Reduce Items & Attributes via Navigation

Cmpt 767 - Visualization

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[based on slides by Munzner / Möller]

Data Reduction

- Cannot make sense of everything at once
- Reduce amount shown
  - items (rows of a table / elements)
  - attributes (columns of a table / dimensions)

Reduction through Data manipulation

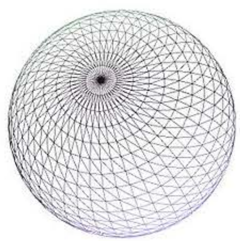
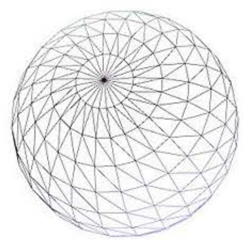
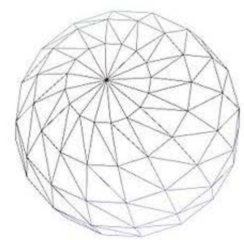
- simple filtering
  - items
  - attributes
- simple aggregation
  - items
  - attributes
- attributes: dimensionality reduction
  - linear
  - non-linear

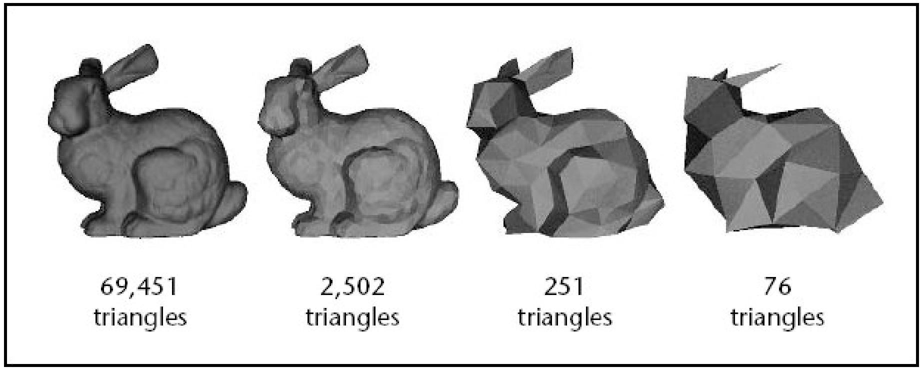
Today - Reduction through navigation

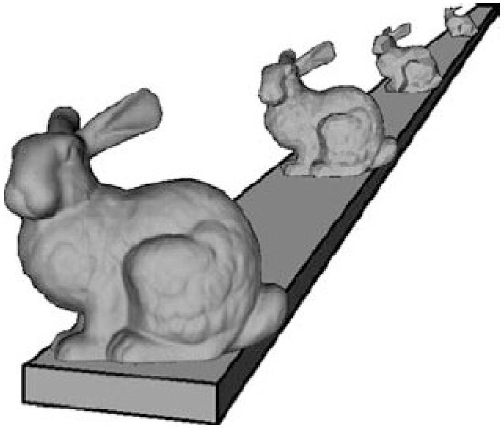
- Item reduction: navigation (camera-oriented)
  - geometric vs. semantic zooming
  - pan/translate
  - constraints + combinations
- Aggregate reduction (camera-oriented)
  - slice
  - cut
  - project
- Embed: focus + context
  - selective filtering
  - geometric distortions

Geometric zoom

- same object (geometry) / different levels of detail

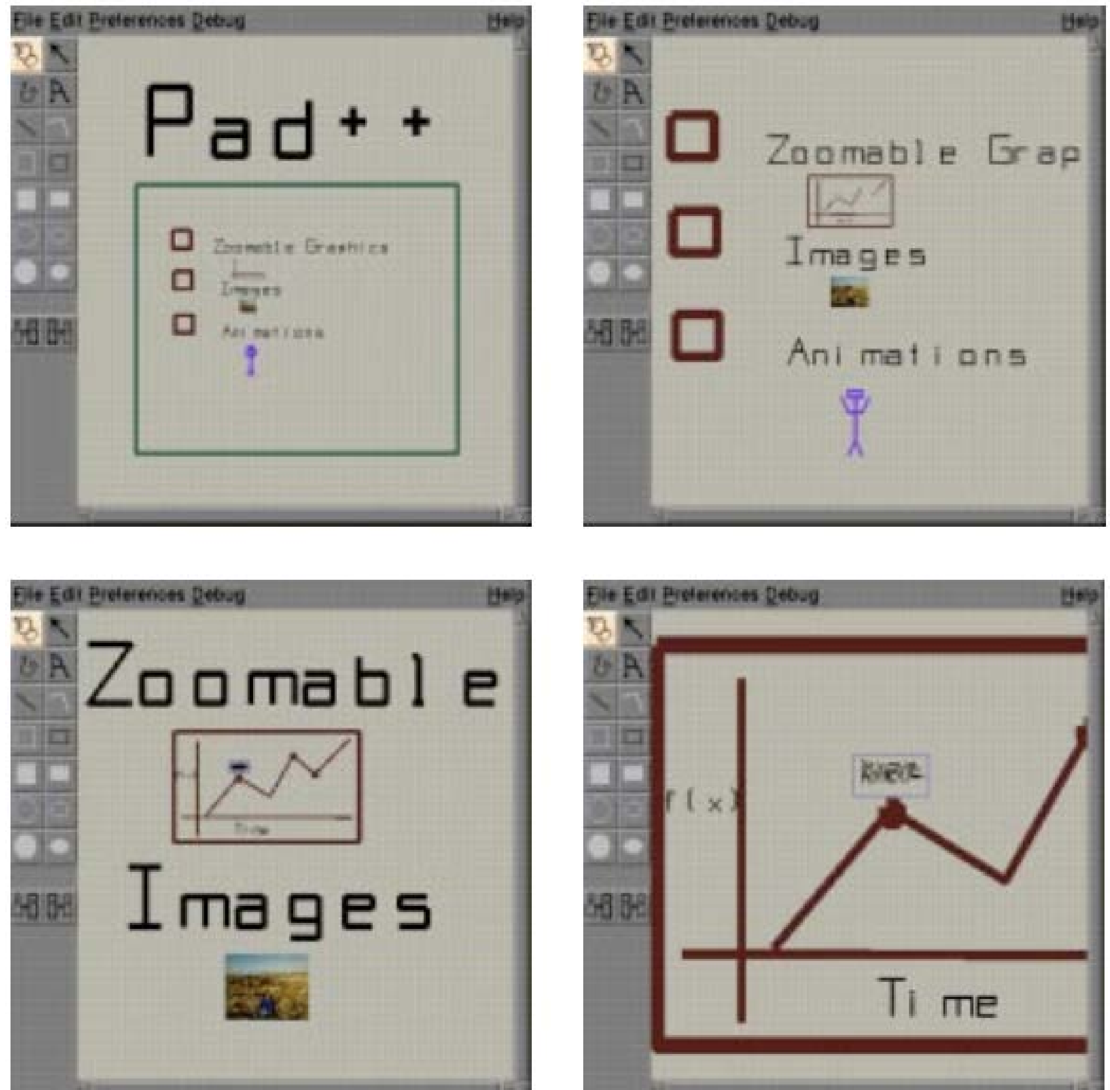
Image					
Vertices	~5500	~2880	~1580	~670	140
Notes	Maximum detail, for closeups.				Minimum detail, very far objects.

