Journal of the Association for Information Systems

Volume 8 | Issue 2 Article 7

2-6-2007

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Rajiv Kishore

Recommended Citation
Kishore, Rajiv (2007) "Editorial Preface - JAIS Special Issue on Ontologies in the Context of Information Systems.," *Journal of the Association for Information Systems*, 8(2), .
DOI: 10.17705/1jais.00117
Available at: https://aisel.aisnet.org/jais/vol8/iss2/7

Journal of the Association for Information Systems
JAIS

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Editorial Preface - JAIS Special Issue on Ontologies in the Context of Information Systems.

Rajiv Kishore and Ram Ramesh
Guest Editors
School of Management
State University of New York at Buffalo

Abstract:

Ontologies, in the information systems context, deal with the structures of the world about which an information system informs, or to which it responds based on changes in that world. Ontologies are fundamental for system interoperability and integration; for increasing intelligence, flexibility, and reasoning around system responses and behaviors; for negotiating the meanings of the data in the system; and for innovating with new business models. Their importance has grown with the rise of enterprise systems, the semantic web, knowledge management systems, and new forms of value system integration, among other factors. This special issue of *Journal of the Association of Information Systems* (JAIS) on Ontologies in the Context of Information Systems contains three papers presenting contributions to the theory, domain knowledge, and methodologies for applying ontologies in the Information System (IS) field.

This issue has been produced according to the developmental review process of JAIS. As part of this process, we followed three broad stages: (1) screening of extended abstracts, (2) developmental review of papers selected based on the extended abstracts, and (3) peer review of papers selected in the developmental review stage.

We received 66 abstracts in response to the Call for Submission. Of these we invited authors of 12 abstracts to submit full papers. We received 10 papers in response. After the developmental evaluation by the editors and reviewers, one paper was rejected. The authors of the remaining nine papers were asked to develop and revise them based on detailed reviewers' comments. We received seven revised manuscripts. These papers were then sent for peer reviews that resulted in inviting authors of three papers to submit revised papers. One paper was withdrawn at this stage and we received two revisions. Another paper that had been reviewed for the JAIS special issue on Systems Analysis and Design was moved to the special issue of ontologies based on its contents. These three papers underwent another round of reviews and were finally accepted. They reflect a wide range of ontologies-related issues and methods applied in the research and development of ontologies for information system domain.

The special issue opens with an article by Wales, Shalin, and Bass on the development of a naming convention and a related ontology for scientific work and distant actions by a robotic rover as part of the National Aeronautical and Space Administration's (NASA) Mars Exploration Rover (MER) mission during 2001-2004. This paper is written in an ethnographic style, which readers may find to be quite different from the style of qualitative papers usually found in the IS literature.

Wales, Shalin, and Bass describe the development of an ontology of action and a naming convention to help interdisciplinary teams in the MER mission collaborate on the development of scientific plans for Mars rovers, essentially robots that execute actions in a distant physical environment – the Martian surface. This domain involves high uncertainty, high variability, and time- and mission-criticality. The naming conventions and the ontology of action had to provide unambiguous semantics and terminology to facilitate communication among interdisciplinary teams and for software systems used for real-time planning and action requests in a dynamic environment. Furthermore, the ontology and naming conventions also had to be flexible enough so that they could be adjusted to support mission scientists and engineers who were requesting new objects and new actions as they were themselves learning from the rover's activities in the Mars exploration mission. The authors describe the grounded theory and ethnographic approaches that they used to develop communication and organize professional discourse for the mission and the resulting naming conventions and ontology they developed over the course of the mission.

The approach and methods described in this paper can be applicable to other domains that involve team-based work in dynamic environments where actions and decision making are contingent upon immediate past actions. For example, product life cycle management (PLM) in high-velocity markets requires IT support for sensing customer needs, generating new product ideas, developing and testing prototypes, and servicing customers. These tasks might involve interdisciplinary teams who interact and make decisions in a dynamic environment characterized by constantly shifting customer needs. Another area that could benefit from the principles and method described in this article is global software development by geographically-distributed teams using an agile approach. The agile development environment might entail changes that have to be communicated about and incorporated during the development project.

