TM4L: Creating and Browsing Educational Topic Maps

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Abstract. In this article we describe TM4L - an environment for building, maintaining, and using standards-based, ontology-aware e-learning repositories. It is based on the idea that concept-driven access to learning material implemented as a Topic Map can bridge the gap between a learner and targeted knowledge. One of the driving goals of this work is to increase the reusability of available educational resources by enabling the use of a developed subject ontology with courses on the same subject with different stricture. Another goal of TM4L is to support an efficient context-based retrieval of learning content tailored to the needs of a learner working on an educational task. The paper focuses on three aspects of the TM4L environment: domain modeling, editing capabilities and the interface for exploring the learning collection. The key features of the TM4L functionality are illustrated with some examples.

Keywords: e-learning repositories, digital libraries, semantic web, ontologies, topic maps, XTM

Introduction

Information seeking is the process through which individuals seek to find information in order to clarify or confirm knowledge about a specific topic. In this paper we focus on information seeking as *goal-driven behavior*, the goal being the resolution of a problem resulting from a particular task. Therefore, the goal of information seeking is seen as being achieved by locating relevant or useful information. Our interest in information seeking is related to task-performing information support in e-learning, that is, support for a learner's exploration of a topic of interest in order to solve an educational task. In this context information seeking is an activity that originates from a task generating an information need and entailing some form of strategy (Garcia, E. and Sicilia, MA 2003) including *how* and *where.*

Task-performing information support on the web is not always an easy and straightforward process. Much of the retrieved information is inaccurate, biased, out-of-date, or just not thorough enough. One major challenge for learners is to filter out irrelevant documents from the search engine results. For example, if we try Google with the keywords "Prolog" and "lists" it responds with about 300,000 hits. Moreover, a large part of the references provided in the first few pages are introductory notes on Prolog lists. Many of the listed pages are simply different parts or versions of the same site. There are high quality teaching resources on Prolog Lists but they are buried somewhere in the pile of the 300,000 web pages. What we need is technology, which allows learners to find information about a particular subject rather than retrieving documents, which satisfy a given query. For example, a learner may be interested in courses dealing with Object-Oriented Programming rather than in courses where the term "Java" or "C++" is stated.

Another complication with the query-based search is that normally students have no precise idea of what they can find in a learning collection. In that context, they have difficulties to decide which terms to use to describe their information need in order to find out the information they are looking for. Many query modifications may be necessary to achieve their goal. Typically students have not sufficient skills to reformulate in an efficient way their queries.

Ontology-based information seeking is a promising approach to enhance the existing search practice with features enabling users to better express their information needs or to improve their exploratory style (Aussenac-Gilles and Mothe, 2004). This involves users' interaction with concepts and relations embodied in ontologies in a dialogue that can be interpreted as a query or used to suggest paths leading to casual encounters. Finding a common ontology for the entire web is next to impossible, but if we focus on a particular domain, we can specify concepts and relations providing ground for knowledge sharing.

Our work in task-performing information support involves groups of users, with possibly different degree of utilization of the information, depending on their goals and background. Our typical users are university students or corporate trainees. Another group of users includes instructors (authors of learning material) who need to have access to all views on the learning collection along with the possibility of modifying its structural and ontological characteristics.

In this paper we propose a concept-driven access to learning repositories implemented as Topic Maps with the goal of bridging the gap between the learner and the knowledge domain. By using knowledge standards, such as Topic Maps (TM) (Park and Hunting, 2002), it is possible to incorporate learning content in semantically rich data models. The expressive power of Topic Maps, commonly perceived as a method for indexing information resources, places the standard very close to Artificial Intelligence and knowledge modeling. Topic Maps resemble semantic networks and conceptual graphs but offer more - a unique, standards-based way of encoding and exchanging knowledge on the Web. Topic Maps provide an external meta-structure (a knowledge navigation layer) in form of a dynamic, semantically based hypertext. As a result, TM-based courseware can offer the following benefits (Dichev, Dicheva and Aroyo, 2004):

- *For learners:* efficient context-based retrieval of learning resources; better awareness in subject-domain browsing; information visualization; customized views, personalized guidance, and context-based feedback.
- *For instructors:* effective management and maintenance of knowledge and information; personalized courseware presentations; distributed courseware development; reuse, sharing and exchange of learning materials, collaborative authoring.

