

Animation

DSC 106: Data Visualization

Jared Wilber

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)

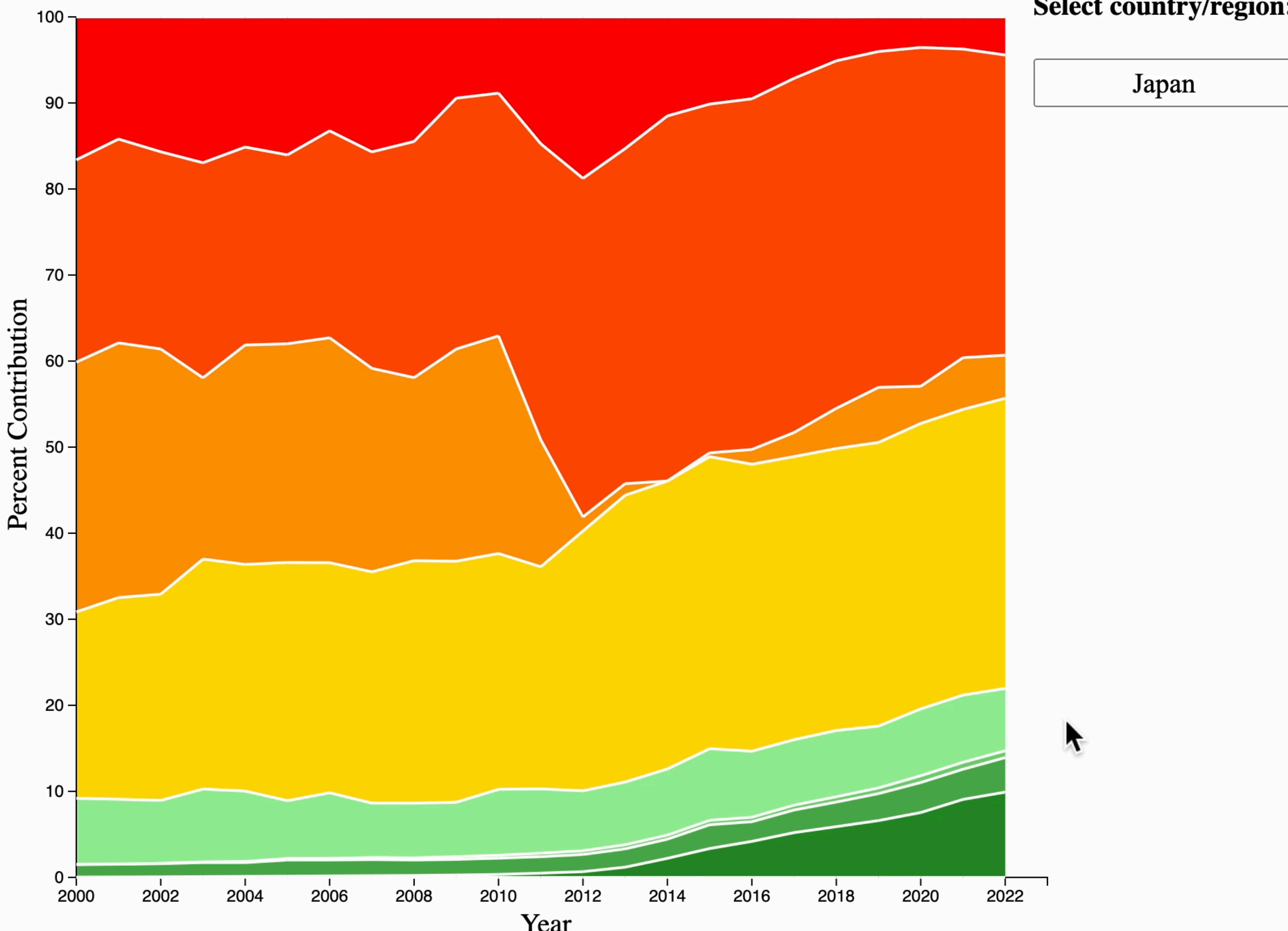
Example: Adding a tooltip to Name Grapher

`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](#)

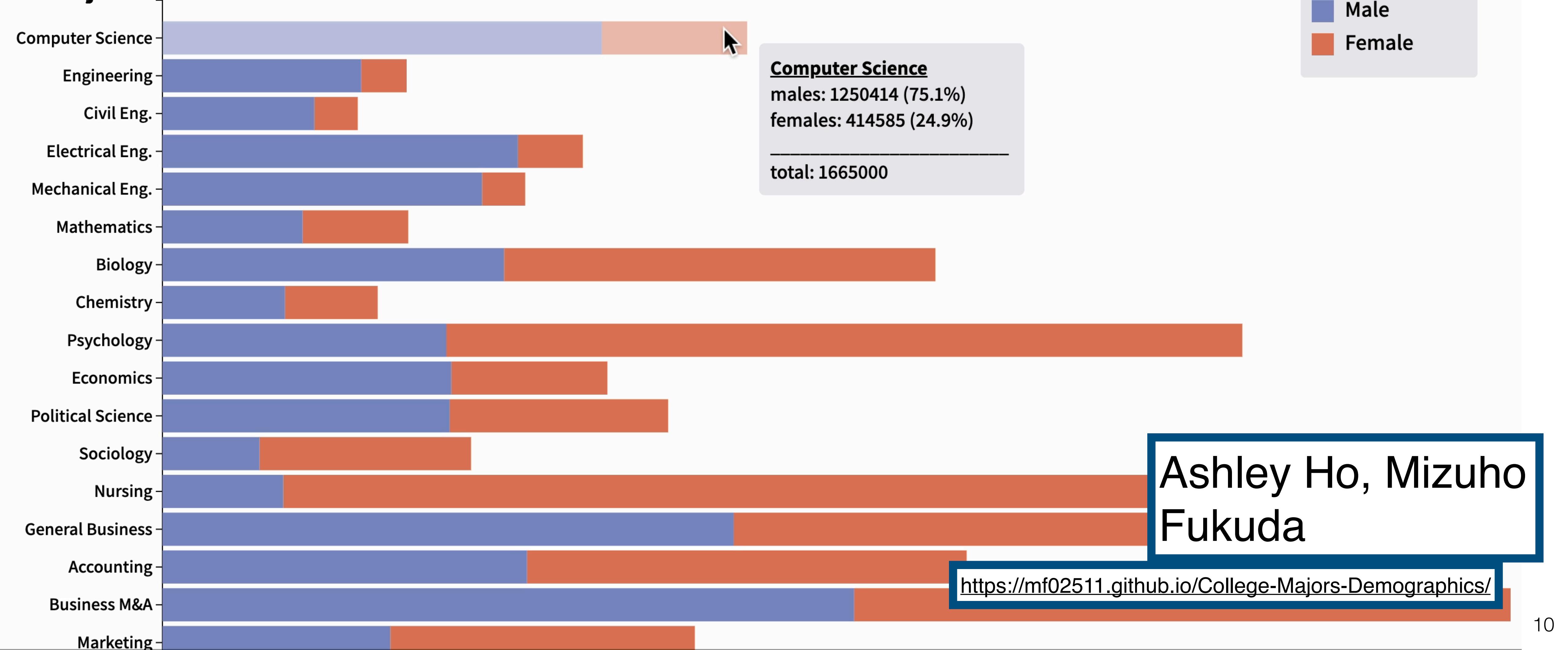
data source: [2022 ACS Detailed Field of Degree and Median Annual Earnings](#)

Gender

Race

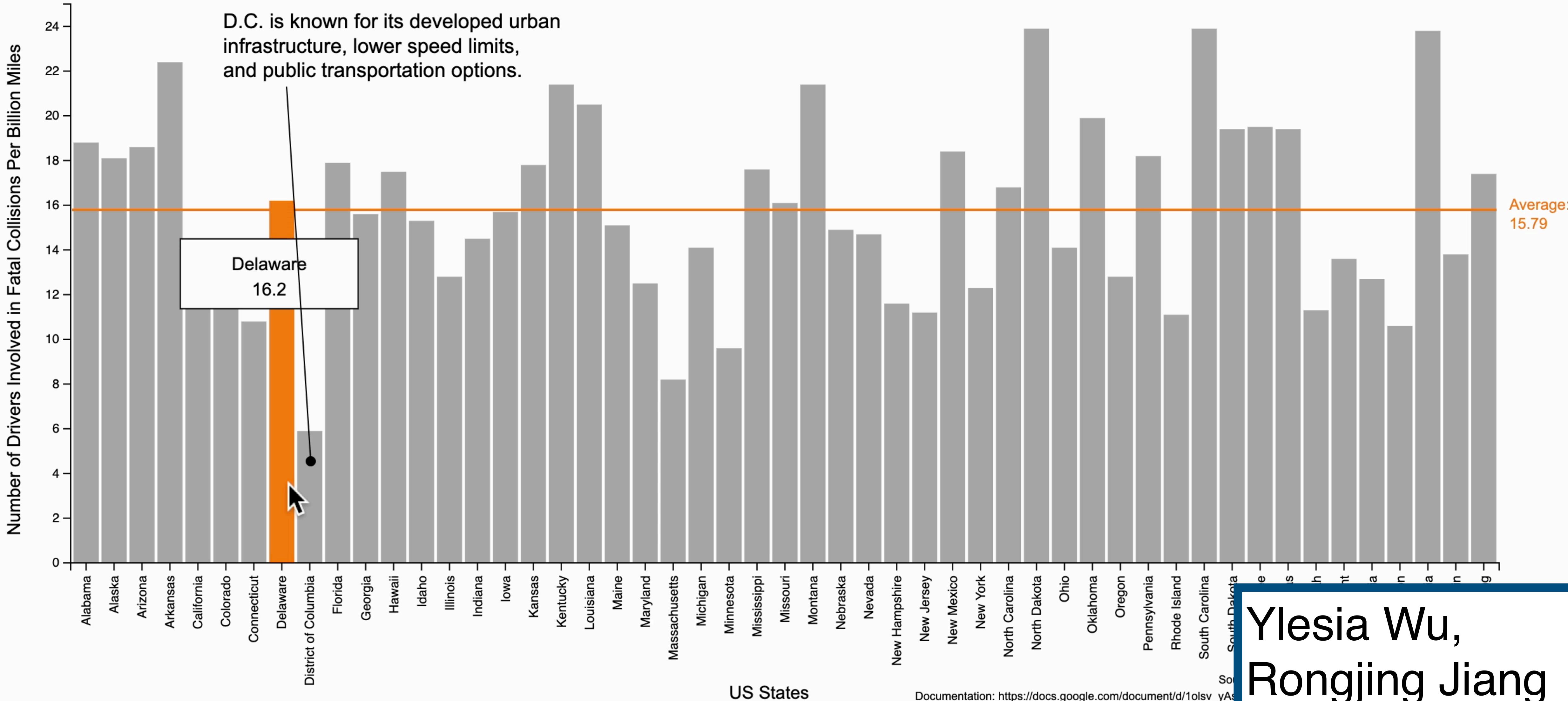
Age

Major



Good Drivers? Bad Drivers?

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



Ylesia Wu,
Rongjing Jiang

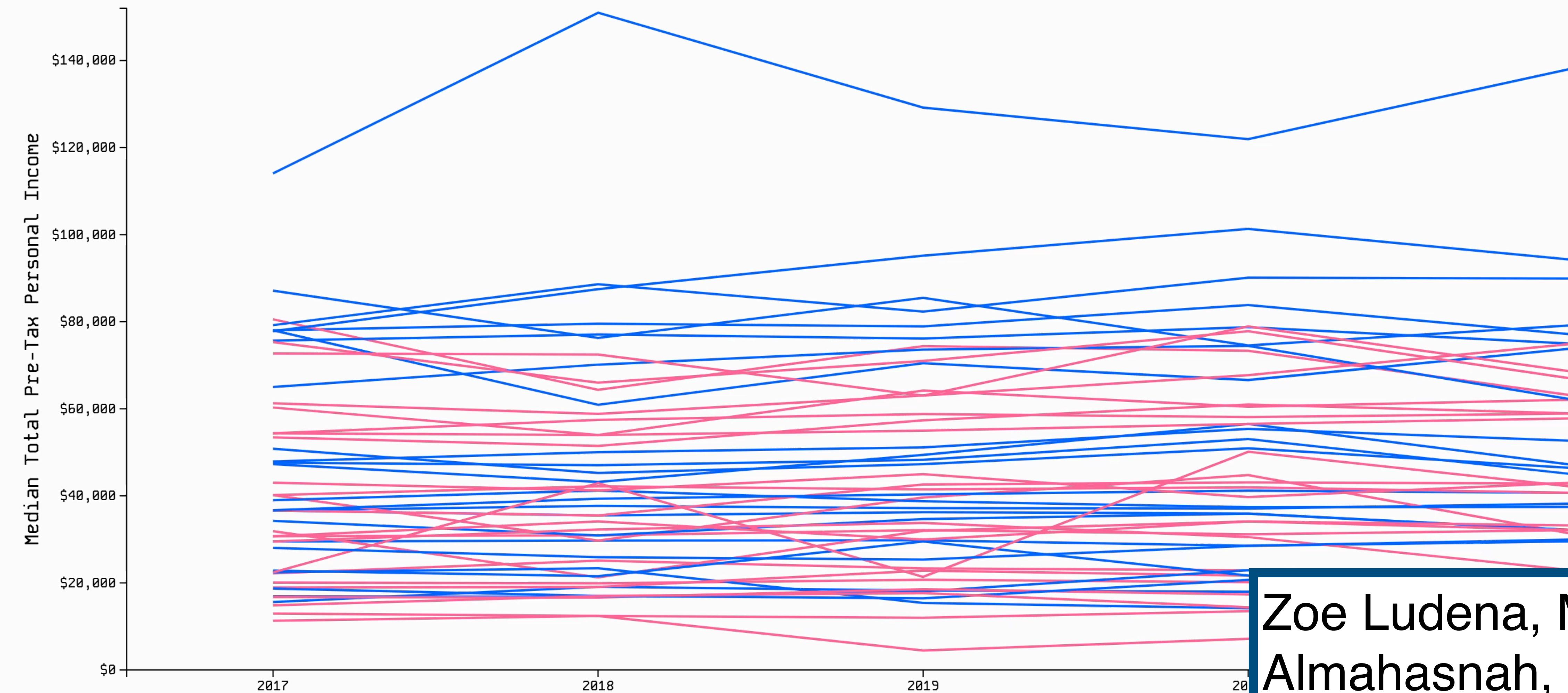
Documentation: https://docs.google.com/document/d/1olsv_yAs

All Occupations

Overlap? Try "Ctrl -"/"Ctrl +" or "Cmd -"/"Cmd +"

Income Per Gender for All Occupations

Male
Female



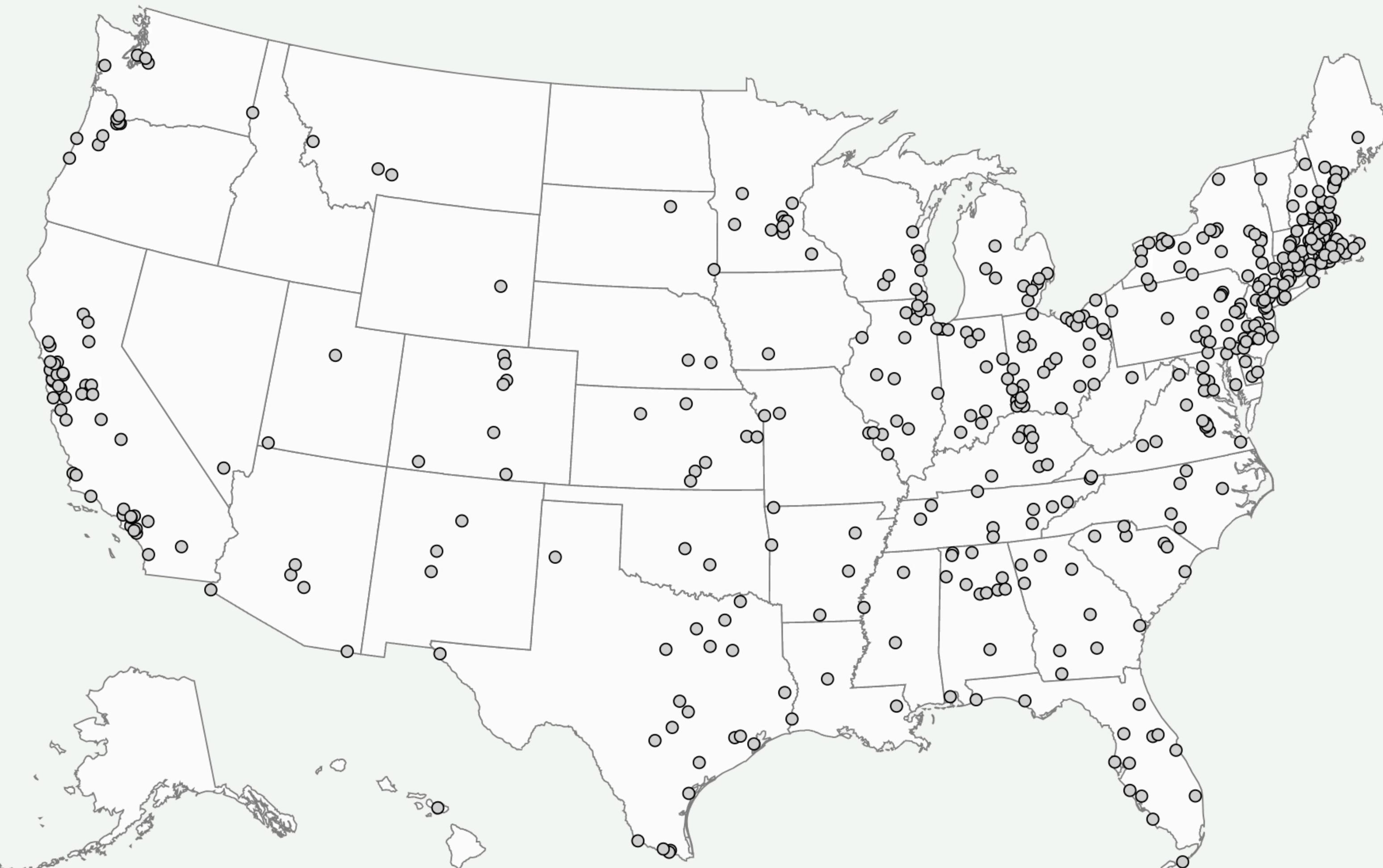
Zoe Ludena, Maryam
Almahasnah,
Anastasiya Markova

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.



