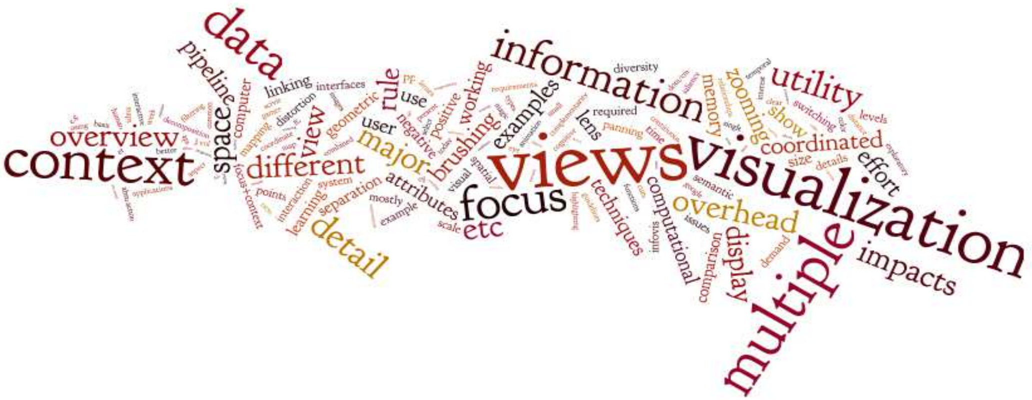

Information Visualization

Basics

SCHMALKALDEN UNIVERSITY OF APPLIED SCIENCES

Graphics+Interaction Laboratory

Materials curtesy of and based on slides by Denis Kalkofen, Marc Streit, Alexander Lex and Dieter Schmalstieg

Today‘s Topic

- Techniques for interactive systems
  - Manipulation of viewing
  - Synchronization of multiple views
  - Interactive detail
  - Filtering, etc.
- All common to Sci- and InfoVis
- All only valuable for computer-based visualization
- What about the basics of showing information, e.g., data types, color, visual variables, human perception, etc.?

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Today‘s Agenda

- The Visualization Pipeline
- Basic Visualization techniques valid for both InfoVis and SciVis
  - Focus and Context
  - Multiple Coordinated Views

Visualization

- https://www.ventusky.com/?p=50.702;10.445;9&l=gust&m=icon&w=fast

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Visualization Pipeline

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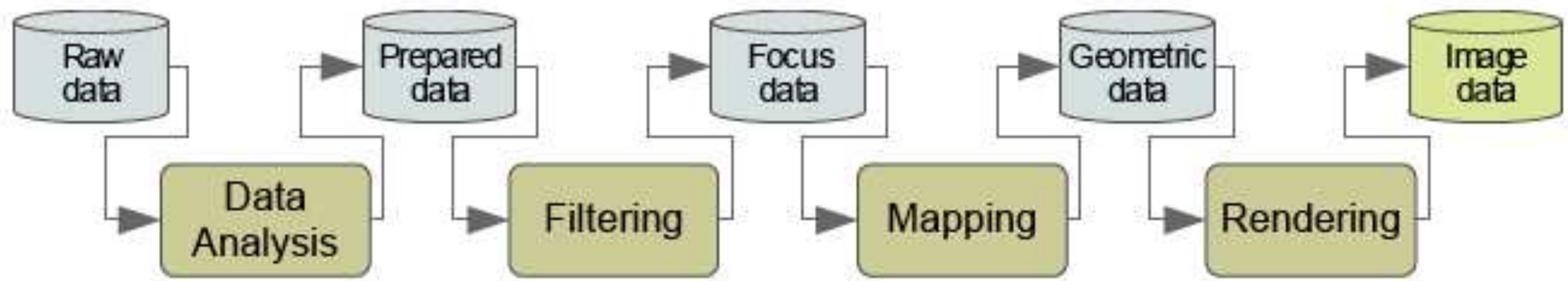
Visualization pipeline

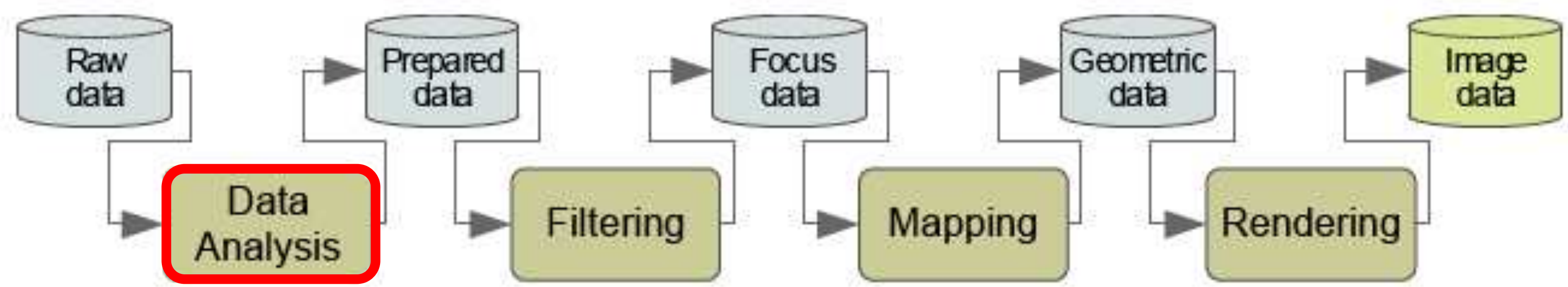
- A model for the steps necessary to produce images from data



[dos Santos and Brodlie 2004]

Data Analysis

- Noise removal / reduction
- Interpolation of missing values
- Correction of erroneous measurements
- Mostly done by computer → no or little user interaction



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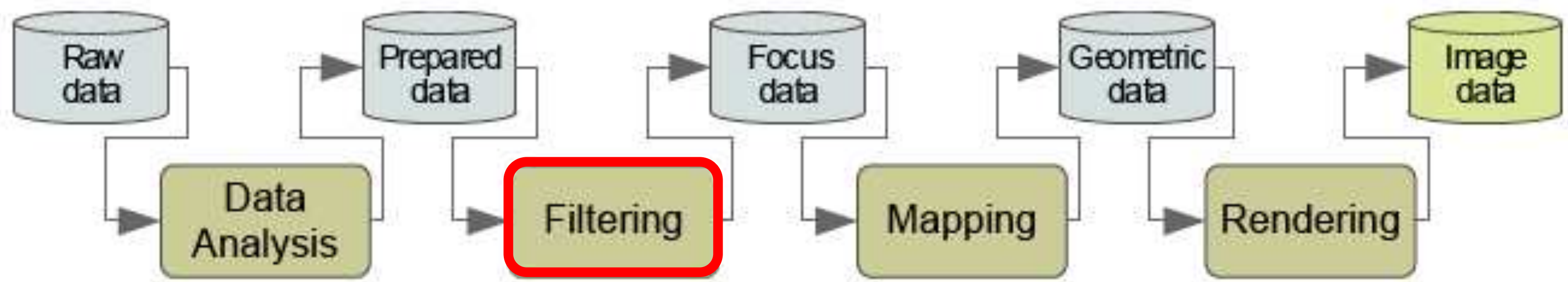
Filtering

