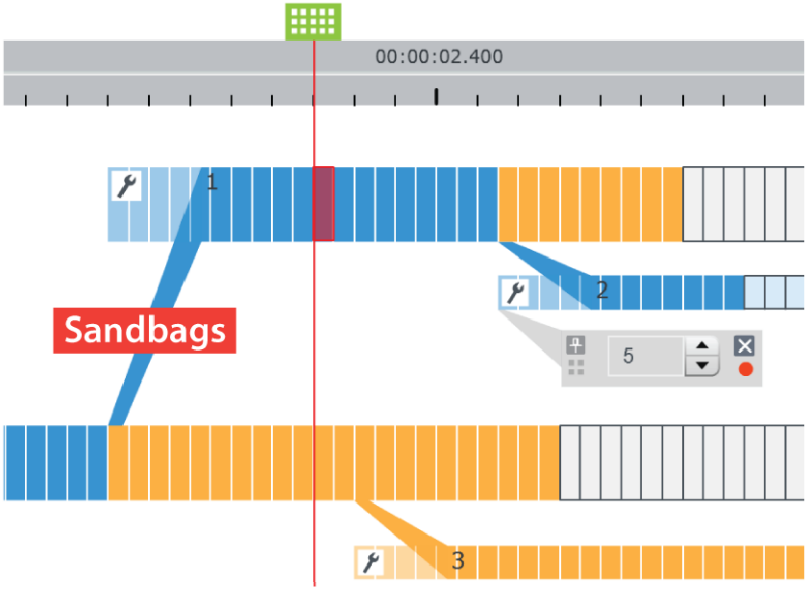
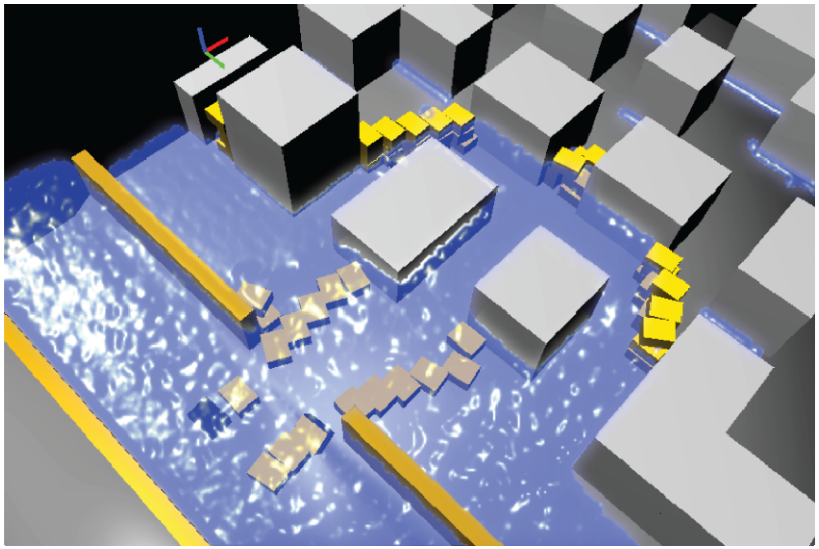




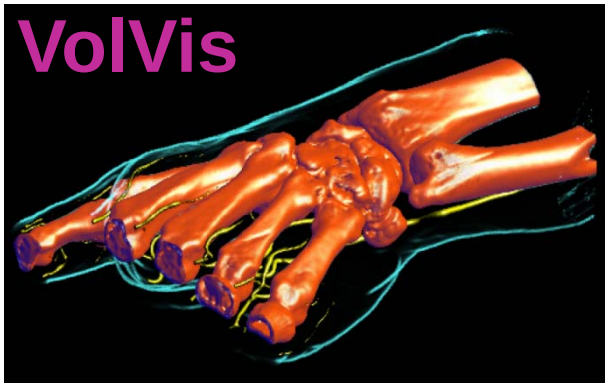
Visual Computing – Quo Vadis?

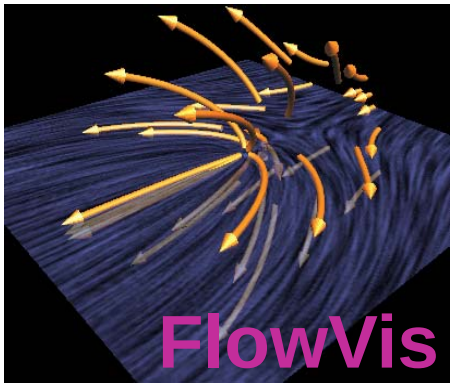
Eduard Gröller

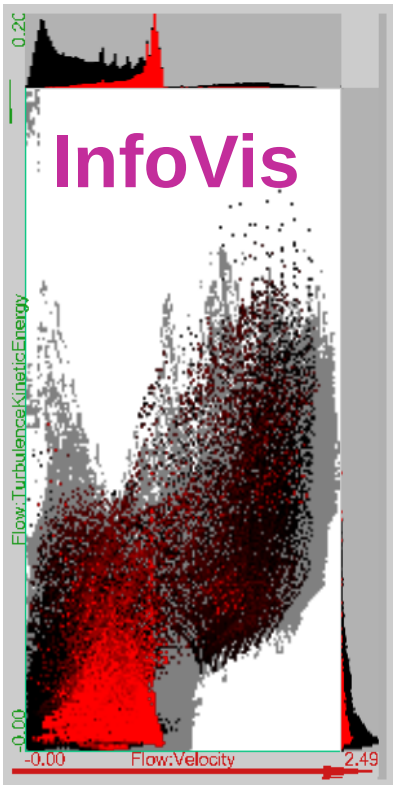
Institute of Computer Graphics and Algorithms
Vienna University of Technology

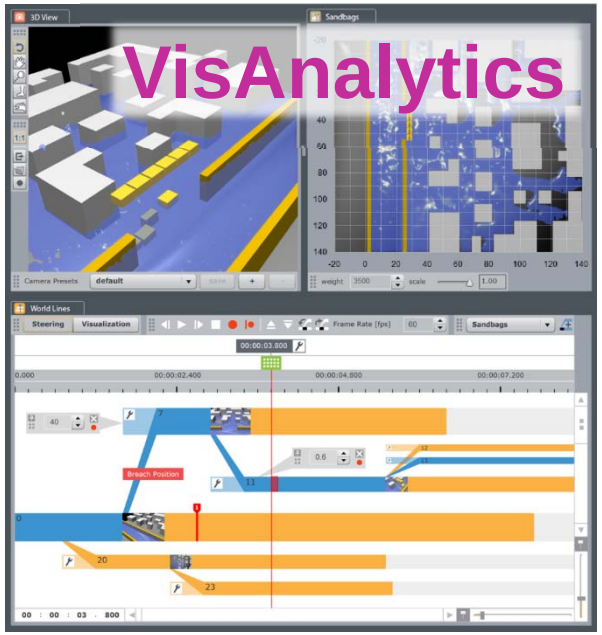
(Data) Visualization

"The use of computer-supported, interactive, visual representations of (abstract) data to amplify cognition"



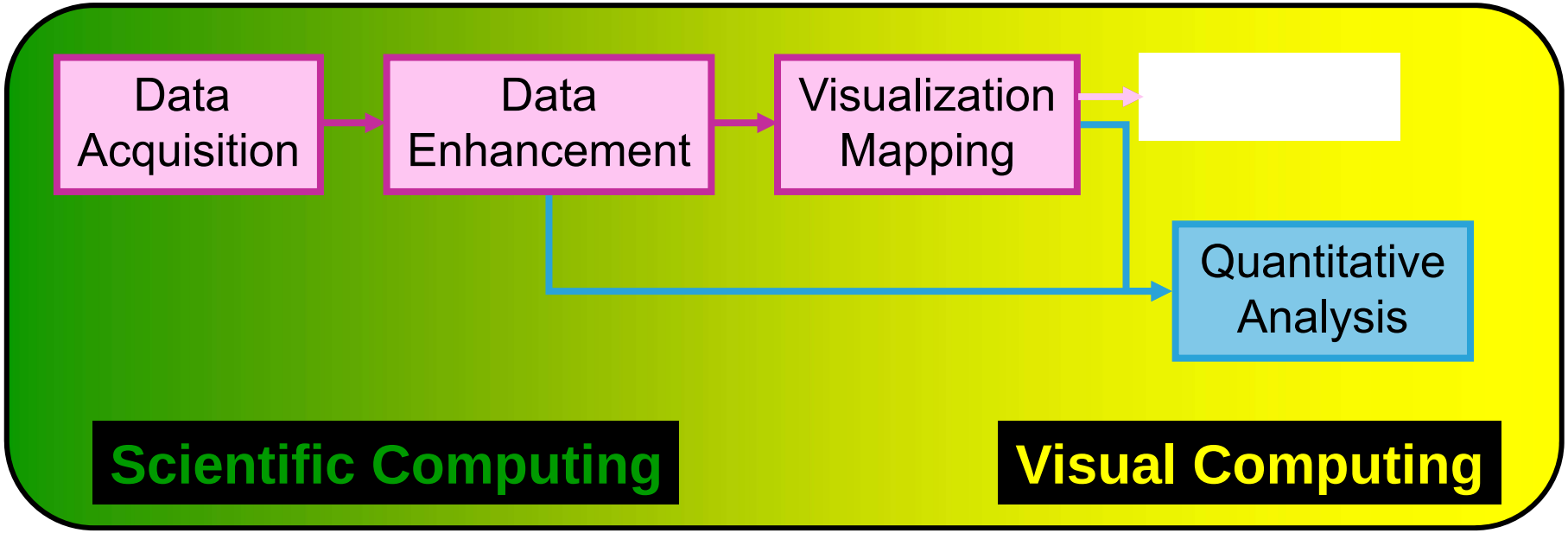






- Data is increasing in complexity and variability

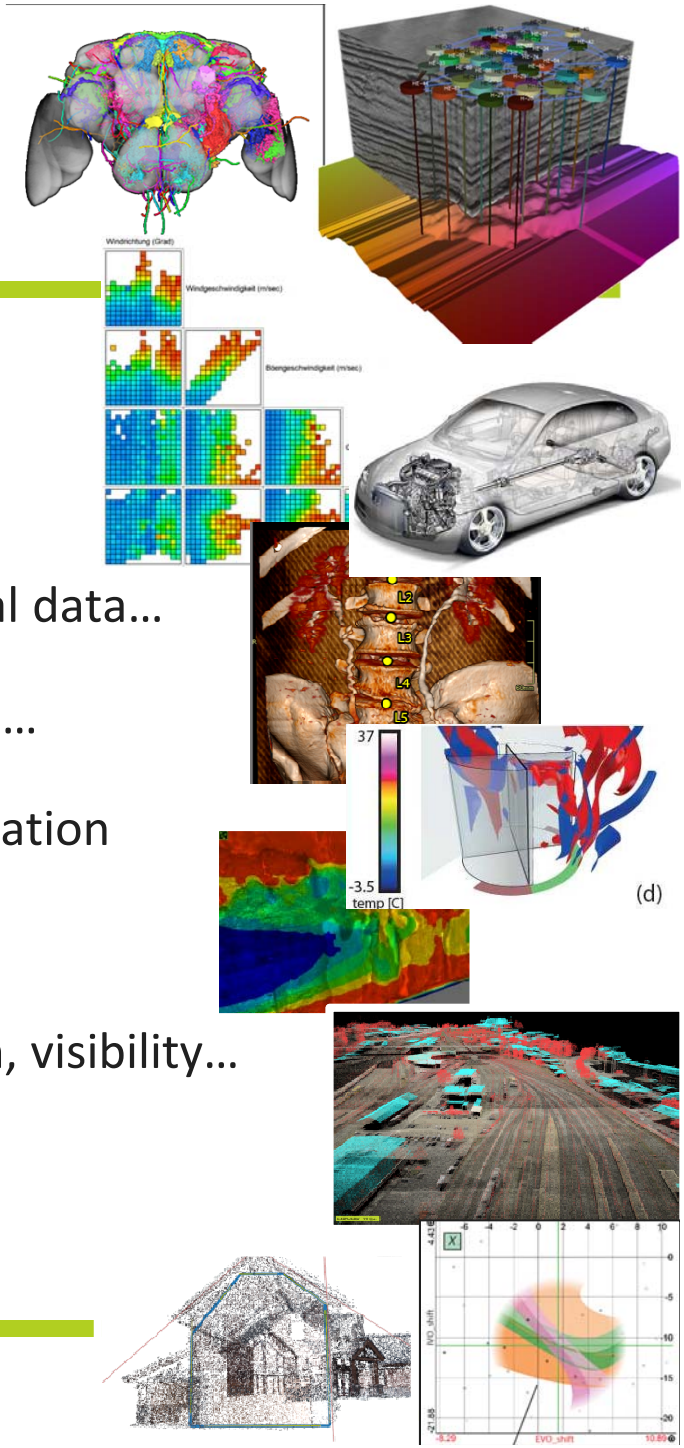
Visualization Pipeline



- Visualization is part of Visual Computing
- Visual Computing is acquistion, representation, processing, analysis, synthesis, and usage of visual information

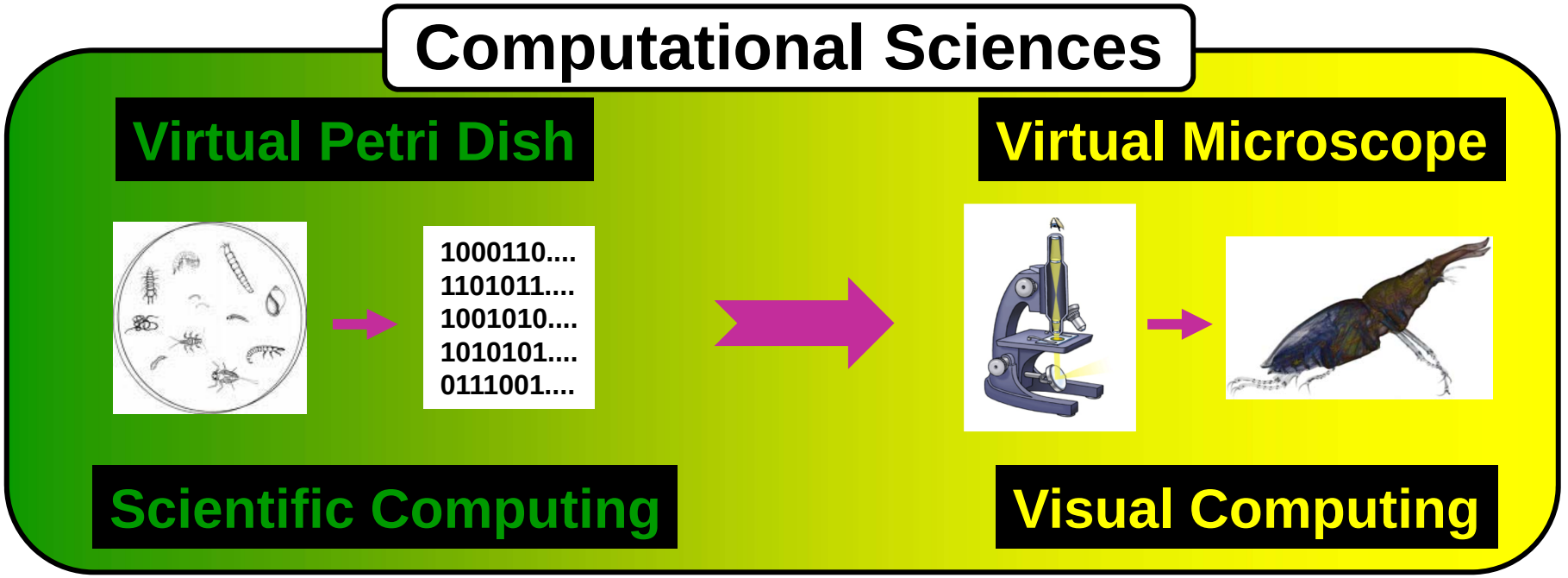
Visual Computing is a Lot…

- **Computer Graphics**
  graphical user interfaces, animations ...
- **Computer Vision /Pattern Recognition**
  modeling human vision…
- **Visualization**
  displaying volume- and other high-dimensional data…
- **Interactive Visual Analysis**
  presenting multidimensional data for analysis…
- **Visual Sensors**
  recording methods for obtaining visual information
- **Modeling**
  digital models from data/images
- **Rendering**
  real-time visualization, illumination simulation, visibility…
- **Virtual/Augmented Reality**
  combining real and virtual environments
- **Human-Computer-Interaction**
  the interface between users and computers

