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Towards a Descriptive View of Context Usage in Context-Aware U-Learning System

Raoudha SOUABNI[a*], Ines BAYOUDH SAADI[a], Kinshuk[b] & Henda BEN GHEZALA[a]
[a] *RIADI Research Laboratory - ENSI, Manouba University, Tunisia*
[b]*School of Computing and Information Systems, Athabasca University, Canada*
*souabni_raoudha@yahoo.fr

Abstract: Research in ubiquitous learning (U-learning) has gained attention of a large number of researchers and a number of ubiquitous learning systems are now available in the literature. Majority of these systems have been developed to resolve a specific problem in a given context; their development approaches do not dictate ubiquitous context usage requirements to fill in. U-learning systems developers need to have a clear and a general view of how their intended systems make use of the ubiquitous context. This paper introduces a comprehensive view of context usage through three different view-points inspired from Dowson's work (Dowson, 1993) each one capturing a particular aspect of context handling. Then a set of facets is associated to each given aspect in order to study, understand and appropriately describe it. The findings of this research are aimed to provide context-aware u-learning system developers a clear understanding of the context usage in such systems and help in underlining the requirements of the u-learning environment. This research is also aimed to help in comparing and evaluating context-aware u-learning systems according to the descriptive system views.

Keywords: context-awareness, ubiquitous learning, context modeling, context analyzing and management, context execution

1. Introduction

The quality of distance learning is strongly linked to its degree of adaptation to the learning context (Liu & Yang, 2005). This has led to the evolution of distance learning environments into context-aware environments, particularly into ubiquitous ones (Ogata, Akamatsu, & Yano, 2005), with particular focus on learning context. These environments aim to provide the necessary means to take into account the context and assist learners in following a learning situation personalized to their contexts. However, current context-aware u-learning applications are often developed in ad-hoc manner to resolve a specific problem in a given context. Such ad-hoc approaches did not dictate general requirements of ubiquitous context usage; subsequently developed applications rarely fulfill environmental requirements. Hence, u-learning system developers need to have a clear view and understanding of the different aspects of u-learning context usage.

The context usage world in u-learning environments deals with the locations where the context is established and handled. Three interactive domains are inspired in this research from Dowson's work (Dowson, 1993) - to describe processes in process centered software engineering environment - dealing with the three aspects of the context usage (figure 1): *context modeling*, *context analyzing and managing*, and *context execution domain*.

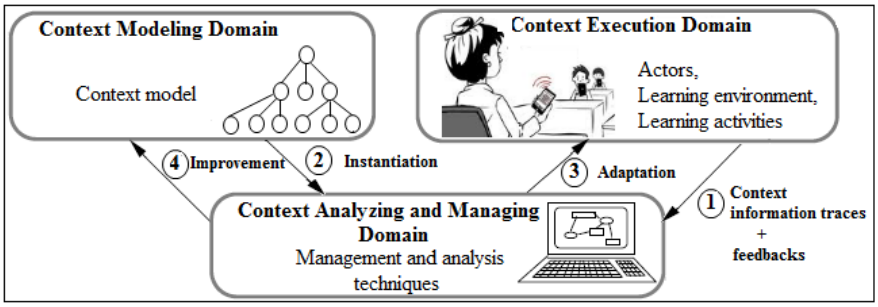

Figure 34. Ubiquitous Learning Context Usage World

2. The context Modeling View

The *context modeling* domain contains the model of the ubiquitous learning context. The context modeling view depicts, throw its three facets, the represented objects covered by the context model, their properties and the degree of faithfulness of the context model. The *coverage* facet concerns the contents to be modeled. The *description* facet treats the properties of what is represented. The *faithfulness of the modeling approach* facet describes the extent to which the established model describes faithfully the real world. Table 1 summarizes the detail of the *context modeling view*'s facets.

