Information Visualization

Interacting with Data

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Graphics+Interaction Laboratory

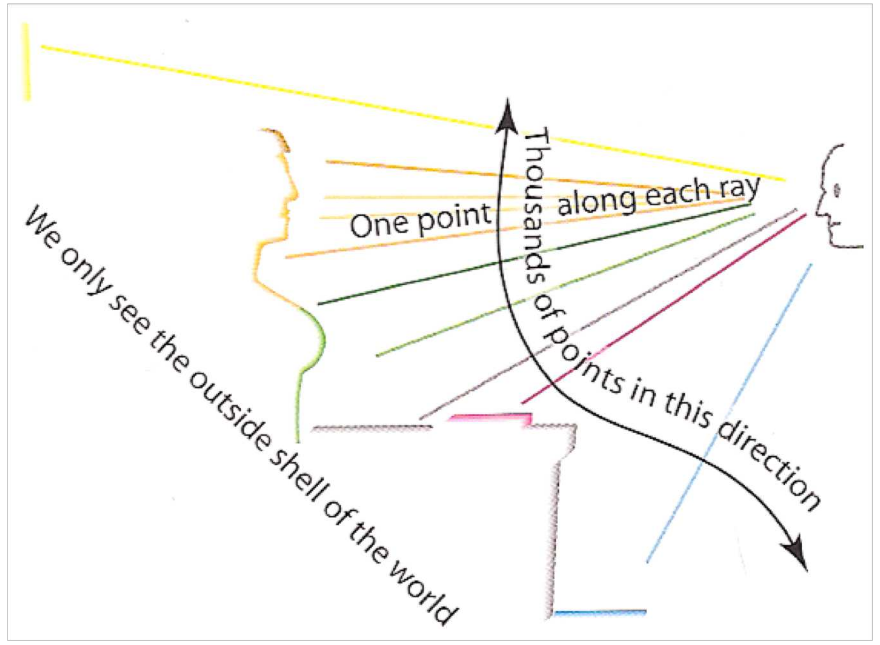
material curtesy of Prof. Tamara Munzner

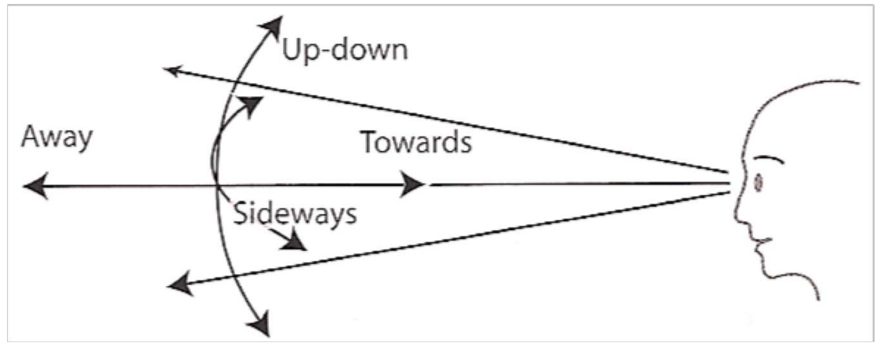
Overview first, zoom and filter, then details-on-demand.

Ben Shneiderman, 1996

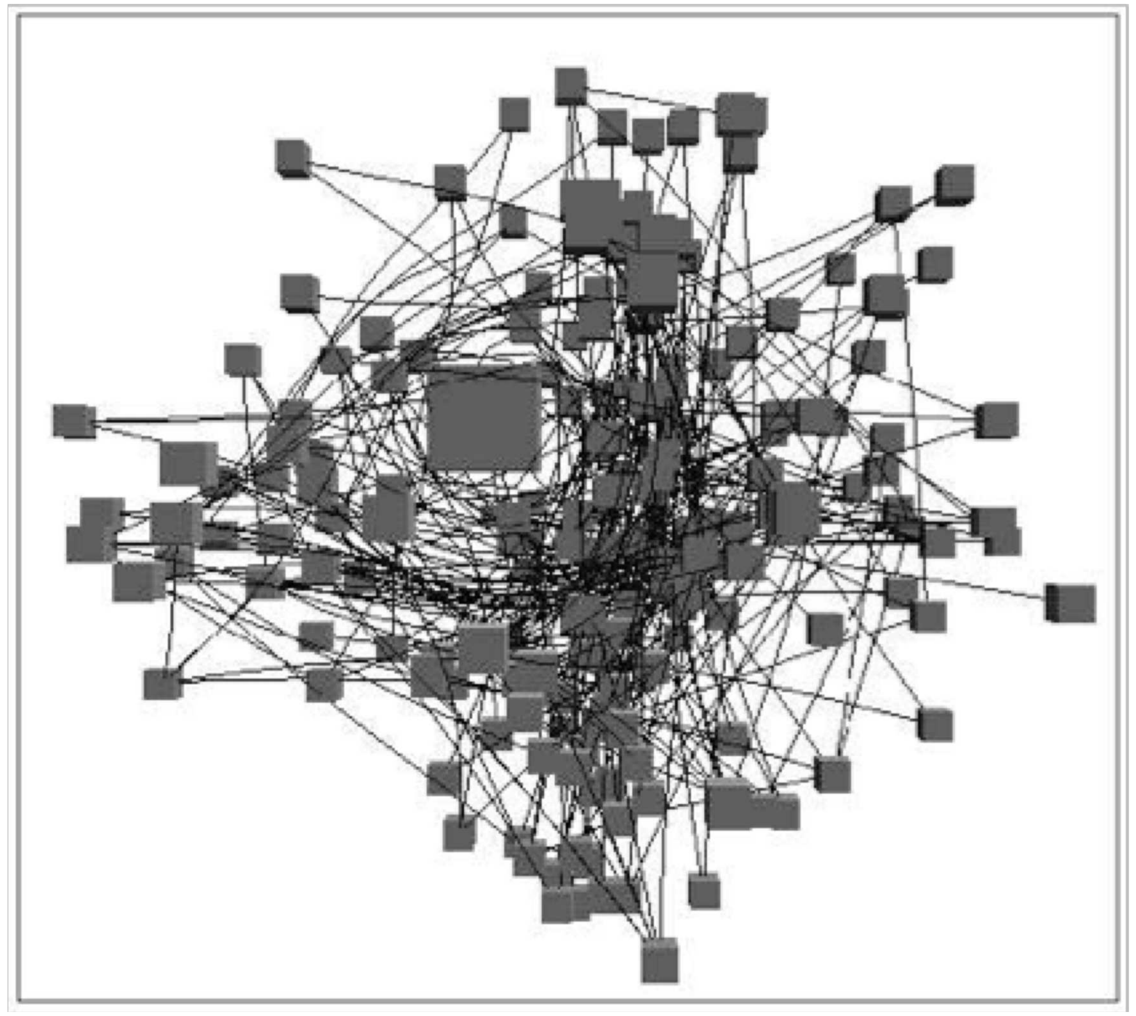
Depth vs Position

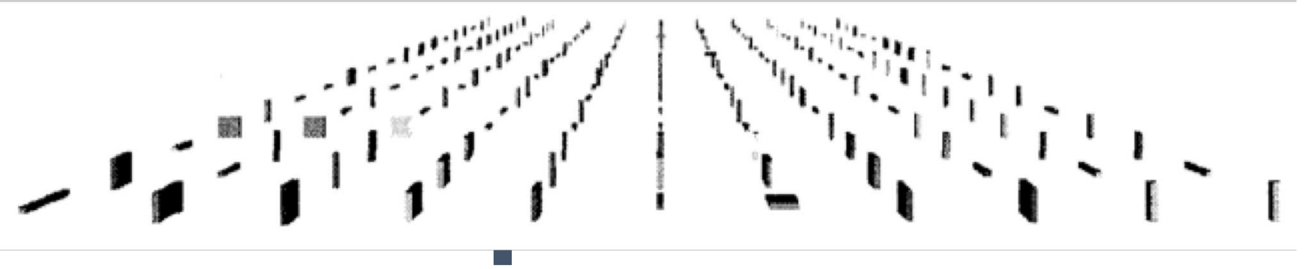
- rankings for planar spatial position, not depth!
- we don't really live in 3D; we see in 2.05D
  - up/down and sideways: image plane
  - acquire more info quickly from eye movements
- away: depth into scene
  - only acquire more info from head/body motion

