

Pop-Out, Illusions, Interaction

DS 4200
FALL 2020

Prof. Cody Dunne
NORTHEASTERN UNIVERSITY

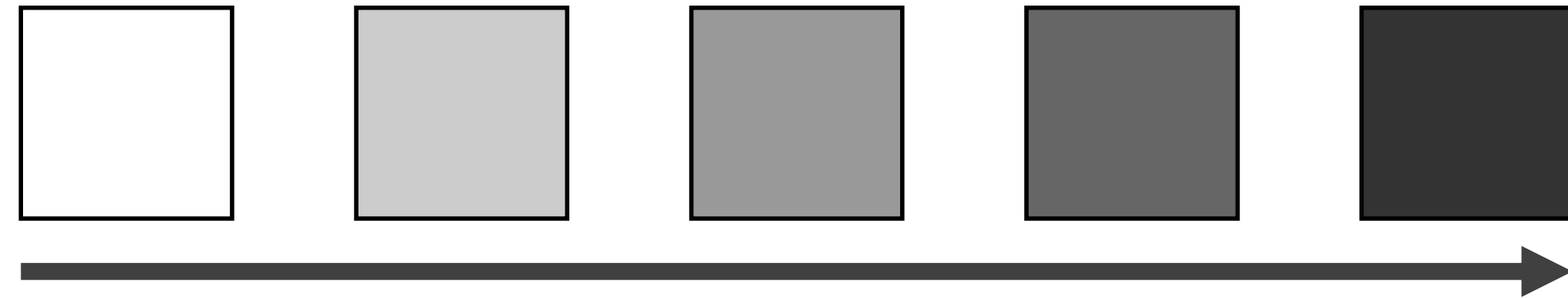
Slides and inspiration from Michelle Borkin, Krzysztof Gajos, Hanspeter Pfister, Miriah Meyer, Jonathan Schwabish, and David Sprague

CHECK-IN

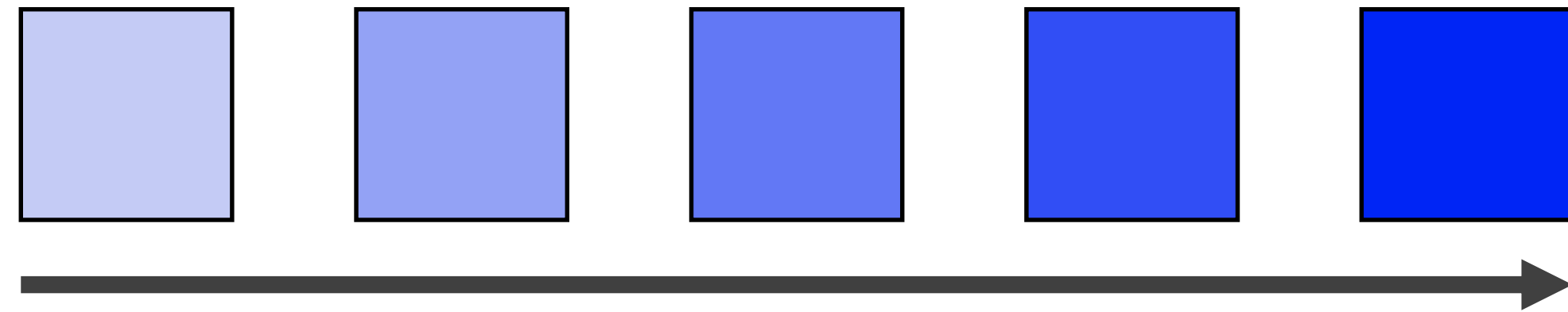
PREVIOUSLY, ON DS 4200...

Color Vocabulary and Perceptual Ordering

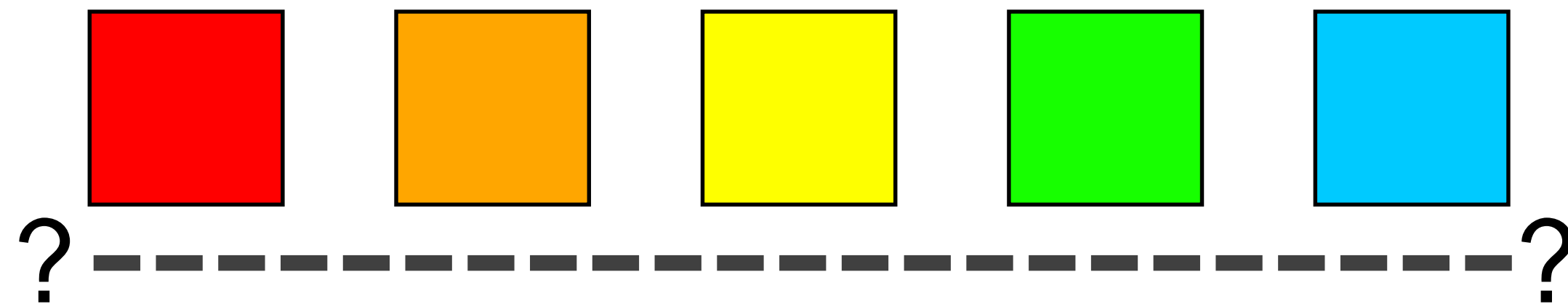
Darkness (Lightness)



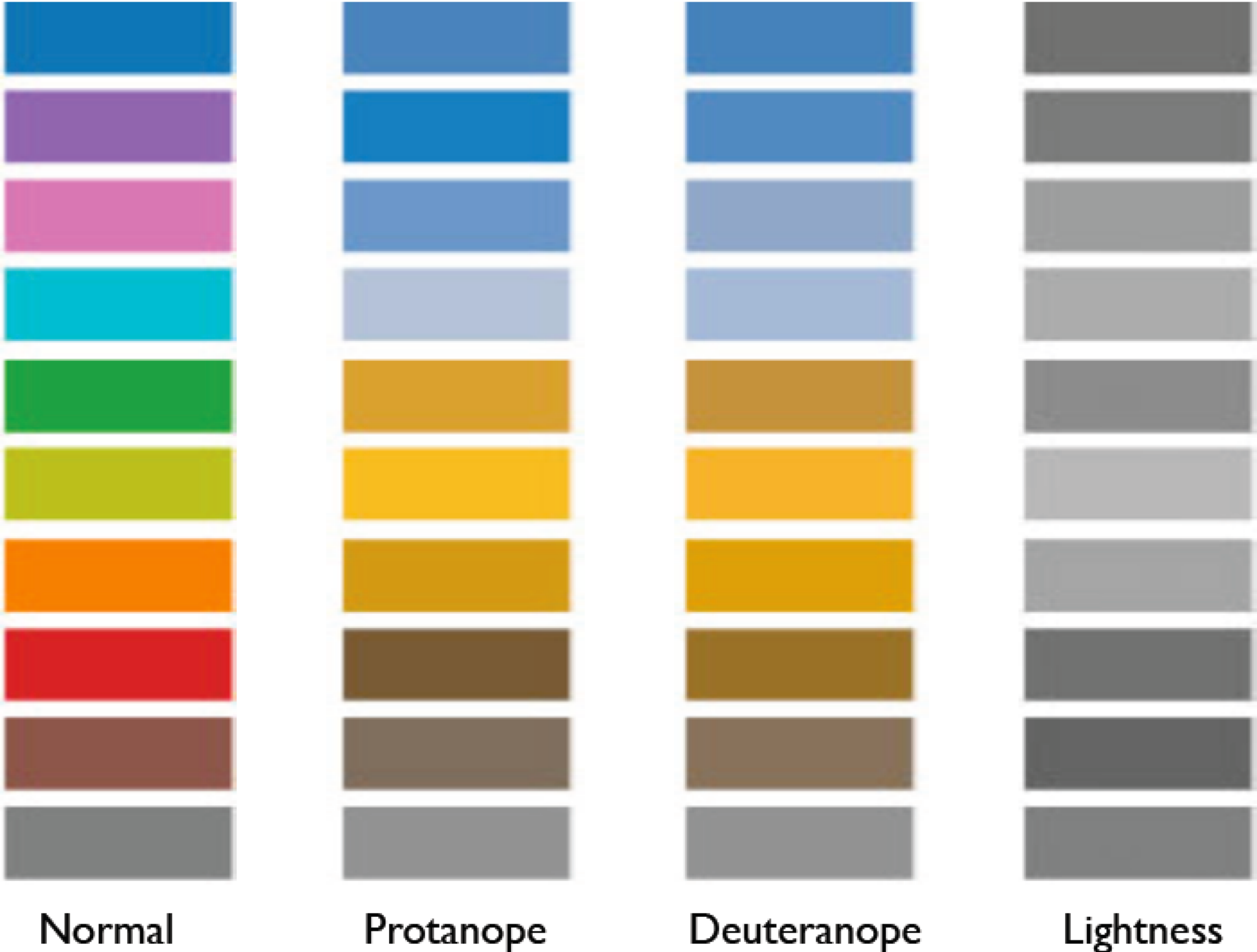
Saturation



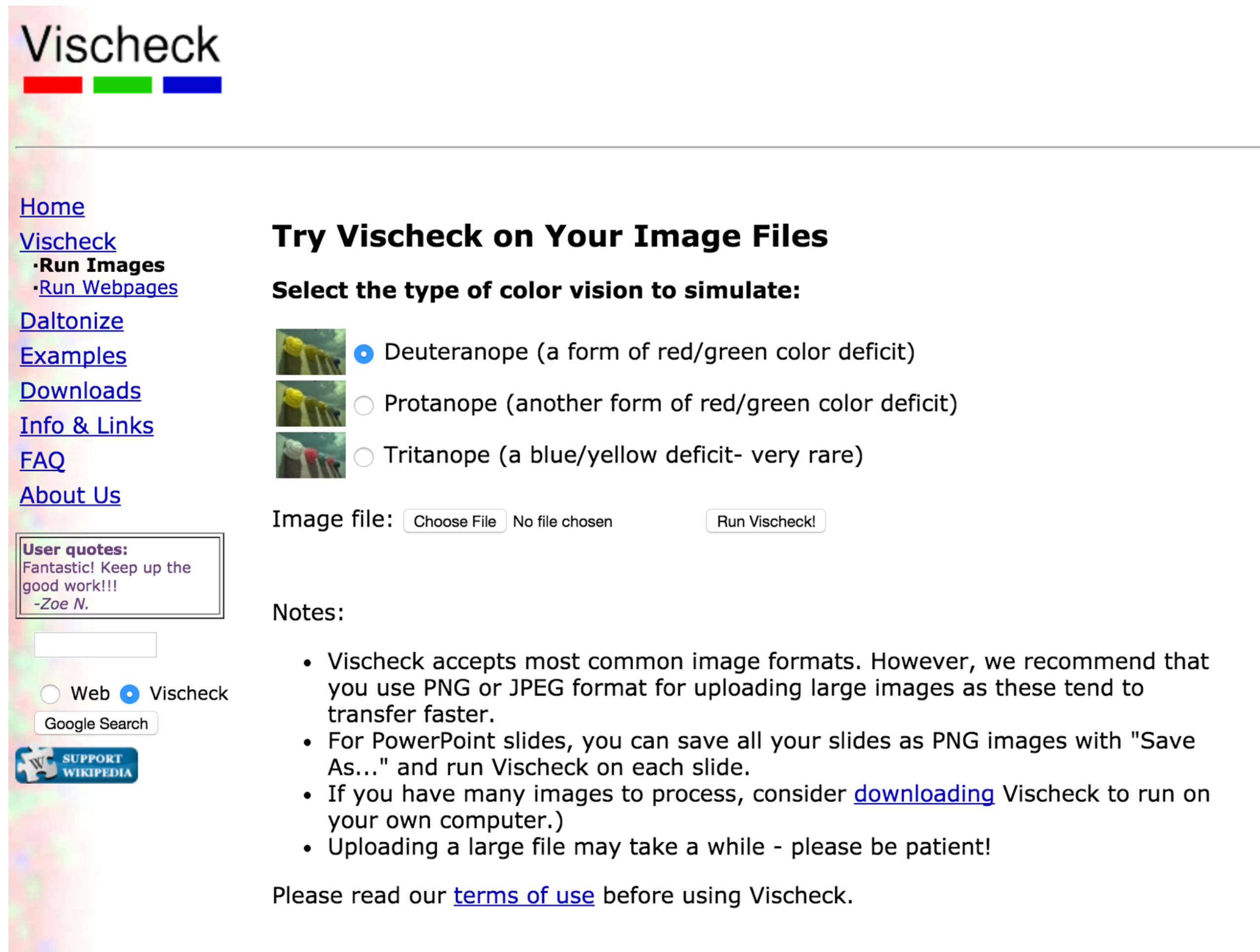
Hue



Color Deficiencies (Color Blindness)



Check your images/colormaps for issues!



Vischeck

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Examples
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Try Vischeck on Your Image Files

Select the type of color vision to simulate:

- Deuteranope (a form of red/green color deficit)
- Protanope (another form of red/green color deficit)
- Tritanope (a blue/yellow deficit- very rare)

Image file: No file chosen


Notes:

- Vischeck accepts most common image formats. However, we recommend that you use PNG or JPEG format for uploading large images as these tend to transfer faster.
- For PowerPoint slides, you can save all your slides as PNG images with "Save As..." and run Vischeck on each slide.
- If you have many images to process, consider [downloading](#) Vischeck to run on your own computer.)
- Uploading a large file may take a while - please be patient!

Please read our [terms of use](#) before using Vischeck.

User quotes:
Fantastic! Keep up the good work!!!
-Zoe N.

Web Vischeck





Colblindor

Home ▾ CVD Essentials ▾ Color Blindness Tests ▾ Color Tools ▾
Contact

Coblis — Color Blindness Simulator

If you are not suffering from a color vision deficiency it is very hard to imagine how it looks like to be colorblind. The **Color BL**indness Simulator can close this gap for you. Just play around with it and get a feeling of how it is to have a color vision handicap.

As all the calculations are made on your local machine, no images are uploaded to the server. Therefore you can use images as big as you like, there are no restrictions. Be aware, there are some issues for the "Lens feature" on Edge and Internet Explorer. All others should support everything just fine.

So go ahead, choose an image through the upload functionality or just drag and drop your image in the center of our **Color BL**indness Simulator. It is also possible to zoom and move your images around using your mouse - try it out, I hope you like it.

Drag and drop or paste your file in the area below or: No file selected.

Trichromatic view:	Anomalous Trichromacy:	Dichromatic view:	Monochromacy:
<input checked="" type="radio"/> Normal	<input type="radio"/> Red-Weak/Protanomaly	<input type="radio"/> Red-Blind/Protanopia	<input type="radio"/> Monochromacy
	<input type="radio"/> Green-Weak/Deuteranomaly	<input type="radio"/> Green-Blind/Deuteranopia	<input type="radio"/> Blue-Congenital
	<input type="radio"/> Blue-Weak/Tritanomaly	<input type="radio"/> Blue-Blind/Tritanopia	

Use lens to compare with normal view: No Lens Normal Lens Inverse Lens

[Reset View](#)

FREE Color Blind Check

New kind of color blindness test! Try **Color Blind Check** and test type and severity of your color vision deficiency.

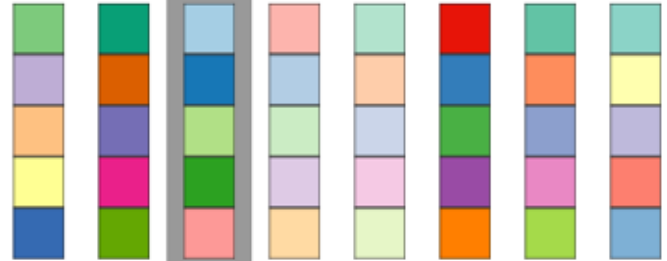


Color Brewer

Number of data classes: 6 how to use | updates | downloads | credits

Nature of your data:
 sequential diverging qualitative

Pick a color scheme:



Only show:
 colorblind safe
 print friendly
 photocopy safe

Context:
 roads
 cities
 borders

Background:
 solid color
 terrain

color transparency

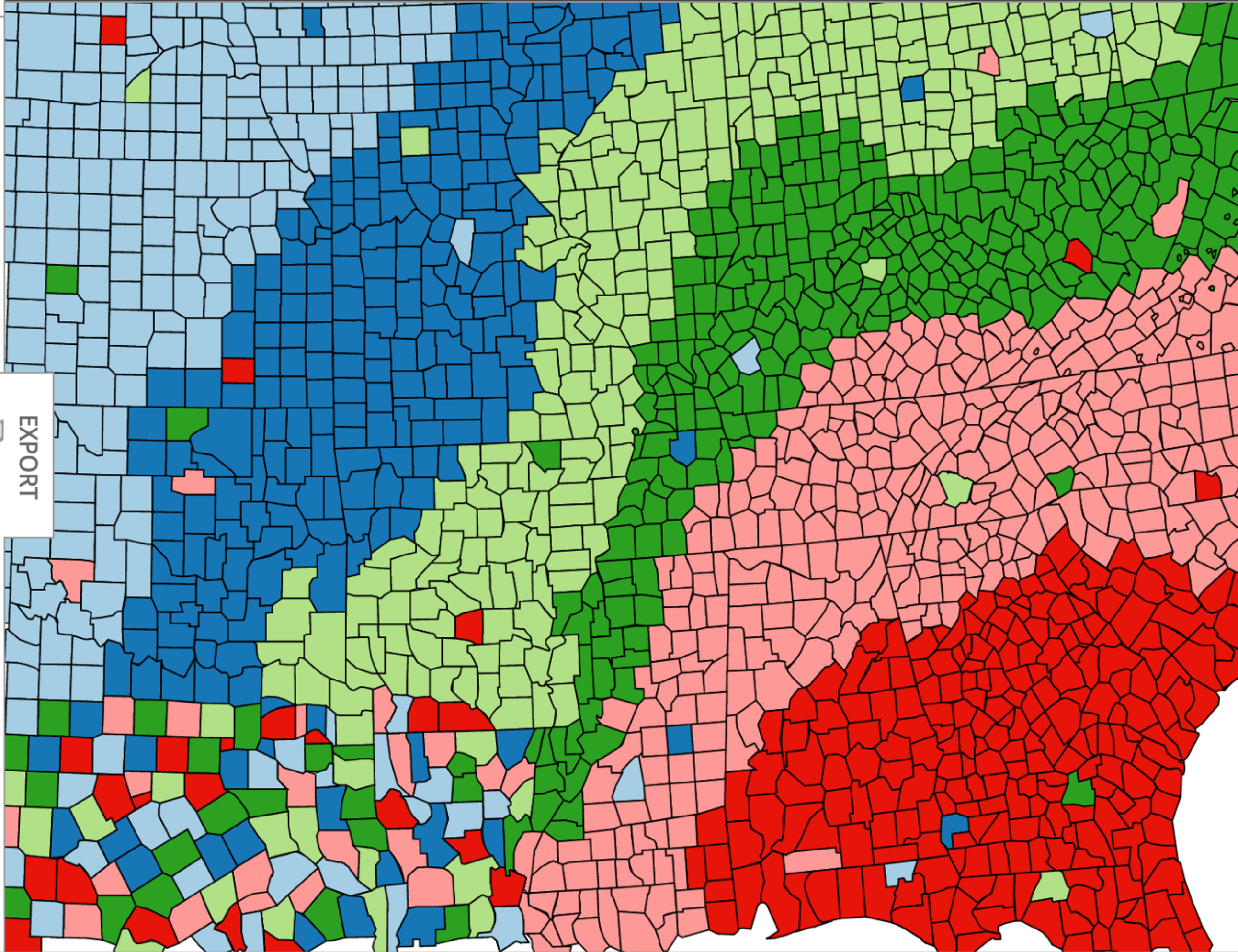
6-class Paired

EXPORT

HEX

- #a6cee3
- #1f78b4
- #b2df8a
- #33a02c
- #fb9a99
- #e31a1c

COLORBREWER 2.0
color advice for cartography



<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

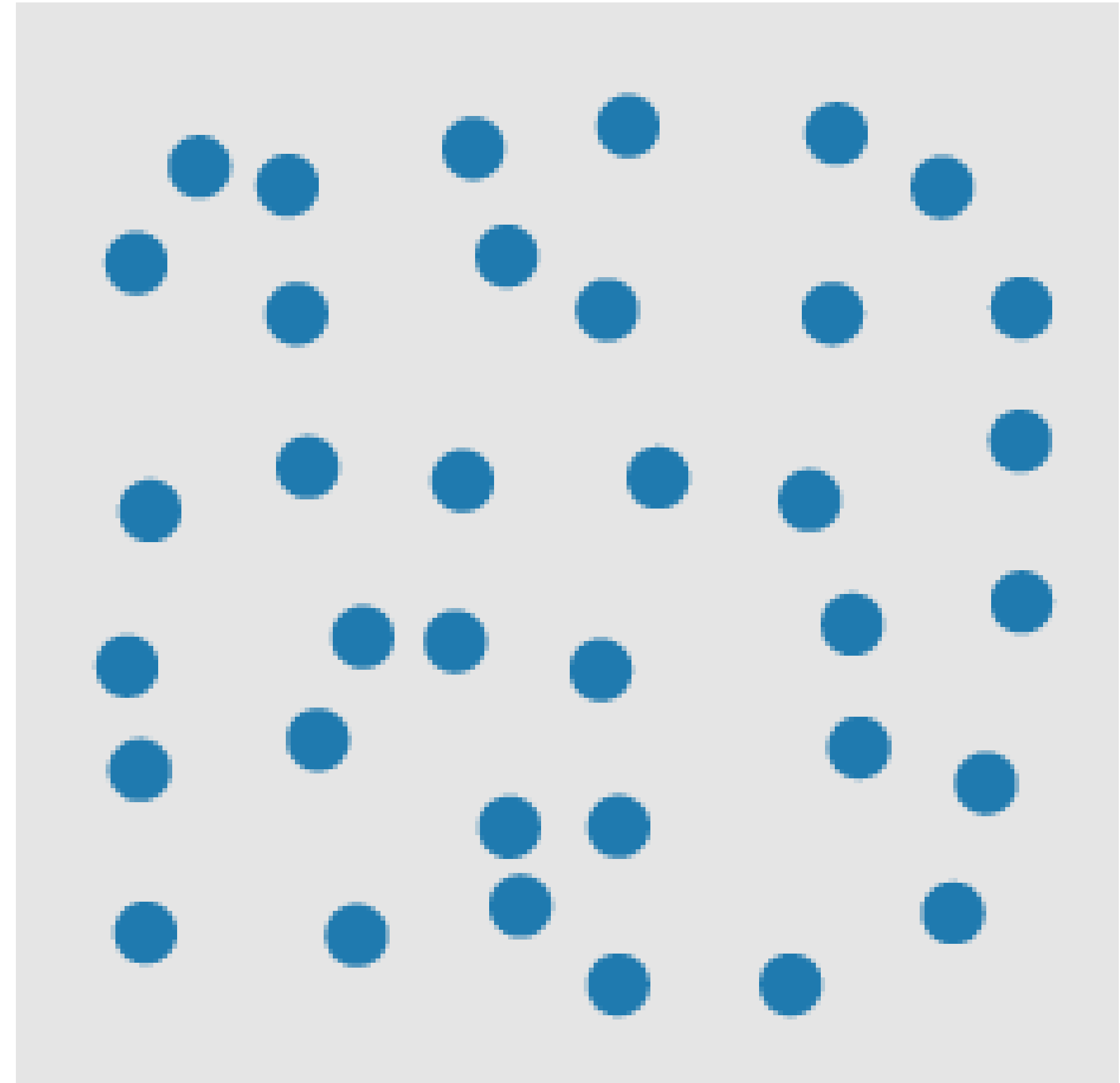
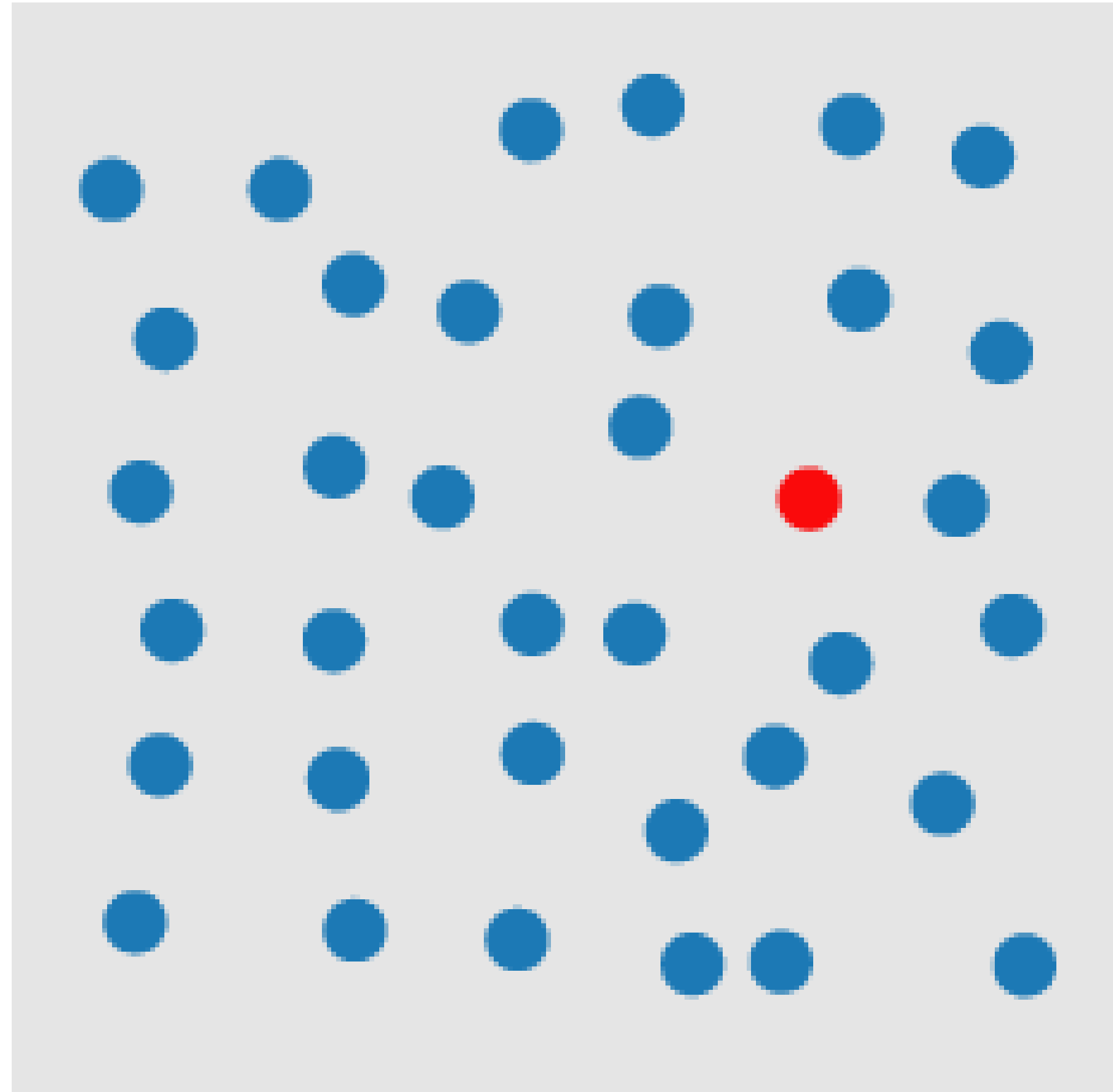
Use Color Brewer etc. for picking scales

Don't forget aesthetics!

Now, ON DS 4200...

