Ch 11/12: Manipulate, Facet Paper: Paramorama

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CPSC 547, Information Visualization Week 7: 24 Oct 2017

www.cs.ubc.ca/~tmm/courses/547-17F



Today

• timing

- -presentation topics
- -projects
 - -meetings timing
 - -proposal expectation walkthrough
 - -team (or potential team) sync-ups
- -today's reading discussion, Q&A
- -break
- -Matt Brehmer guest lecture 3:30
 - -Timelines Revisited
 - -ChartAccent
 - -tools discussion

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Presentations & Projects



Presentation topic choices

- presentation topic choices due this Friday (Oct 27) at noon
 - -post your choice to discussion thread on Canvas: I 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 7, 14, 21, 28, Dec 5
 - –I'll assign days soon
 - -I'll assign papers (from this year's VIS conf) at least I week before your presentation
 - -more on presentation expectations next time (Oct 31)

Presentation topics: Pick one or two

- data types
 - networks
 - trees
 - geographic data
 - high-dimensional data
 - text data
 - space & time
 (spatiotemporal data)
 - trajectories
 - sequences & events
 - multi-attribute tables
 - spatial fields

- domains
 - machine learning
 - genomics
 - medicine
 - sports
 - digital humanities
 - sense making
- topics
 - color
 - design
 - perception
 - uncertainty
 - analysis process

- techniques
 - parallel coordinates
 - dimensionality reduction
 - clustering
 - matrix views
 - multiple view coordination

Groups

- finalize by this Fri Oct 27 at latest
 - -post to project matchup thread on discussion board to confirm your group
 - -please post with current status report, even before that!
 - who's still looking, who's resolved

Meetings

- each group needs signoff: at least one meeting -in some cases followup meeting needed; in some cases you're already set
- meetings cutoff is 5pm Thu Nov 2
- major blocks of available time
 - -Tue 10/24 5-6
 - -Wed 10/25 4-6:30
 - -Thu 10/26 3:30-6:30
 - -Fri 10/27 5-6
 - -Mon 10/30 flexible all day
 - -Tue 10/31 5-7
 - -Wed | |/| 5:30-6:30
 - -The 11/2 3:30-5

Projects overall schedule

- Pitches: Tue Oct 17 in class
- Groups finalized: Fri Oct 27 5pm
- Meetings cutoff: Thu Nov 2 at 5pm
- Proposals due: Mon Nov 5 at 10pm –(no readings due Tue Nov 6)
- Peer Project Reviews I: Tue Nov 20 in class
- Peer Project Reviews 2: Tue Dec 5 in class
- Final presentations: Tue Dec 12 1-5pm
- Final papers due: Fri Dec 15 at 11:59pm

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Proposals

- projects: written proposals due Mon Nov 5 10pm -(no readings due Tue Nov 6)
- heading
 - -project title (real title, not just "CPSC 547 proposal" can change later)
 - -name & email of every person on team (do not include student numbers)
- intro: brief description of what you're proposing to do, at high level -include personal expertise in this area (for each group member)
- for design studies: domain, data, task
 - -definitely in domain terms
 - -get started on abstraction (even if preliminary)
 - do discuss scale of data: # items, # levels in each categorical attrib, range of ordered attribs
- for technique projects: explain proposed context of use

Proposals II

- proposed infovis solution (what you know so far)
 - -do include illustration of what interface might look like, could be hand drawn sketch or mockup made with drawing program
 - -do include scenario of use (how user would use solution to address task)
- implementation plan (high-level: platform, language, libraries)
 - -clarify your scope/goal: building on work of others to enable more ambitious project, vs rolling your own to learn tool. amount of work depends on your existing expertise
- milestones
 - -break into meaningful smaller pieces. specific to your project, in addition to generic
 - -for each, estimate target date of completion and hours of work
 - -be explicit about who will do what: work breakdown between group members
 - -time scope: 70 hrs per person across whole project
 - -very typical to structure as possibilities: after A&B, decide on C and do 2 of D-G

Proposals III

- <u>http://www.cs.ubc.ca/~tmm/courses/547-17F/projectdesc.html#proposals</u>
- also, consult final report structure to have future goal in mind <u>http://www.cs.ubc.ca/~tmm/courses/547-17F/projectdesc.html#final</u>

<u>tdesc.html#proposals</u> al in mind <u>tdesc.html#final</u>

Paper: Paramorama



Paramorama: Visualization of Parameter Space for Image Analysis

• requirements

- -RI 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

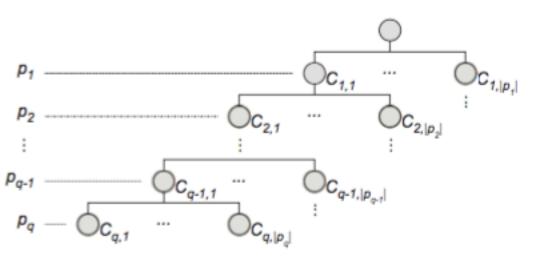
[Visualization of Parameter Space for Image Analysis. Pretorius, Ruddle, Bray, Carpenter. TVCG 12(17):2402-2411 2011 (Proc. InfoVis 2011).]

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

	<i>p</i> ₁	p 2	 p_{q-1}	p_q
$\overset{t_1}{:}$	$x_{1,1}$:	$x_{2,1}$	 $x_{q-1,1}$:	$\overset{x_{q,1}}{:}$
$t_{ p_q }$	$x_{1,1}$	$x_{2,1}$	 $x_{q-1,1}$	$x_{q, p_q }$
$t_{ p_q +1}$	$x_{1,1}$	$x_{2,1}$:	 $x_{q-1,2}$:	$x_{q,1}$
$t_{2 p_q }$	$x_{1,1}$:	<i>x</i> _{2,1} :	 $x_{p-1,2}$:	$\stackrel{x_{q, p_q }}{:}$



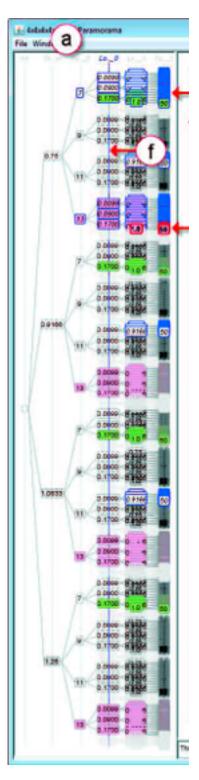
Overview

- 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

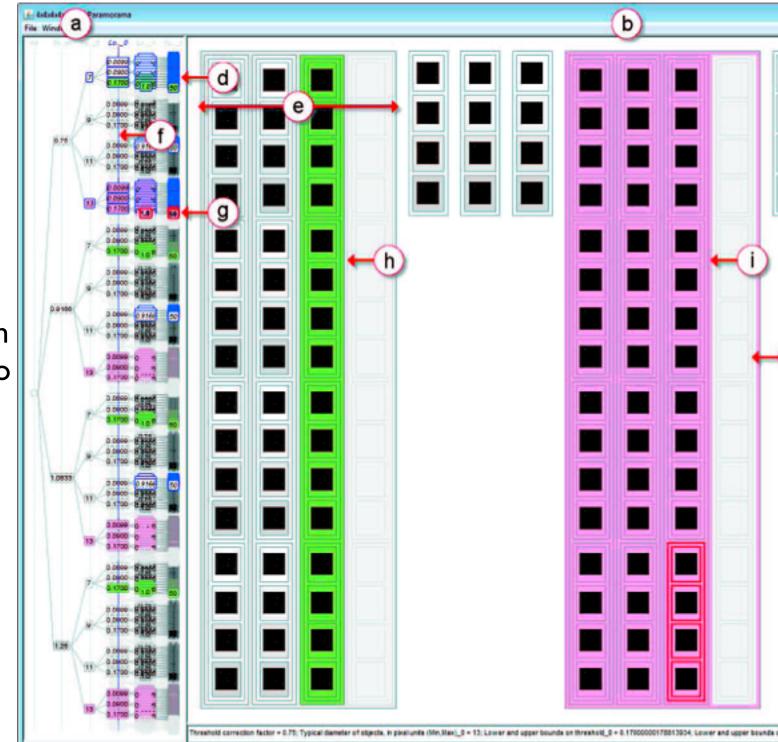
[Fig 4.Visualization of Parameter Space for Image Analysis. Pretorius, Ruddle, Bray, Carpenter.TVCG 12(17):2402-2411 2011 (Proc. InfoVis 2011).]

view ratio



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
 - vertical blue line
 - cut through tree
- ex: || blue subtrees highlighted in overview, II regions shown on right.



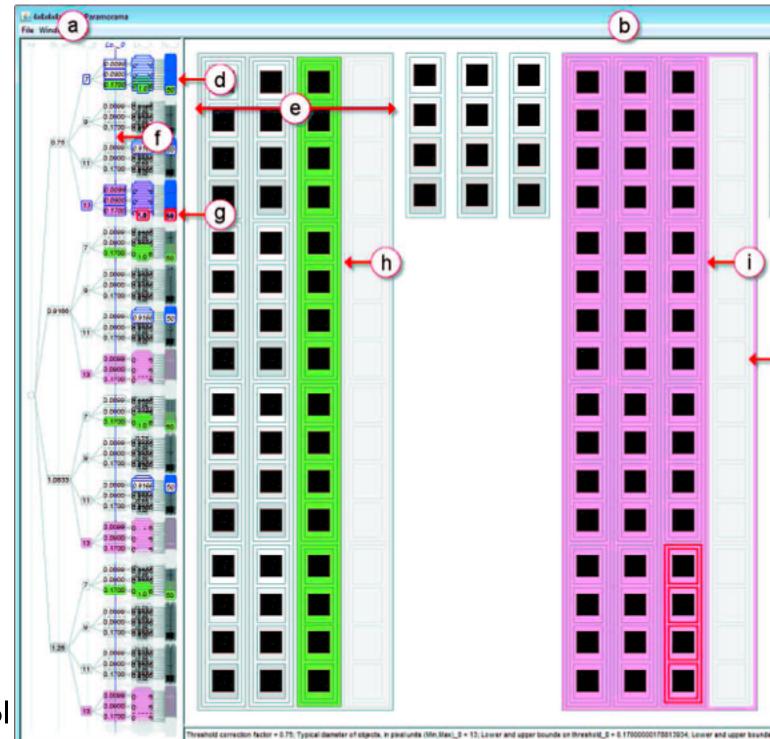
[Fig 4. Visualization of Parameter Space for Image Analysis. Pretorius, Ruddle, Bray, Carpenter. TVCG 12(17):2402-2411 2011 (Proc. InfoVis 2011).]

	0
	Subtree selection level Subtree selection level 1 2 3 4 5 Tag (setal vew) Prostile
Is on Dreshold_1 = 1.0.	* * * 0.75 1.0 -

Interaction

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

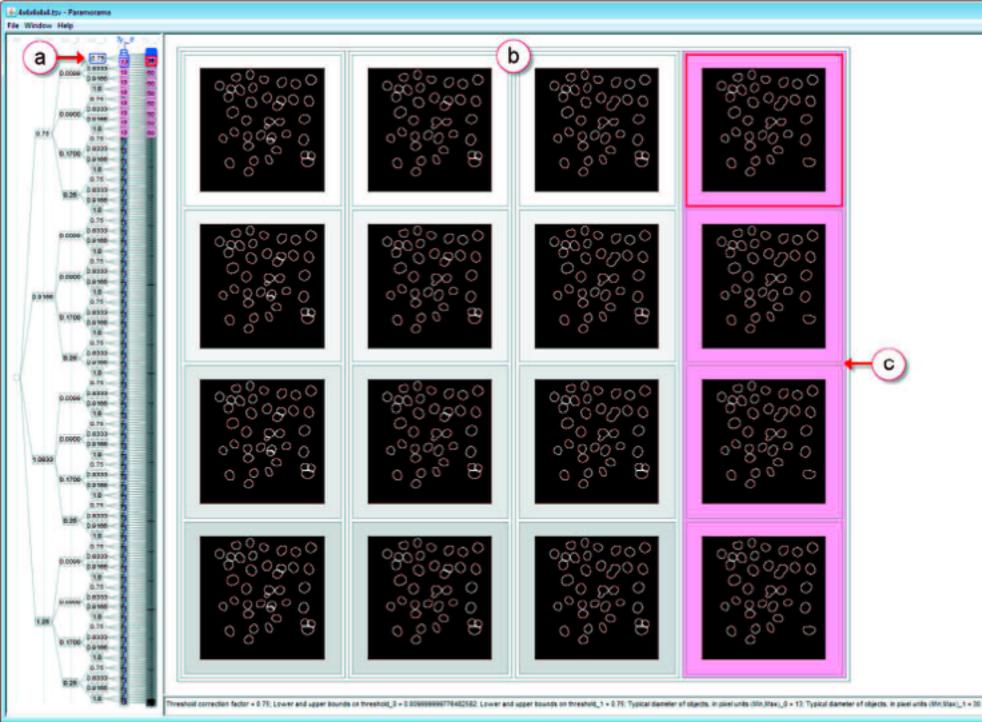
[Fig 4. Visualization of Parameter Space for Image Analysis. Pretorius, Ruddle, Bray, Carpenter. TVCG 12(17):2402-2411 2011 (Proc. InfoVis 2011).]



	0 •
	Subtree selection level Subtree selection level 1 2 3 4 5 Tag (detail view) Positive Positive Positive Positive Positive Positive Reset all as untagged Positive Positive Reset all as untagged Positive Po
de on Breehold_1 = 1.5.	8 4 0.75 1.0 -

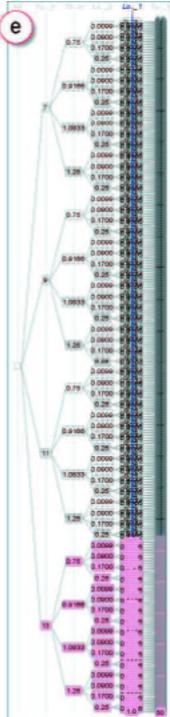
Case study: novice user

• 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).]

