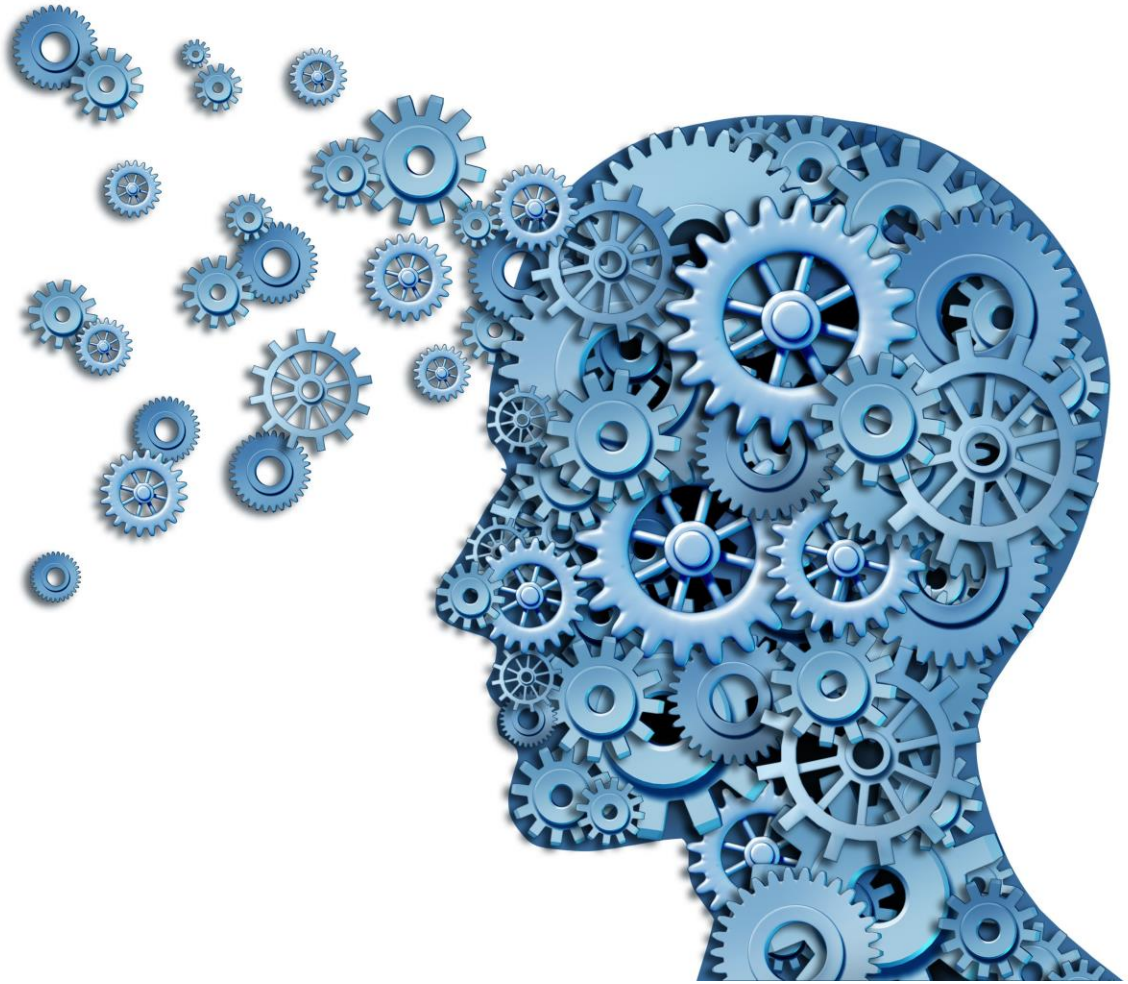
Neural & Behavioral Modeling

Week 3

Agent-based Models

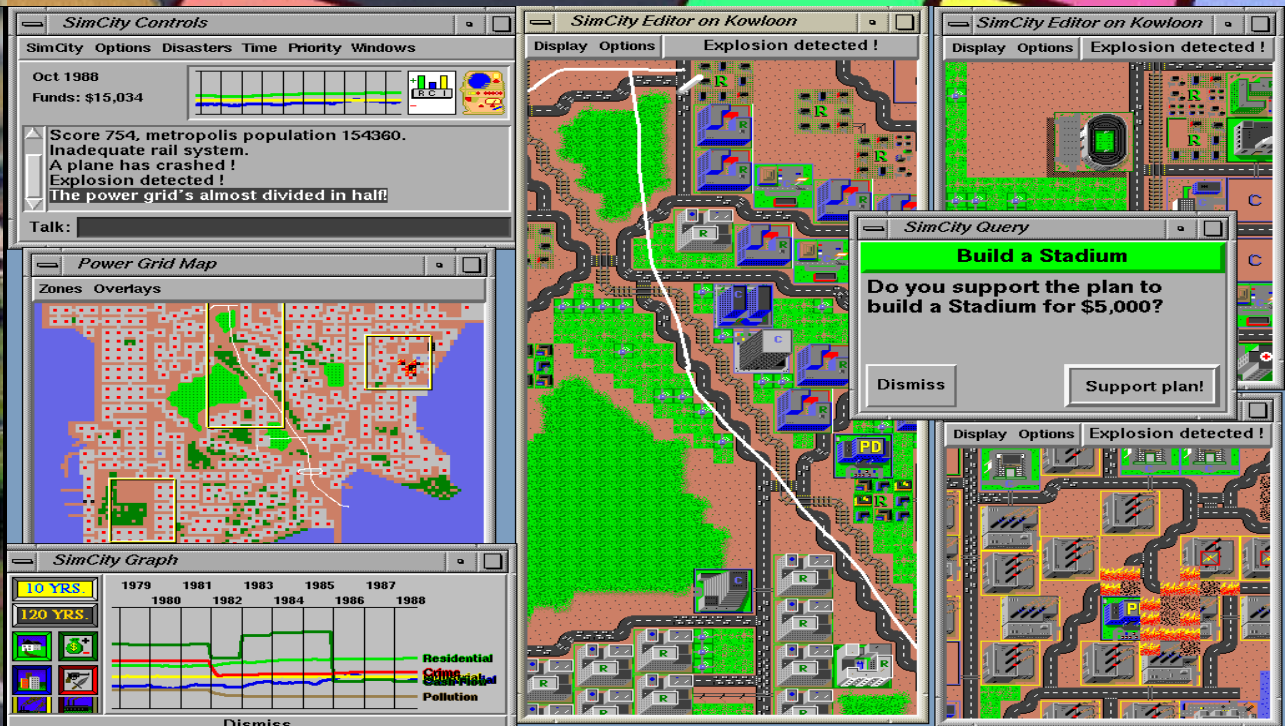


by Tsung-Ren (Tren) Huang 黃從仁


Aurora Tickle
$68,671


TWO POINT
CAMPUS


SIMCITY


SimCity Controls
SimCity Options Disasters Time Priority Windows
Oct 1988
Funds: $15,034
Score 754, metropolis population 154360.
Inadequate rail system.
A plane has crashed !
Explosion detected !
The power grid's almost divided in half!
Talk:
Power Grid Map
Zones Overlays
SimCity Graph
10 YRS
120 YRS
1979 1980 1981 1982 1983 1984 1985 1986 1987 1988
Residential
Pollution
Dismiss
SimCity Editor on Kowloon
Display Options
Explosion detected !
SimCity Query
Build a Stadium
Do you support the plan to build a Stadium for $5,000?
Dismiss
Support plan!

https://www.youtube.com/watch?v=s49L1A9xh3w

Agent-based Modeling for Psychology

Research Aspect	Field Studies	Lab Experiment	Archival Studies	ABMs
Control and realism	Low control; high realism	Medium control; medium realism	Low control; medium realism	High control; low realism
Scale	Medium to high scale	Low to medium scale	High scale	High scale
Nonlinear dynamics	Medium visibility	Low visibility	Medium visibility	High visibility
Mechanism	Medium clarity	High clarity	Low clarity	High clarity

Smith, E. R., & Conrey, F. R. (2007). Agent-based modeling: A new approach for theory building in social psychology. *Personality and Social Psychology Review*, 11(1), 87-104.

Eberlen, J., Scholz, G., & Gagliolo, M. (2017). Simulate this! An introduction to agent-based models and their power to improve your research practice. *International Review of Social Psychology*, 30(1).

Jackson, J. C., Rand, D., Lewis, K., Norton, M. I., & Gray, K. (2017). Agent-based modeling: A guide for social psychologists. *Social Psychological and Personality Science*, 8(4), 387-395.

