

Ch 11/12: Manipulate, Facet Paper: Paramorama

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CPSC 547, Information Visualization
Week 6: 15 Oct 2019

www.cs.ubc.ca/~tmm/courses/547-19

Timing

- today
 - presentation topics
 - discussion catchup: color second half
 - discussion catchup: spatial, networks, abyss-explorer, genealogy
 - discussion for today's reading: manipulate, facet, paramorama
- next week
 - no class!
- Oct 29
 - readings: reduce, embed, TopoFisheye paper
 - more on presentations & project proposals
 - guest lectures TBA

Presentations & Projects

Presentation topic choices

- presentation topic choices due next Friday (Oct 25) at 5pm
 - post your choice to discussion thread on Canvas: 1 or 2 topic choices
 - ok to have more than one person with same choice
 - timing: let me know if a specific day is bad for you (“veto day”)
 - from this set: Nov 5, 12, 19, 26, Dec 4
 - I’ll assign days soon
 - I’ll assign papers (from this year’s VIS conf) at least 1 week before your presentation
 - more on presentation expectations next time (Oct 29)

Presentation topics: Pick one or two

- data types
 - networks
 - trees
 - geographic data
 - high-dimensional data
 - text data
 - temporal data
 - space & time
(spatiotemporal / trajectory data)
 - sequences & events
 - multi-attribute tables
 - spatial fields
 - models (ML or other)
- domains
 - machine learning
 - genomics
 - medicine
 - sports
 - digital humanities
 - sensemaking
 - (other, if not too narrow)
- topics
 - color
 - perception
 - uncertainty
 - analysis process
 - personal data
- comparison & similarity
- communication, presentation, storytelling
- techniques
 - dimensionality reduction
 - feature extraction
 - clustering
 - matrix views
 - multiple view coordination

Project Groups

- finalize by this Fri Oct 25 at latest
 - helpful to post with current status reports, even before that!
 - who's still looking, who's resolved
 - definitely post to confirm when finalized

Project Meetings

- each project needs signoff: at least one meeting
 - I've already signed off for some projects in pre-pitch meetings
 - in some cases one meeting will be enough and I'll sign off then
 - in some cases followup meeting will be needed!
- meetings cutoff is 6pm Fri Nov 1
 - check my potential availability calendar (updated frequently)
 - send email with proposed times
 - don't wait until the last minute, I'm heavily booked
 - no meetings next week (Mon Oct 21 - Fri Oct 25)

Paper: Paramorama

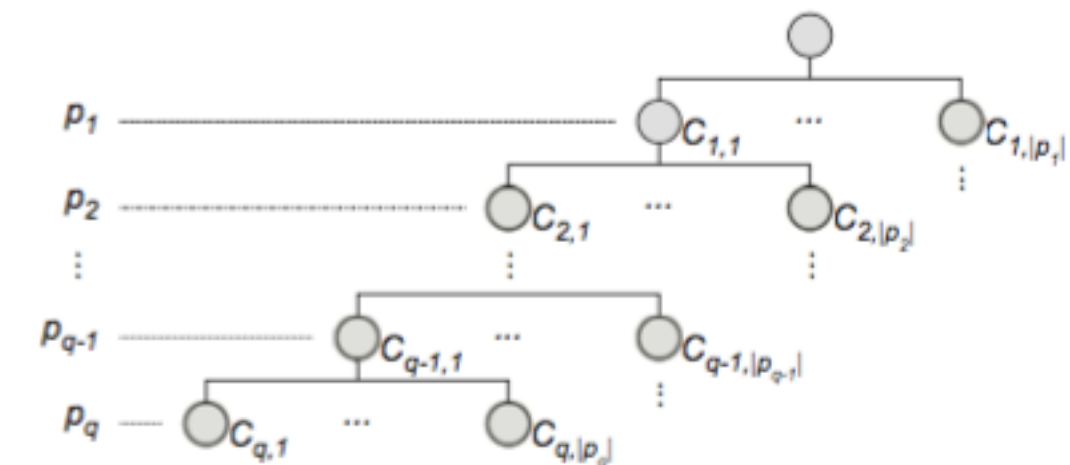
Paramorama: Visualization of Parameter Space for Image Analysis

- requirements
 - R1 separate out specification of input params and inspection of output
 - from slow computations (actual image processing)
 - R2 enable param optimization. three classes of params, focus on hard ones:
 - aliases: input once, never change, minimal effort
 - nominal params: pick from list, never change, minimal effort
 - continuous params: essential to find right thresholds; difficult & time consuming
 - only 3-7 out of the 5-20 total params need to be carefully sampled
 - R3 analyze outcomes for reference image wrt input params: find good vs bad
- strategy
 - offline batch processing to compute, then interactive exploration of output
 - user selects module, subset of continuous params, range, and target # samples

Data

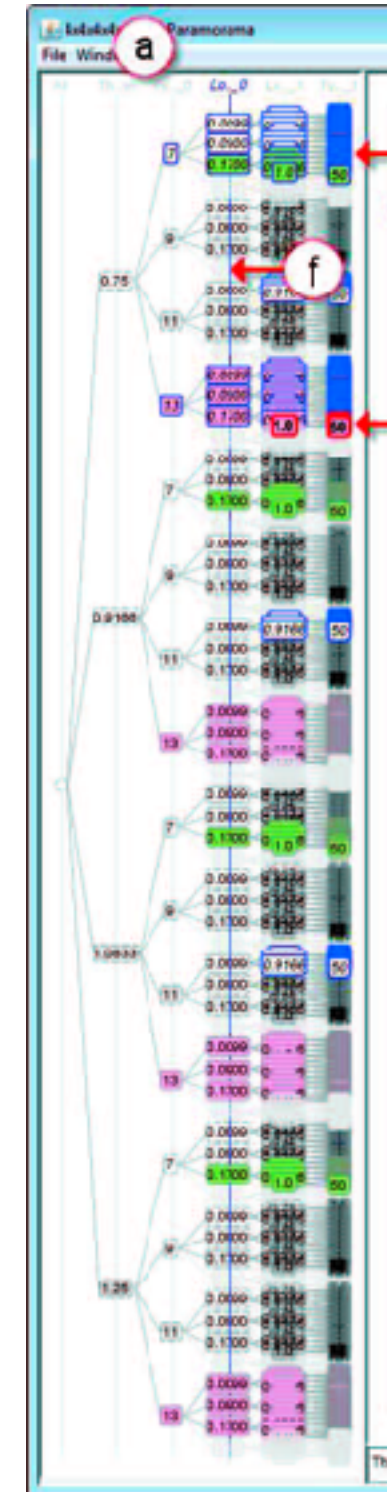
- data: samples & output
 - CellProfiler full pipeline has 150-200 params
 - 10-20 modules w/ 5-20 params each
- derived data: table
 - rows are unique combos of sampled param values
 - columns are user-selected params
- derived data: hierarchical clustering
 - root contains all tuples
 - each level represents user-selected parameter
 - path from the root to each leaf represents unique combination of sampled parameter
 - reorder parameters to change leaf order
 - instead of reorder columns in table

	p_1	p_2	...	p_{q-1}	p_q
t_1	$x_{1,1}$	$x_{2,1}$	...	$x_{q-1,1}$	$x_{q,1}$
\vdots	\vdots	\vdots		\vdots	\vdots
$t_{|p_q|}$	$x_{1,1}$	$x_{2,1}$	...	$x_{q-1,1}$	$x_{q,|p_q|}$
$t_{|p_q|+1}$	$x_{1,1}$	$x_{2,1}$	...	$x_{q-1,2}$	$x_{q,1}$
\vdots	\vdots	\vdots		\vdots	\vdots
$t_{2|p_q|}$	$x_{1,1}$	$x_{2,1}$	...	$x_{p-1,2}$	$x_{q,|p_q|}$
\vdots	\vdots	\vdots		\vdots	\vdots



Overview

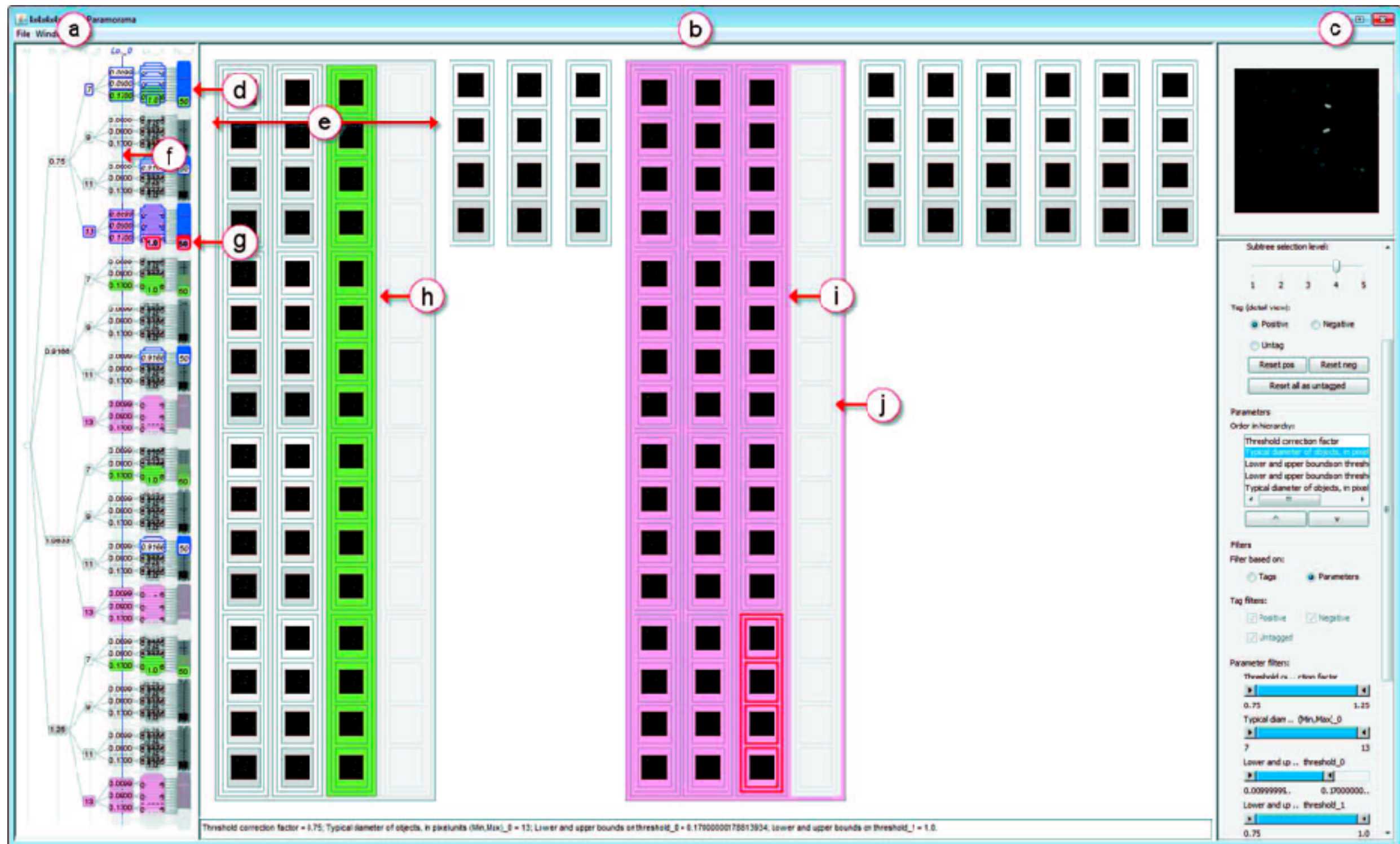
- cluster hierarchy of sampled params
- primary navigation control
 - user selects areas, linked highlighting in refinement view
- visual encoding spatial position: rectilinear node-link view
 - considerations: compactness, linear ordering, skinny aspect ratio
 - rejected: icicle plots & tree maps vs node-link
 - rejected: radial vs rectilinear
- vis enc: color
 - perceptually ordered, colourblind-safe
 - luminance high, saturation low



[Fig 4. Visualization of Parameter Space for Image Analysis. Pretorius, Ruddle, Bray, Carpenter. TVCG 12(17):2402-2411 2011 (Proc. InfoVis 2011).]

Refinement view: Custom layout

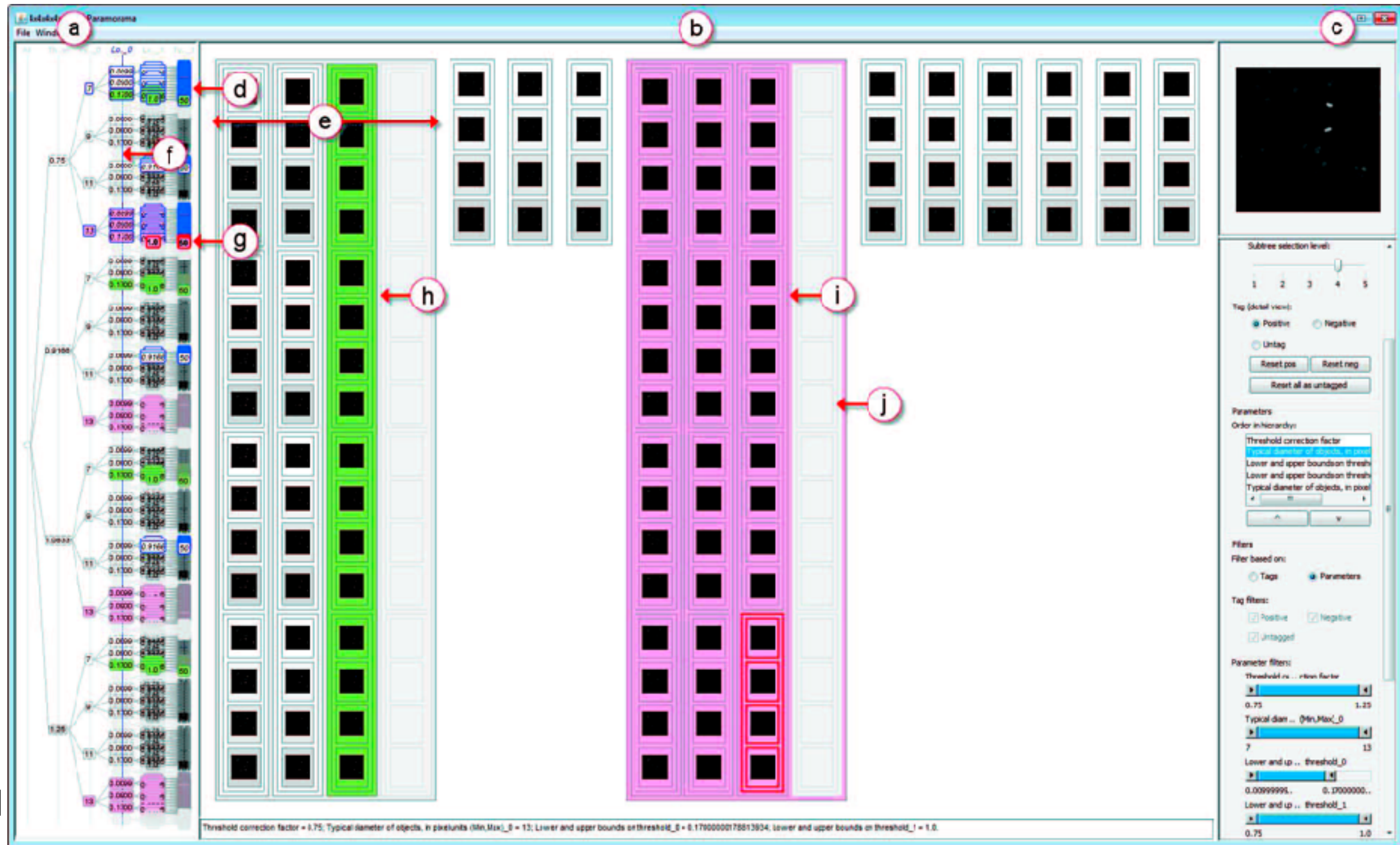
- outputs in adjacent but visually distinct areas
- preserve top-to-bottom order from overview
- dynamically control parameter level to lay out side by side
 - so contiguous regions in cluster hierarchy map to refinement view
 - cut through tree
- ex: II blue subtrees highlighted in overview, II regions shown on right.



[Fig 4. Visualization of Parameter Space for Image Analysis. Pretorius, Ruddle, Bray, Carpenter. TVCG 12(17):2402-2411 2011 (Proc. InfoVis 2011).]

Interaction

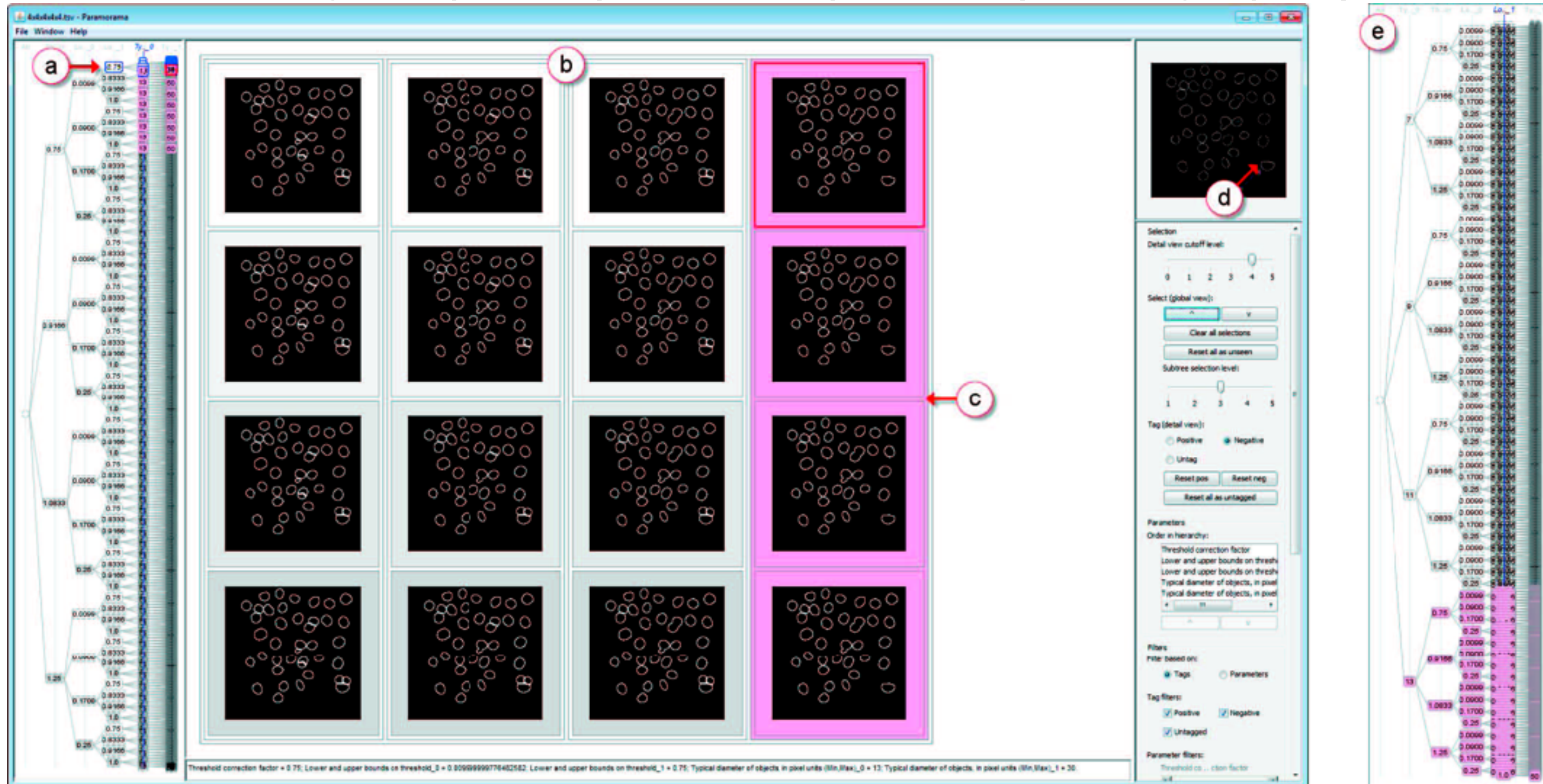
- multiple views w/ 3 scales
 - overview
 - mid-level refinement
 - detail view for selected single image (top right)
 - shortcut: next unselected subtree
- linked highlighting
 - selection blue
 - focus red
- tagging: good (green) vs bad (magenta)
- filtering: range or tags
- detail text view on control panel not popups



[Fig 4. Visualization of Parameter Space for Image Analysis. Pretorius, Ruddle, Bray, Carpenter. TVCG 12(17):2402-2411 2011 (Proc. InfoVis 2011).]

Case study: novice user

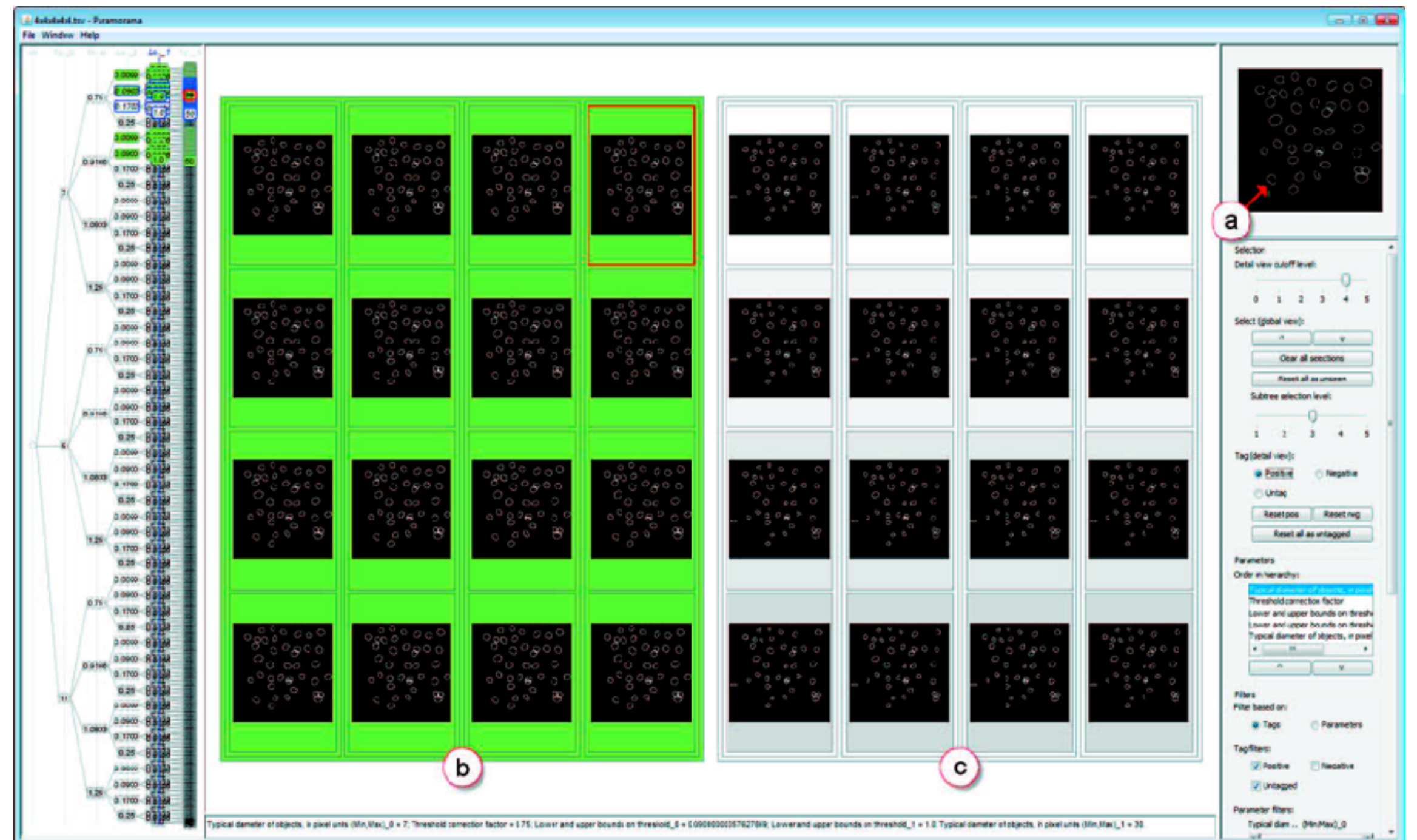
- speed: 10 min to find contiguous part of parameter space that yields high-quality results



[Fig 6. Visualization of Parameter Space for Image Analysis. Pretorius, Ruddle, Bray, Carpenter. TVCG 12(17):2402-2411 2011 (Proc. InfoVis 2011).]

Case study: expert user

- quality: higher quality result from considering over 3K images



[Fig 7. Visualization of Parameter Space for Image Analysis. Pretorius, Ruddell, Bray, Carpenter. TVCG 12(17):2402-2411 2011 (Proc. InfoVis 2011).]

Ch 10: Manipulate

How?

Encode

→ Arrange

→ Express



→ Separate



→ Order



→ Align



→ Use



→ Map

from **categorical** and **ordered** attributes

→ Color

→ Hue



→ Saturation



→ Luminance



→ Size, Angle, Curvature, ...



→ Shape



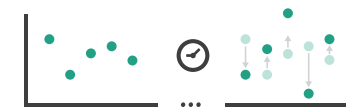
→ Motion

Direction, Rate, Frequency, ...

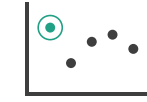


Manipulate

→ Change



→ Select



→ Navigate

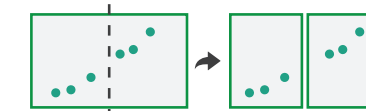


Facet

→ Juxtapose



→ Partition



→ Superimpose



Reduce

→ Filter



→ Aggregate



→ Embed



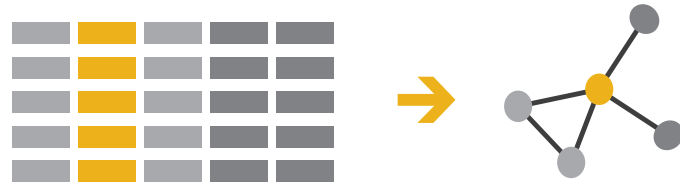
What?

