USER PROFILE-BASED SERVICE DISCOVERY for eHEALTH

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Abstract: Personalization is not very common in Service-oriented Architecture and Service discovery in practice, yet very important as it enables to find more specific and relevant services. This is especially true in the case of complex service, where the system tries to find an optimal combinations of services that together can satisfy a (complex) request. We describe the relation between personalization and service discovery in general, and then concretize this in the proposed Service Discovery Framework (SDF). Personalization effectively improves the quality of the discovery algorithm in SDF. As an application, we show its benefits in the context of eHealth.

1 INTRODUCTION

Personalization is regarded as one of the most compelling features of service-oriented systems (Papazoglou et al., 2007) and mobile computing (see (Wang et al., 2008)) disciplines. Personalization refers to a set of preferences, data, rules and settings that are used by a device or service to deliver a customized version of capabilities to the user (Kobsa, 2007; So et al., 2009; Wagner et al., 2002) as a means of providing user-centered services. User-centered and personalization support customers in selecting their preferred service from the rapidly increasing publishing of services.

In the past few years, personalization has been used in various application areas such as e-commerce, e-learning to assists users in finding, adapting and using services that fulfil their needs, given their personal profile, mobility and context (see (Lankhorst et al., 2002)). Personalization is concerned with matching and negotiation between user requirements and abilities on the one hand and service offerings and resulting adaptation of network and application level services on the other hand (Lankhorst et al., 2002).

In the realm of service discovery, we see personalization as an advanced form of service discovery: a set of services that meet the core requirements of a user are further scrutinized for compliance with the user personal desires and constraints. Consequently, personalization offers a quality user profile and an accurate representation of the user's physical and emotional behavior (Lankhorst et al., 2002). To build and maintain effective personalization, appropriate user preferences, interests, and behaviors are required (see (Ghosh and Dekhil, 2009)). In a way, personalization covers all functionality regarding discovery and management of users with respect to their preferences, demands and wishes. Therefore, it is important that personalization should be transparently incorporated as one of the main components of service discovery in addition to context-awareness and semantics.

A user profile is often used to classify users into predefined user segments (such as, by demographics or tastes) or to capture their behavior including their private interests and preferences (see (Shmueli-Scheuer et al., 2010)). One of the key challenges pointed by (Ramanathan and Kapoor, 2009) is to construct accurate user models containing demographic interests, preferences, intent and behavior information. A user profile can be obtained in various ways. It can be explicitly defined by the user, such as during registration for a service. Additional information about the user can be obtained through *user profiling*: the process of implicitly learning user characteristics from data associated with that user. Data sources for user profiling include among others the user browsing sessions, the user's own generated content, the user's social interactions with friends in the user's social network (e.g. the user's discussions with others), click-through data extracted from search logs, or even other user profiles using collaborative filtering techniques (Shmueli-Scheuer et al., 2010). Personalized systems employ various personalization methods like machine learning, information retrieval, bayesian networks see (Wang, 2010; Kobsa, 2007) to derive additional assumptions about users. Generally, the more informa-

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tion is collected about users, the better the quality of personalization will be. As a result, the process of personalization usually consists of user modeling and adaptation. User modeling (Wang, 2010) is concerned with building user models, while adaptation creates personalized services based on the user profile.

The contribution of this paper is formalized context-aware profile-based service discovery with particular emphasis to eHealth services. In addition, we address user authentication and authorization methods for user profile and services. We assess the impact of personalization on facilitating service discovery, service selection and service matching. We exemplify our work within the domain of eHealth services motivated by the fact that it is not common to find identical health cases with similar context, particularly in developing countries that are usually synonymous with wider variations in culture, beliefs and general living conditions. Such variations occasions added importance for personalization especially in eHealth services that are core to developing countries.

This paper is organized as follows. Section 2 explains related work. We overview personal profile in section 3. In section 4 we present the proposed service discovery framework. We discuss personalization on eHealth in section 5. Finally, we conclude in section 6 where we highlight some of the future research directions.

2 RELATED WORK

the last couple of years various researchers have addressed the problem of personalization for different applications (for example e-learning and e-commerce, etc). The rapid growth and deployment of services and information makes personalization one of the important research topics. However, the application of personalization in service discovery has not been widely studied. Semantic and contextualization of service was given more emphasis in the process of service discovery than personalized service discovery.

