Analisi e Visualizzazione di Reti Complesse

DV05 - Rules of Thumbs
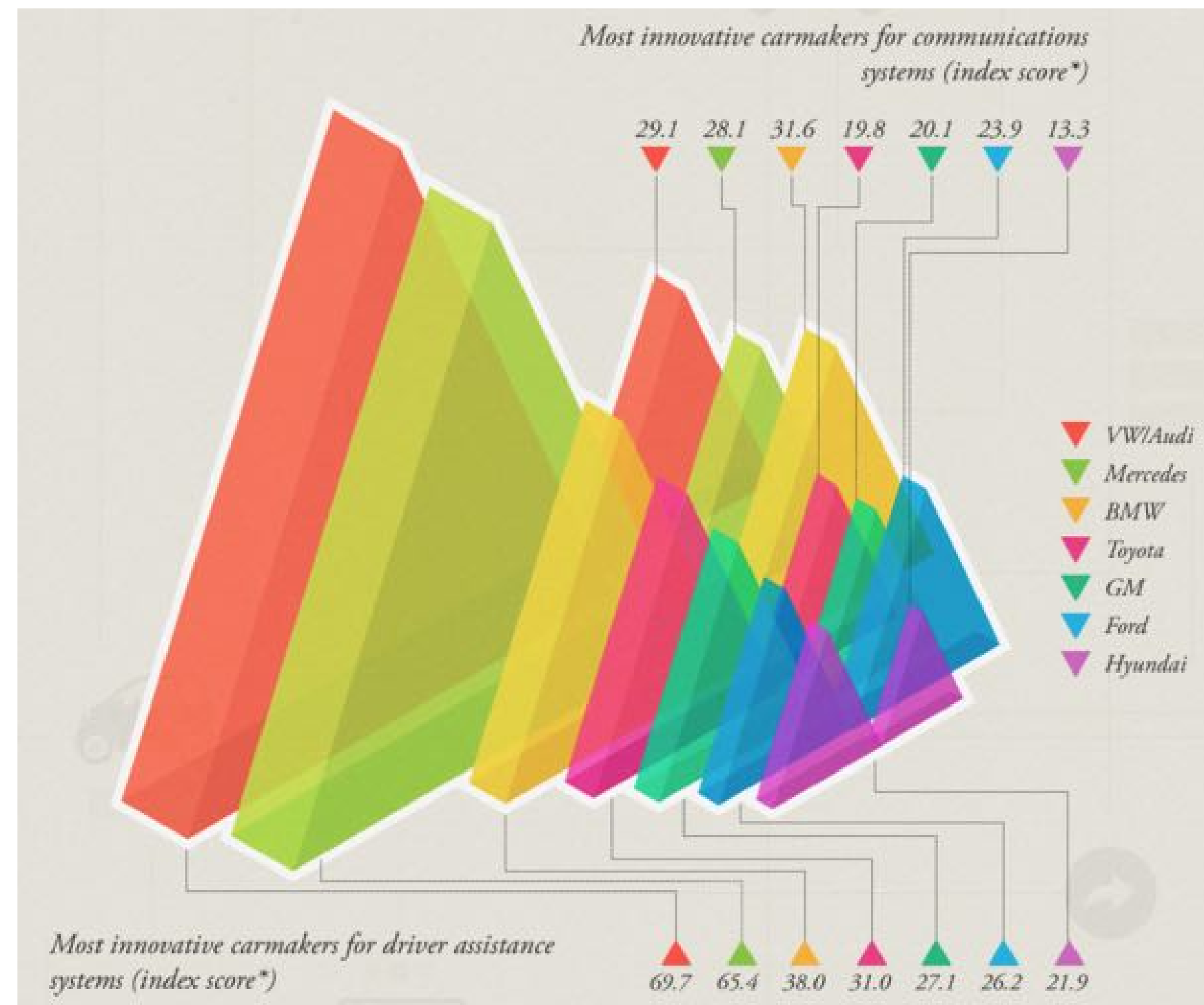
Prof. Rossano Schifanella
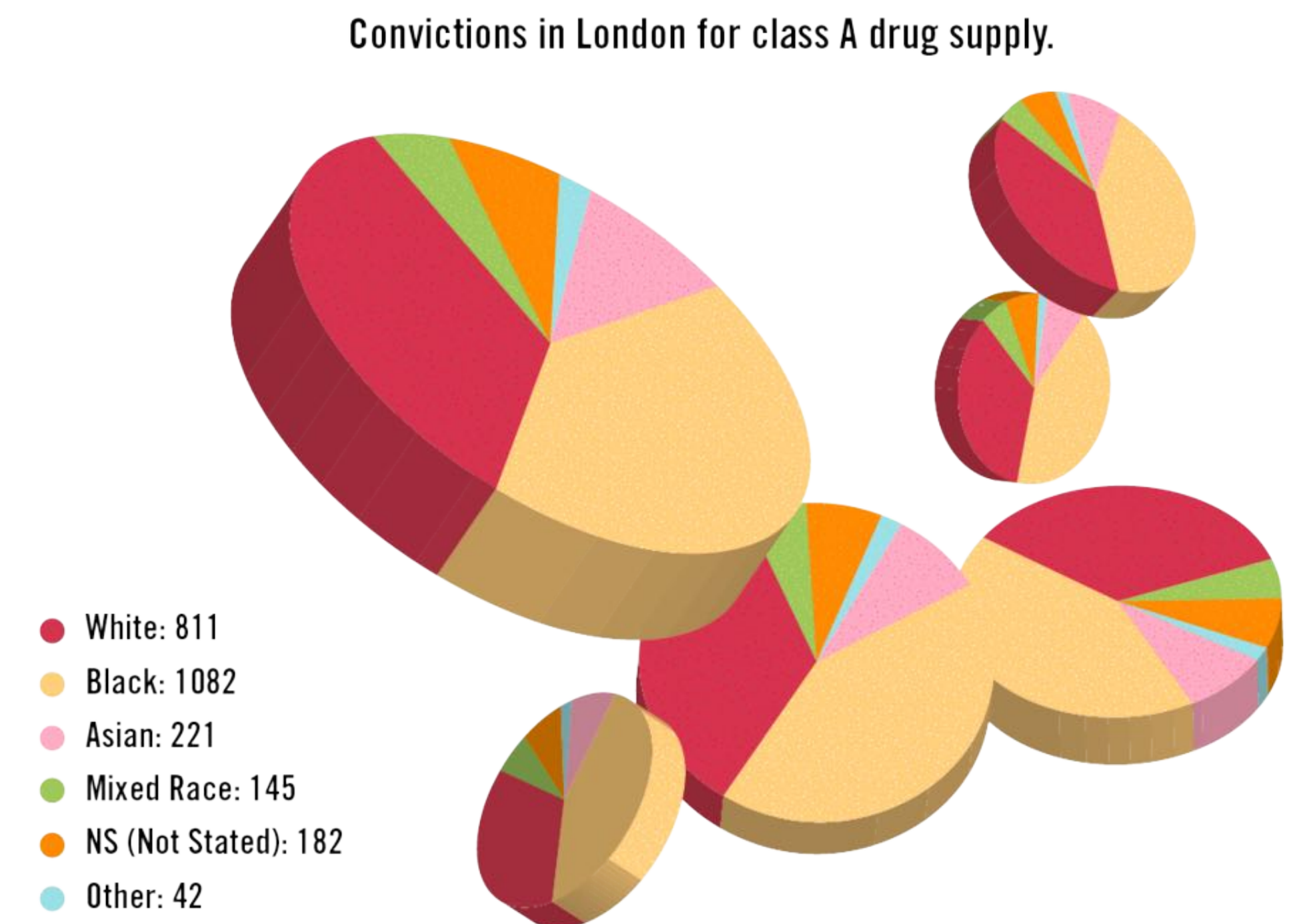
Rules of Thumbs

Rules of Thumb Summary

- No unjustified 3D
- No unjustified 2D
- Eyes beat memory
- Resolution over immersion
- Overview first, zoom and filter, details on demand
- Responsiveness is required
- Function first, form next

Unjustified 3D all too common, in the news and elsewhere

Most innovative carmakers for communications systems (index score*)

29.1 28.1 31.6 19.8 20.1 23.9 13.3

VW/Audi
Mercedes
BMW
Toyota
GM
Ford
Hyundai

Most innovative carmakers for driver assistance systems (index score*)

69.7 65.4 38.0 31.0 27.1 26.2 21.9

Convictions in London for class A drug supply.

White: 811
Black: 1082
Asian: 221
Mixed Race: 145
NS (Not Stated): 182
Other: 42

http://viz.wtf/post/13782649777/eye-popping-3d-triangles

http://viz.wtf/post/139002022202/designer-drugs-ht-ducqn

Depth vs power of the plane

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

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

→ **Magnitude** Channels: **Ordered** Attributes

Position on common scale

Position on unaligned scale

Length (1D size)

