Consumption of Profile Information from Heterogeneous Sources to Leverage Human-Computer Interaction

María de Lourdes Martínez-Villaseñor[1] and Miguel González-Mendoza[2]

[1] Universidad Panamericana Campus México, Augusto Rodin 498,
Col. Insurgentes-Mixoac, México, D.F., México
[2] Tecnológico de Monterrey, Campus Estado de México
Carretera Lago de Guadalupe Km 2.5,Atizapán de Zaragoza, Edo. de México, México
lmartine@up.edu.mx,mgonza@itesm.mx

Abstract. Ubiquitous computing brings new challenges to system and application designers. It is not enough to deliver information at any time, at any place and in any form; information must be relevant to the user. Ubiquitous user model interoperability allows enrichment of adaptive systems obtaining a better understanding of the user, but conflict resolution is necessary to deliver the best suited values despite the existence of international standards for different concepts. In this paper, we present the algorithm of conflict resolution to consume of profile information from the ubiquitous user model. We illustrate the enrichment of user models with one elemental concept for human-computer interaction: the language concept.

Keywords: User modeling interoperability, ubiquitous user model, human computer interaction, conflict resolution.

1 Introduction

System designers must take into account that it is not enough to deliver information at any time, at any place and in any form; information must be relevant to the task, background and knowledge of the users [1]. A better understanding of the user helps high functionality applications where general assumptions about the users and stereotypes are not enough for the system to interact cooperatively. Each system and application has valuable but partial information about the user that is worth sharing in order to enrich user models. Although ubiquitous user modeling can improve the usability and usefulness of the human-computer interaction, it is important to decrease the effort associated with creating a user model [1]. We argue that integrating profile information of heterogeneous sources, and enabling ubiquitous user modeling interoperability can leverage human-computer interaction, prevent the user from repeated configurations, and decrease the effort to know the user. Making sense of gathered information from heterogeneous sources entails handling syntactic and semantic heterogeneity, and dealing with different possible conflicts as described in [2]. Syntactic and structural standard language and ontology provide a necessary but not sufficient

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condition for exchange. Mediation between concepts is also necessary between to build semantic bridges between representations.

In previous work [3], we presented a framework for ubiquitous user interoperability that enables sharing user model information with a mixed approach to bridge the gap between the mentioned approaches as [4] recommend. In this paper, we present the algorithm of conflict resolution to consume profile information from the ubiquitous user model. We provide an example to illustrate how consumption of even one concept, elemental for human-computer interaction entails handling great syntactic and semantic heterogeneity. An algorithm of conflict resolution and selection of best value to deliver is necessary despite the existence of international standards for this concept. The rest of the paper is organized as follows: in section 2 we present algorithm for the consumption of profile information from a ubiquitous user model to leverage human-computer interaction. We describe our demonstration of concept consumption and results in section 3. We conclude an outline our future work in 4.

2 Consumption of Profile Information from an Ubiquitous User Model to Leverage Human-Computer Interaction

The conflict resolution process fetches the best value available for each concept in consumer´s request. As a precondition of consumption algorithms, the Ubiquitous User Model Interoperability Ontology (U2MIO) is required which contains the user model concept scheme, concept schemes and mappings of previously integrated sources and their instances. U2MIO mediator fetches the value candidates for each concept in the consumer request. The interoperability engine performs a best value selection for each concept in the consumer request. If a value is extracted from concept with an *exactMatch* semantic relation, it is at least considered equivalent and the data type and enumeration constraints (if available) have been checked.

