Lecture 7: Depth/Occlusion

Information Visualization
CPSC 533C, Fall 2006

Tamara Munzner

UBC Computer Science

3 October 2006

Readings Covered

Ware, Chapter 8: Space Perception and the Display of Data in Space

Tufte, Chapter 3: Layering and Separation

Extending Distortion Viewing Techniques from 2D to 3D Data. M. Sheelagh T. Carpendale, David J. Cowperthwaite, and F. David Fracchia, IEEE Computer Graphics and Applications, Special Issue on Information Visualization, 17(4), pp 42 - 51, July 1997. http://pages.cpsc.ucalgary.ca/~sheelagh/personal/pubs/cga97.pdf

EdgeLens: An Interactive Method for Managing Edge Congestion in Graphs. Nelson Wong, M. Sheelagh T. Carpendale, Saul Greenberg, Proc. InfoVis03, pp 51-58. http://pages.cpsc.ucalgary.ca/~sheelagh/personal/pubs/2003/wong-carp-infovis03-submit.pdf

Hierarchical Edge Bundles: Visualization of Adjacency Relations in Hierarchical Data. Danny Holten, Proc. InfoVis06, to appear http://www.win.tue.nl/~dholten/papers/bundles_infovis.pdf

Further Readings

Cheops: A Compact Explorer For Complex Hierarchies. Luc Beaudoin, Marc-Antoine Parent, Louis C. Vroomen, Proc. IEEE Vis 1996, pp 87-92.

Depth and Occlusion

- Space Perception
  - depth
- Layering and Separation
  - visual layering
- 3DPS
  - graphs embedding in 3D vs. 2D
- EdgeLens
  - interactive occlusion control of 2D graph edges

Space Perception

- static
    - occlusion
    - perspective projection
        - linear, texture gradient
    - depth of field
    - atmospheric (fog, depth cueing)
    - lighting and shadows
        - shape from shading
        - cast shadows
- moving
    - structure-from-motion
        - motion parallax (head motion)
- binocular
    - binocular disparity (stereopsis)
    - convergence
        - amount eyes rotate toward center of interest
        - like optical range finder

Space Perception

- droplines,
- background grids

- depth cueing
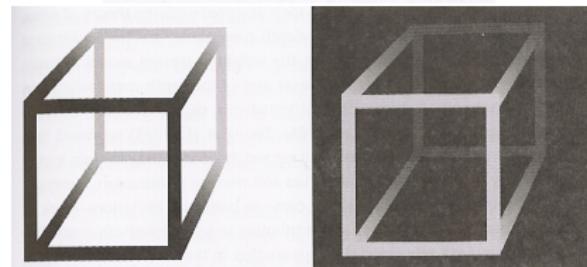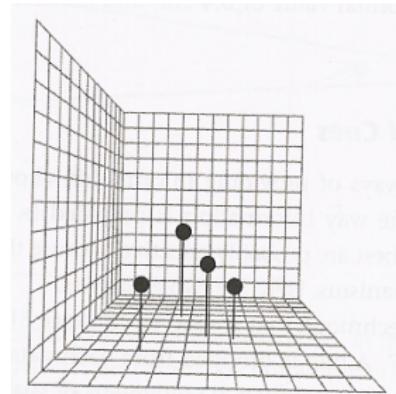
Ware, Information Visualization: Perception for Design, Chap 8

Layering And Separation

Tufte, Envisioning Information, Chap 3

Visual Clutter

▶ subtler background than foreground
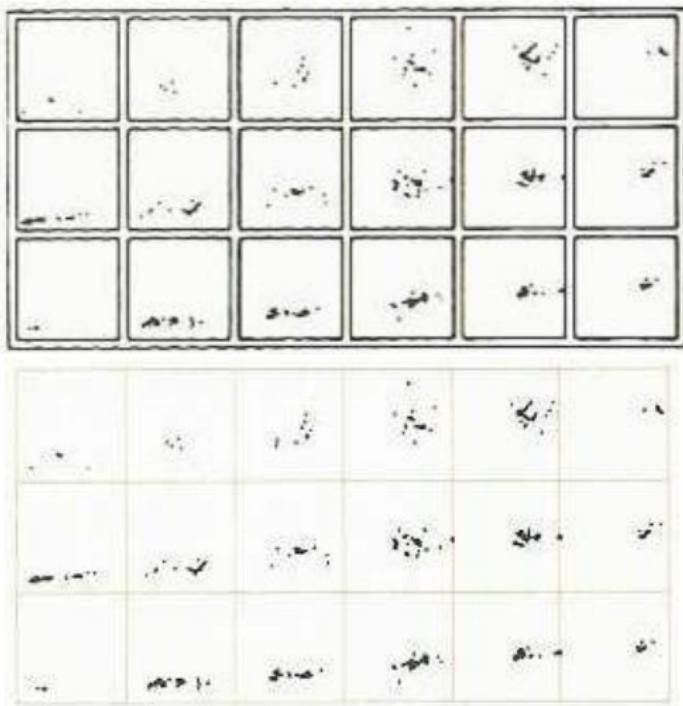
3DPS

