Interaction

1

What is Interaction?

- From Google: Reciprocal action between a human and a computer
- One of the two main components in infovis
  - Representation
  - Interaction
- Interaction is what distinguishes infovis from static visual representations on paper

2

Interaction

- How do you define “interactive”?

3

Response Time

- 0.1 sec
  - animation, visual continuity, sliders
- 1 sec
  - system response, conversation break
- 10 sec
  - cognitive response

4

Interaction Types

- Keim's taxonomy (TVCG '02) includes
  - Projection
  - Filtering
  - Zooming
  - Distortion
  - Linking and brushing

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Interaction Types

- Dix and Ellis (AVI '98) propose
  - Highlighting and focus
  - Accessing extra info – drill down and hyperlinks
  - Overview and context – zooming and fisheyes
  - Same representation, changing parameters
  - Linking representations – temporal fusion

We will roughly follow this order in this class

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Brushing

- Applies when you have multiple views of the same data
- Selecting or highlighting a case in one view generates highlighting the case in the other views
- Very common technique in InfoVis

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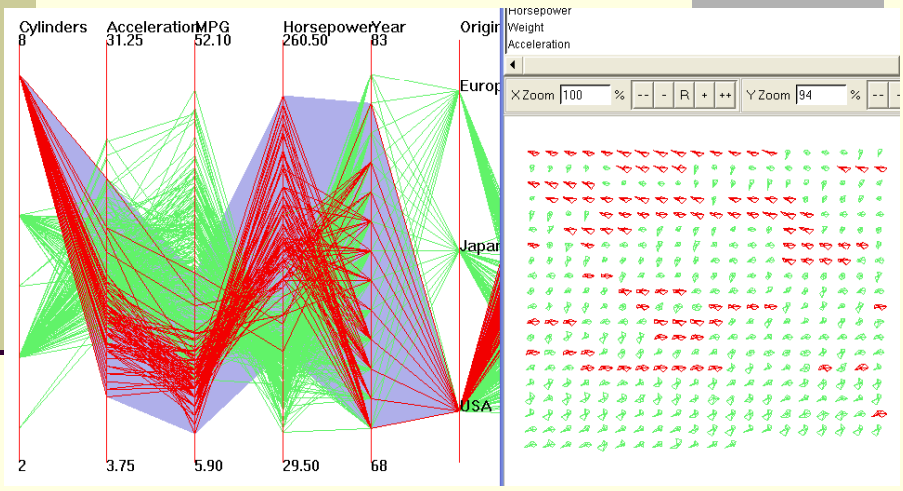
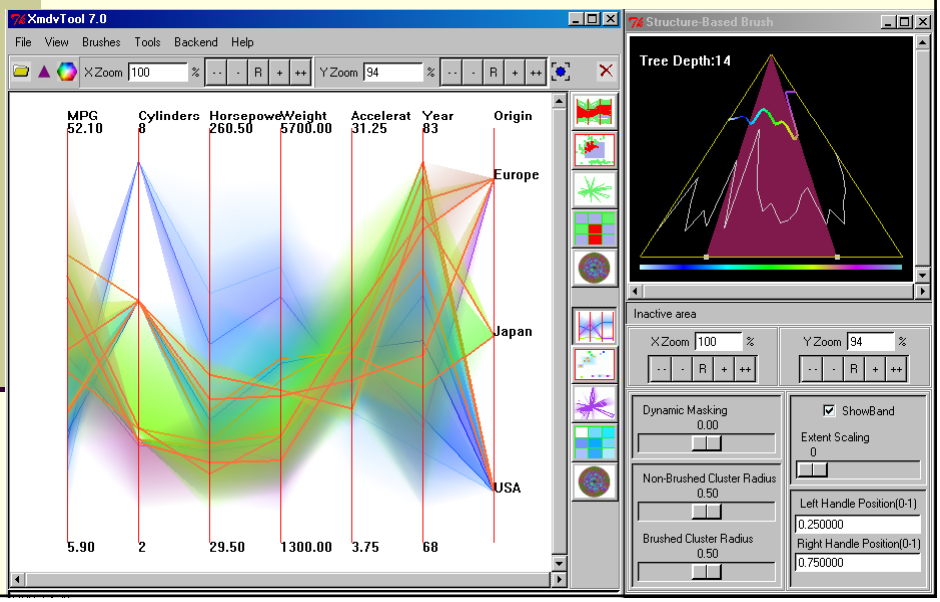
N-D Brushing (demo)



8

Structure-Based Brushing (demo)



Filtering/Limiting

- Changing the set of data cases/dimensions being presented
  - Focusing
  - Narrowing/widening

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Video

- Filter for Boolean variables

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Dynamic Query

- DB Queries

Select house-address
From atl-realty-db
Where price >= 200,000 **and**
price <= 400,000 **and**
bathrooms >= 3

12

Typical Query Response

- 124 hits found
  - 1. 748 Oak St. - a beautiful …
  - 2. 623 Pine Ave. -
  - …
- 0 hits found

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Problems

- Must learn language
  - Only shows exact matches
  - Don’t know magnitude of results
  - No helpful context is shown
  - Reformulating to a new query can be slow
  - ...

