Lecture 9: Navigation/Zooming

Information Visualization
CPSC 533C, Fall 2009

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Wed, 7 October 2009

News - again

- no class next week (Mon Tgiving, Wed also no class)
- project meetings required by Fri Oct 23
  - I'm gone all next week
  - so only 2 weeks left - this one + week after next!

Readings Covered

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

Tufte, Chap 2: Macro/Micro

A review of overview+detail, zooming, and focus+context interfaces. Andy Cockburn, Amy Karlson, and Benjamin B. Bederson. ACM Computing Surveys 41(1), 2008.

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

Further Reading

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

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.

What Kind of Motion?

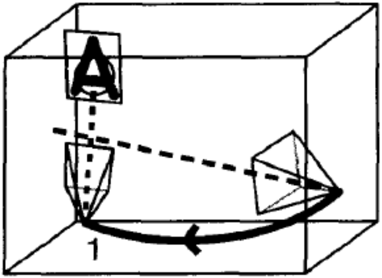
- rigid
  - rotate/pan/zoom
  - easy to understand
  - object shape static, positions change
- morph/change/distort
  - object evolves
    - beating heart, thunderstorm, walking person
  - multiscale/ZUI
    - object appearance changes by viewpoint
  - focus+context
    - carefully chosen distortion

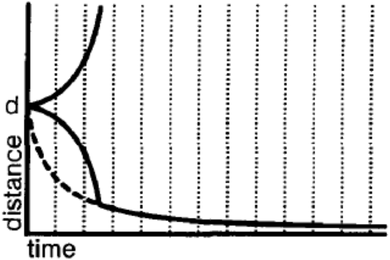
Ware Chapter 10 - Spatial Navigation

- 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!
  - covered more in Cockburn survey

Rapid Controlled Movement

- move to selected point of interest
    - normal to surface, logarithmic speed
- constrained motion example





[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 relevant 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.]

Survey

- taxonomy
  - overview+detail: spatial separation
  - zooming: temporal separation
  - focus+context: integrated

  - cue-based: selectively highlight/suppress
    - crosscutting
- structure
  - describe technique
  - empirical study results
    - low-level task: target acquisition
    - high-level task: explore search space

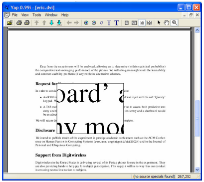
A review of overview+detail, zooming, and focus+context interfaces. Andy Cockburn, Amy Karlson, and Benjamin B. Bederson. ACM Computing Surveys 41(1), 2008.

Overview+Detail

A review of overview+detail, zooming, and focus+context interfaces. Andy Cockburn, Amy Karlson, and Benjamin B. Bederson. ACM Computing Surveys 41(1), 2008.

Overview+Detail Issues

- linked navigation
  - shortcut navigation, thumbnail to detail
  - explore overview without changing detail
    - if fully synchronized could not explore
  - detail changes immediately shown in overview
- their defn: lens as O+D
  - since O and D separated in z/depth
  - nonstandard usage, I'm not a fan



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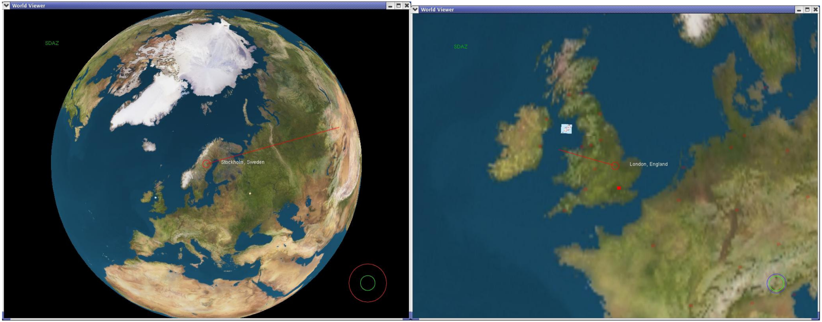
Zooming