[View Project Writeup Here](#)

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 recognition, please select the box one at a time first.

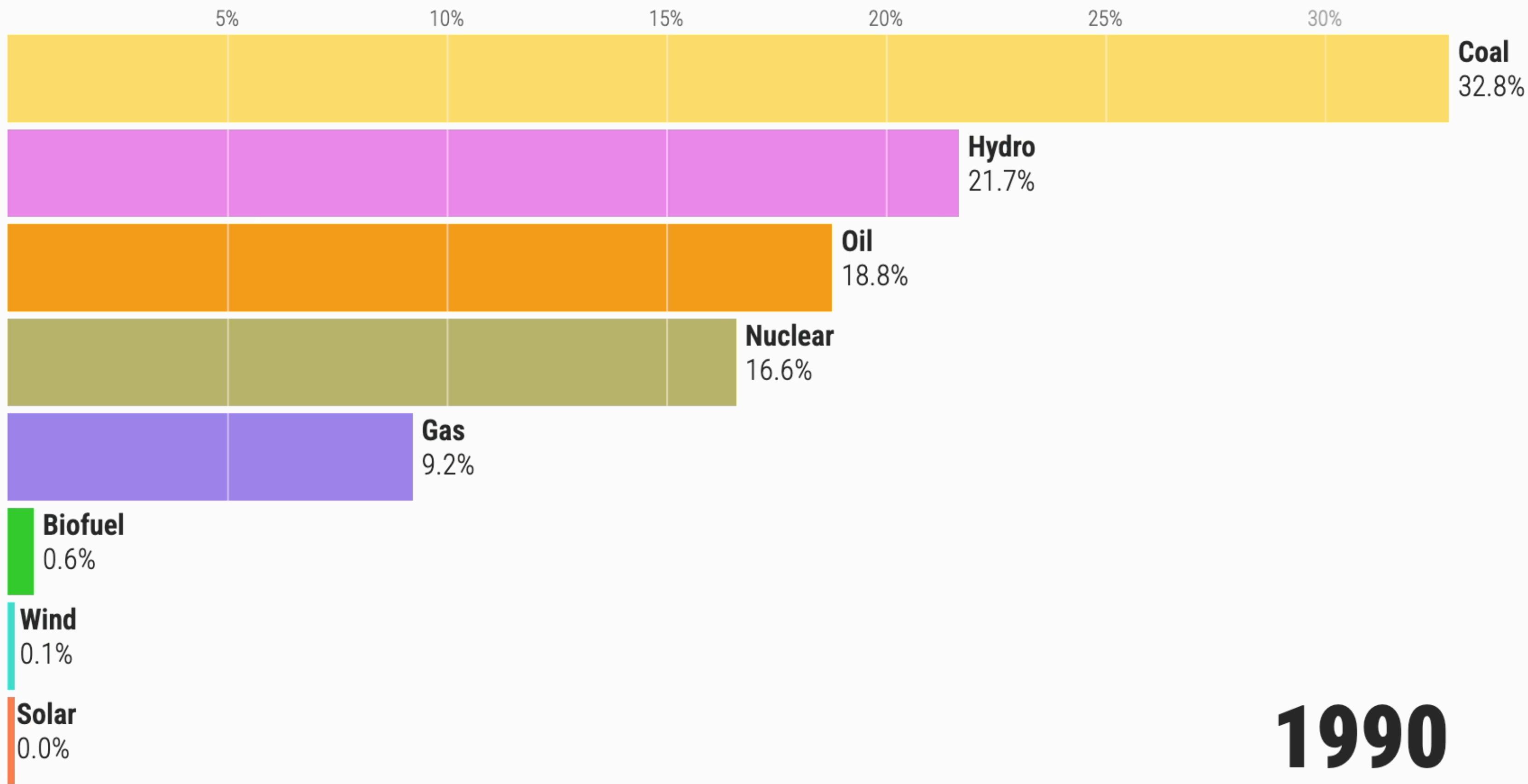
- Show English
- Show Spanish
- Show French
- Show Arabic
- Show German
- Show Italian
- Show Dutch
- Show Portuguese

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](#).



1990



Replay

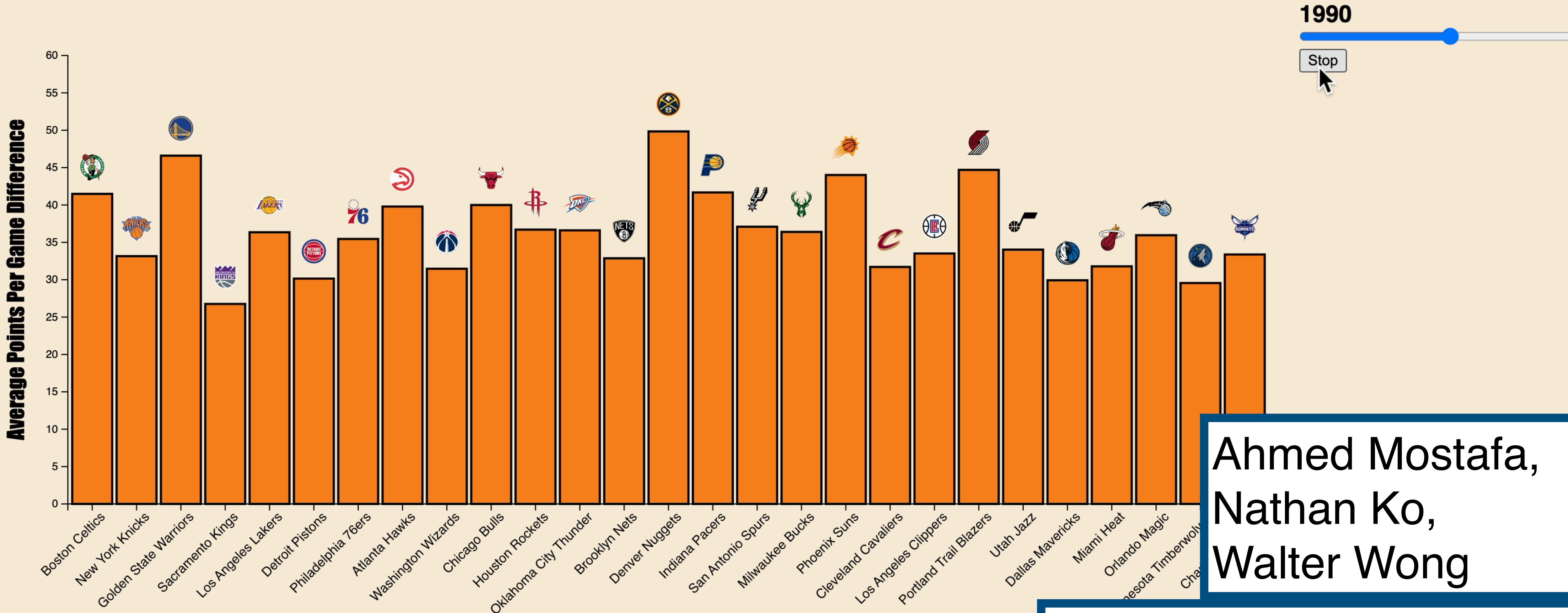
Naga Shivani Katta,
Saloni Patnaik,
Shreya Pakala

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



Is Defense Dying in the NBA?

NBA Teams Difference in Average Points per Game in 1990 From All Time Lowest Average



Ahmed Mostafa,
Nathan Ko,
Walter Wong



Choose Energy Type:

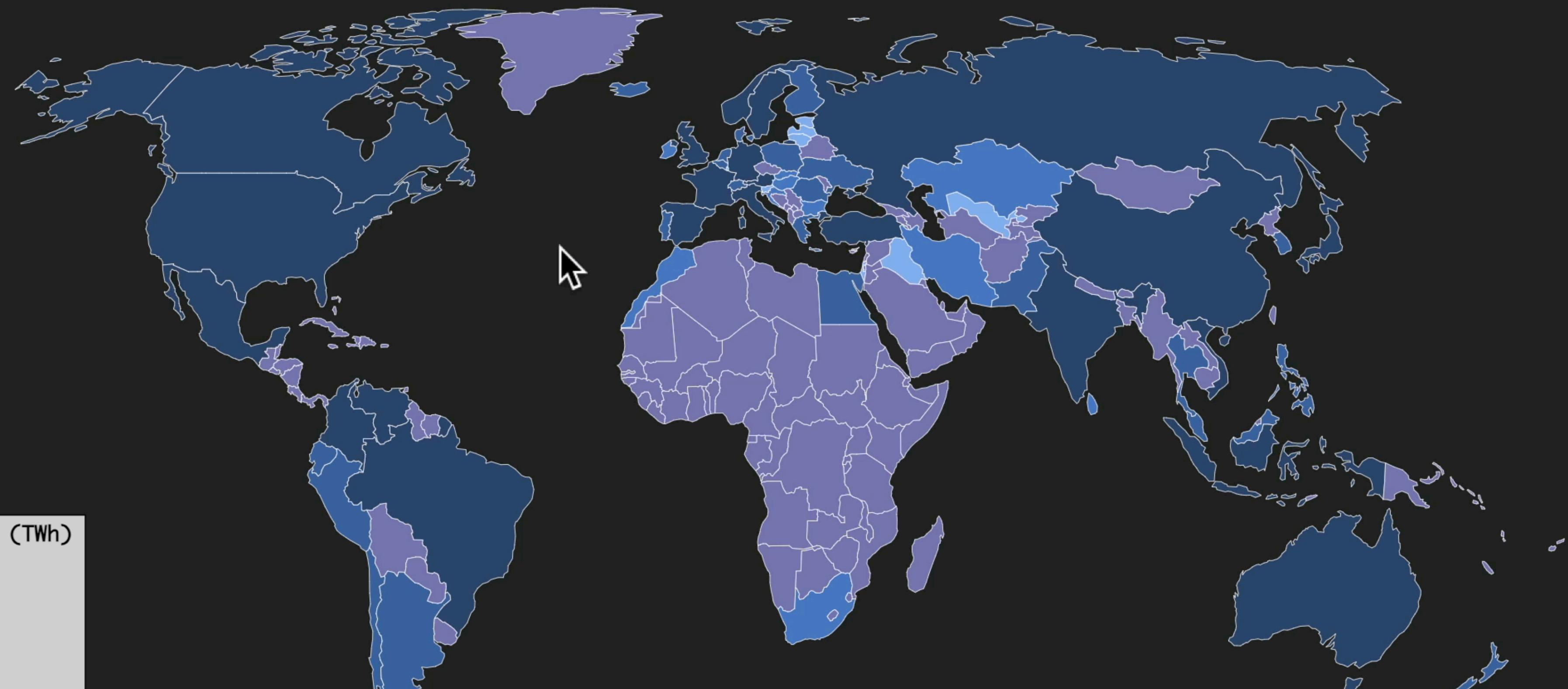
Renewables Consumption

YEAR: 2021

Highlight Country:

Type a country name

Hover over each country to see the % change in that countries energy consumption



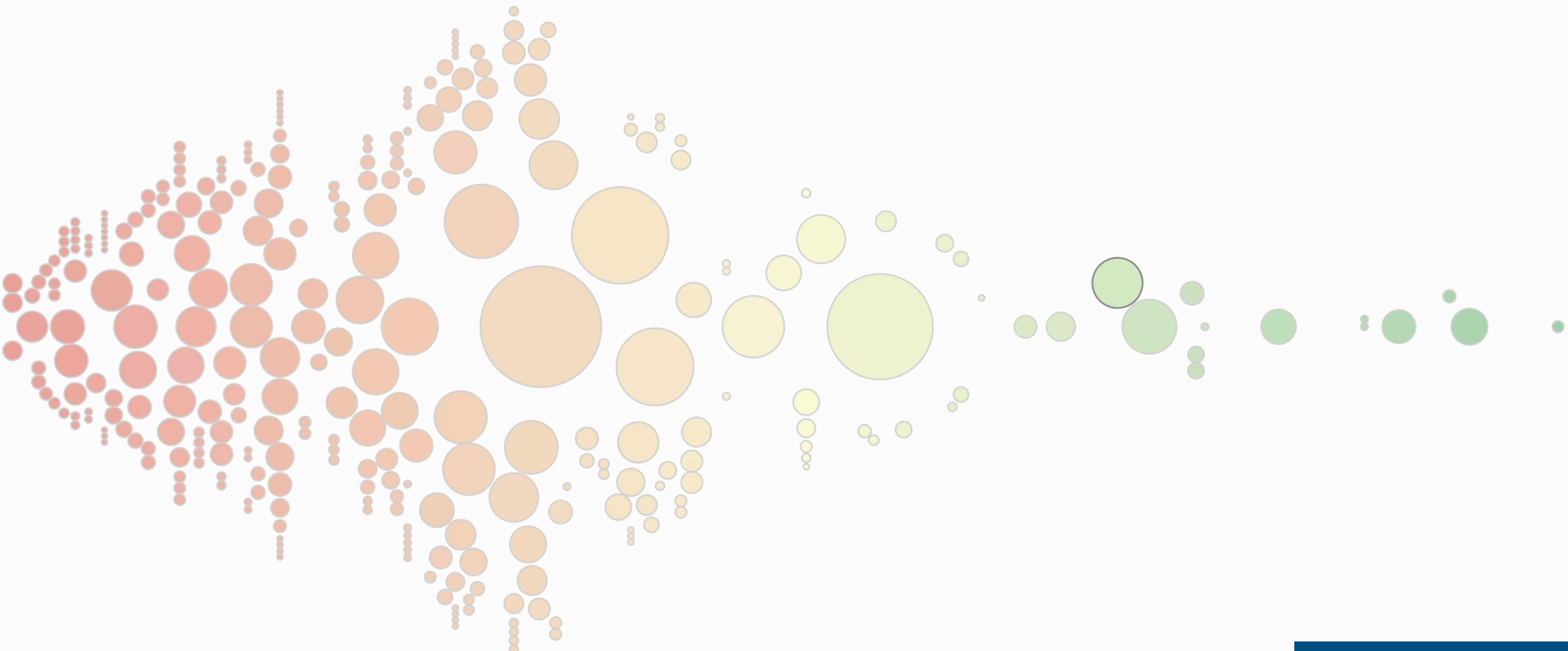
Keenan Serrao,
Ansh Mujral

<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

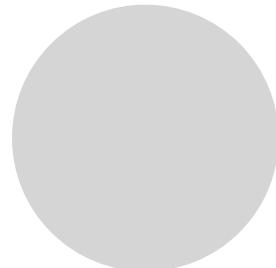
Animation Goals

Direct attention

Increase Engagement

Explain a Process

Understand a State Transition



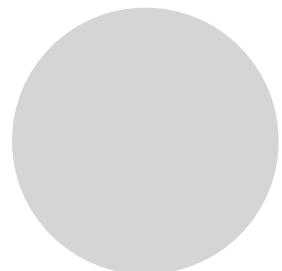
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Direct attention

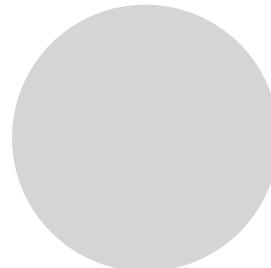
Increase Engagement

Explain a Process

Understand a State Transition

Motion as a visual cue

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



7.5 fps



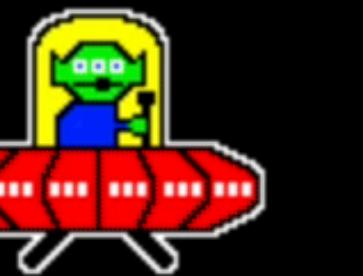
15 fps



30 fps



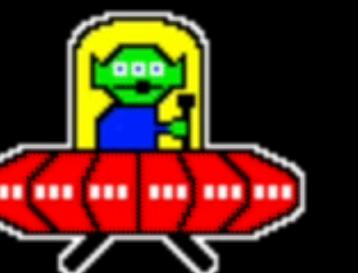
60 fps



60 fps



30 fps



15 fps



7.5 fps



Animation Goals

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Motion as a visual cue

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every 100ms).

Animation Goals



Direct attention

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Explain a Process

Understand a State Transition

Motion as a visual cue

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

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).

