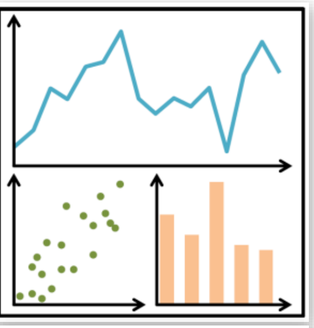
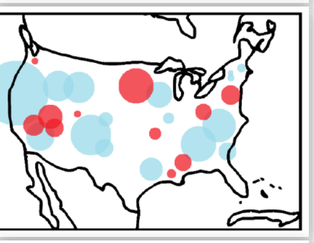
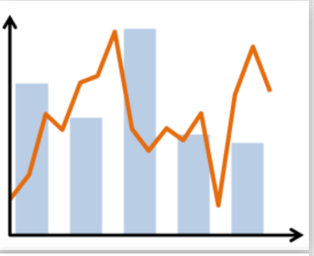
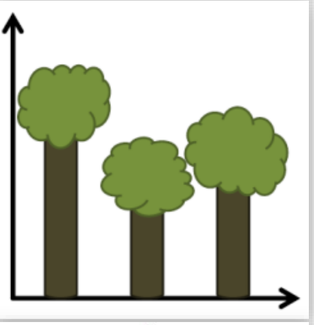
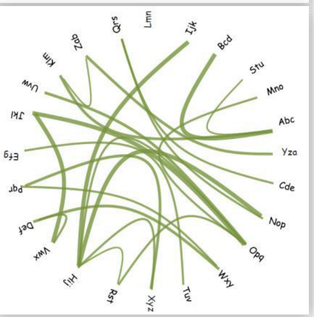






Interaction

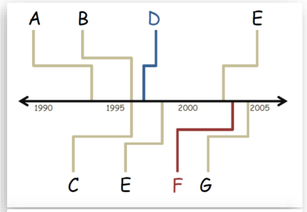
CS 7250

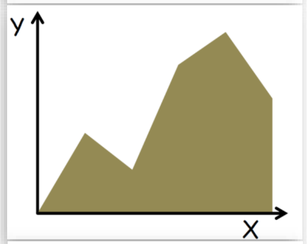
SPRING 2020

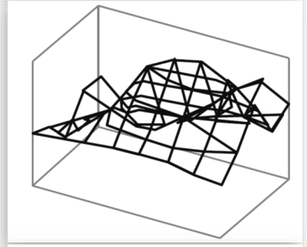
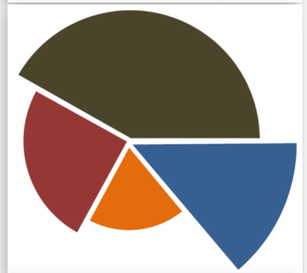
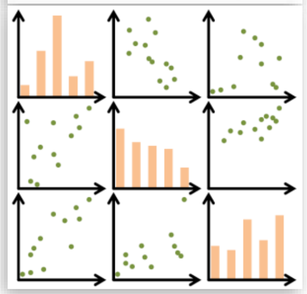
Prof. Cody Dunne

NORTHEASTERN UNIVERSITY

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



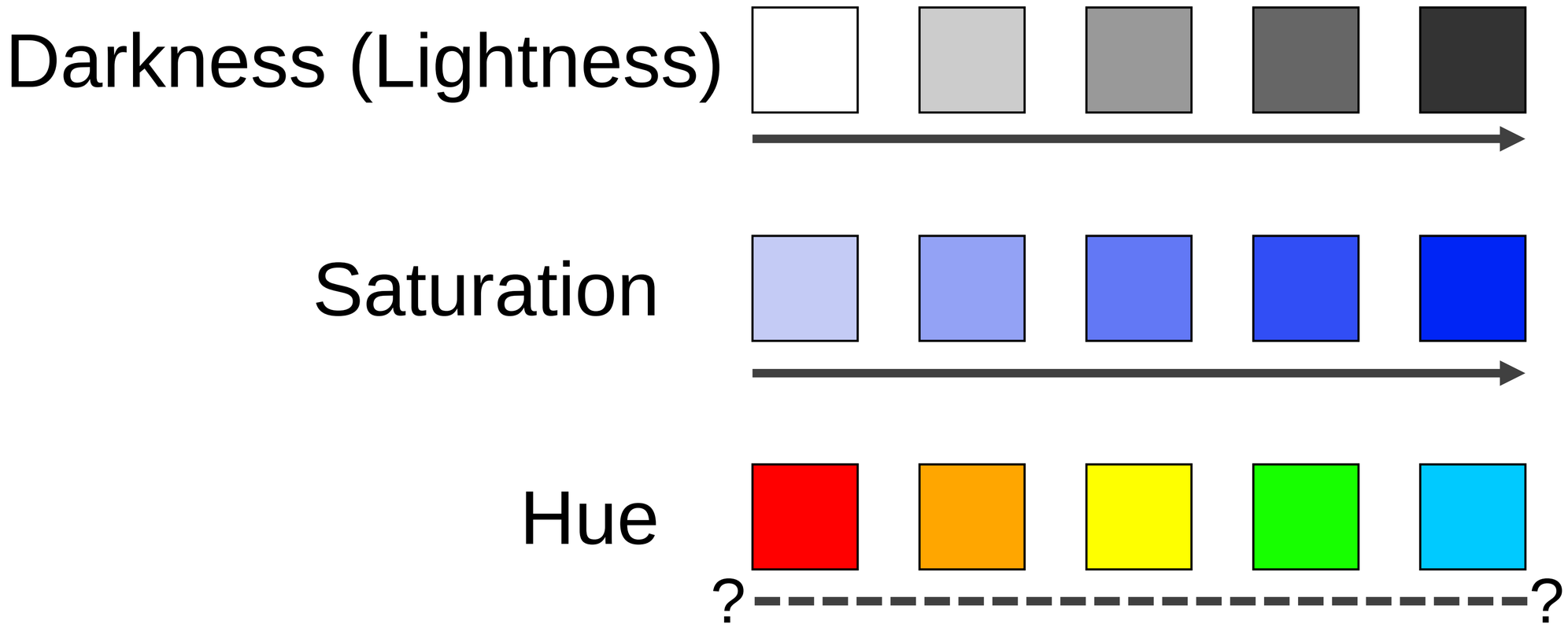


Burning Questions?