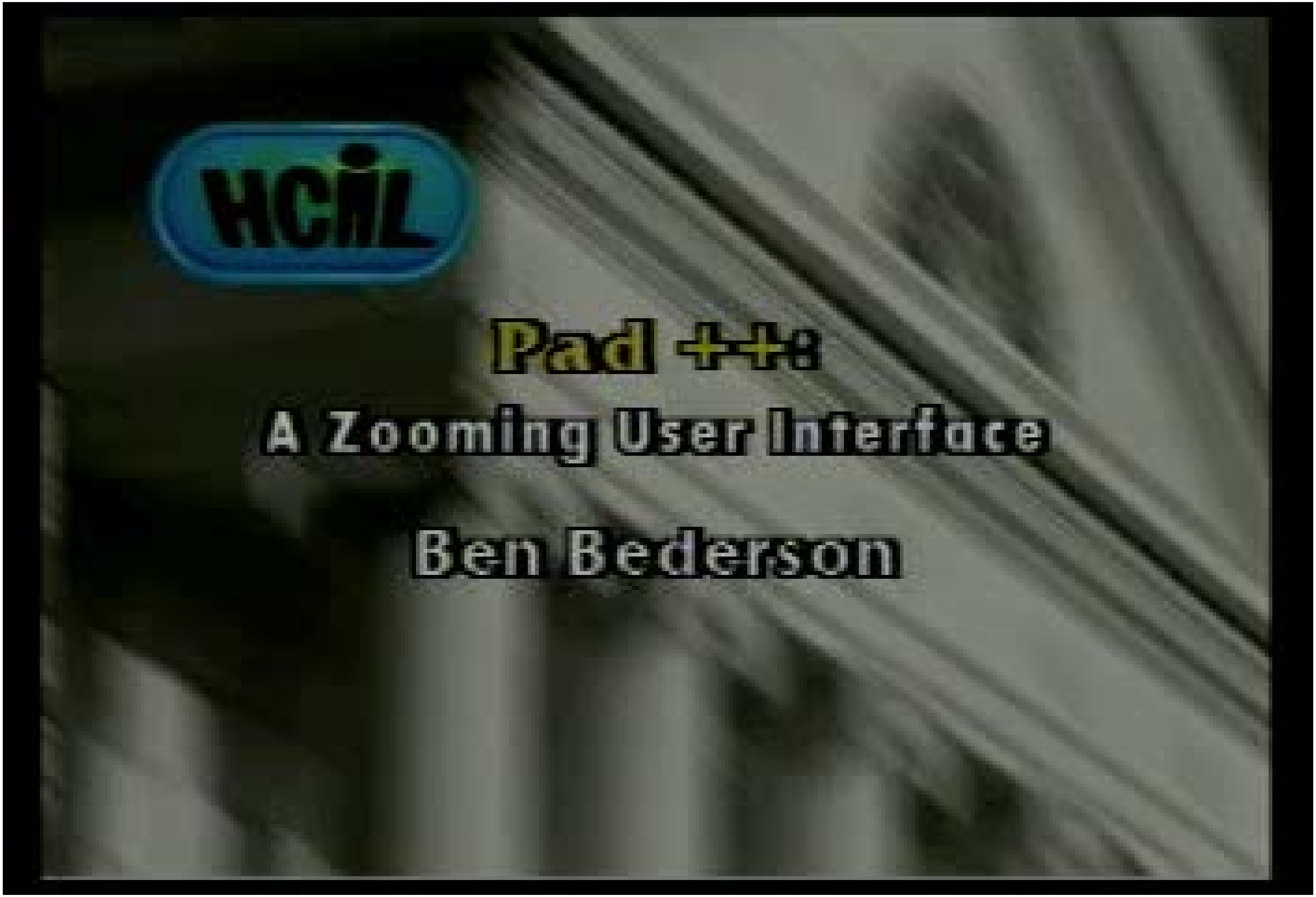




Pad++

- “infinitely” zoomable user interface (ZUI)
- video

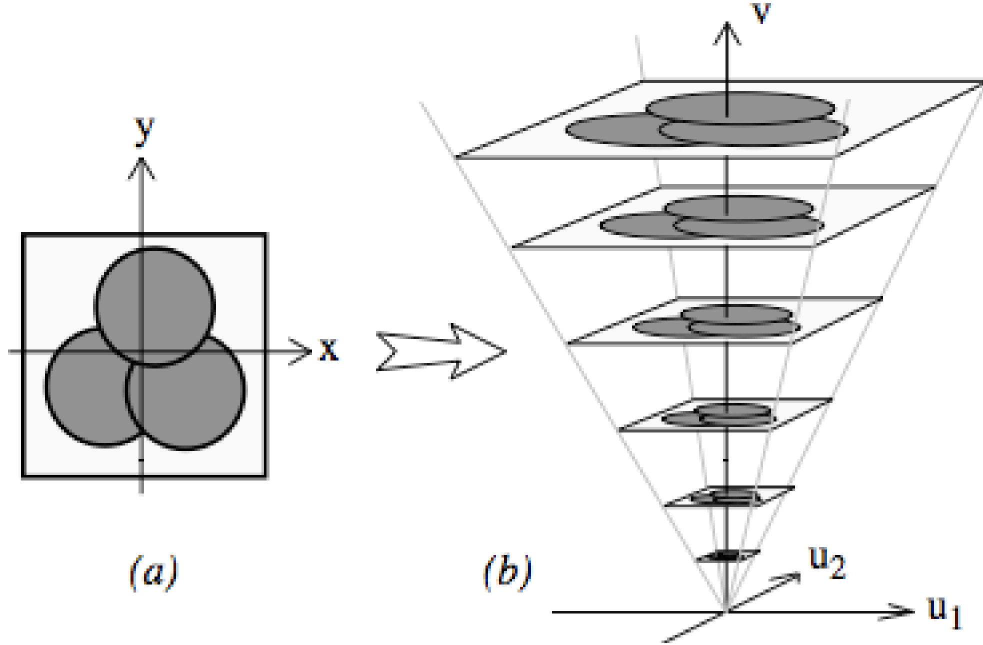



Pad ++:
A Zooming User Interface
Ben Bederson

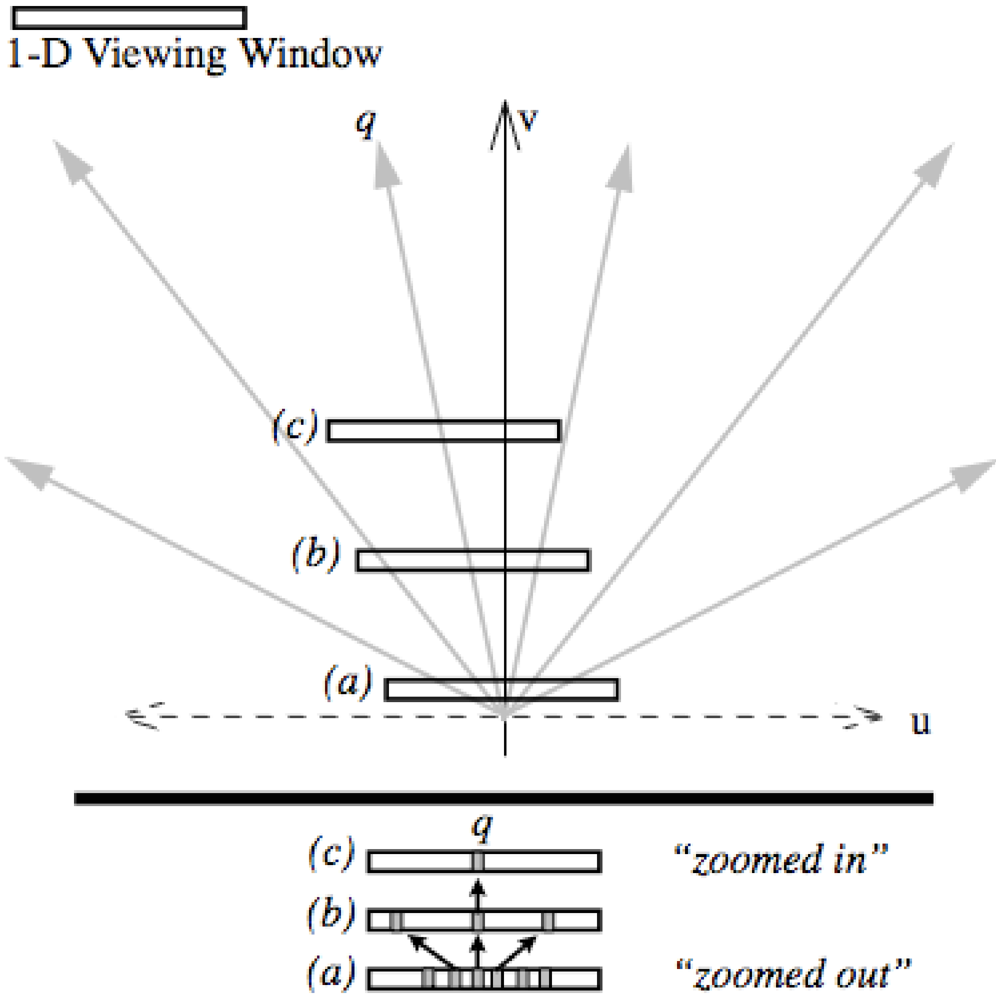
A brief discussion on scale space diagrams

Space-Scale Diagrams

- help us reason about navigation and trajectories
- what should be visible at what zoom level
- how do we automatically change zoom?



1D Version



Pan-Zoom Trajectories

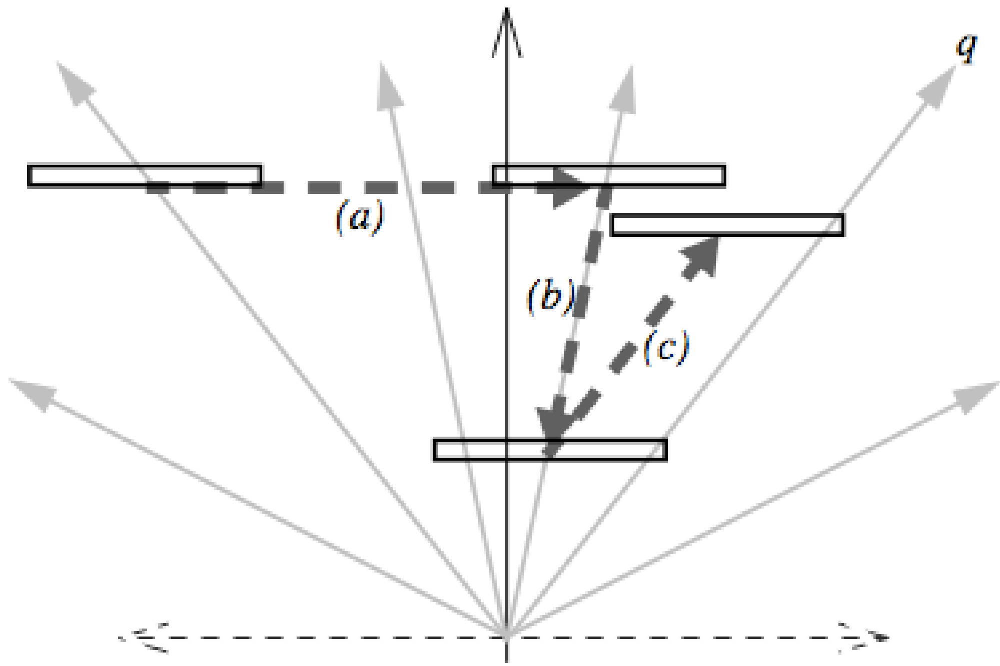


Figure 6. *Basic Pan-Zoom trajectories are shown in the heavy dashed lines:. (a) Is a pure Pan,. (b) is a pure Zoom (out), (c) is a "Zoom-around" the point q.*

Simple trajectory

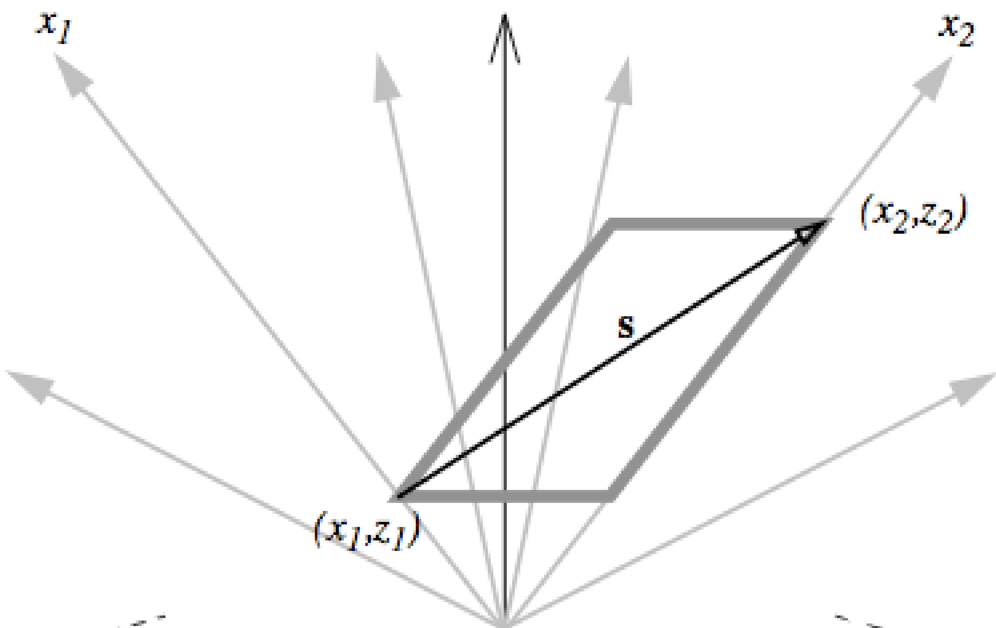


Figure 7. *Solution to the simple joint pan-zoom problem. The trajectory* **s** *monotonically approaches point 2 in both pan and zoom.*

Efficient trajectory

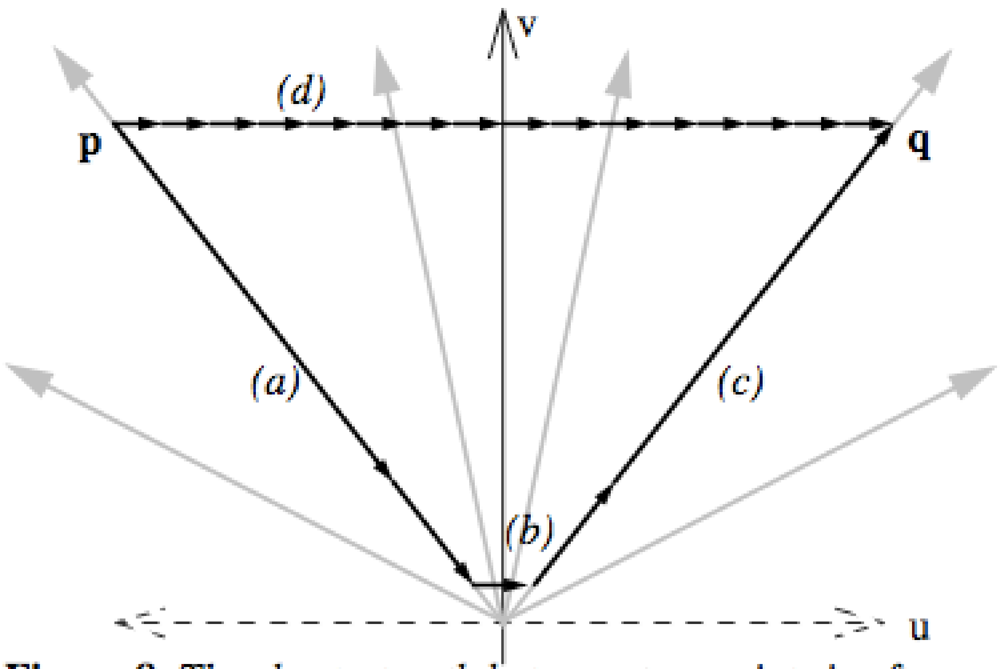


Figure 8. *The shortest path between two points is often not a straight line. Here each arrow represents one unit of cost. Because zoom is logarithmic, it is often "shorter" to zoom out (a), make a small pan (b), and zoom back in (c), than to make a large pan directly (d).*