2D displace+magnify

3D displace+magnify
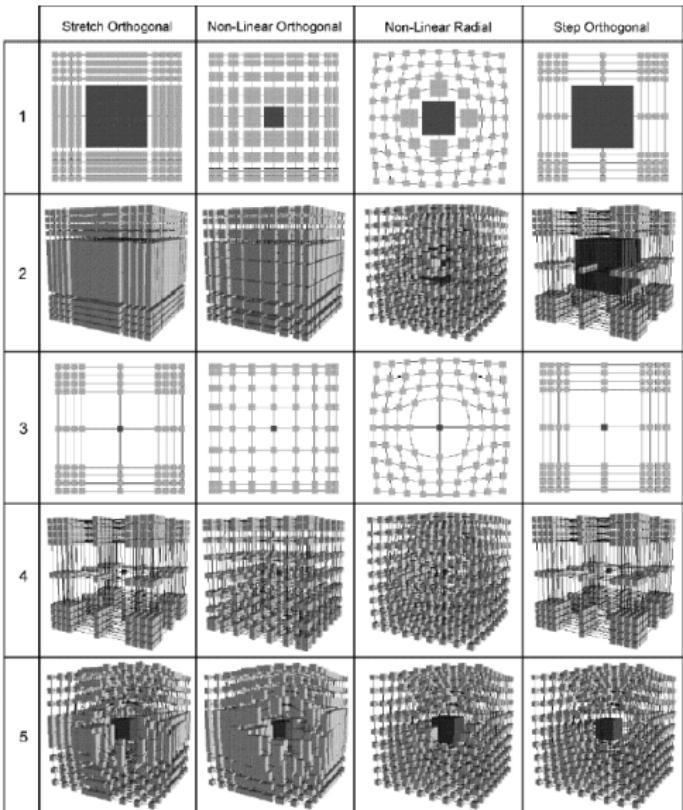
2D displace only

3D displace only

visual access distortion

	Stretch Orthogonal	Non-Linear Orthogonal	Non-Linear Radial	Step Orthogonal
1				
2				
3				
4				
5				

Visual Access Distortion

- naive 2D ← 3D extension yields occlusion
  - same problem as van Wijk
- graph-based solution
  - move geometry according to viewpoint
  - magnify focus only
  - introduce curves into formerly straight lines
- focus+context approach
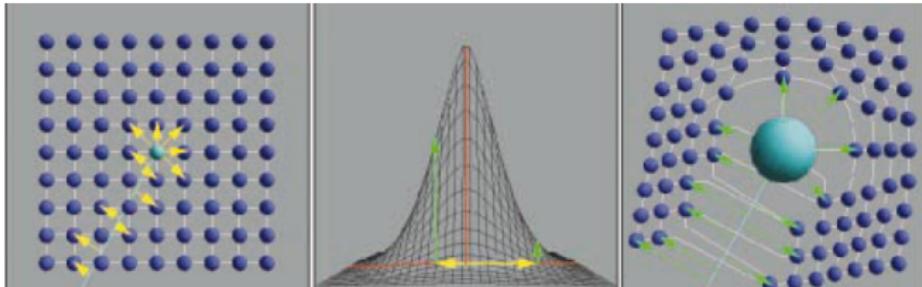
[Extending Distortion Viewing Techniques from 2D to 3D Data. Carpendale et al. CG&A 17(4):42-51, July 1997]

