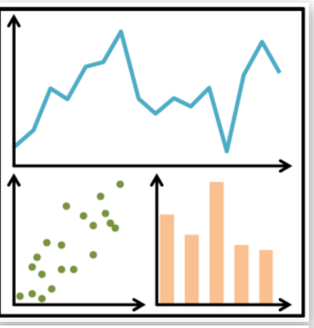
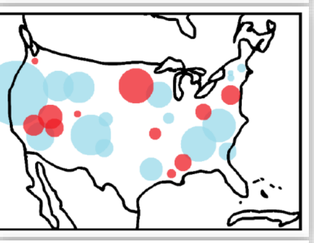
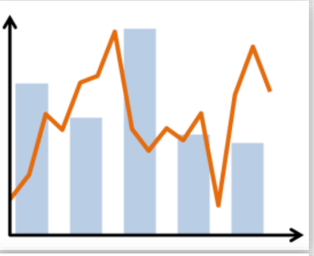
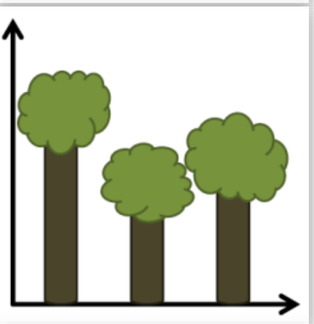
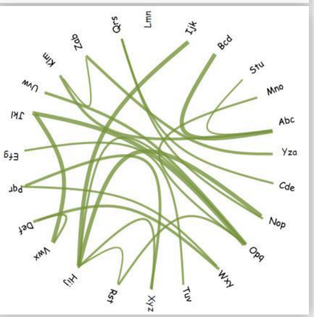






Pop-Out, Illusions, Interaction

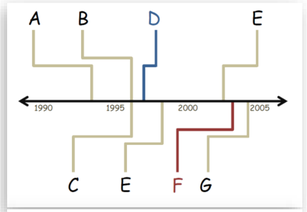
DS 4200

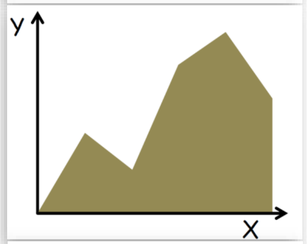
FALL 2020

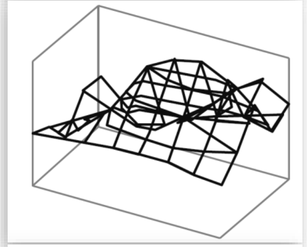
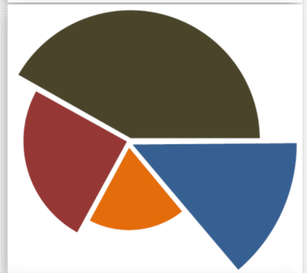
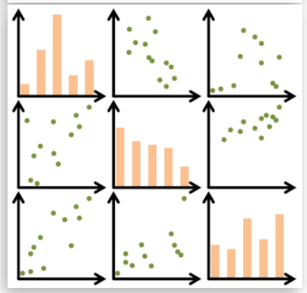
Prof. Cody Dunne

NORTHEASTERN UNIVERSITY

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



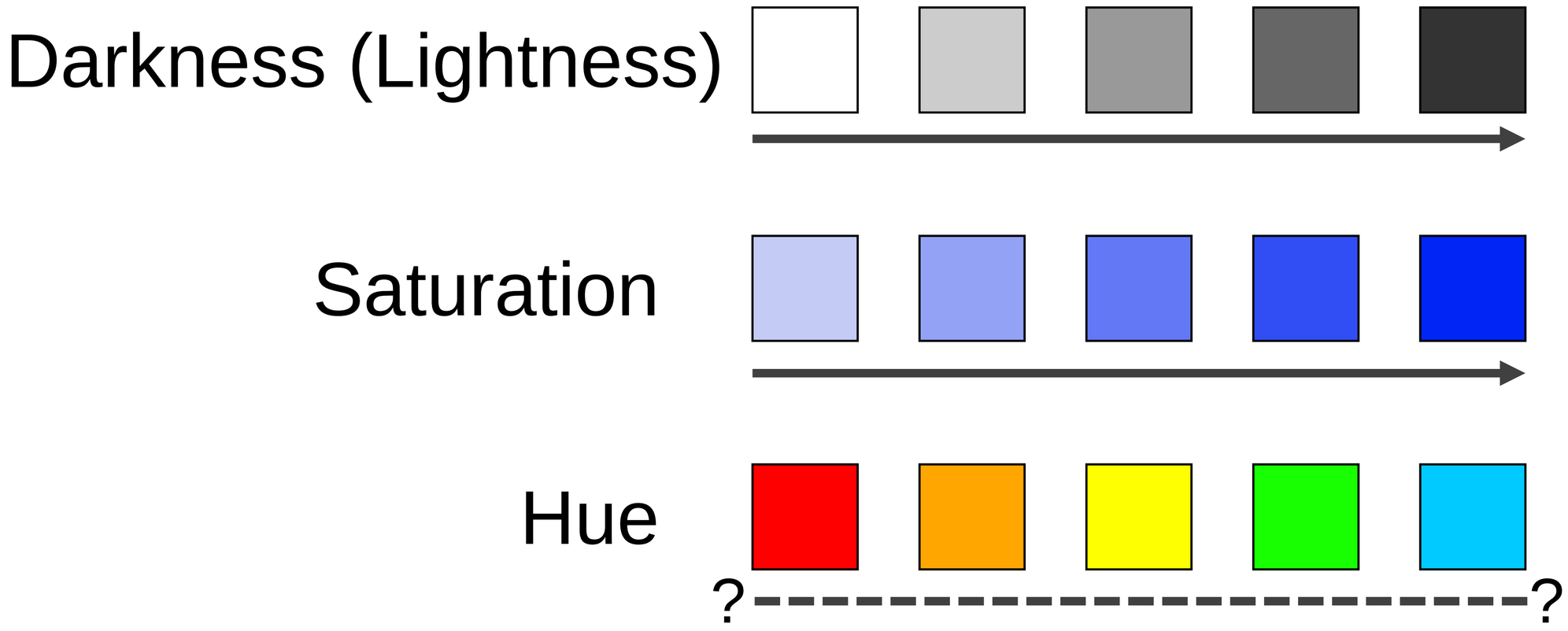


Check-in

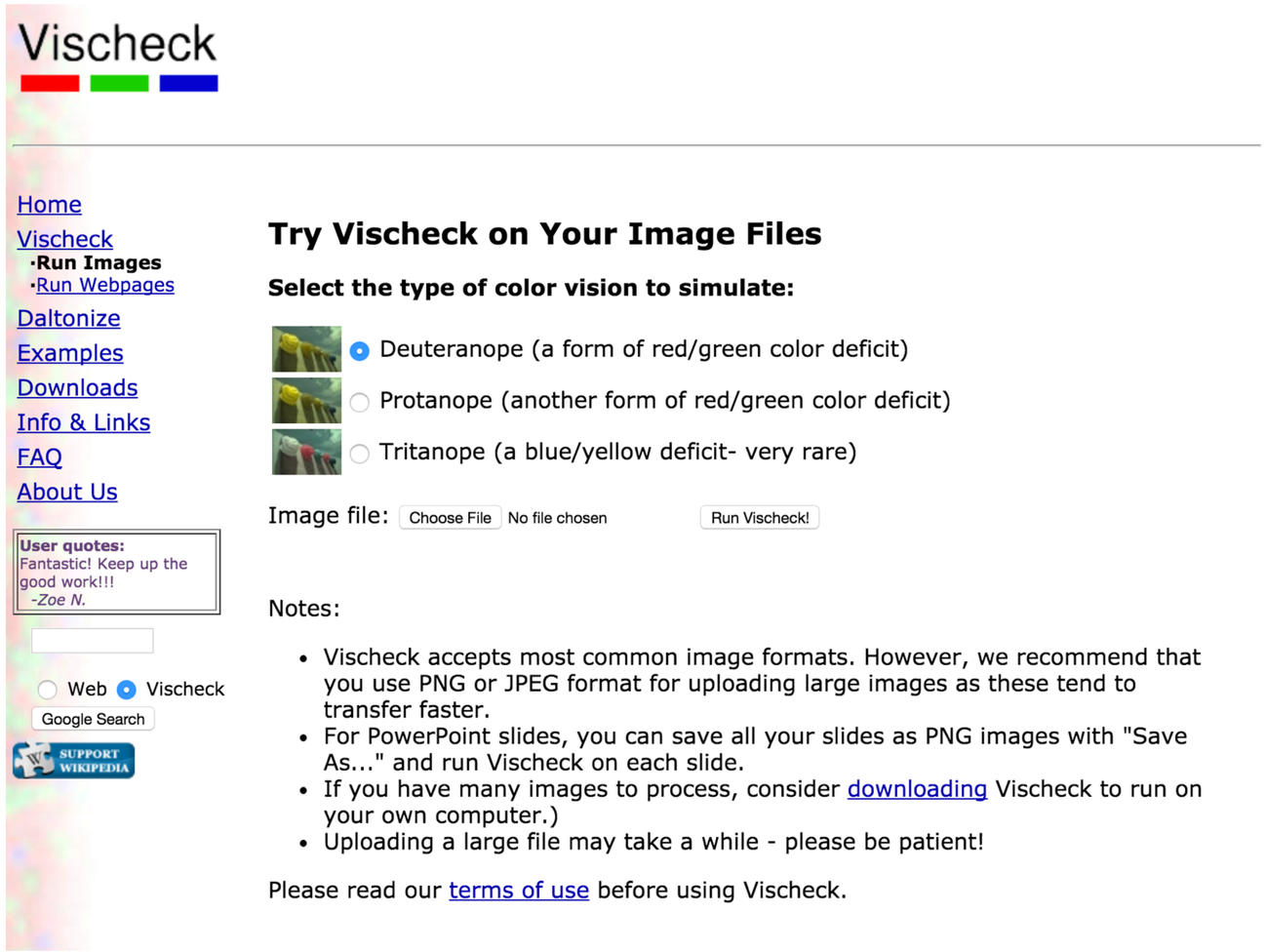
PREVIOUSLY, ON DS 4200…

Color Vocabulary and Perceptual Ordering



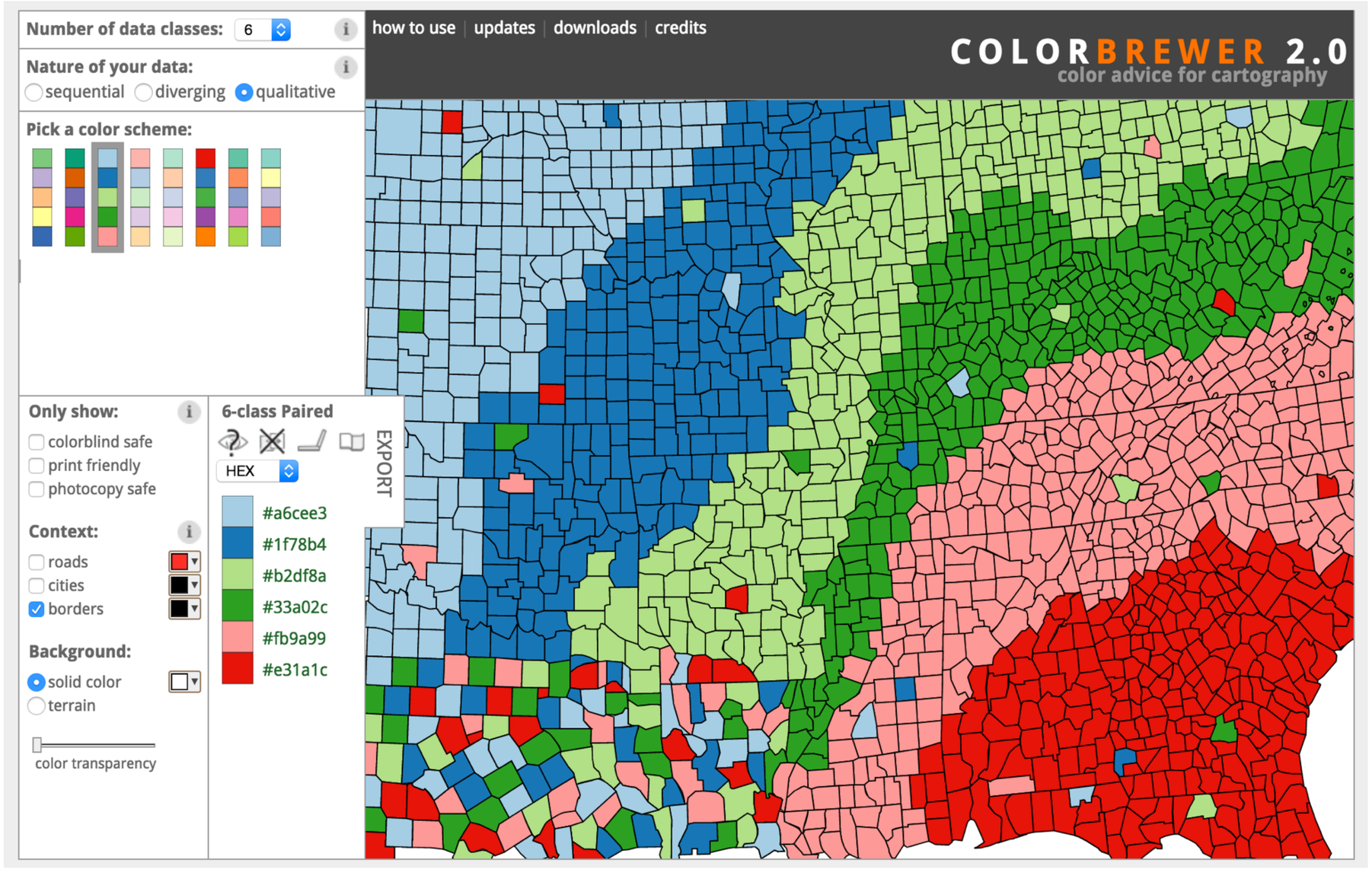
Color Deficiencies (Color Blindness)

Check your images/colormaps for issues!



http://www.vischeck.com/vischeck/vischeckImage.php https://www.color-blindness.com/coblis-color-blindness-simulator/

Color Brewer



http://colorbrewer2.org

Color Advice Summary

Use a limited hue palette

- Control color “pop out” with low-saturation colors
- Avoid clutter from too many competing colors

Use neutral backgrounds

- Control impact of color
- Minimize simultaneous contrast

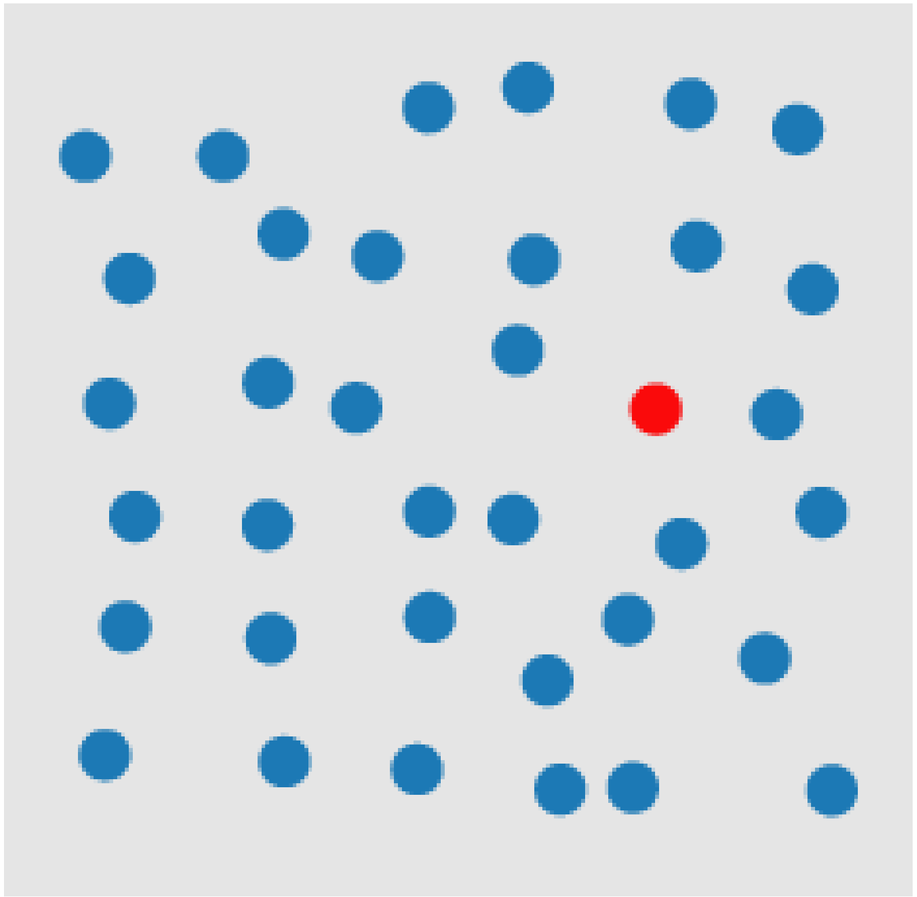
Use Color Brewer etc. for picking scales

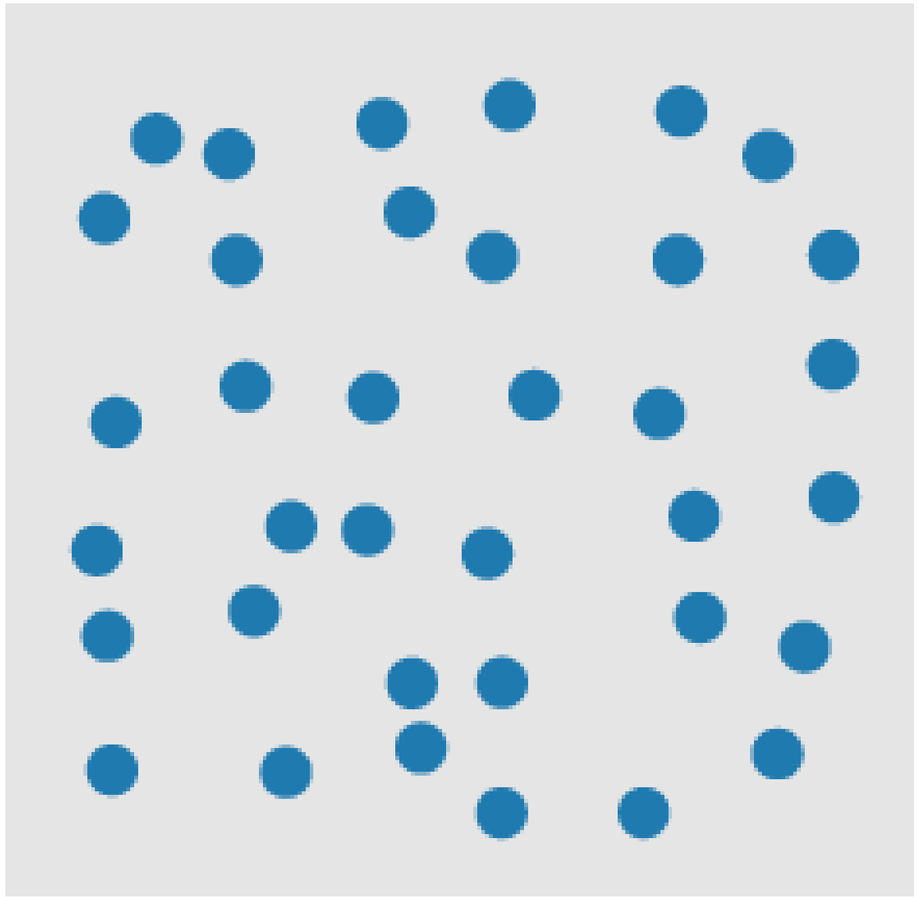
Don’t forget aesthetics!

