

Strengthening the Reporting of Empirical Simulation Studies (STRESS)

Agent based simulation guidelines STRESS-ABS

Section/Subsection	Item	Recommendation
1. Objectives		
Purpose of the model	1.1	Explain the background and rationale for the model. Methods – Model Overview Appendix A - Purpose
Model Outputs	1.2	State the qualitative or quantitative system level outputs that emerge from agent interactions within the ABS. Appendix A – Design Concepts Define all quantitative performance measures that are reported, using equations where necessary. Specify how and when they are calculated during the model run along with how any measures of error such as confidence intervals are calculated Methods – Study Design Methods – Statistical Analysis
Experimentation Aims	1.3	If the model has been used for experimentation, state the research questions that it was used to answer. a.) Theory driven analysis. – Provide details and reference the theories that are tested within the model. N/A b.) Scenario based analysis – Provide a name and description for each scenario, including a rationale for the choice of scenarios and ensure that item 2.3 (below) is completed. Methods – Study Design c.) Design of experiments – Provide details of the overall design of the experiments with reference to performance measures and their parameters (provide further details in <i>data</i> below). N/A d.) Simulation Optimisation – (if appropriate) Provide full details of what is to be optimised, the parameters that were included and the algorithm(s) that was be used. Where possible provide a citation of the algorithm(s). N/A
2. Logic		
Base model overview diagram	2.1	Provide one or more of: state chart, process flow or equivalent diagrams to describe the basic logic of the base model to readers. Avoid complicated diagrams in the main text. Methods – Model Overview & Figure 1
Base model logic	2.2	Give details of the base model logic. This could be text to explain the overview diagram along with extra details including ABS product and process patterns. Include details of all intermediate calculations. Appendix A – Process Overview and Scheduling

Scenario logic	2.3	Give details of any difference in the model logic between the base case model and scenarios. This could be incorporated as text or, where differences are substantial, could be incorporated in the same manner as 2.1. Methods – Study Design
Algorithms	2.4	Provide further detail on any algorithms in the model that (for example) mimic complex or manual processes in the real world (i.e. scheduling of arrivals/appointments/operations/maintenance, operation of a conveyor system, machine breakdowns, etc.). Sufficient detail should be included (or referred to in other published work) for the algorithms to be reproducible. Pseudo-code may be used to describe an algorithm. Appendix A – Process Overview and Scheduling Appendix A – Initialization
Components	2.5	2.5.1. Environment Describe the environment agents interact within, indicating its structure, and how it is generated. For example, are agents bound within a homogeneous grid, or do they have continuous movement through a detailed landscape incorporating geographic or environmental information? Appendix A – Entities, States and Variables
		2.5.2. Agents List all agents and agent groups within the simulation. Include a description of their role in the model, their possible states, state transitions, and all their attributes. Appendix A – Entities, States and Variables Describe all decision-making rules that agents follow in either algorithmic or equation form. Appendix A – Entities, States and Variables Where relevant authors should report: <ul style="list-style-type: none"> • The data that agents access (i.e. internal attributes or external information from the environment) and how it is used. • The objectives agents seek to achieve. • The algorithms, optimisations, heuristics and rules that agents use to achieve objectives. • How agents work together within a group along with any rules for changes in group membership. • Predictions of future events and adaptive action.

2.5.3. Interaction Topology	<p>Describe how agents and agent groupings are connected with each other in the model define:</p> <ul style="list-style-type: none"> • with whom agents can interact, • how recipients of interactions are selected • what frequency interaction occurs. • How agents handle and assign priorities to concurrent events <p>It is recommended that interactions are described using a combination of equations pseudo-code and logic diagrams.</p> <p>Report how interactions are affected by agent states and the environment state</p> <p>Appendix A – Entities, States and Variables</p>
2.5.4 Entry / Exit	<p>Where relevant, define how agents are created and destroyed in the model.</p> <p>Appendix A – Entities, States and Variables Appendix A – Initialization</p>

