Lecture 8: Multiple View Methods

Information Visualization
CPSC 533C, Fall 2011

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Required Readings

Chapter 6: Multiple View Methods

The Visual Design and Control of Trellis Display R. A. Becker, W. S. Cleveland, and M. J. Shyu (1996). Journal of Computational and Statistical Graphics, 5:123-155.

Further Reading

Cerebral: Visualizing Multiple Experimental Conditions on a Graph with Biological Context. Aaron Barsky, Tamara Munzner, Jennifer L. Gardy, and Robert Kincaid. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2008) 14(6):1253-1260, 2008.

Building Highly-Coordinated Visualizations In Improvise. Chris Weaver. Proc. InfoVis 2004. p 159-166.

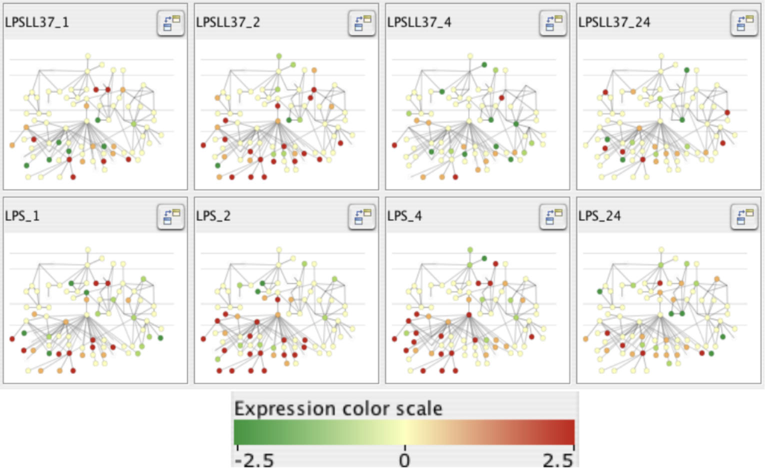
Exploring High-D Spaces with Multiform Matrices and Small Multiples. Alan MacEachren, Xiping Dai, Frank Hardisty, Diansheng Guo, and Gene Lengerich. Proc InfoVis 2003. p 31-38.

Configuring Hierarchical Layouts to Address Research Questions. Adrian Slingsby, Jason Dykes, and Jo Wood. IEEE TVCG 15(6), Nov-Dec 2009 (Proc. InfoVis 2009).

Multiple View Methods

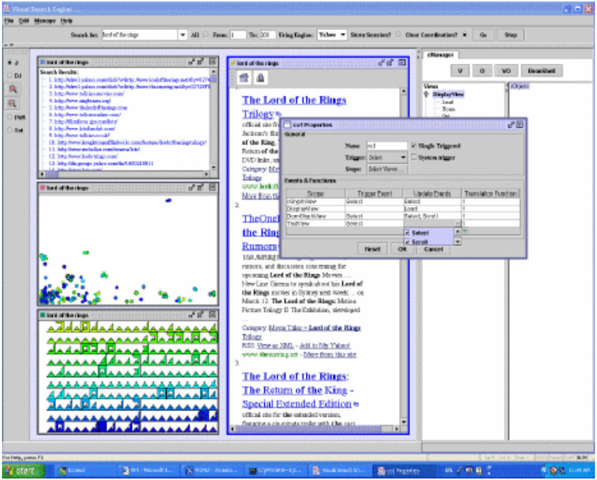
- linking/coordination choices
  - linked highlighting
    - is contiguous in one view distributed in another?
  - linked navigation
- view choices
  - encoding: same or multiform
  - dataset: same or small multiple
  - data: all or subset (overview/detail)
  - spatial ordering of views
- many combinations possible