Efficient trajectory

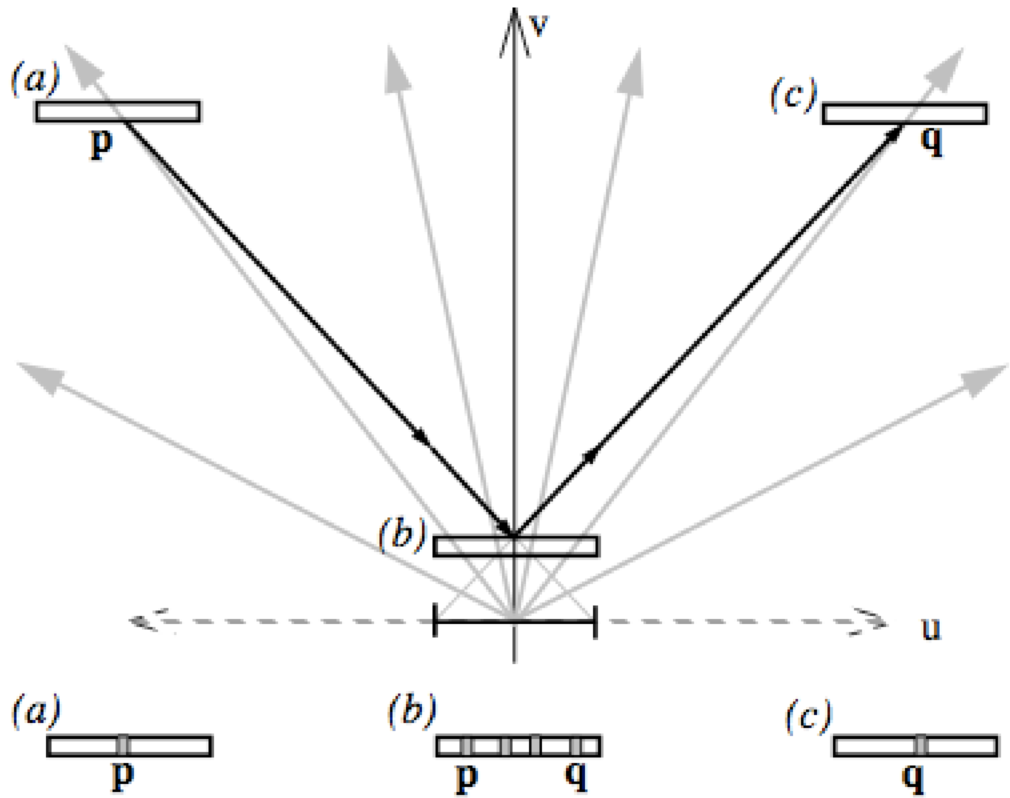
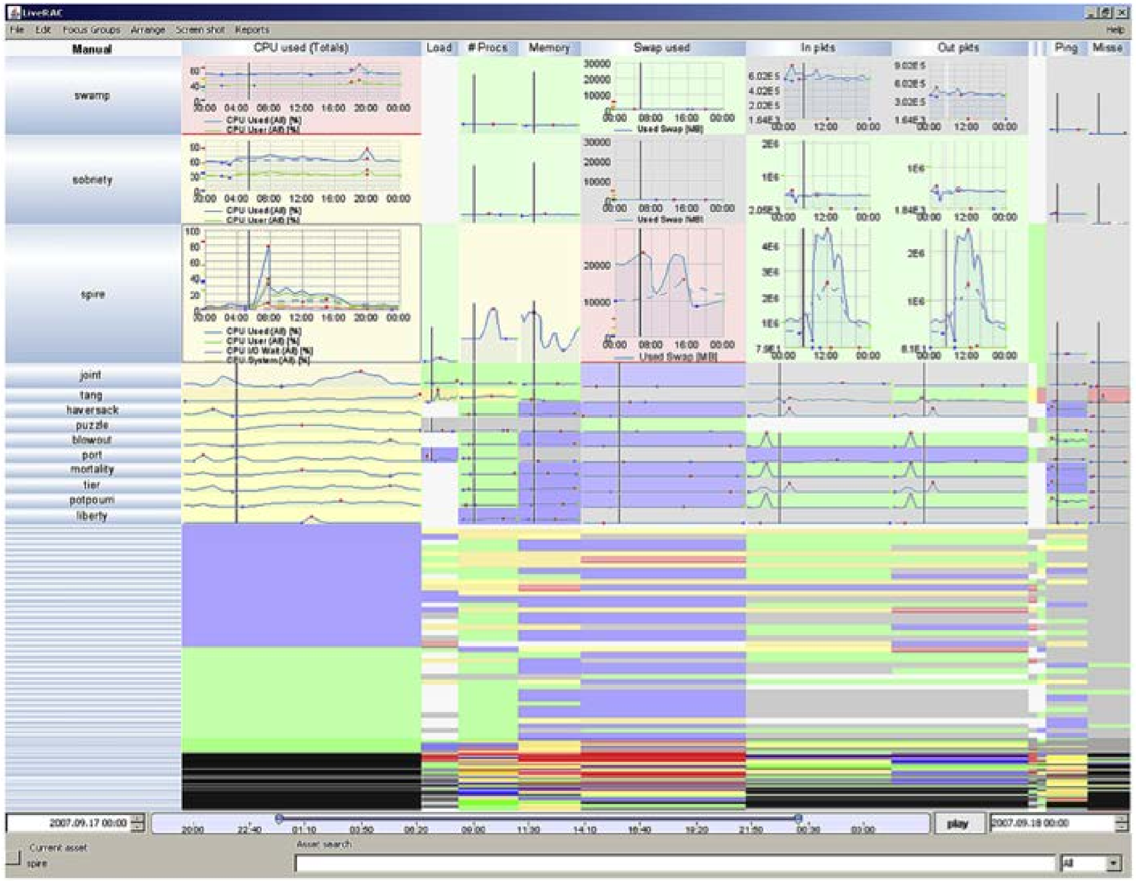


Figure 10. *The shortest zaww path between* **p** *(a) and* **q** *zooms out till both are within the window (b), then zooms in (c). The corresponding views are shown below the diagram.*

Semantic Zoom

- visual encoding changes depending on space



LiveRAC: Interactive Visual Exploration of System Management Time-Series Data

Multi-scale display

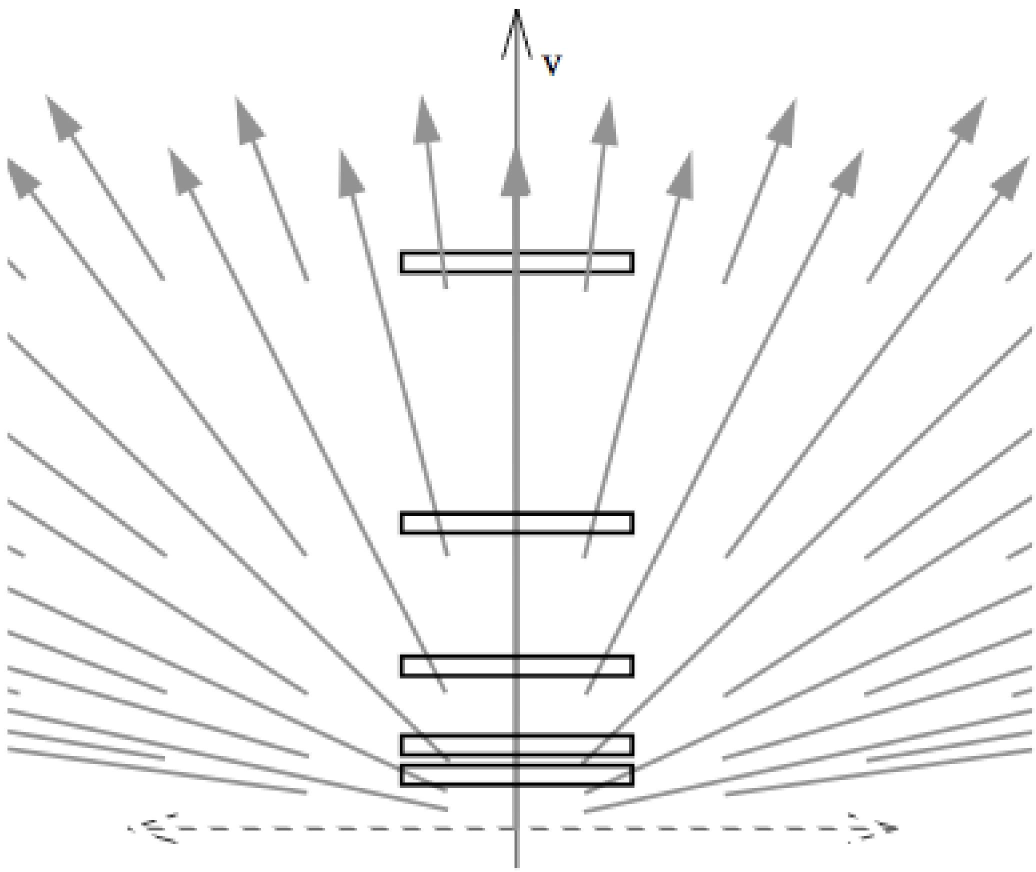
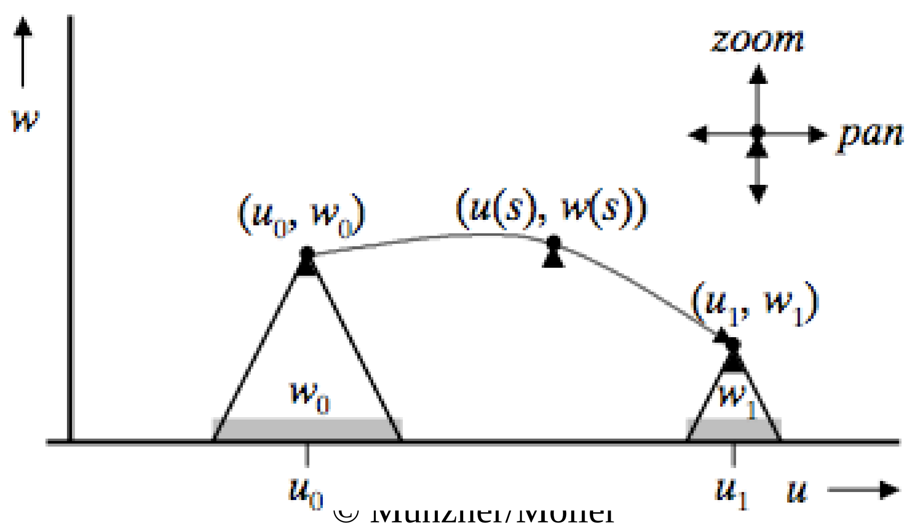


Figure 12. *Fractal grid in 1D. As the window moves up by a factor of 2 magnification, new gridpoints appear to subdivide the world appropriately at that scale. The view of the grid is the same in all five windows.*

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



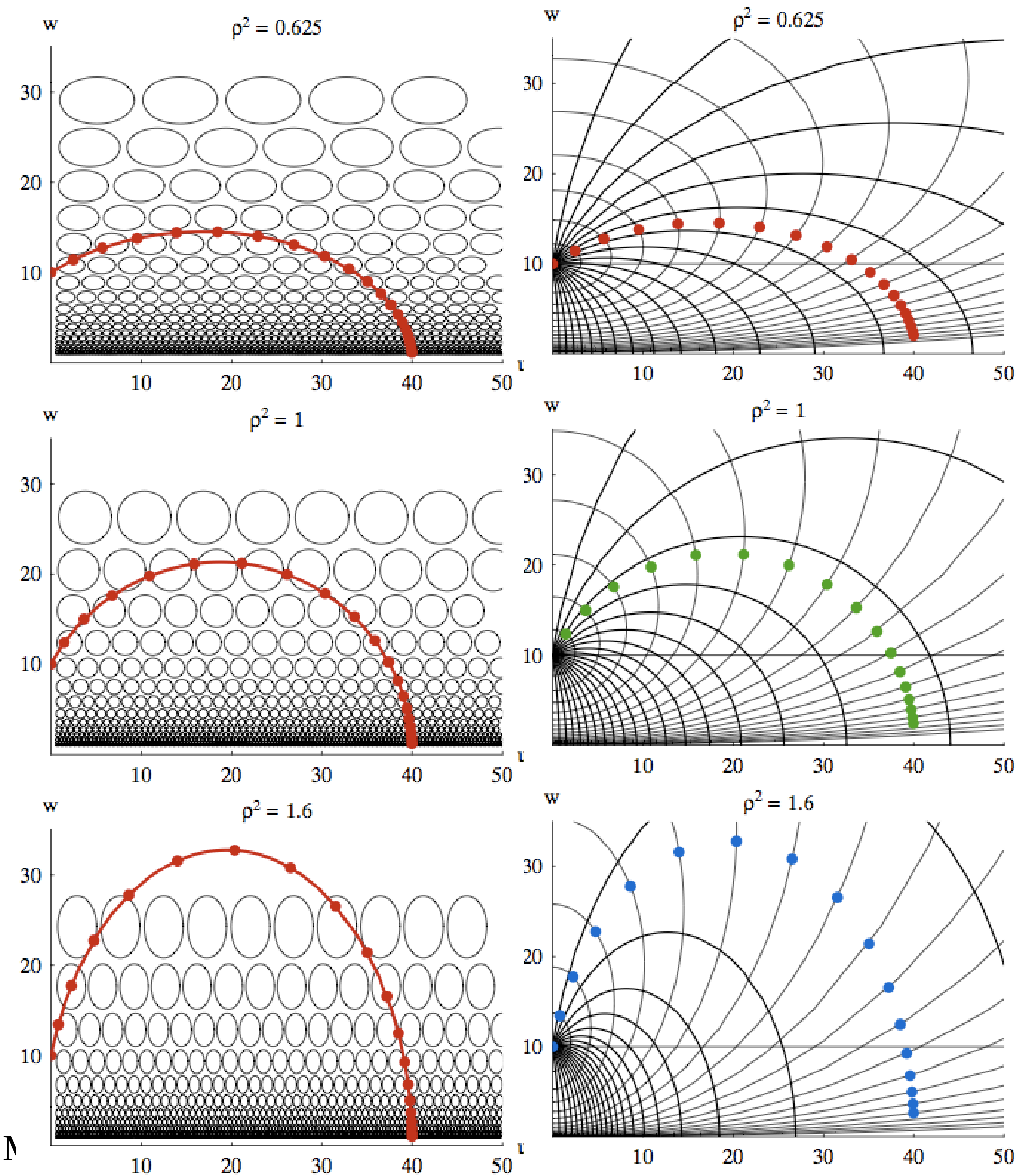
Speed-Dependent Automatic Zooming

- Speed-Dependent Automatic Zooming for Browsing Large Documents
  - Takeo Igarashi and Ken Hinckley, Proc. UIST'00, pp. 139-148.
- automatic zoom
  - amount depends on how far to pan
- demo/video
  - www-ui.is.s.u-tokyo.ac.jp/~takeo/java/autozoom/autozoom.htm
  - www-ui.is.s.u-tokyo.ac.jp/~takeo/video/autozoom.mov


