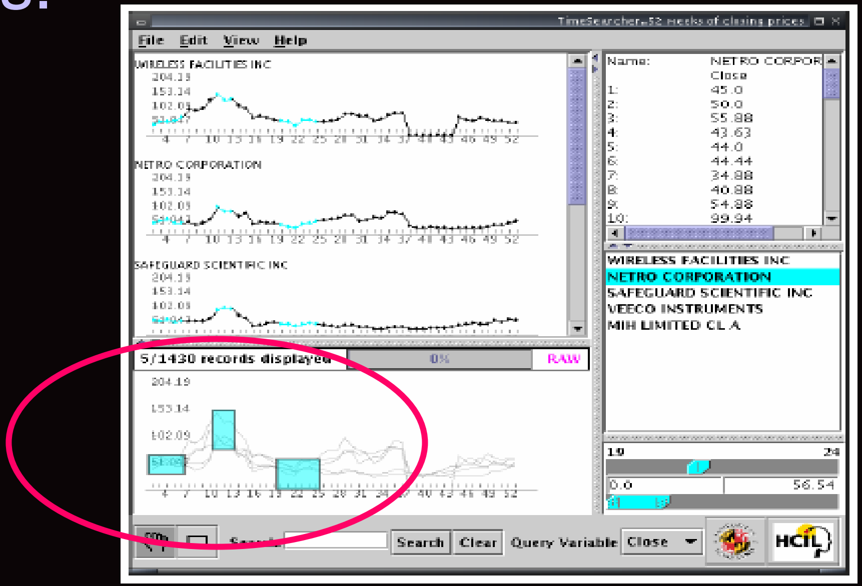
Brushing & Linking

Qiang Kong
03/24/2004

Part I Overview

- **Brushing**
  - Allowing the user to move a region around the data display to highlight or select groups of data points.



TimeSearcher

- *Visual Queries for Finding Patterns in Time Series Data*
  Harry Hochheiser, Ben Shneiderman. University of Maryland, Computer Science Dept. Tech Report #CS-TR-4365, UMIACS-TR-2002-45

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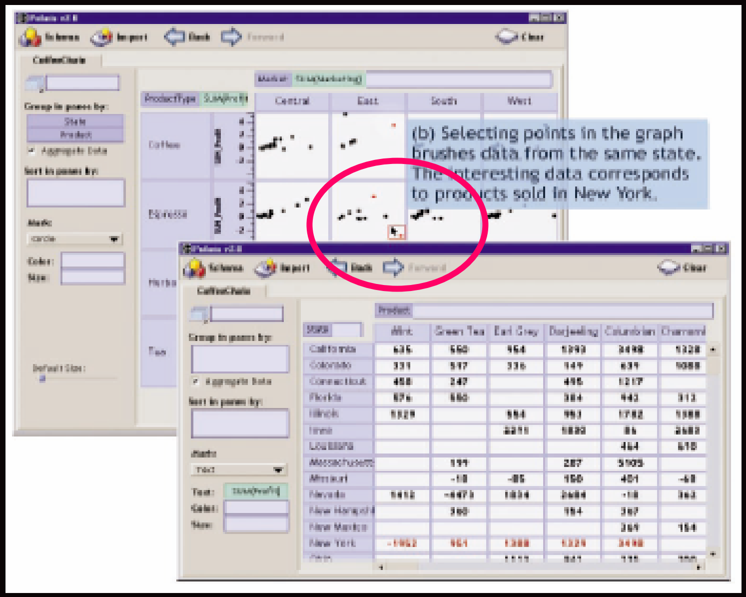
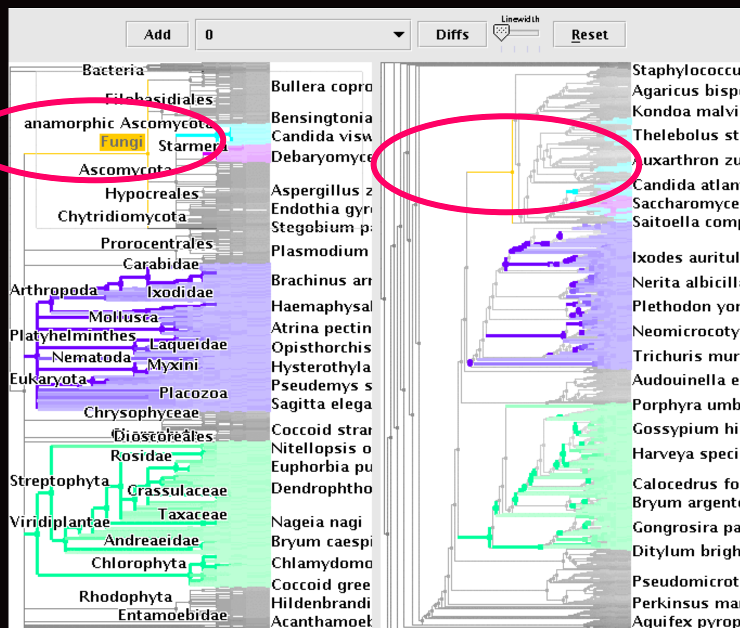


Polaris

- *Polaris: A System for Query, Analysis and Visualization of Multi-dimensional Relational Databases* Chris Stolte, Diane Tang and Pat Hanrahan, IEEE Transactions on Visualization and Computer Graphics, Vol. 8, No. 1, January 2002.

