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A SURVEY ON USER PROFILE MODELING FOR PERSONALIZED SERVICE DELIVERY SYSTEMS

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ABSTRACT

User profiles have been suggested to enable personalized adaptations and decrease unnecessary dialogues between the user and the system. In this paper, we first discuss the role of the user profile for personalized service delivery systems, and then analysis the formation of a user profile, after that, we investigate the current user profile modeling approaches. Finally, the challenges of user profile modeling are discussed and future research directions are concluded.

KEYWORDS

User profile, personalization, Human computer interaction.

1. INTRODUCTION

Personalized service delivery systems are adaptive systems that could adapt their behaviors to meet particular Needs, Requirements and Desires (NRDs) (Salem and Rauterberg 2004) of the users. Examples of such systems are personalized entertainment (Shi 2005), query enhancement (Korfhage 1984, Pretschner 1999), digital libraries (Amato 1999) and the personalization of websites (Goel 2002), customized museum tours (Oppermann 2005), or exhibitions (Kraemer and Schwander 2003), etc. These systems aim to make adaptive systems more usable, present the user with what they want to see, as well as speed up and simplify interactions, etc. For example, Oppermann (2005) has identified four characteristics of the personalized service delivery system behaviors to be adapted to the user to meet his/her NRDs: (1) the information and service selection (content needed by the user), (2) the functionality (features needed to perform tasks), (3) the information presentation (modality and coding needed to receive the content), and (4) the human-computer interaction (methods needed to enter commands or data and to receive information and services).

The information of a user which can reflect his/her NRDs on the preferred system behaviors explicitly or implicitly is called a user profile or a user model. It is usually be integrated into the system to impart the user knowledge to the system to enable personalized adaptations and avoid “unnecessary” dialogues between the system and the user. In this paper, we provide an overview of existing practices and discuss foreseeable trends in user profile modeling in personalized service delivery systems.

This paper is organized as follows: in section 2, we investigate the current user profile modeling practices in personalized service delivery systems. After that, we examine the user profile creation methods in section 3. Following section 3, the challenges of user profile modeling, creating are discussed and possible research directions are presented in section 4. Finally, the main conclusions are drawn in section 5.

2. CURRENT USER PROFILE MODELLING FOR PERSONALIZED SERVICE DELIVERY SYSTEMS

In this section, we first discuss the role of a user profile. Then, the formation of a user profile model is analyzed, after that the current user profile modeling approaches are investigated.

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2.1 The role of a user profile

Many works discussed and investigated the role of user profile for adaptation. For example, In (Kavcic 2000), Alenka Kavcic pointed out that a user profile helps the user finding or accessing relevant information, tailoring information presentation to the user, or adapting the interface to the user. Storey V. C. (2004) proposed the role of user profiles for context-aware query is to increase the accuracy of web pages returned from the Web. Judy Kay (2001) identified three main ways that a user model can assist in adaptation: (1) interpret user actions to eliminate the ambiguity. A example is describe by Shari Trewin and Pain (Trewin 1997) whose system monitored the typing problems displayed by users with motor difficulties so that it could identify difficulties such as long key depression errors; (2) the user model can drive the internal actions of the system. This is the goal of systems which filter information, select the right system functionalities, etc. on behalf of the user. For example, Goel (2002) implemented an adaptive system that uses the user profile to create a view of a subset of a web site most relevant to him/her; (3) machine actions can be controlled by a user model to improve the quality of the interaction. A very simple example might involve the system tailoring its presentation form to the user. More sophisticated cases involve adaptation of the content as well as the form of the presentation. For example, Zhao (1998) discussed the design considerations of a personalized browser for inexperienced elderly users. The advantage of the browser is that it can be tailored to the personal needs and preferences automatically and achieve personalization by observing the discourse between the user and browser. User interface adaptation and personal information space adaptation are combined to address simplicity and usefulness issues for inexperienced users. These three ways are illustrated in Figure 1 where the double vertical lines delimit the interaction between the user and a system.

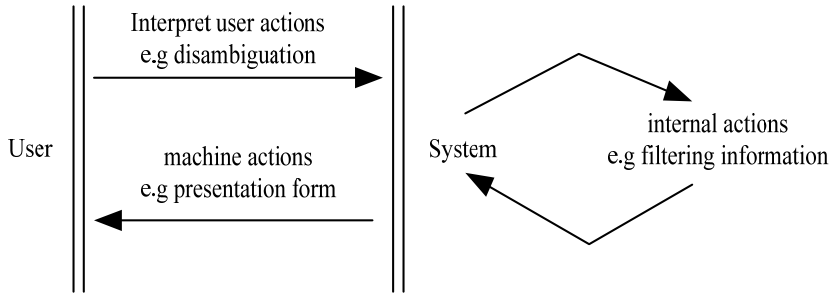

Figure 1. Role of the user model in adaptation (taken from Judy Kay 2001)

2.2 The formation of a user profile model

Personalized service delivery systems have been discussed and developed since the early days of computing. In the eighties, the computing paradigm was user-adaptiveness where the user and task characteristics are considered for adaptation (Edmonds 1981; Kobsa and Wahlster 1989). Later, in the nineties with technology developments interests developed beyond user-adaptiveness and moved more generally to context-adaptiveness (Schilit, Adams et al. 1994; Dey and Abowd 1999) where the context of use is also considered for adaptation. Context of use is a categorization of the actual situation under which the service is delivered by the system. It implies the user's NRDs on system behaviors.

