CONSTRUCTION OF A USER PROFILING SYSTEM FOR SAS MOBILE OLAP

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User profiling is the act of building up a profile of the users to have an accurate idea of what they want to do. In this research, we apply the user profile creation into an OLAP context under a mobile environment with the ultimate goal of constructing a User Profiling System (UPS). A UPS personalizes the query sent to the server according to the user's preferences. In this paper, we introduce the SAS Mobile OLAP (SMO) project. First, we present several applications of user profiling, the methods used to construct a profile and an evaluation method for such systems. Then, the results obtained are projected on an OLAP query's customization system. We finally attempt to propose an implementation using the SAS platform in a mobile environment.

Keywords: SAS OLAP Server, User Profiling, User Preferences, Query Personalization, Mobile OLAP

1. Introduction

User profiling is the act of building up a profile of the users to have an accurate idea of what they want to do. These profiles are used to group and prioritize the activities of users. Knowing who your users are and what they want is the first, vital step in meeting their needs. User profiling is based on the following general criteria:

- Skills/experiences
- Background
- Language skills
- Demographic group
- Activity or information requirement

The user profile can take different forms to represent the aspects of the user such as: cognitive process underlying the behaviors, user skills regarding to expert skills, preferences and characteristics, etc.

Independently, scientists were interested in Data Mining and especially in OLAP [11]. From this, new techniques have been developed to help the user in decision making. But as the number of wireless devices is constantly growing, a new need is emerging: the user has to make decisions directly from his/her mobile device [17].

1.1 Research Objectives

In this paper, we present the SAS Mobile OLAP (SMO) project. SMO proposes several applications of user profiling. The methods used to construct a user profile and then evaluation methods for User Profiling Systems are introduced and the obtained results are projected on an OLAP query's customization system with the use of mobile devices.

1.2 Outline

In the next section, we outline the state-of-art of user profiling as well as some of its most important applications. Section 3 aims at building a User Profiling System (UPS) and at proposing an evaluation method for this system. Section 4 outlines the implementation phases of SMO. The paper concludes with future directions of the work.

2. User Profiling

In this section, we first go through the state-of-art concerning the user profiling. We then detail the different applications for such a system.

2.1 Related work

User profiling or user modeling is usually traced back to The works of [1], [8], [21], [23] and [24]. Since then, numerous application systems were developed and progressions have been made over these early work. First, systems were without distinction between system components and the components that serve user modeling purposes. Then, from the mid-eighties onwards, separations were made [15].

The main UPSs that were developed in both academic (UMT, BGP-MS, UM) and commercial (Groupe Lens, Personalization Server) context are summarized as follows:

UMT allows the user model developer the definition of hierarchically ordered user stereotypes, and of rules for user model inferences as well as contradiction detection [4].

BGP-MS allows assumptions about the user and stereotypical assumptions about user groups to be represented in a first-order predicate logic. A subset of these assumptions is stored in a terminological logic. Inferences across different assumption types (i.e., types of modals) could be defined in a first-order modal logic [16], [22].

UM is a toolkit for user modelling that represents assumptions about the user's knowledge, beliefs, preferences, and other user characteristics in attribute value pairs [13], [14].

Groupe Lens employs various collaborative filtering algorithms for predicting users' interests. Predictions are based on ratings explicitly provided by users (e.g. in on-line forms), implicit ratings derived from navigational data (e.g. products that the online customer viewed and products that have been put into the shopping cart), and data from transaction history (e.g. products purchased in the past) [20].

Personalization Server allows for the definition of rules that assign individual users to one or more user groups based on their demographic data (e.g. gender and age), information about the user's system usage, and information about the user's software, hardware and network environments. Rules can also be defined for inferring individual assumptions about the user from his/her navigation behavior, and for personalizing the content of web pages. The operation of Personalization Server thus follows very much the "stereotype approach" from classical user modelling research [2].

