

# Visual Analytics— Role of Interaction

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

# HW01

- Checking in:
  - How is it going?
  - Any big hurdles?

# Plan for Today

- Interaction and Analysis
  - Definition
  - Interaction with data and problem space
  - Interaction with visual interfaces
- Demo: plotly

Rewind

Humans and machines have **complimentary strengths**

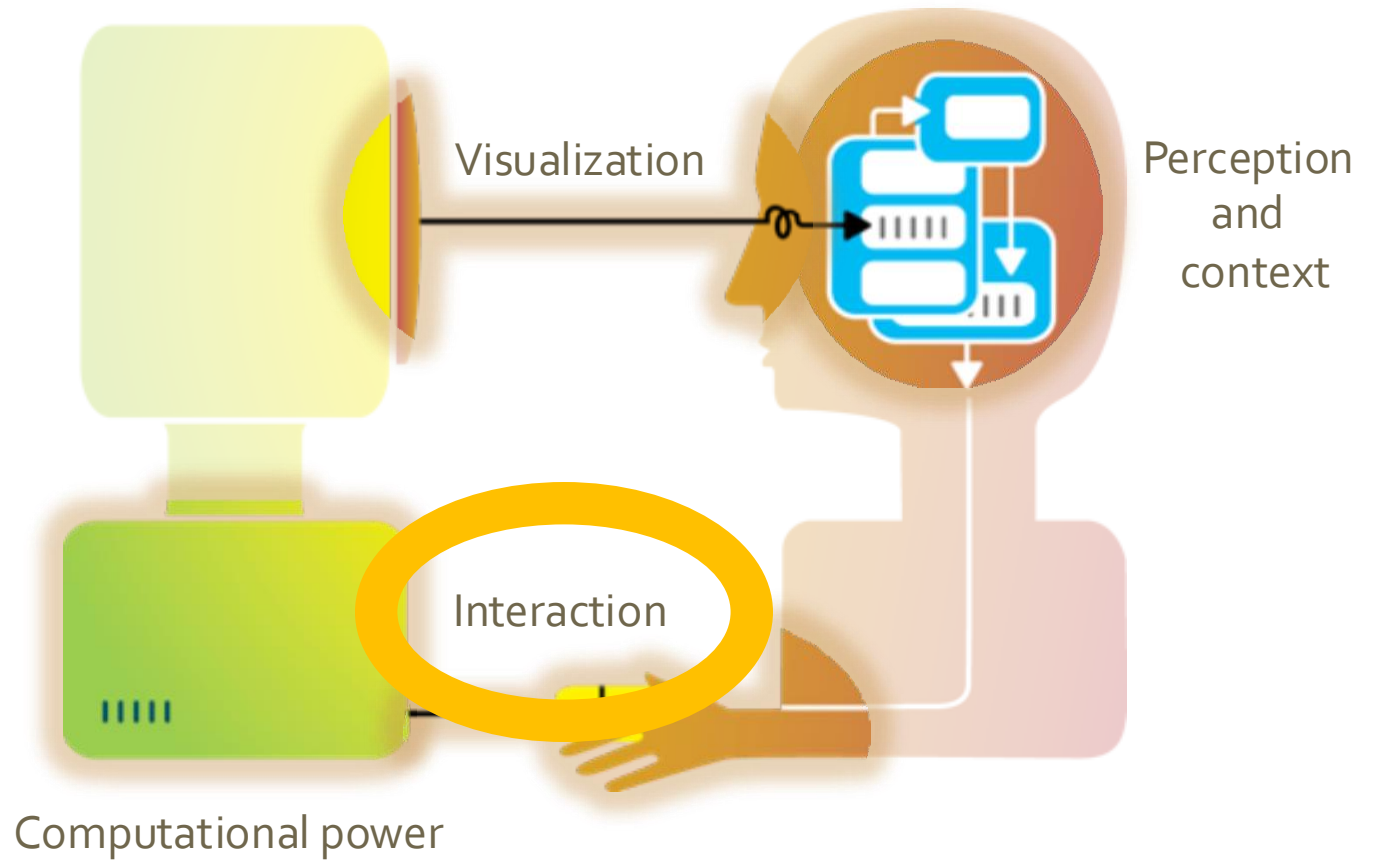


Image credit: Ali Ansari

# Interaction

## Visualization

- Conceptualized as a dialogue between a human user and the visualization system over a central object of interest: the data

## HCI

- Characterize via seven concepts
  1. Dialogue
  2. Transmission
  3. Control
  4. Tool Use
  5. Optimal Behavior
  6. Embodiment
  7. Experience

# 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

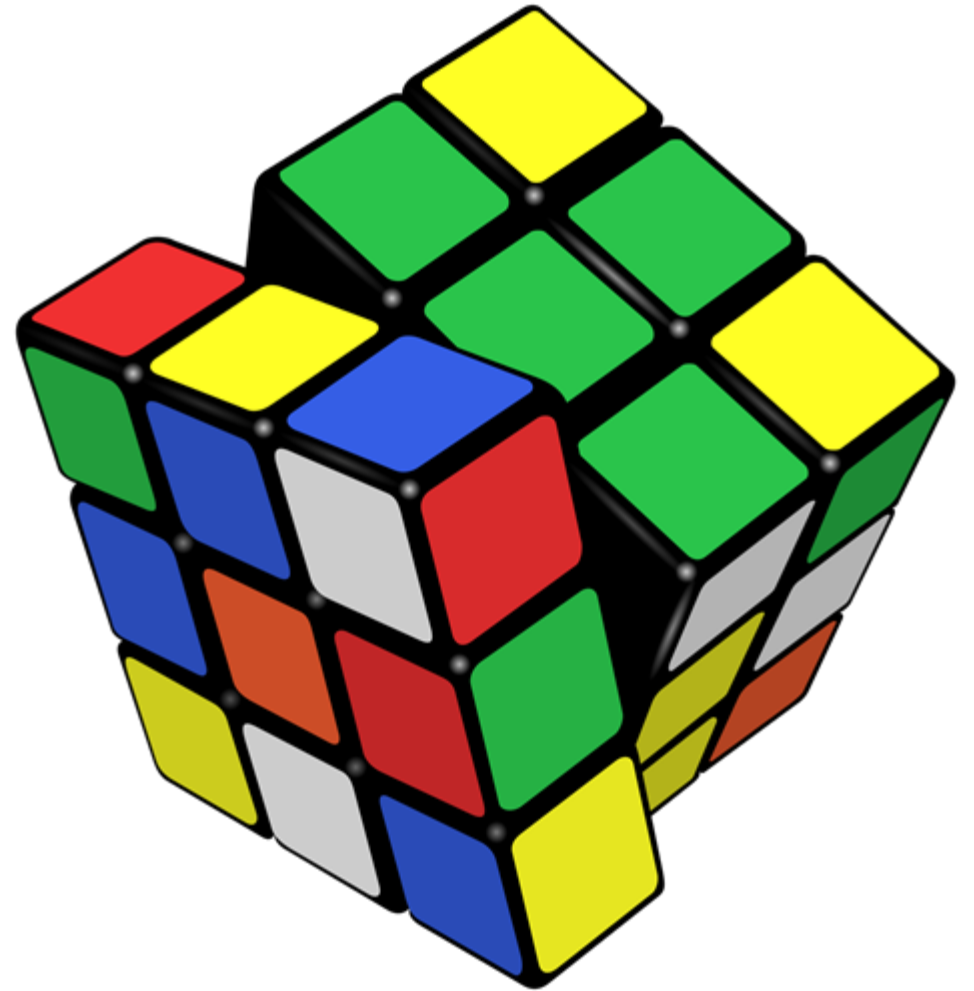
# Interaction

- 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<sup>1</sup>

<sup>1</sup>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**”

