High Performance Visualization :
Scaling Rendering and Perception

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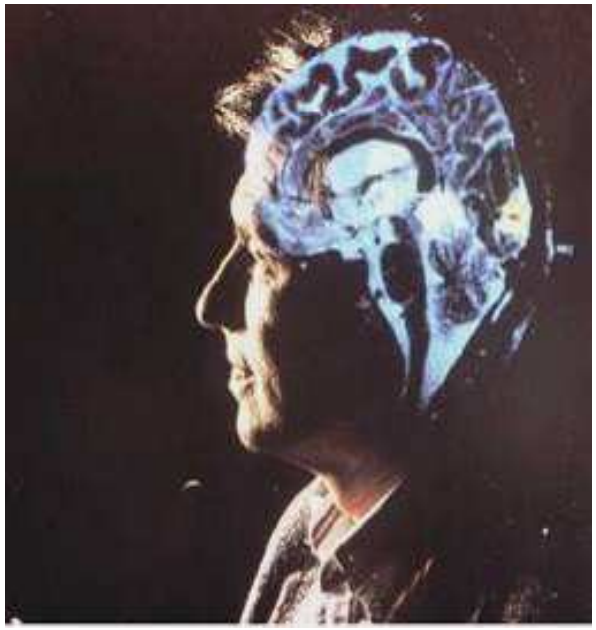
Topic Overview

- Trends in Scientific Computing
- Virginia Tech HPC
- Scaling Rendering
- Scaling Perception
  - Visual Perception
  - Visualization Displays



Img: Max Plank Inst.

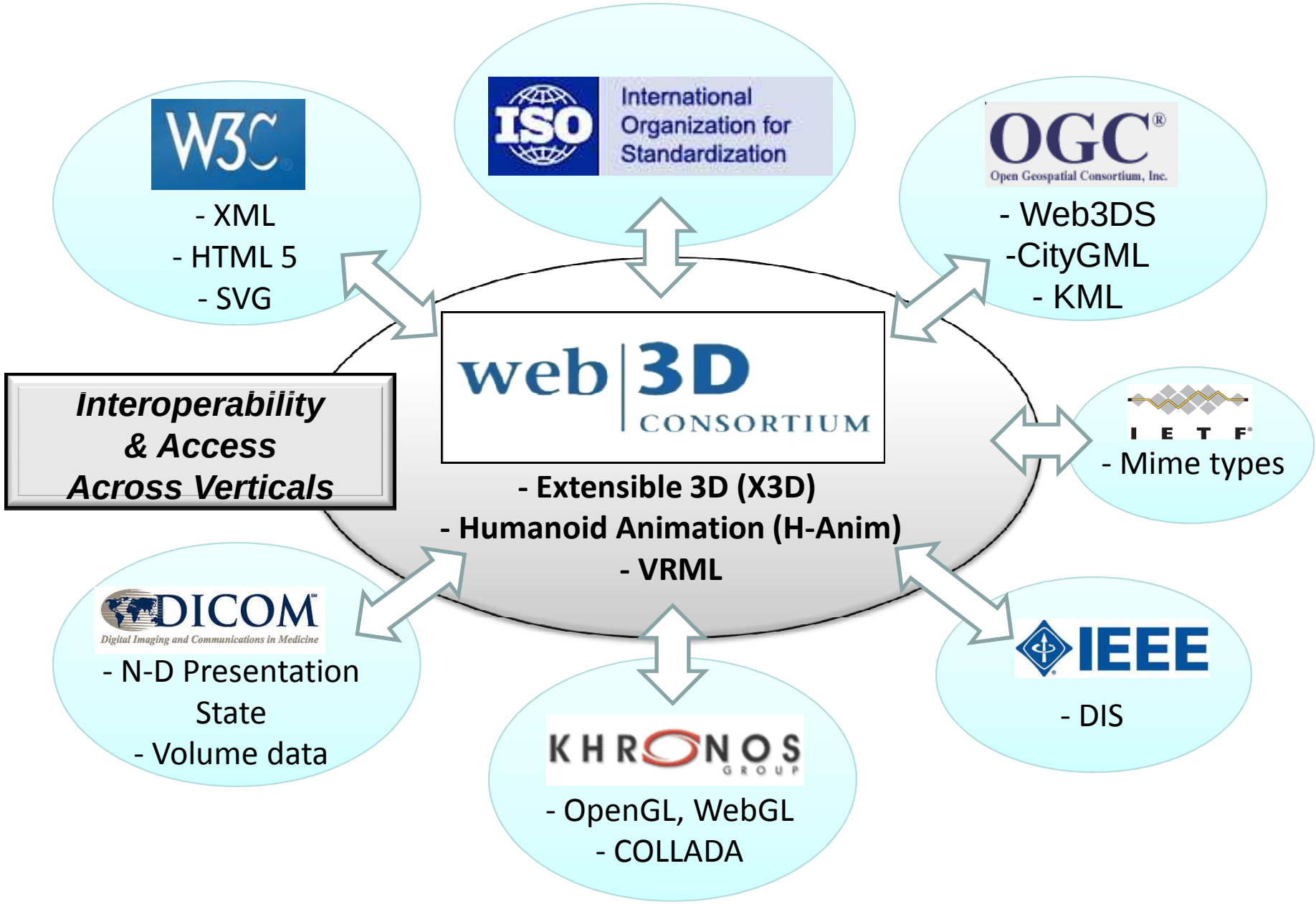
Trends in Scientific Computing

- National and Regional Consortia are developing common resources and infrastructures
- Hardware portfolio
  - Different tools for different jobs:
    - Shared memory machines
    - Clusters
    - GPU / GPGPU, …

Trends in Scientific Computing

- Software
  - Web portals support novices and communities of users
  - Standards and common formats enable the repeatability of science
  - Visualization and collaboration considered a requirement
  - *in-situ* Visualization
    - Fast I/O
    - ‘Remote’ users / clients

Web3D Collaboration & Convergence



Virginia Tech HPC

See more at:

www.arc.vt.edu

- Centralized IT
  - Support Services
    - Consulting
    - Installs & allocations
    - System & data center administration
    - Project and proposal development
  - Trainings & Faculty development
- Applications and users from across the university !

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VT HPC Infrastructure

- Campus datacenter, NOC
- Visualization center: VT Visionarium
- Machine portfolio:
  - Clusters (System X, HESS, Ithaca,…)
  - Shared memory machines (SGI UV)
  - GPUs (VisCube, Athena, …)
- National High-speed Networks
  - National Lambda Rail (100 GigE)

US NLR

The Network for Advanced Research and Innovation

www.nlr.net

Owned by the U.S. research and education community, NLR is the ultra high-performance, 12,000-mile innovation platform for a wide range of academic disciplines and public-private partnerships.