Previously, on CS 7250…

Color Vocabulary and Perceptual Ordering

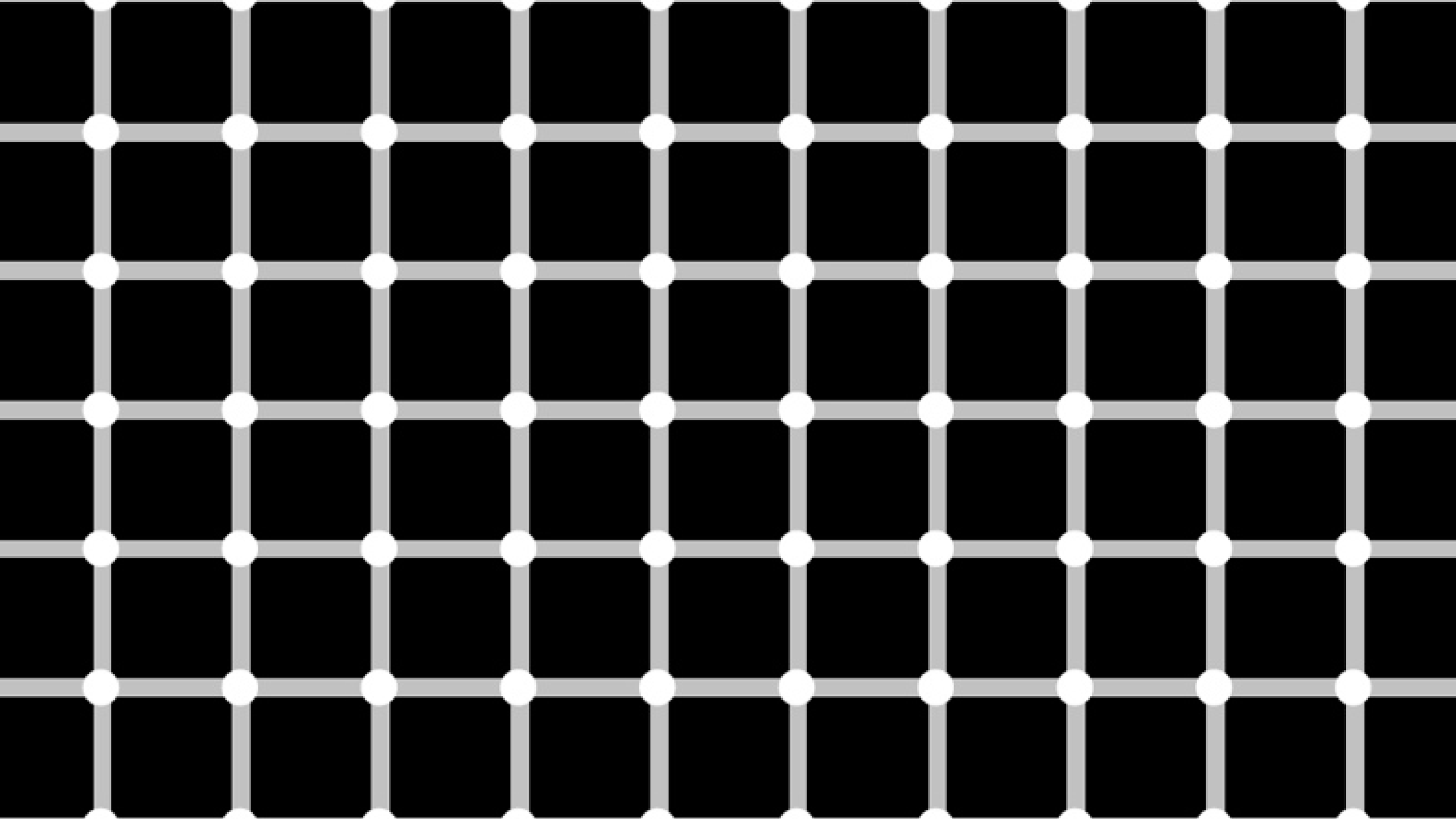


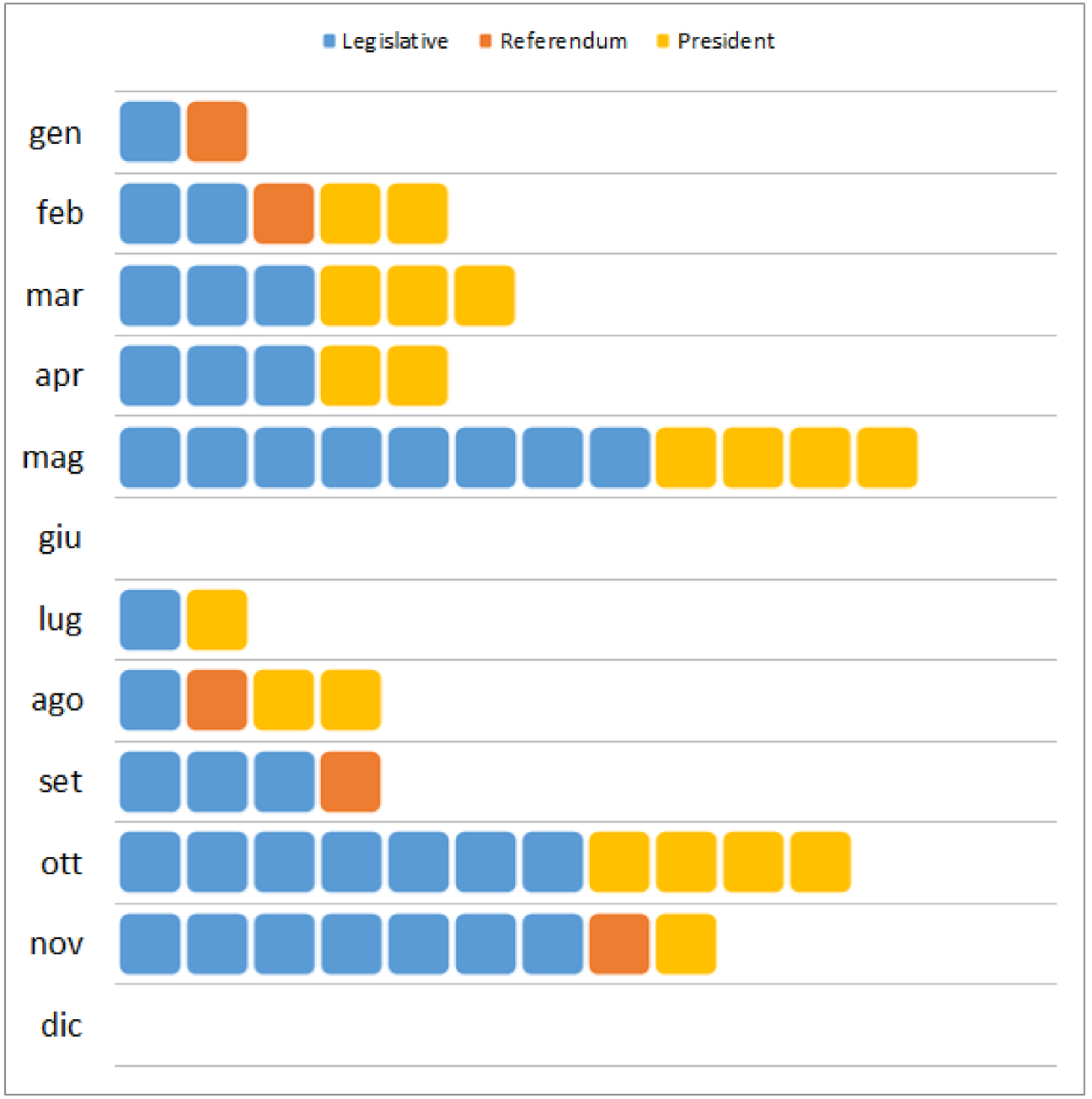
“Simultaneous Contrast”

Avoid gradients as backgrounds or bars!

Now, on CS 7250…

One Last Illusion...




Legislative
Referendum
President
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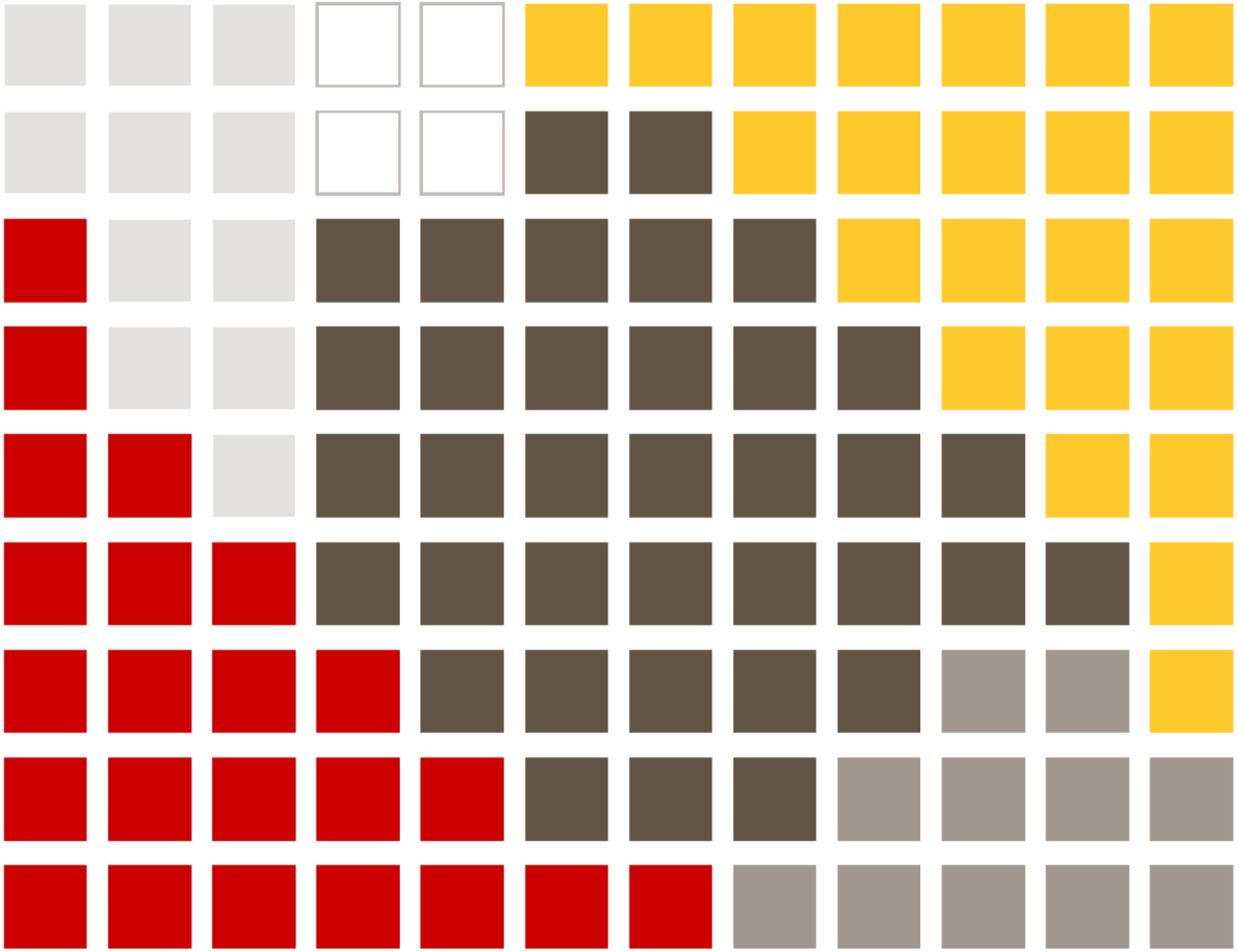


108

COURSE OPTIONS
TOWARD CCIS
MEANINGFUL
MINOR

- Bouvé (4 courses)
- CAMD (23 courses)
- COE (11 courses)
- COS (35 courses)
- CSSH (23 courses)
- DMSB (12 courses)

Hall of Fame or Hall of Shame

FiveThirtyEight

Politics Sports Science & Health Economics **Culture**

DEC. 31, 2015 AT 7:01 AM

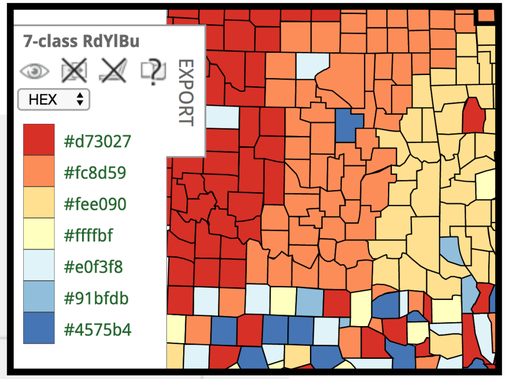
Our 47 Weirdest Charts From 2015

By Andrei Scheinkman

Filed under 2015 Year In Review

We made more than 1,500 charts in 2015 at FiveThirtyEight. Many were bar charts, line charts and scatterplots — but not all. Here are some of the more unusual graphics we published.

FiveThirtyEight, 2015



[ColorBrewer 'RdYlBu' scale, 2013]

The Puzzling Speed Of Dan Feyer

Solve times for the past 1,208 New York Times crossword puzzles, by day of the week

