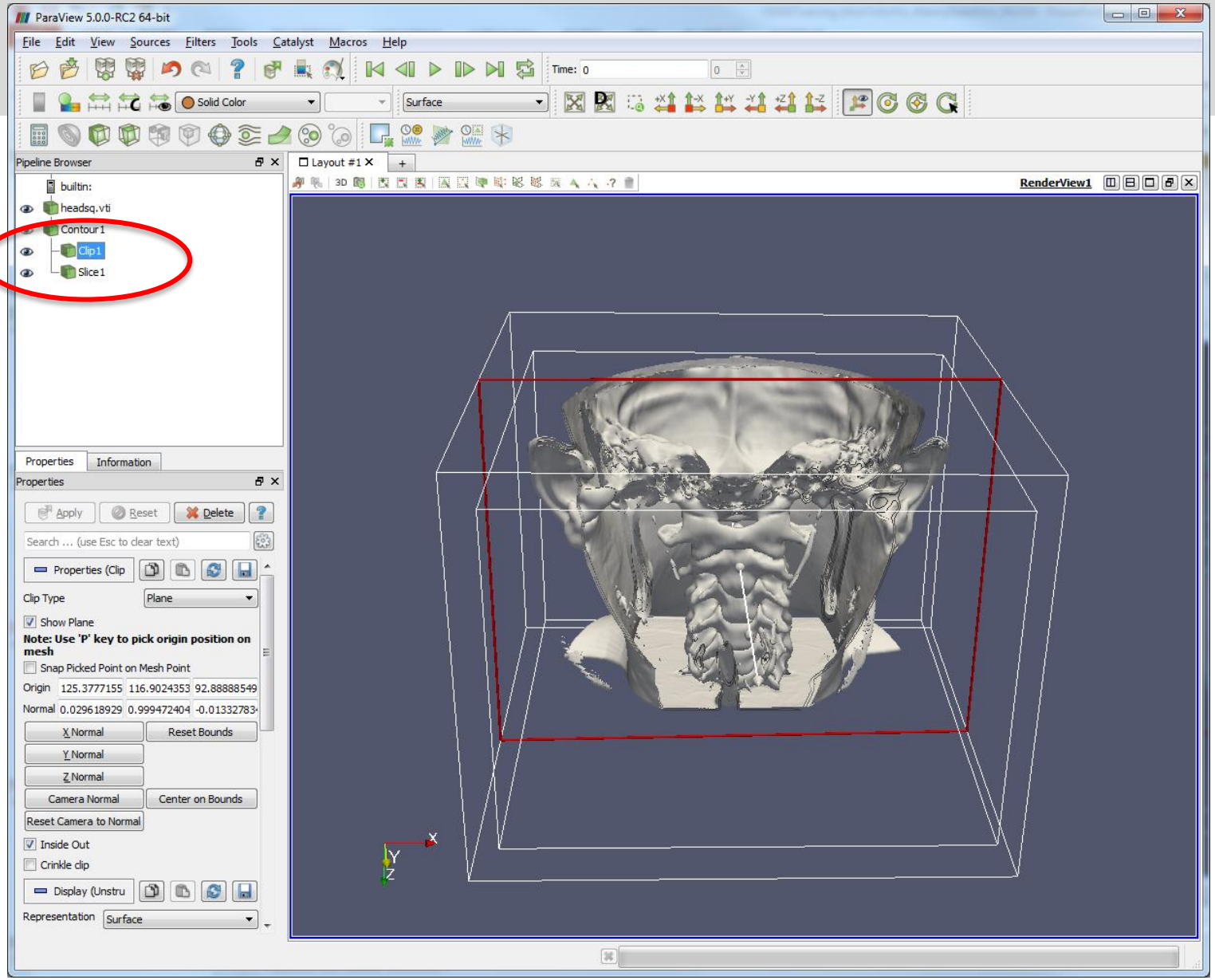
PURDUE POLYTECHNIC

PIPELINE BROWSER



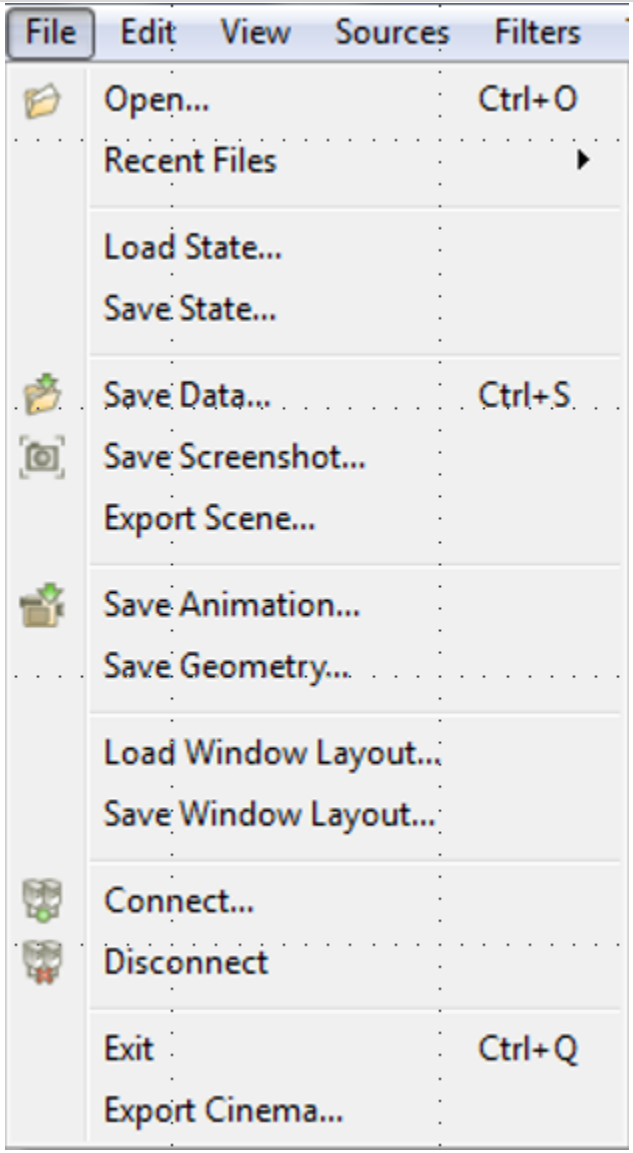
Q: How do we combine (show) the Clip and Slice views at the same time?

PURDUE POLYTECHNIC



PURDUE
POLYTECHNIC

Many Options to Save Your Work