Results

- single, multiple foci
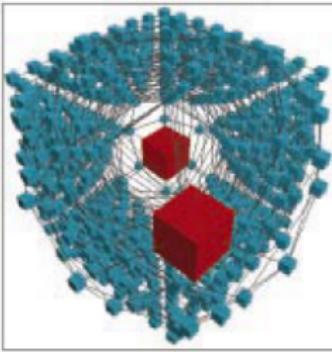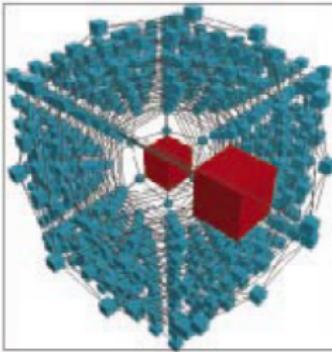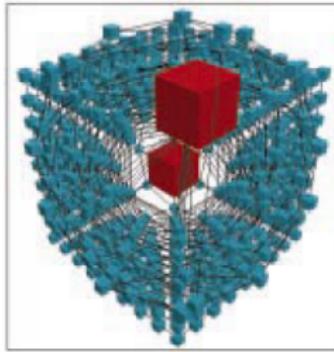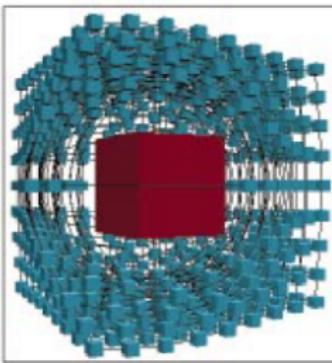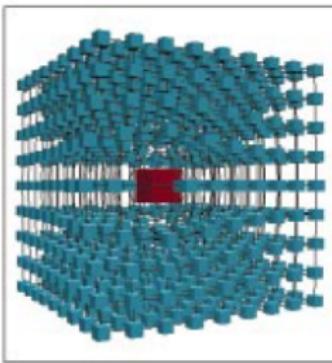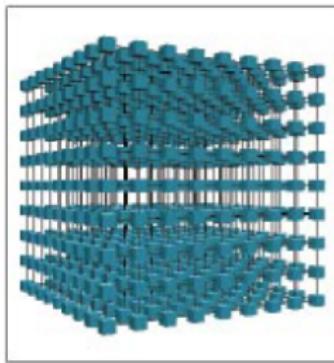
[Extending Distortion Viewing Techniques from 2D to 3D Data. Carpendale et al. CG&A 17(4):42-51, July 1997]

Results

- randomly positioned nodes instead of grid
  - closer to real dataset
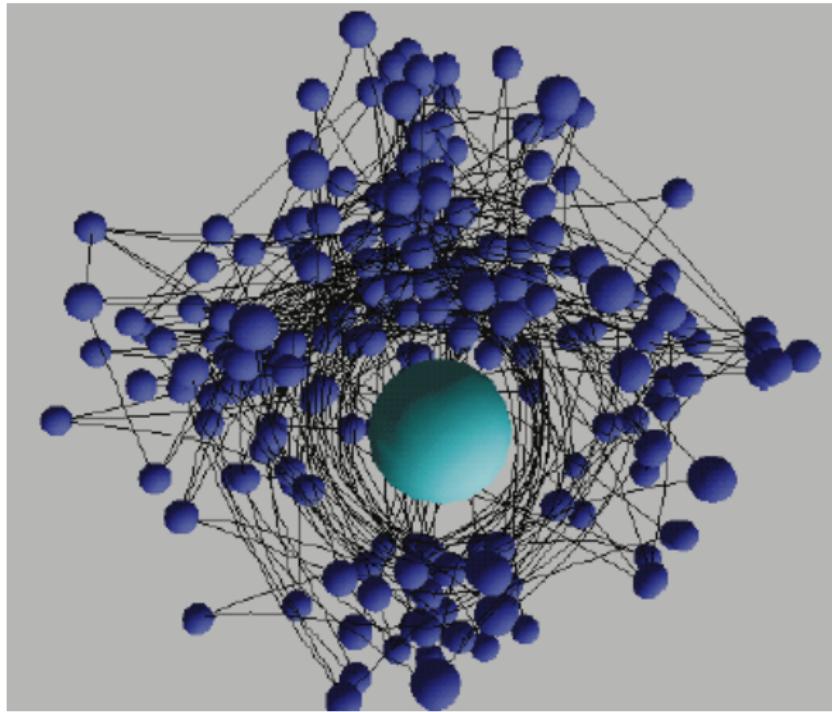
[Extending Distortion Viewing Techniques from 2D to 3D Data. Carpendale et al. CG&A 17(4):42-51, July 1997]

Critique

Critique

- sophisticated way to navigate 3D graphs
- purely technique paper
  - not a design study
- interesting discussion I'd like to see
  - more analysis of why 3D necessary
    - cites Ware 3x improvement
  - occlusion workaround vs. occlusion avoidance
- never shown on real data
  - hard to draw conclusions from toy datasets

Information Density: Codimension

- want balance between clutter and void
- topological approach to describing density
- diff between structure and surrounding space
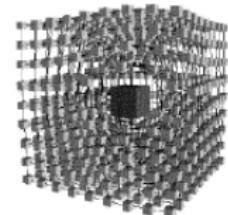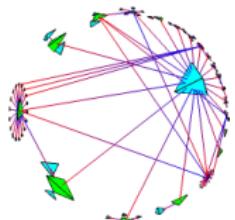
	dim space	- dim structure	= codim	
webviz	3	1 circle	2	sparse
H3	3	2 hemisphere	1	
3DPS	3	3 cubic grid	0	dense

