A PHILOSOPHICAL PERSPECTIVE OF MULTIAGENT-BASED SIMULATION IN THE SOCIAL SCIENCES

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Abstract

From the very beginning of the multiagent-systems paradigm, the sources of analogies between agent-based technologies and models of actual social systems fomented interdisciplinary efforts between computer and social scientists. Nowadays this trend reflects an intense interface of research across the computer and social sciences, under the umbrella of a consolidated scientific field, which is called agent-based social simulation. Several reasons prompt a philosophical analysis of this scientific domain, relevant to both computer and social scientists that use multiagent systems. Conventional methodologies of computer science and artificial intelligence model the mechanism of executing a program in a computer like a process of formal inference. However, in [1, 2] the formal and empirical-generative perspectives of computation are demonstrated to be inadequate to secure the goals of simulation in the social sciences. Particular emphasis is given to agent-based simulation methods. Simulation does not resemble formal demonstrations or generative mechanisms that deductively explain how certain agent-based models are sufficient to generate emergent macrostructures of interest. The description of scientific practice implies additional epistemic conceptions of scientific knowledge. Previous works identified three kinds of knowledge that account for a comprehensive description of the discipline: formal, empirical and intentional knowledge [3, 4]. This extended abstract summarizes claims we have further presented in [1] and published in [2]: The use of formal conceptions of computation to describe simulation is refuted, the roles of programming languages according to intentional accounts of computation are identified, and the new role of iconographic programming languages and aesthetic machines in simulation platforms are characterized.

1 Introduction

From the very beginning of the multiagent-systems paradigm, the sources of analogies between agent-based technologies and models of actual social systems fomented interdisciplinary efforts between computer and social scientists. Nowadays this trend reflects a new interface of research across the computer and social sciences, under the umbrella of a consolidated scientific field, usually called agent-based social simulation. Several reasons prompt a philosophical analysis of this scientific domain, relevant to both computer and social scientists. In general, agent-based models and simulations have been contributing to an inter- and multi-disciplinary scientific praxis, which contributes to establishing new alternatives to traditional scientific methodologies. This should lead to the elaboration of new philosophical perspectives about the rules of the game as they are currently played in simulation.

The goal of our work presented and published in [1, 2, 3, 4] has been to characterize the actual practice of computation for modelling social theory and phenomena with agent-based models, especially with reference to its epistemological basis and the particular kind of scientific knowledge that this methodology is providing. In particular, in [3, 4] we demonstrated that the logic of social simulation implies at least three distinct types of program verification in computer science, which reflect an epistemological distinction in the kind of knowledge one can have about programs or simulations. Whereas such knowledge may ultimately be characterized as merely interpretative the role of complexity sciences suggests a further categorization beyond the traditional borders of formal and empirical knowledge, reflecting three distinct contexts of scientific practice and knowledge: formal, empirical and intentional knowledge.

Recently, a number of essays debated epistemological perspectives on social science simulation (see [5]). Either by viewing simulation as a process of imitation, stylized facts, or intentional adequacy

between programs and theory, the tendency is to emphasize the interpretative character of social science in simulation, notwithstanding its application as a useful methodology for approaching complexity. Nevertheless, while the interpretative character of social science is being slowly recognized into simulation, the formal character of computer science pervades the scientific culture of simulation, as well as most of its methodological arguments. However, the formal perspective alone does not seem to be compatible with simulation in the social sciences. Recent work, presented in [1] and published in [2], demonstrated the classical account of computation to be inadequate to secure the goals of simulation in the social sciences. Simulation does not resemble formal deductive demonstrations or generative mechanisms that explain how certain agent-based models are sufficient to generate emergent macrostructures of interest. The justification of results implies additional epistemic conceptions of scientific knowledge for describing the practice of simulation. Moreover, it implies recognizing the emergence of new kinds of programming languages in computer science, which are iconographic rather than textual and aesthetical rather than abstract. In this context our article [2] is composed of two parts:

First Part, FDE refutation: The first part consists of a characterization of the unsatisfactory role of the classical theory of computation in social simulation. Traditional scientific methodologies often characterize the concept of program execution as a process of formal inference. To some extent, this recalcitrant tradition results from conflating the terms "program computation" and "program execution" into one single meaning, conveying the same ontological status to two fundamentally distinct processes. Considerations of brevity and simplicity led us to call this tradition the FDE argument, as per Formal Deduction through Execution. Notwithstanding, our goal is quite the opposite, namely to demonstrate that simulation shall not be legitimized under the presumption of being an outcome of a calculus of formal inference. Having this in mind, we will set up the conditions to refute the FDE argument. The objection to FDE suggests yet another objection to the current methodological and philosophical thinking in the literature, particularly to the one advocated by Robert Axelrod: our objection to characterizing simulation as an alternative methodology to deduction and induction.

Second Part, The role of programming languages in simulation: A more informative way to analyse the methodological and epistemological status of simulation is to examine how simulations are programmed. The second part of our work discusses the role of programming languages in simulation, according to intentional accounts of computation. The role of intentional methodologies becomes crucial once it is realised that, rather than one kind of program and programming language, two kinds of programs and programming languages are used in the implementation of a simulation: Programs as text and programs as icons; and languages as abstract machines and languages as aesthetic machines. The use of abstract languages confirms that the simulation method incorporates both formal and empirical methodologies. The use of aesthetic languages demonstrates that the simulation method depends fundamentally on intentional methodologies. While the use of textual programming languages demonstrates that the logic of simulation incorporates formal and empirical methods, the use of iconographic languages largely surpasses the use of formal and empirical methodologies. The results of a simulation are outcomes of experimental setups, but the results of the experiments can hardly be represented by material conditions of necessity relating facts about the objective behaviours of the program. The results are appropriately characterized by conditions of intentionality that relate aesthetic components in the program, negotiated according to a limited level of consensus.

References

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