



# Interactive Visual Analysis Tools – ParaView –

Tutorial: Interactive Visual Analysis of Scientific Data

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# What Is ParaView?

- Open-source, cross-platform application for visualization and analysis of 2D/3D/4D datasets
- Developed by *Kitware*, based on *Visualization Toolkit (VTK)*
- Modular, scalable distributed-memory parallel architecture
- Client/Server visualization
- Pipeline-based data processing
- Extensive scripting and batch processing capabilities
  
- Tutorial part is based on ParaView's Version 3.14.1
- See <http://www.paraview.org/> for download, extensive documentation and application examples

# Which Data Formats Can Be Handled?

## Name

<a href="#">LSDynaReader</a>	Read LS-Dyna databases	<a href="#">NetCDF Reader</a>	Reads regular array CF conventions.	<a href="#">CSV Reader</a>	Reads a comma-separated
<a href="#">PVD Reader</a>	Load a dataset stored in PVD	<a href="#">BYU Reader</a>	Reads Movie.BYU files	<a href="#">MFIxReader</a>	Reads a dataset in MFIx file
<a href="#">XML PolyData Reader</a>	Reads serial VTK XML PolyData	<a href="#">Wavefront OBJ Reader</a>	Reads Wavefront .OBJ files	<a href="#">FLUENTReader</a>	Reads a dataset in Fluent file
<a href="#">XML Unstructured Grid Reader</a>	Reads serial VTK XML Unstructured Grid	<a href="#">proSTAR (STARCD) Reader</a>	Reads geometry in proSTAR	<a href="#">OpenFOAMReader</a>	Reads OpenFOAM data files
<a href="#">XML Image Data Reader</a>	Reads serial VTK XML Image Data	<a href="#">XDMF Reader</a>	Reads XDMF (eXtensible Data Model Format)	<a href="#">COSMO Reader</a>	Reads a cosmology file into
<a href="#">XML Structured Grid Reader</a>	Reads serial VTK XML Structured Grid	<a href="#">PDB Reader</a>	Reads PDB molecule files	<a href="#">ExodusIIReader</a>	Reads an Exodus II file to pr
<a href="#">XML Rectilinear Grid Reader</a>	Reads serial VTK XML Rectilinear Grid	<a href="#">XYZ Reader</a>	Reads XYZ molecule files	<a href="#">Restarted Sim Exodus Reader</a>	Reads collections of Exodus
<a href="#">XML Partitioned Polydata Reader</a>	Reads the summary file for a partitioned PolyData	<a href="#">PLOT3D Reader</a>	Reads ASCII or binary PLOT3D	<a href="#">SLAC Data Reader</a>	
<a href="#">XML Partitioned Unstructured Grid Reader</a>	Reads the summary file for a partitioned Unstructured Grid	<a href="#">Spy Plot Reader</a>	Reads files in the Spy Plot	<a href="#">SLAC Particle Data Reader</a>	
<a href="#">XML Partitioned Image Data Reader</a>	Reads the summary file for a partitioned Image Data	<a href="#">Restarted Sim Spy Plot Reader</a>	Reads collections of Restarted Sim Spy Plot	<a href="#">Particles Reader</a>	Reads particle data.
<a href="#">XML Partitioned Structured Grid Reader</a>	Reads the summary file for a partitioned Structured Grid	<a href="#">spcTh history reader</a>	Reads an spcTh history and properties.	<a href="#">VPIC Reader</a>	Reads distributed VPIC files
<a href="#">XML Partitioned Rectilinear Grid Reader</a>	Reads the summary file for a partitioned Rectilinear Grid	<a href="#">DEM Reader</a>	Reads a DEM (Digital Elevation Model)	<a href="#">WindBlade reader</a>	Reads WindBlade/Firetec s
<a href="#">XML MultiBlock Data Reader</a>	Reads a VTK XML MultiBlock	<a href="#">VRML Reader</a>	Load the geometry from VRML	<a href="#">NetCDF CAM reader</a>	Reads unstructured grid data a cell connectivity file set as
<a href="#">XML Hierarchical Box Data reader</a>	Reads a VTK XML-based Hierarchical Box Data	<a href="#">PLY Reader</a>	Reads files stored in PLY	<a href="#">NetCDF POP reader</a>	Reads rectilinear grid data f
<a href="#">Legacy VTK Reader</a>	Reads files stored in VTK Legacy	<a href="#">STL Reader</a>	Reads ASCII or binary STL	<a href="#">Parallel NetCDF POP reader</a>	Reads rectilinear grid data f
<a href="#">Partitioned Legacy VTK Reader</a>	Reads files stored in VTK Legacy	<a href="#">Gaussian Cube Reader</a>	Produce polygonal data by reading a Gaussian Cube file.	<a href="#">NetCDF MPAS reader</a>	Reads unstructured grid MP
<a href="#">EnSight Reader</a>	Reads EnSight 6 and 6.2	<a href="#">Image Reader</a>	Reads raw regular rectilinear grid data from a file. The dimensions and type of the		
<a href="#">EnSight Master Server Reader</a>	Reads files in EnSight's Master Server	<a href="#">POP Reader</a>	Reads data files from the Parallel Ocean Program (POP).		
<a href="#">Tecplot Reader</a>	Reads files in the Tecplot	<a href="#">AVS UCD Reader</a>	Reads binary or ASCII files stored in AVS UCD format.		
<a href="#">NetCDF Reader</a>	Reads regular arrays from NetCDF CF conventions.	<a href="#">Meta File Series Reader</a>	Reads a series of meta images.		
		<a href="#">Nrrd Reader</a>	Reads raw image files with Nrrd meta data.		
		<a href="#">FacetReader</a>	Reads ASCII files stored in Facet format.		
		<a href="#">PNG Series Reader</a>	Reads a PNG file into an image data.		
		<a href="#">JPEG Series Reader</a>	Reads a series of JPEG files into an time sequence of image datas.		
		<a href="#">TIFF Series Reader</a>	Reads a series of TIFF files into an time sequence of image datas.		
		<a href="#">Phasta Reader</a>	Reads the parallel Phasta meta-file and the underlying Phasta files.		
		<a href="#">Enzo Reader</a>	Reads multi-block dataset from an Enzo file.		
		<a href="#">Flash Reader</a>	Reads multi-block dataset from a Flash file.		
		<a href="#">SESAME Reader</a>	Reads SESAME data files, producing rectilinear grids.		