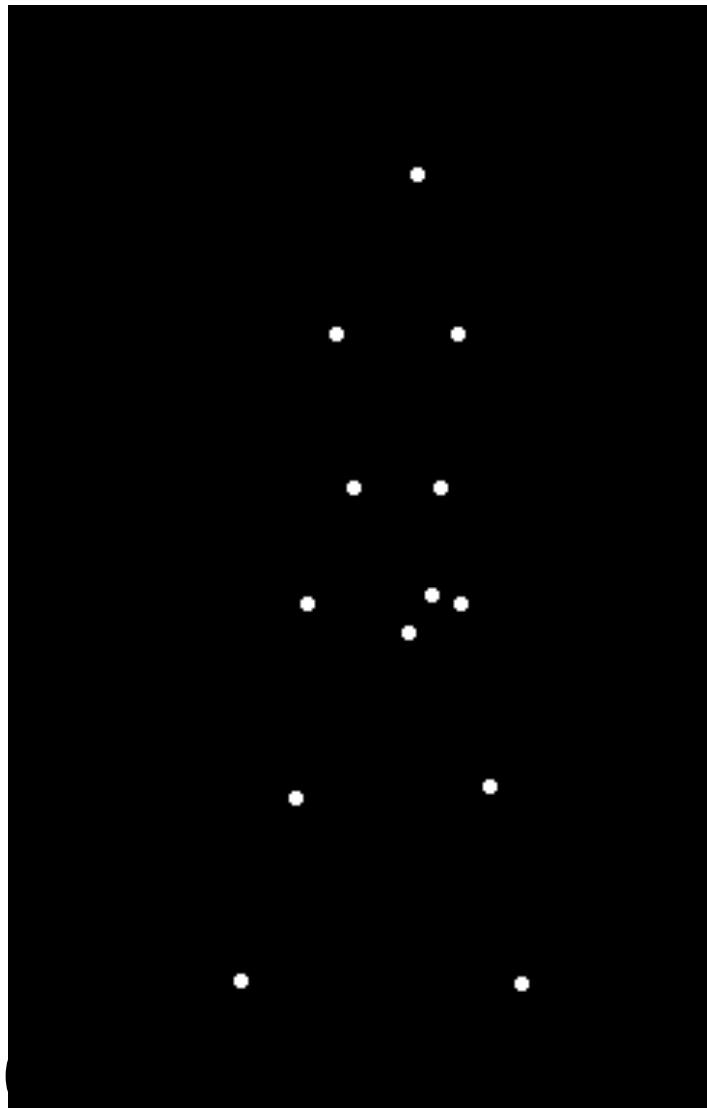
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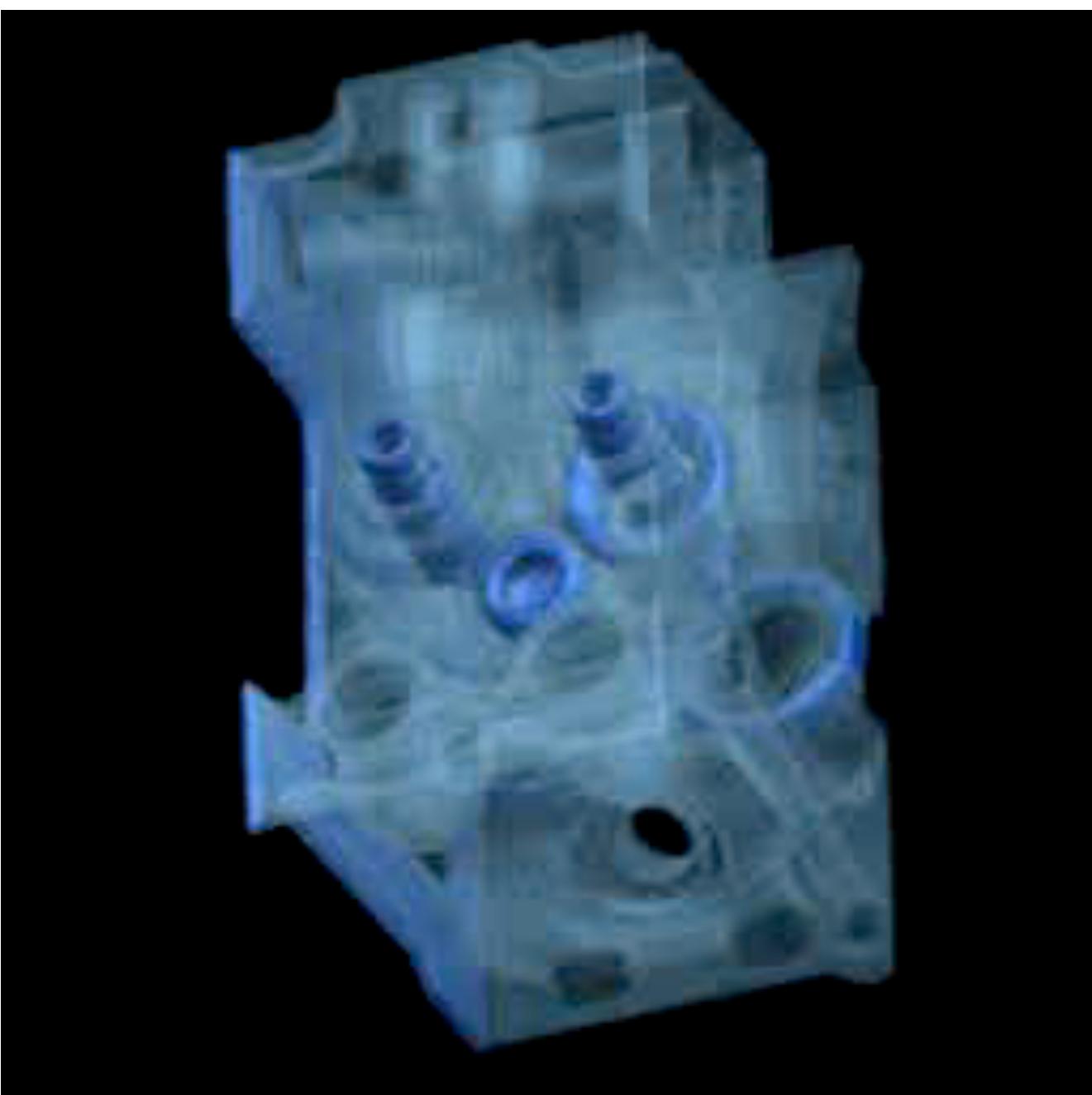
Animation Goals

Direct attention



Increase Engagement

Explain a Process



Understand a State Transition

Animation Goals

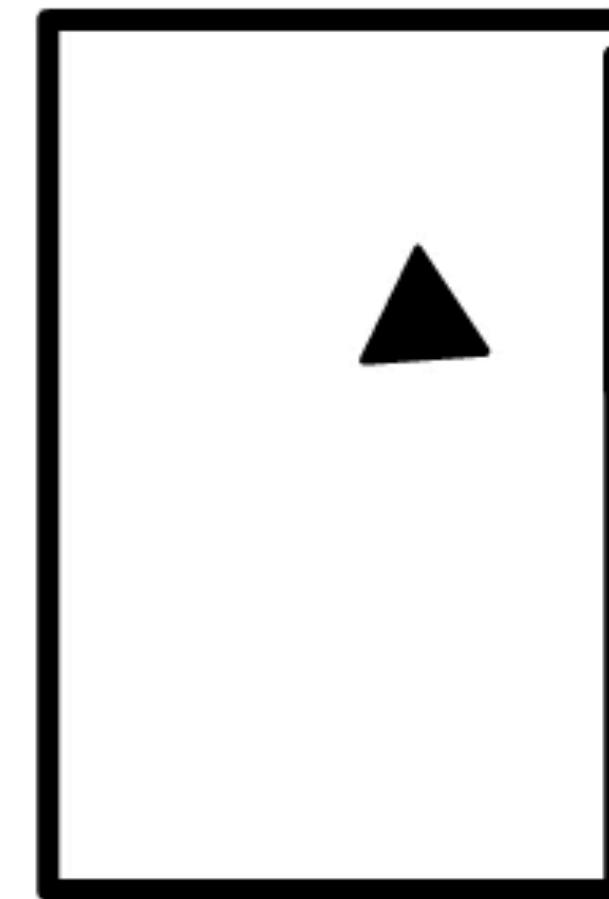
Constructing narratives & anthropomorphizing

Direct attention

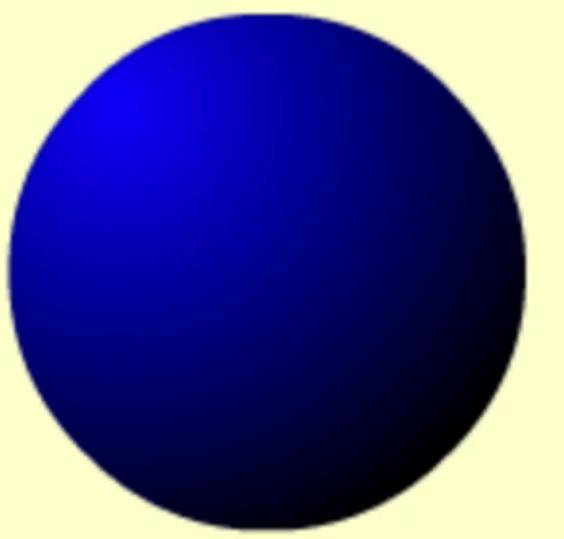
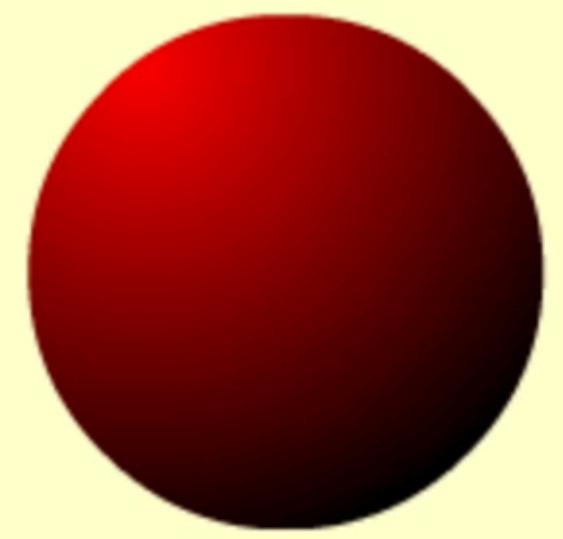
Increase Engagement

Explain a Process

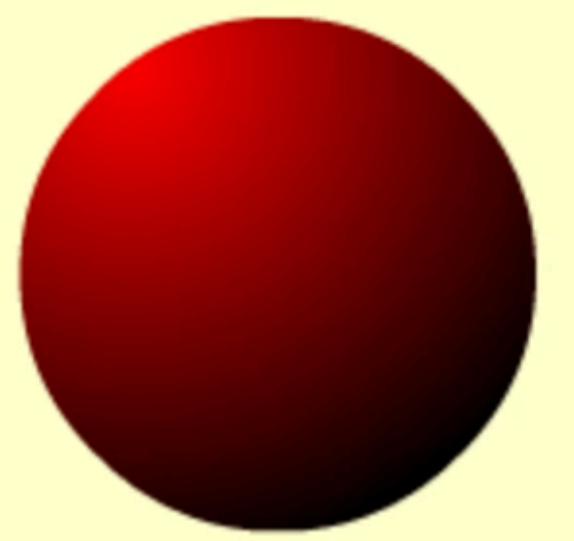
Understand a State Transition



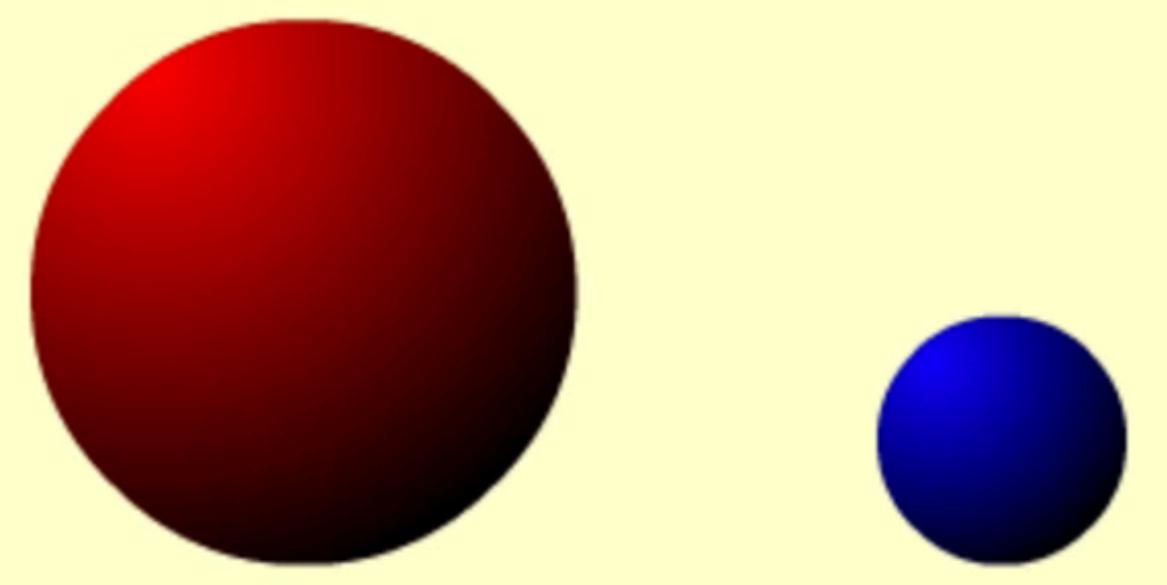
What's happening in this film?



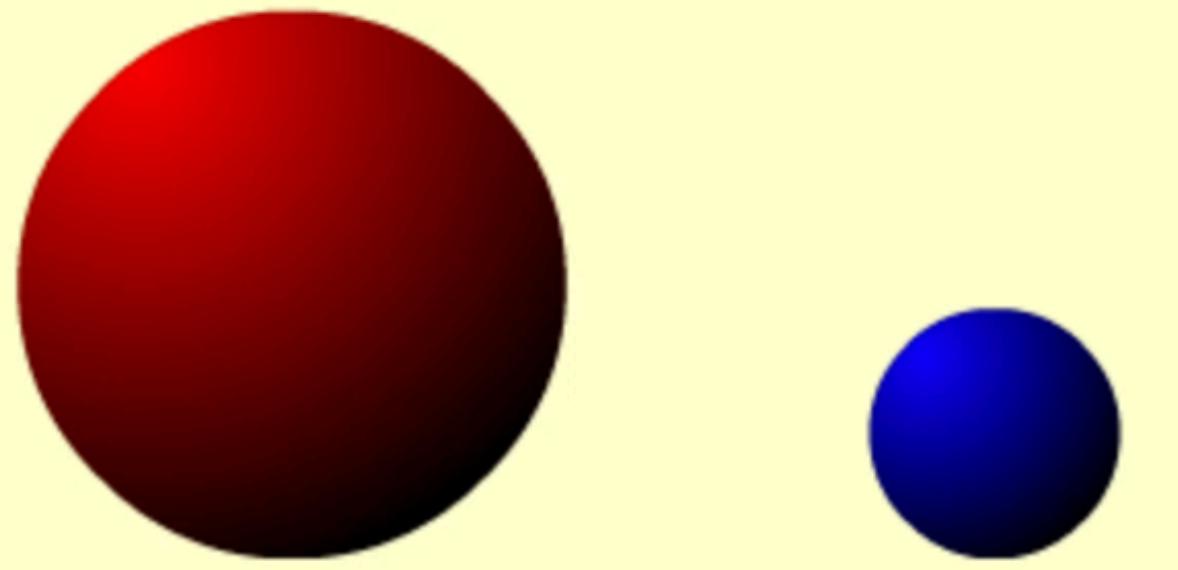
[Michotte 1946]



[Michotte 1946]



[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

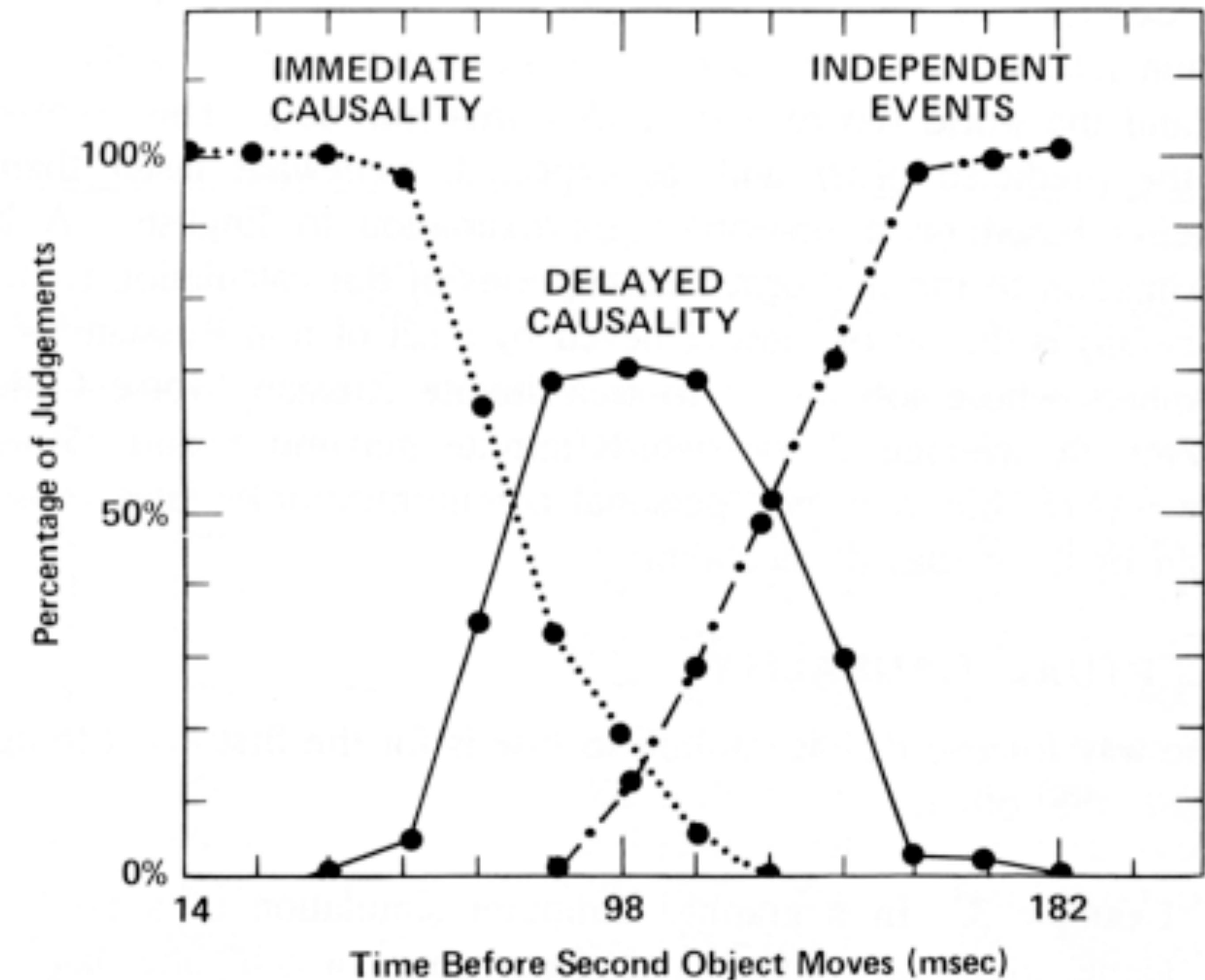
Attribution of Causality.