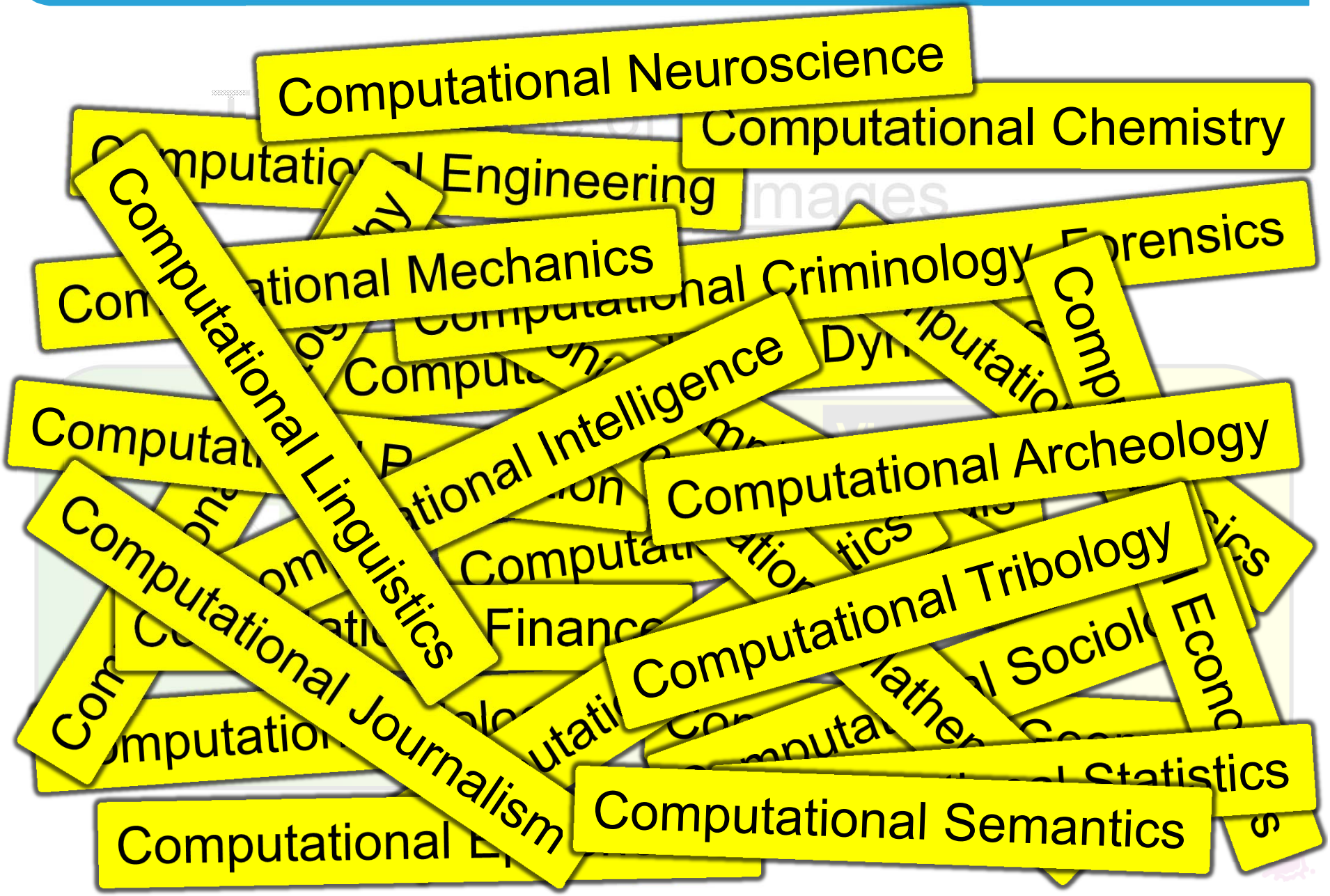


Visual Computing embedded in Science

The purpose of visual computing is insight, not images



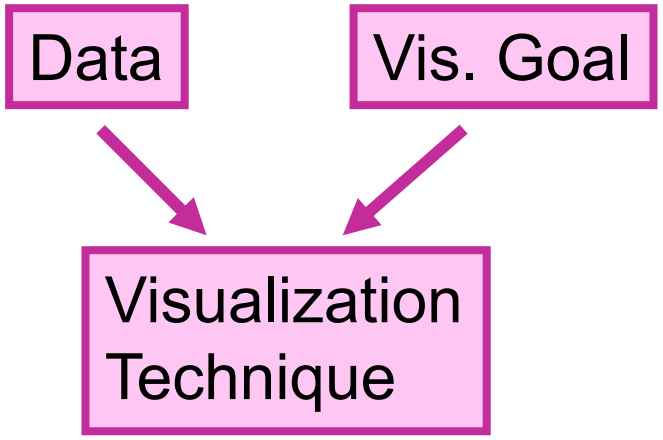
Visual Computing embedded in Science



Challenges in Visual Computing

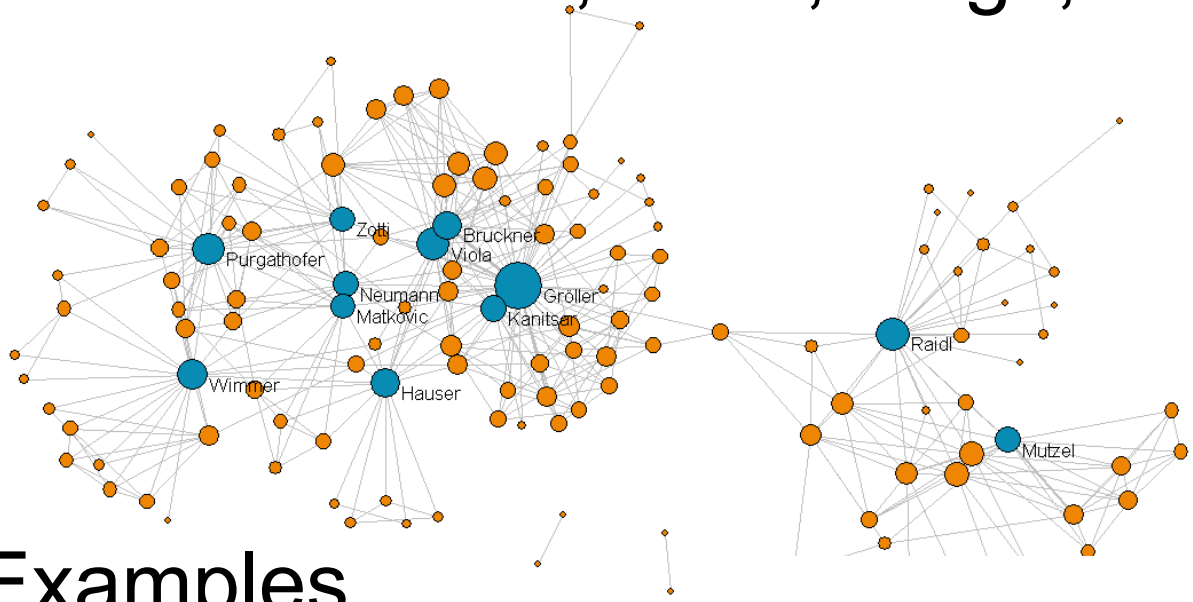
New Data Sources - Novel Imaging Modalities

- Challenges
  - Very large (abstract) data sets
  - High-dimensional, multi-valued, multi-modal, heterogeneous
  - Time varying
    - Spatially sparse/dense, temporally sparse/dense
    - Need for registration
    - Need for feature extraction
- Examples
  - Web 2.0
  - Sonar Explorer



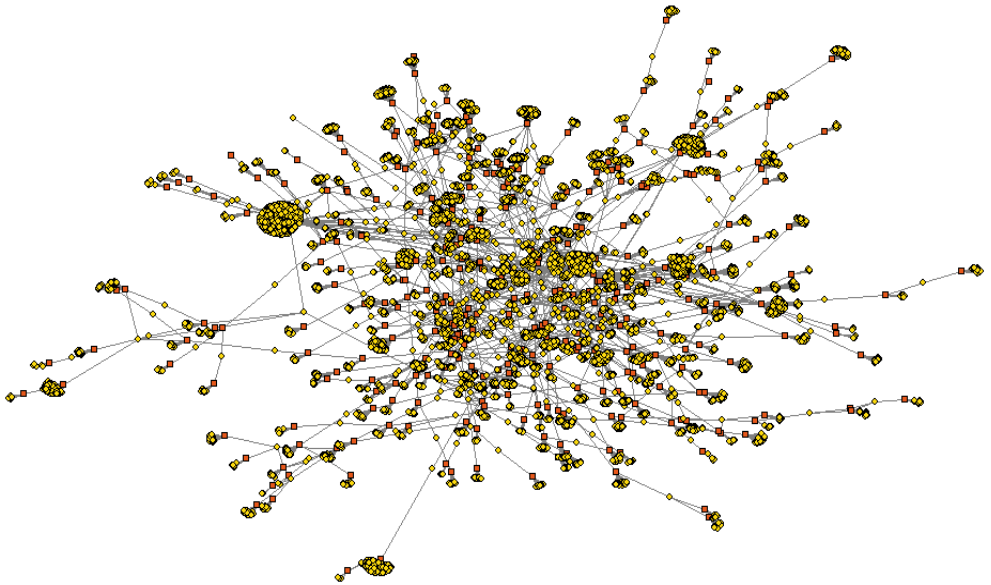
New Data Sources – Web 2.0

- Social networks, wikis, blogs, data warehouses



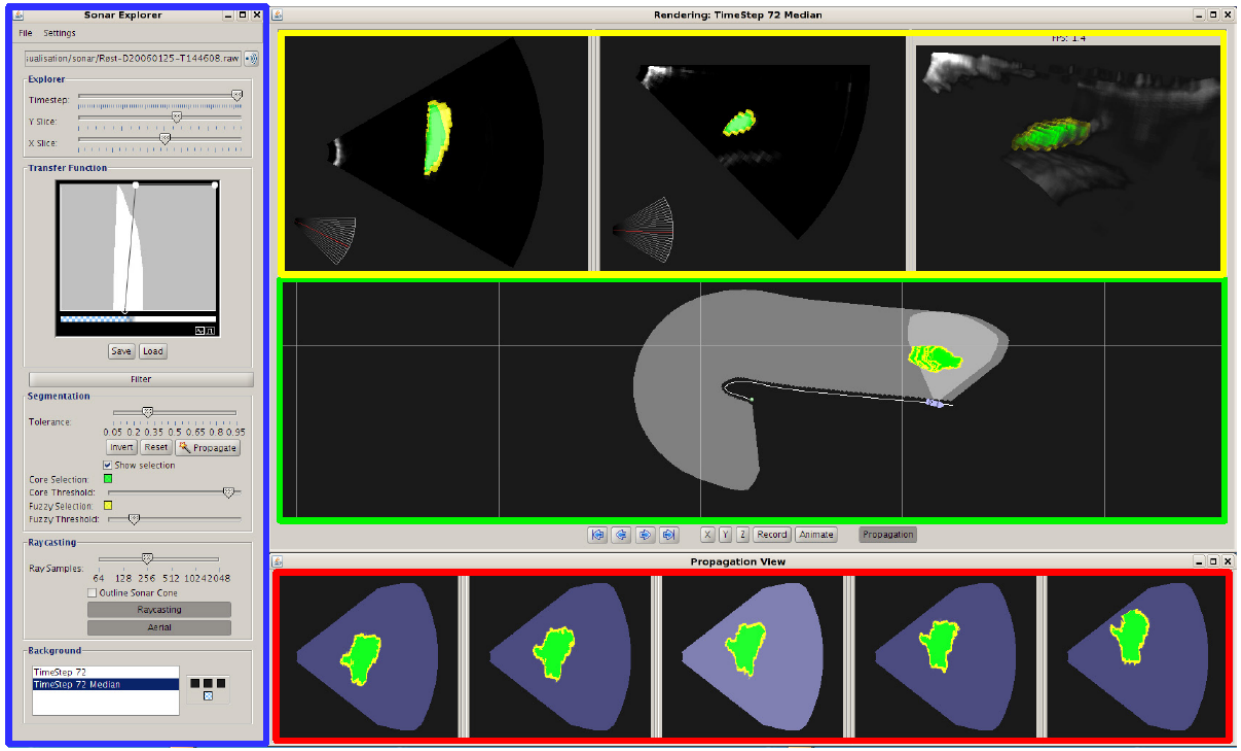
[Pfeffer]

- Examples
  - Facebook
  - Twitter
  - LinkedIn
  - YouTube

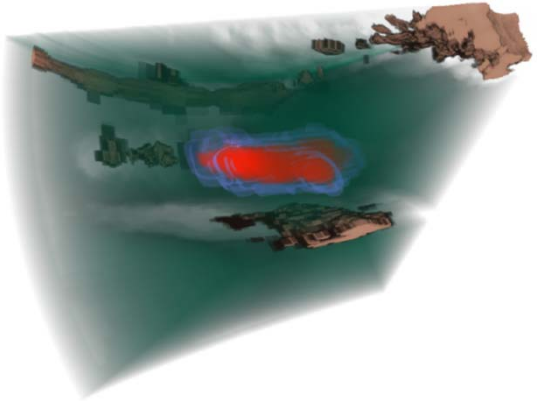


Novel Imaging Modalities – Sonar Explorer (1)

- 4D sonar data
- Cones with res: 25x20x1319
- Ping rate 1 Hz
- 2 GB/ping
- Time steps overlapping
- Highly anisotropic
- Noisy
- Signal strength reduced with spreading and absorption

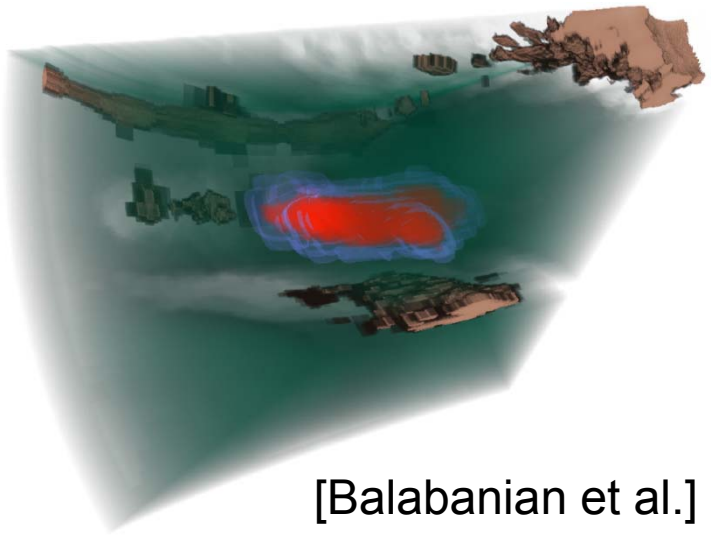


[Balabanian et al.]