60 puzzles
40
20
0

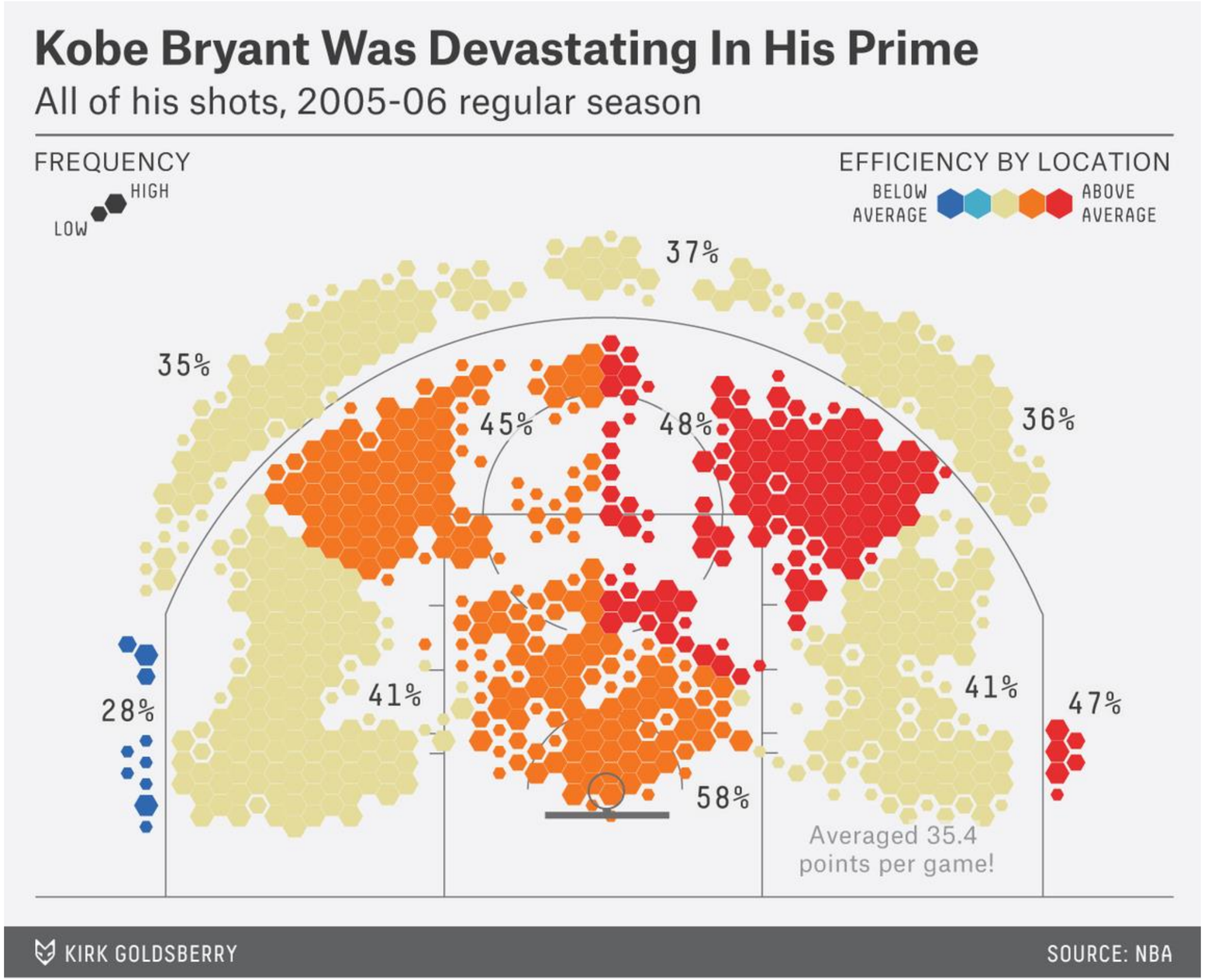
MONDAY
TUESDAY
WEDNESDAY
THURSDAY
FRIDAY
SATURDAY
SUNDAY

0 2 4 6 8 10 12

Minutes to solve

FIVETHIRTYEIGHT

[FiveThirtyEight, 2015]



FiveThirtyEight, 2015

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

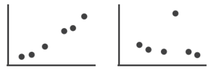
Change

Select

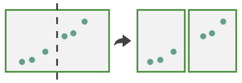
Navigate

Facet

Juxtapose



Partition



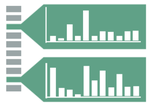
Superimpose

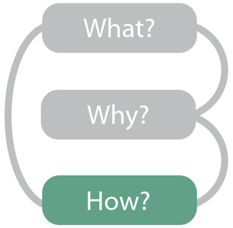
Reduce

Filter

Aggregate

Embed

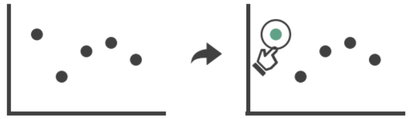




Manipulate

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 by providing 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.