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	
Selection	•
0 L 2 3 4 5	
Select (global view))	
V North American	
Clear al selectors	
Reset all as unseen	
Subtree selection level:	
i 2 i i i	ł
Teg (detail view):	
O Positive 🔹 Negative	
() Uniting	
Reset all as untagged	
Parameters	
Olde in hierardhy:	
Threshold correction factor Lower and upper bounds on thresh Lower and upper bounds on thresh Typical diameter of objects, in powel 4 10 1 1	
Thes	
Piter based on: Tags O Parameters	
Tag filtersi V Pasitive V Negative	
Vintaged	
Parameter filters: Threshold co ction factor	
be be	-



Case study: expert user

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

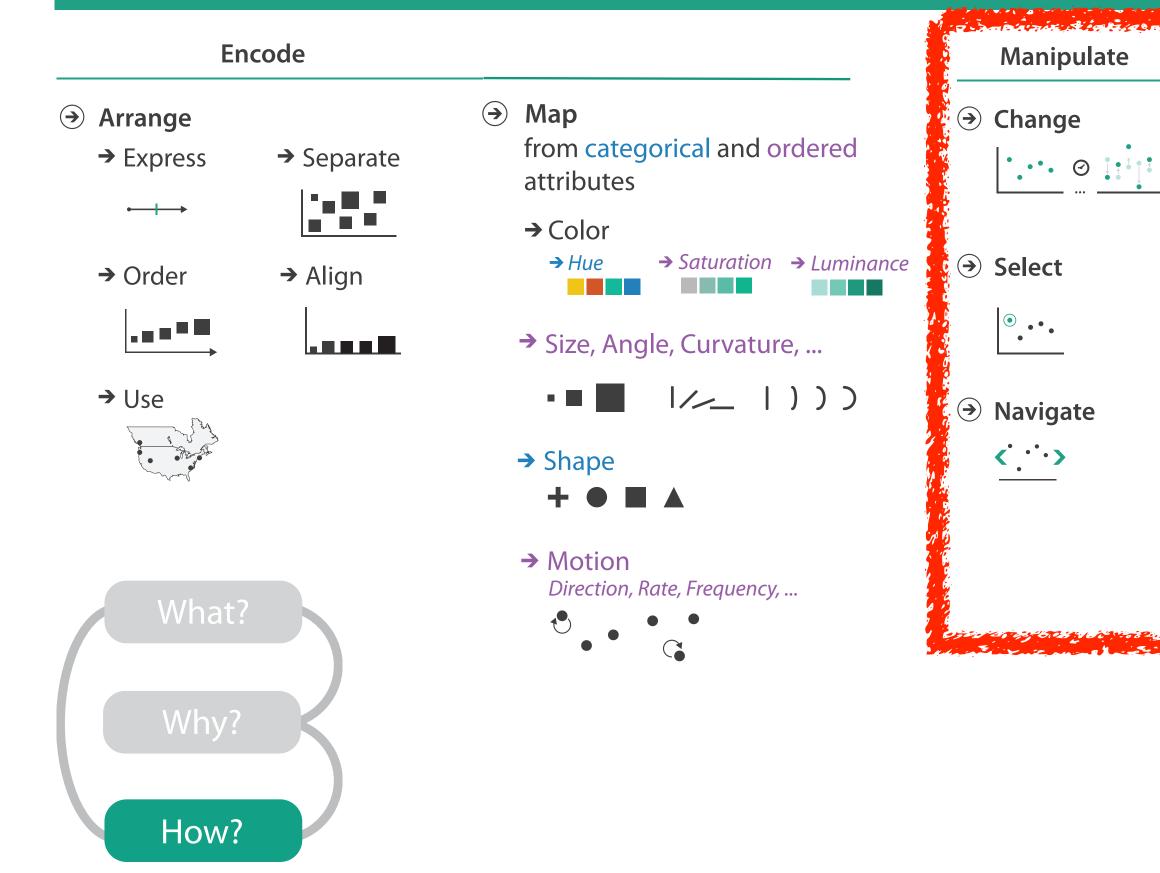


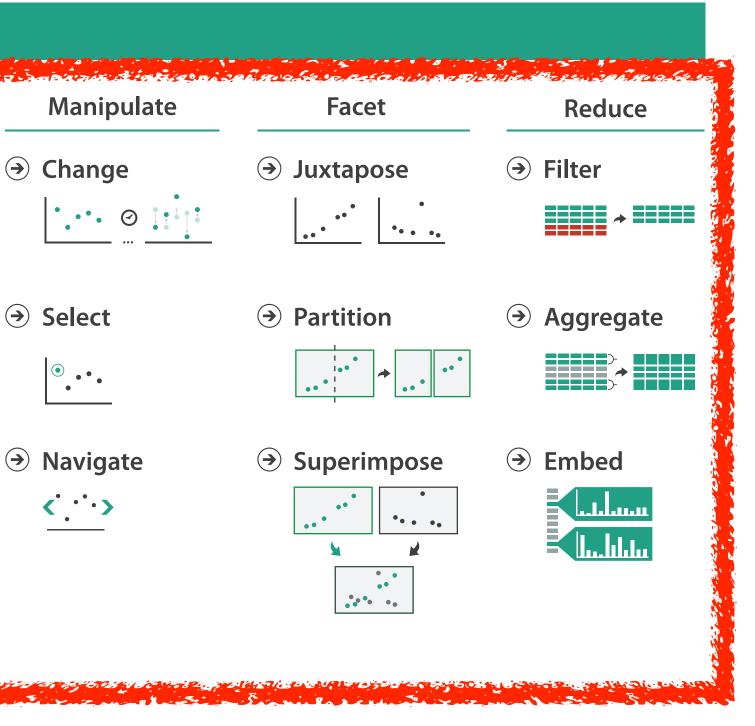
[Fig 7. Visualization of Parameter Space for Image Analysis. Pretorius, Ruddle, Bray, Carpenter. TVCG 12(17):2402-2411 2011 (Proc. InfoVis 2011).]

Ch 10: Manipulate

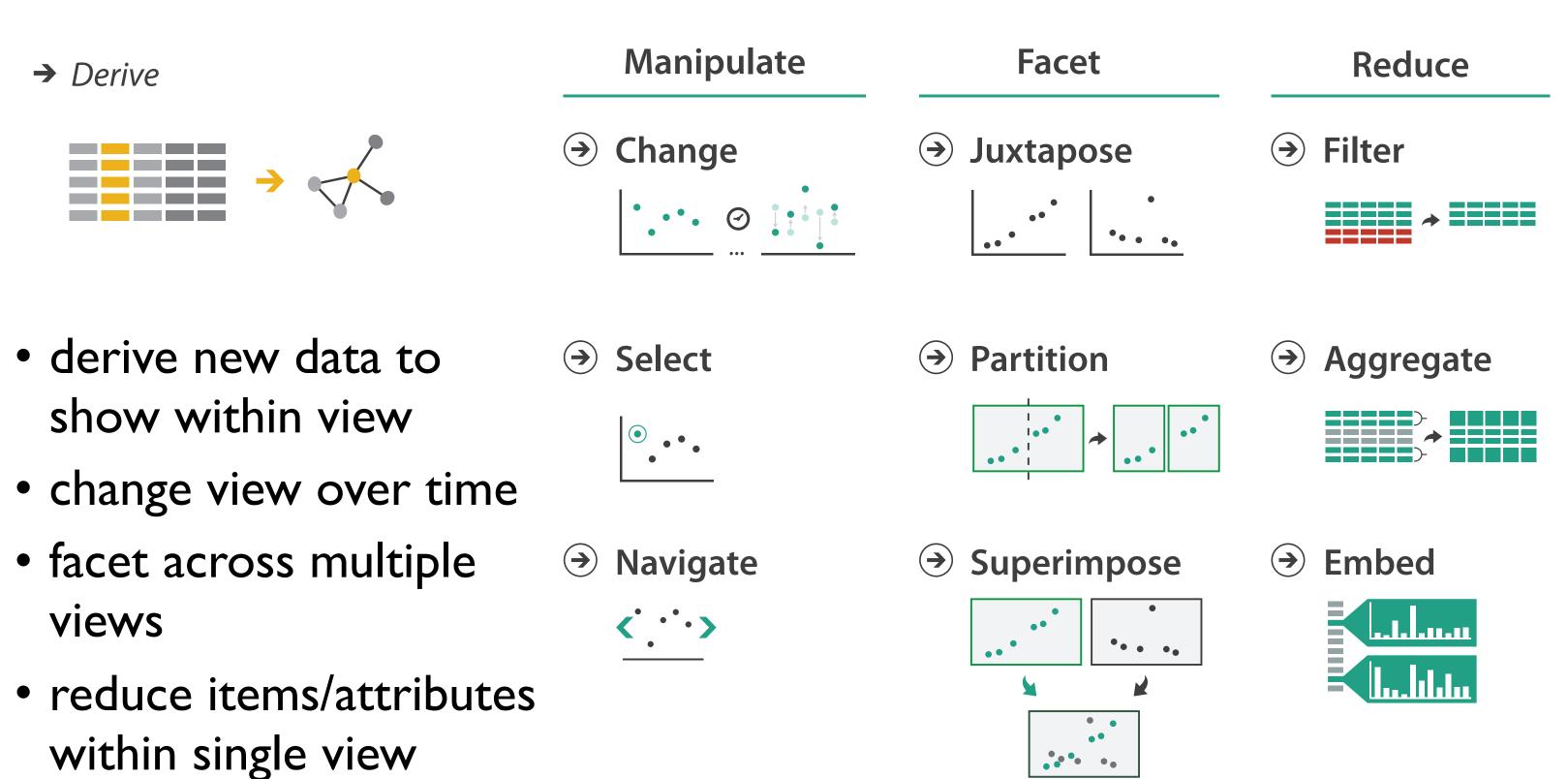


How?

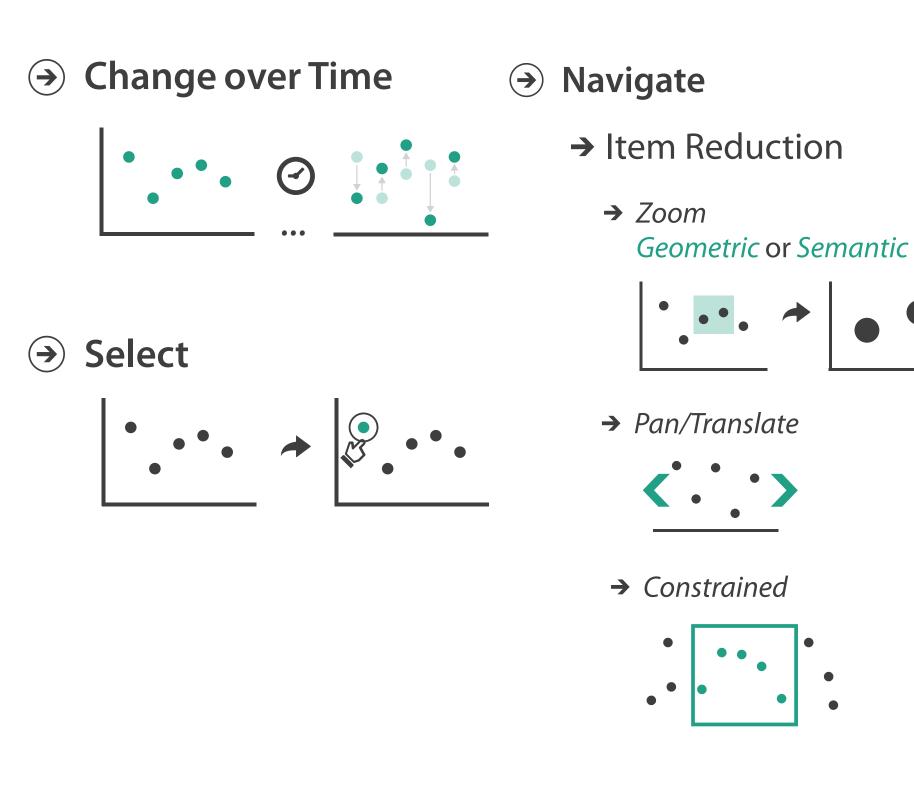




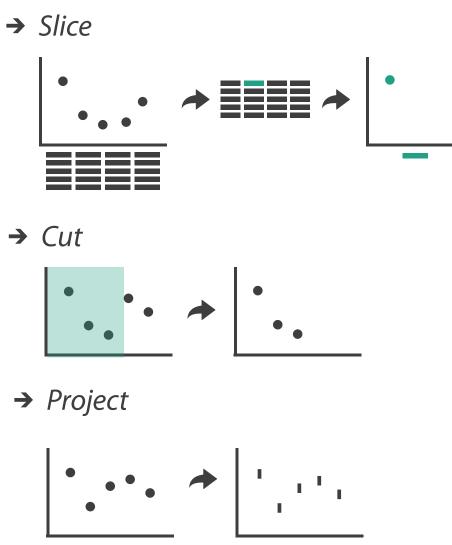
How to handle complexity: I previous strategy + 3 more



