

Lecture 7

Interactive views

DTS204TC Data Visualisation



Outline

- Manipulate views
- Multiple views

How to handle complexity?

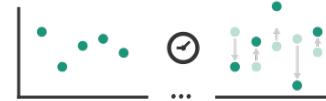
→ Derive



- derive new data to show within view
- change view over time
- facet across multiple views

Manipulate

→ Change



→ Select



→ Navigate

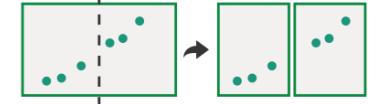


Facet

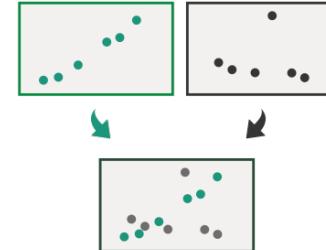
→ Juxtapose



→ Partition



→ Superimpose



Manipulate View

→ Change over Time

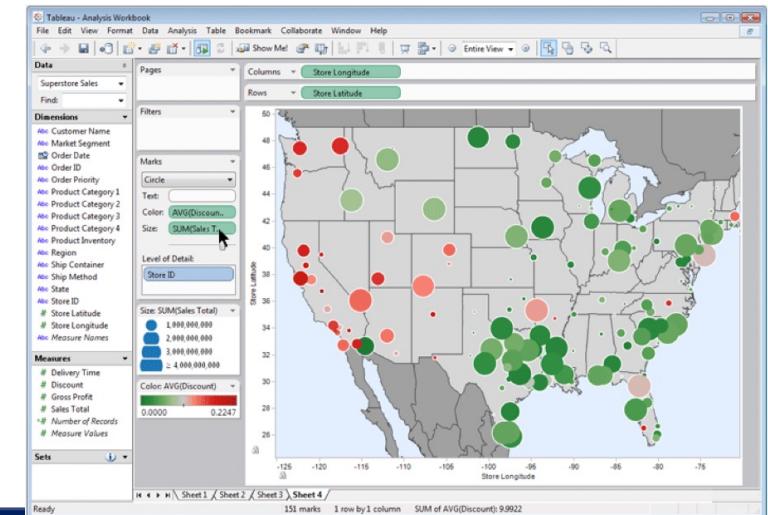
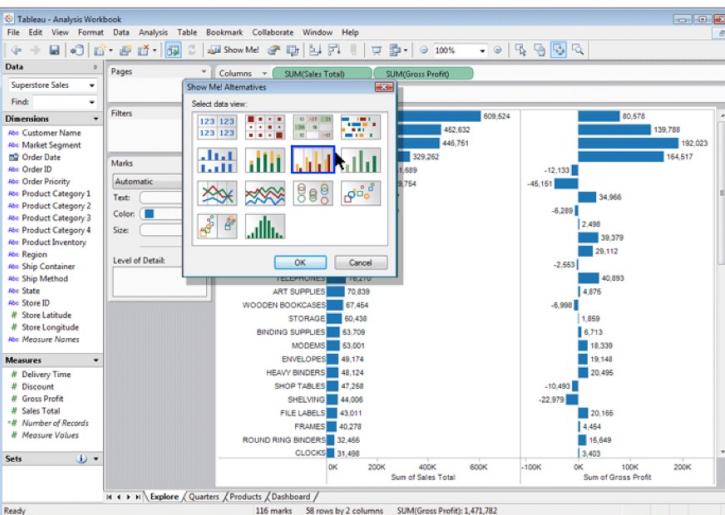
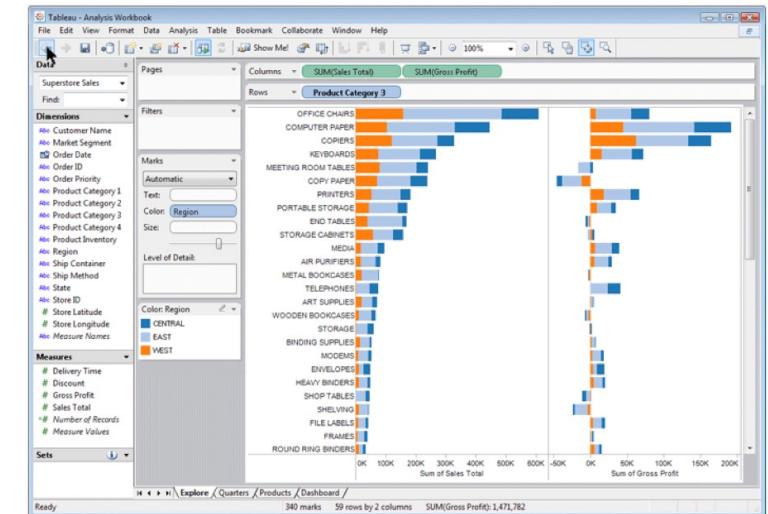
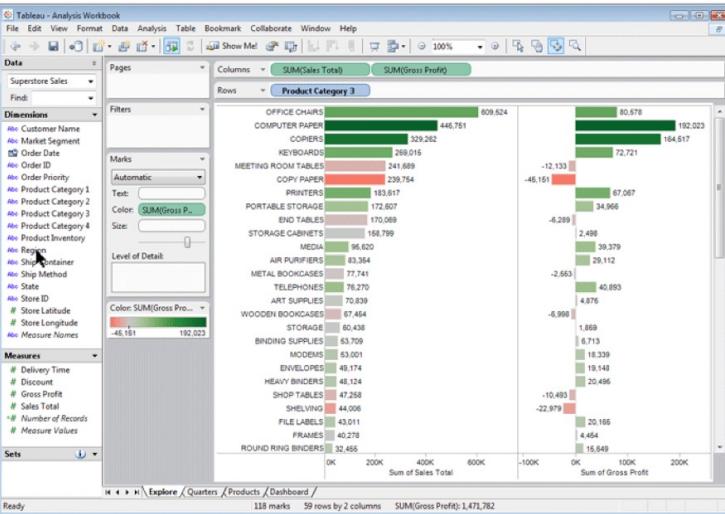


Manipulate View (change over time)

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

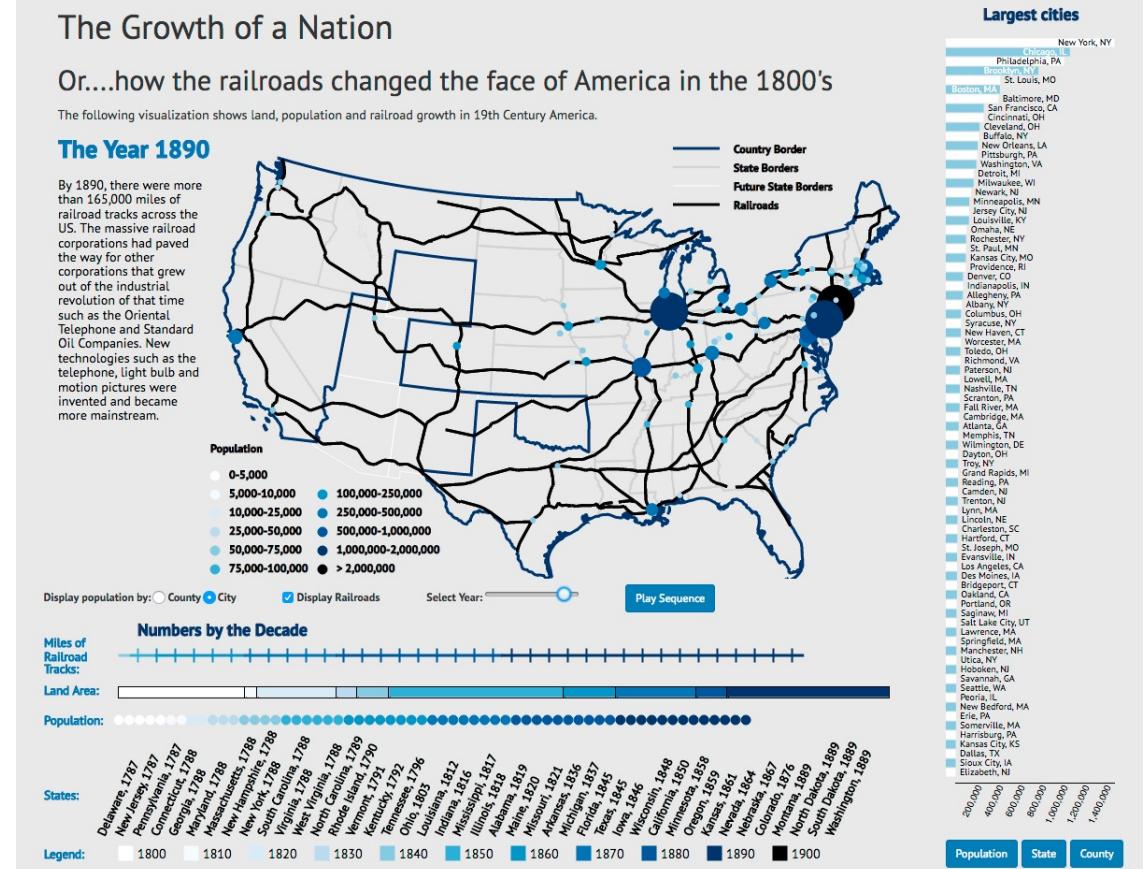
Manipulate View (change over time)

