Lecture 9: Space/Layers/Order

Information Visualization
CPSC 533C, Fall 2007

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Readings Covered

Ware, Chapter 8: Space Perception and the Display of Data in Space

Tufte, Chapter 3: Layering and Separation

Hierarchical Edge Bundles: Visualization of Adjacency Relations in Hierarchical Data. Danny Holten, Proc. InfoVis06, to appear
http://www.win.tue.nl/~dholten/papers/bundles_infovis.pdf

Tufte, Chapter 6: Narratives of Space and Time

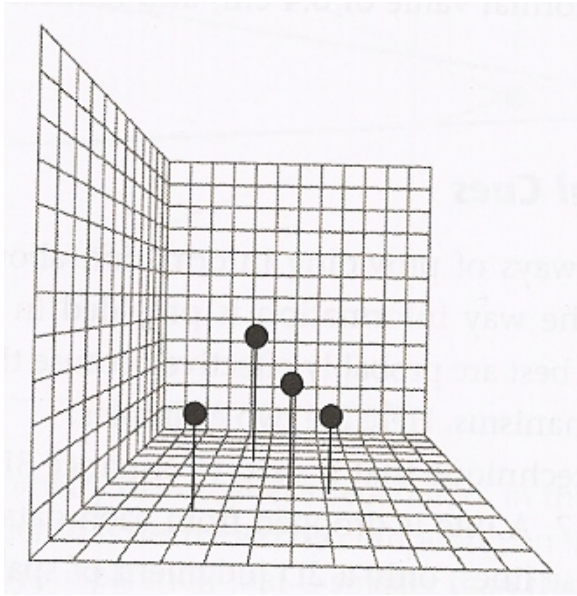
VisDB: Database Exploration using Multidimensional Visualization, Daniel A. Keim and Hans-Peter Kriegel, IEEE CG&A, 1994
http://www.dbs.informatik.uni-muenchen.de/dbs/projekt/papers/visdb.ps

Ware: Space Perception

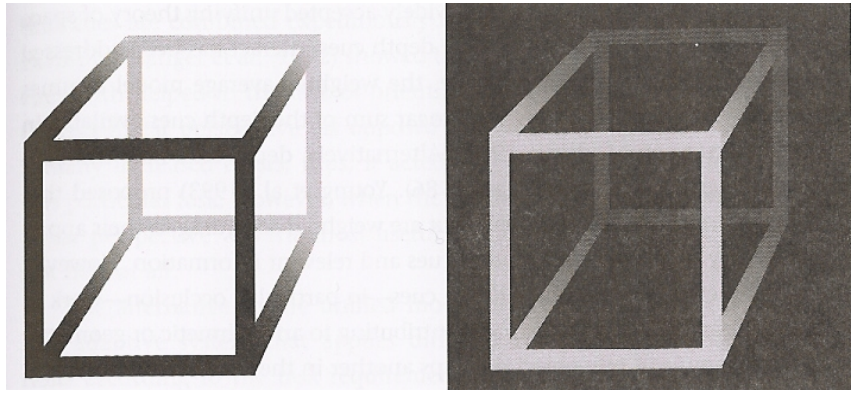
- static
  - occlusion
  - perspective projection
    - linear, texture gradient
  - depth of field
  - atmospheric (fog, depth cueing)
  - lighting and shadows
    - shape from shading
    - cast shadows
- moving
  - structure-from-motion
    - motion parallax (head motion)
- binocular
  - binocular disparity (stereopsis)
  - convergence
    - amount eyes rotate toward center of interest
    - like optical range finder

Ware: Space Perception

- droplines,
- background grids



- depth cueing



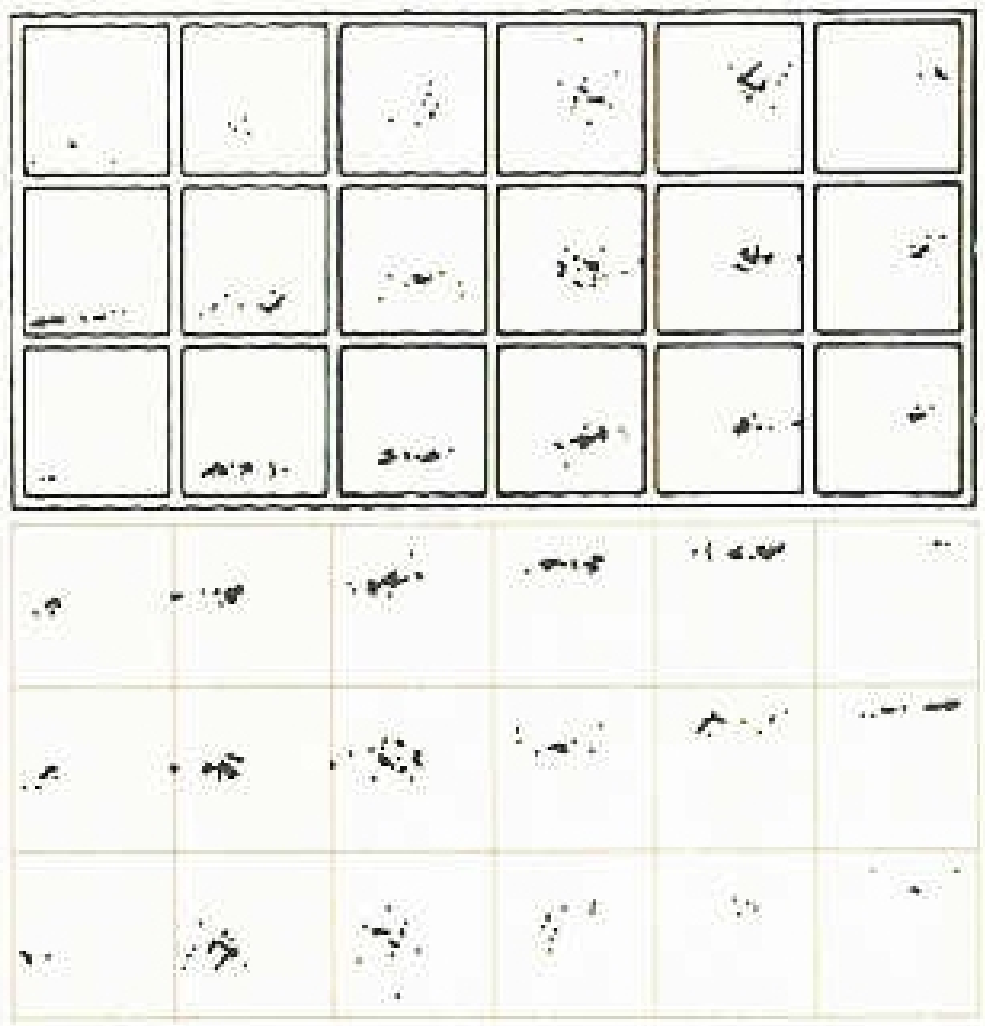
[Ware, Information Visualization: Perception for Design, Chap 8]

Layering And Separation

[Tufte, Envisioning Information, Chap 3]