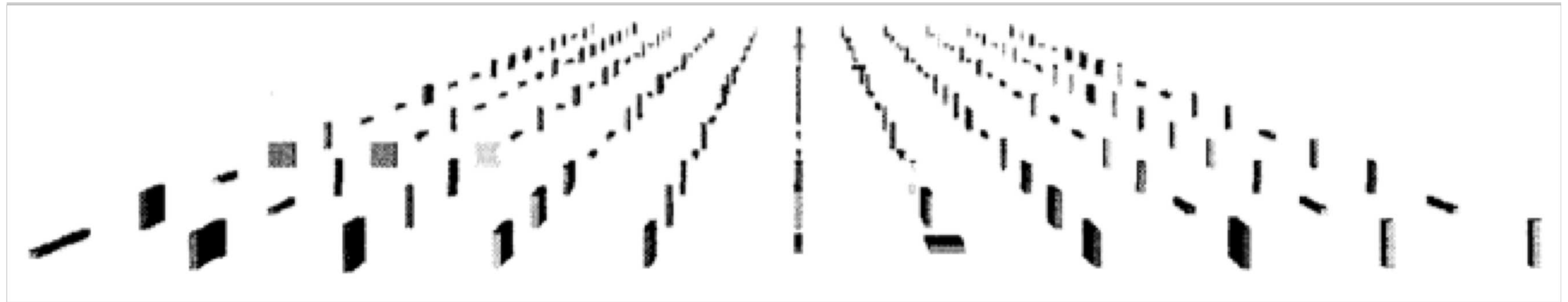




Occlusion and Motion Parallax



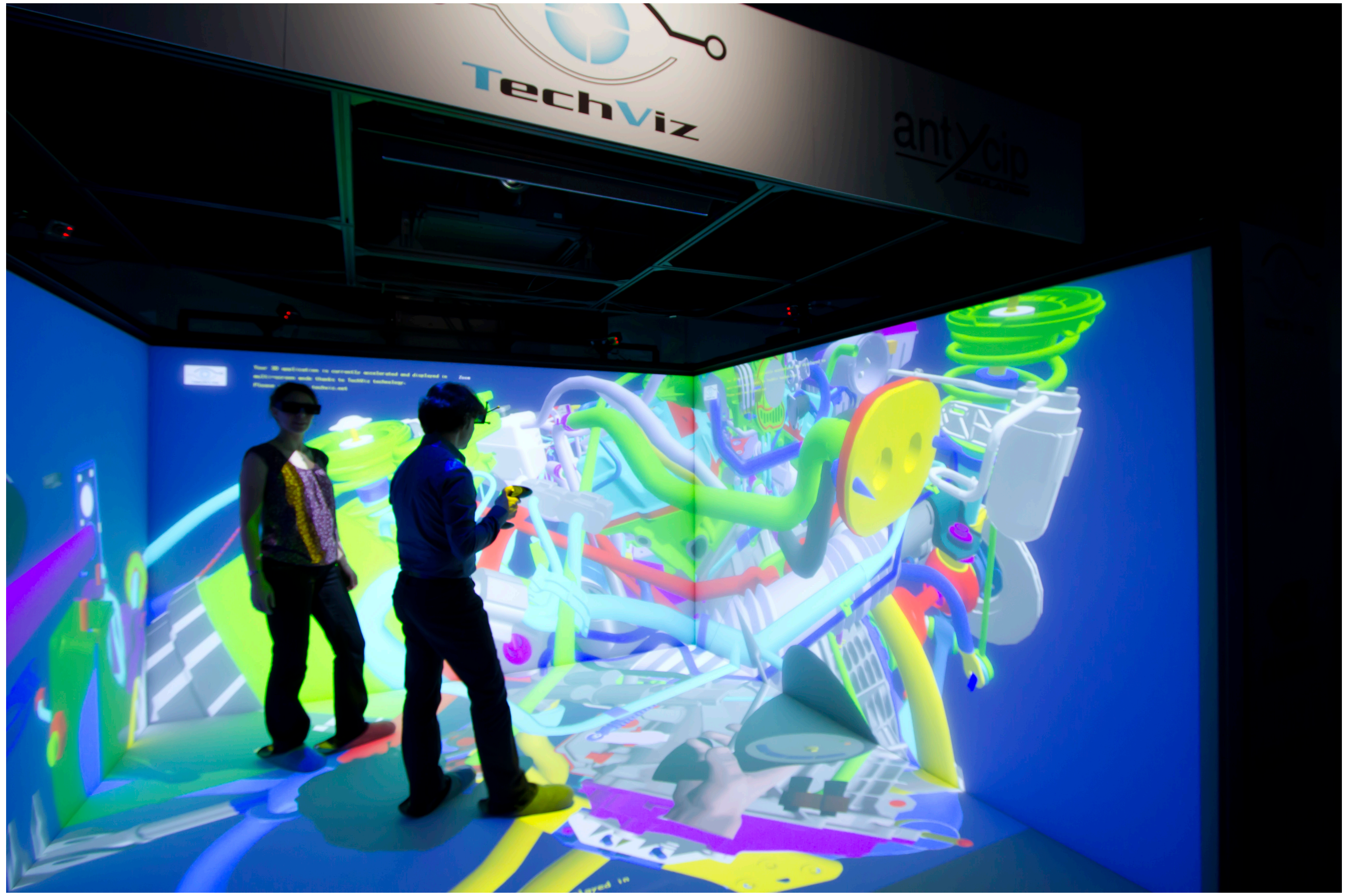




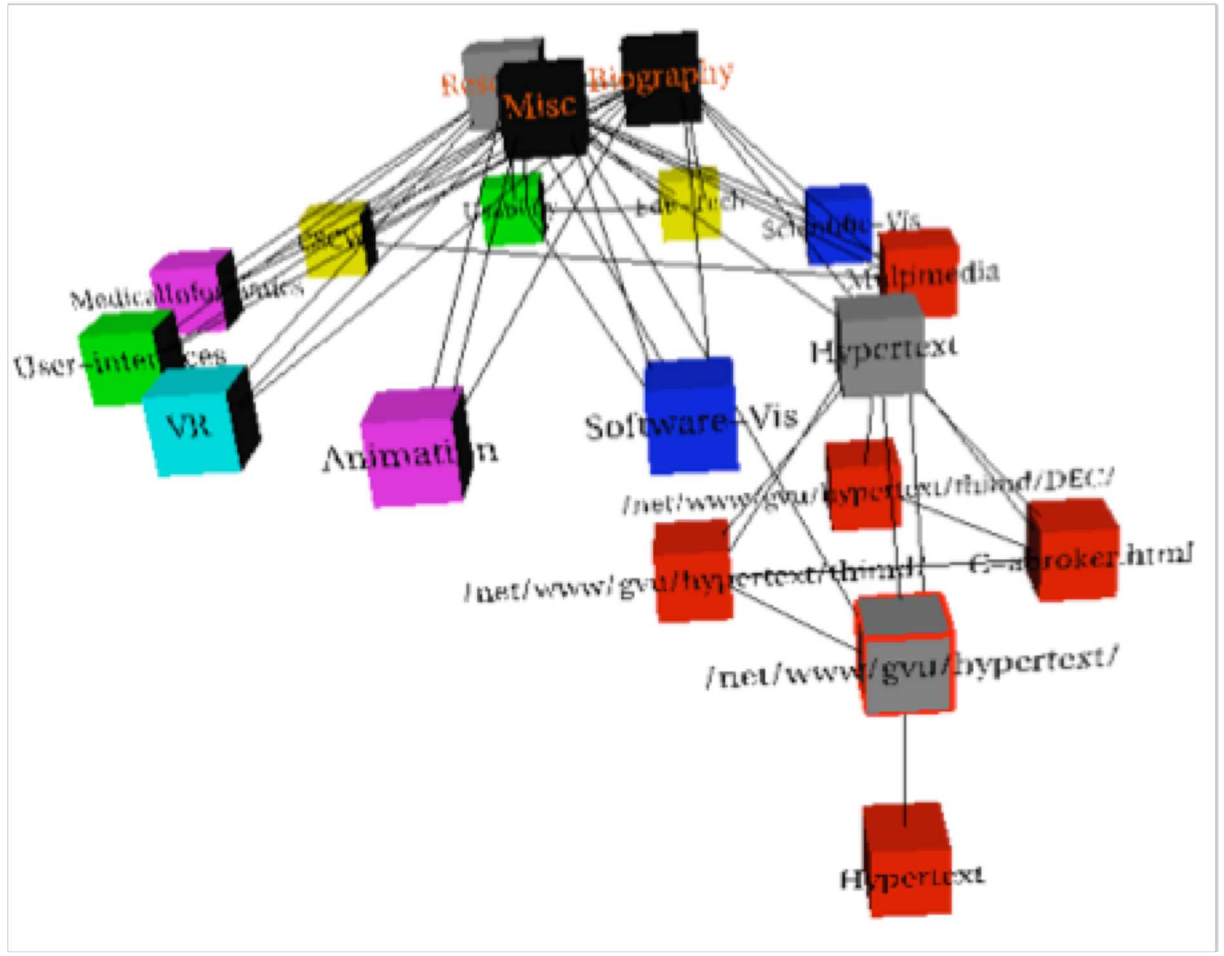
- Size as encoding channel is lost!
- Power of the plane is lost!

Other Cues

- Familiar size (comparability)
