

Interactive

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Slides taken, reformatted, and used from Tamara Munzner (UBC,
Canada)

How to handle complexity: 1 previous strategy

→ *Derive*



Derive new data to show within view

How to handle complexity: 1 previous strategy

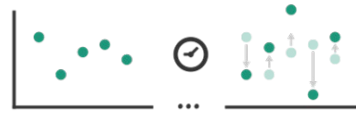
→ *Derive*



- Derive new data to show within view
- Change view over time
- Facet across multiple views

Manipulate

→ Change



→ Select



→ Navigate

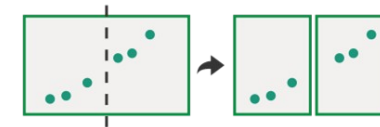


Facet

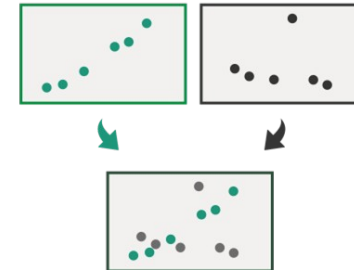
→ Juxtapose



→ Partition



→ Superimpose



Manipulate

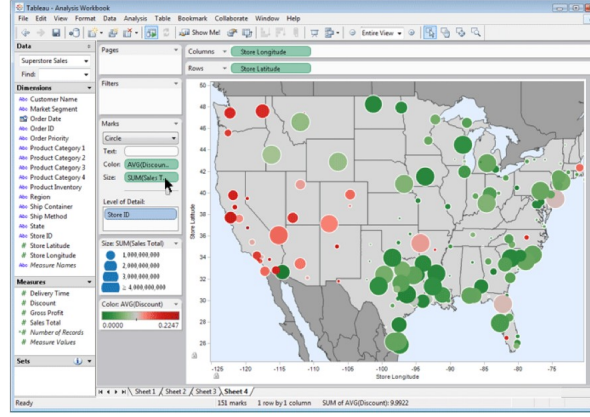
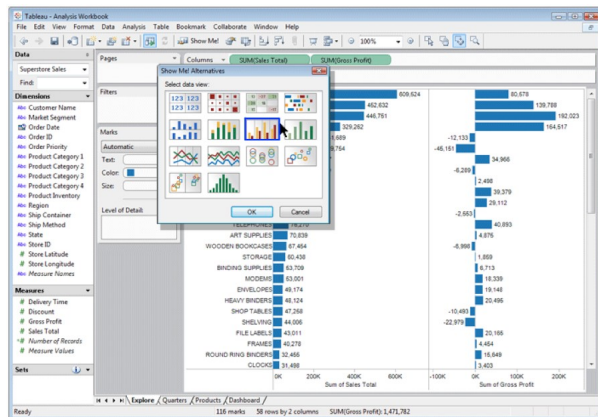
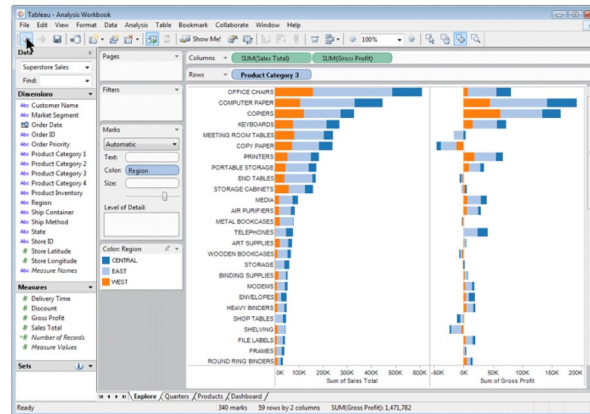
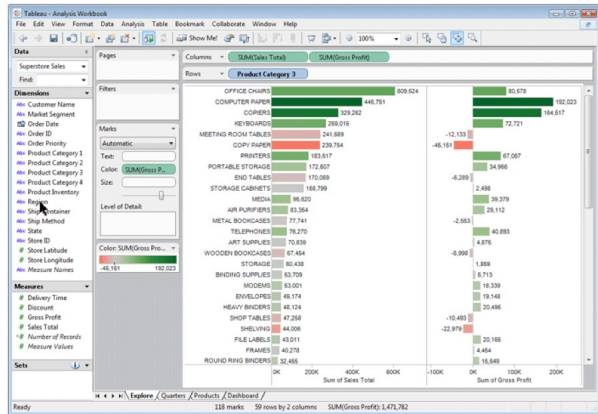
➔ Change over Time