Currently available commercial TM software is mainly aimed at supporting rapid development of TM-based applications (e.g. Ontopia Knowledge Suite [URL: Ontopia], Mondeca Intelligent Topic Manager [URL: Mondeca], etc.). There are some available TM authoring tools but they are either too general (not suitable for end users), such as Atop [URL: ATop] or designed for a very specific educational task, such as BrainBank (Lavik and Nordeng, 2004), Cyrille [URL: Ceryle], etc. We are not aware of existing general education-oriented TM tools that can be used to facilitate the creation, maintenance, search, and visualization of Topic Maps-based learning resources. This was our motivation for designing a general framework for ontology-aware digital course libraries and using it to develop TM4L - a specialized environment for creating, maintaining, and using TM-based learning repositories. In this article we discuss briefly the framework and present the authoring environment TM4L (Topic Maps for e-Learning).

A Framework for TM-based Learning Repositories

The proposed framework is aimed at supporting the development of *ontology-aware* repositories of learning materials. It is focused on enabling authors to capture, share and access knowledge. Subject ontologies aim at capturing domain knowledge in a generic way, and provide a commonly agreed upon representation vocabulary of a subject domain, which may be shared and reused across people and applications. An important issue within ontology editing is the underlying ontology model or "structure" that is to be edited. In our framework for developing repositories of learning resources it is a network of concepts. This involves creating views of a specific domain in terms of domain concepts and relationships among them that suggest the semantics of the resources relevant to that domain. Such a conceptual structure would enhance information seeking within the repository since the set of concepts, relationships, and inference rules defined by the domain ontology constrain the possible interpretations.

Thus the proposed general framework of ontology-aware discipline-specific repositories is based on building a domain conceptual structure and using it for structuring and classification of learning content. The classification involves linking learning objects (content) to the relevant ontology terms (concepts), i.e. using the ontological structure to *index* the repository content. An assumed and implicit purpose of the conceptual exploration is that some form of learning will occur. By browsing the map, the learner will gain insight into the domain. Moreover, understanding the relationships between the resources will insure efficient topical access to them.

By providing shared agreement on the subjects meaning, ontologies can serve as a means of establishing a conceptually concise basis for communicating knowledge for many purposes, for example, in ontology-based merging of digital repositories. The proposed framework utilizes the advantages of concept-based and standards-based content organization to benefit both learners and instructors (authors). For learners it supports efficient contextual information seeking relevant to their needs and for authors - reusability, shareability, and exchangeability of created instructional materials.

We have proposed a layered information structure of the learning material repository consisting of three layers, each of which captures a different aspect of the repository information space (conceptual, resource-related, and contextual):

- *Semantic layer*: contains a conceptual model of the knowledge domain in terms of *key concepts* and *relationships* among them.
- *Resource layer*: contains a collection of diverse information resources associated with the specific knowledge domain.
- *Context layer*: contains specifications of different views (contexts) on the repository resources depending on a particular goal, type of users, etc., by dynamically associating components from the other two layers.

We want to provide the learner with access methods that go beyond the scan of a long list of resources. In our model, a user's access to the learning collection is mediated by a multi-layered browsable conceptual map of the subject domain. Strictly speaking, the access to the learning collection is mediated by a set of browsable maps corresponding to the set of contexts or perspectives defined on the learning collection. Exploiting the map metaphor, the set of contexts or perspectives on a learning collection are analogous to the different types of maps used in practice, eg, physical maps, political maps, economic maps, climate maps, population maps, etc.

The developed framework for ontology-aware learning repositories is described in detail in (Dicheva and Dichev, 2004a). This general framework requires using Semantic Web technologies that support efficient organization, retrieval, and interchange of information on the Web. We have chosen the ISO XTM (XML Topic Maps) standard [URL: XTM] to implement the developed framework. In the next sections we discuss our implementation - the Topic Maps-based authoring environment TM4L.

Topic Maps for e-Learning (TM4L)

The underlying structure of concept-based learning resources normally can not be derived from a particular textbook or course syllabus. Besides the fact that textbooks and courses are frequently changed, their structures are often founded on improper categorization. The structures are sometimes based on non-fundamental concepts instead of being derived from deeper principles. There are often inconsistencies of categorization and as a result the learning resources are ill structured from the viewpoint of reusability. If we aim at reusable model it should be founded on a more stable structure.