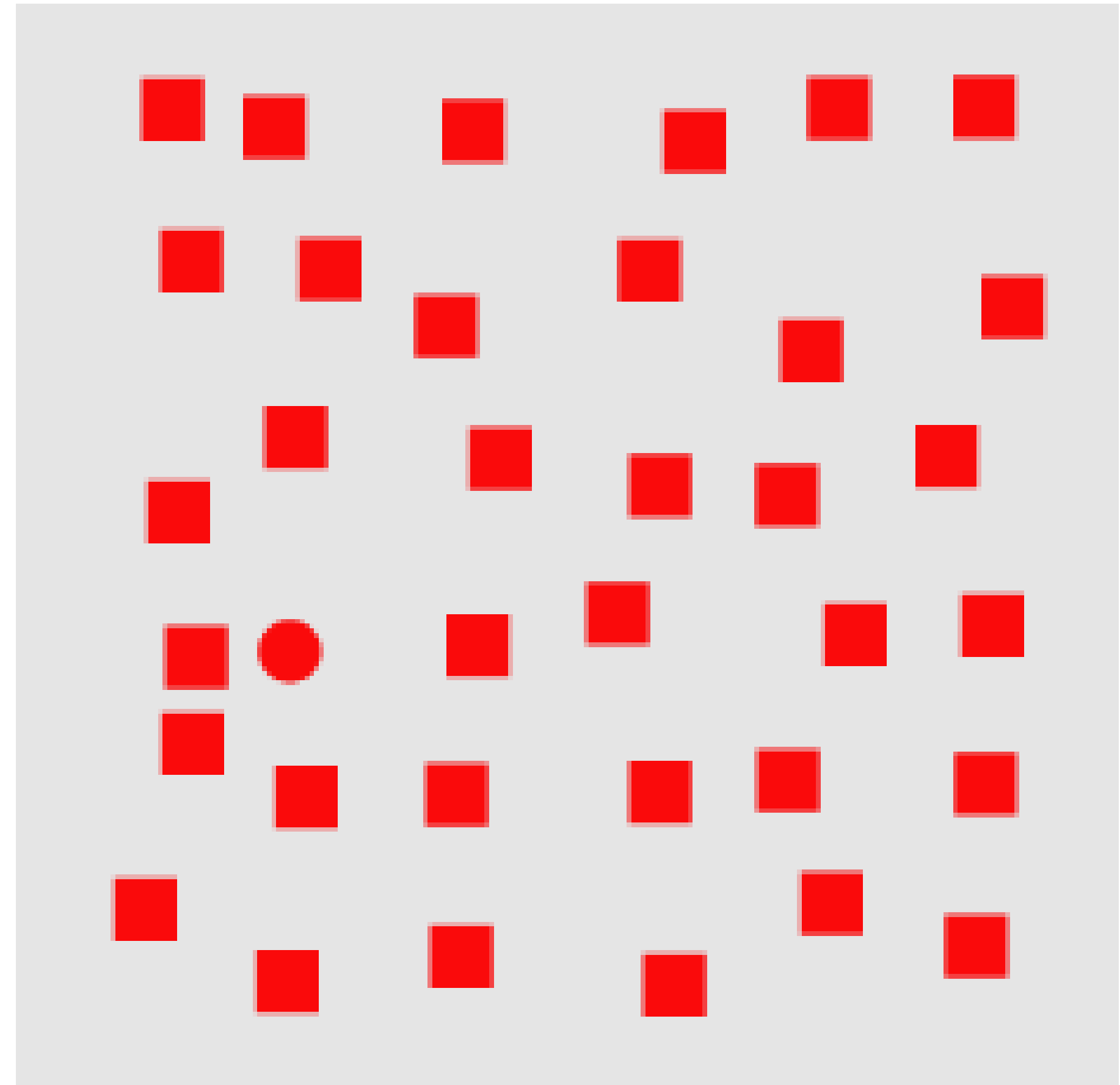
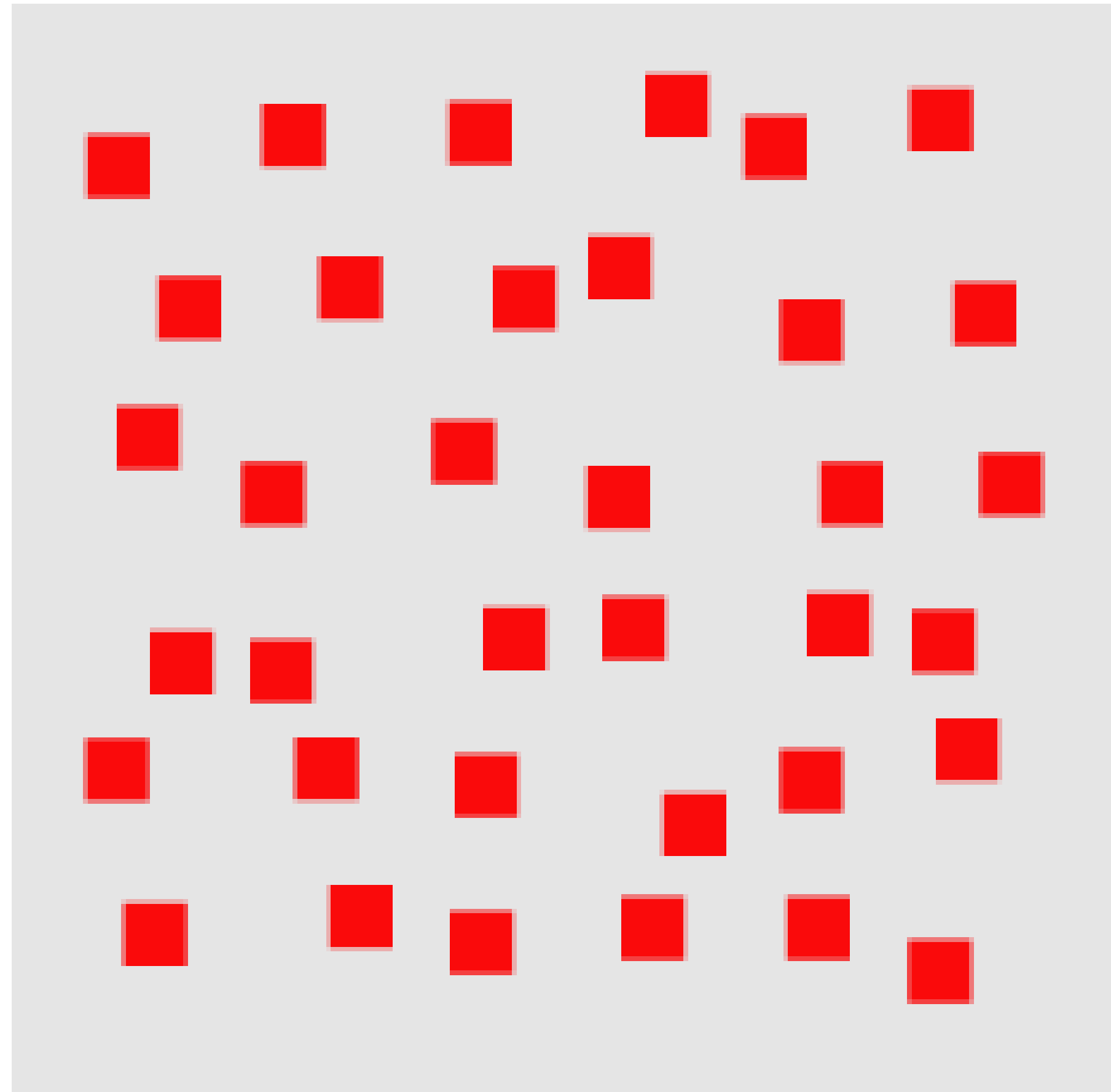
POP-OUT EFFECTS

POP-OUT EFFECTS



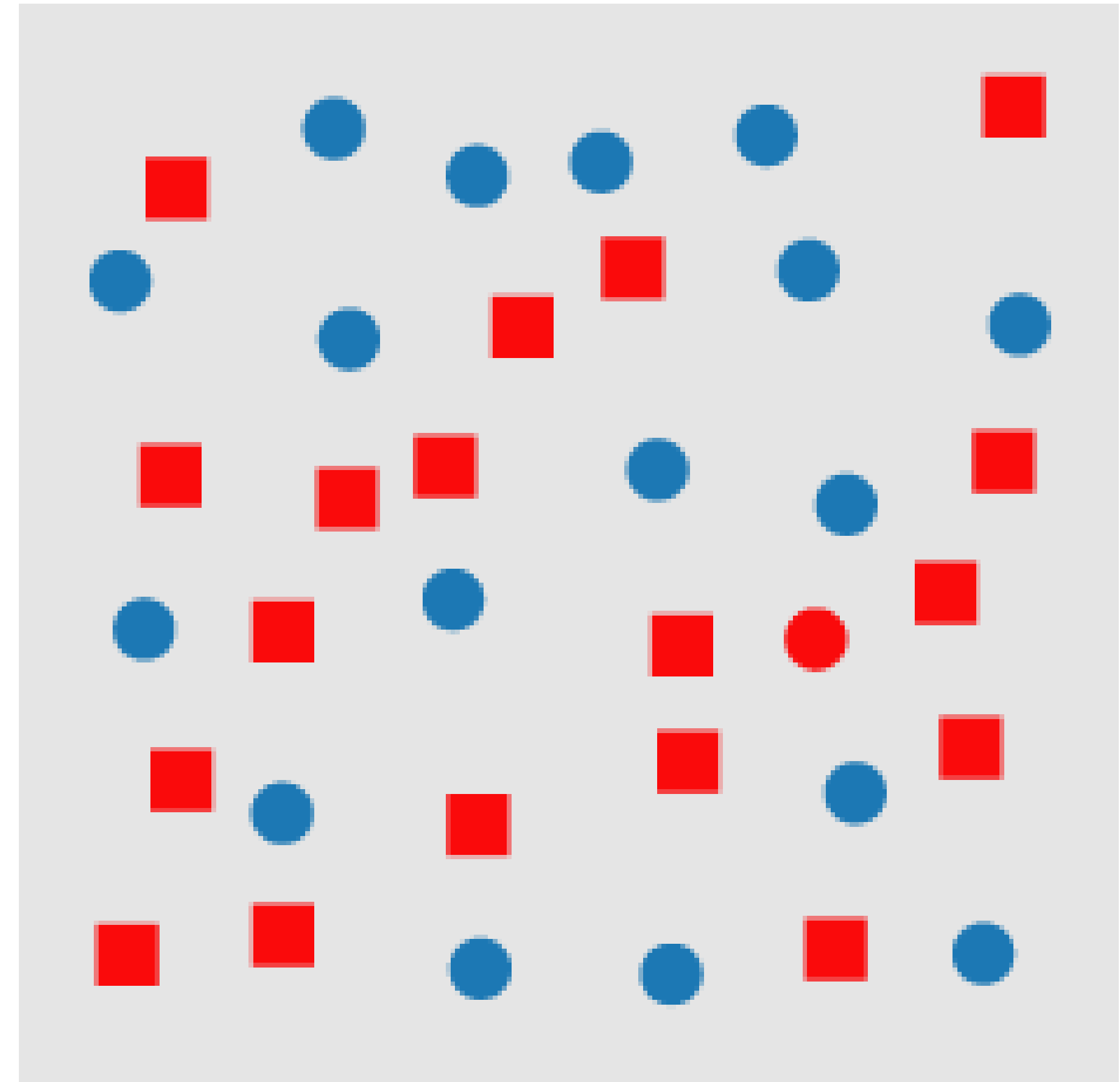
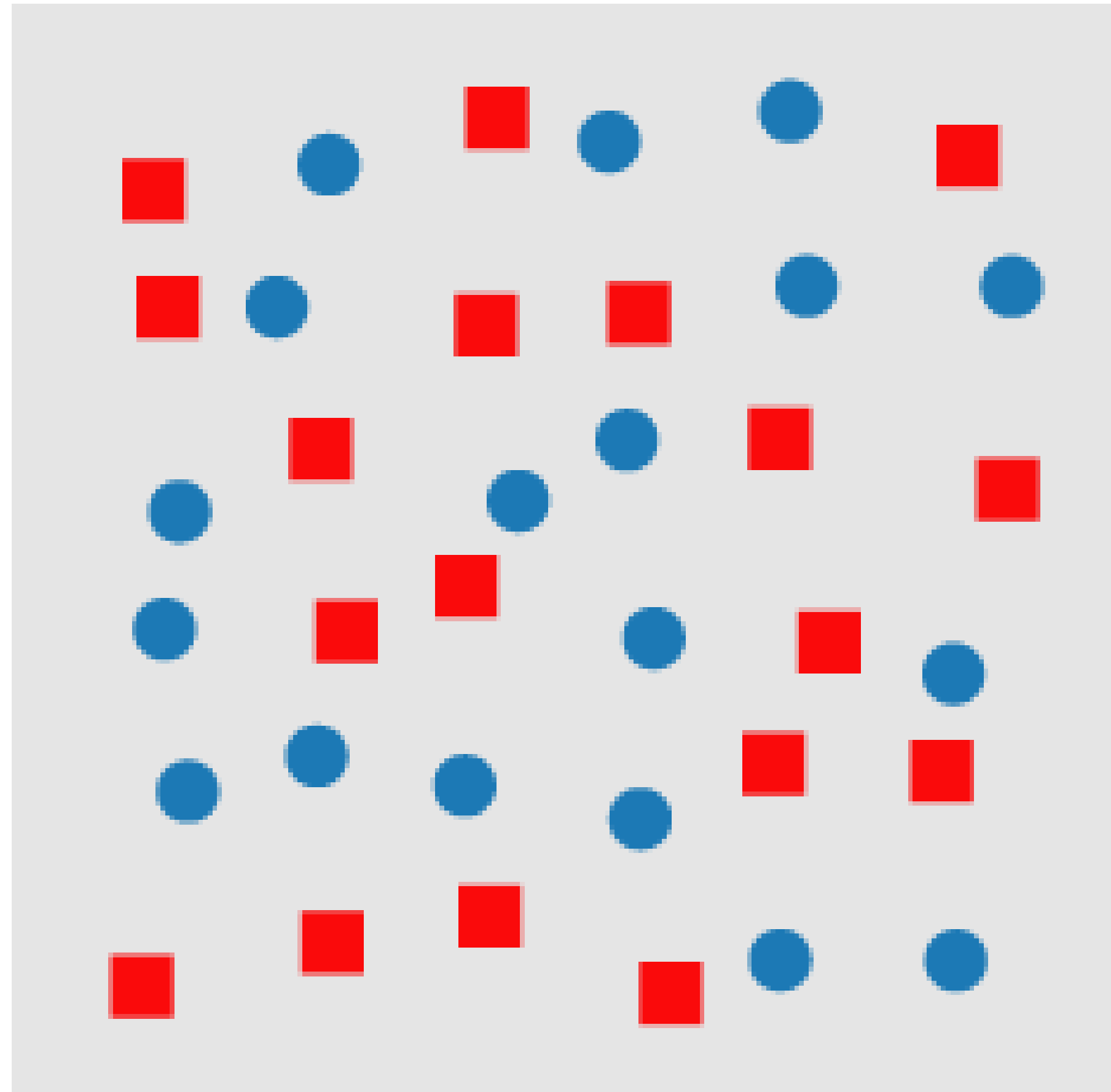
COLOR

POP-OUT EFFECTS



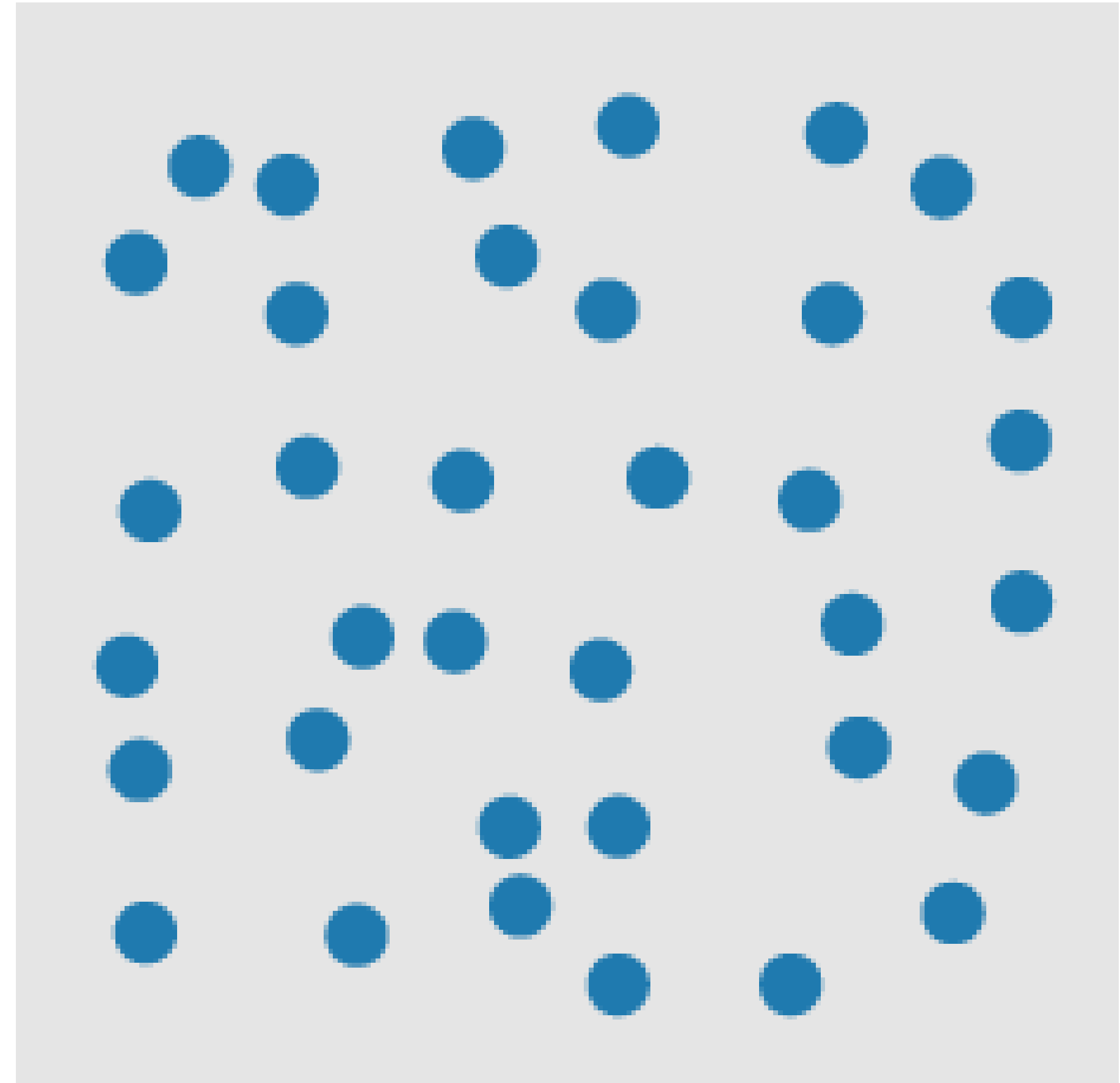
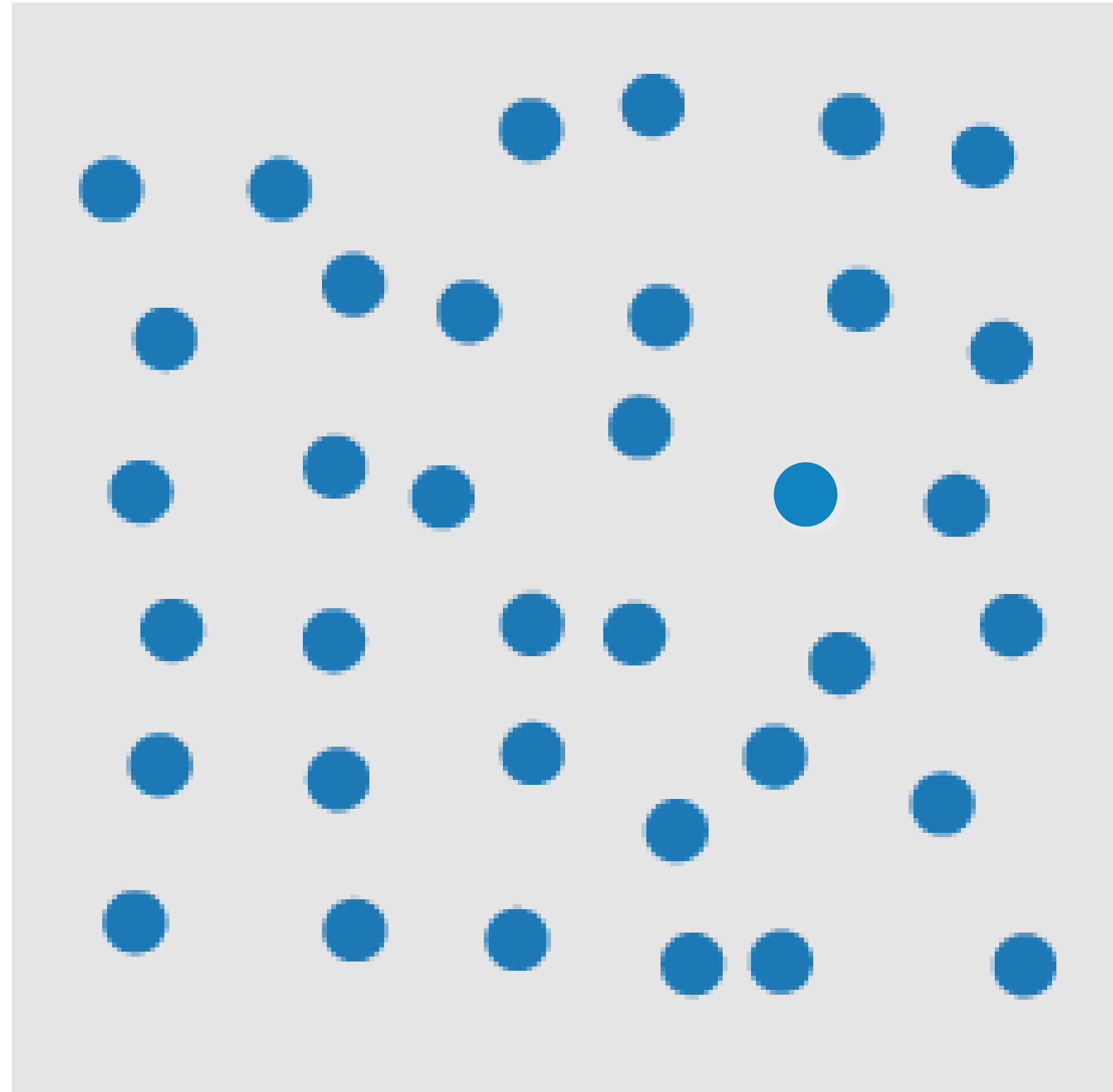
SHAPE

POP-OUT EFFECTS



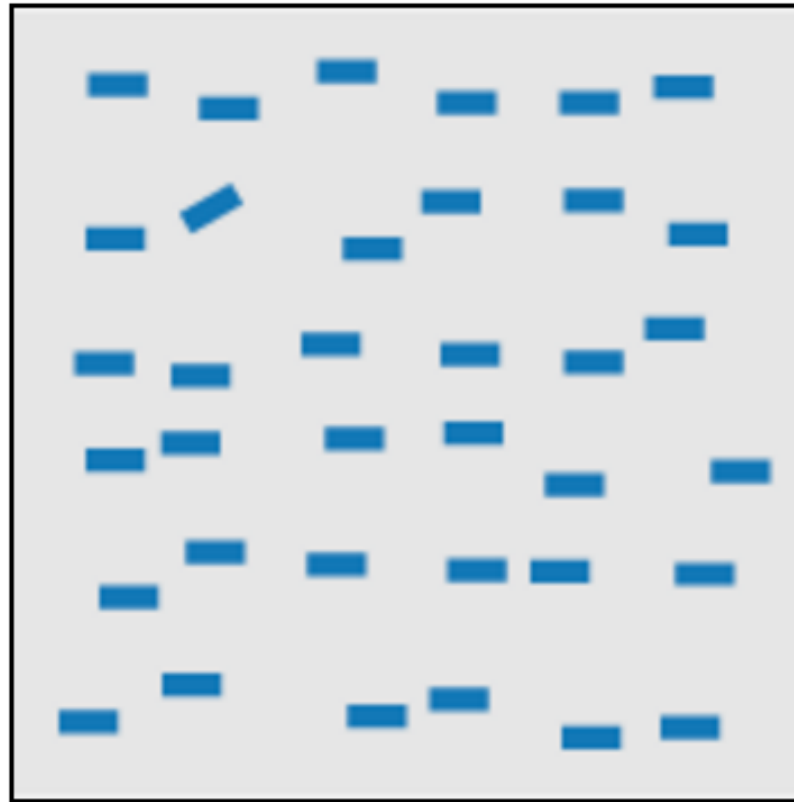
“CONJUNCTION” (HARDER TO FIND RED CIRCLE!)

POP-OUT EFFECTS

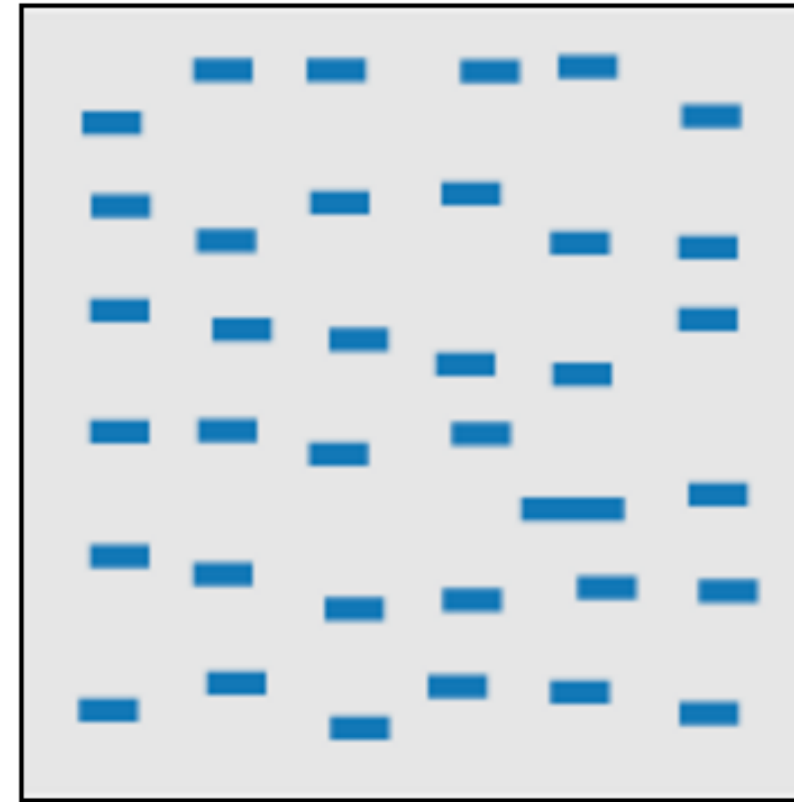


MOTION

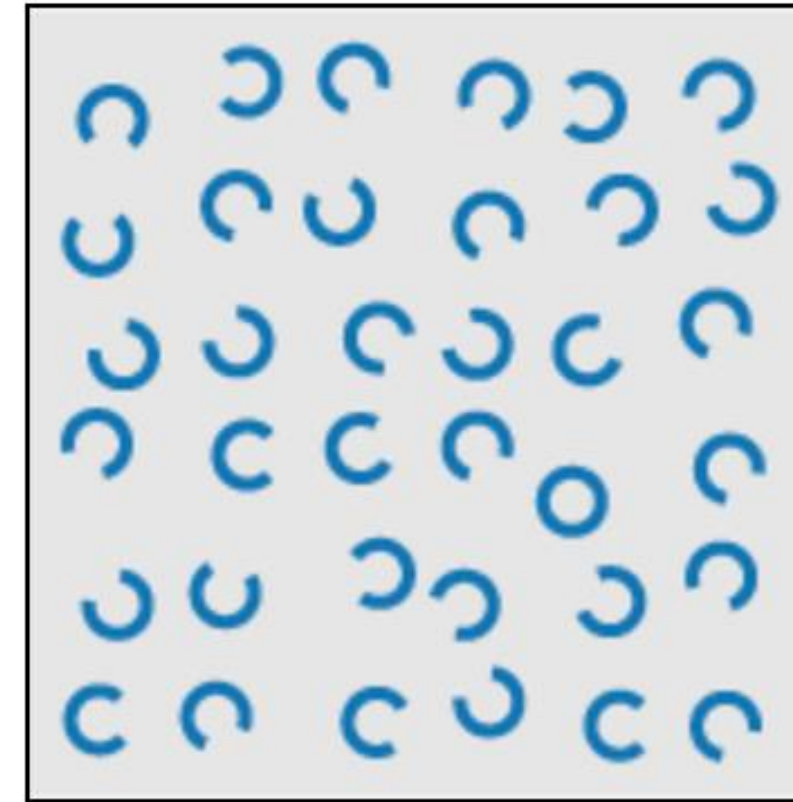
POP-OUT EFFECTS



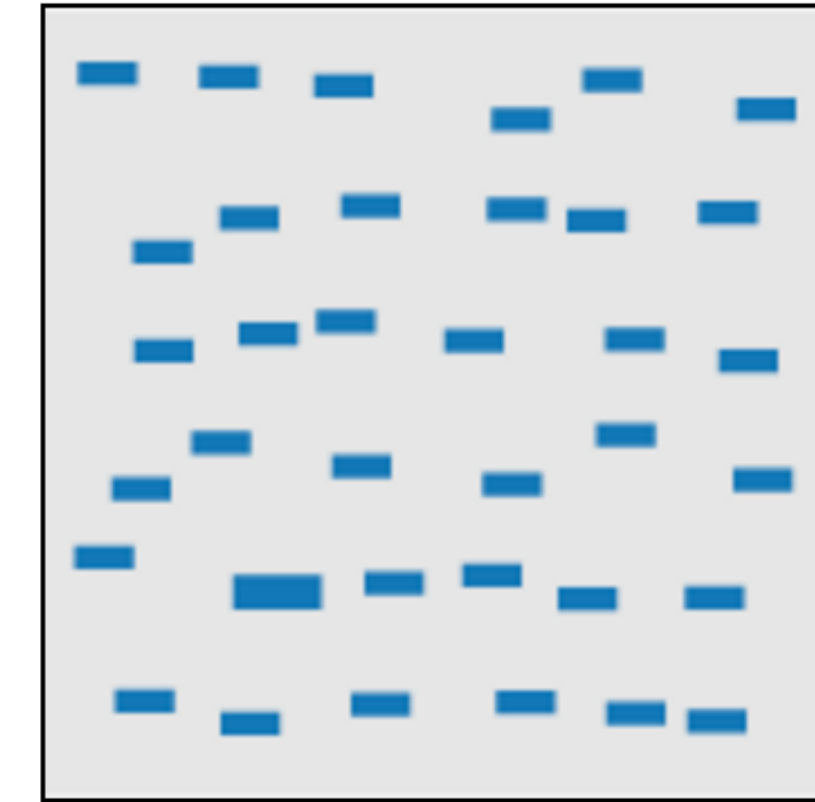
line (blob) orientation
Julész & Bergen 83; Sagi & Julész 85a, Wolfe et al. 92; Weigle et al. 2000



