Ch 6: Rules of Thumb
Paper: Artery Vis

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CPSC 547, Information Visualization
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http://www.cs.ubc.ca/~tmm/courses/547-15

News

- marks out for Tue (Q4)
  - avg 90, min 63, max 100
  - clear trend of improvement, nice job!
- correction on Strahler numbers
  - colored by tree traversal order, not Strahler number
  - thanks to Mike for spotting the bug!

VAD Ch 6: Rules of Thumb

- No unjustified 3D
  - Power of the plane, dangers of depth
  - Occlusion hides information
  - Perspective distortion loses information
  - Tilted text isn't legible
- No unjustified 2D
- Eyes beat memory
- Resolution over immersion
- Overview first, zoom and filter, details on demand
- Function first, form next

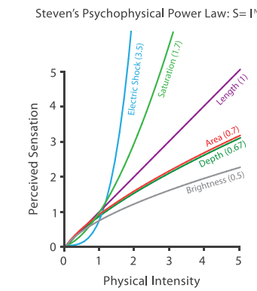
- (Get it right in black and white)

No unjustified 3D: Power of the plane

- high-ranked spatial position channels: **planar** spatial position
  - not depth!

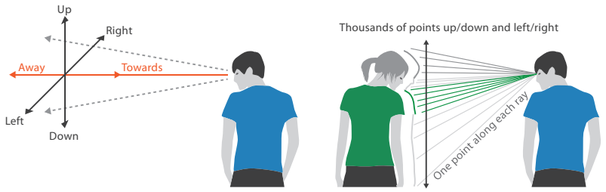
Magnitude Channels: Ordered Attributes

Position on common scale
Position on unaligned scale
Length (1D size)
Tilt/angle
Area (2D size)
Depth (3D position)



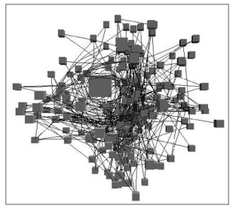
No unjustified 3D: Danger of depth

- we don't really live in 3D: we **see** in 2.05D
  - acquire more info on image plane quickly from eye movements
  - acquire more info for depth slower, from head/body motion



Occlusion hides information

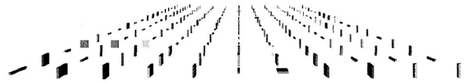
- occlusion
- interaction complexity



[Distortion Viewing Techniques for 3D Data. Carpendale et al. InfoVis1996.]

Perspective distortion loses information

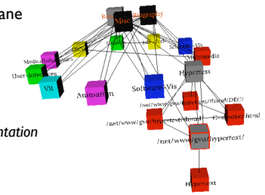
- perspective distortion
  - interferes with all size channel encodings
  - power of the plane is lost!



[Visualizing the Results of Multimedia Web Search Engines. Mukherjea, Hirata, and Hara. InfoVis 96]

Tilted text isn't legible

- text legibility
  - far worse when tilted from image plane



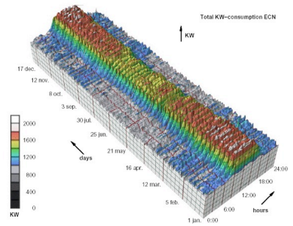
- further reading

[Exploring and Reducing the Effects of Orientation on Text Readability in Volumetric Displays. Grossman et al. CHI 2007]

[Visualizing the World-Wide Web with the Navigational View Builder. Mukherjea and Foley. Computer Networks and ISDN Systems, 1995.]

No unjustified 3D example: Time-series data

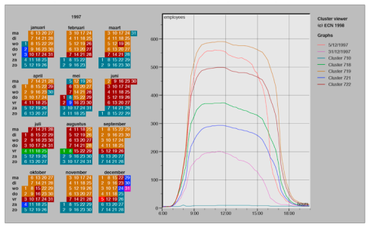
- extruded curves: detailed comparisons impossible



[Cluster and Calendar based Visualization of Time Series Data. van Wijk and van Selow, Proc. InfoVis 99.]

No unjustified 3D example: Transform for new data abstraction

- derived data: cluster hierarchy
- juxtapose multiple views: calendar, superimposed 2D curves

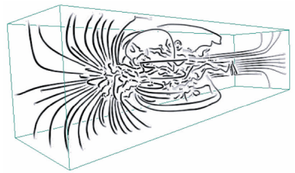


[Cluster and Calendar based Visualization of Time Series Data. van Wijk and van Selow, Proc. InfoVis 99.]

Justified 3D: shape perception

- benefits outweigh costs when task is shape perception for 3D spatial data
  - interactive navigation supports synthesis across many viewpoints

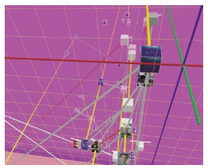
Targets
Spatial Data
Shape



[Image-Based Streamline Generation and Rendering. Li and Shen. IEEE Trans. Visualization and Computer Graphics (TVCG) 13:3 (2007), 630–640.]

