Reviews

Juraj Schenk: Methodological Problems of Multi-Agent Modelling in Sociology
Stimul, Bratislava 2011, 163 p.

Every science – and sociology is no exception – runs research in the best possible way to produce, modify, or absorb new methods and methodological innovations in its effort to understand and explain its subject. Multi-agent modelling is one such methodological innovation which did not originate in sociology, but in cybernetics and informatics. This new methodological innovation has begun to penetrate the social sciences and, more significantly, sociology in the last two decades. On a global level, there is a rapid increase in publications, models, specialized professional journals and scientific institutions which deal with the use and development of agent and multi-agent models in various scientific disciplines. Here, a key question suggests itself: what are the possibilities and limits of multi-agent modelling in sociological research? Juraj Schenk's monograph *Methodological Problems of Multi-Agent Modelling in Sociology* published by Stimul publishing house in 2011 fills a gap in Slovak sociology, particularly in its methodological instruments. At the same time, the book mediates a view on the dynamic development and extensive production in discourse about the possibilities and problems related to the use of multi-agent modelling in sociological and social science research. The author has tried to place the basic characteristics and the development of multi-agent models within the context of paradigmatic changes in science, in relation to basic methodology problems in sociology and in connection with a theoretical tradition of social systems with a nonlinear dynamic character.

The publication comprises eight chapters – *Multi-agent modelling as a methodological innovation, General methodological characteristics, The problem of context, Problems related to theoretical definitions of nonlinear dynamic systems: three principles of inherent dynamics, The problem of emergence: strong, weak and semi-strong emergence, The problem of generative mechanisms, Methodological problems,* and finally *A model of the cognitive division of labour*.

The first chapter introduces the issue of multi-agent modelling, how it entered social science and, of course, sociology. The author gives three reasons why multi-agent modelling is worth paying attention to. The first reason is a fixed and nontrivial approach, which allows for new possibilities of sociological analysis. Secondly, multi-agent modelling is primarily focused on the research of social dynamics and dynamic nonlinear systems. The third reason highlighted by the author is the fact that in Slovak sociology, multi-

agent modelling has been left unnoticed. Because of this, J. Schenk decided to introduce multi-agent modelling from the view of its methodological problems, particularly general methodological problems, which "*are relevant for the sociological learning process and its development*." (p. 8)

The second chapter deals with agent or multi-agent modelling from the perspective of its basic characteristics. Professional literature provides many alternative terms for this approach. Often, it is possible to find such terms as multi-agent modelling, agent modelling or agent-based modelling (ABM), multi-agent systems (MAS) or computational sociology. Multi-agent modelling has its sources in cybernetics and computer science and in cognitive science. This has greatly influenced the terminology and methodological background of the approach. Apart from this, various, often mutually competing variants of self-organizing theories and nonlinear dynamic systems can be applied within this approach. According to Schenk, theories such as the following fit within this category – social entropy, synergetics, chaos theory, complexity theory (Kauffmann 1995), complex adaptive systems theory (Holland 1995), and the theory of autopoietic systems (Maturana – Varela 1987; Luhmann 2007). Schenk also says that specifically sociological theories are also of importance in the shaping of multi-agent modelling, particularly network exchange theory, collective action theory and social dilemmas theory. The author highlights the successful use of some ideas, which originated in sociological theories in multi-agent modelling. This refers specifically to Granovetter's The Strength of Weak Ties (Granovetter 1973), Milgram's 'six degrees of separation' and Watts' 'small world concept' (Watts 1999) as well as the iterated prisoner's dilemma and other strategies for the solution of elementary interactions (Kollock 1998).