Change any of the other choices

- encoding itself
- Parameters
- Arrange: rearrange, reorder
- Aggregation level, what is filtered
- Interaction entails change
- Powerful and flexible

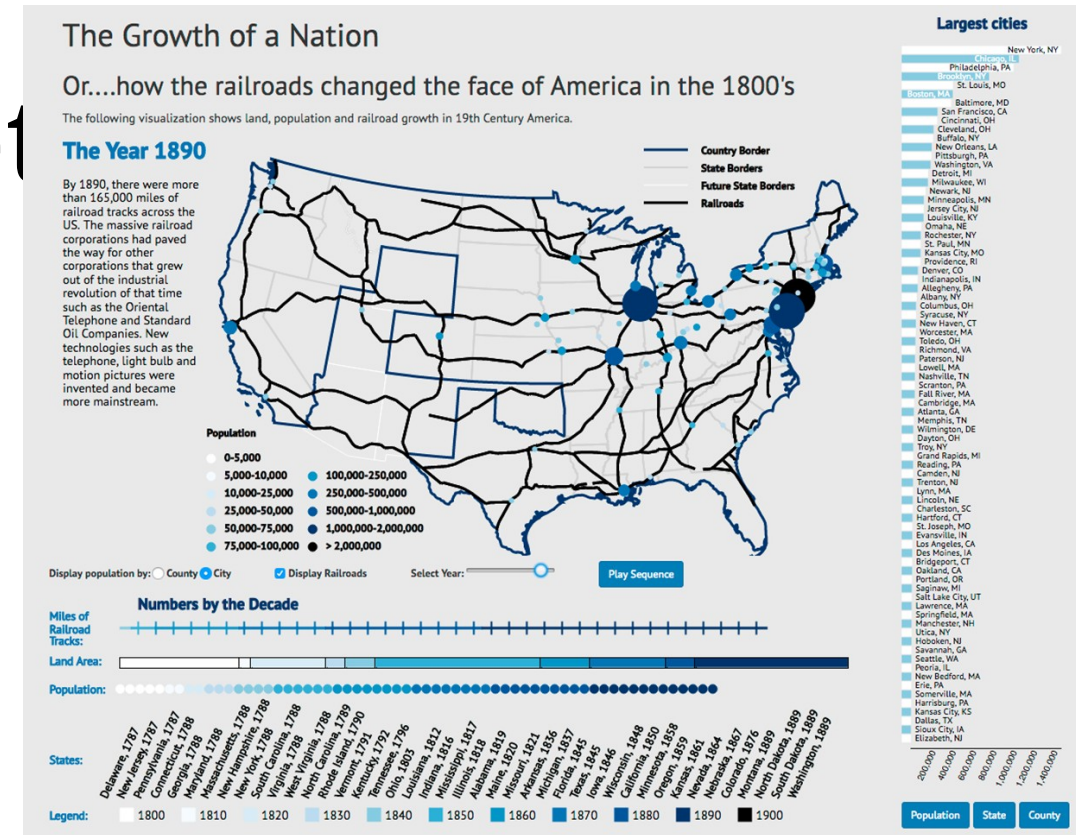
Idiom: Re-encode



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

Idiom: change parameter

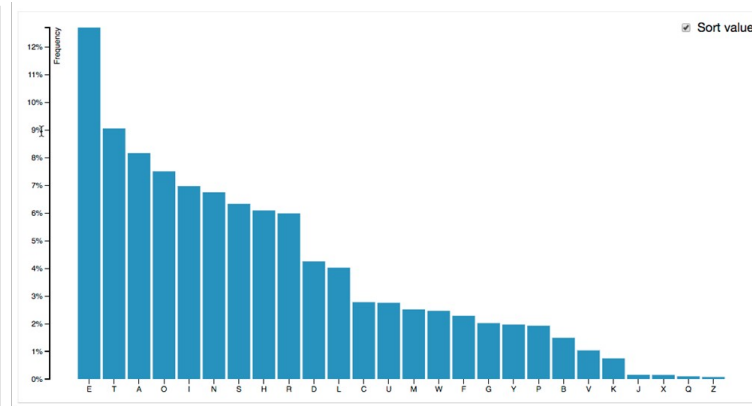
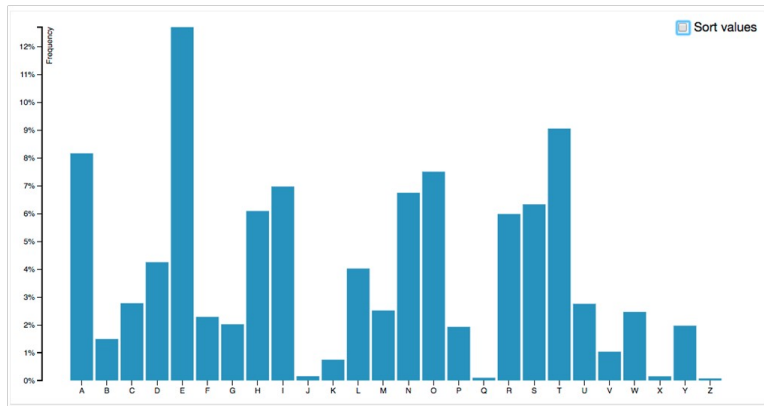
- Widgets and controls
 - Sliders, buttons, radio buttons, check boxes, drop downs/comboboxes
- Pros
 - Clear affordances
