State of the Field: InfoVis

Visualization Research Challenges Fall Workshop, NSF/NIH

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Nomenclature

infovis, scivis

foovis, barvis

names are unfortunate historical accidents

- but too late to change

- infovis not unscientific
- scivis not uninformative

not scivis iff data generated by scientists

Infovis/Scivis Distinction

is spatialization given (scivis) or chosen (infovis)

my infovis definition

- interactive visual representation to help person do a particular task

infovis: not just how, also which

- huge space of possibilities: random walk ineffective
- strive to create design guidelines, prescriptive advice

separation

- now judged by somewhat different criteria
  - InfoVis Symposium vs. IEEE Visualization
- funding bases different
  - intelligence vs. simulation

Stages

invention

- invent new visual metaphors

characterization

- when is which metaphor useful: design guidelines

automation

- automatically detemine which to use

scaling

- handling big datasets

State of the Field

conveniently, considerable analysis lately!

- 10th InfoVis symposium in 2004
- InfoVis Contest 04 data: history of the field

influential authors and themes

- extracted from
  www.cs.ubc.ca/~tmm/papers/contest04

Influential Themes

- Focus+Context
  - Mackinlay/Robertson/Card (PARC), Furnas (Bellcore)
- graphic design
  - Tufte (Yale)
- sensemaking
  - PARC [including Rao, Pirolli]
- linked views
  - Cleveland/Becker (Bell Labs)
- high dimensionality
  - Worlds within Worlds, Feiner
  - dimensionality reduction, Chalmers, (PNNL)
- dynamic queries
  - Shneiderman (Maryland)
- zoomable user interfaces [ZUIs]
  - Pad/Pad++, Bederson
  - space-scale diagrams, Furnas

Theme: Focus+Context

merge overview and detail into single view

many names

- Focus+Context [Rao 94]
- nonlinear magnification [Keahey 97]
- fisheye views [Furnas 86, Sarkar 94]
- pliable surfaces [Carpendale 95]
- hyperbolic methods [Lamping 95, Munzner 97]
- stretchable rubber sheets [Sarkar 93, Munzner 03]

navigation/layout technique

- not tied to particular dataset or application

F+C: Generalized Fisheye Views

Furnas (Bellcore), CHI 86

- source code, calendars

```
    1 #define DIG 40
    2 #include <stdio.h>
...4 main()
    5 {
    6       int c, i, x[DIG/4], t[DIG/4], k = DIG/4, noprint = 0;
...8       while((c=getchar()) != EOF){
    9             if(c >= '0' && c <= '9'){
...16            } else {
   17                  switch(c){
   18                        case '+':
...27                        case '-':
...38                        case 'e':
 >>39                             for(i=0;i<k;i++) t[i] = x[i];
   40                             break;
   41                        case 'q':
...43                        default:
...46                  }
   47                  if(!noprint){
...57                  }
   58            }
   59            noprint = 0;
   60      }
   61 }
```

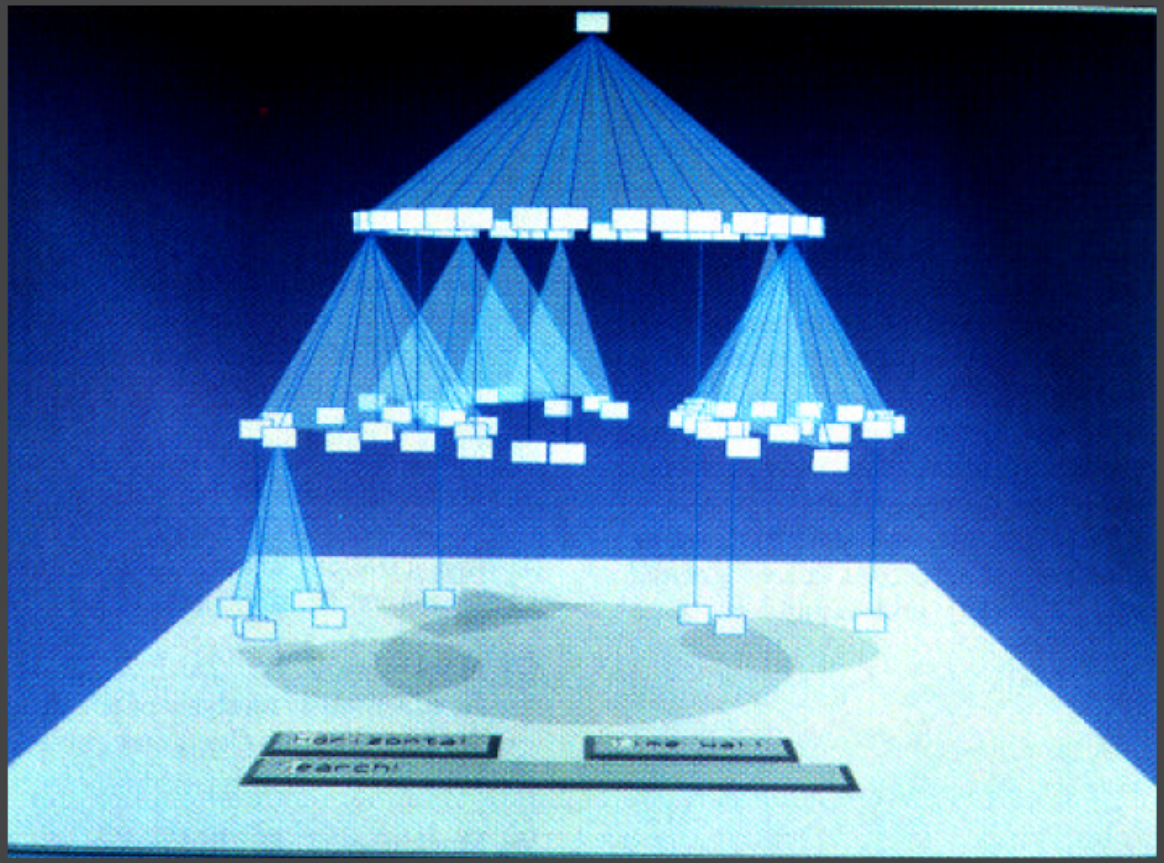
Figure 4. A fisheye view of the C program. Line numbers are in the left margin. "..." indicates missing lines.

[George W. Furnas, Generalized Fisheye Views. SIGCHI 86, www.si.umich.edu/~furnas/Papers/FisheyeCHI86.pdf]

