Animation

DSC 106: Data Visualization

Sam Lau

UC San Diego

Announcements

Final project prototype due Friday.

All OHs are project OHs, starting this week.

FAQs:

1. How does the final project grade breakdown work? 40% total:

   3% proposal, 7% prototype, 15% video, 15% final submission.

Final Project Prototype

Requirements:

Working web page with visualization, at least one interaction working, and basic descriptive text.

Graded on completion.

Implementing Interactions in D3 and Svelte

Example: Name Grapher

`js-lecture/name-grapher/components/NameGrapher01.svelte`

(demo)

Example: Adding filtering to Name Grapher

`js-lecture/name-grapher/components/NameGrapher02.svelte`

(demo)

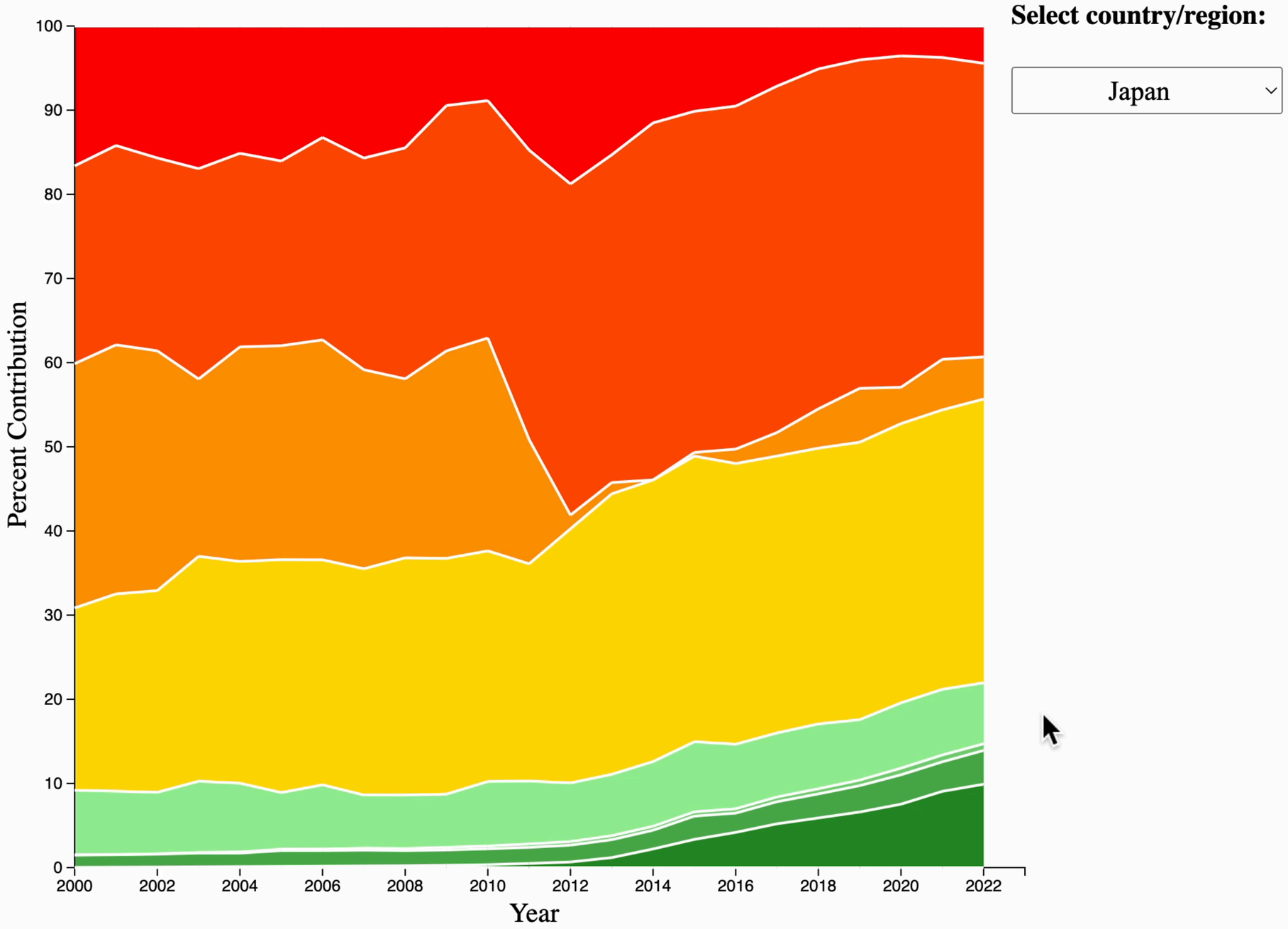
Example: Adding a tooltip to Name Grapher

`js-lecture/name-grapher/components/NameGrapher03.svelte`

(demo)

Neat Project 3 submissions!

Where has **Japan** been getting its electricity from in the 21st century?



Saathvik Dirisala,
Tyler Kurpanek

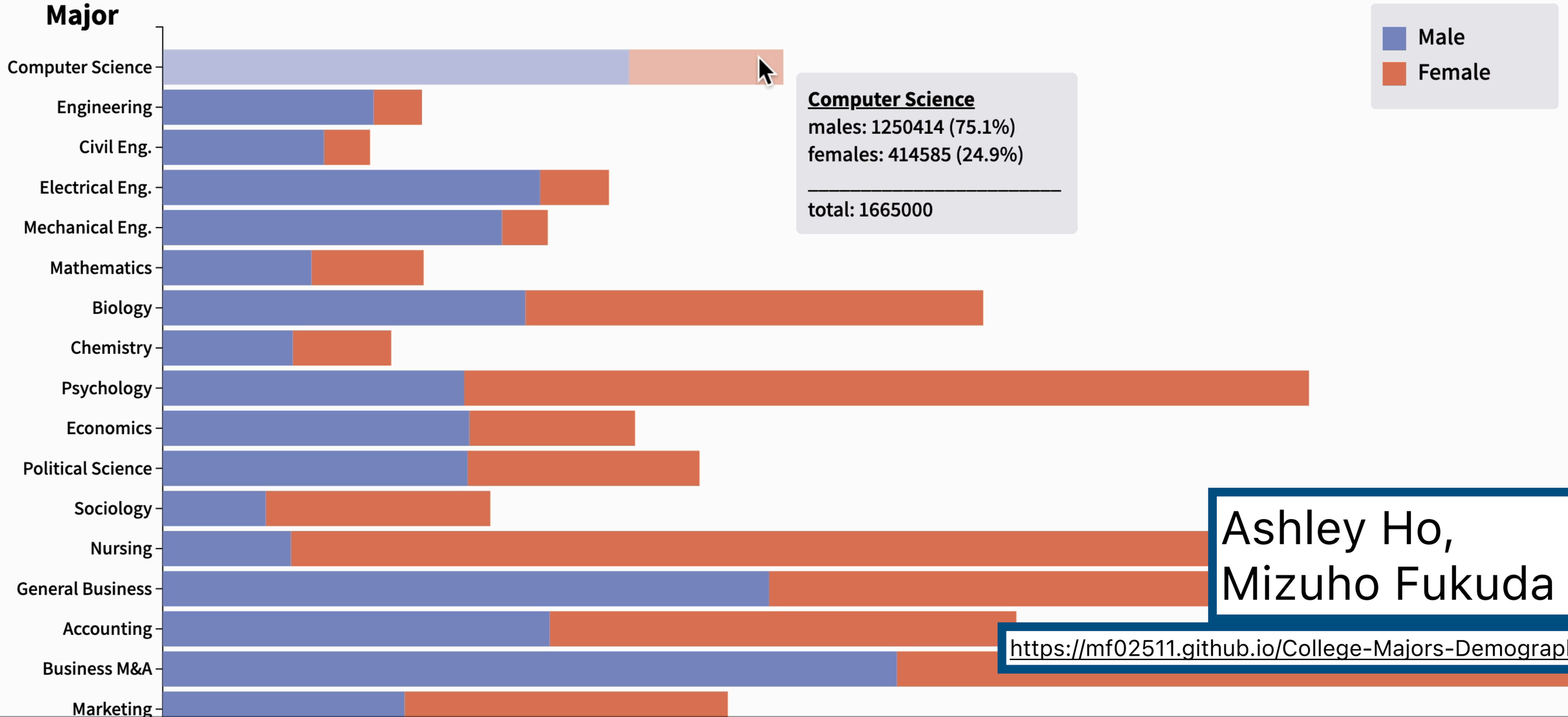
https://saathvikpd.github.io/project3_1/

College Majors in the U.S. Workforce by Demographic (2022)

read more about this visualization

data source: 2022 ACS Detailed Field of Degree and Median Annual Earnings

Gender | Race | Age



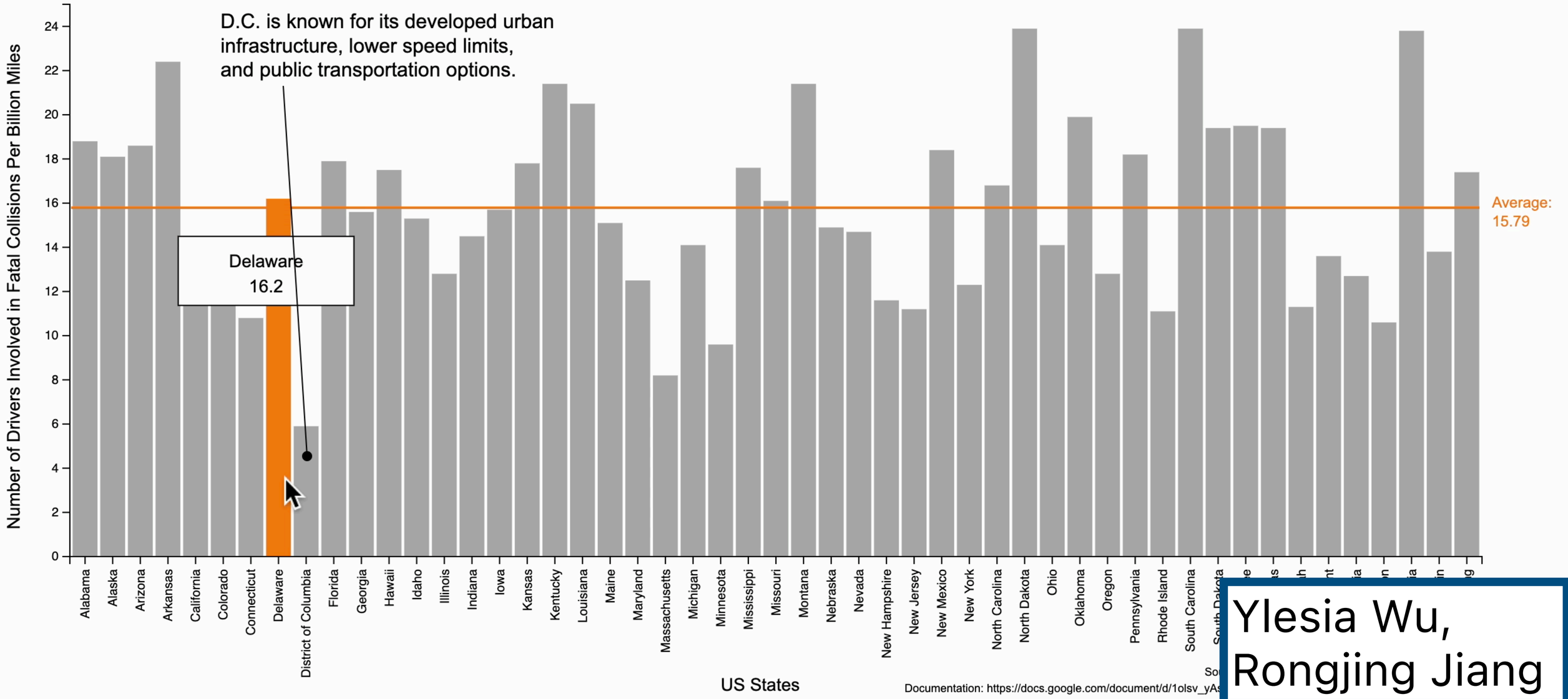
Ashley Ho,
Mizuho Fukuda

https://mf02511.github.io/College-Majors-Demographics/

Total Number | Speeding | Alcohol | Not Distracted | No Previous Accident

Good Drivers? Bad Drivers?

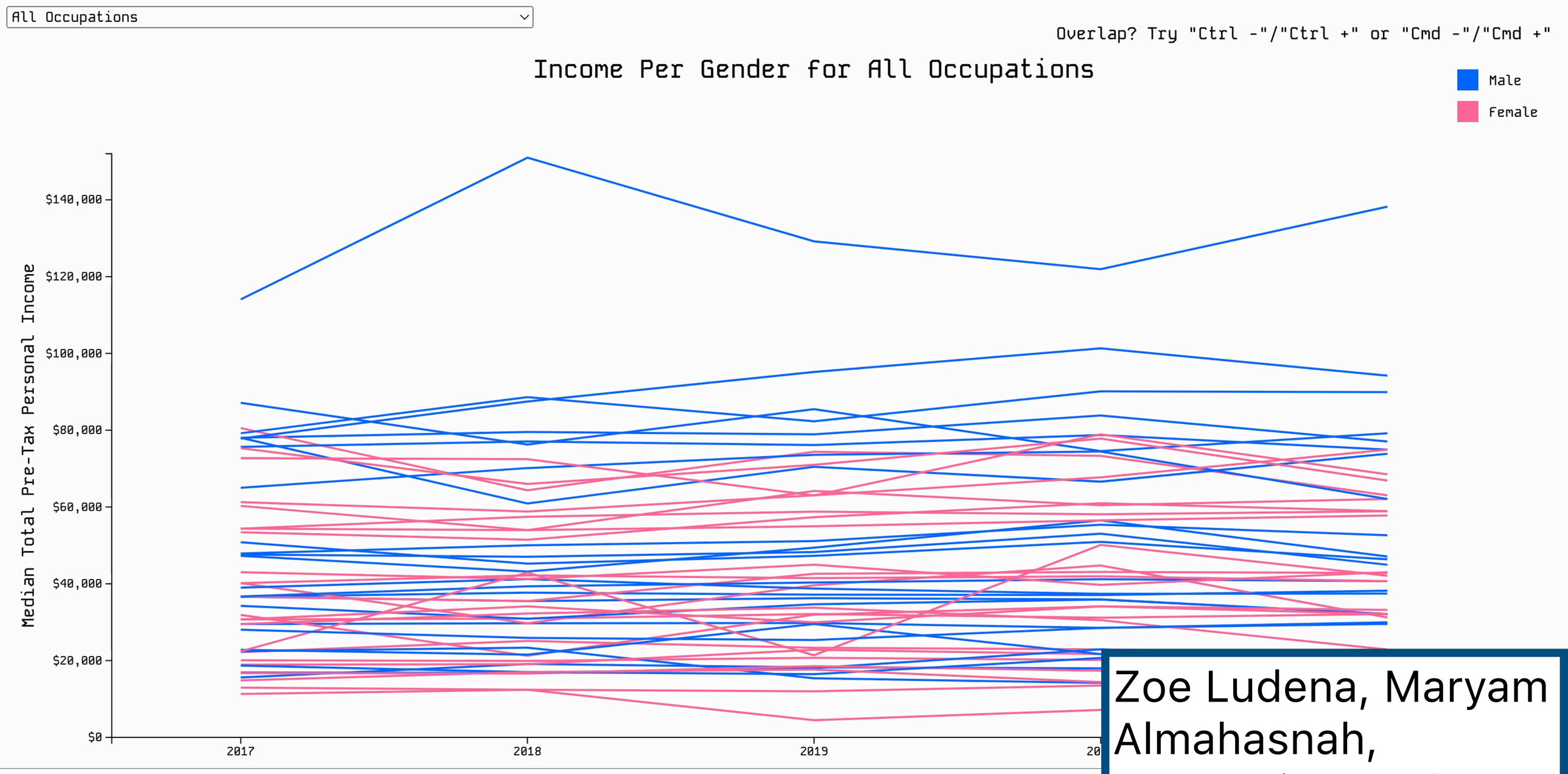
Number of Drivers Involved in Fatal Collisions Per Billion Miles in 50 US States