Tilt/angle

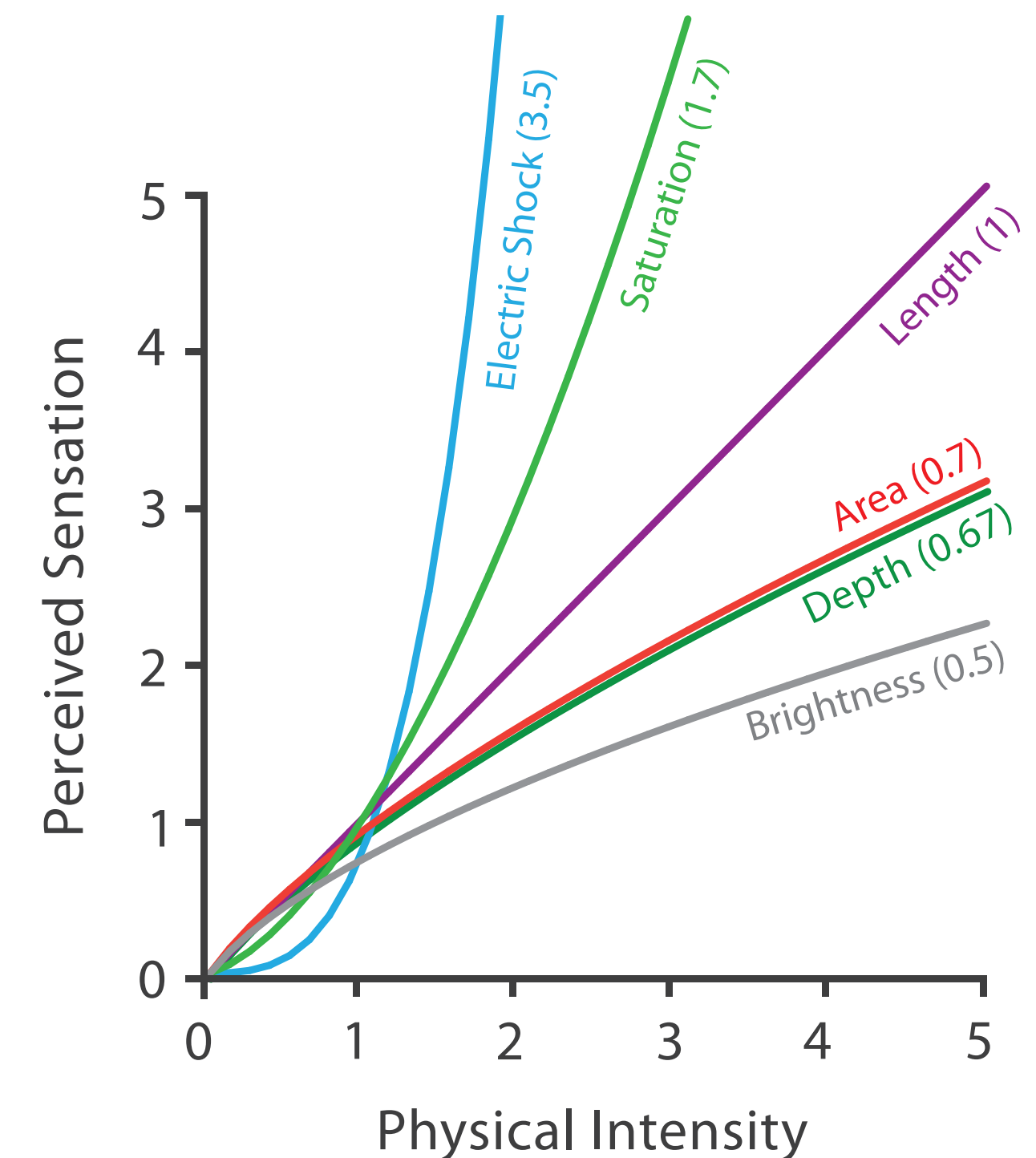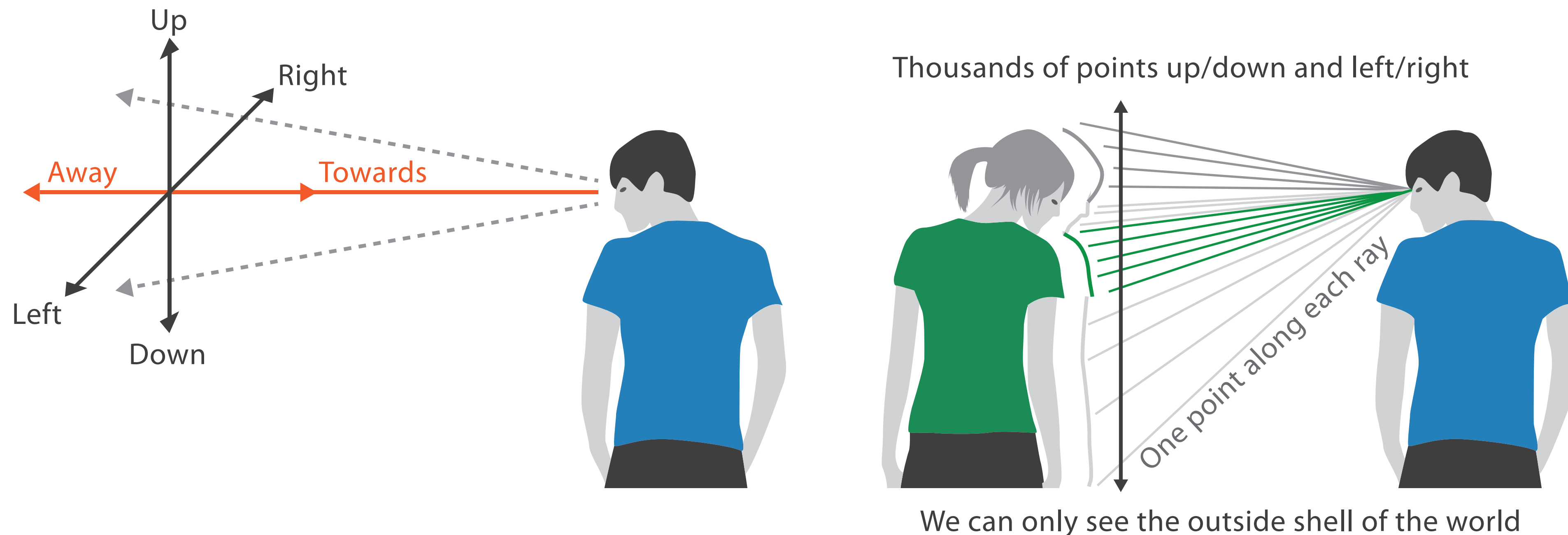Area (2D size)

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
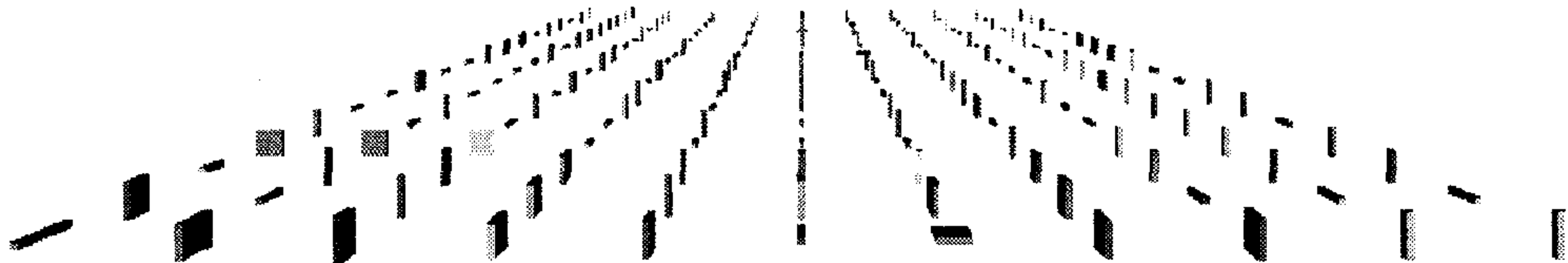 - acquire more info for depth slower, from head/body motion

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 can resolve, but at cost of time and cognitive load

[Distortion Viewing Techniques for 3D Data. Carpendale et al. InfoVis1996.]
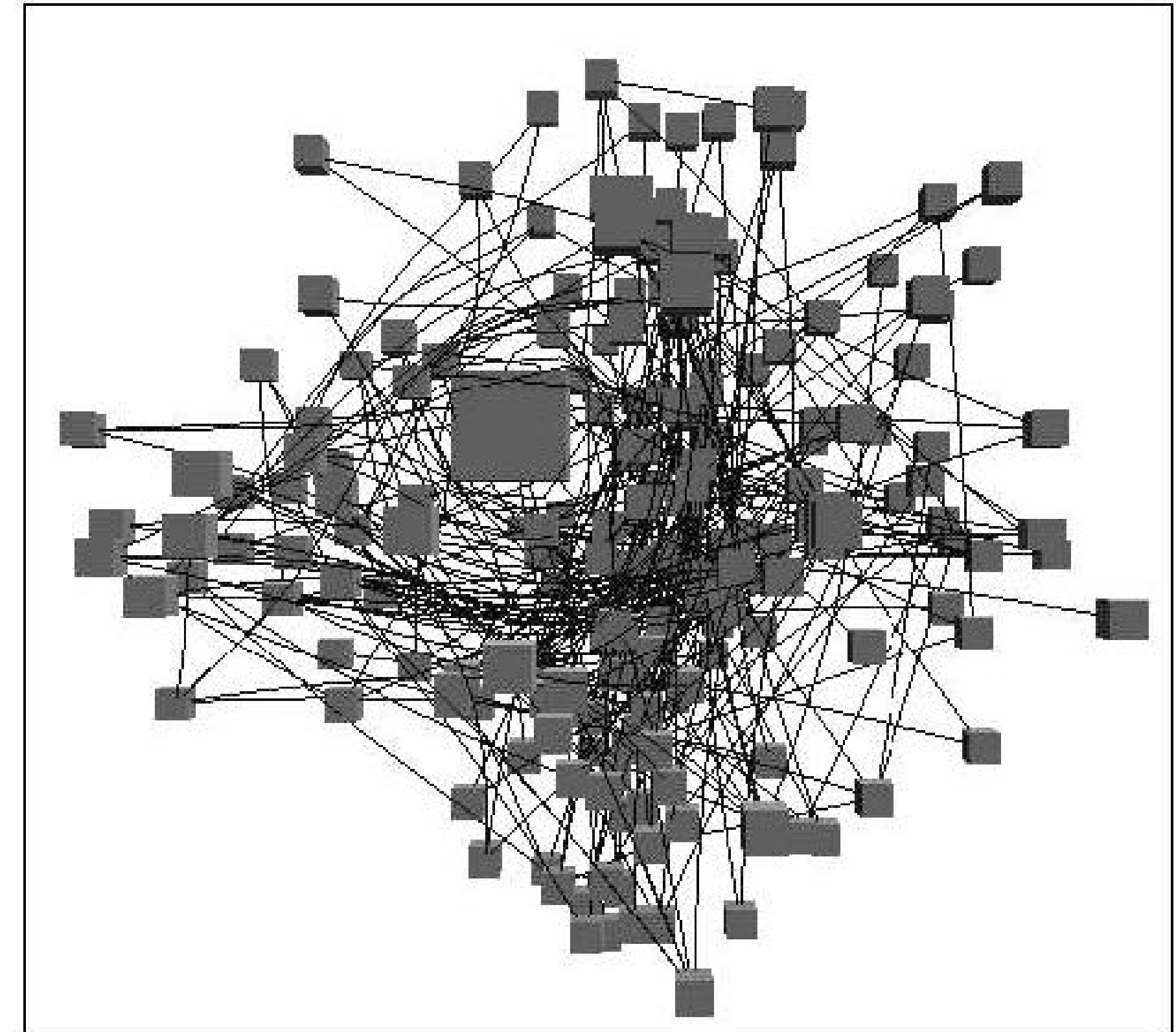
Perspective distortion loses information

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

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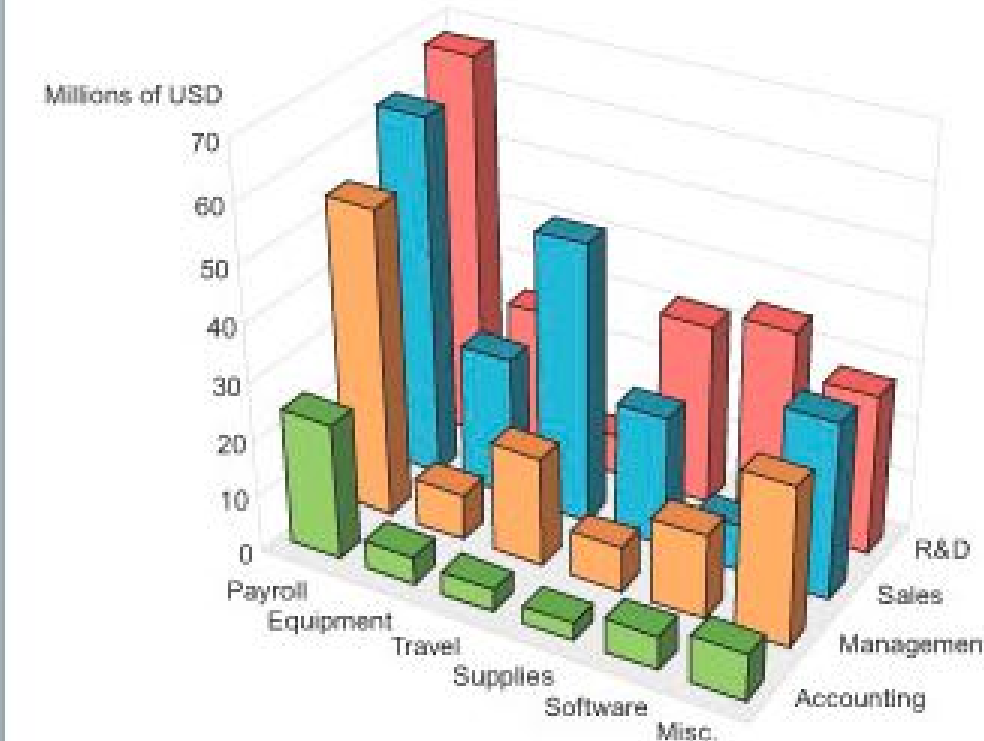Mukherjea, Hirata, and Hara. InfoVis 96]

