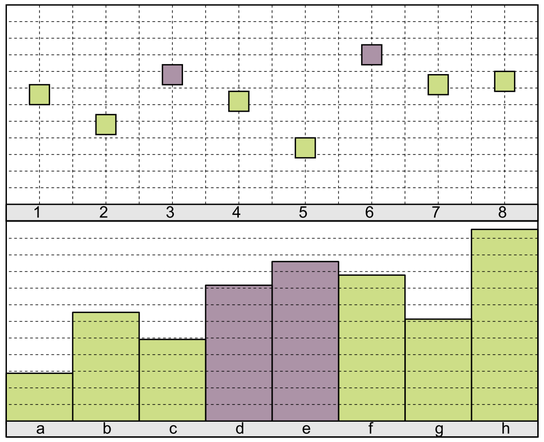
Data Visualization (CSCI 627/490)

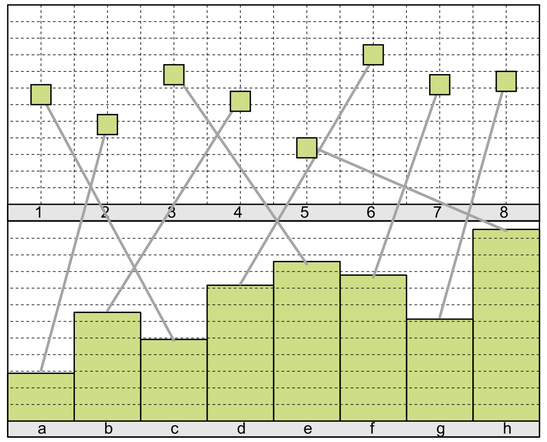
Filtering & Aggregation

Dr. David Koop

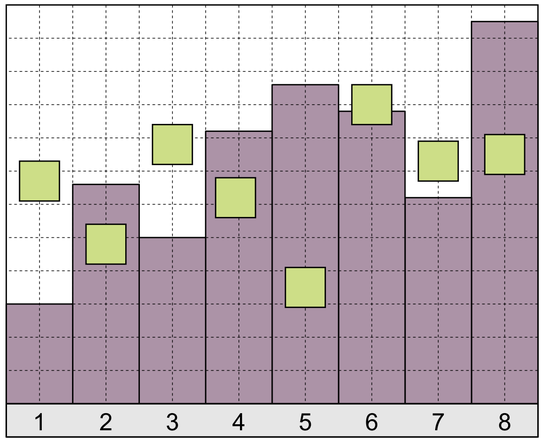
Composite Visualization Techniques



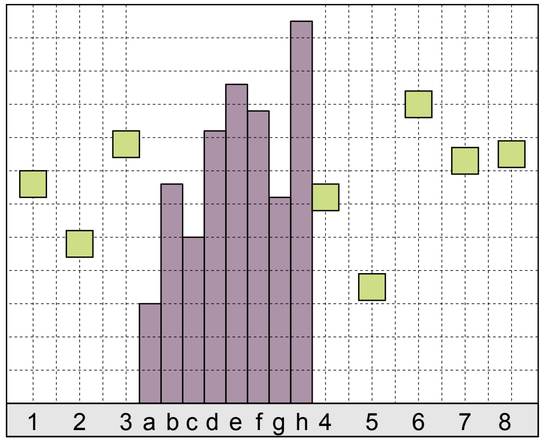
(a) Juxtaposed views.



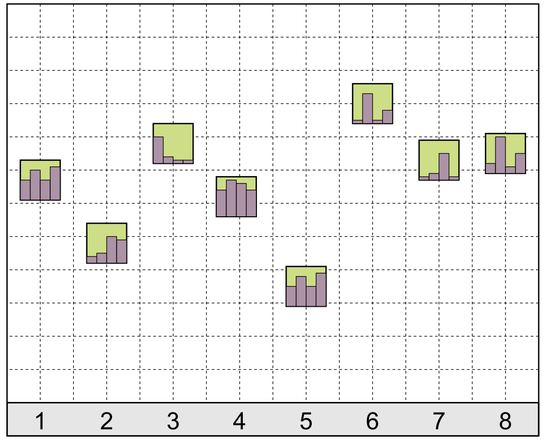
(b) Integrated views.



(c) Superimposed views.



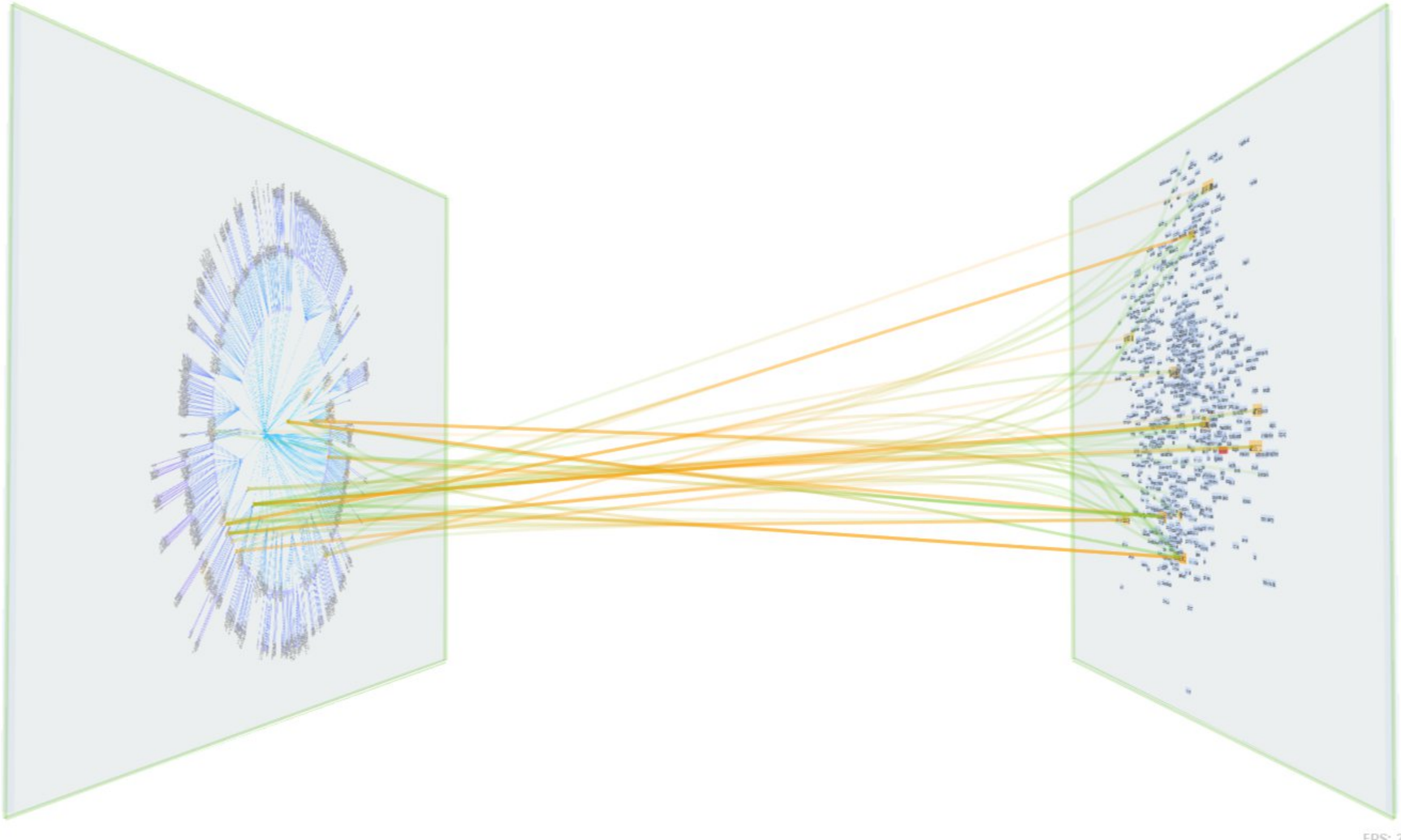
(d) Overloaded views.



(e) Nested views.

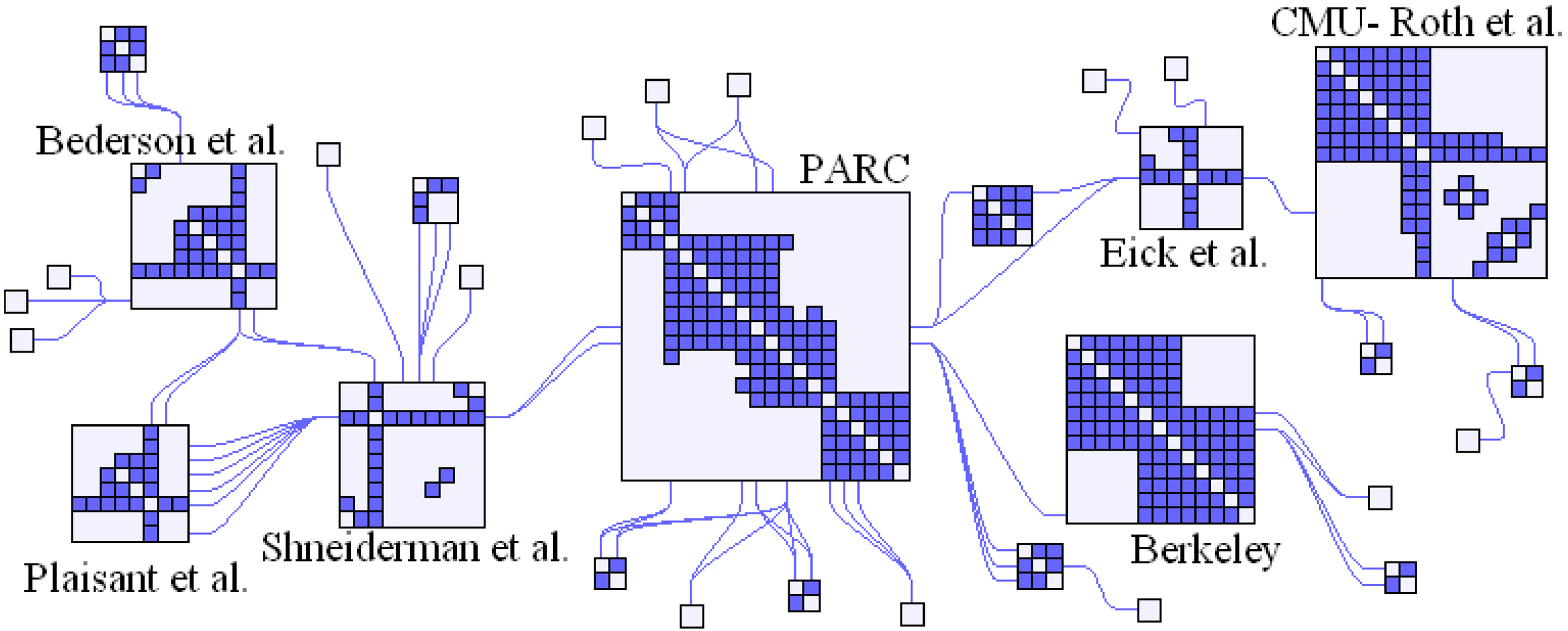
[W. Javed and N. Elmqvist, 2012]

What is this technique?



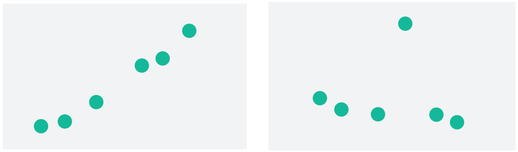
[VisLink, Collins and Carpendale, 2007]

What is this technique?