The concept of a user profile (personalization) usually refers to a set of preferences, information, rules and settings that are used by a device or service to deliver a customized version of capabilities to the user ((So et al., 2009)). To capture user preference and interest, ontology based user modeling has widely been adopted. Ontology helps to develop an effective mechanism for user query contextualization based on both current and previous search history (So et al., 2009).

According to Petersen (Petersen et al., 2009), a user profile contains information on the goals, the needs, the preferences and the intentions of that user. The user profile provides an interface to access this user information, including its static profile, preferences, context information (location, presence, device capabilities, etc), service specific personal information and the history of service usage and so on. The provided function will be used to discover the services requested by the user.

Typically a user profile includes her/his individual preferences together with technical constraints of his/her means of communication (devices and equipments) and his environment (Wagner et al., 2002). Based on semantically enriched service descriptions a service request management is then performed including a service discovery and execution. During service discovery and selection, decisions that have to be made will not necessarily lead to one definitive outcome. Requirements could be met not by just one service or service component, but by a set of them, or none at all (Wagner et al., 2002). Therefore (Wagner et al., 2002) state that the process of service discovery can take the personal user preferences, semantically rich user profile and context information of the user into account.

2.1 Context-aware Models for Personalization

Context-awareness refers to systems that are able to adapt their services to the user context. Services can be selected according to both the current user context and her/his preferences for this context. Context-aware profiles aim at indicating which service is relevant for a user when he is in a given situation. The main idea of the context based profile (Mehta et al., 2005) is to allow users to define the profiles and potential context in which these profiles should be used. Context can be thought of as the “extra” often implicit, information (i.e. associations, facts, assumptions), which makes it possible to fully understand an interaction, communication or knowledge representation (Mehta et al., 2005). They propose the use of a common ontology based user context model as a basis for the exchange of user profiles between multiple systems and, thus, as a foundation for cross-system personalization.

In our model the user context can be obtained in two ways: the user announces her current profile in her request or the context manager dynamically generates the users context (location, weather, etc) from the context provider devices such as GPS, sensors etc.

A *user context* (as summarized in Figure 1) consists of two categories (static and dynamic). The static category describes the demographic data of the mobile user. These are user data about name, gender, age, language etc. The dynamic further classified as environmental and information world. The environment category provides situational context information like the actual location and the environment. The third category captures the user's "information world" e.g. read documents and visited Web pages - thus reflecting the user's interests (Kuck and Gnasa, 2007).

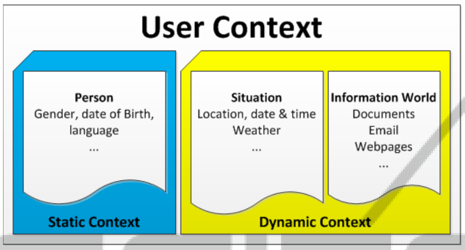

Figure 1: Context of mobile user (Kuck and Gnasa, 2007).

Some of the advantages of using context-awareness in healthcare domain are large number of situations and related tasks, mobility of patients, health professionals and some equipments; limited financial and human resources; and the need to cut cost while improving the quality of service to an increase number of people. In addition, the expectation to access, process, and modify the healthcare information anywhere and anytime using handheld devices is another reason to use context-awareness. Alike other systems, contextualization encounters different challenges such as how often the contextual information needs to be collected, when is some information is old, not reliable, missing, or just plain wrong? Is it the same for normal, abnormal and emergency cases? Health professionals and patients are involved in a variety of tasks and processes and their information needs vary based on their location, time, environment and involved activity. The knowledge of their current activity may assist in deciding which of the healthcare professionals should be reached for some medical tasks or decision making.

2.2 Personalization and Service Discovery

Personalized search is seen by the research community as a means to decrease search ambiguity and return results that are more likely to be interesting to a particular user and thus providing more effective and efficient information access (Sieg et al., 2007; Park et al., 2009). One of the key factors for accurate personalization information access is user profile and user context. There are many factors that contribute for the delineation of personalization such as: the user's short-term information need, such as a query or localized context of current activity, semantic knowledge about the domain being investigated, and the user's profile that captures long-term interests.