Now, on DS 4200…

Pop-out Effects

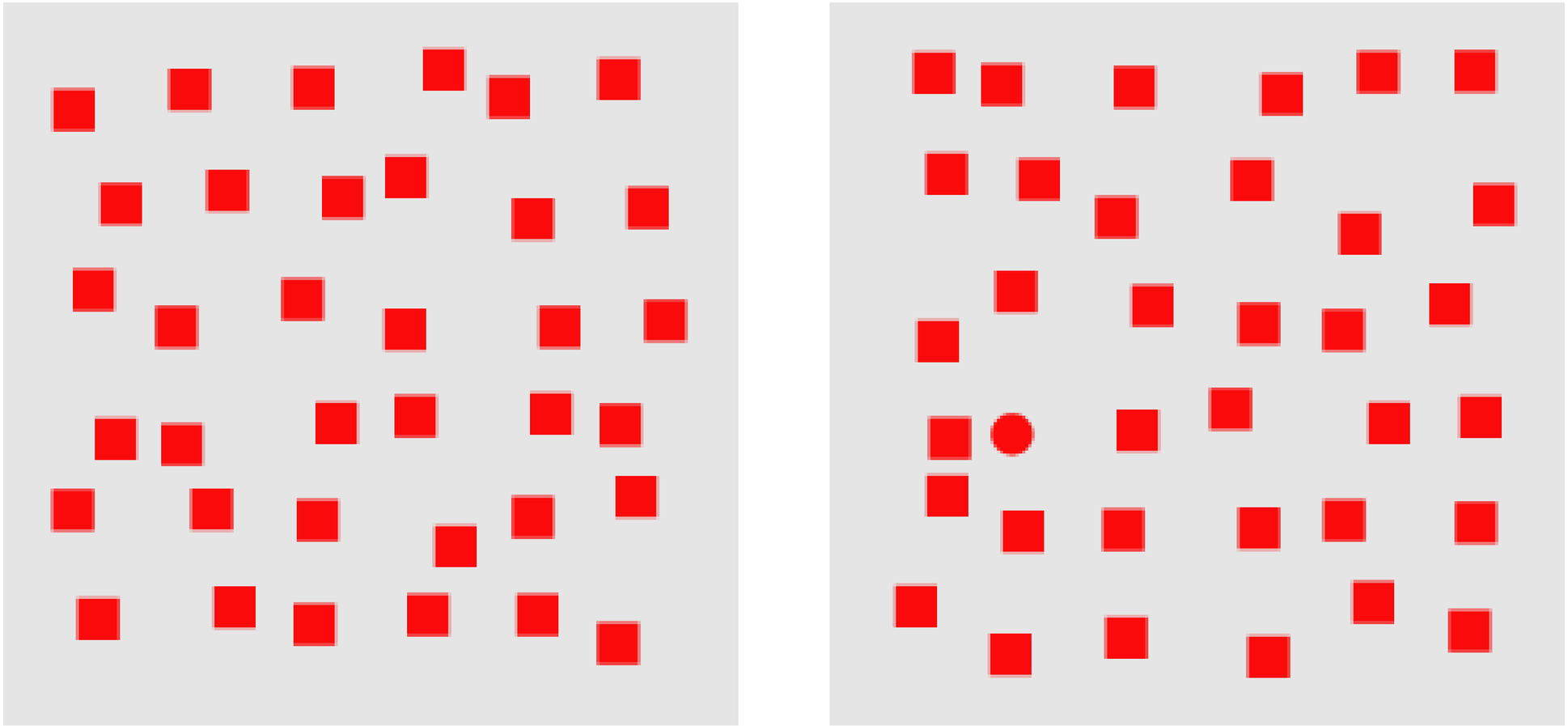
Pop-Out Effects





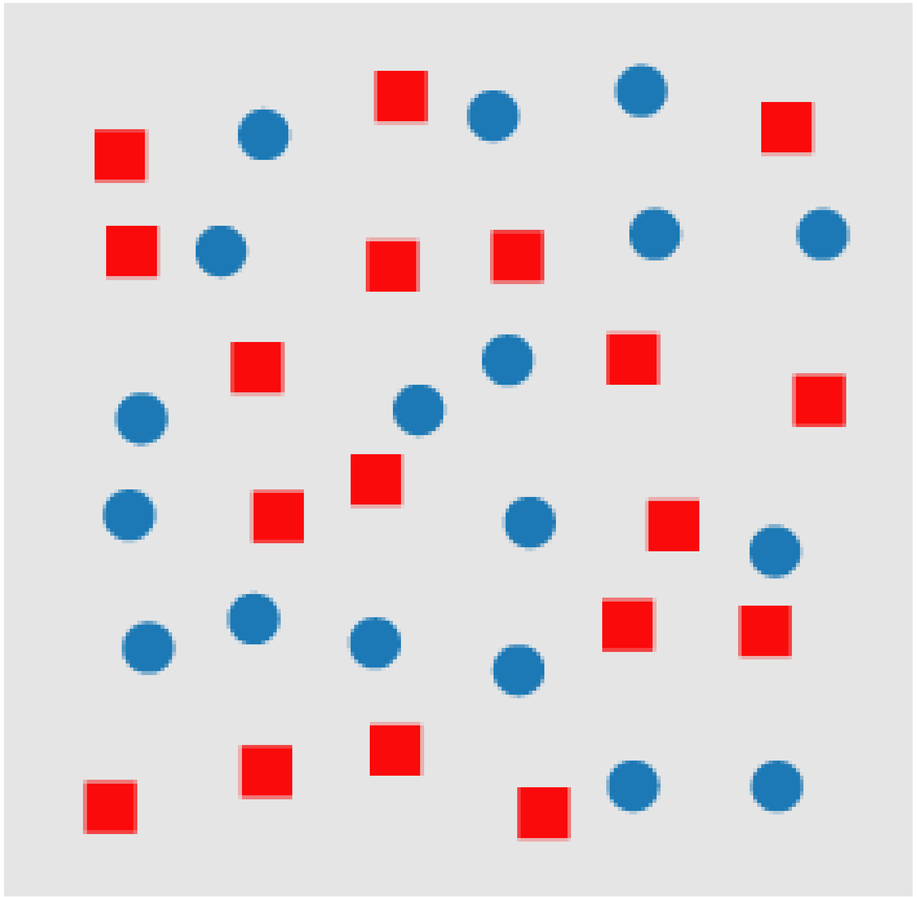
Color

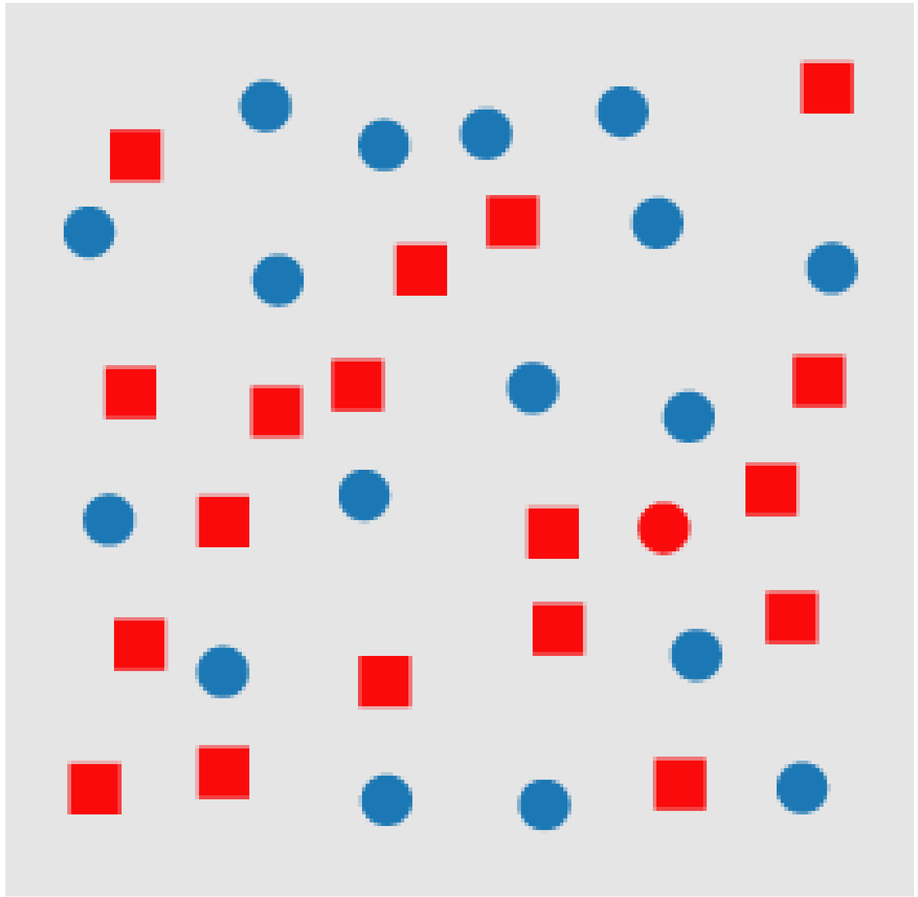
POP-OUT EFFECTS



SHAPE

POP-OUT EFFECTS

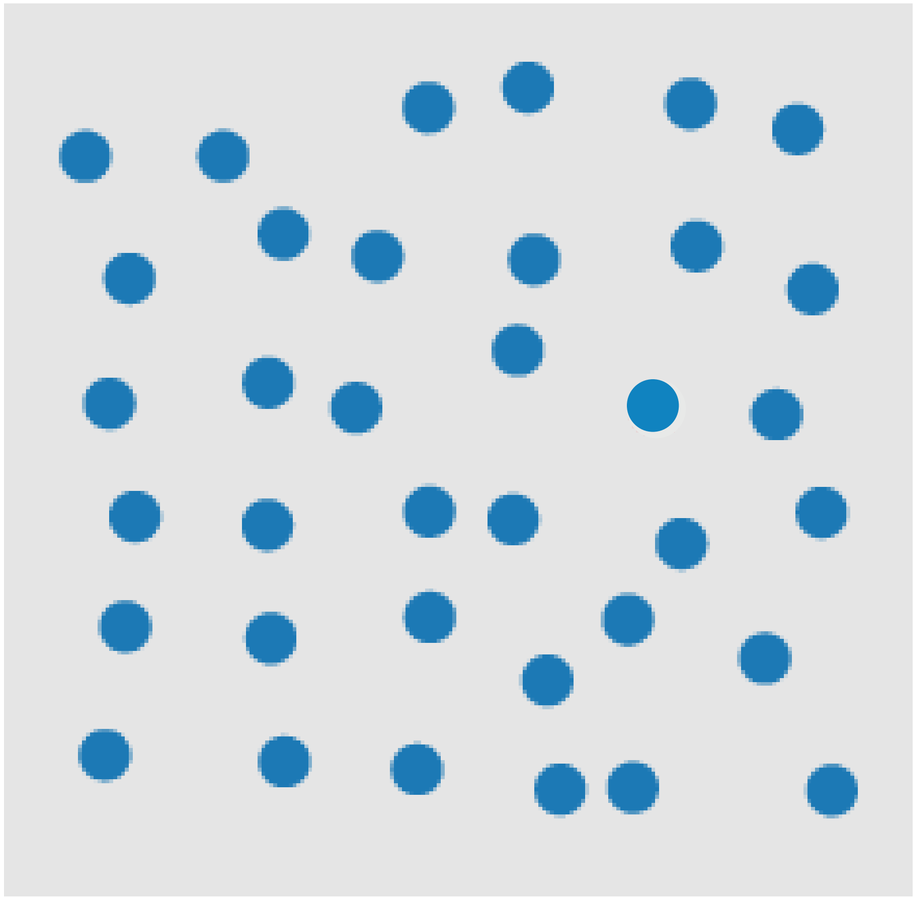


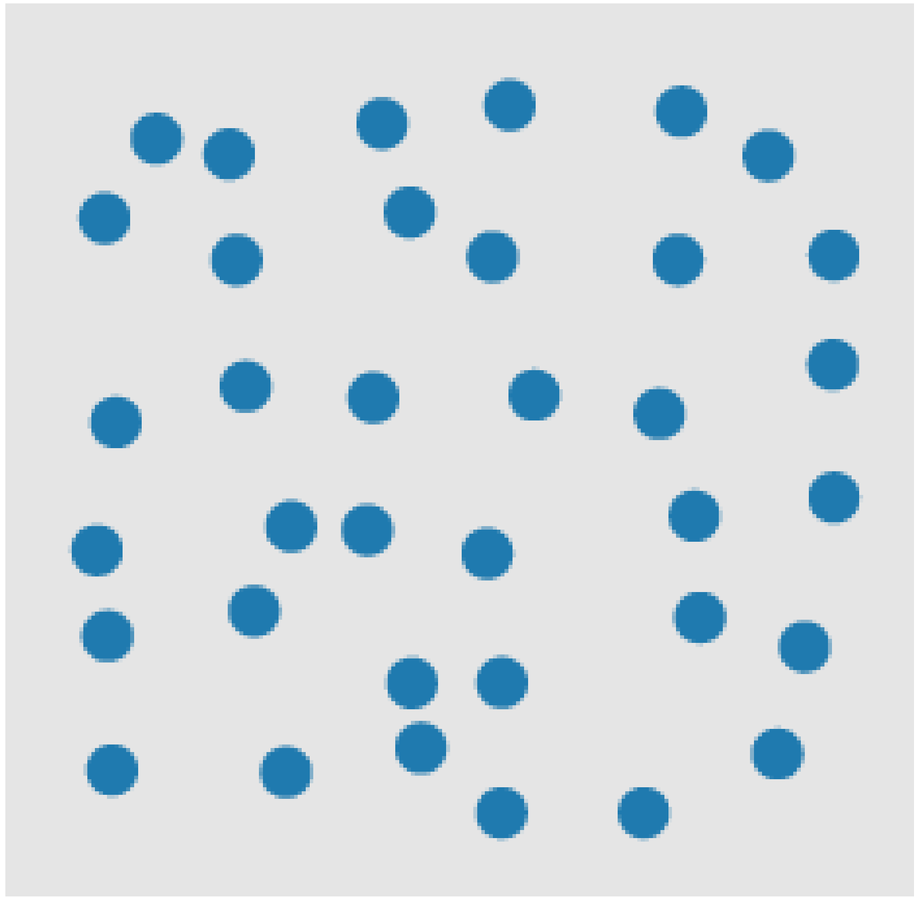


"CONJUNCTION" (HARDER TO FIND RED CIRCLE!)

Healey, 2012

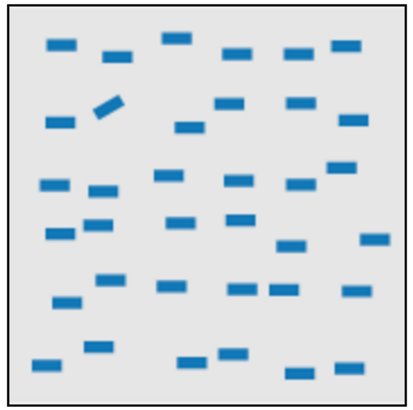
Pop-Out Effects



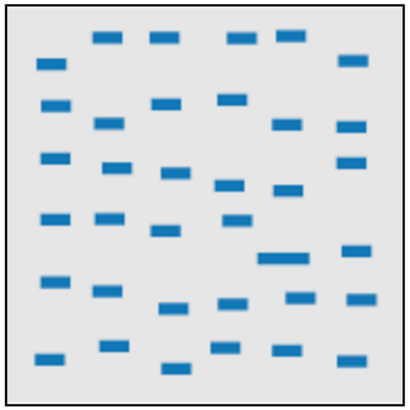


Motion

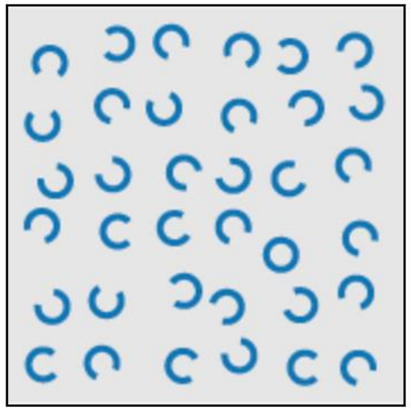
POP-OUT EFFECTS



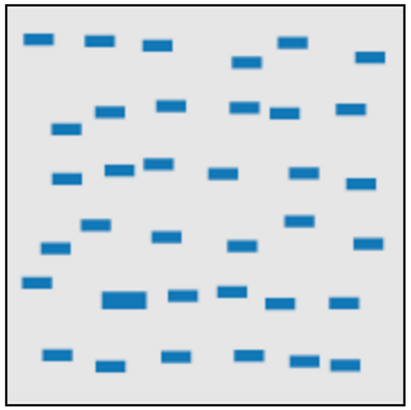
line (blob) orientation
Julész & Bergen 83; Sagi & Julész 85a, Wolfe et al. 92; Weigle et al. 2000



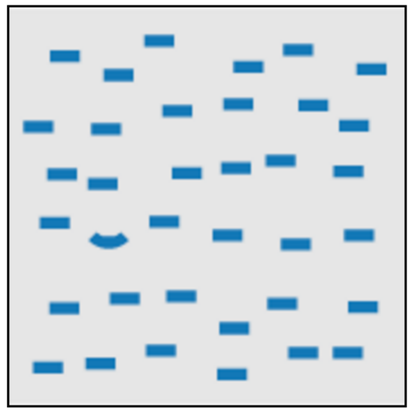
length, width
Sagi & Julész 85b; Treisman & Gormican 88



