Using Dynamic Fuzzy Ontologies to Understand Creative Environments

Silvia Calegari and Marco Loregian

Dipartimento di Informatica, Sistemistica e Comunicazione,
Università degli Studi di Milano Bicocca,
via Bicocca degli Arcimboldi 8,
20126 Milano, Italy
{calegari, loregian}@disco.unimib.it

Abstract. This paper presents a method to model knowledge in creative environments using dynamic fuzzy ontologies. Dynamic fuzzy ontologies are ontologies that evolve in time to adapt to the environment in which they are used, and whose taxonomies and relationships among concepts are enriched with fuzzy weights (i.e., numeric values between 0 and 1). Such cognitive artifacts can provide for higher user awareness in learning environments, as well as for greater creative stimulus for knowledge discovery. This paper gives the definitions of dynamic fuzzy ontologies, the details of how fuzzy values are dynamically assigned to concepts and relations, and presents an experimental evaluation of the proposed approach.

1 Introduction

ATELIER (Architecture and Technologies for Inspirational Learning Environments) is an EU-funded project that is part of the Disappearing Computer initiative[1]. The aim of the project is to build a digitally enhanced environment supporting creative learning processes in architecture and interaction design education. The ATELIER studio is a room in which students feel comfortable with technology and which they can fully configure to fit their needs [1]. Several technologies have already been adopted to build a complex system to support students, and make their work easier, so they can focus more on their actual tasks rather than on learning how to use the system. The ATELIER software infrastructure provides the means for devices and applications to communicate. It also includes a hyper-media database (HMDB) that is used to store all digital material collected by the students.

Students in creative learning environments work daily with very large amounts of documents created during group projects. It is important that they can easily find and access their own data, as well as those of others, and also that they have means to sort, annotate and browse such digital material. The contents that they create and collect (e.g., digital pictures, handmade sketches, notes,

[1] http://www.disappearing-computer.net

H. Legind Larsen et al. (Eds.): FQAS 2006, LNAI 4027, pp. 404–415, 2006.

videos) can be analyzed in different ways and from different points of view since the same item can be given different meanings and relevance according to the *context* in which it is used.

Context can be defined as "the location, identity and state of people, groups and computational and physical objects" [2]. In ATELIER, an approach has been studied to provide students with contents that can enhance their learning experience by presenting surprising yet meaningful information. The approach relies on an ontology and exploits user profiles and system history, also considering the specific applications that students are using [3].

More precisely, to support students in creative practices an ontology-driven selection facility (including the metrics and an algorithm) has been developed to move from one document to another in a creative path without involving users in typing and explicit query writing. This research has been the starting point for the work presented in this paper, highlighting the need for a more flexible knowledge representation in the creative environment.

The main contribution of this paper is the description of how we shifted from a "classical" ontology [4] to a **dynamic fuzzy ontology**, where dynamic refers to the maintenance process [5] and scalability of the representation. We define the properties of such an artifact and describe the steps through which it has been built and evaluated.

A fuzzy ontology is an ontology whose instances are weighted according to their semantic representativeness of the class to which they belong. Instances of concepts have a *membership value* that is ranged between 0 and 1. Membership assumes a higher value for those instances that "better" represent the concept. Calegari and Ciucci presented a more complete introduction to fuzzy ontologies [6], from which the following definition (later complemented by Definition 2) is derived:

Definition 1. *A **fuzzy ontology** is an ontology extended with fuzzy values assigned through the functions*
$m : Instances \mapsto [0, 1]$
$v : Property\_values \mapsto [0, 1]$

Section 2 presents the metrics to assign the fuzzy values to a given ontology. The values can be updated at runtime, so that the ontology consistently represent the status of the system with respect to the domain of interest. The ontology evolves in time and can be considered a *dynamic* fuzzy ontology [5, 6].

The proposed approach is evaluated experimentally in Section 3, where some data are analyzed and an interactive tool developed for ATELIER is presented. Sections 4 and 5 present related work and concluding remarks.

2 Building the Fuzzy Ontology

In order to make an ontology dynamically adapt to the context in which it is used, i.e., to what students are doing with documents and applications, the ontology has to be updated according to actions taking place.