To find the most appropriate services, service discovery protocols should exploit context. The most appropriate service is not always the nearest or the highest quality rather, it varies according to the user's preferences. More importantly, user criteria change with their context. A user might generally prefer to use the most popular services, but in a particular case, might want to use only high-quality services (Park et al., 2009). A service discovery starts from the local service repository/registory. If it fails to find an appropriate service in the local repository or registry, it propagates request/discovery queries to other appropriate repositories/registries. If the requested service is found, the matchmaking process will be performed to select the appropriate service based on the user context and user preference (profile) (Park et al., 2009).

Discovery corresponds to the activity of locating a service that meets certain functional criteria. Selection is related to the activity of evaluating and ranking the discovered services to identify the ones that fulfill a set of non-functional properties and user preferences requested by the actual user. Most of the existing techniques rely on syntactic descriptions of services interfaces to find services with disregard to non functional service parameters (Badr et al., 2008). Incorporating user contexts and user preferences in the process of service discovery brings quality service discovery that can improve search results and provides a better means for user to identify their service information needs (Badr et al., 2008; Park et al., 2009).

3 USER PROFILE

The main purpose of user profile is to keep track of the user related information to control its availability and facilitate service access for its users, and to realize a better user experience. Besides, personalization helps to identify a service delivery mechanism (text, audio, video, etc.), to choose the type of service to be delivered with respect to user preferences (physical, psychological, environmental, and so on) and to create a global personalization scheme (ETSI, 2005). User profile may contain many individual data items (information, preference and rules) coming from different sources (Choi and Han, 2008; Petersen et al., 2009; ETSI, 2005). When a user wishes to have the behavior of services personalized to his/her requirements a profile will be required (ETSI, 2005). The value of some of these items will (1) either not change (static) or (2) change very irregularly and (dynamic) and (3) some may be individually changed by the user.

A single user may be associated with multiple profiles. It is therefore important that users have the flexibility to decide on the profile to use or better, the system should automatically detect the current profile. For instance, a user may move from office to a meeting room requiring him to access services on a small device. Users can often control the type of service provided, as well as the look and feel of the interface, by indicating their choice through their profile. In (Petersen et al., 2009) a user plays a number of roles in personalization system. A typical user in personalization will have at least two roles such as the user role and the administrator role.

User profile can be segmented into private and group (clustered). The private profile contains only individual data i.e. personal data, and preferences. Group profile is generated from the private profile from the users who share similar interests and preferences. For example, for healthcare works we can group users based on their job or educational status: specialist, general practitioners, nurses, pharmacist, etc.; and patients can be grouped or clustered by the disease type: HIV patient, TB patient, diabetic, etc. This type of clustering improves the service selection and service matchmaking process since they share similar information. Furthermore, this segmentation assists to push (broadcast) some information to the users with the same preferences (for instance, for healthcare workers new disease break out, new vaccination, training etc. and for patents medical time, consultation and education etc).

User profile determines the method of service delivery. For example a vision impaired person wishes to get the service in audio and the hearing impaired user wishes to receive in text rather than audio (Choi and Han, 2008; Petersen et al., 2009; ETSI, 2005). Additionally, user profiles may require to be prioritized to avoid conflicting profiles. A user may have several preferences, however, services might not be available for the preferences to match. Hence, after filtering out the relevant needs of the users preference required to be prioritized. The priority of user preferences will help to relax the matchmaking process. In line to this (Petersen et al., 2009; ETSI, 2005) stated eHealth profiles to be allocated higher priorities than non-eHealth profiles. eHealth profiles are considered as more important than personal profiles (normal profiles) as they contain information (extracted from electronic health records) and preferences (Choi and Han, 2008; Petersen et al., 2009; ETSI, 2005).

Generally, the user profile should address the following questions: where a user is located, what her job/ profession is, what her preferences (interest) is, what the context of the user is, who the provider of the service is, the cost and availability of the service (Petersen et al., 2009; ETSI, 2005).