Goals for today: Agent-based Modeling

Learning a new way of characterizing dynamic systems

And connecting models of different spatial scales

Learning cellular automata models

The simplest form of agent-based models

Learn to develop agent-based models in Python

To explain the HOW behind social phenomena

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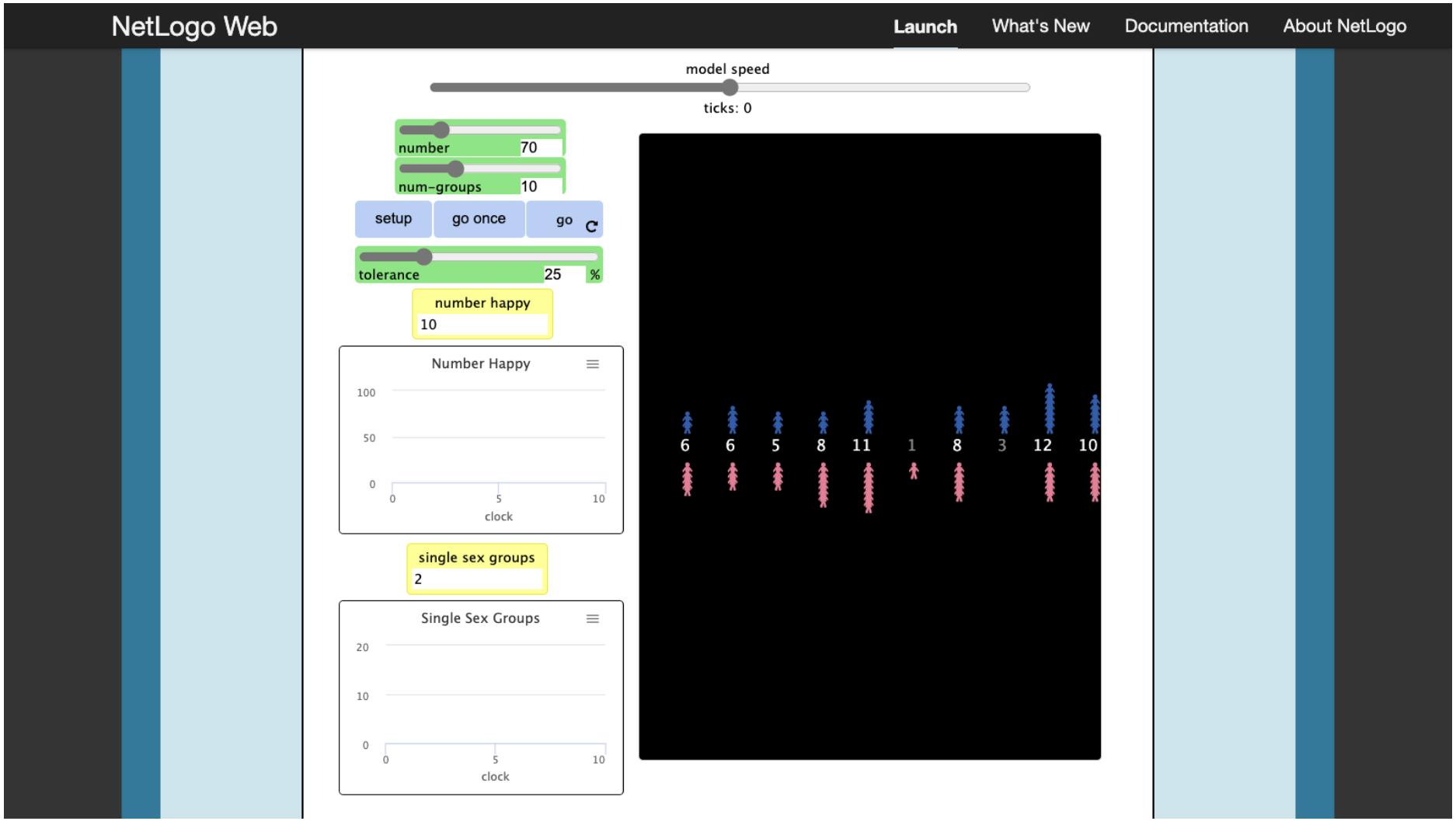
Agent-based models & simulators

You have seen them!



Features of agent-based models

The basic unit of simulation: agent

Each agent has some features (sex, tolerance, memory capacity, etc.)
and often interacts with neighboring agents or environments (i.e., locality)

Variability & randomness

Agents have individual differences
Environments have some randomness

Interactions / Hypotheses

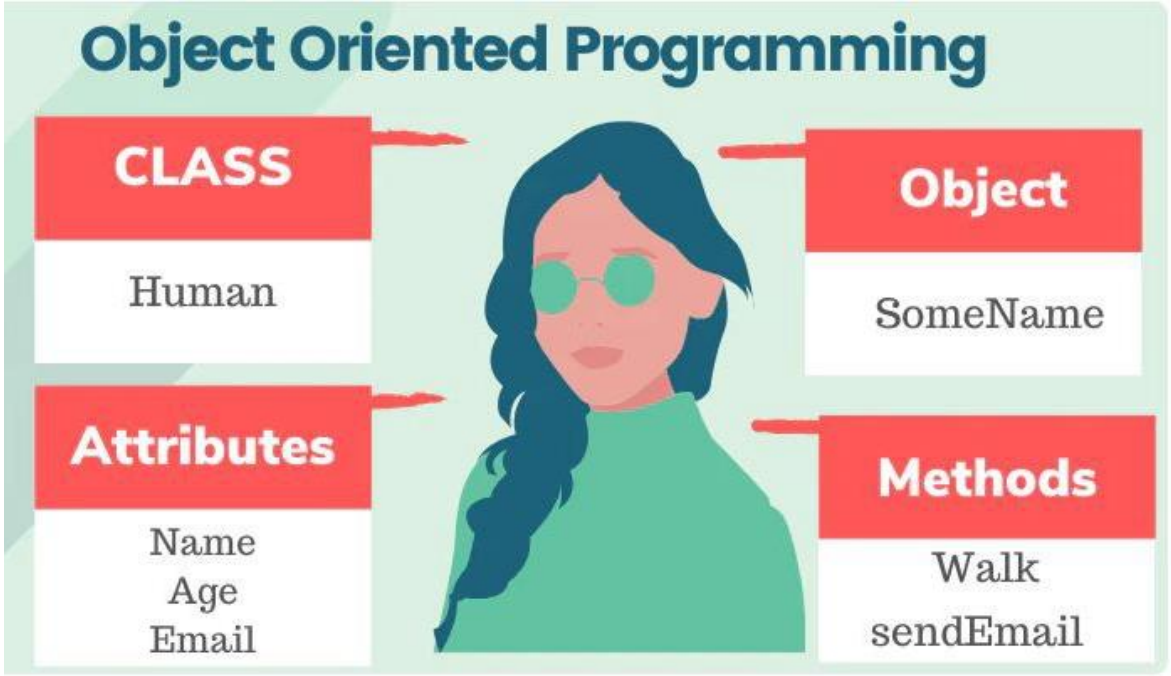
Complex phenomena can result from simple interaction rules/mechanisms

Implementation of agent-based models

Object-oriented Programming (OOP)

Each class (e.g., male/female) →each instance (e.g., male/female individual)

Each object has it own properties & methods



Programming Languages

Any (C++, Python, Matlab, etc.)