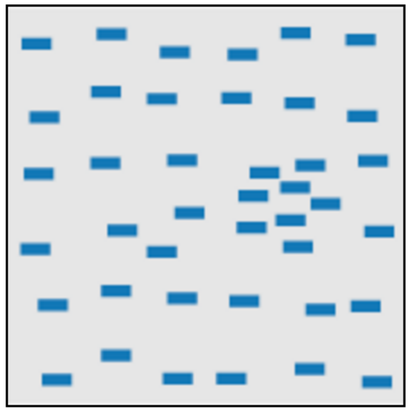
closure
Julész & Bergen 83



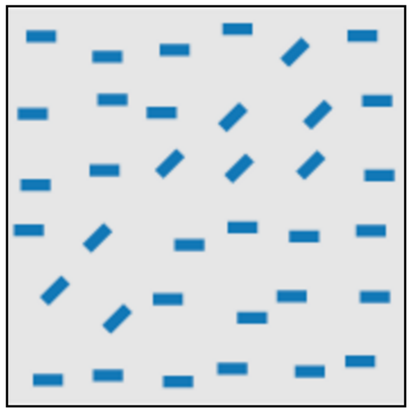
size
Treisman & Gelade 80; Healey & Enns 98; Healey & Enns 99



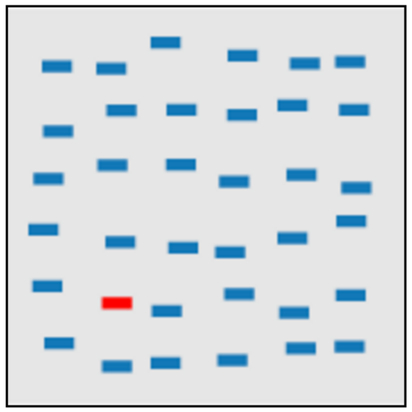
curvature
Treisman & Gormican 88



density, contrast
Healey & Enns 98; Healey & Enns 99



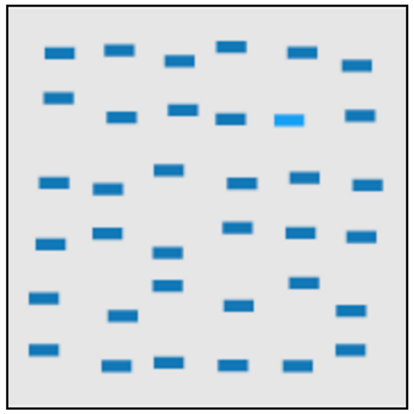
number, estimation
Sagi & Julész 85b; Healey et al. 93; Trick & Pylyshyn 94



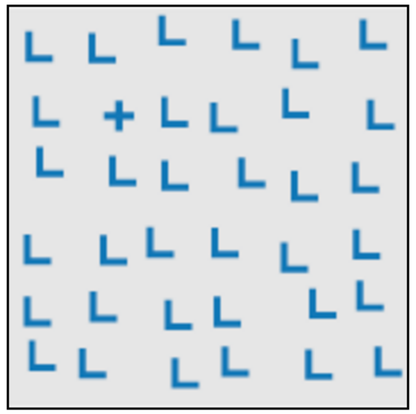
colour (hue)
Nagy & Sanchez 90; Nagy et al. 90; D'Zmura 91; Kawai et al. 95; Bauer et al. 96; Healey 96; Bauer et al. 98; Healey & Enns 99

Healey, 2012

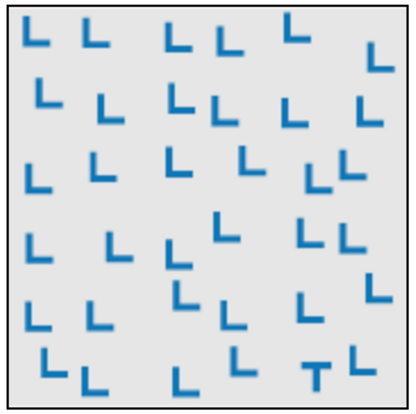
POP-OUT EFFECTS



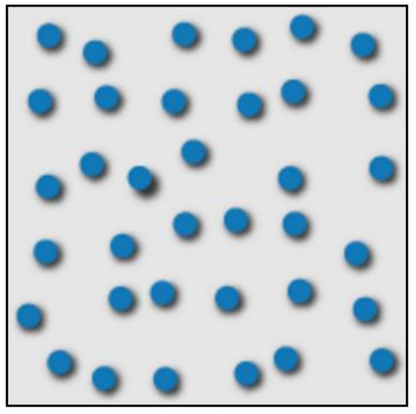
intensity, binocular lustre
Beck et al. 83; Treisman & Gormican 88; Wolfe & Franzel 88



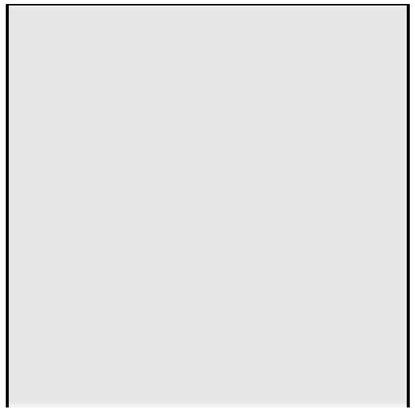
intersection
Julész & Bergen 83



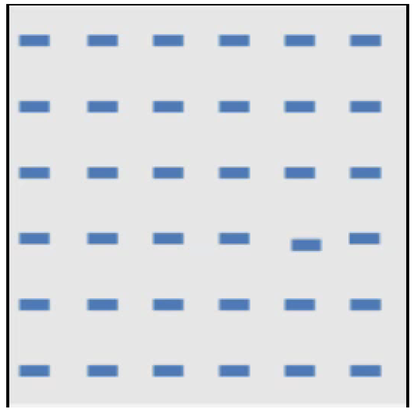
terminators
Julész & Bergen 83



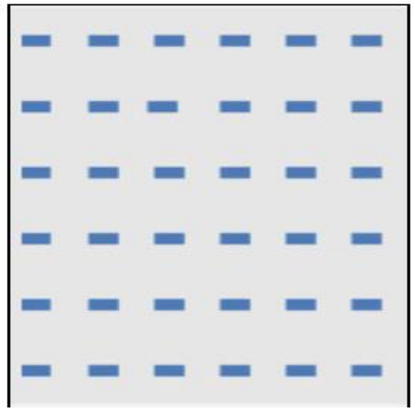
3D depth cues
Enns 90b; Nakayama & Silverman 86



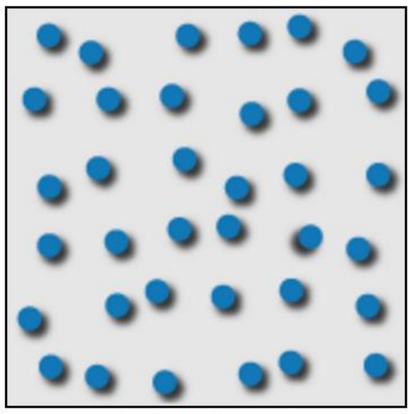
flicker
Gebb et a. 55; Mowbray & Gebhard 55; Brown 65; Julész 71; Huber & Healey 2005



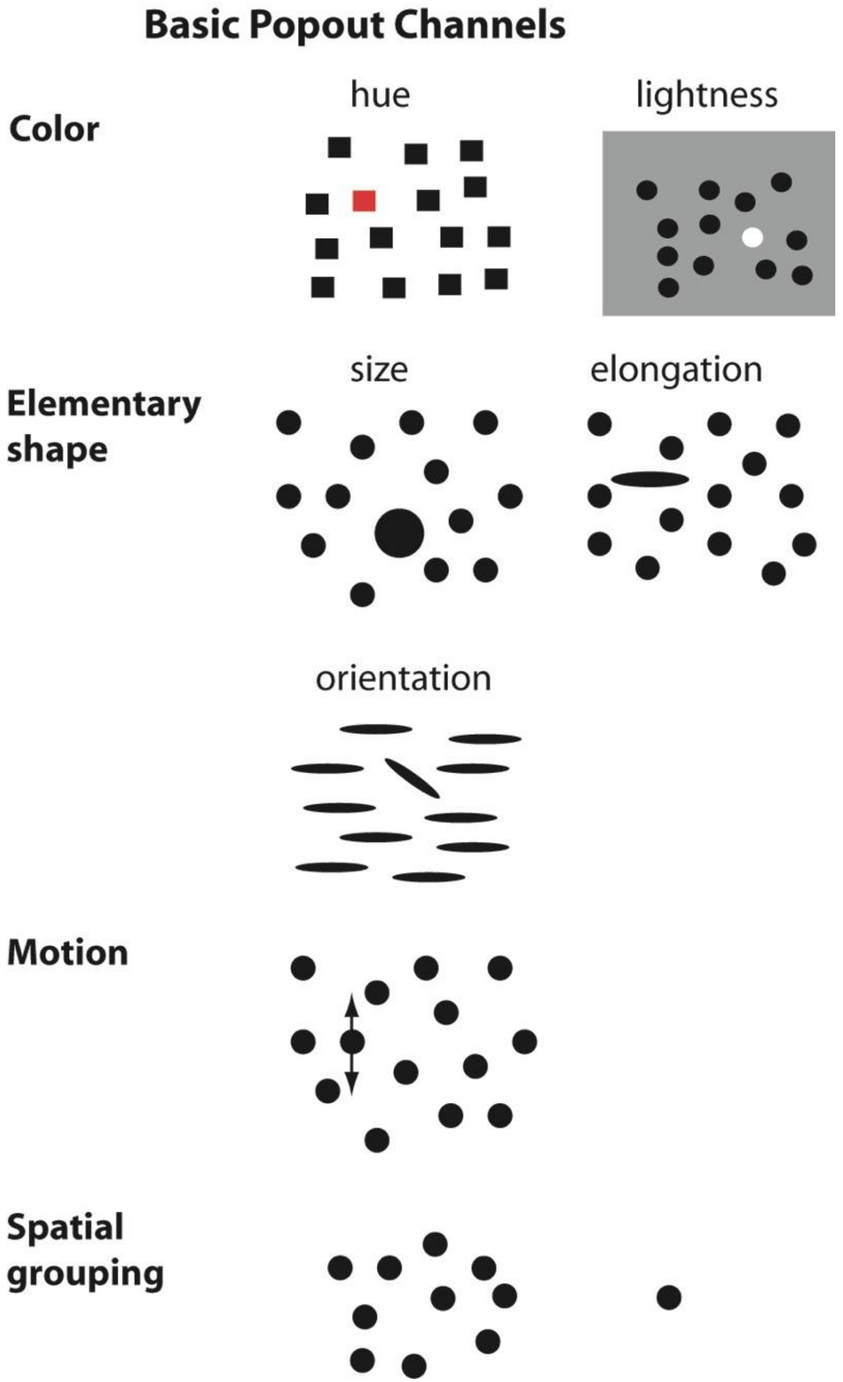
direction of motion
Nakayama & Silverman 86; Driver & McLeod 92; Huber & Healey 2005



velocity of motion
Tynan & Sekuler 82; Nakayama & Silverman 86; Driver & McLeod 92; Hohnsbein & Mateeff 98; Huber & Healey 2005



lighting direction
Enns 90a



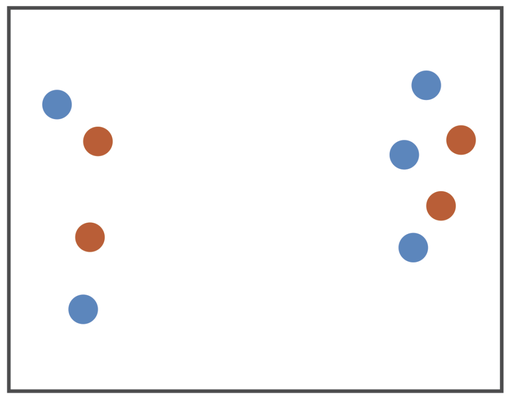
Use these "popout" effects to help design effective visualizations!

(E.g., draw viewer's attention to main points, effective redundant encodings, etc.)

Discriminability and Separability

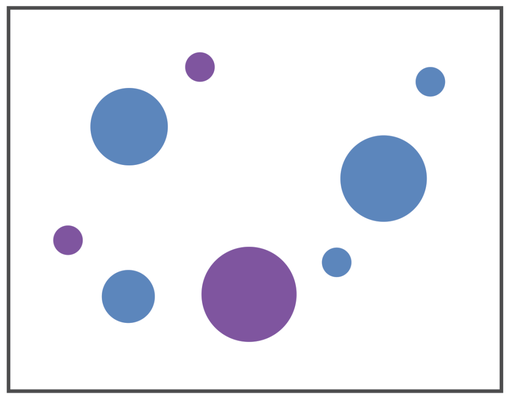
The question of discriminability is: if you encode data using a particular visual channel, are the differences between items perceptible to the human as intended?

Position
+ Hue (Color)



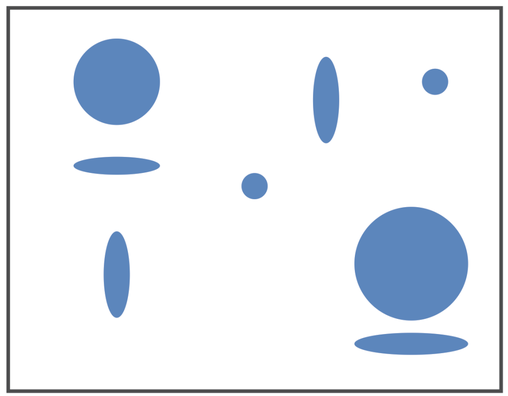
Fully separable

Size
+ Hue (Color)