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Dynamic Query

- Specifying a query brings immediate display of results
- Responsive interaction (< .1 sec) with data, concurrent presentation of solution
- “Fly through the data”, promote exploration, make it a much more “live” experience

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Dynamic Query Constituents

- Visual representation of world of action including both the objects and actions
- Rapid, incremental and reversible actions
- Selection by pointing (not typing)
- Immediate and continuous display of results

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Idea at heart of Dynamic Query

- There often simply isn't one perfect response to a query
- Want to understand a set of tradeoffs and choose some "best" compromise
- You may learn more about your problem as you explore

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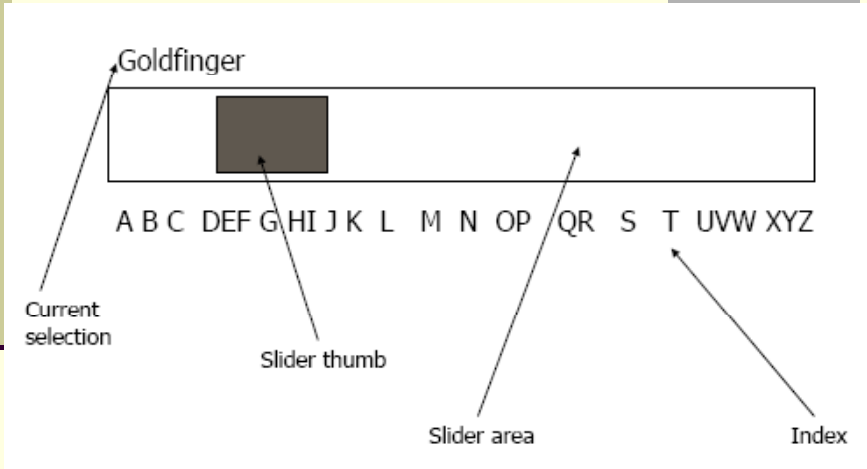
Alphaslider



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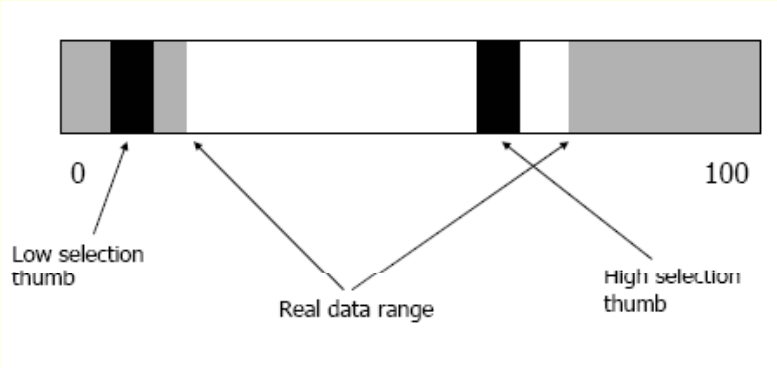
Rangeslider



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Videos

- 1. Ben's dynamic query talk
- 2. Filmfinder
- 2. Ben's spotfire talk

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DQ Strengths

- Work is faster
- Promote reversing, undo, exploration
- Very natural interaction
- Shows the data

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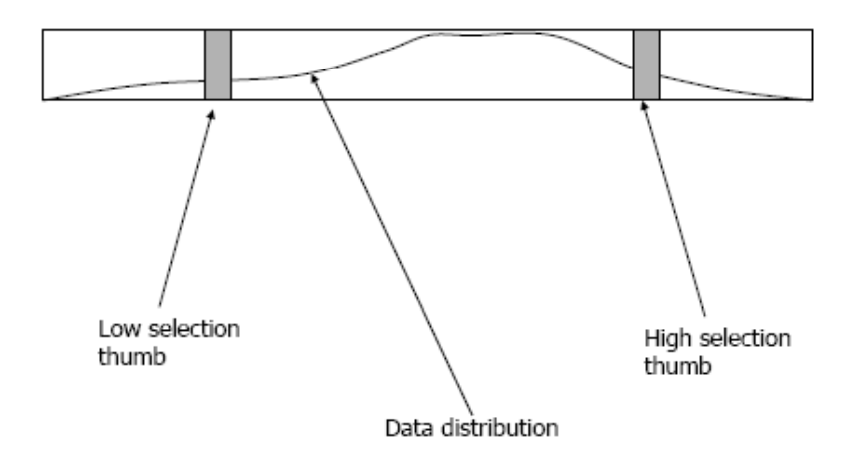
Data Visualization Sliders



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Brushing Histograms

- Qing Li, Xiaofeng Bao, Chen Song, Jinfei Zhang, Chris North, Dynamic Query Sliders vs. Brushing Histograms, *Proc. of ACM CHI 2003*, April 2003, Fort Lauderdale, Florida, April 2003
- Qing Li, Chris North, Empirical Experiment of Dynamic Query Sliders and Brushing Histograms, *Proc. of IEEE Information Visualization 2003*, Seattle, Washington, October 2003

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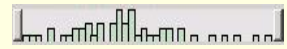
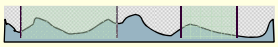
Design Iterations

- 1st Stage: Plain DQ sliders
- 2nd stage: Add histograms on slider to clarify skewed distributions, but caused more confusion
- 3rd stage: Changed thumbs from arrows to bars, added mouse cursor
- Future: change to brushing, redesign histograms, continuous line, pixel-level granularity





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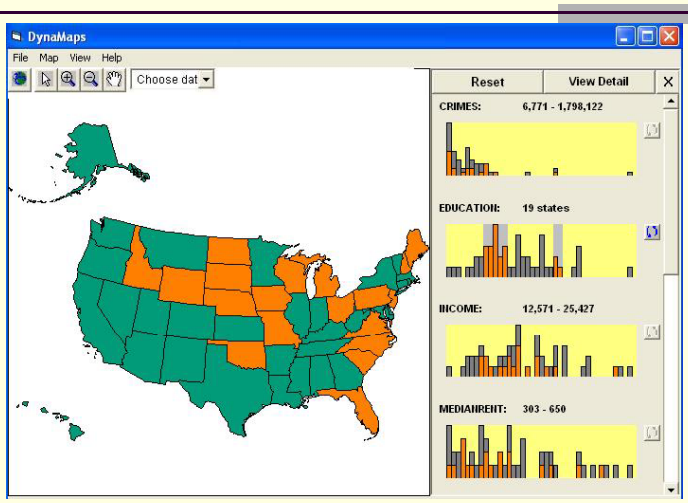
Brushing Histograms



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Brushing Histograms

- Special case of brushing
- Data values represented in histograms that can be clicked on and selected (controls region)
- When items selected there, the corresponding item(s) are highlighted in main view windows

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DQ vs. BH

- Empirical Study
  - Use DataMaps, a geographic (US states) data visualization tool
- Have participants do different tasks with both methods
  - How many states have pop between x and y in 1970?
  - Given 3 states, which has the lowest median income?
  - What's the relationship between education and income?
  - List states with pops. 0->x and y->z.
  - What kind of a state is Florida?

