FOUR PHASES IN SYSTEMS MODELING - PHASE III: MODEL EVALUATION

Quote of the Day

"Truth is the intersection of independent lies."

--- Richard Levins (1970)

I. SOME IMPORTANT TERMS

1. Generality, Realism, and Precision

Levins (1966) recognized the existence of trade-offs among generality, realism and precision in model-building (**Levins' trichotomy**). He claimed that one can maximize only two (not all three) simultaneously, but all three can be improved at the same time to a certain level during the model-building process.

- **Generality**: the number of systems or situations to which the model applies.
- **Realism**: the degree to which model structure (including variables, assumptions, relationships) resembles the real system.
- **Precision**: the degree to which model behavior numerically matches that of the real system, i.e., the accuracy of the model predictions (output).

2. Verification

- Model verification refers to the process in which the correctness of the computational algorithms or computer code of a model is demonstrated. It usually involves debugging and detecting logical errors.
- Verification simply means to make sure that the simulation model does what it is supposed to do numerically. That is, the mathematical formulation and computer simulation are a faithful translation of the conceptual model.
- A verified model is not necessarily a validated or even useful model.

3. Validation

- Validation is a demonstration that a model within its domain of applicability possesses a satisfactory range of accuracy consistent with the intended application of the model (Rykiel 1996).
- Validation is a process to determine the relative usefulness of a model in a given context.
- Validation refers to model quality with respect to the objectives of the modeling project (Haefner 1996)
- Whether or not a model is "valid" depends greatly on validation criteria.

4. Calibration

- Calibration is the estimation and adjustment of model parameters and constants to improve the agreement between model output and a data set.

- Calibration procedures can be used to estimate parameter values that are otherwise unknown.
- Calibration is different from, though related to, parameter estimation.

II. MODEL EVALUATION (OR VALIDATION)

Model evaluation involves several aspects:

- Assess the reasonableness of the model structure and the interpretability of functional relationships within the model
- Evaluate the correspondence between model behavior and the expected patterns of model behavior
- Examine the correspondence between model predictions and the data from the real system
- Determine the sensitivity of model predictions to changes in the values of important parameters

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Suggested Readings

Barlas, Y. 1996. Formal aspects of model validity and validation in system dynamics. System Dynamics Review 12:183–210.

Rykiel, Jr., E. J. 1996. Testing ecological models: the meaning of validation. Ecological Modelling 90:229-244.

FOUR PHASES IN SYSTEMS MODELING -
PHASE IV: MODEL USE

Quotes of the Day

"A model is a caricature of nature... The simplest version of nature can be perturbed numerically with its responses being indications of the directions nature may take."

--- Scavia, D., G.A. Lang, and J.F. Kitchell (1988)

"Every theory of the course of events in nature is necessarily based on some process of simplification and is to some extent, therefore, a fairy tale."

--- Sir Napier Shaw

PHASE IV: MODEL USE

- Develop and execute the experimental design for the simulations
  - Deterministic vs stochastic
  - Follow the same general principles of experimental design (e.g., factorial design)
- Analyze and interpret the simulation results
  - Deterministic vs stochastic
  - # of replicate simulations for stochastic models
  - Single-value predictions vs. time-series predictions
  - Statistical analysis for stochastic models
- Examine additional types of management policies or environmental situations
- Communicate the simulation results.