Why?

How?

How to handle complexity: 1 previous strategy + 3 more

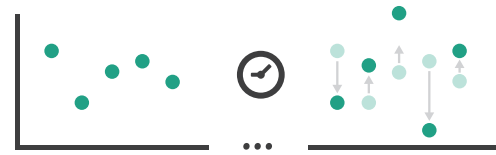
→ *Derive*



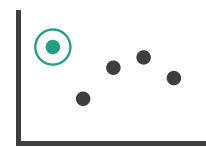
- derive new data to show within view
- change view over time
- facet across multiple views
- reduce items/attributes within single view

Manipulate

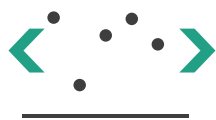
→ Change



→ Select

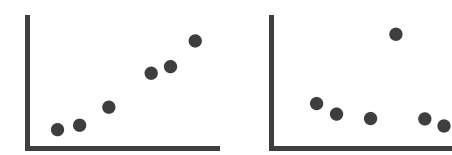


→ Navigate

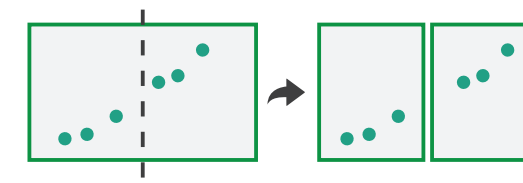


Facet

→ Juxtapose



→ Partition

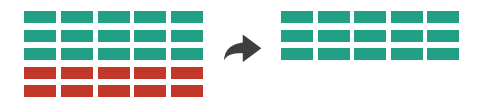


→ Superimpose



Reduce

→ Filter



→ Aggregate

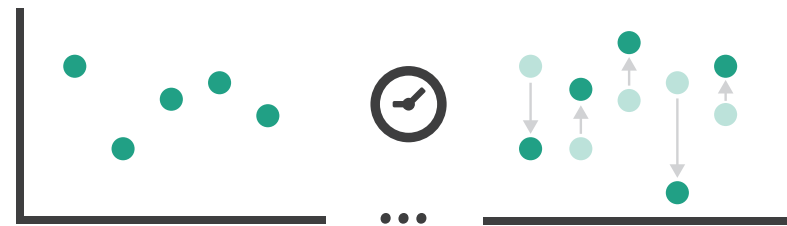


→ Embed

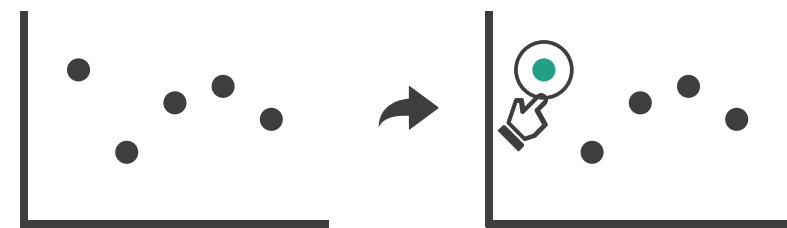


Manipulate

→ Change over Time



→ Select



→ Navigate

→ Item Reduction

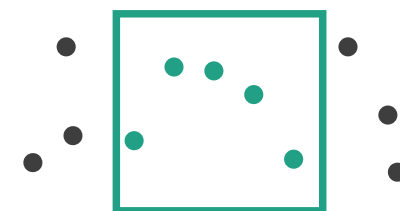
→ Zoom
Geometric or *Semantic*



→ Pan/Translate

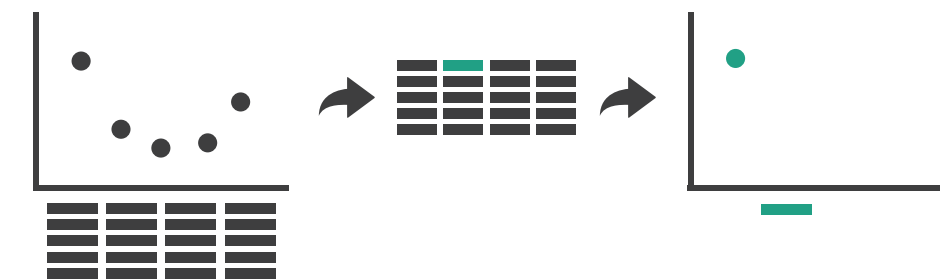


→ Constrained

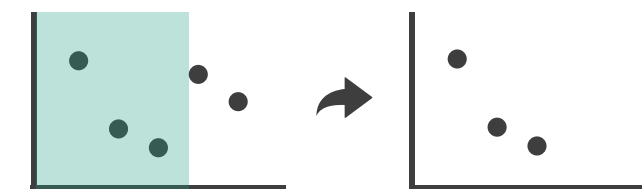


→ Attribute Reduction

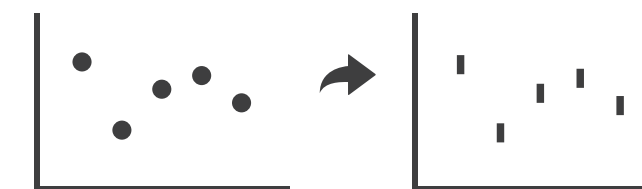
→ Slice



→ Cut



→ Project



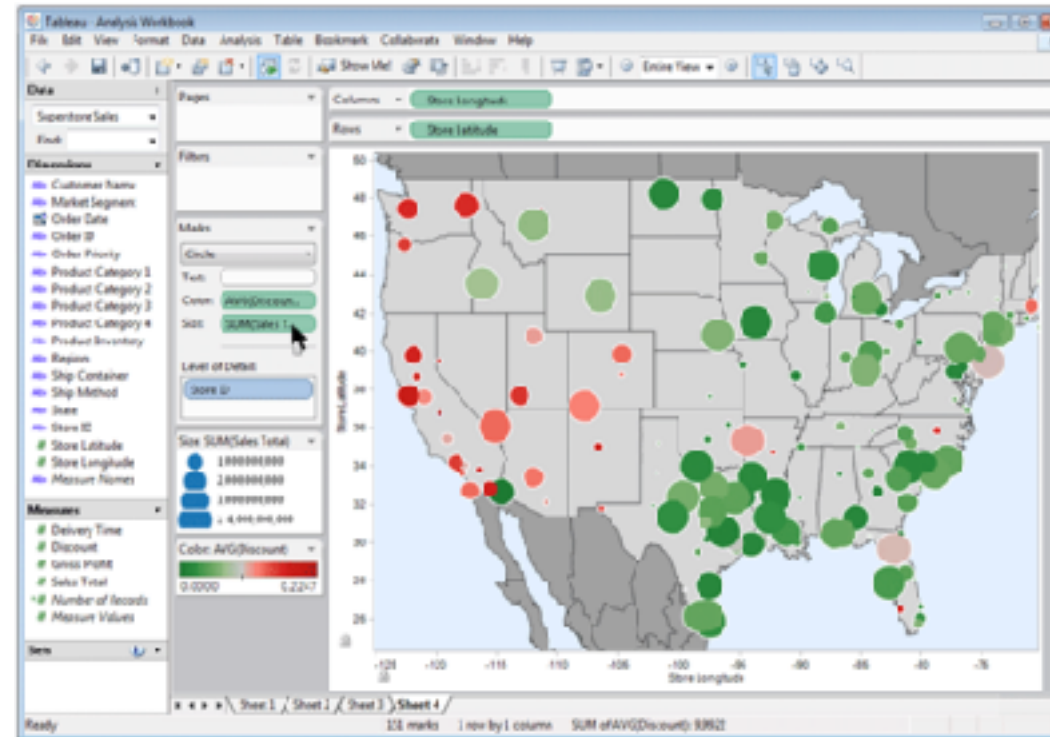
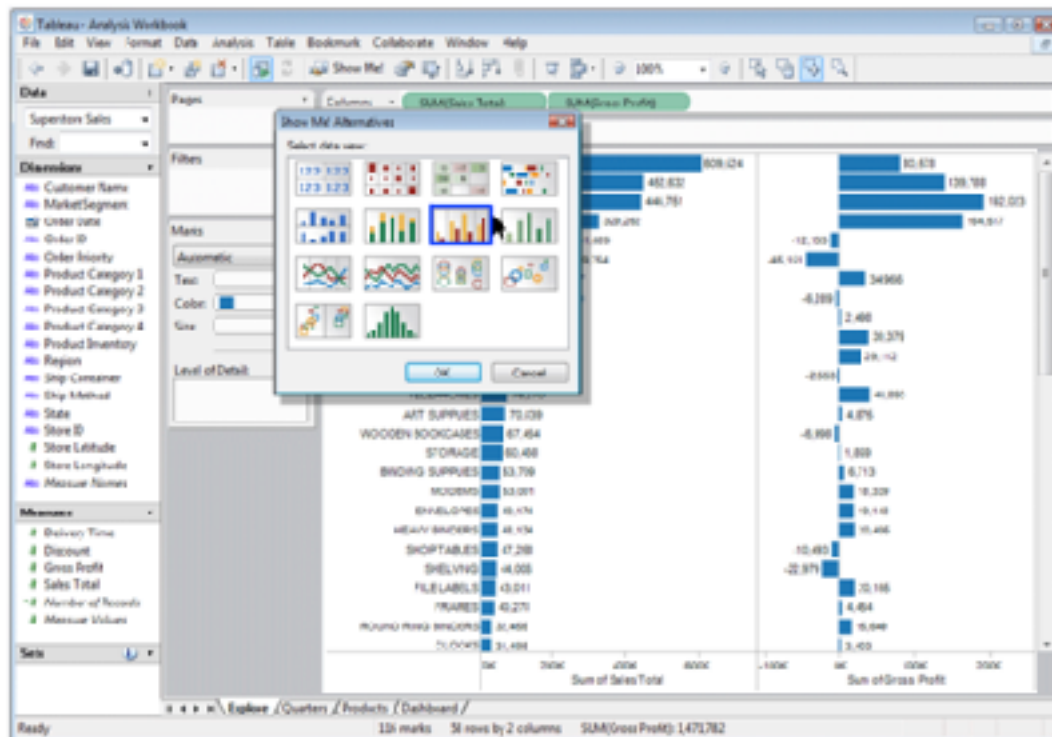
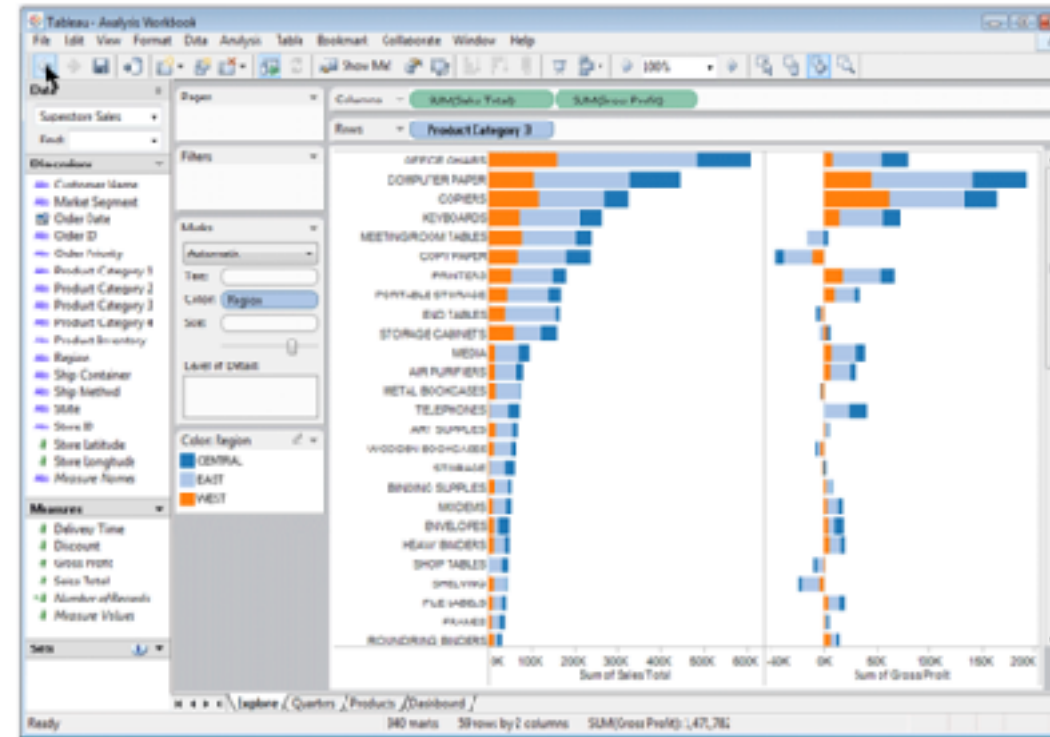
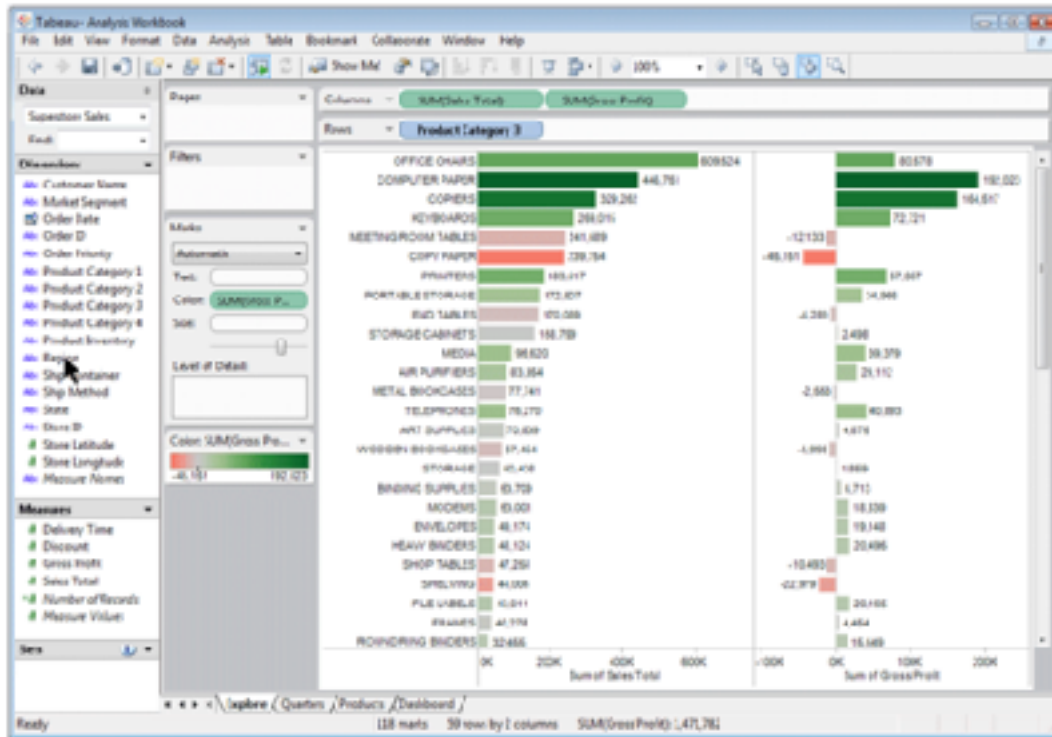
Change over time

- change any of the other choices
 - encoding itself
 - parameters
 - arrange: rearrange, reorder
 - aggregation level, what is filtered...

 - interaction entails change

Idiom: Re-encode

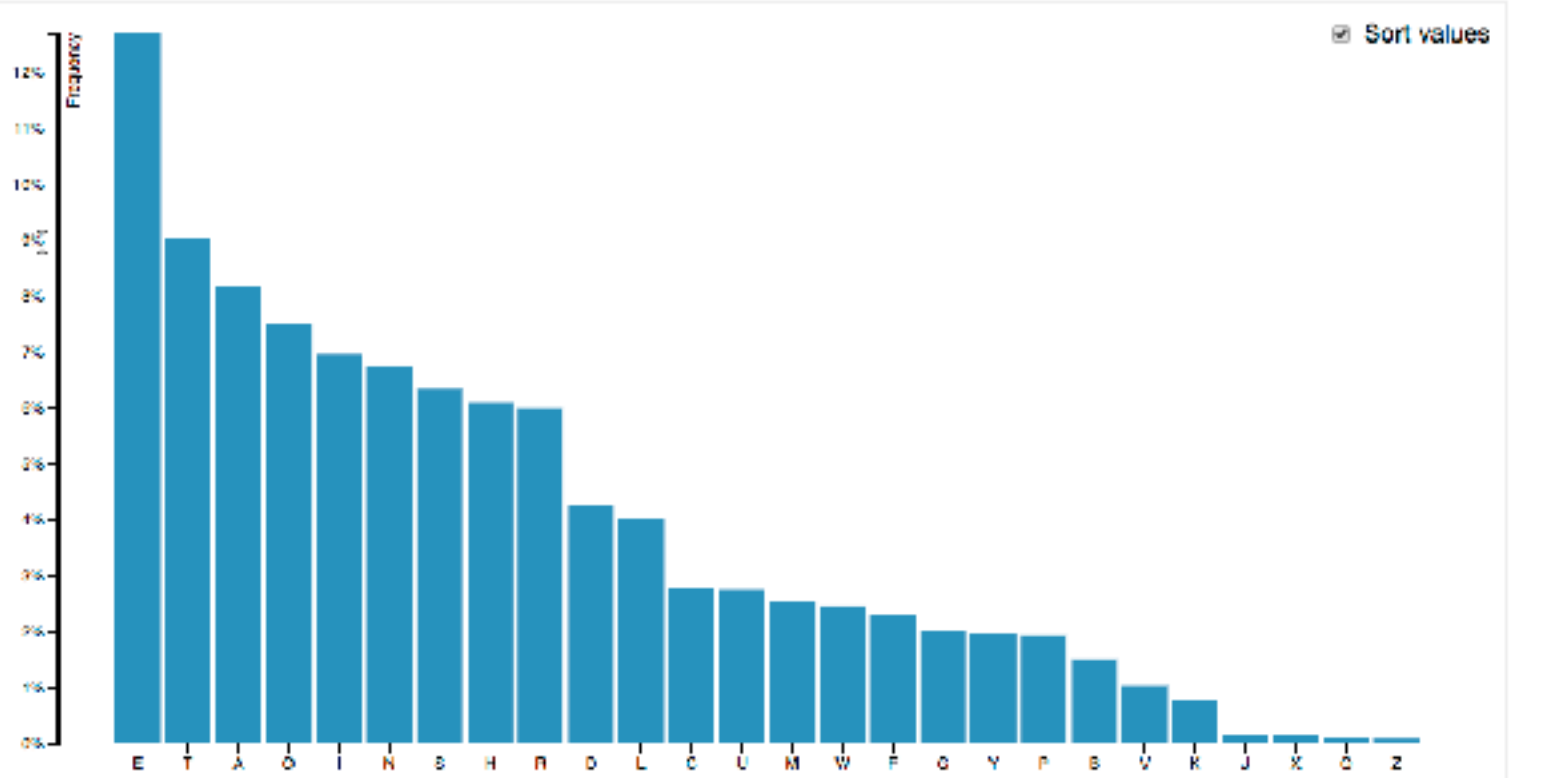
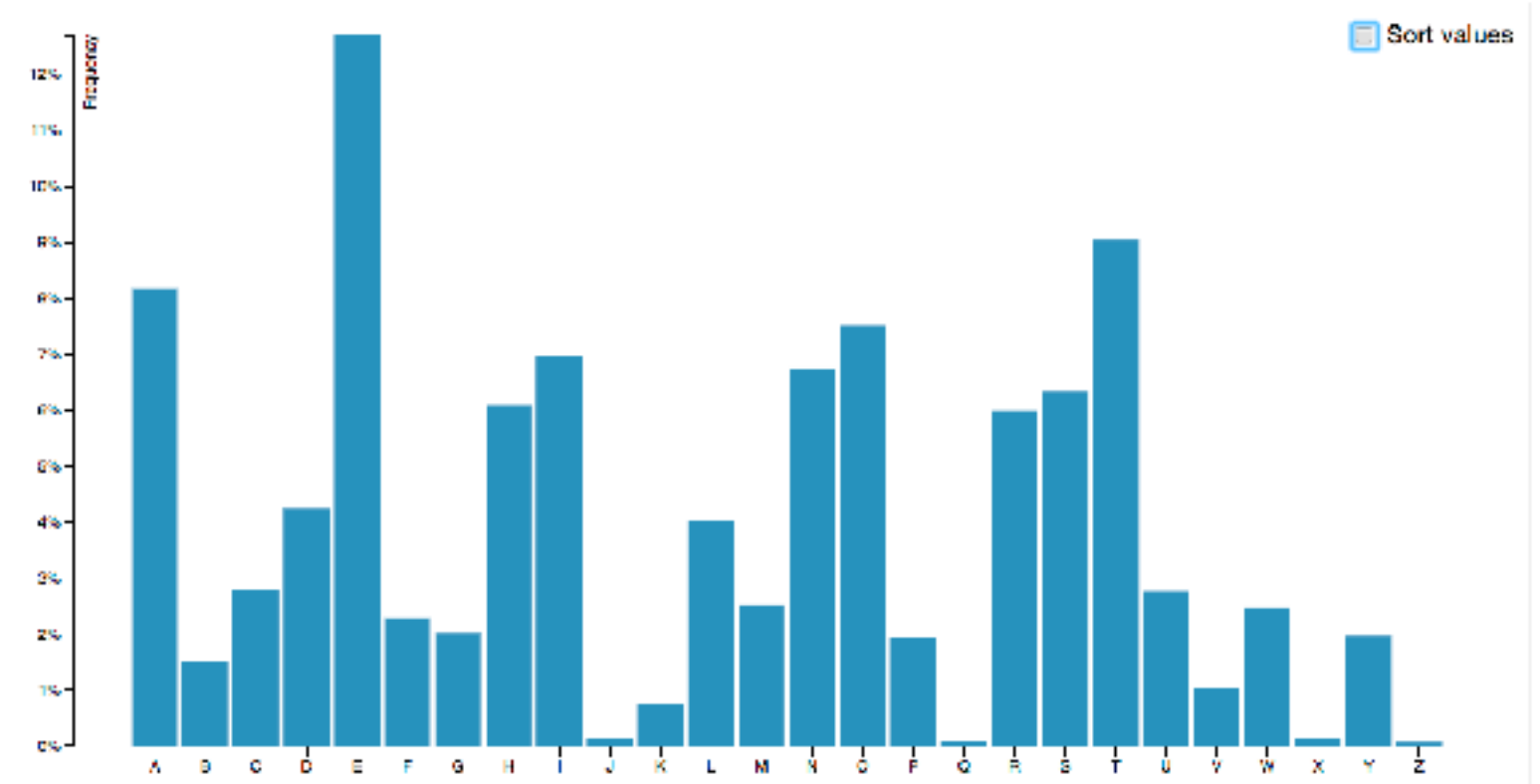
System: Tableau



made using Tableau, <http://tableausoftware.com>

Idiom: **Change order/arrangement**

- what: simple table
- how: data-driven reordering
- why: find extreme values, trends

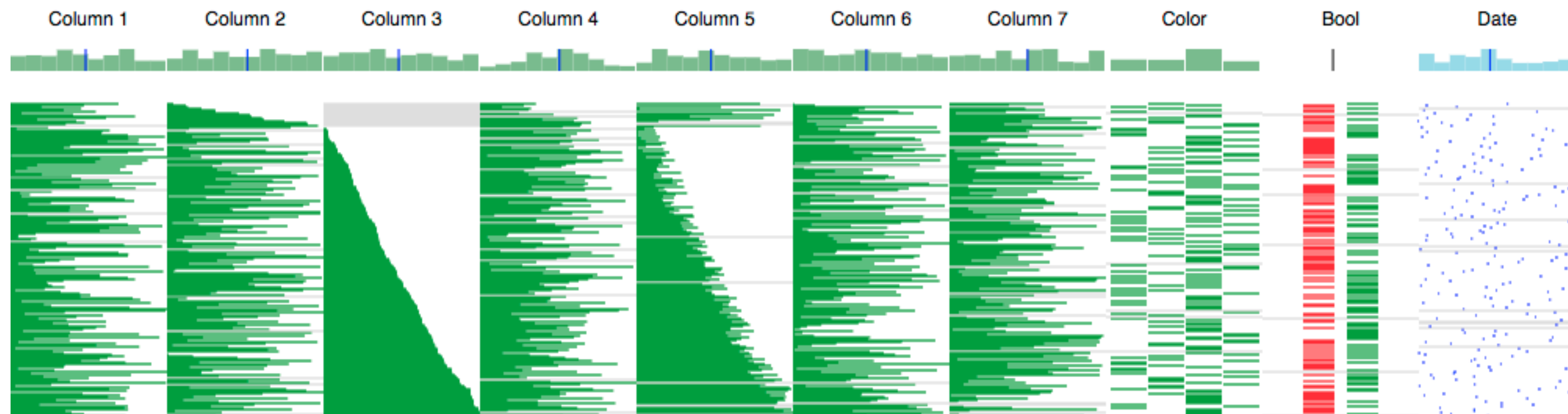


[Sortable Bar Chart](<https://blocks.org/mbostock/3885705>)

Idiom: **Reorder**

System: **DataStripes**

- what: table with many attributes
- how: data-driven reordering by selecting column
- why: find correlations between attributes

