Managing the Evolution of Dataflows with VisTrails

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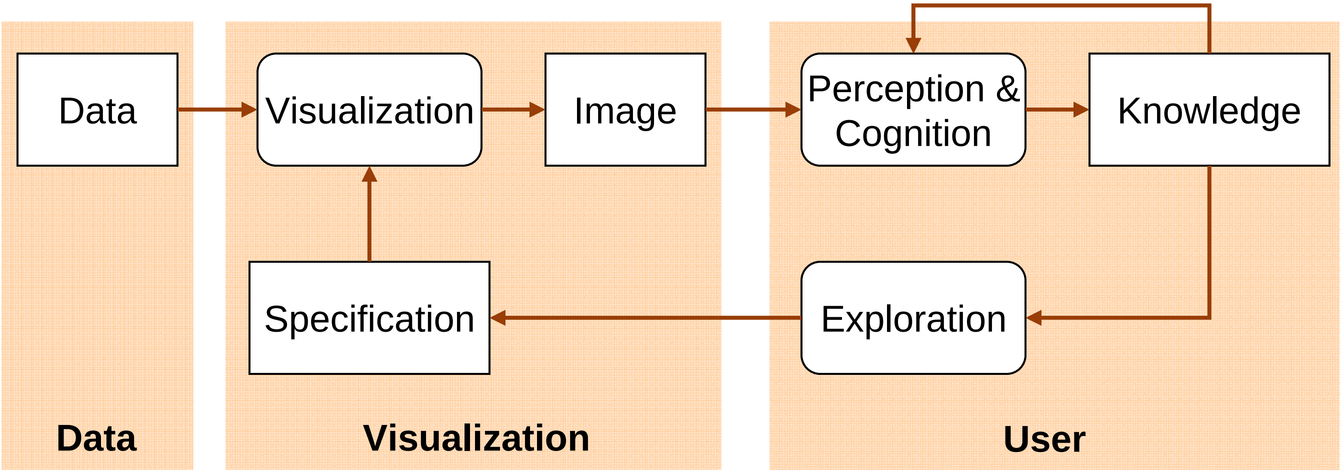
Data Exploration through Visualization

- Hard to make sense out of large volumes of raw data, e.g., sensor feeds, simulations, MRI scans
- Insightful visualizations help analyze and validate various hypothesis
- But creating a visualization is a complex process