Or the popular NetLogo

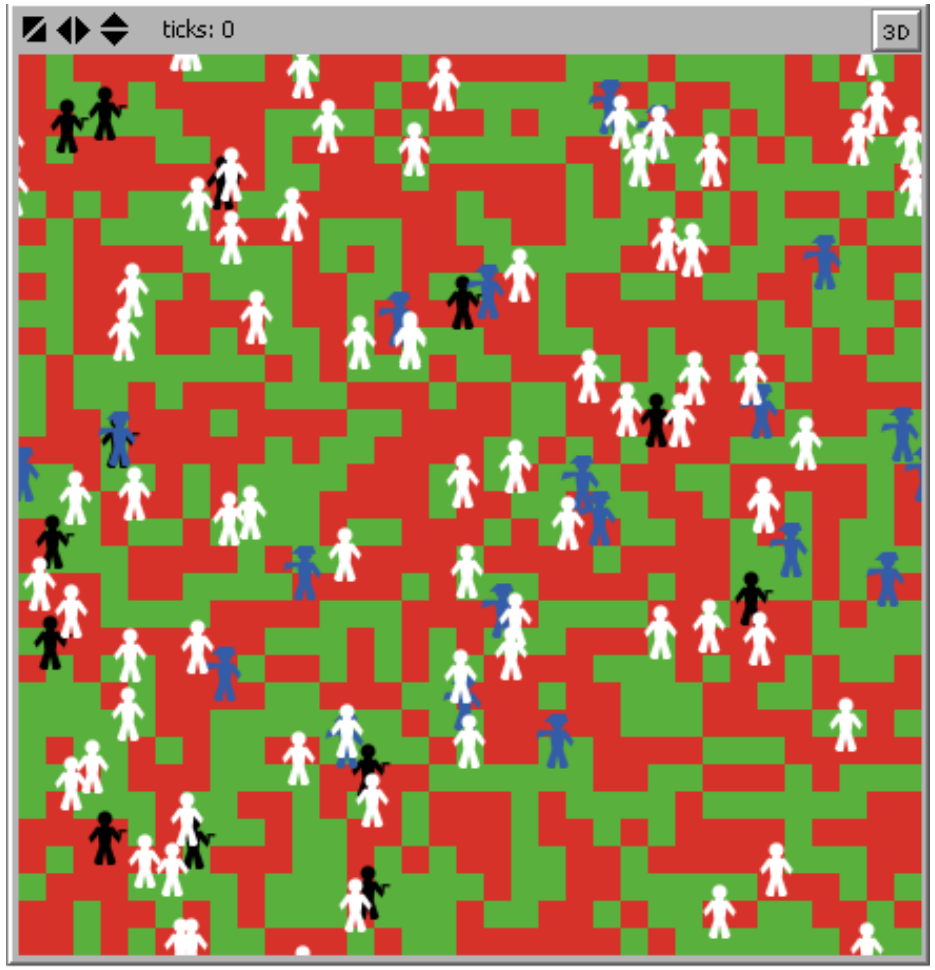
Types of models

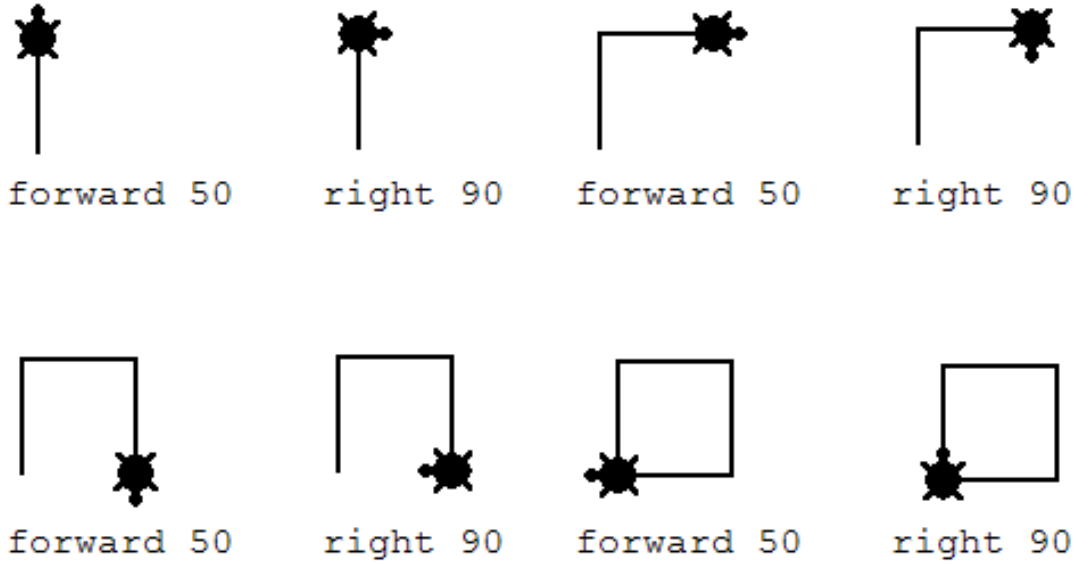
Cellular automata (agent = grid point)

Agent model (agent ≠ grid point)

NetLogo

Originated from Logo, an educational programming language





Agent=turtle

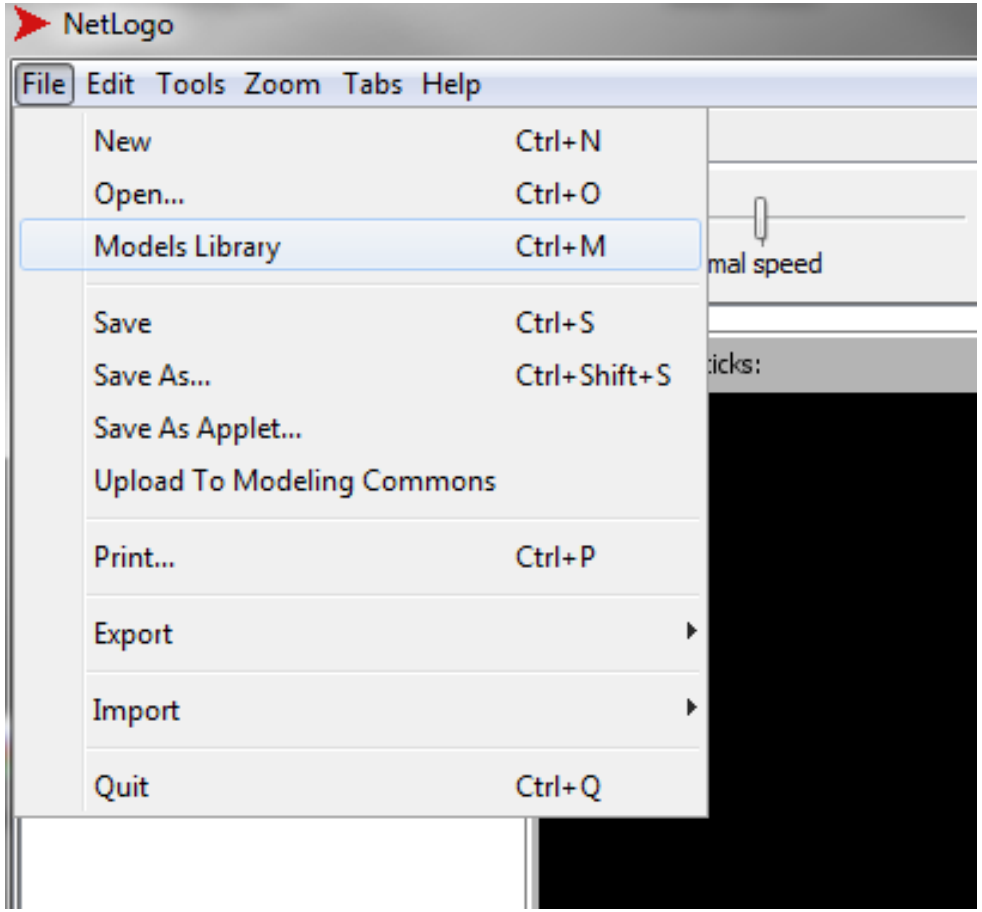
grid point=patch

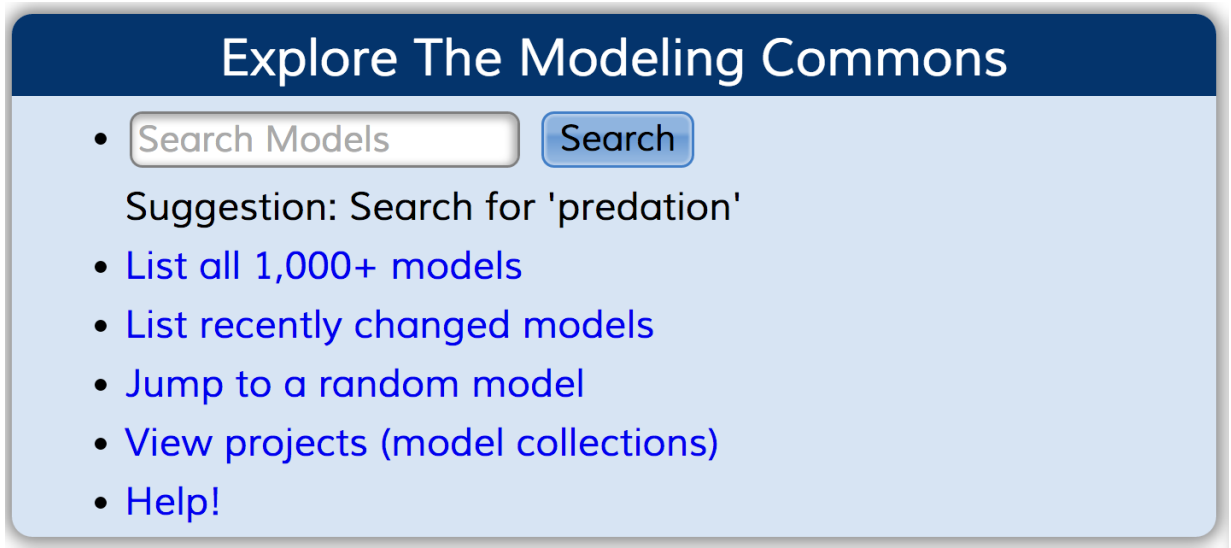
You=observer

The best way to learn NetLogo

First follow the three tutorials here.