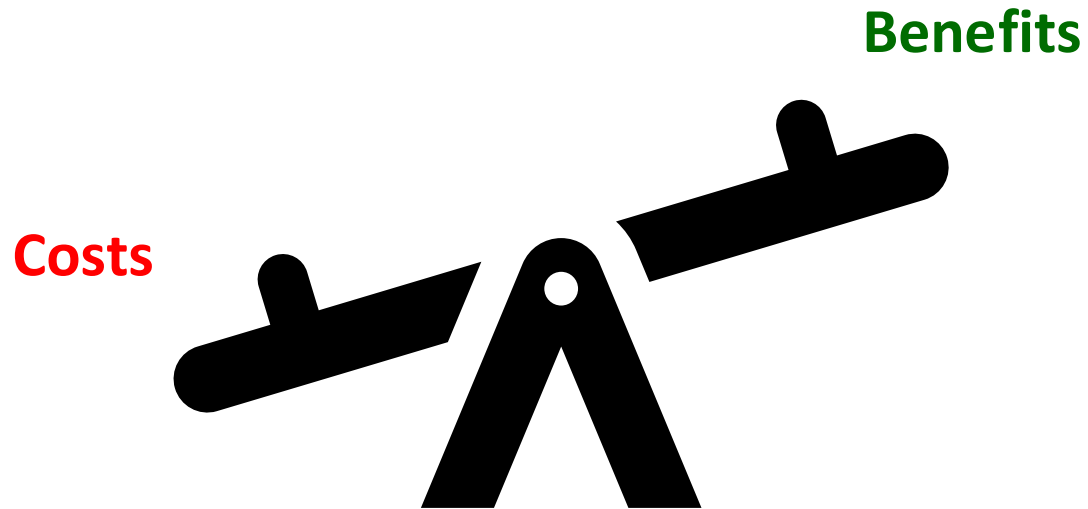
## Discussion

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



# 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



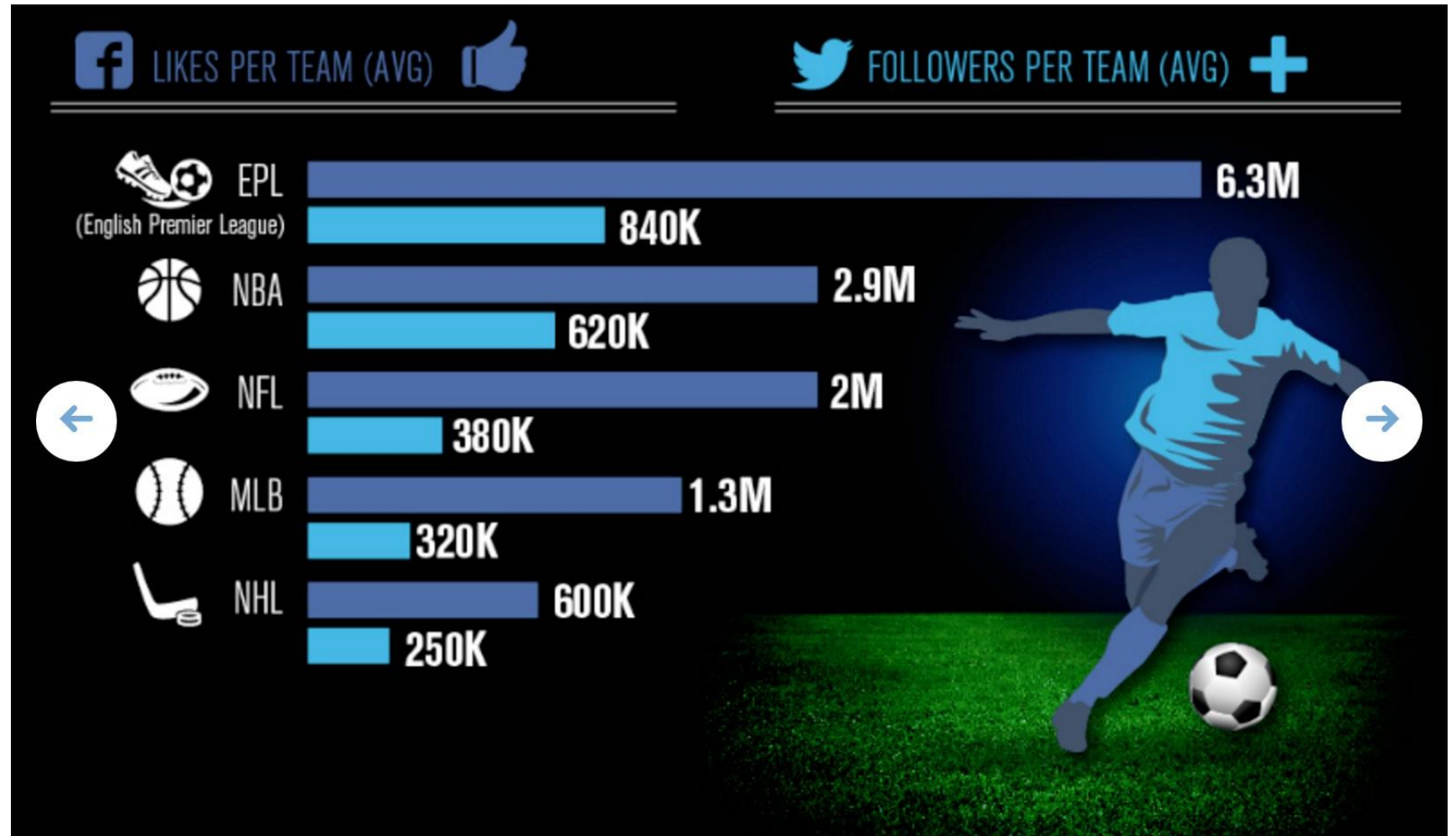
# Example: Tower of Hanoi

Rule1 Rule2 Rule3



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



