ANALYSIS OF MEANS FOR BUILDING CONTEXT-AWARE RECOMMENDATION SYSTEM FOR MOBILE LEARNING

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ABSTRACT

One of the rapidly developing tools for online learning is learning through a mobile environment. Therefore, developing and improving mobile learning environments is an active topic now. One of the ways to adapt the learning environment to the user's needs is to use his context. Context of the user consists of the current context in online learning environment and physical context. This paper concentrates on the physical context and ways to improve the user's experience in a learning environment. For this an ontology-based system is presented, and Learning Context ontology is extended for User Context ontology. Also, a use-case is provided to show situations which will be covered by such an approach.

KEYWORDS

Context, Context-Awareness, Adaptive Learning, Learner-Centered, Mobile Learning.

1. INTRODUCTION

In recent years, we have witnessed a rising interest in and acceptance of Vygotsky's social development theory (Wertsch & Sohmer, 1995), connectivism (Siemens, 2005) and other modern pedagogical theories, which argue for learners' active involvement in the learning process and construction of knowledge through social interactions.

Success in online teaching and learning can largely depend on the available means or tools students have to be connected to pedagogical resources. These, in turn, rely on the information related to the learners' current context in online learning environments as well as in social networks and instant messaging systems, and furthermore on physical context such as locations, current activity, or place. Such information reveals how present the student is and what could be an appropriate resource to recommend to him to reinforce his learning strategy. If employed in an appropriate way, this information could greatly increase the learning efficiency.

One of the main development of the online presence approach concerns mobile learning environments. Indeed, mobile learning environments have to take into account many parameters of the learners' context including location, current state of mind, activity and the user's environment. Furthermore, mobile learning environments, because of the worldwide deployment of smartphones, are one of the most active developing fields now: for example, e-learning applications make up 10% of all mobile applications (Focus RH, 2017). Thus, designing an app which is able to recommend an appropriate pedagogical resource according to the physical context of the learner is an important challenge. Learners are connected through their mobile phones, and this mobile phone is like a "part of them". So, for efficient user-application interaction the mobile phone should provide an automatic adaptation of its content and system behavior to learner state and needs.

2. RELATED WORK

Context-aware applications have been the subject of debates among researchers in different domains (Armstrong et al., 2000). Based on the requirements and characteristics of each of these domains, the term "context" has been interpreted in different ways (Bazire & Brézillon, 2005), and different approaches have been applied to capture the contextual information. One of these domains is Ubiquitous Learning environment. This approach contains two underlying contexts, namely the learning context and the mobile context.

2.1 Definition of context

We follow the definition of context provided by (Anind, 2001): "context is any information that can be used to characterize the situation of an entity. An entity can be a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves".

In our project, context dimensions are time, user's physical activity (walking, biking, running etc.), user's location and calendar information. The User Context ontology is based on these context dimensions. Learning situation is presented as a set of parameters: 1) learning activity; 2) learning content; 3) learner –whether the user involved in learning process; 4) context of the learner.

2.2 Formal description of domain

For providing common underlying language of the items in domain, ontology approach is chosen.

There are several metadata standards for description of learning objects. The Dublin Core metadata initiative (dublincore, 2017) contains base description of learning resources, but it does not contain attributes describing the pedagogical perspective of a document. Also, there is IEEE LOM (Learning Object Metadata) that was developed under (imsglobal, 2006). IEEE LOM has technical standards, recommended practices, and guidelines. Technical standards allow taking into account more details about learning objects. So, in this work IEEE LOM is used.

According to the best practices of reusing domain ontologies, most of used ontologies are inherited. Therefore, consequent ontologies will be used for describing learning systems. LOM-FR (LOM-FR, 2017) that is a IEEE LOM extension for France. Learning Context Ontology (IntelLEO D3.2, 2010) describes learning situations: learner activity and the result of it, the time when the activity takes place, online environment where it takes place etc. The User Model ontology (IntelLEO D3.2, 2010) provides a formal representation of a learner: his profile information, short / long term goals, and preferences. The Competences ontology (IntelLEO D3.2, 2010) provides information about the level of skills that the subject has. The subject can be represented as a user or a LOM object. The User Context ontology represents the context of a learner based on concepts such as Time, Place, Calendar, PhysicalActivity (Madkour et al., 2013). (Torniai et al., 2008) provides information about equipment (smartphone). The activities ontology (IntelLEO D3.2, 2010) allows modeling the learner's activities as reading, quizzing, etc. The Annotations ontology (IntelLEO D3.2, 2010) allows modeling user's ratings of materials for keeping it as user's history.

3. DESCRIPTION OF THE SYSTEM ARCHITECTURE

In spite of the fact that the provided architecture of recommendation system takes into account the user's long-term goal, it makes recommendation relevant to current user's state and doesn't provide a plan for future learning. The first time the user opens the system, it creates a model for him based on his profile information. Further usage of the system makes the user's model more accurate. User's context can be subject to change his model even during the offline time. To take into account these changes, user's calendar will be used.