Part I Overview

- **Linking**
  - Visually indicating which parts of one data display correspond to that of another



TreeJuxtaposer

- *TreeJuxtaposer: Scalable Tree Comparison using Focus+Context with Guaranteed Visibility* Tamara Munzner, Francois Guimbretiere, Serdar Tasiran, Li Zhang, and Yunhong Zhou. SIGGRAPH 2003

Part I Overview

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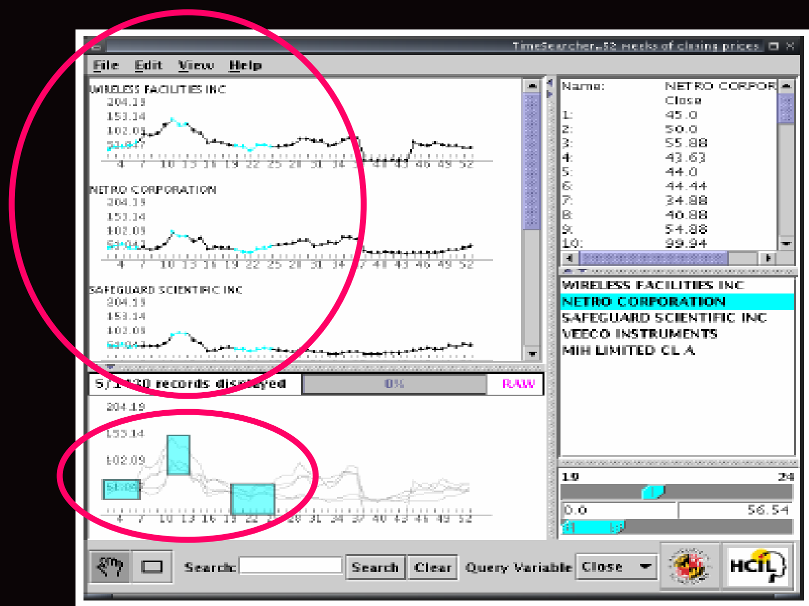

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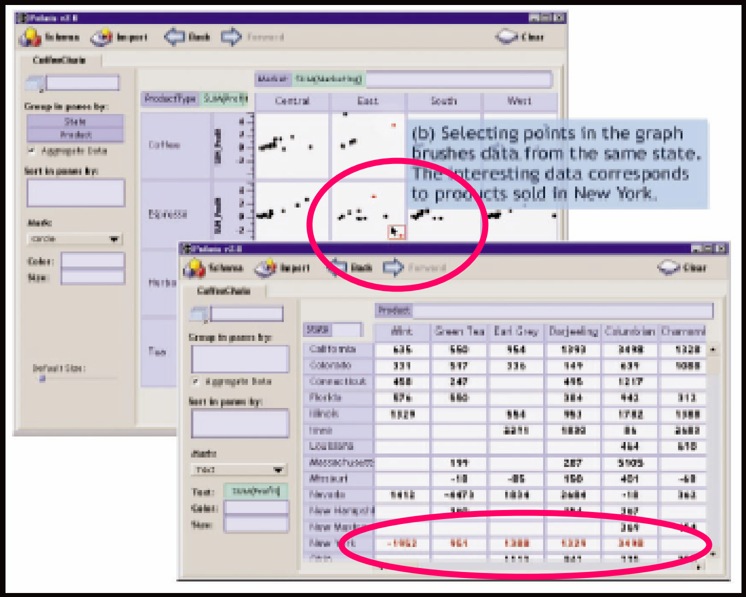

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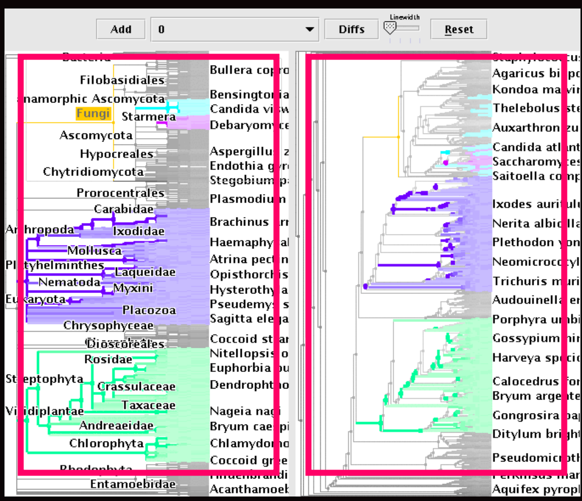
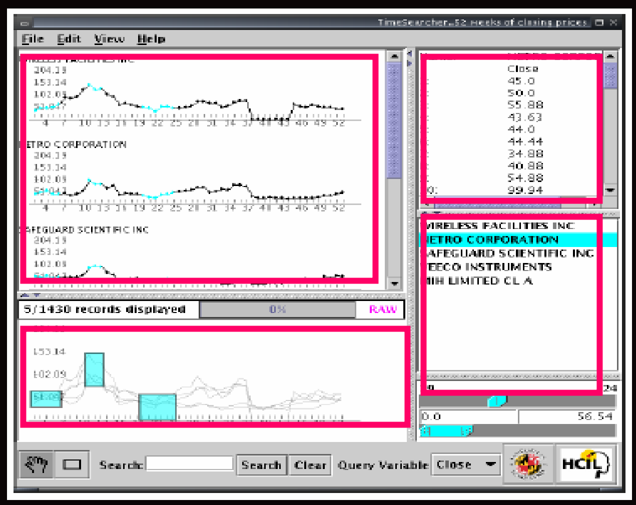
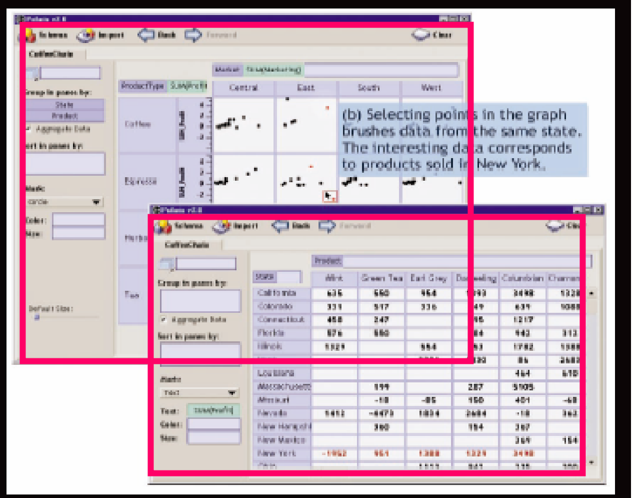
Part I Overview

- Idea from the previous three applications
  - Brushing and linking are often used together in multiple views applications







Part II Guidelines for Using MV

- Guidelines for Using Multiple Views in Information Visualization

  M. Q. Wang Baldonado, A. Woodruff, A. Kuchinsky, Proceedings of AVI 2000, Palermo, Italy, May 2000, pp. 110-119

- VizCraft: A Multidimensional Visualization Tool for Aircraft Configuration Design