3.1 Challenges of User Profile

Personalization (personal profile) is not without challenges. Some of the challenges are: how can personal information be gathered, how is this information stored in a persistent and ubiquitous manner (this is applicable for infrastructure-less networks), how can the changes always be reflected in the services rendering process? In addition, privacy is the other bottleneck in personalization. In regard to gathering information, we propose pull and push model as well as manual and automatic information gathering. Manually, the user will fill in the form and continuously update the profile whenever there is a change whereas in automatic information gathering especially, in mobile ad hoc networks, every node can broadcast its profile to the immediate neighbor node and gathering information from profile providers and devices such as sensors, GPS, etc. In the case of user profile privacy, in our framework, we proposed user authentication and authorization model to secure the user profile from privacy threat.

3.2 User Profile Privacy

Personalization is beneficial for service consumers and service providers. However, its benefit may be counteracted by privacy constraints. Personalized systems need to address the privacy constraints, including user personal privacy preferences, the privacy law and the regulation of the company or industry (Wang, 2010; Kobsa, 2007). Similarly, it has been tacitly acknowledged for many years that personalized interaction and user modeling have significant privacy implications, due to the fact that personal information about users needs to be collected to perform personalization (Kobsa, 2007). Mobile devices can provide useful personalized services that are based on usage patterns and the current user location. Both are tracked in central servers, which creates new privacy problems.

According to literature (Kobsa, 2007; Wang and Kobsa, 2009; Wang, 2010), a significant number of people revealed their concern of disclosing personal data to the Internet. This implies that if users are not given guarantees of keeping their personal information secured, then they are not willing to disclose this kind of information.

The personalized system tends to provide users to block the privacy from any unauthorized entities. For example the X-ray images and other important patients data can be blocked from the service providers, even only authorized healthcare workers can get access to the specified medical information.

An important issue of the proposed system is user authentication and authorization. Authentication checks the identity of the user. Authorization deals with role based access control. Privilege will be given to the users (human or systems) with the respect to the role they played. For example, PERMIS (for more details (Chadwick et al., 2008)) is one of eminent role based access control (authorization) system used in many applications.

3.3 Working Example

John works in non governmental charity organization. After a few days in a charity work he feels a little discomfort. He has fever, headache and nausea. The village health extension worker (HEW) diagnoses a laboratory examination (blood, stool, etc), however, all the results are negative. The HEW makes additional examination to find the cause to administer the appropriate treatment. But the case of John cannot be resolved in the health post as there is only one small laboratory and there is no specialist. Thus the HEW decides to access the health system to get additional help. After logging into the system, the HEW fills the form, entering the diagnosis made, the administered medication, the patient's symptoms, the patient's history, John's preferences and the location of the hospital. After accessing John's medical history (Electronic Health Record) remotely, the HEW learns that John has a mild hypertension case and is allergic for antibiotics, and John prefers not to have an injection. Based on this information, some services are retrieved from the repository. After the system receives the information, it forwards all this information to John's family doctor (if any) and the emergency dispatch center (emergency dispatch center is a specialized or referral hospital near by the given location area). This dispatch centers which has good medical facilities and a number of specialists. While receiving this emergency request the system will forward the cases to the appropriate specialist to assist the patient remotely. These emergency team will communicate the patient's private doctor and forward the prescription to the attending healthcare worker to administer the treatment.

As shown in Figure 2 a user may use two ways of requesting a service: (1) using voice and (2) using text or/and video (depending on the bandwidth in developing countries context). As most of the population in developing countries is illiterate, especially in the rural areas, voice based communication will increase the number of eHealth system users. Furthermore, users who own a smart phones and can use the features of the smart phone or PDA, can query service using text and video (if the infrastructure allows). As depicted in the Figure 2, the user can press a button and send a voice request. The voice server (VoiceXML) converts the voice data into text data, and forward the converted request to the application server. After receiving the request, the application server will forward the request to the appropriate emergency dispatch centers (EDC) based on the location. EDC is a center which is set up based on the geographical location. This center should have a number of specialist doctors, good health facilities and services. After evaluating the user request, the EDC forwards the request to the appropriate specialists. The specialists evaluate the user request, verify and access the patient's history (EHR), communicate with the family doctor (if any) of the patient, and access the service repository. Finally, the treatment and its procedure is forwarded to the mobile of the requesting HEW.