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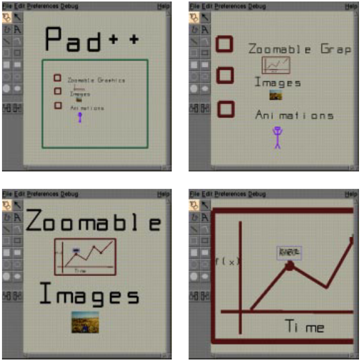
Zooming

- standard zooming
  - hard to make intuitive zoomout control
- semantic zooming
  - different representations at different scales
  - zoomable user interfaces (ZUIs)
- space-scale diagrams
- challenge: stability

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

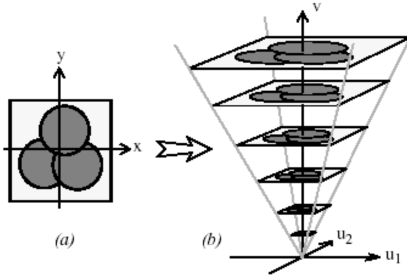
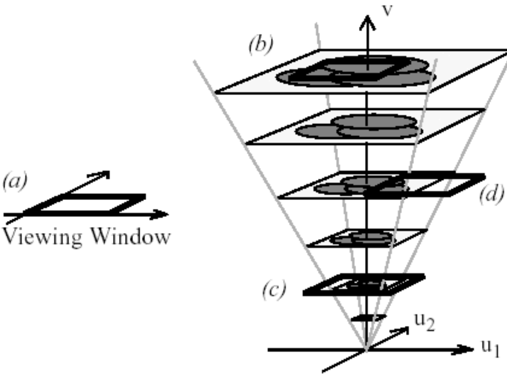


Figure 1. *The basic construction of a Space-Scale diagram from a 2D picture.*

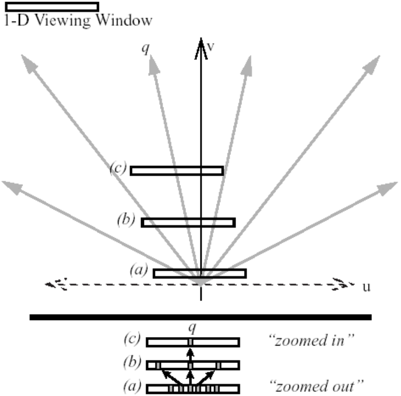
[Space-Scale Diagrams: Understanding Multiscale Interfaces. George Furnas and Ben Bederson, Proc SIGCHI '95.]

Viewing Window



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

1D Version



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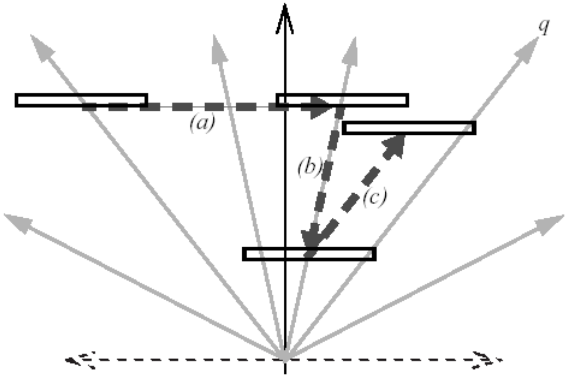
Pan-Zoom Trajectories



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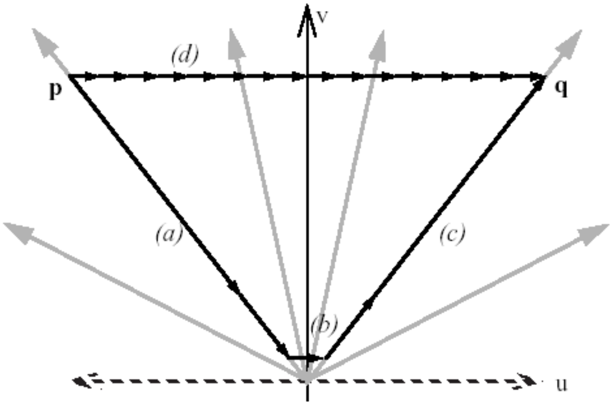
Shortest Path



