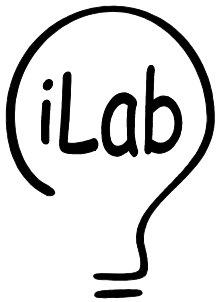
An Interactive 3D Integration of Parallel Coordinates and Star Glyphs

Elena Fanea

Sheelagh Carpendale

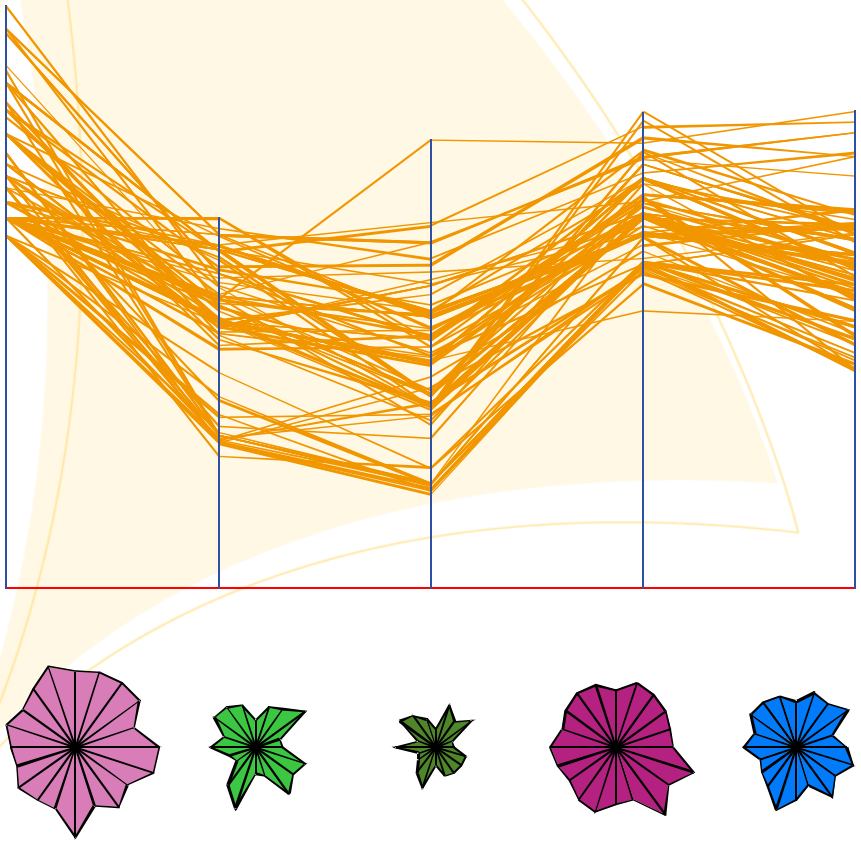
Tobias Isenberg

Interactions Lab, University of Calgary



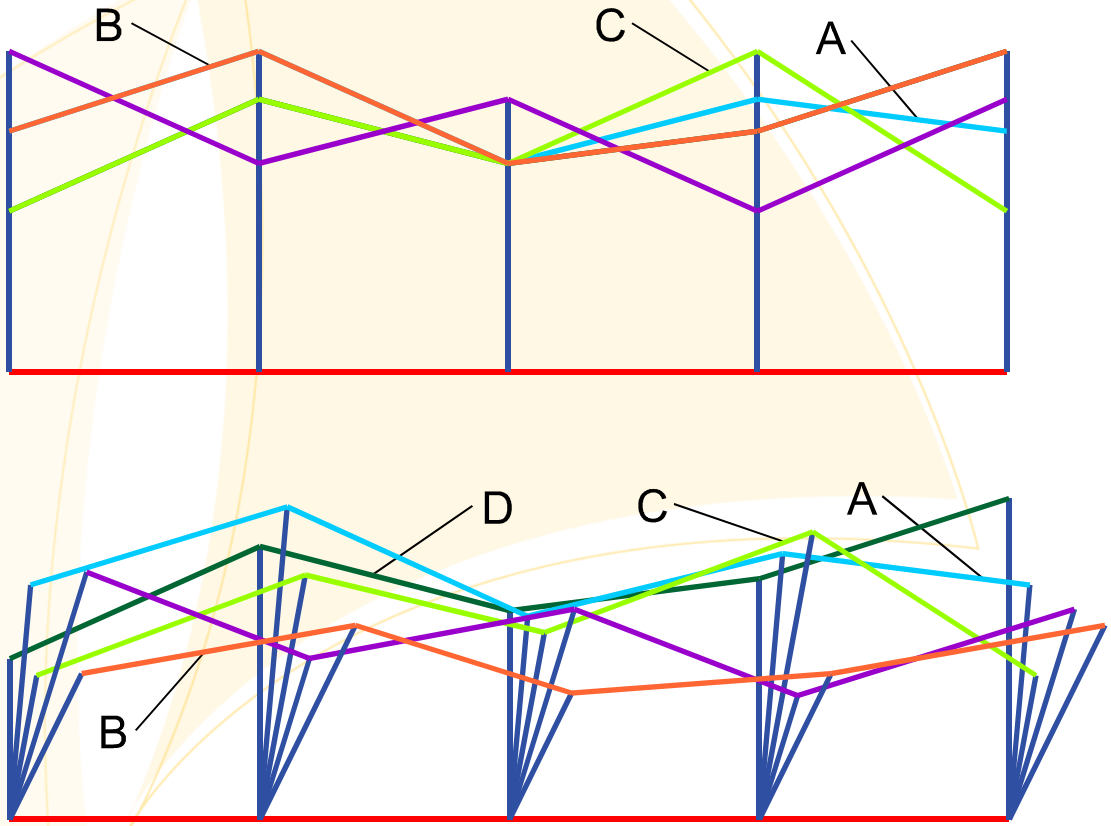
Introduction and Motivation

- visualization techniques for multi-dimensional data sets
  - parallel coordinates
  - star glyphs
- combine both in interactive 3D visualization
- related work
  - [Hackstadt and Malony, 1995]: Kiviat tubes
  - [Tominski et al., 2004, 2005]: visualization of time series data in 3D



