

2. Simulation

The Five Functions of Simulations:

(from Hartmann 1996)

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5. As a pedagogic tool — to gain understanding of a process.

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- Solution of a set of equations describing a complex (e.g. bottom-up) interaction.
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- *Continuous*: not so clear-cut: background theory v. model assumptions

Q: does more realistic assumption \rightarrow more accurate prediction?

“A simulation is no better than the assumptions built into it” — Herbert Simon

2. Heuristic Tool

Where the theory is not well developed, and the causal relationships are not well understood:

- theory development = guessing suitable assumptions that may imitate the change process itself
- but how to assess assumptions independently?

Durlauf: Is there an underlying optimisation by agents?
(Complexity and Empirical Economics, *EJ*, 2005)

3. Substitute for Experiment

When actual experiments are perhaps:

- *pragmatically* impossible: scale, time
- *theoretically* impossible: counterfactuals
- *ethically* impossible: e.g. taxation, no minimum wage

or to complement lab experiments

4. Tool for Experimentalists

- to inspire experiments
- to preselect possible systems & set-ups
- to analyse experiments
(statistical adjustment of data)

5. For Learning

A pedagogic device through play ...

See Mitchell Resnick. *Turtles, termites, and traffic jams: Explorations in massively parallel microworlds*. MIT Press, 1997.

Play with NetLogo models, and experience emergence:
Life is famous, and others too.

Summary

A simulation imitates one process by another process

**With Social Sciences: few good descriptions of static aspects, and even fewer of dynamic aspects
(Remember: existence, uniqueness, stability)**

Robust Predictions from Simple Theory

(from Latané, 1996)

Four conceptions of simulation as a tool for doing social science:

- 1. As a scientific tool: theory + simulation + experimentation**
- 2. As a language for expressing theory: natural language; mathematical equations; computer programs**
- 3. As an “easy” alternative to thinking: robust coding**
- 4. As a machine for discovering consequences of theory: if this, then that.**

A Third Way of Doing Science

(from Axelrod & Tesfatsion 2006)

Deduction + Induction + Simulation.

- **Deduction: deriving theorems from assumptions**
- **Induction: finding patterns in empirical data**
- **Simulation: assumptions → data for inductive analysis**

S differs from D & I in its implementation & goals.

S permits increased understanding of systems through controlled computer experiments

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Adam Smith's Invisible Hand → prices

Schelling's segregation model:

People move because of a weak preference for a neighbourhood that has at least 33% of those adjoining the same (colour, race, whatever) → segregation.