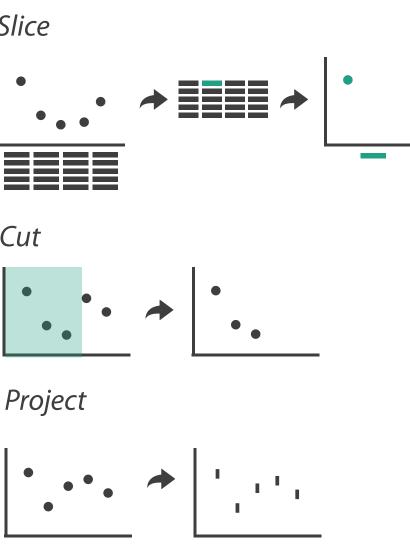
Manipulate



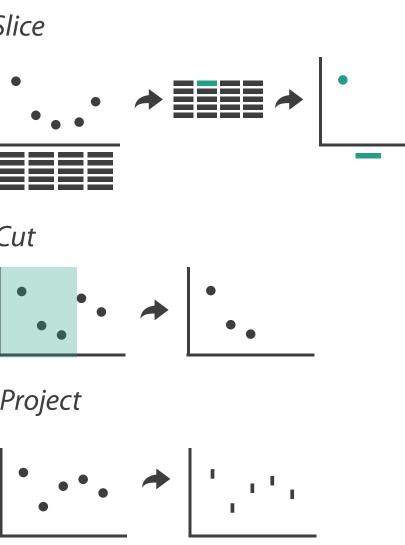
→ Attribute Reduction



→ Cut



→ Project



Change over time

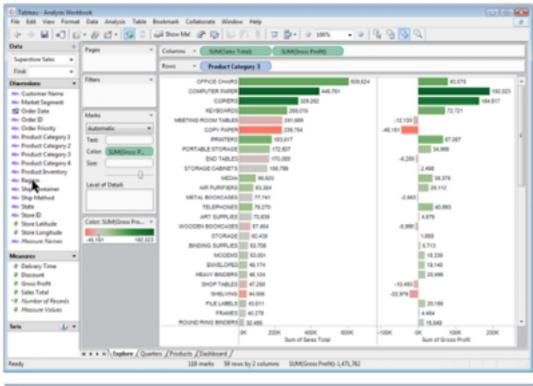
- change any of the other choices

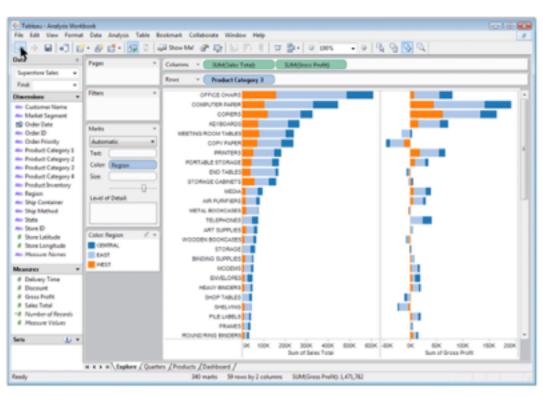
 encoding itself
 - -parameters
 - -arrange: rearrange, reorder
 - -aggregation level, what is filtered...
 - -interaction entails change

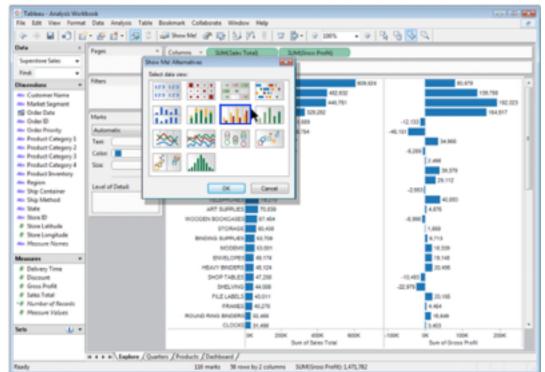
24

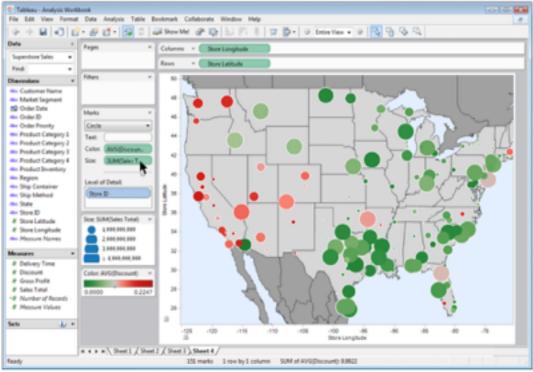
Idiom: Re-encode

System: Tableau









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

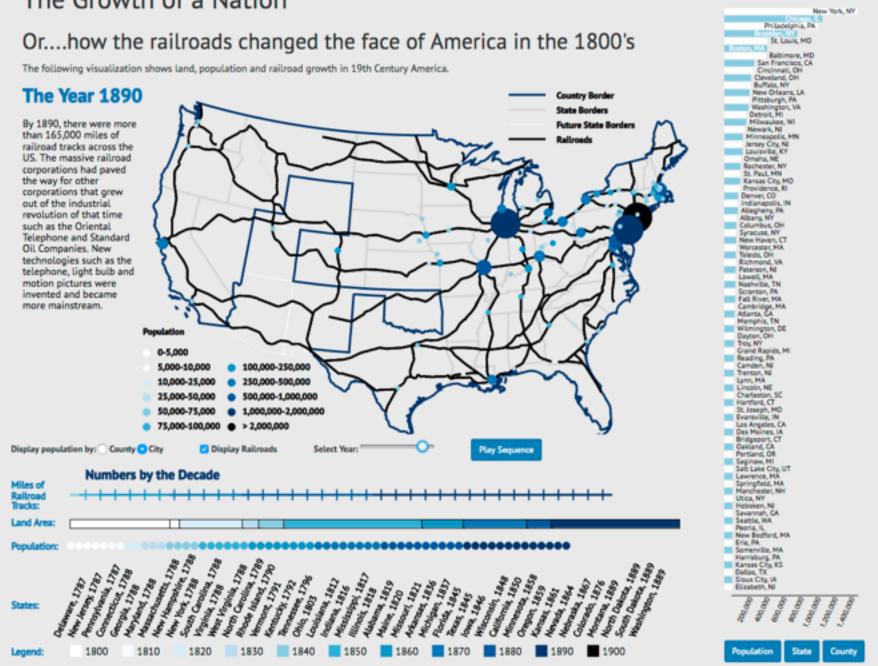
25

Idiom: Change parameters

- widgets and controls
 - -sliders, buttons, radio buttons, checkboxes, dropdowns/comboboxes
- pros
 - -clear affordances, self-documenting (with labels)
- cons
 - -uses screen space
- design choices
 - -separated vs interleaved
 - controls & canvas

slide inspired by: Alexander Lex, Utah

The Growth of a Nation

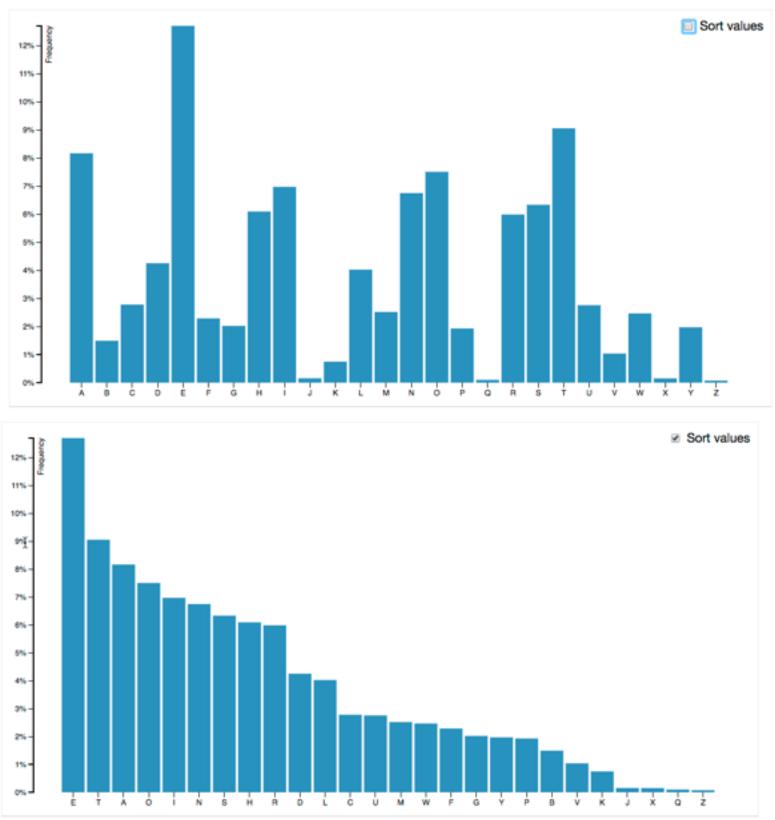


[Growth of a Nation](http://laurenwood.github.io/)

Largest cities

Idiom: Change order/arrangement

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

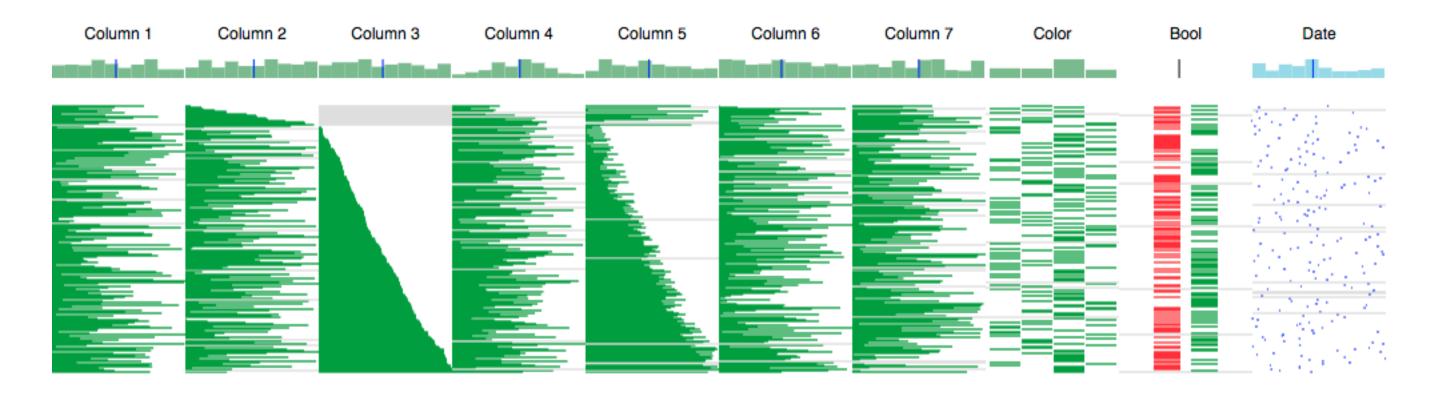


[Sortable Bar Chart](https://bl.ocks.org/mbostock/3885705)

Idiom: **Reorder**



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

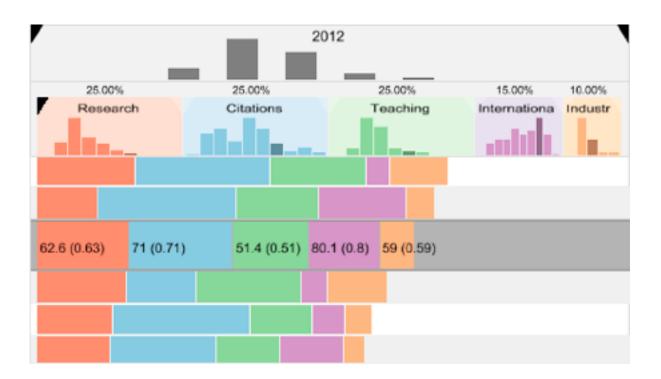


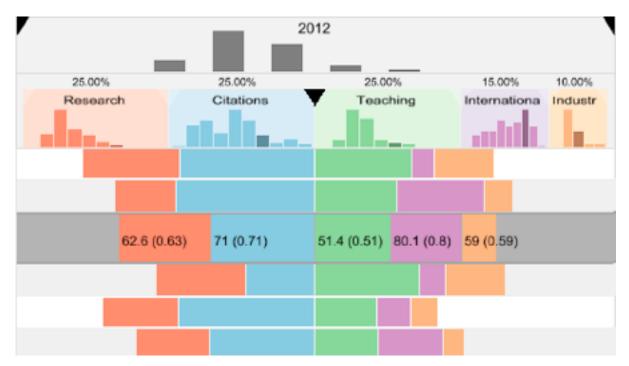
[http://carlmanaster.github.io/datastripes/]

System: **DataStripes**

Idiom: Change alignment

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





[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.]

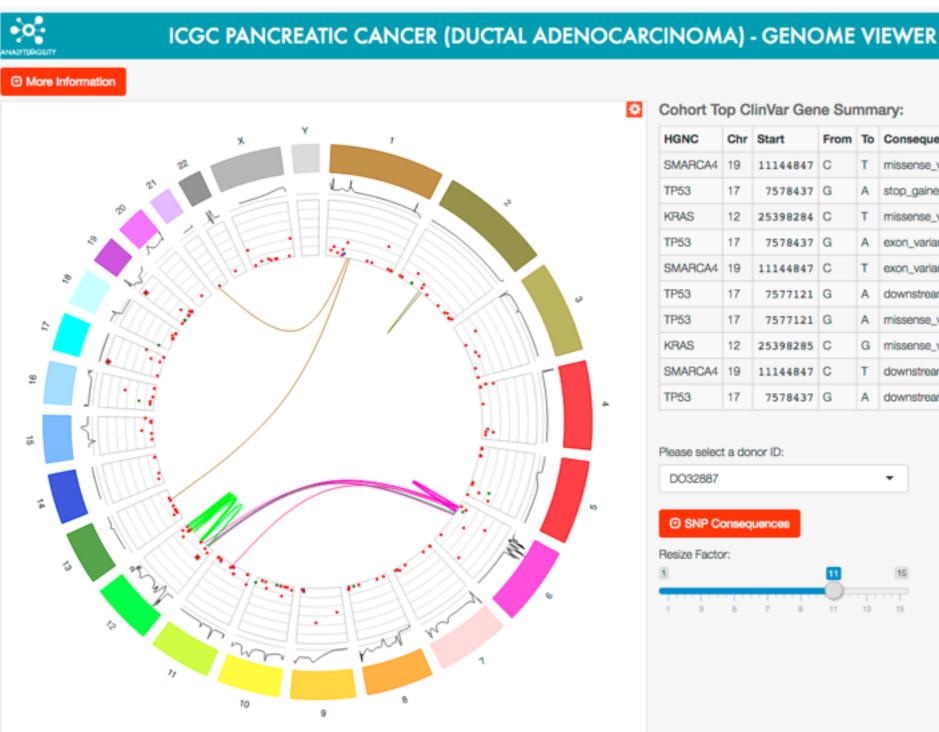


System: LineUp

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/

HGNC	Chr	Start	From	То	Consequence	Count
SMARCA4	19	11144847	С	т	missense_variant	18
TP53	17	7578437	G	A	stop_gained	18
KRAS	12	25398284	С	т	missense_variant	12
TP53	17	7578437	G	А	exon_variant	10
SMARCA4	19	11144847	С	т	exon_variant	8
TP53	17	7577121	G	А	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: Animated transitions