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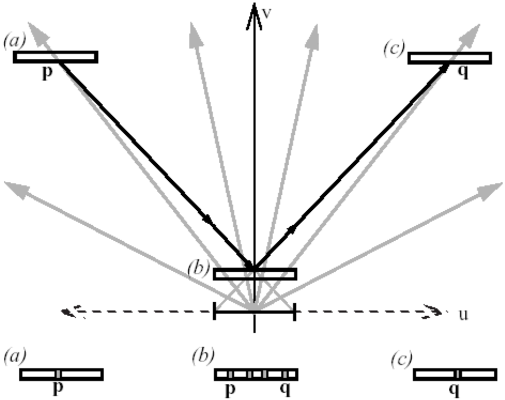
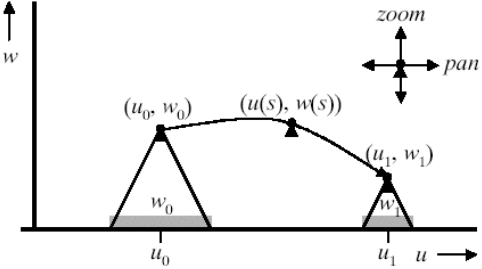
Shortest Path, Details



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

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

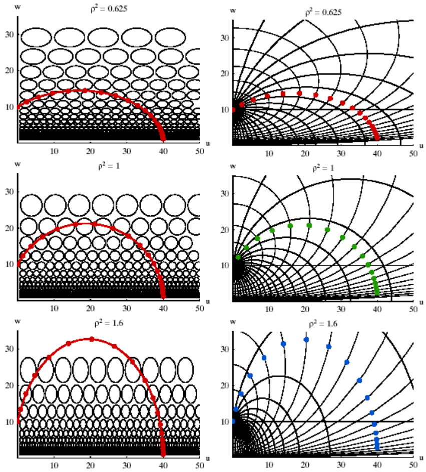


Smooth and Efficient Zooming and Panning. Jack J. van Wijk and Wim A.A. Nuij, Proc. InfoVis 2003, p. 15-22

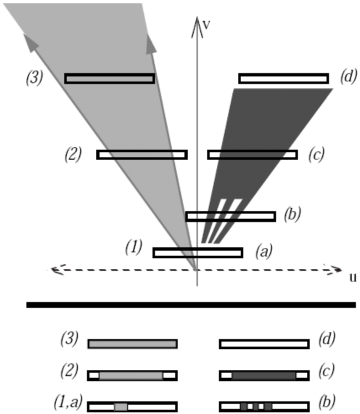
Optimal Paths Through Space

- 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



Semantic Zooming



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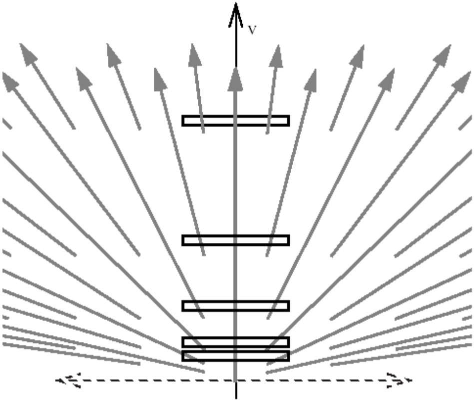
Multiscale Display



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

Multiscale Desert Fog

- 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

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

View-Navigation Theory

- 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 of outlinks
  - not overwhelmed by choices

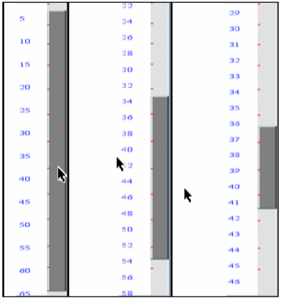
[Effective View Navigation, CHI 97, George Furnas]