TeraGrid, NASA, Large Hadron Collider..
EU partner :TeliaSonera

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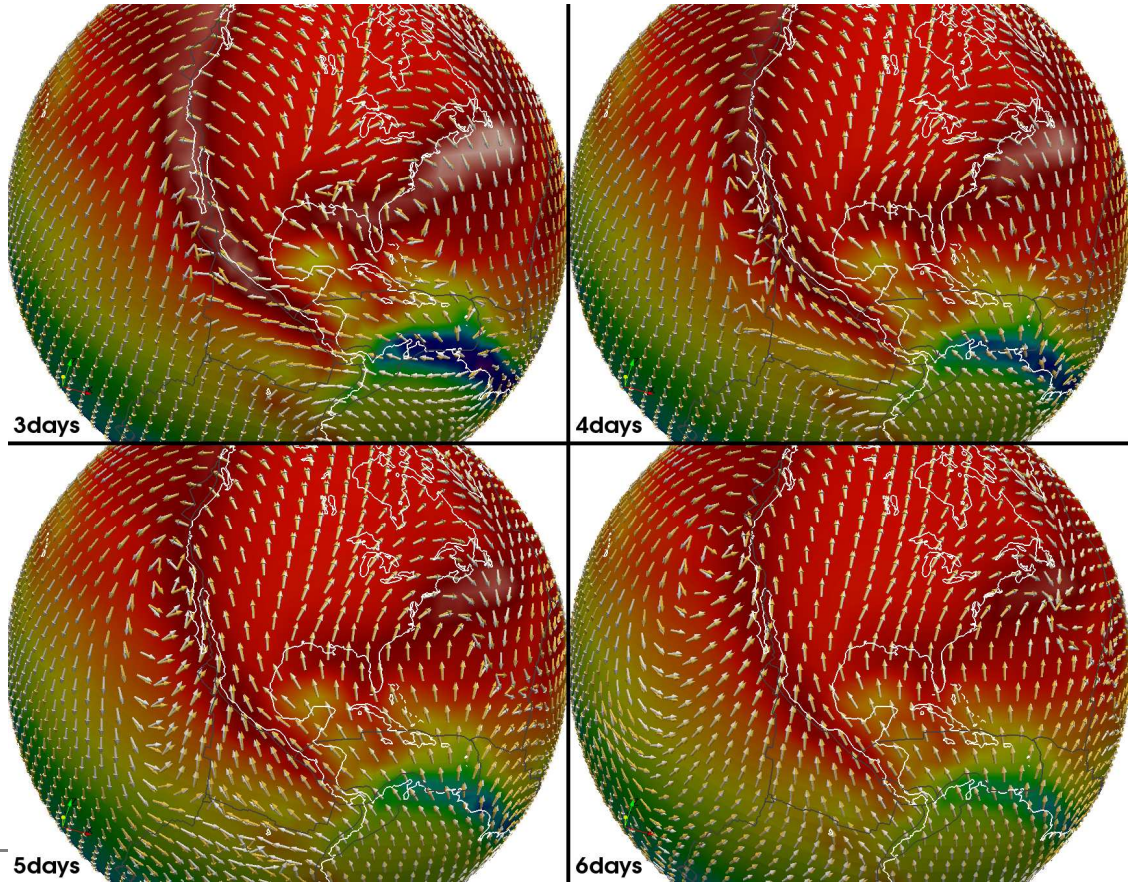
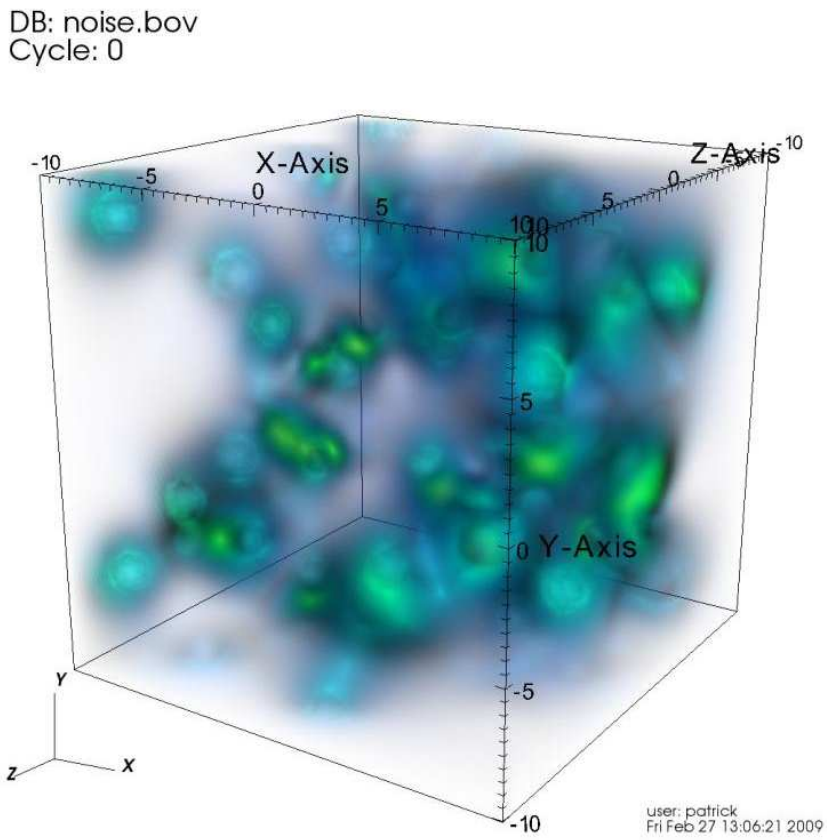
Virginia Tech GPUs

- VisCube
- Athena (32 Fermi GPUs)
- Hokiespeed
  - NSF
  - Scaling Hybrid CPU/GPU work
  - Green Computing



