

# 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	Facet
→ <b>Change</b> 	→ <b>Juxtapose</b> 
→ <b>Select</b> 	→ <b>Partition</b> 
→ <b>Navigate</b> 	→ <b>Superimpose</b> 

# Manipulate

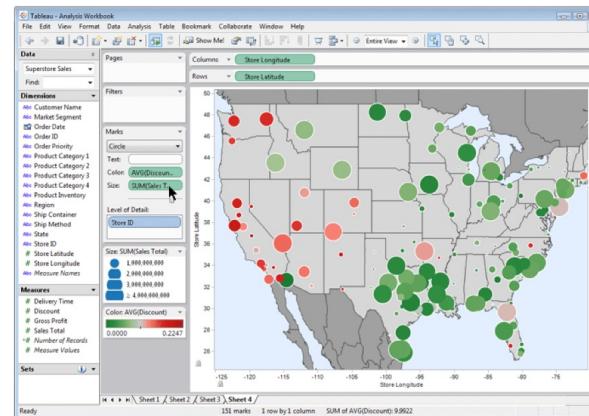
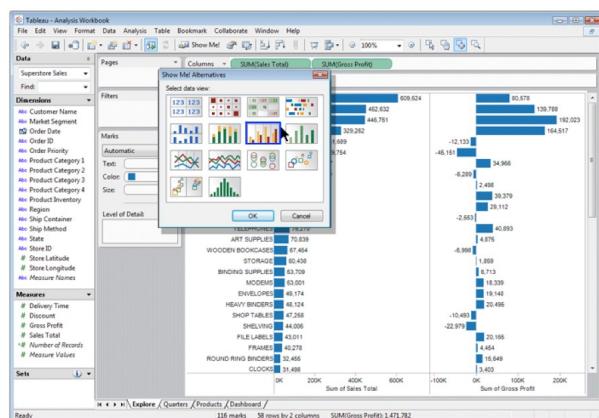
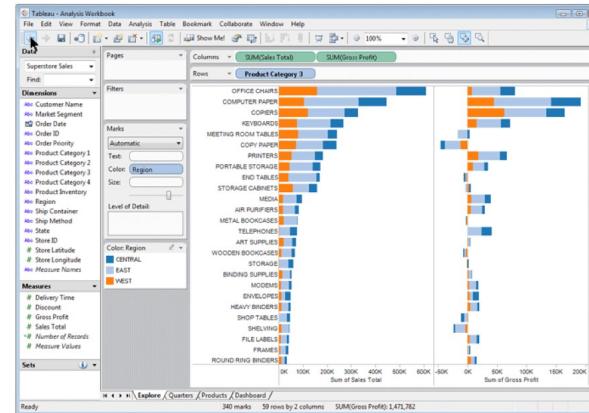
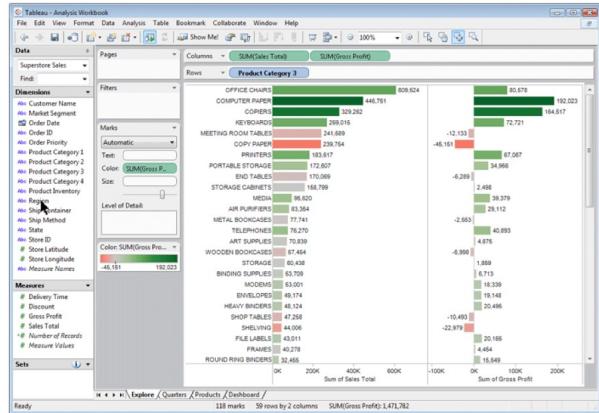
## → Change over Time



