IDEA GROUP PUBLISHING
701 E. Chocolate Avenue, Hershey PA 17033-1117, USA
Tel: 717/533-8845; Fax 717/533-8661; URL-http://www.idea-group.com
ITP4103

Tell Me What You Know Or I'll Tell You What You Know:

Skill Map Ontology For Information Technology Courseware

Witold Abramowicz, Marek Kowalkiewicz and Piotr Zawadzki
Department of Computer Science, The Poznan University of Economics, Poznan, Al. Niepodleglosci 10, 60-967, Poland
{W.Abramowicz, M.Kowalkiewicz, P.Zawadzki}@kie.ae.poznan.pl

ABSTRACT

This paper is a result of researches being conducted on creating knowledge exchange platform for corporate environment. The project's target is to integrate traditional eMarketplace with topic maps technology and to introduce new technology – Skill Maps – for representing individual employee's knowledge. There is a need to create common ontology for Topic Maps and Skill Maps in order to coherently represent knowledge and knowledge profiles. Therefore, this project focuses on describing Topic Maps, introducing Skill Maps and proposing ontology for both of them.

TOPIC MAPS - INTRODUCTION

Topic Maps is an ISO standard, which has been established as an answer to the problem of coherent representation of relations between topics (or ideas) and associating those topics with actual documents (topic occurrences). It is based on concepts and relations, as in conceptual graphs. Primarily, the standard was established in order to provide means for uniform document index representation, but soon it turned out, that Topic Maps can be used in clustering document repositories.

Among many potential Topic Maps applications, the ISO specification enumerates the following:

- Qualifying the content and/or data contained in information objects as topics to enable navigational tools such as indexes, cross-references, citation systems, or glossaries.
- Linking topics together in such a way as to enable navigation between them. This capability can be used for virtual document assembly, and for creating thesaurus-like interfaces to corpora, knowledge bases, etc.
- Filtering information set to create views adapted to specific users or purposes. For example, such filtering can aid in the management of multilingual documents, management of access modes depending on security criteria, delivery of partial views depending on user profiles and/or knowledge domains, etc.
- Structuring unstructured information objects or facilitating the creation of topic-oriented user interfaces that provide the effect of merging unstructured information bases with structured ones. The overlay mechanism of topic maps can be considered as a kind of external markup mechanism, in the sense that an arbitrary structure is imposed on the information without altering its original form. [8]

Topics, associations and occurrences are main Topic Maps components. Using those elements, you can create maps in document repositories. Below, we briefly describe those main components:

- Topics – the term topic refers to the element in the topic map that represents the subject being referred to. Topics can be categorized. They can have zero or more topic types. Topics can also have names. The standard names for topics are: base name, display name and sort name. Each topic can have facets – elements for storing additional information, for example topic profiles. [1], [9]
- Associations – a topic association is a link element, showing relationships between topics. Association can have types (influenced by, required by, written in etc.) and roles (influencer, influenced; prerequisite, result; document, language). [1], [9]
- Occurrences – occurrences link topics to one or more relevant information resources. An occurrence can be anything, most often it is URL, or document (article, picture, video etc.). Occurrences can have roles and role types (web based training, computer based training, MS Word document, flash animation, knowledge base etc.). [1], [9].

SKILL MAPS

Topic Maps technology is an advanced solution of the problem of structuring, storing and representing knowledge within corporation. However, Topic Maps seem to provide too much limited instruments if we need to represent knowledge of each employee within corporation, or if we need to provide those employees with mechanisms enhancing searching in knowledge repositories that can take into consideration state of employee's knowledge and skills, while conducting searches. It turns out, that in order to make mentioned problems feasible, we need to extend Topic Maps technology, by creating new structures for storing information about employees, their knowledge and skills. Our proposed name for those new structures is Skill Maps.

The Skill Map is created by copying specified Topic Map objects and adding individual modifications. The two-tiered Topic Maps architecture is enhanced by adding the third, upper tier. In order to specify, which Topic Map objects are to be copied into Skill Map, we have divided Topic Map objects into two groups: abstract objects and non-abstract objects.

Non-abstract objects are those directly related to representation of state of employee's knowledge, such as topics pointing at courseware (topics of courseware type), or associations representing relations among pieces of courseware.

Abstract objects, on the other hand, store additional information, which is helpful when navigating and retrieving data from Topic Map. An example of abstract objects could be document author, relations between documents and their categories, etc. Those objects are not required in order to represent employee's knowledge, and as such are not stored in Skill Map.