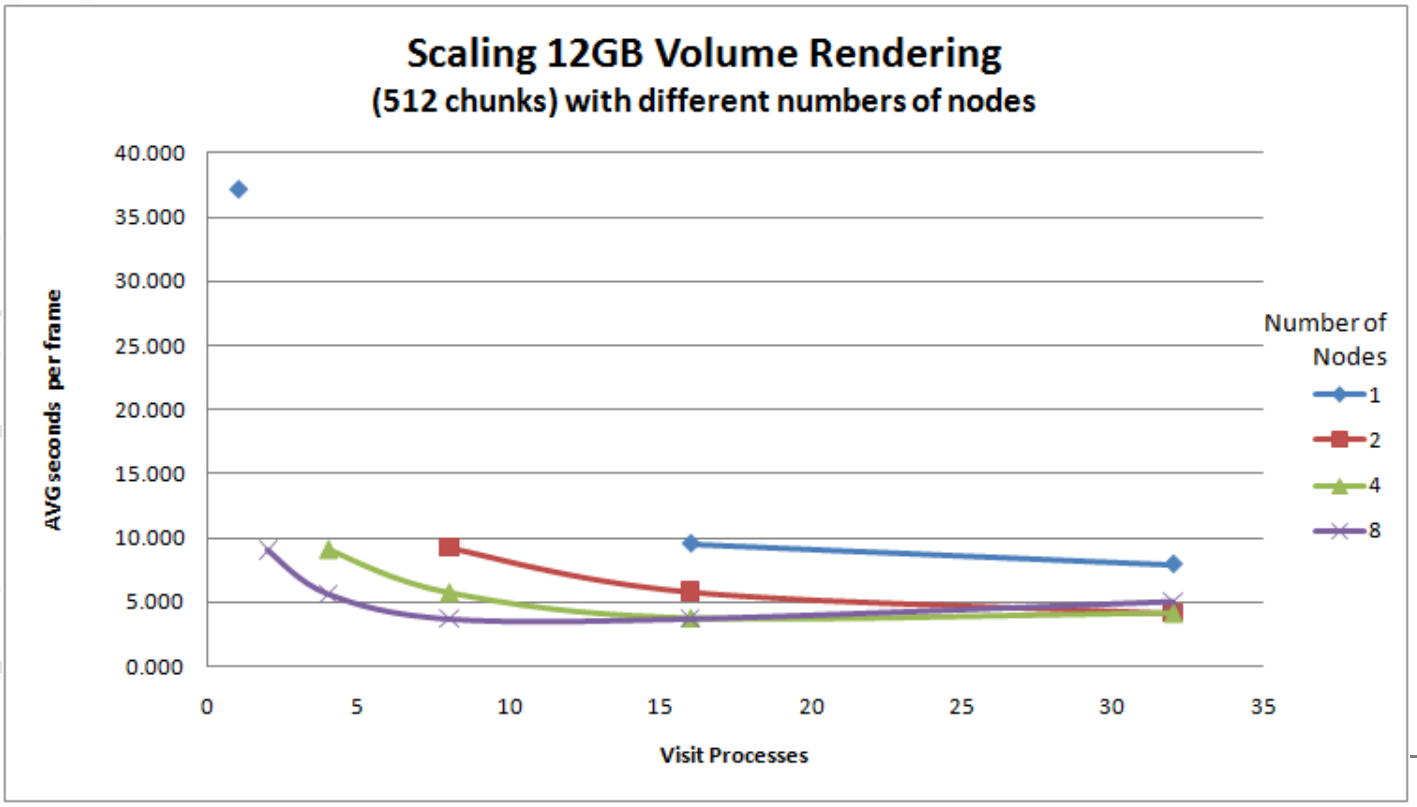
Scaling Rendering

- Benchmarking clusters and algorithms to recommend user job size and allocations
  - Machines at Oak Ridge National Lab (National Center for Computational Science)
  - Noise.silo data set (@ 12 Gigabytes)



Scaling Rendering

- Varying the number of nodes and processes for volume rendering with raycasting (CPU)



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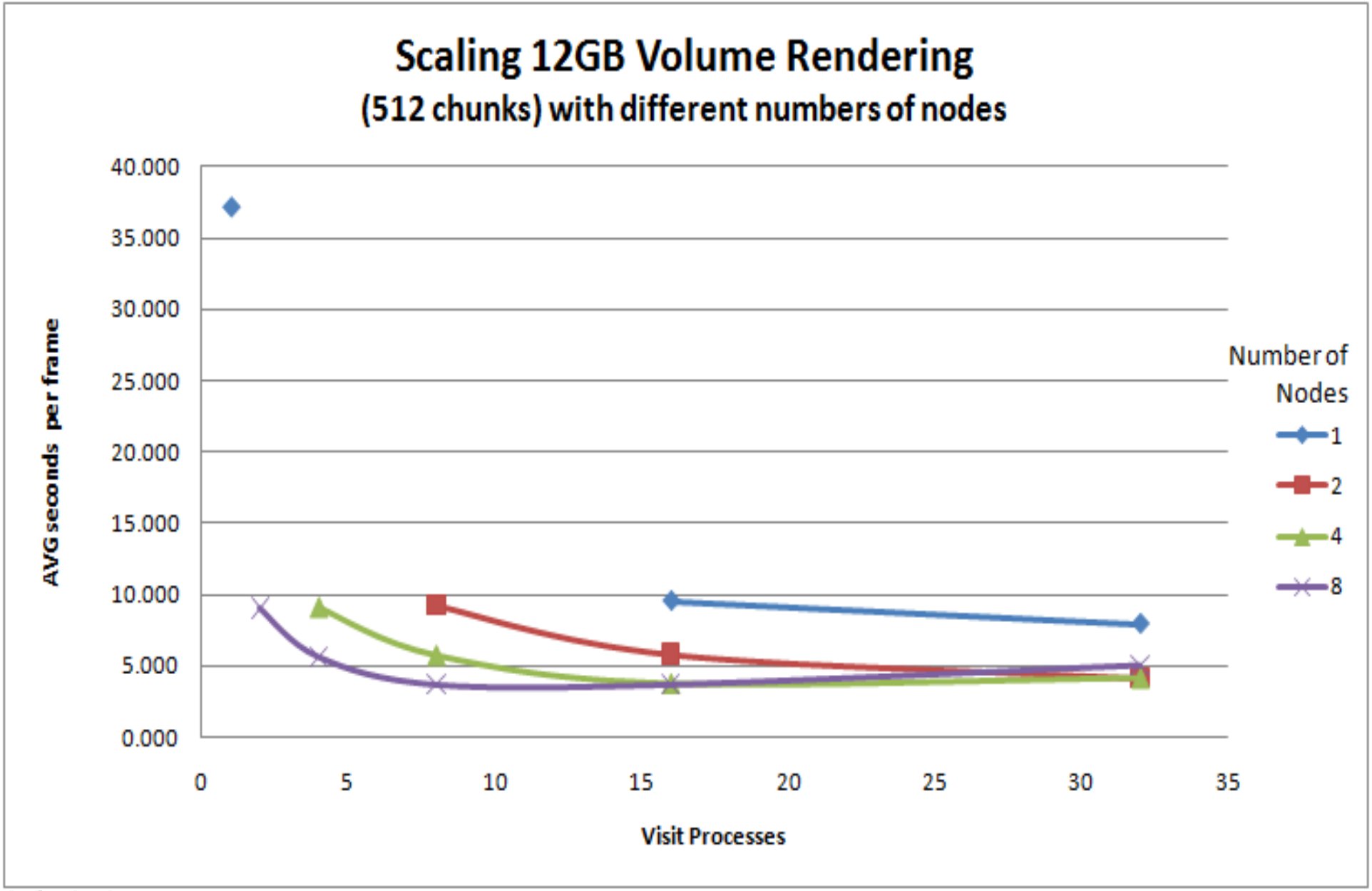

