Lecture 7: Single View Methods

Information Visualization
CPSC 533C, Fall 2011

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Required Readings

Chapter 5: Single View Methods

Trellis paper moved to Multiple Views on Monday

Further Reading

Milestones in the History of Thematic Cartography, Statistical Graphics, and Data Visualization. Friendly and Denis. http://www.math.yorku.ca/SCS/Gallery/milestone/

Bars and Lines: A Study of Graphic Communication. Zacks and Tversky. Memory and Cognition 27(6):1073-1079, 1999.

Multi-Scale Banking to 45 Degrees. Heer and Agrawala. IEEE TVCG 12(5) (Proc. InfoVis 2006), Sep/Oct 2006, pages 701-708.

Overview Use in Multiple Visual Information Resolution Interfaces. Lam, Munzner, and Kincaid. Proc. InfoVis 2007.

VisDB: Database Exploration using Multidimensional Visualization. Keim and Kriegel. IEEE CG&A, 1994

Principles, Methods, and Techniques...

- part 1: principles (3 chapters)
  - **why** underlying many design decisions
  - data, visual encoding, interaction
- part 2: methods (4 chapters)
  - **what** are the axes of the (current) design space
  - taxonomy of design considerations
    - how many views? single, multiple
    - how to reduce what's shown? data, dimensions
- part 3: techniques (3 lectures [$\sim$4 chapters...])
  - analyze techniques by **which** methods/principles used
  - tables, graphs, (text/logs), spatial
  - grouped by data type to follow nested model
    - technique level design happens after data type chosen at abstraction level

... and Practice

- part 4: practice (2 lectures)
  - problem identification and task abstraction
  - validation at problem, abstraction, technique levels
  - research process/papers

Experiment

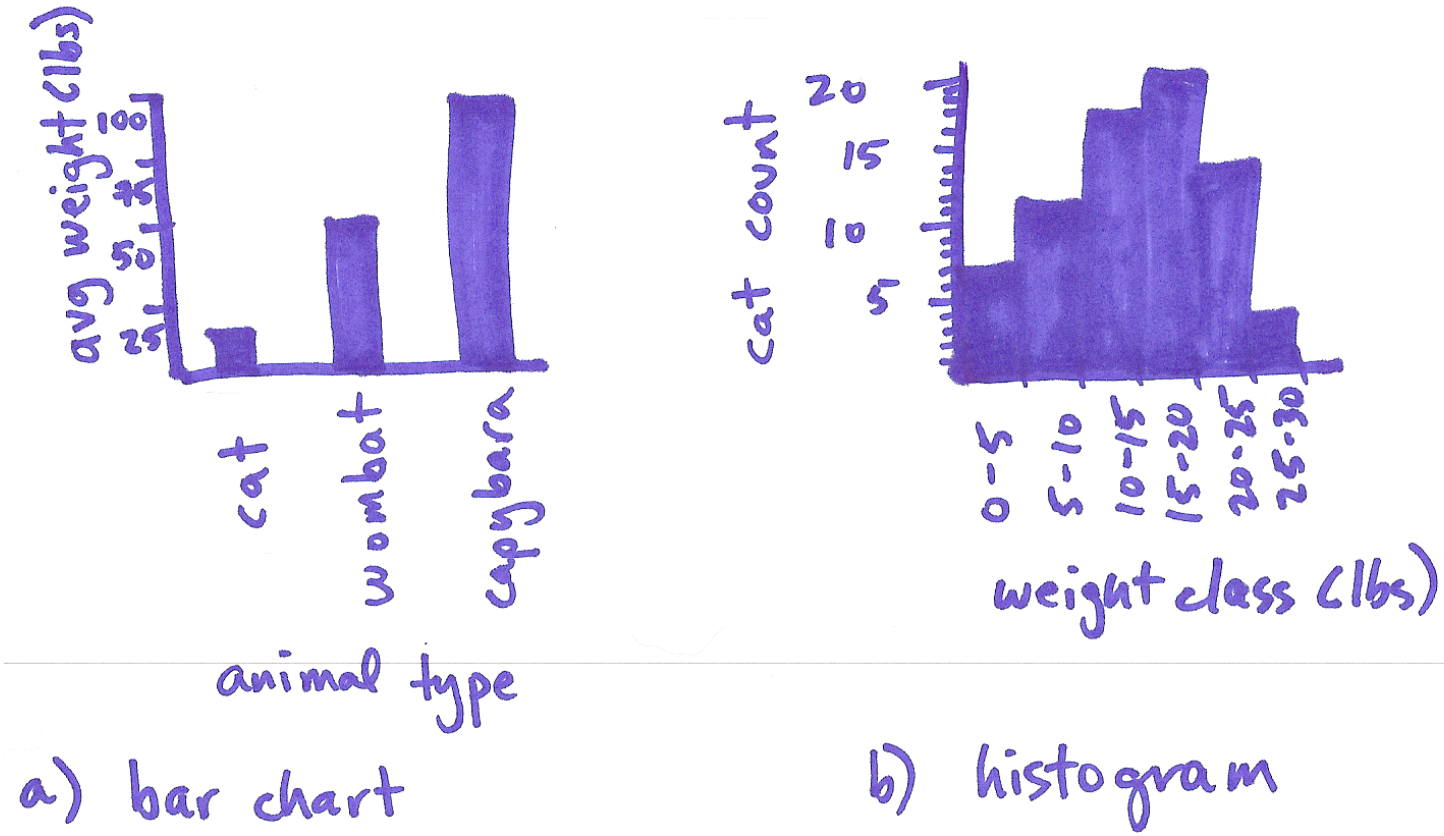
- which lecture style works best?
- summarize chapters thoroughly
  - last several lectures
  - if book doing its job, maybe other choices viable!
- summarize lightly
  - also bring up other ideas/approaches
  - more time for discussion
  - trying this today
- end of class: get feedback from you

Single View Methods

- all information integrated in one view
- basic visual encodings
  - spatial position
  - color
  - other channels
  - pixel-oriented techniques
- visual layering
  - global compositing
  - item-level stacking
- glyphs