- Shadows and shading (depth and structure)
- Stereo (depth)
- Perspective environment



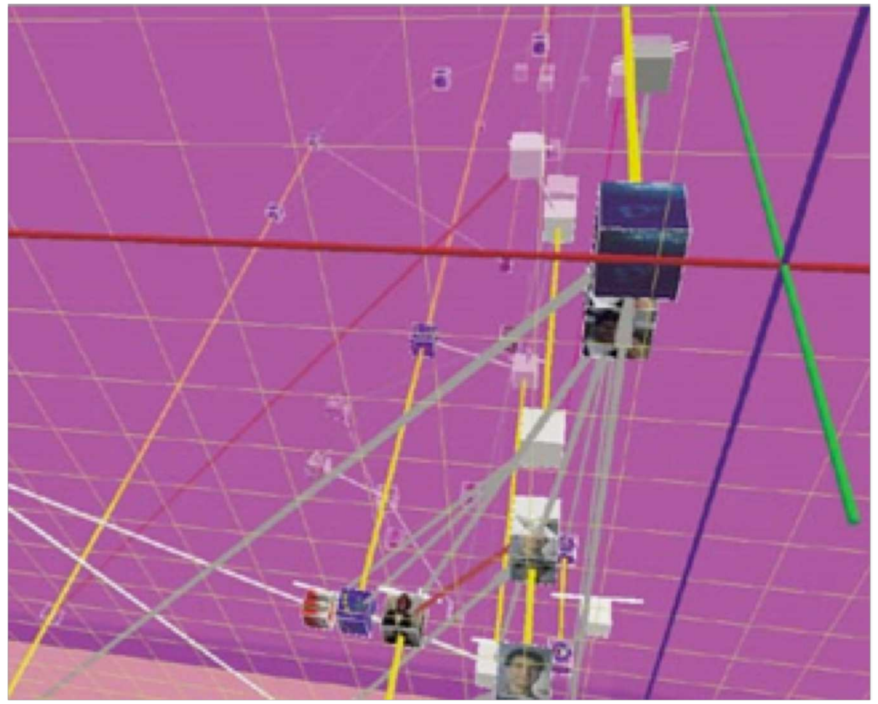
Legibility



- Tilted text loses legibility
- Overlaps

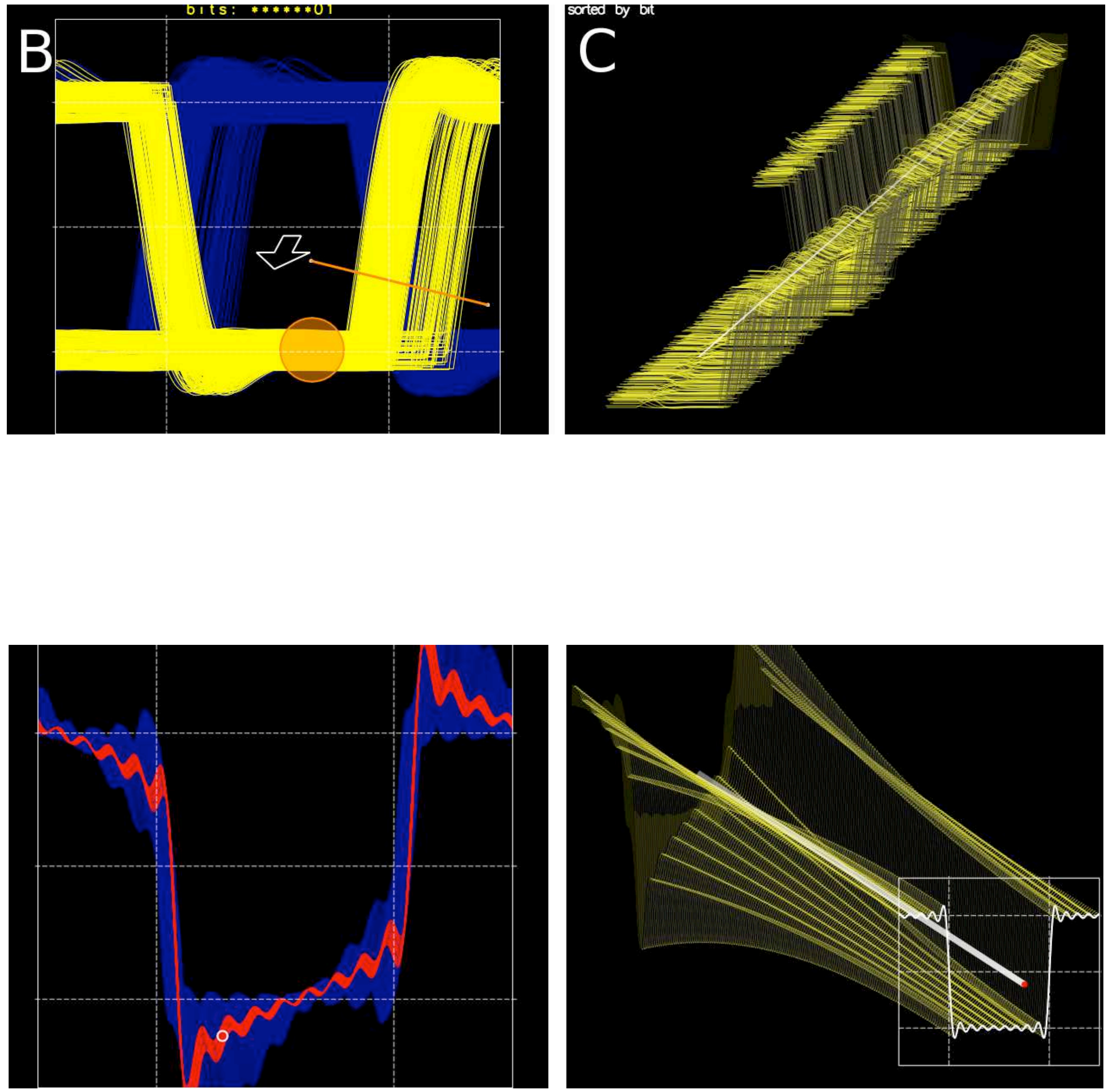
3D needs purpose!