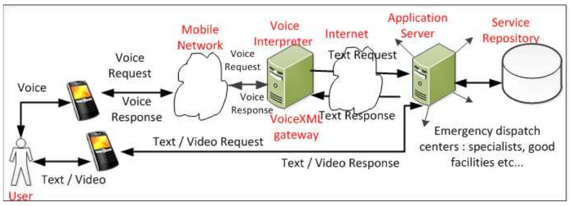

Figure 2: Personalized user service request.

A voice based querying services has its own challenges. But in the case of Ethiopia it is very important since the majority of the population does not speak English rather can they use their own language. Choosing the language to be localized is another challenge since many languages are spoken in Ethiopia. In our project we plan to use Amharic and English as a medium of communication in our system. The former is understood by many of the people and is the working language of the country and the latter is used as a medium of instruction for secondary and tertiary education.

4 SERVICE DISCOVERY FRAMEWORK

In this section we first introduce the discovery problem, and then describe the SDF framework to handle this problem. This framework extends the description

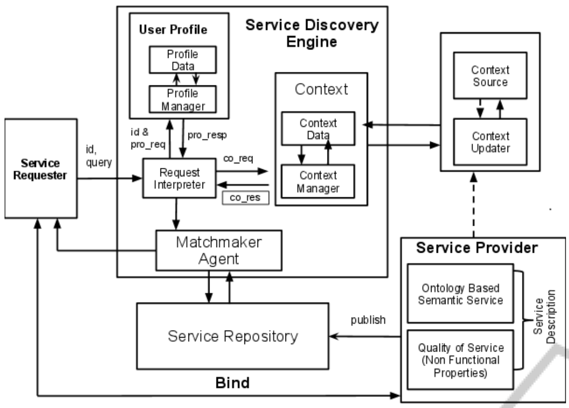

Figure 3: The Service discovery framework (SDF).

from previous section, see Figure 2.

4.1 The Profiled Discovery Problem

Service discovery is about functional matching of atomic services. The service composition problem can be described as the problem of finding an optimal combination that together can satisfy a (complex) request. We use the term complex discovery for the combination of service discovery and service composition. We follow the approach from (Kanagwa, 2009), and shortly overview the approach. Services are described by their effect in terms of how they transform their input message into an output message. We use the convenience of Hoare Logic (He and Hoare, 1998) and write $\{P\}\,S\,\{Q\}$ to describe that service S will transform an input satisfying condition P into an output satisfying condition Q. We assume a set $\mathcal{S}$ of so-called elementary services. Services may be combined to form new services. For example, the service $S_1;S_2$ is the service in which the execution of service S_1 is followed by S_2. The semantics of this compound service is derived as follows:

$$\{P\}\,S_1;S_2\,\{Q\} \Leftrightarrow \exists_R\,[\{P\}\,S_1\,\{R\} \wedge \{R\}\,S_2\,\{Q\}]$$

Other ways to combine services are optional, repetitive and parallel execution.

Let $\mathcal{S}^+$ contain all elementary services from $\mathcal{S}$ and be closed under the composition operators discussed above. A request q is described as a combination $q = (\mathsf{Pre}, \mathsf{Post})$. A profiled request (q,P) is the combination of a request q and a preference profile P. The solution space for request q is: $\mathsf{Sol}(q) = \left\{S \in \mathcal{S}^+ \,\middle|\, \{\mathsf{Pre}\}\,S\,\{\mathsf{Post}\}\right\}$ From this set $\mathsf{Sol}(q)$ the cheapest solution is selected:

$$\mathsf{argmax}_{S\in\mathsf{Sol}(q)}\mathsf{Pref}(S,q,P)$$

where $\mathsf{Pref}(S,q,P)$ indicated how well solution S in the context of question q is to be preferred given profile P. This problem however is computationally intractable. In (Kanagwa, 2009) a similarity calculus is described that evaluates the similarity $\mathsf{Sim}(q,S)$ between a request q and service S as an estimation of its successfulness in satisfying request q, by introducing a similarity calculus for predicates. So $\mathsf{Sim}(\mathsf{Pre},\mathsf{Pre}(S))$ expresses the similarity of the requested precondition Pre with the advertised precondition of service S. Analogously, $\mathsf{Sim}(\mathsf{Post}(S),\mathsf{Post})$ expresses the similarity the advertised post condition with the requested one. The similarity calculus is used to select a set of candidates for further investigation to find a proper solution.

