

Introduction to Bioengineering

BIOE/ENGR.80

Stanford University


Spring 2020 Class Slides

Day 17
13 May 2020

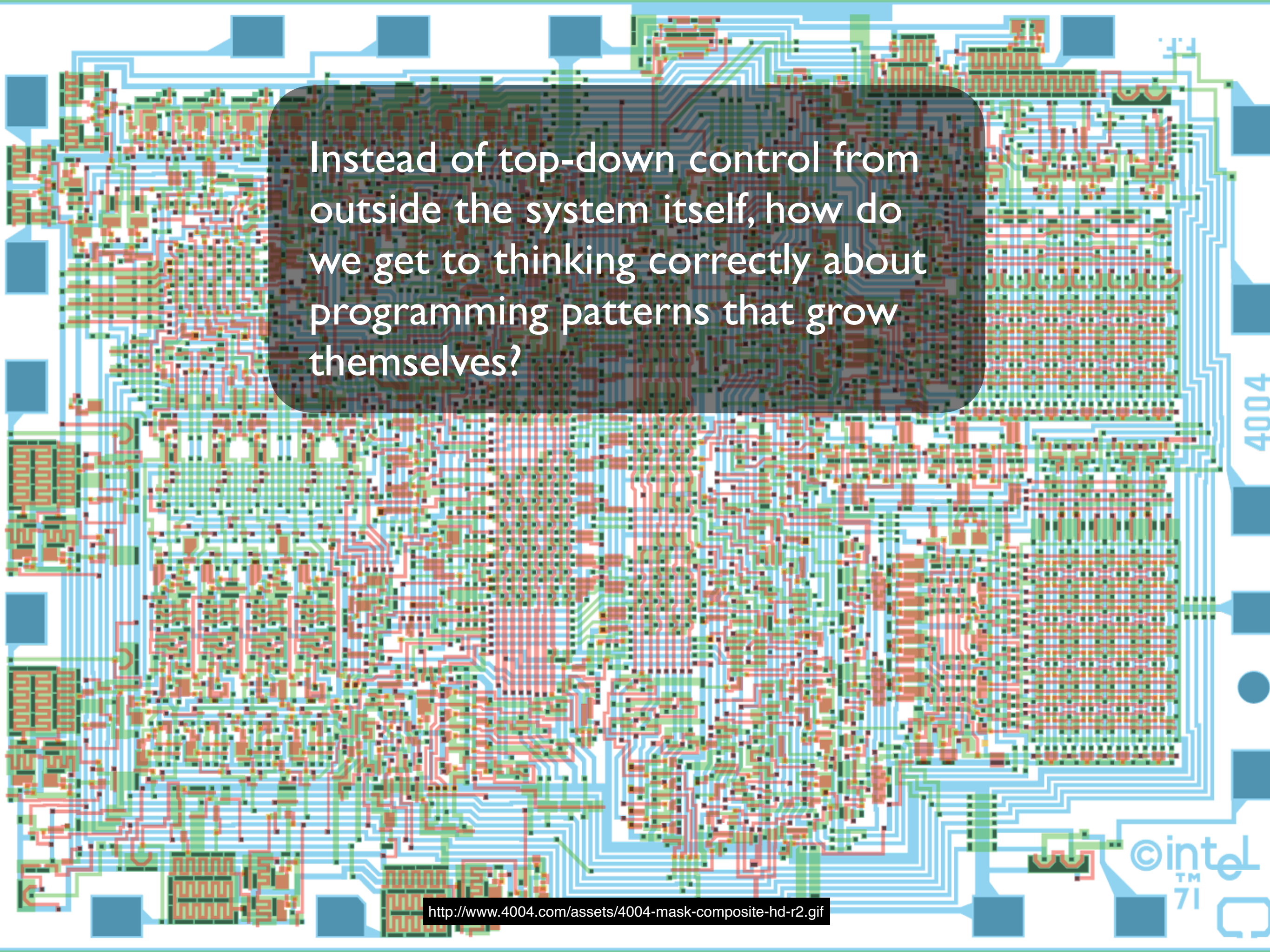
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In self-mixing molecular systems dominated by atomic-scale thermal noise (i.e., diffusion) how are we ever going to bioengineer precision patterning by autonomous systems?