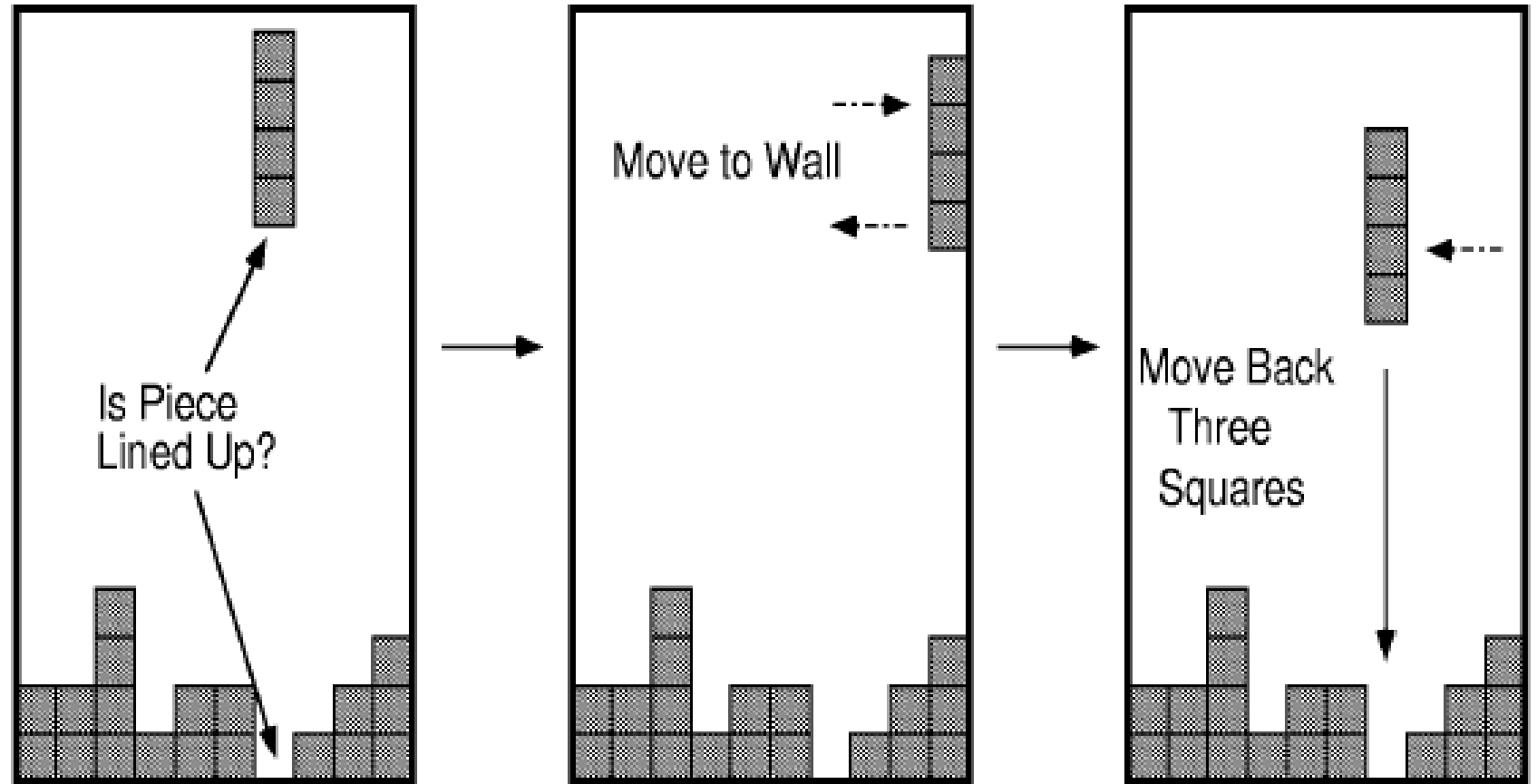
Is changing the page internal or external?



## 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**

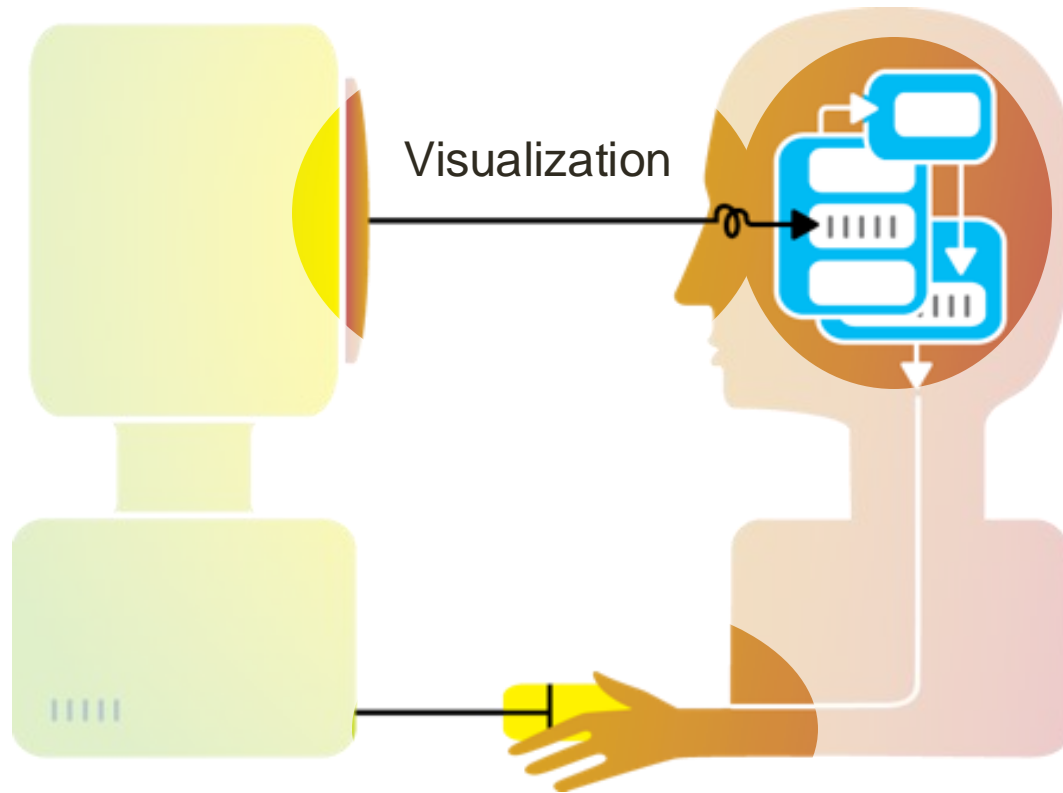
# Example: Tetris Behavior



# Part II

## Interaction with a Visual Interface

So far...