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Findings

Functioned more as its own infovis tool

- Brushing histograms better and more highly rated for more complex discovery tasks
  - Attribute correlation, compare, and trend evaluation
  - Functioned more as its own infovis tool
- Dynamic queries better for simpler range specification tasks
  - Single range, multiple ranges, multiple criteria
  - Functioned more as auxiliary control for other vizs

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Excentric Labeling

"Excentric Labeling: Dynamic Neighborhood Labeling for Data Visualization"

Jean-Daniel Fekete, Catherine Plaisant

SIGCHI conference on Human Factors in Computing systems in 1999

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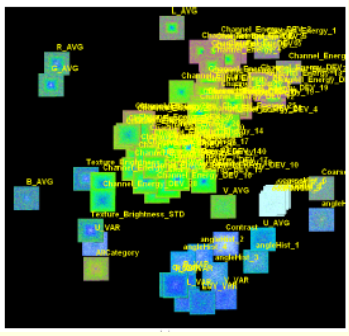
In this paper….

- Labeling challenges in Information abundant InfoViz applications.
- Informal Taxonomy of Labeling Techniques
- Excentric Labeling method introduced



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Labeling Challenges…

- Readable
- Non-ambiguously related to its graphical object
- Does not hide any pertinent information.

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Taxonomy of labeling…

Type	Technique	Comments/Problems
STATIC	No label	No labels!
	Label-only-when-you-can (i.e. after filtering objects)	Need effective filters. Labels are rarely visible.
	Rapid Label-All	High risk of overlaps or ambiguous linking to objects
	Optimized Label-All	Often slow - may not be possible
	Optimized Label-All with aggre-gation and sampling	Effective but application dependant- may not be possible

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Taxonomy of labeling…

- Dynamic

One at a time	Cursor sensitive balloon label	Requires series of precise selection to explore space (slow), cannot reach overlapped objects.
	Cursor Sensitive label in side-window	Same as above. Constant eye movement can be a problem, but avoids occlusion of other objects.
	Temporal brushing (Cleveland)	More labels visible at a time, but overlapping problem.

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Taxonomy of labeling…

- Dynamic

Global display change	Zoom until labels appear	May require extensive navigation to see many labels (can be effectively combined with semantic zooming, e.g., Pad++)
	Filter until labels appear	May require several filtering to see labels (can be effectively combined with Zooming, e.g., starfields)

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Taxonomy of labeling…

- Dynamic

Focus + context	Overview and detail view without deformation	Effective when objects are separated enough in the detail view to allow labels to fit (not guaranteed.)
	Overview and detail with deformation/ transformation (i.e.fisheye or magic lenses)	Deformation might allow enough room for labels to fit. (not guaranteed). May require tool or mode to be selected.
	Global deformation of space (e.g., Hyperbolic Browser)	Requires intensive navigation and dexterity to rapidly deform the space and reveal all labels (e.g., by fanning the space).

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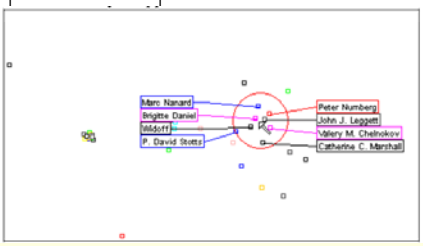
Taxonomy of labeling…

- Dynamic

Sampling	Dynamic sampling (Chalmers et al.)	Few labels are visible.
NEW	Excentric labeling	Fast, no tool or special skill needed. Spread overlapping labels, and align them for ease of reading.



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Algorithm

- 1. Extract each label and position for interesting graphic objects in the focus region.
- 2. Compute an initial position.
- 3. Compute an ordering.
- 4. Assign the labels to either a right or left set.
- 5. Stack the left and right labels according to their order.
- 6. Minimize the vertical distance of each set from the computed initial position.
- 7. Add lines to connect the labels to their related graphic object.

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Excentric Labeling

- Demo

http://www.cs.umd.edu/hcil/excentric/#prototypes

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Excentric Labeling

- Comparison of excentric with virtual instantaneous zoom.
  - a 60% speed advantage for the excentric
  - Easily learnable after a little practice.
  - No of operations in zoom was much more

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Details-on-Demand

- Term used in infovis when providing viewer with more information/details about data case or cases
- May just be more info about a case
- May be moving from aggregation view to individual view
  - May not be showing all the data due to scale problem
  - May be showing some abstraction of groups of elements
  - Expand set of data to show more details, perhaps individual cases

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Zooming/Panning

- Zooming in - the interaction that changes the current display from a view of a lower level of detail to a view of a higher level of detail.
- Zooming out - the interaction that changes the current display from a view of a higher level of detail to a view of a lower level of detail.
- Panning - the interaction that changes the current display from a subregion of a view to an adjacent sub-region of the same view. There can be overlaps between the two regions.