- 3D is legitimate choice for spatial data
- 3D needs careful justification for abstract data



3D can be justified

- Constrained navigation
- Drawer opening metaphor



Interaction: Classes of Change

- Selection (data channels)
- Highlighting (filter)
- Viewpoint: navigating (user)
- Spatial order: sorting (user filter)
- Visual encoding (mapping)

Latency and Feedback

- 0.1 sec: perception and cognition
- 1 sec: action response
- 10 sec: unit task (combined)

Interaction Principles

- Interaction costs
  - Interplay between automatic and interactive
- Spatial cognition
  - Systematic distortions: hierarchical sorting
  - Landmarks: spatial memory

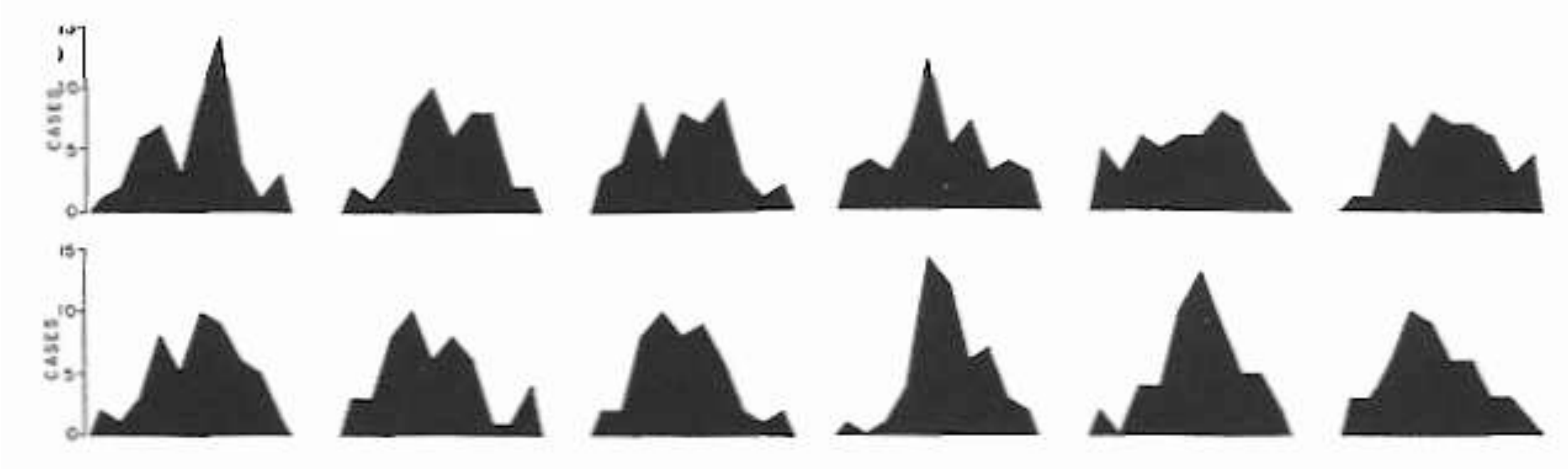
Animation

- Storytelling (narrative)
  - careful choreography to direct eyes to right spot
  - vs datasets with simultaneous change many places
- Transitions between configurations
  - powerful technique, very common
- Video-style playback of multi-frame sequence
  - good: compare by flipping between two things
  - bad: compare between many things


BBC FOUR

Animation

- Small multiples: show time using space
  - overview: show each time step in array
  - compare: side-by-side easier than temporal
    - external cognition instead of internal memory
  - general technique, not just for temporal changes



Edward Tufte, The Visual Display of Quantitative Information, pg 169

Animation

literal

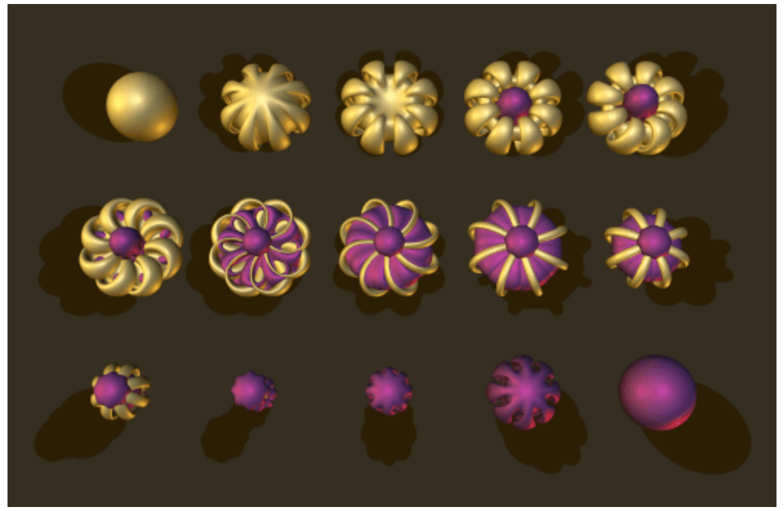
abstract

Time for time

Space for time

Small Multiples

- show time using space
- also can be good for showing process



Animation vs. Small Multiples

- Tversky [1] argument:
  - intuition that animation helps is wrong
- meta-review of previous studies
  - often more info shown in animation view so not a fair comparison
  - carefully chosen segmentation into small multiples better than animation if equivalent information shown

1. Animation: Can It Facilitate? Barbara Tversky, Julie Morrison, Mireille Betrancourt. International Journal of Human Computer Studies 57:4, pp 247-262, 2002.

Animated Transitions

- general and powerful idea
  - transitions, not motion as visual encoding
- benefits
  - attracts attention
  - facilitates object constancy
  - implies causality
  - emotionally engaging
- this paper: statistical graphics
  - design principles controlled experiments

- Animated Transitions in Statistical Data Graphics. Jeffrey Heer and George G. Robertson. IEEE TVCG (Proc. InfoVis 2007) 13(6): 1240-1247, 2007.