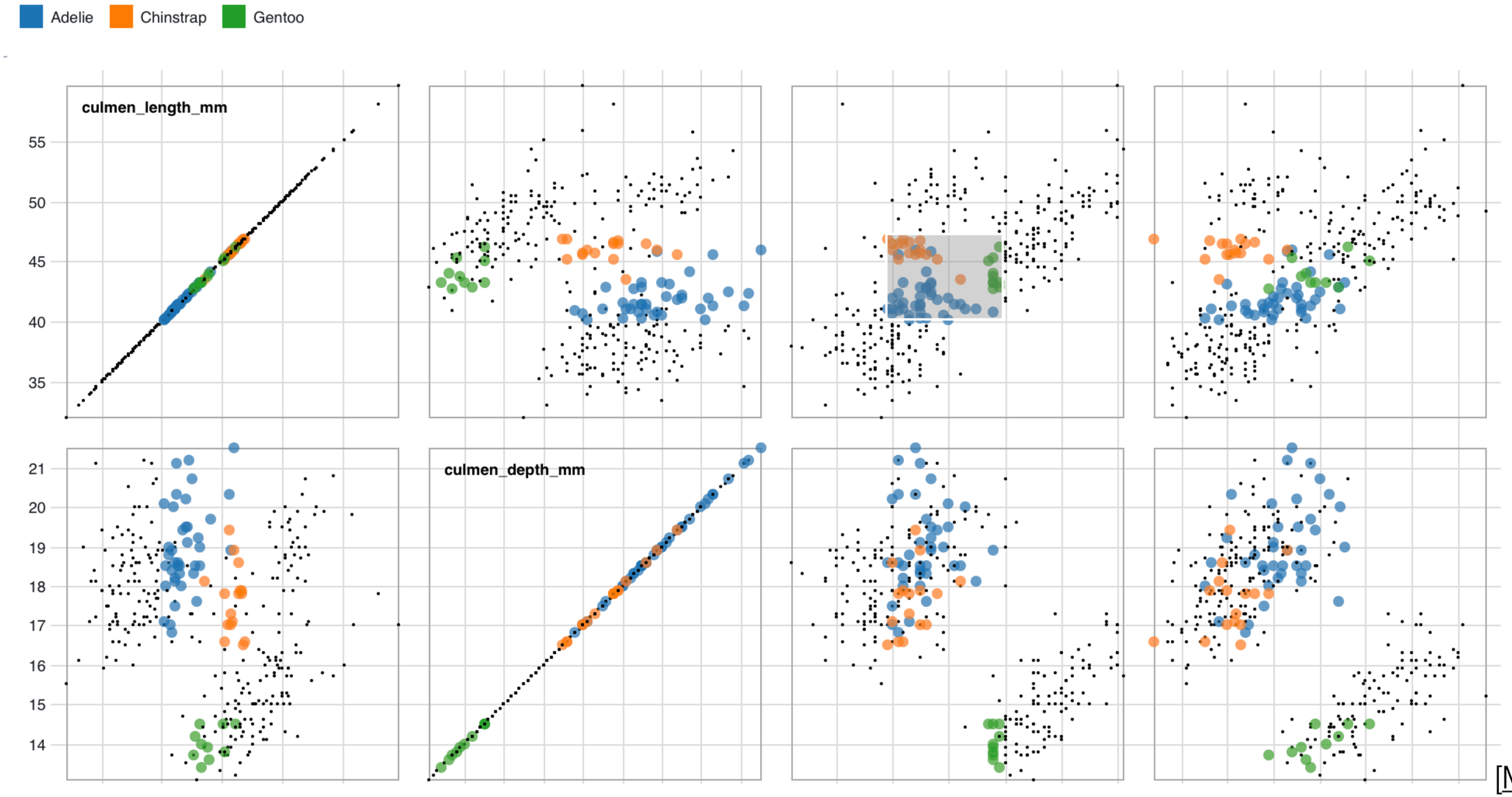
[NodeTrix, N. Henry et al., 2007]

Multiple Views

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

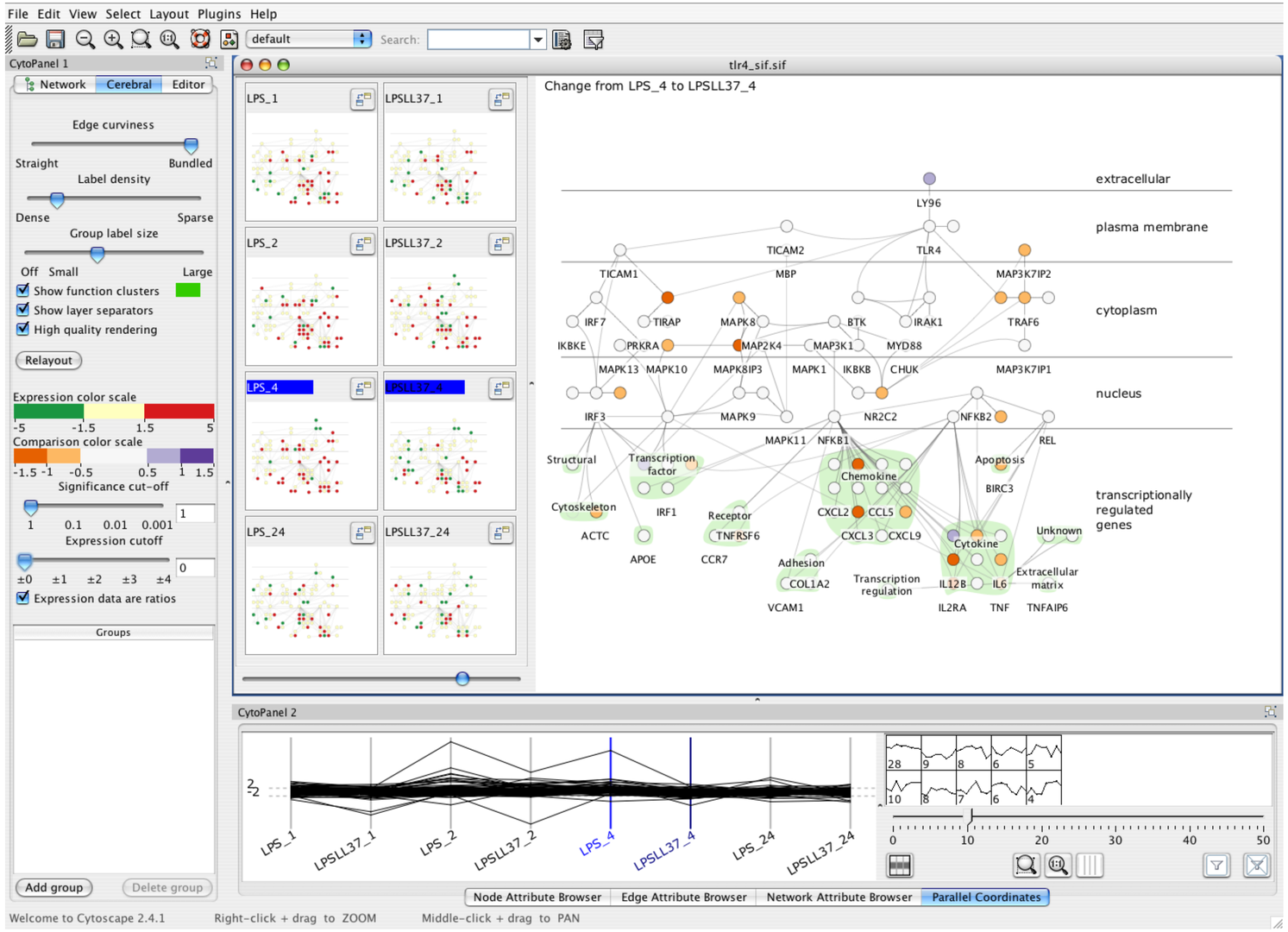
[Munzner (ill. Maguire), 2014]

Brushing



[M. Bostock]

Multiform & Small Multiples



[Barsky et al., 2008]

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
  - Progress on Implementation
- Due Wed., Nov. 9

Assignment 5

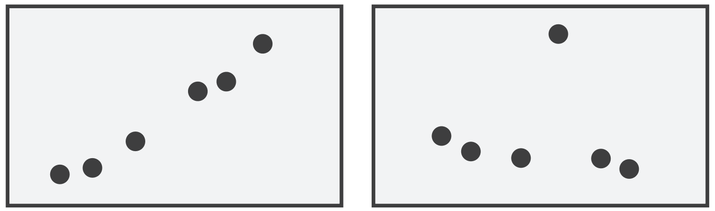
- Focus on Multiple Views and Interaction
- Soon…

Navigation across multiple views

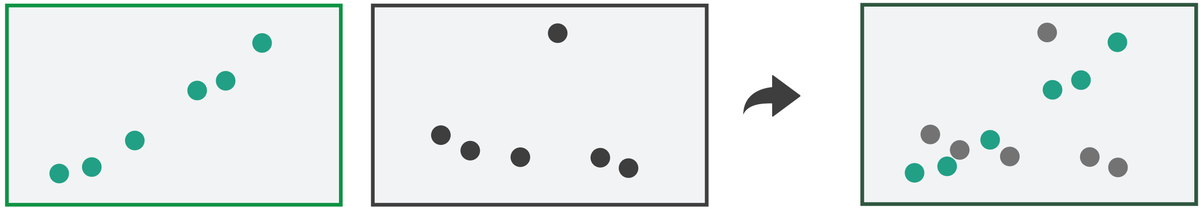
- Often navigation in one view updates navigation in another
- Example: Maps: overview shifts as you move around in detail view
- Selections in one view may trigger selections in another

Multiple Views

Partition into Side-by-Side Views



Superimpose Layers



[Munzner (ill. Maguire), 2014]

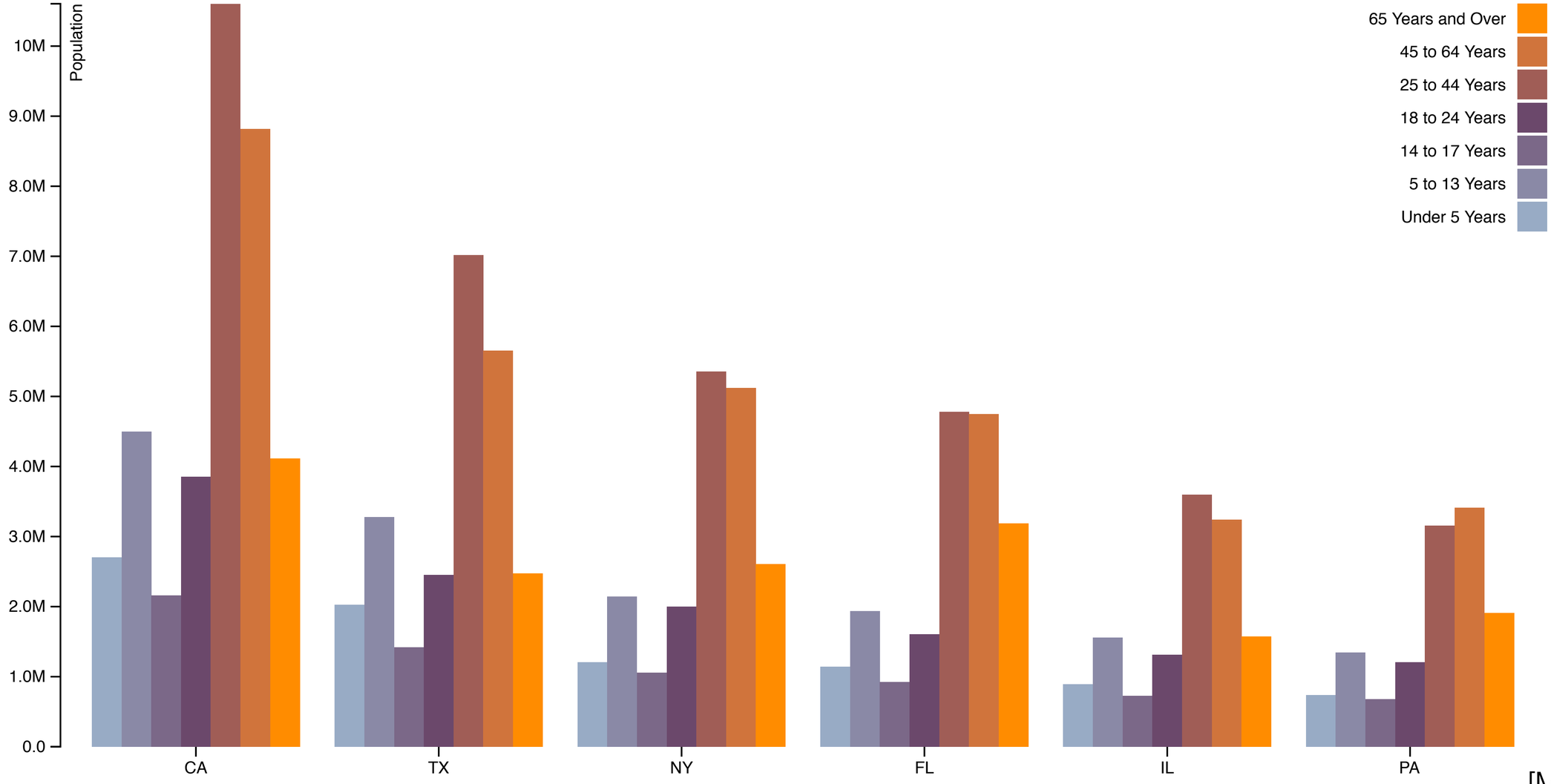
Partitioned Views

- Split dataset into groups and visualize each group
- Extremes: one item per group, one group for all items
- Can be a hierarchy
  - Order: which splits are more "related"?
  - Which attributes are used to split? usually categorical