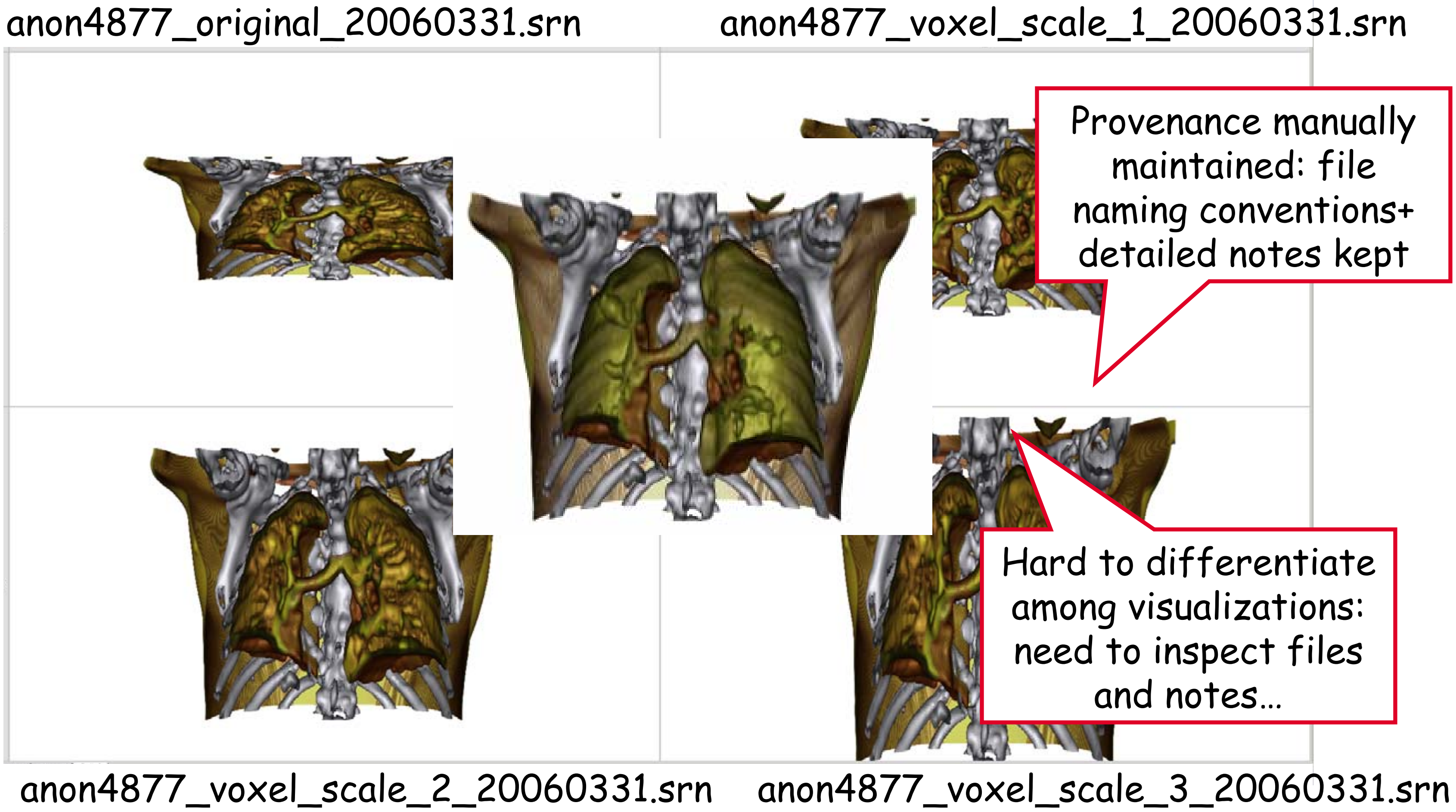


Visualization Systems: State of the Art

- Systems: SCIRun, ParaView
- Visual programming for creating *visualization pipelines*—dataflows of visualization operations
  - Simplify and automate and the creation of visualizations
- Hard to create and compare a *large number* of visualizations
- Limitations:
  - No separation between the specification of a dataflow and its instances
  - No provenance tracking mechanism
  - Users need to manage data and metadata

The generation and maintenance of visualizations is a major bottleneck in the scientific process

Example: Visualizing Medical Data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anon4877_voxel_scale_3_20060331.srn

Provenance manually maintained: file naming conventions+ detailed notes kept

Hard to differentiate among visualizations: need to inspect files and notes…

VisTrails: Managing Visualizations

- Streamlines the creation, execution and sharing of complex visualizations
  - VisTrails manages the data, scientists can focus on *science!*
- Infrastructure for large-scale data exploration through visualization
  - Systematic maintenance of visualization *provenance*: akin to an electronic lab notebook
  - Interactive comparative visualization
- Not a replacement for visualization systems: provides infrastructure that can be combined with and enhance these systems
- Many important applications. Some ongoing collaborations:
  - Harvard Medical School (radiation oncology); OHSU (environmental observation and forecasting systems); UCSD (biomedical informatics)

VisTrails

Evolving dataflow

Link to video:
http://www.cs.utah.edu/~juliana/talks/videos/vistrails_evolvingdataflow_spx.avi

