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Architecting Personalized Information Retrieval and Access Services in Data Intensive Domains

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ABSTRACT

Although personalized information retrieval and access has been regarded as effective means to diminish the problem of information overload in the time critical, data intensive, distributed and dynamic environments, its implementation is extremely difficult due to the openness of users' information needs, which are changing over time under different situations, scenarios, personal preferences, some of which cannot be predicted. Therefore, centralized system design principle that dominates the system design in the field is not feasible due to its limited adaptability to deal with dynamic changing environments. In this paper we present our ongoing research regarding a plug-and-play service architecture for personalized, situation aware information retrieval and access services, which offers a new way of thinking about the retrieval of personalized information for time critical applications.

INTRODUCTION

Information is globally distributed, and it is supported by the continuous growth in Information Communication Technology, which is enabling the fast development of organizational networks. Furthermore, the availability and popularity of small mobile devices have accelerated the growth of user mobility in the field [1]. Organizations and information seekers now have the privilege of any time any where information access via wired or wireless networks [2]. However, this increase in information availability cannot guarantee that users are able to retrieve and access the information they really need in a reasonable time. This is because the above mentioned technical advances have led to many organizations, if not all, having to operate in more complex environments characterized by huge volumes of information, heterogeneous information resources, and dynamically changing information structures. At same time, the user's information needs have also been changing dynamically over time in different situations and scenarios with various personal or organizational preferences. In these situations, information needs may be short lived. All these changes make it more difficult for the information seeker to find the "right information" in the "right format" at the "right time". The problem is amplified in the domains like crisis response networks, where the accuracy of the retrieved information and obtaining it in time critical situations are extremely important. Therefore there is an increasing requirement for personalized information retrieval and access that is able to meet the dynamically changing, personalized information needs in today's data intensive, dynamic environments.

The concept of personalization in the context of information retrieval and access is not new. The development of personalization techniques like user profiling, personal tools, and recommendation systems has shown that it is technically possible to carry out a personalized information search. However, most current personalized applications lack the flexibility and adaptability to deal with rapidly changing user information needs, set in a dynamic environment, since they are designed as implementation artifacts, i.e. the personalization techniques are hard-coded in the applications. Changes in organizational or personal information needs may lead to a need to redesign a complete application. To satisfy flexibly personalized information needs in a dynamic situation, while simultaneously being able to adapt to and use the available personalization technologies, calls for a new applicable architecture for information retrieval and access, which are able to support the use of reusable, loosely coupled, cohesive plug-and-play component. This will allow the applications to be quickly reconfigured to meet changed information needs.

In this paper we present our ongoing PhD research with regard to a plug-and-play service architecture for personalized, situation aware information retrieval and access in data intensive, distributed and dynamic environments. Some of the important theories and concepts that are used as a basis for this research are explained in the next section. Our research approach is explained and discussed in section 3. Conclusion and future work are discussed in section 4.

THEORIES & CONCEPTS

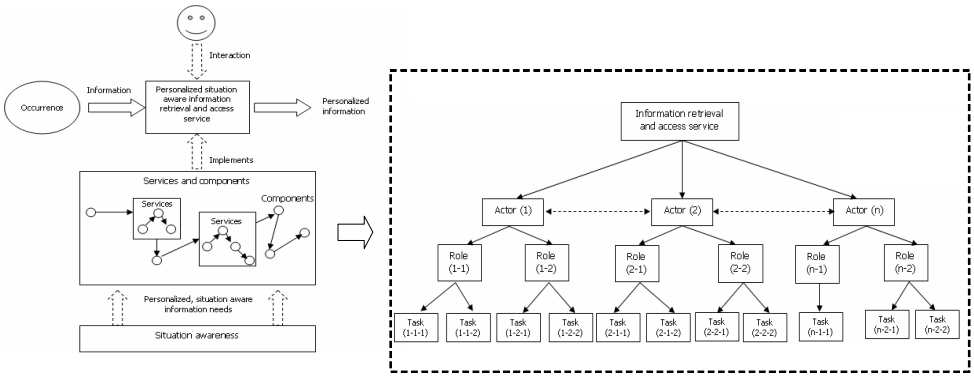
Component-Based Service-Oriented Design Principle

Component-based development (CBD) provides a method for "building enterprise-scale solutions as a process of selection, reconfiguration, adaptation, assembling and deployment of encapsulated, replaceable and reusable components" [3] that are able to "accommodate ever-changing requirements, in a cost-effective, timely manner" [3]. Our approach, which consists of using components in a more behavior-oriented way to present the process as services, will help us to model information retrieval and access services and requirements at a higher-level, in a domain-specific, but implementation-independent way [3], and help us to provide a design principle for the proposed "plug-and-play" architecture.

Situation Awareness

Role based personalization coupled with advanced user profile techniques are not sufficient to reflect users' actual information needs. This is because the actual information needs are decided by the roles a user adopts in society, or in his or her application domain, and his or her current situation. To satisfy better personalized information needs, personalized information retrieval and access should be a process of adaptation, where applications provide role relevant information based on a dynamically and automatically perceived user's situation. The work of Endsley [11] [12] provides a set of well defined concepts and a widely accepted Situation Aware (SA) framework that have been utilized across a wide variety of domains, and we have used Endsley's SA Framework [11] [12] in our research to provide situation adaptive information retrieval.