Gapminder Bubbles

Gapminder, 2018

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

abcdefghijklmnopqrstuvwxyz

Mike Bostock, 2016

Change over Time

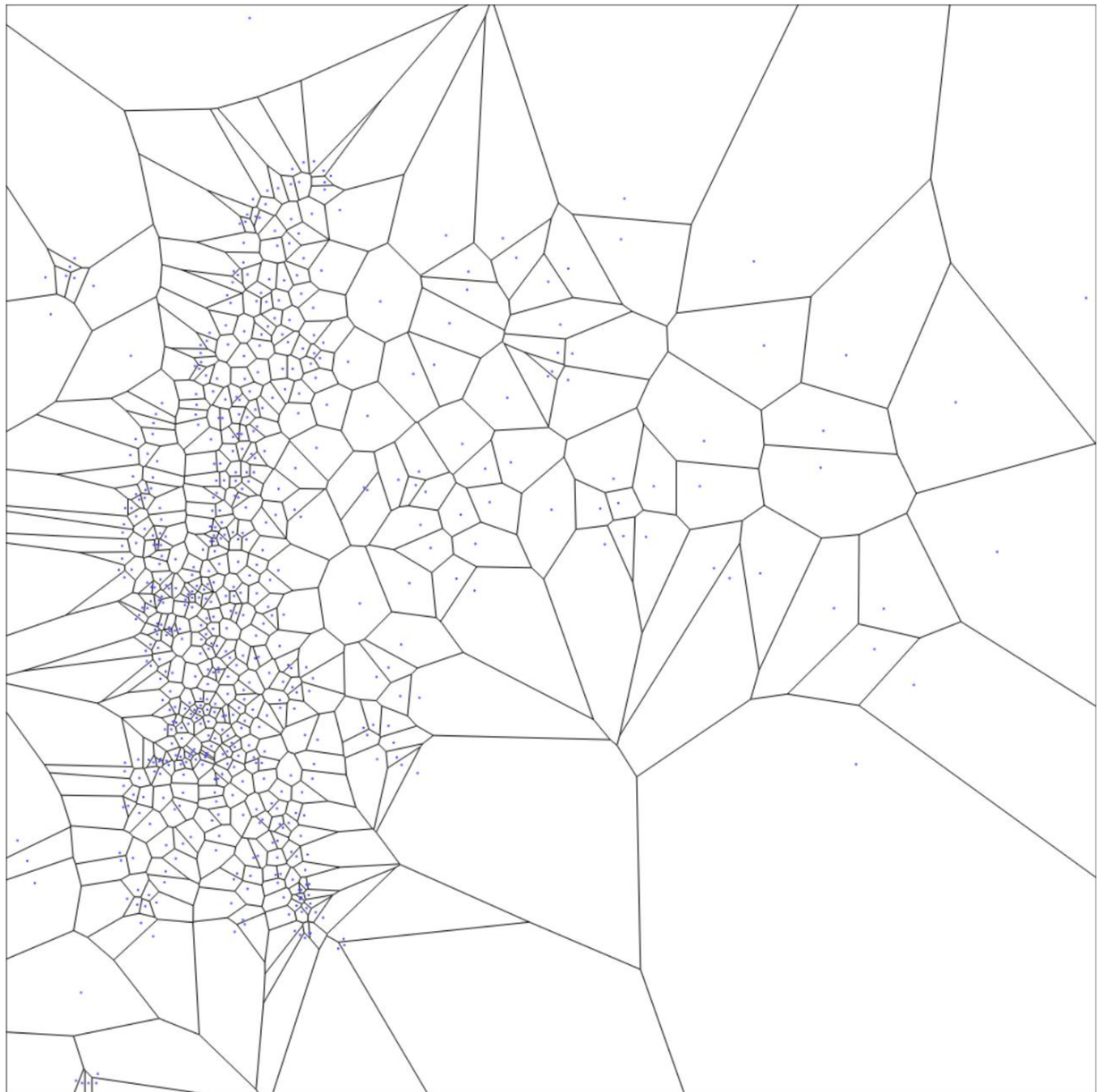
D3 Animated Transitions

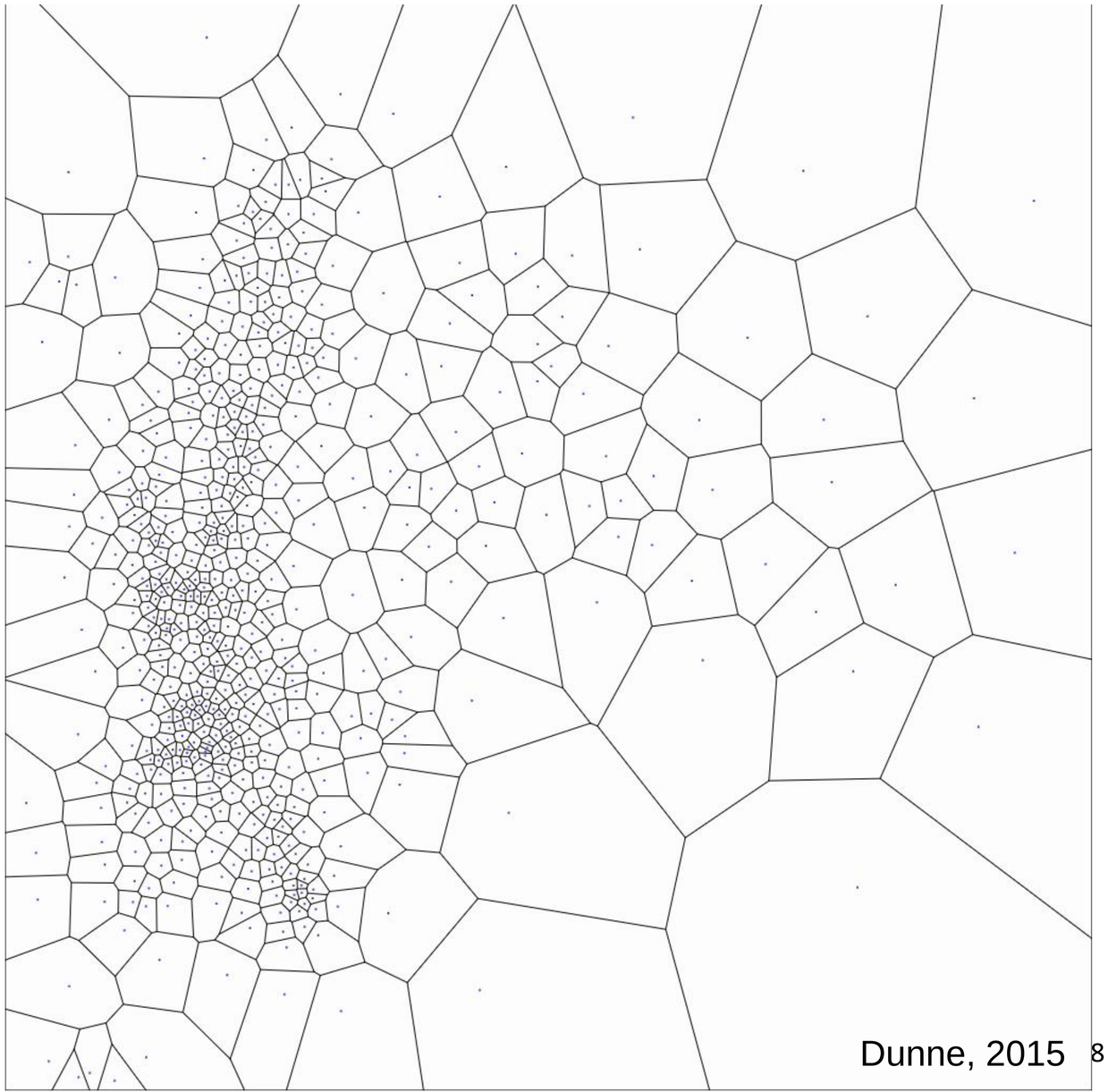
flexible transitions

Mike Bostock, 2011

Change over Time

Centroidal Voronoi Tesselation

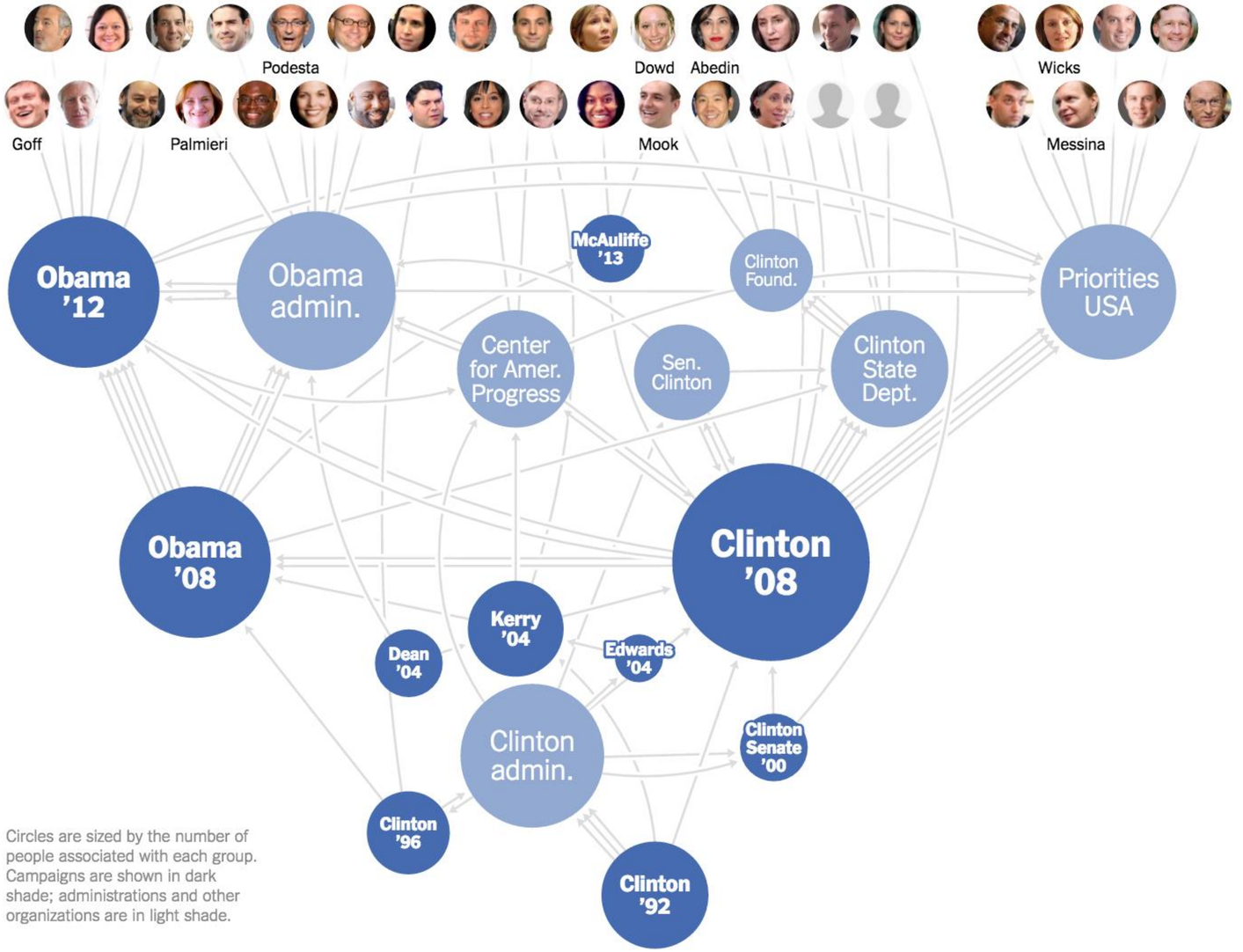




Dunne, 2015

Select

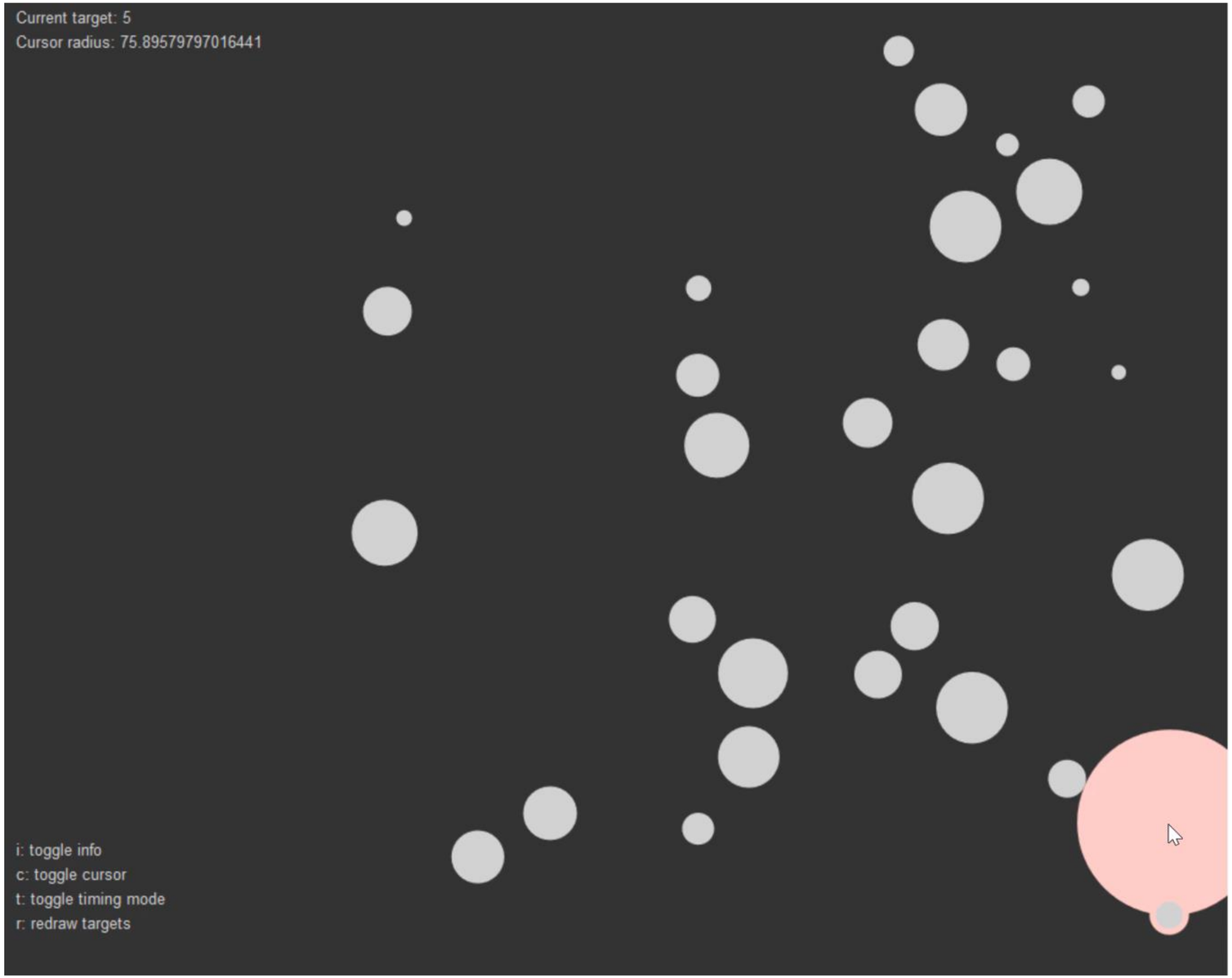
NYT Campaign Connections



NY Times, 2015

Select

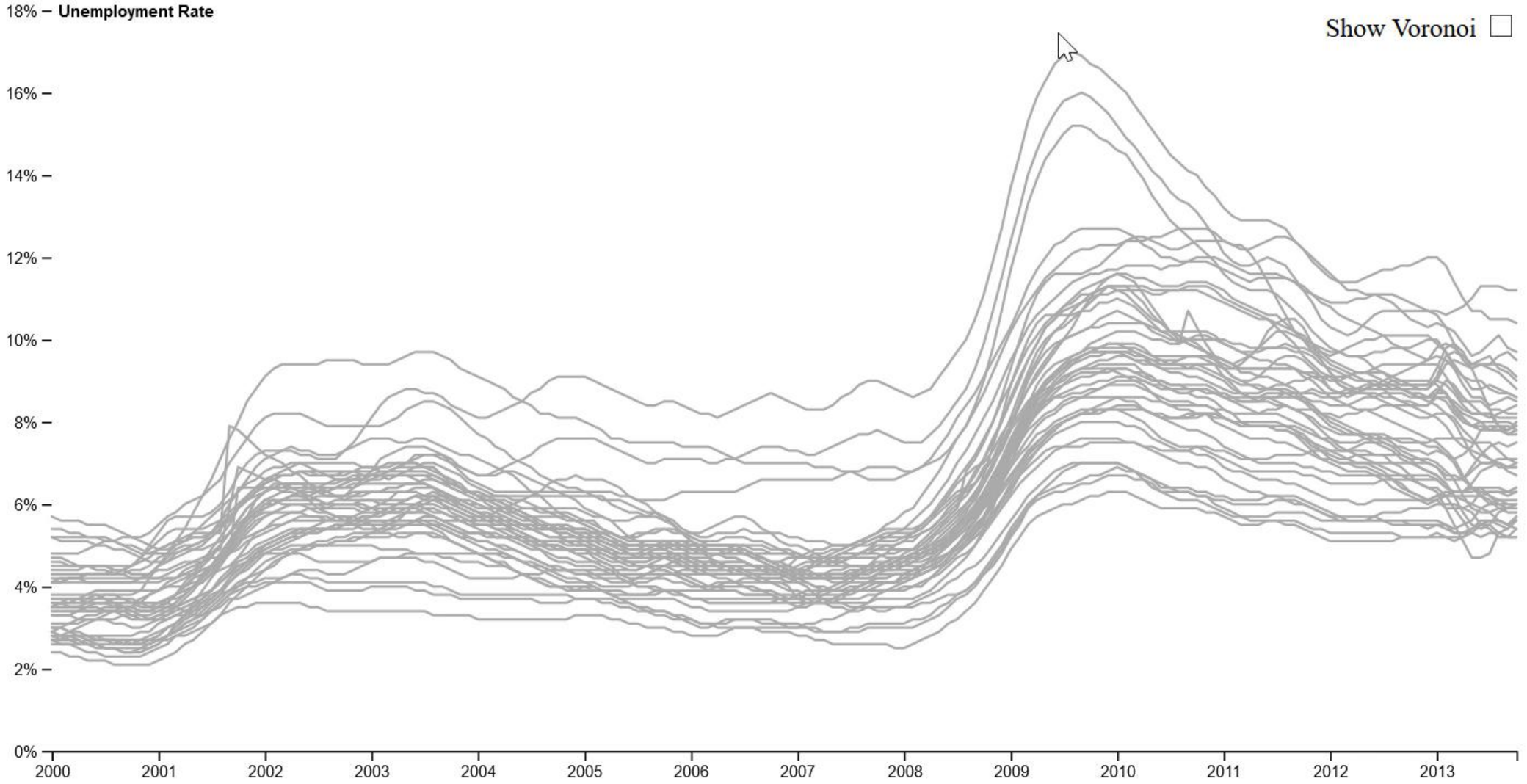