Map Viewer

Optimal Paths Through Space

- at each step, cross same number of ellipses
- minimal number of ellipses total Smooth and Efficient



Constrained vs. Unconstrained navigation

- determines the amount of control
- unconstrained—user can get lost
- animated transitions (very controlled):
  - Autozoom video
  - Heer + Robertson http://vis.berkeley.edu/papers/animated_transitions/

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  – slice
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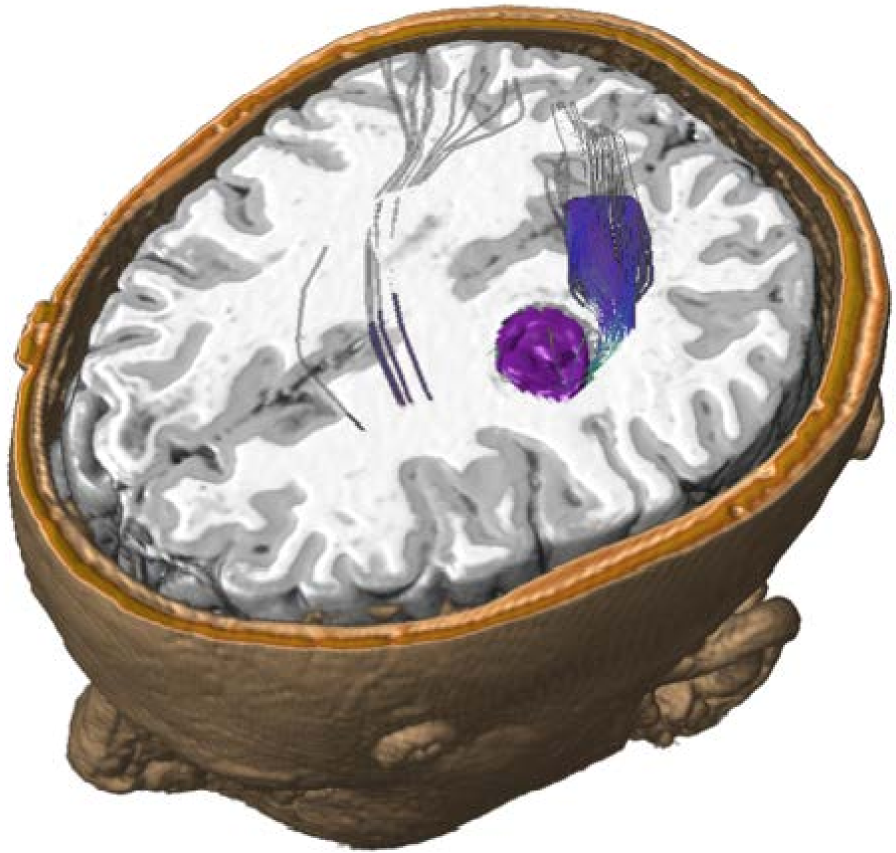
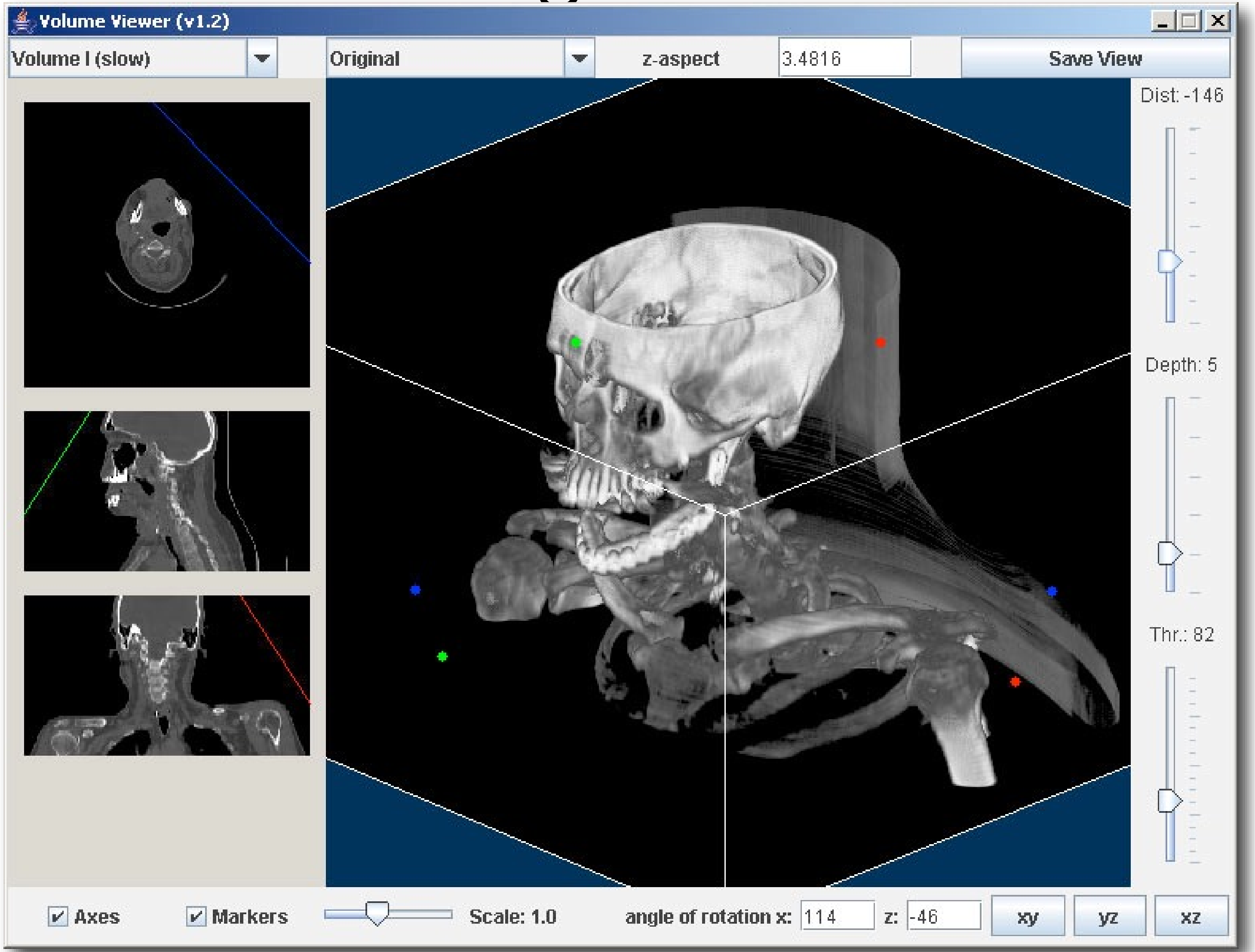
  – geometric distortions

Slicing / Cutting: Spatial Data

- easy to understand metaphor
- reduces data
  from 3D to 2D



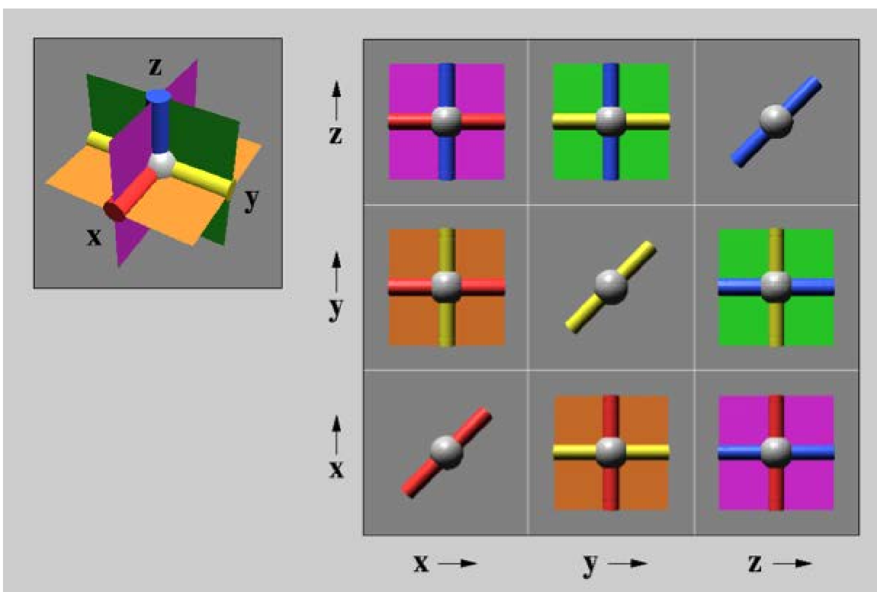
Axis-aligned slices

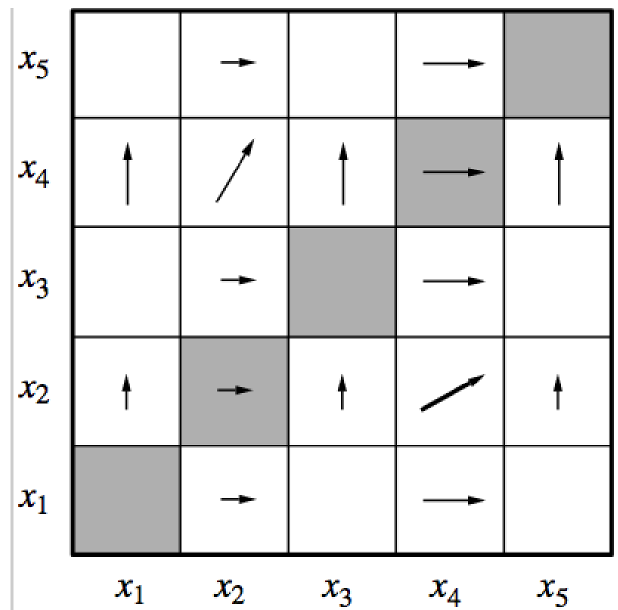


http://rsbweb.nih.gov/ij/plugins/volume-viewer.html

HyperSlice: slicing in multi-d

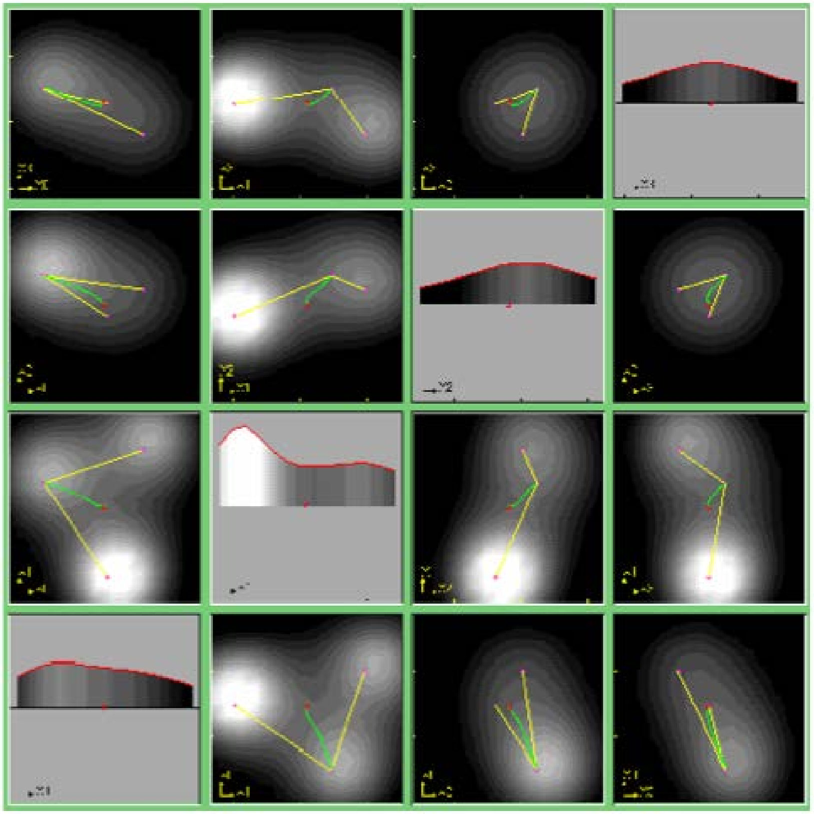
- HyperSlice: matrix of orthogonal 2D slices
  - each panel is display and control: drag to change slice
  - simple 3D example





