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/547-17

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
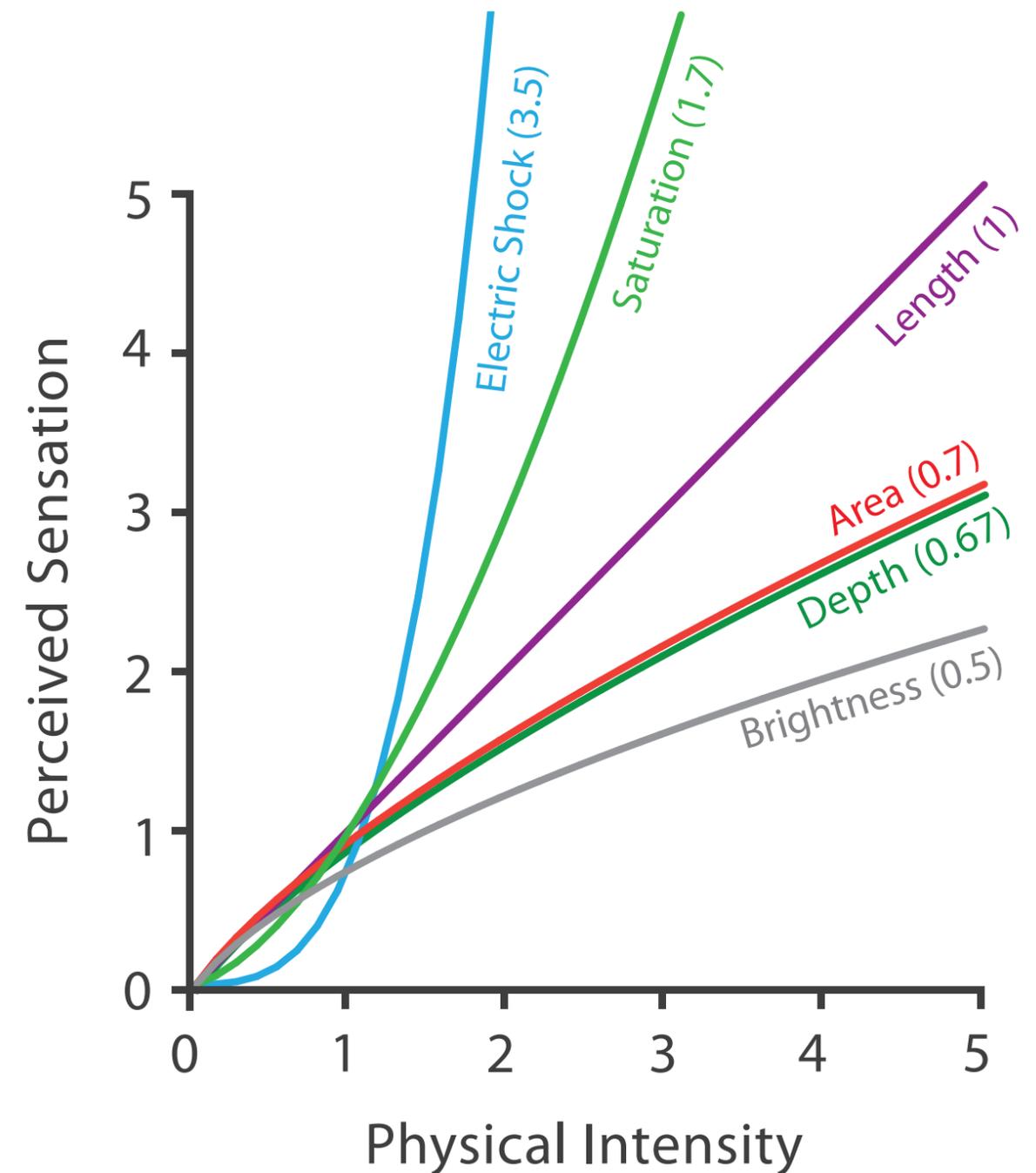
  Length (1D size)

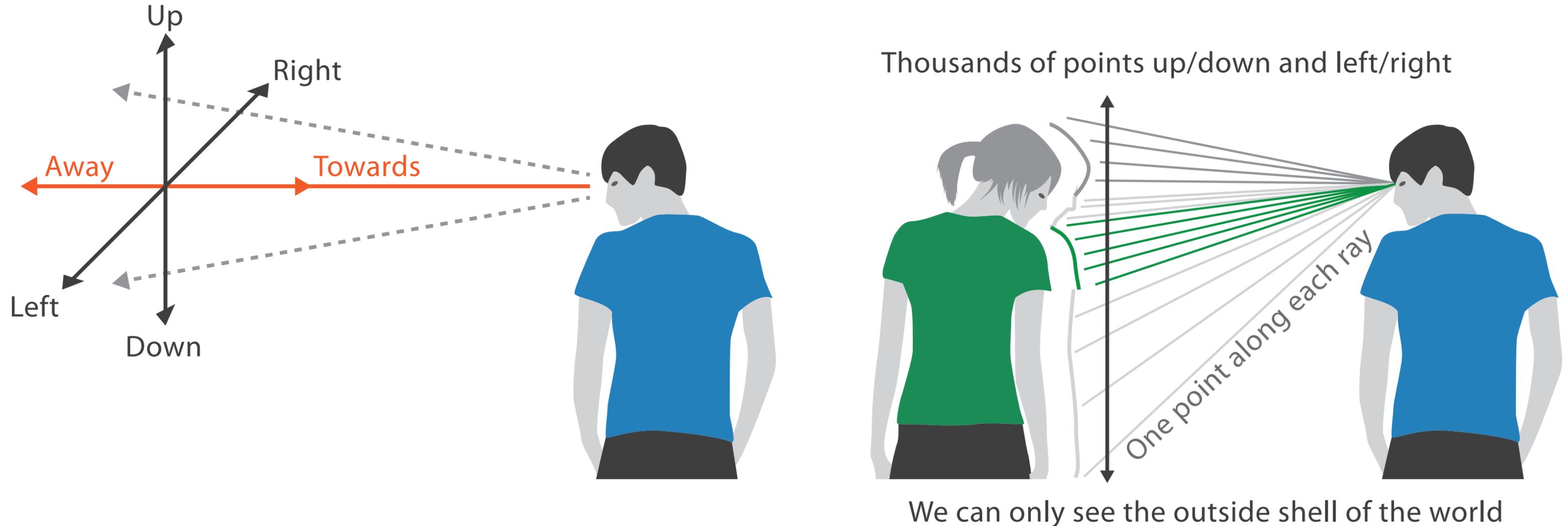 Tilt/angle

  Area (2D size)

  Depth (3D position)