- Selection of data points for visualization
- Mostly user driven
- Examples:
  - Clipping (Min, Max)
  - Statistics
  - User-defined attributes / criteria



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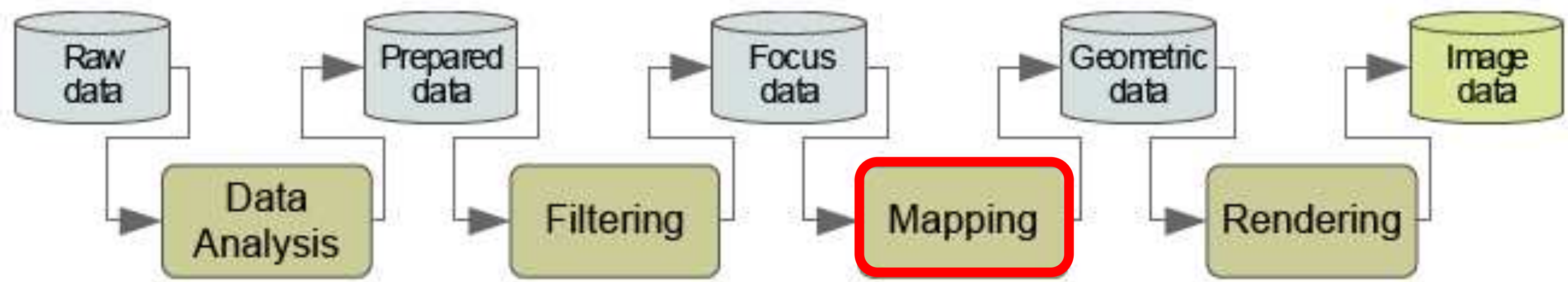
Mapping

- Mapping of data to geometric primitives (points, lines, etc.) and their attributes (color, position, size, etc.)
  - InfoVis: choice of visualization technique
  - SciVis: Transfer function



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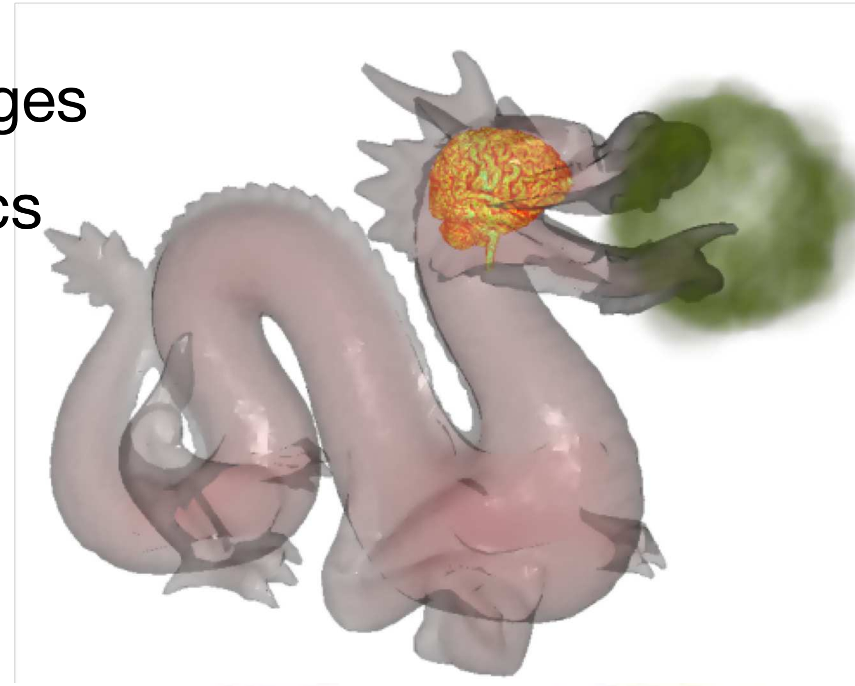
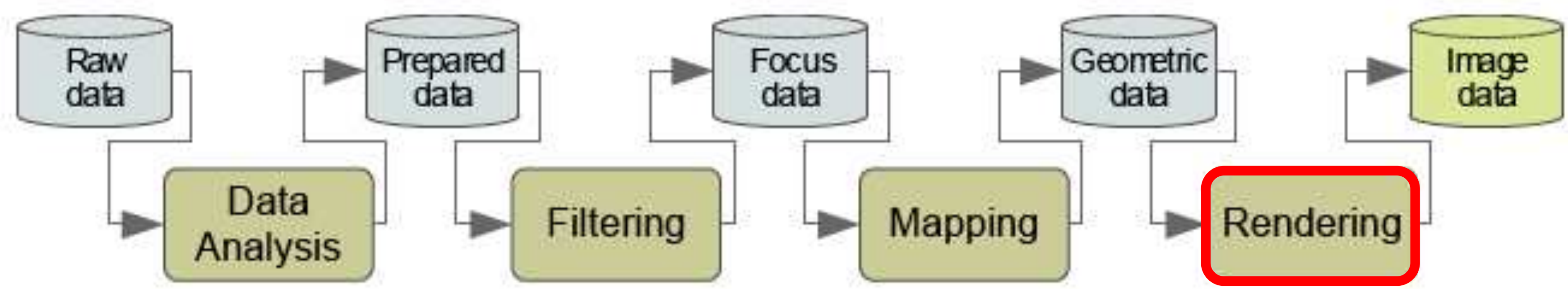
Rendering

- Transform geometric data to images
- Depicted using computer graphics





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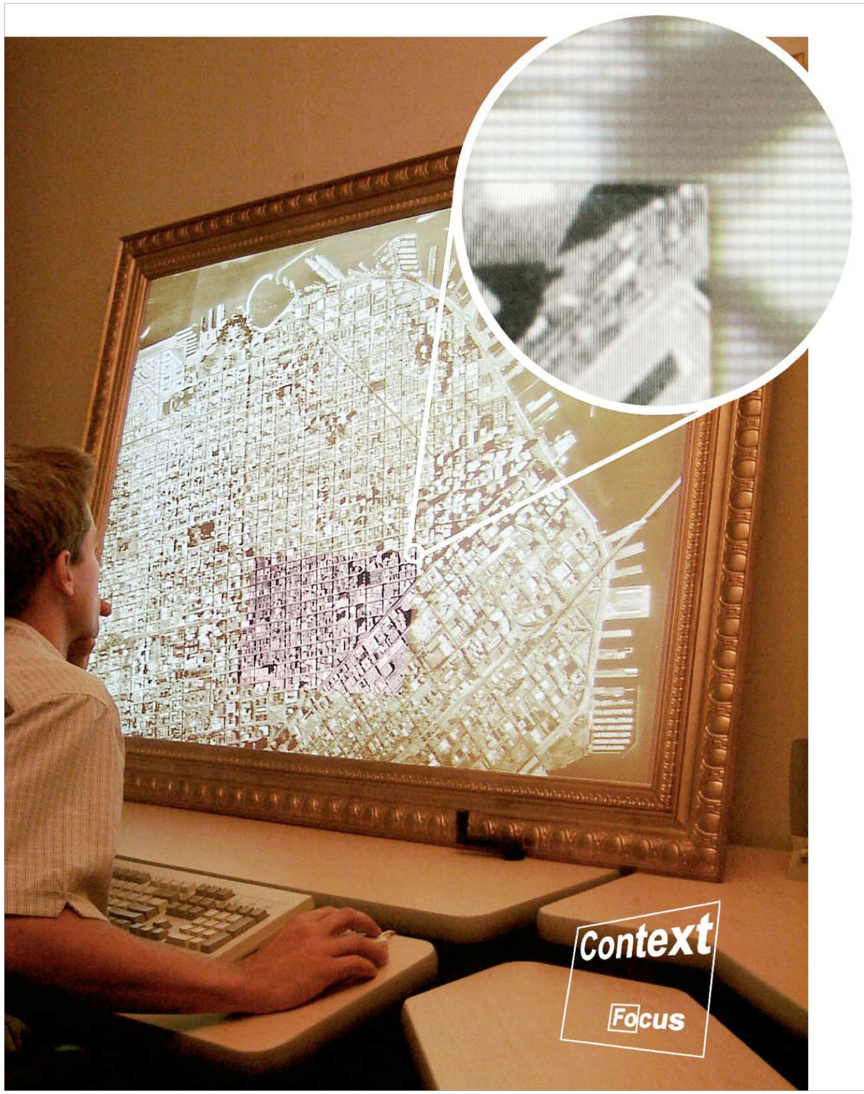
Visualization Pipeline

