Lecture 3, InfoVis MiniCourse

Navigation/Zooming, Focus+Context, Graphs/Trees, Scalability, Task-Centered Design

LaBRI, University of Bordeaux
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Mini-Course Outline

Perception
Frameworks
Color
Space/Order
Depth/Occlusion
High Dimensionality
Interaction
Navigation/Zooming
Focus+Context
Graphs/Trees
Scalability
Task-Centered Design
Spatial Navigation

real navigation only partially understood
  · compared to low-level perception, JNDs
  · 3D vs. 2D: we don’t fly, we walk!

spatial memory / environmental cognition
  · city: landmark/path/whole
  · [The Image of the City, Kevin Lynch, MIT Press 1960]

synthetic vs. real displays
  · even perception not always the same!

[Overestimation of heights in virtual reality is influenced more by perceived distal size than by the 2-D versus 3-D dimensionality of the display. Dixon and Proffitt. Perception, 31, 103–112, 2002]
Pad++

"infinitely" zoomable user interface (ZUI)
Space–Scale Diagrams
reasoning about navigation and trajectories

Figure 1. The basic construction of a Space-Scale diagram from a 2D picture.

[Space–Scale Diagrams: Understanding Multiscale Interfaces
George Furnas and Ben Bederson, Proc SIGCHI ’95.
Viewing Window

1D Version

Pan–Zoom Trajectories

Joint Pan–Zoom Problem

Shortest Path?

Shortest Path

Shortest Path, Details

Speed-Dependent Automatic Zooming

automatic zoom
  · amount depends on how far to pan

[demo]
[www-ui.is.s.u-tokyo.ac.jp/~takeo/java/autozoom/autozoom.htm]

[video]
[www-ui.is.s.u-tokyo.ac.jp/~takeo/video/autozoom.mov]

[Speed-Dependent Automatic Zooming for Browsing Large Documents
www-ui.is.s.u-tokyo.ac.jp/~takeo/papers/uist2000.pdf]
Smooth and Efficient Zooming

$uw$ space: $u = \text{pan}$, $w = \text{zoom}$

- horiz axis: cross-section through objects
- point = camera at height $w$ above object
- path = camera path

[Smooth and Efficient Zooming and Panning.
http://www.win.tue.nl/~vanwijk/zoompan.pdf]
Optimal Paths Through Space

at each step, cross same number of ellipses

cross minimal number of ellipses total
Multiscale Display

What's This?

Fisheye Focus+Context View!

leads to next topic...

More Reading

Pad++: A Zooming Graphical Interface for Exploring Alternate Interface Physics
Bederson and Hollan, Proc UIST 94

Space–Scale Diagrams: Understanding Multiscale Interfaces
George Furnas and Ben Bederson, Proc SIGCHI '95.

Speed–Dependent Automatic Zooming for Browsing Large Documents

Smooth and Efficient Zooming and Panning.
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Intuition
move part of surface closer to eye

stretchable rubber sheet
borders tacked down

merge overview and detail into combined view

Bifocal

transformation

magnification

1D

2D
Perspective Wall

transformation

magnification

1D

2D

[A Review and Taxonomy of Distortion-Oriented Presentation Techniques]
Polyfocal: Continuous Mag

transformation  magnification

[1D]

[2D]

[A Review and Taxonomy of Distortion-Oriented Presentation Techniques]
Fisheye Views: Continuous Mag

transformation  magnification

1D  2D rect  polar  norm polar

[A Review and Taxonomy of Distortion-Oriented Presentation Techniques]
Multiple Foci

same params

diff params

polyfocal magnification function dips allow this
Nonlinear Magnification Functions

transformation
  · distortion

magnification
  · derivative of transformation

directionality
  · easy: compute transformation given magnification derivative
  · hard: compute magnification given transformation integration

new mathematical framework
  · approximate integration, iterative refinement
  · minimize "error mesh"

Expressiveness

magnification is more intuitive control

- allow expressiveness, data-driven expansion

2D Hyperbolic Trees

fisheye effect from hyperbolic geometry
3D Hyperbolic Graphs: H3

3D hyperbolic geometry, tree as backbone

[video]
[graphics.stanford.edu/videos/h3]

Layout

problem
  - general problem is NP-hard
Layout

problem
  • general problem is NP-hard

solution
  • tractable spanning tree backbone
  • match mental model
    "quasi–hierarchica"l"
  • use domain knowledge to construct
    select parent from incoming links
Layout

**Problem**
- general problem is NP-hard

**Solution**
- tractable spanning tree backbone
- match mental model "quasi-hierarchical"
- use domain knowledge to construct select parent from incoming links
- non-tree links on demand
Avoiding disorientation

problem

- maintain user orientation when showing detail
- hard for big datasets

exponential in depth: node count, space needed
Overview and detail

two windows: add linked overview
  · cognitive load to correlate

solution
  · merge overview, detail
  · "focus+context"
Progressive rendering

- Want fast update during user interaction
  - Fill in details when user is idle

Guaranteed frame rate algorithm

H3 discussion: scalability

focus + context layout
  • cognitive limit: if graph diameter >> visible area

[http://www.caida.org/tools/measurement/skitter/viz/hypview/mrtdhypgui_hires.gif]
TreeJuxtaposer

keep root, landmark locations visible
  • move from local F+C to global F+C
  • rubber sheet with borders tacked down
  • guaranteed visibility
  • [demo]