Then check out the official & user-contributed model libraries.



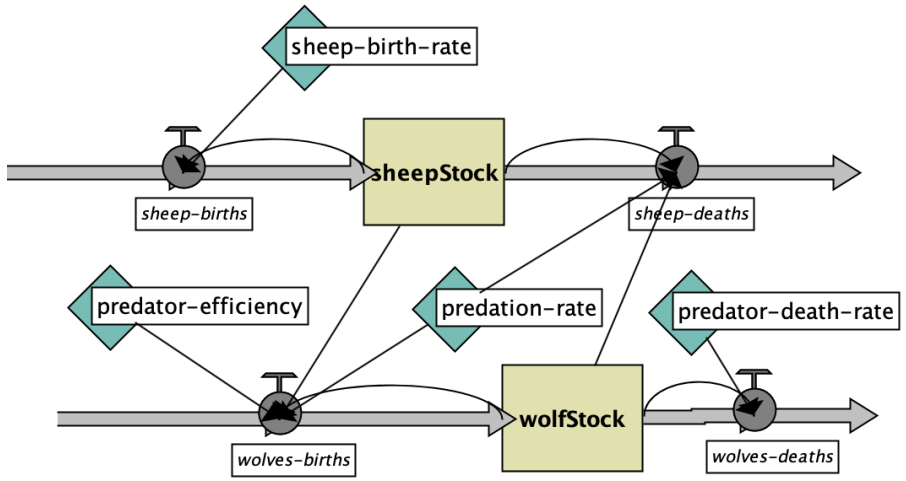


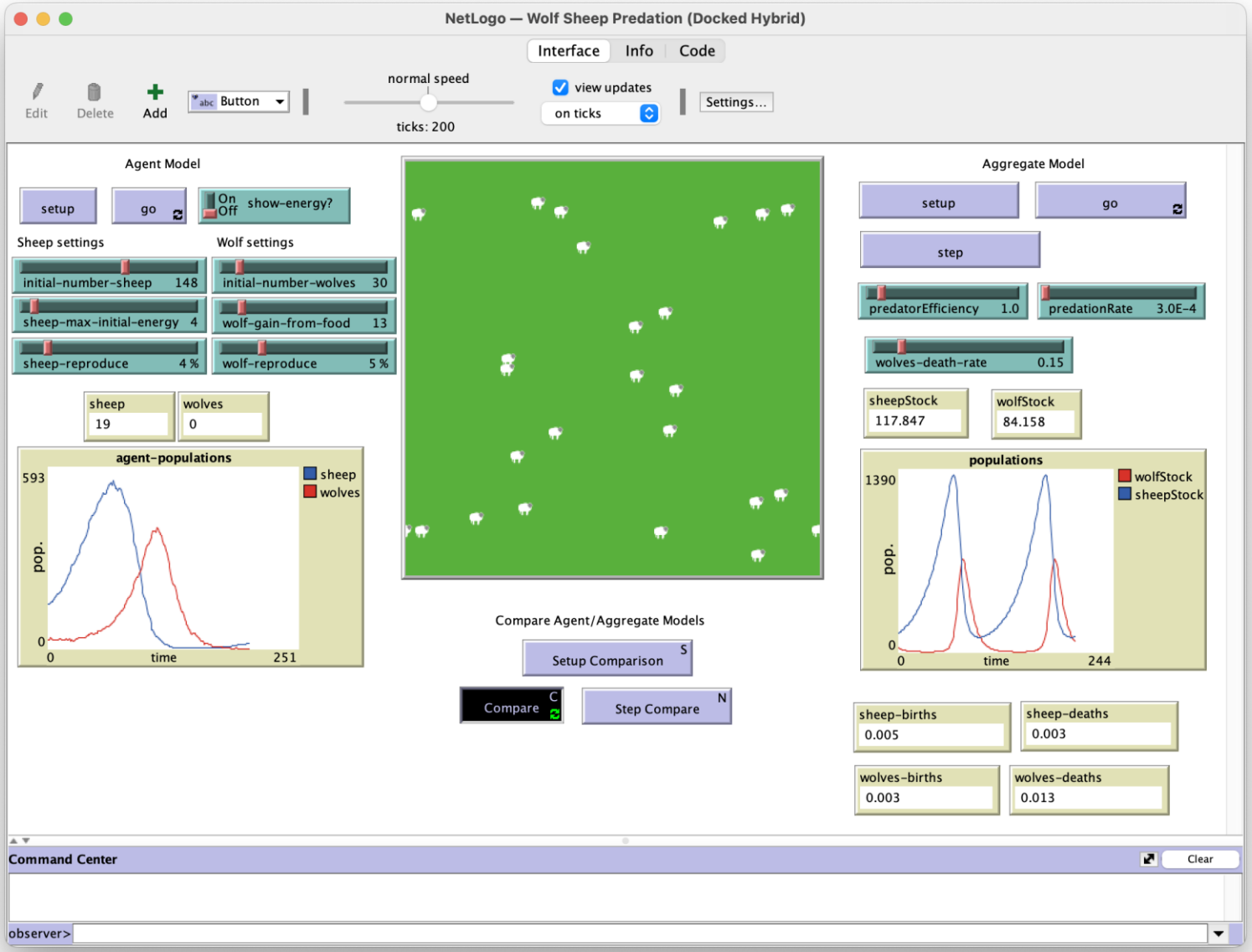
Agent-based model → System Dynamics

Lotka–Volterra Eqs.:

$$\frac{dx}{dt} = \alpha x - \beta xy,$$

$$\frac{dy}{dt} = \delta xy - \gamma y,$$





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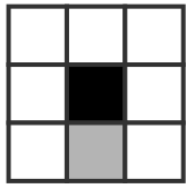
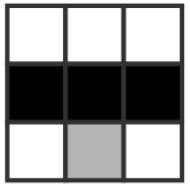
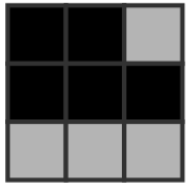
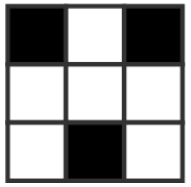
Conway's Game of Life

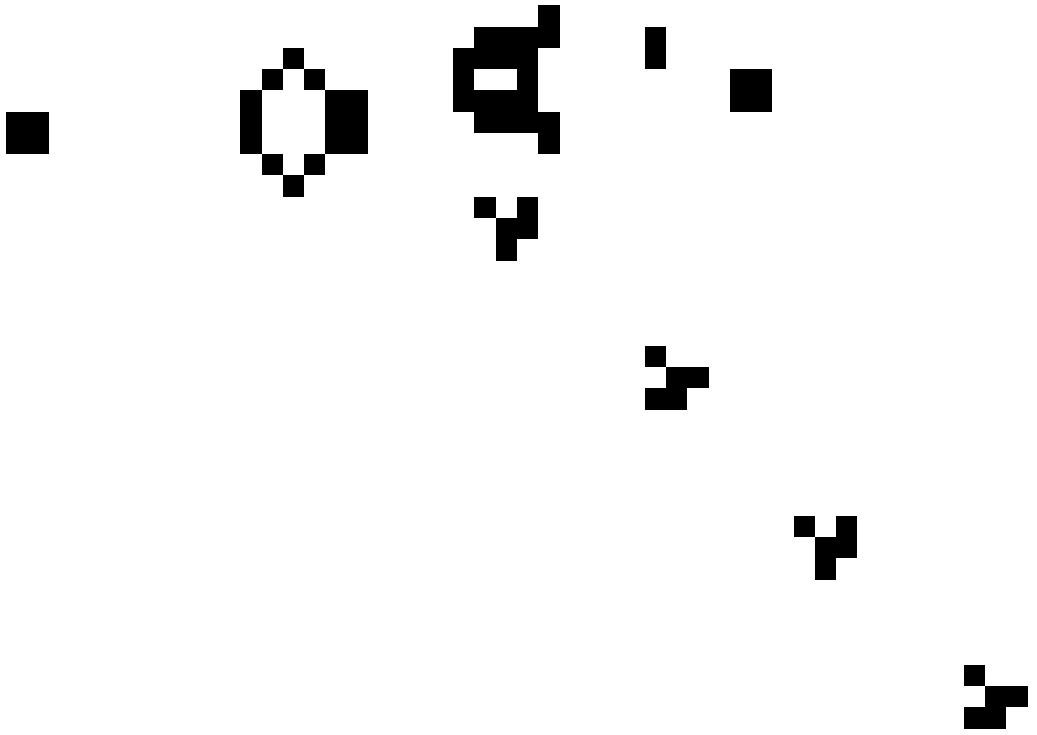
NetLogo: Models Library→Computer Science→Cellular Automata→Life