3D vs 2D bar charts

- 3D bars very difficult to justify!
  - perspective distortion
  - occlusion
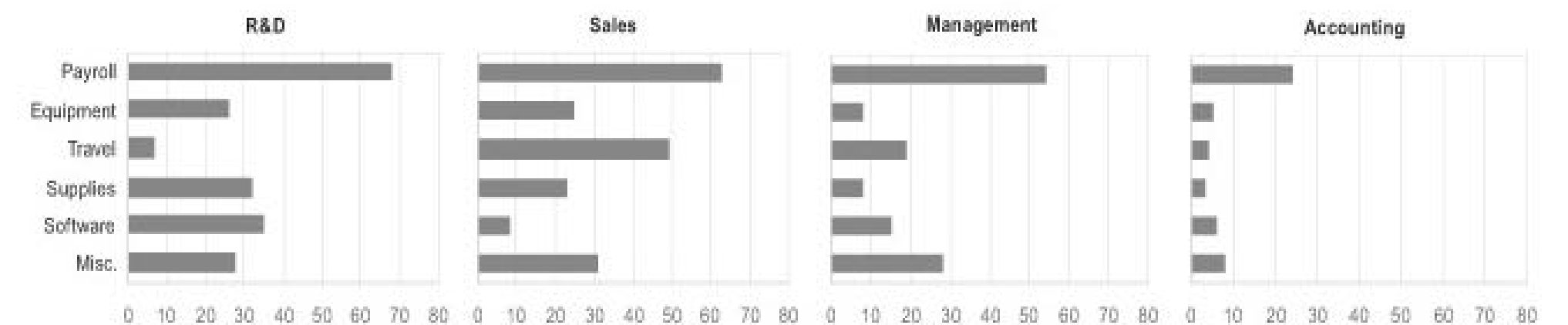- faceting into 2D almost always better choice

[http://perceptualedge.com/files/GraphDesignIQ.html]
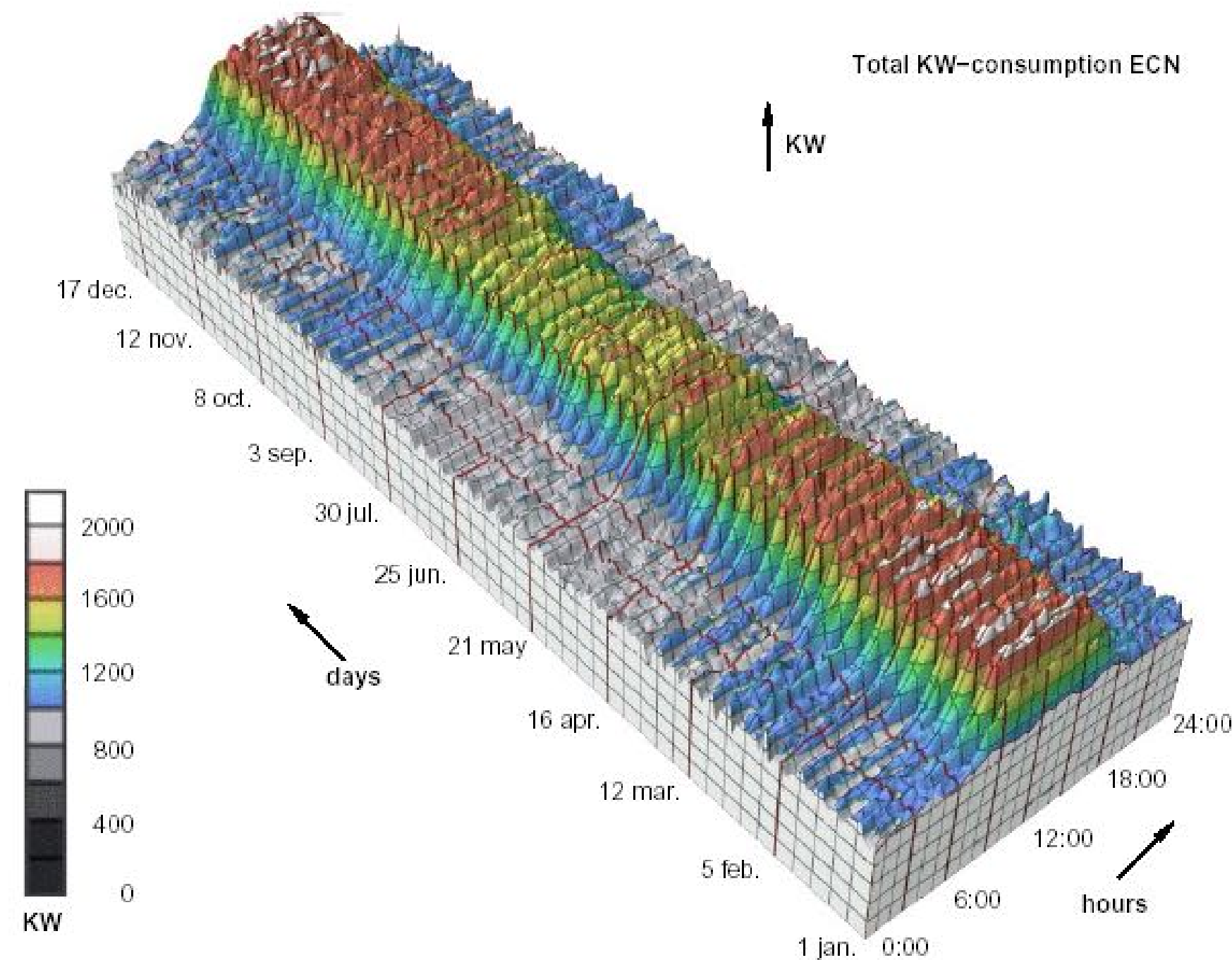
Tilted text isn't legible

- text legibility
  - far worse when tilted from the image plane
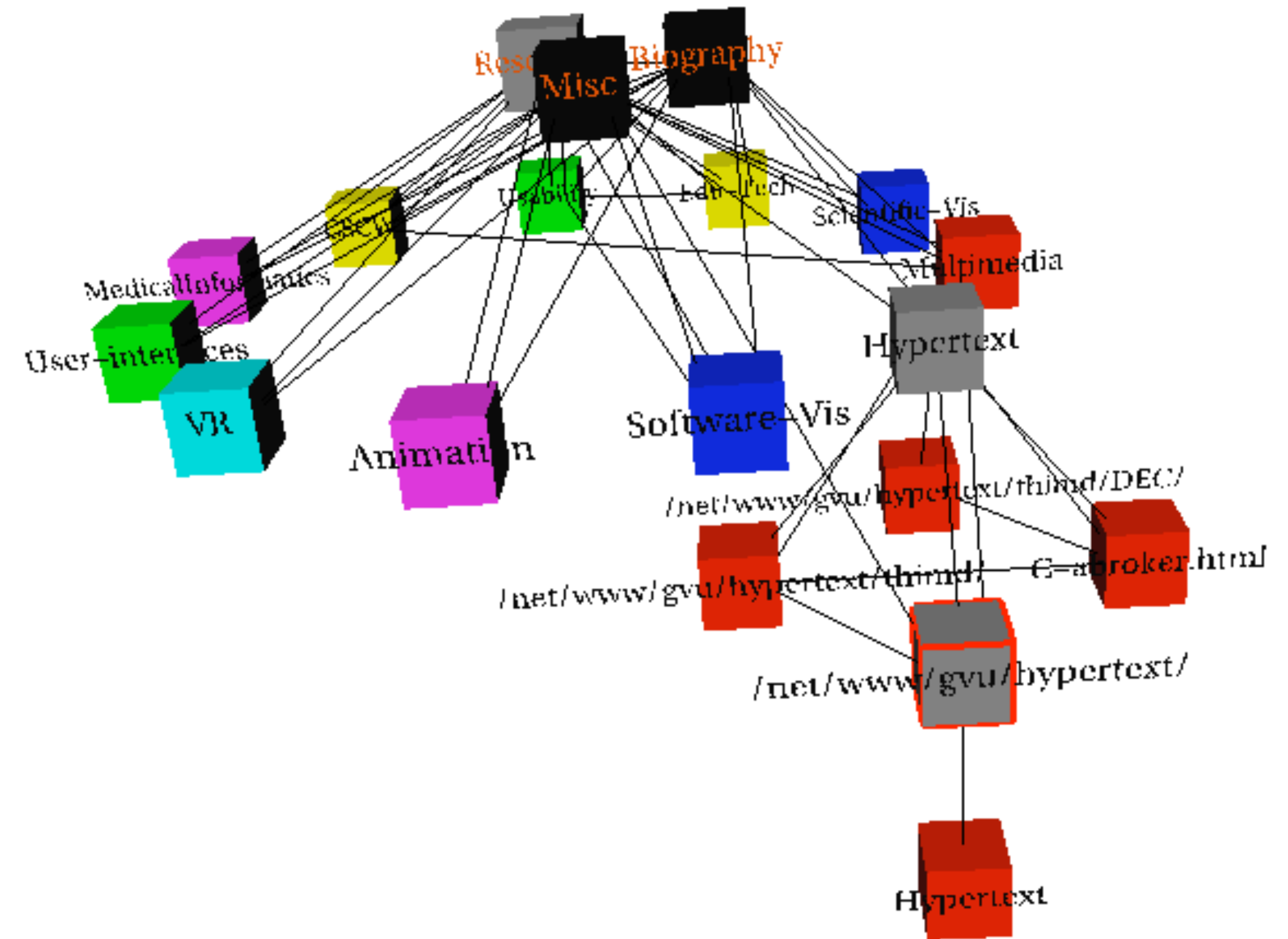
[Visualizing the World-Wide Web with the Navigational View Builder. Mukherjea and Foley. Computer Networks and ISDN Systems, 1995.]

