Entertainment Personalization Mechanism through Cross-Domain User Modeling

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Abstract. The growth of available entertainment information services, such as movies and CD listings, or travels and recreational activities, raises a need for personalization techniques for filtering and adapting contents to customer's interest and needs. Personalization technologies rely on users data, represented as User Models (UMs). UMs built by specific services are usually not transferable due to commercial competition and models' representation heterogeneity. This paper focuses on the second obstacle and discusses architecture for mediating UMs across different domains of entertainment. The mediation facilitates improving the accuracy of the UMs and upgrading the provided personalization.

1. Introduction

Nowadays, digital entertainment content becomes more and more available to consumers via new information services and devices. As a result, consumers increasingly appraise the services enabling them to efficiently navigate through large volumes of available entertainment content and access the most valuable items. This enriches personal entertainment experience and increases consumers' retention, which in turn, boosts the revenue of service providers and content owners. However, this wealth brings with it information overload and rises the need for personalization services.

Providing personalized information retrieval, filtering and recommendation services to the consumers requires users' data, representing their preferences, needs and wishes, to be accessible by service providers [12]. This data is referred in the literature as the user model (*UM*) [10]. Typically, UMs stored by one service are proprietary and tailored to the specific content offered by the service. Since the accuracy (or simply the usefulness) of the provided personalization depends largely on the quality and richness of the input UMs, different services would benefit from enriching their UMs through importing and integrating scattered partial UMs built by other services. We refer to this functionality as *Cross-Domain User Modeling* (CDUM).

CDUM raises a number of open issues. The first deals with the commercial nature of the digital entertainment realm. Due to competition, personalization services usually neither cooperate, nor share their partial UMs. The second deals with customers' privacy. Partial UMs built by service providers may contain private, sensitive information about the customers, which can be disclosed for the requesting service only. Nowadays, there is growing awareness and concern about disclosure and misuse of such information [4]. The third deals with the heterogeneity in the structure, and the incompleteness of the UMs contents. The lack of standard representation, and the specific requirements posed by different personalization technologies, result in personalization services building their models in different, ad-hoc forms. As a result, large numbers of heterogeneously represented and possibly overlapping user data are scattered among various service providers. Thus, there is an emergent need for a mechanism capable of integrating heterogeneous partial UMs for the purpose of providing better personalized services to the customers.

This work discusses the ways of applying CDUM mediation mechanism, initially proposed in [2], in the entertainment domain. This mechanism provides a standardized interface for user modeling data exchange, facilitates translation and integration of partial UMs built by different services, and ad-hoc generation of the UM required by the target personalization service. This bootstraps (if no UM exists), or enriches the UM of the target service and leverages the accuracy of the service personalization.

2 Digital Entertainment and Cross-Domain Personalization

According to Wikipedia (*www.wikipedia.org* – Free Web Encyclopedia), entertainment is "an amusement or diversion intended to hold the attention of an audience or participants". Although other sources provide slightly different (and even ambiguous) definitions, they all coincide on the main sub-domains of entertainment: music, movies, television, radio, tourism and recreation activities, books and literature, humor and others. Clearly, most of them require personalization services to assist users to cope with the vast amount of available information. Moreover, users within these domains, when looking for information, would like to get an immediate and accurate response, or a useful suggestion. They are looking for "a restaurant nearby where we would like to have dinner" or for "a movie in a nearby theatre that we would enjoy" or "an interesting book to read next" and so on. For any of the above, users require immediate and accurate response, which, in turn, requires as rich as possible knowledge about user's interests and needs, and the current context (e.g., time and location, service availability and more). This information may not be readily available to the service providers.

Information Filtering [8] and Recommender Systems [6] are two popular examples of personalized information access services. Although they exploit a wide range of different techniques, both of them attempt at finding information that may interest a user. Recommender Systems are systems that limit the amount of information reaching the user by selecting and displaying the relevant information only. Information

Filtering systems aim at achieving the same functionality through filtering out the irrelevant information from user's incoming information stream.

Growing number of researches tackle the issue of personalization in entertainment. For example, [6] exploits Information Filtering agents to identify movies that a user would find worthwhile. In [14], the authors discuss the Personalized TV Listings system providing a personalized TV guides matching the preferences of individual users. In [5], a variety of recommendation techniques is used to build TV programs schedule answering user's needs. In [1], case-based reasoning technique is exploited to build personal music compilations. NutKing [13] also uses case-based reasoning technique provides personal recommendations for recreation events and tourism activities. Finally, [7] describes online system capable of recommending jokes basing on a small number of jokes' ratings provided by a user.

Typically, service providers independently build up proprietary UMs. Such UMs are not transferable to other services due to commercial competition, privacy restrictions and models' representation heterogeneity. For example, UMs are stored in [6] as ratings of the users movies, whereas in [1] they compilations of music tracks. However, importing partial UMs built by other services, or by other components of the current service, and integrating them with a local UM may enhance the resulting UM, yielding better personalization. We refer to the importing of partial UMs as CDUM.

