Models of Social Dynamics
An Introductory Module

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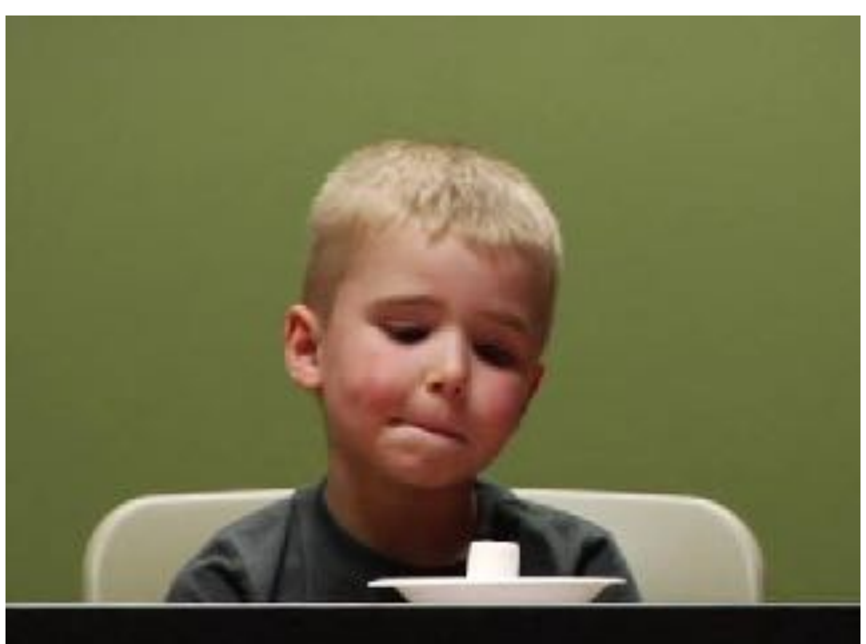
Unit 1: Introduction

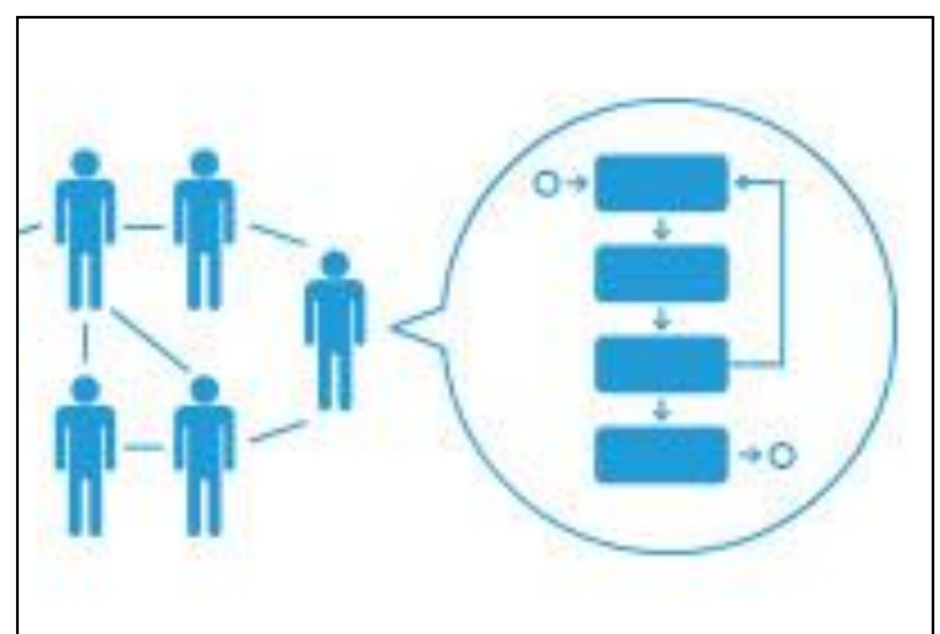
Topics covered

- Contagion
- Opinions and polarization
- Cooperation
- Coordination and norms
- Sociopolitical cycles