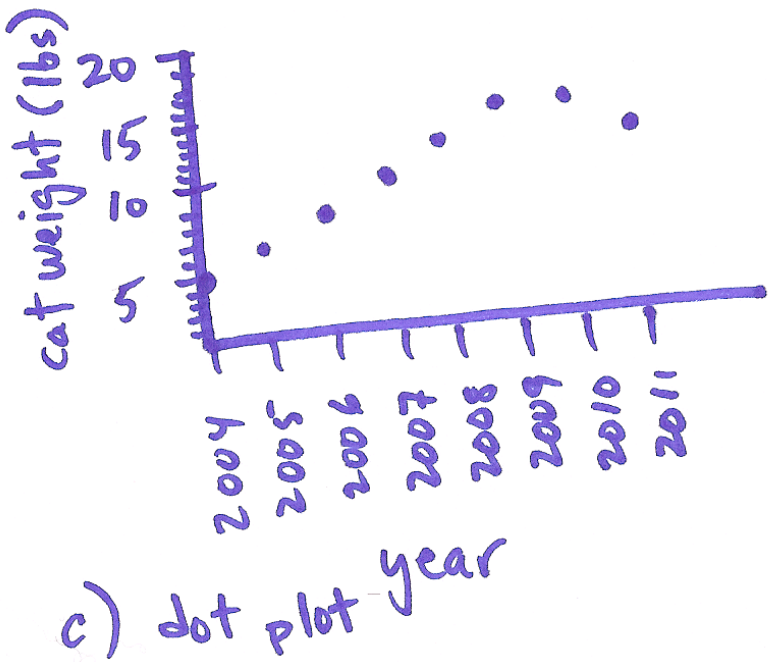
Spatial Position

- most statistical graphics
  - bar chart, histogram

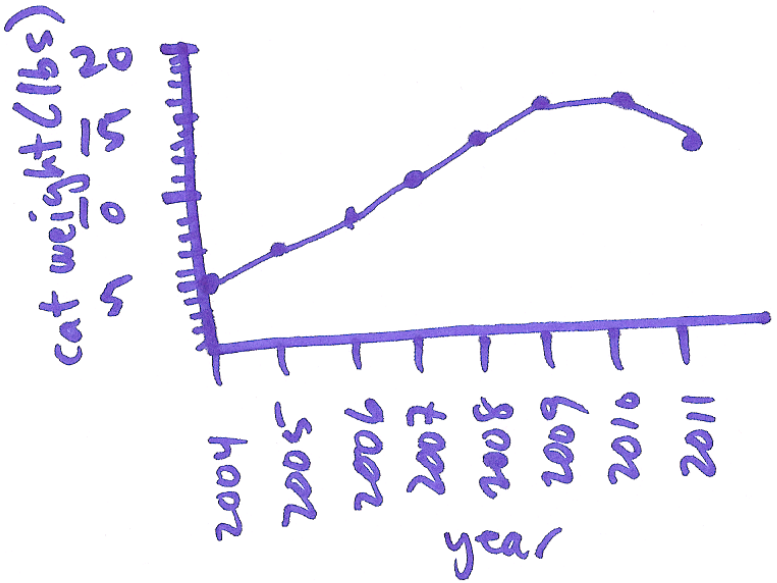


Spatial Position

- most statistical graphics
  - bar chart, histogram, dot plot, line chart



c) dot plot



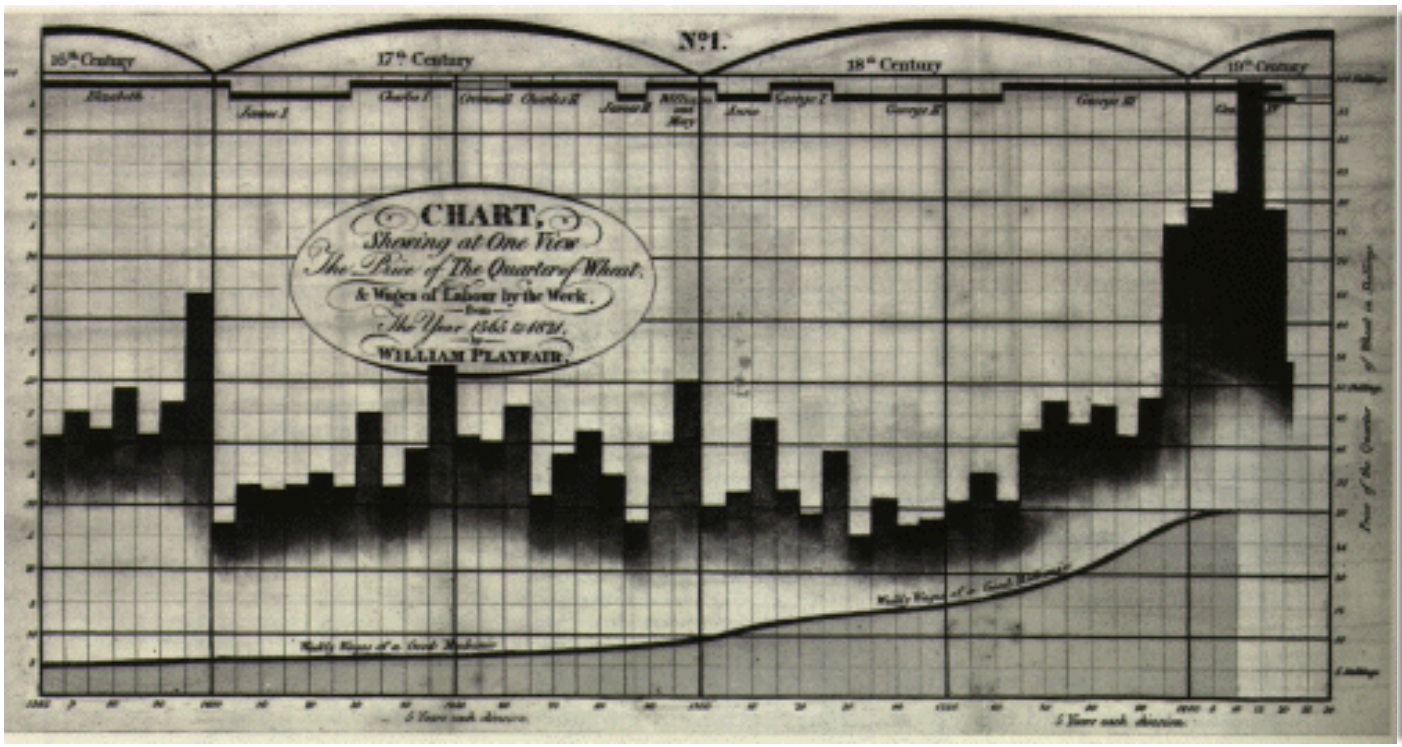
d) line chart

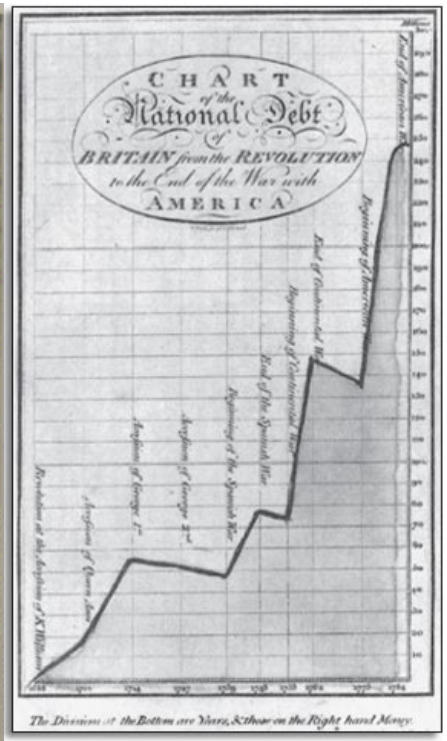
Statistical Graphics

- heavy focus on spatial position for visual encoding
- long history for paper-based views of data
  - springboard for infovis
    http://www.datavis.ca/milestones/
- many ways to make interactive (more later)
- many ways to refine/improve/combine

Line Charts

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

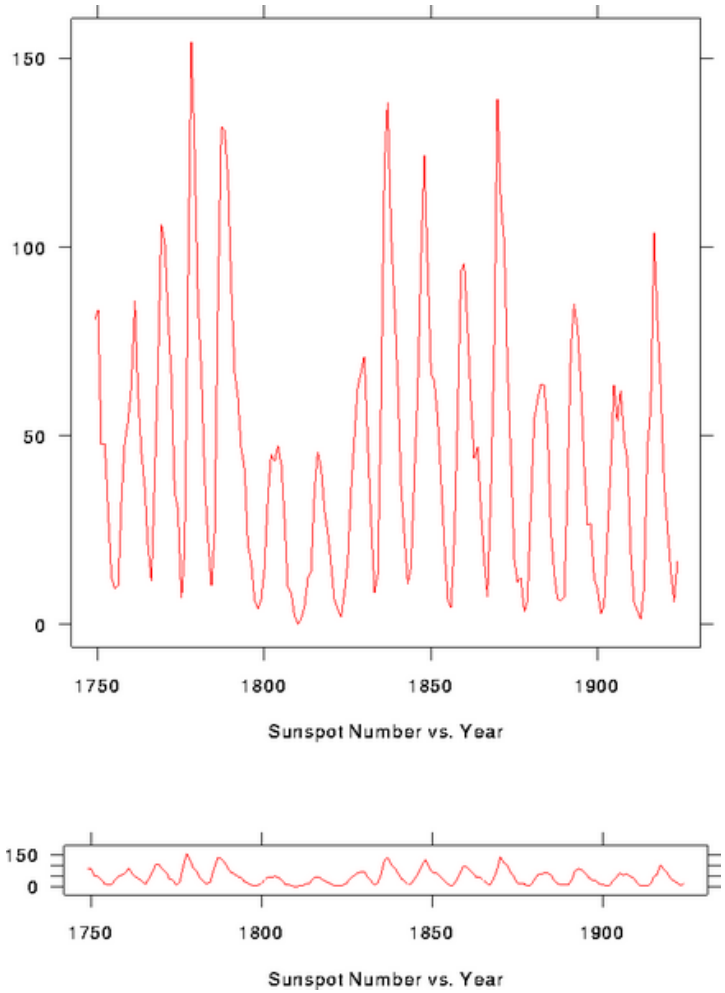




http://labspace.open.ac.uk/file.php/1872/Mu120_3_021i.jpg
http://www.math.yorku.ca/SCS/Gallery/images/playfair-wheat1.gif

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/∼rab/trellis/sunspot.html]