Action-Based Provenance: Example

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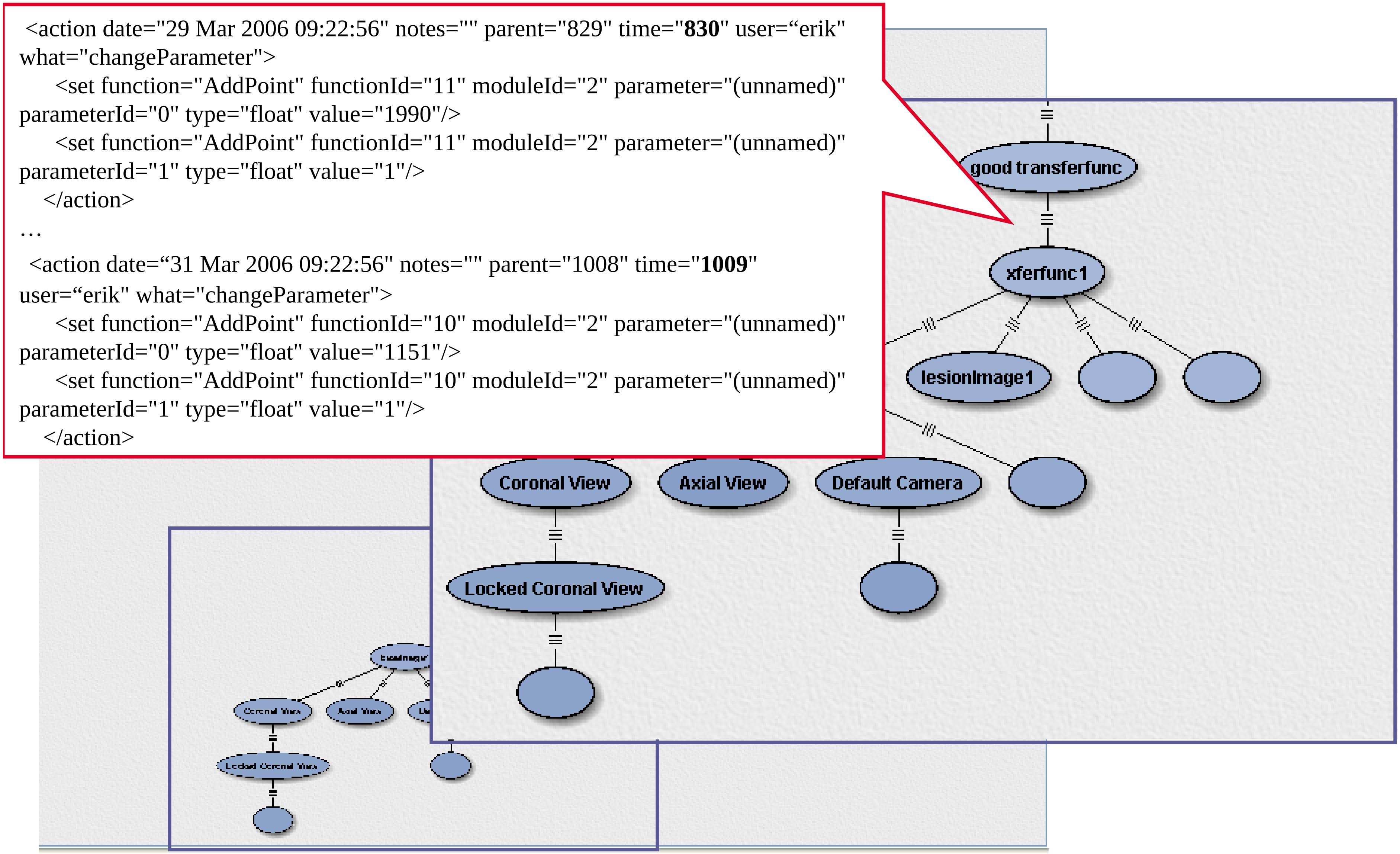
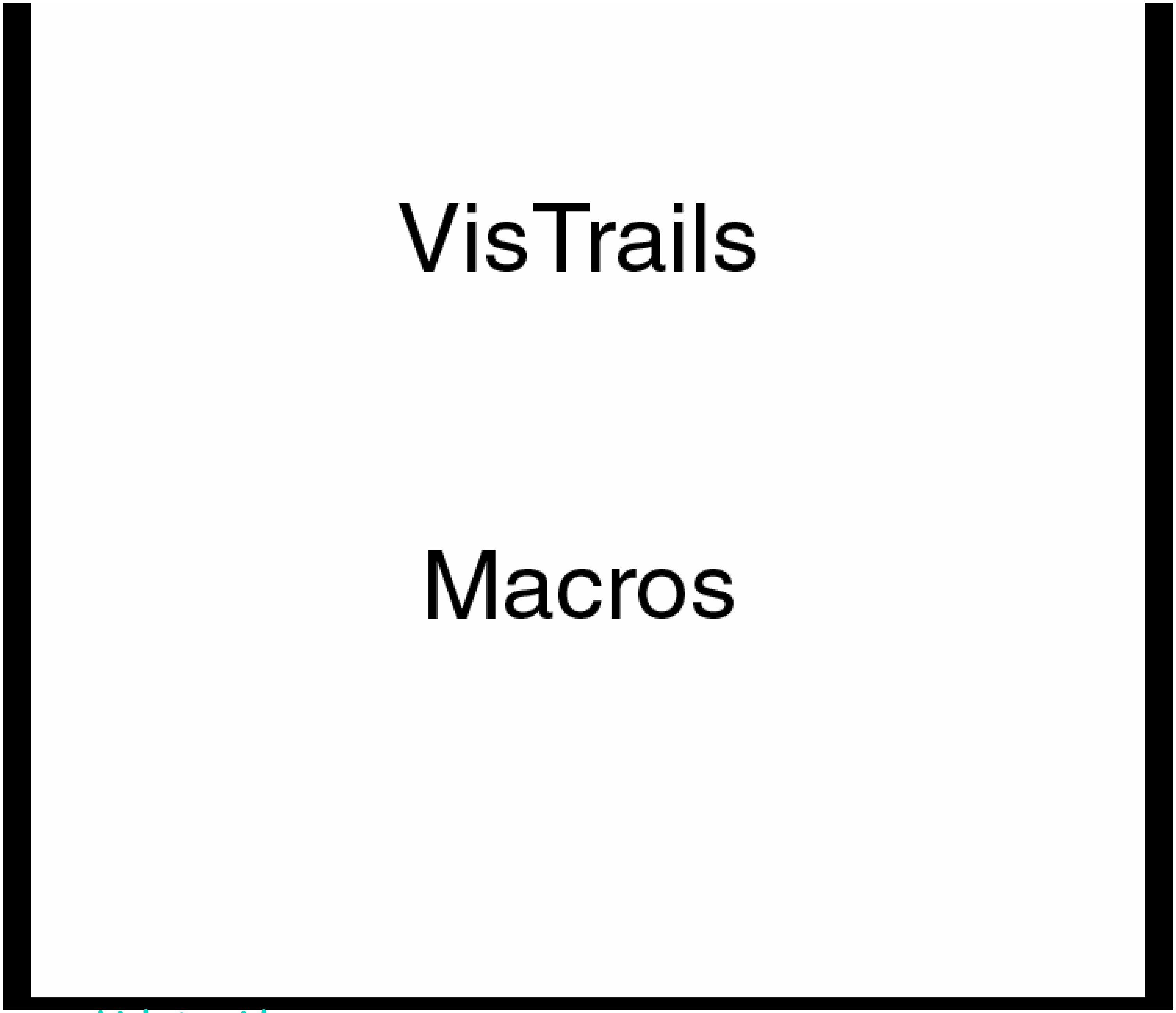


