Ontology

William Buchholz
Bentley College, USA

INTRODUCTION

An ontology comprises the explicitly articulated and shared concepts of a knowledge community or domain. These concepts are arranged formally in a taxonomy and are governed by specifically defined rules and axioms. Ontologies often play an important role in *knowledge management information technology* (KMIT). An enterprise knowledge management IT system, for example, may use an ontology "to facilitate communication, search, storage, and [knowledge] representation" (O'Leary, 1998, p. 58). A general survey of the literature suggests that ontologies are capable of improving performance in a large variety of knowledge management IT functions, especially relative to knowledgebases for best practices, lessons learned, human resource skills, Help Desks, FAQs, document collections, standards and regulations, products, services, proposals, and the like. In addition, as we look to the future, ontologies will function centrally in agent-mediated knowledge management (AMKM), distributed knowledge management (DKM), and the Semantic Web (Daconta, Obrst, & Smith, 2003; Fensel, 2001; Heflin, Volz, & Dale, 2002; McGuiness, 2002), as these technologies become pervasive in a global economy that distributes KM knowledgebases across companies and cultures.

The term *ontology* is rarely used in knowledge management circles. In fact, after researching "the KM literature both in print and online" and visiting KM Europe for "two consecutive years," Mika and Akkermans (2004) only "found prototypes of ontology-based KM applications in the ontology literature, [and] very few of the KM sources even mentioned the use of ontologies." When ontologies were mentioned, they were termed "future KM technologies." In the opinion of Mika and Akkermans, "The relation between KM and technology is only superficially developed in the business-oriented side of KM" (p. 6). Holsapple and Joshi (2004) are in the process of remedying this situation by developing a high-level, general knowledge management ontology that "provides a unifying view of KM phenomena" that will help researchers, educators, and practitioners (p. 593) "to characterize KM technologies,…structure KM case studies, and…develop a KM model for competitive analysis" (p. 594). To provide a deeper understanding of just such an ontology, and to offer a general sense of the ontological aspect of IT in KM, this article defines the history, purpose, scope, and function of the term *ontology*.

Ontology has its origins in philosophy, and to this day informs a vital approach to philosophical inquiry. Philosophical ontology deals with metaphysical aspects of the nature of existence, touching upon the various meanings, relationships, and instances of the abstract, the concrete, the general, and the specific. It could be said that historically much of philosophy has been devoted to constructing a high-level ontology, an abstract model of reality, its primary constituents, their essential/accidental characteristics, and the various relationships that pertain among them.

Ontological philosophers often examine existence by delineating its parts categorically in accordance with an explicit theory. Aristotle's categories, syllogisms, definitions, and axioms, for example, form the basis of identifying, classifying, and theorizing about existence in just this way. So too have modern philosophers such as Kant, Peirce, Husserl, Whitehead, and Heidegger (Sowa, 2000, pp. 56-77) attempted to understand reality through categorization and logic. Much of their philosophical groundwork, in fact, forms the basis of *ontology* as it is presently understood in practical applications for computerized systems of information. Additionally, the mathematician and logician Stanislaw Lesniewski supplied a key component of the computerized sense of *ontology* when he used "an artificial formal language to represent his formal theory of parts (mereology)." He thereby "inaugurated philosophy's use of artificial languages and formal logic in expressing ontologies" (Mayhew & Siebert, 2004, pp. 1-2). Thus, the philosophical sense of the word *ontology*, with its long and rich history, forms much of the theoretical and logical base of the computer sense of the word. The relatively modern use of *ontology*, as applied to computerized information systems, appears first in 1967 in G.H. Mealy's "Another Look at Data," a paper dealing with "the foundations of data modeling" (Smith, 2004, p. 22).

Today's computerized ontologies attempt to capture some aspect of the explicit knowledge of a specific domain, such as medicine, accounting, finance, or engineering. With this knowledge, the ontology helps a computer agent or program function in some practical way to operationalize the key concepts made explicit and constrained by highly specified rules. An agent operating on the Semantic Web, for example, could theoretically consult various ontologies distributed on the Web to gather the meaning of key terms, assertions, processes, and actions that would allow the agent to shop for your dinner, buy your favorite wine, get the best price available for both, make sure that everything is delivered at a specified time, charge your credit card, and have your garage door open when you arrive home for dinner. Only an agent with a brain could perform all these activities. But computerized agents do not have brains. They have ontologies—ontologies to consult in carrying out your instructions for dinner. Computers cannot understand as humans do; but ontologies help to create the illusion that they can.

Within the last 40 years, *ontology* has become a central component in computerized information processing, especially in constructing large databases (sometimes termed knowledgebases). Ontologies have also figured predominantly in software application development, Artificial Intelligence initiatives, Web services, e-business, information and document retrieval, e-commerce, decision-support, medical informatics, the Semantic Web technologies, and, of course, in various IT applications of knowledge management. Within all these areas, the highly theoretical (philosophical) view of the term *ontology* undergirds the very pragmatic outcomes sought in computerized knowledge systems. Ontologies, formal and informal, will continue to be major functional elements in the design, maintenance, handling, and implementation of the large-scale information stores at the heart of knowledge management initiatives.

