

Designing Consensus:

Gamified Modeling and Simulation of Collaborative Decision-Making

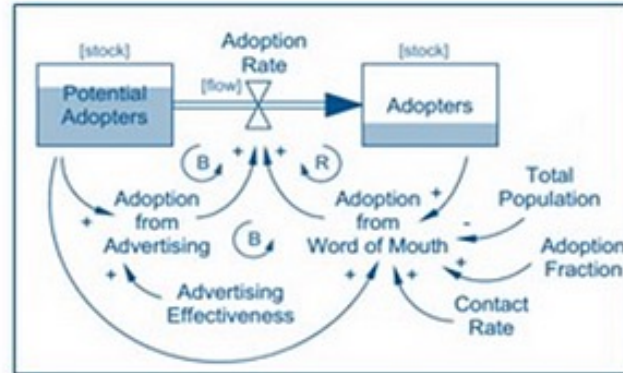
Instructor: Jin Gao

IAP 2025 (Non-Credit)

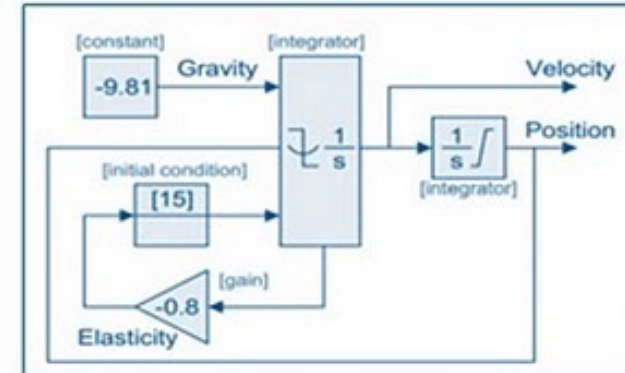
2025.01.23

gaojin@mit.edu

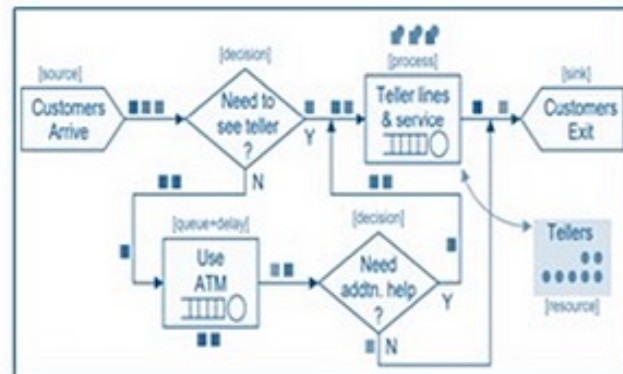
Date	Topic	Contents
Jan 23	System Dynamics and Simulation Games (SLG)	<ul style="list-style-type: none">• From a macro perspective, introduction to system dynamics as an approach for modeling complex systems.• Introduction to the core mechanisms behind classical SLGs that utilize system dynamics concepts, such as SimCity.
	Workshop	<ul style="list-style-type: none">• Sketch out the system's dynamic loops and diagrams of your game.• Share your game design with the class, play others' board games, make suggestions, and refine your design.• Develop and build your game at home (physical or digital)



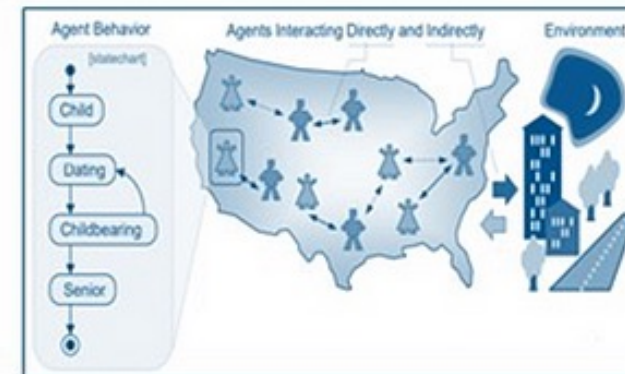
System Dynamics



Dynamic System

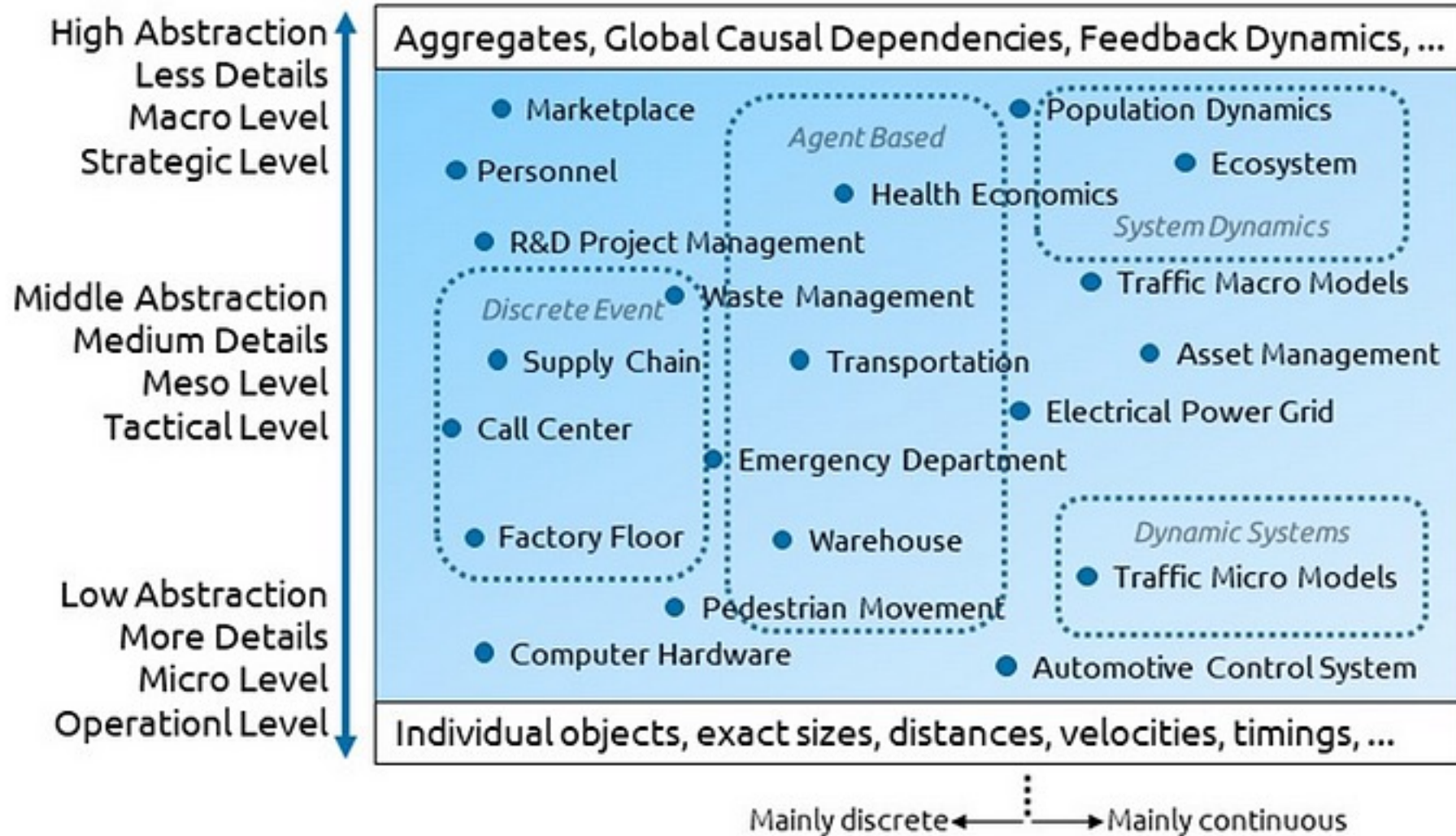


Discrete Event

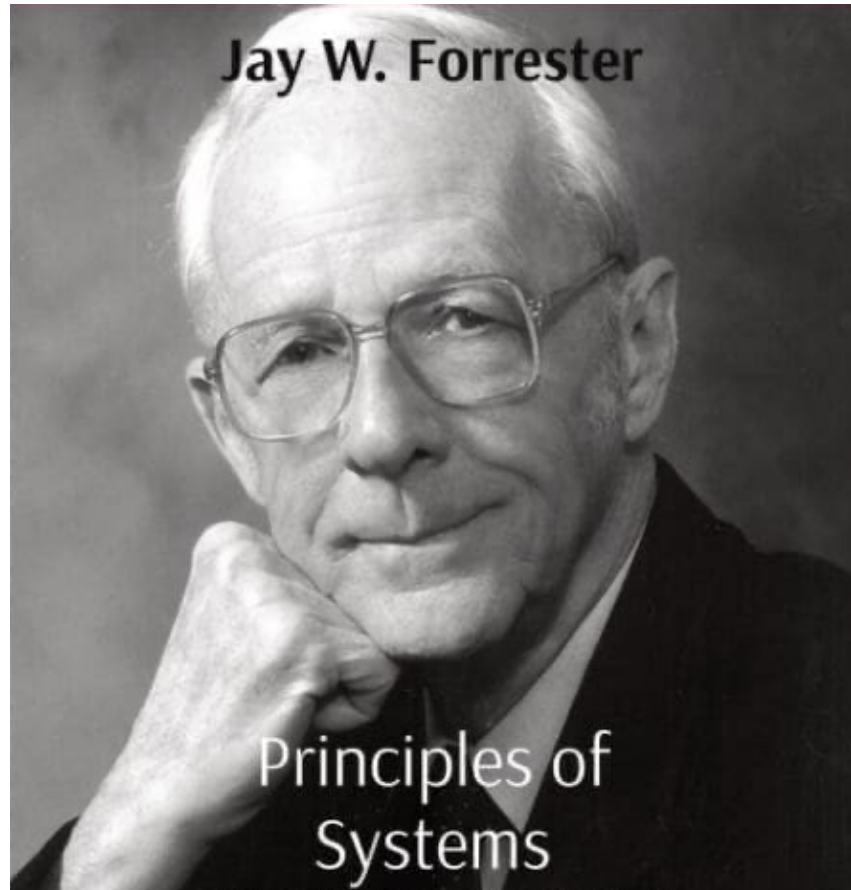


Agent Based

The family of simulation modelling (Borshchev & Filippov, 2004)

