Communicating with Data – Interactive Visualization

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Slides based off slides courtesy of Jordan Crouser (https://jcrouser.github.io/)

Plan for Today

- Interaction: a definition
- Interaction with data and problem space
  - Relationship between interaction and understanding
  - Roles interaction plays
- Interaction with visual interfaces
  - Basic interaction types
  - Sample interaction methods
- Demo: coordinated multiple views

Rewind

Humans and machines have **complimentary strengths**

Visualization

Perception and context
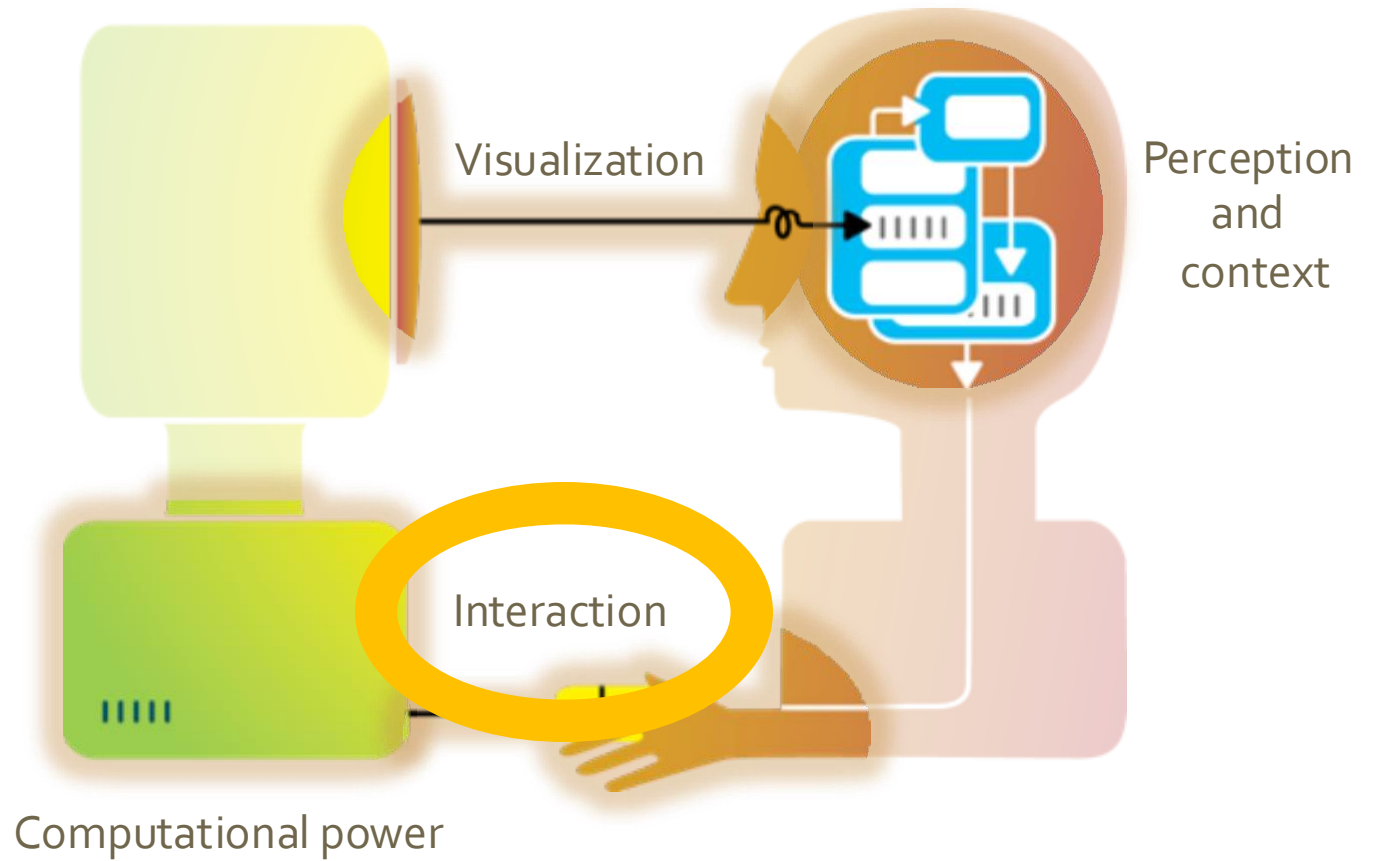
Interaction

Computational power

Image credit: Ali Ansari

Interaction (def.)

"Interaction for visualization is the interplay between a person and a data interface involving a data-related intent, at least one action from the person and an interface reaction that is perceived as such."

Mandatory Components

- Interplay
- Person
- Data Interface
- Action
- Action-Reaction
- Reaction Perceived as Such
- Data-Related Intent

Interaction

- Methods by which humans **create knowledge** through the manipulation of an interface

- Low level: **between human and interface**
  - the set of operations available
  - the relationship between the human and the visualization

- High level: between **human and problem space**
  - a cognitive act *enabled* by the tool
  - does not need to take place exclusively within them
  - might be distributed across multiple tools

Example: Rubik's Cube

What **low-level** interactions can you have?

What **high-level** interactions can you have?
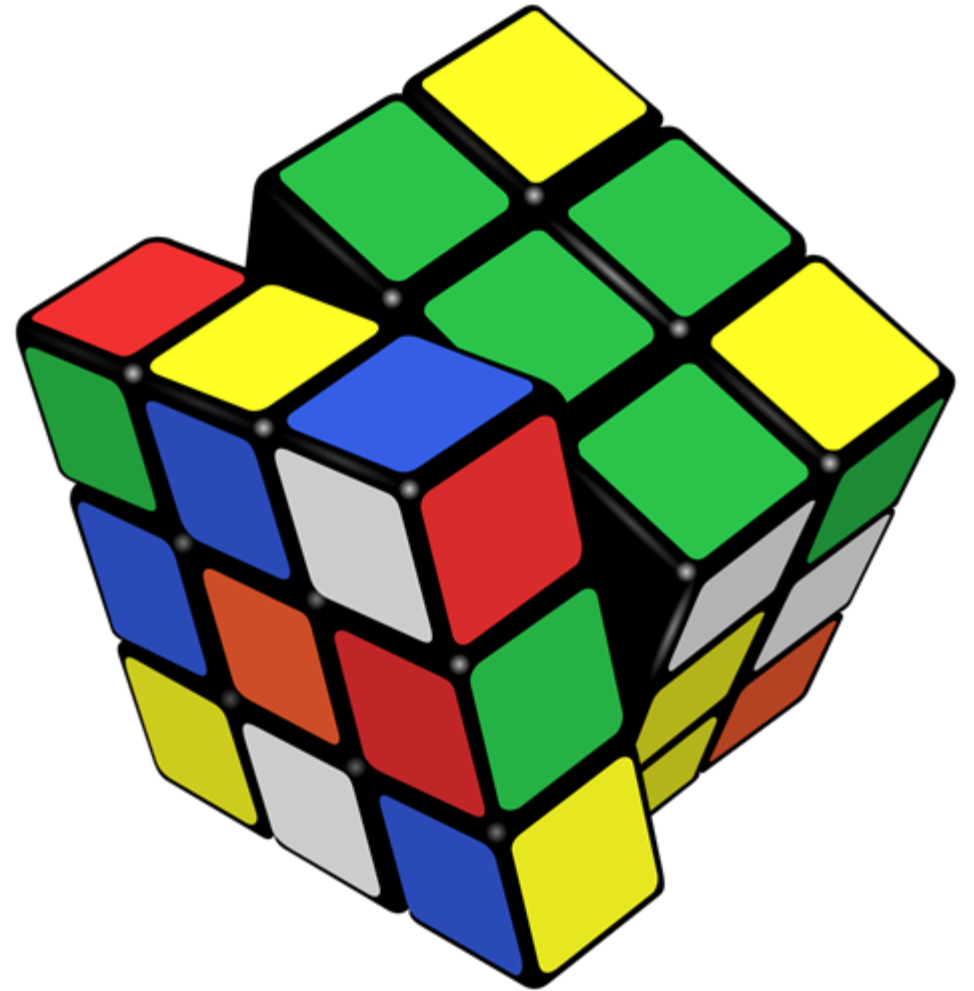
Part I: High Level

Interaction with
Data / Problem Space

Interaction and analysis

- Interaction is the observable result of a cognitive process: "an externalization of thought"

- In visualization, there is a growing belief that interaction and analysis are **actually the same thing!**

- **Analytic discourse:** the idea that knowledge is constructed, tested, refined, and shared through the interactive manipulation of an interface[1]

[1]Pike, W. A., Stasko, J., Chang, R., & O'Connell, T. A. (2009).
The science of interaction. Information Visualization, 8(4), 263-274.