F+C: Cone Trees

Robertson, Mackinlay, and Card (PARC), CHI 91

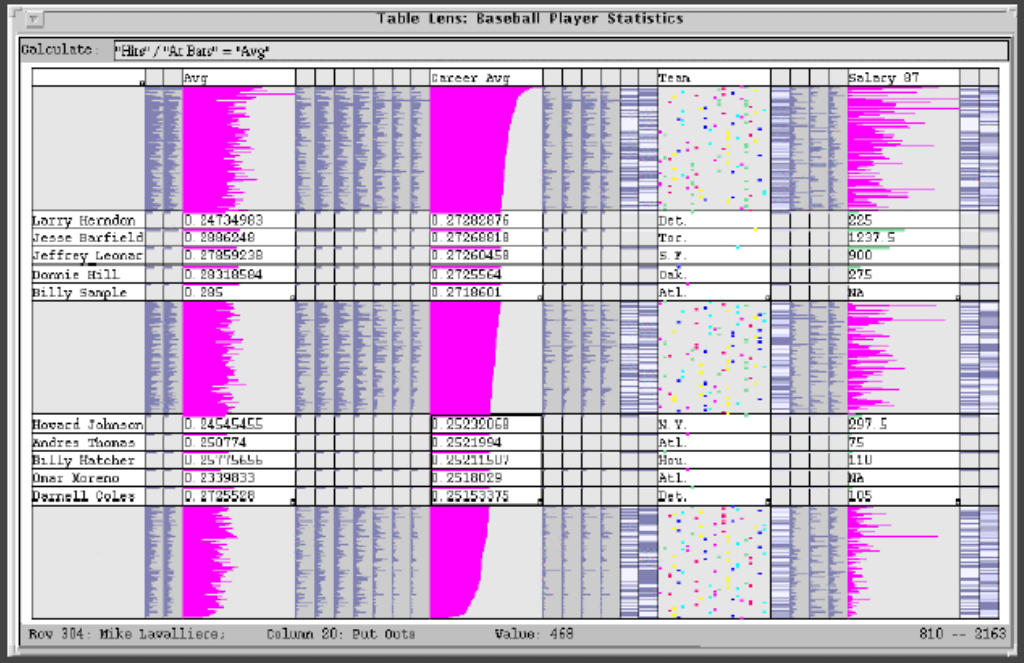
- org charts, filesystems



F+C: Table Lens

Rao and Card (PARC), CHI 94

- spreadsheets

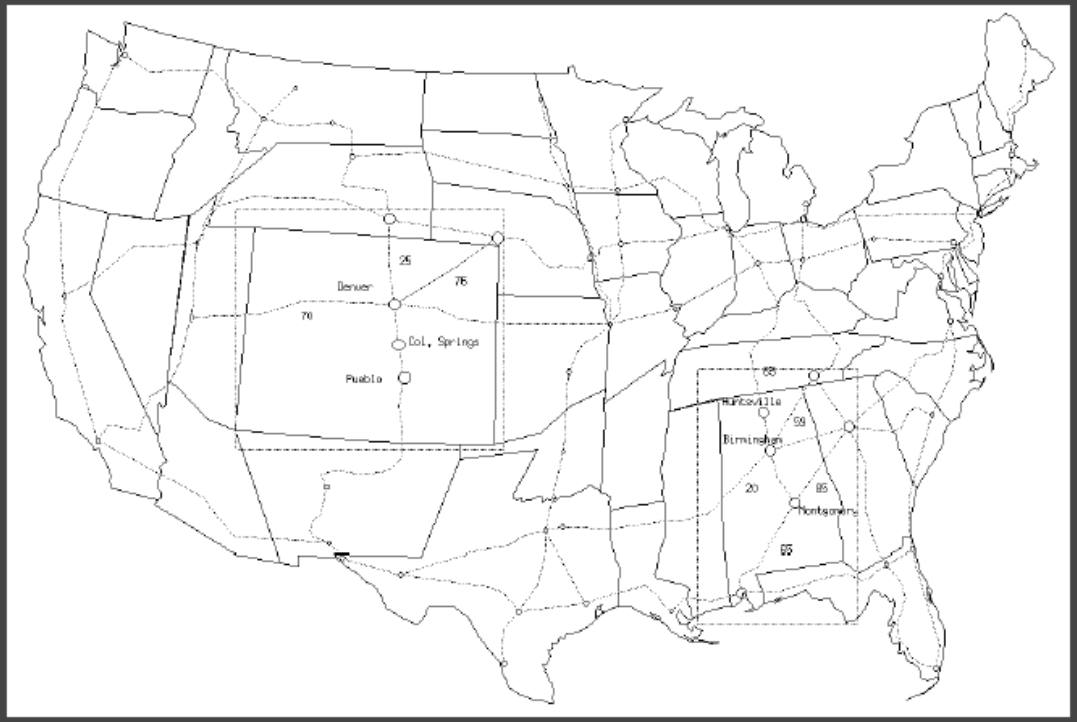


[The Table Lens: Merging Graphical and Symbolic Representations in an Interactive Focus + Context Visualization for Tabular Information. Ramana Rao and Stuart Card, SIGCHI 94, citeseer.nj.nec.com/545353.html]

F+C: Stretchable Rubber Sheets

Sarkar et al (Brown), UIST 93

- maps



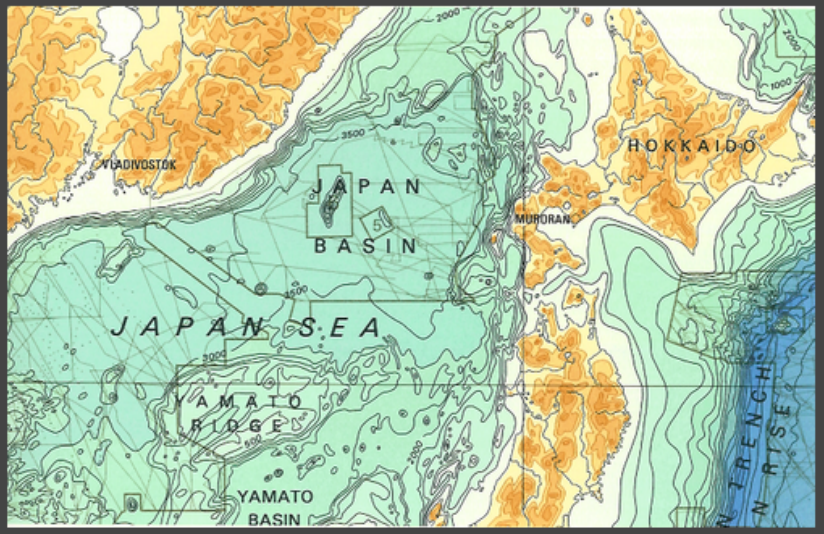
[Stretching the Rubber Sheet: A Metaphor for Viewing Large Layouts on Small Screens.
Manojit Sarkar, Scott S. Snibbe, Oren J. Tversky, Steven P. Reiss. UIST 93, citeseer.ist.psu.edu/sarkar93stretching.html]

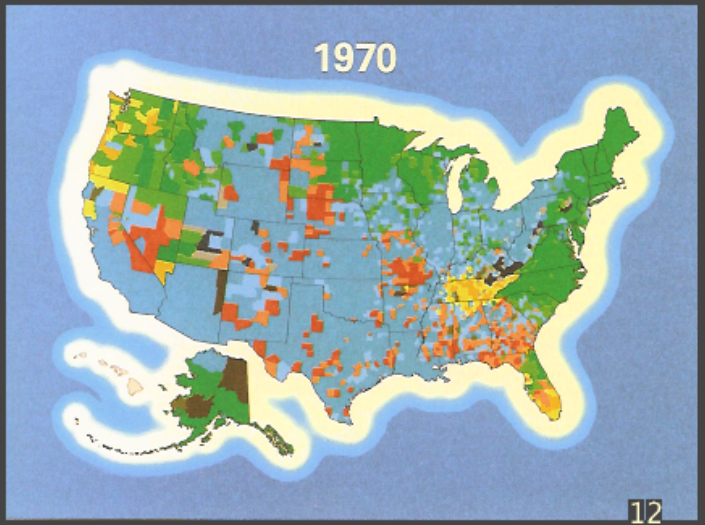
Theme: Graphic Design

Tufte trilogy (Yale): curated design gallery

- The Visual Display of Quantitative Information
- Envisioning Information
- Visual Explanations

guidelines only for explanatory, not exploratory!