## 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?

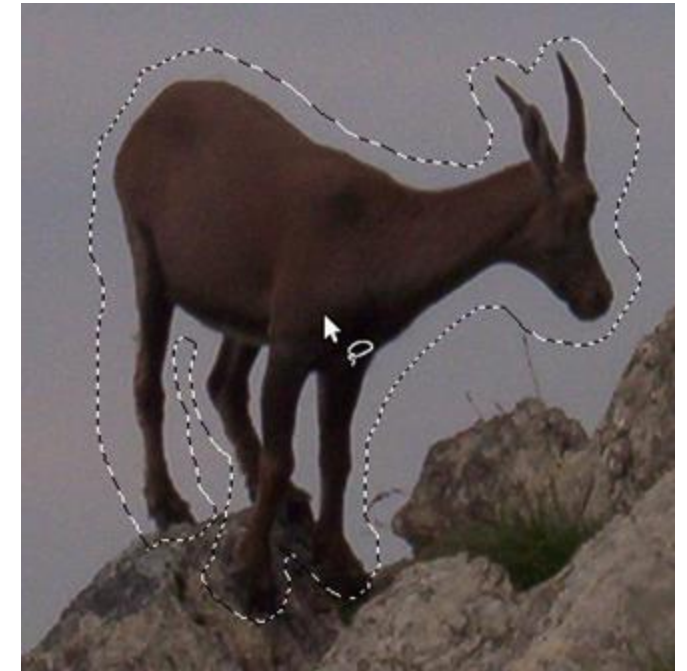
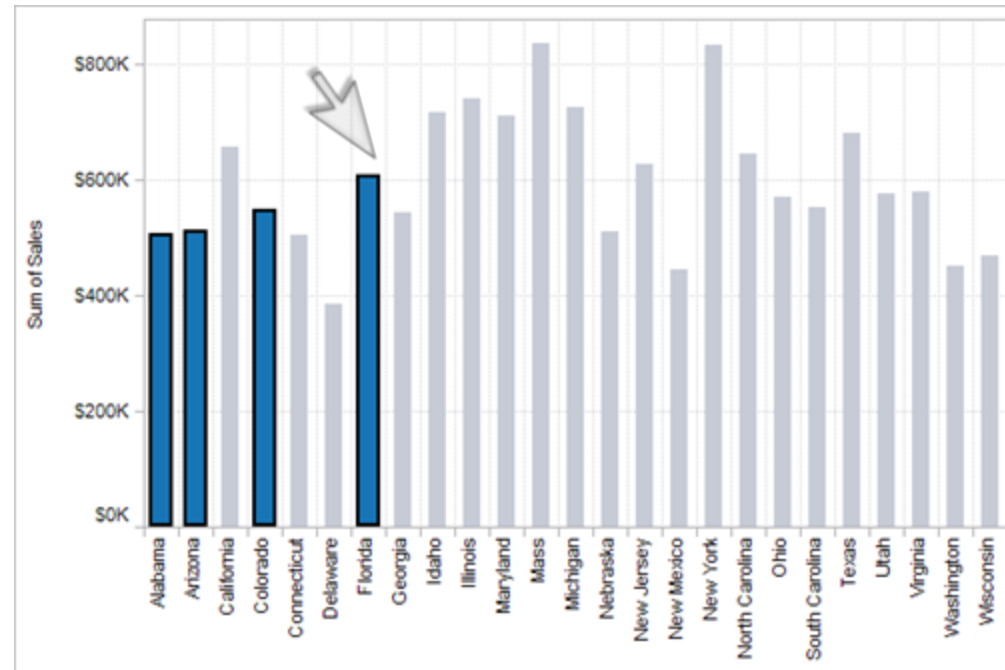
# Yi, Kang, Stasko and Jacko (2007)

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., 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.