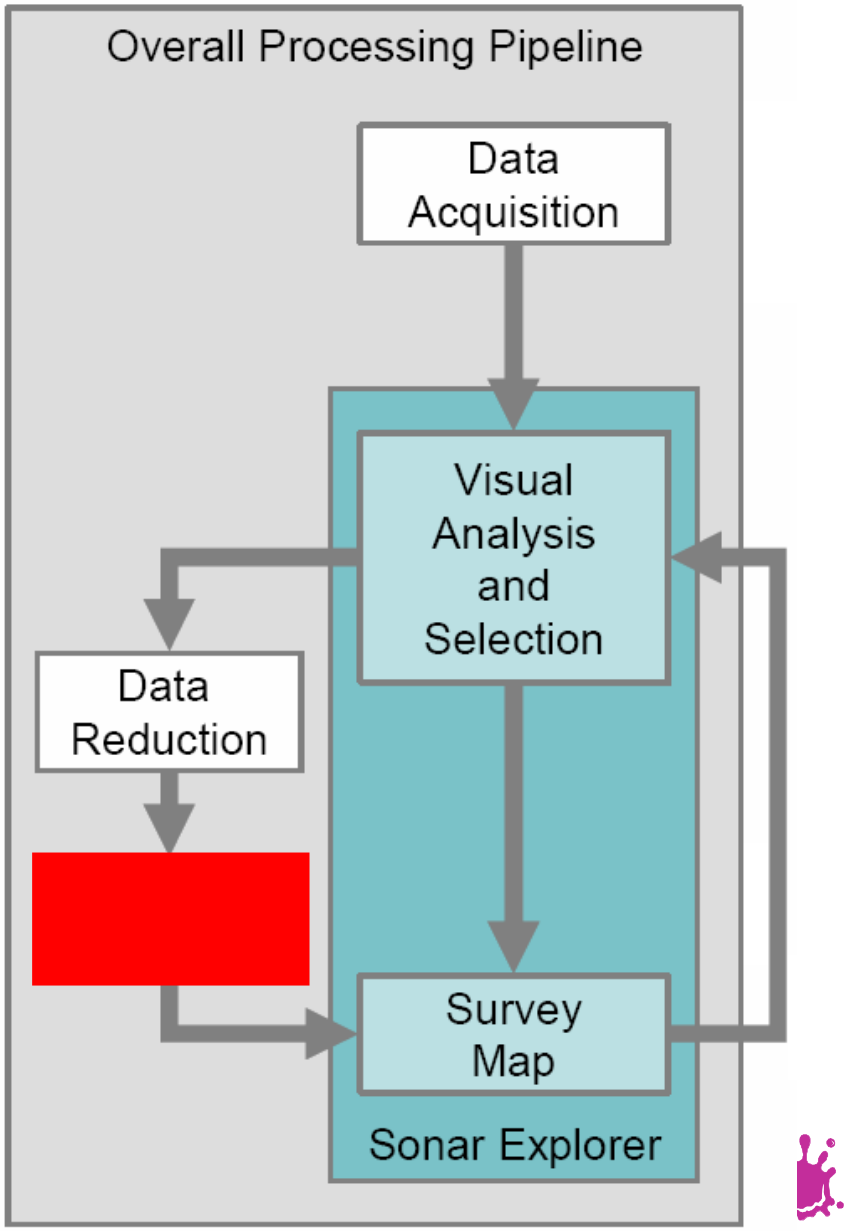


Novel Imaging Modalities – Sonar Explorer (2)

- Fish school monitoring
  - Size of school
  - Center of gravity
  - Shape parameters
  - Motion characteristics

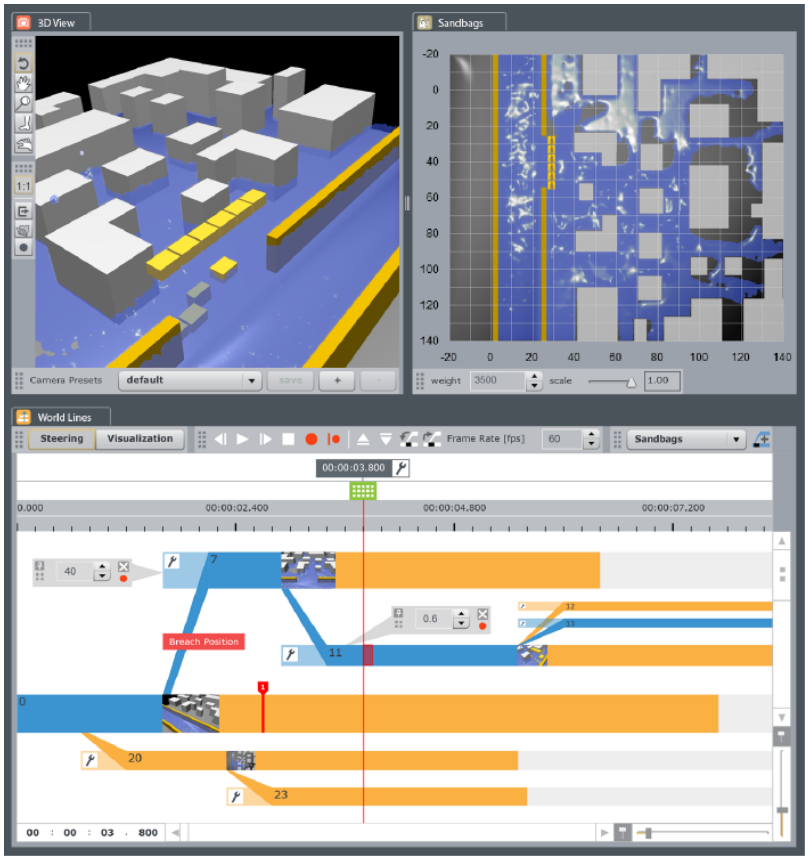


[Balabanian et al.]



Challenges in Visual Computing

- New Data Sources - Novel Imaging Modalities



Visual Steering to Support Decision Making in Visdom

J. Waser, R. Fuchs, H. Ribičić, Ch. Hirsch,
B. Schindler, G. Blöschl, E. Gröller

Visdom

vrvis

Flood emergency assistance

- **New Orleans 2005: 17th canal levee breach**

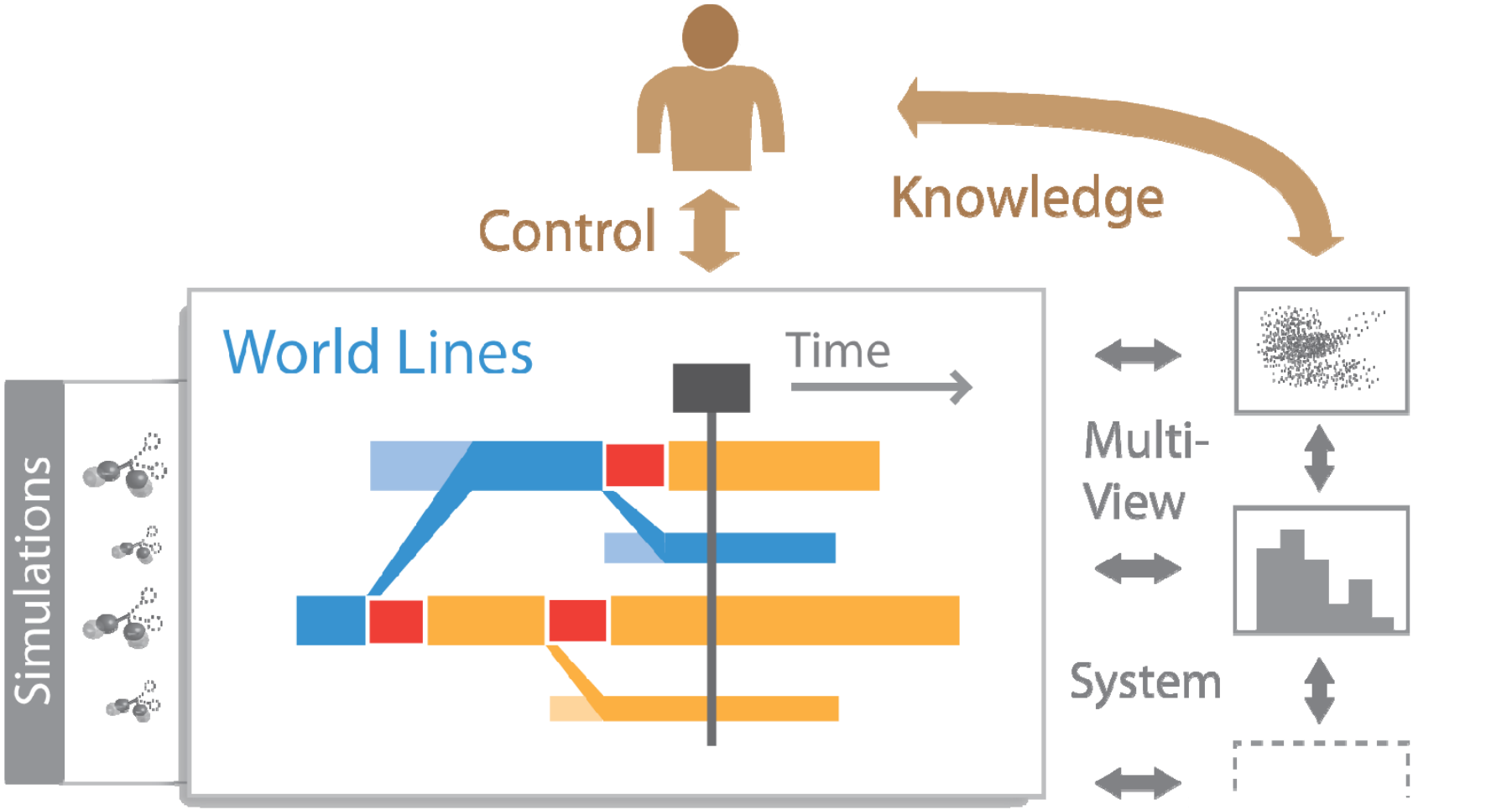
Image courtesy of USACE, US Army Corps of Engineers

Flood emergency assistance

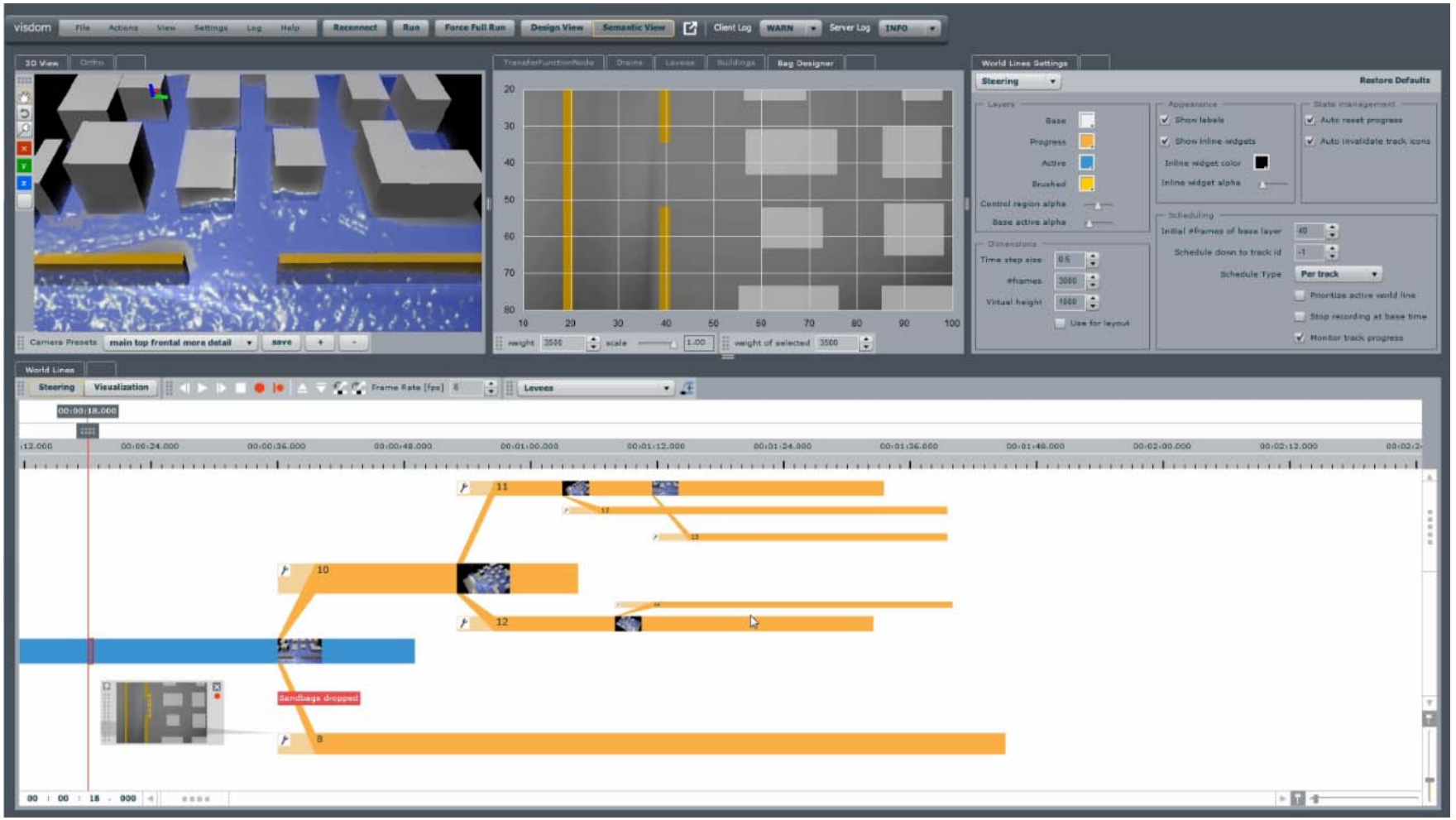
- **Evaluation of breach-closure techniques in a laboratory model**

A. Sattar, A. Kassem, and M. Chaudhry. 17th street canal breach closure procedures. Journal of Hydraulic Engineering, 134(11):1547–1558, 2008.

Computational Steering: World Lines



Video: World Lines - Features



Challenges in Visual Computing

- New Data Sources - Novel Imaging Modalities
- Ensembles, Uncertainty, Parameter Spaces
-
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-
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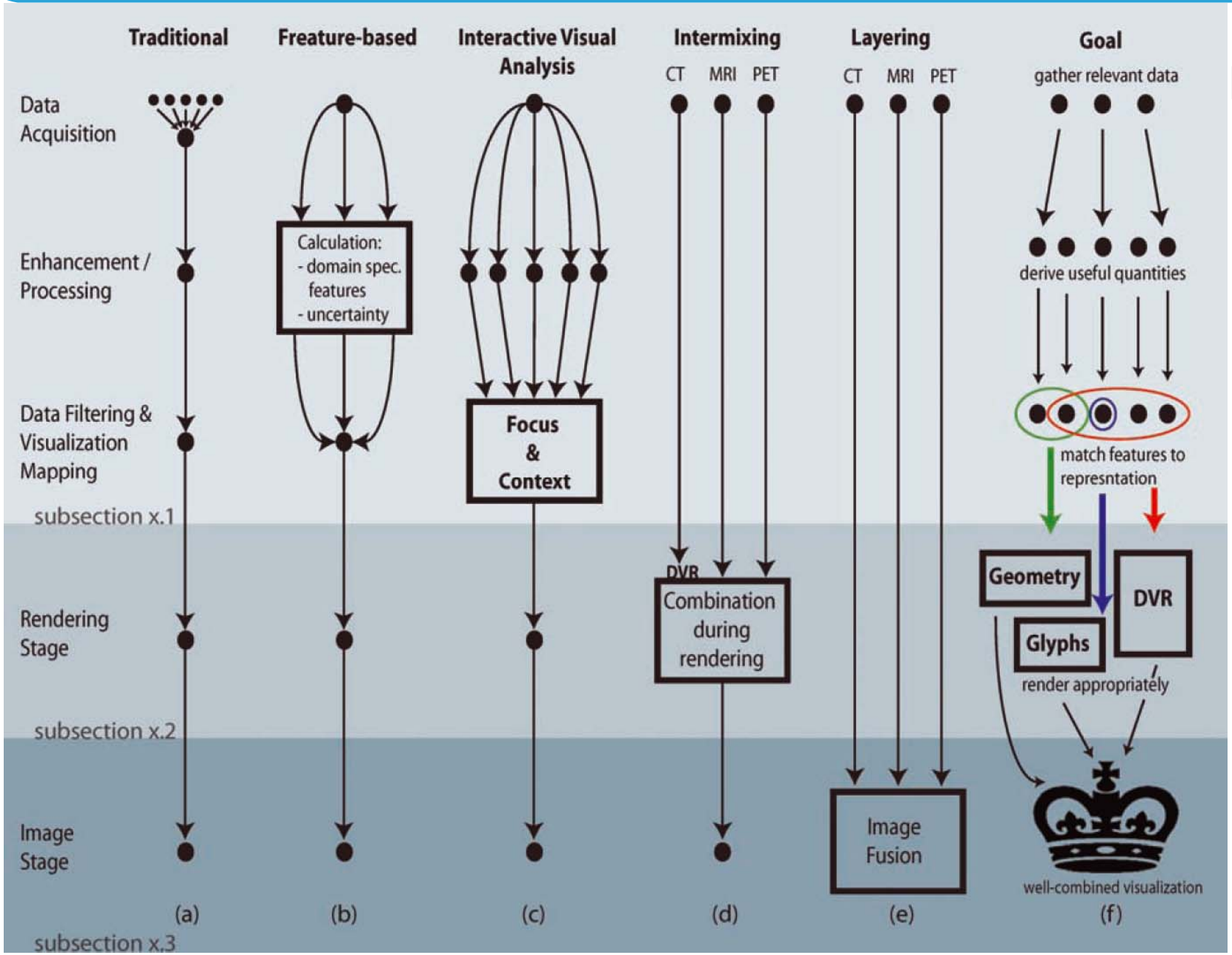
-
-