3. Data

Data sources	3.1	<p>List and detail all data sources. Sources may include:</p> <ul style="list-style-type: none"> • Interviews with stakeholders • samples of routinely collected data, • prospectively collected samples for the purpose of the simulation study, • public domain data published in either academic or organisational literature. Provide, where possible, the link and DOI to the data or reference to published literature. <p>All data source descriptions should include details of the sample size, date ranges and use within the study.</p> <p>Methods – Model Overview & Table 1 Appendix A – Entities, States and Variables & Table A.1</p>
Pre-processing	3.2	<p>Provide details of any data manipulation or filtering that has taken place before its use in the simulation, e.g. interpolation to account for missing data, removal of outliers or filtering of large scale data.</p> <p>Appendix A – Entities, States and Variables & Table A.1</p>
Input parameters	3.3	<p>List all input parameters in the model, providing a description of each parameter and the values used. For stochastic inputs provide details of any continuous, discrete or empirical distributions used along with all associated parameters. Where applicable define the time/spatial dependence of parameters and any correlation structure.</p>

Appendix A – Process Overview and Scheduling

Clearly state:

- Base case inputs
- Inputs used in experimentation, where different from the base case.
- Where optimisation or design of experiments has been used, state the range of values that parameters can take.

Where theoretical distributions are used, state how, , these were selected and prioritised above other candidate distributions.

Assumptions	3.4	Where data or knowledge of the real system is unavailable, state and justify the assumptions used to set input parameter values and distributions; agent interactions or behaviour; or model logic.
-------------	-----	---

Appendix A – Validation

4. Experimentation

Initialisation	4.1	State if a warm-up period has been used, its length and the analysis method used to select it.
----------------	-----	--

N/A

State what if any initial agent and environmental conditions have been included. For example, the initial agent population size, agent states and attributes, initial agent network structure(s), and resources within the environment. Report whether initialisation of these variables is deterministic or stochastic.

Appendix A – Initialization

Run length	4.2	Detail the run length of the simulation model and time units.
------------	-----	---

Methods – Model Overview

Methods – Study Design

Appendix A – Entities, States and Variables

Estimation approach	4.3	State if the model is deterministic or stochastic. If the model is stochastic, state the number of replications that have been used. If an alternative estimation method has been used (e.g. batch means), provide full details.
---------------------	-----	--

Methods – Study Design

5. Implementation

Software or programming language	5.1	State the operating system and version and build number.
----------------------------------	-----	--

State the name, version and build number of commercial or open source ABS software that the model is implemented in.

Methods – Model Overview

State the name and version of general-purpose programming languages used (e.g. Python 3.5.2). Where packages, frameworks and libraries have been used provide all detailed including version numbers.

Methods – Statistical Analysis

Random sampling	5.2	State the algorithm or package used to generate random samples within the software/programming language used e.g. Mersenne Twister or
-----------------	-----	---

		Java.Random version x.y N/A
Model execution	5.3	<p>If the ABS model has a time component, describe how time is modelled (e.g. fixed time steps or discrete-event). State the order of variable updating within the model. In time-stepped execution state how concurrent events are resolved.</p> <p>Appendix A – Entities, States and Variables</p> <p>If the model is parallel, distributed and/or use grid or cloud computing, etc., state and preferably reference the technology used. For parallel and distributed simulations the time management algorithms used. If the HLA is used then state the version of the standard, which run-time infrastructure (and version), and any supporting documents (FOMs, etc.)</p> <p>N/A</p>
System Specification	5.4	<p>State the model run time and specification of hardware used. This is particularly important for large scale models that require substantial computing power. For parallel, distributed and/or use grid or cloud computing, etc. state the details of all systems used in the implementation (processors, network, etc.)</p> <p>N/A</p>
6. Code Access		
Computer Model Sharing Statement	6.1	<p>Describe how someone could obtain the model described in the paper, the simulation software and any other associated software (or hardware) needed to reproduce the results. Provide, where possible, the link and DOIs to these.</p> <p>This can be provided as a GitHub link in the supplemental materials.</p>