The lack of a shared understanding and consistency in using conceptual structures on a textbook and course level might be compensated by using domain ontologies. From this viewpoint we conceive a domain ontology as a conceptual reference system, with a collection of concepts, relations between concepts and classification hierarchies. The resulting conceptual schema could serve as an aid for integrating related resources from different repositories.

However, there are challenges involved in the domain ontology development process: it can be difficult and costly (Shirky, 2005). Arriving at a representation of a domain requires deep knowledge of that domain, which allows identifying its boundaries, selecting which concepts to define and at what level of detail, and deciding how these concepts should be related. Further, concepts should account for multiple perspectives depending on the context in which the ontology is being used. All these assume tools that can support a sufficient range of operations in the ontology development process, such as ontology design, implementation, browsing and merging of ontologies, searching for resources, multiple perspectives, etc.

One way to minimize the cost of concept-based repository development is to make the created ontologies reusable. Fortunately, the domain ontology component whose development is costly is more stable (in comparison to resources) and therefore reusable. Ideally a classification should be objective in that the criteria used to classify are not subject to the whim of the person doing the classifying. Classification based on a domain ontology satisfies these criteria. The fact that 'Imperative Languages' is a subclass of 'Programming Languages' and that 'C' is an instance of 'Imperative languages', is independent of human judgment or interpretation. This fact suggests reuse not only of learning objects but also of domain knowledge and instructional knowledge.

Thus our goal was to develop an authoring environment in view of two additional considerations: conformance to the Topic Maps standard, coupled with facilitating the task of learning content authoring. Taking into account these considerations, we designed an environment, TM4L, which enables the creation, maintenance, and use of ontology-aware learning repositories based on Topic Maps. Ontologies and Topic Maps are complementary technologies that aim at giving a more global vision than terminologies, thesauri and concepts systems. While ontologies provide semantic interoperability, the Topic Maps specification ensures syntactic interoperability.

The authoring environment TM4L provides support in conceptual structure design and maintenance through its functionality for editing, browsing, and combining such structures, coupled with support for relating concepts, linking concepts to resources, merging ontologies, external searching for resources, defining perspectives, etc. The TM4L front end is a user-friendly interface, which helps/guide the users to easily create and update topics (concepts) and their relations and related resources. The back end is based on TM4J [URL: TM4J] **–** an open source Java-based Topic Map API for creating, editing and deploying Topic Maps. The TM4L environment consists of a TM Editor and a TM Viewer.

The TM4L Editor

The TM4L Editor is an ontology editor allowing the user to build ontology-driven learning repositories using Topic Maps. It provides ontology and metadata engineering capabilities coupled with basic document management facilities. The TM4L Editor benefits from the Topic Maps' fundamental feature to support easy and effective merge of existing information resources while maintaining their meaningful structure. This allows for flexibility and expediency in re-using and extending existing repositories (Dicheva, Dichev, Sun and Nao, 2004). The learning content created by the Editor is fully compliant with the XML Topic Maps (XTM) standard and thus interchangeable and interoperable with any standard XTM tools.

The TM4L Editor is Topic Maps-based, thus the main objects that it manipulates are topics (representing domain ontology concepts), relationships between them, resources, and contexts (represented by themes). It includes four different sections (views): *Topic Map*, *Topics*, *Relationships*, and *Themes*. The user interface uses the Tab metaphor; each tab is associated with a different view on the Topic Map: Topics, Relationships and Themes view. Screenshots from the TM4L Editor interface (the Topics and Relationship sections) is shown on Fig. 1.