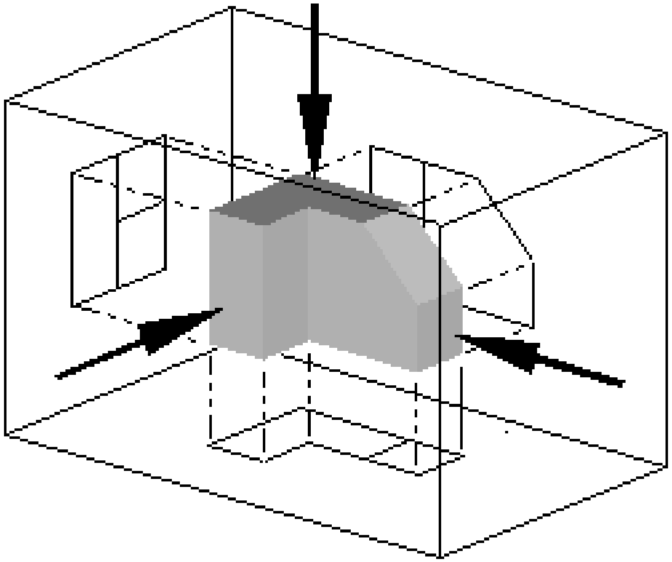
Example

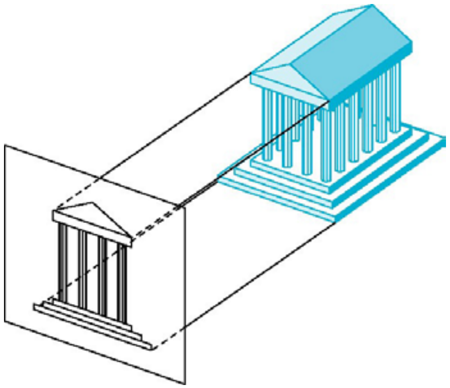
- 4D function Sum(i=0...3) $w_i/(1 + |x - p_i|^2)$
- diagonals = standard graph



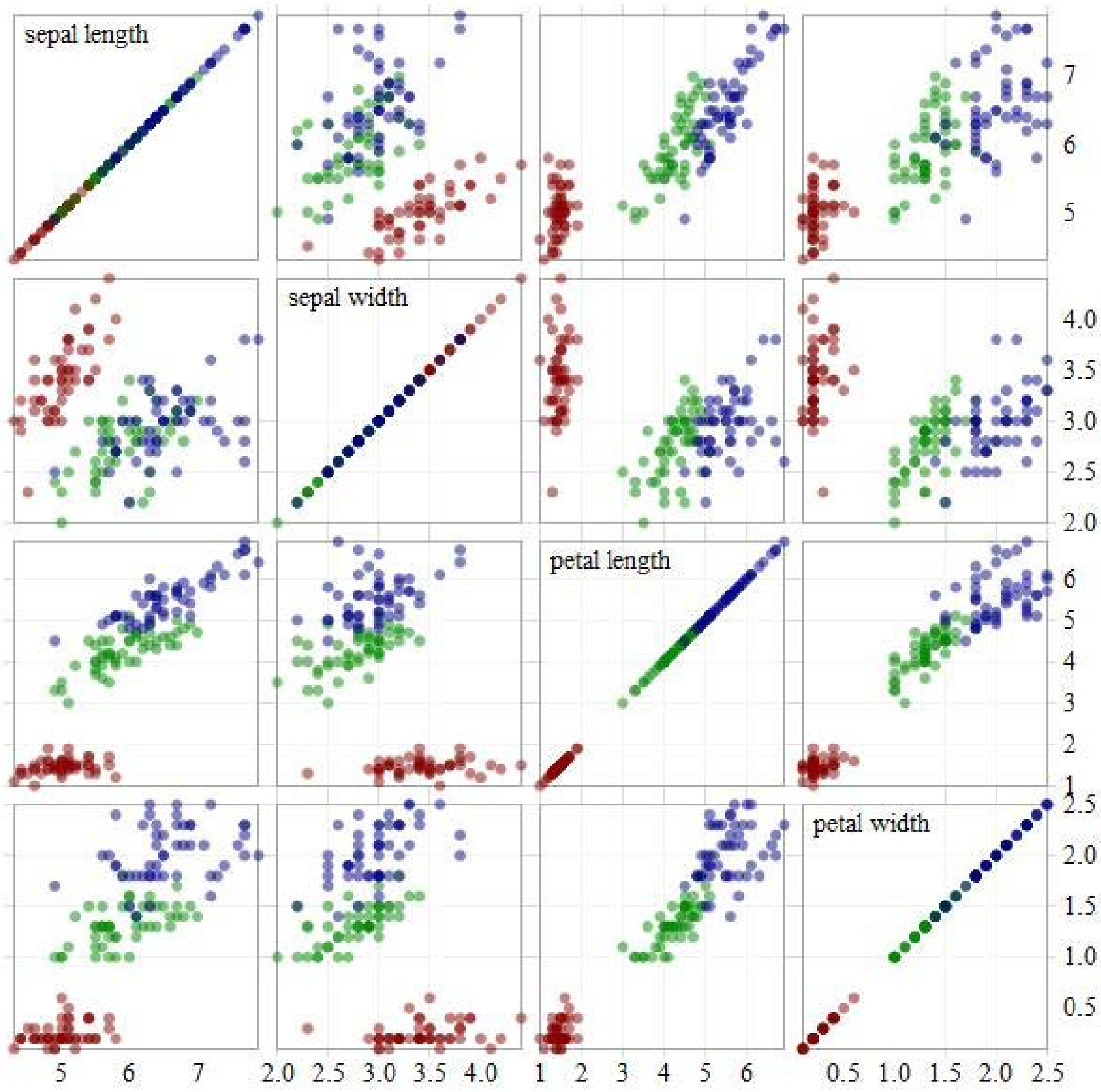
(orthographic) Projections

- (axis-aligned) orthographic: remove all information about filtered dims
  – hypercube: 3D to 2D, 4D to 3D



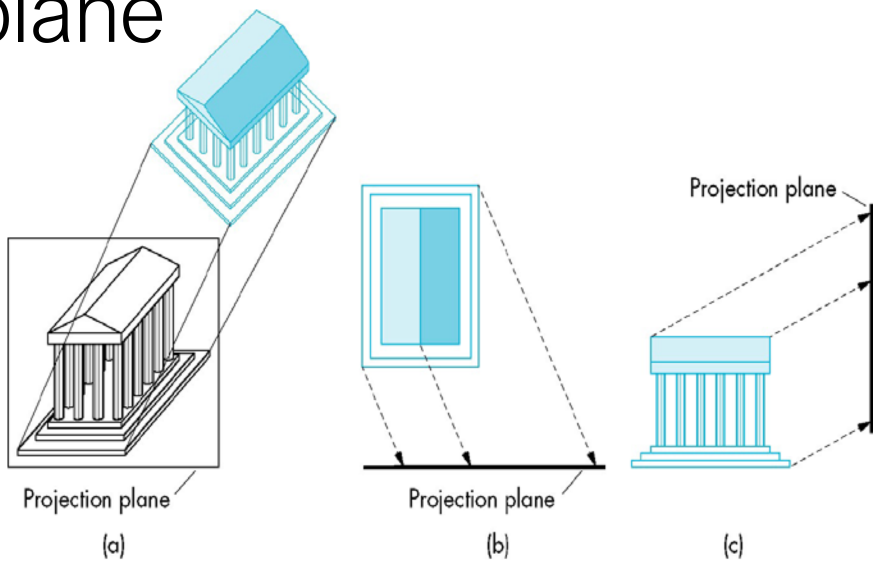


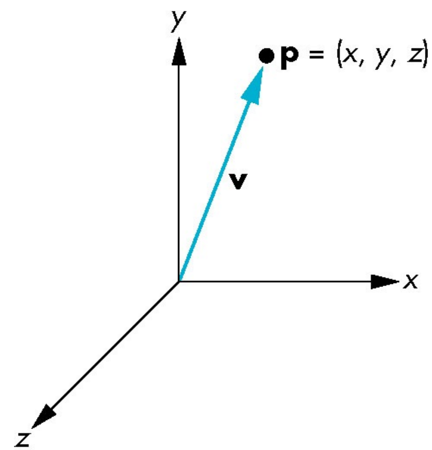
SPloM: orthographic projections in multi-d



Oblique (parallel) projections

- Projectors are not normal to projection plane



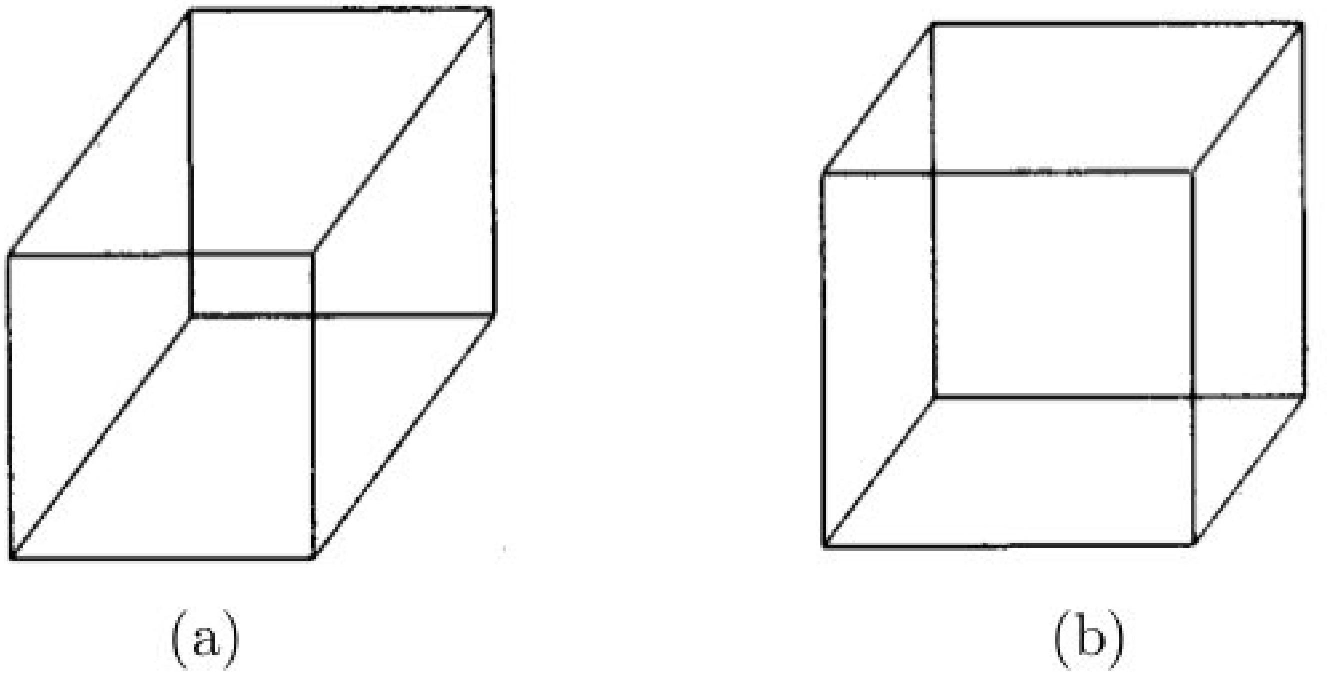


- Most drawings in textbooks use oblique projection

Common oblique projections

- **Cavalier projections**
  - Angle α = 45 degrees
  - Preserves the length of a line segment perpendicular to the projection plane
  - Angle φ is typically 30 or 45 degrees
- **Cabinet projections**
  - Angle α = 63.7 degrees or arctan(2)
  - Halves the length of a line segment perpendicular to the projection plane – more realistic than cavalier