Interaction as a reasoning aid

- Interaction happens in the **context** of a problem or goal-directed activity

- This context helps the human identify relevant concepts and **link** them into appropriate structures

- **Interaction** brings together background contexts and current observations

- This is known as "**situated cognition**"

Discussion

Hypothesis: the more ways a user can '**touch**' their data (by changing their form or exploring them from different perspectives), the more insight will accumulate.

True or False?

Reality Check

- Requires human time and attention
- Increases perceptual and exploration costs
- Implementation costs
- Multiple user studies find no increase in performance

Benefits

Costs
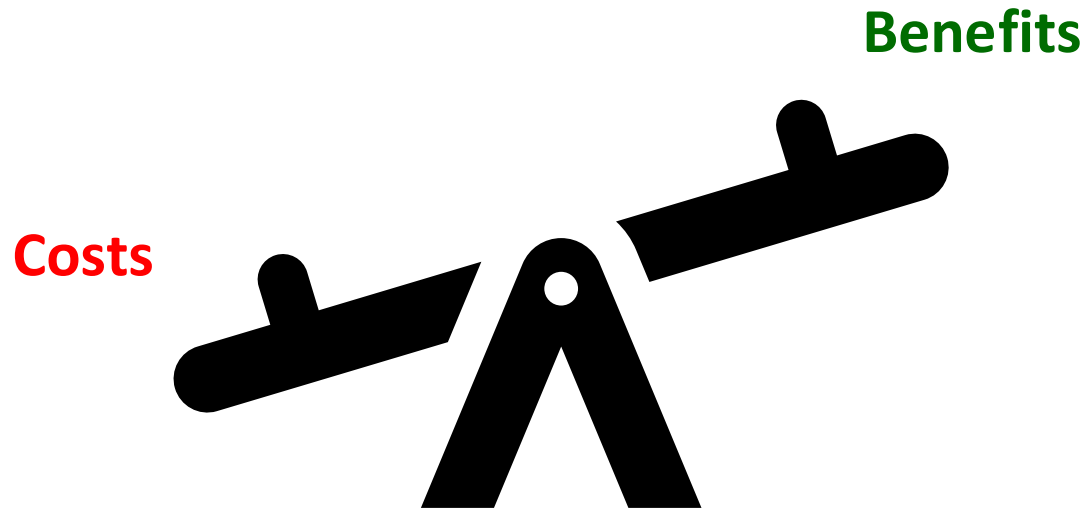
Interaction as Distributed Cognition

- Visualization is often used as a tool to "**offload**" storage or computation from the human's brain

- In order for this to be useful, we have to be able to "**reload**" parts of the data and operate on it

- Internal (in your head) vs. external (on the screen) representations

- Consider the impact of the **affordances** of the interface

Distributed Cognition as a Theoretical Framework for Information Visualization
Zhicheng Liu, Nancy J. Nersessian, and John T. Stasko

Example: Tower of Hanoi

Orange

Donut

Coffee

1. Only one disk can be transferred at a time.
2. A disk can only be transferred to a pole on which it will be the largest.
3. Only the largest disk on a pole can be transferred to another pole.

Example
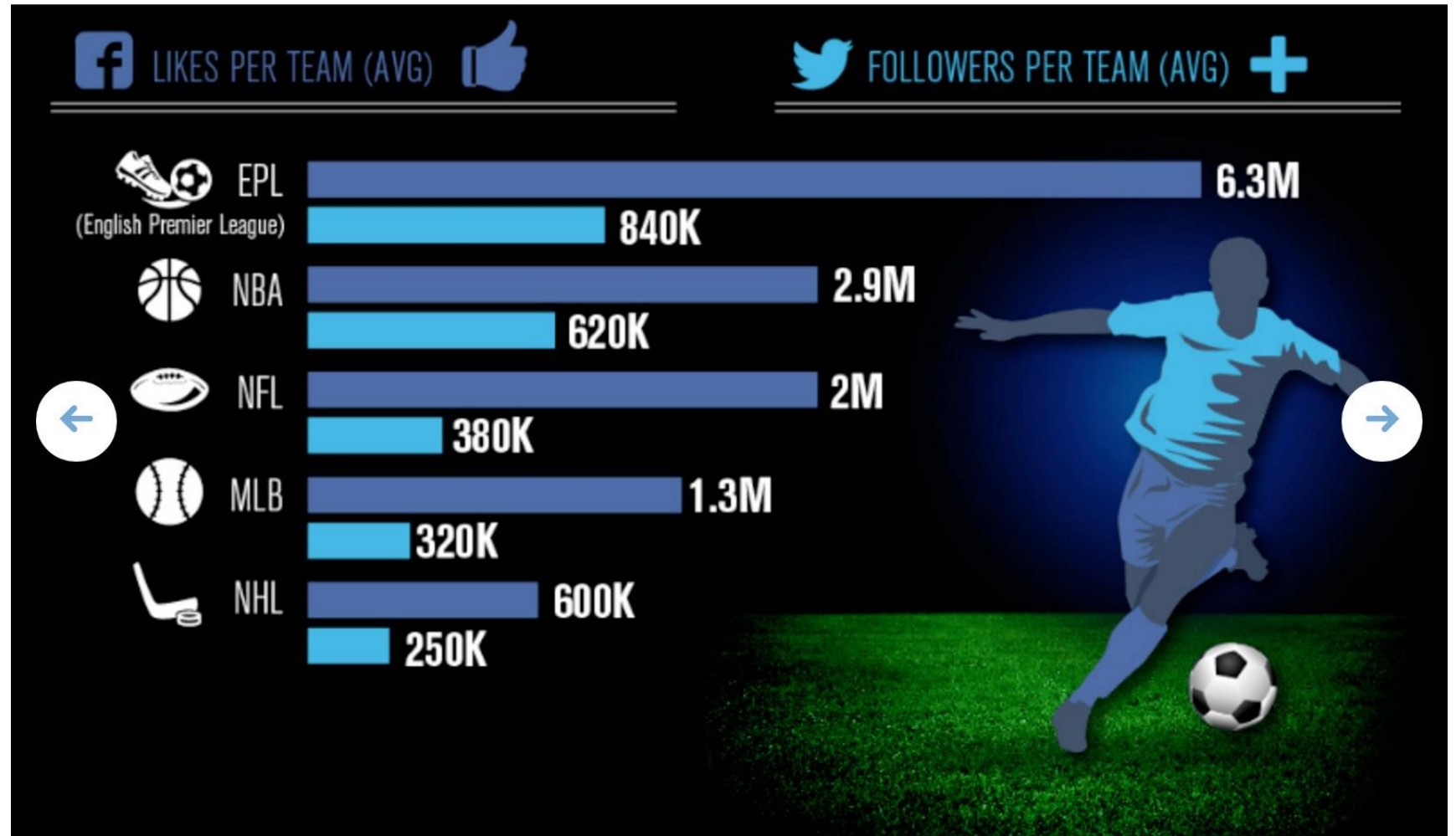
Is changing the page internal or external?