Visualization of Multi-Variate Scientific Data



[Fuchs& Hauser]

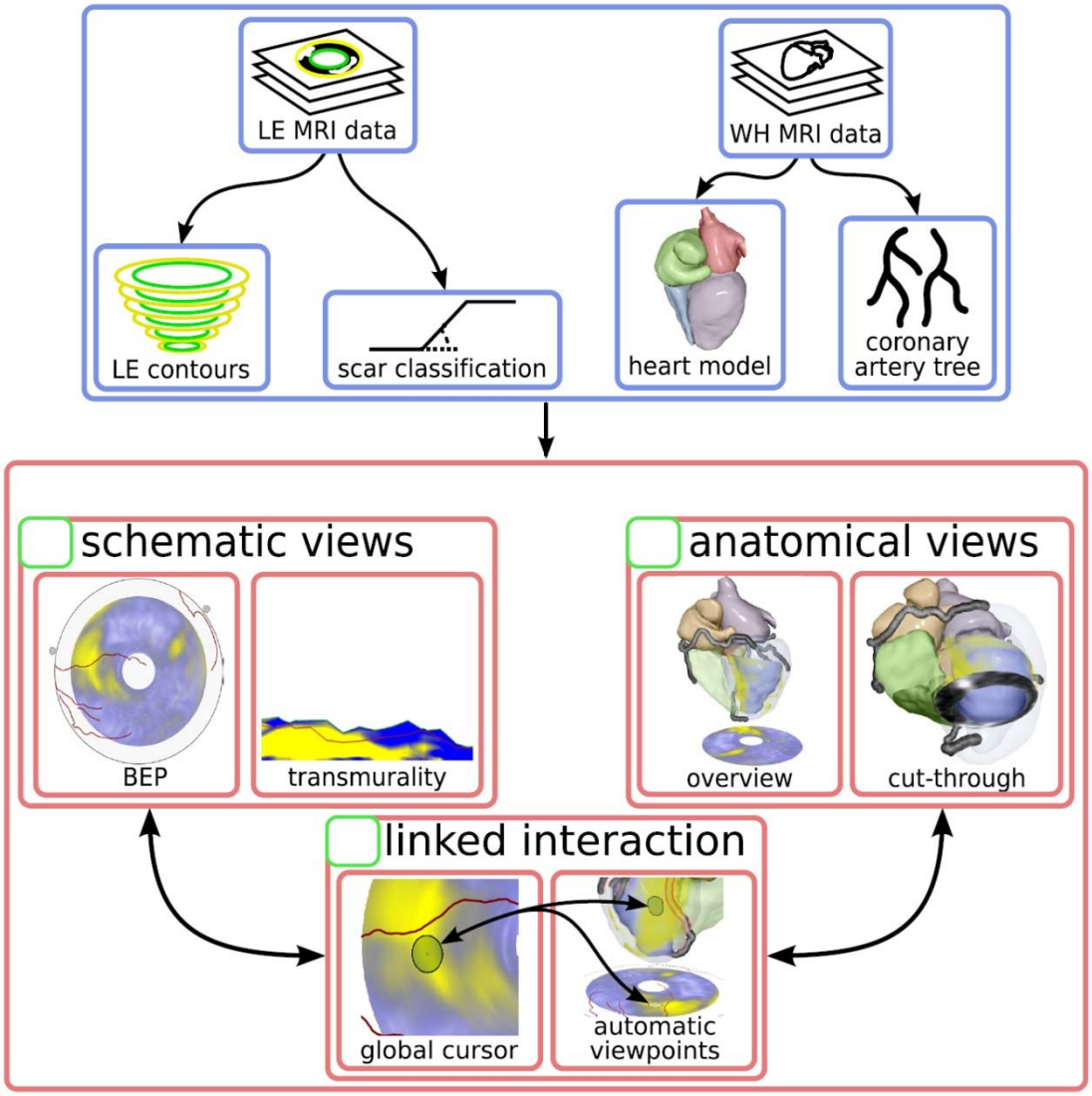
Coping with Complexity and Variability

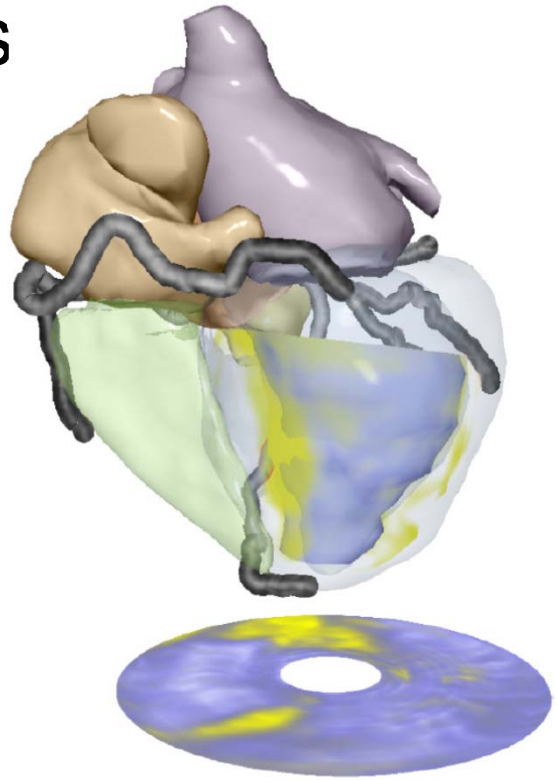
- Reducing data complexity well established
  - Sub-setting
  - Slicing
  - Projection
  - Dimension reduction
  - Clustering

- Reducing visual complexity ??
  - Integrated views
  - Comparative visualization
  - Fuzzy visualization
  - …

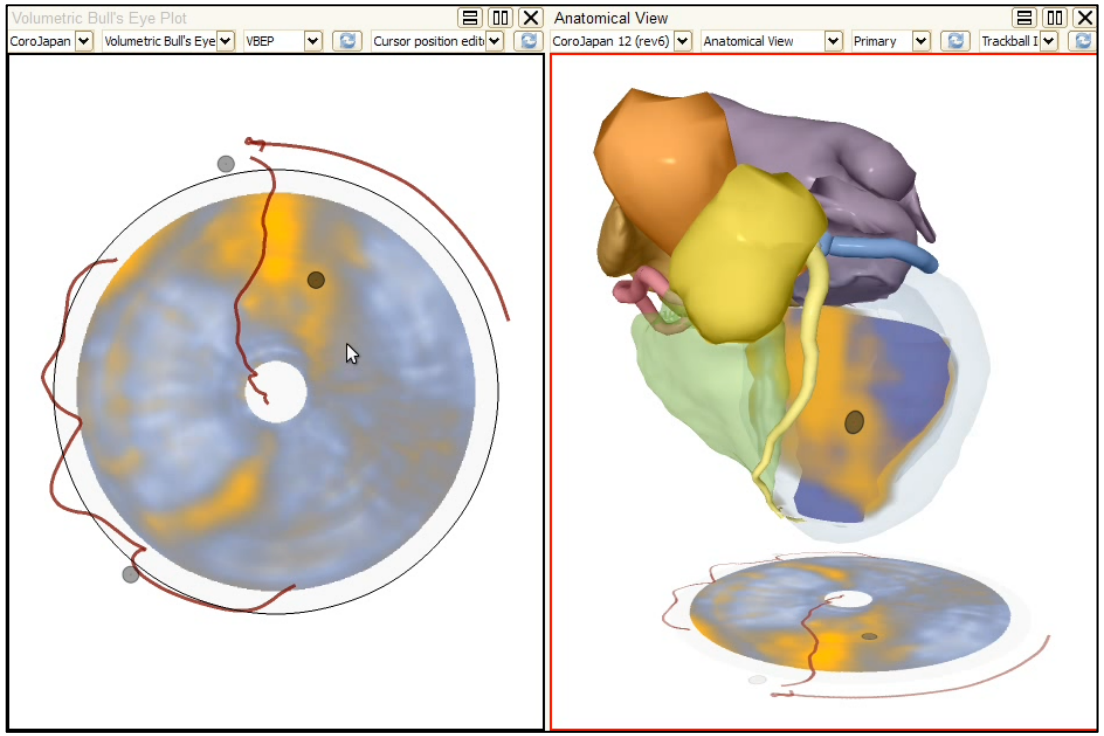
Cardiac Data Visualization [Termeer et al.]

