# Ch 6: Rules of Thumb
# Paper: Artery Vis

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*CPSC 547, Information Visualization*
***Day 5: 19 January 2017***

http://www.cs.ubc.ca/~tmm/courses/547-17

## News

- marks out for Thu (day 5)
  - lect 2 avg 86, min 73, max 94
  - lect 3 avg 85, min 78, max 98
  - lect 4 avg 88, min 84, max 100
  - lect 5 avg 89, min 84, max 100
- today:
  - continue & finish Decoding Exercise
    - please sit in same groups as last time
  - then switch over to discussion



## 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)

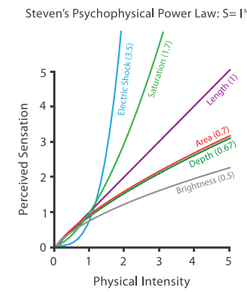


## No unjustified 3D: Power of the plane

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

Magnitude Channels: Ordered Attributes

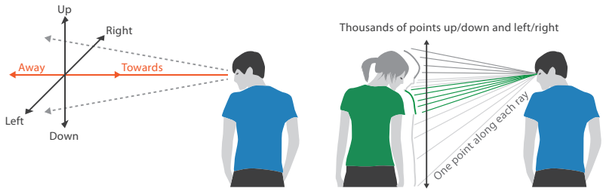
Position on common scale
Position on unaligned scale
Length (1D size)
Tilt/angle
Area (2D size)
Depth (3D position)






## 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





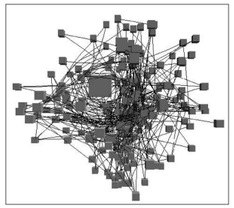


We can only see the outside shell of the world



## 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!

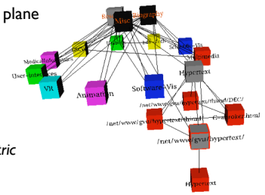
*[Visualizing the Results of Multimedia Web Search Engines. Mukherjea, Hirata, and Hara. InfoVis 96]*



## 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]*

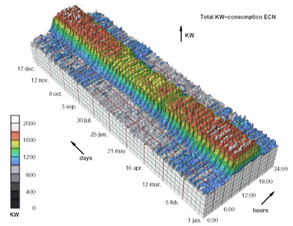


*[Visualizing the World-Wide Web with the Navigational View Builder. Mukherjea and Foley. Computer Networks and ISDN Systems, 1995.]*



## No unjustified 3D example: Time-series data

- extruded curves: detailed comparisons impossible

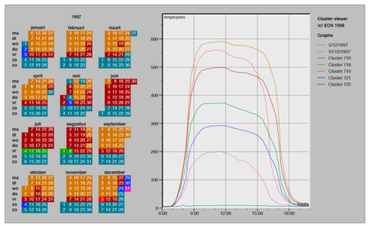



*[Cluster and Calendar based Visualization of Time Series Data. van Wijk and van Selow, Proc. InfoVis 99.]*



## No unjustified 3D example: Transform for new data abstraction

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



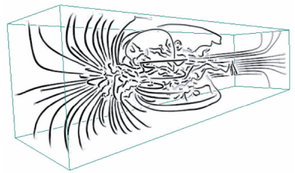
*[Cluster and Calendar based Visualization of Time Series Data. van Wijk and van Selow, Proc. InfoVis 99.]*



## 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

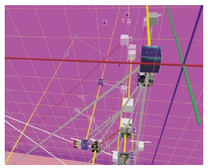


*[Image-Based Streamline Generation and Rendering. Li and Shen. IEEE Trans. Visualization and Computer Graphics (TVCG) 13:3 (2007), 630–640.]*



## 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

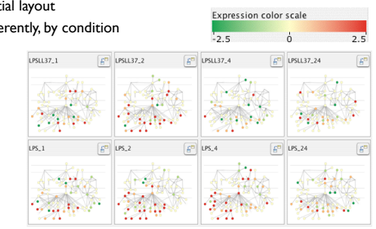
animation — small multiples

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

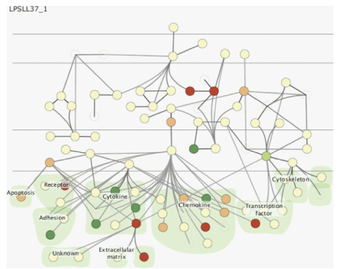



*[Cerebral: Visualizing Multiple Experimental Conditions on a Graph with Biological Context. Barsky, Munzner, Gardy, and Kincaid. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2008) 14:6 (2008), 1253–1260.]*



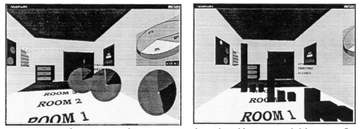
## Why not animation?