We will therefore define the solution space as a mapping that indicates the correctness of solutions: $\mathsf{Sol}(q) : \mathcal{S}^+ \to [0,1]$ which may be defined for request $q = (\mathsf{Pre},\mathsf{Post})$ as follows:

$$\begin{aligned}&\mathsf{Sol}((\mathsf{Pre},\mathsf{Post}))(S)\\ &\quad = \mathsf{Sim}(\mathsf{Pre},\mathsf{Pre}(S)) \cdot \mathsf{Sim}(\mathsf{Post}(S),\mathsf{Post})\end{aligned}$$

Here $\mathsf{Sim}(\mathsf{Pre},\mathsf{Pre}(S)$ expresses to what extent the precondition of request q satisfies the precondition of service S. In (Kanagwa, 2009) the similarity between predicates P and Q is defined as the likelihood of the implication $P \Rightarrow Q$, or: $\mathsf{Sim}(P,Q) = \mathsf{Val}(P \Rightarrow Q)$. For more information on the function Val, see (Kanagwa, 2009).

Notice that in (Kanagwa, 2009) some heuristics are described to find a most suitable compound service. As suggested in (Paolucci et al., 2002) we consider three stages of capability matchmaking (including user context, service context, user preferences etc.):

1. Exact match: Both output and input of a service S are equivalent to the request:

   $$\mathsf{Pre}(S) = \mathsf{Pre} \wedge \mathsf{Post}(S) = \mathsf{Post}$$

2. Plug-in match: The outputs of service S are more specific than requested, or its inputs require less information than the requested:

   $$\mathsf{Pre} \Rightarrow \mathsf{Pre}(S) \vee \mathsf{Post}(S) \Rightarrow \mathsf{Post}$$

3. Subsumed match: The output of a service S can only partial fulfill the request, or the input required by the service are more specific than the request provides:

   $$\mathsf{Pre}(S) \Rightarrow \mathsf{Pre} \vee \mathsf{Post} \Rightarrow \mathsf{Post}(S)$$

4. Not match: if non of the above are applicable.

The ultimate goal of match making is to determine the contents that satisfied user preferences and interests. For this, the matching algorithm starts with the most specific expression which best fits the user's wishes and in the case that no matching can be found, the user query required to be relaxed (expanded).

4.2 Preference Calculus

Input and output based matching alone can not guarantee the retrieved service is usable. Taking the profile P into account, we get for each service $S \in \mathcal{S}^+$ the suitability score $\mathsf{Suit}(S,q,P)$:

$$\mathsf{Suit}(S,q,P) = \mathsf{Sol}(q)(S) \cdot \mathsf{Sim}(P,S) \qquad (1)$$

The handling of user preferences may be modified for those cases where preferences are not easily determined as exact numbers. A discrete set of values is more appropriate for such cases. A naive approach in such a case is to only register whether there is a preference for a service or not. However, we feel such a boolean approach will be too restrictive for general application. We therefore propose to use a fuzzy approach, and consider preference as a linguistic variable that can take, according to the MoSCoW Prioritization scheme for project management (Clegg and Barker, 2004) one of the following values: (1) *Must have* (2) *Should have* (if at all possible), (3) *Could have* (if it does not effect anything else) and (4) *Won't have* (this time but would like in the future), extended with the value (5) *Don't want*. The value of $\mathsf{Sim}(P,S)$ then is expressed as such a MoSCoW value.

Referring to Formula (1), we have to combine the outcome of $\mathsf{Sol}(q)(S)$ with the MoSCoW value. A very simple approach is to convert the MoSCoW values to numbers as follows: m(*Must have*) = 1, m(*Should have*) = 0.75, m(*Could have*) = 0.50, m(*Won't have*) = 0.25 and m(*Don't want*) = 0. This leads to:

$$\mathsf{Suit}(S,q,P) = \mathsf{Sol}(q)(S) \cdot m(\mathsf{Sim}(P,S)) \qquad (2)$$

4.3 The Architecture

The framework presented in our previous work (Tegegne et al., 2010), see Figure 3, depicts an overall process of service discovery. A user may send a request to the request interpreter. The profile agent personalizes the request, while the context agent will add context specific extensions to the request. Then the enriched request is forwarded to the matchmaker agent. The matchmaker agent selects the best candidate for the submitted request as described in the previous subsection, using the service repository agent to supply the base knowledge (their identity and their semantics) of the elementary agents ($\mathcal{S}$). The result is transmitted to the service requester to be communicated with the requester.