PURDUE
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Save Your Work

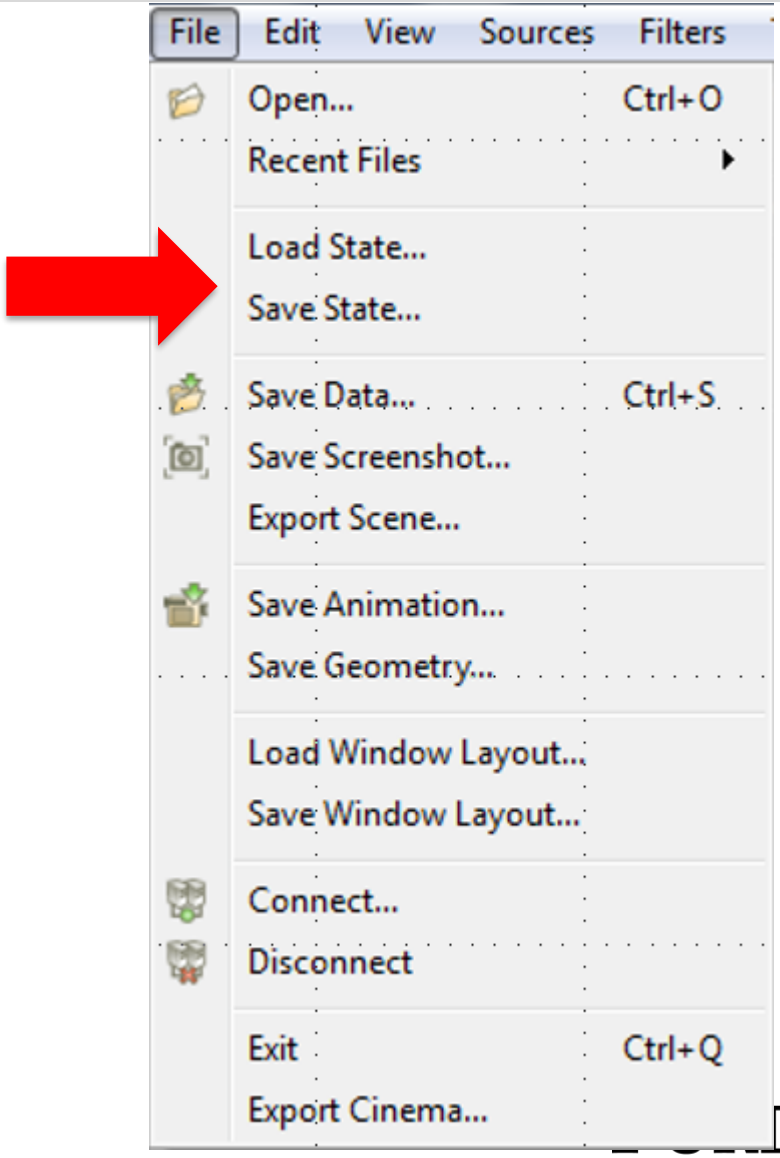
Save State

save the state of the visualization pipeline itself,
including all the pipeline modules, views, their layout, and their properties.