Documentation: https://docs.google.com/document/d/1olsv_yA

Ylesia Wu,
Rongjing Jiang

https://ylesia-wu.github.io/dsc106-project3/

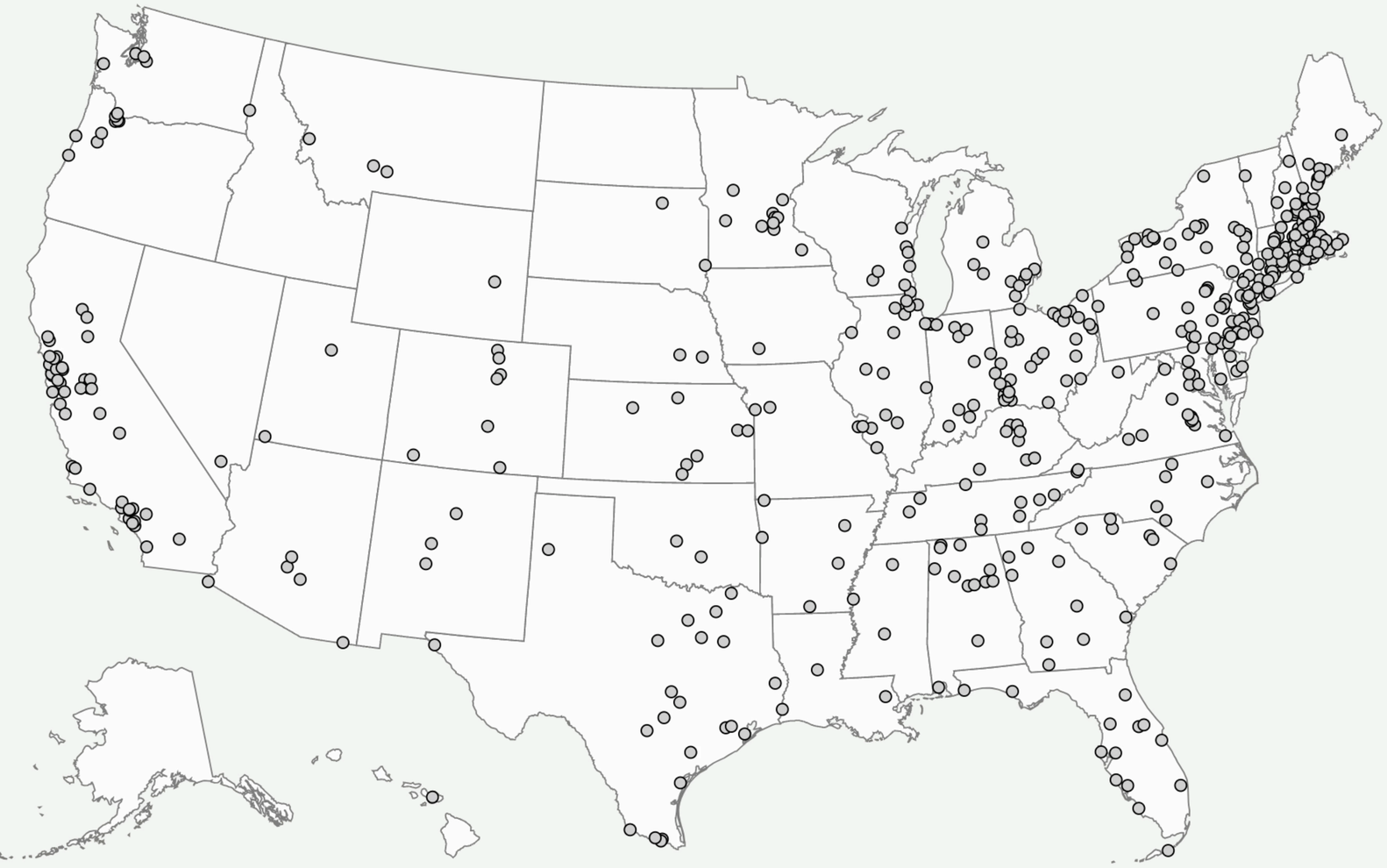


Zoe Ludena, Maryam Almahasnah, Anastasiya Markova

https://zoeludena.github.io/dsc106-Interactive-Income/

Pattern of US City Names: Does it show pattern of culture migration and immigration in US history?

Explore the spread pattern of those US cities with names identical to cities in other cultures of the world.
Utilizing the checkbox and provided context to explore how the spread pattern of cities reflects the historical influence of different cultures.
Hover and zoom in on cities for more details.



Frequently Seen Immigrating Culture Languages

Please select the checkbox on the right side to see cities in the US that have their name from a specific foreign language origin. For ease of pattern recognization, please select the box one at a time first.

- [ ] **Show English**
- [ ] **Show Spanish**
- [ ] **Show French**
- [ ] **Show Arabic**
- [ ] **Show German**
- [ ] **Show Italian**
- [ ] **Show Dutch**
- [ ] **Show Portuguese**

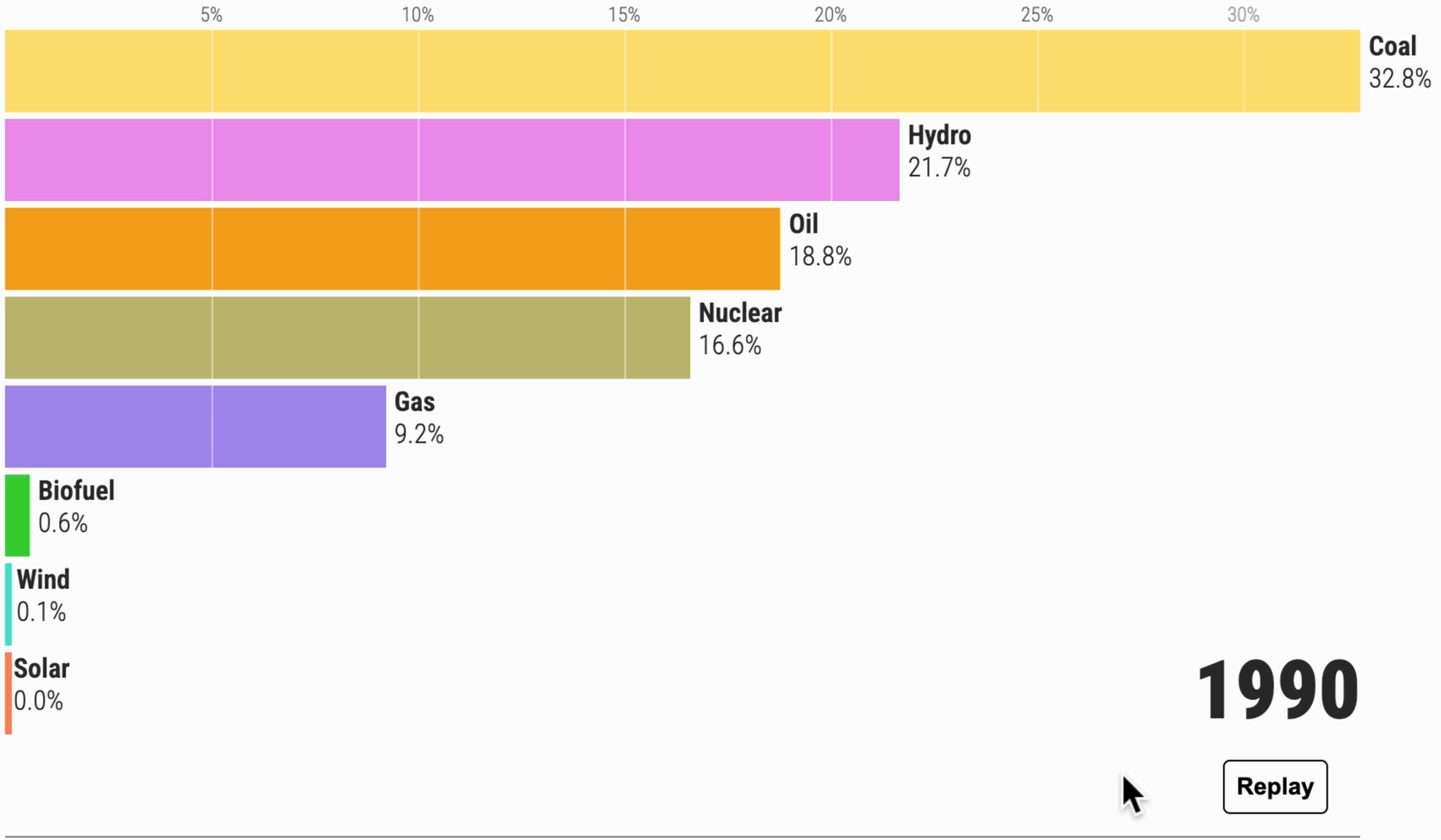
View Project Writeup Here

Evelyn Huang,
Feiyang Jiang

https://fjiang316.github.io/dsc106-project3/

Sources of Electricity

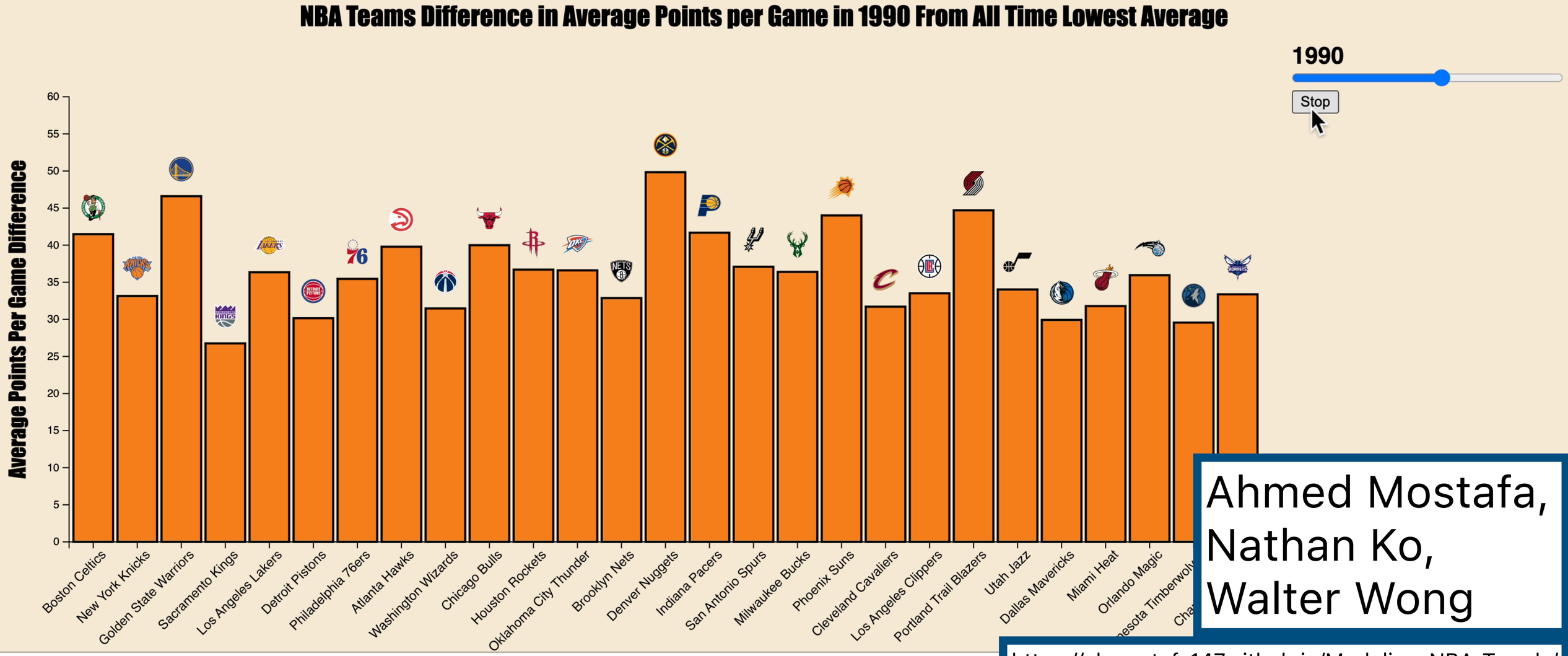
*Percentage breakdown of different energy sources utilized for electricity production throughout the world between 1989 and 2021. Check out the design overview **here**.*



Naga Shivani Katta,
Saloni Patnaik,
Shreya Pakala

https://shreya2031.github.io/Bar-chart-race/

Is Defense Dying in the NBA?



Ahmed Mostafa,
Nathan Ko,
Walter Wong

https://ahmostafa147.github.io/Modeling-NBA-Trends/

Minutes in Game: 1

Players are moving into the top and middle lanes. Players who are going to the bottom lane are helping the player in the jungle at their buffs.