2.2 Applications of User Profiling

User profiling is used in different ways and different fields either to make systems more adaptive or to make their results more relevant. The most important uses of user profiling are presented in the following subsections.

2.2.1 Teaching Systems

In the early teaching systems, the goal was to build a clever teacher able to communicate knowledge to the individual student. Recent and emerging work focuses on the learner exploring, designing, constructing, making sense and using adaptive systems as tools. Correspondingly, systems are being built to give the learner greater responsibilities and control over all aspects of the learning, and especially over the learner model which is at the core of user-adaptation. A parallel trend is the growing acknowledgement of the importance of the learner's social context [9], [12].

2.2.2 Natural Language Processing

The fields of user modelling and natural language processing have been closely linked since the early days of user modelling. Natural language systems consult user models in order to improve their understanding of users' requirements and to generate appropriate and relevant responses. At the same time, the information natural language systems obtain from their users is expected to increase the accuracy of their user models [30].

2.2.3 Adaptive Hypermedia

Adaptive hypermedia is a relatively new direction of research on the crossroads of hypermedia and user modelling. Adaptive hypermedia systems build a model of the goals, preferences and knowledge of each individual user, and use this model throughout the interaction with the user, in order to adapt to the needs of that user [5].

2.2.4 Human-Computer Interaction Field

A fundamental objective of human-computer interaction research is to make systems more usable, more useful, and to provide users with experiences fitting their specific background knowledge and objectives. The challenge in an information-rich world is not only to make information available to people at any time, at any place, and in any form, but specifically to say the "right" thing at the "right" time in the "right" way. Designers of collaborative human-computer systems face the formidable task of writing software for millions of users (at design time) while making it work as if it were designed for each individual user (only known at use time) [10].

3. The User Profiling System

As we introduced the user profiling process in the previous section, we can now focus on the building of such a system and its evaluation.

3.1 Building a User Profile

The automatic nature that involves the building of a user profile makes it a prime candidate for application of machine learning techniques. The essential issues of the work accomplished on this subject are about how to represent the user model and how to overcome the different challenges and limitations such as: the amount of the used datasets, the data labeling problem, etc.

There are two main dimensions that allow us to distinguish different approaches of user modelling. The first dimension is about the form of the user profile (preferences, behavior, etc). The second dimension is with respect to whether they model individual users or communities of users.

Situations in which the user repeatedly performs a task that involves selecting among several predefined options appear ideal for using standard machine learning techniques to form a model of the user. One example of such a task is processing e-mail by deleting some messages and filling others into folders. Another example is to determine which news articles to read from a web page. In such situations, the information available to the user to describe the problem and the decision made can serve as the training data for a learning algorithm. The algorithm will create a model of a user's decision making process that can then be used to emulate the user's decisions on future problems [28].

Another challenge is met when building a user profile and it is coming from knowledge representation issue. It is about filling gaps and replacing missed information using the existing information, this will lead to use the predictive statistical models [29], [31].

3.2 Evaluating the User Profiling System

If the user model is indeed being used to make a difference in a software system such as adapting the software system to the user, then one should ask whether the user model adaptations actually improve the software system. Also, what types of users benefit from the adaptations? It may very well be that some user model adaptations are less beneficial to some classes of users. The method of evaluation that is often used is the empirical evaluation. Empirical evaluation refers to the appraisal of a theory by observation in experiments. The key to good empirical evaluation is the proper design and execution of the experiments so that the particular factors to be tested can be easily separated from other confounding factors. For example, one may want to test whether a software system with a user model works better than the same system without a user model, test the effect of different levels of user modelling or different user model parameter settings, or test different user interfaces. These factors, which are under the control of the experimenter, are termed independent variables because their values can be varied independently of other variables by the experimenter. Dependent variables are variables whose values depend on the values of other variables [7].