Taxonomy of Transitions

- Change viewpoint
- Change spatial substrate
- Filter
- Reorder
- Change time
- Change visual mapping
- Change data schema

Congruence Principles

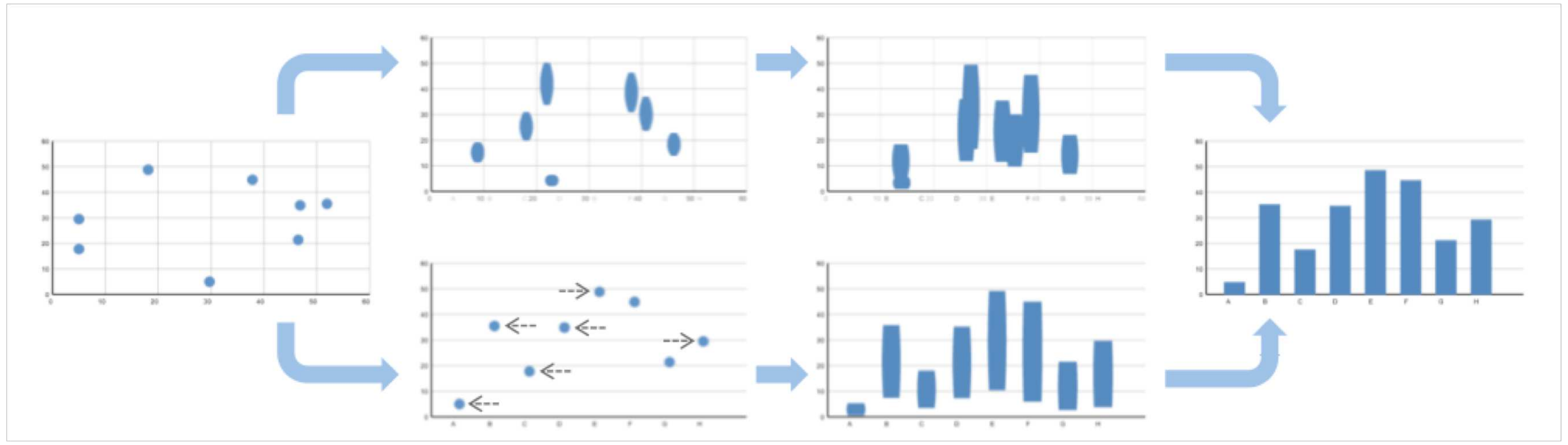
- internal and external representations should match
  - both structure and content
- principles
  - maintain valid data graphics during transitions
  - use consistent mappings (semantic-syntactic)
  - respect semantic correspondences
  - avoid ambiguity

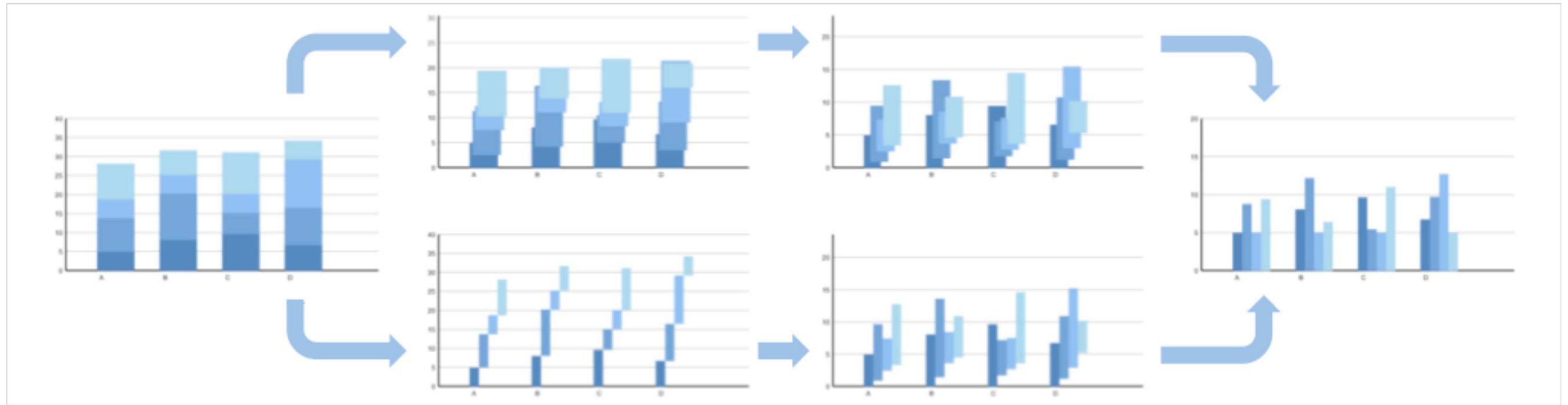
Apprehension Principles

- external representation structure and content should be readily and accurately perceived and comprehended

- principles
  - group similar transitions - gestalt (common fate)
- minimize occlusion
- maximize predictability
  - slow-in, slow-out
- use simple transitions
  - use staging for complex transitions
  - make transitions as long as needed, but no longer

Staging





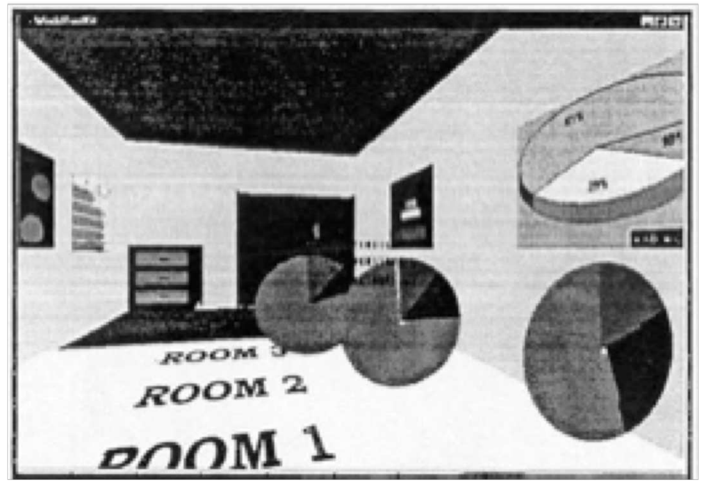
Animated Transitions in Statistical Data Graphics. Jeffrey Heer and George G. Robertson. IEEE TVCG (Proc. InfoVis 2007) 13(6): 1240-1247, 2007.

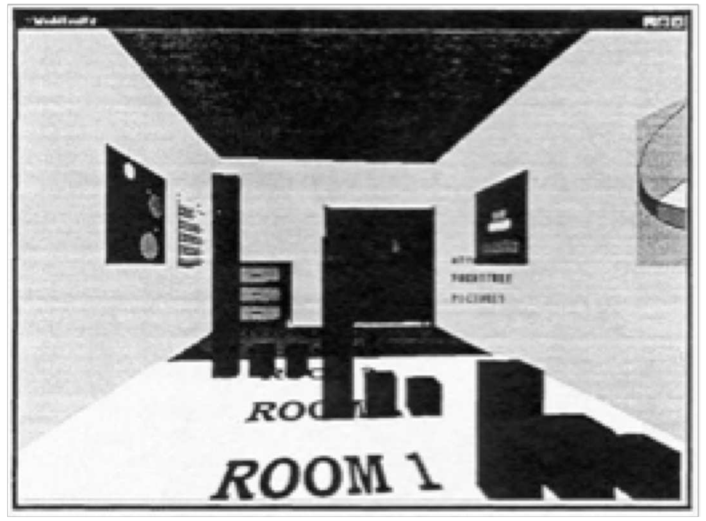
Staging Experiments

- study 1: object location tracking
  - animation always helped
    staged animation almost always helped
- study 2: value change estimation
  - animation helps in some cases
  - staging not significant help
- preference: staged anim mostly, anim always
- guideline: avoid overly complex multi-staging