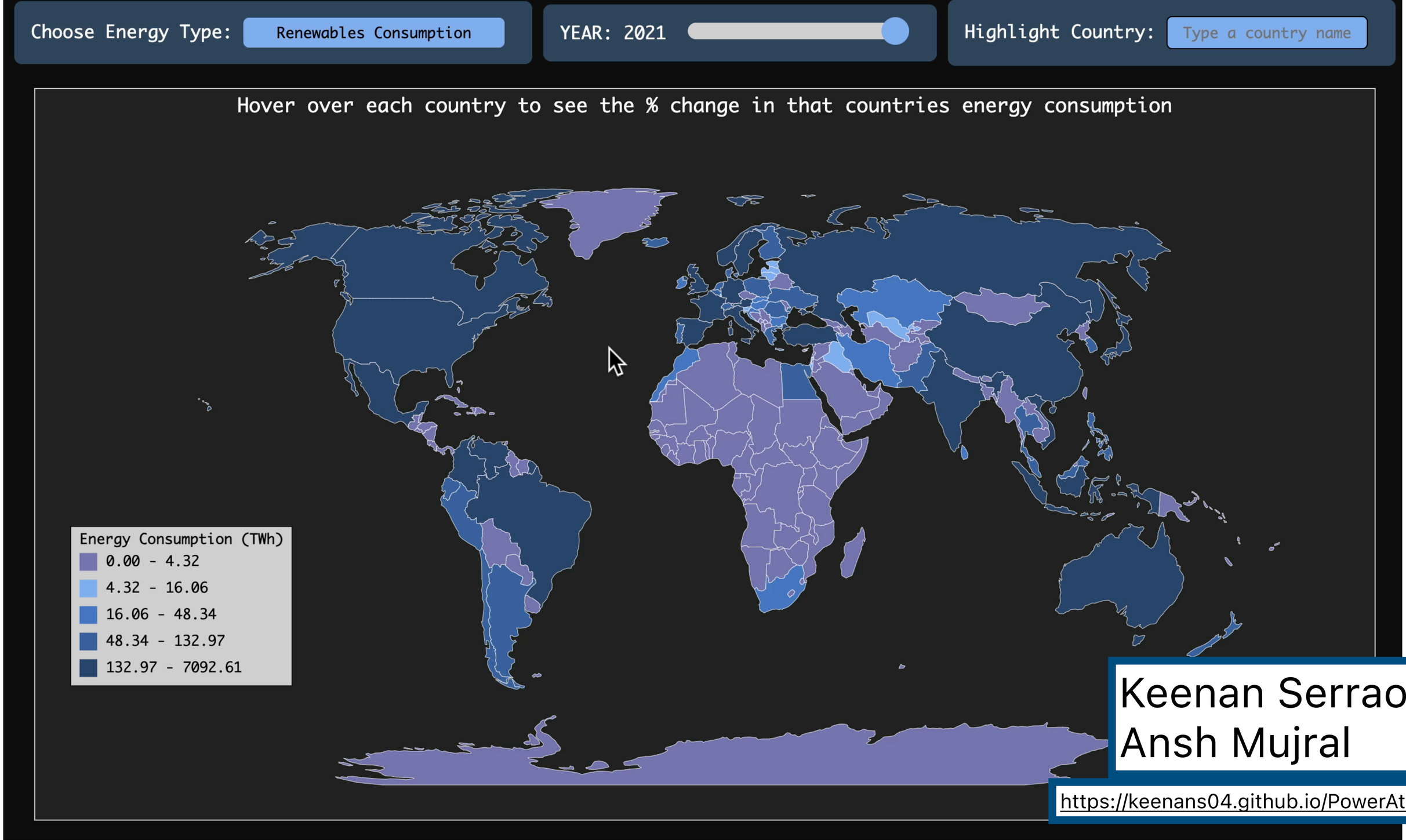
Team Win

Hexbin Heatmap

All Data

Nathen Lee, Siddharth Vyasabattu, Sean Perry

https://sean1572.github.io/LeagueOfLegendsLocationAnaysis-/



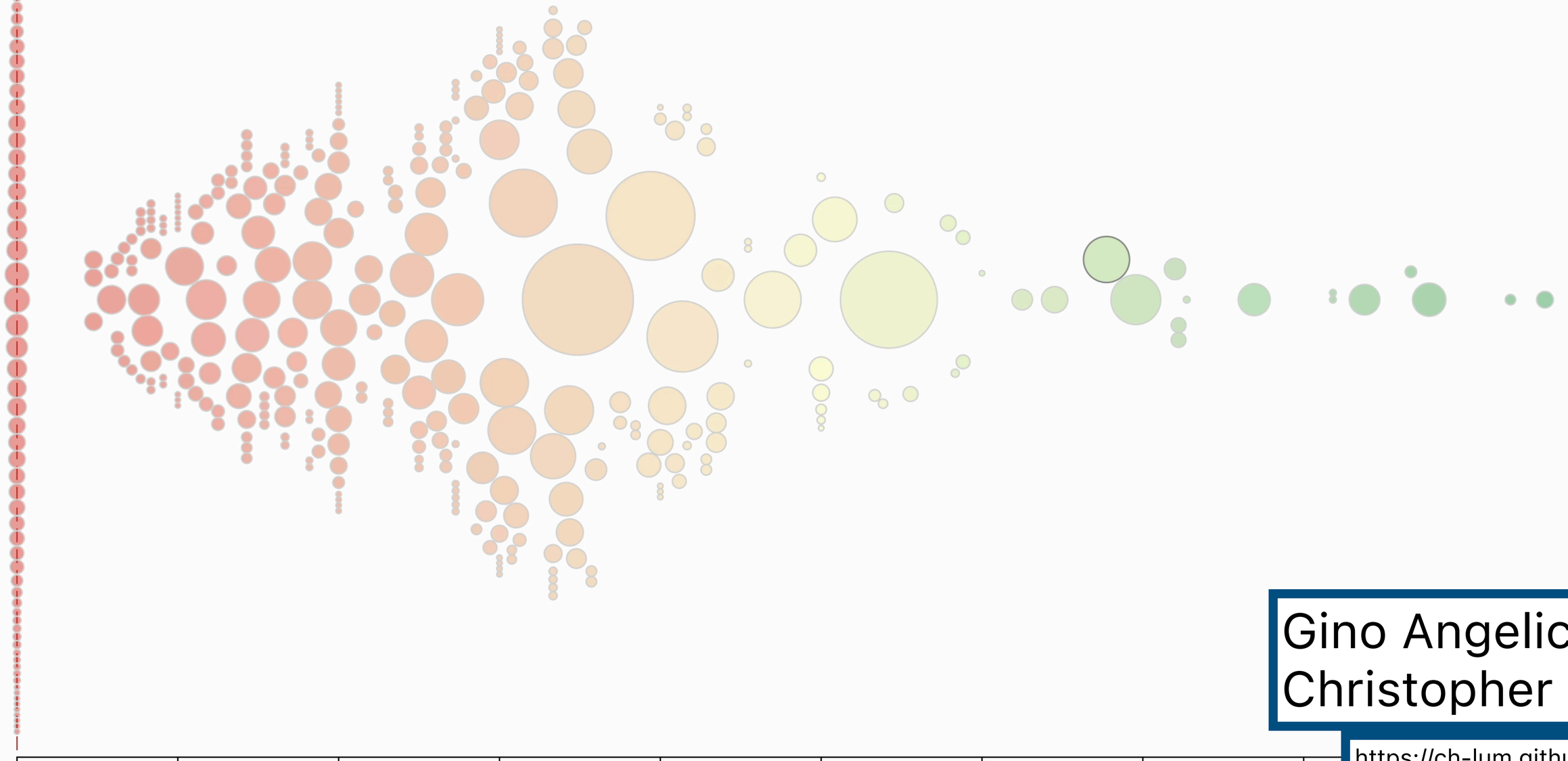
Keenan Serrao,
Ansh Mujral

https://keenans04.github.io/PowerAtlas/

When our words are used

Hover, click, search, and scroll through the vocabulary of 1360 Facebook comments on a POTUS post announcing the creation of 14 million jobs. Only includes words that appear in 10 or more comments.

great



Gino Angelici,
Christopher Lum

https://ch-lum.github.io/proj3

What inspired you from these examples?

Animation

Animation Goals

Direct attention

Increase Engagement

Explain a Process

Understand a State Transition

Animation Goals

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Explain a Process

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Animation Goals

Motion as a visual cue

Smooth motion is perceived at ~10 frames / sec (1 frame every 100ms).

Direct attention

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Explain a Process

Understand a State Transition

7.5 fps

15 fps

30 fps

60 fps

60 fps

30 fps

15 fps

7.5 fps

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Pre-attentive, stronger than color, shape, etc.

More sensitive to motion at our periphery.

Similar motions perceived as a group (gestalt principle of common fate).

Animation Goals

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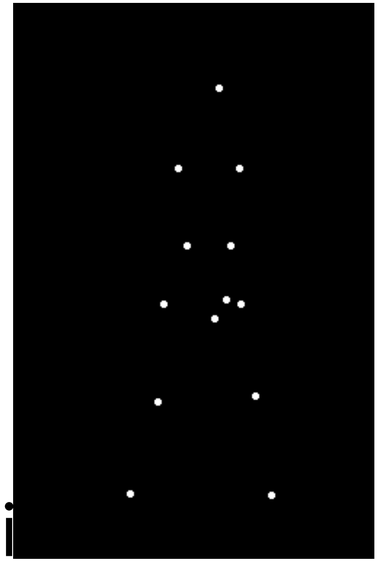

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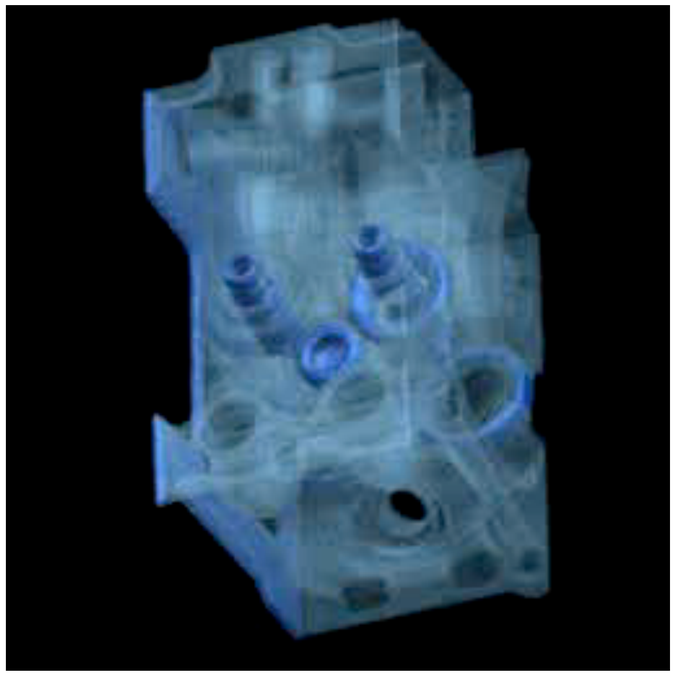

Animation Goals

Constructing narratives & anthropomorphizing

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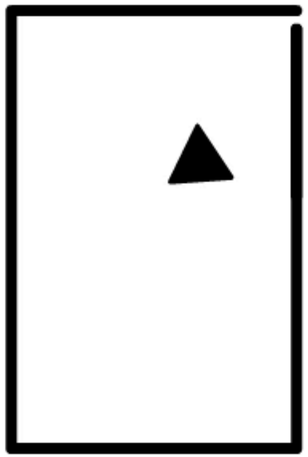
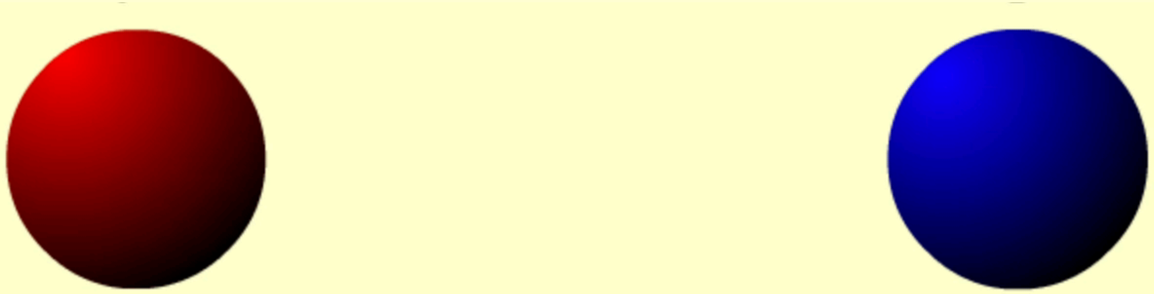


What's happening in this film?

Join at
slido.com
#4918

Heider, Fritz, and Marianne Simmel. "An experimental study of apparent behavior." *The American journal of psychology* 57.2 (1944): 243-259.



[Michotte 1946]

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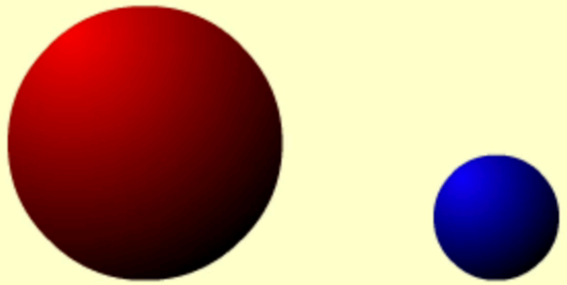
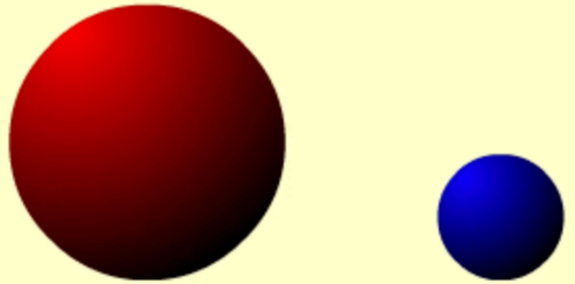


[Michotte 1946]



[Michotte 1946]

Animation Goals

Direct attention

Increase Engagement

Explain a Process – the perception (or attribution) of causality.

