A Contextualization Service for a Personalized Access Model

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Abstract. Personalization paradigm aims at providing users with the most relevant content and services according to many factors such as interest center or location at the querying time. All this knowledge and requirements are organized into user profiles and contexts. A user profile encompasses metadata describing the user whereas a context groups information about the environment of interaction between the user and the system. An interesting problem is therefore to identify which part of the profile is significant in a given context. This paper proposes a contextualization service which allows defining relationships between user preferences and contexts. Further, we propose an approach for the automatic discovery of these mappings by analyzing user behavior extracted from log files.

1 Introduction

Personalization paradigm aims at adapting applications as much as possible to the user preferences and to the user context. Adaptation may concern several aspects, such as system reconfiguration, communication protocols, data sources selection, query reformulation, data layout, or users feedback handling. Data personalization refers to the set of techniques which allow providing users with the most relevant content. There exist two approaches for adapting and customizing application interactions: User Centric Personalization and Context-Aware Application.

Considering only one of the previous approaches may not be satisfactory for many applications. Indeed, the same user, with different profiles, may prefer listening news during breakfast and listening Rn’B music while driving a car. Alternatively, the same user, at his home context, may have different domains of interest related to his hobbies or to his job. Thus, allowing applications to combine both approaches leverages their adaptability to the benefit of the users.

The goal of this paper is to show, through the definition of a specific service called contextualization, how a Personalized Access Model (PAM) can operate on both profile and context. Given a profile model and a context model, Contextualization is defined as a cross-filtering process, run periodically over the user’s interaction log file to extract possible associations
A contextualization service between profile and context instances (called contextual preferences). The contextualization service is part of a set of services composing the PAM and aiming to provide high level mechanisms to build personalized applications.

This paper is organized as follows. Section 2 gives an overview of the PAM architecture and services. Section 3 defines the contextualization service. Section 4 reports on related works. Section 5 concludes the paper with current results and further research.

2 PAM: The Personalized Access Model

Our definition of a personalized access model aims to provide a generic set of concepts and techniques which can be deployed over a given architecture to make applications adaptable to users’ profiles and contexts. The figure 1 gives an overview of the main components of a PAM.

![Personalized Access Model Architecture](image)

**FIG. 1 – Personalized Access Model Architecture**

The persistency layer deals with the storage and the access to the profiles and to the contexts. It includes the profile and the context catalogs. The functional layer is composed of services for profile and context management, and personalized access services. Finally, the communication layer provides a communication interface between the PAM and users or applications. The role of this layer is, on one hand, to give access to the profiles and the contexts database and, on the other hand, to enable calling the PAM services. The components of the three layers of the PAM are built around profile and context meta models which are generic enough to be adapted to a wide range of applications and which are open to integrate specific knowledge not included initially. More details on the PAM can be found in Abbar et al. (2008).

3 The Contextualization Service

The contextualization service aims at identifying relationships between user preferences and contexts. To achieve this task, the process we propose takes as input the user behavior captured in log files. This process is divided into three steps: result partitioning, mapping initialization, and context specificity check (see figure 2).
3.1 Notation and Problem definition

A user profile is a set of preferences $P_u = \{p_1, \ldots, p_n\}$. Each preference $p_i$ is composed of a predicate $pr_i$ and a weight $w_i$, i.e. $p_i = (pr_i, w_i)$. The weight $w_i$ is a real number expressing the importance of the predicate $pr_i$ for the user. The predicate characterizes a given concept. It is a triplet $\langle$concept, operator, value$\rangle$, e.g. $\langle$Genre, =, 'Drama'$\rangle$.

A context $c_j$ is defined as a set of pairs $\langle$attribute, value$\rangle$, e.g. $\langle$location, 'Paris'$\rangle$. We consider that a context is represented by its identifier $c_j$. The set $C$ is the set of contexts which are of some interest for the application, i.e. $C = \{c_1, \ldots, c_m\}$.

For a given user whose profile is $P_u$, the profile contextualization consists in specifying a set $M$ of mappings which relates the user preferences with the contexts of $C$:

$$M(P_u, C) = \{m(p_i, c_j, \delta) | p_i \in P_u, c_j \in C, \delta \in [-1, 1]\}$$

where $\delta$ is the mapping score of $p_i$ with respect to the context $c_j$.

According to the value of $\delta$, there are three interpretations of the mapping $m(p_i, c_j, \delta)$: a positive mapping ($\delta > 0$) indicates that the predicate $pr_i$ has to be satisfied in the context $c_j$, a negative mapping ($\delta < 0$) points out that the predicates $pr_i$ would not be satisfied in the context $c_j$, and a neutral mapping ($\delta = 0$) specifies that the predicate $pr_i$ is irrelevant in the context $c_j$.

