# Lecture 6: Space/Order

## Information Visualization
## CPSC 533C, Fall 2006

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UBC Computer Science

28 September 2006

# Readings Covered

The Visual Design and Control of Trellis Display R. A. Becker, W. S. Cleveland, and M. J. Shyu Journal of Computational and Statistical Graphics, 5:123-155. (1996). http://cm.bell-labs.com/stat/doc/trellis.jcgs.col.ps

Envisioning Information. Edward Tufte. Graphics Press, 1990. Chapter 4: Small Multiples, Chapter 6: Narratives of Space and Time

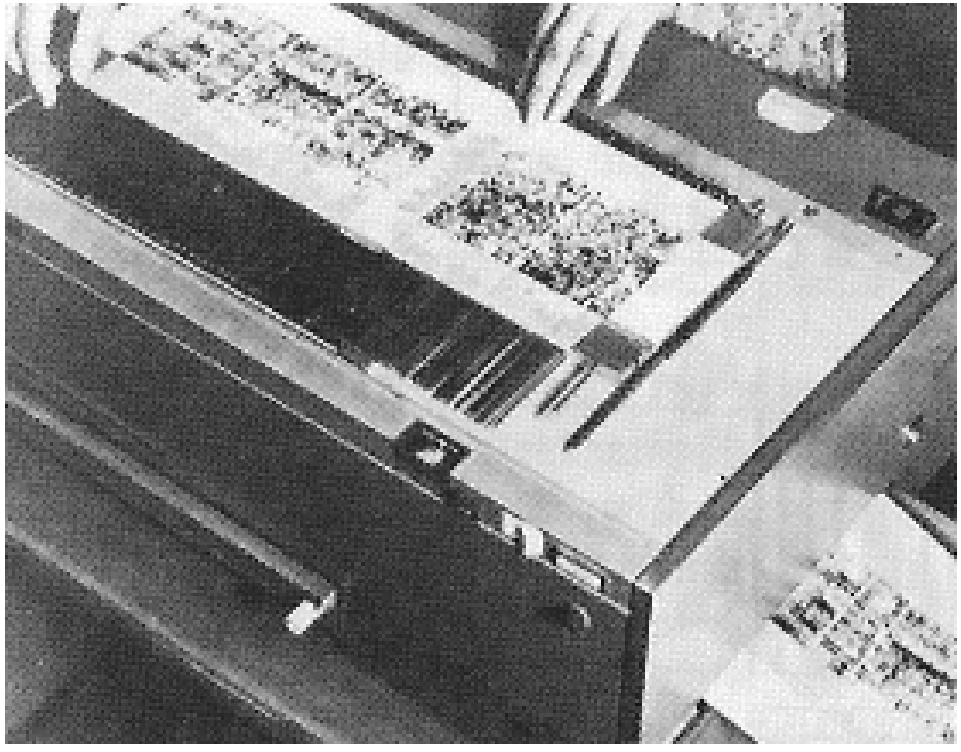
VisDB: Database Exploration using Multidimensional Visualization, Daniel A. Keim and Hans-Peter Kriegel, IEEE CG&A, 1994 http://www.dbs.informatik.uni-muenchen.de/dbs/projekt/papers/visdb.ps

# Space and Order

- Trellis
  - find order automatically: main-effects
  - dot plots, matrices of small multiples
- VisDB
  - choice of spacefilling pixel pattern
- small multiples
  - side by side better than comparing to memory
- narratives of space and time
  - using spatial position to encode temporal data
  - derived spaces

# Manual Ordering: Bertin

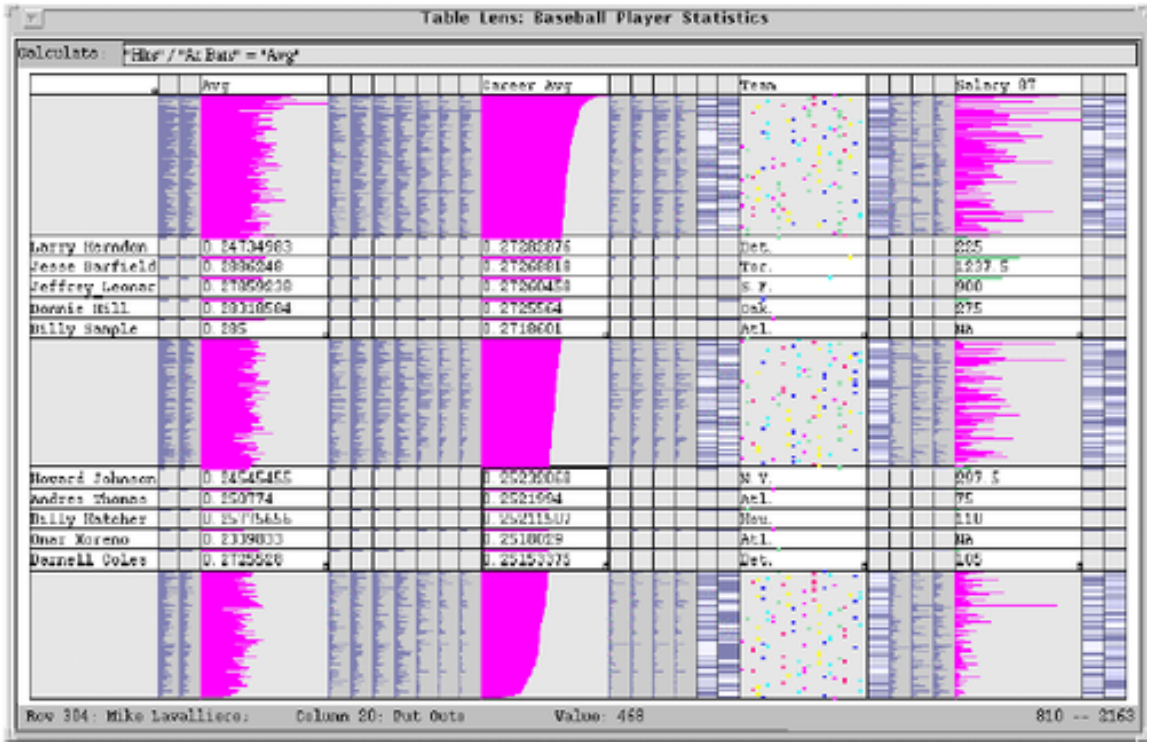
- reorderable matrices - manually!