As a next step we need to “deprogram” how we think about making patterns at the macroscopic scale...

A young boy with glasses and a wooden stick is drawing a pattern in the sand on a beach. The pattern consists of several interconnected loops and lines. The background shows the ocean waves, a forest of trees, and a large rock on the left. The scene is brightly lit, suggesting a sunny day.

We've grown up learning to make patterns. But, our approach to pattern making is typically 'hand of god' mode (i.e., draw the pattern from outside the pattern itself).

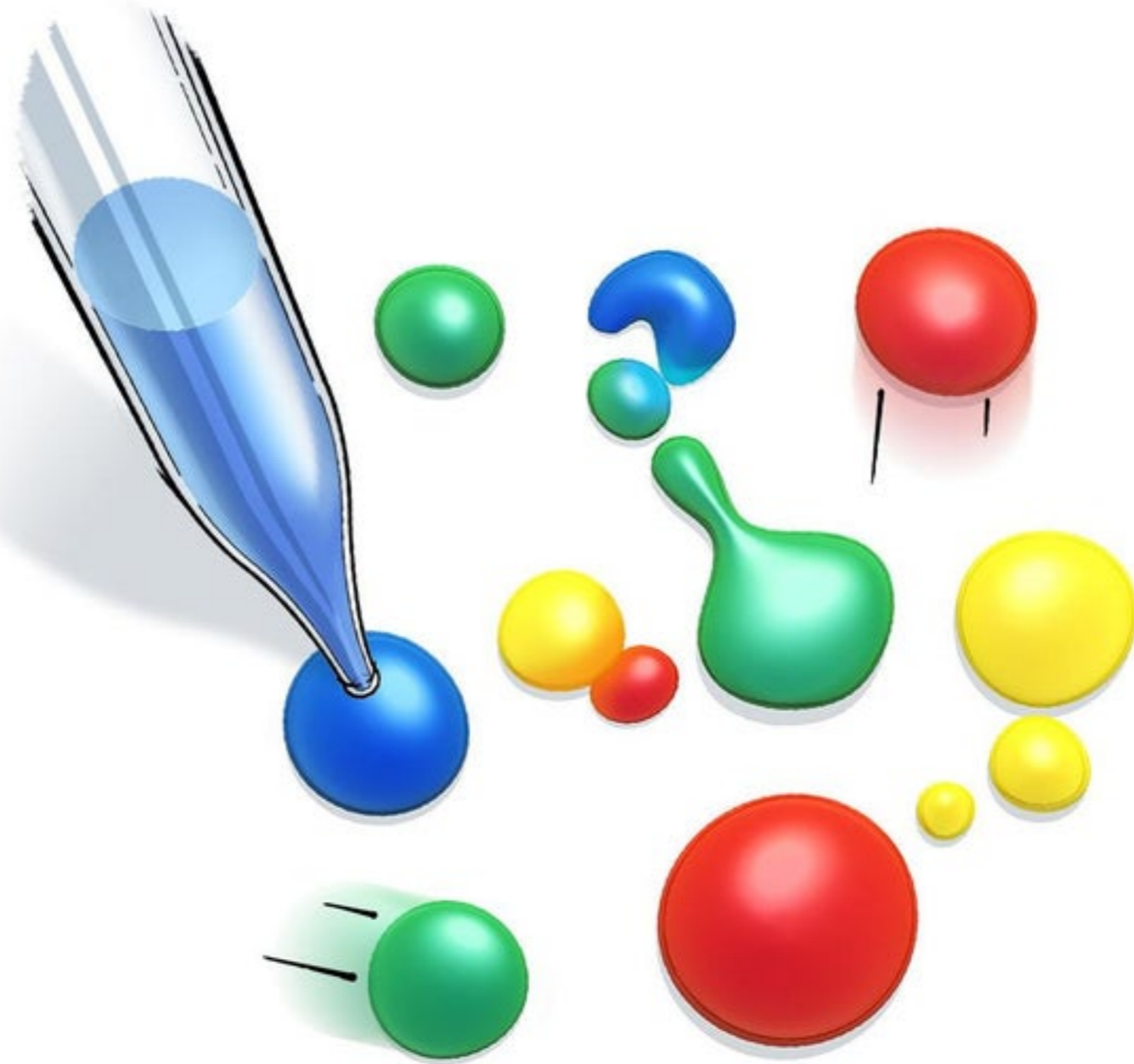
The background of the slide is a complex, multi-colored circuit board layout. It features a dense network of red, green, and blue traces connecting various components. A central, dark grey rounded rectangle contains white text. The overall aesthetic is technical and digital.