Glyphs, Views, and Regions

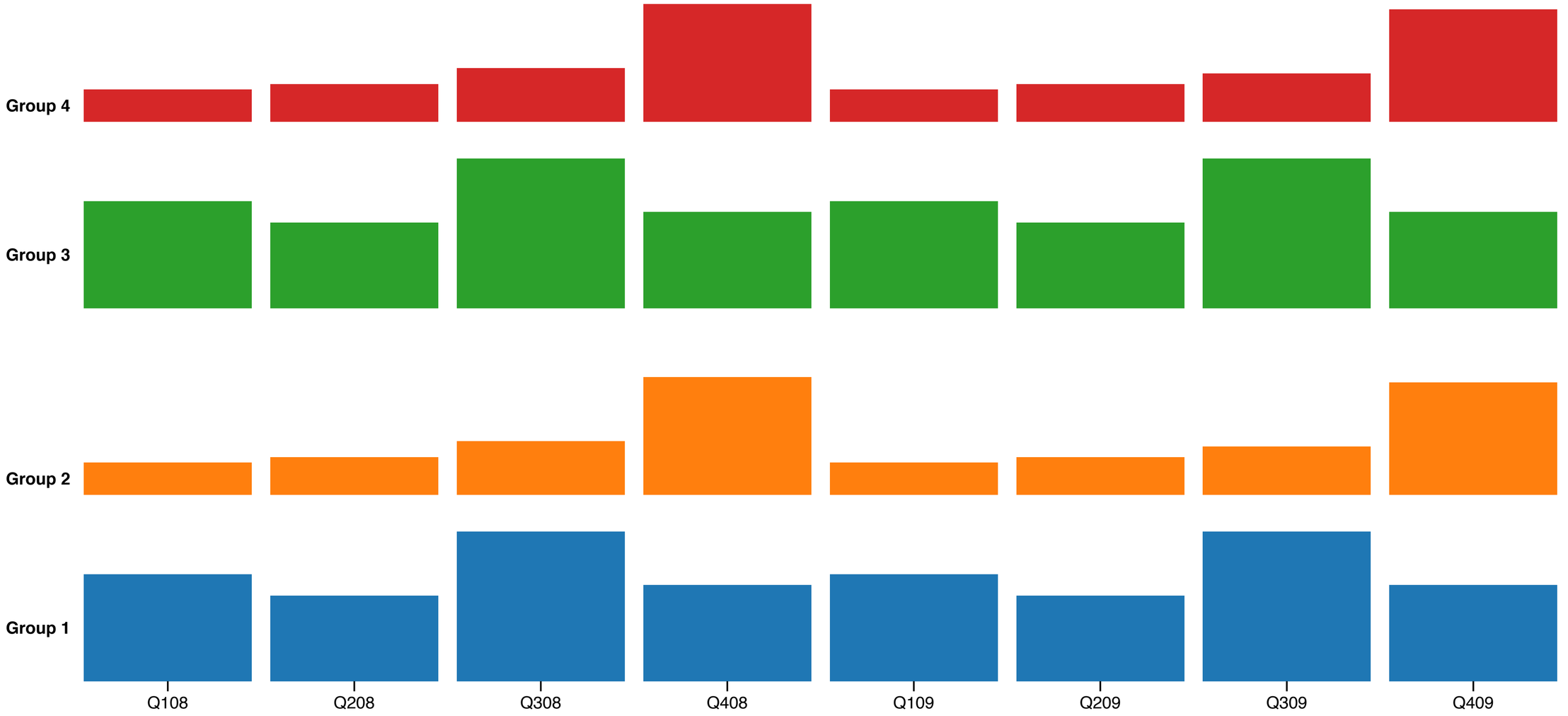
- Glyphs are composed of multiple marks
- Views are a contiguous region of space
- A region is usually associated with a group of data
- Blurry lines of distinction between them

Example: Grouped Bar Chart



[M. Bostock]

Example: Small Multiples Bar Chart

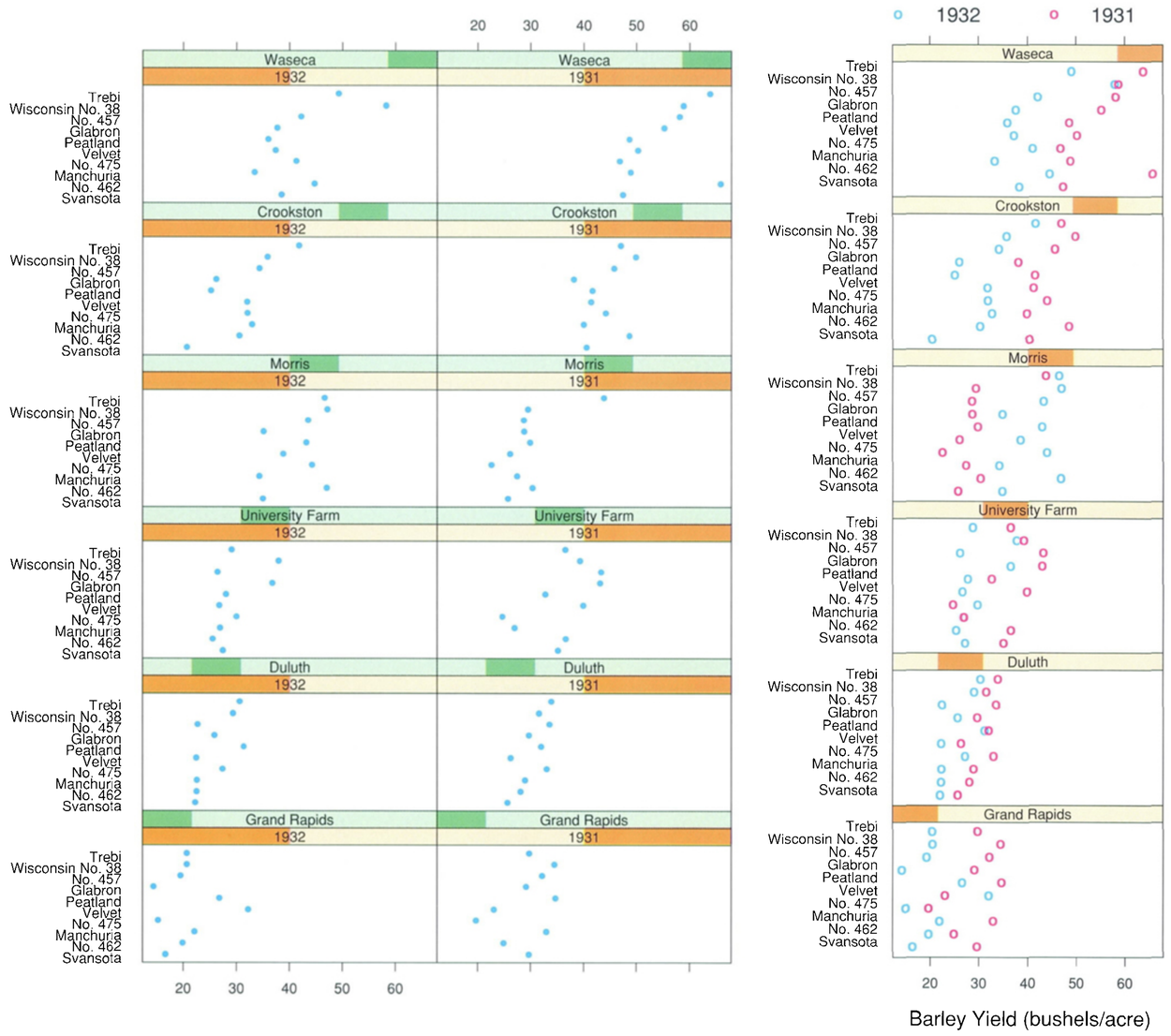


[M. Bostock]

Matrix Alignment & Recursive Subdivision

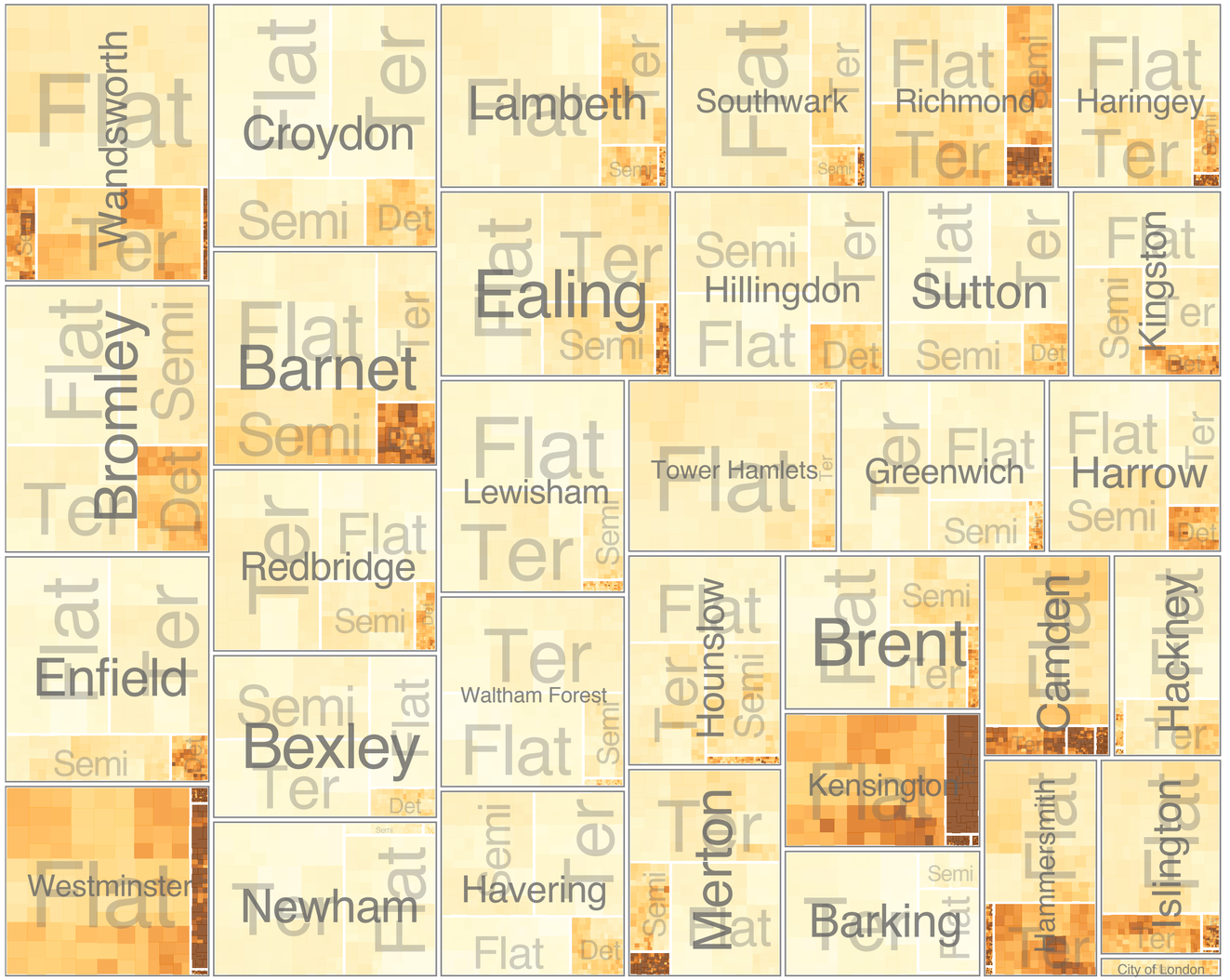
- Matrix Alignment:
  - regions are placed in a matrix alignment
  - splits go to rows and columns
  - main-effects ordering: use summary statistic to determine order of categorical attribute
- Recursive subdivision:
  - Designed for exploration
  - Involves hierarchy
  - User drives the ways data is broken down in recursive manner

