Lecture 8: Multiples/Interaction

Information Visualization
CPSC 533C, Fall 2007

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Readings Covered

Ware, Chap 10: Interacting with Visualizations. first half, p 317-324

Tufte, Chap 4: Small Multiples

State of the Art: Coordinated & Multiple Views in Exploratory Visualization. Jonathan C. Roberts. Proc. Conference on Coordinated & Multiple Views in Exploratory Visualization (CMV) 2007.

Building Highly-Coordinated Visualizations In Improvise. Chris Weaver. Proc. InfoVis 2004

Exploring High-D Spaces with Multiform Matrices and Small Multiples. Alan MacEachren, Xiping Dai, Frank Hardisty, Diansheng Guo, and Gene Lengerich. Proc InfoVis 2003.

Further Readings

Toolglass and magic lenses: the see-through interface. Eric A. Bier, Maureen C. Stone, Ken Pier, William Buxton, and Tony D. DeRose. Proc. SIGGRAPH'93, pp. 73-76.

Excentric Labeling: Dynamic Neighborhood Labeling for Data Visualization. Jean-Daniel Fekete and Catherine Plaisant. Proc. CHI'99, pages 512-519.

Ware Interaction

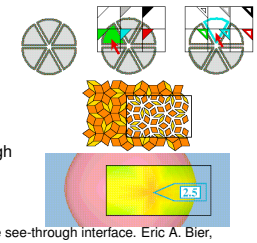
- low-level control loops, data manipulation
  - choice reaction time
    - depends on number of choices
  - selection time: Fitts' Law
    - depends on distance, target size
  - path tracing
    - depends on width
  - learning: power law of practice
    - also subtask chunking

Ware Interaction

- low-level control loops
  - two-handed interaction: Guiard's theory
    - coarse vs. fine control e.g. paper vs. pen positioning

Two-Handed Interaction Example

- toolglass: semi-transparent click-through tool
- magic lens: see-through tool



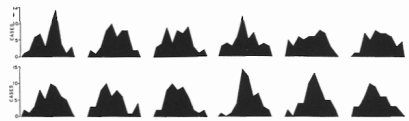
[Toolglass and magic lenses: the see-through interface. Eric A. Bier, Maureen C. Stone, Ken Pier, William Buxton, and Tony D. DeRose. Proc. SIGGRAPH'93, pp. 73-76.]

Ware Interaction

- low-level control loops
  - two-handed interaction: Guiard's theory
    - coarse vs. fine control e.g. paper vs. pen positioning
  - vigilance
    - difficult, erodes with fatigue
  - control compatability
    - learning/transfer: adaption time depends
  - hover/mouseover/tooltip
    - faster than explicit click

Small Multiples

- several small windows with
  - same visual encoding
  - different data
  - shown side by side

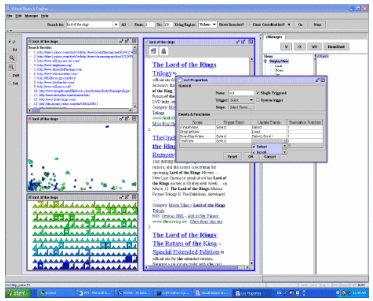


[Edward Tufte. The Visual Display of Quantitative Information, p 172]

Coordinated Multiple Views (CMV)

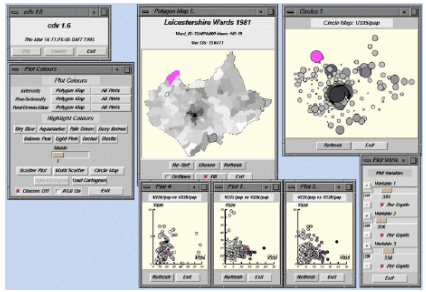
- more general than small multiples
- multiple views
  - multiform: different visual encodings of same data
  - different resolutions of same encoding
    - overview+detail
- power of linking
  - linked highlighting (brushing)
  - linked navigation
  - linked parameter changes

CMV Example: Visual Search Engine



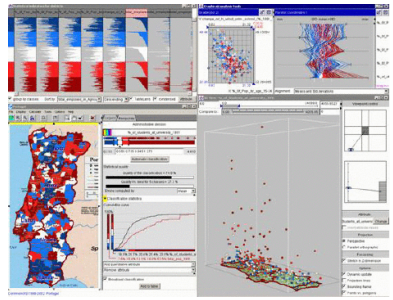
[VSE from Boukhelfia, Roberts, and Rodgers, Figure 3 of State of the Art: Coordinated & Multiple Views in Exploratory Visualization.

CMV Example: cdv



[cdv from Dykes, Figure 2 of State of the Art: Coordinated & Multiple Views in Exploratory Visualization. Roberts, Proc. CMV 2007]

CMV Example: CommonGIS



[CommonGIS from Andrienko and Andrienko, Figure 4 of State of the Art: Coordinated & Multiple Views in Exploratory Visualization.

Replace, Replicate, Overlay

- when to do which
- design problem
  - always replace: too much reliance on memory
  - always replicate: too many windows
  - always overlay: too much clutter in single window

Architectural Issues

- must play nicely with other views
  - rendering, preprocessing, responding to commands
- most issues also true for scalability of single view
  - guaranteed response time independent of dataset size
- loose confederation
  - multithreaded, each component can work in background
- tighter confederation: return control to master regularly (TJ,H3)
  - divide work into pieces, enqueue
  - continue serving queue when control is returned

Animated Transitions

- animated transitions vs. jump cuts
  - object constancy
  - guaranteed frame rate avoids slowdown with large data
- early PARC architectural solution: Cognitive Co-Processor
  - split work into small chunks
  - animation vs. idle states
  - governor controls frame rate
- video: 3D Rooms

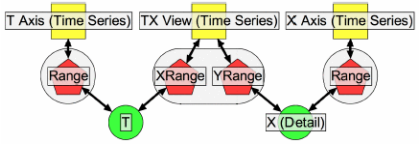
[The cognitive coprocessor architecture for interactive user interfaces. George Robertson, Stuart K. Card, and Jock D. Mackinlay, Proc. UIST '89, pp 10-18.]