Direct attention

Increase Engagement

Explain a Process

Understand a State Transition



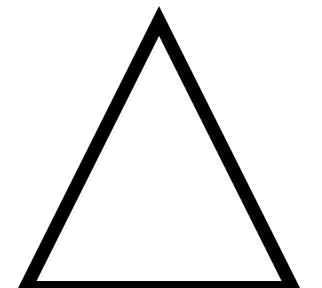
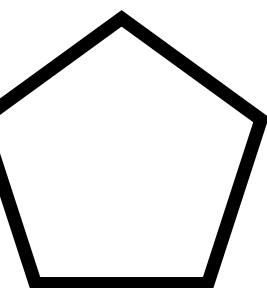
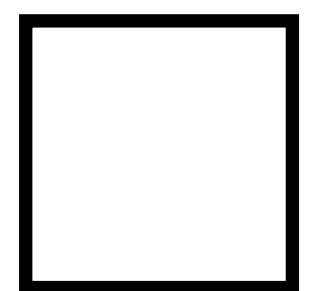
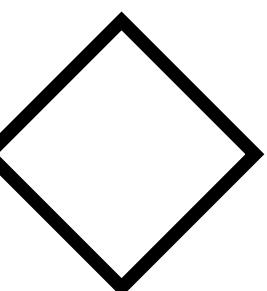
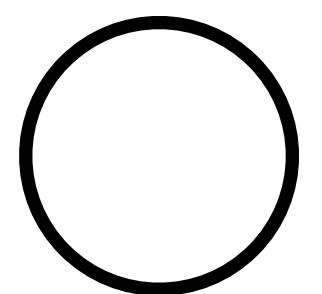
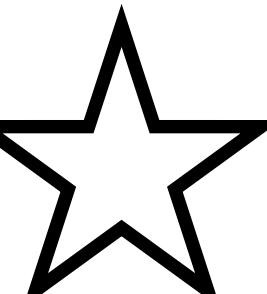
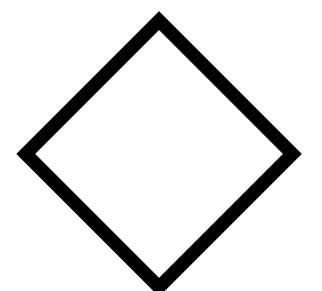
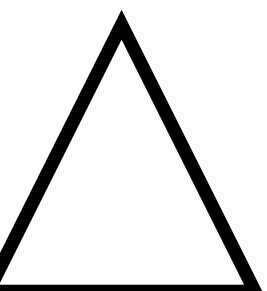
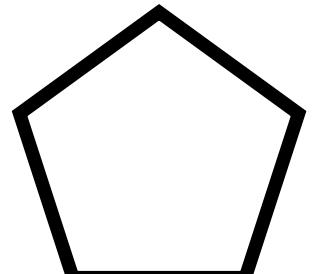
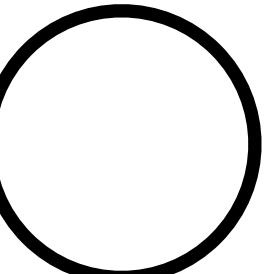
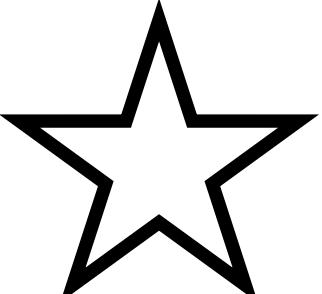
Animation Goals

Direct attention

Increase Engagement

Explain a Process

Understand a State Transition



Start

End

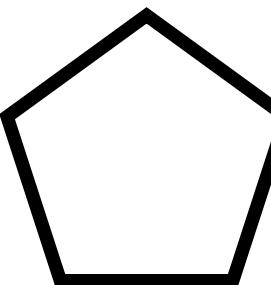
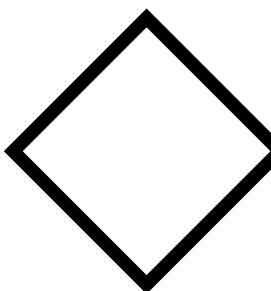
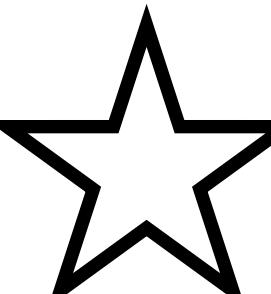
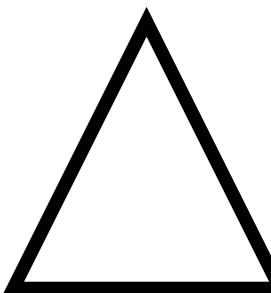
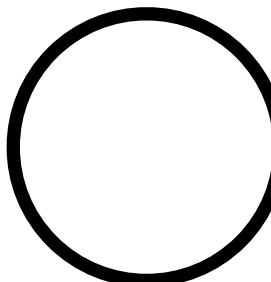
Animation Goals

Direct attention

Increase Engagement

Explain a Process

Understand a State Transition

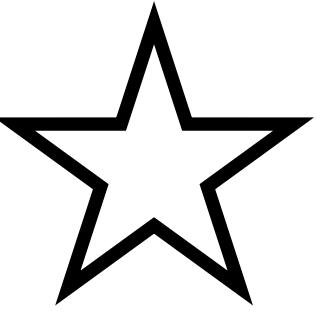


Start

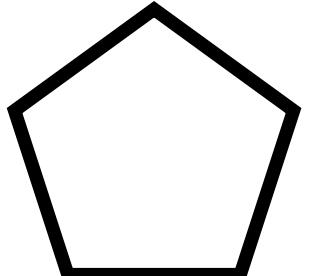
End

Animation Goals

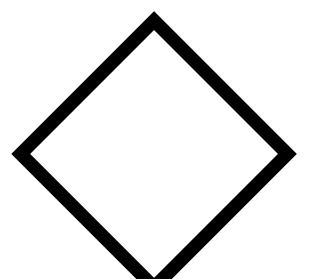
Direct attention



Increase Engagement



Explain a Process

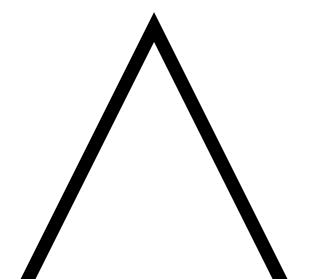
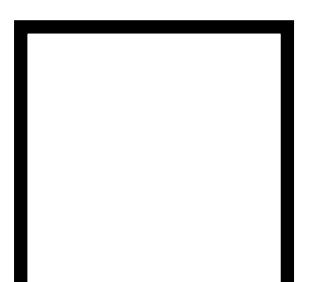
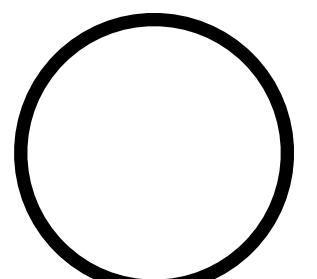


Understand a State Transition

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?

Direct attention

Increase Engagement

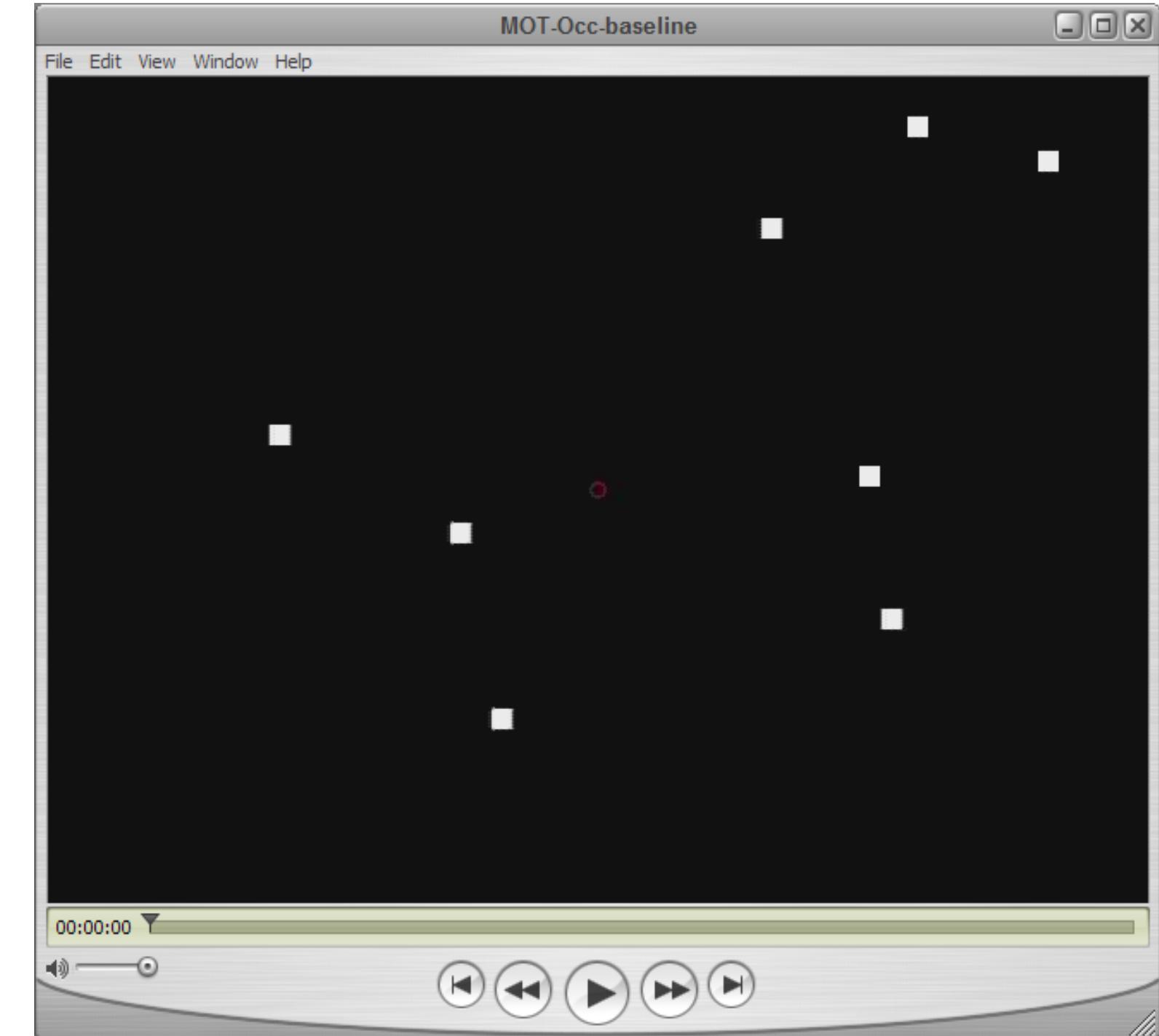
Explain a Process

Understand a State Transition

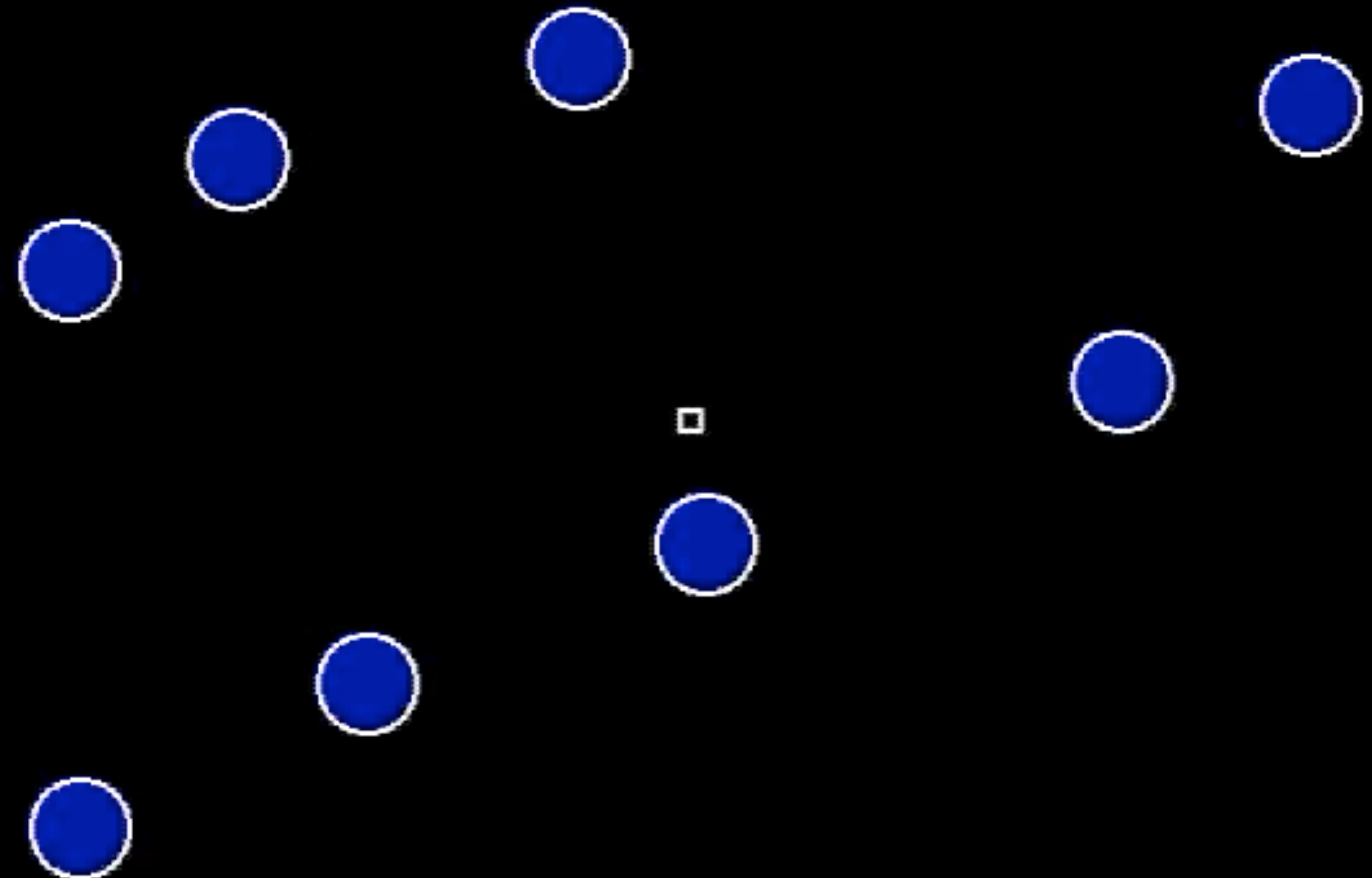
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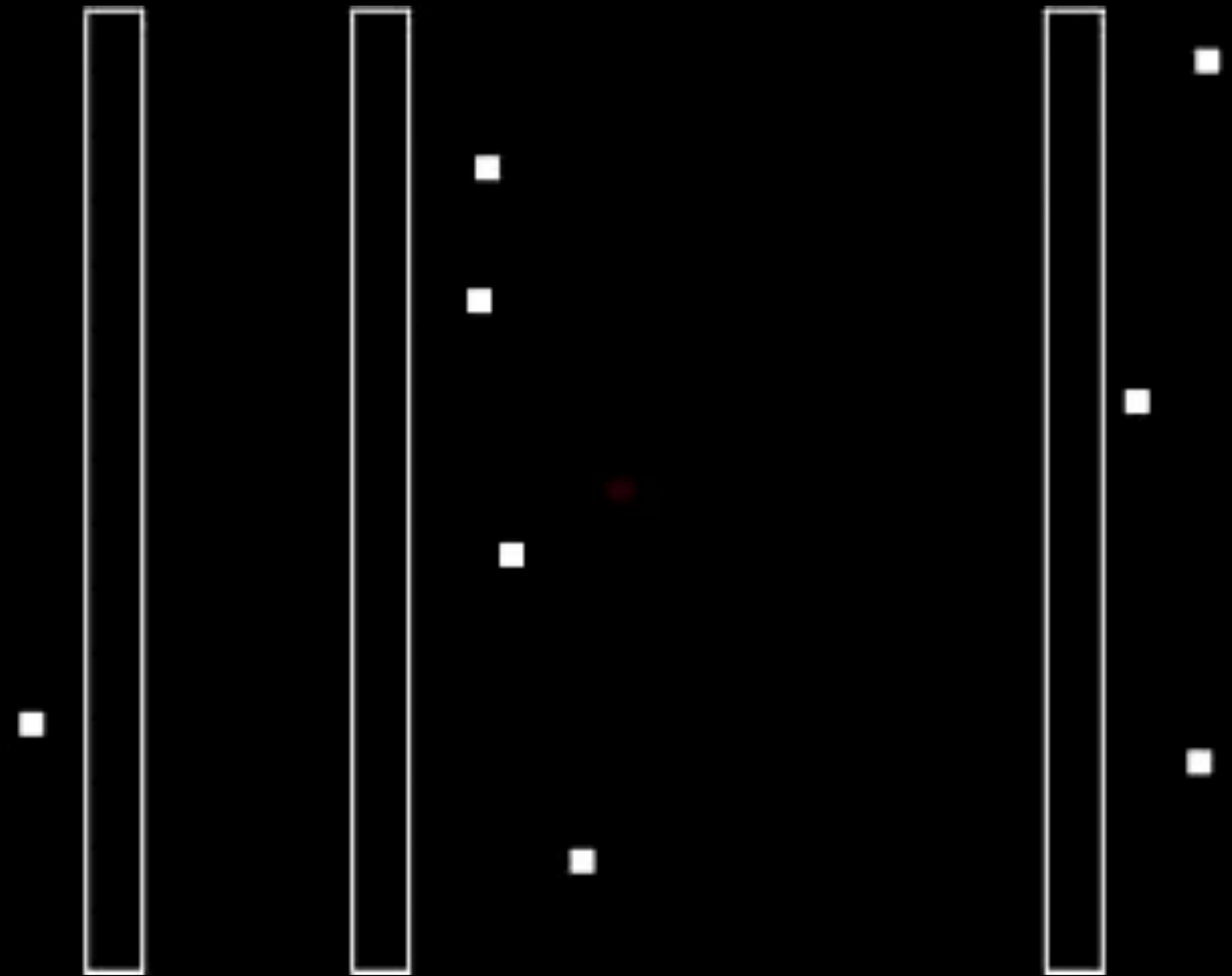
May be too fast or too slow.