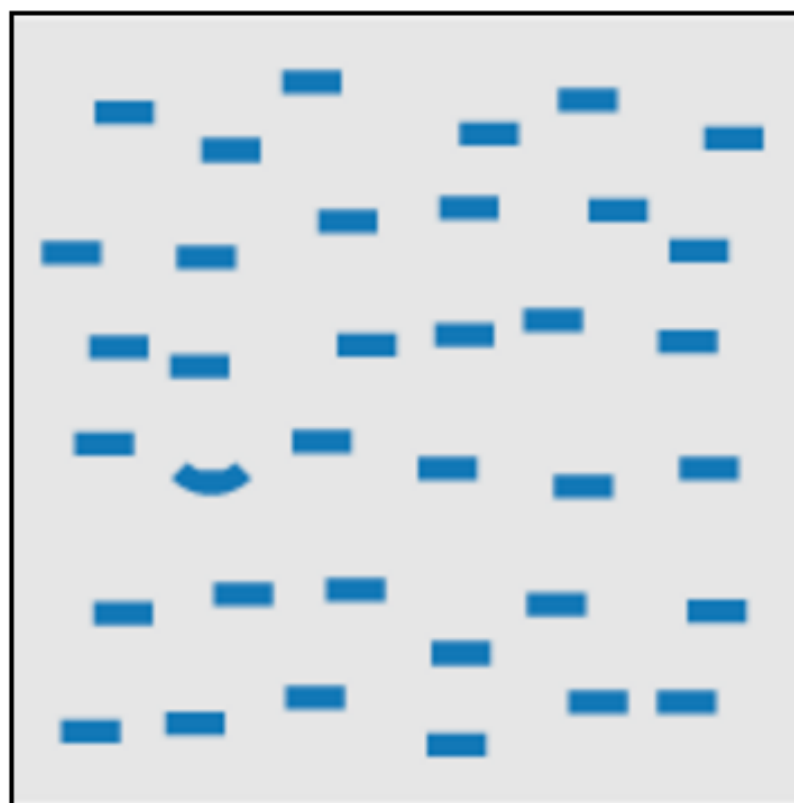
length, width
Sagi & Julész 85b; Treisman & Gormican 88



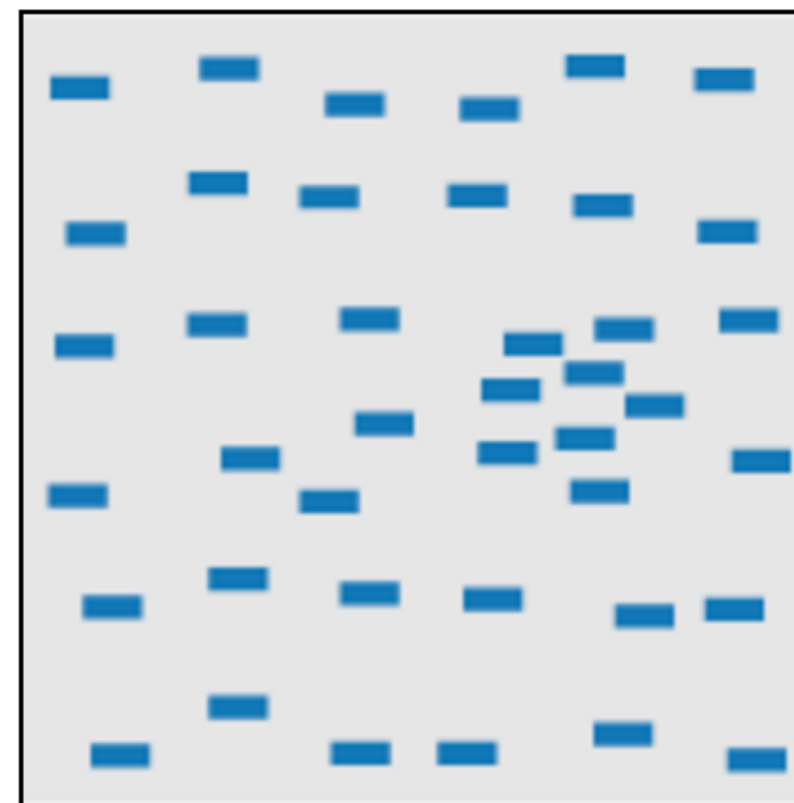
closure
Julész & Bergen 83



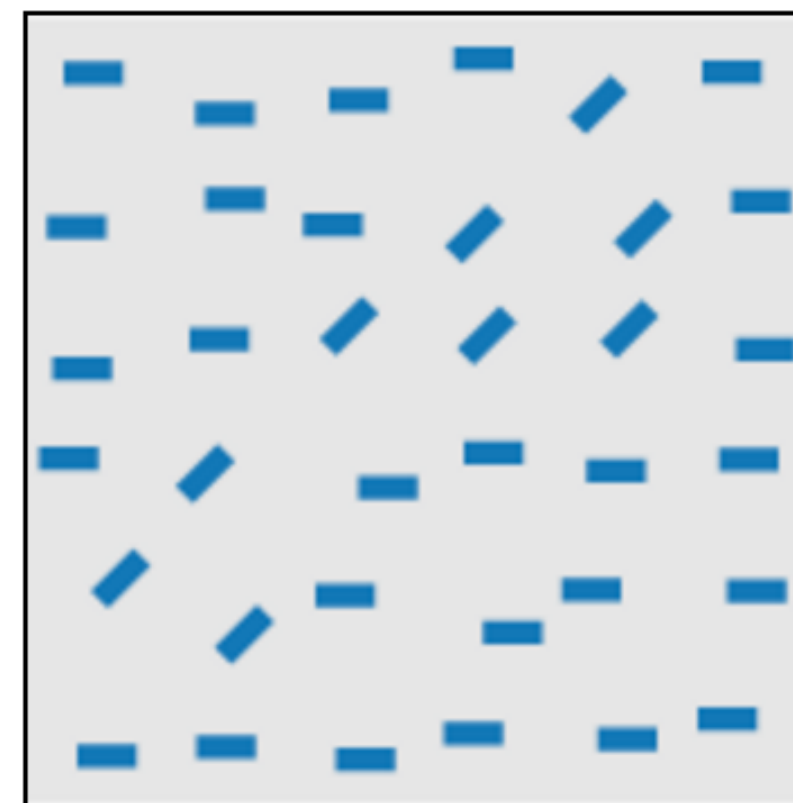
size
Treisman & Gelade 80; Healey & Enns 98; Healey & Enns 99



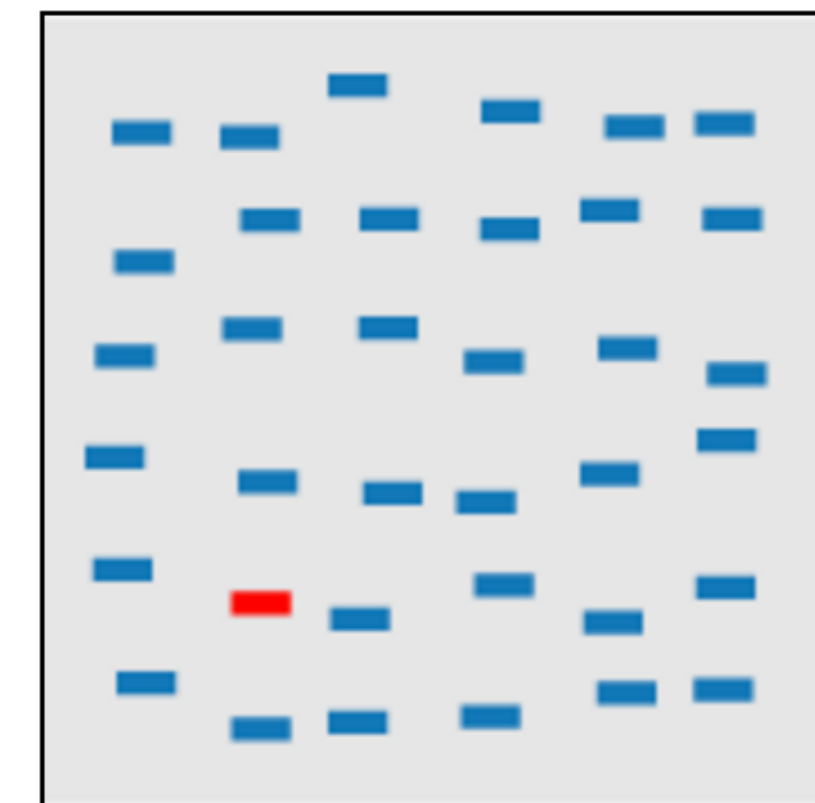
curvature
Treisman & Gormican 88



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

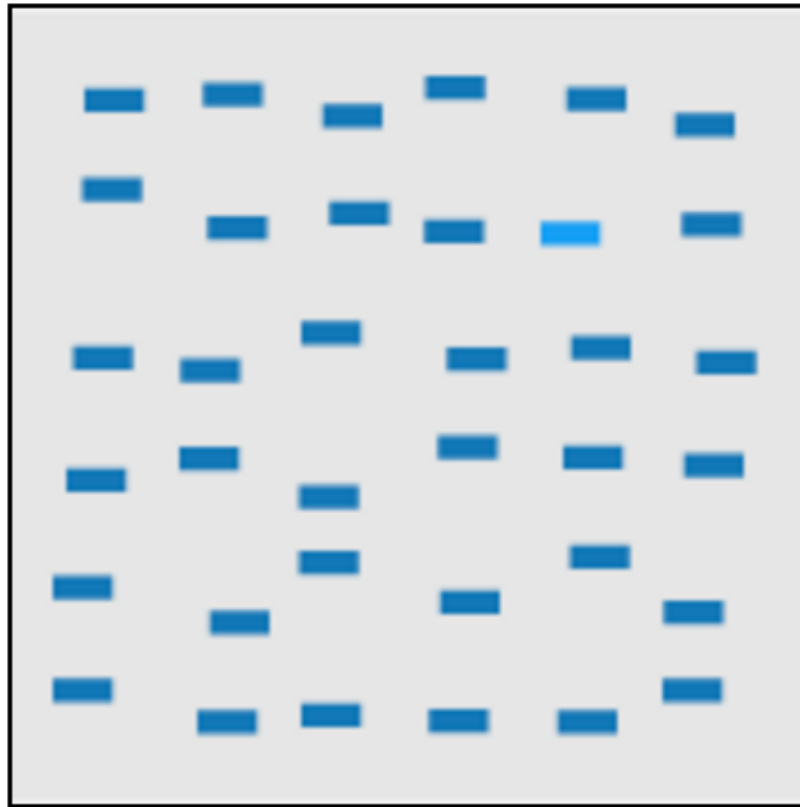


number, estimation
Sagi & Julész 85b; Healey et al. 93; Trick & Pylyshyn 94

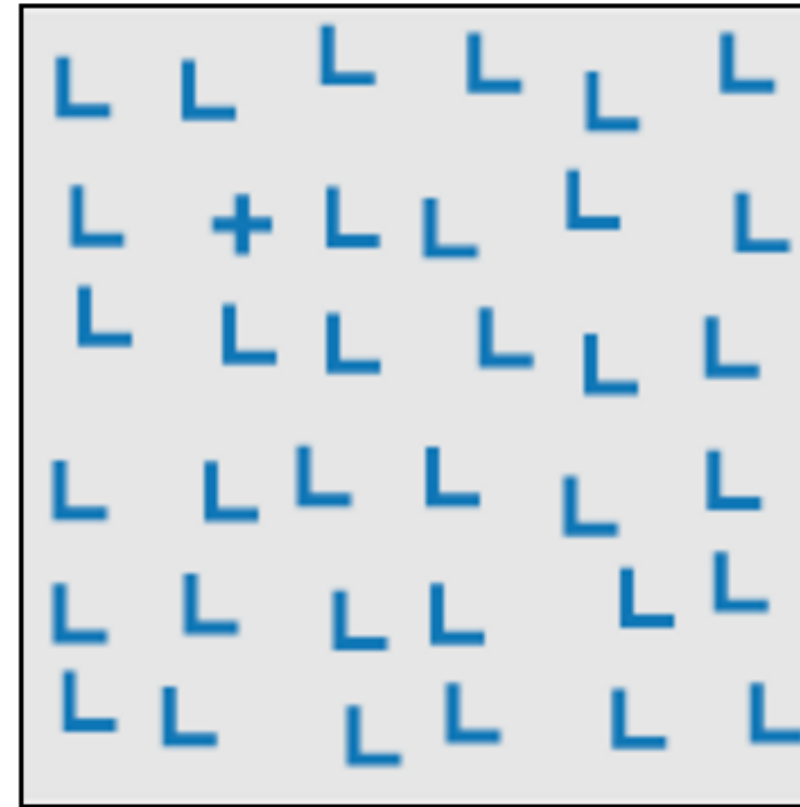


colour (hue)
Nagy & Sanchez 90; Nagy et al. 90; D'Zmura 91; Kawai et al. 95; Bauer et al. 96; Healey 96; Bauer et al. 98; Healey & Enns 99

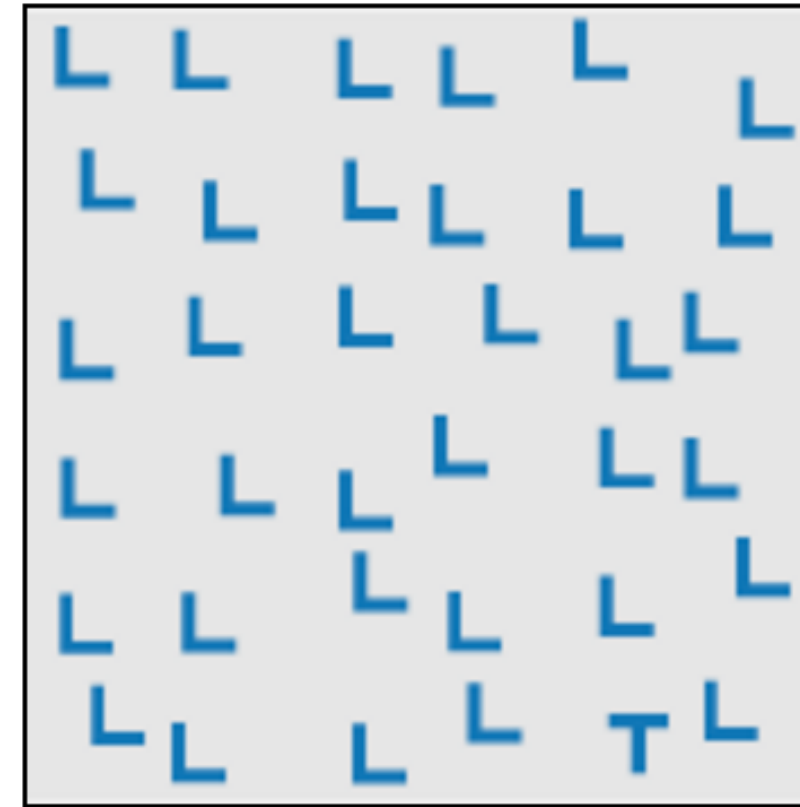
POP-OUT EFFECTS



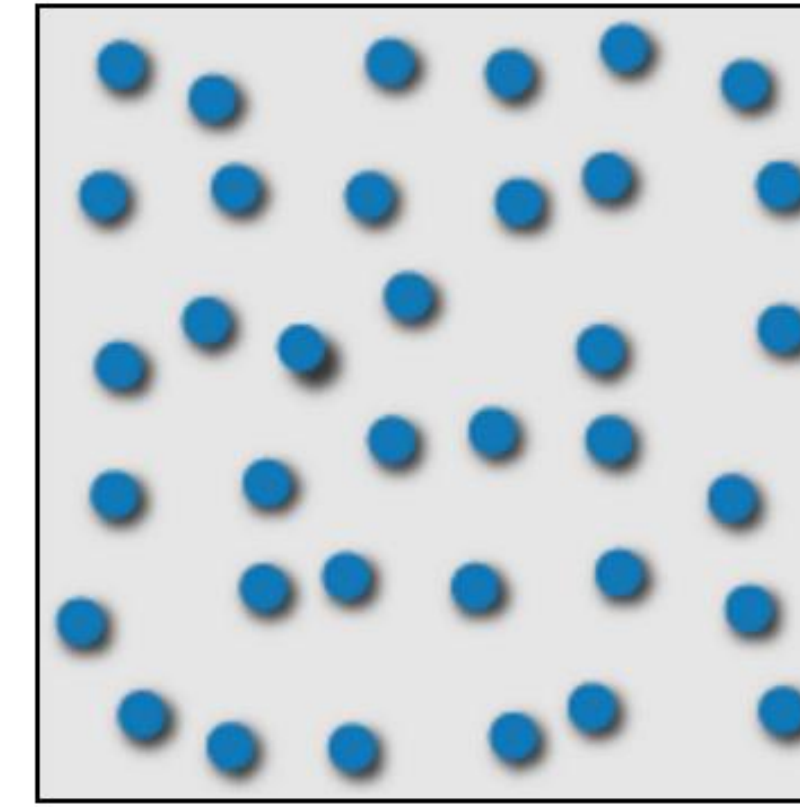
intensity, binocular lustre
Beck et al. 83; Treisman & Gormican 88; Wolfe & Franzel 88



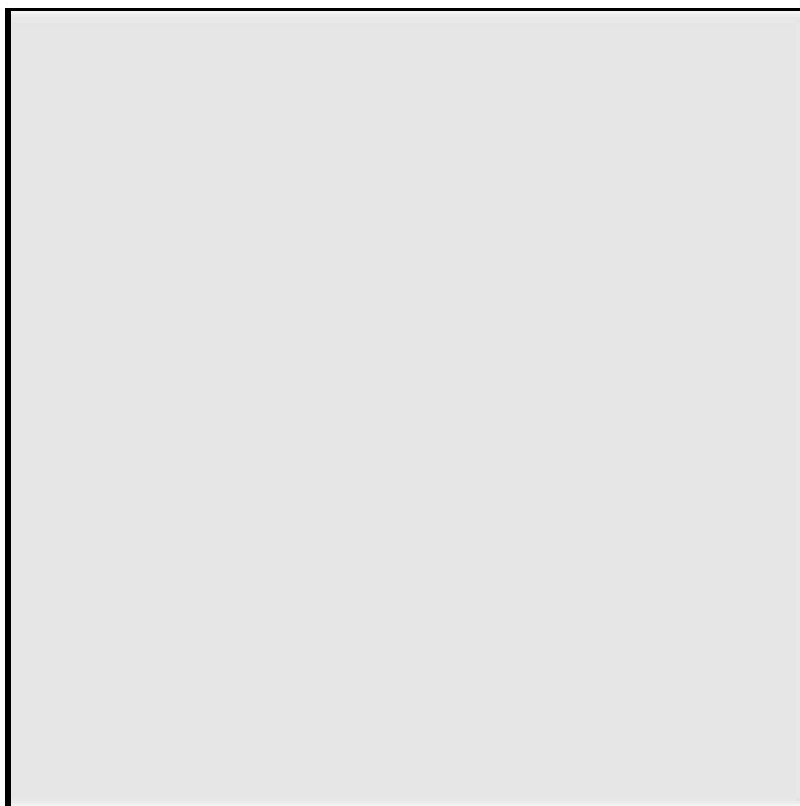
intersection
Julész & Bergen 83



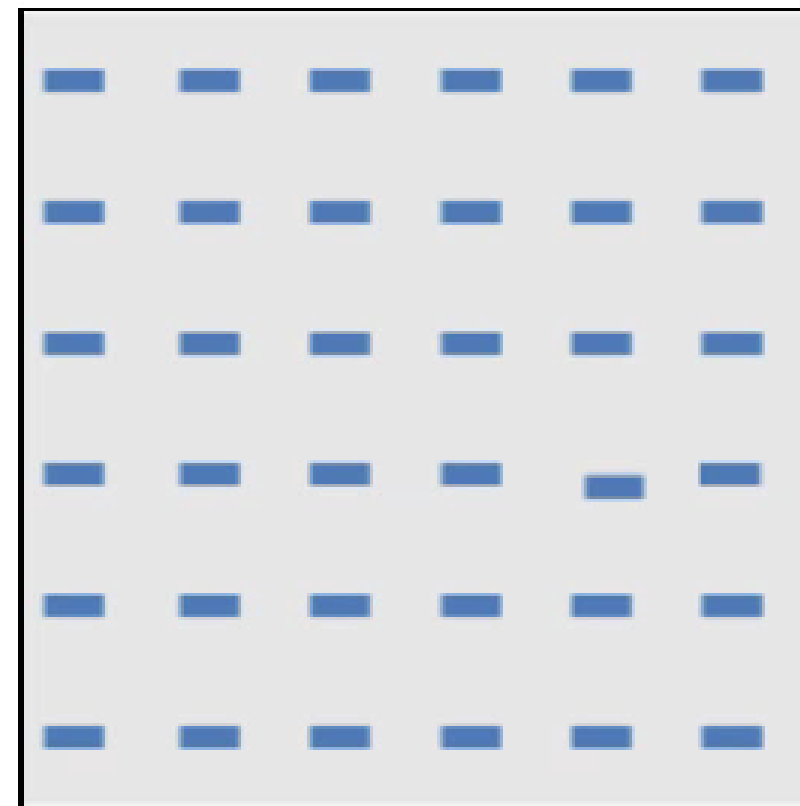
terminators
Julész & Bergen 83



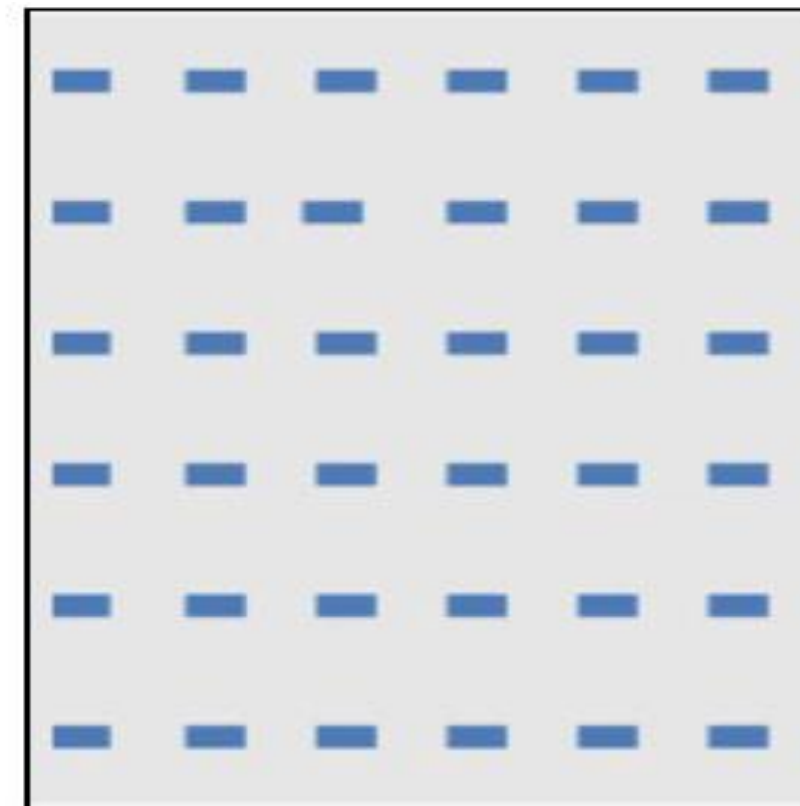
3D depth cues
Enns 90b; Nakayama & Silverman 86



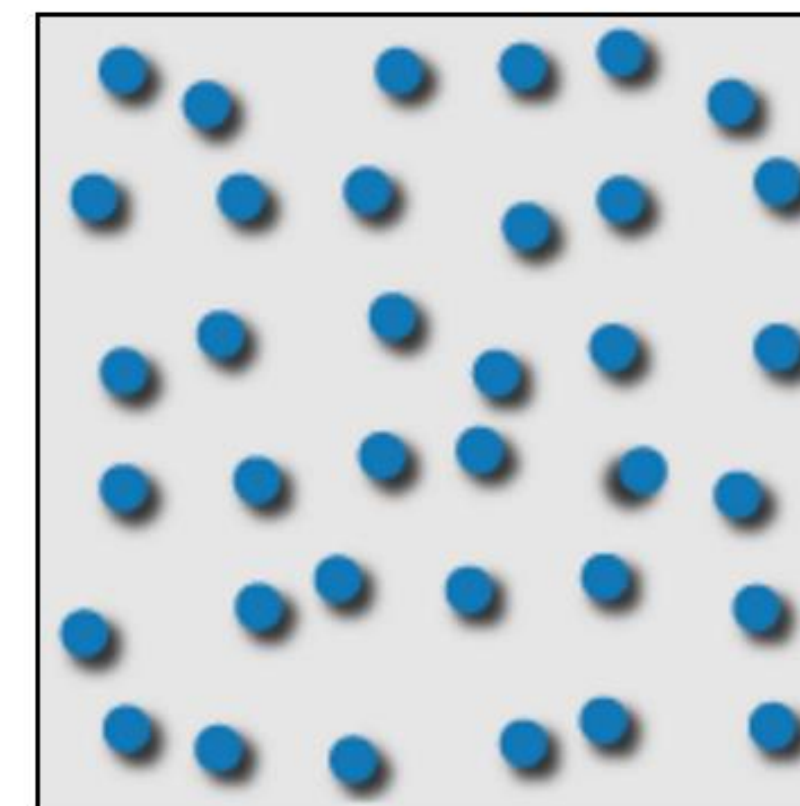
flicker
Gebb et a. 55; Mowbray & Gebhard 55; Brown 65; Julész 71; Huber & Healey 2005



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

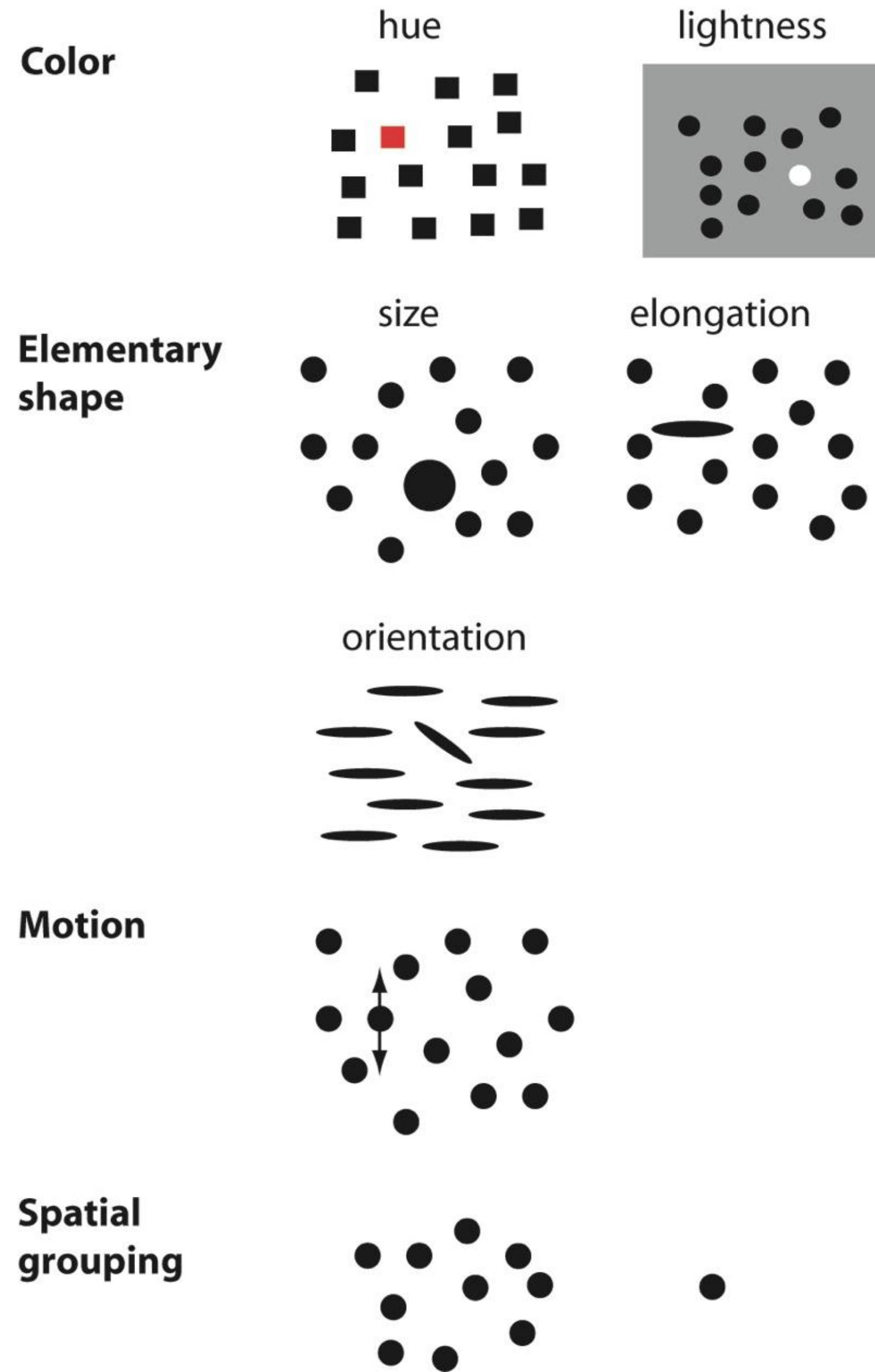


velocity of motion
Tynan & Sekuler 82; Nakayama & Silverman 86; Driver & McLeod 92; Hohnsbein & Mateeff 98; Huber & Healey 2005



lighting direction
Enns 90a

Basic Popout Channels



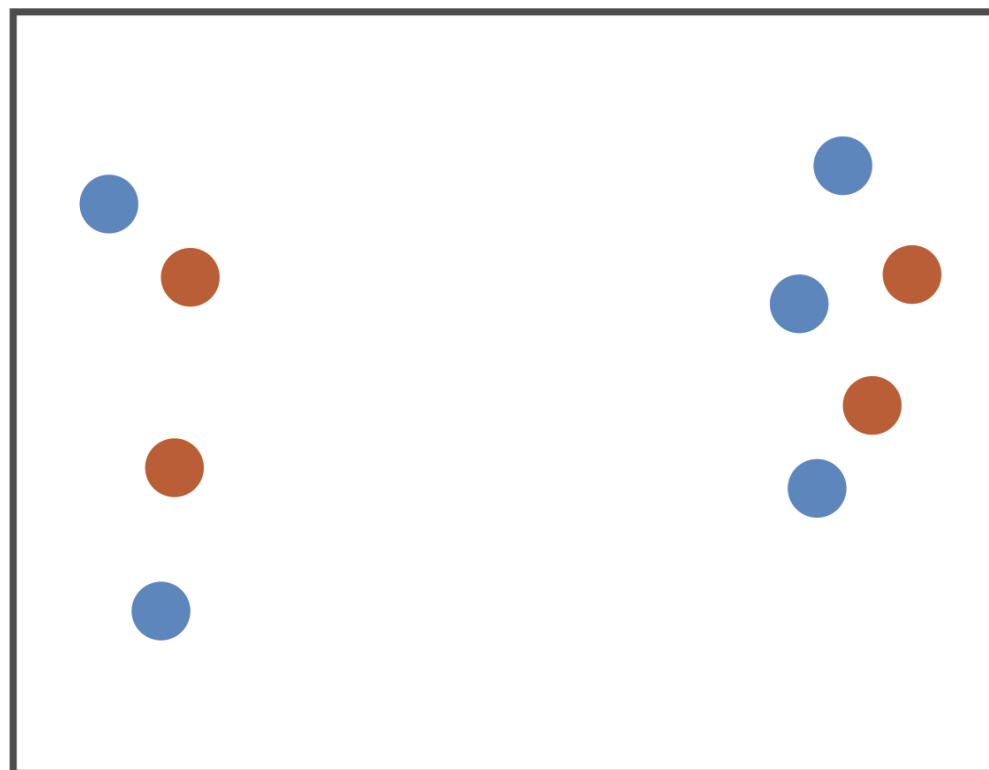
Use these “popout” effects to help design effective visualizations!

