# Handle Complexity: Manipulate (Interaction)

# How?

## Encode

- Arrange
  - Express
  - Separate
  - Order
  - Align
  - Use
- Map
  from categorical and ordered attributes
  - Color
    - *Hue*
    - *Saturation*
    - *Luminance*
  - Size, Angle, Curvature, ...
  - Shape
  - Motion
    *Direction, Rate, Frequency, ...*

## Manipulate

- Change
- Select
- Navigate

## Facet

- Juxtapose
- Partition
- Superimpose

## Reduce

- Filter
- Aggregate
- Embed

What?

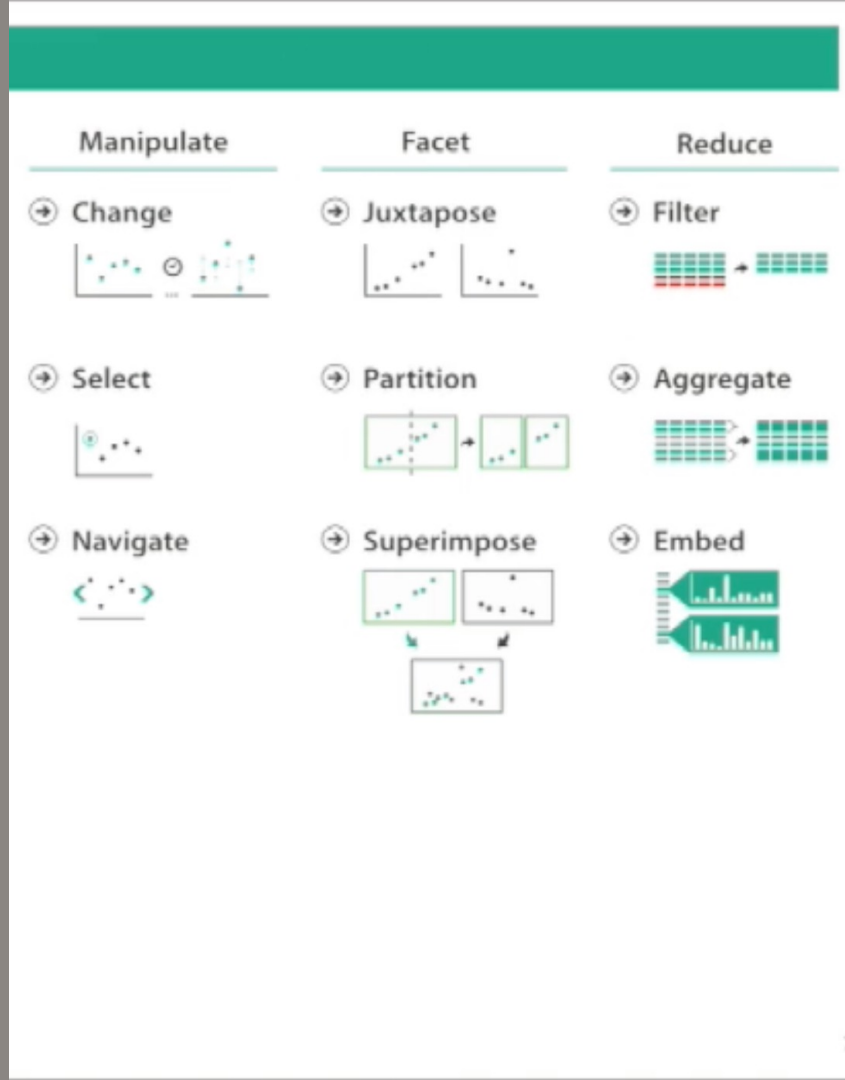
Why?

How?

# Handle Complexity

- If what we have before does not work
  - Using one static view to solve problems is the best
    - If it is possible
    - If it is not too complicated to understand
  - If the data or tasks are too complicated, do not insist on **one static view** to solve all problems

- **Change view (what you see) over time**
- Facet across multiple view (next topic)
- Reduce item/attribute within single view (next next topic)

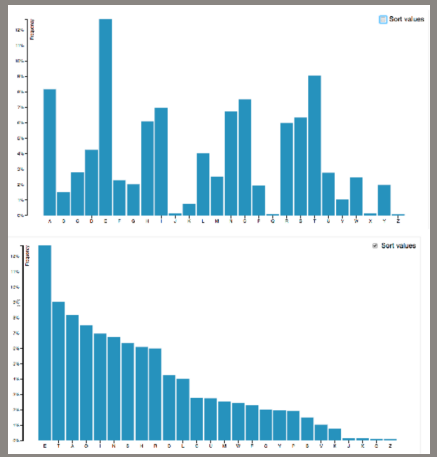


# Change over Time or by User's Need

- Change over time: animation
- Change by user's need: interaction

- What can we change?
  - Visual encoding
  - Parameters
  - Arrange: rearrange, reorder
  - Alignment
  - ……

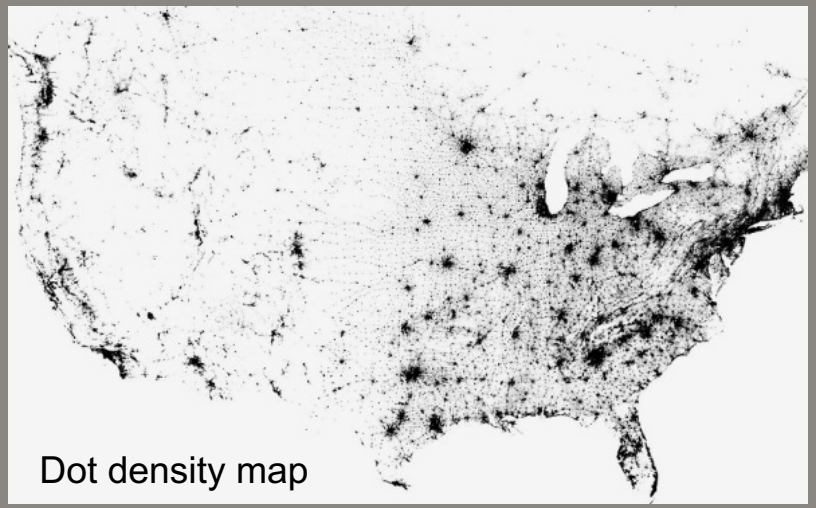
  - Interaction entails change
- Powerful and flexible