- idiom: Re-encode



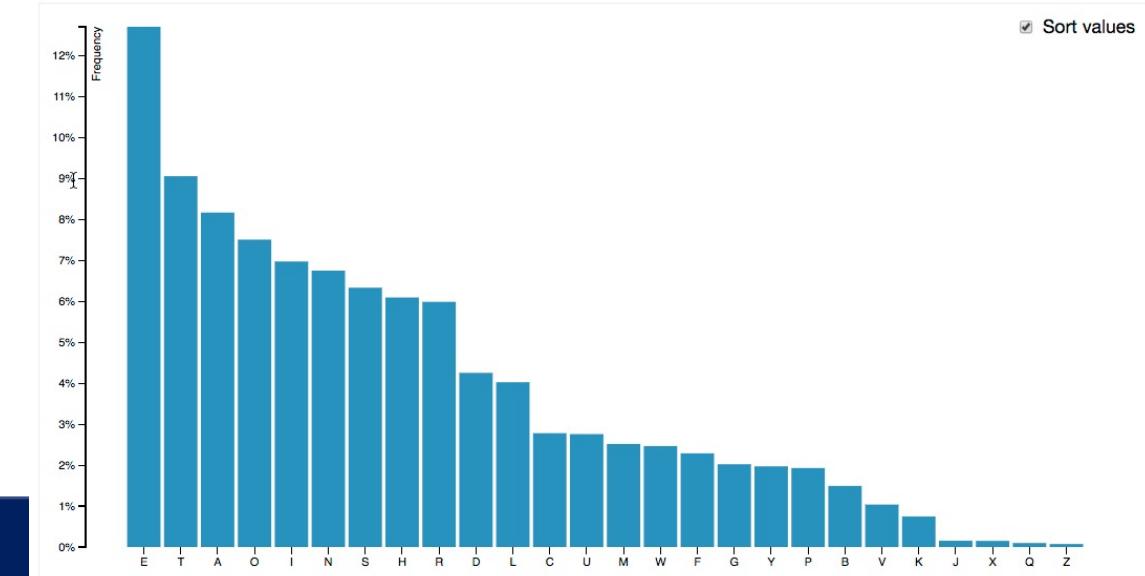
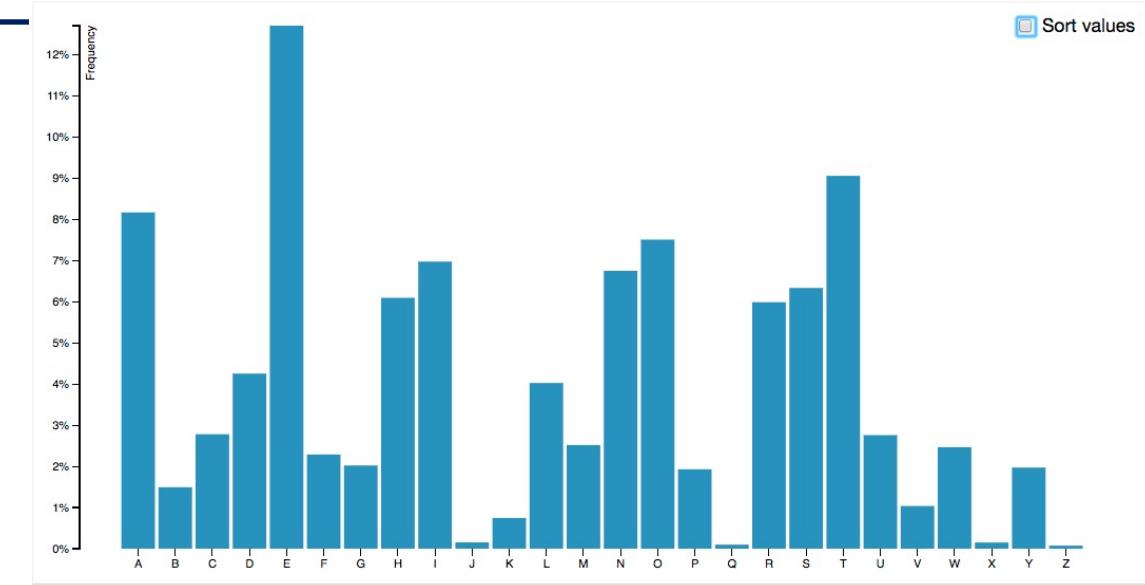
Manipulate View (change over time)

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



Manipulate View (change over time)

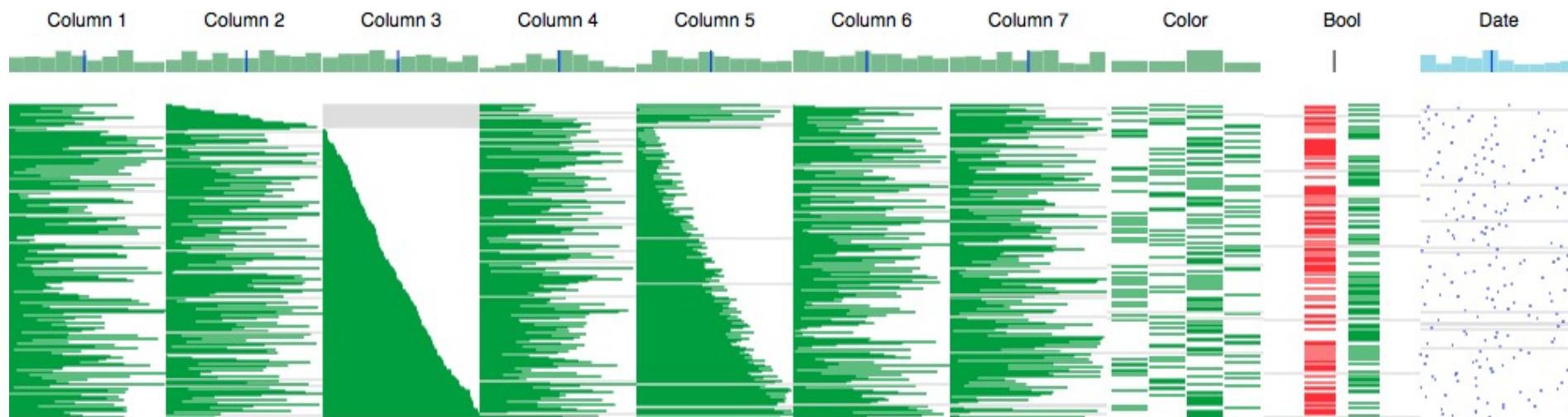
- idiom: Change order/arrangement
 - what: simple table
 - how: data-driven reordering
 - why: find extreme values, trends



[Sortable Bar Chart] <https://observablehq.com/@d3/sortable-bar-chart>

Manipulate View (change over time)

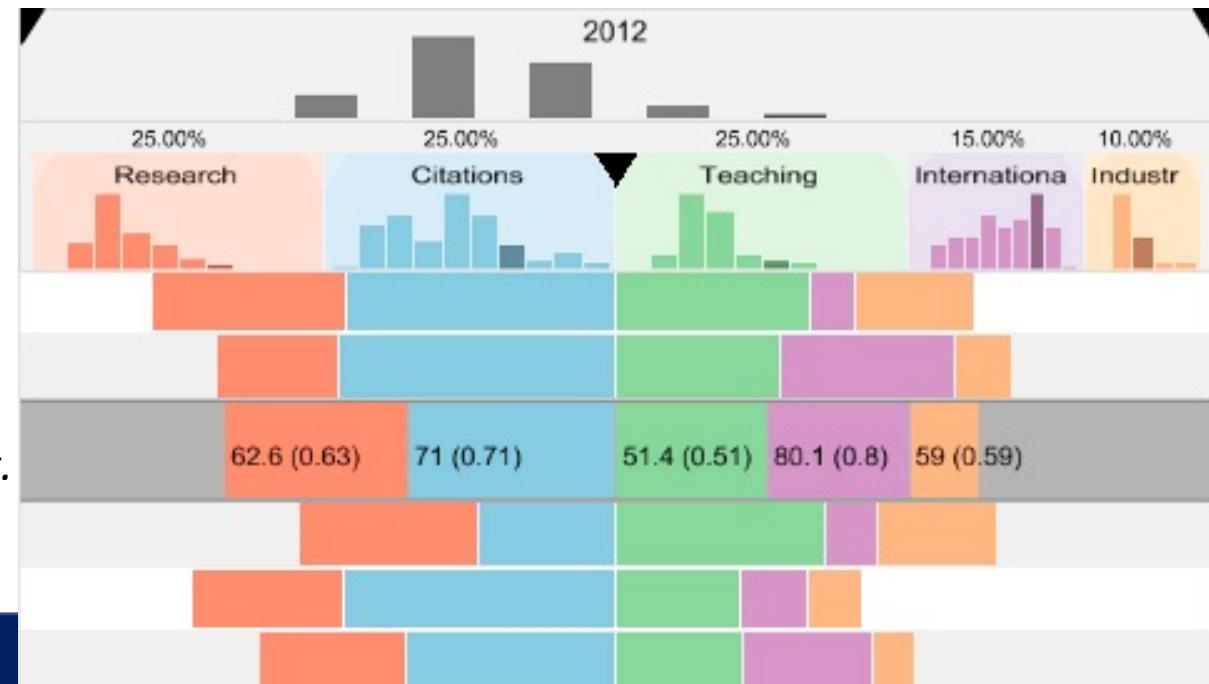
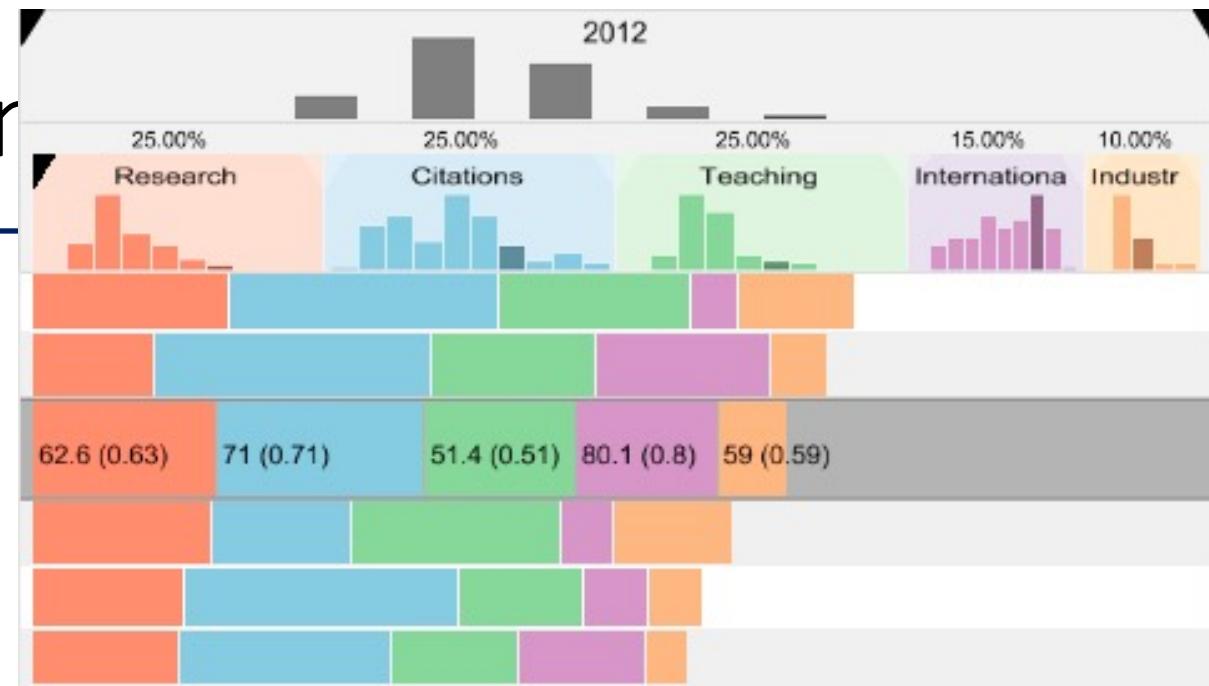
- idiom: Reorder
 - what: simple table
 - how: data-driven reordering
 - why: find extreme values, trends