Understand a State Transition

Animation Goals

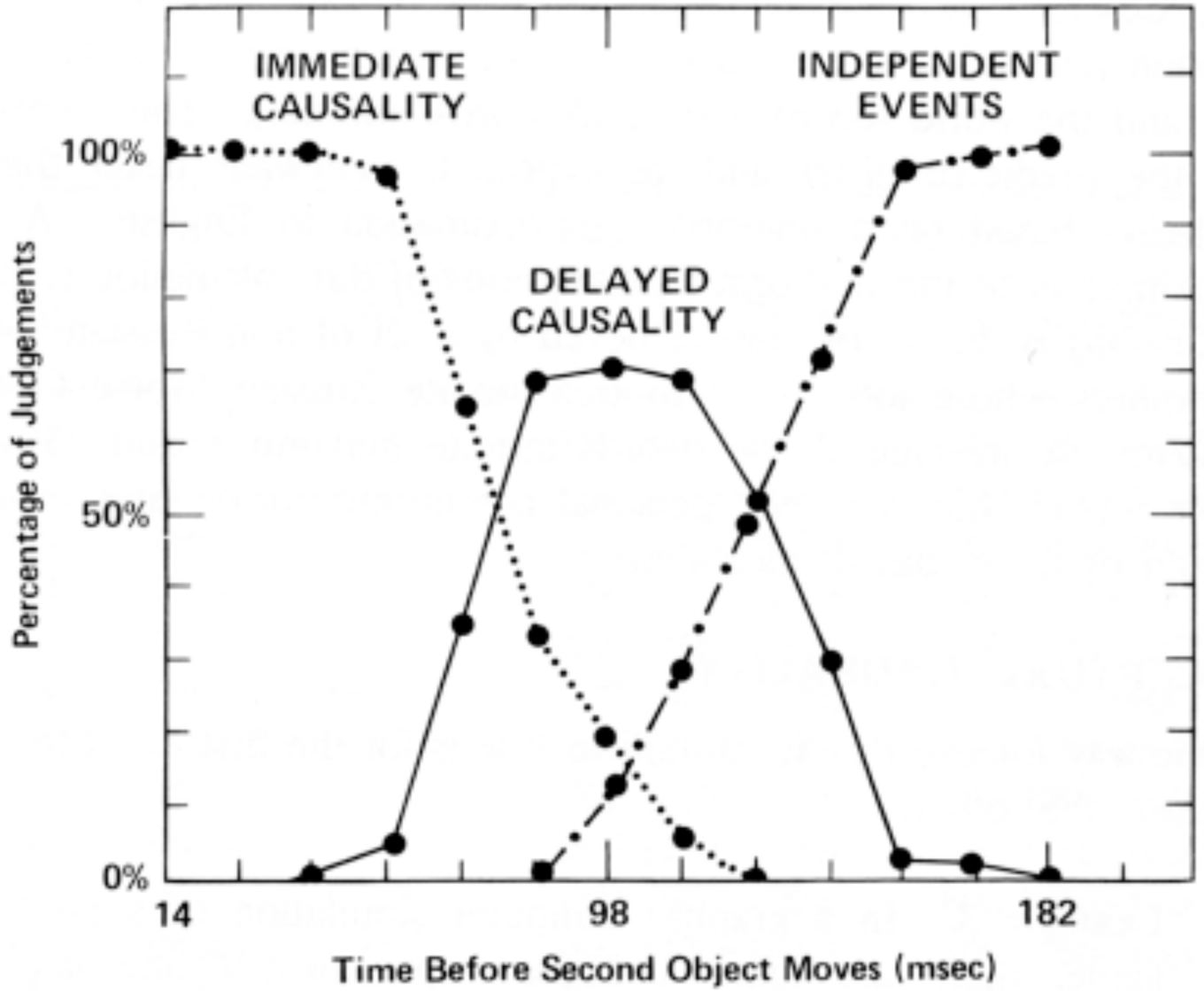
Attribution of Causality.

Direct attention

Increase Engagement

Explain a Process

Understand a State Transiti



[Reprint from Ware 2004]

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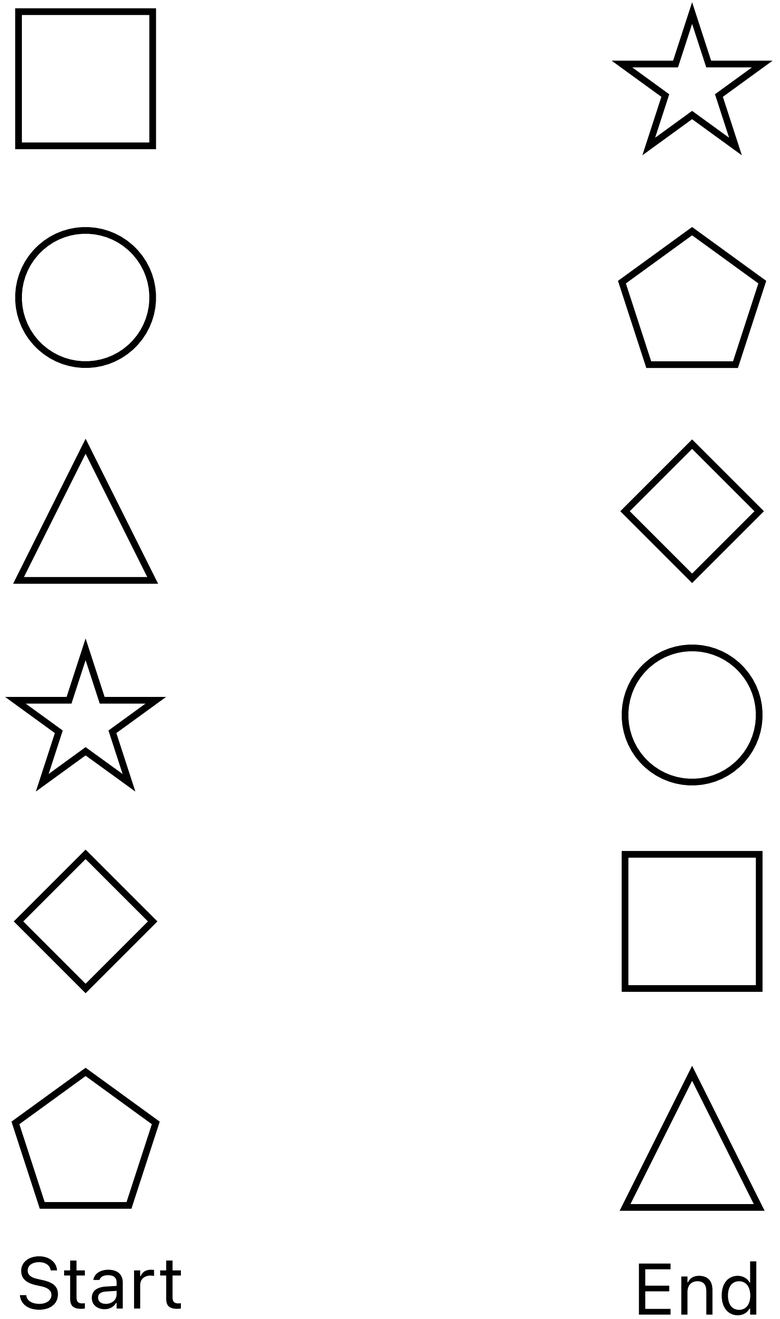

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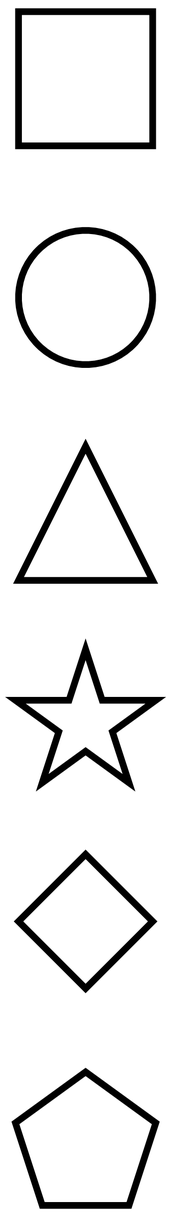
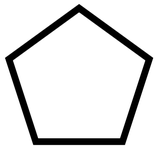


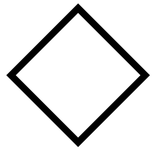
Start

End

Animation Goals



Direct attention



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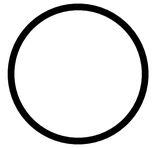

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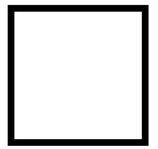
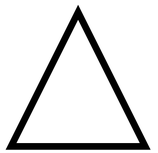


Understand a State Transition

Animation can show transition better, but...

May be too fast or too slow.

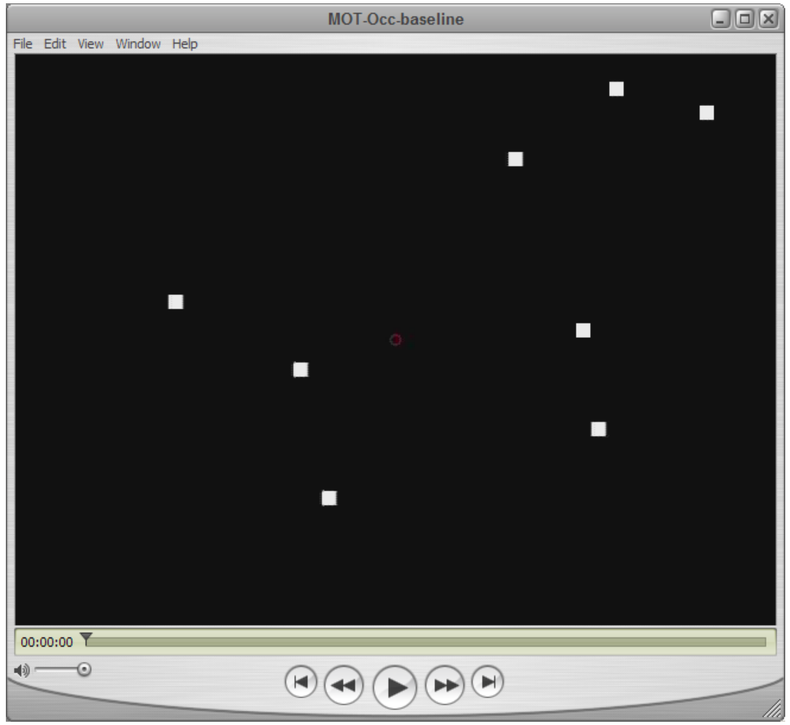
Too many objects may move at once.



End

Animation Goals

How many dots can we track at once?