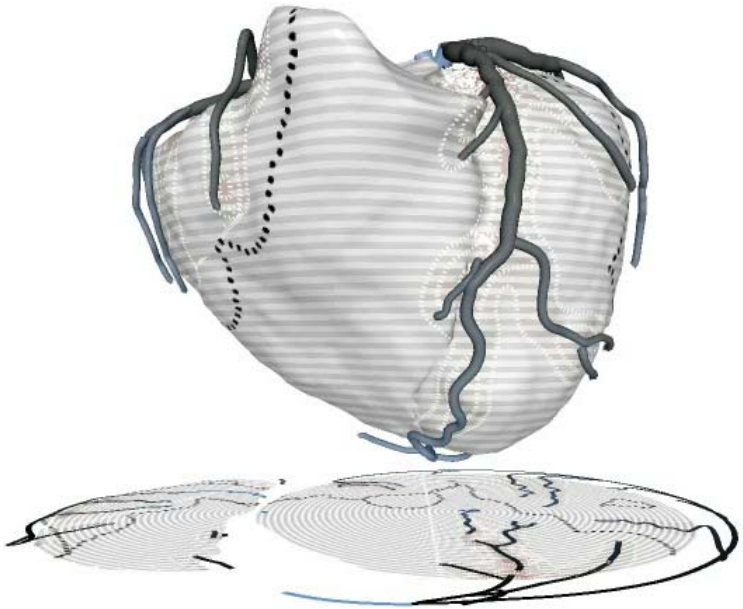
- Fusion of 4 diverse data types

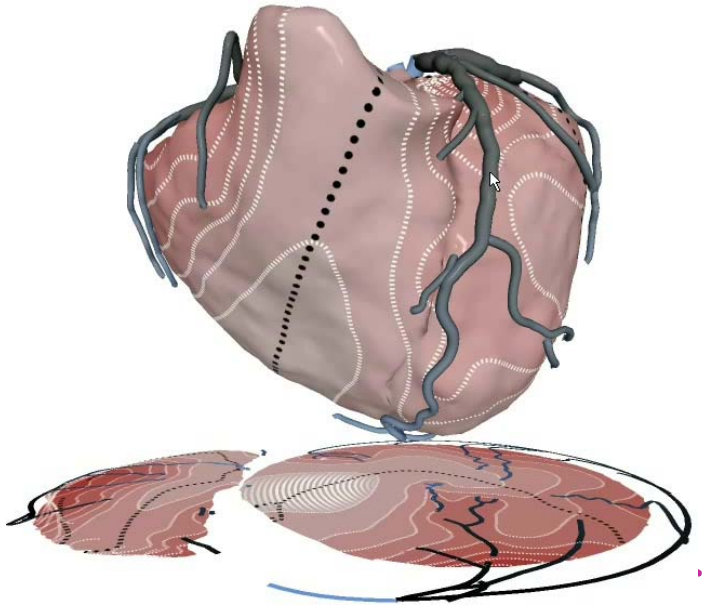




Cardiac Data Visualization - Examples

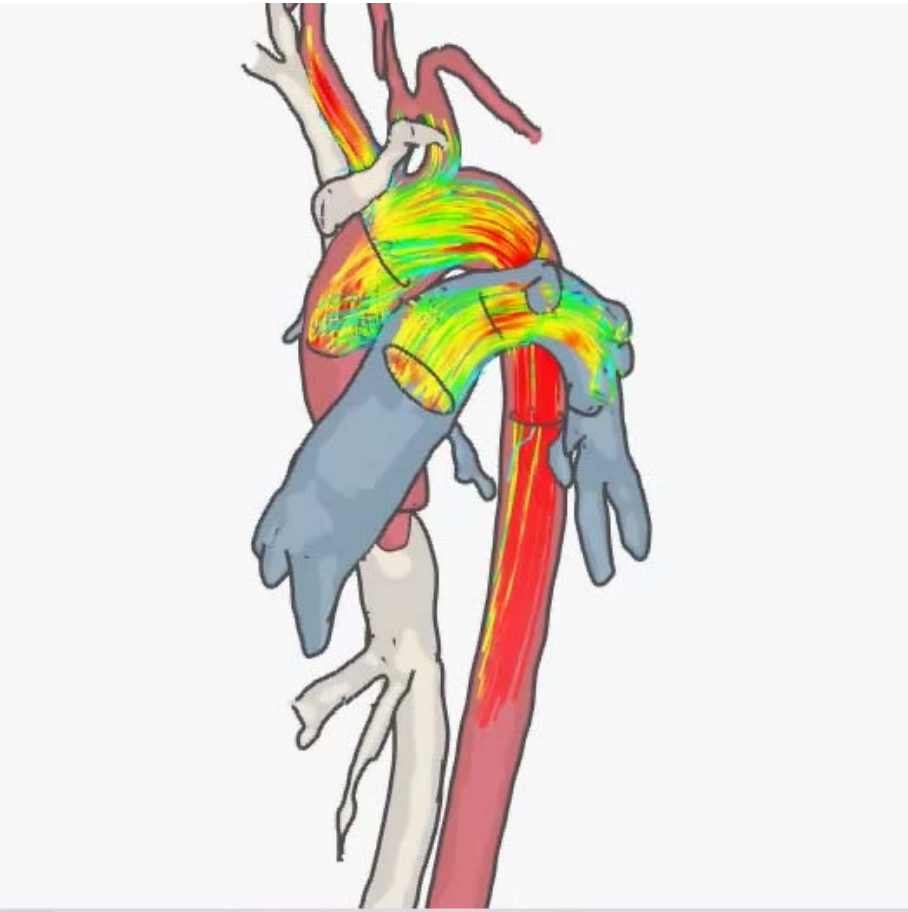


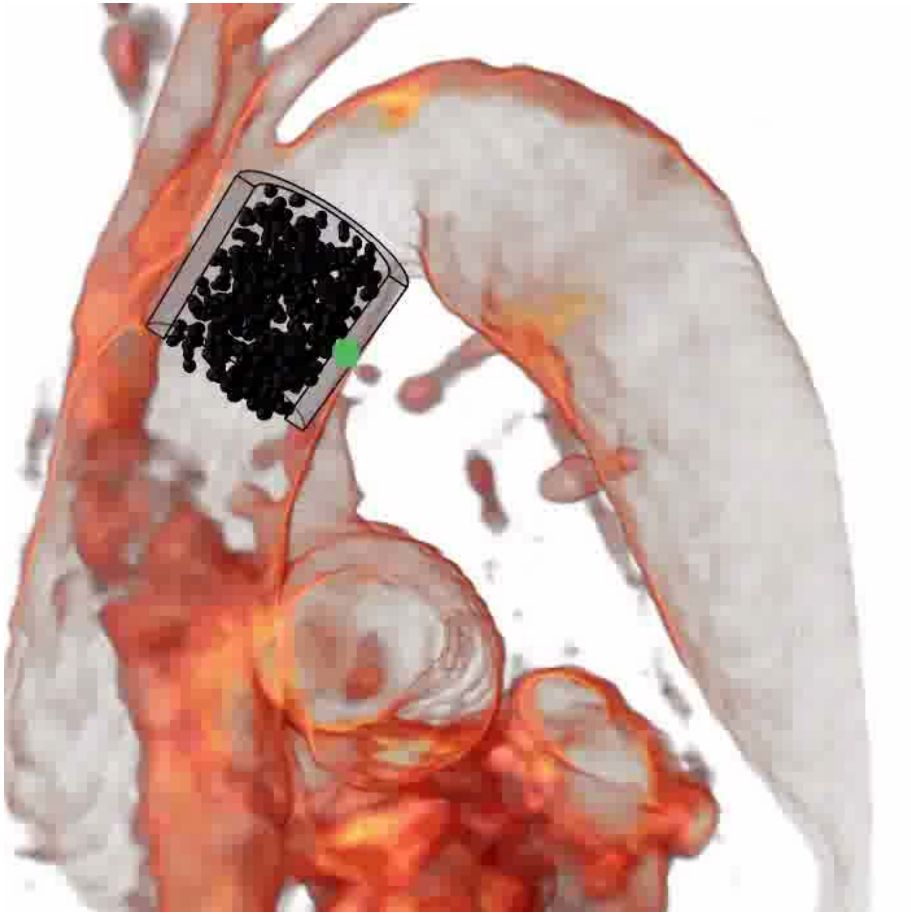




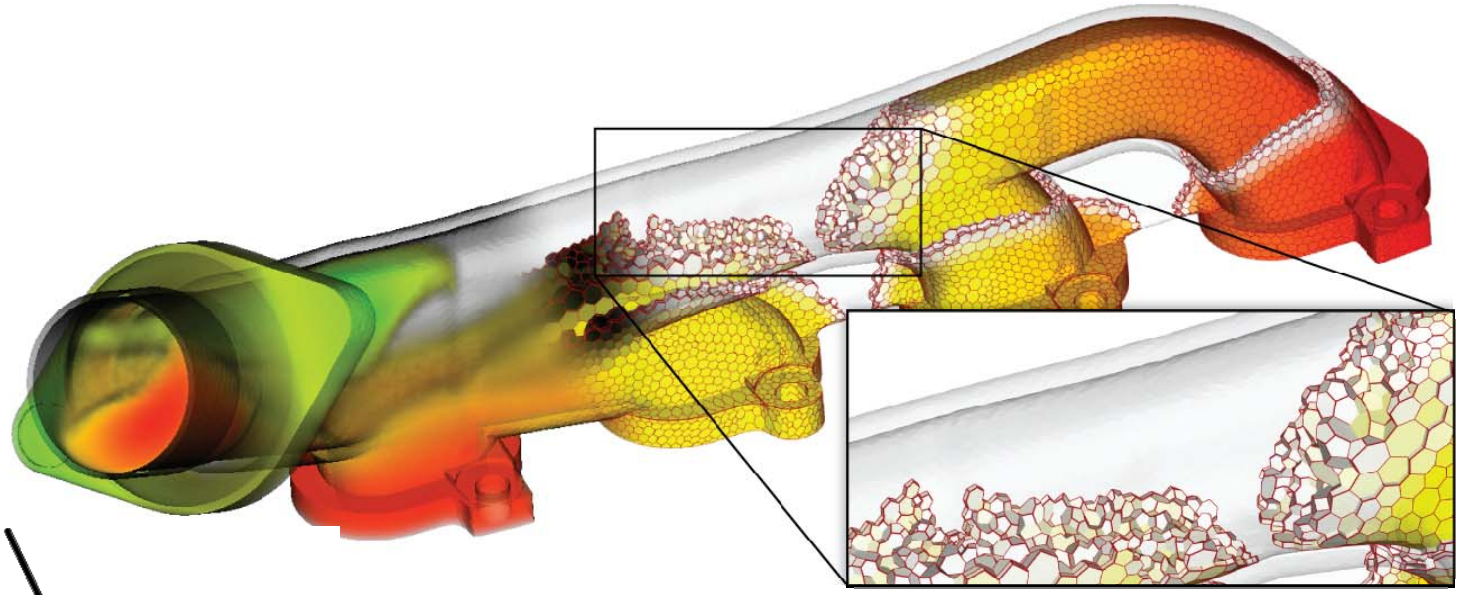
- Interactive navigation
- Perfusion simulation
- Stenosis simulation

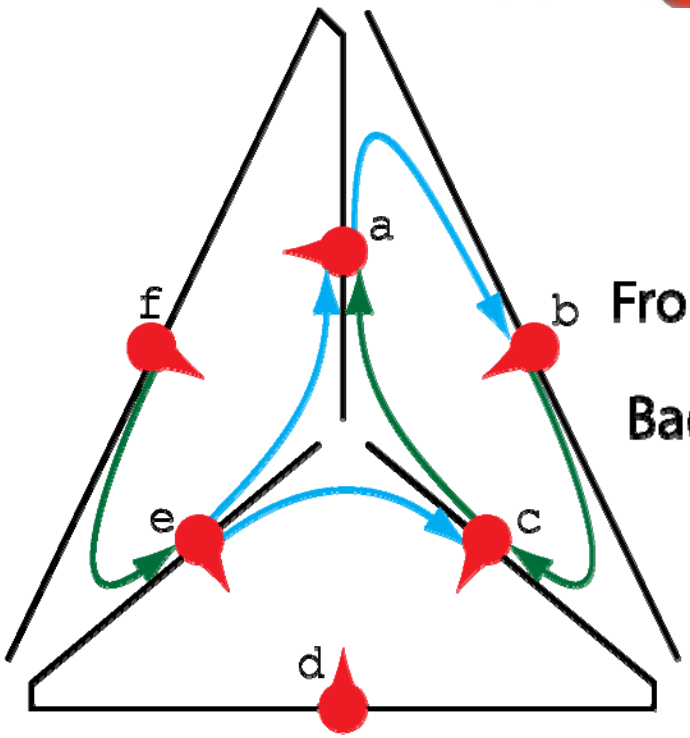
4D MRI Blood Flow [van Pelt et al.]





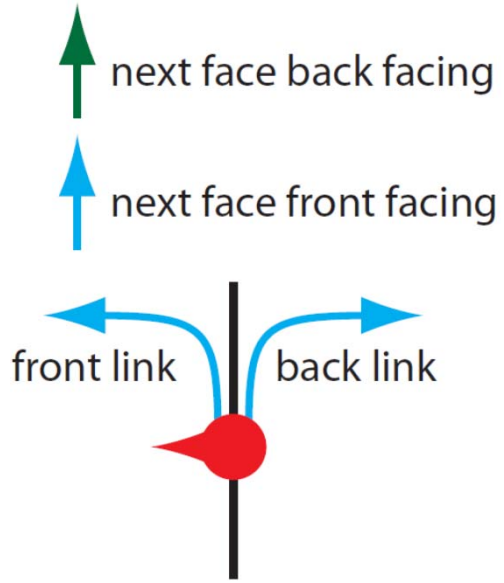
Generalized Polyhedral Grids [Muigg, Doleisch et al.]





Face Sequences

Front	[c]	[e]	[c]
	[c d e]	[a f]	[b]
Back	[a - a]	[b -]	[-]



Challenges in Visual Computing

- New Data Sources - Novel Imaging Modalities
- Ensembles, Uncertainty, Parameter Spaces
- Multivariate, Heterogeneous Data
-
-
-
-
-

Visual Analytics (↔ SciVis ↔ InfoVis)

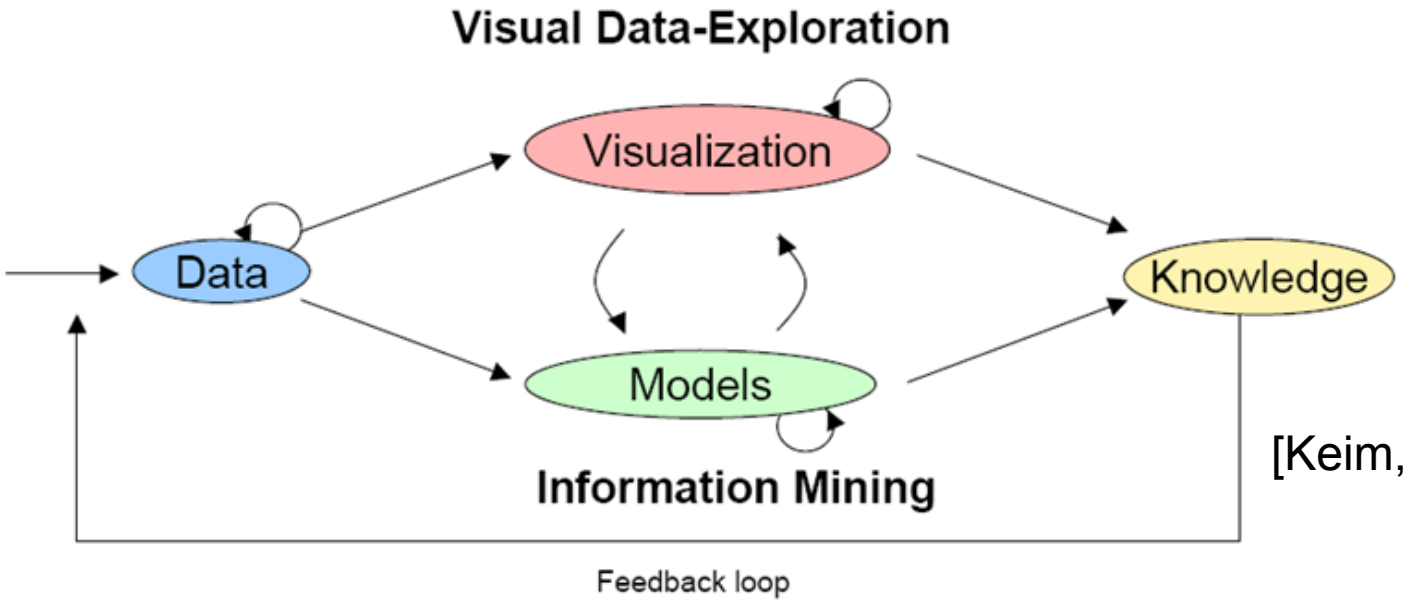
"Visual Analytics is the science of analytical reasoning facilitated by interactive visual interfaces"

What do we have?

- Automatic Knowledge Discovery & Information Mining
- Interactive Visual Data-Exploration

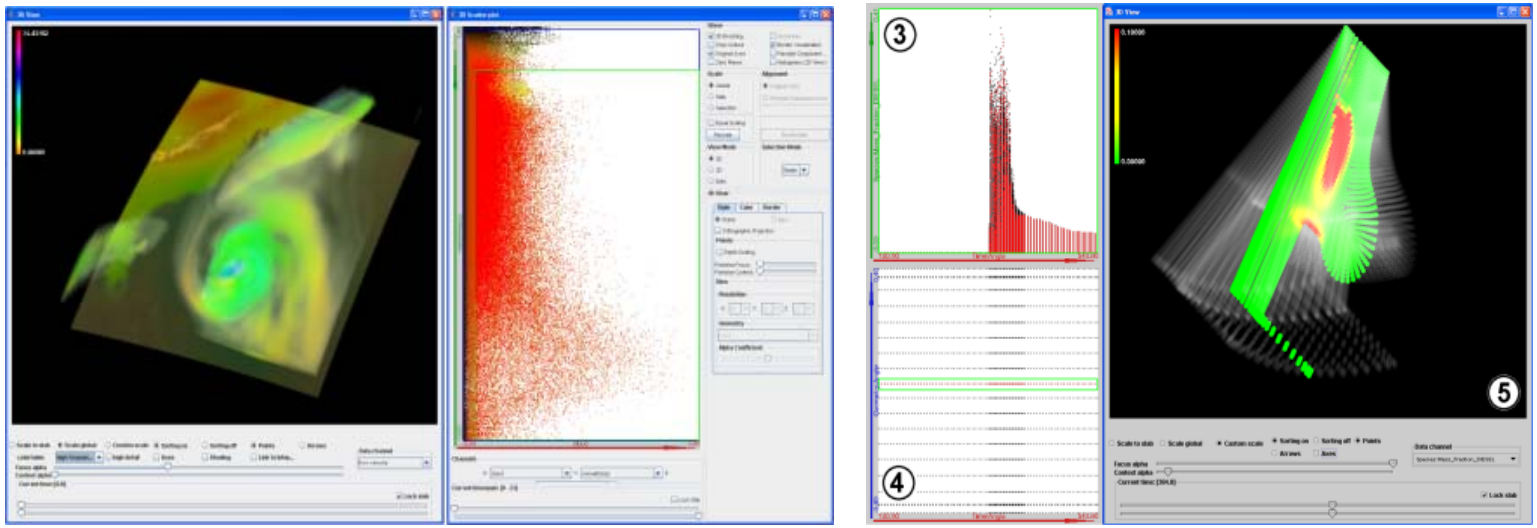
What do we need?

Tight Integration of Visual and Automatic Data Analysis Methods with Database Technology for a Scalable Interactive Decision Support



[Keim, Thomas]

SimVis: Interactive Visual Analysis of Large & Complex Simulation Data



Helmut Doleisch et al.