  A. Goel, C.A. Baker, C.A. Shaffer, B. Grossman, R.T. Haftka, W.H. Mason, L.T. Watson, Proc IEEE Visualization '99

- WEAVE: a system for visually linking 3-D and statistical visualizations, applied to cardiac simulation and measurement data

  D. L. Gresh, B. E. Rogowitz, R. L. Winslow, D. F. Scollan, C. K. Yung October 2000 Proceedings of the conference on Visualization '00

Part II Guidelines for Using MV

- What is a Multiple View system?
  - Systems that use two or more **distinct views** to support the investigation of a single conceptual entity.
- How can views differ from each other?
  - Differ in the **data set**
  - Differ in the **visual representation**

Part II Guidelines for Using MV

- Problems need to be resolved
  - Why to use multiple views?
  - When to use multiple views?
    - About view selection
  - How to use multiple views?
    - About view presentation
    - About view interaction

Three dimensions on which
the model of the multiple views are based

Part II Guidelines for Using MV

- Why to use Multiple Views?
  - Can't display everything in one view
    - Scale:
      - Many attributes
      - Many items
    - Complex data
      - Multiple data tables (Relational databases)
      - Multiple data types (e.g. tables, images)
    - Need different visualizations for different parts of data

[http://infovis.cs.vt.edu/cs5764/Fall2001/lectures/lecture14.ppt]

Part II Guidelines for Using MV

- Problems need to be resolved
  - Why to use multiple views?
  - When to use multiple views?
    - About view selection
  - How to use multiple views?
    - About view presentation
    - About view interaction

Part II Guidelines for Using MV

- Aspects of impact on the system utility
  - Cognitive aspect
    - The time and effort required to learn the system
    - The load on the user's working memory
    - The effort required for comparison
    - The effort required for context switching
  - System aspect
    - Computational requirements
    - Display space requirements

Part II Guidelines for Using MV

- 1. Rule of diversity

Use multiple views when there is a diversity of ***attributes,***
models,
user profiles,
level of abstraction, or
genres.

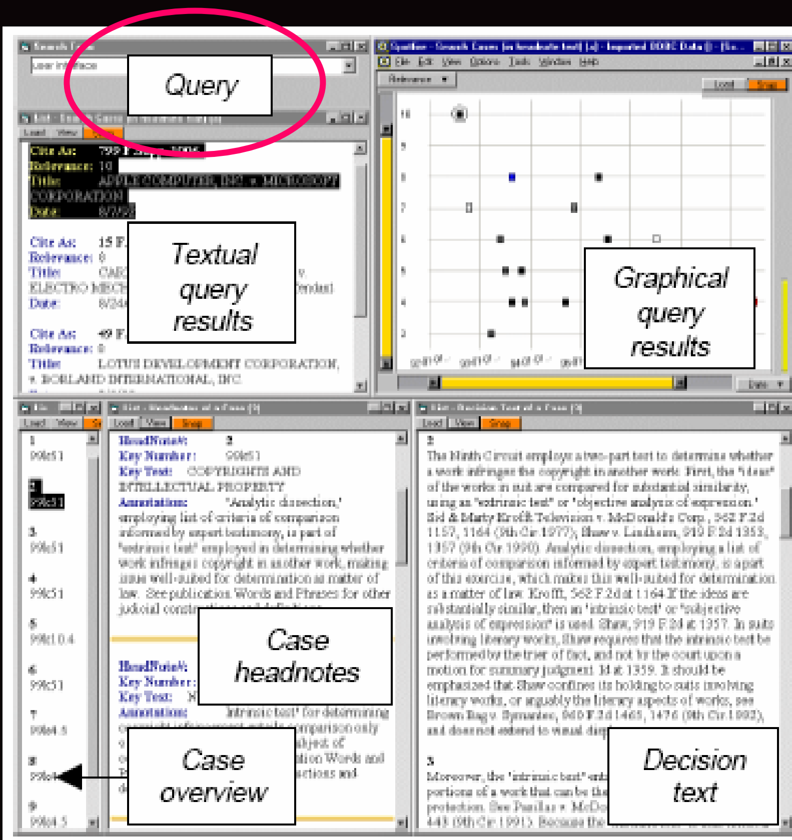


Figure 1: A multiple views presentation of diverse information relating to legal cases [20].

Part II Guidelines for Using MV

- 1. Rule of diversity
  - Use multiple views when there is a diversity of attributes, models, user profiles, level of abstraction, or genres.
  - Major positive impacts on utility
    - Working memory
  - Major negative impacts on the utility
    - Leaning
    - Computational overhead
    - Display space overhead

Part II Guidelines for Using MV

- 2. Rule of complementarity

Use multiple views when different views bring out ***correlations and/or disparities.***

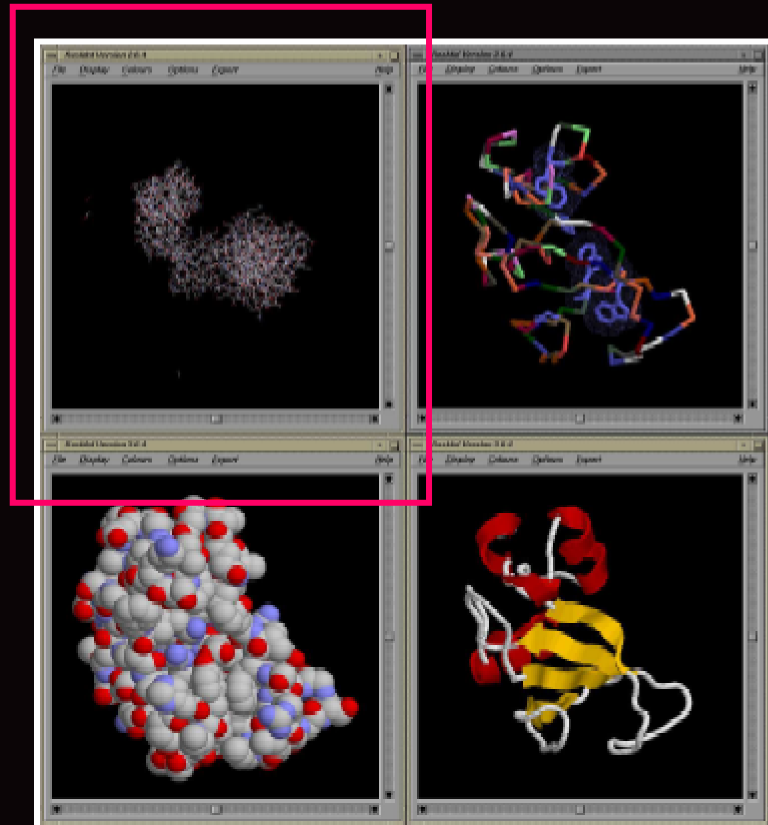


Figure 2: Complementary views of the barnase molecule [24]. Reprinted by permission of Wiley-Liss, Inc., a subsidiary of John Wiley & Sons, Inc.