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.]
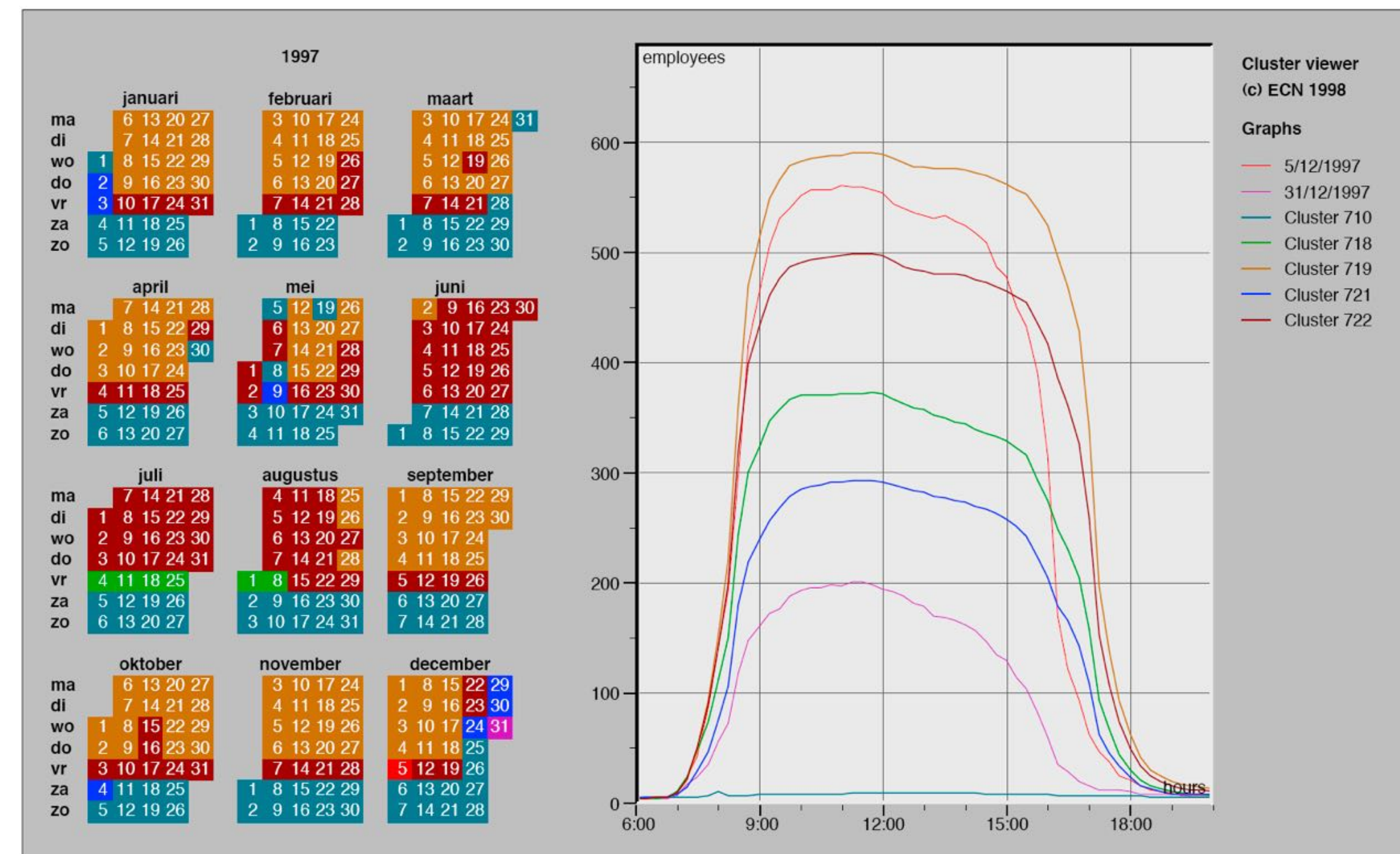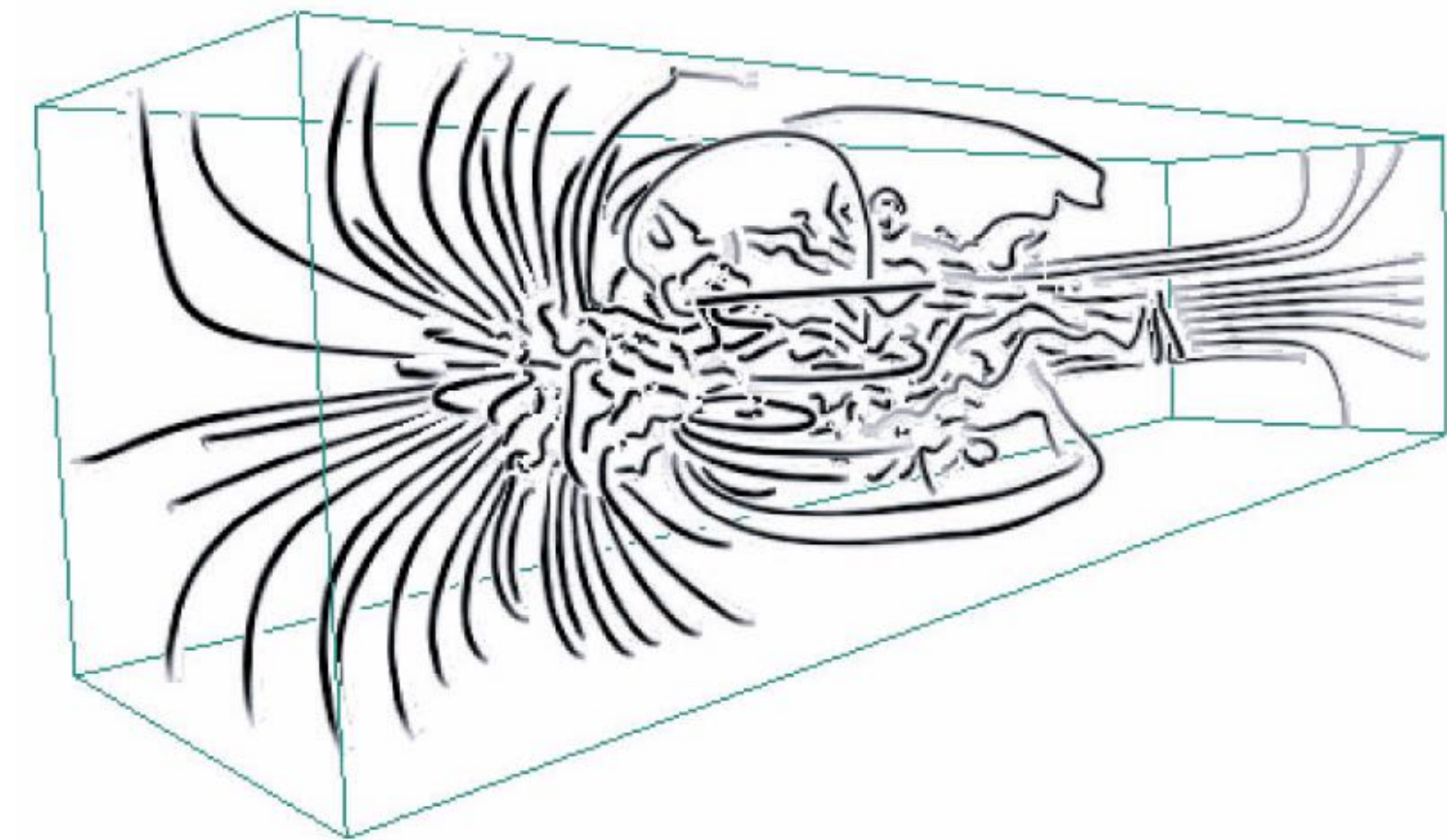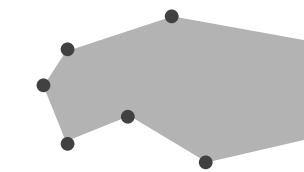
Justified 3D: shape perception

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


Targets

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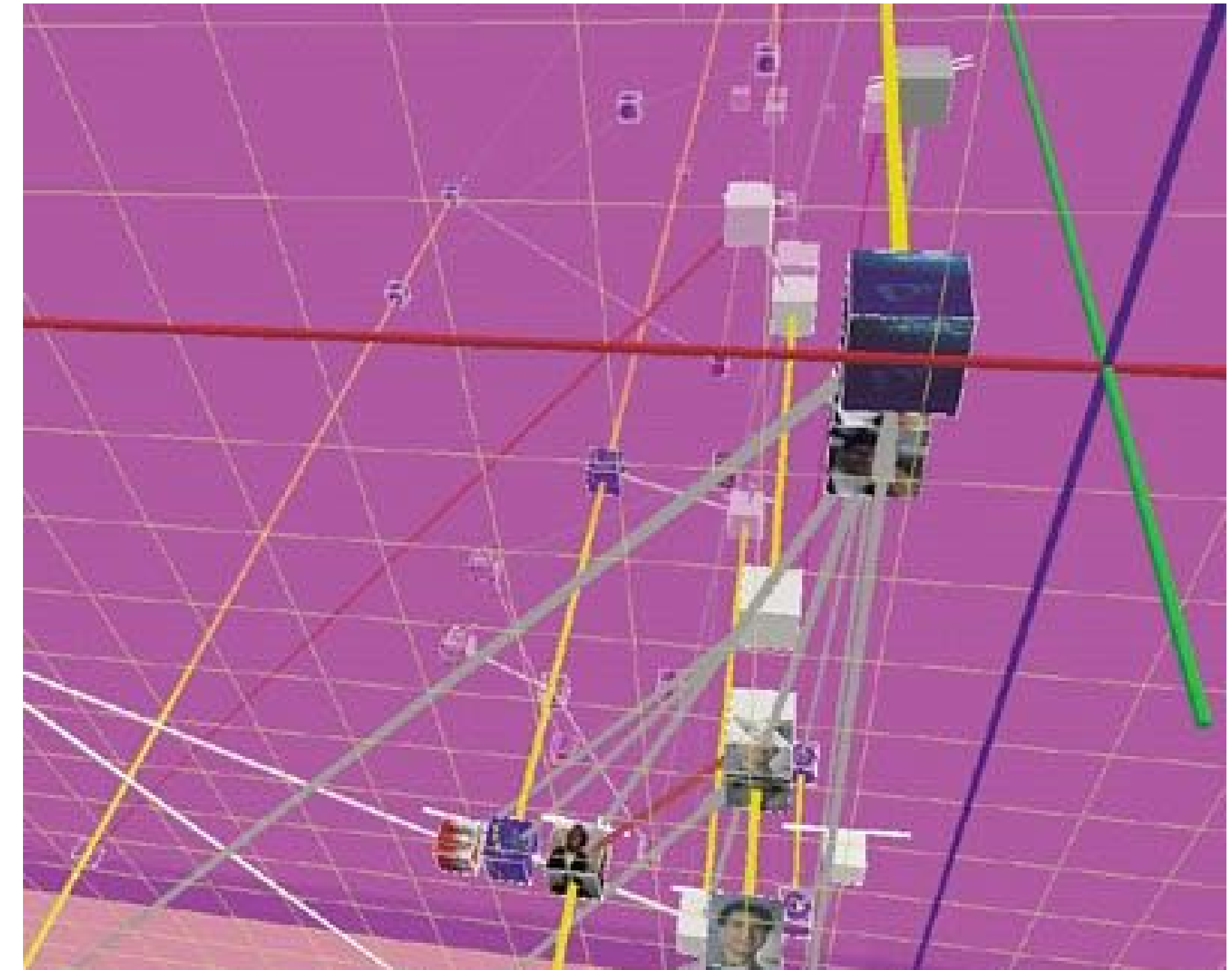
[WEBPATH-a three dimensional Web history. Frecon and Smith. Proc. InfoVis 1999]

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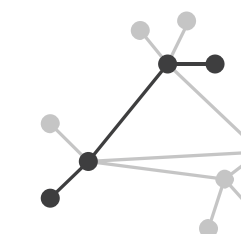 - be especially careful for search results, document collections, ontologies