Figure 1. Plug-and-play architecture



RESEARCH IN PROGRESS

Plug-and-Play Architecture

From our perspective, information retrieval and access is triggered by an "occurrence", which causes a problem that has to be solved. As a result, we believe the goal of information retrieval and access is to find specific information that can be used to help to solve the problem. Since all the occurrences are expected to differ due to different causes, circumstances, involved actors, and even some unpredictable factors, to speed up the information acquisitions, it is very important to obtain only the "relevant" information regarding the current occurrence instead having to deal with a standardized information provision. Based on above premise, we propose a plug-and-play service architecture that will allow high level information needs to be mapped to adaptable and available technical units by decomposing the information needs into possible fragmentations, i.e. services or components based on our concepts of actor, role and task as shown in figure 1.This decomposition process can be used to generate small and replaceable services or components that can continuously perceive changing occurrence situations and can be "plugged-and-played" to personalize information acquisitions. The composition of the plug-and-play services or components that can be used to satisfy specific information needs is decided by the situation, in which the information needs are formed. This requires personalized information acquisitions for each particular occurrence situation.

Situation-Based Adaptation and Role-Based Personalization

The under lying solution for most personalized applications is to predefine options by analyzing users' information needs and categorizing and classifying users into different groups of interests based on the user profiles. Categorization and classification of users mostly depends on their roles in the application domains. Thus role based personalization is the main concern of the current research in the filed. However, role based personalization using advanced user profile techniques is not sufficient to reflect the actual needs of the information seeker because their actual needs are decided on the role an information seeker adopts in the society, and on the his or her current situation. We assume that, to better satisfy personalized information needs, role based personalization and situation based adaptation are required in the context of information retrieval and access. Since the situation changes dynamically due to changing occurrence, personalized information retrieval and access should be a process of adaptation, where applications provide personalized information based on dynamically and automatically detecting an information seeker's situation. The defined situations should be reconfigurable by the users to allow adaptation to changes in "occurrence".

Figure 2. Situation-based adaptation and role-based personalization

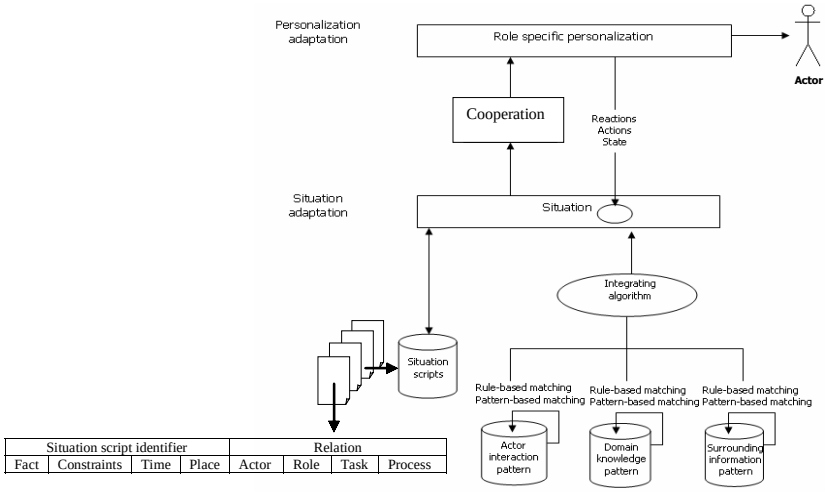


Figure 2: Situation-based adaptation and role-based personalization

In our research, role based information needs can be detected by accessing domain knowledge. Since situation changes dynamically, it is necessary to extract the information continuously from the environment to modify or refine the perceived situation. Furthermore, although the situations influence the involved actors' actions or states in the application, contrarily, actors' actions and states also influence the changes of the situation. Thus, integrating the domain knowledge, continuously obtained information from the surrounding environment, and the actors' reaction pattern into a consistent picture is the way used to create the situation picture in our research. It is not feasible to specify all the situations for different occurrences, automatically detecting a new situation based on collected usage history data is required. Predefined situations can be model as tuple of {identifier {Fact, Constrains, Time, Place}, relation {Actor, Role, Task, Process}} and stored as situation scripts as accessible historical data. Domain knowledge, actors' interaction, and surrounding information and their matching rules, rule based matching, or pattern based matching, or both, should be stored in databases for future access.

CONCLUSION AND FUTURE WORK

In this paper, we present a new way of thinking for personalized situation aware information retrieval and access based on a component-based and service-oriented design principle. It should allow us to realize independent service implementation and service modeling, and to integrate the high level personalized information requirements and low level technical availability. Our new service architecture provides users the possibility to quickly configure the information acquisition applications by choosing required "plug-and-play" services or tasks, which will increase the reusability, flexibility, adaptability and scalability for personalized information retrieval and access services in data intensive, time critical, distributed and dynamic environments.

In the next phase of our research, concepts and proposed architecture will be applied in other cases for the further validations. Non-functional issues such as quality, flexibility, security, scalability, availability etc., will be associated with the architectural framework to measure the success of the approach.

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