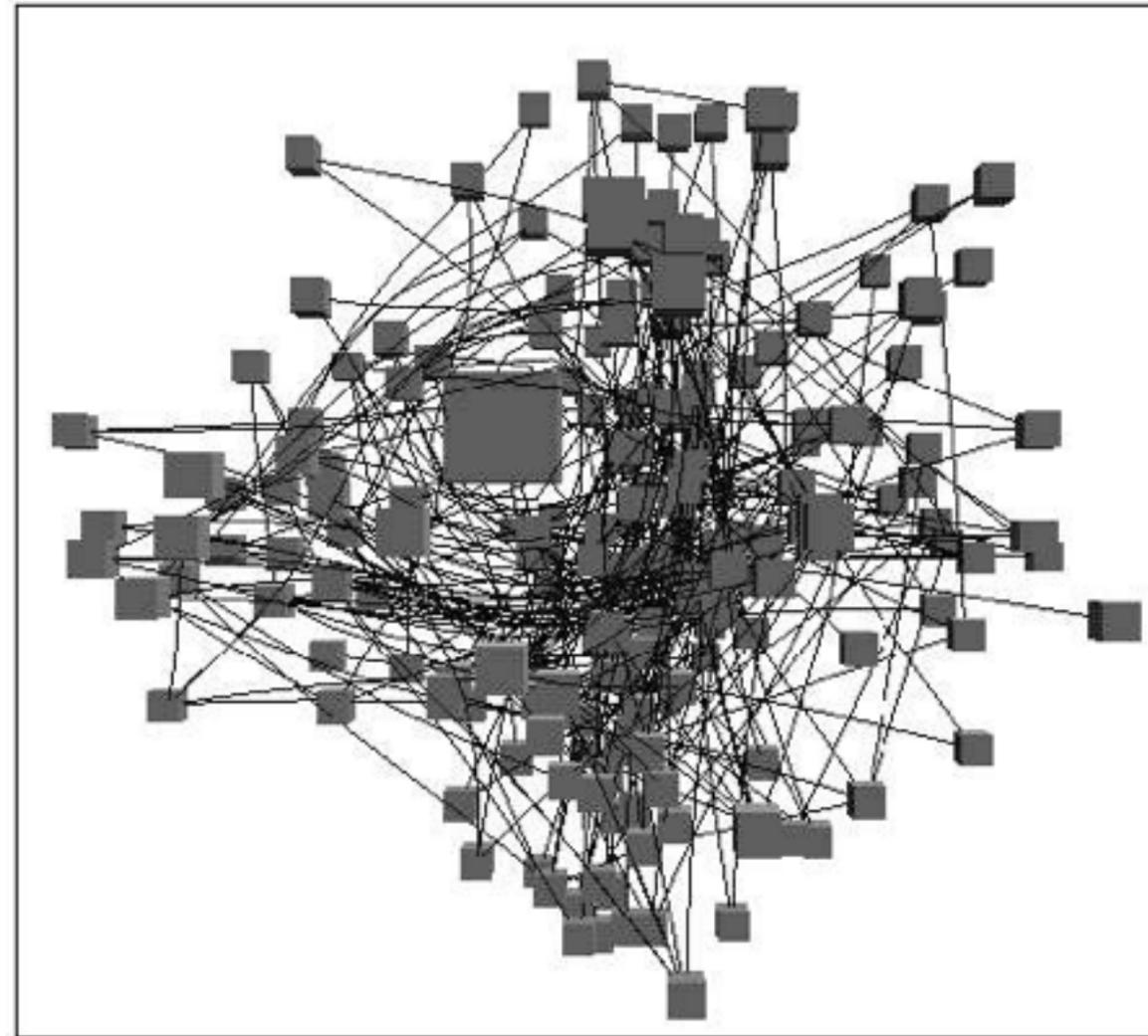Steven's Psychophysical Power Law: $S = I^N$

Electric Shock (3.5)

Saturation (1.7)

Length (1)

Area (0.7)

Depth (0.67)

Brightness (0.5)

Perceived Sensation

Physical Intensity

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

Up

Right

Away   Towards

Left

Down

Thousands of points up/down and left/right

One point along each ray

We can only see the outside shell of the world
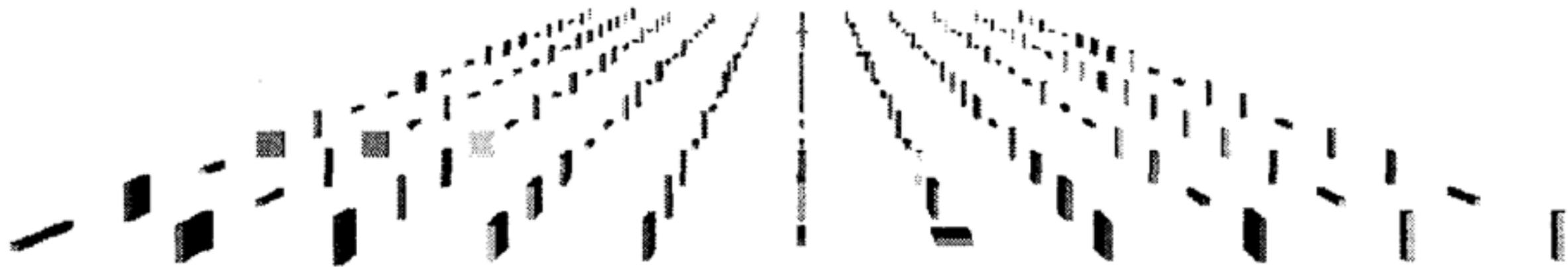
Occlusion hides information

- occlusion
- interaction complexity

[Distortion Viewing Techniques for 3D Data. Carpendale et al. InfoVis 1996.]

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.
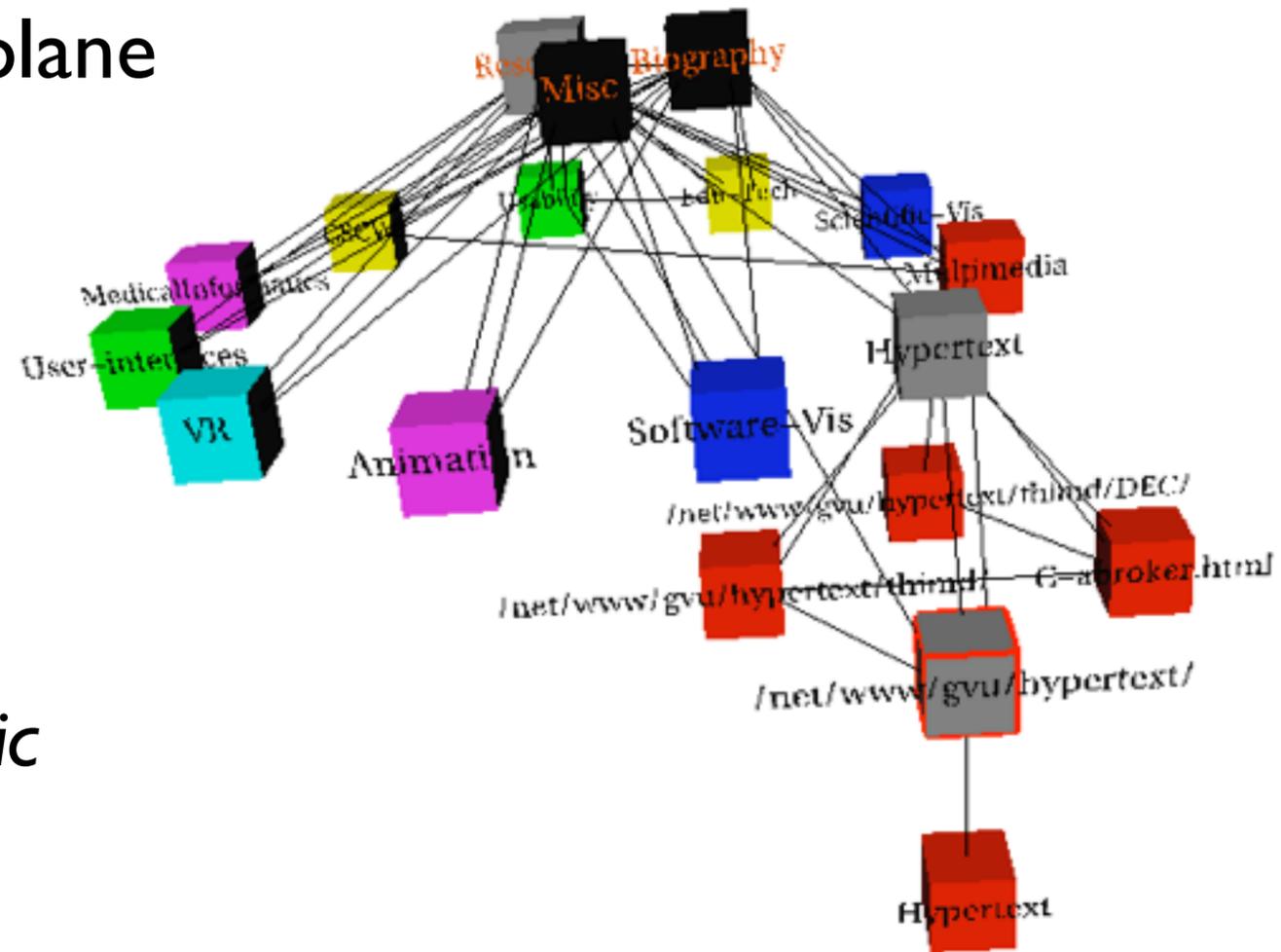*Mukherjea, Hirata, and Hara. InfoVis 96]*