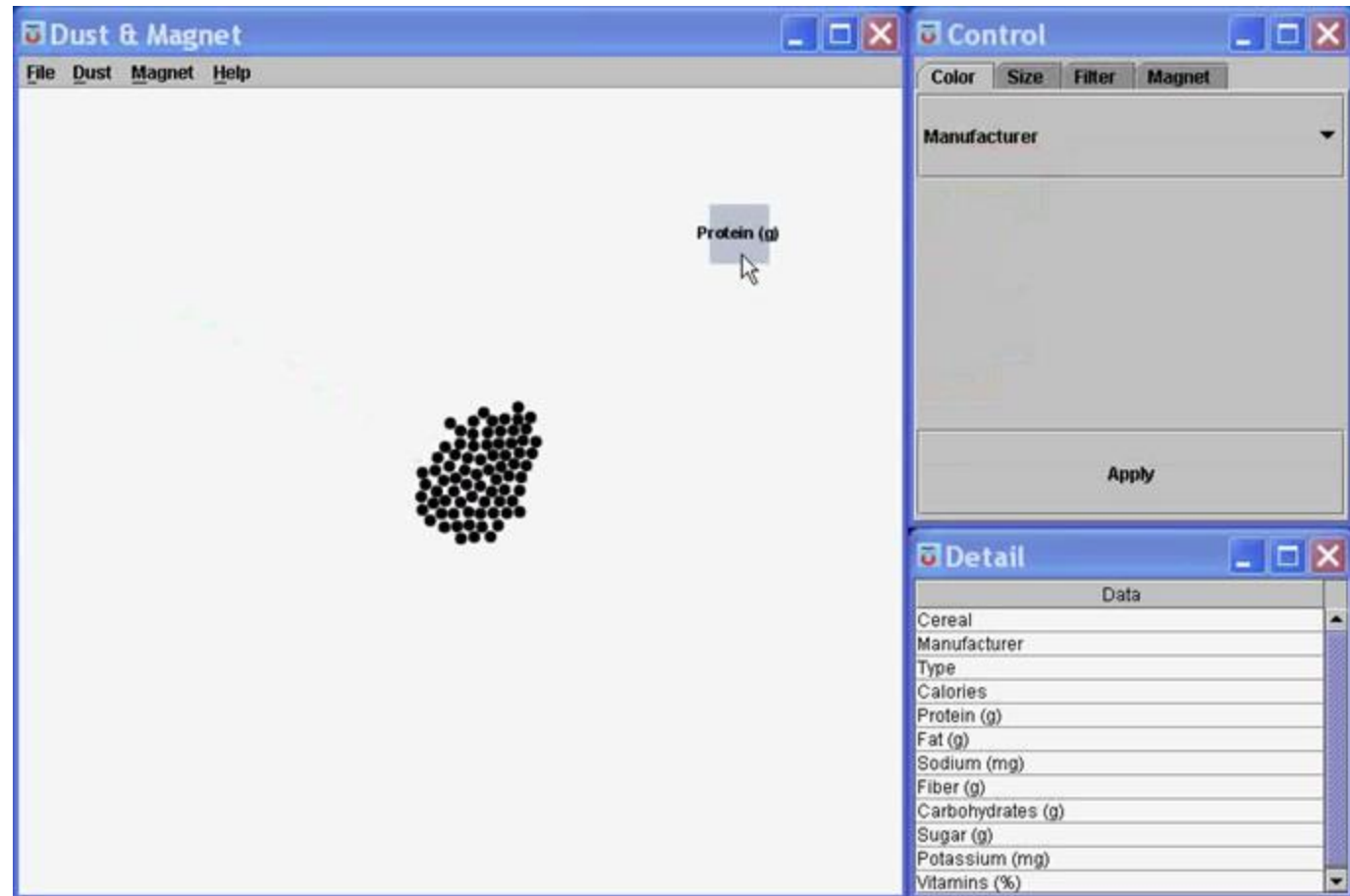
# 1. Select

Mark something as interesting: direct



# 1. Select

Mark something as interesting: indirect

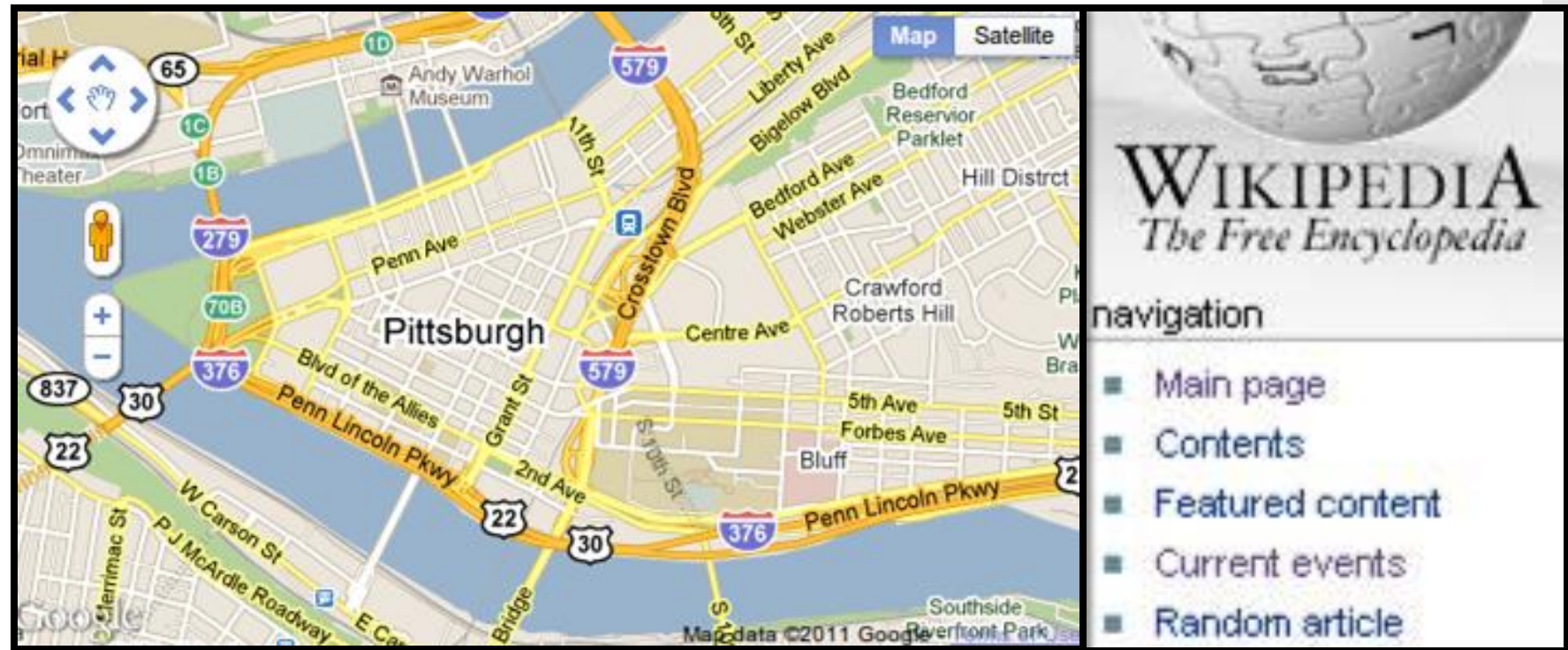




## 2. Explore

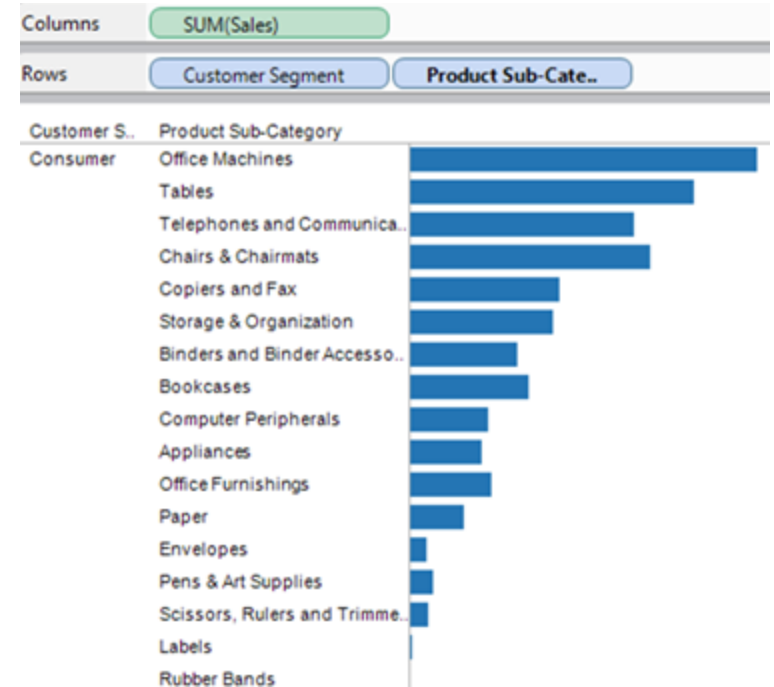
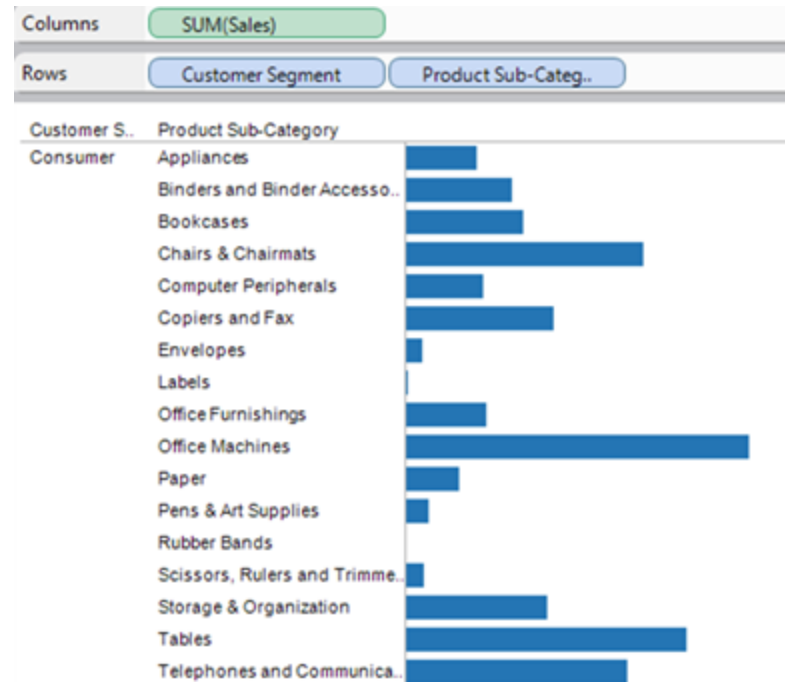
Show me something else

- Scroll bars
- Panning
- Direct-Walk (e.g. hyperlink traversal)