Instead of top-down control from outside the system itself, how do we get to thinking correctly about programming patterns that grow themselves?

How do we get to this level of bioengineering?!



We're going to use a simpler abiotic system to change how we think about making patterns...



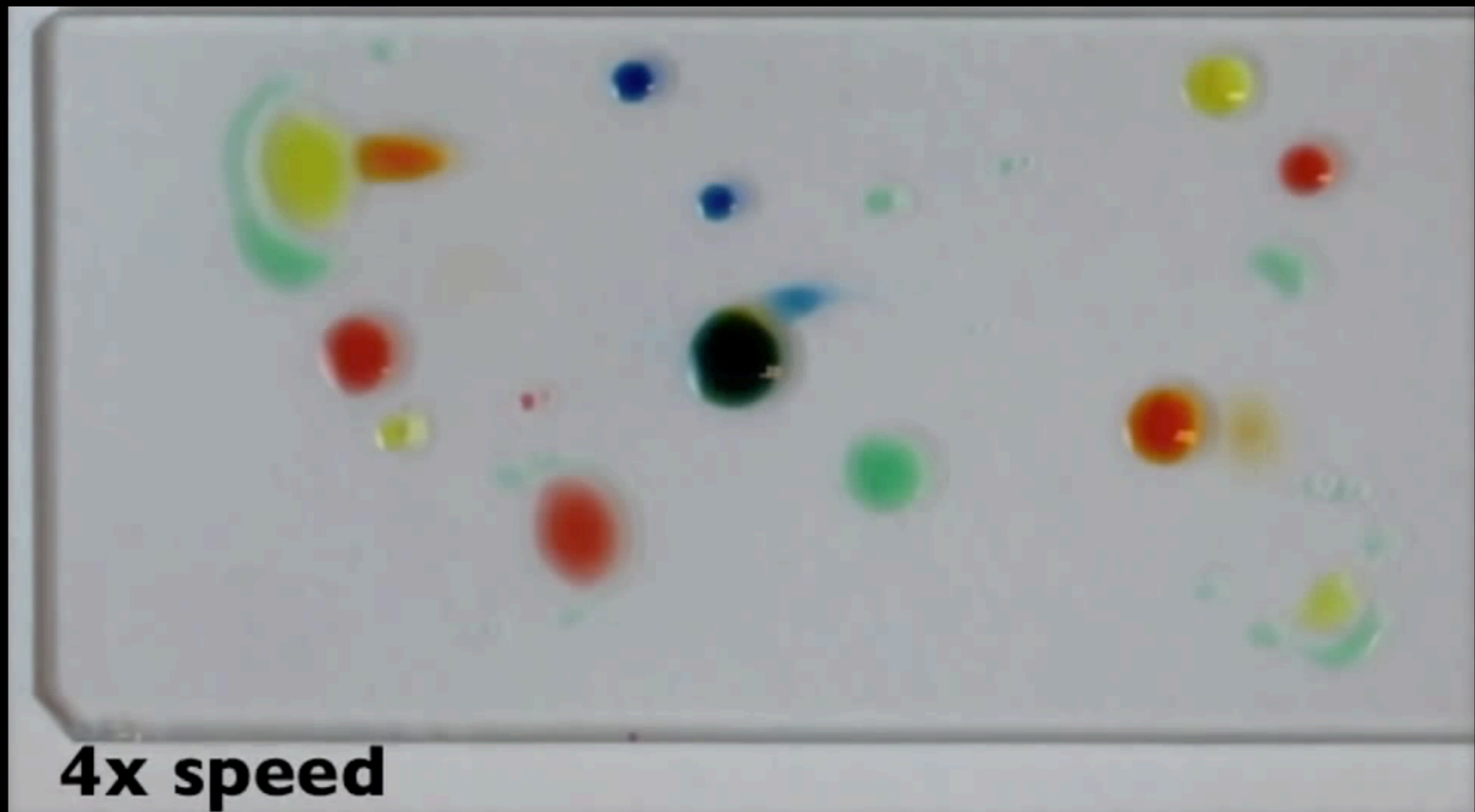
Droplets of food coloring on clean glass spontaneously generate complex motion.