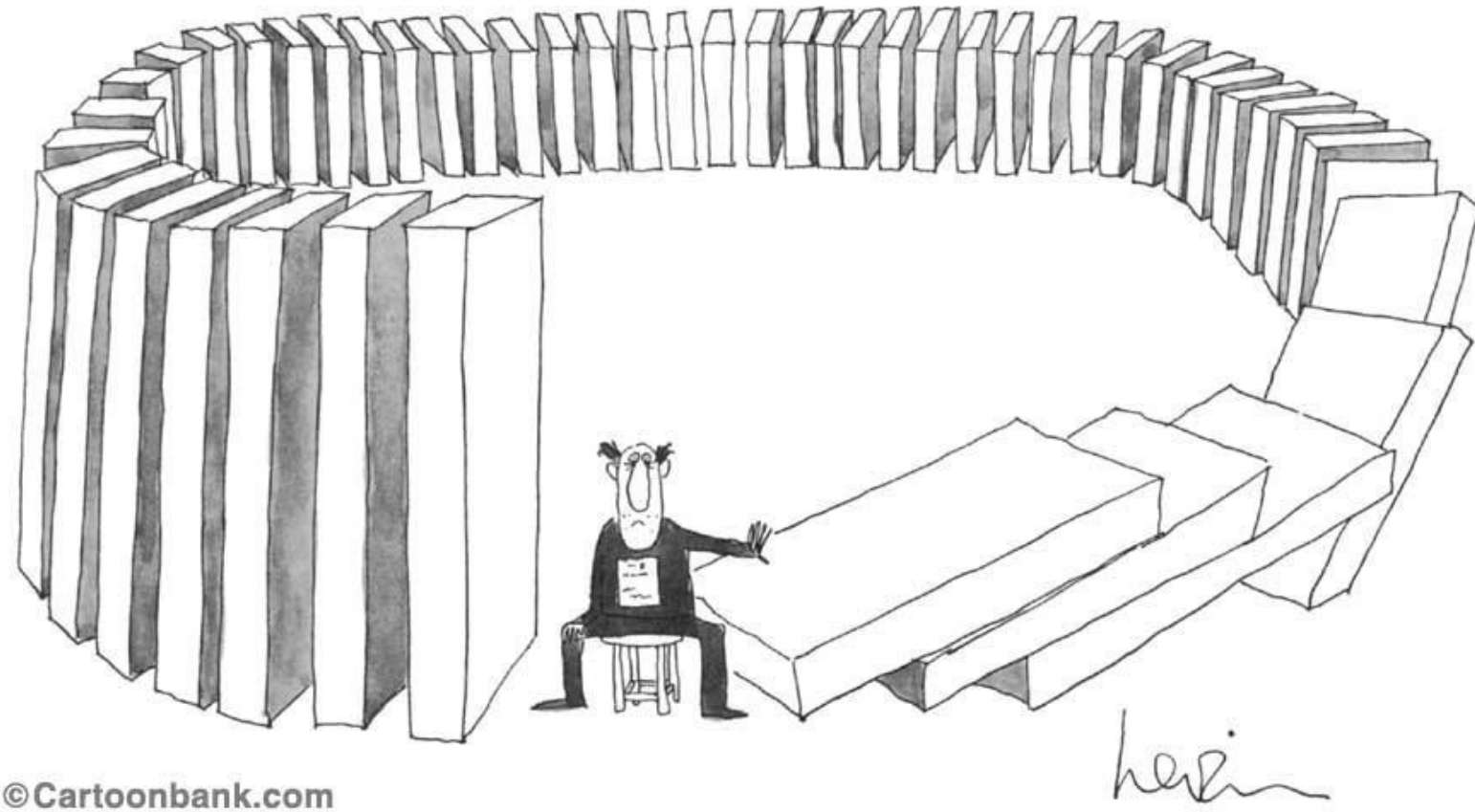


System Dynamics – a Heritage

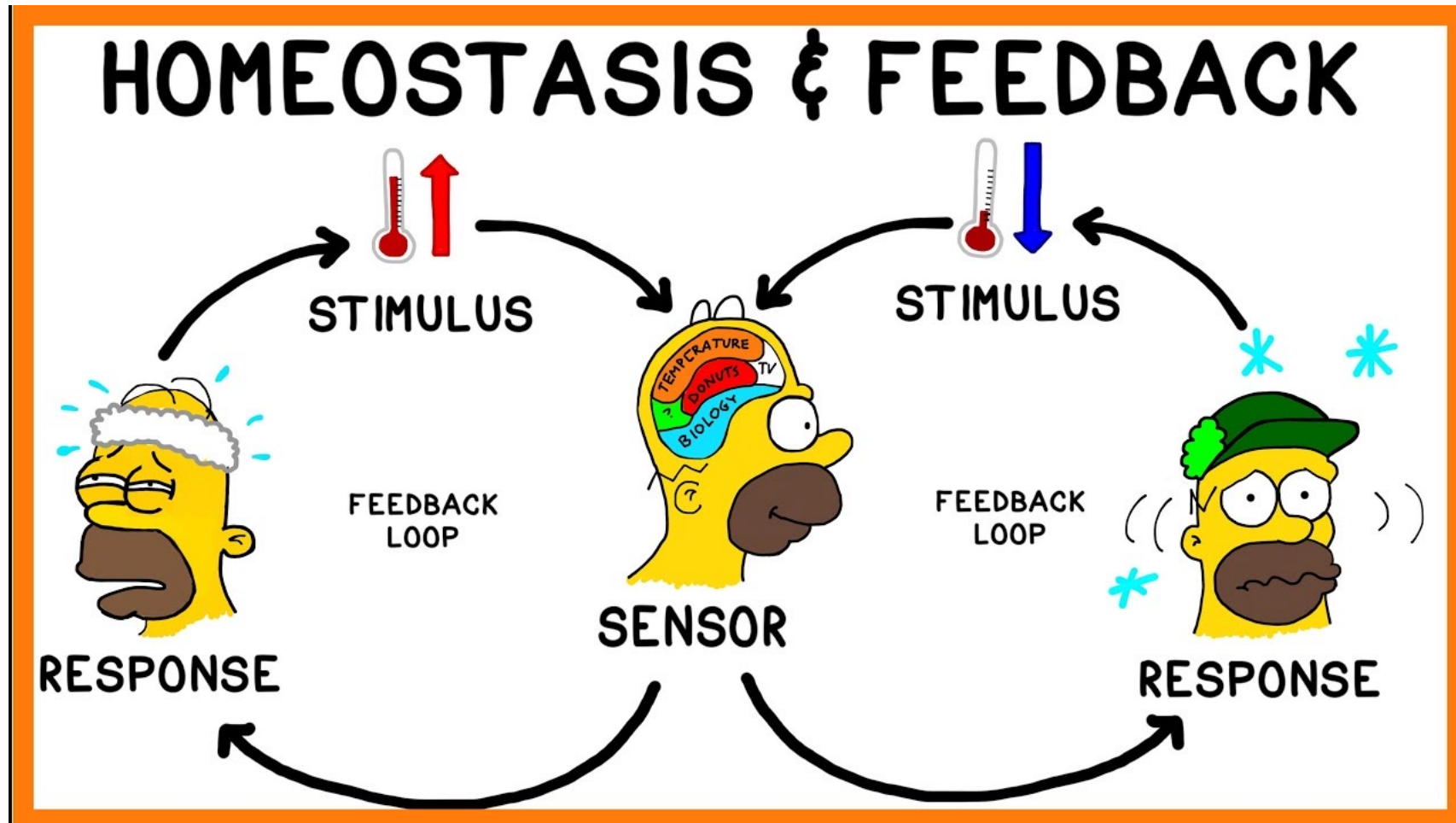


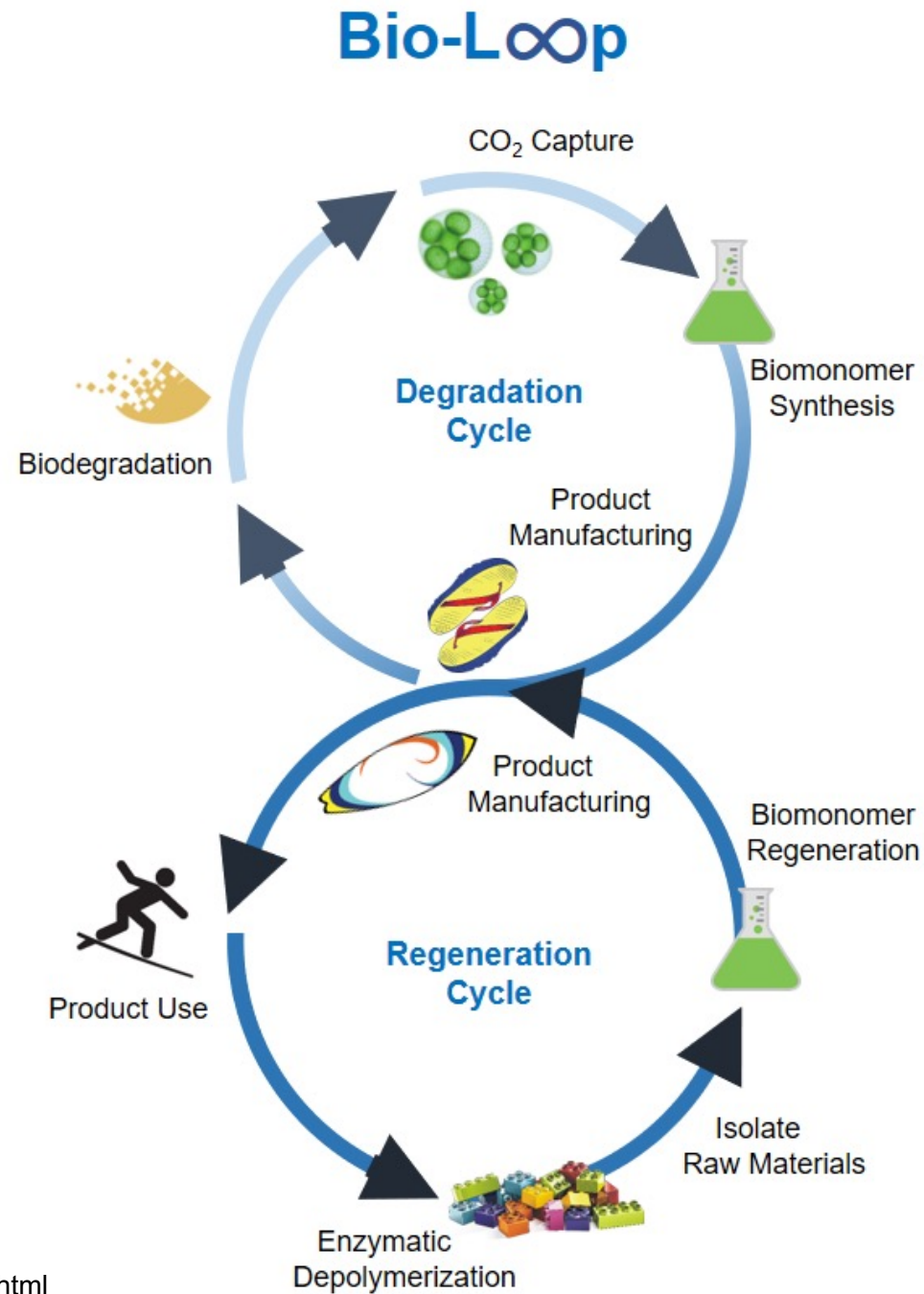
System Dynamics was born at MIT Sloan in the 1950s and developed by Prof. Emeritus Jay W. Forrester. System Dynamics helps us understand, design, and manage change. Using data and technology, System Dynamics models the relationships between all the parts of a system and how those relationships influence the behavior of the system over time.