[Edward Tufte, Envisioning Information, p 91 & 82]

Theme: Big Picture

PARC (including Pirolli)

sensemaking

- understand large document collections
- very high-level task
- information foraging

cognitive co-processor

- architecture for interactivity

big picture, beyond single visual metaphor

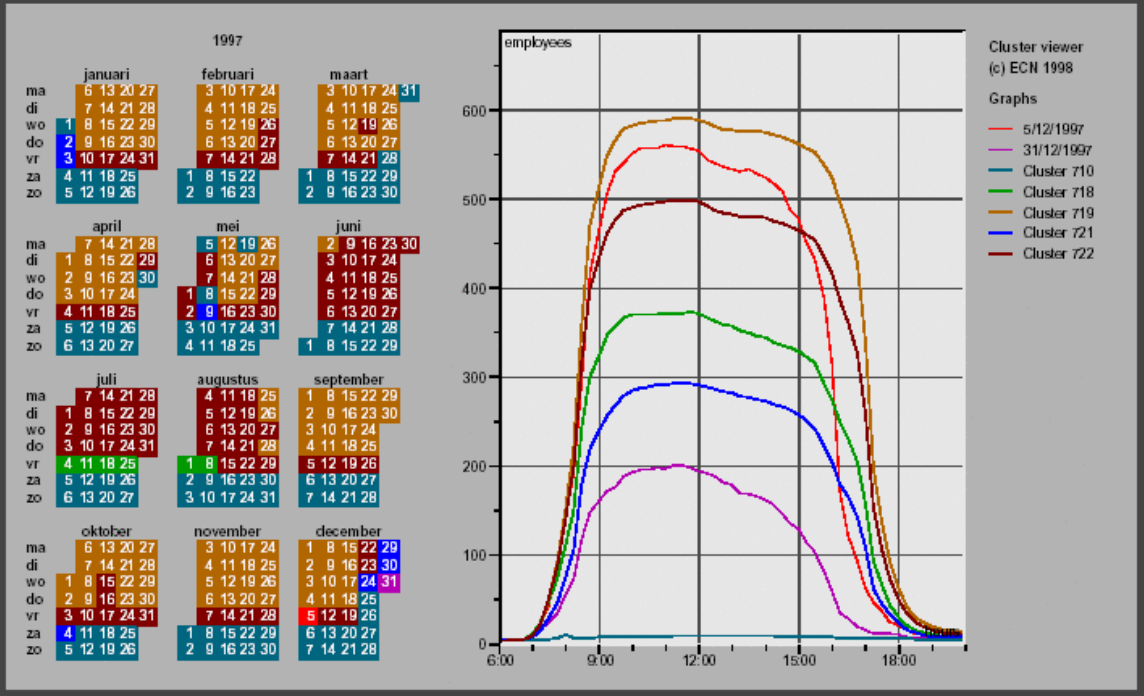
Theme: Linked Views

Cleveland and Becker (Bell Labs)

- Brushing Scatterplots, 1988.

van Wijk and van Selow (Eindhoven)

- Cluster-Calendar, InfoVis 99

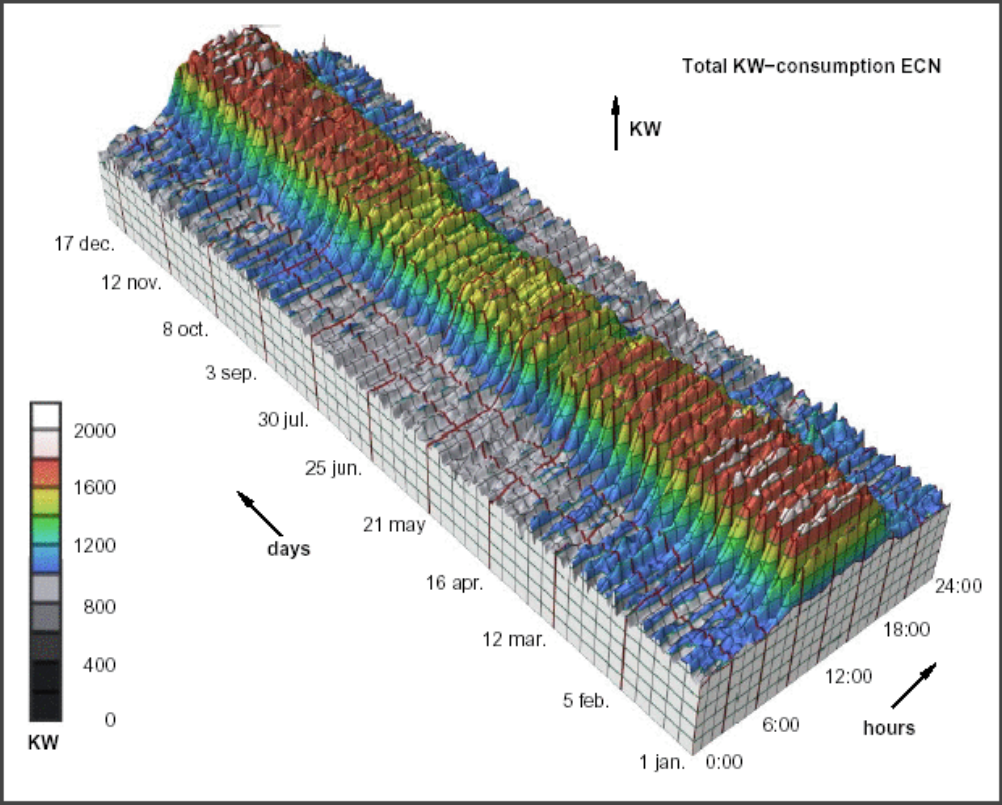


[Cluster and Calender based Visualization of Time Series Data.Jarke J. van Wijk and Edward R. van Selow, InfoVis 99, citeseer.nj.nec.com/vanwijk99

Issue: 3D vs. 2D

3D extrusion pretty but not useful

- daily, weekly patterns hard to see

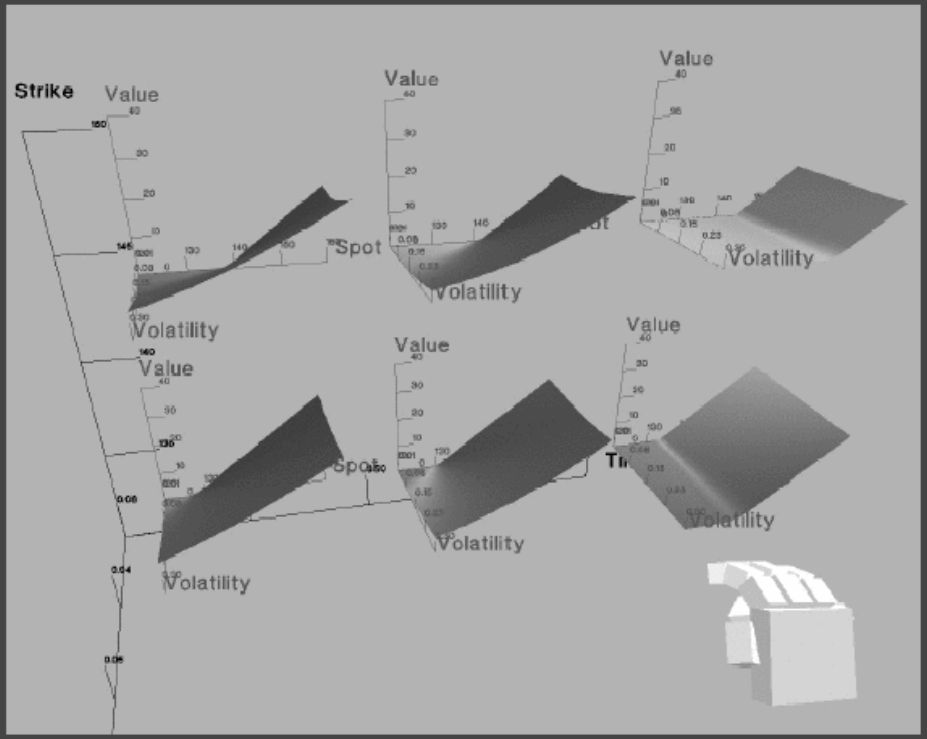


[Cluster and Calender based Visualization of Time Series Data.Jarke J. van Wijk and Edward R. van Selow, InfoVis 99, citeseer.nj.nec.com/vanwijk99cluster.html]