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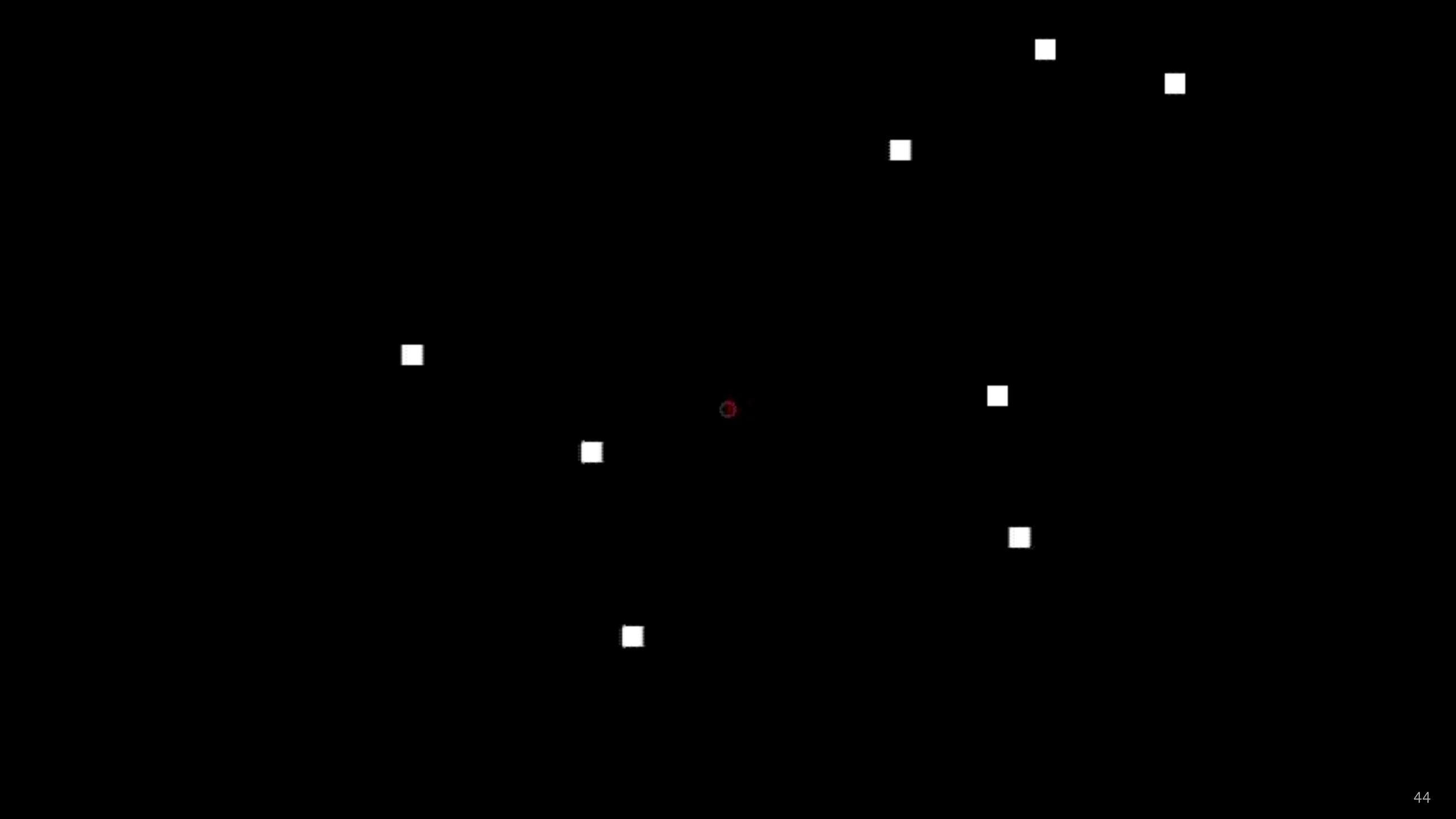
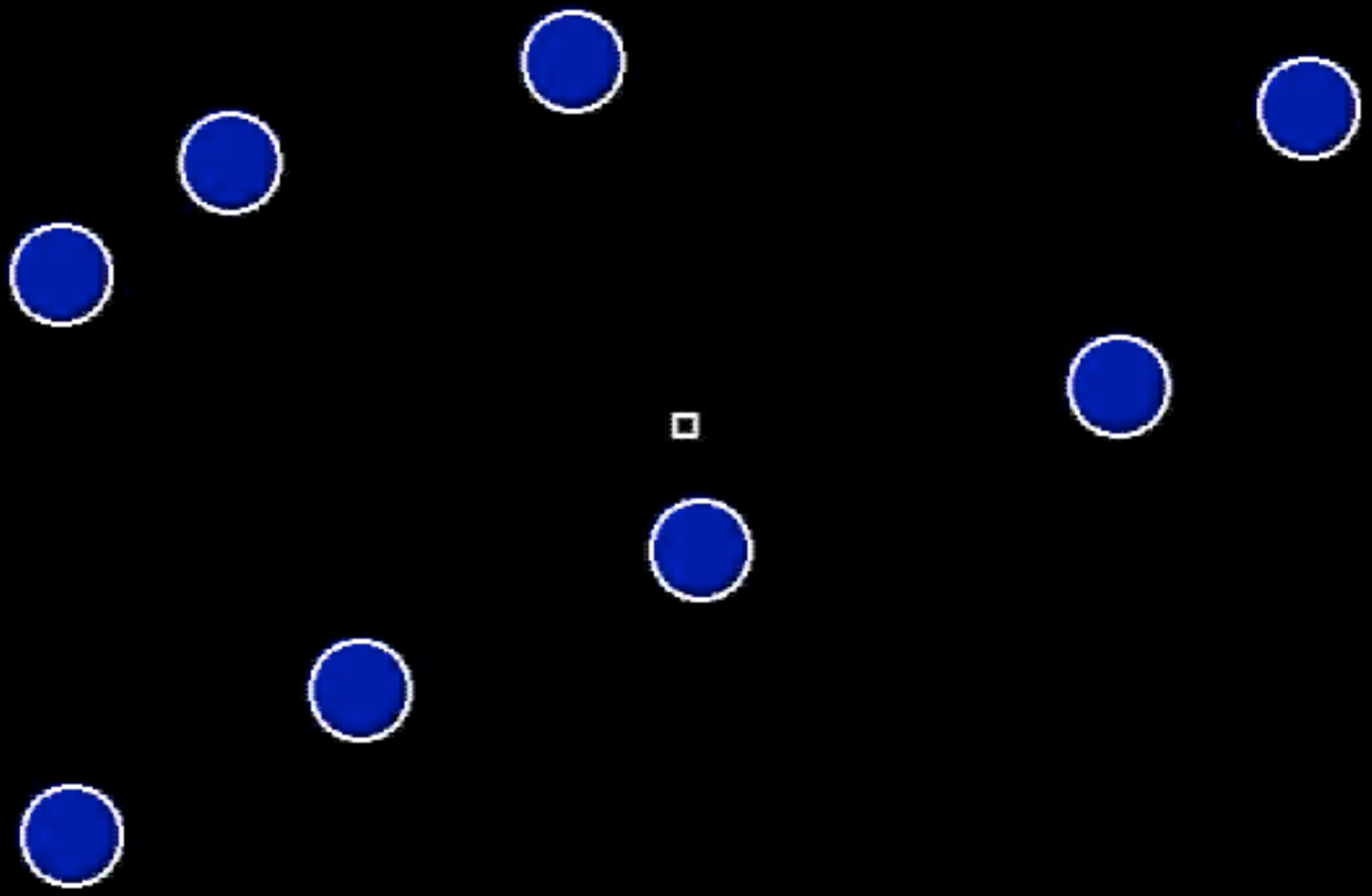
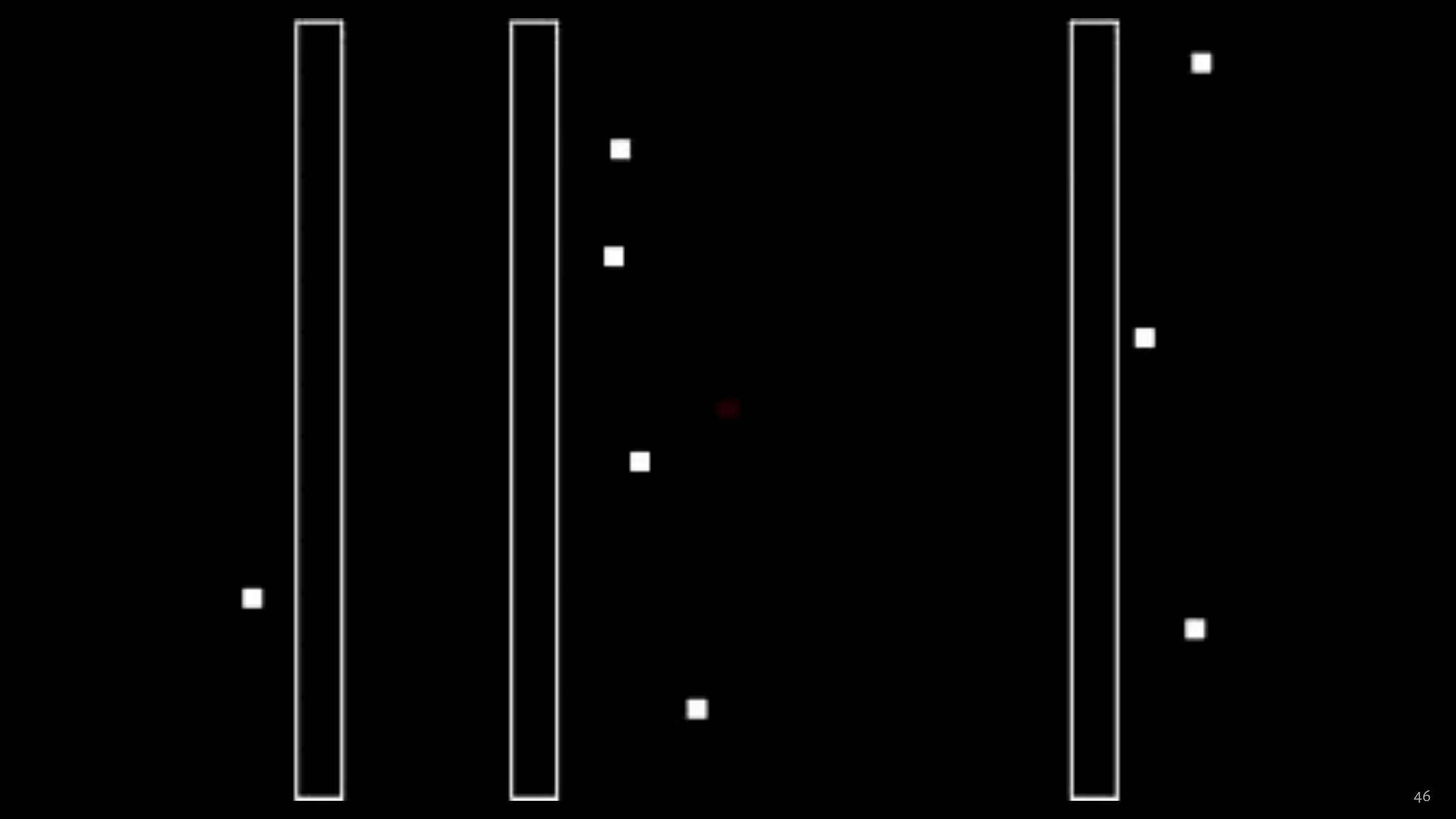
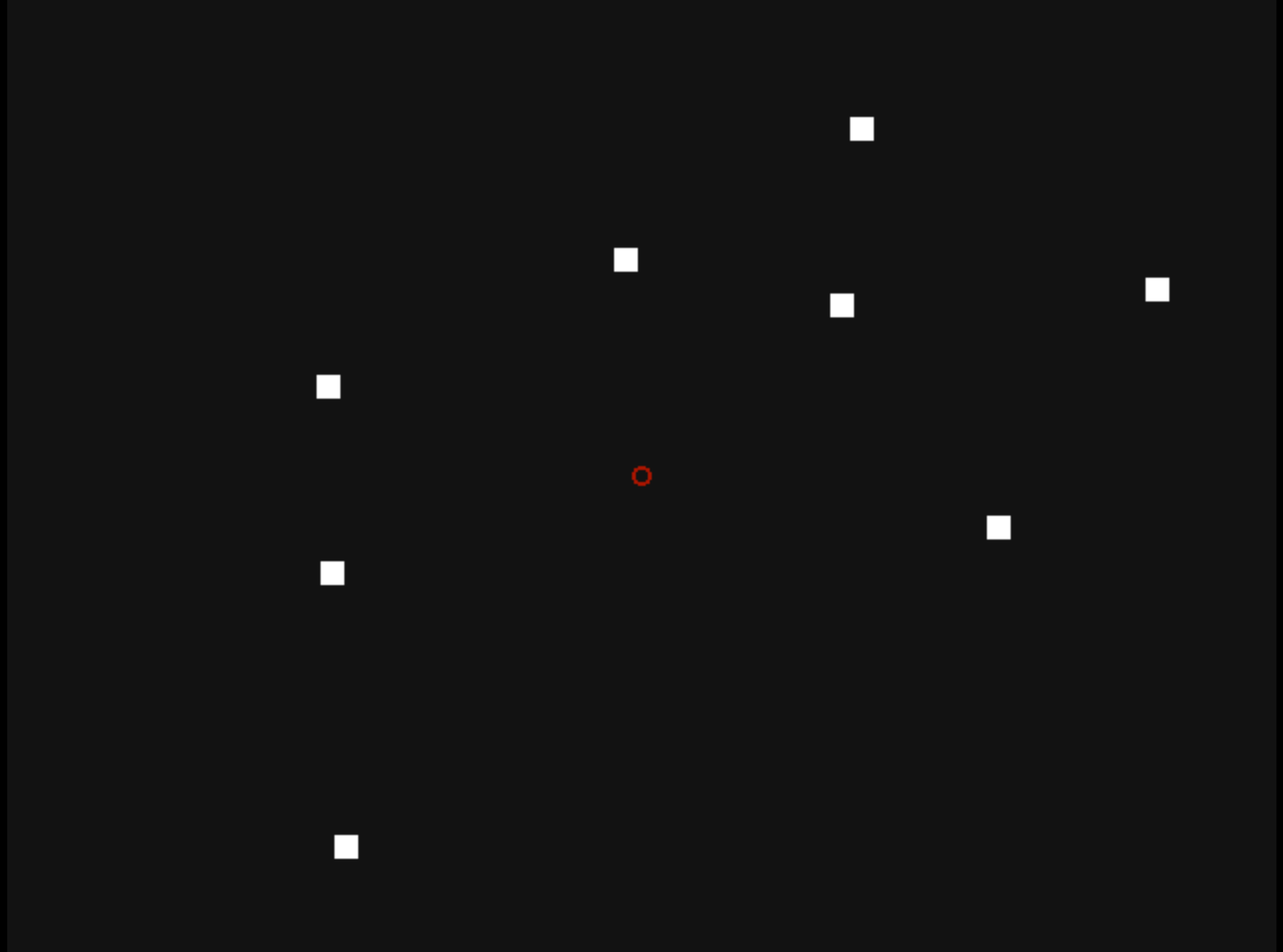
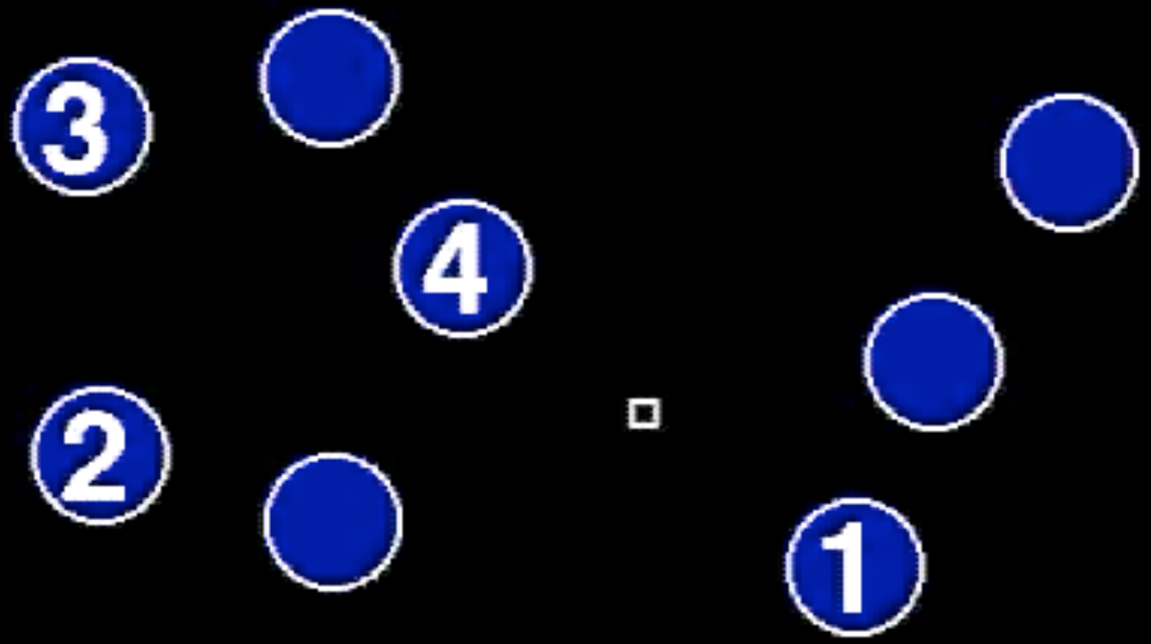






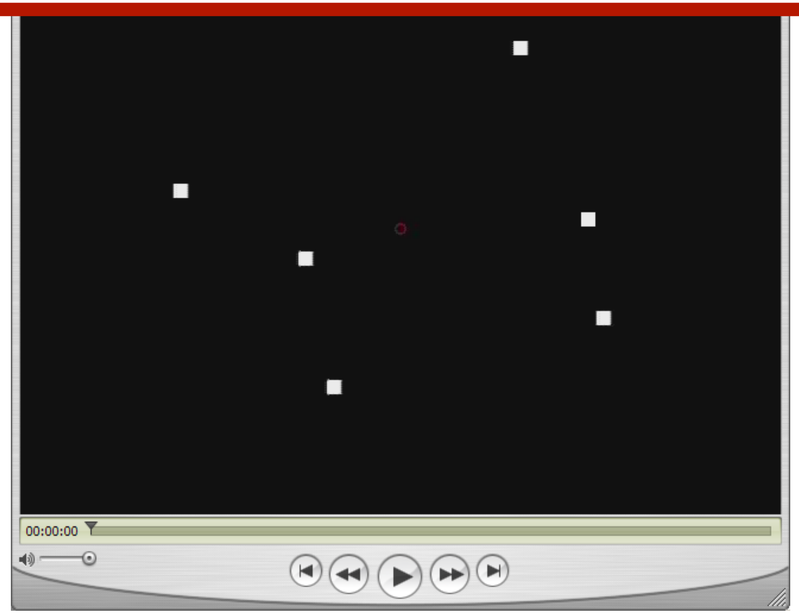



3
4
2
1

Animation Goals

How many dots can we track at once?