Under-population 1  < 2

Over-crowding 2  2, 3

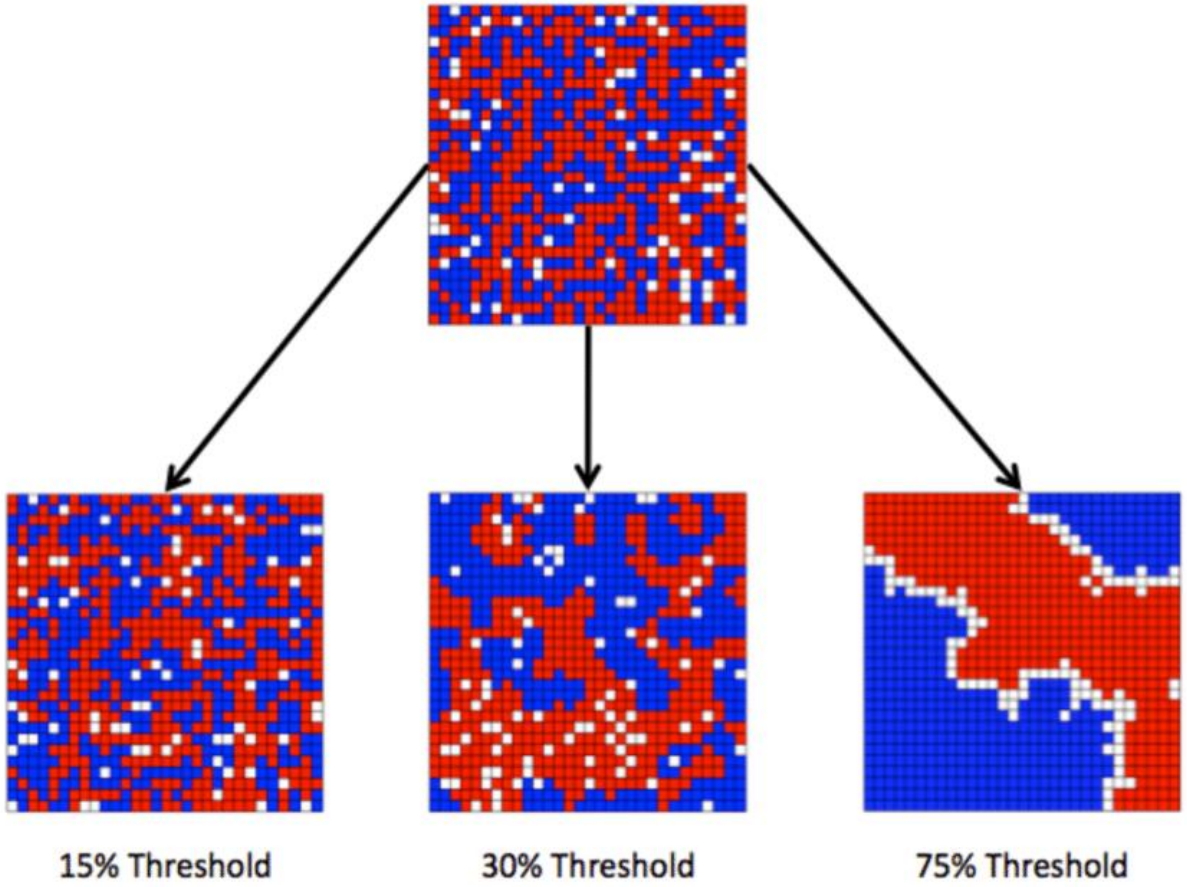
Survival 3  > 3

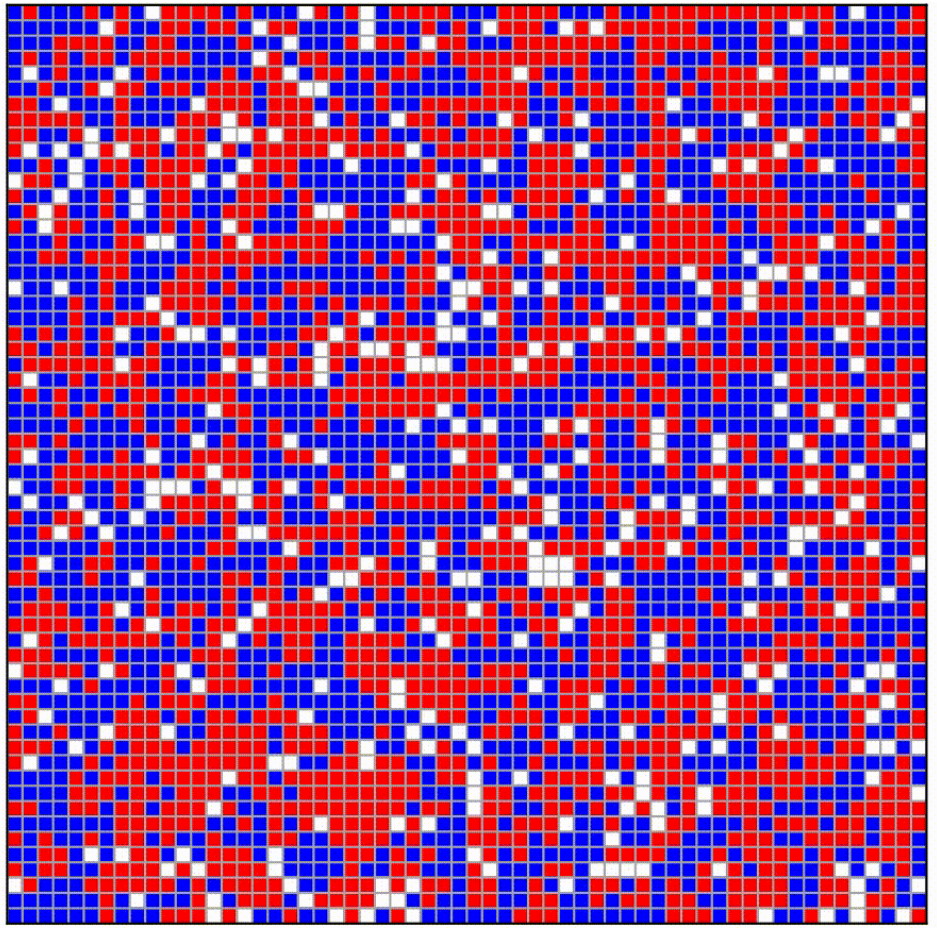
Reproduction 4  3



Schelling's (1971) & Nowak et al. (1990)

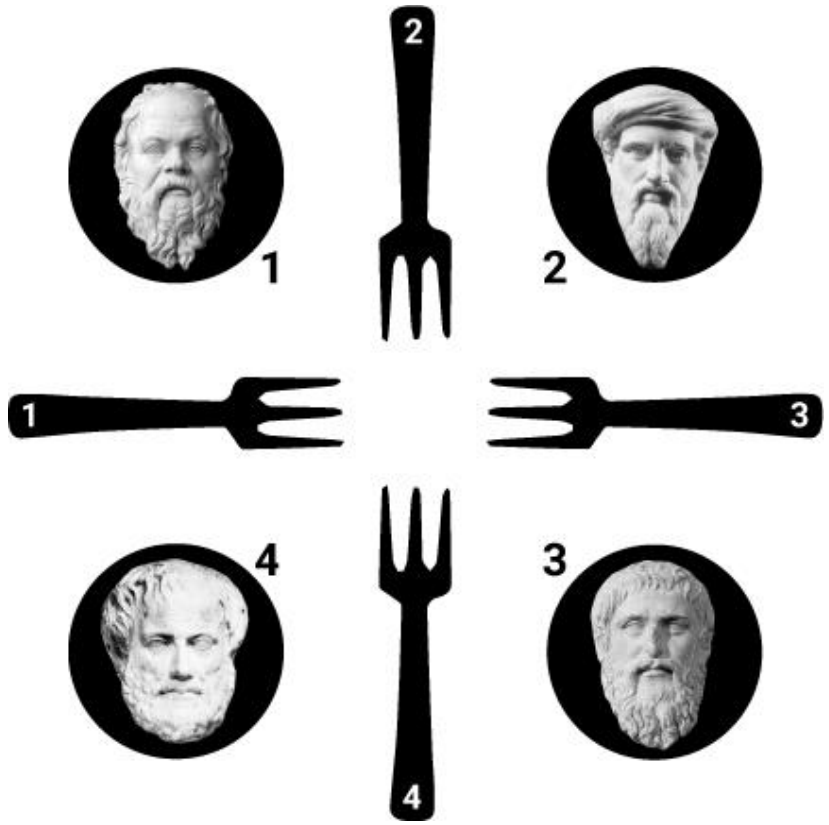
NetLogo: Models Library→Social Science→Segregation