Theme: High Dimensionality

low-high: 4-10 dimensions

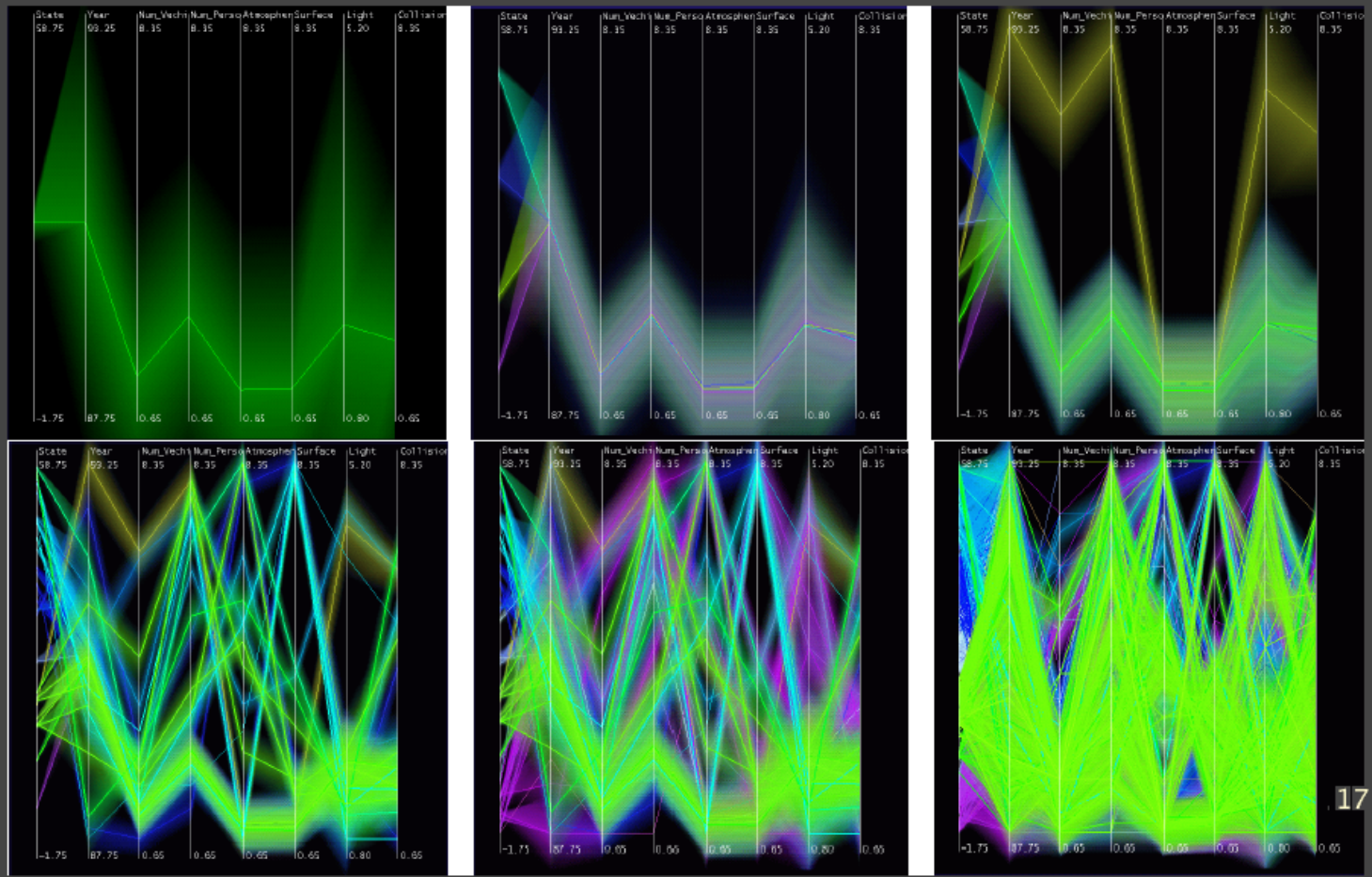
- Worlds within Worlds, n-Vision
- Feiner and Besher (Columbia), UIST 90



[Worlds within Worlds: Metaphors for Exploring n-Dimensional Virtual Worlds. Steven Feiner and Clifford Beshers, UIST 90]

HighD: Parallel Coordinates

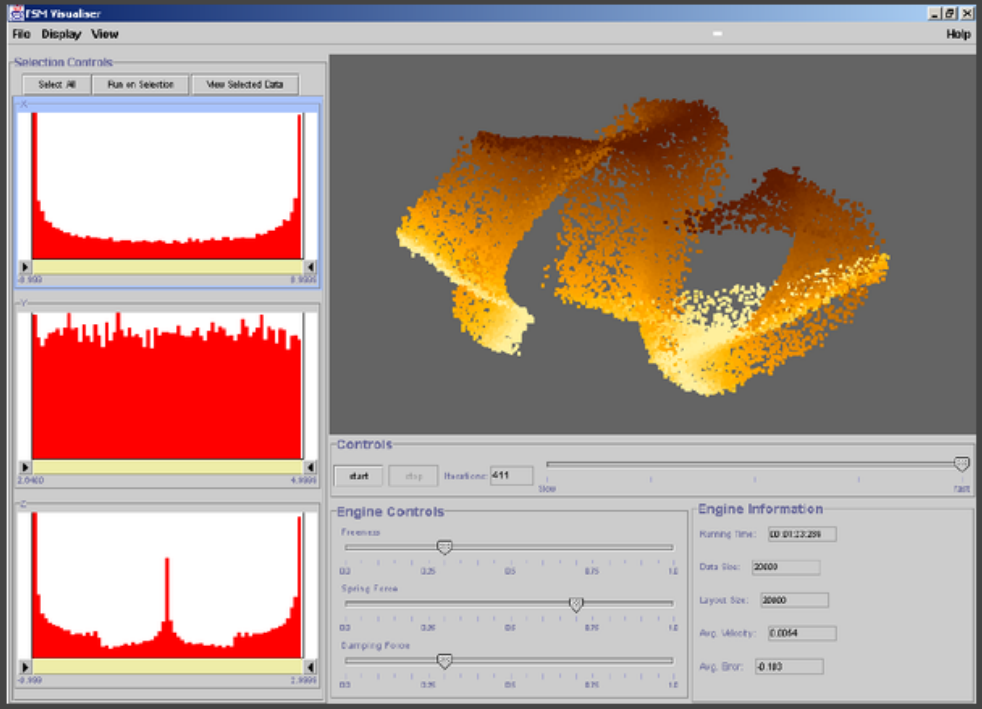
- medium-high: dozens. Inselberg/Wegman, 89-90