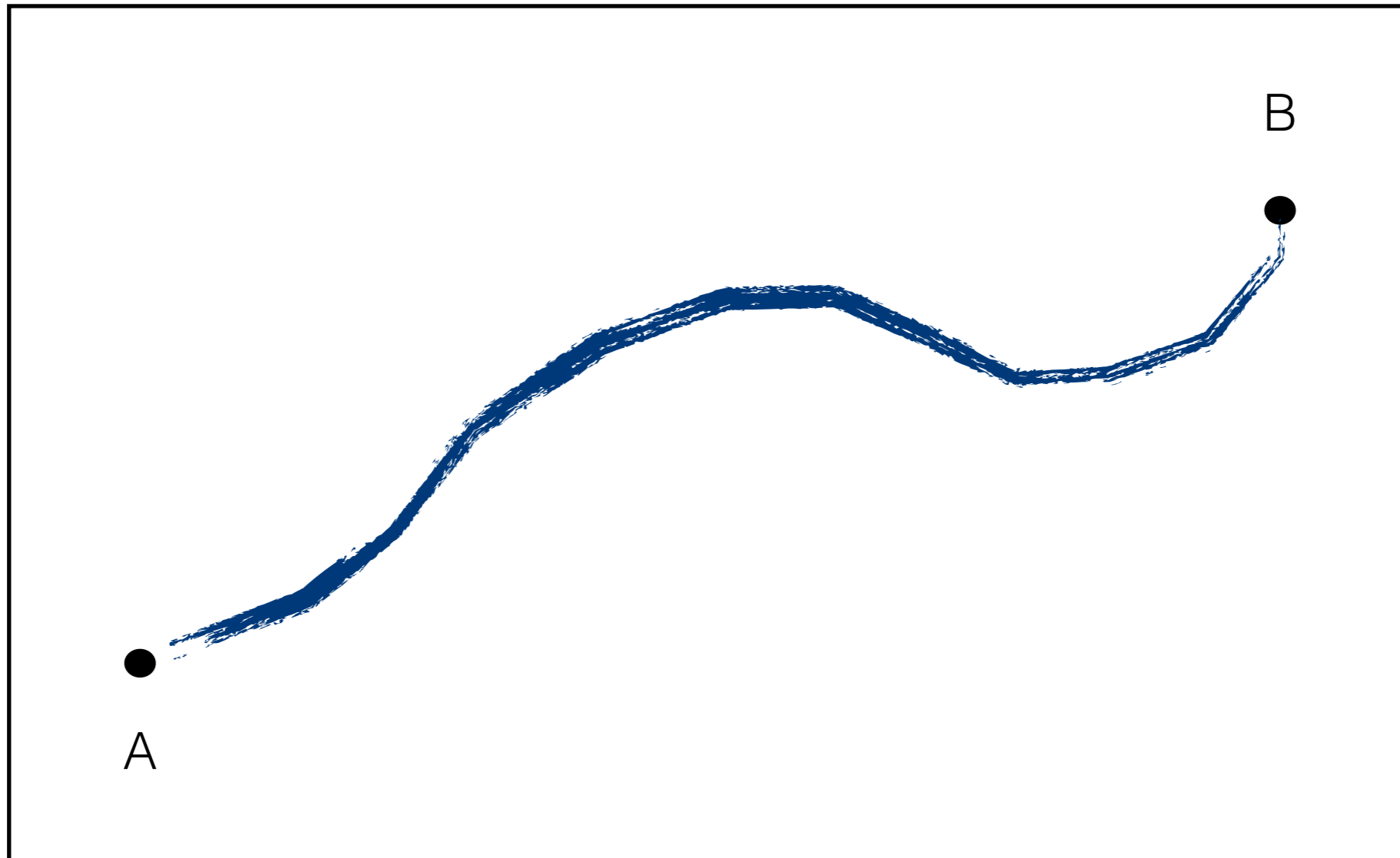
4x speed

What are the rules of droplet behavior?