 - Self documenting (with labels)
- Cons
 - Uses screen space
- Design choices
 - Separated vs interleaved
 - Controls vs canvas



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

Idiom: change order/arrangement

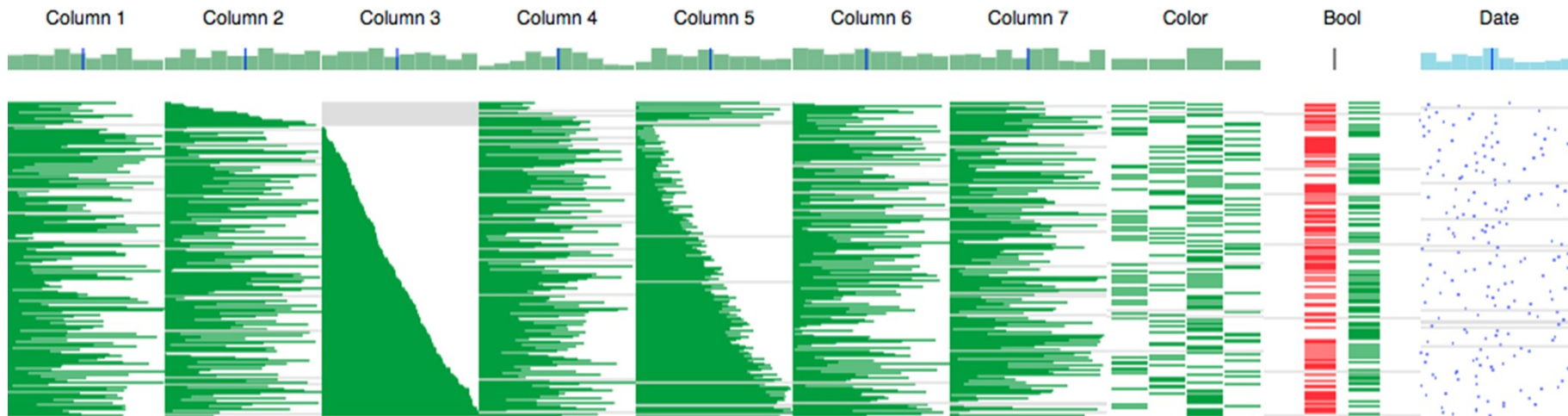
- What: simple table
- How: data-driven reordering
- Why: find extreme values, trends



made with D3

Idiom: reorder system DataStripes

- What: table with many attributes
- How: data-driven reordering by selecting column
- Why: find correlations between attributes