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

Discriminability and Separability

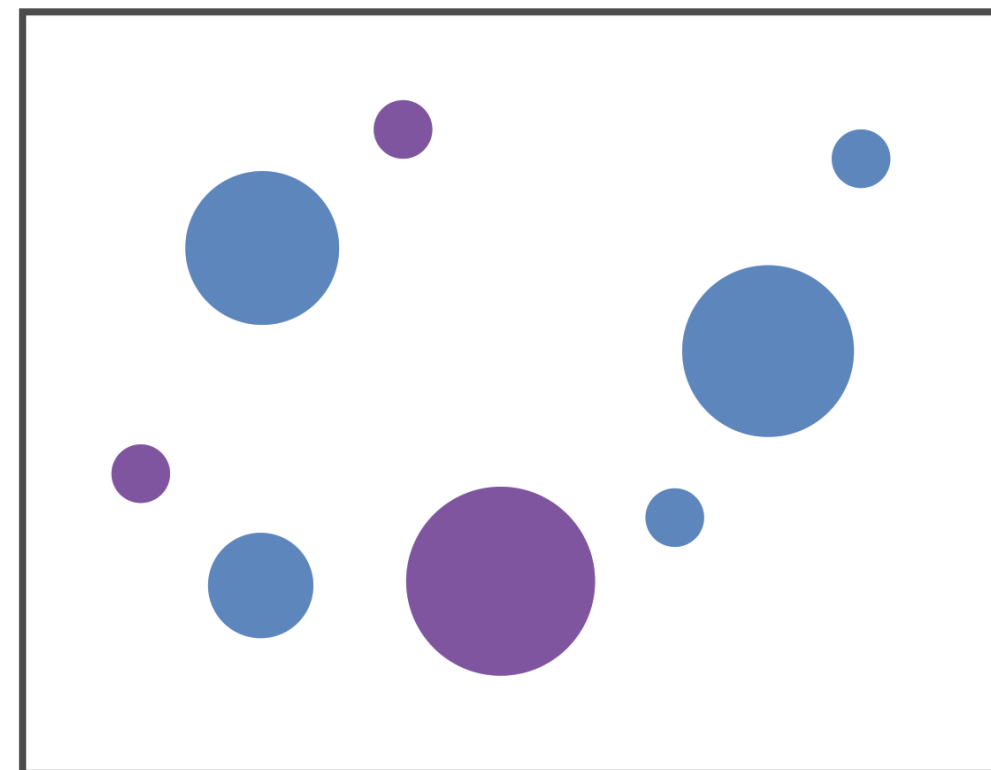
The question of discriminability is: if you encode data using a particular visual channel, are the differences between items perceptible to the human as intended?

Position
+ Hue (Color)



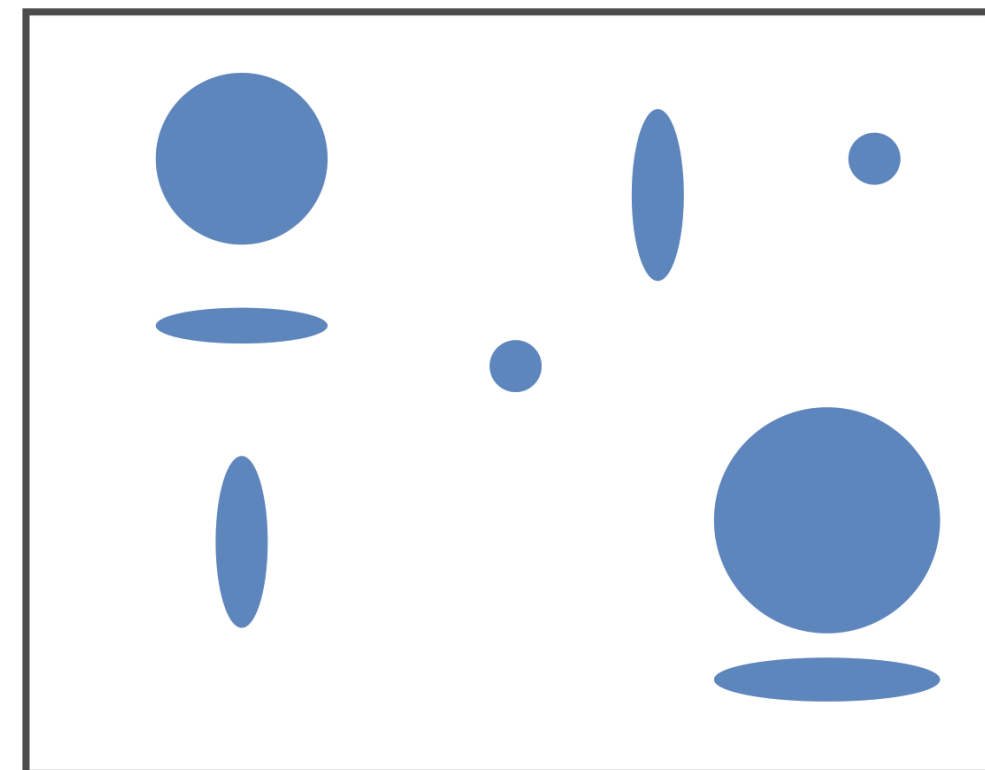
Fully separable

Size
+ Hue (Color)



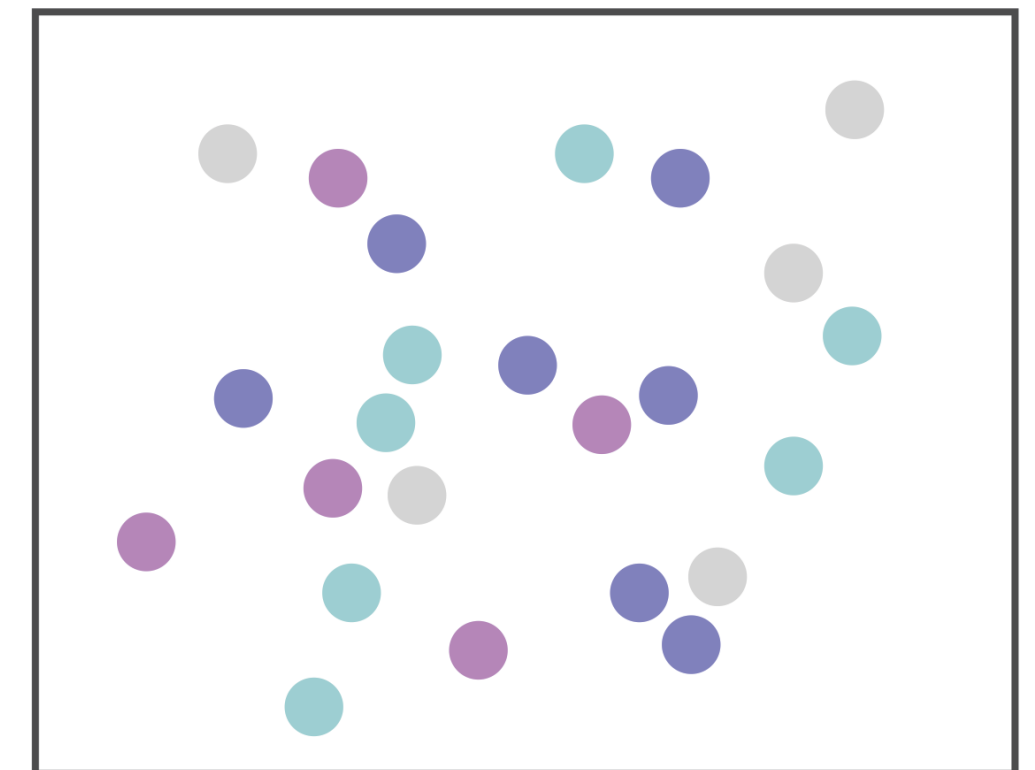
Some interference

Width
+ Height



Some/significant
interference

Red
+ Green

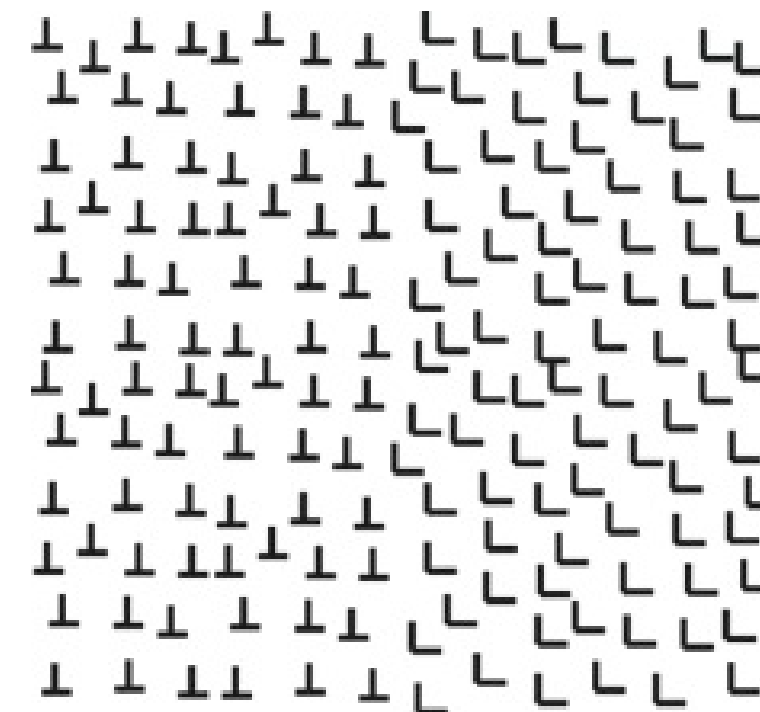
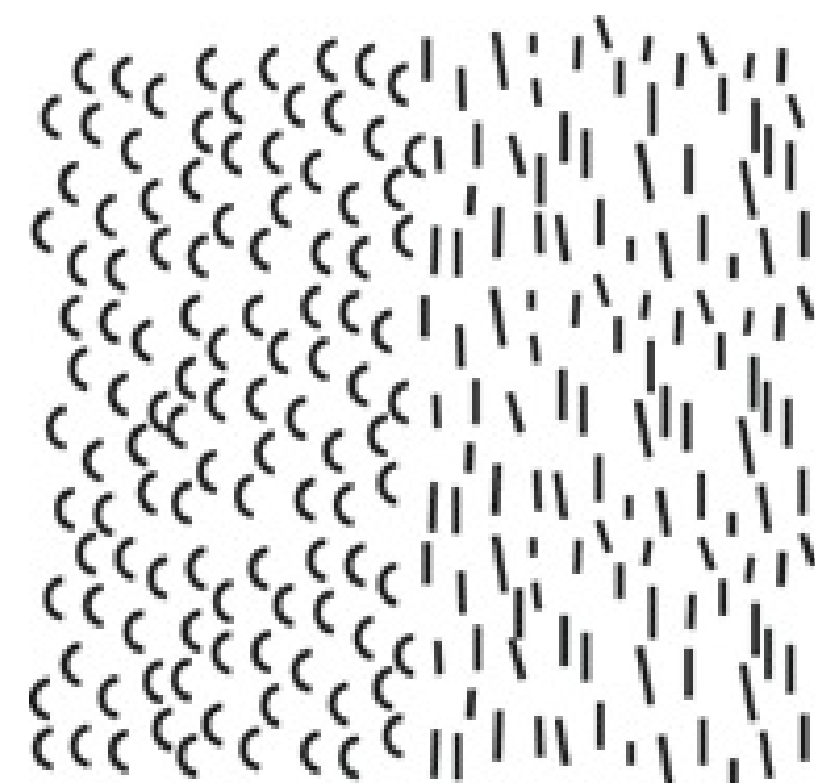
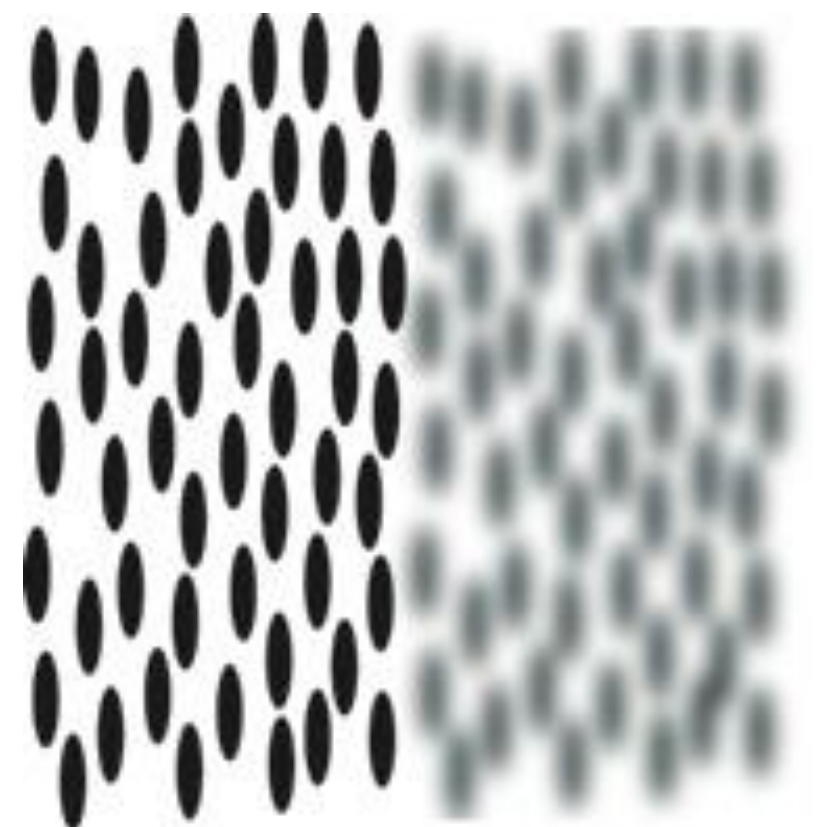
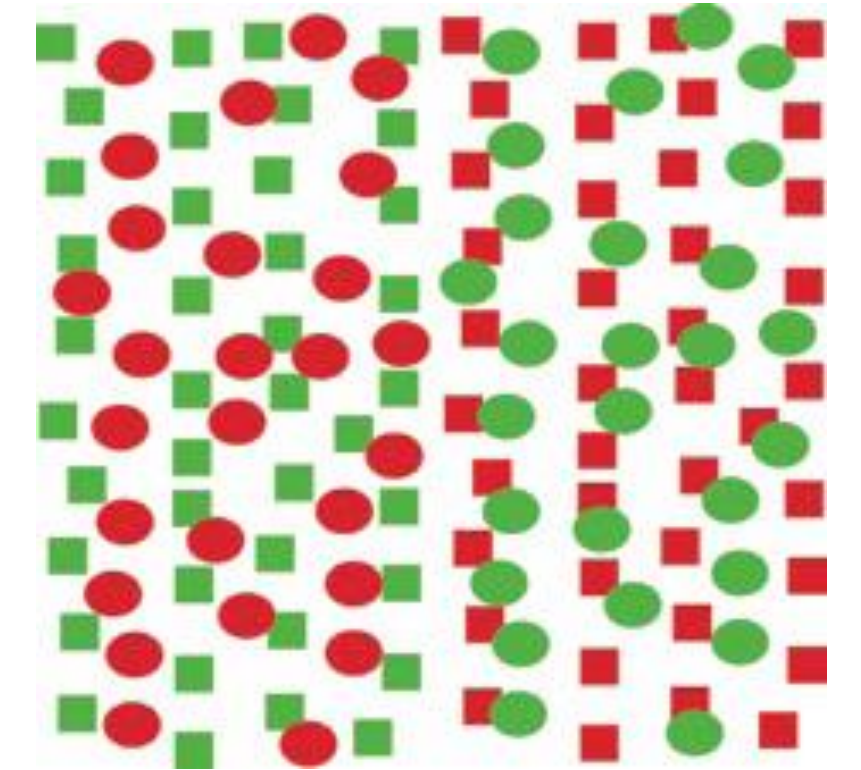
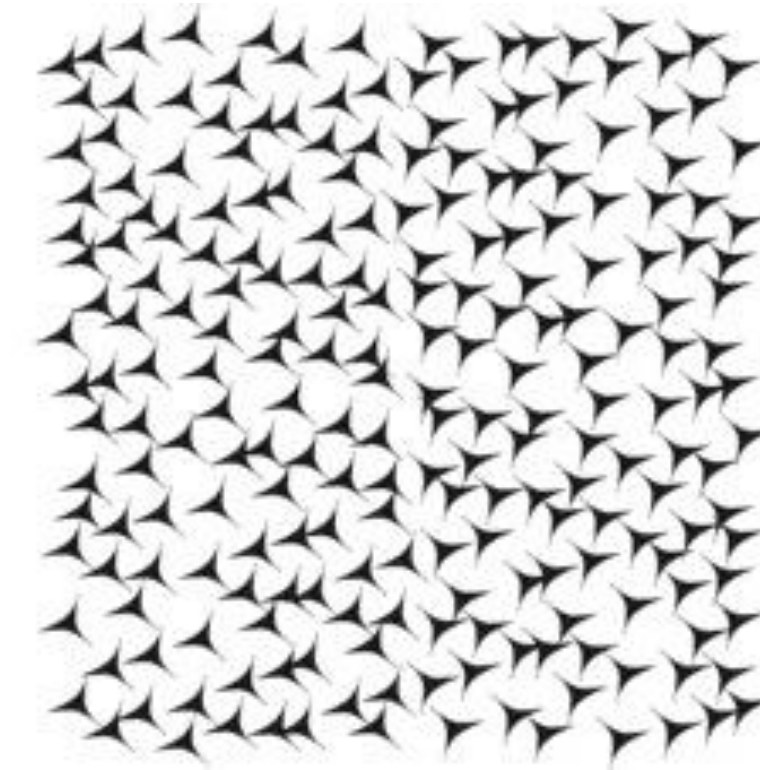
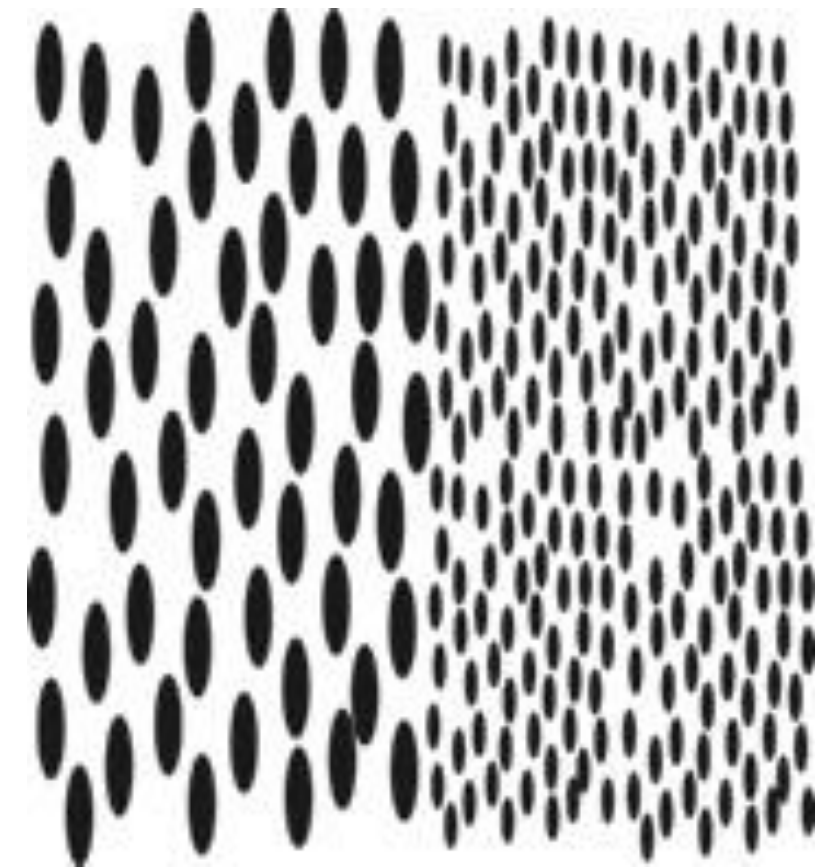
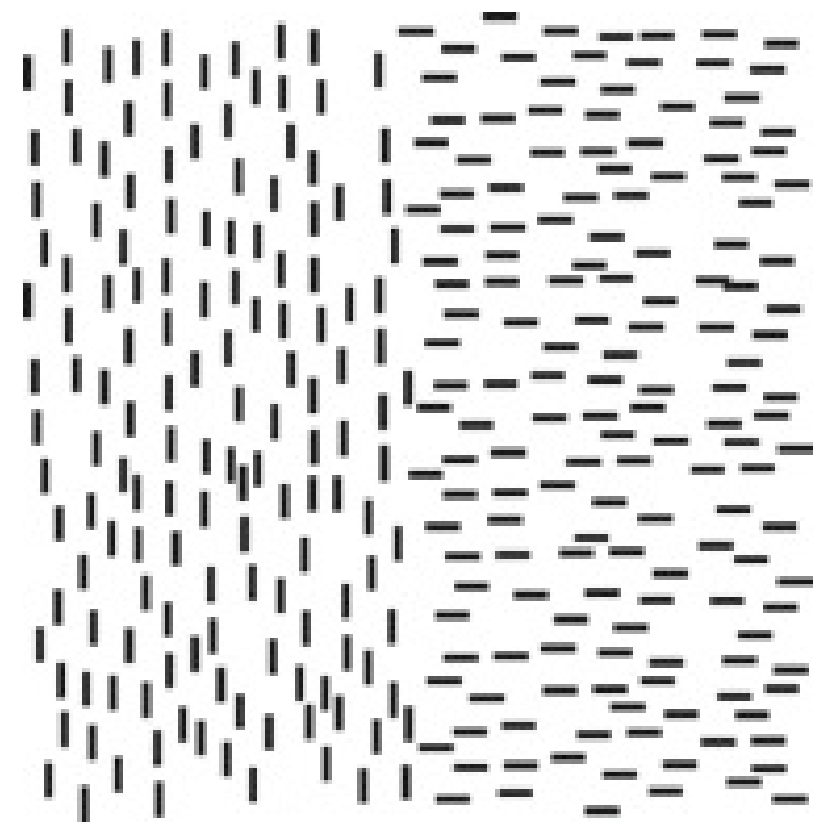


Major interference

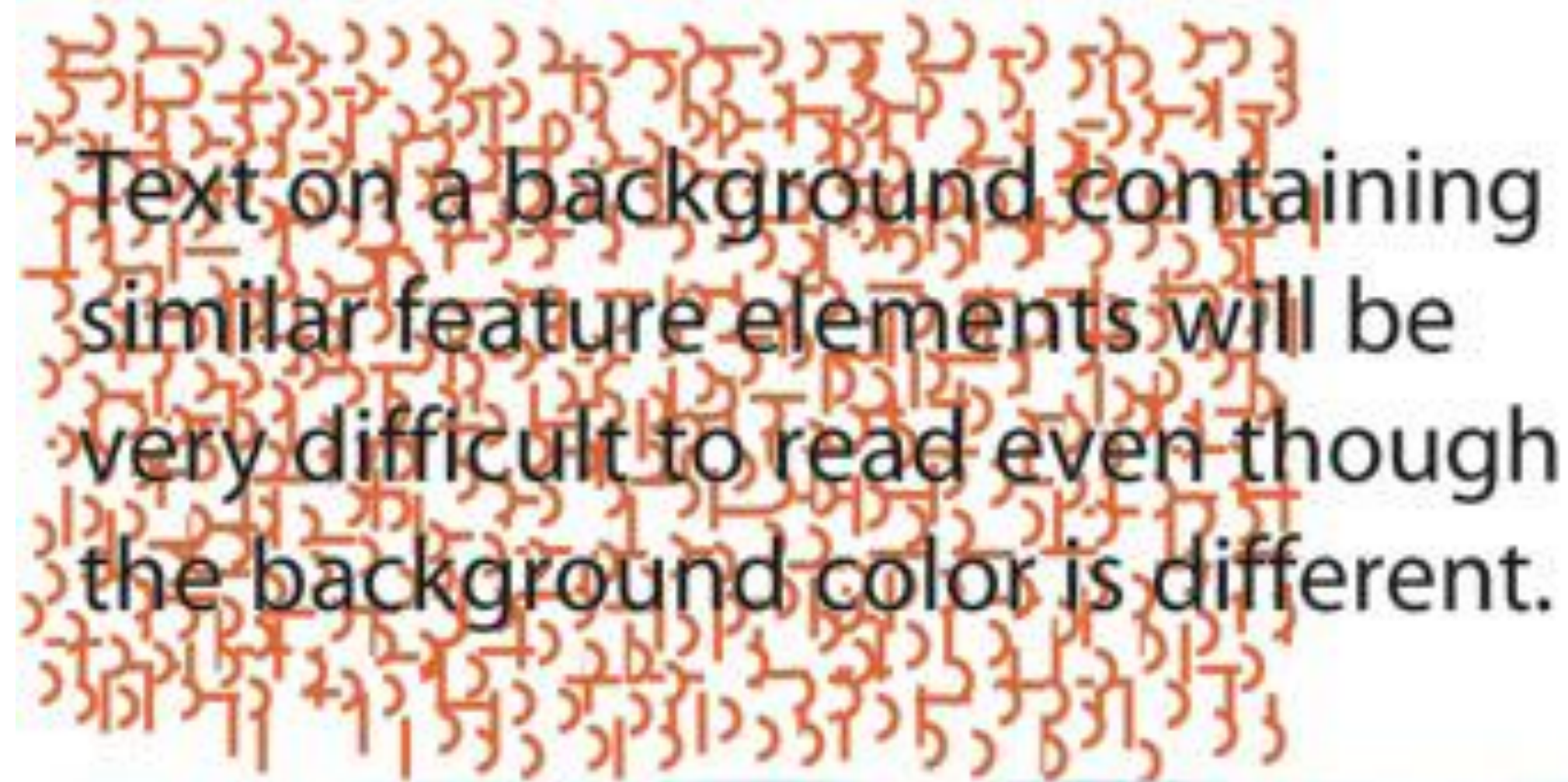
Textures

easy

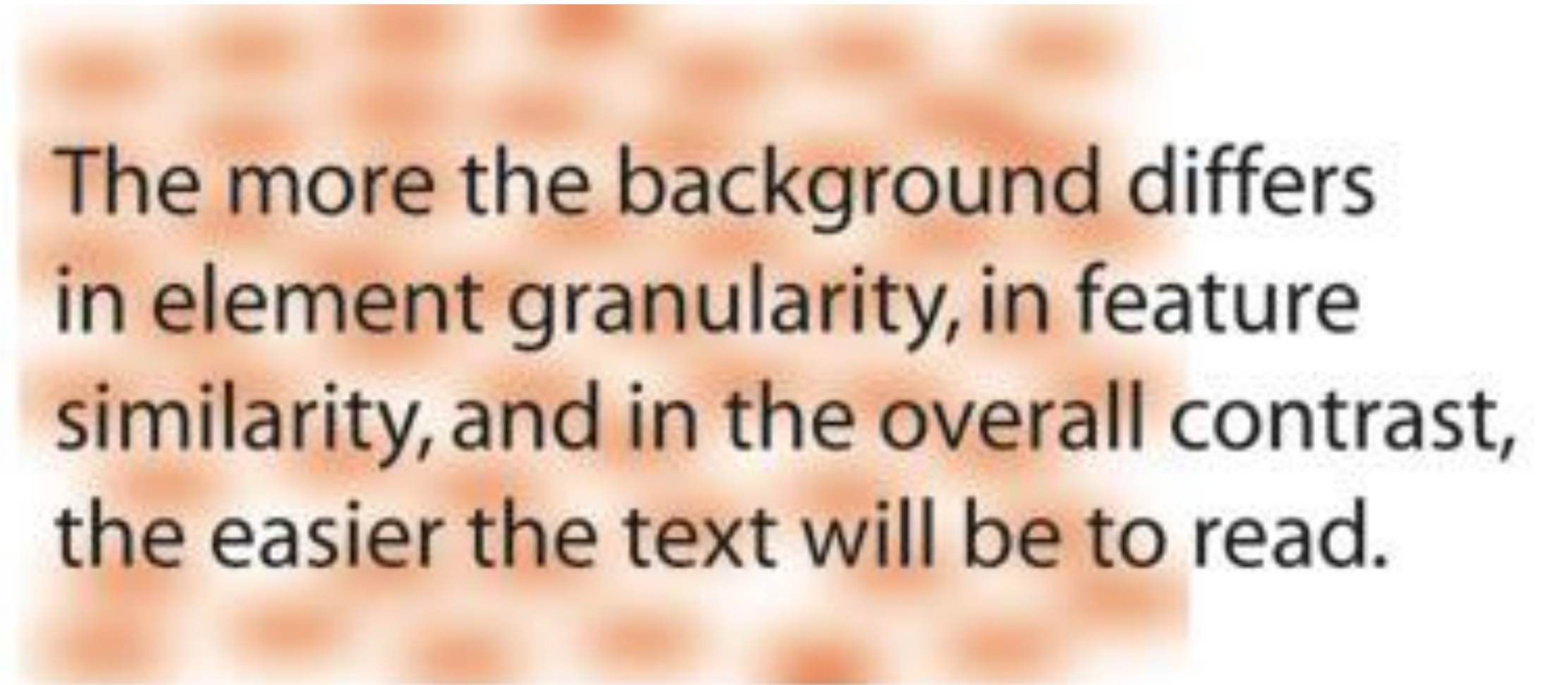
hard



Textures: Interference



Text on a background containing similar feature elements will be very difficult to read even though the background color is different.




