# Lectures 3&4: Facet into Multiple Views

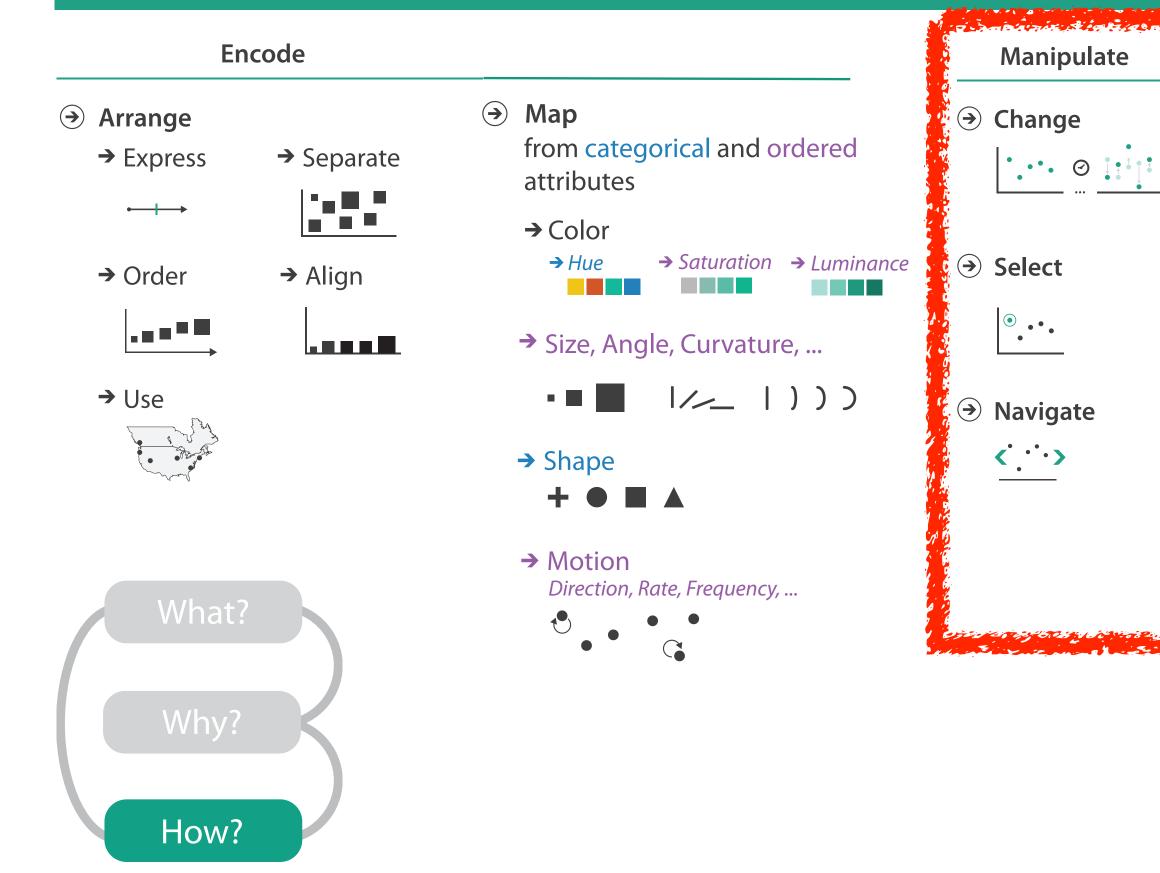
#### Tamara Munzner

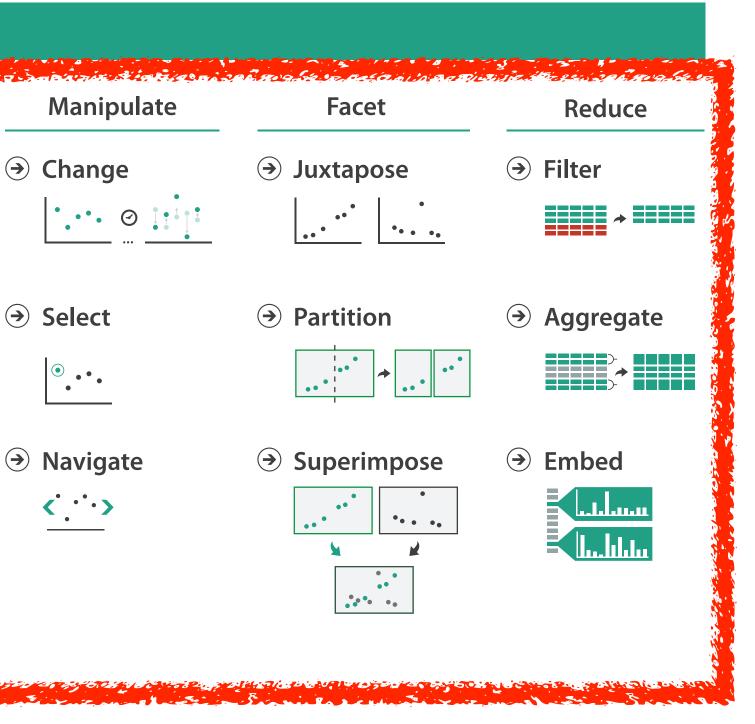
Department of Computer Science University of British Columbia

DSCI 532: Data Visualization 11 Lectures 3&4: 27 & 29 March 2017

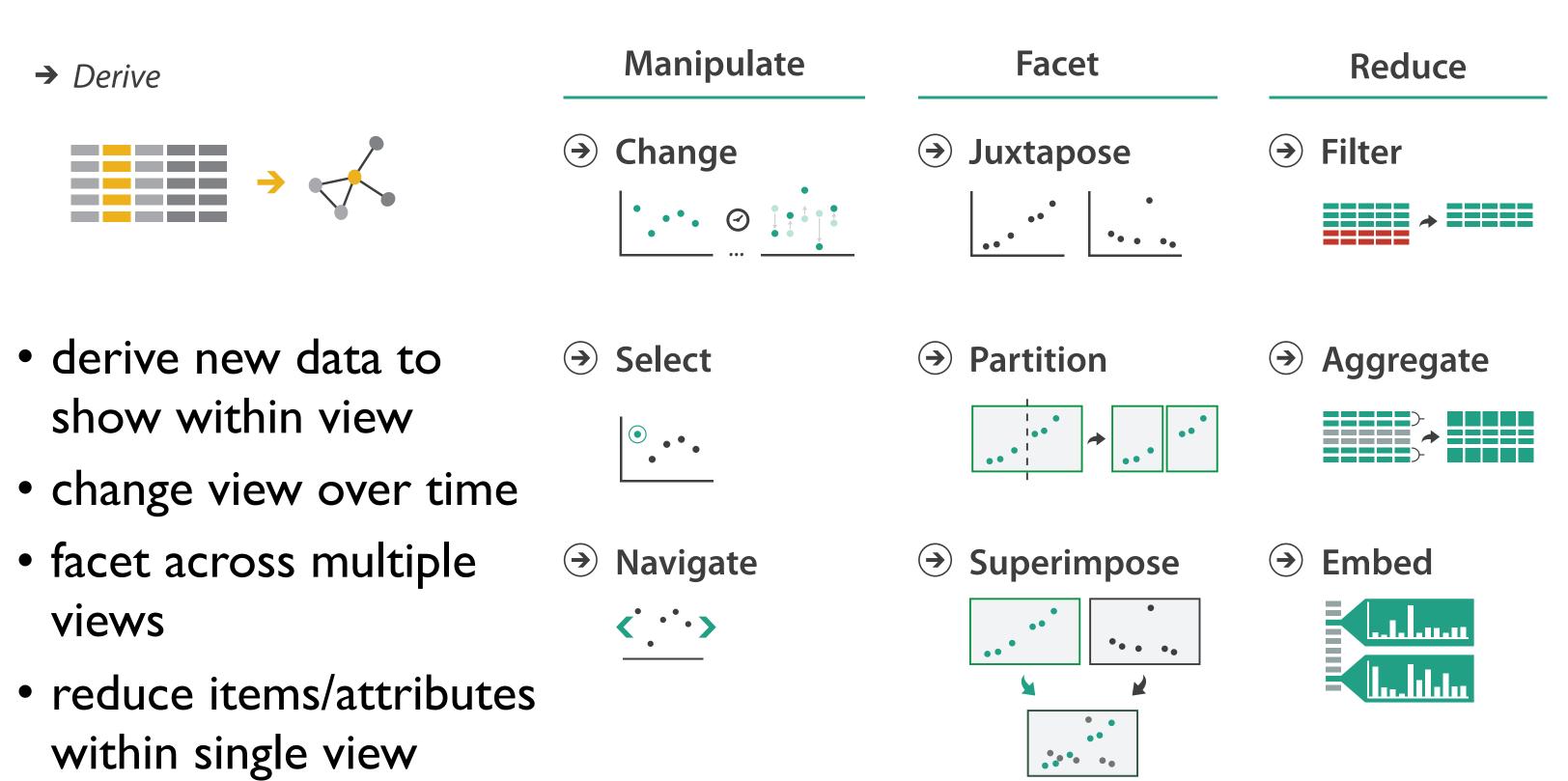
https://github.ubc.ca/ubc-mds-2016/DSCI\_532\_viz-2\_students