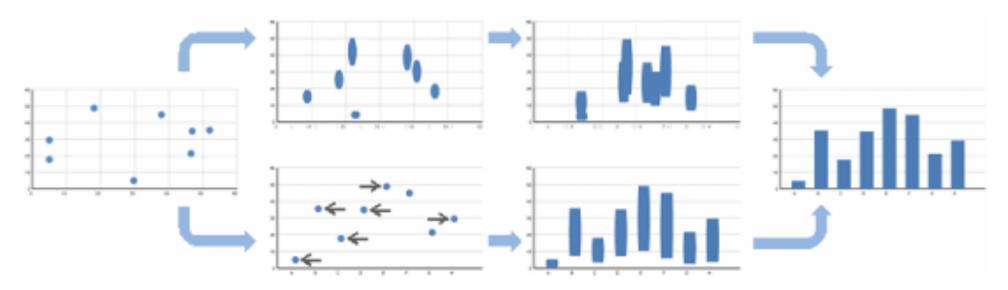
smooth interpolation from one state to another

-alternative to jump cuts, supports item tracking

-best case for animation

-staging to reduce cognitive load

• example: animated transitions in statistical data graphics

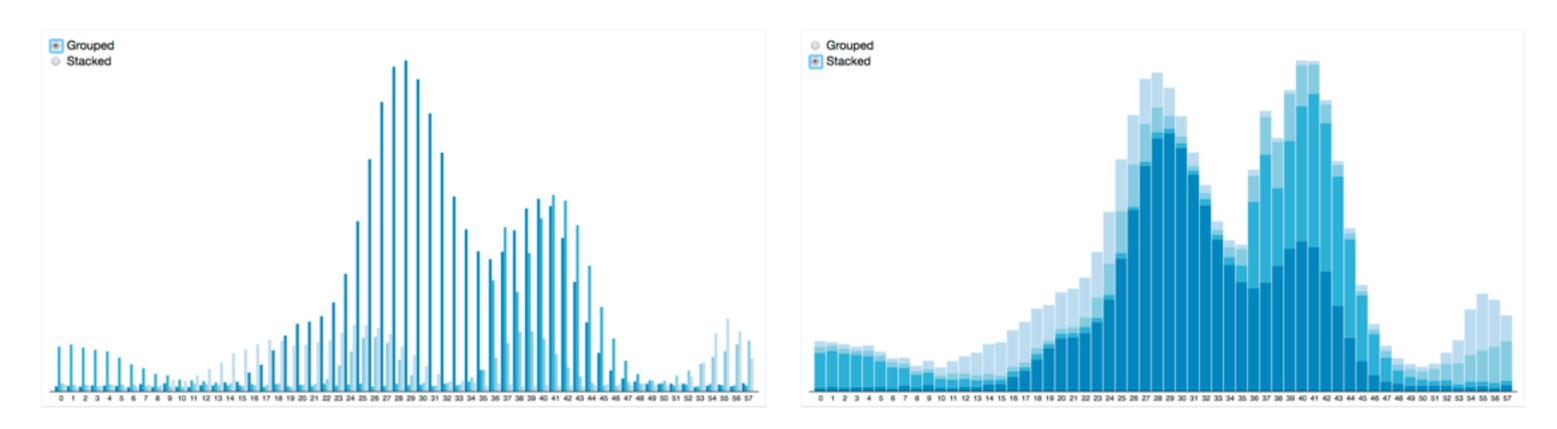


video: vimeo.com/19278444

[Animated Transitions in Statistical Data Graphics. Heer and Robertson. IEEE TVCG (Proc InfoVis 2007) 13(6):1240-1247, 2007]

Idiom: Animated transitions - visual encoding change

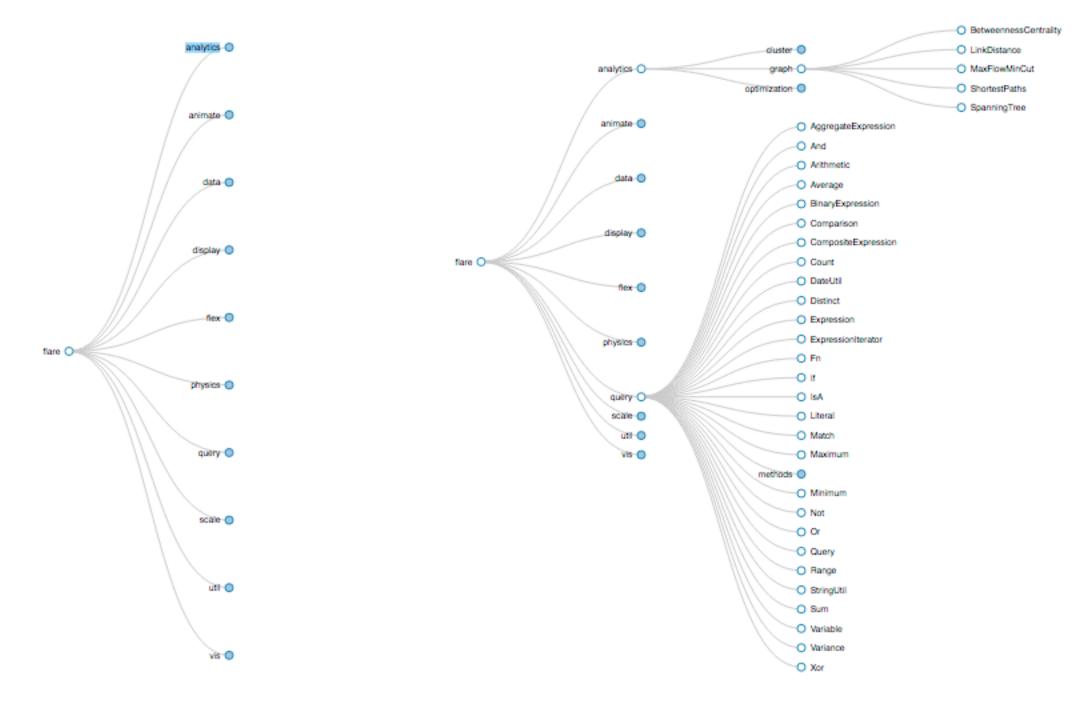
- smooth transition from one state to another
 - -alternative to jump cuts, supports item tracking
 - -best case for animation
 - -staging to reduce cognitive load



[Stacked to Grouped Bars](http://bl.ocks.org/mbostock/3943967)

Idiom: Animated transition - tree detail

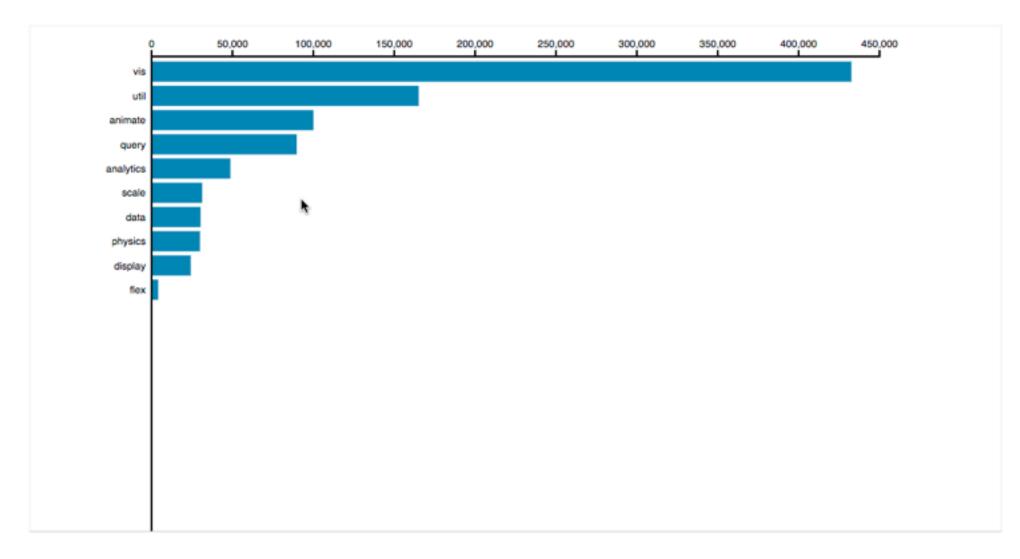
 animated transition – network drilldown/rollup



[Collapsible Tree](https://bl.ocks.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://bl.ocks.org/mbostock/1283663)

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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?

<u>slide inspired by: Alexander Lex, Utah</u>



Details first

Mobile News Visualization Reality

vimeo.com/182590214

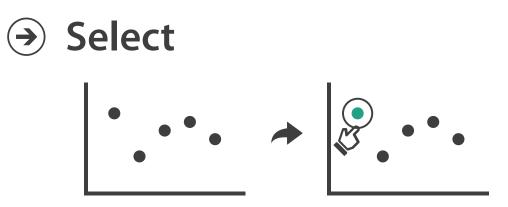


Data visualization and the news - Gregor Aisch (37 min)

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

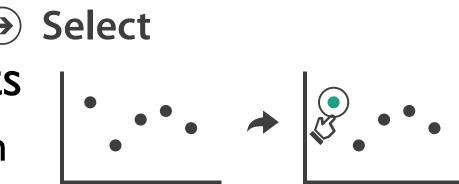
Selection

- 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, ...)



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

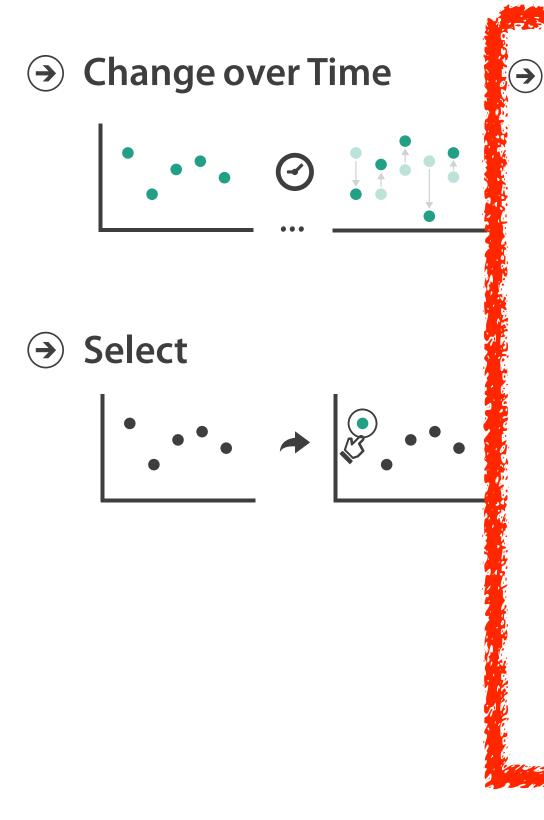


Tooltips

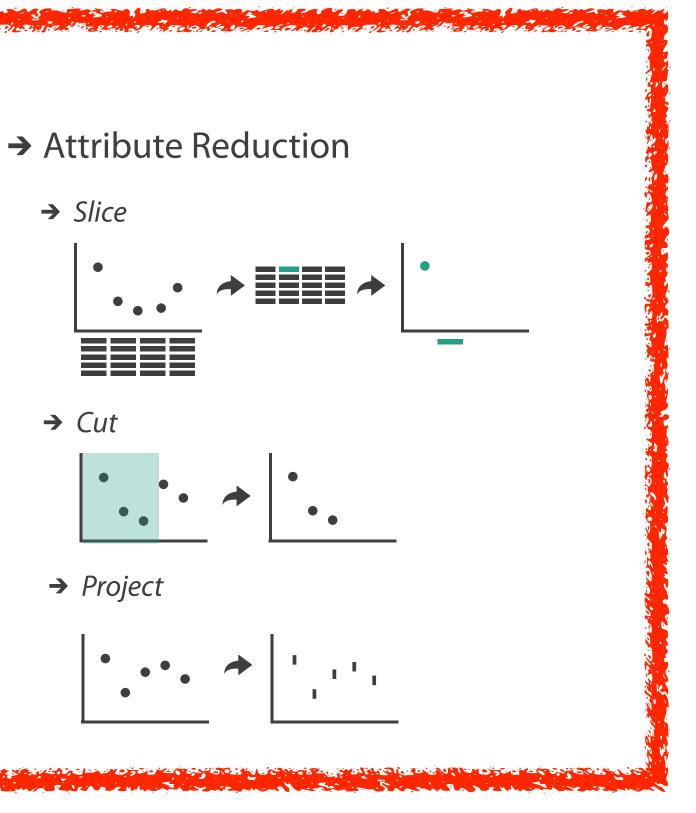
- popup information for selection
 - -hover or click
 - -can provide useful additional detail on demand
 - -beware: does not support overview!
 - always consider if there's a way to visually encode directly to provide overview
 - "If you make a rollover or tooltip, assume nobody will see it. If it's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

ovide overview s' important, make it explicit."

