

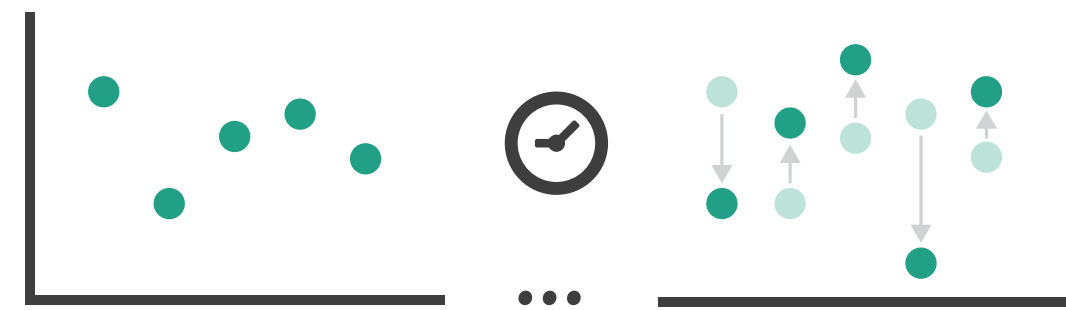
Data Visualization (CSCI 627/490)

Multiple Views & Filtering

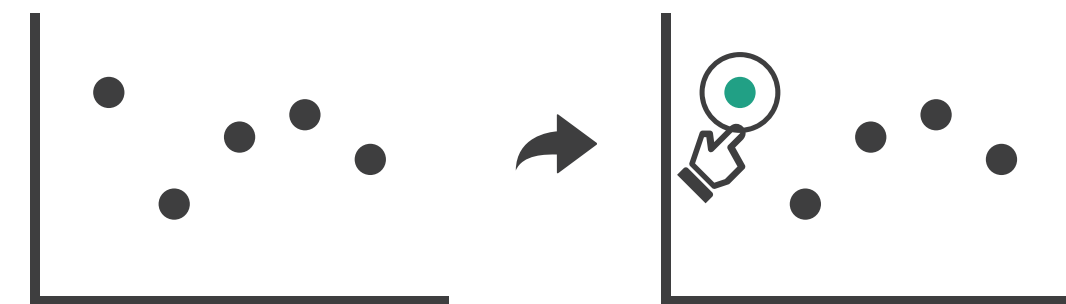
Dr. David Koop

Interaction Overview

➔ Change over Time



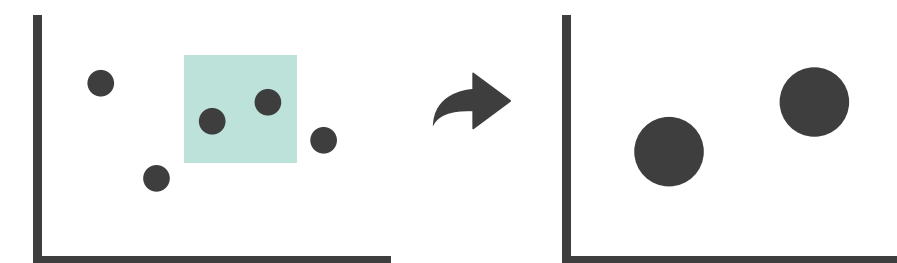
➔ Select



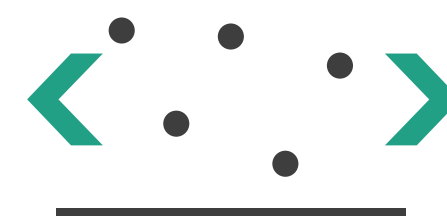
➔ Navigate

➔ Item Reduction

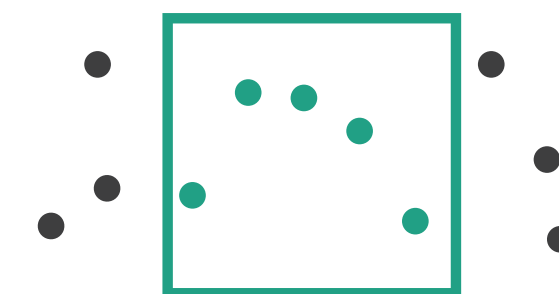
➔ Zoom
Geometric or *Semantic*



➔ Pan/Translate

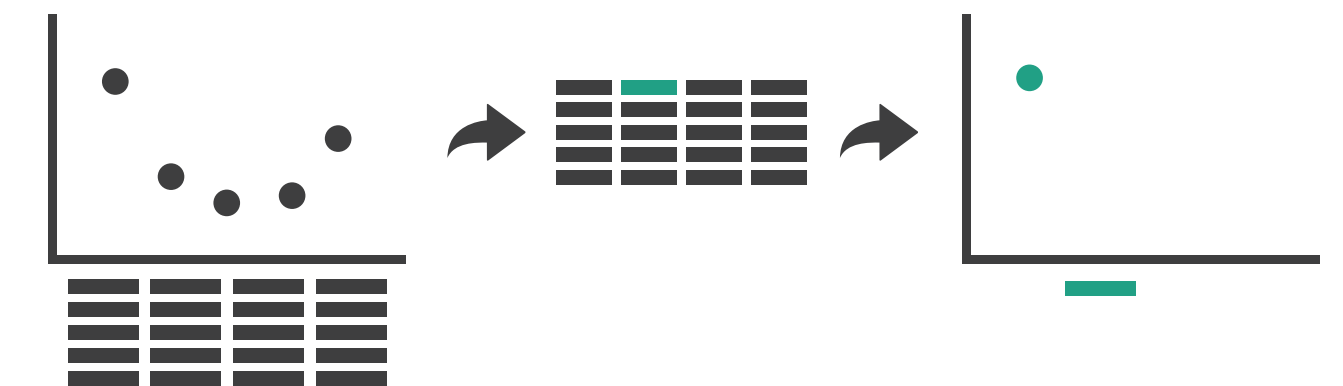


➔ Constrained

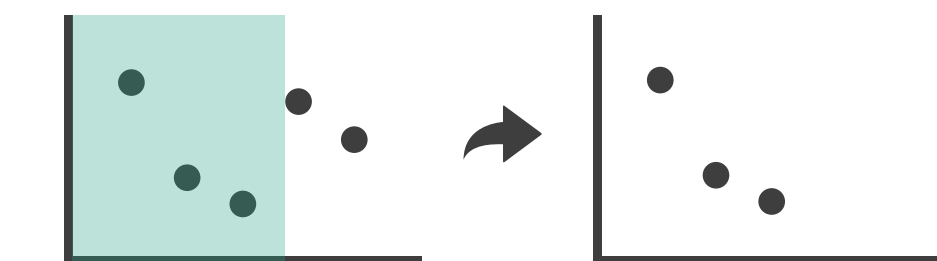


➔ Attribute Reduction

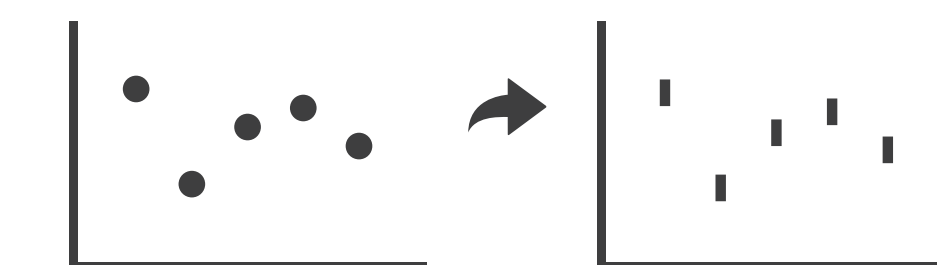
➔ Slice



➔ Cut

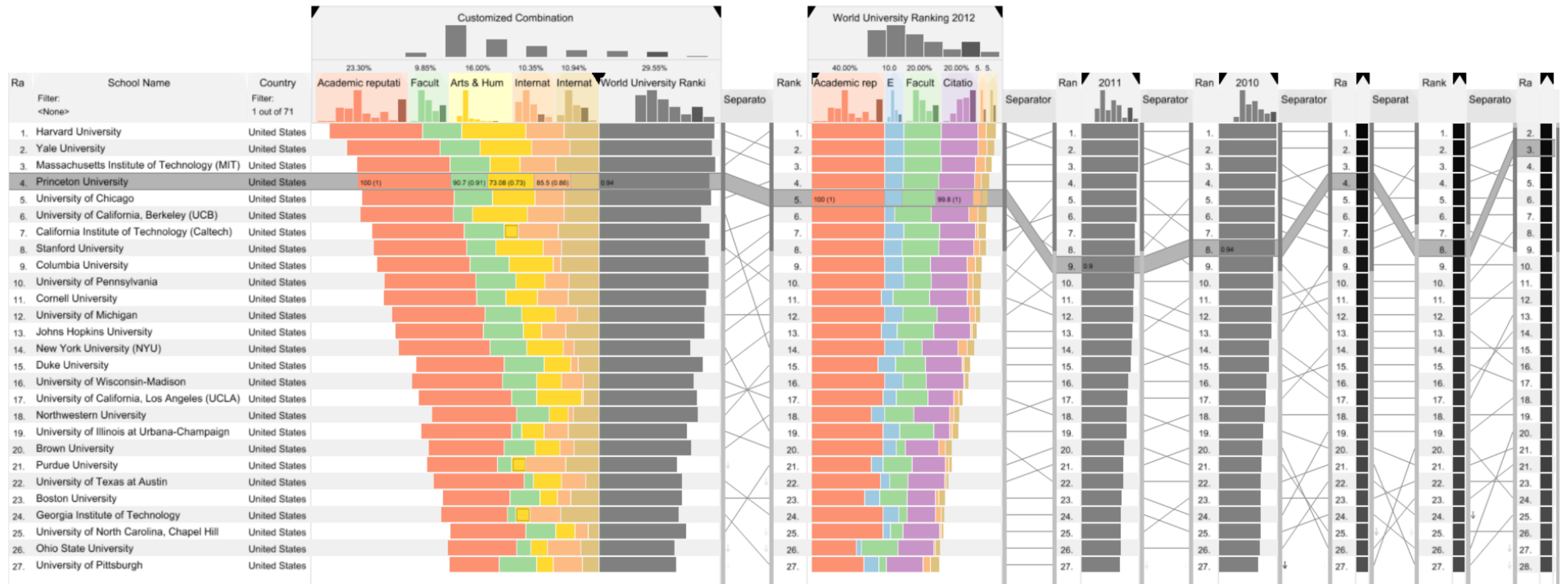


➔ Project



[Munzner (ill. Maguire), 2014]

Sorting & Slope Graphs: LineUp



[Gratzl et al., 2013]

Animation: Jump Cut vs. Animated Transitions

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Animation: Jump Cut vs. Animated Transitions

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Animation: Jump Cut vs. Animated Transitions

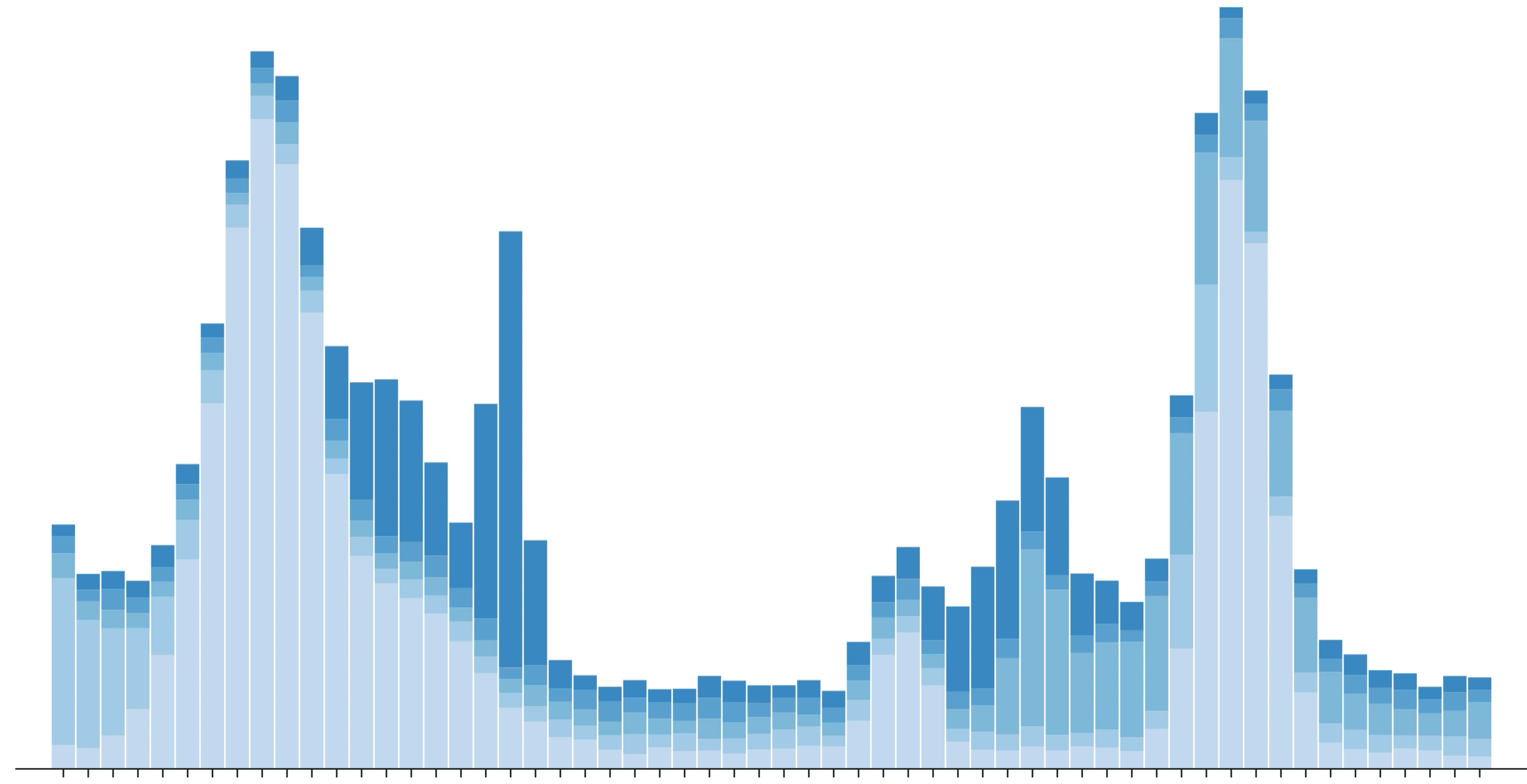
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Animated Transitions

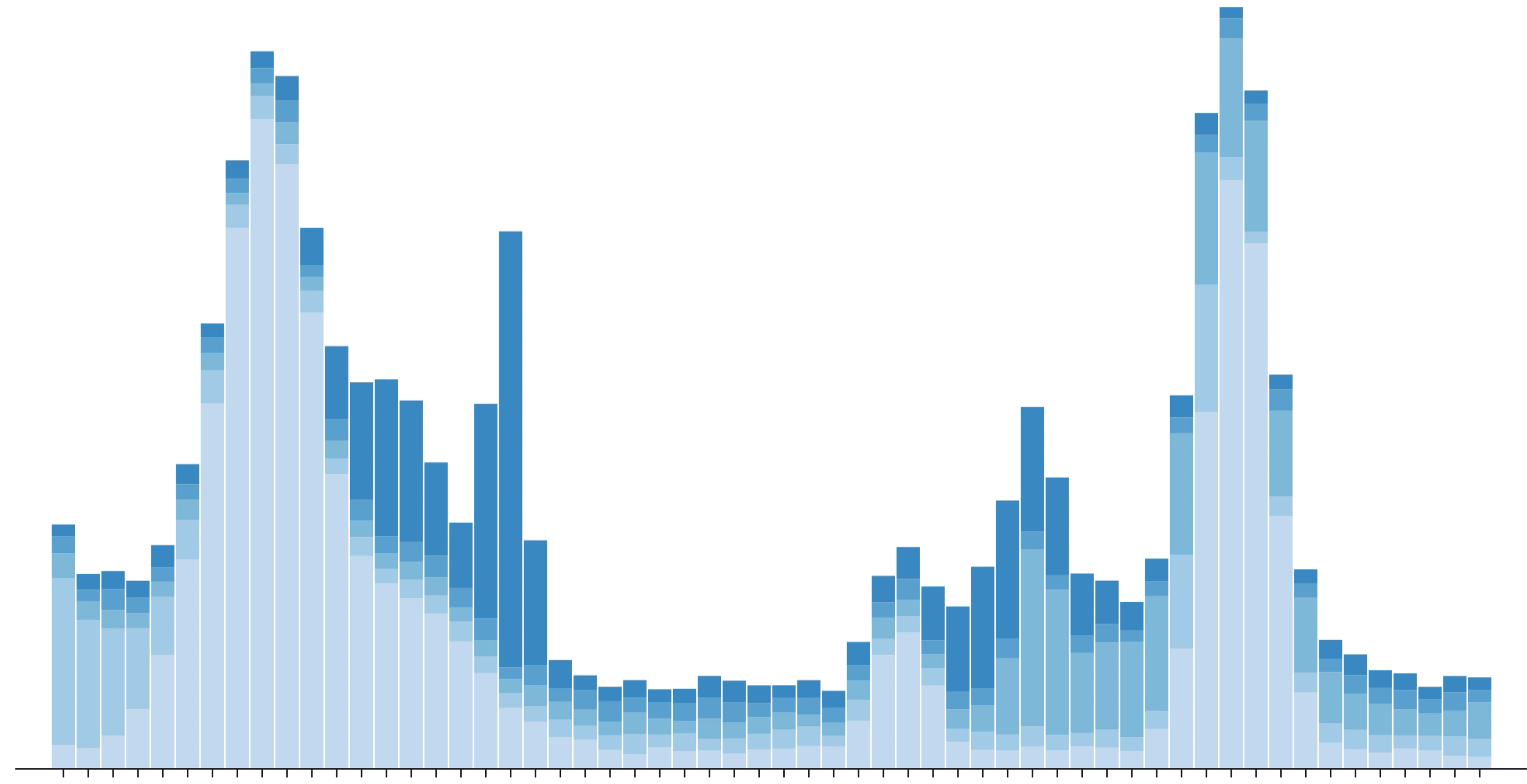
☐ Stacked ☒ Grouped



[M. Bostock]

Animated Transitions

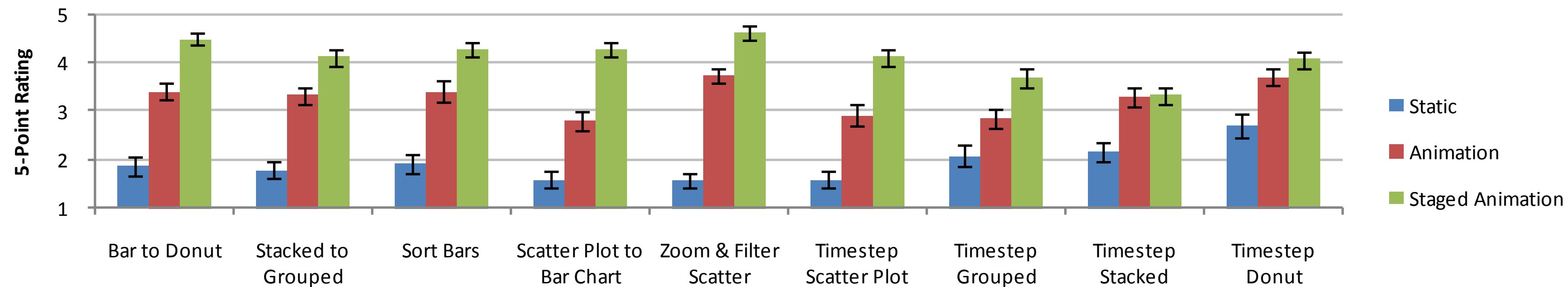
☐ Stacked ☒ Grouped



[M. Bostock]

Heer and Robertson Study

- User Preferences: Staged animation > animation > static transitions



- Animation improves graphical perception
- Staging is better (do axis rescaling before value changes)
- Avoid axis rescaling when possible

[Heer and Robertson, 2007]

Selection

- Selection is often used to initiate other changes
- User needs to select something to drive the next change
- What can be a selection target?
 - Items, links, attributes, (views)
- How?
 - mouse click, mouse hover, touch
 - keyboard modifiers, right/left mouse click, force
- Selection modes:
 - Single, multiple
 - Contiguous?