The empirical evaluation concerns the user profiling systems globally, indeed; there are evaluation methods to evaluate the predictive statistical models. They have been evaluated using mainly the following techniques: recall and precision, which are borrowed from the field of Information Retrieval; and predicted probability, accuracy and utility, which are sourced from machine learning [31].

4. The SAS Mobile OLAP Project

The SAS Mobile OLAP (SMO) project is essentially the implementation of a User Profiling System for OLAP application. Within this application, the integration capabilities of SAS development environment are used to integrate the SAS OLAP server as the back-end. This backend offers access to the multidimensional data base by using the MDX query language [19]. In this section, a short introduction to Mobile OLAP is followed by an overall architecture of the prototype and an implementation using Java technologies.

4.1 Mobile OLAP

In the last years, On-Line Analytical Processing (OLAP) and data warehousing (DW) have become major research areas in the database community. The two main parts which are essential are the modelling of data, which has been extensively dealt with, and the visualization of data, which researchers have been interested in only for the last few years. The latter has to be taken into account while we deal with mobile environment. Indeed, there are a lot of physical constraints inherent to mobile devices. These constraints refer to what the device itself can offer, thus its limitations like the screen size, the number of pixels, the number of colors and many others.

In the next section, we present a type of architecture which can handle the physical constraints on one part and the query's customization on the other part. Both processes are executing on the middleware server. Query's customization helps to get a better output from the SAS OLAP server, according to the user's preferences whereas the physical constraints are handled when the middleware application sends back to the mobile device the summarized results of the query.

4.2 Architecture

Coming from the fact that multiple independent components are involved and integrated, SMO is a multi-tier application. Such components are the client side application, which is running in a mobile device, and the SAS OLAP Server, which is a component of SAS Intelligence Platform. Another component is the middleware applications that grant the communication between the two ends of SMO, namely the front-end and the back-end. The architecture of SMO is illustrated in Figure 1.

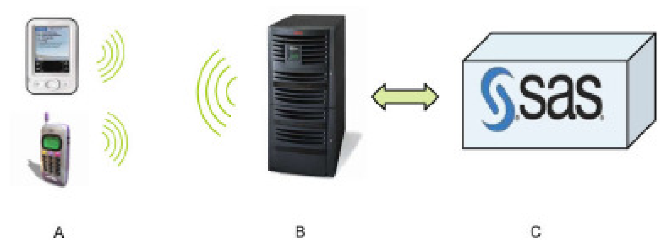

Figure 1: Architecture of SMO

A. Mobile OLAP Client: This application is located on the mobile device and must offer the GUI services that allow the user to interact with the system, and the connection to the middleware.

B. Middleware Application: This application is the most important in the whole system. This application contains the profiling system. It allows the transfer of data between the OLAP server and the OLAP client.

C. SAS OLAP Server: This is a multidimensional data store designed from the outset to provide quick access to pre-summarized data, generated from vast amounts of detailed data [25].

4.3 Implementation

The Java technology is used in this application in different ways and in several locations. In the client side, J2ME is used to develop an application that allows the user to connect to the server, then to create an MDX query, to send it to the server and finally to show the results in an appropriate way.

Another location where Java is used is the middleware application. The Java technology used is J2EE and it is the most appropriate technology to develop server side applications. A subset of this technology is used, namely Web services technology and Servlets. Web services are used to allow the communication between the mobile client and the middleware application. Then the Servlet is used to permit the middleware application to interrogate the OLAP Server. JDBC technology is used to allow the middleware application to store the users' data in a database.
OLAP Server side is a SAS OLAP server application, which is a Java Servlet that grants access to the multidimensional data.

The most important part of the system is the middleware application. This part contains most of the logic of the system. Figure 2 shows the component's diagram which illustrates the structure of the middleware application and the relationship between its components.