BACKGROUND: ONTOLOGY DEFINED

While never pretending to duplicate exactly the workings of the human imagination or experience, ontologies attempt to capture conceptually the rational building blocks of the mind by modeling our knowledge of reality. The whole purpose of this is to give the computer humanlike, albeit modest, thinking ability, by providing an explicit vocabulary for things, ideas, actions, relations, and approved behaviors. Ontologies with the expressive power that provides these capabilities are generally termed *formal ontologies*.

FORMAL ONTOLOGY

A formal ontology seeks to capture the essence of selected aspects of existence by stating explicitly and formulaically the concepts of the various constituents of the domain being modeled and the relationships that pertain among them. Ontologies are said to be "formal" or "formalized" when they are capable of being rendered into a computer programming language. Probably the single most famous definition of *ontology* is offered by Gruber (1993), who defines ontology simply as "an explicit specification of a conceptualization." Concepts, Gruber notes, are abstract, "simplified view[s] of the world" (p. 1) that become the models for the objects and ideas of some part of the world as we know it. Guarino and Giaretta (1995), emphasizing that purpose determines how these concepts are specified, note that an ontology can give only a "partial account of a conceptualization" (p. 7). Knowledge, after all, is in the mind of the beholder, and an ontology will necessarily represent only the point of view of the ontology builder. An ontology, in short, will never be omniscient nor all-encompassing.

What follows examines two inherent aspects of Gruber's classic ontology definition: *explicitly specified concepts* and the *relationships* among them.

Explicitly Specified Concepts

The concepts, which represent selected aspects of reality in a formal ontology, are variously termed *entities*, *objects*, or *elements*. Concepts can represent concrete entities (books, cameras, toads, clouds), abstract notions (fictional places, ideas, theories), beliefs, processes, tasks, goals, events, states, or methods—in short, anything that needs to be modeled in the knowledge domain (the universe of discourse). Entities can further be specified to make explicit some chosen characteristics or attributes, such as color, size, price, manufacturer, location, name, and the like. Ontologists thus work with *declarative representations*, also termed *declarative knowledge* or *declarative formalisms*, because they are using descriptive logic to represent symbolically a selected set of real-world objects and events in their abstract models or knowledge representations.

Ontologies formally express concepts, not just words. For example, the word "cell" in an ontology must clearly represent its concept; ambiguity is not allowed. To *disambiguate* "cell," a *polyseme* or word with multiple meanings, the ontologist needs to create an unequivocal nomenclature that reflects accurately the usage context and the purpose of the ontology. The nomenclature must also be formalized, that is, rendered to allow the ontology to be set into formal notations used in first-order predicate logic that can be translated into any suitable programming language. Thus, the various possible meanings of cell, from biological (AnimalCell, PlantCell), to jail (JailCell), to phone (CellPhone), to electronic engineering (BatteryCell), must be indicated overtly and succinctly in the nomenclature of the concept itself. In addition, the ontology should supply concept definitions in Natural Language sen-

Related Content

Coping With the Infodemic With Scientific Knowledge Management: A Case Study of COVID-19 Scientific Evidence Observatory
Jorge Biolchini, Eliane Azevedo Gomes, Elaine Cristina Ferreira Diasand Tatiana Figueiredo (2022). *Handbook of Research on Essential Information Approaches to Aiding Global Health in the One Health Context (pp. 14-35).*
www.irma-international.org/chapter/coping-with-the-infodemic-with-scientific-knowledge-management/293091

A Virtual Intelligent Creativity Matrix for Employees Clustered Interactivity Network with Knowledge Development Program
Iraj Mahdavi, Hamed Fazlollahtabar, Nezam Mahdavi-Amiri, Mohsen Arabmaghsudiand Mohammad Hassan Yahyanejad (2014). *International Journal of Knowledge-Based Organizations (pp. 65-79).*
www.irma-international.org/article/a-virtual-intelligent-creativity-matrix-for-employees-clustered-interactivity-network-with-knowledge-development-program/109591

Indigenous Digital Sovereignty: Data Cooperatives as the New Standard for an Inclusive Digital Economy?
Silvio Andrae (2025). *Revaluation and Preservation of Indigenous Knowledge Systems in Modern Society (pp. 425-446).*
www.irma-international.org/chapter/indigenous-digital-sovereignty/379120

Metaphor Use in Knowledge Management
Daniel Andriessen (2011). *Encyclopedia of Knowledge Management, Second Edition (pp. 1118-1124).*
www.irma-international.org/chapter/metaphor-use-knowledge-management/49058

Knowledge Management of Intangible Cultural Heritage in the New Media Era
Li Liu (2026). *International Journal of Knowledge Management (pp. 1-18).*
www.irma-international.org/article/knowledge-management-of-intangible-cultural-heritage-in-the-new-media-era/409311