#### How?





## How to handle complexity: I previous strategy + 3 more



#### Facet

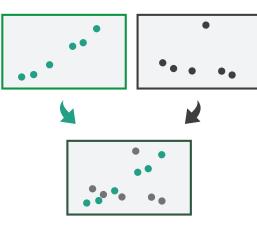




#### Partition







4

### Juxtapose and coordinate views

- linked views
  - simultaneously visible multiple views
  - linked together such that actions in one view affect the others

- → Share Encoding: Same/Different
  - $\rightarrow$  Linked Highlighting



→ Share Data: All/Subset/None



Share Navigation

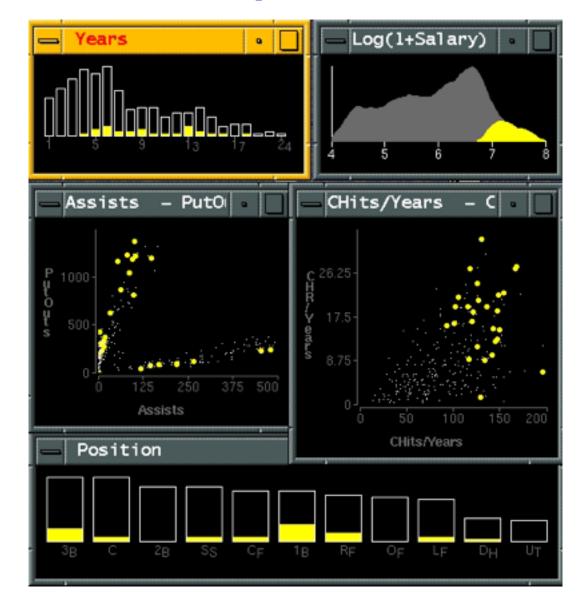






## Idiom: Linked highlighting

- see how regions contiguous in one view are distributed within another
  - -powerful and pervasive interaction idiom
- encoding: different
  - multiform
    - rationale: single monolithic view has strong limits on number of attributes that can be shown simultaneously
- data: all shared

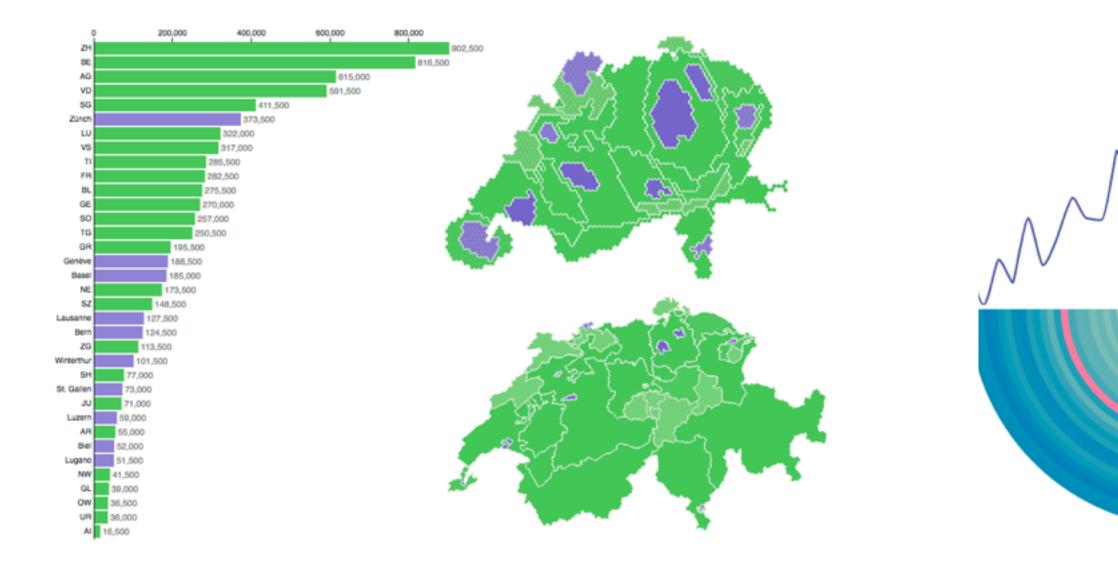


[Visual Exploration of Large Structured Datasets. Wills. Proc. New Techniques and Trends in Statistics (NTTS), pp. 237–246. IOS Press, 1995.]

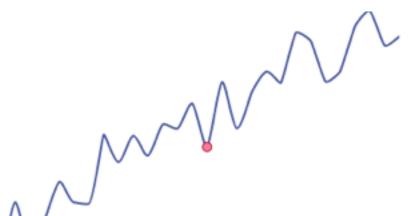
#### System: **EDV**

### Linked views

• unidirectional vs bidirectional linking



http://www.ralphstraumann.ch/projects/swiss-population-cartogram/





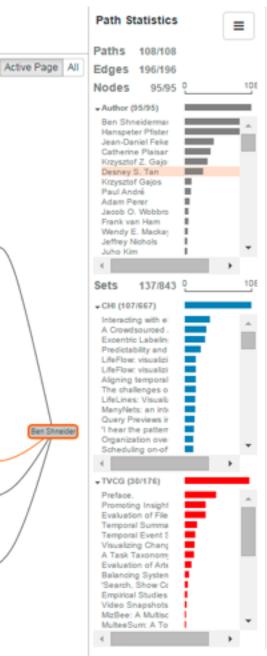
#### http://peterbeshai.com/linked-highlighting-react-d3-reflux/

### Complex linked multiform views



#### https://www.youtube.com/watch?v=aZF7AC8aNXo

#### System: Pathfinder



## Idiom: bird's-eye maps

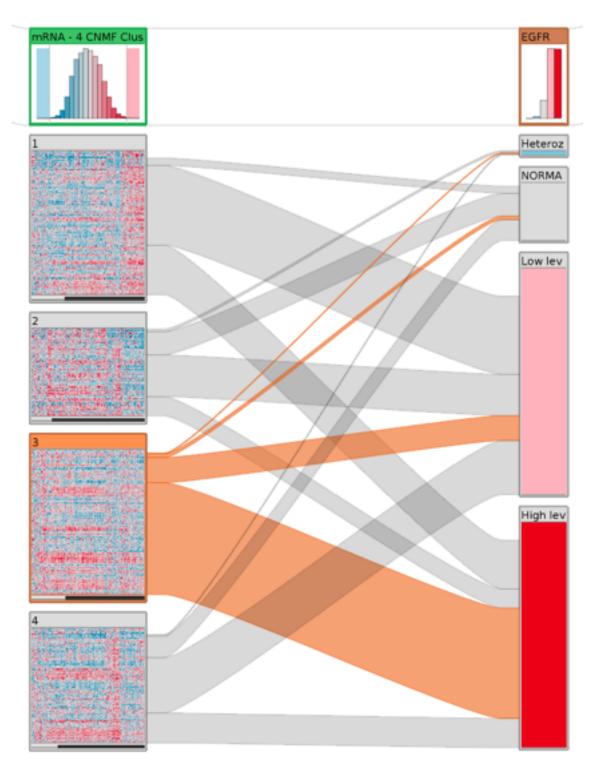
- encoding: same
- data: subset shared
- navigation: shared
   –bidirectional linking
- differences
  - -viewpoint
  - -(size)
- overview-detail



[A Review of Overview+Detail, Zooming, and Focus+Context Interfaces. Cockburn, Karlson, and Bederson. ACM Computing Surveys 41:1 (2008), 1–31.]