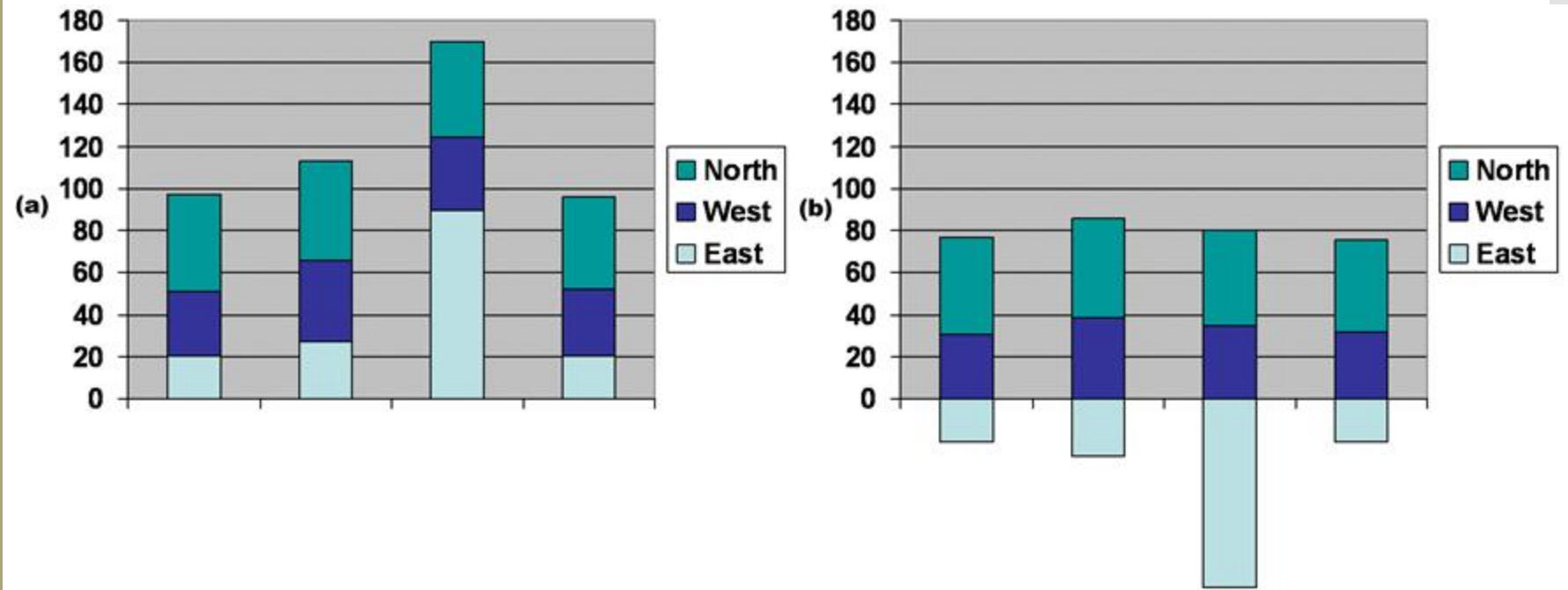
### 3. Reconfigure

Show me a different arrangement: sorting



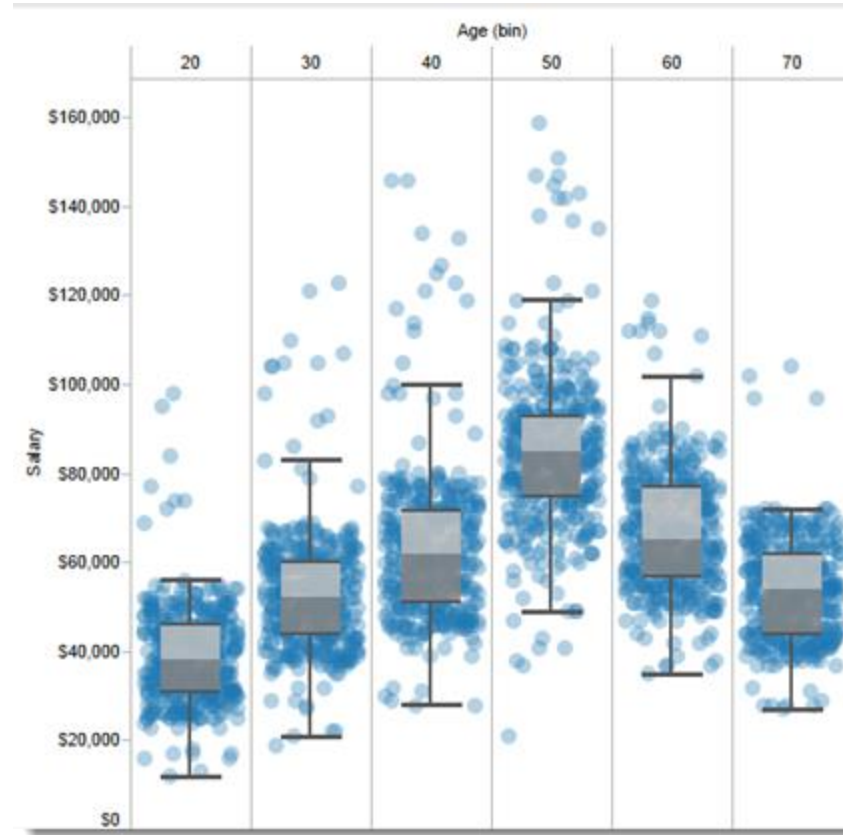
### 3. Reconfigure

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





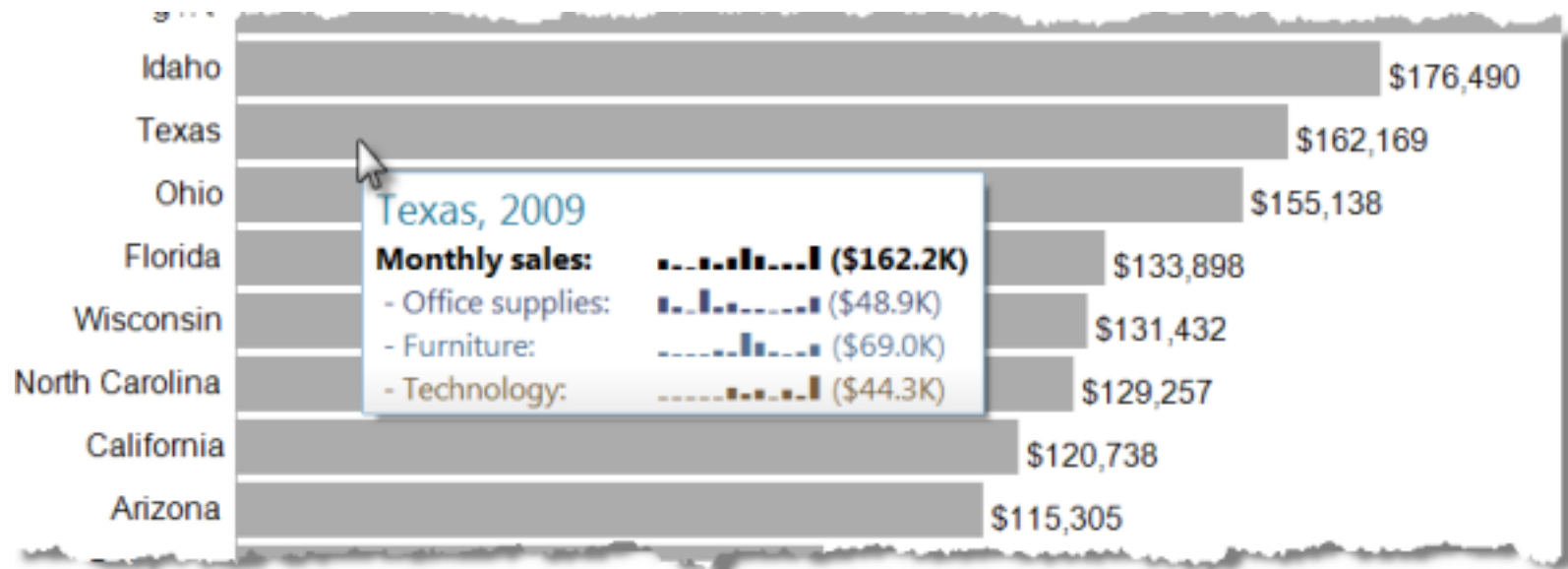
## 5. Abstract / Elaborate

Show me more or less detail: zooming



5. Abstract /  
Elaborate

Show me more or less detail: tooltips





## 6. Filter

Show me something conditionally

**NameVoyager:** Explore baby names and name trends letter by letter

Looking for the perfect baby name? [Sign up for free](#) to receive access to our expert tools!