Think in the System Level



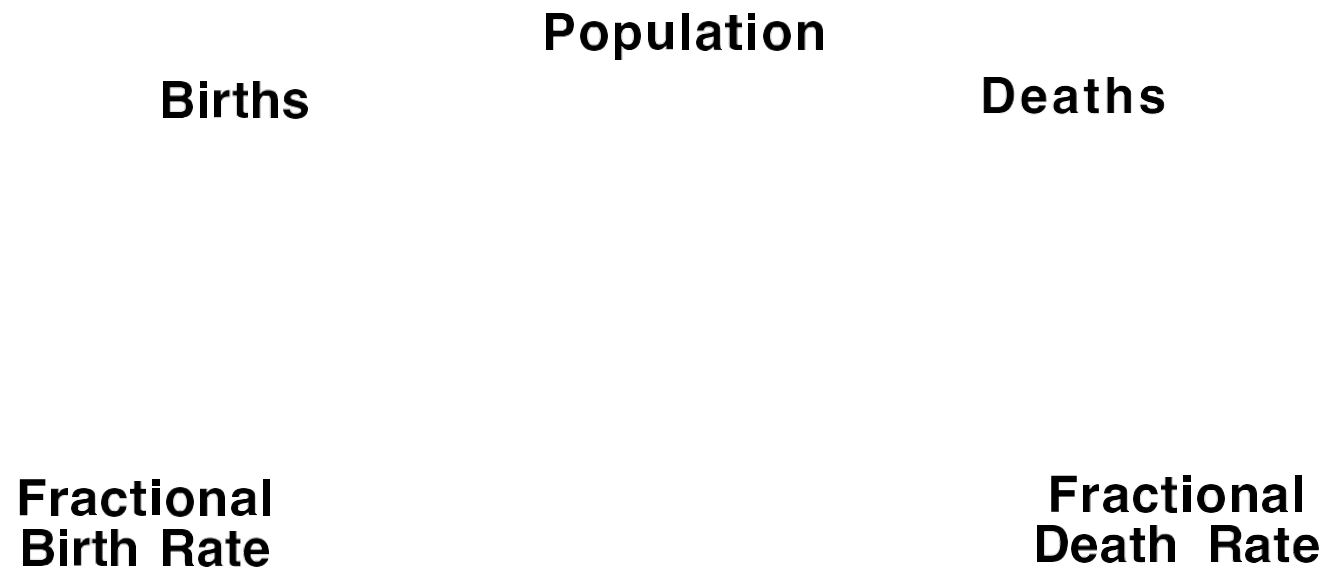
©Cartoonbank.com





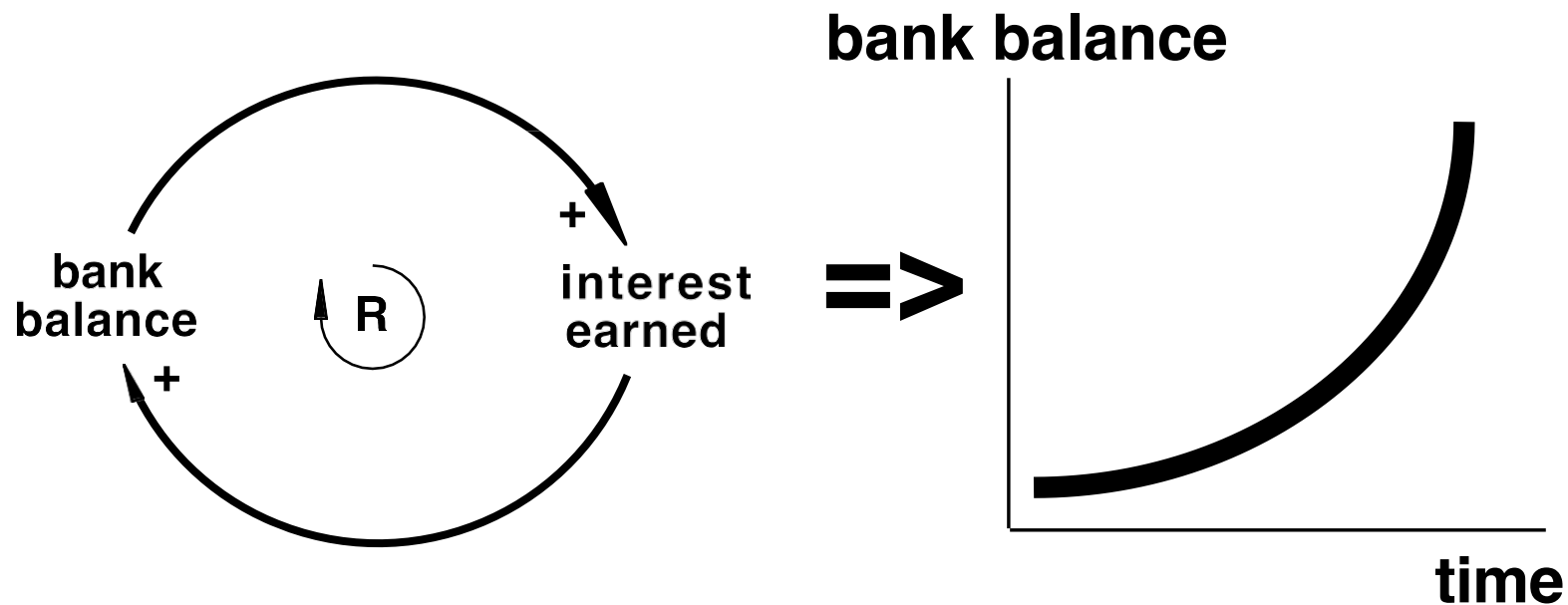
Construction of System Dynamic Model

Basic Elements: Parameters

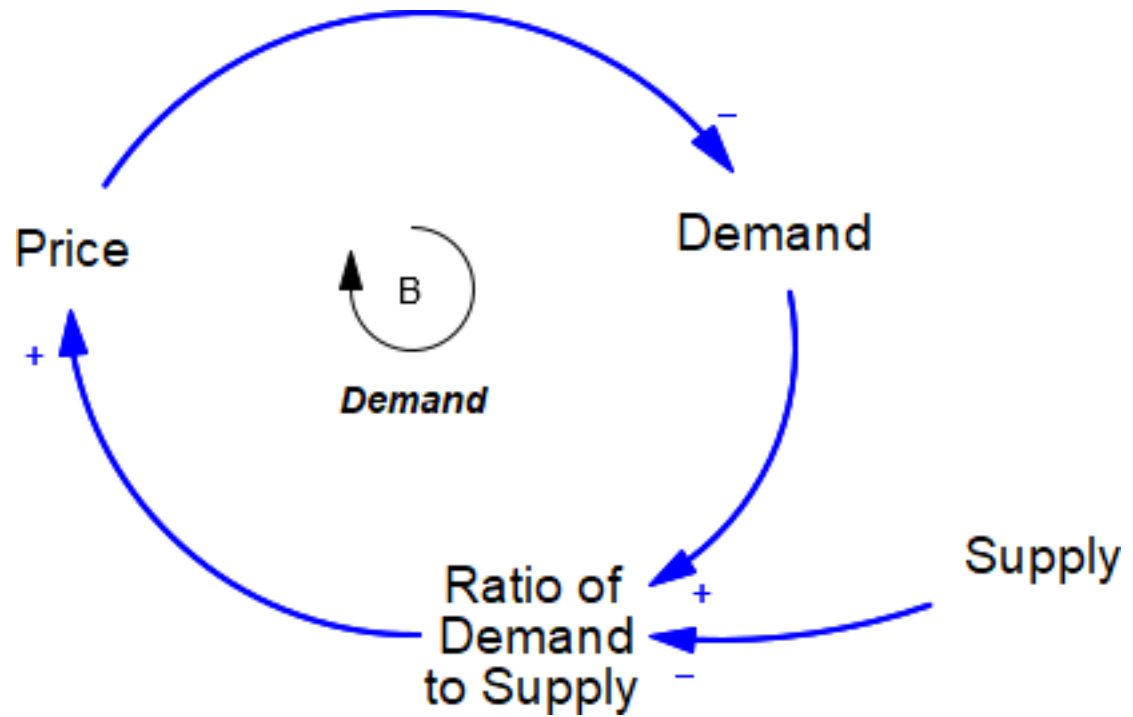


Structure and Behavior: Reinforcing Loops

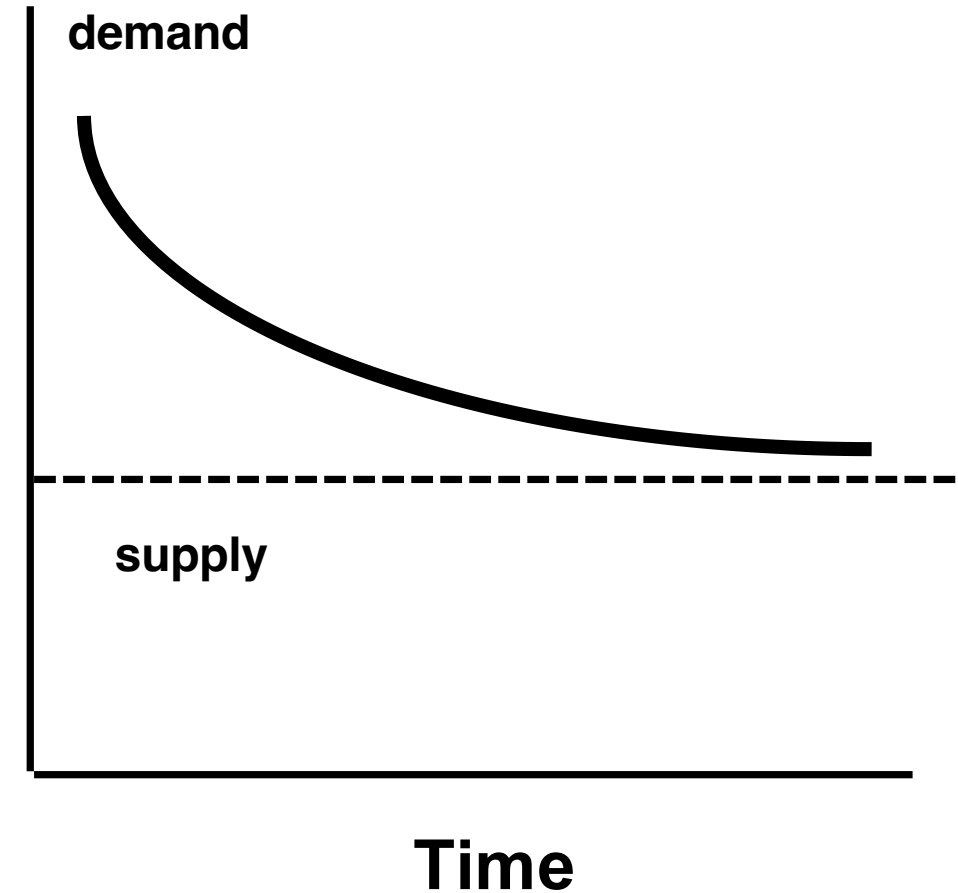
- Loops with all positive (or an even number of negative) links are reinforcing feedback loops.
- Reinforcing loops create exponential growth or decline.