## System: Google Maps

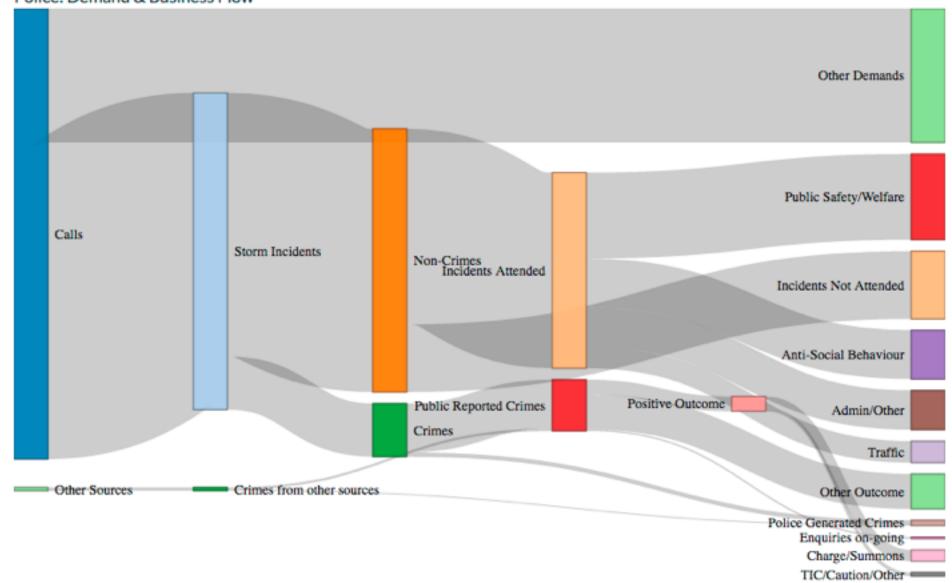
#### **Overview-detail**



#### https://www.youtube.com/watch?v=UcKDbGqHsdE



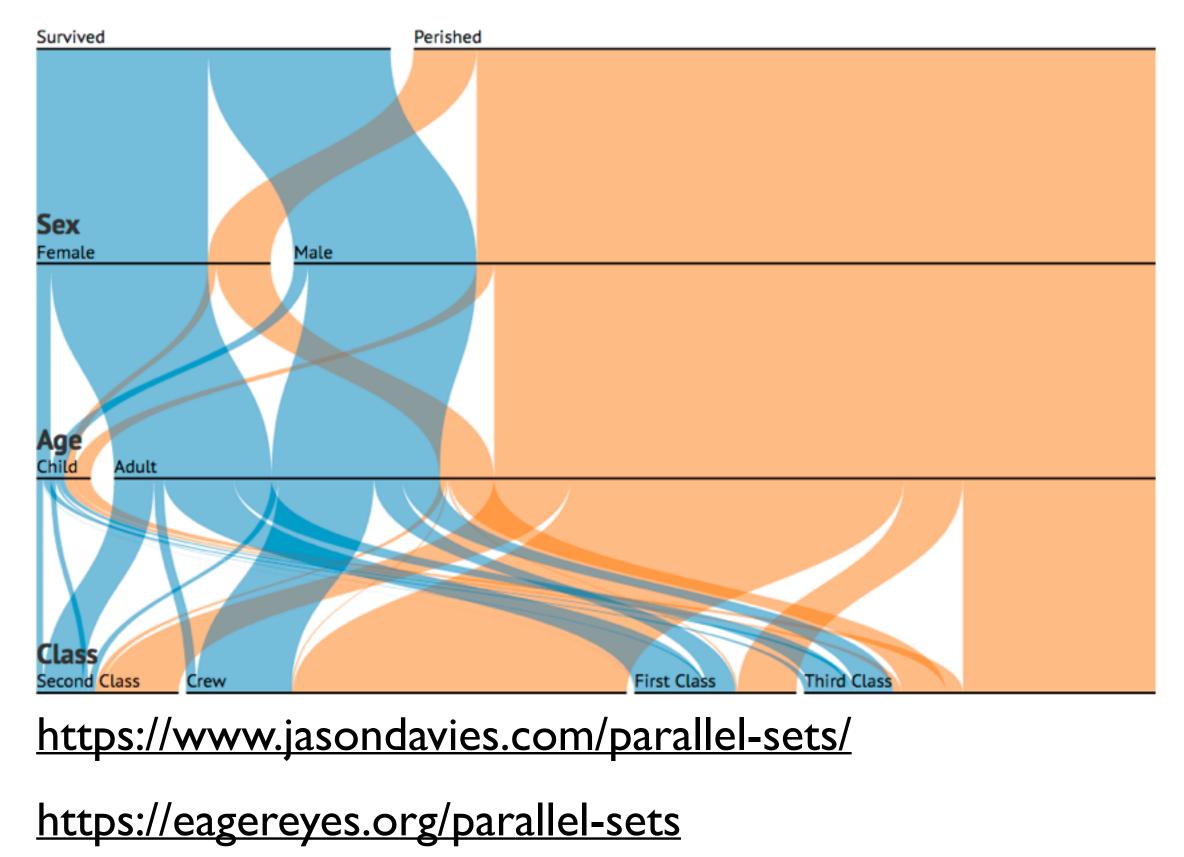
## Shiny example



Police: Demand & Business Flow

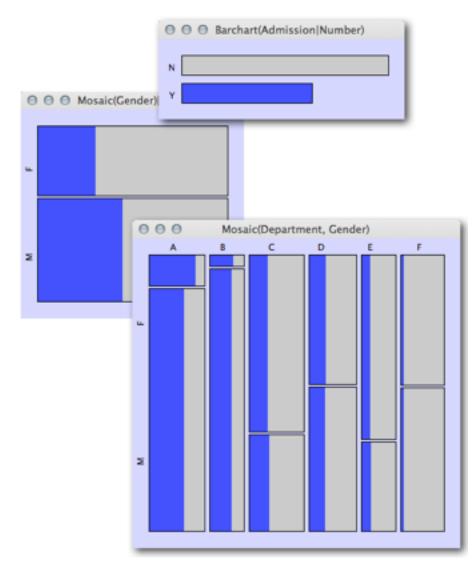
#### https://gallery.shinyapps.io/TSupplyDemand/

### Idiom: Parallel sets



## Idiom: Mosaic plots





<u>http://www.theusrus.de/blog/understanding-mosaic-plots/</u>

http://www.theusrus.de/Mondrian/

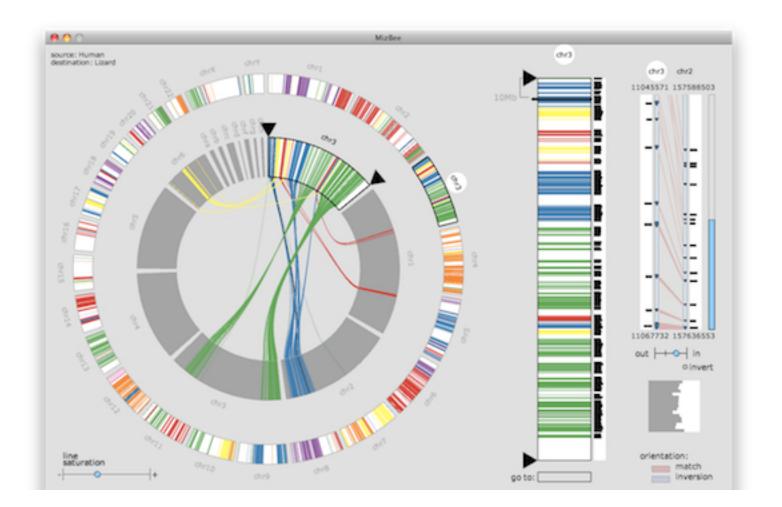
http://www.theusrus.de/blog/making-movies/

#### System: Mondrian

#### **Overview-detail**



- multiscale: three viewing levels
  - -tooling: processing (modern version: <u>p5js.org</u>)



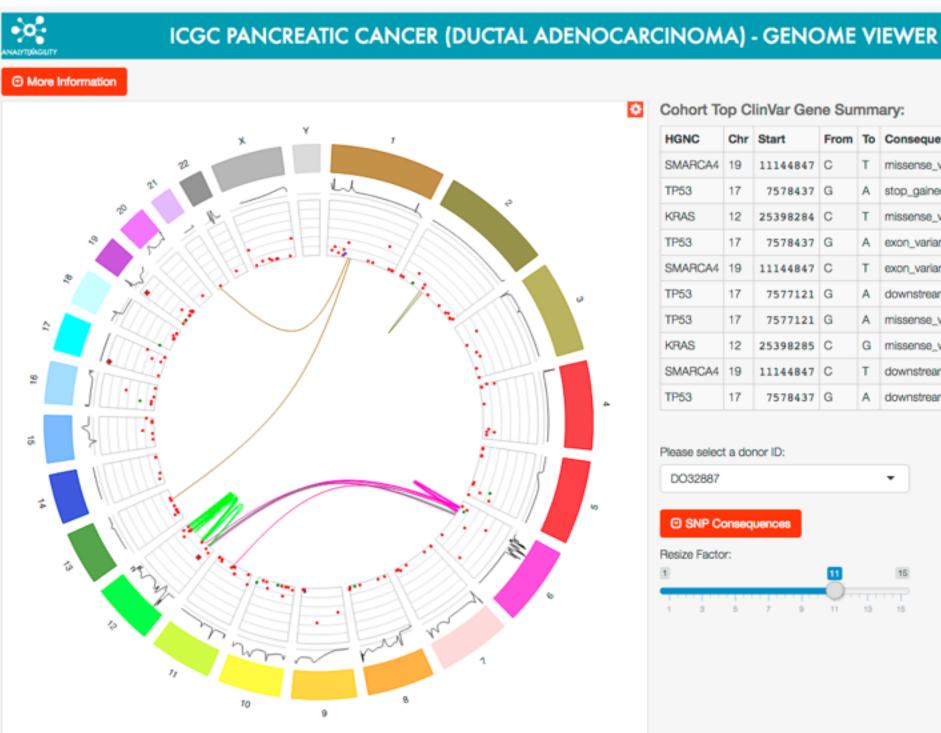
#### https://www.youtube.com/watch?v=86p7brwuz2g

#### System: MizBee

## Shiny example

- APGI genome browser -tooling: R/Shiny

  - -interactivity
    - tooltip detail on demand on hover
    - expand/contract chromosomes
    - expand/contract control panes



