ONTOLOGY-BASED COLLABORATIVE MODEL FOR E-LEARNING

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ABSTRACT

One of the most important prerequisites in base plan for long-term development of all countries is high education level in society what includes e-learning studies. The time is coming when global tasks could be solved only with communication and learning in world level. We offer to help here by establishing learning and communicating communities in 21th century learning road and so establish bridges through learning of natural sciences. With the progression of E-learning in society there is exponential growth of E-learning resources or knowledge items on the internet observed.

The ontological engineering methodology is widely used in many domains of computer and information science, cooperative information systems, intelligent information integration, information retrieval and extraction, knowledge representation, and database management systems. Several attempts introducing universal ontology for E-Learning materials have had only modest success.

The goal of this paper is to work out and create ontological communication road in e-Learning. The paper presents, a proposed ontological-based model for e-Learning.

INTRUDUCTION

Knowledge management includes acquiring or creating knowledge, transforming it into a reusable form, retaining it, and finding and reusing it. There is an important change of educational focus from remembering large amounts of knowledge to ability to solve problems and quickly find necessary information. It makes important influence for changing learning methods from traditional lectures and presentation materials to active use and structure of information. Growing importance of learning games, analysis of situations and research will take part in learning methods (Cakula 2001). E-learning courses have to serve various learner groups and can be presented in many different forms. There are novice learners, intermediate and advanced up to experienced students. Furthermore, E-learning courses can be attended by dependent or independent learners who study full-time or part-time. On the other hand E-learning is based on certain prerequisites, such as management, culture, and IT (Maurer et.al. 2001). Abreast evolution IT and Web technologies E-learning acquires a great popularity – it is useful in tertiary education, e.g. universities, also in lifelong learning scope.

With the progression of E-learning in society there is exponential growth of E-learning resources or knowledge items on the internet observed. It is becoming increasingly difficult to find and organize relevant materials. Most of E-learning materials are created for some specific course, event etc. The authors of those materials are in general lecturers, professors, and teachers – people working in educational sphere and having interests to share their e-learning materials as wide as it is possible for all the people who can take some benefit of them. Teaching staff creating e-learning materials and placing them into web are glad if their work helps some another educator to make new materials or use existing materials in lectures. But it is fairly difficult to find later e-learning materials placed in the web. It is difficult also for authors of those materials; not to mention for people who haven't even new about existing similar materials into web.

In order to look in some existing materials and use them or adapt them for using in educational work, most of the educators are working to create new materials an put them into web – with strong probability that there are a lot of similar materials putted into web by other people. Hence there are created almost identical resources about many subjects. But most of those materials has a short lifetime - information is often lost, duplicated or remains unused. Marking content with descriptive terms, also called keywords or tags, is a common way of organizing content for future navigation, filtering or search.

By sharing and reusing the E-learning materials on the internet there are two typical problems. A typical search problem is - given a sublist of properties and tags, find a document. This problem can be solved by using more or less popular searching algorithms on internet. A typical annotation problem is dual one - given a document and a sublist of properties, find some appropriate tags for it to make this document maximally available for sharing and reusing.

The problem considered in this paper is – how to investigate distributed two-way tagging services as a self-evolving infrastructure, which would allow to share and reuse the knowledge of developers of E-learning materials.

On the other side, the term ontology is widely used in many domains of computer and information science: in cooperative information systems, intelligent information integration, information retrieval and extraction, knowledge representation, and database management systems. Many different definitions of the term are proposed. One of the well-known definitions of ontology is Gruber's (Gruber 1993).There are some useful and widespread ontologies describing generic objects - Web resources (Dublin Core), people (VCard, FOAF), discussion forum comments (SIOC). Several attempts introducing universal ontology for E-Learning materials have had only modest success. But there are a lot of ontologies and taxonomies, using for solutions of E-learning content managing problems in concrete areas or for concrete goals (Ghani 2000), (Gladun et.al. 2007), (Henze et.al. 2004).

The goal of the research is to model collaboration between distributed tagging services, storing knowledge items such as bookmarks or index-cards and promote sharing and reusing of them using ontology.