Baby Name >

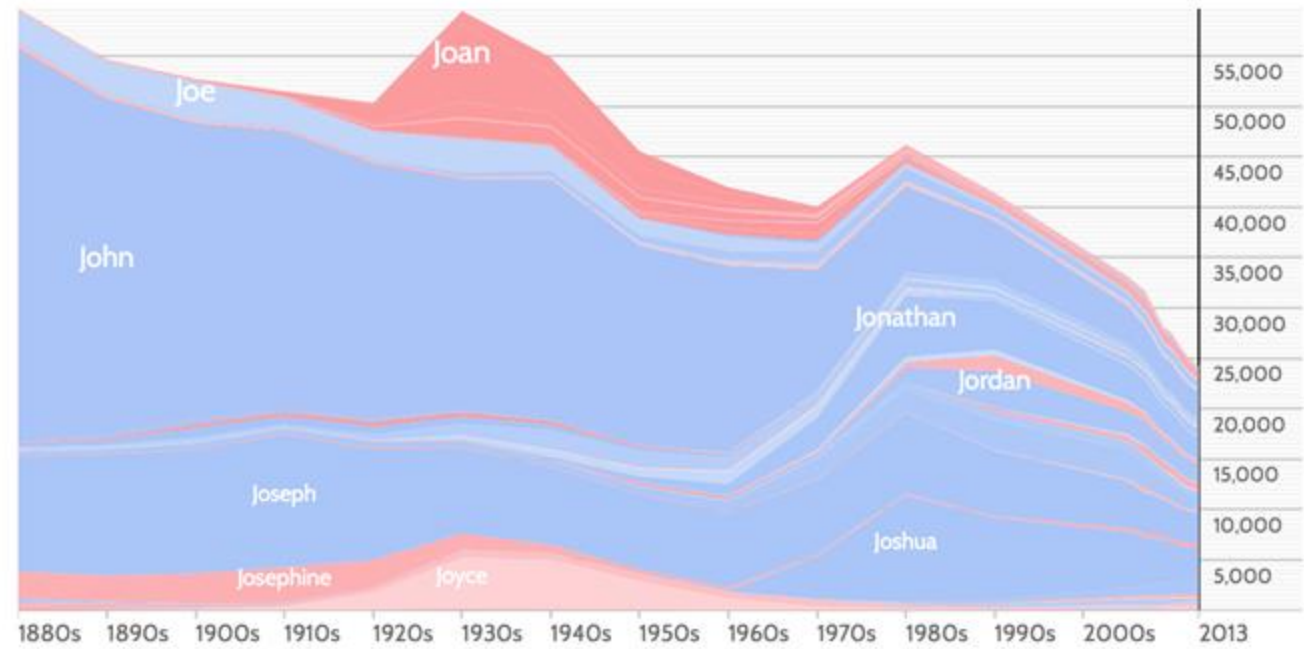
☒ Both ☐ Boys ☐ Girls

boys	1000	500	100	25	1
girls	1000	500	100	25	1

Current rank:

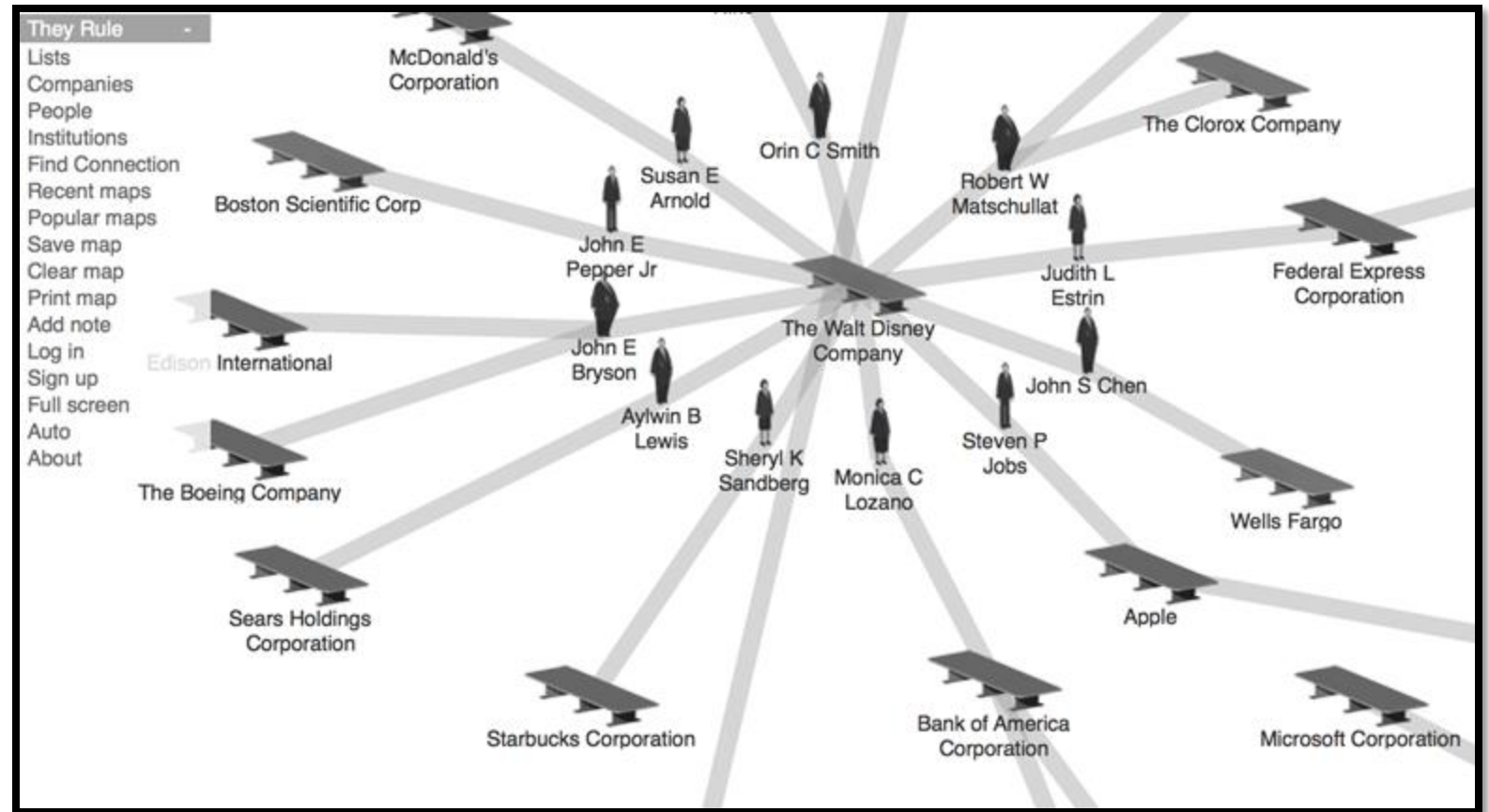
Names starting with 'JO' per million babies

