



Advanced ParaView

Dave DeMarle at Sixth OpenFOAM workshop

About Kitware, About ParaView

- Kitware – open source, cross platform (mac, windows, linux, HPC Unixes) software
 - CMake – cross platform build environment builder
 - VTK – visualization toolkit
 - ParaView – front end application to build scalable VTK visualizations
- Code is free, large communities contributes to it and offer free help
- Kitware charges \$ for 1:1 training/support/custom development

Credit Where Credit Is Due

- vtkOpenFOAMReader
 - ? Terry Jordan, National Energy Technology Lab
 - Initial version in VTK 2006
 - ? Philippose Rajan, ?
 - Bug fixes and optimizations.
 - 2009 Takuya Oshima, Niigata University
 - Overhaul
 - “Token-based FoamFile format lexer/parser, performance/stability/compatibility enhancements, gzipped file support, lagrangian field support, variable timestep support, builtin cell-to-point filter, pointField support, polyhedron decomposition support, OF 1.5 extended format support, multiregion support, old mesh format support, parallelization support for decomposed cases”
 - 2010 Mark Olesen, Faurecia
 - Updates to recent OpenFOAM syntax

Requirements for this tutorial

- ParaView 3.10.1 (120Mb download)
 - <http://www.paraview.org/paraview/resources/software.html>
- Data set from section 2.3 of openFOAM tutorial
 - <http://www.openfoam.com/docs/user/>
 - run
 - cp -r \$FOAM_TUTORALS/multiphase/interFoam/laminar/damBreak .
 - cd damBreak
 - blockMesh
 - interFoam
 - damBreak[|Fine|Parallel]

What's not in the OpenFOAM tutorial?

- ParaView 3.10 updates
- Parallel ParaView
- MultiView
- Temporal Processing
- Quantitative Analysis
- Batch/reproducible workflow
- Extensibility

ParaView 3.10 Updates

- User's Manual included
 - http://paraview.org/Wiki/ParaView/Users_Guide/Table_Of_Contents
 - Exercise: help and investigate OpenFOAM reader
- Numpy based calculator (grad, curl, divergence etc)
 - Exercise: help on python calculator
- Context menus
 - click on object to make it active, right click to control
- Sortable Spreadsheet View
- Parallel Coordinates View
- Parallel rendering infrastructure overhauled