#### https://gallery.shinyapps.io/genome\_browser/

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SMARCA4	19	11144847	С	т	missense_variant	18
TP53	17	7578437	G	A	stop_gained	18
<b>KRAS</b>	12	25398284	С	т	missense_variant	12
TP53	17	7578437	G	A	exon_variant	10
SMARCA4	19	11144847	С	т	exon_variant	8
TP53	17	7577121	G	Α	downstream_gene_variant	6
TP53	17	7577121	G	A	missense_variant	6
KRAS	12	25398285	С	G	missense_variant	4
SMARCA4	19	11144847	С	т	downstream_gene_variant	4
TP53	17	7578437	G	А	downstream_gene_variant	4

#### Cohort Top ClinVar Gene Summary



DO3288

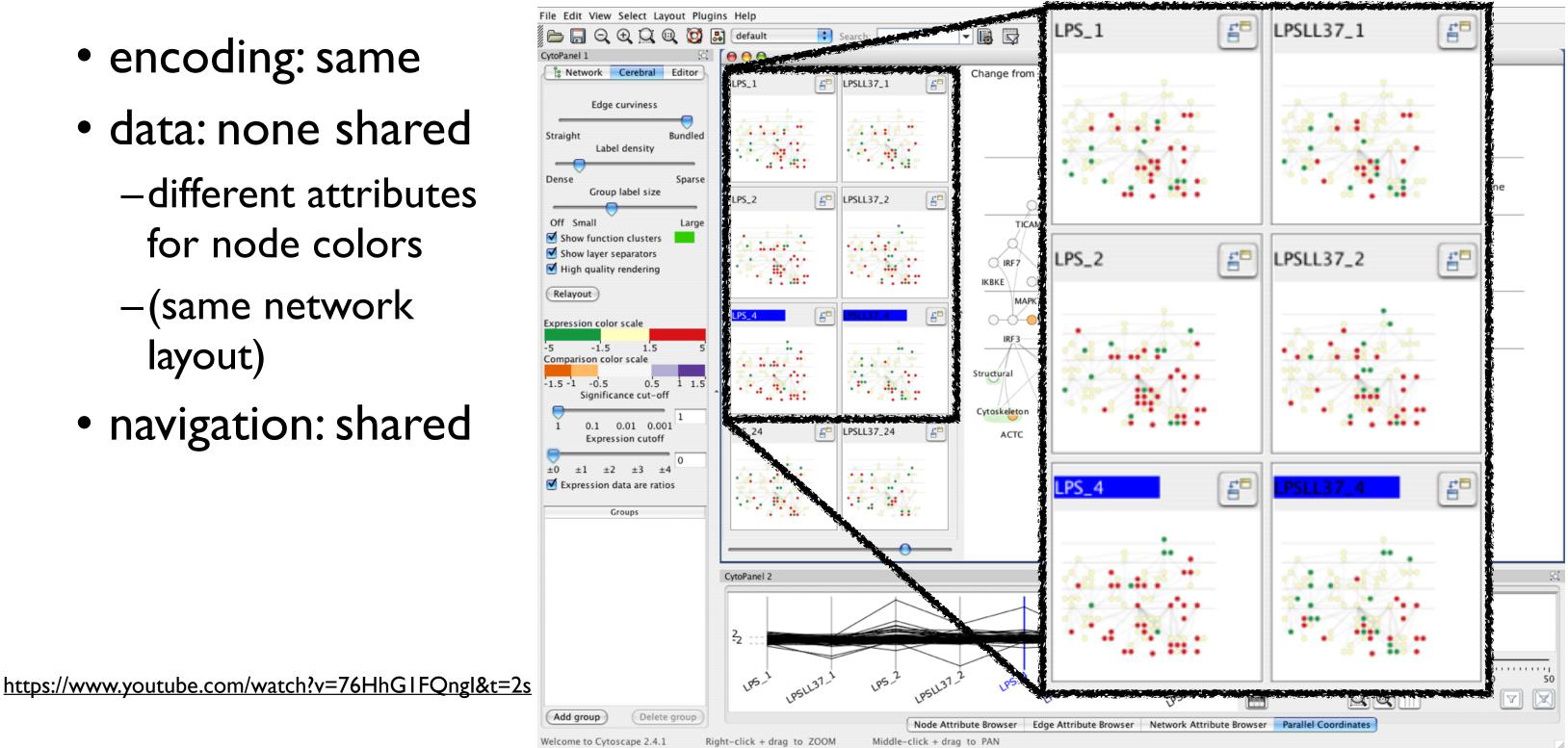
SNP Consequence





## Idiom: Small multiples

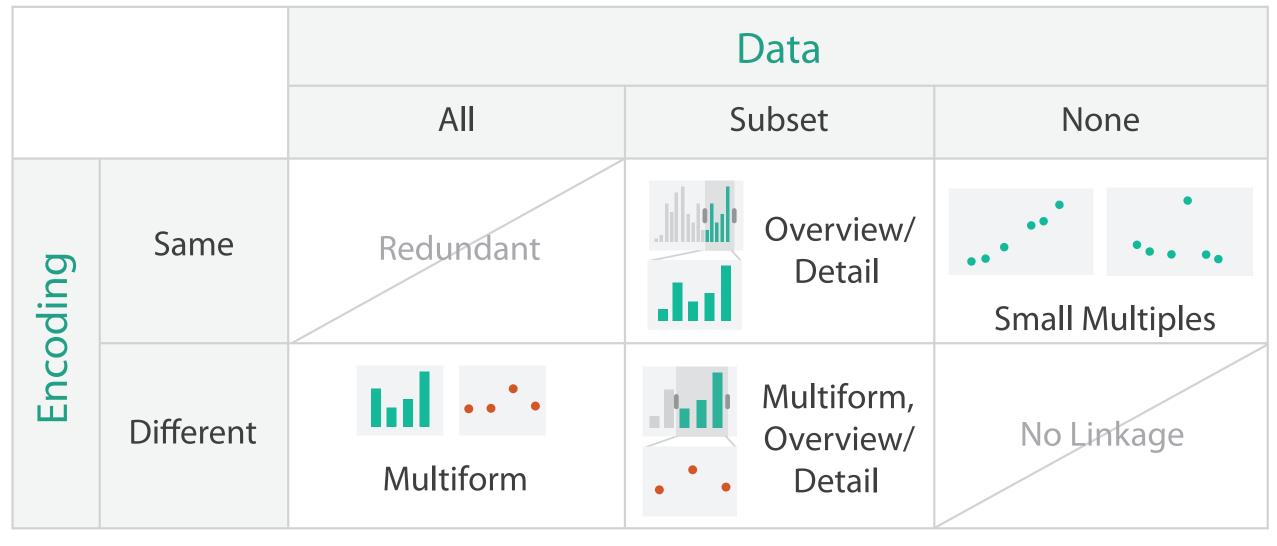
- encoding: same
- data: none shared
  - -different attributes for node colors
  - -(same network layout)
- navigation: shared



[Cerebral: Visualizing Multiple Experimental Conditions on a Graph with Biological Context. Barsky, Munzner, Gardy, and Kincaid. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2008) 14:6 (2008), 1253–1260.]

#### System: Cerebral

### Coordinate views: Design choice interaction

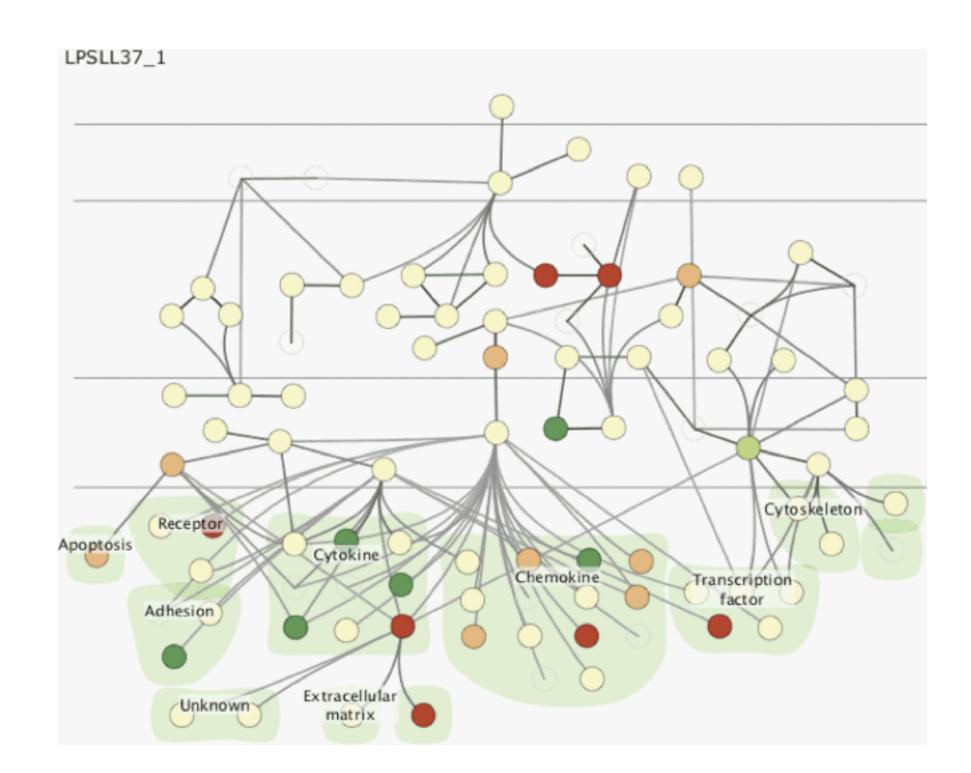


- why juxtapose views?
  - -benefits: eyes vs memory
    - lower cognitive load to move eyes between 2 views than remembering previous state with single changing view
  - -costs: display area, 2 views side by side each have only half the area of one view