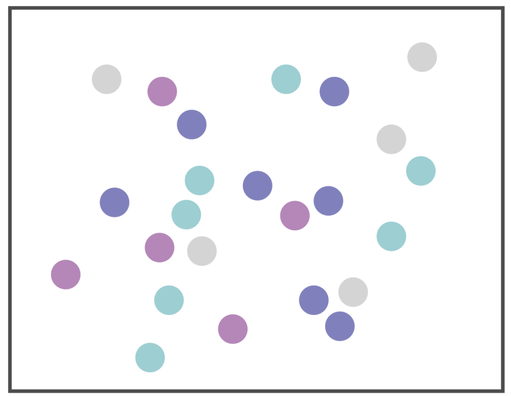
Some interference

Width
+ Height



Some/significant interference

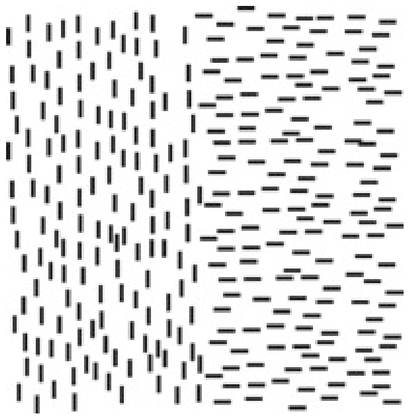
Red
+ Green

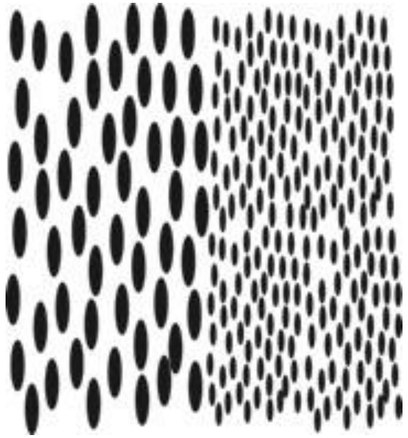


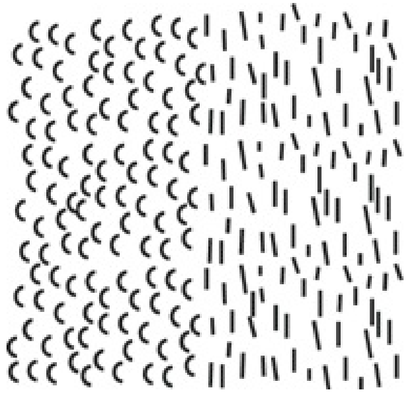
Major interference

Textures

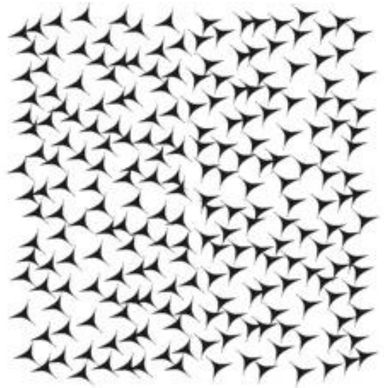
easy

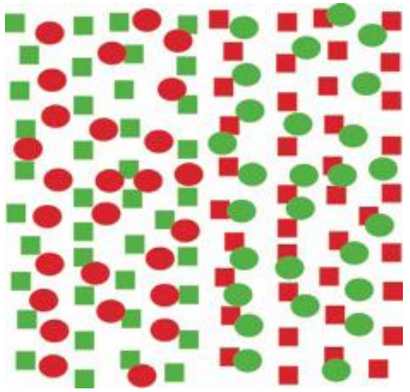


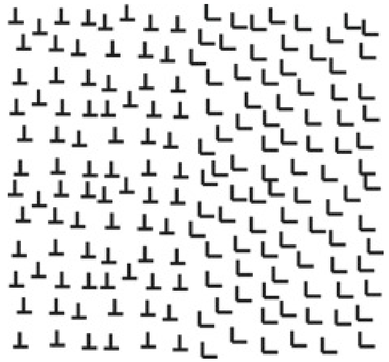




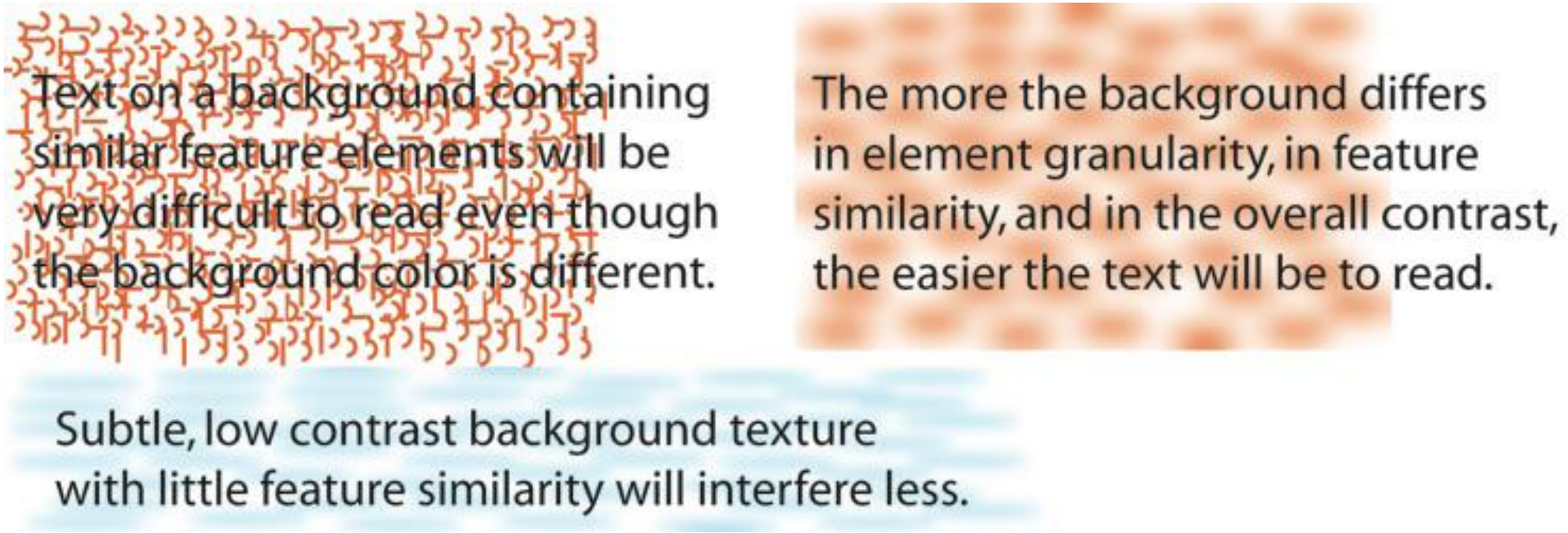
hard







Textures: Interference



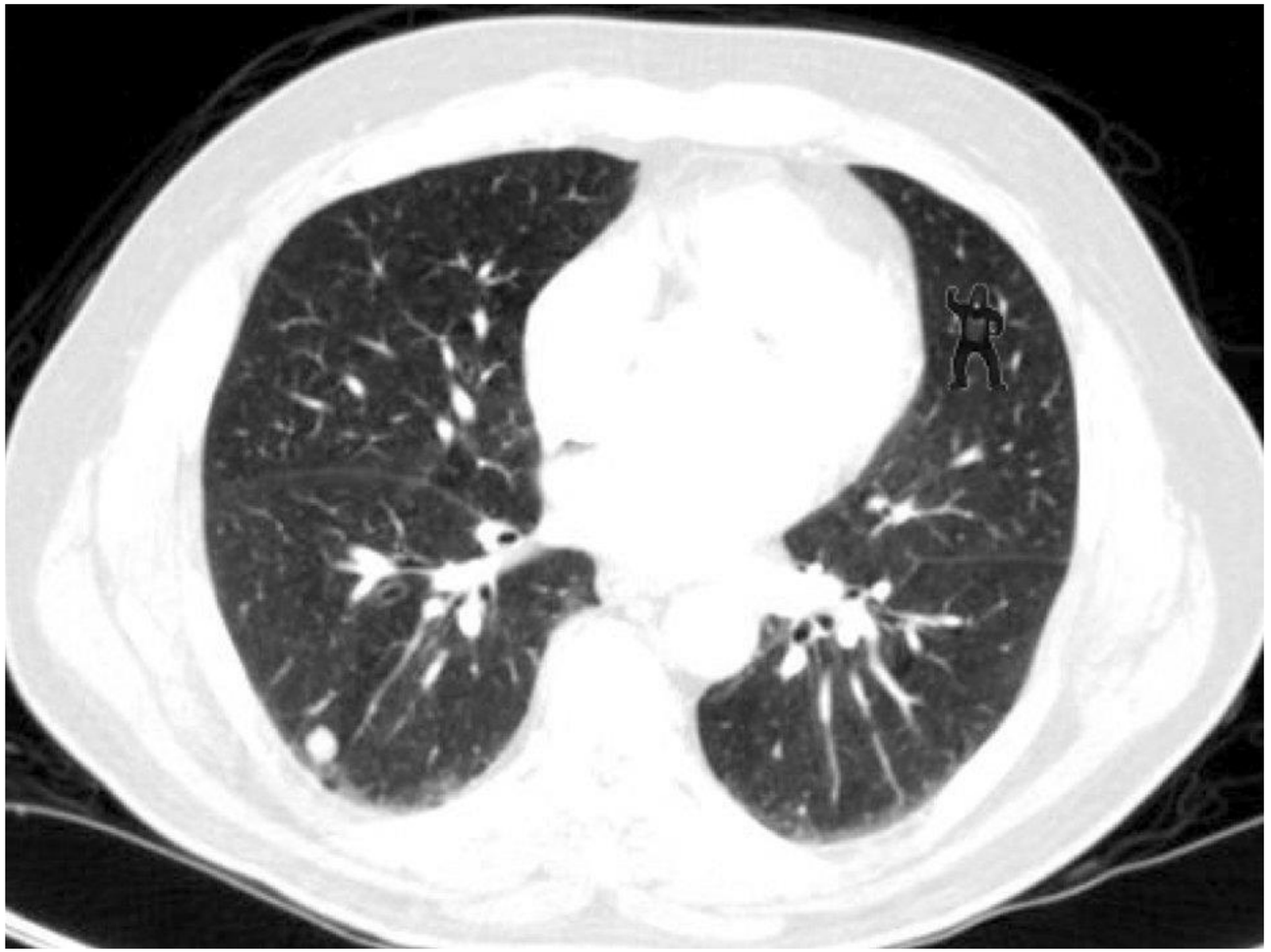
Illusions and Tricks

Visual Attention & Change Blindness


How many passes does the team in white make?

Visual Attention & Change Blindness

Task: Identify the lumps/nodules in the patient's lungs to look for cancer or abnormal growth.

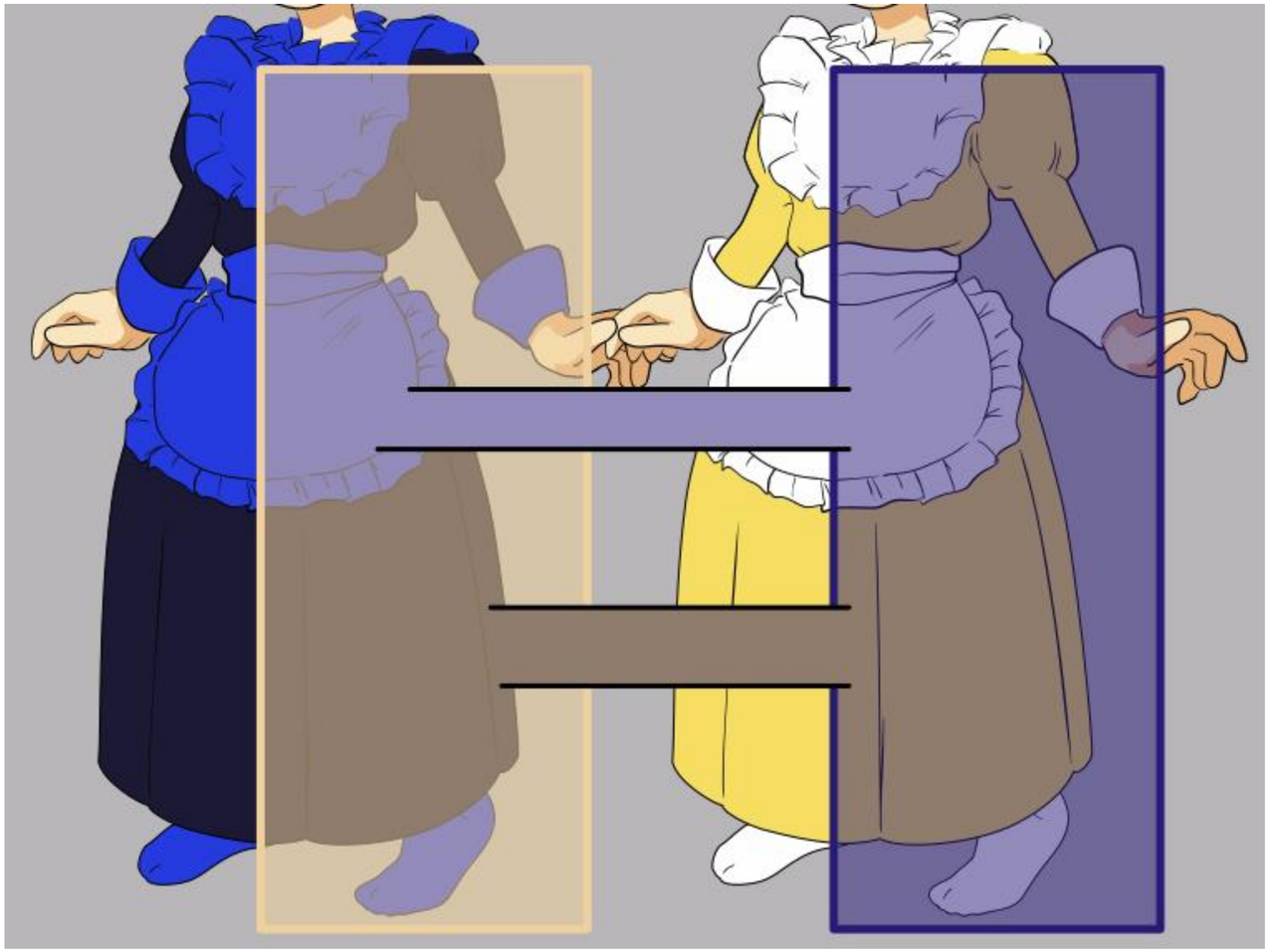


83% of the radiologists missed the gorilla!

http://search.bwh.harvard.edu/new/pubs/DrewVoWolfe13.pdf

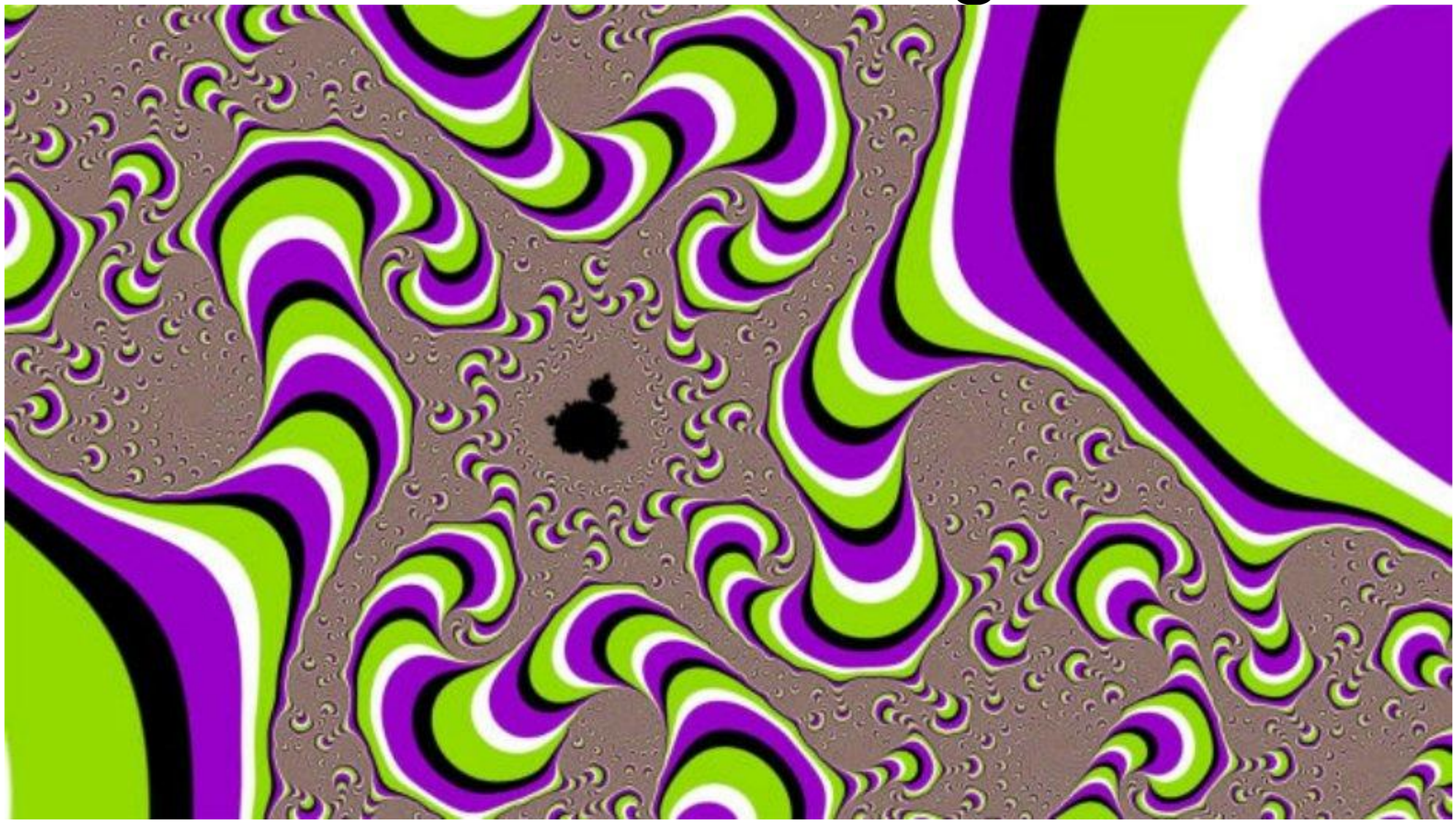
The Dress:

blue/black or yellow/white?



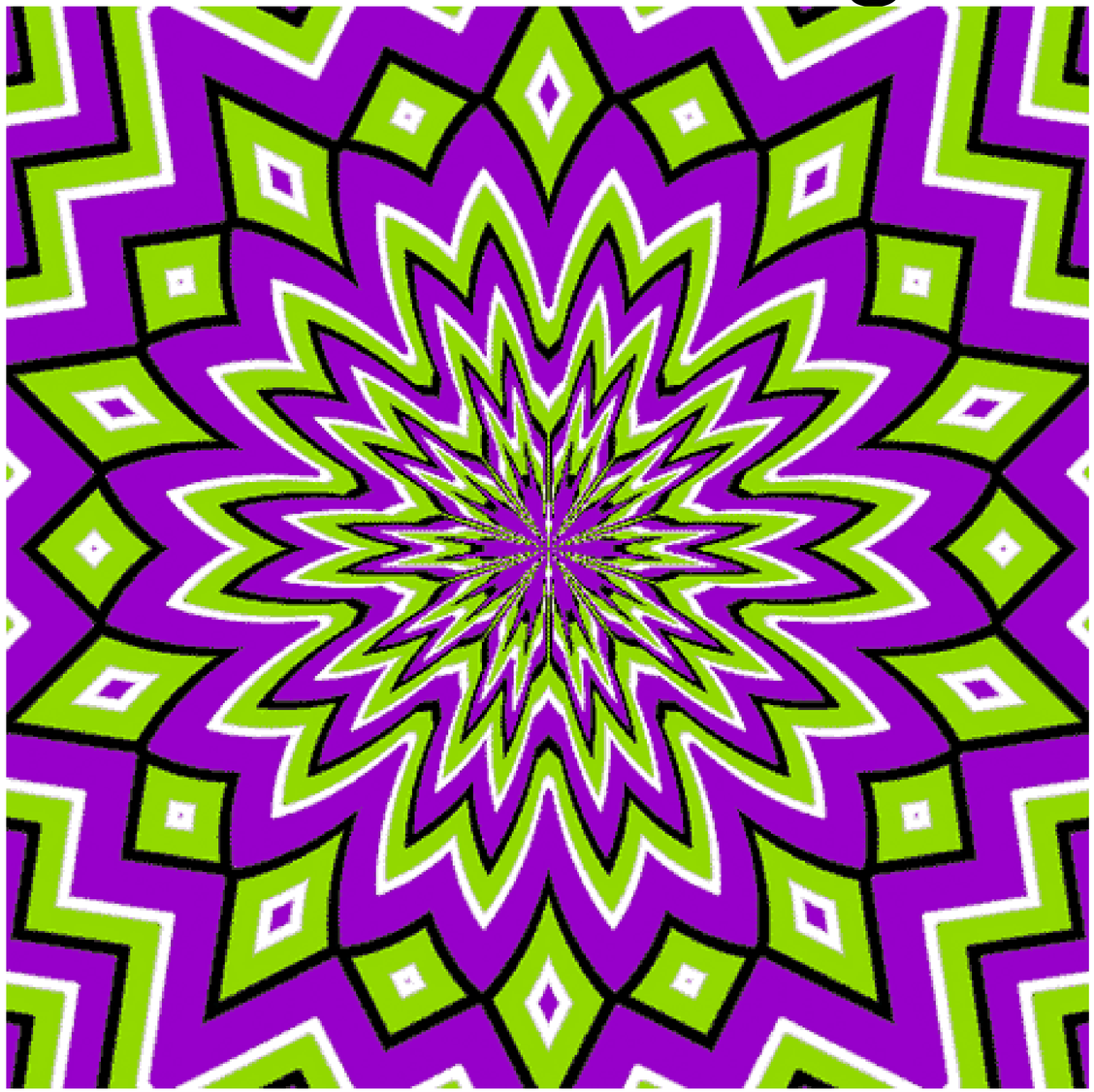
https://en.wikipedia.org/wiki/The_dress

Still or moving?



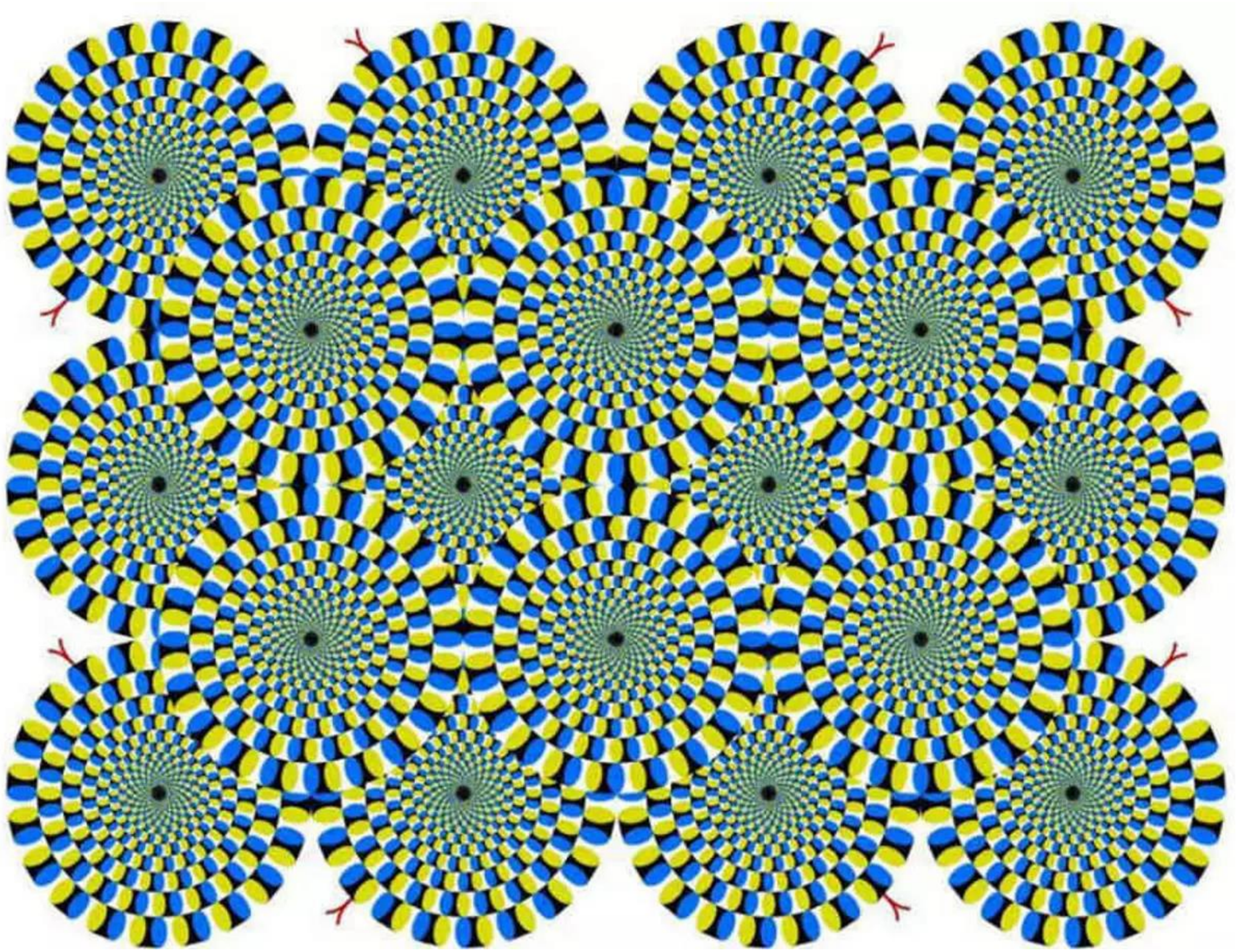
Griffin, 2015

Still or moving?