Highlighting

- Selection is the user action
- Feedback is important!
- How? Change selected item's visual encoding
 - Change color: want to achieve visual popout
 - Add outline mark: allows original color to be preserved
 - Change size (line width)
 - Add motion: marching ants



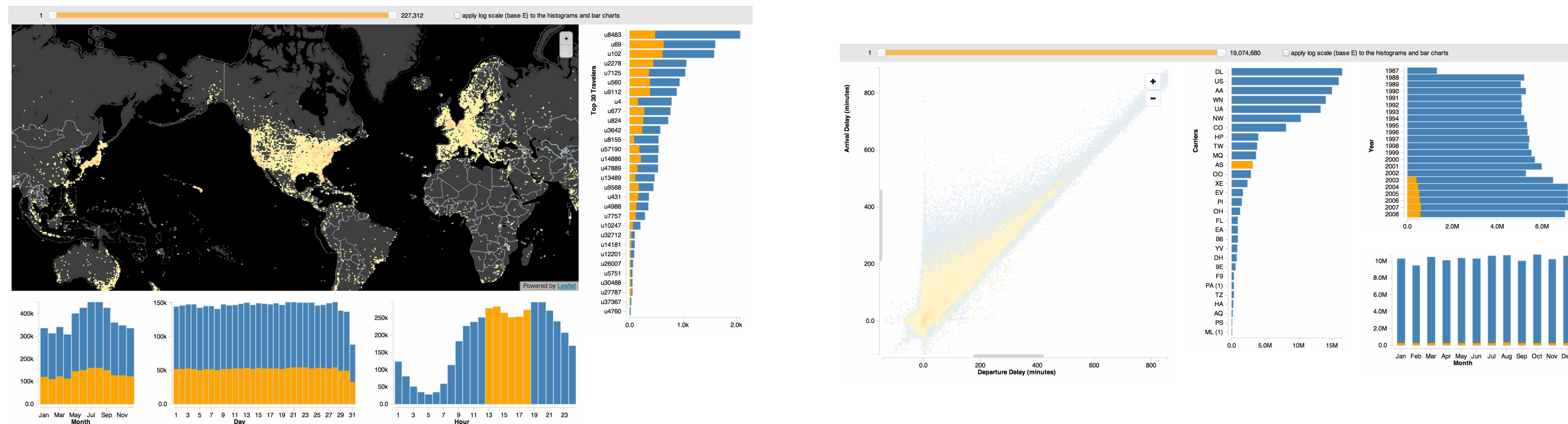
Highlighting

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Interaction Latency

- The Effects of Interactive Latency on Exploratory Visual Analysis, Z. Liu and J. Heer, 2014
- Brush & link, select, pan, zoom



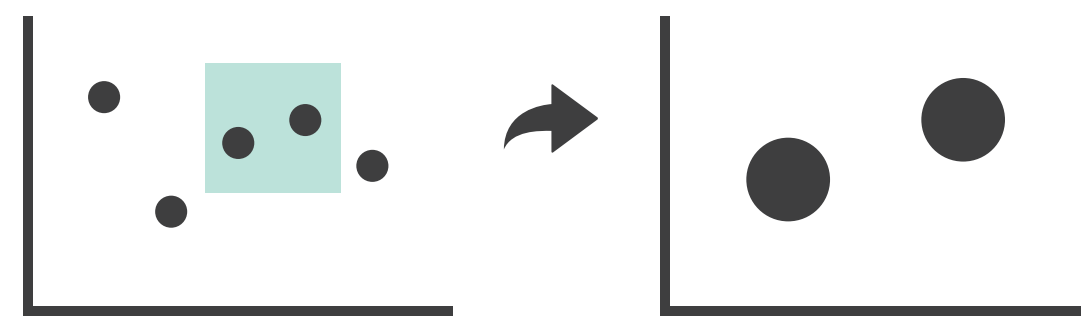
- 500ms added latency causes significant cost
 - decreases user activity and dataset coverage
 - reduces rate of observations, generalizations, and hypotheses

Navigation

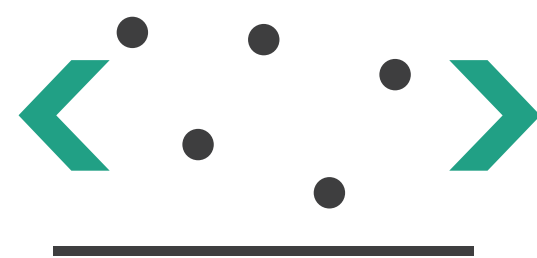
→ Item Reduction

→ Zoom

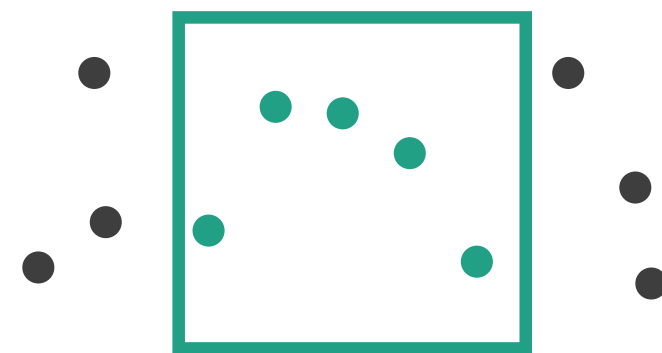
Geometric or *Semantic*



→ Pan/Translate



→ Constrained

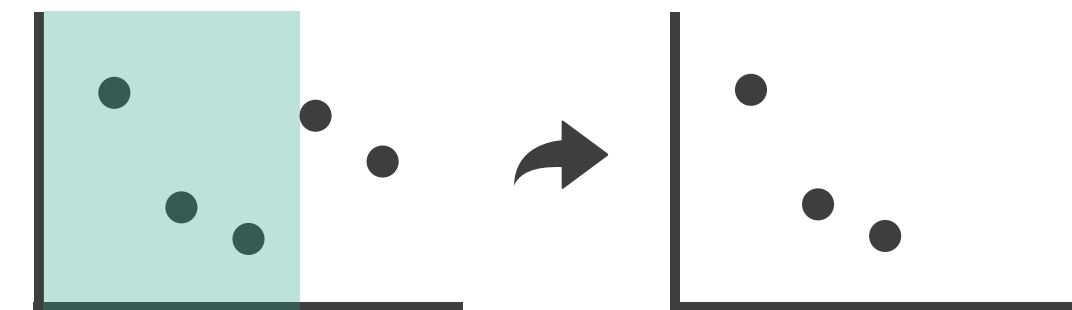


→ Attribute Reduction

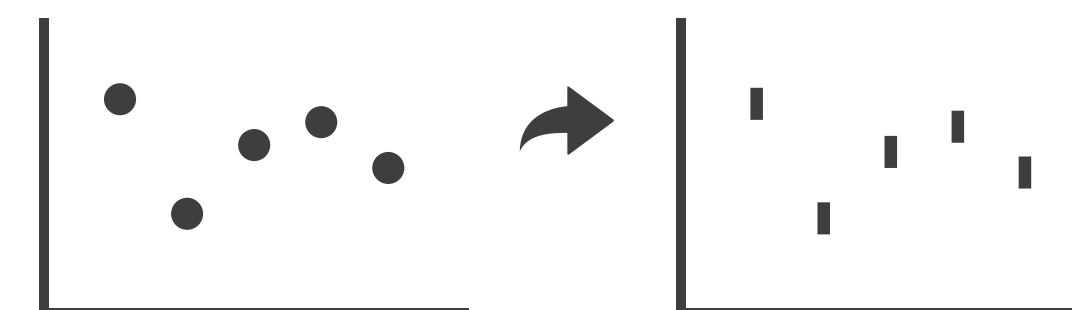
→ Slice



→ Cut



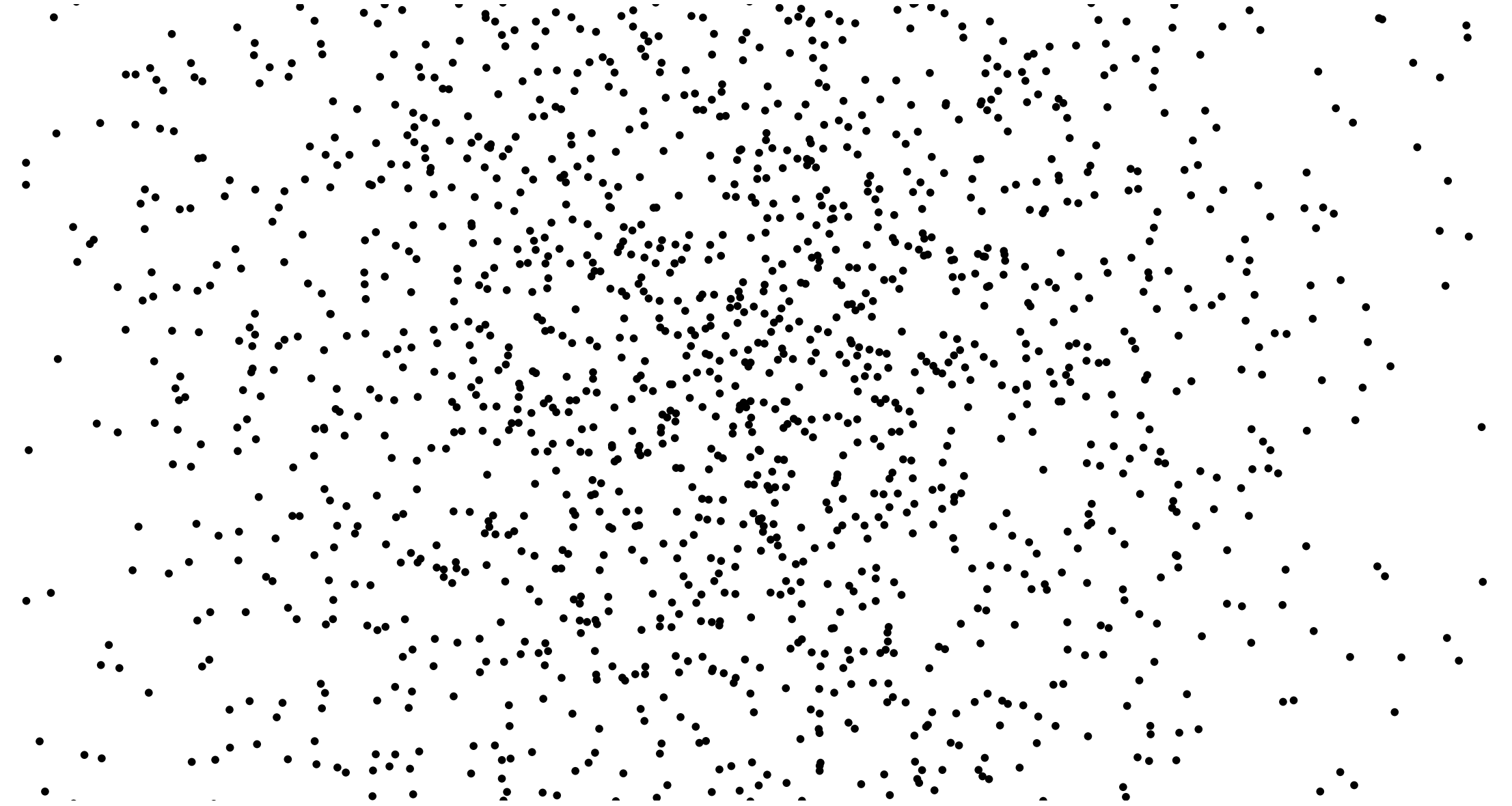
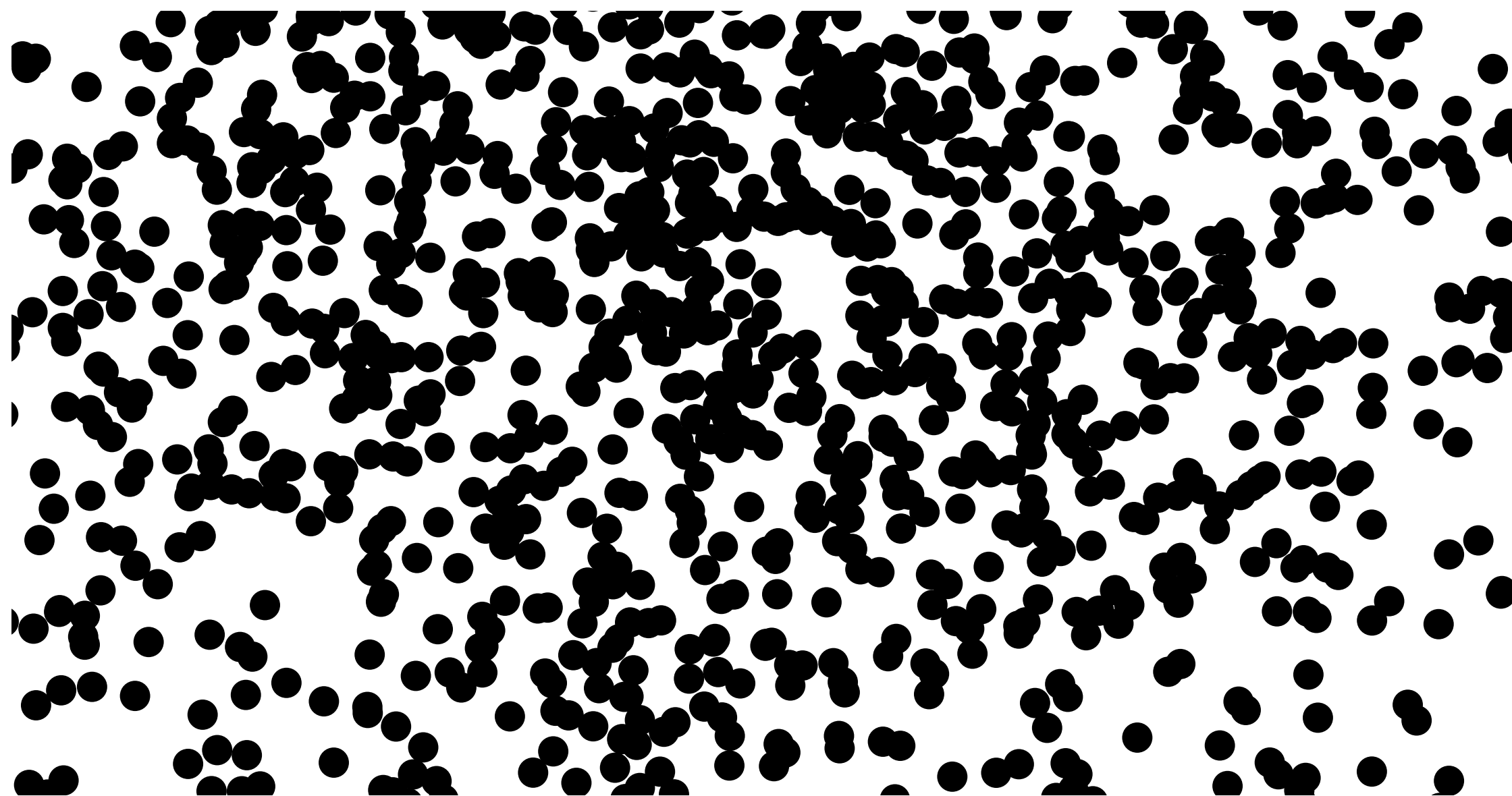
→ Project



[Munzner (ill. Maguire), 2014]

Geometric vs. Semantic Zooming

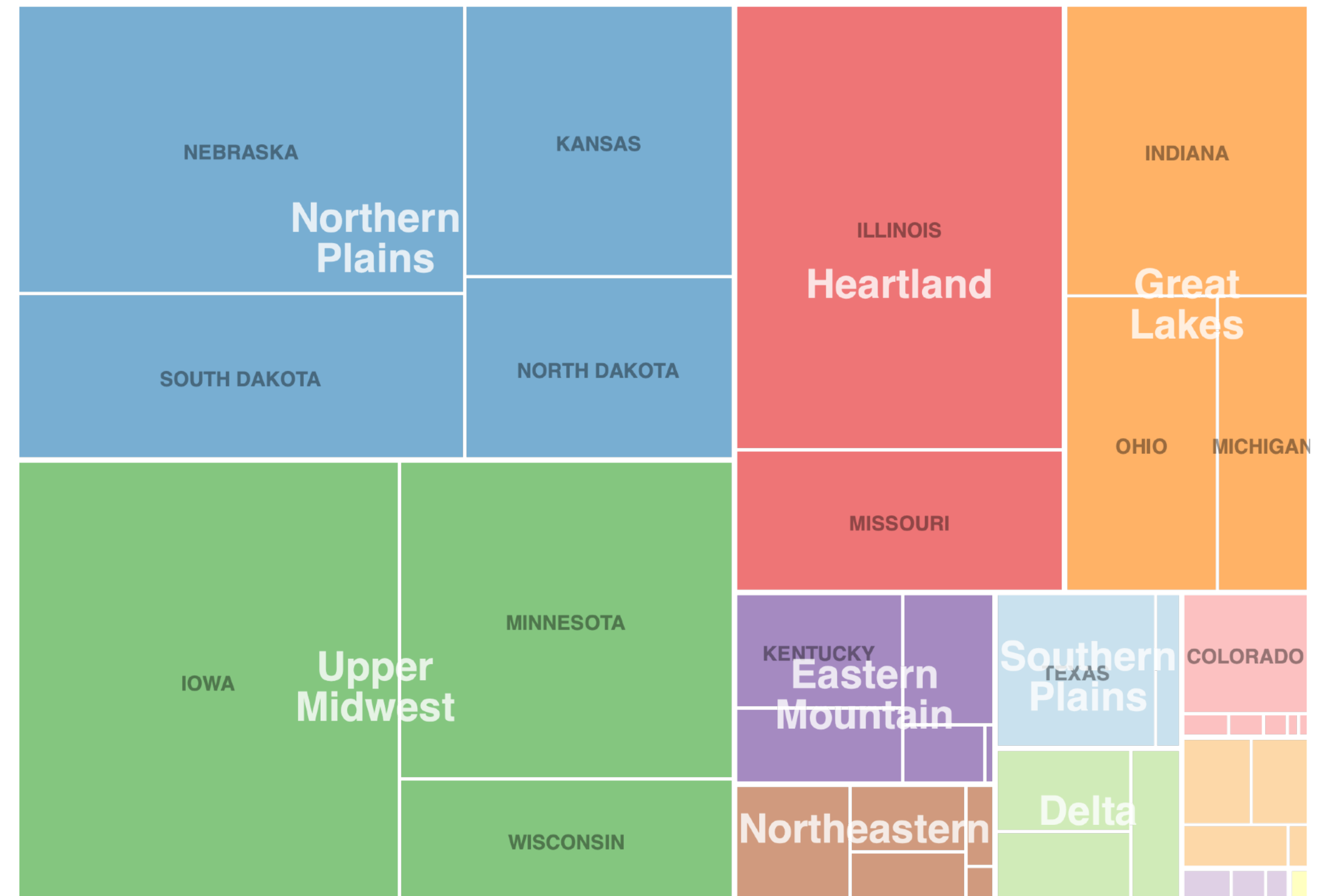
- Geometric zoom: like a camera
- Semantic zoom: visual appearance of objects can change at different scales