Example: Trellis Matrix Alignment



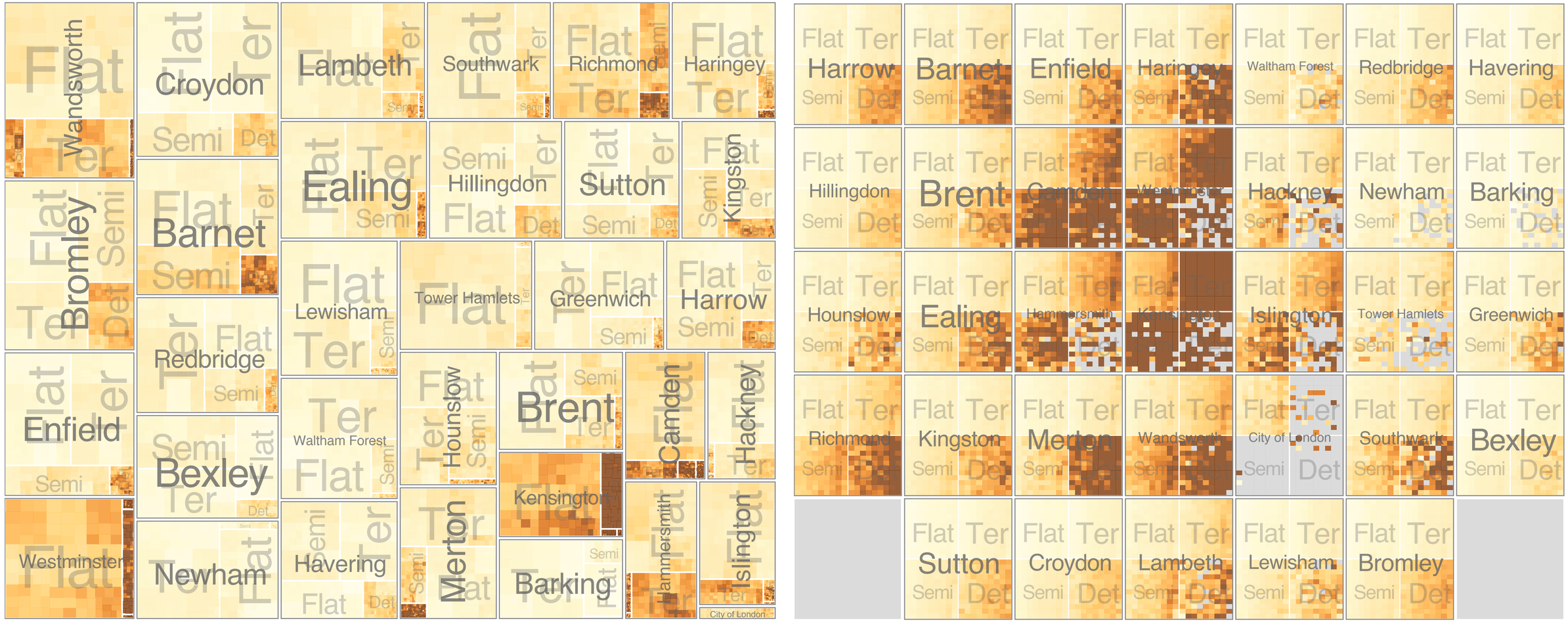
[Becker et al., 1996]

Recursive Subdivision



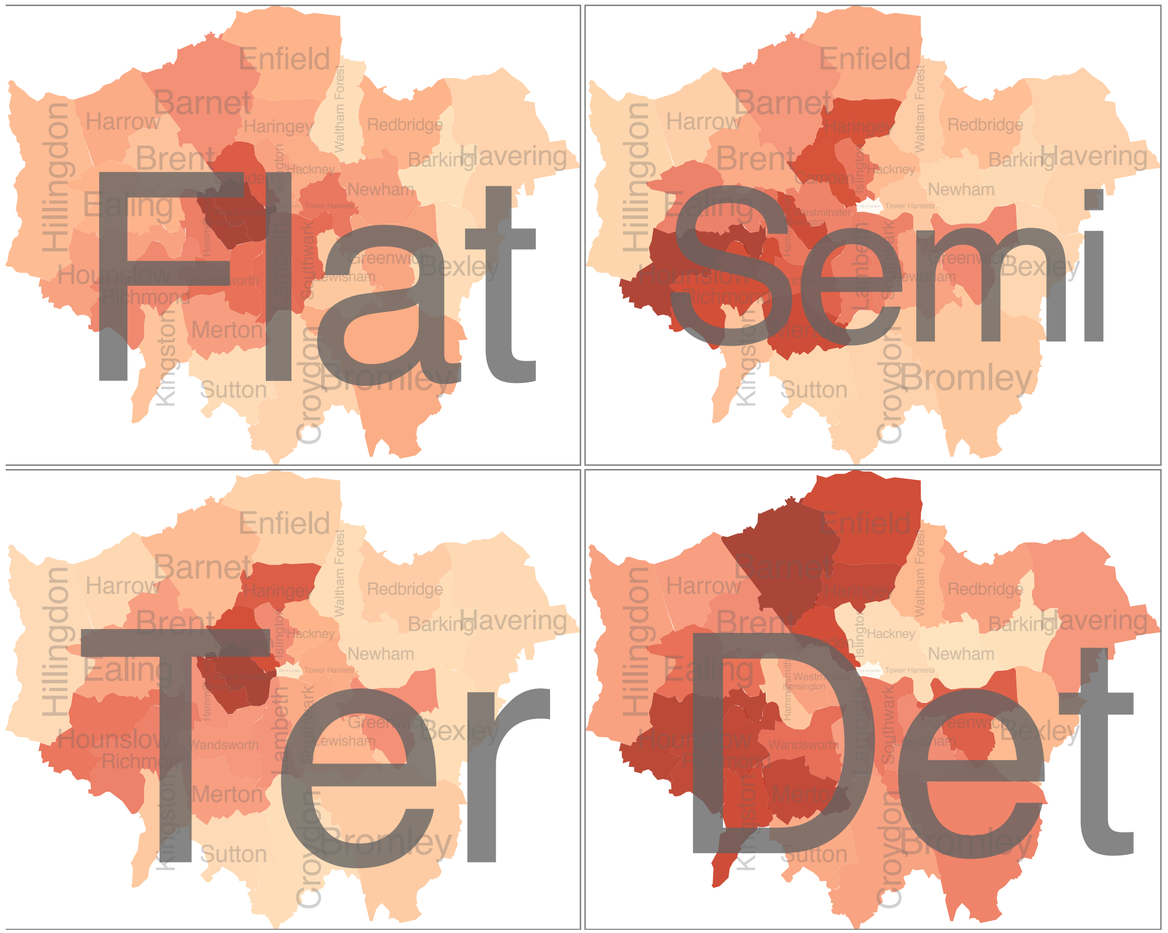
[Slingsby et al., 2009]

Example: HiVE System



[Slingsby et al., 2009]

Example: HiVE System



[Slingsby et al., 2009]

Reducing Complexity

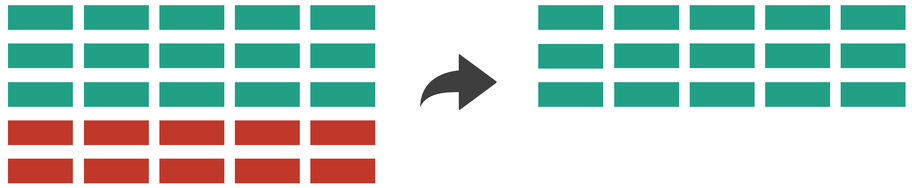
Reducing Complexity

- Too many items or attributes lead to visual clutter
- Interaction and Multiple Views can help, but often lose the ability to start understanding an entire dataset at first glance
- **Reduction** techniques show less data to reduce complexity
- Can reduce items or attributes (both are **elements**)
- **Filtering**: eliminate elements from the current view
  - "out of sight, out of mind"
- **Aggregation**: replace elements with a new element that represents the replaced elements
  - summarization is often challenging to design
- Another method is **focus+context**: show details in the context of an overview

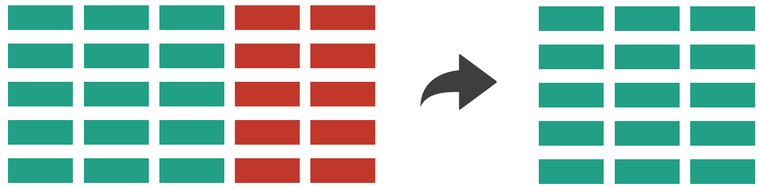
Overview: Reducing Items & Attributes

Filter

- Items

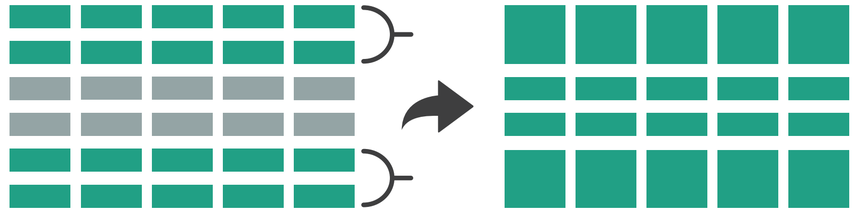


- Attributes

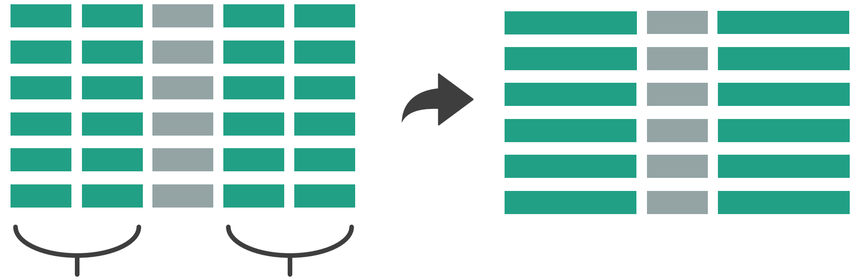


Aggregate

- Items



- Attributes



[Munzner (ill. Maguire), 2014]

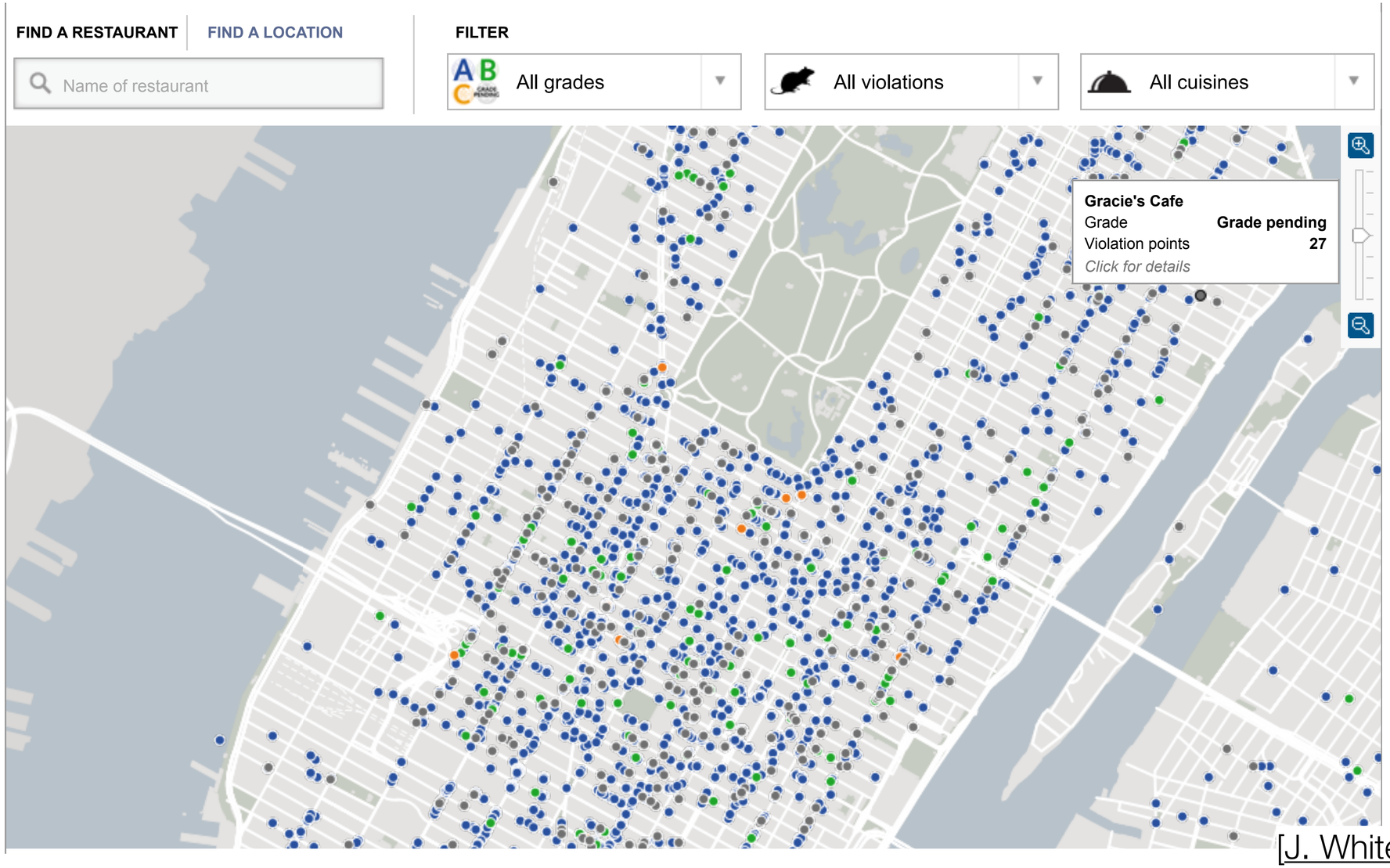
Filtering

- Just don't show certain elements
- Item filtering: most common, eliminate marks for filtered items
- Attribute filtering:
  - attributes often mapped to different channels
  - if mapped to same channel, allows many attributes (e.g. parallel coordinates, star plots), can filter
- How to specify which elements?
  - Pre-defined rules
  - User selection

