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An XML-based schema definition for model sharing and reuse in a distributed environment ☆

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Abstract

This research leverages the inherent synergy between structured modeling and the eXtensible Markup Language (XML) to facilitate model sharing and reuse in a distributed environment. This is accomplished by providing an XML-based schema definition and two alternative supporting architectures. The XML schema defines a new markup language referred to as the Structured Modeling Markup Language (SMML) for representing models. The schema is based on the structured modeling paradigm as a formalism for conceiving, representing and manipulating a wide variety of models. Overall, SMML and supporting architectures allow different types of models, developed in a variety of modeling platforms to be represented in a standardized format and shared in a distributed environment. The paper demonstrates the proposed SMML through two case studies.
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Keywords: Model management; Model sharing; Structured modeling; eXtensible Markup Language (XML); Distributed computing environments

1. Introduction

With the recent advances in computer and telecommunication technologies, organizations are increasingly dependent on management models for data analysis and decision support. Accordingly, the number and complexity of management models and of modeling platforms dramatically increased rendering such models a corporate (and national) resource. "Modeling in the large" as denoted by Muhanna and Pick [51] explicitly recognizes models as a resource and modeling as an ongoing process that should be supported. The focus is on the management of large shared model bases. Such a view of modeling and the emphasis on reuse is growing within the decision support community [41]. Model reuse can take several forms including the ability to use the same model with a different data set or with a different solver, and to use the same model in a different modeling environment. The notion of reuse can also be extended to include composing and integrating models from existing models. Supporting the modeling process in general, and "modeling in the large" in particular is the ability to represent models at a higher level of abstraction, i.e., meta-modeling.

However, in practice, models use a myriad of languages and task specific representations that include textual descriptions of problem statements, modeling languages, and graphical notation. While some model

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representations offer distinct advantages such as model-data independence, others have data intertwined with the model structure. Moreover, several representations (and modeling environments) can be used within the same organization for addressing the same type of model. To share and reuse models in such environments, individual translators will need to be developed for each pair of model representation schemes. This solution is not scalable, particularly in the context of distributed inter-organizational setting. Moreover, such representations are not directly amenable to architectures supporting distributed environments. Last, but not least, such representation schemes are often paradigm dependent. In effect, without a unified scheme for representing the structure and semantics of models that preserves model-data, model-solver, and model-paradigm independence, efforts to support "modeling in the large" and to leverage existing investments in models through sharing and reuse are seriously curtailed.

Two important developments offer promising results, namely, structured modeling (SM) and eXtensible Markup Language (XML). In the quest for expressive model representation, structured modeling received a great deal of attention in the literature. SM as defined by Geoffrion [26] is a "formal mathematical and computer-based environment for conceiving, representing and manipulating a wide variety of models". SM has many of the features desired in model management systems, which makes it a very useful tool for model representation. SM provides a coherent conceptual framework for modeling based on a single modeling system, irrespective of the underlying modeling paradigm.

The recent development of eXtensible Markup Language (XML) emphasized the importance of content information by making it possible for designers to create and manage their own sets of tags [6]. Accordingly, XML facilitates searching for specific content-based information as well as moving documents across applications and systems, i.e., model exchange in a distributed environment. Modelers using different modeling tools or environments can communicate using the common XML representation. While Geoffrion [26] demonstrated different ways of rendering a structured model as a web document, not much research has been done to represent structured models using XML.

This research leverages the inherent synergy between SM and XML to facilitate model sharing and reuse in a distributed environment. This is accomplished through the development of an XML-based schema definition and supporting architectures. The XML schema defines a new markup language referred to as the Structured Modeling Markup Language (SMML) for representing models. The schema is based on the structured modeling paradigm as a formalism for conceiving, representing and manipulating a wide variety of models. In effect, the proposed language allows for:

- Representing different types of models that are developed using a variety of modeling platforms in a standardized format.
- Sharing and publishing models among model users regardless of their modeling environments.
- Reusing models (developed for different data sets, for different solvers, and in different modeling environments) without the need for re-writing models for each tool.
- Creating a lifetime repository (archive) of models in an environment and a platform independent format. Accordingly, the models are reusable, even after a particular environment is rendered obsolete.

The paper is organized as follows: the next two sections provide a brief review of model representation and XML. Next, we highlight the advantages of using structured modeling and XML for model representation followed by a description of the schema definition for SMML. We then present two alternative supporting architectures followed by case studies demonstrating the applicability of the proposed representation. The final section concludes the paper.

2. Model representation

Model management (MM) emerged in the mid-seventies in the context of managing models in decision support systems (DSS) [54,57]. While a comprehensive review of the model management (MM) literature can be found elsewhere [3,12,41], it is worth noting that much of the motivation behind MM focused around finding ways for developing, storing, manipulating, controlling, and effectively utilizing models in an organization [50]. Inherent in such functionality is the ability to represent models at a higher level of abstraction, i.e., meta-modeling.

2.1. Requirements for model representation

Requirements for model representation evolved over the years to accommodate the increasing demands by analysts and users. Initial interest focused on abstracting away from low-level input formats and moved on to emphasize representing models at a higher level of abstraction to facilitate model management functions.

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