Targets

Network Data

➔ Topology
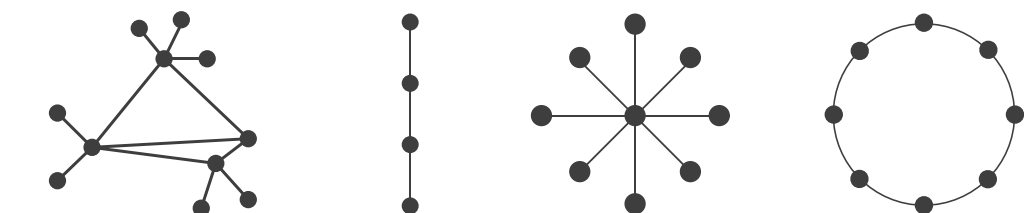
➔ *Paths*

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

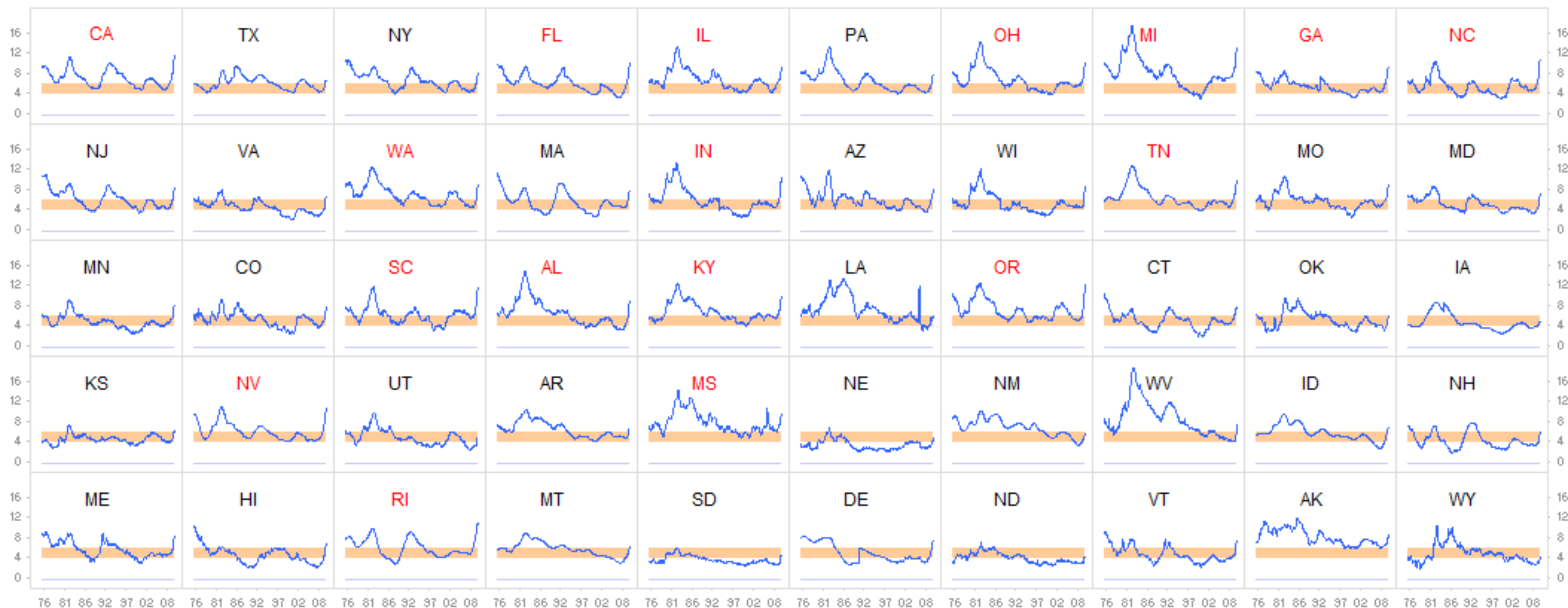**literal**   **abstract**

animation   small multiples

← show time with time   show time with space →
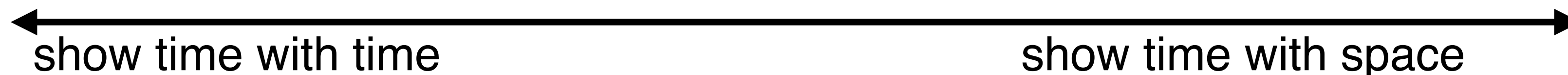
Eyes beat memory example: Cerebral

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

Monthly Unemployment Rates by State, Jan 1976 - Apr 2009

Source: Bureau of Labor Statistics

Notes: The orange band denotes a "normal" unemployment rate (4%-6%);

State code in red: unemployment rate in April 2009 is higher than the US average

Kepler's Tally of Planets

NASA's Kepler mission has discovered more than 1,000 confirmed planets orbiting distant stars. Planets with known sizes and orbits are shown below, including Kepler 452b, a planet in the habitable zone of its star. Related Article »

Relative size of planets

Earth · Neptune ● Jupiter

Relative size of Mercury's orbit

● Sun   Mercury

Stars and planets are enlarged for visibility.
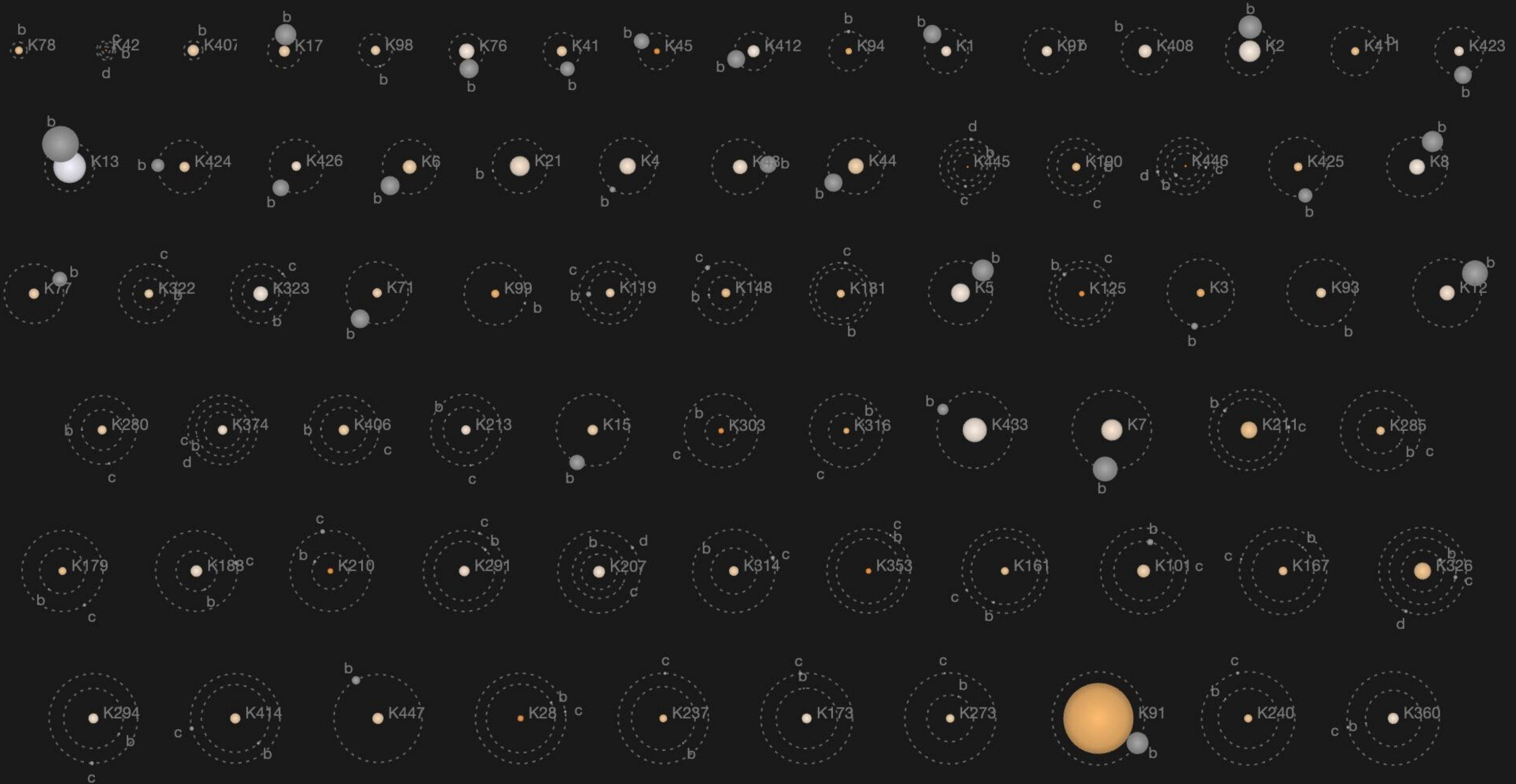
Relative size of stars

● Sun ● 2 times ● 3 times as wide

Star temperature

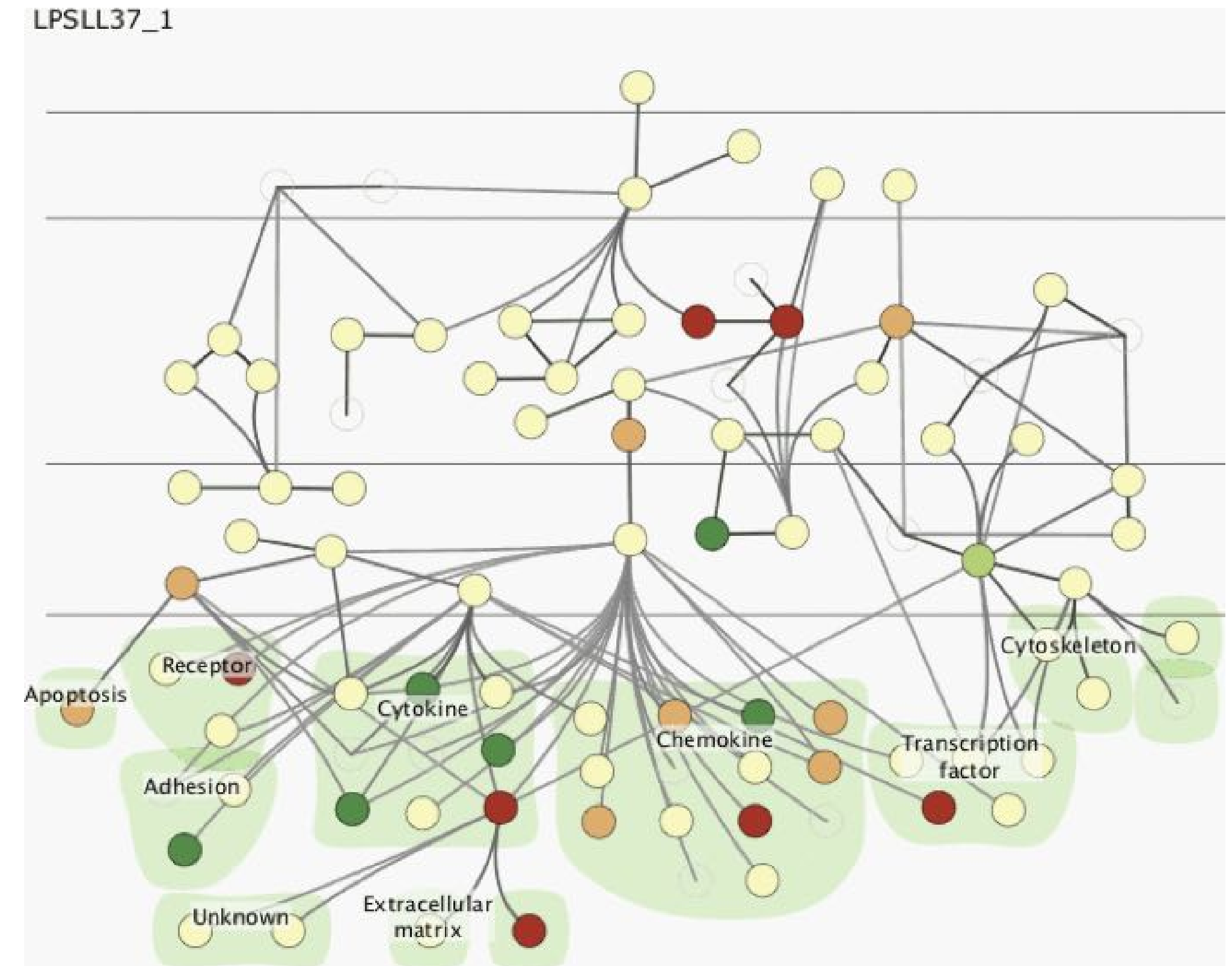6,500° ● ● ● ● ● ● ● ● ● 16,000° F

Sort by system size   Sort by order of discovery

Why not animation?