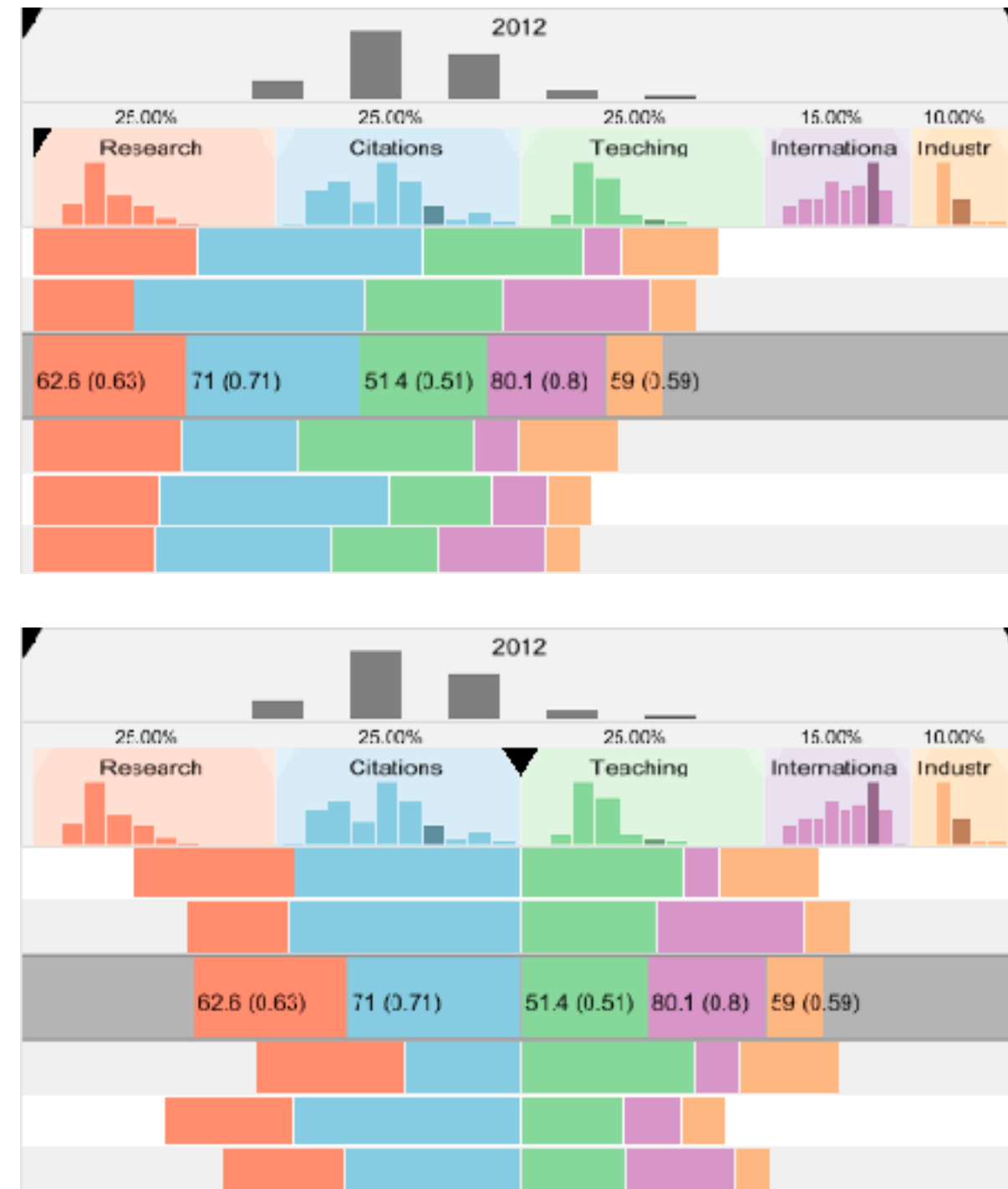


[\[http://carlmanaster.github.io/datastripes/\]](http://carlmanaster.github.io/datastripes/)

Idiom: **Change alignment**

- stacked bars
 - easy to compare
 - first segment
 - total bar
- align to different segment
 - supports flexible comparison

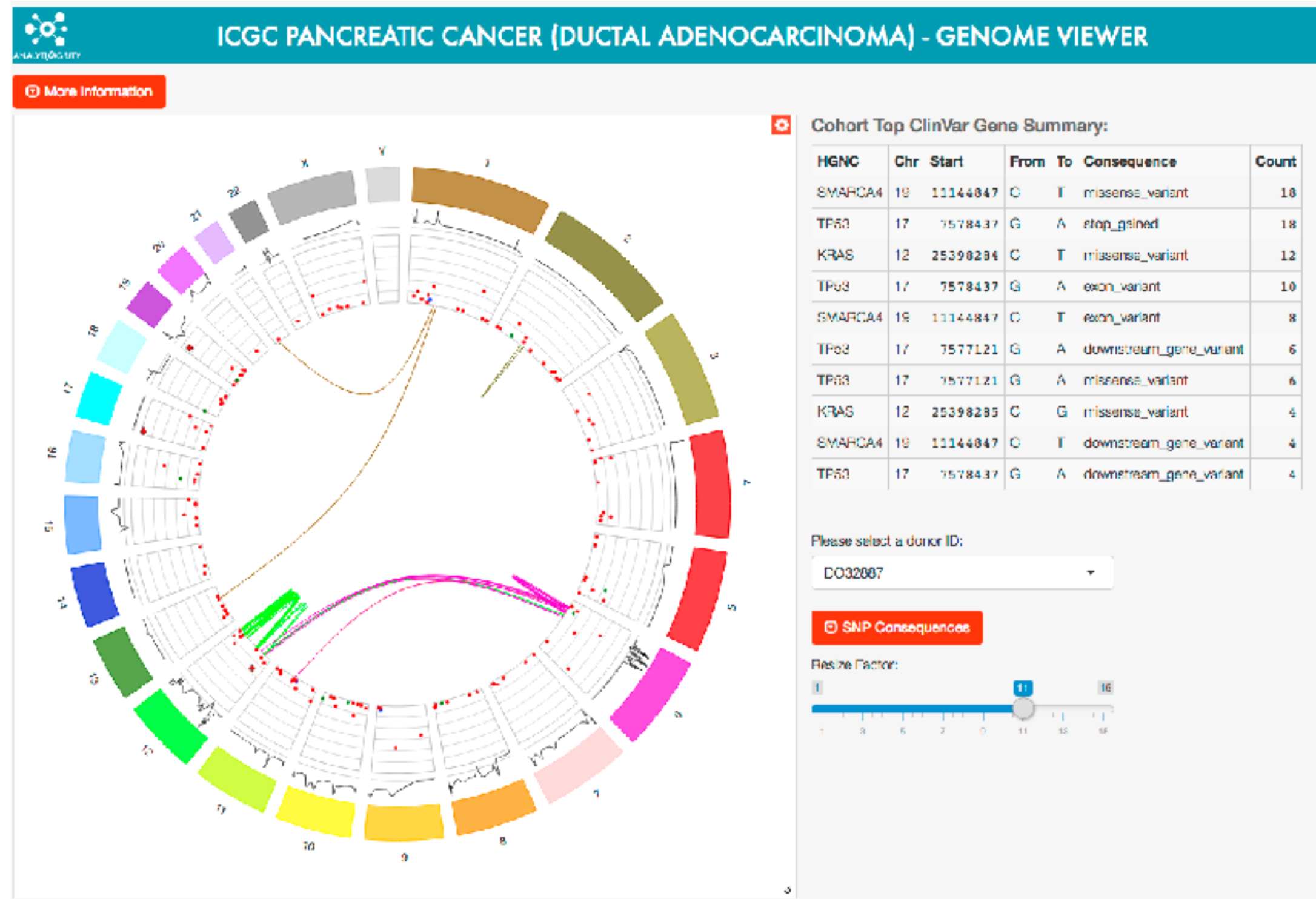
System: **LineUp**



[LineUp: Visual Analysis of Multi-Attribute Rankings. Gratzl, Lex, Gehlenborg, Pfister, and Streit. IEEE Trans. Visualization and Computer Graphics (Proc. InfoVis 2013) 19:12 (2013), 2277–2286.]

Shiny example

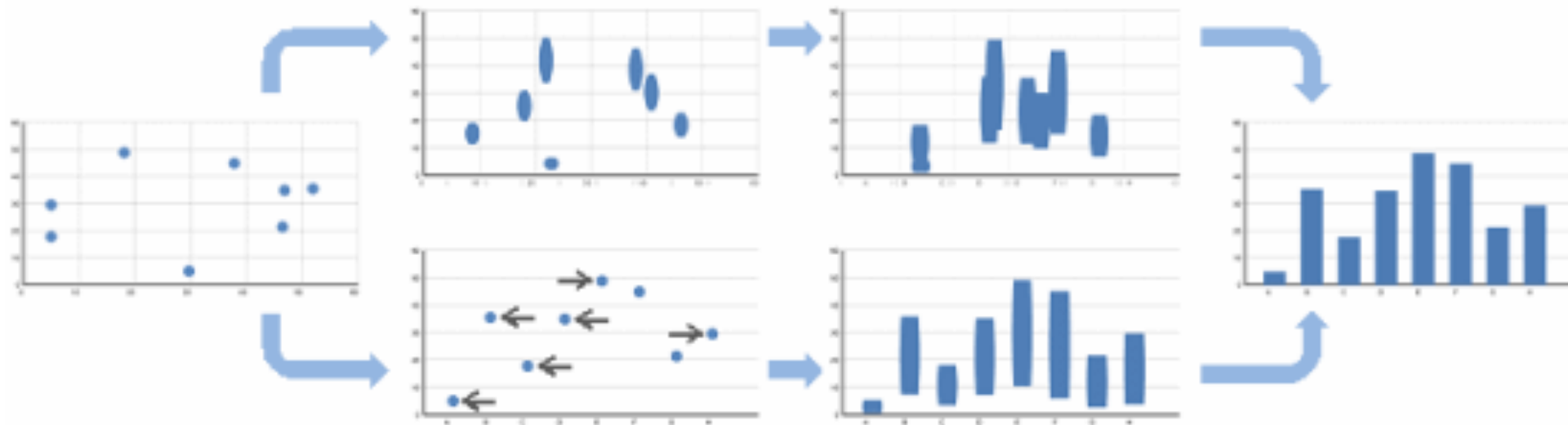
- APGI genome browser
 - tooling: R/Shiny
 - interactivity
 - tooltip detail on demand on hover
 - expand/contract chromosomes
 - expand/contract control panes



https://gallery.shinyapps.io/genome_browser/

Idiom: **Animated transitions**

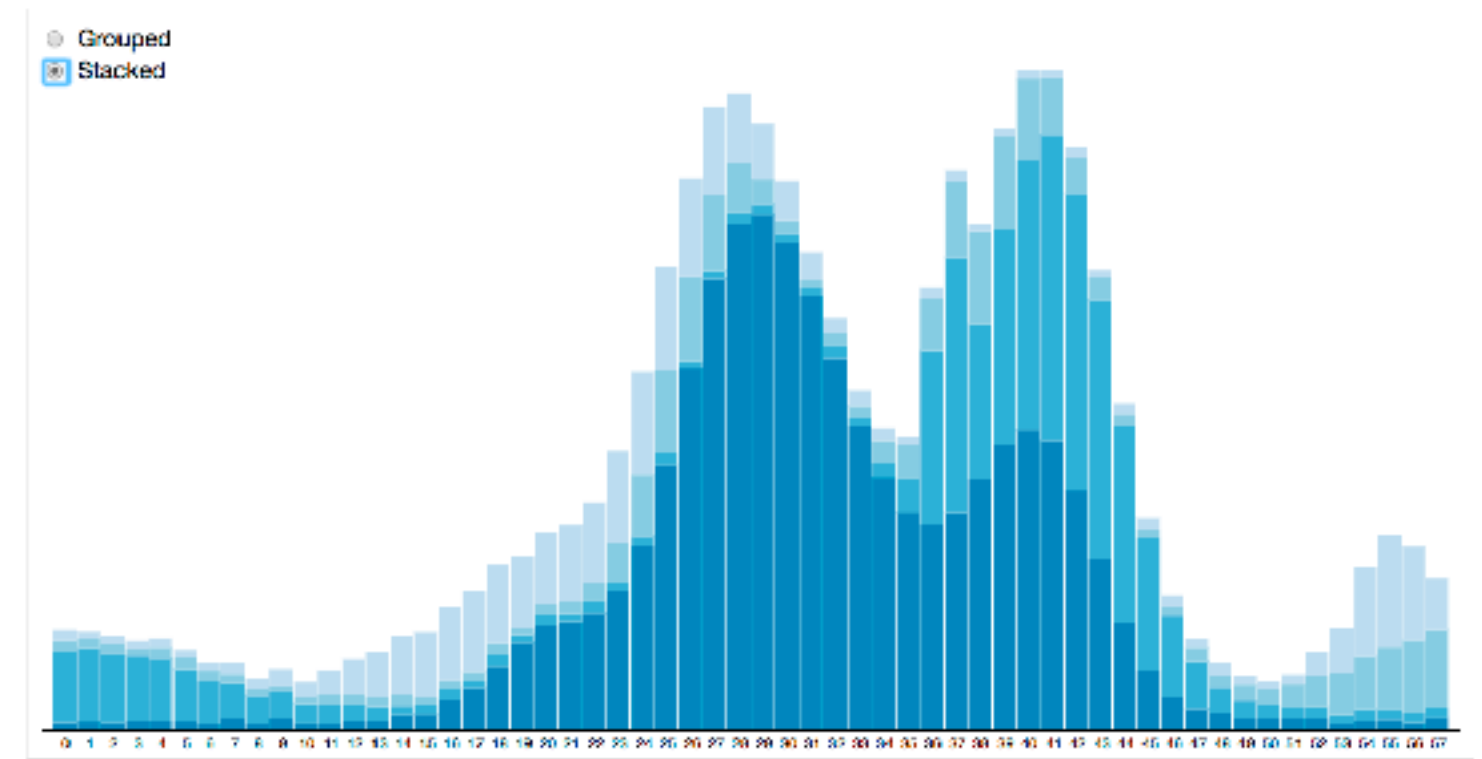
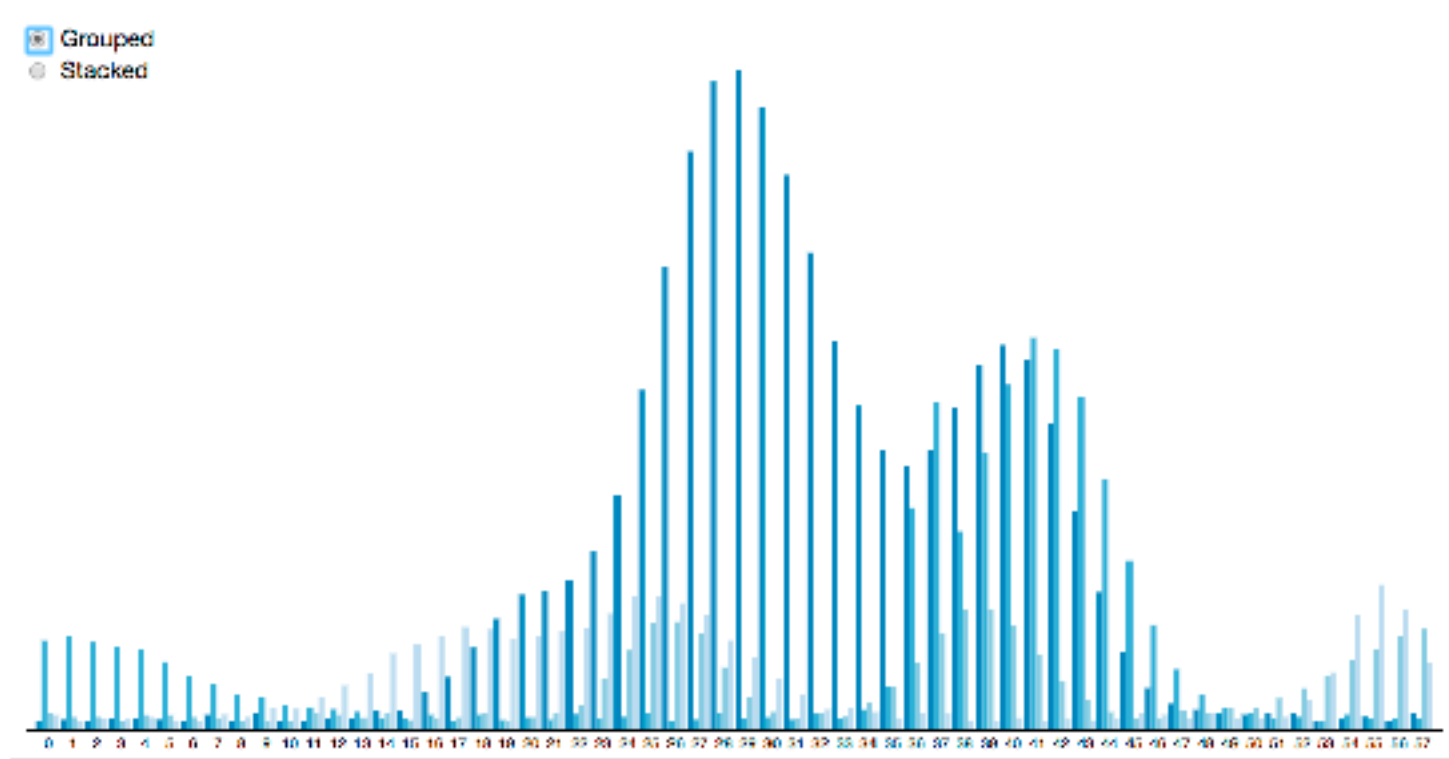
- smooth interpolation from one state to another
 - alternative to jump cuts, supports item tracking
 - best case for animation
 - staging to reduce cognitive load
- example: animated transitions in statistical data graphics



video: vimeo.com/19278444

Idiom: **Animated transitions** - visual encoding change

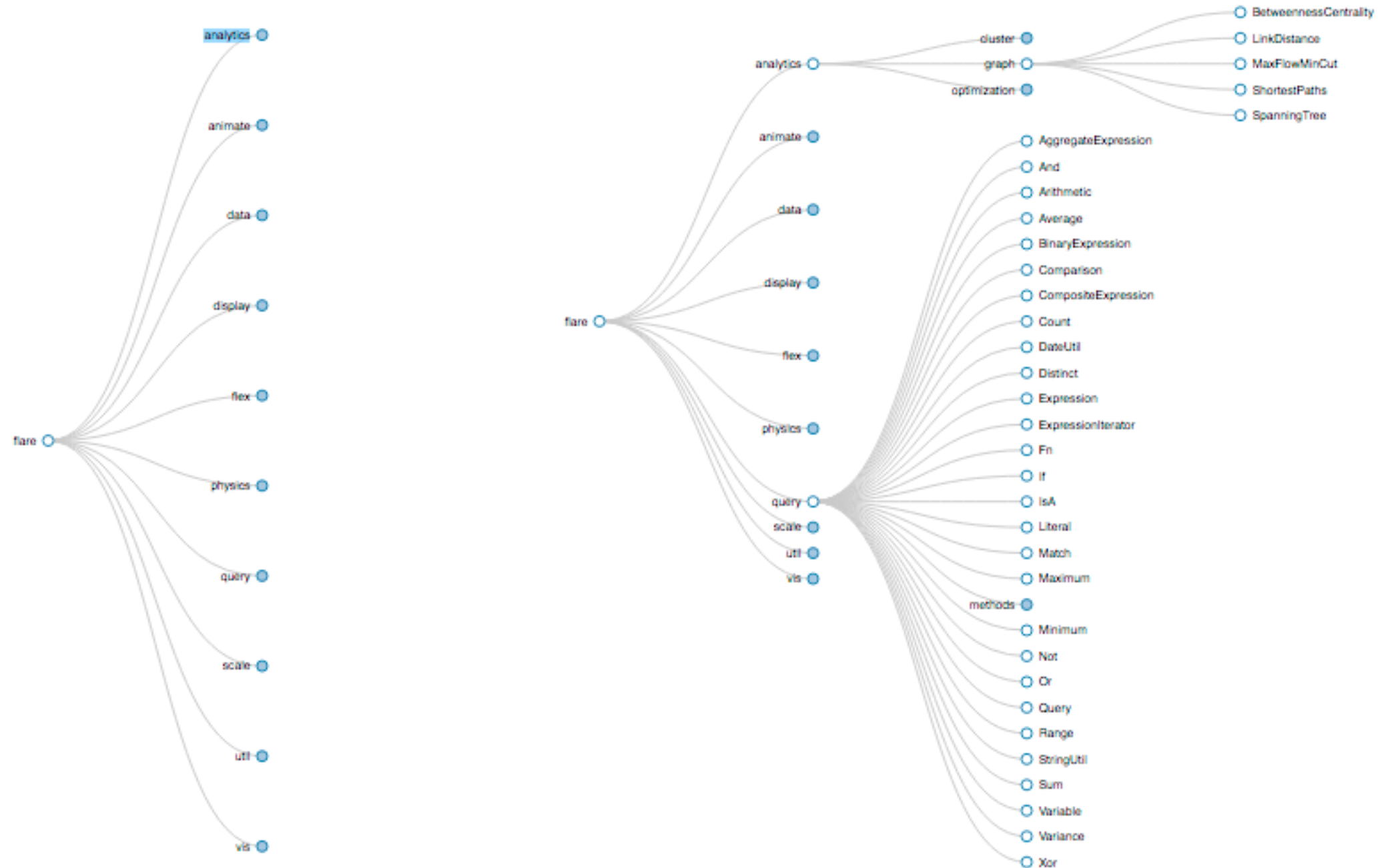
- smooth transition from one state to another
 - alternative to jump cuts, supports item tracking
 - best case for animation
 - staging to reduce cognitive load



[Stacked to Grouped Bars] (<http://blocks.org/mbostock/3943967>)

Idiom: **Animated transition - tree detail**

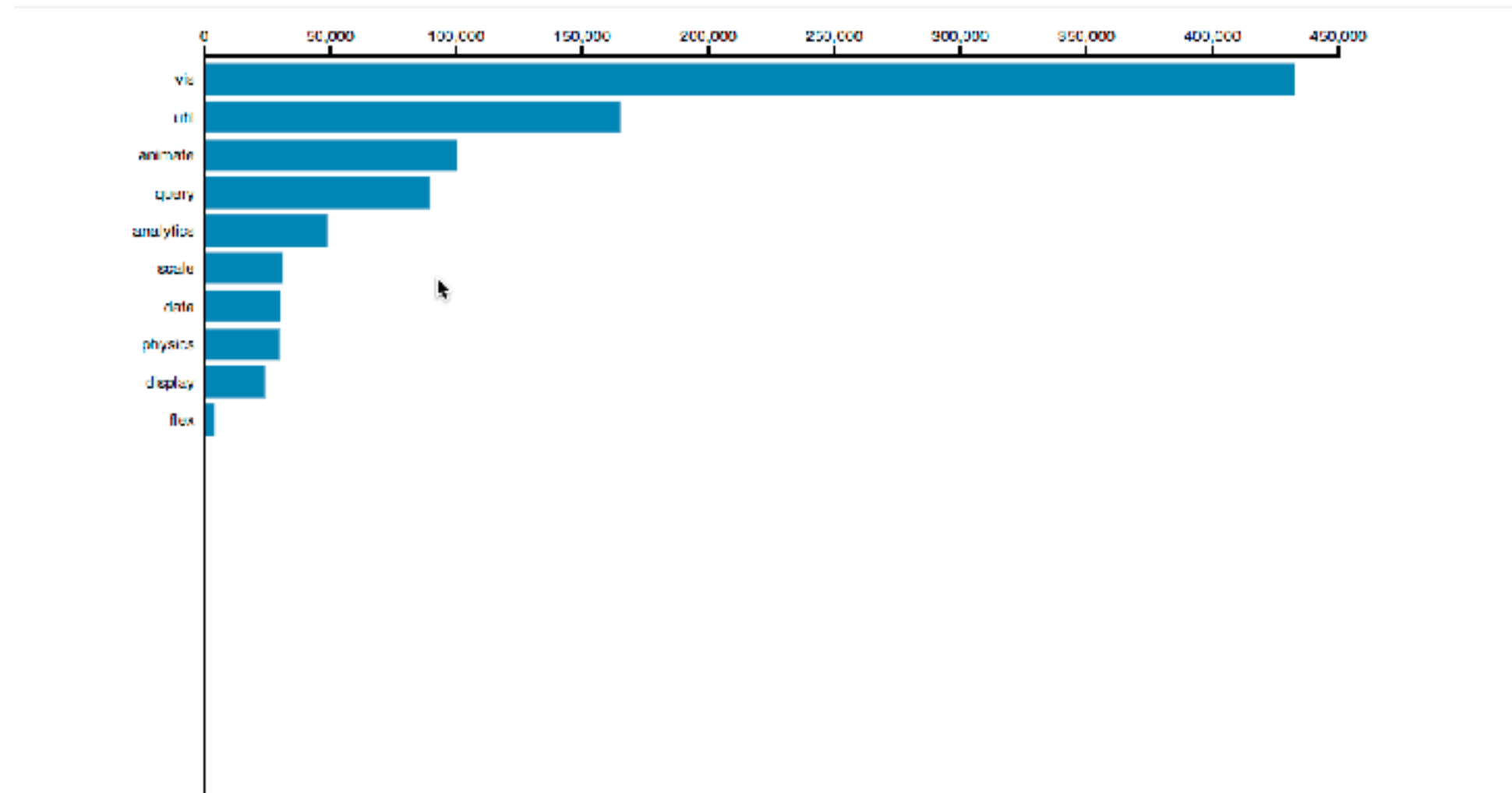
- animated transition
 - network drilldown/rollup



[Collapsible Tree](<https://blocks.org/mbostock/4339083>)

Idiom: **Animated transition - bar detail**

- example: hierarchical bar chart
 - add detail during transition to new level of detail

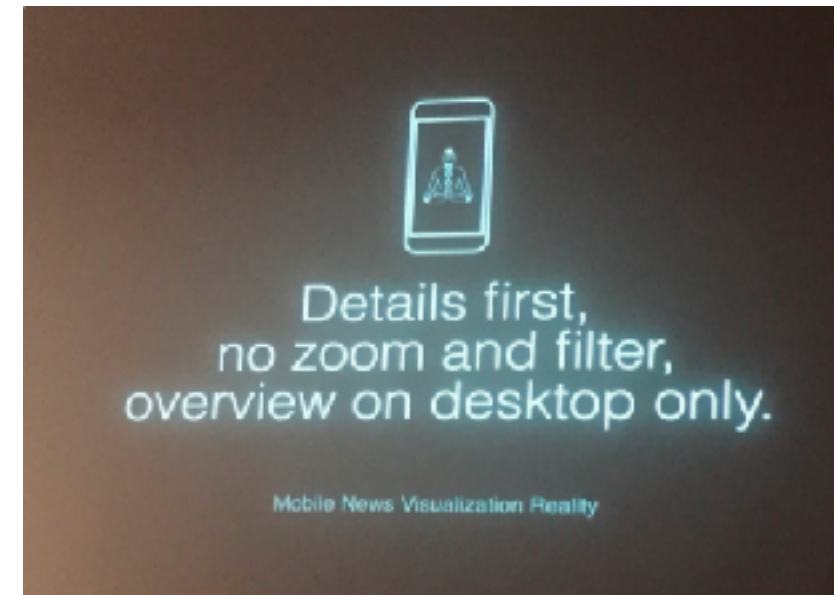


[Hierarchical Bar Chart](<https://blocks.org/mbostock/1283663>)

Interaction technology

- what do you design for?
 - mouse & keyboard on desktop?
 - large screens, hover, multiple clicks
 - touch interaction on mobile?
 - small screens, no hover, just tap
 - gestures from video / sensors?
 - ergonomic reality vs movie bombast
 - eye tracking?

slide inspired by: Alexander Lex, Utah



Data visualization and the news - Gregor Aisch (37 min)
vimeo.com/182590214

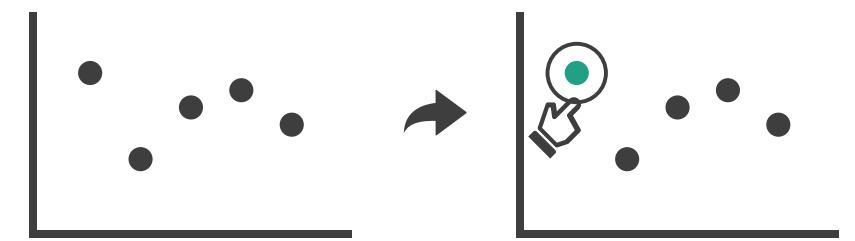


I Hate Tom Cruise - Alex Kauffmann (5 min)
www.youtube.com/watch?v=QXLfT9sFcbc

Selection

- selection: basic operation for most interaction
- design choices
 - how many selection types?
 - interaction modalities
 - click/tap (heavyweight) vs hover (lightweight but not available on most touchscreens)
 - multiple click types (shift-click, option-click, ...)
 - proximity beyond click/hover (touching vs nearby vs distant)
 - application semantics
 - adding to selection set vs replacing selection
 - can selection be null?
 - ex: toggle so nothing selected if click on background
 - primary vs secondary (ex: source/target nodes in network)
 - group membership (add/delete items, name group, ...)