Considering the user as a person that supports life-learning approach. In this case, she has some learning strategy. Therefore, the following user's characteristics can be specified. First, the user has an e-learning resource system that specifies material that the user learns on his own or in school or university (e.g. a university system that provides structured learning content divided in lessons). Second, the user makes planning in his calendar and connects the calendar events to learning materials in the e-learning resource system if it is possible. If it is not, the user comments the events by adding keywords or topics relevant for the event. Also, in the end the user makes notes whether the event was accomplished or not.

3.1 Description of the learning environment

Actions, performed by the system when the user opens the application, are provided below.

First, it gathers information about the user's context: his local time; where he is (location); his activity; makes rough estimate of the number of people around him (many people, few people, nobody); checks if headphones are plugged in or not and if the user is particularly close to a specific location.

Second, it checks the user's calendar: processing all events which have happened since the last session. Processing events means enriching the user model with the skills that user has obtained or honed while offline. If the learning event is specified in the calendar and there is some learning material attached, the system should analyze the LOM description of this learning object and add it to the model of user. It impacts the upcoming user events and extracts user current needs and predicts the time that the user could spend in the system.

Then, the system makes recommendation in the following way: it determines and ranges domains, topics, or keywords that will be interesting based on base information like user's profile, user's history, long-term goals and the gathered information etc. Then, it estimates the level of expertise of the user in these areas. It will be useful if the user forgets some material and wants to review it. Also, it is easier to learn new material by making association rules with the one that is already learned or being learned; after that, it makes recommendation of some learning material as presented in Figure 2.

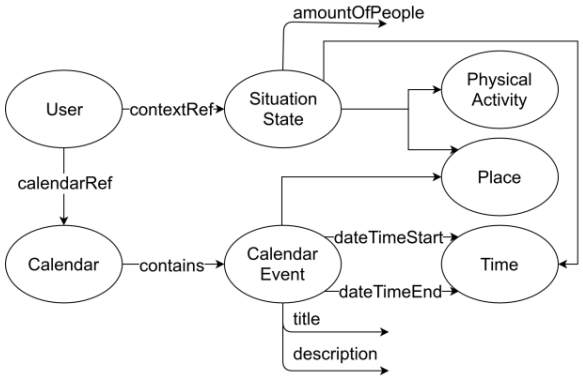

Figure 1. User context ontology.

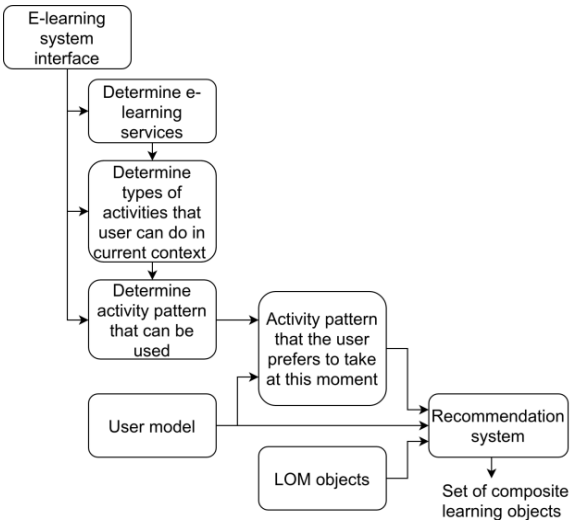

Figure 2. Structure of the proposed recommendation system.

3.2 Design of the recommendation system

The recommendation system uses mix content-based and context-based techniques. The user context defines the type of activity that the user can do and the LOM objects that are appropriate to him in this current situation. Firstly, the system checks available e-learning services (for example, spell checker, quizzes engine, text / audio / video viewer, etc.). Then, it determines the types of activities and activity patterns that are suitable to the user based on the available e-learning services and the user's context. The type of activity is a composition of learning resource type (evaluation, questionnaire, guide, etc.) and the LOM format.

Determine learning pattern as a way of learning data representation. Examples of learning patterns are different types of quizzes (yes-, no- questions, one choice or multiple choice tests, etc.), video, audio, text material with or without quizzes build in the lesson or at its end, etc. Composite learning object can be built as a combination of atomic learning objects. This allows learning object to be a combination of a learning pattern and learning data. Figure 2 shows the structure of our recommendation system.

3.3 Use Case

Consider the following use case of our system. The user is a student. He uses a calendar for planning his time. In the calendar, the events are labeled with such information as full description, the topics, and the location. Now, the user is going by tram to his classes. Usually he has a few different lessons a day, so, he has a large variety of things to review: prepare to his classes and for the upcoming events or explore the domains within the scope of his interest. To cope with this amount of learning materials, the user uses the provided system. This system does not make the choice for him, but it provides him with recommendations on what to study in the current period of time, taking into account his plans for the day and the available amount of time that he could spend in the system. After system approves with user amount of time that he plans to study it provides him with learning material.

4. CONCLUSION

In this work we design the architecture of a context-aware e-learning system to enrich user's model with his context that accurate recommendations. To demonstrate the designed system we suggest a use case. Our next step will be to implement the system's prototype and to evaluate its effectiveness in real environment. One of the directions for future work is to connect calendar events with learning objects provided an external e-learning resource system and then take them into account when measuring the user's growing competence outside of provided system.

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