EdgeLens

- interactive control over edge occlusion

- user study: spline better than bubble
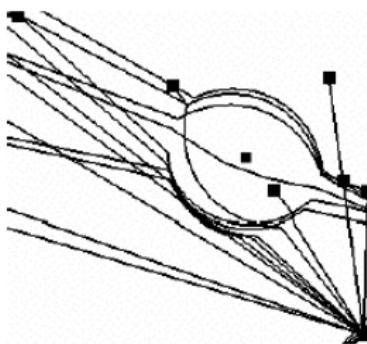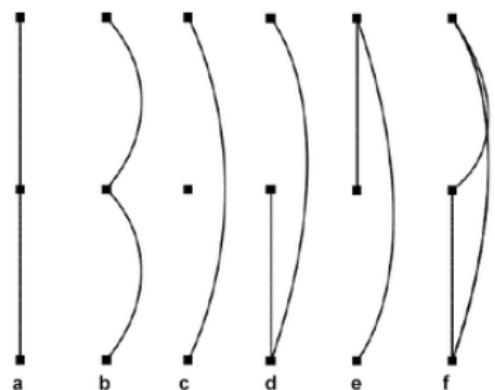
Figure 5a: Bubble approach   Figure 5b: Spline approach
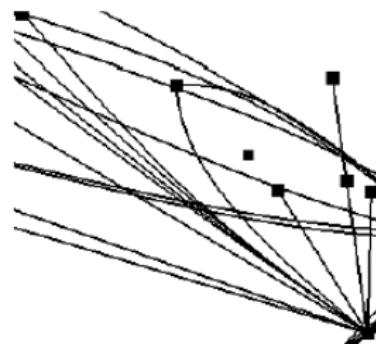
[EdgeLens: An Interactive Method for Managing Edge Congestion in Graphs. Wong, Carpendale, and Greenberg. Proc. InfoVis03, pp 51-58.]

EdgeLens Final Algorithm
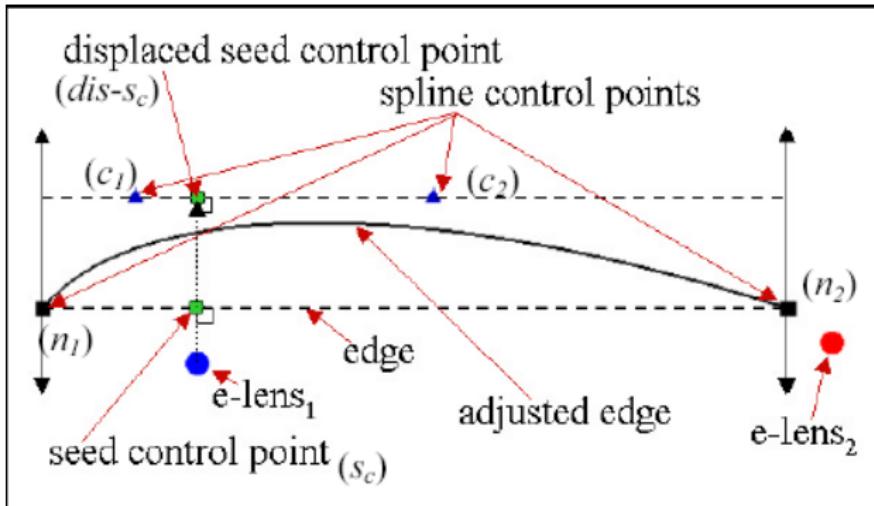
- decide which edges affected
- calculate displacements
- calculate spline control points
- draw curves

[EdgeLens: An Interactive Method for Managing Edge Congestion in Graphs. Wong, Carpendale, and Greenberg. Proc. InfoVis03, pp 51-58.]