No unjustified 3D

- 3D legitimate for true 3D spatial data
- 3D needs very careful justification for abstract data
  - enthusiasm in 1990s, but now skepticism
  - be especially careful with 3D for point clouds or networks



[WEBPATH-a three dimensional Web history. Frecon and Smith. Proc. InfoVis 1999]

No unjustified 2D

- consider whether network data requires 2D spatial layout
  - especially if reading text is central to task!
  - arranging as network means lower information density and harder label lookup compared to text lists
- benefits outweigh costs when topological structure/context important for task
  - be especially careful for search results, document collections, ontologies

Targets
Network Data
Topology
Paths

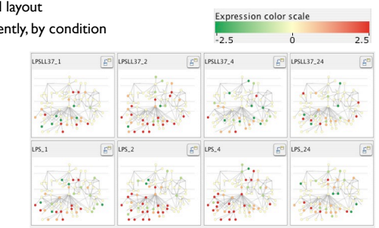
Eyes beat memory

- principle: external cognition vs. internal memory
  - easy to compare by moving eyes between side-by-side views
  - harder to compare visible item to memory of what you saw
- implications for animation
  - great for choreographed storytelling
  - great for transitions between two states
  - poor for many states with changes everywhere
    - consider small multiples instead

literal	abstract
animation	small multiples
show time with time	show time with space

Eyes beat memory example: Cerebral

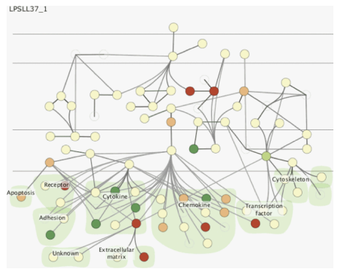
- small multiples: one graph instance per experimental condition
  - same spatial layout
  - color differently, by condition



[Cerebral: Visualizing Multiple Experimental Conditions on a Graph with Biological Context. Barsky, Munzner, Gardy, and Kincaid. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2008) 14:6 (2008), 1253–1260.]

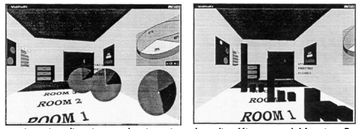
Why not animation?

- disparate frames and regions: comparison difficult
  - vs contiguous frames
  - vs small region
  - vs coherent motion of group
- change blindness
  - even major changes difficult to notice if mental buffer wiped
- safe special case
  - animated transitions



Resolution beats immersion

- immersion typically not helpful for abstract data
  - do not need sense of presence or stereoscopic 3D
- resolution much more important
  - pixels are the scarcest resource
  - desktop also better for workflow integration
- virtual reality for abstract data very difficult to justify



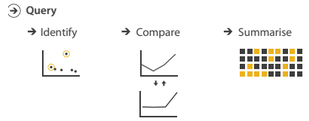
[Development of an information visualization tool using virtual reality. Kirner and Martins. Proc. Symp. Applied Computing 2000]

Overview first, zoom and filter, details on demand

- influential mantra from Shneiderman

[The Eyes Have It: A Task by Data Type Taxonomy for Information Visualizations. Shneiderman. Proc. IEEE Visual Languages, pp. 336–343, 1996.]

- overview = summary
  - microcosm of full vis design problem



- nuances
  - beyond just two levels: multi-scale structure
  - difficult when scale huge: give up on overview and browse local neighborhoods?

[Search, Show Context, Expand on Demand: Supporting Large Graph Exploration with Degree-of-Interest. van Ham and Perer. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2009) 15:6 (2009), 953–960.]

Function first, form next

- start with focus on functionality
  - straightforward to improve aesthetics later on, as refinement
  - if no expertise in-house, find good graphic designer to work with
- dangerous to start with aesthetics
  - usually impossible to add function retroactively

Further reading: Books

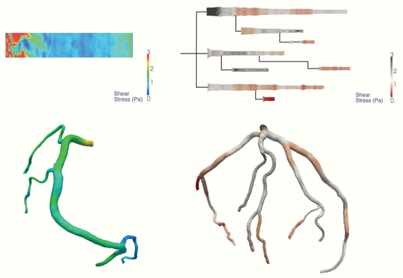
- Visualization Analysis and Design. Munzner. CRC Press, 2014.
  - Chap 6: Rules of Thumb
- The Non-Designer's Design Book. Williams. Peachpit Press, 2008.
- Visual Thinking for Design, Colin Ware, Morgan Kaufmann 2008.
- Information Visualization: Perception for Design, 3rd edition, Colin Ware, Morgan Kaufmann, 2013.