HighD: Dimensionality Reduction

high-high: dozens or hundreds of dimensions

- multidimensional scaling, Chalmers

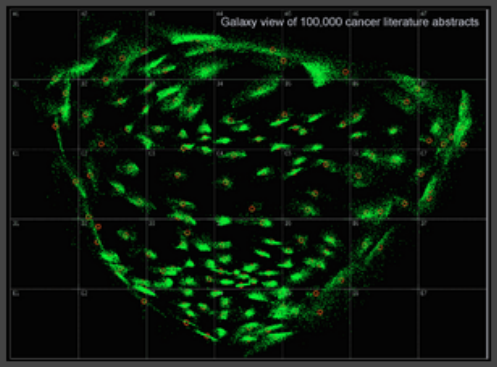


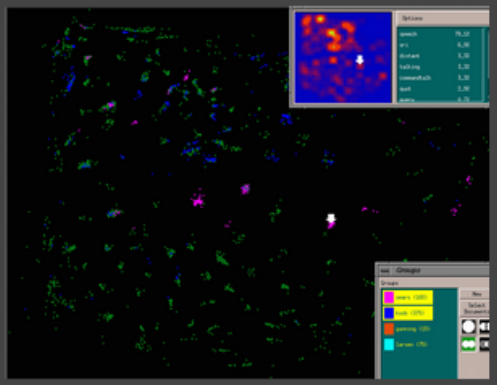
[Fast Multidimensional Scaling through Sampling, Springs and Interpolation. Alistair Morrison, Greg Ross, Matthew Chalmers, Information Visualization 2(1) March 2003]

HighD: Themescapes/Galaxies

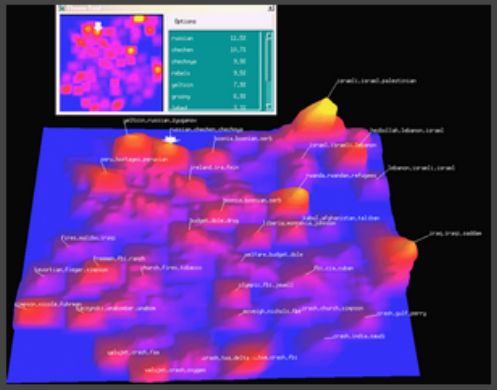
MDS output: beyond just drawing points (PNNL)

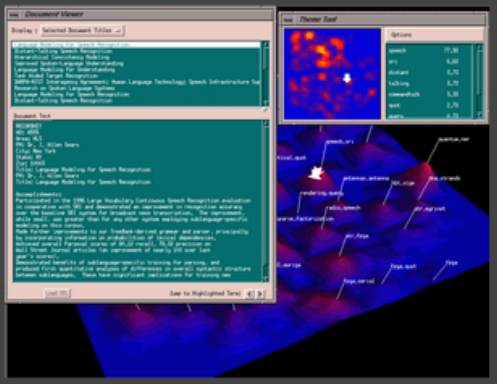
- galaxies: aggregation





- themescapes: terrain/landscapes

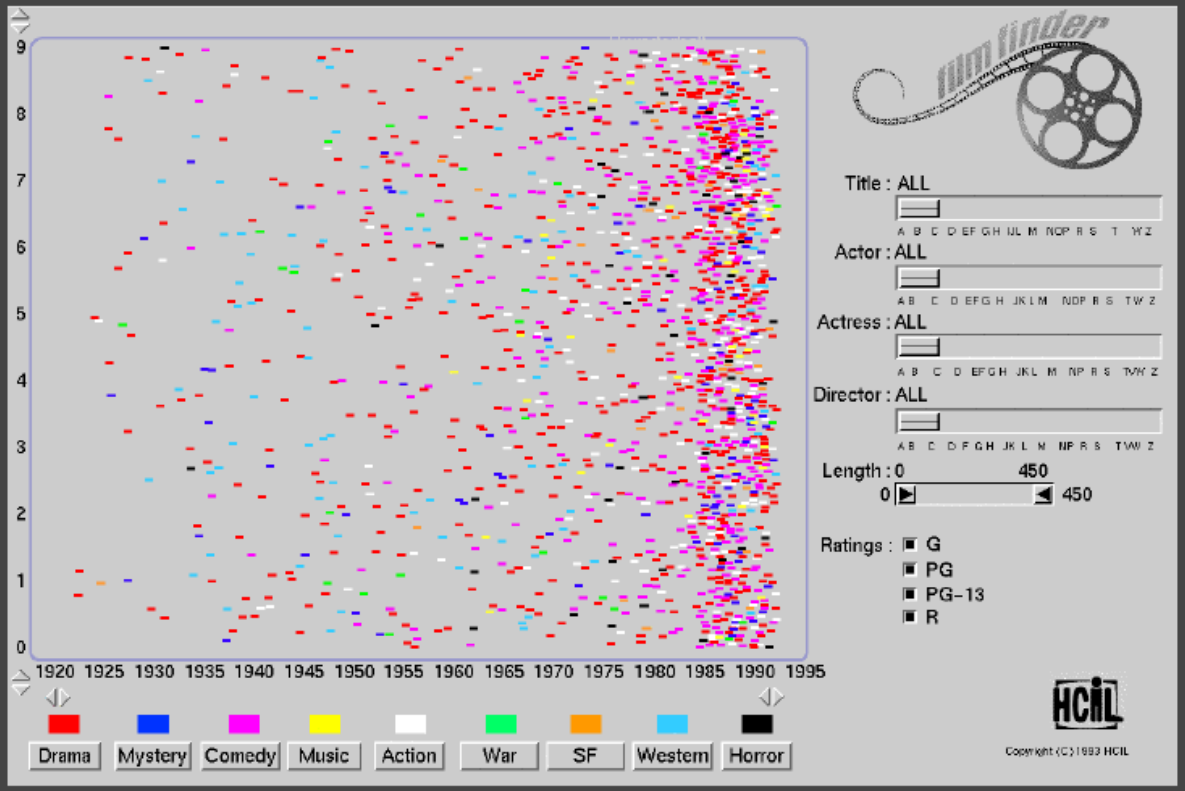




Theme: Dynamic Queries

Ahlberg and Shneiderman (Maryland), CHI 94

- databases: real estate, movies



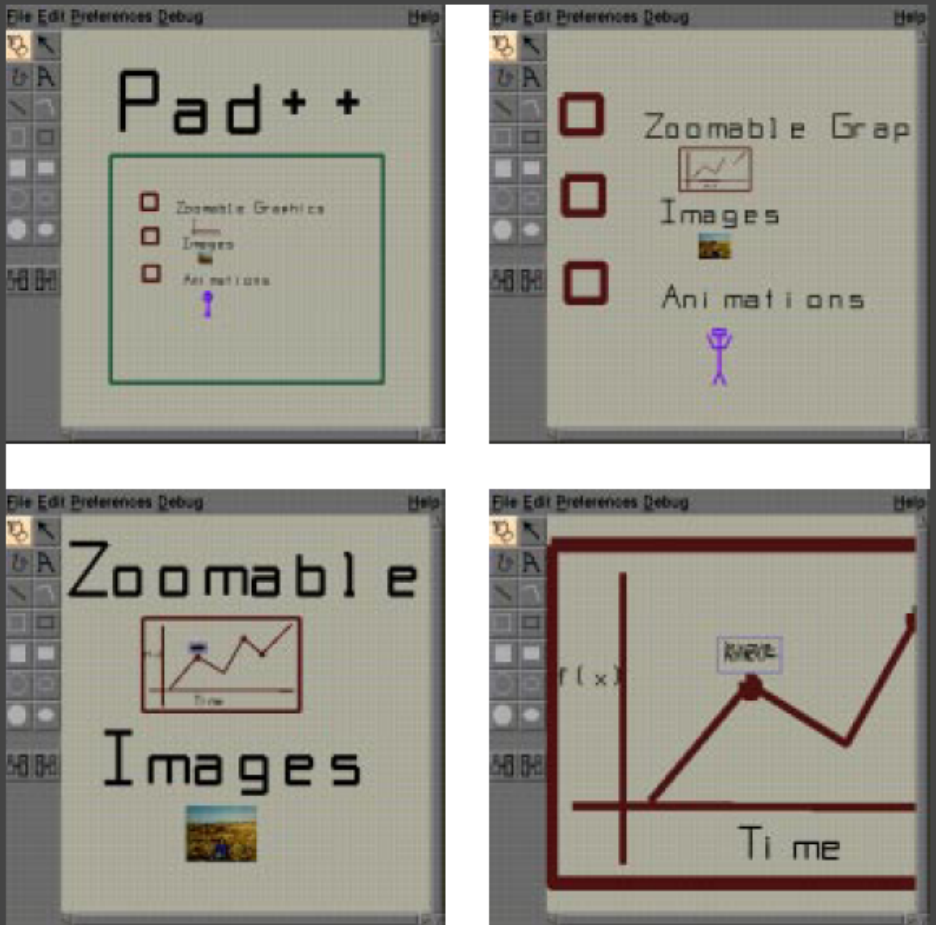
[Visual information seeking: Tight coupling of dynamic query filters with starfield displays. Chris Ahlberg and Ben Shneiderman, SIGCHI '94]