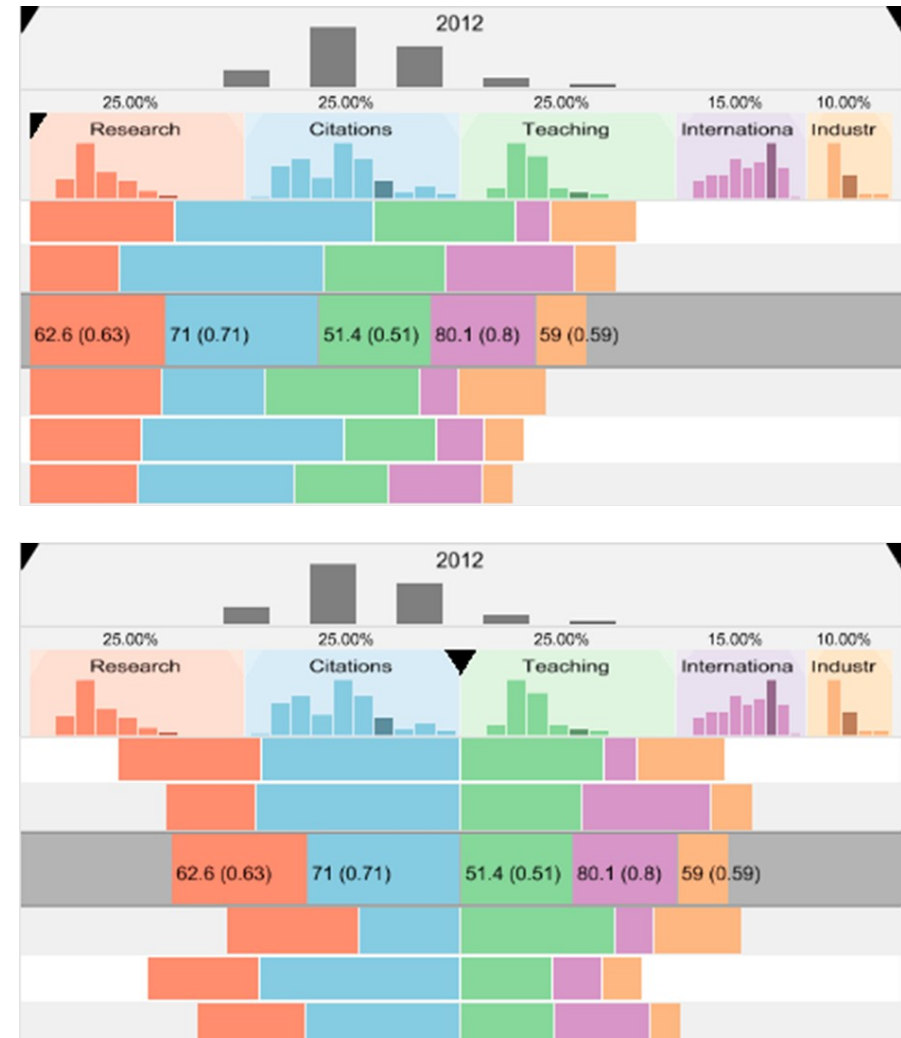
<http://carlmanaster.github.io/datastripes/>