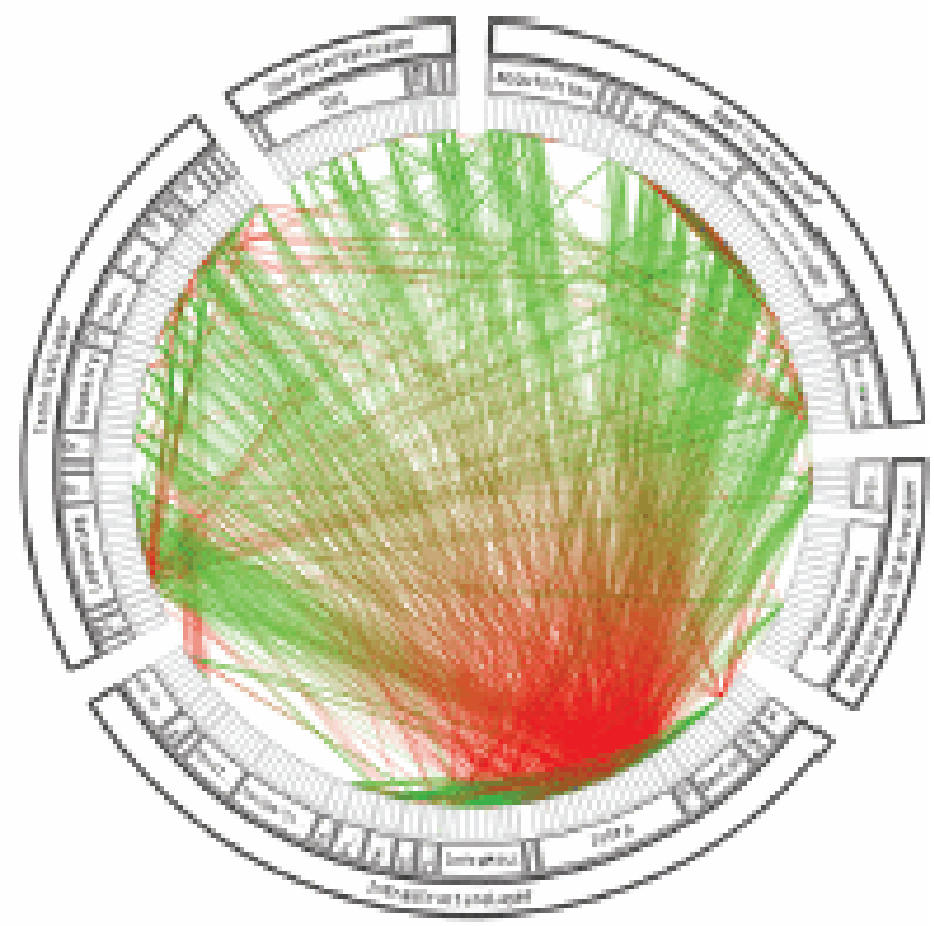
Visual Clutter

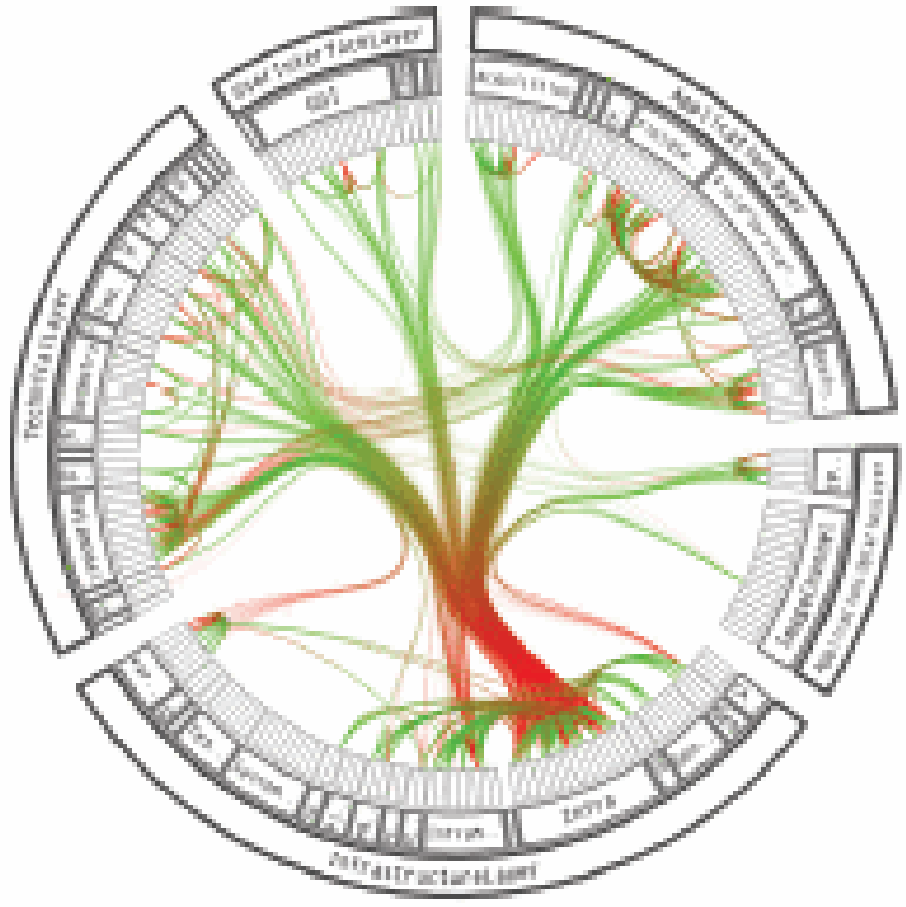
- subtler background than foreground



[Tufte, Envisioning Information, Chap 3]

Hierarchical Edge Bundles

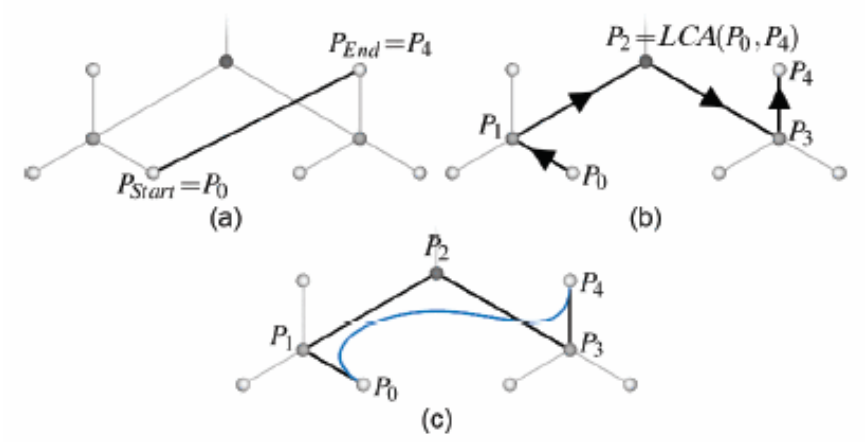


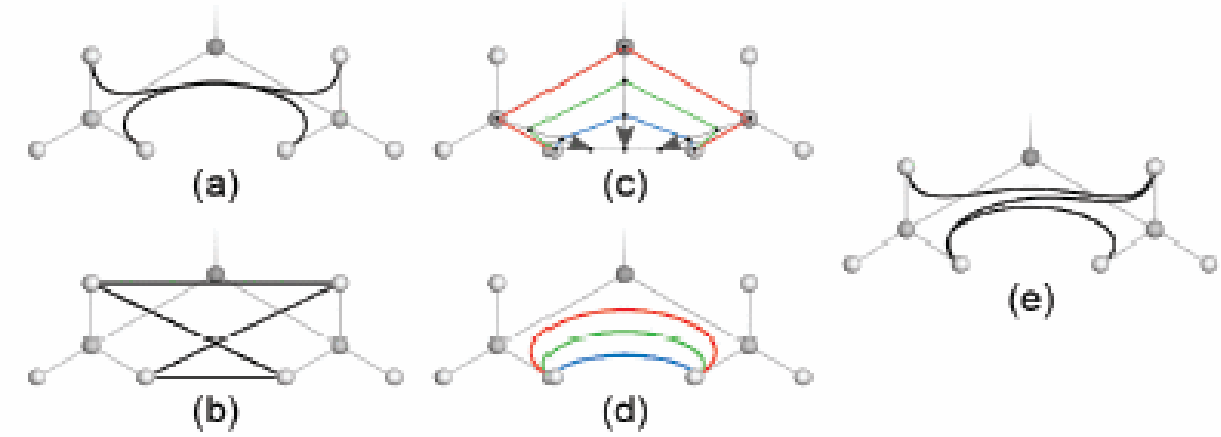


[Hierarchical Edge Bundles: Visualization of Adjacency Relations in Hierarchical Data. Danny Holten, Proc. InfoVis06.]