## Why not animation?

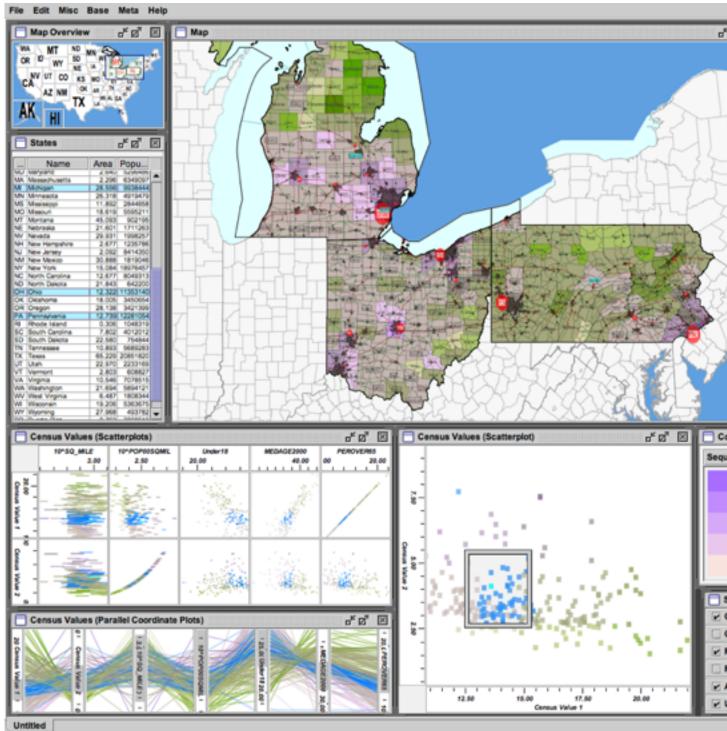
- disparate frames and regions: comparison difficult
  - -vs contiguous frames
  - -vs small region
  - -vs coherent motion of group
- safe special case

   animated transitions



## System: Improvise

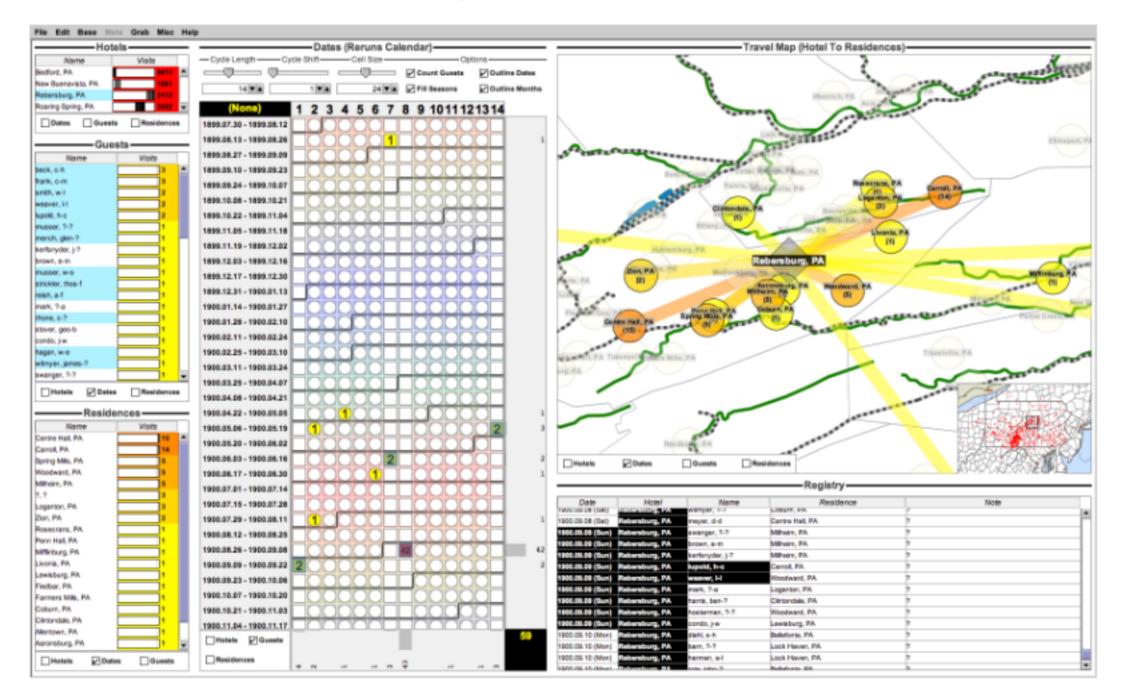
- investigate power of multiple views
  - -pushing limits on view count, interaction complexity
  - -how many is ok?
    - open research question
  - -reorderable lists
    - easy lookup
    - useful when linked to other encodings



[Building Highly-Coordinated Visualizations In Improvise.Weaver. Proc. IEEE Symp. Information Visualization (InfoVis), pp. 159–166, 2004.]

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### Video: Visual Analysis of Historical Hotel Visitation Patterns

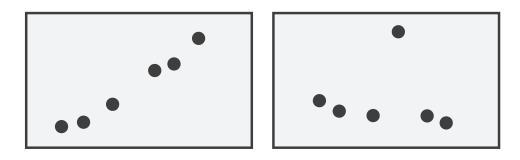


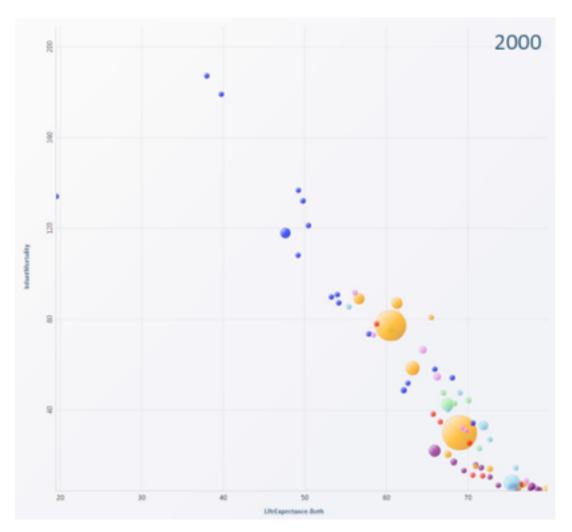
#### https://www.youtube.com/watch?v=Tzsv6wkZoiQ

http://www.cs.ou.edu/~weaver/improvise/examples/hotels/

### Partition into views

- how to divide data between views 
   Partition into Side-by-Side Views
  - -split into regions by attributes
  - -encodes association between items using spatial proximity
  - -order of splits has major implications for what patterns are visible
- no strict dividing line
  - -view: big/detailed
    - contiguous region in which visually encoded data is shown on the display
  - -glyph: small/iconic
    - object with internal structure that arises from multiple marks

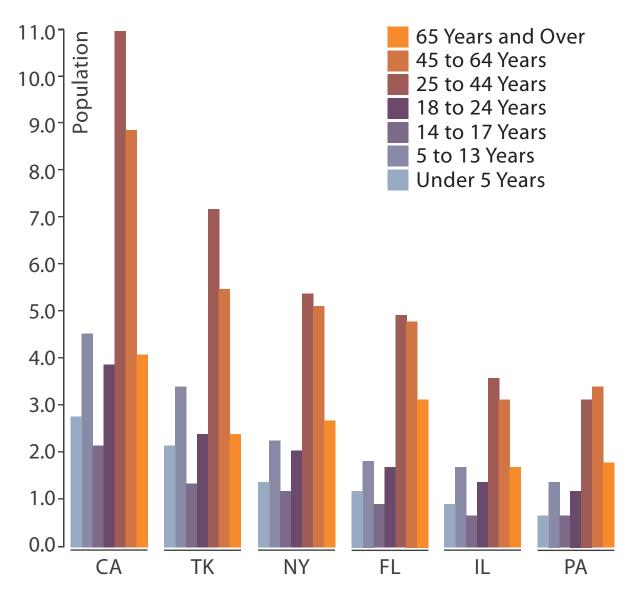






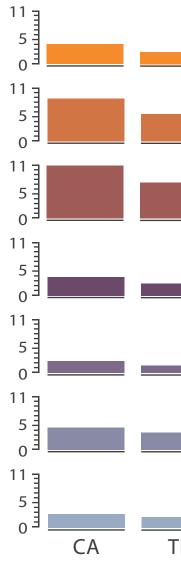
## Partitioning: List alignment

- single bar chart with grouped bars
  - -split by state into regions
    - complex glyph within each region showing all ages
  - -compare: easy within state, hard across ages