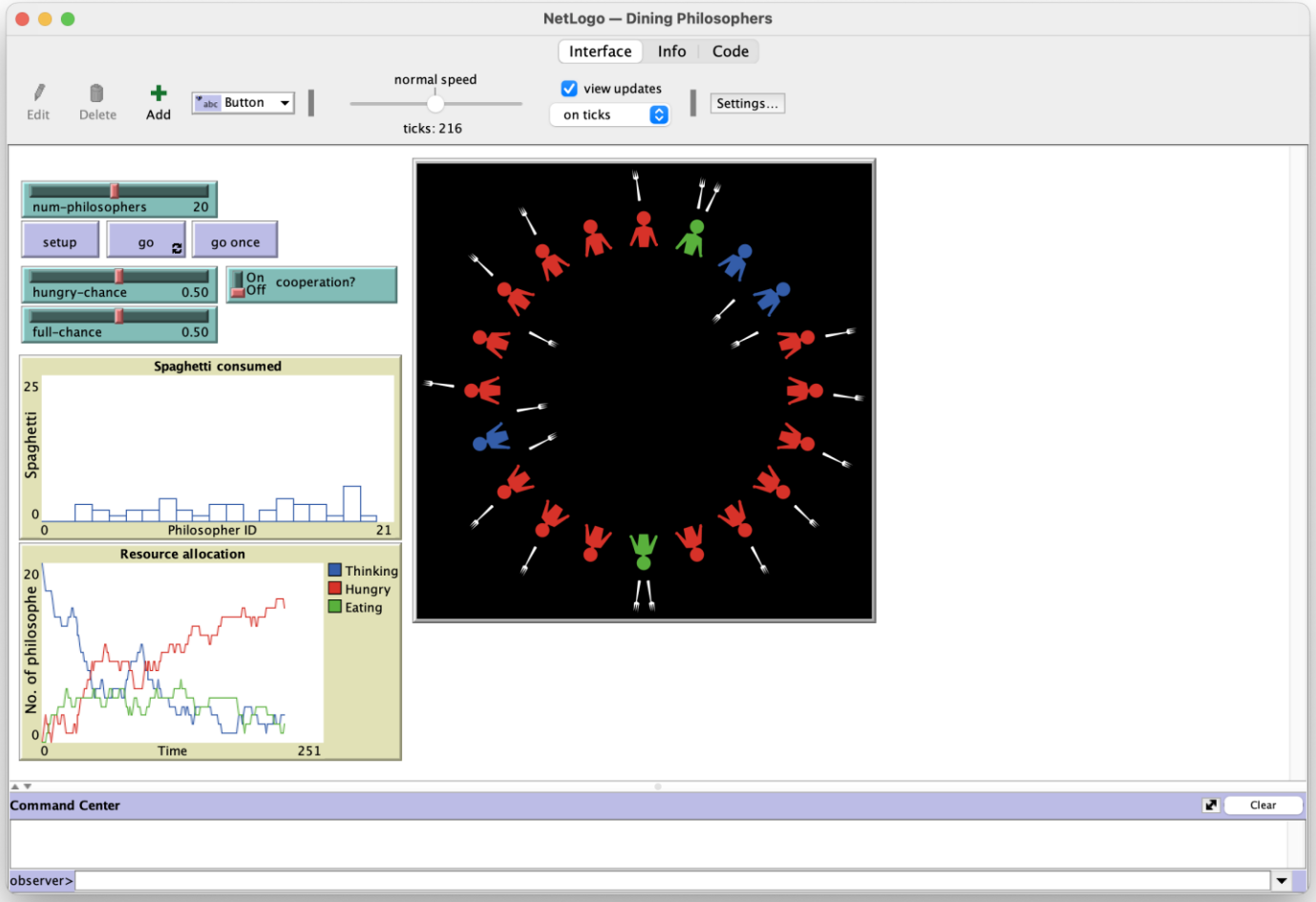




Dining Philosophers

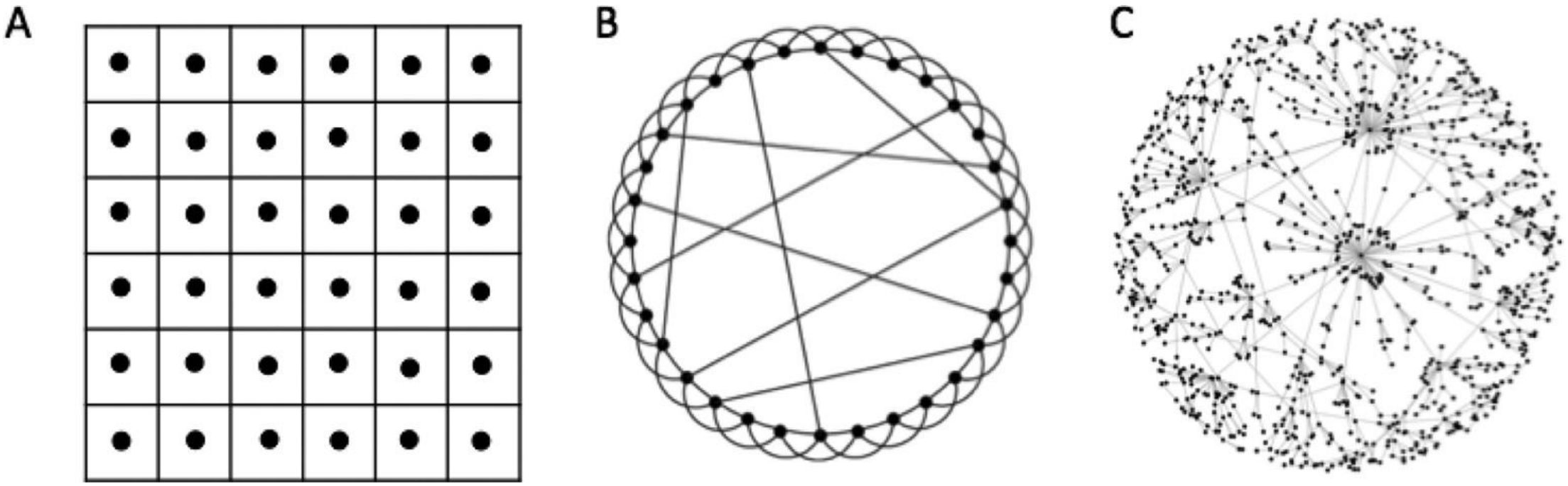
Models Library→Computer Science→Cellular Automata→Dining Philosopers