1. Two droplets at a distance will _____.
2. Two droplets that are in contact with each other will either:
 - (a) _____, if they have the same PG%
 - (b) _____, when they have different PG%.
3. Droplets will do _____ when they borders (edge of slide, sharpie ink).

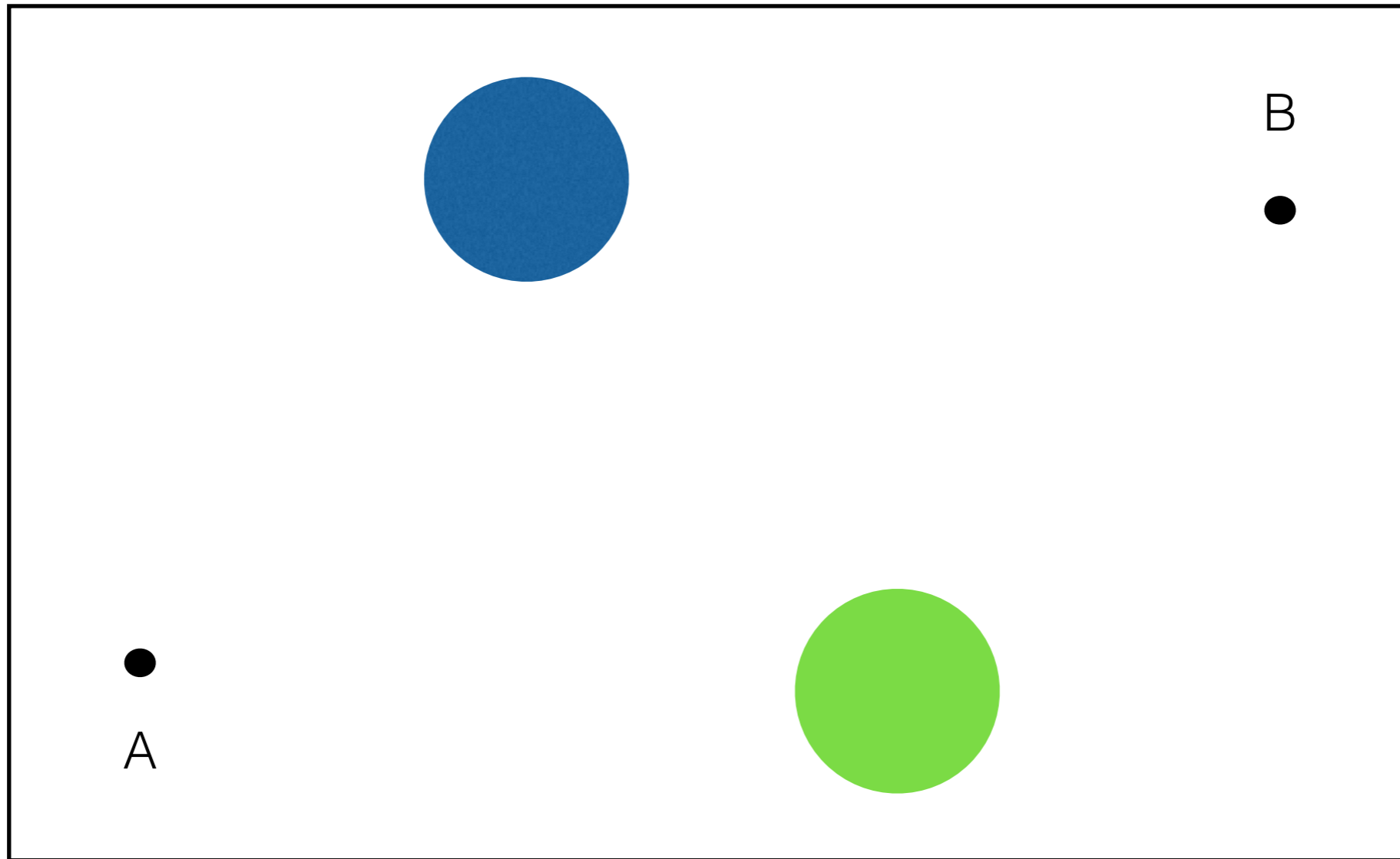


Challenge 1 — ‘hand of god’