Hierarchical Edge Bundles

- bundle by hierarchy using splines

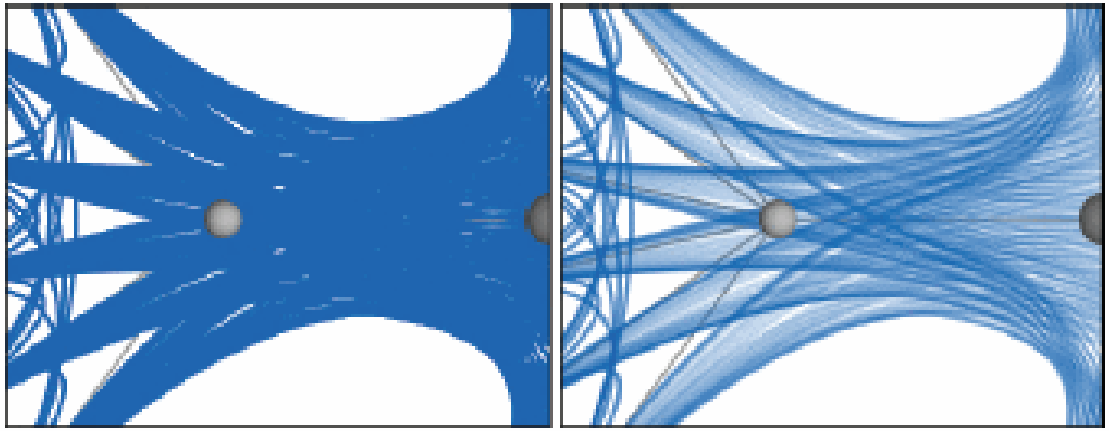




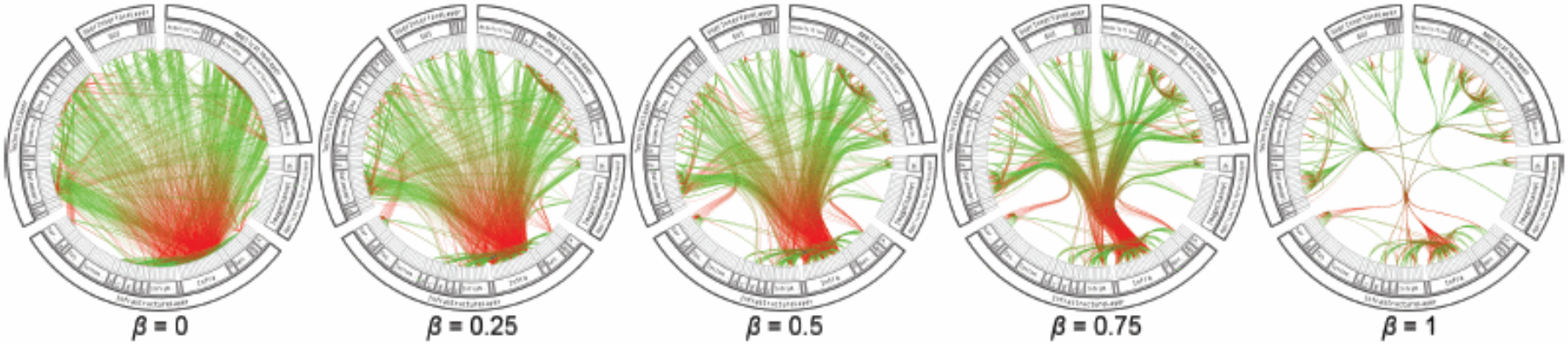
[Hierarchical Edge Bundles: Visualization of Adjacency Relations in Hierarchical Data. Danny Holten, Proc. InfoVis06.]

Hierarchical Edge Bundles

- alpha blending



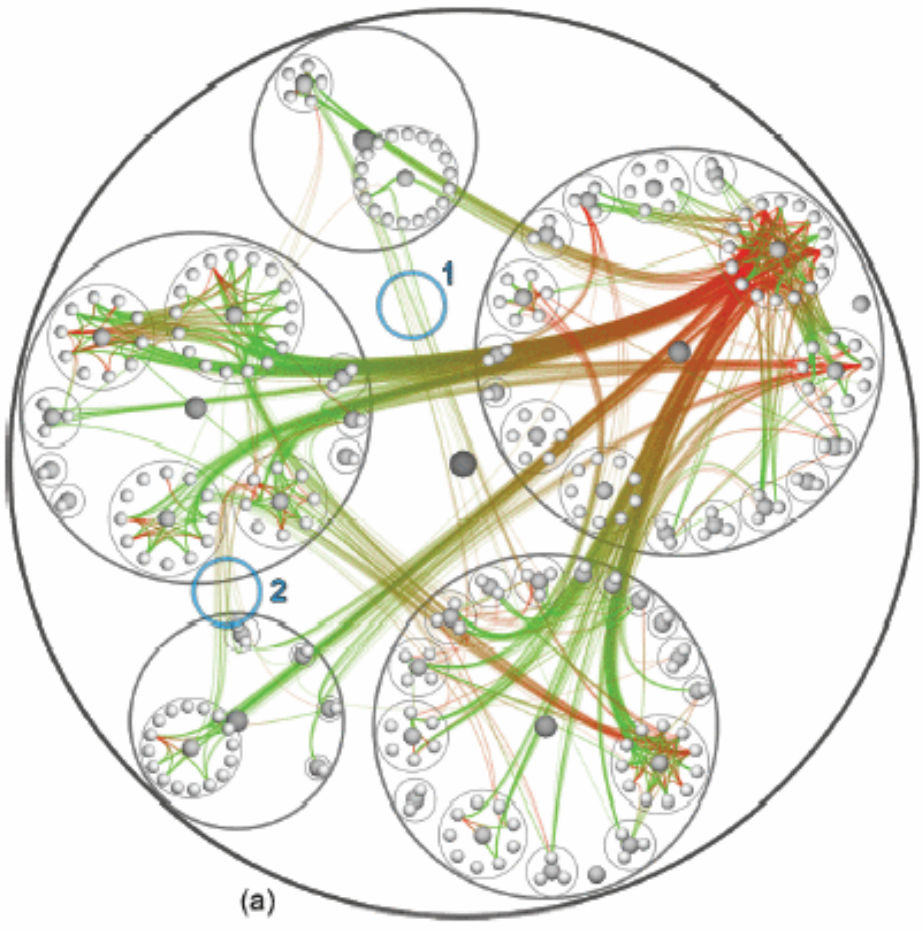
- bundling strength

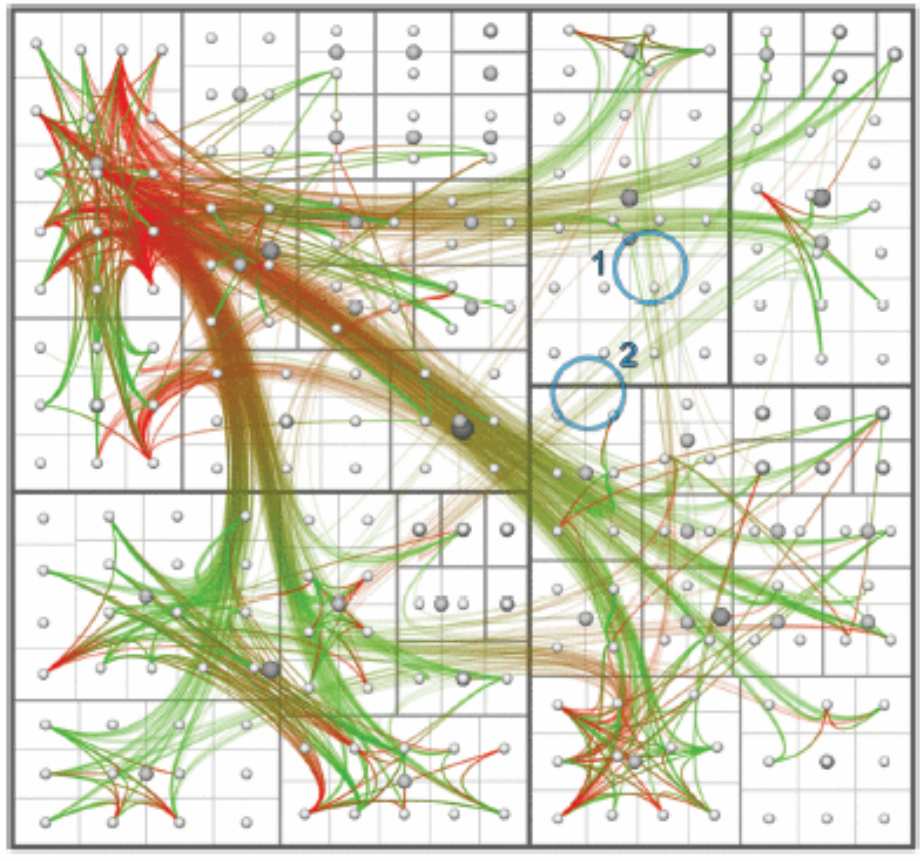


[Hierarchical Edge Bundles: Visualization of Adjacency Relations in Hierarchical Data. Danny Holten, Proc. InfoVis06.]

