State of the Field: InfoVis

Visualization Research Challenges
Fall Workshop, NSF/NIH

Tue Sep 21 2004

Tamara Munzner
University of British Columbia CS
Nomenclature

infovis, scivis

foovis, barvis

tnames 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 determine 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, Piroli]

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

```c
#define DIG 40
#include <stdio.h>
...
main()
{
  int c, i, x[DIG/4], t[DIG/4], k = DIG/4, noprint = 0;
...
  while((c=getchar()) != EOF)[
    if(c >= '0' && c <= '9')[
      } else {
        switch(c){
          case '+':
            case '-':
            case '*':
              for(i=0;i<k;i++) t[i] = x[i];
            break;
          case 'q':
            default:
            ...
        }
      }
    if(!noprint){
      ...
    }
    noprint = 0;
  }
}
...
```

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, citeeseer.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)
van Wijk and van Selow (Eindhoven)
  · Cluster–Calendar, InfoVis 99
Issue: 3D vs. 2D

3D extrusion pretty but not useful
- daily, weekly patterns hard to see

Theme: High Dimensionality

low–high: 4–10 dimensions

- Worlds within Worlds, n–Vision
- Feiner and Besher (Columbia), 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 U. van Wijk and Wim A. A. Nuij, InfoVis, 2003]
ZUI/LOD: Level of detail

Rivet: Stolte et al, InfoVis 99
· processor performance tuning

3. We are able to focus the area of interest to 2000 cycles -- few enough cycles that we can use animation for further investigation.

4. The instruction mix chart lets us see what types of instructions are in the pipeline during the time interval of interest.

2. There are periods of increased pipeline stall throughout the execution.

1. The overview displays stall and throughput information for the entire execution.

[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

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
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!