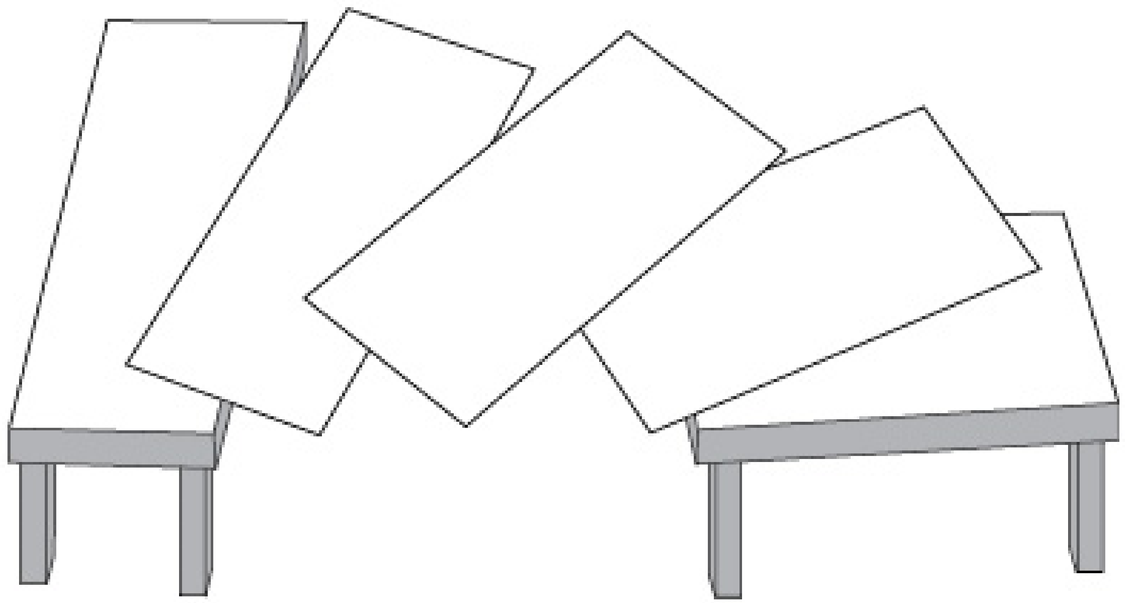
Griffin, 2015

Still or moving?



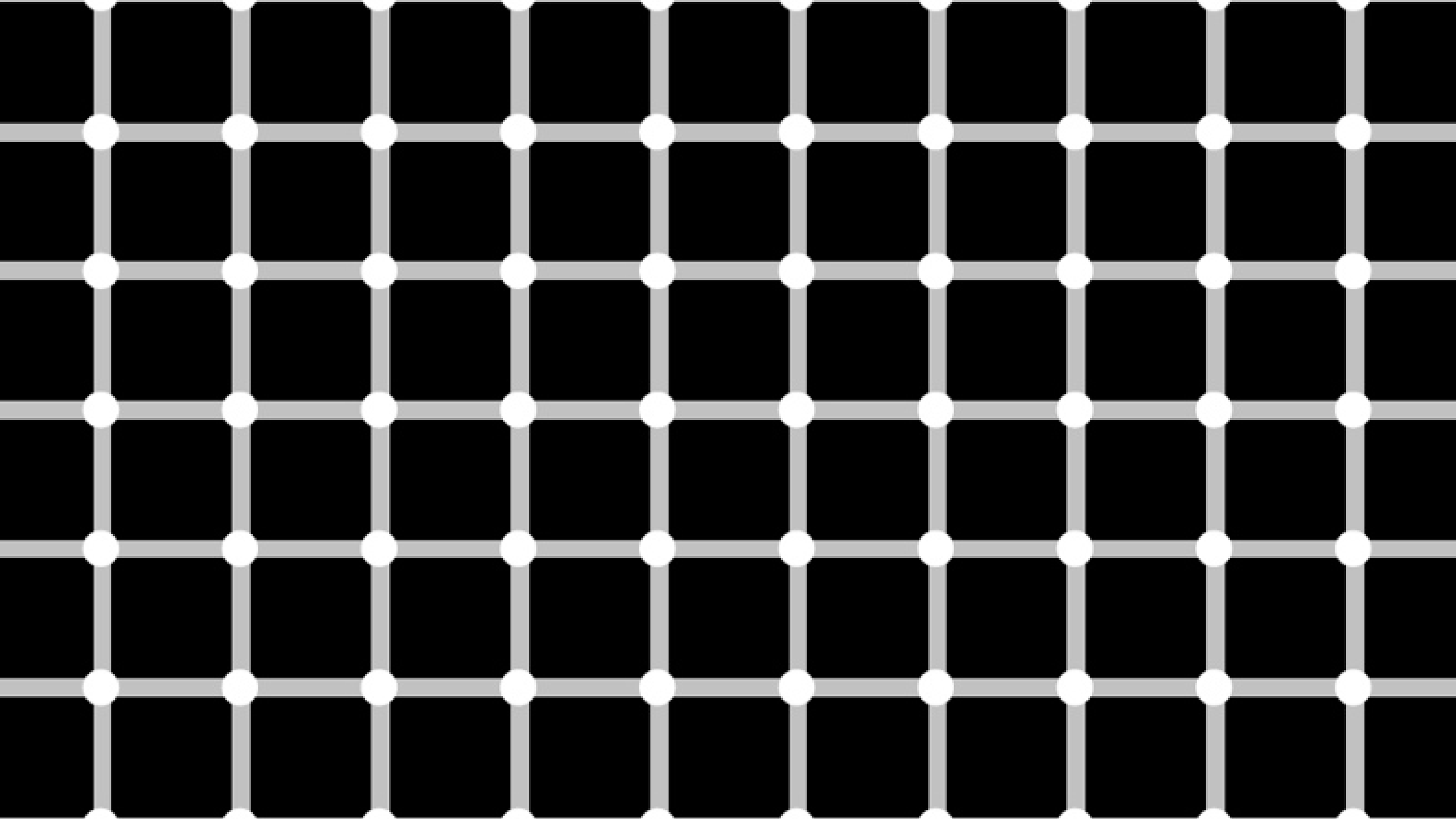
Griffin, 2015

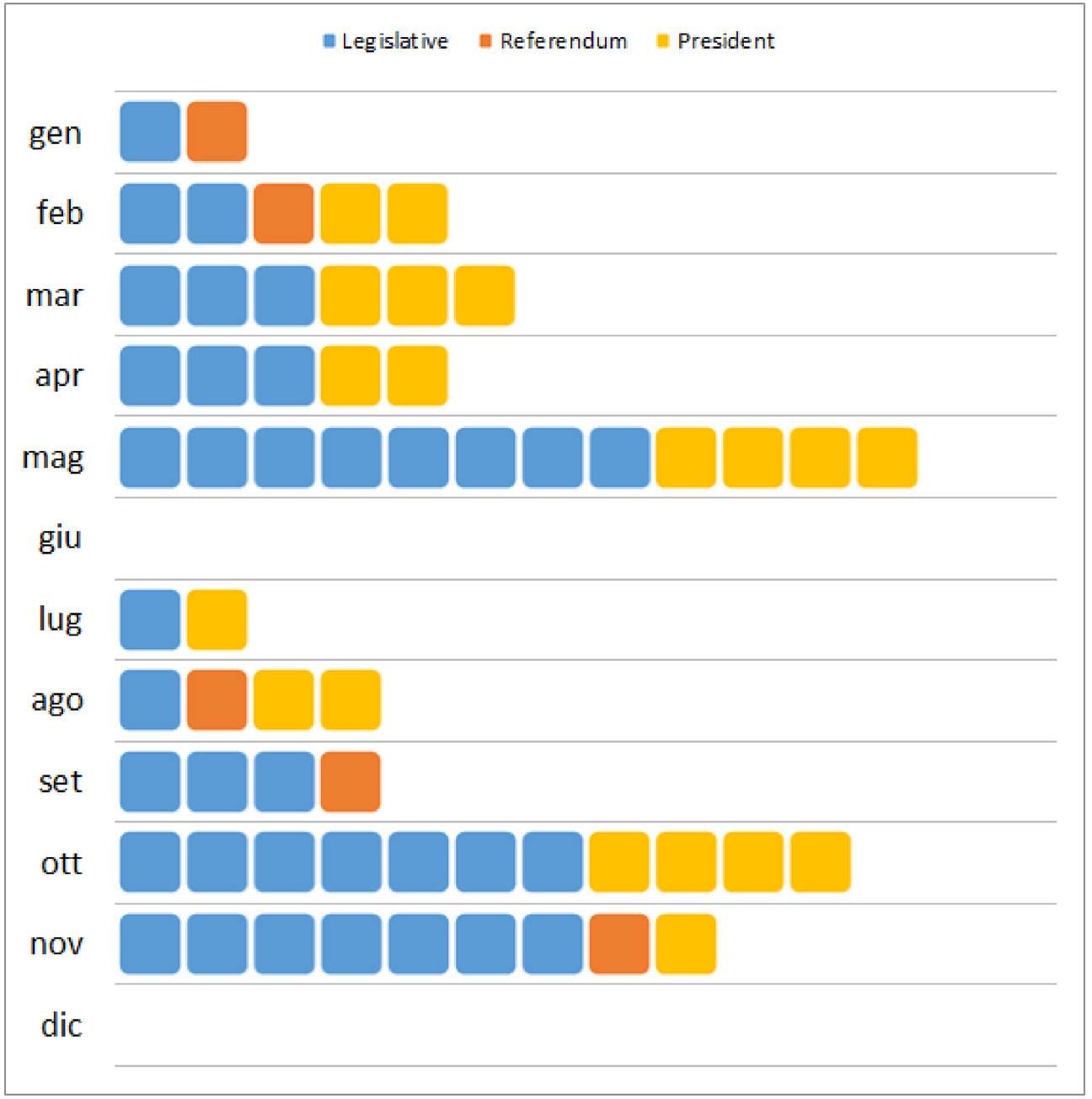
Shepherd's Table Illusion



Illusion based on how we perceive depth/perspective...

http://mentalfloss.com/article/28862/brainworks-explaining-optical-illusions-and-other-mental-tricks

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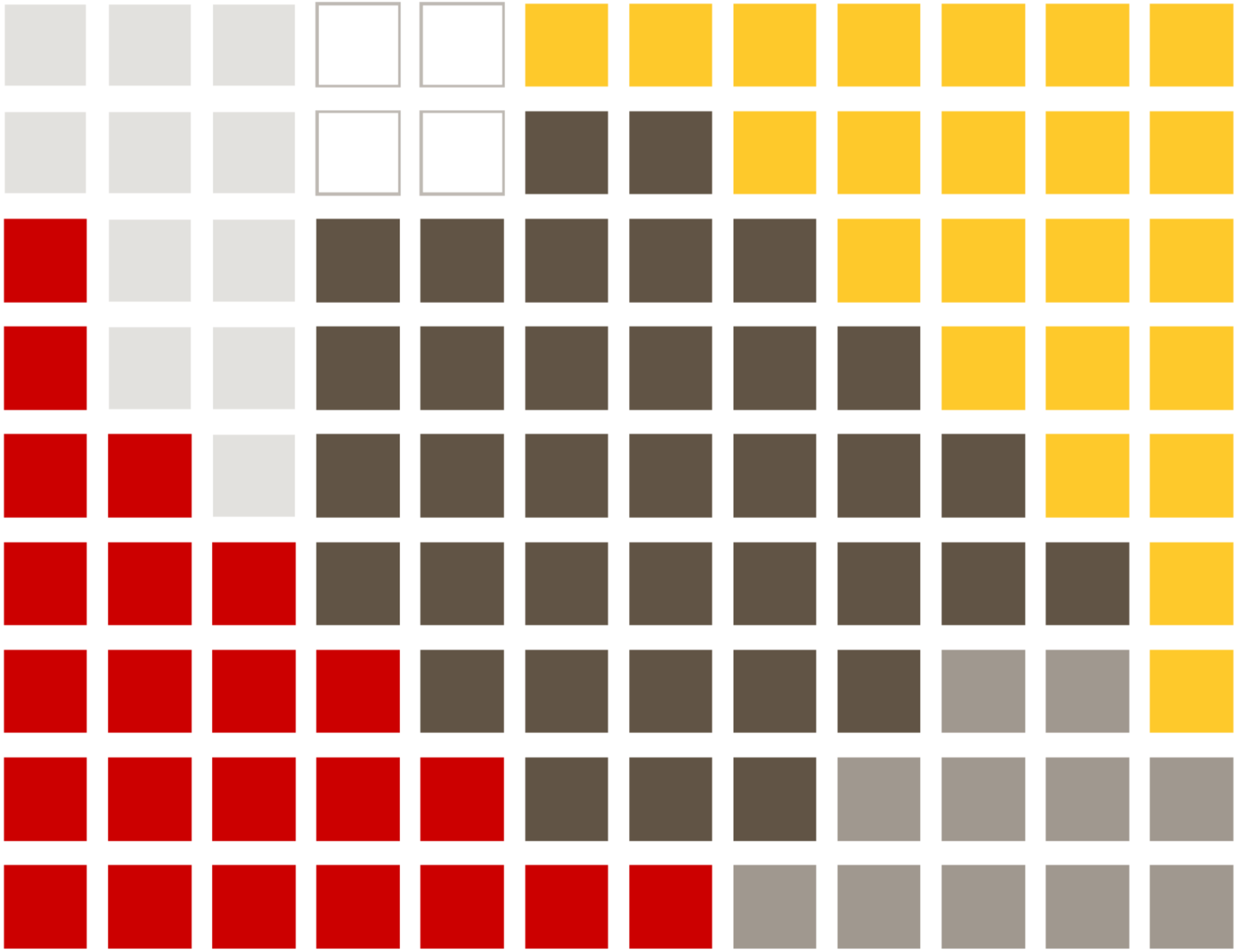


108

COURSE OPTIONS
TOWARD CCIS
MEANINGFUL
MINOR

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

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

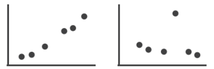
Change

Select

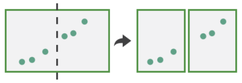
Navigate

Facet

Juxtapose



Partition



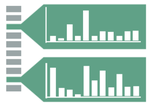
Superimpose

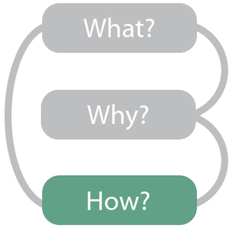
Reduce

Filter

Aggregate

Embed

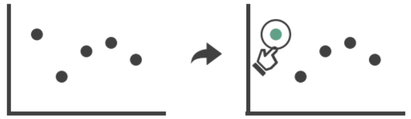




Manipulate

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.

