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A FORTHCOMING USEFUL TOOL: ENHANCING UNDERSTANDING OF MODELS THROUGH ANALYSIS

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ABSTRACT

Simulation is used increasingly throughout research and development for many purposes. While model output is often the primary interest, insights into the system gained through the simulation process can also be valuable. These insights can come from building and validating the model as well as analyzing its behaviors and output; however, much that could be informative may not be easily discernible through traditional approaches, particularly for complex models.

The author is developing an analysis tool to provide simulation modelers with additional information about the models they are using. The focus is to extend the information available. A key component is a compiler for a C-like language in which modelers specify (code) their models. With the ability to directly monitor and record interactions, additional information could be presented to the modeler in order to facilitate new insights.

EXTENDED ABSTRACT

It is often stated by users of simulation that its primary benefit is not necessarily the data produced, but the insight that building the model provides. Paul et al. discuss this in (Paul et al. 2005), noting that "simulation is usually resorted to because the problem is not well understood."

Simulation is used increasingly throughout research and development for many purposes. While model output is often the primary interest, insights into the system gained through the simulation process can also be valuable. These insights can come from building and validating the model as well as analyzing its behaviors and output; however, much that could be informative may not be easily discernible through traditional approaches, particularly for complex models. This work explores new approaches for the simulation community to complement current methods used to gain insights into models, their behaviors and the systems they represent.

A prime problem with model descriptions, whether in textual or graphical notations, is that even in simple models, descriptions are often difficult to fully comprehend. Paul accurately states (Paul and Kuljis 2010):

> Even when we think we know what we are modeling there are many problems: we do not have the software skills to know if the software is doing the right thing; we cannot be certain that the logic of the problem is faithfully represented in the model; we cannot be sure that the assumptions built into the model, the uses it was designed to be put to and not put to, will be adhered to by future users etc. And then with the passage of time, and probably with some model updates, corrections, and possible changes of logic, we cannot be sure of the way the model works at all.

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For some systems and the models that represent them, recognizing interactions among components provides useful information about the systems. Often these interactions occur indirectly and often with time delays between cause and effect. These interactions may not be easily noticed when observing animations of the simulations and are often not captured by the data typically collected and reported at the conclusion of simulations. Understanding the "whys" of behaviors is an often unstated goal of simulation activities.

Insights can arise from many different sources. One can be surprised to discover relationships between seemingly-unrelated events. One can also gain insight when something that is expected to happen does not occur. Sometimes events can happen with regularity or in groupings that may not be noticed by a modeler and may reveal important aspects of the simulated system. Often these facts are not immediately obvious, particularly in large simulations (Overstreet and Levinstein 2004, Nance et al. 1999). Anecdotal reports from modelers support the frequent difficulty of detecting important aspects of their models which when pointed out are quite useful.

My primary interest is in extending current research in model analysis and program understanding to assist modelers in obtaining more insights into their models. The tools I am developing use various model analysis techniques, similar to those used in the software engineering community. Some of the techniques are known but have not been applied to modeling issues in the simulation community. For example, techniques developed in the compiler community for code optimization can be applied to models to reveal subtle interactions among model components. Additionally, some techniques used with expert systems allow those systems to explain their reasoning when queried. We believe these techniques can also benefit modelers and model users.

My preliminary results indicate these code analysis techniques, when applied to even modest simulation models, can reveal aspects of those models not readily apparent to the builders or users of the models. These analyses can often reveal important aspects of systems that are not readily observable in model-driven animations or even in examining data produced by simulations during execution. My interest is in providing both model builders and model users with additional techniques that can give them improved understanding of their models.

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