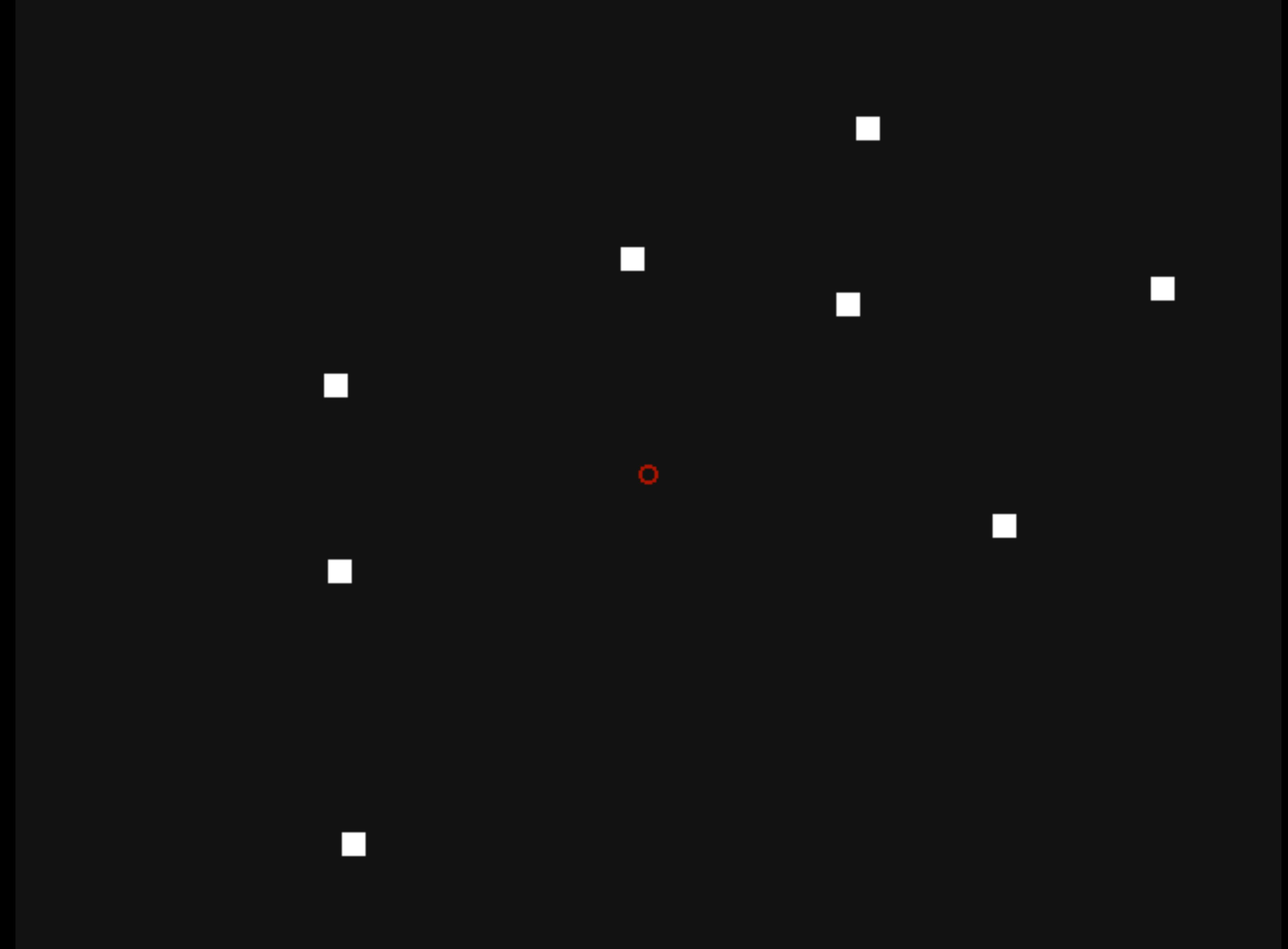
Too many objects may move at once.

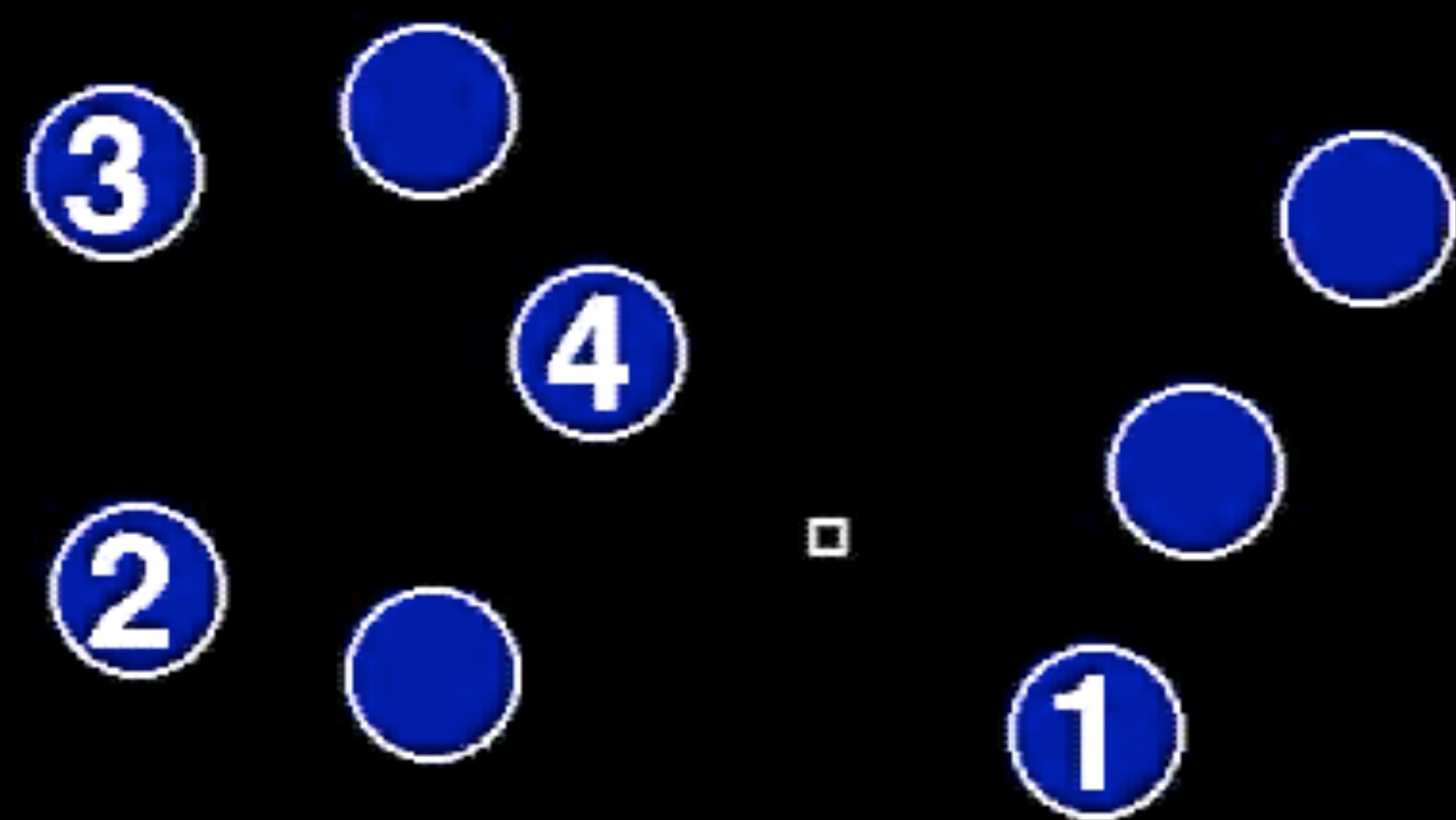












Animation Goals

How many dots can we track at once?

4-6. Difficulty increases significantly at 6.

Direct attention

Increase Engagement

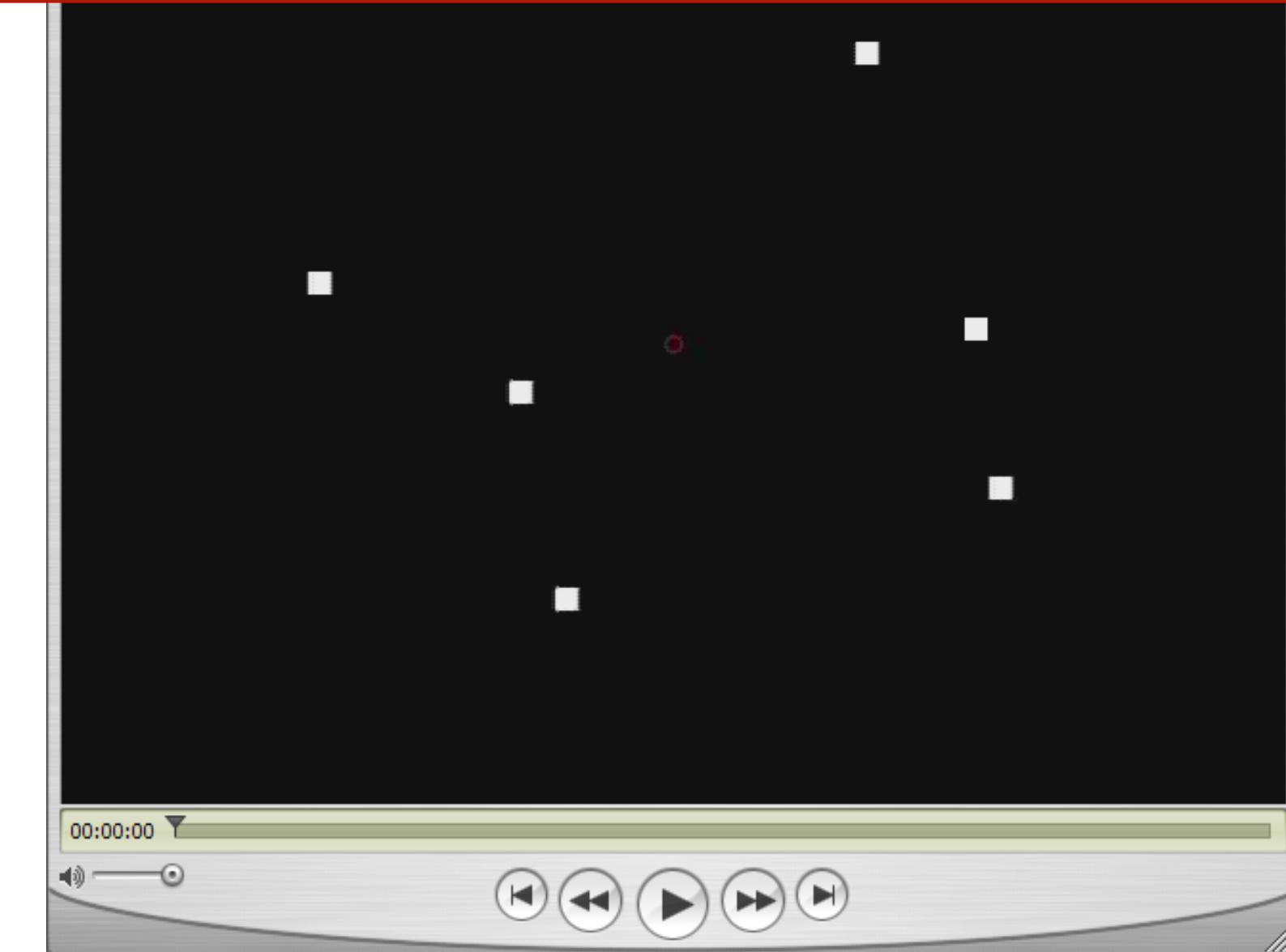
Explain a Process

Understand a State Transition

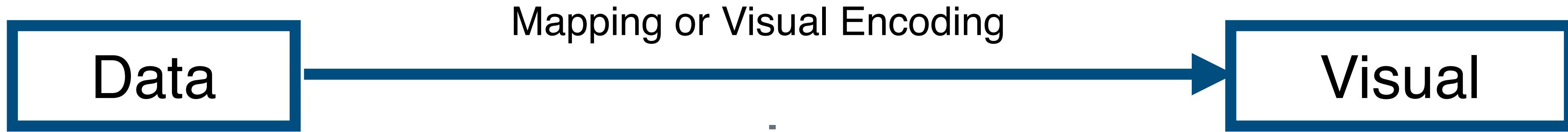
Animation can show transition better, but...

May be too fast or too slow.

Too many objects may move at once.



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

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.*

Principles of Animation

Congruence

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

Effectiveness

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

Apprehension

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

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

Maintain **valid data graphics during transitions**
Respect **semantic correspondence & object constancy**
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.

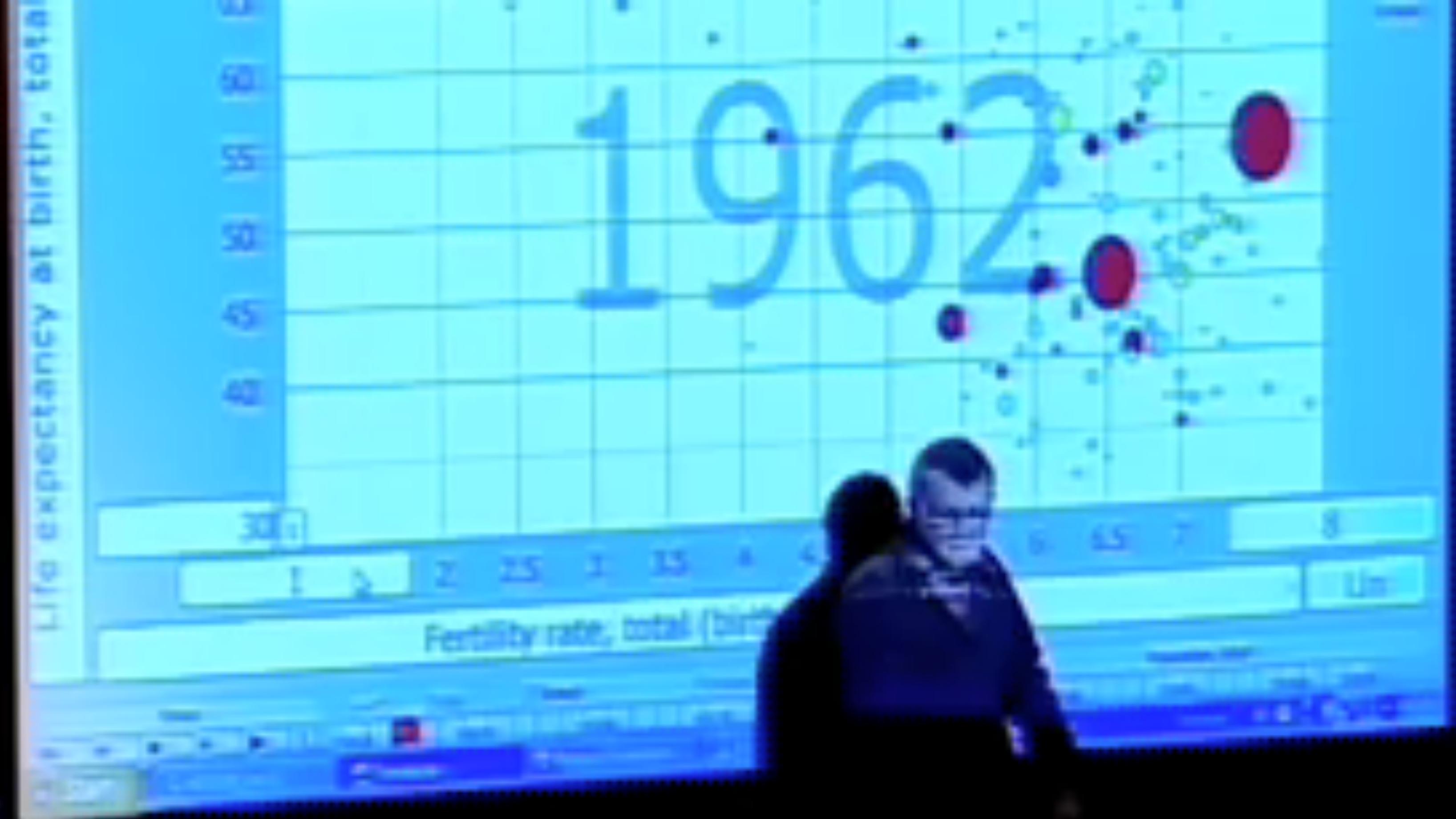
Axis re-scaling hampers perception

Avoid if possible (use common scale)

Maintain landmarks better (delay fade out of lines)