This is referred to as the application state or,
just, state.

In paraview, you can save the state using the File Save State. . . menu option.

Conversely, to load a saved state file, you can use File Load State. . . .



Save Your Work

Save Data

You can save the dataset produced by any pipeline module in ParaView, including sources, readers, and filters.

To save the dataset in paraview, begin by selecting the pipeline module in the Pipeline browser to make it the active source.

For modules with multiple output ports, select the output port producing the dataset of interest.

To save the dataset, use the File Save Data menu or the button in the Main Controls toolbar. You can also use the keyboard shortcut Ctrl + S (or + S).

The Save File dialog will allow you to select the filename and the file format. The available list of file formats depends on the type of the dataset you are trying to save.

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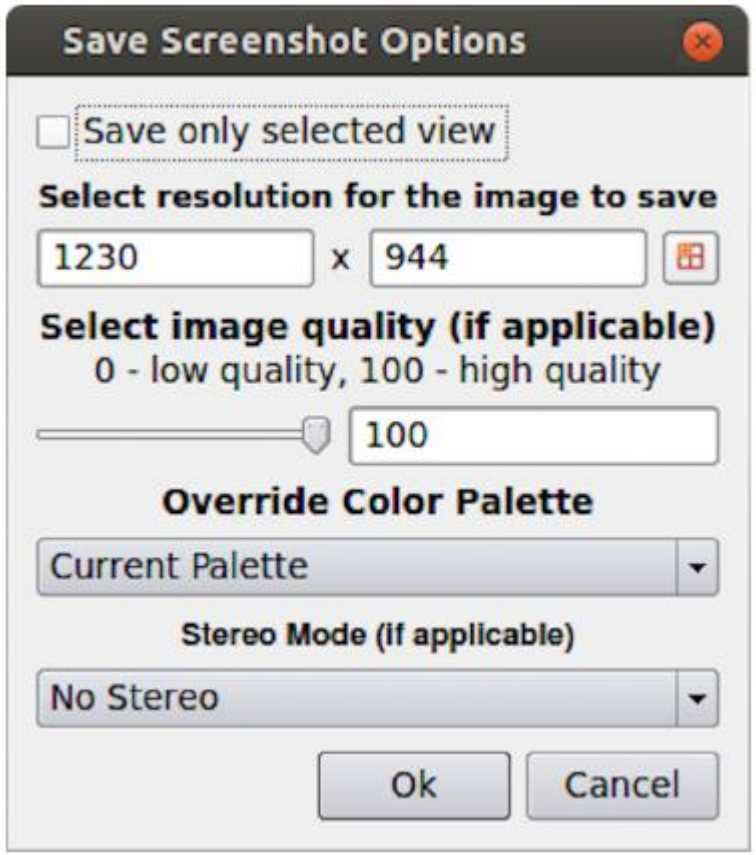
Save Your Work

Save Screenshot

To save the render image from a view in paraview, use the File Save Screenshot menu option. This will pop up the Save Screenshot Options dialog (Figure 8.3).

This dialog allows you to select various image parameters, such as image resolution and image quality (which depends on the file format chosen).



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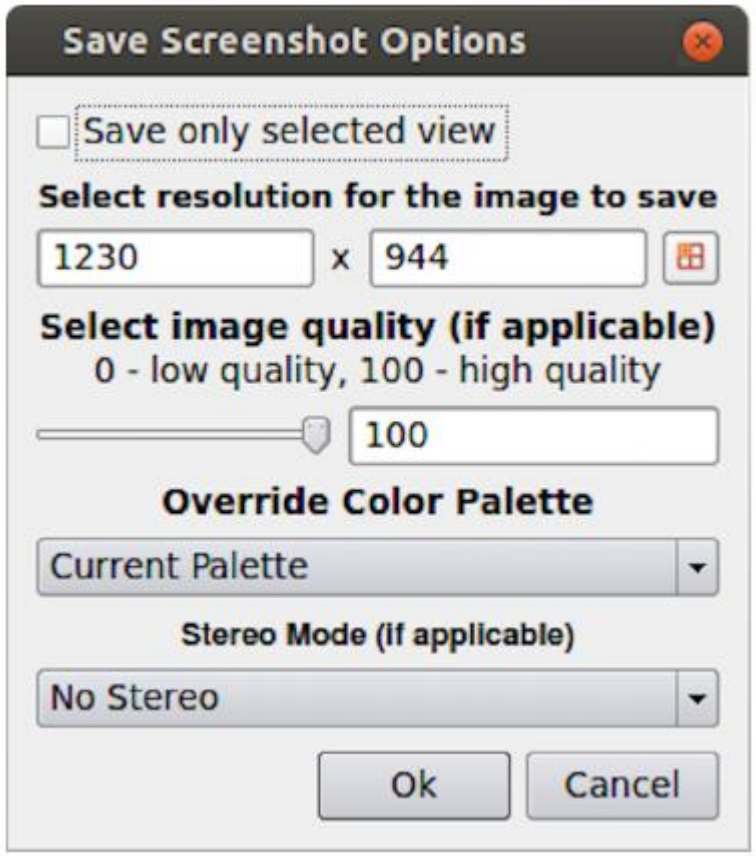
Save Your Work

