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MWAIS 2009 Proceedings | Midwest (MWAIS)

5-2009

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ABSTRACT

While managers in today's global business environments are thrusting for swifter, more flexible, and scalable decision support, technical challenges pertaining to model sharing arise due to the limited capabilities of current model representation techniques. In this research, we propose that ontologies can improve model representation and thus support sophisticated model management capabilities such as model integration and composition in distributive collaborative environments. The proposed solution extends SMML and builds upon previous literature in the semantic web to provide a model representation language that is capable of capturing model structure as well as semantics.

Keywords

Model management, model representation, ontologies.

INTRODUCTION

In order to utilize decision models as knowledge resources, firms might think of sharing and re-using the same model with different datasets, for instance, or with a different solver in a different modeling environment in case they decided to collaborate with partners on a joint product development project. Even if the firm is not involved in some form of collaboration, enterprise integration and support analysis of the firm is yet another concern (Goul and Corral 2007).

Basic functionalities of Model-based decision support systems DSS served managers for a considerable period of time at which interoperability and scalability of information systems were not comprising issues. Such functionalities include gathering relevant data, conceiving and selecting analytical decision models. In modern heterogeneous business environments, however, such functionalities may not provide all the needed support, as more managers are choosing to collaborate and the current infrastructure is not supportive. One approach to this dilemma is to improve model representation in order to provide distributed model management support. The bottom line is to construct a model representation scheme that can be interpreted by different translators communicating among heterogeneous environments. In this regard, considerable research efforts have been conducted to address the quest for distributed model management in general. Of particular relevance the work conducted by (Geoffrion 1987; Adams and Hale 1988; Dolk 1988; Kim 2001; El-Gayar and Tandekar 2007; Deokar and El-Gayar, 2009)

In this research, we propose that ontologies can provide something similar to a virtual cross-platform in distributive decision making environments through highlighting their capabilities in reasoning and querying. Basically, we address the following question: how can ontolgies capabilities be utilized to enable model sharing and re-use in distributed decision making environments?

BACKGROUND

The domain of model management MM centers on the study of computer-based methods for representing models and automating modeling processes (Chang, Holsapple et al. 1993).MM with its underlying services, provide access and control of modeling resources. Such resources include models, model solvers, modeling platforms, and languages such as the General Algebraic Modeling Language (GAMS), and model schemas. Some of the functionalities of MM resemble those of (DBMS) such as model description, manipulation, and control (Dolk 1986). One important function of MM is model selection. Model selection deals with identifying a model type for a specific problem instance (Banerjee and Basu 1993) after the model is selected and the problem is represented, the model instance is formulated.

[1] Amit Deokar and Omar El-Gayar contributed to this paper as well. They are not listed as authors because they served on the conference committee for the MWAIS 2009 conference.

Executing most of MM functionalities relies on the way models are represented. According to (Konsynski and Sprague 1986), model representation deals with the development of a model language that should accommodate graphic, tabular, forms of specification, and semantics.

Structured modeling SM (Geoffrion 1987) was the harbinger for a new generation of model representation languages with more expressive power. Accordingly, many researchers who tried to utilize SM capabilities to manage large model bases and improve integrated modeling environments deployed it in their frameworks or model representation languages such as (Dolk, 2000; Kim 2001;El-Gayar and Tandekar 2007).

Structured modeling markup language SMML (El-Gayar and Tandekar 2007) is an XML-based language. It emphasizes representing models at higher levels of abstraction (e.g. meta-modeling, which resembles XML as a meta-language) by incorporating the meaning of the data or the context in which these models are applied. The MODEL element, for example, has some attributes such as name level, description, type, and keyword in addition to other attributes that describes the content and the structure of a model. This pretty much resembles what the XML has offered to the WWW by describing the structure as well as the content of the web pages. In the same way, flexibility in model representation is meant to facilitate inferences about these models, as the standardization of different types of models is possible.

The semantic web, as opposed to XML, can convey the meaning of the exchanged information. Semantic web relies on Ontolgies (Fensel, Lausen et al. 2007). Ontologies are explicit conceptualizations that describe the semantics of information resources and reason about them. Examples of Ontologies include WordNet for English terms, CYC for common sense knowledge such as time and space. Decision Models, just like the knowledge represented these ontologies, are resources that need to be managed so that they can be shared and re-used swiftly. This resemblance between data and models can provide a potential for mapping the semantic web technologies to MM functionalities.

ONTOLOGIES FOR MODEL REPRESENTATION

Ontologies are being deployed to standardize terminology pertaining to business processes and shared knowledge. Such standardization is supposed to provide well-defined meaning. For example, (De Medeiros and Karla, 2008) utilized ontologies to provide more accurate analysis of processes. They identified three basic building blocks in their approach: ontologies, generic and domain specific, references to associate meanings to labels, and a reasoner to derive new knowledge. In order to attach semantics, they created a semantic annotated version of the mining extensible markup language MXML and used an optional property called modelReference to map to the ontologies. We will be using a similar approach by building upon SMML and borrowing concepts from the semantically annotated web services description language SA-WSDL (W3C, 2007). The resulting model representation language might be called SA-SMML. The reason for choosing SA-WSDL is that both SMML and WSDL are XML-based language and both can benefit from semantic annotations to improve interoperability. Thus, the same approach used for SA-WSDL may be adapted for SA-SMML.