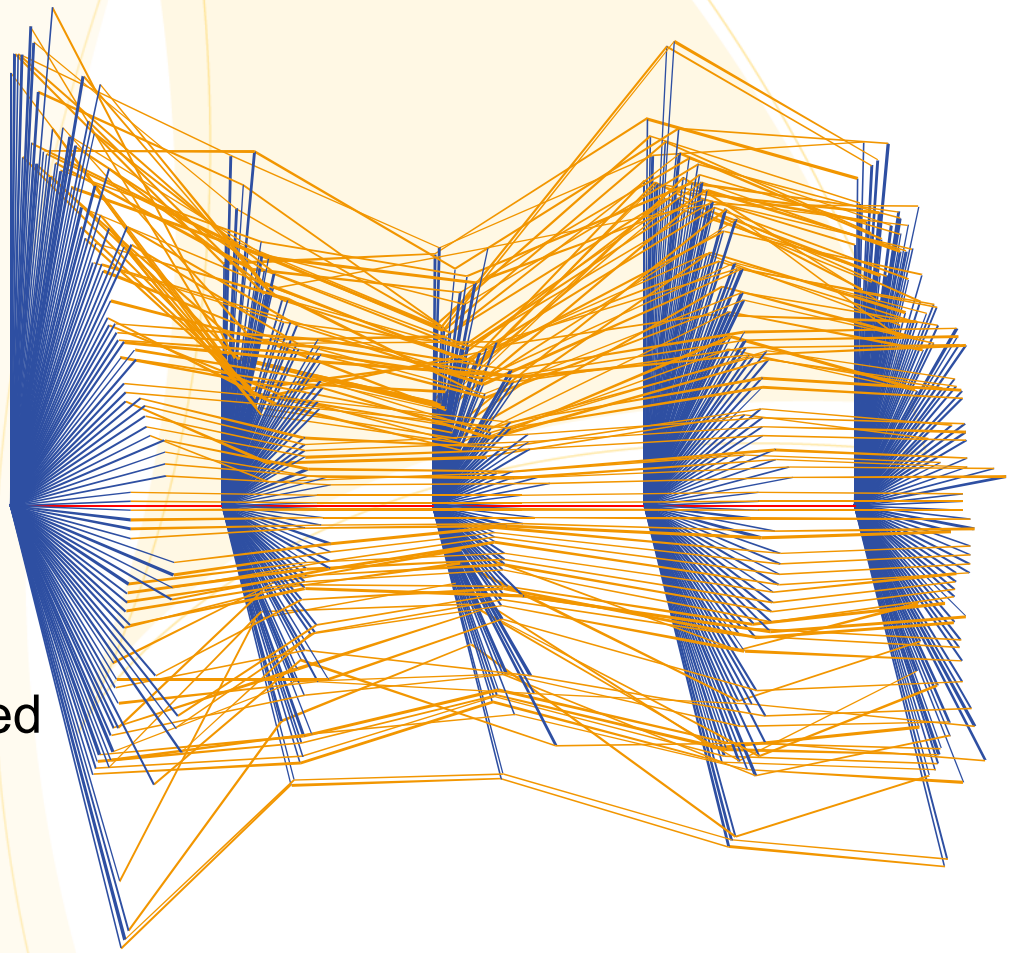
Problems with Parallel Coordinates

- tuples partially hidden behind other tuples, path unclear (tuple A following path B or C?)
- unfolding to reveal hidden tuple path and to clarify path (B)
- entirely hidden tuples also revealed (tuple D)



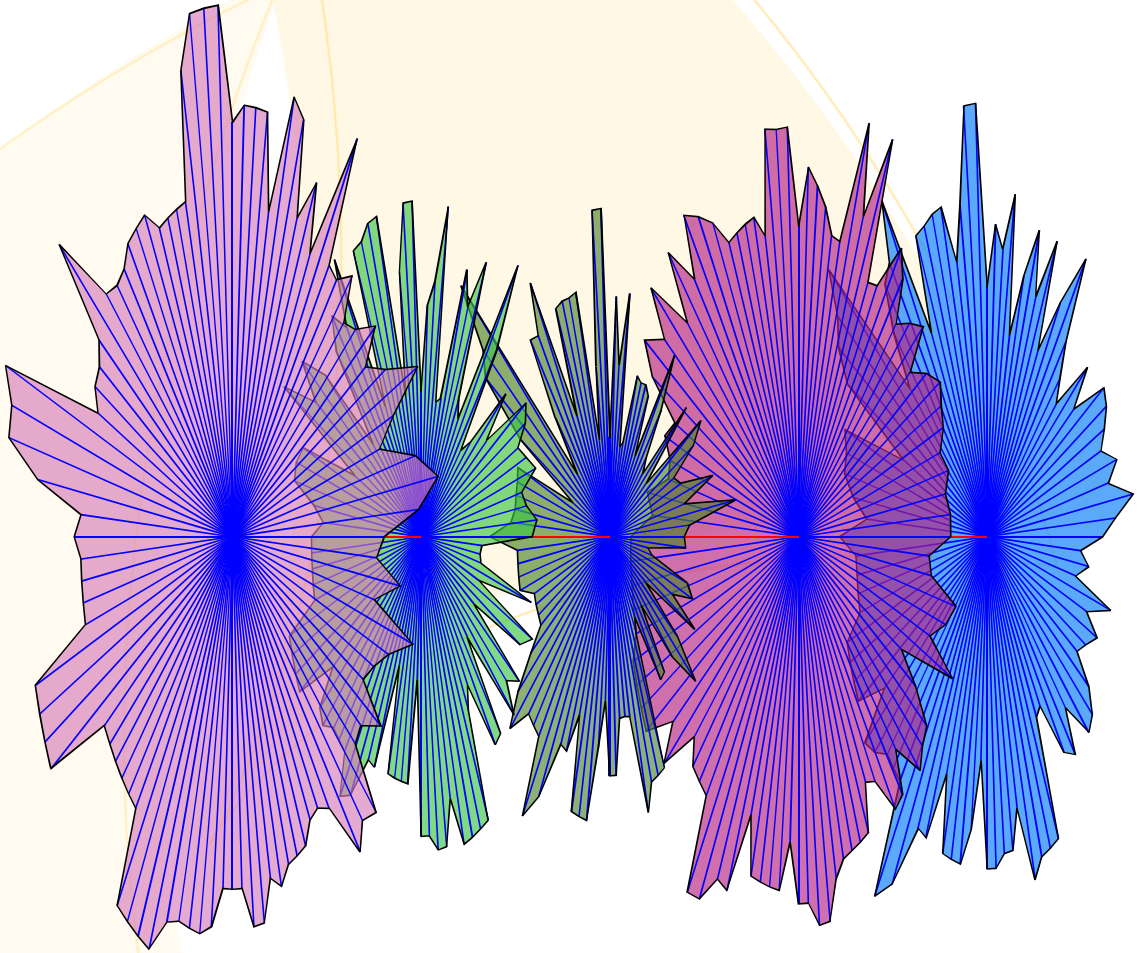
Unfolding Parallel Coordinates into Parallel Glyphs