The more the background differs in element granularity, in feature similarity, and in the overall contrast, the easier the text will be to read.

Subtle, low contrast background texture with little feature similarity will interfere less.

ILLUSIONS AND TRICKS

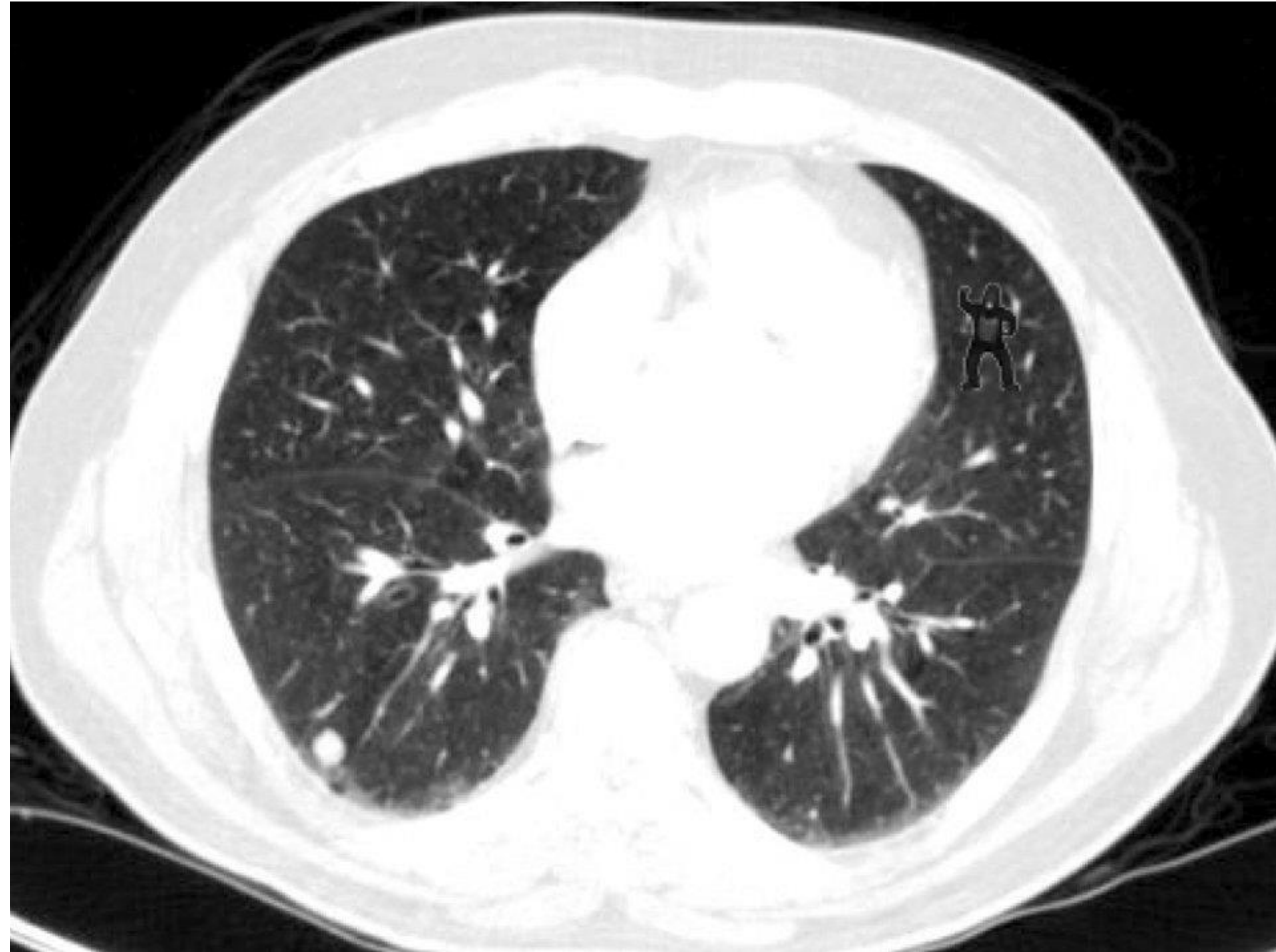
Visual Attention & Change Blindness



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.



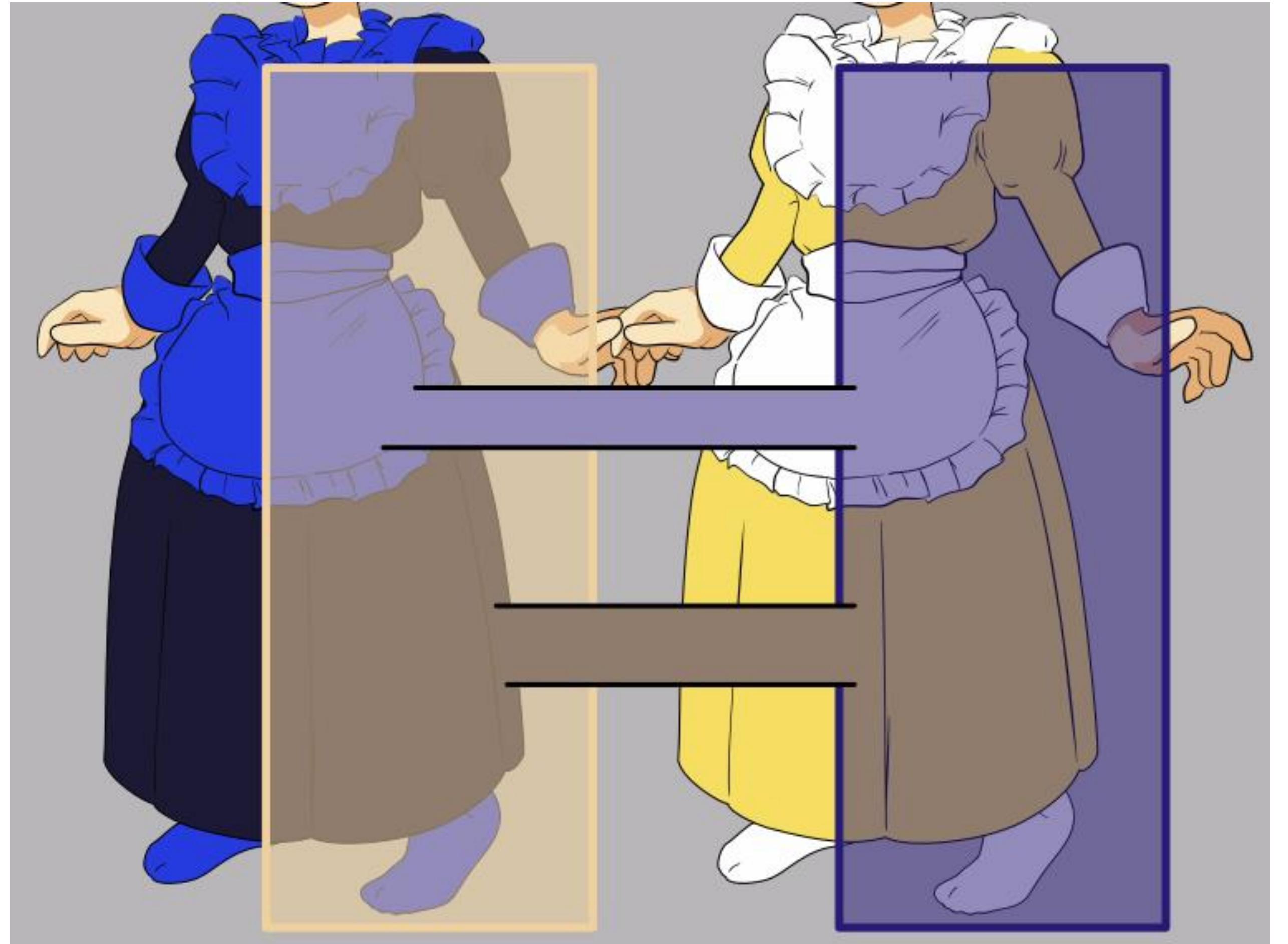
83% of the radiologists missed the gorilla!

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



The Dress:

blue/black or yellow/white?

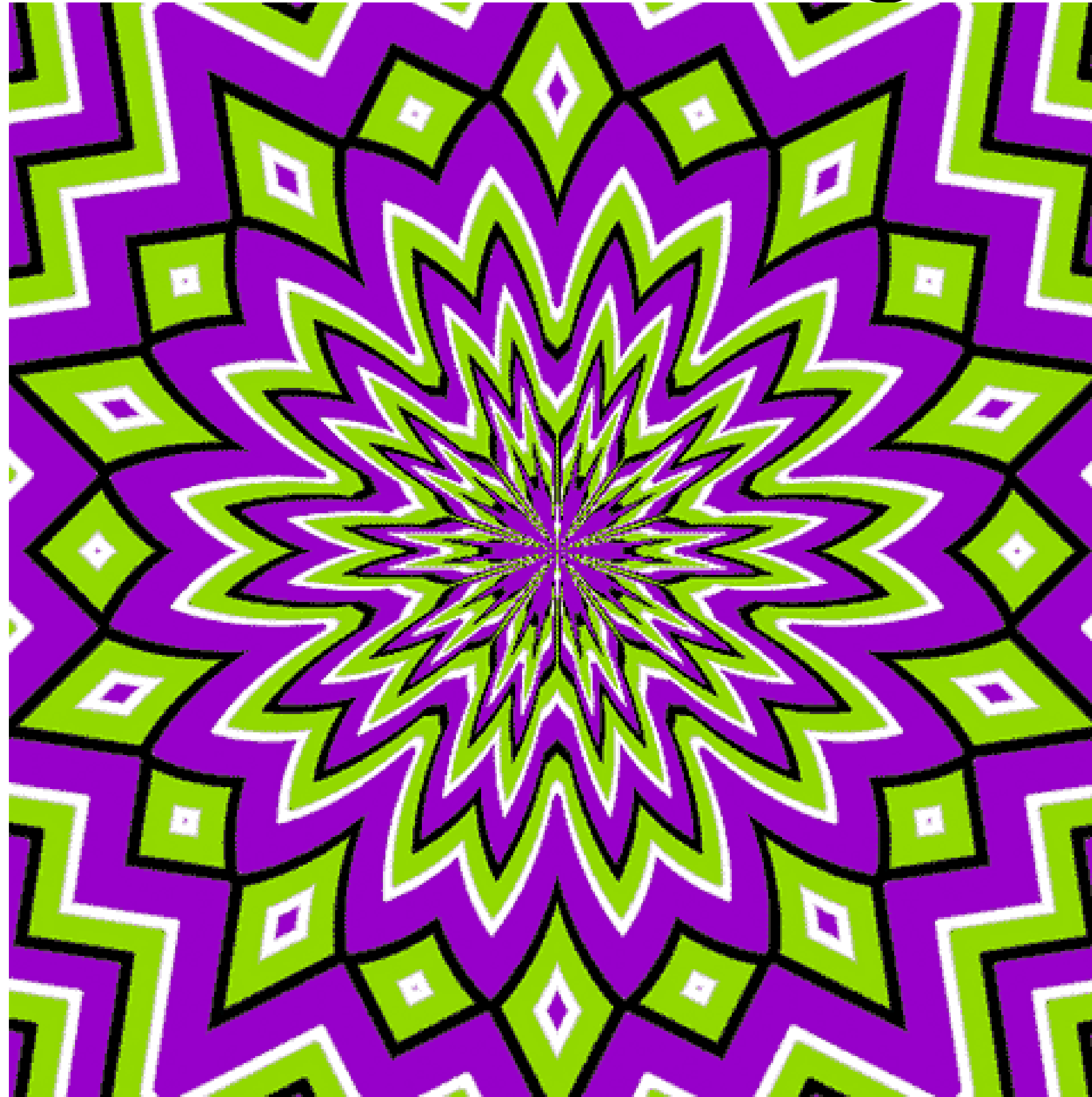


https://en.wikipedia.org/wiki/The_dress

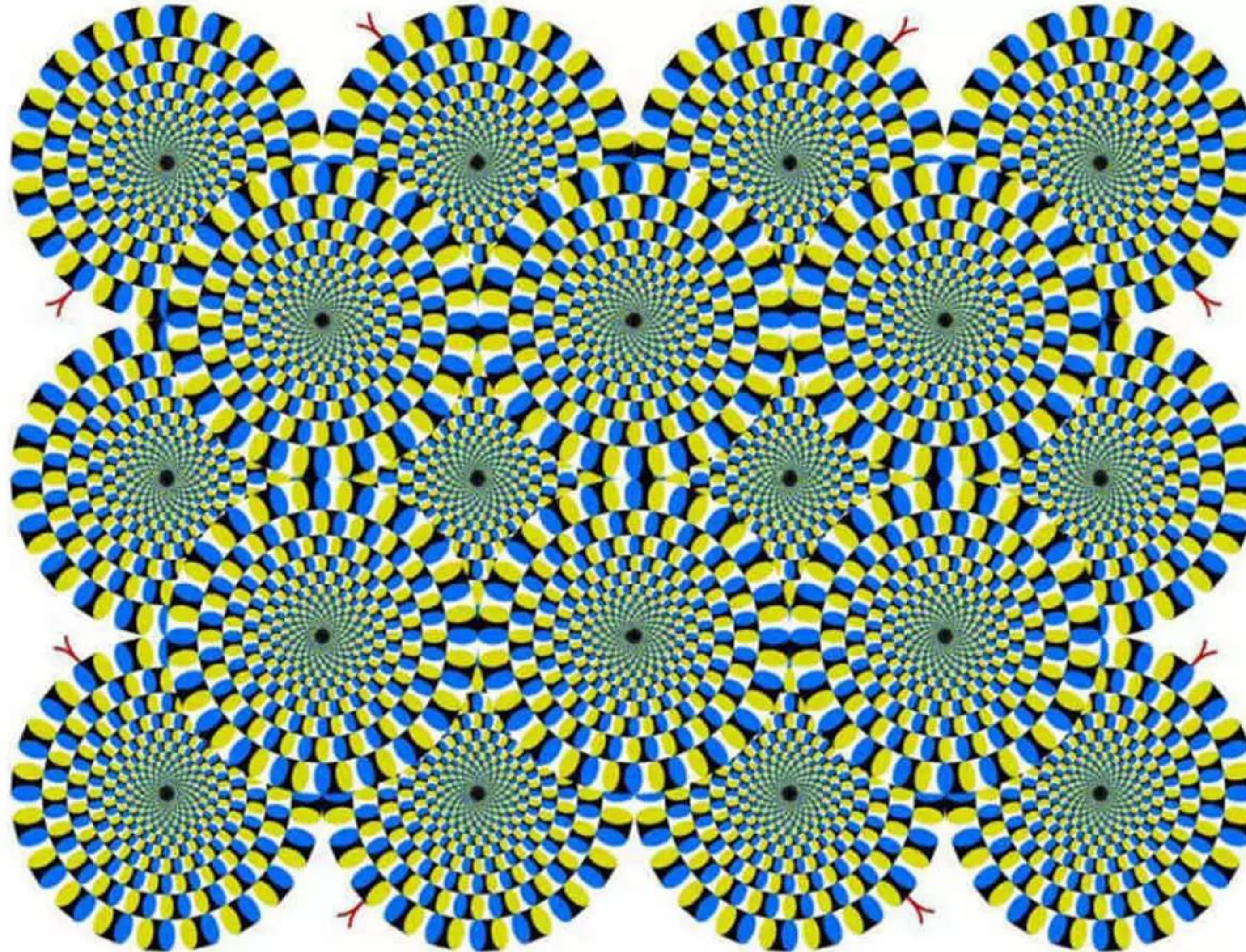
Still or moving?



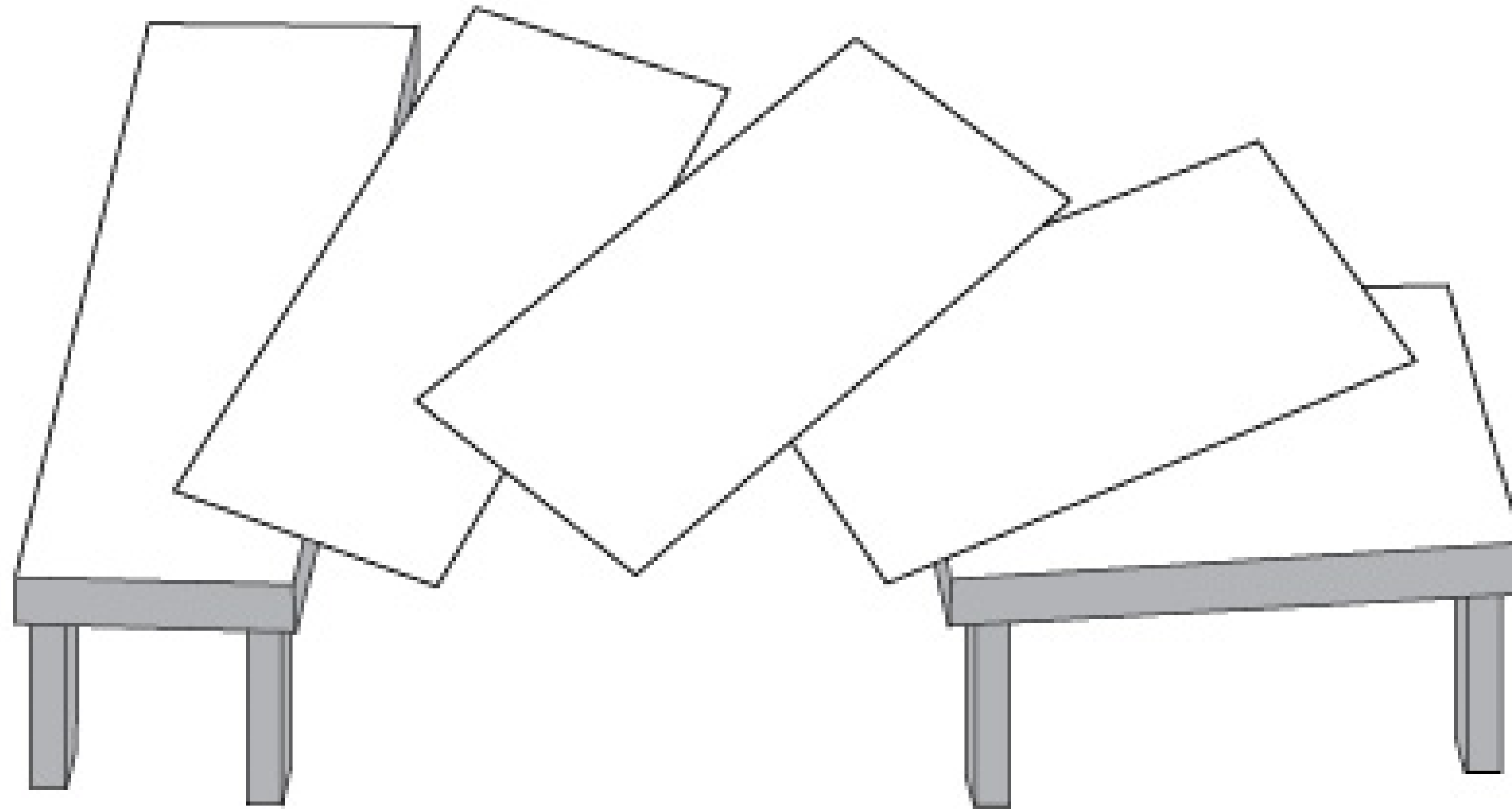
Still or moving?



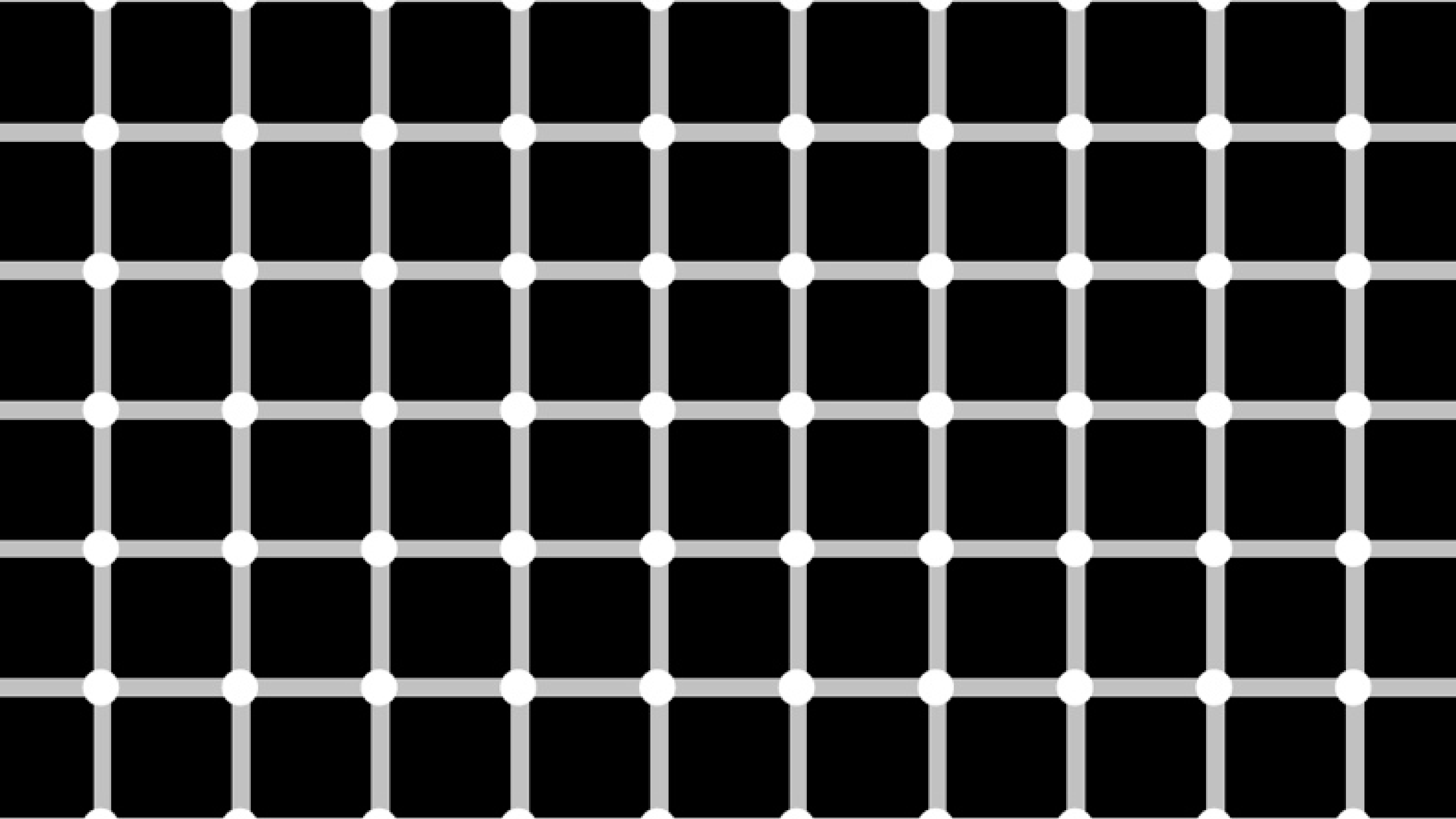
Still or moving?

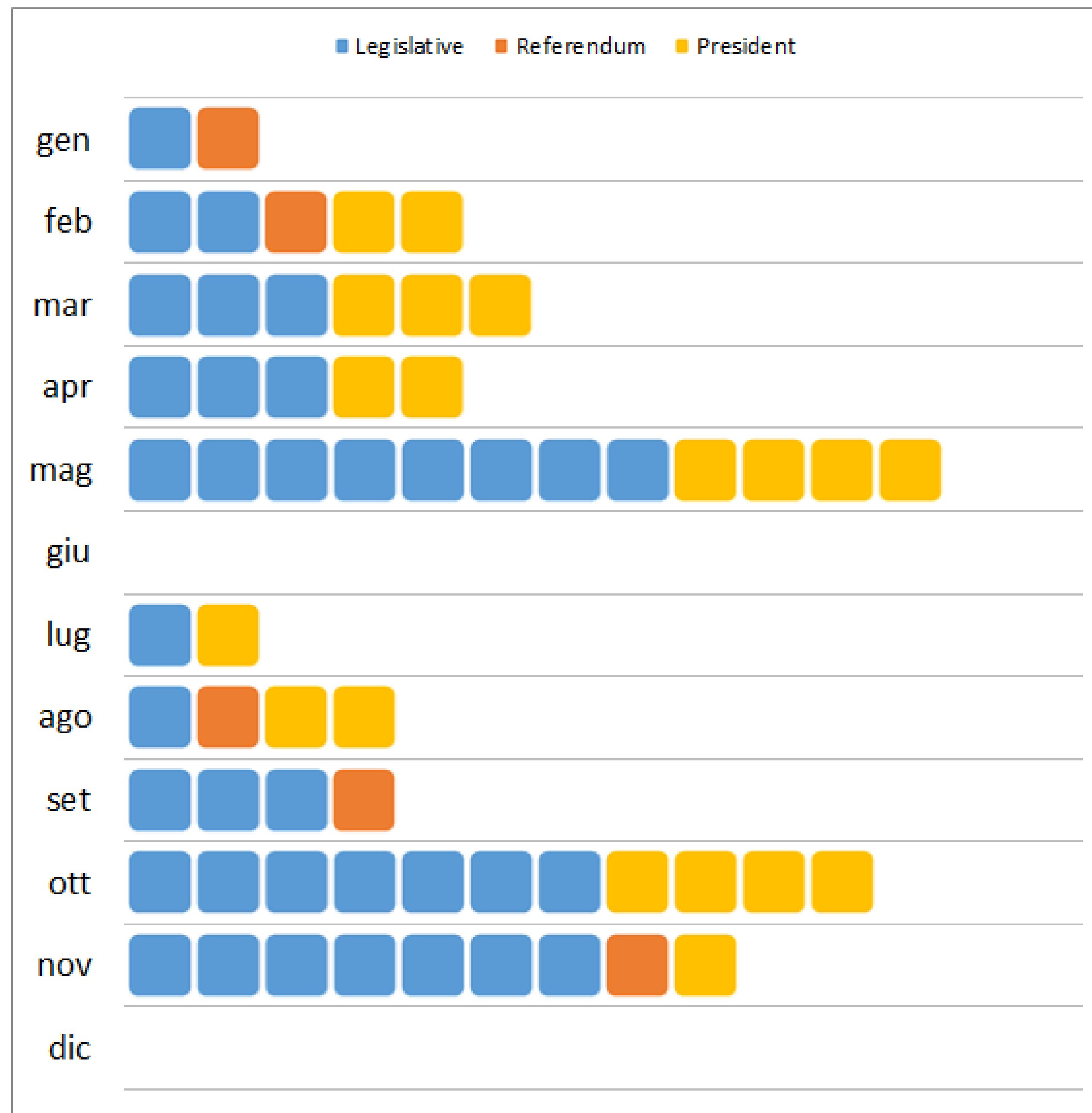


Shepherd's Table Illusion



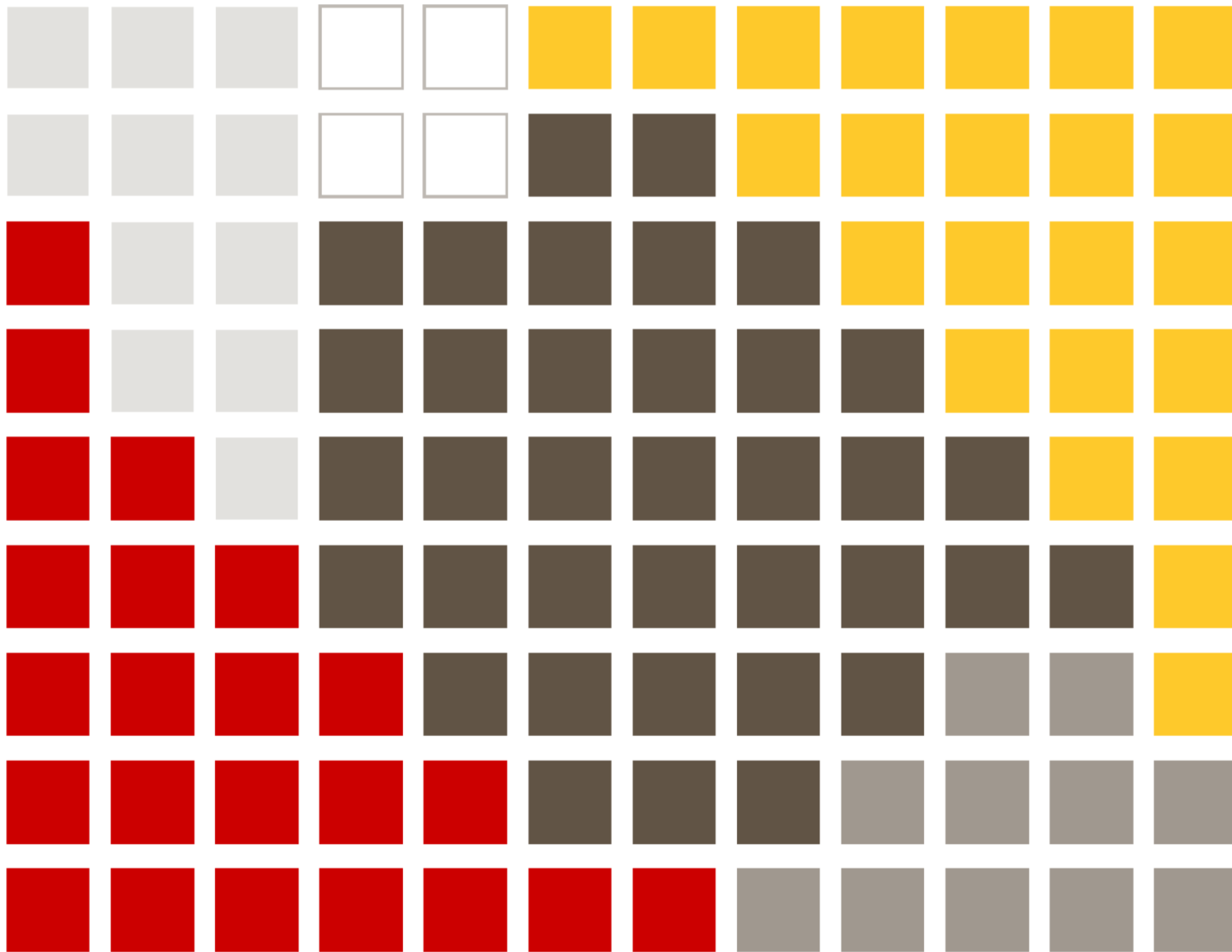
Illusion based on how we perceive depth/perspective...