Challenges in Visual Computing

- New Data Sources - Novel Imaging Modalities
- Ensembles, Uncertainty, Parameter Spaces
- Multivariate, Heterogeneous Data
- Visual Analytics (↔ SciVis ↔ InfoVis)
-
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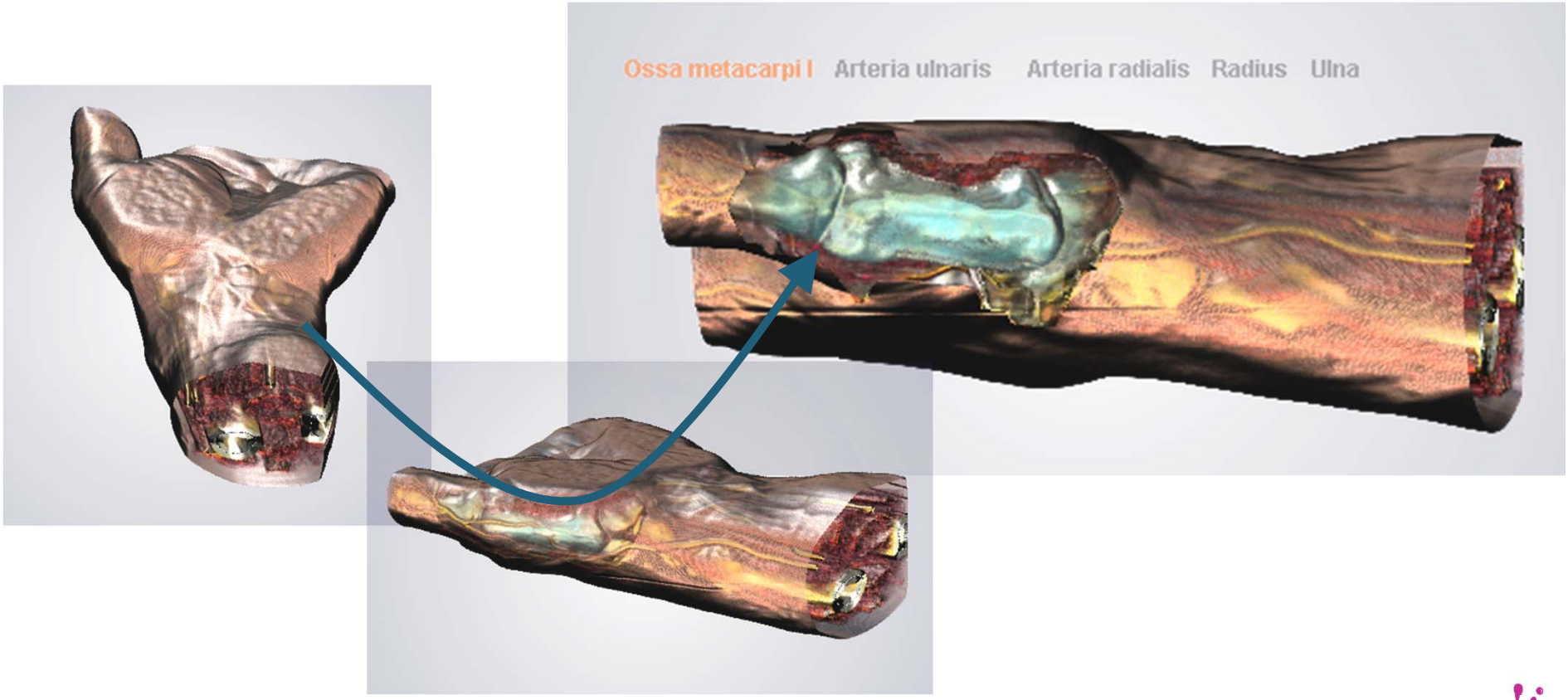
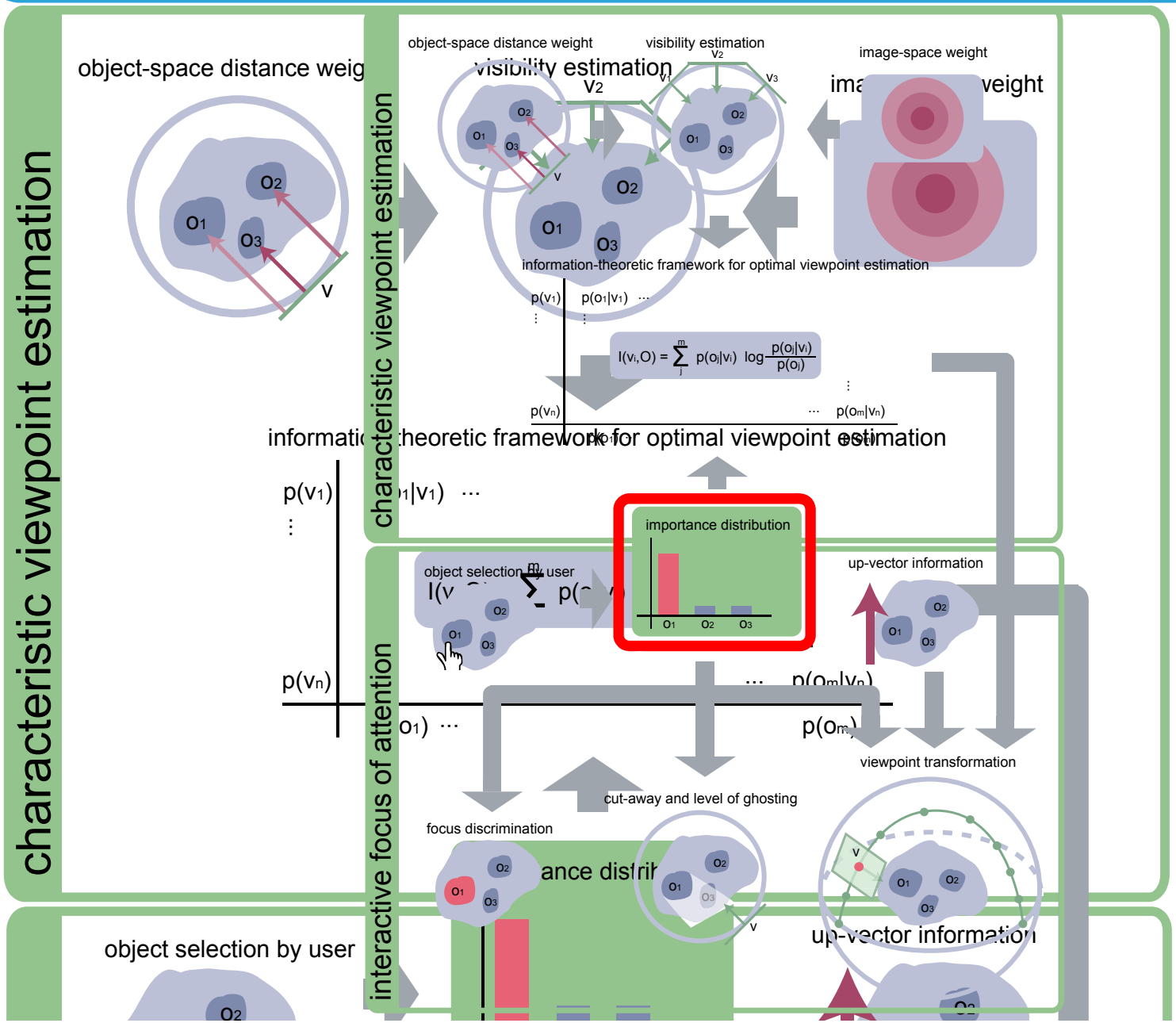
Importance-Driven Focus of Attention (1)

- Guided navigation between characteristic views

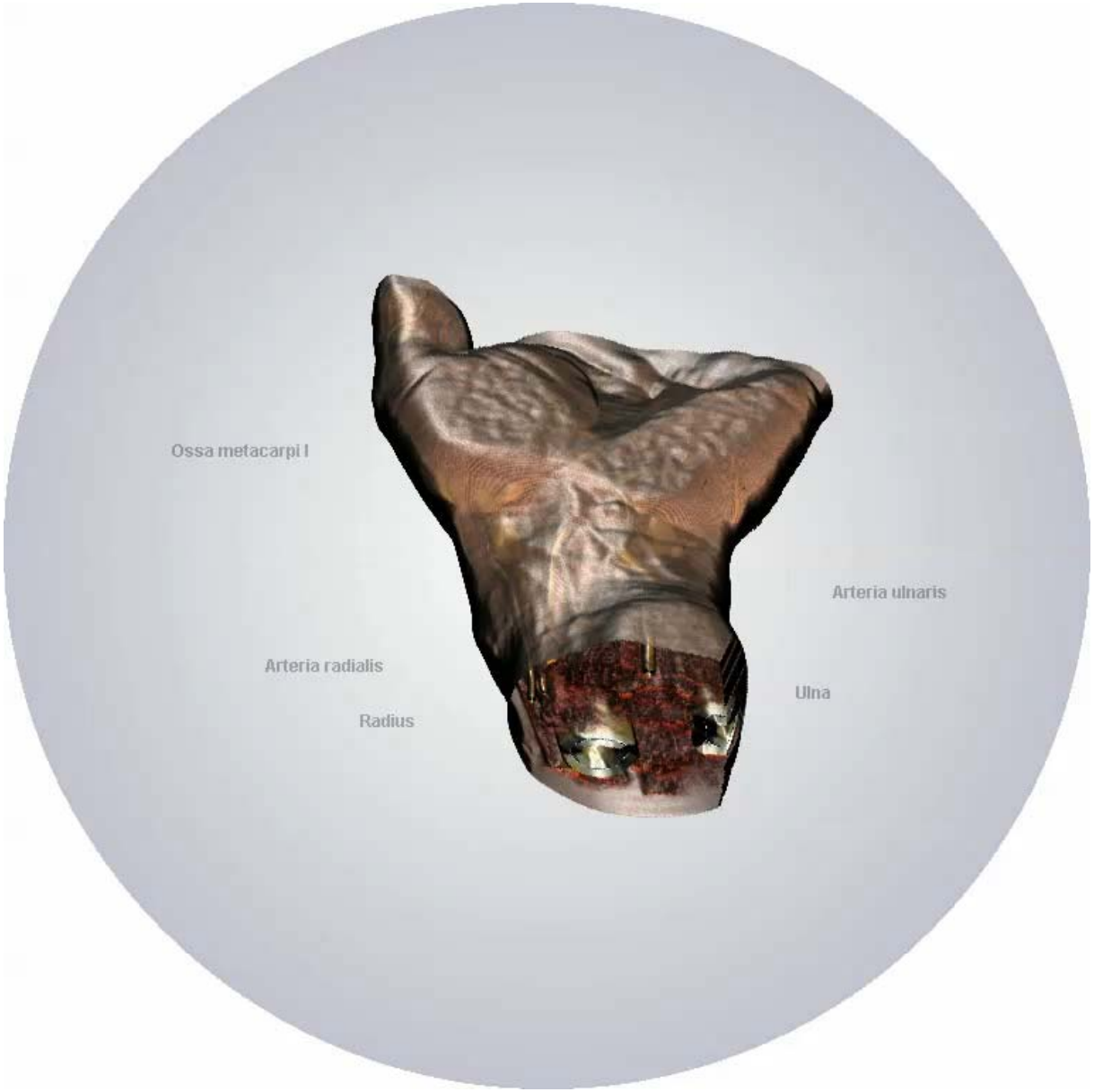
[Viola et al.]



Importance-Driven Focus of Attention (2)

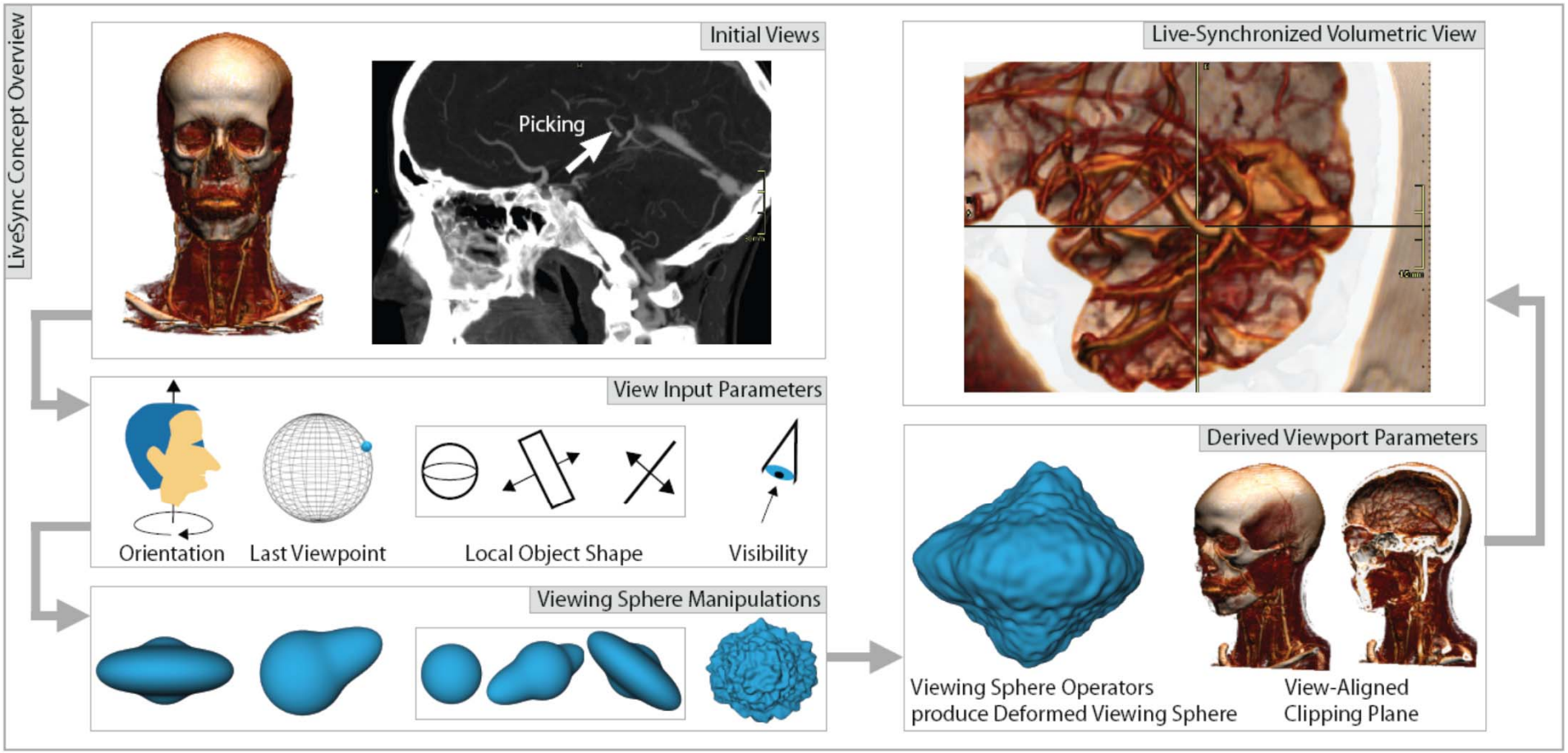


Importance-Driven Focus of Attention (3)



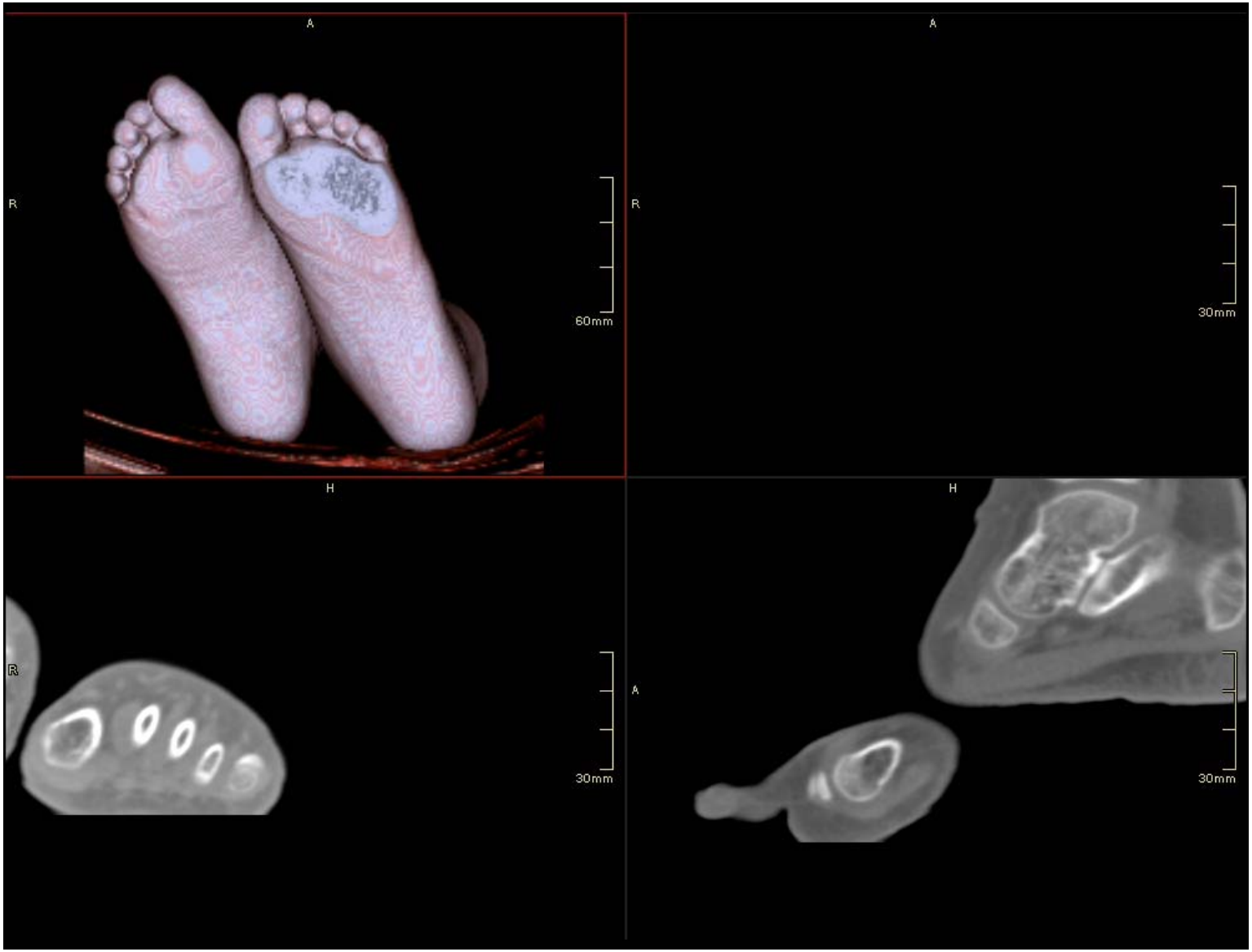
Knowledge-Based Navigation (1)

- Interaction with 2D slices
- Automatic generation of expressive 3D views



[Kohlmann et al.]

Knowledge-Based Navigation (2)



[Kohlmann et al.]

