Building, Exploiting, and Sharing Personal Digital Memories in SPECTER and SharedLife

Alexander Kröner

German Research Center for Artificial Intelligence
Stuhlsatzenhausweg 3, 66123 Saarbrücken, Germany
Alexander.Kroener@dfki.de

Abstract. Intelligent environments allow for creating dense records of user actions, which can be exploited for immediate user support as well as for creating user models, which adapt over time to user behavior. In this article, previous work concerning the building, exploitation, and sharing of a so-called *personal digital memory*, which was conducted in the projects SPECTER and SharedLife, is summarized with a special focus on its potential for life long user modeling.

Nowadays, the building of user models from perceptions made by an intelligent environment is a common practice. Such models may be exploited for a broad range of applications, such as personalization or decision support. The recording of the underlying perceptions and their interpretations has various benefits: in addition to direct user support on the basis of past actions, such "digital memories" enable a system to learn the user's habits. This report summarizes selected results related to this topic, which were obtained in research funded by the German Ministry of Education and Research under grants 524-40001-01 IW C03 (project SPECTER) and 01 IW F03 (project SharedLife).

Building digital memories: User models rely on statements about users, which are often the result of an interpretation of previously perceived user actions. However, in the long-term run, additional knowledge might require a re-interpretation of these actions. This suggests to keep records of the underlying perceptions, which are *free from subjective changes*, and to enable in parallel user-oriented *subjective interpretations*. Furthermore, since it is difficult to predict if some perceptions might become relevant for future interpretation, *perceptions should (ideally) not be discarded*.

The SPECTER memory model [1] supports these goals by various distinct components, and thus provides an potential infrastructure for life long user modeling. Incoming perceptions (actions in their temporal and spatial context) are temporally stored in a "short-term memory". It is limited in size and serves the interpretation of perceptions. In addition, a *context log* serves as a long-term storage for perceptions. It is coupled with a *personal journal* whose entries represent interpretations of perceptions, enriched by explicit user feedback (e.g., ratings). The following example illustrates the interplay of these components: If the perceptions "P disappeared from shelf S", "P appeared at kiosk K", and

"user logged in at K" are reported to the short-time memory in a certain time span, then the system (a) copies them to the context log, (b) creates an interpretation "user looked at P" and stores it in the journal, (c) communicates a list of similar journal entries to the user, and (d) records the provided support in the journal. The context log stores the original perceptions for a re-interpretation at a later point of time, while the journal carries their current interpretation, which might become subject of changes. These result from of a collaborative *reflection* process, where user and system (which is embodied by a virtual character) negotiate recent journal entries. Feedback obtained in that process is exploited to refine a *user model* describing the user's long-term preferences. We realized this memory model as server-based application, which relies on RDF for representing memory contents. For analyzing the journal in terms of user modeling, we experimented with various techniques ranging from domain-specific hypotheses to machine learning.

Exploiting digital memories: In order to learn about how users exploit such long-term structures, we conducted a series of studies in an audio CD shopping scenario, which addressed shopping support from personal digital memories (cf. [2]). It comprised several phases: the exploration of a commercial Internet store, reflection on a desktop PC, and shopping in mockups of two physical stores where the system supported the user via a PDA connected to the personal digital memory. During all phases, user actions related to CD shopping (e.g., "Looking at CD A") were automatically recorded in the digital memory.

A challenging aspect of this study was the amazing performance of the human memory: one hypothesis was that participants would not use the digital memory if the desired information is readily available in their natural memory. Therefore, we repeated the experiment one year later with 9 of the 20 initial participants on the basis of the previously built memories. With respect to the long-term aspect, the study revealed various results: we coined the notion *recomindation* in order to describe one of the most popular functions: the (situated) reminding on past events with the goal to express a recommendation regarding the user's next actions. Furthermore, according to free text answers to a questionnaire, the purpose of reflection was perceived as a way to review past experiences and to annotate them (45% of the answers) and as a way to learn about oneself, in particular, about personal preferences (20% of the answers). However, during shopping participants made little use of functions on the basis of the actual nature of the digital memory such as browsing journal entries along the timeline. In contrast, functions making use of the content of the digital memory were very successful: 35.8% of all function uses addressed the recall of specific information such as known prices for some CD. We speculate that this might be an effect of this phase's temporal constraints, which suggested concentrating on selecting CDs instead of reflecting on the actual background of the system's recommendations.

Sharing digital memories: Human decision making usually takes not only the decision maker's personal experiences into account, but also experiences made by other persons. The sharing of digital memories allows for supporting

this process with non-subjective information as well as subjective interpretations. Here, a challenge is to balance the need for protecting sensitive data with the technical requirement to support search and discovery processes across multiple personal memories. Feedback from a focus group emphasized a strong need for keeping control of memories and for making situational exceptions [3]. The 23 participants understood the need for automated sharing mechanisms, but expressed concerns regarding the efforts needed to configure these.

SharedLife addresses these comments with a mix of approaches. On the basis of a peer-to-peer connection, information may be exchanged between personal journals. A message-based mechanism enables the manual handling of incoming requests (for journal entries) and the respective answers. In addition, the system proposes access policies on the basis of requested contents, which enable an automated treatment of similar requests in the future. Requests and answers are recorded in the personal journal of users involved in a sharing process; the system exploits this data in order to support the user in a reflection on sharing behavior (e.g., concerning the performance of some sharing policy). This approach is complemented by a *community memory*, which is running on a dedicated server accessible by all users at any time. It serves as a public search index for data stored in user models and journals, which the respective user marked explicitly as "public". In order to evaluate this approach, we set up a grocery shopping scenario. There, a user can retrieve from the digital memories of several simulated users information such as recipes, shopping actions, and comments regarding products and stores. Its technical basis is a software-based simulation of three grocery stores, which provide various IT-based services (e.g., product recommendations and navigation support). These services work independently from SharedLife. The latter enables the user to access memories shared by other people, and to exploit that information to refine the stores' services. The evaluation with 20 participants in a shopping scenario showed that user support on the digital memories was perceived to be helpful [4]; however, more research will be required to learn about long-term effects in this particular setting.

References

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