

PersonalTVware: A Proposal of Architecture to Support the Context-aware Personalized Recommendation of TV Programs

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ABSTRACT

The arrival of Digital TV has ensued the growth in the volume of TV programs offered by TV operators increasing the difficulty by users in locating relevant content. In addition, TV users are not required to have as their main task to search for information as it is the case of the Internet. Within this scenario, the recommender systems stand out as a possible solution for this problem. However, the context has rarely been explored during the recommendation process. This paper presents a proposal of architecture of support to context-aware personalized recommendation for Digital TV – entitled PersonalTVware. Finally, a recommender process is described grounded on the proposed architecture.

Categories and Subject Descriptors

H.3.3 [Information Storage and Retrieval]: Information Search and Retrieval—*Information filtering, Selection process*;
H.4 [Information Systems Applications]: Miscellaneous.

General Terms

Algorithms, Design, Experimentation

Keywords

Recommender Systems, Context-Awareness, Interactive Digital TV

1. INTRODUCTION

One of the consequences of the digital revolution was exactly the increase in content options offered through Digital TV (terrestrial, satellite and cable) [13]. Thus, the difficulty in finding the content the user wishes in a transparent way among the available TV program option increased [3]. The traditional tool known as Electronic Program Guide (EPG), therefore, has not efficiently responded to the needs the user has for information. EPG simply displays long lists of TV programs requiring the user to spend a great deal of time looking for information on his favorite programs. Due to the large number of content, finding information on TV programs via EPG by means of a remote control has turned into a hard task. In view of the above-mentioned problem related to the information overload

vis-à-vis the Digital TV [2], the execution of new studies for the development of systems whose purpose is to enable the access to TV programs through a personalized approach is justified. Thus, several works have proposed solutions based on the classical approach of content personalized recommendation [2] [3] [13].

However, most recommender systems for Digital TV have rarely considered the user's context information in carrying out the recommendation [1], which restricts the quality of the generated results. Usually, the recommendation process is based on the level of interest either explicitly obtained or implicitly inferred from the use background of individual or the community of people having similar interests. Without the notion of context, the level of interest can only provide general recommendation.

Thus, this work proposes that some questions related to context can be exploited such as, **who** is the user who is watching television at that moment? **Where** is the user located? In his house? In his office? **How** is the user watching television? Through a mobile, portable or fixed device? **When** does he usually watch a specific type of TV program? In the evening upon arriving at home from work or on Sunday morning? **What** content is considered relevant by the user? Depending on his context, the user may have different preferences and needs.

The research object consists in the investigation of how such contextual dimensions can be exploited during the personalized recommendation process. This work, therefore, is based on the hypothesis that the context can influence the user's preferences when he watches television and proposes the exploration thereof as a promising approach aiming at improving the quality of recommendation in the Digital TV scenario. This article presents the PersonalTVware architecture in order to enable the user to receive the personalized recommendation of content at the right and adequate time and place to the access device.

2. RELATED WORK

PTV [3] was one of the pioneering personalized recommendation projects for Digital TV content, and it has become a reference landmark for many initiatives, which investigate Digital TV information overload. PTV is a system providing an Internet-based personalized TV listings service. Differently from

PersonalTVware designed for both middlewares of European and Brazilian standards – DVB-MHP [9] and GINGA [8], respectively. Zhang and Zheng [13] have developed TV programs personalized recommendation based on the specification of TV-anytime standard metadata and on the Content-based Filtering technique. A fuzzy inference system was used as a method for automatically analyzing the user’s preferences obtained from the usage history. Blanco [2] has submitted a proposal for a personalized content recommendation approach that exploits the Semantic Web technologies. This new approach was proposed in the AVATAR project, within which a personalized recommendation system that makes use of MHP, TV-Anytime and Web Ontology Language (OWL) was developed.

In contrast with the PersonalTVware, the above-mentioned works fail to exploit the user’s context during the recommendation process. Thus, the investigation of the intersection of the recommendation systems as the context-aware systems for the provision of relevant content has increasingly received more attention from the academic community [1].