Change any of the other choices

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

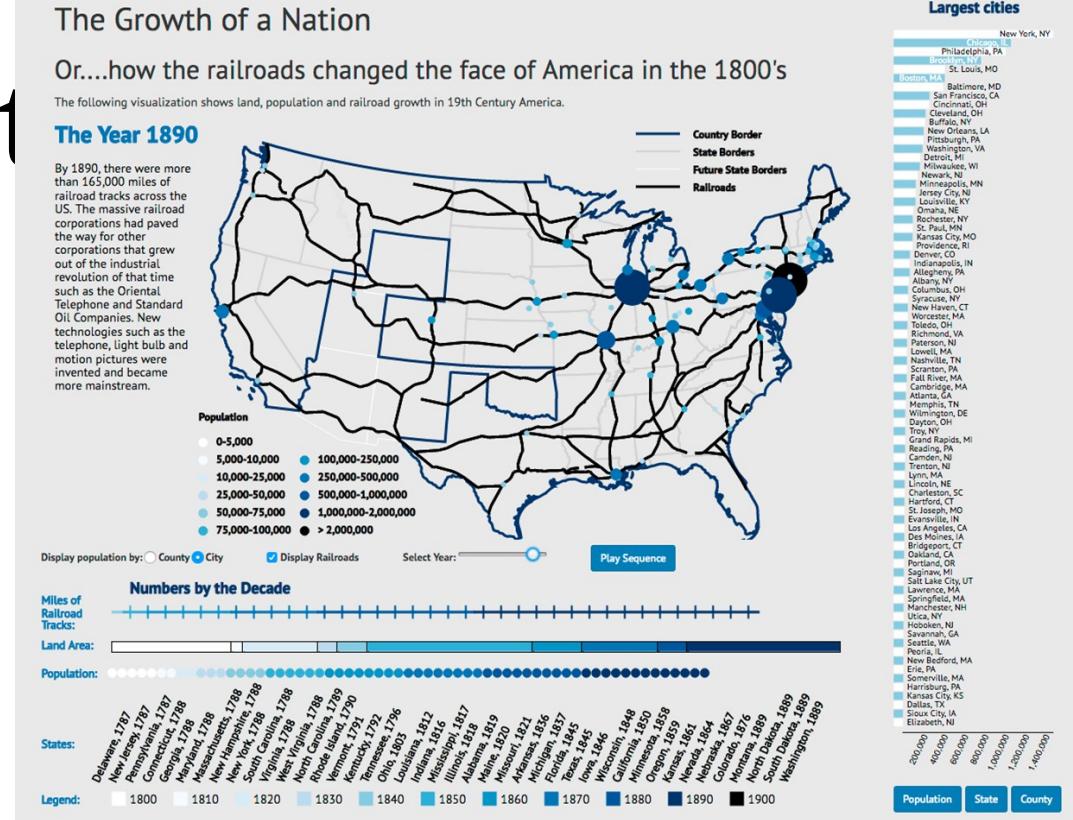
# Idiom: Re-encode



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

# Idiom: change parameter

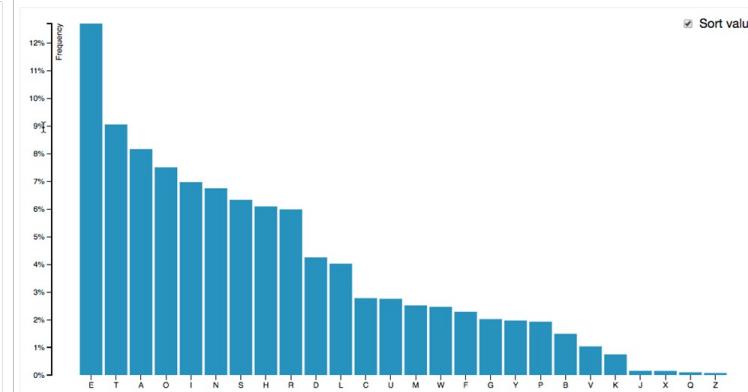
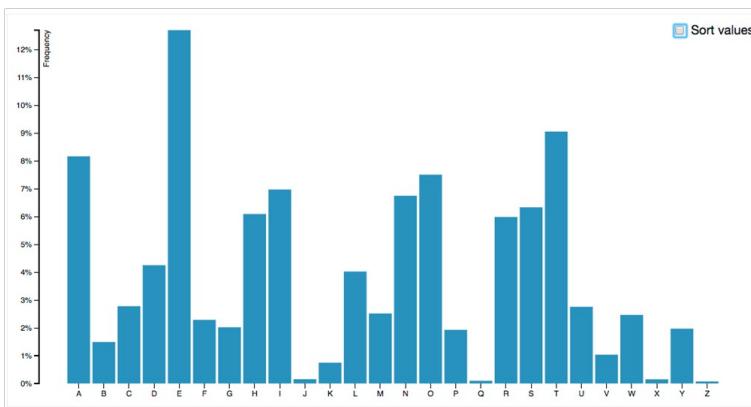
- Widgets and controls
  - Sliders, buttons, radio buttons, check boxes, drop downs/comboboxes
- Pros
  - Clear affordances
  - Self documenting (with labels)
- Cons
  - Uses screen space
- Design choices
  - Separated vs interleaved
    - Controls vs canvas