Manipulate



Navigate → Item Reduction → Slice → Zoom *Geometric* or *Semantic* → Pan/Translate → Cut · • > → Constrained → Project



Navigate: Changing viewpoint/visibility

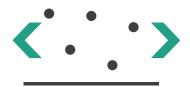
- change viewpoint
 - -changes which items are visible within view
- camera metaphor
 - -pan/translate/scroll
 - move up/down/sideways

Navigate

 (\rightarrow)

→ 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

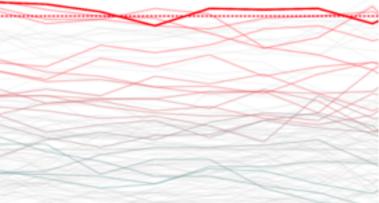
https://eagereyes.org/blog/2016/the-scrollytelling-scourge [How to Scroll, Bostock](<u>https://bost.ocks.org/mike/scroll/</u>)

<u>slide inspired by: Alexander Lex, Utah</u>

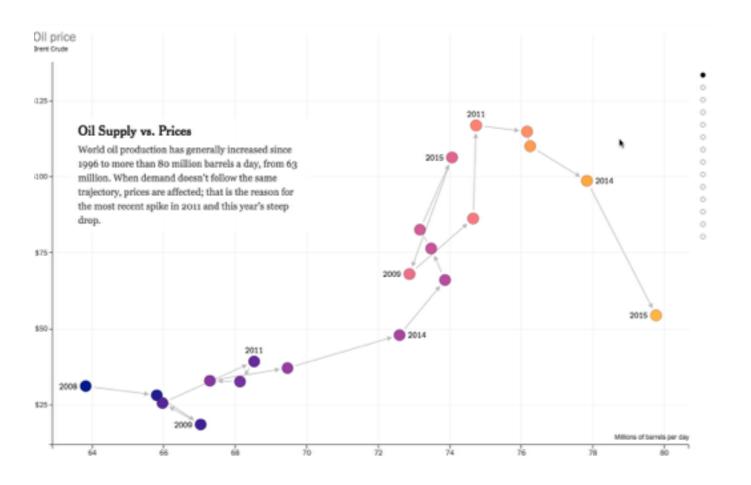


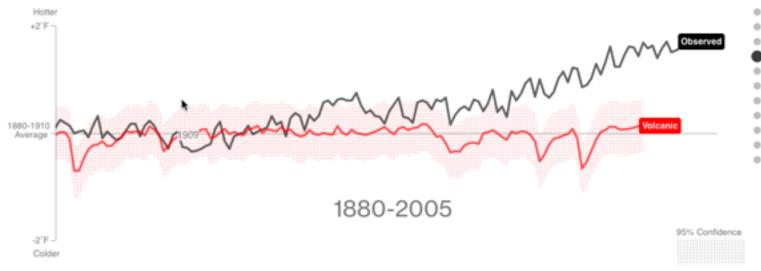


Scroll To Start Animation



Scrollytelling examples





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

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

slide inspired by: Alexander Lex, Utah



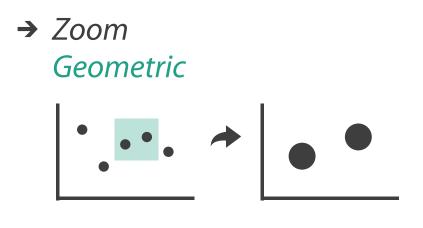
Navigate: Changing viewpoint/visibility

- 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

 (\rightarrow)

→ Item Reduction



→ Pan/Translate



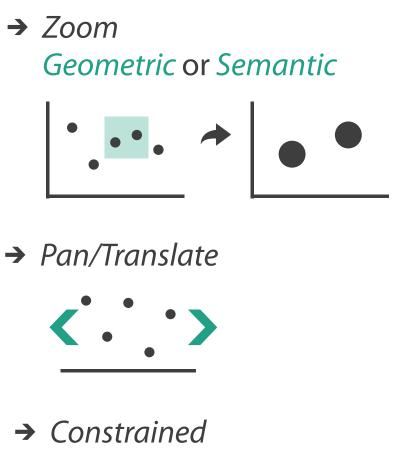
Navigate: Unconstrained vs constrained

- 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

 (\rightarrow)

→ Item Reduction





Idiom: Animated transition + constrained navigation

• example: geographic map

-simple zoom, only viewport changes, shapes preserved

Zoom to Bounding Box



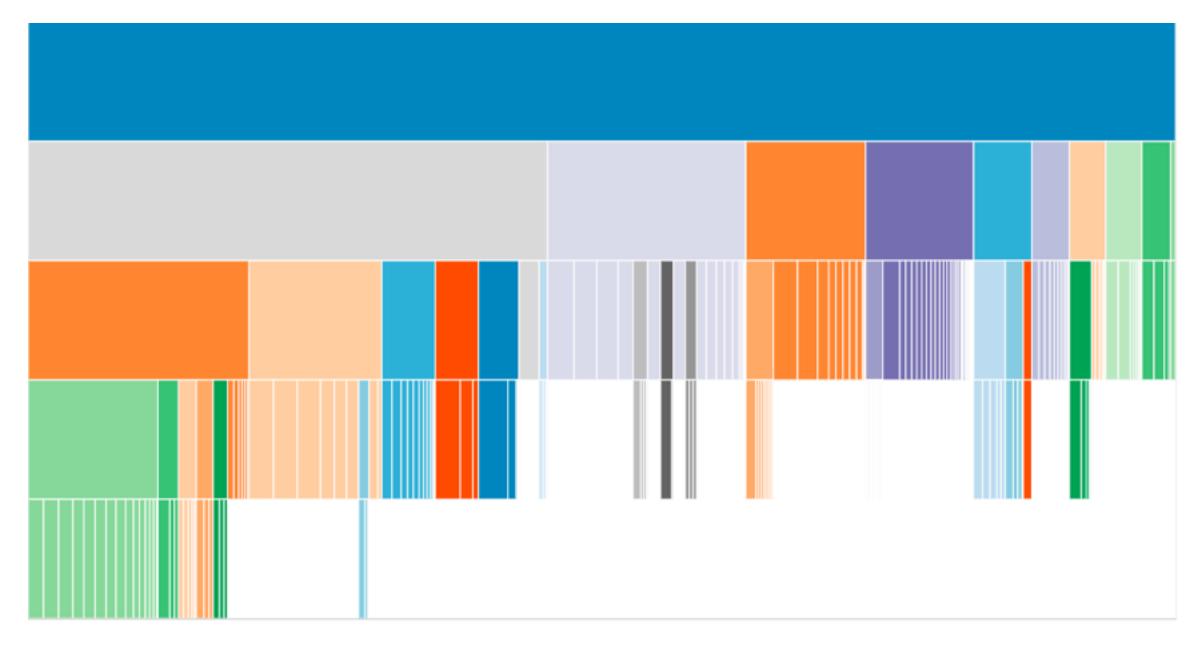
[Zoom to Bounding Box](https://bl.ocks.org/mbostock/4699541)



Idiom: Animated transition + constrained navigation

• example: icicle plot

-transition into containing mark causes aspect ratio (shape) change

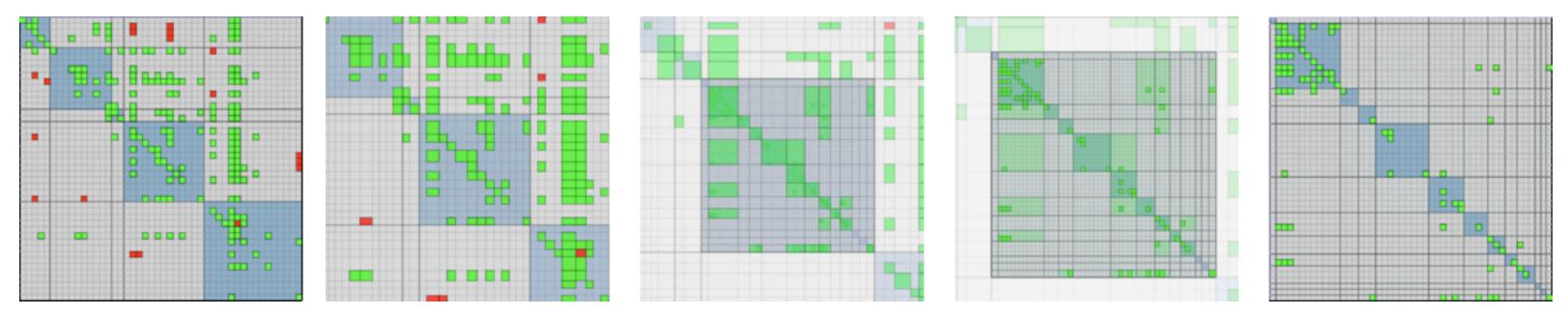


[Zoomable lcicle](https://bl.ocks.org/mbostock/1005873)



Idiom: Animated transition + constrained navigation

- example: multilevel matrix views
 - -add detail during transition
 - -movie: http://www.win.tue.nl/vis1/home/fvham/matrix/Zoomin.avi
 - -movie: http://www.win.tue.nl/vis1/home/fvham/matrix/Zoomout.avi
 - -movie: http://www.win.tue.nl/vis1/home/fvham/matrix/Pan.avi



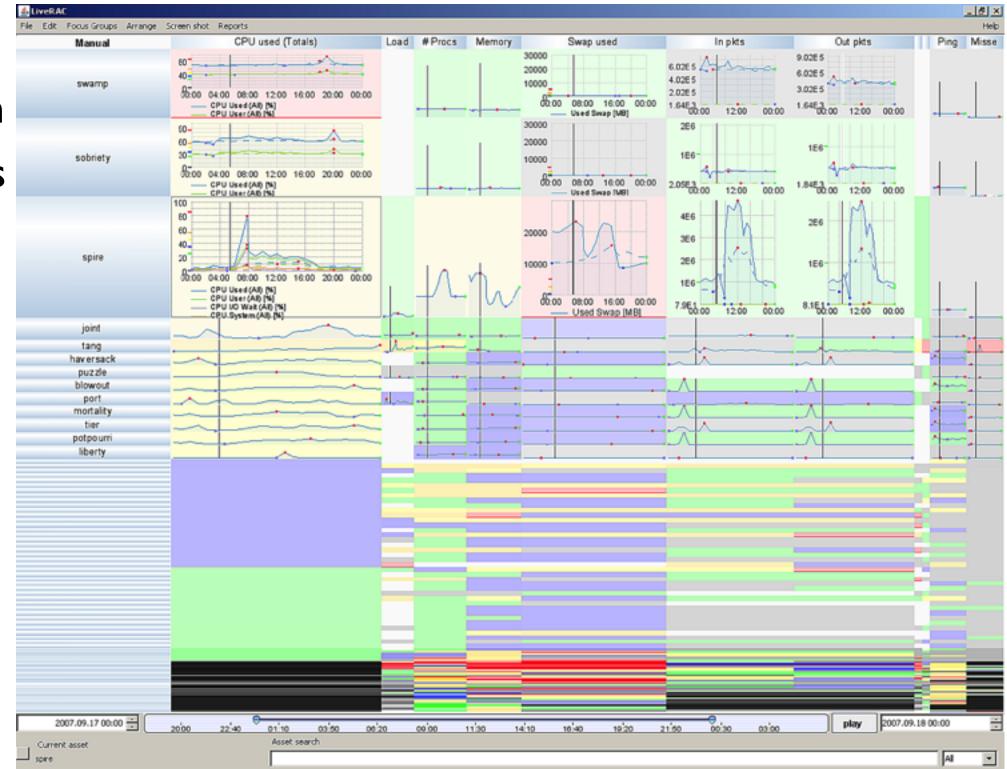
[Using Multilevel Call Matrices in Large Software Projects. van Ham. Proc. IEEE Symp. Information Visualization (InfoVis), pp. 227–232, 2003.]



Idiom: Semantic zooming

• 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



[LiveRAC - Interactive Visual Exploration of System Management Time-Series Data. McLachlan, Munzner, Koutsofios, and North. Proc. ACM Conf. Human Factors in Computing Systems (CHI), pp. 1483–1492, 2008.]

System: LiveRAC

Navigate: Reducing attributes

continuation of camera metaphor

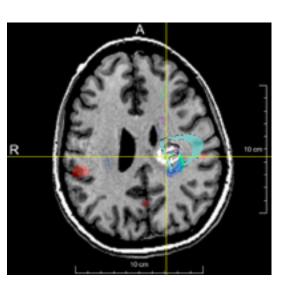
-slice

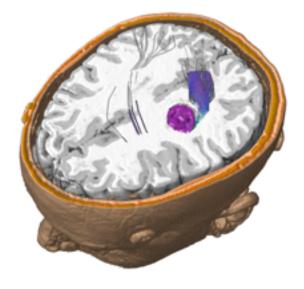
- show only items matching specific value for given attribute: slicing plane
- axis aligned, or arbitrary alignment

-cut

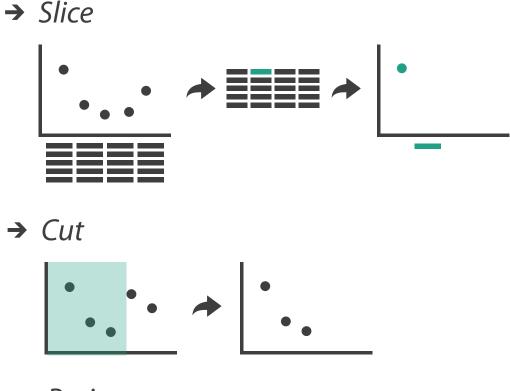
- show only items on far slide of plane from camera
- -project
 - change mathematics of image creation
 - orthographic (eliminate 3rd dimension)
 - -perspective (foreshortening captures limited 3D information)

[Interactive Visualization of Multimodal Volume Data for Neurosurgical Tumor Treatment. Rieder, Ritter, Raspe, and Peitgen. Computer Graphics Forum (Proc. EuroVis 2008) 27:3 (2008), 1055–1062.]