3. PERSONALTVWARE PLATFORM

This work has been based on the hypothesis that the user may have different preferences as to content depending on his current and also past context. There is a classic definition of context given by Dey [4] that is most accepted and referenced in the academic community: “Context is any information that can be used to characterize the situation of entities. An entity, by itself, can be a person, place or object that is considered relevant for the interaction between a user and an application, including the user and the application itself”. As such, in the Digital TV scenario, to be aware of the context information of the user’s interaction is relevant for the personalized selection and adaptation of contents to be presented to the user [5]. The user’s context can be managed in order to determine what type of TV program is more adequate for recommendation.

3.1 Example Use Scenario

To illustrate the applicability of the PersonalTVware, a use scenario will be initially presented.

“Soon as she gets to the Gym on Monday at 07:30 P.M., Fernanda begins her treadmill work out. She enjoys watching TV programs on sports in her portable device while she works out. Nevertheless, Fernanda does not wish to waste time looking for a TV program through various TV channels. She, therefore, uses to access information on the Digital TV schedule in a personal way by means of a recommendation system that presents a list of recommended TV programs in accordance with her profile and current context.”

3.2 Context Identification

Through the presented use scenario it is possible to identify some context information implicitly present such as “Fernanda”, “Monday at 07:30 P.M.”, “gym”, “treadmill work out”, “portable device”. Such information has to do with contextual dimensions: **who** (identity), **when** (time), **where** (location), **what** (activity) and **how** (a way to identify how the elements of context are collected). To efficiently exploit the user’s context, a context

model geared towards the organization of the main context information extracted from the use scenario was specified. The model is used as a reference in the construction of metadata structures in XML Schemes [12] used in the representation of context information.

3.3 Architecture

The architecture proposed was designed to offer support to the development of applications of context-aware personalized recommendation in a modular and flexible way. The architecture comprises two subsystems: the user’s device and the service provider. The user’s device subsystem could be implemented in a set-top box, a portable computer or a mobile phone, or else, a Mobile TV equipped with an onboard middleware such as GINGA or MHP. The communication between the subsystems will be bidirectional in format through a service interface based in a Web service using HTTP and TCP protocols under the return channel of the device to transmit and receive metadata. Figure 1 illustrate the architecture with their respective modules.

In the user’s device, the Recommendation Manager module interfaces between the client applications and the other modules of the architecture, and it is responsible for the management of the recommendation process by coordinating the other modules of the system. When the user wishes to be informed as to which TV programs have been recommended, he is required by means of a request by the application software to the manager in order that the context-aware personalized recommendation process as described under subsection 3.4 be executed. In addition, the Relevance Feedback [2] also falls under the action of this module enabling the user to assess from among the recommended TV programs those it considers either relevant or irrelevant. This way, this functionality will allow for the expansion the choice restrictions imposed by the filter refining future recommendations.

The User Context Manager module is responsible for the access, acquisition in an implicit way and conversions of the information within the user current context, fact that should generate a history of past contexts. The user-context information will be represented by means of metadata structures in XML Schemas based on the specified-context model.

The User Profile Manager module is responsible for the access and acquisition of the information that constitute the user profile in an explicitly way. Through its components the user will be able to specify information such as personal data (name, age, gender, occupation) and preferences (TV programs, director, actor, topics, among others). This information will be described in accordance with the specifications of metadata of the TV-Anytime [10] and MPEG-7 [6] standards making the representation standardized and structured. In addition to this, owing to privacy and safety reasons, the user profile will be stored only in the user’s device.

The User Context Interpreter module is responsible for inferring implicit preferences per channels and TV program genres from the interpretation of the current and past context information obtained through User Context Manager module. The approach used for performing the inference is based on the use of a set of rules.

