Models and Simulations 2006

The Dark Side of the Force:

When computer simulations lead us astray

and „model think" narrows our imagination

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Overview

1. Different Uses of Computer Simulations

2. Requirements for Explanatory Simulations

3. Examples of Simulations that Fail to Explain
   a) Simulations of the "Evolution of Cooperation"
   b) Simulations of the "Social Contract"

4. Lessons to be Learned from these Failures

1. Uses of Computer Simulation

- ## Exploration
  - Proving "logical possibilities"
  - Proving the logical soundness of a set of assumptions
  - Exploring consequences of given assumptions

- ## Prediction
  - Predicting future events

- ## **Explanation**
  - Giving causal explanations for past or future events

2. "Explanatory" Simulations

Criteria for *explanatory* Computer Simulations

1. Empirical Adequacy

   · All causally relevant factors must be represented in the Computer Simulation

2. Stability (or Robustness)

   · The simulation results must be stable within the range of measurement inaccuracies of the input parameters

3. Descriptive Appropriateness or Non Triviality

   · All important aspects of the empirical process should be reflected in the simulation

How Simulations can Fail to Explain

A computer simulation is explanatory only if it "**closely fits reality**" that is if it is *adequate*, *stable* and *non trivial*.

1. If a computer simulation is not empirically adequate, it does not explain

2. If a computer simulation is not stable, we cannot know whether it explains

3. If it is not descriptively appropriate, it "misses the point"

3. a) Simulations that Lead Astray

Typical features of *Axelrod-style* simulations:

1. Either constructed from a set of *plausible assumptions* or from a common mathematical model or derived from another Axelrod-style simulation

2. Not related to any particular empirical situation or process.

3. Conclusions are drawn by inductive generalization from the simulation results.

A Basic Example

Cooperation on anonymous markets (Schüßler)

1. **Plausible assumptions** to describe an "anonymous market": Players (engaged in a repeated prisoner's dilemma) may break off interaction any time.

2. **Simulation results**: Depending on the choice of parameter values, cooperation prevails on an "anonymous market".

3. **General Conclusion**: Simulation establishes a point against the normativist assumption that cooperative behavior depends on central authority or strong social bonds.

Basic Example (continued)

The major limitation of this kind of reasoning:

- Normativistic Sociology (Durkheim, Tönnies) does not at all rely on a claim about the logical impossibility of cooperation on anonymous markets, but only on its factual impossibility (given human nature as it is).

- Schüßler's simulation – as is frankly admitted by him – is hardly a challenge to the normativist point of view. But then, what would it be good for?

An Example from Social Sciences

The Challenge: Explaining the "Live and Let Live" Cooperation that emerged on some stretches of the front line during World War I.

- Ashworth's traditional approach: Explanation through a thick historical narrative.

- Axelrod's new approach: Based on Ashworth's narrative as well as on computer simulations of the "evolution of cooperation"

Question: Does the simulation based approach add anything in terms of explanatory power?

Social Science Example (cont.)

The Response:

- *Ashworth* finds an intricate set of factors: strategical deadlock, soldier's desire to survive, "bureaucratic structure of aggression", empathy with the enemy, "esprit de corps", branch of service

- *Axelrod* captures only the strategical situation

- The payoff parameters cannot be measured (Violation of requirements 1 and 2)

=> **Axelrod's simulations can hardly add anything to the historical explanation**

Examples from Biology?

- Large number of simulation studies (triggered by Axelrod's and Hamilton's work)

- **But**: No empirical examples in biology where any of these simulations could be applied (Dugatkin: Cooperation among Animals, 1997**)**

"A look at the best known examples of reciprocity shows that simple models of repeated games do not properly reflect the natural circumstances under which evolution takes place. Most repeated animal interactions do not even correspond to repeated games." (Hammerstein, 2003)

Conclusion

The lesson to be learned:

Purely theoretical simulations do not increase our understanding of the empirical phenomena. Quite the contrary, they lead us away from the real questions.

"Most certainly, if we invested the same amount of energy in the resolution of all problems raised in this discourse, as we do in publishing of toy models with limited applicability, we would be further along in our understanding of cooperation." (Hammerstein, 2003)

3. b) Narrowing of imagination

Computer simulations as a modern tool to answer age old questions

Skyrms on the Evolution of the Social Contract:

"How do we get from the hunt hare equilibrium to the stag hunt equilibrium? ... We can ask these questions using modern tools - which are more than Hobbes and Hume had available, but still less than we need for fully adequate answers." (Skyrms, 2004)

Question: Are the answers gained with "modern tools" really better?

Social Contract Philosophy

Classical social contract philosophy:

- Normative:
  - Do we need government?
  - How can government be justified?
  - What kind of government is justified?

- Descriptive:
  - How does political order evolve from anarchy?

(20th century addition: questions of social justice)

Simulating the Social Contract

Skyrms answer to the descriptive question (how does order evolve?) of the social contract:

How much progress have we made in addressing the fundamental question of the social contract: "How can you get from the noncooperative hare hunting equilibrium to the cooperative stag hunt equilibrium?" The   outlines of a general answer have begun to emerge. Over time there is some low level of experimentation with stag hunting. Eventually a small group of stag hunters comes to interact largely or exclusively with each other. This can come to pass through pure chance and the   passage of time in a situation of interaction with neighbors. ... The small group of stag hunters prospers and can spread by reproduction and imitation. The process is facilitated if reproduction or imitation neighborhoods are larger than interaction neighborhoods. (Skyrms, 2004)

Are the "modern tools" really better?

Limitations of Skyrm's simulation model:

- Complete omission of *rulership* and *submission* as the probably most important factors in the genesis of political order.

- Contrary to historical experience, the spontaneous evolution of political order without the institution of government is possible in Skyrm's model.

Question: Did "model think" (i.e. thinking about the models while forgetting about the subject matter) cause these oversights?

4. Final Conclusions

- Explanatory simulations require a thorough understanding of the empirical processes to be simulated

- Simulations are only as good as their "fit to reality"

- Where measurement is not possible, simulating is not worth while

- Computer simulations that do not explain are hardly more than: **computer generated metaphors** or **model based story telling**