[Bertin, Graphics and Graphic Information Processing, p 34]

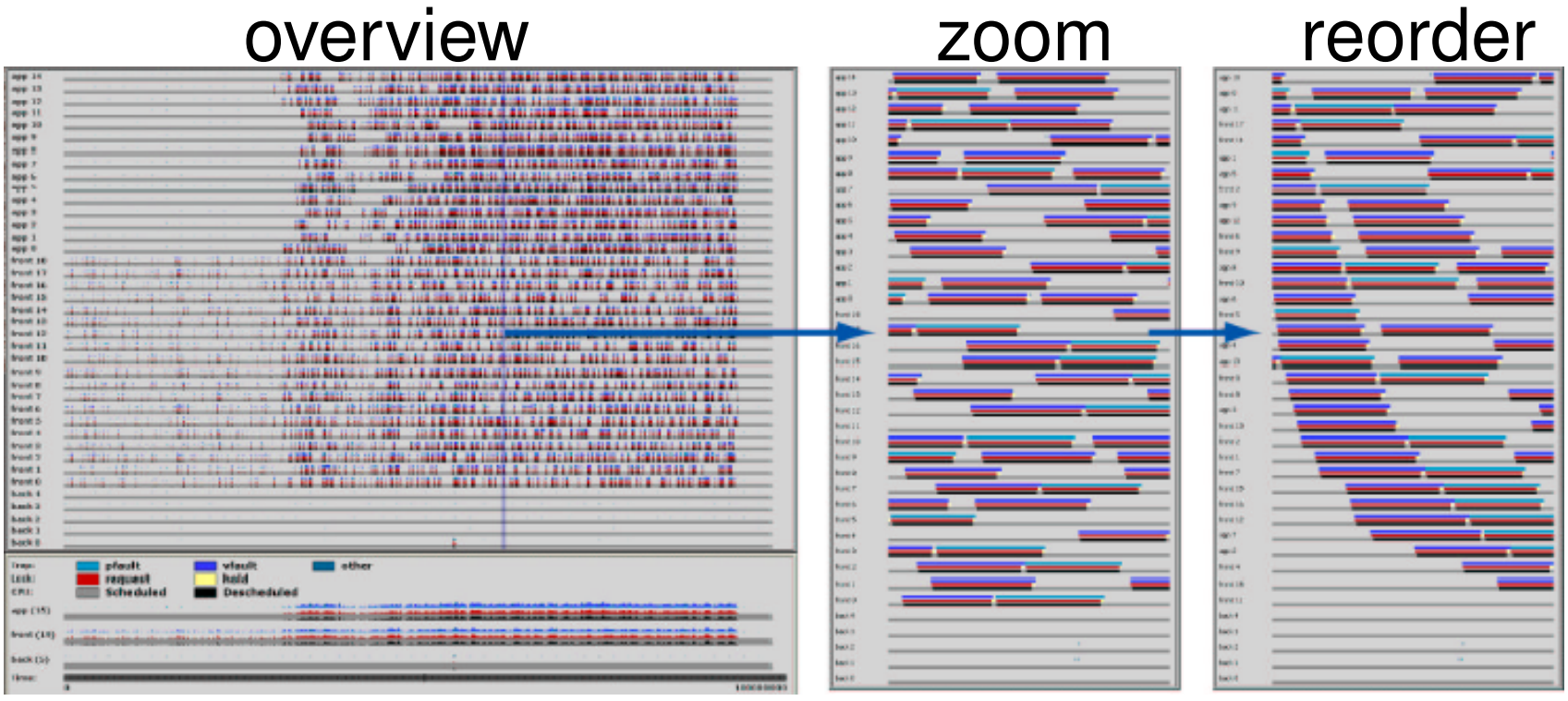
# Interactive Ordering: Table Lens

- click to sort by columns
- also, is focus+context approach
- demo: www.inxight.com/products/sdks/tl



# Interactive Ordering: Rivet

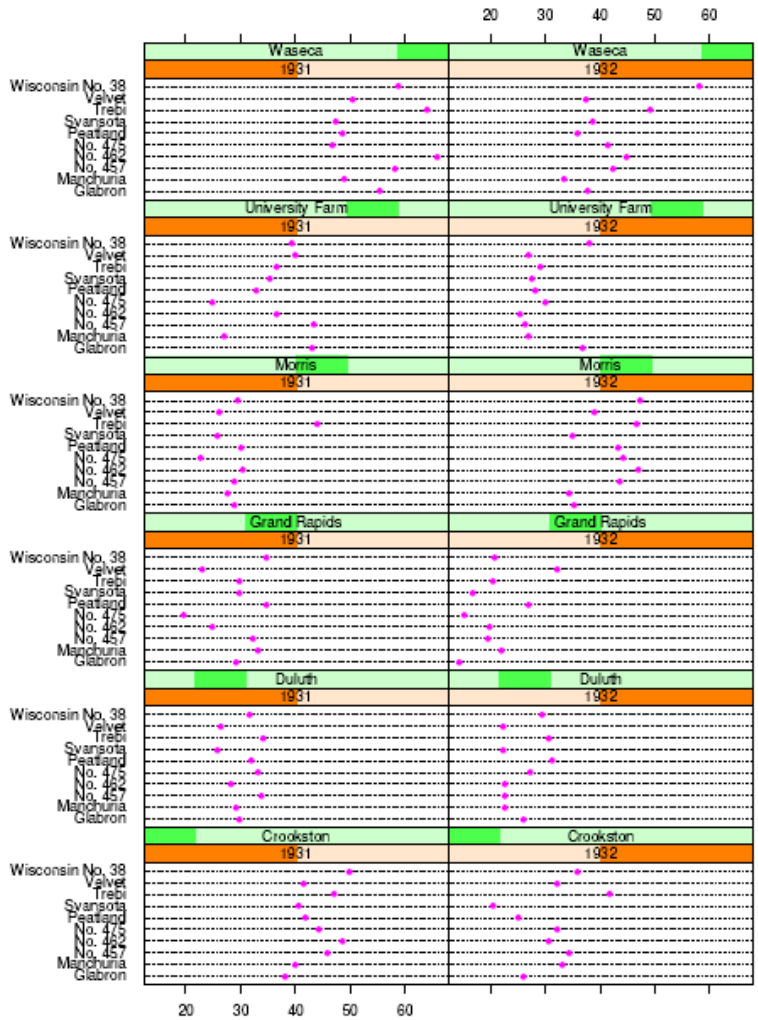
- performance analysis of parallel system
  - order: machine name vs. lock acquisition time



