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Doctoral School of Philosophy

.

THE USING LIMITS OF COMPUTER SIMULATIONS IN ECONOMIC RESEARCH

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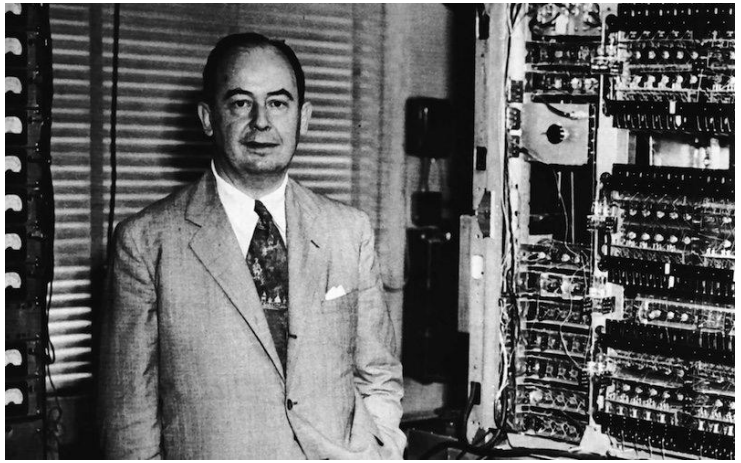
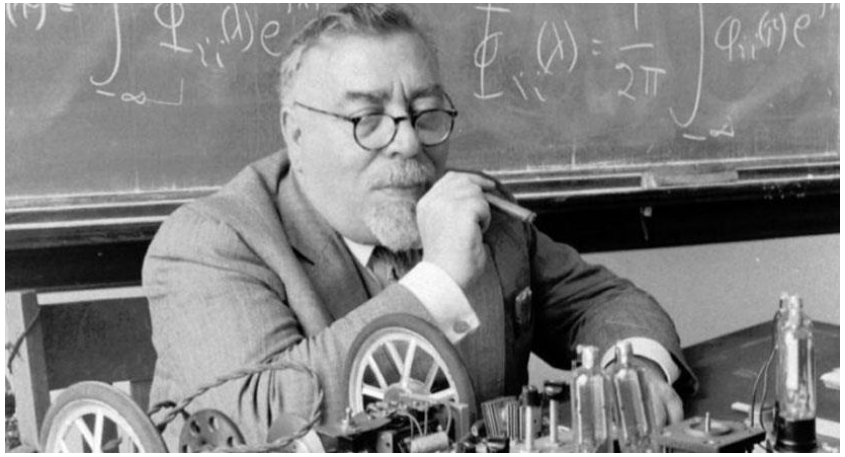
A BRIEF HISTORY

COMPUTER SIMULATIONS AND ECONOMICS



John von Neumann

Theory of Games and Economic Behavior (1944)

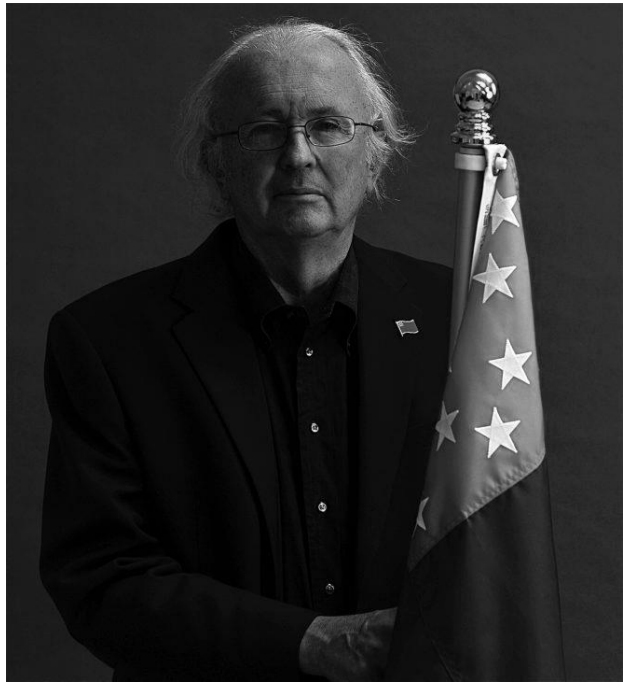


Norbert Wiener

«One of the most potent tools in reanimating a science is mathematics»