4-6. Difficulty increases significantly at 6.



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Increase Engagement

Explain a Process

Understand a State Transition

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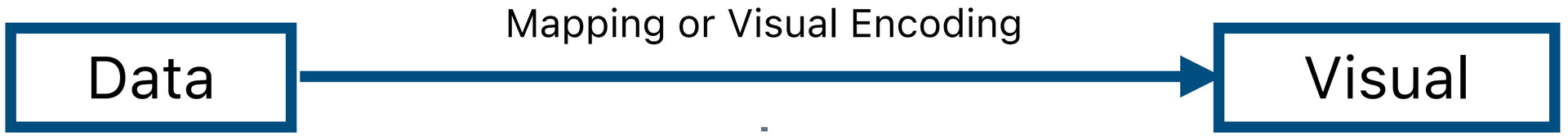
Effective Animations



Expressiveness

A set of facts is *expressible* in a visual language if the sentences (i.e. the visualizations) in the language express *all the facts in the set of data, and only the facts in the data.*

Effectiveness

A visualization is more *effective* than another if the information it conveys *is more readily perceived* than the information in the other visualization

Mackinlay, Jock. "Automating the design of graphical presentations of relational information." *Acm Transactions On Graphics (Tog)* 5.2 (1986): 110-141.

Principles of Visualization

Expressiveness

A set of facts is *expressible* in a visual language if the sentences (i.e. the visualizations) in the language express *all the facts in the set of data, and only the facts in the data.*

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A visualization is more *effective* than another if the information it conveys *is more readily perceived* than the information in the other visualization

Principles of Animation

Congruence

The structure and content of the external representation should correspond to the desired structure and content of the internal representation.

Apprehension

The structure and content of the external representation should be readily and accurately perceived and comprehended

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Congruence

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Apprehension

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Maintain **valid data graphics during transitions**
Respect **semantic correspondence**
  Marks should always represent the same data tuples.
Avoid **ambiguity**
  Different operations should have distinct animations.

Experiments

Experiment 2

Study Conclusions / Principle of Apprehension

Appropriate animation **improves** graphical perception.

Simple transitions beat “do one thing at a time”

Simple staging was preferred and showed benefits

but timing important and in need of study.

Axis **re-scaling hampers perception**

Avoid if possible (use common scale)

Maintain landmarks better (delay fade out of lines)

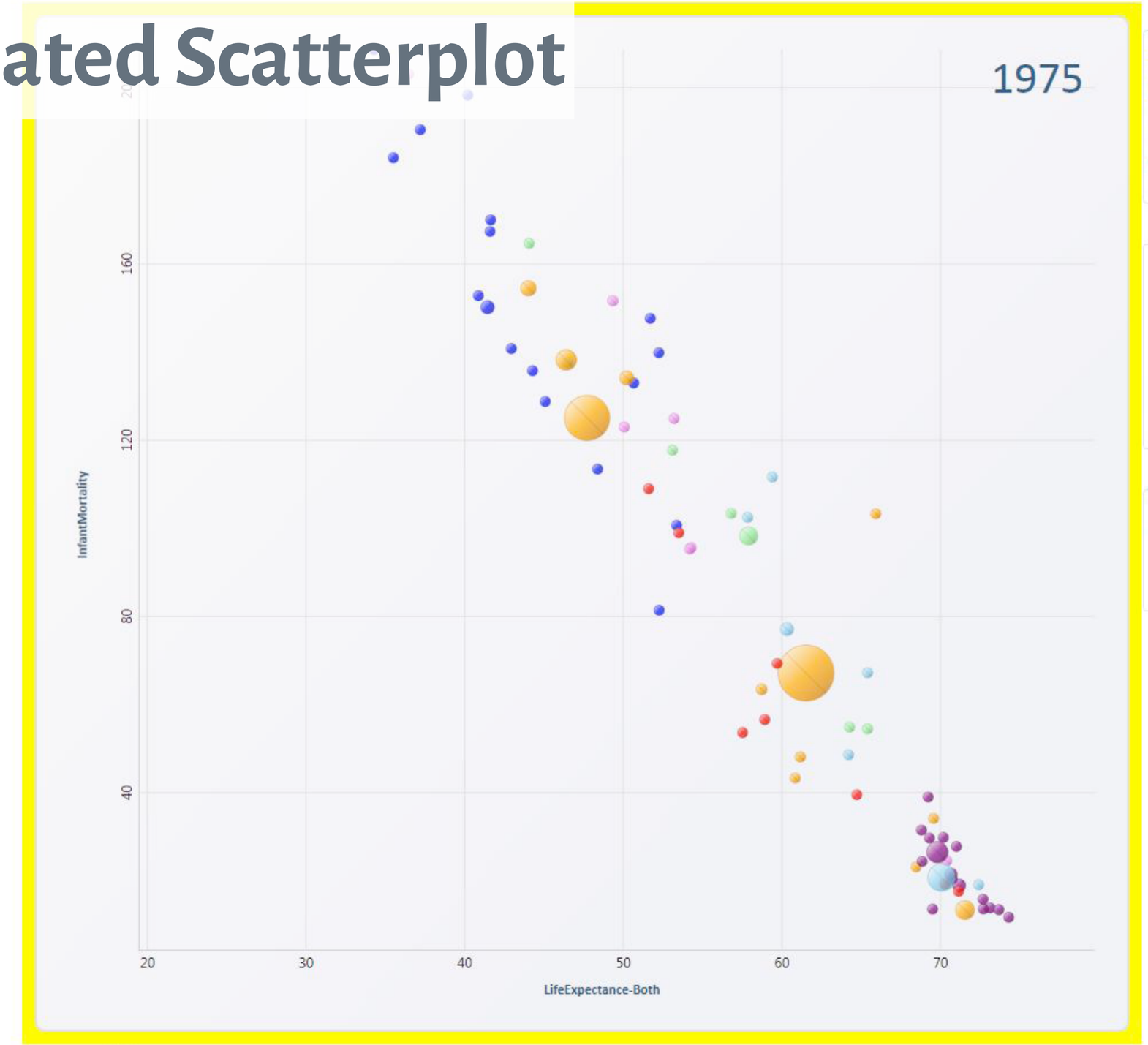
Subjects preferred animated transitions

2.5
3
3.5
6.5
7

1962
Life expectancy at birth, total
Fertility rate, total

2.5
3
3.5
6.5
7

Animated Scatterplot



Color Legend (continent)

- Africa
- Asia
- Europe
- Middle East
- North America
- Oceania
- South America

Task

Select two countries with decreasing InfantMortality, but little change in life expectancy.

Ctrl-Click on a country (in chart) to set an answer.

Answers set: 0/2

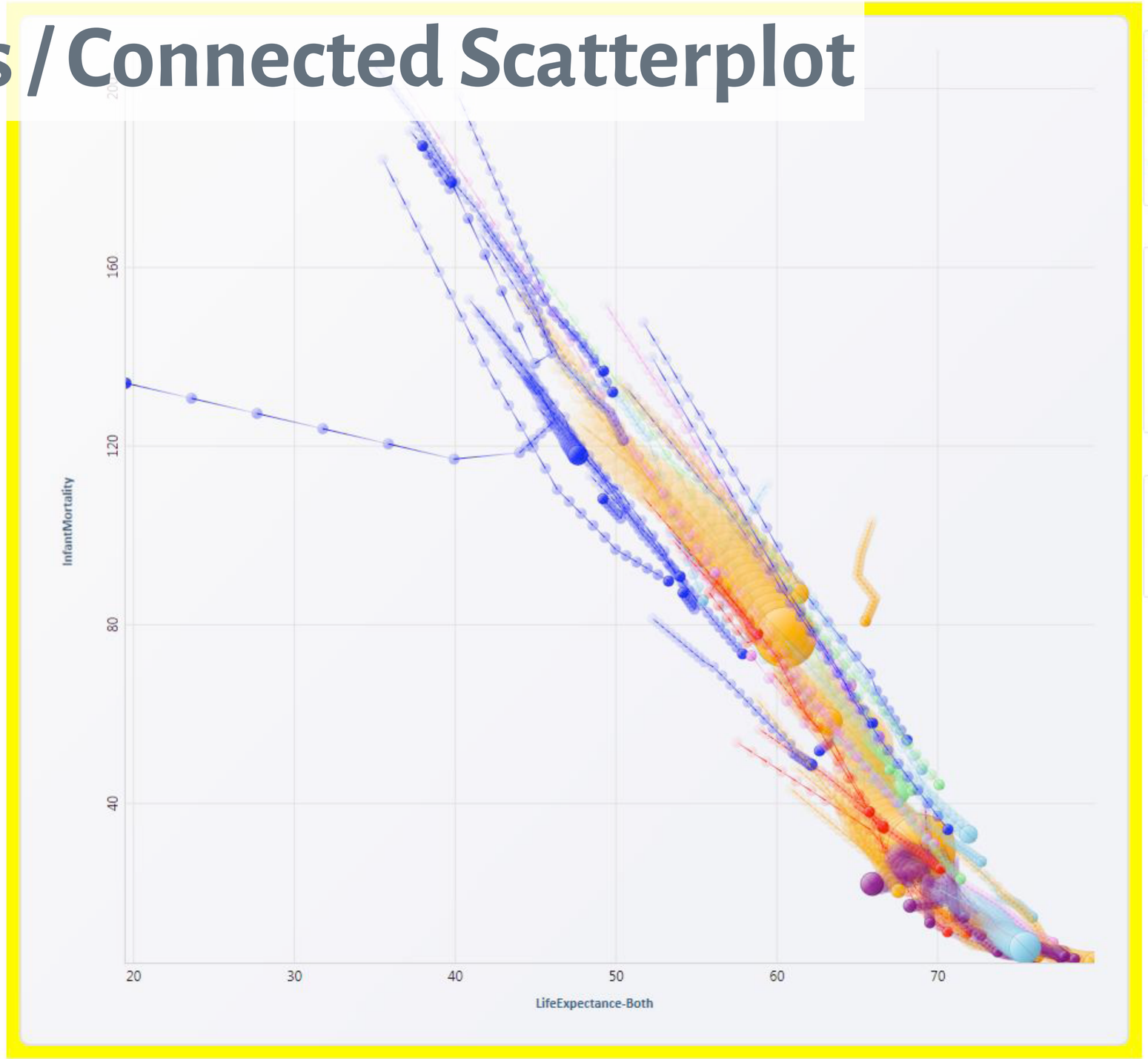
Next

Click on "Next" when finished (or "Give Up" if you cannot find all the answers)

Give Up | Next

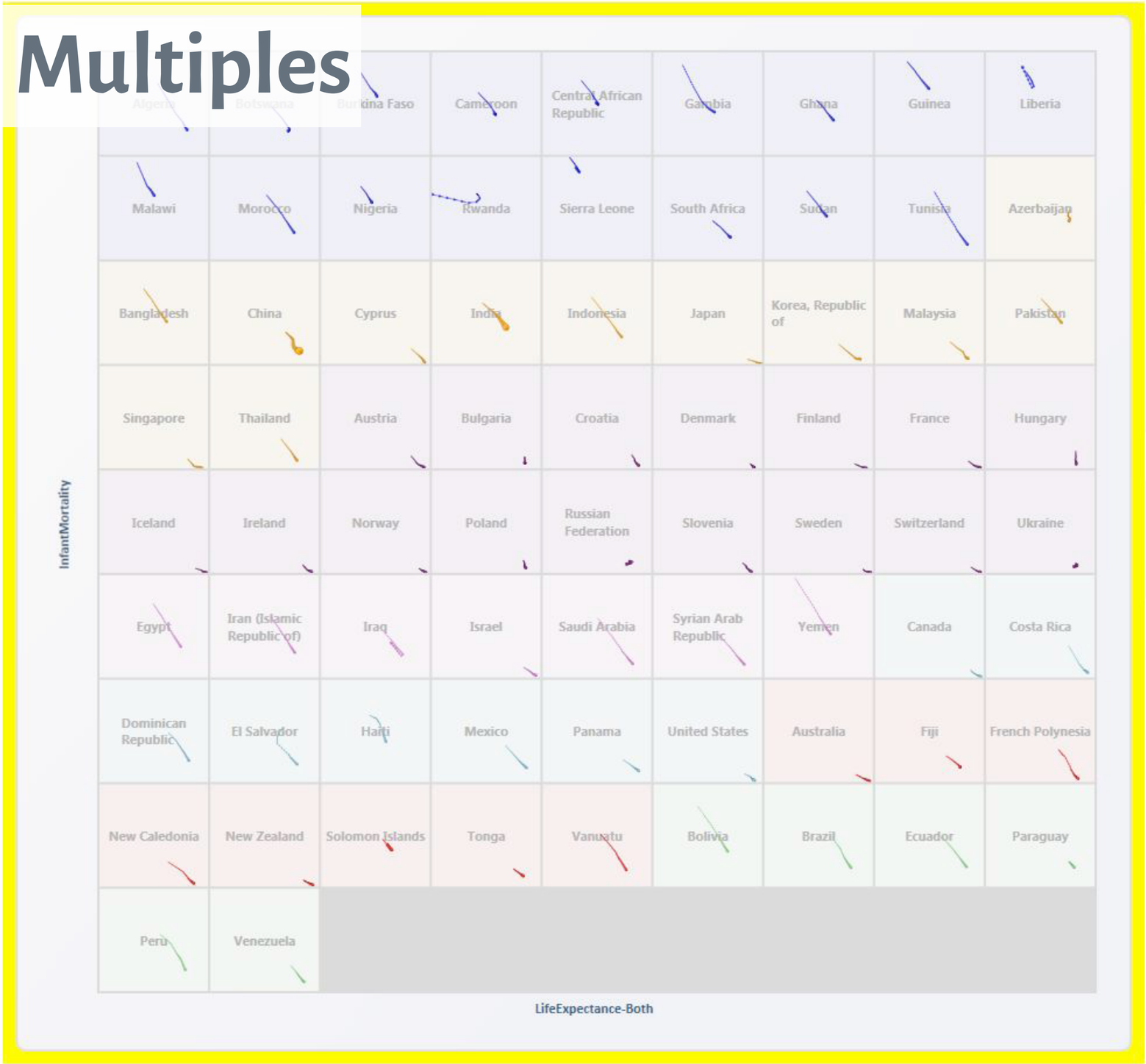
Robertson, George, et al. "Effectiveness of animation in trend visualization." *2008*

Traces / Connected Scatterplot



Robertson, George, et al. "Effectiveness of animation in trend visualization." *2008*

Small Multiples



Color Legend (continent)

- Africa
- Asia
- Europe
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- Oceania
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Task

Select two countries whose InfantMortality dropped first, then increased later.

