Lecture 7: Multiples/Interaction
Information Visualization
CPSC 533C, Fall 2009
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Readings Covered
Ware, Chap 10: Interacting with Visualizations. first half, p 317-324
Tufts, Chap 4: Small Multiples
Building Highly-Coordinated Visualizations In Improvise. Chris Weaver.
Proc. InfoVis 2004
The Visual Design and Control of Trellis Display. R. A. Becker, W. S.
Cleveland, and M. J. Shyu Journal of Computational and Statistical
Exploring High-D Spaces with Multiform Matrices and Small Multiples.
Alan MacEachren, Xiping Dai, Frank Hardisty, Diansheng Guo, and Gene

Further Readings
Toolsglass and magic lenses: the see-through interface. Eric A. Bier,
Maureen C. Stone, Ken Pier, William Butson, and Tony D. DeRose.
Proc. SIGGRAPH'93, pp. 73-76.
State of the Art: Coordinated & Multiple Views in Exploratory
Multiple Views in Exploratory Visualization (CMV) 2007
The cognitive coprocessor architecture for interactive user interfaces
George Robertson, Stuart K. Card, and Jack D. Mackinlay. Proc. UIST
Eclectic 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
  - two-handed interaction: Guiard’s theory
- coarse vs. fine control e.g. paper vs. pen positioning
- magic lens: see-through tool
  - Toolglass and magic lenses: the see-through interface. Eric A. Bier,
    Maureen C. Stone, Ken Pier, William Butson, and Tony D. DeRose.
    Proc. SIGGRAPH'93, pp. 73-76.

Ware Interaction: Data Manipulation
- low-level control loops
  - 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

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

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]

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

Replace, Replicate, Overlay
- when to do which
  - design tradeoffs
  - must play nicely with other views
  - rendering, preprocessing, responding to commands
- design tradeoffs
  - 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
- divide work into pieces, enqueue
- continue serving queue when control is returned
- always replace: too much reliance on memory
- always replicate: too many windows
- always overlay: too much clutter in single window

Architectural Issues
- architectural issues
  - 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

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

Animated Transitions
- animated transitions vs. jump cuts
- 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

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

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 Butson, and Tony D. DeRose.
    Proc. SIGGRAPH'93, pp. 73-76.

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Multiform Matrices and Small Multiples
- matrices for bivariate exploration (SPLOM and other)
- vs. small multiples for univariate
- per-column variables: type of cancer mortality
- per-row forms: scatterplot, choropleth/thematic map
- left bright green: high income, low cervical cancer
- right dark green: low income, high breast cancer
- hypot: not screened
- hypot: late childbearing


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


Example: Complex Application
- select data decoupled from data
- selection-dependent loading, filtering, projection
- highlighting: user-customizable differentiation of selected vs. unselected items
- video

Critique
- careful attention to statistics and perception
- finding signals in noisy data
- trends, outliers
- exploratory data analysis (EDA)
- Tukey work fundamental, Cleveland continues

Automatic Dotplot Ordering: Trellis
- 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

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, subspaces, conditioning, ...
  - conditioning: filter in/out of given range on another var
  - video

Excentric Labels

- show labels around mouseover region
- demo

Critique

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