- starting point:
  2D parallel coordinates
- inherent order of tuples
- move into 3D:
  - treat each tuple individually
  - rotate tuple's *x*-*y*-plane around pivot axis
  - angle of first to last tuple between 0º and 360º
  - tuple planes equally spaced
- result: 3D visualization

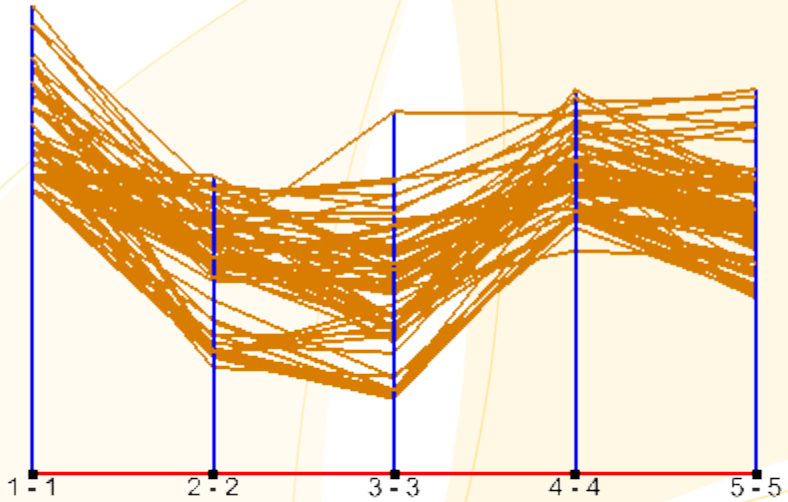


Parallel Glyphs = Parallel Coordinates + Star Glyphs

- full 360º unfolding: star glyphs emerge per dimension
- represent values for given dimension for all tuples
- 3D interactions
  - rotation around axes
  - translation, scaling
- transparency
- tuple polylines removed for better overview

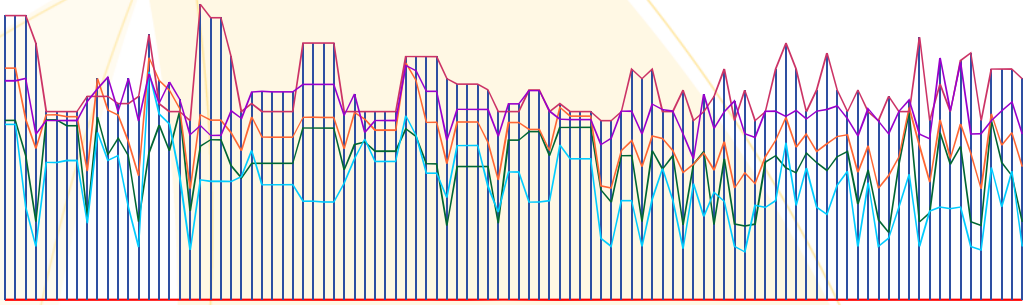


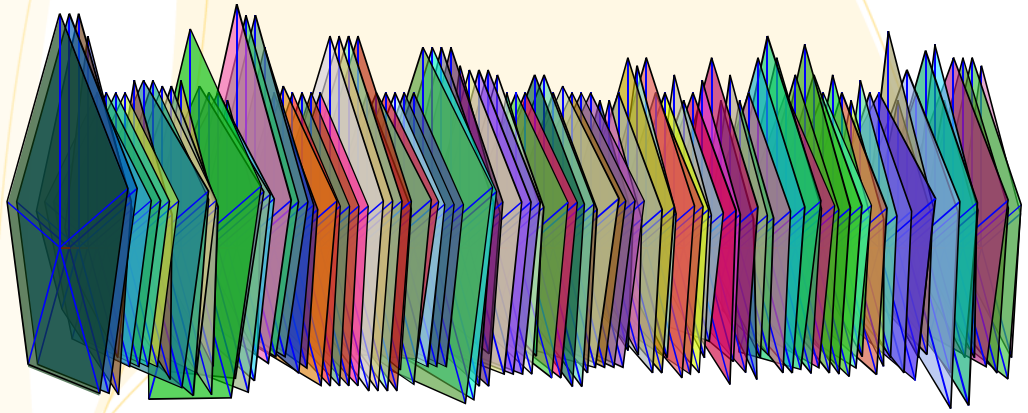
Video: Unfolding Parallel Glyphs and Interaction in 3D