4 nodes, 16 processes
8 nodes, 6 processes

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Scaling Perception

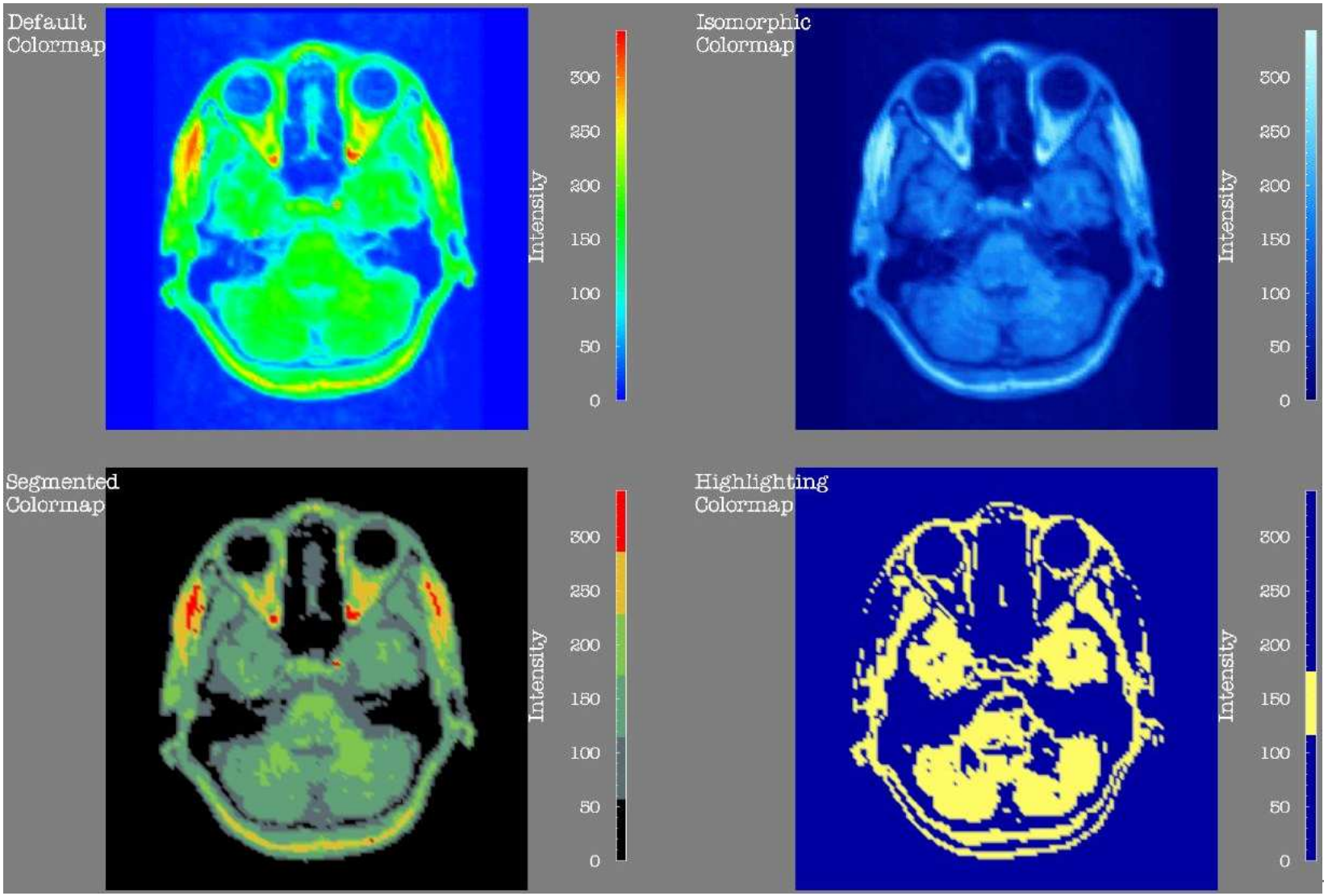
- Brain is 8 lbs; 3 is devoted to visual perception !
- **Goal:** to increase throughput on our highest bandwidth sense WHILE maintaining accuracy
- Leverage human's parallel and pre-attentive processing
- How to create effective presentations and displays?

Research -> Practice

- Know your data

Data Type	Quantitative	Ordinal	Nominal
Graphical Representation	position length angle / slope area volume color / density (Cleveland and McGill, 1980)	position density color texture connection containment length angle slope area volume (Mackinlay, 1986)	position color texture connection containment density shape length angle slope area volume (Mackinlay, 1986)

Color and Interpretation

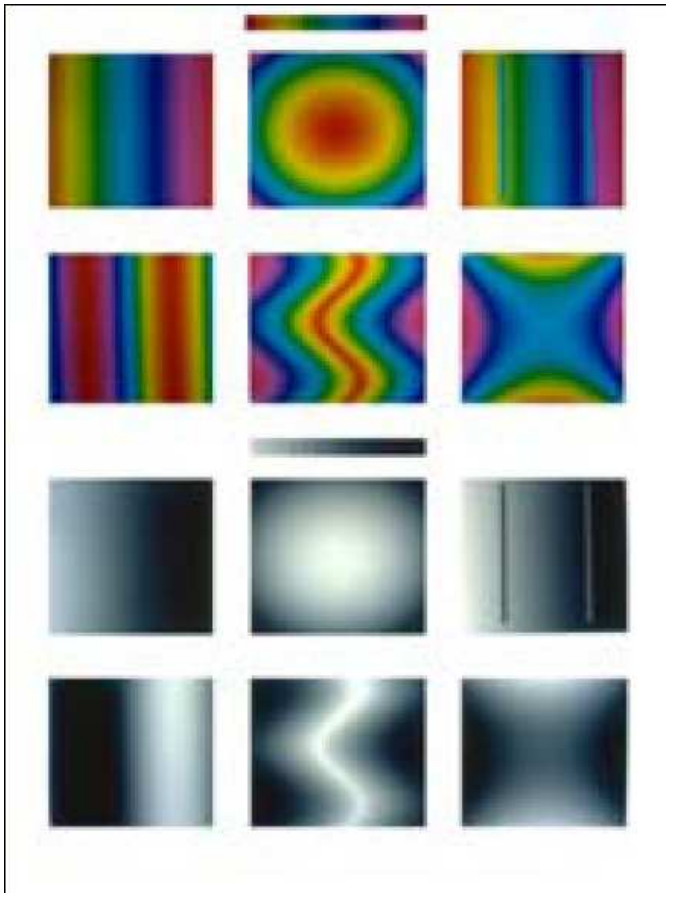


Img: IBM

Features: Color

- Luminance channel
  (3x spatial accuity)
- Red / Green channel
- Yellow / Blue channel

The rainbow spectrum is not a perceptually linear sequence (not pre-attentive)!
(Keller 1993; Ware, 2000)