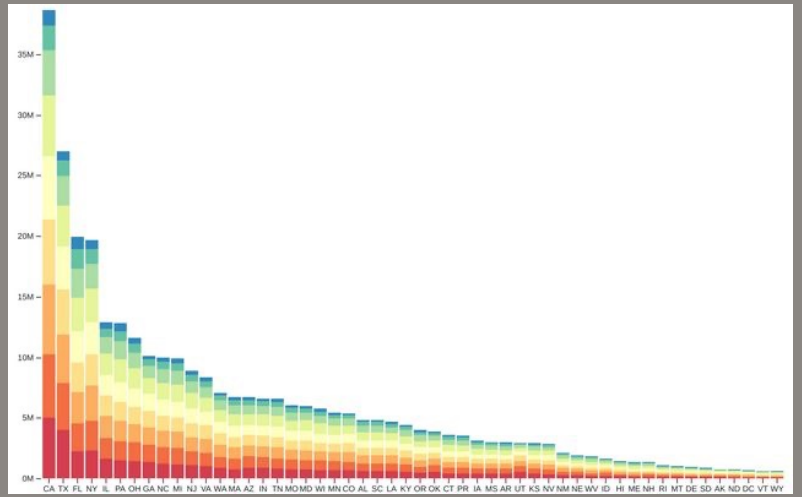



# S08-01

# Idiom: re-encode

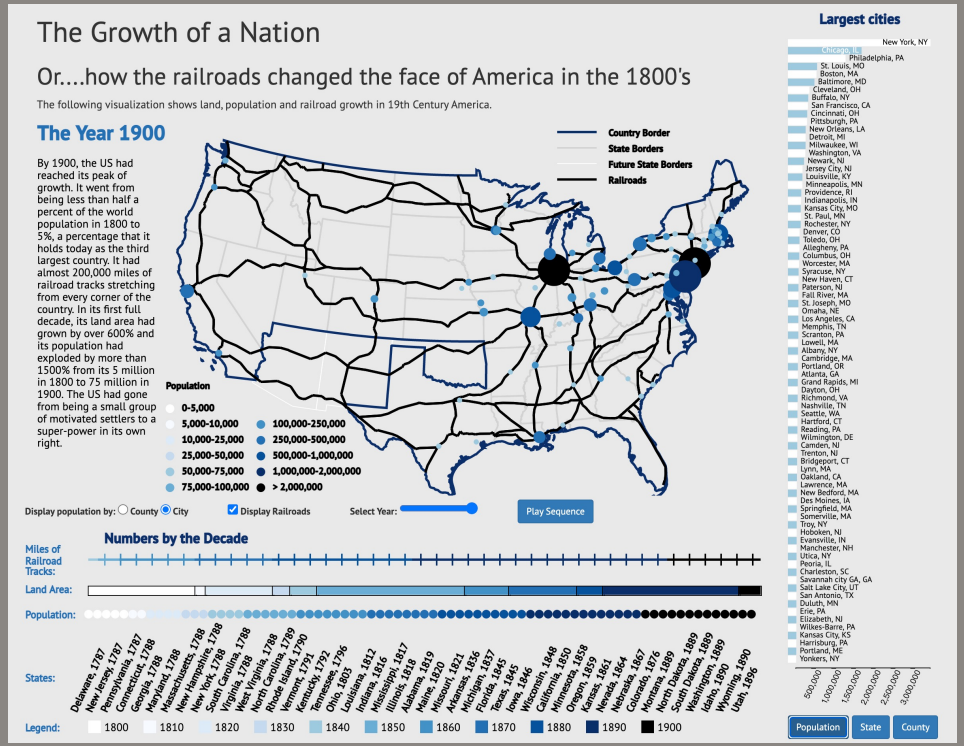
- Different idioms serve different tasks. Users may want to complete different tasks from your tool. You cannot show all idioms on the screen
- Re-encode (different idioms) same data by user's need (interaction)
- Example: choropleth map <-> bar chart
  - Serve different purposes: observe the population distribution over the space vs find the state with the n-th most population



# Idiom: Change Parameters

- Add widgets/controls for users to control what a subsets of data should be show on the visualization
  - Sliders, buttons, radio buttons, checkboxes, dropdowns, comboboxes
- Pros:
  - users can control it so users can clearly know what happen,
  - self-documenting
- Cons: use screen space



