

Lecture 6: Statistical Graphics

Information Visualization

CPSC 533C, Fall 2009

Tamara Munzner
UBC Computer Science

Mon, 28 September 2009

Readings Covered

Multi-Scale Banking to 45 Degrees. Jeffrey Heer, Manesh Agrawala. IEEE TVCG 12(9) (Proc. InfoVis 2004). Sep/Oct 2006, pages 703-708.
 Animated Transitions in Statistical Data Graphics. Jeffrey Heer and George C. Robertson. IEEE TVCG (Proc. InfoVis 2007) 13(6): 1240-1247, 2007.
 Scented Widgets: Improving Navigation Cues with Embedded Visualizations. Wesley Willett, Jeffrey Heer, and Manesh Agrawala. IEEE TVCG (Proc. InfoVis 2007) 13(6): 1129-1136.
 Graph-Therapeutic Scagnostics. Leland Wilkinson, Anushka Anand, and Robert Groeman. Proc. InfoVis 05

Additional Readings

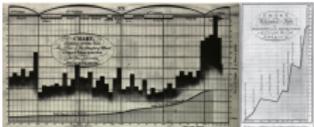
Visual information seeking: Tight coupling of dynamic query filters with starfield displays. Chris Ahlberg and Ben Shneiderman. Proc. SIGCHI '94, pages 313-317
<http://www.math.yorku.ca/SCS/Gallery/miastore/>
 Metric-Based Network Exploration and Multiscale Scatterplot. Yves Chirosta, Fabien Jourdan, Guy Melancon. Proc. InfoVis 04, pages 135-142.
 The Elements of Graphing Data, William S. Cleveland, Hobart Press 1984.

Statistical Graphics

- long history for paper-based views of data
 - springboard for infovis
 - <http://www.math.yorku.ca/SCS/Gallery/miastore/>
- improving line charts
- improving scatterplots
 - interactive dynamic queries
 - multiscale structure
 - matrix of scatterplots, level of indirection
- improving statistical graphics
 - animated transitions between graphics
 - making widgets more information-dense

Line Charts

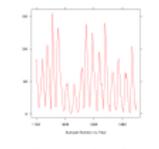
- invented by William Playfair (1759-1823)
- also bar charts, pie charts, ...



http://databank.spsm.ac.uk/Files.php?ID=MS120_1821.png
<http://www.math.yorku.ca/SCS/Gallery/origins/playfair-1821.gif>

Banking to 45 Degrees

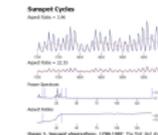
- previous work by Cleveland
- perceptual principle: most accurate angle judgement at 45 degrees
- pick line graph aspect ratio (height/width) accordingly



www.research.att.com/~csdy/teach/visinfo/lineplot.html

Multiscale Banking to 45

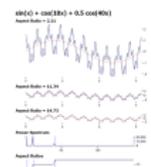
- frequency domain analysis
- find interesting regions at multiple scales



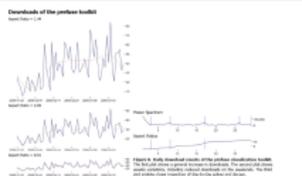
[Multi-Scale Banking to 45 Degrees. Heer and Agrawala, Proc. InfoVis 2006 <http://banking45.info/papers/banking/>]

Choosing Aspect Ratios

- FFT the data, smooth by convolve with Gaussian
- find interesting spikes/ranges in power spectrum
- call nearby regions if too similar, ensure overview shown
- create trend curves for each aspect ratio



Multiscale Banking to 45



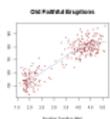
[Multi-Scale Banking to 45 Degrees. Heer and Agrawala, Proc. InfoVis 2006 <http://banking45.info/papers/banking/>]

Critique

- very nice generalization of old idea
- does not require interactivity to reap benefits

Scatterplots

- encode two input variables with spatial position
- show positive/negative/no correlation between variables



<http://upload.wikimedia.org/wikipedia/commons/1/19/Chart2of2d.png>

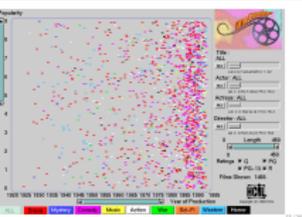
Interactive Scatterplots: Dynamic Queries

- tight coupling: immediate feedback after action
- fast, lightweight visual exploration
- vs. composing SQL query

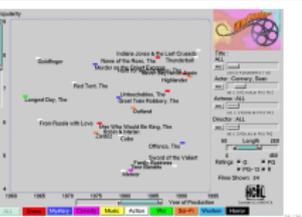


[Visual Information Seeking: Tight Coupling of Dynamic Query Filters with Starfield Displays. Chris Ahlberg and Ben Shneiderman, Proc. SIGCHI '94, p. 313-317] <http://www.cs.wisc.edu/~bshneider/papers/visinf94/>

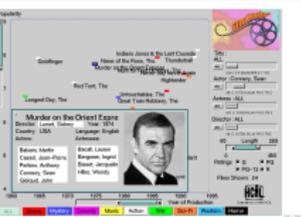
FilmFinder



FilmFinder

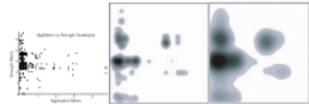


FilmFinder



Multiscale Scatterplots

- blur shows structure at multiple scales
- convolve with Gaussian
- slider to control scale parameter interactively
- easily selectable regions in quantized image



[Metric-Based Network Exploration and Multiscale Scatterplot. Yves Chirosta, Fabien Jourdan, Guy Melancon. Proc. InfoVis 04]

SPLOM: Scatterplot Matrix

- show all pairwise variable combos side by side
- matrix size grows quadratically with variable count

[Graph-Theoretic Scagnostics, Wilkinson, Anand, and Goodson. Proc InfoVis 05.]