Algorithm 1. Conflict resolution and selection of best values to deliver

Require: U2MIO ontology, C_s set of concepts in request
Ensure: V_i* *(best values for every required concept)*
1: Receive cd_i from consumer request C_s
2: **for all** concepts cd_i in C_s
3: get restriction facet collection F for cd_i
4: get concept requested V_i with *exactMatch* in U2MIO
5: **if** V_i is empty
6: get concept requested V_i with *closeMatch* in U2MIO
7: **end if**
8: **if** V_i is not empty
9: **if** F is not empty
10: **for all** v_j in V_i
11: **for all** f_k in F
12: **if** v_j satisfies f_k
13: increase restriction satisfaction rcc_j
14: **end if**
15: **end for**

```
16:          end for
17:          v_i*= v_j with max(rcc_j)
18:       else   comment: no facets to check
19:          v_i*= v_j with more recent effective date
20:       end if
21:     else  comment: no value available for this concept
22:       v_i*=ϕ
23:     end if
24: end for
25: Deliver V_i*
```

If this conflict resolution algorithm (algorithm 1) is implemented having XML consumer documents that describe an application user model or a web service description, the compatibility can be checked in the following XML constraining facets *length, minLenght, maxLenght, pattern, enumeration, whiteSpace, maxInclusive, maxExclusive, minInclusive, minExclusive, totalDigits,* and *fractionDigits*.

3 Demonstration of Concept Consumption

We exemplify how the process of conflict resolution delivers interchangeable values despite of the great semantic heterogeneity of *language* concepts of the sources. International standards (ISO 639 language codes for example)[5] help in the identification of languages, but they are not universally adopted. We previously integrated the corresponding concept schemes from Facebook LinkedIn and Google+ to the ubiquitous user model. Even if the concept tags are very similar, frequently the content meaning is only significant to the profile provider. The automatic process of concept alignment established semantic mappings between the language concepts of the social network concept schemes and the ubiquitous user model scheme (U2M).

The process of consumption of profile information is used to enrich the basic demographic information of the Microsoft HealthVault using provider's method *putThings*. Although all concepts of this profile are considered, we focus in the language concept to illustrate the conflict resolution. We show the resulting semantic mapping determined by the process of concept alignment in figure 1. Partial concept schemes focusing in language concepts of each source (Facebook, Linkedin and Google+) and the profile consumer (MS HealthVault) are shown. The green arrows represent relations determined as skos:*exactMatch* (concepts are interchangeable) and red arrows correspond to skos:*closeMatch* (concepts are related) relations. When the profile consumer requests for *language* value, its concept scheme is integrated to the user model determining semantic mappings with U2M concept scheme, and then the process of conflict resolution retrieves concept restrictions in order to deliver the best suited value. In this case, the language concept type refers to a vocabulary of ISO-639-1 (1995) and restricts its value to its content. Although this vocabulary refers to a standard, the code used is already superseded with more recent revisions. The value of Google+ for the language satisfies the type and vocabulary restriction and is therefore delivered.

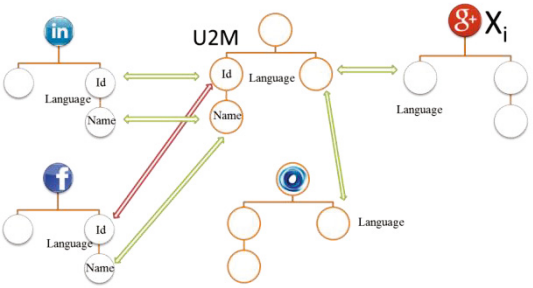

Fig. 1. Language concepts semantic mappings

4 Conclusions and Future Work

We presented the conflict resolution process to fetch the best value selection for requested values from a previously integrated user model. Although standards help when reusing and sharing profile information, mediation and conflict resolution is needed when the sources are heterogeneous and autonomous. Conflict resolution process that exploits the information contained in the source like preferred values, data types and other restrictions is useful. We illustrate the enrichment of user models with one elemental concept for human-computer interaction: the *language* concept. For future work, we want to prove that enabling ubiquitous user model interoperability with our framework can decrease the effort of user model design and leverage human-computer interaction. We are trying to use external vocabularies and ontologies, and considering situational aspects to make the conflict resolution more accurate, in order to deliver the best suited values according to the service and user's current situation.

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