Multiscale Banking to 45

- frequency domain analysis
- find interesting regions at multiple scales

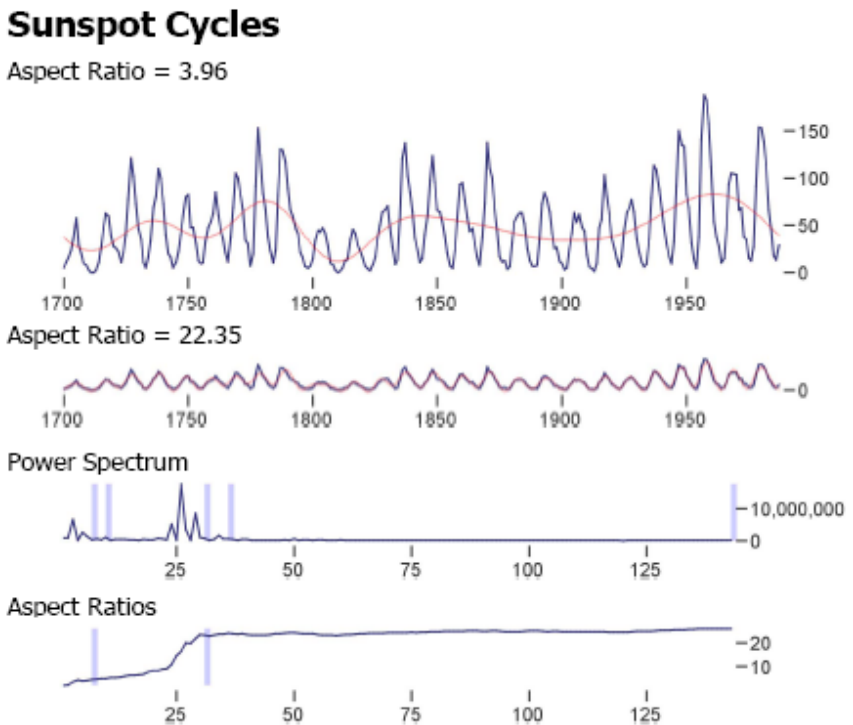
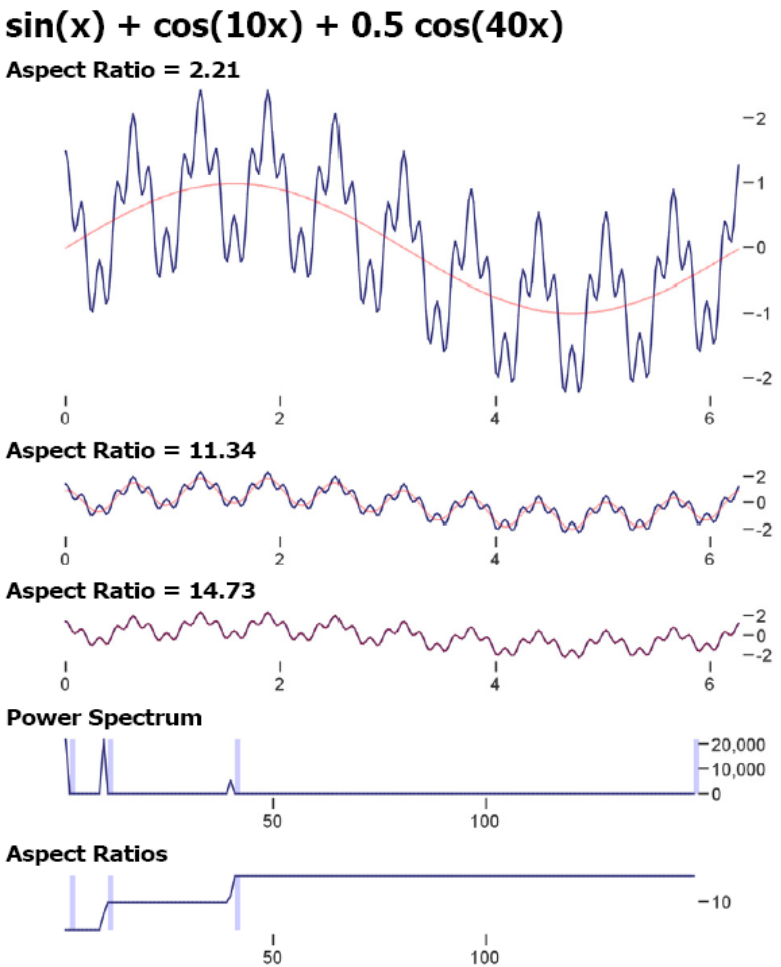


Figure 5. Sunspot observations, 1700-1987. The first plot shows low-frequency oscillations in the maximum values of sunspot cycles. The second plot brings the individual cycles into greater relief.

[Multi-Scale Banking to 45 Degrees. Heer and Agrawala, Proc InfoVis 2006 vis.berkeley.edu/papers/banking]

Choosing Aspect Ratios

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



Multiscale Banking to 45

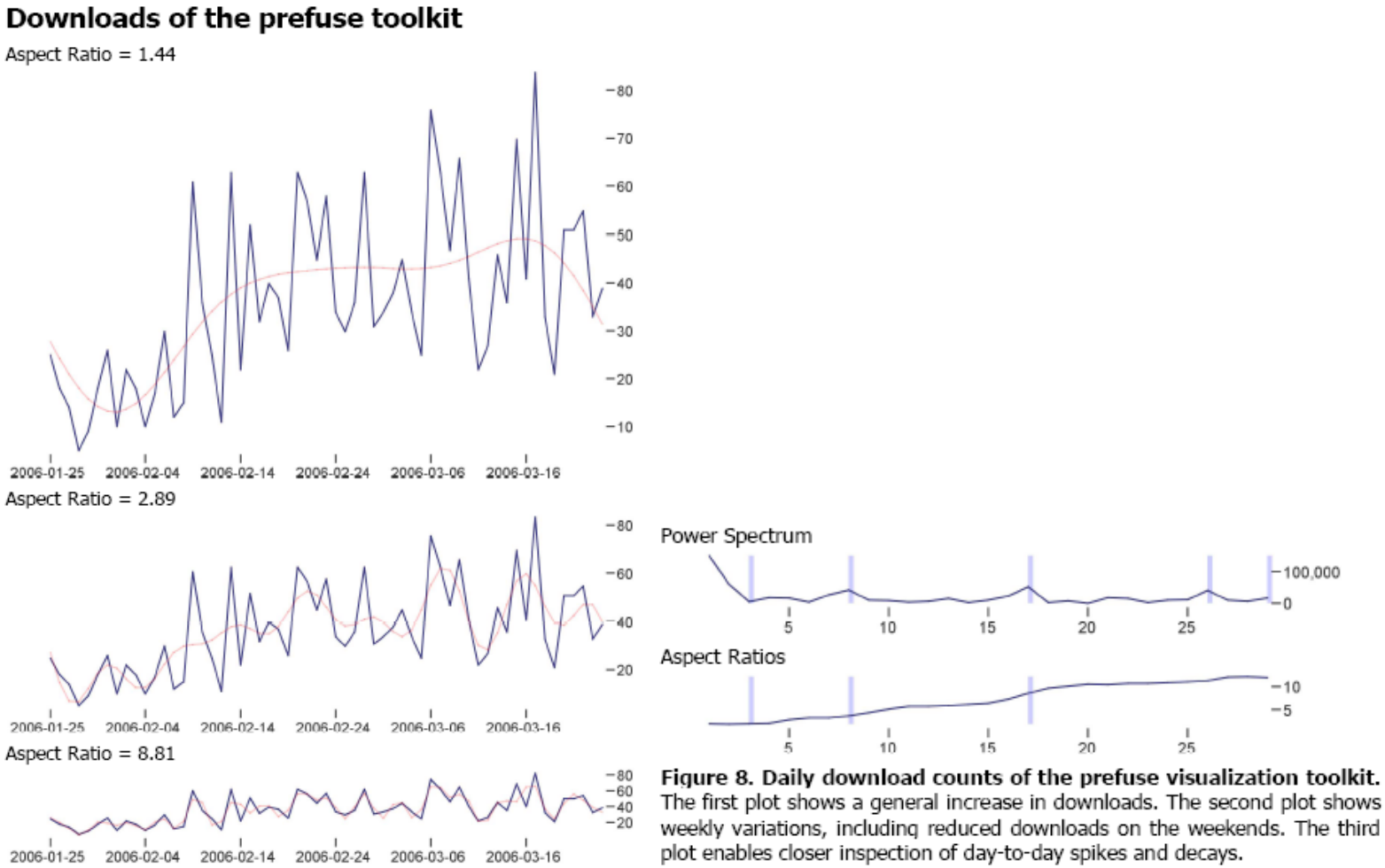
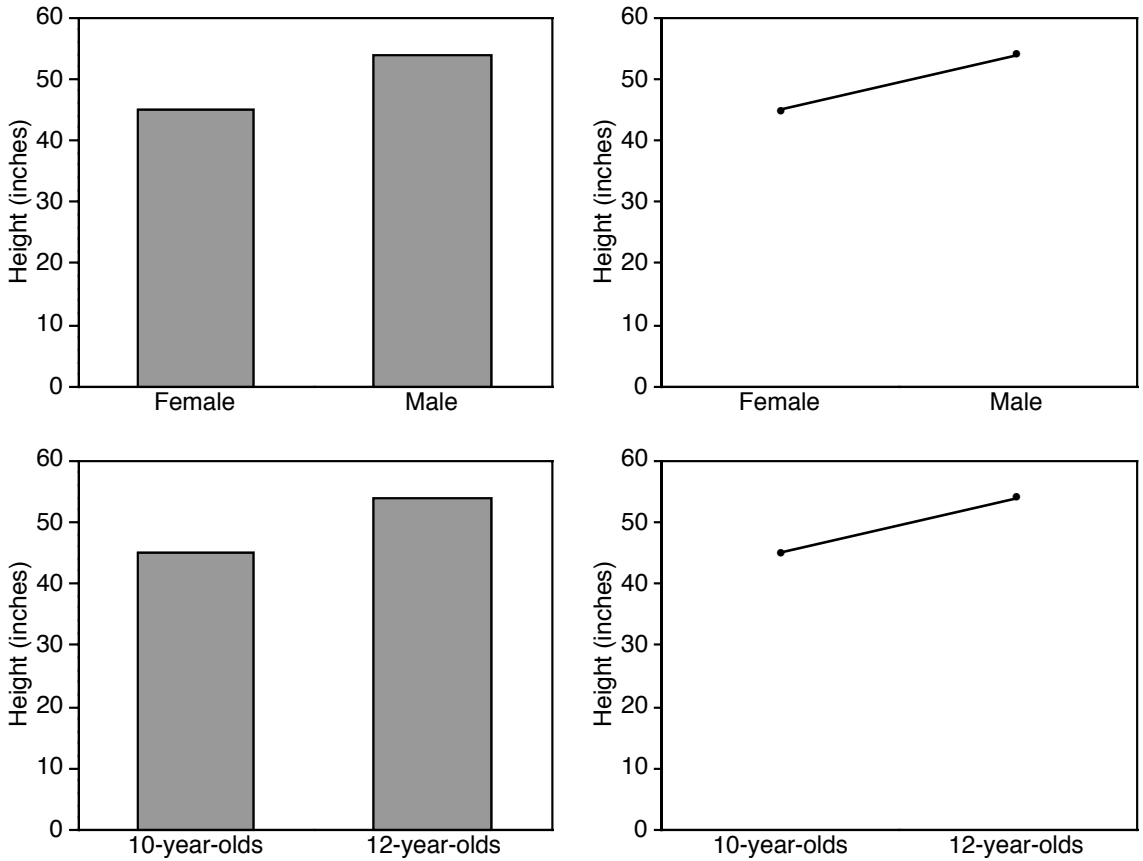


Figure 8. Daily download counts of the prefuse visualization toolkit. The first plot shows a general increase in downloads. The second plot shows weekly variations, including reduced downloads on the weekends. The third plot enables closer inspection of day-to-day spikes and decays.