Balancing Loops

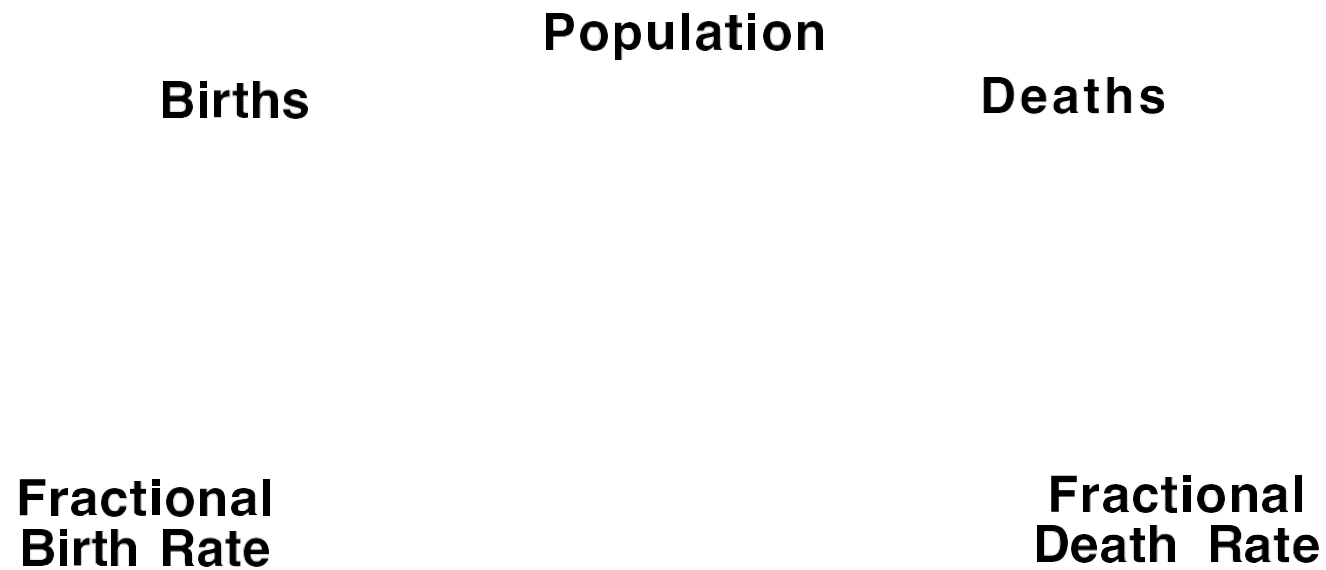


⇒

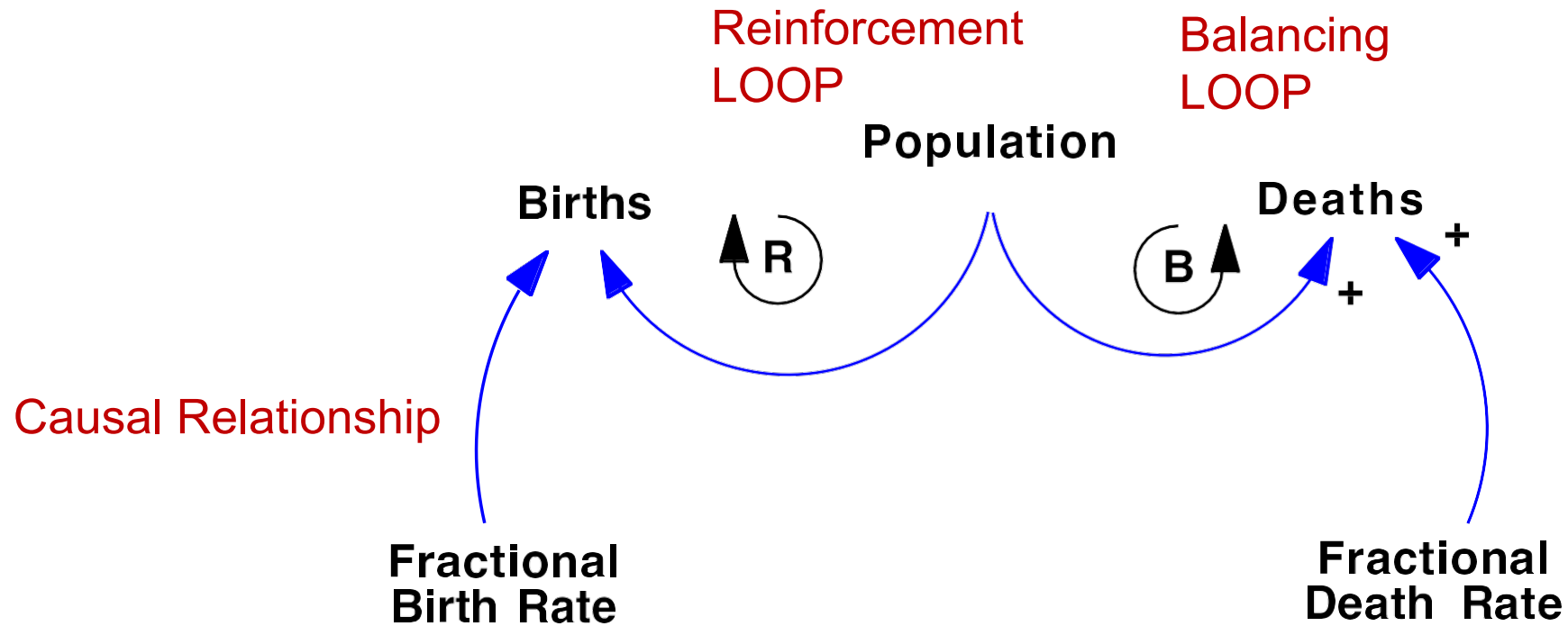


- Balancing loops move a system towards a goal. They give a system stability.

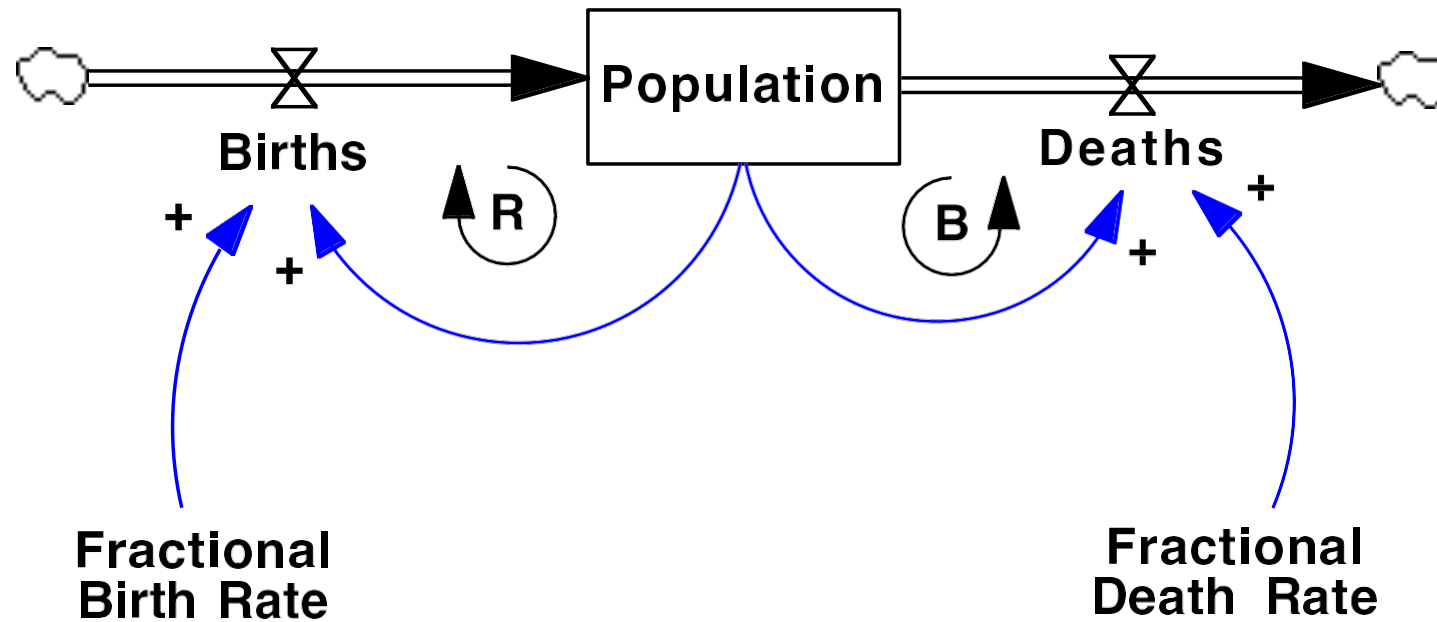
Basic Elements: Parameters



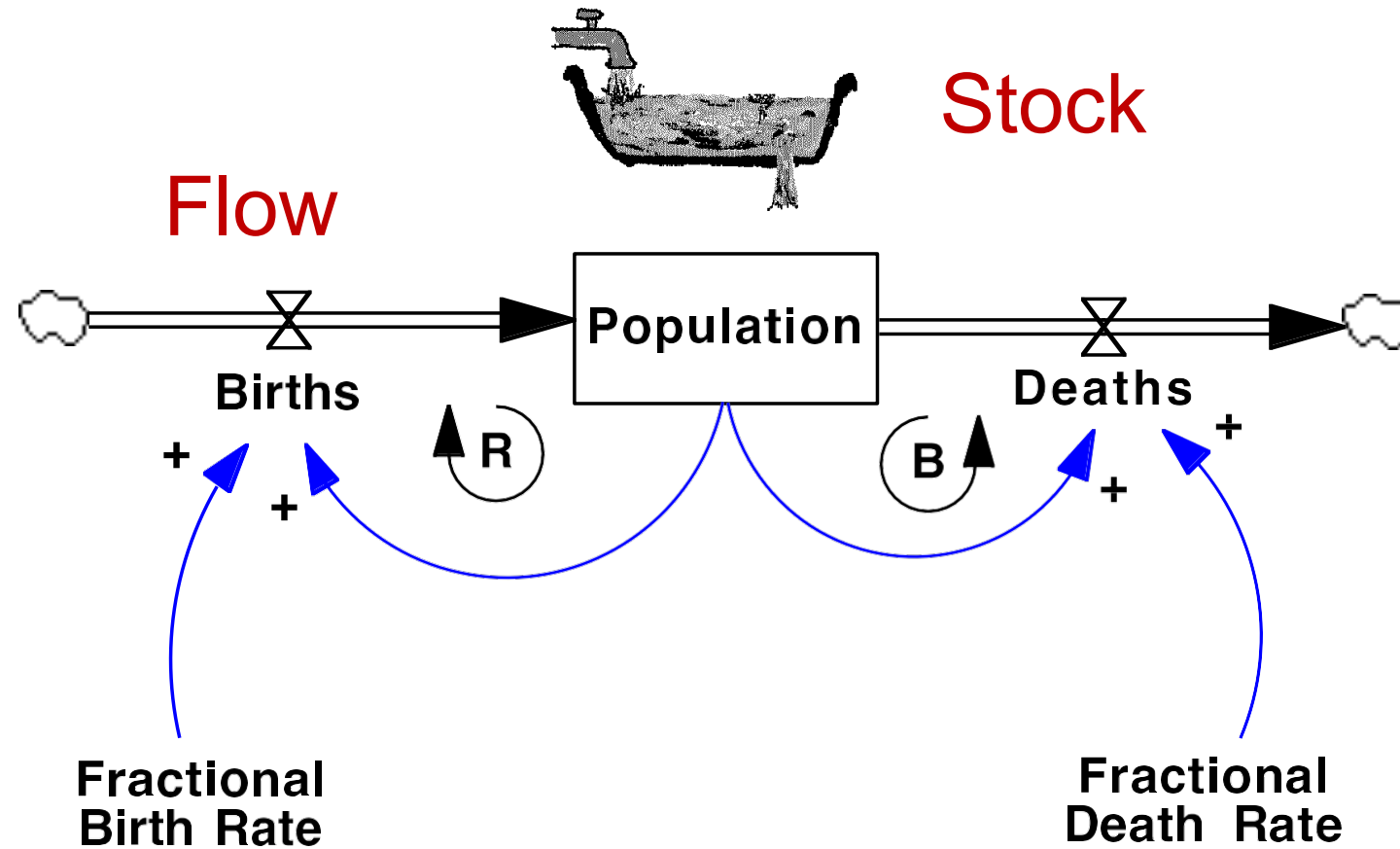
Basic Elements: Parameters and Relationships