Small Multiples vs Animation



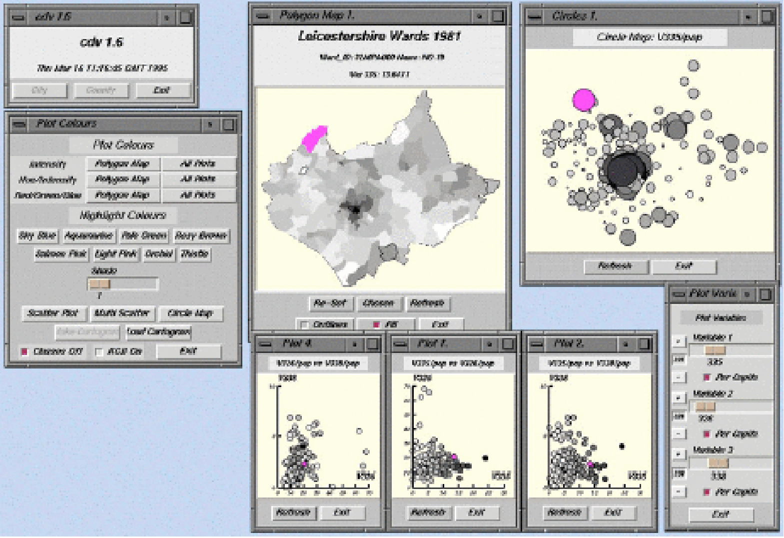
[Barsky et al. Cerebral: Visualizing Multiple Experimental Conditions on a Graph with Biological Context. Proc. InfoVis 2008. p 1253-1260.]

CMV Example: Visual Search Engine



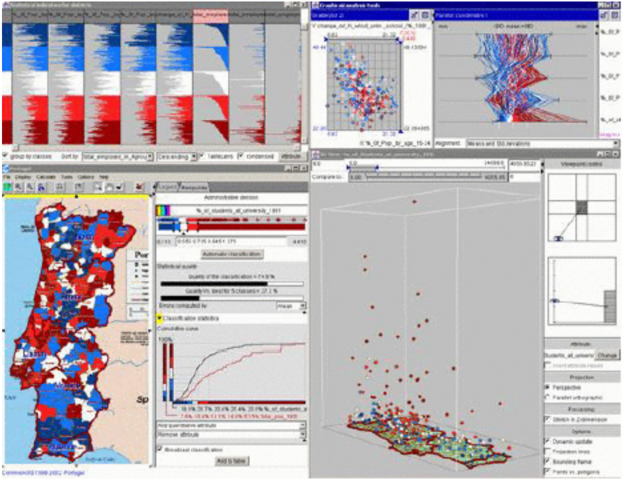
[VSE from Boukhelfia, Roberts, and Rodgers, Figure 3 of State of the Art: Coordinated & Multiple Views in Exploratory Visualization. Roberts, Proc. CMV 2007]

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. Roberts, Proc. CMV 2007]

Replace, Replicate, Overlay

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

Architectural Issues

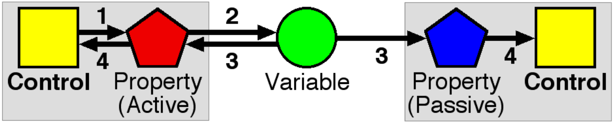
- must play nicely with other views
  - rendering, preprocessing, responding to commands
- most issues also true for scalability of single view
  - guaranteed response time independent of dataset size

- 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

Improvise

- tightly integrated coordination approach
  - components with many external control capabilities

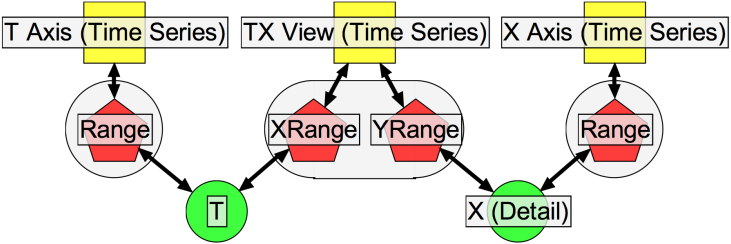
- live properties
  - value slots, ports
  - change in response to user action
  - naive approaches fall into cycles



[Fig 1. Weaver. Building Highly-Coordinated Visualizations In Improvise. Proc. InfoVis 2004, p. 159-166]

