An ontology based Web Annotation System to create new learning practices

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Abstract. Web2.0 is a conceptual framework that aims at enhancing the World Wide Web with semantic and social functionnalities. For this framework to fully develop, there is a need for concrete applications in different domains. This paper presents an effort to instanciate the Web2.0 concepts in a teaching/leanring context. An ontology based collaborative multimedia annotation tool that features pedagogical functionnalities is presented. An original approach to design software based on ontologies is used. A pedagogical scenario, from the KPLAB European project, that makes use of the tool to train medical staff to handle pediatric surgical operations is presented.

Keywords: Web2.0**,** Annotation, social software, ontology.

1 Introduction

Web2.0 considers two dimensions into the World Wide Web: the semantic Web and social Web. The semantic Web goal is to provide machine readable Web intelligence that would come from hyperlinked vocabularies, enabling Web authors to explicitly define their words and concepts. The idea allows software agents to make smart inferences that go beyond the simple linguistic analysis [1] using formal standard representation like RDF, RDFS and OWL. The semantic Web is based on the use of ontologies. Ontology is basically a description of the key concepts in a given domain including the rules, properties and relationships between concepts. The social Web is the name given to the part of online activities requiring collaborative user participation. In this context, the tools which offer a cooperative content generation are called social software. These tools have in common an egalitarian social structure; they aggregate all user contributions into shared representations of collective belief [2].

Social software has been used to support traditional classes [3]. For instance, lecture notes in Wiki form allow students to modify, extend, question or seek clarification on the information presented. But without a simple interface [4] or an explicit guidance, this kind of annotation can be too loose for learners who lack, by nature, confidence in their knowledge. Due to this, some educational social software embody pedagogical frameworks providing structures that help the learner [5].

In this paper, we first review some research contributions that aim to support learning using Web2.0 annotation. Second, we present the proposed annotation tool, entitled WASYS, which uses ontologies to guide the user in the annotation activity. Finally, we describe a pedagogical scenario that used WASYS, in which multi-disciplinary learners annotate a video that shows a simulated pediatric surgical operation. This empirical case is being investigated in the context of the KP-LAB European project [6].

2 Related work

This section reviews few research efforts that focussed on the application of social and semantic software in teaching/learning. The most popular tools and cases that use annotation for the purpose of learning are briefly presented.

2.1 Web2.0: learning with social software

The new generation of social software like blogs and wikis, or technological approaches such as collaborative filtering/recommender systems, shared tagging and social navigation become popular in online learning [7]. However, the roots of social software in this context can be traced back to the early nineties [8]. Collaborative filters have long been used for learning and social navigation techniques have been applied in various educational contexts [5].

The PROLEARN network of excellence has recognized the obvious trend to use social software in professional learning. It sketched some key requirements for a new type of platforms called "Collaborative adaptive learning platforms" (CALP). One of the ideas is to connect people through content. In order to allow efficient exchange between *connected* people, the system must have semantic capabilities based on the use of ontologies. SITIO [9], a Social Semantic Recommendation Platform, features such functionnalities. This type of structured exchange offers formal reasoning and inference strategies to classify and relate information.

2.2 Annotation based learning

In the context of this paper, annotation refers to comments, notes, explanations or external remarks that can be attached to a document or a selected part of a document without modifying it. Annotating collaboratively is of great interest to the educational, professional and scientific communities.

FilmEd is a prototype application developed by the Australian GrangeNet broadband research network, which combines videoconferencing over access grid nodes with collaborative, real-time sharing of an application that enables annotation of video content between multiple groups at remote locations [10]. This application allows a user to define their hierarchical segmentation of the video based on a basic XML file. However, it doesn't use any formal description or domain ontology, and does not allow the definition of pedagogical scenari for an annotation activity.

OntoElan [11] solves this problem allowing the use of ontologies to annotate videos. But this application doesn't propose a collaborative and structured annotation session useful in a learning context. ConAnnotator [12] features the possibility of collaborative annotation based on the use of OWL ontologies, but has no pedagogical functionnalities.

In [13], authors have evaluated the impact of a shared document annotation tool in collaborative learning. They observed hiegher learning outcomes and better performance. However, they found that visually oriented students produce higher level annotations compared to students that have different perceptive styles. SMARTNotes [14] is a collaborative web annotation tool which allows learners and their tutor to collaborate around HTML course document. It uses a model of annotation based on an RDF description which characterizes only the annotation semantics (Highlighting, Consign, Conversation and Indication). It has no possiblity to annotate continuous media and the tool doesn't support the definition of a structured pedagogical scenario. MemoNote [15] is a personal semantic annotation tool dedicated to teachers. It provides a *personal memory* that contains all personal annotations made on documents during various teaching activities (preparing a lesson, delevery, marking exams …). For this purpose, MemoNote annotation functionalities are context-sensitive, and can particularly adapt to the pedagogical context of the annotation (domain, teaching level …). No sharing, collaboration or group possibilities are supported.

3 WASYS : Web Annotation SYStem

WASYS is a system that allows the creation and visualisation of annotations related to a content item. The tool adapts to the user application context. This adaptation is based on the use of ontologies to define the type of content item (i.e. video, audio, text …), the granularity of the content item fragments (i.e. page, image, timestamp …) and the concepts of the business domain (i.e. actors' activity in a scene, actors' decision, actors' behaviour, object in the scene, paragraph in a text, word in a text …). It is a Web annotation system that implements the social and semantic concepts of Web2.0.