Modifications stored in Skill Map represent the following facts:

- Knowledge resources accessed by an employee
- Level of skills in individual topics
- Employee's interest in topic

Moreover, employees can enter modifications on their own. They can modify topic associations. For example, employee's can remove unneeded associations, they can create new ones. Due to that, Skill Maps provide users with means of catalogue personalization. Those modifications can also be used in order to maintain Topic Map associations (for example locate invalid associations or introduce new ones)

Data stored in Skill Maps is virtually unusable without access to the lower tier – Topic Map. Because of the fact, that we store only non-abstract objects modifications and additional information, in order to generate Skill Map, we need to retrieve non-abstract objects from the

This paper appears in *Issues and Trends of Information Technology Management in Contemporary Organizations,* the proceedings of the Information Resources Management Association International Conference. Copyright © 2002, Idea Group Inc.

Topic Map. After retrieving non abstract objects, applying modifications and introducing additional information, the Skill Map is prepared.

We propose storing one Skill Map for each employee. However, it is possible to create and store Skill Maps for workgroups, if such option turns out to be more effective in specific situations.

In our model, we propose terminology, which is based on Topic Maps terminology. For example: Skill Map's objects are named: Skills, Skill Associations, Skill Facets, and Skill Scopes. The Skill Occurrence term is equal to Occurrence in Topic Map (while those two objects point at the same document).

We propose using Skill Maps only for user's knowledge analyses and determining document's relevance. If there is a need to use Skill Maps for catalogue representation, or navigating knowledge resources, we propose using SMTM (Skill Map + abstract Topic Map).

SMTM is a product of merging Skill Map with selected objects taken from Topic Map. The selected objects are abstract ones – the objects omitted when creating the Skill Map. By generating such structure, we construct a coherent map, which afterwards can be used for navigating and personalizing stored knowledge.

FORMALIZATION NEEDS

Ontologies are a concept taken from the Artificial Intelligence, and provide definitions for the vocabulary used to represent knowledge in a given domain. Ontology formalizes the semantics of objects and relations in a universe of discourse and provides a set of terms which can be used to talk about these objects and relations.

In this article we want to propose sample ontology for structuring the information technology courseware.

Developing such unified ontology is part of the project dedicated to creating The Knowledge eMarketplace for Courseware Distribution held at The Department of Computer Science of The Poznan University of Economics. The main goal of this project is the integration of existing implementation solutions, dedicated to electronic markets with knowledge representation techniques such as Topic Maps. Additional equipping the platform with enhanced functionality is also taken into consideration as further part of the work.

Knowledge eMarketplace as a platform for Courseware Distribution employs eMarketplace's build-in mechanisms.

This ontology serves as a framework for structuring information technology knowledge based on Topic Map solution. Equipped with the taxonomic formalism designed for these structures we enhanced our system with properties for future merging processes. Topic Map for IT courseware will be able to incorporate the suppliers' structures of their learning materials.

Automating the process of merging new learning units into existing structure of associations will allow us to avoid the misclassification errors.

In case of situation that our supplier uses his own ontology, we propose the process of mapping any inconsistencies in these structures, which is possible through one of the standard functions of DAML+OIL language.

Such process is an additional functionality and improvement of distributing the courseware either within organization (corporate version of the platform) or through the Internet (community version) [4]

ONTOLOGY GUIDELINES

Ontology is an explicit specification of a conceptualization. The term is borrowed from philosophy, where Ontology is a systematic account of Existence. For AI systems, what "exists" is that which can be represented. When the knowledge of a domain is represented in a declarative formalism, the set of objects that can be represented is called the universe of discourse. This set of objects, and the describable relationships among them, are reflected in the representational vocabulary with which a knowledge-based program represents knowledge. Thus, in the context of AI, we can describe the ontology of a program by defining a set of representational terms. In such ontology, definitions associate the names of entities in the universe of discourse (e.g., classes, relations, functions, or other objects) [5] with human-readable text describing what the names mean, and formal axioms that constrain the interpretation and well-formed use of these terms. Formally, ontology is the statement of a logical theory.

Metadata schemas and ontologies are very closely related; it could be said that the former are a special case of the latter (the knowledge representation languages used to express ontologies often being more expressive than the data models underlying common metadata schemas).