Pragmatic vs. Epistemic Action

- **Pragmatic actions** move a person and their analysis closer to the desired destination

- **Epistemic actions** enable humans to leverage environmental structures to **link internal structures**

- The purpose of some actions is not for the effect they have on the environment but **for the effect they have on the humans**

Example: Tetris Behavior

Is Piece Lined Up?

Move to Wall

Move Back Three Squares
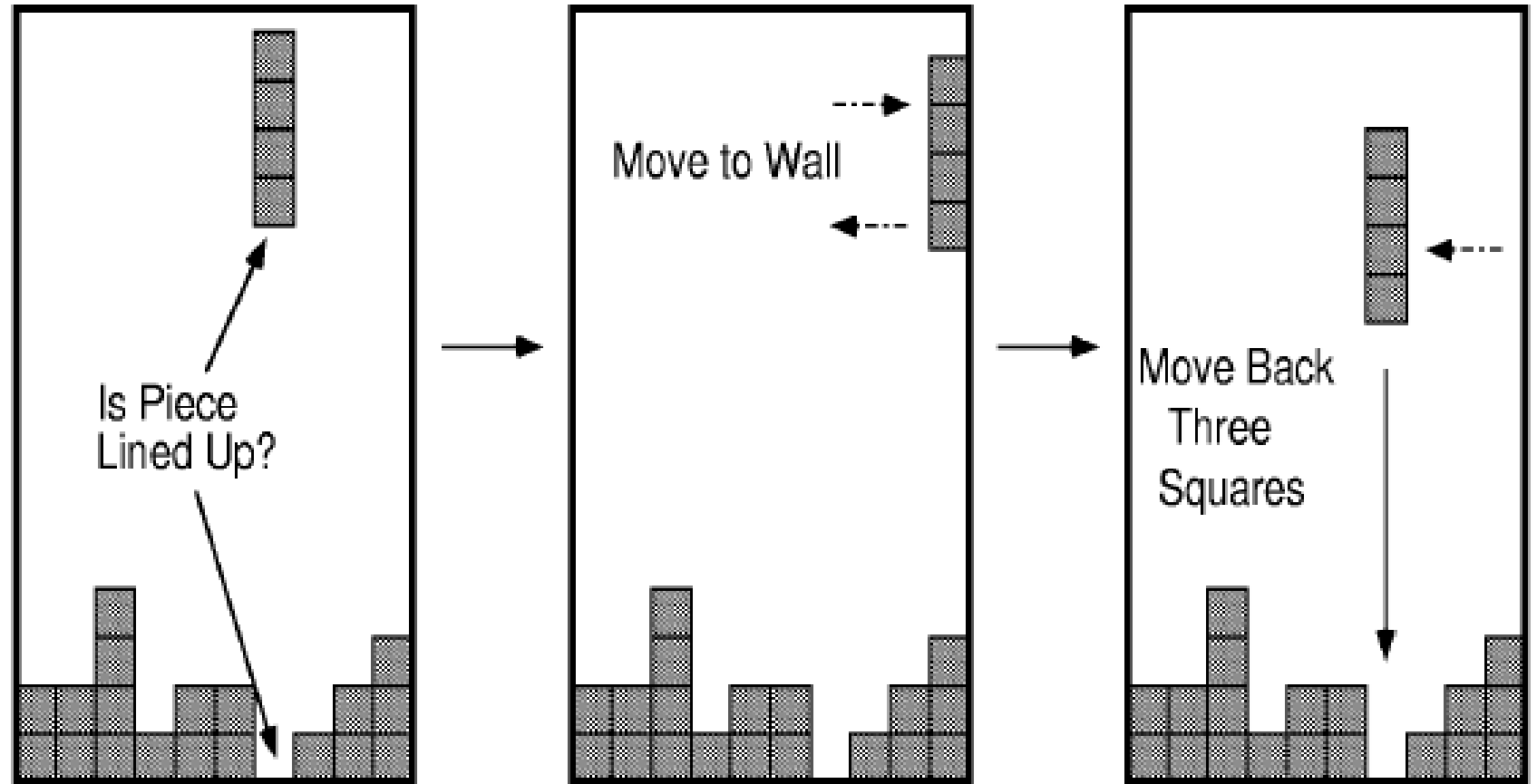
Part II

Interaction with
a Visual Interface

So far…
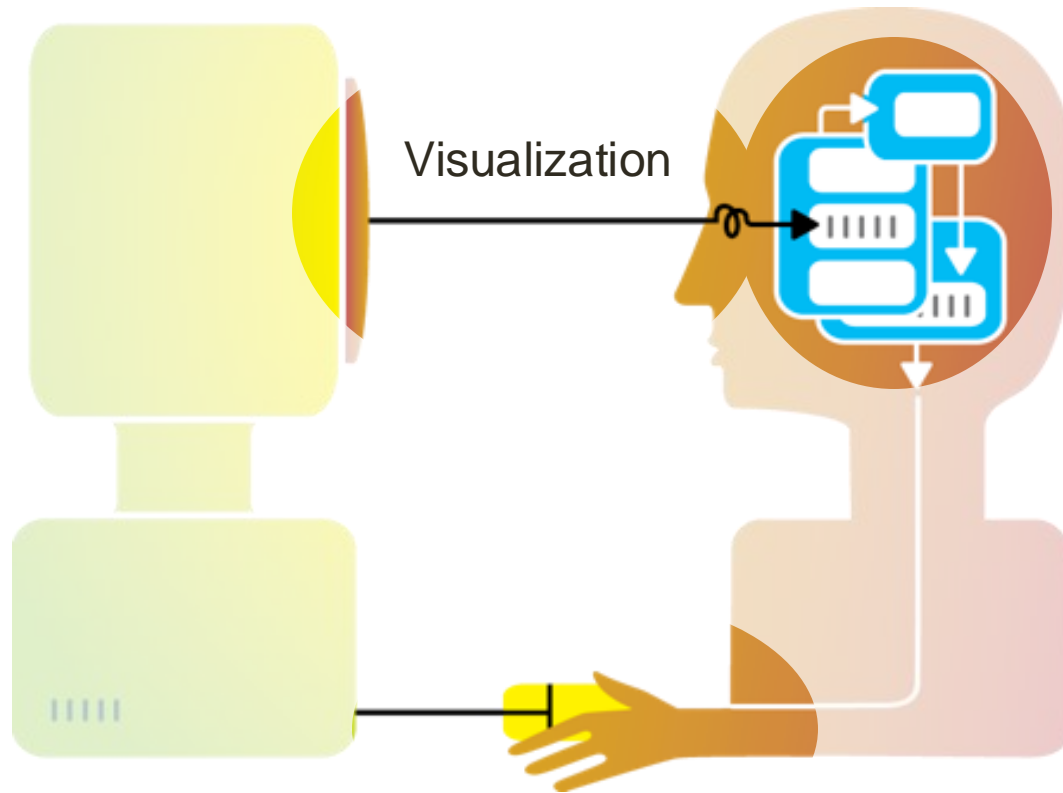
Visualization

Flashback: interaction as a reasoning aid

- Interaction is situated in the **context** of a problem or goal-directed activity

- **Question:** what kinds of things might someone want to do using a visualization?

Yi, Kang, Stasko and Jacko (2007)

1. Select: mark something as interesting
2. Explore: show me something else
3. Reconfigure: show me a different arrangement
4. Encode: show me a different representation
5. Abstract/Elaborate: show me more or less detail
6. Filter: show me something conditionally
7. Connect: show me related items

Yi, J. S., ah Kang, Y., Stasko, J. T., & Jacko, J. A. (2007). Toward a deeper understanding of the role of interaction in information visualization. Visualization and Computer Graphics, IEEE Transactions on, 13(6), 1224-1231.