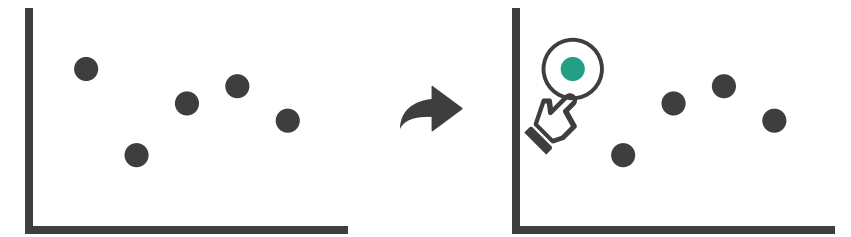
➔ Select



Highlighting

- highlight: change visual encoding for selection targets
 - visual feedback closely tied to but separable from selection (interaction)
- design choices: typical visual channels
 - change item color
 - but hides existing color coding
 - add outline mark
 - change size (ex: increase outline mark linewidth)
 - change shape (ex: from solid to dashed line for link mark)
- unusual channels: motion
 - motion: usually avoid for single view
 - with multiple views, could justify to draw attention to other views

➔ Select

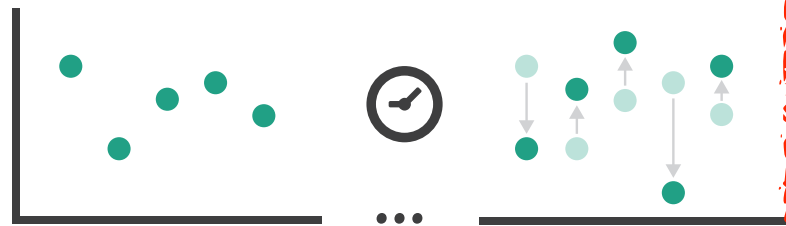


Tooltips

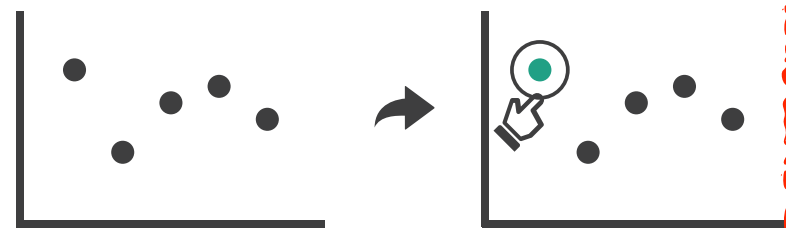
- popup information for selection
 - hover or click
 - can provide useful additional detail on demand
 - beware: does not support overview!
 - always consider if there's a way to visually encode directly to provide overview
 - “If you make a rollover or tooltip, assume nobody will see it. If it's important, make it explicit.”
 - Gregor Aisch, NYTimes

Manipulate

→ Change over Time



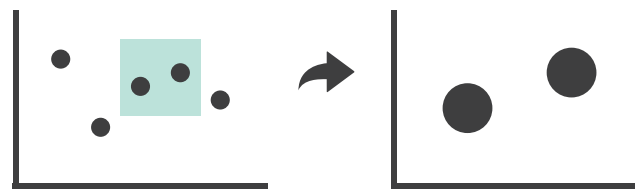
→ Select



→ Navigate

→ Item Reduction

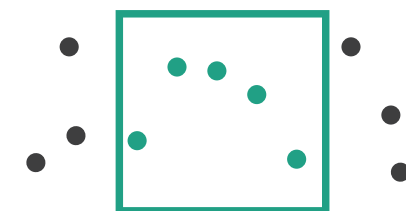
→ Zoom
Geometric or Semantic



→ Pan/Translate

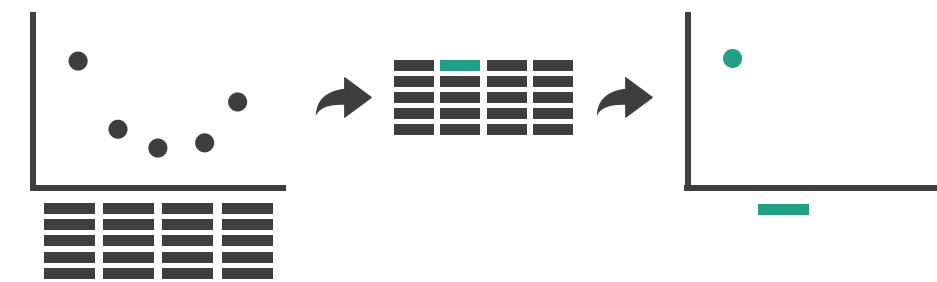


→ Constrained

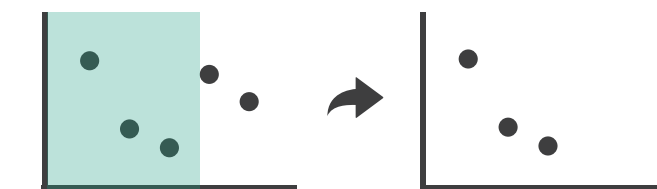


→ Attribute Reduction

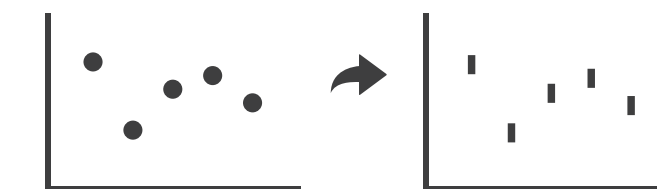
→ Slice



→ Cut



→ Project



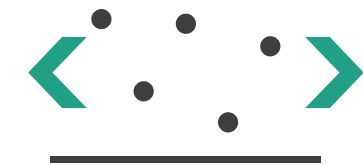
Navigate: Changing viewpoint/visibility

- change viewpoint
 - changes which items are visible within view
- camera metaphor
 - pan/translate/scroll
 - move up/down/sideways

➔ Navigate

➔ Item Reduction

➔ *Pan/Translate*



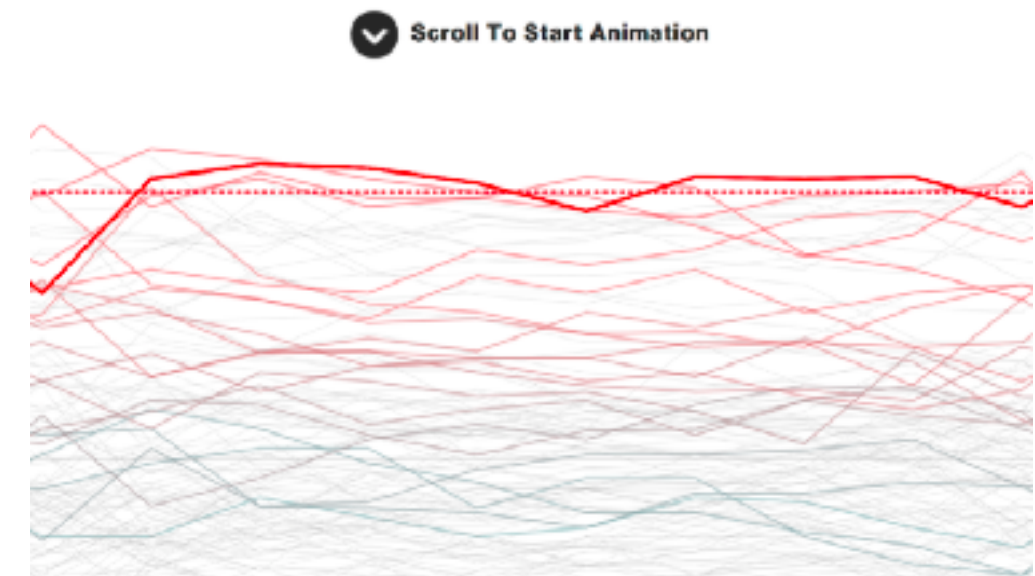
Idiom: Scrollytelling

- how: navigate page by scrolling (panning down)
- pros:
 - familiar & intuitive, from standard web browsing
 - linear (only up & down) vs possible overload of click-based interface choices
- cons:
 - full-screen mode may lack affordances
 - scrolljacking, no direct access
 - unexpected behaviour
 - continuous control for discrete steps

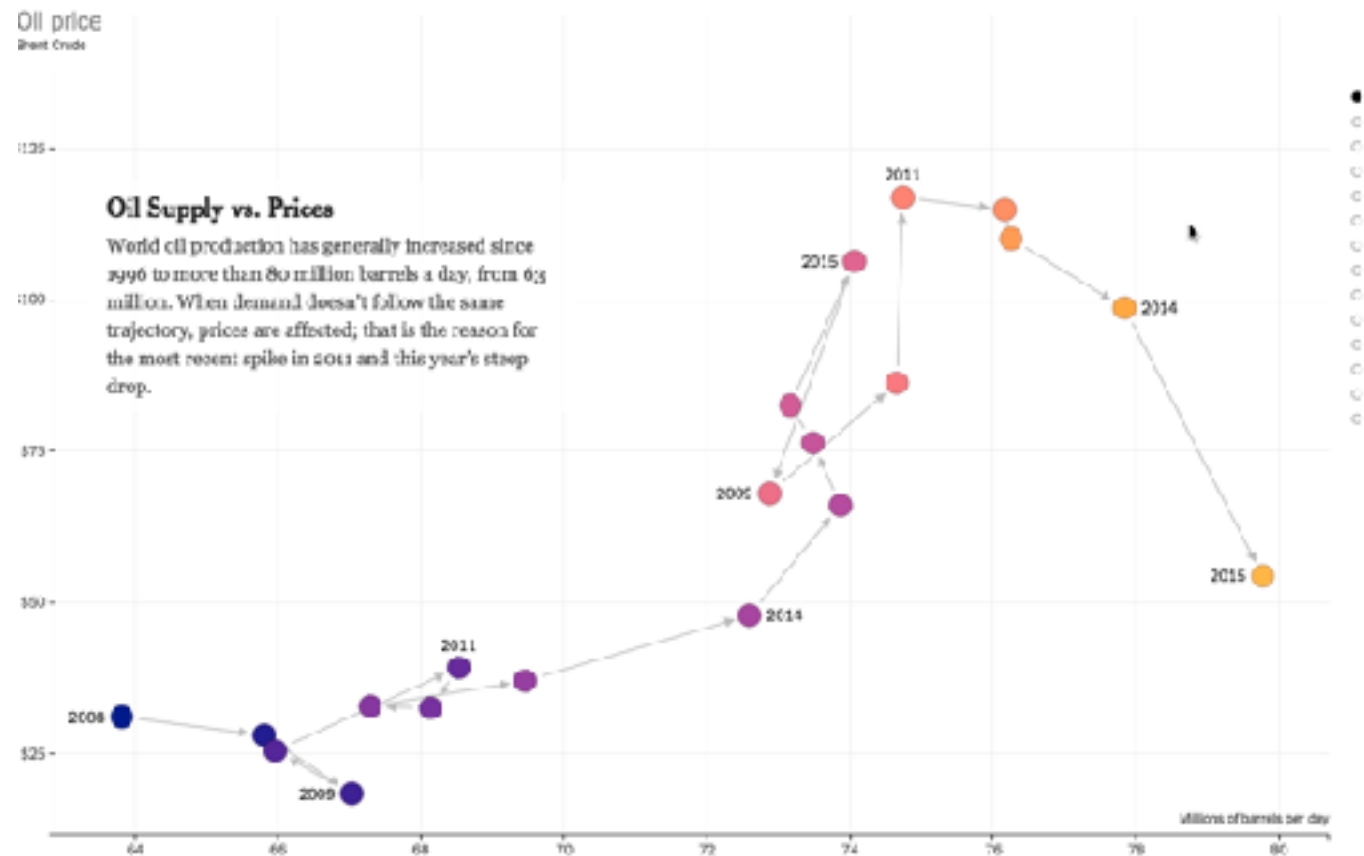
<https://eagereyes.org/blog/2016/the-scrollytelling-scourge>

[How to Scroll, Bostock](<https://bost.ocks.org/mike/scroll/>)

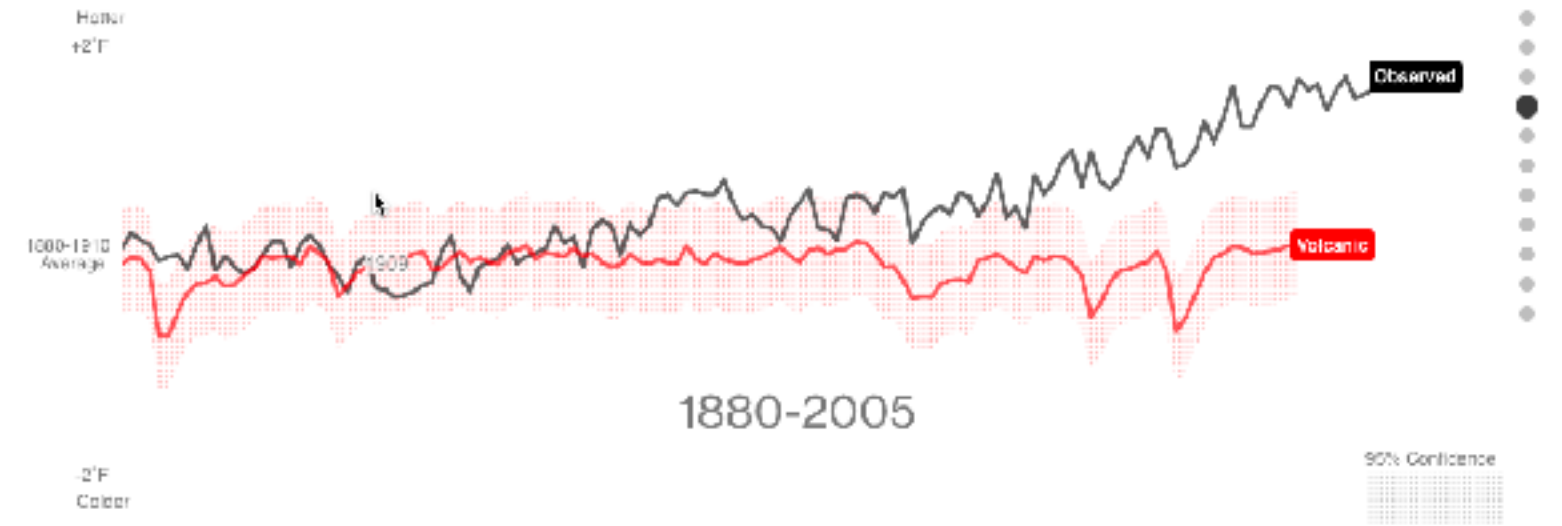
slide inspired by: Alexander Lex, Utah



Scrollytelling examples



https://www.nytimes.com/interactive/2015/09/30/business/how-the-us-and-opeac-drive-oil-prices.html?_r=1



<https://www.bloomberg.com/graphics/2015-whats-warming-the-world/>

slide inspired by: Alexander Lex, Utah

Navigate: Changing viewpoint/visibility

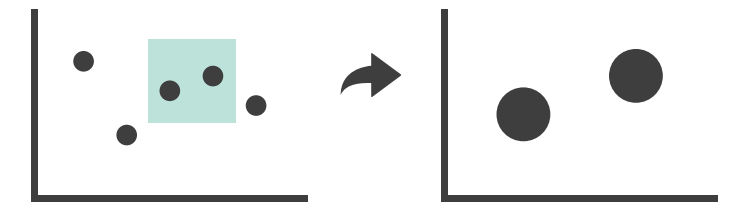
- change viewpoint
 - changes which items are visible within view
- camera metaphor
 - pan/translate/scroll
 - move up/down/sideways
 - rotate/spin
 - typically in 3D
 - zoom in/out
 - enlarge/shrink world == move camera closer/further
 - geometric zoom: standard, like moving physical object

➔ Navigate

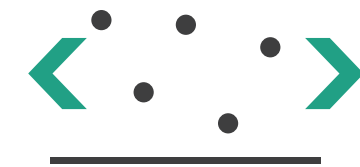
➔ Item Reduction

➔ *Zoom*

Geometric



➔ *Pan/Translate*



Navigate: Unconstrained vs constrained

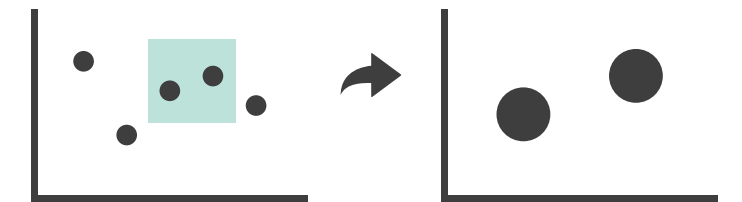
- unconstrained navigation
 - easy to implement for designer
 - hard to control for user
 - easy to overshoot/undershoot
- constrained navigation
 - typically uses animated transitions
 - trajectory automatically computed based on selection
 - just click; selection ends up framed nicely in final viewport

➔ Navigate

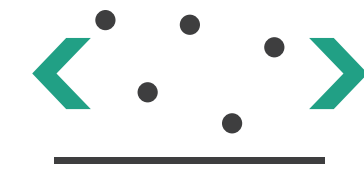
➔ Item Reduction

➔ Zoom

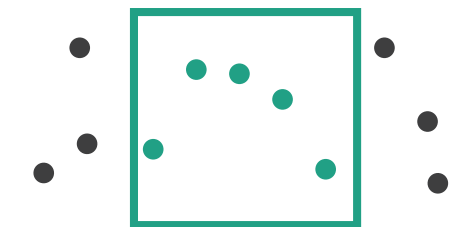
Geometric or *Semantic*



➔ Pan/Translate



➔ Constrained



Idiom: **Animated transition + constrained navigation**

- example: geographic map
 - simple zoom, only viewport changes, shapes preserved

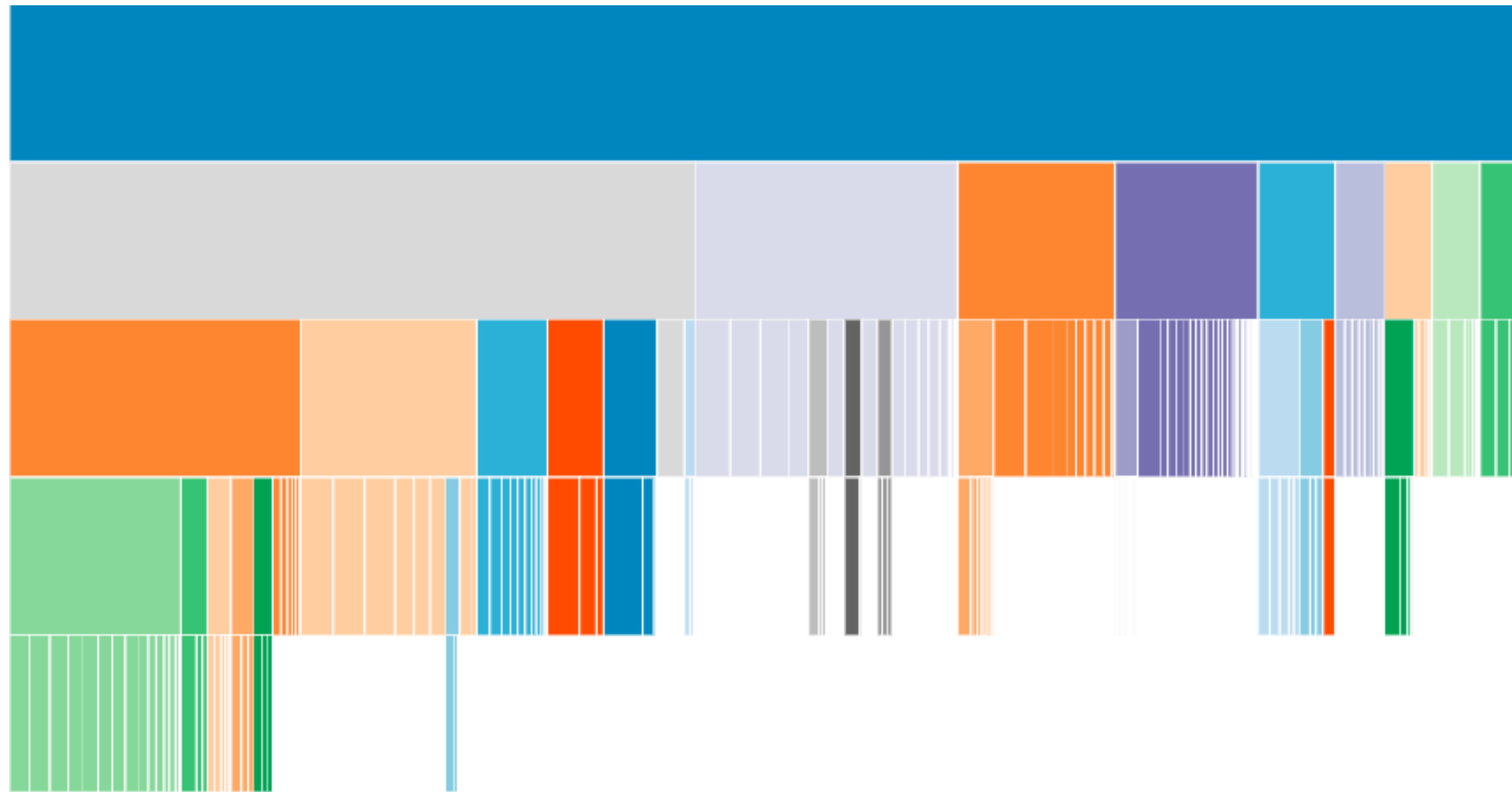
Zoom to Bounding Box



[Zoom to Bounding Box](<https://blocks.org/mbostock/4699541>)

Idiom: **Animated transition + constrained navigation**

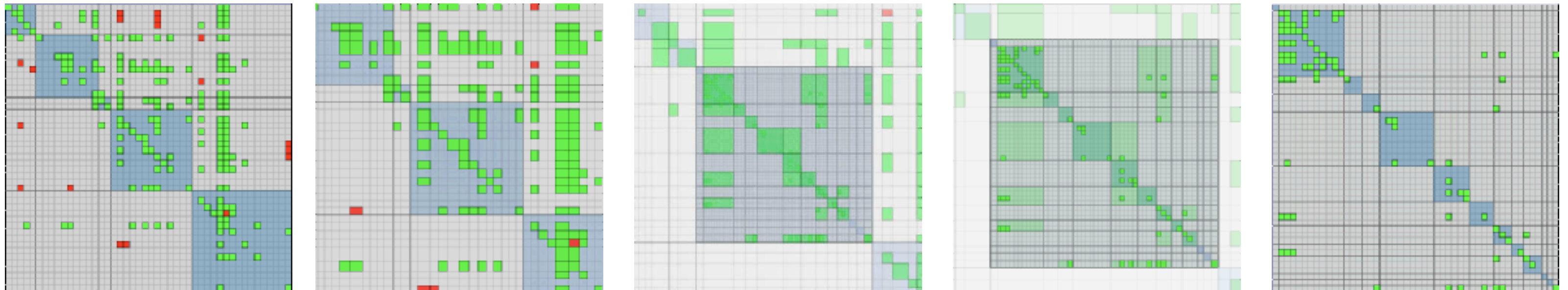
- example: icicle plot
 - transition into containing mark causes aspect ratio (shape) change



[Zoomable Icicle](<https://bl.ocks.org/mbostock/1005873>)

Idiom: **Animated transition + constrained navigation**

- example: multilevel matrix views
 - add detail during transition
 - movie: <http://www.win.tue.nl/vis/home/fvham/matrix/Zoomin.avi>
 - movie: <http://www.win.tue.nl/vis/home/fvham/matrix/Zoomout.avi>
 - movie: <http://www.win.tue.nl/vis/home/fvham/matrix/Pan.avi>