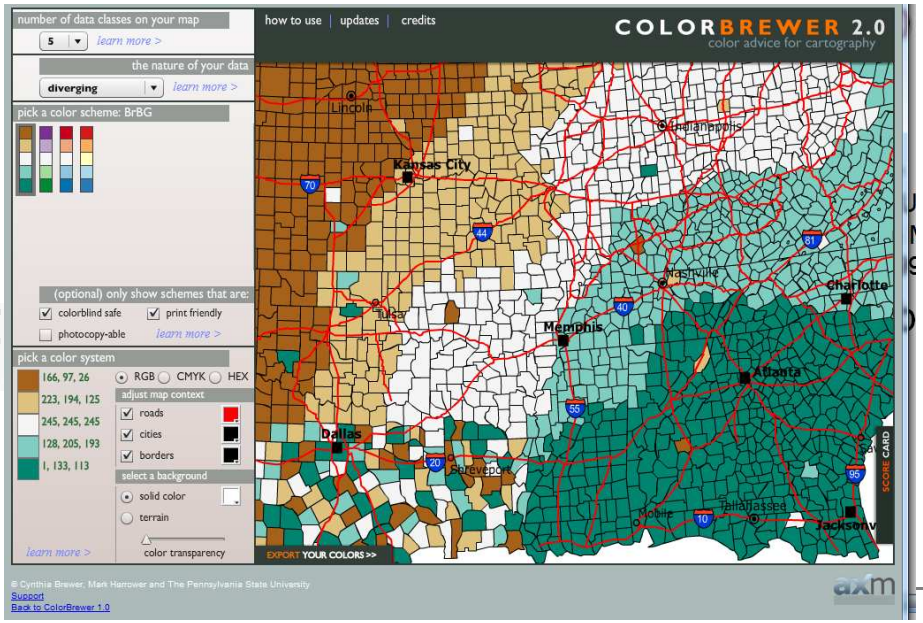


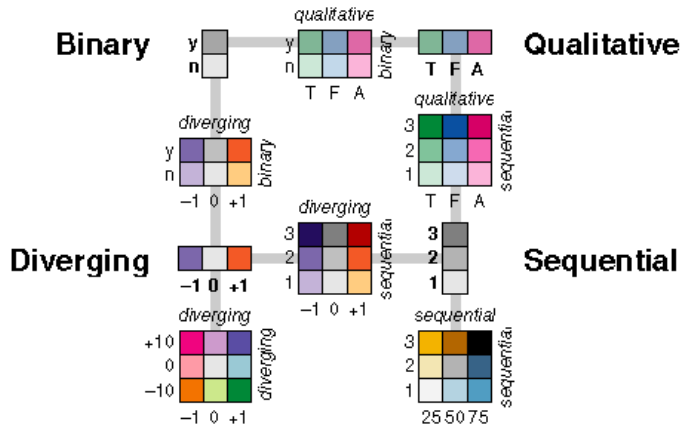
Research -> Practice

- Ordering, Spatial sensitivity to Rainbow
  - David Borland, Russell M. Taylor II, "Rainbow Color Map (Still) Considered Harmful," IEEE Computer Graphics and Applications, pp. 14-17, March/April, 2007
- Consider Tasks
  - Christian Tominski, Georg Fuchs, Heidrun Schumann, "Task-Driven Color Coding," Information Visualisation, International Conference on, pp. 373-380, 2008 12th International Conference Information Visualisation, 2008
- Diverging maps are better for Sci Vis
  - Kenneth Moreland “Diverging Color Maps for Scientific Visualization“ Advances in Visual Computing Lecture Notes in Computer Science, 2009, Volume 5876/2009, 92-103,

Lessons from Cartography

- Sequential, Divergent, Qualitative maps
- C. Brewer. Color Use Guidelines for Mapping and Visualization. In Visualization in Modern Cartography, pages 123–147, Tarrytown, NY, 1994. Elsevier Science.
- http://colorbrewer2.org/

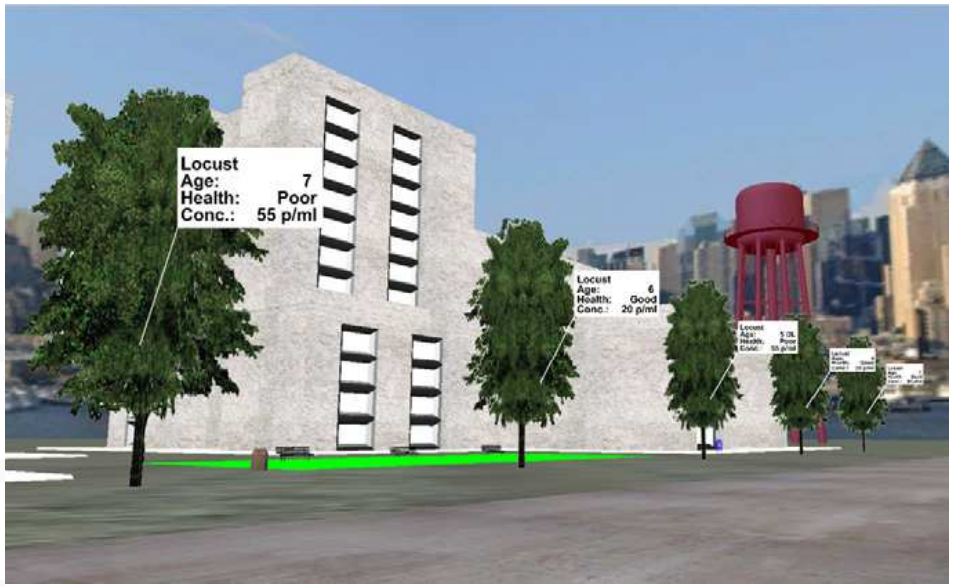




Go back to Cindy's page or PSU Geography or GeoVISTA

Dr. Cynthia Brewer / Department of Geography / The Pennsylvania State Univers

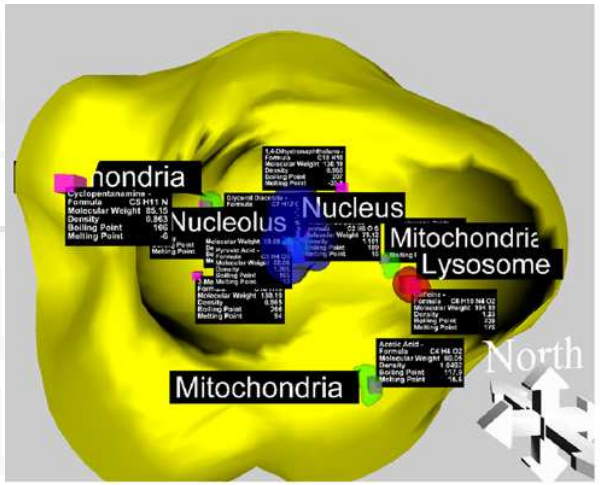
Information Rich Virtual Environments (IRVEs)