Theme: ZUI/Level of Detail

zoomable user interfaces
space-scale diagrams
navigation trajectories
multiscale views

ZUI/LOD: Pad++

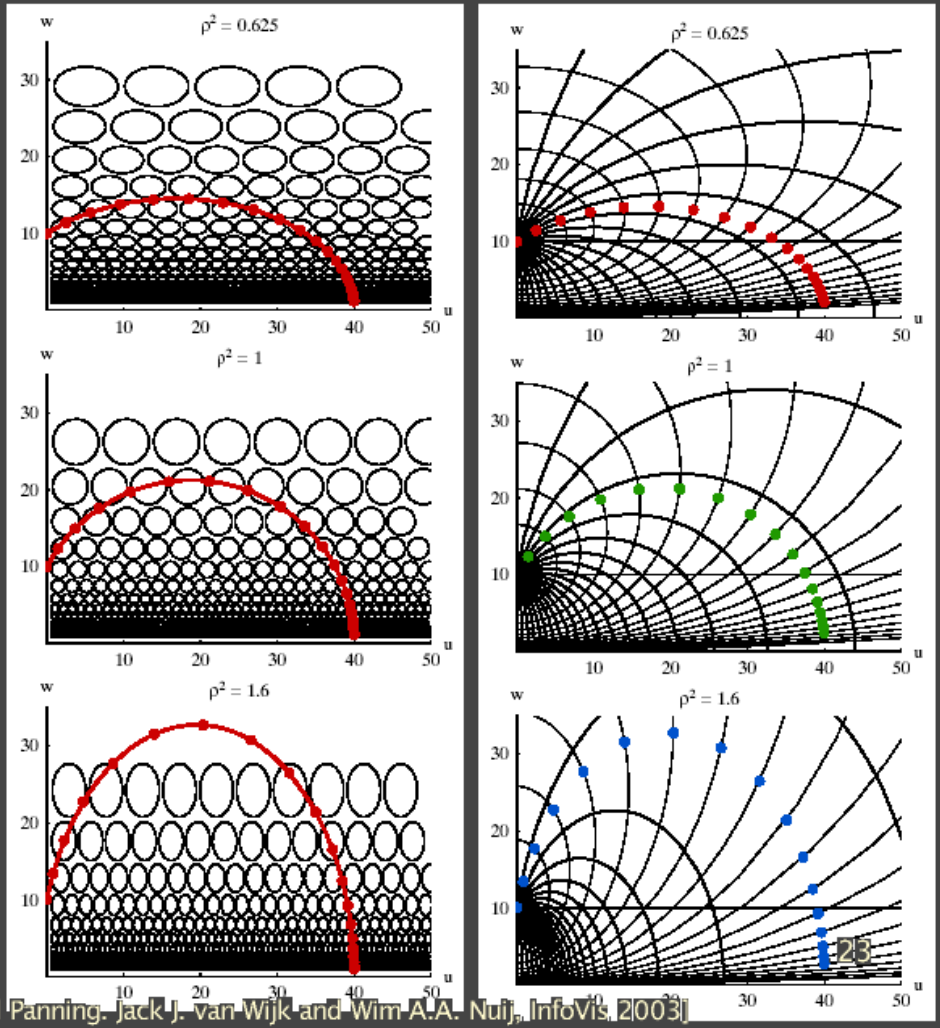
Bederson (Bellcore) and Hollan, UIST 94



ZUI/LOD: Navigation Trajectories

at each step, cross same number of ellipses

cross minimal number of ellipses total

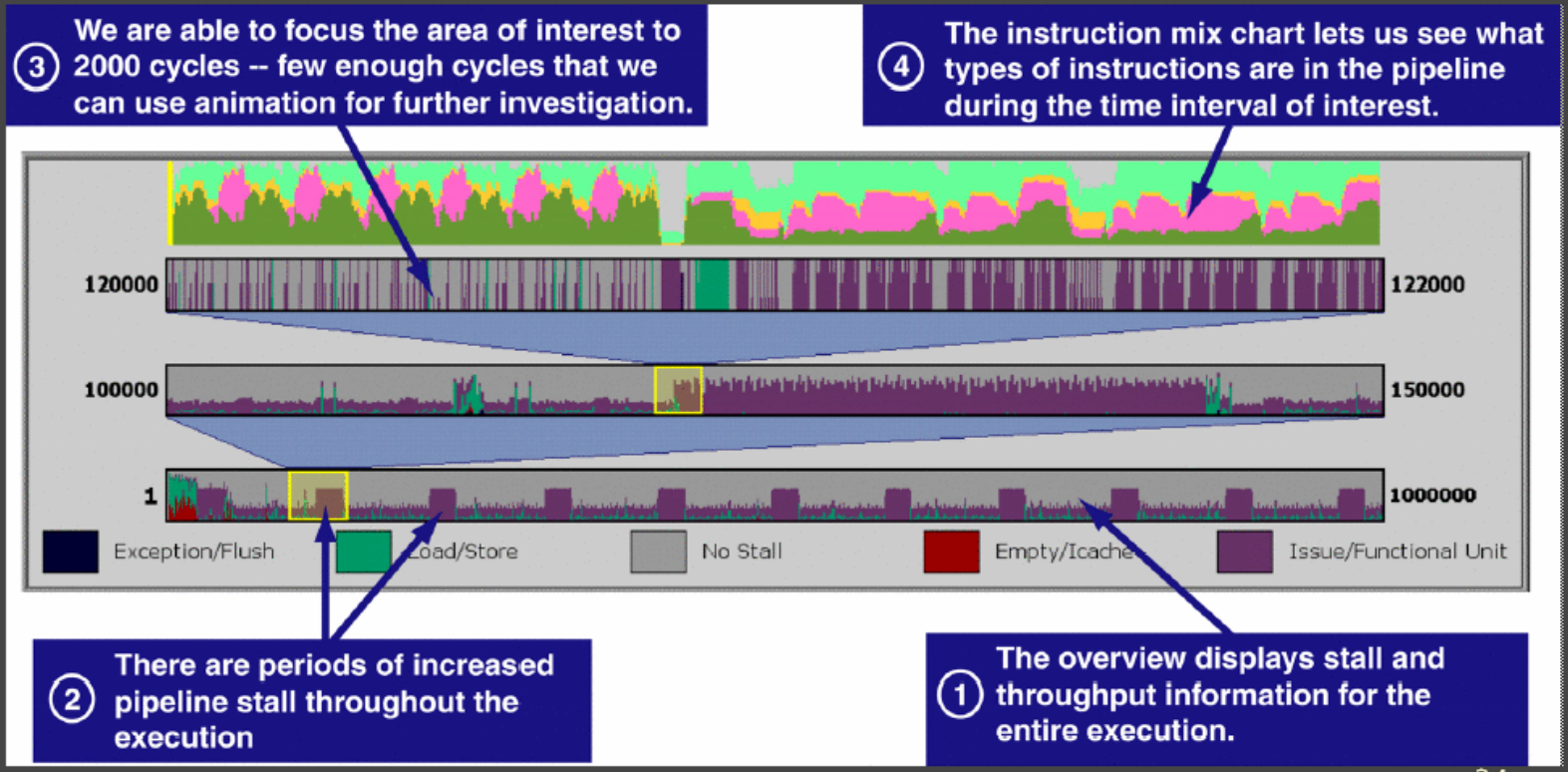


[Smooth and Efficient Zooming and Panning. Jack J. van Wijk and Wim A.A. Nuij, InfoVis 2003]

ZUI/LOD: Level of detail

Rivet: Stolte et al, InfoVis 99

- processor performance tuning