Models

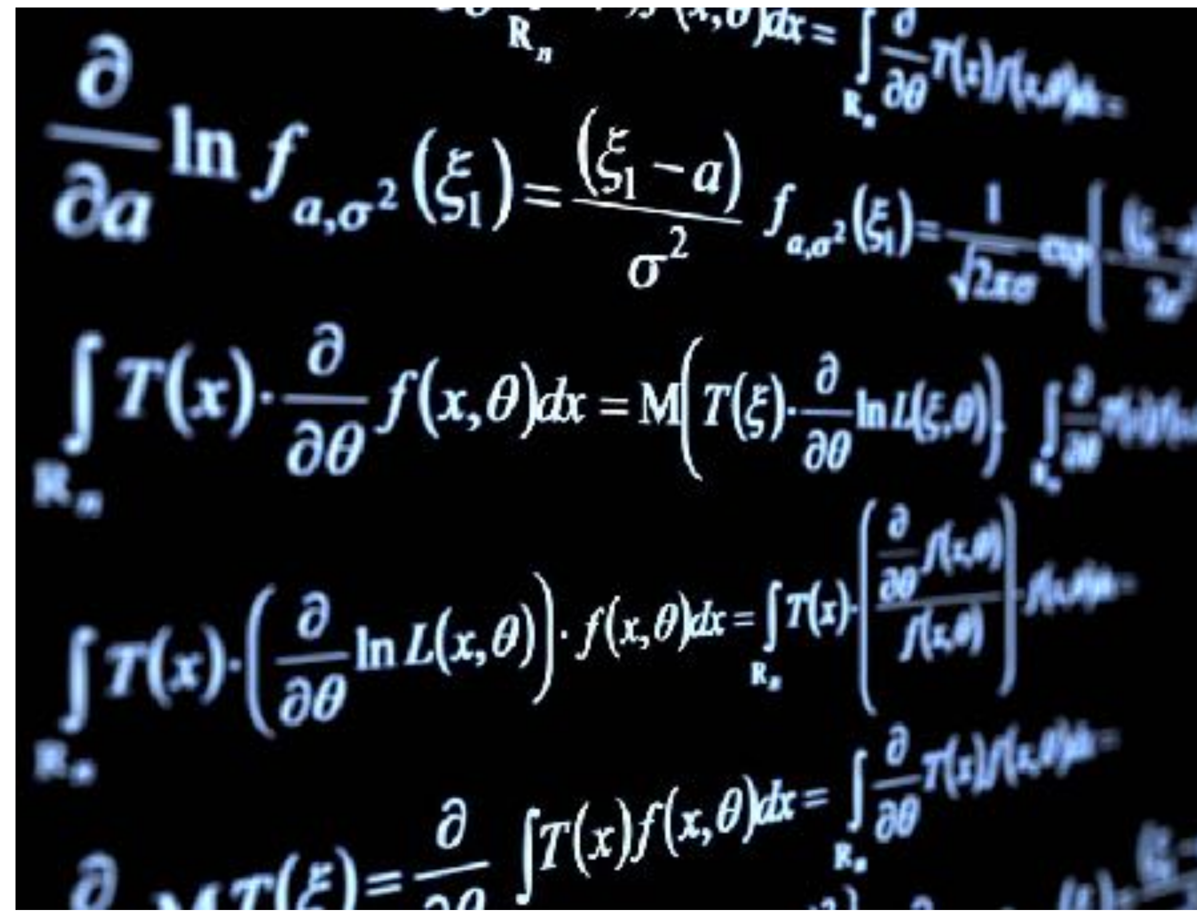
Models are structures (abstract or physical) that can potentially represent real-world phenomena.





Formal models

- A simplified version of a system with a specification of parts and relationships between them
- A logical engine for turning assumptions into conclusions