The second article, by Kim, Fox, and Sengupta, describes the TOVE ISO 9000 Micro-Theory they developed for evaluating an organization's quality management processes and practices with respect to the ISO 9000 standards. Even though TOVE ISO 9000 is an ontology, it is called a micro-theory because it is developed as a detailed model for solving problems in the particular domain. The paper demonstrates the application of this micro-theory by comparing the quality inspection system of an international manufacturer of steel products with ISO 9001 requirements for inspection and testing. This is a paper in the design science tradition where a design artifact embodying general ontological principles is built and evaluated.

TOVE ISO 9000 micro-theory is an instantiation of the Toronto Virtual Enterprise (TOVE) core ontologies of measurement, traceability, and quality management systems. It provides a model for evaluating an organization's compliance to standards or regulatory requirements based on a descriptive model of the organization. Both models are developed using the TOVE ontologies that are specified formally using McCarthy and Hayes' situation calculus. This is a first-order language that allows for representing dynamically changing "worlds." Because it is formally specified, this micro-theory allows automated theorem proving and inferencing. However, this implies a high-level of ontological commitment to the modeled domain, contrary to the principle of minimal ontological commitment, a requirement suggested for a knowledge model to be considered an effective ontology.

The methodology for evaluating compliance to the ISO 9000 standards involves development of a motivating scenario that is a detailed narrative about the specific tasks that need to be performed or problems that need to be solved. Motivating scenarios allow the abstraction of general concepts that are characterized as informal competency questions stated using informal, non-ontological terminology. Informal questions are converted into formal competency questions using the terminology provided by the ontology/micro-theory. Answers to formal competency questions provide an evaluation of the organization's compliance to ISO 9001 requirements.
These answers can be automatically deduced because axioms that define and constrain the terminology are specified in first-order logic.

The authors have also shown the generality of their micro-theory by demonstrating that the "native" TOVE ISO 9000 is a superset of a more general ontology that is used for assessing quality compliance. The approach described in the paper, therefore, provides general principles and methods for building ontologies and micro-theories for evaluating compliance to other regulatory requirements (for example - the Sarbanes Oxley regulations).

The third paper, by Fonseca and Martin, analyzes the differences between computational ontologies and conceptual schemata. The authors argue that there is a natural distinction between ontologies and conceptual schemata and they should, therefore, be conceptualized to operate at two distinct epistemic levels. The authors observe that many researchers treat a conceptual schema as essentially the same as a computational ontology. They claim that the origin of confusion between these two concepts lies in the similarity between them and in the fact that research on the use of ontologies in information systems is a relatively recent effort.

Fonseca and Martin discuss the differences and similarities between computational ontologies and conceptual schemas using two concepts: objectives and objects. With respect to objectives, computational ontologies should focus on explanation and information integration grounded in assumptions about invariant conditions that define the domain of interest. In contrast, conceptual schemas should focus on linking the general ontological categories with particular observations to be classified in an information system by enabling the measurement and classification of the observed facts. With respect to object, computational ontologies should focus on the invariant conditions of the domain of interest in the real world, i.e., the general and assumed categories that are taken to define the domain. Conceptual schemas should act as links, connecting the ontologies with the data, or "facts." Thus, their object should be the relationship between ontological categories and the permissible range of variation among the facts related to those categories.

The authors take the position that computational ontologies have a broader scope than conceptual schemata, as they aim to explain a world that is not as limited as the specific world modeled by a conceptual schema. Ontologies may contain extra information that will help establish the meaning of other concepts in the ontology. In contrast, conceptual schemata are limited to concepts and terms that will be included in the data stored in the information system. In their view, computational ontologies should be constructed so as to specify a priori assumptions concerning the invariances that underlie the measurement and explanatory processes, while conceptual schemata should relate those categories to dimensions of measurable variation in the domain of interest. While conceptual schemata are the foundations of data and knowledge base systems – specifying their design, creation, application and maintenance, computational ontologies occur at a layer above, addressing the capabilities of inference engines built on top of data and knowledge base systems.

This special issue would not have been possible without the support of many colleagues. First and foremost, we are very grateful to Paul Gray who, recognizing the importance and critical role of ontologies in the IS field, suggested the special issue of JAIS to us way back. Next, we wish to record our appreciation for Sirkka Jarvenpaa for giving us the opportunity to organize this special issue. We are also thankful to Yair Wand for his involvement, guidance, and advice as the guest senior editor during all stages of the editorial process and to Kalle Lyytinen, the current editor of JAIS, for his continued support.

We also wish to record our sincere appreciation to the reviewers who spent countless hours reviewing papers during various stages of the editorial process.

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Journal of the Association for Information Systems
ISSN: 1536-9323