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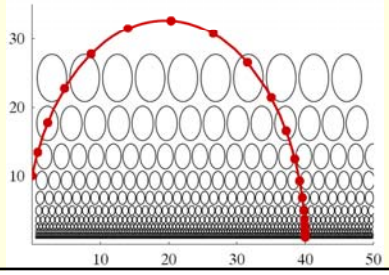
Panning and Zooming

- Panning in high levels of detail can be time consuming
  - Solution: zoom out, pan, and zoom in
  - Drawbacks: jitter in the process
- Improvement: Smooth and Efficient Zooming and Panning (van Wijk and Nuij, Infovis 03)



42

Panning and Zooming

- "Speed-Dependent Automatic Zooming for Browsing Large Documents" Igarashi & Hinckley, Proc. UIST'00, pp. 139-148.
  - Keep constant perceptual scrolling speed
  - Scale X Speed = Constant

Video!

43

Zooming and Panning

- SpaceTree: Supporting Exploration in Large Node Link Tree, Design Evolution and Empirical Evaluation Grosjean, Plaisant and Bederson, InfoVis 2002
  - A zooming environment that dynamically lays out branches of a tree to best fit and available screen space
  - Video

44

DragMag

- Colin Ware, Marlon Lewis: The DragMag image magnifier. CHI 95 Conference Companion 1995: 407-408
- video

45

Distortion

- Distortion - an operation that increase the screen space allocated to some objects in the display while decreasing the screen space allocated to other objects.

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Magnifier Lens

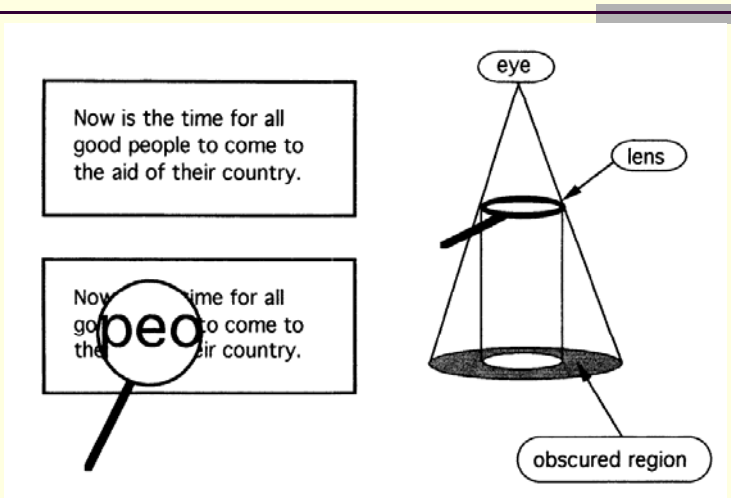
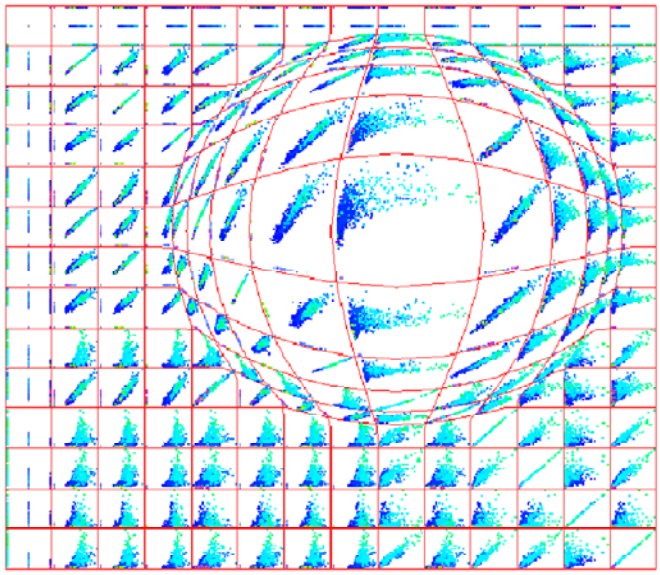


Figure from [Robertson & Mackinlay UIST 93]

47

FishEye Lens [Furnas86]



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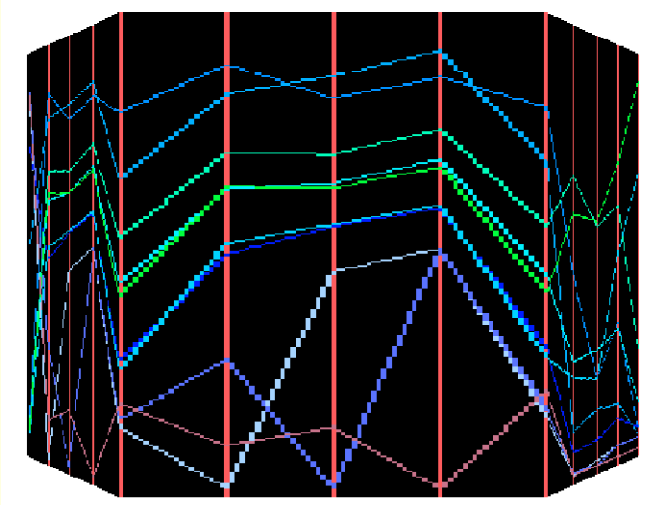
Fisheye Menus

- Bederson, B. B. (November 2000)
  Fisheye Menus
  Proceedings of ACM Conference on User Interface Software and Technology (UIST 2000), pp. 217-226, ACM Press.
- Video

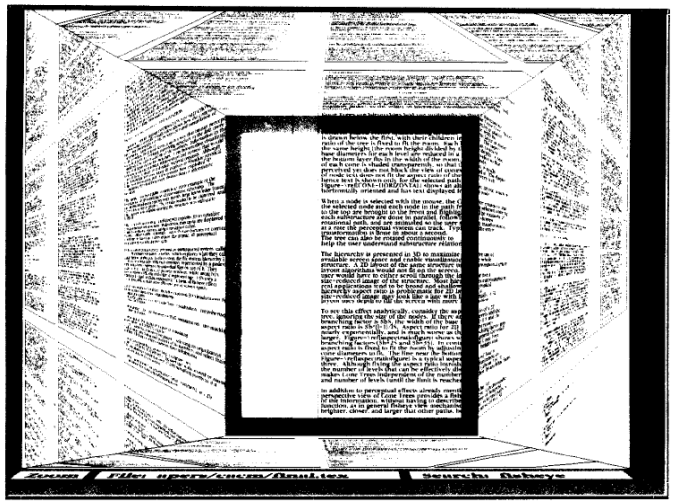
49

Perspective Wall [MRC91]