What can models do for us?

Prediction

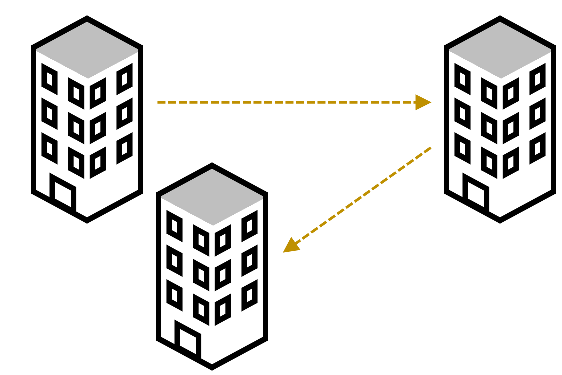
Precision

Tractability

Mental models

Hypothesis formation and the articulation of parts

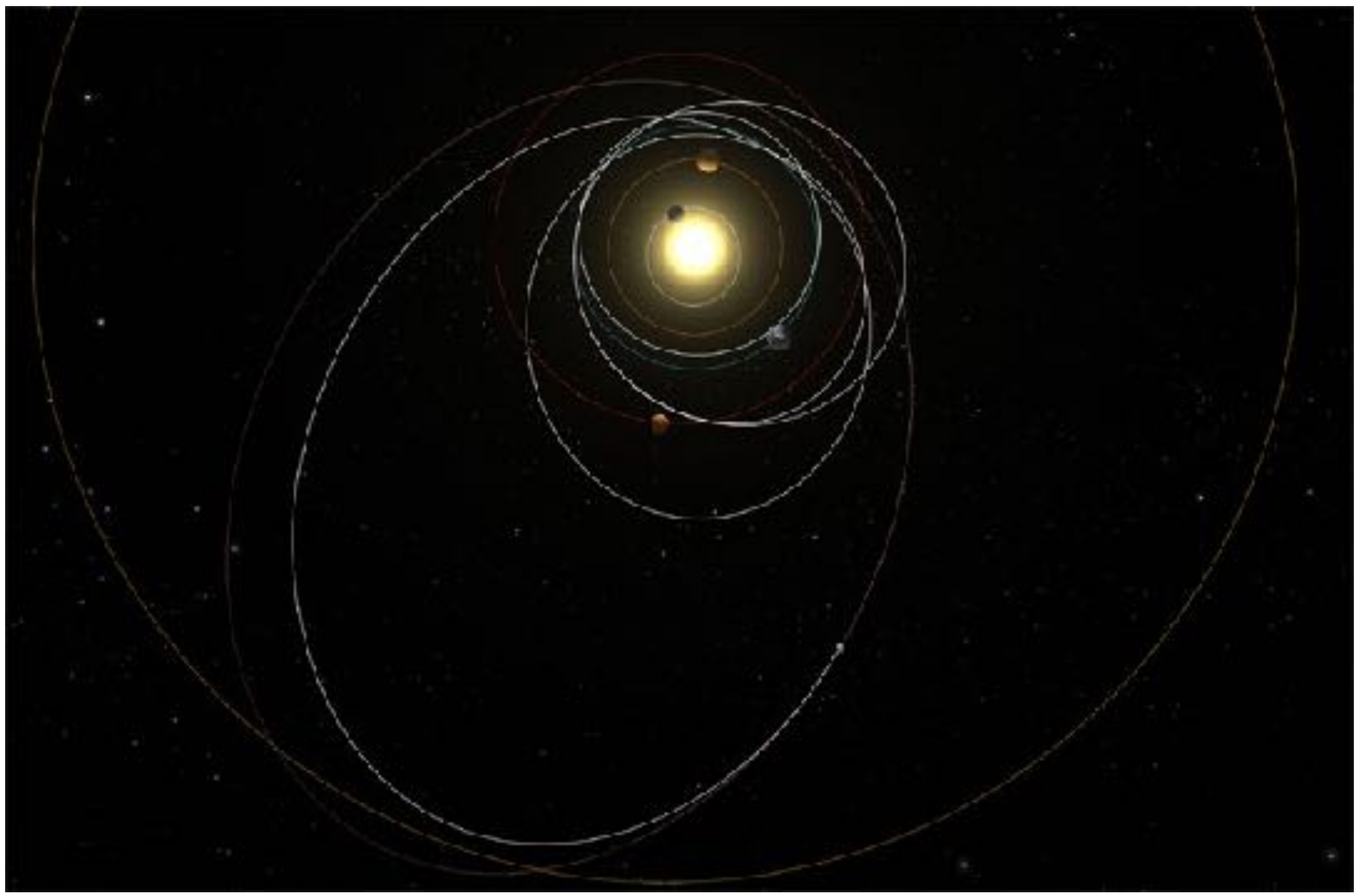
- Science: We want to explain some behavior of some system