[M. Bostock]

Assignment 4

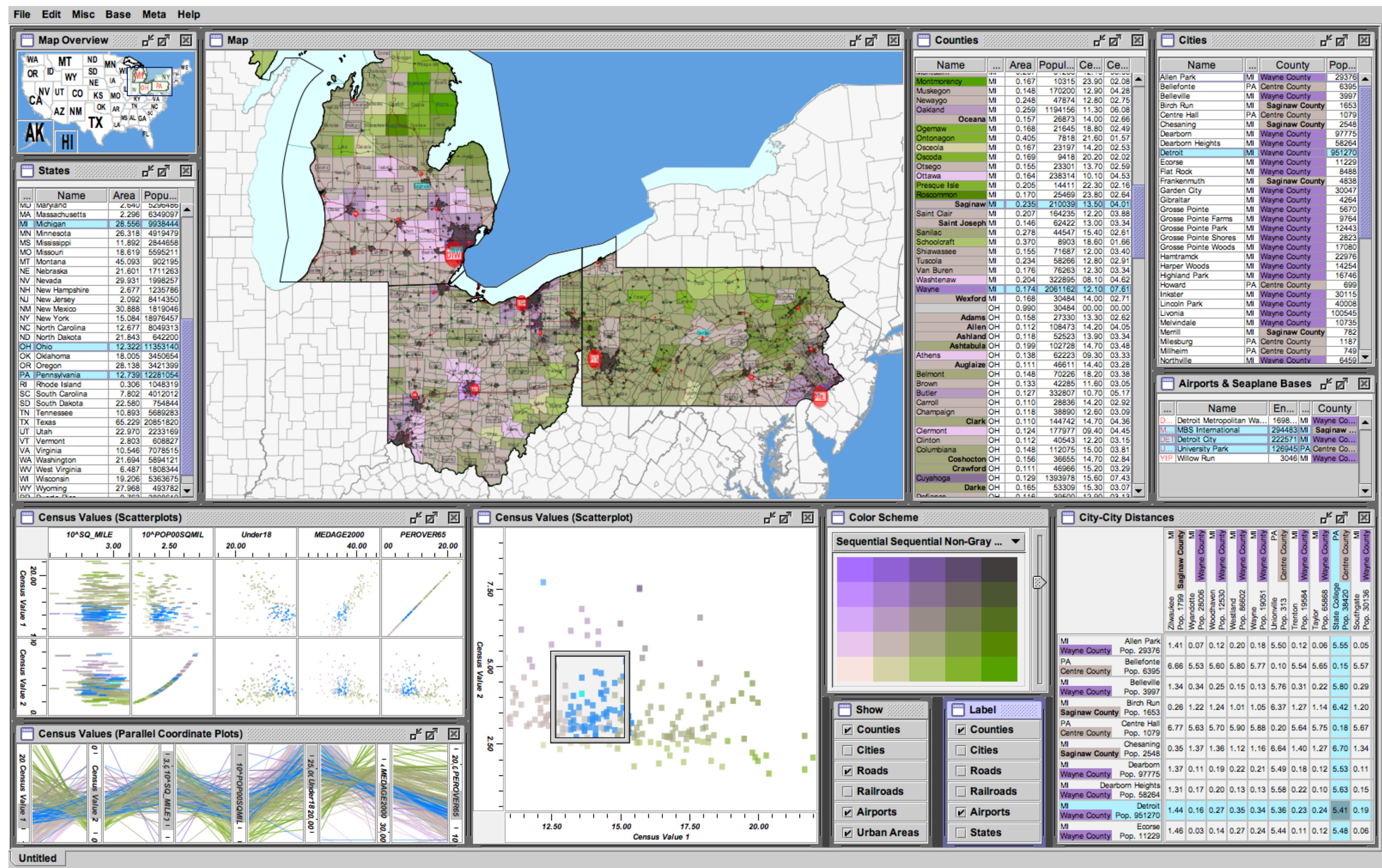
- Geospatial Visualizations & Treemap
 - Choose colormaps carefully
 - Add legend
- Choropleth Example can be useful for Part 2 but build from Part 1



Project Design

- Feedback:
 - Data Manipulation?
 - Questions lead, not technique!
 - Be creative! (interaction too) <https://xeno.graphics>
- Work on turning your visualization ideas into designs
- Turn in:
 - Three Designs Sketches, including one bad design
 - One Bad Design
 - Progress on Implementation
- Due Wed., Nov. 9

Multiple Views



[Improvise, Weaver, 2004]

Multiple Views

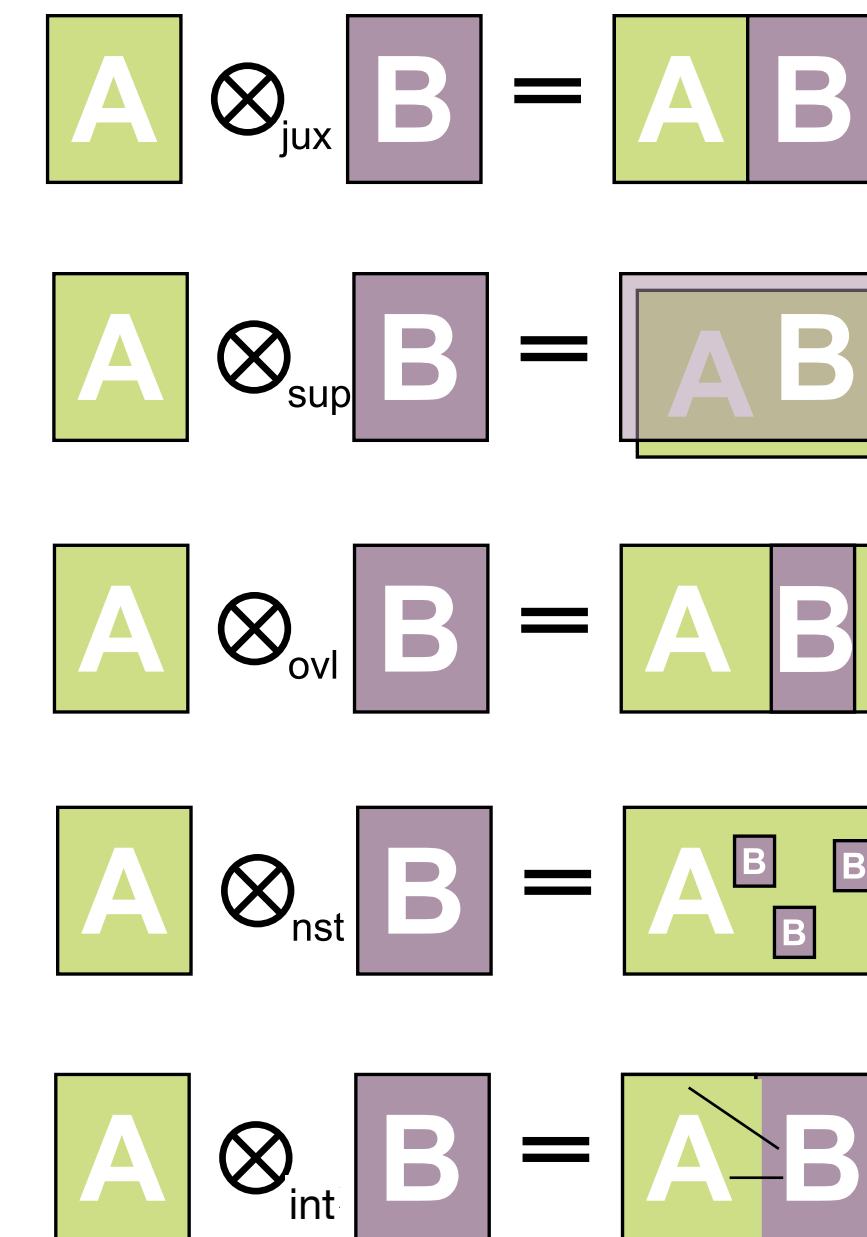
- Why have just one visualization?
- Sometimes data is best examined in more than one view
 - Clutter/visual overload
 - Different attributes (cannot show all attributes in one view)
 - Different scales (task requires overview or detail)
 - Different encodings (no single encoding is optimal for all tasks)
- Eyes Beat Memory (Ch. 6)
 - Aiding working memory:
side-by-side/layers > animated > jump cuts
 - Showing all visual elements at once → don't need to remember

Multiple Views

- Big questions:
 - How to partition display or layer views?
 - How to coordinate views (e.g. navigation, selection)?
 - What data is shared?

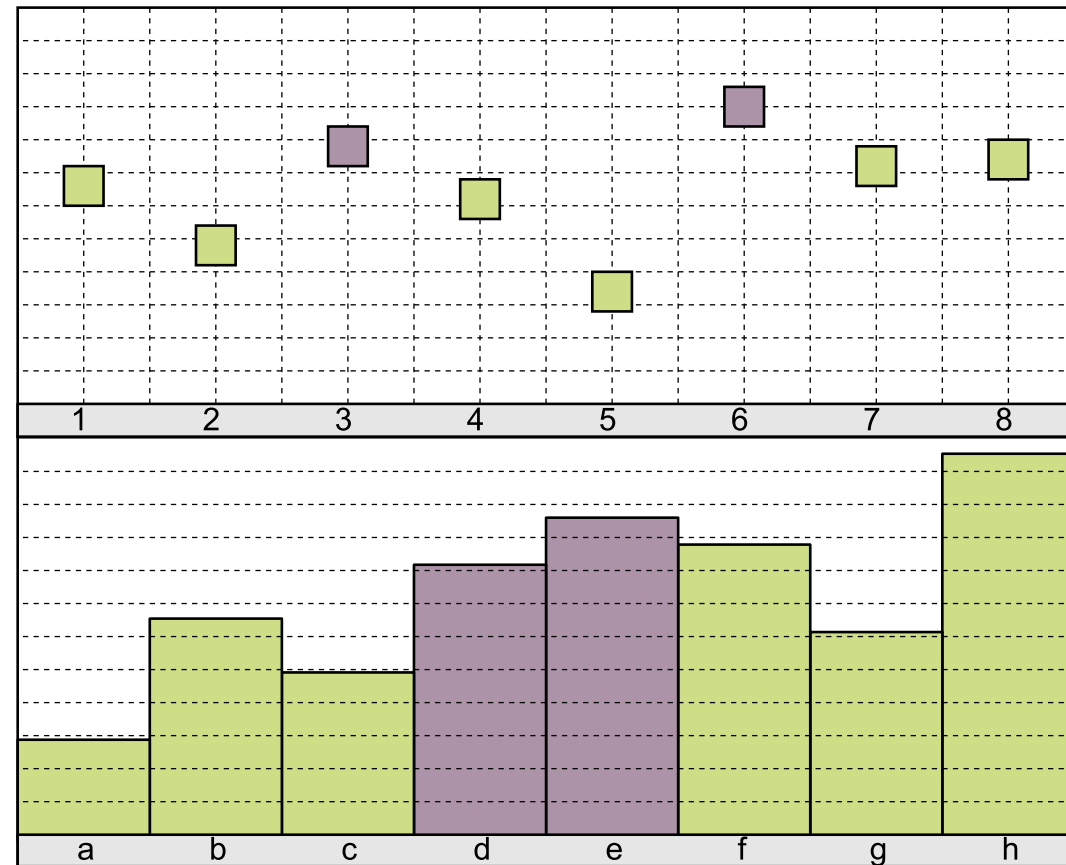
Design Space of Composite Visualization

- Composite visualization views (CVVs)
 - Includes Coordinated multiple views (CMV)
 - + More!
- Design Patterns:
 - Juxtaposition: side-by-side
 - Superimposition: layers
 - Overloading: vis meshed with another
 - Nesting: vis inside a vis (recursive vis)
 - Integration: "merge" views + links

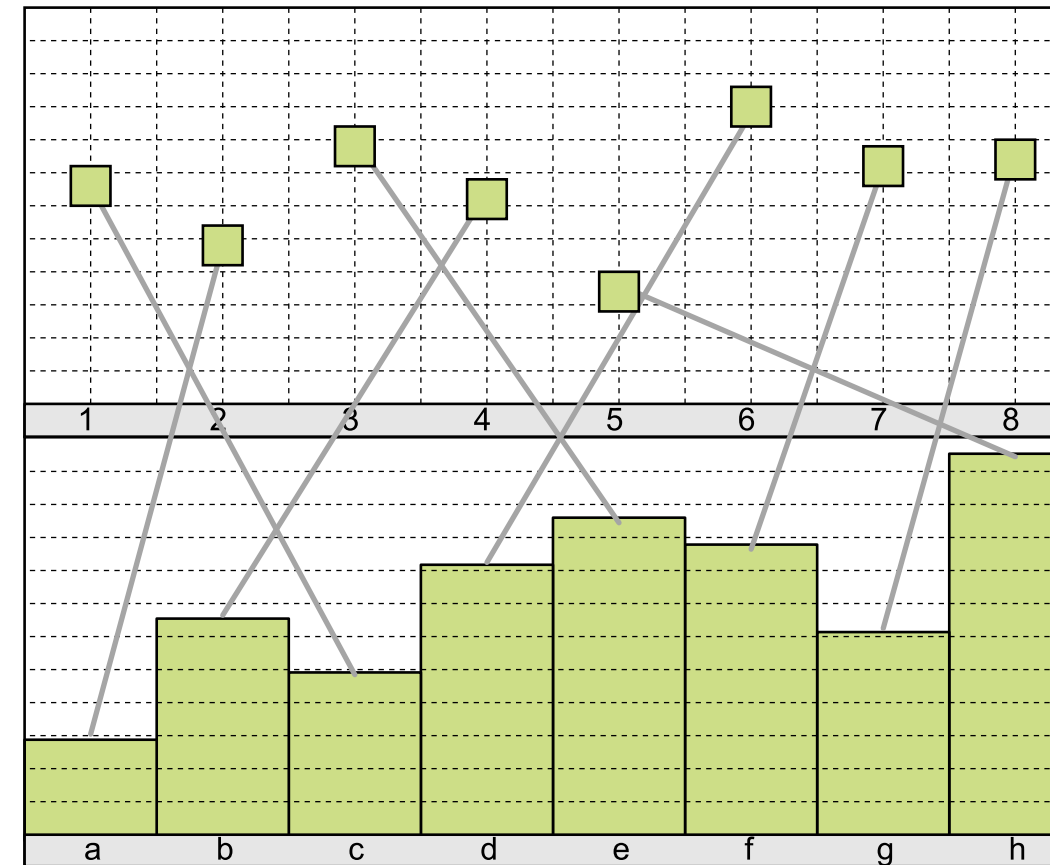


[W. Javed and N. Elmqvist, 2012]

