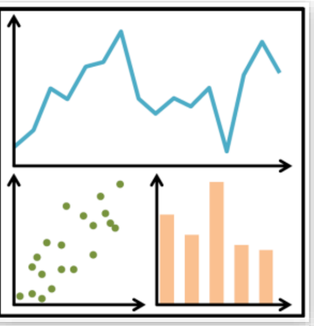
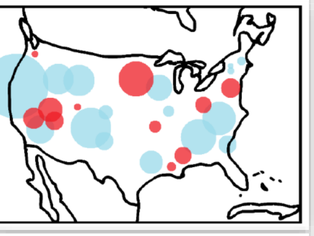
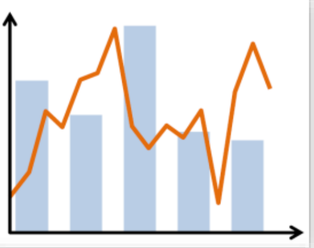
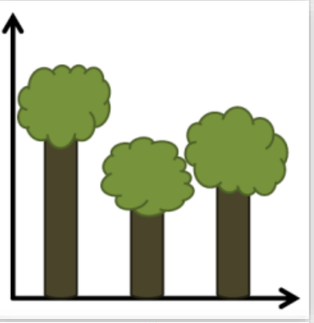
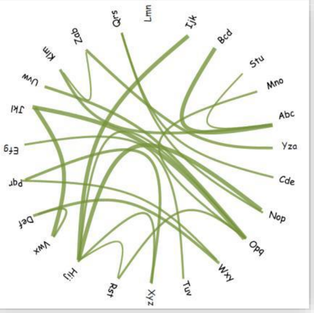






Lecture 12: Interaction, Animation

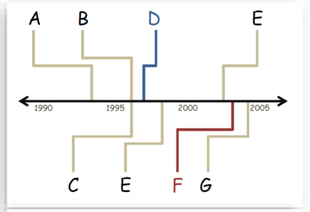
CS 7250

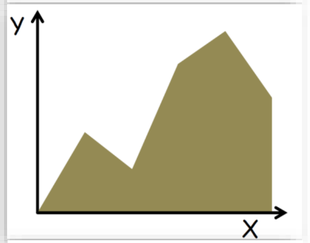
SPRING 2021

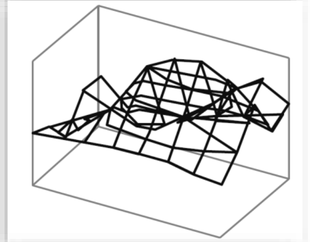
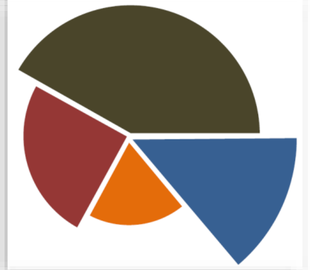
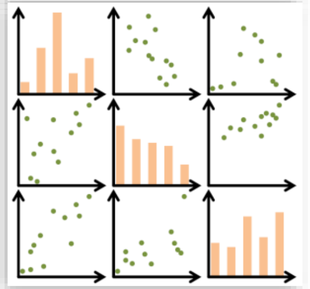
Prof. Cody Dunne

NORTHEASTERN UNIVERSITY

Slides and inspiration from Michelle Borkin, Krzysztof Gajos, Hanspeter Pfister, Miriah Meyer, Jonathan Schwabish, and David Sprague





Checking In

MID-TERM COURSE EVALS

Thank you to the 8 of you who participated!

POLL: WHAT DO YOU THINK OF VAD AS A TEXTBOOK?

- A: It’s great!
- B: It’s fine.
- C: Meh ¯_(ツ)_/¯
- D: I don’t really like it.
- E: It’s terrible!

Poll: Have we been giving enough time for in-class activities?

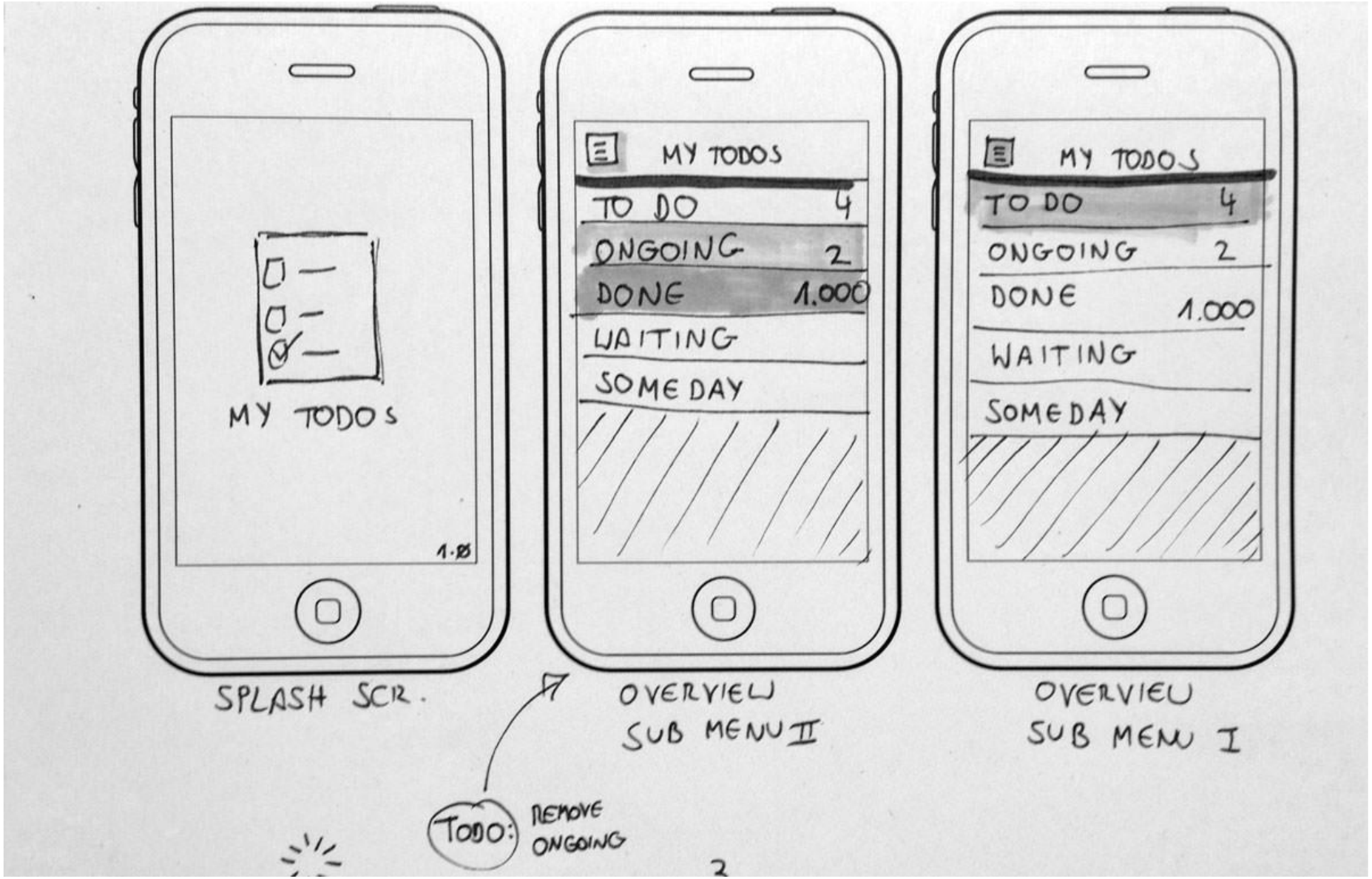
- A: Yes, more than enough. I generally have a fair bit of spare time.
- B: Usually, but sometimes I feel rushed.
- C: Meh ¯_(ツ)_/¯
- D: I often have enough time to finish and am usually rushing.
- E: I almost never get it finished in the time allotted.

Poll: Would you like a brief break during class to get up and move?

- A: Yeah, that would be great!
- B: Sure.
- C: Meh ¯_(ツ)_/¯
- D: No, but I wouldn’t really mind one.
- E: No, that really feels unnecessary.

Previously, on CS 7250…

Sketching of Interactivity



Now, on CS 7250…

INTERACTION

Goals for Today

- Learn when and why to use interaction.
- Learn the “Shneiderman Mantra”.
- Learn the basic interactive functions for visualizations.

Interaction

Why interaction?

- Complexity reduction
- Static = specific story told to you, versus interactive = viewer discovers the story
- Enables data exploration, insight, reasoning for oneself
- Makes it personal to the viewer
- Dive deeper!

Interaction

A few footnotes...