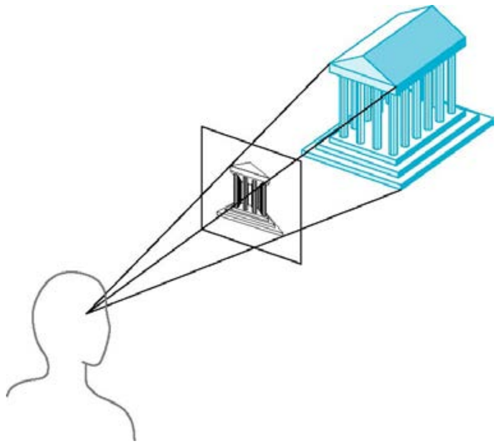
Common oblique projections

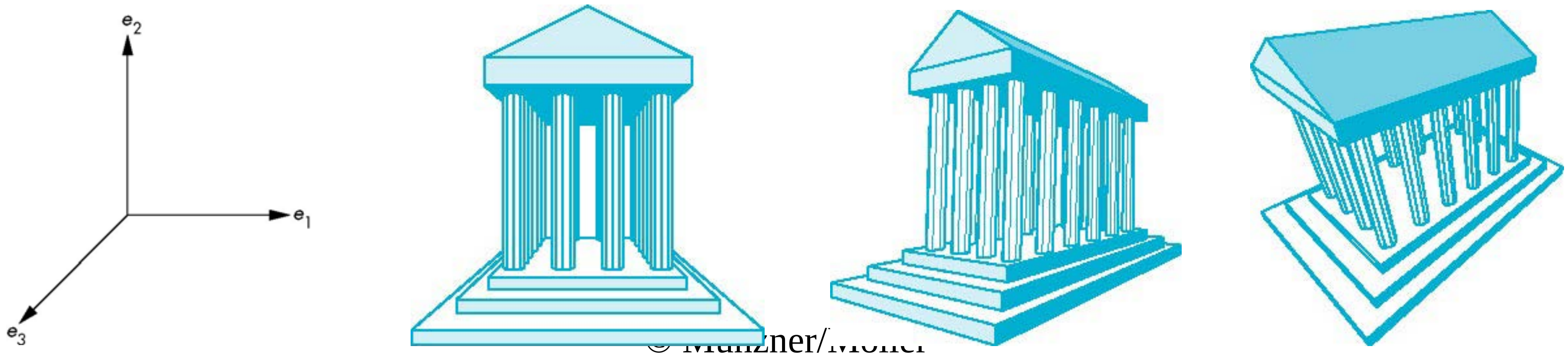


(a) Cavalier projection and (b) cabinet projection.

(perspective) Projections

- some info about filtered dims remains
- mimics human visual system in 3D
- not as effective in multi-D





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  - geometric vs. semantic zooming
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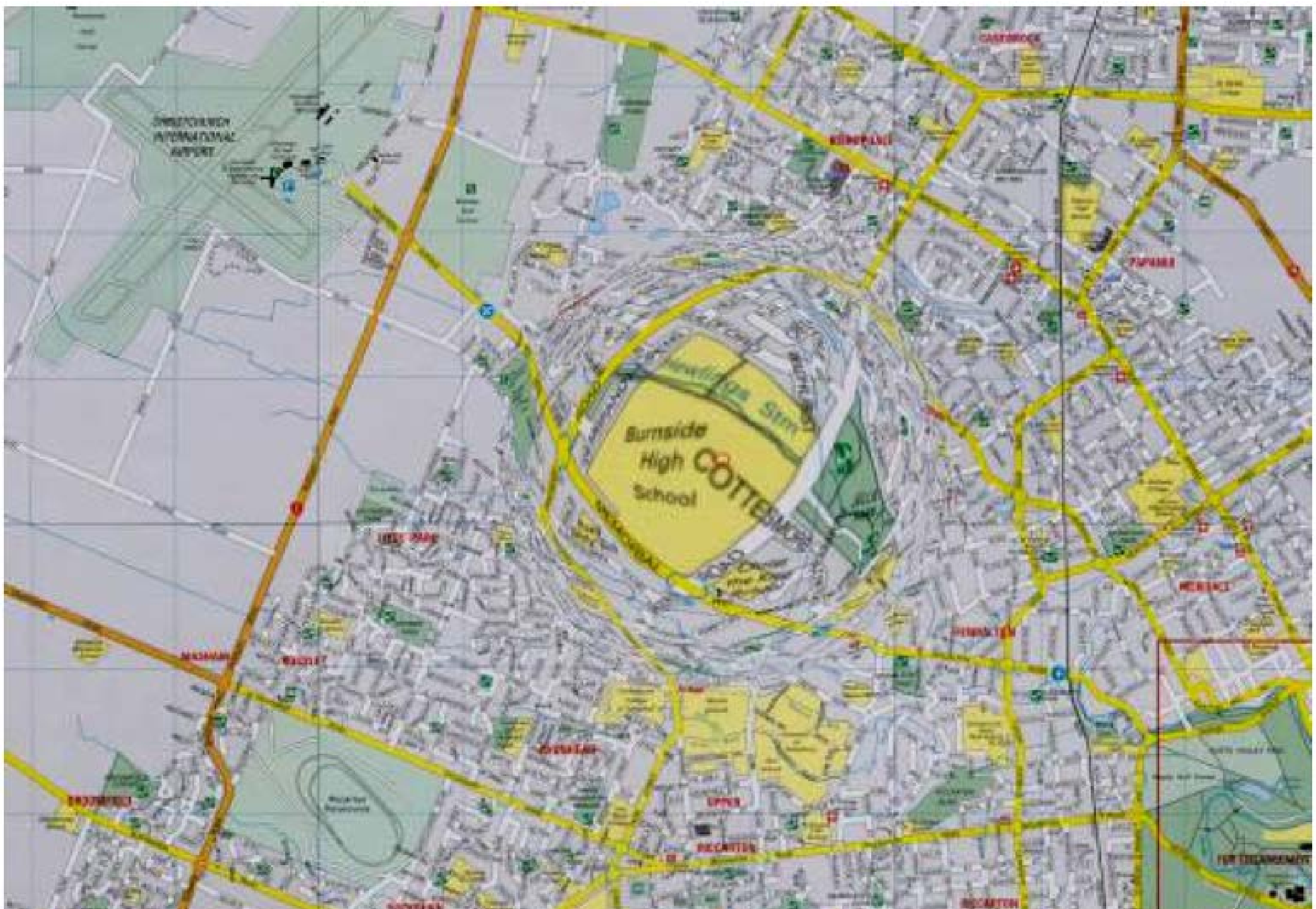
Taxonomy

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

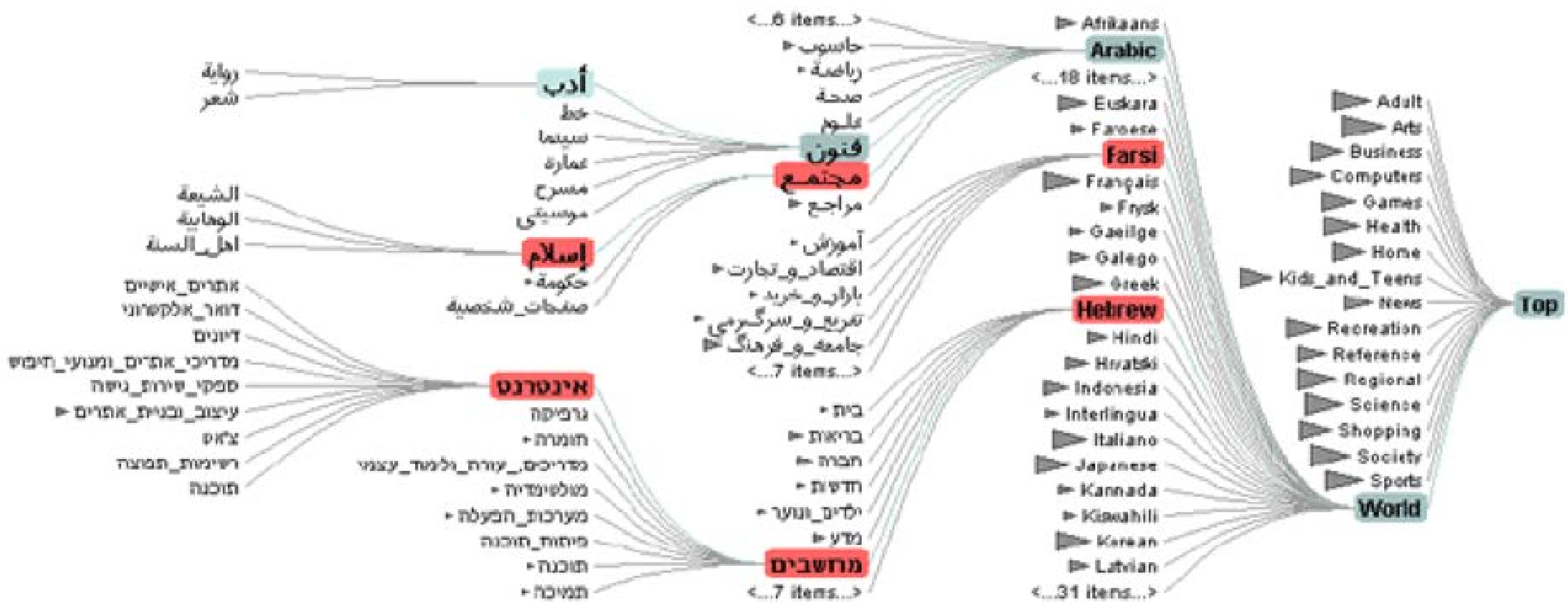
Focus+Context

- integrate focus and context in single view



Elision: DOITrees Revisited

- elision is the act of omitting items
- 600,000 node tree
- multiple foci

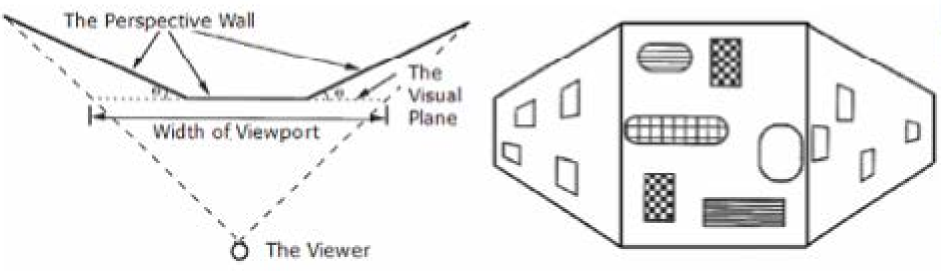


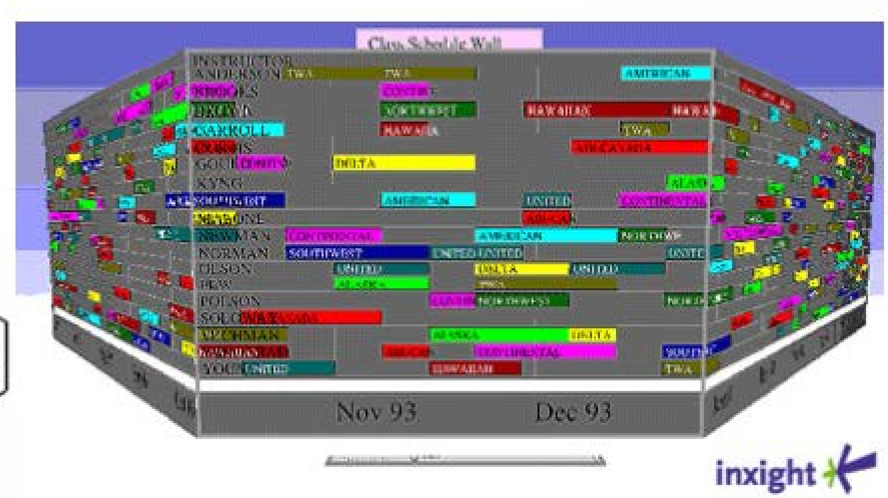
Distortion-based techniques

- geometric distortions
- moveable lenses, evocative of the real-world use of a magnifying glass lens
- stretching and squishing a rubber sheet
- working with vector fields