- A system can be decomposed into **parts** and **interactions** between those parts

- No single best decomposition for a system. Depends on your question.

Newton's Model of Gravity



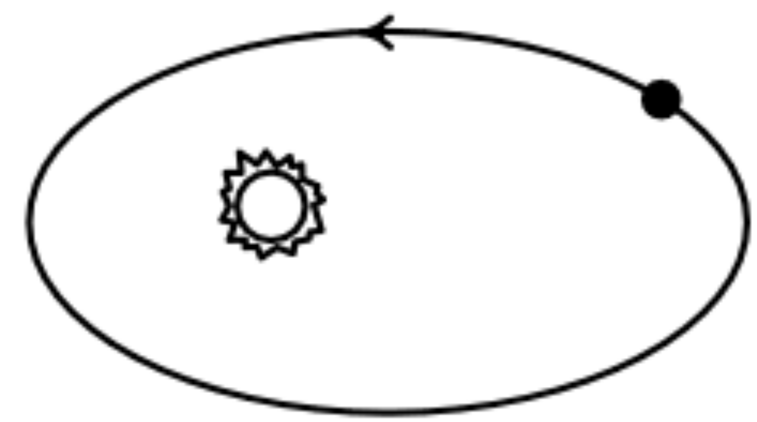
Brahe

Kepler

Newton

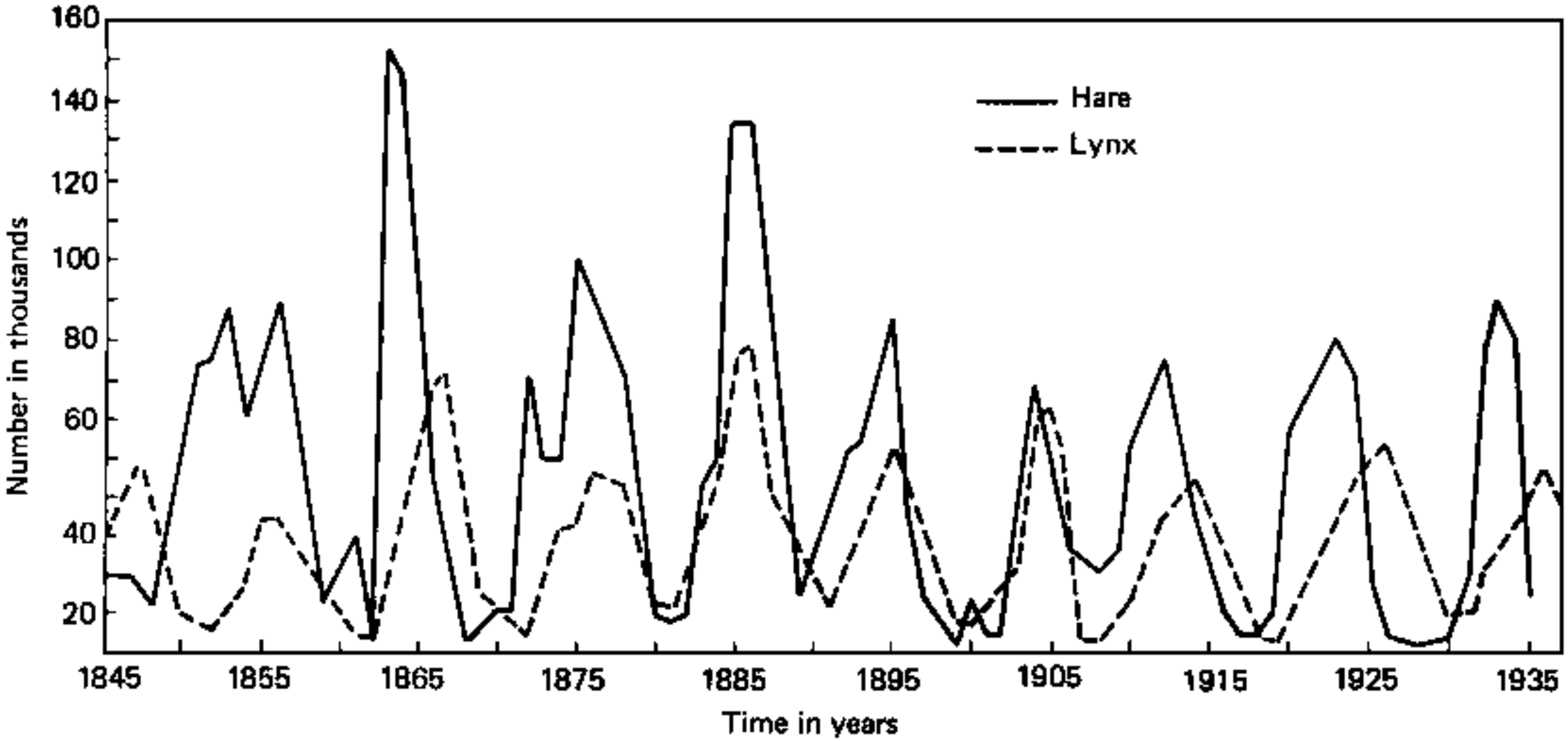
Newton's Model of Gravity

- Assumptions: Inverse square law + Newton's 2nd law of motion
- Others had proposed inverse square law (Hooke, Wren, Halley). Newton was first to test consequences of this rule.
- Showed that the orbit of a particle acted upon by a force would be elliptical (1687)



$$\vec{F} = G\frac{m_1 m_2}{|r_{12}|^2}\hat{r}$$

Lotka-Volterra model of predator-prey interactions

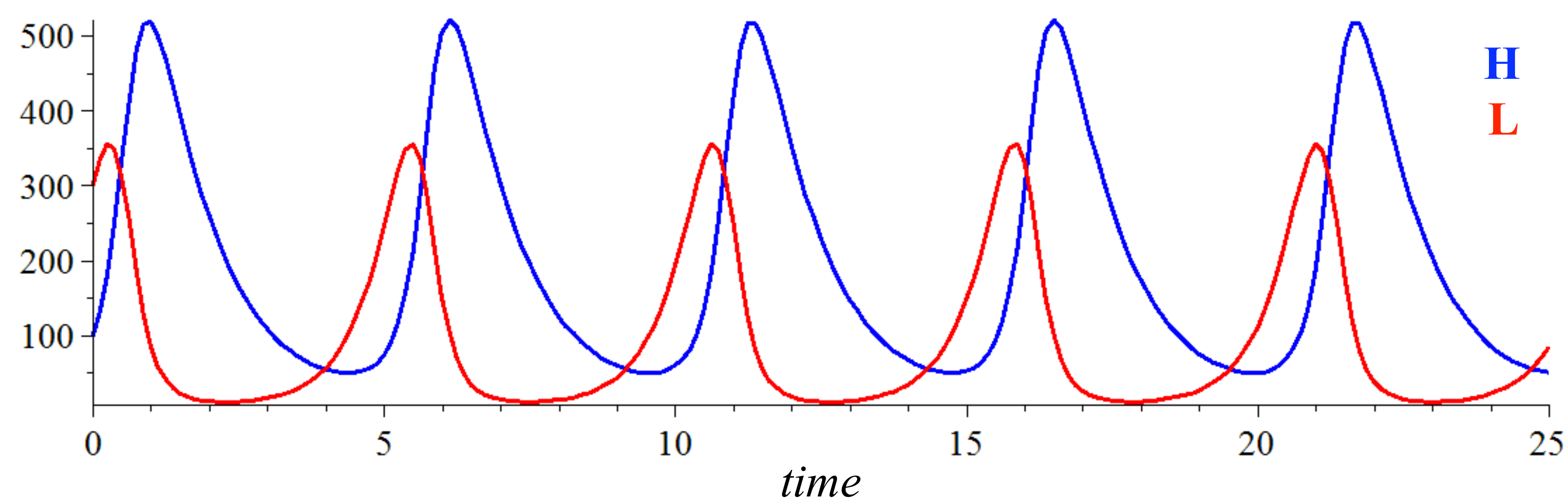


Lotka-Volterra model of predator-prey interactions

Lynx eat hares.
More lynx means
fewer hare

Hares reproduce in
the absence of
predators

Lynx die/migrate in
the absence of prey.