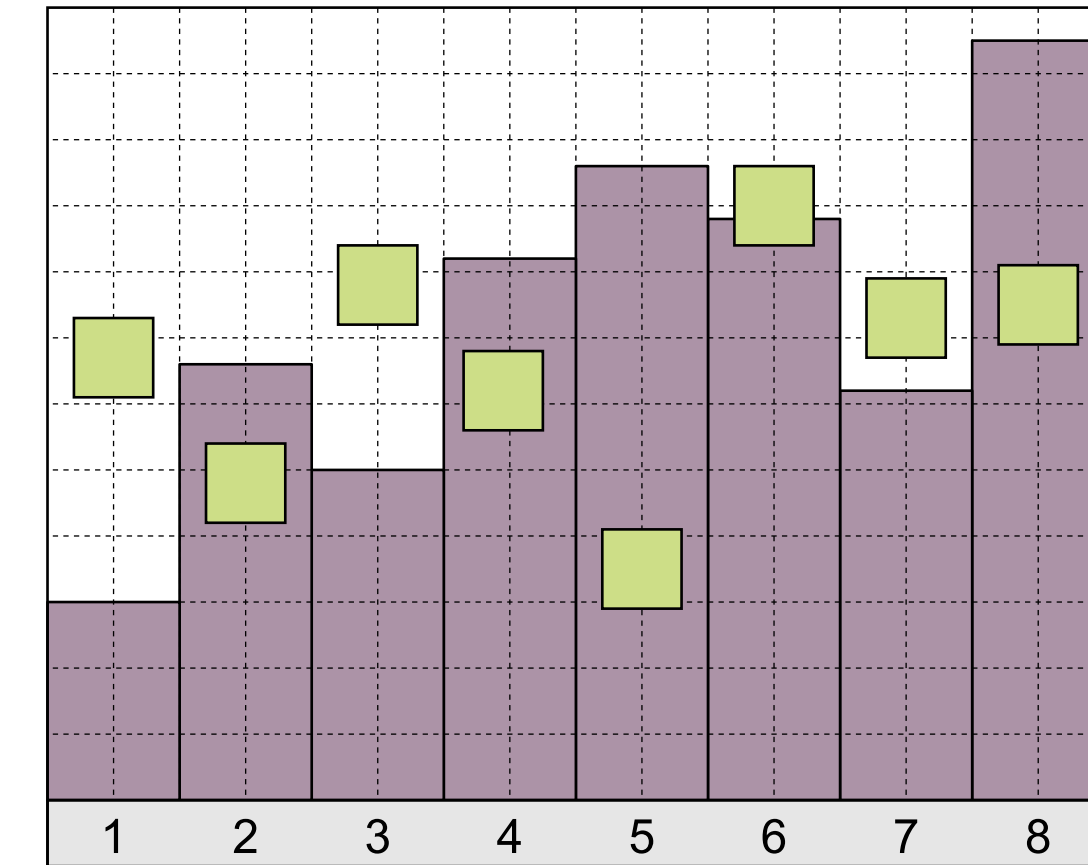
Composite Visualization Techniques



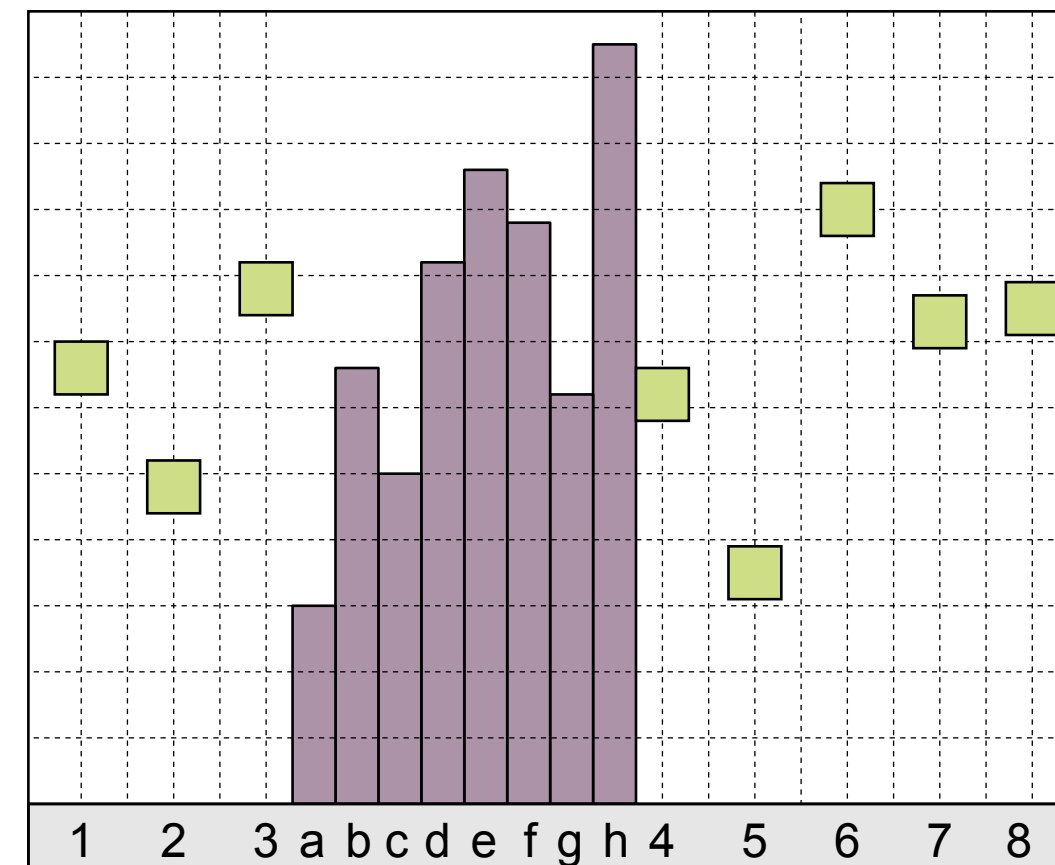
(a) Juxtaposed views.



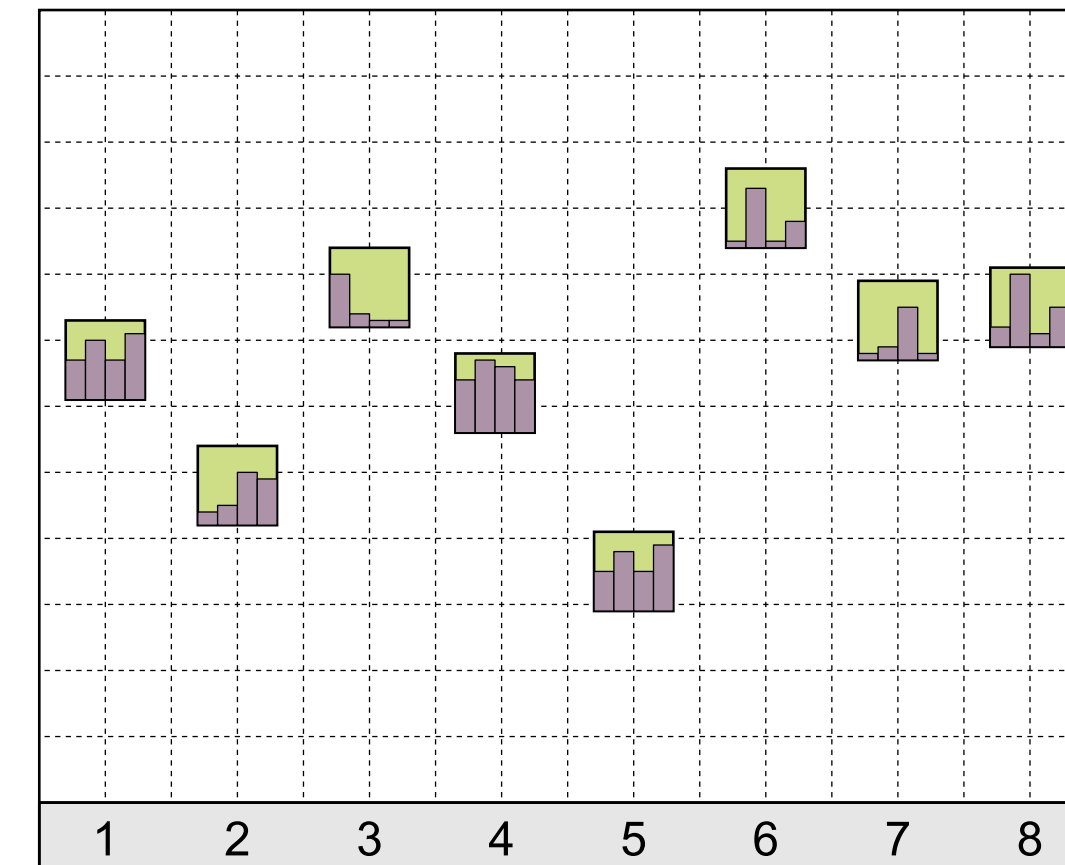
(b) Integrated views.



(c) Superimposed views.



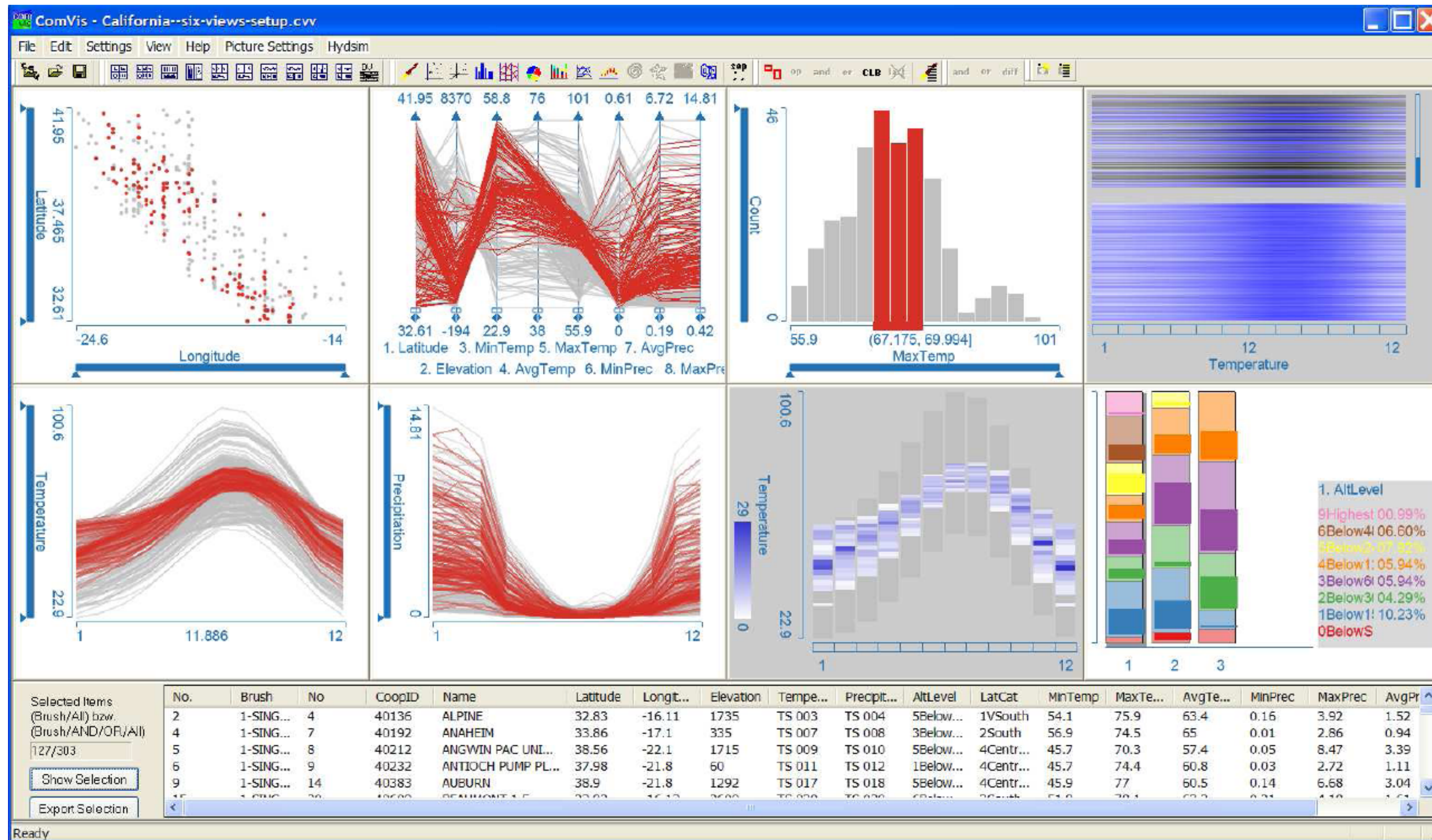
(d) Overloaded views.



(e) Nested views.

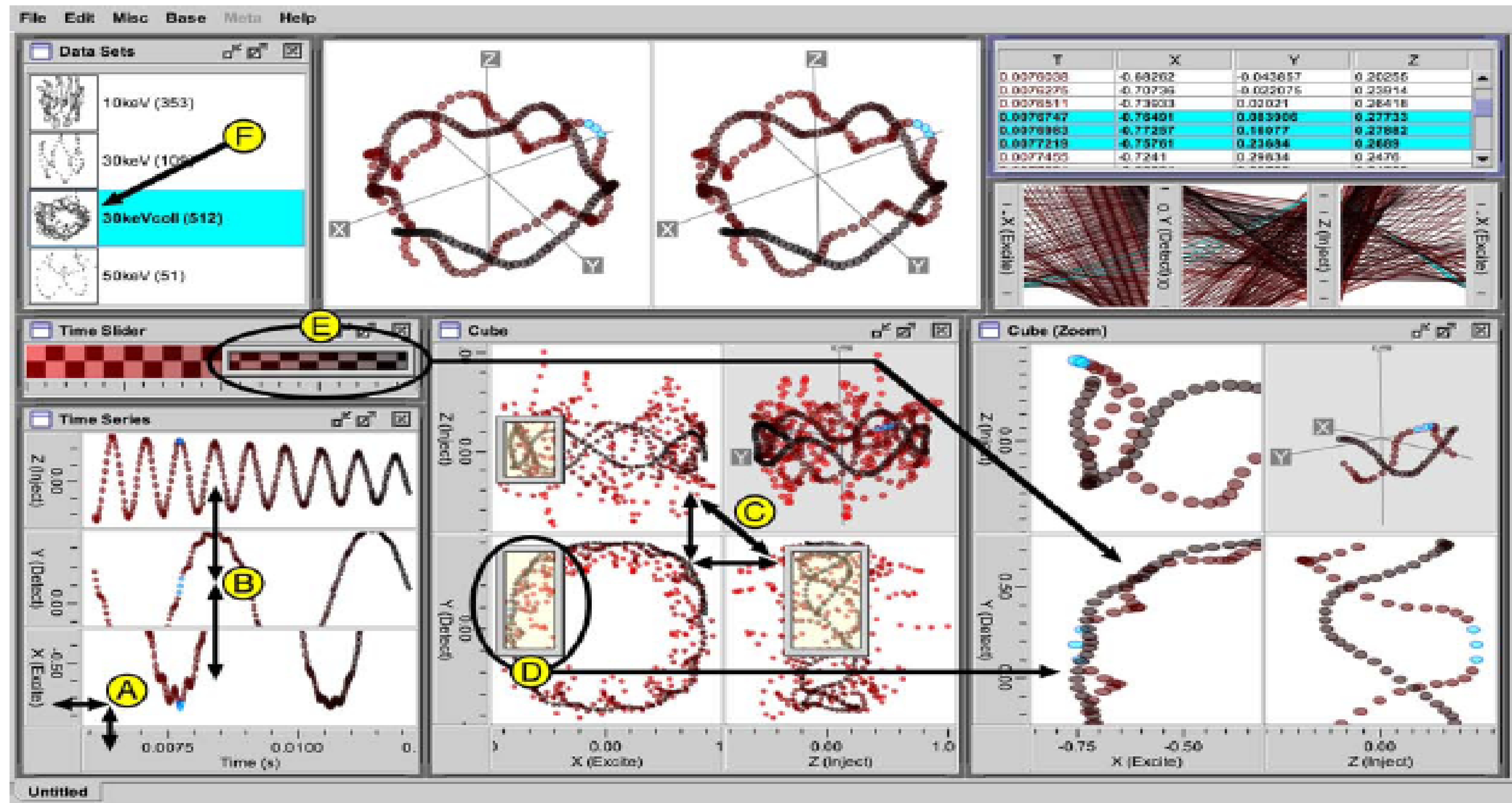
[W. Javed and N. Elmqvist, 2012]

Juxtaposition



[ComVis, K. Matkovic et al., 2008]

Juxtaposition



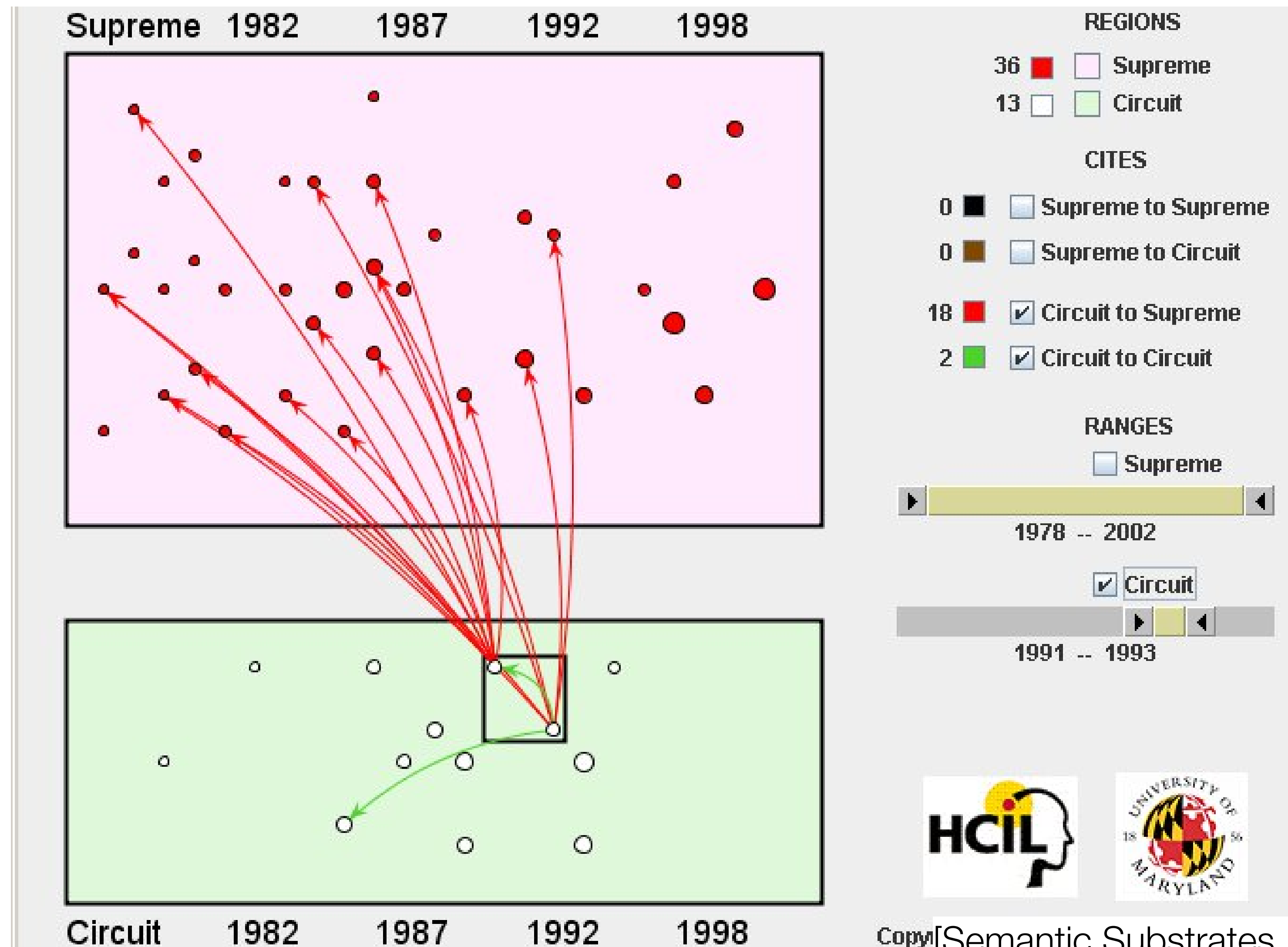
[Improvise, C. Weaver, 2004]

Juxtaposition Guidelines

- Benefits:
 - The component visualizations are independent and can be composed without interference
 - Easy to implement
- Drawbacks:
 - Implicit visual linking is not always easy to see, particularly when multiple objects are selected
 - Space is divided between the views, yielding less space for each view
- Applications: Use for heterogeneous datasets consisting of many different types of data, or for where different independent visualizations need to be combined.