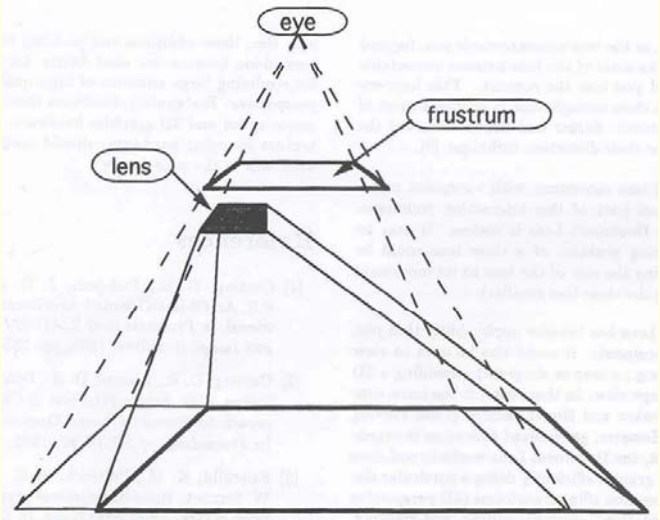
50

Document Lens
[Robertson & Mackinlay UIST 93]



51

Document Lens
[Robertson & Mackinlay UIST 93]

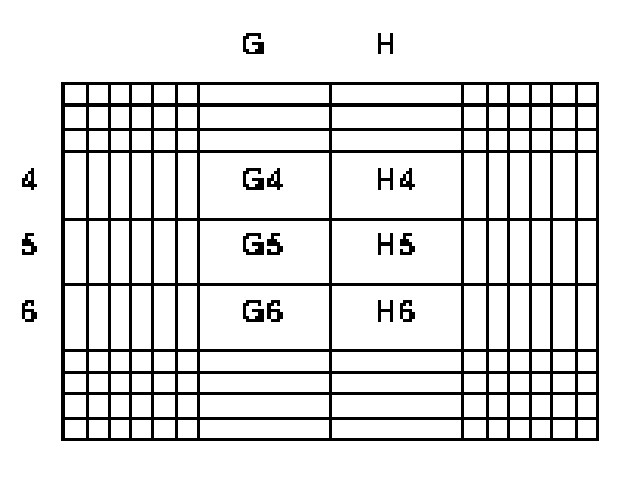


52

Document Lens
[Robertson & Mackinlay UIST 93]

53

Table Lens [RC95]



54

Table Lens [RC95]

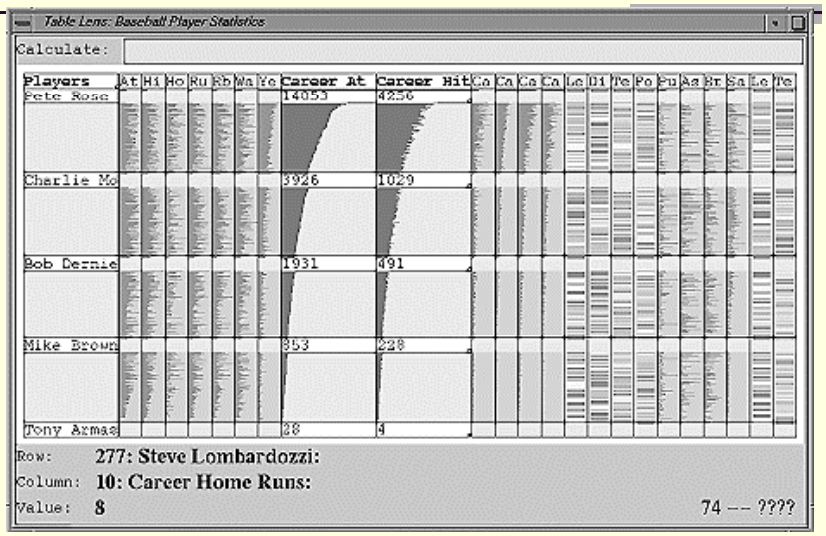
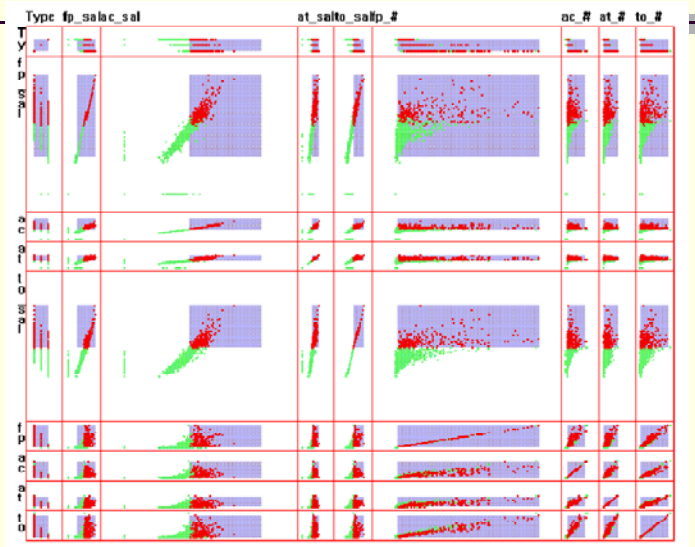