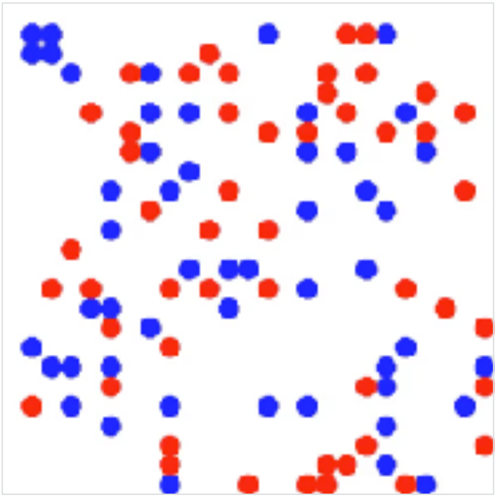
Disadvantages of mathematical modeling

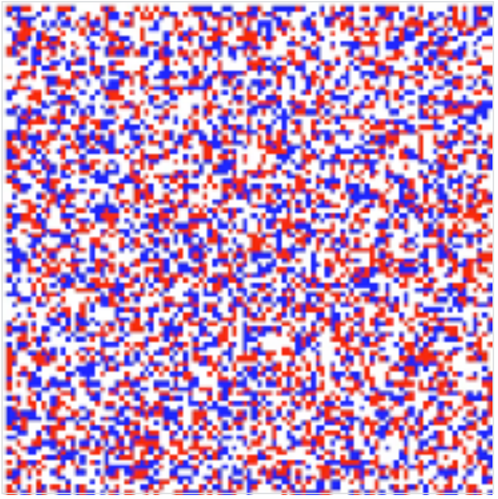
- **Limited realism.** Models assume a lot of homogeneity to make them tractable. Most social populations have important sources of heterogeneity.

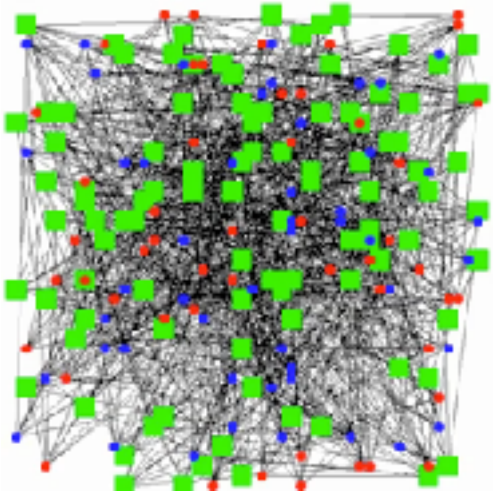
- **Limited intuition.** For those whose deep math training, equations often provide limited insight.

- **High bar to entry.** Lack of mathematical training can prevent access to valuable models.

Agent-based models







- A type of **formal model** in which individuals (agents) are simulated as explicit computational entities

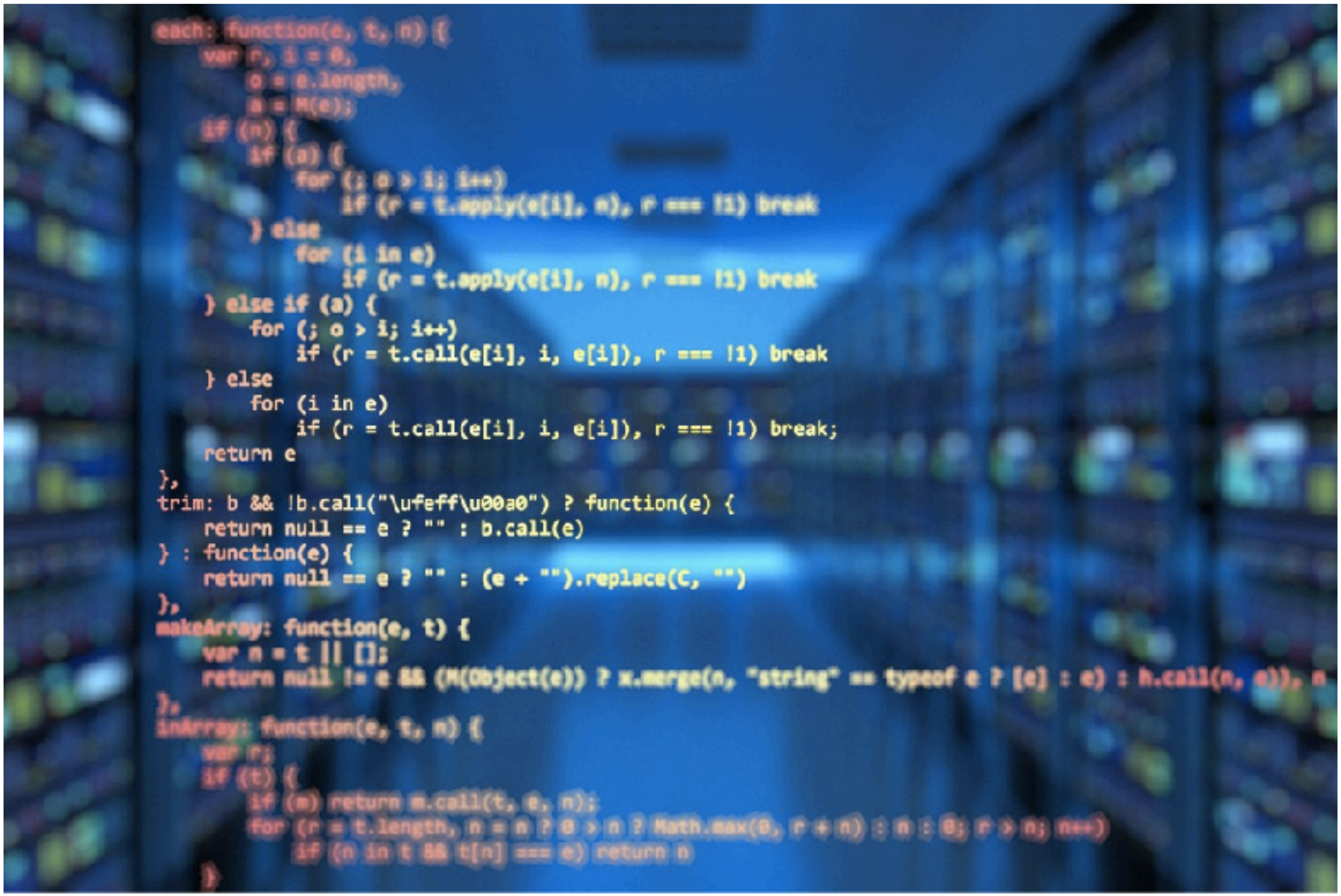
- <u>Costs</u>: Analytical tractability, easy parameter exploration, a certain kind of elegance