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.
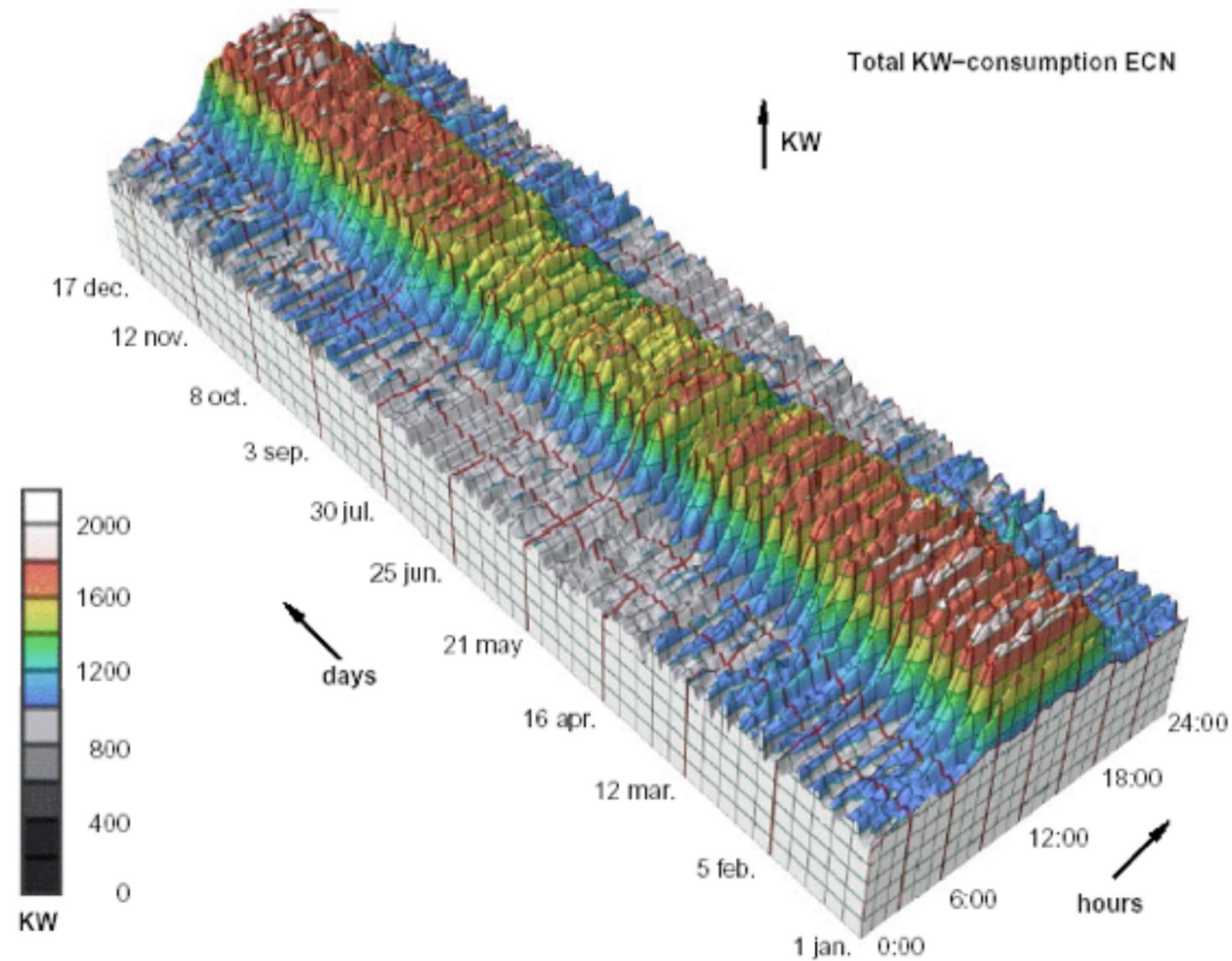*Grossman et al. CHI 2007]*