# User Interface

The screenshot displays a software interface with several key components:

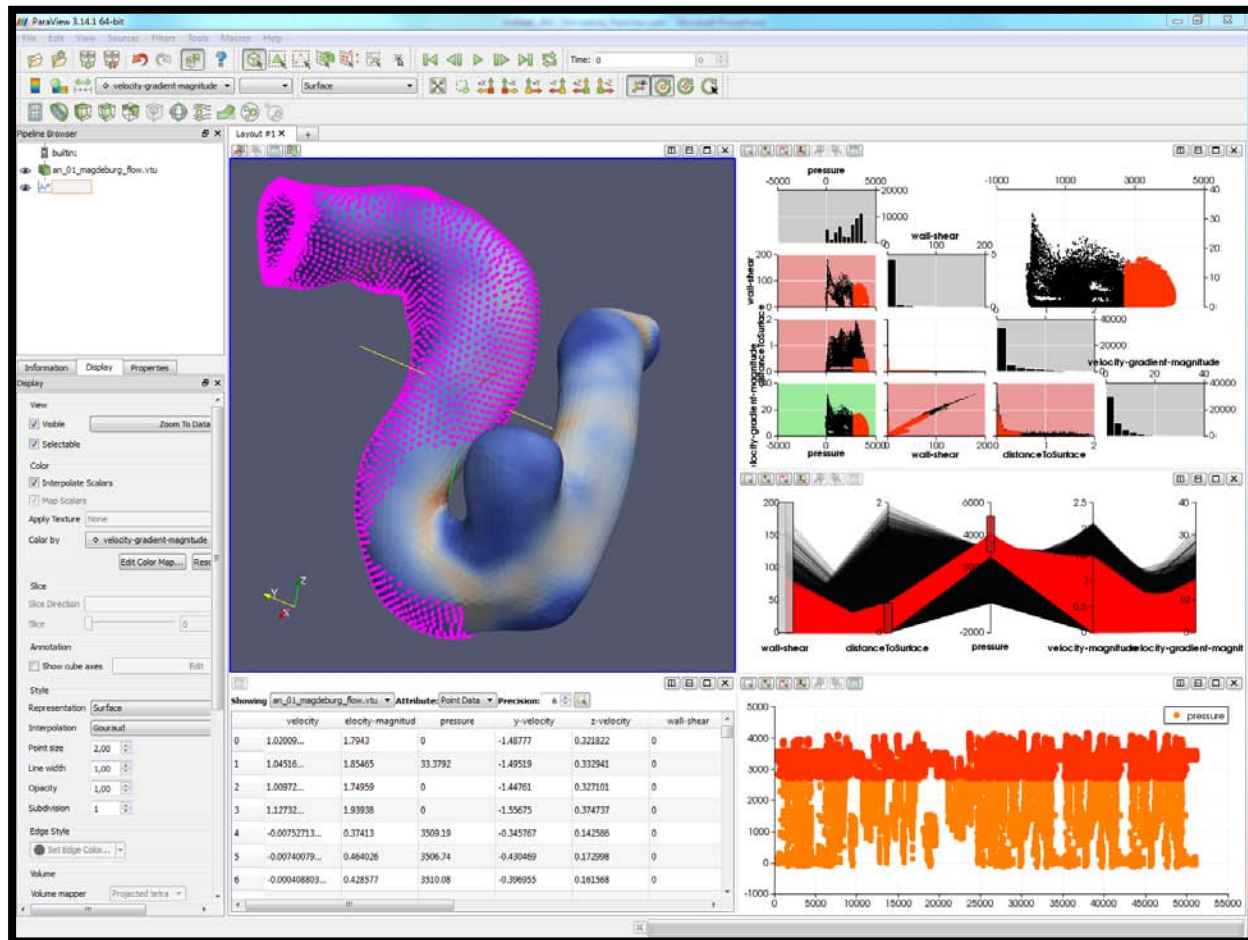
- Top Menu Bar:** Includes File, Edit, View, Sources, Filters, Animation, Tools, and Help.
- Toolbars:**
  - Animation Toolbar:** Contains play, stop, and frame navigation icons.
  - Common Filters Toolbar:** Contains icons for various filter operations.
  - View Configuration Buttons:** Located on the right side of the 3D view, used to switch between different visualization modes.
- Left Panel:**
  - Pipeline Browser:** A tree view showing the data processing pipeline with nodes like ExtractGrid2, Contour1, Clip1, StreamTracer1, TubeFilter1, ExtractSelections1, ExtractHistogram1, and ProbeLine1.
  - Object Inspector:** Shows properties for the selected object, including a table of Process ID and Index.
  - Animation Inspector:** Controls playback settings such as Current Time, Start Time, End Time, and No. Of Frames.
- Central Area:**
  - Bar Chart View:** A histogram showing the distribution of data points across a range from 0.21 to 0.64.
  - 3D View:** A 3D visualization of a complex object with a color scale for Density, ranging from 0.203 (blue) to 0.655 (red).
  - Spreadsheet View:** A table displaying numerical data for various parameters across 16 rows.
 