Hierarchical Edge Bundling

- (mostly) agnostic to layout





[Hierarchical Edge Bundles: Visualization of Adjacency Relations in Hierarchical Data. Danny Holten, Proc. InfoVis06.]

Critique

- flexible and general idea
- simple - after you see it
- successful example of creating foreground layer

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

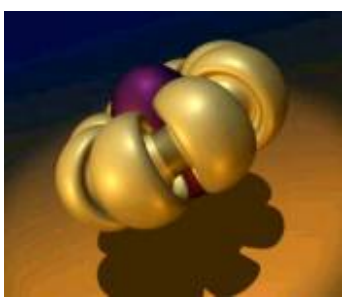
[www.geom.uiuc.edu/docs/outreach/oi/evert.mpg]
[www.astroshow.com/ccdpho/pluto.gif]

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



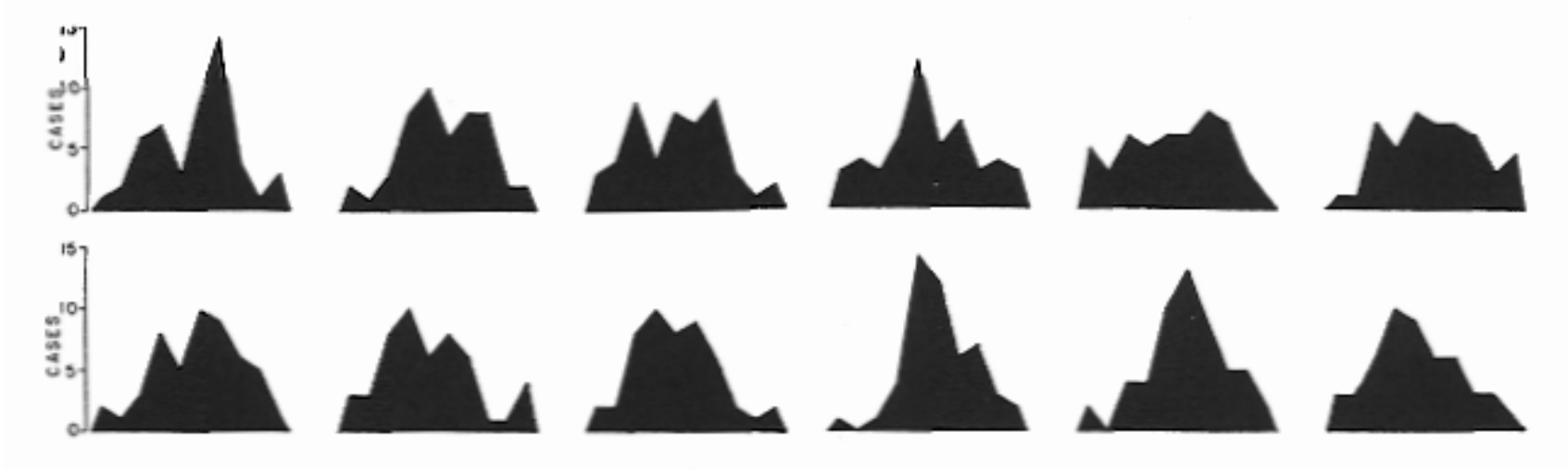

[www.geom.uiuc.edu/docs/outreach/oi/evert.mpg]
[www.astroshow.com/ccdpho/pluto.gif]

Space vs. Time: Showing Change

literal abstract

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

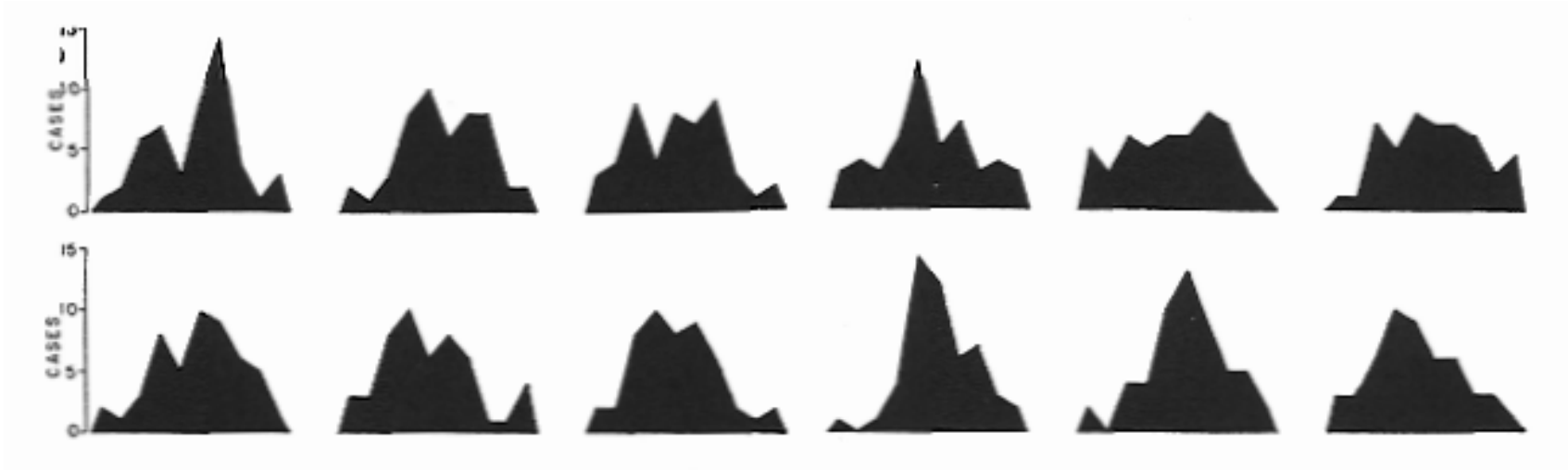


Space vs. Time: Showing Change

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

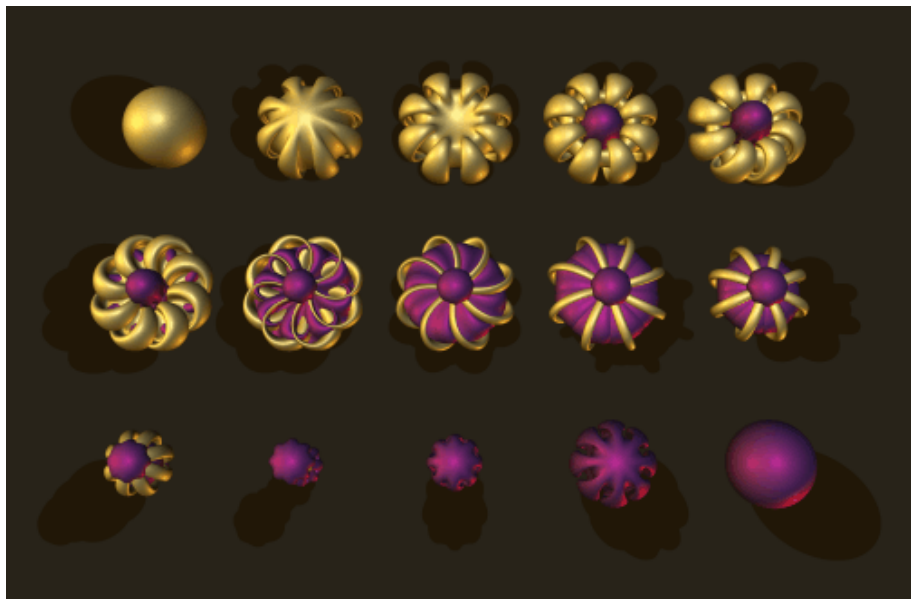


Space vs. Time: Showing Change

literal abstract

time for time space for time

- small multiples: show time using space
  - also can be good for showing process



[www.geom.uiuc.edu/graphics/pix/Video_Productions/Outside_In/postcard.comp.html]

