

# Towards an Emergence-Driven Software Process for Agent-Based Simulation

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**Abstract.** In this paper we propose an emergence-driven software process for agent-based simulation that clarifies the traceability of micro and macro observations to micro and macro specifications in agent-based models. We use the concept of hyperstructures [1] to illustrate how micro and macro specifications interact in agent-based models, and show that the reductionism/non-reductionism debate is important to understand the reliability of agent-based simulations. In particular, we show that the effort expended in the verification of agent-based simulations increases exponentially with the number of micro and macro specifications, and that the reliability assessment of non-anticipated results in simulation is in practice not possible. According to these results we claim to be impossible in practice to verify that an agent-based conceptual model has been implemented properly as a computational model, since we do not usually know what we want the output to be a priori. We thus advocate that the classic process of verification, validation and exploration of non-anticipated results is not reliable in agent-based simulation, and call into question the applicability of traditional software engineering methods to agent-based simulation.

## 1 Introduction

The software process is the set of activities and results that produce a software product. In Software Engineering the attributes of a software product refer to the *non-functional* characteristics displayed by the product once it is installed and put to use. These attributes characterize the product's dynamic behaviour and the use made of the product, where reliability and usability are among the most fundamental ones (see [19]).

Meanwhile, the Agent-Based Simulation product differs in various senses from the classical one. Similarly, the process of product development in **Agent-Based**

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<sup>‡</sup> Partially supported by FCT/PRAXIS XXI, Portugal, grant number BD/21595/99.

<sup>¥</sup> Partially supported by CNPq, Brazil, grant number 301041/95-4, and by project MAPPEL (PROTEM-CC, CNPq/NSF), grant number 680033/99-8.