[Multi-Scale Banking to 45 Degrees. Heer and Agrawala, Proc InfoVis 2006 vis.berkeley.edu/papers/banking]

Bar vs Line Charts

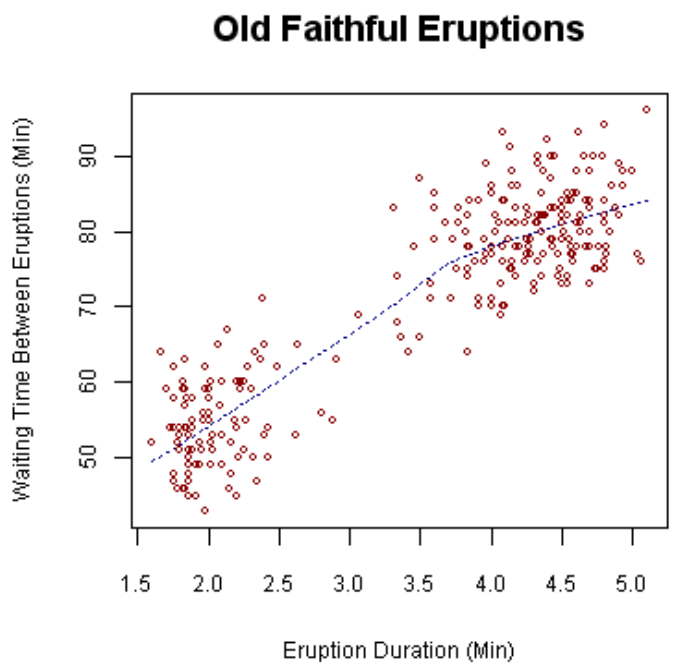
- line implies trend, do not use for categorical data



[Fig 2. Zacks and Tversky. Bars and Lines: A Study of Graphic Communication. Memory and Cognition 27(6):1073-1079, 1999.]

Scatterplots

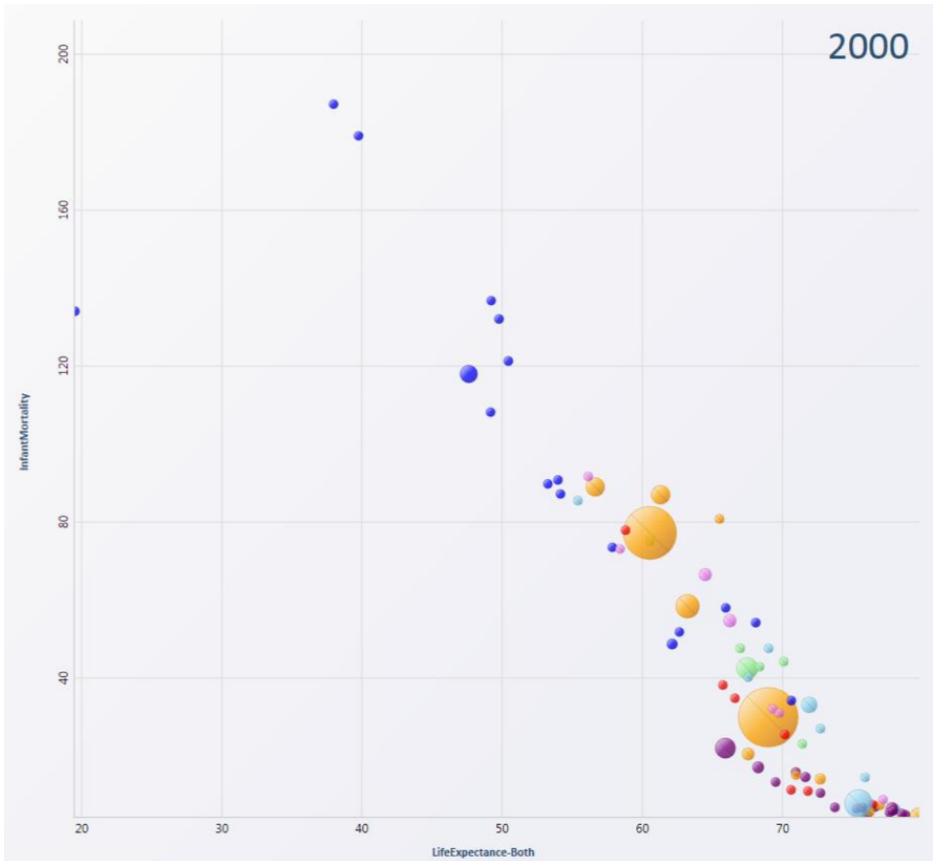
- encode two input variables with spatial position
  - show positive/negative/no correllation between variables
  - show clusters: clumpiness/density, shape, overlap



[http://upload.wikimedia.org/wikipedia/commons/0/0f/Oldfaithful3.png]

Scatterplots

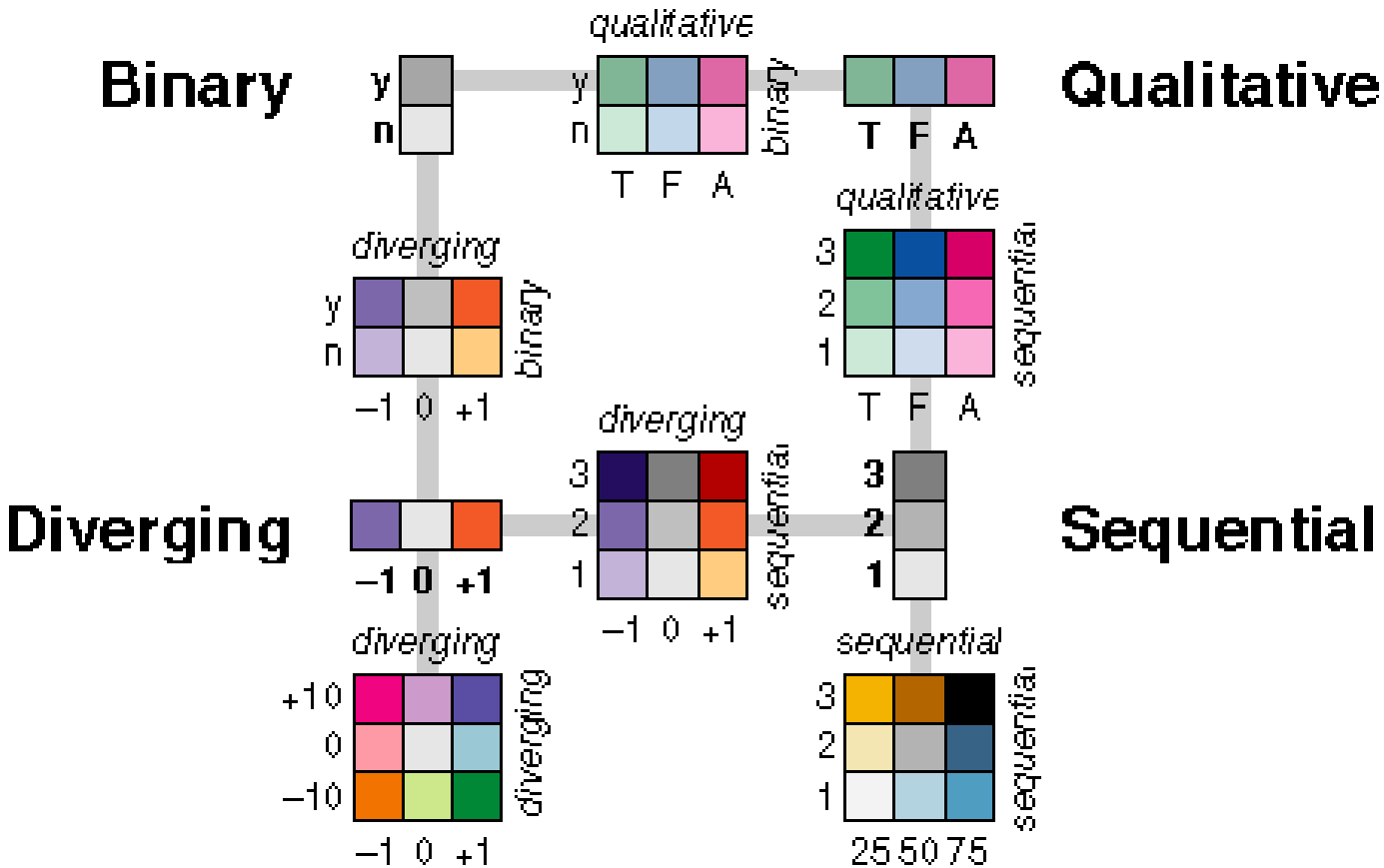
- or compare correlation/clusters for two position attributes against more attributes encoded with color/shape



[Fig 1c. Robertson et al. Effectiveness of Animation in Trend Visualization. IEEE Trans. on Visualization and Computer Graphics 14(6):1324-1332 (Proc. InfoVis08), 2008.]