- Video:
  Lark – modifying attributes in the visualization pipeline

Focus and Context



Categorization of Focus and Context Techniques

- Needed when **all information can not be shown** at once
- Overview + Detail
  - spatial separation
- Zooming interfaces
  - temporal separation
- Focus + Context (at the same time, in the same place)
  - present focus and context in single view

Overview + Detail

- Simultaneous display of overview and detailed view
  - in distinct space
- Examples
  - google maps
  - thumbnails for page overviews
  - computer games
  - lenses
- Widely used

Overview + Detail: Maps in Games

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Overview + Detail: World in Miniature

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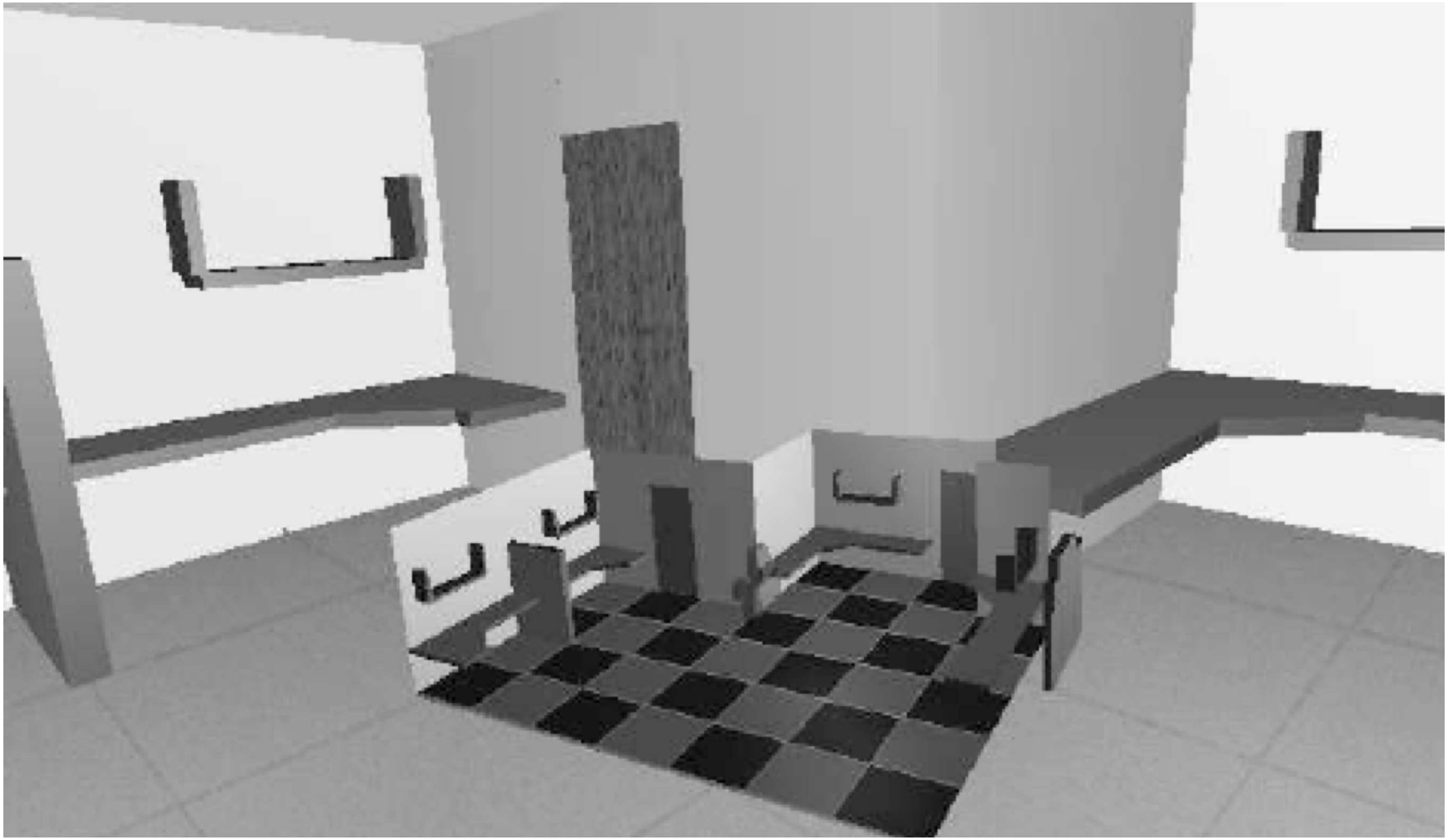
Overview + Detail: World in Miniature



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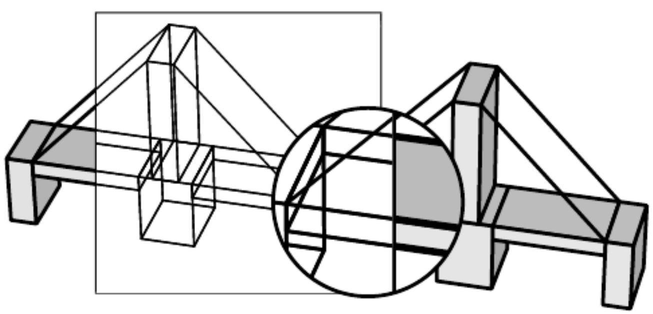
Overview + Detail: Lenses