Subjects preferred animated transitions



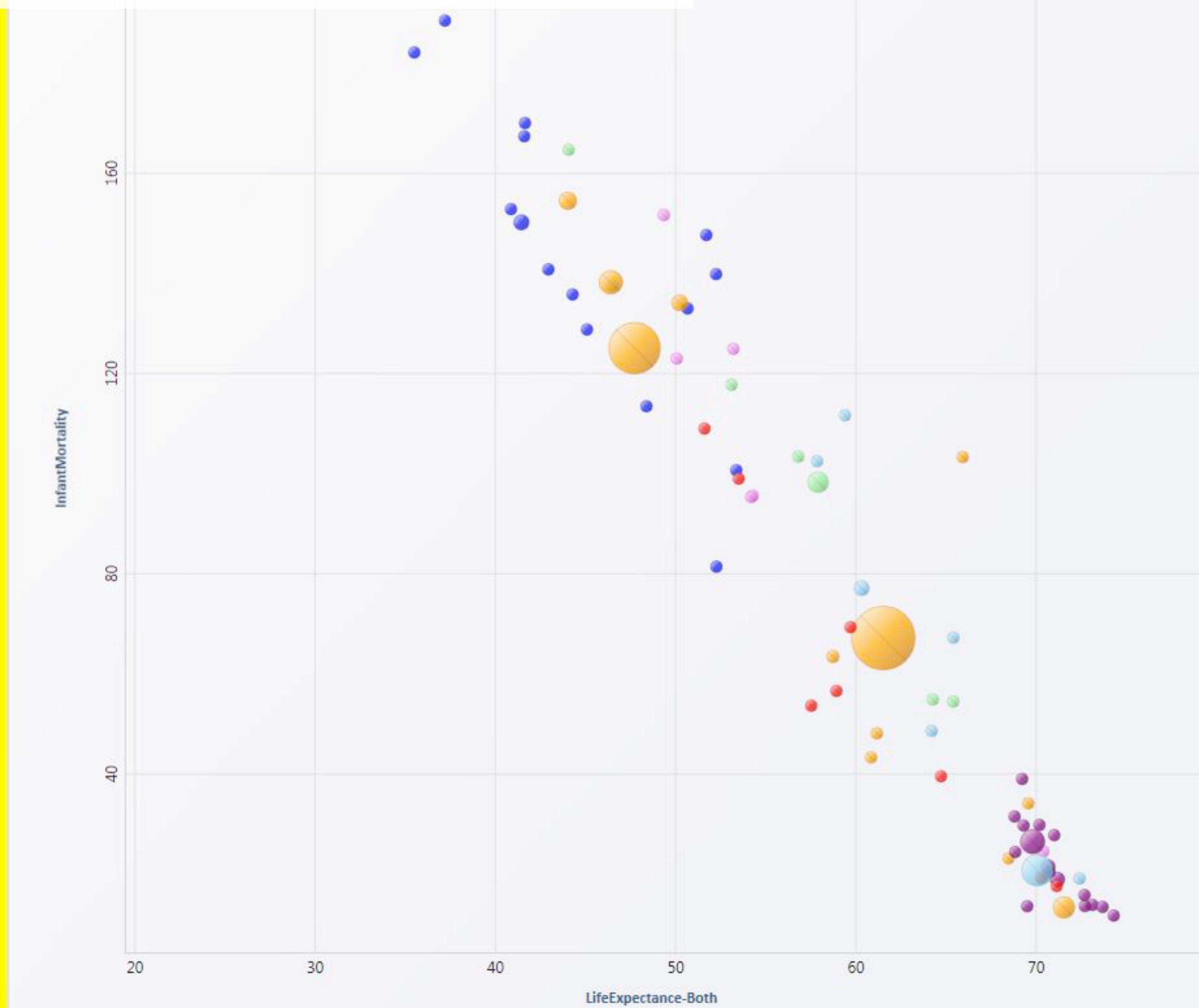


TED



Animated Scatterplot

1975



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

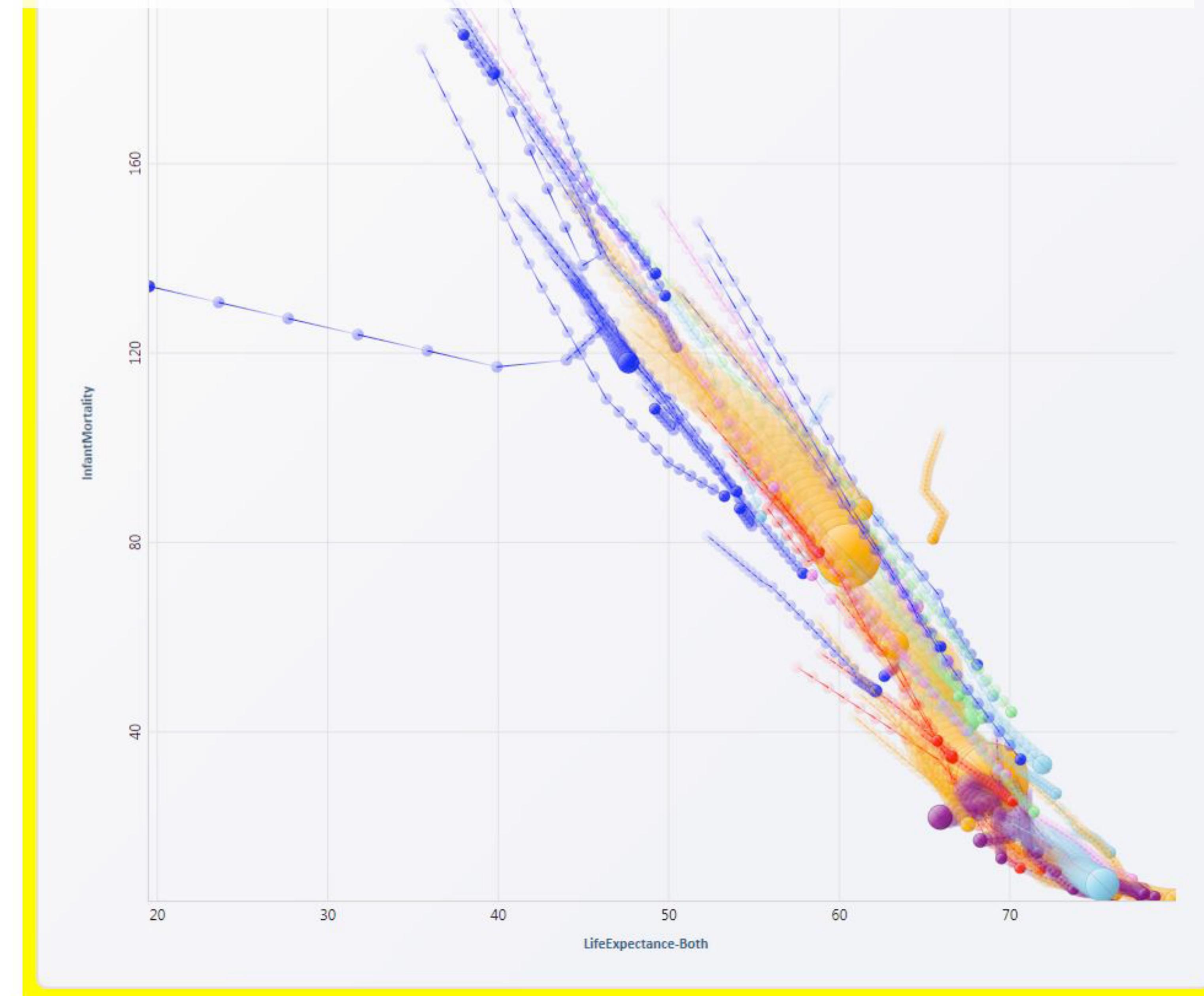
Next

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

Give Up

Next

Traces / Connected Scatterplot



Color Legend (continent)

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

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

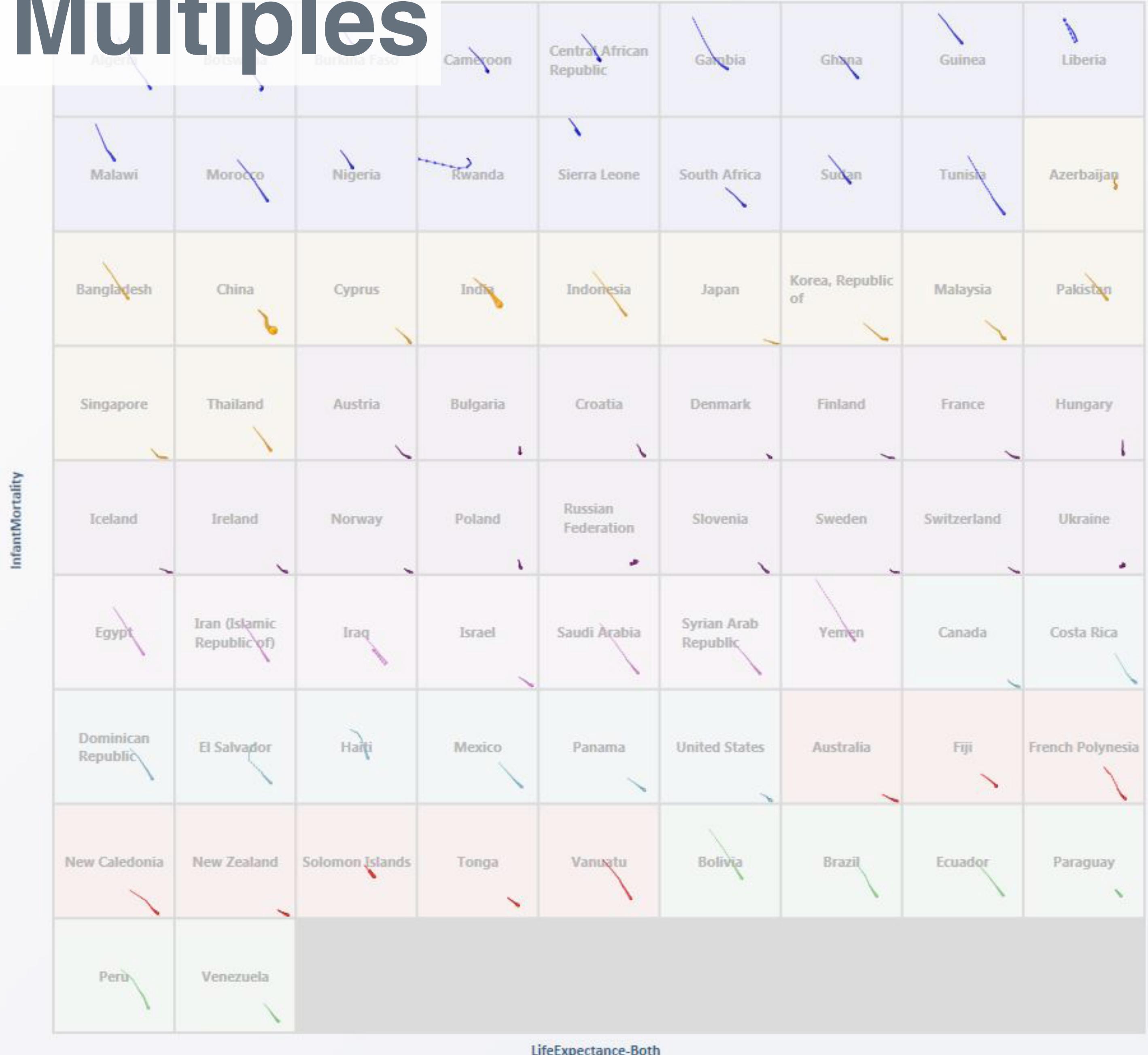
Next

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

Give Up

Next

Small Multiples



Color Legend (continent)

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

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

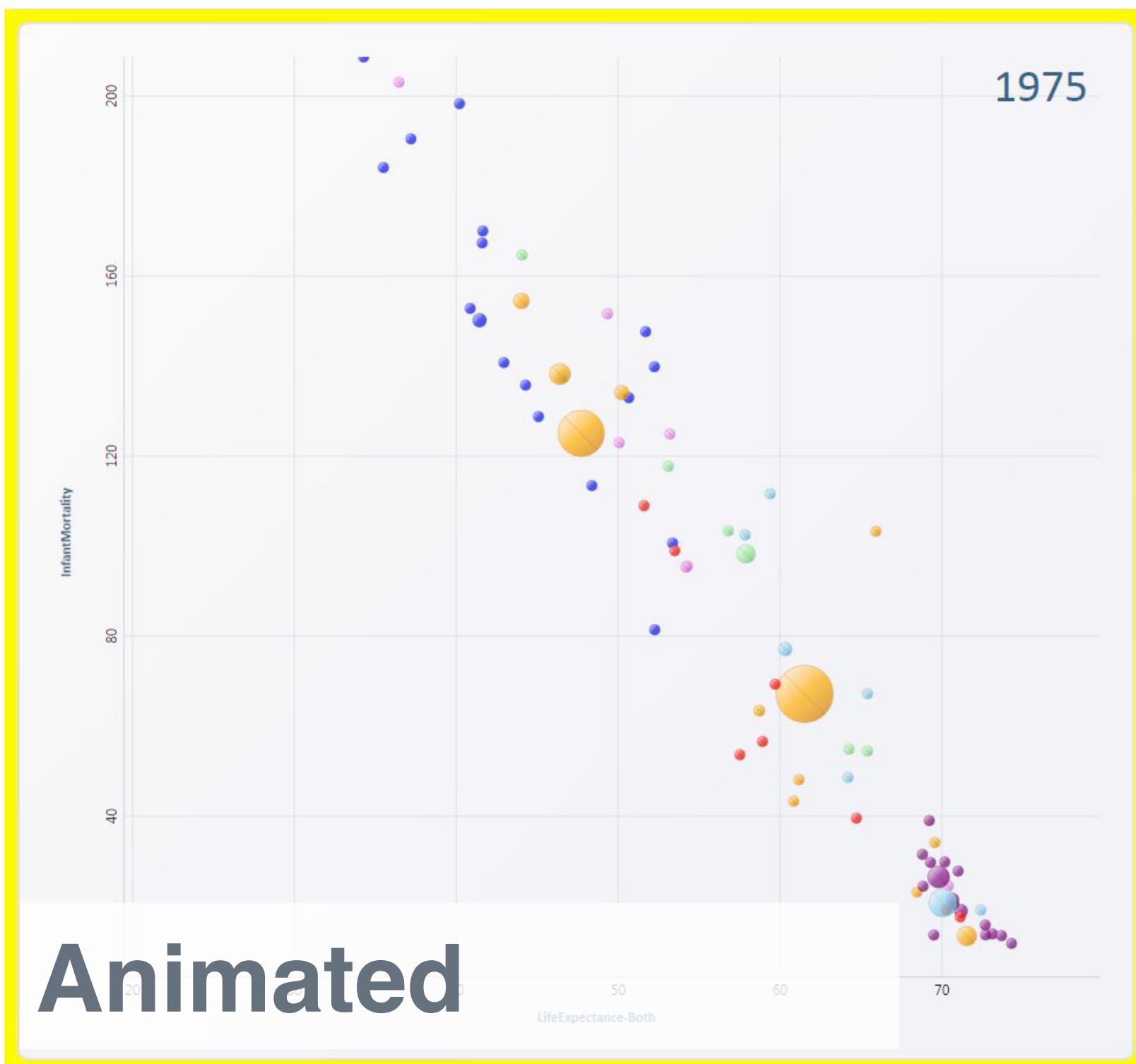
Click on "Next" when finished (or "Give Up" if you cannot find all the answers)

[Give Up](#)

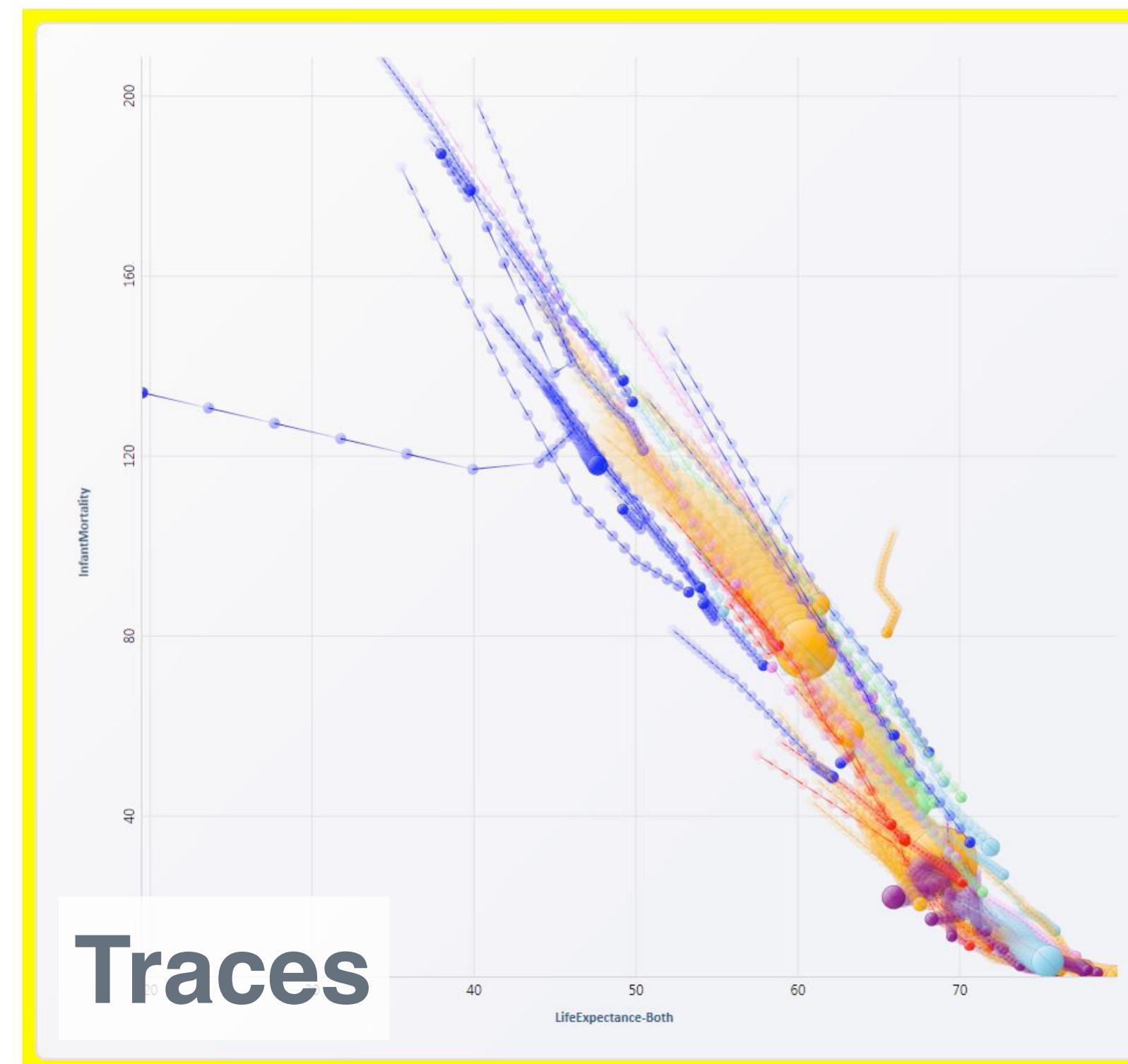
[Next](#)

Study Conclusions

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



Animated



Traces



Small Multiples

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

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.