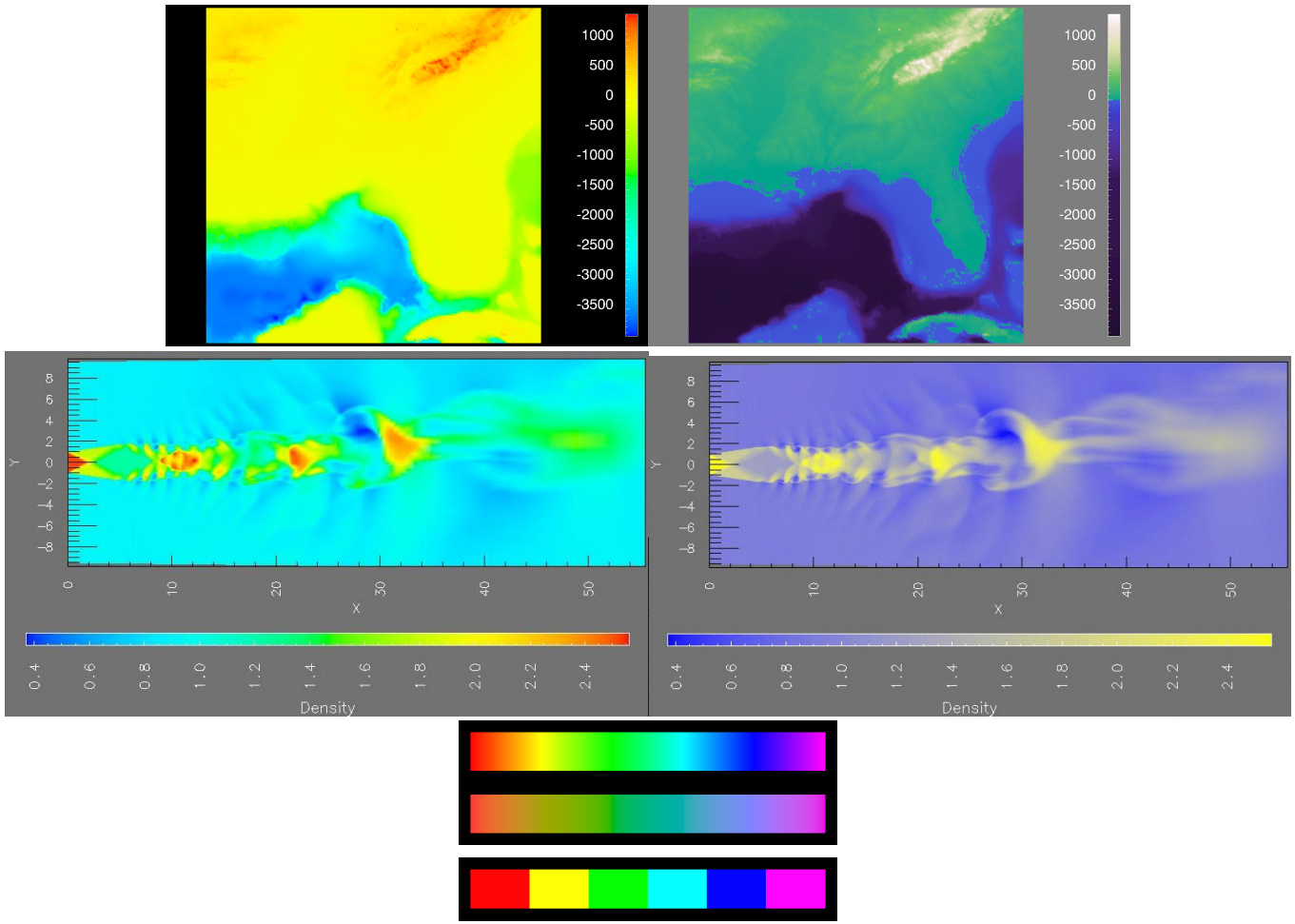
Colormap Taxonomy

- http://www.colorbrewer.org



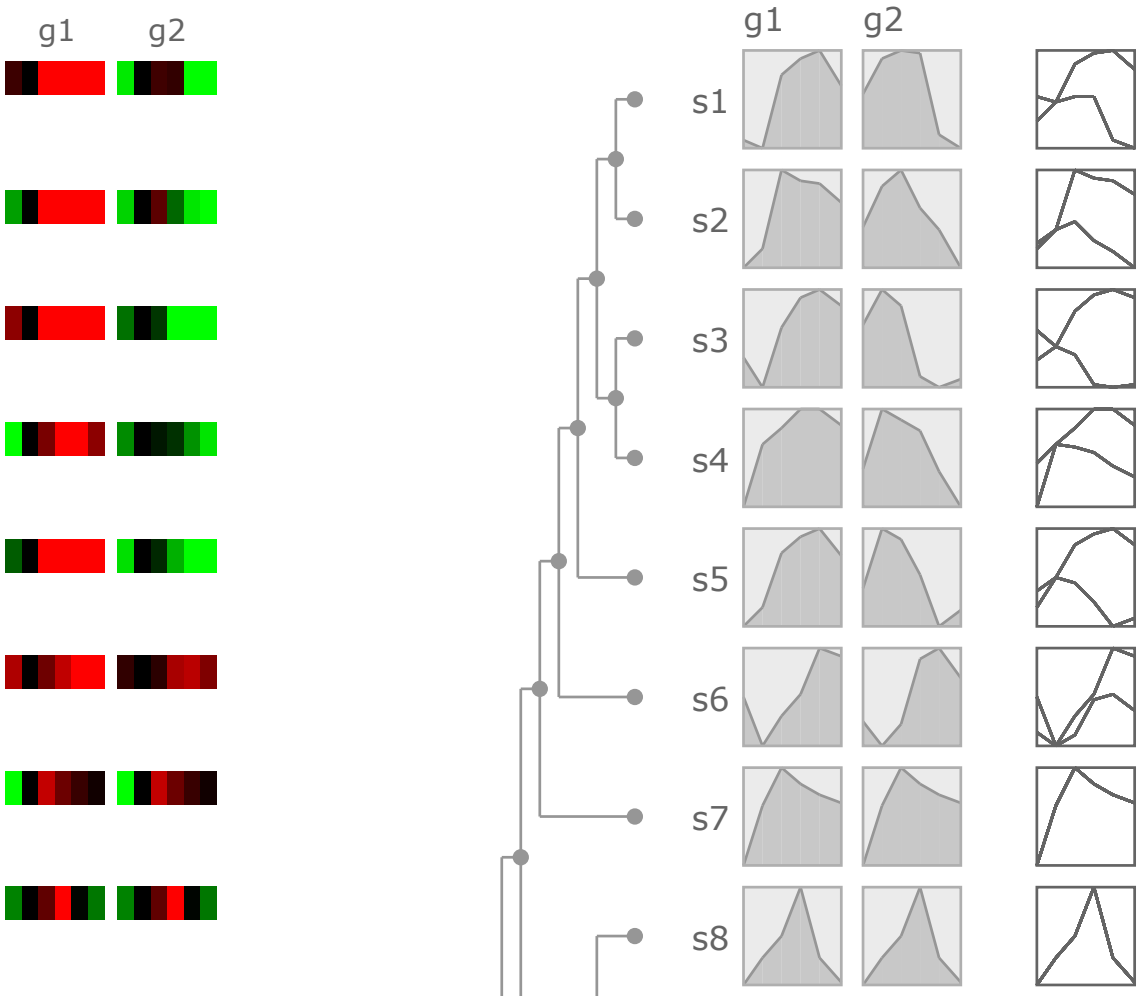
[Brewer, www.personal.psu.edu/faculty/c/a/cab38/ColorSch/Schemes.html]