Bubble Cursors



Grossman and Balakrishnan, 2005; Anand Kulkarni, 2010

Select

Voronoi Cursors



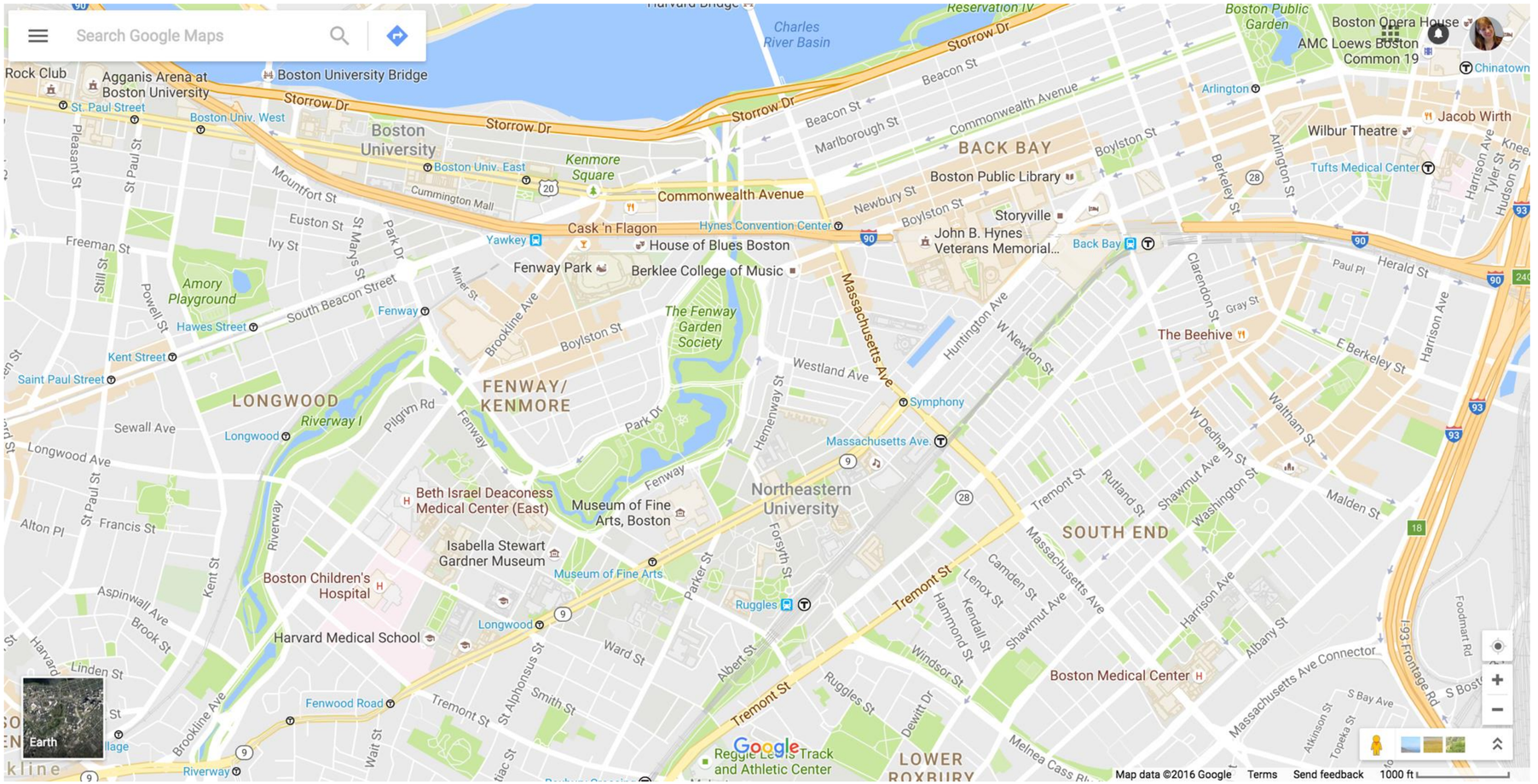
Mike Bostock, 2019

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

  - *Pan/Translate*

  - *Constrained*

Navigation



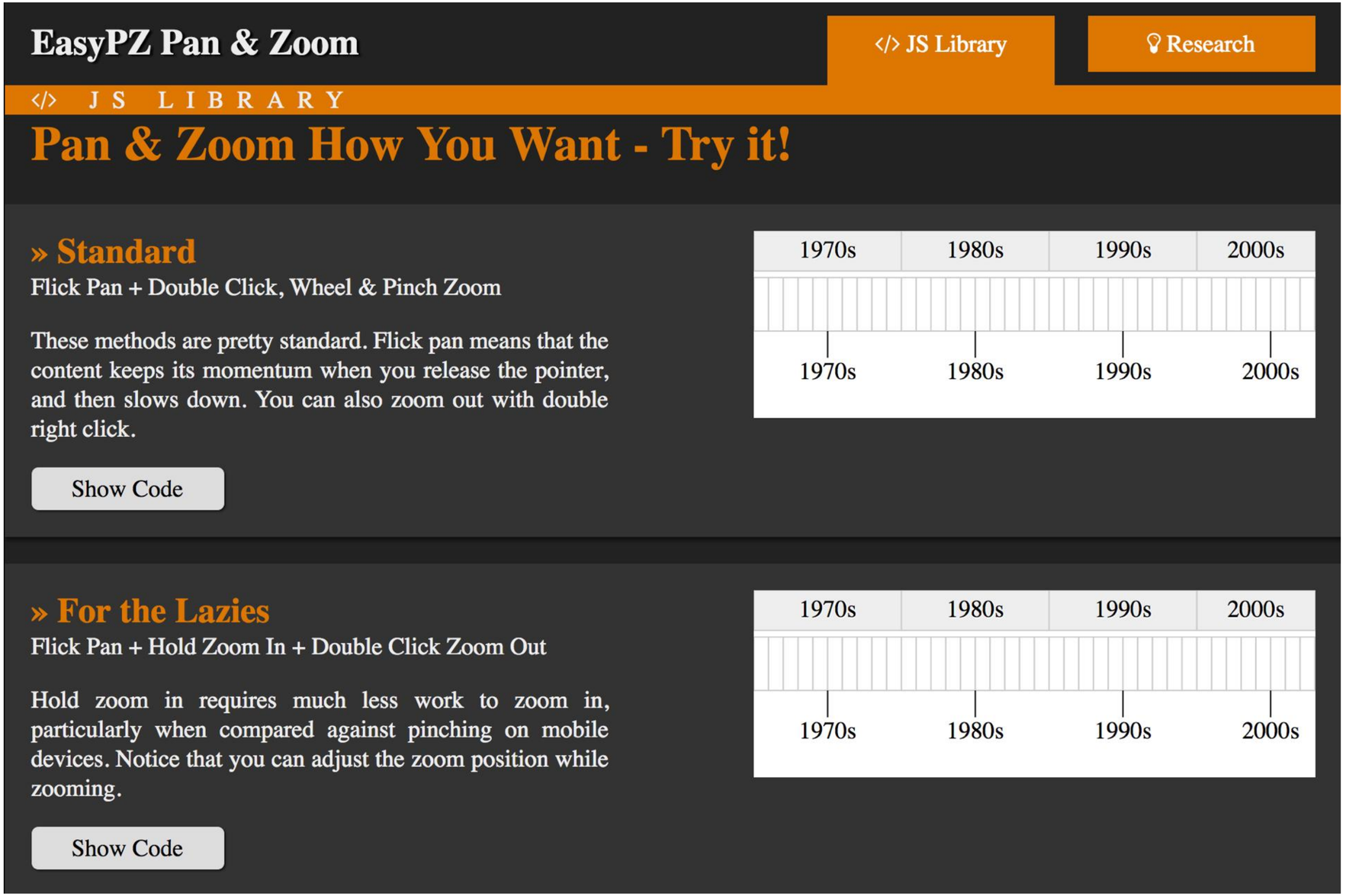
[Google Maps, 2020]

IN-CLASS EXERCISE

Zoom techniques

In-class activity: experiment with zooming and panning

easypz.io



Michail Schwab
PhD student
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*