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COURSE OPTIONS
TOWARD CCIS
MEANINGFUL
MINOR



- White square: Bouvé (4 courses)
- Red square: CAMD (23 courses)
- Light Gray square: COE (11 courses)
- Dark Gray square: COS (35 courses)
- Yellow square: CSSH (23 courses)
- Medium Gray square: 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



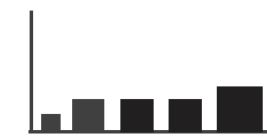
→ Separate



→ Order



→ Align



→ Use



→ Map

from **categorical** and **ordered** attributes

→ Color

→ Hue



→ Saturation



→ Luminance



→ Size, Angle, Curvature, ...



→ Shape



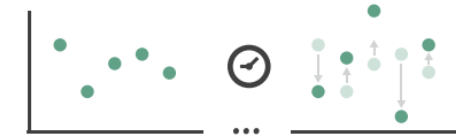
→ Motion

Direction, Rate, Frequency, ...



Manipulate

→ Change



→ Select



→ Navigate

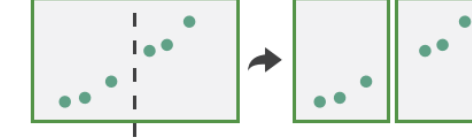


Facet

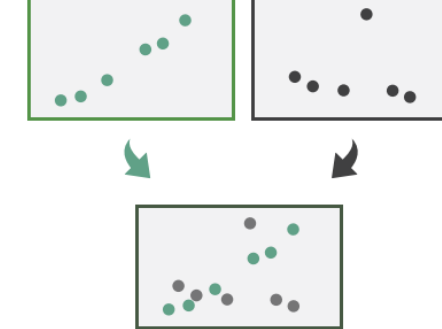
→ Juxtapose



→ Partition



→ Superimpose

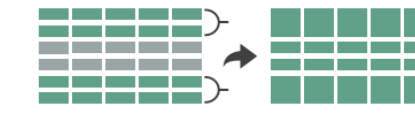


Reduce

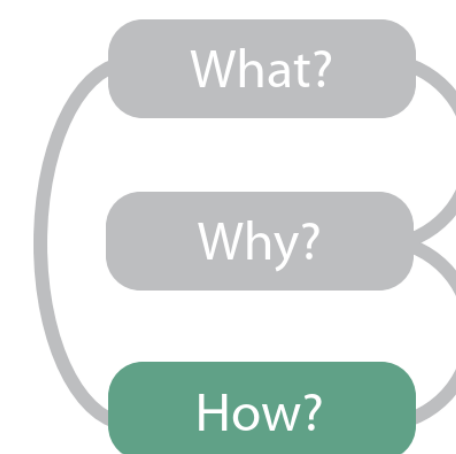
→ Filter



→ Aggregate

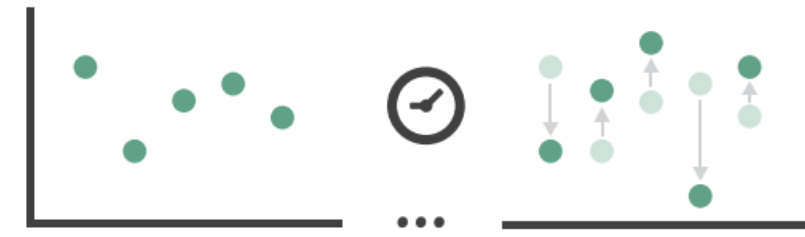


→ Embed

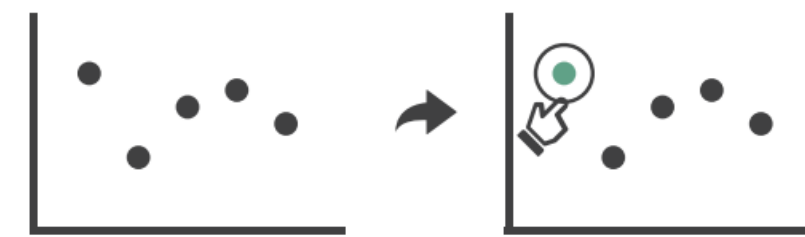


Manipulate

③ Change over Time



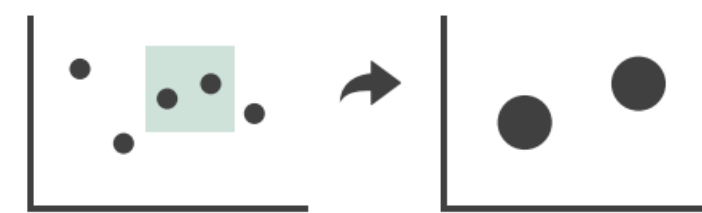
③ Select



③ Navigate

→ Item Reduction

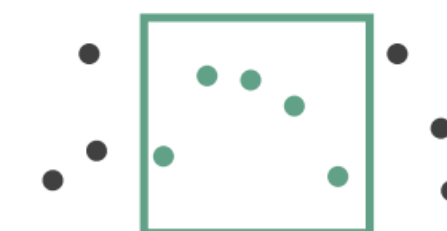
→ Zoom *Geometric or Semantic*



→ 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”



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

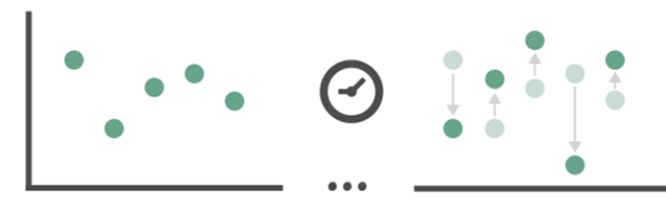
van Ham & Perer approach:

- 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.

Queries and Filtering

Manipulate

① Change over Time



② Select



③ Navigate

→ Item Reduction

→ *Zoom*
Geometric or Semantic



→ *Pan/Translate*



→ *Constrained*

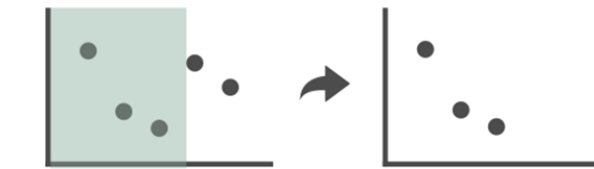


→ Attribute Reduction

→ *Slice*

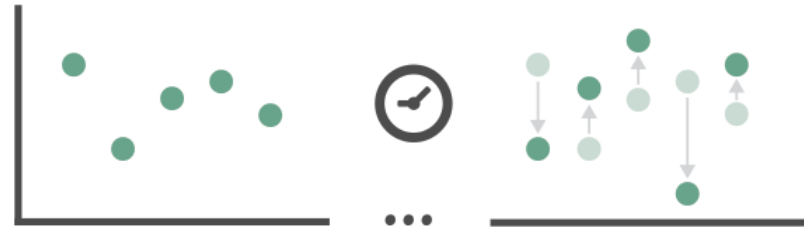


→ *Cut*



→ *Project*



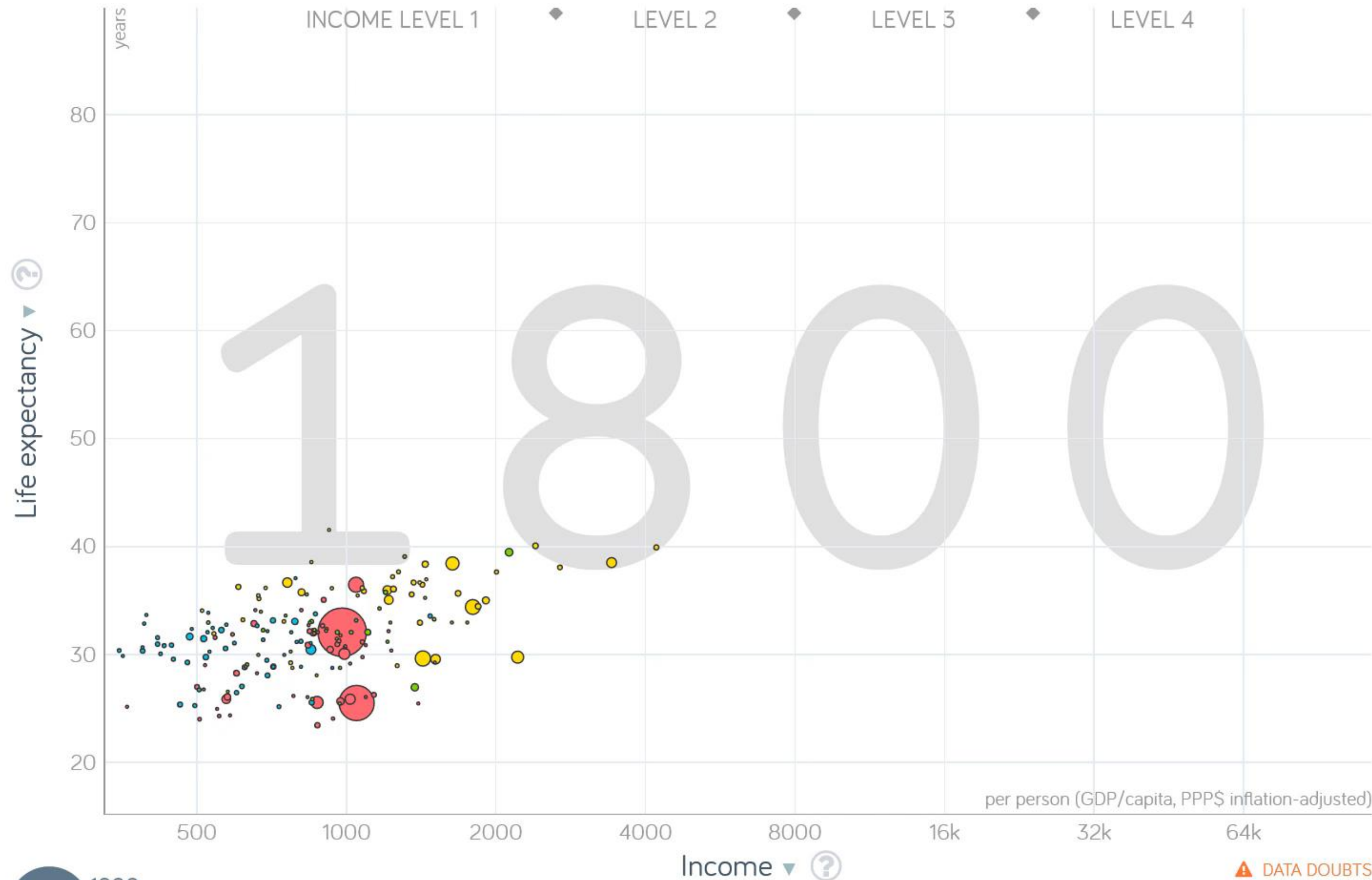


Gapminder Bubbles

Bubbles

FACTS TEACH ABOUT HOW TO USE

Share [Email] [Twitter] [Facebook] [Print] [Code] English



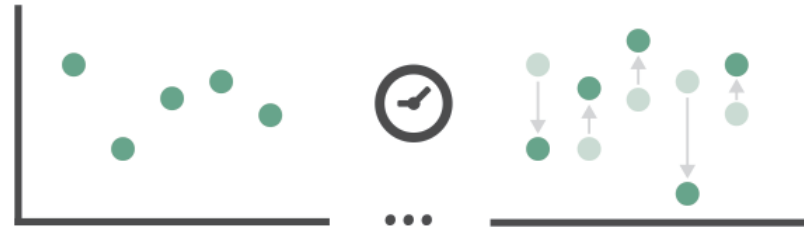
- Select Search...
- Afghanistan
 - Albania
 - Algeria
 - Andorra
 - Angola
 - Antigua and Barbuda
 - Argentina
 - Armenia
 - Australia
 - Austria

Size Population

Zoom [Cursor] [Zoom In] [Zoom Out] [Reset] 100%

OPTIONS PRESENT EXPAND

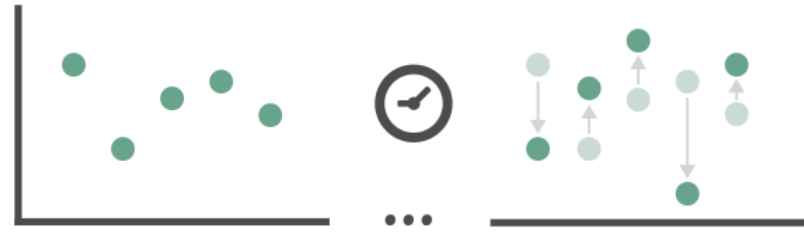
→ Change over Time



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

abcdefghijklmnopqrstuvwxyz

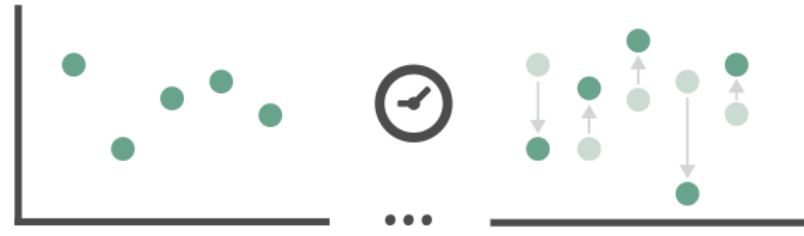
→ Change over Time



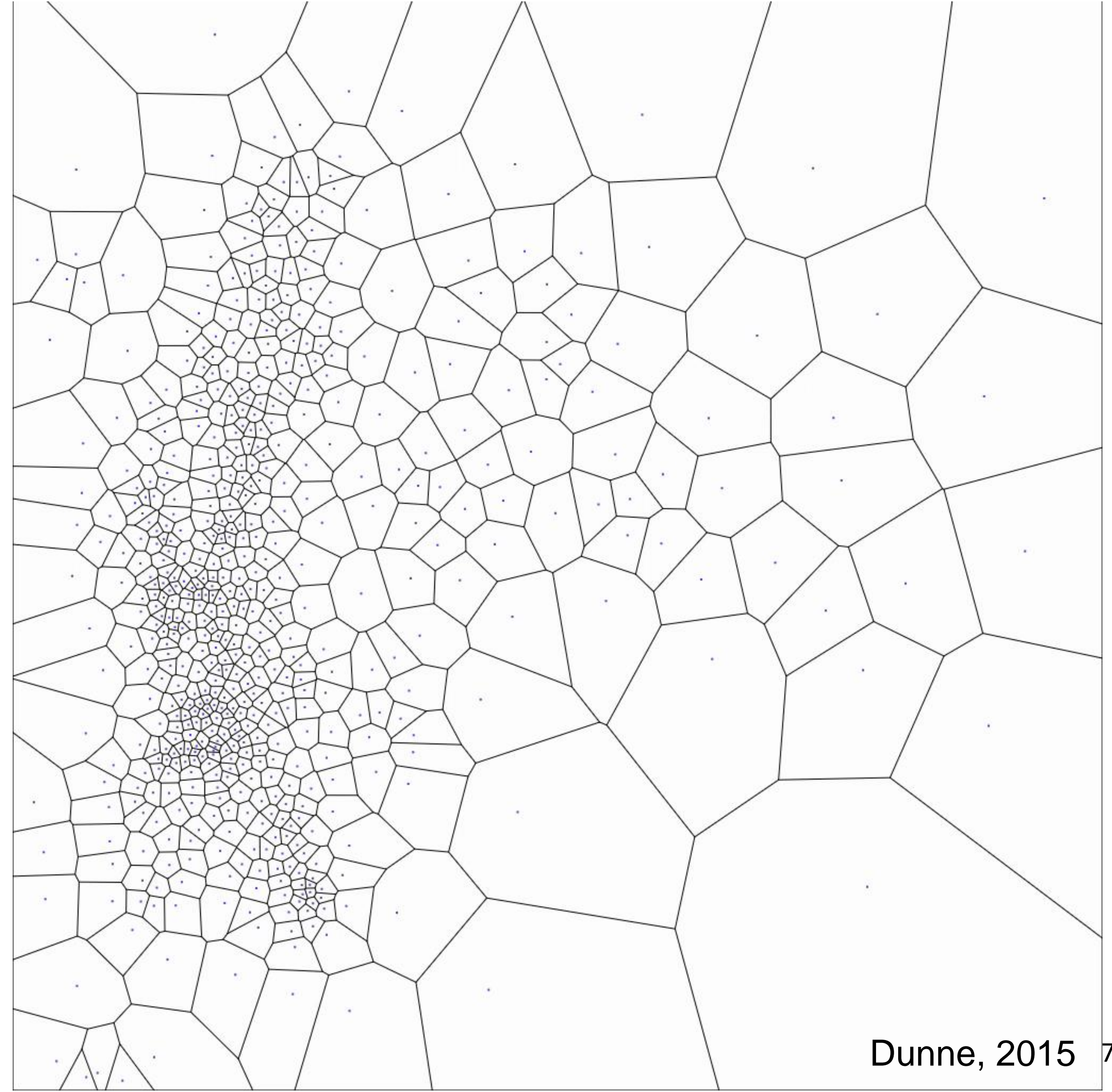
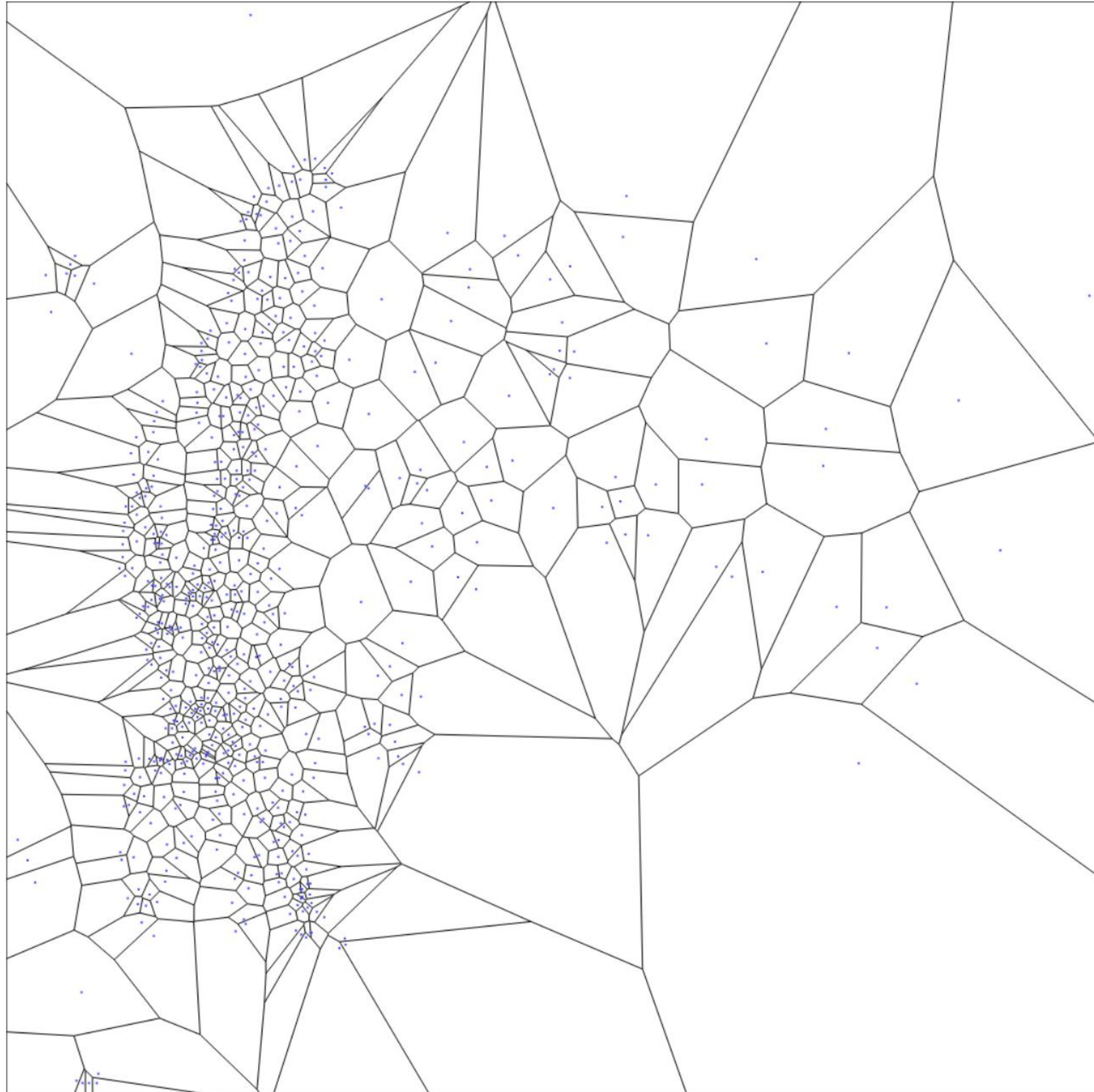
D3 Animated Transitions