Rainbows: The Good, The Bad, The Ugly



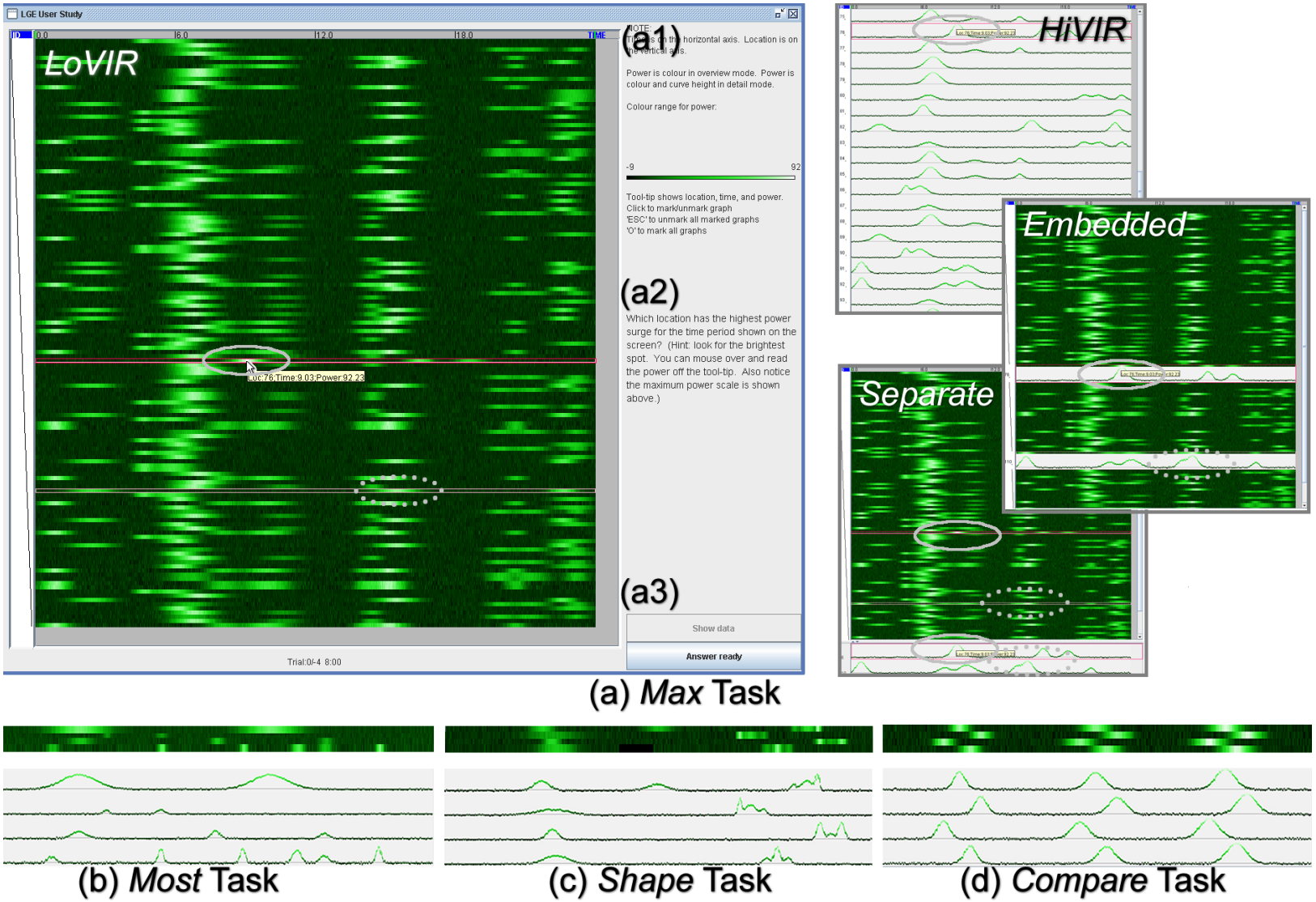
[Fig 1. Rogowitz and Treinish. Data visualization: the end of the rainbow. IEEE Spectrum 35(12):52-59 1998.] [Fig 2,1. Bergman and Rogowitz and Treinish. A Rule-based Tool for Assisting Colormap Selection. Proc. IEEE Vis 1995, p 118-125.] [Kindlmann. http://www.cs.utah.edu/ gk/lumFace]

Accuracy/InfoDensity Tradeoff: Position/Color



[Fig 4b,4a. Meyer et al. Pathline: A Tool for Comparative Functional Genomics. Proc. EuroVis 10, p 1043-1052.]

Tradeoff: Empirical Study

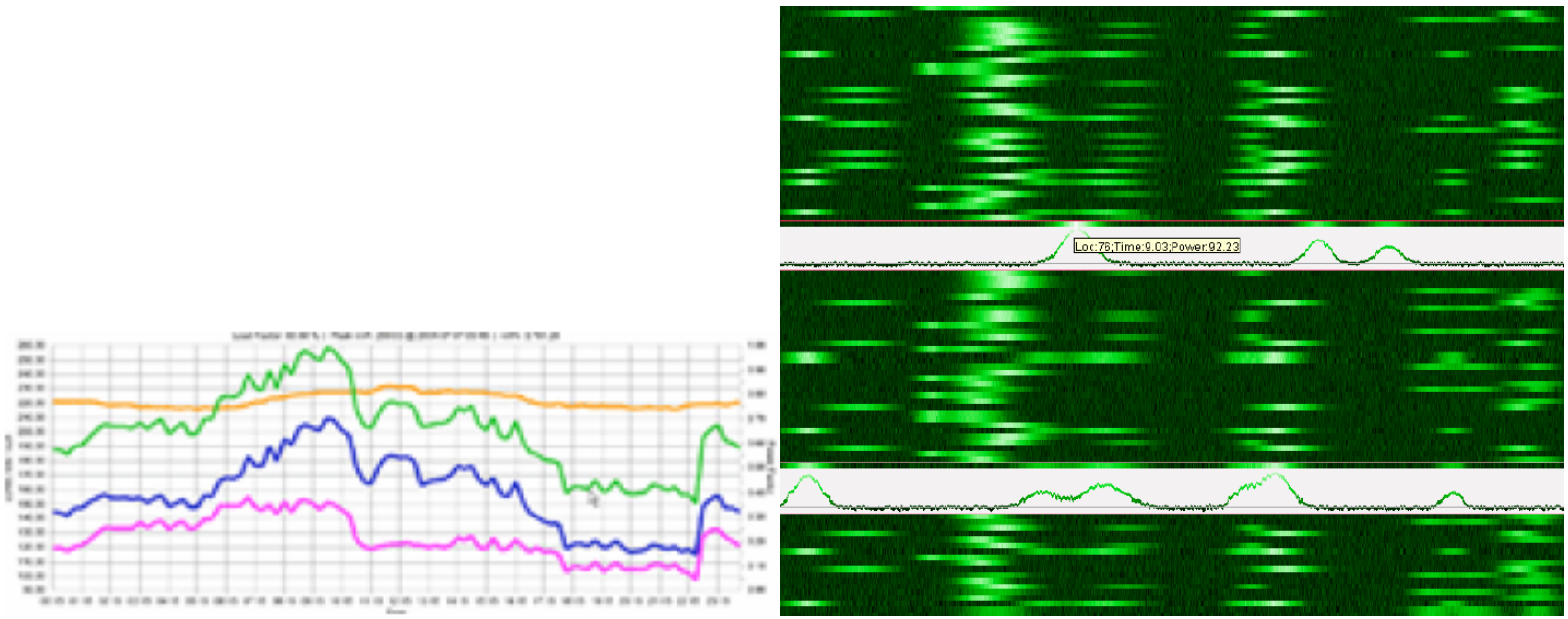


[Fig 1. Lam, Munzner, and Kincaid. Overview Use in Multiple Visual Information Resolution Interfaces. Proc. InfoVis 2007]

Study: Control Room Scenario

Which location has the highest power surge for the given time period? (find extreme value, y-dimension)

A fault occurred at the beginning of this recording, and resulted in a temporary power surge. Which location is affected the earliest? (find extreme value, x-dimension)



[Lam, Munzner, and Kincaid. Overview Use in Multiple Visual Information Resolution Interfaces. Proc. InfoVis 2007]

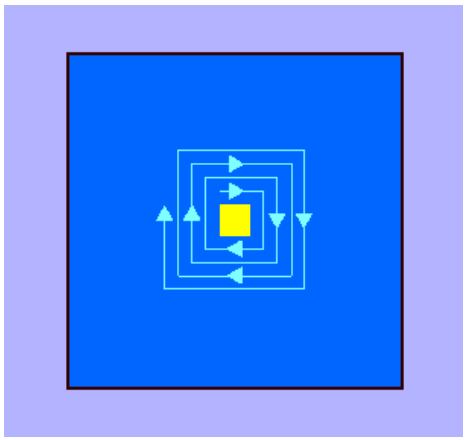
Study: Findings

- tasks
  - Max: simple, local, no comparison
  - Most: complex, dispersed, no comparison
  - Shape: complex, local, comparison
  - Compare: simple, local, comparison
- results
  - low-res / high-density used:
    - simple/local targets
  - (other findings about focus+context vs overview/detail)
- see also horizon graphs study