Authors developed a collaborative model for distributed tagging information referring E-learning materials. System given in this paper provides an ontology that operates not just on one server but can exchange information with a number of similar servers calling tagging services.

It is realized by using top-down ontology based tagging algorithm (should be refernce).

In model considered in this paper ontology helps to receive knowledge items from users and assigns each item to one or more categories by attaching one or more tags. Each service is used by a definite E-learning materials developing community which situated separately. Collaborative model is intended to serve a wide public having diverse interests and needs. Hence E-learning materials can later be find and retrieved by users according to needs or interests.

BASIC DEFINITIONS

Authors of this paper are using some specific terms and definitions. It is significant to arrange about meaning definitions used through presented paper.
Basic definitions used in the paper are:

Knowledge item – material in textual format used in E-learning.
Tags – free form textual labels used for knowledge items. Tags is often used in Internet for allowing people to select and organize information (Gmail), links as bookmarks (del.icio.us), photos (Flickr), blogs (Technorati) and research papers (CiteULike), they can also be a tool for social navigation, helping people to share and discover new information contributed by other community members.
Tagging algorithm – algorithm what analyses given document (E-learning material) and in compliance with results of analysis suggest most accordance tags.
Tags are taken from either an open or a closed vocabulary, but to improve user experience and consistency, the tagging service offers a user a list of suggested tags. To improve quality of suggestions, it also broadcasts request to other similar tagging services. Whenever the user picks most appropriate suggestions or writes in his/her own, this data is stored back to some of the tagging.
Tagging service – the server on which is working tagging algorithm.
Top-Down ontology – "Ontology - an explicit specification of a conceptualization".
In our model are three categories of objects considering - a potentially infinite domain of documents or knowledge items, a finite and extensible list of their properties, and for each property - its possible values or tags, which also come from a finite and extensible list; i.e. tag vocabulary for each property is controlled.
Given a property, there is a bipartite graph relationship (many-to-many) between documents and possible tags.
Collaborative tagging – practice of allowing anyone freely attach tags to content.
It allows sharing and reusing knowledge items for people from different communities, having access to tagging services. Of the web collaborative tagging has grown popular, as it is finding most useful when there is nobody in the "librarian" role or there is simply too much content for a single authority to classify (Golder et.al. 2006).
The model provides faceted browse to alleviate work with system also for people who haven't daily experience of making data bases.
Faceted browse - a way to browse information, or to refine long lists of search results, along multiple dimensions.

TOP DOWN ONTOLOGY DEVELOPMENT

The basic starting point for top-down ontology development is to think of, and decide about, core principles. For instance, do you commit to a 3D view with objects persisting in time or a perdurantist one with space-time worms, are you concerned with (in OWL terminology) classes or individuals, is your ontology intended to be descriptive or prescriptive? (Popovici et.al. 2008), (Salvatore et.al. 2007) . Practically, the different answers to such questions end up as different *foundational ontologies*—even with the same answers they may be different. Foundational ontologies provide a high-level categorization about the kinds of things you will model, such as *process*, *non-agentive-physical-object*, and (what are and) how to represent 'attributes' (e.g., as *qualities* or some kind of *dependent continuant* or *trope*.).

There are several such foundational ontologies, such as DOLCE, BFO, GFO, natural language focused GUM, and SUMO. Within the Wonderweb project, the participants realized it might not be feasible to have one singe foundational ontology that pleases everybody; hence, the idea was to have a library of foundational ontologies with appropriate mappings between them so that each modeler can chose his or her pet ontology and the system will sort out the rest regarding the interoperability of ontologies that use different foundational ontologies. The basis for this has been laid with the Wonderweb deliverable D18, but an implementation is yet to be done. One of the hurdles to realize this is that people who tend to be interested in foundational ontologies start out formalizing the basic categories in logic of their convenience (which is not OWL). For instance, DOLCE—the Descriptive Ontology for Linguistic and Cognitive Engineering—has a paper-based formalization in a first order predicate logic, and subsequent trimming down in lite and ultra lite OWL versions. BFO—the Basic Formal Ontology—too, as well as a version of it in Isabelle syntax, but this version focuses on the mereological basis only Lopez et.al. 2002).