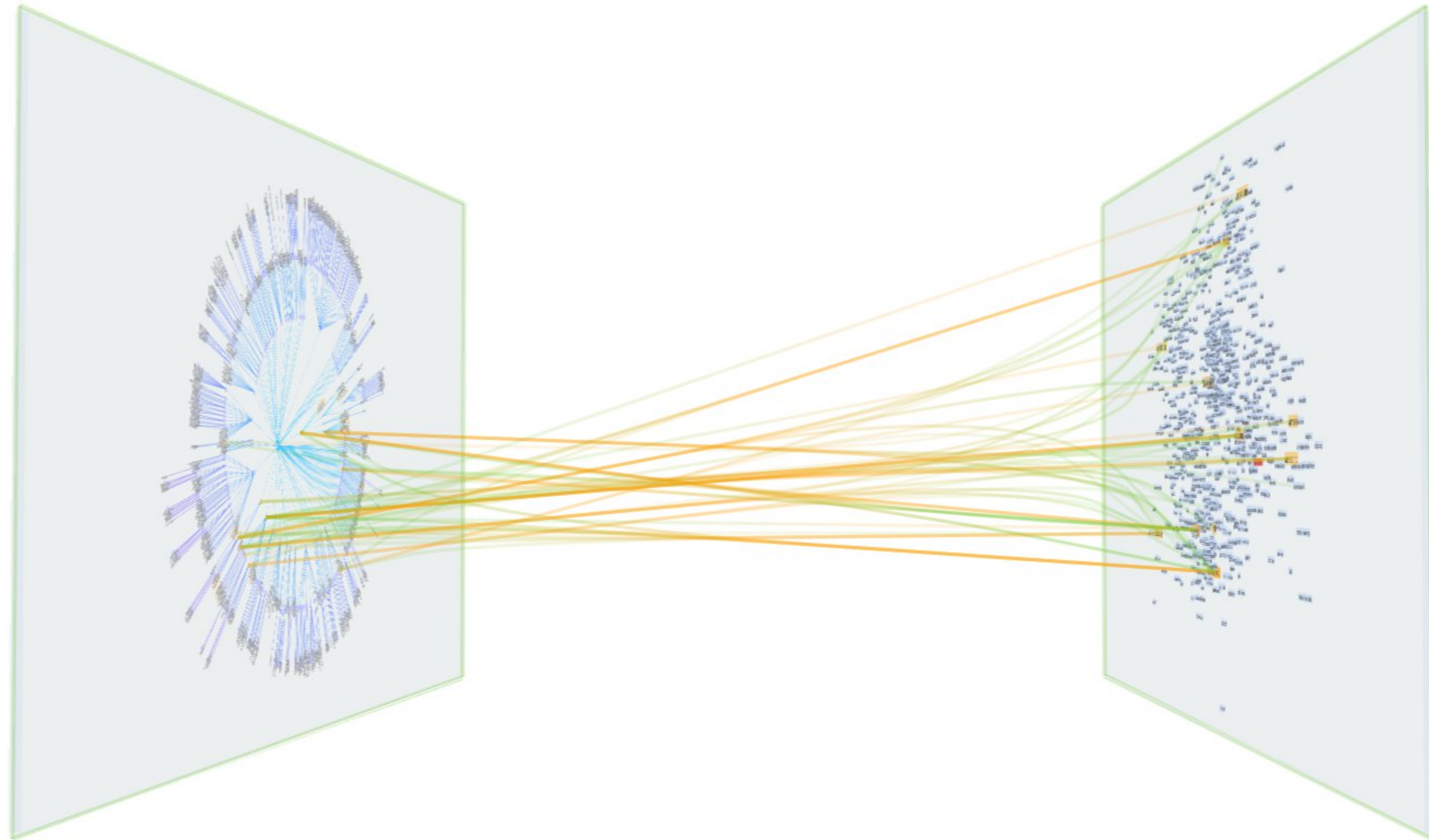
[W. Javed and N. Elmqvist, 2012]

Integration



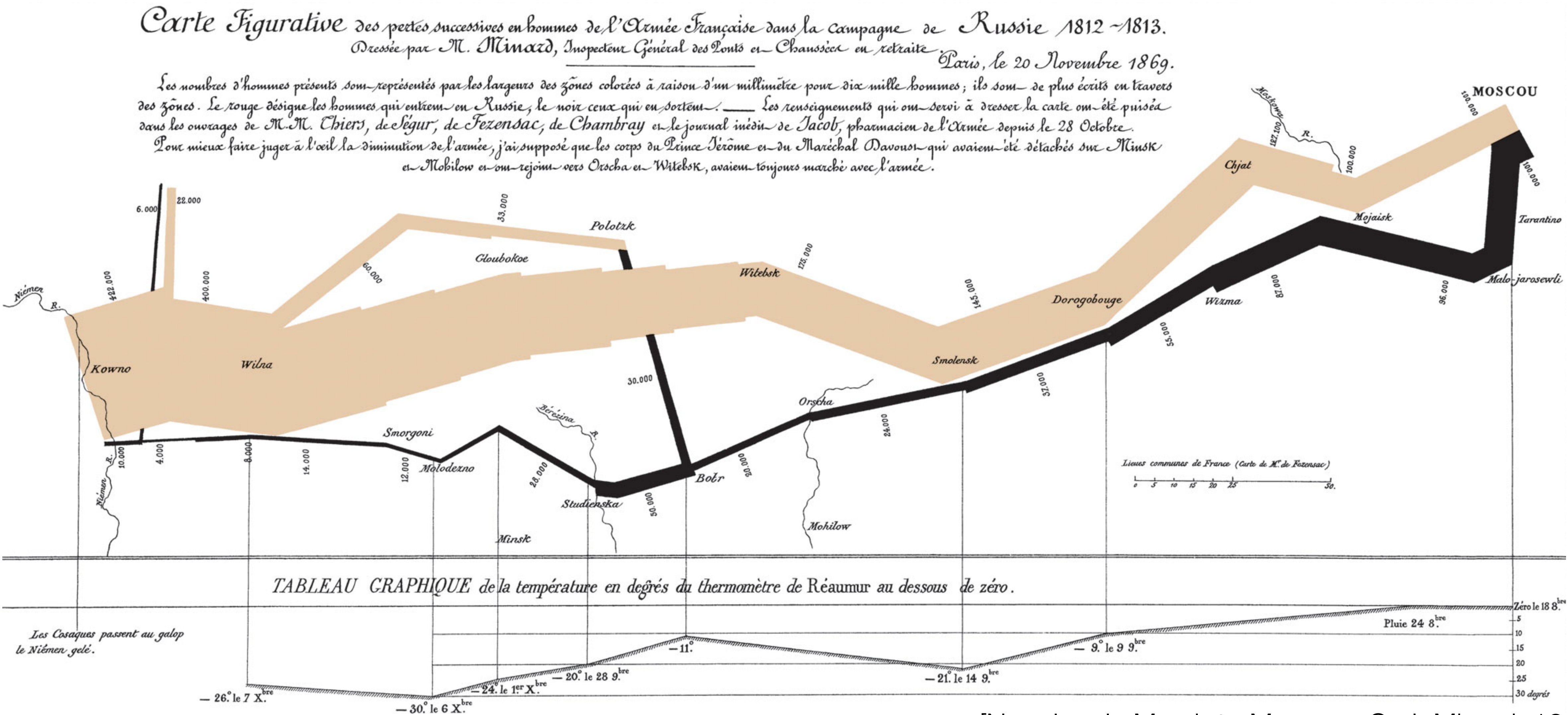
Copy [Semantic Substrates, Schneiderin and Aris, 2006]

Integration



[VisLink, Collins and Carpendale, 2007]

Integration



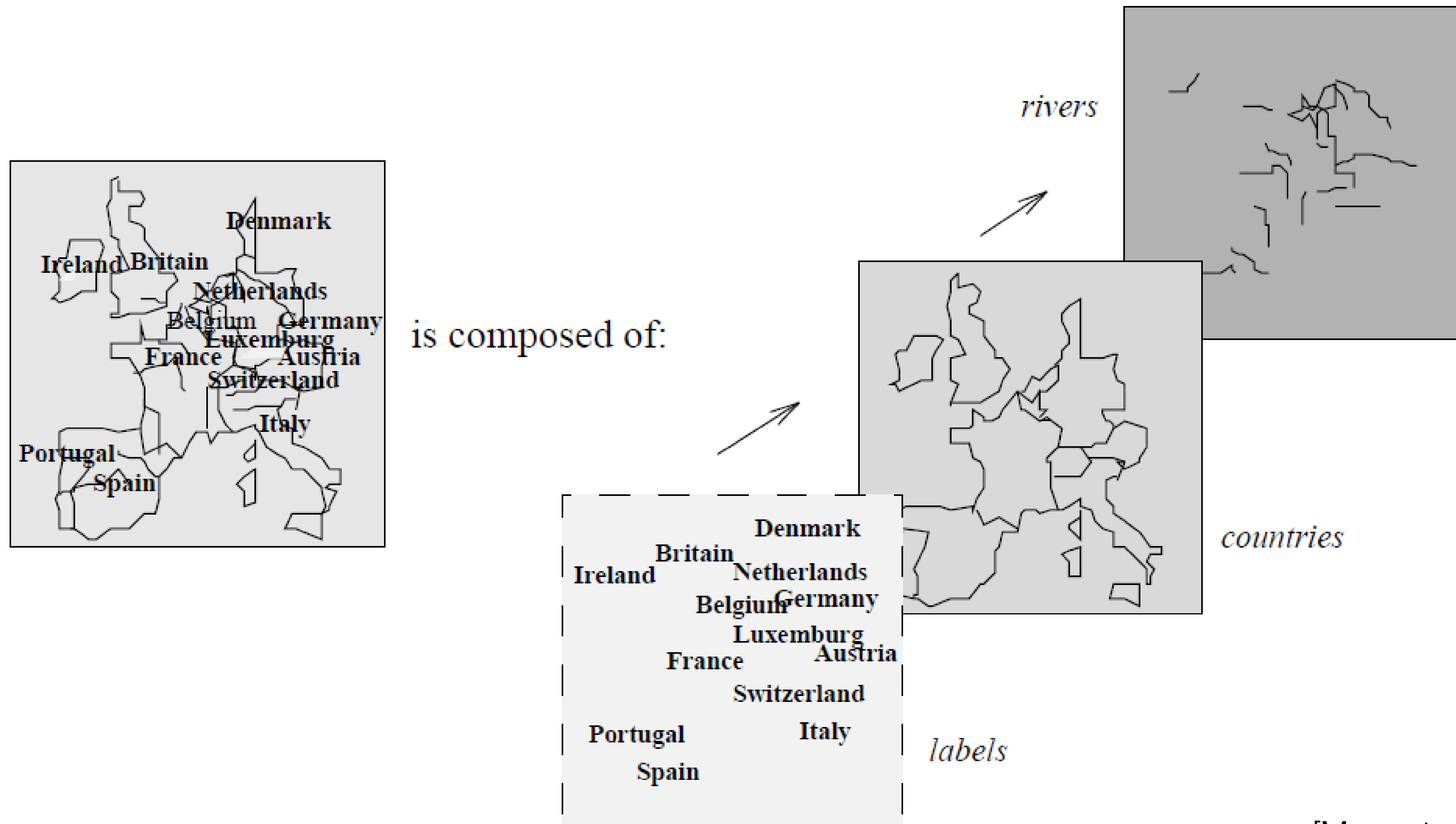
[Napoleon's March to Moscow, C. J. Minard, 1869]

Integration Guidelines

- Benefits:
 - Easy to perceive one-to-one and one-to-many relations between items in components
 - Visualizations are less independent compared to juxtaposed views, but still separate
- Drawbacks:
 - Extra visual clutter added to the overall view
 - Display space is split between the views
 - Some dependencies exist between views to allow for the visual linking
- Applications: Use for heterogeneous datasets where correlation and comparisons between views is particularly important.

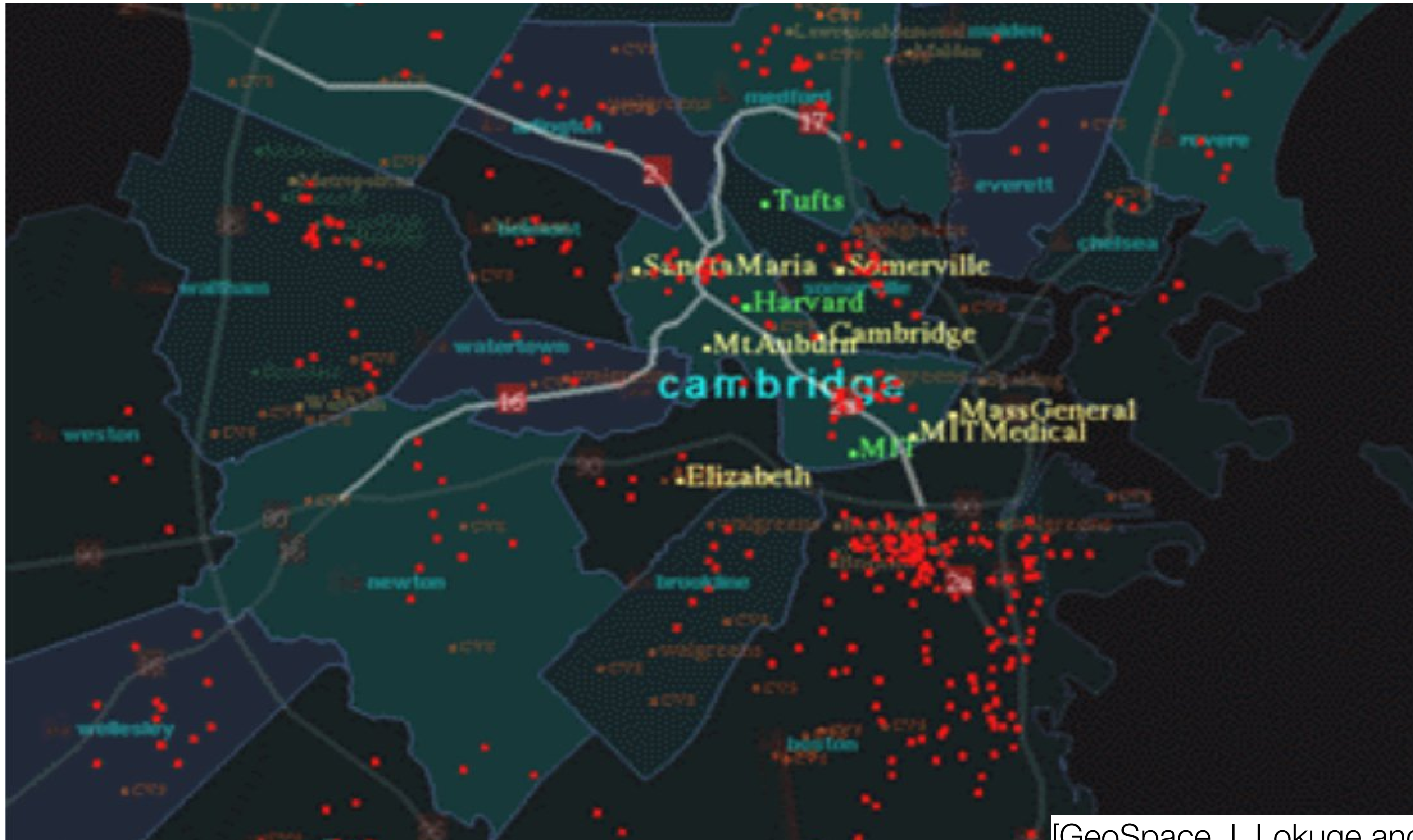
[W. Javed and N. Elmqvist, 2012]

Superimposition



[Mapgets, A. Voisard, 1995]

Superimposition



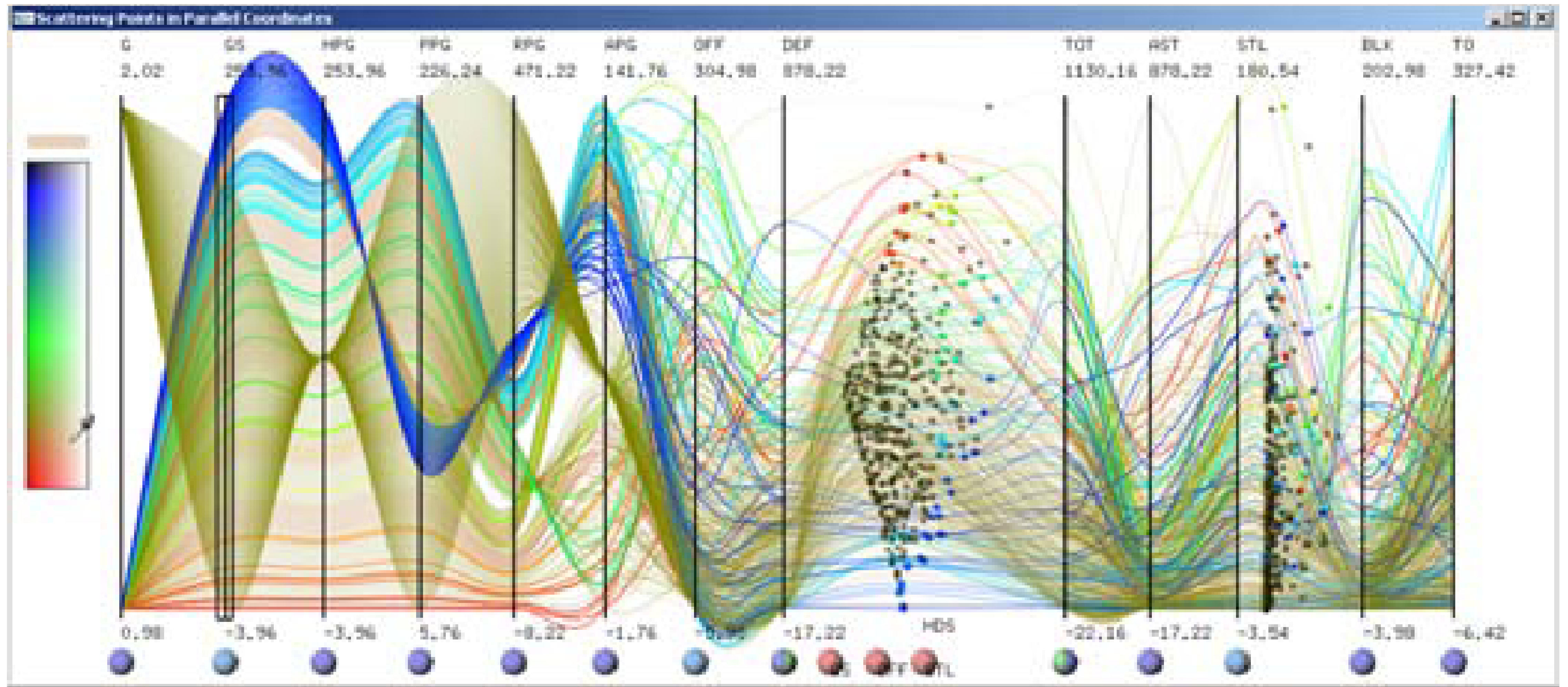
[GeoSpace, I. Lokuge and S. Ishizaki, 1995]

Superimposition Guidelines

- Benefits:
 - Allows direct comparison in the same visual space.
- Drawbacks:
 - May cause occlusion and high visual clutter.
 - The client visualization must share the same spatial mapping as the host visualization.
- Applications: In settings where comparison is common, or where the component visualization views need to be as large as possible (potentially the entire available space).