- Separation in z
- Lens = Alter visualization in locally confined region



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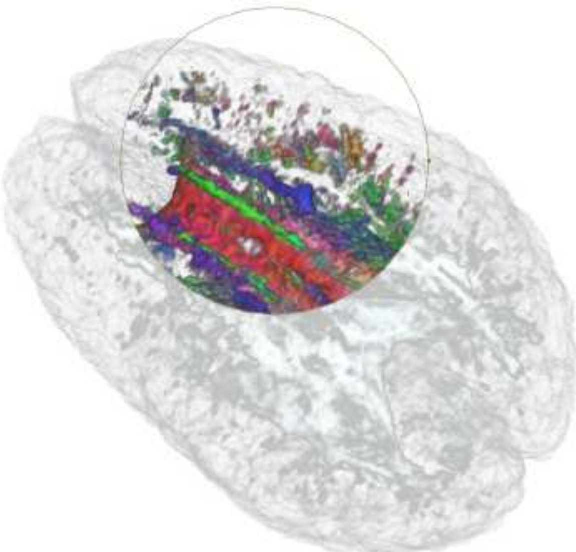
Examples in Sci-Vis



[Ikits and Hansen]

Zooming

- Temporal separation of Overview and Detail
- Can be combined with Overview + Detail
- Modes
  - Continuous
  - Discrete
  - Region select

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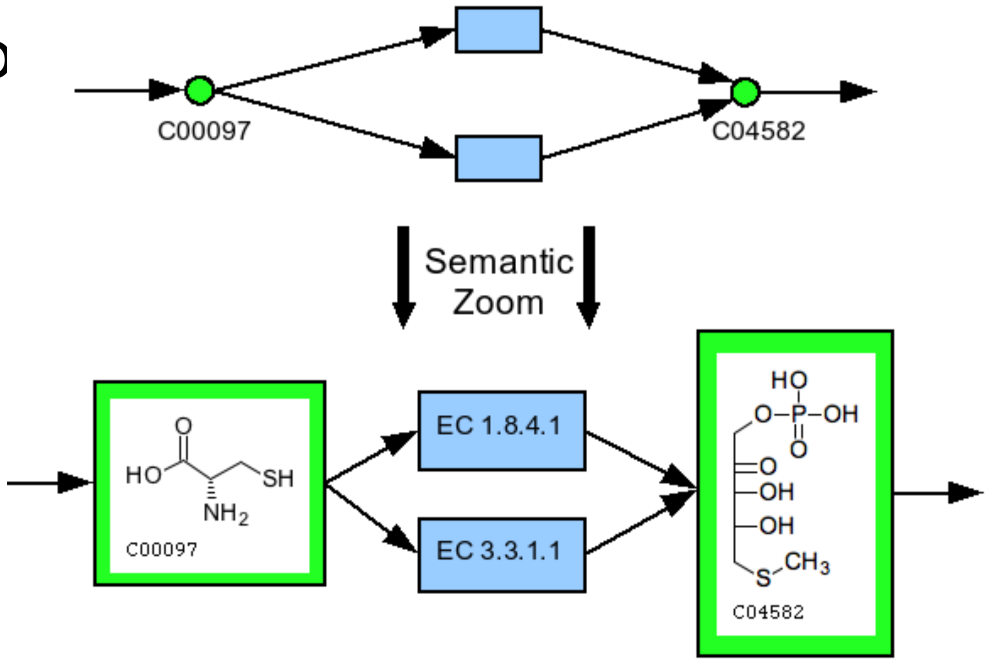
Semantic zoom

- Visualize information in different levels of abstraction
- Objects change (e.g. size, label)
- Example: maps.go



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maps.google.com

- DEMO

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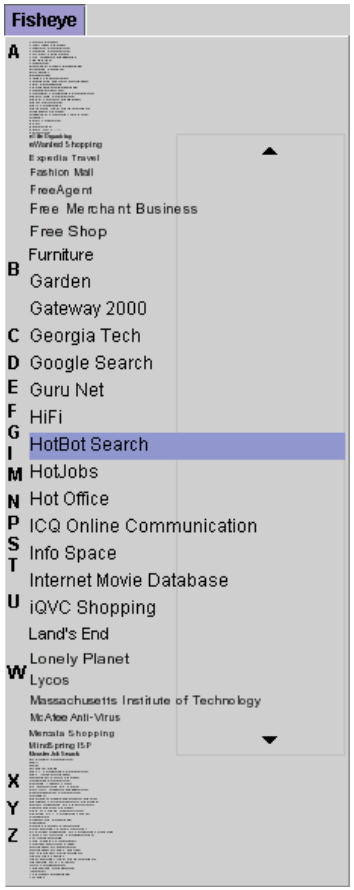
Seamless Focus in Context

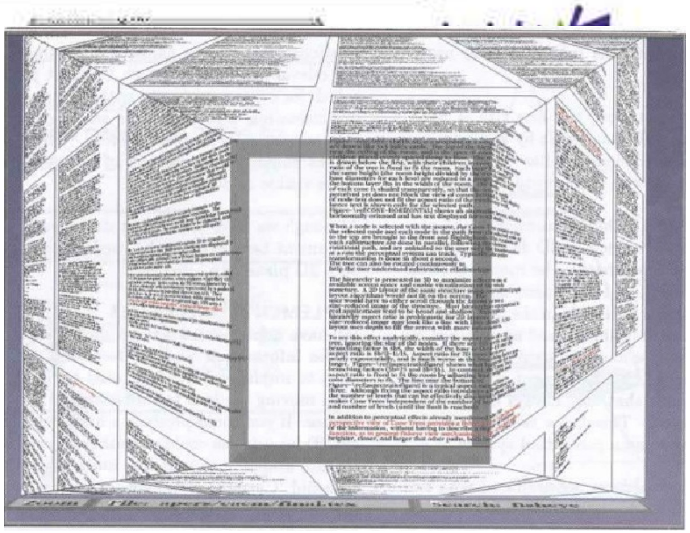
- Integrates focus and context in a single view
- All parts are concurrently visible
- Distortion based
- Cue based

Distortion Examples



FishEye Menus [Bederson 2000]

Perspective Wall
[Mackinlay et al. 1991]



Document Lens [Robertson and Mackinlay 1993]

Perspective Wall

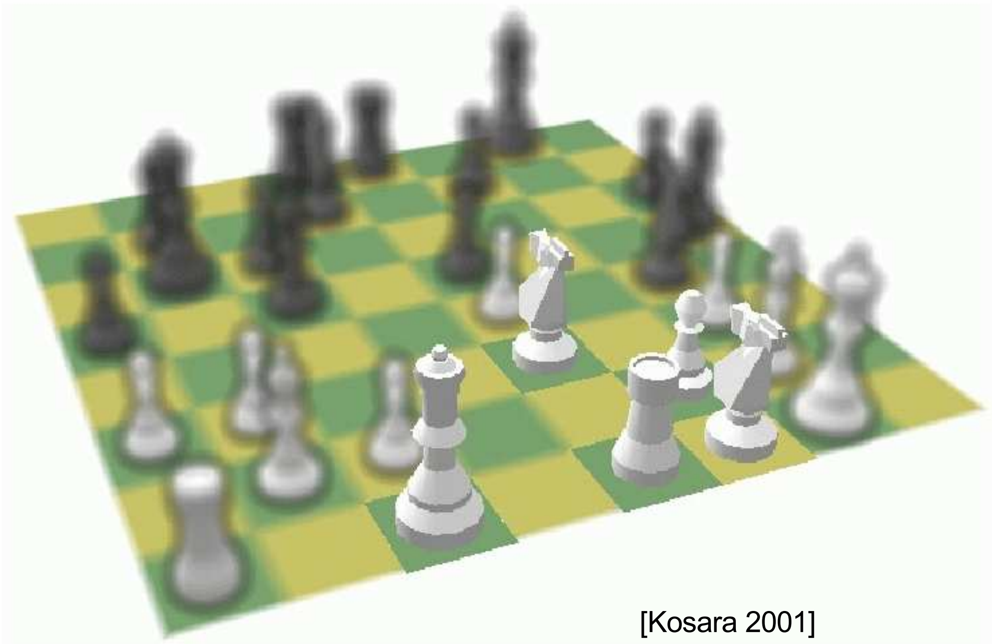
Bifocal Display

Cue-Based Methods

- Adapt how things are rendered, not their size
- Very general

• Modulating saliency
saliency: *the state or quality of an item that stands out relative to neigboring items*