made with D3

Idiom: change alignment

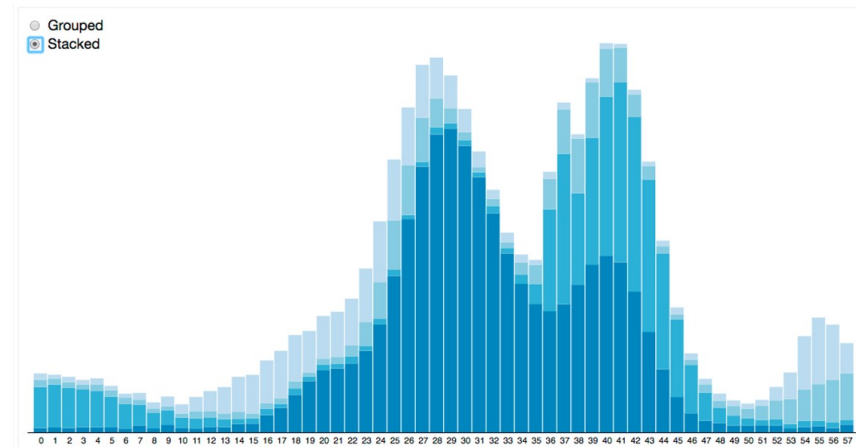
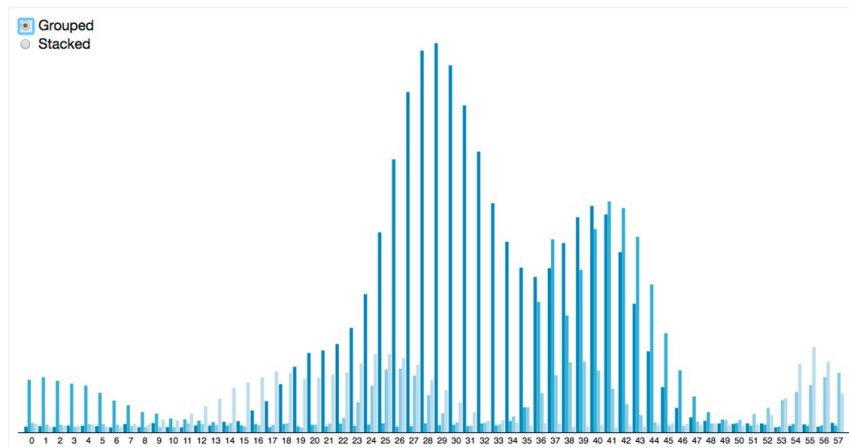
- Stacked bars
 - Easy to compare
 - First segment
 - Total bar
- Align to different segment
 - Supports flexible comparison

[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.]



Idiom: animated transitions – visual encoding change

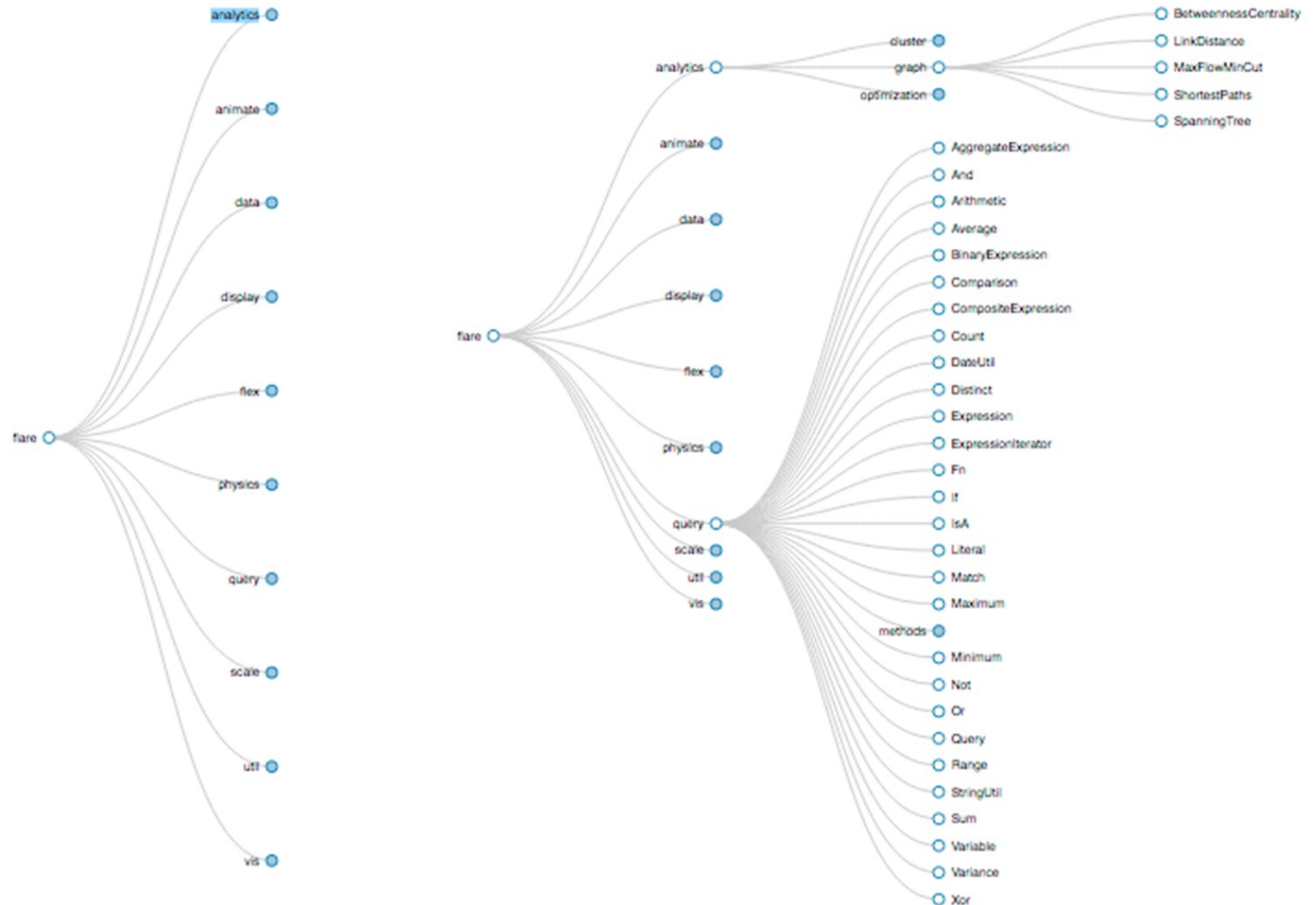
- Smooth transition from one state to another
 - Alternative to jump cuts, supports item tracking
 - Best case for animation
 - Staging to reduce cognitive load



