

Context-aware, Personalized Services for Smart Cities

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Abstract. This work presents a user-centric service deployed in a Smart City by means of mobile devices and Interactive Community Displays (ICDs). The service considers personalization and contextual information to bring city services closer to people living in or visiting a city by interconnecting people, service providers and locations. The personalization is concerned with several issues typically encountered in the representation of user profiles, such as cold-start problem, content filtering and user feedback.

Keywords: Smart city, personalization, context-awareness, user profile adaption, mobility.

1 Introduction

Nowadays it is becoming common to search for domain-related content and activities through mobile devices, such as Smartphones or tablet PCs, along with Interactive Community Display (ICDs), which are multimedia information points offering interactive services on the public thoroughfare [2][6][9]. Anyhow, these services usually do not distinguish users as individuals and provides similar information to users either with different characteristics or in different contexts.

A concrete way to achieve an effective personalization is by means of user profiles storing user preferences that consider the context of the users. Although user profiles use to represent a common practice in personalization systems, they intrinsically bring several issues [1]. For instance, anonymous users do not have an initial profile; so predicting initial user preferences is required to avoid the cold-start problem. Moreover, user profiles' representation should be rich enough to represent preferences which depend on contextual information, and sufficiently compact to be able to be processed in an efficient way. The representation through the insertion of semantics provides the ability to discover, integrate and reuse content. Besides, it makes it possible to match such content with user preferences for a given time or place. Last but not least, user preferences must be adapted according to the user feedback in order to increase the knowledge about the user and thus enhance the personalized flavor of the suggestions.

In this work we present a multi-stage user profile adaptation process by means of semantic representation, preference handling methods and ambient intelligence.

2 System Interaction and Content Provisioning

The user profile adaptation process follows four sequential phases each time the user interacts with the system (Figure 1). In the following, the general process is overviewed and each step is briefly depicted.

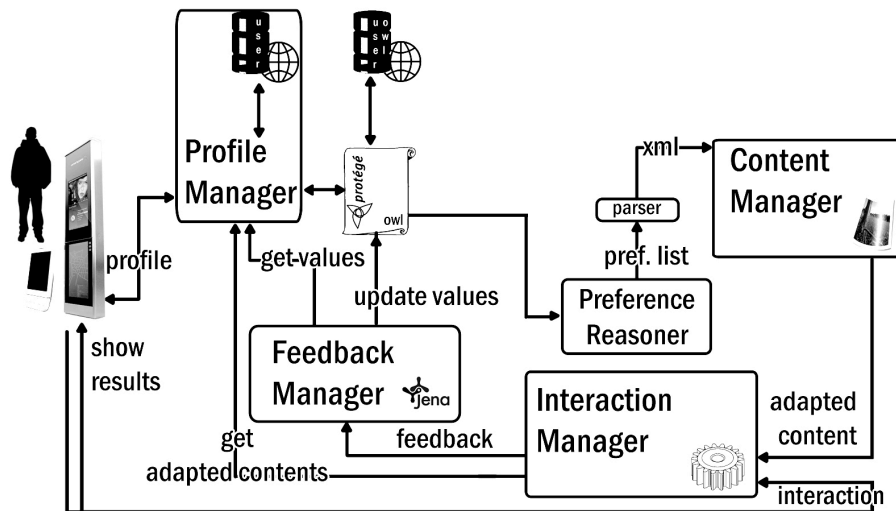


Fig. 1. Overview of the User Profile Adaptation Process

2.1 Adaptation Process

The *Profile Manager* deals with the representation of user preferences. At the first user interaction an initial user profile is assigned and stored according to the profile ontology, which contains weighted contextual preference relations. In the case of new users, the user profiles are created inheriting preferences from predefined user groups. Then, the user profile representation is provided to the *Preference Reasoner* [3][4], which also collects the current context to reason about the corresponding context-aware preferences. The reasoning generates a sorted list of preferences, which are then processed by the *Content Manager* in order to match the appropriate suggestions to be provided. Finally, once the suggestions are provided, the user can express some feedback (implicit or explicit) that is processed by the *Feedback Manager* to update the user profile.

2.2 User Profile Management

The *Profile Manager* represents the user profiles presented above and is supported by a User Model [7][8], that is, a knowledge base and a set of reasoning mechanisms regarding user's characterization in order to outline their preferences and

requirements and adapt the interaction to them. The knowledge base contains facts relating a user (or a group of users [5]) with a user feature and a value (within that feature domain). A user feature might be any perceivable attribute or behavior of the user, observed within the user profile ontology described in the previous section. Specifically, this system counts on a predictive statistical user model [11].

This User Model is populated through experience, that is, each session held with a user increases the knowledge base in order to improve future interactions. The information acquired from the interlocutor is anonymized and shaped into a stereotype, which will be stored as a new group or used to refine an existent one. However, the model supports an initial knowledge load.

2.3 Profile Update based on Provided Feedback

The *Feedback Manager* is responsible for adapting user profiles by processing users interactions and valuations on provided suggestions [10]. The evaluation process follows two modes: (i) explicit evaluation, contemplating an explicit rating of the user on each suggestion; (ii) implicit evaluation, considering user selections on the provided suggestions as positive feedback. In this case, preferences related with such suggestions are rated with a default value.

Once the evaluation is performed, the *Feedback Manager* receives a list of distinct rankings of each preference evaluated in a set of contexts. Thus, the module interacts with the *Profile Manager* to update or create new preference rules based on a given context set.

3 Conclusions and Future Research

This work presents a user profile adaptation process that takes into consideration the context of the user. The adaptation of user profiles and the recommendation of content and activities are based on several factors such as profile assignment, content filtering and user feedback.

In cases where anonymous users use the service, Group User Models prevent the cold start problem. However, in any case, the user profile must be continually adapted based on user interactions and feedback, due to the fact that the initially assigned profile is not close enough to provide the user with personalized content. In fact, the service offers the user the possibility to provide an explicit feedback by means of ratings, and also processes the selections of the users to extract implicit feedback. Since new context-aware preferences can be created and updated in each feedback process, the more feedback received, the more adapted is the profile w.r.t. the user necessities.

The service envisages the customization of content, taking into account not only a user profile, but also the surrounding environment. For this reason, several sensors are required to capture relevant data on the location, interaction and context, thus providing an ambient intelligence.

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