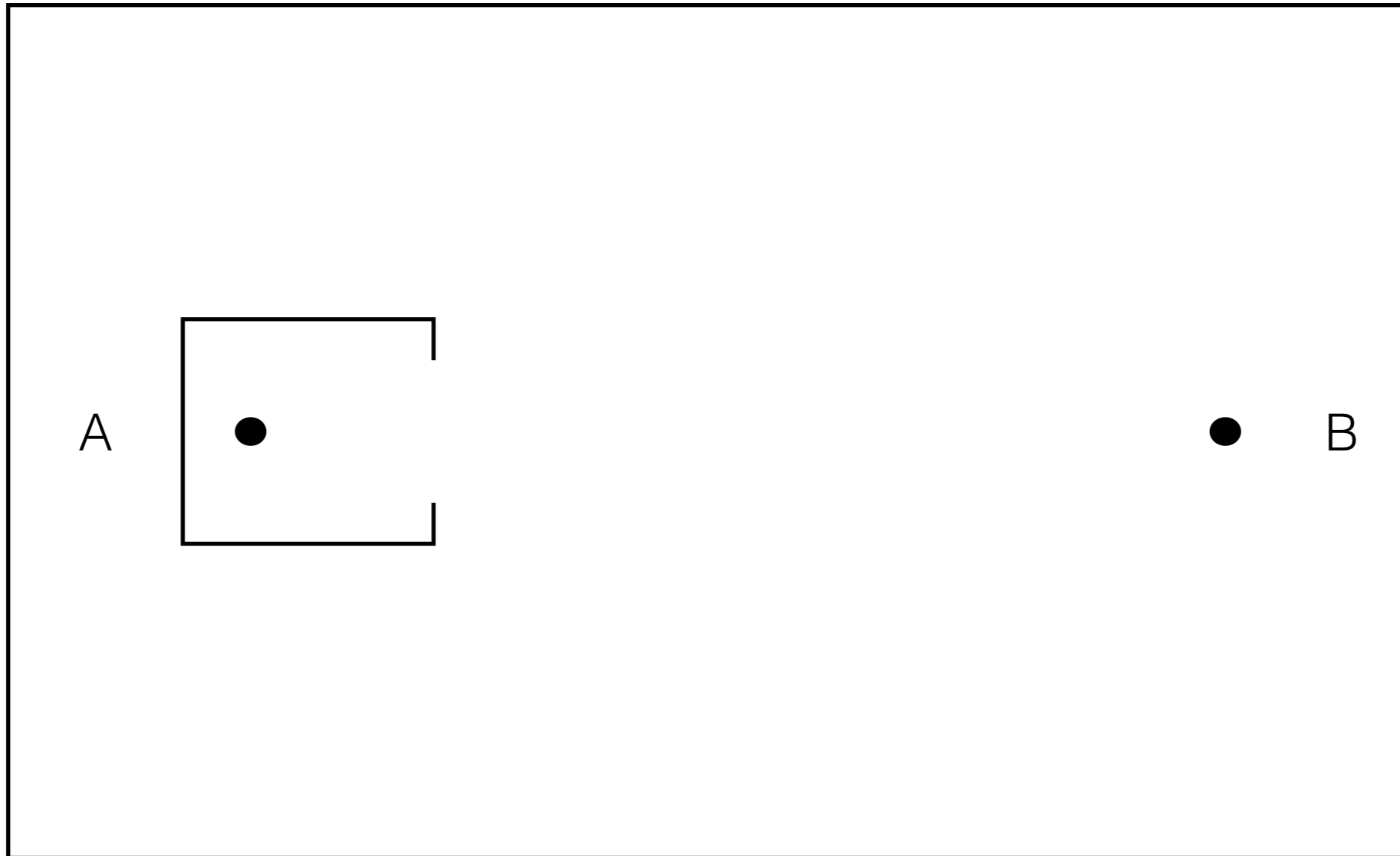
Draw a physical pattern on the slide that gets droplets to move from point A to point B (i.e., you are explicitly directing the behavior from outside the system)

Challenge 2 — ‘external coordinates’