Part II Guidelines for Using MV

- 2. Rule of complementarity
  - Use multiple views when different views bring out correlations and/or disparities.
  - Major positive impacts on utility
    - Working memory
    - Effort for comparison
    - Context switching
  - Major negative impacts on the utility
    - Leaning
    - Computational overhead
    - Display space overhead

Part II Guidelines for Using MV

- 3. Rule of decomposition

Partition complex data into multiple views to create manageable chunks and to provide insight into the interaction among different dimensions

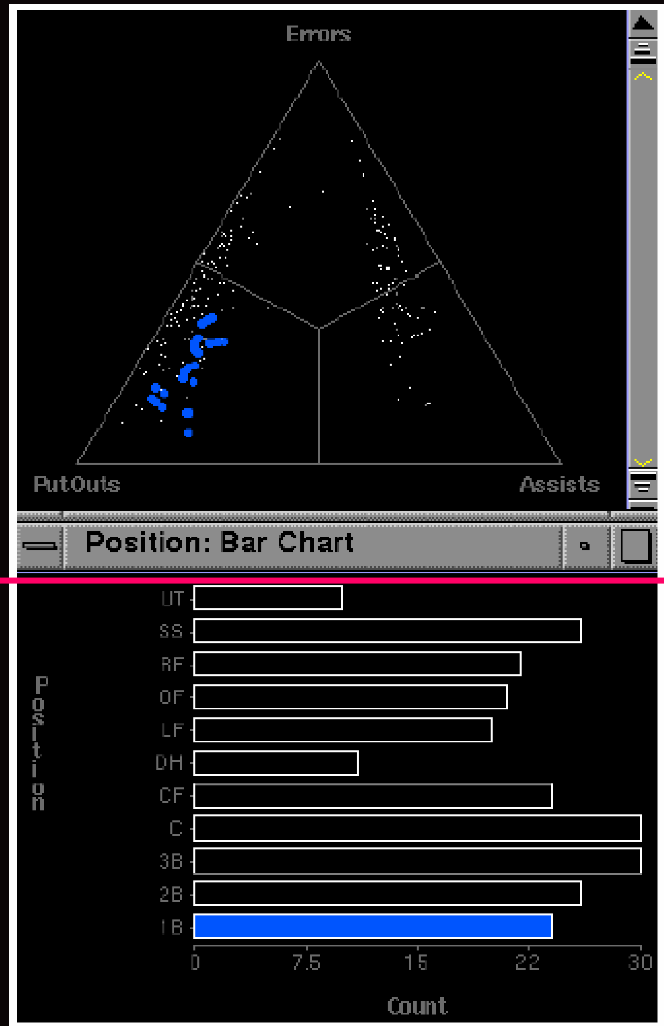


Figure 3: Two views of a single table of baseball data [12].

Part II Guidelines for Using MV

- 3. Rule of decomposition
  - Partition complex data into multiple views to create manageable chunks and to provide insight into the interaction among different dimensions
  - Major positive impacts on utility
    - Working memory
    - Effort for comparison
  - Major negative impacts on the utility
    - Leaning
    - Computational overhead
    - Display space overhead

Part II Guidelines for Using MV

- 4. Rule of parsimony
  - Use multiple views **minimally**.
  - Major positive impacts on utility
    - Leaning
    - Computational overhead
    - Display space overhead
  - Major negative impacts on the utility
    - Working memory
    - Effort for comparison
    - Context switching

Part II Guidelines for Using MV

- Problems need to be resolved
  - Why to use multiple views?
  - When to use multiple views?
    - About view selection
  - How to use multiple views?
    - About view presentation
    - About view interaction

Part II Guidelines for Using MV

- 5. Rule of space/time resource optimization

Balance the spatial and temporal ***costs*** of presenting multiple views with the spatial and temporal ***benefits*** of using the views.

Figure 4: Multiple views of stock data, with a shared x-axis (time) to help the user easily compare the views. *Copyright 2000 Yahoo! Inc.*

Part II Guidelines for Using MV

- 5. Rule of space/time resource optimization
  - Balance the spatial and temporal ***costs*** of presenting multiple views with the spatial and temporal ***benefits*** of using the views.
  - Major positive impacts on utility
    - Computational overhead
    - Display space overhead
  - Major negative impacts on the utility
    - Working memory
    - Effort for comparison

Part II Guidelines for Using MV

- 6. Rule of self-evidence
  - Use ***perceptual cues*** to make relationships among multiple views more apparent to the user.
    - Highlighting
    - Spatial arrangement
    - Coupled interaction
  - Major positive impacts on utility
    - Learning
    - comparison
  - Major negative impacts on the utility
    - Computation overhead

Part II Guidelines for Using MV

- 7. Rule of consistency
  - Make the ***interfaces*** for multiple views consistent and make the ***states*** of multiple views consistent.
    - State: data & user’s viewpoint
    - Interface affordances
  - Major positive impacts on utility
    - Learning
    - comparison
  - Major negative impacts on the utility
    - Computation overhead

Part II Guidelines for Using MV

- 8. Rule of attention management

Use perceptual techniques to ***focus*** the user's attention on the right view at the right time.

