

Overview of a Framework for Ubiquitous User Models Interoperability

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Abstract. Researchers in the user modeling community have been interested in sharing and reuse profile information from heterogeneous sources. Ubiquitous user model interoperability allows enrichment of adaptive systems obtaining a better understanding of the user, and decreases the effort associated with creating a user model. We present a framework that enables the interoperability between profile suppliers and consumers with a mixed approach that consist in central ubiquitous user model ontology and a process of concept alignment. The central ontology is a flexible representation of a ubiquitous user model to cope with the dynamicity of a distributed multi-application environment that provides mediation between profile suppliers and consumers. The process of concept alignment automatically discovers the semantic mappings in order to interpret the information from heterogeneous sources and integrate them into a ubiquitous user model.

Keywords: User modeling interoperability · User modeling · Schema matching

1 Introduction

User models from commonly used systems, applications and devices are valuable sources of personal information that can be shared and reused to obtain a better understanding of the user, prevent repeated configurations, help deal with the “cold start” problem, and decrease the effort associated with creating a user model. Gathering distributed user information from heterogeneous sources to enable user model interoperability entails handling syntactic and semantic heterogeneity [1]. From literature [2, 3], we see that current research in ubiquitous user modeling has two major approaches: (i) standardization based user modeling founded in defining a common ontology and language for the user model; (ii) mediation-based user modeling using mediation techniques to build semantic bridges between representations. Current solutions for ubiquitous user model interoperability must consider the high degree of dynamism of ubiquitous environments. A possible solution to overcome limitations of standardization and mediation approaches, and leverage their advantages is to integrate elements of both approaches as suggested in [2]. We present an overview of a framework for

ubiquitous user interoperability that enables sharing user model information with a mixed approach to bridge the gap between the mentioned approaches. The proposed framework [4] enables the interoperability between profile suppliers and consumers with central ubiquitous user model ontology to provide formal representation of the user profile, and a process of concept alignment to automatically discover the semantic mappings between the user models. Similar mediation approaches do schema mapping with help of the expert designer [5] or forcing the stakeholders to adopt a syntax format [6]. Standardized approaches, on the other hand use fixed standard representation and every interoperability stakeholder must add to this model and to an exchange language [7]. Our approach allows the interoperability process with the least intervention of the stakeholders and has the flexibility to accept new stakeholders without modifying current mappings.

2 Overview of the Framework for Ubiquitous User Model Interoperability

The proposed framework is based on a distributed architecture to share and reuse profile information contained in existing heterogeneous user models. The ubiquitous user model is application and system independent. The framework allows gathering information from profile providers, and integrating a user model representation that can evolve over time. It also enables to consume profile information resolving possible semantic conflicts. Due to the great syntactical and structural differences, as well as the profile providers' and consumers' autonomy, it is practically impossible to develop a static commonly accepted ontology for every domain. The main contributions of this work are the central ontology for ubiquitous user model interoperability and the process of concept alignment to deliver quality mappings between concepts of different sources automatically. The framework has been proven gathering profile information of social network applications, personal devices with sensors, personal health records, and learner management systems [4, 10].

2.1 Ubiquitous User Modeling Interoperability Ontology (U2MIO)

The Ubiquitous User Modeling Interoperability Ontology (U2MIO): (a) Provides semantic support for user model overcoming differences between concepts at knowledge level. (b) Represents a flexible user profile structure which provides the possibility for the ubiquitous user model to evolve during time. (c) Provides representation for new stakeholders in the interoperability process without effort of the provider or consumer system. The ontology reuses SKOS ontology; it can be seen as an aggregation of concept schemes each one representing a profile supplier or consumer, and a central ubiquitous user model concept scheme. Semantic mapping relations are established between each supplier/consumer concept scheme and the ubiquitous user model concept scheme at concept level by the process of concept alignment in order to enable interoperability between user models. The ubiquitous user modeling ontology demands the design of concept schemes, one for each profile provider and the ubiquitous user model concept scheme (Fig. 1). Semantic mapping relations were established with SKOS properties.

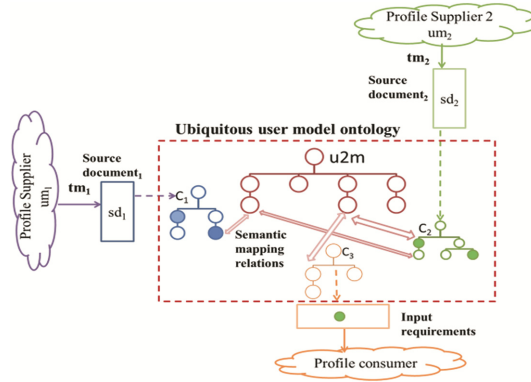


Fig. 1. Interrelations between profile supplier/consumer and ubiquitous user model ontology.

2.2 Process of Concept Alignment

The process of concept alignment is based on a two-tier matching strategy that consists in two phases: element level matching and structure level matching. The process purpose is to determine the mappings between two concept schemes at the granularity of concept elements. This means finding the alignment A' given the pair of schemas X and U where X can be any concept scheme constructed from a profile supplier/consumer document and U will always be the ubiquitous user model concept scheme. One wants to determine all the semantic relations R from the triplet $\langle c_s, c_t, R \rangle$ from all concepts in X to all concepts in U as shown in Eq. (1):

$$R(c_s, c_t) \forall c_s \in C_s, \forall c_t \in C_T \quad (1)$$

Three types of links are considered between two concepts of different concept schemes based on SKOS mapping properties that establish associative, and interchangeability mappings: *skos:exactMatch*, *skos:closeMatch* and *skos:relatedMatch*. In the element level matching phase, the concepts are directly compared to each other without considering the hierarchy structure and values. The goal of element level matching is given concept c_s of the source concept scheme X_s , finding the best concept label c_{tb} from a set of concept candidates for alignment in the target concept scheme X_T . String similarity, semantic similarity and internal structure similarity techniques are used to determine concept similarity. In the structure level matching step, the context of the source and target concepts (neighbors of the concepts in the hierarchy) are considered. The ultimate goal of this process is determine the one-to-one mappings between the concept c_s of the source concept scheme X_s and the best concept c_{tb} from the set of labels C_t of the target concept scheme X_T . From this phase, decision recommendations can be obtained for the inclusion of new concepts, sub collections and collections in the ubiquitous user model concept scheme allowing it to evolve over time. Details of the process of concept alignment are presented in [8, 10].

3 Conclusions and Future Work

The proposed framework enables the interoperability between profile suppliers and consumers with a mixed approach. Central ubiquitous user model ontology (U2MIO) provides the representation of the user profile, and a dynamic process of concept alignment automatically discovers the semantic mappings to align the supplier/consumer concept scheme with the ubiquitous user model concept schema. The process of concept alignment is also responsible of offering recommendation of concept, sub collection and/ or collection addition. These recommendations allow the U2MIO ontology to evolve over time. The central ubiquitous user modeling for interoperability ontology (U2MIO) is a flexible representation of the user profile in order to cope with the dynamicity of ubiquitous environment. Hybrid integration system architecture was proposed in which every stakeholder defines its own schema, but it is mapped to the global ontology U2MIO. In the hybrid approach, new stakeholders (suppliers or consumers) can be easily added without the modification of existing mappings. Specific context in which the service will be provided to the user is not taken into account to determine which values to deliver when consuming profile information. More empirical evaluation is also necessary to refine the model and prove that the solution is practical and generalizable.

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