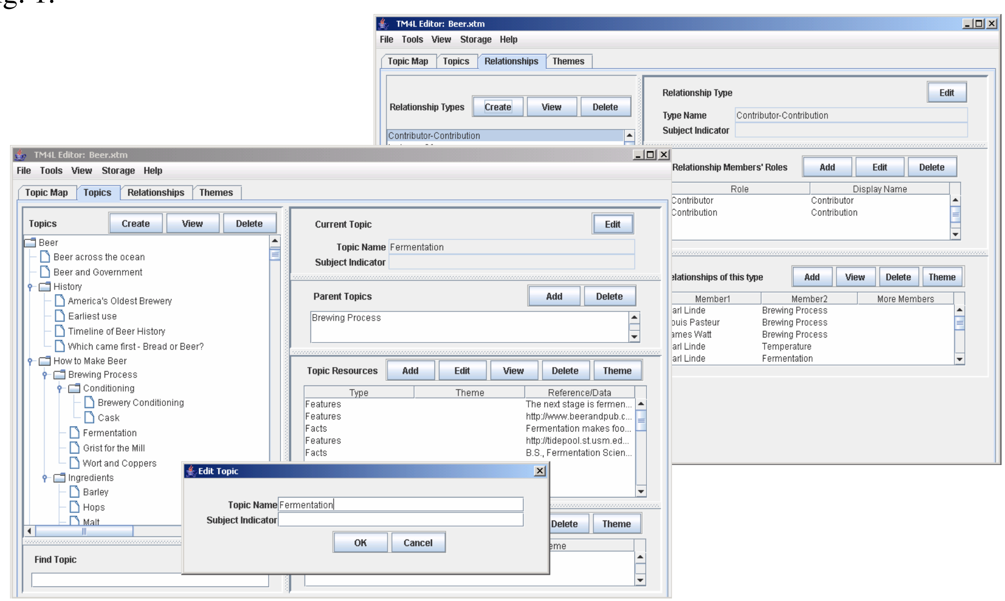

Figure 1. Screenshots from the TM4L Editor interface: Topics and Relationship sections.

Topic Map

In the Topic Map section the author defines metadata (Dublin Core [URL: Dublin Core] and LOM [URL: LOM] compliant) for the newly created Topic Map. This includes: TM Title, Creator, Subject / Main Topic (keywords), Description, Publisher, Contributor, Creation Date, Last Modification Date, Language, Location, Source, Relation, Coverage, IPR / Copyright. Additionally, a Topic Map Subject Indicator is specified. Some LOM tags are automatically included in the TM metadata with pre-specified values, e.g. LOM 4.1 Resource Format ("text/html"), LOM: 5.1 Interactivity Type ("expositive document"), LOM: 5.3 Interactivity Level ("high"), etc.

Topics

In the Topics section the author defines, edits, and deletes topics. Each topic definition includes the following information: *subject indicator*, *names*, *types*, and related *resources*. For each new topic an ID is automatically generated.

Topic categories. Our major concern in designing the Topic Maps Editor was related to the fact that in the TM standard every subject is a topic, which is a powerful idea but will not make much sense to the uninitiated authors. Three different kinds of topics are expected to be used in an educational Topic Map: 'concept' topics needed to build the ontological representation of the specific subject domain, 'utility' topics needed as meta-data fillers in the Topic Map, for example, to specify the different types of educational resources, and 'system' topics needed to represent association types, roles in associations, and other entities required by the TM model. In TM4L we combine the utility and system topics and support two distinct categories of topics: *domain ontology topics* and *utility topics*. The former are defined by the user and listed in the Topics section; the latter are automatically defined by the editor, eg, when a specific authoring activity (such as defining a new relationship type) takes place and are not normally listed in the Topics section. We use the following utility topics categories: association types, association role types, occurrence types, name use types, and themes (for scoping). The category of a topic depends on where it was created by the user, for example, if it was created as a result of user input in the 'Create Relationship Type' dialog, it is an association type.

Topic names. TM4L allows multiple topic names: one *primary* and possibly some *alternative* names. Each name can have alternate names (TM name variants) to be used for special purposes. In this application we have constrained the number of alternate names to four, corresponding to four different purposes of usage of the name: *sort, search, display,* and *draw*.

Topic Types. In compliance with the XTM standard, multiple topic types are allowed. The user is given two ways to declare a topic type (or *parent topic*): either automatically by selecting an existing topic prior to the creation of the new topic, or manually by adding a parent in the 'Parent Topic Panel'.