[\[Stacked to Grouped Bars\] https://observablehq.com/@d3/stacked-to-grouped-bars](https://observablehq.com/@d3/stacked-to-grouped-bars)

Idiom: animated transition – tree detail

- Animated transition
 - Network drilldown/rollup



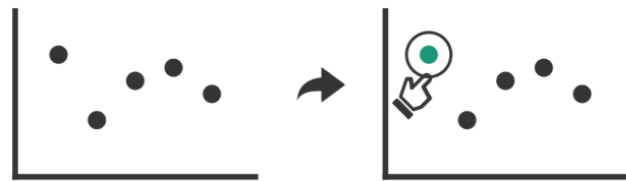
[Collapsible Tree] <https://observablehq.com/@d3/collapsible-tree>

Manipulate

➔ Change over Time

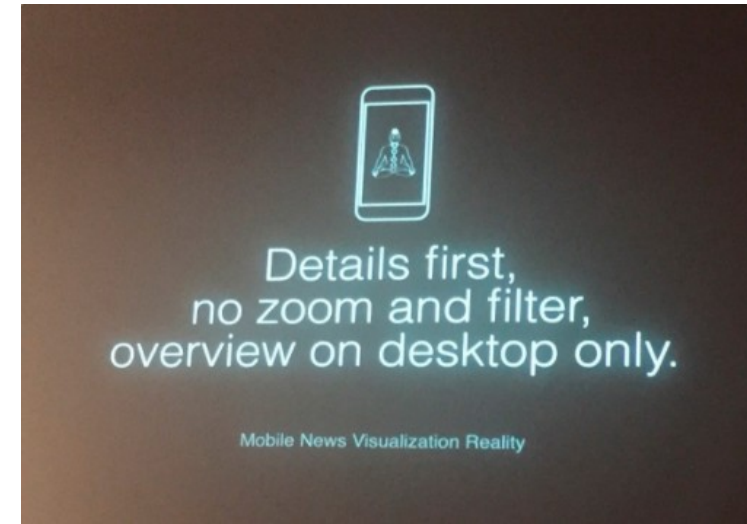


➔ Select



Interaction technology

- What do you design for?
 - Mouse and 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)