In this part of monograph, author offers the reader a comparison between agent-based modelling and the more classic, equation-based modelling (EBM). Comparing these two approaches in modelling enables a better understanding of the possibilities of multi-agent modelling and its significance for sociological research. In the case of EBM, which represents mathematical modelling, the basic components of the model are system variables, and models reflect the structure or dynamics of relations between the variables. EBM models can be characterised as top-down, and their solution is an analytical or empirical solution of equations or a set of equations. Agent or multi-agent modelling is bottom-up. It is a simulation with agents, which represent the acting subject, the model of a social player. Schenk has based his comparison of the two modelling approaches on eight characteristics of both models: components of the model, dynamics, the subject of analysis, the quality of analysis, model construction, the strategy for acting, the population researched, and the main goal of the analysis. He continues by offering possible mutual

relationships of both approaches. Here, he identifies three forms --coexistence, complimentarity and ordering --and finds the latter the most attractive. He concludes that the classic approach to modelling is still justifiable in sociology.

In chapter three and four, Schenk focuses on putting multi-agent modelling into the context of science development and its connection to the theoretical definition of the issue of nonlinear dynamic systems. He draws attention to the development and changes in scientific thinking, to the transition from positivism to post-positivism and anti-positivism. Changes in science and scientific thinking are interrelated with global dynamic changes, which extend into all areas of human life, while nature, technology, forms, and structures of social life are also changing. He introduces concepts that could well be described as metascientific. Specifically, he mentions concepts such as *New Alliance* (Prigogine, Stengers), *New Organum* (Young), *Good Science* (Moss, Edmonds) and *Non-Classical Science* (Černík, Viceník, Višňovský). He concentrates mainly on the concept of non-classical science, which is only taking shape now (p. 36) and which has originated from a non-classical type of rationality. The author regards the concept of non-classical science as "the optimal general context for analysing methodological problems with multi-agent modelling in sociology" (p. 36). One reasons for this is the formation of the complexity paradigm, which is also applied in sociology.

The author bases the issue of the complexity paradigm in sociology on *Sociology and Complexity Science* by Brian Castellani and Frederic Hafferty, who characterise complexity science and deal with its historical development. With respect to the beginning of the complexity paradigm, he notes that sociology turned to complexity approximately ten years ago. The complexity paradigm is fractal and fragmentation is, according to Schenk, based on two dimensions, *scientism versus anti-scientism* and a *micro-system versus macro-system approach*. Schenk, relying on the above authors, says that the complexity paradigm in sociology is based on five key research areas: the analysis of complex social networks, sociocybernetics, computational sociology, the Luhmann School of Complexity and the British-based School of Complexity. Later in the text, he pursues computational sociology and the British-based School of Complexity in more detail and shows their connection to agent and multi-agent modelling or to the place of modelling in respective research orientation.

In the next chapter, the author focuses on three theoretical approaches to studying inherent dynamics of nonlinear dynamic systems. In the wide-ranging territory of complexity theories, he identifies three principles of inherent dynamics of nonlinear systems and related theories and methodologies, namely *autopoiesis, becoming* and *autokinesis*. He introduces every concept separately from a general scientific level to their application in sociology. The author

presents the bases and basic characteristics of these concepts and derived transitions and interpretations in sociology.

On a general level, the concept of autopoiesis or of autopoietic systems was introduced above all by biologists Humberto Maturana and Francisco Varela, who characterised autopoiesis as the biology of knowledge. Niklas Luhman introduced this concept to sociology. The second concept, becoming, was developed mainly by Ilya Prigogine in his theory of dissipative structures. He talks about transition from being to becoming. In sociology, this concept was dealt with and developed by the Polish sociologist Piotr Sztompka. Pierre Vendryès was the first to introduce the concept of autokinesis. In addition, the first to introduce it to sociology was Alexander Hirner. After introducing the basic components and principles of these concepts, Schenk compares all three concepts drawing attention to their shortcomings and to their contribution to and applicability in sociological studies. He concludes his comparison by saying that it is the principle of autokinesis, which can be "productively applied to study self-organizing processes in the spirit of the paradigm of non-classic science" (p. 77). He also refers to the importance of connecting this concept to multi-agent modelling.