- 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.



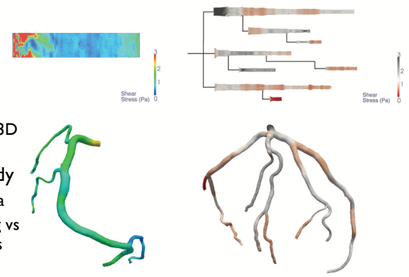
## Further reading: Articles


- 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

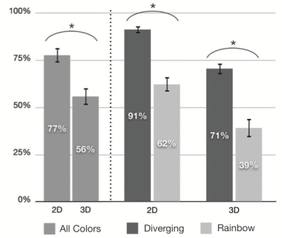
- formative study with experts
  - –task taxonomy
- HemoViz design
- deploy attempt fails
  - –experts balk: demand 3D and rainbows
- quantitative user study
  - –med students, real data
  - –91% with 2D/diverging vs 39% with 3D/rainbows
  - –experts willing to use

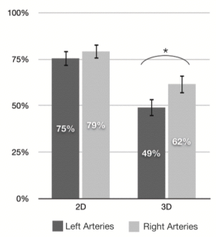



*[Fig 1. Borkin et al. Artery Visualizations for Heart Disease Diagnosis. Proc InfoVis 2011.]]*



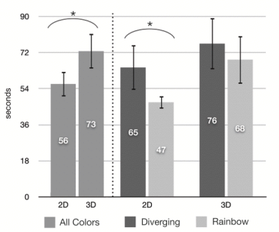
## Study results: Error

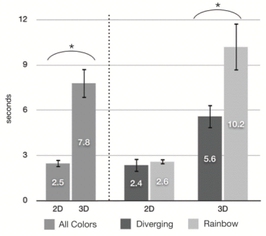





## Study results: Time






## Critique

- many strengths
  - – careful and well justified design, convincing human-subjects experiment
    - bringing visualization best practices to medical domain
- limitation
  - – paper does not clearly communicate why colormap is diverging not sequential
    - answer by email
    - doctors care about extremely high and extremely low ESS (scalar) values
      - – high values (top of scale, dark grey): extreme blood flow patterns may relate to heart malfunctions - but not imminently life threatening and don't indicate plaque locations
      - – low values (bottom of scale, dark red): very diseased regions with lots of plaque, docs care a lot!
      - – much debate from doctors on where is boundary between "normal" and "low" ESS values
        - » most think below 3 Pa are indicative of disease but many argue other values in the 2-4 range.
        - » all docs agree that values below 2 Pa are increasingly dangerous disease levels.
        - » thus map has transition at 3 Pa for the diverging point and truly red below 2 Pa
    - why continuous not segmented?
      - – doctors gain tremendous insight by seeing the subtle patterning of the ESS values
      - – particularly varying values in red region - patterns help them understand disease progression and severity
        - » especially useful for deciding what types of interventions to prescribe for the patient



## Next Time

- reminder: **no class session on Tue Jan 24!**
- but there are readings for Tue, comments due as usual
  - –What I Learned Recreating One Chart Using 24 Tools, Lisa Charlotte Rost
    https://source.opennews.org/en-US/articles/what-i-learned-recreating-one-chart-using-24-tools/
  - –D3: Data-Driven Documents. Michael Bostock, Vadim Ogievetsky, Jeffrey Heer. IEEE Trans. Visualization & Comp. Graphics (Proc. InfoVis), 2011.
    - paper type: system
- class as usual Thu Jan 26
  - –to read for Thu
    - VAD Chap 7: Arrange Tables