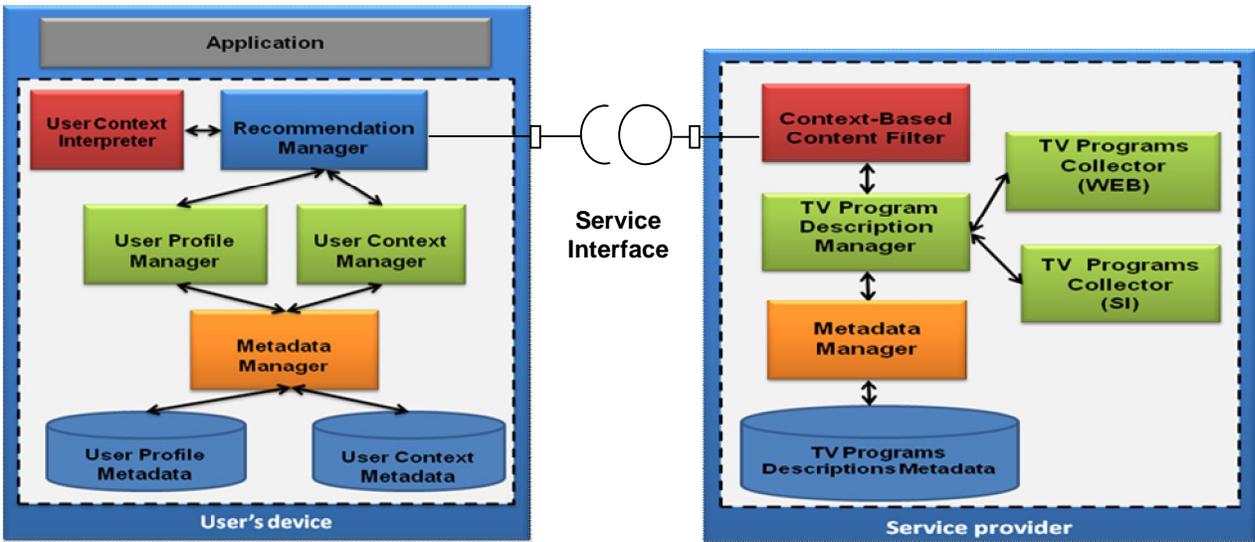


Figure 1. PersonalTVware Architecture

Upon the study of several inferencing methods, the rule-based reasoning method [11] has been selected, since it allows for the definition, in a flexible way, of conditional structures, which reflect the relations among contextual dimensions. If a determined user-context is true, then, corresponding TV programs genres and channels are inferred. For example, if the user's identity 001, recommendation requests on Sunday at 08:00 P.M. in his apartment, using a fixed device (set-top box) **then** he should have an interest in TV programs of the kind of movie-comedy and HDTV channels.

It is also possible to have more than one genre associated to a context condition. This way, asset of rules or contextual preferences can be explicitly defined by the user in accordance with the context variables: location, day, time of interaction and type of access terminal. The inference task for implicit preferences from the history of past contexts is possible through case-based reasoning (CBR) [7], where the context variables (location, day, time of interaction and type of access terminal) define a case. In this type of technique the user preference for a new context is inferred grounded on similar contexts (cases), which had occurred in the past. The context information is captured in an implicit way through the User Context Manager module.

Because of the limitation of the computing resources of the access devices, the Context-Based Content Filter module is located in the services provider. This module is responsible for the filtering of TV programs, which will likely be relevant for the user considering his current context. This way, the filtering process exploits contextual variables (day, time), user profile, his inferred implicit preferences and the descriptions of the contents of the TV programs. The used information filtering has as its base the Content-Based Filtering technique. The TV Program Description Manager module is responsible for the consultation and insertion of information relative to the TV programs. Such information is also described in accordance with the TV-Anytime standard metadata specifications. In both subsystems: user device and services provider, the Metadata Manager module provides the support for the other modules in the architecture, and is

responsible for retrieval, storage and validation of the metadata represented in XML documents. The XML format has been adopted because of the integration with the metadata standards used in the PersonalTVware. This module, therefore, acts as a mediator between the other modules and the database by supplying a set of methods, which enable the handling of metadata in a transparent way.

Finally, the modules: TV Programs Collector (WEB and SI) should be used for capturing information relative to TV programs from outside sources such as WEB and SI (*Service Information*). SI is organized in the shape of tables, which include metadata on services, events, date and time, duration, among other. Thus, the WEB collector allows the system administrator, through a WEB interface, to submit the metadata relative to TV programs. The automatic capture of the schedule grid published in the sites of broadcasters is an alternative that is being investigated. The SI collector is responsible for extracting the metadata from the SI tables provided by each TV broadcaster from a TV signal receiver unit linked to the system. This way both modules are responsible for the automatic updating of the TV program metadata base by means of the submission of the extracted metadata to the TV Program Description Manager module.