Action-Based Provenance

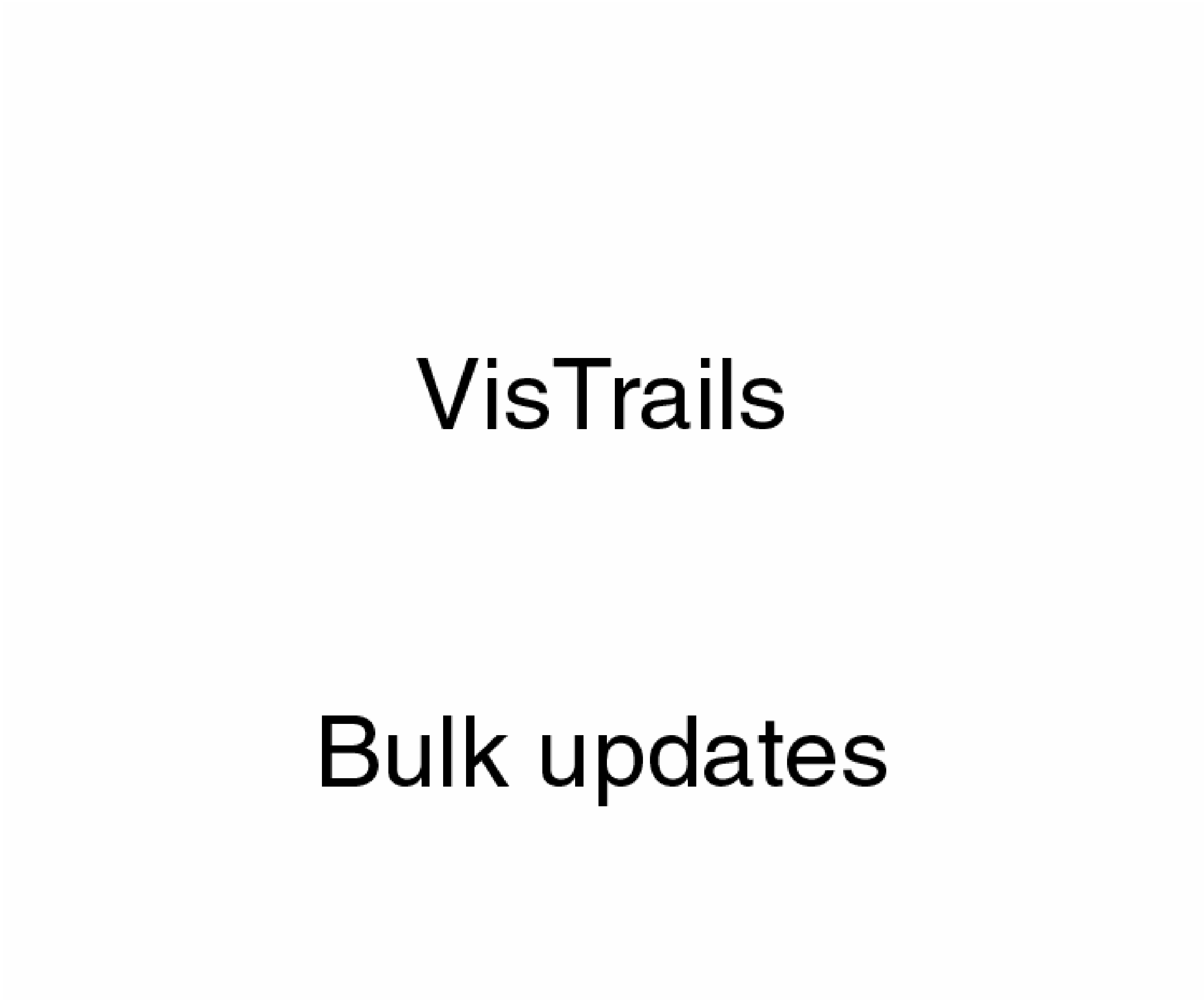
- Uniformly captures both data and process provenance
- Records user actions—compact representation
- Detailed information about the exploration process
  - Results can be reproduced
  - Scientists can return to any point in the exploration space
- History tree structure enables scalable exploration of the dataflow parameter space through
  - Macros: re-use actions for repetitive tasks
  - Bulk updates: quickly explore slices of parameter space