Save Screenshot continued . . .

The dialog also provides an option to change the color palette to use to save the image using Override Color Palette.

By default, paraview will save rendered results from the active view. Optionally, you can save an image comprising of all

the views layed out exactly as on the screen by unchecking the Save only selected view button.

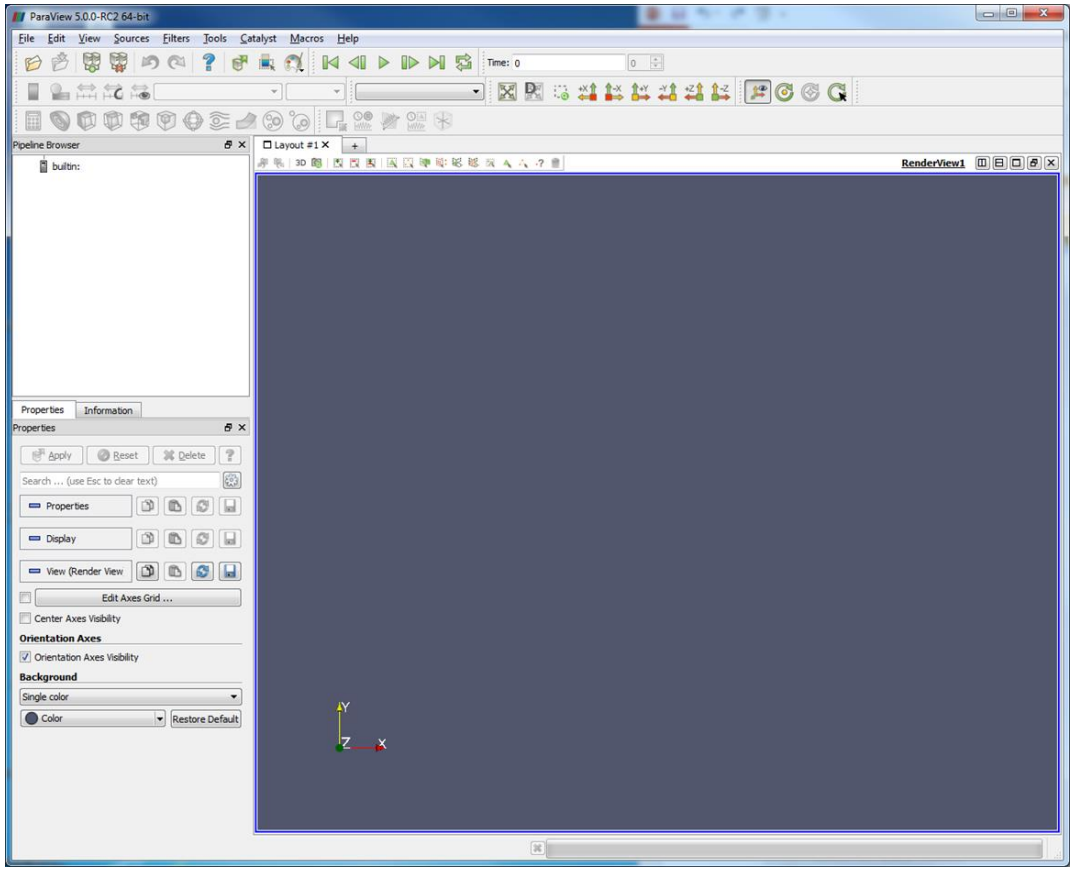


PURDUE POLYTECHNIC

In preparation for the next section

- Delete all objects in the Pipeline Browser
- Select an object in the Pipeline Browser
- Click the Delete button (or right click, then Delete)
- To select multiple objects press and hold the CTRL key while selecting objects

You should be here



PURDUE POLYTECHNIC

Getting Your Data Into VTK File Format

Sample File

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Supported Data Formats

- VTK (http://www.vtk.org/VTK/img/file-formats.pdf)
- EnSight
- Plot3D
- Various polygonal formats
- Users can write data readers to extend support to other formats
- Conversion to the VTK format is straightforward