Animation
Sounds
Highlighting
movement

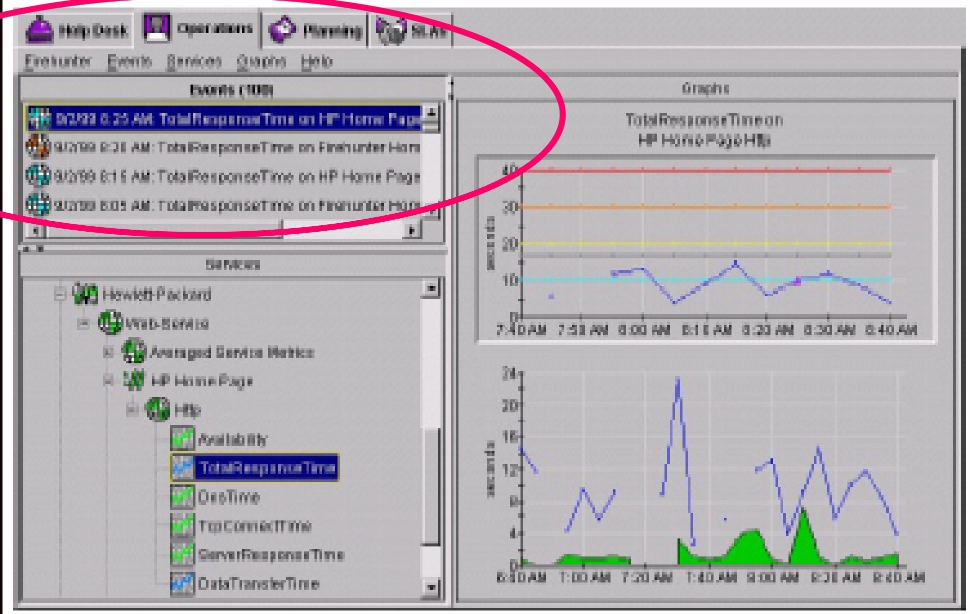


Figure 5: Multiple views of Internet service data. The view in the upper left draws the user's attention to priority events.

Part II Guidelines for Using MV

- 8. Rule of attention management
  - User perceptual techniques to ***focus*** the user's attention on the right view at the right time.
  - Major positive impacts on utility
    - Memory
    - Context switching
  - Major negative impacts on the utility
    - Computation overhead

Part II Guidelines for Using MV

- **Critique**
- Pros
  - Good motivation
  - Nice guidelines and well organized
  - Illustrate guidelines with real applications
- Cons
  - The analysis of “context switching” is confusing
  - Examples are evaluated against **only** one or two of the guidelines.

Part III VizCraft

- Guidelines for Using Multiple Views in Information Visualization

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Part III VizCraft

- Goal
  - **Define** and **set** major design parameters in the conceptual design stage.
  - Each design can be viewed as a point in a multidimensional design space.
    - The point should ***satisfied*** a series of constraints
      - 29 parameters to be considers
    - The point should ***minimize*** the objective function.
      - Take-off gross weight (TOGW)

Part III VizCraft

- Difficulties
  - Evaluating the point is computational expensive
    - *A single aerodynamic analysis cost ½ to several hours*
  - High dimensionality
    - *10-30 parameters*
    - *Impractical for many approaches that often applied to optimization problem*
    - *Difficult for visualizing the design space*

Part III VizCraft

- What does VizCraft do?
  - Evaluate the design with visualization for analyzing the design ***individually***
    - *Objective function*
    - *Constraints violation*
    - *Graphical view*
  - Evaluate the design with visualization for analyzing the design ***in contrast*** to other designs
    - *Investigate a database of designs*