1. Select

Mark something as interesting: direct
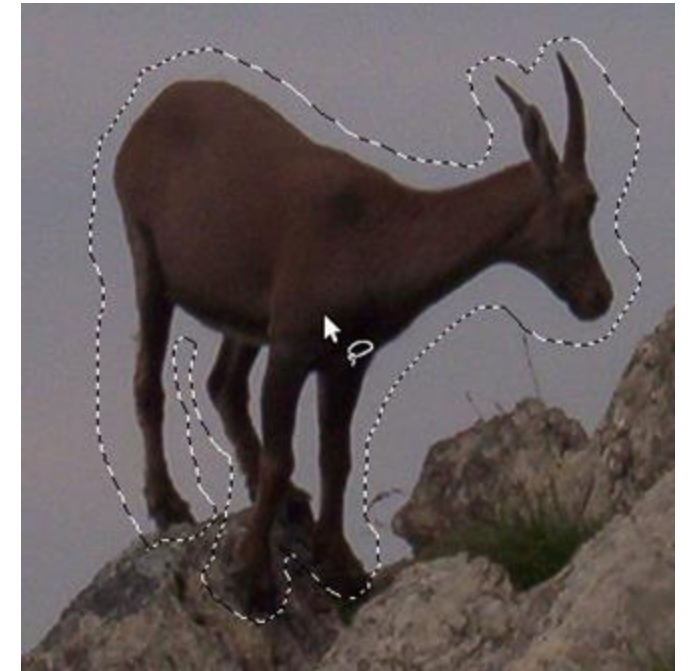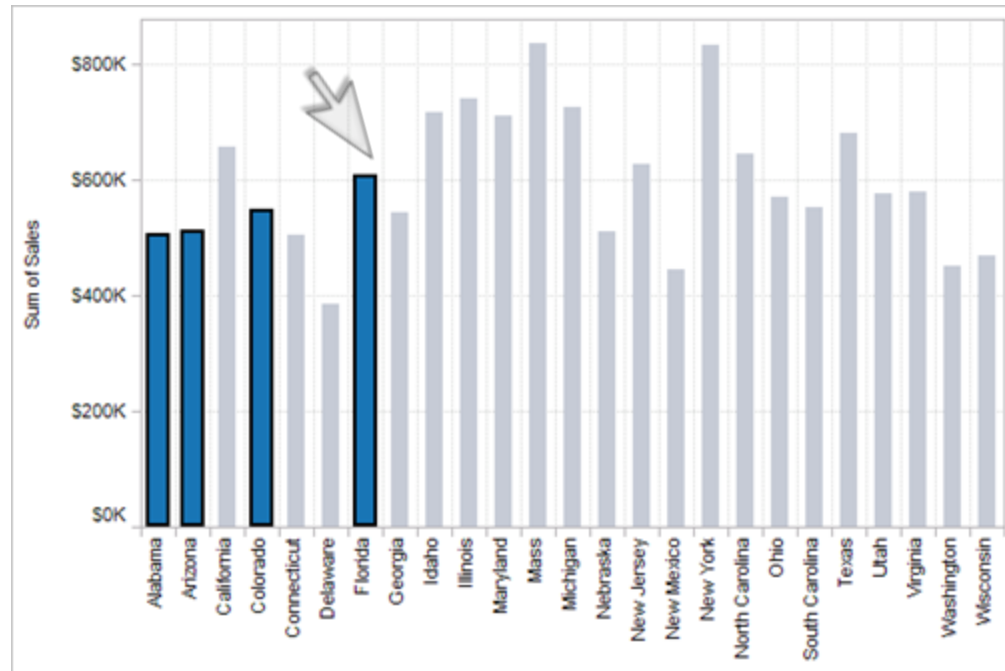
1. Select

Mark something as interesting: indirect
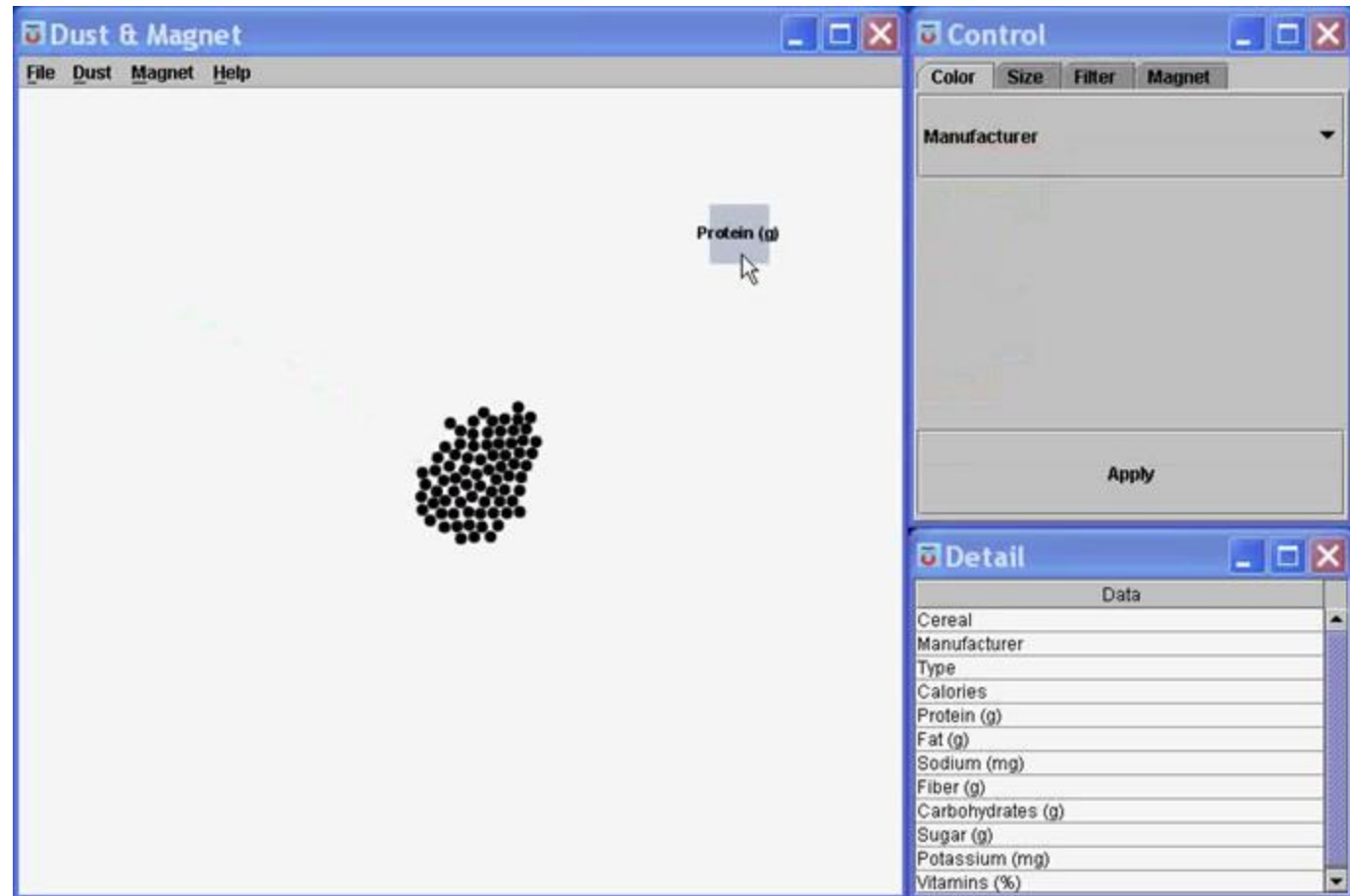
2. Explore

