Publishing and Discovery of intentional services: Goal-driven approach

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Abstract. With the increasing growth in popularity of Web services, discovering relevant Web services becomes a significant challenge. The introduction of intentional services is necessary to bridge the gap between low level, technical software-service descriptions and high level, strategic expressions of business needs for services. Current Web Services technology based on UDDI and WSDL does not make use of this "intention" and therefore fails to address the problem of matching between capabilities of services and business user needs. In this research work, we propose publishing and discovery of services based on intentions they satisfy by extending the actual registry to build the intentional one. We also focus on the part of discovery of intentional services concerning the formulation of the user's requests. Our contribution consists of proposing a goal meta-model for user's request using ontologies, the descriptor to be published in the registry and the matching algorithms between services' intentions and users' goals using similarity metrics.

Keywords: intentional service, goal, intentional service publishing, intentional service discovery, Ontology.

1 Introduction

Within a decade, Web services and SOA became a viable technical solution for the development of information systems. They provide flexibility in maintenance and evolution of systems, and ensure a high degree of interoperability between heterogeneous systems [14] [15]. A major problem in the use of SOA is the discovery of appropriate services that meet business needs [9]. This difficulty will increase with the number and variety of web services available online. The technological tools currently available (such as WSDL for Web Service Description Language and UDDI for Universal Description Discovery and Integration) are semantically poor and conceptually far from the concerns of the user. As many writers have observed, there is a "conceptual mismatch" between the service provider side located on operational level, and the user's needs whose are expressed in business terms.

The work presented in this thesis is built on earlier work in which the model $\mathcal{ISM}$ (Intentional Services Model) has been proposed for modeling and describing services in business terms [9], [10], [19]. $\mathcal{ISM}$ shares with other approaches the need to describe service to ease their retrieval but departs from their *function driven* perspective to propose an *intention drive* service description. As a consequence, $\mathcal{ISM}$ service descriptions will bring out the business intention that the service allows to fulfill with pre and post conditions instead of defining the signatures of operations that can be invoked on class objects. We believe that this approach contributes to resolve the current mismatch of languages between low level services descriptions such as WSDL statements and business perceived services.

Therefore, this work is part of the platform iSOA and specifies the capacity to search services in the registry using goal driven approach. It is related to the problem of publishing, querying and discovering of intentional services based on user goal and on the service intention.

We use this framework and this methodology to specify and implement the registry of the iSOA platform. Specifically, it will lead us to choose the most effective techniques for intentional services discovery and suggest matching algorithms to select the services that best meet user needs.

This article is organized as follows: first we present the research question concerning the discovery of services based on the goal they satisfy. Then, we introduce the proposed solution to this problem. The idea consists of proposing a goal meta-model used for formulating user query, the ontologies needed in the discovery and finally, the intentional descriptor required for intentional services publishing will be defined and implemented in an extended registry.

Before we conclude our work, we present the related work in this domain and how we compare other approaches to our solution.

2 Research question

The problem addressed in this thesis deals with the publishing and discovery of intentional services. Users formulate their needs in natural language in which they express a query with one goal to be achieved (Fig. 1).

The reply of natural language queries raises two major problems:

- Several intentional services candidate can match this query with variable degrees of similarity. For example, a query such as "*gather information*" may correspond to the intentional service "*integrate data*" with a degree of similarity 85% and another intentional service "*reassemble files*" with a degree of similarity 45%.
- The answer to a query could be an individual intentional service, as it could be in some cases a group of several intentional services that the user may compose to meet its needs. For example, "*accept delivery of goods*" may correspond to the intentional services "*acquire products*", "*enter the product in stock*" and "*enter in stock the delivered goods"*.

The solution of these problems requires three steps: (i) defining a service descriptor that allows the intentional publication in a registry, (ii) developing a query language

that helps to discover intentional services published in the registry and (iii) specifying an approach to perform intentional service discovery based on similarities calculation.

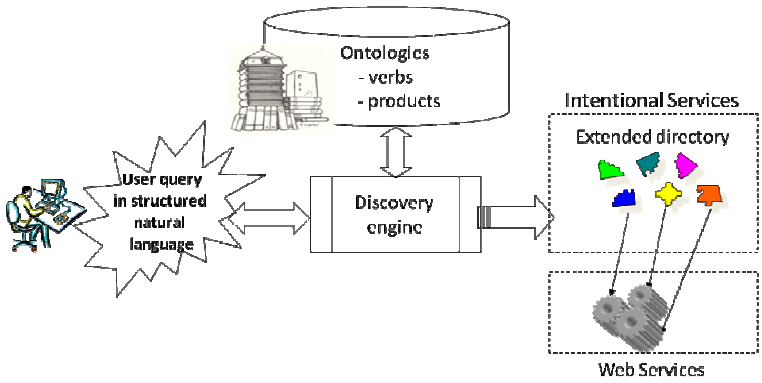

Fig. 1. *Intentional services Querying*.