Inverse Representation

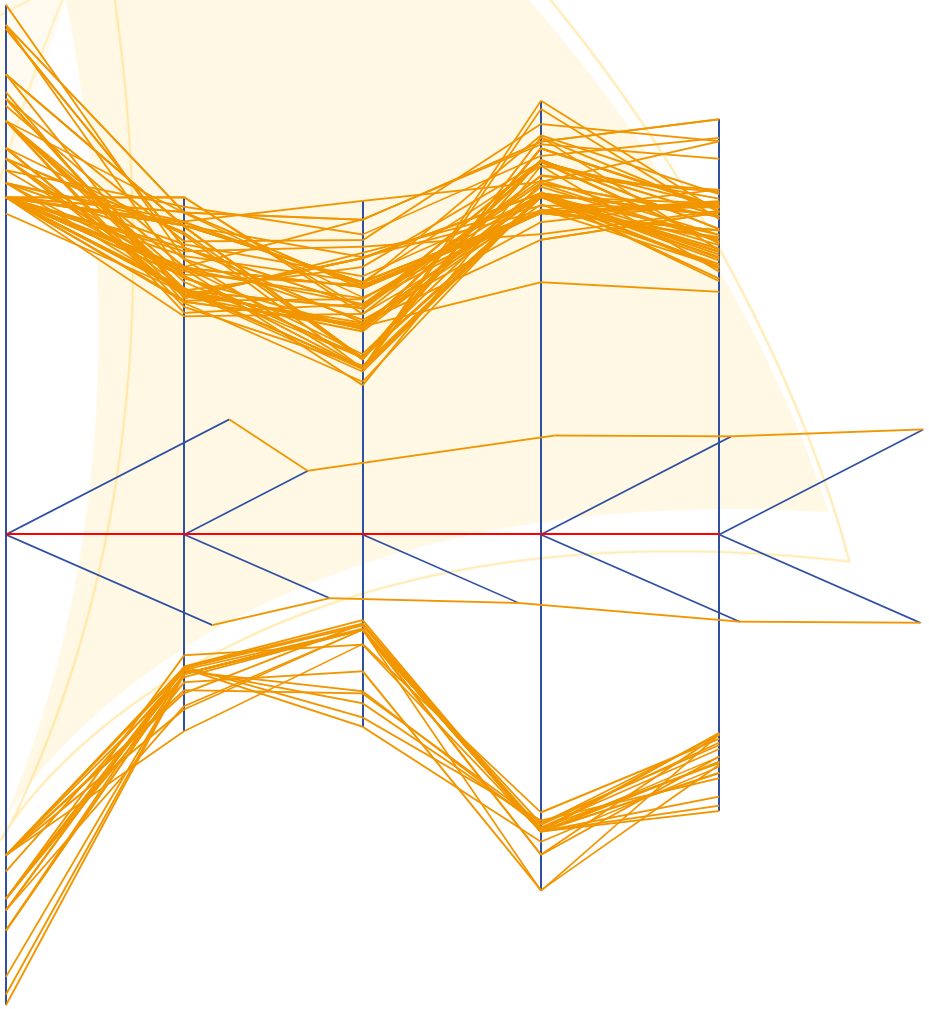
- tuples on *x*-axis of parallel coordinates (instead of dimensions)
- one star glyph represents one tuple with its values (instead of one dimension with values from all tuples)



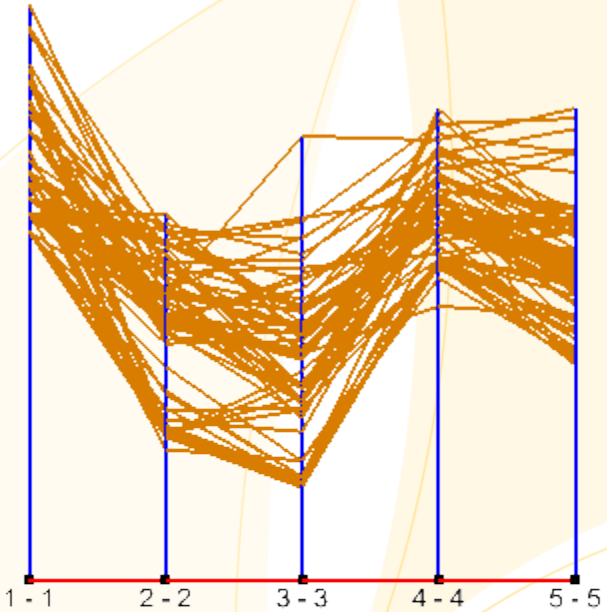


Interaction: Tuple Re-Ordering in 3D

- tuple re-ordering around pivot axis
- individually and grouped
- standard selection techniques (brushing etc.)
- focus+context mirrored views