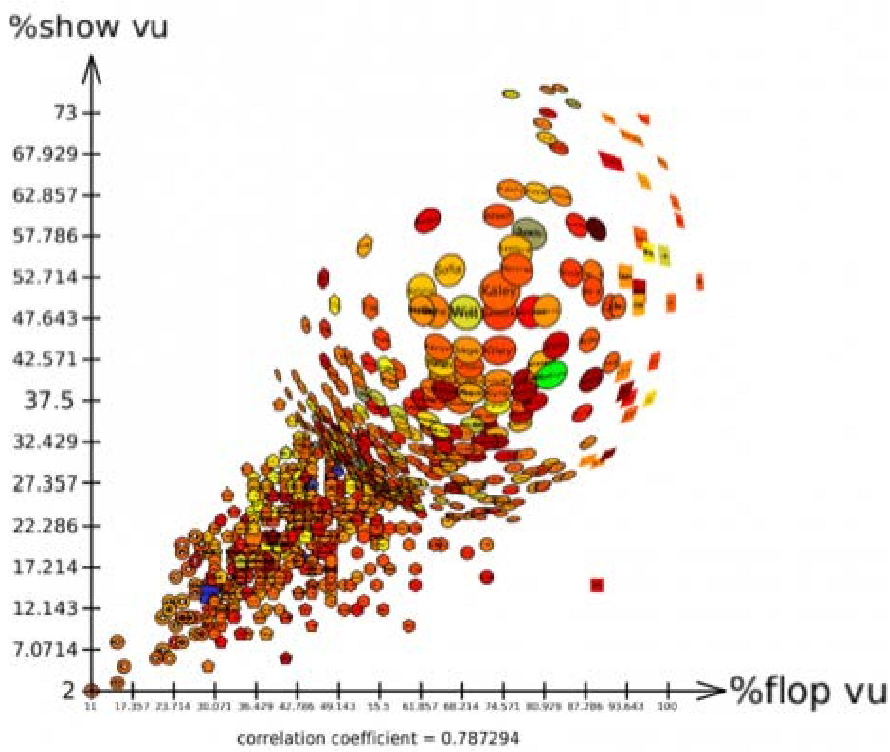
Geometric distortion - 3D Perspective

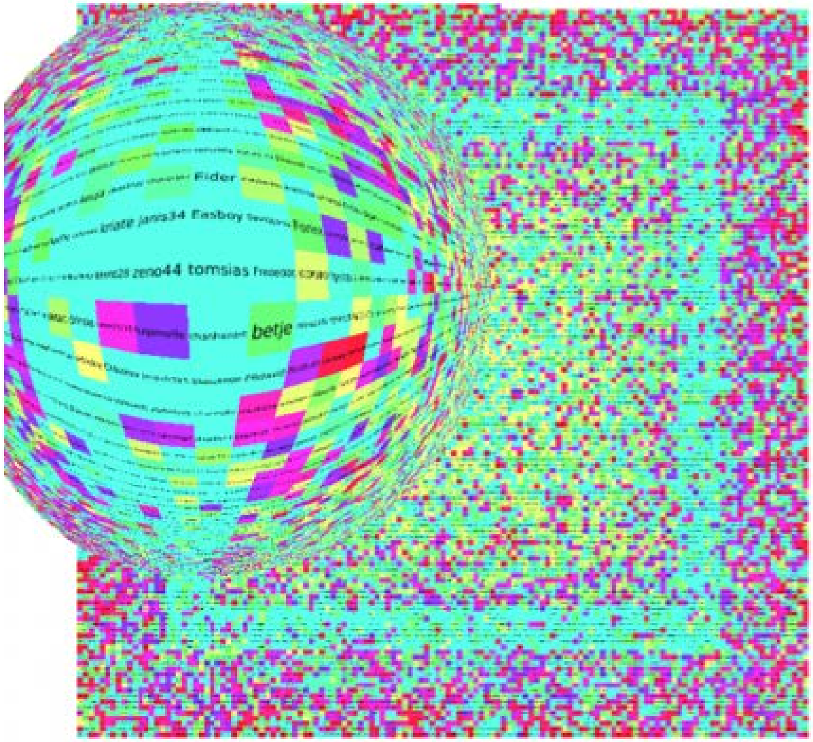
- move part of surface closer to the eye
  - perspective wall





Fisheye lens





Distortion - Fisheye

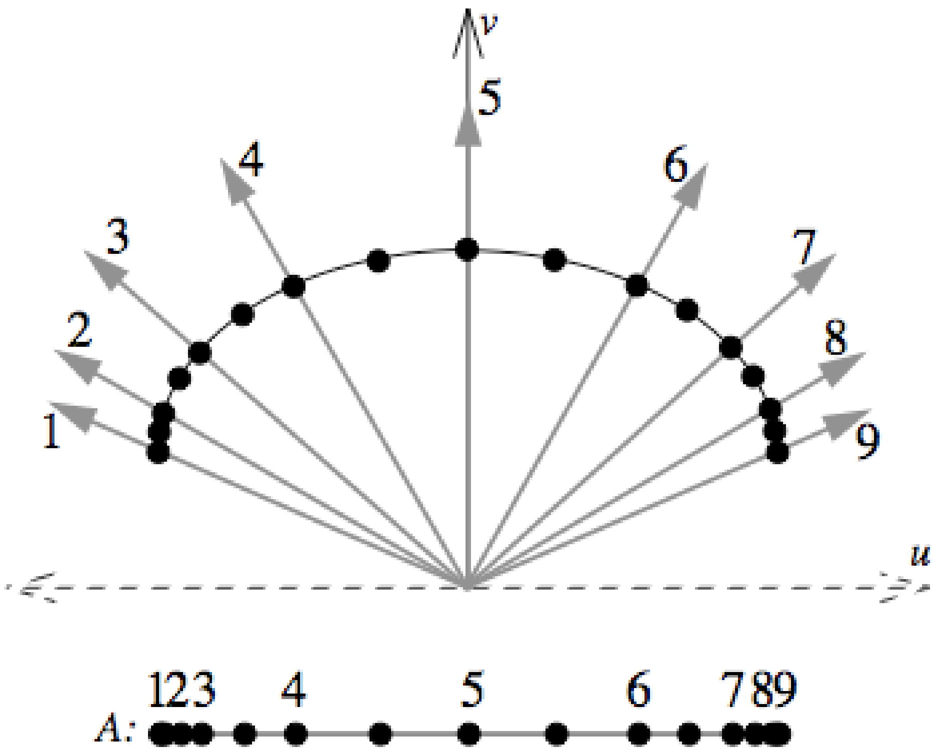
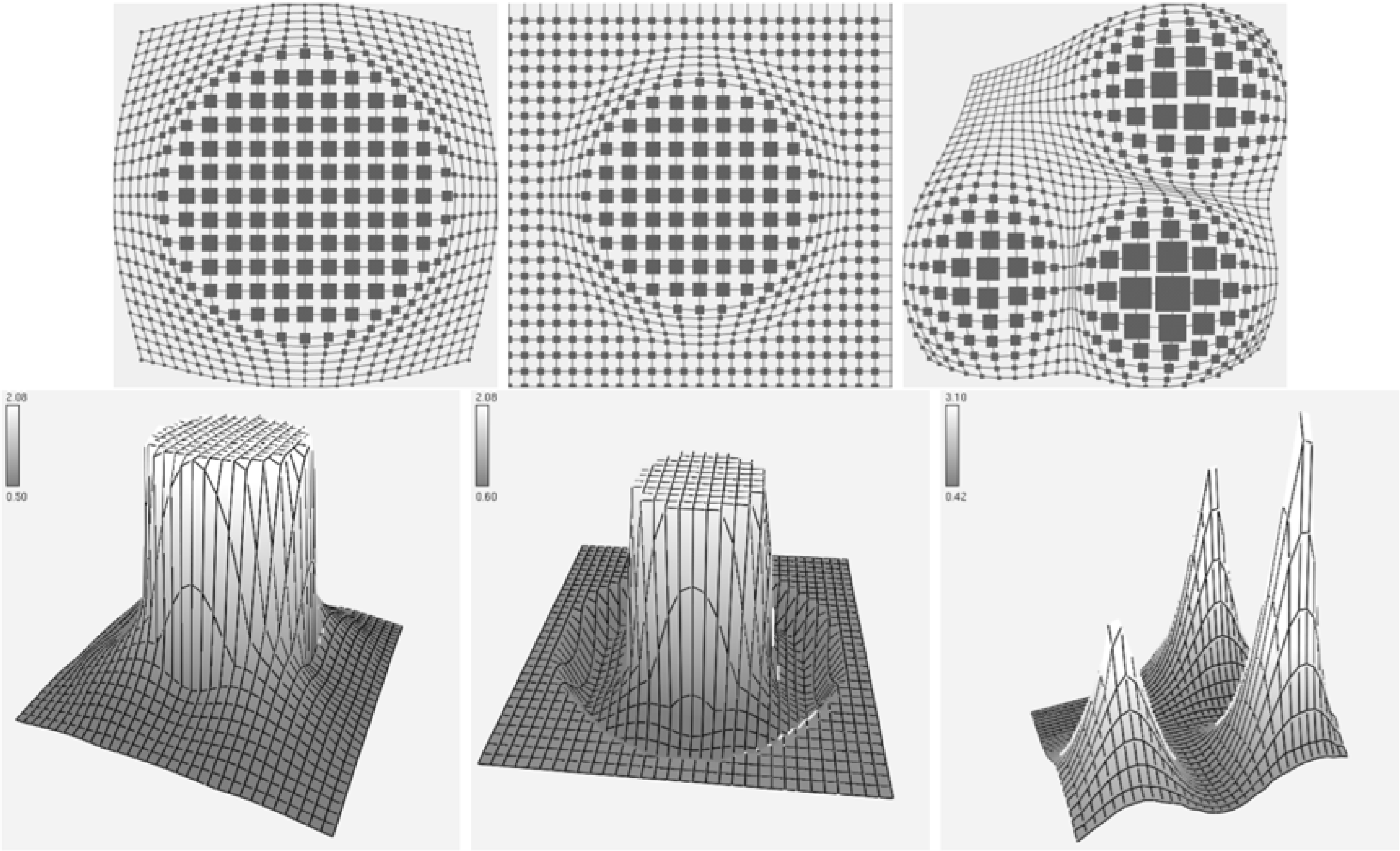