- Examples:
  - Highlighting
  - Text labels
  - Focus blurring
  - Halos
  - Modulate image properties such as contrast, brightness



[Kosara 2001]

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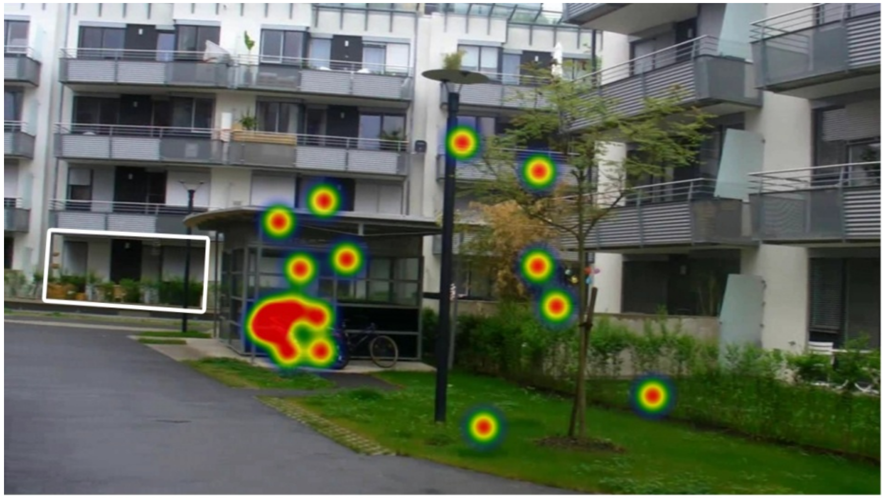
Saliency Modulated

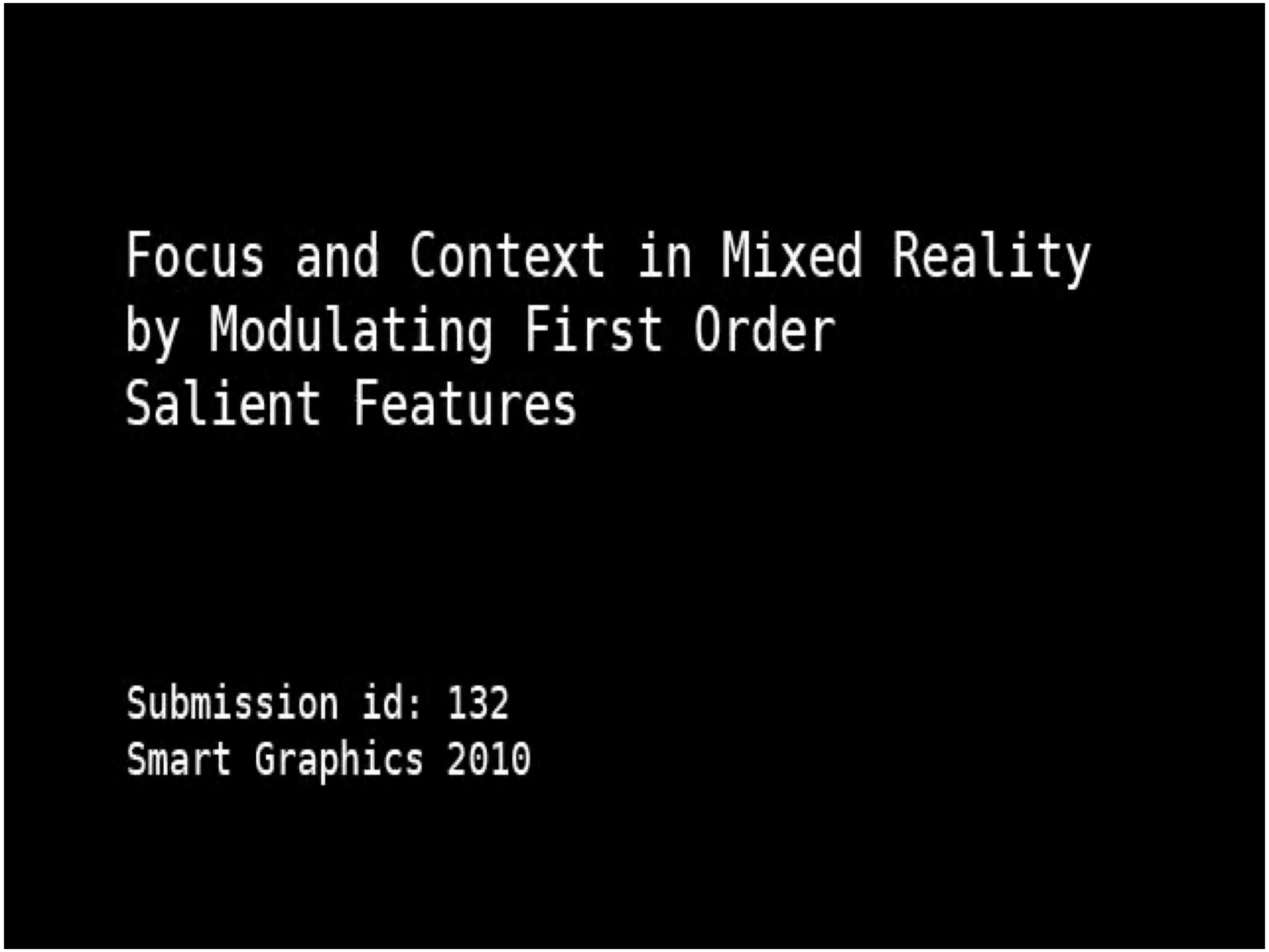
Original



Modulated

[Mendez et al. 2010]

Saliency Modulated



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Coordinated & Multiple Views

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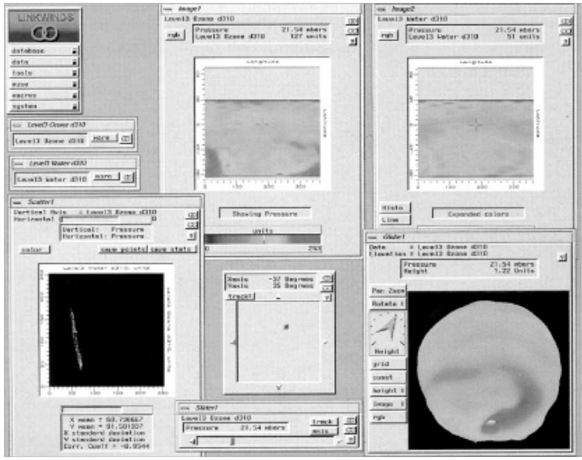
Coordinated & Multiple Views