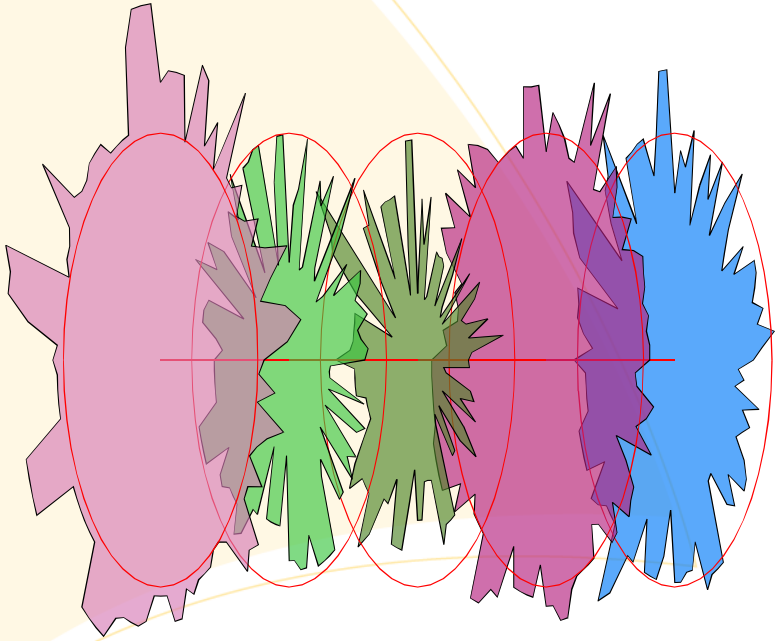


Video: Focus+Context Interaction

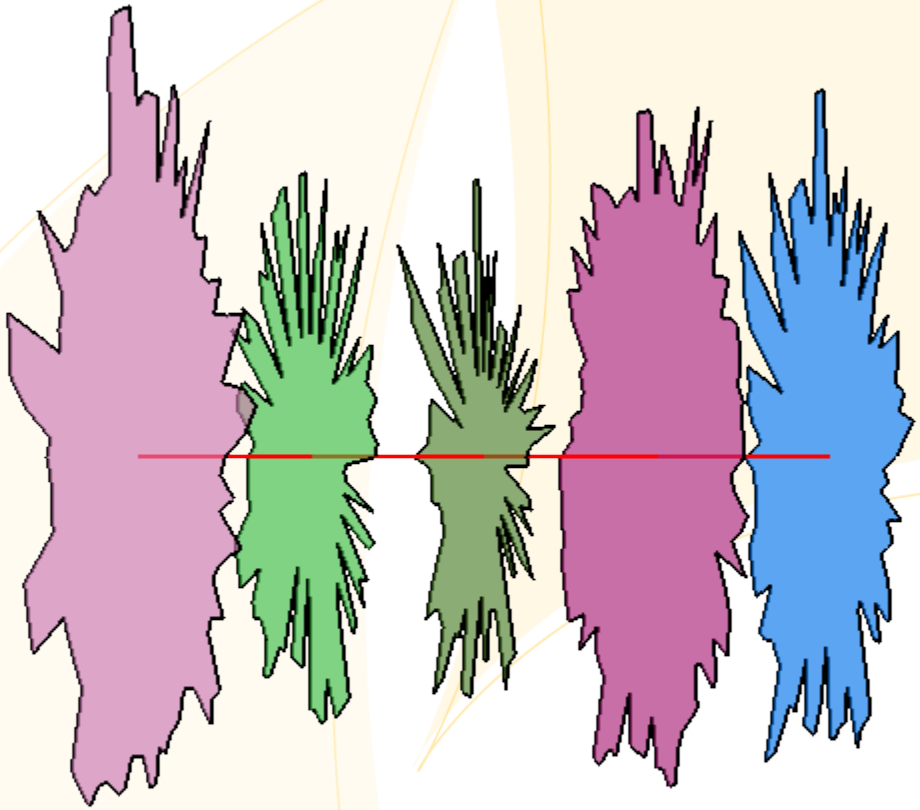


Ring Ruler Interaction

- perception of 3D lengths usually misleading
- orthographic projection
- ring ruler interaction
  - circle drawn onto glyph plane
  - centered on *x*-axis
  - parallel for all glyphs
- correct comparison of values
  - within a star glyph/dimension
  - across glyphs/dimensions if they are related