flexible transitions

→ Change over Time



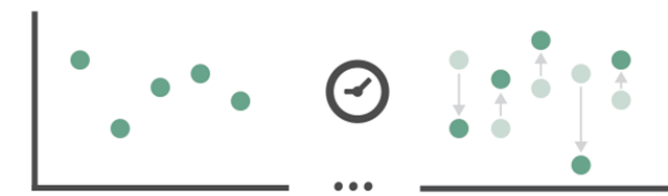
Centroidal Voronoi Tessellation



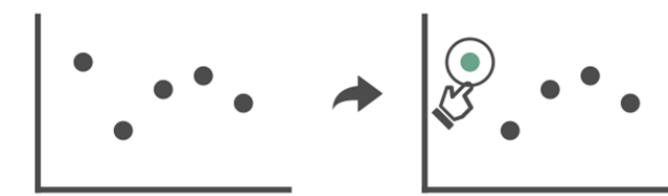
Queries and Filtering

Manipulate

② Change over Time



② Select



② Navigate

→ Item Reduction

→ Zoom
Geometric or Semantic



→ Pan/Translate



→ Constrained



→ Attribute Reduction

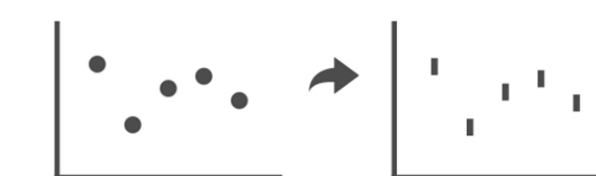
→ Slice



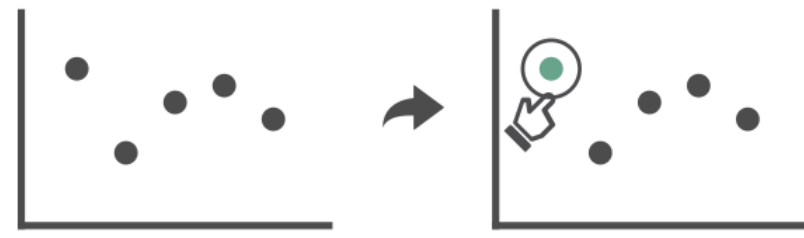
→ Cut



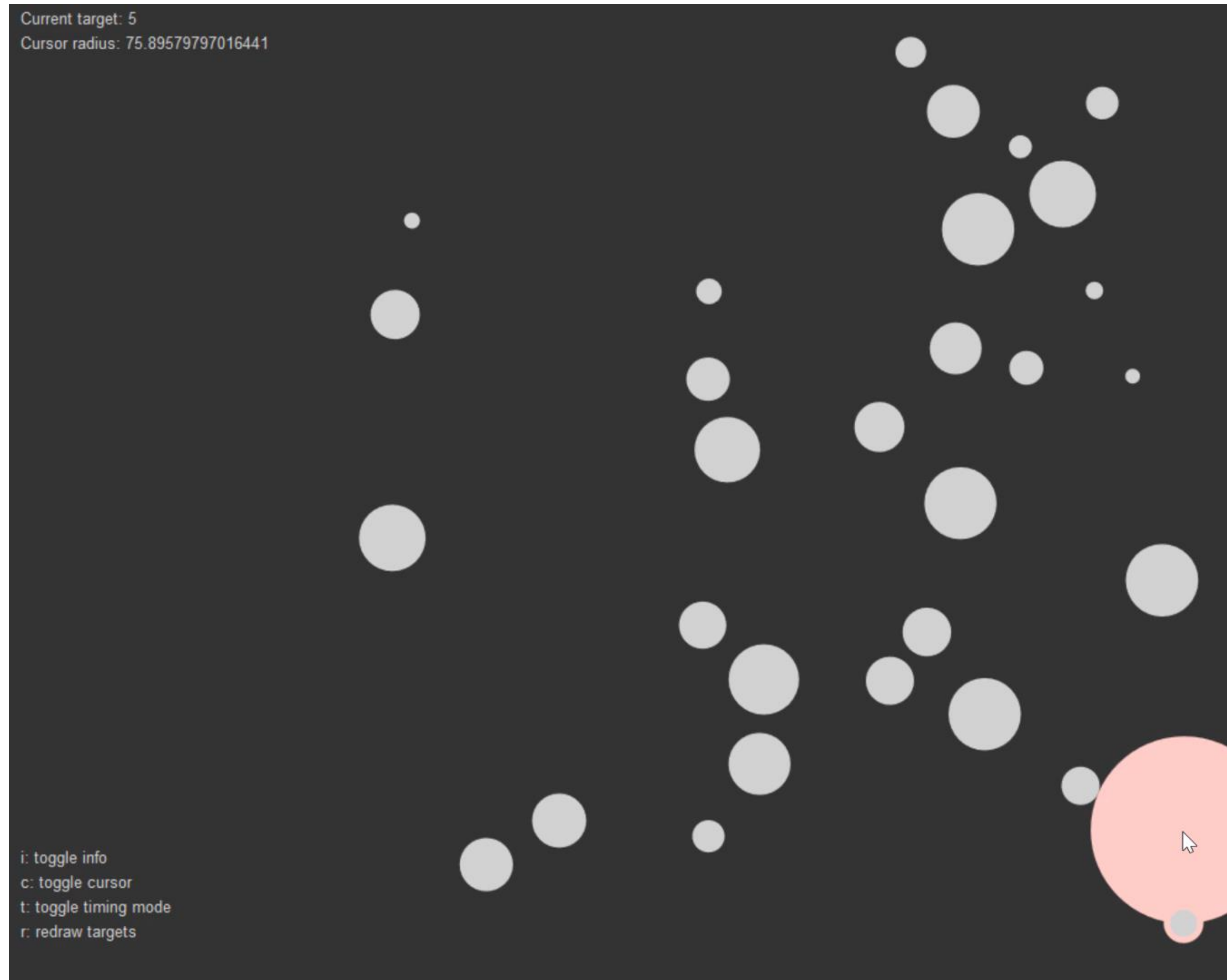
→ Project



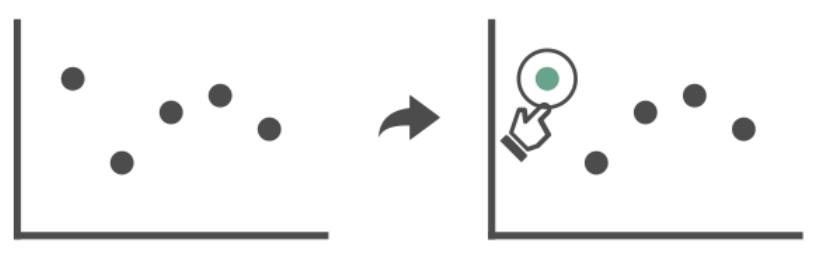
→ Select



Bubble Cursors



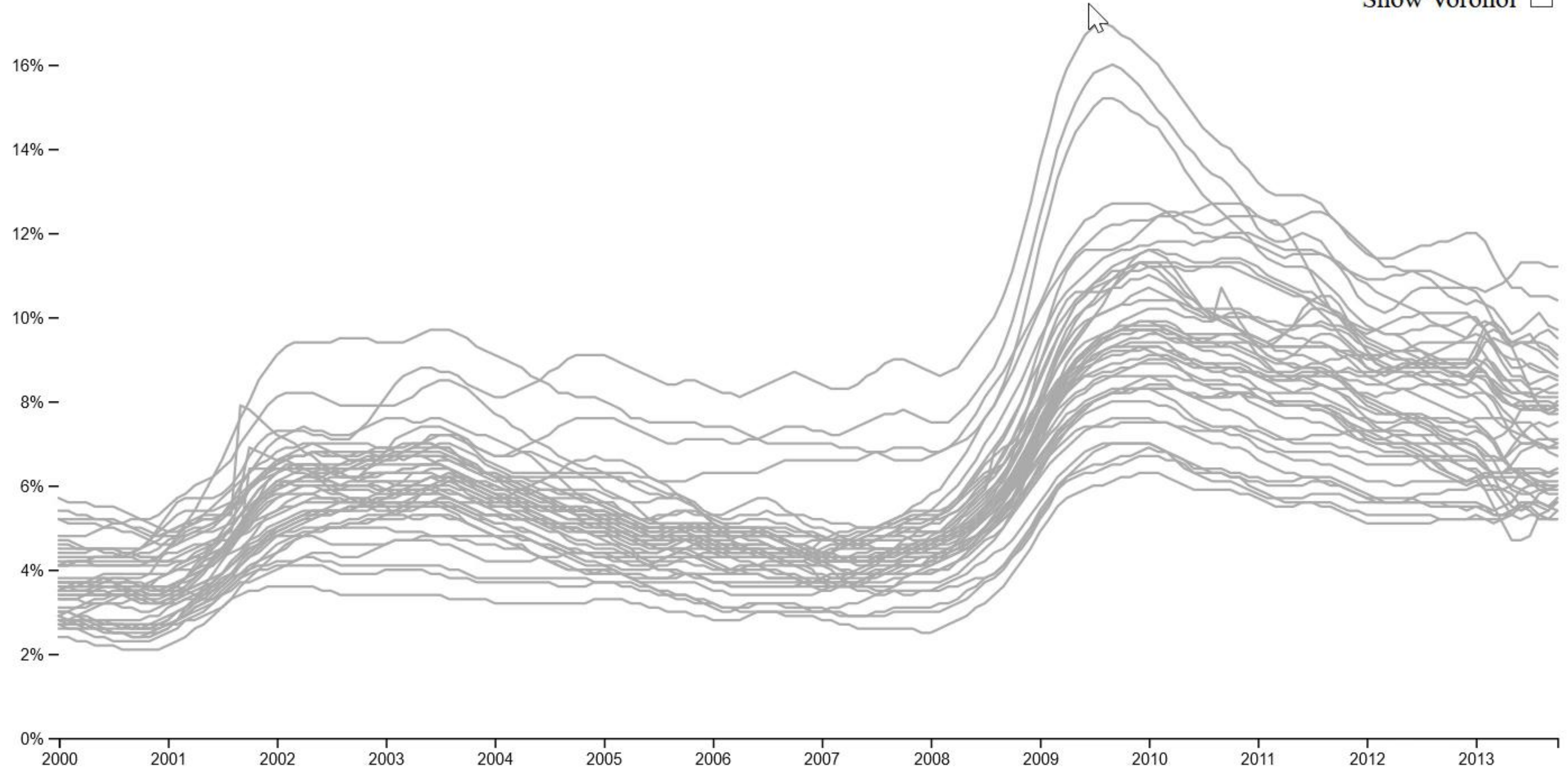
→ Select



Voronoi Cursors

18% – Unemployment Rate

Show Voronoi

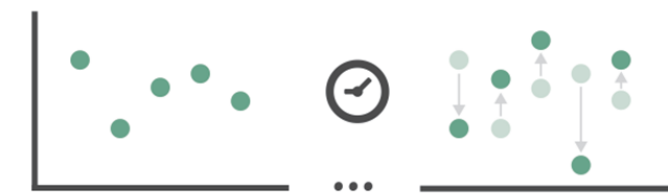


IN-CLASS EXERCISE

Queries and Filtering

Manipulate

② Change over Time



② Select



② Navigate

→ Item Reduction

→ *Zoom*
Geometric or Semantic



→ *Pan/Translate*



→ *Constrained*



→ Attribute Reduction

→ *Slice*



→ *Cut*



→ *Project*



→ Navigate

→ Item Reduction

→ Zoom

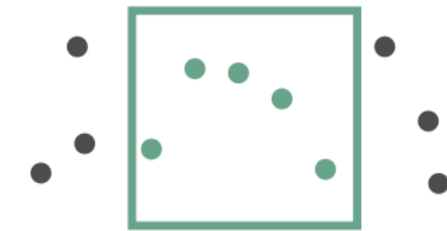
Geometric or Semantic



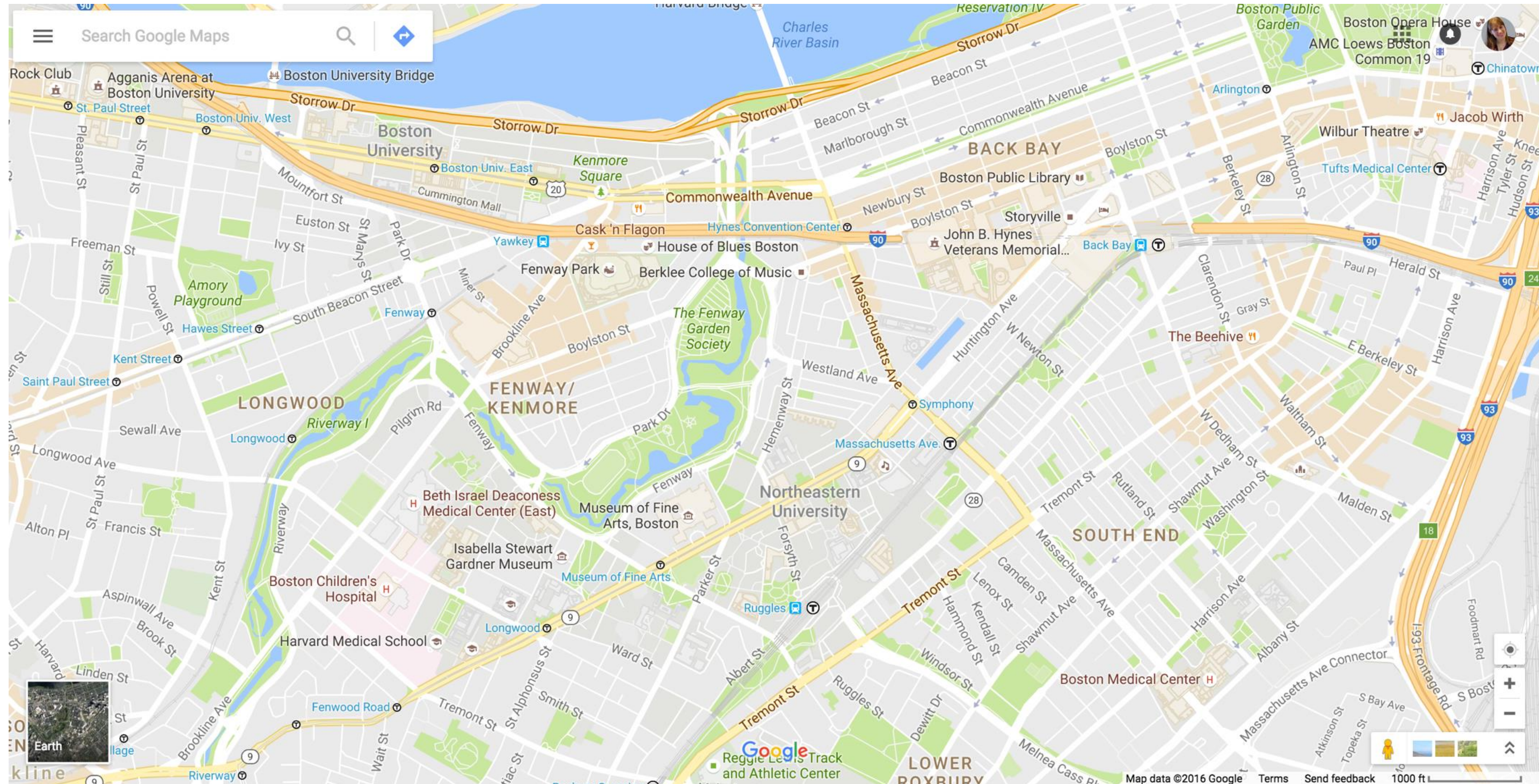
→ Pan/Translate



→ Constrained



Navigation



Google Maps, 2020



IN-CLASS EXERCISE

Zoom techniques

In-class activity:
experiment with
zooming and panning

easypz.io



EasyPZ Pan & Zoom </> JS Library 💡 Research

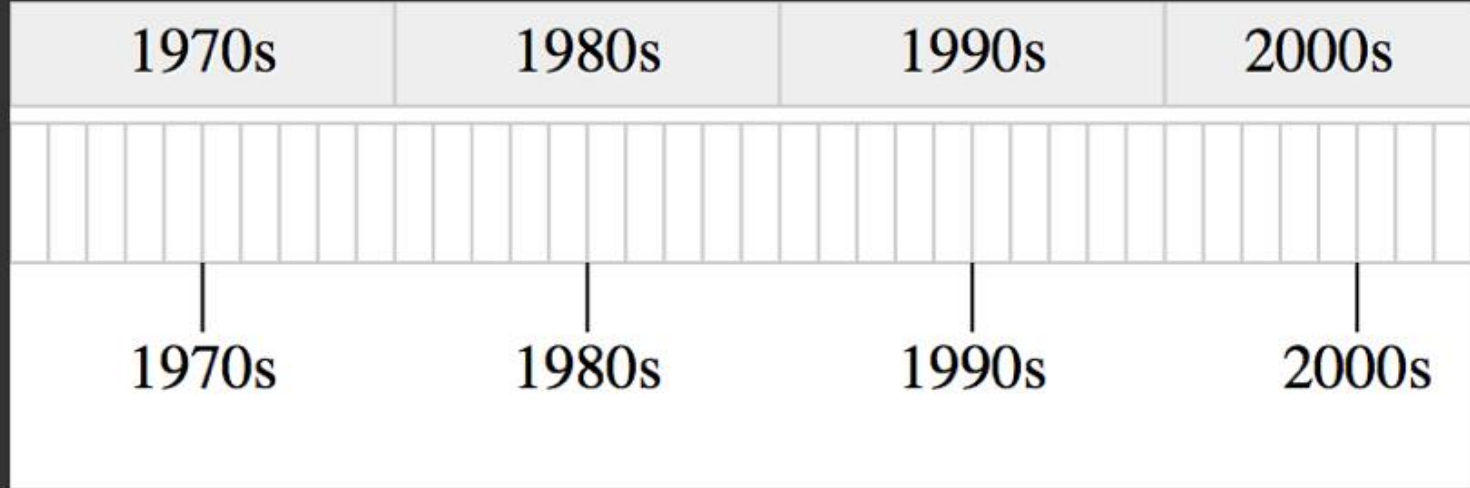
</> JS LIBRARY

Pan & Zoom How You Want - Try it!

» Standard
Flick Pan + Double Click, Wheel & Pinch Zoom

These methods are pretty standard. Flick pan means that the content keeps its momentum when you release the pointer, and then slows down. You can also zoom out with double right click.

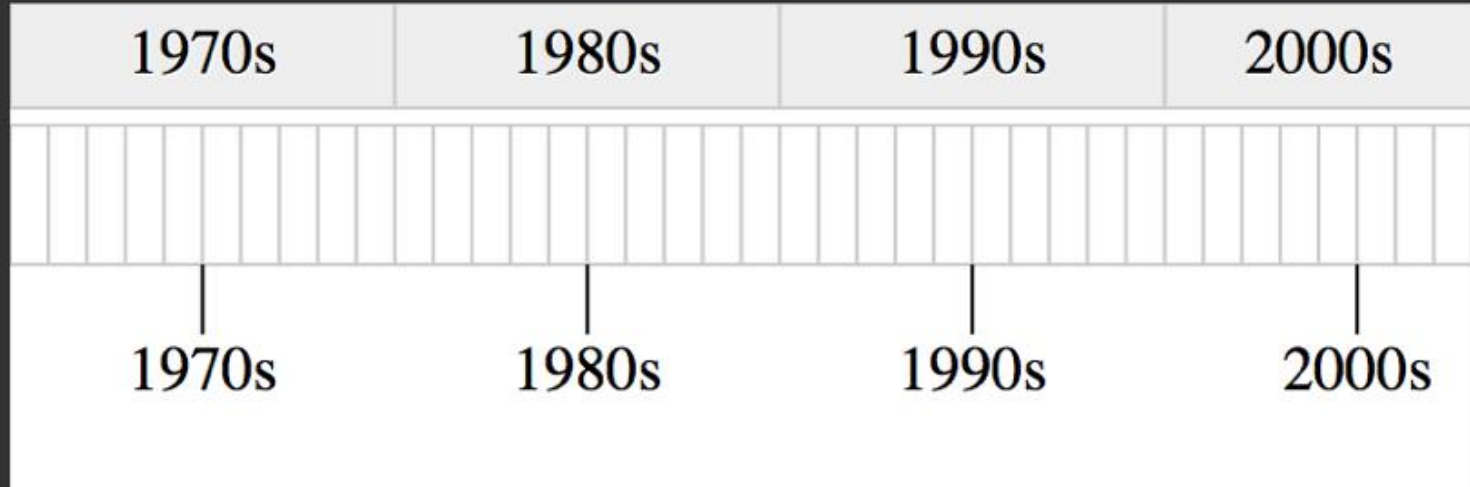
Show Code



» For the Lazies
Flick Pan + Hold Zoom In + Double Click Zoom Out

Hold zoom in requires much less work to zoom in, particularly when compared against pinching on mobile devices. Notice that you can adjust the zoom position while zooming.

Show Code

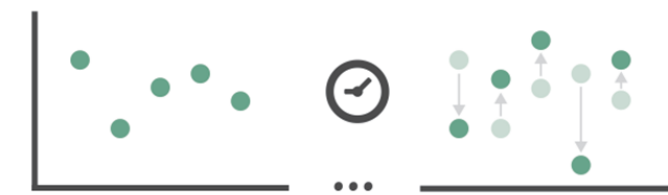


[Michail Schwab](#)
PhD student
Khoury Data Visualization

Queries and Filtering

Manipulate

② Change over Time



② Select



② Navigate

→ Item Reduction

→ Zoom
Geometric or Semantic



→ Pan/Translate



→ Constrained



→ Attribute Reduction

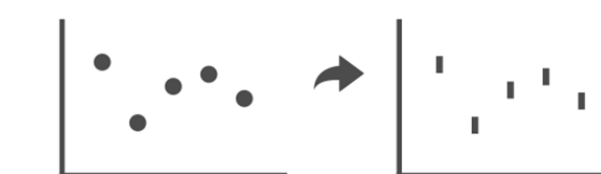
→ Slice



→ Cut



→ Project



→ Attribute Reduction

→ *Slice*



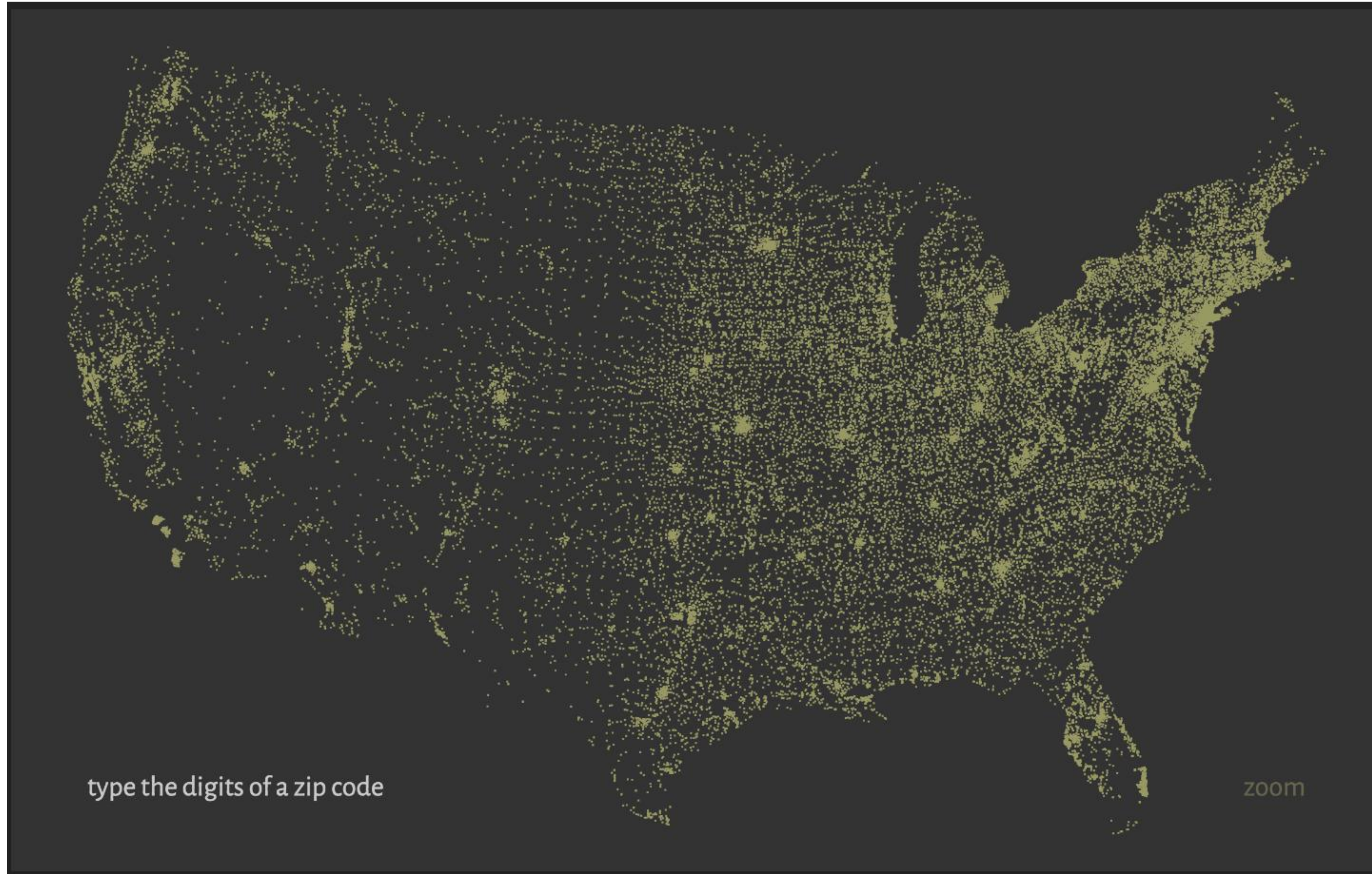
→ *Cut*



→ *Project*



Queries and Filtering



[Ben Fry, 2014](#)



→ Slice



→ Cut



→ Project



Queries and Filtering

KAYAK Hotels Flights Cars Packages Activities More ▾

BOS ↔ WAS | Oct 14 → Oct 20 | Economy | 1 traveler | [Change](#)

2614 of 5112 flights | Friday | Thursday | cabin | traveler

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

\$253 Relax your legs, not your standards. The most legroom in coach. (Based on the average fleet-wide se... **jetBlue**

[View Deal](#) \$253 nonstop [Select](#) JetBlue.com Ad

\$132 Hacker Fare **spirit** Spirit Airlines / United

[View Deal](#) 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](#) 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.

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

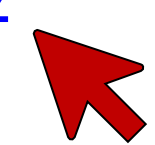
Show landing times ▾

Airports

- Depart/Return same

Boston

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



→ Attribute Reduction

→ *Slice*



→ *Cut*



→ *Project*

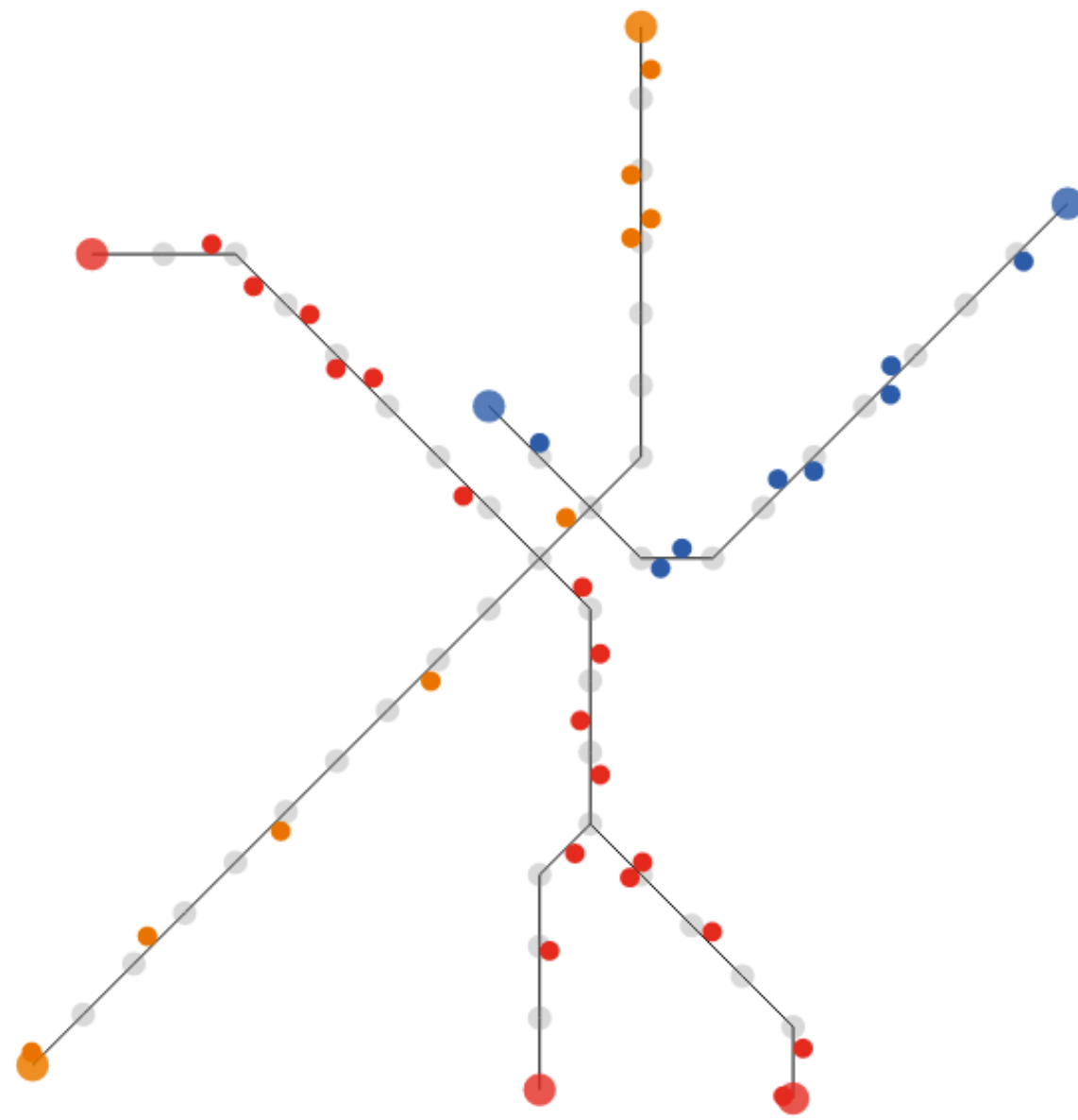


Projection



IN-CLASS EXERCISE

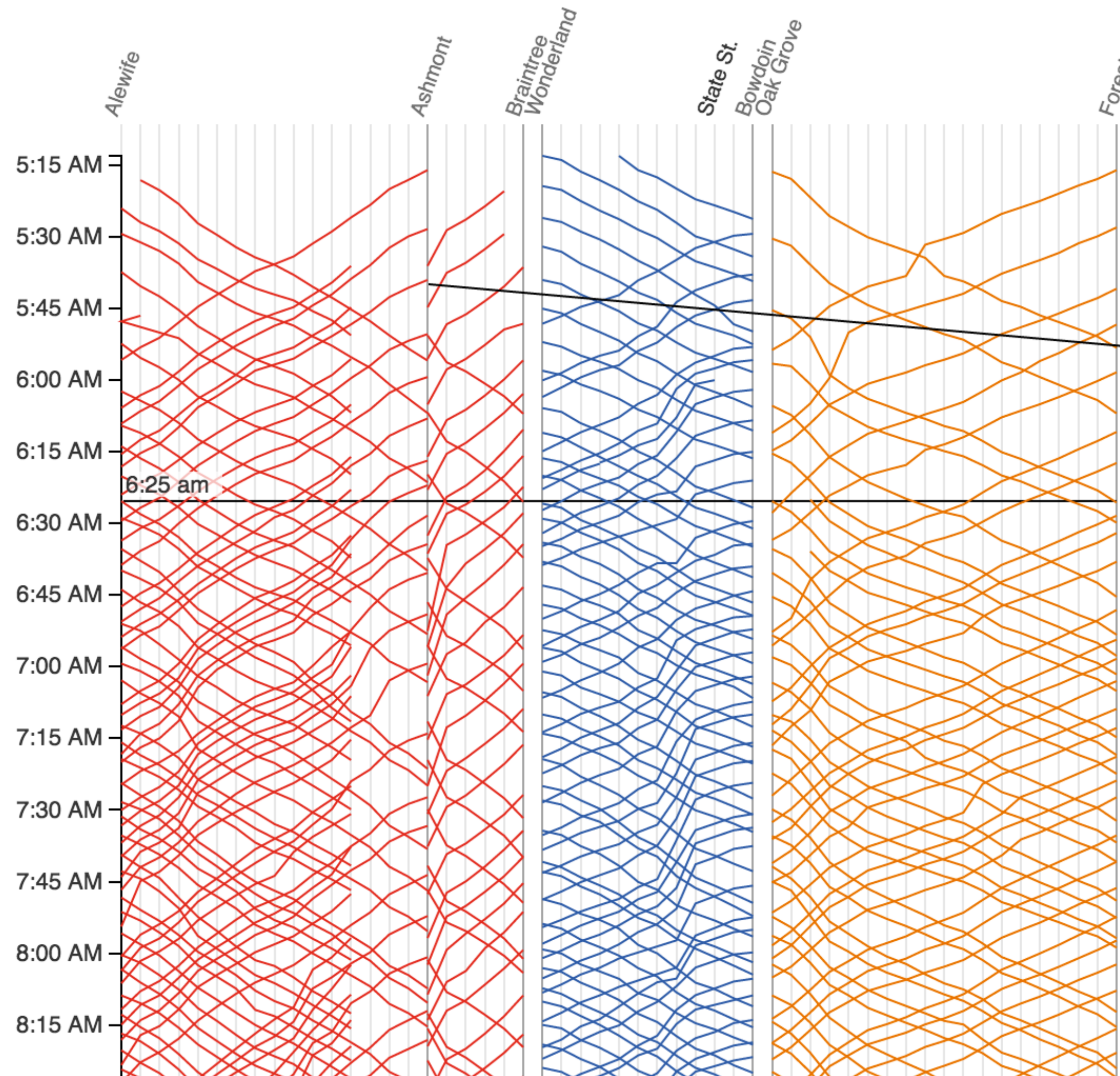
MBTAVis: Excellent WPI course final project



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.