Annotating manually consists of observing a content item and adding semantic data. The set of data to be used is formally described using one or multiple ontologies. Practically, WASYS offers three types of annotation. A structural annotation to simply break down the content item into fragments. An informal annotation to associate free text with fragments and formal annotation which consists of marking fragments with instances of the semantic data. In this last case, we use also an graphical style ontology to adapt the representation of the semantic data in the user's view (**Fig. 1**).

WASYS manages two types of users. The first type of user is an instructor who has the responsibility to create and configure the annotation scenario. A scenario breaks down into annotation sessions (or episodes). Several ontologies can be used during one session. A scenario describes the content items, the ontologies, the users and their roles, the permissions assigned to the users and other parameters used during the

annotation activity. The instructor can annotate a content item. In this case, annotations consist in identifying relevant fragments in the content. It's possible to attach questions or information to each fragment. Instructors can also navigate into the content item to visualize statistics about the participants' annotations.

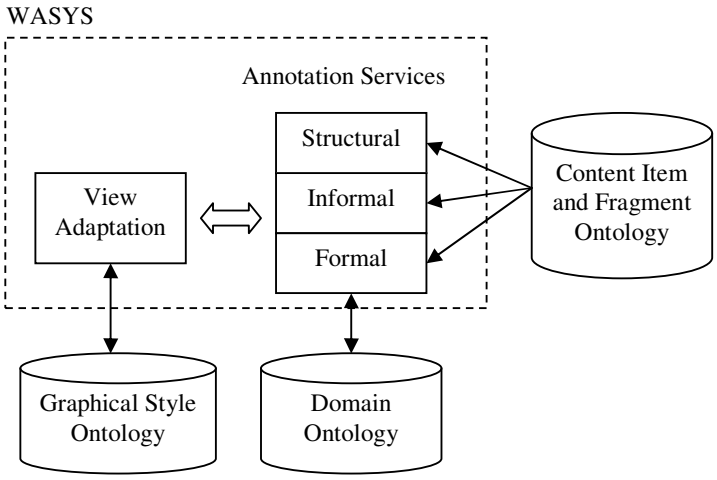

Fig. 1. conceptual view of WASYS.

Participants are the second type of user of the system. They use the annotation tool in the context of a scenario set up by an instructor. Participants annotate the content based on one or several ontologies chosen by the instructor. The annotation can be done in several sessions; an annotation session can take few minutes or several days. A participant can also visualize their annotations beside those made by instructors or other participants. An annotation session can be collaborative. In this case, participants create synchronously annotations.

4 Pedagogical scenario

WASYS uses different ontologies related to a specific application domain. For example, we defined an ontology in which we manipulate concepts, properties and restrictions accordingly to requirements defined in a pedagogical scenario run at Karolinska Institute. This scenario consists of involving multi-disciplinary practionners into a simulated pediatric operation. Participants are offered to participate in realistic activities, to reflect on these, to get feedback from instructors, to discuss the events, and to observe the team activities on video. The simulation is filmed. Each individual participant reviews the video and annotates the events according to a description given by the instructors. Participants gather then to relflect collectively on the operation by comparing their annotations and getting feedback

from instructors. The object of the learning activity is to train skills, learn more about neonatal resuscitation, and learn more about teamwork rules and mechanisms. We consider, here, only the annotation related to teamwork.

The content item is a video that has a name, a description and an author, in addition to the date and the place the movie has been filmed. A single type of fragment is used. It consists of a sequence of images defined by the number of the first image and the number of last image. The concepts used during the annotation are events observable in the movie scene. An annotation is described by the name of the author and some other information related to the role of the author (instructor or participant) (**Fig. 2**).

Fig. 2. Events to annotate by participants and instructor for the pediatric use case.

For this case, we use three distinct OWL ontologies to adapt the domain model:

- The content item vocabulary,
- The fragment vocabulary,
- The annotation concept vocabulary.

These three ontologies are used to generate dynamically the java classes of the domain model when an annotation session is started. The presentation tier on the client side offers an adapted view to annotate the content item with a certain fragment granularity and a limited and structured contextual concept vocabulary for the scenario defined by an instructor.

5 Conclusion

This paper presented an application of the Web2.0 concepts in teaching/learning. We described the specification and design of a multimedia annotation tool. This tool allows instructors to set up a pedagogical scenario based on annotating a shared content item. Annotation can be informal or formal based on one or several OWL ontologies describing the application domain. The tool allows collaborative

synchronous creation of annotations and reflective activity by visualizing the annotations of a group.

The system has been designed based on 3-tier architecture (presentation, domain and persistence layers). Ontologies have been used at each of these layers to adapt the tool to the application domain. On the presentation layer, ontologies are used to adapt the graphical views. On the domain (or business) layer, ontologies are used to create dynamically classes that represent the domain model. On the persistent layer, ontologies are used to index and structure the storage of annotations.

The system has been applied in a real setting to train multi-disciplinary medical staff in pediatric surgery and teamwork. Results under continuous investigation show interesting results for boundary crossing and reflective learning.

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