Generation of a centralized UM as a composition partial UMs stored by different personalization services is proposed in [9]. To accomplish this task, each service maintains a mechanism capable of extracting the needed user modeling data and updating the general model. A similar approach is discussed in [11] proposing the use of Unified User Context Model (UUCM) for improving the UMs built by the individual services. To provide personalization, each service extracts the required data from the UUCM, delivers the service, and updates the UUCM.

3 Decentralized User Modeling Data Mediation in Entertainment

The above studies focus on a centralized user modeling mechanism. A decentralized approach, basing on a *mediator* that generates an ad-hoc UM, according to the requirements of a *target* service, was proposed in [2]. The *mediator* is responsible for: (1) Determining UMs representation of the *target* service, (2) Identifying the services that may provide the needed user modeling data, (3) Integrating the partial UMs and generating UM for the *target* service. Figure 1 illustrates the above process:

1. A *target* service identifies a user requiring personalization and queries the *mediator* for the UM related to the application domain of the service.
2. The *mediator* identifies the personalization domain, and determines the representation of the UM in the *target* service.
3. The *mediator* extracts from the knowledge base (KB) a set of remote services that can provide the partial domain-related UMs.
4. The *mediator* queries the remote services for the partial UMs of the user.
5. Services, storing the needed information, send the local partial UMs.
6. The *mediator* integrates the partial UMs (using the KB) and assembles ad-hoc domain-related UM.

7. The generated domain-related model is sent to the *target* service facilitating provision of a personalized service.

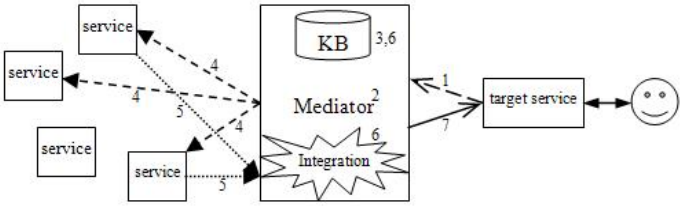

Fig. 1. Functional Flow of the Mediation Process

In order to illustrate the functionalities of the above mediator in the domain of digital entertainment, consider the following example. A big company developed a network of Web-sites supporting personalized entertainment services provision. The network contains music, movies, TV, books and humor personalization Web-sites.

Consider a user requiring a personalized recommendation for a movie. To obtain an accurate UM, the movies Web-site sends a list of available movies to the mediator, and queries it for the movies' UM of the user (step *1*). The mediator analyzes UMs representation in the domain of movies (for the sake of simplicity we assume that the UM is represented as a list of user's favorite genres and their respective weights), and identifies the remote Web-sites that can provide valuable partial UMs (steps *2* and *3*).

Clearly, only the Web-sites from domains, which are closely related to movies, can provide valuable partial UMs. Let us assume that user's favorite movie genres can be inferred from his partial UMs in the domains of TV, books and music, whereas humor-related partial UM can not enrich movies-related partial UM.

The mediator communicates TV, books and music Web-sites and queries them for their local UMs of the user (step *4*). As in our example all the Web-sites are owned by one company, it is reasonable to assume that the issues of commercial competition and privacy are alleviated. Thus, Web-sites storing the user's partial UMs, respond to the query and send their local UMs (step *5*). The mediator integrates the acquired partial UMs into a single UM (step *6*). As the UM is constructed, it is transferred to the movies Web-site, which can provide more accurate personalization.

4 Preliminary Results and Future Research

Preliminary experiments, demonstrating the possibility of cross-domain integration of partial UMs in movies recommendations, were conducted in [3]. There, we partitioned movie ratings UMs to different databases by splitting them according to the movie genres (simulating different, but related domains). The accuracy of the recommendations generated by a single genre UMs was compared with the accuracy of the recommendations generated by the combined UMs (the complete database). The results showed that the recommendations' accuracy was similar, concluding that cross-genre recommendation (as a case of cross-domain personalization) is feasible.

Within the PEACH project [15], we are working towards the provision of personalized guidance and support during museum visits. The visitors are equipped with personal hand-held devices that act as a personal guide through displaying to the user personalized presentations. To bootstrap the initial UM, we import user data from NutKing tourism planning system [13], storing UMs as cases describing user's general travel preferences, and interactions between NutKing and the user during the route planning (queries launched, viewed attractions, chosen route etc).

In the future, we plan to study the issue of semantic distance between different domains, as different domains may be of different relevance to the target domain. Another issue is overcoming the heterogeneity and resolving the conflicts between partial UMs in order to alleviate their integration and to build more accurate UMs.

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