Mappings are discovered by analyzing the user history $H$ captured in log files. The profile contextualization process takes as input a non-contextualized user profile $P_u$, the user history $H$ and the set $C$ of contexts handled by a given application. It returns the set of mappings $M(P_u, C)$.

The remaining of this section details each steps of the process as presented in figure 2.

3.2 Result Partitioning

This first step consists in identifying which content the user liked and which he disliked. This phase produces two sets containing respectively relevant contents and irrelevant contents for each context. In the following, $POS(P_u, c_j)$ and $NEG(P_u, c_j)$ denote respectively the set of relevant and irrelevant contents in the context $c_j$ for a user profile $P_u$.

The identification of relevant and irrelevant contents in the log is done by analyzing actions that the user performed on those contents. Further, relevance of contents in the POS and NEG sets may differ with regard to the type of the action applied to them. In POS set for example,
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A bought product is more important for a given user than visualized one even if user spent a lot of time on it. Thus we propose to organize all possible actions in a relational table which describes actions with their eventual weights. Actions with positive weights are said positive actions and contents on which they are performed are considered as being relevant to the user, whereas actions with negative weights are said negative actions, and contents on which they are applied are considered as being irrelevant.

3.3 Mappings initialization

The second step consists in initializing the possible mappings between the user profile predicates and contexts. This is done by computing the occurrence frequencies $\delta_{ij}^+$ and $\delta_{ij}^-$ of each profile predicate in $POS(P_u, c_j)$ and $NEG(P_u, c_j)$ respectively. The value of $\delta_{ij}$ depends on whether the frequency $\delta_{ij}^+$ (respectively $\delta_{ij}^-$) satisfies a given condition $\gamma^+$ ($\delta_{ij}^+$) (respectively $\gamma^-$ ($\delta_{ij}^-$)) as for instance a threshold.

If only $\gamma^+$ ($\delta_{ij}^+$) holds, i.e. a sufficient part of the relevant results satisfies the predicate, a positive mapping $m(p_i, c_j, \delta_{ij}^+)$ is created. Similarly, if only $\gamma^-$ ($\delta_{ij}^-$) holds, a negative mapping $m(p_i, c_j, \delta_{ij}^-)$ is created. If both $\gamma^+$ ($\delta_{ij}^+$) and $\gamma^-$ ($\delta_{ij}^-$) are not satisfied, a neutral mapping $m(p_i, c_j, 0)$ is created. Finally, if both $\gamma^+$ ($\delta_{ij}^+$) and $\gamma^-$ ($\delta_{ij}^-$) hold, the predicate corresponds to a user preference which is always valid. Thus, a positive mapping $m(p_i, c_j, \delta_{ij})$ is created with $\delta_{ij}$ equal to the average of $p_i$ frequencies in the set union of relevant and irrelevant results ($\delta_{ij} = freq(p_i, POS(P_u, c_i) \cup NEG(P_u, c_i))$).

3.4 Context specificity check

This step prunes mappings which relate the same profile predicate to all contexts. These mappings correspond to the last case discussed in section 3.3 and concern profile predicates which have not to be contextualized as they have to be considered in all contexts. For example if the user watches only movies in English, then all relevant results will satisfy the predicate “language="English"”, but the same will be true for all irrelevant results too. This kind of predicates has to be taken into account in all contexts as it corresponds to a general user preferences. The result of this step is a set of valid mappings between the user profile and contexts.

3.5 Mapping construction algorithm

Discovering automatically contextual preferences is a complex task. Therefore, we made a simplifying hypothesis for the design of the algorithm : All user actions express positive preferences and are of the same importance. As explained before, the algorithm takes as input a user profile $P_u$, logs of user $H$, a set of contexts $C$ and a threshold $\gamma$ for mapping validation. The main step of the algorithm is to compute the frequency in the log of each user predicate for each context. Then, following the value of those frequencies, mappings will be created.

If the predicate has an occurrence frequency that satisfies $\gamma$ in all contexts, then a positive mapping $m(p_i, C, AVG(F))$ is created, attesting that predicate $p_i$ holds in all contexts of the set $C$, with $AVG(F)$ the average of all frequencies of apparition. This predicate is always satisfied independently of the context, thus, it can be seen as a user view characteristic.
Algorithm 1 Automatic mapping discovery

Require: the user profile \( P_u = \{p_1, \ldots, p_n\} \), the user behavior \( H \), the set of possible contexts \( C = \{c_1, \ldots, c_m\} \), the threshold \( \gamma \).