Show me something else
- Scroll bars
- Panning
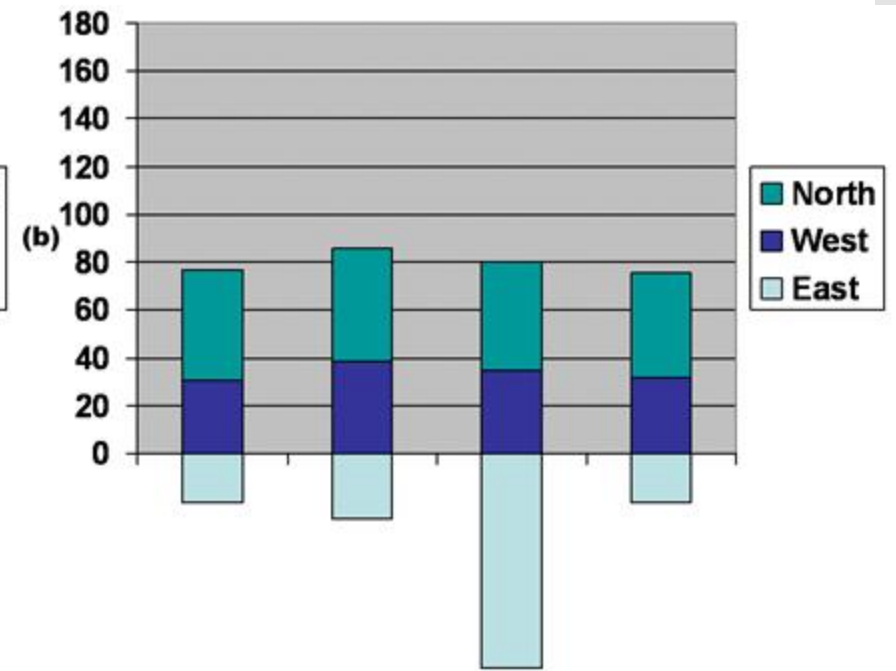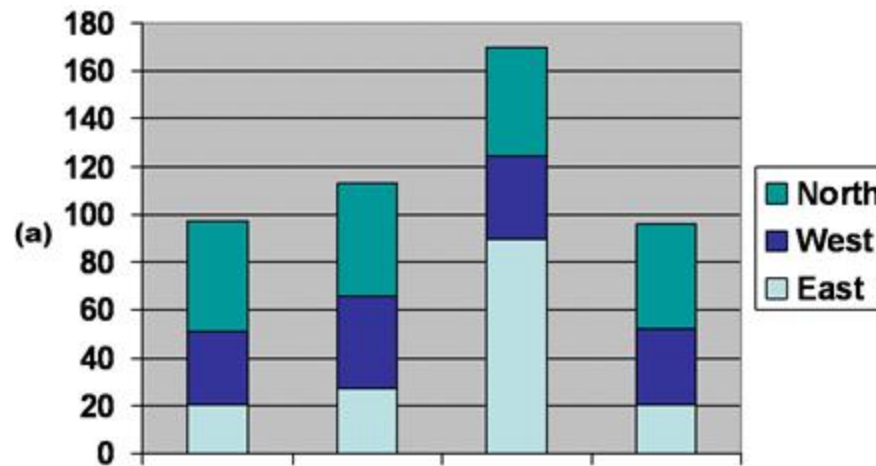- Direct-Walk (e.g. hyperlink traversal)
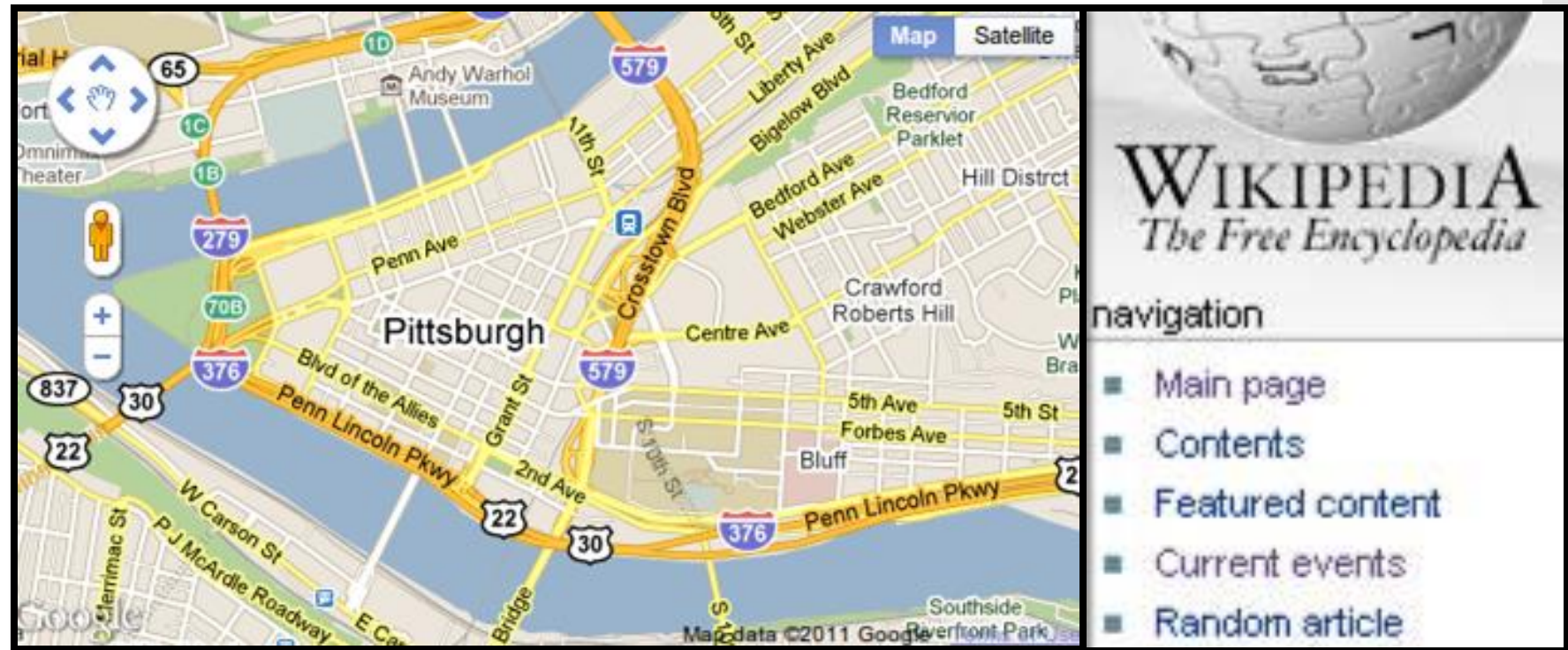
3. Reconfigure