- Interaction requires human time and attention
- Human-guided search vs. Automatic feature detection vs. Interactive visualizations
- Find balance between automation and relying on the human in the loop to detect patterns

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

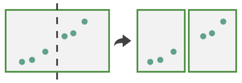
Select

Navigate

Facet

Juxtapose

Partition



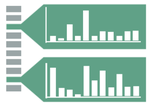
Superimpose

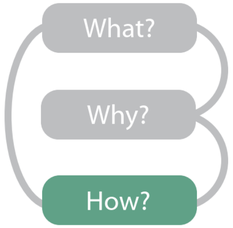
Reduce

Filter

Aggregate

Embed

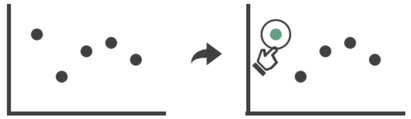




Manipulate

Change over Time

Select



Navigate

→ Item Reduction

→ *Zoom*
Geometric or *Semantic*

→ *Pan/Translate*

→ *Constrained*

→ Attribute Reduction

→ *Slice*

→ *Cut*

→ *Project*

Interaction

Key Concepts:

- Change over time
  - Encodings, Animated Transition
- Selection
  - Highlight
- Navigation
  - Pan/Translate, rotate, zoom

“Overview first, zoom and filter, and details on demand.”

- Ben Shneiderman

“The Shneiderman Mantra”

Shneiderman, 1996

Interaction

Shneiderman Mantra:

- Overview — provide high-level view/summary
- Zoom and Filter — enable data discovery and exploration, support search/tasks
- Details on Demand — do not overwhelm the viewer. Provide extra information as needed

There are many visual design guidelines but the basic principle might be summarized as the Visual Information Seeking Mantra:

Overview first, zoom and filter, then details-on-demand
Overview first, zoom and filter, then details-on-demand
Overview first, zoom and filter, then details-on-demand
Overview first, zoom and filter, then details-on-demand
Overview first, zoom and filter, then details-on-demand
Overview first, zoom and filter, then details-on-demand
Overview first, zoom and filter, then details-on-demand
Overview first, zoom and filter, then details-on-demand
Overview first, zoom and filter, then details-on-demand
Overview first, zoom and filter, then details-on-demand

Each line represents one project in which I found myself rediscovering this principle and therefore wrote it down it as a reminder. It proved to be only a starting point in trying to characterize the multiple information-visualization innovations occurring at university, government, and industry research labs.

“Search, show context, expand on demand”

- van Ham & Perer

Interaction

van Ham & Perer approach:

- Search — pick subset of data to focus on.
- Show context — show connected or relevant data for the user's current interests.
- Expand on demand — user chooses to expand the context in a direction of interest.

van Ham & Perer, 2009

Queries and Filtering

Manipulate

Change over Time

Select

Navigate

Item Reduction

- *Zoom*
  Geometric or *Semantic*

- *Pan/Translate*

- *Constrained*

Attribute Reduction

- *Slice*

- *Cut*

- *Project*

Gapminder Bubbles

Gapminder, 2018

D3 General **Enter**, **Update**, **Exit** Pattern

abcdefghijklmnopqrstuvwxyz

Mike Bostock, 2016
(can use *selection.join* to simplify)