Ensure: the set of contextualization mappings \( \mathcal{M} \)

1: \( \mathcal{M} \leftarrow \emptyset \)
2: for all \( p_i \in P_u \) do
3: \hspace{1em} Compute \( F = f_1, \ldots, f_M \) such as \( f_k = \text{Freq}(pr_i, c_j, H) \) (where \( \text{Freq}(pr_i, c_j, H) \) is the frequency of the predicate \( pr_i \) in \( H \) when the context is \( c_j \)).
4: \hspace{1em} if \( \exists i, j \mid f_i \geq \gamma \land f_j < \gamma \) then
5: \hspace{2em} for all \( f_k \in F \) do
6: \hspace{3em} if \( f_k \geq \gamma \) then
7: \hspace{4em} \( \mathcal{M} \leftarrow \mathcal{M} \cup m(p_i, c_k, f_k) \) \{the predicate holds in the context\}
8: \hspace{3em} else
9: \hspace{4em} \( \mathcal{M} \leftarrow \mathcal{M} \cup m(p_i, c_k, 0) \) \{the predicate does not hold in the context\}
10: \hspace{2em} else
11: \hspace{3em} if \( \forall f_k \in F, f_k < \gamma \) then
12: \hspace{4em} \( \mathcal{M} \leftarrow \mathcal{M} \cup m(p_i, C, 0) \) \{predicate which does not hold in any context\}
13: \hspace{3em} else
14: \hspace{4em} \( \mathcal{M} \leftarrow \mathcal{M} \cup m(p_i, C, \text{AVG}(F)) \) \{predicate that holds in all contexts (user view)\}
15: \hspace{1em} \text{return } \mathcal{M} \)

If any occurrence frequency of a given predicate satisfies \( \gamma \), then a neutral mapping \( m(p_i, C, 0) \) is created attesting that the predicate \( pr_i \) is not contextual. In other words, the predicate is not relevant for contexts of the set \( C \). That is the case of rarely (occasionally) used predicates.

If the predicate is frequent in some contexts only, the predicate is contextual. Indeed, it is relevant to take it into account in some contexts, then mappings \( m(p_i, c_k, f_k) \) are created for each of these contexts with the correspondent frequency, and to ignore it in the others where neutral mapping \( m(p_i, c_k, 0) \) are created for each of the remainder contexts.

4 Related Works

Recently, contextualization of user profile and preferences has attracted attention. In (Holland and Kiessling, 2004) authors propose a framework for contextual preferences, called situated preferences. In this approach, both user profiles and situations are modelled in an Entity-relationship model, then, contextualization of preferences is modelled uniquely as M:N relationship (pid, sid), expressing that the preference pid holds in the situation sid. No detail are given about relationship construction. In their research, (Stefanidis and Pitoura, 2008) introduced context into the database field. The context which is a set of contextual attribute (e.g. Age, weather) is used to rank database tuples w.r.t a given query. Contextual preferences are explicitly specified by users and are of the form \(<\text{contextState}, \text{preferencePredicate}, \text{Score}>\). The difference with our proposition, is that authors consider a user profile as being a part of the context while we clearly separated these two concepts, this may be due to the different point of view we consider. An automatic discovery of contextual preferences was initiated by (Agrawal et al., 2006). In (Bunningen et al., 2007) contextual preferences are also automat-
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ically generated by observing and analyzing user histories. Preference are modeled through
description-logical frame, and the discover of contextual preferences is done automatically by
calculating the probability that an element be the best one in a particular context.

5 Conclusion

In this paper, we have presented a personalization service, called contextualization, which
allows finding dependencies between user profiles and contexts by exploiting user-application
interaction logs. The service can be used at design time or periodically as a maintenance
service which keeps up to date the semantic links between profiles and contexts for a given
application. The contextualization service is a service among several others which constitute a
coherent personalized access model (PAM). Further research will focus on the binding service
which exploit, at execution time, the mappings generated by the contextualization service to
make user queries sensitive to user profile, to interaction context or to both of them.

References

Abbar, S., M. Bouzeghoub, D. Kostadinov, S. Lopes, A. Aghazaryan, and S. Betge-Brezetz
In Actes des 24èmes Journées Bases de Données Avancées, Guilherand-Granges, France.
international conference on Management of data, Chicago, IL, USA, pp. 383–394.
In 11th international conference on Extending database technology, Nantes, France, pp.
344–355.

Résumé

La personnalisation vise à fournir à l’utilisateur les contenus les plus pertinents par rapport à divers critères. Ces informations sont organisées en profils utilisateur et en contextes d’interaction. Un problème intéressant est alors de déterminer quelle part du profil est significative dans un contexte donné. Cet article propose un service de contextualisation qui permet de définir les relations entre les préférences utilisateurs et les contextes. Nous proposons également une approche automatique pour la découverte de ces relations en analysant les traces du comportement de l’utilisateur.