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

OrthoZoom

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



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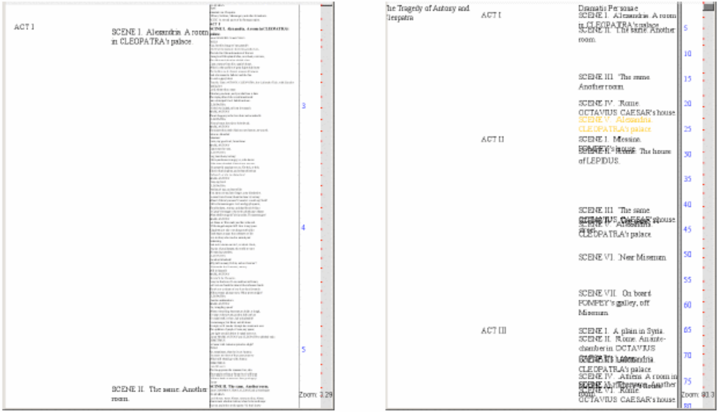
OrthoZoom

- multi-scale table of contents [video]



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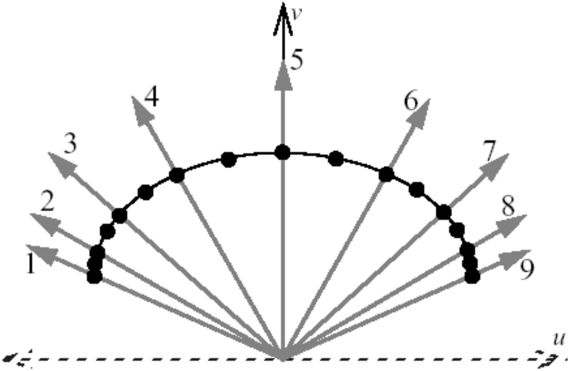
What's This?



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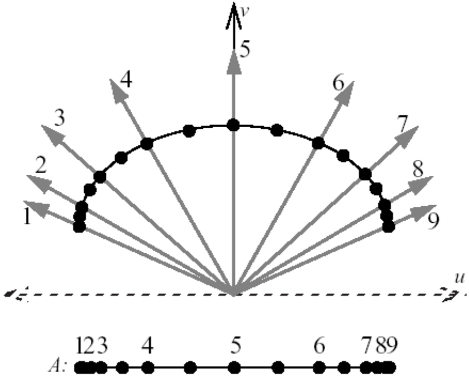
Fisheye Focus+Context View



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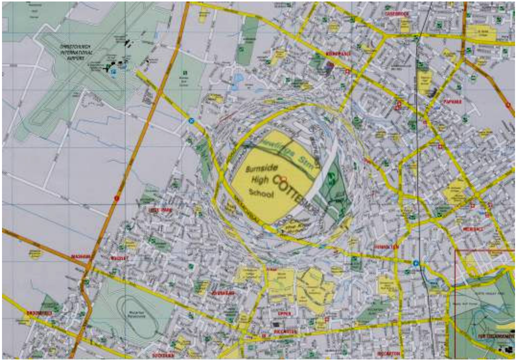
Focus+Context

- a lot more on this next time



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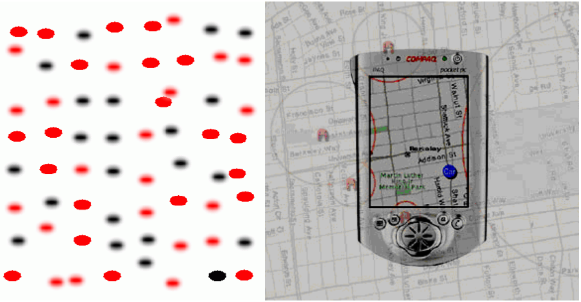
Cue-based Techniques

- semantic depth of field - blur
- halos - arcs show offscreen info scent



[A review of overview+detail, zooming, and focus+context interfaces. Andy Cockburn, Amy Karlson, and Benjamin B. Bederson. ACM Computing Surveys 41(1), 2008. Fig 14.]

Evaluation

- complex picture of costs/benefits
  - spatial separation
    - costs: real estate, mental integration overhead
  - zooming
    - costs: cognitive load
    - anim transitions help, but don't solve
    - concurrent, unimanual over serial or bimanual
  - focus+context
    - strengths: overview, graphs
    - costs: distortion
- can combine: e.g. zooming + multiple views

Macro/Micro

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