Change over Time

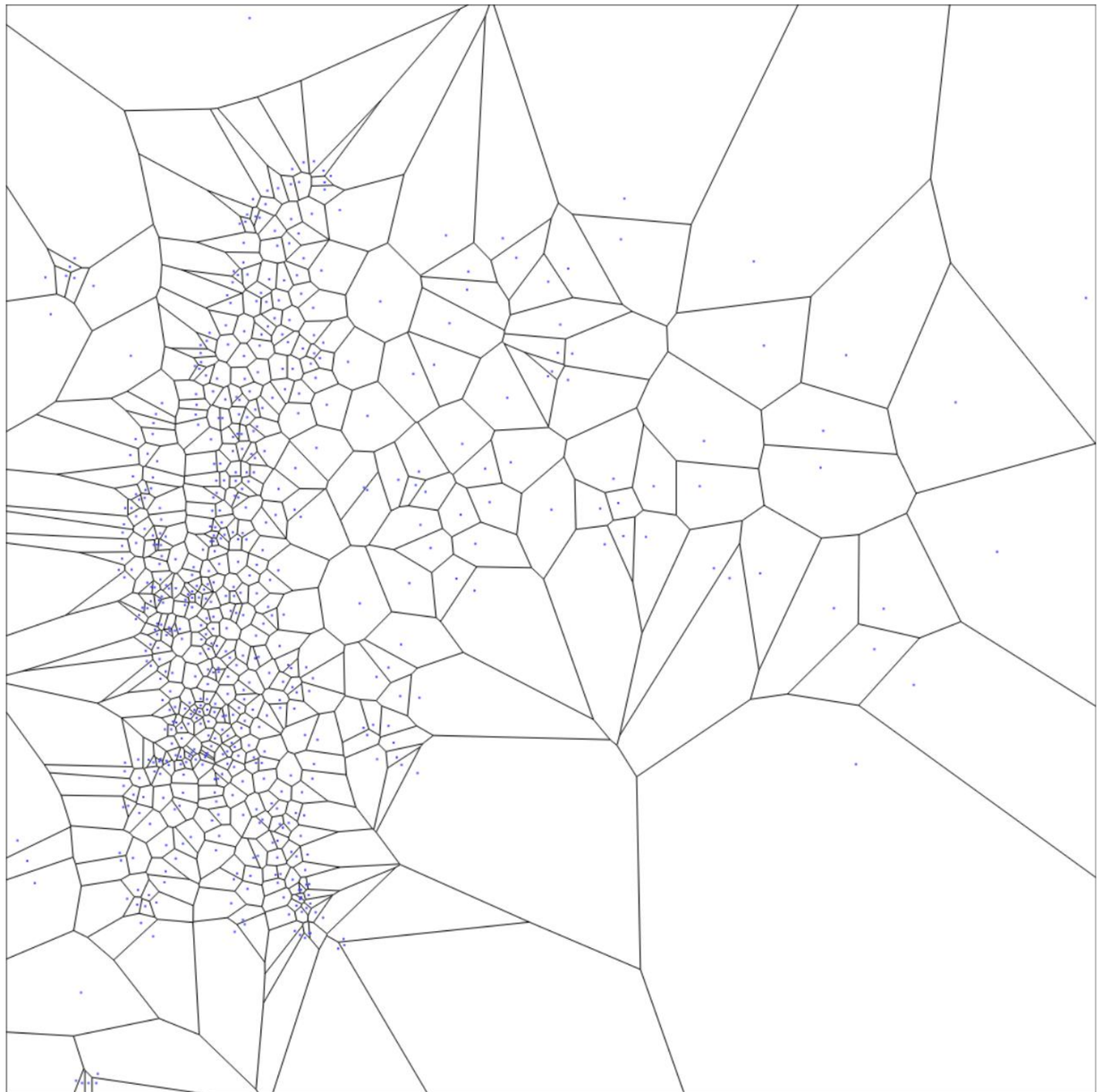
D3 Animated Transitions

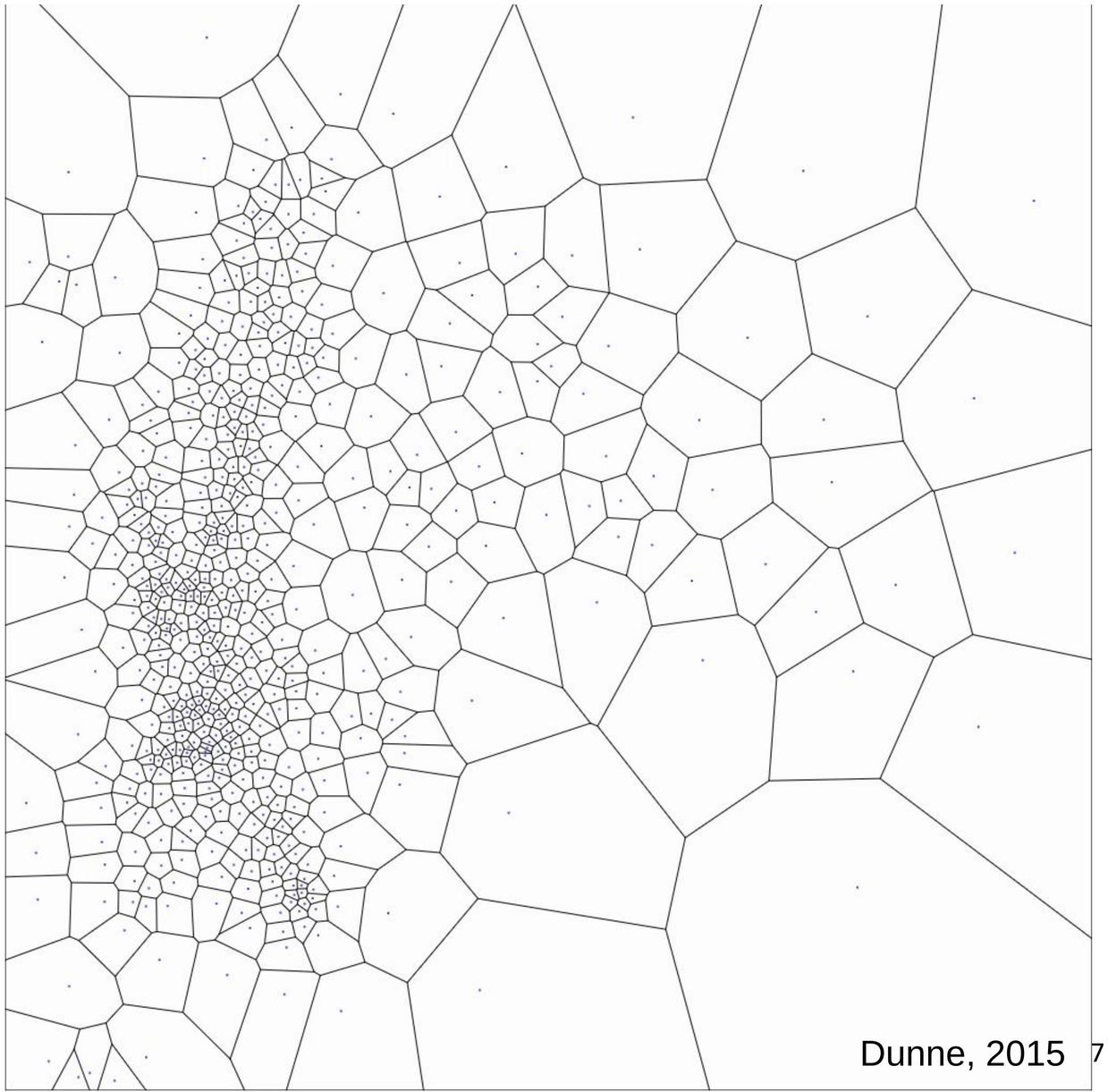
flexible transitions

Mike Bostock, 2011

Change over Time

Centroidal Voronoi Tesselation





Dunne, 2015

Queries and Filtering

Manipulate

Change over Time

Select

Navigate

→ Item Reduction

→ *Zoom*
Geometric or *Semantic*

→ *Pan/Translate*

→ *Constrained*

→ Attribute Reduction

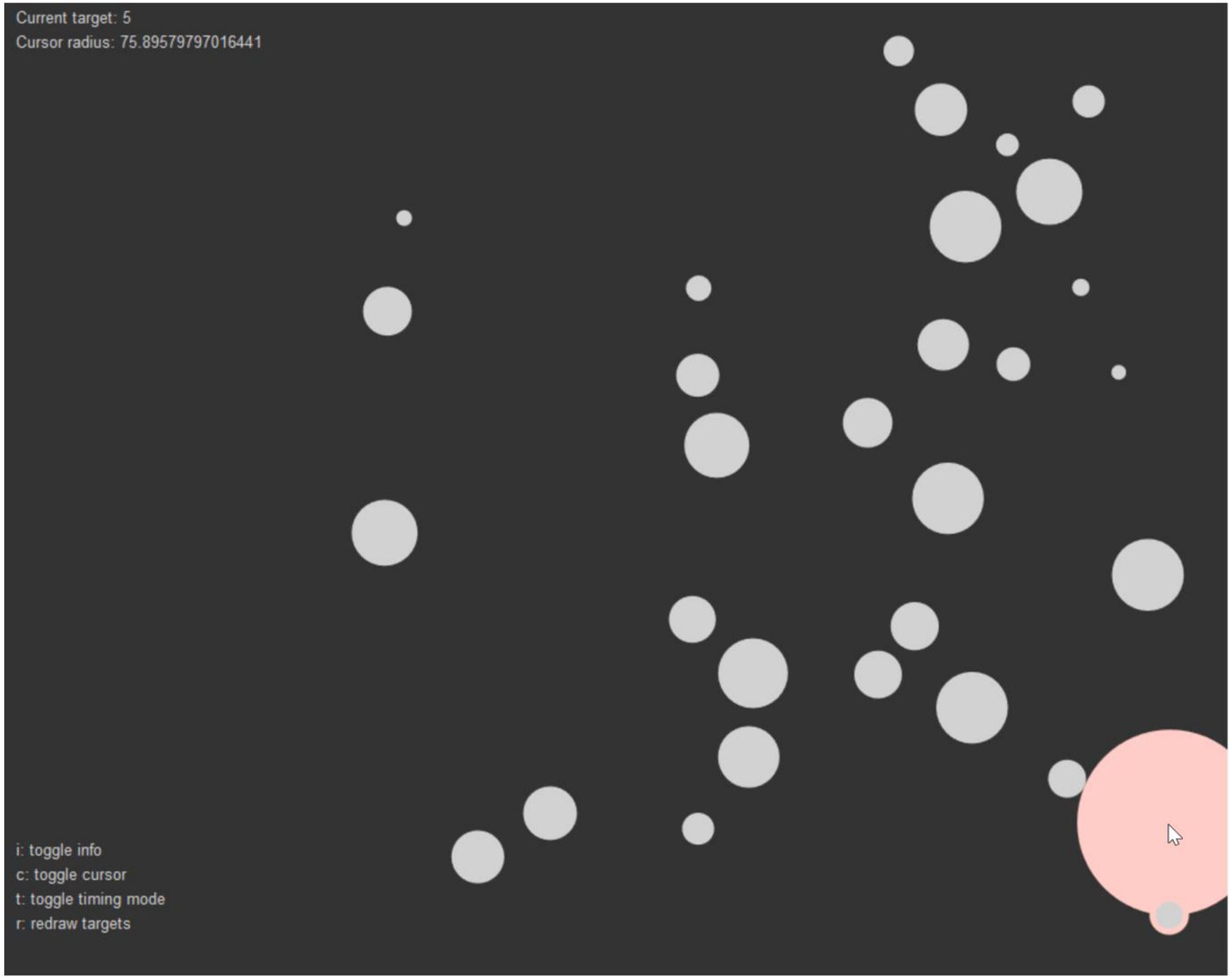
→ *Slice*

→ *Cut*

→ *Project*

Select

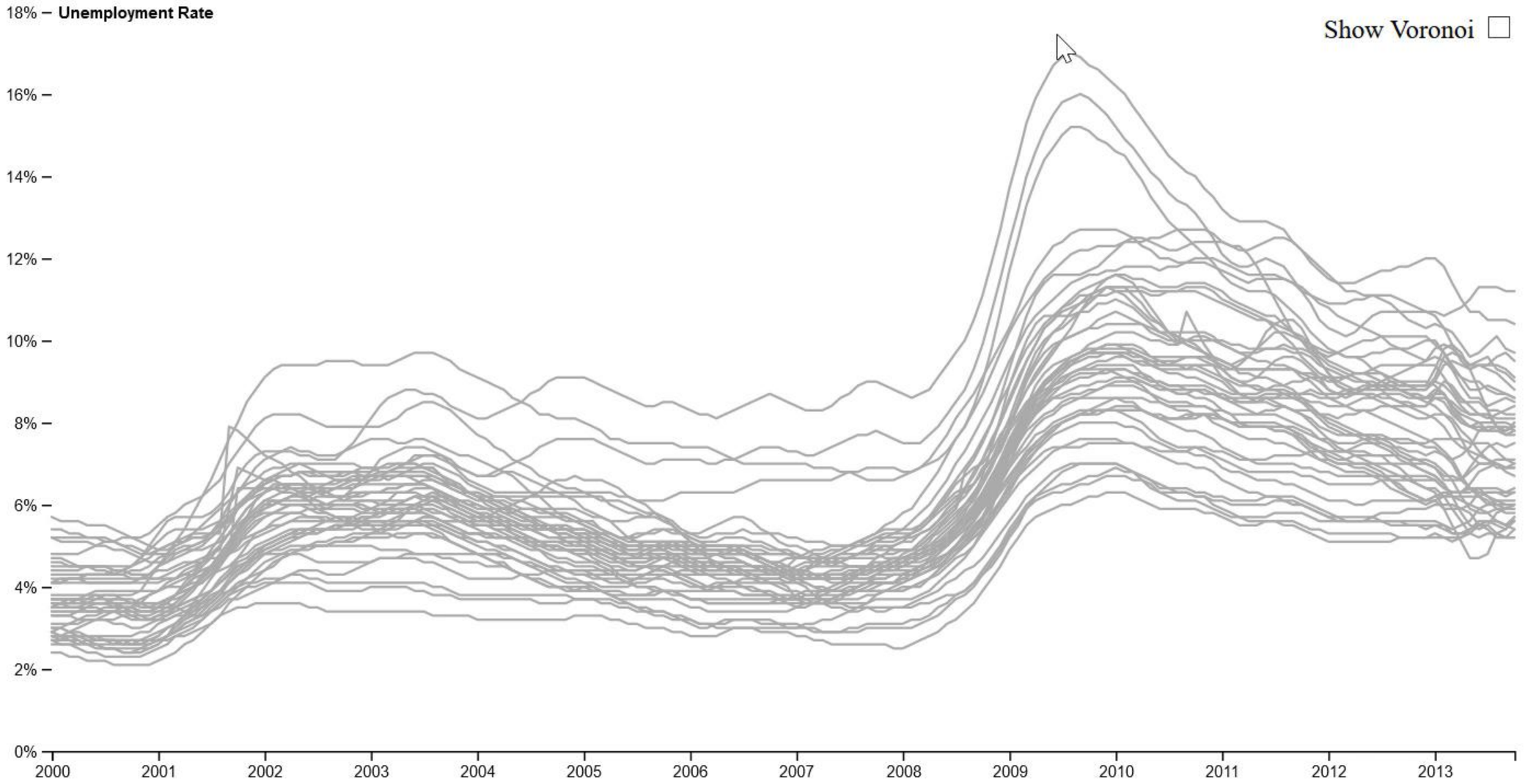