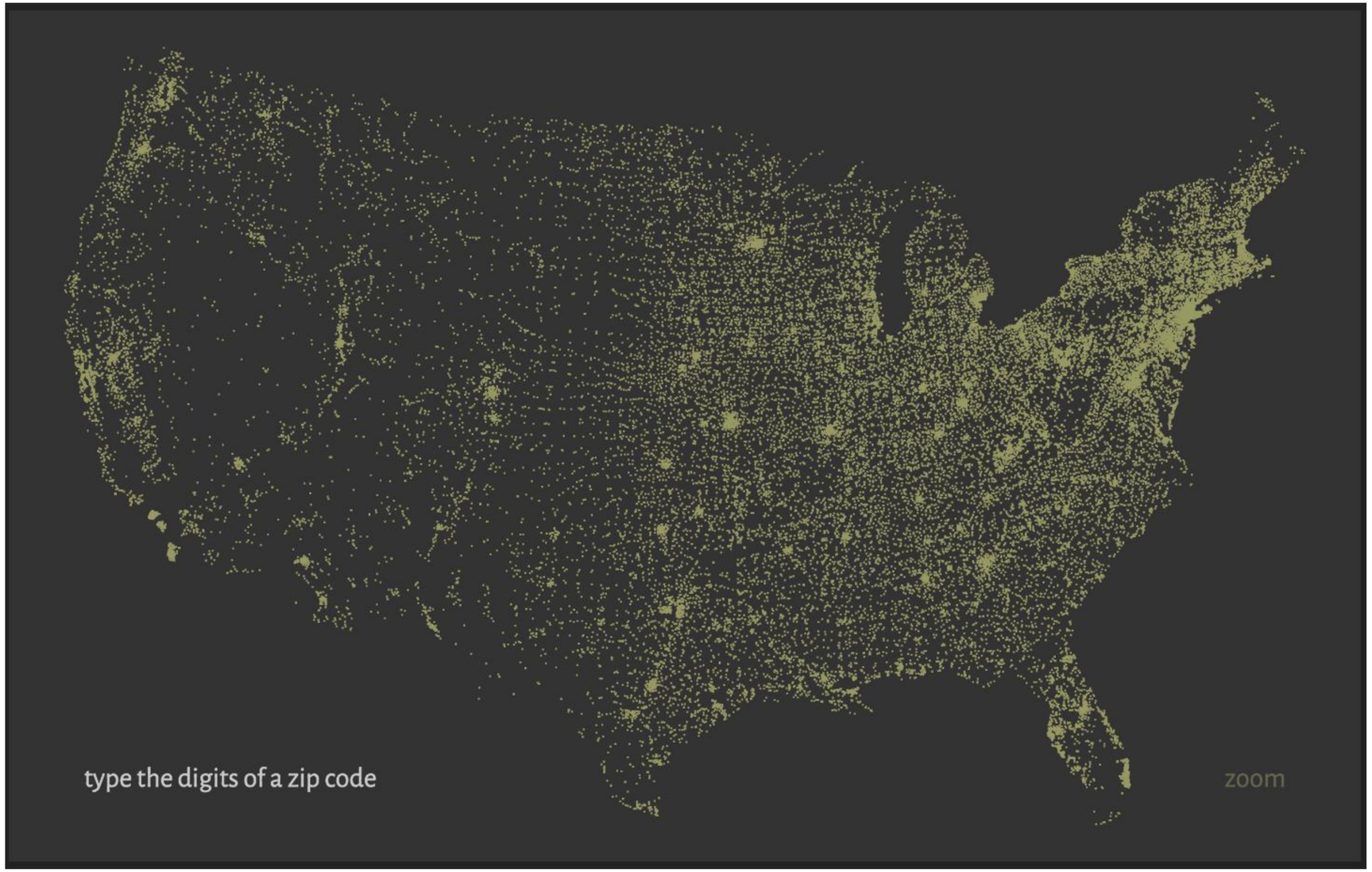
➔ Attribute Reduction

➔ *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*

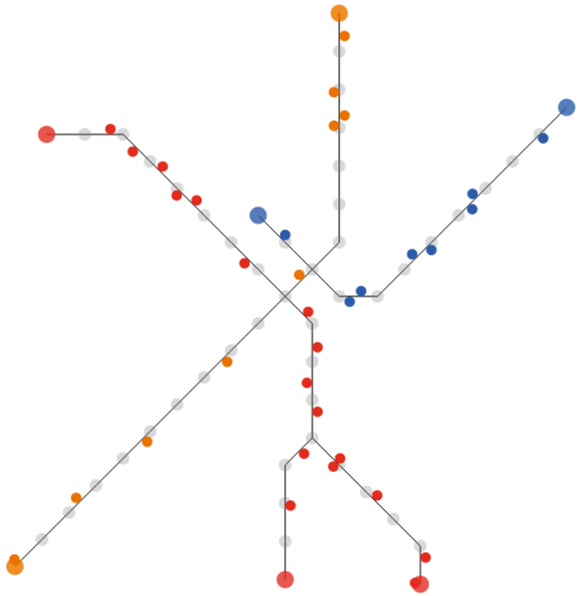
➔ *Project*

Projection

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

IN-CLASS EXERCISE

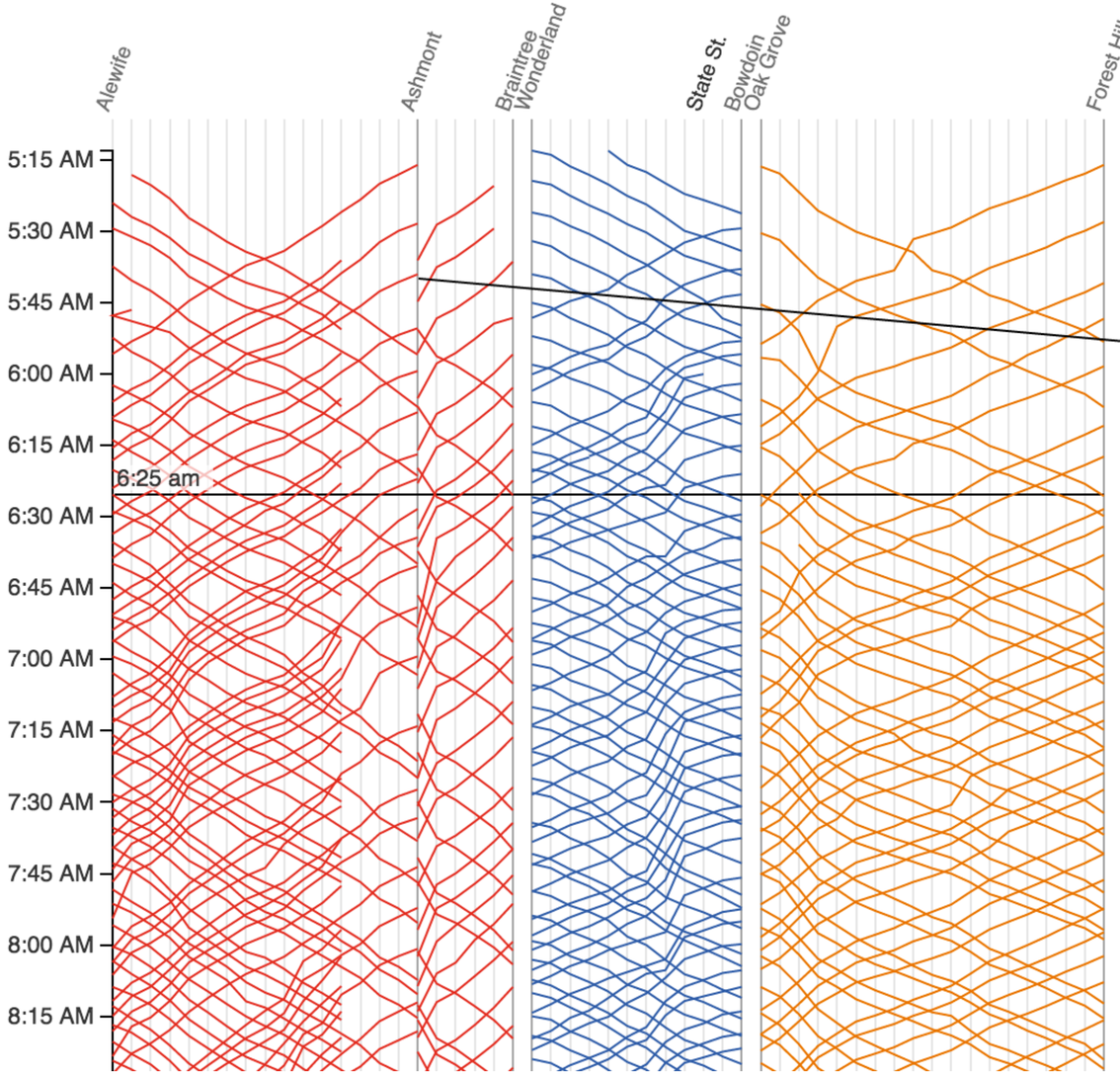
MBTAVis: Excellent WPI course final project



Locations of each train on the red, blue, and orange lines at 6:25 am. Hover over the diagram to the right to display trains at a different time.

Trains are on the right side of the track relative to the direction they are moving.

See the morning rush-hour, midday lull, afternoon rush-hour, and the evening lull.



Service starts at 5AM on Monday morning. Each line represents the path of one train. Time continues downward, so steeper lines indicate slower trains.

Since the red line splits, we show the Ashmont branch first then the Braintree branch. Trains on the Braintree branch "jump over" the Ashmont branch.

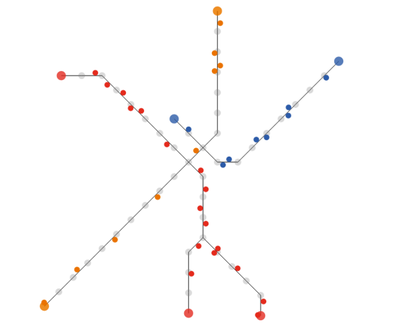
Train frequency increases around 6:30AM as morning rush hour begins.

Barry & Card, 2014

In-Class Critique — MBTAVis

15m

In-Class Critique — MBTAVis



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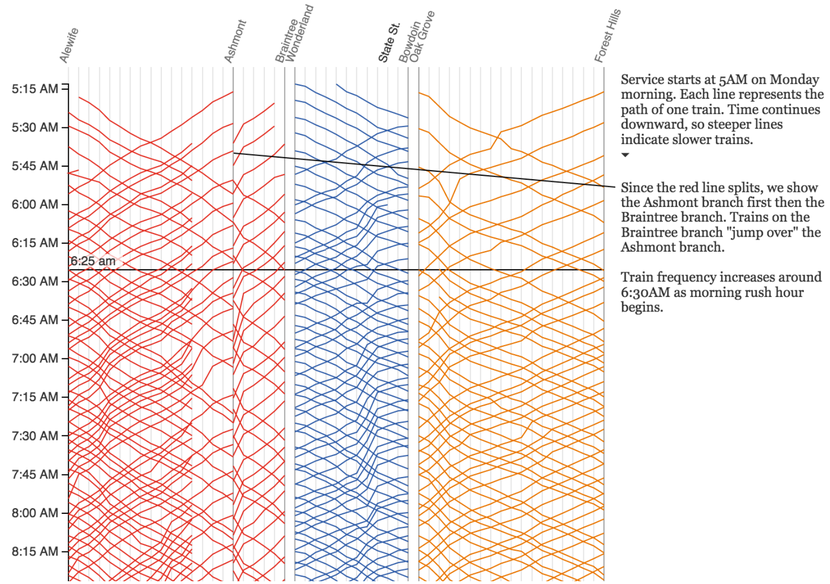

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Train frequency increases around 6:30AM as morning rush hour begins.

