Trusted Simulation

An Organizing Framework for Considering Model Quality

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Goal: Expand our concept of model quality around the ultimate goal of calibrating user trust in a model

In an ideal modeling project, the user would be given all the information they need to properly calibrate their trust in the model. The model wouldn't be perfect, but the user would understand its strengths and weaknesses and could use that information to determine when and how the model should be used.

This framework is not intended to be considered as an after-the-fact evaluation structure for simulation models. Instead, we suggest that it help to drive the entire modeling process to ensure successful calibration of user trust.

Model Characteristics

Applicability

Is the model directly addressing a problem relevant to its intended use? Are the results of the model, including any analysis, relevant to the intended audience?

Applicability must consider the causal structure of the model. Causal assumptions should align with relevant literature, expert knowledge, user needs, and analytic requirements for the model context.

Performance

The focus of model performance is generally on "V&V", or verification and validation. *Verification* tests whether the mathematical and computational versions of the model are accurate given the conceptual model they represent. In other words, is the model implemented correctly?

Validation tests how well the model's results match the real-world system it is meant to represent. In other words, does the model do a good job of replicating the real world?

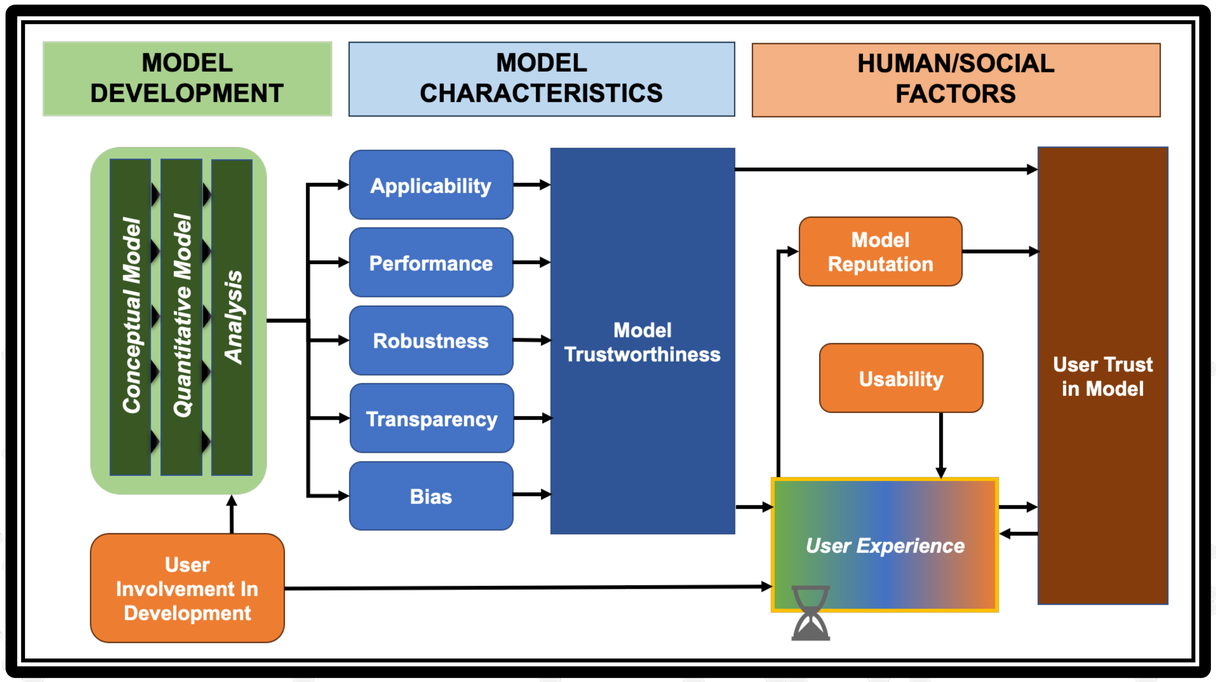
Robustness

Robustness is the ability of a model to perform well under different conditions. A robust model is more generalizable.

Standard approaches include uncertainty quantification (UQ) and sensitivity analysis. UQ involves characterizing uncertainty of inputs (time series, parameters, equations, causal structure) and propagating those through the model to determine uncertainty in results. Sensitivity analysis investigates how much influence each input has on the output.

Context: Model Purpose and Intended Audience

Model quality must be considered in context. For example, a model intended to demonstrate a theory to students has different quality requirements than a model used by a hiring manager to make workforce decisions.



Transparency

One of the strengths of system dynamics models are their potential to be clearly communicated, even to non-experts.

To facilitate calibration of trust, users should be able to understand model structure and equations. Results should be interpretable and users should have a clear understanding of how the model generated the results.

Bias

System dynamics models often utilize literature, expert knowledge, and data, all of which can be biased. Consideration of bias thus requires explicit assessment of potential bias in all relevant information sources, as well as identification and qualitative and quantitative assessment of alternative assumptions.

Human/Social Factors

User Involvement in Model Development

User trust and willingness to use a model are greatly improved when users are involved in the design and development process.

Determining the intended audience, working with that audience to understand their problems and questions, and involving the audience in the model building process can increase understanding and acceptance of the model, and can help the audience to properly calibrate their trust in the model.

Usability

A model that is easy to understand and use, that is not prone to error, and that gives the user the information they want and need can help the user to appropriately calibrate their trust in the model.

A wide body of knowledge on usability exists, focusing on learnability, efficiency of use, memorability, error rate, and user satisfaction. In system dynamics, usability is largely determined by the user interface and communication about the model and analysis.

Model Reputation

Trust is neither static nor solely individual. The roll-out of a model and the user's history can be central in determining trust.

This component of trust touches on previous experiences a user considers relevant, including the reputation of system dynamics modeling itself, previous experiences with the project team, and previous experiences with other simulation modelers in general.

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