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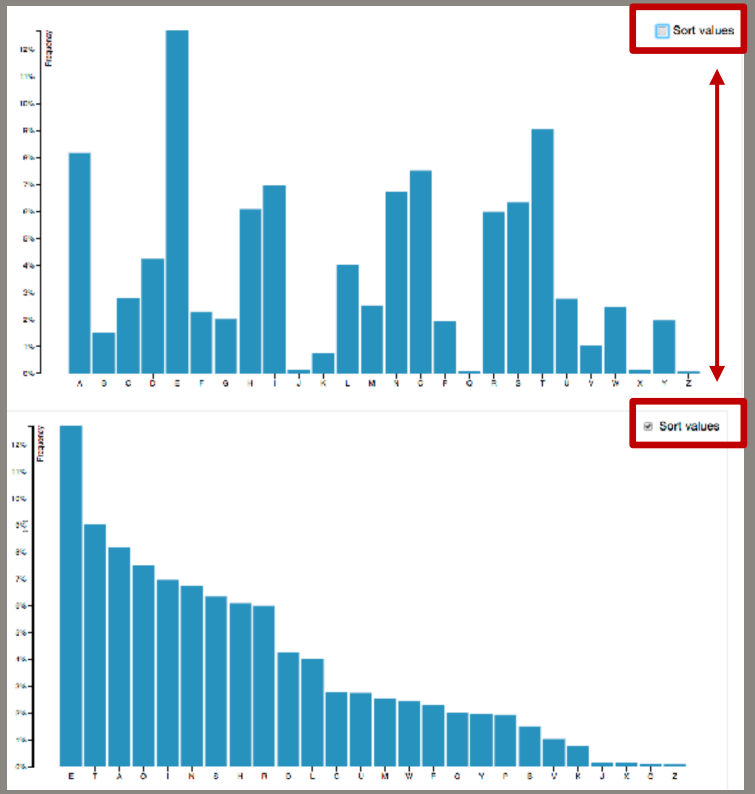
# Idiom: Change order/arrangement

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




https://observablehq.com/@d3/sortable-bar-chart

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

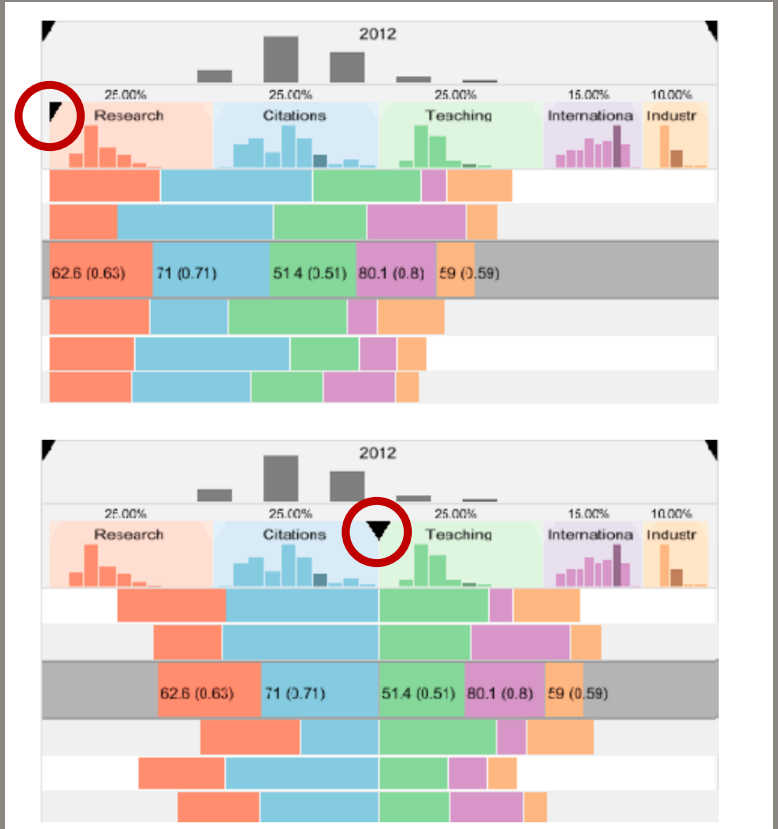
# Idiom: Reorder

- Reordering may be more powerful than you think
- Observe correlation between columns (attributes)?

# Idiom: Change Alignment

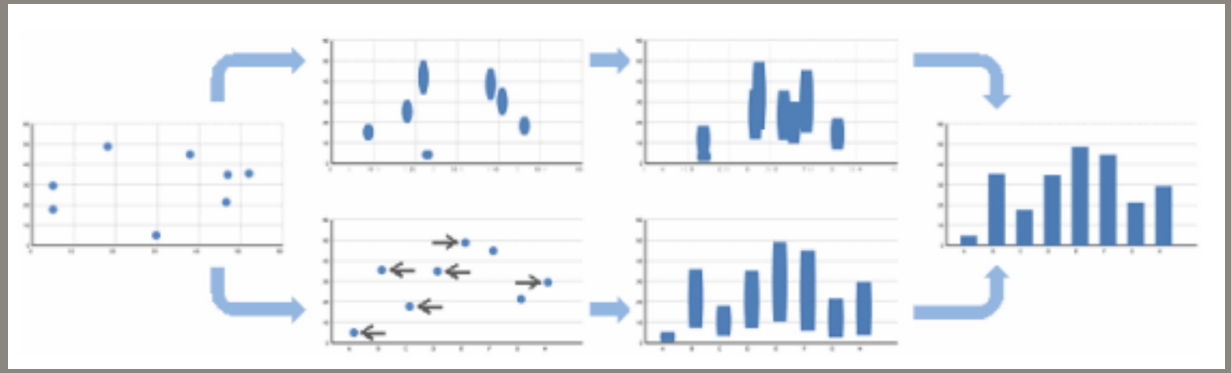
- Stacked bars
  - Easy to compare
    - First segment
    - Total bar
- Align to different segment
  - Supports flexible comparison