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

# Idiom: change order/arrangement

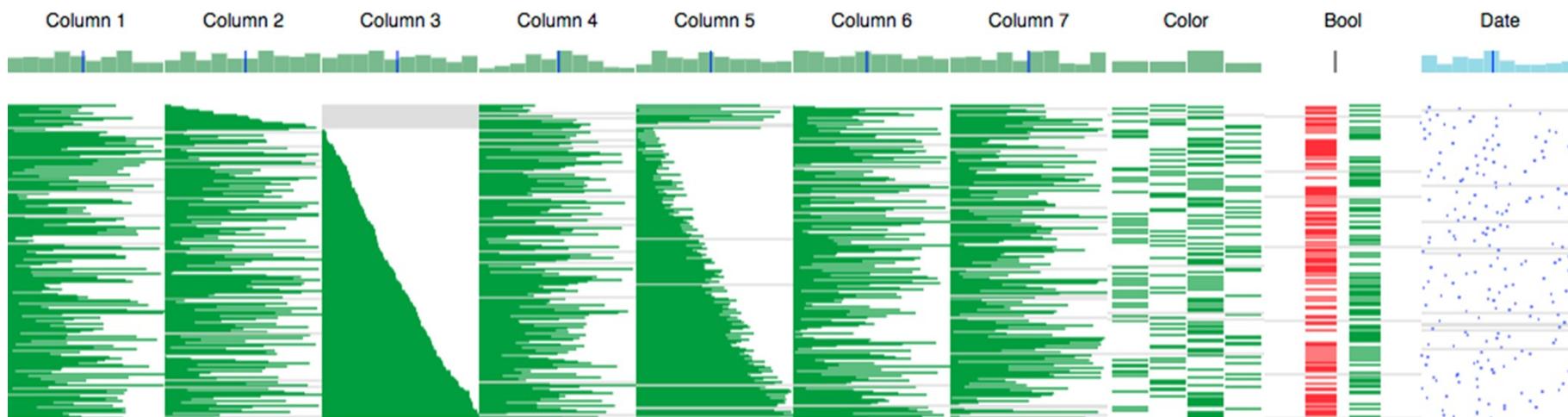
- What: simple table
- How: data-driven reordering
- Why: find extreme values, trends



*made with D3*

# Idiom: reorder system DataStripes

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



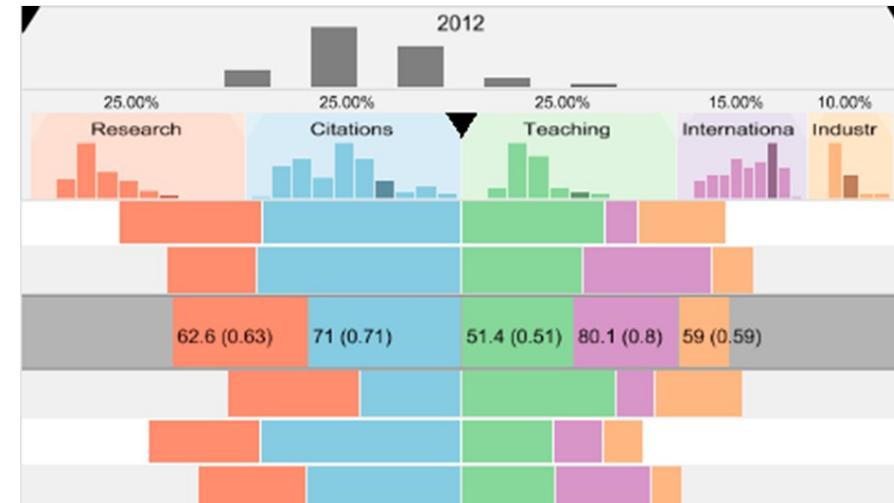
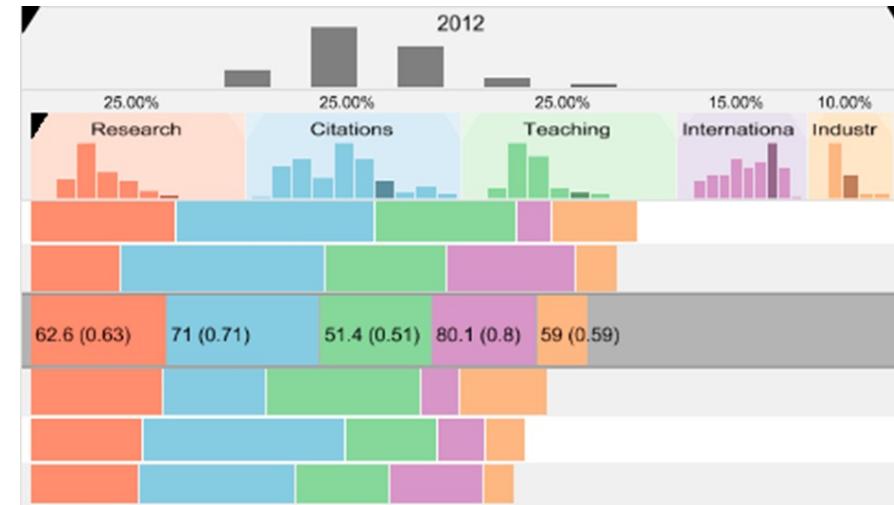
<http://carlmanaster.github.io/datastripes/>