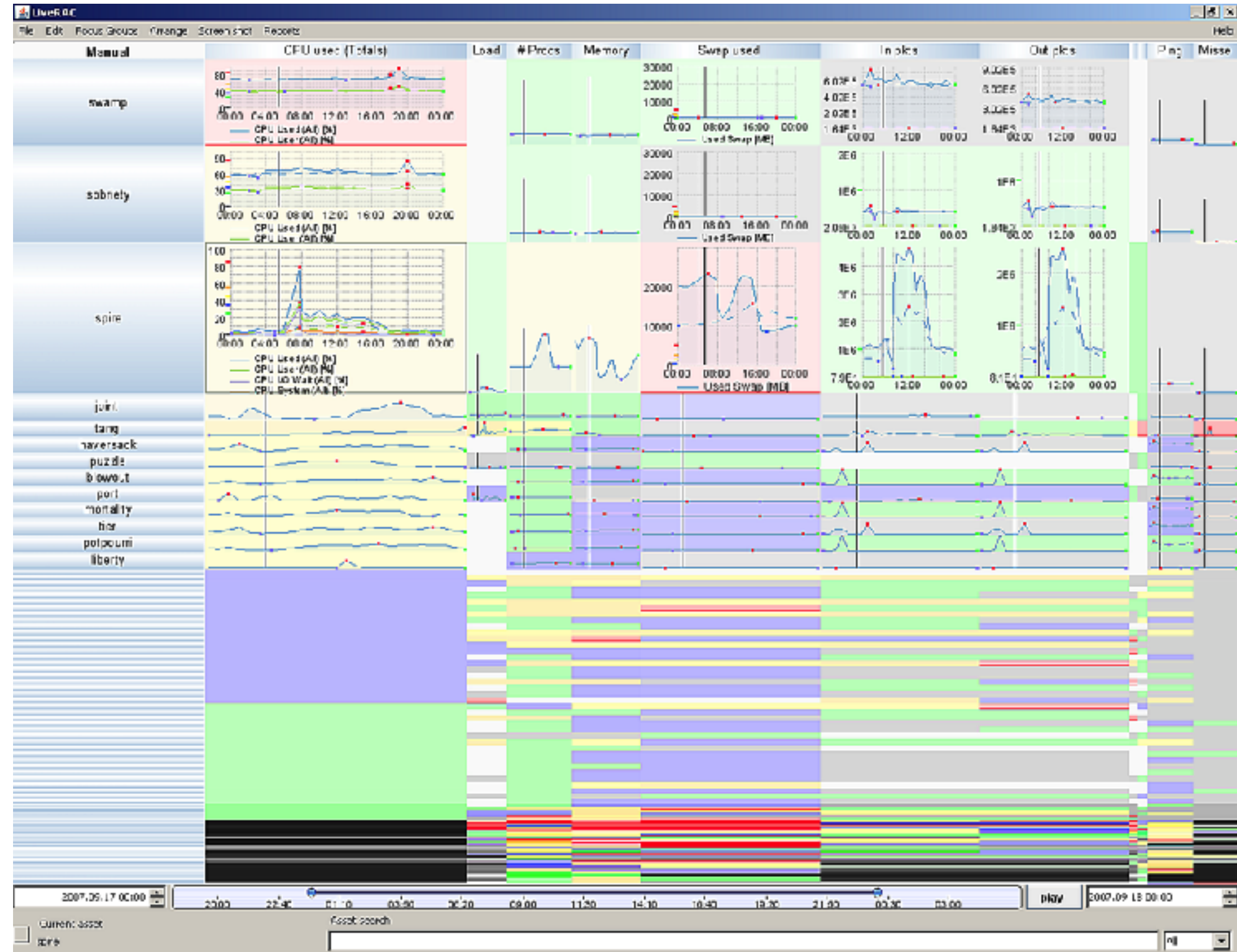


[Using Multilevel Call Matrices in Large Software Projects. van Ham. Proc. IEEE Symp. Information Visualization (InfoVis), pp. 227–232, 2003.]

Idiom: Semantic zooming

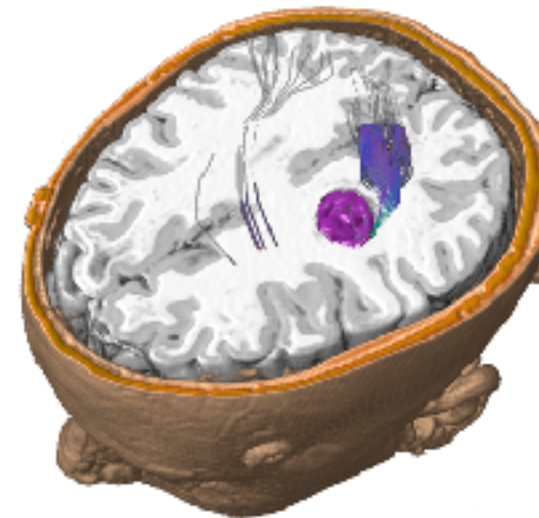
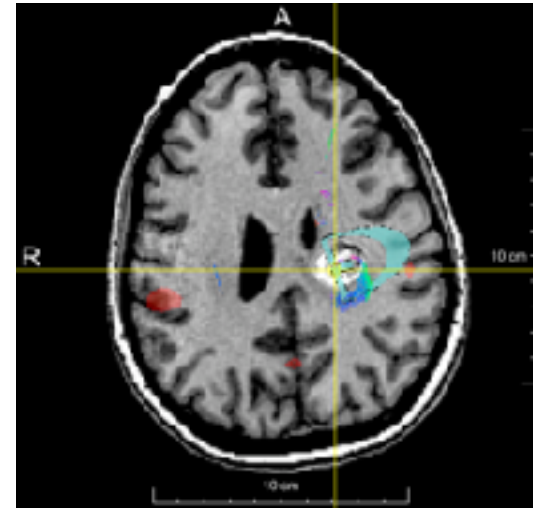
System: LiveRAC

- semantic zoom
 - alternative to geometric zoom
 - resolution-aware layout adapts to available space
 - goal: legible at multiple scales
 - dramatic or subtle effects
- visual encoding change
 - colored box
 - sparkline
 - simple line chart
 - full chart: axes and tickmarks



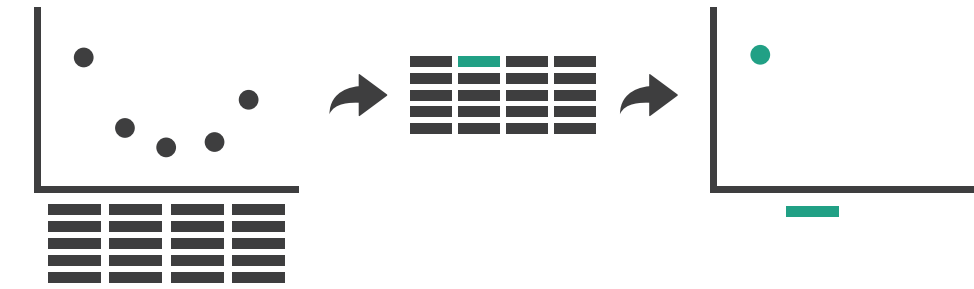
Navigate: Reducing attributes

- continuation of camera metaphor
 - slice
 - show only items matching specific value for given attribute: slicing plane
 - axis aligned, or arbitrary alignment
 - cut
 - show only items on far side of plane from camera
 - project
 - change mathematics of image creation
 - orthographic (eliminate 3rd dimension)
 - perspective (foreshortening captures limited 3D information)

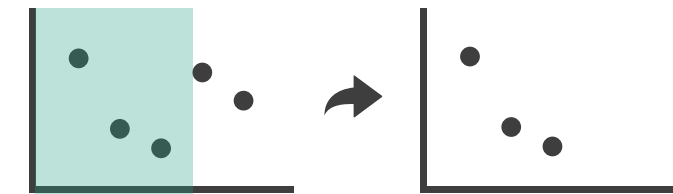


→ Attribute Reduction

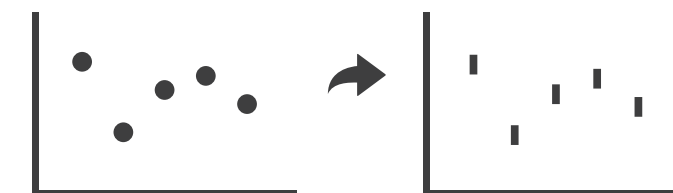
→ *Slice*



→ *Cut*

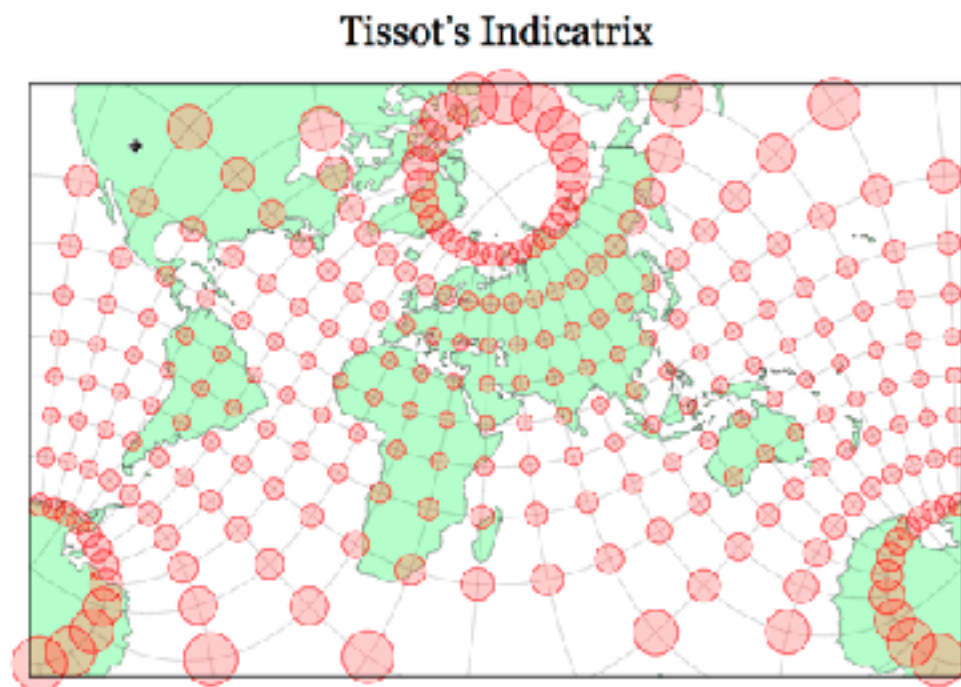


→ *Project*

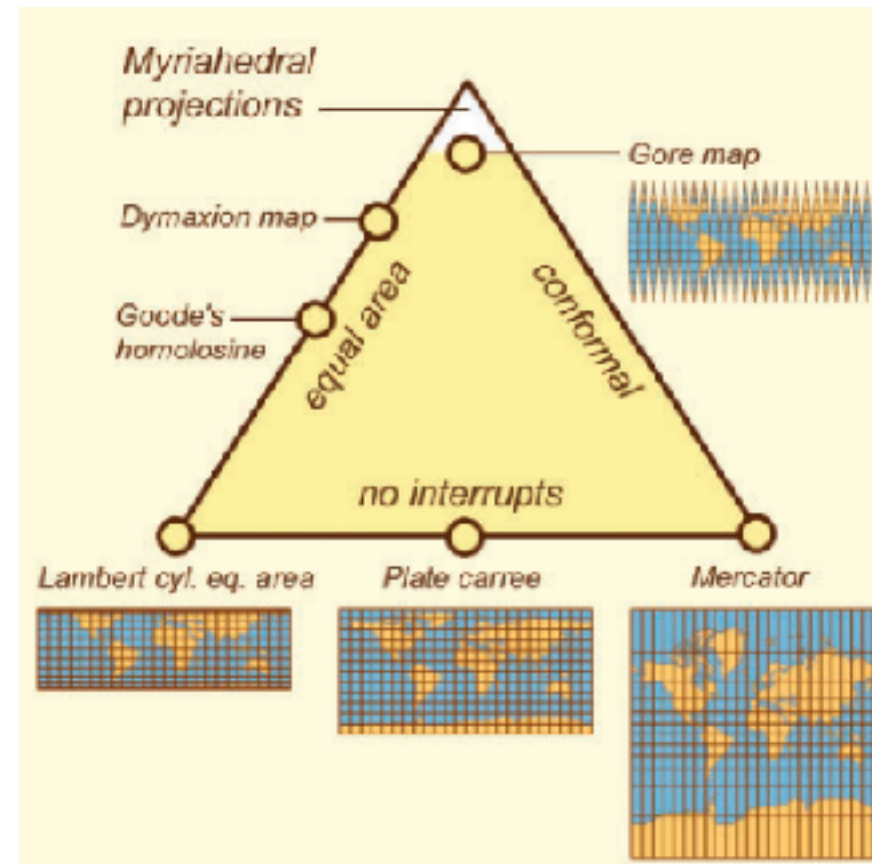


Navigate: Cartographic projections

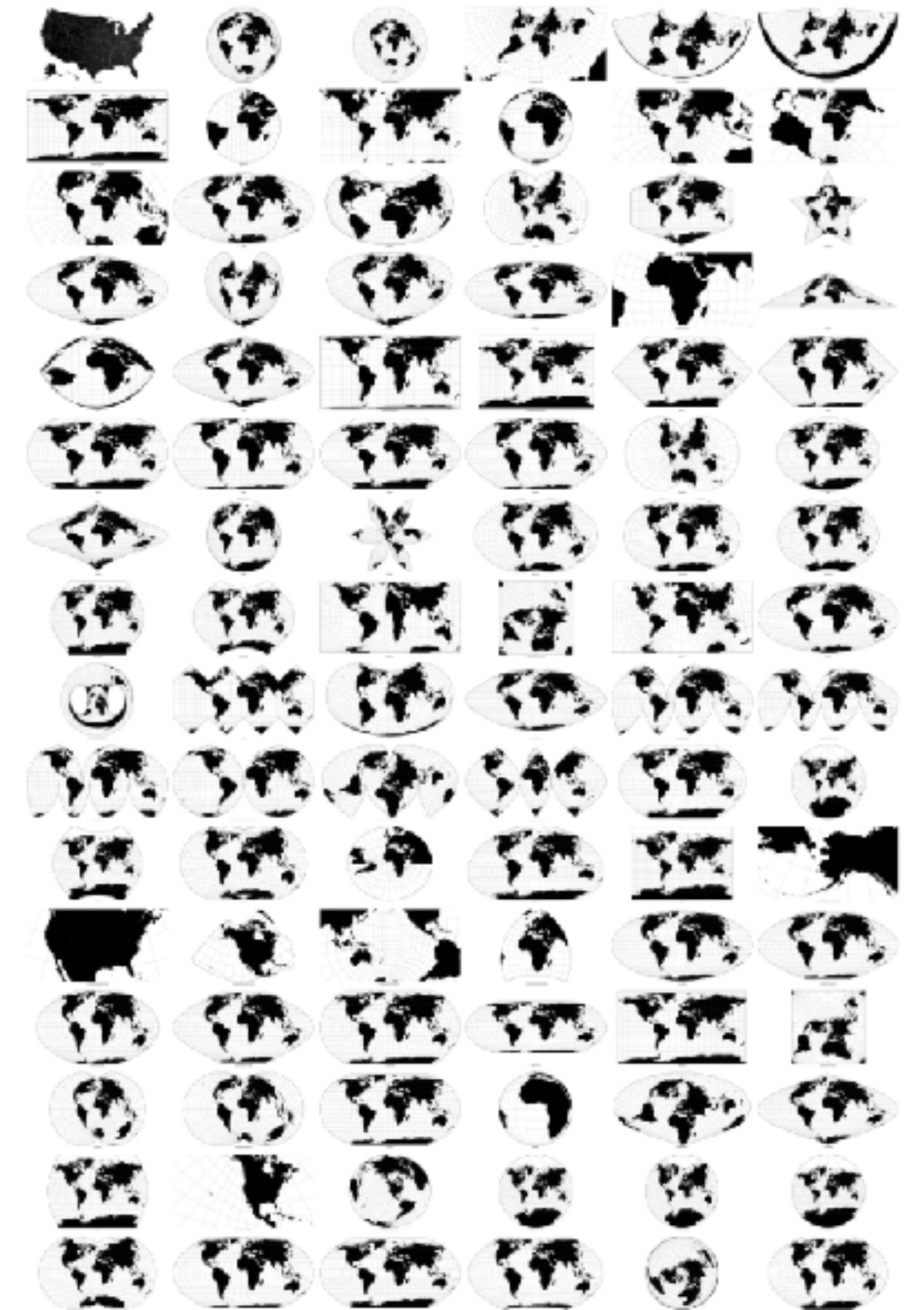
- project from 2D sphere surface to 2D plane
 - can only fully preserve 2 out of 3
 - angles: conformal
 - area: equal area
 - contiguity: no interruptions



<https://www.jasondavies.com/maps/tissot/>



<https://www.win.tue.nl/~vanwijk/myriahedral/>



[Every Map Projection](<https://bl.ocks.org/mbostock/29cddc0006f8b98eff12e60dd08f59a7>)

Interaction benefits

- interaction pros
 - major advantage of computer-based vs paper-based visualization
 - flexible, powerful, intuitive
 - exploratory data analysis: change as you go during analysis process
 - fluid task switching: different visual encodings support different tasks
 - animated transitions provide excellent support
 - empirical evidence that animated transitions help people stay oriented

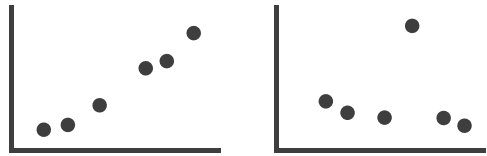
Interaction limitations

- interaction has a time cost
 - sometimes minor, sometimes significant
 - degenerates to human-powered search in worst case
- remembering previous state imposes cognitive load
 - *rule of thumb: eyes over memory*
 - *hard to compare visible item to memory of what you saw*
 - ex: maintaining context/orientation when navigating
 - ex: tracking complex changes during animation
- controls may take screen real estate
 - or invisible functionality may be difficult to discover (lack of affordances)
- users may not interact as planned by designer
 - NYTimes logs show ~90% don't interact beyond scrollytelling - Aisch, 2016