Bubble Cursors



Grossman and Balakrishnan, 2005; Anand Kulkarni, 2010

Select

Voronoi Cursors



Mike Bostock, 2019

Queries and Filtering

Manipulate

Change over Time

Select

Navigate

→ Item Reduction

→ *Zoom*
Geometric or *Semantic*

→ *Pan/Translate*

→ *Constrained*

→ Attribute Reduction

→ *Slice*

→ *Cut*

→ *Project*

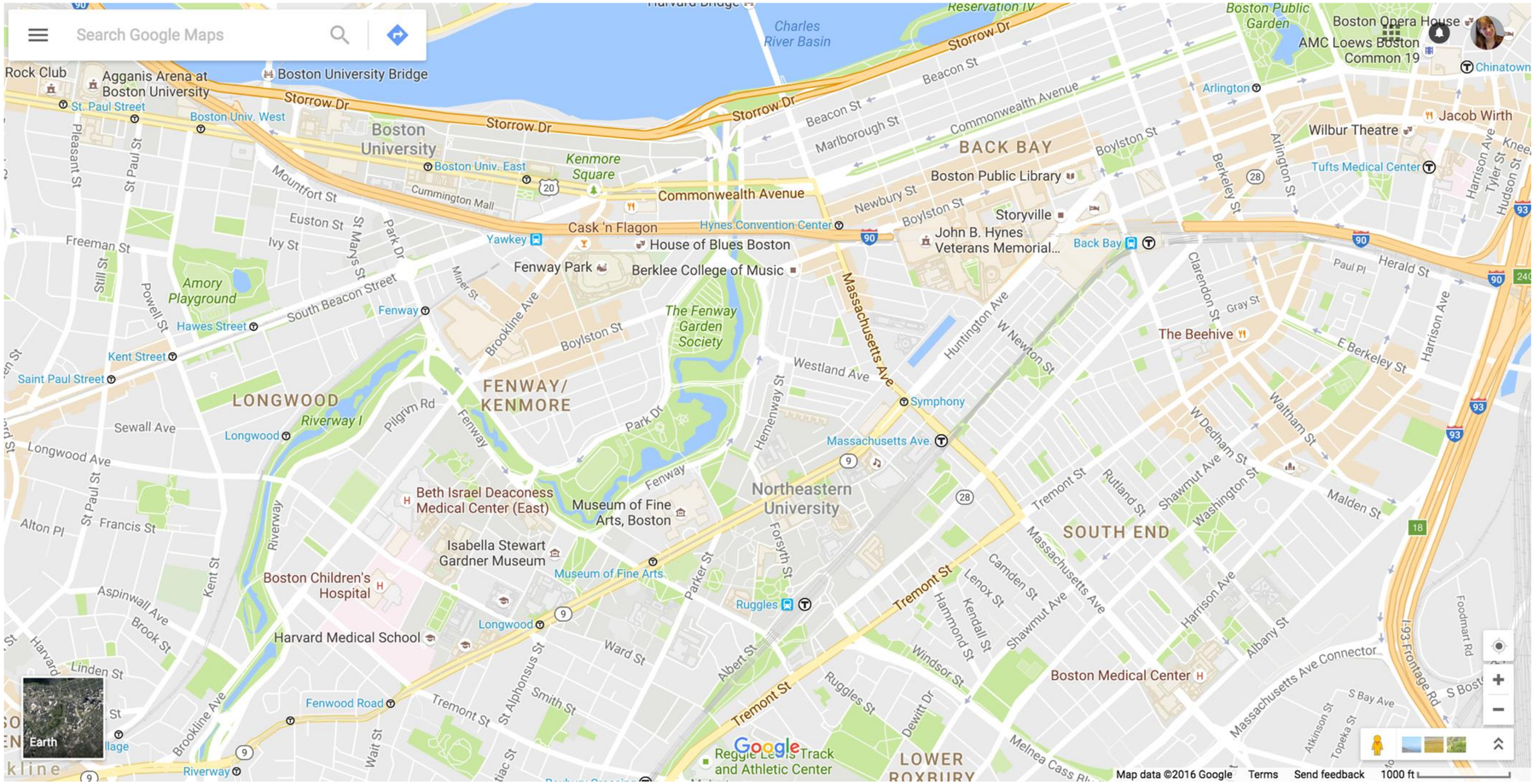
➔ Item Reduction

➔ *Zoom*
Geometric or *Semantic*

➔ *Pan/Translate*

➔ *Constrained*

Navigation



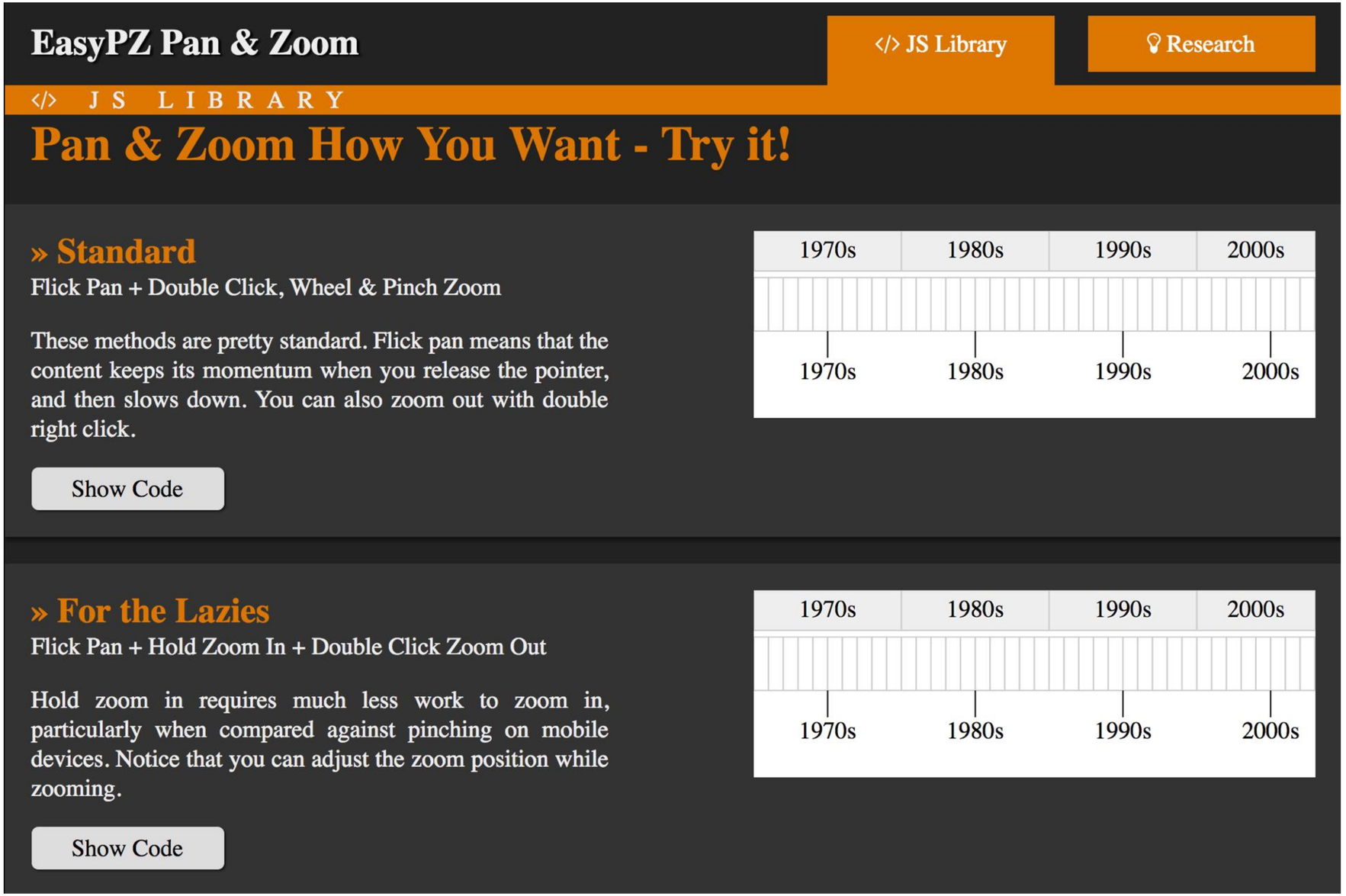
[Google Maps, 2020]