Resources. Resources can be internal and external. Internal resources are short pieces of information about a concept, such as definition, short description, some characterizations, etc., stored locally in the Topic Map. External resources can be any addressable learning objects on the Web referenced by their URI. For authors' convenience, some resource types are pre-defined however the author is allowed to define their own types. We have predefined the LOM 5.2. Learning Resource Types: exercise, simulation, questionnaire, diagram, figure, graph, index, slide, table, narrative text, exam, experiment, problem statement, self assessment, and lecture. In addition, we have predefined types of learning resources relevant to characterizing subject domain concepts: definition, description, example, and graphical representation.

Relationships

Relationships in our model are represented by Topic Map associations. Each relationship has a *type* (eg, 'is-component-of') and one or more *members* (concrete topics) along with the *roles* they play in the relationship. There is a pool of pre-defined relationship types (such as 'class-subclass') that the authors can use. In the Relationships section of the Editor the author can define relationship types and roles, create relationships by specifying their types, roles, and role players, and edit and delete relationships. When defining relationships the author selects all involved entities – relationship type, members, and roles, from presented lists, so that input errors are minimized. The scope (context) within which the assertion made by a relationship is valid can be defined in the Theme section. If none such is present, the scope is unconstrained and the relation is always valid.

Instead of adopting a single "perspective" on classes of concepts, our model includes three basic concept hierarchies. In this way we are able to create more expressive conceptual structures that include various classifications of certain concepts. For example, operators can be classified by *arity* (unary, binary, and so on) or by type (arithmetic operator, Boolean operator, String operator, and so on); Prolog facts can be classified as "part-of" the basic Prolog constructs (along with queries, rules etc.) or as "sub-class" of Prolog rules, etc. By enabling different perspectives, we can model different classifications of topics at the same time.

Contexts (Views)

We conceive the notion of context as derived from two principles: *the principle of grouping* and *the principle of locality*. According to the first principle the context is a notion related to grouping. Grouping can be based on different assumptions. In everyday practice we apply different grouping rules and different grouping schemas. We perceive context as a generalization of grouping: it combines all types and patterns of grouping (Dichev and Dicheva, 2005). That's why the notion of context is so elusive, despite the various model proposed and developed (Giunchiglia, 1993; Guha, 1991; Sowa, 1992). Our perception of context is as an abstraction, capturing the localization principle in a variety of aspects. For example the principle of locality applied to a given topic in terms of the topics directly or indirectly related to it, determines the context of relevant topics. If we chose another localization strategy i.e. select a specific relation type, then we arrive to a new type of context (perspective). For example if we select the “whole-part” dimension we can see the topics from a specific hierarchical perspective. Thus the proposed approach to contexts captures also the notion of *perspectives* (or viewpoints).

TM4L allows authors to define contexts through the use of relations and scope (theme). The notion of theme makes it possible to express multiple viewpoints on a single set of learning resources and provide personalized views for different groups of learners. The theme mechanism of TM4L enables any information provided about a topic to be qualified by defining a context within which the information is valid. Theme may be used to define several different perspectives on the same set of information. For example, theme may be used to separate "beginner" resources from "intermediate" or "advanced" resources, thus enabling different sets of information to be presented to learners on different levels.

The TM4L Editor is implemented in Java and uses the TM4J Topic Map Engine [URL: TM4J], which is an open source providing a comprehensive API that allows creating and modifying Topic Map structures stored either in-memory or persistently in a database. The Editor has open modular architecture that allows an easy extension of its functionality.

The TM4L Viewer

We consider the exploration practice as the process of finding information that is relevant to the learner’s current tasks. There is a tendency towards browsing in terms of exploration, and the TM4L Viewer should therefore be enhanced to better support both browsing and the combination of search and browse activities. The exploration practice differs from information querying in that no specific question needs to be answered. Instead, the user/learner wants to know about relevant information at a more global level, e.g. to see what information is available in terms of their current information needs. Exploration also differs from general analysis in that the issue is not to oversee the entire collection in a holistic way but only inspect those parts relevant to the learner’s current task. The exploration of large information spaces is a difficult task, especially if the user is not familiar with the terminology used to describe information. Conceptual models of a domain in terms of thesauri or ontologies can remedy this problem to some extent. Exploration on the level of concepts and relationships can be used as a navigation and query formulation mechanism fostering semantic exploration and discovery. In order such an ontological framework to be useful, there is a need for interactive tools for exploring large information sets based on conceptual knowledge (Grand and Soto, 2002).

