TOWARDS A NEW AUTHORING ENVIRONMENT: OVERVIEW OF SOME ONTOLOGY-BASED SYSTEMS

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This paper presents some requirements for a new ontology-based authoring environment. By analyzing some systems that use ontologies for several tasks, we identified some features and purposes and showed how they can contribute to help define a new authoring environment based on ontologies to represent information before a document is published. The systems analysed fulfil specific tasks such as semantic annotation, visualization, document review and argumentation, information extraction and text engineering. By identifying some key features, it was clear that none of the tools could deliver the solution as a whole, but the integration of similar purpose tools into an interoperable environment can be a great contribution to ontology-based authoring environments. Even though Semantic Web technologies have revealed a trend in the use of ontologies for information processing, yet substantial work needs to be done to gather these initiatives in order to build an interoperable new authoring environment that takes advantage of present and new technologies.

Keywords: Semantic Web, ontology, knowledge representation, authoring, electronic publishing.

INTRODUCTION

In the Semantic Web [1], many discussions surround the way computers will support production and management of the enormous amount of information on the World Wide Web, and how artificial intelligence can foster these tasks. New ways to manage this volume of information are needed, considering crucial points such as scalability, change rate, lack of referential integrity, multiple knowledge sources, diversity of content, linking and inferencing, among others [2].

In order to be available on the Semantic Web, information sources and online systems need to be compliant with the W3C recommendations, more specifically to the way content is supported to allow machine interpretation and interoperability. Semantic Web ontologies are potential tools to be used in establishing a common language for the description and understanding of specific knowledge sets of an organization, thus enhancing the management of its projects, people, documents and products [3].

Though extensive work has been done to facilitate information processing, availability, searching, storing and retrieval, there is yet a long road to go on finding solutions regarding knowledge production. A new paradigm of knowledge production resides in the new possibilities of authoring, which has shifted from linear documents, to non linear hyperlinked ones. Close attention needs to be drawn towards what the impacts will be on authors, editors and managers who create and manage content, taking into account the shifting from paper to electronic publishing [4].

We are now in a moment of “scientific revolution” [5] that affects the publishing of scientific research, characterized by the new ways of dissemination. A moment of scientific rethinking, and new ways of production and presentation of information are emerging [6], what Gibbons named mode II of scientific production [7]. It is the new Cyberscience [8], which is characterized by the development of new forms of research. In this scenario, new tools will be available for authors to produce knowledge and to make scientific literature available under the impact of information and communication technologies, which takes us back to the previsions of Vannevar Bush [9] and Martin Greenberger [10]. And this all seems to be already happening.

ONTOLOGY AND METADATA

Ontologies are formal representations and explicit specifications of a concept [11]. With the advent of the Semantic Web, working groups have presented a wide number of ontology based technologies for use and representation of information that is already published. The present issue in the development of tools and technologies to be used in the Semantic Web is that they need to share the same language, and massive reasoning has to be considered for machine and human processing. Ontology languages have been adapted and transformed, such as the present standard OWL [12] that overcomes the limitations present in XML and RDF(S). The use of ontologies to support knowledge exchange is now the main focus of technology developers who wish to have their services used via the conceptual mega-structure that the Semantic Web is destined to be.

The use of ontologies has been successfully applied for various purposes on the Semantic Web, namely information localization, integration, querying, presentation, navigation and visualization [13]. One may think of how this ontological background can be used for the production of new knowledge in electronic publishing.

Metadata, which is data describing data, is not only used for presenting information about the publication itself such as bibliographic descriptions, but also descriptive information about the context, quality and the characteristics of a data [14]. In the Semantic Web, metadata is described via Dublin Core standards [15], and to represent information via metadata is a crucial ingredient in order to enhance retrieval **after** publication [16]. The question now lays on how metadata could be represented and structured by the author himself and/or by knowledge engineers **before** a document is published. We believe that most of the information management problems (related to information production, representation, availability and retrieval) could be alleviated with the use of ontologies during knowledge production. We may think of how an authoring environment may emerge, where authors can be supported and guided in the authoring task, via a conceptual model provided by global and domain ontologies that will help him/her link the document to the available information sources, in a structured way.

Studies reveal the tendency of using ontologies as basis for knowledge representation, sharing, management, modelling, engineering, education, among others. If we use the same rationale into the authoring task, we conclude that ontologies might as well be a valuable asset in the production of content for the Semantic Web. Thus, our future studies aim towards the idea of using ontologies as a basis for knowledge and document production, by making the author aware of the knowledge structures of the subject he is writing about, providing him with a common language that can be located, accessed, retrieved, reused and disclosed within a semantically controlled and unambiguous environment.