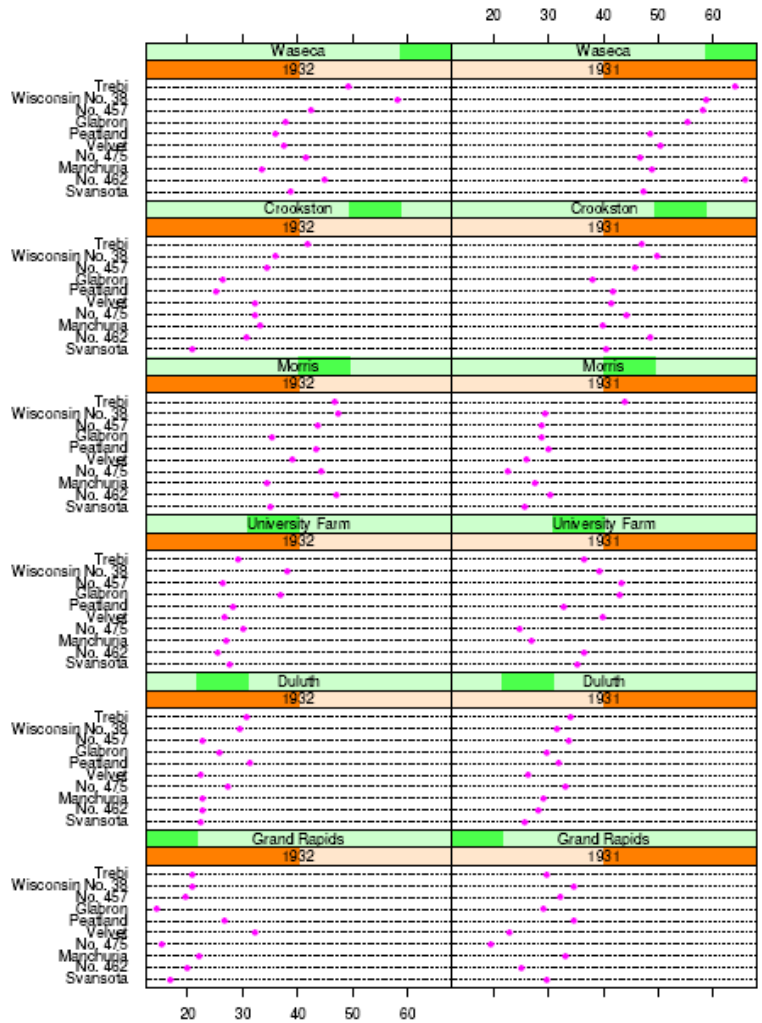

[Bosch, Performance Analysis and Visualization of Parallel Systems Using SimOS and Rivet: A Case Study, HPCA6, 2000. graphics.stanford.edu/papers/rivet_argus]

# Automatic Ordering: Trellis

alphabetical site,variety




use group median



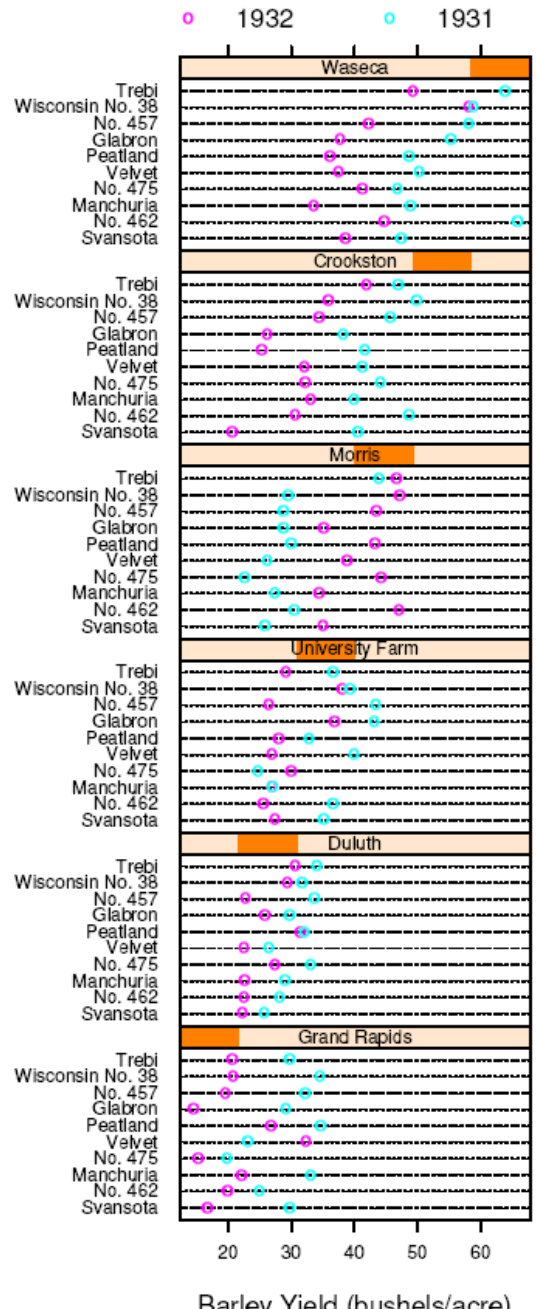

[The Visual Design and Control of Trellis Display. Becker, Cleveland, and Shyu. JCSG 5:123-155 1996. cm.bell-labs.com/stat/doc/trellis.jcgs.col.ps]

# 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

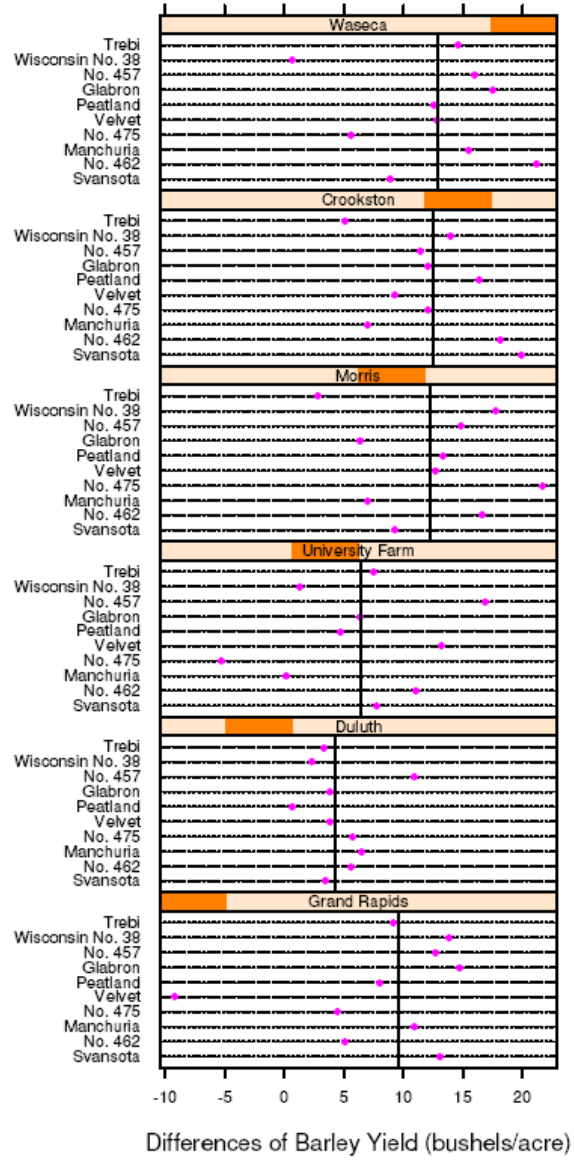



[The Visual Design and Control of Trellis Display. Becker, Cleveland, and Shyu. JCSG 5:123-155 1996. cm.bell-labs.com/stat/doc/trellis.jcgs.col.ps]