Change the alignment point by interactions



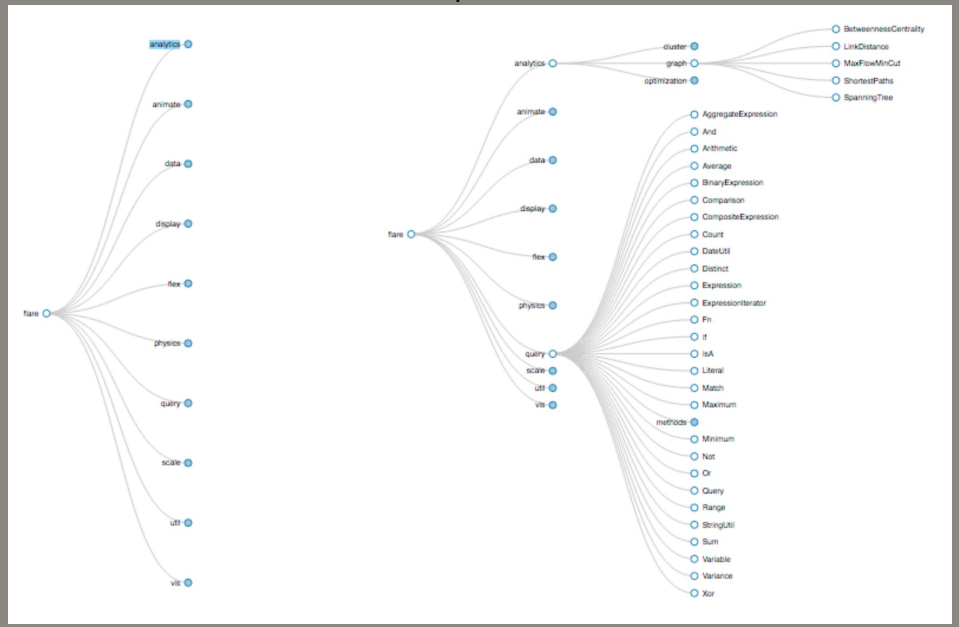
# Idiom: Animated Transition (Important!!!)

- Smooth interpolation from one state to another
  - Alternative to jump cut, supports item tracking
    - Best case for animation
  - Staging to reduce "**cognitive load**"
  - Use can know what happen between two view without explanation
- https://vimeo.c om/19278444



# Idiom: Animated Transition

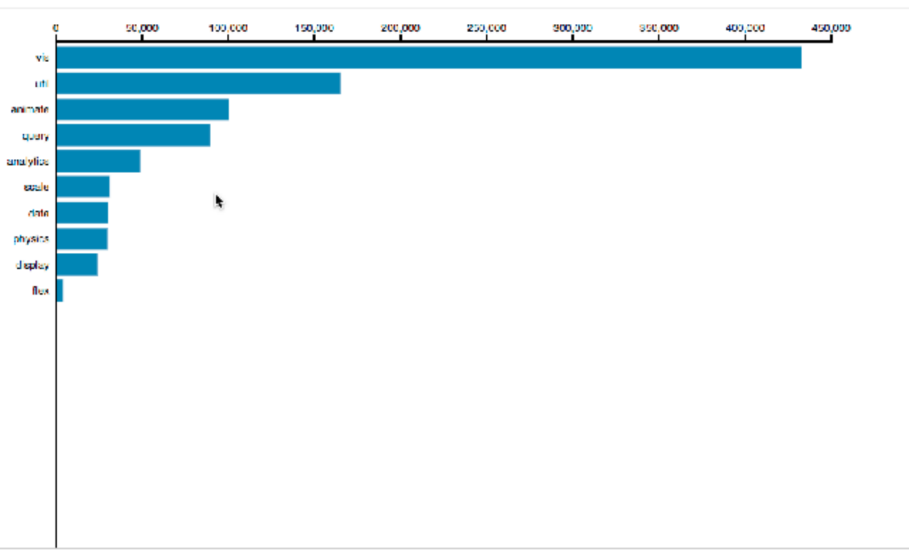
- Animated transition
  - Network drilldown/rollup




https://bl.ocks.org/mbostock/4339083

# Idiom: Animated Transition

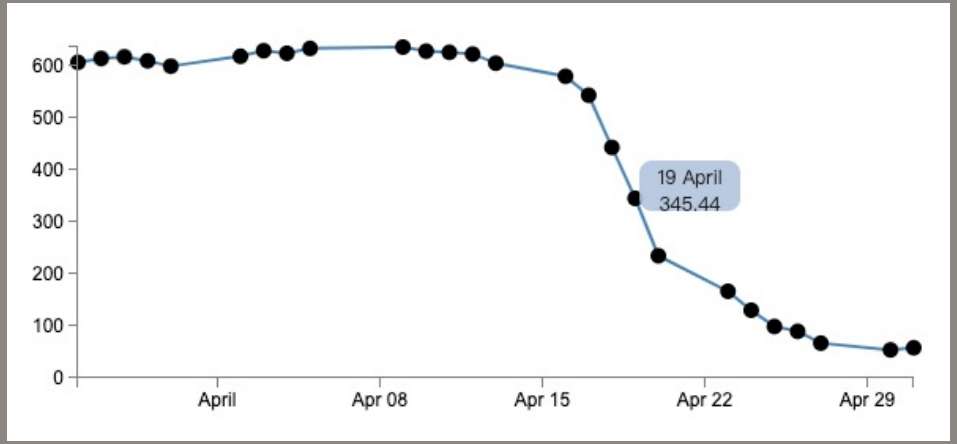
- Example: hierarchical bar chart
  - Add detail during transition to new level of detail