Coordinating Axes

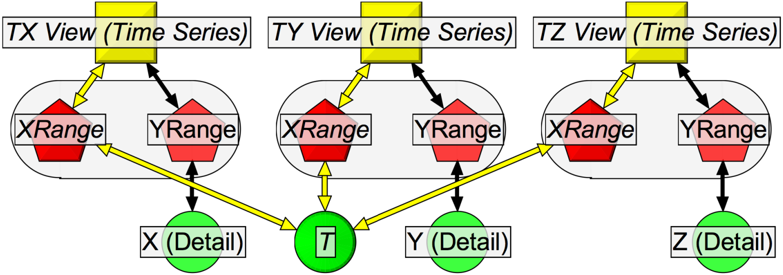
- scatterplot from components



[Fig 5. Weaver. Building Highly-Coordinated Visualizations In Improvise. Proc. InfoVis 2004, p. 159-166]

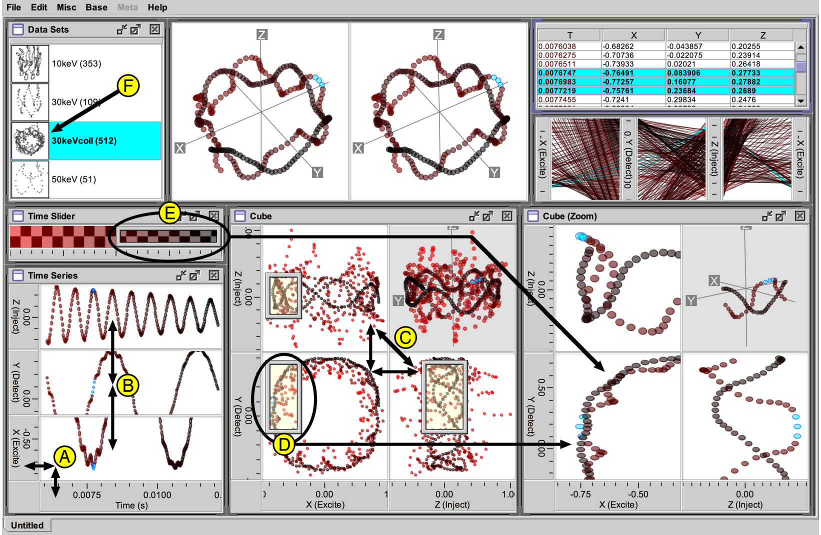
Coordinating Multiple Scatterplots

- sync horizontal but not vertical scrolling



[Fig 6. Weaver. Building Highly-Coordinated Visualizations In Improvise. Proc. InfoVis 2004, p. 159-166]

Example: Complex Application



[Fig 4. Weaver. Building Highly-Coordinated Visualizations In Improvise. Proc. InfoVis 2004, p. 159-166]

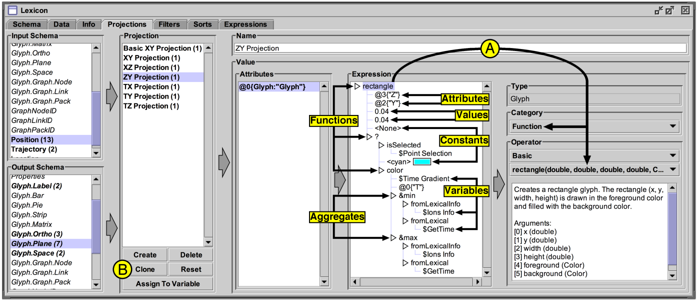
Video

- building up coordination
  - encoding: same or multiform
  - dataset: same or small multiple
  - data: all or subset (overview/detail)
- background updating of views (upper left dot)
- list views for search coupled with other multiform views
- coordination analysis (controls/variables)
- selection decoupled from data

[http://www.cs.ou.edu/ weaver/academic/publications/weaver-2004a-movie.zip
]

Critique

- strengths
  - sophisticated and powerful approach to coordination
- weaknesses
  - large learning curve to build new apps



[Fig 2. Weaver. Building Highly-Coordinated Visualizations In Improvise. Proc. InfoVis 2004, p. 159-166]

Multiform Matrices and Small Multiples

- univariate exploration: small multiples
- bivariate exploration: matrices (SPLOM and other)

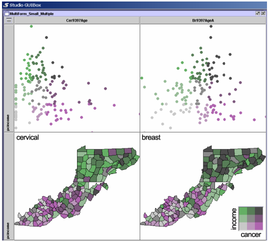
- encoding: same or multiform
- dataset: same or small multiple

- techniques
  - juxtaposition
  - sorting/ordering
  - manipulation
  - linking multiple bivariate views

[MacEachren et al. Exploring High-D Spaces with Multiform Matrices and Small Multiples. Proc InfoVis 2003, p 31-38.]