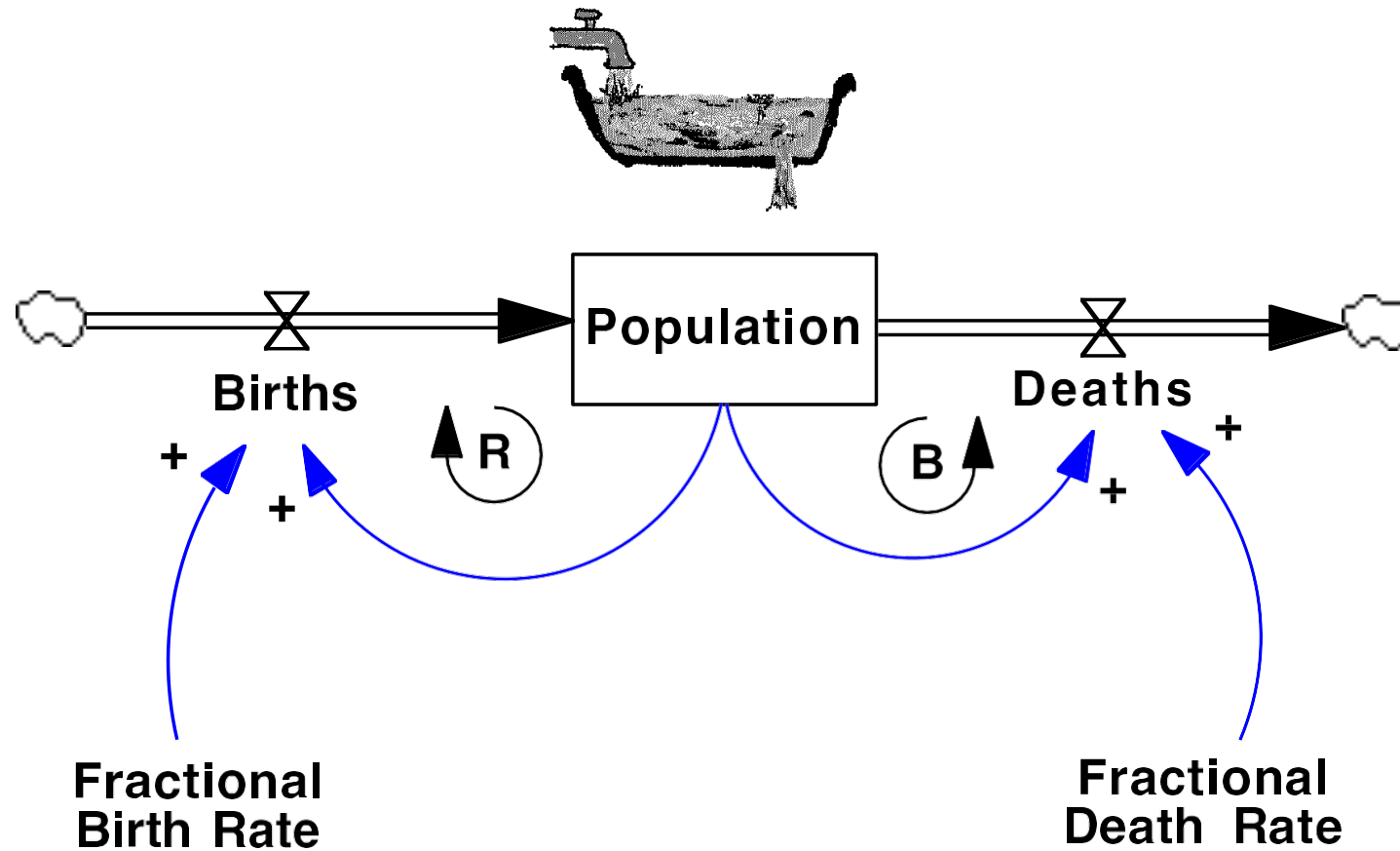
Basic Elements: Stock, Flow, Loops and Relationships