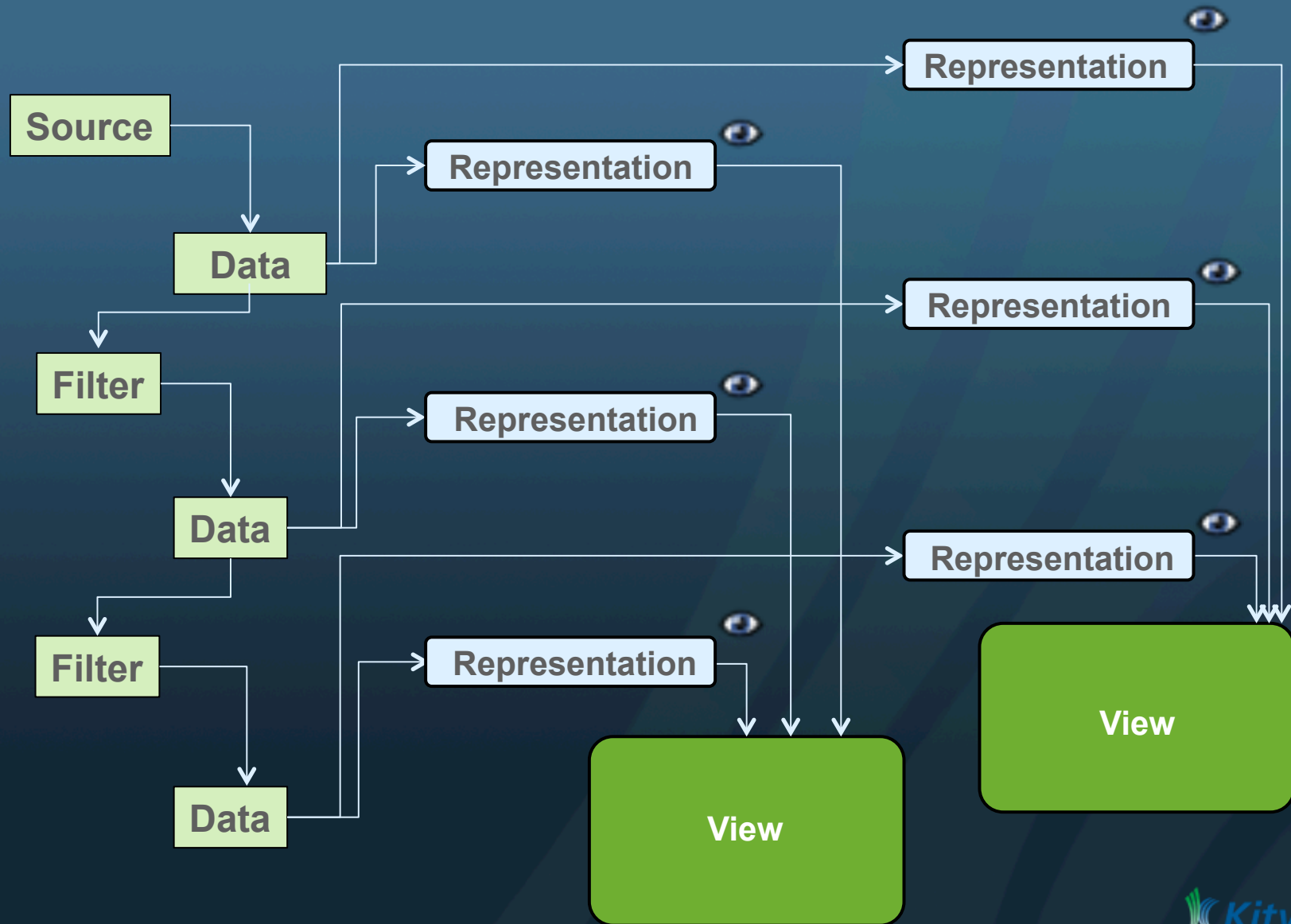
Parallel ParaView

- When reconstructPar is not an option (not enough RAM on any one machine)
 - Run pvserver as a parallel job
 - Connect client to that server
 - Open case, choose decomposed case option
- **Exercise: view damBreakParallel with all cores**

Multi-Views and Comparative View

- Multiple Views
 - Many windows on all data throughout the pipeline
 - Split view
 - Link cameras
 - Exercise: Visually compare “p” and “p_rgh” in damBreakFine

Multi-View visualization pipeline



Comparative View

- Specialization of Multi-View
- Visualize 1 or 2D parameter space
 - Where parameters are any property of a filter along the pipeline
- **Exercise: view different time steps simultaneously in damBreakFine**

Temporal Processing

- Temporal Annotation
 - Label time value that 3D view shows
- Integrate values over time
 - For each point/cell compute max/min/avg/stdev
 - **Exercise: find cells with maximum pressure**
- Path Lines
 - Advect across both time and space
- Interpolation between time steps
 - Produces smoother animations without jump discontinuities at time steps

Quantitative Analysis

- Selection : arbitrary subset of another dataset
 - Cells/points by location
 - Cells/points by value
 - Cells/points by identity
 - Blocks by identity
- Active selection shown in all applicable views simultaneously
 - Spreadsheet View <-> 3D View
- Various ways to create selections

Quantitative Analysis

- What's going on here?
 - Rubber band to select in 3D view
- Where is this going on?
 - Edit -> Find Data
 - Spreadsheet View -> Sort -> Select Rows
- Exercise: What is pressure value in cell with max pressure?
- Exercise: Use plot selection over time filter to plot variation over time of some of those cells

Quantitative Analysis

- Combine filtering, selection, and multi-view
- **Exercise: show pressure along break**
 - 1) Define curve to plot on
 - Extract surface
 - Select cells through to pick out just break
 - 2) Probe along curve defined by intersection with a plane
 - Plot on Intersection curve

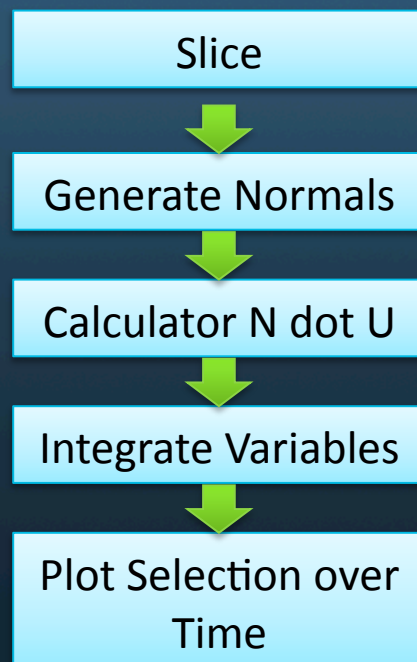
Quantitative Analysis

- Material Analysis, use topological filters
- Exercise find area/volume of a droplet and its average velocity
 - 1) Clip by scalar volume fraction to extract “water”
 - 2) Connectivity filter to isolate “droplets”
 - 3) Selection to pick one droplet
 - 4) Integrate variables to find area/volume and total velocity