Preliminary version of SA-SMML

In SA-WSDL, the model reference is an extension attribute that is used to point to semantic concepts. In the context of SA-SMML, similar attribute, modelRef, can be applied to point to the SMML ontology, as illustrated in Figure 1. This Ontology, written in OWL (W3C, 2004), describes the semantics of model instance in SMML domain ontology as illustrated in Figure 1.The same approach could be followed by using an attribute called domainRef. This attribute can point to the domain ontology for a particular value in a particular domain, such as the supply chain domain. The OWL editor's API in Protege can be deployed in the prototype to incorporate model semantics that the query processor will be using to reason about the client's request as can be noticed from Figure 1.

For semantics annotation, another approach would be to embed the semantic model for that value and use just one attribute, which is the modelRef. The idea is to point any number of external ontologies using modelRef for describing the semantics of model structure and instance and then embed the semantic model for that value. Thus, modelRef will be used to point the semantics of that value internally.

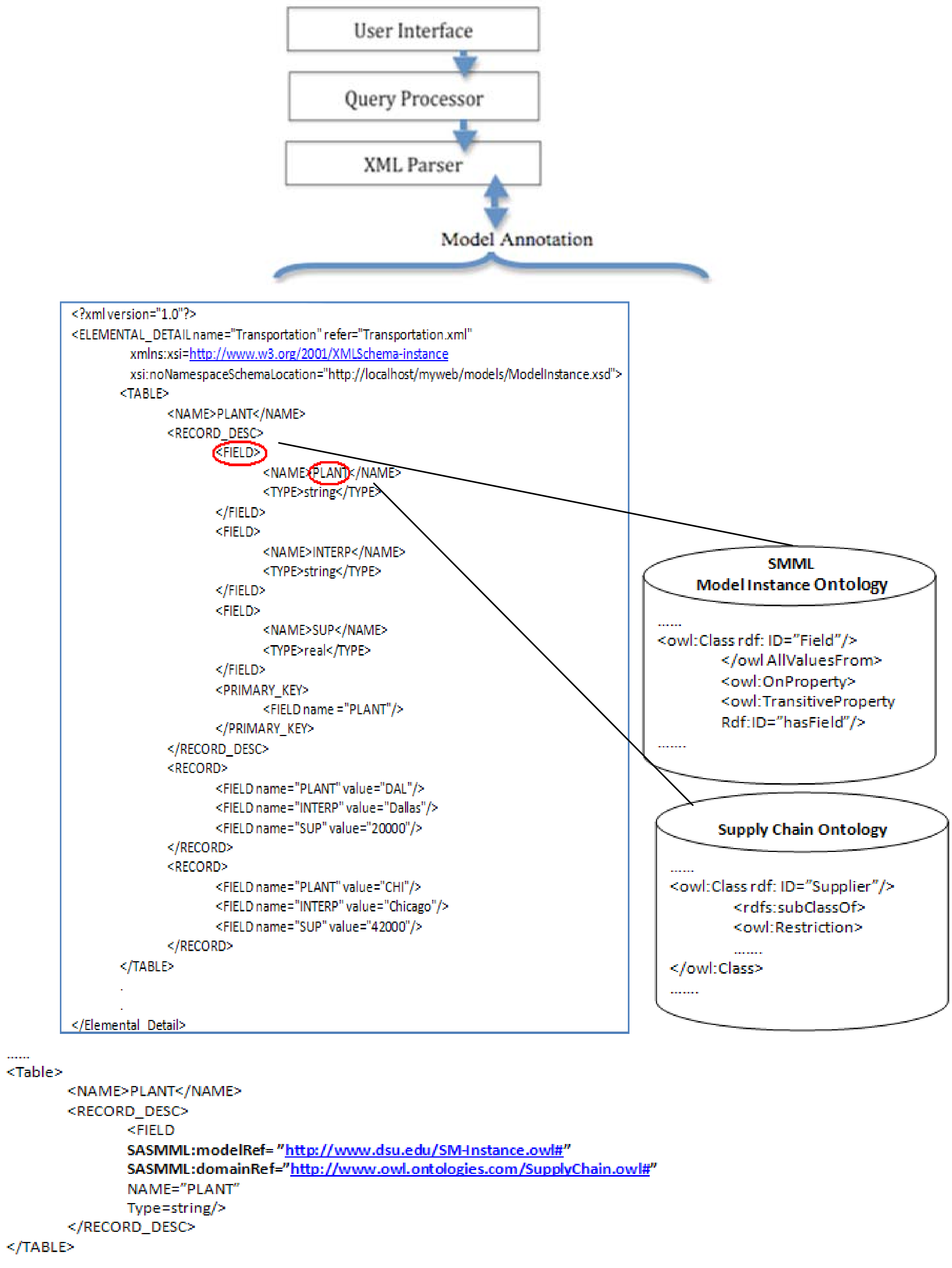

Figure 1. Preliminary Prototype

CONCLUSION

Current infrastructure in heterogeneous business environments hardly supports distributive decision-making. Findings to date illustrate a potential in deploying ontologies in order to improve model representation. SA-SMML presents this potential. It is unique in the sense that it is specifically designed for representing decision making models and annotating them with semantics. This preliminary SA-SMML version represents a starting point towards developing a distributive model management system.

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