In the meantime, leaner OWL versions of DOLCE and BFO have been made available, which are intended to be used for development of ontologies in one's domain of interest. These files can be found on their respective websites at the LOA and IFOMIS. To read them leisurely and make a comparison—and finding any correspondence—of the two foundational ontologies somewhat easier, I have exported the DOLCE-lite and BFO 1.1 OWL versions in a Description Logics representation and Manchester syntax rendering (generated with the Protégé ontology development tool). Whereas DOLCE-Lite is encoded in SHI, BFO is simpler (in ALC); that is, neither one uses all OWL-DL capabilities of SHOIN(D). Another difference is that BFO-in-owl is only a bare taxonomy (extensions do exist though), whereas DOLCE-Lite makes heavy use of object properties. More aspects of both foundational ontologies will be addressed in the lecture.

A different approach to the reuse of principal notions is to use *ontology design patterns* (ODPs), which is inspired by the idea of software design patterns. Basically, ODPs provide mini-ontologies with formalized knowledge for how to go about modeling reusable *pieces*, e.g. an *n*-ary relation or a relation between data type values, in an ontology (in OWL-DL), so that one can do that consistently throughout the ontology development and across ontologies. ODPs for specific subject domains are called *content* ODPs, such as the 'sales and purchase order contracts' or the 'agent role' to represent agents, the roles they play, and the relations between them, and even an attempt to consistently represent the classification scheme invented by Linnaeus with an ODP.

PROPOSALS FOR MODEL

There are a lot of manners for solving above mentioned typical search and typical annotation problems. Unfortunately those solving can't be fully used in searching and annotation because into existing applications in general some border cases are well studied and incorporated. They are poorly usable for sharing, finding and reusing e-learning materials which are mostly not satisfying those border cases. Considered model is developed on purpose to counterbalance border cases mentioned bellow:

- Very large amount of indexed documents (Google, de.icio.us) vs. a small amount of indexed documents e.g. manual annotations, ontology reasoning for certain subject areas. Some ontology examples and descriptions are given in (Bechhofer et.al. 2004), (Bloehdom et.al. 2004), and (Wang et.al. 2003).

Authors are interested in a number of documents, which is large (10-100 thousand). They cannot be processed with full text search and something like Google rank alone; they also cannot be quickly and consistently annotated by a single term either.

- Very many information servers, such a global Web with documents and their keywords, or just one server to store annotations.

Authors of model are looking into some servers, where each of them represents community of people with the certain interests – educational institutions, and model their collaboration.

- Almost no collaboration between the content developers vs. content developers complying with certain ontology e.g. developed for some projects, like IMS.

Model is developed to supply collaboration between authors of knowledge items despite own interests of each separate person.

- Very many possible tags, e.g. many millions of possible keywords and phrases as in full text search (Google). Or on the contrary - very few tags e.g. naive Bayes, which can classify resources as either "spam" or "non-spam" (naïve Bayes algorithm is examined in (Dumais et.al. 2000), (Formann 2006), (Ghani 2000), (Krithara 2004), (Rennie et.al. 2001)).

Authors are interested in the number of tags, which come from a controlled vocabulary; where there is some difficulty barrier to add new things, but it is possible by imposing too drastic user rights management.

- Tags, which are truly global and the same for anyone, e.g. by using a fixed taxonomy or folksonomy – short for "folk taxonomy" (Farrell et.al. 2006), (Golder et.al. 2006), vs. tags which are user specific (del.icio.us).

Authors are interested in partly overlapping tag spaces, which could at some point become mature enough to be merged between several institutions. On the other hand, institutions and even their branch offices and teams should have some autonomy w.r.t. properties and their value ranges.

- Very few properties (author, date, generic tags) as in del.icio.us or Flickr vs. very many or even unlimited number of properties - as in full-fledged Semantic Web application.

The model provides large, but limited number of properties as is appropriate for e.g. a faceted browse interface.