No matter it belongs to user adaptive system or context adaptive system, the personalized service delivery system in general needs the user profile to represent the user's NRDs on desired system behaviors to enable personalized adaptations and avoid the "unnecessary" dialogues between the system and the user. For user-adaptive personalized service delivery systems where the user and task characteristics are considered for adaptations, the formation of the user profile is a sub set of the intersection collection between the real world user model and the system's available system behaviors. The real world user model includes the user's personal demographic information (age, gender, grade...), user's capabilities (background knowledge, proficiencies, cognitive and non-cognitive abilities...), user's interests, and etc information. The systems behaviors are the system interactions with the user, which may include the service functionalities, service contents, service presentation forms, service delivery ways, etc. The intersection

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collection between the real world user model and the system's available behaviors includes information items which can reflect the user's NRDs on the preferred system behaviors. Generally, the more of these information items are included in the user profile, the more usability and personalization the system could bring to its users (refer to figure 3). However, at the same time, the more complex of the user profile, the more work the system needs to create, manage and update it. So, the system designer needs to make a balance between complexity and usability. For example, in (Kavcic 2004), Alenka Kavcic pointed out that a perfect user model for adaptation in educational hypermedia should include all features of the user behavior and knowledge that affect their learning, performance, and efficiency of the educational hypermedia. However, because the construction of such a complex model is very difficult, simplified models which are sub sets of the intersection collection between the user and the educational hypermedia system behaviors are used in practice. Similar example and conclusion can also found in (Kobsa 1990); for the context-adaptive personalized service delivery systems where the context of use is also considered for system behavior adaptation, the main contents of the user profile is a subset of the intersection collection among the real world user model, the available system behaviors and the context of uses (see figure 2). The information items in this sub set can reflect the user's context-aware NRDs on the preferred system behaviors. For example, the user profile in (Yu 2004) is composed of two parts: user's preferences and history activities (tracks). The user can update the preferences according to his/her specific contexts. The history is ordered by time-space and theme (e.g. conference). Similar example presented in (Suh 2005), user profile is categorized into two according to its characteristics: one is static, the other is dynamic. Static user-related information is personal information such as name, age, address books, etc. Also, information which a user can initially set as his service-specific desires through Graphical User Interface (GUI) offered by Service Provider is considered as static. In case of the dynamic user profile, there can be the meaningful context information integrated from preliminary contexts describing user's biological conditions such as stress level, etc.

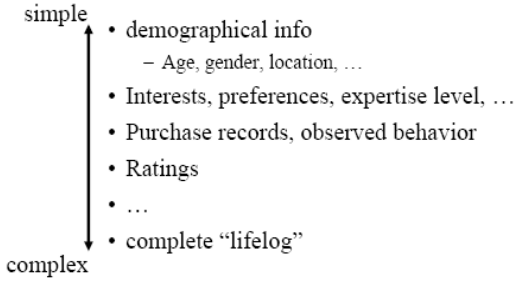

Figure 2. User profile for User-adaptive systems

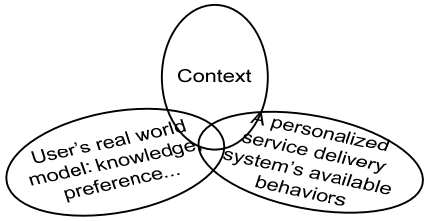

Figure 3. User profile can be simple or complex (taken from Pattie Maes 2005)

2.3 User modeling approaches

Generic user profile models (Avare Stewart 2004) have been considered as one approach for user profile modeling. Generic user profile models are, in theory, systems which have, among other aspects, two major goals: 1) generality: which would allow a model of the user to be usable in a variety of application content domains; 2) expressiveness: in that the model is able to express a wide variety of assumptions about the user. However, due to the vast increase of possible scenarios in different application fields with their inherent different demands and constraints, it is unlikely to have a generic user model to work for a variety of application content domains. Instead, as Kobsa (2007) pointed out that one can expect to find a variety of generic user modeling systems, each of which is going to support only few of the very different future manifestations of personalization. Currently, the research on a generic user profile model is still mostly theory, not in practice yet. The sate of the art of user profile modeling is application specific (Maes 2005).

The information in the user profile can be static or dynamic. The static information includes the user's personal demographic information (date of birth, gender, nationality…), user's capabilities (background knowledge, expertise level…), long-term interest which is the user's long evolving commitment to certain kinds of services, etc. For static information elements in the user profile, some information elements such as gender or expertise level can be simply modeled with Attribute-Value Pairs (Christopher Staff 2003).