The first key issue of this thesis focuses on specifying the intentional descriptor to be published in the registry and on the publication of aggregated intentional services. Additionally, it seeks to couple intentional service with software services executable by market standards. We rely on the concept of intentional atomic service which enriches the operational web service[1] with the concept of intention.

2.1 Meta-model of intentional services

The publishing of intentional services is the first step toward building the intentional registry. For this reason, we use the intentional model ISM [9] to present the services in the registry where the concept of goal is originally used in this model. An *intentional service* is a service captured at the business level, in business comprehensible terms and described in an intentional perspective, i.e. focusing on the intention it allows to achieve rather than on the functionality it performs. The model defines each intentional service as building brick in the application by associating it with the situational knowledge in the interface. Each intentional service fits a particular situation in order to achieve a particular intention.

The model of intentional service of [9, 19], takes the form of a composition of services based on graphs, AND/OR tree of goals. The composition of services driven by goals introduces a composition on several levels: for the highest service level, which may be strategic in nature, is broken down itself into sub/intentional services, may require a new de/composition to achieve the intentional services (Fig. 2).

[1] Web services are one possible technological solution for implementing intentional service. But this notion of intentional service is not limited to a specific technology.

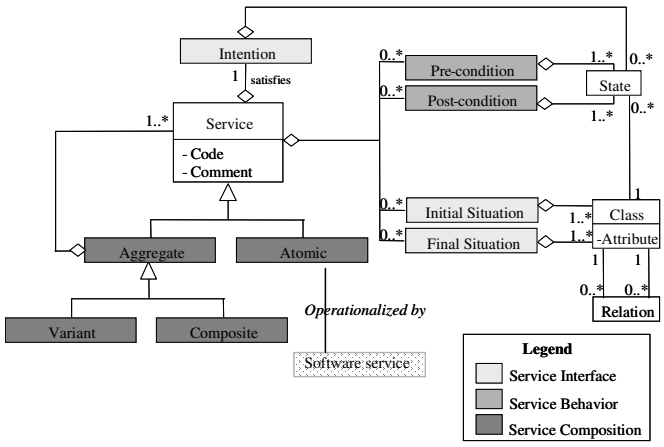

Fig. 2. *Intentional Service Model [9, 19].*

2.2 User query

We assume that the user needs are driven by goals, and are expressed using a language easily understandable by non-expert domain users, which is different from service models definition languages that require technical knowledge of the area.
In this thesis, we focus on user needs expressed in structured natural language. We propose an ontology based solution for the interpretation of these needs. The implementation of the ontology requires the prior definition of a goal model for expressing queries. This model will allow the exploitation of ontology to find similarities between the components of the user query and the attributes that make up the targeted intentional services published in the registry. In addition, we could reformulate user needs in order to enlarge the searching possibilities.

2.3 Discovery of intentional services

The third issue of interest is service discovery in the registry. The methodology proposed in [9] has no mechanisms for finding services at intentional level in the registry. A process proposal that aims at locating intentional services can contribute to enriching the methodology. Finding intentional service consists in establishing the matching between the goal (what a user of the registry is seeking to achieve) and intention displayed by the service (what the service guarantees to meet).

In our work, we propose mechanisms for finding intentional services available in the registry. The finding process can integrate several aspects including:

- The intentional services retrieval, i.e. select services in the registry based on the characteristics of the descriptor.
- Metrics of similarity: We need to measure how two intentions are semantically similar even if they are not expressed in the same way.

3 Proposed solution

To address the problems identified in the previous section, our approach focuses on four elements: first, we introduce the goal meta-model proposed to analyze the requests made by the user in structured natural language. Second, we propose our Ontologies needed to assist in resolving user queries. Third, we propose the use of annotation to specify the descriptor to be published in the registry. Finally, we propose the use of similarity metrics in our discovery algorithm. The elements of our proposed solution are discussed in the following paragraphs:

3.1 Goal meta-model

In this thesis, we focus on user needs expressed in structured natural language. We propose an ontology based solution for the interpretation of these needs. The implementation of the ontology requires the prior definition of a goal model for expressing queries. This model will allow the exploitation of ontology to find similarities between the elements of the user query and the attributes of the intentional services published in the registry.