Multiform Bivariate Small Multiple

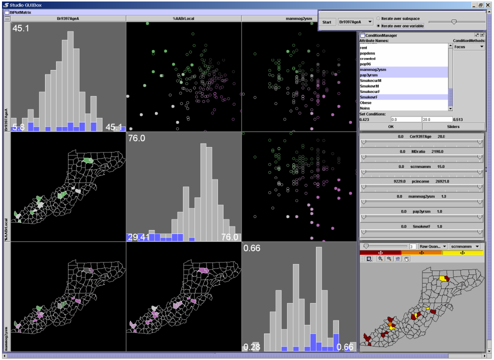
- common variable: per capita income
- per-column variables: type of cancer mortality
- per-row forms: scatterplot, choropleth/thematic map
- left bright green: high income, low cervical cancer
  - hypoth: not screened
- right dark green: low income, high breast cancer
  - hypoth: late childbearing



[Fig 3. MacEachren et al. Exploring High-D Spaces with Multiform Matrices and Small Multiples. Proc InfoVis 2003, p 31-38.]

Multiform Bivariate Matrix

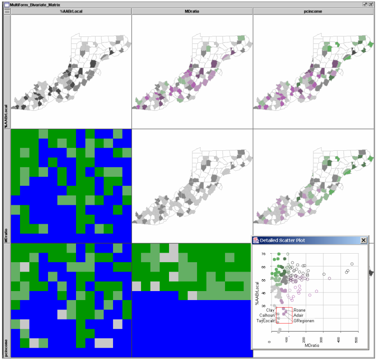
- scatterplots/maps, histograms along diagonal
  - per-col vars: mortality, early detection, recent screening
- univariate map var: screening facility availability



[MacEachren et al. Exploring High-D Spaces with Multiform Matrices and Small Multiples. Proc InfoVis 2003, p 31-38.]

Spacefill Form

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



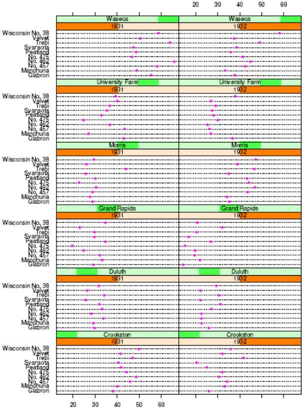
[Exploring High-D Spaces with Multiform Matrices and Small Multiples. MacEachren et al, Proc. InfoVis 2003.]

Sorting/Ordering and Linking

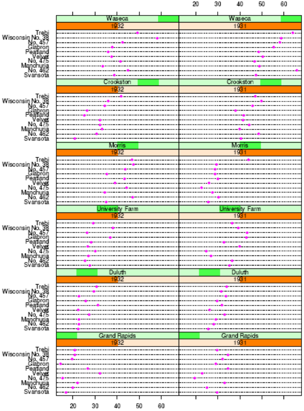
- sorting/ordering
  - manual: direct manipulation from user
  - automatic: conditional entropy metric
  - automatic: hierarchical clustering to find interesting
- linking
  - highlighting
  - many others
    - background color, subspace, conditioning, ...
  - conditioning: filter in/out of given range on another var
- video
  - InfoVis 2003 DVD

Automatic Dotplot Ordering: Trellis

alphabetical site,variety



use group median



[The Visual Design and Control of Trellis Display. Becker, Cleveland, and Shyu. JCSG 5:123-155 1996]

Trellis Structure

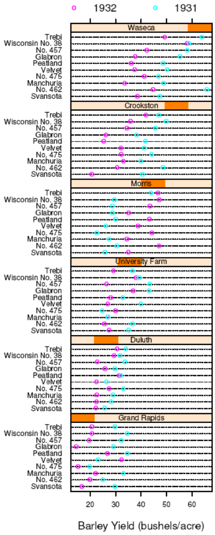
- conditioning/trellising: choose structure
  - pick how to subdivide into panels
  - pick x/y axes for indiv panels
  - explore space with different choices
    - multiple conditioning
- ordering
  - large-scale: between panels
  - small-scale: within panels