# Partial Residuals

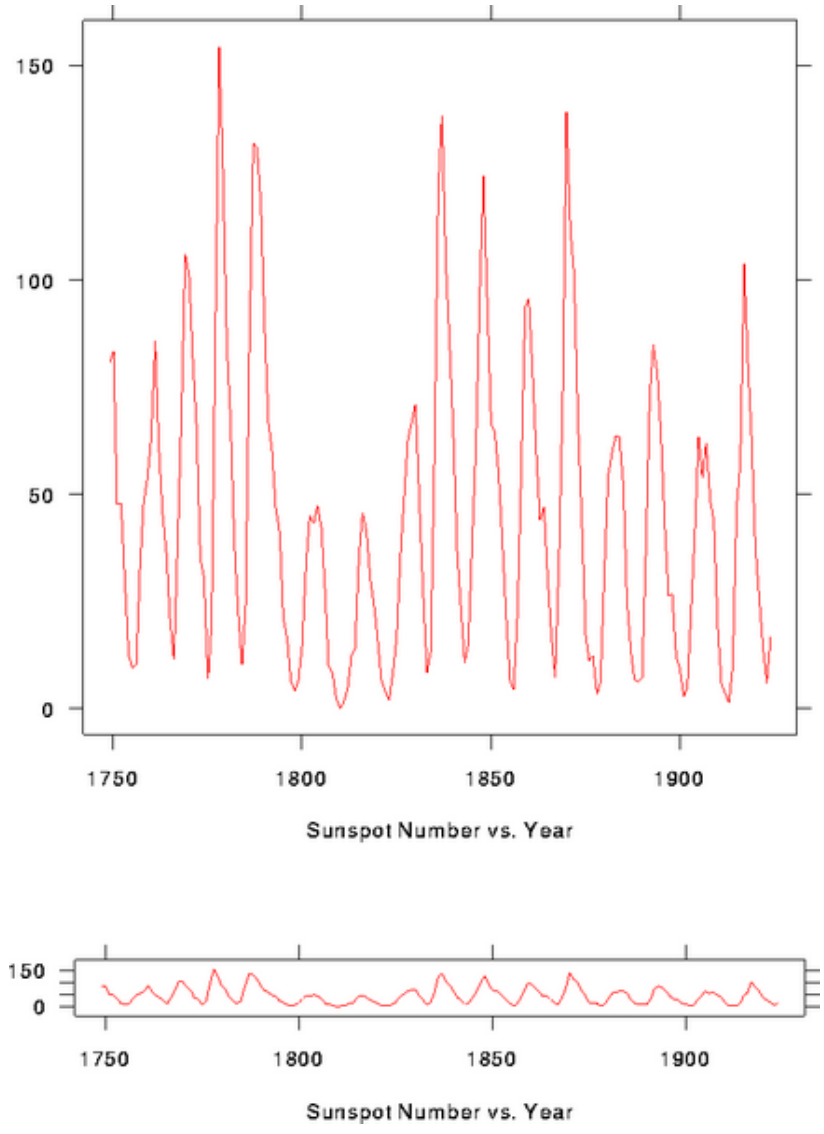
- fixed dataset, Morris data switched
- explicitly show differences
  - take means into account
  - line is 10% trimmed mean (toss outliers)

[The Visual Design and Control of Trellis Display. Becker, Cleveland, and Shyu. JCSG 5:123-155 1996. cm.bell-labs.com/stat/doc/trellis.jcgs.col.ps]



# Banking to 45 Degrees

- mentioned but not explained in this reading
- perceptual principle: most accurate angle judgement at 45 degrees
- pick aspect ratio (height/width) accordingly




[www.research.att.com/∼rab/trellis/sunspot.html]

# Multiscale Banking to 45

- frequency domain analysis

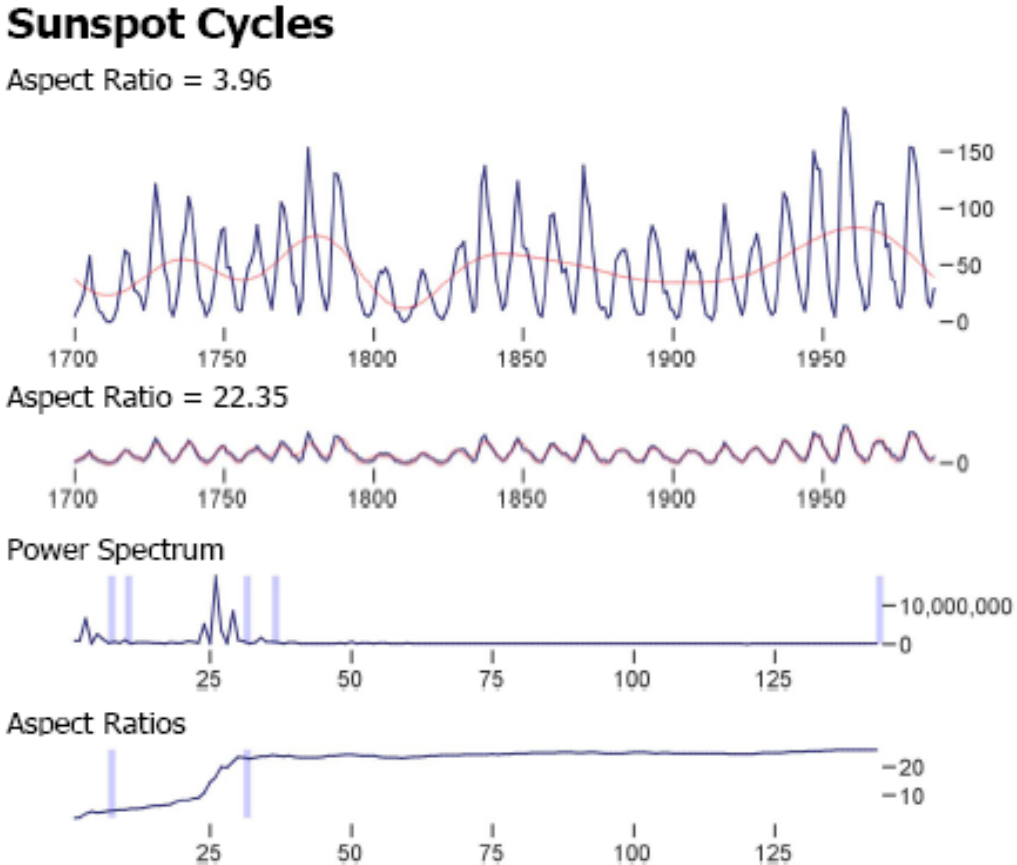
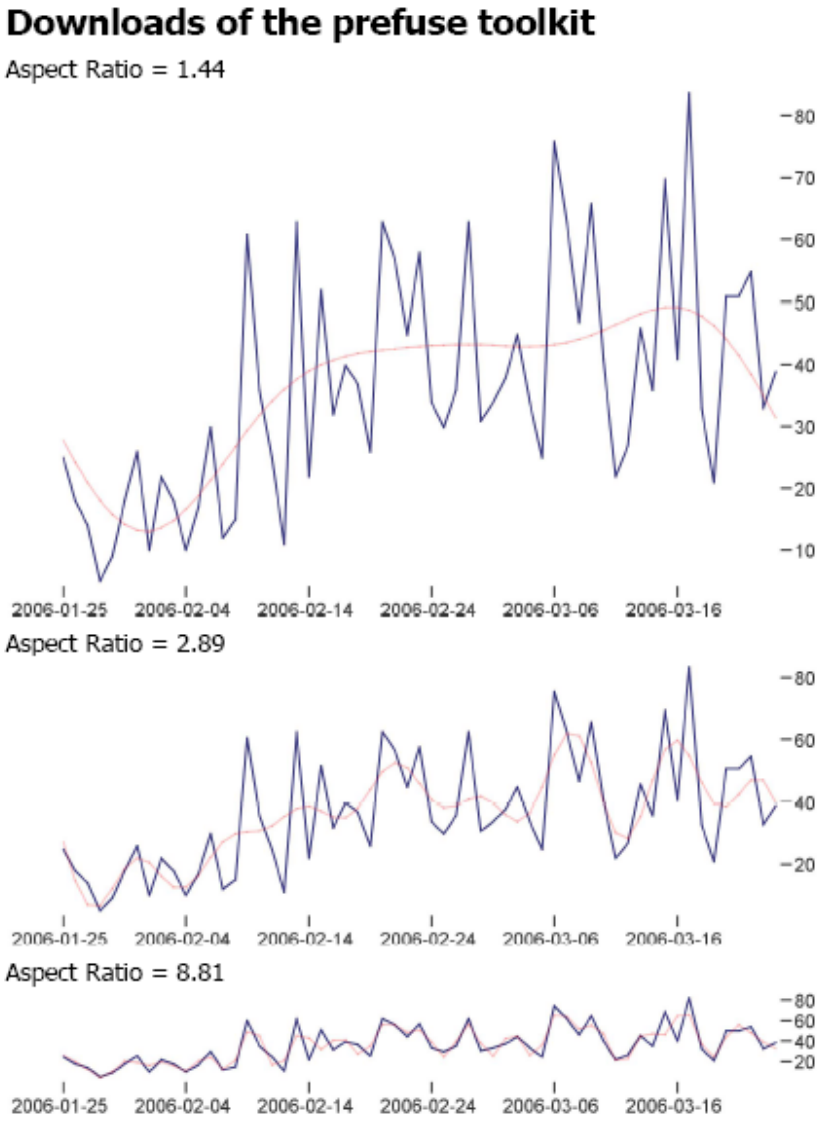



