Lecture 11: Navigation

Information Visualization
CPSC 533C, Fall 2007

Tamara Munzner

UBC Computer Science

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Readings Covered

Ware, Chap 10: Interacting With Visualizations (2nd half)

Tufte, Chap 2: Macro/Micro

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

Smooth and Efficient Zooming and Panning. Jack J. van Wijk and Wim A.A. Nuij, Proc. InfoVis 2003, p. 15-22

OrthoZoom Scroller: 1D Multi-Scale Navigation. Catherine Appert and Jean-Daniel Fekete. Proc. SIGCHI 06, pp 21-30.

Further Reading

Speed-Dependent Automatic Zooming for Browsing Large Documents Takeo Igarashi and Ken Hinckley, Proc. UIST 00, pp. 139-148.

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

Rapid Controlled Movement Through a Virtual 3D Workspace Jock Mackinlay, Stuart Card, and George Robertson. Proc SIGGRAPH '90, pp 171-176.

Effective View Navigation, George W. Furnas, Proc. SIGCHI 97, pp. 367-374

Critical Zones in Desert Fog: Aids to Multiscale Navigation, Susanne Jul and George W. Furnas, Proc. UIST 98

Design Guidelines for Landmarks to Support Navigation in Virtual Environments Norman G. Vinson, Proc. SIGCHI 99.

Tuning and testing scrolling interfaces that automatically zoom Andy Cockburn, Joshua Savage, Andrew Wallace. Proc CHI 05.

What Kind of Motion?

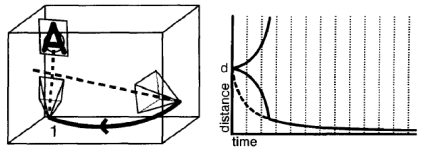
- rigid
  - rotate/pan/zoom
  - easy to understand
  - object shape static, positions change
- morph/change/distort
  - object evolves
    - beating heart, thunderstorm, walking person
  - multiscale/ZUI
    - object appearance changes by viewpoint
  - focus+context
    - carefully chosen distortion

Ware Chapter 10 - Spatial Navigation

- world in hand
  - good: spinning discrete objects
  - bad: large-scale terrain
- eye in hand
  - explicitly move camera
- walking
  - real-world walking
  - terrain following
- flying
  - unconstrained 6DOF navigation
- other: constrained navigation!

Rapid Controlled Movement

- move to selected point of interest
  - normal to surface, logarithmic speed
- trajectories as first-class objects



[Rapid Controlled Movement Through a Virtual 3D Workspace. Mackinlay, Card, and Robertson. Proc SIGGRAPH '90, pp 171-176.]

Spatial Navigation

- real navigation only partially understood
  - compared to low-level perception, JNDs
- spatial memory / environmental cognition
  - city: landmark/path/whole
- implicit logic
  - evolved to deal with reality
  - so we'll learn from synthetic worlds
  - but we can't fly in 3D...
- how much applies to synthetic environments?
  - even perception not always the same!

Design Guidelines for VE Landmarks

- Ware's derived guidelines
  - enough so always can see some
  - visually distinguishable from others
  - visible and recognizeable at all scales
  - placed at major paths/junctions
- others, only some of of these crossover for infovis!
  - need all 5 types of landmarks
    - path,edge,district,node,landmark
  - concrete not abstract
  - asymmetry: different sides looks different
  - clumps
  - different from "data objects"
  - need grid structure, alignment

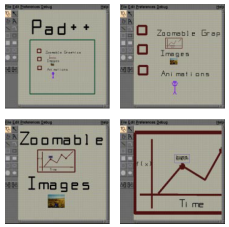
[Design Guidelines for Landmarks to Support Navigation in Virtual Environments. Vinson, Proc. SIGCHI 99.]

Macro/Micro

- classic example: map
  - arms-length vs. up-close
- paper vs. computer screen
  - 300-600 dpi vs. 72 dpi (legally blind)
  - finally changing
- possibly available for projects
  - 22" 200dpi IBM T221 display
  - 9 Mpixels (4000x2000)

Pad++

- "infinitely" zoomable user interface (ZUI) [video]



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

Space-Scale Diagrams

- reasoning about navigation and trajectories

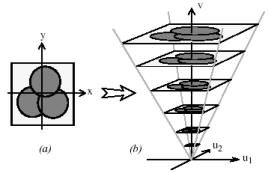
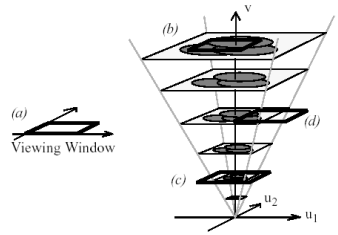


Figure 1. *The basic construction of a Space-Scale diagram from a 2D picture.*

Space-Scale Diagrams: Understanding Multiscale Interfaces George Furnas and Ben Bederson, Proc SIGCHI '95. www.cs.umd.edu/hcil/pad++/papers/chi-95-spacescale/chi-95-spacescale.pdf

Viewing Window



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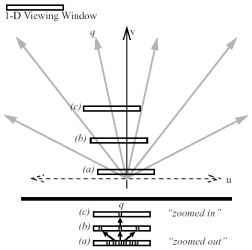
1D Version



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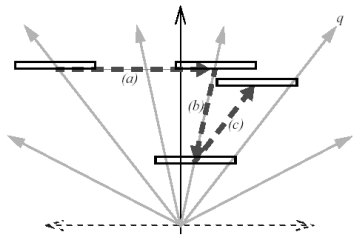
Pan-Zoom Trajectories



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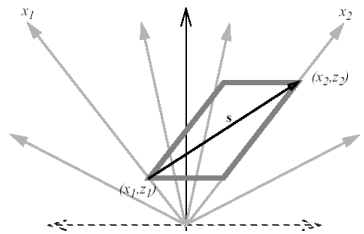
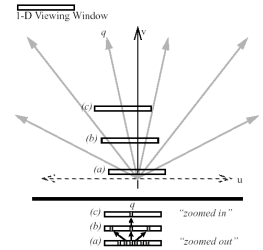
Joint Pan-Zoom Problem



Space-Scale Diagrams: Understanding Multiscale Interfaces George Furnas and Ben Bederson, Proc SIGCHI '95. www.cs.umd.edu/hcil/pad++/papers/chi-95-spacescale/chi-95-spacescale.pdf

Shortest Path?