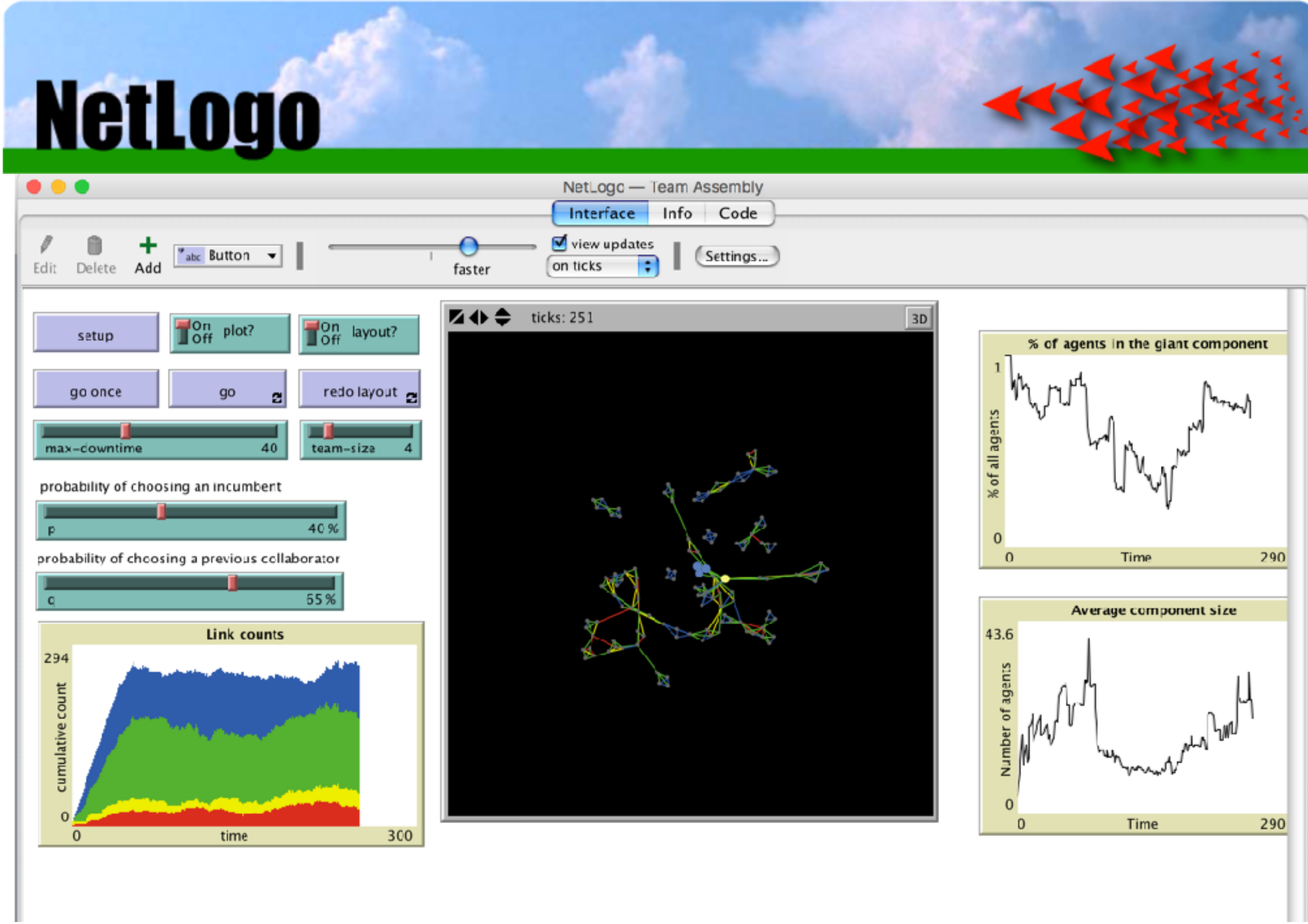
- <u>Benefits</u>: Can account for greater complexity, heterogeneity, and structure (such as spatial or network structure). Can help us to understand emergent phenomena. Lower bar to entry.

- Tradeoff relative to research questions being asked

Both mathematical and agent-based models are valuable!

