

Ontologies for Ubiquitous Adaptive Learning Environments

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1 Introduction

The new vision on computing, i.e. Pervasive Computing [1], and the technological advancements, e.g., Semantic Web, re-organize the way how people use, and interact with the technology. Not surprisingly, learning is one of the domains which closely follows and even motivates such a fundamental shift. In this regard, Table 1 extended from [2] demonstrates the shift and the convergence between the learning and technology. Personalization, adaptivity and ubiquity (i.e. pervasiveness), within the context of this paper, are of importance.

Table 1. The shift in the technology and the convergence between the learning and the technology [2].

<i>Learning</i>	<i>Technology</i>
Personalized	Personal
Learner Centered	User Centered
Situated	Mobile [Dynamic]
Adaptive	Context-aware
Collaborative	Networked
Ubiquitous	Ubiquitous
Lifelong	Durable

First of all, computing is not predefined to any time or any location anymore but it is rather ubiquitous. Pervasive Computing is considered to be the third wave in the computing where the first wave is main frame computing – one computer for many users-, the second wave is personal computing – one computer per user -, and the third wave is the one where many computers are available for many users [3]. In this respect, learning is also not limited to predefined times or places, whenever wherever, and formal education has become insufficient

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to provide people with the all required knowledge and skills, people need to continually enhance these abilities [4]. On the one hand the CAL (Computer Assisted Learning) systems using desktop computers are not embedded in the real world, and are not mobile, therefore those systems hardly support anytime and anywhere learning [5]. On the other hand most of the smart labs simply remediate the physical space to the classroom. Going pervasive means enlarging or, in another words, augmenting the physical space rather than re-mediating the physical space to the classroom [6].

Secondly, Pervasive Computing envisions that computing shall immerse into the daily life which requires computing systems to be intelligent in order to be adapted to the different settings and to the different users so that users will not really realize or bother about the computing applications and devices around [3]. A successful realization of such an approach can greatly improve the user experience since it is personalized and adapted to the context of the user in which she is engaged. The focus of learning is more on personalization with the goal to enhance learning and performance [7] through considering that learners differ in prior knowledge, skills and abilities, have different demographic backgrounds and show different affective states. Emergence of pervasive learning led to a complete understanding of adaptivity by considering the fact that e-learning systems shall not only provide a user-tailored experience through personalization but shall also adapt (to) the setting in which learners are engaged through context-awareness.

Naturally these objectives introduce many challenges; how do we realize such pervasive learning environments and intelligence, thus adaptivity and context-awareness, how intelligent will they be, who will take the control - learner or system - and how? This paper is based on an interdisciplinary research project on adaptive learning environments. Its interdisciplinary nature is built upon a firm collaboration between three main research domains, namely, instructional science, methodology, and computer science. The focus of the instructional science domain is on the effect of learner control and learners' perception of control by taking into account the individual differences of learners and their learning behaviors. The methodology domain aims at exploring the possibilities and challenges of applying ideas from Computerized Adaptive Testing and Item Response Theory in item-based learning environments for adaptive item selection in order to hasten the learning process and increase motivation. Finally, the computer science domain explores enabling technologies and standards to realize adaptivity through context-awareness in ubiquitous learning environments. In this paper the mutual, as well as distinctive, vision and goals of each domain are presented and discussed from a computer science perspective. Thereafter, we argue for an ontology based approach - justified by the constructed perspective - for ubiquitous, adaptive learning environments. Ontologies, in the context of this project, are to be employed at development time and at run-time in terms of automatic code generation and reasoning respectively. We will demonstrate a possible preliminary use of rule based policies built upon an upper context ontology and a domain context ontology in order to provide adaptive instruction. Automatic code generation will be subject to another publication..

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