[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

Total KW-consumption ECN

[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
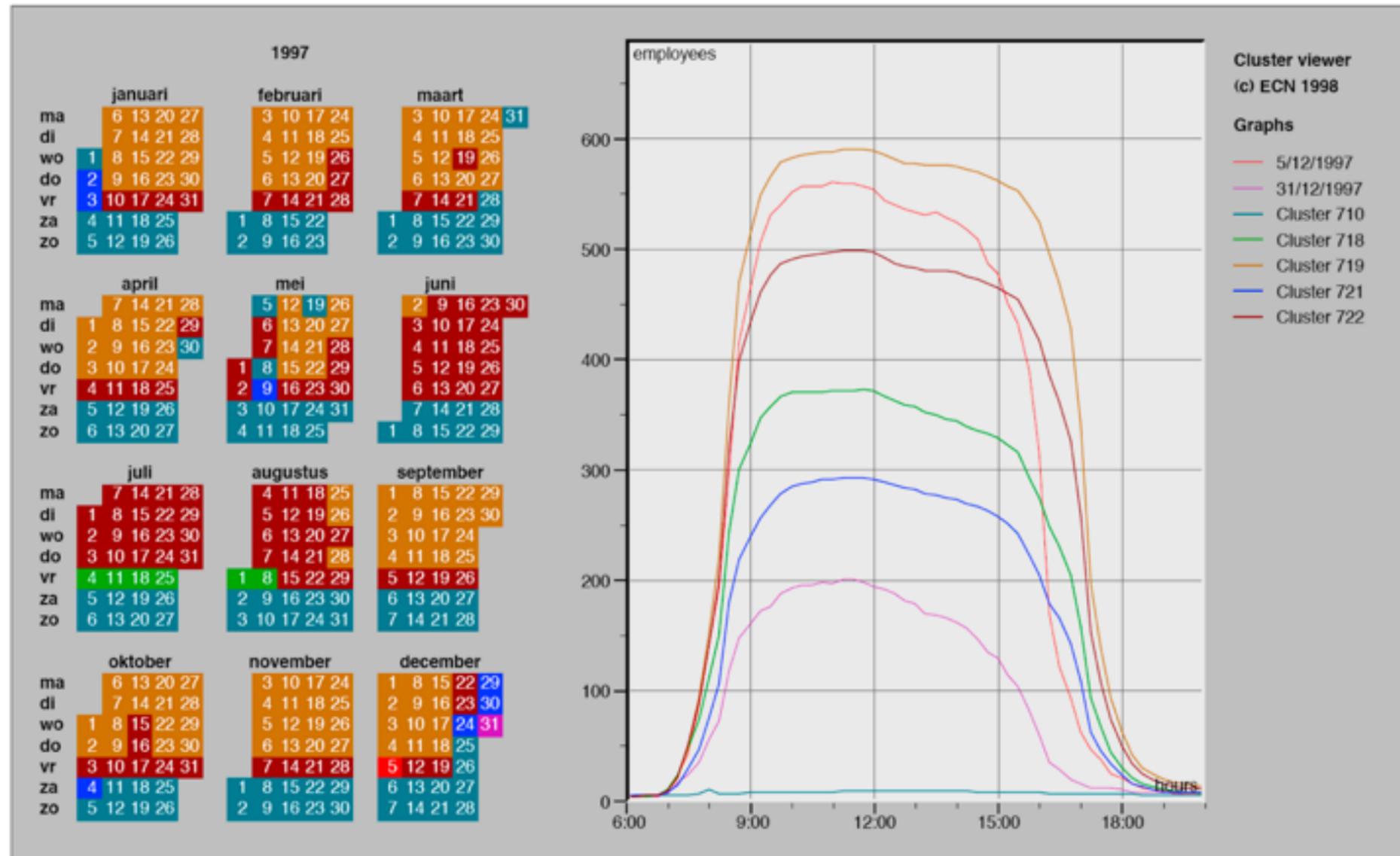
[Cluster and Calendar based Visualization of Time Series Data. van Wijk and van Selow, Proc. InfoVis 99.]
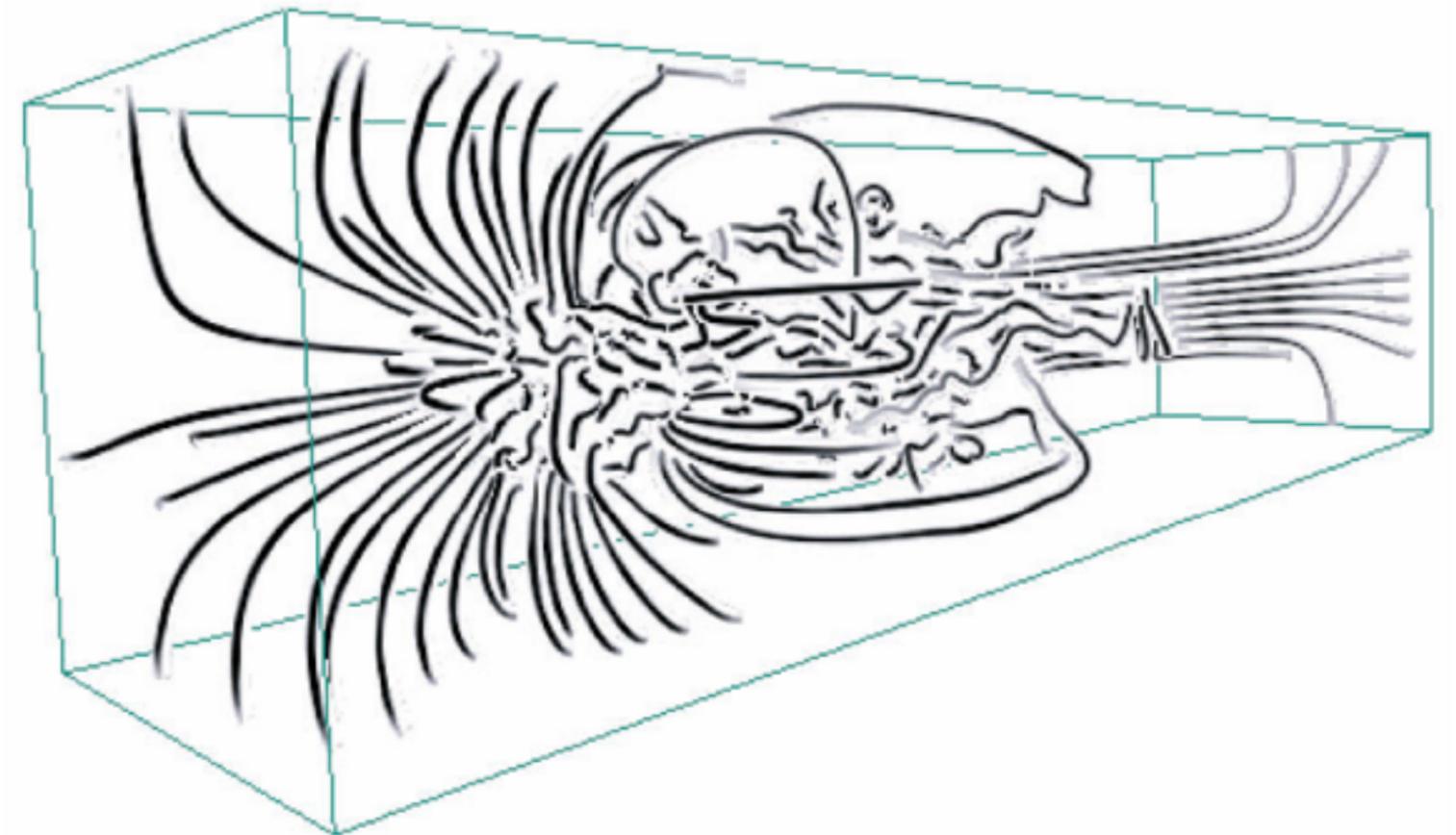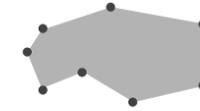
Justified 3D: shape perception

- benefits outweigh costs when task is shape perception for **3D** spatial data

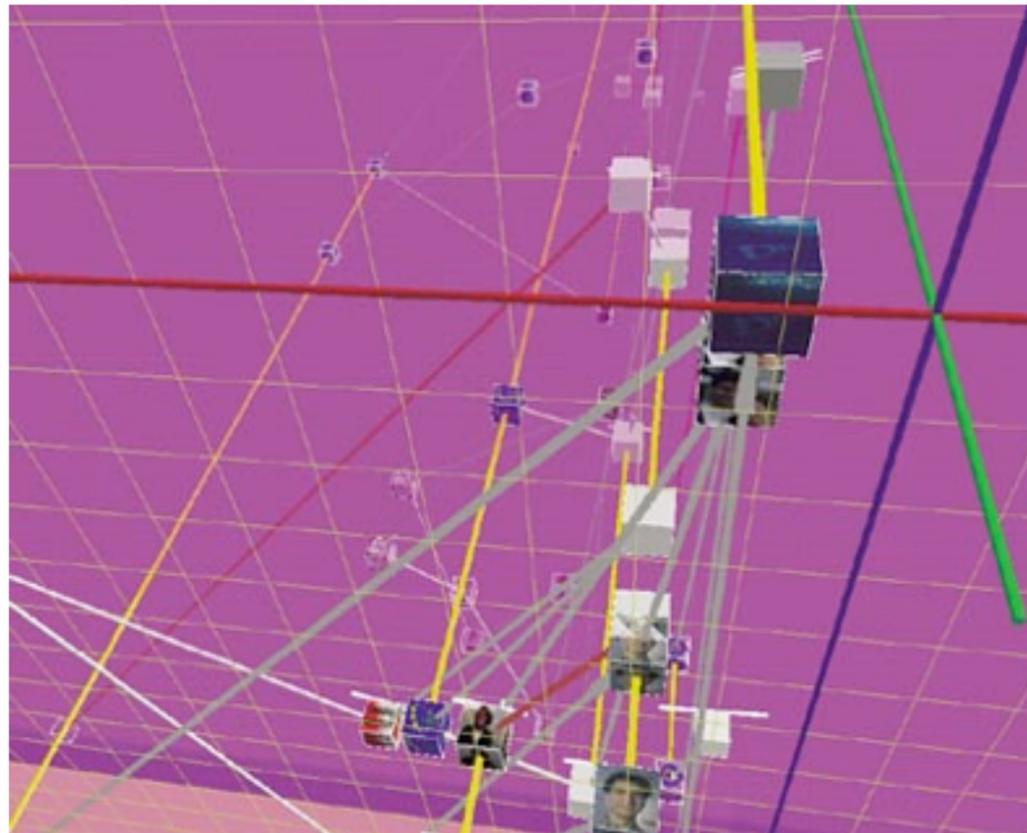 - interactive navigation supports synthesis across many viewpoints

🗄 Targets
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⊕ Spatial Data

➜ Shape

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
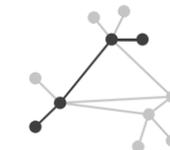 - be especially careful for search results, document collections, ontologies