VTK Simple Legacy Format

VTK simple legacy format (http://www.vtk.org/VTK/img/file-formats.pdf)

- ASCII or binary
- Supports all VTK grid types
- Easiest for data conversion

```
# vtk DataFile Version 2.0                    ] (1)
Really cool data                              ] (2)
ASCII | BINARY                                ] (3)
DATASET type                                  ]
...                                           ] (4)
POINT_DATA n                                  ]
...                                           ]
CELL_DATA n                                   ] (5)
...                                           ]
```

Part 1: Header

Part 2: Title (256 characters maximum, terminated with newline \n character)

Part 3: Data type, either ASCII or BINARY

Part 4: Geometry/topology. *Type* is one of:

`STRUCTURED_POINTS`
`STRUCTURED_GRID`
`UNSTRUCTURED_GRID`
`POLYDATA`
`RECTILINEAR_GRID`
`FIELD`

Part 5: Dataset attributes. The number of data items *n* of each type must match the number of points or cells in the dataset. (If *type* is `FIELD`, point and cell data should be omitted.

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Simulated Temperature

The data

- Simulated temperature values
- Sample size: 100 x 100
- Rectilinear Grid

100 100

20.18	20.36	20.54	20.73	20.93	21.13	21.35	21.58
20.36	20.72	21.08	21.46	21.85	22.26	22.68	23.14
20.53	21.07	21.61	22.17	22.75	23.36	23.99	24.67
20.70	21.41	22.13	22.86	23.63	24.42	25.26	26.15
20.86	21.74	22.62	23.53	24.47	25.45	26.48	27.57
21.02	22.05	23.10	24.17	25.28	26.43	27.64	28.92
21.17	22.35	23.54	24.77	26.03	27.35	28.73	30.18
21.31	22.63	23.96	25.33	26.74	28.21	29.74	31.35
21.44	22.88	24.35	25.85	27.40	29.00	30.67	32.43
21.56	23.12	24.71	26.33	28.00	29.73	31.52	33.41
21.66	23.34	25.04	26.77	28.54	30.38	32.29	34.28
21.76	23.53	25.33	27.15	29.03	30.96	32.96	35.05
21.85	23.70	25.58	27.50	29.46	31.47	33.56	35.73
21.92	23.85	25.81	27.80	29.83	31.91	34.07	36.31
21.99	23.98	26.00	28.05	30.14	32.29	34.50	36.79
22.04	24.09	26.16	28.26	30.41	32.60	34.86	37.18
22.09	24.18	26.29	28.44	30.62	32.85	35.14	37.50
22.12	24.25	26.40	28.57	30.78	33.04	35.35	37.73
22.15	24.30	26.48	28.67	30.91	33.18	35.51	37.89
22.17	24.34	26.53	28.74	30.98	33.27	35.60	37.99
22.18	24.36	26.56	28.78	31.03	33.31	35.64	38.02
22.18	24.37	26.57	28.78	31.03	33.31	35.63	38.00
22.18	24.36	26.55	28.77	31.00	33.27	35.58	37.92
22.17	24.34	26.53	28.73	30.95	33.20	35.48	37.80
22.15	24.31	26.48	28.66	30.87	33.10	35.35	37.65
22.13	24.27	26.42	28.58	30.76	32.97	35.19	37.45
22.11	24.23	26.35	28.49	30.64	32.81	35.00	37.23
22.08	24.17	26.27	28.37	30.49	32.63	34.79	36.97

PURDUE POLYTECHNIC

vtk Format

 # vtk DataFile Version 2.0
Rectilinear grid of temperature values
ASCII
DATASET RECTILINEAR_GRID

```
# vtk DataFile Version 2.0                    ] (1)
Really cool data                              ] (2)
ASCII | BINARY                                ] (3)
DATASET type                                  ]
...                                           ] (4)
POINT_DATA n                                  ]
...                                           ] (5)
CELL_DATA n                                   ]
...                                           ]
```

Part 1: Header

Part 2: Title (256 characters maximum, terminated with newline \n character)

Part 3: Data type, either ASCII or BINARY

Part 4: Geometry/topology. *Type* is one of:

```
STRUCTURED_POINTS
STRUCTURED_GRID
UNSTRUCTURED_GRID
POLYDATA
RECTILINEAR_GRID
FIELD
```

Part 5: Dataset attributes. The number of data items *n* of each type must match the number of points or cells in the dataset. (If *type* is FIELD, point and cell data should be omitted.