Filter vs. Query

- Queries start with an empty set of items and **add** items
- Filters start with all items and **remove** items

Example: NYC Health Dept. Restaurant Ratings

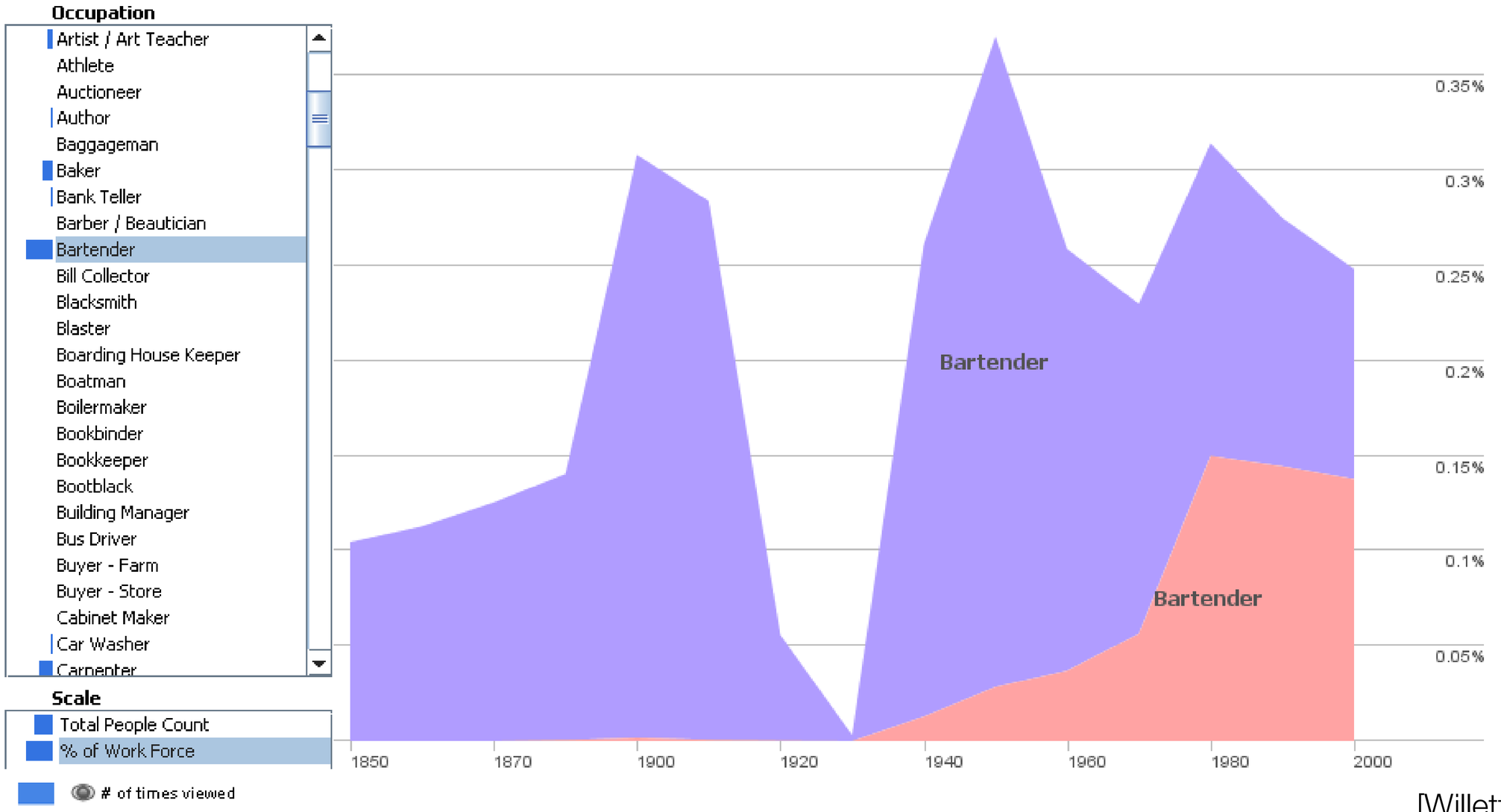


[J. White, New York Times]

Dynamic Filters

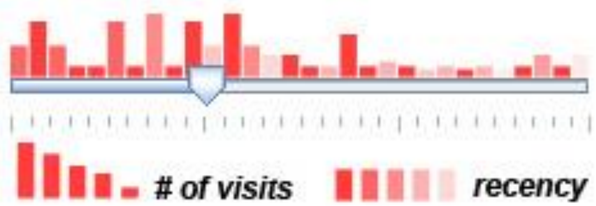
- Interaction need not be with the visualization itself
- Users interact with **widgets** that control which items are shown
  - Sliders, Combo boxes, Text Fields
- Often tied to attribute values
- Examples:
  - All restaurants with an "A" Grade
  - All pizza places
  - All pizza places with an "A" Grade

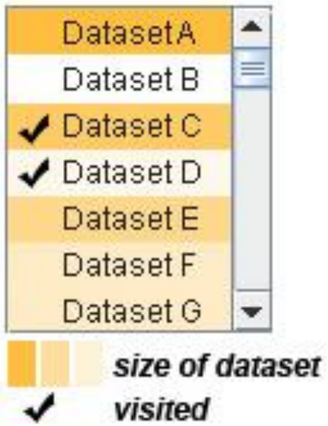
Scented Widgets

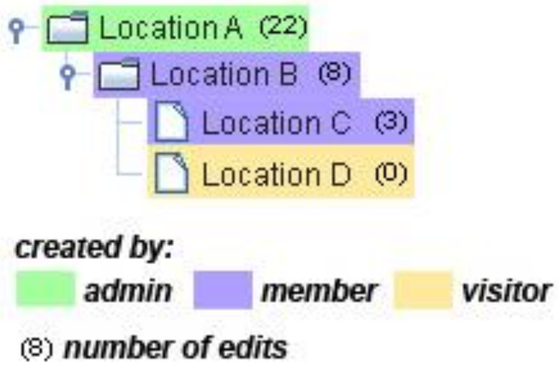


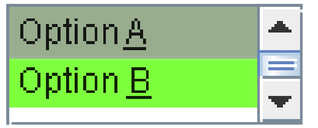
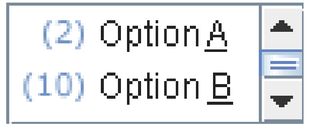
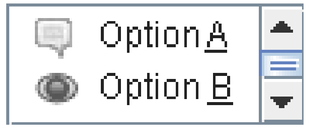
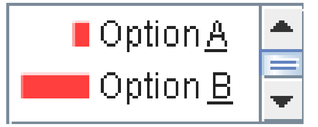
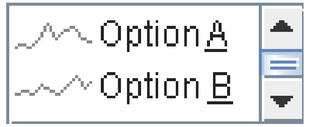
[Willett et al., 2007]

Scented Widgets



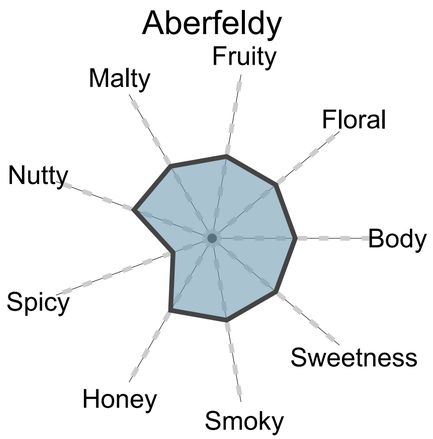


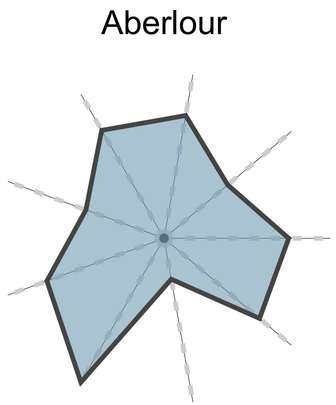


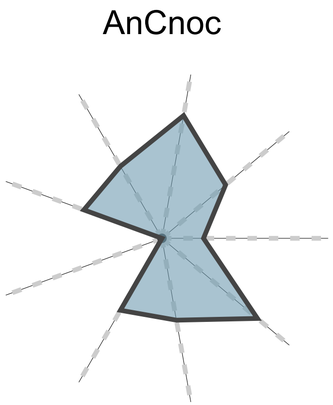
Name	Description	Example
Hue	Varies the hue of the widget (or of a visualization embedded in it)	
Saturation	Varies the saturation of the widget (or of a visualization embedded in it)	
Opacity	Varies the saturation of the widget (or of a visualization embedded in it)	
Text	Inserts one or more small text figures into the widget	
Icon	Inserts one or more small icons into the widget.	
Bar Chart	Inserts one or more small bar chart visualizations into the widget	
Line Chart	Inserts one or more small line chart visualizations into the widget	

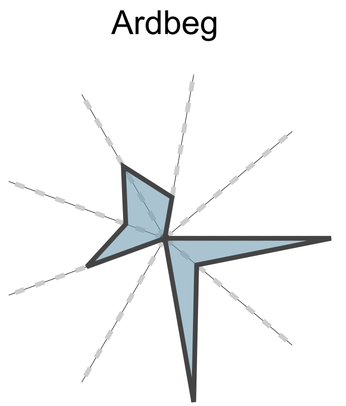
[Willett et al., 2007]

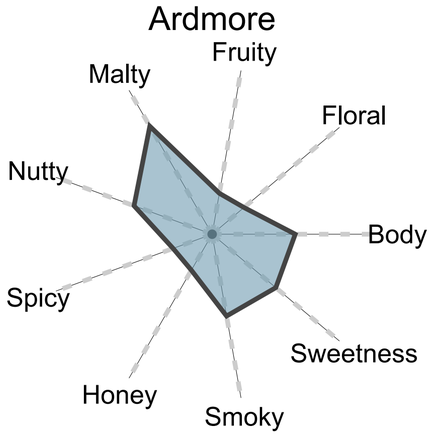
Star Plots (aka Radar Charts)