https://observablehq.com/@d3/hierarchical-bar-chart

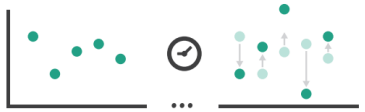
# Manipulate

- Example of selection
  - Tooltip to show detail of selected item




## Manipulate

### Change



### Select

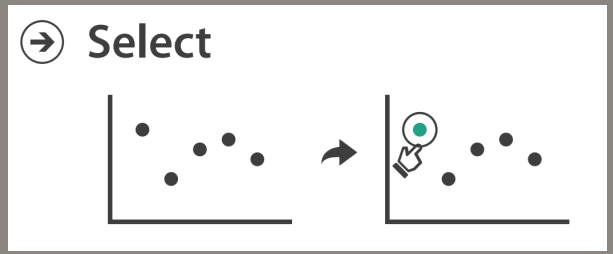
### Navigate

# Interaction Technology

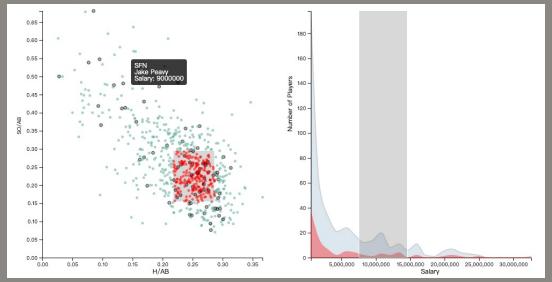
- What do you design for?
  - Mouse & keyboard on desktop?
    - Large screens, hover, multiple clicks
  - Touch screen (smartphone, tablet)
    - Small screens, no hover, just tap
- Gesture from videos/sensors?
  - Ergonomic reality vs movie bombast
- Eye tracking?
  - VR AR devices

# Selection

- Selection: basic operation for most interaction




- Design choices
  - how many selection types?
    - Interaction types (actions)
      - 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 (for the selection set)
      - 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)

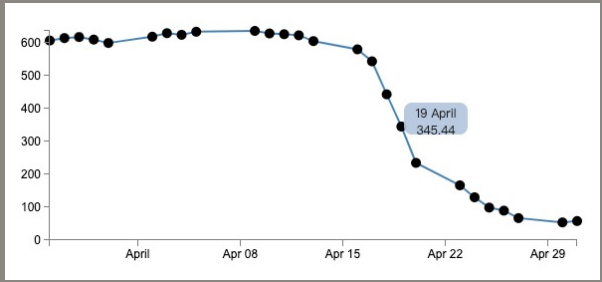


# Highlight the Selection

- Highlight: change visual encoding for selection target
  - 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 detailed on demand
    - Beware: does not support overview
      - Always consider if there is a way to visually encode directly to provide overview
      - If you make a rollover or tooltip, assume nobody will see it. If it is important, make it explicit



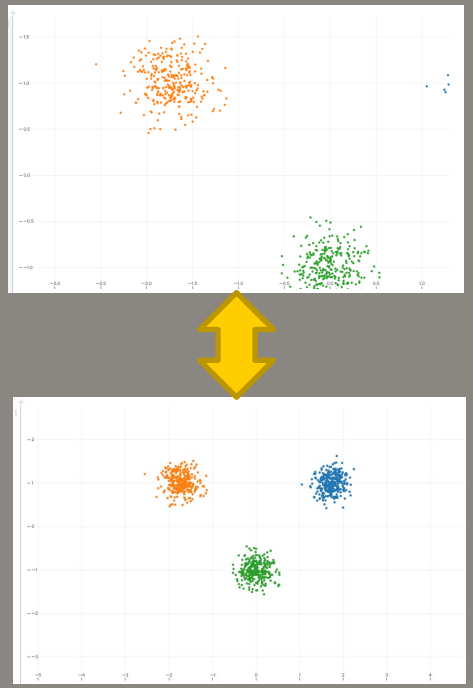
# S08-02

# Responsiveness is Required

- Visual feedback
  - 0.1 second: perceptual processing
    - Mouseover highlighting – ballistic motion
  - 1 second: immediate response
    - Fast response after mouse click, button press
  - 10 seconds: brief tasks
    - Bounded response after dialog- mental model of heavyweight operation (with processing icon)

# Manipulate

- Example of navigation: zoom and pan



- Navigate
  - Item Reduction
    - *Zoom*
      *Geometric* or *Semantic*
    - *Pan/Translate*
    - *Constrained*

Manipulate

- Change
- Select
- Navigate

# Navigate: Changing Item Visibility

- Change viewpoint
  - Changes which items are visible within view
  - Camera metaphor
    - **Rotate**: especially in 3D
    - **Pan/translate:** move up/down/sideway
    - **Zoom**
      - Geometric zoom: familiar semantics
      - semantic zoom: adapt object representation based on available pixels
        - Dramatic change, or more subtle one

## Navigate

### ➔ Item Reduction

➔ *Zoom*
*Geometric* or *Semantic*

➔ *Pan/Translate*

➔ *Constrained*

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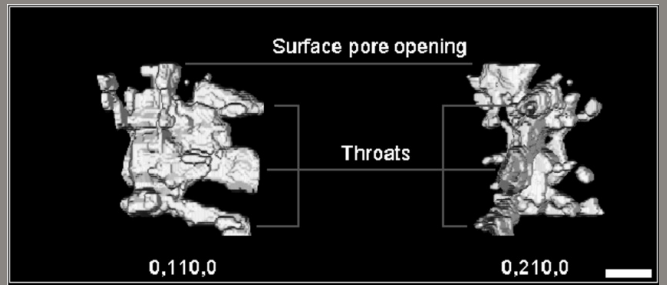


