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User identification for cross-system personalisation

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ABSTRACT

Currently, there is an increasing demand for user-adaptive systems for various purposes in many different domains. Typically, personalisation in information systems occurs separately within each system. The recent trends in user modeling rely on cross-system personalisation, i.e., the opportunity to share information across multiple information systems in order to improve user adaptation. Cooperation among systems in order to exchange user model knowledge is a complex task. This paper addresses a key challenge for cross-system personalisation which is often taken as a starting assumption, i.e., user identification.

In this paper, we describe the conceptualization and implementation of a framework that provides a common base for user identification for cross-system personalisation among web-based user-adaptive systems. However, the framework can be easily adopted in different working environments and for different purposes.

The framework represents a hybrid approach which draws parallels both from centralized and decentralized solutions for user modeling. To perform user identification, we propose to exploit a set of identification properties that are combined using an identification algorithm.

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1. Introduction

Nowadays personalisation is regarded as crucial in many areas, such as e-commerce, e-learning, tourism and cultural heritage, digital libraries, travel planning and interaction in instrumented environments. As a consequence, a large number of user-adaptive systems have been developed. In a user-adaptive system, the available personal information about a user (preferences and system's assumptions about the current user's state) are stored in a user model (UM). Applications can build a model of the user in different ways, e.g. exploiting the information the user has entered upon registration, clustering users in stereotype categories, tracking user behavior and reasoning about his/her interests and competencies, learning from interaction with the user, and allowing the user to inspect and change his/her model [9]. The model of the individual user is often conceived as an overlay of the domain model. This allows the user's current state with respect to domain concepts to be recorded. On the base of such user information, the system uses reasoning strategies to derive further knowledge about the user from the user information, to update the model, and to choose adaptation strategies and techniques.

The proliferation of user-adaptive systems, especially on the web, represents a chance for users to interact with many of them. This implies the possibility that a lot of data on a specific user (e.g. characteristics, preferences, knowledge, interests, goals, activities) are replicated over many applications. Thus, the user profile is inherently distributed.

The major challenge is to develop environments where user-adaptive systems cooperate in a "many-to-many paradigm" to exchange knowledge about the user [35].

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This scenario represents cross-system personalisation, i.e., the chance of sharing information across multiple information systems in order to improve user adaptation [29,37]. Thus, information about a user, which is originally scattered across multiple systems, is combined to obtain maximum leverage and reuse of information. In recent years, researchers have extensively explored cross-system personalisation for different purposes and in different domains. Research to date has focused mainly on user model representation, data integration, conflict resolution, application of semantic web techniques for user modeling, privacy, security and trust, etc.

This paper addresses a key challenge for cross-system personalisation that is often taken as a starting assumption, i.e., the identification of users across systems. In user-adaptive systems, identifying a user means to *authenticate* the user when accessing the system, e.g. through cookies, password management and registration forms.

In cross-system personalisation, user identification refers to the process of identifying a subject by its characteristics.

In this paper, we describe the conceptualization and implementation of a framework that provides a common base to perform user identification for cross-system personalisation among user-adaptive systems. More specifically, we focus on those user-adaptive systems provided on-line, known as web-based systems. Notice that the user identification problem is not only limited to user-adaptive systems: it applies to all systems that need to identify users. More specifically, user identification may be relevant and needed in several domains, e.g. finance, telecommunications and manufacturing. Typically, systems working in such domains need to perform user identification to make a financial transaction secure, or to ensure that a business contract is related to the corresponding person. Another domain in which user identification is particularly relevant is healthcare, where user identification is the identification of patients. It is evident that, in this specific domain, correct user identification is crucial.

Therefore, the framework we propose can be adopted easily in different working environments and for different purposes.

In Section 2, we present an overview of the cross-system personalisation issues. Section 3 presents an application scenario showing the relevance for user identification for cross-system personalisation. The framework is presented in Section 4, which includes the conceptual description of the approach (Sections 4.1–4.3) and a description of the identification algorithm (Section 4.4). Some implementation remarks are made in Section 5; while Section 6 describes an instantiation for the case study presented in Section 3.

In Section 7, an evaluation of the algorithm is reported. Section 8 illustrates the privacy issue, while Section 9 offers an overview of the related work which inspired this research. Finally, Section 10 concludes the paper providing some future directions and open issues of the current project.

2. From user models to interoperable user models

Recently, user-adaptive systems have been widely deployed in different areas and for different tasks.[1] Although these systems are heterogeneous, many of them concern similar domains. The knowledge about a user represented in the applications working in similar domains shows a partial overlap. This is because the knowledge represented in a system is strictly related to the domain in which the system acts. For this reason, even if the user model of a system is defined independently by the other systems, applications in the same domain may be similar in the information they maintain.

The great proliferation of user-adaptive systems means that a user is likely to interact with many such systems. Since each of them builds its own model of the user [30], the result is that the user profile is scattered across multiple systems. Thus, there is no common "memory" of all user activities, preferences and characteristics, which would allow effective adaptation to the user's current state. One way of achieving a rather complete picture of a user's experience is to allow systems to share user data. This is especially valuable when a user's interaction with an information system is part of a larger task that covers several interactions with different systems [18,31]. This is cross-system personalisation: the sharing of information across multiple systems to improve user adaptation [29,37].

There are many advantages to cross-system personalisation.[2]

Kobsa and Koenemann [25] seek to use cross-system personalisation to speed up the phase of the user model initialization. Vassileva states that cross-system personalisation relieves users from the pain of training new systems [39]. In fact, every time users interact with a system for the first time, they have to provide data they may have already provided to other applications. On the contrary, users typically do not appreciate wasting time to explicitly fill in their model for the applications they use. More generally, Berkovsky assumes that cross-system personalisation enhances the user model knowledge stored in a system (we refer this to *qualitative* improvement) [4]. Carmagnola et al. [12] and Schwartz et al. [23] make reference to an increased amount of information about users, since there is the chance to benefit from the efforts led by other modelers and systems. Cross-system personalisation gives the model increased coverage, because more aspects can be covered by the aggregated user model, including the user model features that one system could not acquire by itself (we should refer to this as *quantitative* improvement).[3]

To summarize, the additional knowledge about the user, which comes from cross-system personalisation, allows systems to obtain a deeper understanding of the user, leading to more appropriate adaptation.

[1] For an extensive survey on adaptive systems, the interested reader can refer to Kobsa [27].

[2] For a more detailed overview, see Carmagnola and Cena [12].

[3] Notice that qualitative and quantitative improvements are connected. As stated by Vassileva "the more information is available, the more adequate the user model and consequently the adaptation process will be" [39].

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