More Reading


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Hermann survey

true survey, won't try to summarize here

nice abstraction work by authors
  · Strahler skeletonization
  · ghosting, hiding, grouping
Animated Radial Layouts

static radial layouts: known algorithm

Dynamic Graph Layout

little previous work
  · DynaDAG [North, Graph Drawing 95]
  · DA–TU [Huang, Graph Drawing 98]

minimize visual changes
stay true to current dataset structure

[video]
Animation

polar interpolation

maintain neighbor order

[http://ballando.sims.berkeley.edu/papers/infovis01.htm]
SpaceTree

focus + context tree
  · animated transitions

semantic zooming

[demo]

Treemaps

containment not connection

Node and link diagram  Treemap

difficulties reading
Cushion Treemaps

show structure with shading
· scale parameter controls global vs. local

Cushion Treemaps

application
  · SequoiaView, Windows app
  · hard drive usage
  · http://www.win.tue.nl/sequoiaview/

treemap strength
  · showing an attribute
Graphs: Matrix vs. Node–Link

large software project, implementation vs. spec
link matrix vs. node network

matrix  force-directed  layered subset

Matrices

uniform, recursive, stable
subdivide by
total component count  visible subcomponent count

Zooming

abstraction levels

linear interpolation plus crossfade trajectories: will read van Wijk 03 in week 6
Additional Encoding

color: call allowed by spec
color: local region closest red
transparency: call density

histograms: size distribution

Tasks Successfully Supported

- visual categorization
  - i.e. libraries with mostly incoming calls

- previous summary shown to be incomplete

- spotting unwanted calls

- determining component dependencies
Multiscale Small-World Graphs

More Reading

Graph Visualisation in Information Visualisation: a Survey.
http://citeseer.nj.nec.com/herman00graph.html

Animated Exploration of Graphs with Radial Layout.
http://bailando.sims.berkeley.edu/papers/infovis01.htm


Cushion Treemaps. Jack J. van Wijk and Huub van de Wetering,

Using Multilevel Call Matrices in Large Software Projects.

Multiscale Visualization of Small World Networks.
http://www.lirmm.fr/~fjourdan/Publication/ACJM03.pdf
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Million Items Viz

scaling up treemaps
  · 1600x1200 pixels, million items
item
  · atomic object displayed as distinguishable contiguous area using one viz technique

[Interactive Information Visualization of a Million Items
Jean-Daniel Fekete and Catherine Plaisant, Proc InfoVis 2002
Rendering Techniques

shading not outline
- visually distinguish items with less pixels

show overlap
- calculate with stencil buffer

transparency, stereo
- only for interactive/transient exploring

[Interactive Information Visualization of a Million Items
Jean-Daniel Fekete and Catherine Plaisant, Proc InfoVis 2002
Interaction Techniques

flipping/blinkings
dynamic queries
  - assign depth
  - change Z-buffer with slider
excentric labels

animated transitions
  - stabilized layouts
  - separate translation, scaling
  - switching representations

[no video]
Incremental Dynamic Queries

dynamic queries: user-controlled slider
Data Structures

setup
- data set

selection
- picking particular range slider

querying
- moving the slider

maximum hit set
- state of other sliders
- extreme range of this slider
- precompute bins in the range so slider movement fast
Critique

good: complexity analysis

bad: far too little detail to replicate

- nothing on incremental rendering
- insufficient on computation data structures
More Reading

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

Design and Evaluation of Incremental Data Structures and Algorithms
for Dynamic Query Interfaces. Egemen Tanin, Richard Beigel, Ben
Shneiderman, Proc. InfoVis 1997
http://citeseer.nj.nec.com/tanin97research.html
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Task Analysis

what is the user's general job?
how might infovis help – specific tasks?

do humans need to keep model of complex data inside head?
  · if small dataset, maybe don't need infovis
  · if humans don't need to directly understand, automate instead of visualize!

working directly with users very helpful
  · driving problems keeps you honest
  · they know tasks
  · you know design possibilities
Methodology

iterative refinement
  · user is not always right
  · initial discussion is start, not end

scenario
  · exactly how would tool be used
  · detailed examples

mockup
  · sketch on paper what interface would look like
  · much less work than programming
  · can try and discuss several alternatives

cognitive walkthrough
  · think about places where users might make mistakes
Evaluation

adoption
  · is it used?

anecdotal
  · did somebody discover something?

formal user studies
  · large groups for statistical significance
  · show it was XX% faster or YY% fewer errors
  · cannot design good experiment without training!
  · collaborate with psychologist, HCI

informal usability evaluations
  · generally much faster

justify design given conceptual framework
  · visual encoding given task and data
More Reading

Task-Centered User Interface Design
Clayton Lewis and John Rieman

entire short book available online as shareware
http://hcibib.org/tcuid/