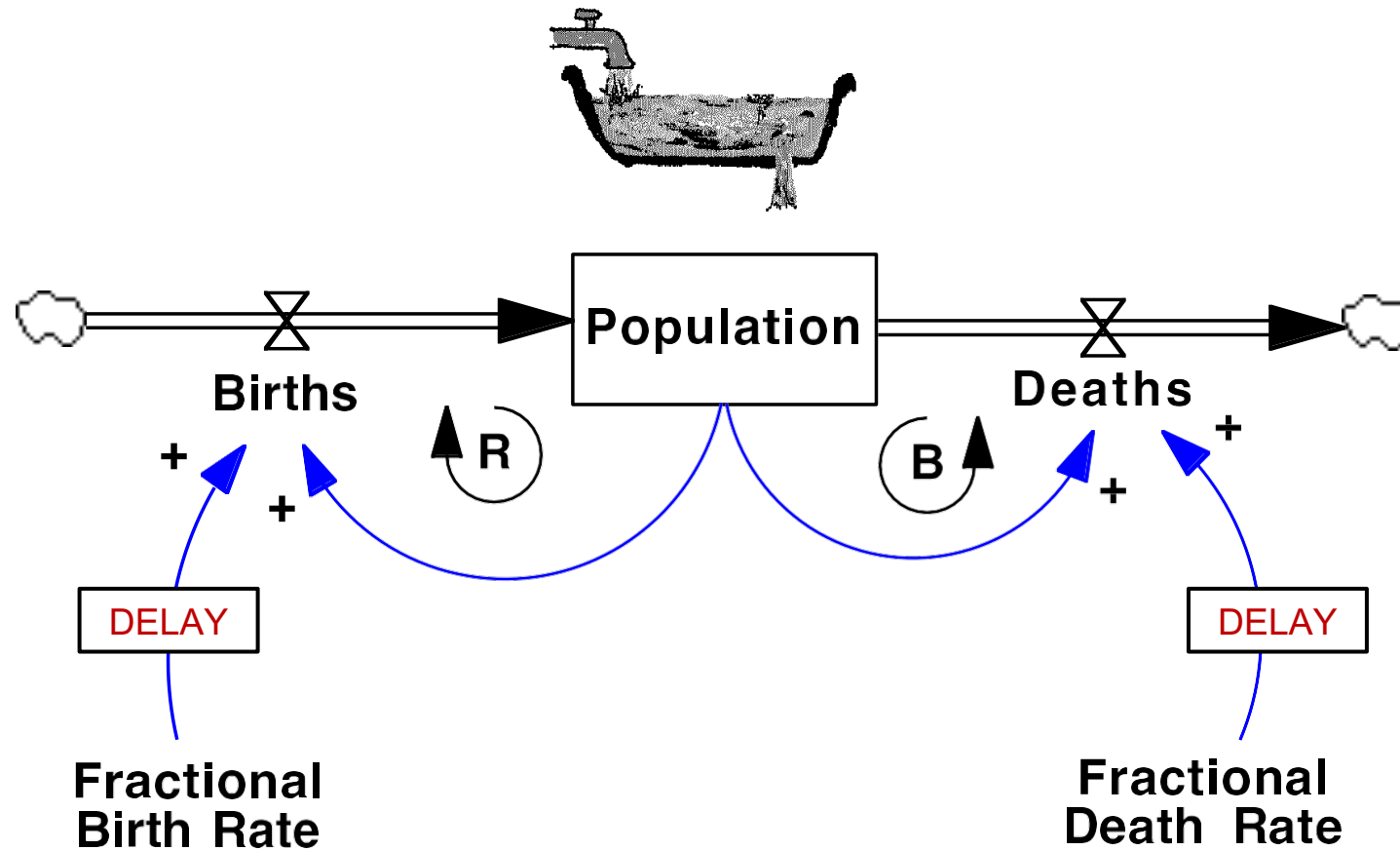
Basic Elements: Stock and Flow



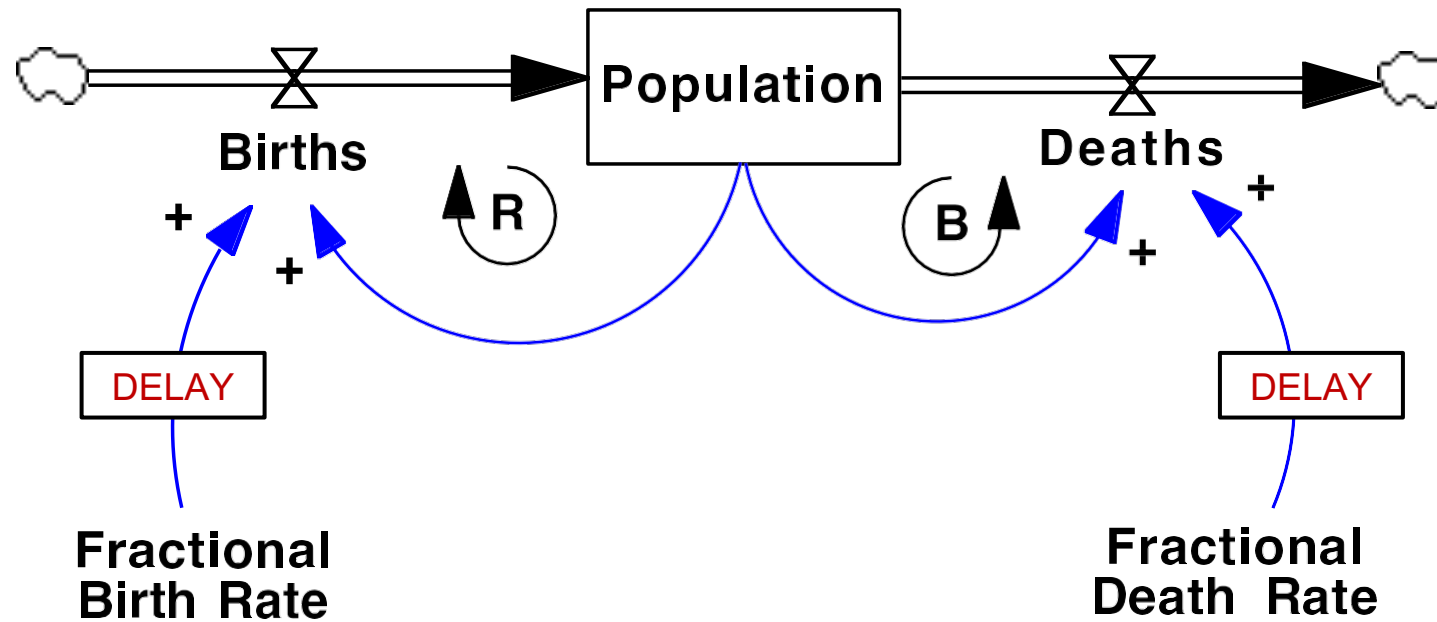
Basic Elements: Bring them together 1.0



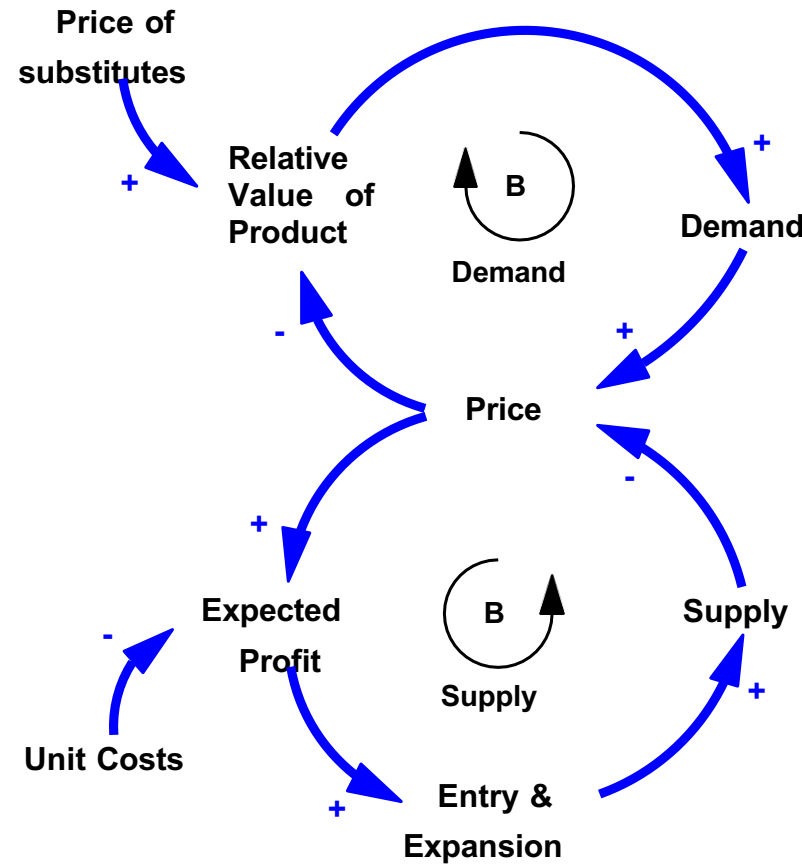
Basic Elements: Delay



Basic Elements: Delay

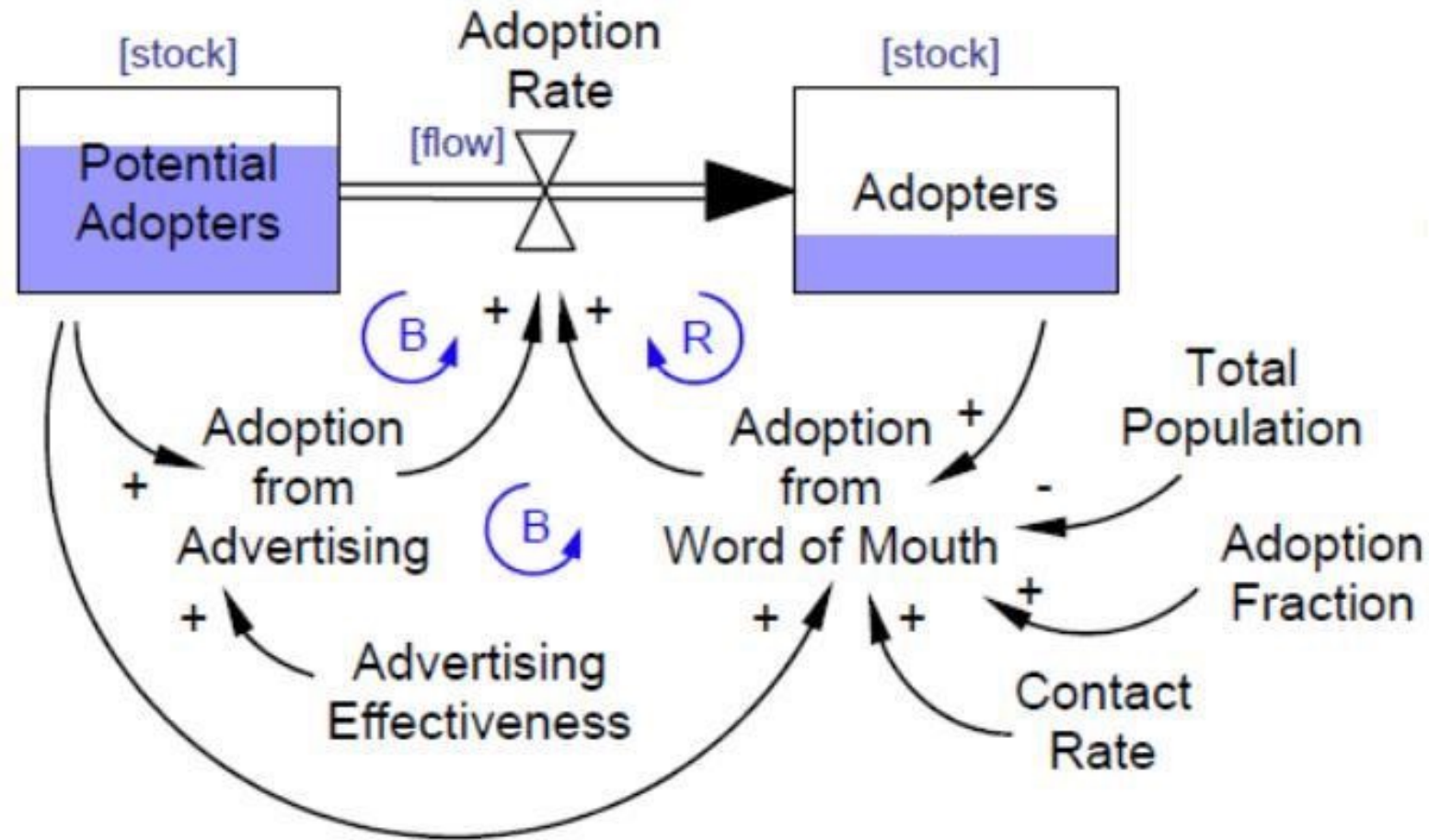


Classic Models



Supply and Demand

Classic Models



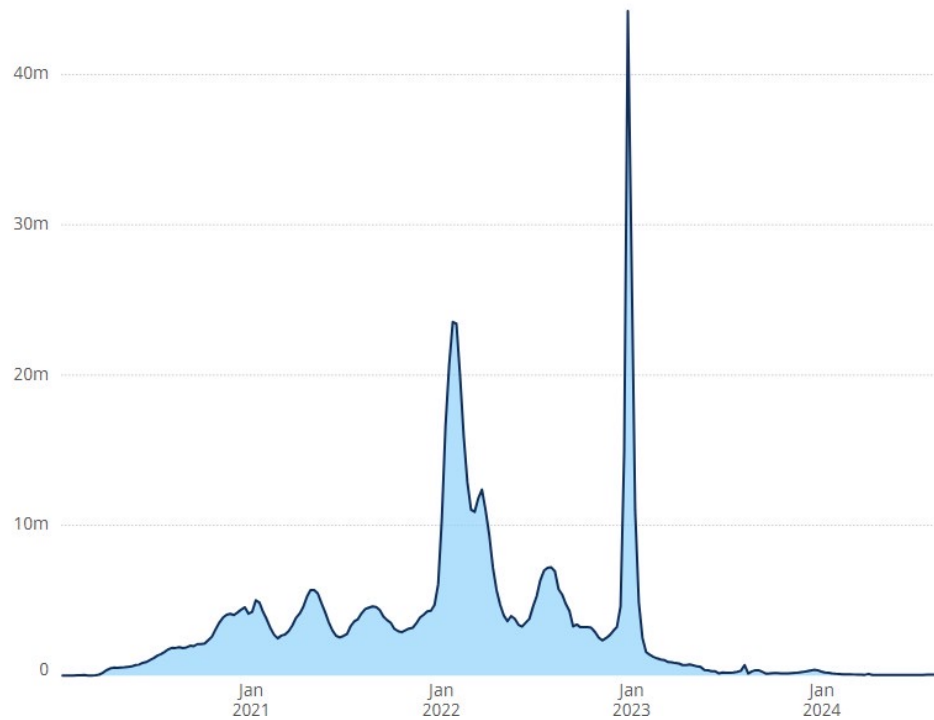
Bass Diffusion Model

Model Demo

COVID-19 Example

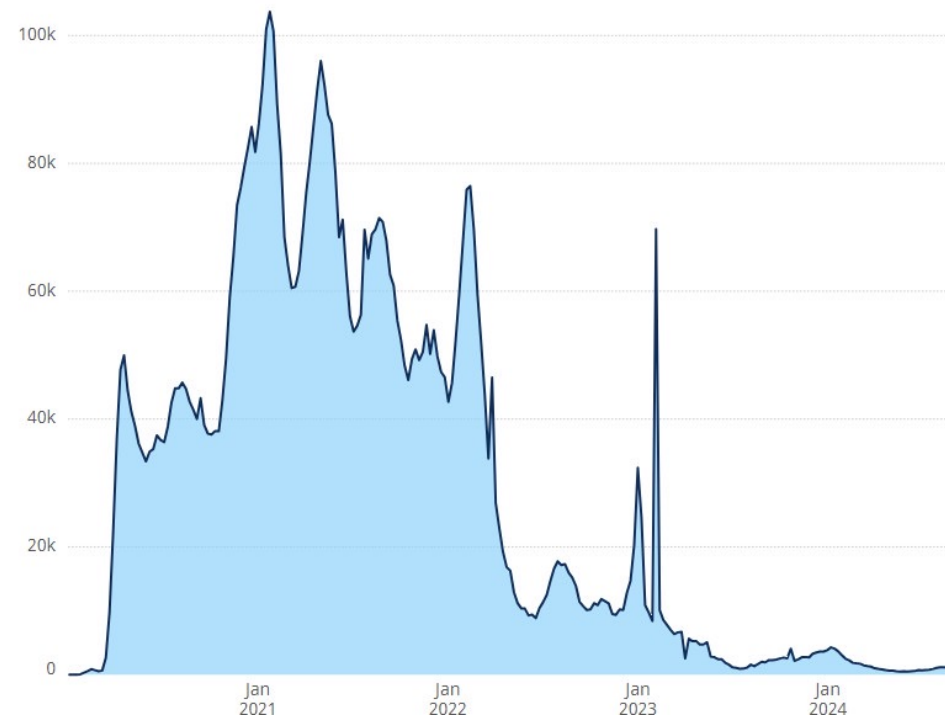
Total COVID-19 cases reported to WHO (weekly)