From neighbors to friends

Interactions can be restricted to friends defined by a social network



Or totally unrestricted agents who bump around

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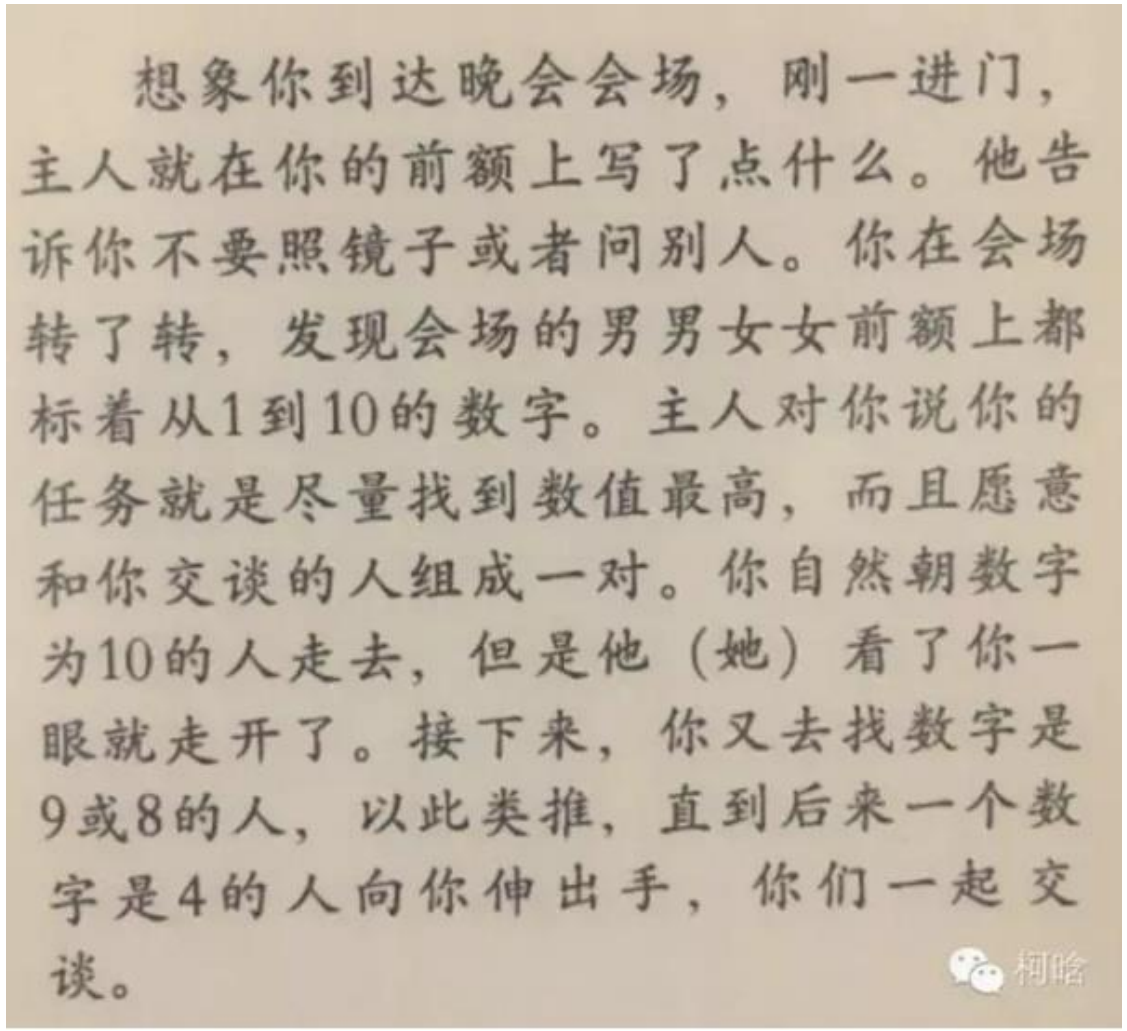
MIT Matching Game

It is falsely claimed to be conceived by the economist Dan Ariely


想象你到达晚会会场，刚一进门，主人就在你的前额上写了点什么。他告诉你不要照镜子或者问别人。你在会场转了转，发现会场的男男女女前额上都标着从1到10的数字。主人对你说你的任务就是尽量找到数值最高，而且愿意和你交谈的人组成一对。你自然朝数字为10的人走去，但是他（她）看了你一眼就走开了。接下来，你又去找数字是9或8的人，以此类推，直到后来一个数字是4的人向你伸出手，你们一起交谈。

The Matching Hypothesis Reexamined

S. Michael Kalick and Thomas E. Hamilton III
University of Massachusetts, Boston

Although experimental tests have not tended to support the matching hypothesis, correlational studies have consistently found positive intracouple attractiveness correlations among actual couples. The present investigation sought to reconcile the findings of experimental and correlational studies by probing the relation between individual choices and systemwide patterns of couple formation. This was accomplished through the use of a series of mate-selection simulations. In the first simulation, the hypothetical individuals were given no awareness of their own attractiveness level, but they were programmed to demand an attractive partner; in the second simulation, they sought a partner who matched their own attractiveness level; and, in the third simulation, they used a combination of these two criteria. Each simulation culminated in a substantial intracouple attractiveness correlation. Most notably, the simulation based on pure attractiveness seeking produced a correlation in the upper range of those reported in actual studies of existing couples. Thus, it is inappropriate to infer that existing research has established a substantial role of matching in social choice. The use of models such as those provided by the simulations is proposed as a means of facilitating backward inference from systemwide patterns to the individual choices and behaviors that may produce these patterns.

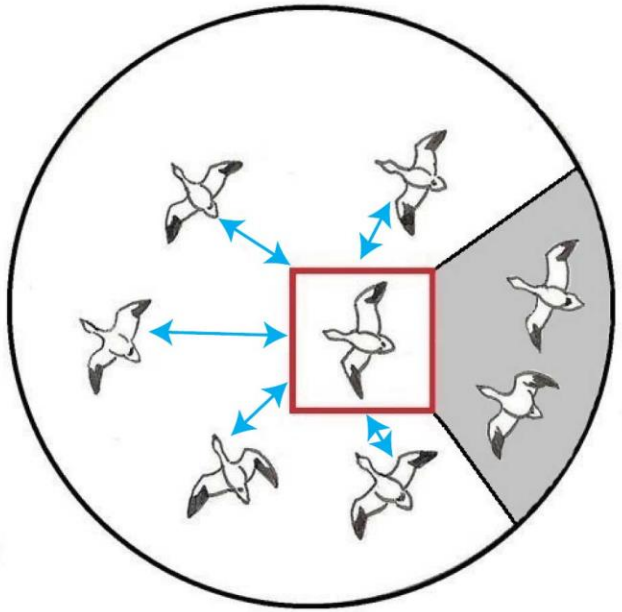
Bird-oid (BOID) Model (1/2)

How does individual bird estimate the group direction?

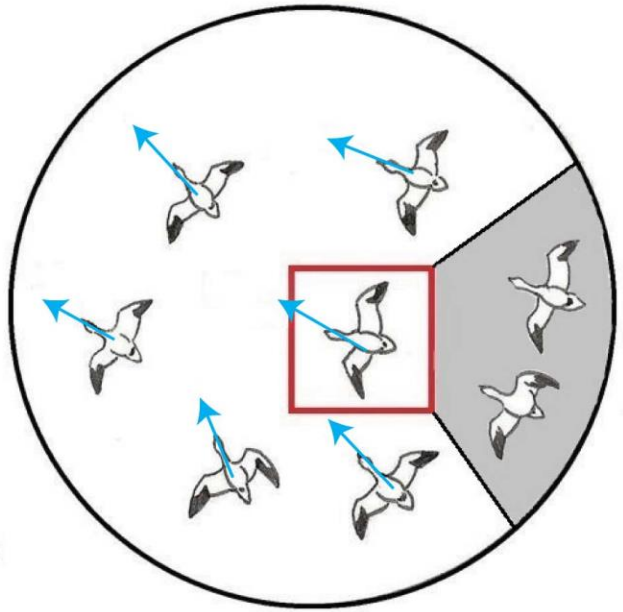
Bird-oid (BOID) Model (2/2)