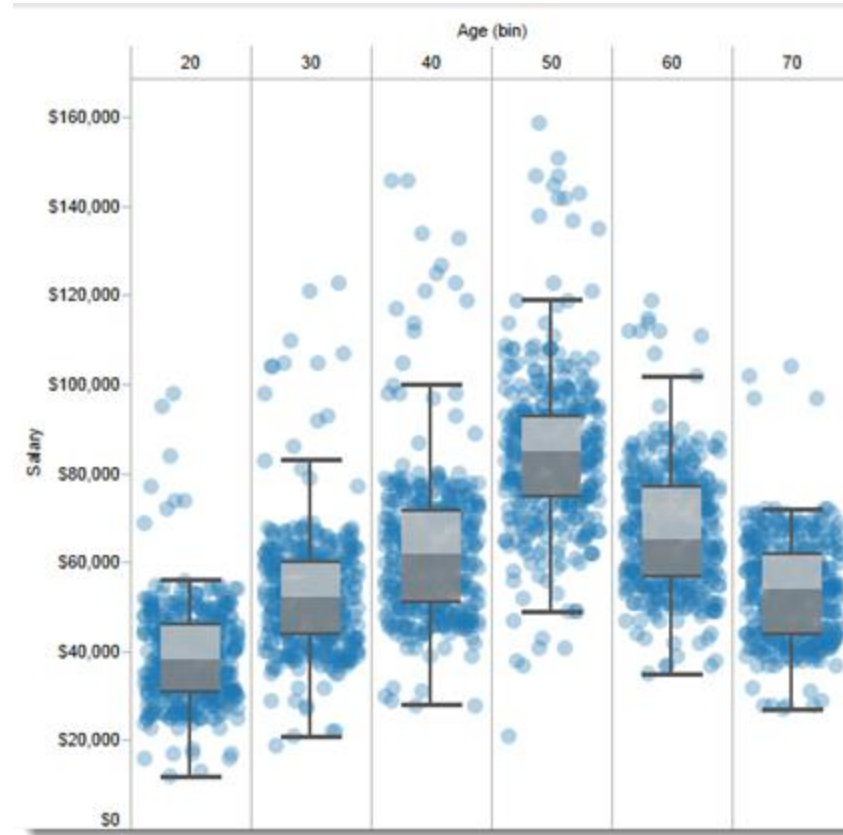Show me a different arrangement: sorting
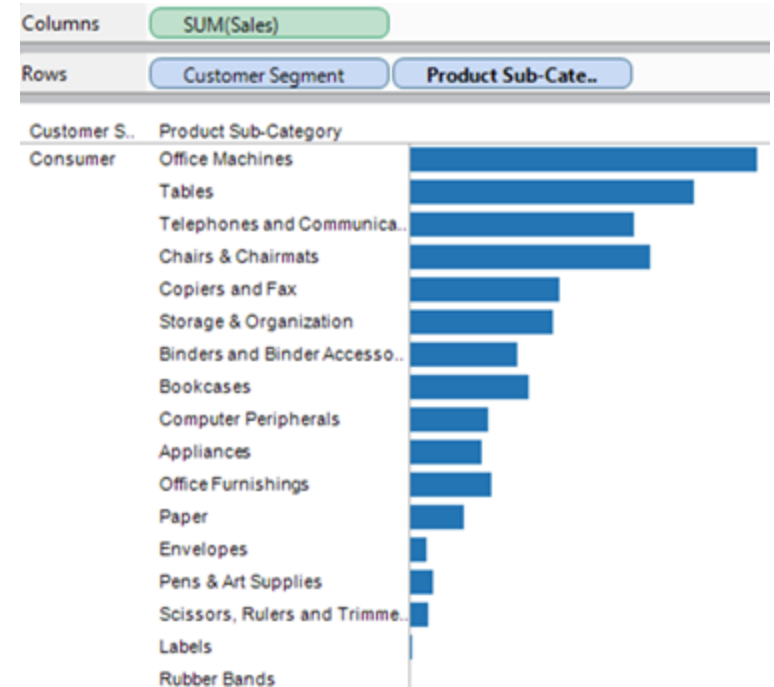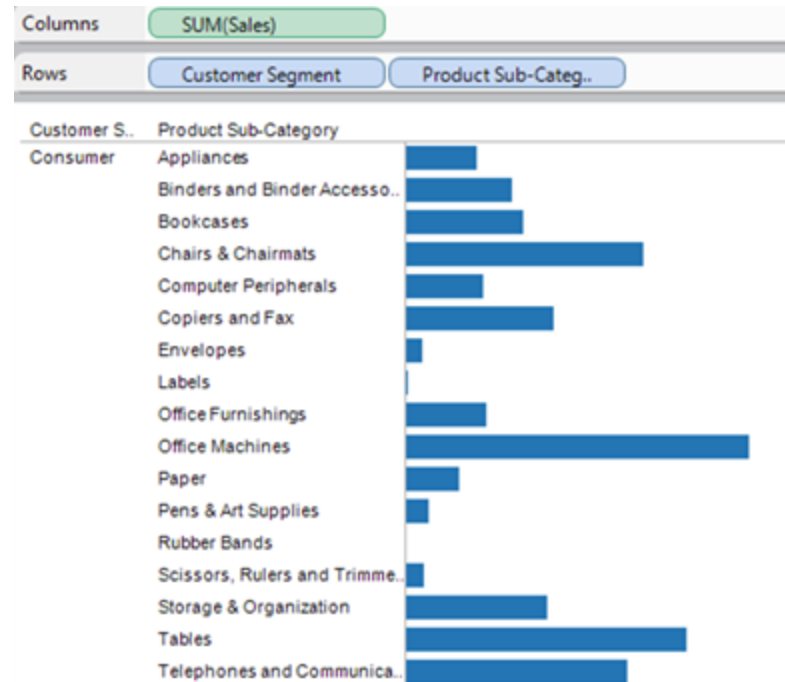
3. Reconfigure

Show me a different arrangement: baseline adjustment

3. Reconfigure

Show me a different arrangement: reduce occlusion (jitter)

4. Encode

Show me a different representation: visualization type, color, size, orientation, etc.

5. Abstract / Elaborate

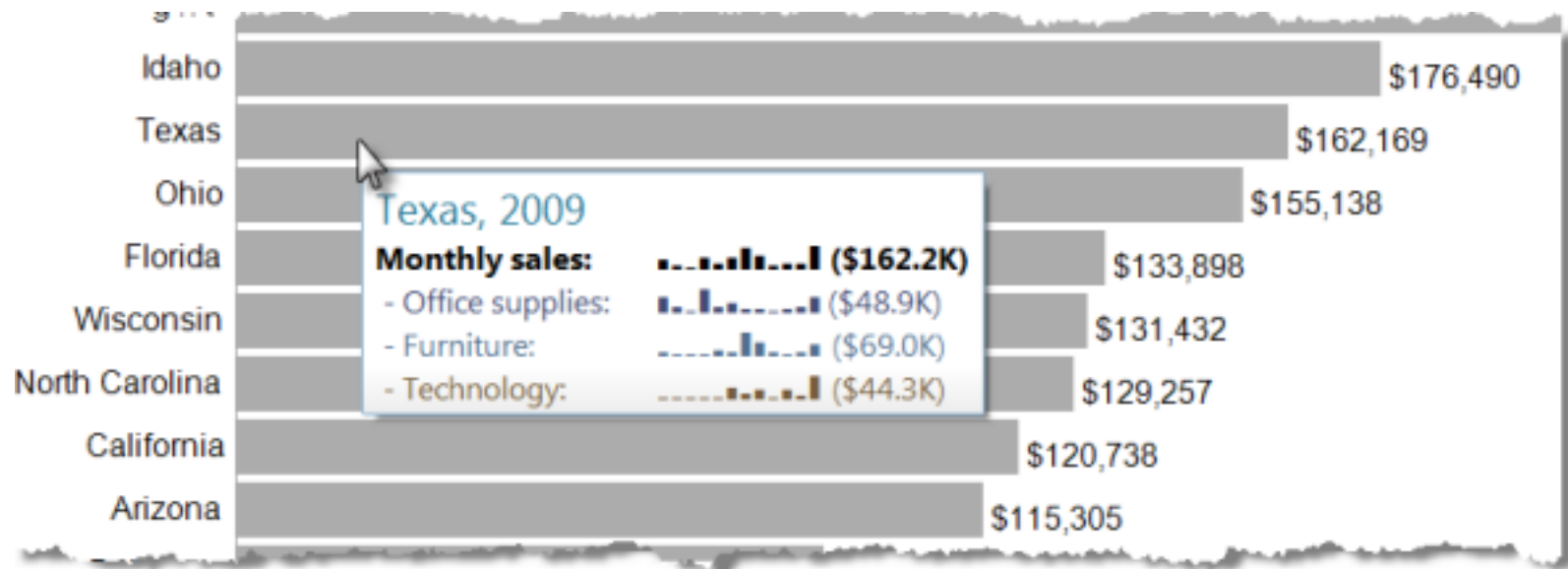Show me more or less detail: drill up/down