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

15
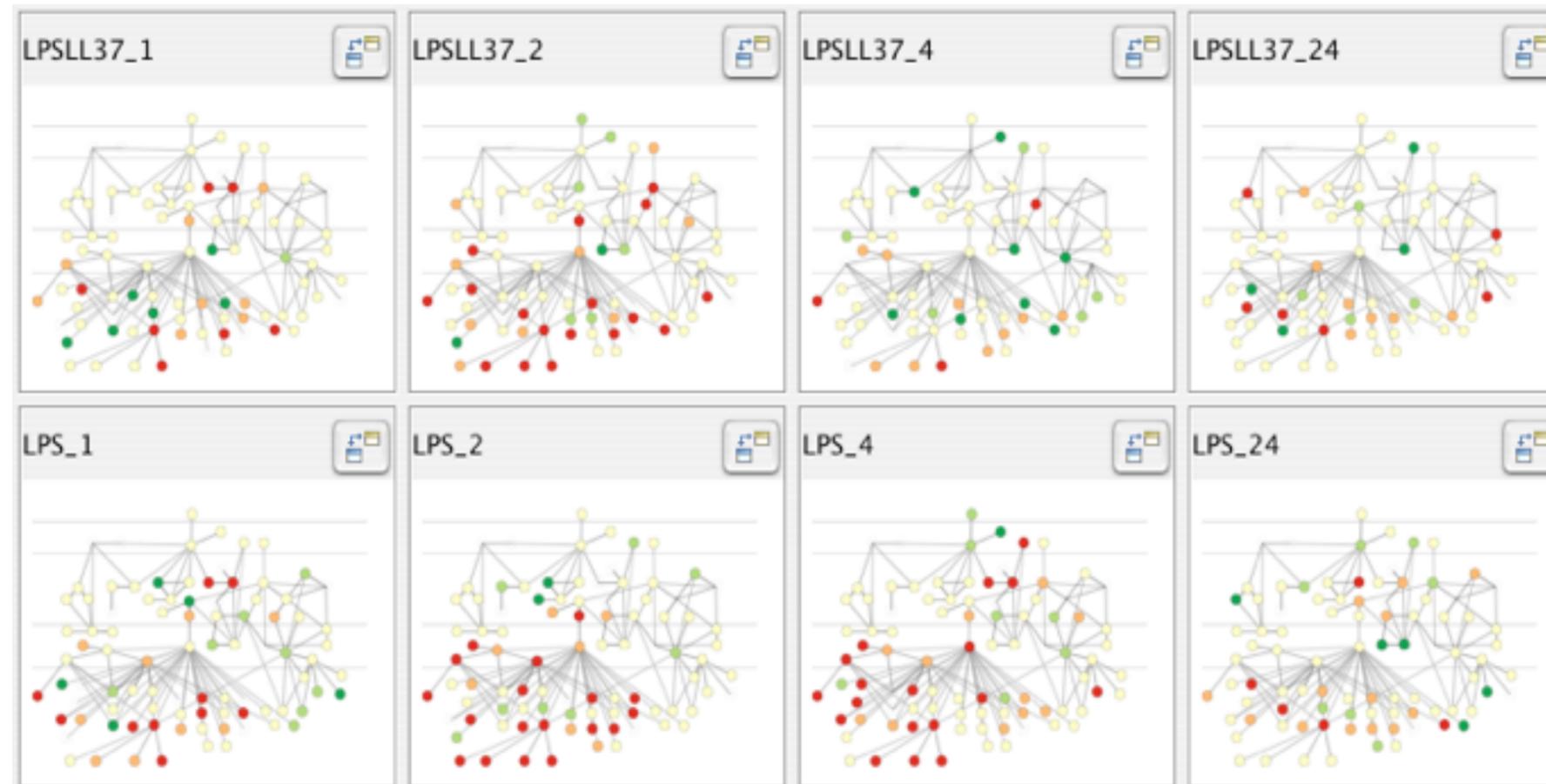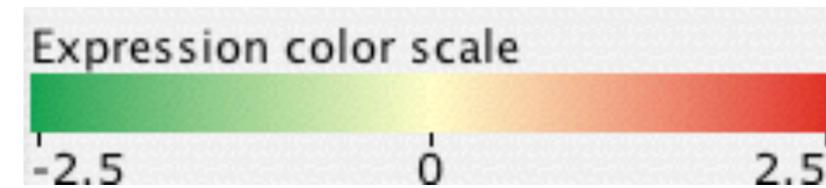
Why not animation?

