Chapter 7.2
Bridging the Gap between Mobile Application Contexts and Web Resources

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ABSTRACT

Context-awareness is highly desired, particularly in highly dynamic mobile environments. Semantic Web Services (SWS) address context-adaptation by enabling the automatic discovery of distributed Web services based on comprehensive semantic capability descriptions. Even though the appropriateness of resources in mobile settings is strongly dependent on the current situation, SWS technology does not explicitly encourage the representation of situational contexts. Therefore, whereas SWS technology supports the allocation of resources, it does not entail the discovery of appropriate SWS representations for a given situational context. Moreover, describing the complex notion of a specific situation by utilizing symbolic SWS representation facilities is costly, prone to ambiguity issues and may never reach semantic completeness. In fact, since not any real-world situation completely equals another, a potentially infinite set of situation parameters has to be matched to a finite set of semantically defined SWS resource descriptions to enable context-adaptability. To overcome these issues, the authors propose Mobile Situation Spaces (MSS) which enable the description of situation characteristics as members in geometrical vector spaces following the idea of Conceptual Spaces (CS). Semantic similarity between situational contexts is calculated in terms of their Euclidean distance within a MSS. Extending merely symbolic SWS descriptions with context information on a conceptual level through MSS enables similarity-based matchmaking between real-world situation characteristics and predefined resource representations as part of SWS descriptions. To prove the feasibility, the authors provide a proof-of-concept prototype which applies MSS to support context-adaptation across distinct mobile situations.

DOI: 10.4018/978-1-60566-290-9.ch009

INTRODUCTION

Current and next generation wireless communication technologies will encourage a widespread use of available resources – data and services - via a broad range of mobile devices resulting in the demand for a rather context-adaptive resource retrieval. Context-adaptation is a highly important feature across a wide variety of application domains and subject to intensive research throughout the last decade (Dietze, Gugliotta & Domingue, 2007; Schmidt & Winterhalter, 2004; Gellersen, Schmidt & Beigl, 2002). Whereas the context is defined as the entire set of surrounding situation characteristics, each individual situation represents a specific state of the world, and more precisely, a particular state of the actual context (Weißenberg, Gartmann & Voisard, 2006). Particularly, a situation description defines the context of a specific situation, and it is described by a combination of situation parameters, each representing a particular situation characteristic. Following this definition, context-adaptation can be defined as the ability of Information Systems (IS) to adapt to distinct possible situations.

To achieve this, we base on a promising technology for distributed and highly dynamic service oriented applications: Semantic Web Services (SWS). SWS technology (Fensel et al., 2006) addresses context-adaptation by means of automatic discovery of distributed Web services as well as underlying data for a given task based on comprehensive semantic descriptions. First results of SWS research are available in terms of reference ontologies – e.g. OWL-S (Joint US/EU ad hoc Agent Markup Language Committee, 2004) and WSMO (WSMO Working Group, 2004) – as well as comprehensive frameworks (e.g. DIP project[1] results). However, whereas SWS technology supports the allocation of appropriate services for a given goal based on semantic representations, it does not entail the discovery of appropriate SWS goal representations for a given situation. Particularly in mobile settings, the current situation of a user heavily determines the intentional scope behind a user goal and consequently, the appropriateness of particular resources. For instance, when attempting to retrieve localized geographical information, the achievement of a respective goal has to consider the location and device of the user.

Despite the strong impact of a (mobile) context on the semantic meaning and intention behind a user goal, current SWS technology does not explicitly encourage the representation of domain situations. Furthermore, the symbolic approach - describing symbols by using other symbols without a grounding in the real world - of established SWS and Semantic Web (SW) representation standards in general, such as RDF (World Wide Web Consortium, W3C, 2004a), OWL (World Wide Web Consortium, W3C, 2004b), OWL-S (Joint US/EU ad hoc Agent Markup Language Committee, 2004), or WSMO (WSMO Working Group, 2004), leads to ambiguity issues and does not entail semantic meaningfulness, since meaning requires both the definition of a terminology in terms of a logical structure (using symbols) and grounding of symbols to a conceptual level (Cregan, 2007; Nosofsky, 1992). Moreover, while not any situation or situation parameter completely equals another, the description of the complex notion of a specific situation in all its facets is a costly task and may never reach semantic completeness. Apart from that, to enable context-adaptability, a potential infinite set of (real-world) situation characteristics has to be matched to a finite set of semantically defined parameter representations. Therefore, we claim, that fuzzy classification and matchmaking techniques are required to extend and exploit the current functionalities provided by SWS and match the specific requirements of context-aware mobile applications.

Conceptual Spaces (CS), introduced by Gärdenfors (Gärdenfors, 2000; Gärdenfors, 2004) follow a theory of describing entities at the conceptual level in terms of their natural characteristics similar to natural human cognition in order