5. Abstract / Elaborate

Show me more or less detail: zooming

5. Abstract / Elaborate

Show me more or less detail: tooltips

6. Filter

Show me something conditionally
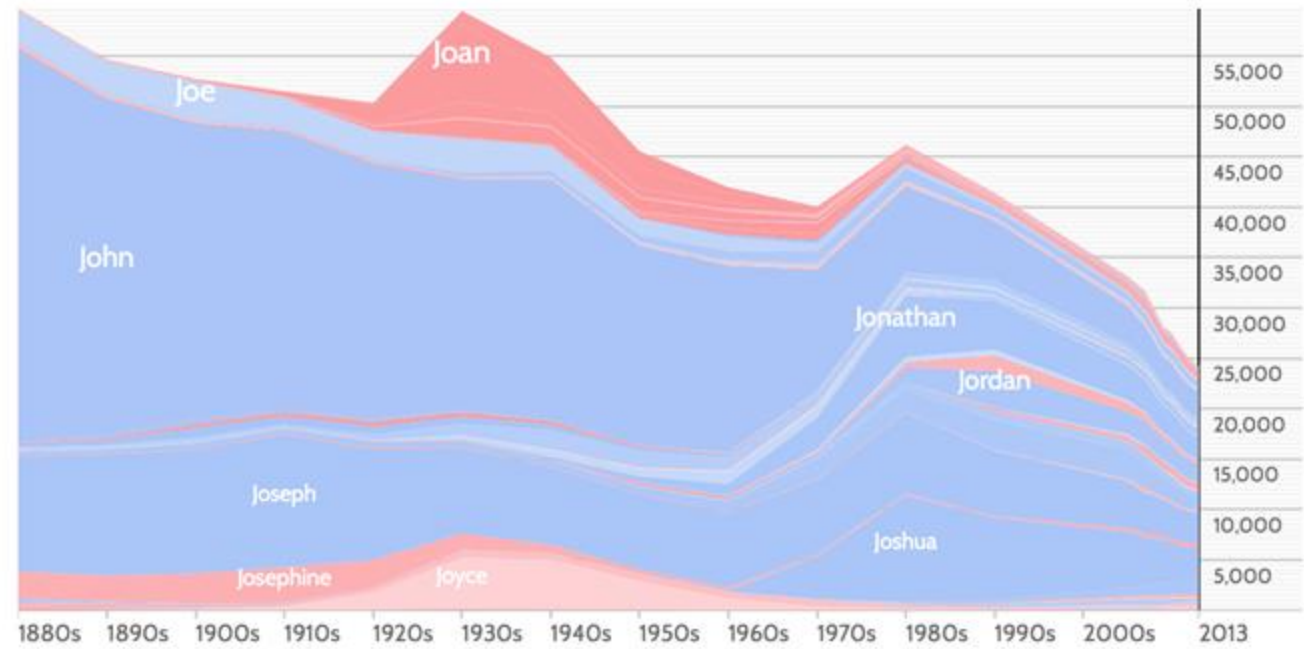
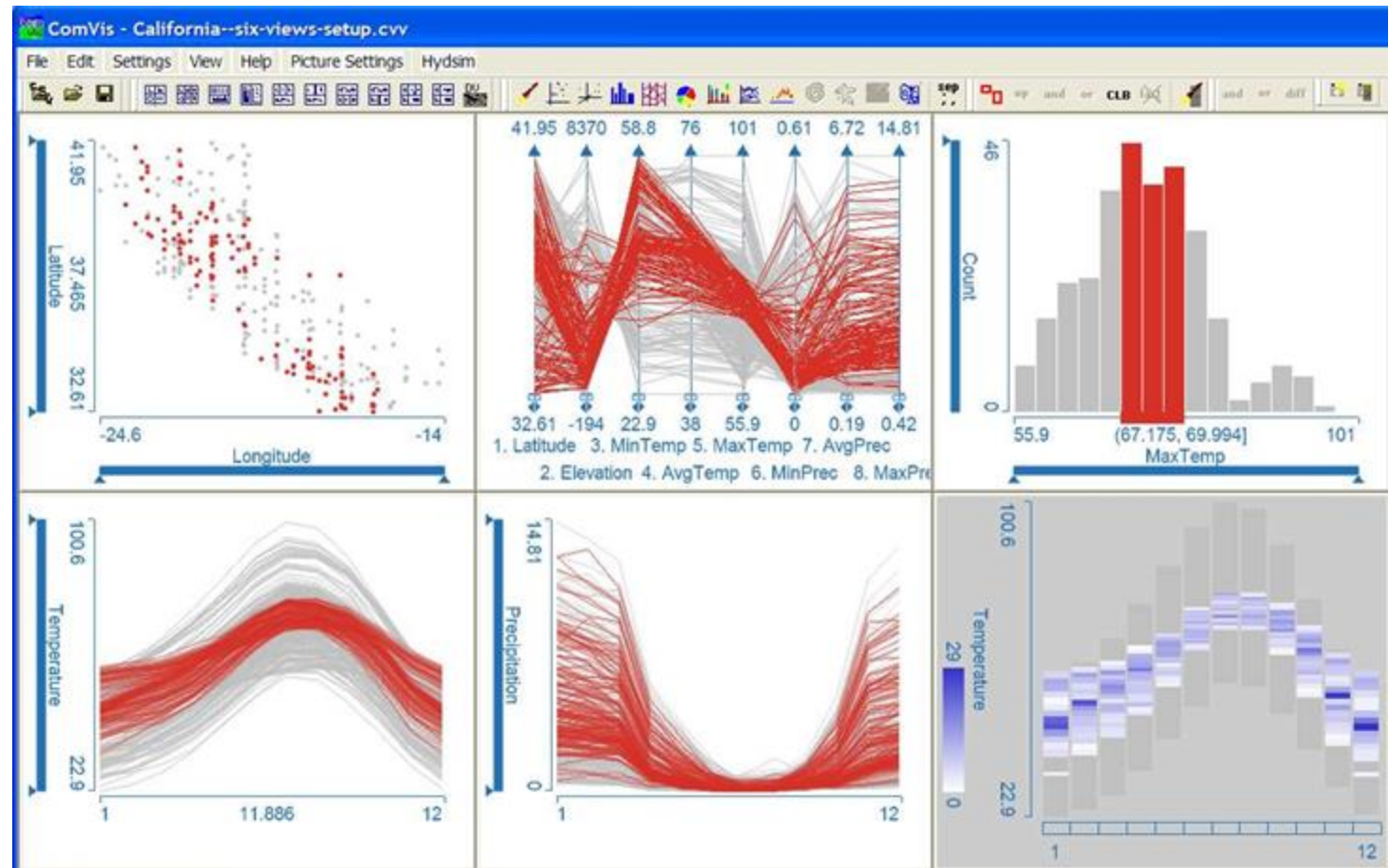# 7. Connect

