Exploiting the Link Between Personal, Augmented Memories and Ubiquitous User Modeling

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Abstract. Dense logging of a user's interactions with an intelligent environment enables the creation of artificial memory structures, which augment the user's natural memory. In this article we discuss the interrelationship between such augmented memories and ubiquitous user modeling, and the particular benefits of linking both concepts. On the basis of a prototype implementation, we illustrate how ubiquitous user modeling contributes to the building of personal, augmented memories, and discuss how the latter one may enrich ubiquitous user models and thus grant other applications access to memory content. We conclude with a discussion of how users may exploit such hybrid systems to share their personal memories with other users.

1 INTRODUCTION

Driven by promising applications in the field of user modeling and decision support, research on mechanisms for augmenting a user's natural memory with information automatically captured in the user's context has been conducted since many years (see for instance [2], [5], [6]). Following that tradition, the project SPECTER researches how a personal, augmented memory can be built and exploited in an everyday scenario, in particular, shopping (cf. [4]). SPECTER's event-based memory is created from dense logs of data automatically captured in its user's context. In this article we describe how ubiquitous user modeling may contribute to building and exploiting this specific kind of data structure.

2 BUILDING AUGMENTED MEMORIES

The basis of augmented memories in SPECTER are *perceptions*, which are built from sensor data recorded in so-called *RDF:Stores*. In brief, these can be described as lightweight sensor memories, which implement based on a unique interface for each sensor specific storage and access mechanisms. RDF:Stores allow applications to access sensor information via a push as well as a pull service. This allows an efficient communication between SPECTER and the environment: Whenever SPECTER enters a new environment, it can poll all information available from the sensors' RDF:Stores at once via the pull mechanism. Later, SPECTER will be automatically notified about changes in the environment via the push mechanism.

These "sensory" memories feed a short-term memory with perceptions. There, incoming perceptions undergo a plan-based situation recognition mechanism, which initiates the construction of entries for the long-term memory and triggers situated user support.

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This way of building augmented memories can be complemented with ubiquitous user modeling: its centralized, uniform structure allows SPECTER to exploit other application's sensing and processing capabilities in order to build entries in the augmented memories and to determine the user's current context. The user benefits from such linking as well, since feedback provided to the ubiquitous user model becomes accessible to SPECTER.

For example, the personalized ambient audio notification (PAAN) service for intelligent environments models the user's preferred musical genres in order to generate personalized music (cf. [1]). This allows to discretely inform the user about private events in public places. These music genre preferences are shared with U2M, and can be edited by the user in the U2M user model editor. SPECTER may apply these preferences in order to adapt retrieval processes performed on the augmented memory.

3 EXPLOITING AUGMENTED MEMORIES

Augmented memories may serve diverse purposes, for instance, context-based reminding and recommending for decision support (cf. the *recomindation* paradigm described in [7]). Despite a clear focus on personal use, it might be reasonable to share parts of the personal memory with other users or application—for instance, the user may select favorite items from the augmented memories, and provide these as examples to the environment in order to receive links to similar items offered there. Such communication may range from submission of somewhat neutral items (e.g., some product seen without personal rating) to complex descriptions of situations representing confidential user actions and/or personal options.

This information has to be delivered to interested applications, which may not only process them for serving the user/system's request, but also for building their own user model. Now the augmented memory described in this article resembles a specific kind of user model on its own, which means that the whole communication is a typical ubiquitous user modeling process. Consequently a ubiquitous user modeling platform qualifies for realizing the exchange; this platform has on the hand to protect privacy and application constraints, and on the other hand to provide any external application with access to the augmented memory.