[Visualizing Application Behavior on Superscalar Processors. Stolte, Bosch, Hanrahan, Rosenblum. InfoVis 99, graphics.stanford.edu/papers/rivet_pipeline]

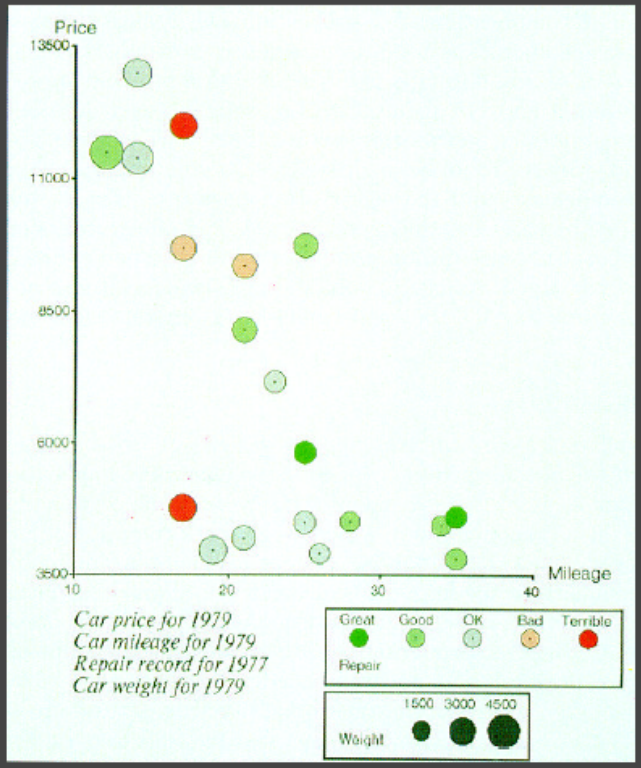
Other Important Ideas

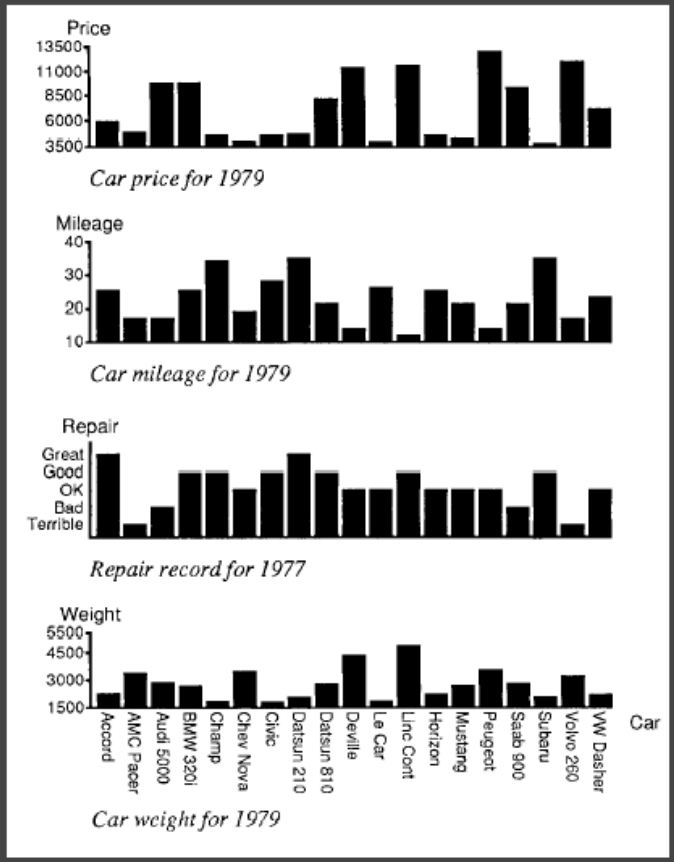
automatic design
pixel-oriented techniques
scalability

Automatic Design

APT, Jock Mackinlay PhD (Stanford), 1986

- later: SAGE, Roth (CMU)

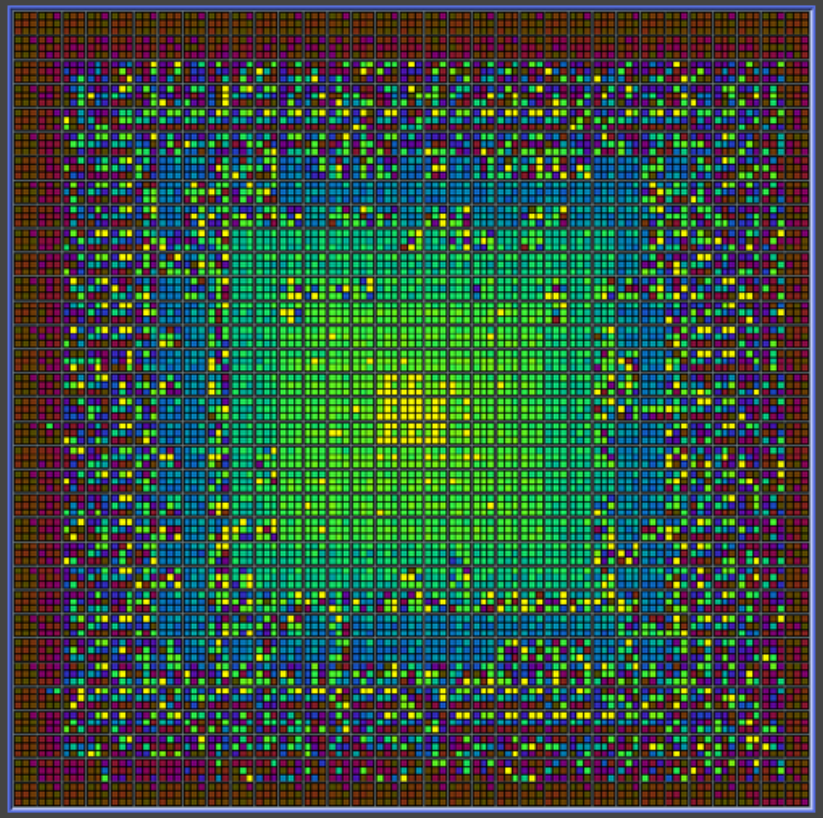




Pixel-Oriented Techniquese: VisDB

Keim and Kriegel, IEEE CG&A 1994

- databases



[VisDB: Database Exploration using Multidimensional Visualization. Daniel A. Keim and Hans-Peter Kriegel, IEEE CG&A, 1994]