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vtk Format

```
# vtk DataFile Version 2.0
Rectilinear grid of temperature values
ASCII
DATASET RECTILINEAR_GRID
DIMENSIONS 100 100 1

X_COORDINATES 100 float
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52
53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76
77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99

Y_COORDINATES 100 float
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52
53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76
77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99

Z_COORDINATES 1 float
0
```

* Although this is a 2D grid, the z-coordinate must be included and represented in the DIMENSIONS

PURDUE POLYTECHNIC

vtk Format

```
# vtk DataFile Version 2.0
Rectilinear grid of temperature values
ASCII
DATASET RECTILINEAR_GRID
DIMENSIONS 100 100 1
X_COORDINATES 100 float
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52
53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76
77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99
Y_COORDINATES 100 float
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52
53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76
77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99
Z_COORDINATES 1 float
0
POINT_DATA 10000
SCALARS temperature  float
LOOKUP_TABLE default
```

* x-dimension * y-dimension * z-dimension

PURDUE POLYTECHNIC

vtk Format

```
# vtk DataFile Version 2.0
Rectilinear grid of temperature values
ASCII
DATASET RECTILINEAR_GRID
DIMENSIONS 100 100 1
X_COORDINATES 100 float
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64
65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
95 96 97 98 99
Y_COORDINATES 100 float
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64
65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94
95 96 97 98 99
Z_COORDINATES 1 float
0
POINT_DATA 10000
SCALARS temperature  float
LOOKUP_TABLE default
20.18 20.36 20.54 20.73 20.93 21.13 21.35 21.58 21.82 22.09 22.38 22.70 23.06 23.46 23.92 24.44 25.05 25.77
26.63 27.68 28.99 30.68 32.90 35.99 40.50 47.61 60.00 84.65 142.03 300.00 300.00 300.00 300.00 300.00
300.00 300.00 300.00 289.04 288.50 287.82
:
:
```

PURDUE POLYTECHNIC

SAMPLE DATA FILE

Data Files

Header.txt
xCoordinates.txt
yCoordinates.txt
zCoordinates.txt
lookUpTable.txt

Task:

Combine these files into one file and save

SampleData.vkt

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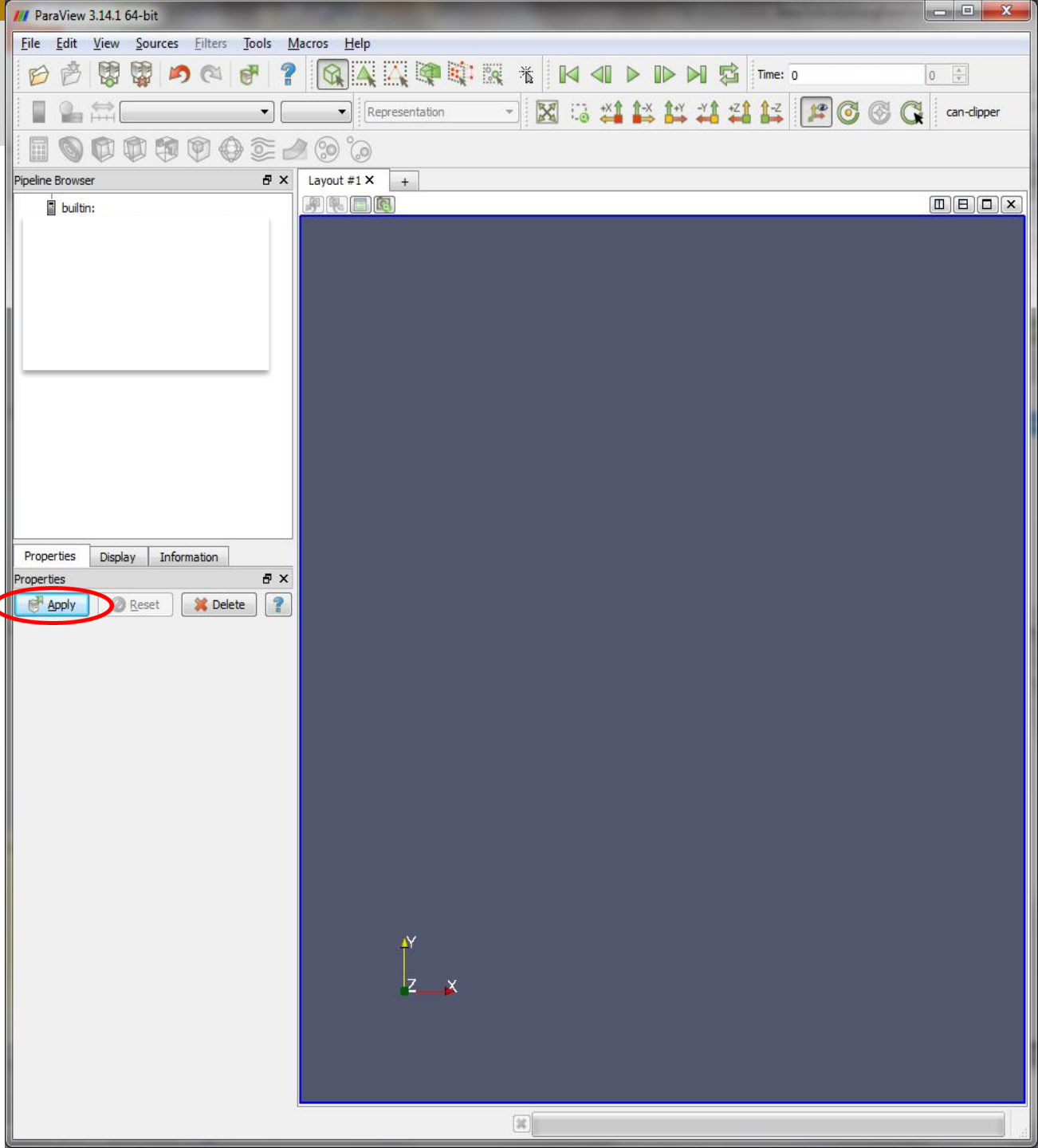
- Open data file (the file that you just created and saved
- Click **Apply**