Part III VizCraft

- *Walkthrough*

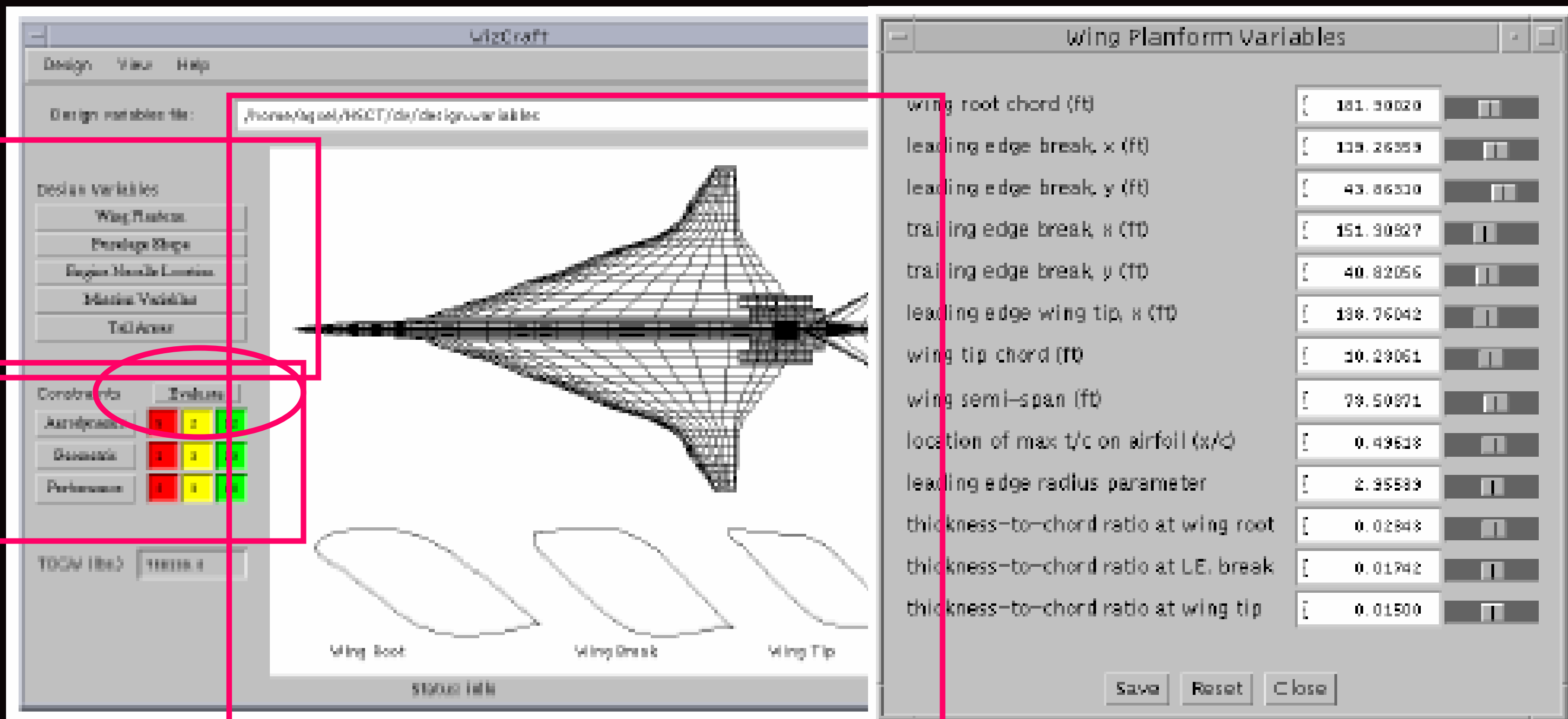
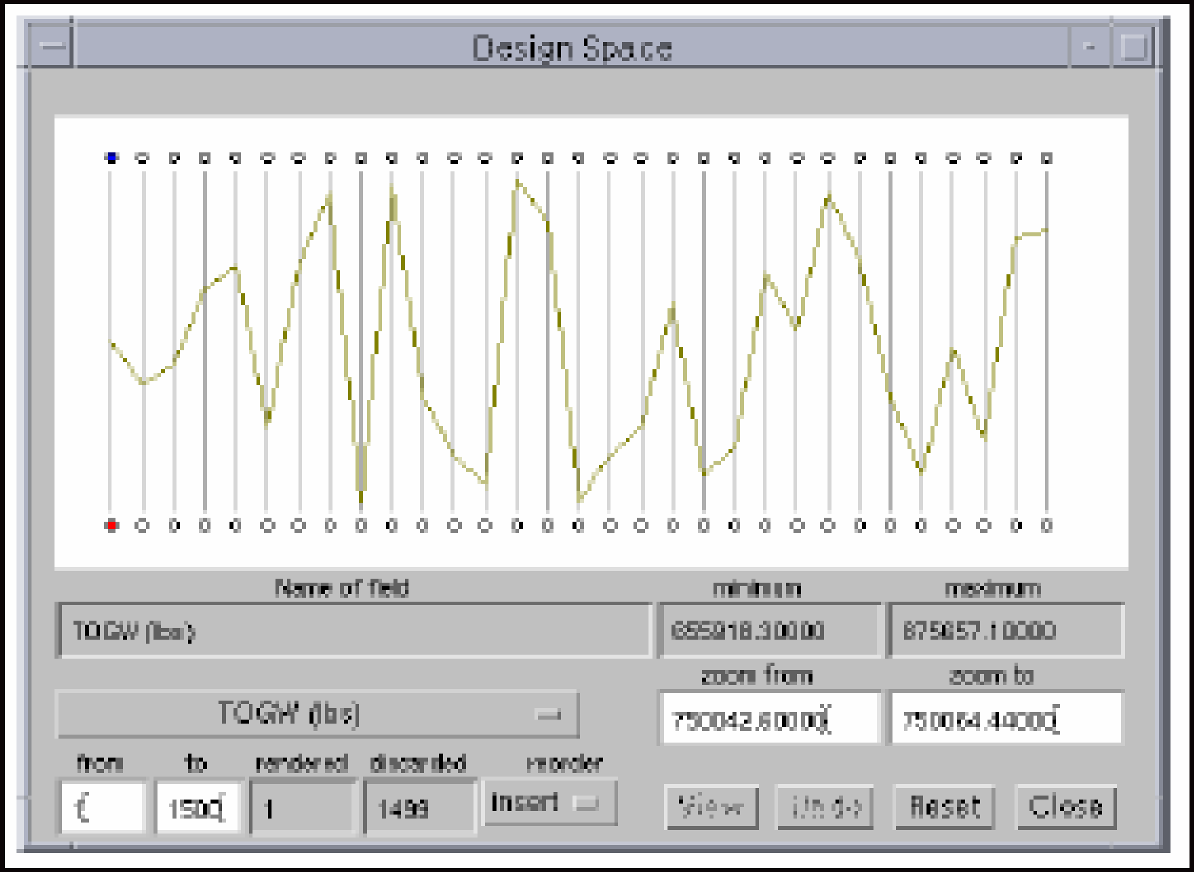


Figure C1. VizCraft design view window. To make observation easier, the vertical dimension of the wing cross-sections has been magnified.