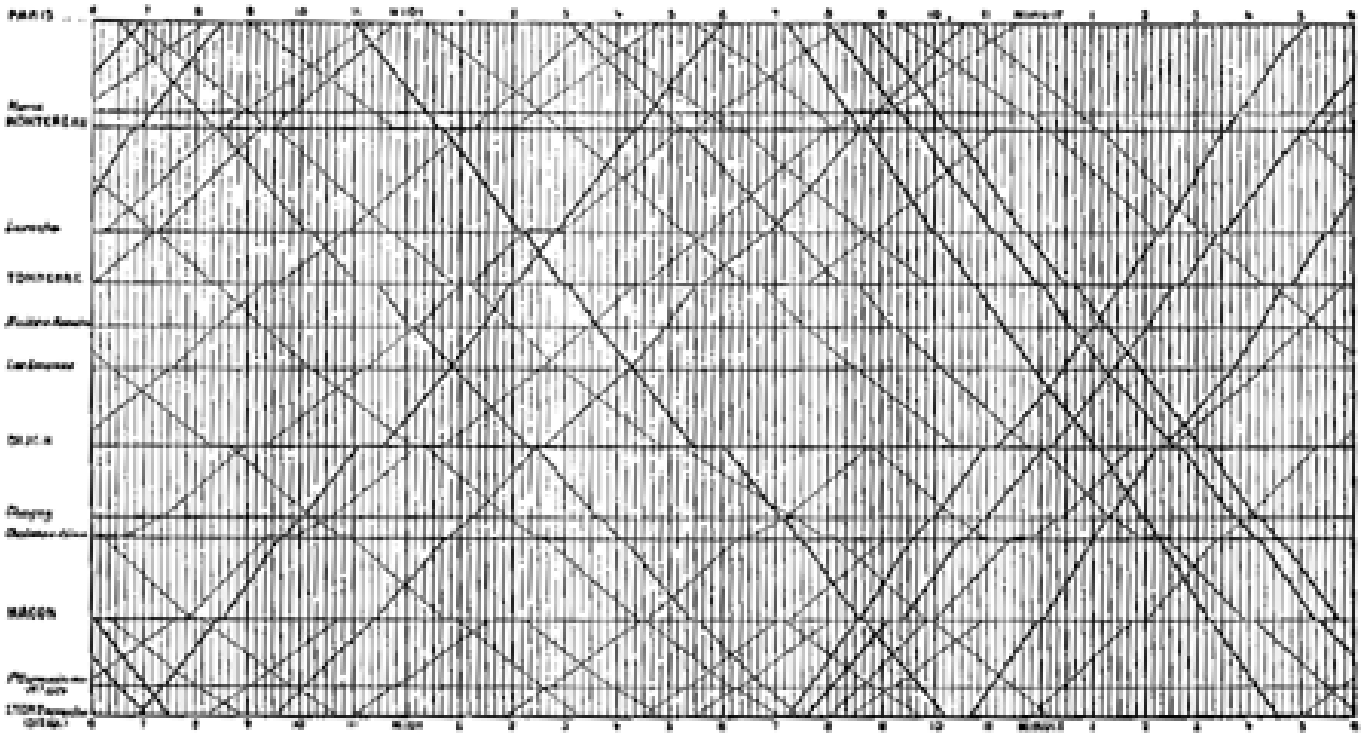
Animation vs. Small Multiples

- 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



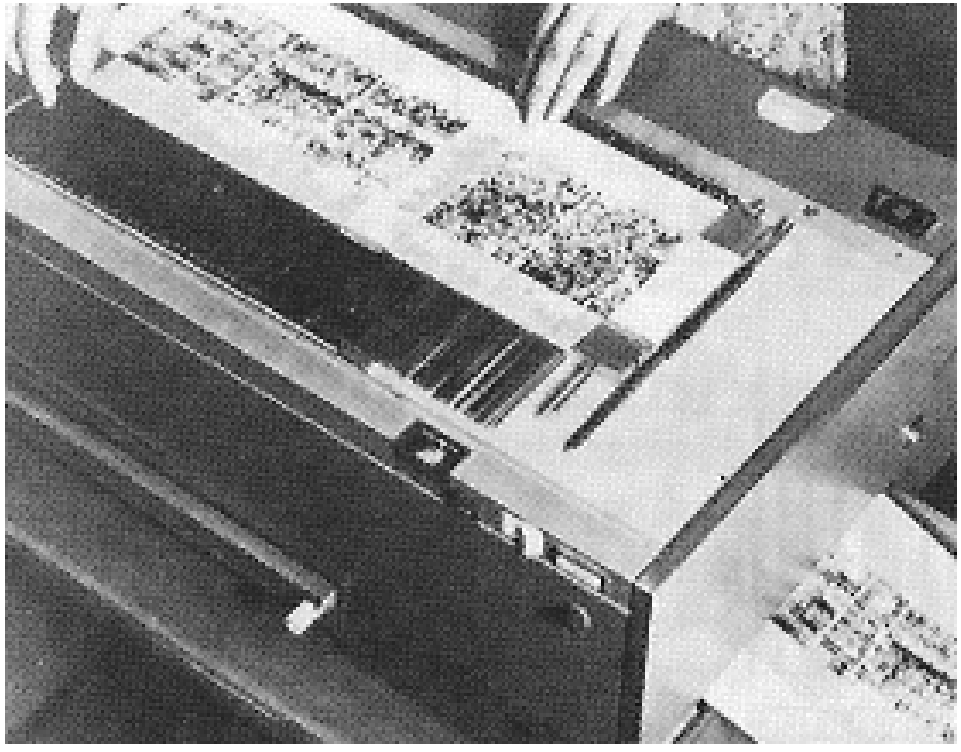
[Tufte I p 31, www.nap.edu/html/hs_math/images/tl_f8.gif]

Sorting and Ordering

- derived spaces for ordering
- spatial position as strongest perceptual cue
- finding the right order
  - automatically
  - through exploration

Manual Ordering: Bertin

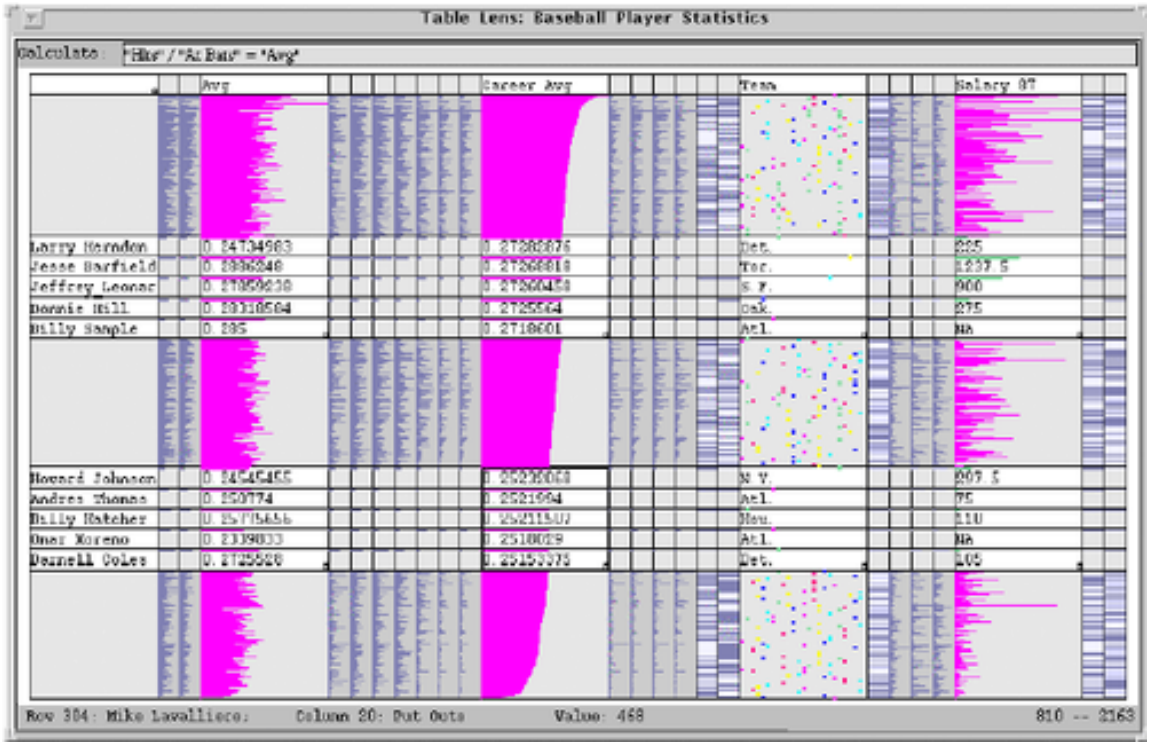
- reorderable matrices - manually!



