Context- and Domain-Aware Semantic Web Services

Sascha Roth¹  Bernhard Humm¹  Michael Rebstock²
sascha.roth@computer.org  b.humm@fbi.h-da.de  michael.rebstock@h-da.de

Hochschule Darmstadt - University of Applied Sciences
— ¹Faculty of Computer Science —
— ²Faculty of Economics and Business Administration —

Abstract: This research proposal introduces an approach for Semantic Web Services that includes context information when querying a service. Thereby, a mapping between context information and domain knowledge helps to reduce the service candidates and ideally enables to compute a subset of formerly undecidable queries without any user intervention.

1 Introduction

“Service composition is today largely a static affair. All service interactions are anticipated in advance and there is a perfect match between output and input signatures and functionality” [PvdH07]. Obviously, service compositions, commonly implemented as executable business processes, lack agility beginning with the way they are built. Semantic Web Services are a promising technology to overcome this issue. It is widely agreed that there does not exist a global ontological model for all possible services, so that specific domain knowledge exists. Queries for requesting a service often do not include the context information when making a request, or, at least do not provide a mapping between the context information and the domain of a service consumer.

This proposal starts with an example using the set theory. First, a naïve example illustrating the core idea is described, such that the major advantage of the proposed solution is clarified and resulting challenges are explained considering related work. Then, expected research outcomes are presented outlining the problem, thesis and impact of a solution. Finally, a brief research agenda gives information on how the proposed approach will be refined and evaluated.

2 Context and Domain Knowledge in Semantic Web Services

As aforementioned, it is widely agreed that no global ontology model for all possible services exists, so that a specific domain knowledge $D$ must exist (see
For a published Semantic Web Service $S$ (see Figure 1(b)), a request is given by query $q$ (see Figure 2(a)). Further, an intuitive processing of the ontology results with an undecidable question having a set of results $R$ (see Figure 3(a)), also known as homonyms, since there are several meanings for one term which lead to semantic ambiguity (cf. [RFP08, p. 110]). Hence, it is not computable whether the intention of $q$ is to buy distilled or to buy sparkling water, nor is it decidable to buy printer or toilette paper (cf. Figure 3(a)). Semantic ambiguity is a major problem challenging today’s Semantic Web Service community. The additional context information $C | C \subseteq D$ (see Figure 2(b)) enables the computation of $R^* = R \setminus (D \setminus C)$ (see Figure 3(b)). Obviously, there is a more efficient way for calculating the set of results $R^*$ without considering all elements of $S$ and computing all elements of $R$. However, sending $C$ with $q$ let a mediation engine conclude that $R' = R \setminus R^*$ are services, parameters, or service compositions that are not candidates for answering $q$, i.e. wrong services, parameters, or service compositions for $q$. With the context information $C'$ (see Figure 2(c)), the possible candidates are reduced so that the formerly undecidable query $q$ becomes computable avoiding any user interaction (cf. Figure 3(c)). This approach helps to minimize the amount of user intervention, as required [RFP08, p. 7]. In this example, $C$ and $C'$ could be gained from positioning devices similar as location-based services do. However, context information for employees could also be matched against the domain model, such that more plausible results can be calculated.

Context consideration already has been used (e.g. [RFP08 sec. 8.3]). However, the aforementioned approach is considered as novel since it takes the already existing
domain knowledge [RFP08, p. 5] as an additional dimension into account when making a decision. Ideally, the context information is an excerpt of the domain knowledge enabling more precise results. Moreover, imprecise context information could query an user intervention such that a context $\Leftrightarrow$ domain mapping knowledge base evolves over time. The introduced approach is a naive illustration, which avoids facing real world domain knowledge and queries. A major challenge is to close the gap between the introduced approach and real world services. Context information and domain knowledge mapping mechanisms have to be found, combined and evaluated with existing approaches using context information (e.g. [RFP08, sec. 8.3], [YSPL07]). In particular rating mechanisms (see e.g. [RFP08, p. 162]) have to be re-evaluated, since more precise results are expected due to the additional mapping of context information to specific domain knowledge.

### 3 Final Problem Statement

Service ambiguity needs human user intervention. Obviously, this constitutes a problem, since services ideally are autonomously chosen and invoked. Complete autonomy is an unreachable target. Therefore, approaches have to try to eliminate unreasonable choices, and maximize the amount of computable situations. It is to prove whether or not sending context information with a service request significantly reduces complexity/candidates in terms that less paths have to be analyzed/considered for an invocation. The vision is that a set or subset of formerly not computable queries becomes computable or reduced to a set of more reasonable choices for user interventions, or, in the worst case, remains unchanged. A solution would have multiple impacts. First, better performance is expected due to a reduced lookup effort, i.e. reduced search tree, for services. Second, more precise service recommendations are possible, i.e. automatic service compositions may enable more precise service mediation having analyzed the context within services are used for with respect to the underlying domain. Third, not only service lookups, but rather parameter mapping and service compositions are influenced by this approach. Consequently, it is to expect that all components within a semantic
infrastructure benefit from the additional context information when querying a service. After discussing the impact, the limitations of the introduced approach is outlined. Given query $q$ and context information $C$, it is not expected to entirely eliminate non-computational cases, but rather to reduce the initial tree of choices. Applied to the example containing useless choices in $R$, this means reducing to a set of choices that are more reasonable in the given context, i.e. finding $R^\ast$. This approach positively influences the learning behavior of an artificial intelligence (AI) component commonly used for service mediation. In particular manually chosen services within a given context could be used to develop and refine the domain model more precisely and to provide a domain/context mapping with learning strategies commonly used in AI engineering.

4 Research Agenda

This section gives a cross-grained overview on how to proceed with the research. A more detailed project plan has to be found in later stages. First, extensive literature review covering, but not limited to, the following topics: Semantic Web Services, ontology engineering, AI, in particular relevant lazy learning strategies. Second, evaluation of real world ontology models for a specific domain concerning the possibility to provide context information for service consumers and find an appropriate degree of context granularity. Third, developing concepts of how to provide context information with a query in order to gain on precision in the service mediation process. Fourth, find an existing, ideally mature, code base in order to implement the developed concepts in terms of an exploratory prototype enabling to demonstrate the benefit of the found concepts on a real world example. Fifth, development of the aforementioned exploratory prototype demonstrating practical relevance and feasibility. During research, publishing results and concepts early, e.g. as work in progress, is of great relevance, to gain feedback.

References