- disparate frames and regions: comparison difficult
  - vs contiguous frames
  - vs small region
  - vs coherent motion of group

- safe special case
  - animated transitions

Animation: Blink comparator

- just two contiguous frames is a special case: animation beats side by side

  - blink comparator used to discover Pluto
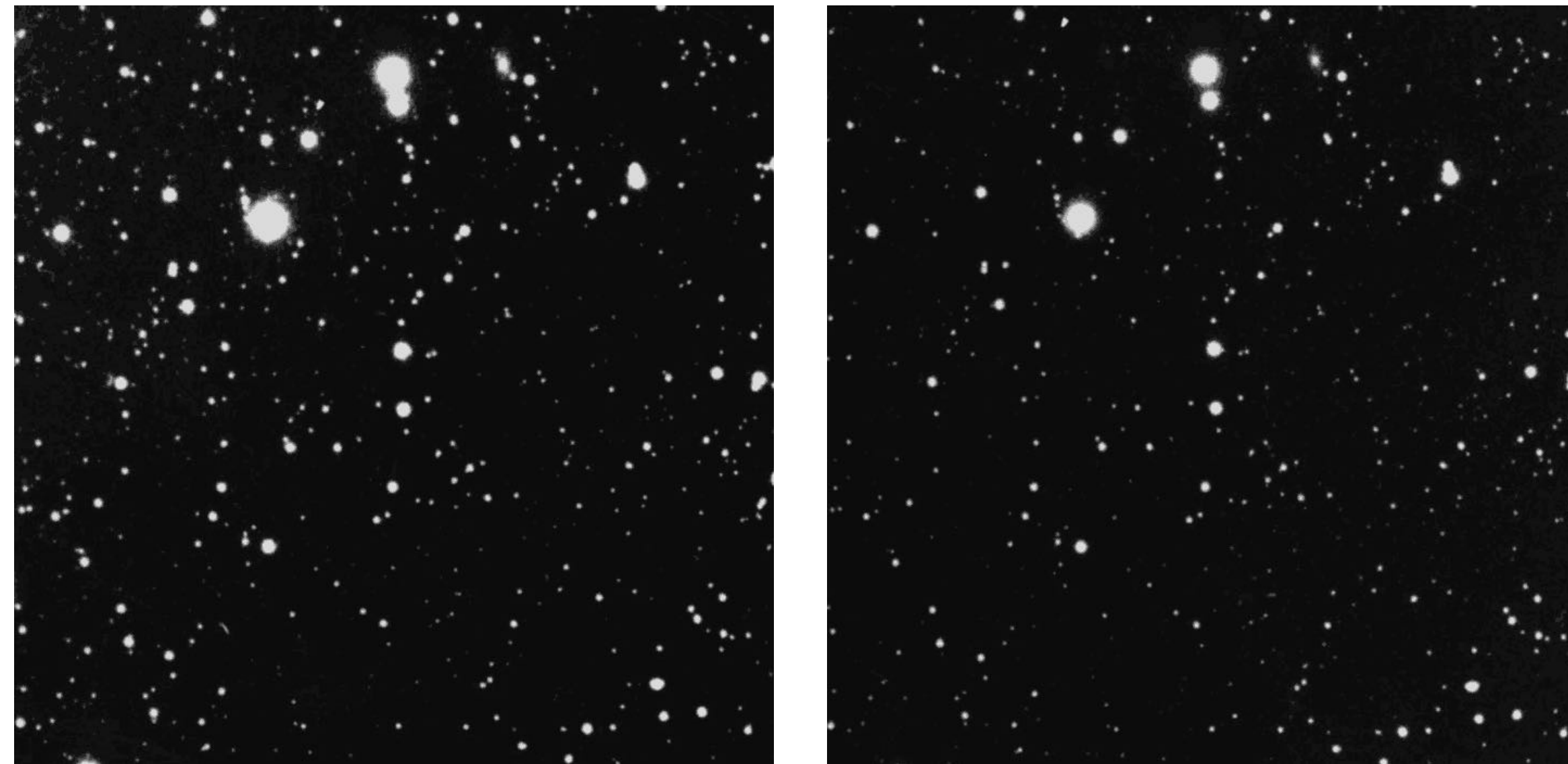
side by side

https://www.sightsize.com/the-blink-comparator/

Animation: Blink comparator

- just two contiguous frames is a special case: animation is great!
  - blink comparator used to discover Pluto
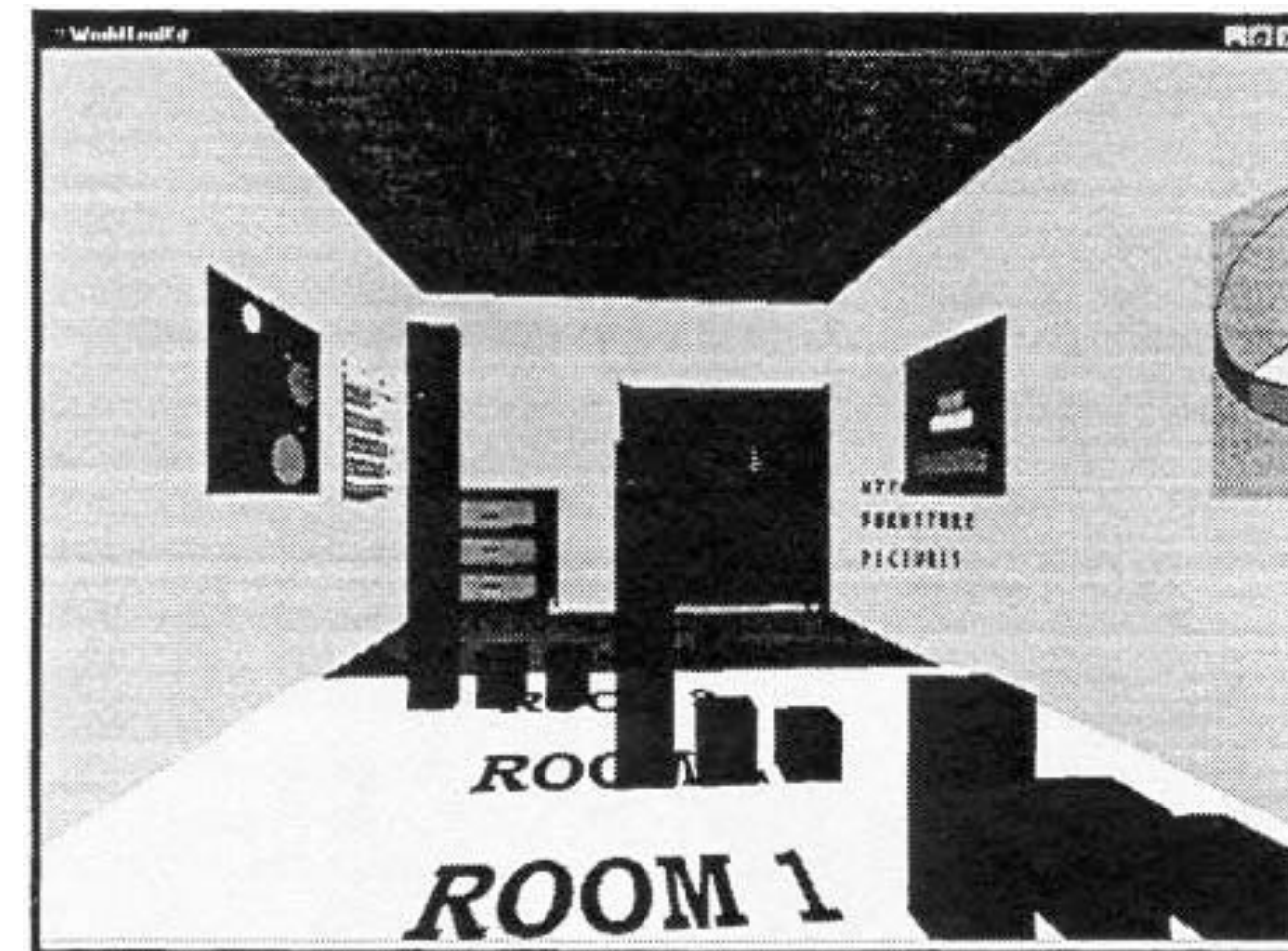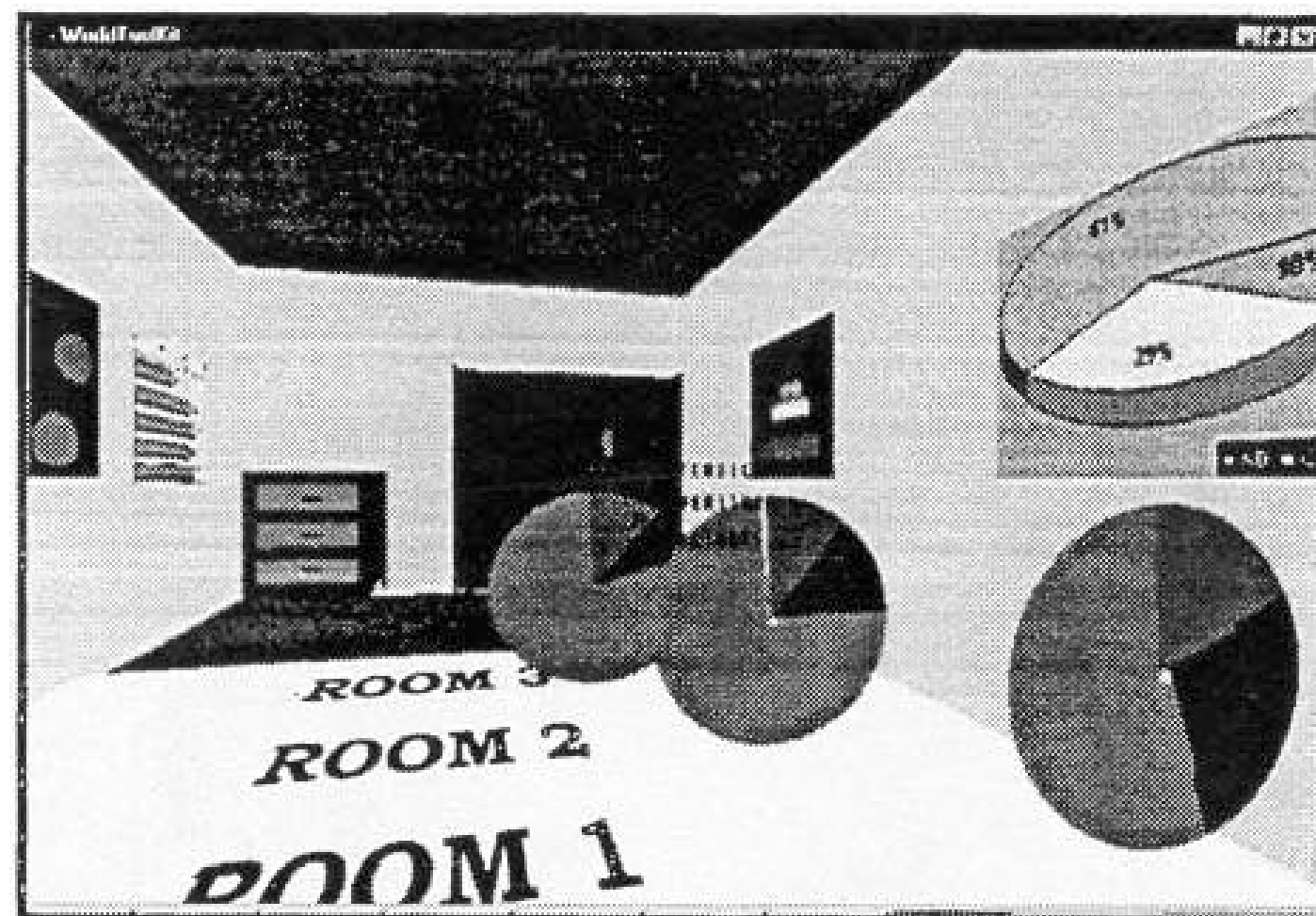