This procedure provides a straightforward approach for sharing memories between a user and diverse ubiquitous computing applications; in addition, it opens the way for sharing memories between users. The great success of blogging (cf. [8]), shared knowledge sources (e.g., Wiki), collaborative tagging (e.g., *del.icio.us*) and similar applications sometimes associated with the notion Web 2.0 is an impressive demonstration of the high demand for such exchange between users. Sharing personal, augmented memories by means of

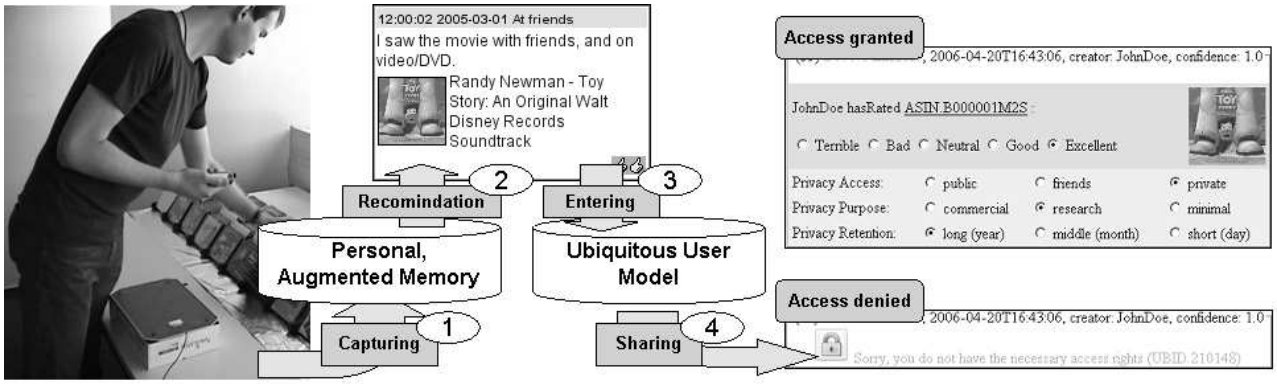

Figure 1. The artificial memory records CDs the user looked at. The user may later reflect on these experiences, and publish selected parts in an ubiquitous user model where it becomes accessible to external applications and other users.

ubiquitous user modeling is one way to transfer such ideas to ubiquitous computing.

Figure 1 depicts this idea by means of the applications SPECTER and U2M. Events observed in the user's environment are automatically captured in SPECTER's personal memory (1). SPECTER exploits such information for recomindation—in our example, the event is shown where the user encountered a certain audio CD the first time (2). At any time the user may decide to submit such information to the ubiquitous user model realized by U2M (3). In our example, the user shares his ratings of audio CDs he discovered in the store. U2M makes the data accessible to other users with respect to the user's privacy preferences (4). The user may specify these for the current sharing process (and thus attach situational constraints), or rely on U2M's default reasoning which derives sharing preferences for the involved objects, actions, etc. from personal defaults set in the ubiquitous user model (cf. [3]).

Future work. Our example illustrates a sharing process that includes activities performed manually by the user. While this approach provides the user with precise control over the shared memories, it requires an amount of attention the user will not be able (or willing) to devote to sharing during other activities. Now the user could specify default preferences on privacy, trust and other aspects of sharing in preparation of such activities, but this requires precise planning of future actions which is not only cumbersome, but also cannot take into account unexpected sharing opportunities.

Automated and/or assisted sharing of personal, augmented memories in ubiquitous computing environments is a way to handle such issues. It forms the background of research in the recently started project SHAREDLIFE; in a multi-user scenario we plan to explore various questions related to sharing memories, including:

- How can community structures serve the situated lookup of information?
- How can the users' sharing behavior be exploited to strengthen communities?
- How can personal sharing preferences be specified using reflection on past events?

4 CONCLUSION

In this article we discussed how personal, augmented memories created from perceptions in an intelligent environments relate to ubiquitous user modeling. On the basis of a prototype implementation, we showed how ubiquitous user modeling may contribute to the building of such personal memories, and how these may exploit a platform for ubiquitous user modeling in order to share memory content with other applications and users. The latter process will be in the focus of our future activities, which will address issues related to automated and semi-automated sharing of personal memories.

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