With this model want to solve two related problems:

- How to prompt user to annotate something consistently.
- How to cover against possibility if tagging changes show signs of vandalism or inexperience.

When user has added a document, it is necessary to add some tags to document for making it able for sharing and reusing. Model uses human intelligence "sparingly" - annotators are not library science experts, are not very committed to annotate anything, but the goal is to add new knowledge items and denote them consistent.

THE PROPOSED MODEL FOR LEARNING TAGGING

For solving a problem of sharing and reusing the E-learning materials among different user communities' authors developed a self learning tagging algorithm. During a man's supervised learning phase algorithm receives knowledge items from the learning set $k_1,...k_N$, and assigns each item to one or more categories by $T = \{t_1, t_2 ... t_m\}$.

If the same tag is received from several machines, the respective weights have added. User has his primary tagging service; denote it by S_1. The tag suggestions ($M \times J$ suggestions) get ordered globally by their weight.

attaching one or more tags $t_1,...t_m$ ($N >> m$, both N and m may increase).

After the learning phase the tagging algorithm receives items and assigns them to the given categories itself. During this latter phase the supervisor may reverse some classification decisions made by the algorithm and add more items to the learning set. Hence there is a single property p with domain $K = \{k_1, k_2 ... k_N\}$ and range

There are two cases possible for E-learning materials tagging algorithms:

if there are multiple properties, algorithm's condition should allow some of them stay undefined;

if there are single property (such as in Del.icio.us, Flickr and similar wide used applications), it is required(Bekere et al. 2008).

In real faceted browse, tagging and similar systems knowledge items with many properties are more useful than single-property as they provide more flexible search and filtering, but at the first approximation it is quite impossible to make multi-property system having no bases and tests in single-property environment. In this paper a single property is considered. The reasons are following:

Web applications with unstructured ("one dimensional") tag space have been immensely popular (Del.icio.us, Filckr); Based on results for a single-property tagging system it is possible to design a multi –property system.

Wherever correlations between different properties are not considered, each property and its respective tag space are independent from the other ones (Bekere et.al. 2009).

There are a number of tagging services $S_1, S_2, ..., S_j$. All the servers are situated separately and each tagging service has direct connection to every other tagging service. So it represents full graph with j nodes, each of them represents a server working in different educational institutions. There are different communities of users – developers of E-learning materials. Each user has rights to add knowledge items only in data base deployed on "his" server or tagging service

Every time a user adds a new knowledge item to the system, it is broadcasting to all the tagging services S_j Each service analyzes given knowledge item and returns appropriate tags suggestions with respectable weights.

As result user is given two separate ordered lists of those tags having the greatest weight: $(t', t'', ..., t^{(n)})$ - tags list of neighbor services and $(T', t'', ... t^{(n)})$ - tags list from user's primary service. If user picks some of the tags $t^{(i)}$ (from other services), then the current knowledge item is added to the neighbor service's learning set which have suggested the users chosen tag. Users own tagging service updates its learning set in any case. User may also choose to use other tags not suggested by any service – he has possibility to write new tags.

Let $K = \{k_1, k_2 ... k_N\}$ be the set of all possible items for tagging. For each tagging service S_j, $j = 1...J$ (Fig. 1) denote by $P_{ji} : K \mapsto [0,1]$ the probability distribution of the tag t_i. I. e. $P_{ji}(k_n)$ is the probability that the users of S_j tag resource k_n with the tag t_i. Thought multiplier effect of frequent use many tags the function of probability P will became continued, and by different knowledge items k_n function $P_{ji}(k_n)$ - the probability that the users of S_j tags resource k_n with the tag t_i - will take different values.

In Figure 1 there is a diagram, demonstrating functionality of system. It represents process when one knowledge item is added to system – step by step.