IN-CLASS EXERCISE

Zoom techniques

In-class activity in breakout rooms: experiment with zooming and panning

easypz.io



Michail Schwab
PhD 2020
Khoury Data Visualization

Queries and Filtering

Manipulate

- **Change over Time**

- **Select**

- **Navigate**
  - Item Reduction
    - *Zoom*
      Geometric or *Semantic*

    - *Pan/Translate*

    - *Constrained*

  - Attribute Reduction
    - *Slice*

    - *Cut*

    - *Project*

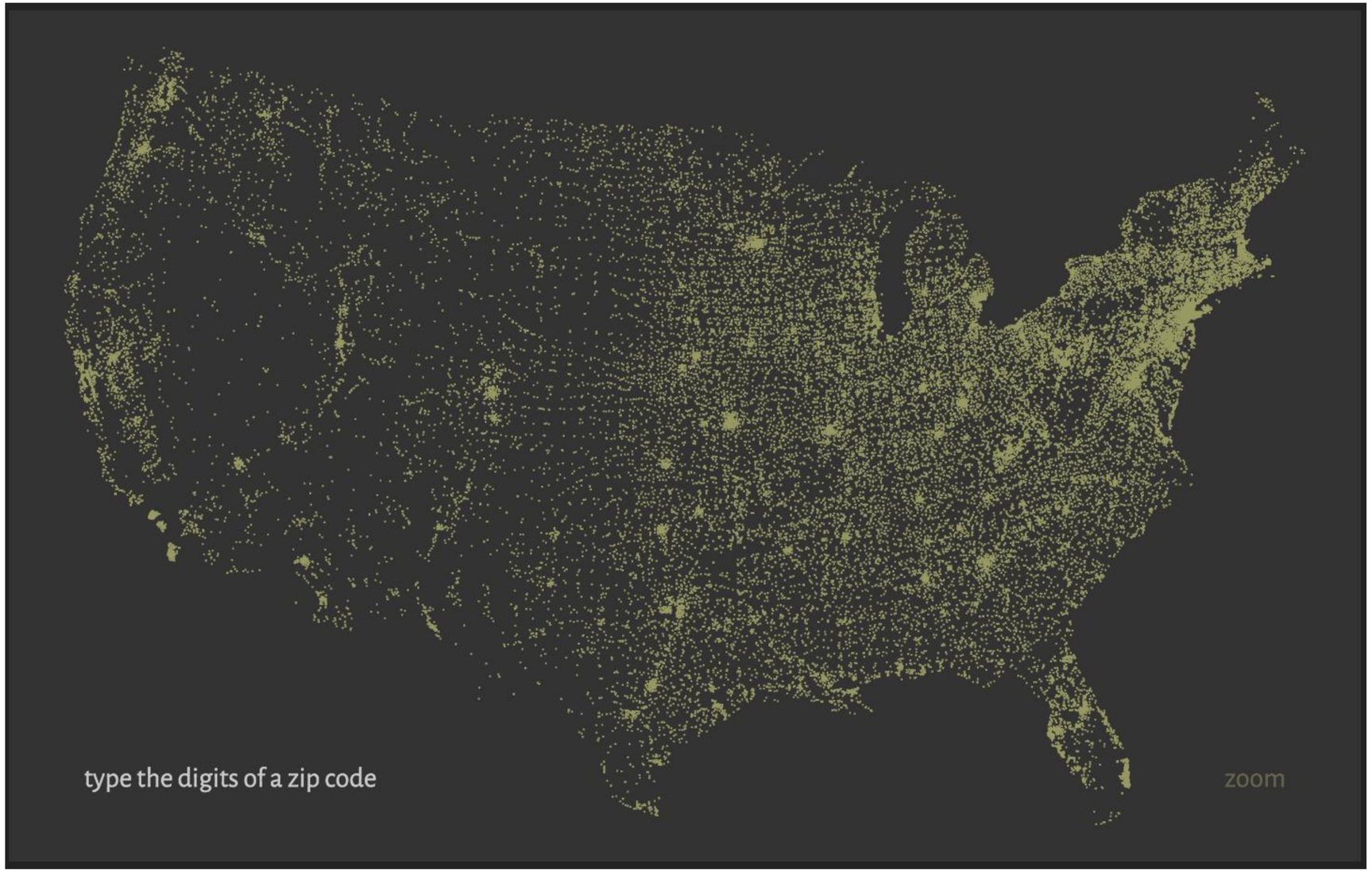
➔ Attribute Reduction

➔ *Slice*

➔ *Cut*

➔ *Project*

Queries and Filtering



[Ben Fry, 2014]

➔ Attribute Reduction

➔ *Slice*

➔ *Cut*

➔ *Project*

Queries and Filtering

KAYAK Hotels **Flights** Cars Packages Activities More

BOS ↔ WAS (2614 of 5112 flights) | Oct 14 Friday → Oct 20 Thursday | Economy cabin | 1 traveler | Change

Advice: BUY Learn more

Create a price alert

Stops
- nonstop $202
- 1 stop $132
- 2+ stops $416

Times Show all

Take-off Boston (BOS)
Fri 5:00a - 10:00p

Take-off Washington (WAS)
Thu 10:30a - 11:00p

Show landing times

Airports

Depart/Return same

Boston
- BOS: Logan Inter… $124
- Boston (Back Bay)… $187
- Boston (South Sta… $187

Sort by: **Price** Recommended Duration More | Round-trip | Segment

$253 View Deal

Relax your legs, not your standards.
The most legroom in coach. (Based on the average fleet-wide se…
$253 nonstop Select
JetBlue.com Ad

jetBlue

$132 Hacker Fare View Deal

Spirit Airlines / United
8:54p BOS → **10:29p** BWI 1h 35m nonstop
7:32p BWI → **11:11p** BOS 3h 39m 1 stop (EWR)
Show details Economy
Commutair DBA United Express operates flight 4850.

$136 United View Deal

United
9:25a BOS → **1:17p** BWI 3h 52m 1 stop (EWR)
7:32p BWI → **11:11p** BOS 3h 39m 1 stop (EWR)
Show details Economy
Republic Airlines DBA United Express operates flight 3546.
Commutair DBA United Express operates flight 4850.

[Kayak, 2020]

➔ Attribute Reduction

➔ *Slice*

➔ *Cut*

➔ *Project*

Scented Widgets

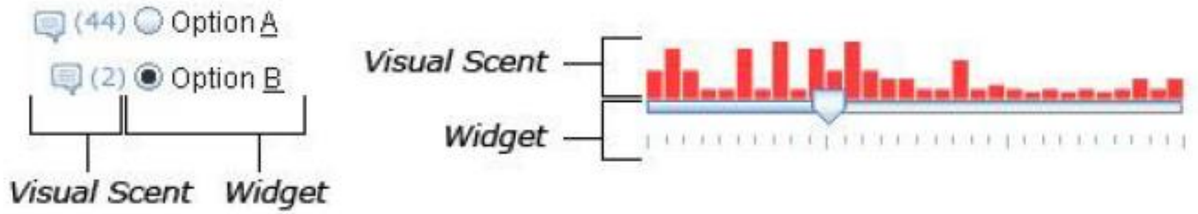


Figure 1. Widgets with visual information scent cues. Left: Radio buttons with comment counts. **Right**: Histogram slider with data totals.

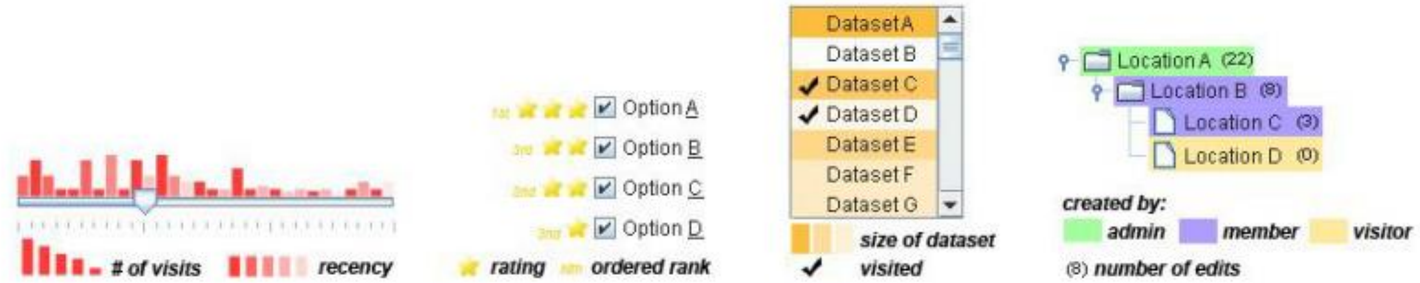


Figure 2. Examples of several scent encodings. From left to right: 1. A slider with visit totals encoded as a bar chart with recency encoded as opacity. 2. Checkboxes with star rankings encoded using icons and rank values displayed as text. 3. A list box with dataset sizes encoded using opacity and a visited/not visited value encoded using an icon. 4. A tree with author categories encoded using hue and edit totals encoded as text.