**Figure 5. Sunspot observations, 1700-1987.** The first plot shows low-frequency oscillations in the maximum values of sunspot cycles. The second plot brings the individual cycles into greater relief.

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

# Multiscale Banking to 45



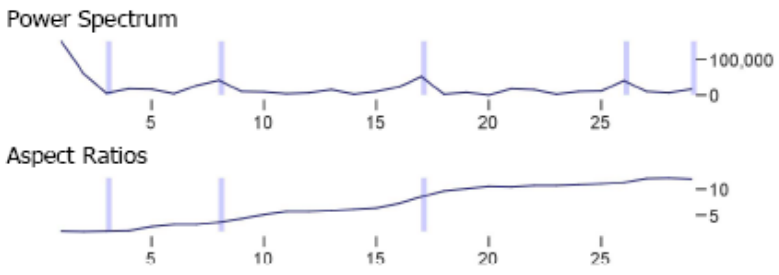



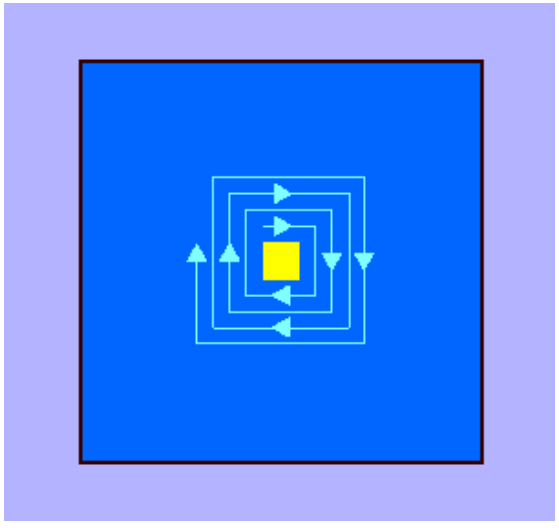

**Figure 8. Daily download counts of the prefuse visualization toolkit.** The first plot shows a general increase in downloads. The second plot shows weekly variations, including reduced downloads on the weekends. The third plot enables closer inspection of day-to-day spikes and decays.