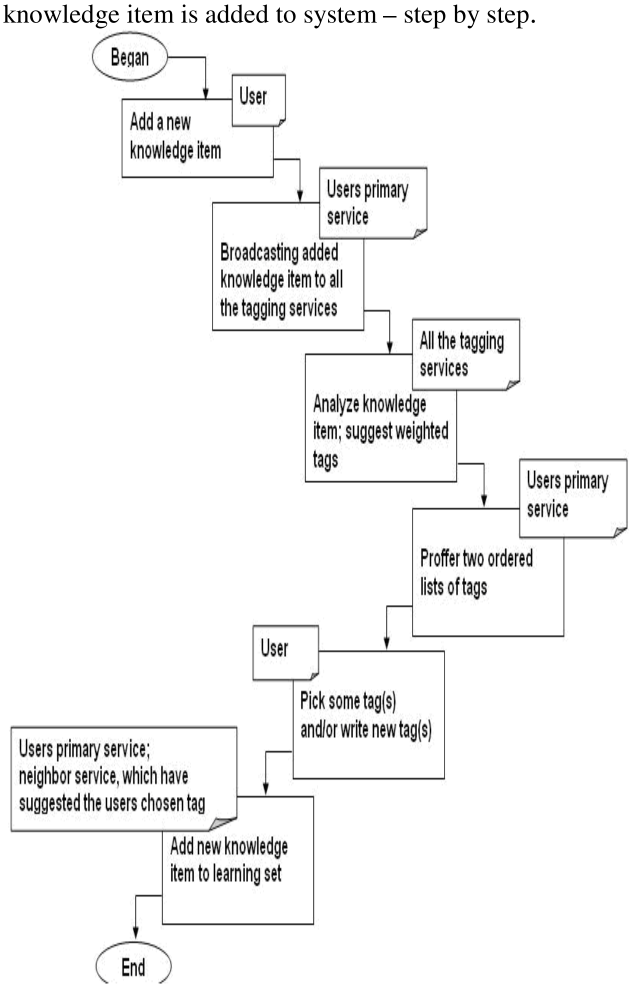

Figure 1. Diagram in general represents functionality of system (Balode et al. 2008).

As shown in diagram, every time a user adds a new knowledge item to the system, user's primary service is broadcasting added item to all the tagging services. Each service analyzes given knowledge item and returns appropriate tags suggestions.

That way user sees two separate ordered lists of returned tags having the greatest weight.

User can pick some of the tags from other services and the current knowledge item adds to the neighbor service's learning set which have suggested the users chosen tag, or he can write new tags. Users own tagging service updates all the users added knowledge items picked and new-written tags.

Such way information is not only identified for single users but distributed to service networks. This multiplies increased accessibility and usability. Collaborating tagging service can retain its bias; i.e. it reflects the different interests and taxonomies of its primary users.

DISCUSSION

The article does not suggest any particular ontology. It investigates a networking-based approach to gradually introduce existing ontologies. They grow incrementally - property by property in a decentralized "bottom up" way.

It involves building a mesh of collaborating tagging services, which evolve independently without any global coordination. The only requirement implied by the suggested architecture is ability for the services to call and to implement simple HTTP-based Web services (REST API).

The terms "representational state transfer" and "REST" were introduced of Roy T. Fielding. "[REST] is intended to evoke an image of how a well- designed Web application behaves: a network of web pages (a virtual state-machine), where the user progresses through an application by selecting links (state transitions), resulting in the next page (representing the next state of the application) being transferred to the user and rendered for their use." (Fielding et.al. 2002)

A RESTFul web service is a simple web service implemented using HTTP and the principles of REST. A RESTFul design may be appropriate when the web services are completely stateless.

A caching infrastructure can be leveraged for performance.

If the data that the web service returns is not dynamically generated and can be cached, then the caching infrastructure that web servers and other intermediaries inherently provide can be leveraged to improve performance. However, the developer must take care because such caches are limited to the HTTP GET method for most servers.

The service producer and service consumer have a mutual understanding of the context and content being passed along.

Web service delivery or aggregation into existing web sites can be enabled easily with a RESTful style.

Today REST is a key design idiom that embraces a stateless client-server architecture in which the web services are viewed as resources and can be identified by their URLs. Web service clients that want to use these resources access a particular representation by transferring application content using a small globally defined set of remote methods that describe the action to be performed on the resource. REST is an analytical description of the existing web architecture, and thus the interplay between the style and the underlying HTTP protocol appears seamless.