Manipulate

- **Change over Time**

- **Select**

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

    - → *Pan/Translate*

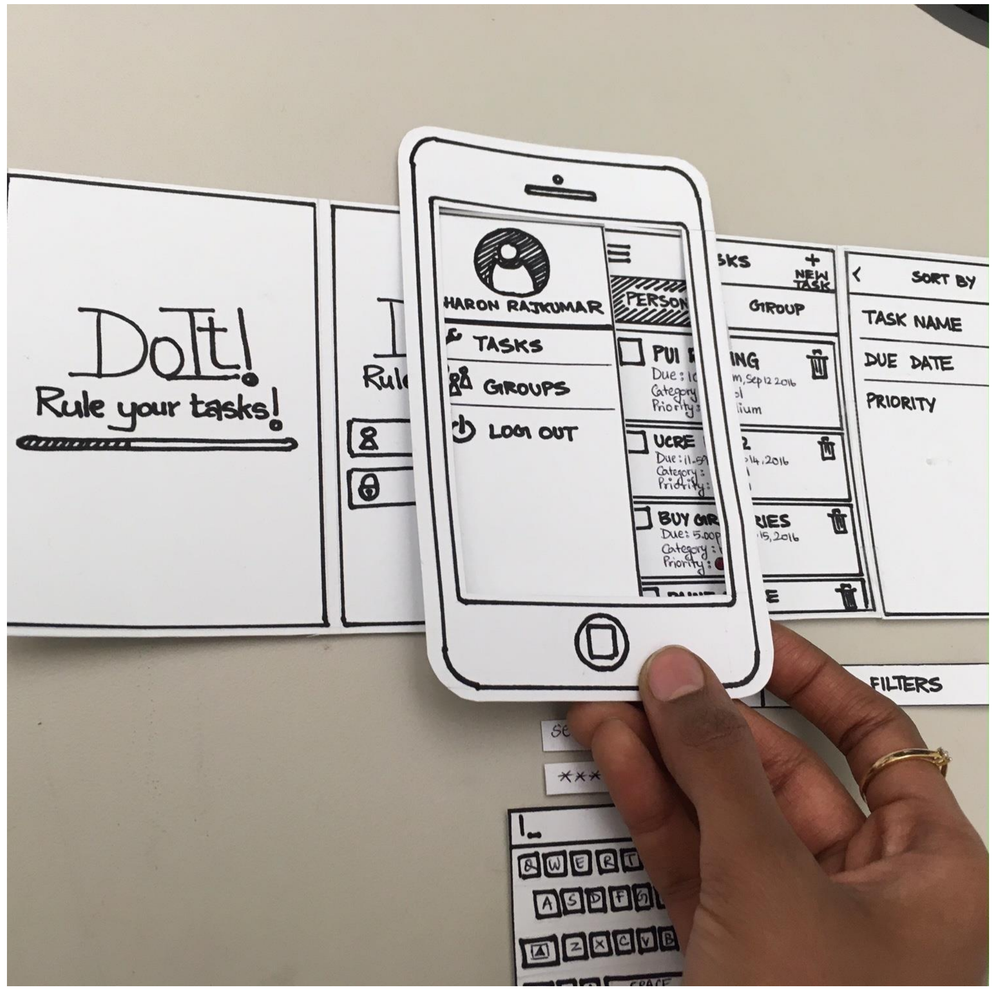
    - → *Constrained*

  - → Attribute Reduction
    - → *Slice*

    - → *Cut*

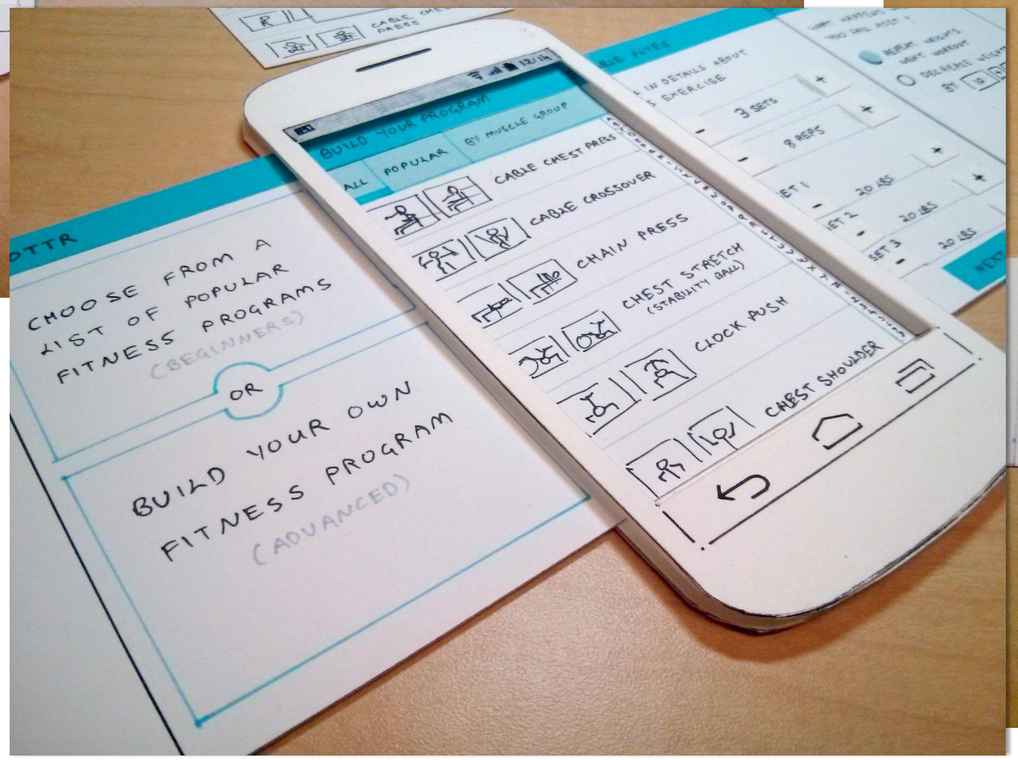
    - → *Project*

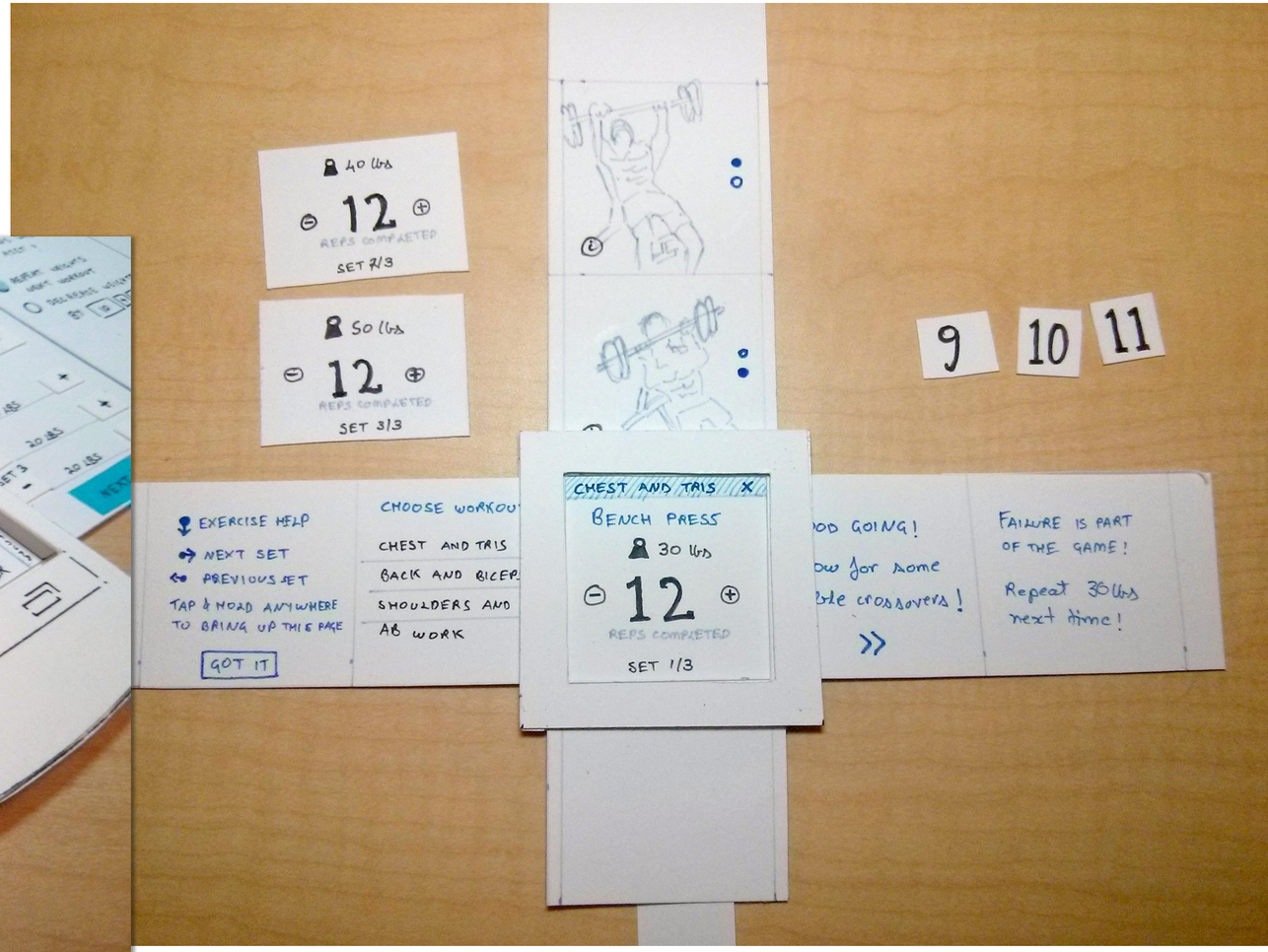