Design Principles
By the term "informativeness" we refer to the extent and type of information that the concept structure should include in order to satisfy the information needs of the envisaged learners. In this respect, we consider a concept structure as informative if it provides a representation of the properties of the involved concepts along with the relations between concepts that is at an appropriate level for the learners to understand.

The predefined relation types for our purposes were selected on the basis of pragmatic considerations. A key consideration was the information overload, related to both the *amount* of information provided and the *ability* to process it. In particular, information overload can result from a concept structure that is too complex (in terms of relations among the concepts), or from a non-carefully designed graphical user interface (Caracciolo, 2005). The set of relation types included as predefined relations was selected partially on the basis of the expected background of our envisaged users. It is relatively small but can be extended with arbitrary number of associations based on the TM standard. Three of the hierarchical relations are the most commonly studied and used semantic relations (although slightly adapted to our purposes), "superclass-subclass", "whole-part" and "class-instance"; the other relation types have been selected especially for capturing concept structures typical in the intended domain: "related-to" and "similar-to".

The additional factors that have influenced our visualization strategy include:

- *Target user group*: e.g. students/ learners.
- *Intended use*: e.g. exploring, searching, comparing, making a decision for relevance, extracting information, etc.
- *Type of information to be displayed*: e.g. graph structures, tree structures, lists, text, documents, links, etc.
- *Technical constraints.*

These observations suggested in turn the following guiding principles with respect to the TM4L Viewer design (Dicheva and Dichev, 2004b):

- Design an information space that offers the learner an ontologically rich representation of information based on different information sources in an integrated fashion.
- Offer personalized support for users with different skills and different information needs.
- Design an easy to use system that supports the learner's exploration in an effective and efficient manner.
- Design a user-friendly tool with an intuitive interface.

Views

To enable multi-purpose exploration TM4L supports multiple views. Interfaces that provide multiple views offer users different perspectives on a selected entity. TM4L visualization strategy is to provide view on demand.

TM4L has been developed as a general information course-task support tool. Therefore, it has a general user interface, not dependent on a specific knowledge area. The goal is to provide an intuitive graphical interface for Topic Map-based learning content navigation. Three views are currently supported by the Viewer: *Graph View*, *Tree View, and Text View*. These views are intended to ease navigation at "hot spots". The graph view includes a semantically expressive, browsable graph (based on HyperGraph) (see Figure 2).

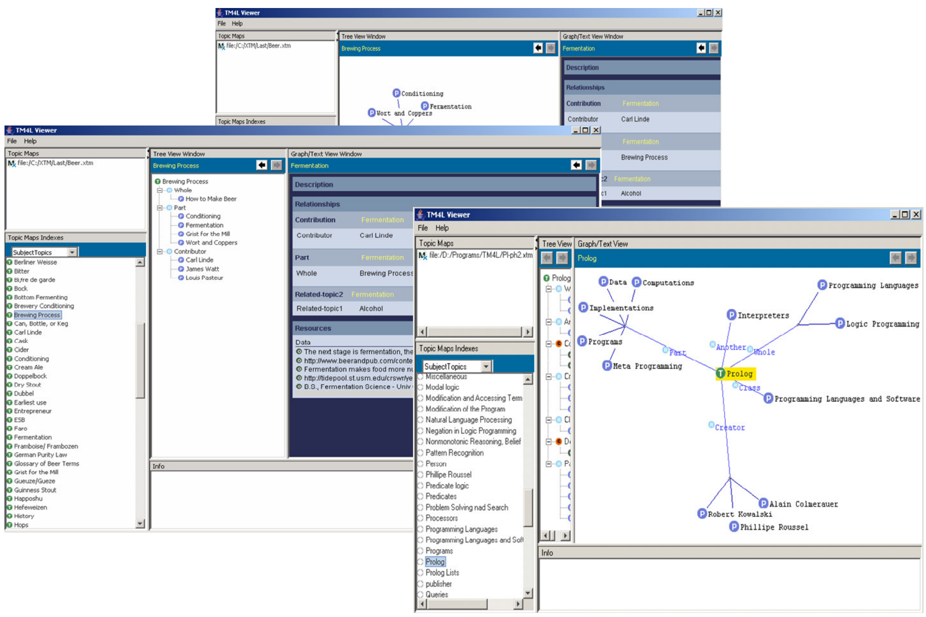

Figure 2. Screenshots from the TM4L Viewer interface.