ONTOLOGY-BASED SYSTEMS

This research presents new possibilities of knowledge sharing by showing some technologies that have ontologies as a front or background for various related tasks. It does not cover all available technologies, and the systems presented do not exhaust the possibilities, but leads to reflexions of potential requirements for a new ontology-based authoring environment for knowledge production and electronic publishing, considering the upcoming Semantic Web.

According to their purposes, we divided the tools in three groups. The first group consists of three tools created to enhance search and conceptual navigation capabilities, by making markups and annotations from documents to terms in the ontologies, namely **Magpie** [17], **Cohse** [18] and **KIM** [19]. In the second group, we present two tools that help users model documents, by creating discourse ontology structures and semantic annotations to foster scientific critic and analysis in reviewing and publishing tasks: **Claimaker** [20] and **Trellis** [21]. In the third group is a system that was made either for the generation of texts from ontologies and information extraction **Gate** [22].

The objective of this analysis is to identify several key features related to knowledge sharing, and how ontologies are being used to represent knowledge. The added value of this research is to fill the gap between the available technologies and what can be envisage as new possible techniques that will foster electronic publishing, more specifically the way authors will make use of these novelties to produce contents for their specific needs.

CRITERIA

By using the systems and seeking in the related referred literature, we organized the collected information in the following categories, adapted to our specific needs from [23, 24, 25]. These methodologies helped us draw the following questions as a guideline.

1. What are the systems **objectives**?
2. What are the general **functions**?
3. What are the t**echnologies** used?
4. What **ontology and description languages** are supported?
5. Do they allow one or more **ontology loading** at a time?
6. Can the available **ontologies be changed** or populated by the user?
7. Is the **semantic annotation** done by hand or automatic?
8. Do they have additional components to allow **granularity** and **interoperability**?
9. What are the **future studies** of the system's developers?

The distribution of tools into the three main groups presented above was based on the framework for understanding and classifying ontology applications [25]. According to this framework, ontology applications can be grouped in three main general categories covering the following areas: i) neutral authoring – definition of a single language to be used by multiple target systems to foster knowledge reuse, maintainability and knowledge retention, to which we considered Document Review and Annotation as a task to provide common language to be shared by reviewers of a peer network; ii) common access to information – is intended for ontology applications that make the available information intelligible by providing a shared understanding of terms and by mapping sets of terms, to allow interoperability and reuse of knowledge resources. Based on this definition we grouped the Semantic Annotation and Visualization category to present the systems that are used for this purpose of knowledge sharing; iii) indexing – in this group we considered the tools used for information retrieval and text engineering, designed to be used as a mechanism for indexing information and allow it to be more easily accessed and reused.

The framework suggested in [24] is focused on the evaluation of ontologies and its related technologies, mainly the aspects of interoperability and scalability of the used technologies, which were used to guide the present analysis of granularity of the tools. Even though the guidelines provided by [23] are directed to accessibility aspects, it was used for the analysis of the automation of annotation aspect.