- 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

LPSLL37_1
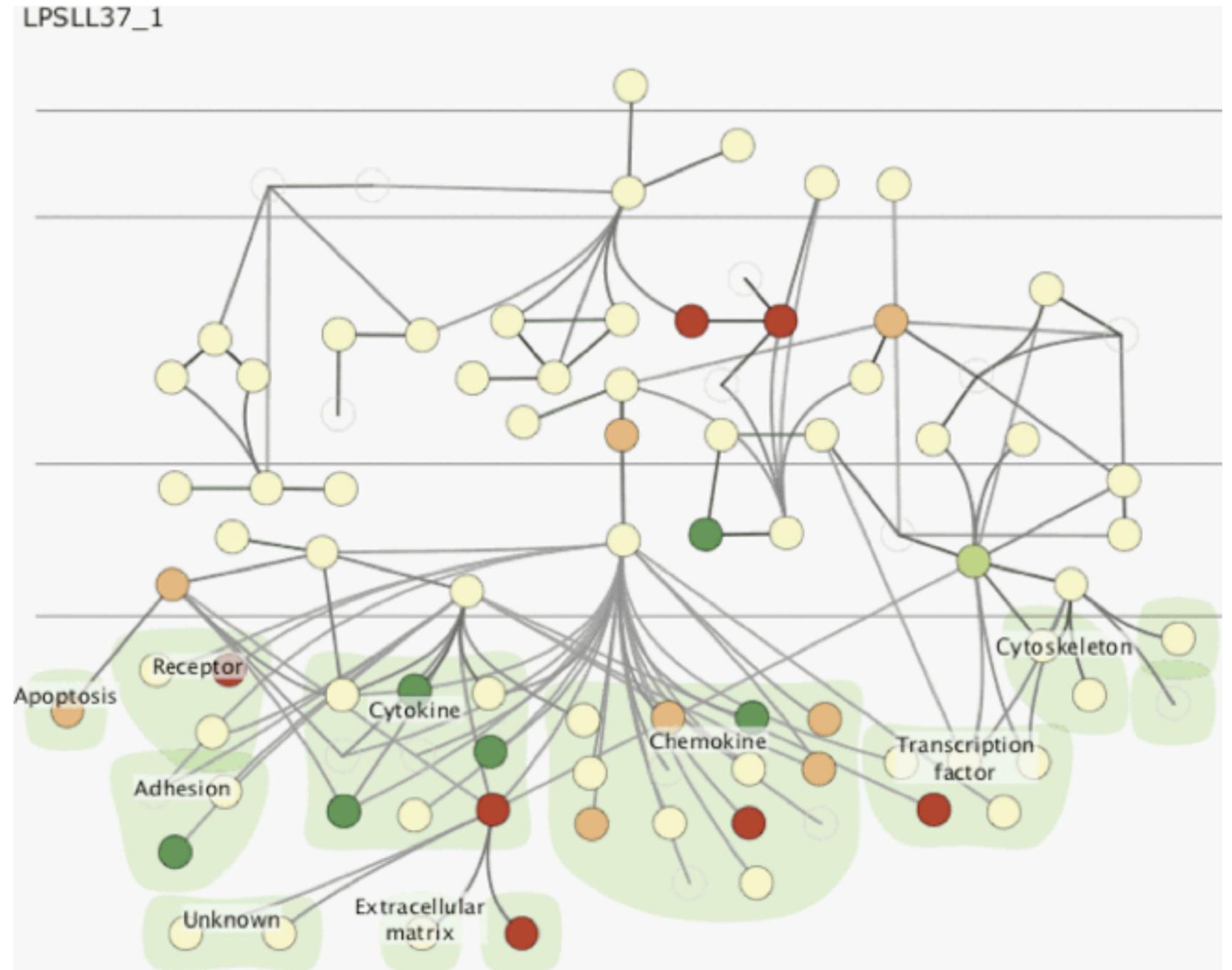
Resolution beats immersion

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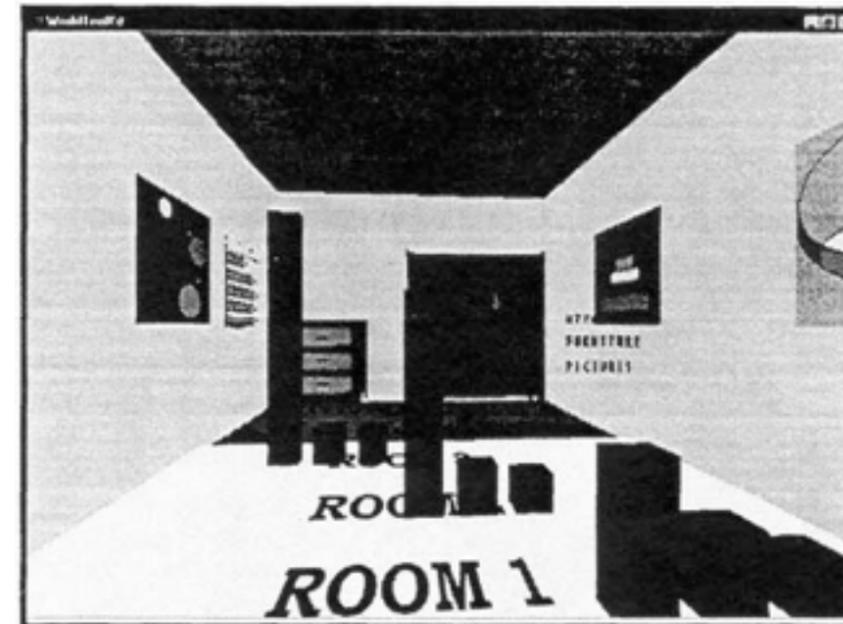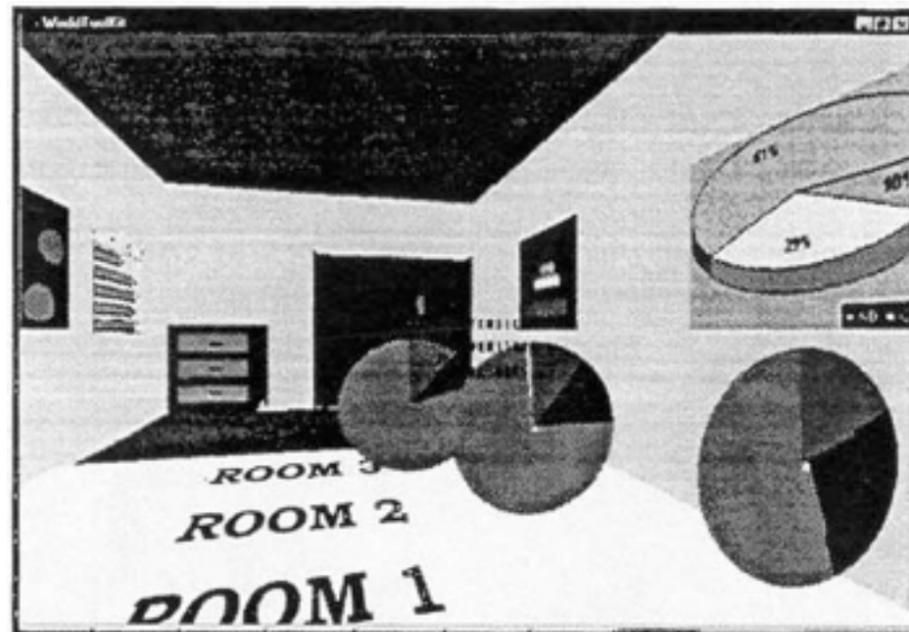
[Development of an information visualization tool using virtual reality. Kirner and Martins. Proc. Symp. Applied Computing 2000]

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

➔ **Query**
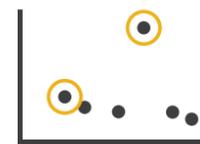
➔ Identify ➔ Compare ➔ Summarise

- 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

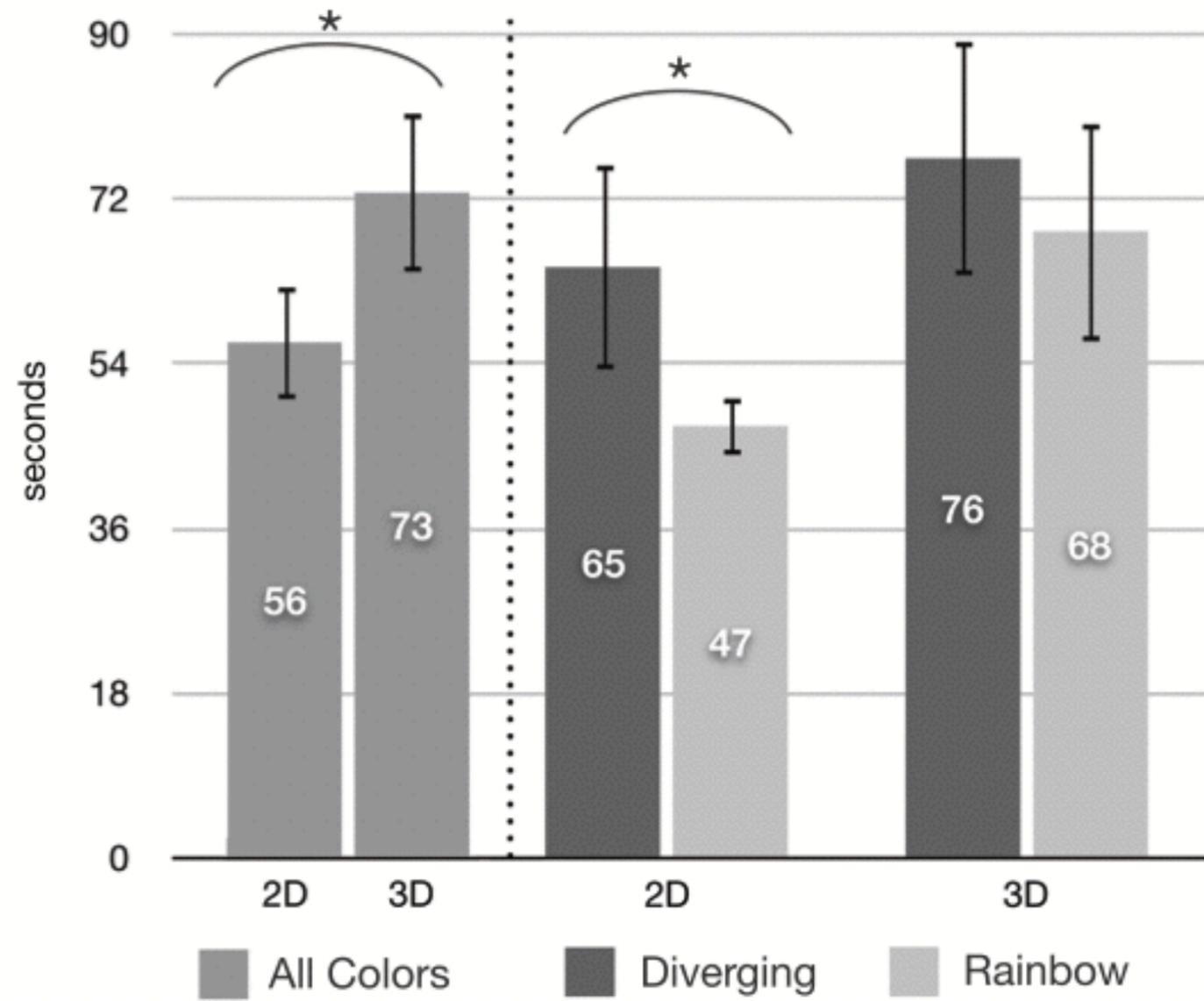- formative study with experts
  - task taxonomy
- HemoViz design
- deploy attempt fails
  - experts balk: demand 3D and rainbows
- quantitative user study
  - med students, real data
  - 91% with 2D/diverging vs 39% with 3D/rainbows
  - experts willing to use