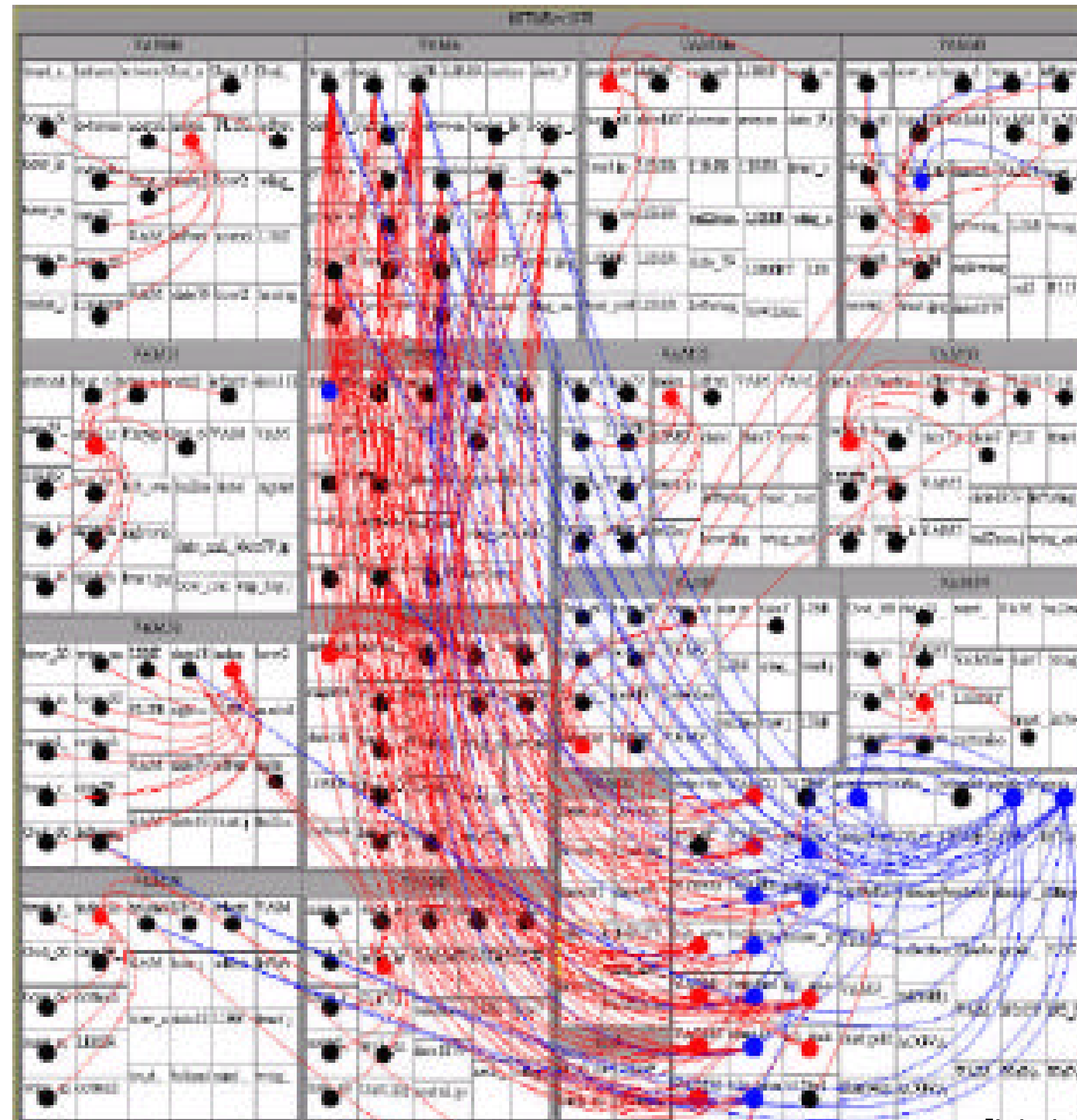
[W. Javed and N. Elmqvist, 2012]

Overloading



[SPCC, X. Yuan et al., 2009]

Overloading



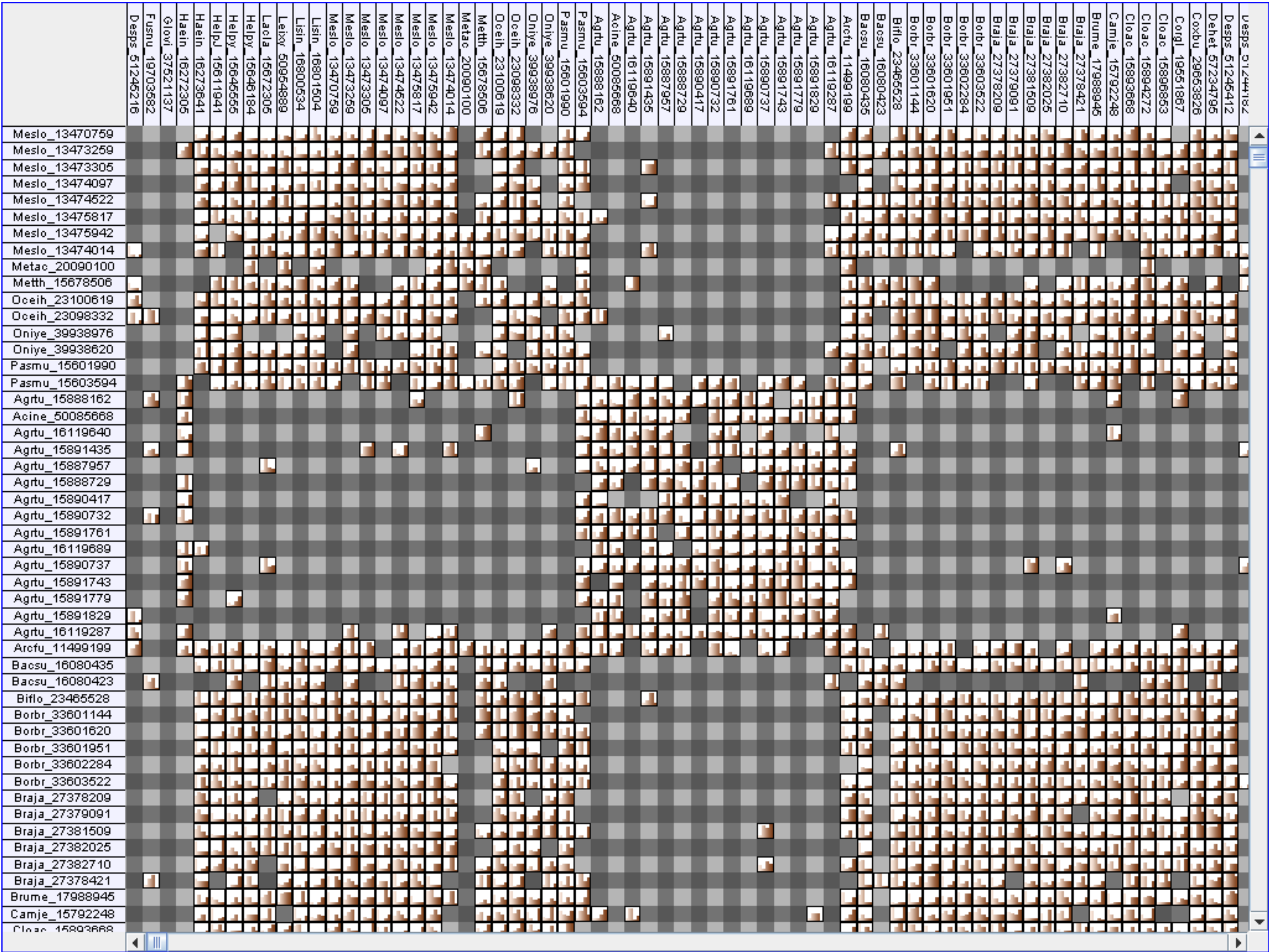
[Links on Treemaps, J.-D. Fekete et al., 2003]

Overloading Guidelines

- Benefits:
 - The client visualization does not have to share the same coordinate space as the host visualization
 - This also yield more flexibility and control over visual clutter
- Drawbacks:
 - Visual clutter is increased
 - Visual design dependencies between components are significant
- Applications: Situations where one visualization can be folded into another to yield a compact (and complex) result.

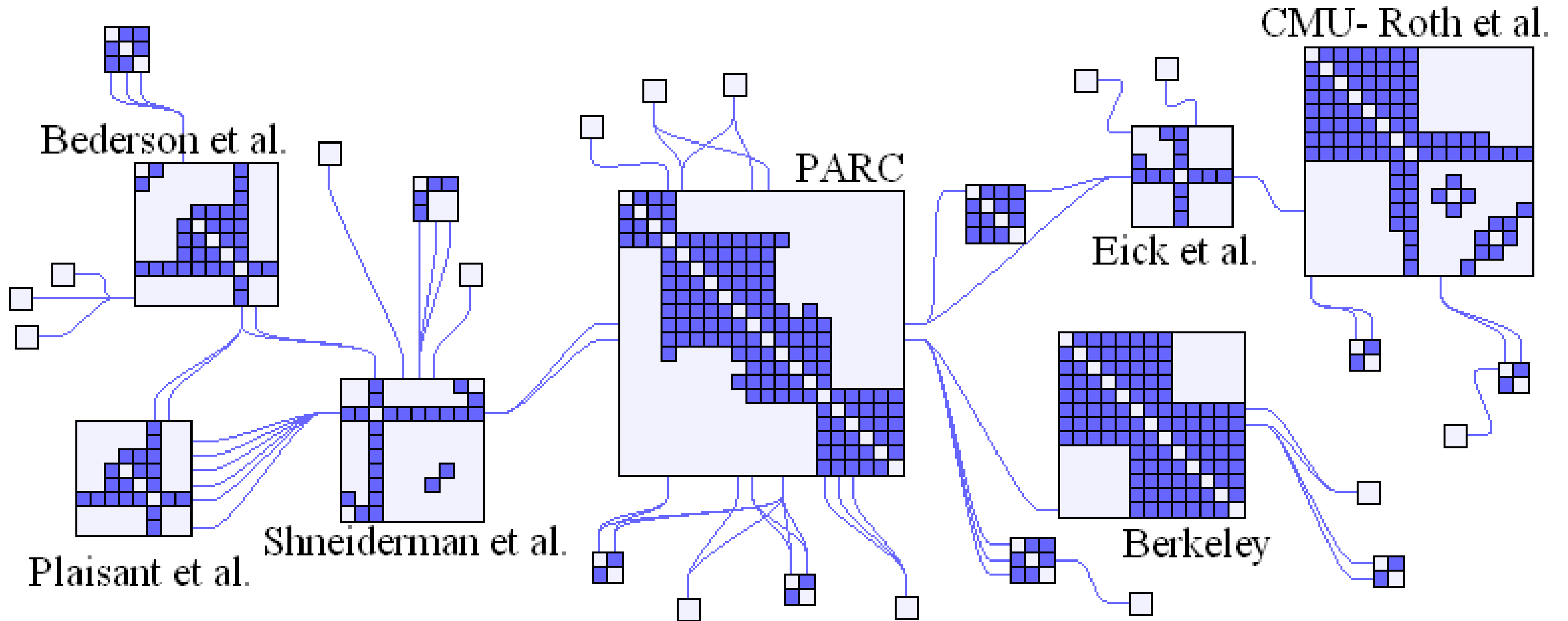
[W. Javed and N. Elmqvist, 2012]

Nesting



[ZAME, N. Elmqvist et al., 2008]

Nesting



[NodeTrix, N. Henry et al., 2007]

Nesting Guidelines

- Benefits:
 - Very compact representation
 - Easy correlation
- Drawbacks:
 - Limited space for the client visualizations
 - Clutter is high
 - Visual design dependencies are high
- Applications: Situations that call for augmenting a particular visual representation with additional mapping

[W. Javed and N. Elmqvist, 2012]

Design Space

- Visualizations: the techniques or idioms used
- Spatial relation: relationship between visual structures in display space
- Data relation: visual relationship between items in different views
 - None: No relation
 - Item-item: One-to-one
 - Item-group: One-to-many
 - Item-dimension: Item in one view is a **scale** in another

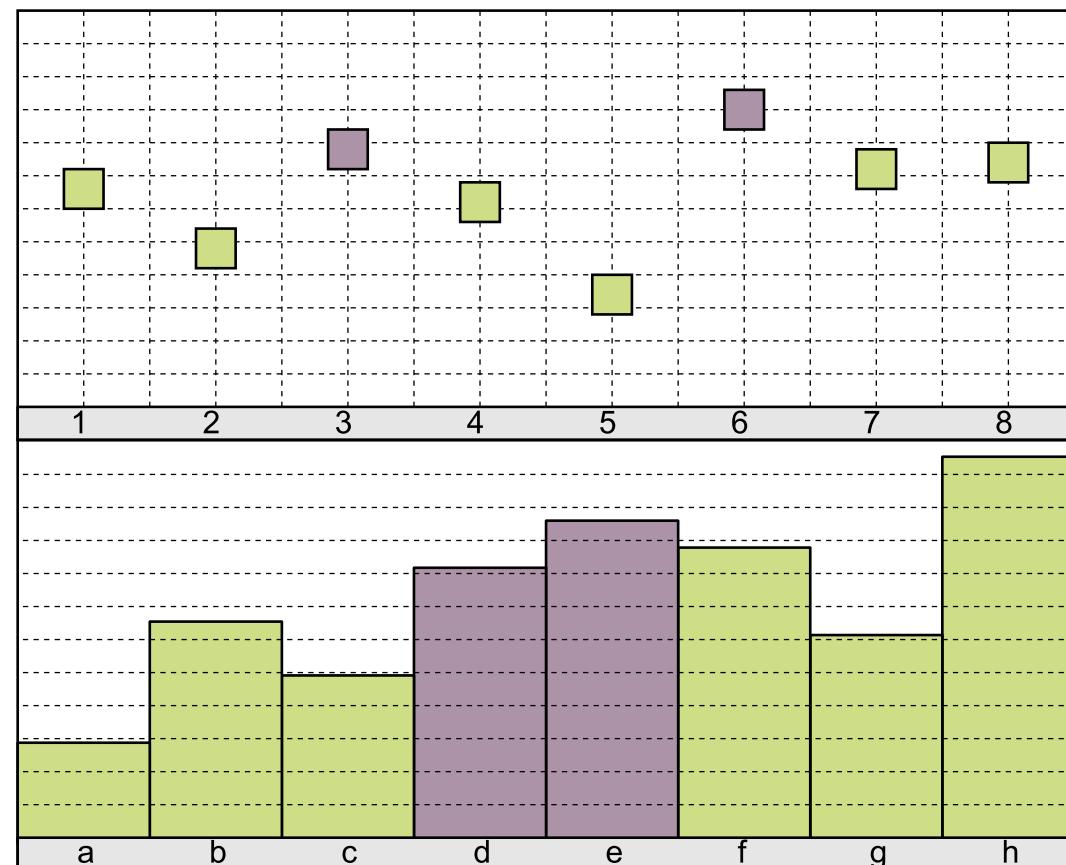
[W. Javed and N. Elmqvist, 2012]

Summary

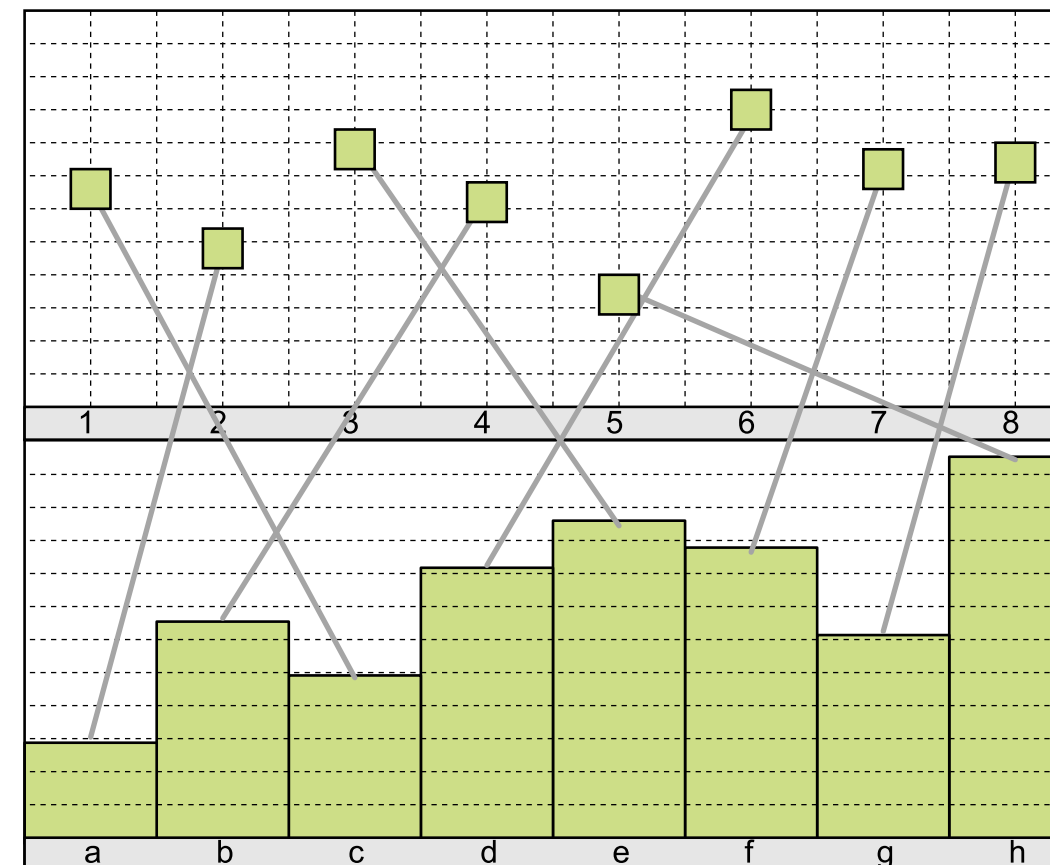
Technique	Visualization A	Visualization B	Spatial Relation	Data Relation
ComVis [24] (Figure 2)	any	any	juxtapose	none
Improvise [39] (Figure 3)	any	any	juxtapose	none
Jigsaw [36]	any	any	juxtapose	none
Snap-Together [30]	any	any	juxtapose	none
semantic substrates [34] (Figure 4)	node-link	node-link	juxtapose	item-item
VisLink [11] (Figure 5)	radial graph	node-link	juxtapose	item-item
Napoleon's March on Moscow [37]	time line view	area visualization	juxtapose	item-item
Mapgets [38] (Figure 6)	map	text	superimpose	item-item
GeoSpace [22] (Figure 7)	map	bar graph	superimpose	item-item
3D GIS [8]	map	glyphs	superimpose	item-item
Scatter Plots in Parallel Coordinates [45] (Figure 8)	parallel coordinate	scatterplot	overload	item-dimension
Graph links on treemaps [14] (Figure 9)	treemap	node-link	overload	item-item
SparkClouds [21]	tag cloud	line graph	overload	item-item
ZAME [13] (Figure 10)	matrix	glyphs	nested	item-group
NodeTrix [17] (Figure 11)	node-link	matrix	nested	item-group
TimeMatrix [44]	matrix	glyphs	nested	item-group
GPUVis [25]	Scatterplot	glyphs	nested	item-group