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

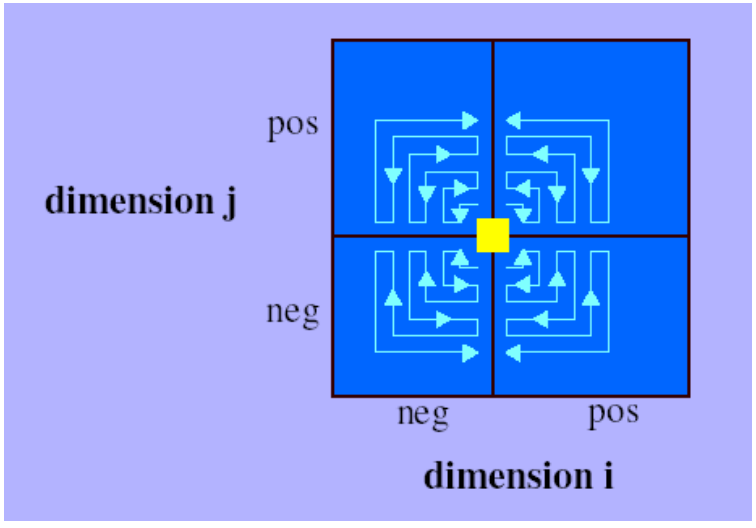
# VisDB: Spacefilling Pixels

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

spiral



2D

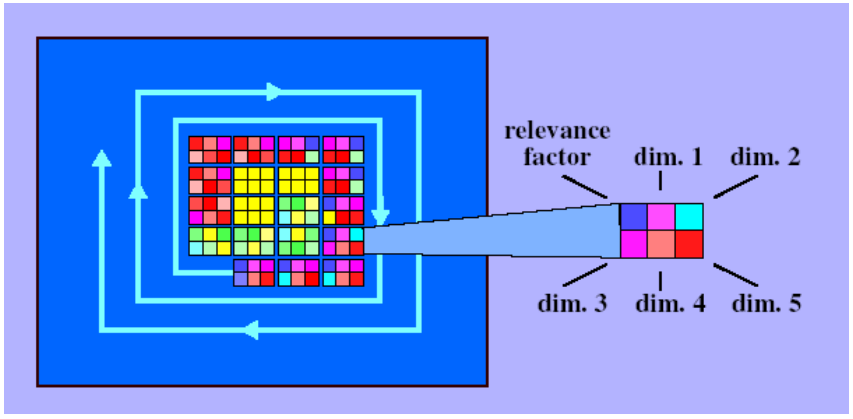


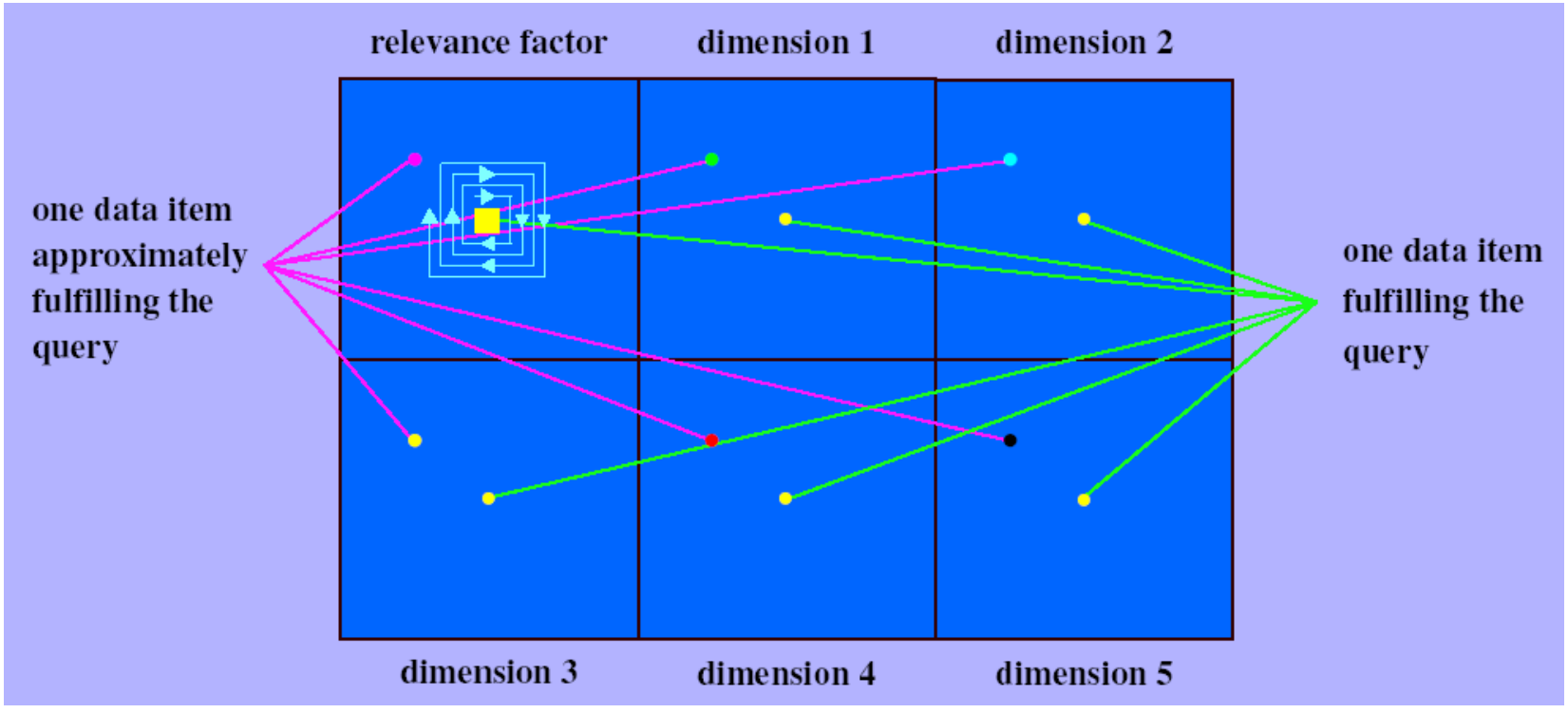

[VisDB: Database Exploration using Multidimensional Visualization, Keim and Kriegel, IEEE CG&A, 1994 www.dbs.informatik.uni-muenchen.de/dbs/projekt/papers/visdb.ps]