The fifth chapter concentrates on the issue of emergence and its various forms. This chapter is important (with respect to methodological problems related to multi-agent modelling) because of the relationship between and transition to micro-level and macro-level. The issue of emergence is associated with science in general and goes beyond the boundaries of sociology. The author puts the problem into the context of the classical dispute between individualism and holism, which in sociology, as well as in other scientific branches, takes on a number of versions. He differentiates between two basic forms, or rather phases of the dispute – ontological and methodological. In order to compare both points of view, he deliberately chooses the radical versions and then analyses them on the basis of seven parameters: 1. philosophical viewpoint, 2. analytical unit, 3. epistemological viewpoint, 4. character of explanation, 5. direction of explanation, 6. mechanisms used to explain the transition among levels and 7. character of laws.

After that, author discusses various approaches to defining emergence and arrives at two types of differentiation. Firstly, he distinguishes between ontological and epistemological emergence, where epistemological emergence is only "an artefact…of a special model or formalism" (p.88); it is only a method to describe a system. On the other hand, he associates ontological emergence with features of systems or wholes. In addition, he also introduces a second type of differentiation, in which he identifies the so-called "strong, weak, and semi-strong emergence." The concept of weak emergence helps explain the origin of qualitative changes of systems and within systems, which,

according to Schenk, opens up the possibility of simulation using multi-agent modelling. This reflection on multi-agent modelling shows that there are certain restrictions to this approach. Schenk highlights two contemporary nontrivial attempts to solve these issues: the concept of third level of social reality by Sztompka, and emergentism formed by three main approaches – *systemism, concept of social generative mechanisms* and *Sawyer's nonreductive individualism*.

Charter six deals with generative mechanisms, which are of vital importance to multi-agent modelling. This is because multi-agent modelling simulation is used to generate specific macro-structures, which are based on a specific mechanism. Therefore, Schenk focuses on defining the problem of mechanism from a methodological and terminological perspective. He emphasizes the interconnection of micro-level with macro-level and social mechanism.

Chapter seven concentrates on three areas of methodological problems – simulation, strategies for designing multi-agent models and relationship of multi-agent models to sociological theory. With respect to simulation, he deals with stereotypes associated with simulation as a scientific tool. He notes that sometimes, simulation is viewed as a third form of scientific cognition. Then he introduces two basic strategies for designing multi-agent models: KISS (*Keep It Simple, Stupid!*) and KIDS (*Keep It Descriptive, Stupid!).* As the titles suggest, both strategies stress the necessity to simplify the models. However, the second approach requires the model to portray the modelled object as completely as possible.

The author concludes by giving an example of a multi-agent model, which uses a real example to demonstrate the possibilities and problems related to multi-agent-modelling. The author chose the cognitive division of labour by Hegselmann and Krause from their *Truth and Cognitive Division of Labour: First Steps towards a Computer Aided Social Epistemology* as his model. Schenk introduces the basic characteristics and settings of the model and shows the results of the simulation and conclusions, which the authors drew from multi-agent modelling.

In conclusion, it is necessary to highlight that this publication is the first systematically elaborated attempt to introduce multi-agent modelling to Slovak sociology. This monograph offers an erudite and well-structured view on the fundamental methodological problems associated with multi-agent modelling. Evidently, the author has fulfilled his initial intention to introduce multi-agent modelling, its basic principles, key solutions, and fundamental questions with emphasis on the innovative potential of the method. The study is characterised by a consistent and systematic succession of individual chapters, which represent individual problems and issues that arise when applying multi-agent modelling in sociology and science in general. The author critically analyses

theoretical concepts of the dynamics of nonlinear systems and offers several questions and ideas, for which solutions must be found. He points out problems in the relationship between macrostructure and microstructure, which either have not been solved yet or have been solved unsatisfactorily. He also identifies problems related to distinguishing between weak and strong emergence and offers a third form of emergence – semi-strong. This work is a stimulating contribution to the methodology of sociology, mainly with regard to modelling social reality.

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