[W. Javed and N. Elmqvist, 2012]

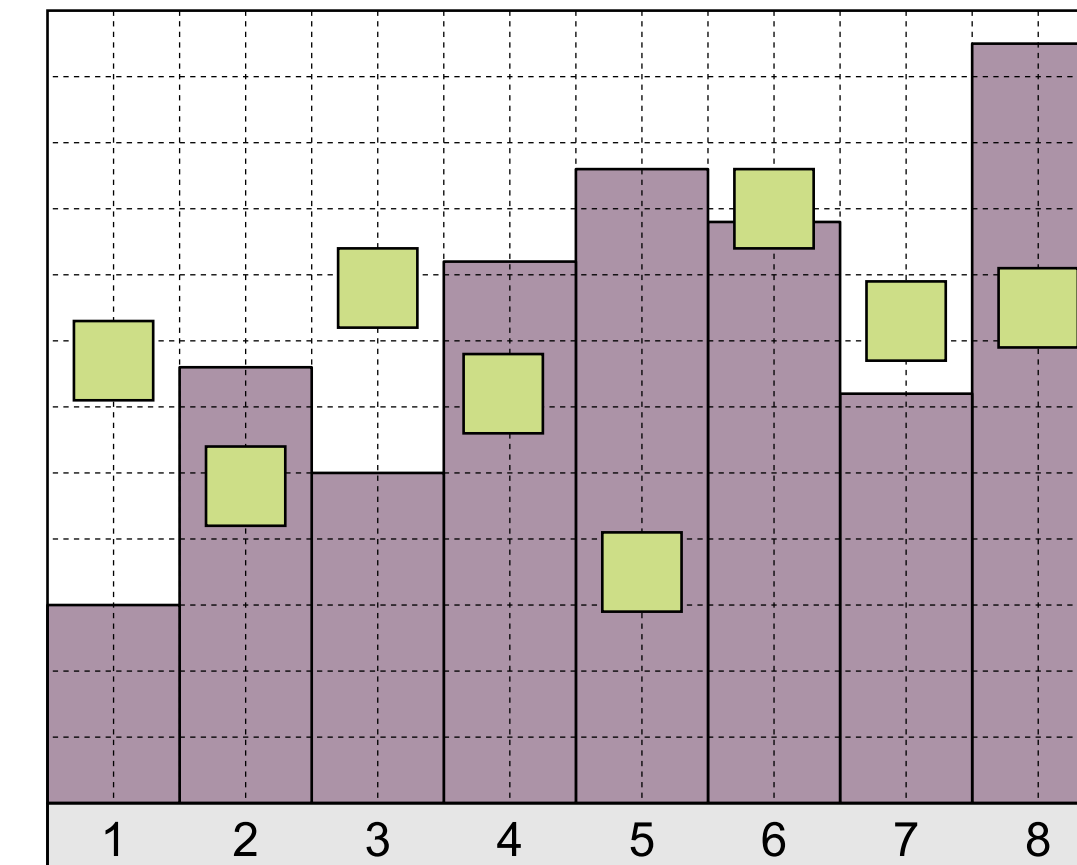
Summary (Scatterplot + Bar Chart)



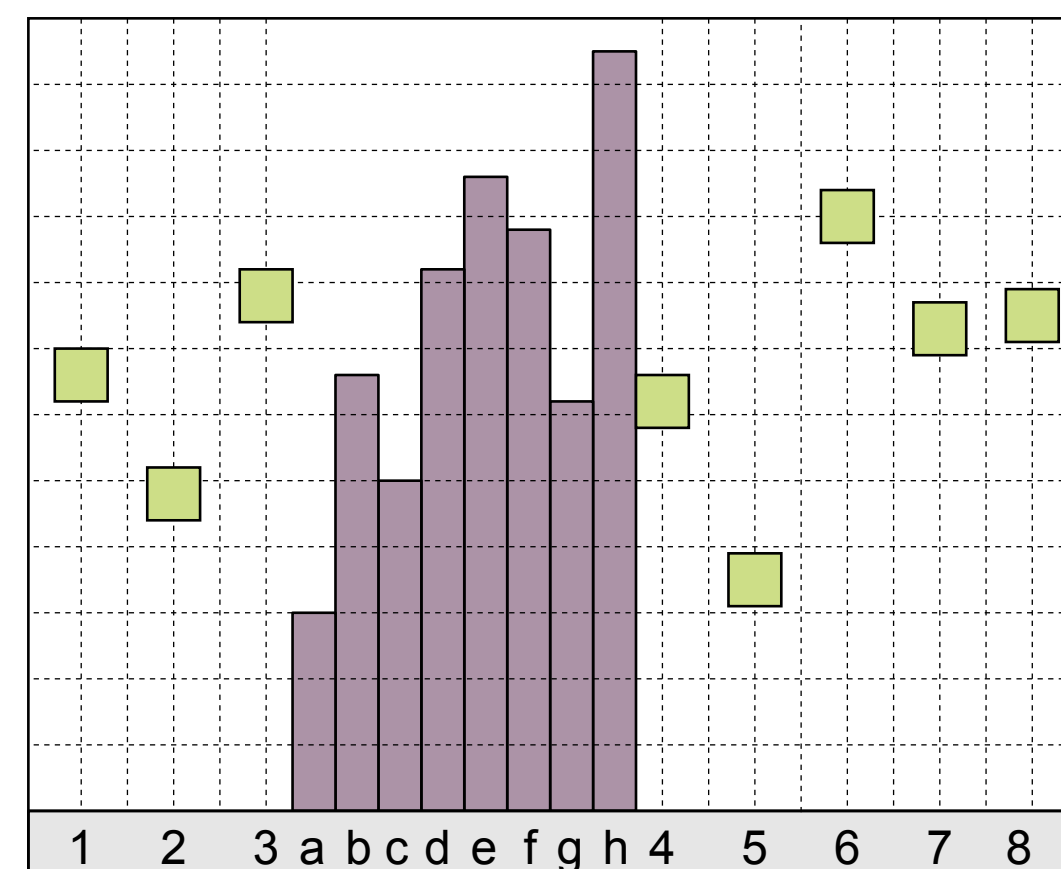
(a) Juxtaposed views.



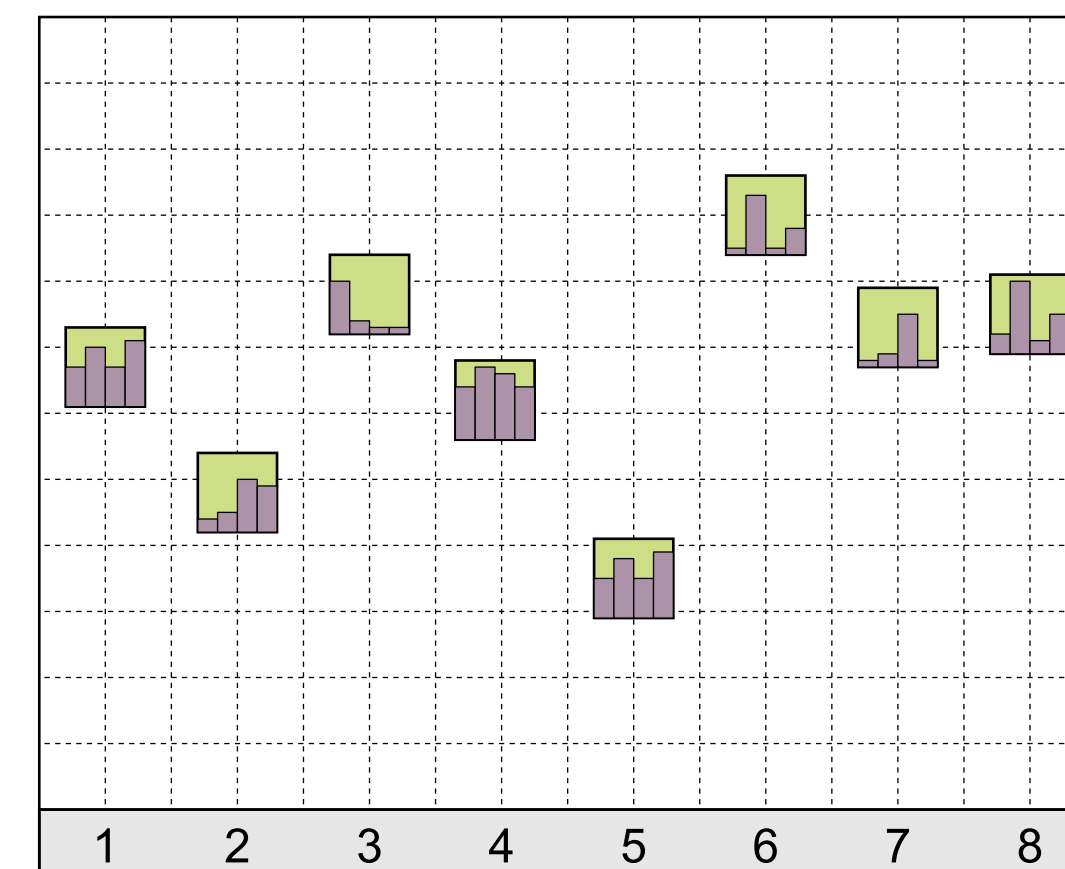
(b) Integrated views.



(c) Superimposed views.



(d) Overloaded views.



(e) Nested views.

[W. Javed and N. Elmqvist, 2012]

Multiple Views

- Facet (noun and verb)
 - particular aspect or feature of something
 - to split
- Partition visualization into views/layers
 - Either juxtapose (side-by-side), superimpose (layer), nest, etc.
 - Depends on data and encoding
 - Generally, superimposing does not scale as well
 - Multiple views eats display space (either large screens or small visualizations)

Multiple Views

→ Share Encoding: Same/Different

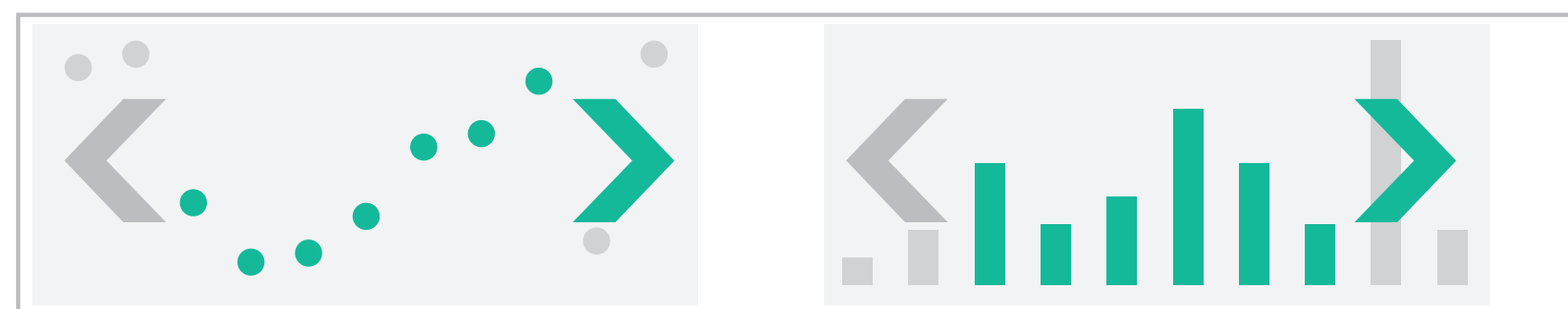
→ *Linked Highlighting*



→ Share Data: All/Subset/None

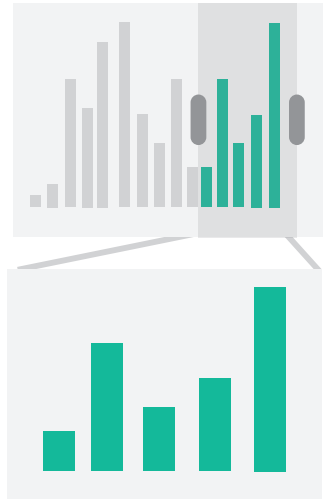
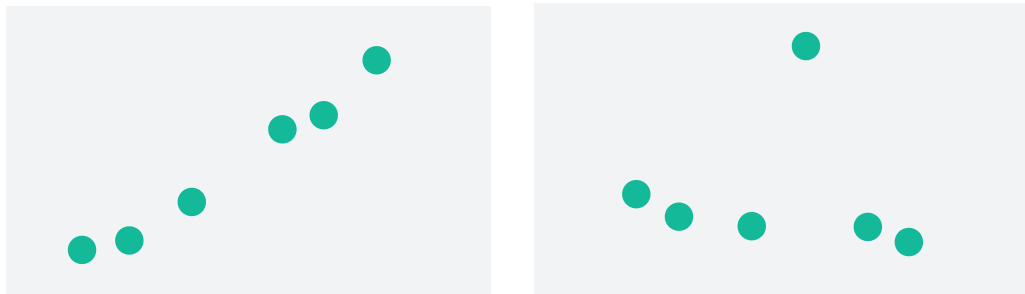
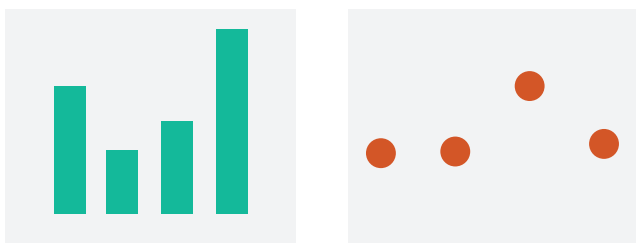



→ Share Navigation



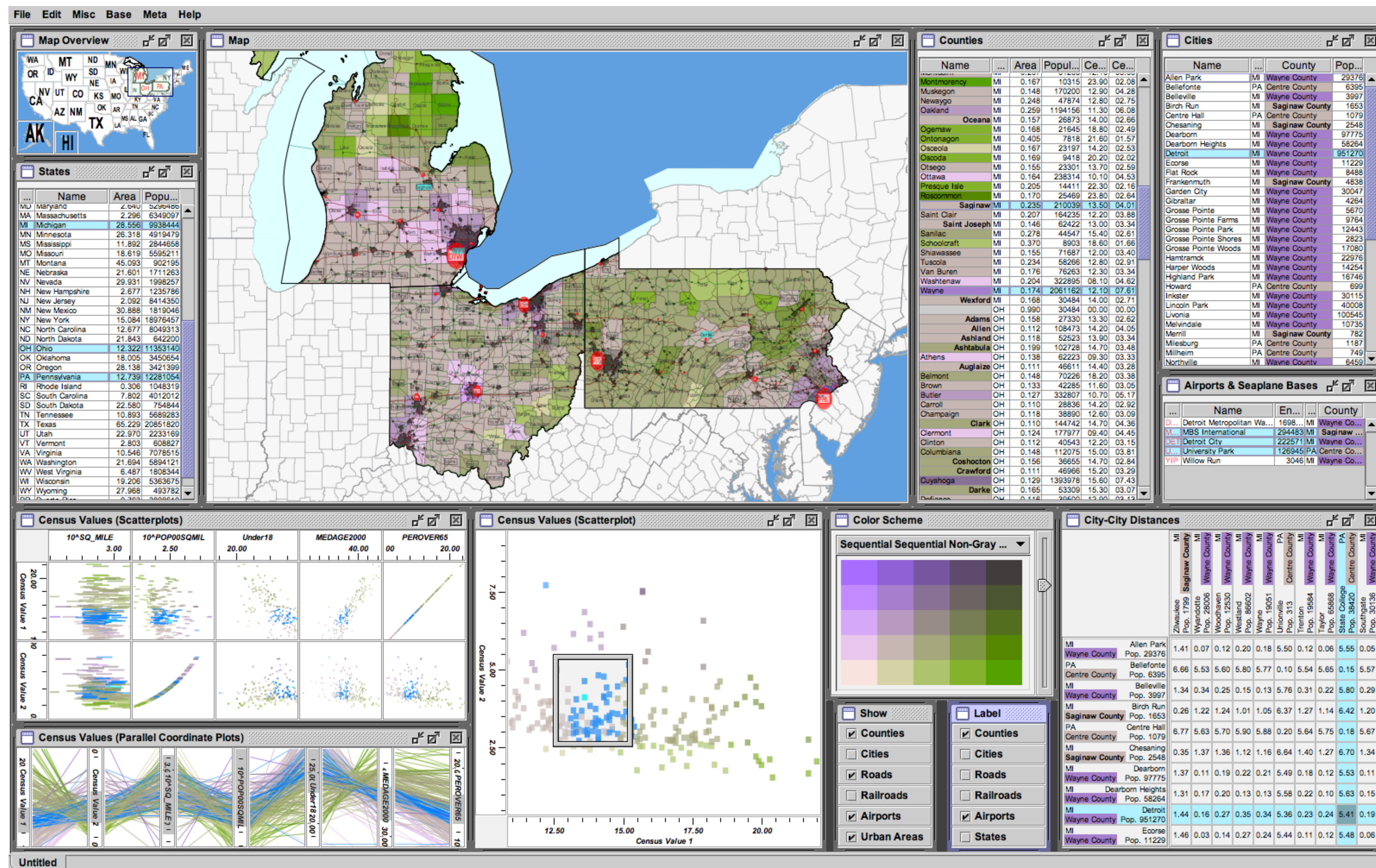
[Munzner (ill. Maguire), 2014]

Multiple Views

		Data		
		All	Subset	None
Encoding	Same	Redundant	 Overview/ Detail	 Small Multiples
	Different	 Multiform	 Multiform, Overview/ Detail	No Linkage

[Munzner (ill. Maguire), 2014]