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!).

Implementing Animation

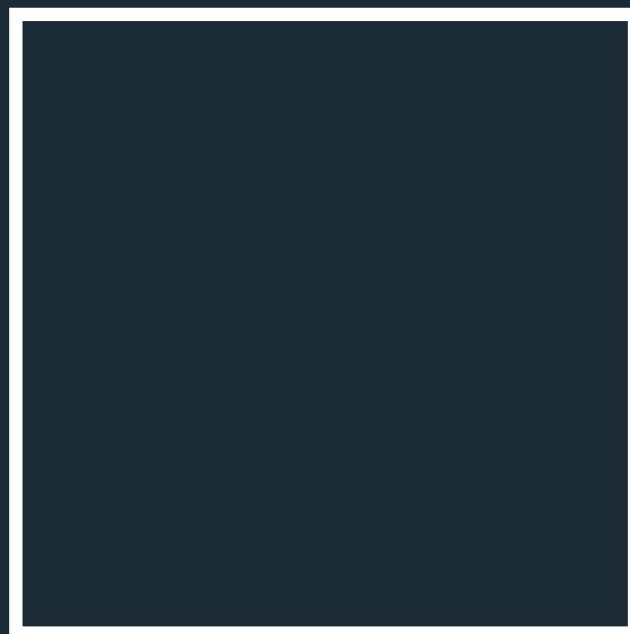
Implementing Animation

Frame-Based Animation

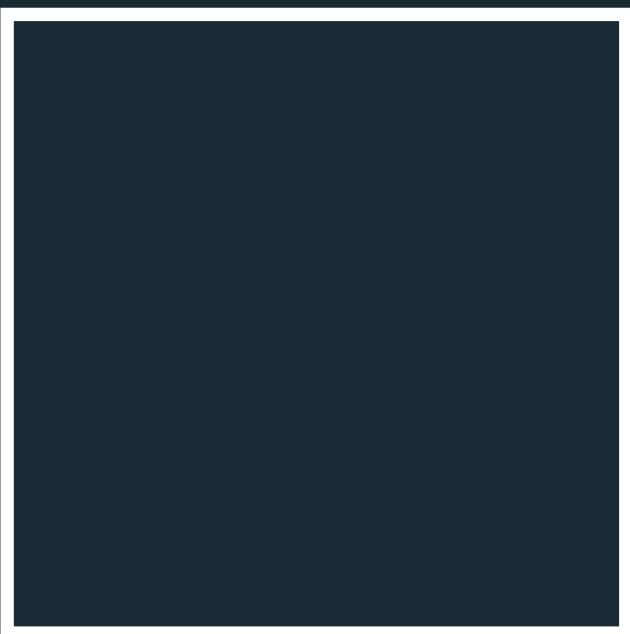
Redraw the scene at regular intervals (e.g., 16ms).

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

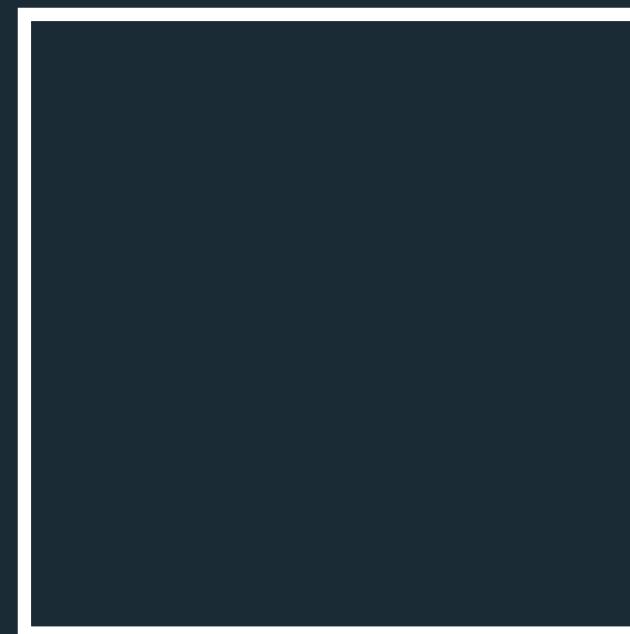
`circle(10, 10)`



`circle(15, 15)`



`circle(20, 20)`



`circle(25, 25)`



1

2

3

4

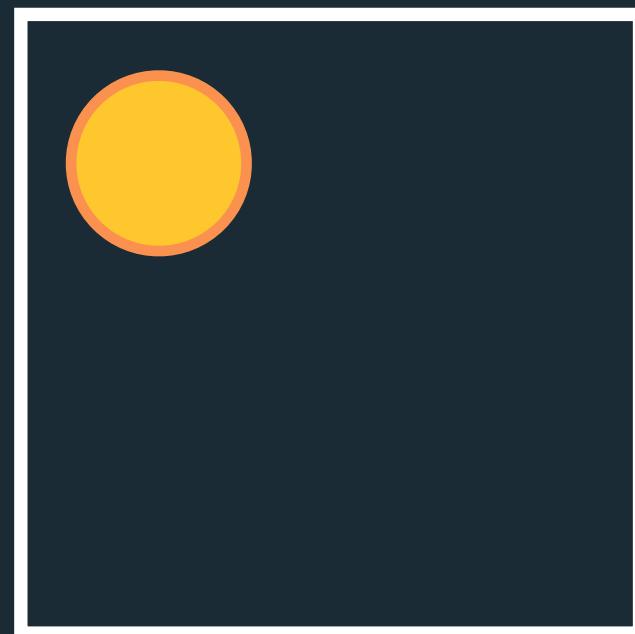
Implementing Animation

Frame-Based Animation

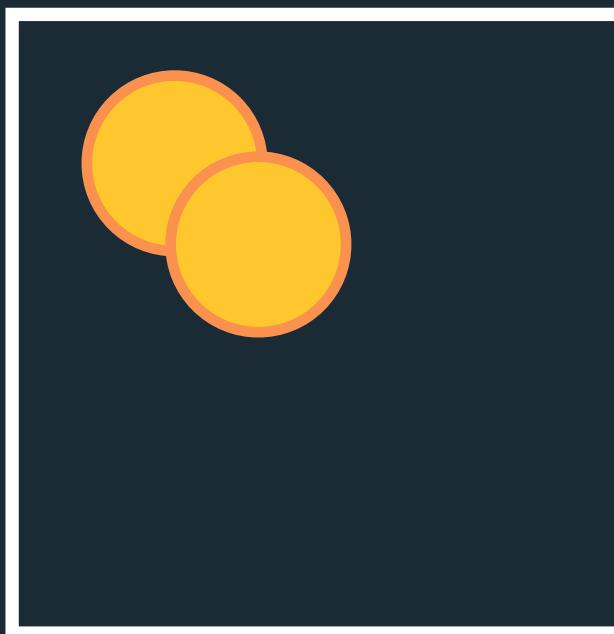
Redraw the scene at regular intervals (e.g., 16ms).