Challenges in Visual Computing

- New Data Sources - Novel Imaging Modalities
- Ensembles, Uncertainty, Parameter Spaces
- Multivariate, Heterogeneous Data
- Visual Analytics (↔ SciVis ↔ InfoVis)
- Interaction (Knowledge-assisted, User-centric)
-
-
-

Scalability

- Challenges [Keim, Thomas]
  - amount of data and dimensionality
  - numbers of data sources and heterogeneity
  - data quality and data resolution
  - dynamicity and novelty
  - data representation and visual resolution

- Examples
  - Focus+Context
  - Aggregation
  - Abstraction and Illustration

macroscopic magnification

Biomechanics

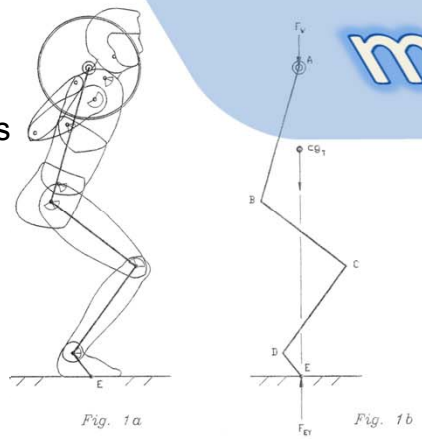
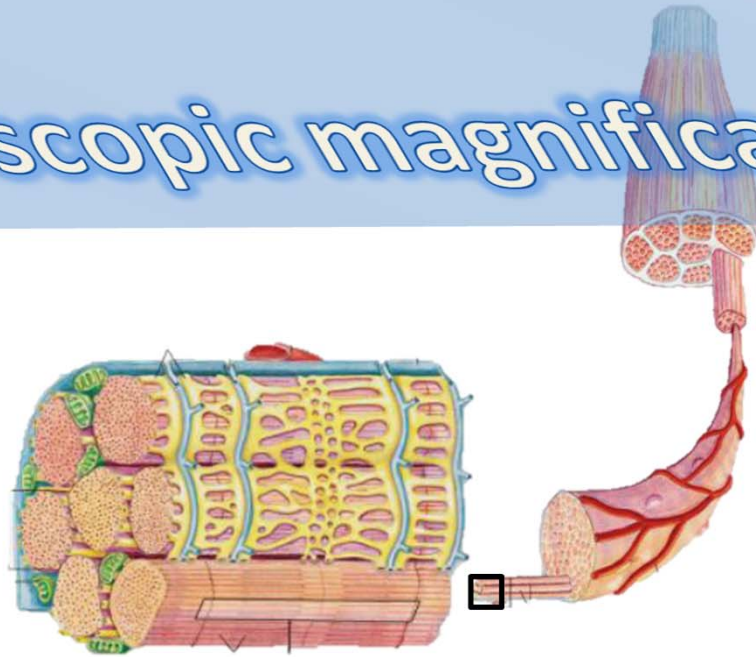
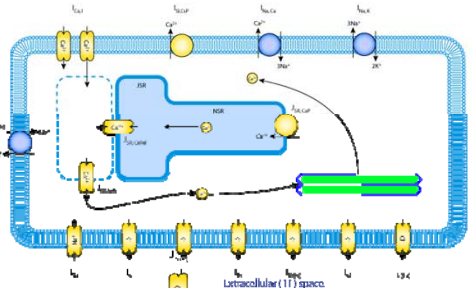


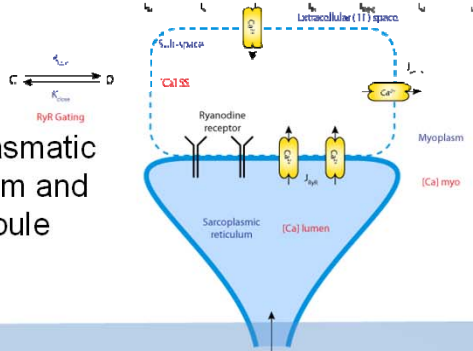
Fig. 1a Fig. 1b

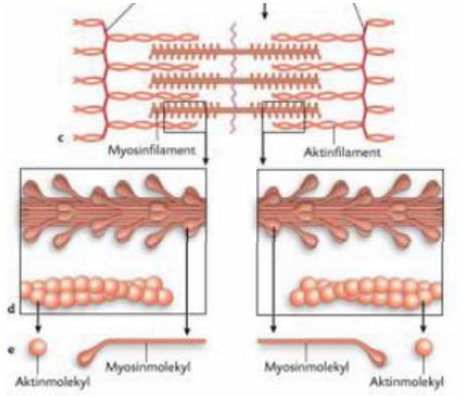


Intracellular space and Membrane



Sarcoplasmatic Reticulum and T-Tubule





Ryanodine Receptor

[Viola et al.]

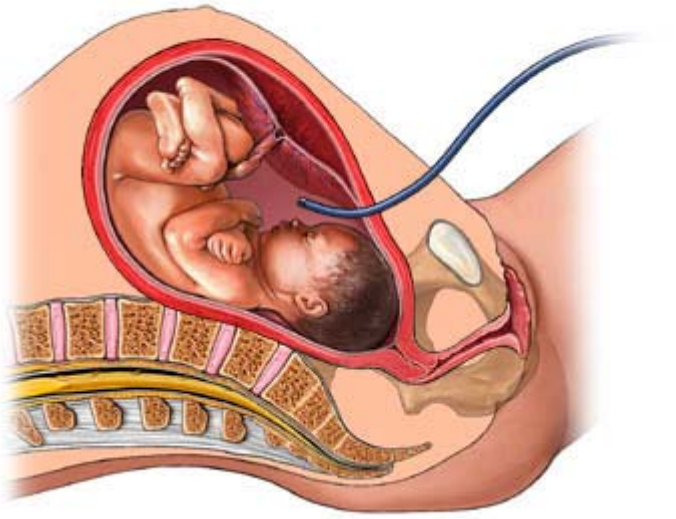
Ivan Viola

microscopic magnification

Challenges in Visual Computing

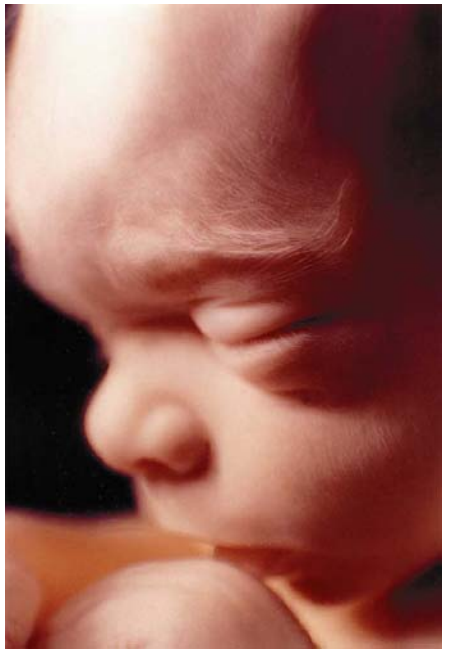
- New Data Sources - Novel Imaging Modalities
- Ensembles, Uncertainty, Parameter Spaces
- Multivariate, Heterogeneous Data
- Visual Analytics (↔ SciVis ↔ InfoVis)
- Interaction (Knowledge-assisted, User-centric)
- Scalability
-
-

- Fetoscopy
  - Invasive procedure



[edu.firstcoastcardio.com]

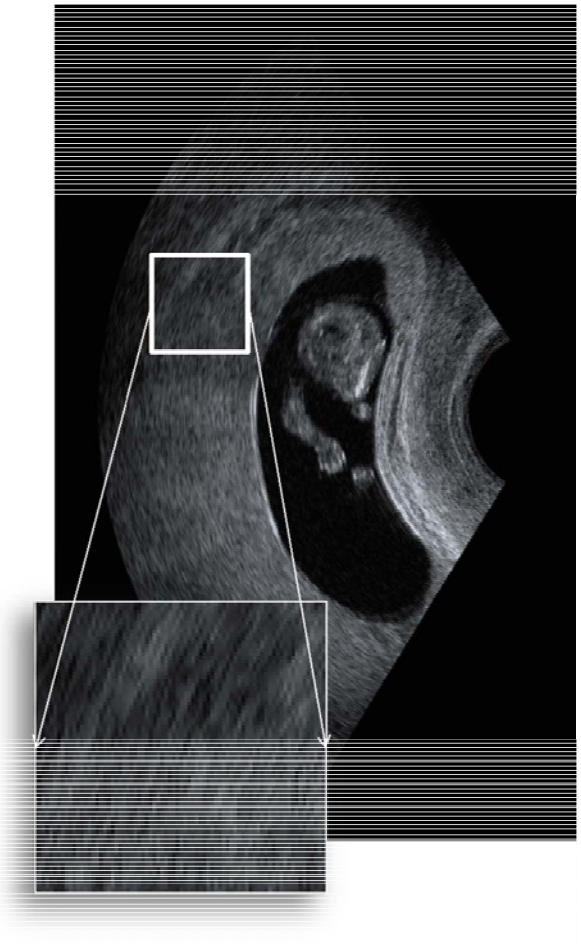
  - „Nice“ images

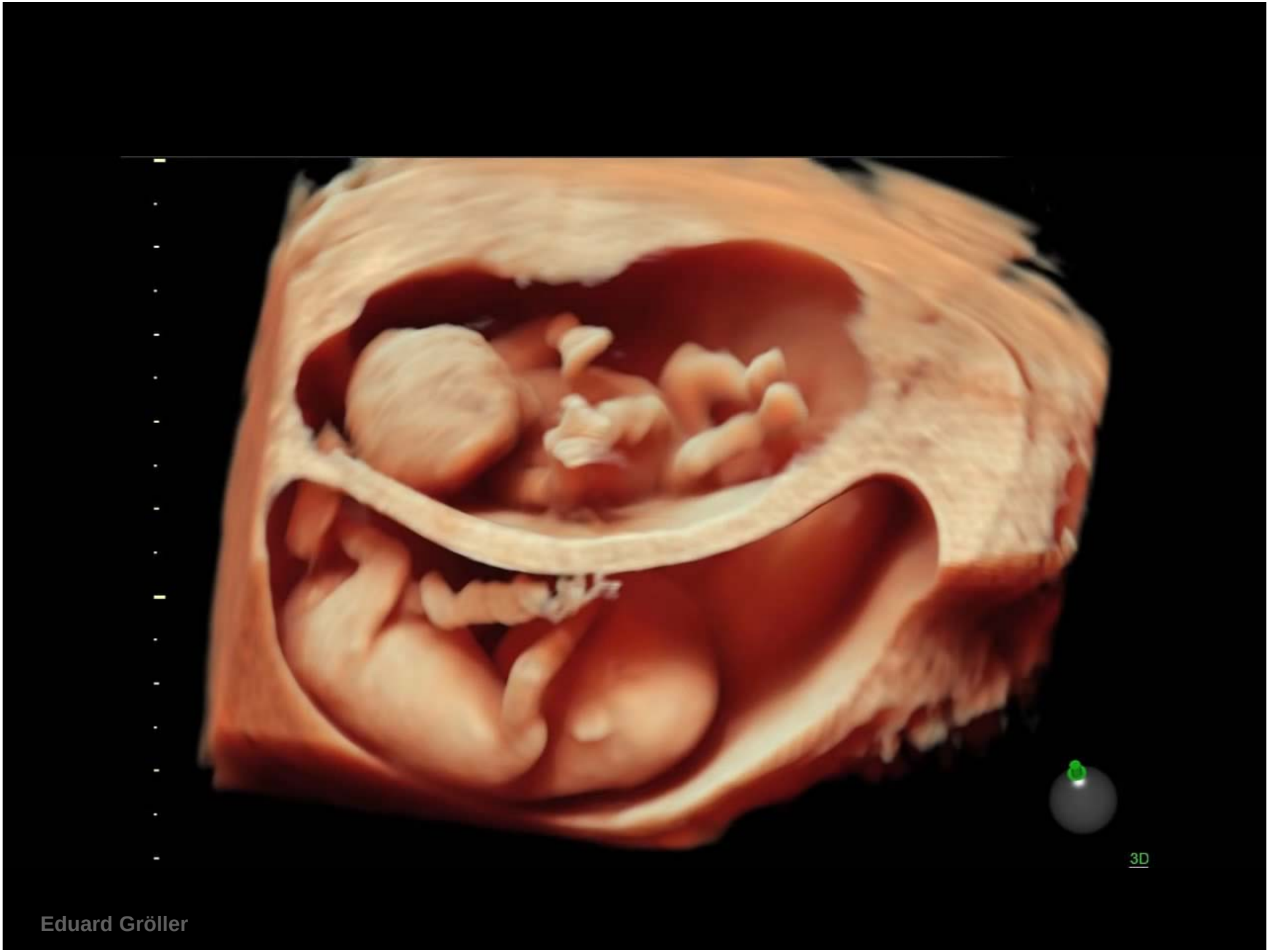


[Skawina, Marsinek]

Virtual Fetoscopy - HD*live* [Varchola et al. 2012]

- Visualization of 4D Ultrasound Data
- Joint project with Kretztechnik (GE)




3D
Eduard Gröller

- Aesthetics enhances
  - Clinical confidence
  - User interest
  - User involvement

NEXT

SKYCAST

Overhead this month in parts of the world

Early October
Comet ISON visible

October 18
Penumbral lunar eclipse

Baby Pictures "The number one thing parents want to see is if babies have ten fingers and ten toes," says engineer Karl-Heinz Lumpi. His team developed software that shows the digits in full-color 3-D. Beyond allaying parents' curiosity, the more exact image of what's going on in the womb may play a role in diagnostics. Doctors who were formerly resigned to a blurred heartbeat can now see inside that organ's chambers.

It's all in the lighting. The image starts out like a traditional 3-D ultrasound's. Then a computer program adds virtual illumination, mimicking how light plays across human skin—reflecting, casting shadows, and giving shape. As in regular photography, the light source is movable. Plus the image is rotatable, so wriggling fingers, or a floating umbilical cord like this eight-month fetus's, likely won't hinder a thorough exam. *—Johnna Rizzo*

PHOTO: BERNARD BENOIT, SCIENCE SOURCE

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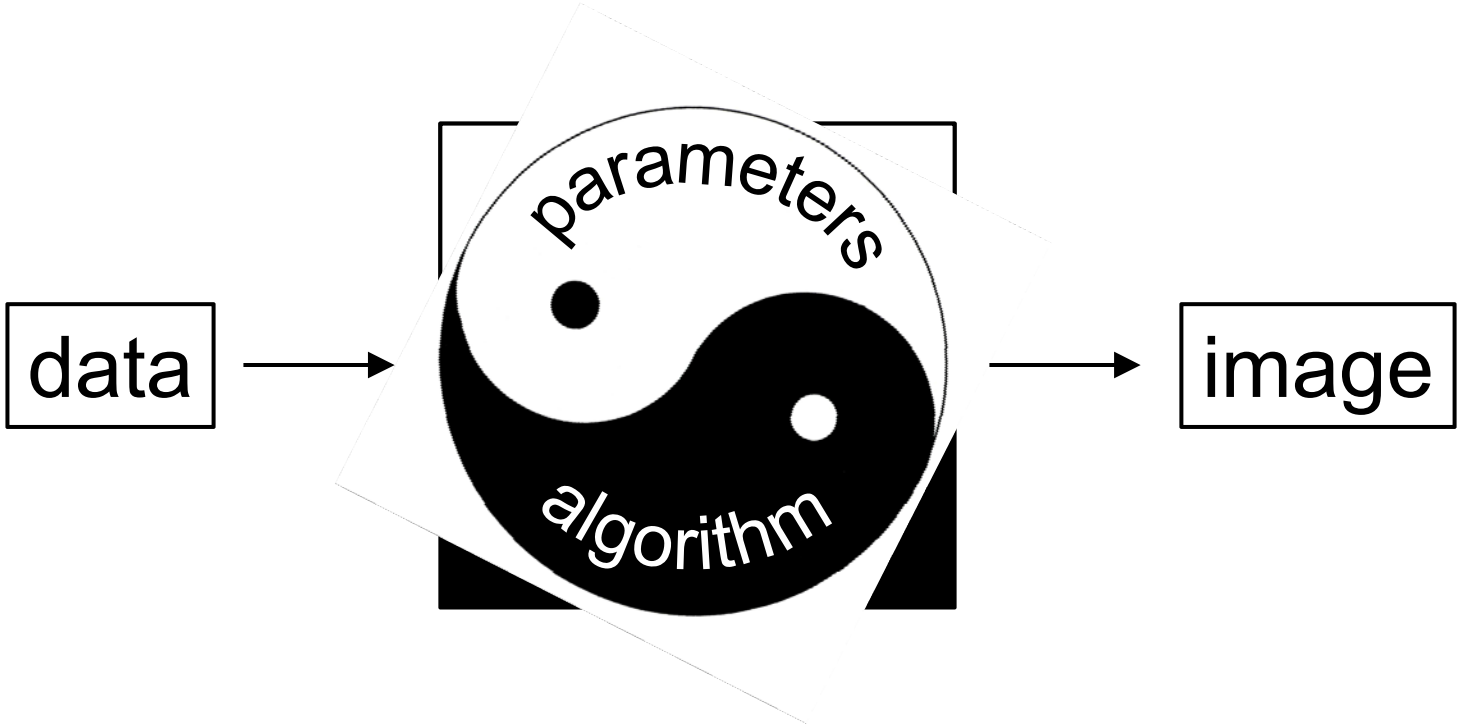
Challenges in Visual Computing