EXERCISE: VISUALIZE SAMPLE DATA

Add Contour Plot

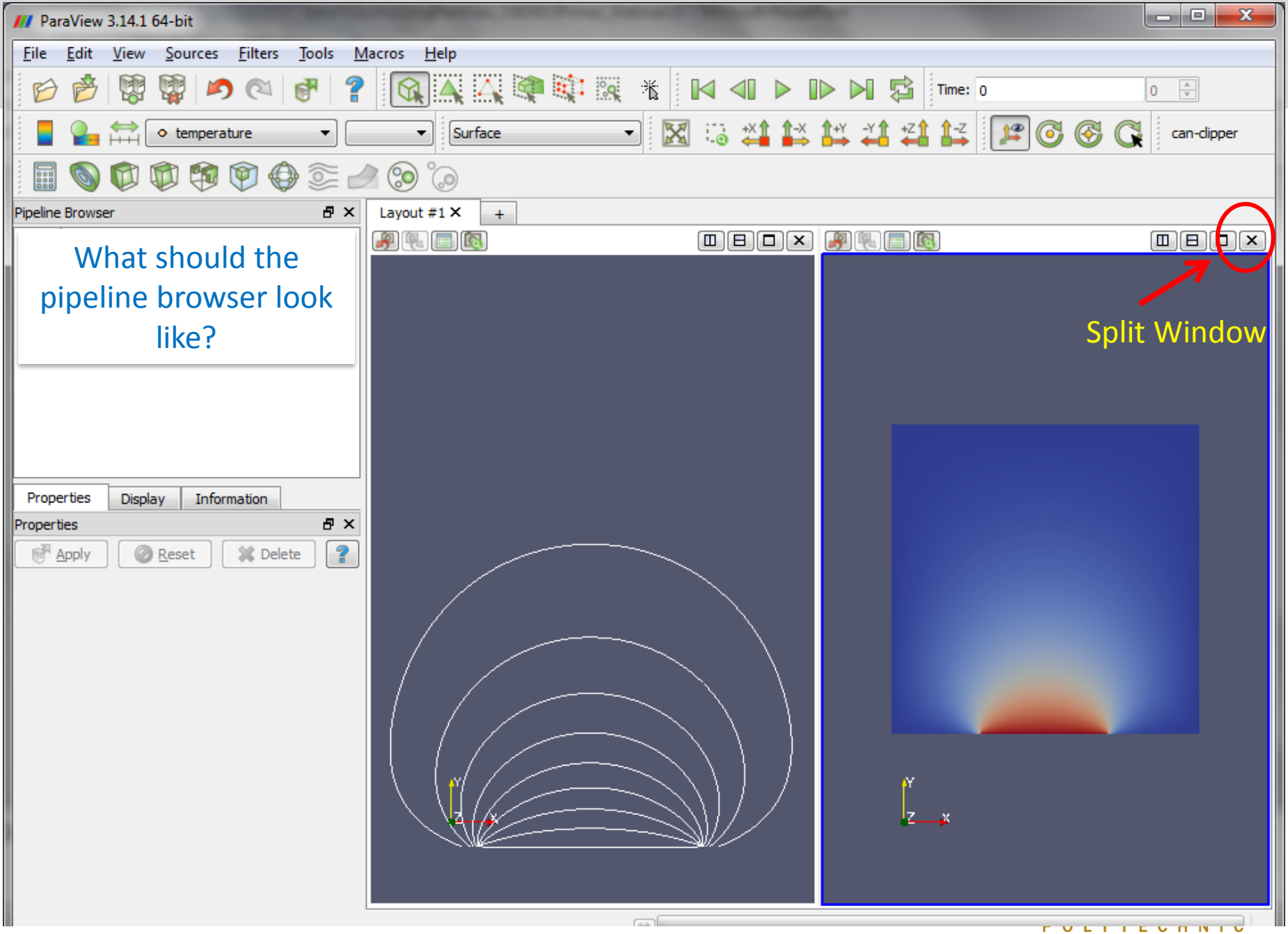
Set the range of values

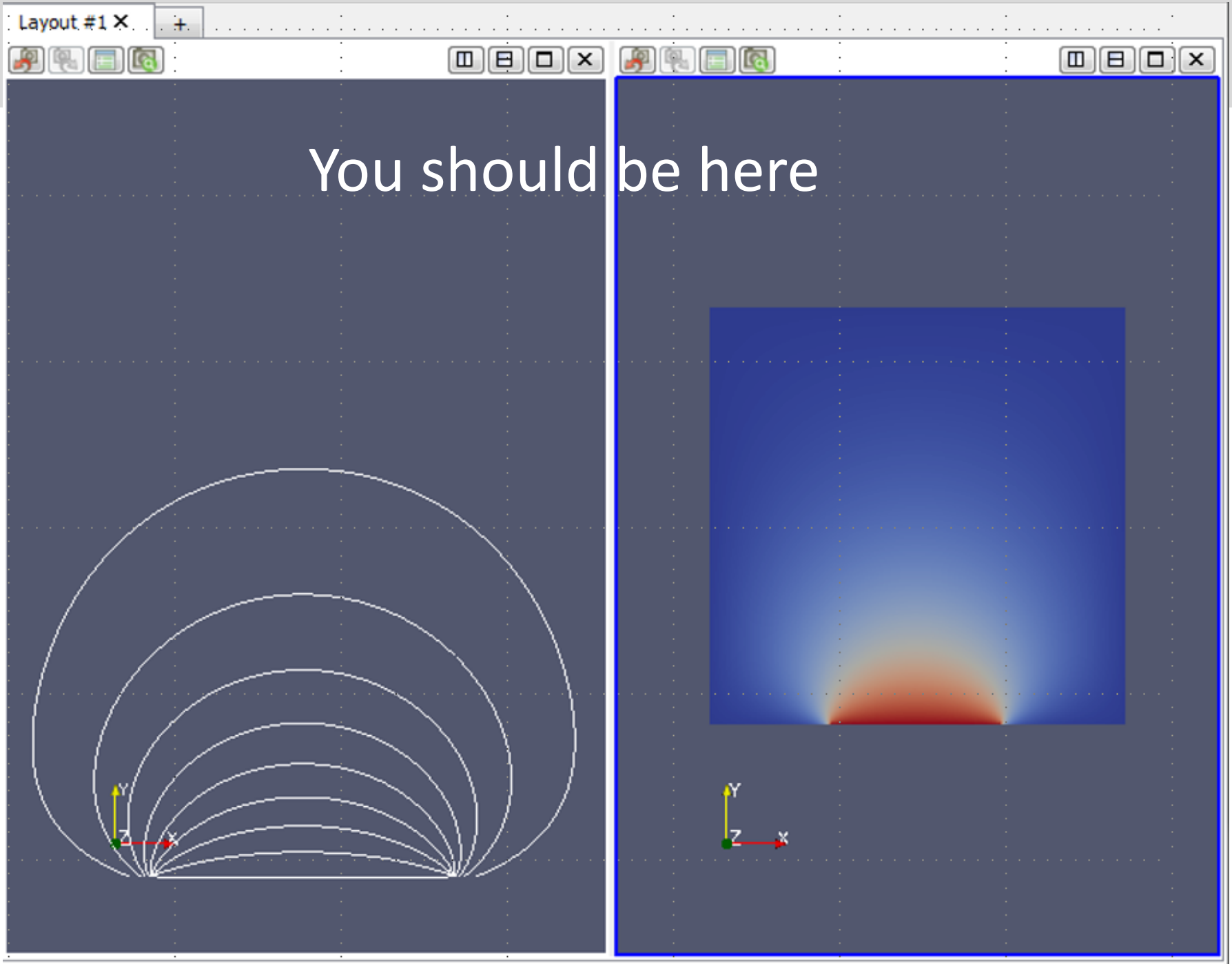
From 20.01

To: 300

Step 10

PURDUE POLYTECHNIC


ParaView 3.14.1 64-bit
File Edit View Sources Filters Tools Macros Help
Time: 0
temperature
Surface
can-clipper
Pipeline Browser
What should the pipeline browser look like?
Properties Display Information
Properties
Apply Reset Delete
Layout #1
Split Window


Layout #1
You should be here
Y
Z
X
Y
Z
X