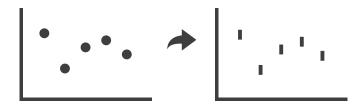




→ Attribute Reduction

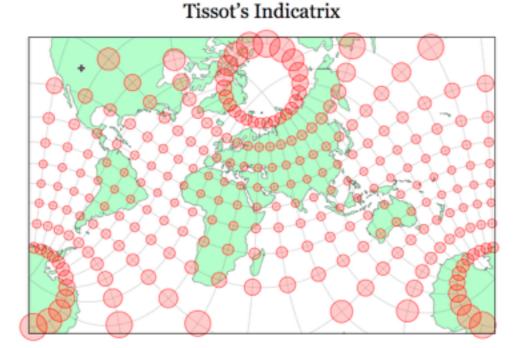


→ Project

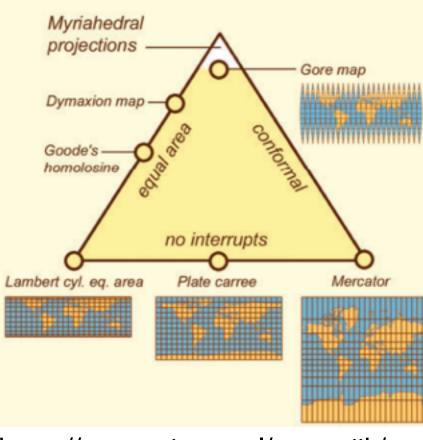


Navigate: Cartographic projections

- 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](<u>https://bl.ocks.org/mbostock/</u> 29cddc0006f8b98eff12e60dd08f59a7) 50

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 11: Facet

Facet

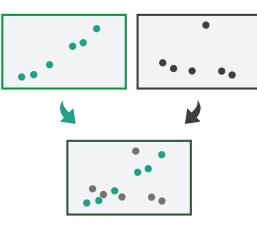




Partition







Juxtapose and coordinate views

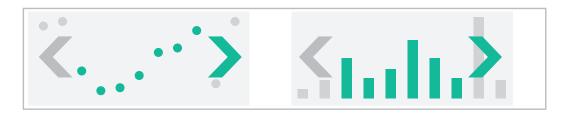
- → Share Encoding: Same/Different
 - → Linked Highlighting



→ Share Data: All/Subset/None

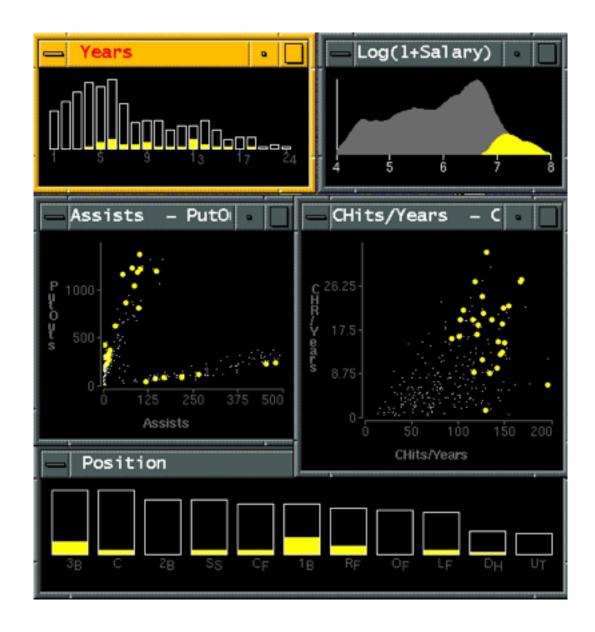


→ Share Navigation



Idiom: Linked highlighting

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

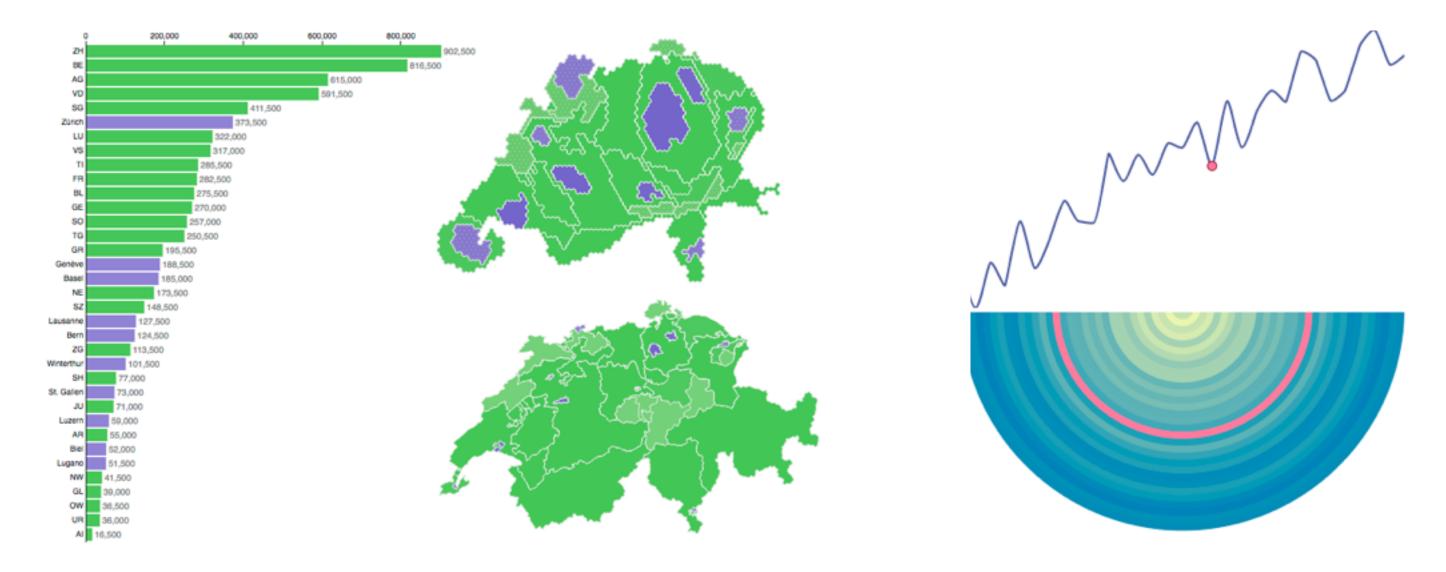


[Visual Exploration of Large Structured Datasets.Wills. Proc. New Techniques and Trends in Statistics (NTTS), pp. 237–246. IOS Press, 1995.]

System: **EDV**

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

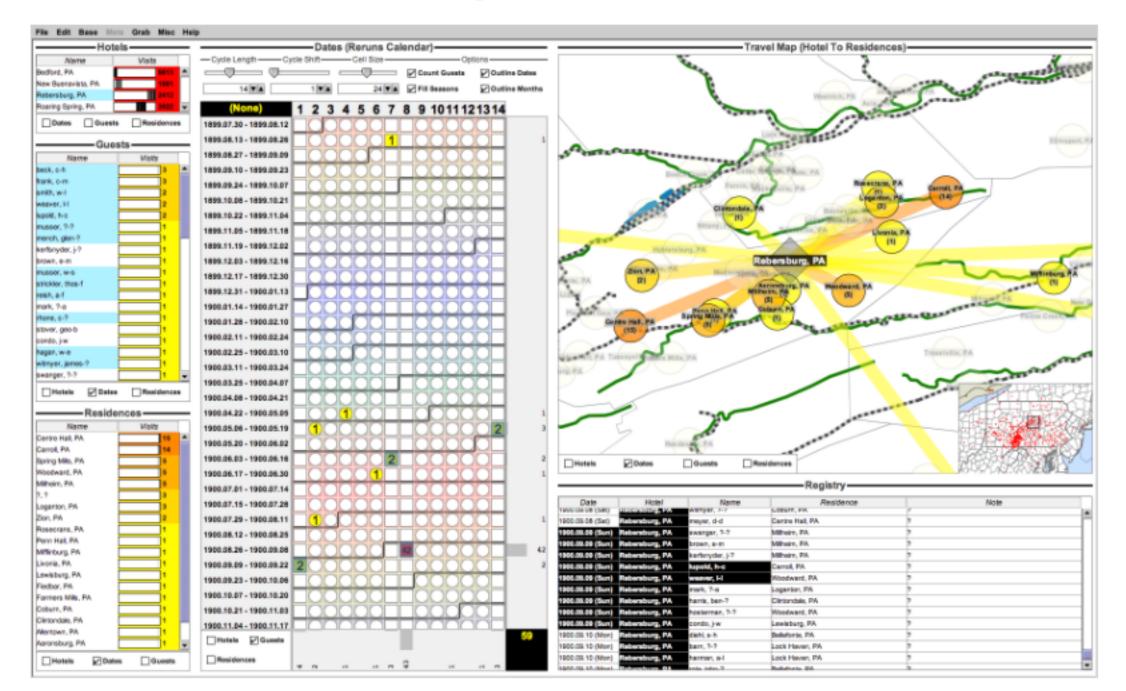


http://buckets.peterbeshai.com/

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

System: **Buckets**

Video: Visual Analysis of Historical Hotel Visitation Patterns



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

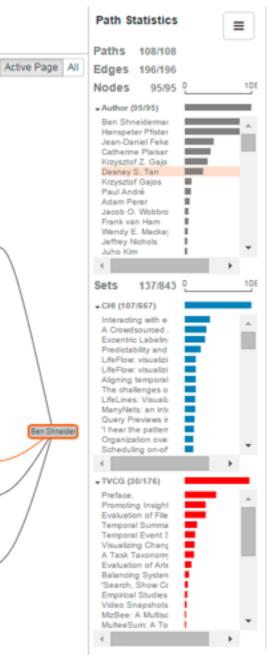
http://www.cs.ou.edu/~weaver/improvise/examples/hotels/

Complex linked multiform views



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

System: Pathfinder



Idiom: Overview-detail views

- 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.]

System: Google Maps

Idiom: Overview-detail navigation

- encoding: same
- data: subset shared
- navigation: shared
 - -unidirectional linking
 - -select in small overview