“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

Change over Time

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

abcdefghijklmnopqrstuvwxyz

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

Change over Time

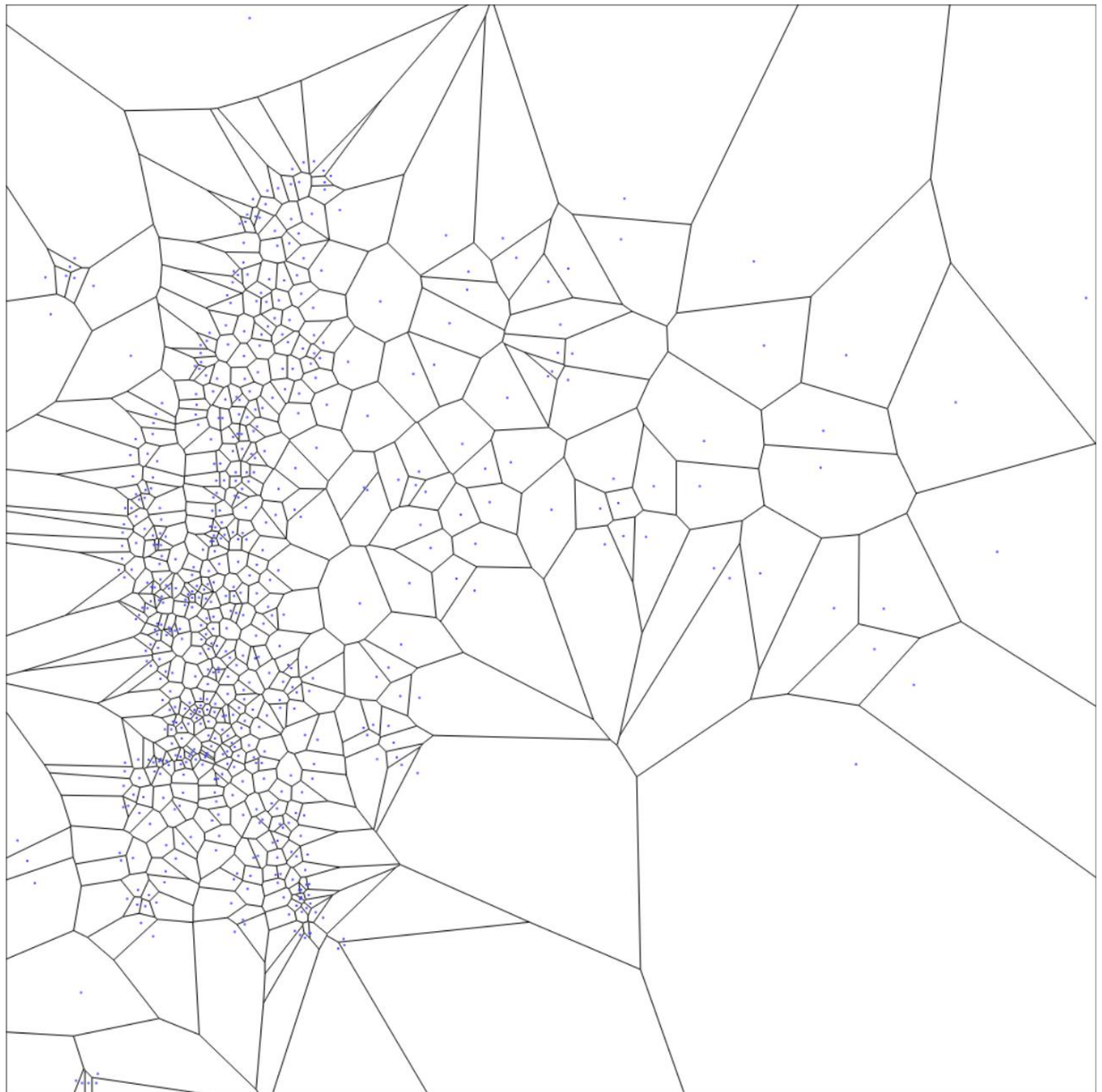
D3 Animated Transitions

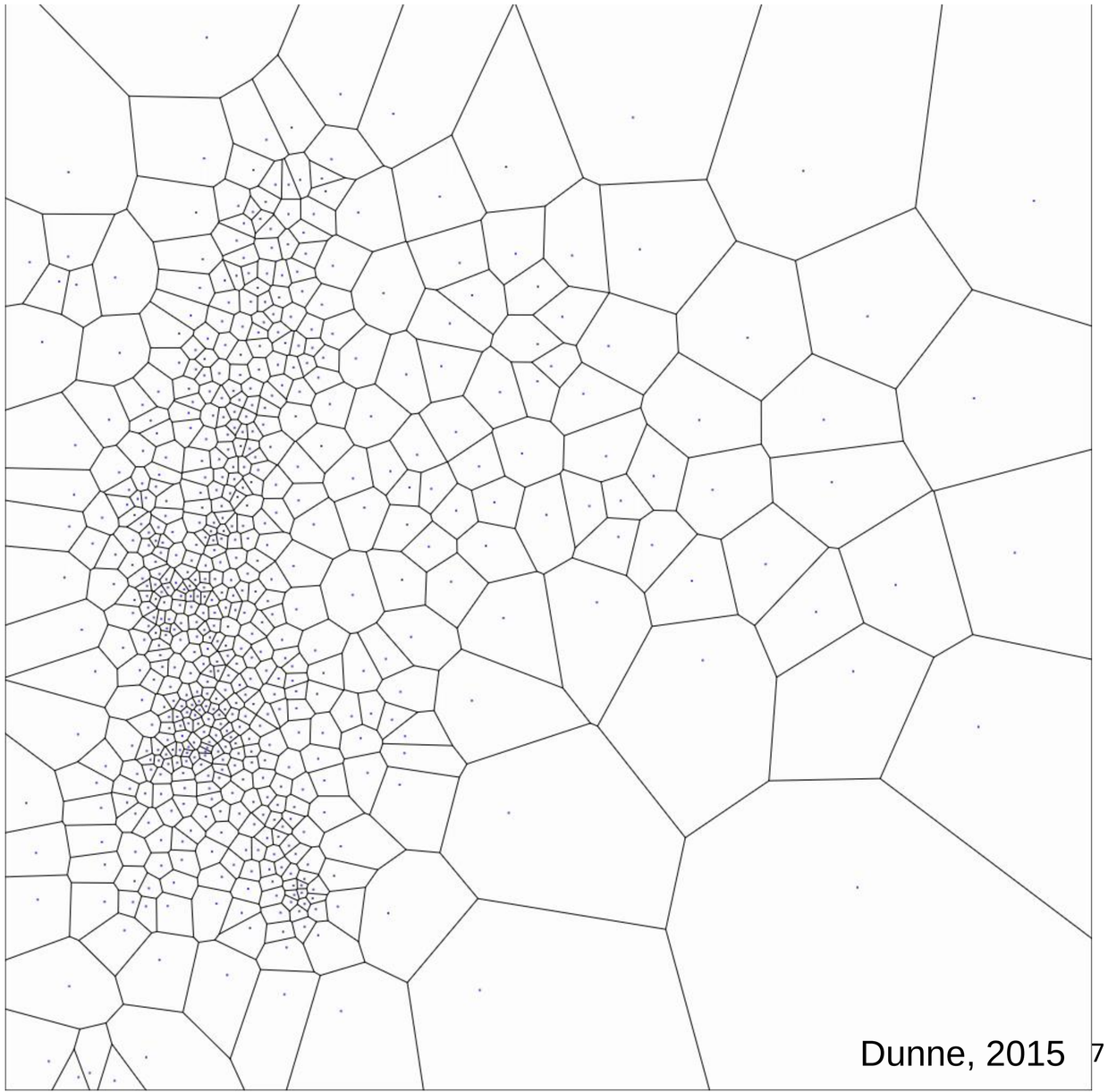
flexible transitions

Mike Bostock, 2011

Change over Time

Centroidal Voronoi Tesselation





Dunne, 2015

Queries and Filtering

Manipulate

Change over Time

Select

Navigate

→ Item Reduction

→ *Zoom*
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→ Attribute Reduction

→ *Slice*

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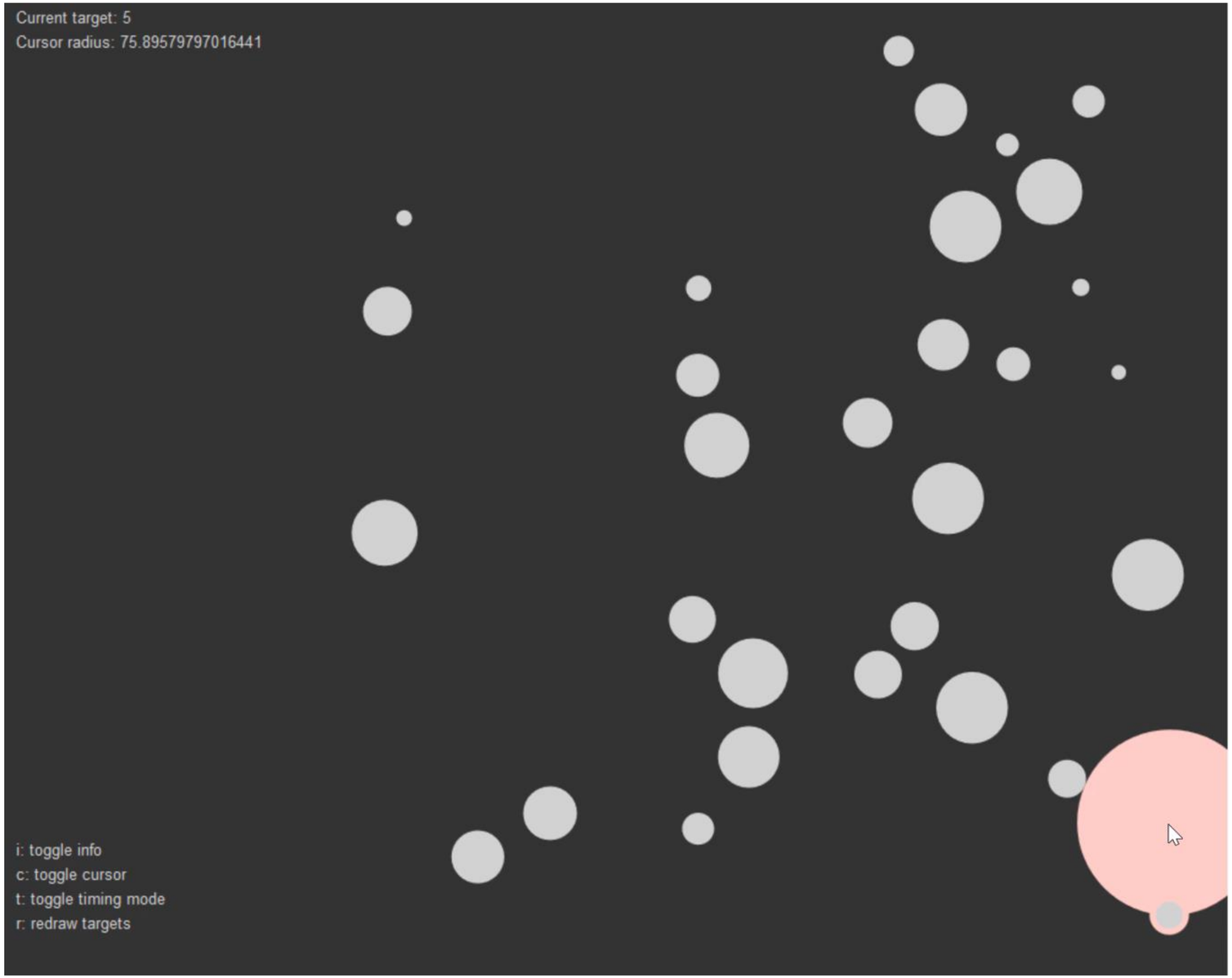
→ *Project*