animated

https://www.sightsize.com/the-blink-comparator/
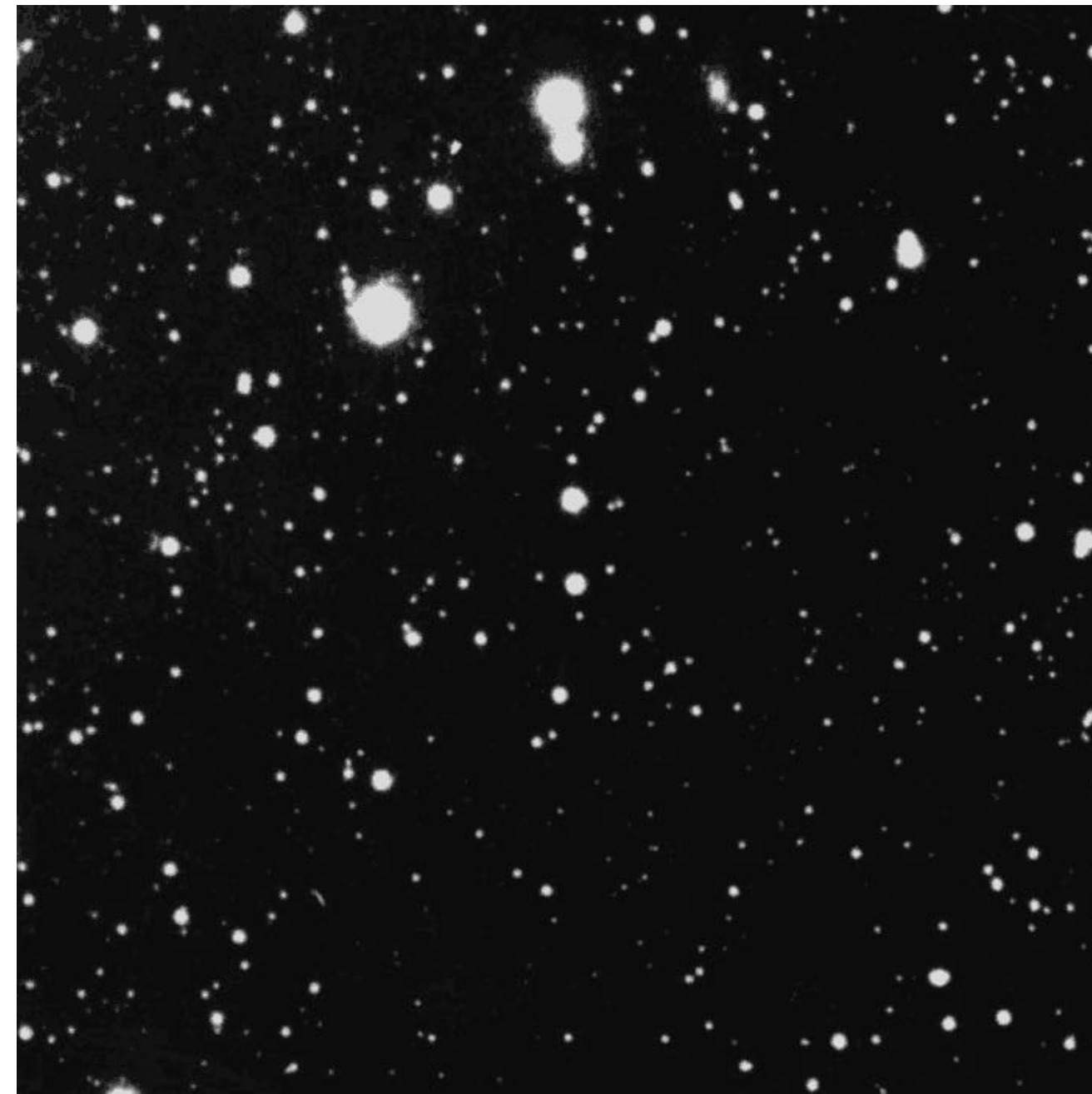
Change blindness

- if attention is directed elsewhere, even drastic changes not noticeable
  - remember door experiment?
- change blindness demos
  - mask in between images https://youtu.be/bh_9XFzbWV8

Resolution beats immersion

- immersion typically not helpful for abstract data
  - do not need sense of presence or stereoscopic 3D
  - desktop also better for workflow integration
- resolution much more important: pixels are the scarcest resource
- virtual reality for abstract data difficult to justify thus far
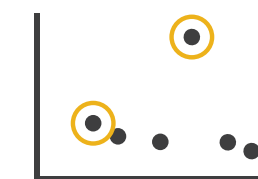 - but stay tuned with second wave, AR (augmented reality) has more promise

[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

- overview = summary
  - microcosm of full vis design problem

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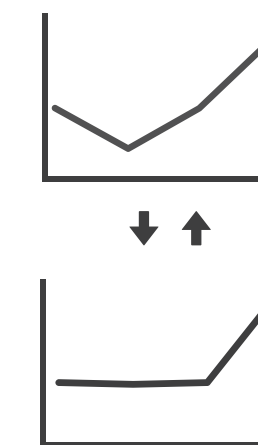
Rule of thumb: Responsiveness is required

- visual feedback: three rough categories

  - 0.1 seconds: perceptual processing

   - subsecond response for mouseover highlighting - ballistic motion

  - 1 second: immediate response

    - fast response after mouseclick, button press - Fitts' Law limits on motor control

  - 10 seconds: brief tasks

    - bounded response after dialog box - mental model of heavyweight operation (file load)

- scalability considerations

  - highlight selection without complete redraw of view (graphics frontbuffer)

  - show hourglass for multi-second operations (check for cancel/undo)

  - show progress bar for long operations (process in background thread)

  - rendering speed when item count is large (guaranteed frame rate)

Function first, form next

- start with focus on functionality

    - possible to improve aesthetics later on, as refinement

    - if no expertise in-house, find good graphic designer to work with

    - aesthetics do matter: another level of function

        - visual hierarchy, alignment, flow

        - Gestalt principles in action

            - (not covered in this class)