The profile manager (PM) gets the user request. Upon first usage, a user may have to supply some base information to set up a profile. The profile manager updates the profile repository. After completion, the PM will send the user a registration conformation message. In the meantime, the profile manager sends the new user information to the authorization and authentication module. Then the user will be provided a certificate. If the user is a registered user, the PM will request an authorization certificate from the authentication and authorization module. The PM also checks the validity of the certificate and checks if the certificate is given by a trust security manager. If the certificate fulfills the above requirements, the PM updates the user profile (preference, interest, context (if exist)). After that the PM will send the user request plus the current user profile to the matchmaking agent (and/or the user if necessary).

All profile data are held in a profile database, which is only accessible via the PM. The PM permits to read or write data only if the requesting application can prove sufficient access rights with a certificate. To enhance security for sensible data, profile entries in the database are encrypted by the PM.

4.4 The Matchmaker

In this section we elaborate the match making functionality from sections 4.1 and 4.2 in some more detail, in terms of the architecture described in 4.3. The function of the match maker is to find the most suitable compound service S given a request q and a profile P, using $\mathsf{Suit}(S,q,P)$ as suitability measure. The match maker thus ensures that the user will receive the service that is pertinent with user preferences and interests.

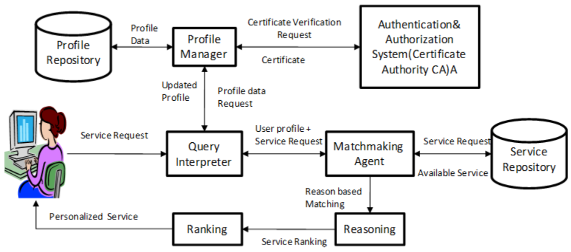

Figure 4: Profile-based service discovery and selection.

In Figure 4 we present the general architecture for the match making process. First, it receives the user profile and preferences from the query interpreter and it combines with service ontology in service repository/registry. After that the match maker selects the advertised (i.e. atomic) services that match with the request. The extracted services will be forwarded to the reasoning module to find the best matching compound services, and rank them according to their applicability. After the matching the reasoning agent will strengthen the matching with extra criteria (QoS, cost etc.). Later the ranking module ranks the extracted services (matched services) based on user preferences, user context and non functional properties of services. Finally, the services with maximal rank will be presented to the requestor. The match maker will further perform consistency check and validity of the user profile and quality of service (Alam et al., 2009).

Algorithm 1: *ServiceDiscovery*.

Request Negotiate:
GetRequest (user,req,pref,context);

Request Interpreter:
Update Profile (user, req, pref **out** req, pref);
Update Context (context **out** context);
P := prefs $\oplus$ context;

Matchmaker:
evaluate function $\mathsf{Sol}(req)$;
if for all S we have $\mathsf{Sol}(req)(S) < \delta$ **then**
failure;
else
return $\mathsf{argmax}_S \mathsf{Suit}(S, req, P)$
end if

This discovery process is summarized in algorithm (1) and in Figure 4. Finally some remarks about authentication and authorization. In the architecture of Figure 4 the user requests services. The query interpreter will send the query to the profile manger. The profile manager checks whether the user is authenticated and authorized. After that, the profile manager retrieves any available user preferences from the profile repository. Finally the user information will be forwarded to the query interpreter. The query interpreter transfers the service request and the user profile (user data and preferences) to the match maker to process service matching.