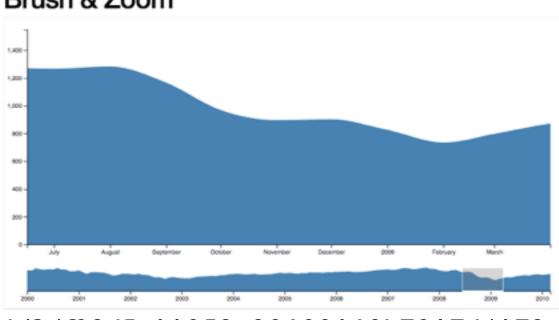
-change extent in large detail view

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



Brush & Zoom

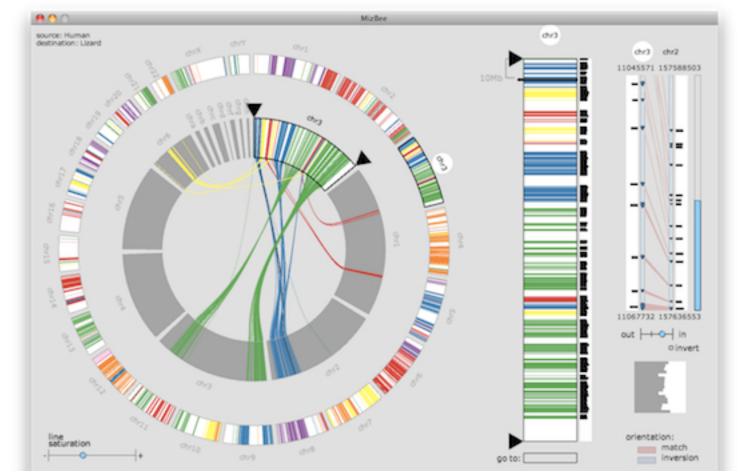


https://bl.ocks.org/mbostock/34f08d5e11952a80609169b7917d4172

Popular / About

Overview-detail

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

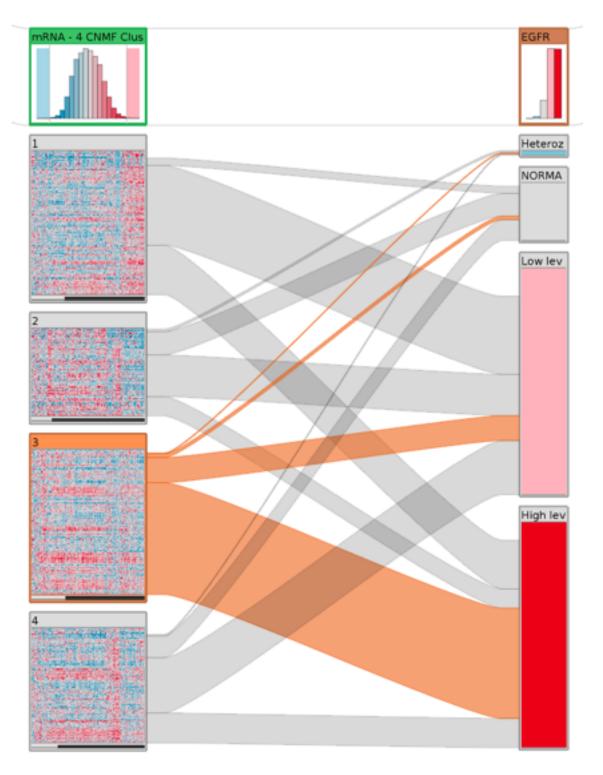




System: MizBee

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

Overview-detail

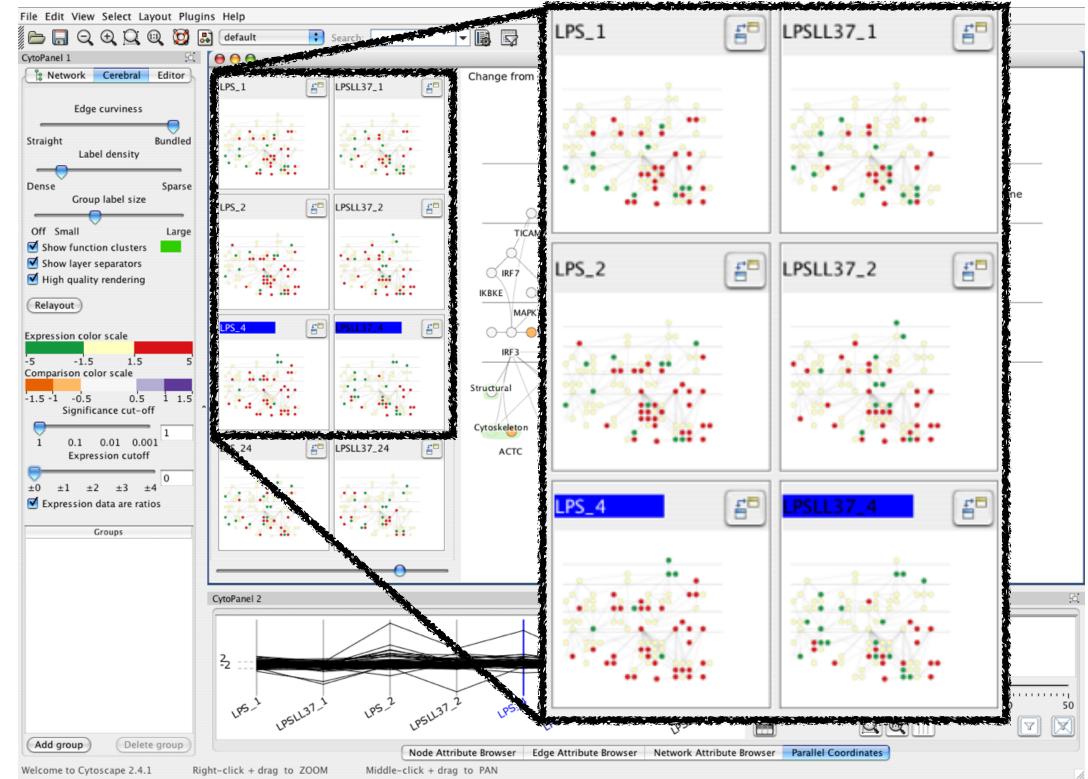


https://www.youtube.com/watch?v=UcKDbGqHsdE



Idiom: Small multiples

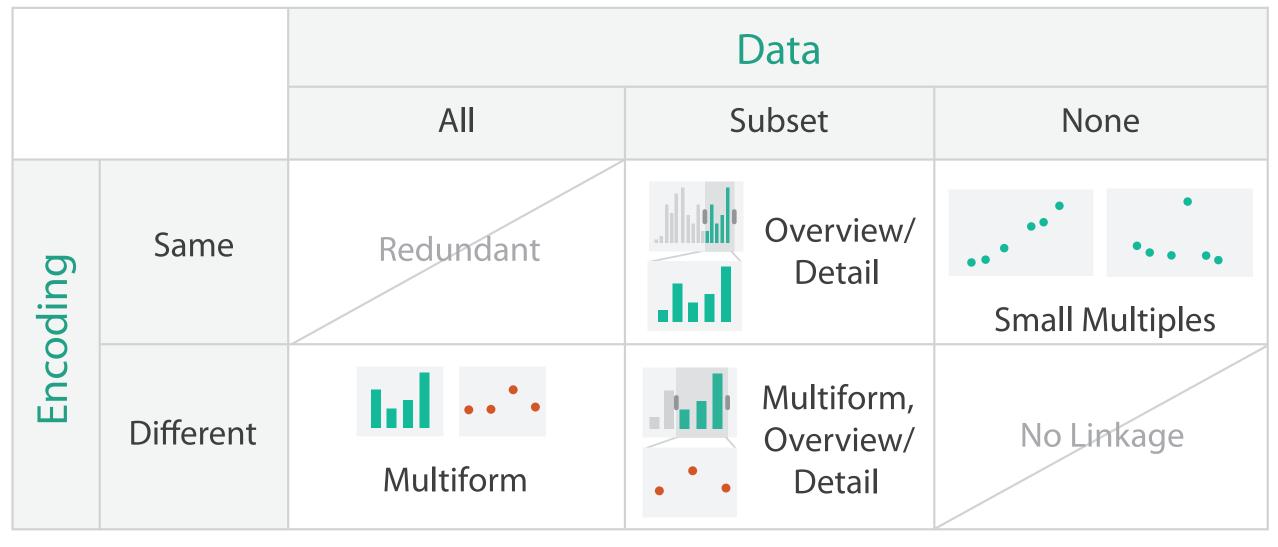
- encoding: same
- data: none shared
 - -different attributes for node colors
 - -(same network layout)
- navigation: shared



[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

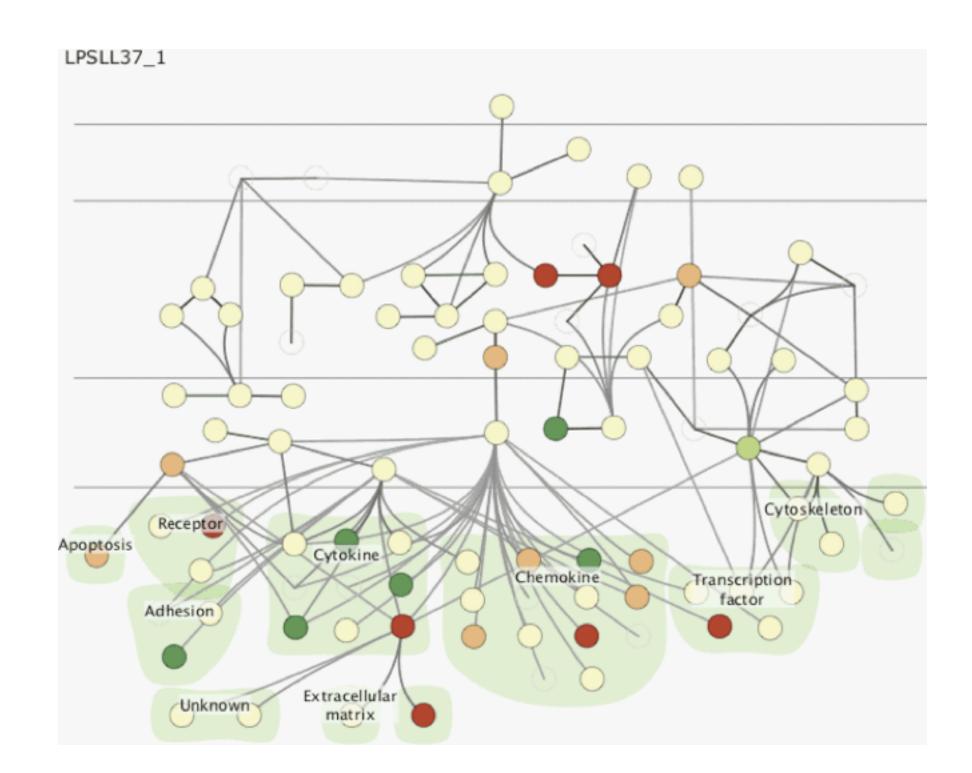


- why juxtapose views?
 - -benefits: eyes vs memory
 - lower cognitive load to move eyes between 2 views than remembering previous state with single changing view
 - -costs: display area, 2 views side by side each have only half the area of one view

Why not animation?

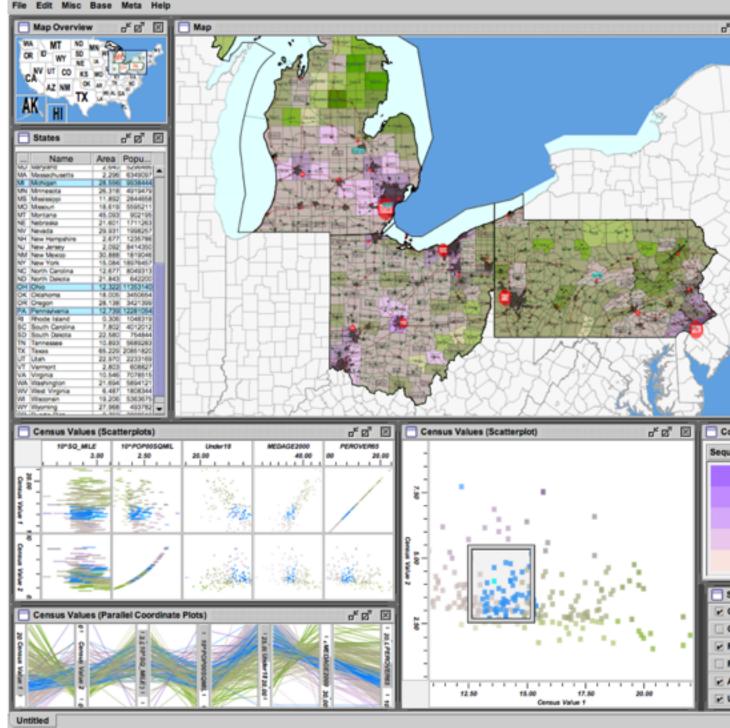
- disparate frames and regions: comparison difficult
 - -vs contiguous frames
 - -vs small region
 - -vs coherent motion of group
- safe special case

 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

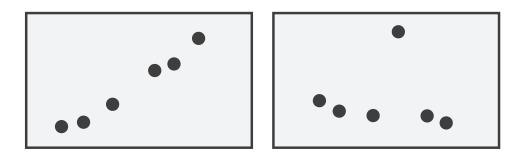


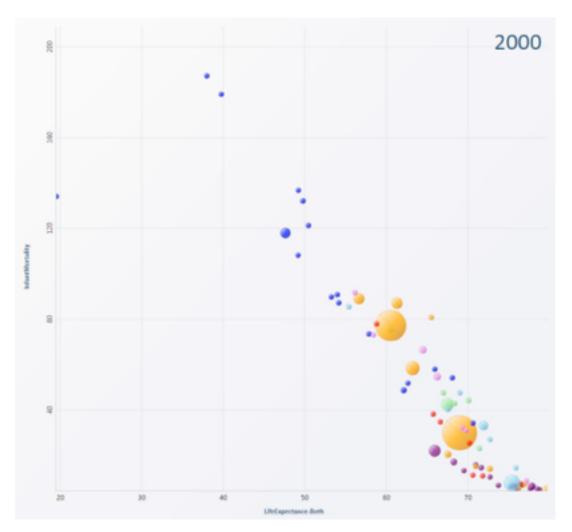
[Building Highly-Coordinated Visualizations In Improvise. Weaver. Proc. IEEE Symp. Information Visualization (InfoVis), pp. 159–166, 2004.]

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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

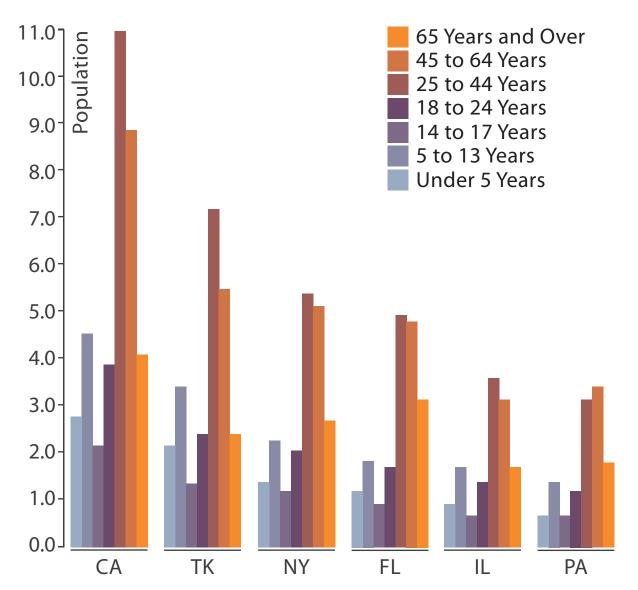






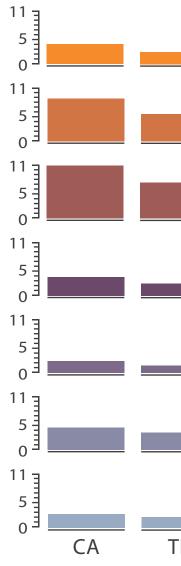
Partitioning: List alignment

- 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



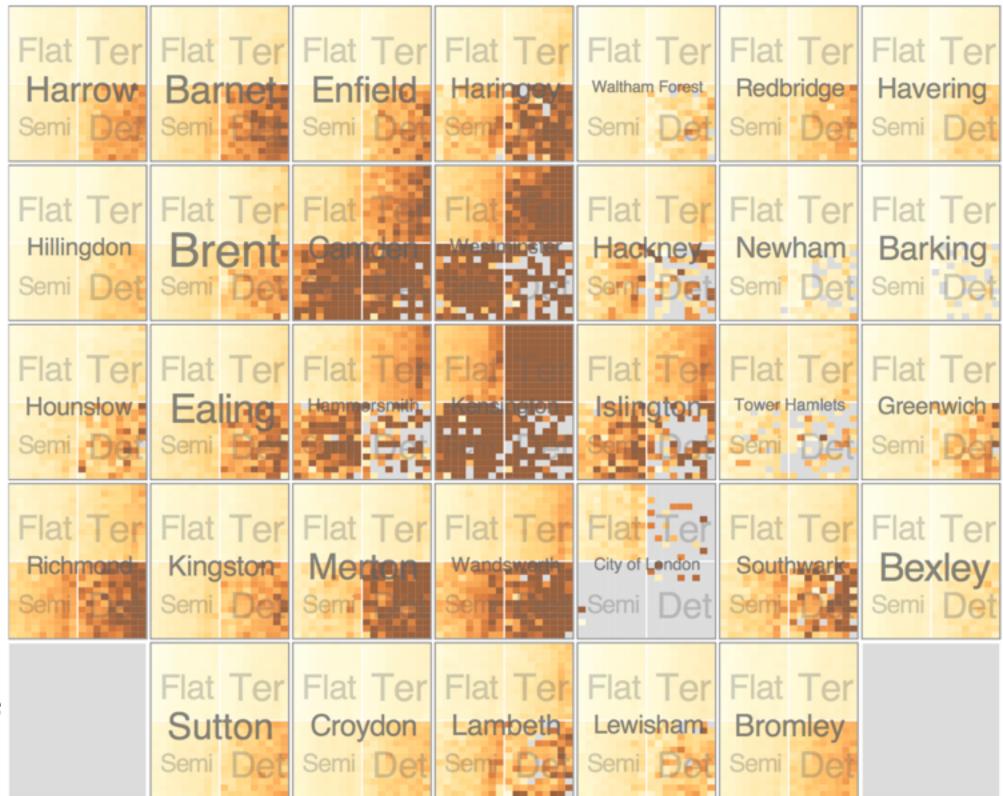


• small-multiple bar charts

	_			
ΓK	NY	FL	IL	PA

- 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.]