Resolution vs. Immersion

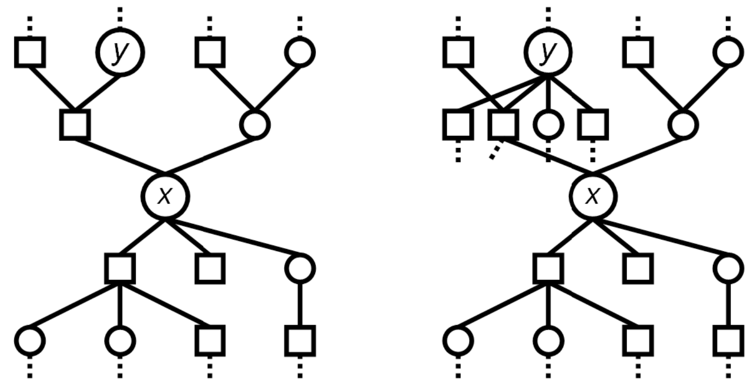
- immersion typically not helpful for abstract data do not need sense of presence or stereoscopic 3D
- resolution much more important
- pixels are the scarcest resource desktop also better for workflow integration
- virtual reality for abstract data very difficult to justify





Genealogical Graphs

- family trees not actually trees
- single person has tree of ancestors, tree of descendants
- pedigree collapse inevitable: diamond in ancestor graph



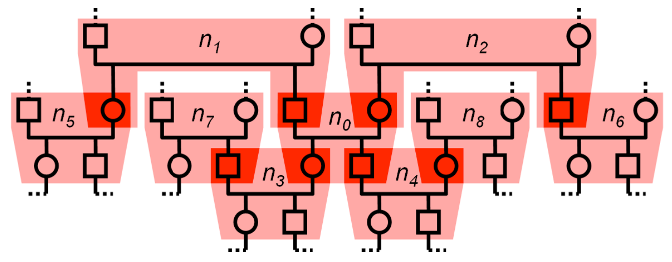
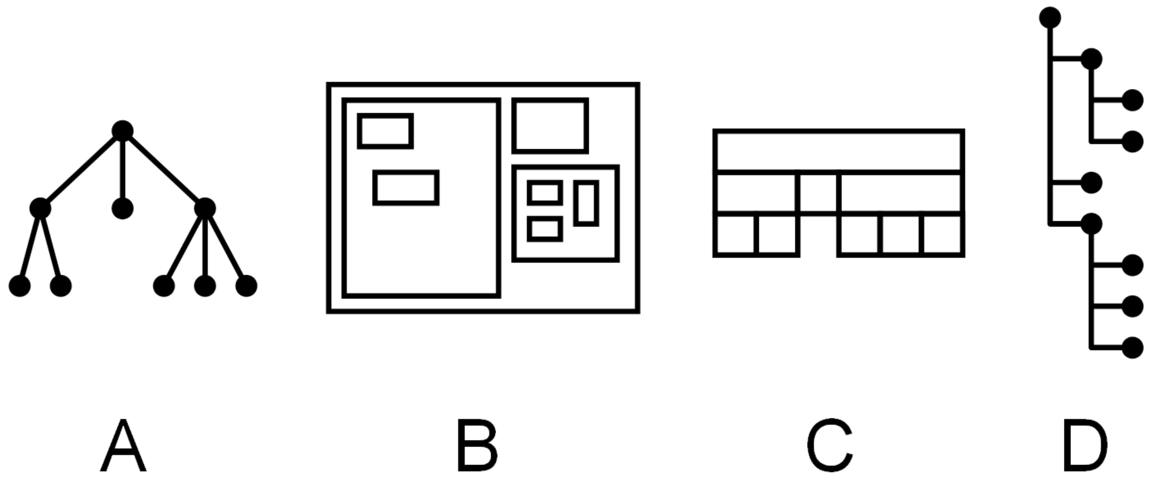


Fig 2/6, McGuffin and Balakrishnan. Interactive Visualization of Genealogical Graphs. Proc. InfoVis 2005, p. 17-24

Graphs: Visual Encoding Alternatives

- rooted: node-link, enclosure, adjacent/align, indent
- fractal: no crossings, but lose ordering by generation



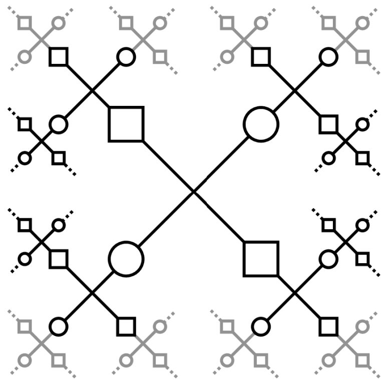


Fig 8/7, McGuffin and Balakrishnan. Interactive Visualization of Genealogical Graphs. Proc. InfoVis 2005, p. 17-24

Graphs: Visual Encoding Alternatives

- free trees
  - node-link
  - enclosure changing root: current focus set
  - generation order still lost

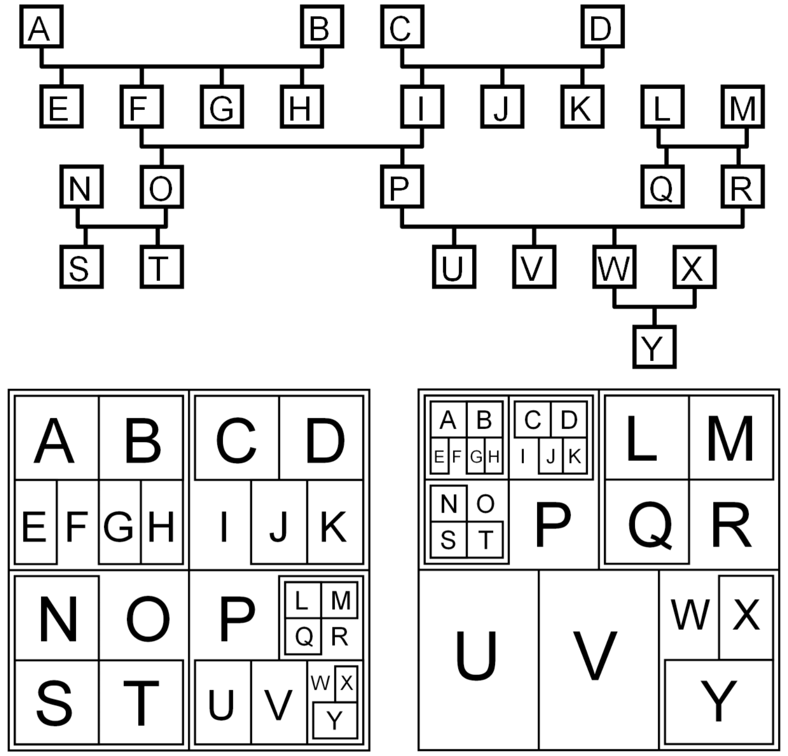


Fig 9, McGuffin and Balakrishnan. Interactive Visualization of Genealogical Graphs. Proc. InfoVis 2005, p. 17-24

Dual Trees

- abstraction requirements
  - explore canonical subsets and combinations
  - easy to interpret, scales well
  - no crossings, nodes ordered by generation
- doubly rooted: x leftmost descend, y rightmost ancestor