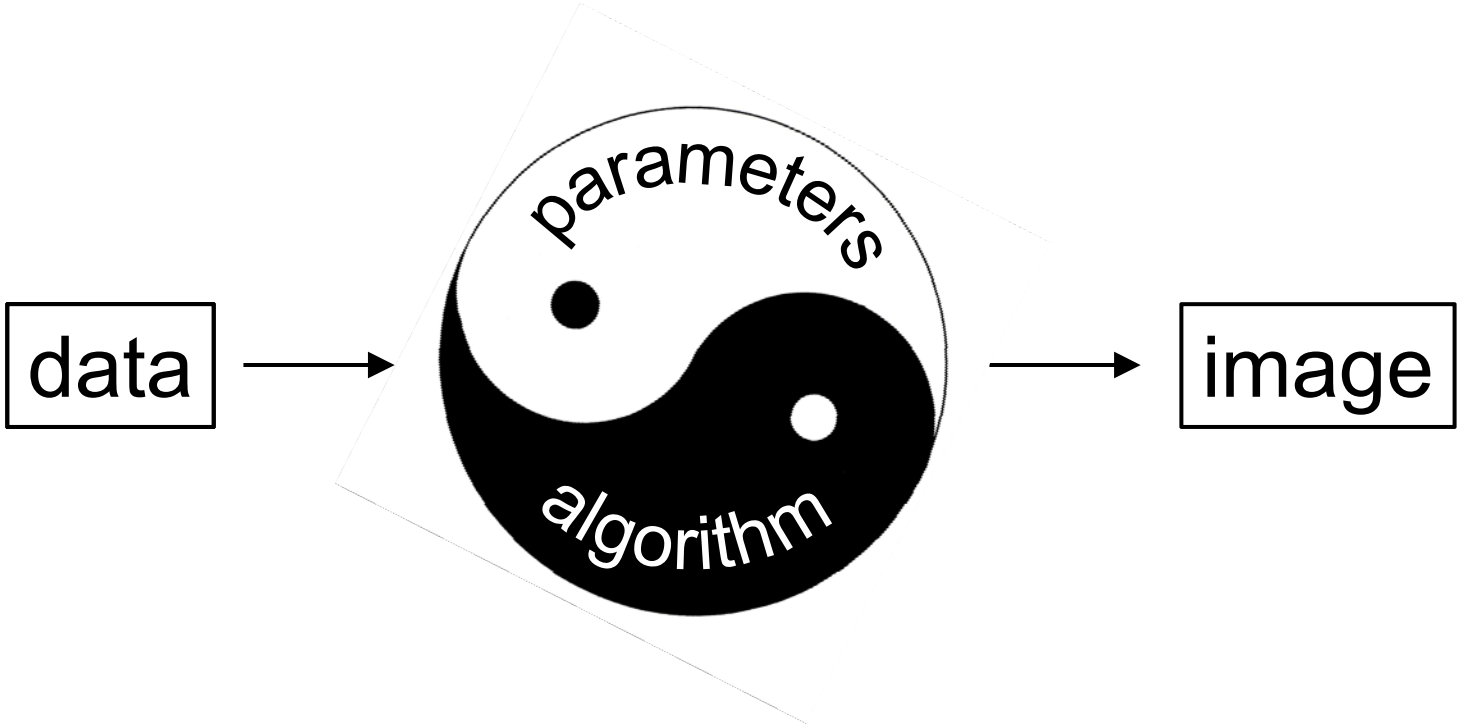
- New Data Sources - Novel Imaging Modalities
- Ensembles, Uncertainty, Parameter Spaces
- Multivariate, Heterogeneous Data
- Visual Analytics (↔ SciVis ↔ InfoVis)
- Interaction (Knowledge-assisted, User-centric)
- Scalability
- Aesthetics
-

Problem Solving: Algorithm + Parameters

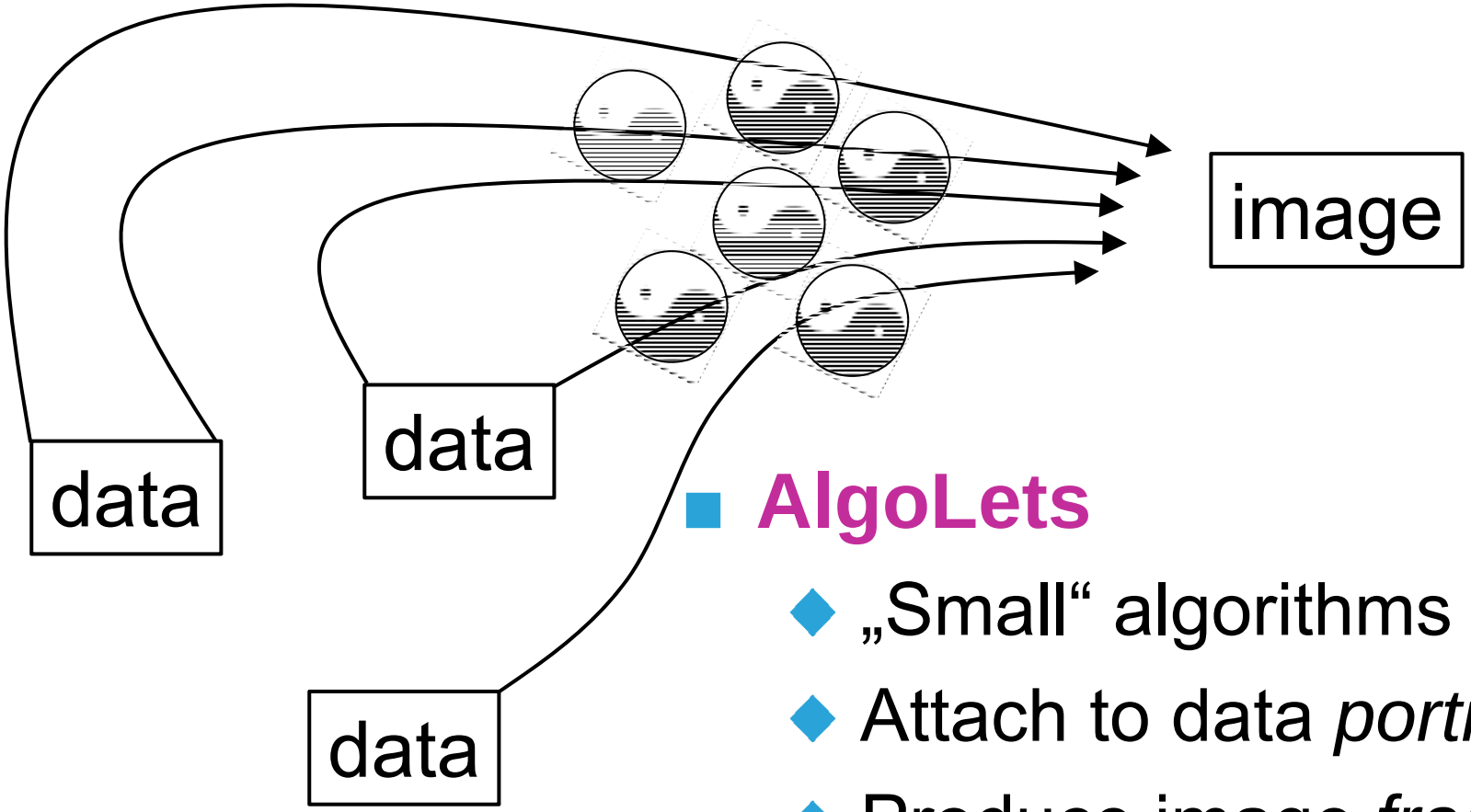


- Parameter space analysis
  - Robustness, stability: well established in other disciplines
  - Increased interest in visualization
    - Variations
    - Esembles
    - Knowledge-assisted visualization

AlgoLets: The Next Generation

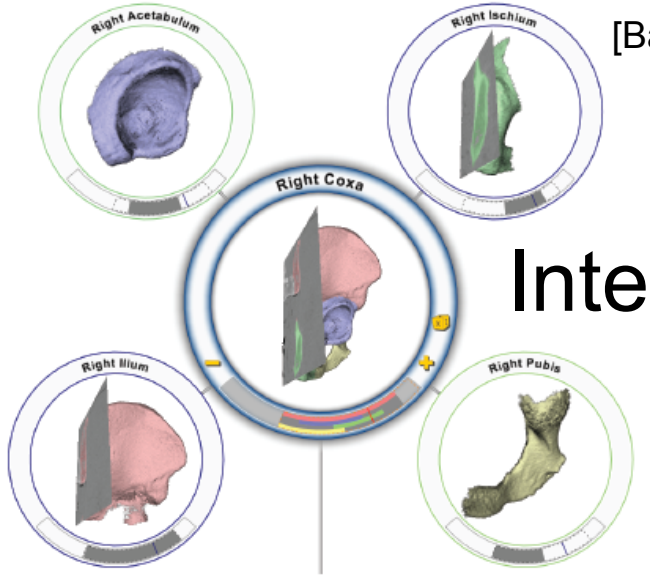


AlgoLets: The Next Generation



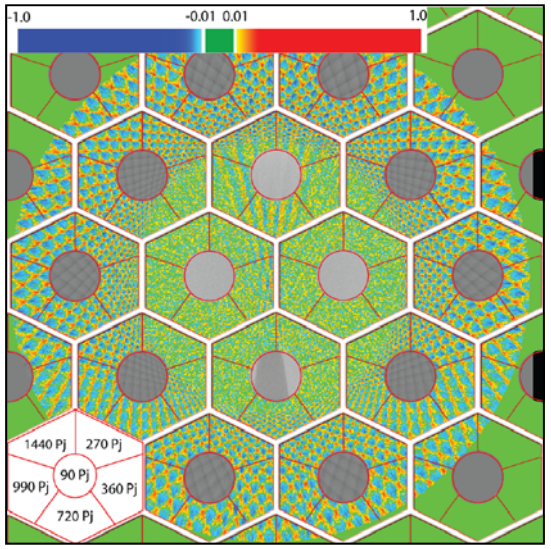
- **AlgoLets**
  - „Small“ algorithms
  - Attach to data *portions*
  - Produce image *fragments*
- Integration of fragments

Visual Computing: Topics for the Future ?



[Balabanian et al.]

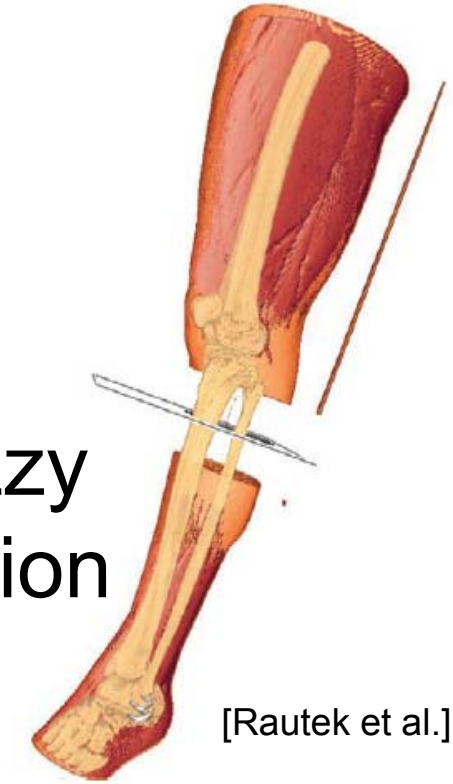
Integrated Views



Comparative Visualization

[Malik et al.]

Fuzzy Visualization



[Rautek et al.]

if *distance to plane is not very low*
then *skin-style is opaque*

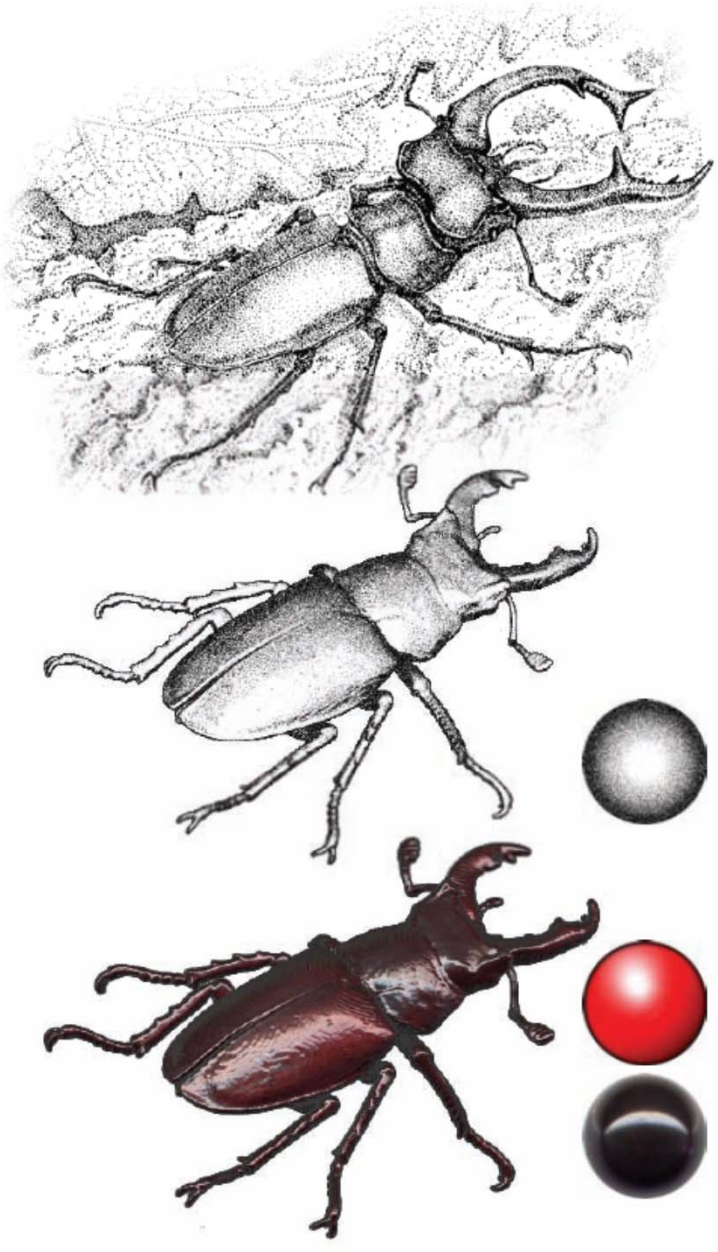
if *distance to plane is very low*
then *skin-style is transparent* and *muscle-style is transparent*

Challenges in Visual Computing

- New Data Sources - Novel Imaging Modalities
- Ensembles, Uncertainty, Parameter Spaces
- Multivariate, Heterogeneous Data
- Visual Analytics (↔ SciVis ↔ InfoVis)
- Interaction (Knowledge-assisted, User-centric)
- Scalability
- Aesthetics
- Visual Computing in the Cloud

Bring **visual computing**
into the workflow of users!!

Thank You for Your Attention



Questions ?
Comments?

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