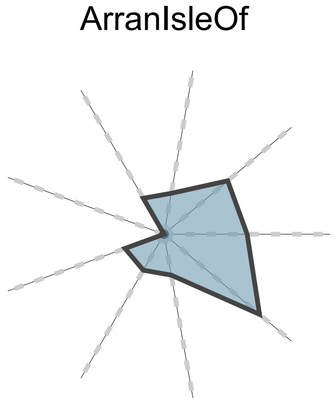


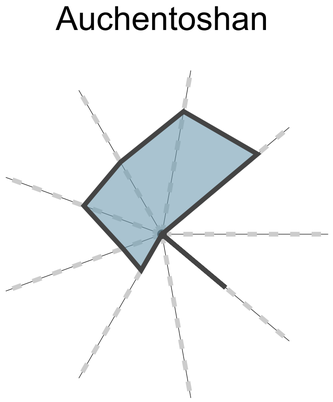


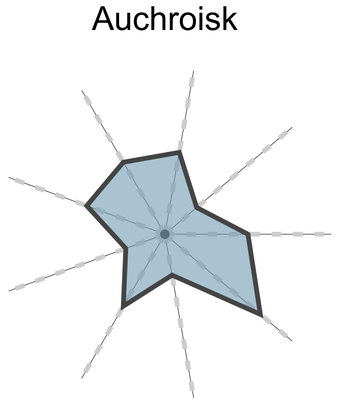






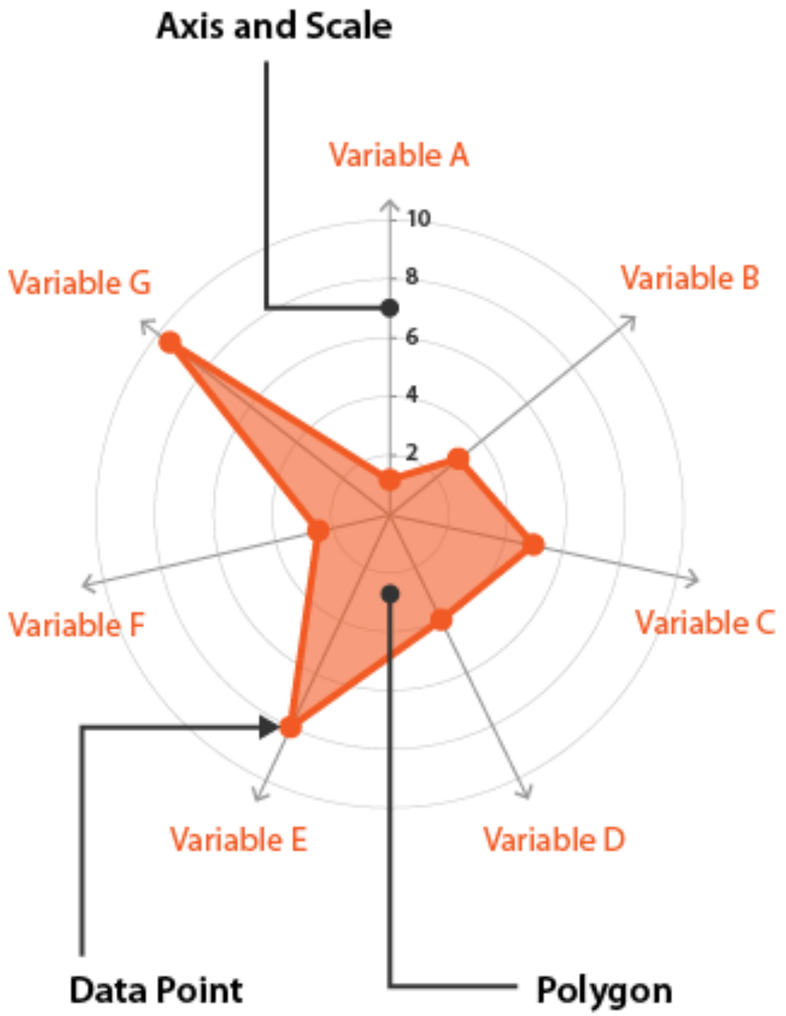






[K. Schaul]

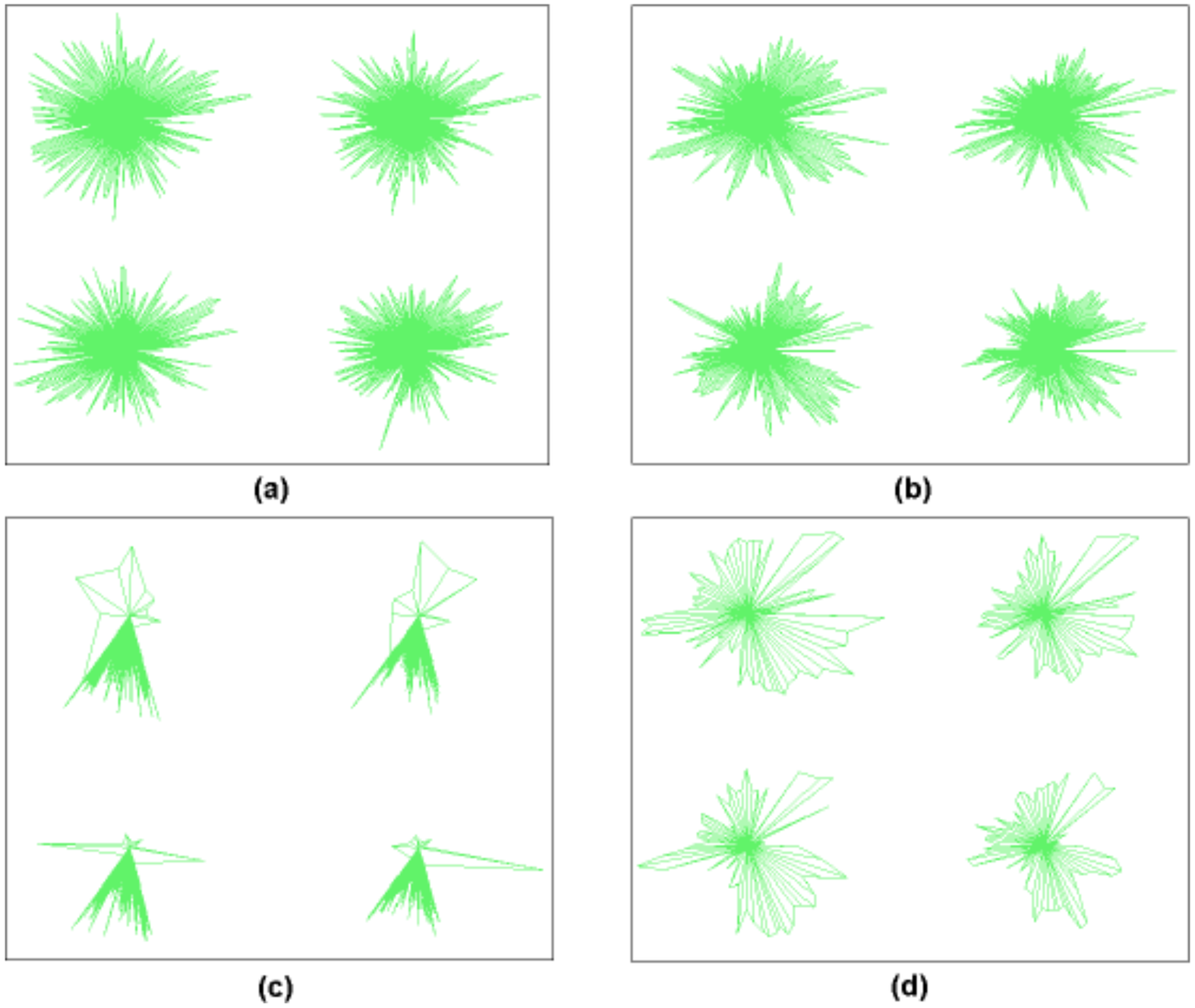
Star Plot / Radar Chart



- Use:
  - Compare variables
  - Similarities/differences of items
  - Locate outliers
- Considerations:
  - Order of axes
  - Too many axes cause problems

[S. Ribecca]

Attribute Filtering on Star Plots



[Yang et al., 2003]

Attribute Filtering

- How to choose which attributes should be filtered?
  - User selection?
  - Statistics: similarity measures, attributes with low variance are not as interesting when comparing items

- Can be combined with item filtering

Aggregation

Aggregation

- Usually involves **derived** attributes
- Examples: mean, median, mode, min, max, count, sum
- Remember expressiveness principle: still want to avoid implying trends or similarities based on aggregation

I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

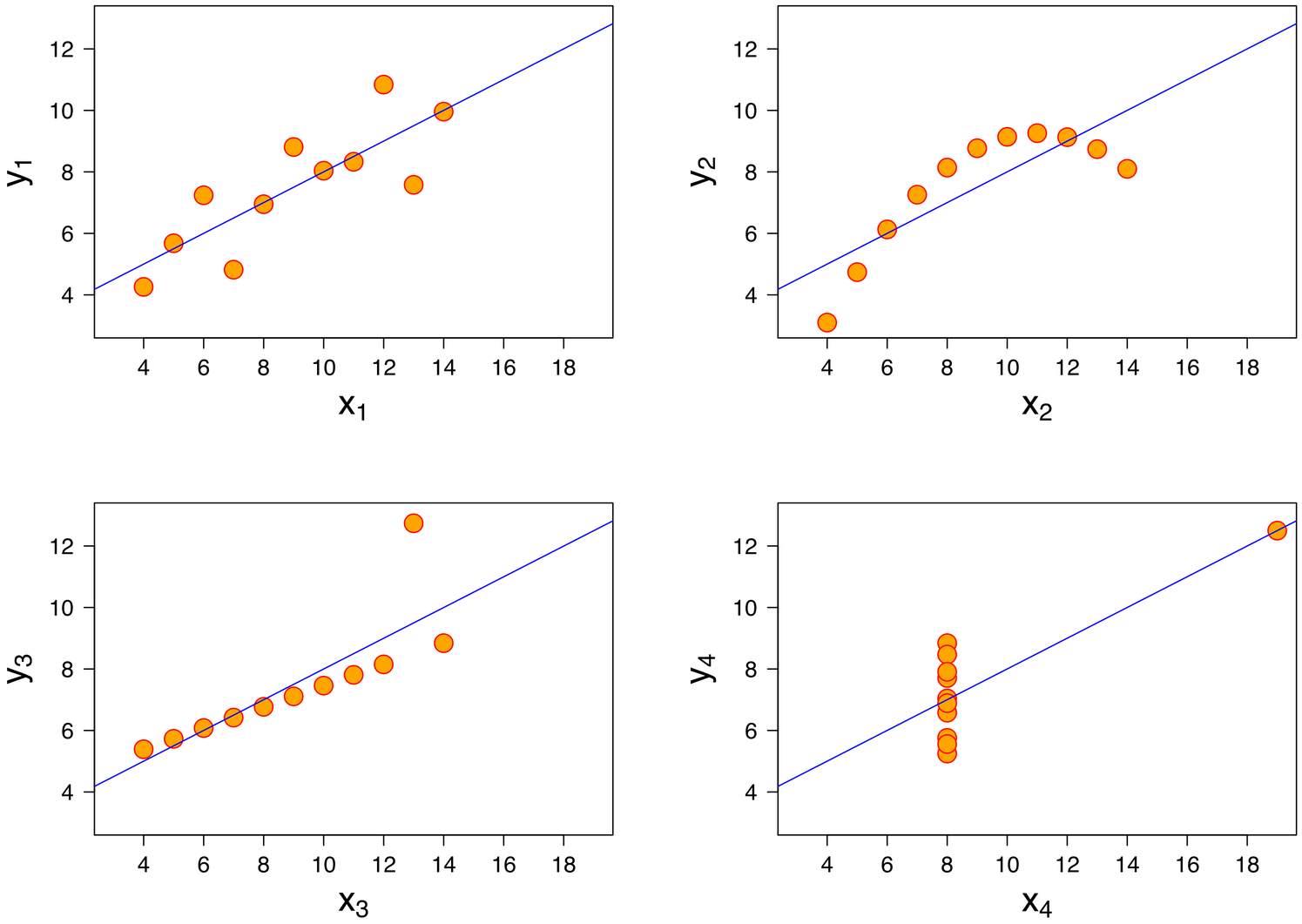
Aggregation

- Usually involves **derived** attributes
- Examples: mean, median, mode, min, max, count, sum
- Remember expressiveness principle: still want to avoid implying trends or similarities based on aggregation

Mean of x	9
Variance of x	11
Mean of y	7.50
Variance of y	4.122
Correlation	0.816

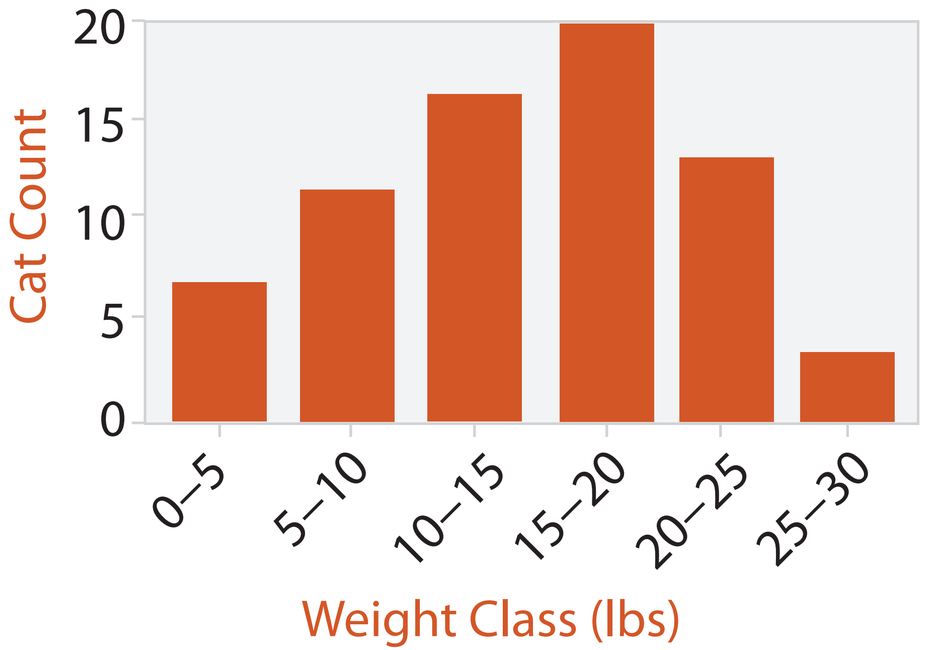
I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