Ctrl-Click on a country (in chart) to set an answer.

Answers set: 0/2

Next

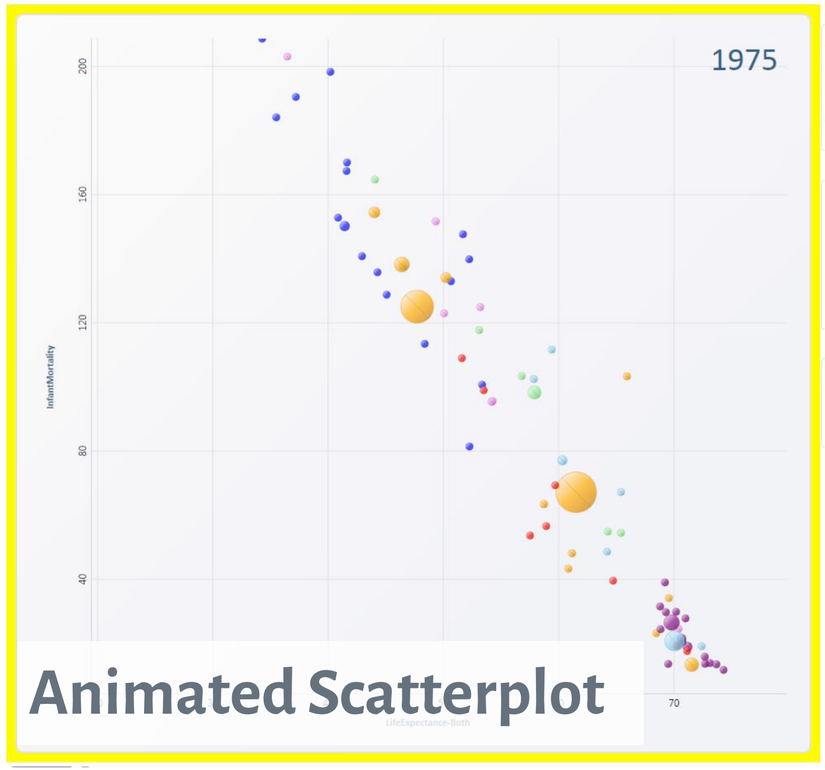
Click on "Next" when finished (or "Give Up" if you cannot find all the answers)

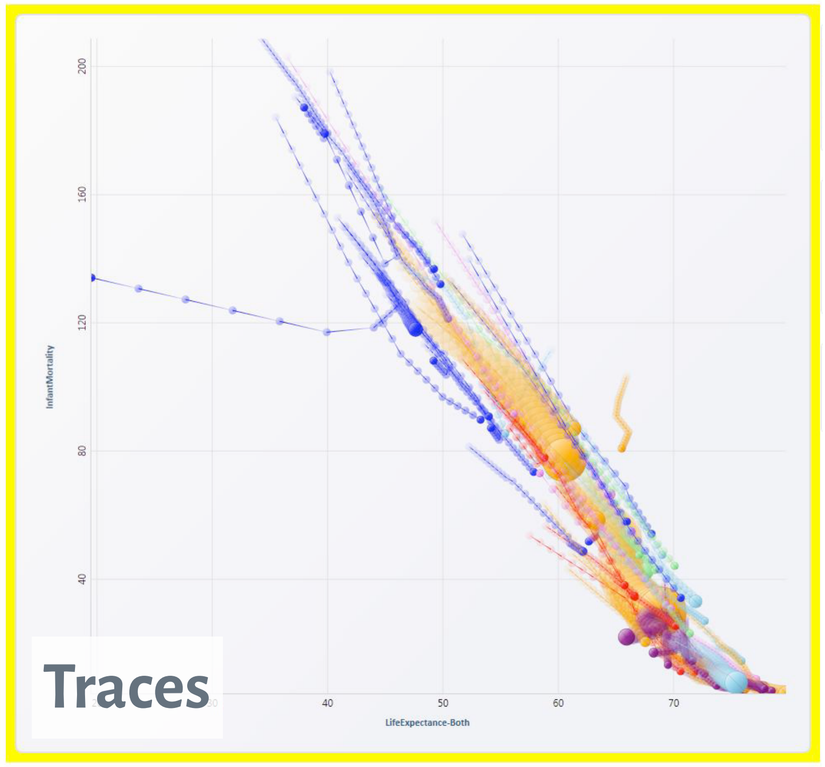
Give Up | Next

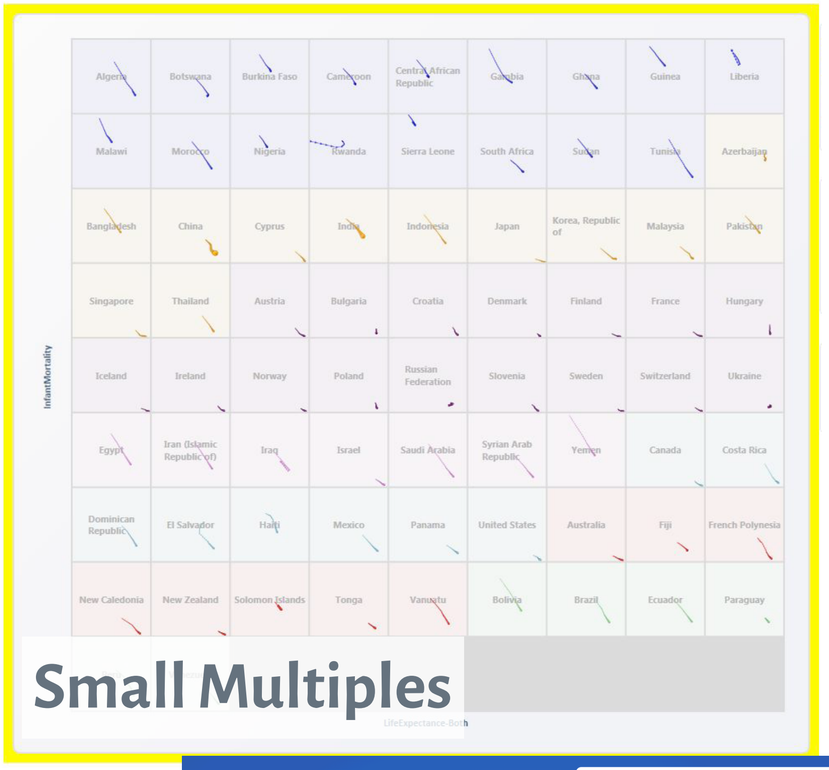
Robertson, George, et al. "Effectiveness of animation in trend visualization." *2008*

Study Conclusions

Analysis Task and Presentation Task.
Presentation condition included narration.
Subjects asked comprehension questions.







Which condition would participants:
be more **accurate**, be **faster**, and **prefer**?

Join at
slido.com
#4918

Study Conclusions

Analysis Task and Presentation Task.
Presentation condition included narration.
Subjects asked comprehension questions.

Animations **10% less accurate** than small multiples.

Presentation: Animation **60% faster** than small multiples.

Analysis: Animation **82% slower** than small multiples.

User preferences favor animation
(even though less accurate and slower for analysis!).

Robertson, George, et al. "Effectiveness of animation in trend visualization." *2008*

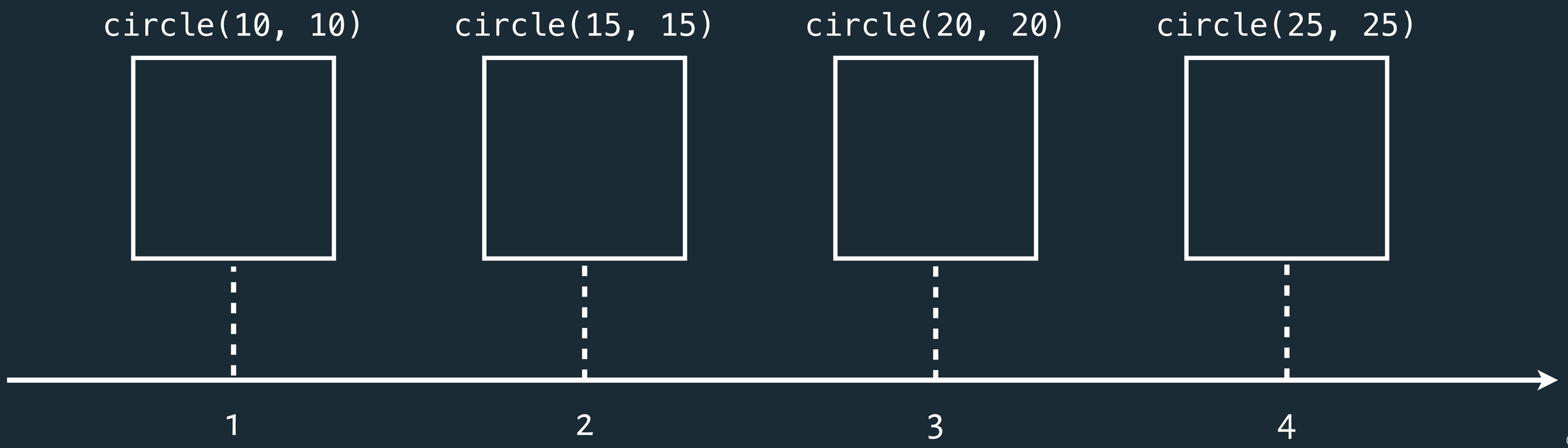
Implementing Animation

Implementing Animation

Frame-Based Animation

Redraw the scene at regular intervals (e.g., 16ms).

Developer defines the redraw function (e.g., Processing, p5.js)



Implementing Animation

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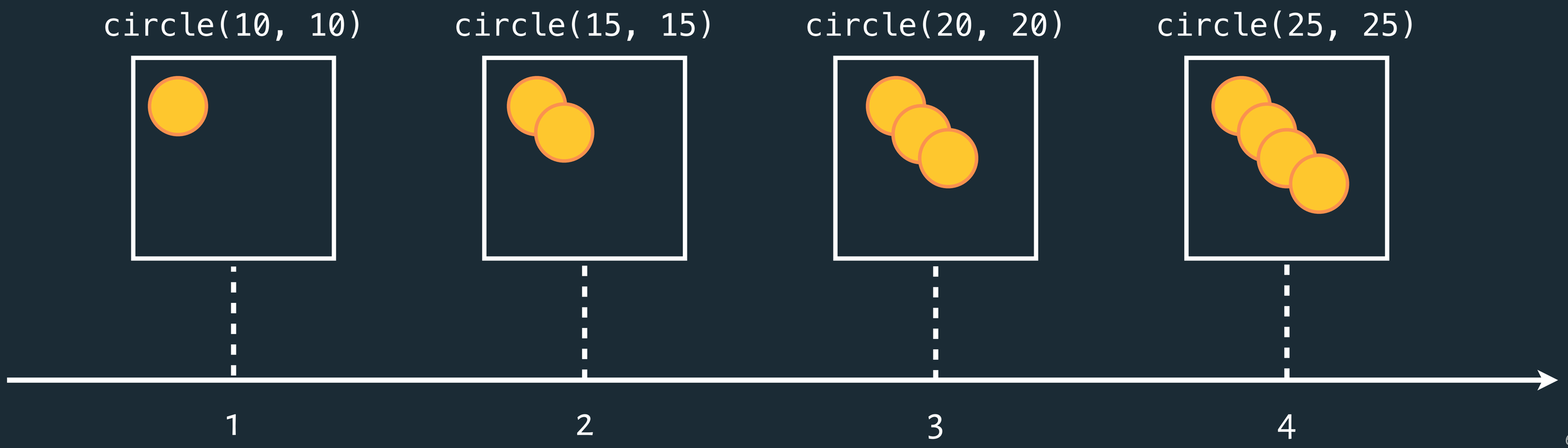
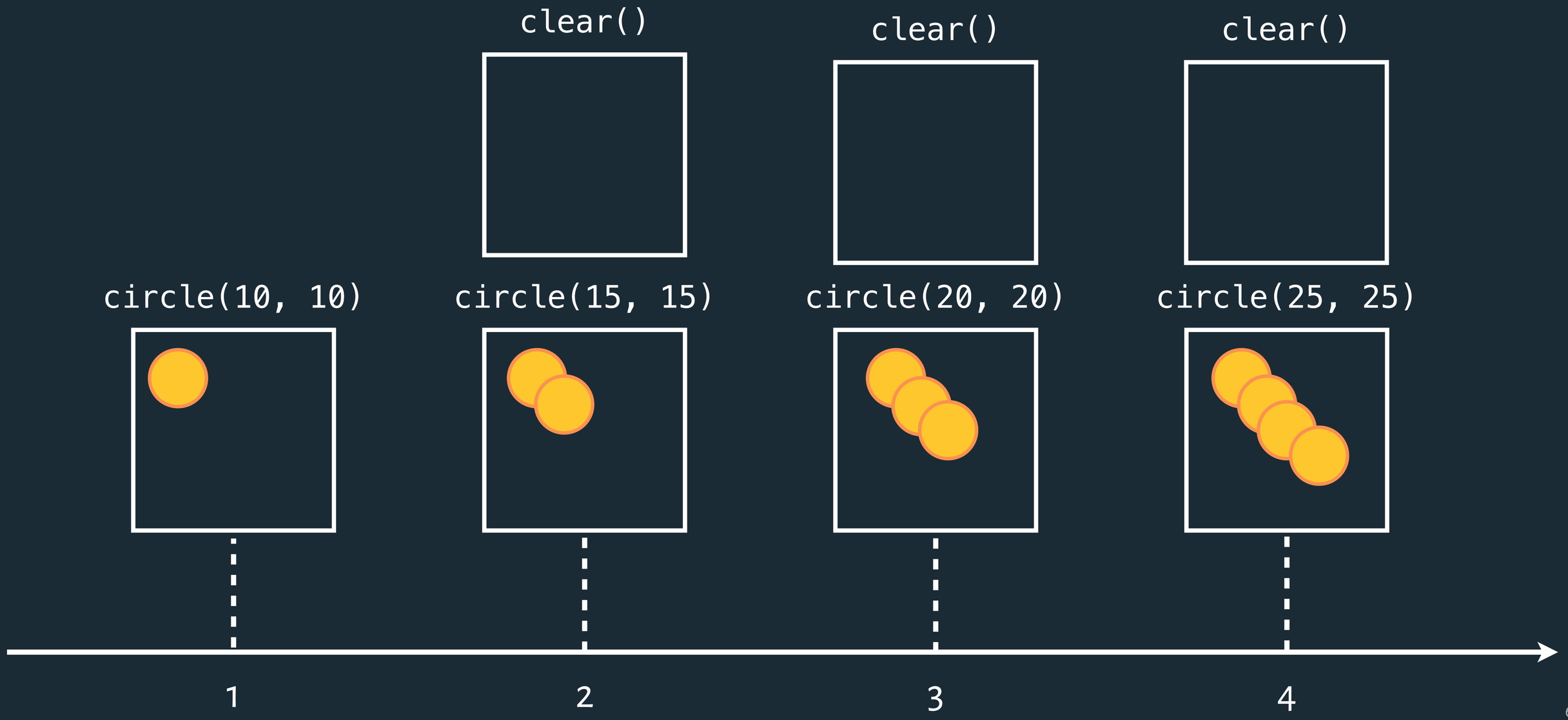
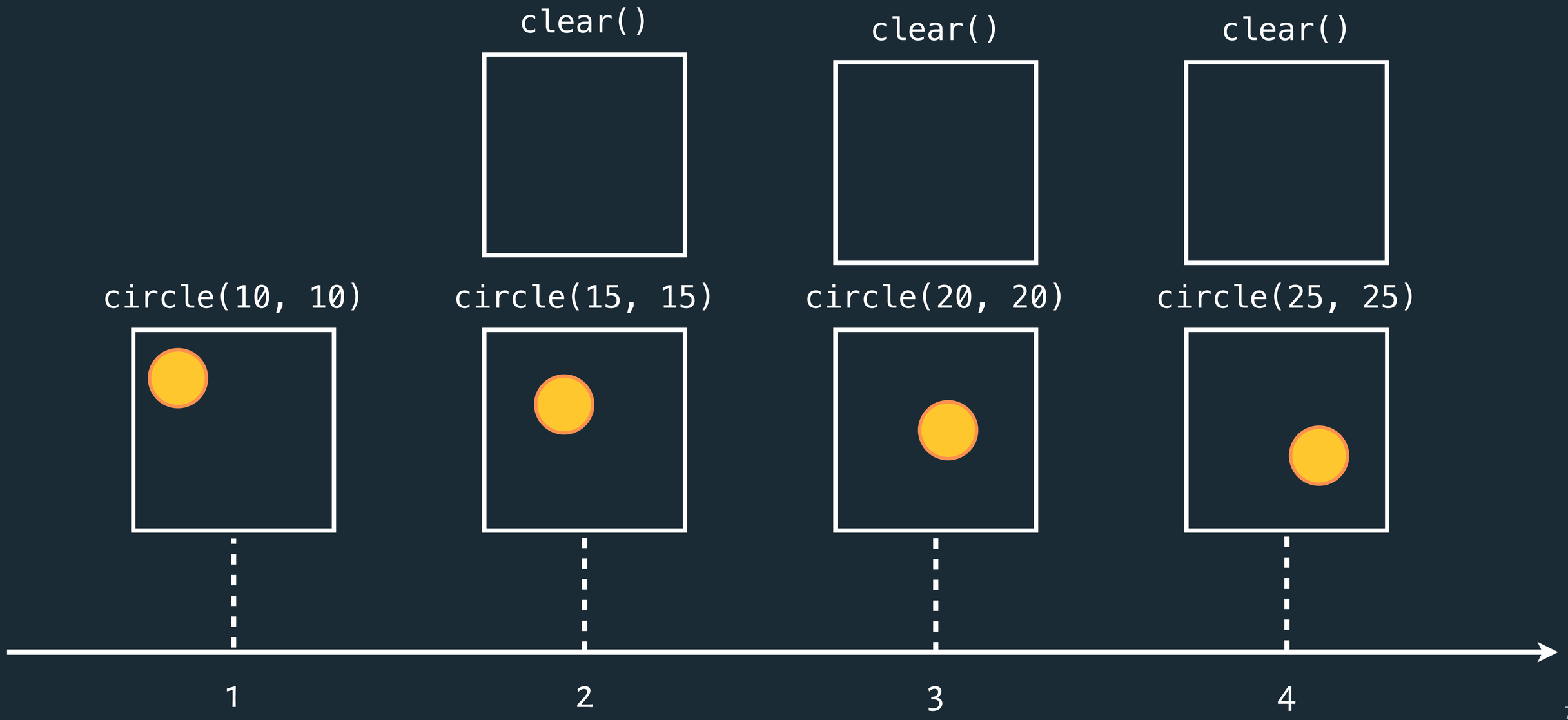