Show me related items: build-out
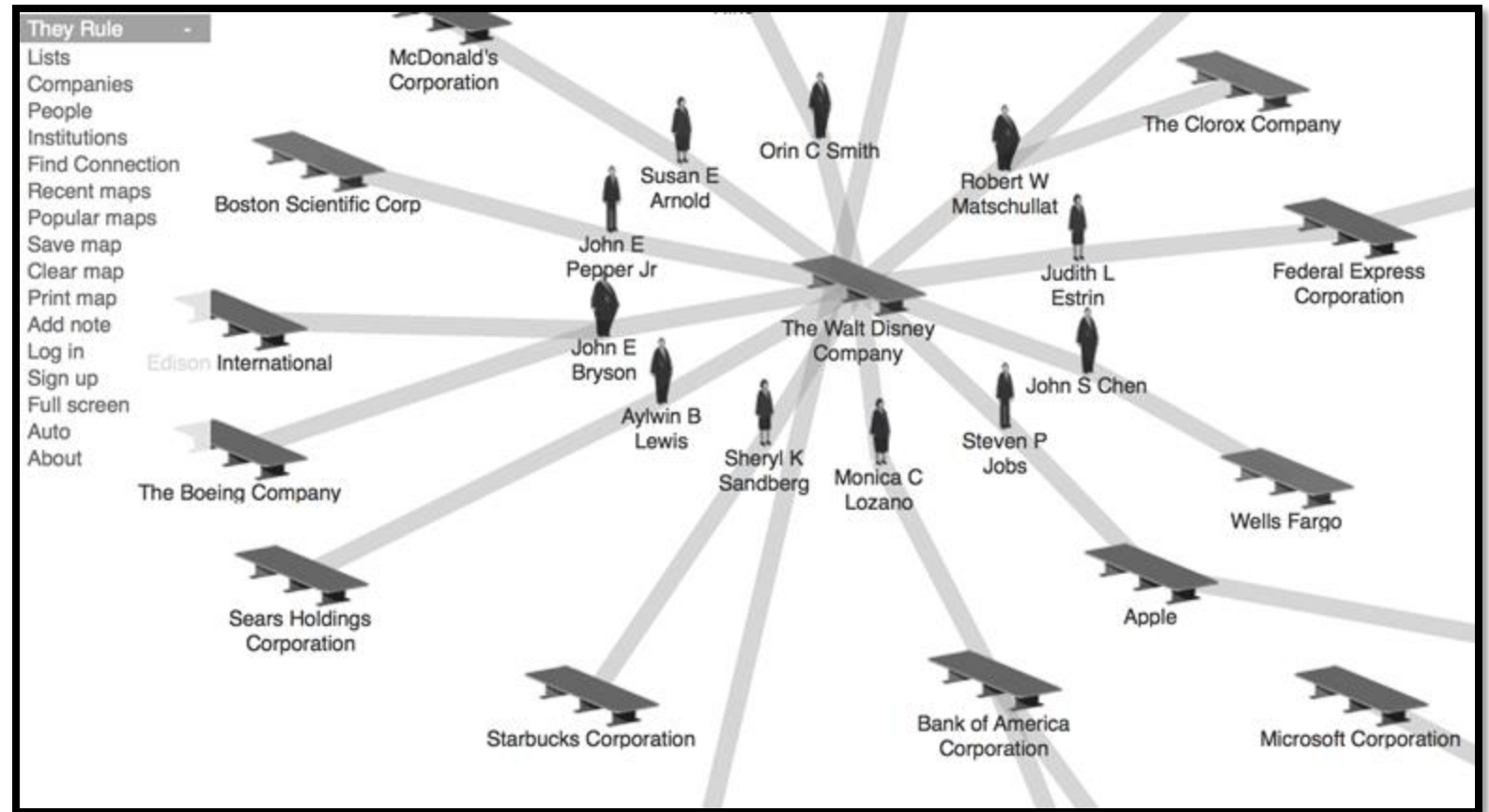
7. Connect

Show me related items: coordinated multiple views (CMV)

Foreshadowing: Multiple views

Different representations

Different data
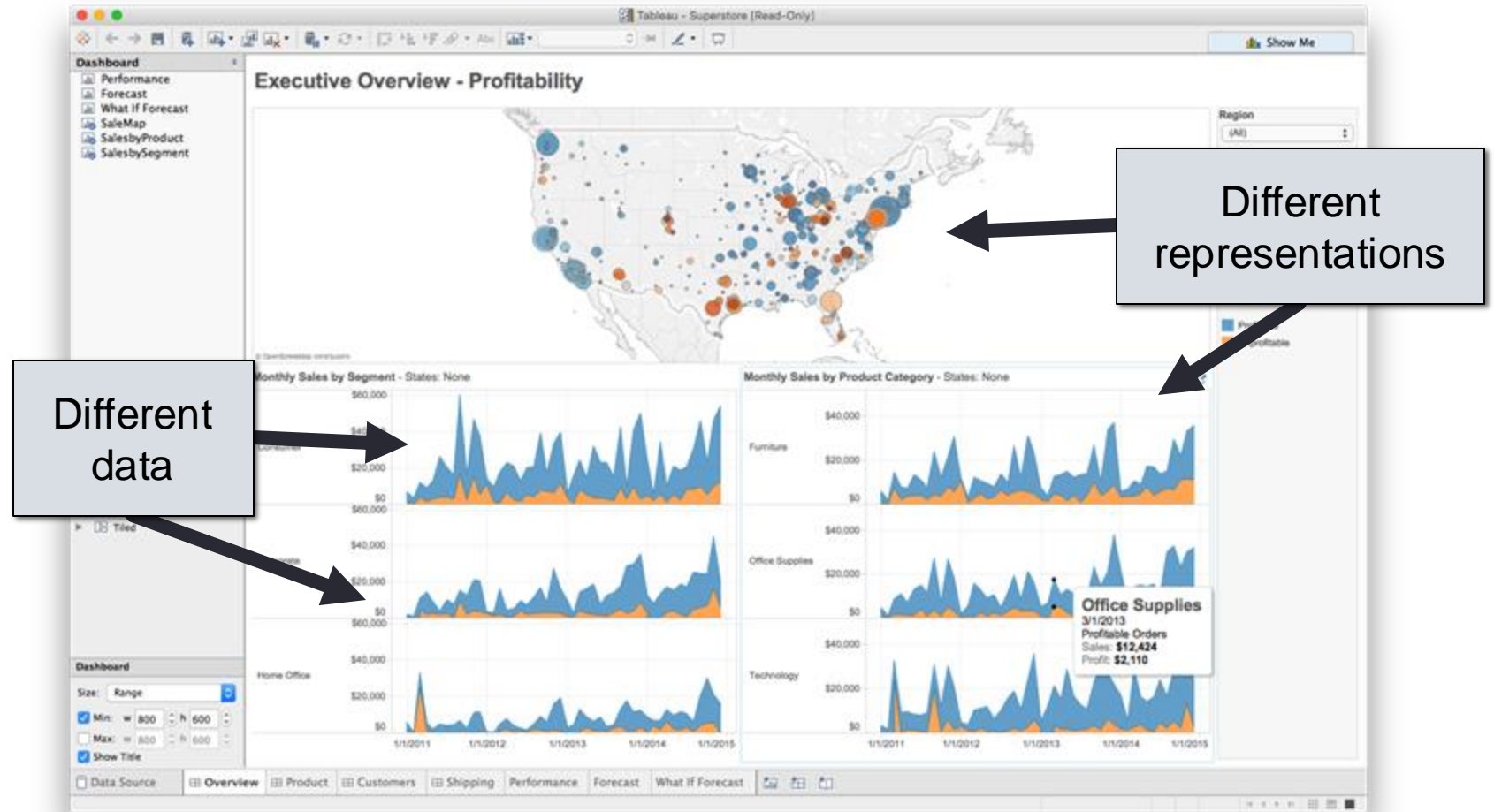
Systems that use **two or more distinct views**
to support the exploration of a single concept or domain

Discussion

What would we need to make this work?

Suggested questions to ask when designing

1. What is the goal of the analysis?
    - Decision-making
    - Better understand a domain or a problem
    - Identify the trends of a phenomenon
    - Forecast the future

   ...etc.

2. What kinds of operations do we need to enable?
3. How can the visualization support those operations?

Demo: coordinated multiple views

Tableau CMV walkthrough and exploration