TABLE 1 – COLLECTED INFORMATION FROM SYSTEMS

Name	Objectives	Functions	Technology	Ontology languages	Ontology load	Ontology change	Semantic Annotation	Granularity	Future Studies
Magpie Semantic Layering	Web pages annotation technology for resources interpretation	Extension for web browsing via linkage to tagged sources Keeps history of visited links in a semantic log KB	Web plug-in	RDF, DAML+OIL, OCML (internal representation for reasoning) and OWL	One at a time, selected by user Subscribed ontologies	User may choose an existing ontology, develop new one, or populate an existing one	Automatic	Service Recipient (Browser Extension , Service Dispatcher & Magpie Collectors Service Provider (Soap Translator and Communication Mngr, Ontology Server, Semantic Log KB)	How to integrate Magpie with a query answer system using visual and natural languages
COHSE The Conceptual Open Hypermedia Project	Annotation tool to support the classification of terms, automatic management of ontology and document cataloguing for authoring and browsing on the web	Create and load ontologies, construct and store annotations, concept browsing	Web server/browser (proxy. Databases and resolvers. WebPlug-in (annotator)	DAML+Oil and OWL	One at a time	Modifiable – user populate via a concept browser (OILed)	Automatic	Ontology and Annotation Services, Cohse DLRS Proxy, Mozilla DLRS/Core/Annotator OILed Ontology Editor (adapted)	Improve the user interface to linking, via ontological navigation, improve onto processing and maintenance with description logics.
KIM Semantic Annotation Platform	Knowledge and information management infrastructure, services for automatic semantic annotation; indexing and retrieval of documents	Semantic annotation of text, indexing and retrieval, query and exploration of formal knowledge	Client-server – KBs and web plug-in for user interface	RDF and OWL extensions	One at a time	Modifiable	Automatic	KIM Ontology, KB, KIM Server, browser plug-in, web user interface, Knowledge Explorer and KB navigation	Semantic annotation performance measures, disambiguation of Name Entity references, Information Extraction
Claimaker Claim Building	Document argumentation and claim modelling via KE and Visualizations Creation of user's discourse ontology for collaborative work and reviewing of literature	View and add concepts related to publications Making claims between them Make sets of concepts Perspective analysis	Web application	XML and RDF	One at a time - Proprietary Scholonto	Modifiable	Manual	ScholOnto's Database , Claim Assistant Tool and MS Word plug-in – Prototyped	Improve visual Input (concept structure visualization) Discovery environment BibTex input of metadata and others
Trellis Capturing and exploiting semantic relationships for information and knowledge management	Make semantic annotations to documents for analysis	Add purposes, sources and statements by making relations between them	Web application	XML, RDF, DAML+OIL and OWL	One at a time - semantic annotation vocabulary, with an independent schema and a domain schema	Modifiable	Manual	Conclusion Editor, Statements Editor, Analysis Editor Unit Editor	Use the approach for user's individual Service descriptions on products
GATE General Architecture for Text Engineering	Information Extraction for NLP	Annotation, visualization, NE recognition	Java, XML/HTML and relational DB	DAML+OIL, OWL	Multiple	Modifiable – selected by user	Automatic	Language Resources Processing Resources Visual Resources	Performance evaluation, regression tests, IR, edit/processing multilingual data, dialogue systems

COMPARISON AND ANALYSIS

The information collected from this analysis is present in table 1. We identified and compared common characteristics and trends on knowledge representation, and defined some key features that can be taken as requirements towards a new authoring environment. This research limited to present the characteristics only of the core systems because they are very representative in their categories, even though we are aware of many other tools that fulfil similar purposes. In future studies we intend to cover more tools in detail, in order to draw a real state-of-the-art in ontology-based knowledge management, production, representation, etc.

The technologies that support the tools here analyzed can be as easy to install as web browser plug-ins (in case of annotation tools) and more complex database Java applications. Though technology is a crucial element to enable implementation of the systems, it will not be discussed in this paper. We consider that a key element when setting up an authoring environment is that they can be easy to use and install, with a friendly user interface that can be used not only by users who can build queries. The components may also be used separately, according to specific needs; however these components should be integrated and interoperable.

The system's ontologies are stored in many knowledge representation languages and formats, such as XML, RDF, DAML, Oil and some in OWL. The later is now the current standard recommendation for the Semantic Web [12], and most of the systems are intend to include this language as a format in the future. The ability to link the system to more than one ontology is an important feature, and also depends on the formats supported by the system. Users may be allowed to populate the ontologies, but yet a sort of proof checking by specialists or ontology engineers is recommended. Once we consider in this study the Semantic Web as the general infrastructure for knowledge sharing, it is important that new authoring environments are compliant with this recommendation to allow interoperability on the web.

SEMANTIC ANNOTATION AND BROWSING

Semantic annotation is the task of linking an object from a text to its semantic description, in this case an ontology. Several annotation tools have been developed to be used in the Semantic Web and provide users the ability to annotate documents for various purposes [see 26, 27]. In this paper we present **Magpie** [17], a tool for semantic browsing on the web. It differs from other annotation tools in a way that it separates the markup from the pages, allowing a more dynamic annotation, considering that pages may change from time to time. As presented in [30], it is interesting to mention that the future in annotation technologies is to allow the annotation to happen in the database systems, not necessarily in the document themselves, considering that most of the information existing in the Web consists of dynamic pages that change considerably, in contrast to static ones. This is what is called *deep annotation,* an "*annotation process that utilizes information proper, information structures and information context in order to derive mappings between information structures*" [28].

Magpie also does entity recognition, annotation and formal representation of an ontology, a conceptual navigation and knowledge acquisition. It was developed to support the interpretation of web documents, by adding an ontology-based semantic layer to them. The ontology is loaded by the user and the terms recognized by this ontology become colored links in the users' page with a list of related knowledge sources semantically connected. It is a plug in that runs and extends standard web browsers, preserving the appearance of the visited pages: the text becomes an enhanced hyperlink structure. The mark-up generated is separate from the documents so that users can add their points of view about the visited web resources. Magpie creates a history log of the visited pages via the annotated concepts and allows users to follow the paths when revisiting the pages.