[<http://carlmanaster.github.io/dastripes/>]

Manipulate View (chart)

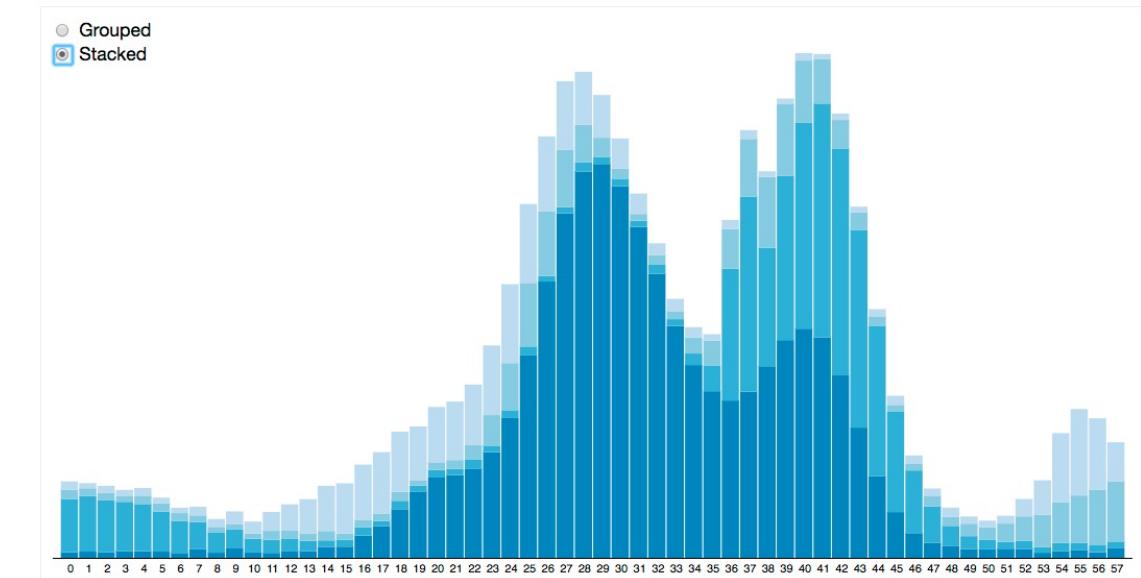
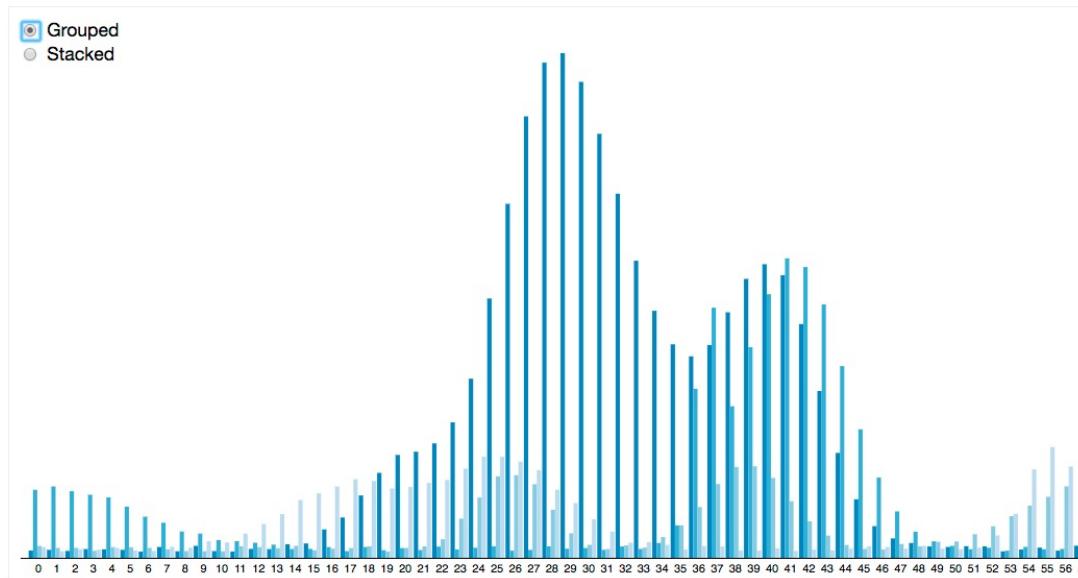
- idiom: change alignment
 - stacked bars
 - easy to compare
 - first segment
 - total bar
 - align to different segment
 - supports flexible comparison



[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.]

Manipulate View (change over time)

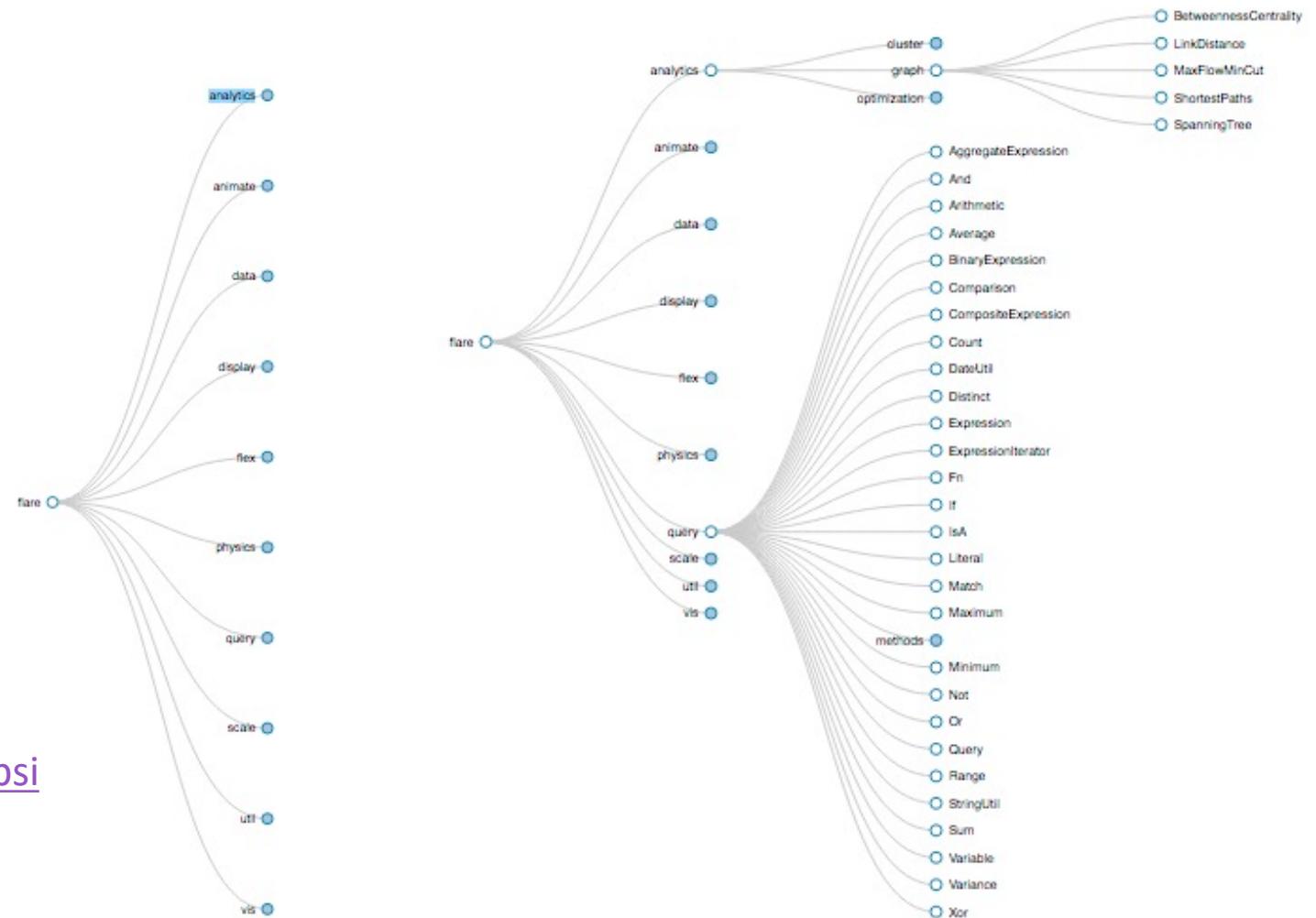
- idiom: Animated transitions
 - smooth transition from one state to another
 - alternative to jump cuts, supports item tracking
 - best case for animation
 - staging to reduce cognitive load



[Stacked to Grouped Bars] <https://observablehq.com/@d3/stacked-to-grouped-bars>

Manipulate View (change over time)

- idiom: Animated transitions – tree detail
 - network drilldown/rollup



Collapsible Tree]

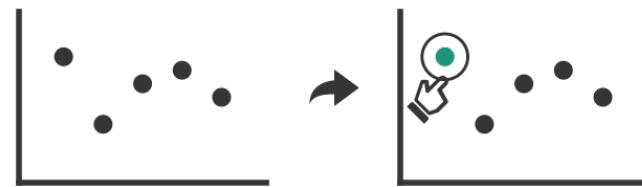
<https://observablehq.com/@d3/collapsible-tree>

Manipulate View

→ Change over Time



→ Select



Manipulate View (Select)

- 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?