Anscombe's Quartet



[F. J. Anscombe]

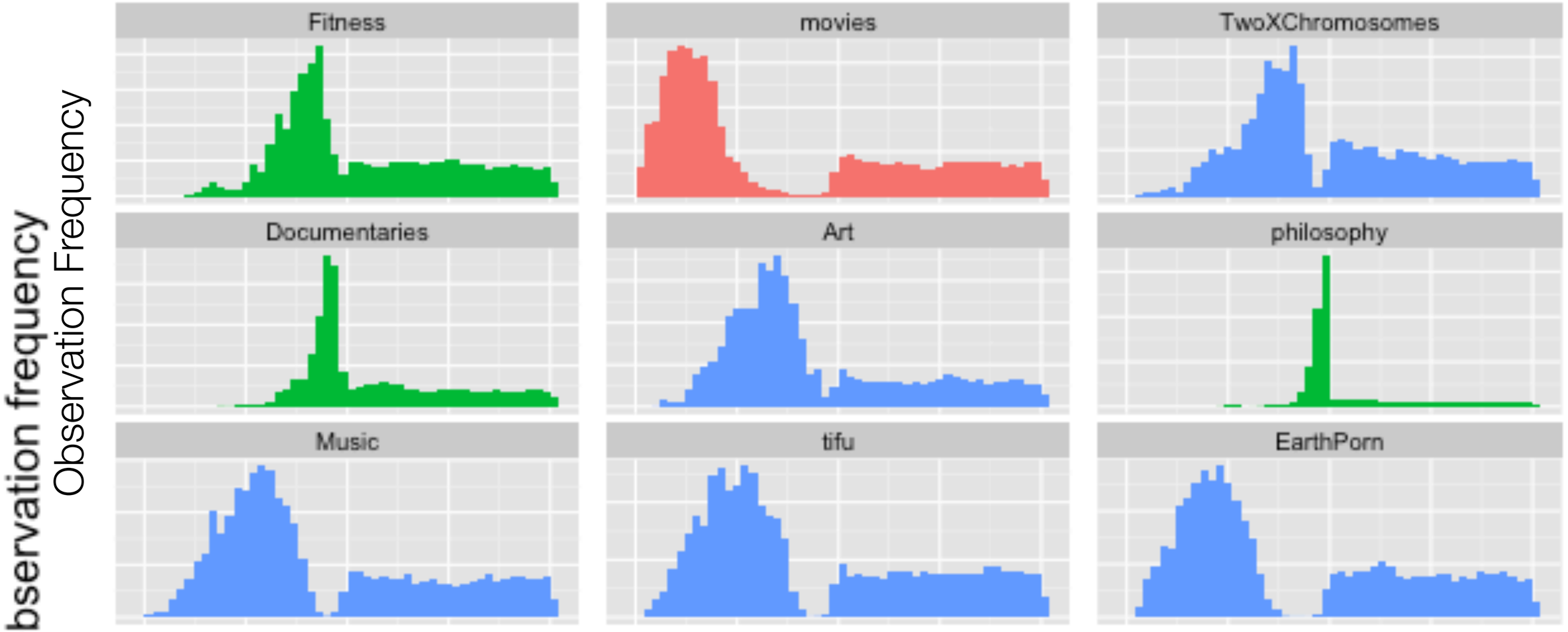
Aggregation: Histograms



- Very similar to bar charts
- Often shown without space between (continuity)
- Choice of number of bins
  - Important!
  - Viewers may infer different trends based on the layout

[Munzner (ill. Maguire), 2014]

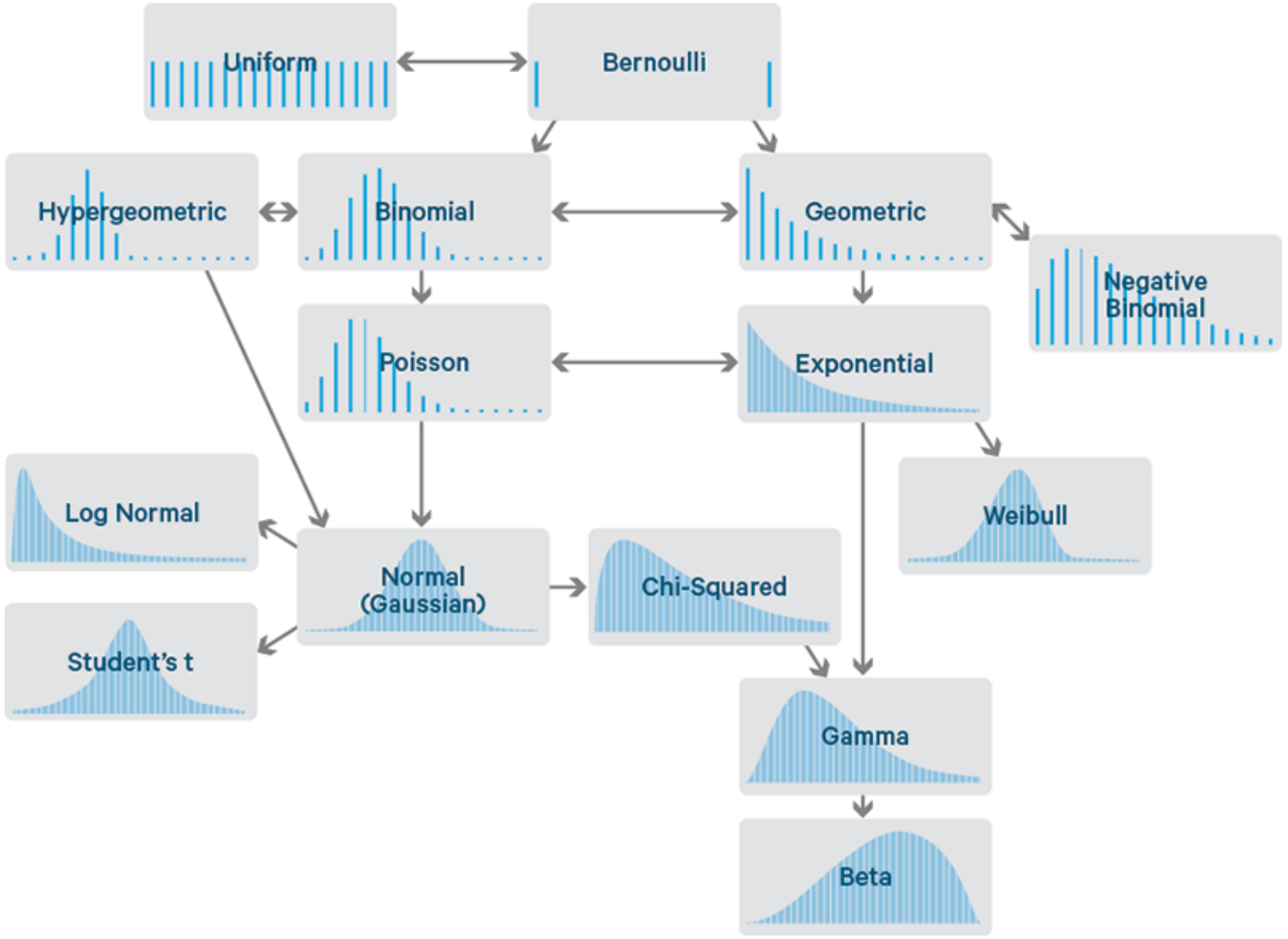
Aggregation: Histograms



Observed ranks of posts by subreddit

["The reddit Front Page is Not a Meritocracy", T. W. Schneider]

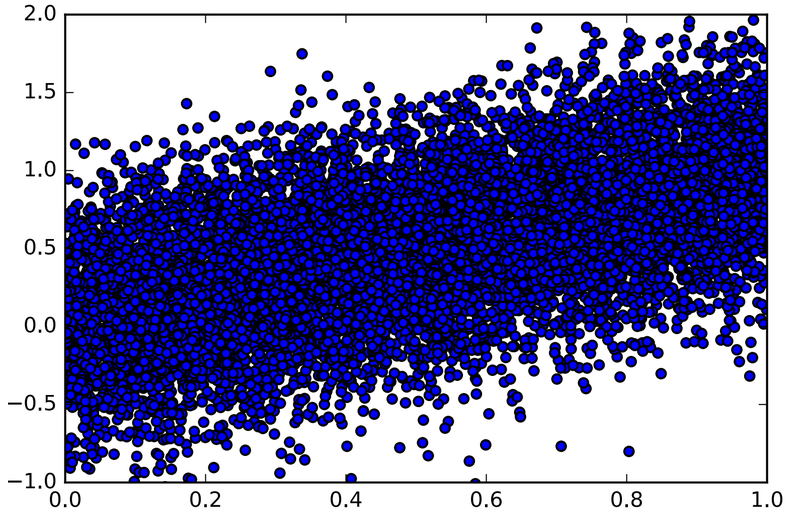
Common Distributions

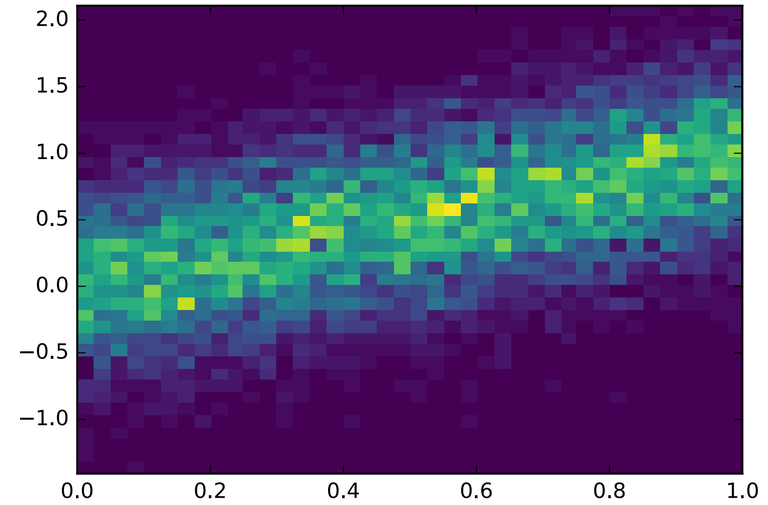


[Cloudera]

Binning Scatterplots

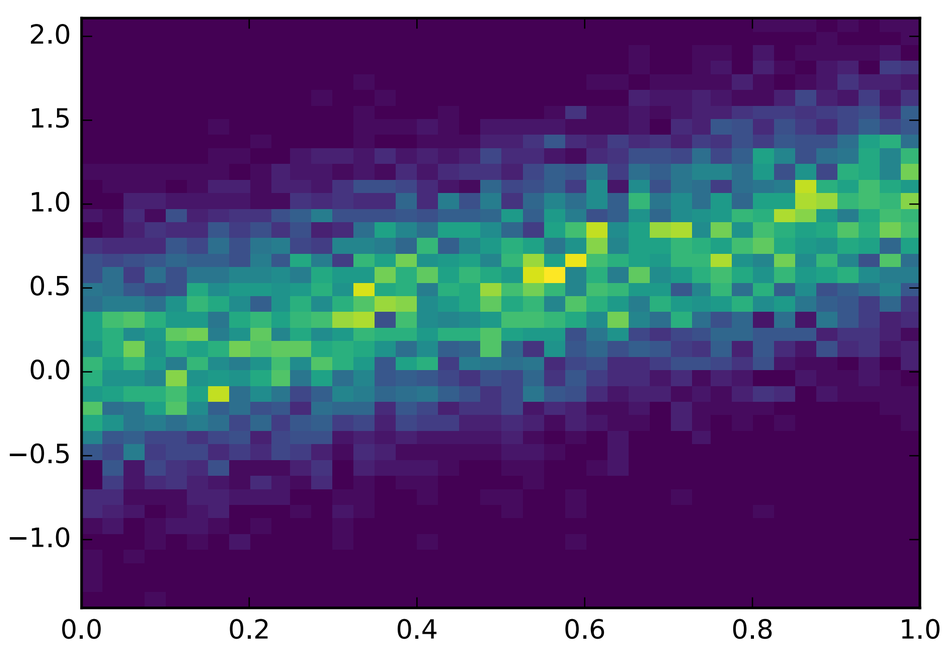
- At some point, cannot see density
- Blobs on top of blobs
- 2D Histogram is a histogram in 2D encoded using color instead of height
- Each region is aggregated