Following the same purposes, the **KIM** [19] platform provides an infrastructure for semantic information annotation, indexing and retrieval from ontologies and knowledge bases. The information extraction happens via NER from the specific KIMO ontology, developed by the group, where the entities in the text are linked to their types, considering relations and attributes as properties. This is an upper-level ontology that represents simple entity types in levels, and allows the integration of other multiple domain-specific ontologies. The knowledge base of the Kim platform represents general entity descriptions that can be shared among many domains and at present more than 80,000 entities are represented in the KB. The annotations generated from the documents via named entities recognition may also become indexes for further information retrieval. Kim also supports information extraction and content management using the Gate system described later on in this paper.

The Kim platform goes beyond the task of annotating documents, by providing input from the annotations to generate indexes and to facilitate information retrieval. These two last mentioned tools were chosen for the present analysis due to its expanded capabilities to deal with semantic data, as well as representing elements that are being searched for the design of a new authoring environment proposed at the end of this work.

Also sharing the same objectives and some additional ones, we mention the **Cohse** [18] project. The project's goal is to implement an ontology-based open hypermedia that can represent conceptual models of document's terms and their relationships via an ontological reasoning service. It provides links between documents via metadata in order to improve consistency and breath of linking the web documents either during retrieval and authoring time. Document's concepts can be linked when authoring, so that other associated documents with same concepts become linked to each other for semantic browsing. This project inspired the group who developed Magpie, but the main difference between them is that Cohse separates web links from the related web pages and makes them conceptual, augmenting them with their semantic classes, while Magpie only supports the interpretation and information gathering.

DOCUMENT REVIEW AND ARGUMENTATION

In electronic publishing environments, review and argumentation of literature is a necessary task that allow peers criticize a submitted paper in order to add critics and judge it acceptable or not for publication. **Claimaker** [20] is a collaborative tool for modelling documents in a peer review environment and for argumentation, combining knowledge engineering to visualization. It is a tool designed for the addition of comments on top of documents, datasets and tools, enabling researches to make claims to describe and debate the contribution of papers and the relationships to related literature. The claims that users add to the system are connected to online versions of the document in a way that they can be used as an index to digital libraries as well, working as another form of information representation, as well as a tool for communication and interpretation of on going researches, in a peer review basis. Users who review the documents create a discourse ontology, which is a common language that the group can use to construct the claim models. When an article is registered in the system, its metadata is imported in a refer format. Users can then add new concepts as claims and interlink them with other concepts and related documents. Concepts can be grouped in sets, according to each specific need, and the system allows visualization of them, providing a perspective analysis of the claims made about the document's concept, which might be conflicting or supporting the idea of the author.

Trellis [21] is a system that shares similar objectives as Claimaker. It provides an infrastructure for users to write their individual feedback about sources they are interested in, by annotating their views and opinions, as well as qualifying and justifying them for decision makers. This is done via an editor that allows the argumentation of many statements a user may need to either support or refute an idea. The semantic markup of the analysis made are represented in an RDF schema and also in a DAML ontology with the terms used for the markup. The annotations can be then used by other tools for search, reasoning and reference of the related information.

Both tools represent a significant step in electronic publishing once it provides an infrastructure for researches to visually browse concept networks that are linked to source documents. It brings another knowledge layer to the task of peer reviewing, by turning the argumentation claims into navigational structures based on claims made by reviewers. These tools are used for modelling existing literature for information analysis, research and teaching activities. However, we may also think that this type of infrastructure can be applied for authoring purposes (individual or collaborative), due to its function to relate claims and statements to the original thoughts in which they were based or inspired to either support or refute it, thus enhancing the simple citation process.

INFORMATION EXTRACTION AND TEXT ENGINEERING

Information extraction helps the automatic representation of objects by recognizing concepts present in texts and automatically generating ways of representing it for information analysis and retrieval. **Gate** [22], an information extraction system content and annotation management, that allows visualization of ontologies related to sources in a document. The linguistic information created from the extraction is stored separately from the textual data and can be referred to the original texts. Gate has been widely used in the natural language generation environments, due to its robust and scalable capacity of dealing with data storage, format analysis and data visualization. It represents ontologies and also provides a graphical user interface for browsing and editing the ontologies in any format. It can also deal with many different language resources for word send disambiguation such as thesaurus and dictionaries. Other tools are also used for natural language processing, such as Ellogon [29], a multi-lingual, cross platform text engineering environment based on natural language processing. It is used for research in natural language processing and language engineering systems. However, the main difference between Gate and Ellogon is that the latter does not provide connections to ontologies, though it can present the extracted information in the form of parse trees. The next step in the development of Ellogon is to have ontologies to support the information extraction.