The interface allows browsing all the topics and relationships defined in the Topic Map as well as filtering some views with respect to selected topic types or relationships. The visual display is not intended to convey the full richness of a TM-based repository, but to show which topics are present and how are they related. Aiming at reducing the information overload, we have chosen at each navigation step to display only the topics most immediately related to the currently selected object. In addition, we have chosen not to show the resources associated with the displayed topics in the Graph view, since the visualization becomes too crowded and unclear. Thus the Graph view represents only 'ontology' objects - topics, relationships, roles (the latter can be also hidden) but not resources.

Perspectives

The TM collection can be viewed from different perspectives:

- Subject Topics
- Relationships
- Topic Types
- Relationship Types
- Resource Types
- Themes.

The TM4L Viewer supports this by offering six corresponding indexes. These indexes provide the starting point for browsing the Topic Map. When the user selects in an index a particular object (topic, relationship, etc.), it becomes the "focus" object and will be displayed in the "Tree View" and "Graph/Text View" panels of the Viewer's window. The view in each panel can be changed to any of the other two. The user can continue browsing the learning content by selecting an object related to the currently displayed one. When navigating, the user can choose in which panel the information about the selected topic is to be displayed. This allows browsing different objects related to the current one without loosing the focus. By exploring the graph in a particular direction the user can obtain a better understanding of its content and thus decide what portion of the repository is relevant to their needs.

Additional features

The following are additional options provided by the TM4L Viewer.

- Visualization manipulation**:** The users can move, resize, and change the topological structure of the graph according to their needs.
- Graphical selection: The selection of a single topic at a time from the graph/text/tree view allows the user to select an object for expansion and thus to select a particular direction for exploration of the Topic Map. By selecting a new object from the Topic Map index it is possible to select a new starting point for exploration.
- Context representation: Context/theme filters can be applied to the content shown in the Viewer. Every topic characteristic may have a scope, which is specified explicitly, as a set of *themes*. A theme is a topic that is used to limit the validity of a set of topics and relations. The objects that are not valid in the specified theme are filtered out.
- Highlighting: whenever an element of the visualization is selected it is highlighted showing the current context.

The user interface displays only small portions of the Topic Map objects at any time. The TM4L Viewer provides an animated and zoom-able view with context sensitive features like click-able topics or selective detail views. For more details see [URL: TM4L].

The current version of the TM4L Viewer is a result of prototyping of different visualization ideas that offered us a rich design alternatives. Its implementation is based on

TMNav, which is part of the TM4J open source project [URL: TM4J]. The whole development process was (and will continue to be) accompanied by formative and summative evaluation techniques to "proof the concepts".

Conclusion

In this article we present work that is aimed at contributing to the development of efficiently searchable, reusable, and interchangeable discipline-specific repositories of learning resources on the Web. We propose the TM4L environment which enables the creation, maintenance, and use of ontology-aware online learning repositories based on the ISO Topic Maps standard. In the last decade, a number of tools for ontology construction have emerged (Denny, 2002); however, they are not appropriate for use in a TM-based environment. Although some currently available ontology editors such as Protégé-2000 (URL: Protégé) have plug-ins allowing export of ontologies to Topic Maps, they do not support essential TM features, which are of significant importance for interoperability of e-learning applications. To our knowledge TM4L is currently the only general educational topic maps Editor and Viewer available. It is free software that can be downloaded from http://compsci.wssu.edu/iis/nsdl/download.html (for the period May-September 2005 it had 1866 downloads.)

We are currently conducting an extensive summative evaluation of TM4L involving instructors (Topic Maps authors), students and experts. In order to find out what are the major difficulties that authors of educational Topic Maps face we conducted a study in which seven Topic Maps were created with the TM4L Editor by different instructors. The results of that study are discussed in (Dicheva and Dichev, 2005). We have also developed a large Java Topic Map, which is currently being used by freshman Computer Science students at Winston-Salem State University. The results of students evaluation will be summarized after the end of the 2005 Fall semester. We believe we will be able to prove that educational Topic Maps can efficiently support students in their self-directed learning where they are actively engaged in seeking trusted relevant information.

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