EdgeLens Techniques

- transparency, color
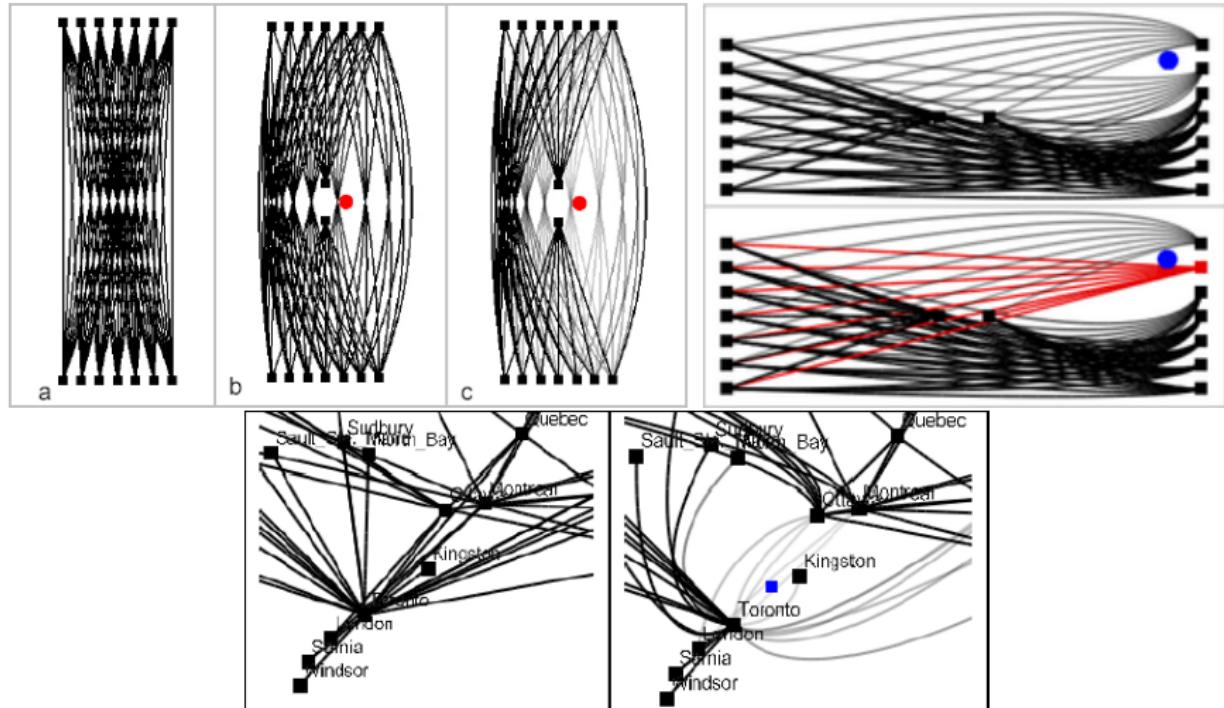
[EdgeLens: An Interactive Method for Managing Edge Congestion in Graphs. Wong, Carpendale, and Greenberg. Proc. InfoVis03, pp 51-58.]

EdgeLens Results
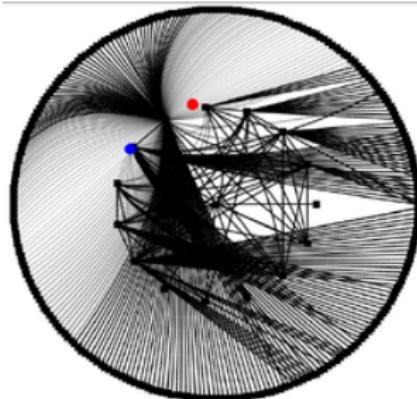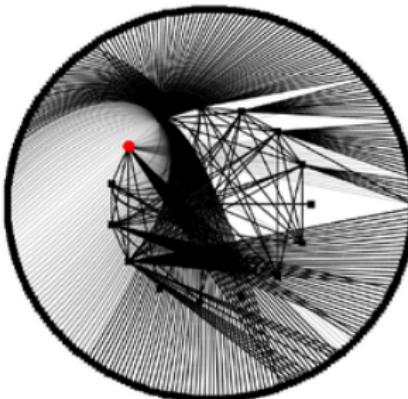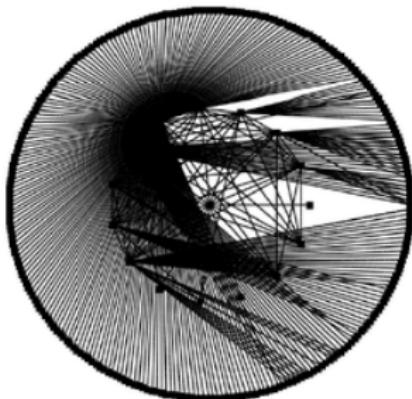
[EdgeLens: An Interactive Method for Managing Edge Congestion in Graphs. Wong, Carpendale, and Greenberg. Proc. InfoVis03, pp 51-58.]

- critique

EdgeLens Results
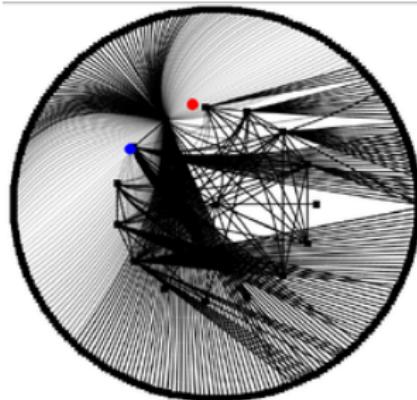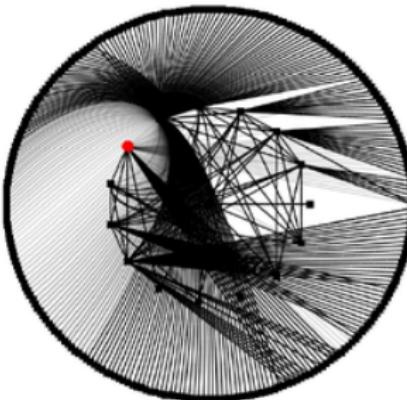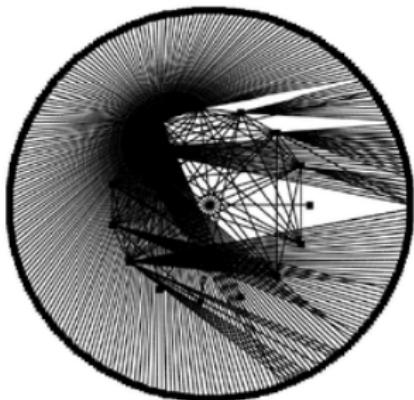
[EdgeLens: An Interactive Method for Managing Edge Congestion in Graphs. Wong, Carpendale, and Greenberg. Proc. InfoVis03, pp 51-58.]