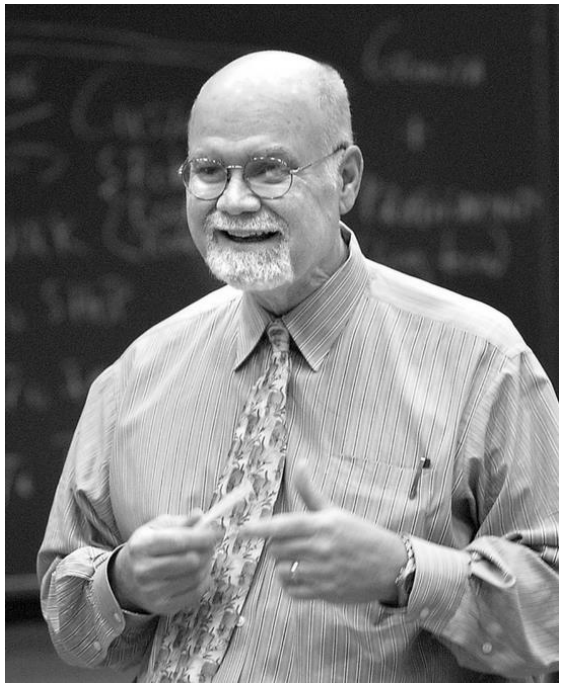
A BRIEF HISTORY

COMPUTER SIMULATIONS AND ECONOMICS



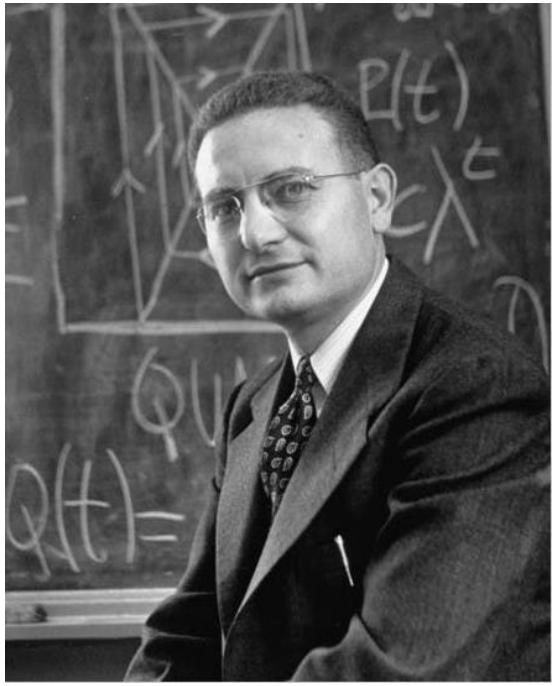
Thomas H. Naylor

Design of computer simulation experiments for economic systems (1966)



W. Earl Sasser

Computer simulation of economic systems ... an example model (1967)

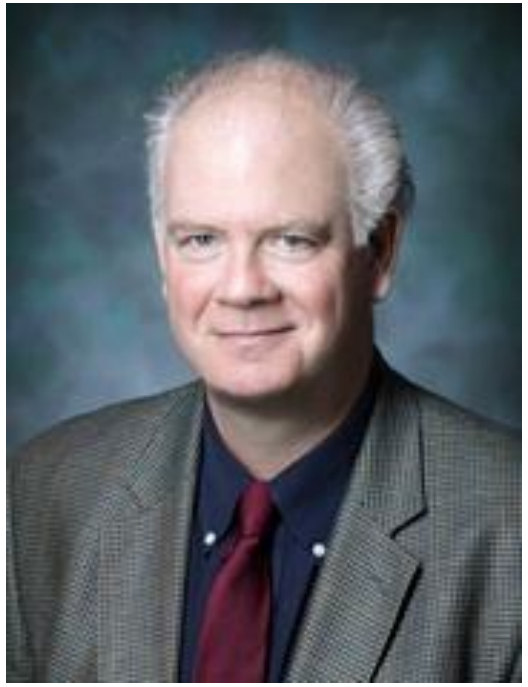


Paul A. Samuelson

Samuelsonian project has relegated simulation to a secondary role (till 1990s)

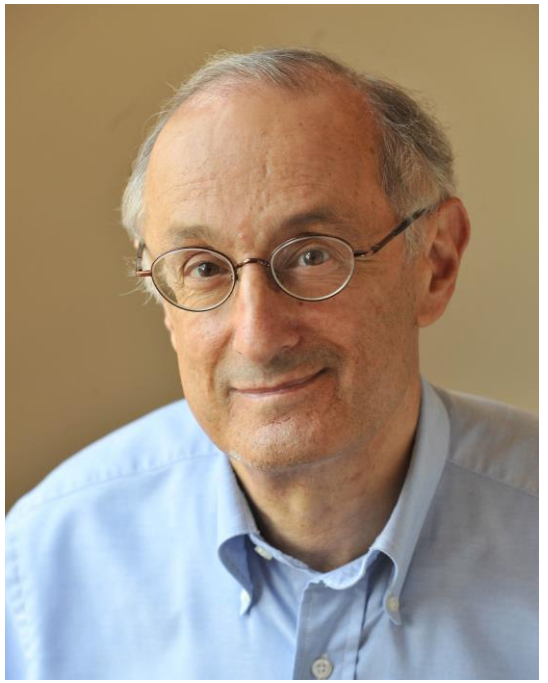
A BRIEF HISTORY

COMPUTER SIMULATIONS AND ECONOMICS



Joshua M Epstein
Growing artificial societies (1996)

Robert Axtell
Growing artificial societies (1996)