Implementing Animation



Implementing Animation



Implementing Animation

Frame-Based Animation

Redraw the scene at regular intervals (e.g., 16ms).

Developer defines the redraw function (e.g., Processing, p5.js)

Transition-Based Animation [Hudson & Stasko, 1993]

Specify a property value, duration, and an "easing" function.

Also called **tweening** (for "in-betweens").

Steps computed via **interpolation**

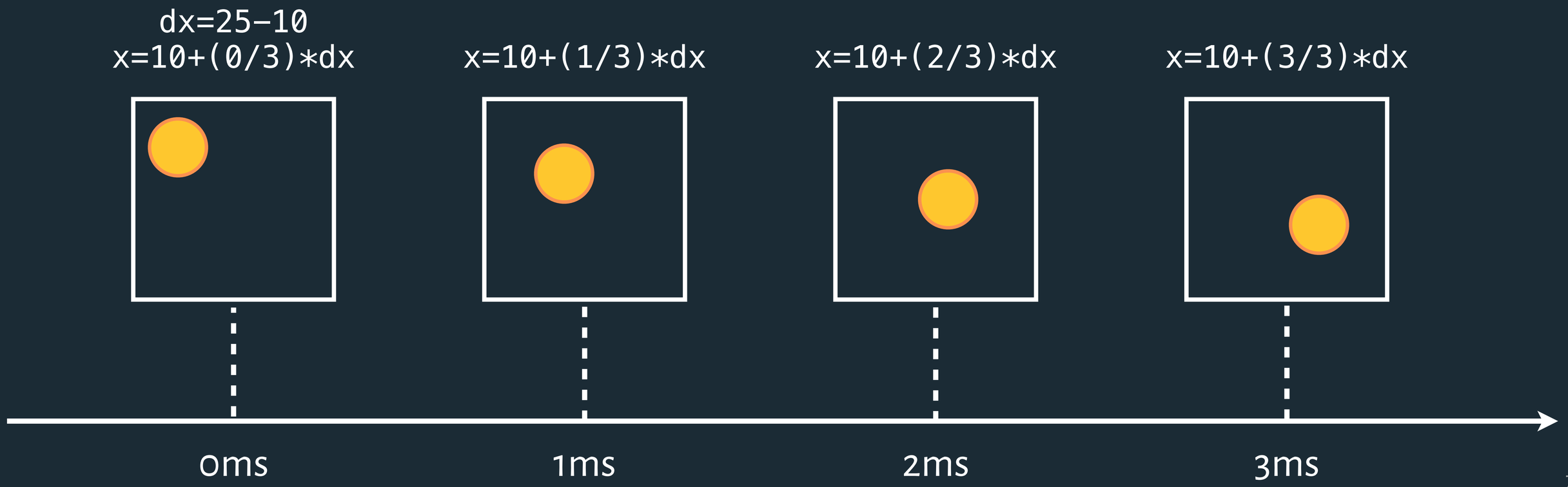
```
step (fraction) { val_now = val_start + fraction * (val_end - val_start); }
```

Timing & redraw managed by UI toolkit.

Implementing Animation

```
From: (10, 10).
To: (25, 25).
Duration: 3 seconds.
```

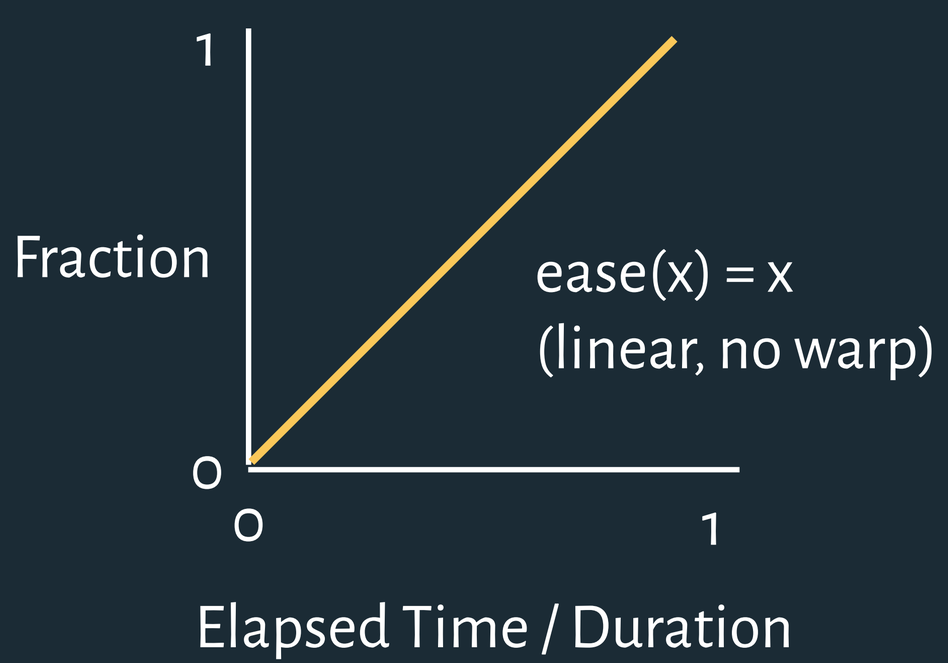
System handles the frame-by-frame updates!

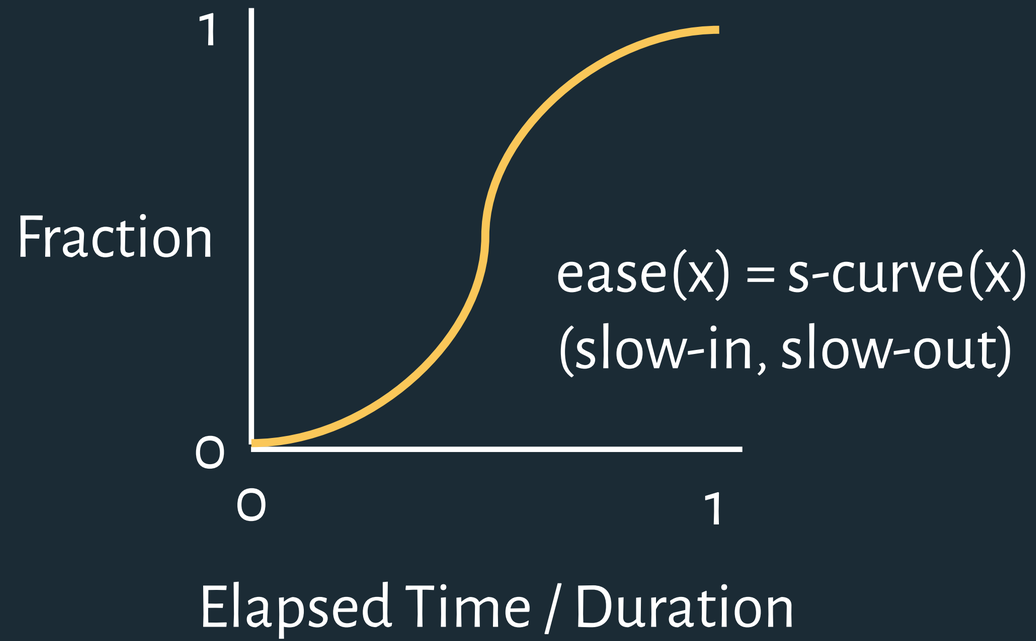


Easing/Pacing Functions

Goals: Stylize animation, improve perception.

Basic idea is to **warp time**: as *duration* goes from start (0%) to end (100%), dynamically adjust the *interpolation fraction* using an easing function.





https://easings.net

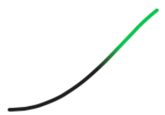
Easing functions specify the rate of change of a parameter over time.

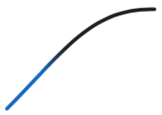
Objects in real life don't just start and stop instantly, and almost never move at a constant speed. When we open a drawer, we push it and it accelerates, then we pull it to stop it, and sometimes it bounces on the floor, and it will finally settle down. Easing functions help us animate things in a more realistic way.

This page helps you choose the right easing function.

Open Source

Help translate site to your language


easeInSine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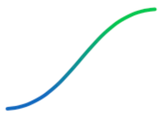
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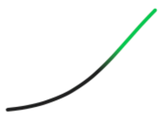
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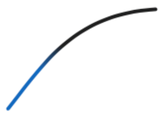
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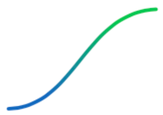
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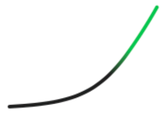
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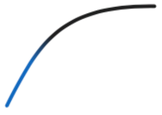
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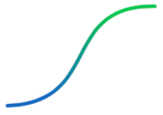
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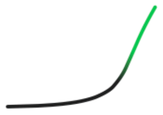
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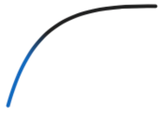
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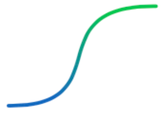
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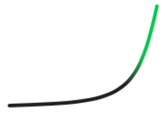
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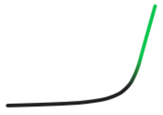
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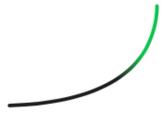
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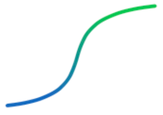
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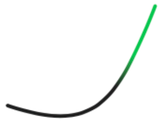
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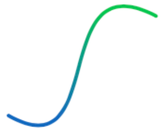
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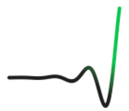
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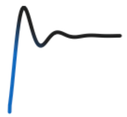
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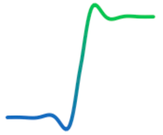
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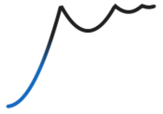
easeOutBounce

easeInOutBounce

Andrey Sitnik and Ivan Solovev

English

Animations in Svelte and D3

For a given element, decide whether you want Svelte to animate or D3 (not both!)

Svelte: https://learn.svelte.dev/tutorial/tweens

D3: https://www.d3indepth.com/transitions/