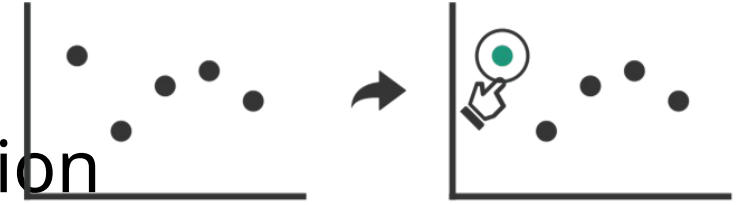
vimeo.com/182590214



I Hate Tom Cruise - Alex Kauffmann (5 min)

Selection

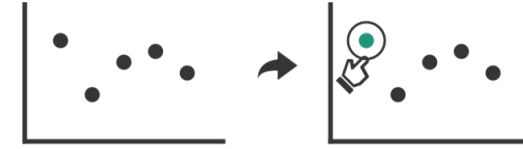
➞ Select



- Selection: basic operation for most interaction
- Design choices
 - How many selection types?
 - Interaction modalities
 - Click/tap (heavy weight) v hover (light weight) available in many screens
 - 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
 - Eg toggle to do nothing selected or click on background
 - Primary vs secondary (ex: source/target nodes in network)
 - Group membership (add/delete items, name group, ...)

Highlighting

➞ Select



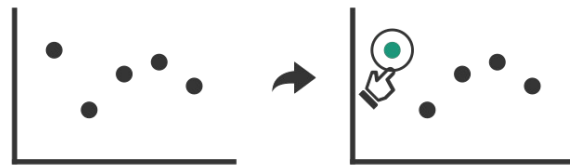
- Highlight: change visual encoding for selection targets
 - Visual feedback closely tied to but separable from selection (interaction)
- Design choices: typical visual channels
 - Change item color
 - But hides existing color coding
 - Add outline mark
 - Change size (increase outline mark)
 - Change shape (solid to dashed ...)
- Unusual channels: motion
 - Motion: usually avoid for single view
 - With multiple views, could justify to draw attention to other views

Manipulate

➔ Change over Time



➔ Select

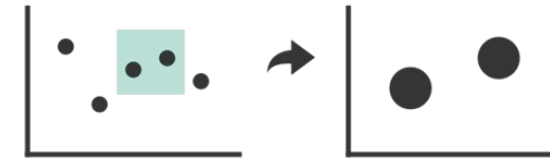


➔ Navigate

➔ Item Reduction

➔ Zoom

Geometric or Semantic



➔ Pan/Translate



➔ Constrained



Navigate: changing viewpoint/visibility

- Change view point
 - Changes: which items are visible within view
- Camera metaphor
 - Pan/translate/scroll
 - Move up/down/sideways

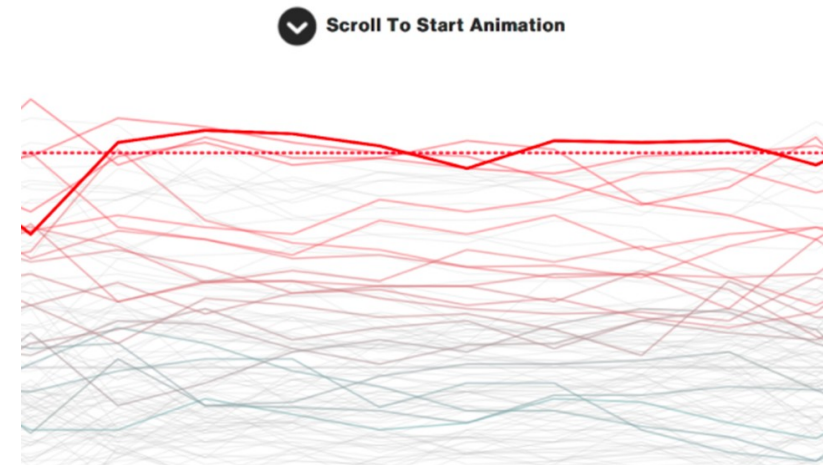
➞ Navigate

➞ *Pan/Translate*



Idiom: scrollytelling

- How: navigate page by scrolling (panning down)
- Pros:
 - Familiar and intuitive, from standard web browsing
 - Linear (only up and 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