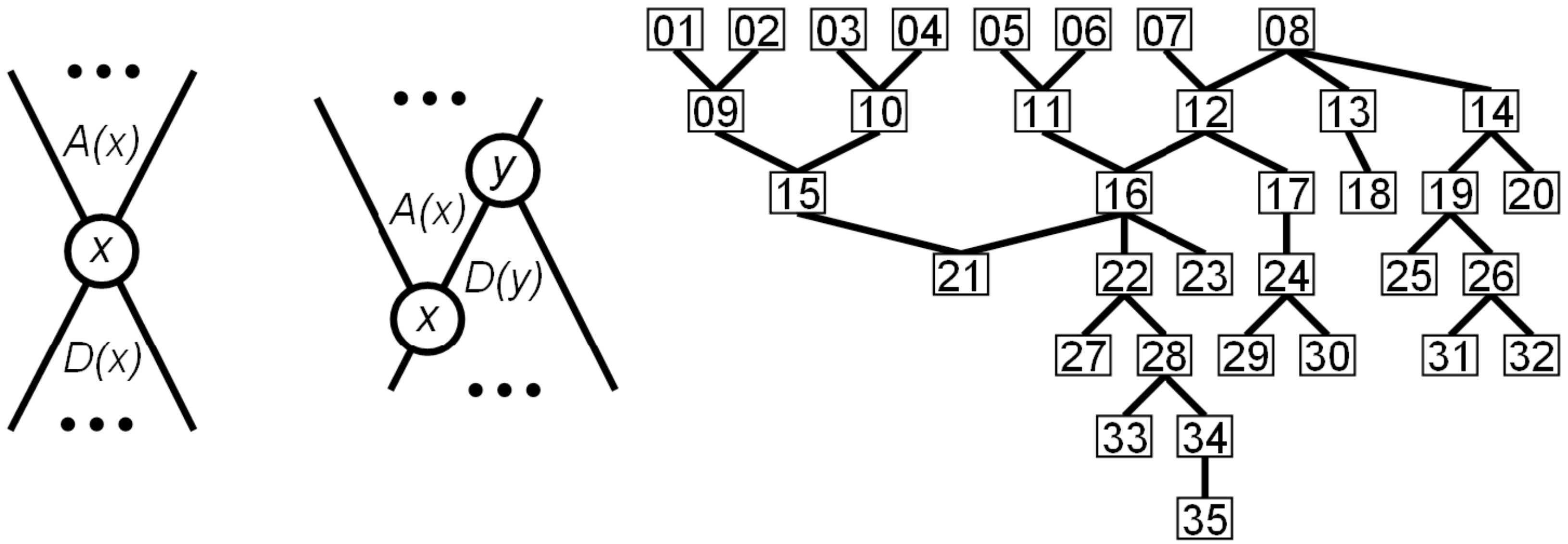


Fig 10, McGuffin and Balakrishnan. Interactive Visualization of Genealogical Graphs. Proc. InfoVis 2005, p. 17-24

Drawing Dual Trees

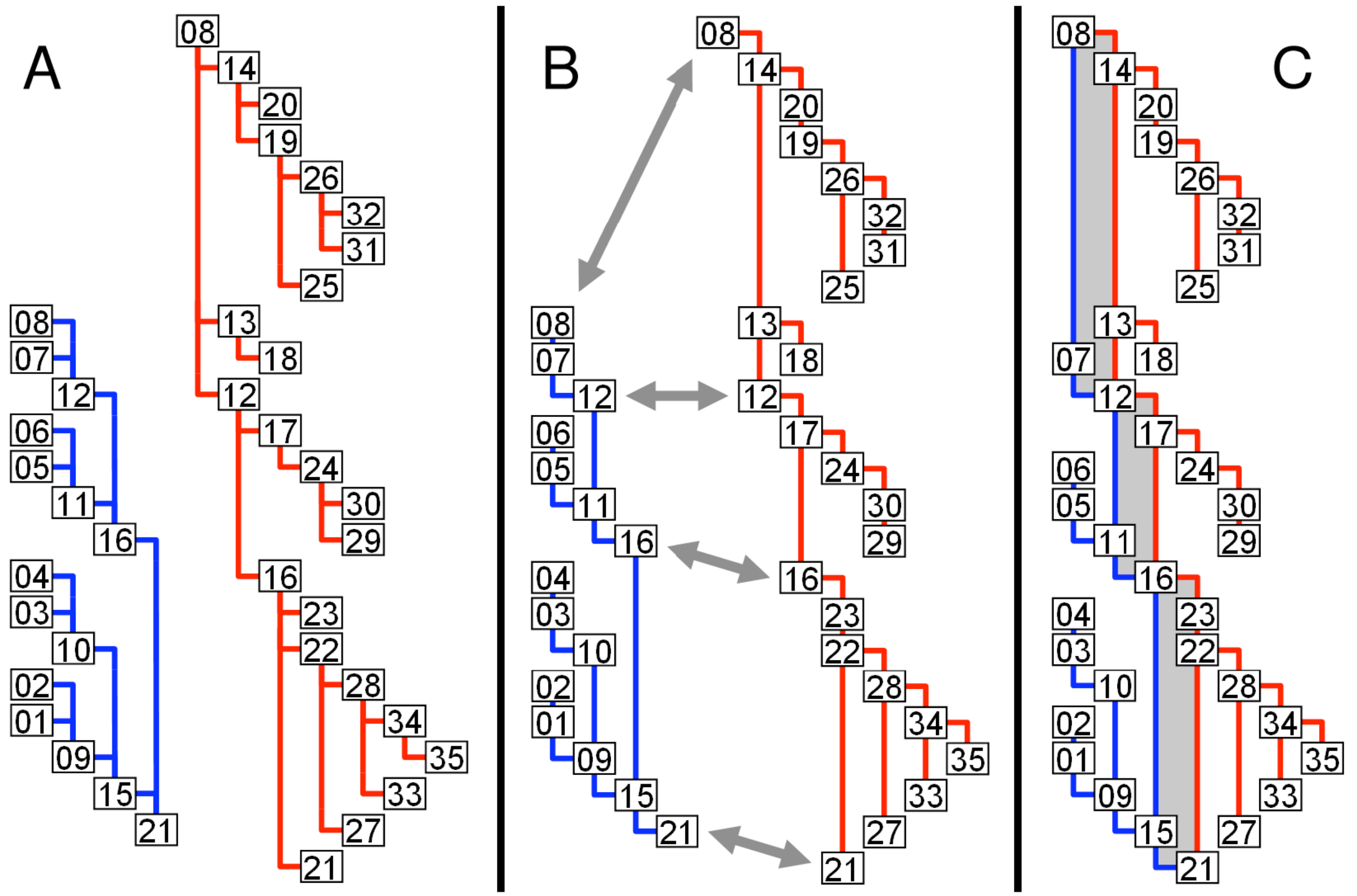


Fig 11, McGuffin and Balakrishnan. Interactive Visualization of Genealogical Graphs. Proc. InfoVis 2005, p. 17-24

