Visualization and Analysis of Massive Data with VisIt

Argonne Training Program on Extreme-Scale Computing

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VisIt Project Introduction (25 min)

- Connecting to ALCF resources
- VisIt Demo (25 min)
- Questions (10 min)



VisIt is an open source, turnkey application for data analysis and visualization of mesh-based data.

- Production end-user tool supporting scientific and engineering applications.
- Provides an infrastructure for parallel post-processing that scales from desktops to massive HPC clusters.
- Source released under a BSD style license.



Density Isovolume of a 3K^3 (27 billion cell) dataset

VisIt supports a wide range of use cases.





Quantitative Analysis





Comparative Analysis



Examples of VisIt's visualization capabilities.



Streamlines



Volume Rendering



Vector / Tensor Glyphs



Molecular Visualization



Pseudocolor Rendering



Parallel Coordinates



VisIt uses MPI for distributed-memory parallelism on HPC clusters.



We are enhancing VisIt's pipeline infrastructure to also support threaded processing.

VisIt is a vibrant project with many participants.

- The VisIt project started in 2000 to support LLNL's large scale ASC physics codes.
- The project grew beyond LLNL and ASC with research and development from DOE SciDAC and other efforts.
- VisIt is now supported by multiple organizations:
 - LLNL, LBNL, ORNL, UC Davis, Univ of Utah, ...
- Over 75 person years effort, 1.5+ million lines of code.



Analysis Example: Evolution of Vorticity

 Goal: Identify and track coherent vortical structures in turbulent flow as time evolves.



Collaboration with Kelly Gaither, TACC et al (IEEE CG&A July/August 2012)

VisIt was used to calculate isosurfaces, identify connected components, and extract component features.

Analysis Example: Turbulence Operators

- Goal: Provide a one set of turbulence tools that can be used across multiple codes.
- Application: Validate RANS model parameters from high fidelity DNS simulations.



Joint work with Oleg Schilling, LLNL

We are developing scripted building blocks for flow analysis, including field means and fluctuations.



Project Introduction VisIt scales well on current HPC platforms.

Machine	Architecture	Problem Size	# of Cores	
Graph	X86_64	20,001 ³ (8 T cells)	12K	
Dawn	BG/P	15,871 ³ (4 T cells)	64K	
Franklin	Cray XT4	12,596 ³ (2 T cells)	32K	3 Co
JaguarPF	Cray XT5	12,596 ³ (2 T cells)	32K	DR online, 112 beer
Juno	X86_64	10,000 ³ (1 T cells)	16K	
Franklin	Cray XT4	10,000 ³ (1 T cells)	16K	the state
Ranger	Sun	10,000 ³ (1 T cells)	16K	
Purple	IBM P5	8,000 ³ (0.5 T cells)	8K	

Scaling Studies of Isosurface Extraction and Volume Rendering (2009)

VisIt is also used daily by domain scientists.

The VisIt team focuses on making a robust, usable product for end users.

- Regular releases (~ 6 / year)
 - Executables for all major platforms
 - End-to-end build process script ``build_visit"
- Customer Support and Training
 - visitusers.org, wiki for users and developers
 - Email lists: visit-users, visit-developers
 - Beginner and advanced tutorials
 - VisIt class with detailed exercises
- Documentation
 - "Getting data into VisIt" manual
 - Python interface manual
 - Users reference manual

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Slides from the VisIt class

VisIt provides a flexible data model, suitable for many application domains.

Mesh Types:

- Point, Curve, 2D/3D Rectilinear, Curvilinear, Unstructured
- Domain Decomposed, AMR
- Time Varying

Fields:

 Scalar, Vector, Tensor, Material volume fractions, Species





VisIt currently supports over 110 file formats.



VisIt employs a parallelized client-server architecture.

Local Components

Parallel Cluster





VisIt automatically switches to a scalable rendering mode for large data sets.



- Rendering Modes:
 - Local (hardware)
 - Remote (software or hardware)
- Beyond surfaces:
 - VisIt also provides scalable volume rendering.

VisIt's infrastructure provides a flexible platform for custom workflows.

- C++ Plugin Architecture
 - Custom File formats, Plots, Operators
 - Interface for custom GUIs in Python, C++ and Java
- Python Interfaces
 - Python scripting and batch processing
 - Data analysis via Python Expressions and Queries.
- Libsim library
 - Enables coupling of simulation codes to VisIt for in situ visualization.





VisIt is used as a platform to deploy visualization research.

Research Collaborations:
 2006 – 2011



UT/TACC Subcontract

- Research Focus:
 - Next Generation Architectures
 - Parallel Algorithms



Scaling research: Scaling to 10Ks of cores and trillions of cells.



Algorithms research: How to efficiently calculate particle paths in parallel.



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Using Vislt on Argonne ALCF Tukey

Argonne Leadership Computing Facility

an Office of Science user facility



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User Guides	Vislt on Tukey
How to Get an Allocation	Getting Started
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Accounts & Access	 Download (https://wci.llnl.gov/codes/visit/download.html) and install Visit (The version installed on Tukey is
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https://www.alcf.anl.gov/user-guides/visit-tukey

Using Vislt on Argonne ALCF Tukey

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	Default number of processors 80
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	Default Time Limit 60
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VisIt Demo