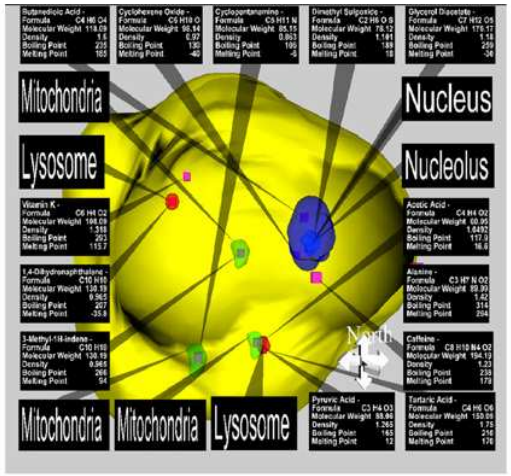


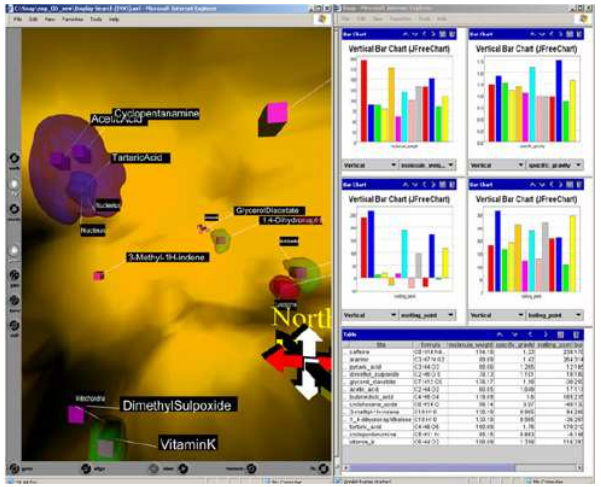
Labelling:

Tradeoffs in

- Depth and
- Gestalt
- cues





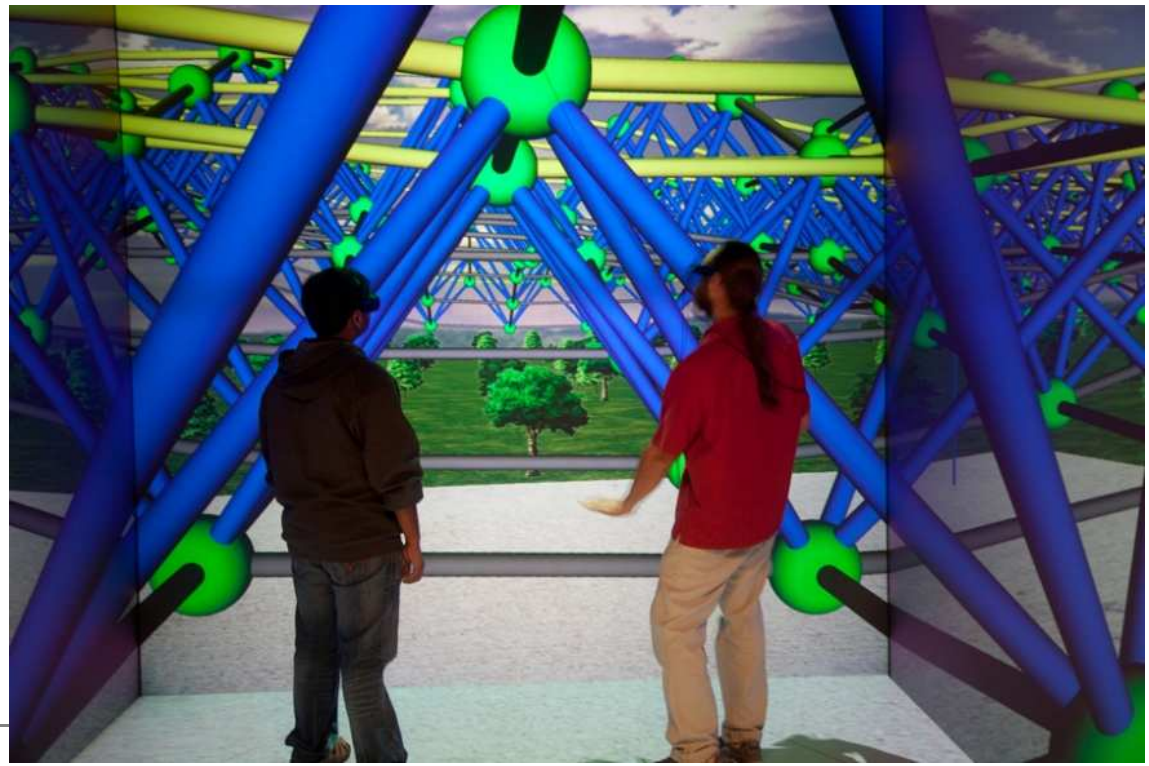


IRVE Layout Techniques

- Graphical configuration of labels on different size displays
- Tasks: Search, Comparison with different information criteria and target:
  - Spatial -> Abstract
  - Abstract -> Spatial
- Users rely on different cues to accomplish their tasks !
- Polys, N., D. Bowman, and C. North, "The Role of Depth and Gestalt Cues in Information-Rich Virtual Environments", *International Journal of Human-Computer Studies*, vol. 69, 2011

Displays

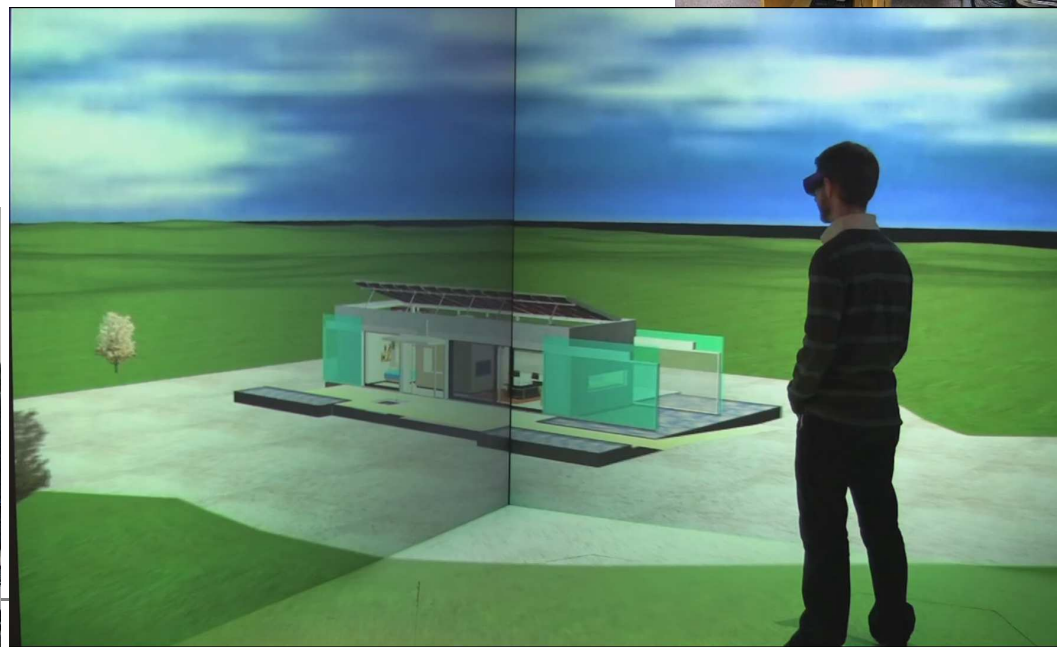
- More pixels means more information
- Size
- Spatial resolution (pixels/inch)
- Brightness
- Color gamut
- Stereoscopy