- critique
  - very nice technique
   - compelling need
  - shown on real data

Cheops

- compact
- show paths through tree
- extreme occlusion deliberately
- browsing/exploration, not topological analysis
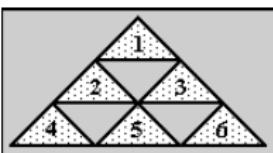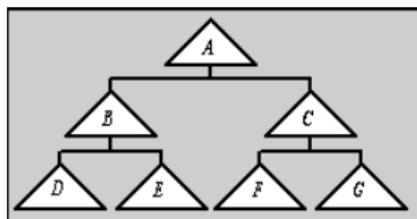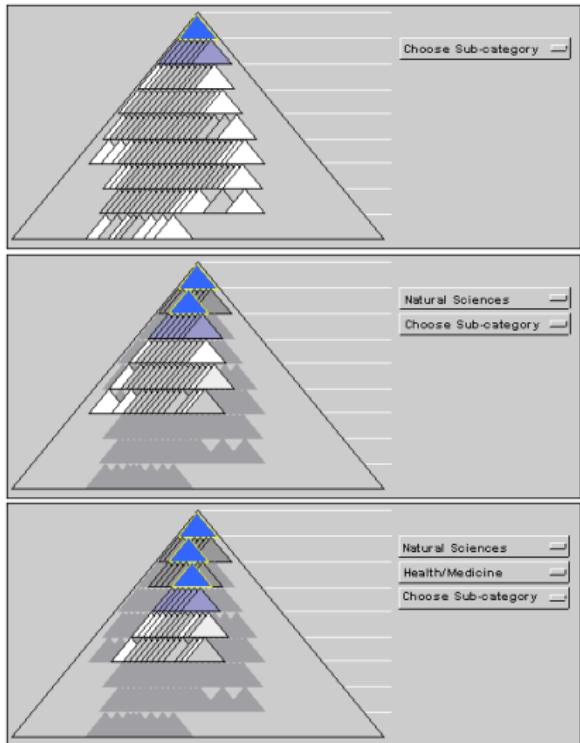
[Cheops: A Compact Explorer For Complex Hierarchies. Beaudoin, Parent, and Vroomen. Proc. IEEE Vis 1996, pp 87-92.]

Cheops Interaction

▶ flip through overloaded visual
 representation choices
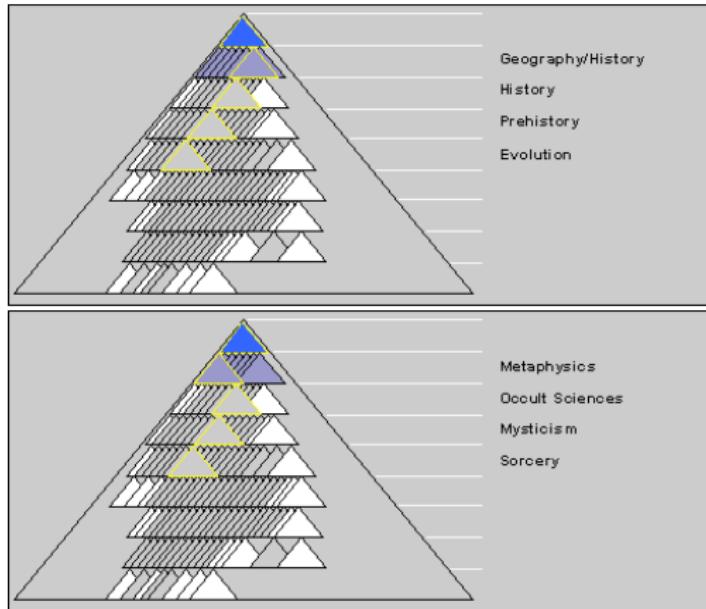
[Cheops: A Compact Explorer For Complex Hierarchies. Beaudoin, Parent, and
Vroomen. Proc. IEEE Vis 1996, pp 87-92.]