Table Lens Distortion in Scatterplots



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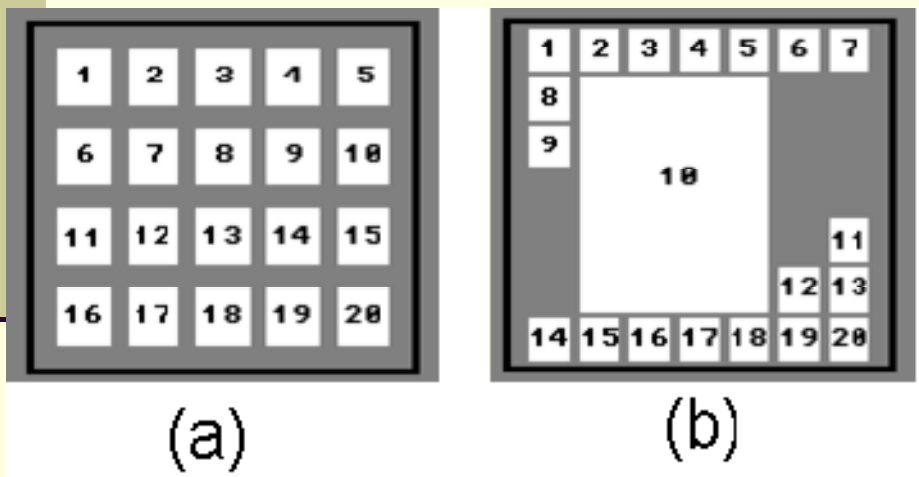
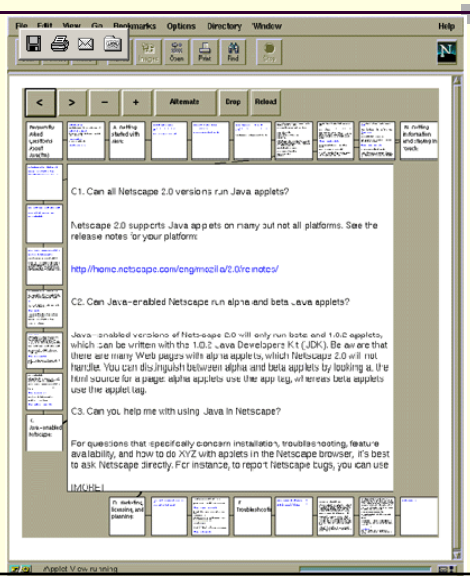
Flip Zooming [Holmquist SIGCHI 97]



Flip Zooming



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Hierarchical Image Browser [Holmquist and Bjőrk SIGGRAPH 98]

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Complex Logarithmic Views for Small Details in Large Contexts. [J. Böttger et al. 06]

- Idea: use the complex logarithm and root functions to show very small details even in very large contexts (video)

Fig. 4. Transition from the identical mapping (left) to the logarithmic mapping (right) using scaled and shifted complex root functions.

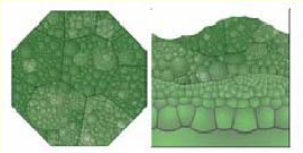

Fig. 10. Voronoi Treemap (left) and complex logarithmic view with one cell in the Voronoi Treemap enlarged (right). The borders of the different hierarchies are transformed to almost horizontal curves.

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SmartSkip

- video

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EdgeLens [Wong at. el. Infovis 03]

- Video

http://grouplab.cpsc.ucalgary.ca/papers/videos/

62

MoireGraph [Jankun-Kelly and Ma Infovis 03]

- Video

http://www.cse.msstate.edu/~tjk/publications/

63

Datelens

- Video
- http://www.cs.umd.edu/hcil/datelens/

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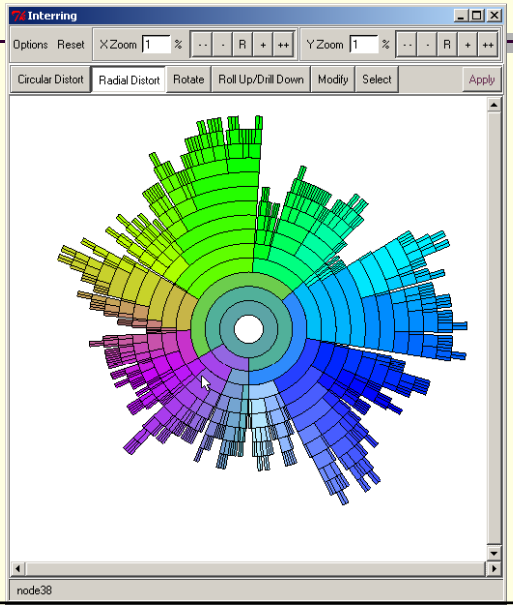
InterRing

InterRing
(infovis02)



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Rearrange View

- Keep same fundamental representation and what data is being shown, but rearrange elements
  - Alter positioning
  - Sort