Select

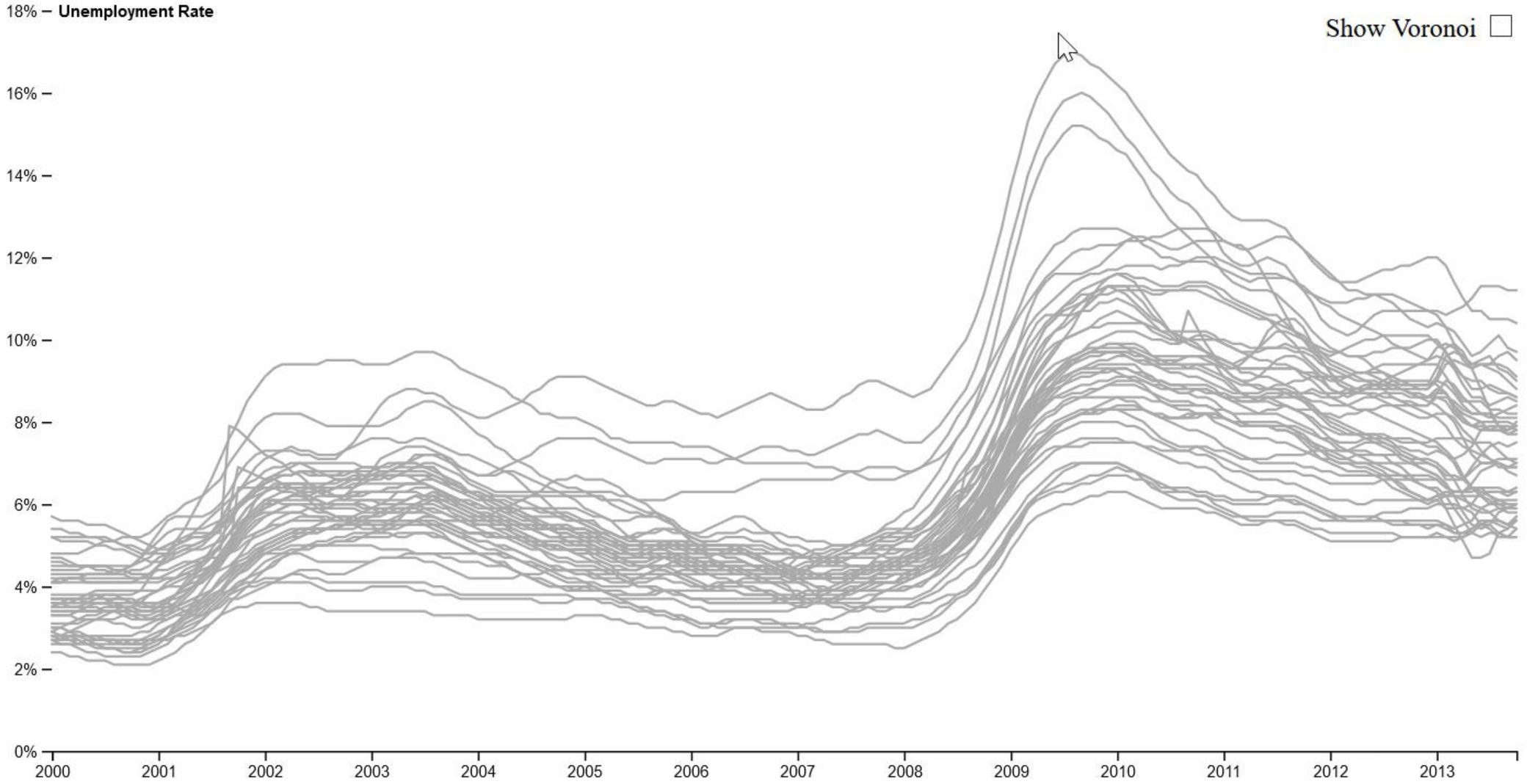
Bubble Cursors



Grossman and Balakrishnan, 2005; Anand Kulkarni, 2010

Select

Voronoi Cursors



Mike Bostock, 2019

IN-CLASS EXERCISE

Queries and Filtering

Manipulate

- **Change over Time**

- **Select**

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

    - *Pan/Translate*

    - *Constrained*

  - Attribute Reduction
    - *Slice*

    - *Cut*

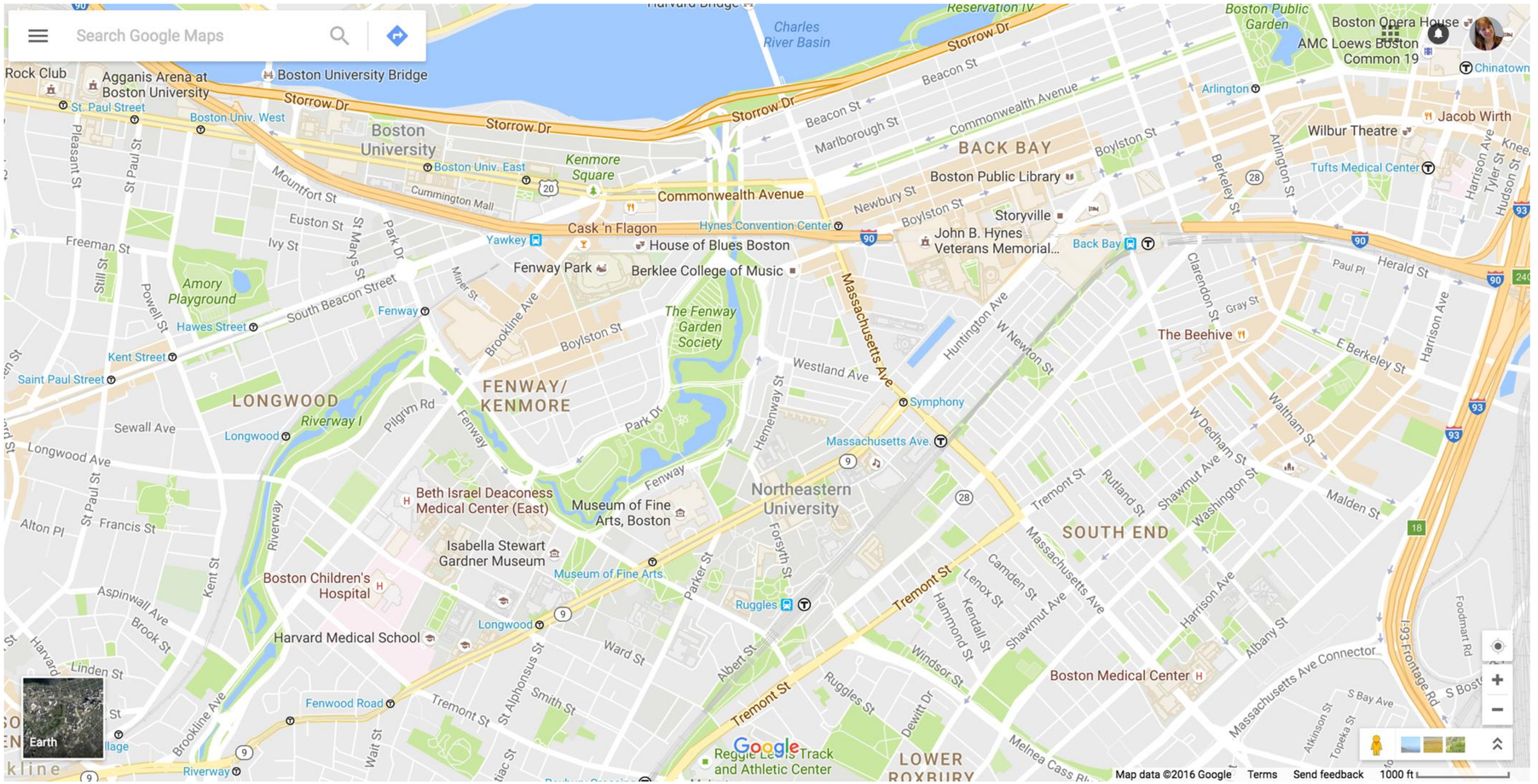
    - *Project*

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

  - *Pan/Translate*

  - *Constrained*

Navigation



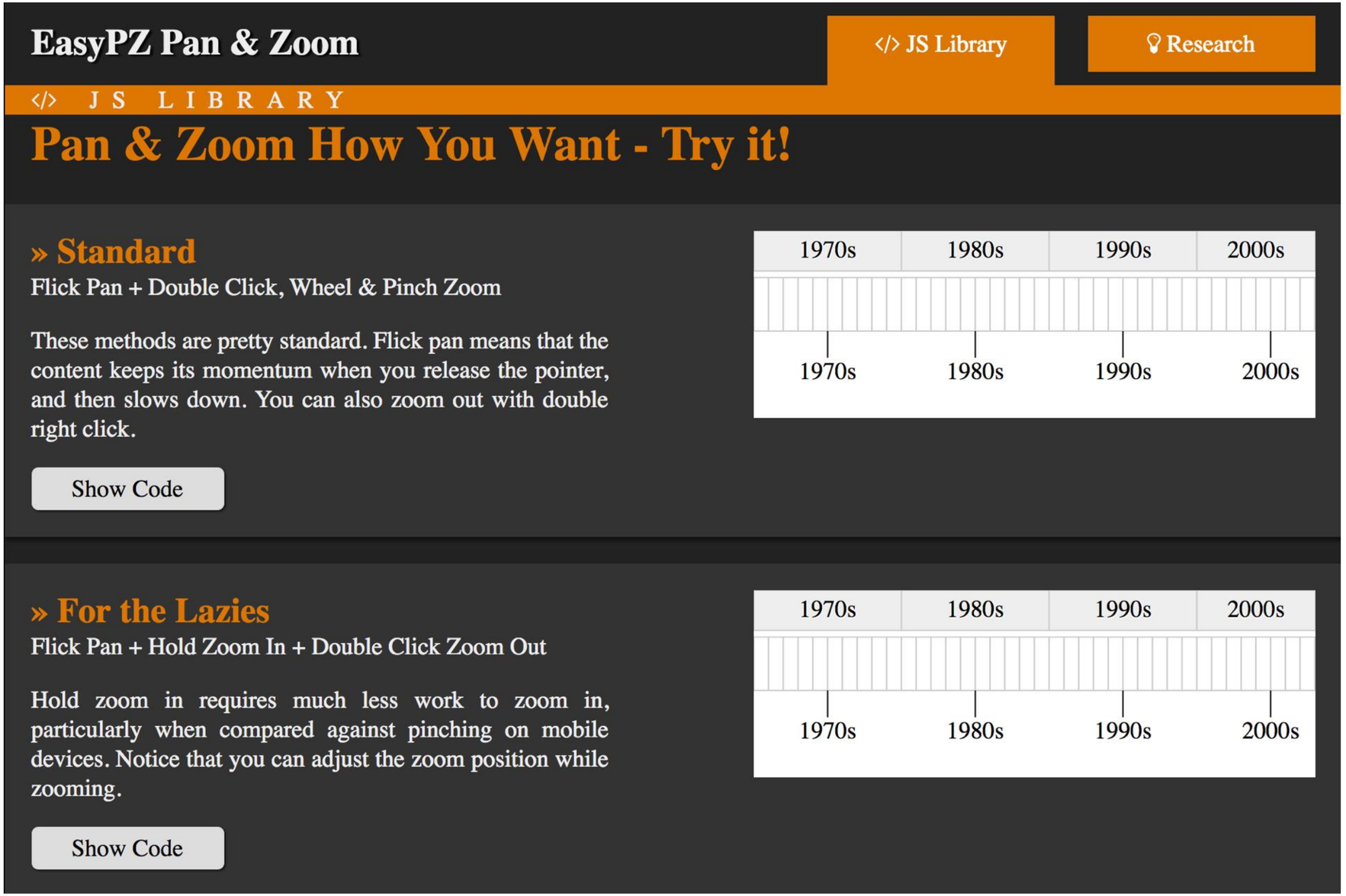
Google Maps, 2020

IN-CLASS EXERCISE

Zoom techniques

In-class activity: 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*

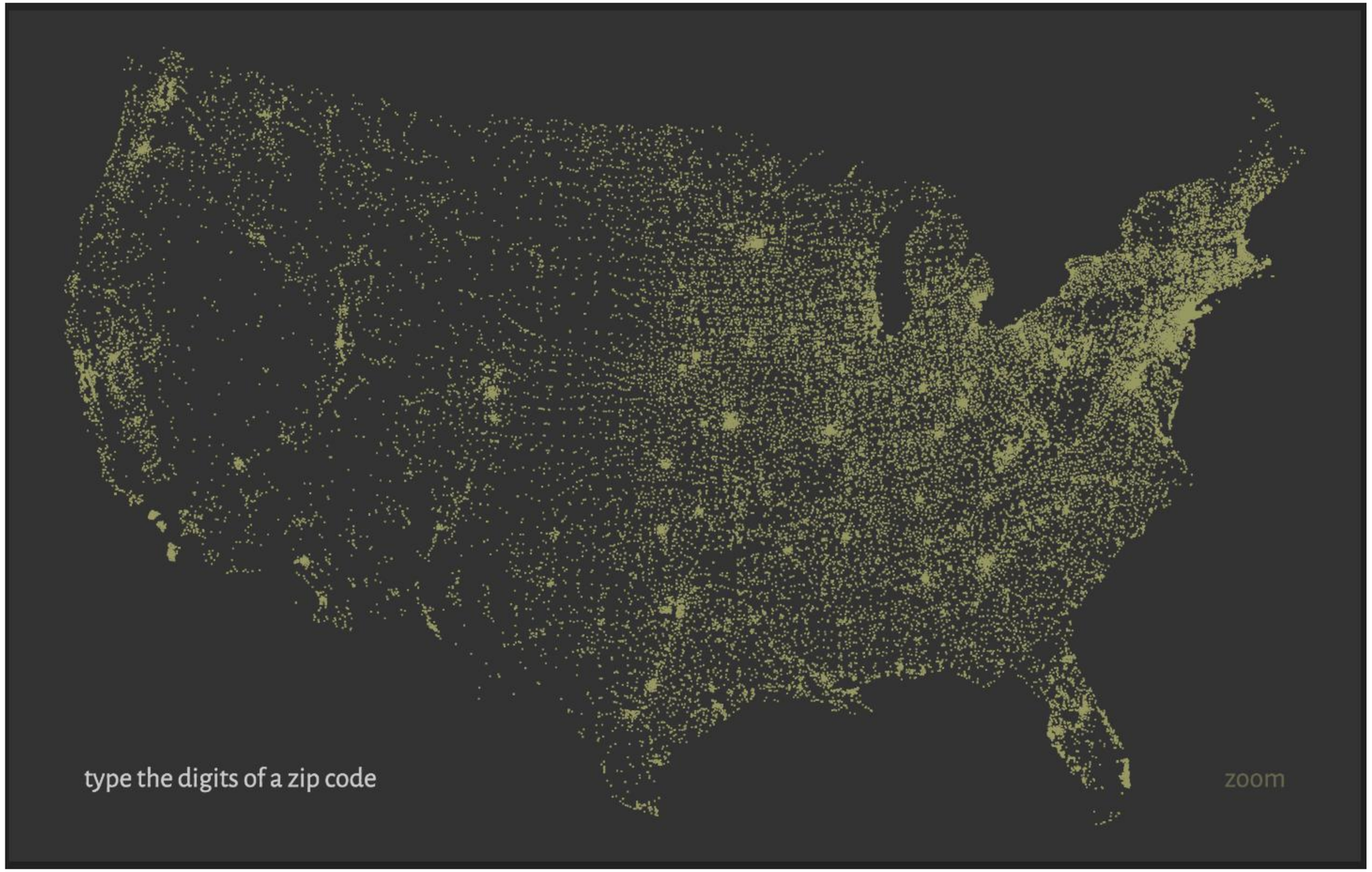
➔ Attribute Reduction

➔ *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

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

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

$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*

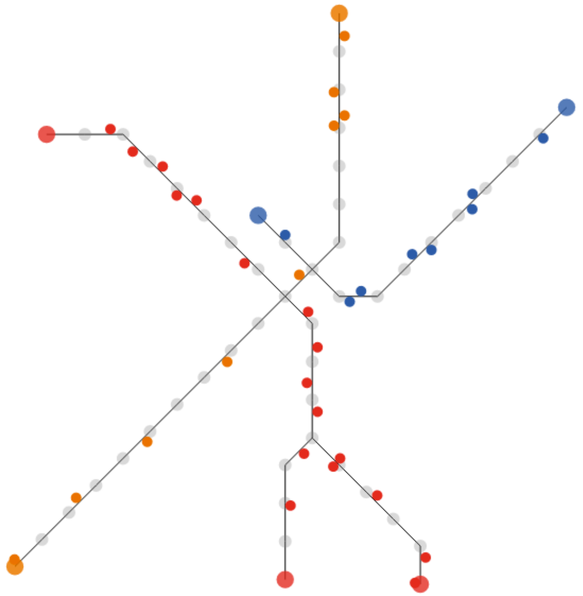
➔ *Project*

Projection

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

IN-CLASS EXERCISE

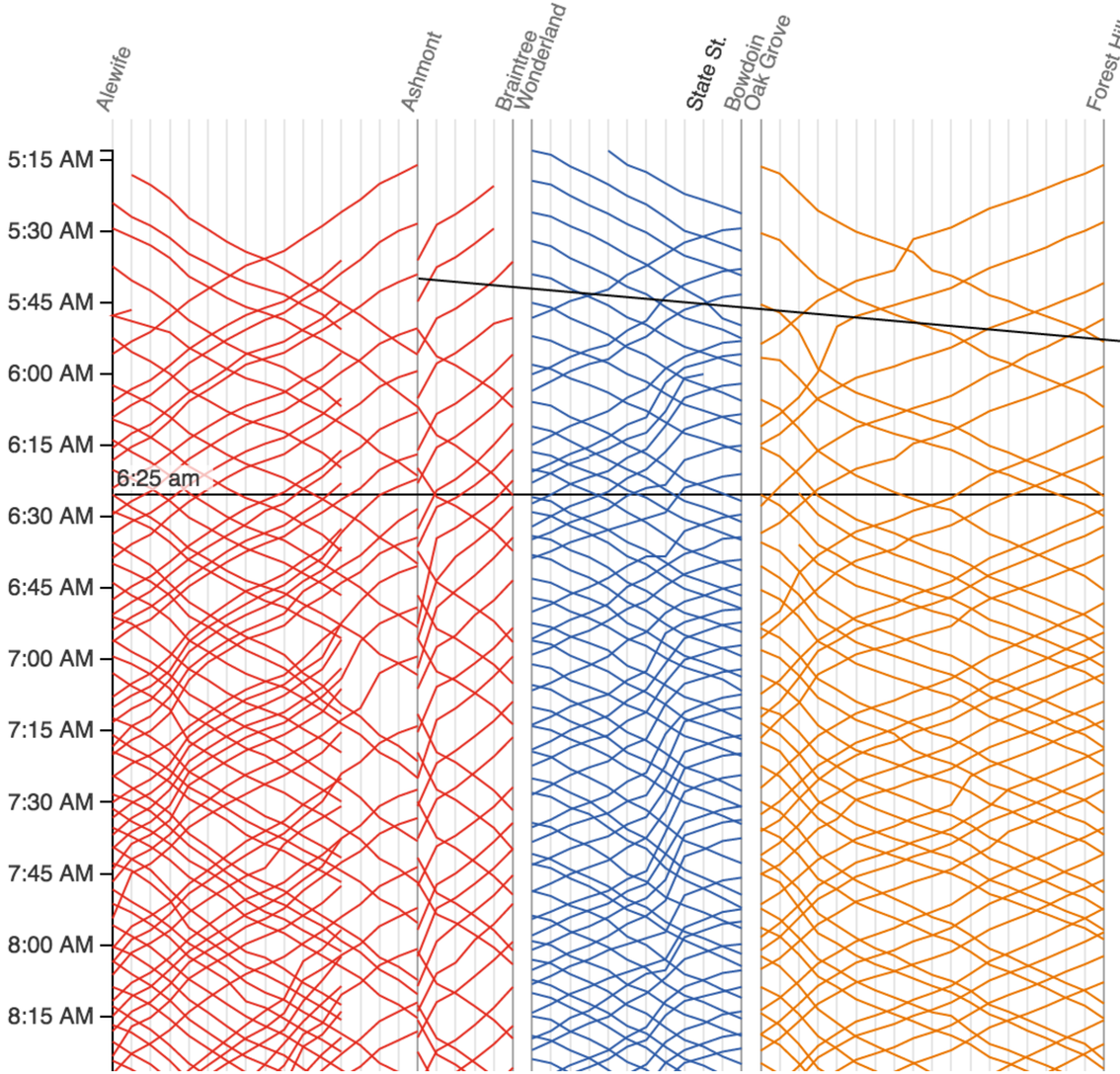
MBTAVis: Excellent WPI course final project



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.

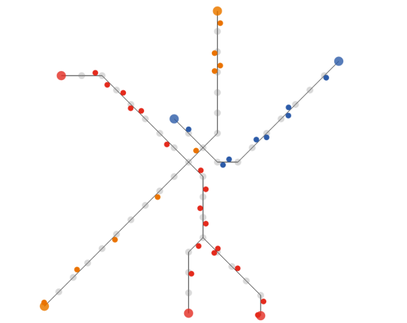
Train frequency increases around 6:30AM as morning rush hour begins.

Barry & Card, 2014

In-Class Critique — MBTAVis

15m

In-Class Critique — MBTAVis



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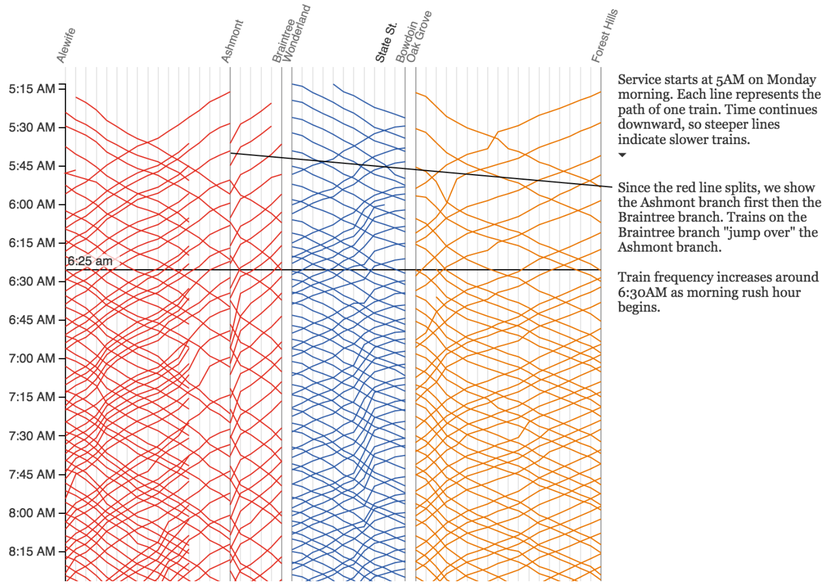
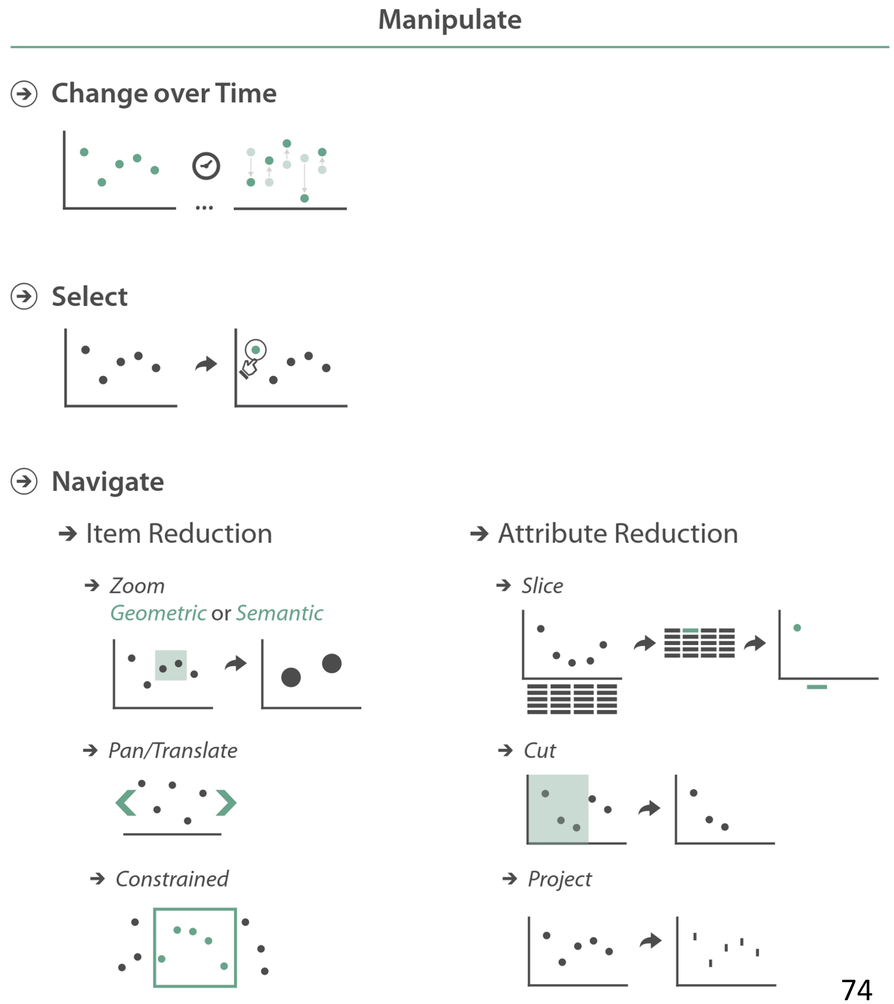
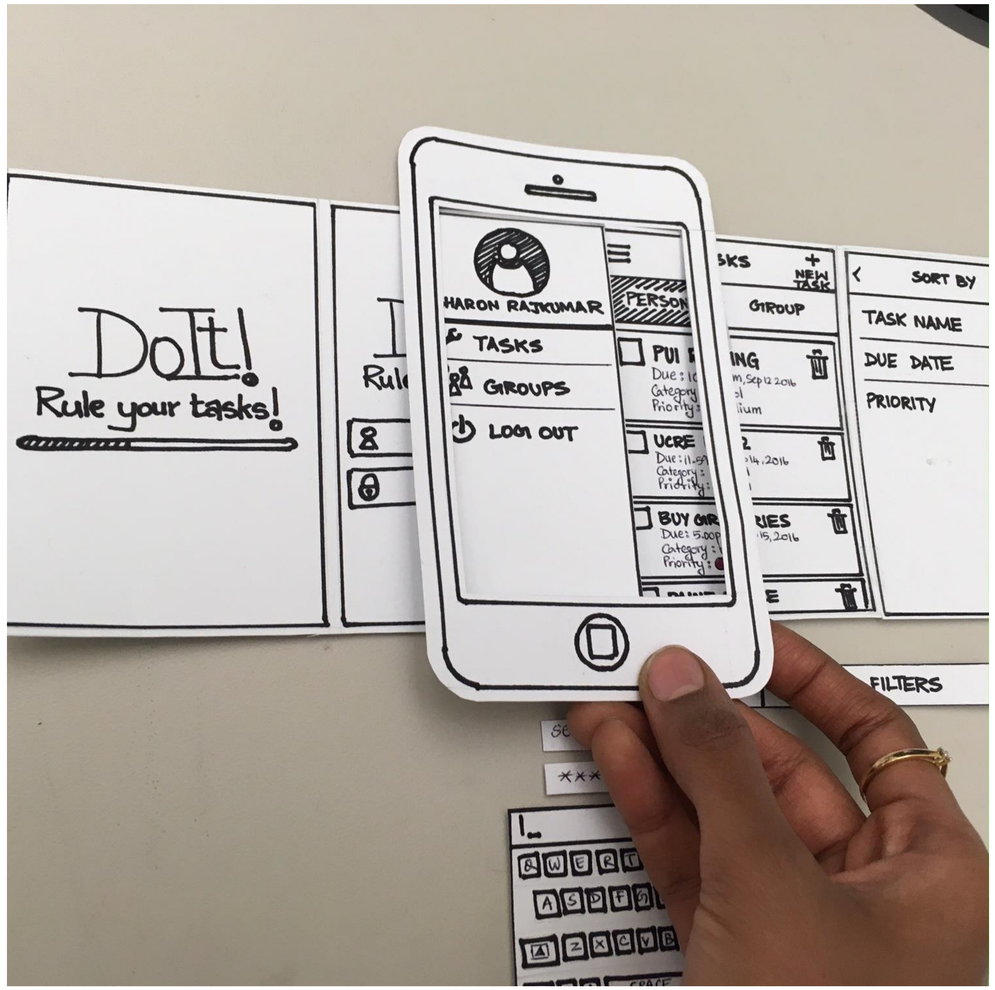