*made with D3*

# Idiom: change alignment

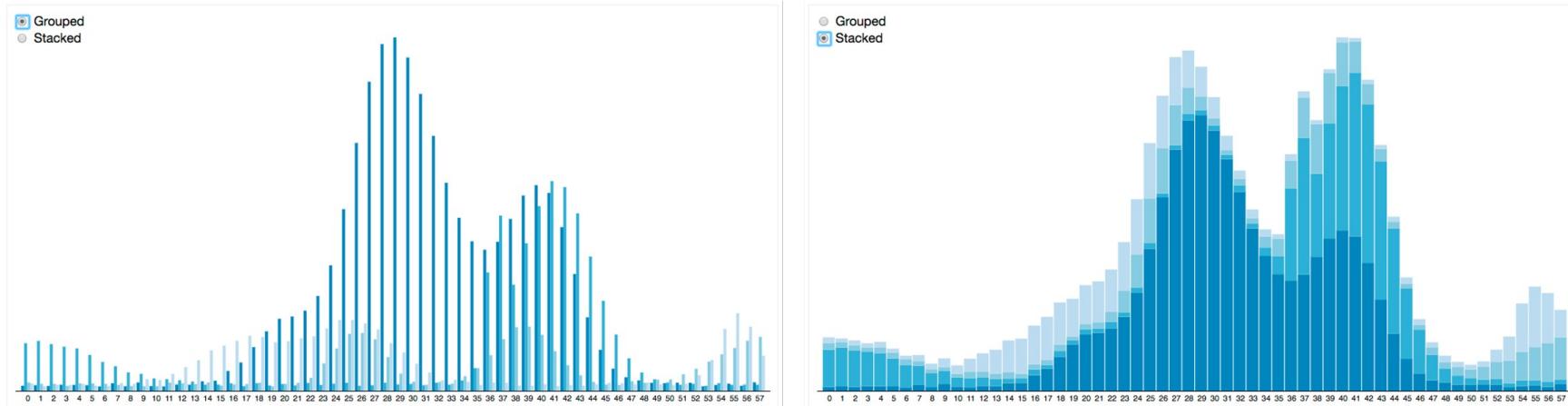
- Stacked bars
  - Easy to compare
    - First segment
    - Total bar
- Align to different segment
  - Supports flexible comparison