Paper Prototyping



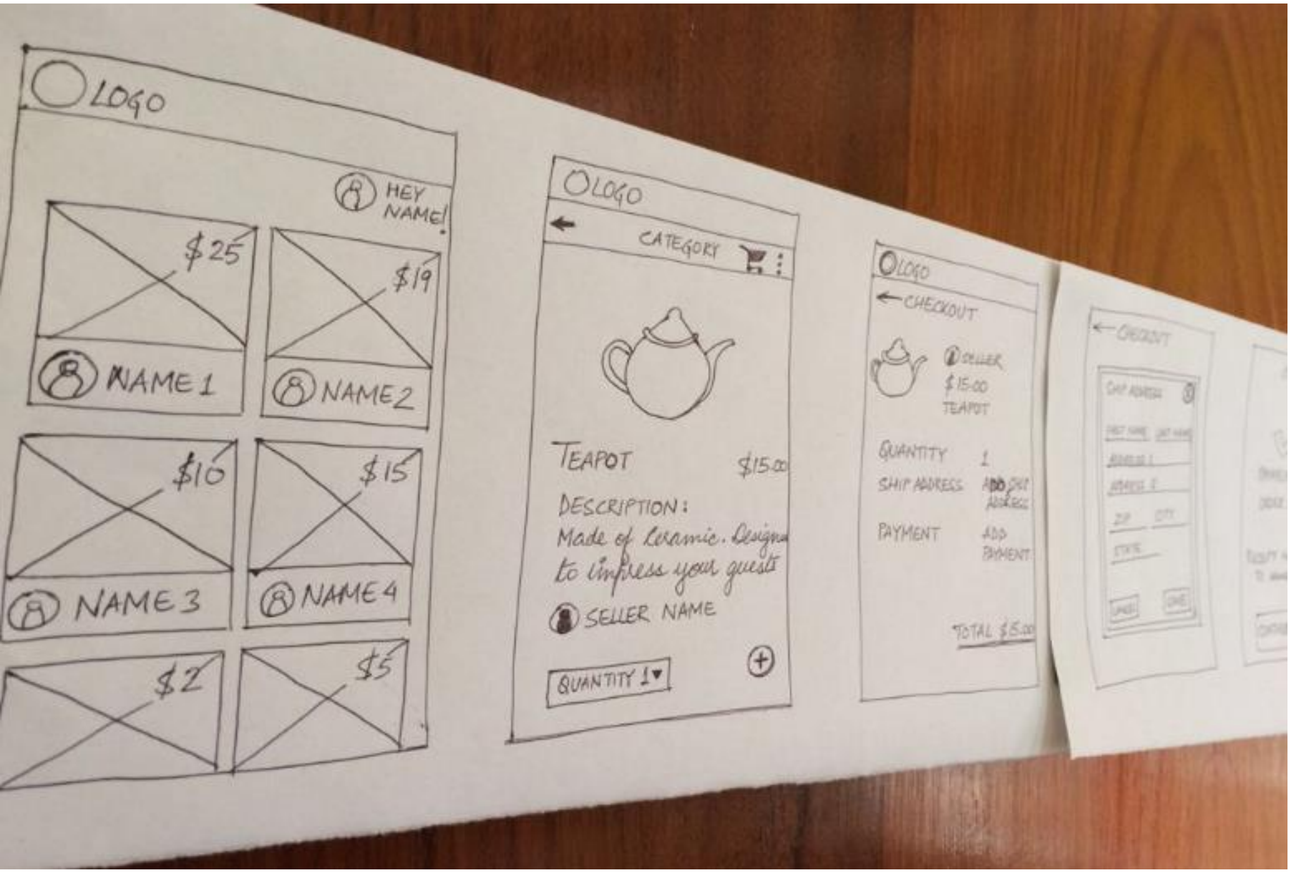
[Analitico, 2013](); [Rajkumar, 2017]()

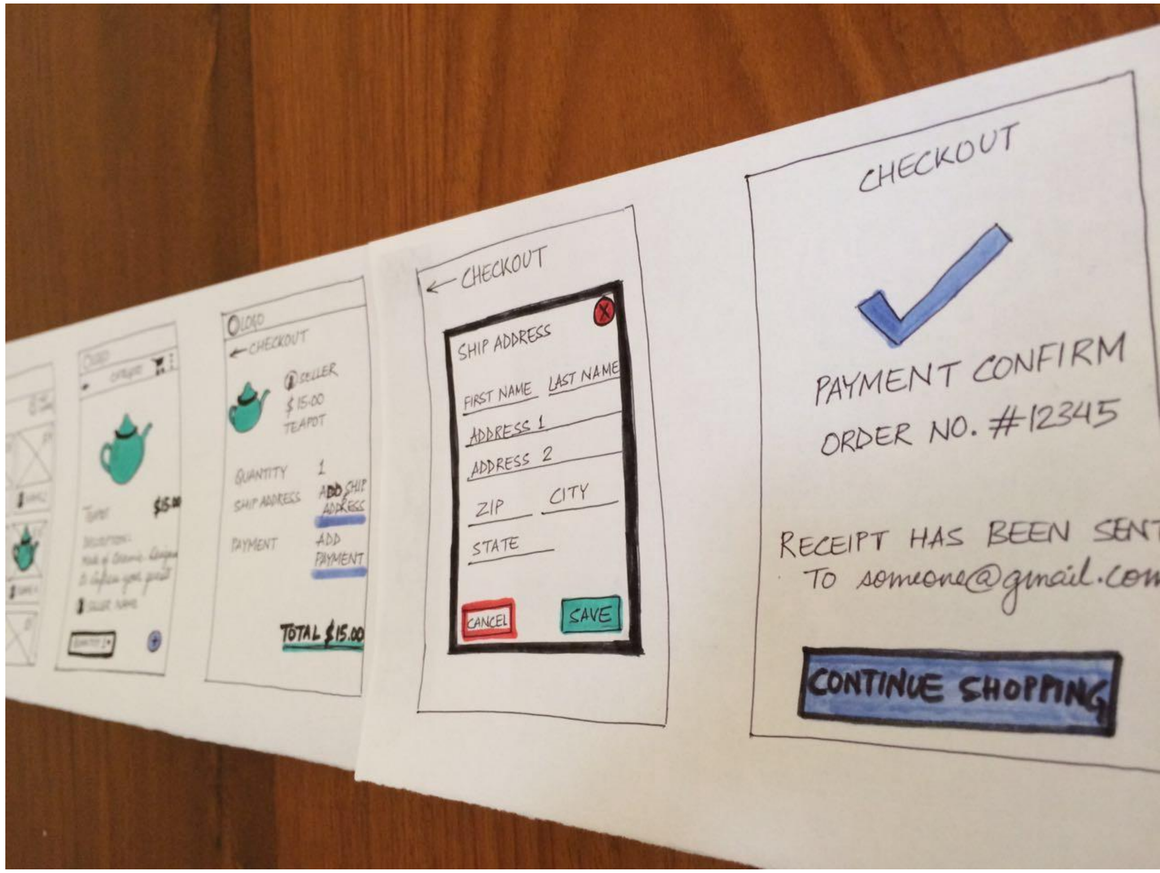
Paper Prototyping





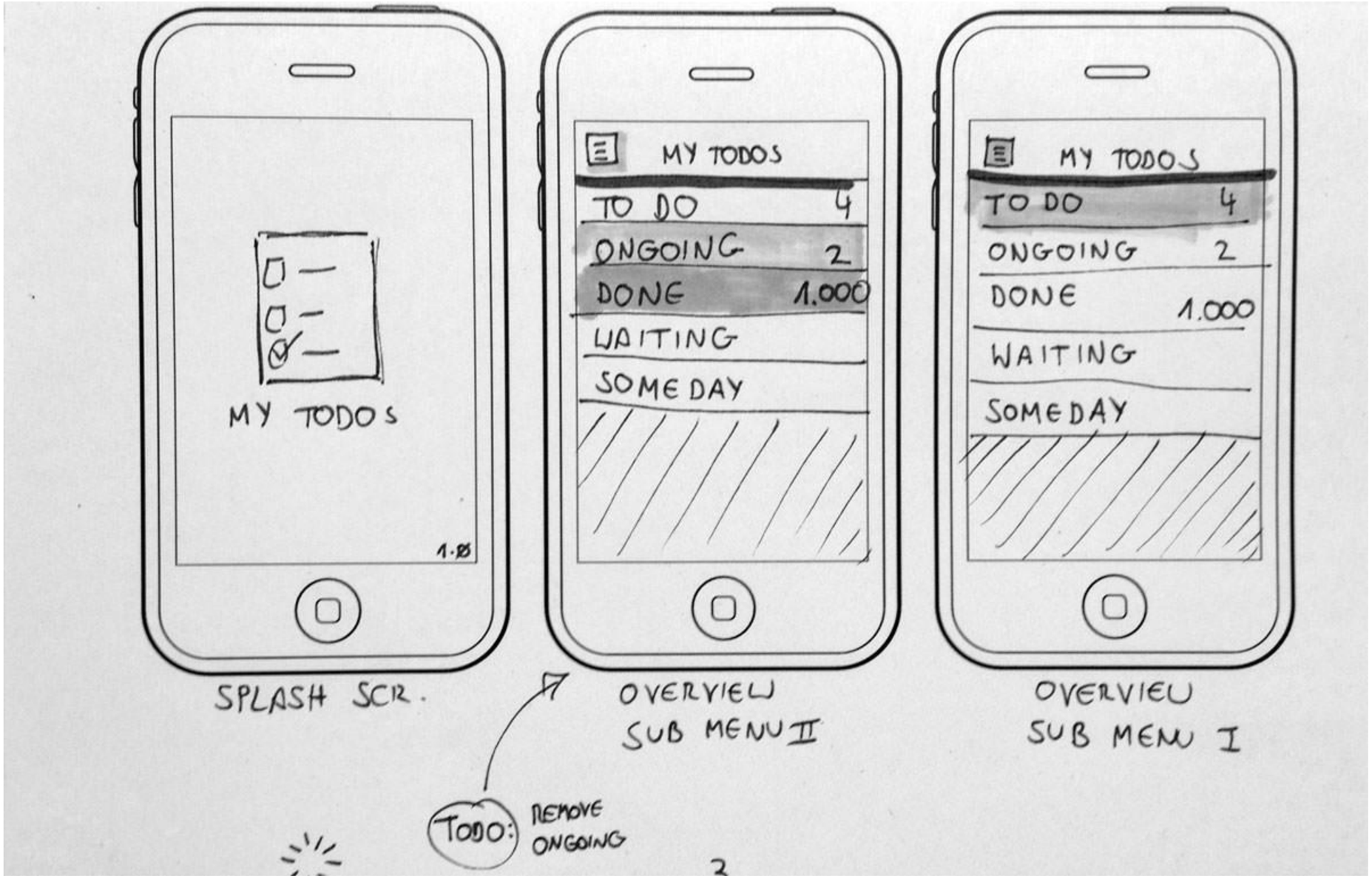
Low Fidelity to High Fidelity





CanvasFlip, 2016

Sketching of Interactivity



Example Usability Test with a Paper Prototype

BlueDuckLabs, 2010