VisTrails

Macros

Link to video:
http://www.cs.utah.edu/~juliana/talks/videos/vistrails_macros.avi



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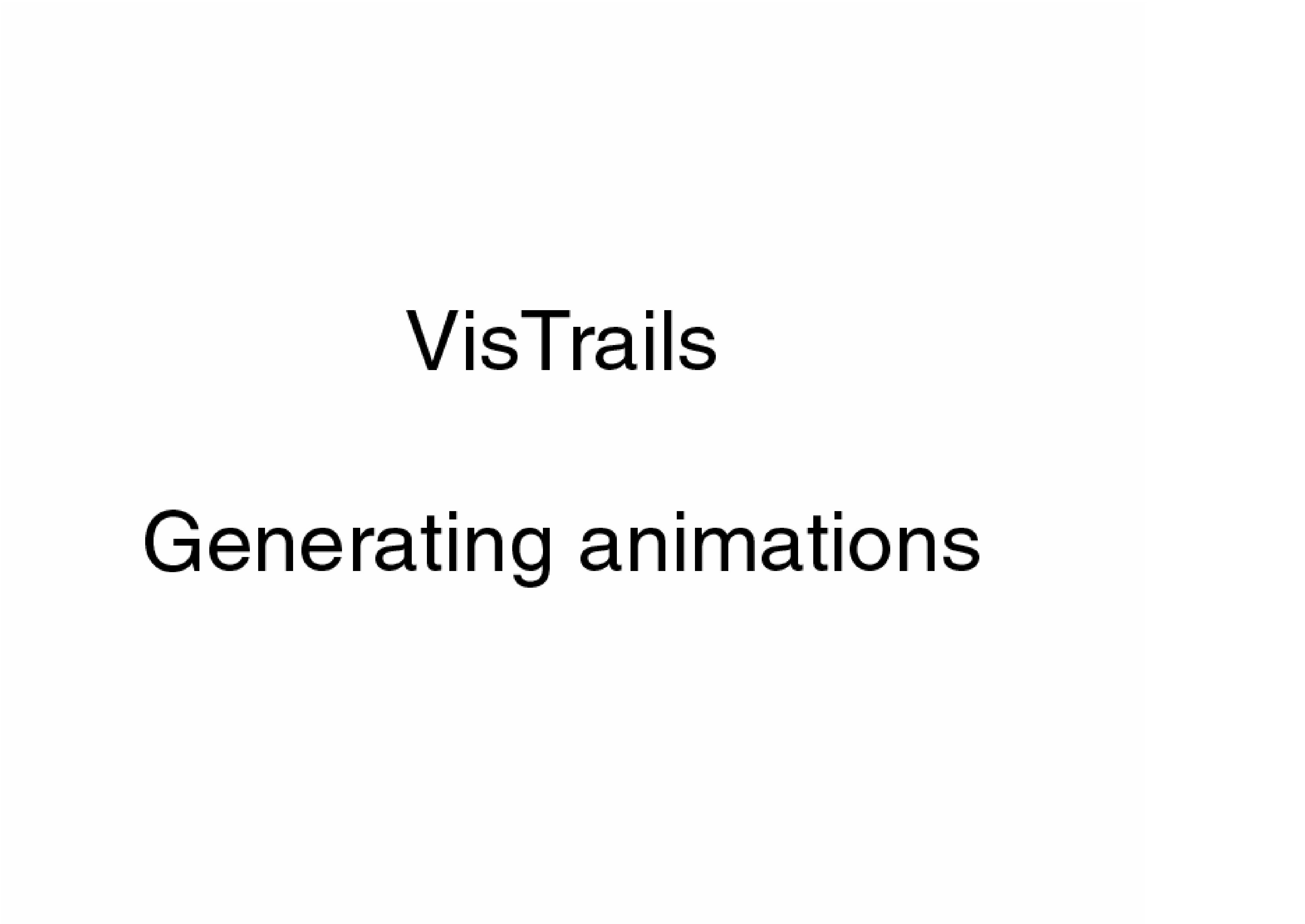
Bulk updates