	Density	Momentum	StagnatorEnergy	Pressure	Temperature	Enthalpy
1	0.256317	124.524 58.0506	0	-15267.8	-99585.7	-208550
2	0.256317	124.524 58.0506	0	-15267.8	-99585.7	-208550
3	0.256317	124.524 58.0506	0	-15267.8	-99585.7	-208550
4	0.256317	124.524 58.0506	0	-15267.8	-99585.7	-208550
5	0.251452	117.216 9.67272	0	-12907.2	-51112.3	-178893
6	0.251452	117.216 9.67272	0	-12907.2	-51112.3	-178893
7	0.251452	117.216 9.67272	0	-12907.2	-51112.3	-178893
8	0.251452	117.216 9.67272	0	-12907.2	-51112.3	-178893
9	0.248809	129.658 -32.1293	0	-15918.3	-62994.9	-220482
10	0.248809	129.658 -32.1293	0	-15918.3	-62994.9	-220482
11	0.248809	129.658 -32.1293	0	-15918.3	-62994.9	-220482
12	0.248809	129.658 -32.1293	0	-15918.3	-62994.9	-220482
13	0.245849	138.732 -40.1441	0	-18581.1	-74395.2	-260383
14	0.245849	138.732 -40.1441	0	-18581.1	-74395.2	-260383
15	0.245849	138.732 -40.1441	0	-18581.1	-74395.2	-260383
  - Bottom Panel:**
    - XY Plot View:** A line graph showing the variation of multiple parameters (Density, StagnatorEnergy, Pressure, Temperature, Enthalpy, KineticEnergy, VelocityMagnitude, Swirl) over a range from 0.00 to 100.00.

# Live-Demo

# IVA of a Cerebral Aneurysm

- Volume mesh composed of 181K tetrahedra
- 9 vertex attributes and 1 cell attribute



# Summary

- ParaView facilitates brushing in physical and attribute space
- Views are linked with each other
- Integrated InfoVis views: table, histogram, scatter plot, scatter plot matrix, parallel coordinates
- Features may be extracted, stored and further investigated
- Analysis sessions may be stored and loaded or even applied to another dataset (works only partially)
  
- Integrating IVA is a big step in a promising direction
- Drawbacks of current implementation:
  - Workflow and plot GUIs not always intuitive
  - Some minor bugs hamper the workflow

# More Tools

- Not many tools incorporate attribute AND physical views
  - Latter crucial for scientific data to depict spatial relations
  - Other IVA tools (tiny selection):
    - Comvis: [www.ii.uib.no/vis/...](http://www.ii.uib.no/vis/...) (send E-mail to: [Kresimir Matkovic](mailto:Kresimir.Matkovic@ii.uib.no))
    - Visplore: [www.cg.tuwien.ac.at/...](http://www.cg.tuwien.ac.at/...) (send E-mail to [Harald Piringer](mailto:Harald.Piringer@cg.tuwien.ac.at))
- Include no physical views:
- GGobi: [www.ggobi.org/](http://www.ggobi.org/)
  - XmdvTool: [davis.wpi.edu/xmdv/](http://davis.wpi.edu/xmdv/)
- Include special views for geospatial data:
- Tulip: [tulip.labri.fr/TulipDrupal/](http://tulip.labri.fr/TulipDrupal/) (physical view in related project *Systrip*)
  - Mondrian: [rosuda.org/Mondrian/Mondrian.html](http://rosuda.org/Mondrian/Mondrian.html)
- Commercial:
- Tableau: [www.tableausoftware.com/products](http://www.tableausoftware.com/products)
  - Spotfire: [spotfire.tibco.com/](http://spotfire.tibco.com/)
- Comprehensive, sorted list: [www.wikiviz.org/wiki/Tools](http://www.wikiviz.org/wiki/Tools)
  - Tools and more information: [www.visual-analytics.eu/related/](http://www.visual-analytics.eu/related/)