- Premise: *View and interact with data through different representations*
- Show the same data in different form

  or

- Show relations between different data sets
- Coordinate interaction
- Some examples seen in Focus and Context section
- Common Types
  - navigational slaving (transformation, rotation)
  - brushing



LinkWinds [Jacobson 1994]

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

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Rule of diversity

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

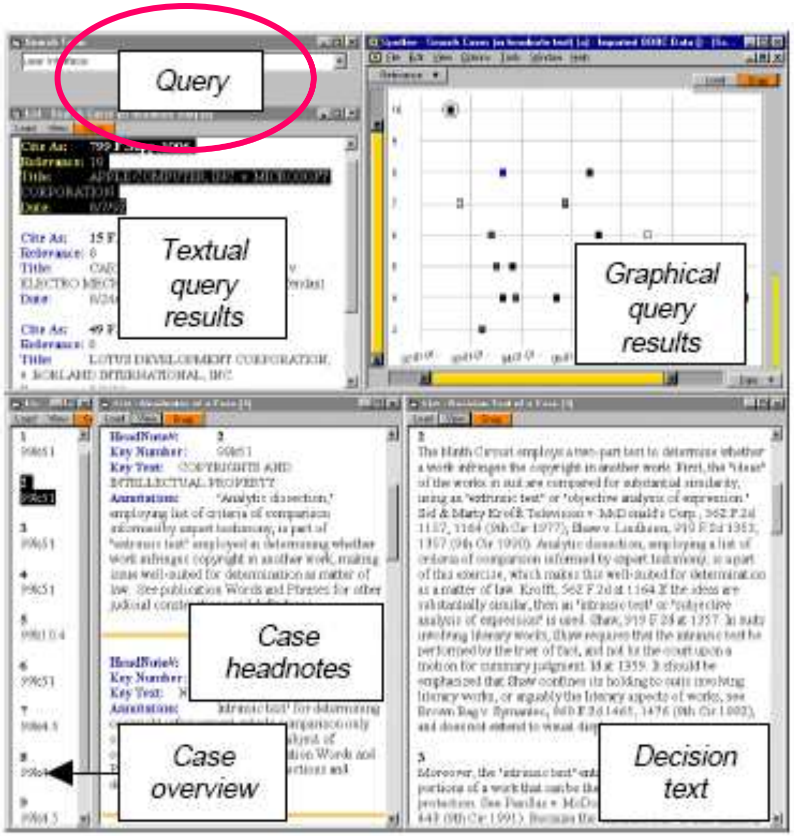

Figure 1: A multiple views presentation of diverse information relating to legal cases [20].

Rule of diversity

- Major positive impacts on utility
  - Working memory
- Major negative impacts on the utility
  - Learning
  - Computational overhead
  - Display space overhead

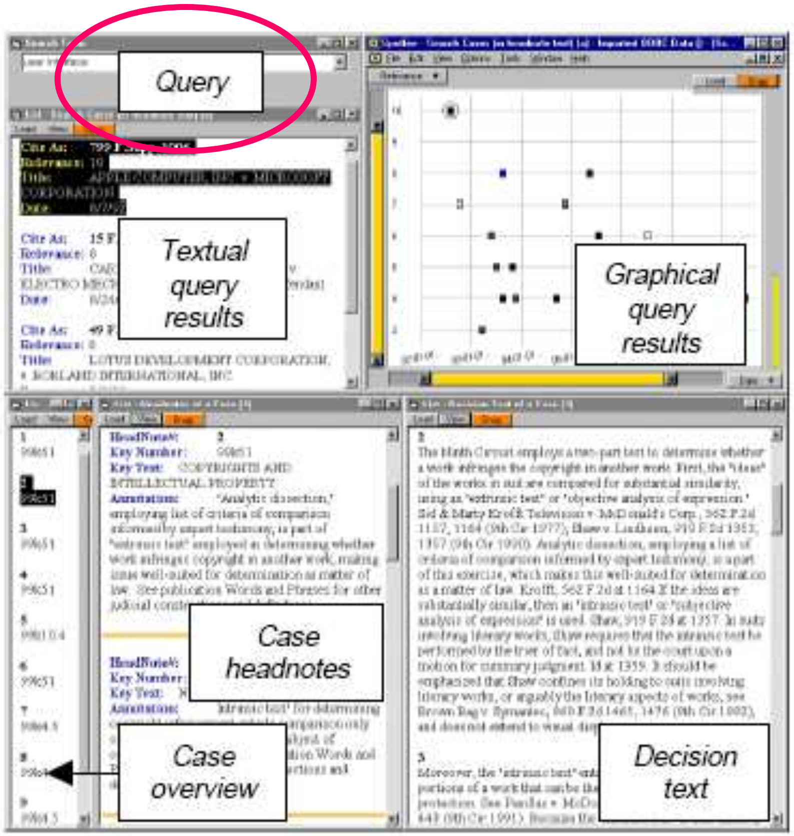

Figure 1: A multiple views presentation of diverse information relating to legal cases [20].

Rule of complementarity

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

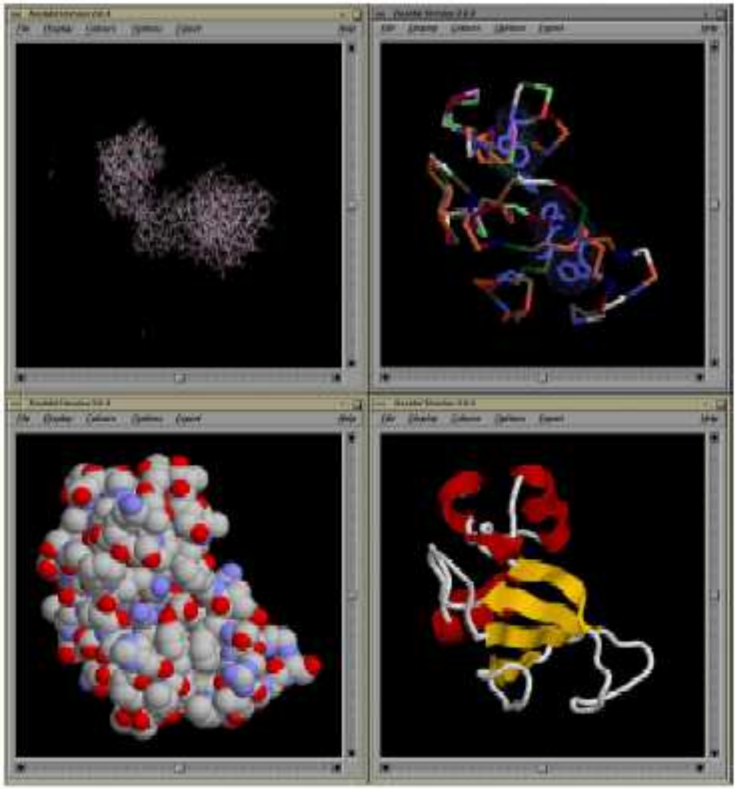

Figure 2: Complementary views of the barnase molecule [24]. Reprinted by permission of Wiley-Liss, Inc., a subsidiary of John Wiley & Sons, Inc.