## Navigate

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## Navigate

### ➔ Item Reduction

➔ *Zoom*
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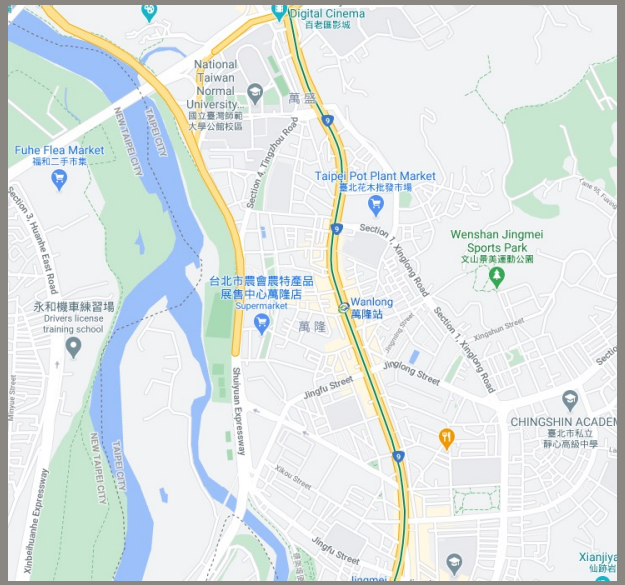
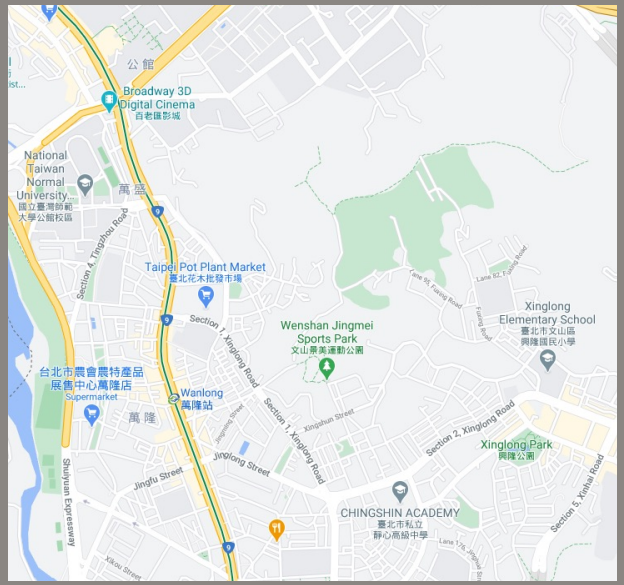
➔ *Pan/Translate*

➔ *Constrained*

# Pan/Translate

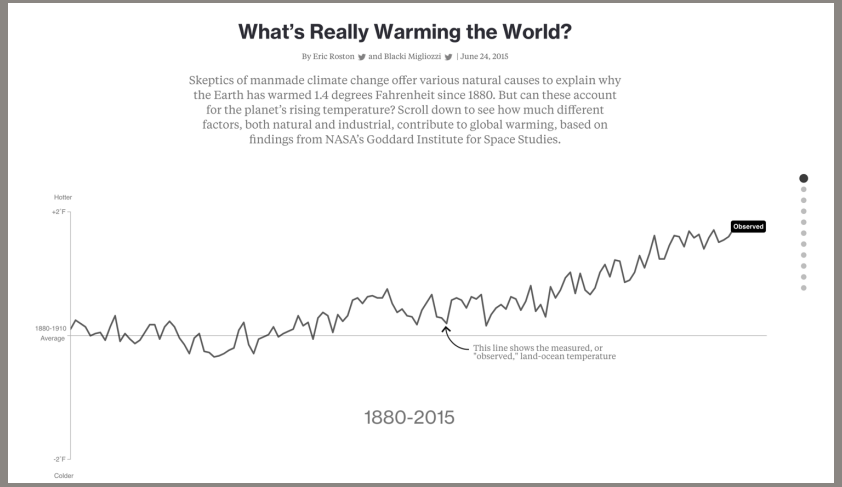
- Google map



# Idiom: Scrollytelling

- How: navigate page by scrolling
- Procs:
  - Familiar & intuitive, from standard web browsing
  - Linear (up and down only) vs clicked based interface
- Cons
  - Scrolljacking, no direct access
  - Unexpected behavior
  - Continuous control for discrete steps




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

More examples: https://vallandingham.me/scroll_talk/examples/
http://vallandingham.me/scroll_demo/

# Navigate: Changing Item Visibility

- Change viewpoint
  - Changes which items are visible within view
  - Camera metaphor
    - **Rotate**: especially in 3D
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    - **Zoom**
      - *Geometric zoom: familiar semantics*
      - *semantic zoom: adapt object representation based on available pixels*
        - *Dramatic change, or more subtle one*

After zooming: people may not only want to see the same plot drawn by more pixels, but also want to see more information of the plot