27-120

Graph-Theoretic Scagnostics

- reduce problem to constant size
 - overview matrix of 9 geometric metrics
- meta-SPLOM: each point represents scatterplot
 - detail on demand to see individual scatterplots

[Graph-Theoretic Scagnostics, Leland Wilkinson, Anantha Anand, and Robert Goodson. Proc InfoVis 05.]

27-124

Measuring Scatterplots

- aspects and measures
 - outliers: outlying
 - shape: convex, skinny, stringy, straight
 - computed with convex hull, alpha hull, min span tree
- trend: monotonic
- density: skewed, clumpy
- coherence: striated

[Graph-Theoretic Scagnostics, Wilkinson, Anand, and Goodson. Proc InfoVis 05.]

27-125

Measuring Scatterplots

[Graph-Theoretic Scagnostics, Wilkinson, Anand, and Goodson. Proc InfoVis 05.]

27-126

Results

[Graph-Theoretic Scagnostics, Wilkinson, Anand, and Goodson. Proc InfoVis 05.]

27-128

Results

[Graph-Theoretic Scagnostics, Wilkinson, Anand, and Goodson. Proc InfoVis 05.]

27-129

Critique

- powerful and elegant method
 - curse of dimensionality is hard problem
- abstraction level clearly appropriate for experts
 - unsuitable for novices
- presentation problem: color use in paper itself

Animated Transitions

- general and powerful idea
 - transitions, not motion as visual encoding
- benefits
 - attracts attention
 - facilitates object constancy
 - implies causality
 - emotionally engaging
- this paper: statistical graphics
 - design principles
 - controlled experiments

[Animated Transitions in Statistical Data Graphics, Jeffrey Heer and George G. Robertson. IEEE TVCG (Proc. InfoVis 2007) 13(6): 1240-1247, 2007.]

27-130

Transition Taxonomy

- change viewpoint
- change spatial substrate
- filter
- reorder
- change time
- change visual mapping
- change data schema

Congruence Principles

- internal and external representations should match
 - both structure and content
- principles
 - maintain valid data graphics during transitions
 - use consistent mappings (semantic-syntactic)
 - respect semantic correspondences
 - avoid ambiguity

Apprehension Principles

- external representation structure and content should be readily and accurately perceived and comprehended
- principles
 - group similar transitions
 - getals common fate
 - minimize occlusion
 - maximize predictability
 - slow-in, slow-out
 - use simple transitions
 - use staging for complex transitions
 - make transitions as long as needed, but no longer

Staging

[Animated Transitions in Statistical Data Graphics, Jeffrey Heer and George G. Robertson. IEEE TVCG (Proc. InfoVis 2007) 13(6): 1240-1247, 2007.]

27-131

Experiments

- study 1: object location tracking
 - animation always helped
 - staged animation almost always helped
- study 2: value change estimation
 - animation helps in some cases
 - staging not significant help
- preference: staged anim mostly, anim always
- guideline: avoid overly complex multi-staging

Critique

- thorough investigation,
 - goes beyond anecdotal evidence

Scented Widgets

- embedded visualizations for standard UI elements
 - graphically compact/terse
 - information scent cues for navigating info spaces

[Scented Widgets: Inspiring Navigation Cues with Embedded Visualizations, Willem Heer, and Agarwal. IEEE TVCG (Proc InfoVis 2007) 13(6): 1129-1136.]

27-132

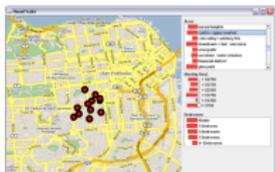
Implemented Scent Types

Table 1. Scent mappings supported by scented widgets

Name	Description	Function
Box	Shows the box of the widget or a visualization embedded into it	 
Selection	Highlights the selected widget or widget set (or visualization embedded into it)	
Opacity	Shows the selected widget or widget set (or visualization embedded into it) with a different opacity	
Text	Shows text or text-based data (e.g., labels) over the widget	
Size	Resizes widget or zooms small areas into the widget	
Box Opacity	Shows text or text-based data (e.g., labels) over the widget with a different opacity	
Line Color	Shows text or text-based data (e.g., labels) over the widget with a different color	

[Scented Widgets: Improving Navigation Cues with Embedded Visualizations. Willett, Heer, and Agrawal. IEEE TVCG (Proc. InfoVis 2007) 13(6):1129-1136.]

Example Application



[Scented Widgets: Improving Navigation Cues with Embedded Visualizations. Willett, Heer, and Agrawal. IEEE TVCG (Proc. InfoVis 2007) 13(6):1129-1136.]

Experiments

- more unique discoveries at first
 - but effect faded over time
- significant preference
- no impairment from clutter

Critique

Critique

- information-dense annotation successful
- good discussion of toolkit issues
- user study solidifies contribution

Reading for Next Time

- Ware, Chapter 10: Interacting with Visualizations: first half, p 317-324
- Tufte, Chapter 4: Small Multiples
- 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.
- 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 (1996). Journal of Computational and Statistical Graphics, 5:123-155.