5 eHealth PERSONALIZATION

Advances in service orientation, mobile and ubiquitous computing, and continuous progress in medical devices and diagnosis methodology are enabling personalized healthcare services to be delivered to individuals at any place and any time (Zhang et al., 2004). These advances deviate from the ”One size fits all” paradigm in healthcare as is common in traditional hospitals, clinics and healthcare centers. Personalized healthcare ensures that healthcare services provisioned to individuals are customized to their prevailing healthcare needs. In most developed countries, personalized healthcare is provided for citizens through home care, wearable devices, online treatment and consultation. In developing countries personalized healthcare could provide an opportunity to compensate for the shortage of professional healthcare workers as well as poor healthcare infrastructures.

Introducing ICT in the healthcare sector is a hot issue, both in developed and developing countries. Several researchers have been conducting researches how to use ICT in supporting healthcare. Many organizations are involved producing in electronic healthcare standards. For example, Health Level 7 is a health informatics standard organization. The main purpose of this organization is developing, publishing and promoting a comprehensive framework for the development of health informatics standards and the employment of the framework to produce protocol specifications for health data interchange, integration, storage and retrieval among diverse data acquisition, processing, and handling systems.

Similarly, the European Telecommunications Standards Institute (ETSI) is an ICT standard organization. ETSI, recently released a first draft personalization on eHealth standard. This draft standard will help to manage the user profiles for personalization of eHealth systems and services according to the user preferences and needs. This profile is an extension of the ‘user profile management(UPM)’ standard developed by ETSI.

5.1 eHealth Service Discovery Framework

Adapting an eHealth system to the individual user is essential for making it safe and easy to deploy and to use as an effective support to independent living. Personalization can thus enhance the user’s trust in the eHealth systems, and make them more readily accepted.

The case for personalization of health information is supported by studies in health communication which have shown that health-education material can be much more effective if customized for the individual patient in accordance with their medical condition, demographic variables, personality profile, and other relevant factors (DiMarco et al., 2009). According to (DiMarco et al., 2009), little work is being done on what we consider the most important factor: tailoring the information to individual needs, experiences, and communication style.

One of the most important aspects needed in system building is information about the intended user goals, needs, moods, preferences, intentions, etc. This information can be acquired through an explicit and implicit process called user modeling. Modeling a user means interpreting user actions within a given system or application. The user model is usually restricted to some characteristics that are supposed to be the most meaningful in the context of the user interaction with the system.

5.2 Key Benefits

Personalization in eHealth has twofold advantages; for the health workers it provides information (such as training, professional guidance and assistance) on the basis of their educational background and job descriptions. On the side of the patient, it provides the necessary patient-oriented health information systems like patient preference, informed consent, self-care and shared patient-doctor decision making.

The main aim of personalizing eHealth is to acquire and capture factual information about the patient, their condition, current treatments, their preferences. This information can be obtained from the patient record except the user contextual information.

Personalizing eHealth besides informing, enabling decision making and persuading the patients, it will give users access to medical treatment and consultation services on the basis of their needs. The health workers also benefit from this personalization in two ways, first they strictly consult their patients based on their preferences, and second the health worker can fetch any information from the personalized system. Patients can get information about the treatment, background information about their conditions (the cause, symptoms, its consequences and so on) and alternative treatment and its effect.

In most of the previous personalized eHealth, the interaction between the system and the patient was fixed and simple (Cawsey et al., 2007). Personalized email or text messages have also been used. This type of personalization does not consider individual preferences and interests. For example if a centralized HIV/AIDS prevention and controlling office sends an instant message to HIV/AID patients to take their medicine on a specified regular time. However this system does not address the individual preference rather it implies "one size fits all" notion.

Service personalization in eHealth will help to design a personalized user interface based on user's abilities, interests and needs. This will create an opportunity in addressing heterogeneous preferences of individual users. For instance, for an illiterate mobile user, it is possible to create an audio based user interface that can be accessed by pressing a single key.

6 CONCLUSIONS

Efficient and accurate service discovery is one of the key challenges of service-oriented systems. In this paper we concretize the use of user profile provided more refined service discovery. To address the privacy concerns that relate to use of user profiles, we have integrated privacy (authentication and authorization) in service personalization. The intended deployment is in transition countries where voice via mobile phone is the most widespread communication mechanism. Consequently, part of the future work is to implement the framework using voice technology based on mobile phone platform as well as developing a corpus for local languages (such as the Ethiopian Amharic) in the healthcare domain.

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