Multiform



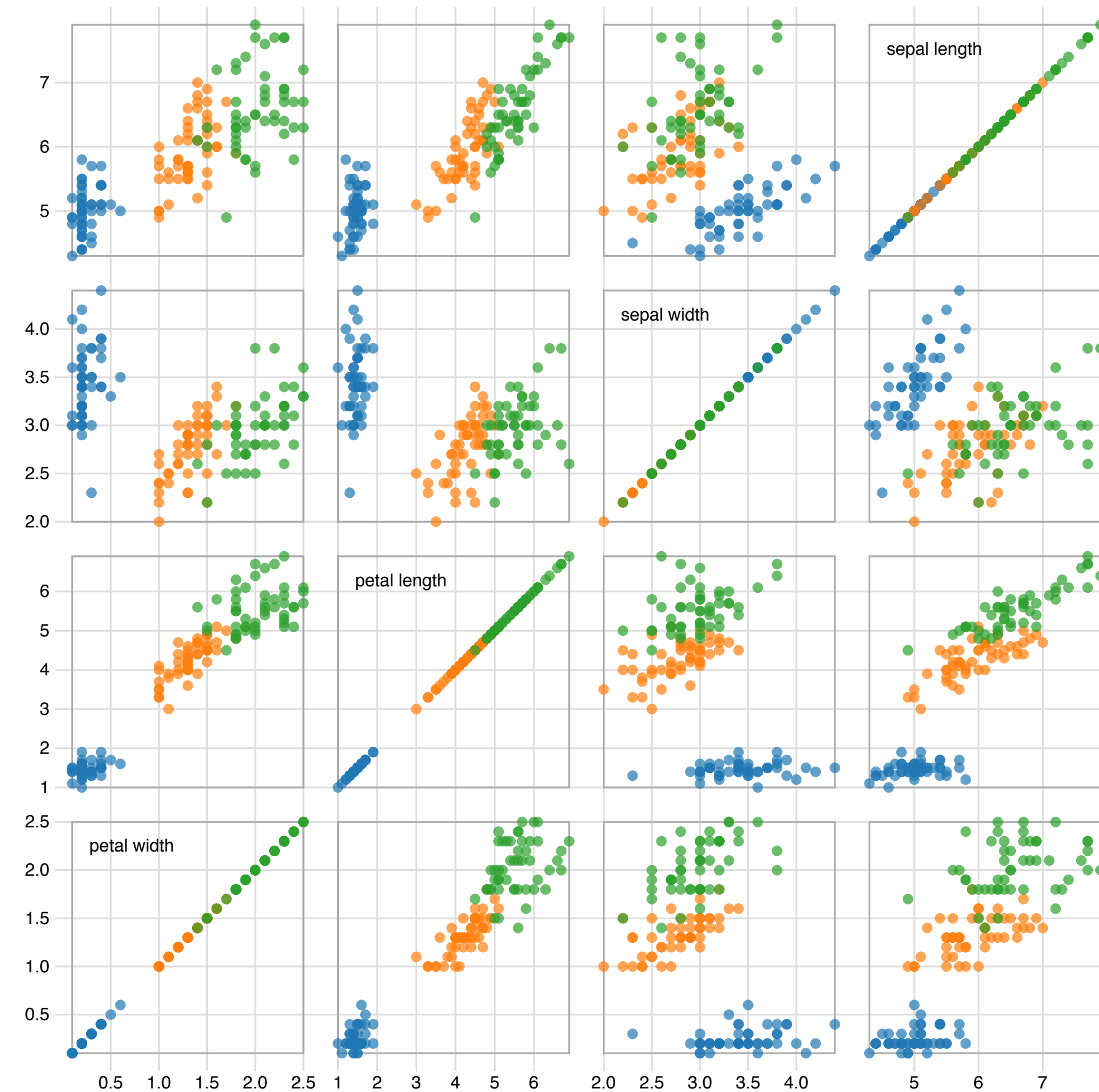
[Improvise, Weaver, 2004]

Multiform Views

- The same data visualized in different ways
- Does not need to be a totally different encoding (all choices need not be disjoint), e.g. horizontal positions could be the same
- One view becomes cluttered with too many attributes
- Consumes more screen space
- Allows greater separability between channels

Small Multiples

- Same encoding, but different data in each view (e.g. SPLOM)



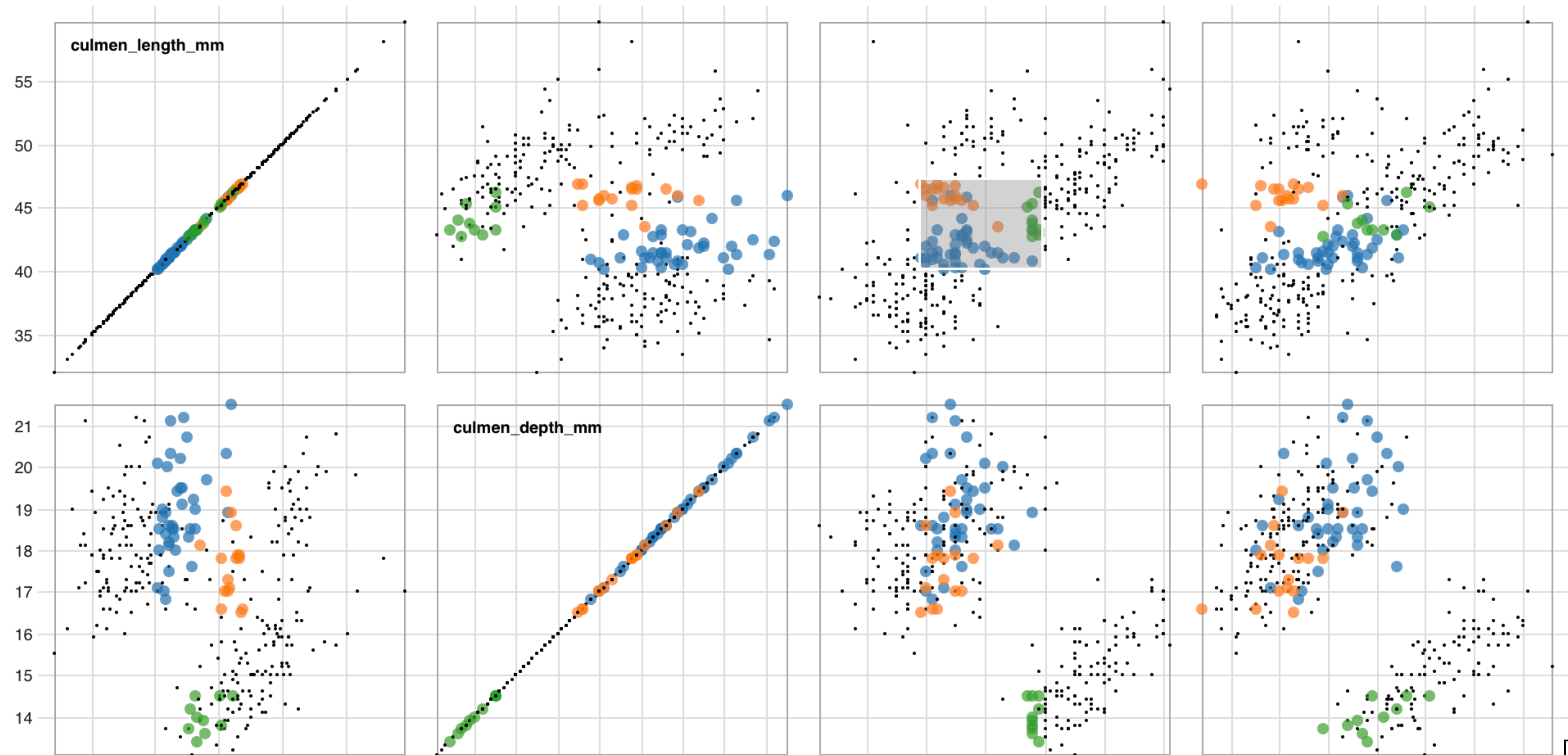
[M. Bostock]

Interaction with Multiform & Small Multiples

- Key interaction with multiform and small multiples: **brushing**
 - also called linked highlighting
- Want to understand correspondences between representation in the different views

Brushing

■ Adelie ■ Chinstrap ■ Gentoo

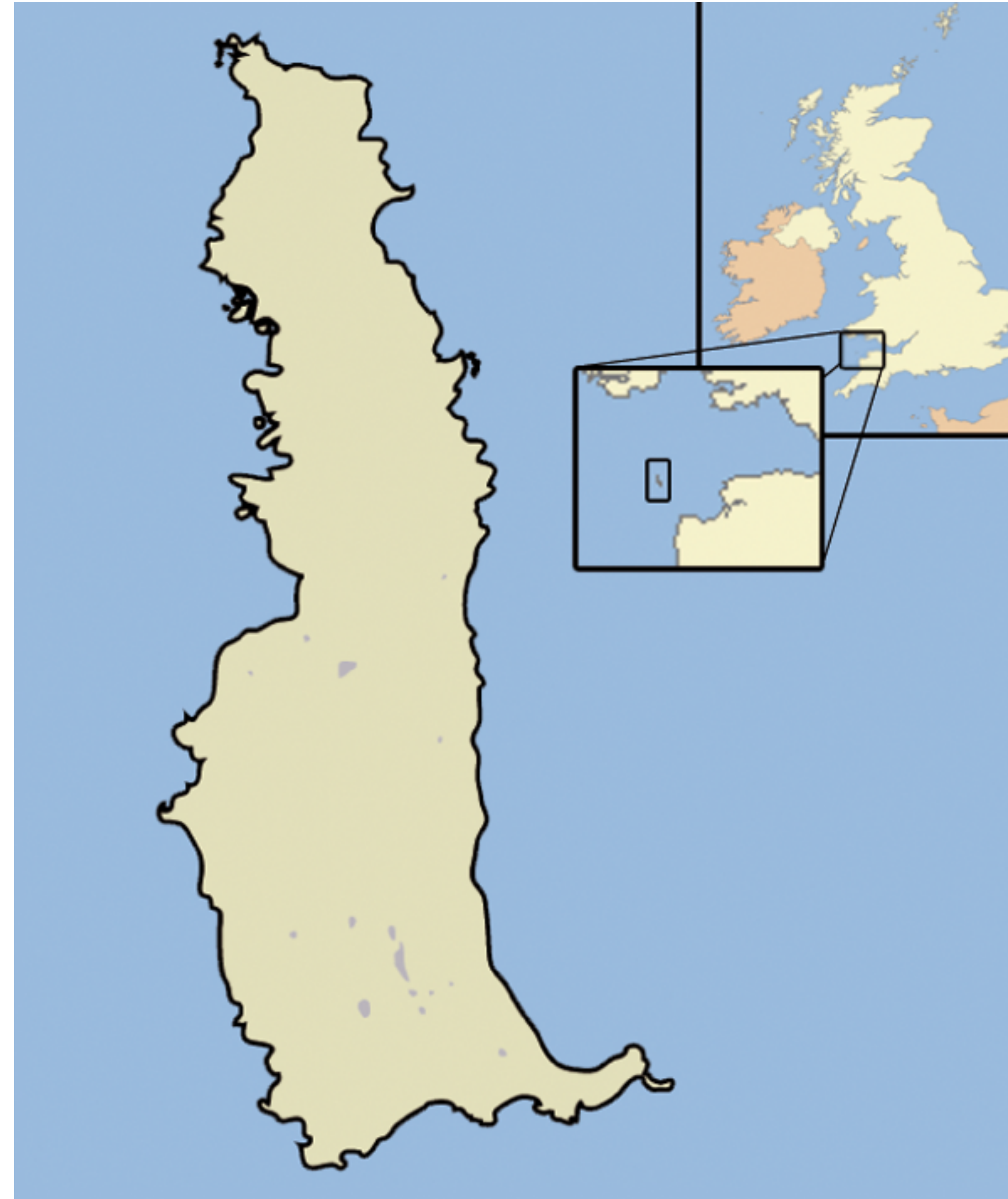


[M. Bostock]

Schneiderman's Mantra

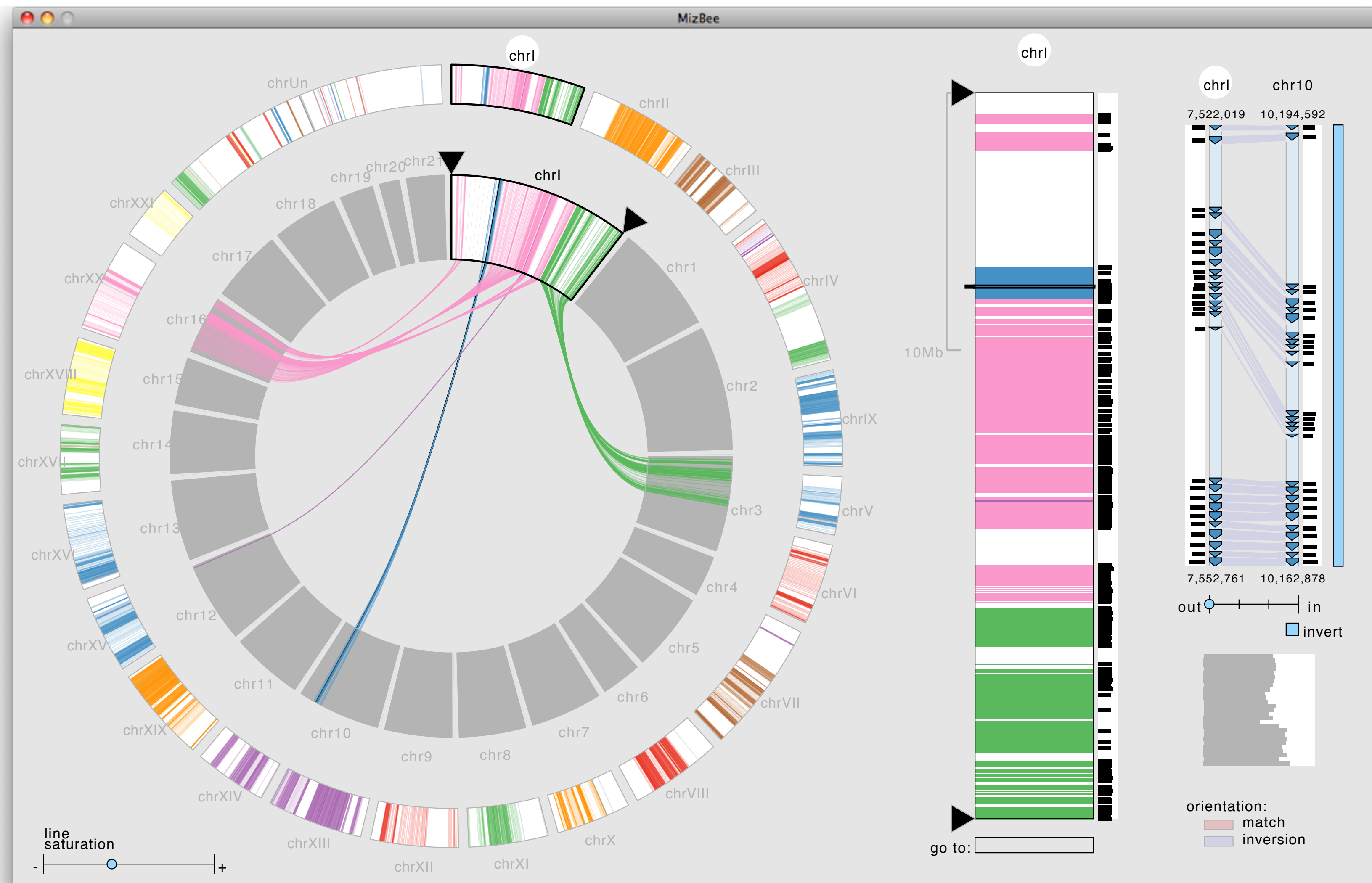
- Visual Information-Seeking Mantra [B. Schneiderman, 1996]:
 - Overview first
 - Zoom and filter (Chapter 13)
 - Details on demand
- Goal of the overview is to **summarize** all of the data
- Want specific **details** about some aspect(s) of the data, need another view/layer
 - May be permanent: side-by-side
 - May be a popup layer: often opaque or separated
- (see textbook Ch. 6.7)

Overview-Detail View



[Wikipedia]

Overview-Detail (Different Encoding)

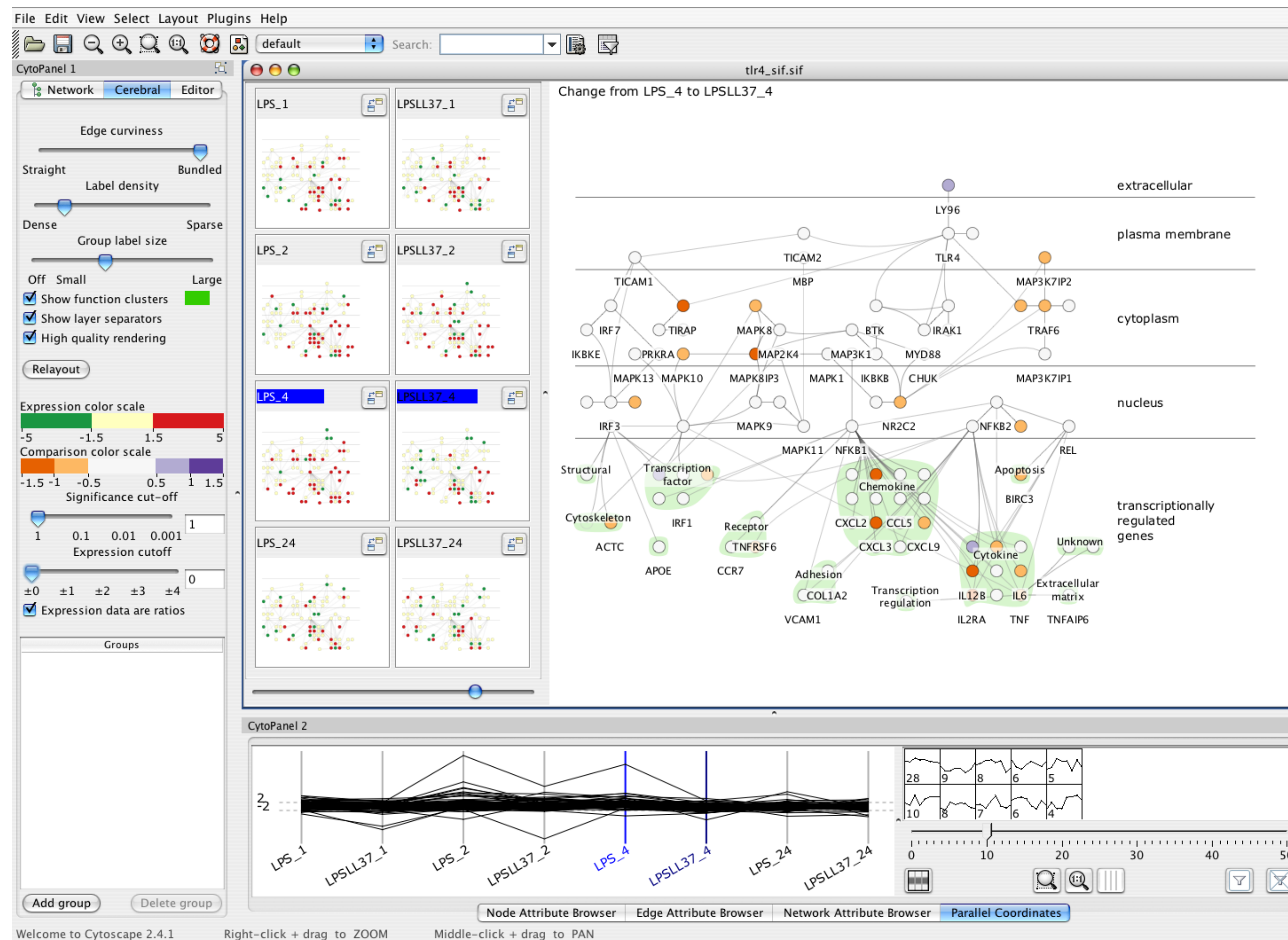


[M. Meyer et al.]

Overview-Detail (with Zoom-Filter)

- Detail involves some subset of the full dataset
- Involves user selection or filtering of some type
- How question: includes facet
- Examples:
 - Maps: partition into two views with same encoding, overview-detail
 - UC Trends: partition into multiple views, coordinated with linked highlighting, overview+detail of expenditures

Multiform & Small Multiples (Cerebral)



[Barsky et al., 2008]