[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

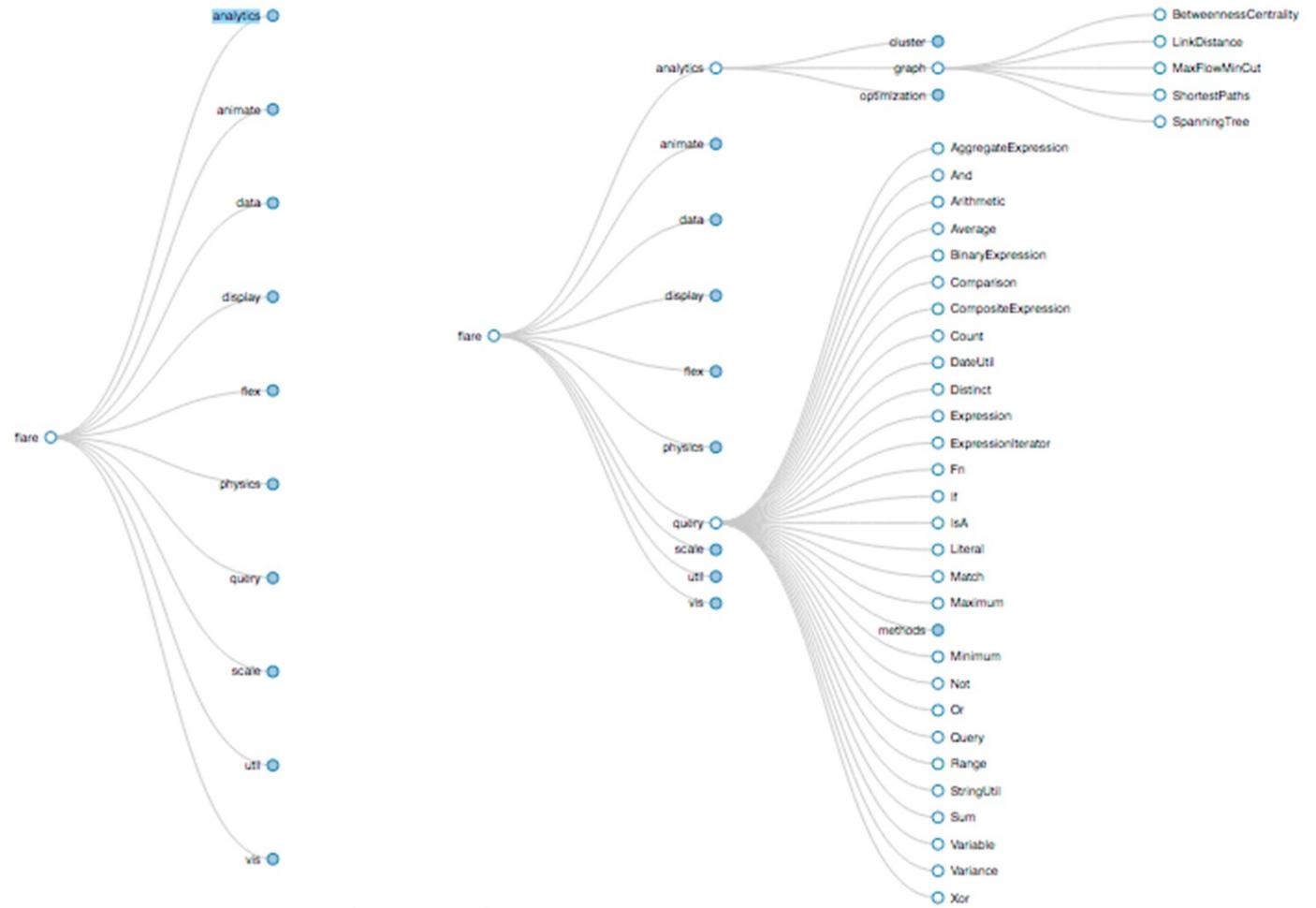
- Smooth transition from one state to another
  - Alternative to jump cuts, supports item tracking
    - Best case for animation
  - Staging to reduce cognitive load



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

# 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)

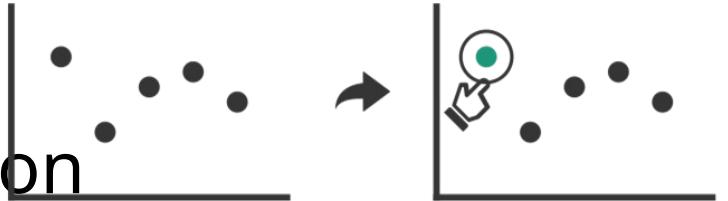
[vimeo.com/182590214](https://vimeo.com/182590214)



I Hate Tom Cruise - Alex Kauffmann (5 min)

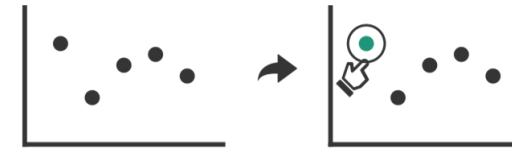
# Selection

→ 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, ...)