per million births



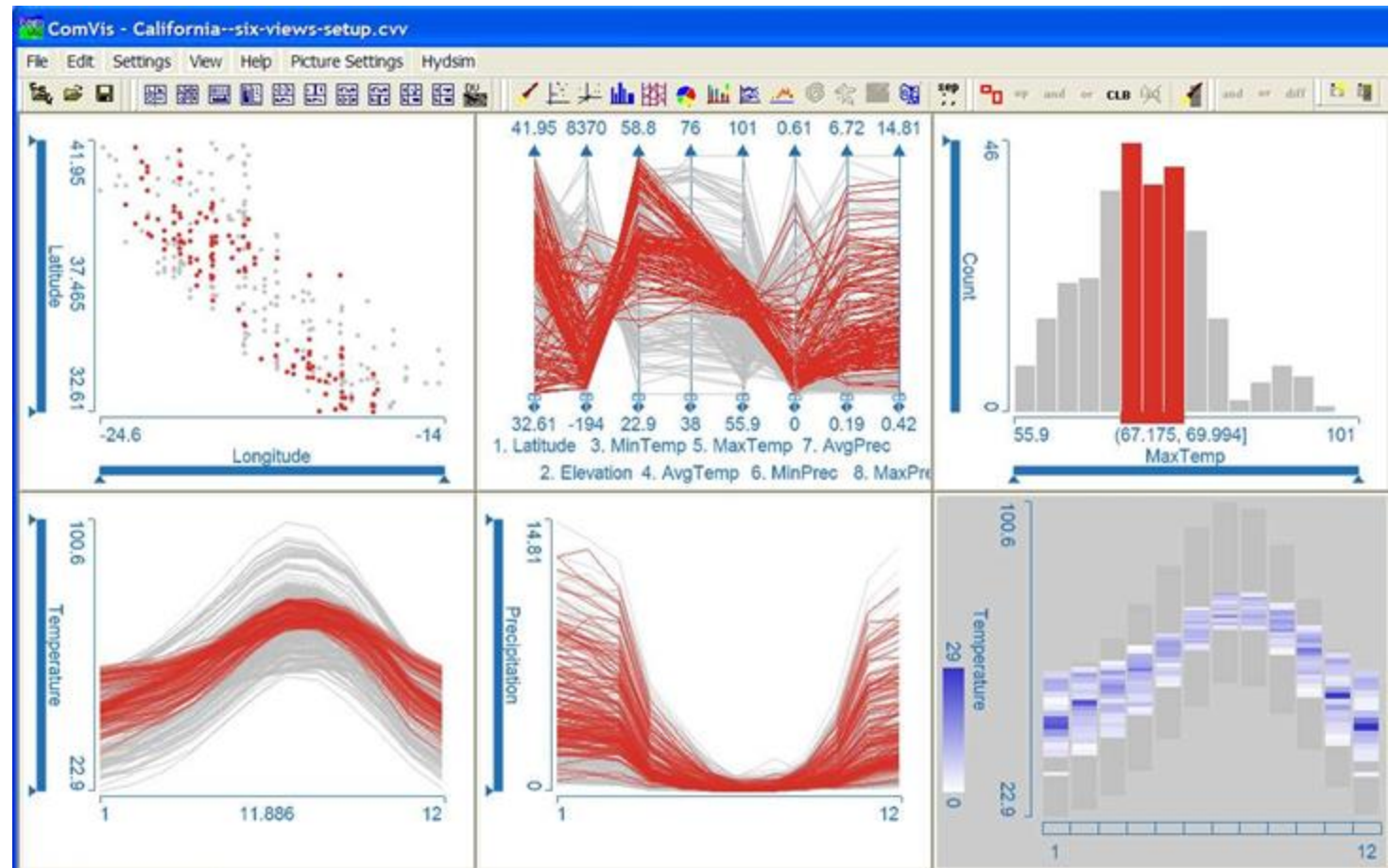
## 7. Connect

Show me related items: build-out

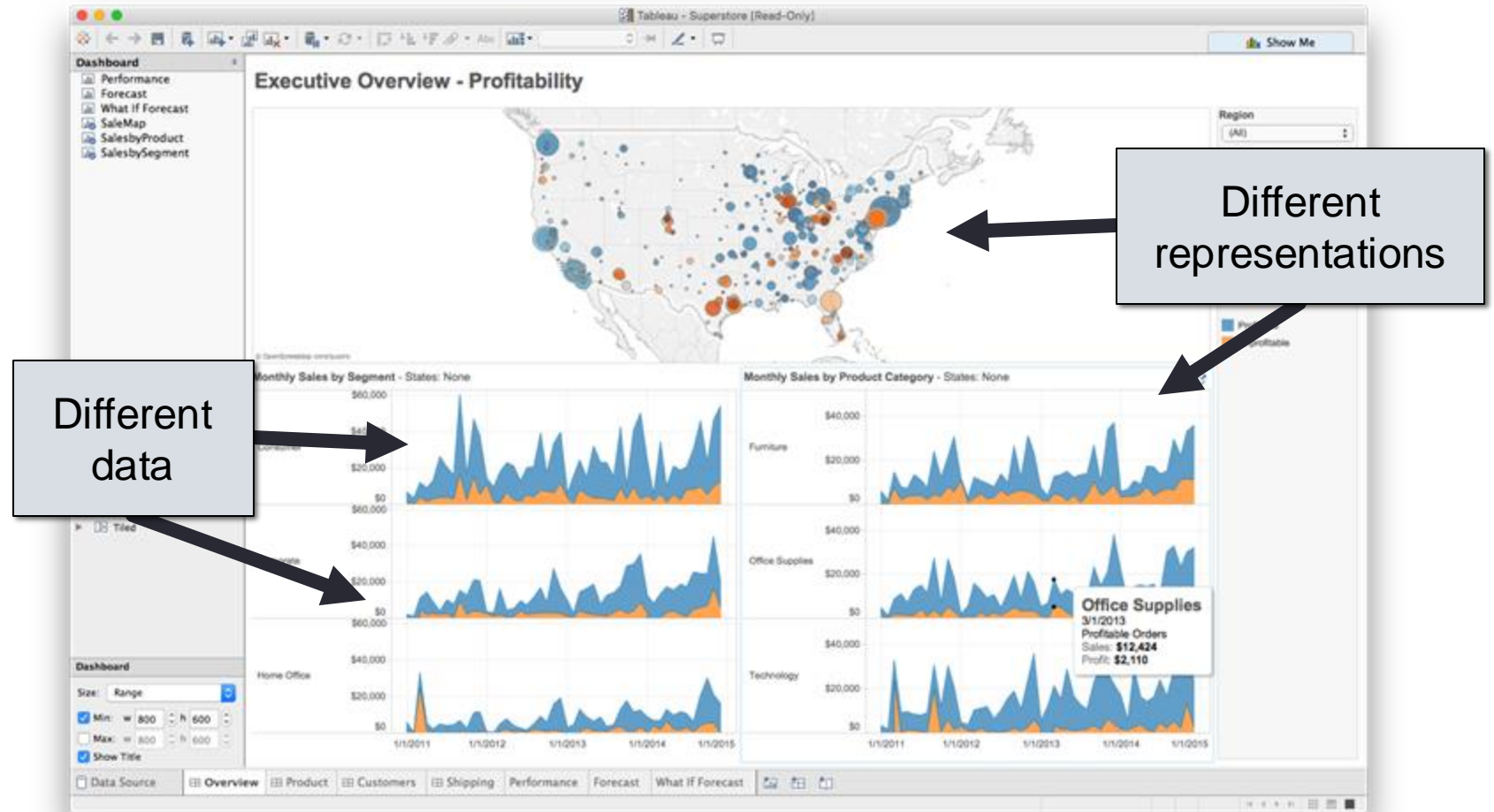


## 7. Connect

Show me related items: coordinated multiple views (CMV)



# Foreshadowing: Multiple views



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?



Plotly Demo