One of the most general taxonomy for the process of describing knowledge is based on the universe of discourse which ontology applies to:

- Top-level ontologies - describe very general concepts like space, time, matter, object, event, action, etc., which are independent from a particular problem or domain: it seems therefore reasonable, at least in theory, to have unified top-level ontologies for large communities of users. [2], [11]
- Domain-specific ontologies and task ontologies - describe, respectively, the vocabulary related to a generic domain (like medicine, or automobiles) or a generic task or activity (like diagnosing or selling), by specializing the terms introduced in the top-level ontology, i.e. ontology for information systems. [6]
- Application-specific ontologies - describe concepts depending both on a particular domain and task, which are often specializations of both of the related ontologies. These concepts often correspond to roles played by domain entities while performing a certain activity, like replaceable unit or spare component. [6]

There are many domain-independent methodological approaches to design criteria in ontological development process as well as evaluation steps for verification of well-constructed structures.

Taking into consideration that until now there is no unified format for building ontologies, the situation in this area is going worse. One of the approaches that are worth mentioning here are Gruber's five design criteria. [5]

Design criteria:

- Clarity: Ontology should effectively communicate the intended meaning of concept which might arise from social situations or computational requirements, the definition should be independent from social or computational context. All definitions should be documented with natural language.
- Coherence: It should sanction inferences that are consistent with the definitions. At the least, the defining axioms should be logically consistent. Coherence should also apply to the concepts that are defined informally, such as those described in natural language documentation and examples.
- Extendibility: Ontology should be designed to anticipate the uses of the shared vocabulary. It should offer a conceptual foundation for a range of anticipated tasks. It should be able to define new terms for special uses based on the existing vocabulary, in a way that does not require the revision of the existing definitions.
- Minimal encoding bias: The conceptualization should be specified at the knowledge level without depending on a particular symbol-level encoding. An encoding bias results when representation choices are made purely for the convenience of notation or implementation.
- Minimal ontological commitment: Ontology should require the minimal ontological commitment sufficient to support the intended knowledge sharing activities. Ontology should make as few claims as possible about the world being modelled. Ontological commitment can be minimized by specifying the weakest theory (allowing the most models) and defining only those terms that are essential to the communication of knowledge consistent with that theory.

The evaluation methods and criteria (consistency, completeness, conciseness, expandability and sensitiveness) used to evaluate ontologies proposed by Gómez-Pérez is the second approach earlier mentioned. He also addresses the possible types of errors made when domain knowledge is structured in taxonomies in ontology (circularity errors, exhaustive and non-exhaustive class partition errors, redundancy errors and incompleteness errors). [7]

Copyright Idea Group Inc.

COURSEWARE ONTOLOGY PROPOSAL

The need to create courseware ontology occurred during researches we conduct. Researches focus on merging eMarketplace technology with knowledge management and state-of-the-art distance learning techniques. We intend to create eMarketplace for learning organizations, where employees will be able to access courseware materials and self improve themselves without need to leave work. As opposed to existing corporate knowledge management technologies, which enable managing knowledge base systems, using the so called corporate memory systems (storing expert knowledge, how-to documents), our system will have to not only provide described functionalities, but furthermore it will have to provide modules for employees' knowledge management and improvement.

Table 1: Proposed topic types

Topic type	Sample Base name	Sample Display name
	Abstract	
company	company_510	Brainbuzz Inc.
author	author_115	John F. Smith
date	date_10	2001-10-04 16:08GMT
theme	theme_19	Novell
product_name	product_name_155	NetWare 6
courseware_type	courseware_type_5	Web Based Training
language	Language_3	English
	Non-abstract	
courseware	courseware_1241	SCO 241: Administration 1: User Services

The proposed system is based on eMarketplace platform in order to be able to employ its mechanisms for knowledge exchange. Additionally, we presume that the organization will acquire knowledge from unstructured sources into document repositories. This mechanism is also supported by eMarketplace platform.

The proposed ontology for describing courseware in Topic Maps includes types and values of topic and association objects, which we consider to be the most important ones in our solution.

Table 2: Proposed associations

Association type	Association Role 1	Association Role 2
	Abstract	
courseware_author	courseware	author
courseware_vendor	courseware	company
courseware_date	courseware	date
courseware_theme	courseware	theme
courseware_product_name	courseware	product_name
courseware_type	courseware	courseware_type
courseware_language	courseware	language
	Non-abstract	
courseware_prerequisite	courseware	courseware
courseware_successor	courseware	courseware
courseware_related	courseware	courseware

As written above, we divide Topic Map objects into abstract and non-abstract ones. Non-abstract elements are required for further users' (employees') knowledge representation; abstract ones provide additional information in maps.