[Fig 1. Borkin et al. Artery Visualizations for Heart Disease Diagnosis. Proc InfoVis 2011.]]
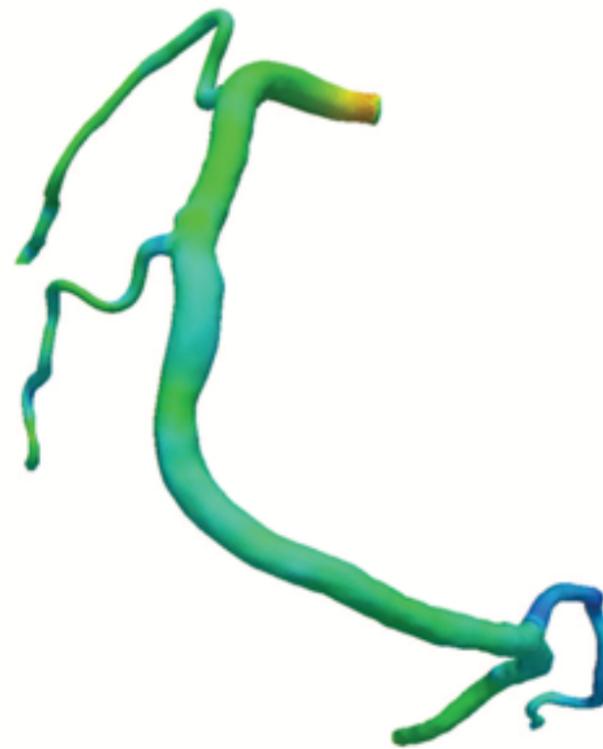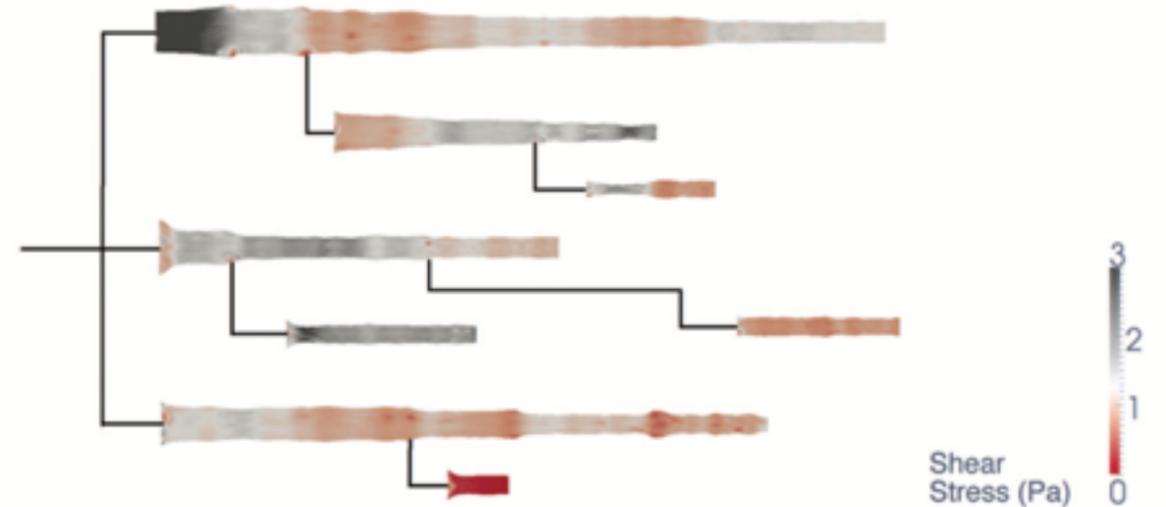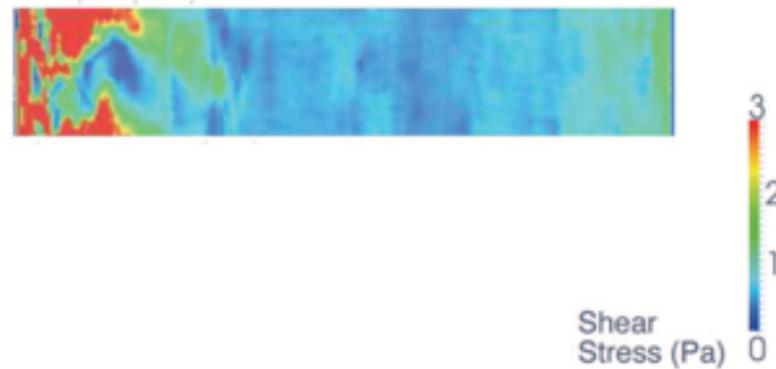