## Navigate

### ➔ Item Reduction

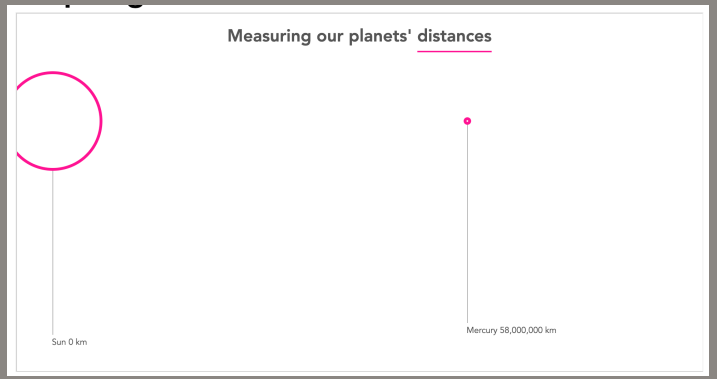
➔ *Zoom*
*Geometric* or *Semantic*

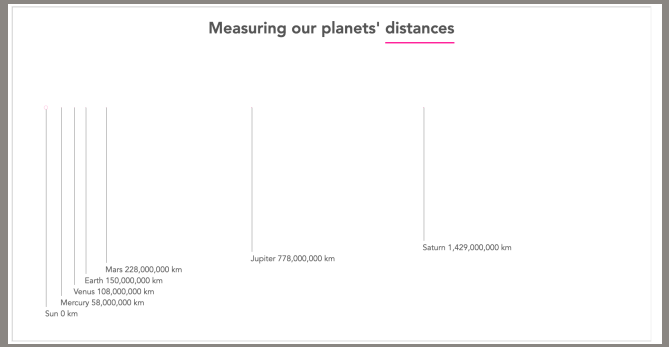
➔ *Pan/Translate*

➔ *Constrained*

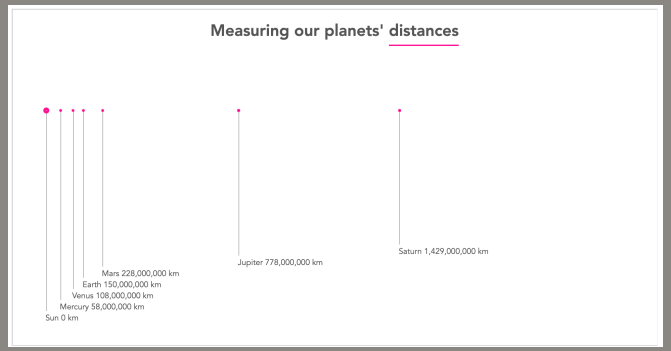
# Geometric vs Semantic Zooming

- https://bl.ocks.org/larsvers/95115f57fb67ac8c0a568fdd28ae8c00



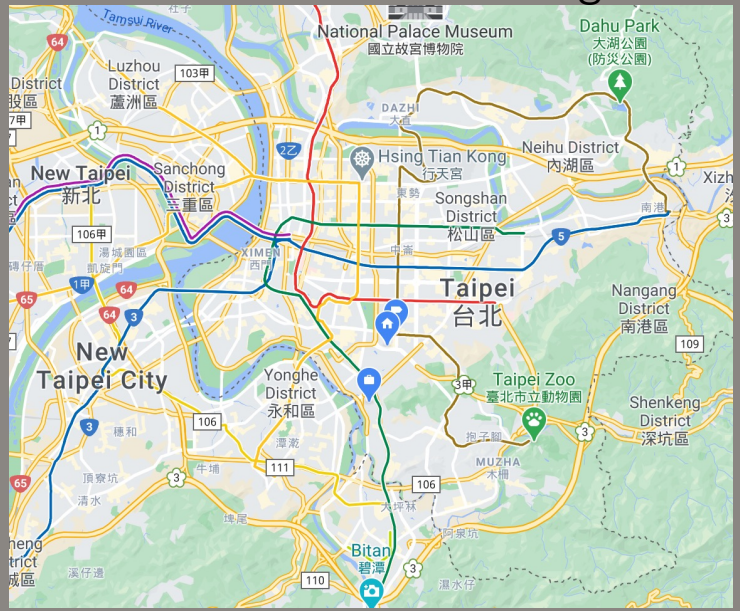

Geometric zooming

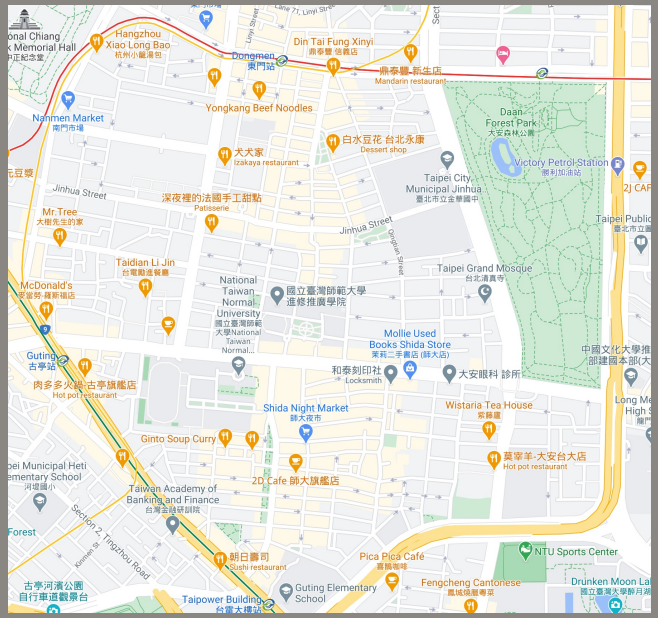



Sematic zooming

# Semantic Zooming

- Google map
  - Utilize the extra pixel to put more information/change the visual encoding