# VisDB Windows

grouped dimensions

separate dimensions

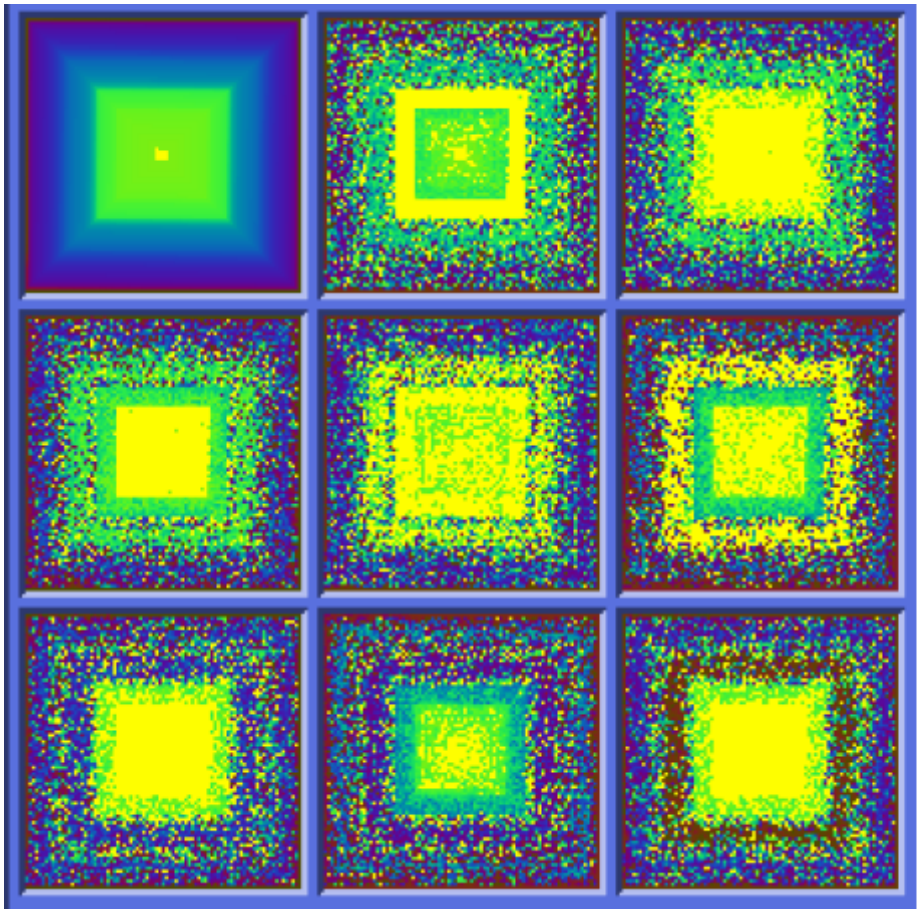


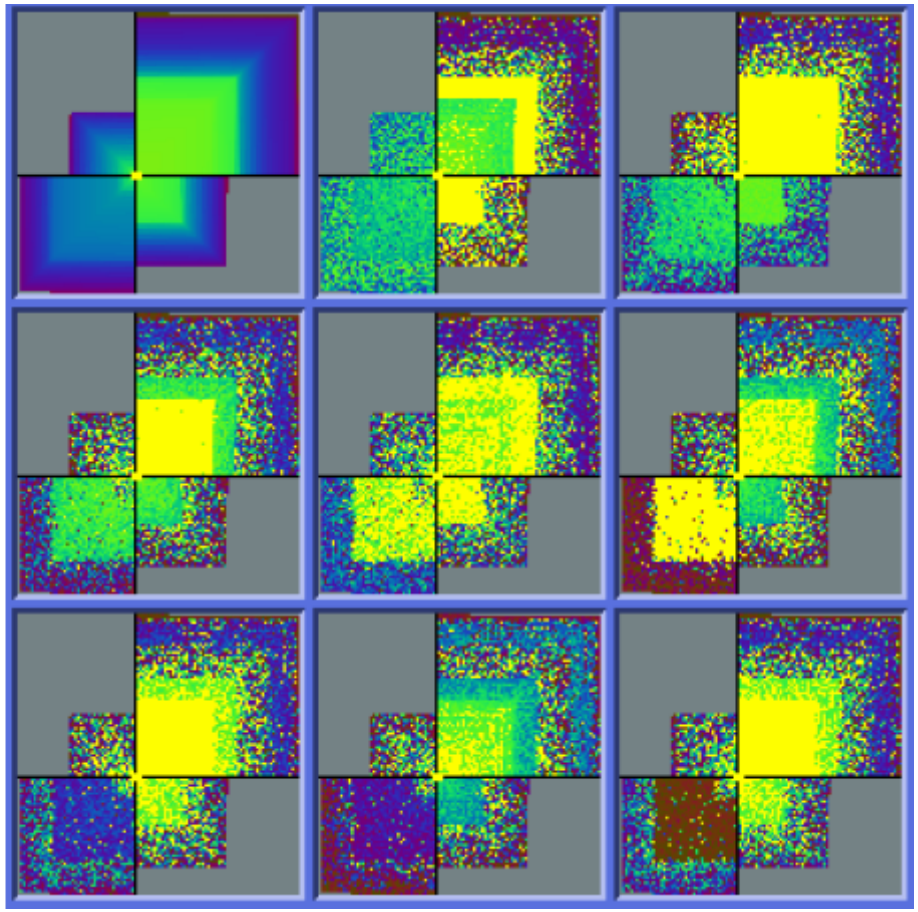

[VisDB: Database Exploration using Multidimensional Visualization, Keim and Kriegel, IEEE CG&A, 1994 www.dbs.informatik.uni-muenchen.de/dbs/projekt/papers/visdb.ps]

# VisDB Results: Separate Dimensions

spiral

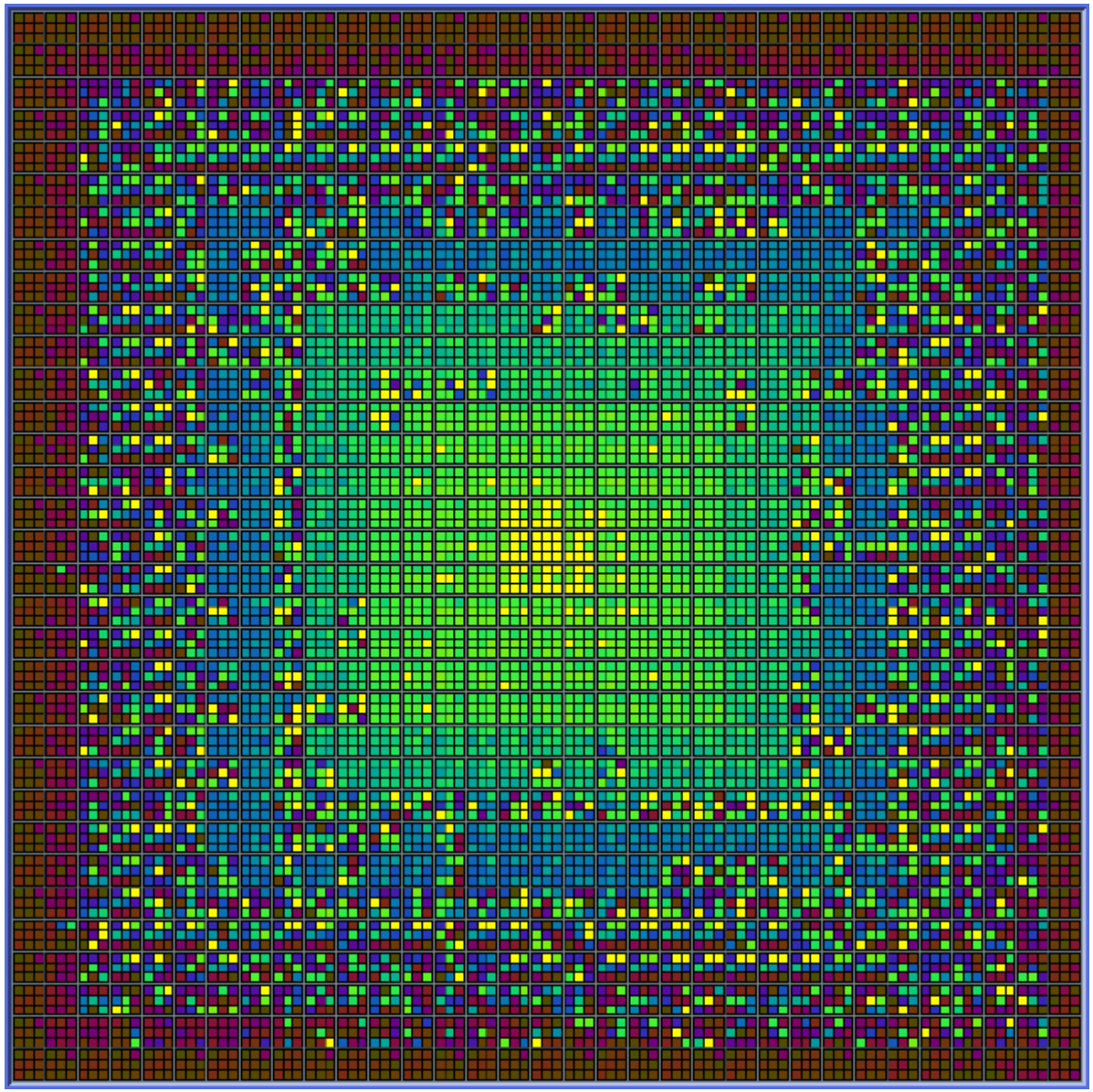


2D



[VisDB: Database Exploration using Multidimensional Visualization, Keim and Kriegel, IEEE CG&A, 1994 www.dbs.informatik.uni-muenchen.de/dbs/projekt/papers/visdb.ps]

# VisDB Results: Grouped Dimensions



[VisDB: Database Exploration using Multidimensional Visualization, Keim and Kriegel, IEEE CG&A, 1994 www.dbs.informatik.uni-muenchen.de/dbs/projekt/papers/visdb.ps]

# Space vs. Time: Showing Change

literal abstract

time for time space for time

- animation: show time using temporal change
  - good: show process

[www.geom.uiuc.edu/docs/outreach/oi/evert.mpg]

# Space vs. Time: Showing Change

literal abstract

time for time space for time

- animation: show time using temporal change
  - good: show process
  - good: compare by flipping between two things

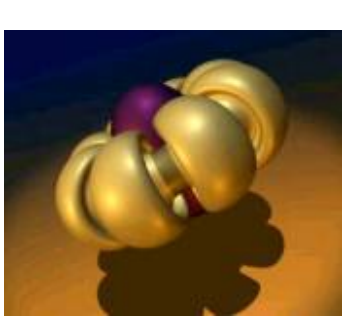
[www.geom.uiuc.edu/docs/outreach/oi/evert.mpg]
[www.astroshow.com/ccdpho/pluto.gif]

# Space vs. Time: Showing Change

literal abstract

time for time space for time

- animation: show time using temporal change
  - good: show process
  - good: compare by flipping between two things
  - bad: compare between many things