The proposed topic types store specific data:

- *company* – courseware vendor's name
- *author* – courseware author's name (if applicable)
- *date* – creation date (can also be a simple string value)
- *theme* – theme, the courseware applies to (i.e. VPN technologies)
- *product_name* – product, the courseware applies to
- *courseware_type* – teaching technology (WBT, CBT, manual etc.)
- *language* – courseware's language
- *courseware* – courseware name (non-abstract topic)

The proposed associations link *courseware* topic with abstract topics as well as with other *courseware* (non-abstract) topics.

Lack of standardization mentioned above forced us to choose a tool for building ontology from the wide range being developed. It seems that one of the most powerful tools is DAML+OIL therefore we opt for incorporating it into our knowledge representation solution.

- KIF – Knowledge Interchange Format is a computer-oriented language for the interchange of knowledge among disparate programs. It has declarative semantics (i.e. the meaning of expressions in the representation can be understood without appeal to an interpreter for manipulating those expressions); it is logically comprehensive (i.e. it provides for the expression of arbitrary sentences in the first-order predicate calculus); it provides for the representation of knowledge about knowledge. [13]
- XOL – Ontology Exchange Language was designed in response to a study of ontology languages performed by the BioOntology Core Group. [12]
- SHOE – The Simple HTML Ontology Extensions. SHOE was developed at the University of Maryland by members of Professor Hendler's research group. [14]
- OML was originally intended to be subservient to the more inclusive CKML (Conceptual Knowledge Markup Language) and to CKP (Conceptual Knowledge Processing). The earlier versions of OML were basically a translation to XML of the SHOE formalism, with suitable changes and improvements. [17]
- DAML stands for the DARPA Agent Markup Language, which is a project being funded by the US Defense Advanced Research Projects Agency. [15]
- OIL stands for the Ontology Interchange Language and has developed by a number of researchers, primarily a group funded by the European Union's Information Society Technologies Program. [16]
- SHOE, DAML, OIL research groups, working together as a committee, created a new language with the best features of their products and several other markup approaches. At the time of this writing, DAML+OIL is the most advanced web ontology language, and it is expected to provide the basis for future web standards for ontologies. DAML+OIL language is being developed as an extension to XML and the Resource Description Framework (RDF). The latest release provides a rich set of constructs with which to create ontologies and to markup information so that it is machine readable and understandable.

PROPOSED ONTOLOGY FOR SKILL MAPS

The ontology proposed for representing courseware in Topic Maps, can be easily employed in Skill Maps, after a few modifications. Skill Maps is an extension of Topic Maps, and as such it has a few more features.

Table 3: Association types, attribute type and values

Association type	Attribute type	Attribute values
courseware_prerequisite	state	unchanged (default), removed, added
courseware_successor	state	unchanged (default), removed, added
courseware_related	state	unchanged (default), removed, added

Copyright Idea Group Inc.

Table 4: Attribute values for each attribute type

Topic type	Attribute type	Attribute values
courseware	done	{0;1}
courseware	passed	<0,1>
courseware	estimated_interest	<0,1>

Because of the fact, that Skill Map is created by copying and modifying Topic Maps, we do not propose any new topic or association types. At the time of writing this document, we have worked out, that we need to add attributes to topics and associations in order to properly represent state of user's knowledge.

Topic Map standard does not propose any attributes that can be added to associations. In Skill Maps, we propose adding one attribute for each non abstract association (skill association).

Attribute type state stores information about changes the user entered in his/her Skill Map. Unchanged is the default value for state attribute, when creating the map. The other attributes can occur either when removing associations (removed replaces unchanged) or when adding new association (added).

We also propose adding three attributes for each skill.

Attribute type done stores information about user's activity. Namely it can say if the Skill Map owner has used the courseware or not. It can have one of two values: 0 (meaning that the user did not use the courseware) and 1 (meaning that the user used the courseware).

Attribute type passed stores information about evaluated user's knowledge. After doing the courseware, the user can attend tests, which will then provide Skill Map with test results. It can have values between 0 and 1, where 0 is the lowest grade and 1 is the highest one.