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

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

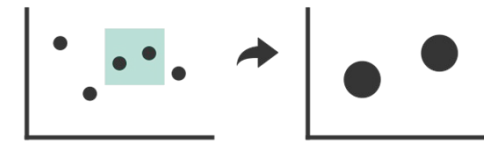
- Unconstrained navigation
 - Easy to implement for designer
 - Hard to control for user
 - Easy to overshoot/undershoot
- Constrained navigation
 - Typically uses animated transitions
 - Trajectory automatically computed based on selection
 - Just click; selection ends up framed nicely in final view

➞ Navigate

➞ Item Reduction

➞ Zoom

Geometric or *Semantic*



➞ Pan/Translate

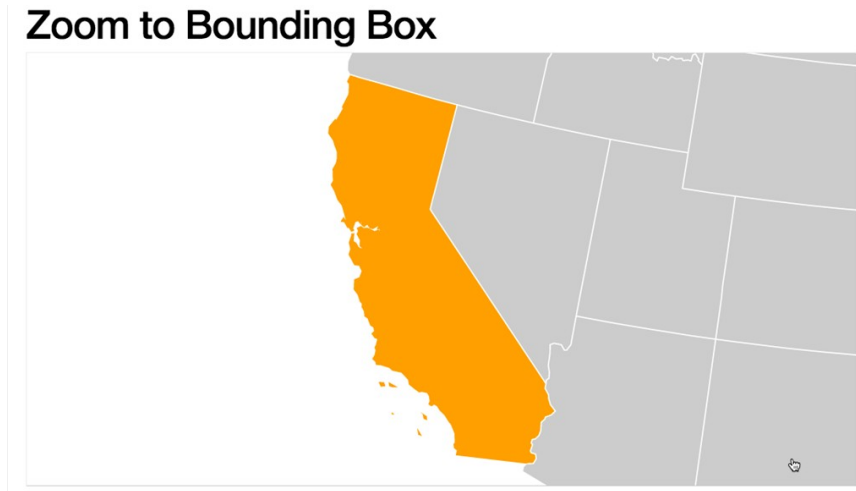


➞ Constrained



Idiom: animated transition +constrained navigation

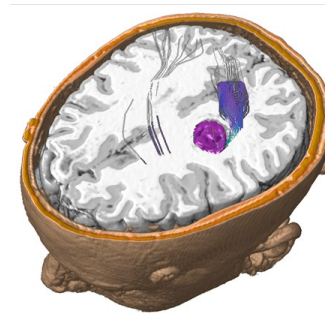
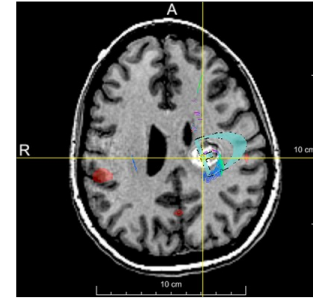
- Example: geographic map
 - Simple zoom, only viewport changes, shapes preserved



[Zoom to Bounding Box] <https://observablehq.com/@d3/zoom-to-bounding-box>

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
 - Perspective
 - Many others...



→ Attribute Reduction

→ Slice



→ Cut



→ Project



[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.]

Interaction benefits

- Major advantage of computer-based vs paper-based visualization
- Flexible, powerful, intuitive
 - Exploratory data analysis: change as you go during analysis process
 - Fluid tasks 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
- 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

How?

Encode

① Arrange

→ Express



→ Separate



→ Order



→ Align



→ Use



① Map

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

→ Color

→ Hue



→ Saturation



→ Luminance



→ Size, Angle, Curvature, ...



→ Shape



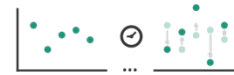
→ Motion

Direction, Rate, Frequency, ...



Manipulate

① Change



① Select



① Navigate



Facet

① Juxtapose



① Partition



① Superimpose



Reduce

① Filter



① Aggregate



① Embed



What?

Why?

How?