3.4 Recommendation Process

Figure 2 illustrates the context-based personalized recommendation process through a diagram of activities. Assuming that the user had explicitly defined his profile, the process begins when the Recommendation Manager module receives a request to retrieve a list of TV programs which have been filtered in accordance with the user profile and implicit preferences inferred from user context identified through his ID. The User Context Manager module is activated to capture and represent the user's current context information such as user's identification, location, day and time of the interaction and type of access device, which should generate a history of the user's contexts. Later, the Recommendation Manager module, having the user's ID checks its respective information from the current context and the user's profile via the User Context Manager and

the User profile Manager modules. Such context information is forwarded to the User Context Interpreter module that should infer implicit preferences by TV program genres by means of a rule-based reasoning method so that the user may receive recommendations as to TV programs, which are adequate to his current context. The Recommendation Manager module receives from the User Context Interpreter the implicit inferred preferences and, then, joins the explicit preferences and personal information as defined in the user profile and sends them to the filtering module. Finally, the Context-based Content Filter module carries out the filtering of the TV programs through the comparison between the contextual variables (day, time), user profile, and his inferred preferences along with the descriptions of the TV programs obtained through the TV Program Description Manager module. This way, upon receiving a request featuring the profile and implicit preferences inferred from a specific user as input, the module executes the filtering of TV programs in order to obtain a list in decreasing order for TV programs based on the value of similarity which will be later forwarded to the Recommendation Manager module.

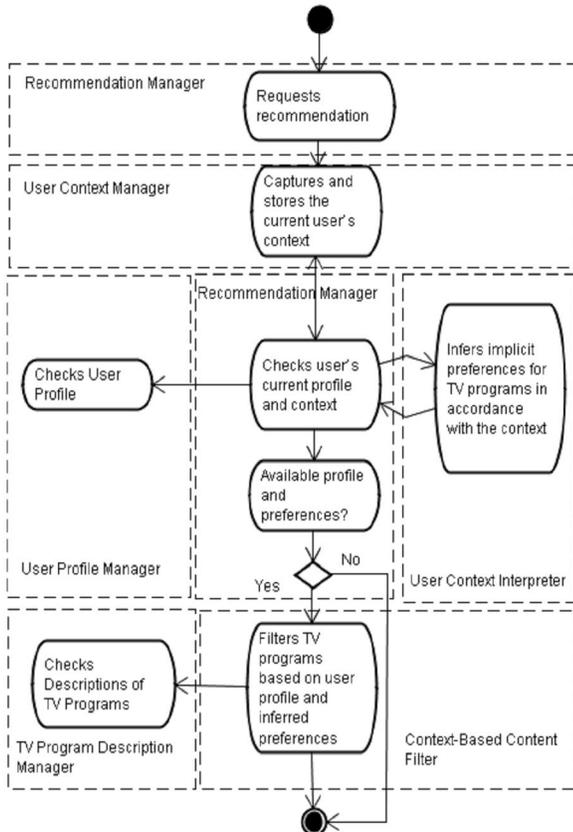


Figure 2. Recommendation Process

4. CONCLUSION AND FUTURE WORK

This paper has attempted to highlight the possibility of exploiting the user's context during the personalized recommendation process as an approach to deal with the information overload problem within the Digital TV scenario. A general view of the proposed architecture for the PersonalTVware was presented

with the objective is to provide a support to the development of application software for context-aware personalized recommendations. A recommendation process that exploits the architecture was further presented. This work, therefore, ought to contribute to the Digital TV interactive application development area that has been increasingly calling the attention of the world academic community, particularly that in Brazil. To the extent digital TV takes hold in Brazil, demand and supply for interactive services will occur, within which personalization will play a major role. Both personalized recommendation application prototypes will be developed in future works and experiments taking into consideration a real environment comprising several interacting users will also be carried out featuring the personalized recommendation applications within several contexts.

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