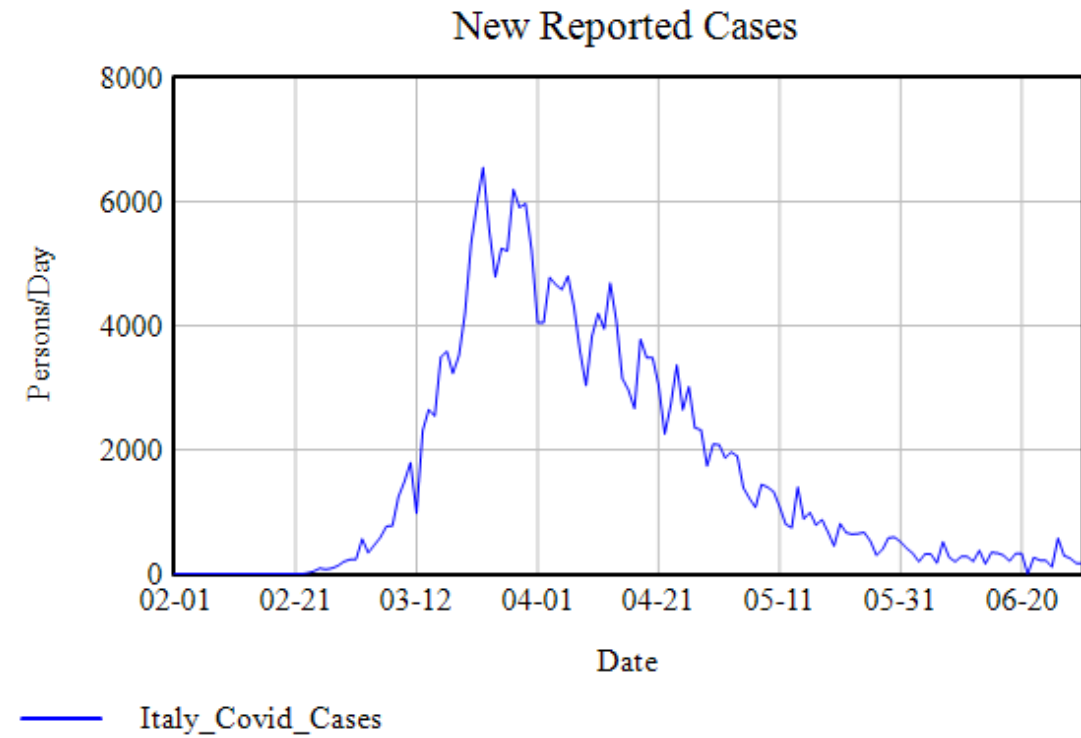
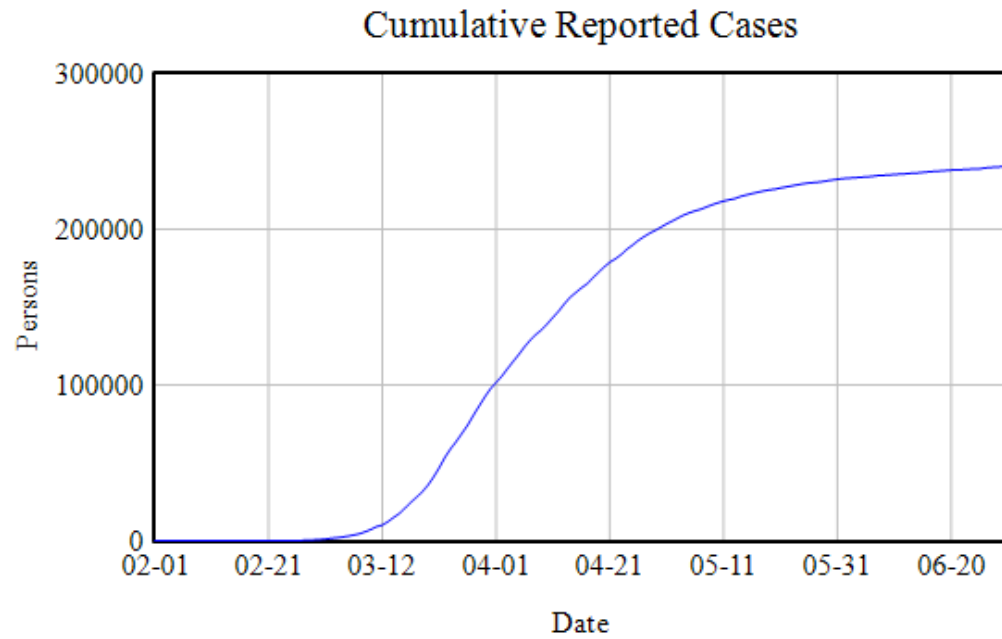
World, January 2020 - present



Total COVID-19 deaths reported to WHO (weekly)

World, January 2020 - present

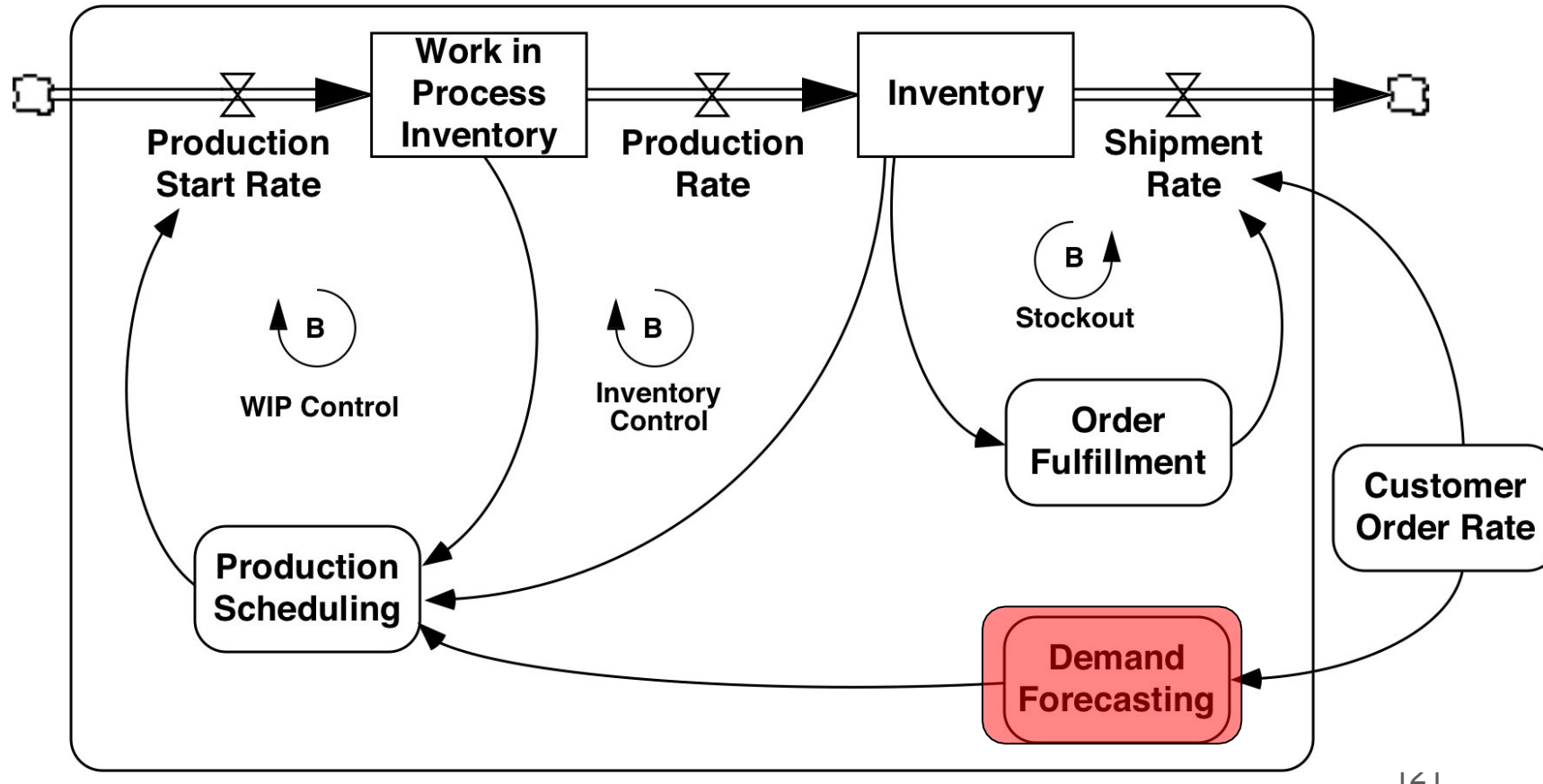




<https://coronavirus.jhu.edu/map.html>

Source: Johns Hopkins University Cases are underreported!