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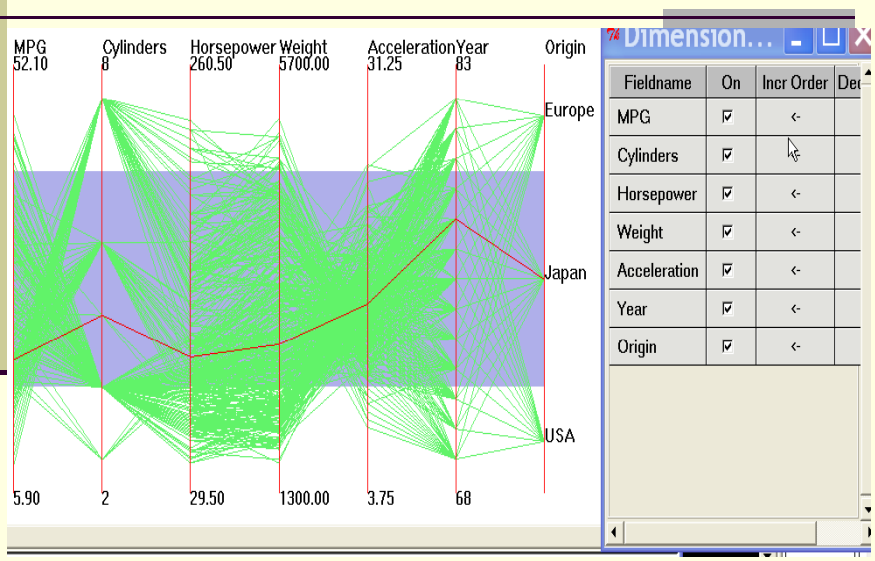
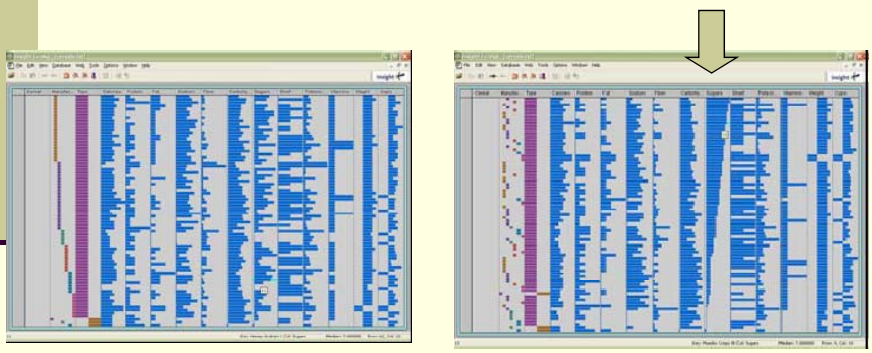
Rearrange



Sorting

- Can sort data with respect to a particular attribute in Table Lens



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Changing Representation

- May interactively change entire data representation
  - Looking for new perspective
  - Limited real estate may force change

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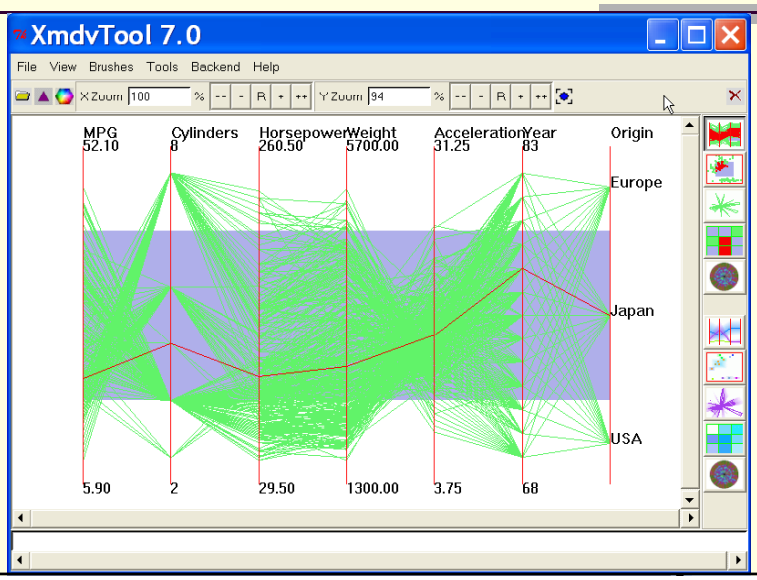
Changing Representation



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Coordinated Views

- Reveal different aspect of the data
- Help navigation

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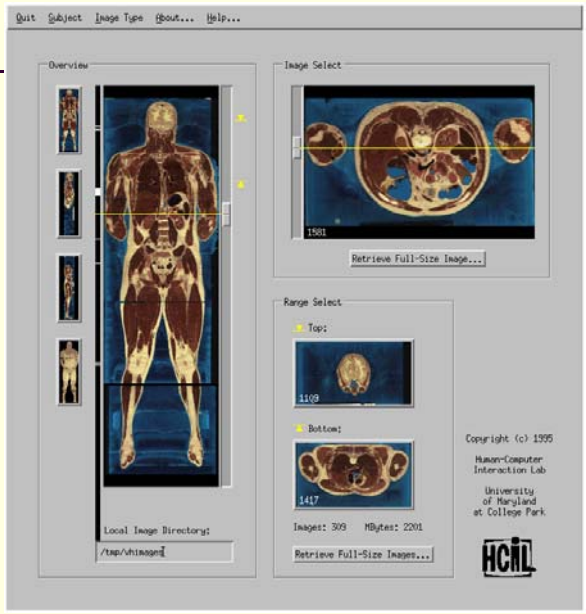
Example – Visible Human Explorer