How to code an agent-based model

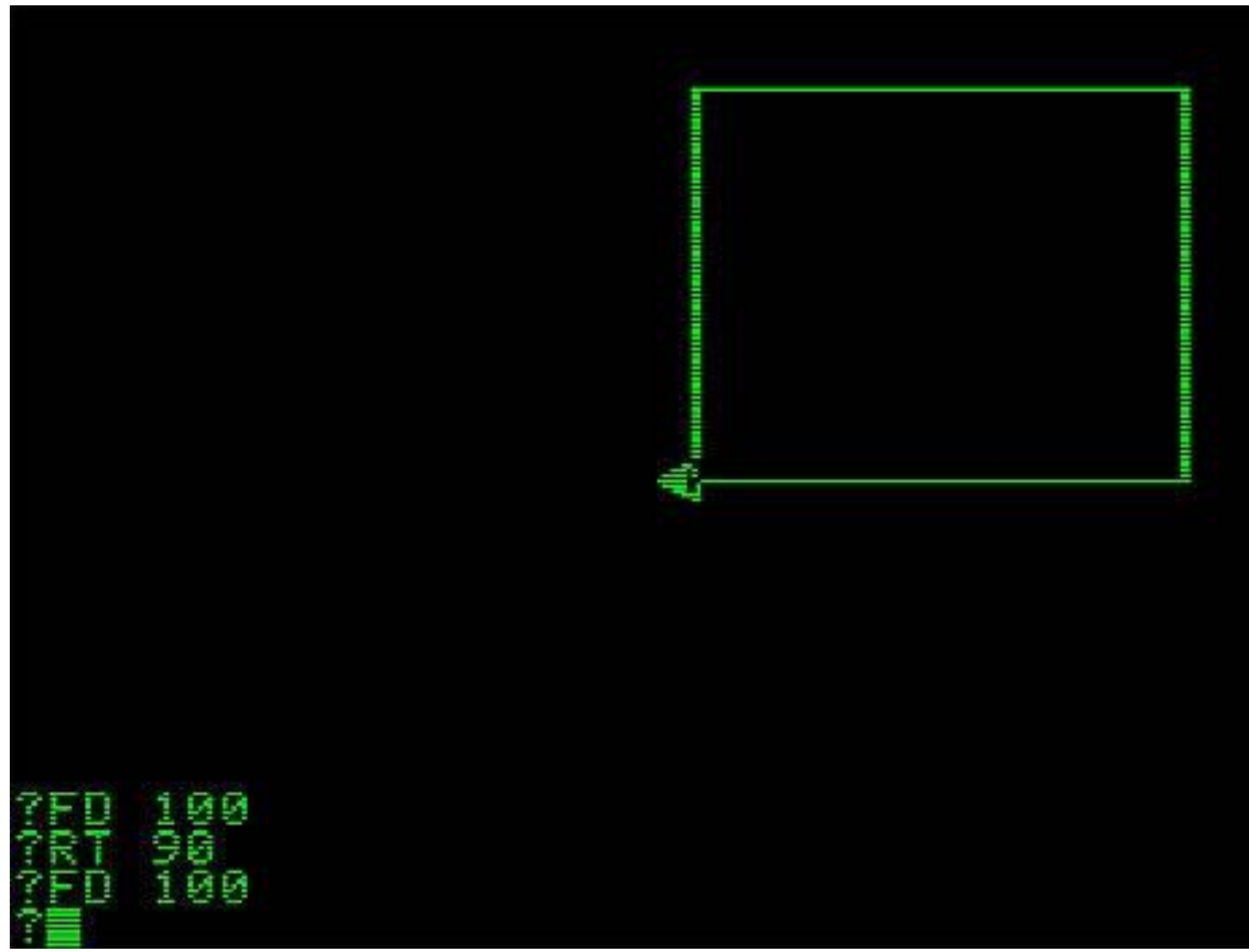




https://ccl.northwestern.edu/netlogo/

Origins

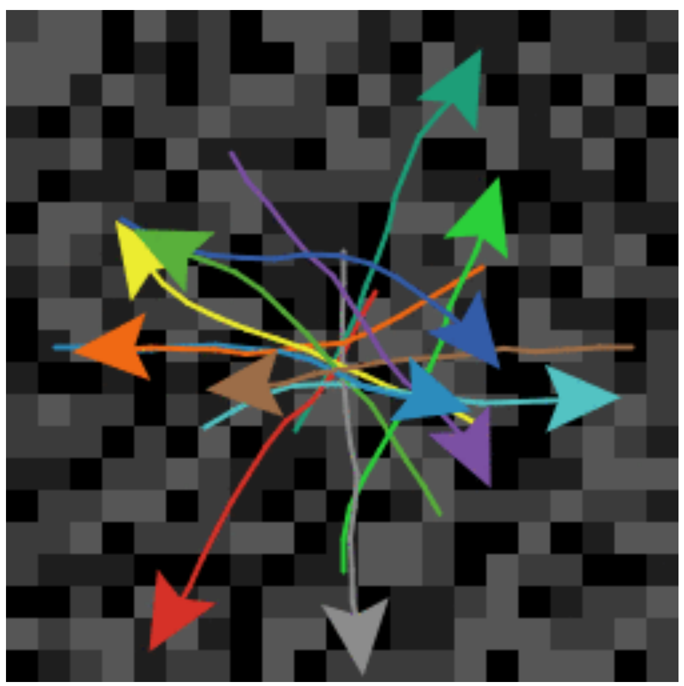
Grey Walter and his tortoise, 1953



Logo: Feurzeig, Papert, & Solomon (1967)