The concept of basic goal we present in our work uses a lexical formalism with verb, target and parameters representing semantic functions of the verb. We support, in this context, the formulation of goals of *ISM* [9] based on a linguistic approach originally developed by [16, 17]. This approach inspired by the case grammar of Fillmore [6] and extensions [5] based on the fact that the semantics of goal is captured by a verb and parameters that correspond to roles associated to the verb. This formalism allows representing user goal and service intention (fig. 3). In this approach, a goal is expressed by a verb, a target and one or more parameters so-called 'direction', 'ways', 'time', 'beneficiary', 'quality', 'quantity' and 'location'. The verb and the target are mandatory while the parameters are optional. In general, any sentence can be expressed by Goal formalism.

This formalism allows representing user needs, and on the other hand, the intentions that intentional services can meet.

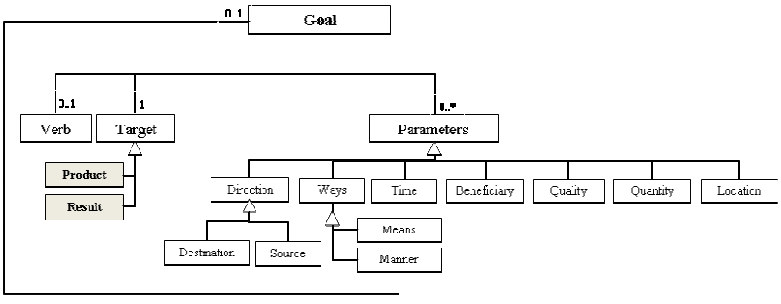

Fig. 3. *Goal meta-model for capturing user needs*

The formalism shows that the 'target' is either 'product' or 'result'. Result is non-tangible object and represents an output of the service. On the other hand, 'product' could be found as input and output.

3.2 Ontologies needed

We propose, from the intentional model, the ontologies needed to match the concepts of user queries with those of intentional services. Sharing the same ontologies allows establishing mappings at the time of service discovery.

However, queries are expressed by the users to find adapted services to solve their business needs. In practice, the needs are expressed as goals to be met. For example, finding a service to specify the requirements for booking a hotel room is reflected by the query "Book a hotel room". For that reason, we can write queries using ontologies and in particular each goal is expressed as a verb, a target and parameters. We differentiate two types of ontologies:

a) **Ontology of verbs** representing syntactic and semantic concepts related to verbs. It gives the different meanings of verbs and characterization of components used by these verbs in sentences of natural language. The specifications of the verb that agrees or refuses to construct sentences are syntactic concepts contained in the ontology. We rely on the classification of verbs in [20] to define this ontology.

b) **Ontology of products** defines a common vocabulary for all objects manipulated during the intentional services search [8]. This ontology is used especially to specify the inputs and outputs provided by the services.

The relation between these two ontologies defines the ontology needed for query resolution. In order to establish this relation, we related each concept in the ontology of products to a verb in the ontology of verbs.

3.3 Use of annotations

We propose to use an annotation approach to implement the intentional descriptions of services whose interpretation is made at the time of publishing the service in the registry (for cost reasons of and standards adoption).

The introduction of intentional perspective enriches the description of operational services. For this reason, we could use a semantic approach to annotate descriptors of Web services to enrich existing standards with intentional descriptions. We justify this choice by three simple reasons: (i) industries prefer updating their existing approaches to complete change, (ii) it is possible to annotate specific intentions using an ontology, which makes searching easier and (iii) from technical point of view: the annotations can be stored inside or outside the description. We propose the use of standard SAWSDL [23] to add intentional annotations then store them in the UDDI. This proposal is justified by [24] who also cited several reasons to show that SAWSDL directly supports the functional model (the formal description of the functionality of services) and data semantics (the formal description of the data exchanged between services). In this context, they demonstrated how SAWSDL can be used to achieve reuse, interoperability and agility. Furthermore, SAWSDL is an

independent approach to semantic representation languages thanks to the separation between the mechanism of semantic annotation and representation of semantic descriptions, which gives developers the flexibility to choose their semantic representation language, reuse models semantic domain, and annotate descriptions with multiple ontologies [2].