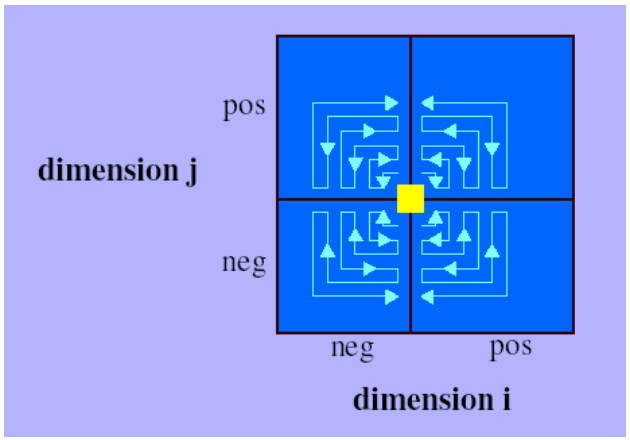
Pixel-Oriented Methods: VisDB

- how to draw pixels?
  - sort, color by relevance
- local ordering

spiral



2D

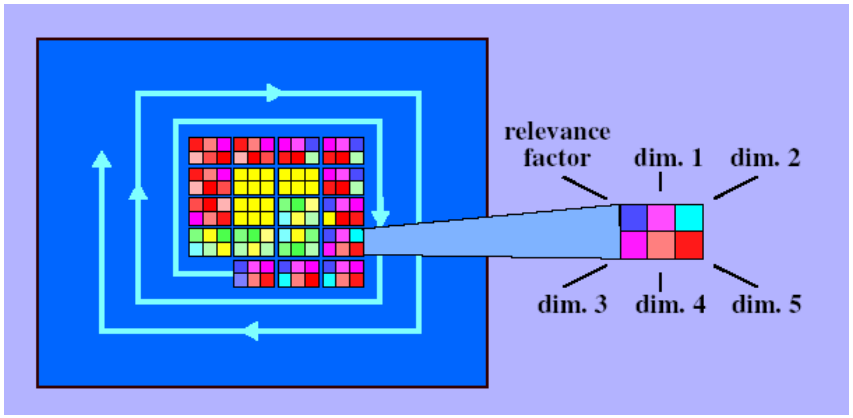


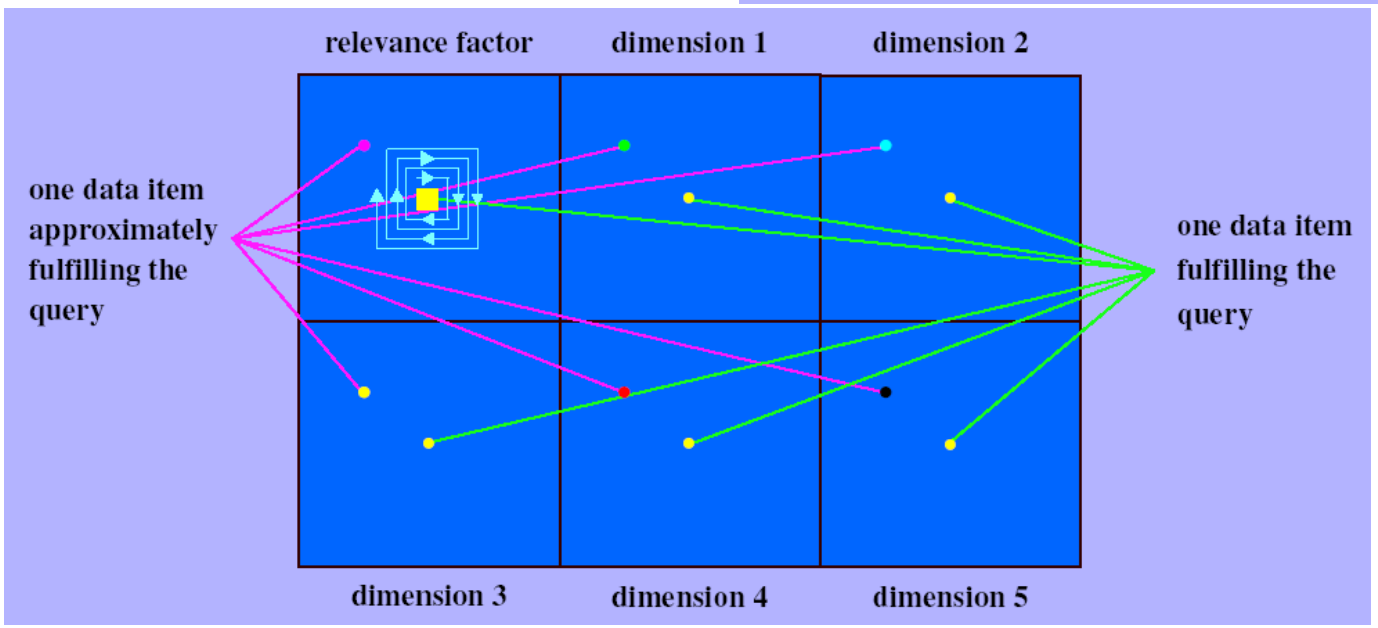
[VisDB: Database Exploration using Multidimensional Visualization, Keim and Kriegel, IEEE CG&A, 1994]

VisDB Windows

grouped dimensions

separate dimensions

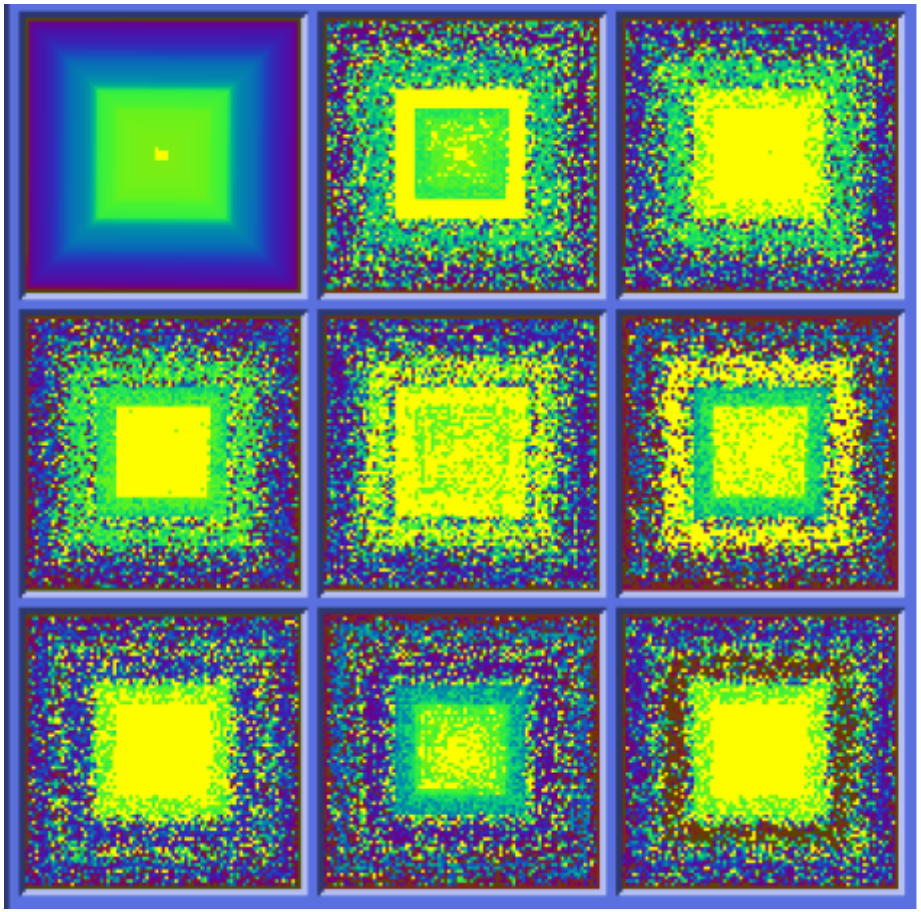




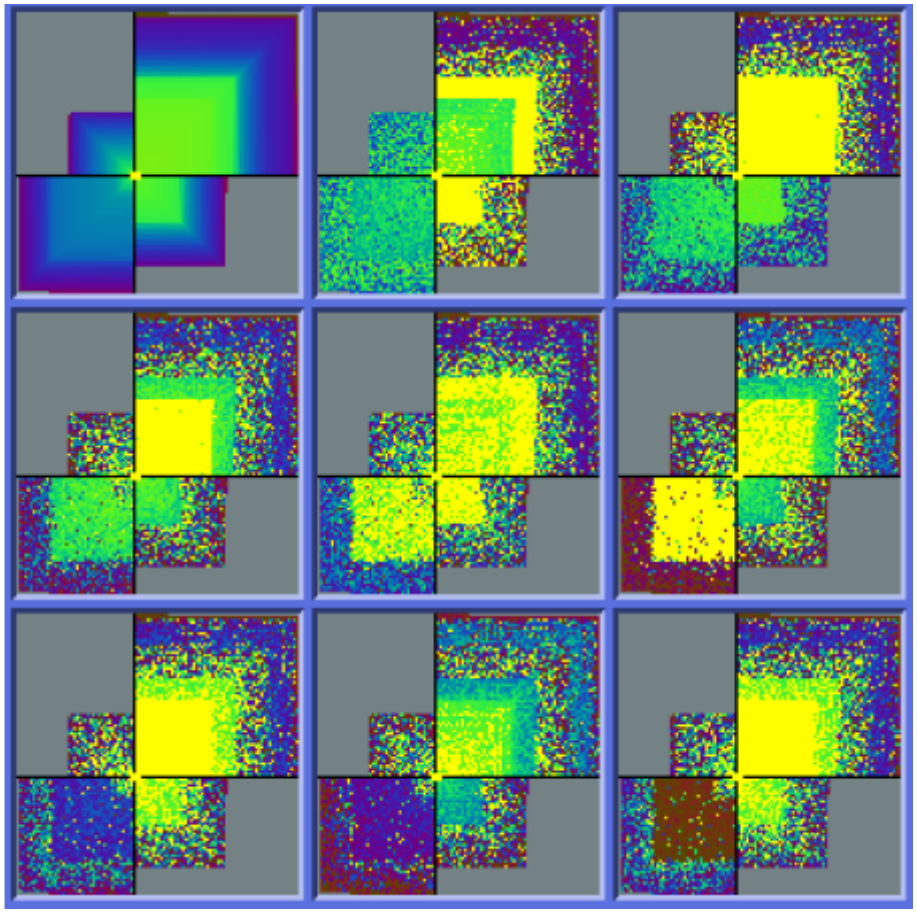
[VisDB: Database Exploration using Multidimensional Visualization, Keim and Kriegel, IEEE CG&A, 1994]

