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TECHNICAL-NOTE

Replicated Computations Results (RCR) Report for ``Towards Standardizing Validation Practices in Agent-Based Modeling: A Hierarchical ABM Validation Framework'

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Replicated Computations Results (RCR) Report for "Towards Standardizing Validation Practices in Agent-Based Modeling: A Hierarchical ABM Validation Framework'

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"Towards Standardizing Validation Practices in Agent-Based Modeling: A Hierarchical ABM Validation Framework" [1] proposes a novel validation framework for the family of simulation models known as agent-based models (ABMs), particularly popular in the social sciences. The framework is based on, first a clear definition of three crucial concepts in ABMs: calibration, verification, and validation, and then a review of 17 validation approaches. This replicated computations results report focuses on the prototypical tool implementation of such framework, Hierarchical ABM Validation (HAV). Considering the replicability material revised by the authors after an iteration, the software was straightforward to install and use, and the experimental results from the paper could be reproduced in seconds on a standard laptop machine. The article receives the badges *Artifacts Available*, *Artifacts Functional*, *Artifacts Evaluated—Reusable* and *Results Validated—Results Reproduced*.

CCS Concepts: • **Computing methodologies → Model verification and validation**;

Additional Key Words and Phrases: RCR report, Agent-based models, Validation, Discrete event simulation

1 Introduction

This is a replicated computations result (RCR) report for the paper "Towards Standardizing Validation Practices in Agent-Based Modeling: A Hierarchical ABM Validation Framework" [1]. The replication of the results of this paper was performed on a Mac machine with ARM architecture. It proceeded as follows. First, the source code of the prototypical python tool used in the paper (Hierarchical ABM Validation - HAV) has been downloaded from its github repository, and installed. This required the installation of the external library Ninja, and of a number of python libraries. Backward compatibility issues connected to one of python libraries required to use a specific version of python, namely 3.10. This work was supported by the authors, and was based on an additional *how to* report provided by the authors. The replicability material provided by the authors focused on the experiments in Table 6 from the main paper. All experimengts in Table 6 were reproduced without problems in seconds.

The final version of the replicability material, obtained after a few interactions with the authors, namely the one considered in this RCR report, has been uploaded in Zenodo with DOI 10.5281/zenodo.17784056.

2 Replication of Computation Results

2.1 Installation

The prototypical tool considered in [1] is distributed as python sourcecode. For this reason, the tool is multi-platform. On a Mac machine with ARM architecture it required the installation of an external library (Ninja), and of a number of python libraries as provided in file `requirement.txt`.

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The authors of [1] made available the tool together with additional auxiliary files in the form of a Zenodo repository with DOI 10.5281/zenodo.17784056, as well as in a github repository https://github.com/AgentLabCn/hav. This was downloaded as an archive folder containing:

- `README.md`: a readme file containing detailed information on the project structure and on how to replicate a number of experiments;
- `requirements.txt`: a txt file used by the source code to install all required libraries;
- `src`: a folder containing the actual source code;
- `test`: a folder containing three case studies, i.e., three simple ABMs to be validated by the tool;
- `LICENSE`: the license file. The authors have selected license Apache License, Version 2.0.

In addition to this, the main text contains a *how to* report report containing detailed installation and usage instructions. This RCR report was performed based on such instructions.

2.2 Repeating the Results from the Paper

The material provided by the authors focused on the experiments in Table 6 from the main paper, which is the only one containing results to be validated. All experiments there could be replicated without problems. In particular, the table refers to one of the case studies, namely a 'Wealth ABM'. However, the experimentation considered all provided case studies, including a simple traffic ABM discussed in the *how to* report for which an expected output was provided. For this last model, the actual output matched the expected one:

```
Validation Results:

Agent level: True
* Simulation Data: ['Speed']
* Benchmark Data: ['Speed_range']
* Validation Method: Validate the rationality of speed distribution using Kolmogorov-Smirnov
        Test

Model level: True
* Simulation Data: ['Congestion']
* Benchmark Data: ['SIR_beta_range']
* Validation Method: Validate the rationality of congestion spread mechanism (Based on SIR
        Model)

Output level: True
* Simulation Data: ['num_vehicles', 'Congestion']
* Benchmark Data: ['Pearson_corr_range']
* Validation Method: Validate the the correlation between traffic flow and congestion rate with
        Pearson Correlation Analysis
```

3 Conclusion

This Replication Computations Results Report confirms the robustness and reproducibility of the Hierarchical ABM Validation (HAV) framework proposed in the paper "Towards Standardizing Validation Practices in Agent-Based Modeling". All experiments from the original work were successfully reproduced on a different platform with low effort, demonstrating the usability and portability of the artifact. The article receives the badges *Artifacts Available*, *Artifacts Functional*, *Artifacts Evaluated—Reusable* and *Results Validated—Results Reproduced*.

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References

[1] Zhou HE, Qi Song, Junchao Lian, and Yiming Liu. 2024. Towards Standardizing Validation Practices in Agent-Based Modeling: A Hierarchical ABM Validation Framework. *ACM Transactions on Modeling and Computer Simulation (TOMACS), to appear* (2024).

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