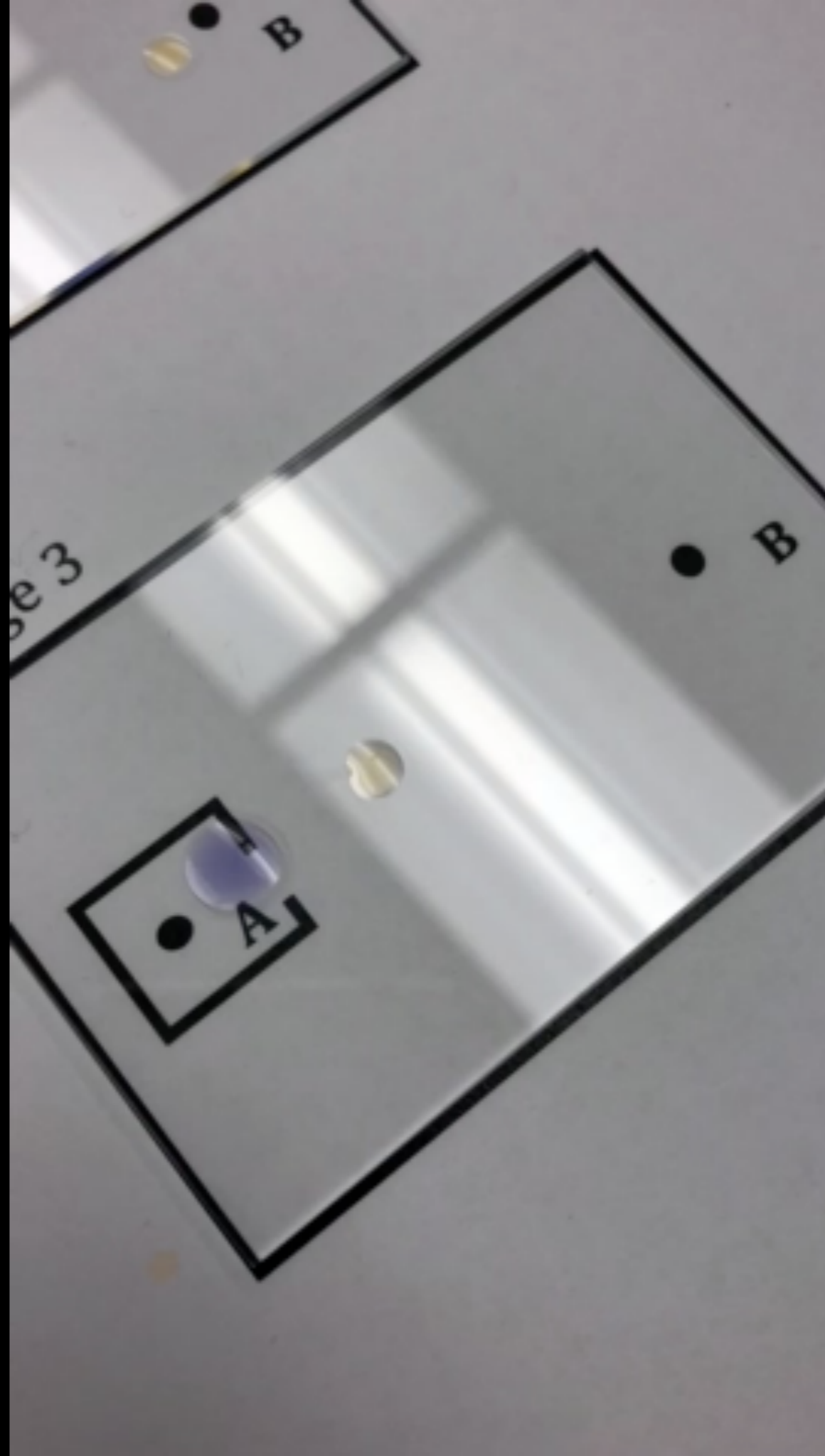
Place droplets on the slide that establish a coordinate system, causing another droplet to move from point A to point B (i.e., you make a coordinate system but droplets otherwise on their own).