NetLogo: Models Library→Biology→Flocking

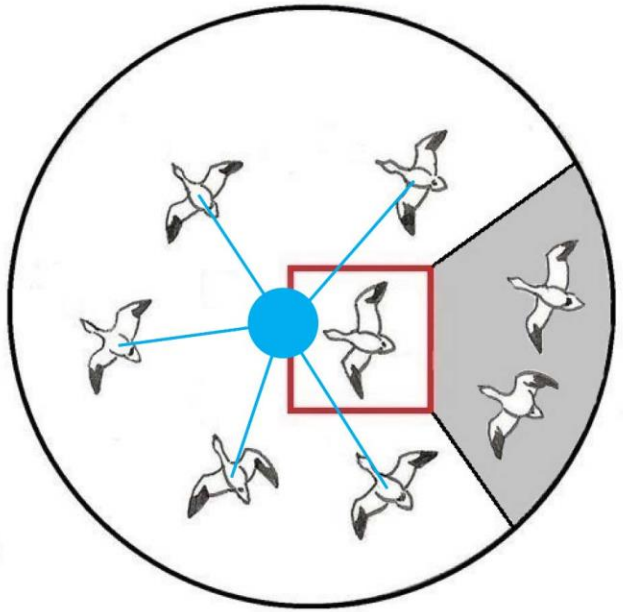
Separation



Alignment



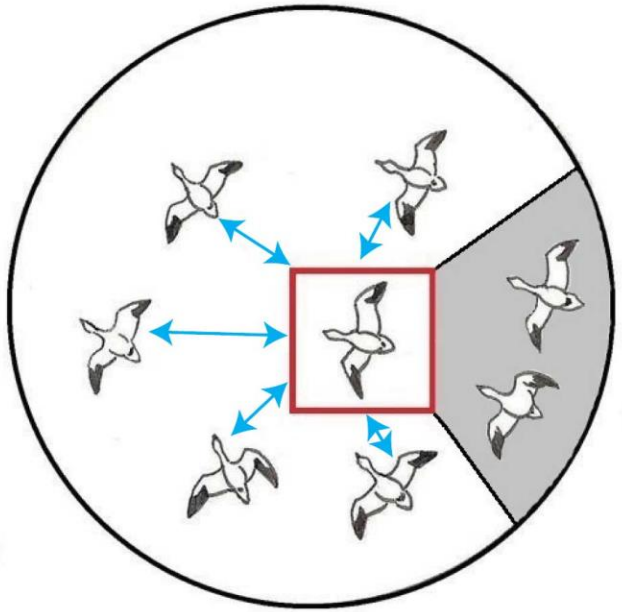
Cohesion



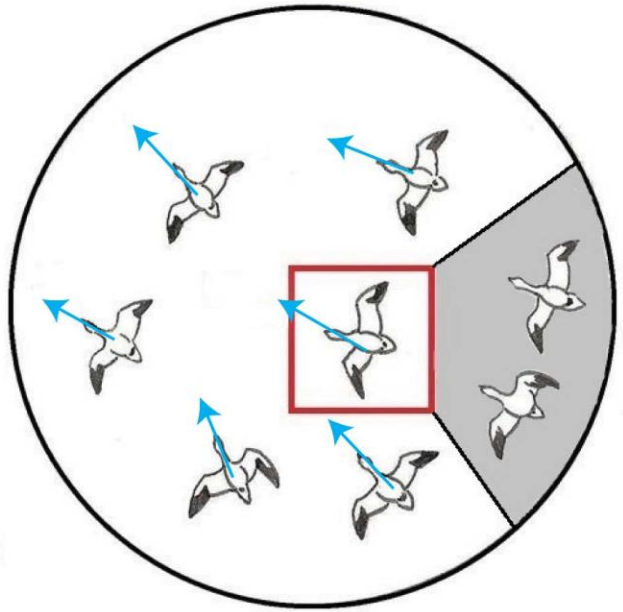
Bird-oid (BOID) Model (2/2)

NetLogo: Models Library→Biology→Flocking

Separation



Alignment



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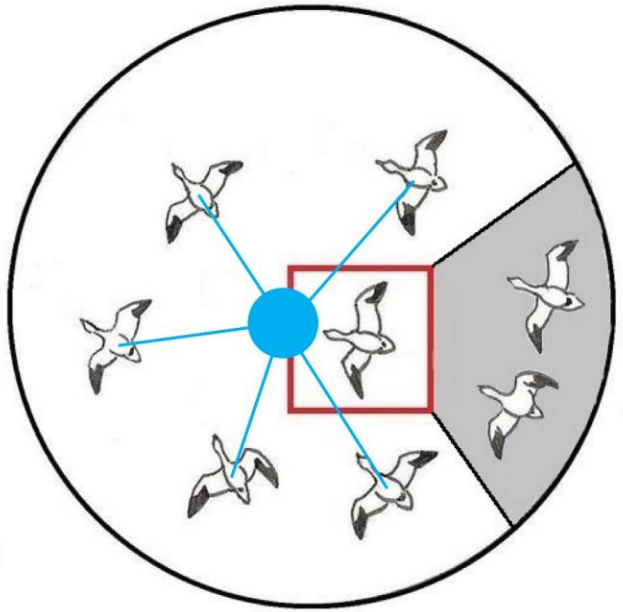


Microeconomics → Macroeconomics

Prisoner's Dilemma → Economic units

Research Article

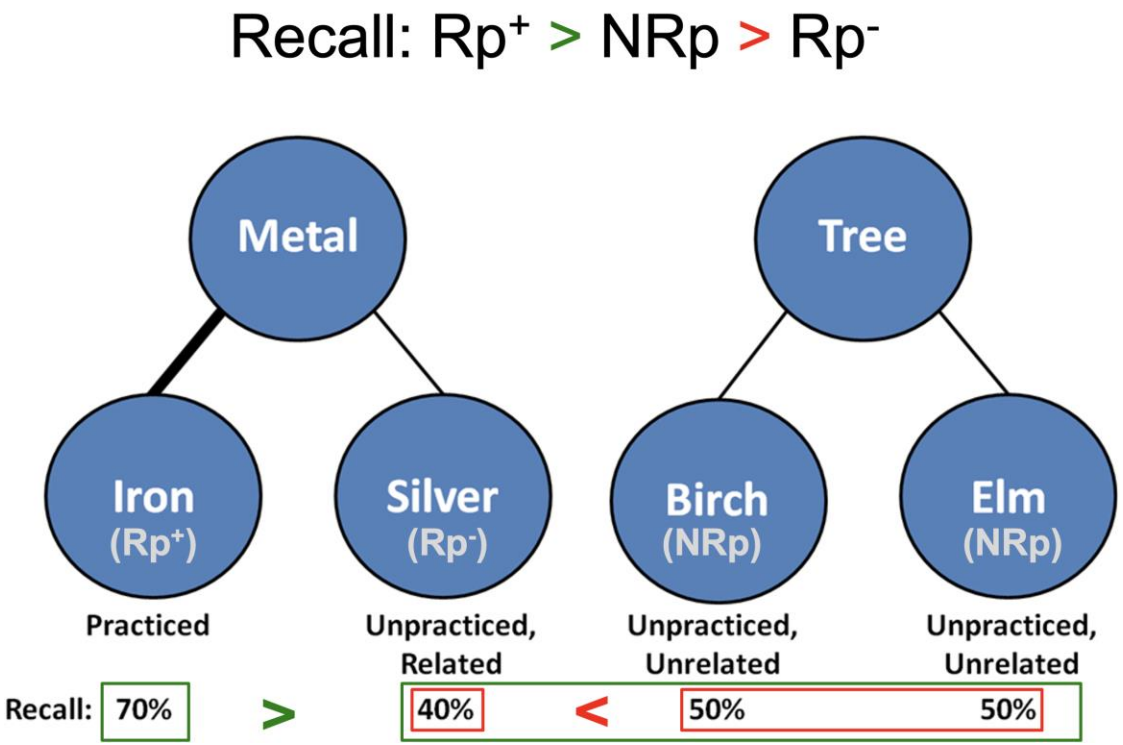
The Emergence of "Us and Them" in 80 Lines of Code: Modeling Group Genesis in Homogeneous Populations

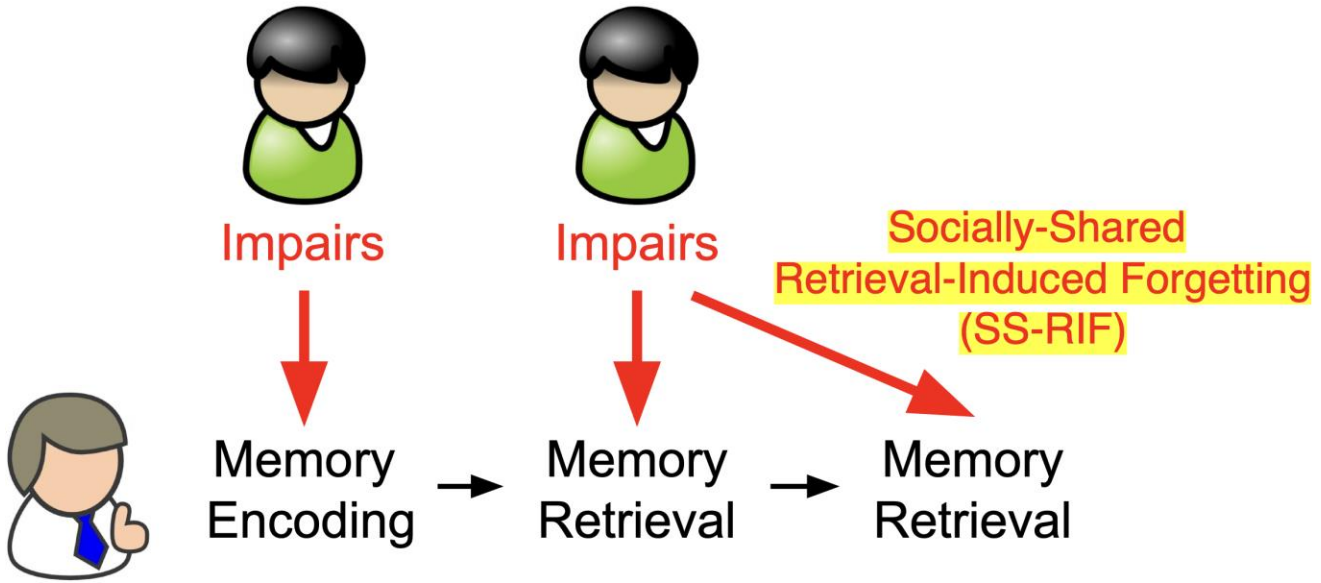
		Player 2	
		Cooperates	Defects
Player 1	Cooperates	1/1	–3/3
	Defects	3/–3	–1/–1

Payoff: Player 1/Player 2

Individual Cognition→ Social Cognition

Retrieval-induced forgetting (RIF) → Socially-shared RIF (SSRIF)





Agent-based models of SSRIF: 1, 2, 3

Game Over