- - -split by age into regions
    - one chart per region
  - -compare: easy within age, harder across states





#### • small-multiple bar charts

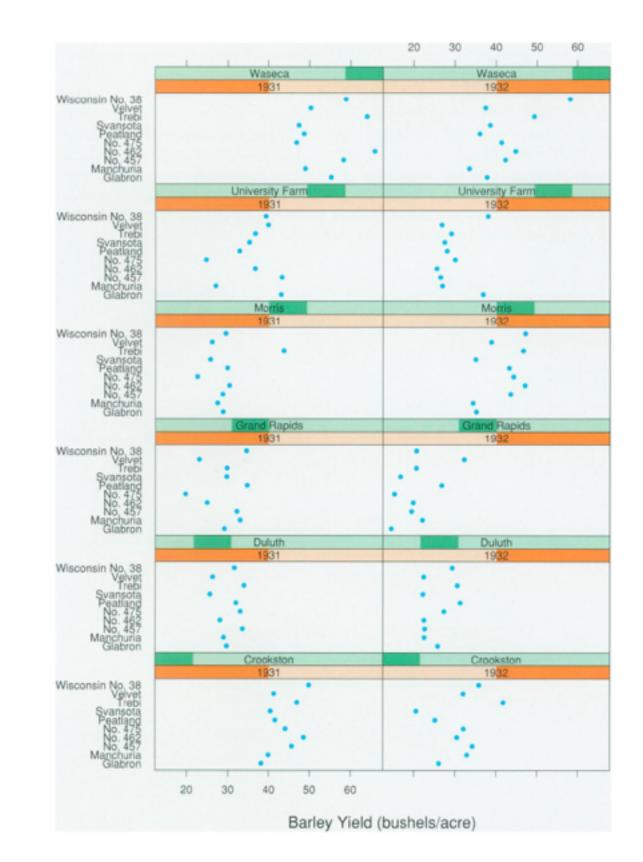
_	_	_		
-K	NY	FL	IL	PA

22

## Idiom: Trellis plots

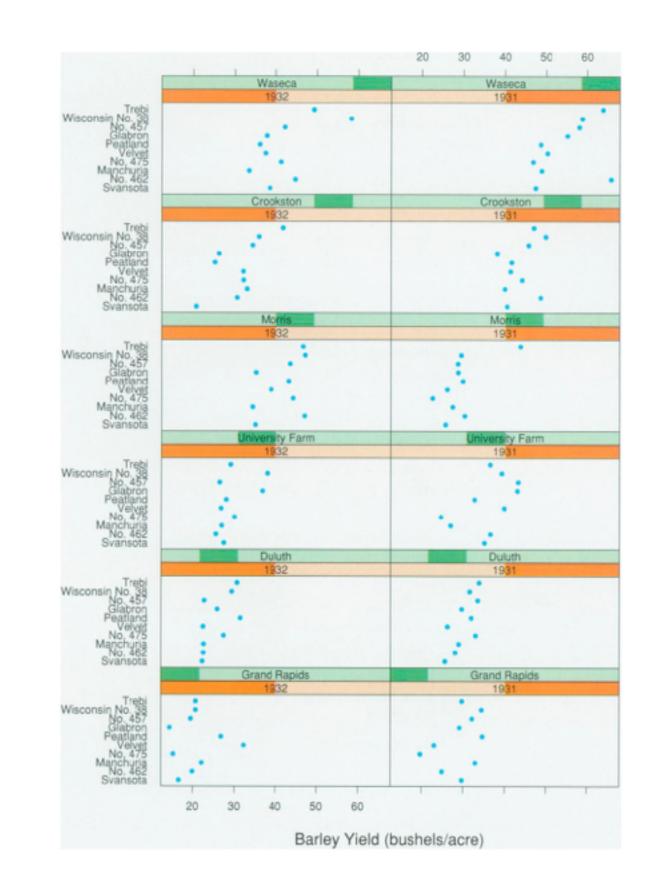
- matrix alignment for small multiple plots

   same issues as alignment for marks within plot!
- partition by
  - -year for columns
  - -site for rows (alphabetical)
- within pane
  - -variety for vertical axis
  - -yield for vertical position



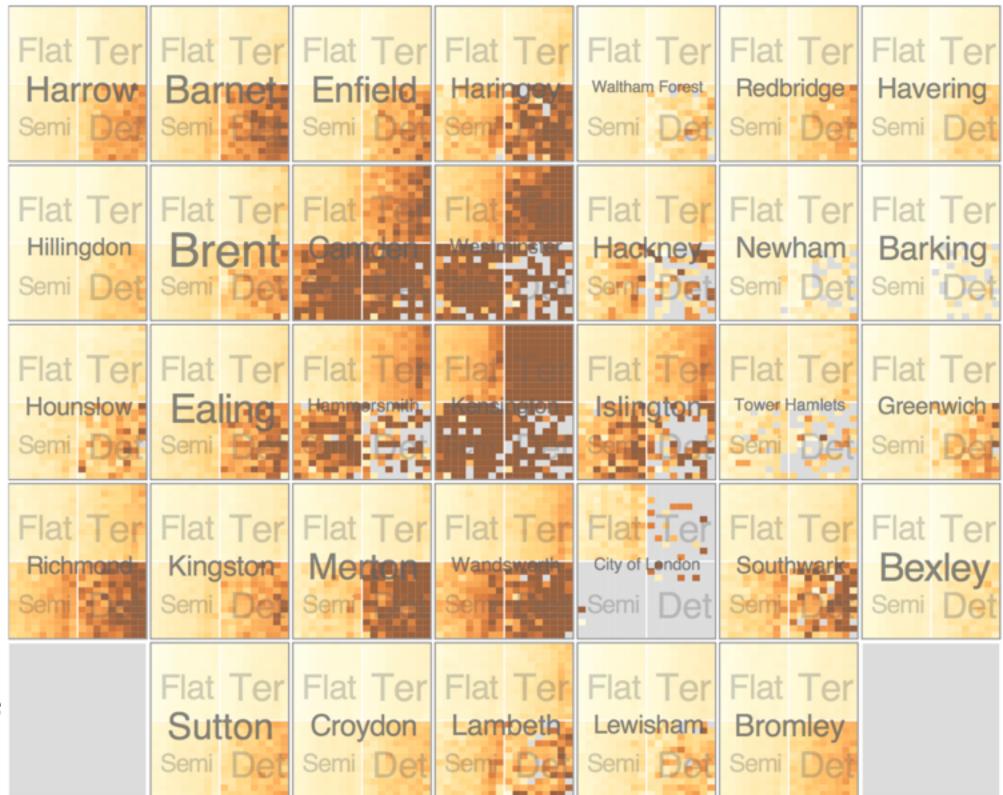
## Idiom: Trellis plots

- main effects ordering
  - order small-multiples plots based on derived data to see trends
  - -order plots by median values
  - -shared vertical axis within each plot ordered by median values within varieties



- split by neighborhood
- then by type
- then time
  - -years as rows
  - -months as columns
- color by price
- neighborhood patterns -where it's expensive -where you pay much more for detached type

[Configuring Hierarchical Layouts to Address Research Questions. Slingsby, Dykes, and Wood. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2009) 15:6 (2009), 977–984.]

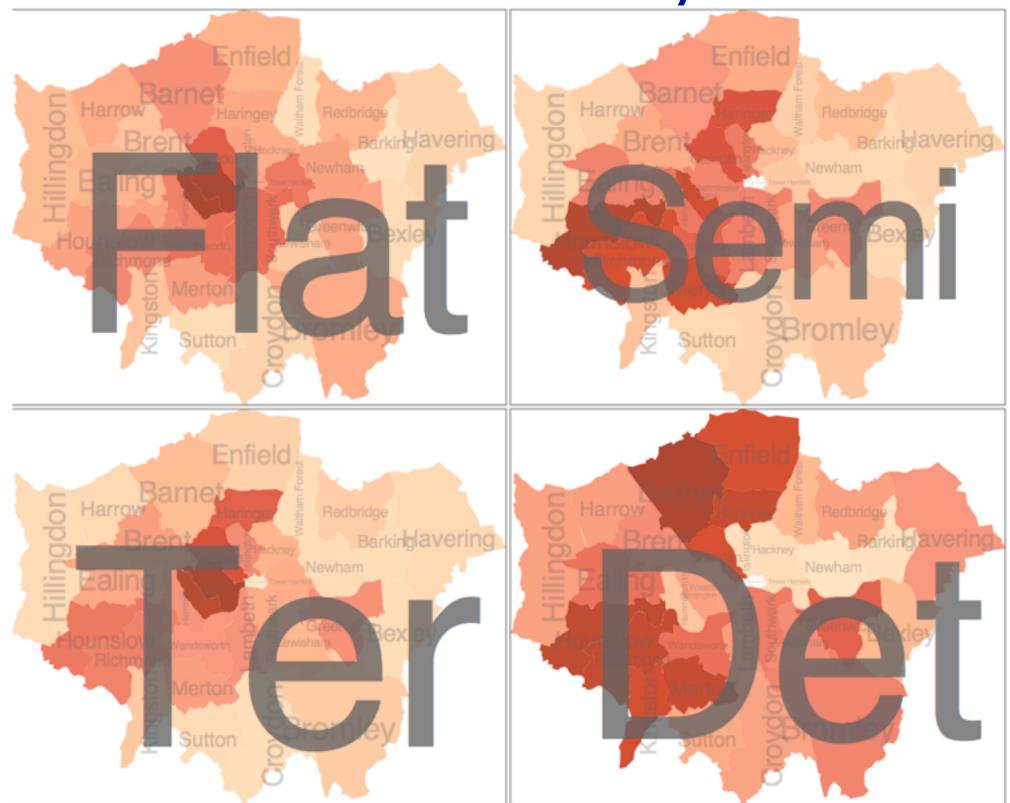


- switch order of splits -type then neighborhood
- switch color
  - -by price variation
- type patterns
  - -within specific type, which neighborhoods inconsistent