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

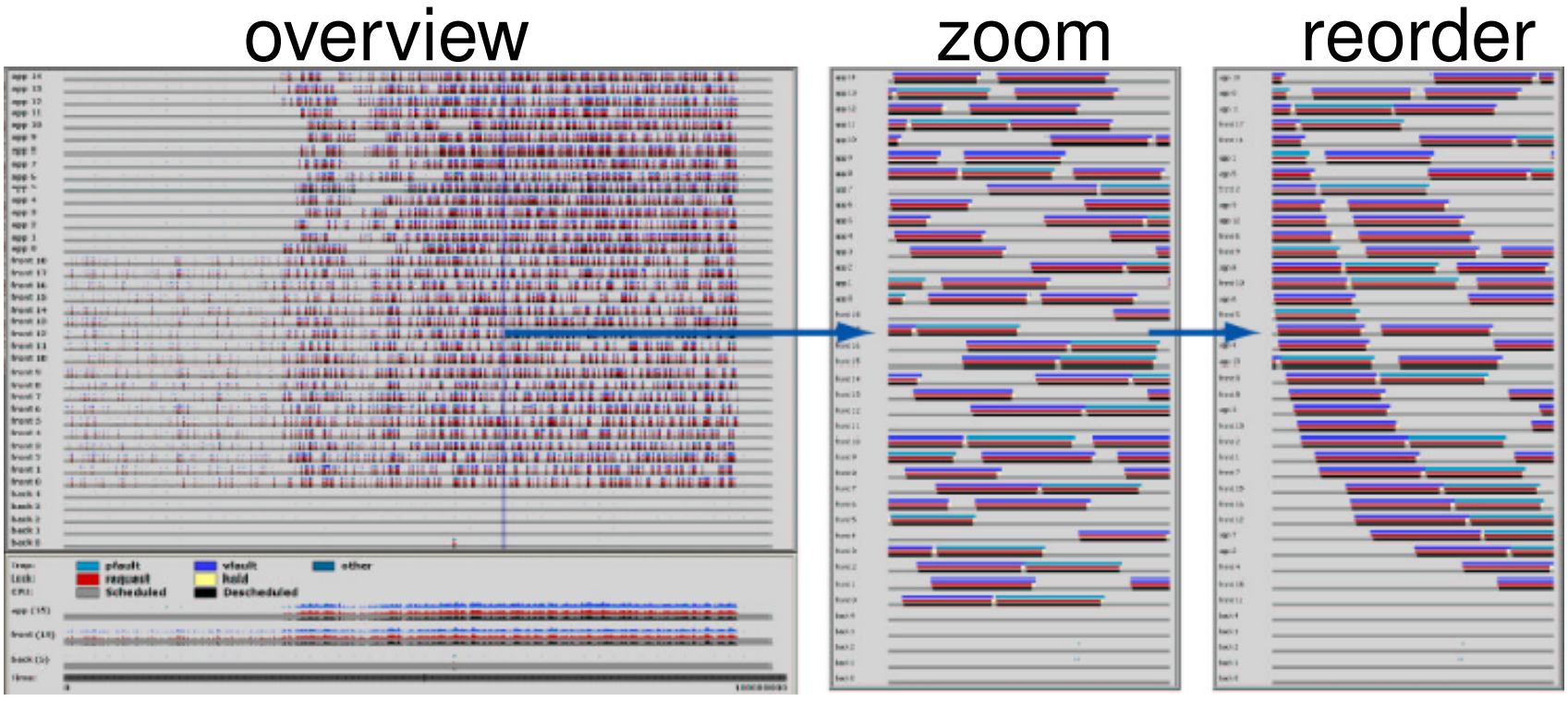
Interactive Ordering: Table Lens

- 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

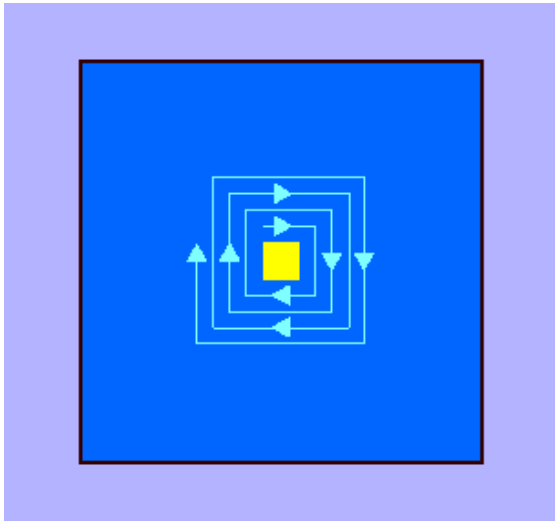


[Bosch, Performance Analysis and Visualization of Parallel Systems Using SimOS and Rivet: A Case Study, HPCA6, 2000. graphics.stanford.edu/papers/rivet_argus]