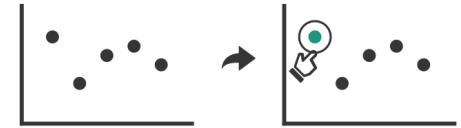
Data visualization and the news - Gregor Aisch (37 min)

vimeo.com/182590214

Manipulate View (Select)

- **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



Manipulate View (Select)

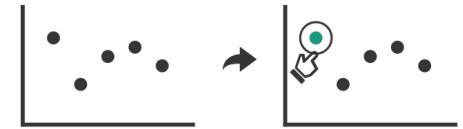
- **Highlighting:** change visual encoding for selection targets → Select
 - visual feedback closely tied to but separable from selection (interaction)
- design choices: typical visual channels
 - change item colour
 - but hides existing colour coding
 - add outline mark
 - change size (ex: increase 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

Manipulate View (Select)

- **Tooltips:** change visual encoding for selection targets

- Talk later

⇒ Select

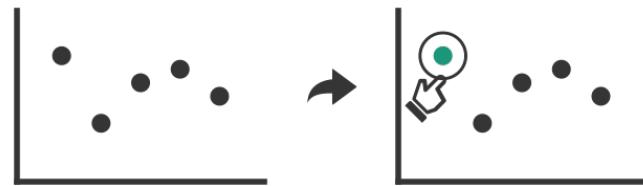


Manipulate View

→ Change over Time



→ Select



→ Navigate

→ Item Reduction

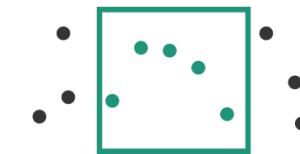
→ Zoom
Geometric or Semantic



→ Pan/Translate



→ Constrained



Manipulate View (Navigate: Changing viewpoint/visibility)

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

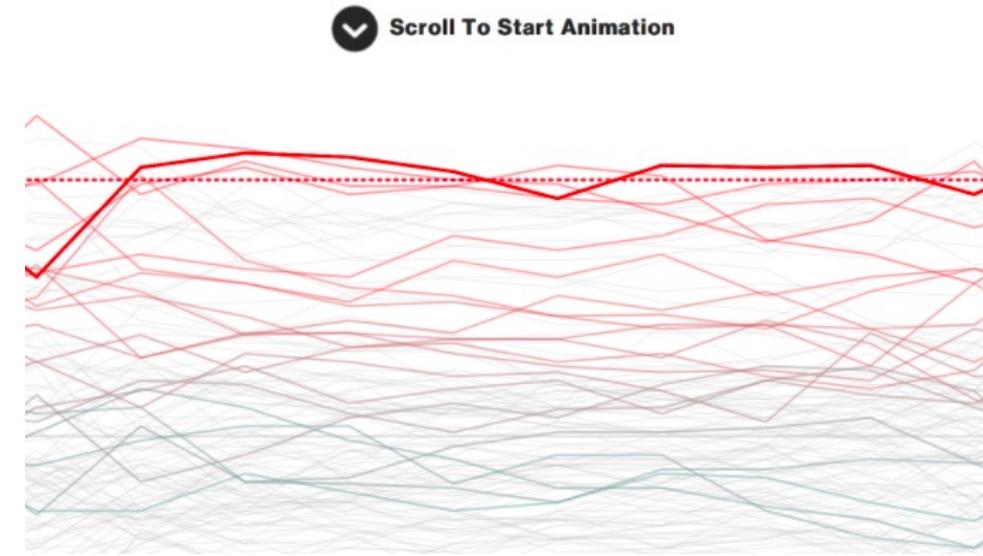
→ **Navigate**

→ *Pan/Translate*



Manipulate View (Navigate: Changing viewpoint/visibility)

- 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
 - scroll jacking, no direct access
 - unexpected behaviour
 - continuous control for discrete steps



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

Manipulate View (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



Manipulate View (Navigate: Unconstrained vs 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://observablehq.com/@d3/zoom-to-bounding-box>

Manipulate View (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
 - perspective
 - many others: Mercator, cabinet, ...

→ Attribute Reduction

→ Slice



→ Cut



→ Project



Manipulate View

- 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

Manipulate View

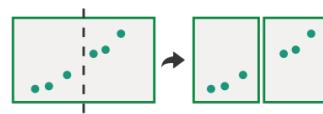
- interaction cons
 - interaction has a time cost
 - sometimes minor, sometimes significant
 - degenerates to human-powered search in worst case
 - remembering previous state imposes cognitive load
 - controls may take screen real estate
 - or invisible functionality may be difficult to discover (lack of affordances)
 - users may not interact as planned by designer
 - NYTimes logs show ~90% don't interact beyond scrollytelling - Aisch, 2016

Multiple Views

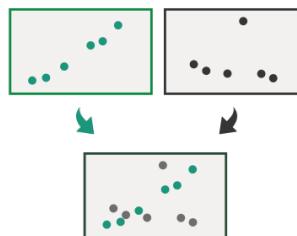
→ **Juxtapose**



→ **Partition**



→ **Superimpose**



Multiple Views (Juxtapose)

- Juxtapose and coordinate views
 - Share Encoding: Same/Different

→ *Linked Highlighting*



→ Share Data: All/Subset/None

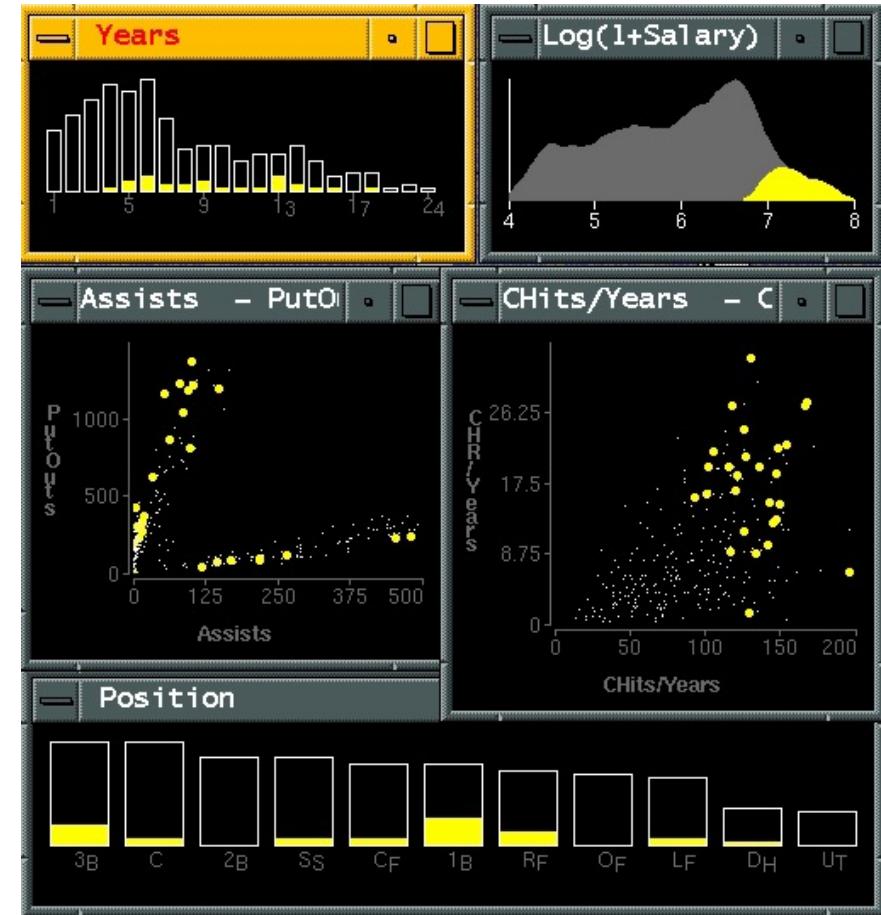


→ Share Navigation



Multiple Views (Juxtapose)

- 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
 - all **items** shared
 - different **attributes** across the views
 - aka: brushing and linking



Multiple Views (Juxtapose)

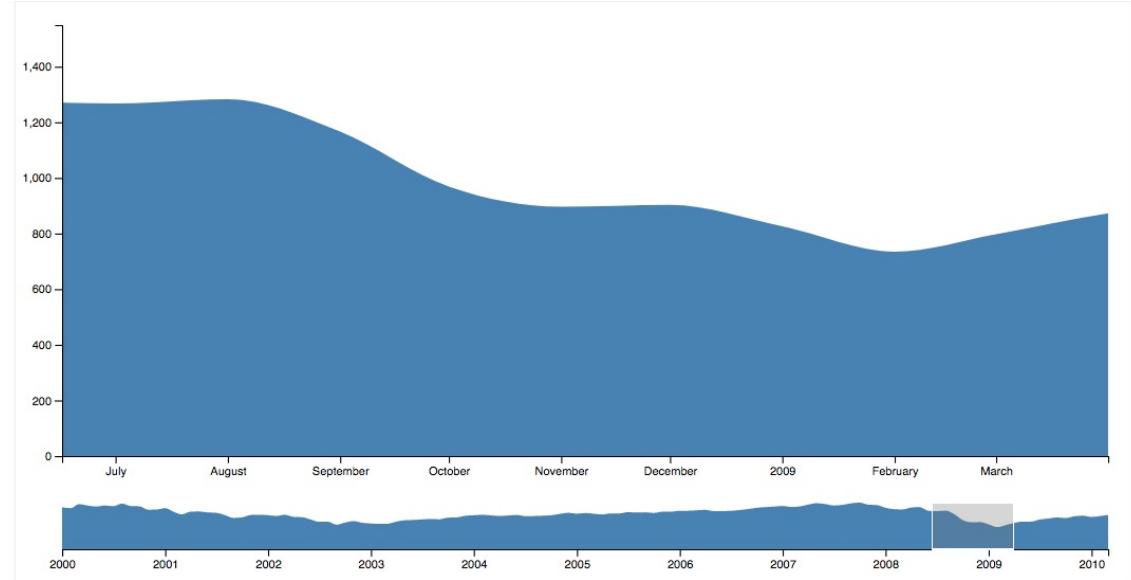
- Idiom: overview-detailed views
 - encoding: same or different
 - ex: same (birds-eye map)
 - data: subset shared
 - viewpoint differences:
subset of data items
 - navigation: shared
 - bidirectional linking
 - other differences
 - (window size)