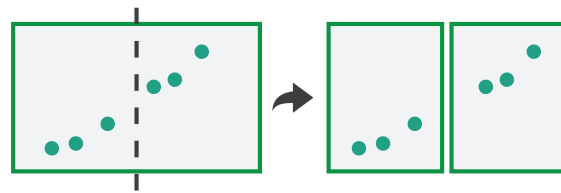
Ch 12: Facet

Facet

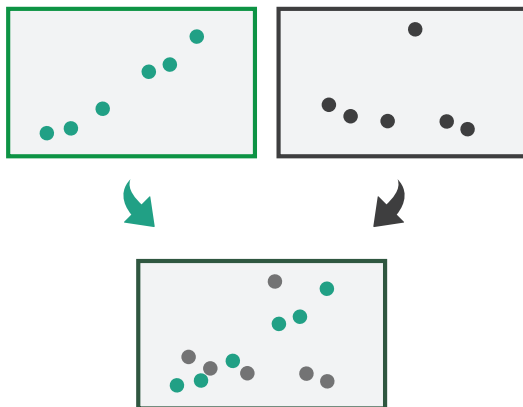
→ Juxtapose



→ Partition



→ Superimpose



Juxtapose and coordinate views

→ Share Encoding: Same/Different

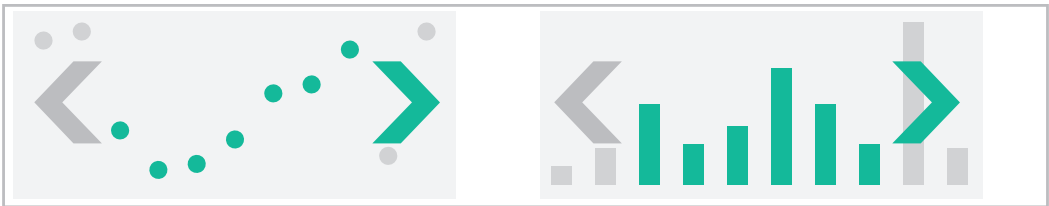
→ *Linked Highlighting*



→ Share Data: All/Subset/None



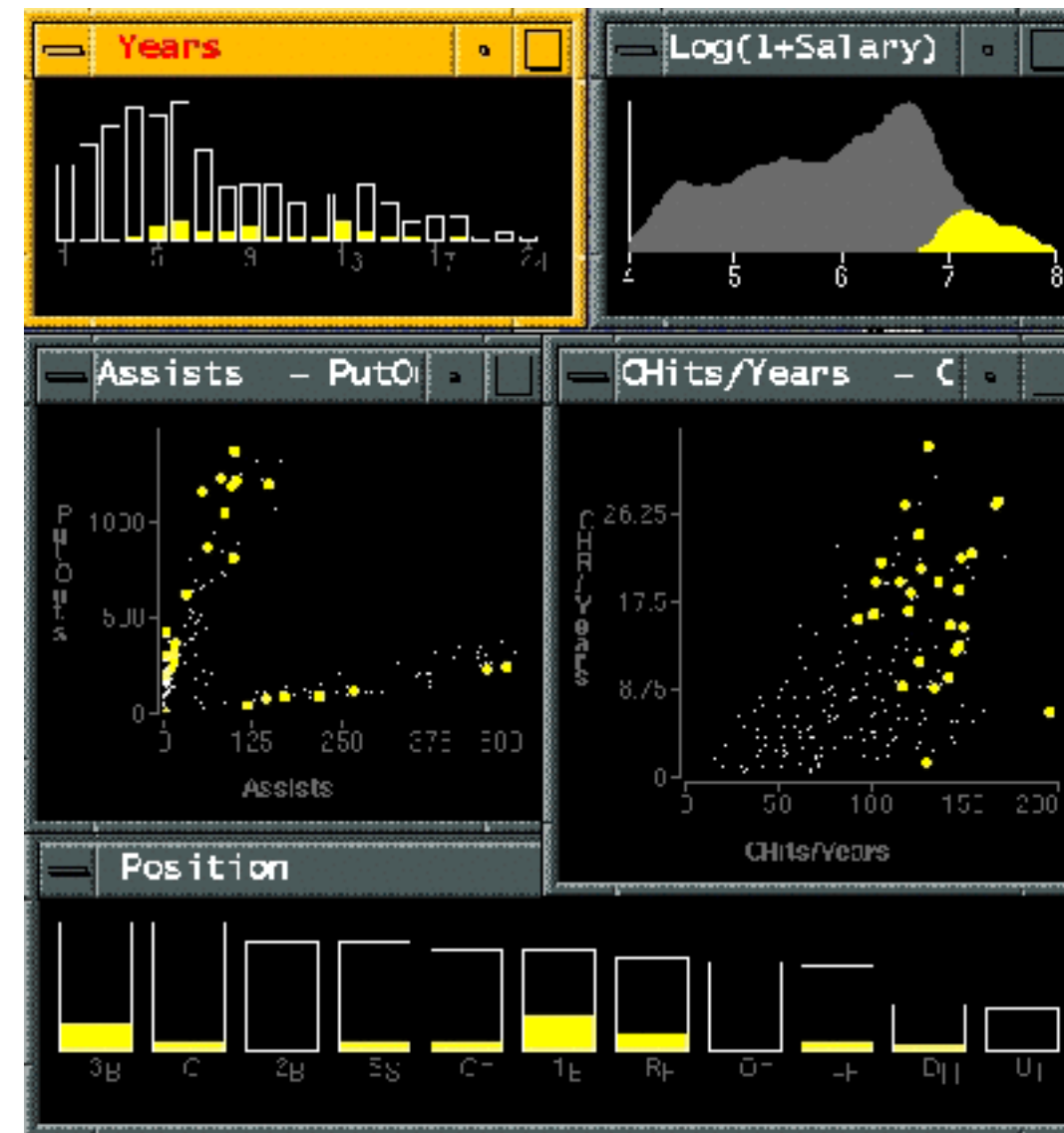
→ Share Navigation



Idiom: **Linked highlighting**

System: **EDV**

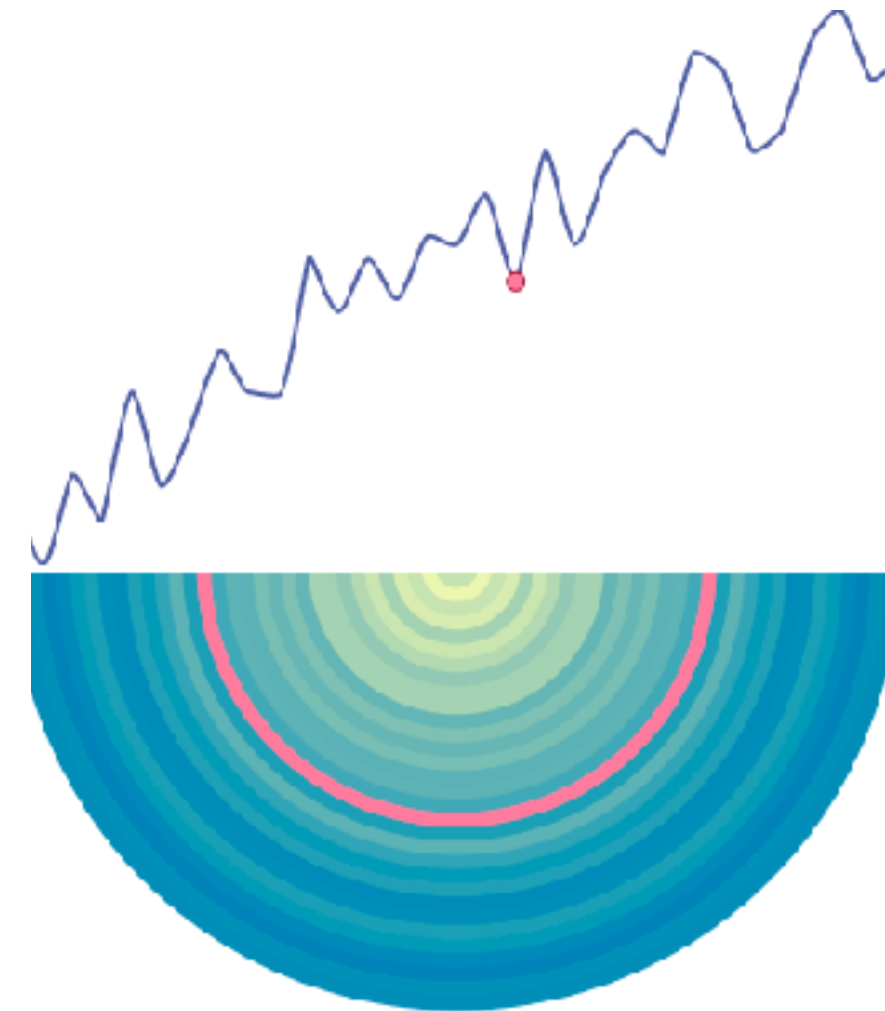
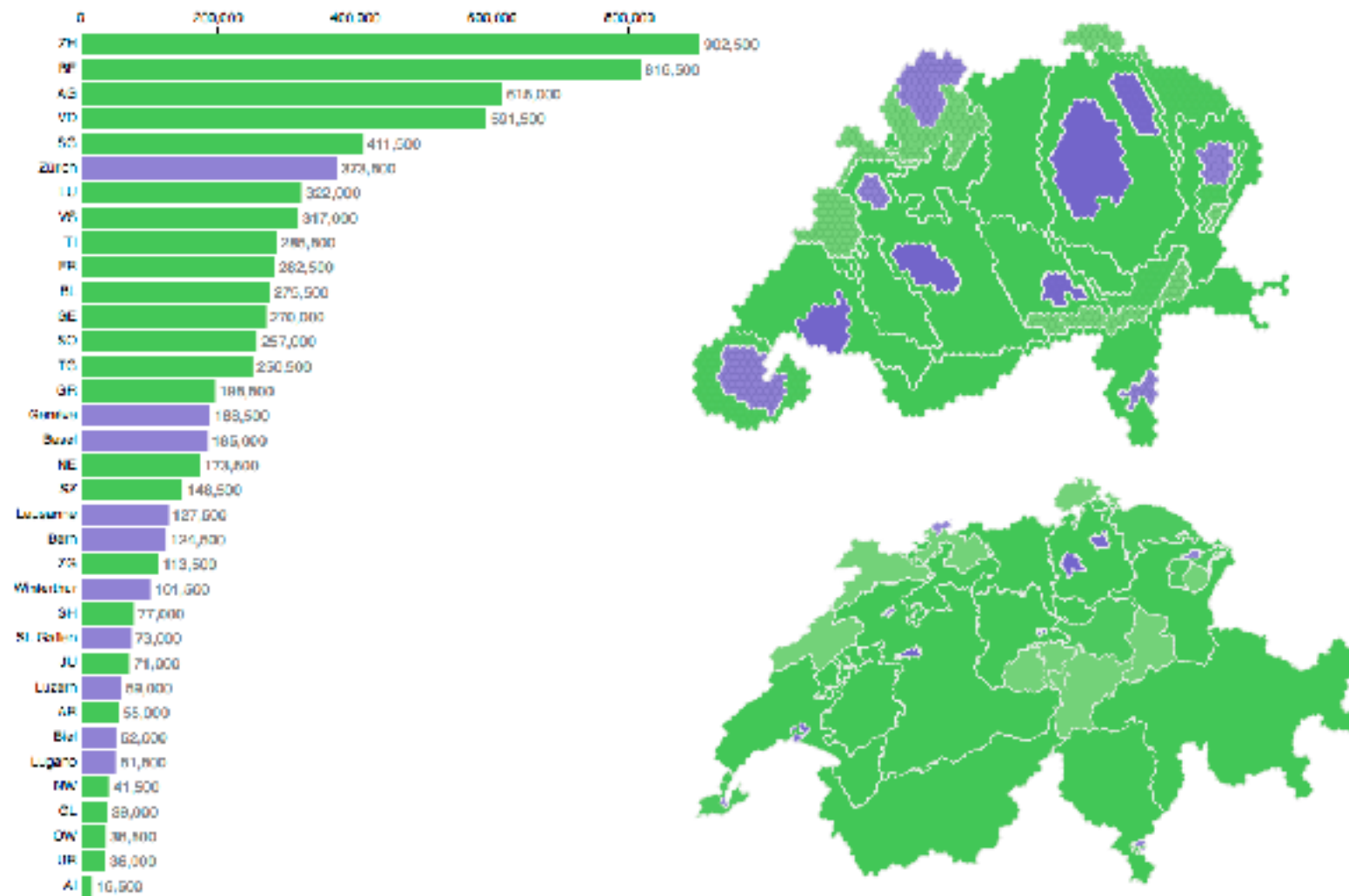
- see how regions contiguous in one view are distributed within another
 - powerful and pervasive interaction idiom
- encoding: different
 - **multiform**
- data: all shared
- aka: brushing and linking



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

Linked views

- unidirectional vs bidirectional linking



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

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

Linked views: Multidirectional linking

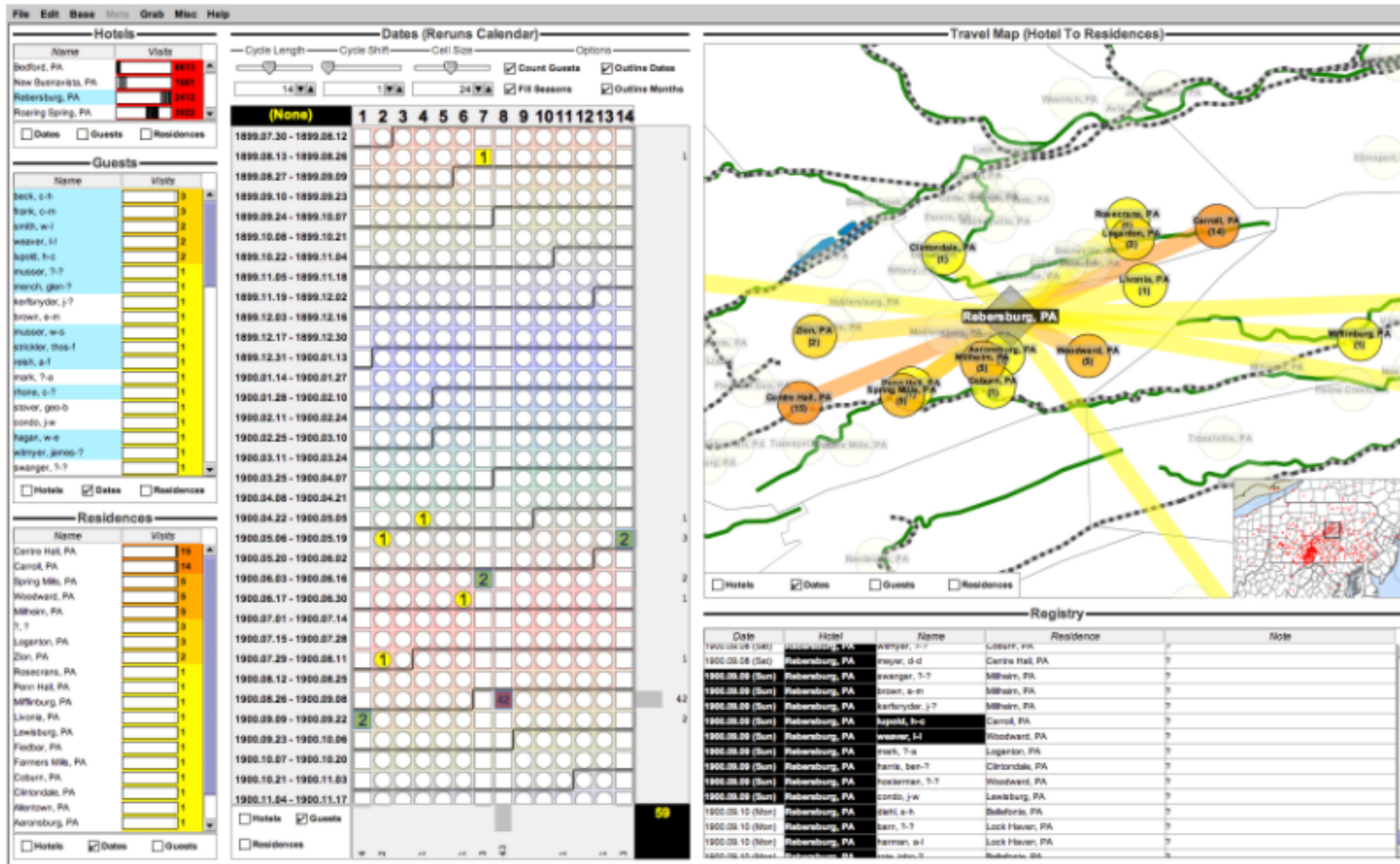
System: **Buckets**



<http://buckets.peterbeshai.com/>

<https://medium.com/@pbesh/linked-highlighting-with-react-d3-js-and-reflux-16e9c0b2210b>

Video: Visual Analysis of Historical Hotel Visitation Patterns

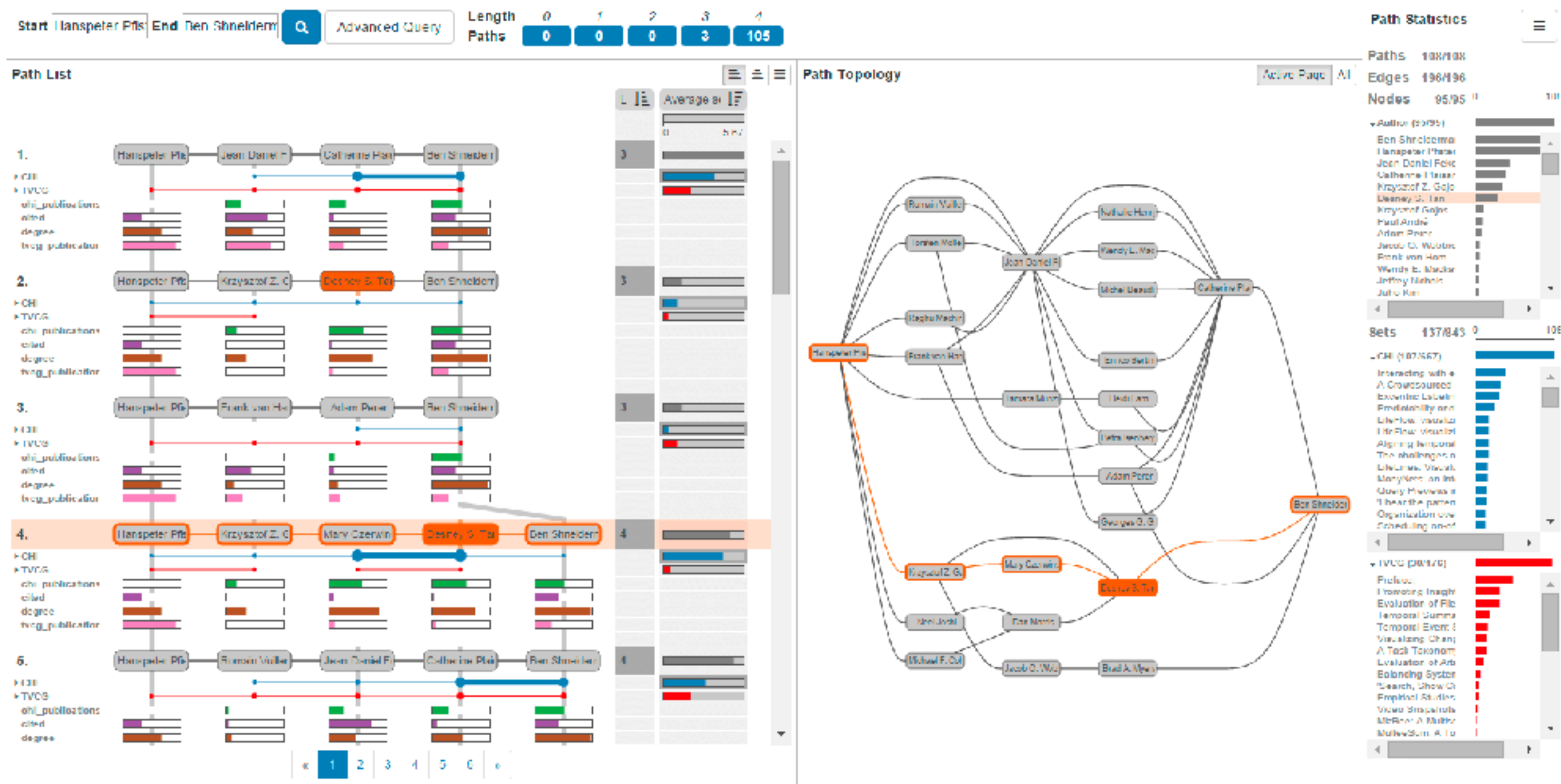


<https://www.youtube.com/watch?v=Tzsv6wkZoiQ>

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

Complex linked multiform views

System: Pathfinder



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

Idiom: Overview-detail views

System: Google Maps

- encoding: same
- data: subset shared
- navigation: shared
 - bidirectional linking

- differences
 - viewpoint
 - (size)

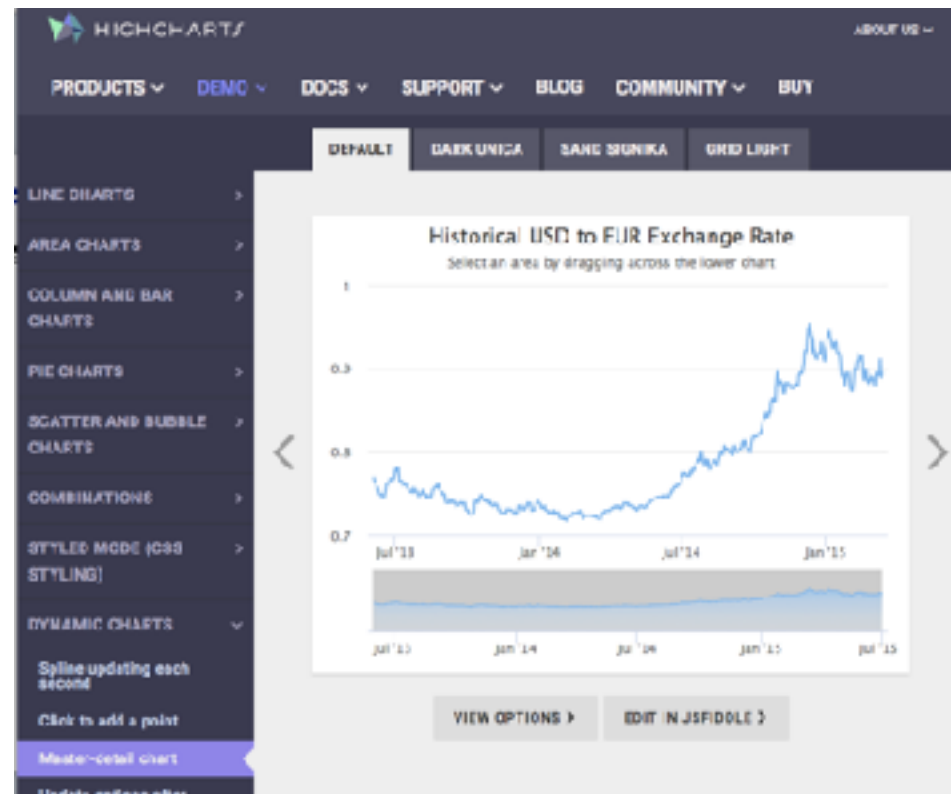
- special case:
birds-eye map



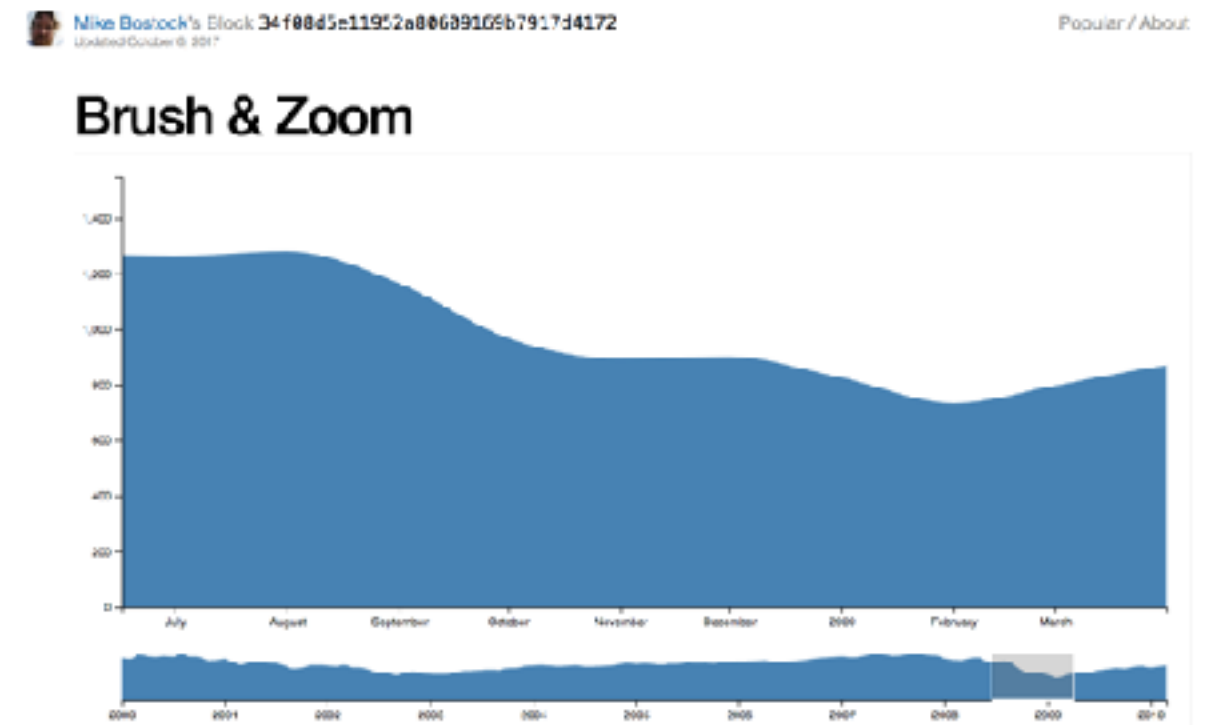
[A Review of Overview+Detail, Zooming, and Focus+Context Interfaces. Cockburn, Karlson, and Bederson. ACM Computing Surveys 41:1 (2008), 1–31.]

Idiom: Overview-detail navigation

- encoding: same
- data: subset shared
- navigation: shared
 - unidirectional linking
 - select in small overview
 - change extent in large detail view



<https://www.highcharts.com/demo/dynamic-master-detail>

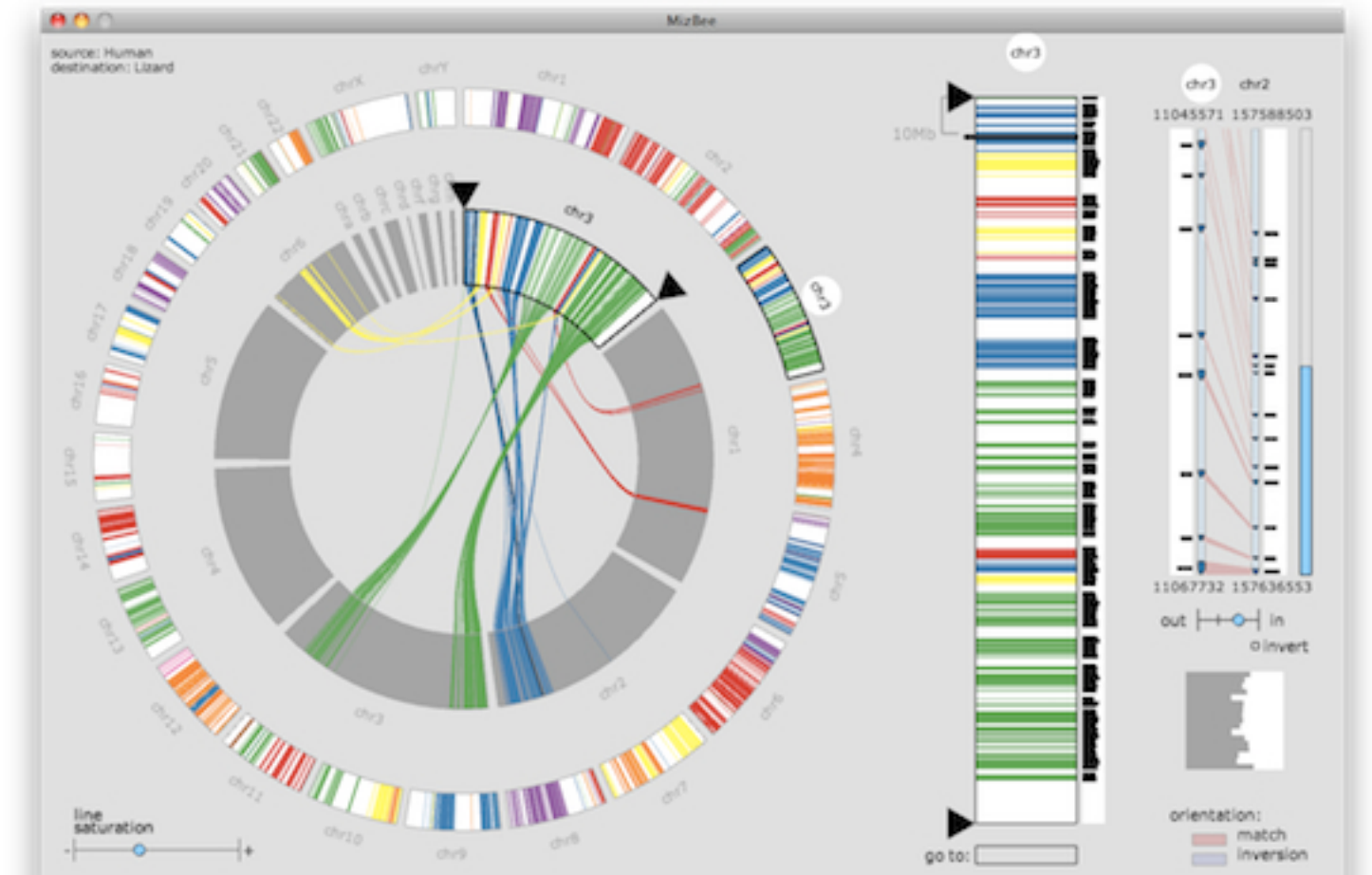


<https://bl.ocks.org/mbostock/34f08d5e11952a80609169b7917d4172>

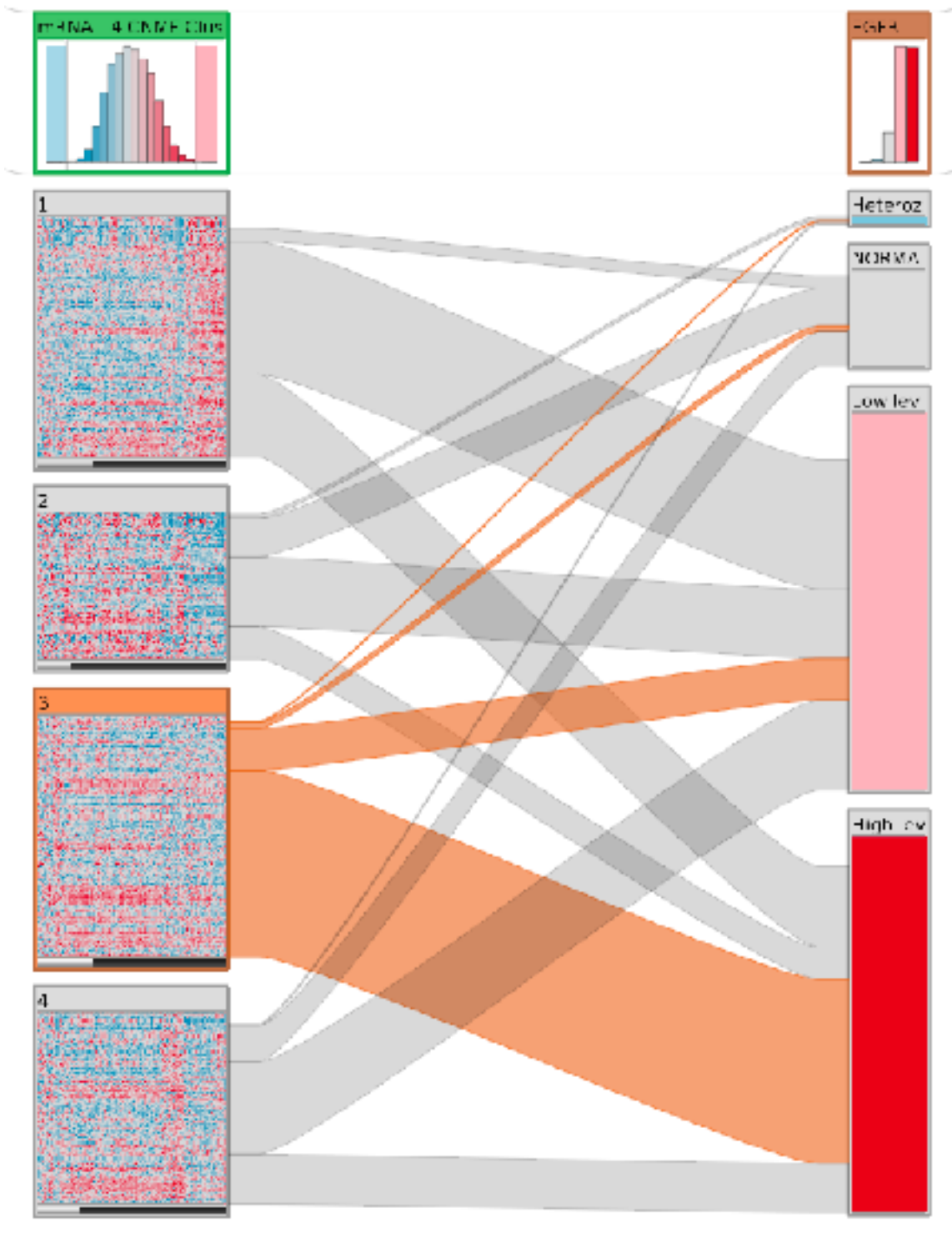
Overview-detail

- multiscale: three viewing levels
 - linked views
 - dynamic filtering
 - tooling: processing (modern version: p5js.org)

System: **MizBee**



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



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

Idiom: **Small multiples**

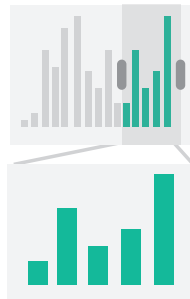
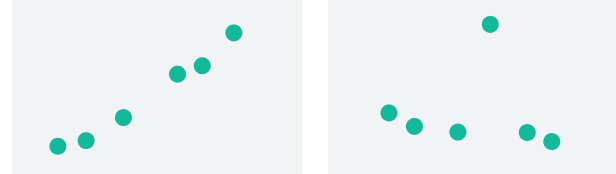


System: **Cerebral**

- 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.]