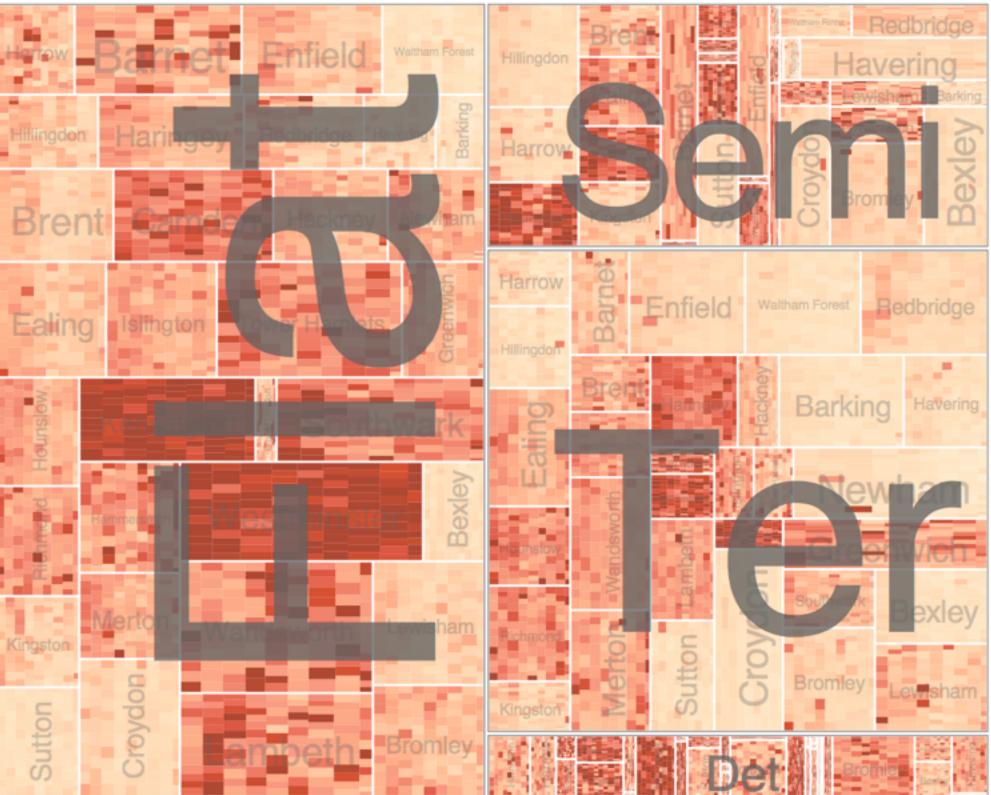
[Configuring Hierarchical Layouts to Address Research Questions. Slingsby, Dykes, and Wood. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2009) 15:6 (2009), 977–984.]

 different encoding for second-level regions -choropleth maps



[Configuring Hierarchical Layouts to Address Research Questions. Slingsby, Dykes, and Wood. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2009) 15:6 (2009), 977–984.]

- size regions by sale counts -not uniformly
- result: treemap

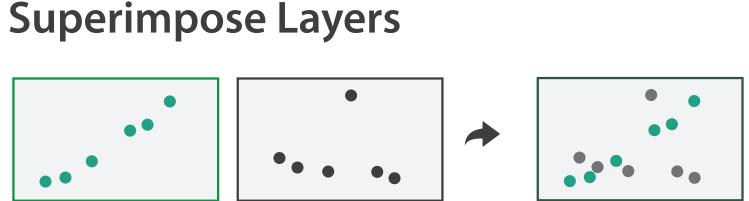


[Configuring Hierarchical Layouts to Address Research Questions. Slingsby, Dykes, and Wood. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2009) 15:6 (2009), 977–984.]

## Superimpose layers

- *layer*: set of objects spread out over region

   –each set is visually distinguishable group
   –extent: whole view
   Superior
- design choices
  - -how many layers, how to distinguish?
    - encode with different, nonoverlapping channels
    - two layers achieveable, three with careful design
  - -small static set, or dynamic from many possible?



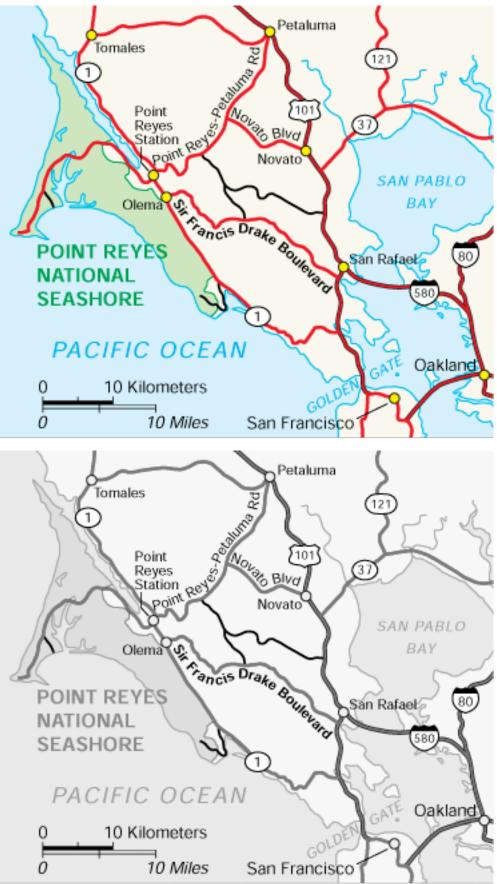
## Static visual layering

- foreground layer: roads -hue, size distinguishing main from minor -high luminance contrast from background
- background layer: regions -desaturated colors for water, parks, land areas
- user can selectively focus attention
- "get it right in black and white" -check luminance contrast with greyscale view

[Get it right in black and white. Stone. 2010. http://www.stonesc.com/wordpress/2010/03/get-it-right-in-black-and-white]



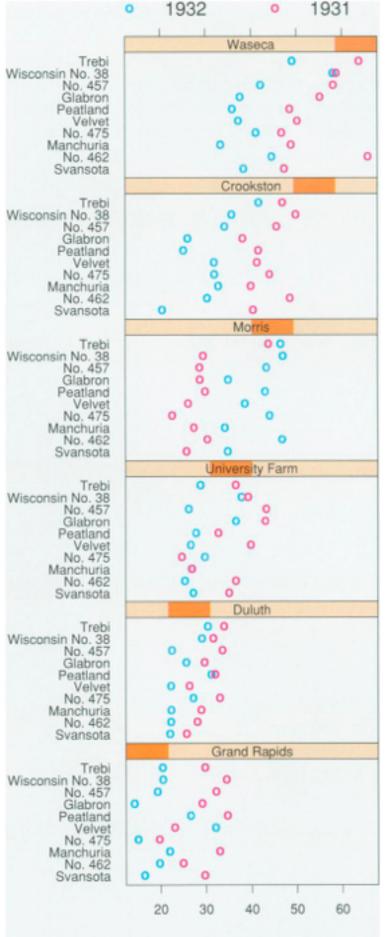




## Idiom: Trellis plots

#### superimpose within same frame -color code by year

Wisconsin No. 38

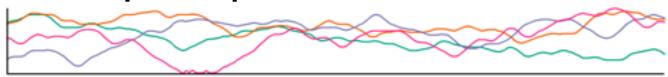


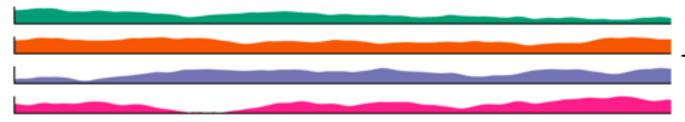
Barley Yield (bushels/acre)

31

## Superimposing limits

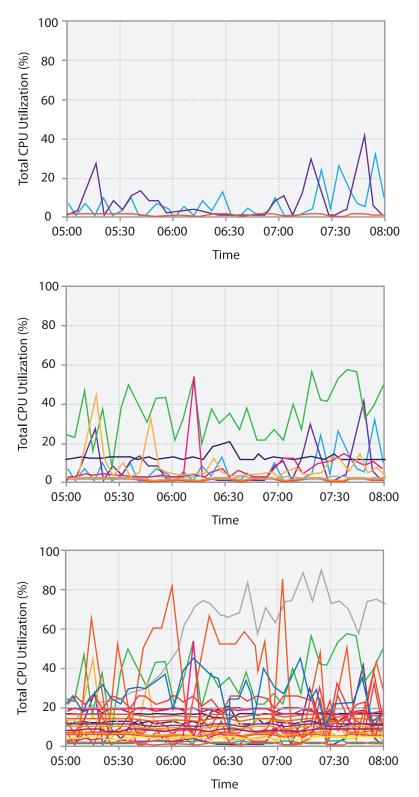
- few layers, but many lines
  - -up to a few dozen
  - -but not hundreds
- superimpose vs juxtapose: empirical study
  - -superimposed for local, multiple for global
  - -tasks
    - local: maximum, global: slope, discrimination
  - -same screen space for all multiples vs single superimposed





[Graphical Perception of Multiple Time Series. Javed, McDonnel, and Elmqvist. IEEE Transactions on Visualization and Computer Graphics (Proc. IEEE InfoVis 2010) 16:6 (2010), 927–934.]