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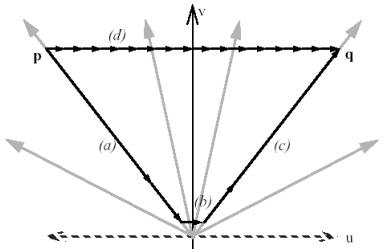
Shortest Path



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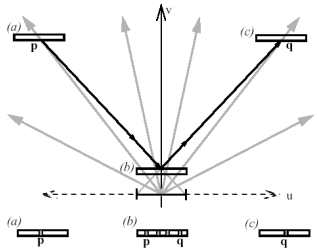
Shortest Path, Details



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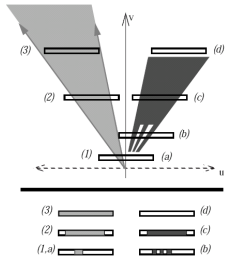
Semantic Zooming



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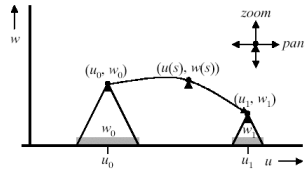
Smooth and Efficient Zooming

- uw space: u = pan, w = zoom
  - horiz axis: cross-section through objects
  - point = camera at height w above object
  - path = camera path



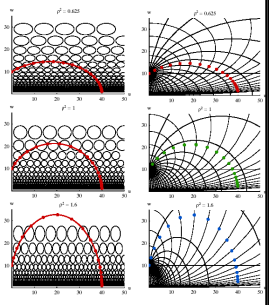
Smooth and Efficient Zooming and Panning. Jack J. van Wijk and Wim A.A. Nuij, Proc. InfoVis 2003, p. 15-22

Optimal Paths Through Space

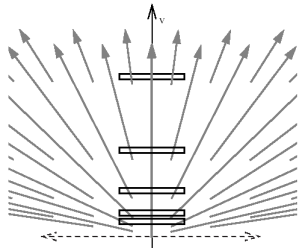
at each step, cross same number of ellipses cross

minimal number of ellipses total Smooth and Efficient

Zooming and Panning. Jack J. van Wijk and Wim A.A. Nuij, Proc. InfoVis 2003, p. 15-22



Multiscale Display



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Multiscale Desert Fog

- Critical Zones in Desert Fog: Aids to Multiscale Navigation
  - Susanne Jul, George W. Furnas UIST 98
- environment devoid of navigational cues
  - not just Pad: 6DOF navigation where object fills view
- designer strategies
  - explicit world creation - fog not made on purpose
    - games - partial counter example
  - island of information surrounded by desert fog
- Pad: min/max visibility distances

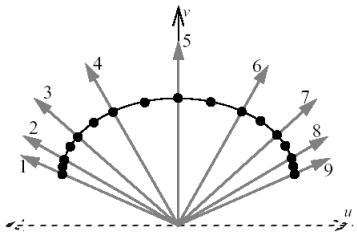
View-Navigation Theory

- Effective View Navigation, CHI 97
  - George Furnas
- characterizing navigability: viewing graph
  - nodes: views
  - links: traversible connections
- 1. short paths between all nodes
  - true in ZUIs (e.g. speed-dependent zooming)
- 2. all views have small number outlinks
  - not overwhelmed by choices

Critical Zones

- region where zoom-in brings interesting views
  - show with navigation "residue"
- unambiguous action choice
  - visible critical zone "residue" of stuff beneath
  - zoom out if see nothing
- extension to VN theory
  - 3. all views contain good residue of all nodes
  - 4. all links must have small outlink-info
  - must build support for these into ZUIs
- do not have "minsize", always use a few pixels
  - they don't address clutter/scalability

What's This?



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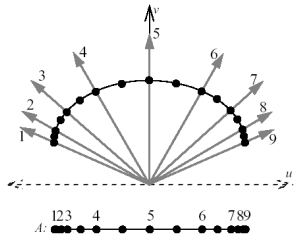
Fisheye Focus+Context View!



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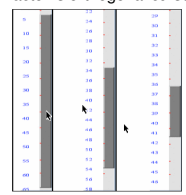
OrthoZoom

- scale/zoom ratio target: 32 bits, 1:3B
  - index of difficulty: ID = $\log(1 + D/W)$
  - D = target distance, W = target size
- control area larger than graphical representation
  - zoom factor is orthogonal cursor-slider distance



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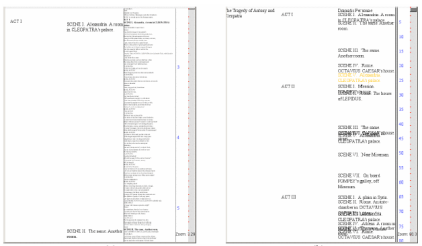
OrthoZoom

- multi-scale table of contents



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