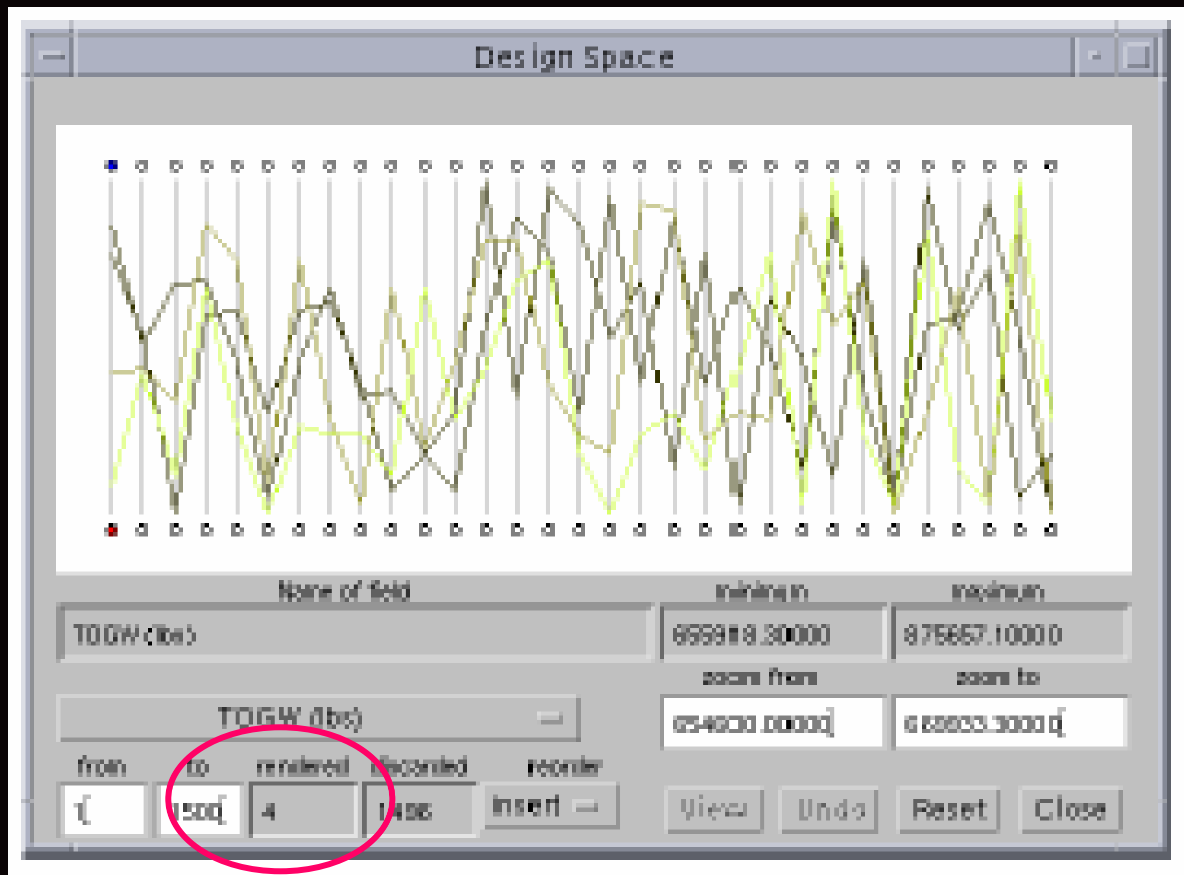
Part III VizCraft

- *Walkthrough*



Part III VizCraft

- *Walkthrough*



Part III VizCraft

- **Critique**
- Pros
  - Good use of parallel coordinates
- Cons
  - No user study or evaluation
  - No colormap for the lines in the parallel coordinates
  - One may not always lucky enough to discover the patterns in the parallel coordinates
  - Provide linking between design space and constraint space will be a plus

Part IV WEAVE

- Guidelines for Using Multiple Views in Information Visualization

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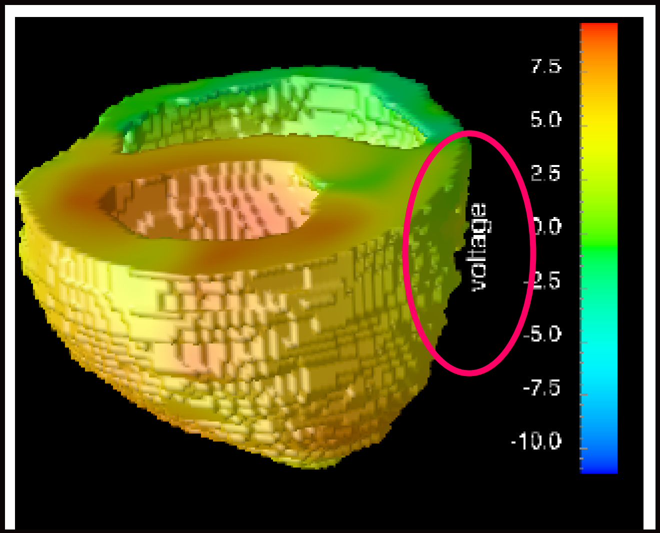
Part IV WEAVE

- What is WEAVE
  - Workbench Environment for Analysis and Visual Exploration
- Applied to cardiac data
  - Effectively study the correspondence of the structure and behavior of the heart

Part IV WEAVE

- Typical visualization can only display only one variable at a time.
  - Little quantitative analysis
  - Little comparison of variables
  - No relationship between behavior and structure