Rule of complementarity

- Major positive impacts on utility
  - Working memory
  - Effort for comparison
  - Context switching
- Major negative impacts on the utility
  - Learning
  - Computational overhead
  - Display space overhead

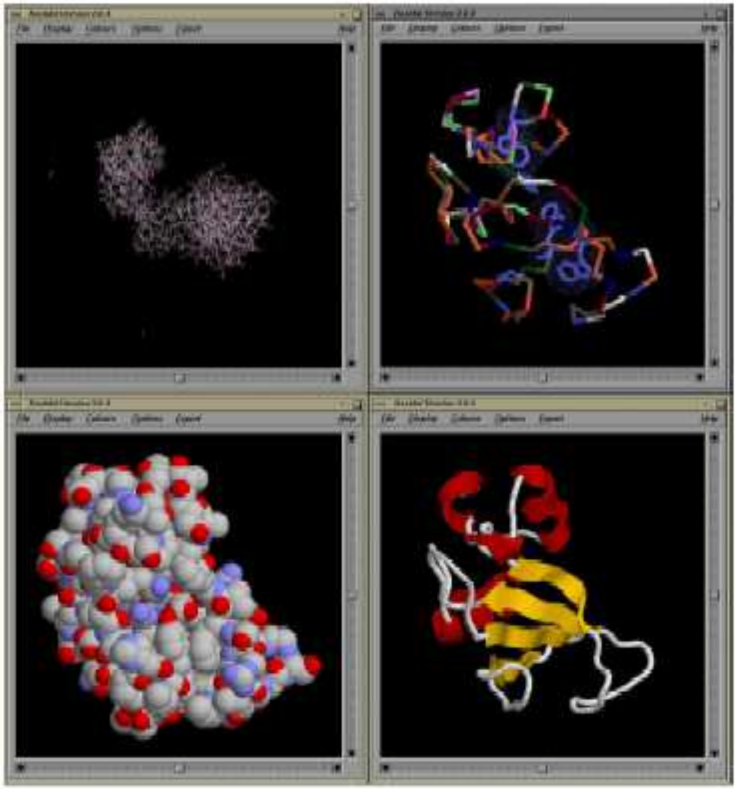

Figure 2: Complementary views of the barnase molecule [24]. Reprinted by permission of Wiley-Liss, Inc., a subsidiary of John Wiley & Sons, Inc.

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Rule of decomposition

Divide & Conquer

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

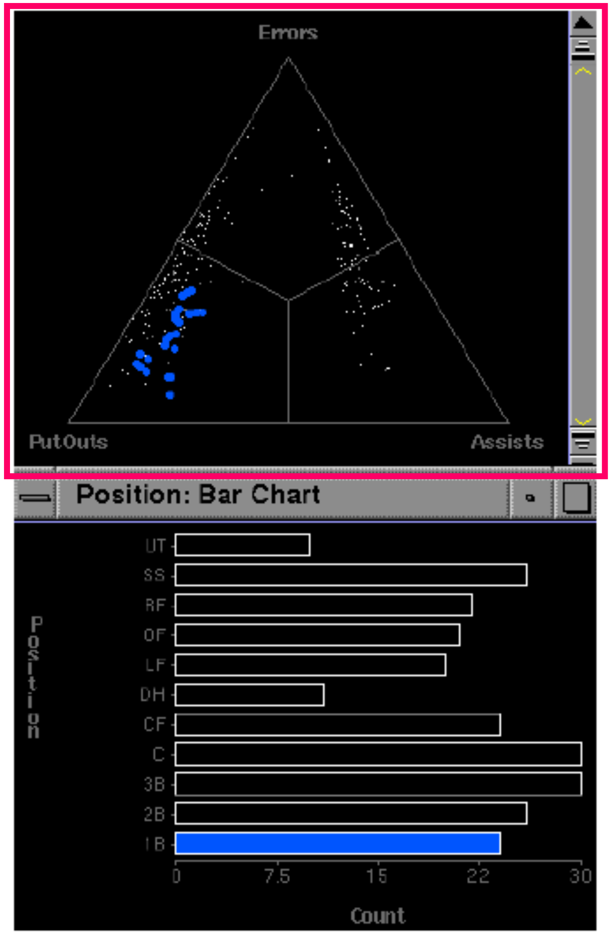

Figure 3: Two views of a single table of baseball data [12].

Rule of decomposition

- Major positive impacts on utility
  - Working memory
  - Effort for comparison
- Major negative impacts on the utility
  - Learning
  - Computational overhead
  - Display space overhead

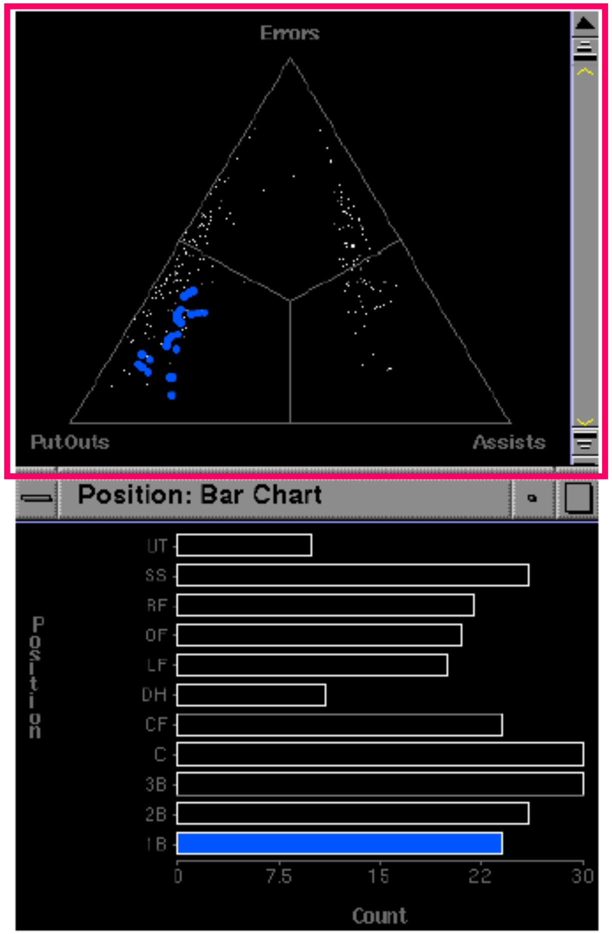

Figure 3: Two views of a single table of baseball data [12].

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Rule of parsimony

Use multiple views minimally.