With this analysis we noticed that these systems provide different features and components for an ontology-based authoring environment. Our purpose is to gather these features and present some requirements for an authoring environment that takes into account the use of ontologies and related technologies to enhance the writing and publishing tasks. The future goal of this work is to design a platform that can integrate these features and compose a new authoring environment.

RESULTING REQUIREMENTS

We propose below some requirements for a new authoring framework that can be considered when deploying a new authoring environment for the Semantic Web, making full use of the potential technologies, in an integrated way. This proposal suggests an ontology-based knowledge production environment, integrated by the available technologies within a platform that allow users (authors, reviewers, publishers, editors, etc) to perform necessary activities when producing knowledge.

• **Authoring** – integration of text processing technologies to the related information resources, ontologies and knowledge bases, in order to provide authors with a hyperlinked environment where s/he can easily navigate through sources and execute authoring tasks, by automatically attributing target sources to his document.

• **Semantic Mark-up and Annotation** – markup and annotation of relevant terms that can be hyperlinked to other documents or ontologies, in an automatic or semi-automatic form, providing support for conceptual navigation, discovery, and metadata generation. Annotation can support authors i) to recognize terms in the document that are linked to ontologies, ii) to attribute metadata elements to concepts in the text, iii) provide a hyperlinked conceptual navigation. Annotation needs to be supported by global and domain ontologies, general categories, index servers, as well as terminologies such as thesauri that can suggest or constrain the use of terms in a specific environment, either for standardization or to avoid ambiguity in specialized communication.

• **Semantic Browsing** – visualization of semantic connections between concepts and their related material available with structured navigation as well as semi or automatic hyperlink to related sources.

• **Metadata generation** –attribution of metadata elements to terms/sentences in the document, semi or automatically, to be executed by the specific actor in this task (author, editor publisher, reviewer) metadata can be created taking into account the term and concept that are actually registered in the document, but it can also be related to broader or narrower terms via ontologies and thesaurus.

• **Multi-ontology support** - the use of one or more ontologies simultaneously, if the subjects being approached go beyond those of the domain ontology, or are more specific than those in a global ontology. Considering multi-domain knowledge, it is fundamental that authoring tools allow the linkage to more than one ontology in the same environment, and issues such as ontology integration and population shall be considered. Some systems are limited to the use of only one ontology at a time.

• **Ontology visualization**: semantic navigation through the ontologies in order to allow knowledge acquisition (by machines and humans) and the attribution/location of a concept inside a hierarchic structure to its related (parent, child) concepts for searching and indexing. The state-of-the art in ontology visualization reveals conceptual navigation environments where users can locate the term in the ontology and check the availability of a particular concept inside a domain.

• **Thesaurus-based term/concept choice** – support for recognition of synonyms and antonyms inside a conceptual structure, to suggest use of preferred terms, to avoid variations, ambiguity, and enhance knowledge representation by attributing only the domain specific concept to its related terms in the domain.

• **Information Extraction** – recognition of related information present in many knowledge sources for indexing purposes.

• **Text Engineering** – identification of semantic elements in a text for natural language processing activities, such as information exchange, translation, operability with other systems, as well as visualization of parse trees that indicate the linguistic structures of sentences.

• **Resource discovery environment** – ontology-based search and navigation through online sources for referencing, citing, etc., by making automatic markup of related sources and creation of hyperlinks from the document to the target pages.

• **Argumentation and peer review** – a structure for document peer review with the purpose of criticizing a paper and judging it for acceptance/rejection by a scientific community of peers, based on a shared ontology to be used by peers.

• **Publishing** – submission of the document to the related publishing houses, editors and conferences for the disclosure of its contents in a formalized way, based on the standards that are prescribed by each one of them. Templates, guidelines and recommendations orient authors in formatting document's structure and metadata according to demands of publishing contexts and companies.

CONCLUSION

From the analysis presented on this paper, we can conclude that there have been many tools developed to support the use of information, considering existing electronic publishing tasks, such as writing, searching, navigating, reviewing or publishing. However, these tools do not provide the solution as a whole to be used by an author when producing knowledge. Still, an author has to gather many different tools together in order to follow the many steps in the publishing cycle. These tools do not fully account for interoperability, and a great effort is eminent towards integrating them and allowing the execution of the publishing tasks by all the stakeholders. The requirements presented in this paper are a conclusion from the analysis made with the tools. If integrated, they can provide an ontology-based environment to support knowledge production and new ways of authoring in the Semantic Web. The next step of our research is to provide a specification of this environment in terms of functions and requirements necessary to implement it.

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