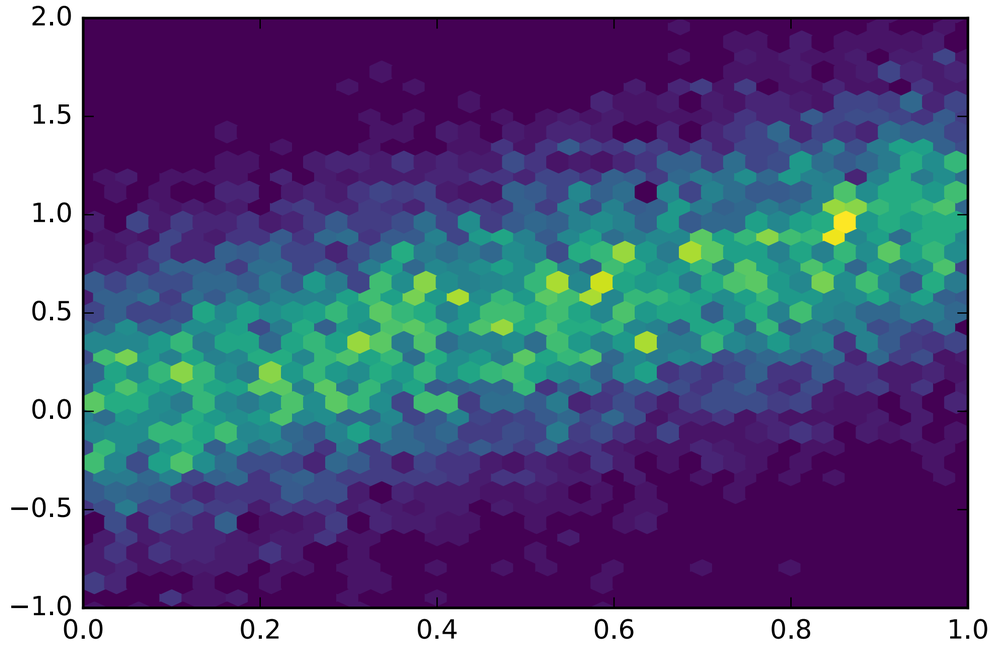




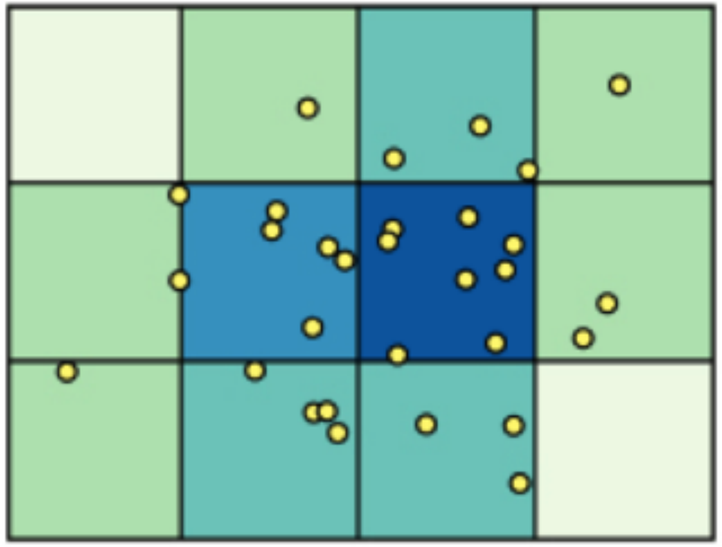
Binning

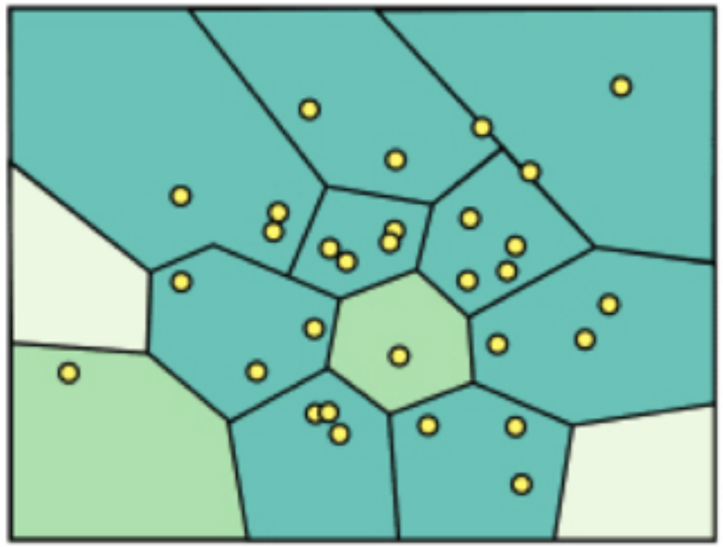
- Hexagonal bins are more circular
- Distance to the edge is not as variable
- More efficient aggregation around the center of the bin

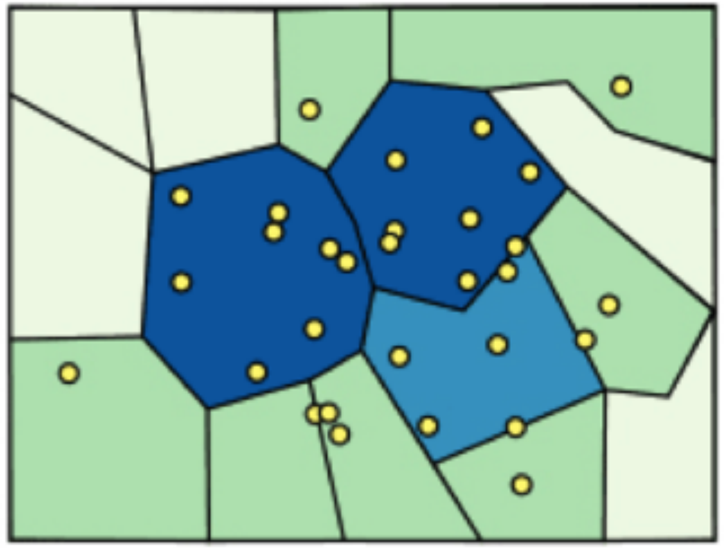




Spatial Aggregation



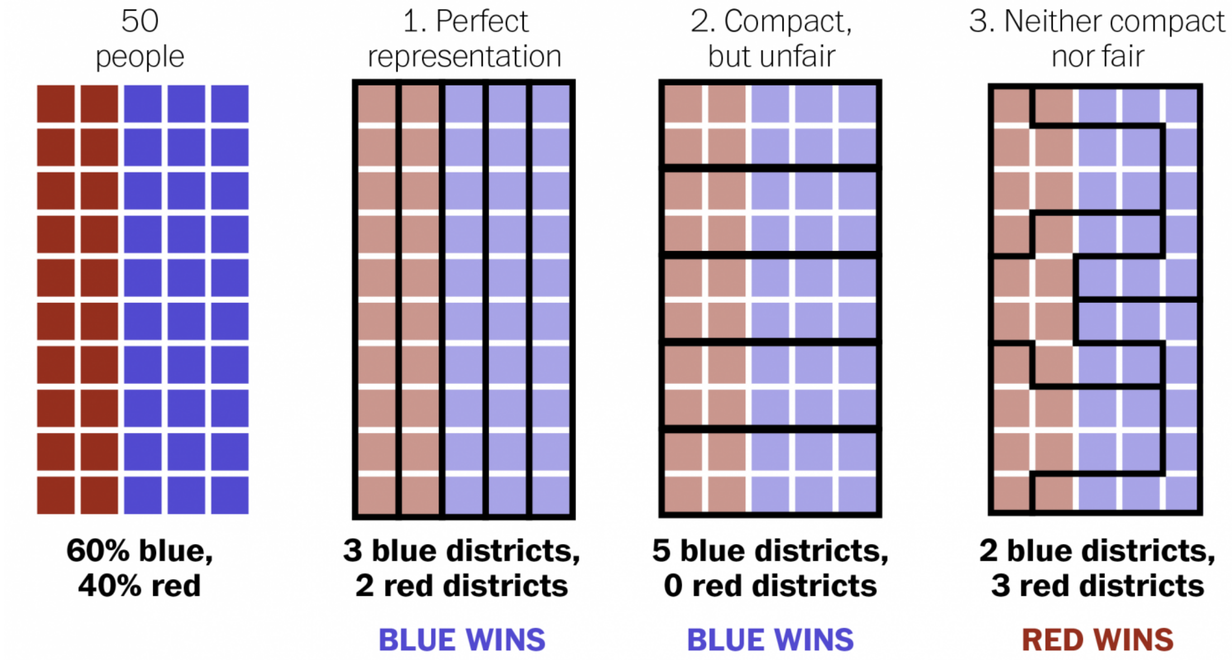


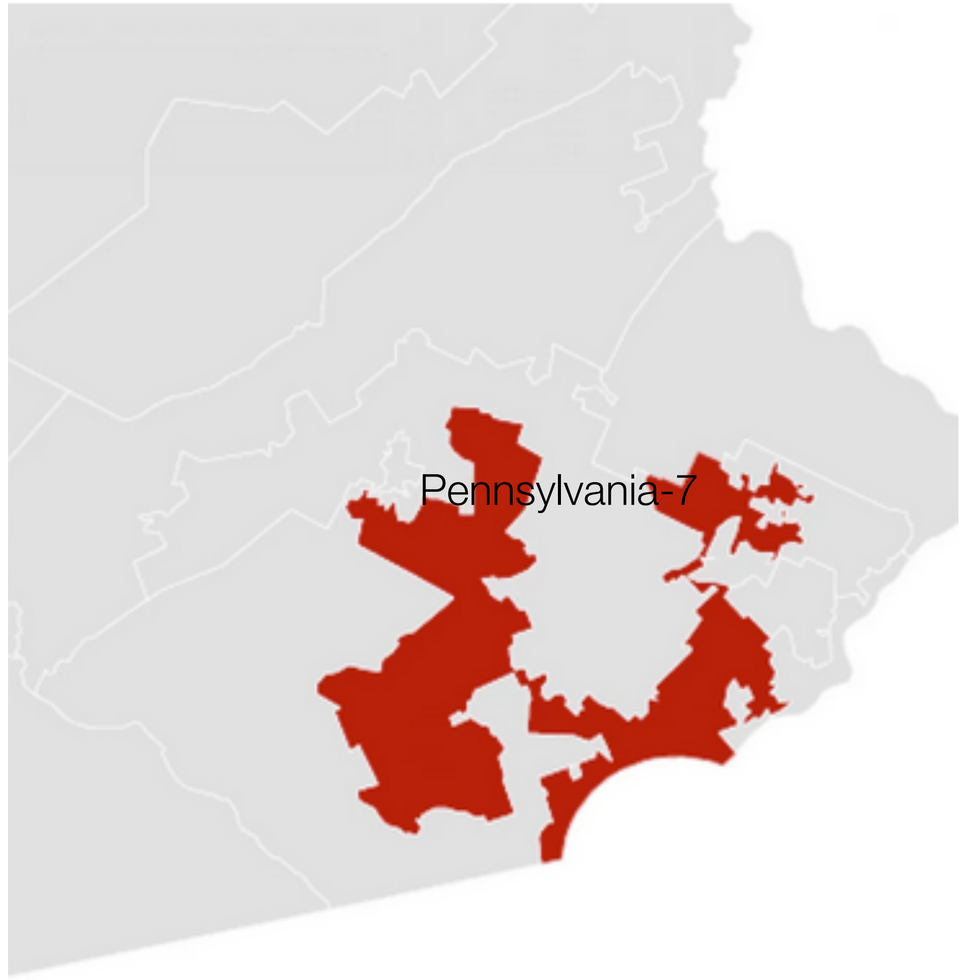


[Penn State, GEOG 486]

Modifiable Areal Unit Problem

- How you draw boundaries impacts the type of aggregation you get
- Similar to bins in histograms
- Gerrymandering





[Wonkblog, Washington Post, Adapted from S. Nass]