- Major positive impacts on utility
  - Learning
  - Computational overhead
  - Display space overhead
- Major negative impacts on the utility
  - Working memory
  - Effort for comparison
  - Context switching

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Linking and Brushing

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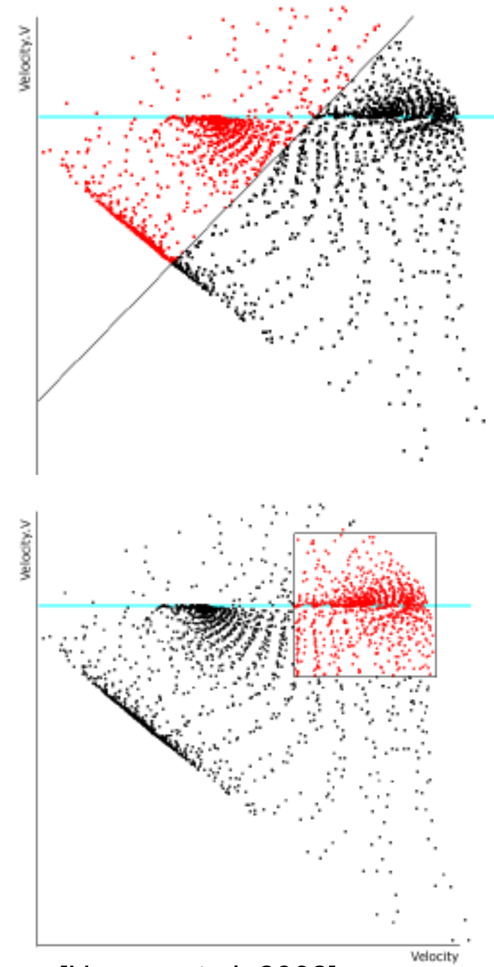
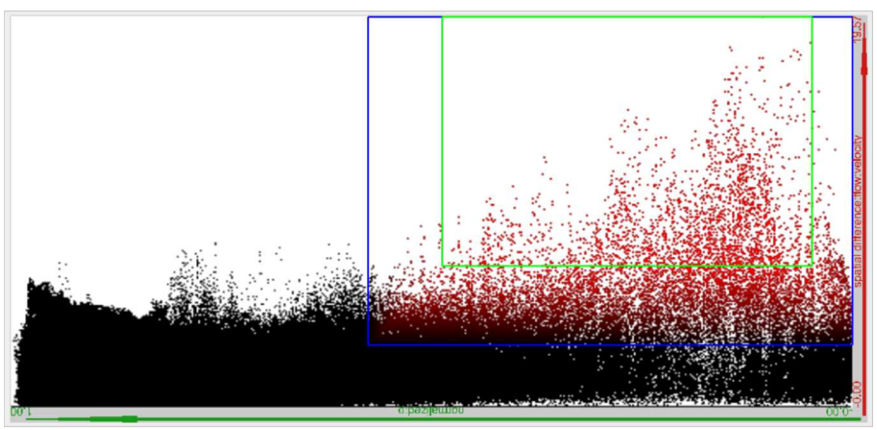
Brushing

- Highlight or select groups of data points using
  - geometric functions such as:
    - rectangles, angles, free-form, lassos, etc.
  - queries
- Can be composite (AND, OR)

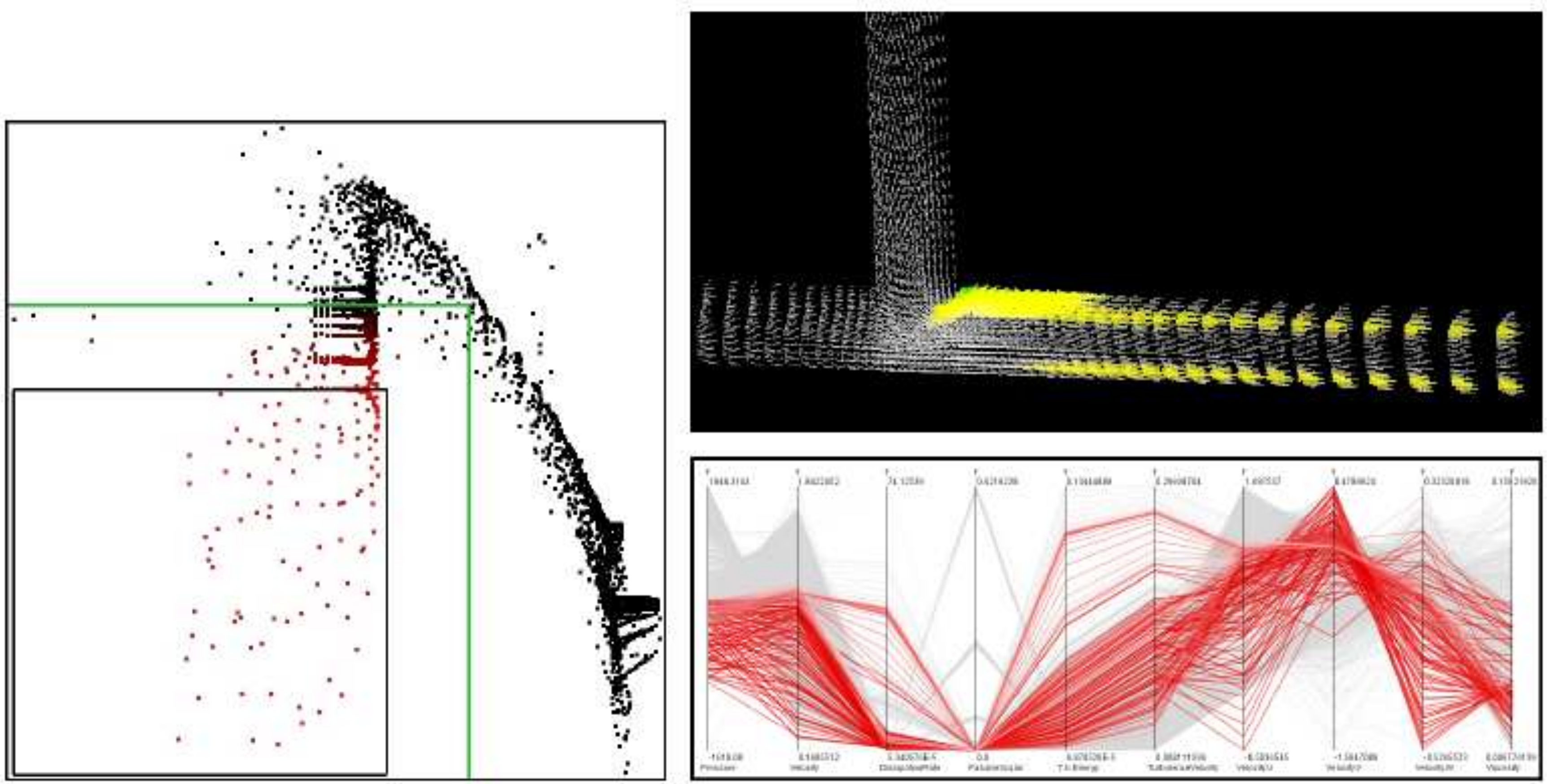


[Hauser et al. 2002]



[Doleisch et al. 2004]

Linking: Brushing in MCV



[Hauser et al. 2002]

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[1] A. Cockburn, A. Karlson, and B. B. Bederson, “A review of overview+detail, zooming, and focus+context interfaces,” ACM Comput. Surv., vol. 41, no. 1, pp. 1-31, 2008.

[2] J. C. Roberts, “State of the Art: Coordinated & Multiple Views in Exploratory Visualization,” in International Conference on Coordinated and Multiple Views in Exploratory Visualization, vol. 0, pp. 61-71, 2007.

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