VisDB Results: Separate Dimensions

spiral

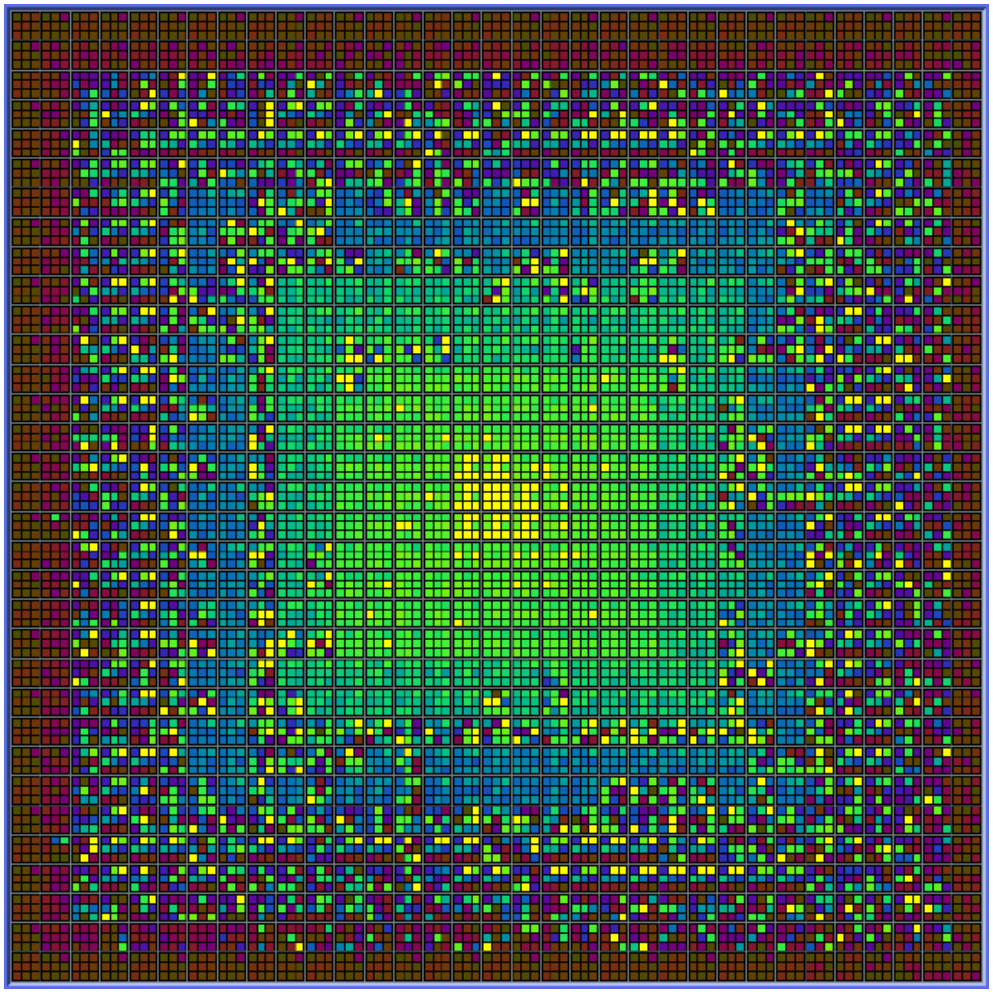


2D



[VisDB: Database Exploration using Multidimensional Visualization, Keim and Kriegel, IEEE CG&A, 1994]

VisDB Results: Grouped Dimensions



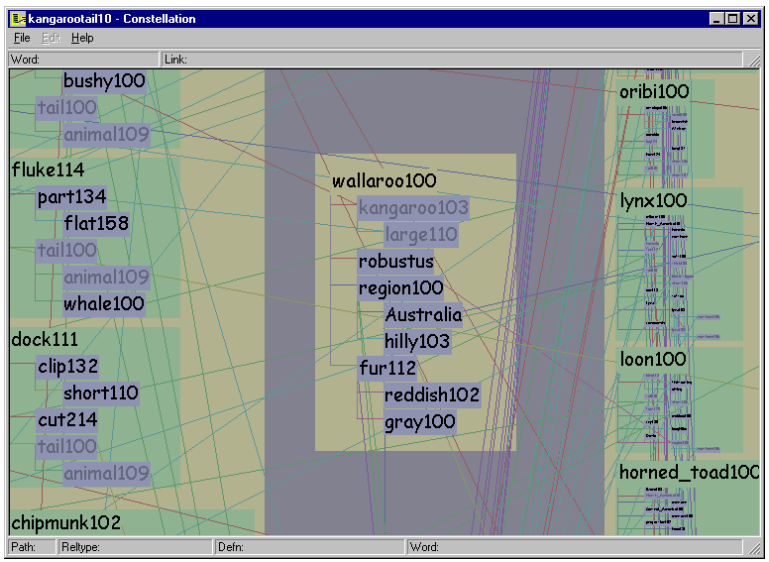
[VisDB: Database Exploration using Multidimensional Visualization, Keim and Kriegel, IEEE CG&A, 1994]

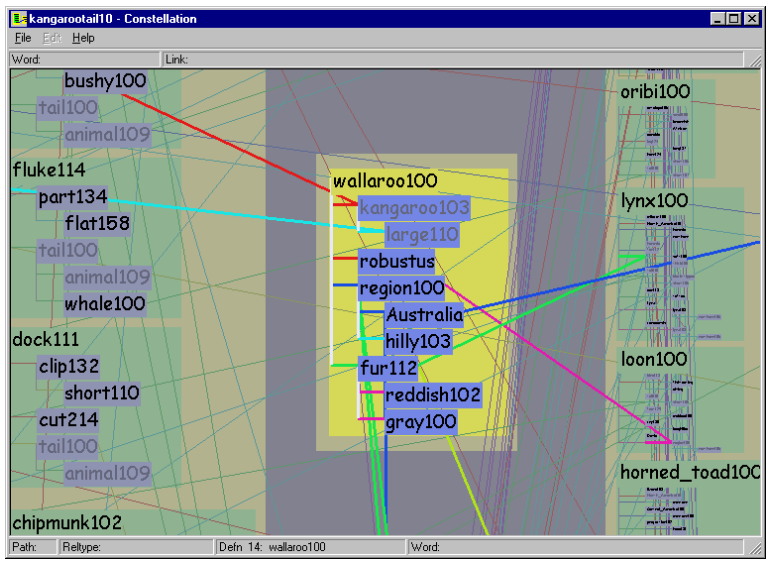
Visual Layering

- beyond simple use of visual channels
- method variants
  - global compositing: everything superimposed
  - item-level stacking
- major consideration
  - static layers: disjoint ranges in channels safest
  - dynamic/interactive layers: more freedom

Visual Layering: Constellation

- global compositing, dynamic layers
- video

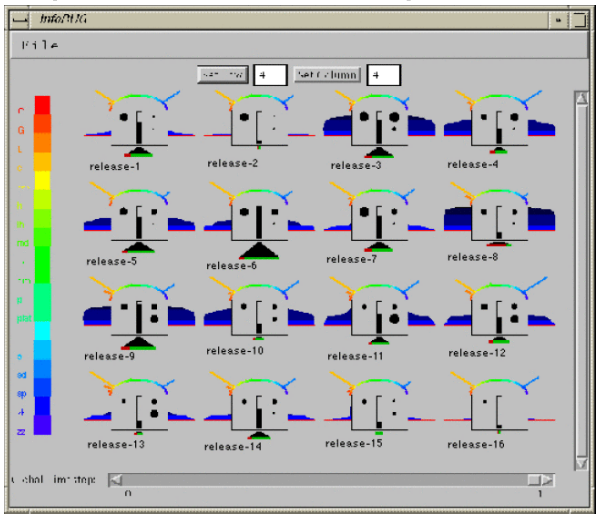


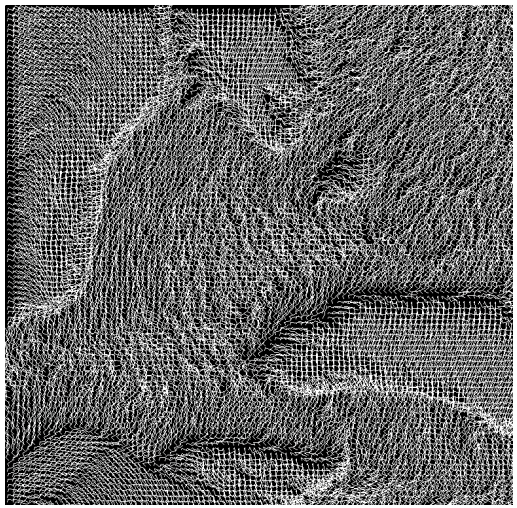


[Munzner. Constellation: Linguistic Semantic Networks. Interactive Visualization of Large Graphs and Networks (PhD thesis) Chapter 5, Stanford University, 2000, pp 87-122. http://graphics.stanford.edu/papers/munzner_thesis]

Glyphs

- compound marks
- macro (small picture) vs micro (texture)





- channel questions
  - separability
  - effectiveness principle: importance matching

[Fig 9. Information Rich Glyphs for Software Management, IEEE CG&A 18:4 1998]
[Fig 2. Smith and Grinstein and Bergeron. Interactive data exploration with a supercomputer. Proc. IEEE Visualization (Vis) 1991, p. 248-254]

Questions/Discussion

Experiment: Feedback

- which lecture style works best?
- summarize chapters thoroughly
  - last several lectures
  - if book doing its job, maybe other choices viable!
- summarize lightly
  - more time for other/further ideas/approaches
  - more time for discussion
  - trying this today
- your preferences?

Reading For Next Time

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.