Willet et al., 2007

➔ Attribute Reduction

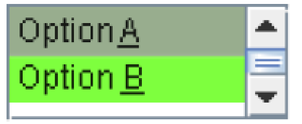
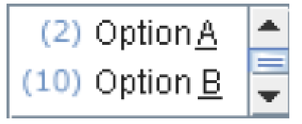
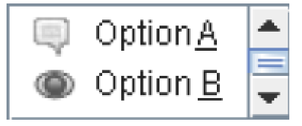
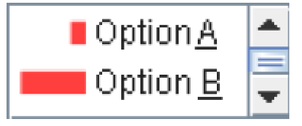
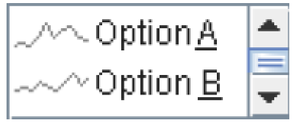
➔ *Slice*

➔ *Cut*

➔ *Project*

Scented Widgets

Table 1. Scent encodings supported by scented widgets

Name	Description	Example
Hue	Varies the hue of the widget (or of a visualization embedded in it)	
Saturation	Varies the saturation of the widget (or of a visualization embedded in it)	
Opacity	Varies the saturation of the widget (or of a visualization embedded in it)	
Text	Inserts one or more small text figures into the widget	
Icon	Inserts one or more small icons into the widget.	
Bar Chart	Inserts one or more small bar chart visualizations into the widget	
Line Chart	Inserts one or more small line chart visualizations into the widget	

Willet et al., 2007

➔ Attribute Reduction

➔ *Slice*

➔ *Cut*

➔ *Project*

Interactive Legends

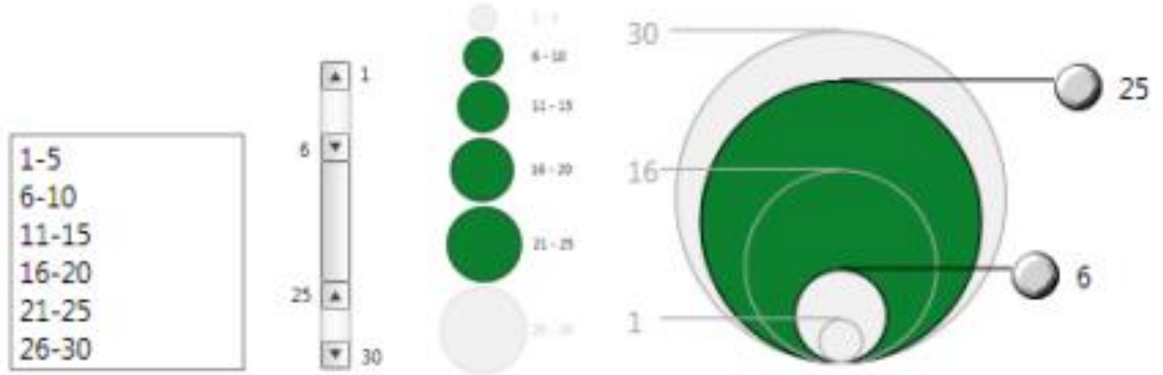


Figure 1: *Standard widgets (left), interactive legends (right)*

Riche et al., 2010

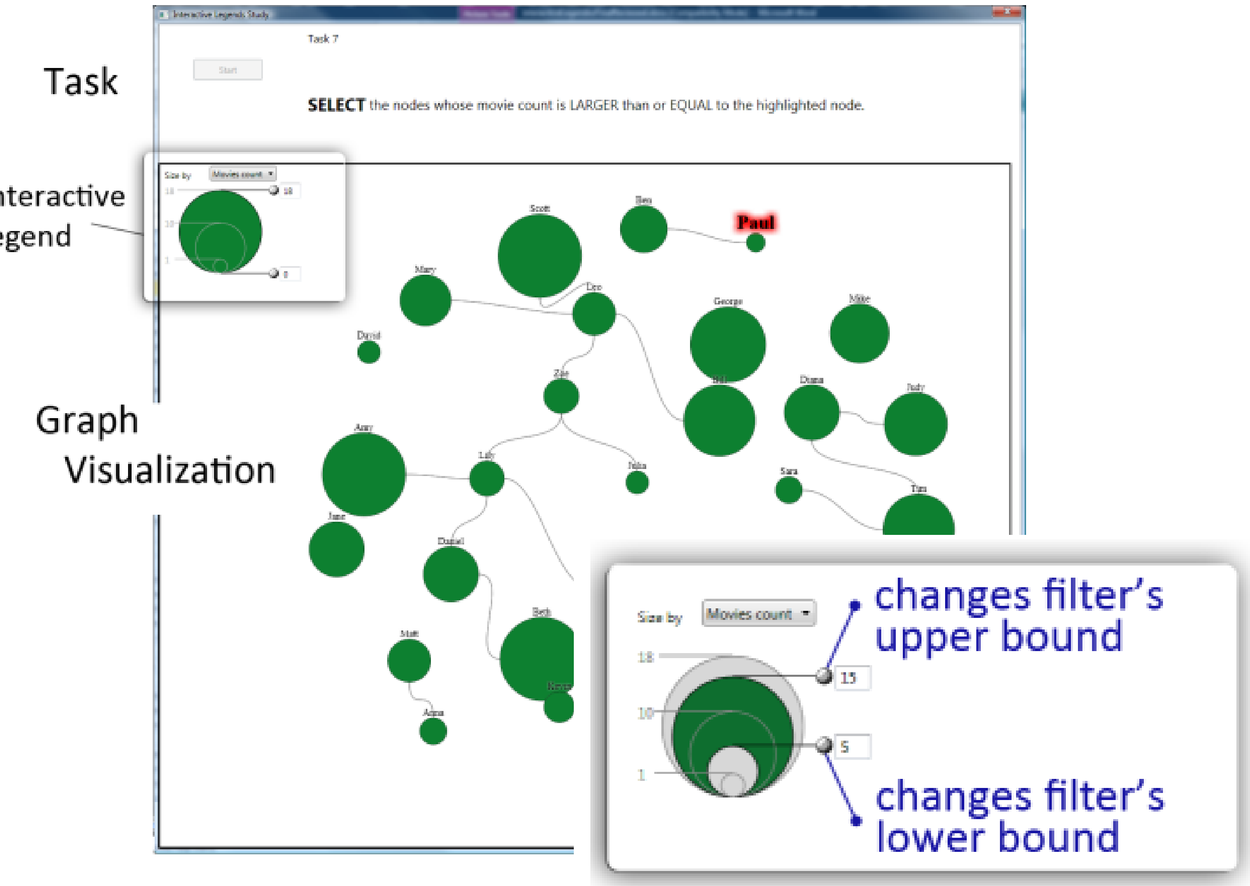
➔ Attribute Reduction

➔ *Slice*

➔ *Cut*

➔ *Project*

Interactive Legends



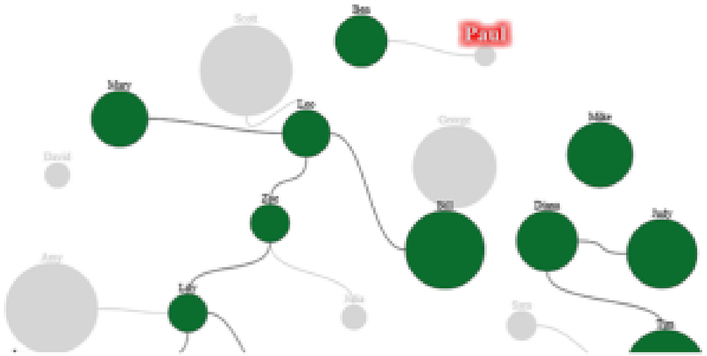


Figure 5: *Interactive legend for controling the size. Handles are provided to filter interactively the visualization.*

Riche et al., 2010

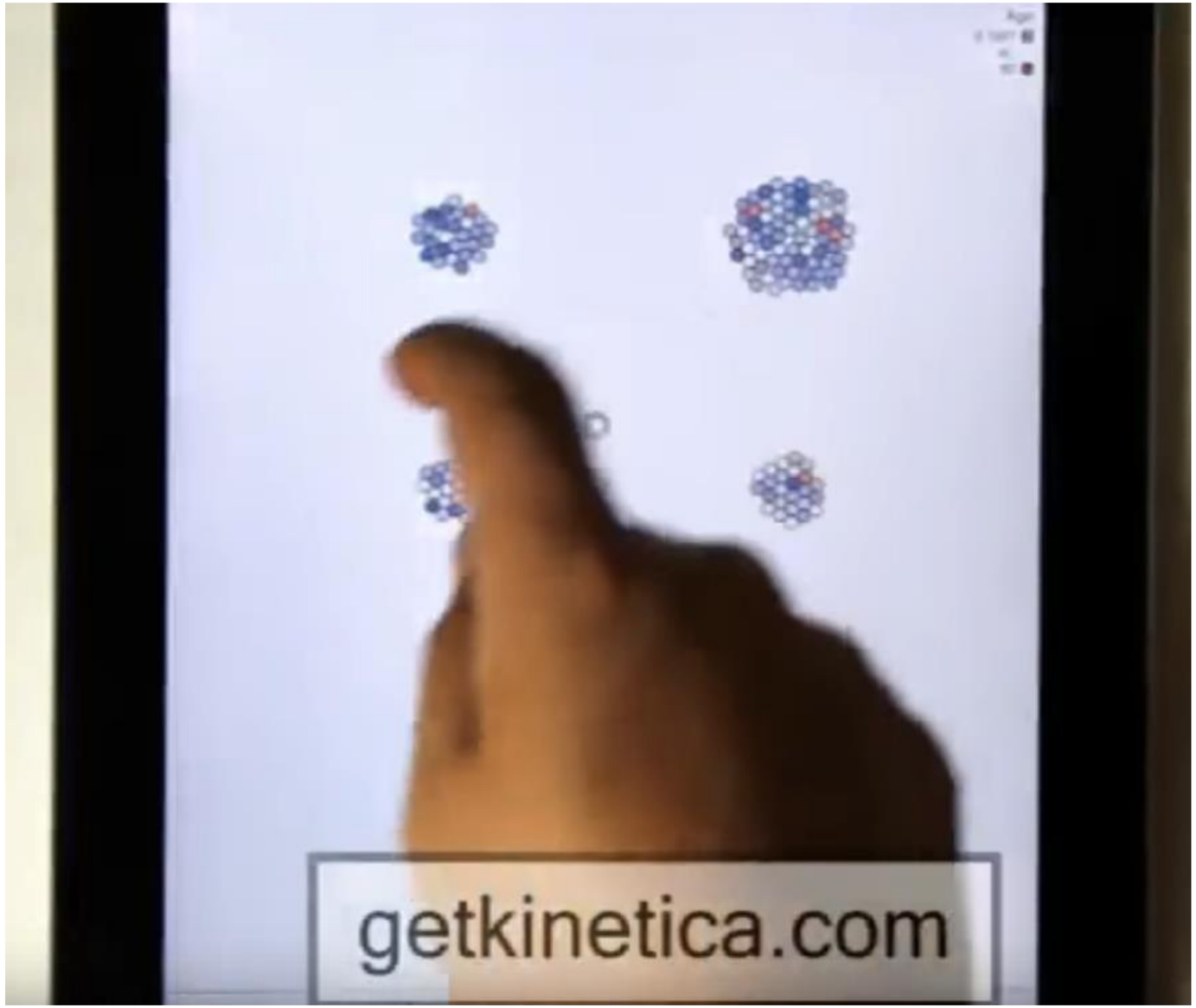
➔ Attribute Reduction

➔ *Slice*

➔ *Cut*

➔ *Project*

Kinetica



[Rzeszotarski and Kittur]