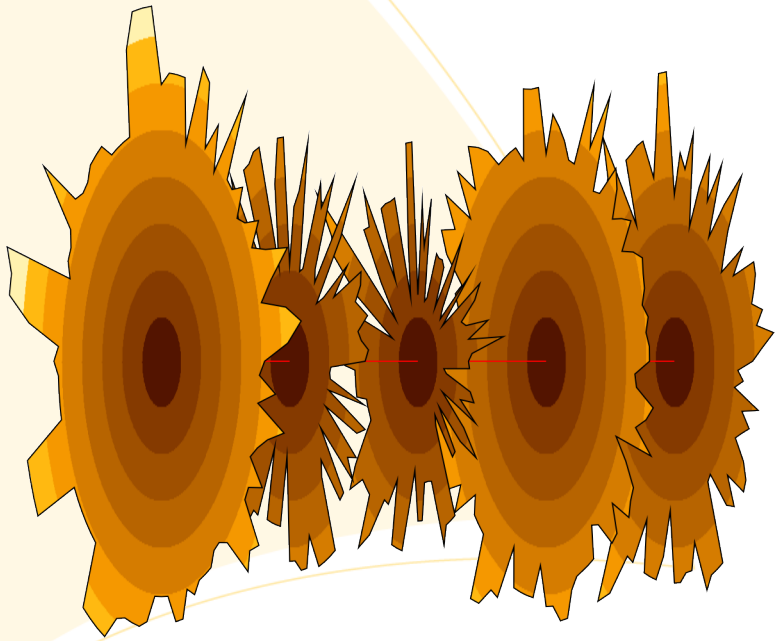


Video: Ring Ruler Interaction



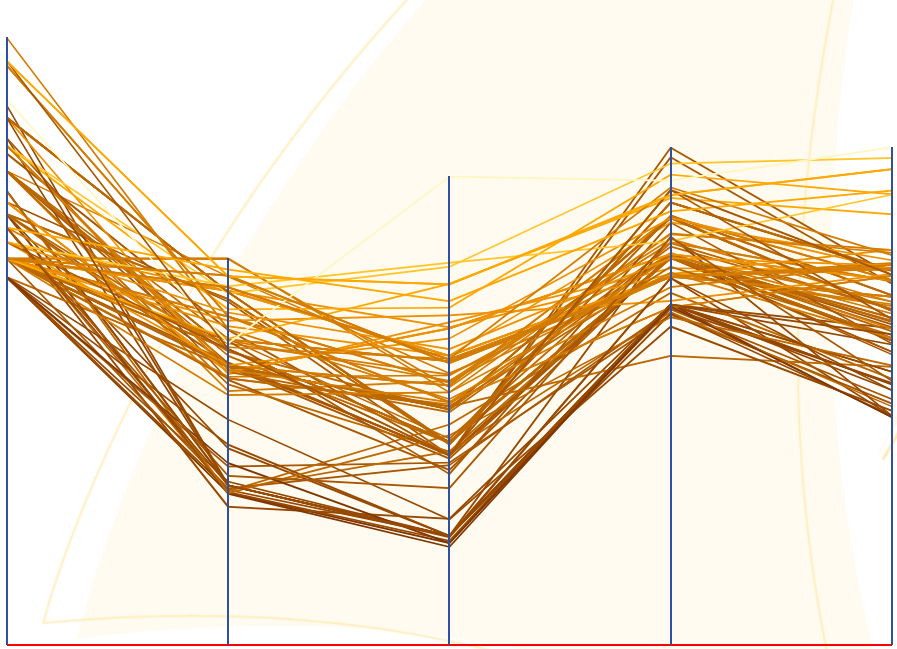
Color Scales for Measuring

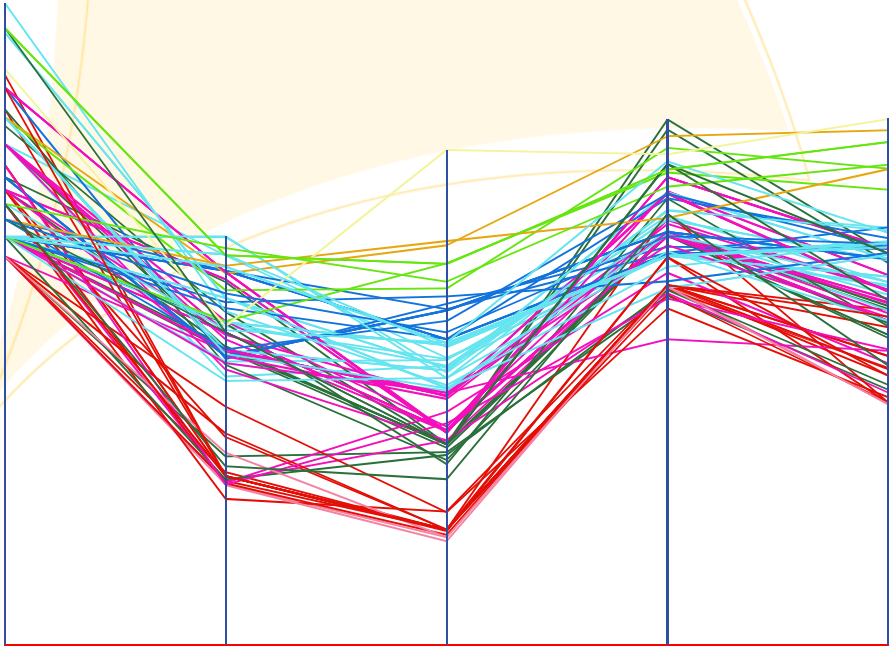
- comparison of values without interaction using color scales
- applied using texture mapping
- example scales [Levkowitz & Herman, 1992]:
  - heated
  - blue-to-yellow
  - blue-to-cyan
  - rainbow
  - optimized, etc.
- stepped color scales for better comparison



Colored Tuples

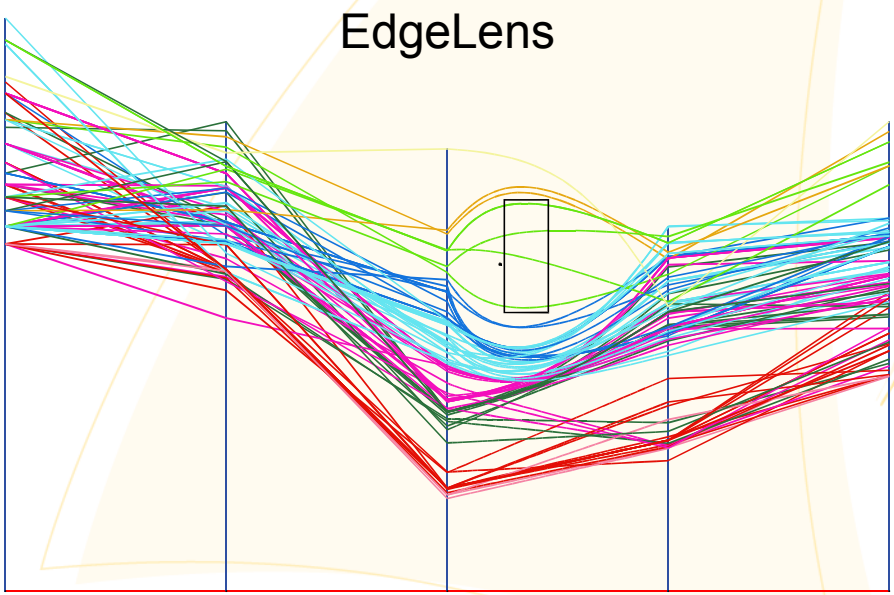
- propagation of color values from color scales to tuples
- depending on chosen pivot dimension
- uniform or stepped uniform scales not very appropriate
- stepped multi-color scale best for identifying trends