Virginia Tech Visionarium

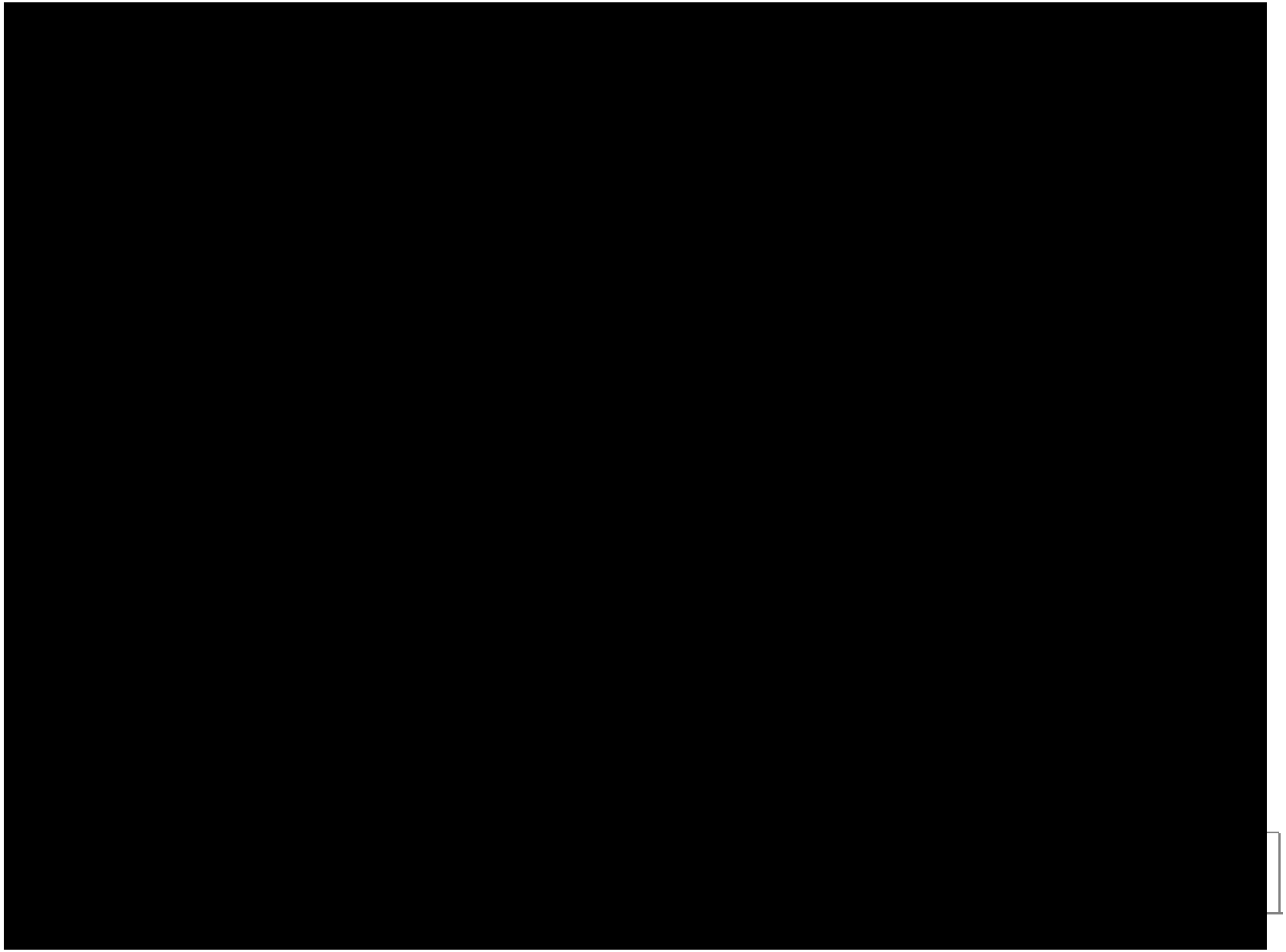
Using the benefits of immersion

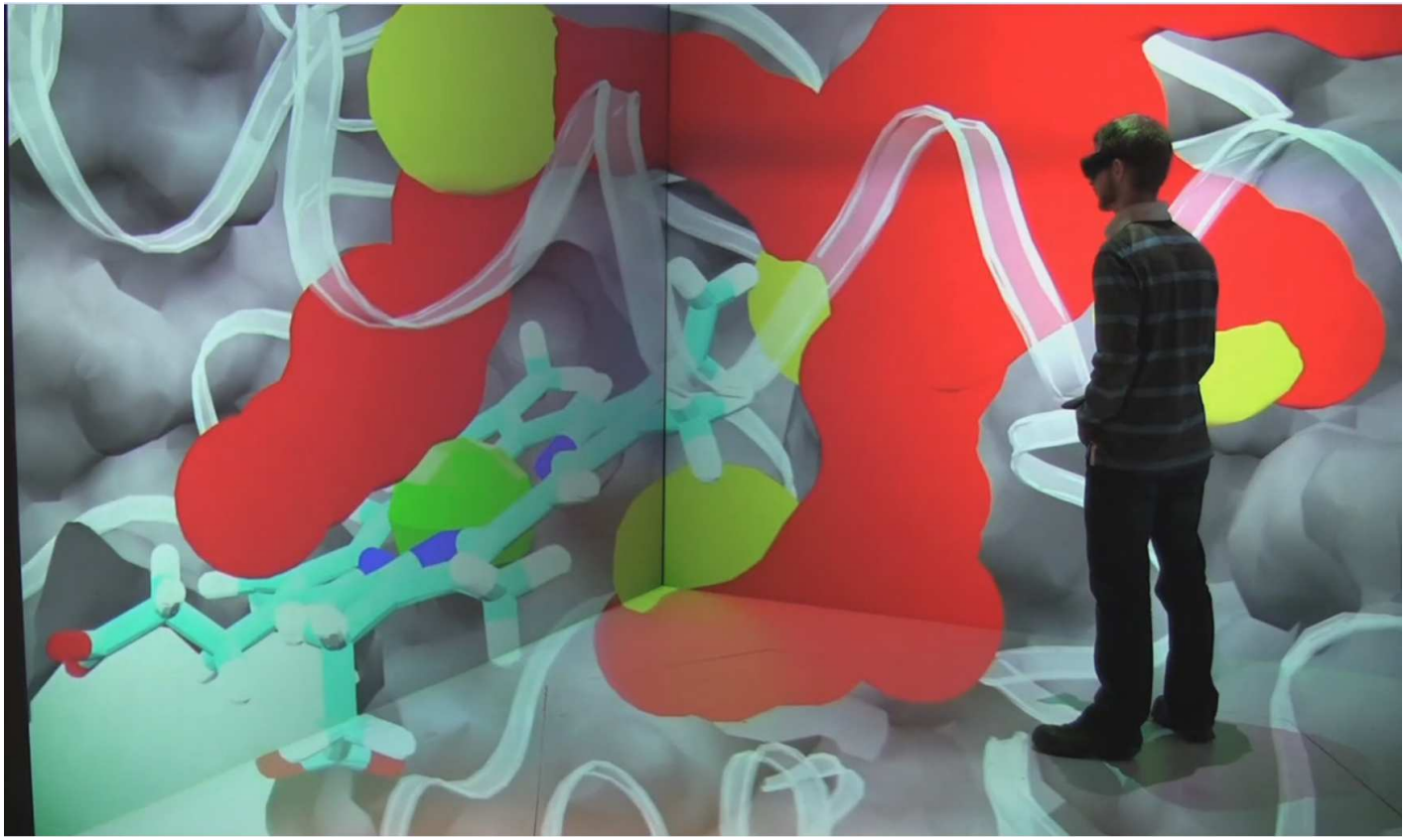
- VisCube (10” 1920x1920 walls, floor)
- Deep Six (6 x 30”)
- Multi-Touch HD (52”)
- Stereo HD (65”)
- Stereo wall