  - main-effects: sort by group median
    - derived space, from categorical to ordered

Confirming Hypothesis

- dataset error with Morris switched?
- old trellis: yield against variety given year/site
- new trellis: yield against site and year given variety
  - exploration suggested by previous main-effects ordering

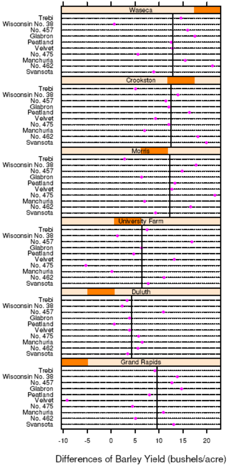
[The Visual Design and Control of Trellis Display. Becker, Cleveland, and Shyu. JCSG 5:123-155 1996]



Partial Residuals

- fixed dataset, Morris data switched
- explicitly show differences
  - take means into account
  - line is 10% trimmed mean (toss outliers)

[The Visual Design and Control of Trellis Display. Becker, Cleveland, and Shyu. JCSG 5:123-155 1996]



Critique

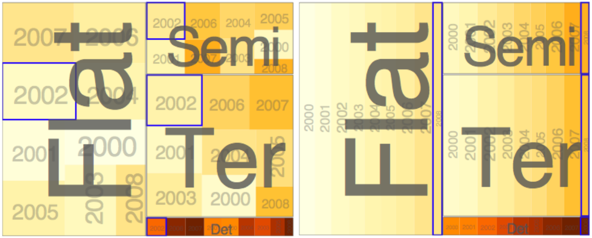
Critique

- careful attention to statistics and perception
- finding signals in noisy data
  - trends, outliers

- exploratory data analysis (EDA)
  - Tukey work fundamental, Cleveland continues

HiVE: Conditioning

- reconfigure conditioning hierarchies to explore data space
- treemaps as spacefilling rectangular layouts
  - each rectangle is conditioned subset of data
  - nested graphical summaries
    - size, shape, color used to show subset properties
    - ordered by conditioning variable
- dimensional stacking:
  - discretization and recursive embedding of dimensions



[Fig 1. Slingsby, Dykes, and Wood. Configuring Hierarchical Layouts to Address Research Questions. IEEE TVCG 15(6), Nov-Dec 2009 (Proc. InfoVis 2009).]

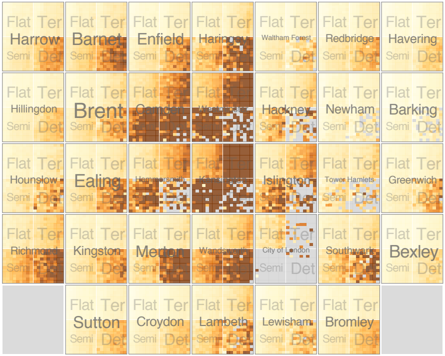
HiVE Example: London Property

- top split: house type. next: neighborhood. next: time
- color: price variance. size: number of sales
- resulting patterns:
  - between neighborhood have different house distributions
  - within neighborhoods have similar prices

[Fig 7a. Slingsby, Dykes, and Wood. Configuring Hierarchical Layouts to Address Research Questions. IEEE TVCG 15(6), Nov-Dec 2009 (Proc. InfoVis 2009).]

HiVE Example: London Property

- top split: neighborhood. next: house type. next: sale time (year). next: sale time (month).
- color: average price. size: fixed.
- resulting pattern: expensive neighborhoods near center



[Fig 2c. Slingsby, Dykes, and Wood. Configuring Hierarchical Layouts to Address Research Questions. IEEE TVCG 15(6), Nov-Dec 2009 (Proc. InfoVis 2009).]

HiVE Video

Critique

- very thoughtful analysis
- prescriptive guidelines
- references backing up arguments

Reading For Next Time

Chapter 7: Item Reduction Methods

A review of overview+detail, zooming, and focus+context interfaces. Andy Cockburn, Amy Karlson, and Benjamin B. Bederson. ACM Computing Surveys 41(1), 2008.