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

Multiple Views (Juxtapose)

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



<https://observablehq.com/@uwnetdata/interaction>

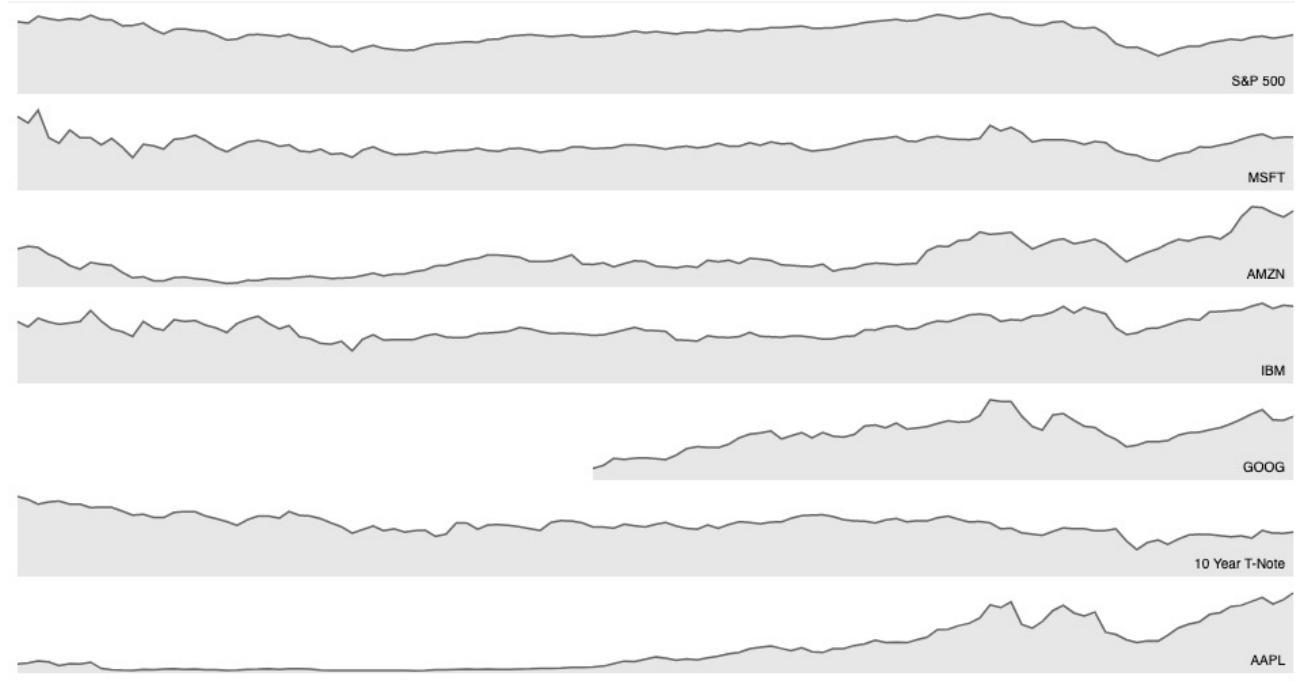
Multiple Views (Juxtapose)

- Idiom: Tooltips
 - popup information for selection
 - hover or click
 - specific case of detail view:
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



Multiple Views (Juxtapose)

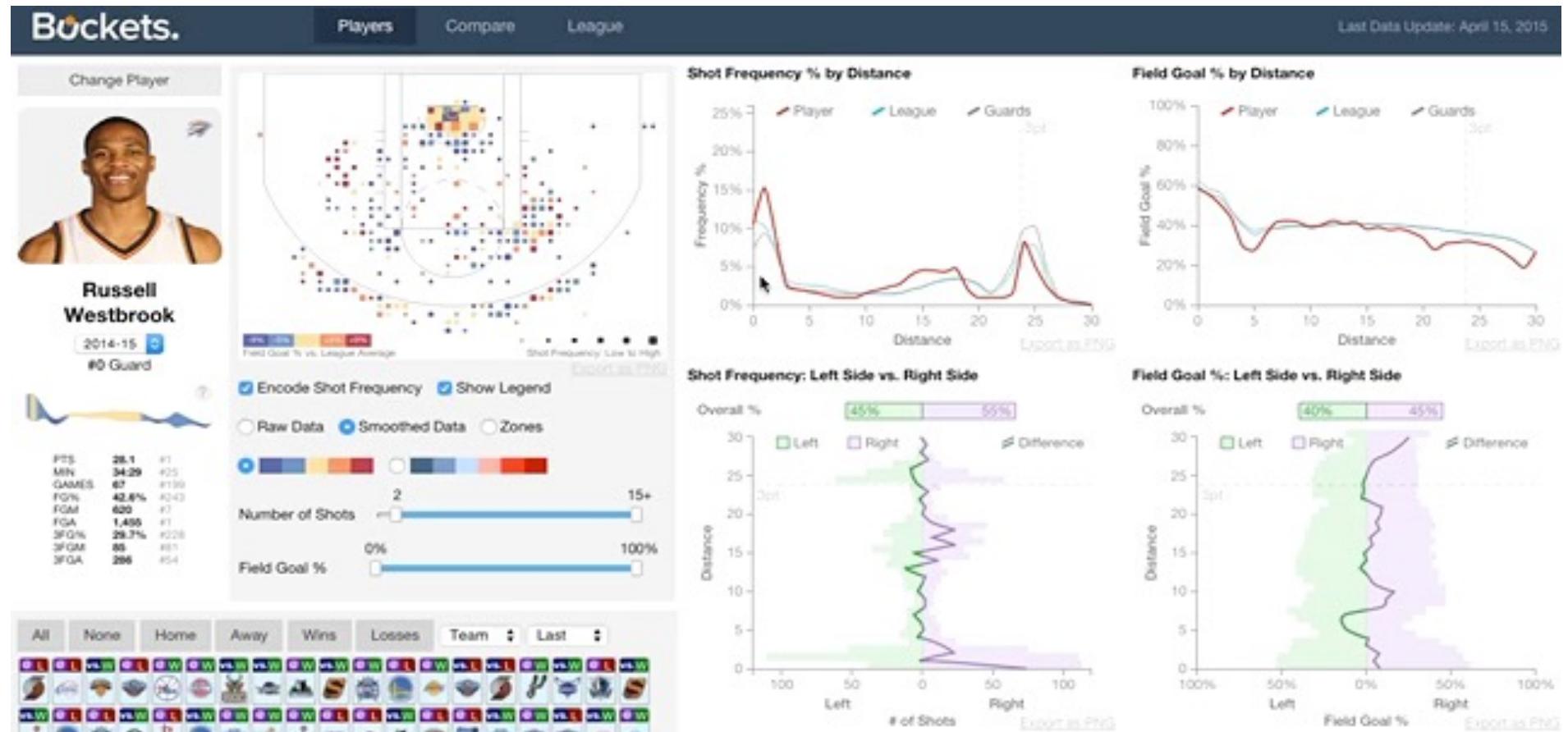
- Idiom: small multiples
 - encoding: same
 - ex: line charts
 - data: none shared
 - different slices of dataset
 - items or attributes
 - ex: stock prices for different companies
 - interactions



Multiple Views (Juxtapose)

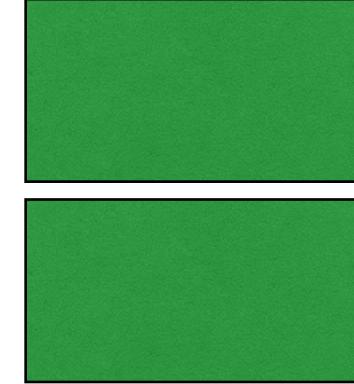
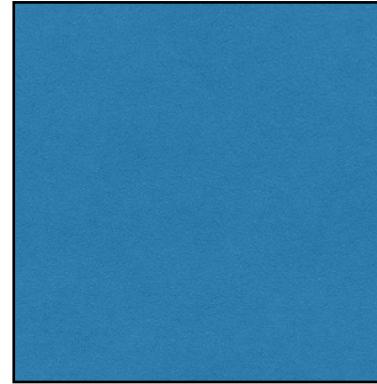
- Idiom: small multiples