Coordinate views: Design choice interaction

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

- why juxtapose views?

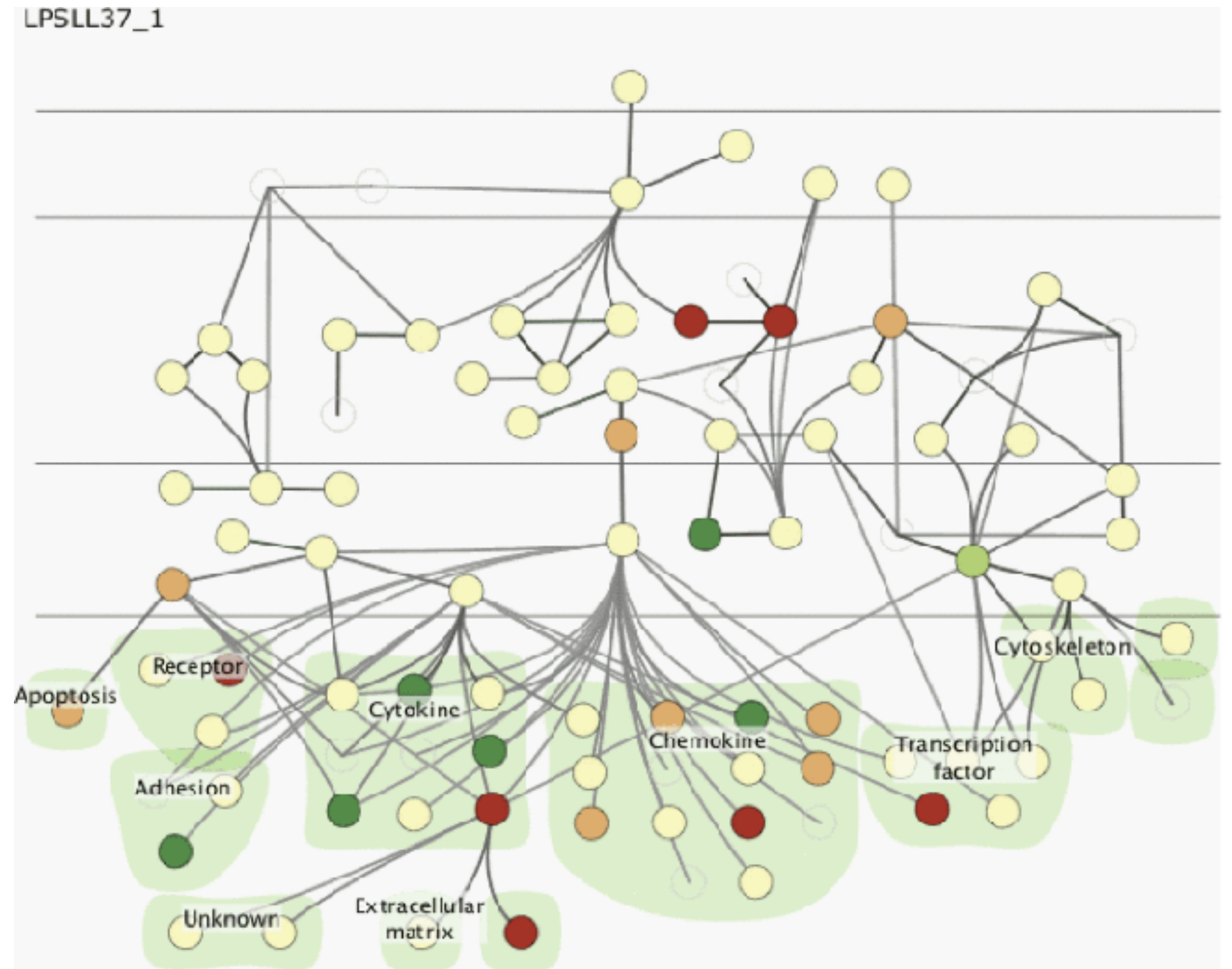
- benefits: eyes vs memory

- 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

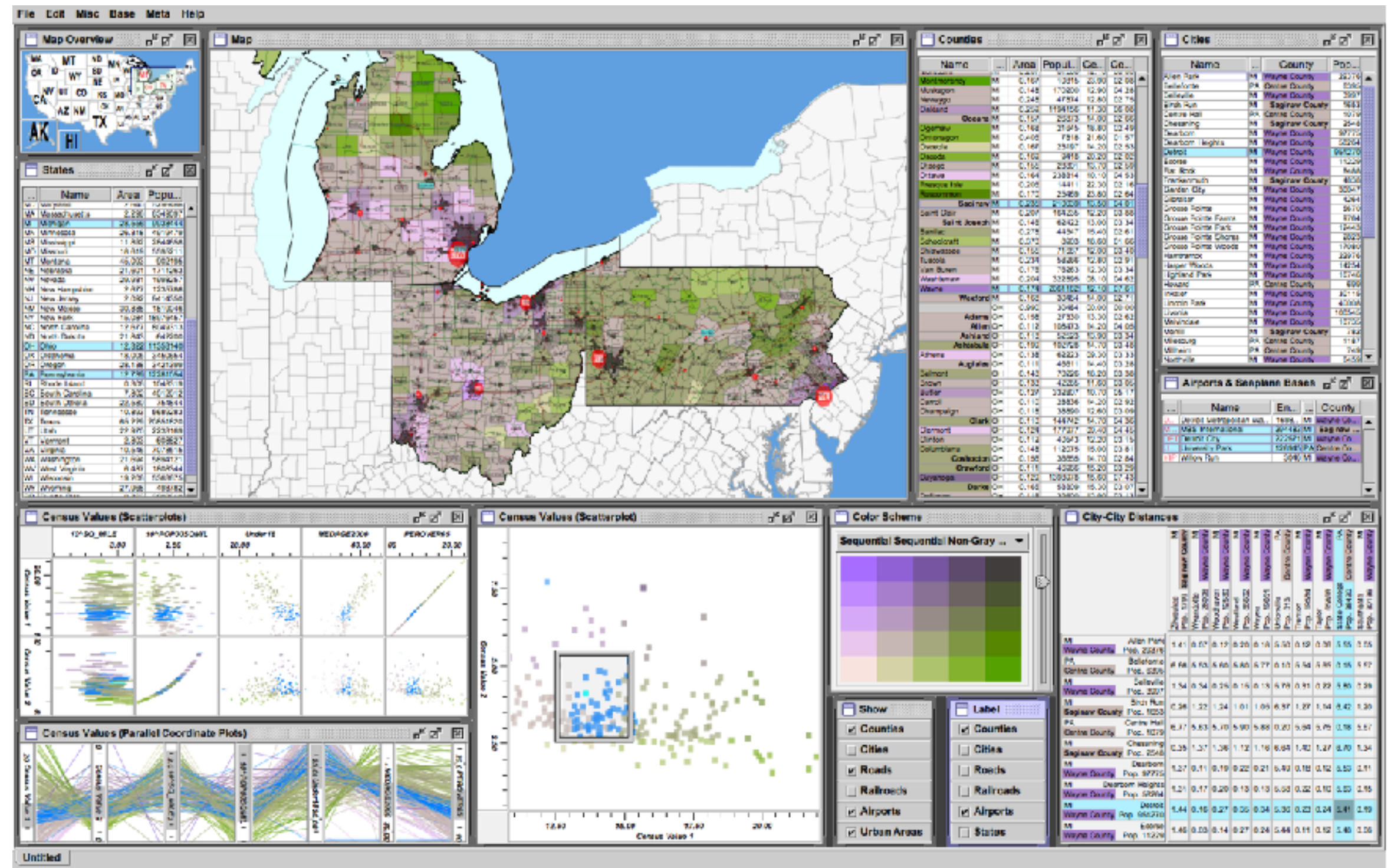
Why not animation?

- 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

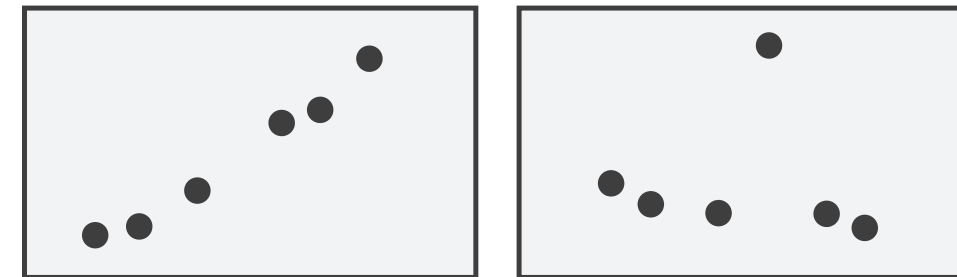


[Building Highly-Coordinated Visualizations In Improvise. Weaver. Proc. IEEE Symp. Information Visualization (InfoVis), pp. 159–166, 2004.]

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



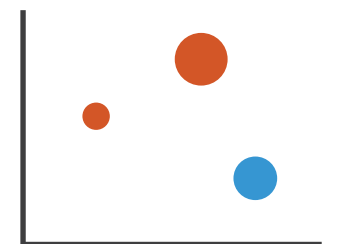
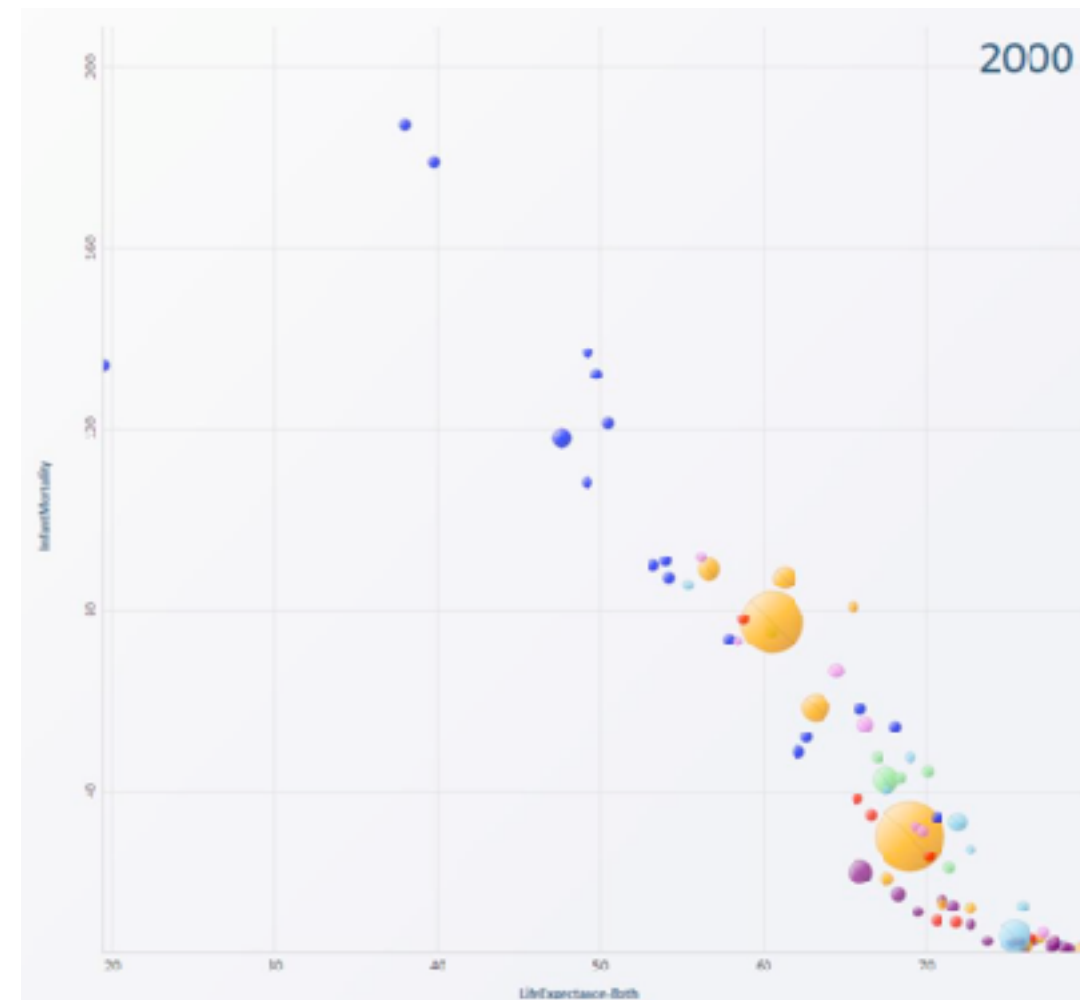
- no strict dividing line

- **view:** *big/detailed*

- contiguous region in which visually encoded data is shown on the display

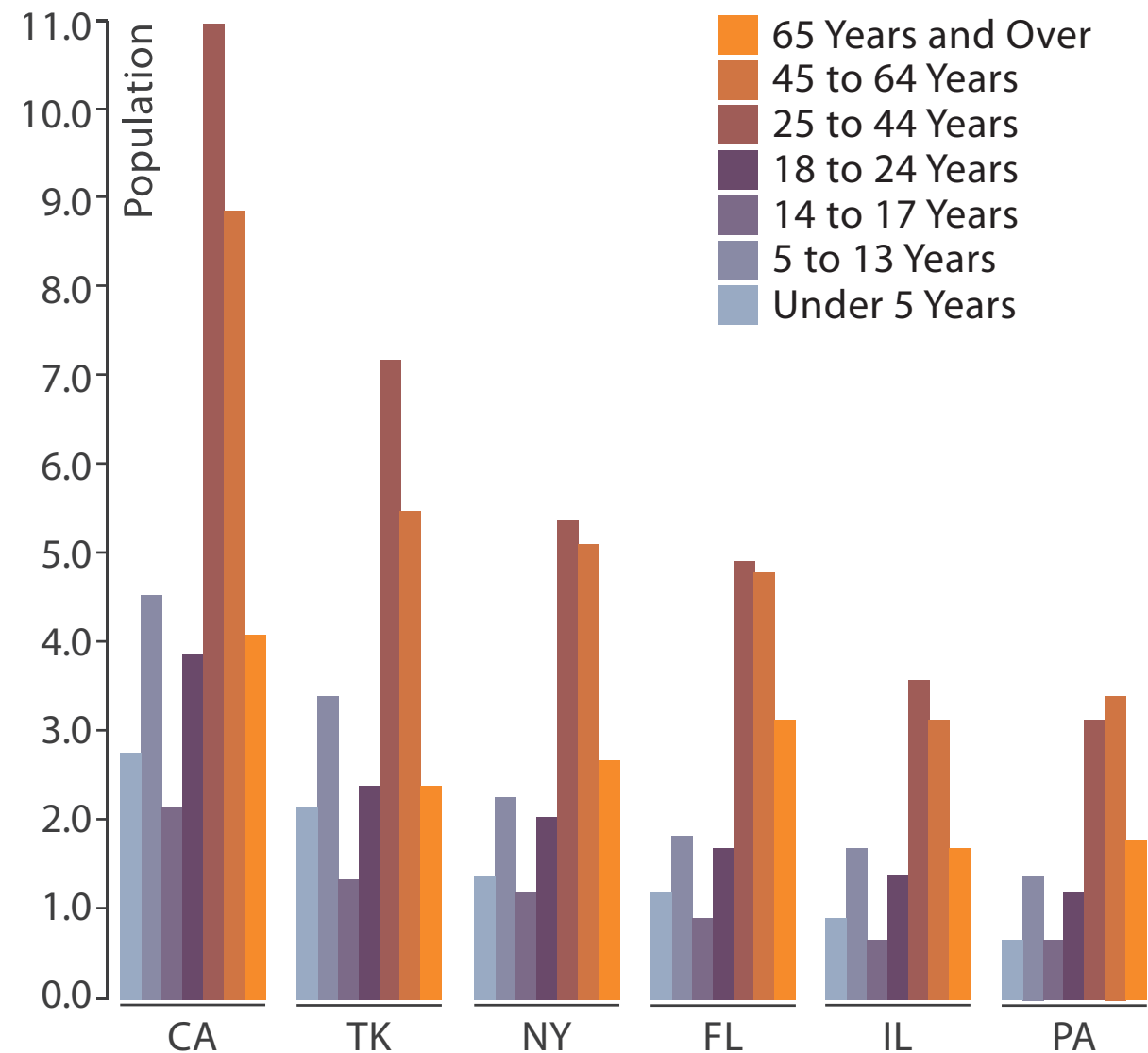
- **glyph:** *small/iconic*

- object with internal structure that arises from multiple marks

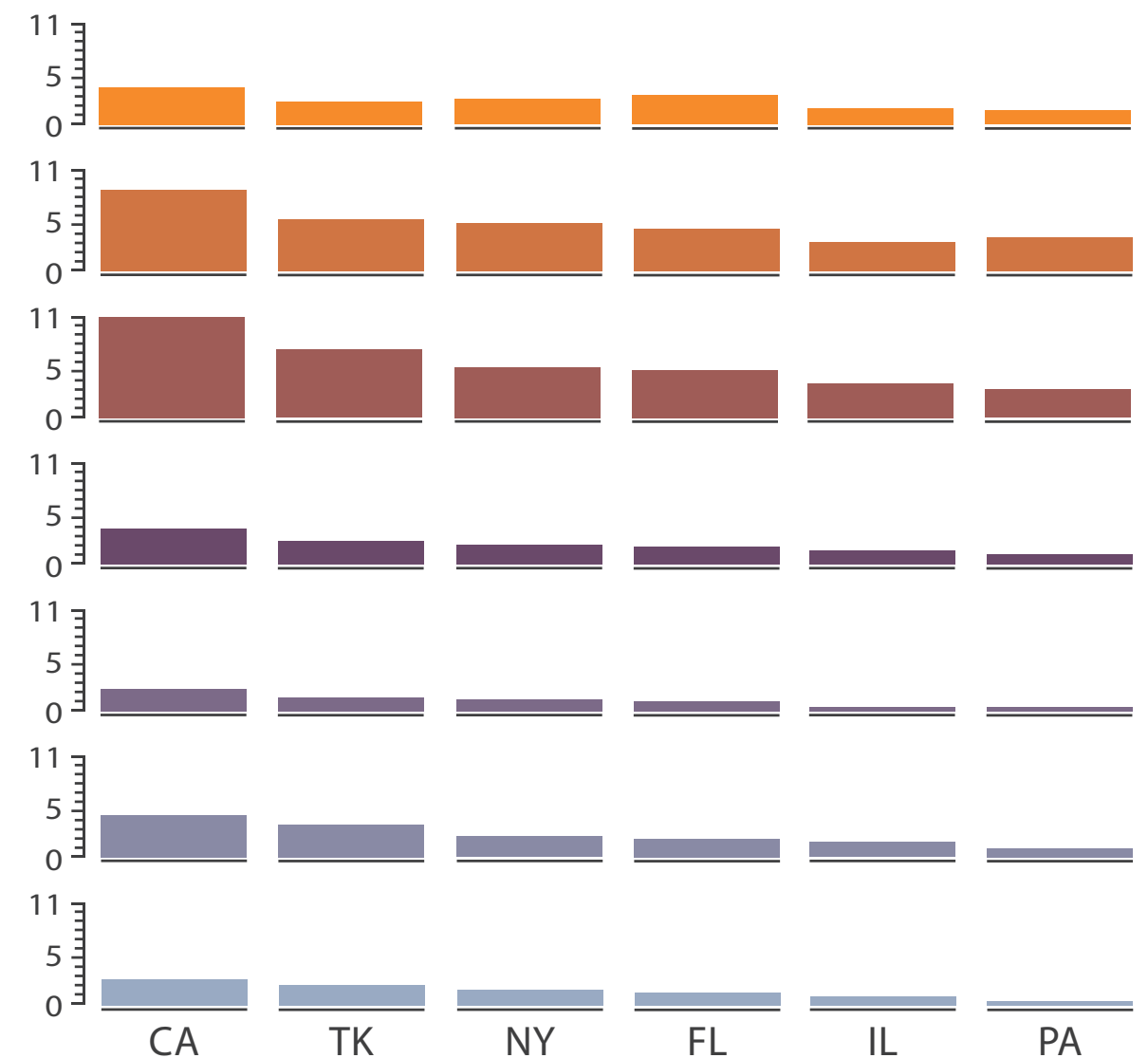


Partitioning: List alignment

- 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



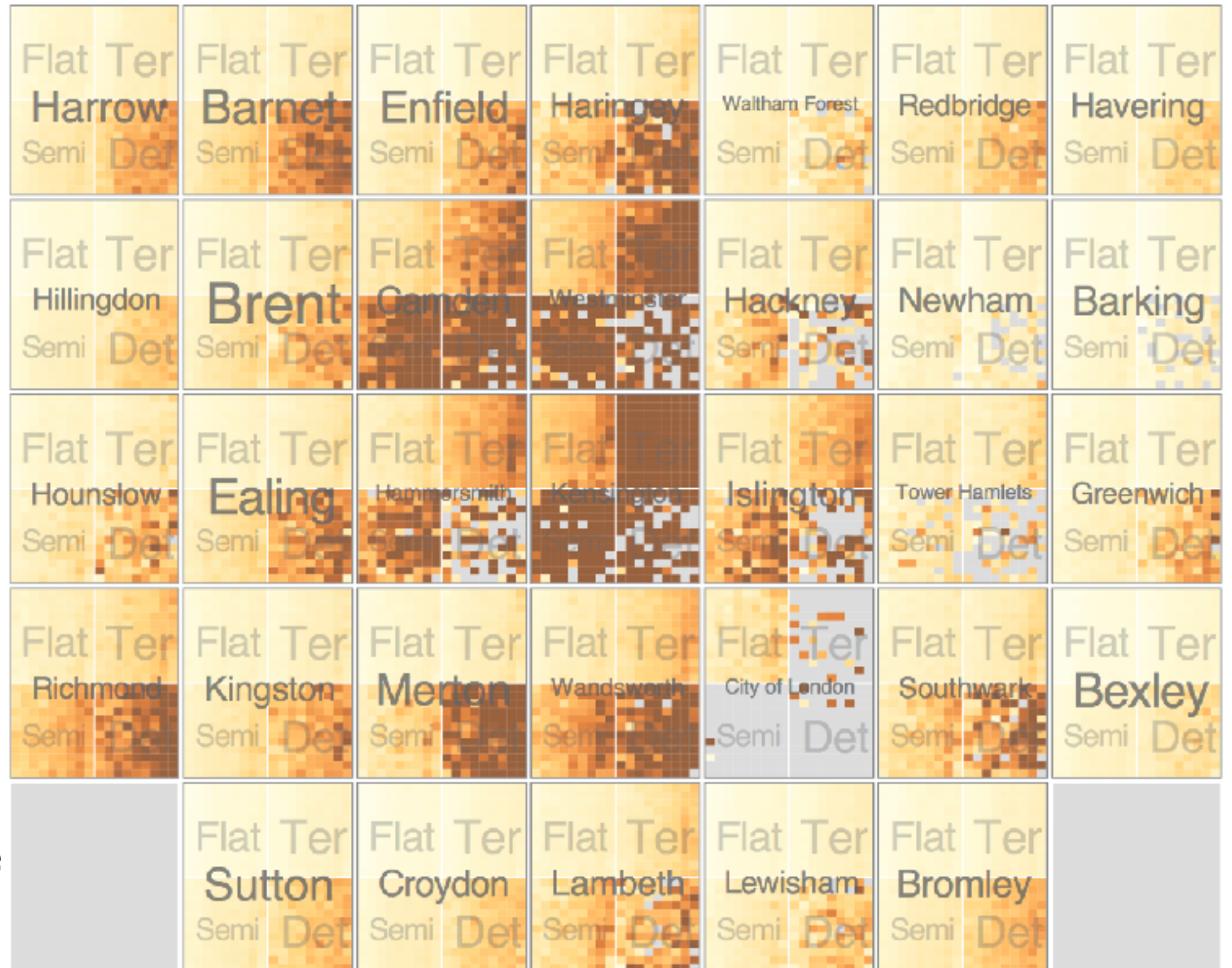
- small-multiple bar charts
 - split by age into regions
 - one chart per region
 - compare: easy within age, harder across states