The main idea is to extend SAWSDL for enhancing expressiveness of service description. In SAWSDL, for a given WSDL element one can use many references to concepts in domain ontology but there is no specification of the semantic information nature: is it a verb, a target, a destination? etc. That is why we propose, in our description, a new attribute called *queryConcept* to give references to the query concepts corresponding in the same order, to the domain concepts listed in the original SAWSDL "*modelReference*" attribute. Indeed, our approach for intentional service description is based on the use of three types of ontologies. The first one contains only the concepts defining terms of query' concepts. The second type of ontologies is the verb Ontology; it is described and classified by Urrego [20]. The third type of ontologies is the product Ontology (Domain Ontology), which contains the semantics of the service domain products (e.g. travel).

In this way, we can define for each WSDL element two attributes. The first attribute, called *queryConcept*, references the corresponding concepts in query terms. The second attribute, called *modelReference*, contains a set of URI corresponding to the first list and which relay the Ontologies of verbs and products. Let's consider the example presented in Figure 4. The example presents the annotation of service named *book_hotel*. We can identify in the goal of this service the verb, the product and the destination. The importance of the extended attribute *queryConcept* is to distinguish the role of each term in the goal.

```
1   <?xml version = "1.0" ?>
2   <!DOCTYPE Intentional_Service SYSTEM "Service.dtd">
3   <Intentional_Service Code ="S_book_hotel">
4     <Atomic_Service>
5       <Interface
6                   serviceConcept="&QueryOntology;#verb &QueryOntology;#product
                    &QueryOntology; #destination“
7                   modelReference="&VerbsOntology;#book
                    &TourismOntology;#hotel  &TourismOntology;#France">
8                 <Intial_Situation> booking not made </Intial_Situation>
9                 <Final_Situation> booking made </Final_Situation>
10  </Interface>
11      …
```

Fig. 4. Example of intentional service descriptor

3.4 Use of similarity metrics

Many approaches have been proposed in various fields to measure the similarities: information systems engineering through the reuse of components, software

engineering to ensure the traceability of software code in the context of literature to index and retrieve documents, or even for the analysis of patterns of heterogeneous databases [25, 26, 27, 28, 29, 30, 31]. These different approaches provide metrics expressed as formulas more or less adapted to different situations. Most of them particularly interested in measuring the similarity between two texts, others look for similarities between the structured models.

Our position is that the mapping must be performed using metrics appropriate to the situation. Two specific criteria allow us to define such situations: first analysis of similarity between simple elements (such as verbs, products …), on the other hand, the analysis of similarity between complex elements (such as models of goals). Different types and properties of simple and complex elements can be identified, thus defining a complex type of metrics useful for measuring similarities [32].

A collection of such metric similarities can be exploited by a complex typology of similarity measures suitable for the analysis of similarities of the texts. Such a typology of similarity measures can be produced consistently and, as in our approach, used for mapping between users needs and services intentions.

5 Related work

Our work fits into the family of research approaches of goal-driven services. Most of these approaches [13, 22, 21, 4], focus on specifying goals in the context of searching Web services that meet these goals. In these approaches, different models have been proposed to specify goals without focusing on the problem of their capture. SATIS [12, 3], proposes ways to assist end users in the explanation of their intentions (goals). Moreover, the approach GODO [7] proposes models and tools to capture the goals of users with the help of an ontology and natural language. SATIS differs from this approach by proposing a process of incremental refinement of user needs to specify the characteristics of web services sought, as is the case in [10, 4]. And it differs from the latter approach in that it relies on models and techniques of semantic web to enrich the description of user needs and thus to suggest ways of reasoning and explanations of web services found to implement a business need.

Concerning the discovery of services, many logical approaches for the discovery of services [8] and hybrid matching algorithms have been proposed [11] using the metric of similarity. Other algorithms [2] make use of the service elements added to the interface. All these algorithms primarily exploit the degree of similarity by modifying the existing metrics. Classification mechanisms have been proposed too [1, 11, 2].

5 Conclusion

This work is in the research context to publish and discover services in a registry said intentional. We intend to design a comprehensive registry that meets the needs of business agents and the goal-driven discovery of these services.

The problem addressed in this article concerns querying and finding of intentional services. A user expresses his needs in natural language in a query with a goal. For this reason, we proposed a model aims to formulate these queries. This model will

allow the exploitation of ontologies to find matching and similarities between the concepts of goals made by user requests and intentions of those services.

The result of our work is a goal model and a proposal for new descriptor to be published in the registry. Finally, our future work will be the proposition of an algorithm to make the matching between the concepts of user query and those of intentional services published in the registry.

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