Inject your other analysis to the model

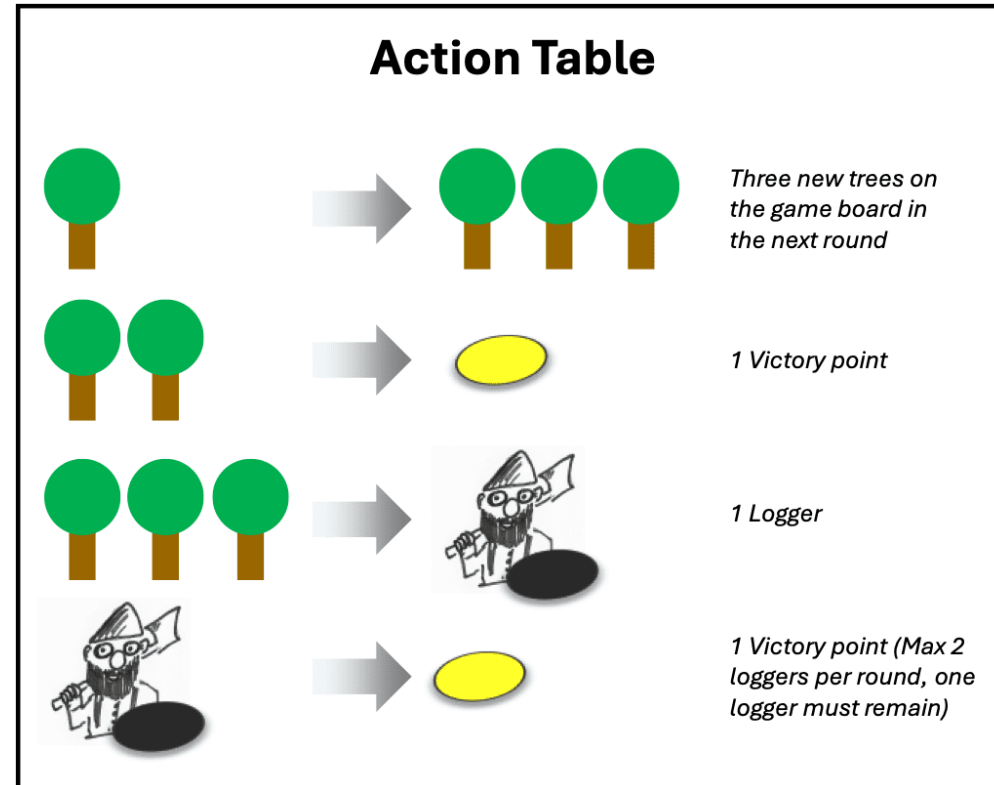
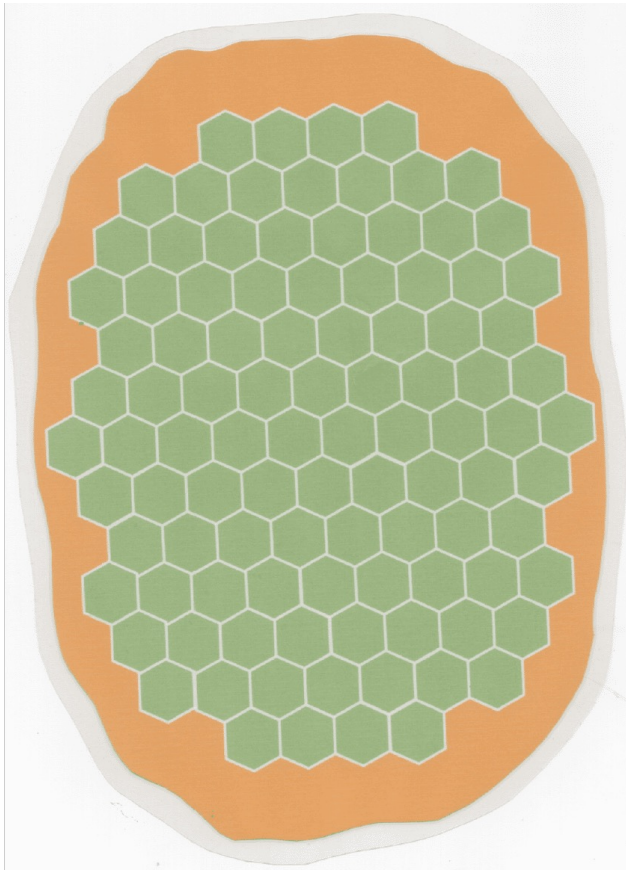


Role of forecasting

Agent Based Modelling vs System Dynamics Modelling

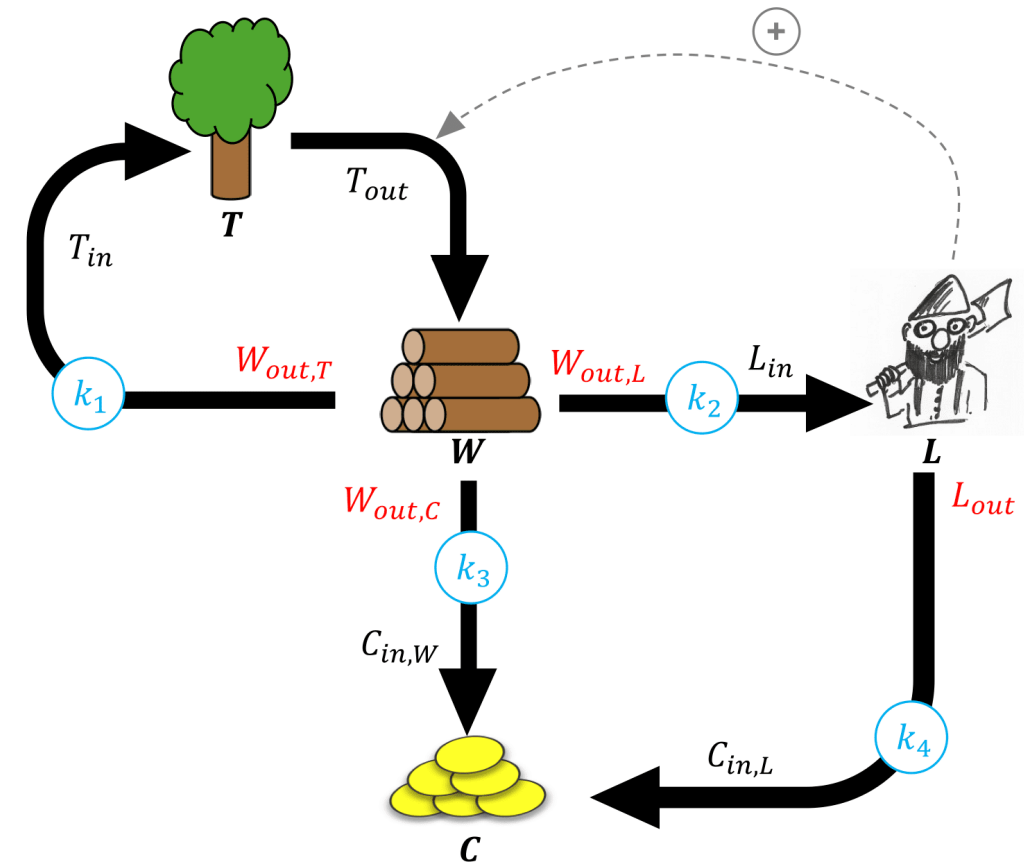
Principle	System Dynamics	Agent-Based Modeling
Building block	Feedback loop connecting behavioral variables	Individual agents connected by feedback loop
Object of interest	Structure of the system	Agents' rules
Research approach	Deductive: infer from structure to behavior	Inductive: infer from individual agents' behavior to system behavior
Development of object of interest over time	Structure is fixed	Agents' rules can be adaptive
Handling of time	Continuous simulation	Discrete or continuous simulation

Board Game using System Dynamics



<https://www.geios.com/read/U5Q11B>

Board Game using System Dynamics



<https://www.geios.com/read/U5Q11B>

Board Game using System Dynamics

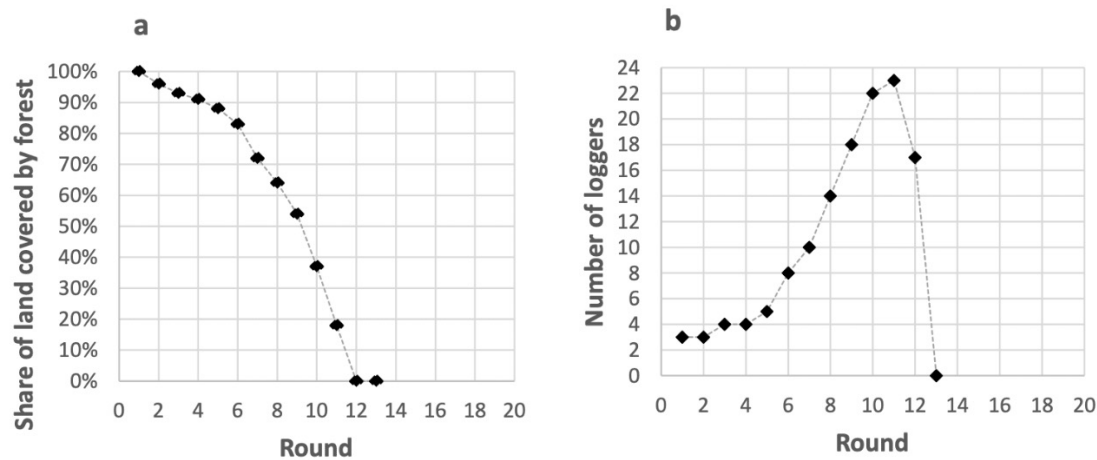
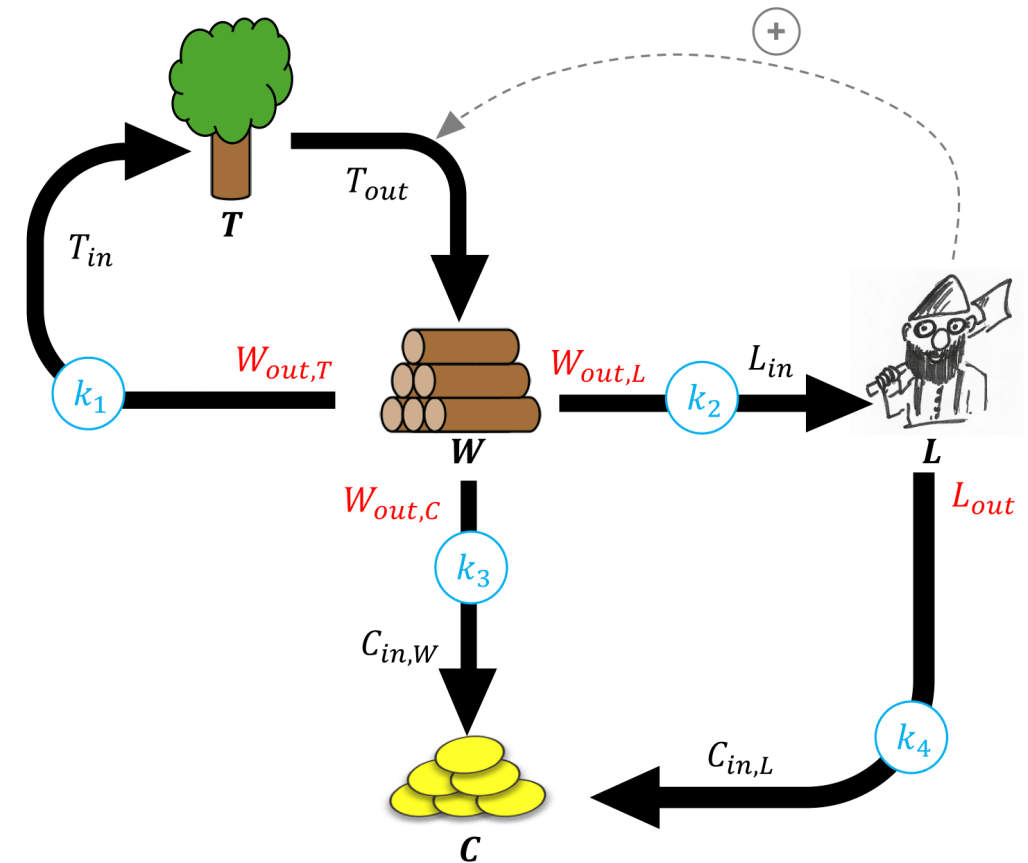


Figure 5. Exemplary results from the game variant "The Basic Game." (a) The proportion of land covered by forest (i.e., the number of trees on the board) and (b) the number of loggers as a function of game rounds.



<https://www.qeios.com/read/U5Q11B>

Larger Games!



<https://playclassic.games/games/city-building-dos-games-online/play-simcity-classic-online/play/>