Partitioning: Recursive subdivision

System: **HIVE**

- 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



Partitioning: Recursive subdivision

System: **HIVE**

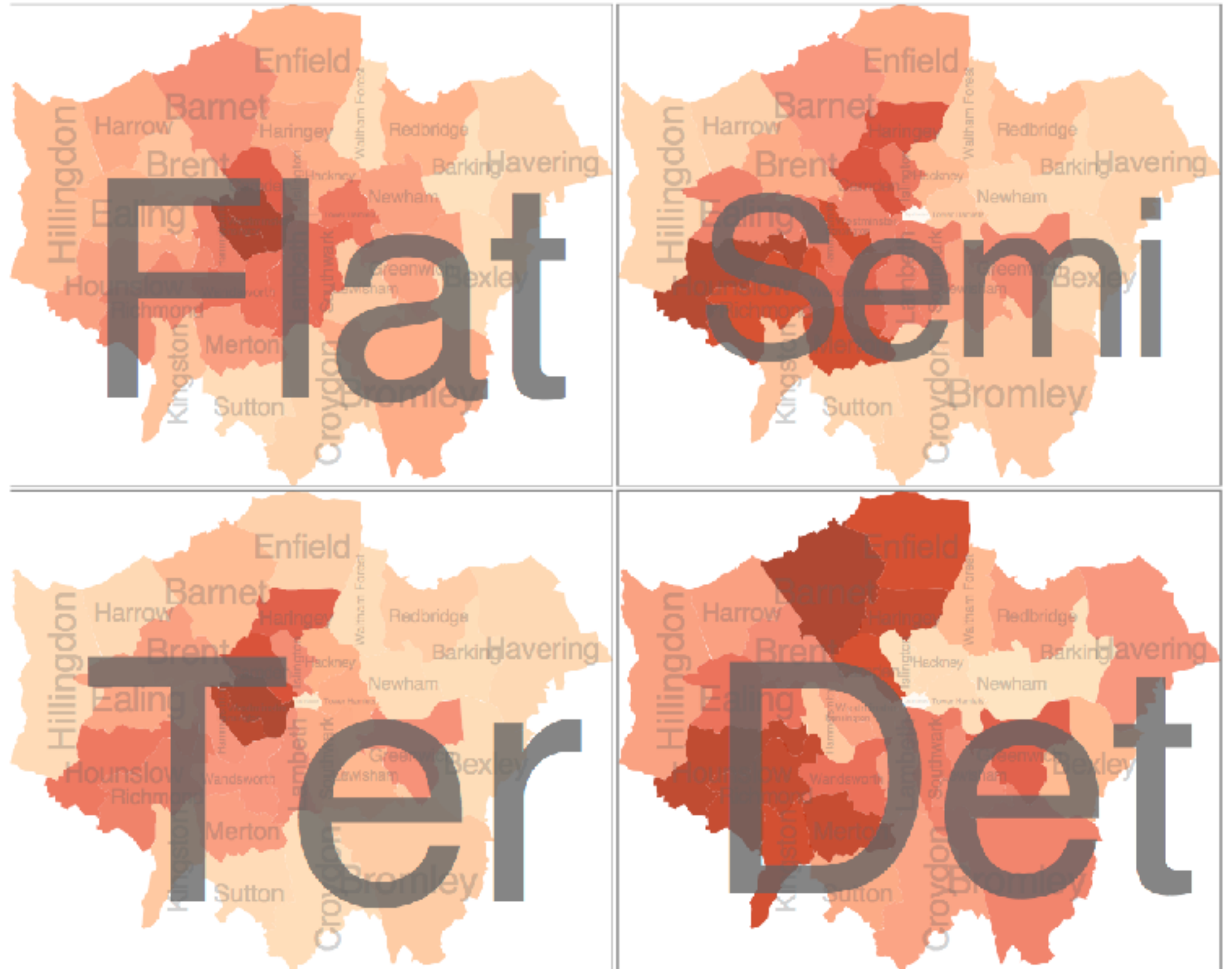
- switch order of splits
 - type then neighborhood
- switch color
 - by price variation
- type patterns
 - within specific type, which neighborhoods inconsistent



Partitioning: Recursive subdivision

System: **HIVE**

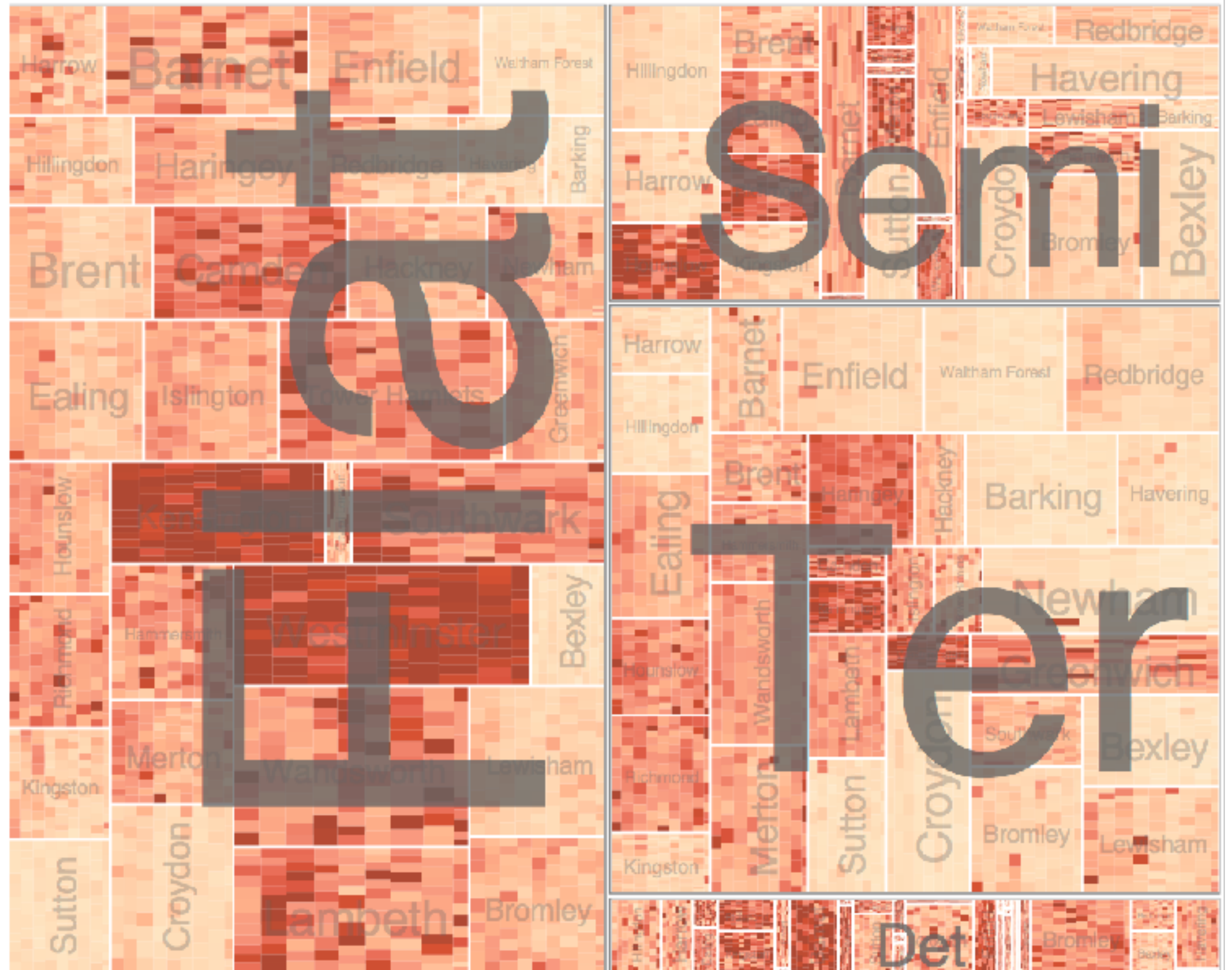
- different encoding for second-level regions
– choropleth maps



Partitioning: Recursive subdivision

System: **HIVE**

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



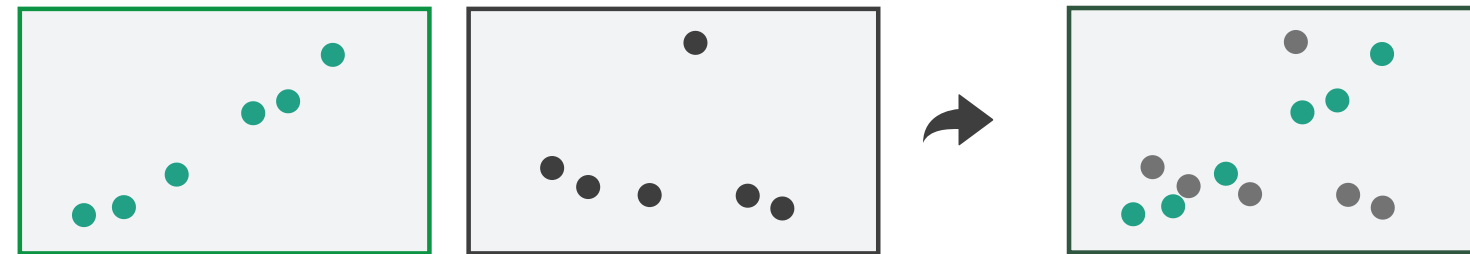
Superimpose layers

- **layer**: set of objects spread out over region
 - each set is visually distinguishable group
 - extent: whole view

➔ Superimpose Layers

- design choices

- how many layers, how to distinguish?
 - encode with different, nonoverlapping channels
 - two layers achievable, 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

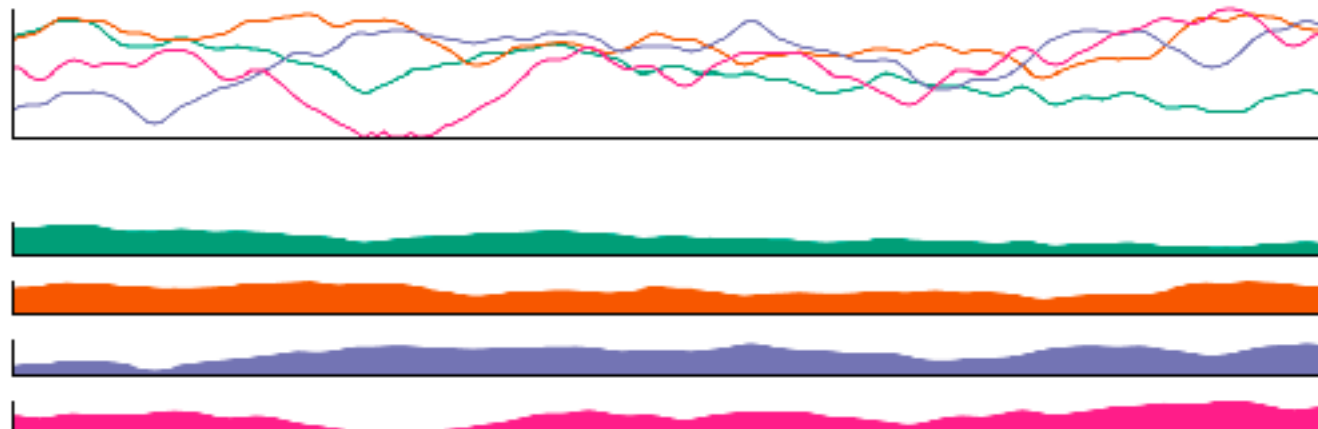


[Get it right in black and white. Stone. 2010.

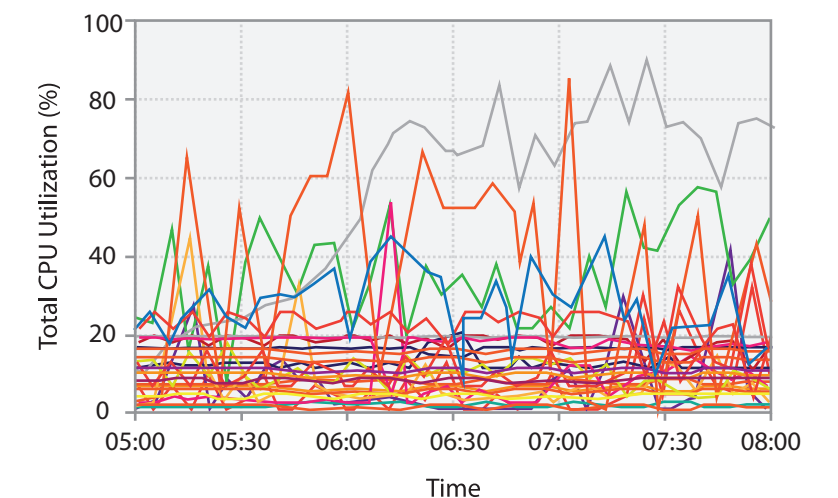
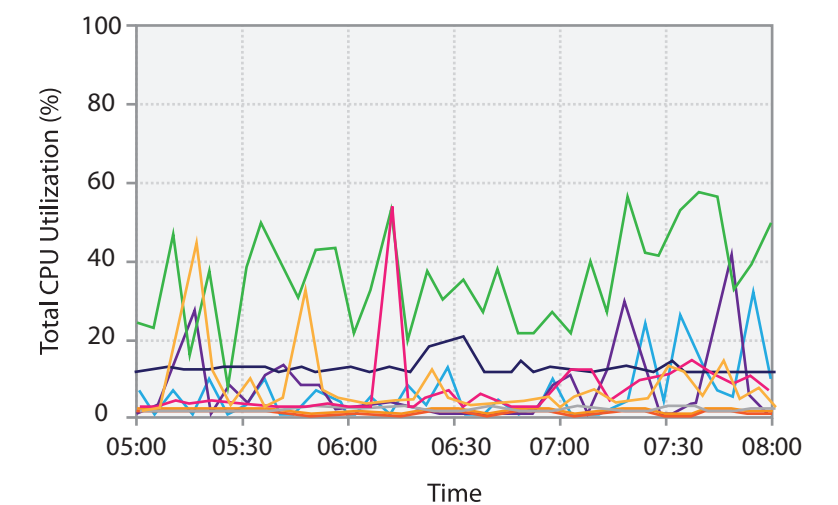
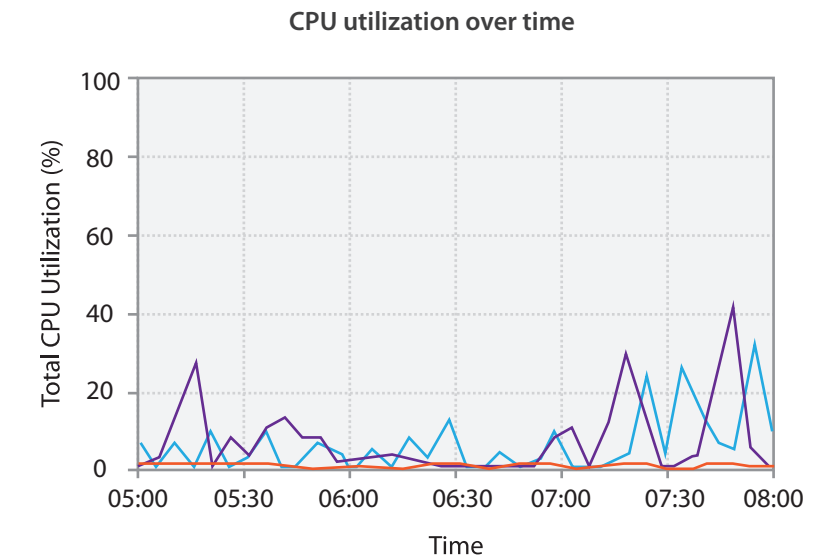
<http://www.stonesc.com/wordpress/2010/03/get-it-right-in-black-and-white>]

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

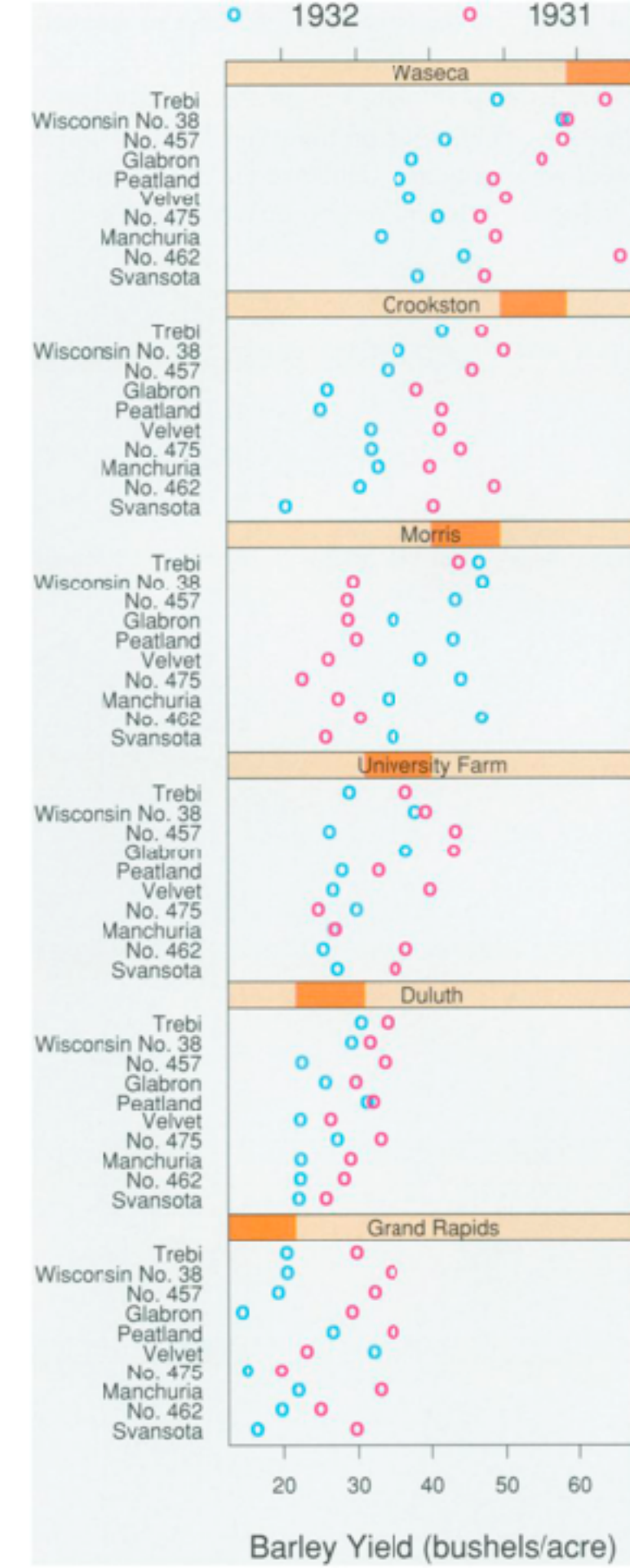


[Graphical Perception of Multiple Time Series. Javed, McDonnel, and Elmquist. IEEE Transactions on Visualization and Computer Graphics (Proc. IEEE InfoVis 2010) 16:6 (2010), 927–934.]



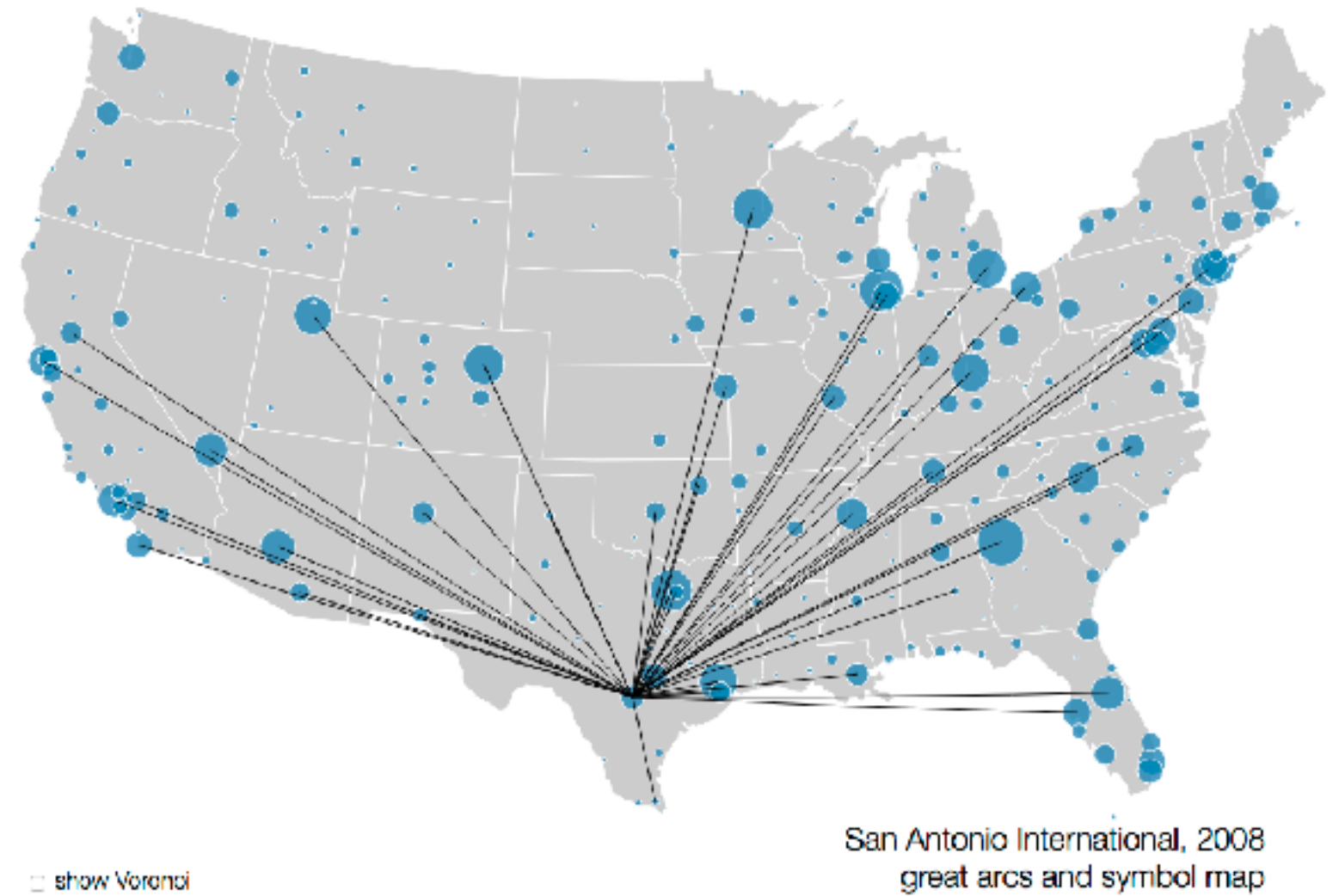
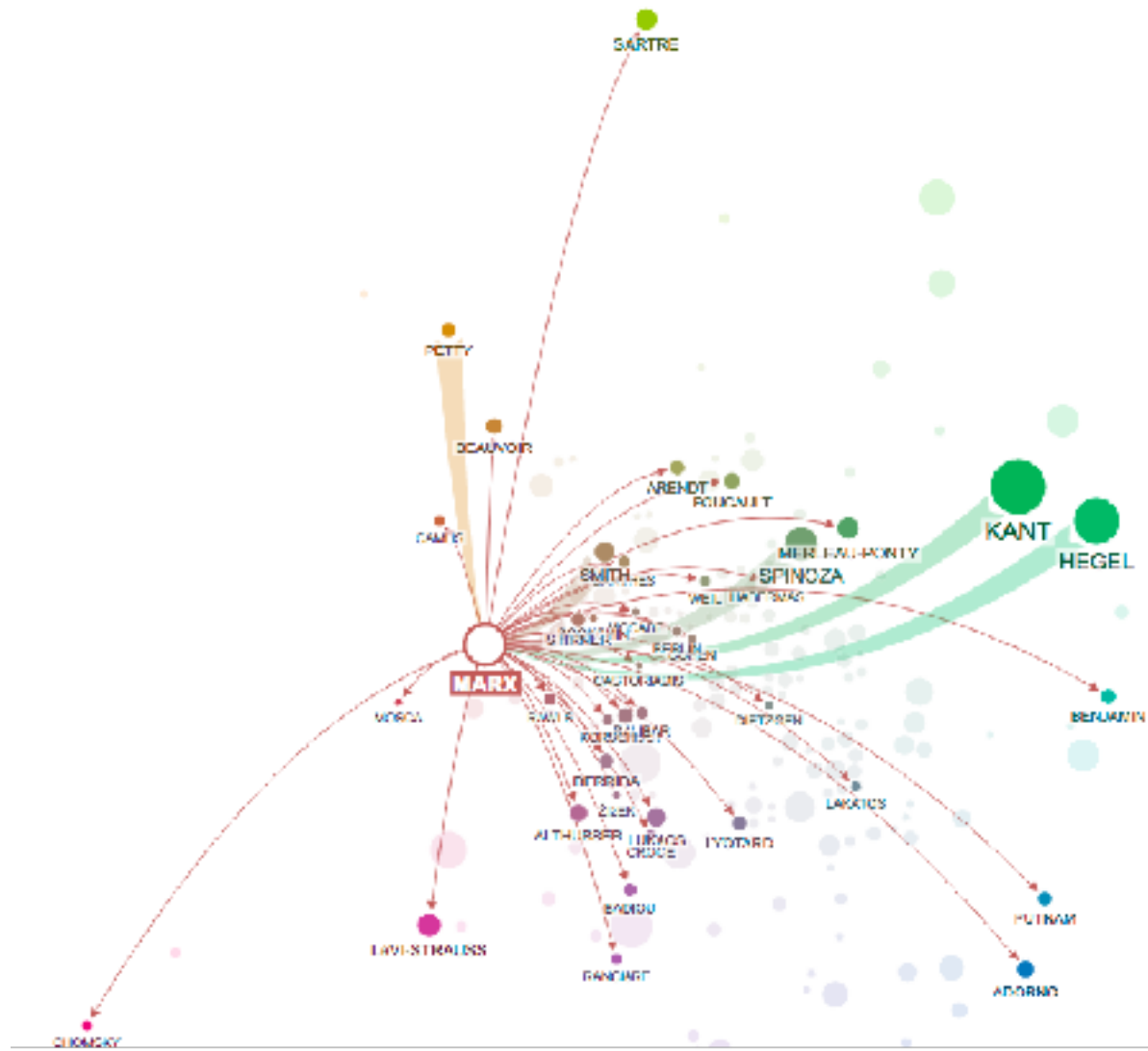
Idiom: Trellis plots

- superimpose within same frame
 - color code by year
- partitioning
 - split by site, rows are wheat varieties
- main-effects ordering
 - derive value of median for group, use to order
 - order rows within view by variety median
 - order views themselves by site median



Dynamic visual layering

- interactive based on selection
- one-hop neighbour highlighting demos: click vs hover (lightweight)



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

<http://mbostock.github.io/d3/talk/20111116/airports.html>

Reading for next time

- VAD Ch 13: Reduce
- VAD Ch 14: Embed
- VAD Ch 15: Case Studies
- Paper: Topological Fisheye Views for Visualizing Large Graphs
 - paper type: algorithm