Attribute type estimated_interest stores information about interest courseware's importance for the user. We estimate this value dynamically, by analyzing user's behavior. 0 means the lowest interest, 1 the highest.

REFERENCES

[1] W. Abramowicz, M. Kowalkiewicz, T. Schmale, P. Zawadzki "Corporate knowledge vs. Knowledge within corporation", Publication for Network Learning Conference in Berlin, 2002

[2] A. Gangemi, N. Guarino, C. Masolo, A. Oltramari "Understanding top-level ontological distinctions", proc. IJCAI 2001 workshop on Ontologies and Information Sharing, 2001

[3] G. Ove Grønmo "Creating semantically valid topic maps", proc. XML Europe Conference, Paris, 2000

[4] T.R. Gruber "A Translation Approach to Portable Ontology Specifications" in Knowledge Acquisition, Stanford University, Knowledge Systems Laboratory, 1993

[5] T.R Gruber "Toward Principles for the Design of Ontologies Used for Knowledge Sharing", International Workshop on Formal Ontology, Padova, Italy, 1993

[6] N. Guarino "Formal Ontology and Information Systems", Proceedings of FOIS'98, Trento, Italy, 1998

[7] A. Gómez-Pérez "Evaluation of Taxonomic Knowledge in Ontologies and Knowledge Bases", proc. of the Knowledge Acquisition Workshop, KAW99, 1999

[8] International Organization for Standardization, ISO/IEC 13250, "Information technology – SGML Applications – Topic Maps", Geneva, 2000

[9] R. Ksiezyk "Answer is just a question [of matching Topic Maps]", proc. XML Europe Conference, Paris, 2000

[10] S. Pepper "The TAO of Topic Maps, finding the way in the age of infoglut", proc. XML Europe Conference, Paris, 2000

[11] J.F. Sowa "Knowledge Representation: Logical, Philosophical, and Computational Foundations", Brooks Cole Publishing Co., Pacific Grove, CA, 2000, ISBN 0-534-94965-7

[12] An XML-Based Ontology Exchange Language at: http://www.ai.sri.com/~pkarp/xol/xol.html

[13] Knowledge Interchange Format at: http://logic.stanford.edu/kif/dpans.html

[14] The Simple HTML Ontology Extensions at: http://www.cs.umd.edu/projects/plus/SHOE/

[15] The DARPA Agent Markup Language at: http://www.daml.org/

[16] The Ontology Interchange Language at: http://www.ontoknowledge.org/oil/

[17] The Ontology Markup Language at: http://www.ontologos.org/OML/OML.html

Copyright Idea Group Inc.
Copyright Idea Group Inc.
Copyright Idea Group Inc.
Copyright Idea Group Inc.

0 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:
www.igi-global.com/proceeding-paper/tell-you-know-tell-you/31702

Related Content

The Fundamentals of Human-Computer Interaction
Kijpokin Kasemsap (2018). *Encyclopedia of Information Science and Technology, Fourth Edition (pp. 4199-4209).*
www.irma-international.org/chapter/the-fundamentals-of-human-computer-interaction/184127

A Service Oriented Architecture for Coordination in Collaborative Environments
Beatriz Jiménez Valverde, Miguel Sánchez Román, Francisco L. Gutiérrez Velaand Patricia Paderewski Rodríguez (2011). *International Journal of Information Technologies and Systems Approach (pp. 79-92).*
www.irma-international.org/article/service-oriented-architecture-coordination-collaborative/51370

An Artificial Intelligent Centered Object Inspection System Using Crucial Images
Santosh Kumar Sahooand B. B. Choudhury (2018). *International Journal of Rough Sets and Data Analysis (pp. 44-57).*
www.irma-international.org/article/an-artificial-intelligent-centered-object-inspection-system-using-crucial-images/190890

Digital Media and New Forms of Journalism
Lambrini Papadopoulouand Theodora A. Maniou (2021). *Encyclopedia of Information Science and Technology, Fifth Edition (pp. 1130-1139).*
www.irma-international.org/chapter/digital-media-and-new-forms-of-journalism/260255

Using ICTs to Check Plagiarism in PhD Research Works in Nigeria: Prospects and Challenges
Floribert Patrick C. Endong (2019). *Enhancing the Role of ICT in Doctoral Research Processes (pp. 24-45).*
www.irma-international.org/chapter/using-icts-to-check-plagiarism-in-phd-research-works-in-nigeria/219930