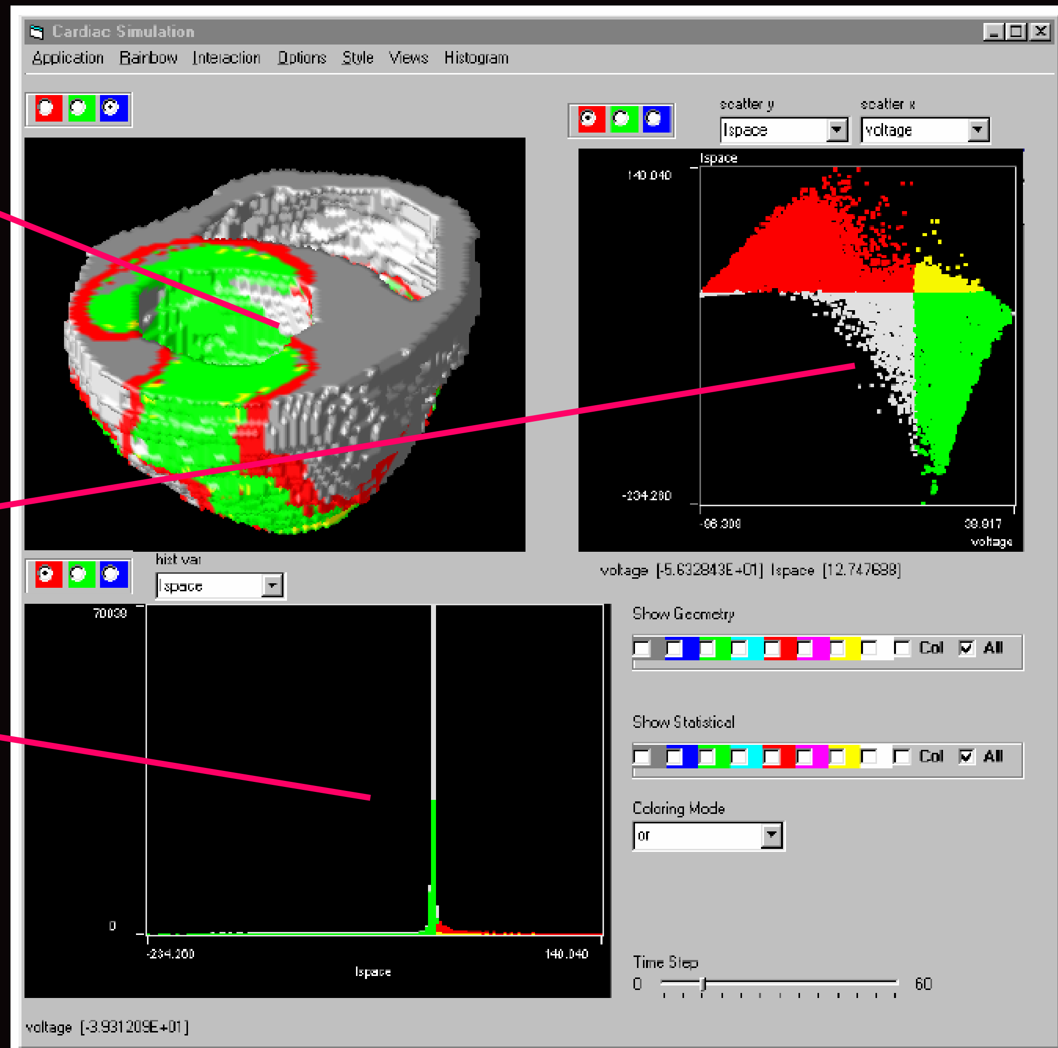


Part IV WEAVE

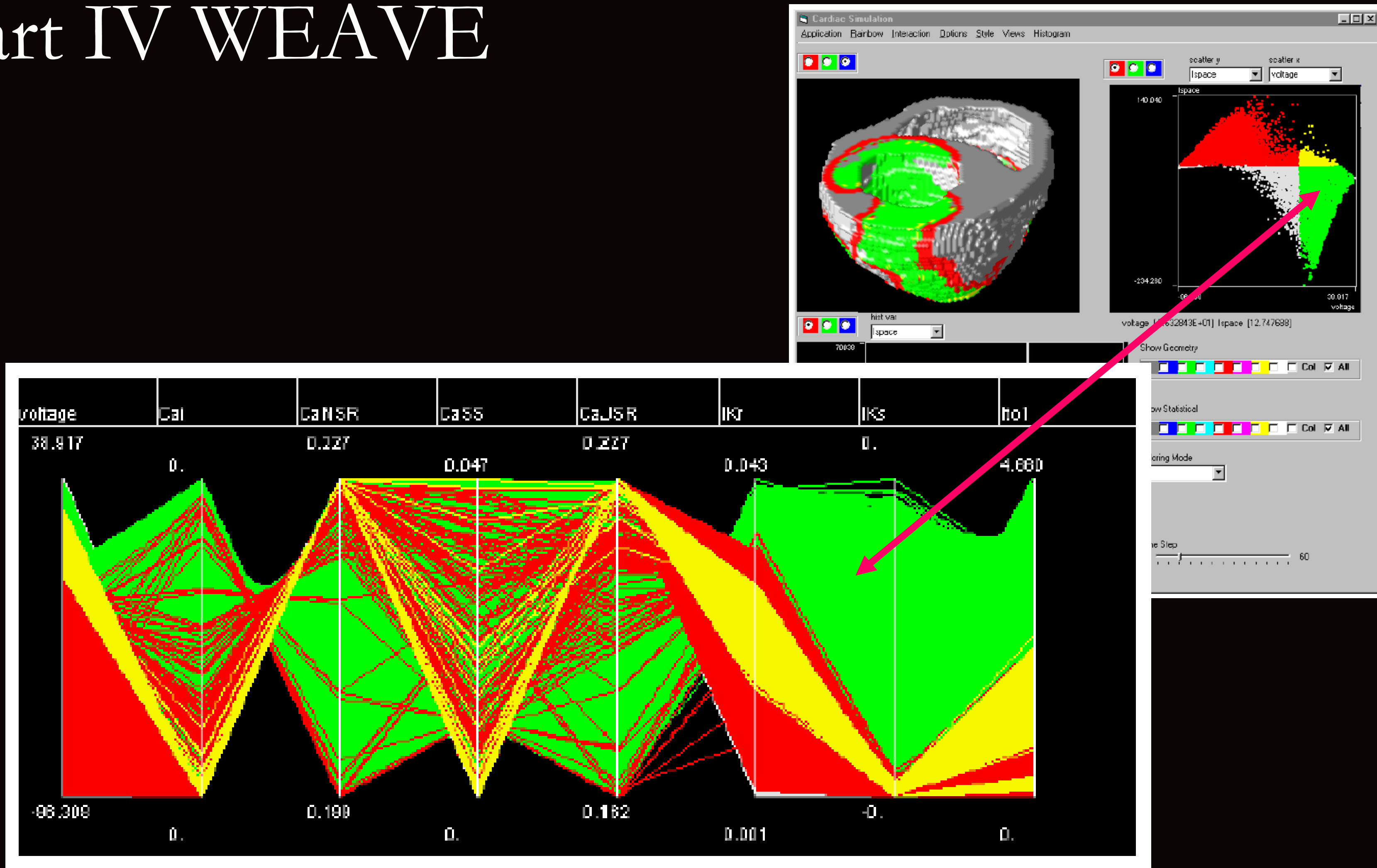
Structure of the heart using
3-D anatomical data

Scatterplot, using measurement data.

Histogram of *Is, using measurement data*



Part IV WEAVE



Part IV WEAVE

- Evaluation using the 8 guidelines
  - 1. Diversity (*three models of data*)
  - 2. Complementarity (*structure vs. behavior*)
  - 4. Parsimony (*showing on demand*)
  - 6. Self-evidence (*excellent linking and brushing*)
  - 5. Space/time resource optimization
  - 3. Decomposition
  - 7. Rule of consistency
  - 8. Rule of attention management
- A quite good multiple view application

Part IV WEAVE

- **Critique**
- Pros
  - Good use of brushing and linking
  - Transparent linking between 3-D visualization and statistical presentation
- Cons
  - No user study or evaluation
  - Relatively less information about the WEAVE system itself

Questions

Thank you!

Reference

- http://www.sims.berkeley.edu/courses/is247/s02/lectures/waterson.ppt
- http://infovis.cs.vt.edu/cs5764/Fall2001/lectures/lecture14.ppt
- VizCraft: A Multidimensional Visualization Tool for Aircraft Configuration Design A. Goel, C.A. Baker, C.A. Shaffer, B. Grossman, R.T. Haftka, W.H. Mason, L.T. Watson, Proc IEEE Visualization '99
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- WEAVE: A System for Visually Linking 3-D and Statistical Visualizations, Applied to Cardiac Simulation and Measurement Data Donna L. Gresh, Bernice E. Rogowitz, R. L. Winslow, D. F. Scollan, and C. K. Yung: IEEE Visualization 2000, pages 489-492.