Table 17: Summary of the Modeling View

Facet	Facet Details		
Coverage	Coverage: Set (Enum {information, relationship})		
Description	**Context information properties**	**Heterogeneity**	Information source: Set (Enum {physical, virtual, logical }) Information type: Set (Enum {sensed, profiled, derived})
		Mobility	Provider: Set (Enum {local, remote}) Update type: Set(Enum{periodical update, update on change, update on request})
		Quality	QoC parameter: Set(Enum {up-to-datedness, trustworthiness, completeness, significance})
		Subjectivity	Multi viewpoint: Boolean Subjectivity_viewpoint: Set(Enum {system, learner, teacher}) Subjective_rate_type: Set(Enum{quantitative, qualitative})
		History	History_recording: Boolean Recorded_information: Set (Object) History_record_format: Enum {Set (Object), function}
		Abstraction	Abstraction_level: Set(Enum {low-level, interpreted, aggregated })
		Granularity	Granularity_level: Enum {low, medium, high}
	Relationship properties	Relation type: Set (Enum{association, dependency, hierarchy, composition, aggregation, instantiation}) Constraints on relation: Boolean	
Faithfulness of the MA	Faithfulness degree: Enum{faithful, moderately faithful, unfaithful}		

3. Context Analyzing and Managing View

The *context analyzing and managing* view is studied in terms of the following three facets. The *construction* facet indicates the construction technique used for building the current context instance. The *analyzing* facet describes how the *analyzing and managing domain* analyzes detected learning context information. It is described by a set of sub facets concerning the context information processing and the context imperfection detection. Finally, the *managing* facet illustrates the used techniques by the associated domain to manage context information. Facets' details are given in table 2.

Table 18: Summary of the Analyzing and Managing View

Facet	Facet Details	
Construction	Construction technique: Enum {central, distributed}	
Analyzing	**Information processing**	Processing technique: Set (Enum {interpretation, aggregation})
	Imperfection detection	Detection technique: Set(Enum{up-to-datedness based, trustworthiness based, completeness based, significance based, QoC combinations}) Detection level: Set (Enum{context acquisition, context processing, context appliance} Imperfection type: Set (Enum {incorrect, inconsistent, incomplete, redundant}) Detection strategy: Set (Enum {Static, Dynamic})
Managing	**History reuse**	History reuse: Boolean Reused objects: Set(Object)
	Imperfection resolution	Resolution technique: Enum{user preferences based, QoC parameters based, drop-latest, drop-all, drop-bad} Resolution time: Enum{design time, execution time} User intervention: Boolean
	System adaptation	Adaptation factor: Set(context object) Adaptation level: Set (Enum{presentation, content, behavior}) Adapted objects: Set (context object) Adaptation type: Enum{adaptativity, adaptability, mixed}
	Recommendation	Recommended material: Set(object) Material type: Enum {internal, external} Recommendation technique: Enum {collaborative, content-based, knowledge-based, hybride}
	Model adaptation	Runtime model adaptation: Boolean
	Model evolving	Model evolving: Boolean Evolving type: Enum{Dynamic, Static}
	History reuse	History reuse: Boolean Reused objects: Set(Object)

4. Context Execution View

The *context execution* view deals with the detection of the context information and users' feedback. It is described with reference to the *context change* facet and *feedback* facet as mentioned in table 3.

Table 19: Summary of the Execution View

Facet	Facet Details
Context change	Context change type: Set (Enum {new information, updated information})
Feedback	Feedback detection: Boolean Feedback type: Set (Enum {quantitative feedback, qualitative feedback, comments, suggestions})

5. Research Issues

The instantiation of the proposed description of the *context usage world* within a list of six context-aware u-learning systems allows their evaluation by bringing out their main features and limits. Based on this evaluation, it is noticed that u-learning systems need to cover the modeling of a very complex and dynamic learning situation combining online and offline information pieces and relationships. Hence, adaptation factors should cover the combination of situation entities, and adaptation should take into consideration adaptation of the content, the presentation and the system behavior. Context model covers very large context information pieces and relationships which are not all needed based on the runtime detected situation. Hence, runtime model adaptation could be applied to reduce monitoring overhead. A main issue for u-learning systems is to cope with the runtime learning context, especially with unforeseen changes that could occur during system execution.

6. Conclusion

In this paper, a descriptive view of the context usage in context-aware u-learning environments is proposed. Three domains composing the *context usage world* are identified and detailed with reference to their associated views. Each view is described by a list of facets and each facet is described by a list of sub-facets or attributes. The suggested description allows establishing a structured baseline from which the three main aspects of context usage can be easily identified and compared. This description was build to respond to the following purposes: to have a clear overview of context usage within every studied u-learning system, to identify its drawbacks and to analyze the possibility to propose new research issues. In this paper, the focus was maintained on how the u-learning context should be used; however, there is still no consensus on *what is learning context*, *how it should be represented*, and *how its representation should be developed*. Hence, next work will focus on the establishment of a common evaluating framework for u-learning systems along four different and complementary worlds (including the context usage world); each world is capturing a particular aspect of u-learning context.

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