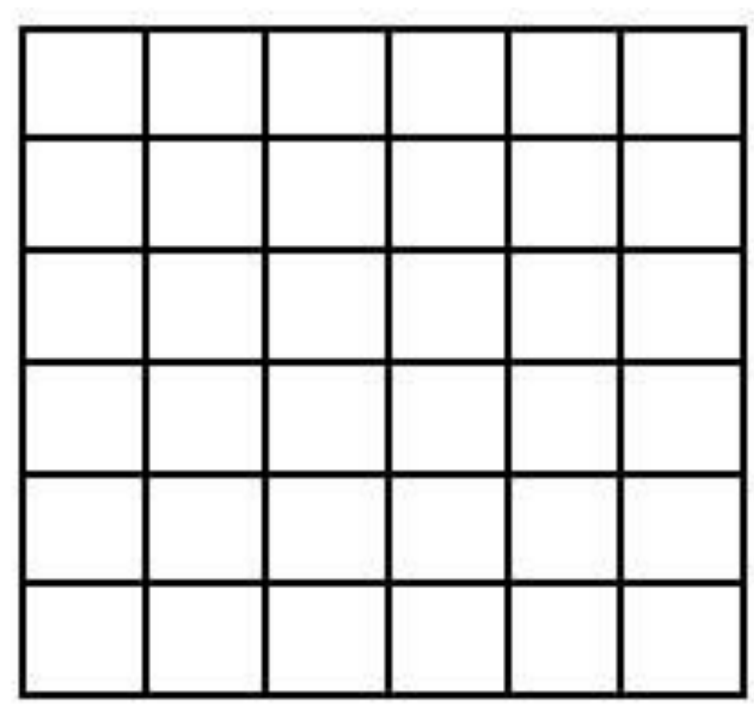
NetLogo Components

Turtles



- mobile
- can die and reproduce
- can be networked
- can occupy patches

Patches



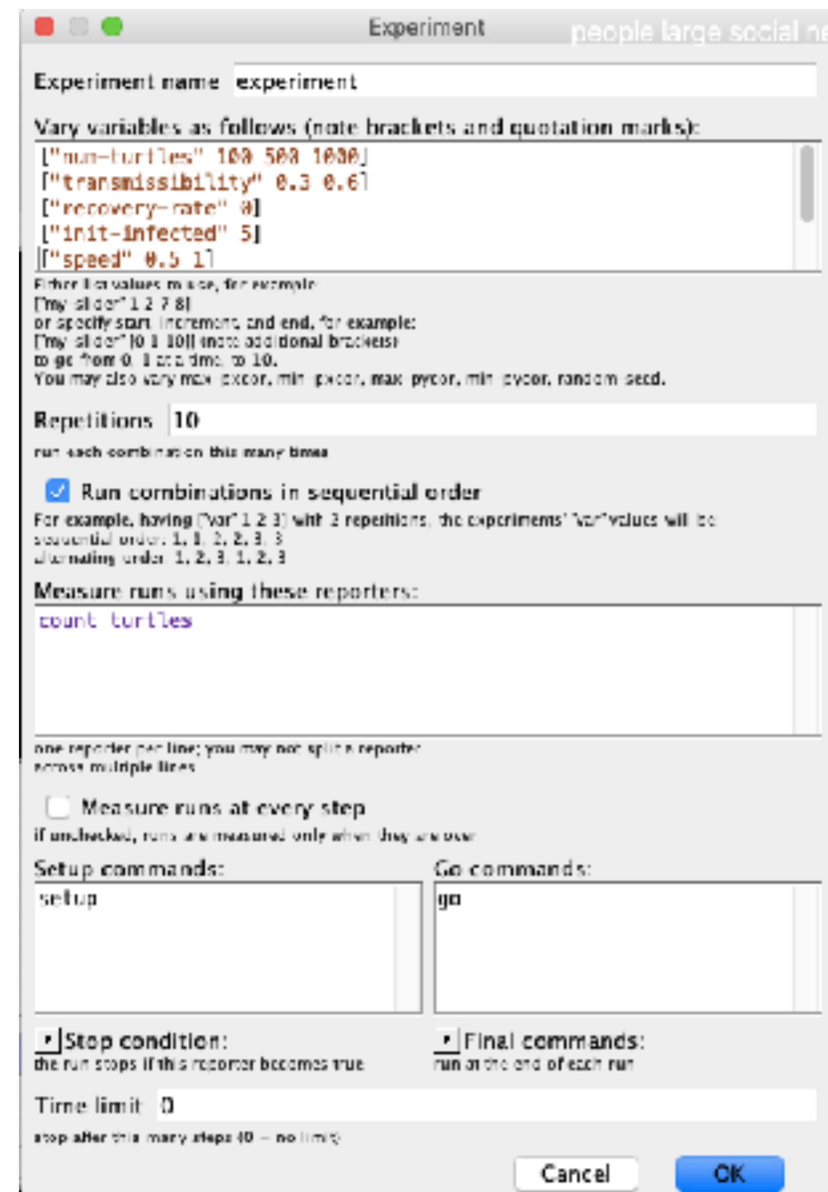
- stationary
- one per location

NetLogo Components

ASKING

```
to move
  ask turtles [ ;;move
    left random turning-angle
    right random turning-angle
    fd speed
  ]
end
```

BEHAVIORSPACE



a simple simulation

CODE: movement.nlogo

Outline of the course

- Unit 1: Introduction
- Unit 2: Contagion
- Unit 3: Opinions and polarization
- Unit 4: Cooperation
- Unit 5: Coordination and norms
- Unit 6: Sociopolitical cycles
- Unit 7: Coda

The 3 Cs:

Communication

Cooperation

Coordination