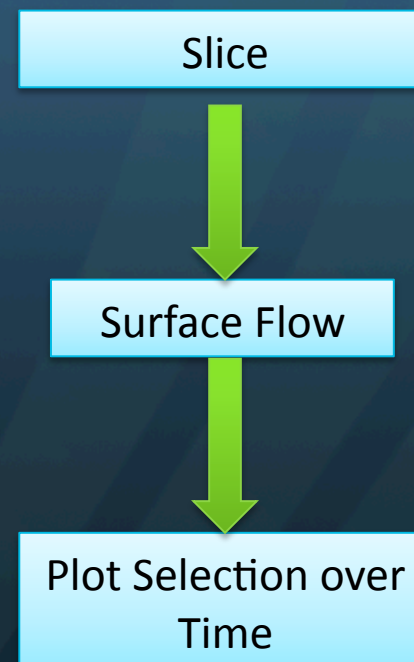
Quantitative Analysis

Exercise: Plot flux through plane over time

- Method one



- Method two



Batch/reproducible workflow

- Custom Filters
 - Create a meta filter from a portion of the pipeline
- Python Trace
 - Record actions you take from GUI as a python script
 - Save as a macro
 - Run as a batch file
- Record/Playback state
 - Save entire pipeline

See Chapter 14 “Scripted Control” in the ParaView User’s Guide for information

Batch/Reproducible Workflow

- Exercise: create a macro to do fragment finding
 - Tools -> Start Trace
 - Slice on Z
 - Connectivity
 - Tools -> Stop Trace
 - File -> Save as Macro
- Exercise: play that back on damBreakPar

Extensibility: Better living through Plugins

- ParaView's strength is flexibility/extensibility
 - Open data processing interface to user
 - We want people to make derived applications
 - We want people to add new features to it
 - It is open source and extensible at runtime(python) or compile time(plug-ins).
- Plugins - compiled c++ library to make ParaView also do X
- Tools->Manage Plugins

Plugin Examples: Advanced Rendering

- LIC - Line integral convolution
 - Convolve flow patterns on GPU
 - Quickly generate views of whole flow pattern
- Manta
 - Interactive software ray tracer (University of Utah)
 - Reflective/Refractive/Shadow effects in serial
 - Extreme geometry scaling in parallel (10 billion polygons/2000 cores = 10 frames per second)
 - Good for rendering wire models (streamlines), point clouds

Plugin Examples: Advanced Rendering

- Eye Dome Lighting
 - Non-photorealistic depth emphasizing effects in GPU
 - Augments color from depth buffer to make depth discontinuities more apparent
 - Good for rendering wire models (streamlines), point clouds
- PointSprite
 - Fast point cloud rendering in GPU
 - Great at rendering point clouds

Plugin Examples: Advanced Rendering

- **Exercise: Compare Point and Line drawing in 3D, Manta, Point Sprite, and EDL Views**
 - Cell Centers to make point cloud
 - Stream Line to make wire mesh
 - Load all three plugins
 - Split and Link Cameras to create four view types
 - Adjust Display Settings (and Manta View Preferences)
 - Point Size, Line Width, Point Sprite Representation Settings, Ray Traced Material properties

ParaView upcoming changes

- 3.12
 - Collaboration
 - Improved Cube Axis/Parallel Rendering
- 4.0
 - Streamlined GUI
 - Simplified Co-Processing/In-Situ
 - Export values to clipboard
 - Text Display, Hover Values
 - Save to Web
 - Better Statistical Analysis Filters
 - Better Find Data

Where to go to for more information

www.paraview.org portal to all things ParaView

- Wiki Page
 - <http://www.paraview.org/Wiki/ParaView>
- Mailing List
 - Sign up-><http://public.kitware.com/mailman/listinfo/paraview>
 - Search -><http://markmail.org/search/?q=list:paraview>
- User Voice - feature request voting
 - “Tell us what you think” link
 - <http://paraview.uservoice.com/forums/11350-general>
- Support
 - <http://www.kitware.com/products/support.html>