Attributes are terms, concepts, variables, facts that are significant to the system and the user, and values can be Boolean reals, or Strings; some information elements such as the knowledge of the user considering uncertainty are modeled with more complex modeling approaches such as rules with certainty factors, fuzzy logic, Bayes probability networks or Dempster-Shafer theory of evidence (Kavcic 2004). If there are interconnections within the static information elements needing to model, the hierarchical tree modeling approach (Goel 2002, Pretschner 1999, Shi 2005, Bauer 2002, lin 2001) where the user information such as preference is modeled by dimensions (e.g., sports, reading), each dimension can be further refined with sub dimensions can be used to model the hierarchical relations between information items. The hierarchical relations usually based on the service ontology of the systems (Goel 2002, Pretschner 1999) or domain ontology (Shi 2005, Kim 2007). For the dynamic information elements such as user's context-aware preference items which depend on the context of use, they are usually modeled with rule-based language modeling approach where the delivery of services relates to the context of use with if-then logic. For example, the rule-based modeling approaches for user preference introduced in (Etter 2006, Bartneck 2006, Oppermann 2005, Kraemer and Schwander 2003) relate the context of use to user's desired services provided by the system. The user preference models in these applications are modeled with unrelated preference items. However, due to these models can't express the relationships among rules, so it is not easy to organize and manage the unrelated preference items. If the number of preference items is many, it will cost more system performances to find right preference items. Moreover, because these rule-based user profile models are based on the common service structure of the system and does not consider building personalized service structure which relates to the user's personalized decision tree (Steffen pawn 2000 and 2005), so, if the user desired service has been removed which is quietly likely because most of the current services are internet-based, it is difficult for the system to recommend alternative services to the user without interruption.

2.4 Source of user profile

In literature, there exist several approaches (Kuflik 2000, Maes 2005,) for creating user profiles:

(1) Users create their own profiles on the basis of their interests, However, Letting the user to input their information explicitly must consider the acceptance of the user and the usability of the system. For example, some user profile information such as the user's date of birth, gender, etc. can be input explicitly by the user by filling in member application forms or questionnaires; However, it is hard to let the user to input his/her preference at event level.

(2) Systems are in charge of profiles construction. With the technology development it is possible to gather some of the user profile information implicitly. For example, Krause (2006) presented a context-aware mobile phone application where the context-dependent personal preferences are learned by identifying individual user states and observing how the user interacts with the system in these states. This learning occurs online and does not require external supervision. The system relies on techniques from machine learning and statistical analysis.

(3) The mixed approach of above, for example some information is entered explicitly by the user, some information is learned implicitly by the system. For example, some static user's demographic information (date of birth, gender, nationality…), user's interest, etc. information are entered by the user explicitly; some dynamic information such as context-dependence user preference is learned by the system implicitly.

3. CHALLENGES

Many works have been done in user profile modeling to enable personalized adaptations and avoid "unnecessary interactions between the user and the system. However, there is still a lot of work to do to improve the user profile modeling to avoid the misbehaving of the system and provide the right service to the user at the right time and location. The following are some challenges identified:

(1) Accuracy: the accuracy of the user profile is a precondition for the system to provide the right services at the right time and location to the user. The ideal condition is that the user profile can reflect the user's NRDs on the desired system behaviors at real time. However, due to the state of the art of the user profile learning is based on mining on the user's past behaviors and predicts what the user might like in the future (Krause 2006, Wang 2006), as the experiment done by Quiroga and Mostafa (2002) suggested, the better

representation of the services, profiles, and relevance feedback mechanisms, the user profile representation, context of use, learning techniques all need to improve the accuracy of the user profile.

(2) Expressiveness: the user profile modeling should be expressive enough to represent the user's NRDs on the desired system behaviors.

(3) The balance between complexity and feasibility: when designing a user profile model for an application, the designer must make a balance between complexity, usability and feasibility, the cost of the system performance (refer to sub section 2.2).

(4) Robustness: With the developing of the internet computing, many of the services provided by personalized service delivery systems are web based services. One of the characteristic of such internet-based services is dynamic. So when designing a user profile, a designer should enable the system to recommend similar services if the user desired services have been removed to increase the robustness of the system.

(5) Ethnical issues: The user's awareness of the user profile modeling abilities of a system is however a necessary prerequisite in order that he or she can decide whether or not to consent to being modeled by the system because (Kobsa 1993):

a) A computer system might pursue non-user interests;

b) The user profile data might be misused, so the privacy protection of the user profile data is important and should be user-awareness.

c) Users should be able to "switch off" a user profile modeling component if he or she does not consent to being modeled;

The designer should highlight these ethnical issues in order to improve the user's acceptance of the system.

4. CONCLUSION

User profile has been an essential component of personalized service delivery systems to enable the personalized adaptations and avoid the "unnecessary" dialogues between the system and the user. The quality of the user profile modeling is a key to deliver the right service to the user at the right time and location. In this paper, we first discussed the role of the user for adaptation, and then analysis the form of user profile needed for adaptation, some examples are given to validate our analysis. After that, user profile modeling approaches are investigated. We present how the dynamic and static user profile information items are modeled differently in the state of the art works. Following that, the challenges of user modeling are discussed. We have identified that accuracy, expressiveness, the balance between complexity and feasibility, robustness and ethnic issues all need to be addressed when designing a user profile model.

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