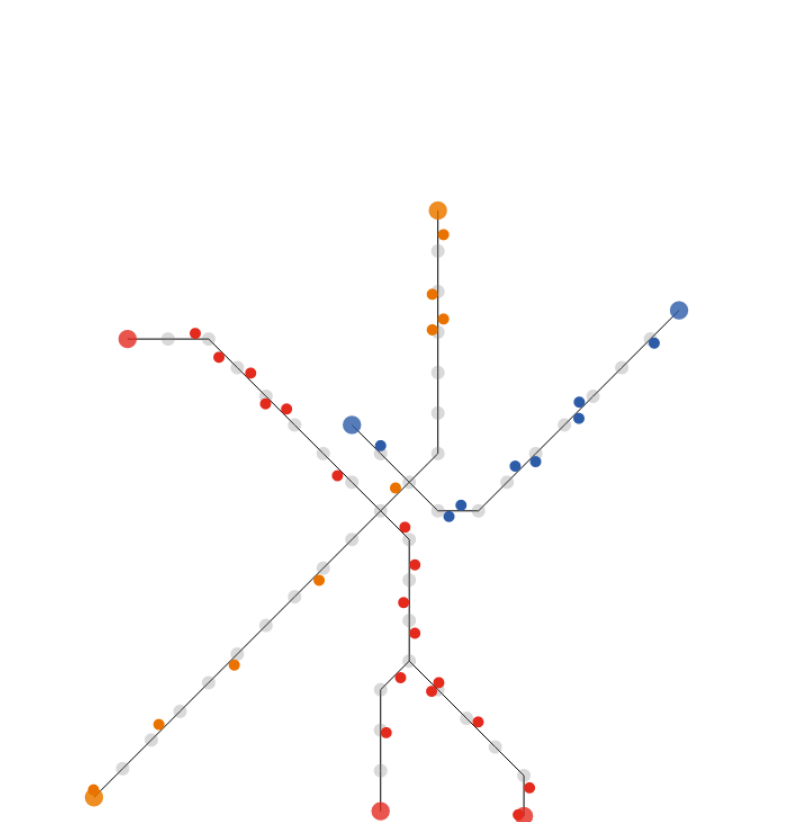
Train frequency increases around 6:30AM as morning rush hour begins.



In-Class Critique — MBTAVis

15m

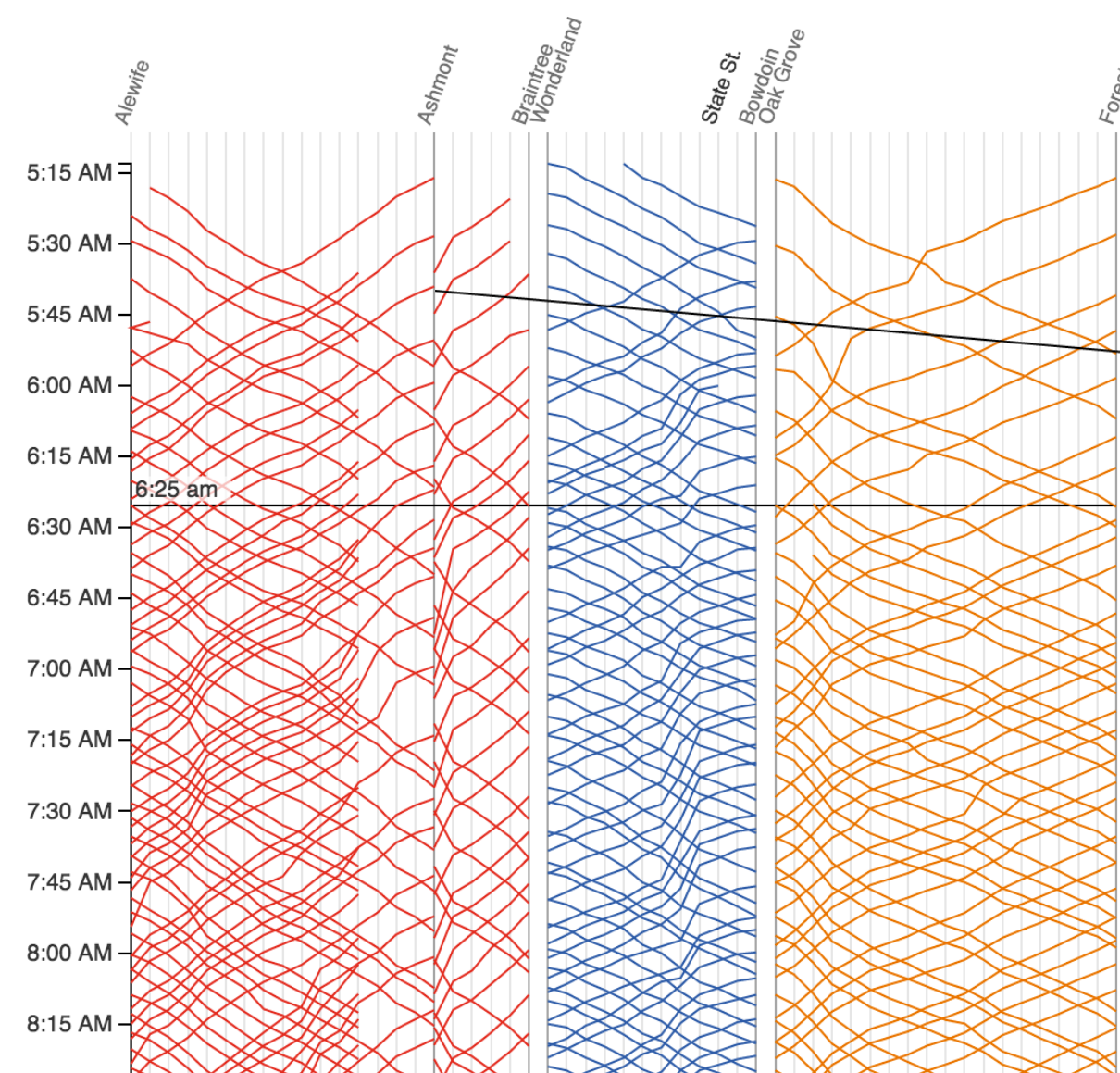
In-Class Critique — MBTAVis



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.

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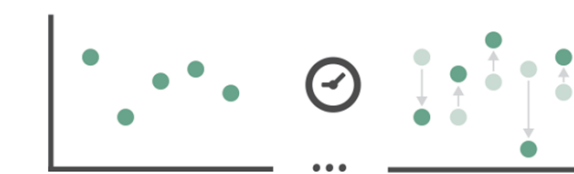
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Train frequency increases around 6:30AM as morning rush hour begins.

Manipulate

① Change over Time



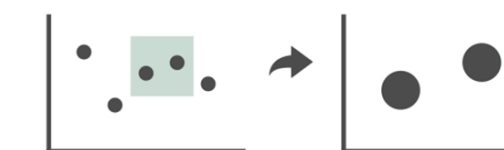
② Select



③ Navigate

→ Item Reduction

→ Zoom
Geometric or Semantic



→ Pan/Translate



→ Constrained



→ Attribute Reduction

→ Slice



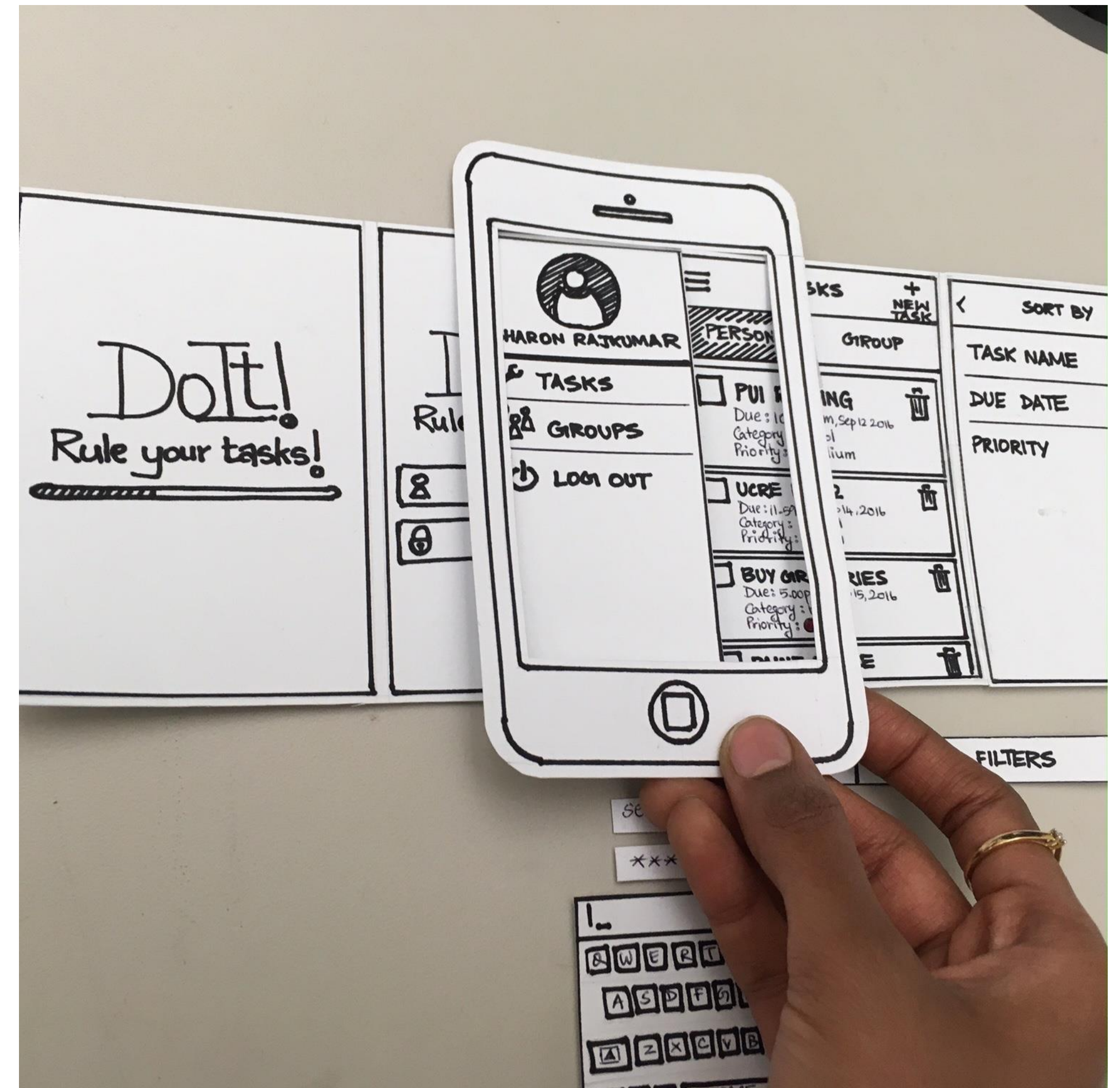
→ Cut



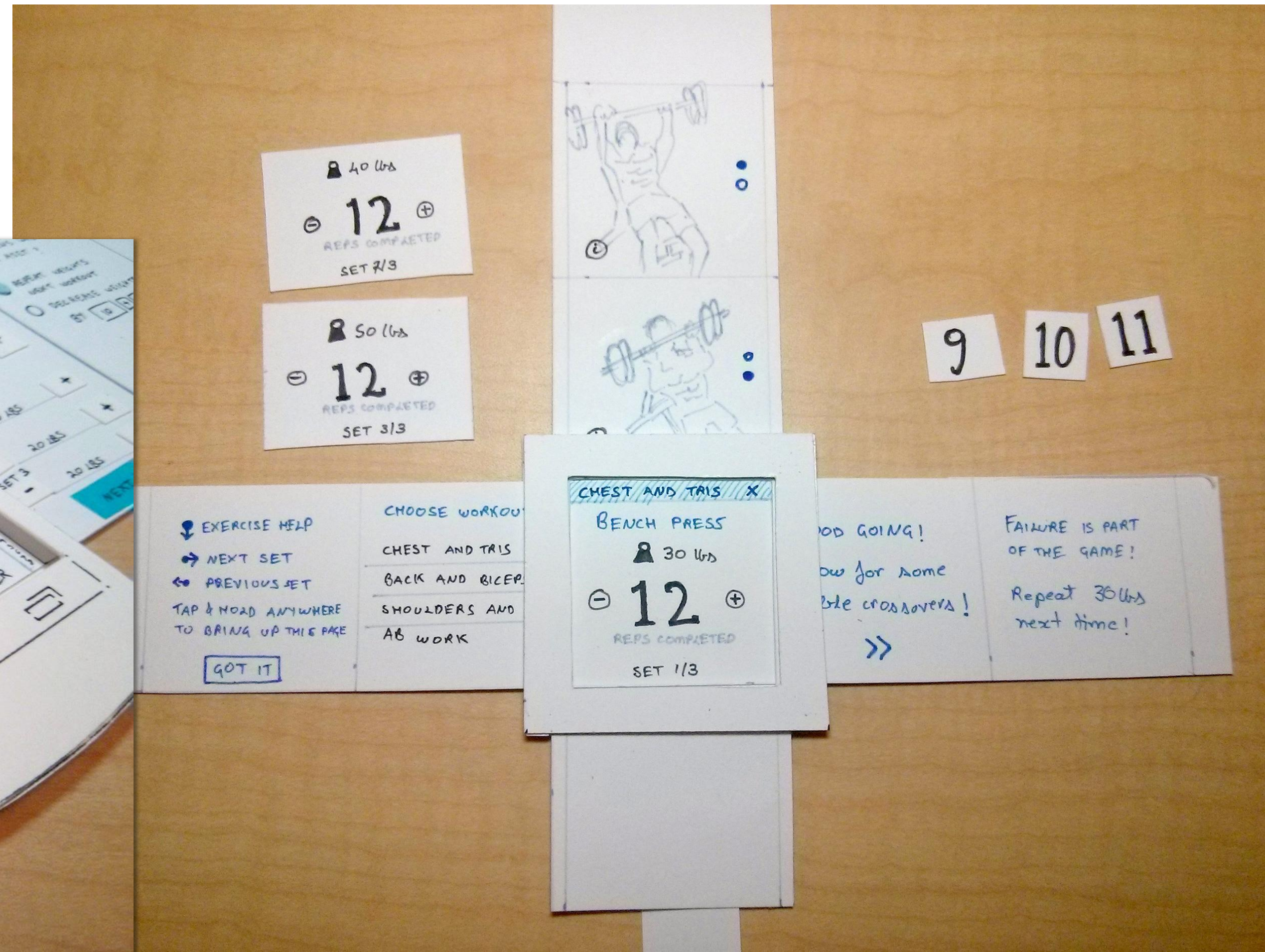
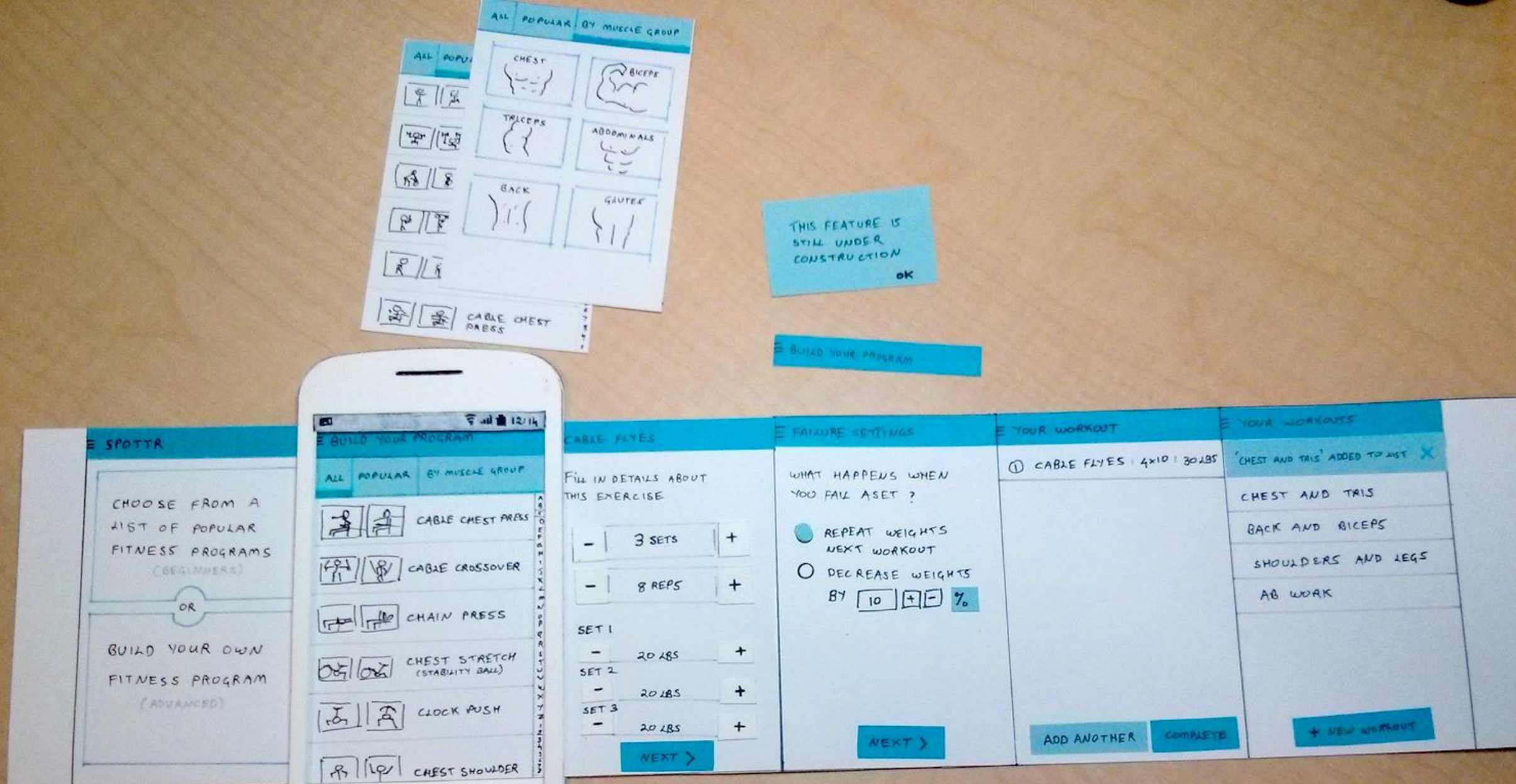
→ Project



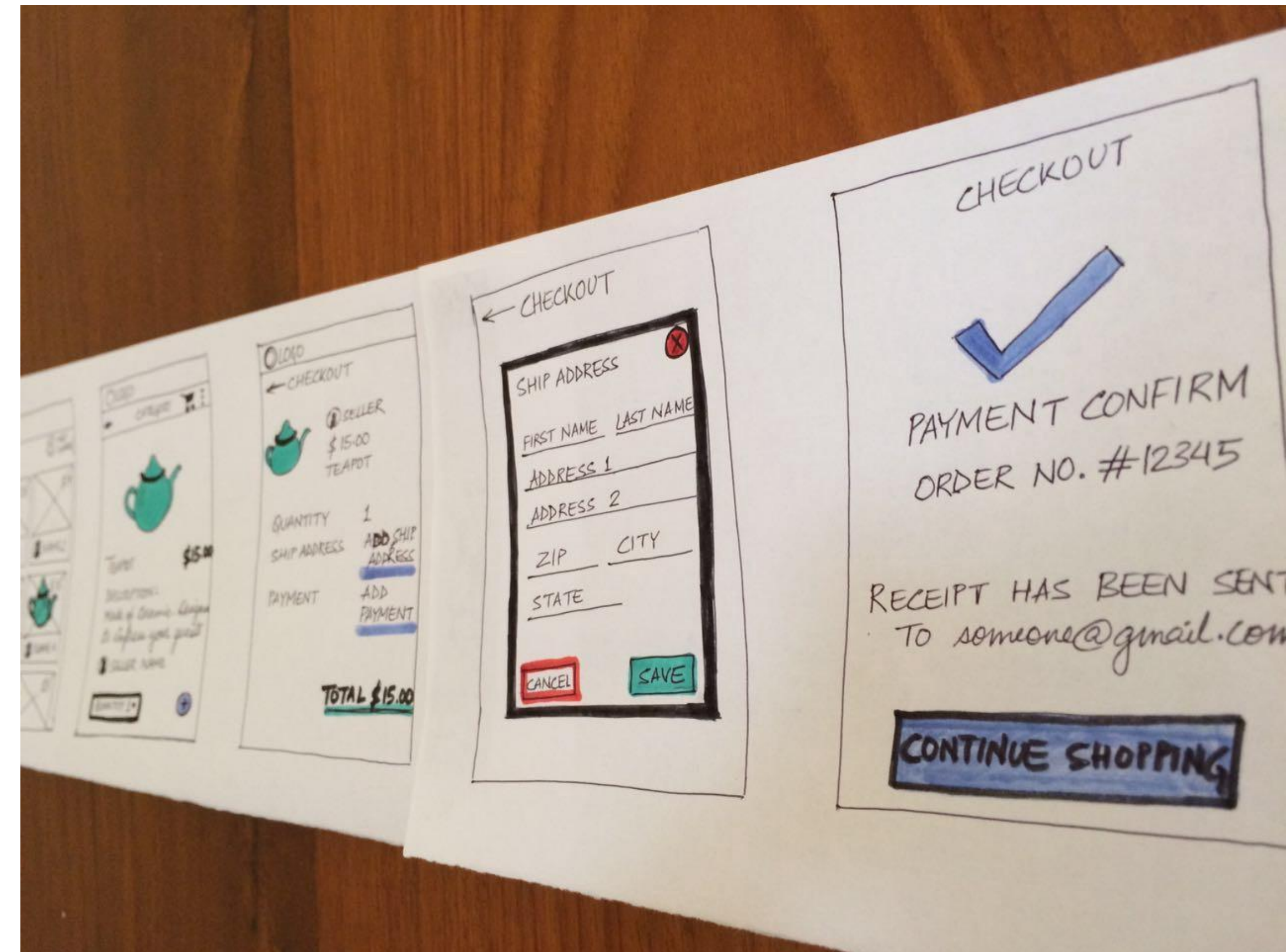
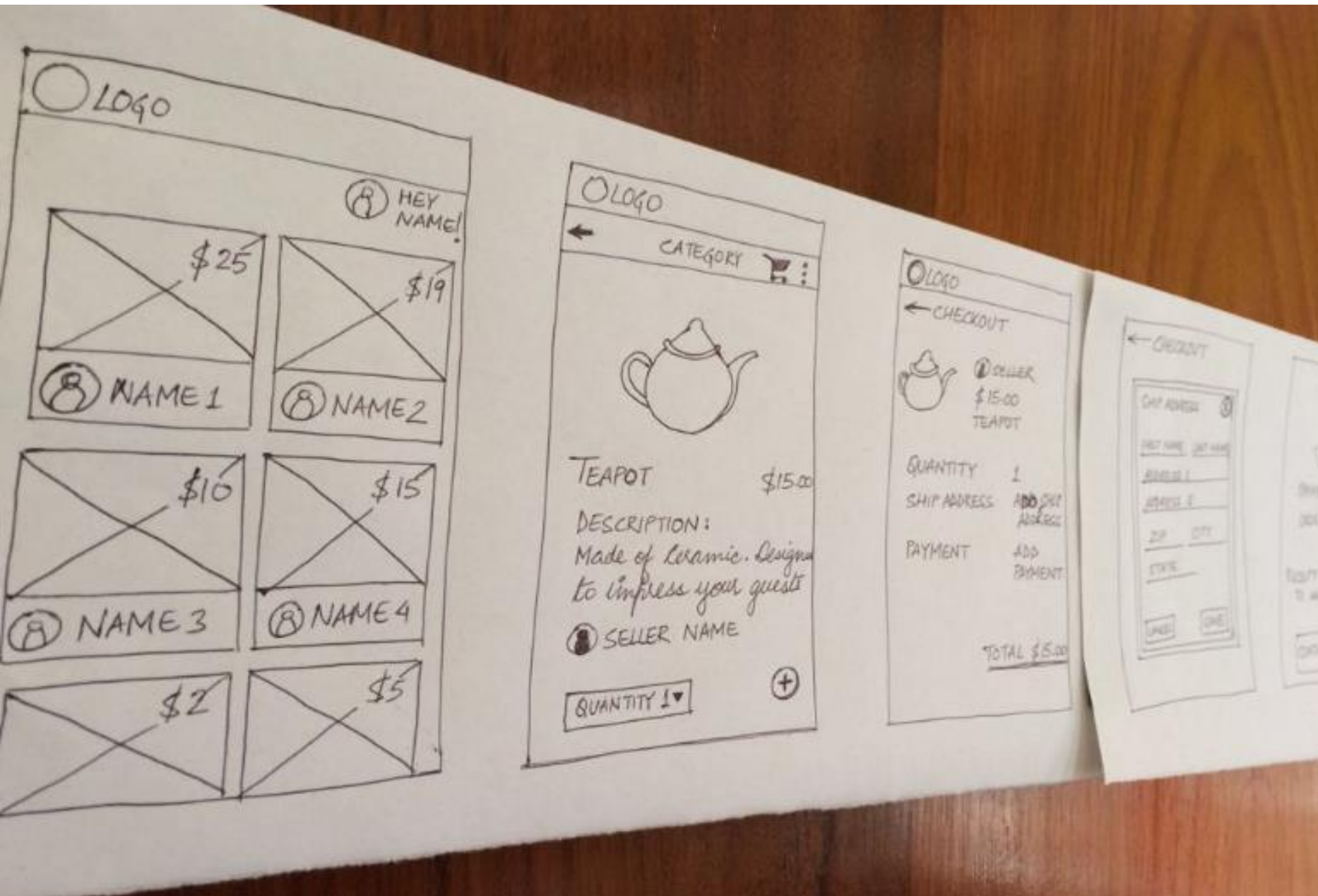
Paper Prototyping



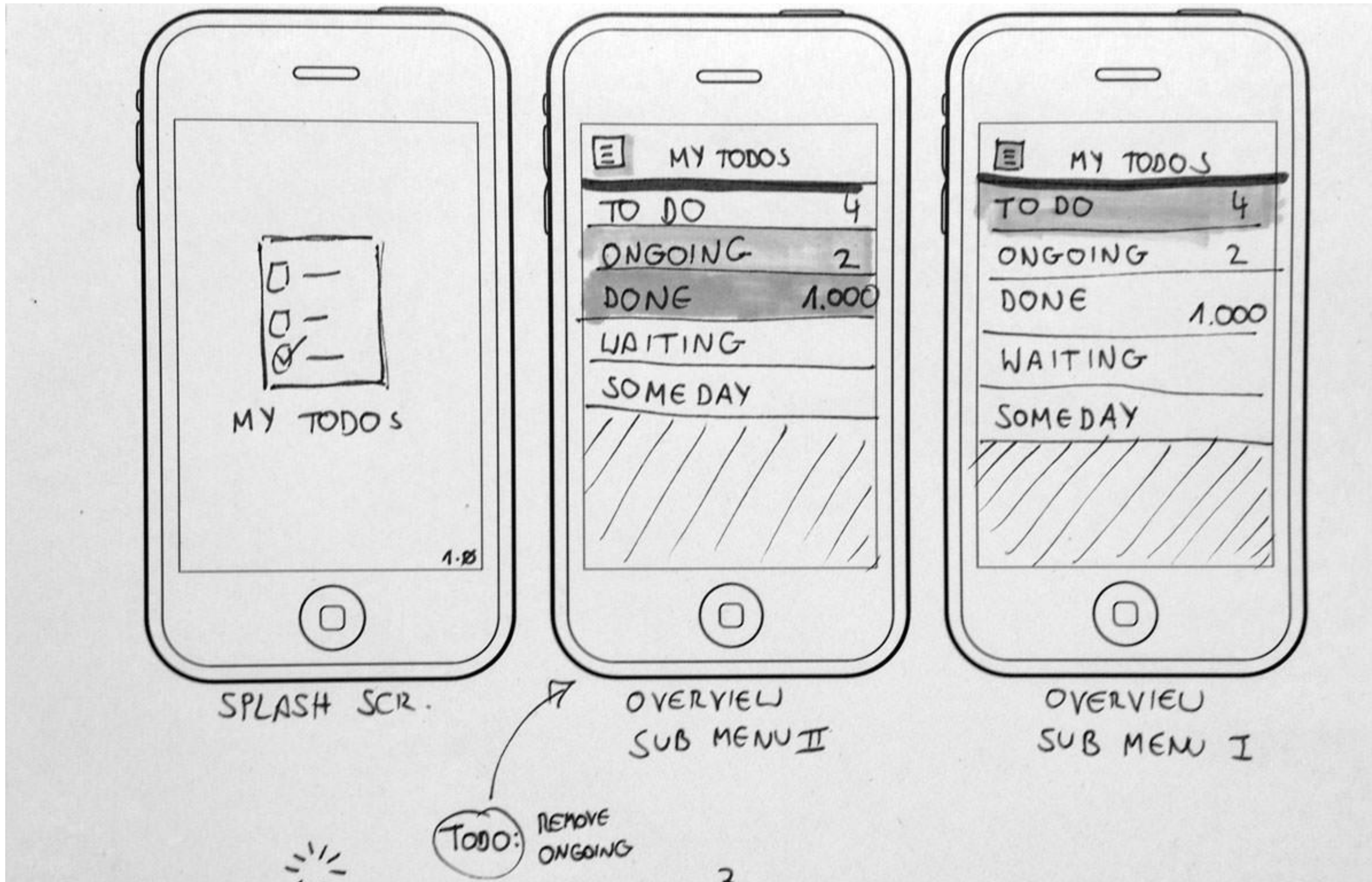
Paper Prototyping



Low Fidelity to High Fidelity



Sketching of Interactivity



Example Usability Test with a Paper Prototype



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.