[www.geom.uiuc.edu/docs/outreach/oi/evert.mpg]
[www.astroshow.com/ccdpho/pluto.gif]

# Space vs. Time: Showing Change

literal — abstract

time for time — space for time

- animation: show time using temporal change
  - good: show process
  - good: compare by flipping between two things
  - bad: compare between many things
    - interference from intermediate frames

[www.geom.uiuc.edu/docs/outreach/oi/evert.mpg]
[www.astroshow.com/ccdpho/pluto.gif]

# Space vs. Time: Showing Change

literal — abstract

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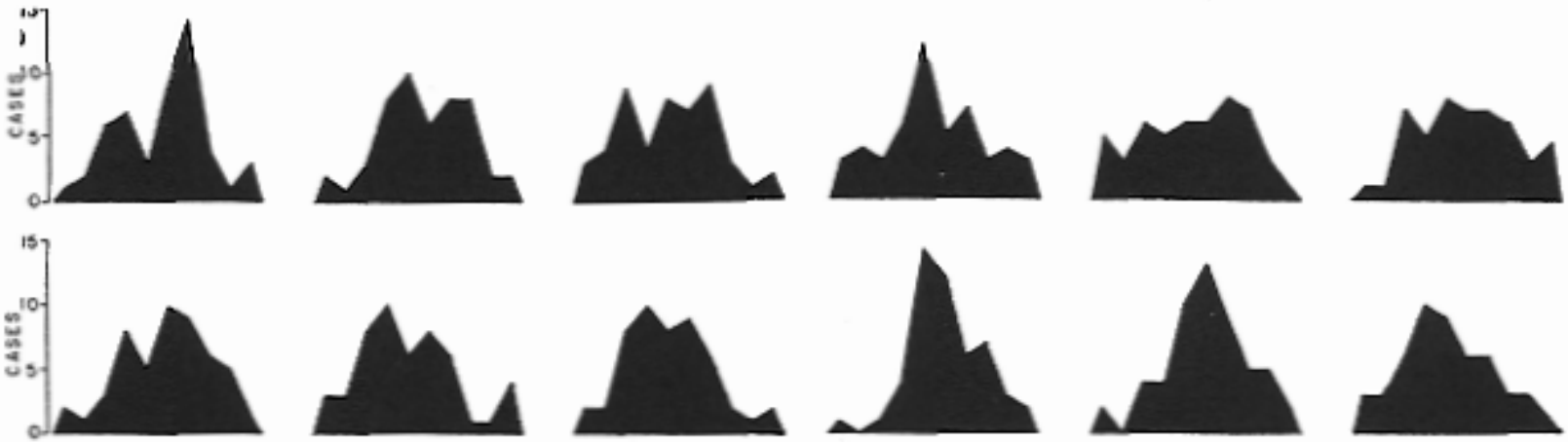
# Space vs. Time: Showing Change

literal abstract

time for time space for time

- small multiples: show time using space
  - overview: show each time step in array
  - compare: side-by-side easier than temporal
    - external cognition instead of internal memory
  - general technique, not just for temporal changes



# Space vs. Time: Showing Change

literal ⟵ · · ·

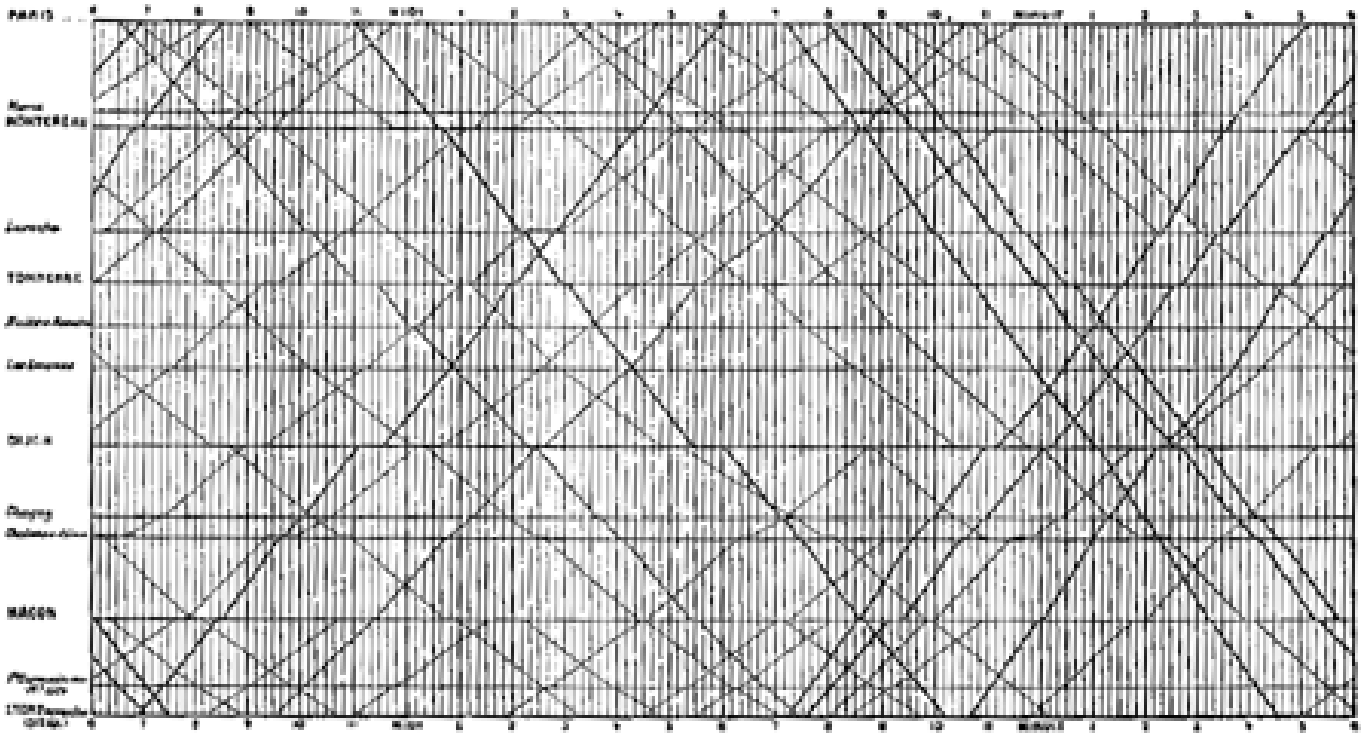
# Animation vs. Small Multiples

- Tversky argument: intuition that animation helps is wrong
  - meta-review of previous studies
  - often more info shown in animation view so not a fair comparison
  - carefully chosen segmentation into small multiples better than animation if equivalent information shown

[Animation: Can It Facilitate? Barbara Tversky, Julie Morrison, Mireille Betrancourt. International Journal of Human Computer Studies 57:4, pp 247-262, 2002.]

# Derived Spaces: Slope

- narrative of space and time
- Marey train schedule, 1885
  - horizontal line length: stop length
  - slope: speed
  - intersection: time/place of crossing



[Tufte I p 31, www.nap.edu/html/hs_math/images/tl_f8.gif]