Study results: Error
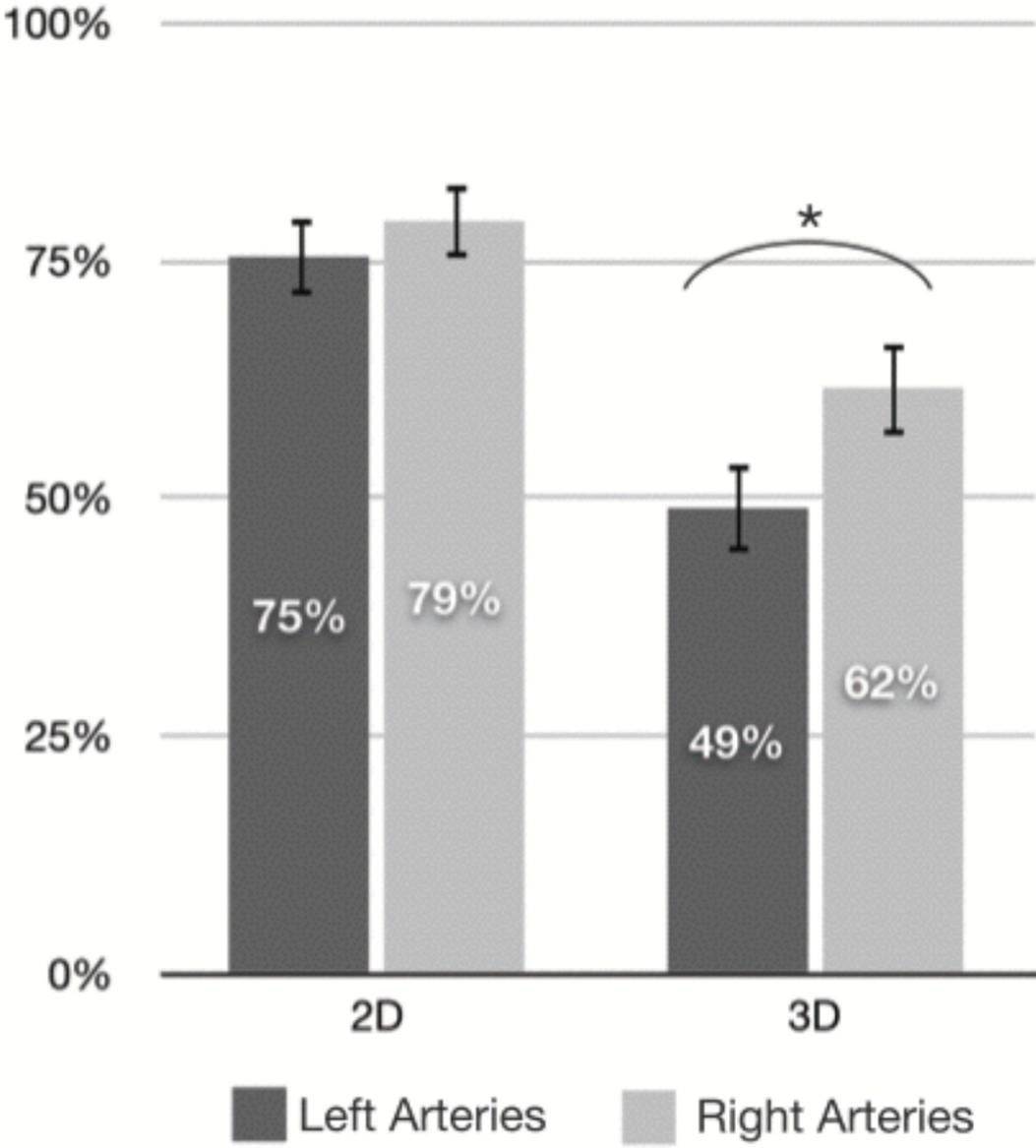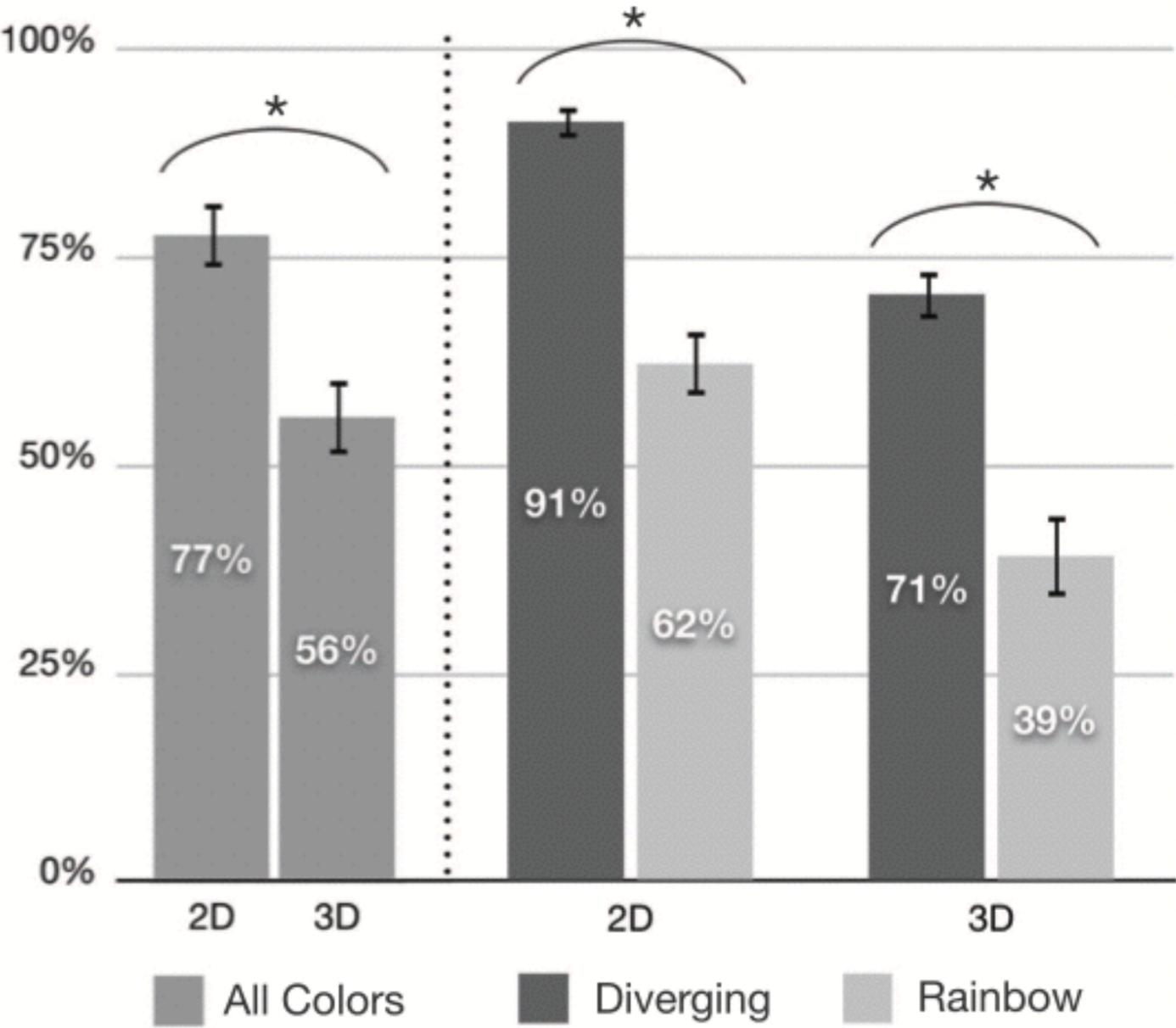
Study results: Time
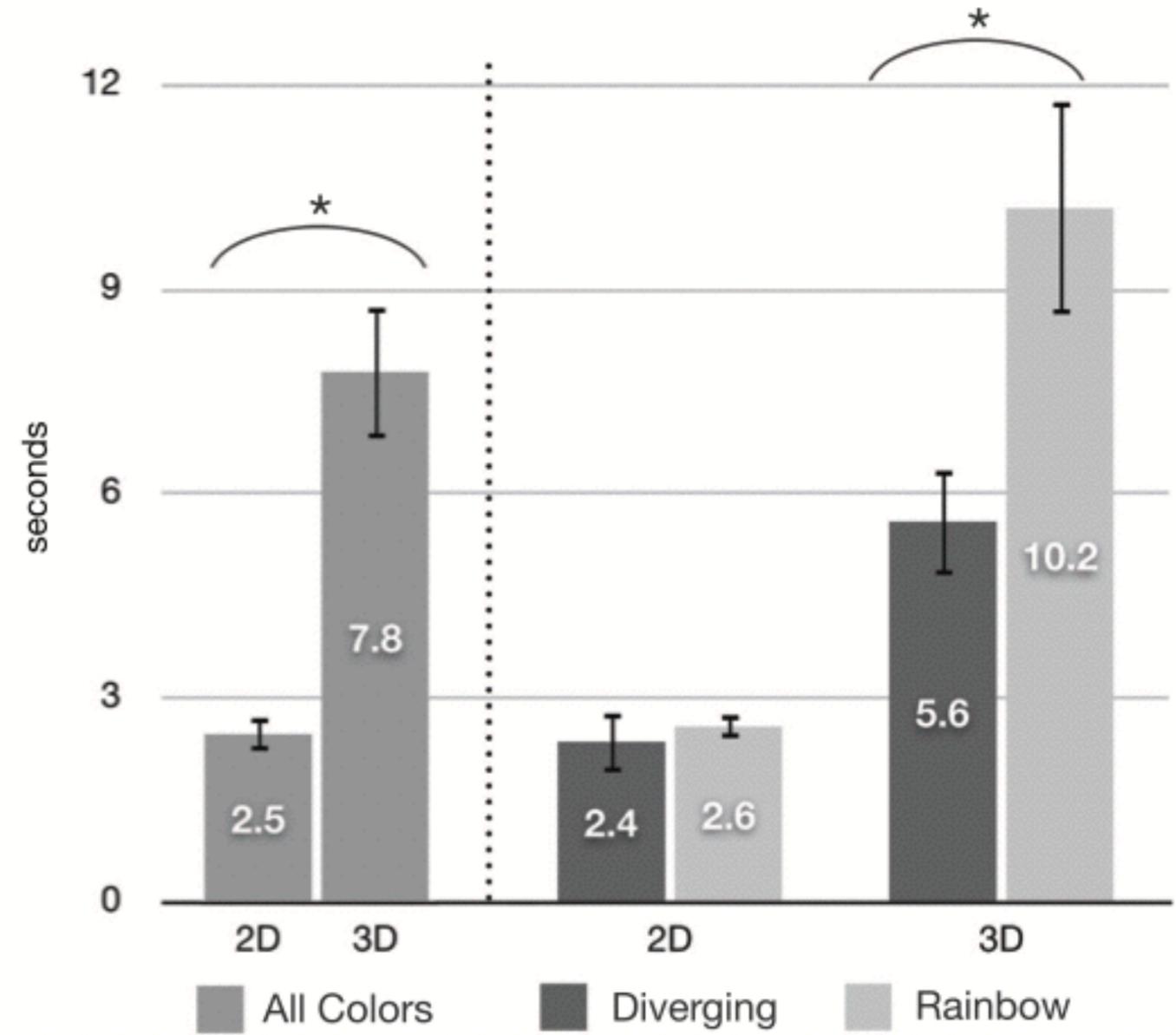
Critique

- 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