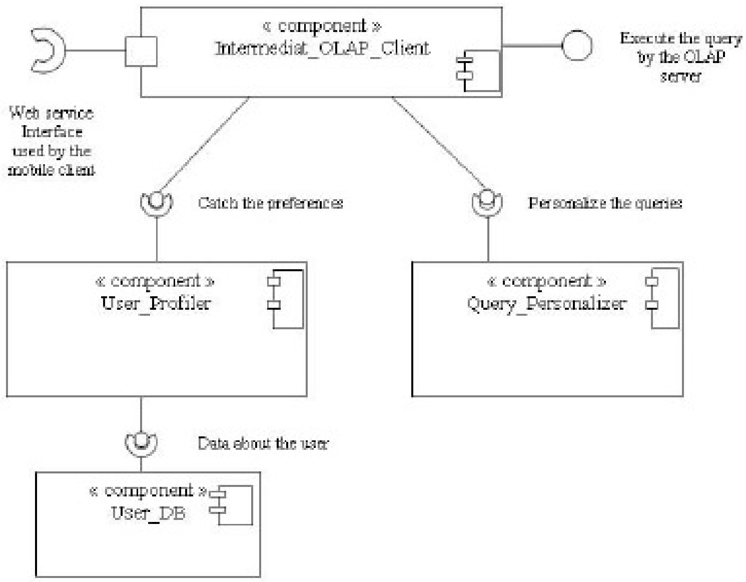

Figure 2: Component's diagram for the middleware application

5. Conclusions and future work

In this paper, we introduced the notion of User Profiling, a theme that many researchers have been interested. This notion is linked to a more recent research activity which is Mobile OLAP. This term is used to describe the porting of contemporary OLAP analysis practices into mobile devices and systems. We outlined the different work related to User Profiling as well as its applications in computer science. We then presented the description of the User Profiling System, from its construction to its evaluation.

Finally, we introduced our SAS Mobile OLAP project by giving a definition before discussing about an implementation based on a SAS platform.

Our future work in our research includes the optimization of the communication process between the various components of our architecture. This system includes a caching feature on the middleware application in order to discharge the SAS OLAP server from redundancy queries. It will also include a disconnected mode on the client's device so that it will allow the client to perform a part of analysis without communicating with the SAS OLAP server.

References

[1] J.F. Allen, A Plan-Based Approach to Speech Act Recognition, Technical Report 131/79. In Department of Computer Science, University of Toronto, Canada, 1979.

[2] ATG Adaptive Scenario Engine (2006). Retrieved July, 23, 2007, from http://www.atg.com/en/products/platform/

[3] L. Bellatreche, A. Giacometti, P. Marcel, H. Mouloudi and D. Laurent, A Personalization Framework for OLAP Queries. In DOLAP'05, ACM International Workshop on Data Warehousing and OLAP, Bremen, Germany, 2005.

[4] G. Brajnik and C. Tasso, A Shell for Developing Non-monotonic User Modeling Systems, International Journal of Human-Computer Studies, Vol 40, No 1, pages 31-62. Academic Press, Inc., Duluth, Minnesota, USA, 1994.

[5] P. Brusilovsky, Adaptive Hypermedia, User Modeling and User-Adapted Interaction, No 11, pages 87- 110. Kluwer Academic Publishers, Netherlands, 2001.

[6] S. Carbery, Techniques for Plan Recognition, User Modeling and User-Adapted Interaction, No 11, pages 31-48. Kluwer Academic Publishers, Netherlands, 2001.

[7] D.N. Chin, Empirical Evaluations of User Models and User-Adapted Systems, User Modeling and User-Adapted Interaction No 11, pages 181-194. Kluwer Academic Publishers, Netherlands, 2001.

[8] P.R. Cohen and C.R. Perrault, Elements of a Plan-Based Theory of Speech Acts, Cognitive Science, No 3, pages 177-212, 1979.

[9] A. El Sadik, Reusability and Adaptability of Interactive Resources. In Web-Based Educational Systems, Journal on Educational Resources in Computing (JERIC), Vol 1, No 4. ACM Press, New York, USA, 2001.

