‘One Size Does Not Fit All’: A Roadmap of Purpose-Driven
Mixed-Method Pathways for Sensitivity Analysis of
Agent-Based Models

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Abstract

Designing, implementing, and applying agent-based models (ABMs) requires a structured approach, part of which
is a comprehensive analysis of the output to input variability in the form of uncertainty and sensitivity analysis
(SA). The objective of this paper is to assist in choosing, for a given ABM, the most appropriate methods of SA. We
argue that no single SA method fits all ABMs and that different methods of SA should be used based on the
overarching purpose of the model. For example, abstract exploratory models that focus on a deeper understanding
of the target system and its properties are fed with only the most critical data representing patterns or stylized
facts. For them, simple SA methods may be sufficient in capturing the dependencies between the output-input
spaces. In contrast, applied models used in scenario and policy-analysis are usually more complex and data-rich
because a higher level of realism is required. Here the choice of a more sophisticated SA may be critical in
establishing the robustness of the results before the model (or its results) can be passed on to end-users.
Accordingly, we present a roadmap that guides ABM developers through the process of performing SA that best fits
the purpose of their ABM. This roadmap covers a wide range of ABM applications and advocates for the routine use
of global methods that capture input interactions and are, therefore, mandatory if scientists want to recognize all
sensitivities. As part of this roadmap, we report on frontier SA methods emerging in recent years: a) handling
temporal and spatial outputs, b) using the whole output distribution of a result rather than its variance, c) looking
at topological relationships between input data points rather than their values, and d) looking into the ABM black
box – finding behavioral primitives and using them to study complex system characteristics like regime shifts,
tipping points, and condensation versus dissipation of collective system behavior.

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