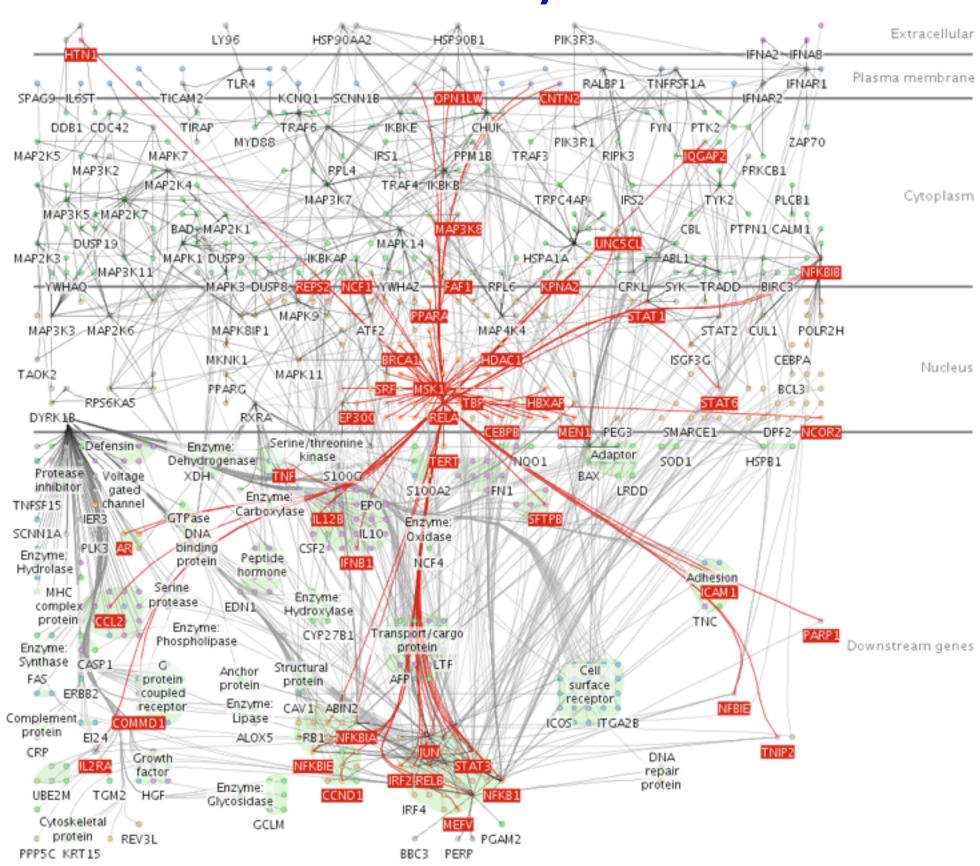




## Dynamic visual layering

- interactive, from selection
  - –lightweight: click
  - -very lightweight: hover
- ex: I-hop neighbors

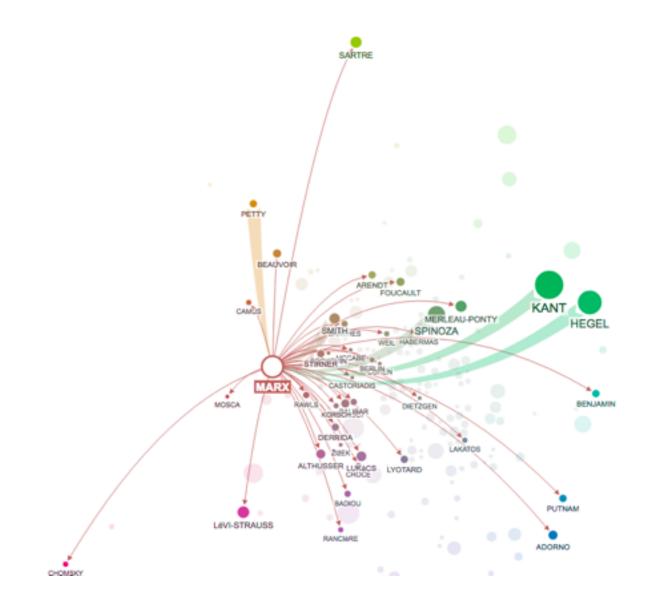
[Cerebral: a Cytoscape plugin for layout of and interaction with biological networks using subcellular localization annotation. Barsky, Gardy, Hancock, and Munzner. Bioinformatics 23:8 (2007), 1040–1042.]

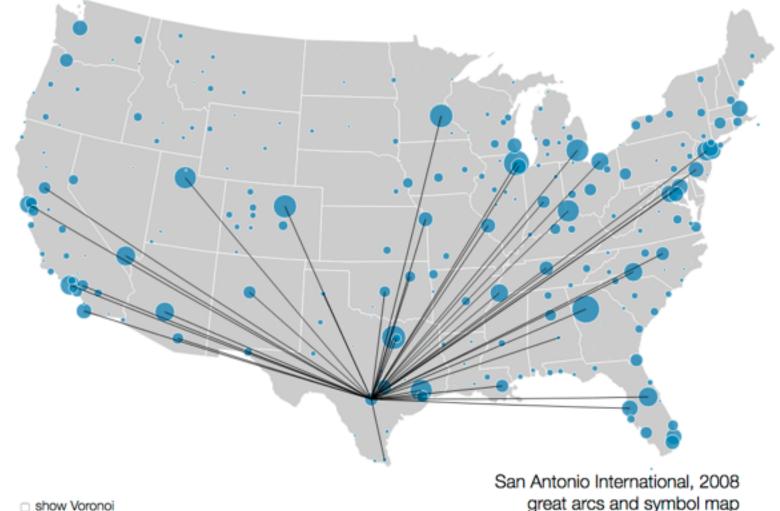


#### System: Cerebral

### Dynamic visual layering

• one-hop neighbour highlighting demos: click vs hover





http://mariandoerk.de/edgemaps/demo/

great arcs and symbol map

#### http://mbostock.github.io/d3/talk/2011116/airports.html

## Further reading

- Visualization Analysis and Design. Munzner. AK Peters Visualization Series, CRC Press, 2014. -Chap 12: Facet Into Multiple Views
- A Review of Overview+Detail, Zooming, and Focus+Context Interfaces. Cockburn, Karlson, and Bederson. ACM Computing Surveys 41:1 (2008), 1–31.
- A Guide to Visual Multi-Level Interface Design From Synthesis of Empirical Study Evidence. Lam and Munzner. Synthesis Lectures on Visualization Series, Morgan Claypool, 2010.
- Zooming versus multiple window interfaces: Cognitive costs of visual comparisons. Plumlee and Ware. ACM Trans. on Computer-Human Interaction (ToCHI) 13:2 (2006), 179–209.
- Exploring the Design Space of Composite Visualization. Javed and Elmqvist. Proc. Pacific Visualization Symp. (Pacific Vis), pp. 1–9, 2012.
- Visual Comparison for Information Visualization. Gleicher, Albers, Walker, Jusufi, Hansen, and Roberts. Information Visualization 10:4 (2011), 289–309.
- Guidelines for Using Multiple Views in Information Visualizations. Baldonado, Woodruff, and Kuchinsky. In Proc. ACM Advanced Visual Interfaces (AVI), pp. 110–119, 2000.
- Cross-Filtered Views for Multidimensional Visual Analysis. Weaver. IEEE Trans. Visualization and Computer Graphics 16:2 (Proc. InfoVis 2010), 192–204, 2010.
- Linked Data Views. Wills. In Handbook of Data Visualization, Computational Statistics, edited by Unwin, Chen, and Härdle, pp. 216-241. Springer-Verlag, 2008.
- Glyph-based Visualization: Foundations, Design Guidelines, Techniques and Applications. Borgo, Kehrer, Chung, Maguire, Laramee, Hauser, Ward, and Chen. In Eurographics State of the Art Reports, pp. 39–63, 2013.