[10] G. Fischer, User Modeling in Human-Computer Interaction, Contribution to the 10th anniversary issue of the journal User Modeling and User-Adapted Interaction (UMUAI), 2000.

[11] J. Han and M. Kamber, Data Warehouse and OLAP Technology: An Overview, Data Mining: Concepts and Techniques, chap 3, pages 105-155. Morgan Kaufmann Publishers, San Francisco, California, USA, 2006.

[12] J. Kay, Learner Control, User Modeling and User- Adapted Interaction, No 11, pages 111-127. Kluwer Academic Publishers, Netherlands, 2001.

[13] J. Kay, The UM Toolkit for Reusable, Long Term User Models, User Modeling and User-Adapted Interaction, No 4, pages 149-196, 1995.

[14] J. Kay, UM: A Toolkit for User Modelling. In 2nd International Workshop on User Modeling, Honolulu, Hawaii, 1990.

[15] A. Kobsa, Generic Modeling Systems, The Adaptative Web: Methods and Strategies of Web Personalization. Springer Verlag, Heidelberg, Germany, 2006.

[16] A. Kobsa and W. Pohl, The BGP-MS User Modeling System, User Modeling and User-Adapted Interaction, No 4, pages 59-106, 1995.

[17] A.S. Maniatis, The Case for Mobile OLAP, Lecture Notes in Computer Science, pages 405-414. Springer Berlin/Heidelberg, 2004.

[18] G. McGovern, Websites: think the way your customers think (September 2003). Retrieved June, 11, 2007, from http://www.gerrymcgovern.com

[19] Microsoft, Multidimensional Expressions (MDX) Reference, SQL Server 2005 Books Online. Retrieved June, 29, 2007, from http://technet.microsoft.com/en-us/library/ms145506.aspx

[20] Net Perceptions (2006). Retrieved July, 23, 2007, from http://www.netperceptions.com

[21] C.R. Perrault, J.F. Allen and P.R. Cohen, Speech Acts as a Basis for Understanding Dialogue Coherence, Report 78-5. In Department of Computer Science, University of Toronto, Canada, 1978.

[22] W. Pohl, Logic-Based Representation and Reasoning for User Modeling Shell Systems, User Modeling and User-Adapted Interaction, No 9, pages 217-282, 1999.

[23] E. Rich, Building and Exploiting User Models. In Department of Computer Science, Carnegie-Mellon University, Pittsburgh, Pennsylvania, USA, 1979.

[24] E. Rich, User Modeling via Stereotypes, Cognitive Science, No 3, pages 329-354, 1979.

[25] SAS, SAS OLAP Server Factsheet (2005). Retrieved July, 11, 2007, from http://www.sas.com/technologies/dw/storage/mddb/

[26] K. Stefanidis, Modeling and Storing Context- Aware Preferences, Technical Report TR 2006-04. In Department of Computer Science, University of Ioannina, Greece, 2006.

[27] C. Stephanidis, Adaptive Techniques for Universal Access, User Modeling and User-Adapted Interaction, No 11, pages 159-179. Kluwer Academic Publishers, Netherlands, 2001.

[28] G.I. Webb, Machine Learning For User Modeling, User Modeling and User-Adapted Interaction, No 11, pages 19-29. Kluwer Academic Publishers, Netherlands, 2001.

[29] S.K.M. Wong and C.J. Butz, A Baysian Approach to User Profiling in Information Retrieval, Technology Letters, Vol 4, No 1, pages 50-56, 2000.

[30] I. Zukerman, Natural Language Processing and User Modeling: Synergies and Limitations, User Modeling and User-Adapted Interaction, No 11, pages 129-158. Kluwer Academic Publishers, Netherlands, 2001.

[31] I. Zukerman, Predictive Statical Models for User Modeling, User Modeling and User-Adapted Interaction, No 11, pages 5-18. Kluwer Academic Publishers, Netherlands, 2001.