Immersive Displays

Gallery @ snoid.sv.vt.edu





Jory Z. Ruscio, Deept Kumar, Maulik Shukla, Michael G. Prisant, T. M. Murali, and Alexey V. Onufriev, ``Atomic level computational identification of ligand migration pathways between solvent and binding site in myoglobin'', Proceedings of the National Academy of Sciences, (USA), 15, 9204-9209 (2008).

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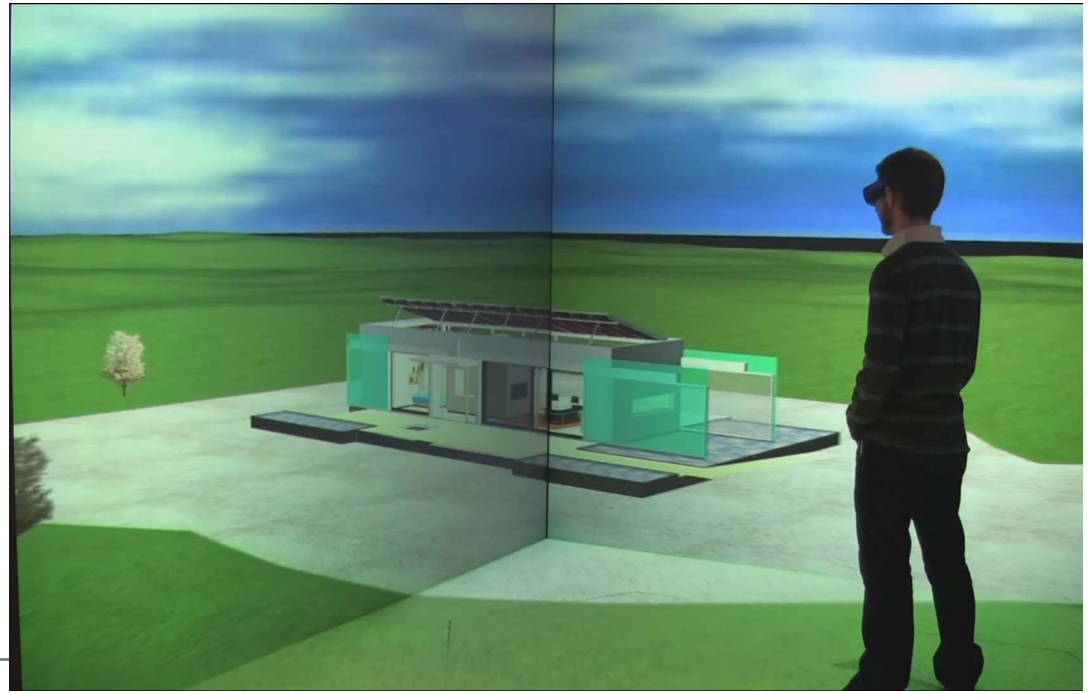
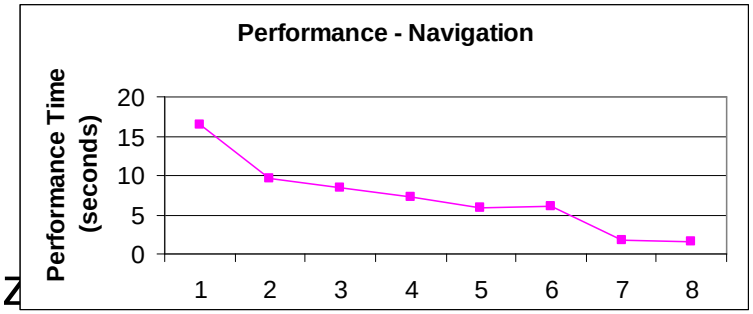
Software Impacts

- Cluster rendering at interactive rates
- Stereoscopy
- Tracking and other input devices
- 3D UI
  - Navigation
  - Selection
  - Manipulation
  - System control

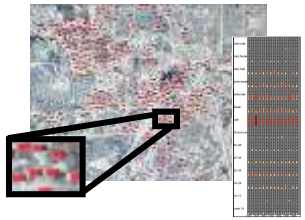


High-resolution displays for analysis



- Fundamental issues:
  - What is the benefit for visualiz
    in terms of Perception, Navigation, Awareness
  - Limits of visual scalability?

- Display design issues:
  - How big? How shaped?



- Visualization design issues:
  - How to embed more information?
- Interaction design issues:
  - How to point? pan? zoom?

What is the impact of large high-resolution displays on analysts?

Impacts on Analysts

"Analytic Force Multiplier"

- 2-10x faster task performance
- Curved displays speed some tasks by 30%
- Reduce frustration by 50%
- Reduce virtual navigation actions by 75%
- Increase physical navigation 300%
- Analyze 22x more data, only 3x more time, while maintaining accuracy
- Greater situational awareness
- Easier interaction
- Short initial learning time

Collaborative Workspace Options

18 Rear-projection blocks
near-seamless
Multi-CPU
Large conference room

Pictures from 2008

See: http://infovis.cs.vt.edu/

50 tiled LCD panels
Touch-sensitive
Multi-CPU
Medium conference room

High Performance Visualization :
Scaling Rendering and Perception

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