Cheops Critique

- pro
  - tiny footprint
    - suitable when main user focus is other task
- con
  - relatively hard to understand
 - singular nodes very salient, but not so important

Hierarchical Edge Bundles
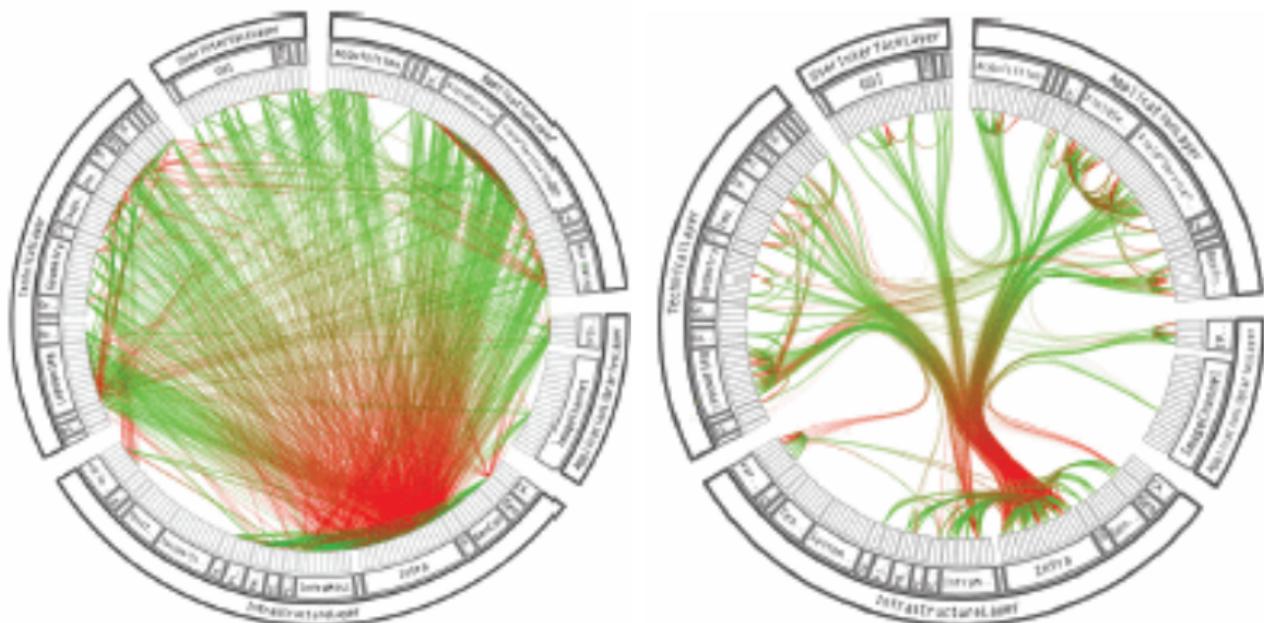
[Hierarchical Edge Bundles: Visualization of Adjacency Relations in Hierarchical Data. Danny Holten, Proc. InfoVis06.]

Hierarchical Edge Bundles

▶ bundle by hierarchy using splines
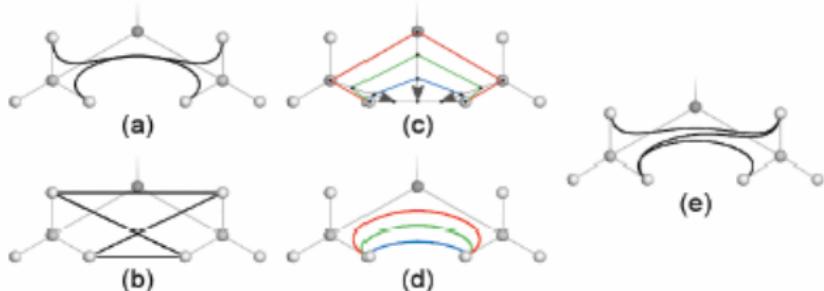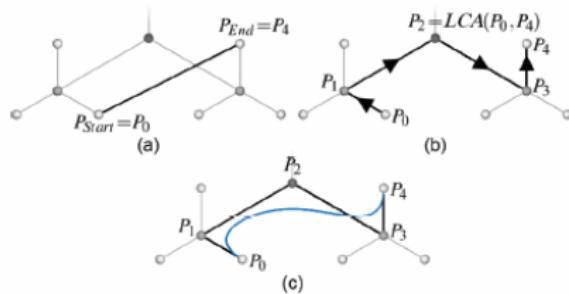
[Hierarchical Edge Bundles: Visualization of Adjacency Relations in Hierarchical Data. Danny Holten, Proc. InfoVis06.]