Figure 14. *Fisheye view.*

Vector-field distortion



Cutting the fisheye open

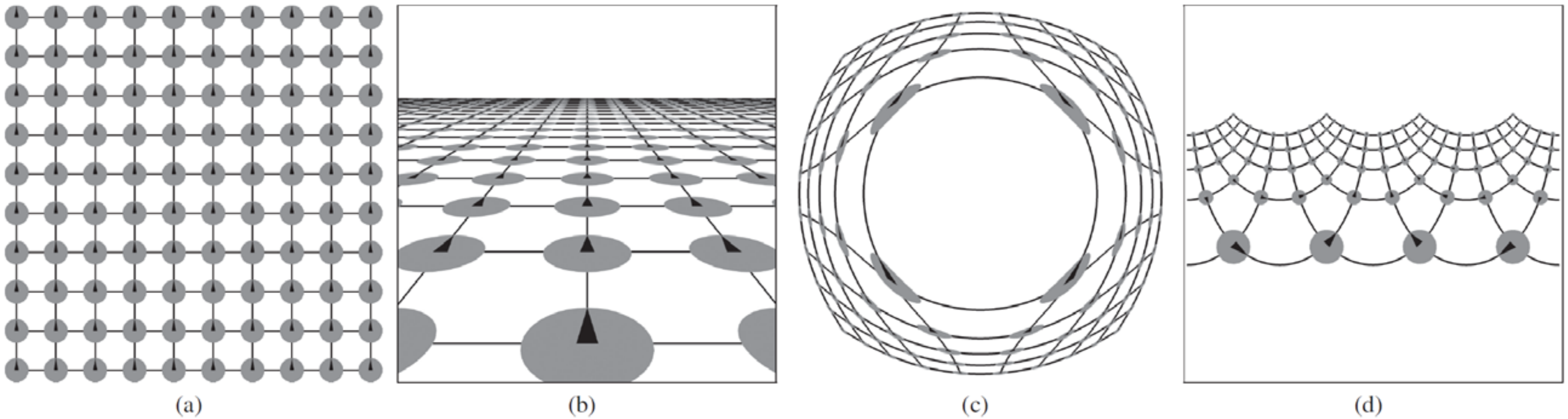
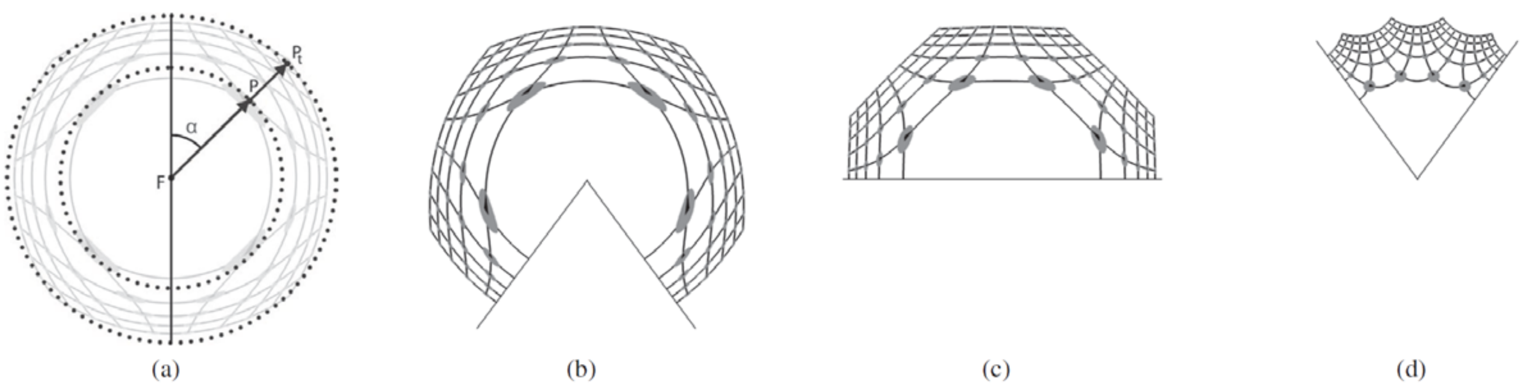
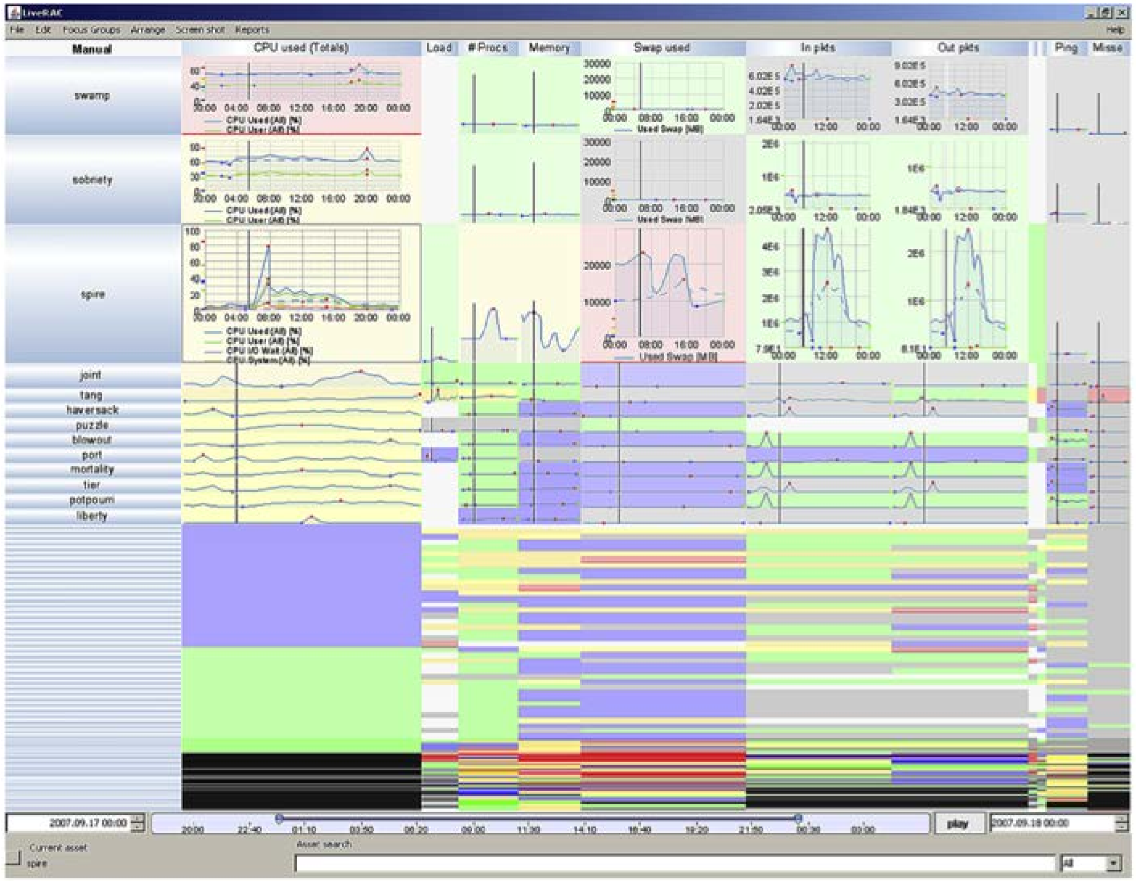


Fig. 2. Identical mapping (a) of a grid of small squares. Perspective (b) and fisheye (c) mapping both enlarge parts of the grid, but introduce compression, visible because circles are mapped to ellipses. The complex logarithmic mapping (d) enlarges parts of the grid without introducing compression.



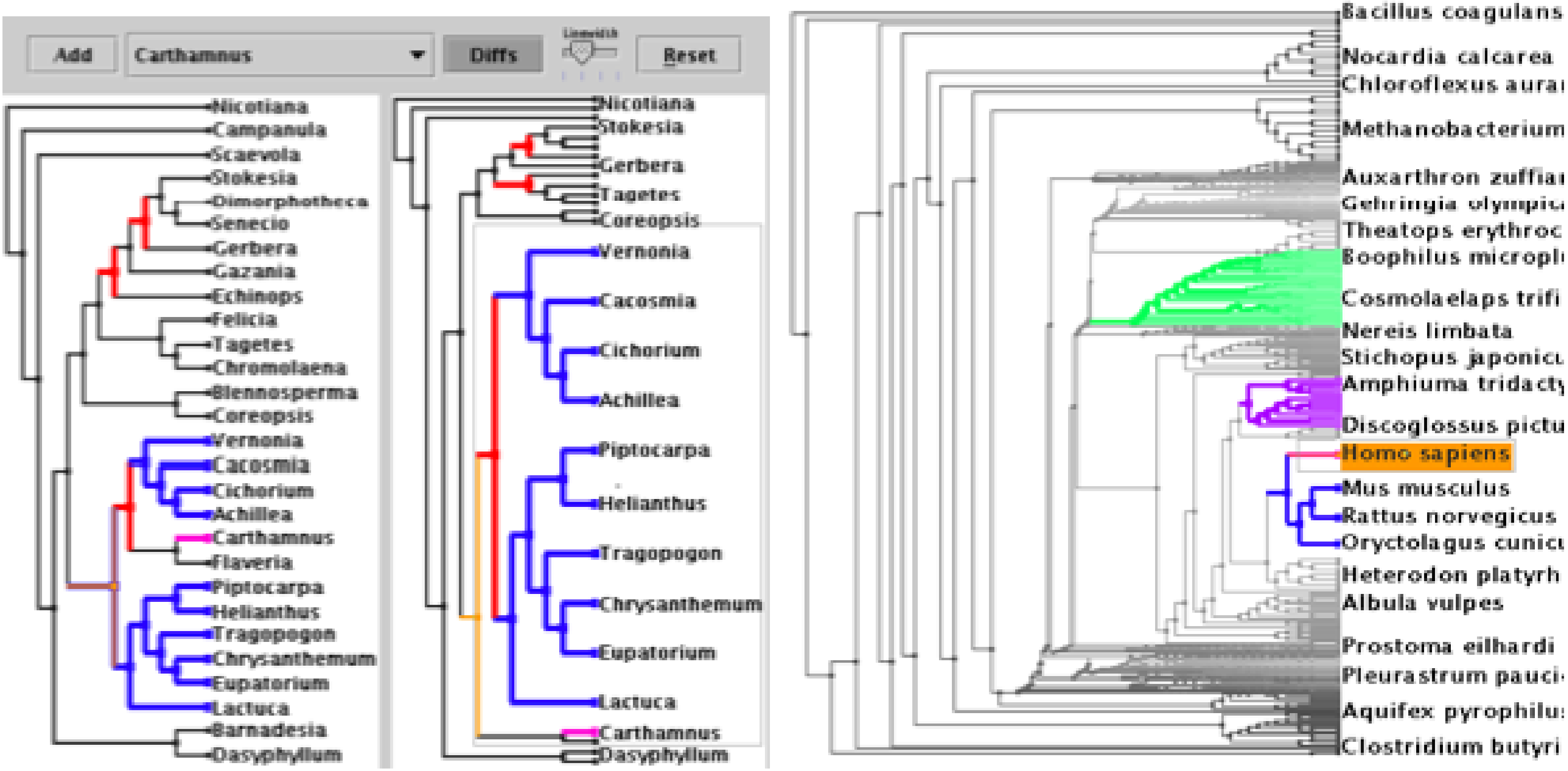
- J. Boettger et al. 2006, “Complex Logarithmic Views for Small Details in Large Contexts”

Rubber-bands



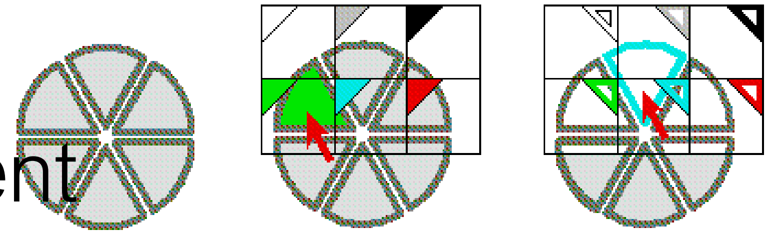
Rubber-bands

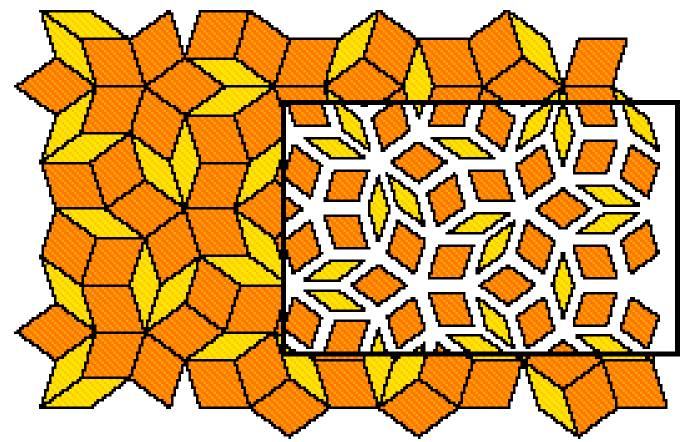
- https://www.cs.ubc.ca/~tmm/papers/tj/

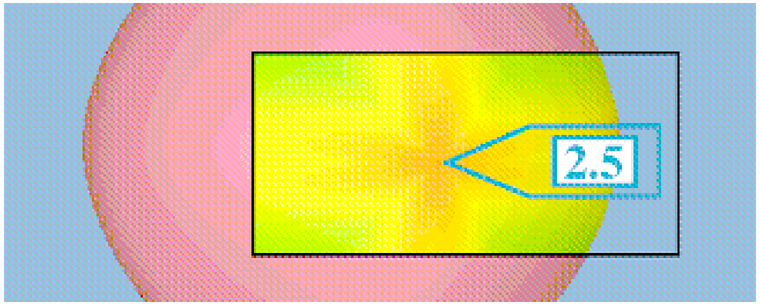


Selective filtering - Toolglass/Lenses : Layering

- two-handed interaction
- toolglass: semi-transparent interactive tool
  - e.g. click-through buttons
- magic lens:
  - e.g. scaling, curvature







Toolglass and magic lenses: the see-through interface. Eric A. Bier, Maureen C. Stone, Ken Pier, William Buxton, and Tony D. DeRose, Proc. SIGGRAPH'93, pp. 73-76.

Distortion challenges

- unsuitable if must make relative spatial judgements (length)
  – graph topology as least problematic case
- overhead of tracking distortion
  – constrained and predictable maybe safest
- how to visually communicate distortion
  – gridlines, shading
- target acquisition problem
  – lens displacing items away from screen location
- mixed results comparing to separate views, temporal nav
- fisheye followup: concern with enthusiasm over distortion
  – what is being shown: selective filtering
  – how it is shown: distortion as one possibility

Distortion costs