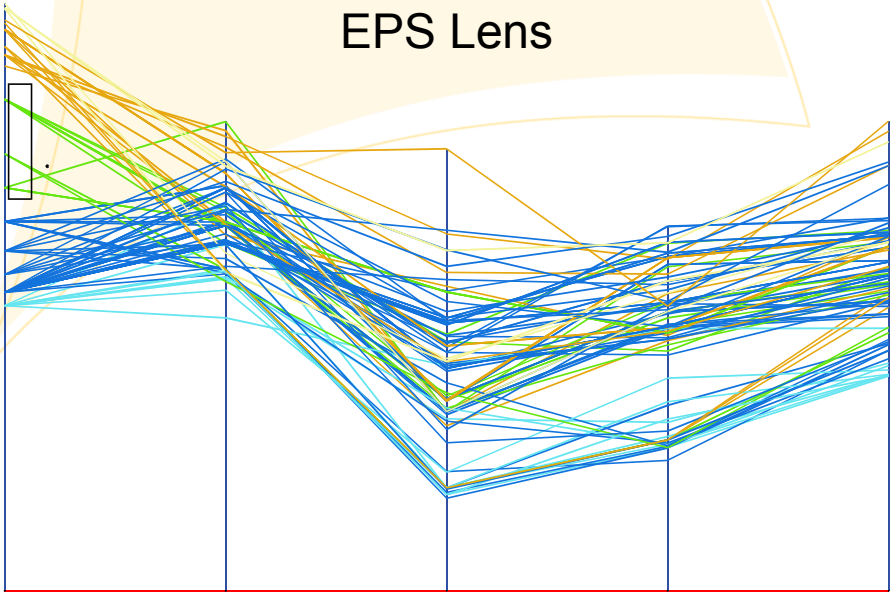




Lens Interaction

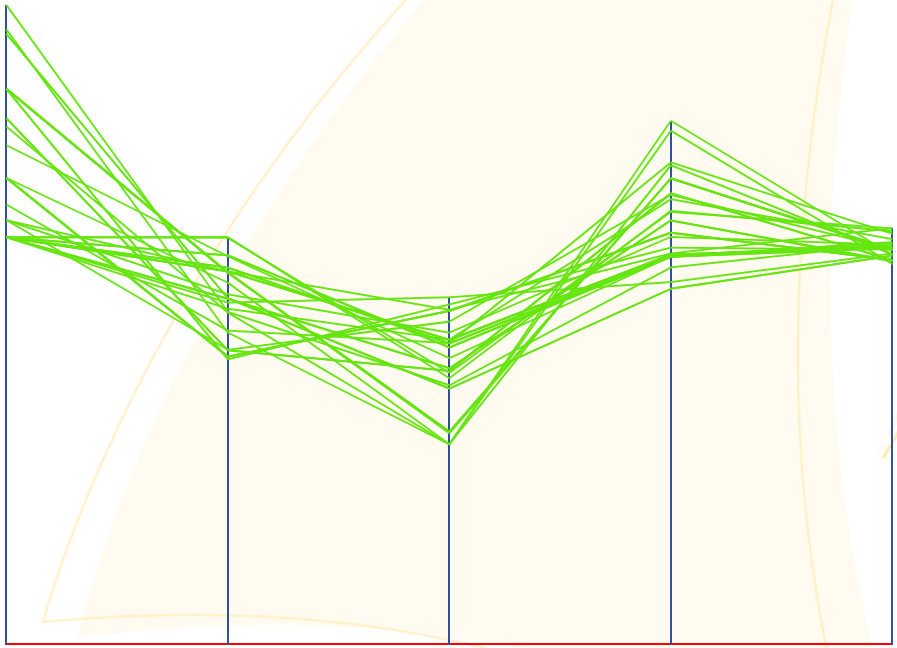
- lens techniques to interactively resolve visual cluttering
  - EdgeLens [Wong et al., 2003]
  - EPS Lens [Carpendale, 2001]

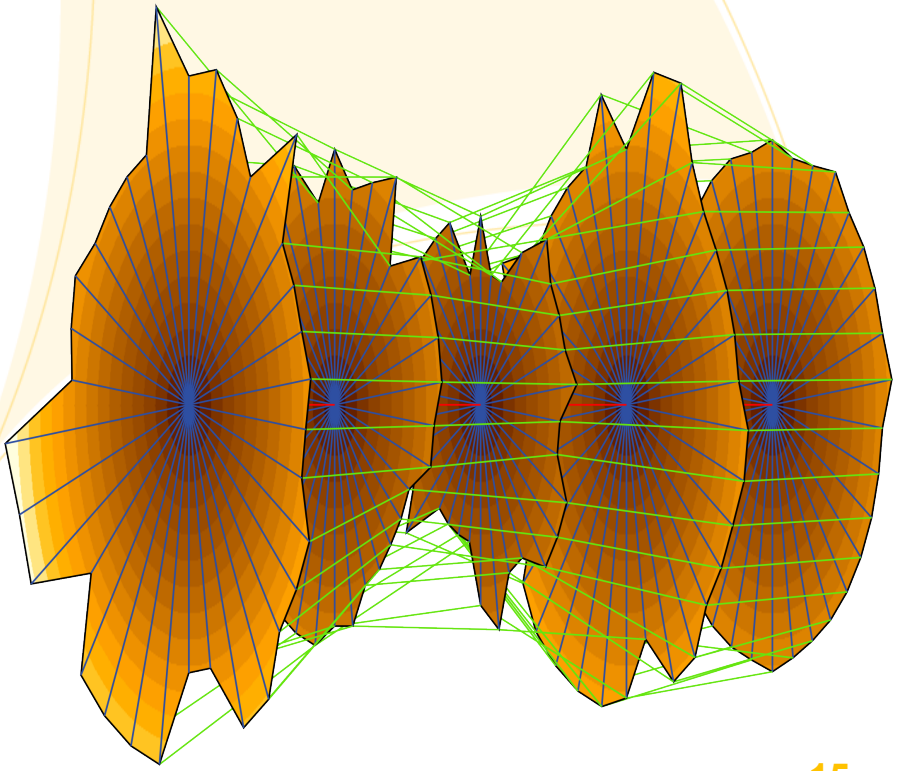




Selection of Data Subset

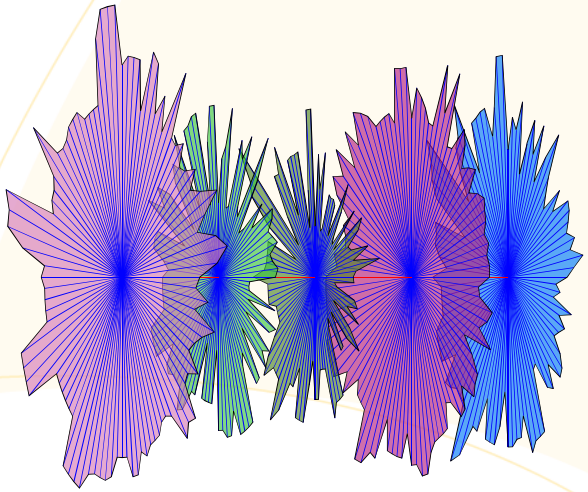
- data subset selection possible using standard techniques (with or without lens interaction)
- Parallel Glyph representation created for subset