Hierarchical Edge Bundles

- alpha blending
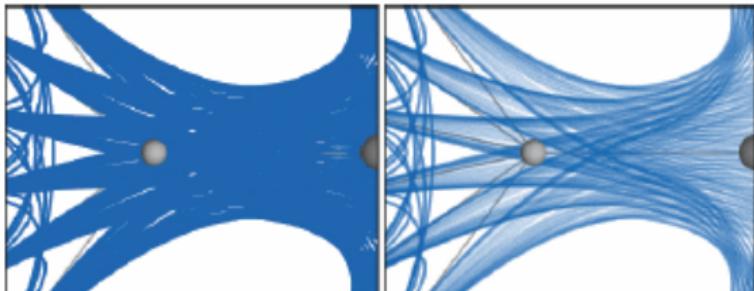
- bundling strength
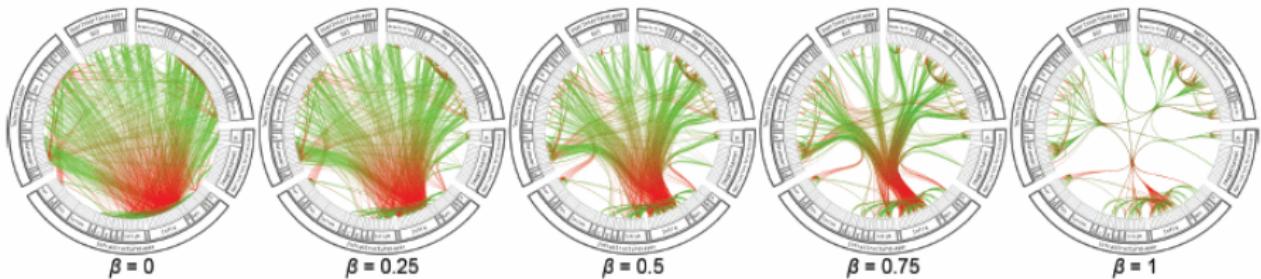
$\beta = 0$ $\beta = 0.25$ $\beta = 0.5$ $\beta = 0.75$ $\beta = 1$

[Hierarchical Edge Bundles: Visualization of Adjacency Relations in Hierarchical Data.
Danny Holten, Proc. InfoVis06.]

Hierarchical Edge Bundling

- ▶ (mostly) agnostic to layout
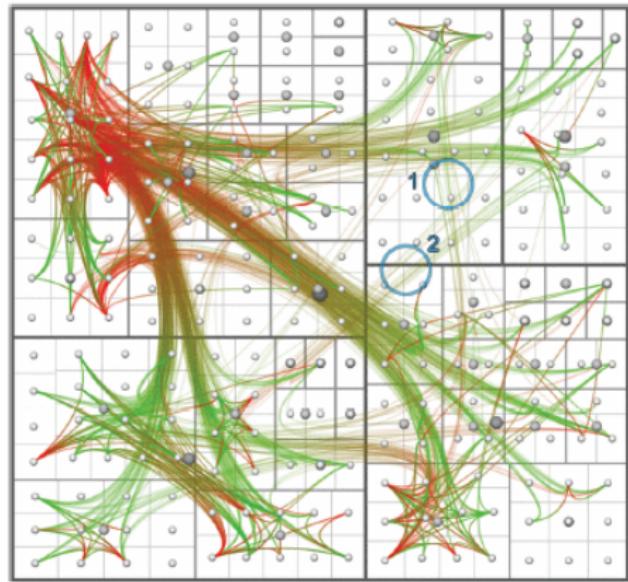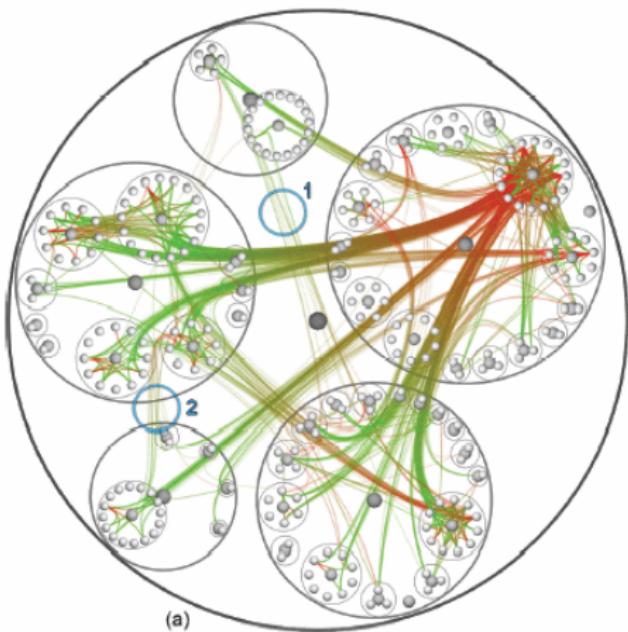
[Hierarchical Edge Bundles: Visualization of Adjacency Relations in Hierarchical Data.
Danny Holten, Proc. InfoVis06.]

Project Resources