Three Layouts

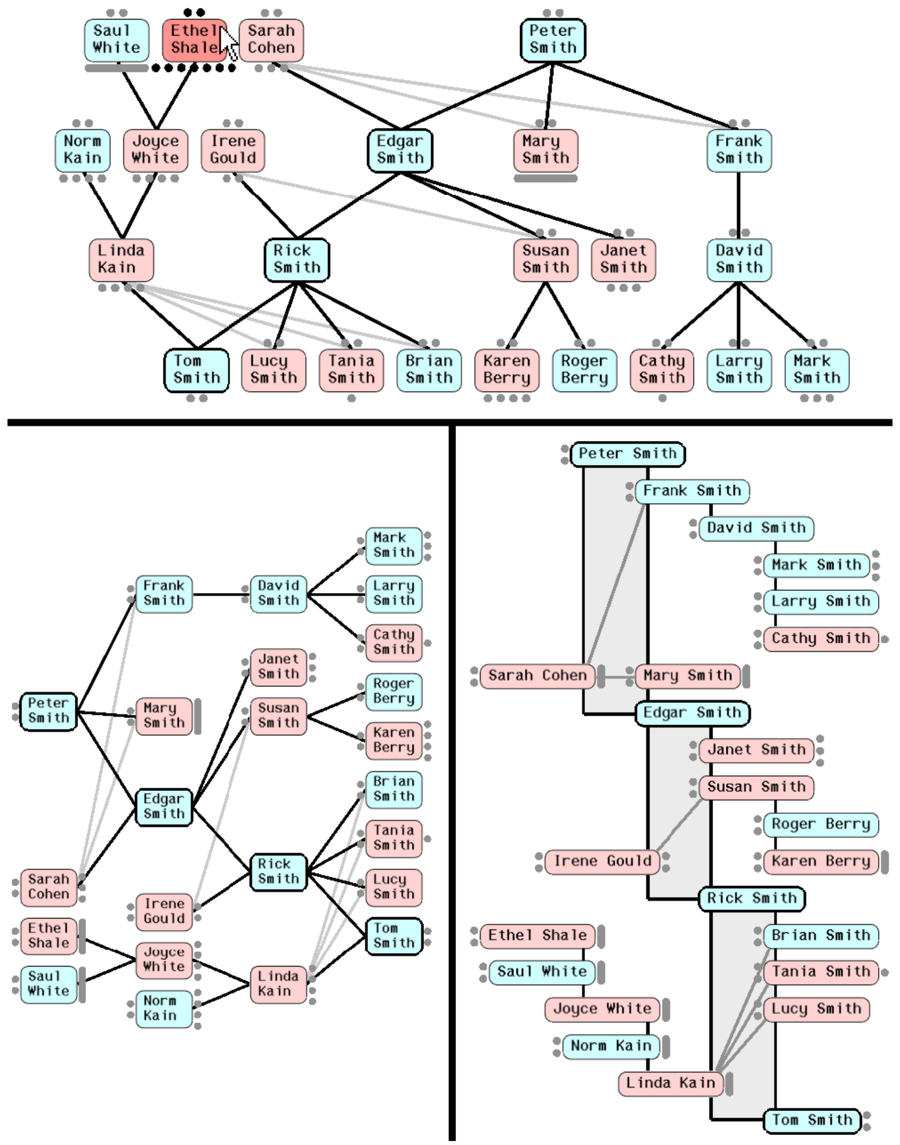


Fig 13, McGuffin and Balakrishnan. Interactive Visualization of Genealogical Graphs. Proc. InfoVis 2005, p. 17-24

Interactive Visualization of Genealogical Graphs

Michael J. McGuffin and Ravin Balakrishnan
University of Toronto

Interaction

- expand/collapse parents or children
  - expand: automatic rotation, collapse
  - three-stage animated transition
    - fade out old nodes to hide
    - move nodes to new positions
    - fade in new nodes to show
  - 2-item marking menu: flick up or down popup menu, allows ballistic gestures
- mouseover hover
  - preview dots: collapsed are expanded

Subtree Widget

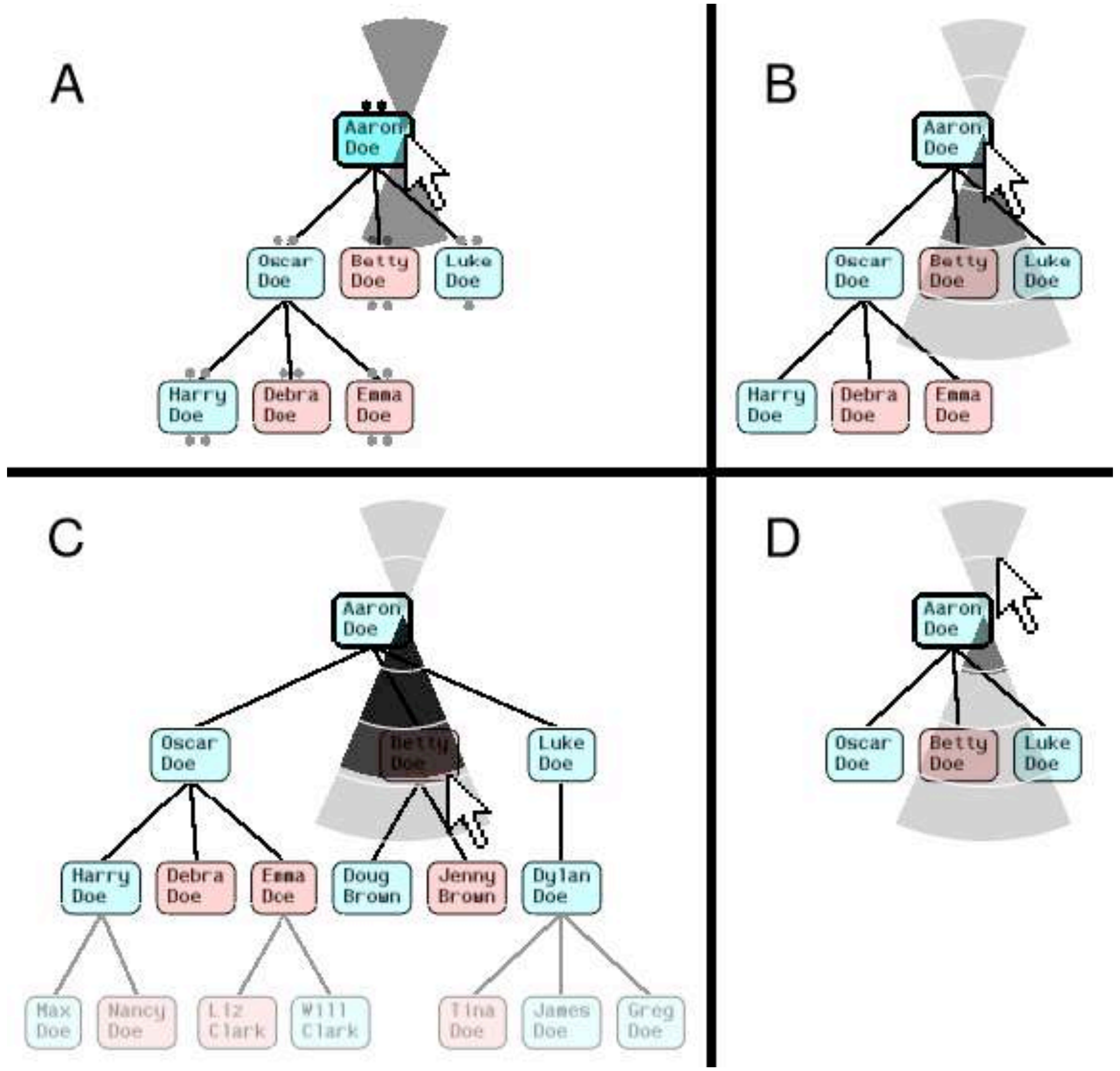


Fig 13, McGuffin and Balakrishnan. Interactive Visualization of Genealogical Graphs. Proc. InfoVis 2005, p. 17-24

Latency Classes

- popup menus
  - appear at current focus point of eye/click
  - gestures
    perceptual processing: sub-second update
- mouseover hover
  - preview dots
  - perceptual processing: subsecond update
- animated transitions
  - immediate response: 1 second

Summary

- Right abstraction
- Careful visual design
- Carefully design