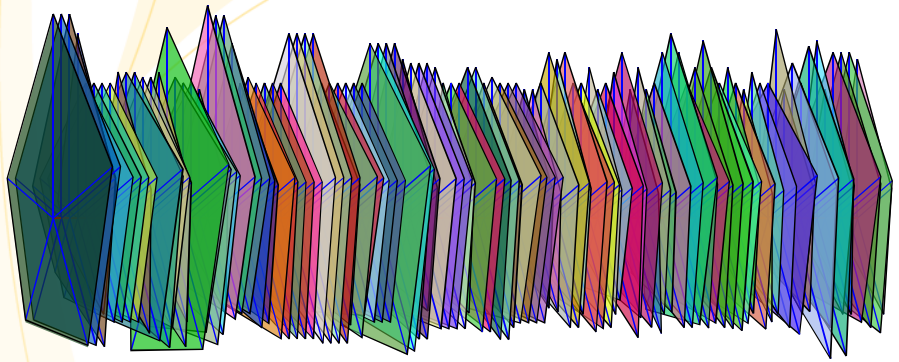




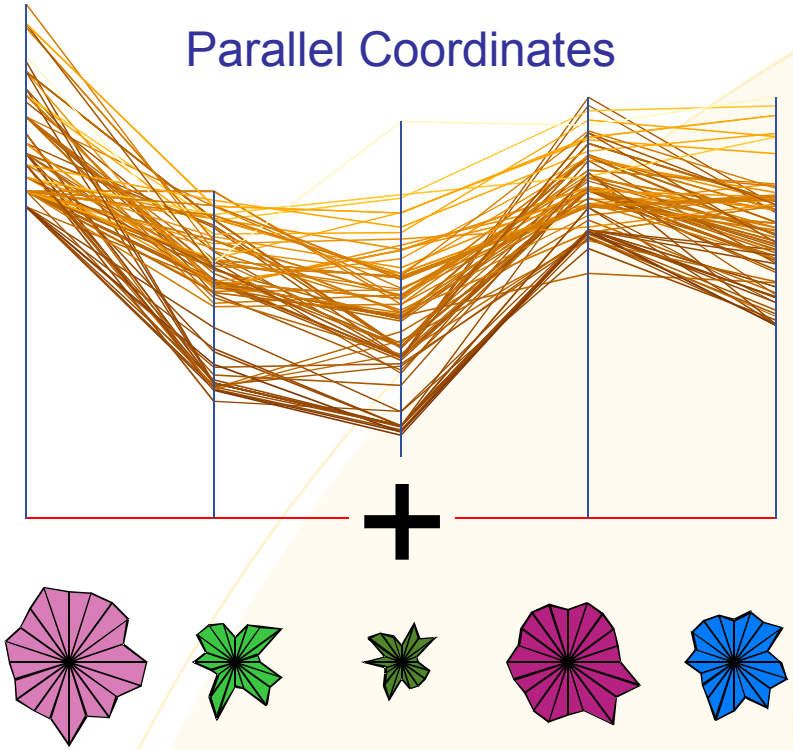
Summary & Future Work

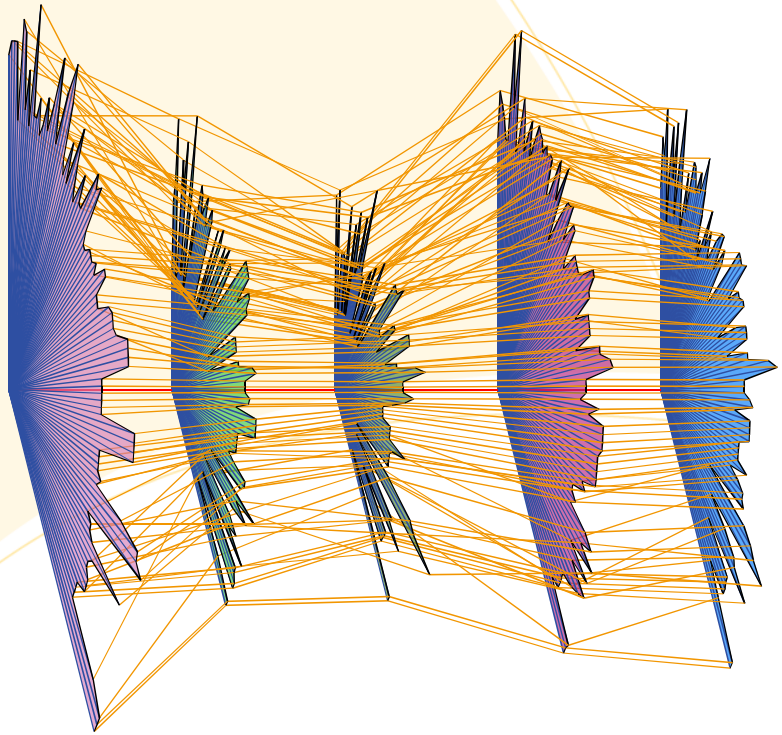
- Parallel Glyphs: 3D visualization combining parallel coordinates and star glyphs
- two inverse representations:
  - data objects over dimensions (regular parallel coordinates)
  - dimensions over data objects (regular star glyphs)
- color scales for comparisons and trends
- new and traditional interaction techniques





Thanks for your attention!





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