Kinetica helps users explore multivariate
data through physics-based interactions.

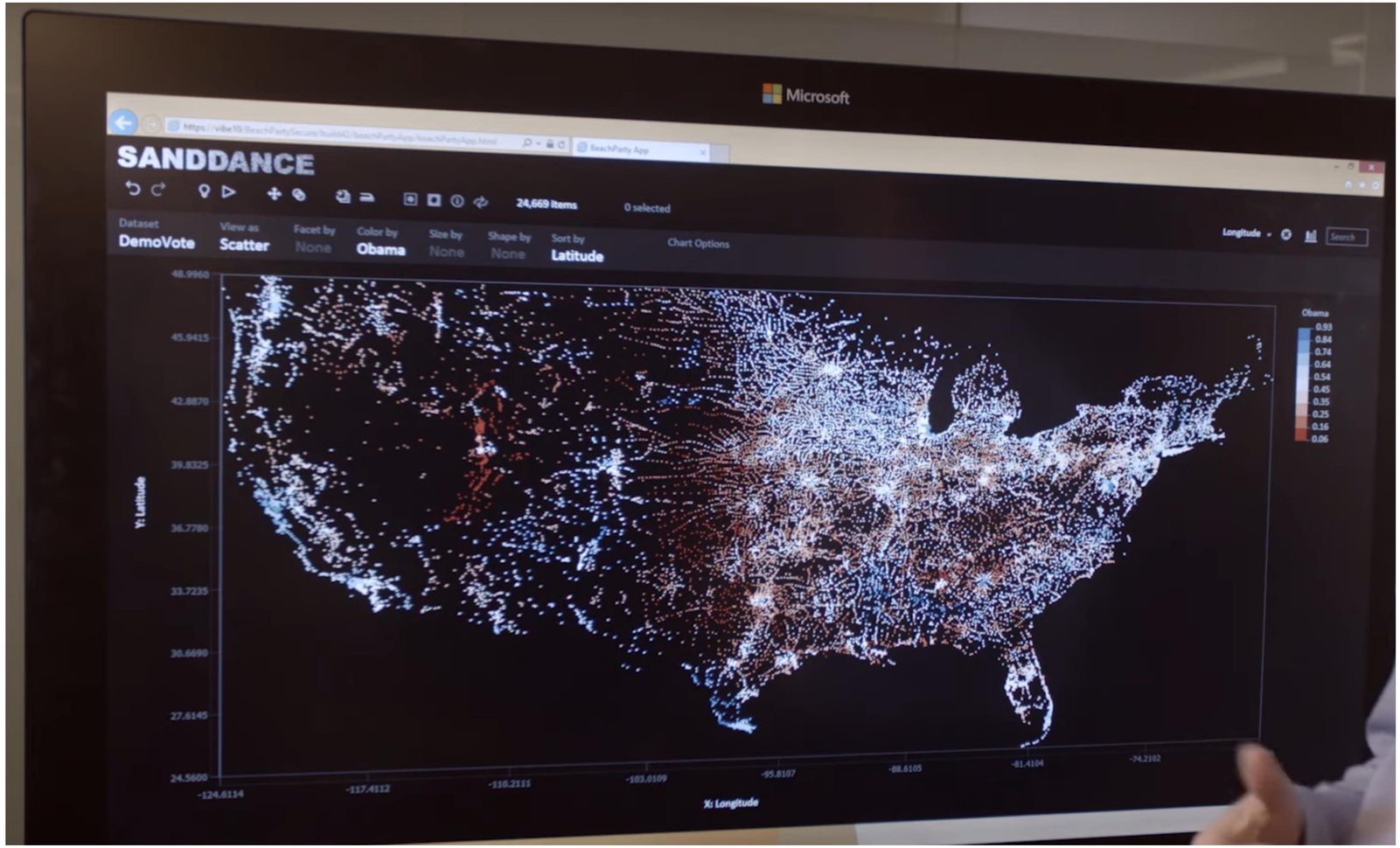
➔ Attribute Reduction

➔ *Slice*

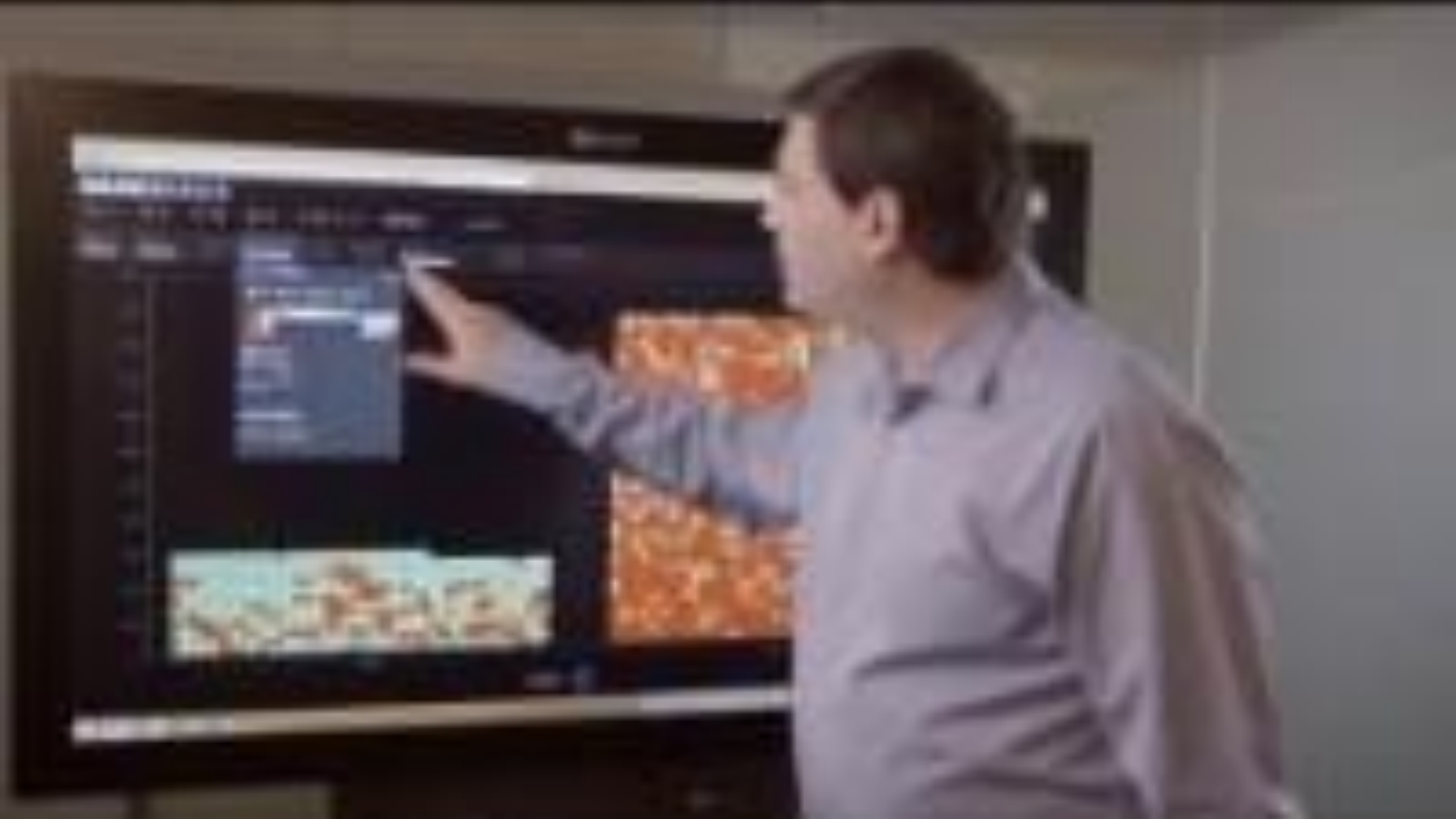
➔ *Cut*

➔ *Project*

Sand Dance



Drucker and Fernandez, 2015



➔ Attribute Reduction

➔ *Slice*

➔ *Cut*

➔ *Project*

Projection

Pandey et al. (inc. Dunne, Borkin), 2019

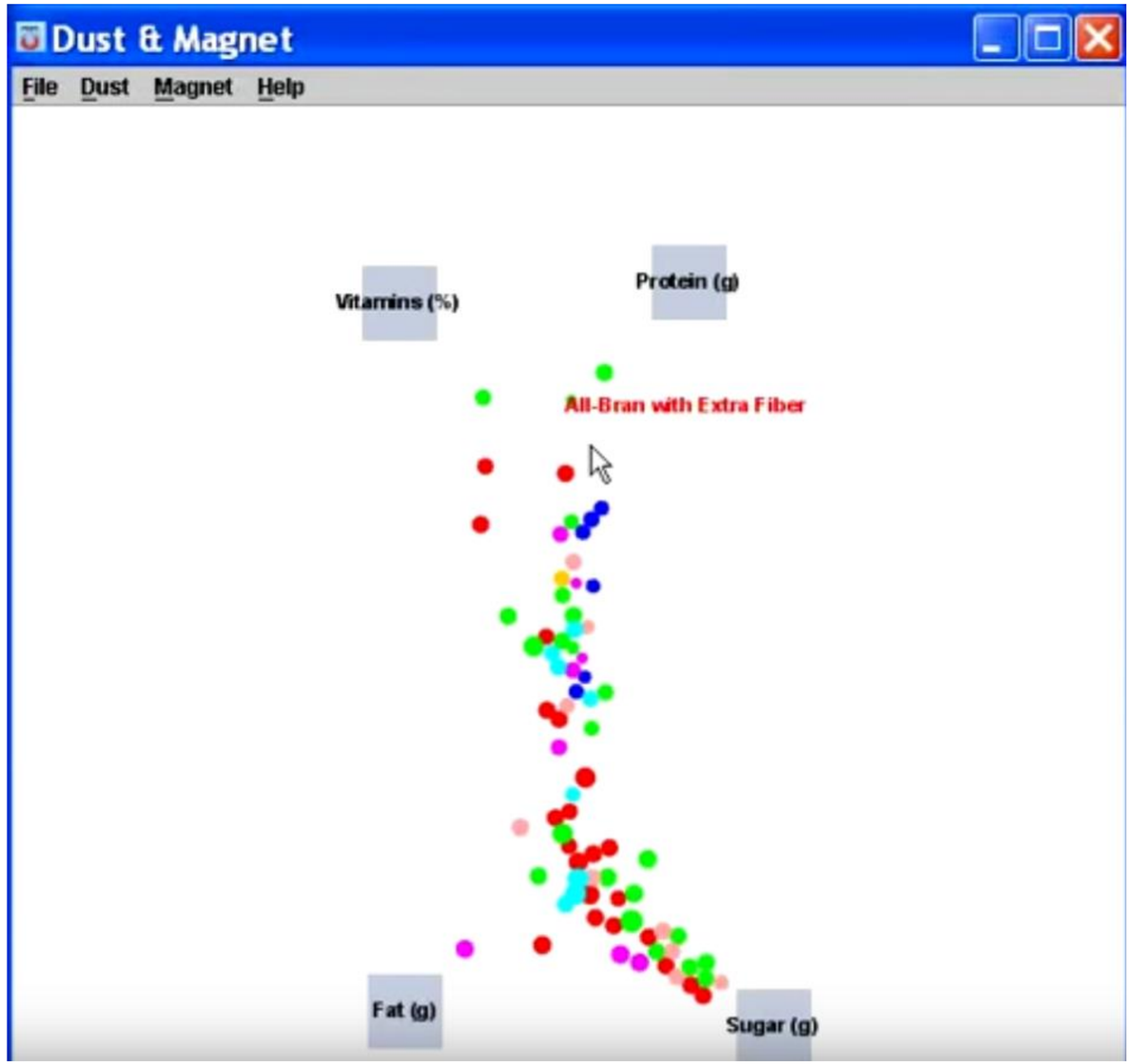
➔ Attribute Reduction

➔ *Slice*

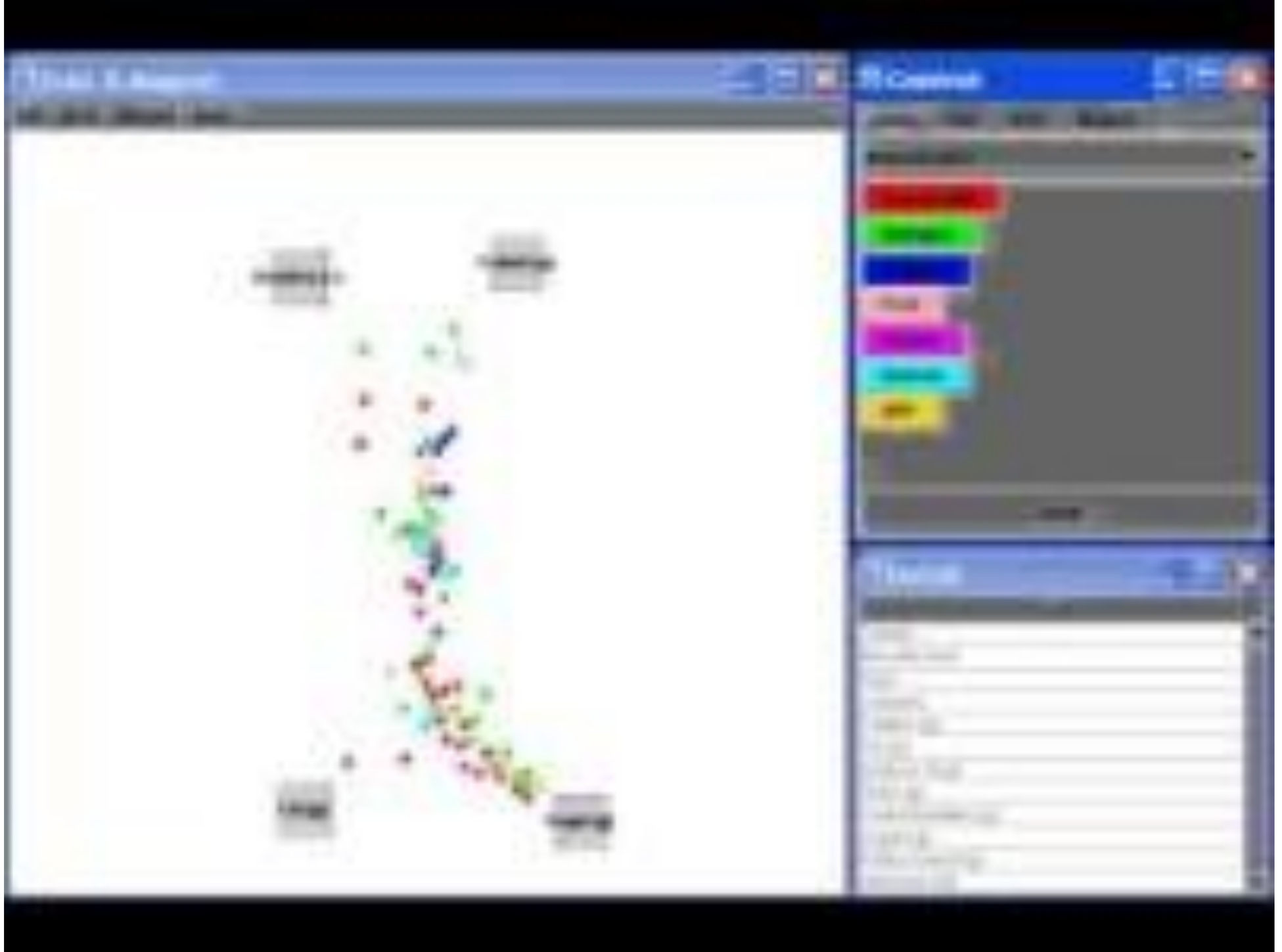
➔ *Cut*

➔ *Project*

Dust & Magnet



Dai et al., 2005



https://www.ted.com/talks/janet_iwasa_how_animations_can_help_scientists_test_a_hypothesis

http://scienceofhiv.org/

https://www.molecularflipbook.org/

Upcoming Assignments & Communication

Look at the upcoming assignments and deadlines regularly!

- Textbook, Readings, & Reading Quizzes — Variable days
- In-Class Activities — 11:59pm same day as class
  F: Lecture, T: Lecture, F: Lecture
- Assignments & Projects— Generally due R 11:59pm
  R (2 days): Project 4 — Data Collection & Exploration, Sketches
  Next R (9 days):
  Assignment 8 — Brushing and Linking in D3
  Project 5 — Final "Interactive" Visualization Sketch, Implementation Plan, & Group Charter

Use Canvas Discussions for general questions, email the TAs/S-LTA/instructor for questions specific to you: codydunne-and-tas@ccs.neu.edu. Include links!

If you're emailing about a particular assignment, please **include the URL of the Submission Details page**. (Canvas documentation.)

If you have a project question, **give us your group number**. E.g., include: `Group ## — Topic` with '##' replaced by your group number and 'Topic' replaced by your topic.