Link to video: http://www.cs.utah.edu/~juliana/talks/videos/vistrails_bulkupdates.avi



VisTrails

Generating animations

Link to video: http://www.cs.utah.edu/~juliana/talks/videos/vistrails_animation.avi

Conclusions

- Identified the problem and proposed the first solution for managing fast-evolving workflows
- Detailed data and process provenance automatically captured
- The VisTrails system

Replaces the lab notebook

Enables large-scale data exploration through visualization

And scientists can do it!

- Focus on visualization, but ideas are applicable to general workflows

Current and Future Work

- Platform for collaborative visualization
  - Distributed synchronization algorithm
- XTrails: support for general workflows
  - Support for Web services (BIRN)
  - Execution over the Grid (Chimera)
- GUI---better interaction with history
- Mine trails—potentially useful information about good visualization strategies
  - Automate generation of visualizations

Acknowledgements

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- We thank
  - Dr. George Chen (Harvard Medical School) for the lung datasets;
  - Gordon Kindlmann (SCI) for the brain data set; and
  - The Visible Human Project for the head.

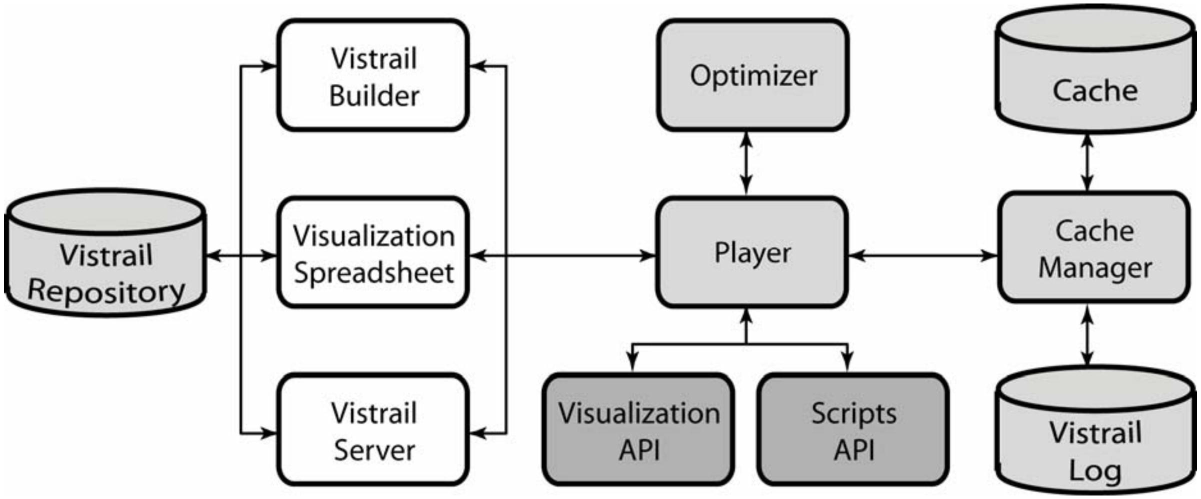
More info about VisTrails

Google vistrails

Or

http://www.sci.utah.edu/~vgc/vistrails/

VisTrails Architecture

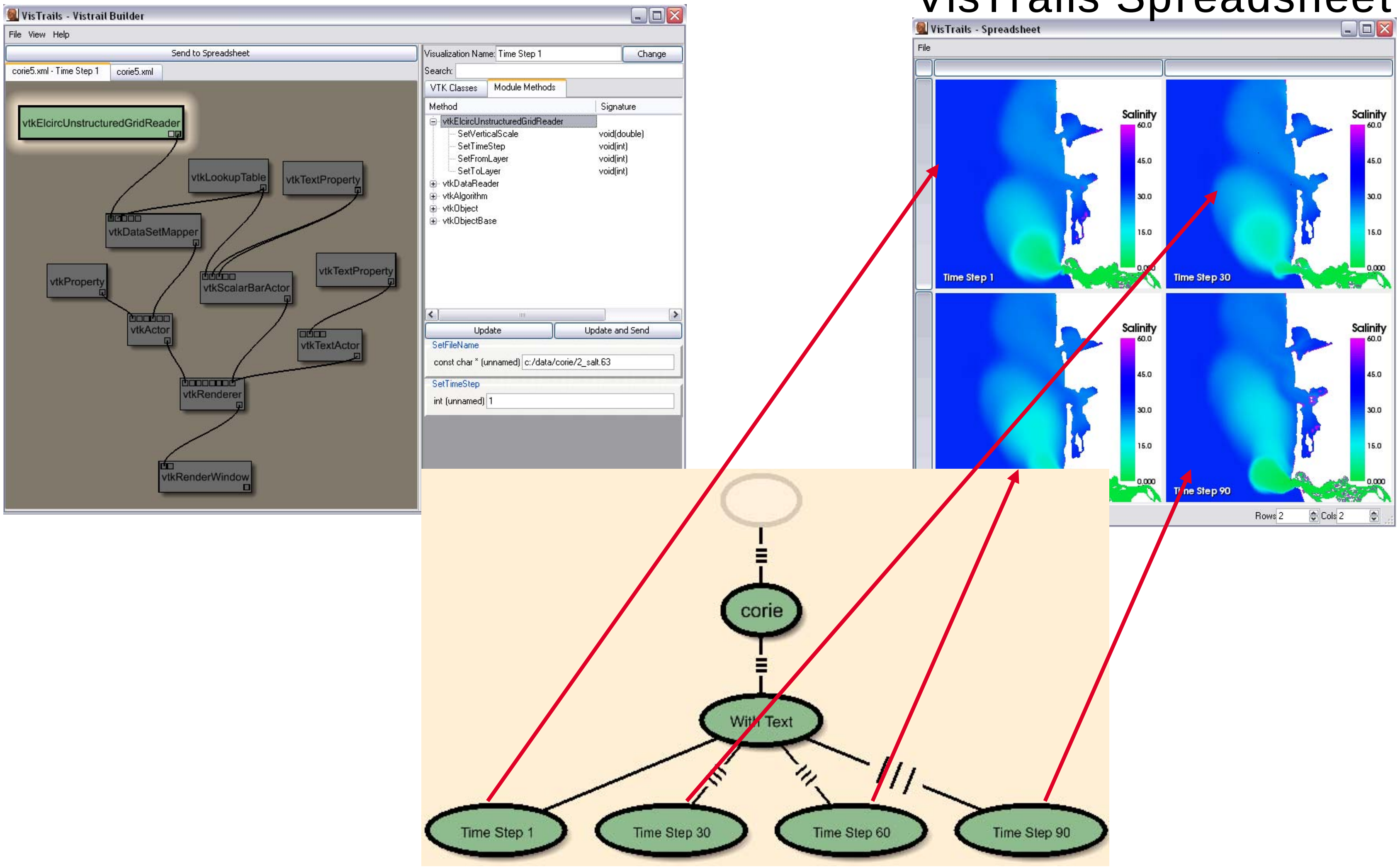


- 15-16k lines of python code
  - Easily integrate components
- Re-use existing free software
  - QT, OpenGL, VTK

VisTrails User Interface

VisTrails Builder

VisTrails Spreadsheet



Visualization Name: Time Step 1

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SetTimeStep	void(int)
SetFromLayer	void(int)
SetToLayer	void(int)
vtkDataReader	
vtkAlgorithm	
vtkObject	
vtkObjectBase	

SetFileName

const char * (unnamed) c:/data/corie/2_salt.63

SetTimeStep

int (unnamed) 1

Rows 2 Cols 2

VisTrails Version Tree