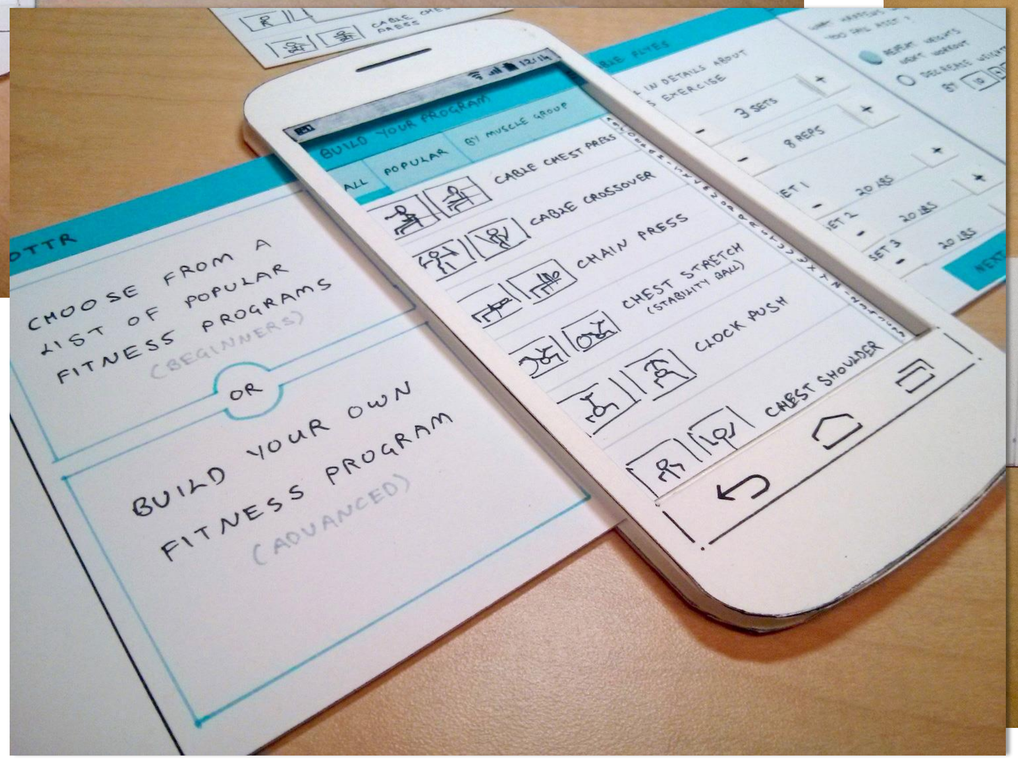


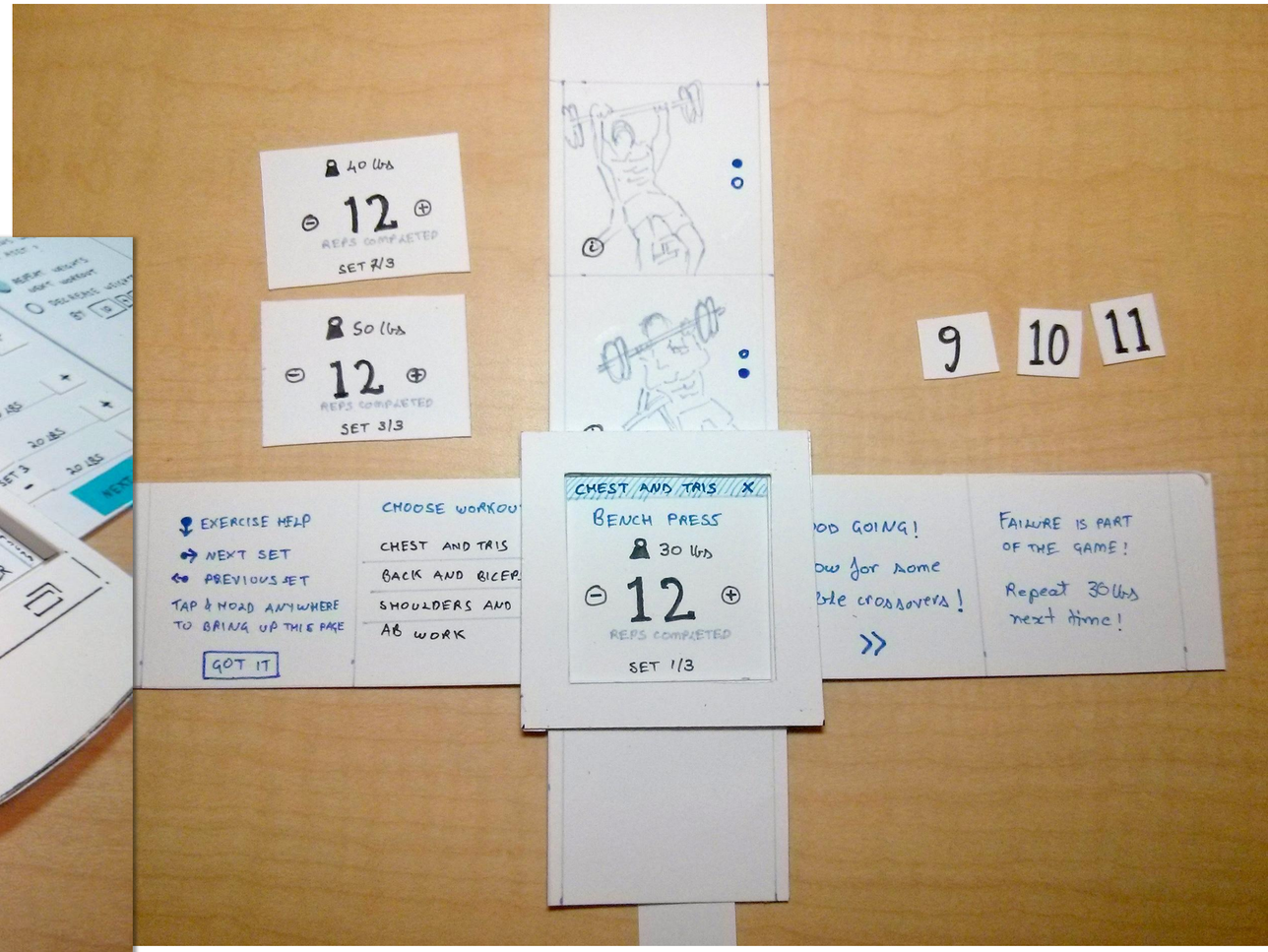
Paper Prototyping



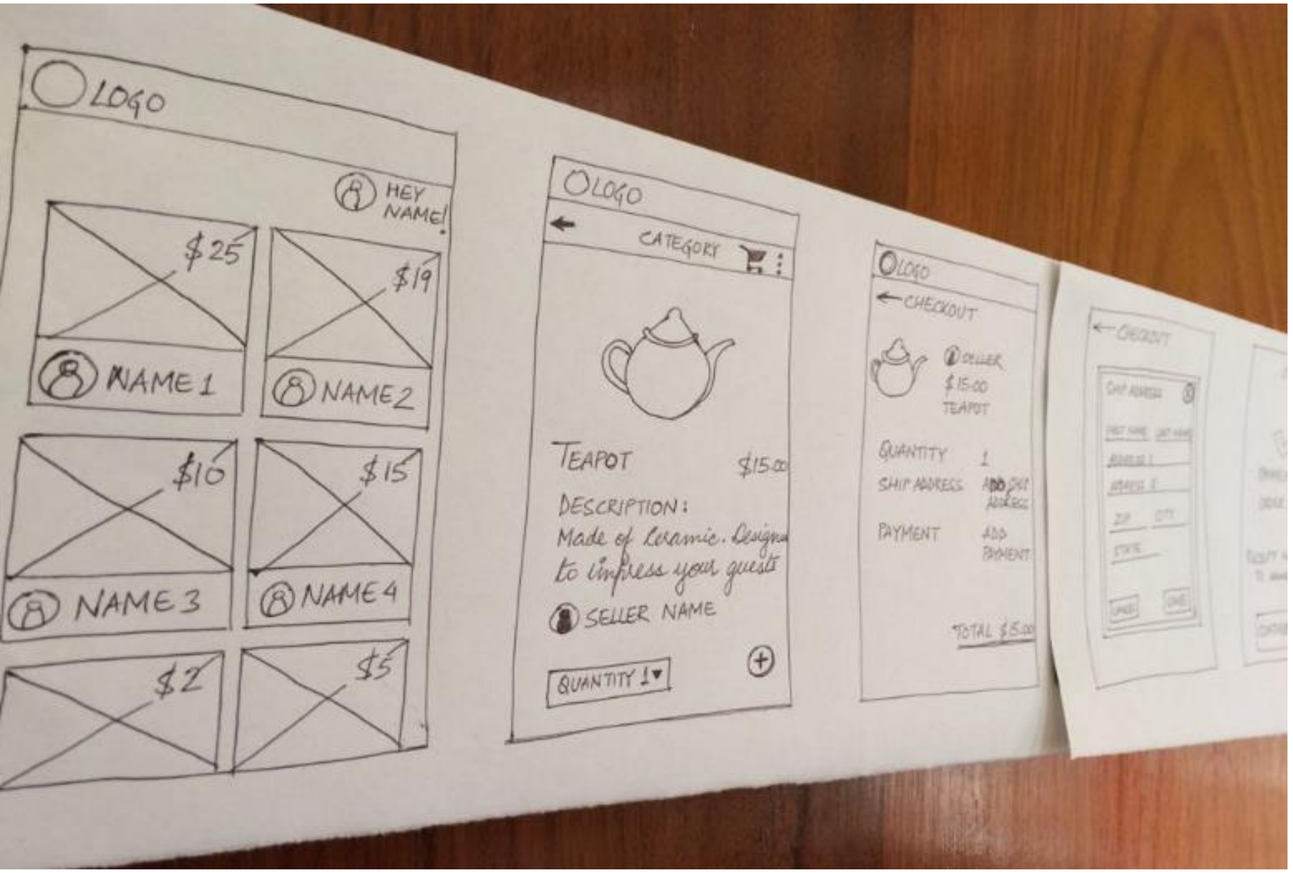
[Analitico, 2013](); [Rajkumar, 2017]()

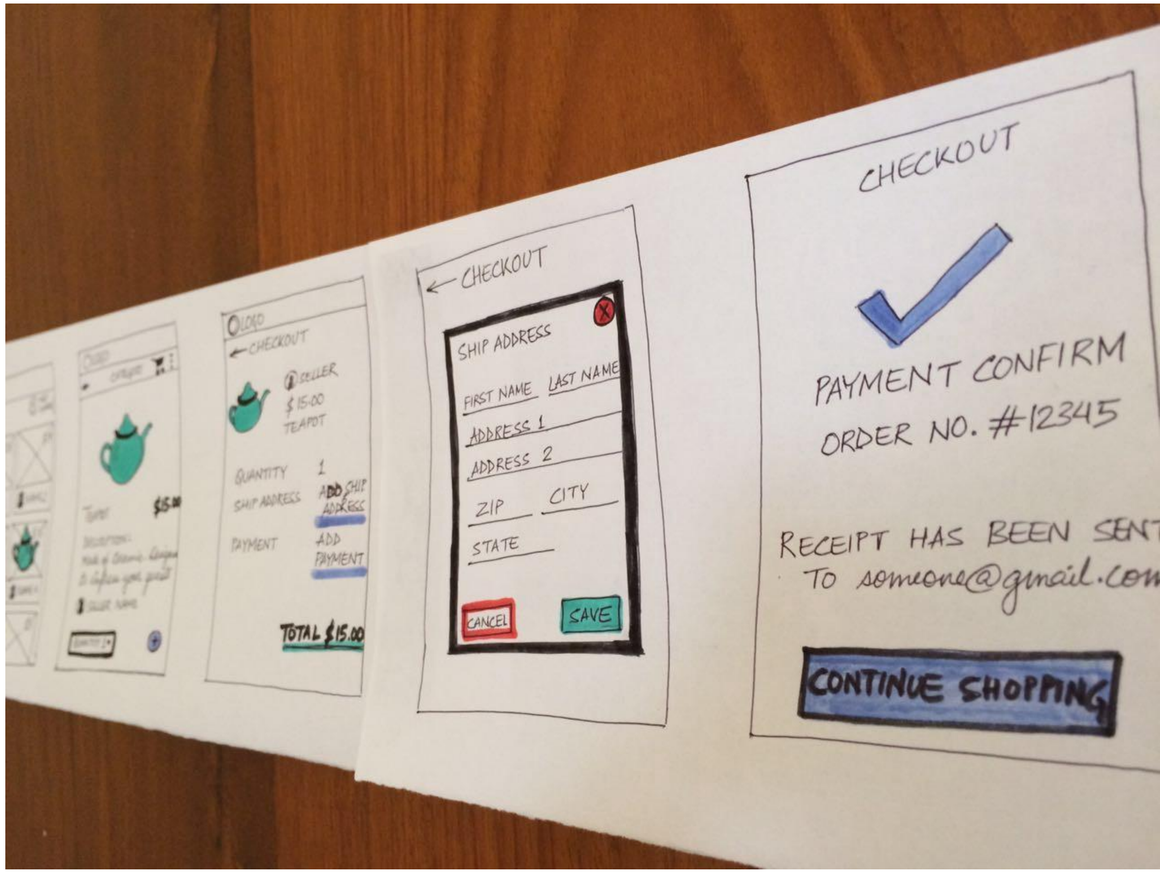
Paper Prototyping





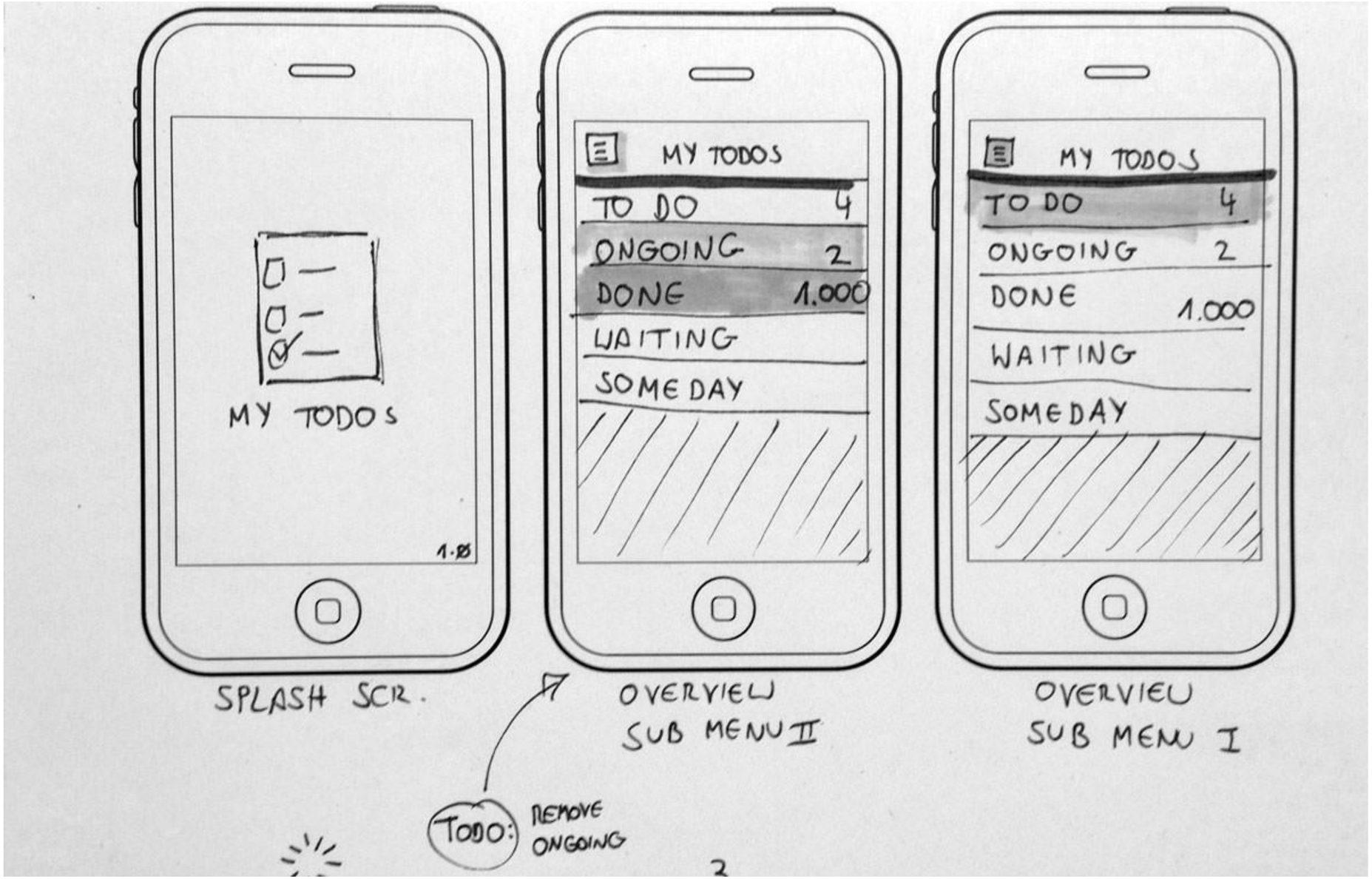
Low Fidelity to High Fidelity





CanvasFlip, 2016

Sketching of Interactivity



Hennigs, 2013

Example Usability Test with a Paper Prototype

BlueDuckLabs, 2010

Upcoming Assignments & Communication

A look at the upcoming assignments and deadlines

- Textbook, Readings & Reading Quizzes

- 2020-11-24 Project 8 — Sprint 3 & Prep for Usability Testing
- 2020-11-25 No Class — Thanksgiving

- 2020-11-30 In-Class Usability Testing — Final Projects

- 2020-12-06 Project 9 — Presentation and Video
- 2020-12-07 In-Class Project Presentations
- 2020-12-09 In-Class Project Presentations

- 2020-12-15 Project 10 — Final Project Deliverables and Sharing with Partners

https://c.dunne.dev/ds4200f20

Everyday Required Supplies:

- 5+ colors of pen/pencil
- White paper
- Laptop and charger

Use **Canvas Discussions** for general questions,
email the **instructor & TAs** for questions **specific to you**.

> 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.