Hence architecture used in provided model is similar as examined in (Farrell et.al. 2006) – "the API follows the REST style, and uses simply constructed GET URLs to fetch data, and POST requests to update or modify data". This approach is useful whenever the possible values for the properties can be enumerated (e.g. as controlled tag vocabularies), whenever they correlate with the text of the respective document.

Tagging based on SVM algorithms become less useful when classifying predominantly non-verbal content such as multimedia files or photos. SVM classifiers and tag suggestions are not very useful for properties having infinite range like arbitrary numeric values, phrase search, etc. (Bloehdom et.al. 2004), (Formann 2006), (Krithara 2004), (Rennie et.al. 2001).

For realising model of collaborating services there is some content management system needed. As the result of collaborating model should be created common knowledge base each user of which can find and, if it is necessary, modify materials, keeping hereto legacy of those knowledge items (version control). Authors prepare that in this case wiki technologies are most suitable.

So the model in general will be made as wikis - Web-based applications that provide content authoring and management functionality in a much simpler manner than its Web counterpart (Leuf et.al. 2001). They simplify the hypertext generation task by offering a restricted syntax for information markup and browser-integrated editing capabilities. Every Wiki instance is a set of dynamically generated HTML pages - its content consists of an overlay network of Wiki articles on the underlying Web platform with its network of HTML pages. Links between articles are handled at the application layer, which resorts to an explicit data model of hypertext. In contrast to the traditional Web, however, Wiki systems store linking information persistently in a database, thus providing link bi-directionality.

There are a lot of wiki softwares used in web content management systems solutions. For realization collaborating services in model the system should provide means for creating and managing new information sources (E-learning materials). In particular this requires means for:

- information organization – all the knowledge items needs to be structured in a meaningful way;
- collaborative authoring – E-learning materials in system should be managed collaboratively, hence multiple users need system support for putting in, tagging, searching and also editing a shared versions resource, even in parallel;
- versioning and updates – the system is required to find a way how a network of changing information resources can be managed flexibly and consistently.

The system will be used by many authors. For all of them should be able following features:

- information retrieval - in order to handle the available knowledge items the system should support search and navigation;
- personalization and context - the way information is accessed can be optimized by taking into consideration the personal profile of the users and the context of the activities currently being carried out;
- security and privacy - as multiple user groups access the same E-learning materials repository it is essential to control and monitor this procedure with the help of appropriate policies and security mechanisms;
- integration component - the system needs to be useful on most of OS platforms, so as authors don't know which platform are using all the possible authors of E-learning materials – future users of system.

Estimating different Wikis authors decided to use XWiki software. Like all the Wiki softwares, XWiki is simply in use and includes a lot of features:

- User rights management (by wiki / space / page, using groups, etc...)
- PDF export
- Full-text search
- Version control
- Content and site design Export and Import
- Plug-ins, API, Programming
- etc.

On top of this, XWiki is platform independent as it was required for better integration and collaboration between different authors of knowledge items. XWiki is also an application wiki that allows the creation of object and classes. This way, forms can be developed in a very short time span and be reused to enter data on the wiki following a specific template. This means that end users can be presented with a page on which the layout is already drawn, where they can directly fill in the fields needed.

CONCLUSIONS

The goal of the paper is to model collaboration between distributed tagging services, storing knowledge items such as bookmarks or index-cards and promote sharing and reusing of them. This paper considers a case when each service is situated separately – in different educational institutions, so each service is used by certain user community. As the result of collaborating model should be created common knowledge base each user of which can find and, if it is necessary, modify materials, keeping hereto legacy of those knowledge items (version control).

For future research and to implement this model, it is planed to use self learning Support Vector Machine based algorithm and graph theory for tagging service collaboration. Users should retain freedom to classify E-learning materials as they see fit, but they may benefit of being nudged in the right direction, e.g. given prompts about possible annotations and warned about mistakes or misspellings.

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