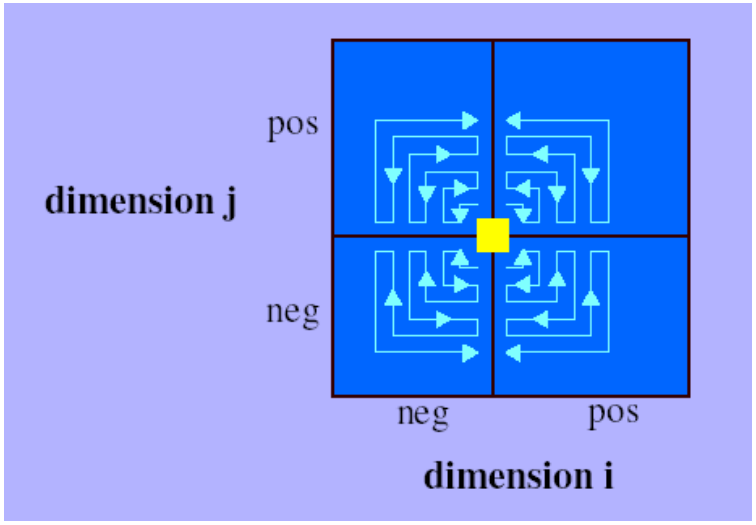
VisDB: Spacefilling Pixels

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

spiral



2D

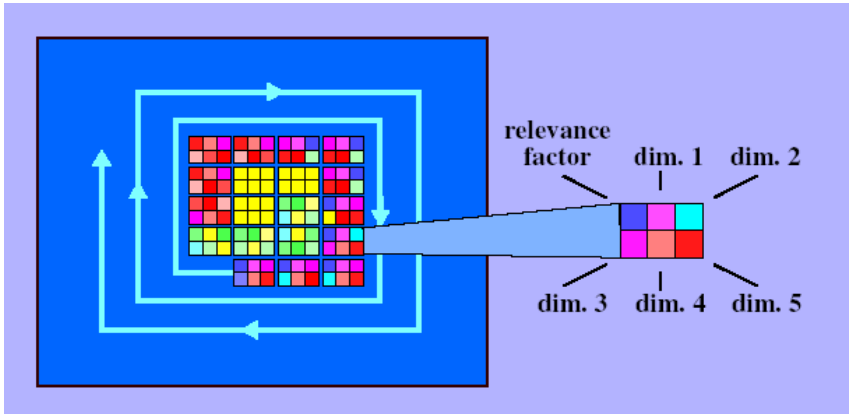


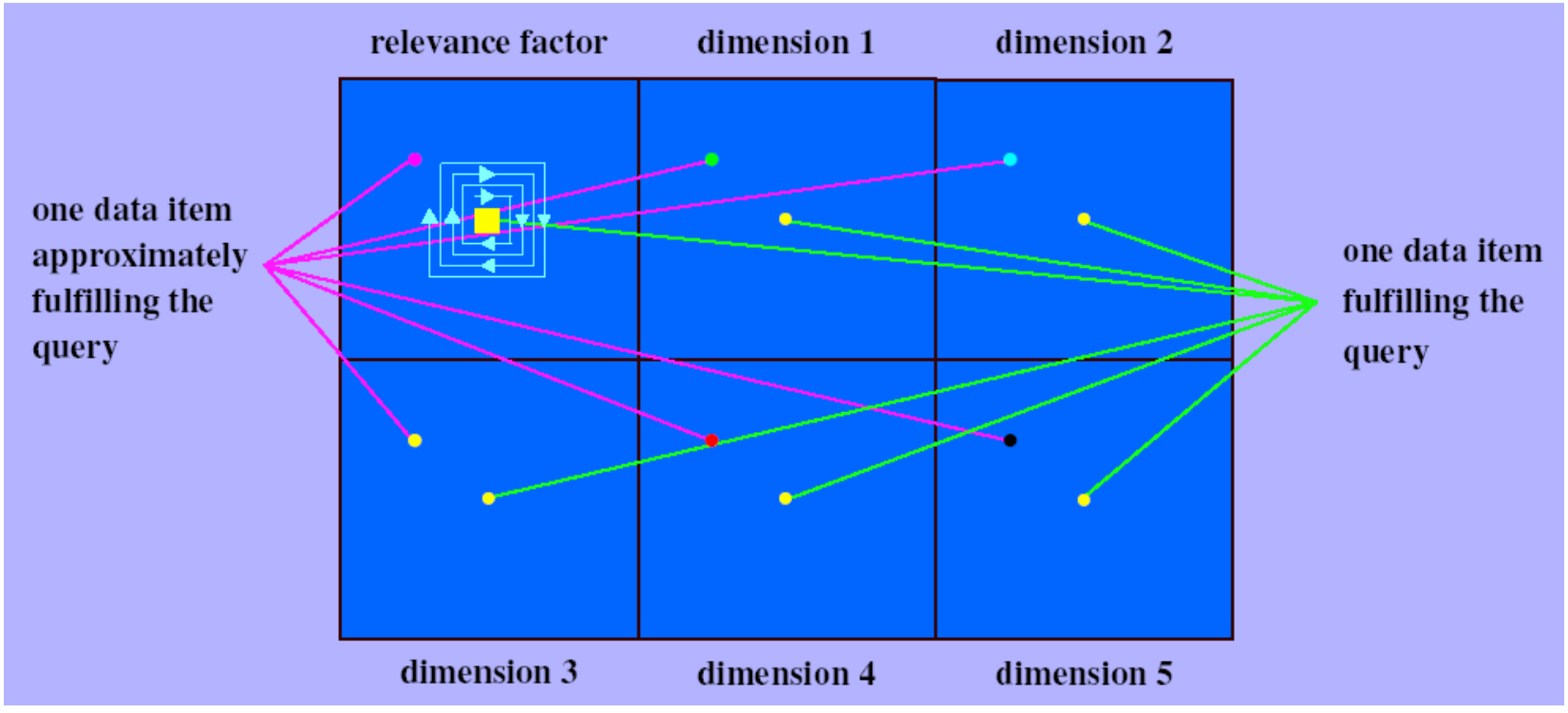
[VisDB: Database Exploration using Multidimensional Visualization, Keim and Kriegel, IEEE CG&A, 1994 www.dbs.informatik.uni-muenchen.de/dbs/projekt/papers/visdb.ps]

VisDB Windows

grouped dimensions

separate dimensions

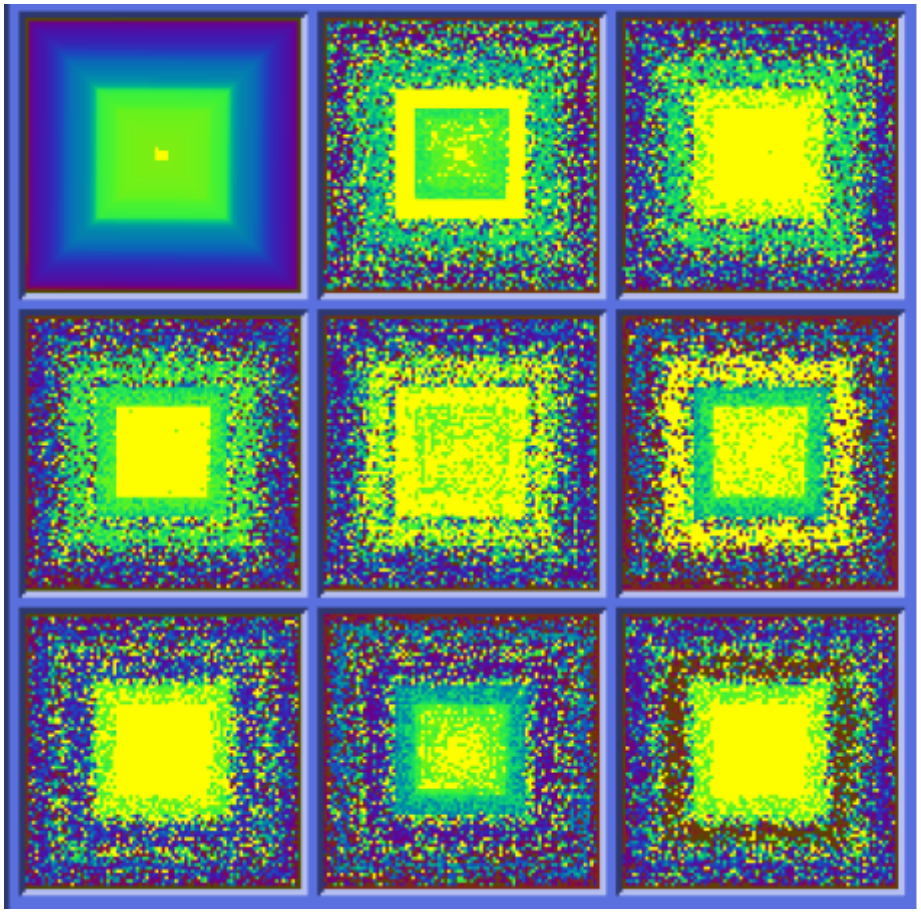




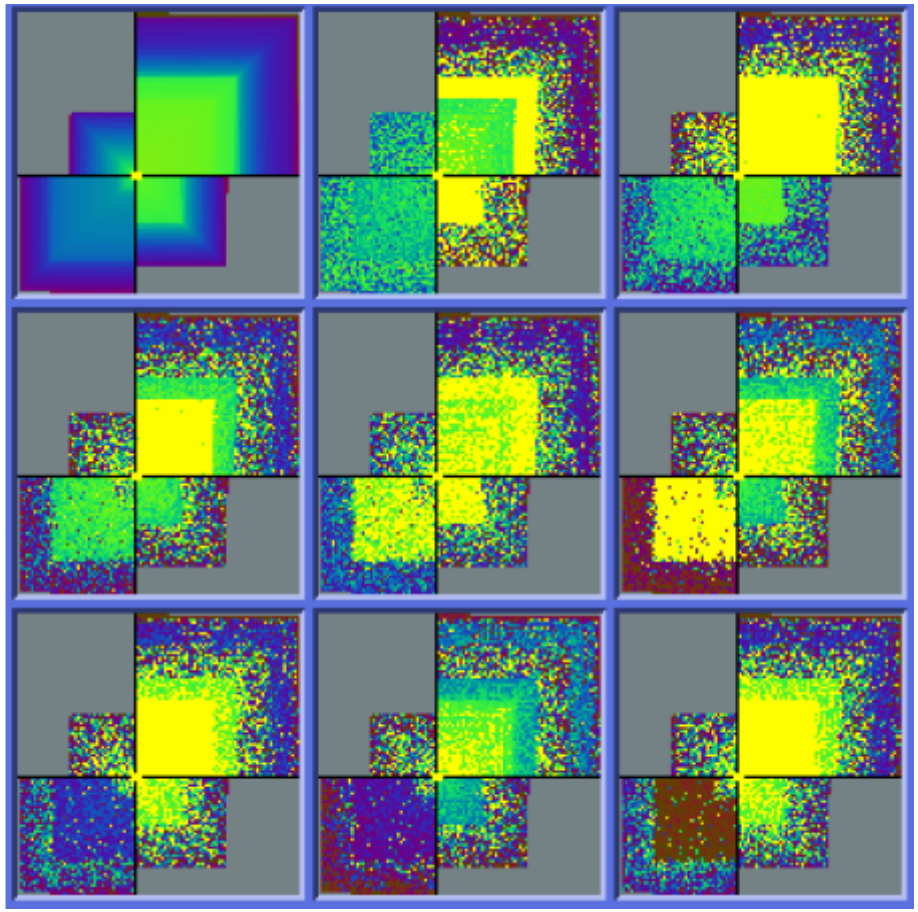
[VisDB: Database Exploration using Multidimensional Visualization, Keim and Kriegel, IEEE CG&A, 1994 www.dbs.informatik.uni-muenchen.de/dbs/projekt/papers/visdb.ps]