video

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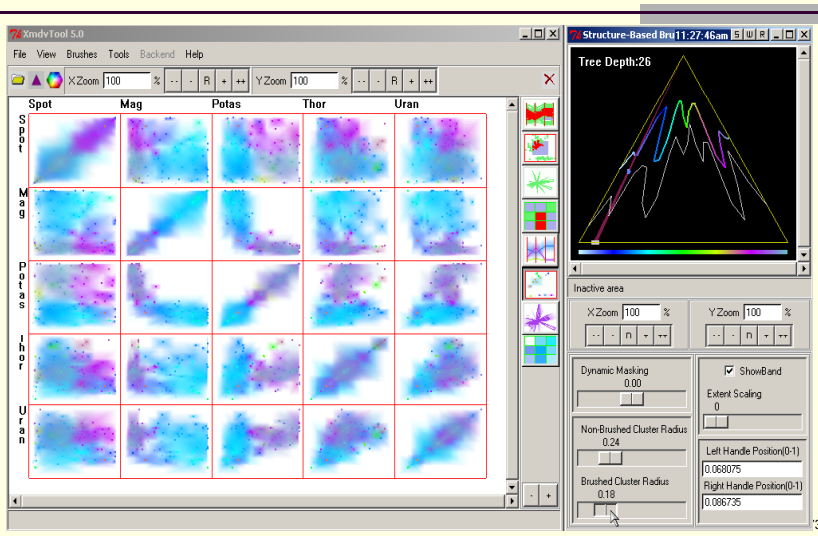
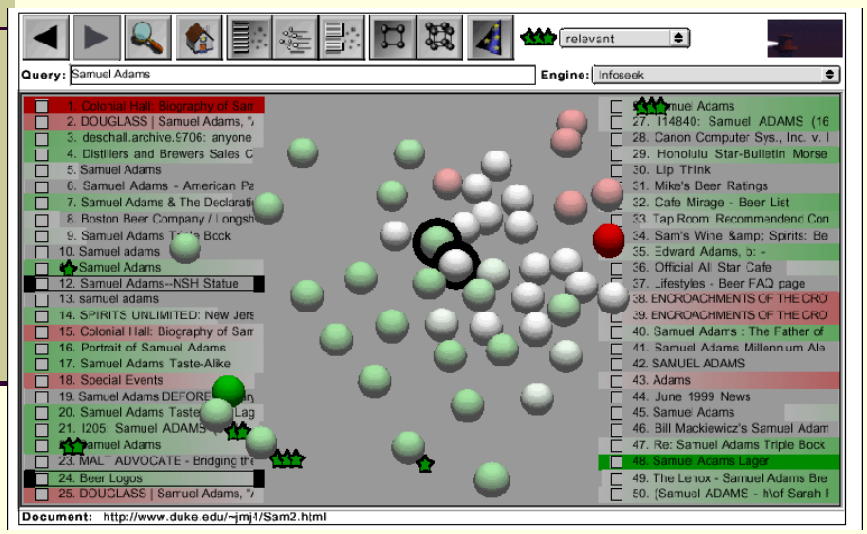
Example – Hierarchical Parallel Coordinates



Example – Lighthouse System



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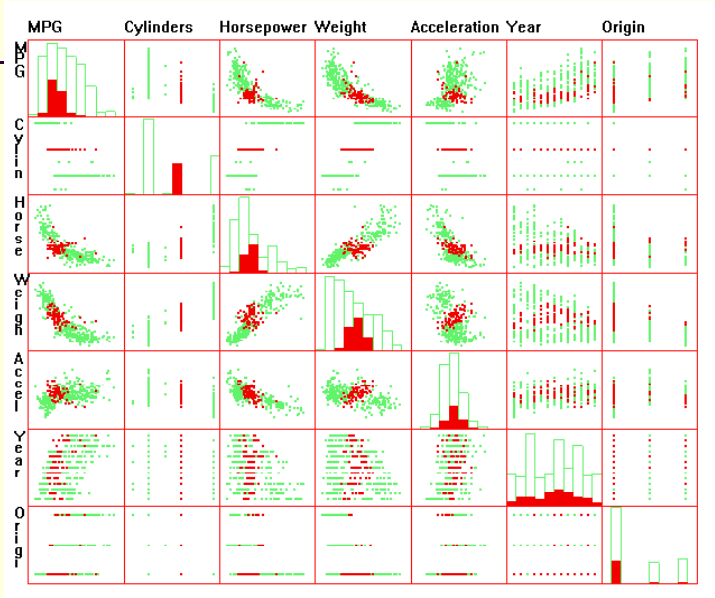
Example – XmdvTool



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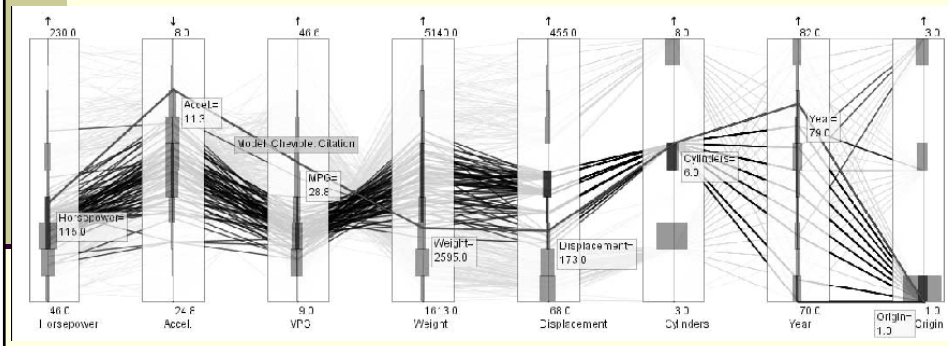
Example – Extended Parallel Coordinates

- Hauser et. al. Infovis 2002



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Highlighting Connections

- Viewer may wish to examine different attributes of a data case simultaneously
- Alternatively, viewer may wish to view data case under different perspectives or representations
- But need to keep straight where the data case is

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View Management

- Robertson, G., Horvitz, E., Czerwinski, M., Hutchings, D., Baudisch, P, Meyers, B., Robbins, D & Smith, G. Scalable Fabric: Flexible task management. In *Proceedings of the working conference on Advanced Visual Interfaces, AVI 2004*, p. 85-89.
- Video

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Animation

- A smooth transition that relates the old display to the new one when display changes in an interface
- A commonly held belief
  - Animation helps users maintain object constancy and thus helps users to relate the two states of the system
- A reported user study [Bederson and Boltman Infovis99]:
  - Increased users' ability to reconstruct info space
  - No penalty on task performance
    - Cost extra in response time vs. Relate two states fasters

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Reference

- John stasko's infovis class slides

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