Improvise

- tightly integrated coordination approach
  - components with many external control capabilities
- live properties
  - value slots, ports
  - change in response to user action
  - naive approaches fall into cycles
- coordinated queries
  - filters, projections

Coordinating Axes

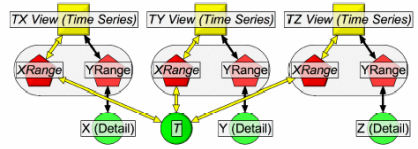
- scatterplot from components



[Building Highly-Coordinated Visualizations In Improvise. Chris Weaver. Proc. InfoVis 2004]

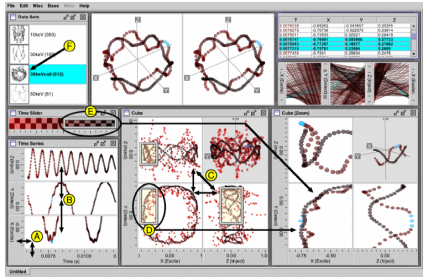
Coordinating Multiple Scatterplots

- sync horizontal but not vertical scrolling



[Building Highly-Coordinated Visualizations In Improvise. Chris Weaver. Proc. InfoVis 2004]

Example: Complex Application



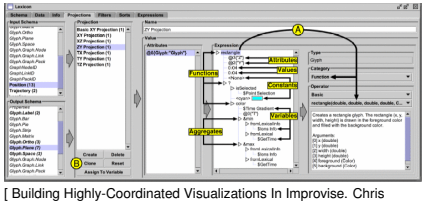
[Building Highly-Coordinated Visualizations In Improvise. Chris Weaver. Proc. InfoVis 2004]

Selection

- selection decoupled from data
- selection-dependent loading, filtering, projection
- highlighting: user-customizeable differentiation of selected vs. unselected items
- video

Critique

- sophisticated and powerful approach to coordination
- but very large learning curve to build new apps



[Building Highly-Coordinated Visualizations In Improvise. Chris Weaver. Proc. InfoVis 2004]

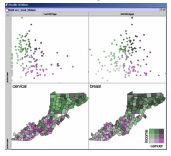
Multiform Matrices and Small Multiples

- matrices for bivariate exploration (SPLOM and other)
  - vs. small multiples for univariate
- uniform vs. multiform multiples
- techniques
  - juxtaposition
  - sorting/ordering
  - manipulation
  - linking multiple bivariate views

[Exploring High-D Spaces with Multiform Matrices and Small Multiples. Alan MacEachren, Xiping Dai, Frank Hardisty, Diansheng Guo, and Gene Lengerich. Proc InfoVis 2003.]

Multiform Bivariate Small Multiple

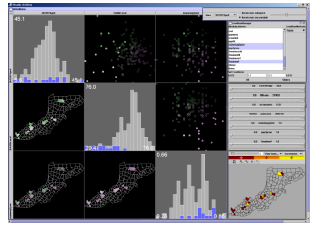
- common variable: per capita income
- per-column variables: type of cancer mortality
- per-row forms: scatterplot, choropleth/thematic map
- left bright green: high income, low cervical cancer
  - hypoth: not screened
- right dark green: low income, high breast cancer
  - hypoth: late childbearing



[Exploring High-D Spaces with Multiform Matrices and Small Multiples. MacEachren et al, Proc. InfoVis 2003.]

Multiform Bivariate Matrix

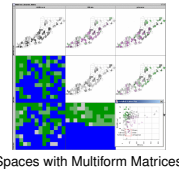
- scatterplots/maps, histograms along diagonal
  - per-column vars: mortality, early detection, recent screening
- univariate map var: screening facility availability



[Exploring High-D Spaces with Multiform Matrices and Small Multiples. MacEachren et al, Proc. InfoVis 2003.]

Spacefill Form

- linked highlight of low doctor ratio counties from scatterplot
- spacefill shows it's roughly half the items



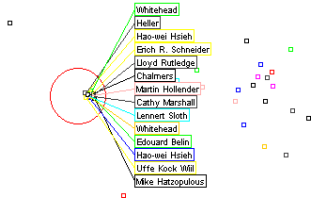
[Exploring High-D Spaces with Multiform Matrices and Small Multiples. MacEachren et al, Proc. InfoVis 2003.]

Sorting and Linking

- sorting
  - manual: direct manipulation from user
  - automatic: conditional entropy metric
  - automatic: hierarchical clustering to find interesting
- linking
  - highlighting
  - many others
    - background color, subspce, conditioning, ...
  - conditioning: filter in/out of given range on another var
- video

Excentric Labels

- show labels around mouseover region
- demo



[Excentric Labeling: Dynamic Neighborhood Labeling for Data Visualization. Jean-Daniel Fekete and Catherine Plaisant. Proc. CHI'99, pages 512-519.] [http://www.cs.umd.edu/hcil/excentric/]

Critique

- great previous work taxonomy
- great explanation of how vis techniques used with specific data can lead to hypothesis generation
- careful use of color