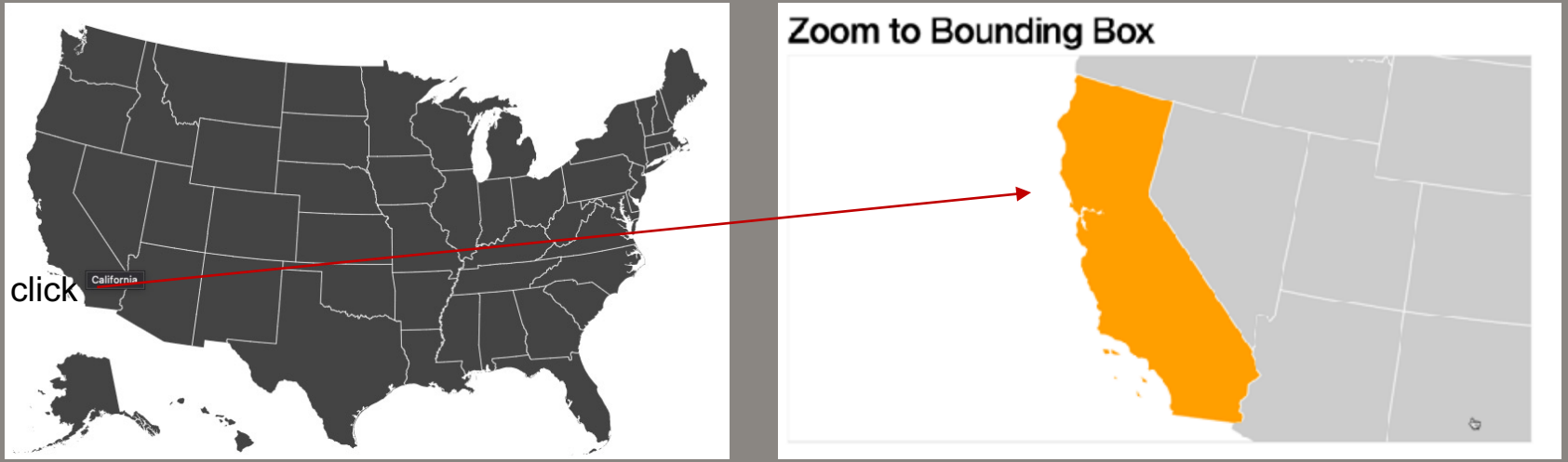
# Navigate: Unconstrained vs constrained

- Unconstrained navigation
  - Users can freely move the virtual camera
    - Easy to implement for designer
    - Hard to control for user
      - Easy to overshoot/undershoot

- Constrained navigation
  - Typically use animated transitions
  - Trajectory automatically computed based on selection
    - Just click: selection ends up framed nicely in final viewpoint

# Idiom: Animated Transition + Constrained Navigation

- Example: geographic map
  - Simple zoom, only viewport change, shape preserved
  - Limit the ways to zoom in (compare with google map)




https://observablehq.com/@d3/zoom-to-bounding-box

# Interaction Procs

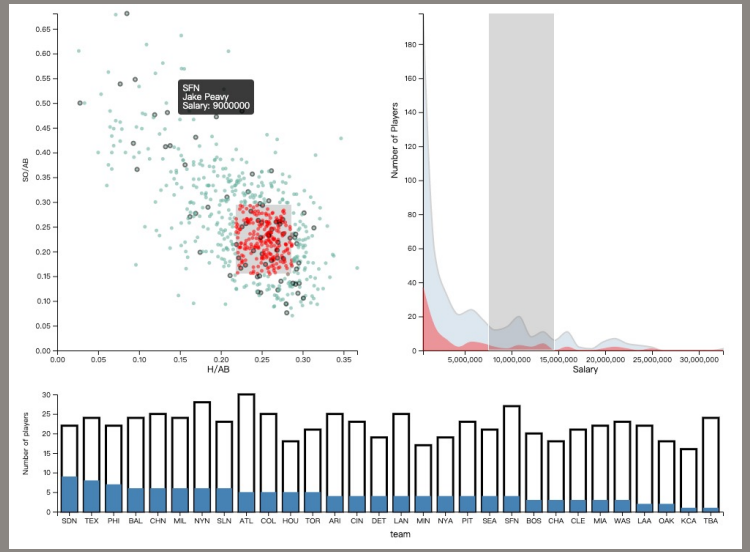
- Major advantage of computer-based
  - vs paper-based visualization
- Flexible, powerful, intuitive
  - Exploratory data analysis: change as you go during analysis process
  - Fluid task switching: different visual encodings support different tasks
- Animated transitions provide excellent support
  - Empirical evidence that animated transitions help people stay oriented

# Interaction Cons

- Interaction has a time cost
  - Sometimes minor, sometimes significant
  - Degenerates to human-powered search in worst case
- 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% do not interact beyond scrollytelling

# Practice

- What manipulation techniques do we use in this vis tool?
  - Change: visual encoding/alignment/reorder/filtered items?
  - Select: click/hover, null/adding/replacing selection?
  - Navigate: rotate/pan/translate/zoom?



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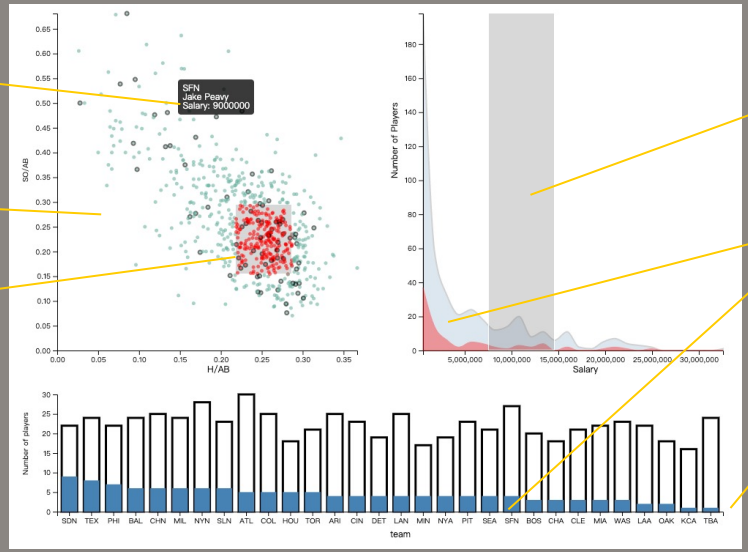
Select: tooltip (hover)

Select: null (click on background)

Select: replacing selection (change visual encoding to highlight selection)




Select: replacing selection

Change: aggregate filtered items

Change: reorder