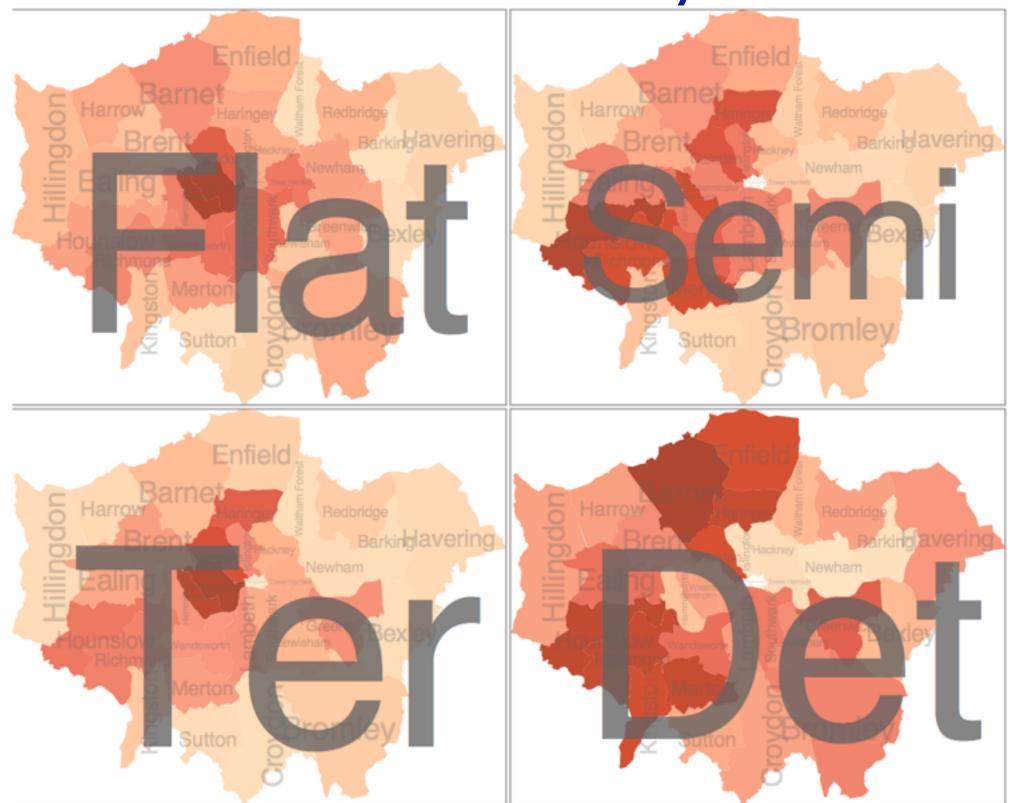


- switch order of splits -type then neighborhood
- switch color
 - -by price variation
- type patterns
 - -within specific type, which neighborhoods inconsistent



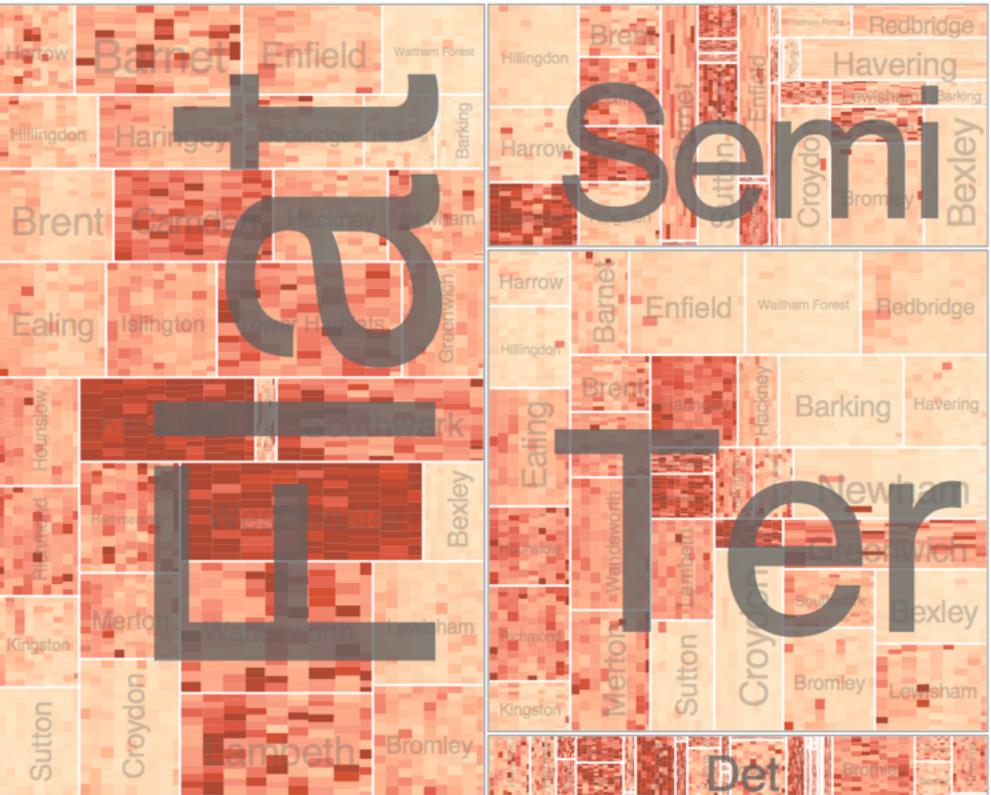
[Configuring Hierarchical Layouts to Address Research Questions. Slingsby, Dykes, and Wood. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2009) 15:6 (2009), 977–984.]

 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

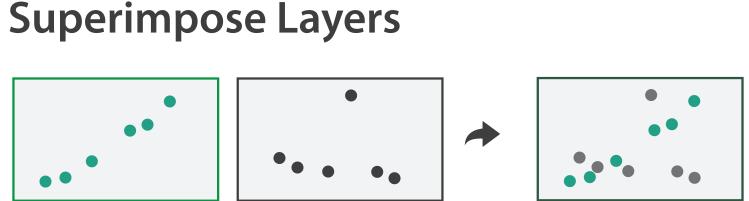


[Configuring Hierarchical Layouts to Address Research Questions. Slingsby, Dykes, and Wood. IEEE Transactions on Visualization and Computer Graphics (Proc. InfoVis 2009) 15:6 (2009), 977–984.]

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?



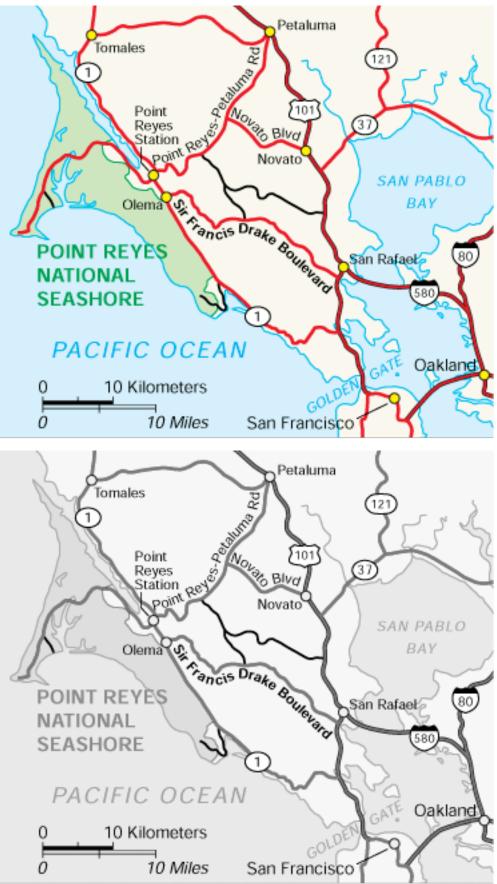
Static visual layering

- 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]

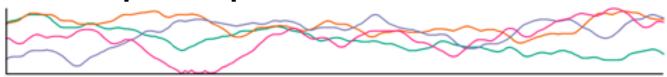


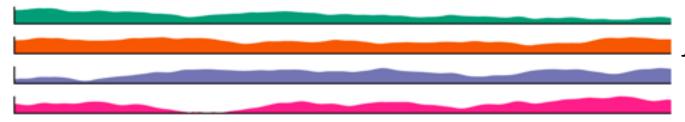




Superimposing limits

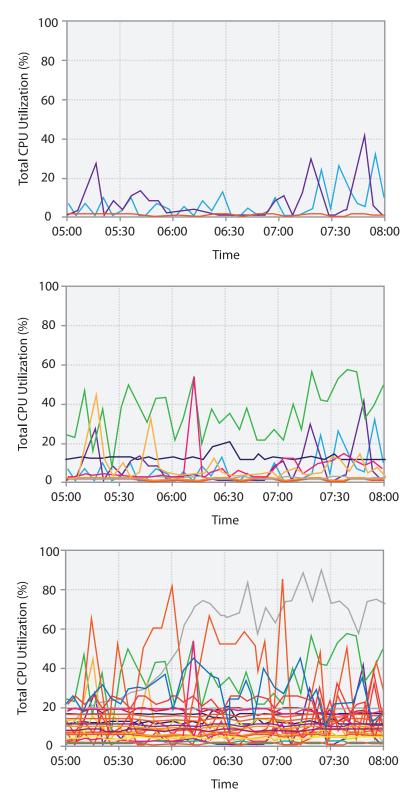
- few layers, but many lines
 - -up to a few dozen
 - -but not hundreds
- superimpose vs juxtapose: empirical study
 - -superimposed for local, multiple for global
 - -tasks
 - local: maximum, global: slope, discrimination
 - -same screen space for all multiples vs single superimposed





[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.]

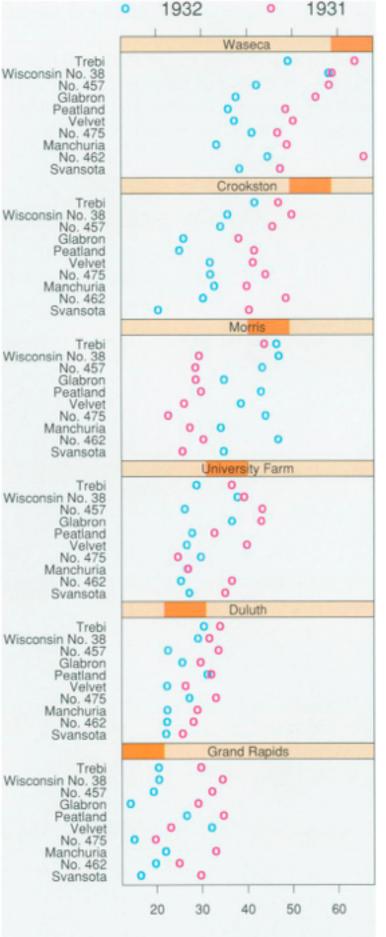




Idiom: Trellis plots

superimpose within same frame – color code by year

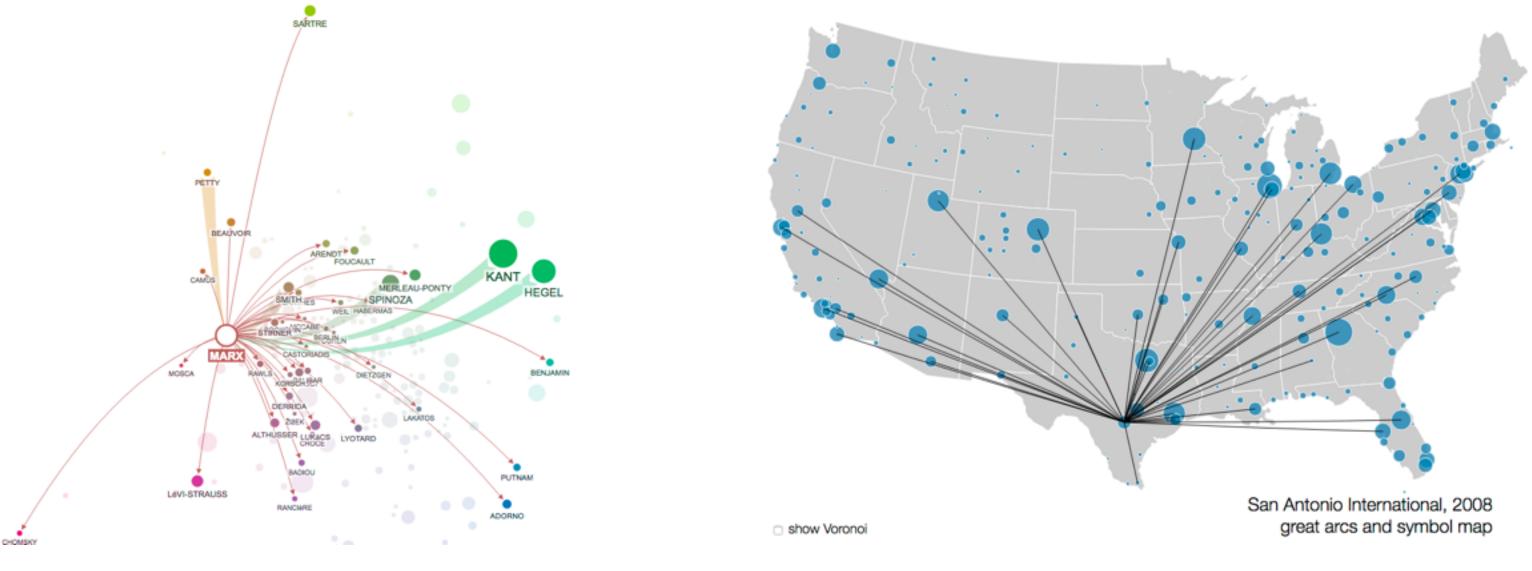
- partitioning
 - -split by site, rows are wheat varieties
- main-effects ordering
 - -derive value of median for group, use to order
 - -order rows within view by variety median
 - -order views themselves by site median



Barley Yield (bushels/acre)

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/2011116/airports.html