- examples



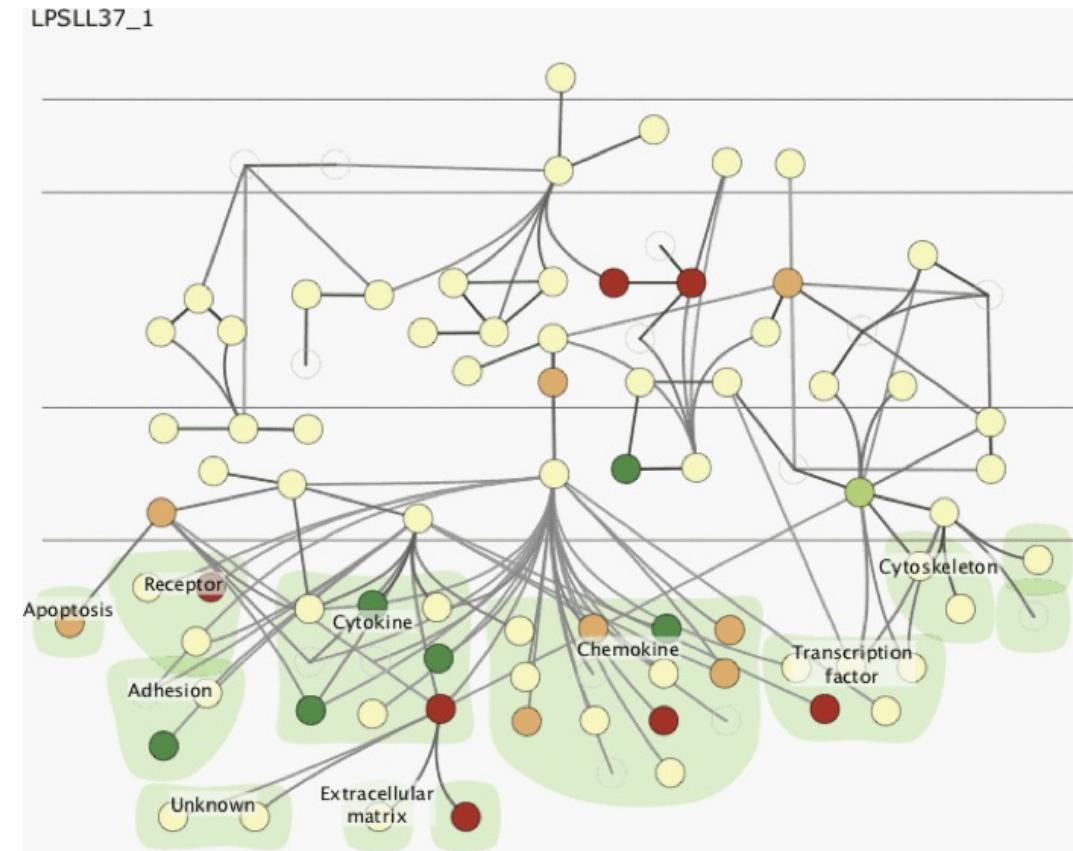
Multiple Views (Juxtapose)

- tradeoffs
 - juxtapose costs
 - display area
 - 2 views side by side: each has only half the area of one view
 - juxtapose benefits
 - cognitive load: eyes vs memory
 - lower cognitive load: move eyes between 2 views
 - higher cognitive load: compare single changing view to memory of previous state



Multiple Views (Juxtapose)

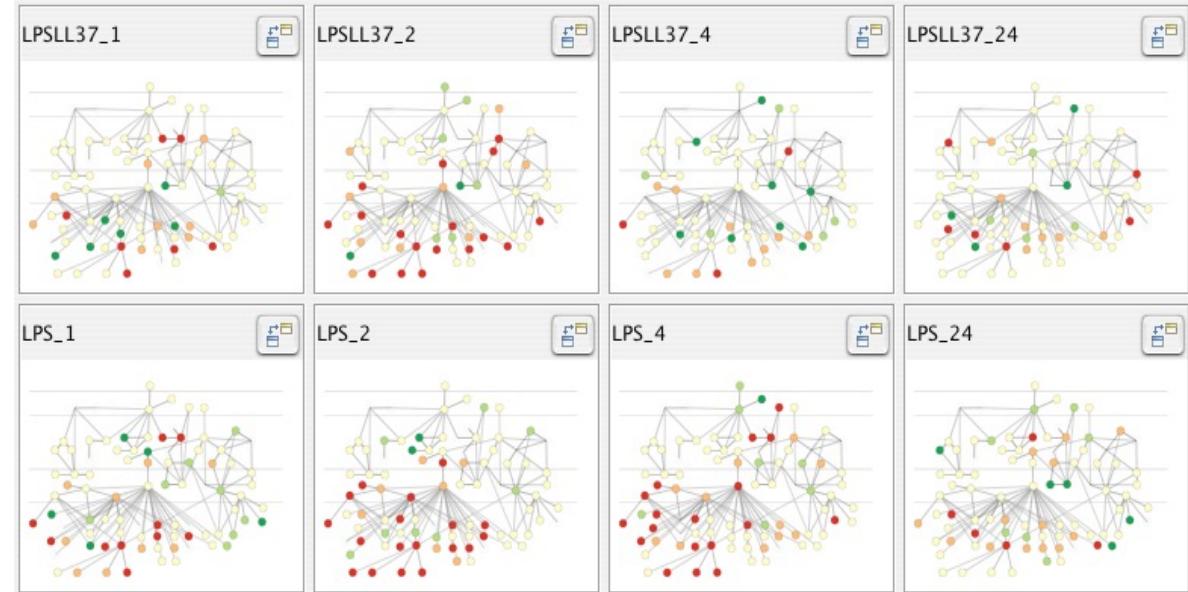
- Juxtapose vs animate
 - animate: hard to follow if many scattered changes or many frames
 - vs easy special case: animated transitions



*[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.]*

Multiple Views (Juxtapose)

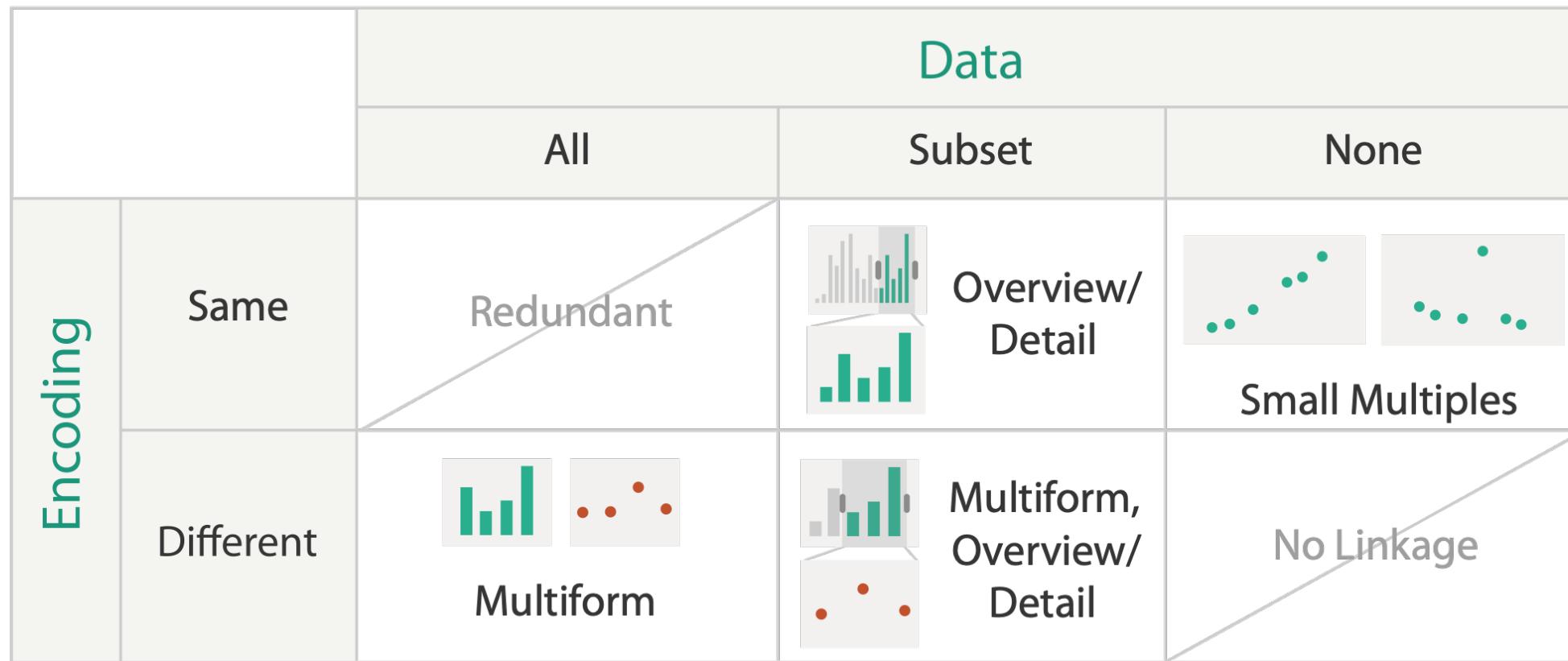
- Juxtapose vs animate
 - animate: hard to follow if many scattered changes or many frames
 - vs easy special case: animated transitions
 - juxtapose: easier to compare across small multiples
 - different conditions (color), same gene (layout)



*[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.]*

Multiple Views (Juxtapose)

- View coordinate: Design choices

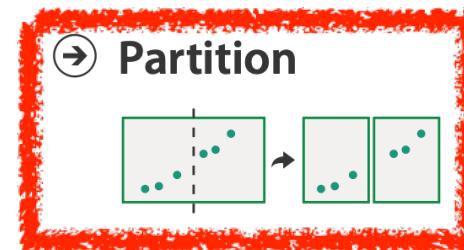


Multiple Views

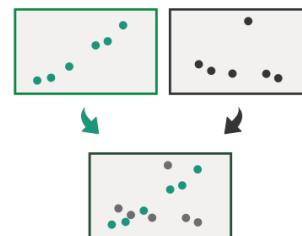
→ Juxtapose



→ Partition



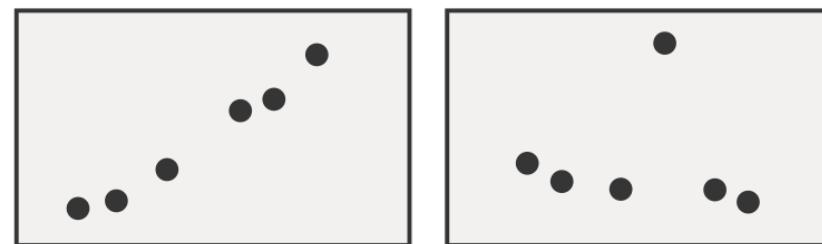
→ Superimpose



Multiple Views (Partition)