Pixel-Oriented Techniquese: SeeSoft

Ball and Eick, Bell Labs, IEEE Computer 1996

- software engineering

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

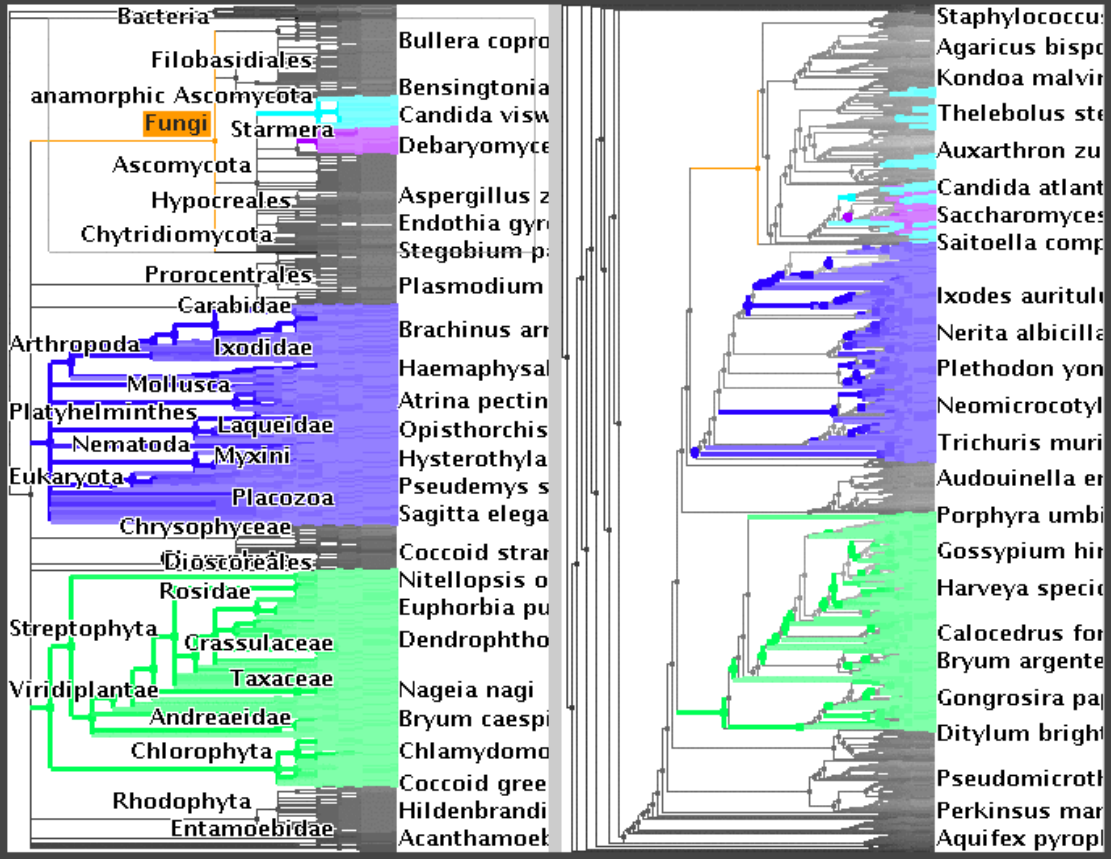
Pixel-Oriented Techniques: displays

high resolution

- large size
- immersiveness

Scaling Up: Stretchable Rubber Sheets

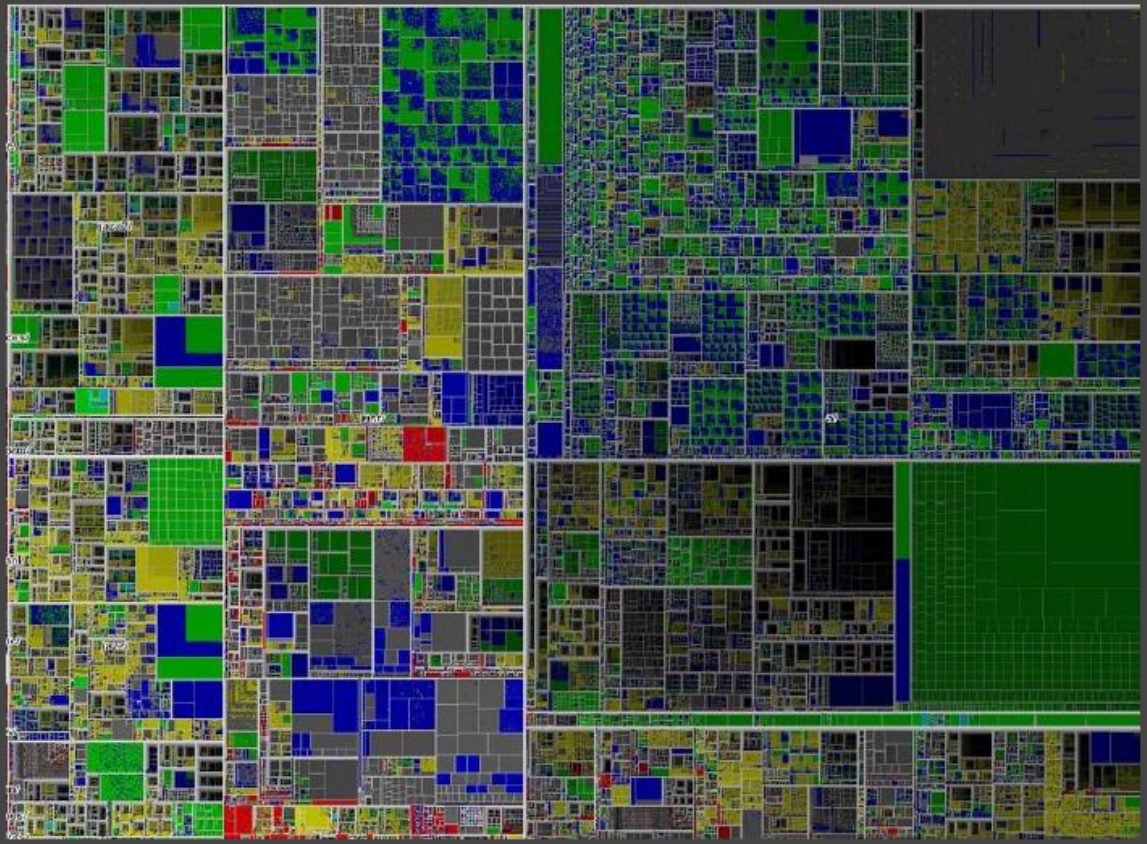
TreeJuxtaposer, Munzner et al, SIGGRAPH 2003



[TreeJuxtaposer: Scalable Tree Comparison using Focus+Context with Guaranteed Visibility. Tamara Munzner, Francois Guimbretiere, Serdar Tasiran, Li Zhang, and Yunhong Zhou, SIGGRAPH 2003, www.cs.ubc.ca/~tmm/papers/tj]

Scaling Up: Treemaps

MillionVis, Fekete and Plaisant, InfoVis 2002



[Interactive Information Visualization of a Million Items. Jean-Daniel Fekete and Catherine Plaisant, InfoVis 2002]

State of Infovis (vs. Scivis)

strengths

- abstraction
- creating new visual metaphors
- design principles
- evaluation
- tasks, connection with users

weaknesses

- scalability
- adoption
- novelty for novelty's sake with visual metaphors
  - need to characterize when effective
  - hard to make effective ones

significant counterexamples both ways!