Robert Axelrod
Advancing the art of simulation in social science (1997)

GENERAL CHARACTERISTICS

COMPUTER SIMULATION METHODS (BASED ON BEHDANI [3])

System dynamics	Discrete event simulation	Multi-agent simulation
System oriented, focused on modelling aggregates	Process oriented, focused on details of a modelled system	Agent oriented, focused on modelling agents and their interactions
Homogeneous system elements; assumed similar characteristics of system elements; averaging of values	Heterogeneous elements	Heterogeneous objects (agents)
No representation on micro level	Elements on micro level are passive objects running through a system in an imitated process (they are attributed neither with intelligence nor with decision making capacity)	Objects on micro level are active agents that cooperate with one another as well as with their environment and make autonomous decisions
Imitation of dynamic behavior by means of feedback loops	Imitation of dynamic behavior by means of events	Imitation of dynamic behavior by means of agents' decisions and interactions
Mathematical formalization based on concept of stocks-and-flows	Mathematical formalization based on concept of event-action-process	Mathematical formalization based on concept of agent environment
Continuous or quasi continuous functions used to describe time flow	Discrete functions used to describe time flow	Discrete functions used to describe time flow
Experimenting through changes in system structure	Experimenting through changes in a process structure	Experimenting through changes in agents' behavior rules (internal/external rules) and in system structure
System structure is stable	Process is stable	System structure is not stable

INTENDED USE OF SIMULATIONS

Support laboratory experiments

- ✓ A specific simulation model in order to generate data needed by the experiment participants for decision-making and/or to determine the effects of their actions;
- ✓ The existing simulation games;
- ✓ Interactive virtual simulation environment that imitates the real-life environment as closely as possible and can be applied to record the participants' answers, responses and actions.

Replace a conventional laboratory experiments

ADVANTAGES OF THE SIMULATION

OVER TRADITIONAL EXPERIMENTS

- ✓ Replicability;
- ✓ The possibility to change parameters that could not be modified in a real system;
- ✓ More flexibility and changeable baseline of boundary conditions;
- ✓ Significantly lower costs, both financial and ethical;
- ✓ Swifter experiment implementation.

REFERENCES

1. Łatuszynska M. Experimental Research in Economics and Computer Simulation. Chapter 11. K. Nermend, M. Łatuszyn´ska (eds.), Selected Issues in Experimental Economics, Springer Proceedings in Business and Economics. 2016, pp. 151-169.
2. Wiener, M. (1954), Invention: The Care and Feeding of Ideas, MIT Press, Cambridge, MA,1993.
3. Behdani B (2012) Evaluation of paradigms for modeling supply chains as complex socio-technical systems. In: Proceedings of the 2012 Simulation Conference WSC. Huntington, California, 9–12 December 2012, pp 1–15.
4. Lehtinen A., Kuorikoski J. Computing the Perfect Model: Why Do Economists Shun Simulation?, Philosophy of Science, 74:3, 2007, pp. 304-329.
5. Naylor T.H., Burdick D.S., Sasser W.E. Design of computer simulation experiments for economic systems, Proceedings of the American Statistical Association, 1966.
6. Sasser W.E., Naylor T.H. Computer simulation of economic systems ... an example model, SIMULATION, 8(1), 1967, pp. 21-32.

THE LIMITS

Epistemic limits

- ✓ The concept of scientific understanding of economists, which emphasizes the priority of analytical rather than numerical accuracy, and also gives priority to the skill of logical argumentation, rather than empirical knowledge of causal mechanisms [Lehtinen A., Kuorikoski J. 2007, 306];
- ✓ Epistemic opacity or the problem of the “black box” - the researcher does not know which processes are taking place inside the software and hardware complex on which the simulation is deployed [Humphreys P. 2004].

Methodological limits

- ✓ The correct choice of one of the types of simulations, for example, based on differential equations, Monte Carlo method, the agent-oriented modeling;
- ✓ Lack of universality, leading to the impossibility of decomposing the simulation into component parts that can be used in various types of simulations, in contrast to analytical models, which can be subjected to crushing to constituent elements with their further combination into new models.

ADAPTATION OF COMPUTER SIMULATIONS FOR ECONOMIC RESEARCH

1) Abandon rigid axiomatic economic models in favor of complex multilevel systems consisting of elements with different properties;

2) Shift the focus from the universality of analytical models to methods of efficient collection of initial data for building complex computational models.

METHODOLOGICAL PROJECT FOR THE DEVELOPMENT AND USE OF COMPUTER SIMULATIONS IN SCIENCE, INDUSTRY AND BUSINESS

NATIONAL RESEARCH UNIVERSITY

TWO KEY APPLIED RESEARCH PROJECTS IN THE FIELD OF ECONOMICS:

1. COMPUTER SIMULATION OF THE RUSSIAN ECONOMY

2. COMPUTER SIMULATION OF THE GLOBAL CLIMATE FOR ECONOMIC FORECASTING

ЦЭМИ

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