→ 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 (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



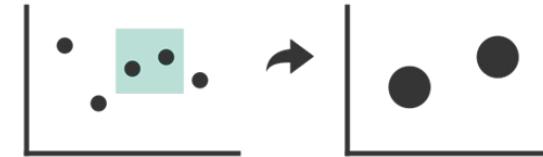
## 🔍 Select



## ➡ 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

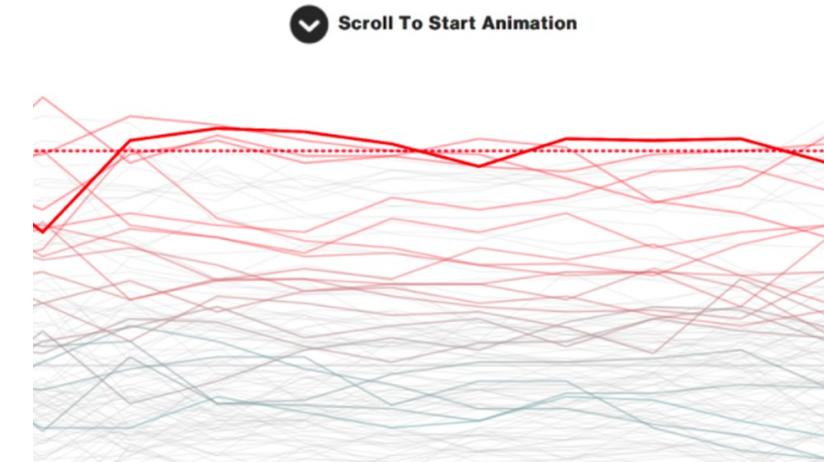
➔ Navigate

➔ 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/>)



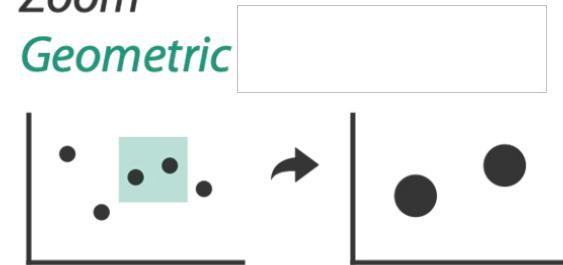
# Navigate: changing viewpoint/visibility

- 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

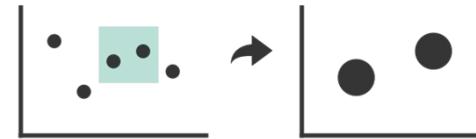
- Unconstrained navigation
  - Easy to implement for designer
  - Hard to control for user
    - Easy to overshoot/undershoot
- Constrained navigation
  - Typically uses animated transitions
  - Trajectory automatically computed based on selection
    - Just click; selection ends up framed nicely in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

➔ Navigate

→ Item Reduction

→ Zoom

*Geometric* or *Semantic*



→ Pan/Translate



→ Constrained



# Idiom: animated transition +constrained navigation

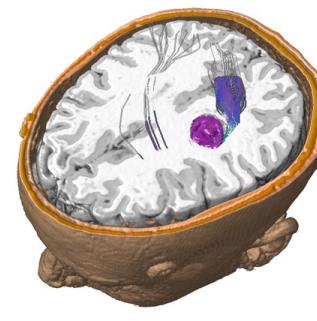
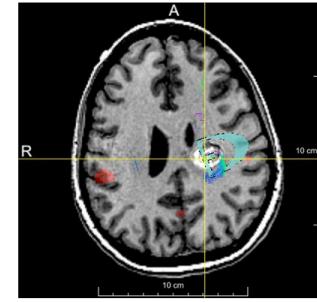
- Example: geographic map
  - Simple zoom, only viewport changes, shapes preserved



[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



# 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

- ④ Arrange
  - Express 
  - Separate 
- ④ Order 
  - Align 
- ④ Use 
  - Separate 

- ④ Map from **categorical** and **ordered** attributes
  - Color
    - Hue 
    - Saturation 
    - Luminance 
  - Size, Angle, Curvature, ...
    - ■ ■■ | / \_ | ) ) )
  - Shape
    - + ● ■ ▲
  - Motion *Direction, Rate, Frequency, ...*
    - ● ● ● ● ●

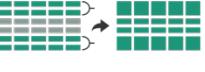
## Manipulate

- ④ Change 
  - ...
- ④ Select 
  - ...
- ④ Navigate 
  - ...

## Facet

- ④ Juxtapose 
  - ...
  - ...
- ④ Partition 
  - ...
  - ...
  - ...
- ④ Superimpose 
  - ...
  - ...

## Reduce

- ④ Filter 
  - ...
  - ...
- ④ Aggregate 
  - ...
  - ...
- ④ Embed 
  - ...
  - ...

What?

Why?

How?