Challenge 3 — ‘autonomous coordination’

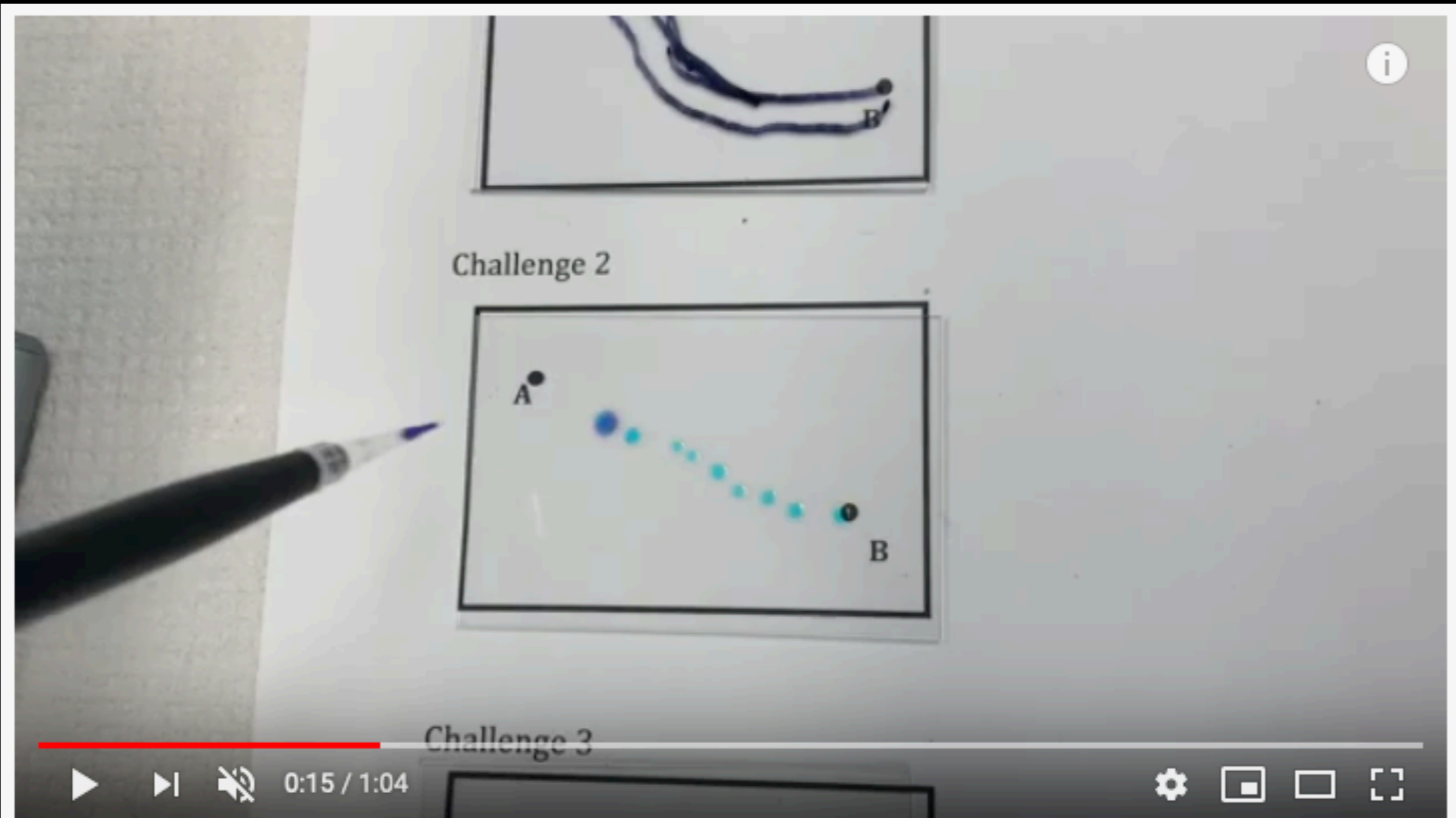


Place droplets only in the seed box that causes a droplet to move from point A to point B (i.e., seed a system that autonomously controls its own behavior).

Examples of
success...



Examples of success...



Droplets Dancing to Baby Shark By: Michelle Bach

39 views • May 31, 2019

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<https://www.youtube.com/watch?v=CtdwOA5mU8s>