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

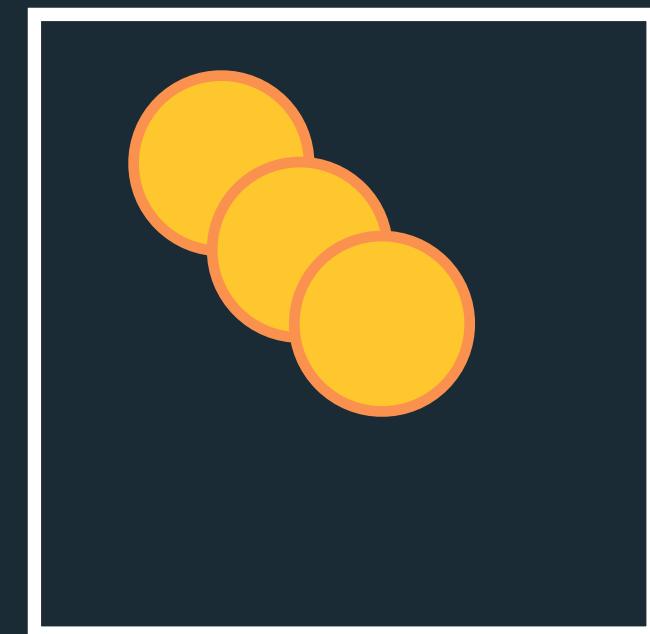
`circle(10, 10)`



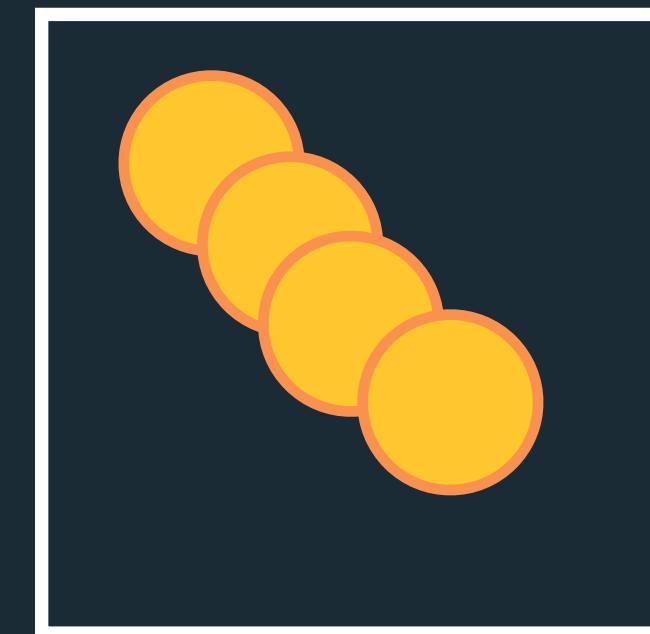
`circle(15, 15)`



`circle(20, 20)`



`circle(25, 25)`



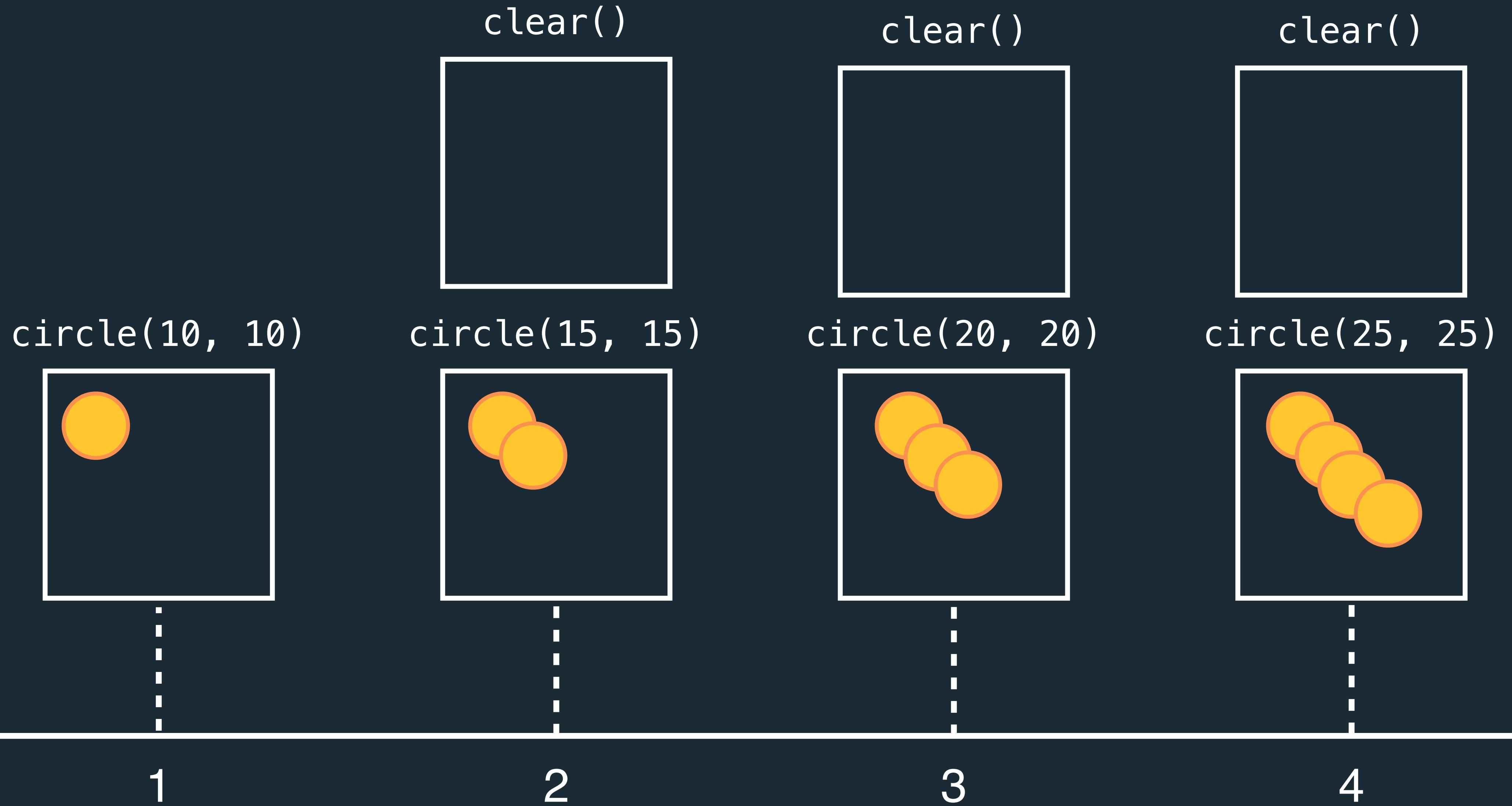
1

2

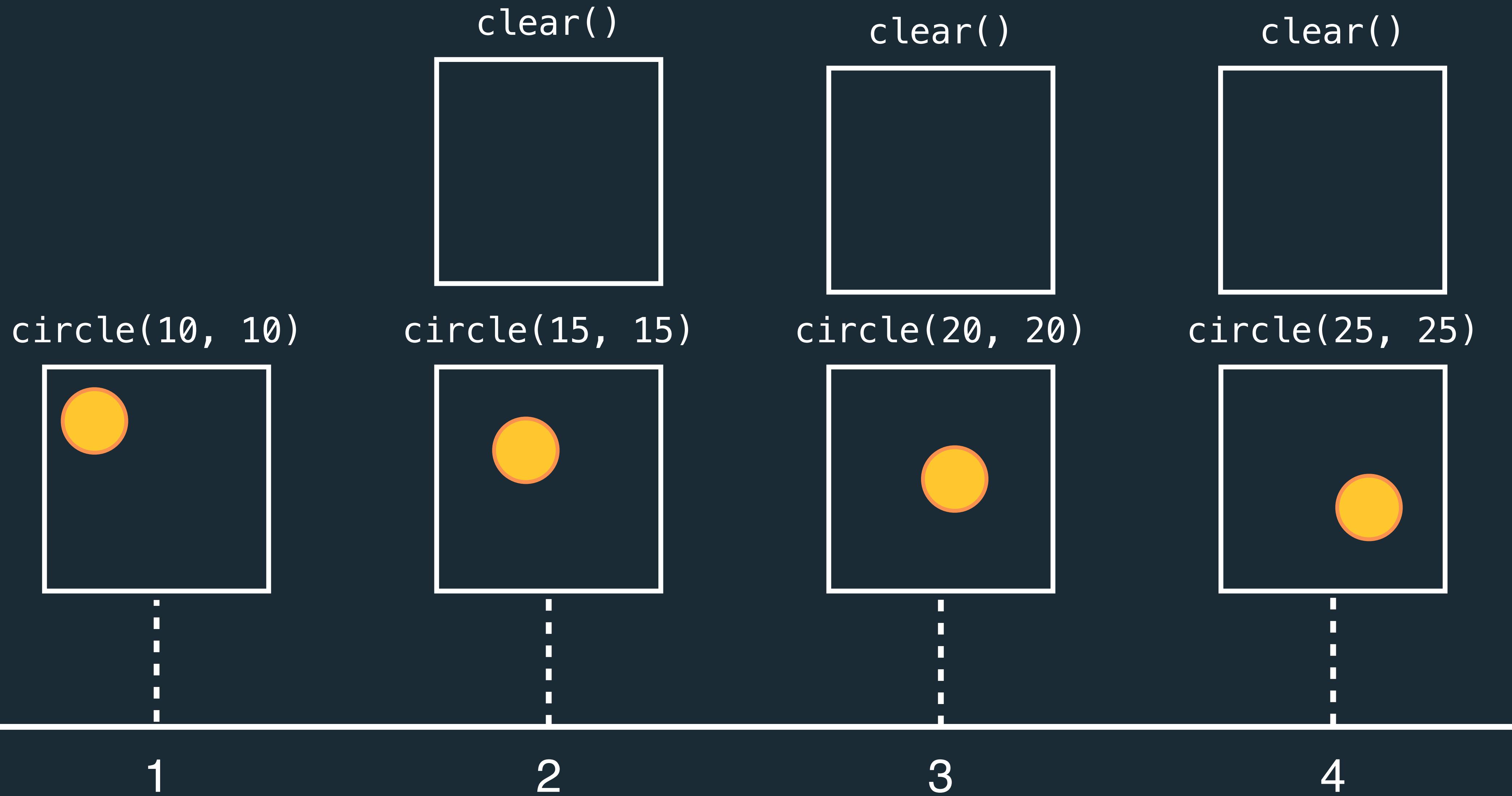
3

4

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) { valnow = valstart + fraction * (valend - valstart); }
```

Timing & redraw managed by UI toolkit.

Implementing Animation

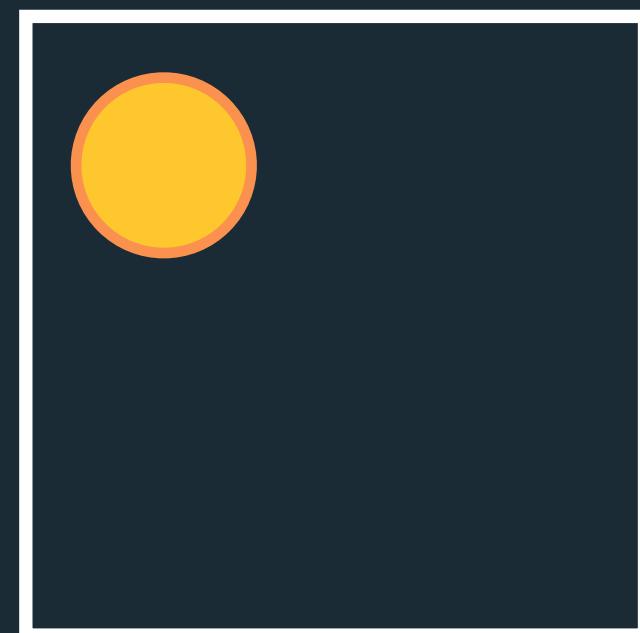
From: (10, 10).

To: (25, 25).

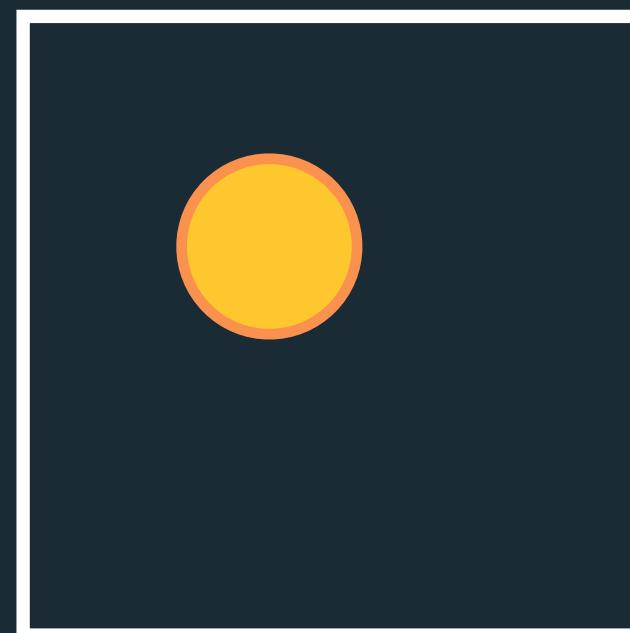
Duration: 3 seconds.

System handles the frame-by-frame updates

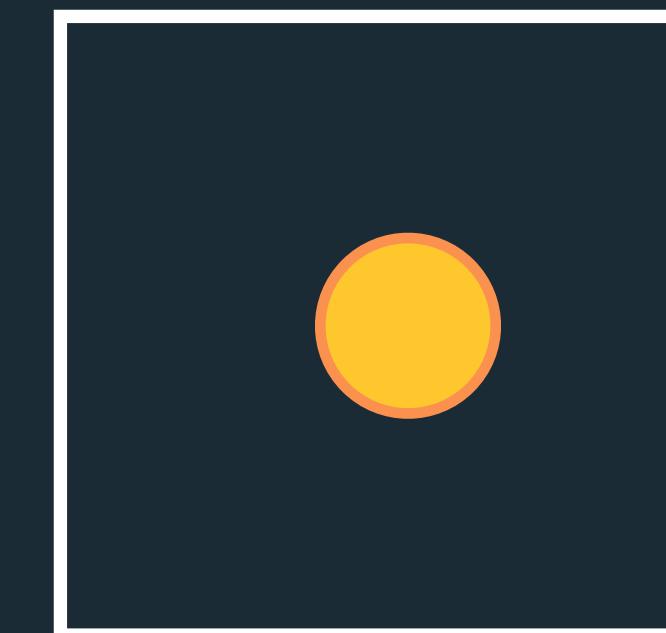
$$\begin{aligned} dx &= 25 - 10 \\ x &= 10 + (0/3) * dx \end{aligned}$$



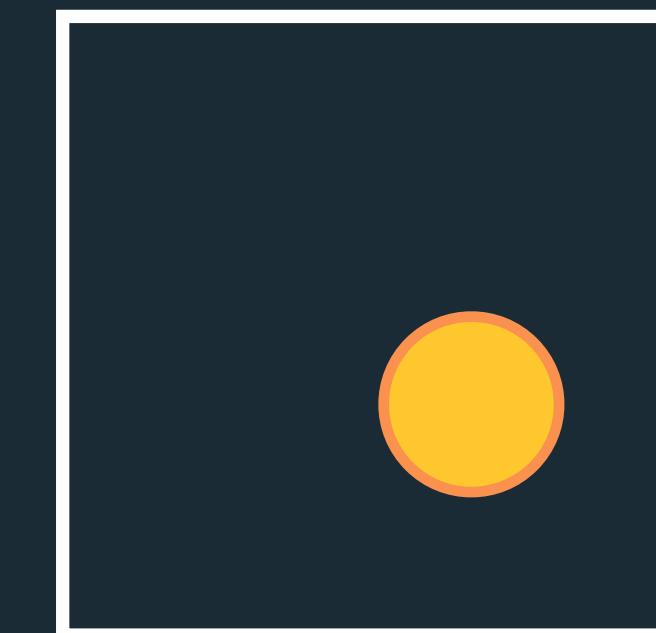
$$x = 10 + (1/3) * dx$$



$$x = 10 + (2/3) * dx$$



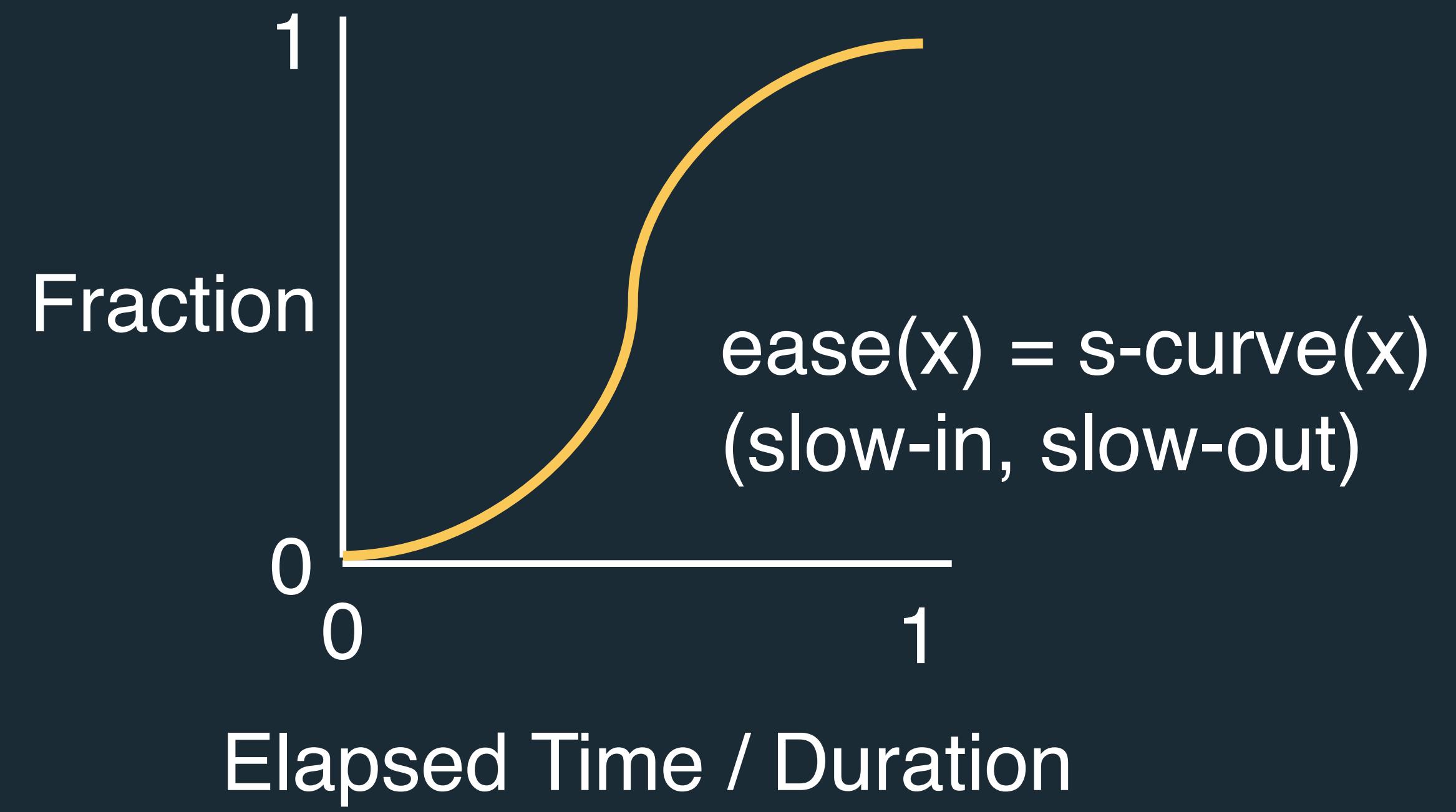
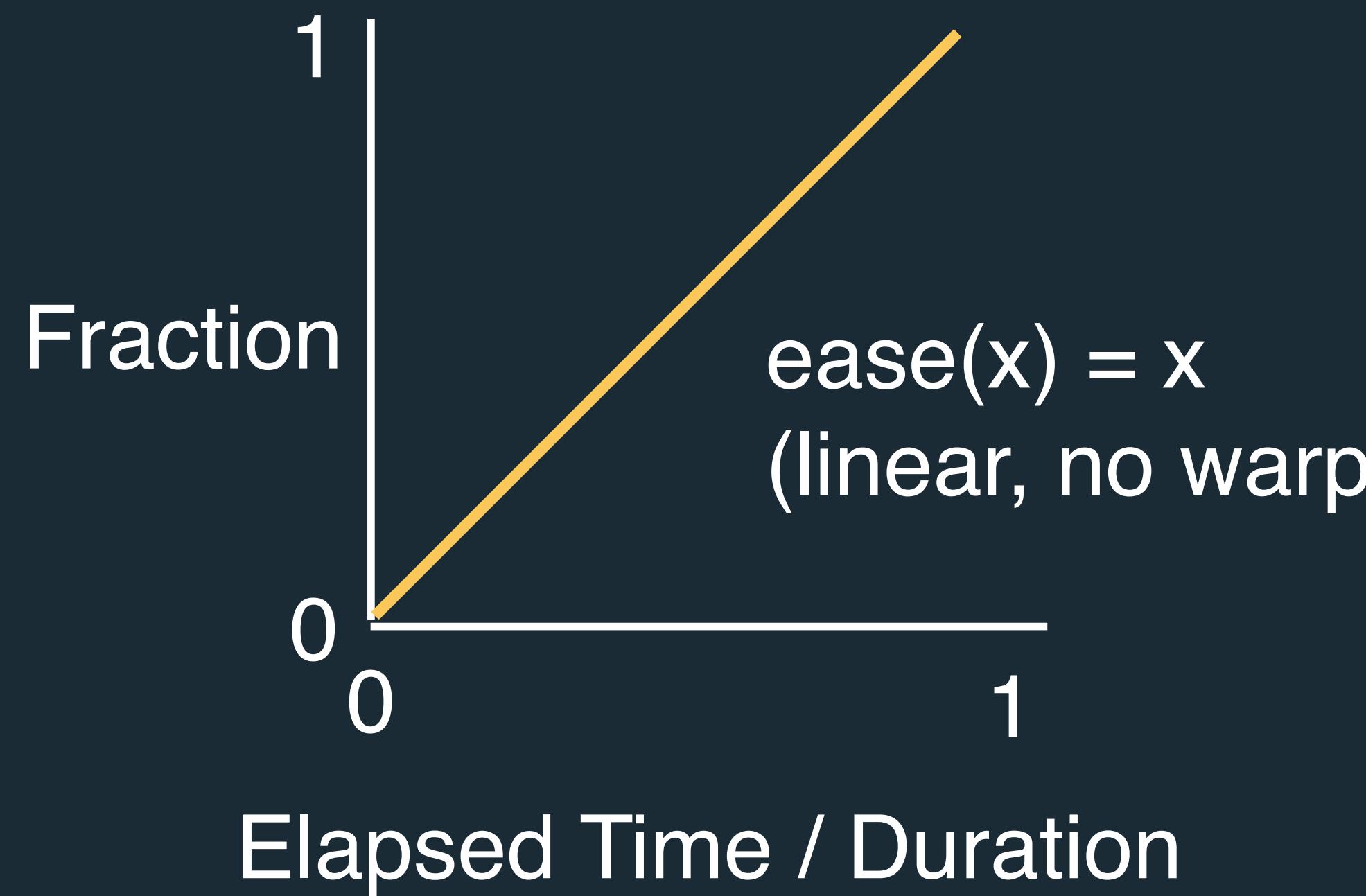
$$x = 10 + (3/3) * dx$$



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.

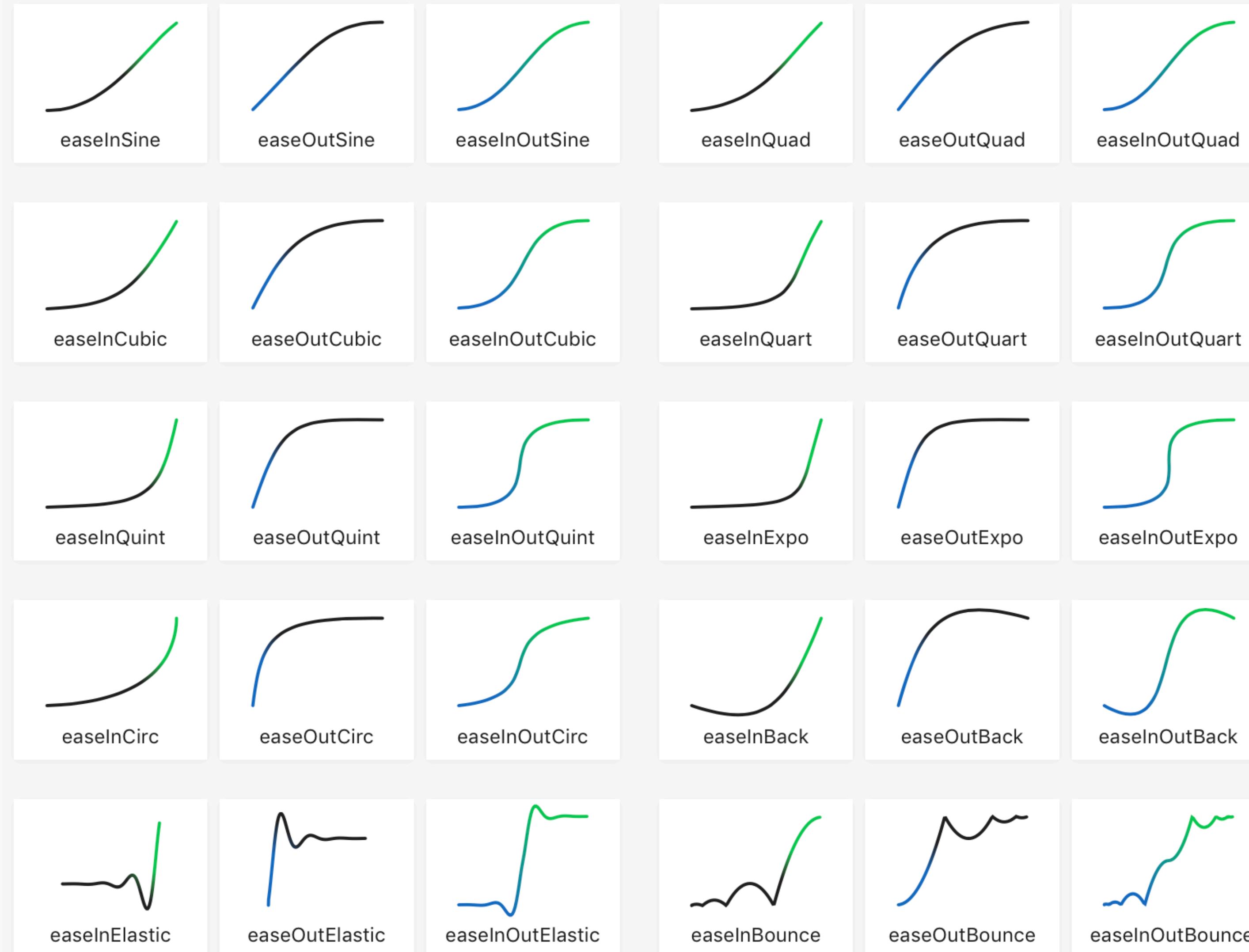


Easing functions specify the rate of change of a parameter over time.

Objects in real life don't just start and stop instantly and almost never move at a constant speed. When we open a door, we first open it slowly, and then it speeds up. Or when you drop a ball on the floor, and it will roll faster and faster until it stops. That's what easing functions do.

Open Source
Help translate
site to your language

This page helps you choose the right easing function.



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/>