- dangerous to start with aesthetics

    - usually impossible to add function retroactively

Form: Basic graphic design ideas

- proximity
  - do group related items together
  - avoid equal whitespace between unrelated
- alignment
  - do find/make strong line, stick to it
  - avoid automatic centering
- repetition
  - do unify by pushing existing consistencies
- contrast
  - if not identical, then very different
  - avoid not quite the same
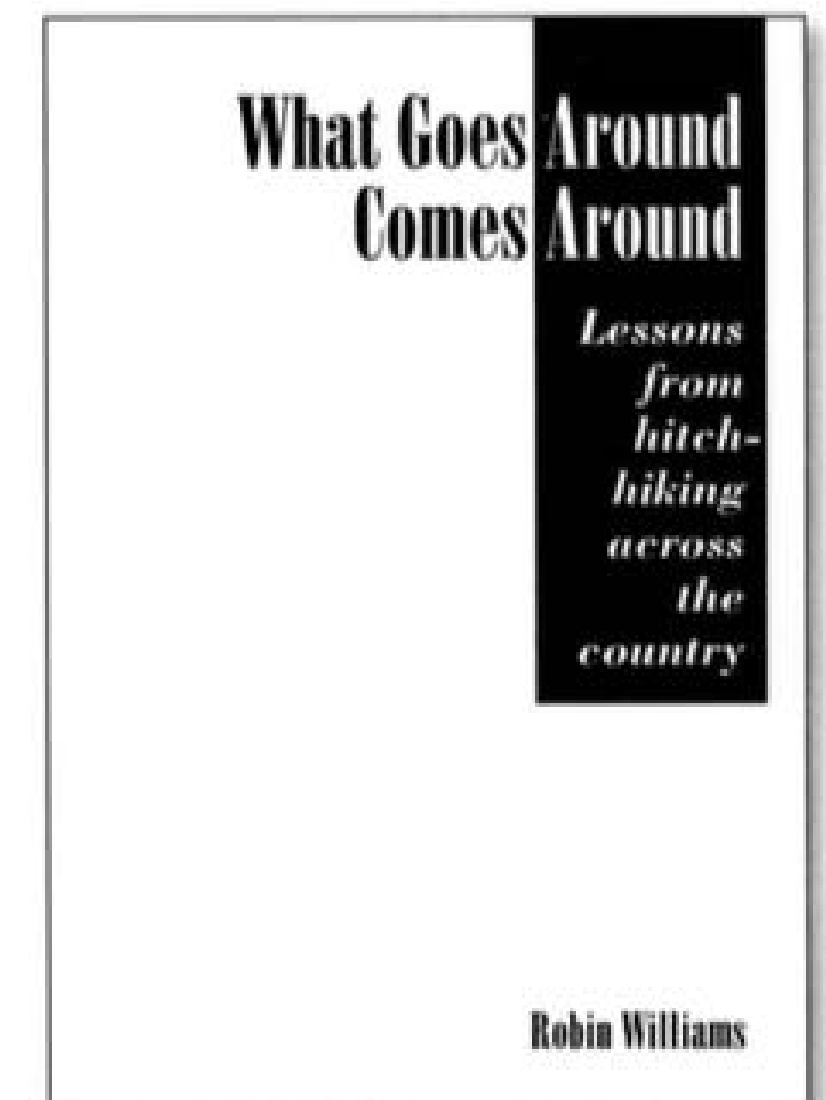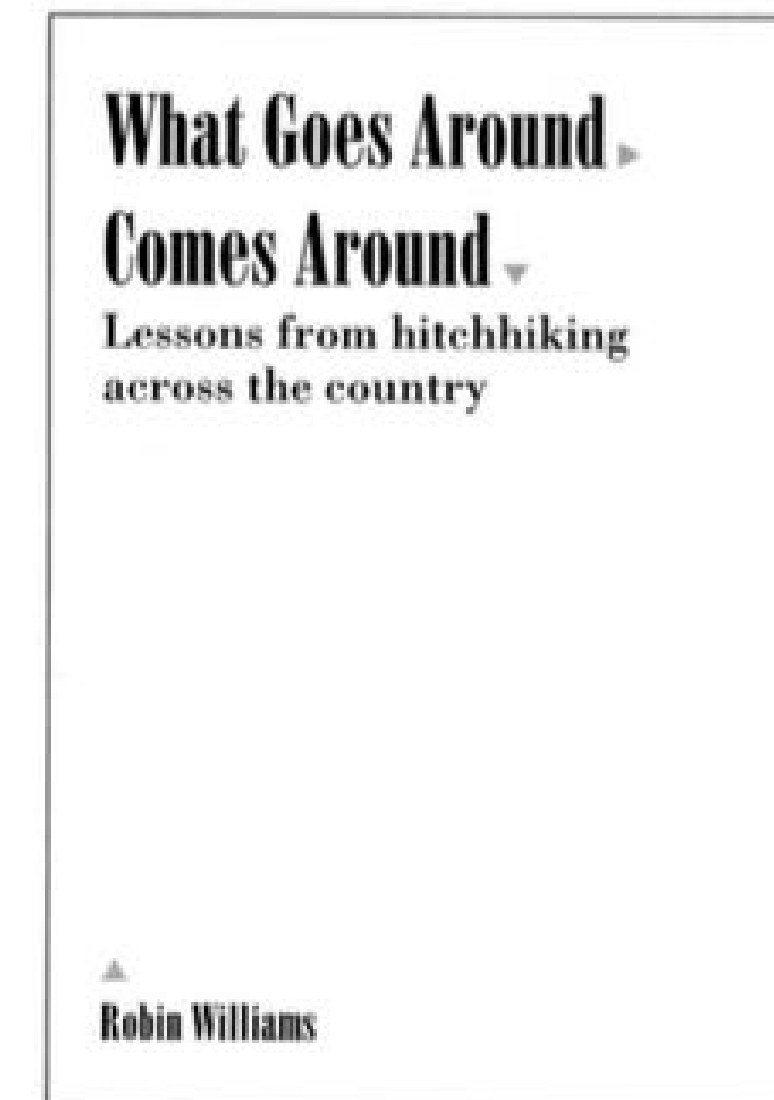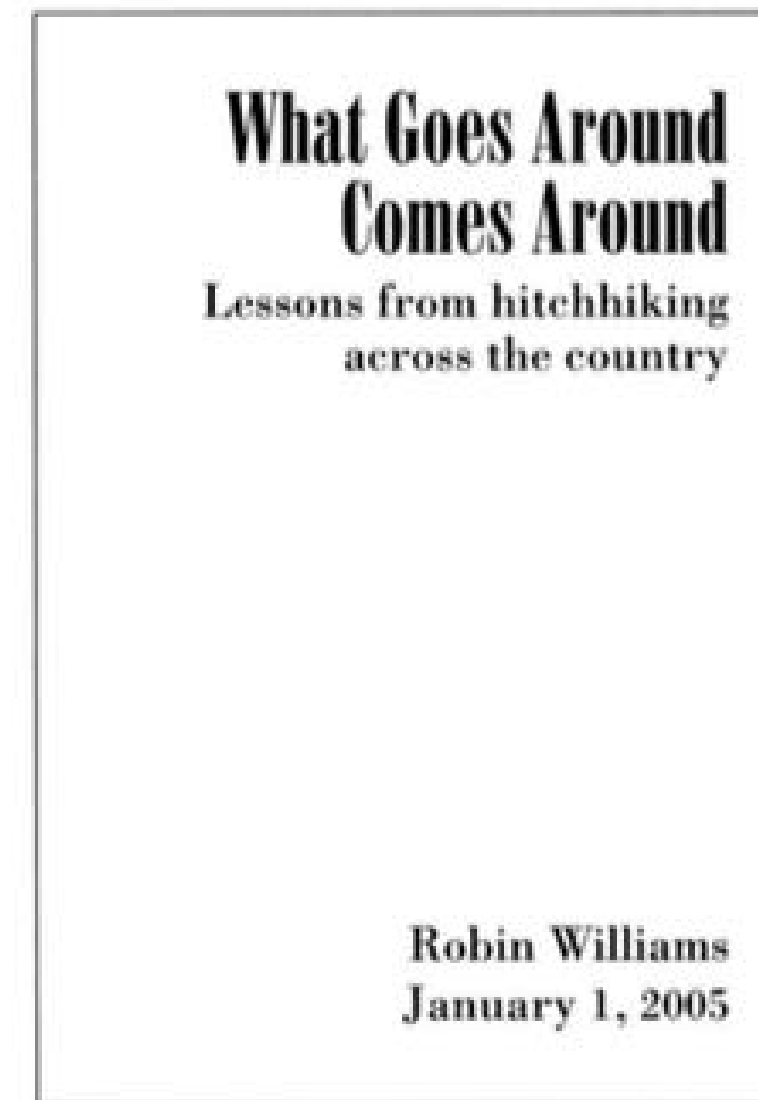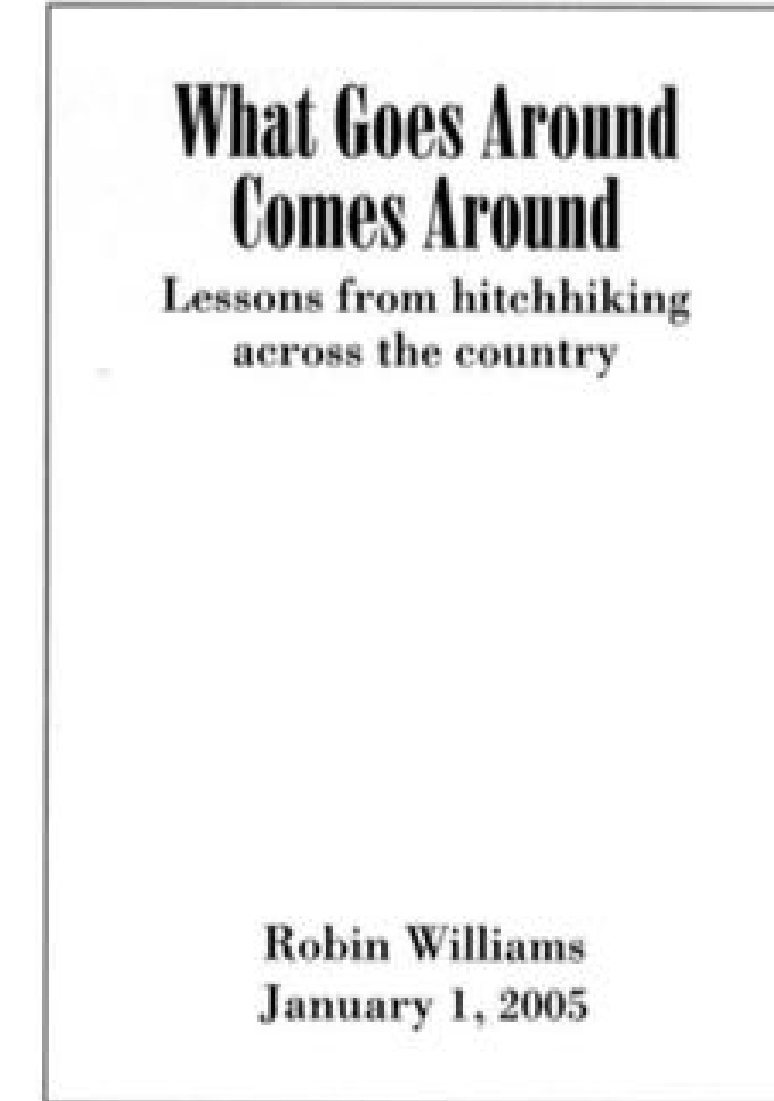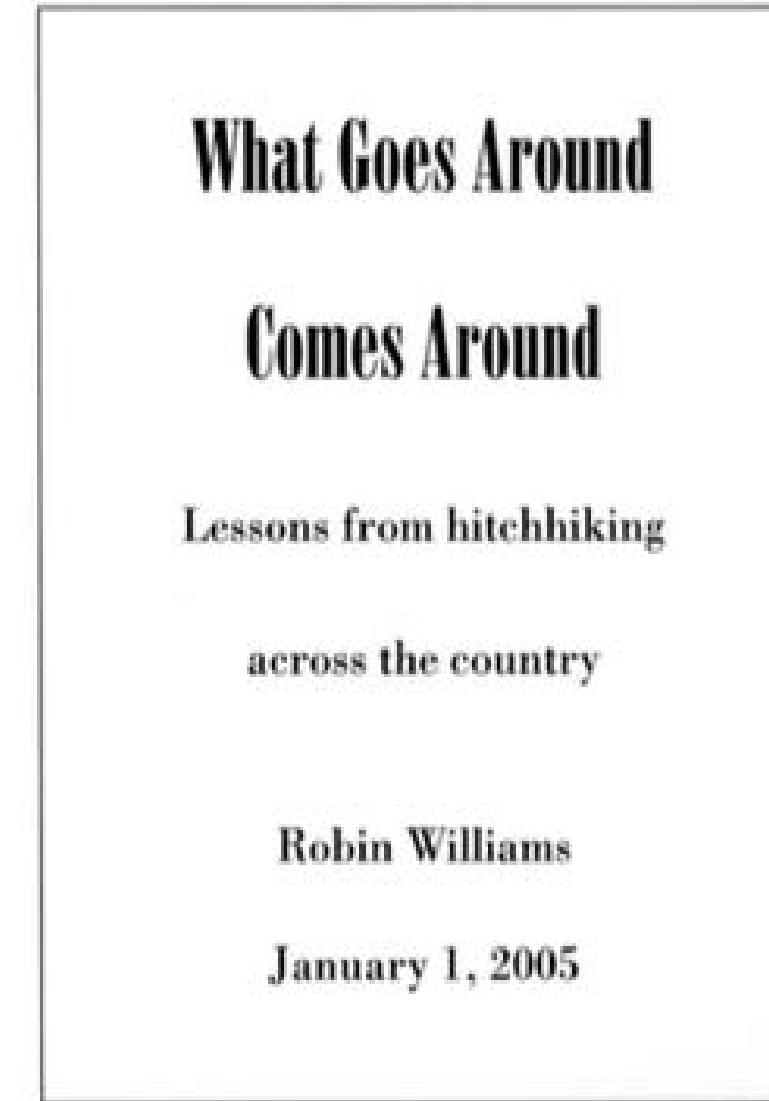
Best practices: Labelling

- make visualizations as self-documenting as possible
  - meaningful & useful title, labels, legends
    - axes and panes/subwindows should have labels
      - and axes should have good mix/max boundary tick marks
    - everything that's plotted should have a legend
      - and own header/labels if not redundant with main title
    - use reasonable numerical format
      - avoid scientific notation in most cases

[https://xkcd.com/833/]
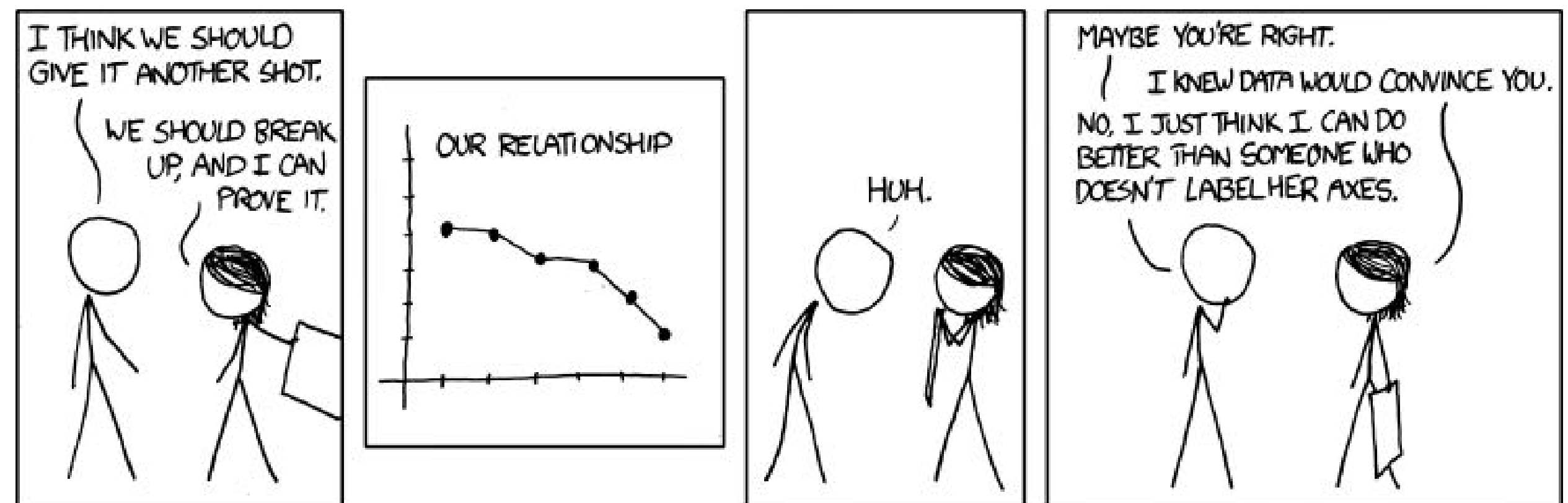
Rules of Thumb Summary

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

Reading Material

[dv3] **Chapter 6 - Rules of Thumbs**

Questions?

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🐦 @rschifan

✉ rossano.schifanella@unito.it

🌐 http://www.di.unito.it/~schifane