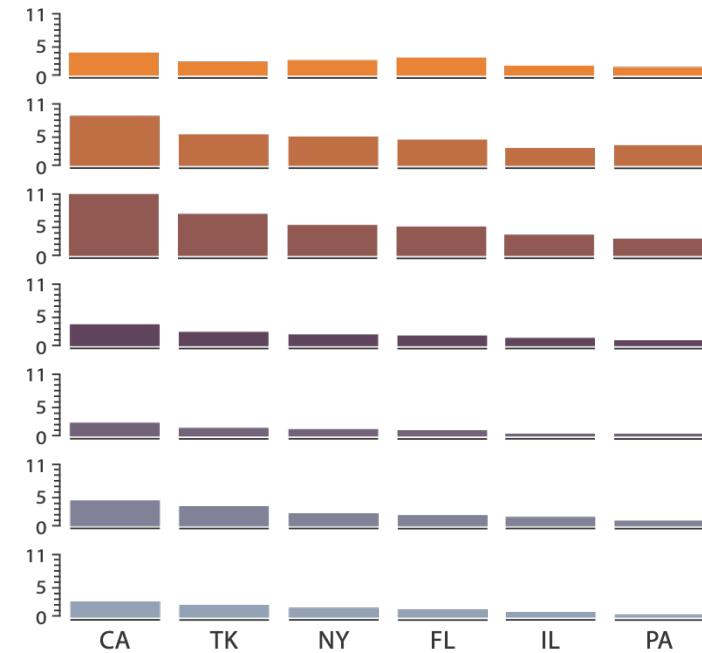
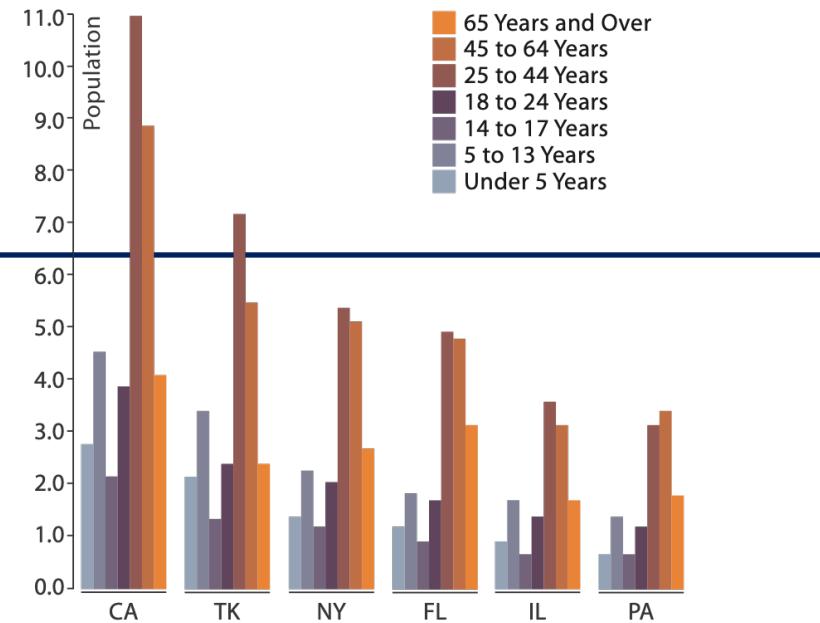
- Partition into views
 - how to divide data between views
 - split into regions by attributes
 - encodes association between items using spatial proximity
 - order of splits has major implications for what patterns are visible

➔ Partition into Side-by-Side Views



Multiple Views (Partition)

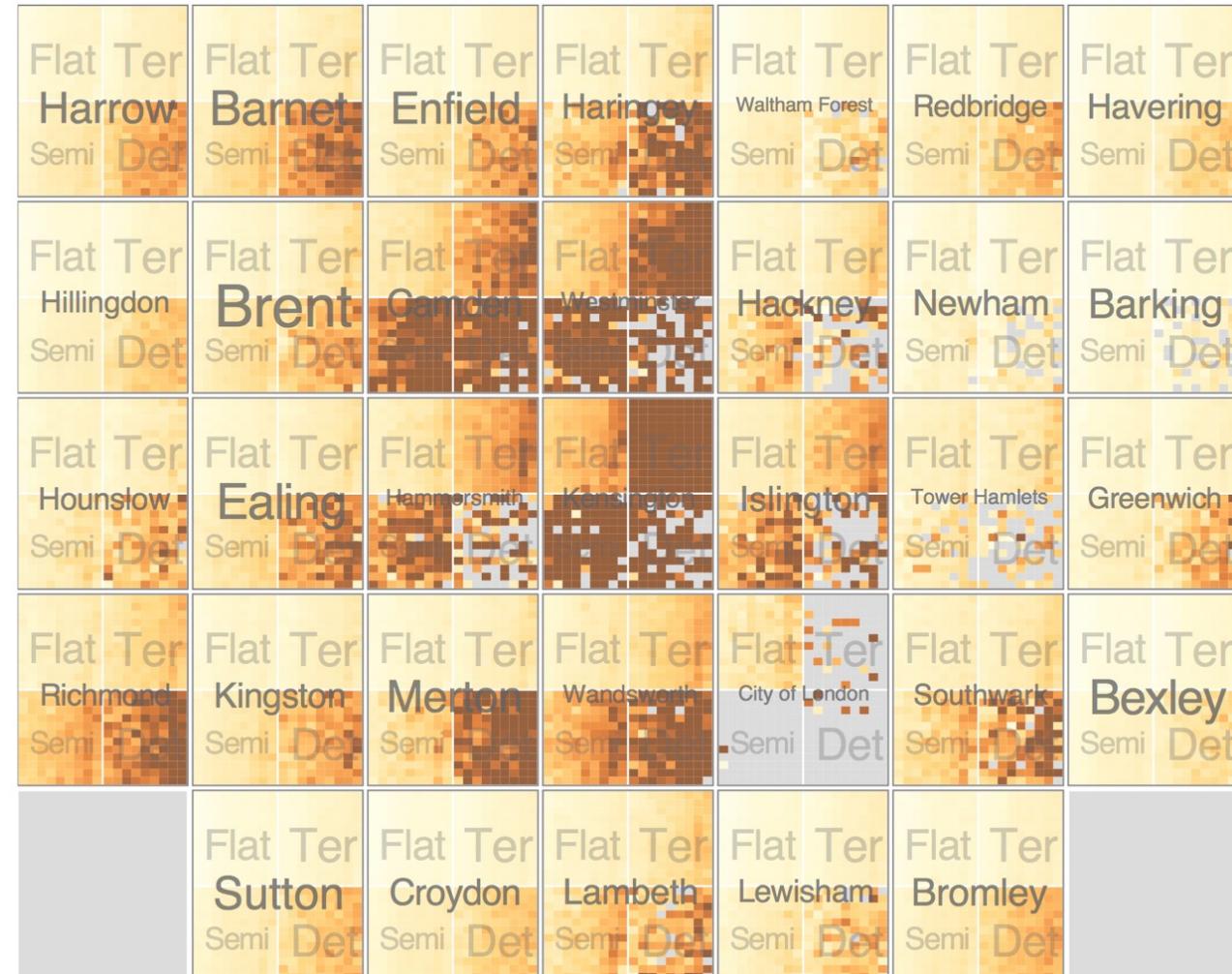
- single bar chart with grouped bars
 - split by state into regions
 - complex glyph within each region showing all ages
 - compare: easy within state, hard across ages
- small-multiple bar charts
 - split by age into regions
 - one chart per region
 - compare: easy within age, harder across states



Multiple Views (Partition)

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.]

- Recursive subdivision
 - split by neighbourhood
 - then by type
 - flat, terrace, semi-detached, detached
 - then time
 - years as rows
 - months as columns
 - colour by price
 - neighbourhood patterns
 - where it's expensive
 - where you pay much more for detached type



Multiple Views (Partition)

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.]

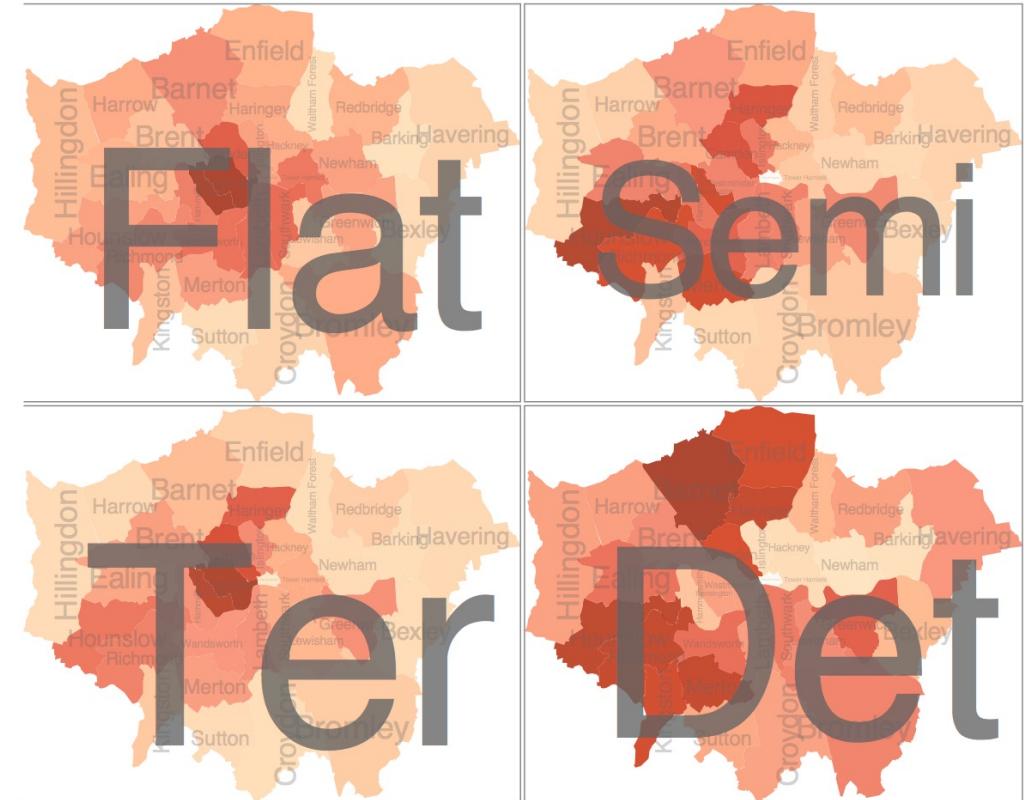
- Recursive subdivision
 - switch order of splits
 - type then neighbourhood
 - switch colour
 - by price variation
 - type patterns
 - within specific type, which neighbourhoods inconsistent



Multiple Views (Partition)

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.]