VisDB Results: Separate Dimensions

spiral

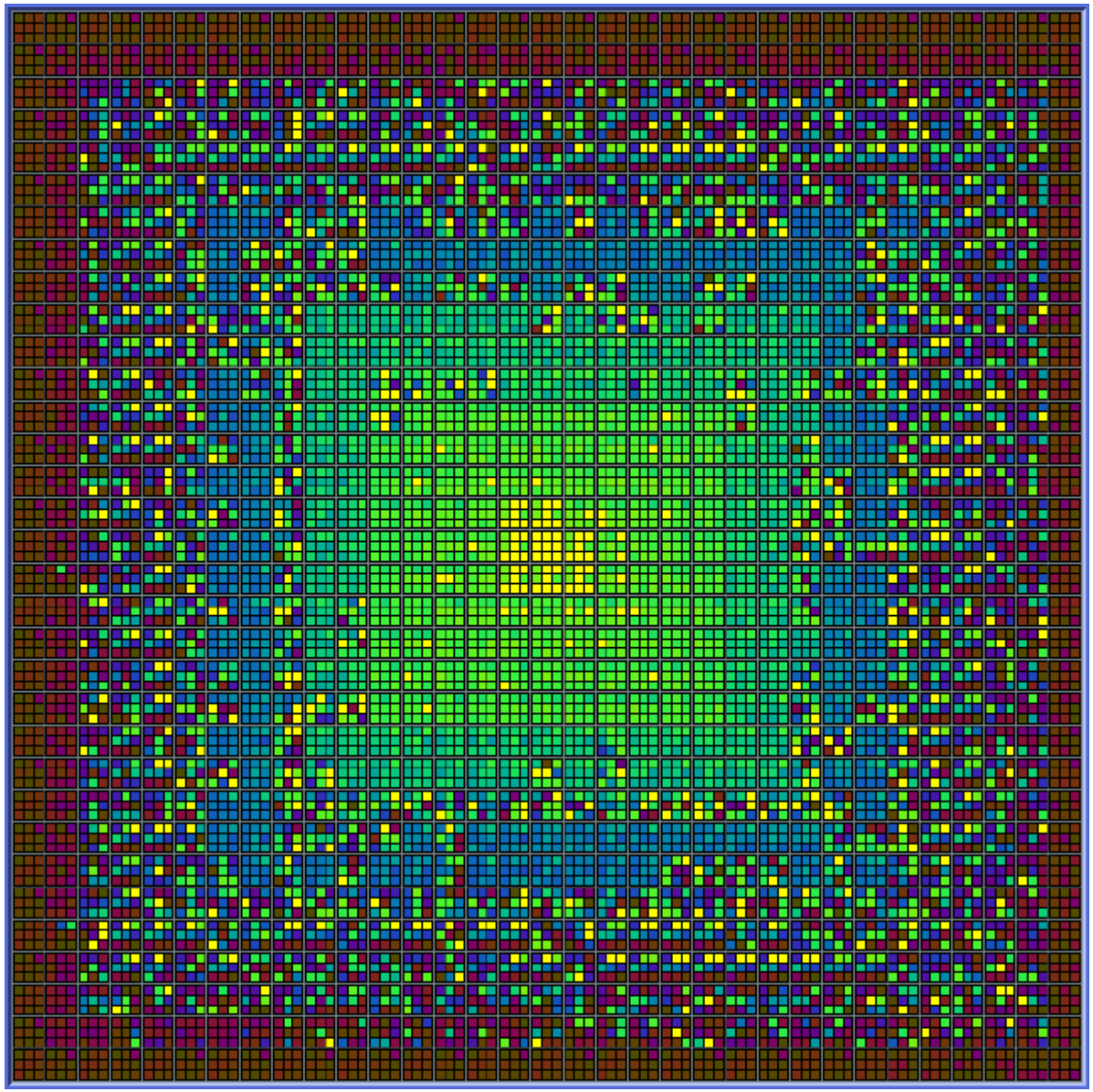


2D



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

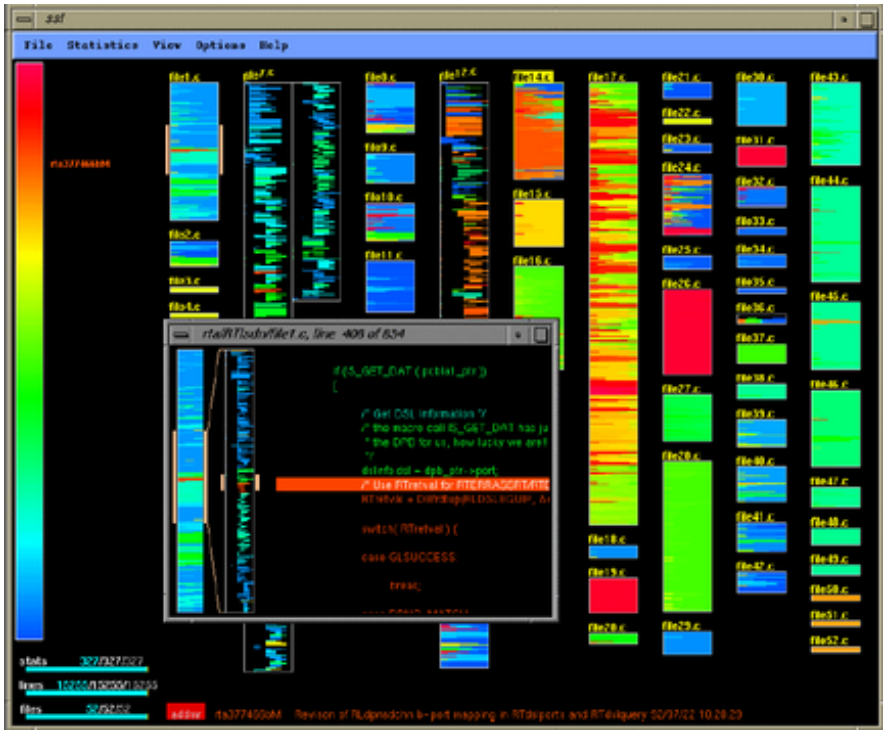
VisDB Results: Grouped Dimensions

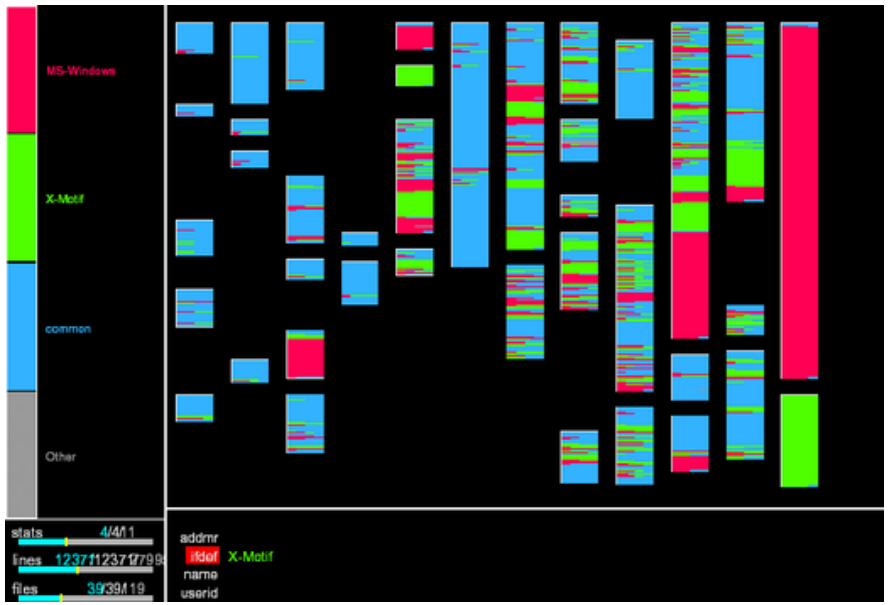


[VisDB: Database Exploration using Multidimensional Visualization, Keim and Kriegel, IEEE CG&A, 1994 www.dbs.informatik.uni-muenchen.de/dbs/projekt/papers/visdb.ps]

Another Pixel-Oriented Example

- SeeSoft from AT&T





[Ball and Eick, Software Visualization in the Large, IEEE Computer 29:4, 1996 citeseer.nj.nec.com/ball96software.html]

VisDB Critique

- pixel-oriented methods have power
- but studies needed
  - are spacefilling curves understandable
  - when does visual complexity overwhelm