Further reading: Articles

- The Use of 2-D and 3-D Displays for Shape Understanding versus Relative Position Tasks. Mark St. John, Michael B. Cowen, Harvey S. Smallman, and Heather M. Oonk. Human Factors 43:1 (2001), 79-98.
- An Evaluation of Cone Trees. Andy Cockburn and Bruce McKenzie. In People and Computers XIV: Usability or Else. British Computer Society Conference on Human Computer Interaction, pp. 425-436. Springer, 2000.
- 3D or Not 3D? Evaluating the Effect of the Third Dimension in a Document Management System. Andy Cockburn and Bruce McKenzie. Proc. CHI 2003, p 434-441.
- Evaluating Spatial Memory in Two and Three Dimensions. Andy Cockburn and Bruce McKenzie. International Journal of Human-Computer Studies. 61(30):359-373.
- Supporting and Exploiting Spatial Memory in User Interfaces. Joey Scarr, Andy Cockburn, and Carl Gutwin. Foundations and Trends in Human-Computer Interaction. 2013. 6:1 1-84.
- Principles of Traditional Animation Applied to Computer Animation. John Lasseter, Proceedings of SIGGRAPH 87, Computer Graphics, 21(4), pp. 35-44, July 1987.
- Animation: Can It Facilitate? Barbara Tversky, Julie Morrison, Mireille Betrancourt. International Journal of Human Computer Studies 57:4, pp 247-262, 2002.
- Structuring information interfaces for procedural learning. Jeffrey M. Zacks and Barbara Tversky. Journal of Experimental Psychology: Applied, Vol 9(2), Jun 2003, 88-100.
- Effectiveness of Animation in Trend Visualization. George Robertson and Roland Fernandez and Danyel Fisher and Bongshin Lee and John Stasko. IEEE Trans. on Visualization and Computer Graphics 14(6):1325-1332, 2008 (Proc. InfoVis08).
- Current Approaches to Change Blindness. Daniel J. Simons. Visual Cognition 7:1/2/3 (2000), 1-15.
- The eyes have it: A task by data type taxonomy for information visualizations. Ben Shneiderman. Proc. Conf. Visual Languages 1996, p 336-343.
- The Notion of Overview in Information Visualization. Kaspar Hornbaek and Morten Hertzum. International Journal of Human-Computer Studies 69:7-8 (2011), 509-525.
- The Information Visualizer, an Information Workspace. Stuart Card, George Robertson, and Jock Mackinlay. Proc. CHI 1991, p 181-186.
- Designing with the Mind in Mind: Simple Guide to Understanding User Interface Design Rules. Jeff Johnson. Morgan Kaufmann, 2010.
- A Framework of Interaction Costs in Information Visualization. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 08) 14:6 (2008), 1149-1156.
- Toward a Deeper Understanding of the Role of Interaction in Information Visualization. Ji Soo Yi, Youn Ah Kang, John T. Stasko, and Julie A. Jacko. TVCG (Proc. InfoVis 07) 13:6 (2007), 1224-1231.
- Get It Right in Black and White. Maureen Stone. Functional Color, 2010.

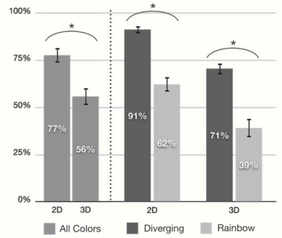
HemoViz: Design study + evaluation

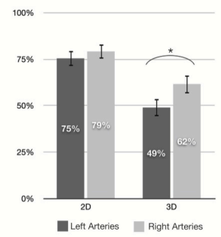
- formative study with experts
  - task taxonomy
- HemoViz design
- deploy attempt fails
  - experts balk: demand 3D and rainbows
- quantitative user study
  - med students, real data
  - 91% with 2D/diverging vs 39% with 3D/rainbows
  - experts willing to use



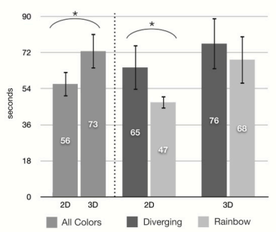
[Fig 1. Borkin et al. Artery Visualizations for Heart Disease Diagnosis. Proc InfoVis 2011.]]

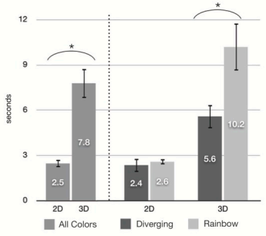
Study results: Error





Study results: Time





Next Time

- to read
  - VAD Ch. 4: Validation
  - D3: Data-Driven Documents. Michael Bostock, Vadim Ogievetsky, Jeffrey Heer. IEEE Trans. Visualization & Comp. Graphics (Proc. InfoVis), 2011.
    - paper type: system
  - guest lecture/demos: Matt Borkin, project resources