- Recursive subdivision
 - different encoding for second-level regions
 - choropleth maps

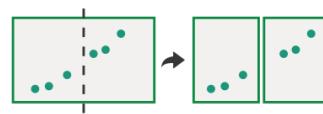


Multiple Views

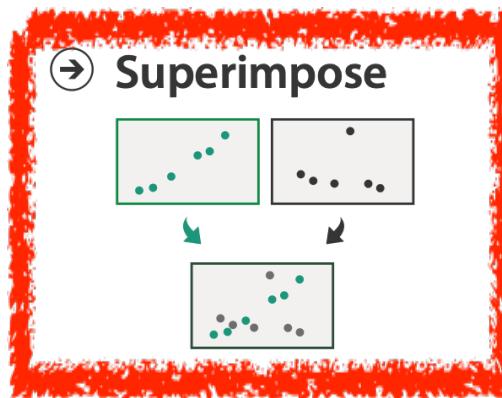
→ Juxtapose



→ Partition



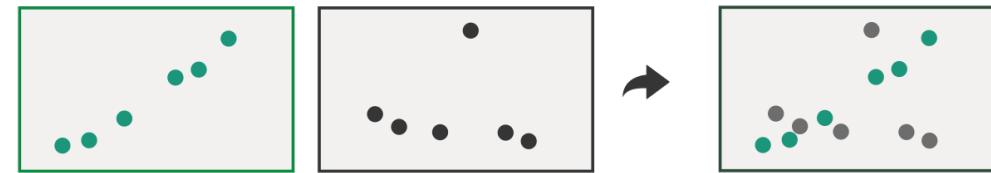
→ Superimpose



Multiple Views (Superimpose)

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

→ Superimpose Layers



Multiple Views (Superimpose)

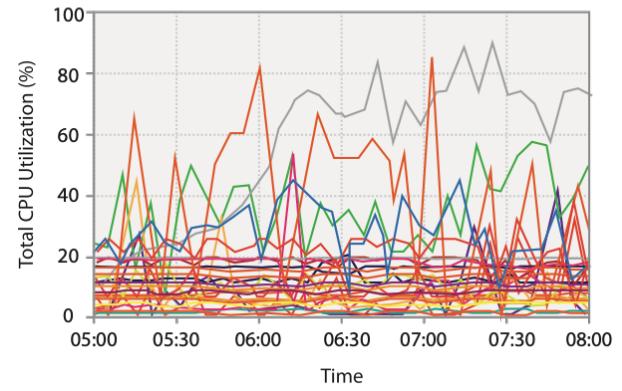
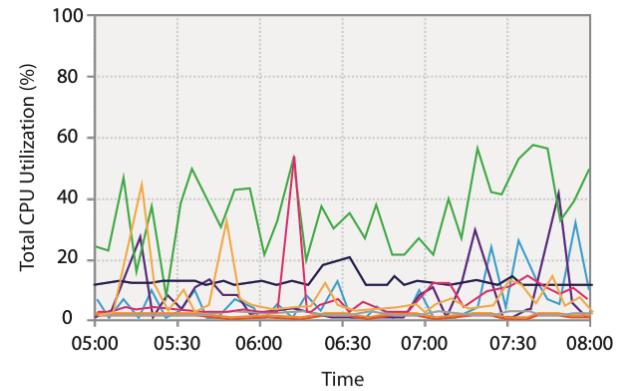
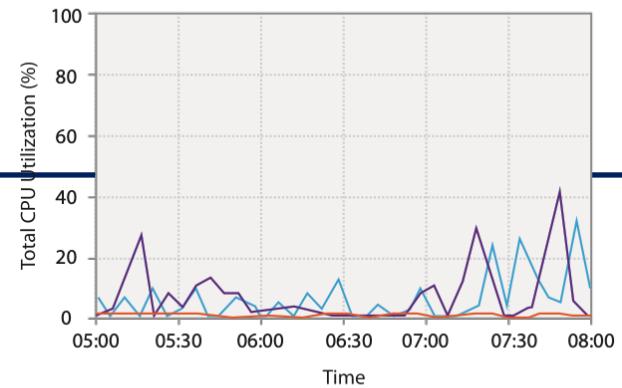
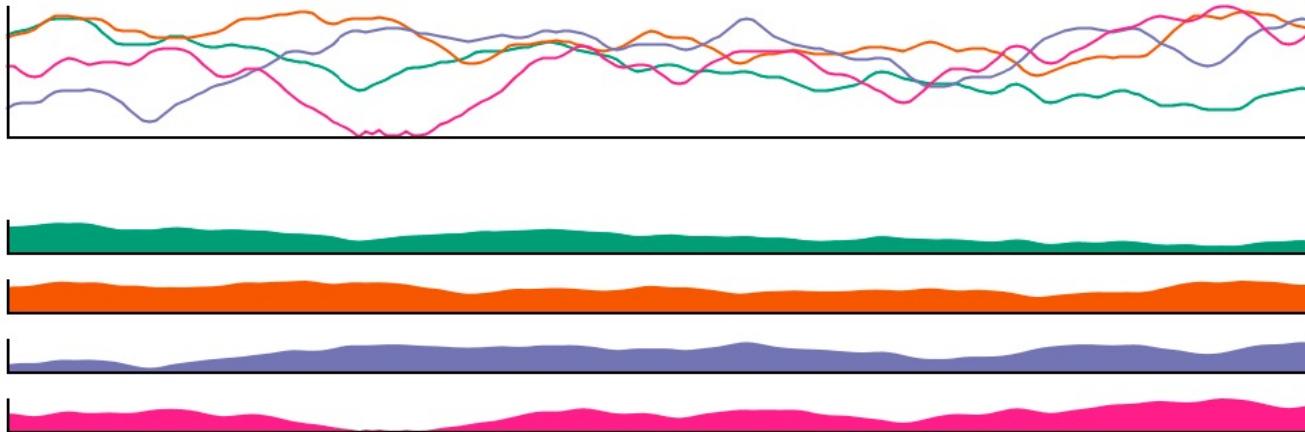
- Static visual Layering
 - foreground layer: roads
 - hue, size distinguishing main from minor
 - high luminance contrast from background
 - background layer: regions
 - desaturated colours for water, parks, land areas
 - user can selectively focus attention



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

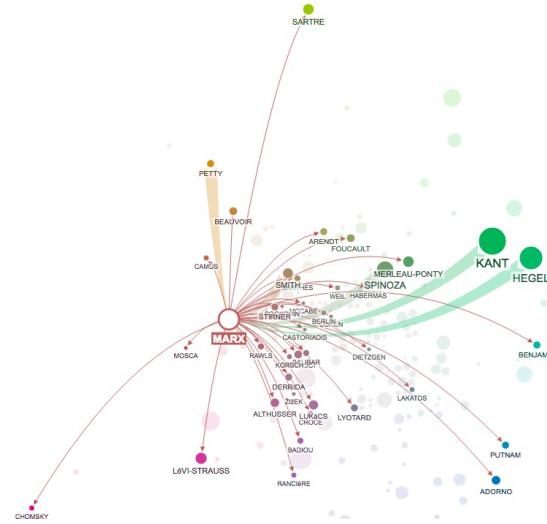
Multiple Views (Superimpose)

- Superimposing limits(static)
 - few layers, more lines
 - up to a few dozen lines
 - but not hundreds
 - superimpose vs juxtapose: empirical study
 - same size: all multiples, vs single superimposed
 - superimposed: local tasks
 - juxtaposed: global tasks, esp. for many charts

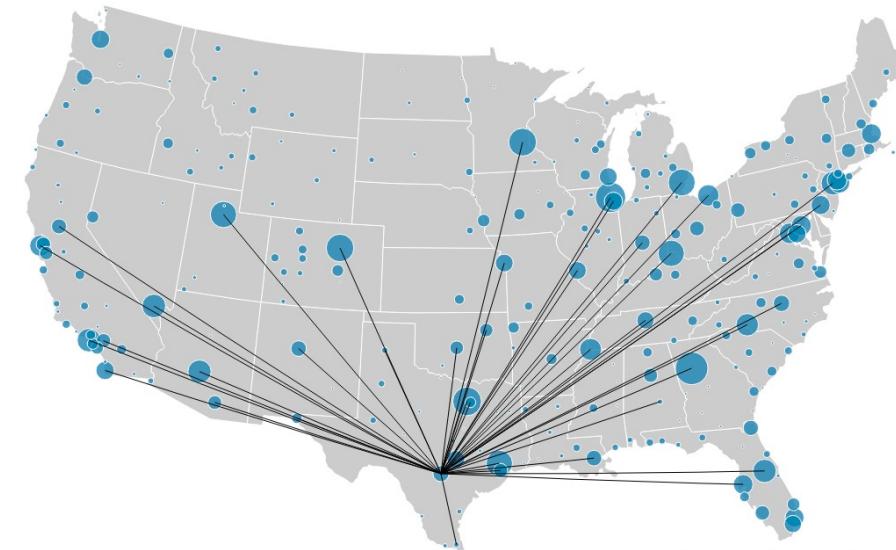


Multiple Views (Superimpose)

- interactive, based on selection
- one-hop neighbour highlighting



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



San Antonio International, 2008
great arcs and symbol map

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

Summary

- Manipulate views

- change over time
- select
- navigate

- Multiple Views

- juxtapose
- partition
- superimpose