

# Web Services Discovery

## *A Novel Social Networks Approach based on Communities*

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**Abstract:** Nowadays Web services have become a new focal point of all the technological market of IT. Their number has grown rapidly and the task of their discovery resting on standards, UDDI and ebXML becomes more and more difficult. These standards have their own inherent limitations; they describe only the functional aspect of Web services and prohibit the possibility of combining them. Most proposed approaches for Web services discovery focused on the description of Web services themselves and neglect their interaction. In this paper we propose a novel approach which combines social networking with the principles of recommender systems for the Web services discovery. We also defined the concept of Web services community in a social network of Web services that gave us the opportunity to establish an abstraction level between the client applications and these last ones.

## 1 INTRODUCTION

Created to facilitate commercial exchanges, Web services take their roots in distributed computing and the advent of the Web. The Web services technology aims to standardize the presentation of services offered by a company and make their access transparent to any type of platforms, through a number of interoperability standards (Yu et al., 2008) (Margaria, 2007) (Papazoglou et al., 2007).

The current approach of Web services composition which consists in defining business processes, i.e. sequences of reusable Web services, is a static approach (Dustdar and Schreiner, 2005). The sequences of Web services are defined in advance. In this case, managing the applications scalability based on Web services integration is a difficult task. Composing Web services dynamically according to their functionalities and constraints that may occur during the process of composition is an approach that may be considered. This approach requires that the discovery process of Web services should be dynamic. The discovery of a Web service is a preliminary step to its use or recess in its selection in a composition process. It is through the mechanism of discovery that we can locate and carry Web services.

To further reduce the task of Web services discovery we propose to create Web services communities that allow us to reduce the search space of these latter. To date there is no definition in terms of consensus of Web services community. Consequently, several definitions have been proposed in the literature. Maamar et al. (2007) considered a community as a means to provide a common description of a desired functionality without referring explicitly to a specific Web service. Benatallah et al. (2003) defined a community as a collection of Web services with common features, although these Web services may have separate non-functional properties, as different providers and different QoS parameters. In this paper, we describe informally, the notion of Web services community as relationship between Web services without any particular weight (house construction, hotel reservation). Besides, a Web service may belong to different communities. More ample details on the construction of services communities are given in section 4.

In this paper we propose a new approach for Web services discovery in the context of social networks. It essentially allows: (i) defining social networks in the context of Web services, (ii) defining Web services community and (iii)

proposing an algorithm for Web services dynamic discovery in the context of social networks. The rest of this paper is organized as follows. Motivation and related work are given in section 2. Section 3 gives an overview of social networks. Section 4 describes our approach for Web services discovery in the context of social networks. Conclusion and future works are given in section 5.

## 2 RELATED WORK

Maamar et al. (2009) used recommender systems in the context of social networks for Web services discovery. Their works consist of proposing two scenarios. The first scenario is: the recommendation-based associations that could enrich the process of composition with additional Web services and are not usually requested by the user. The second one is that recommendation-based associations, with an emphasis on the robustness that could allow direct selection (and possibly automatic) of a Web service, which will replace a failed Web service. Maamar, Wives, Badr, Elnaffar, Boukadi, and Faci, (2011) introduced a semantic dimension for calculating the similarity between Web services in the same spirit as the work proposed by Maamar et al. (2009). Also Maamar, dos Santos, Wives, Badr, Faci and de Oliveira (2011) introduced the concept of Web services competition in addition of the concepts discussed by Maamar et al. (2009) to build social networks for service discovery.

Our approach is based on the interaction between Web services in the context of Web 2.0. We introduce recommendation-based techniques by focusing on social networks to solve Web services discovery problem by allowing these Web services taking advantage of the previous composition scenarios in which they participated. We plan to focus on collaboration-based associations. A scenario that allows us to really introduce the problem of Web services discovery in the context of social networks. It is neither substitution, nor the recommendation of additional Web services proposed by Maamar et al. (2009). Compared to the others approaches, our approach proposes two new kinds of links or associations between Web services in a social network: The collaboration-based associations without any particular weight and recommendation-based associations moderate and expressed by specific weights adjusted dynamically, in the context of Web 2.0, without using semantic techniques. Semantic approaches proposed by Maamar, Wives, Badr, Elnaffar, Boukadi, and Faci

(2011) and that of Maamar, dos Santos, Wives, Badr, Faci and de Oliveira (2011) can not compete with the approaches in the context of Web 2.0 in terms of execution time, which remains a sore point for applications in the world of e-commerce.

## 3 OVERVIEW OF SOCIAL NETWORKS

A social network is a dynamic structure modelled by nodes and edges. Nodes usually refer people and / or organizations and are connected together by social interactions. In recent years, social networks have become very popular. Their fields of applications are varied and are growing day by day. We can quote the e-commerce, the artificial intelligence and the social and political sciences.

The works that introduce social networking in the field of the discovery and the composition of Web services are relatively recent. The social networks of Web services differ from conventional social networks. These last ones are based on the absolute cooperation and mutual assistance between their members (i.e., no competition). By cons, Web services in social networks are especially competitive (Maamar et al., 2009) (Werthner et al., 2007). In a social network of Web services, Web services are in permanent interaction. New links can be formed and existing ones may disappear or be changed.

## 4 SOCIAL NETWORK-BASED APPROACH FOR WEB SERVICES DISCOVERY

The proposed discovery process of Web services rests on the creation of a social network of Web services for one or more registers UDDI. This process is developed as an algorithm for Web services discovery, presented farther in this section. At first we describe how to build a social network of Web services.

### 4.1 Building Social Networks of Web Services

Web services are the only constituents of the social network and designate the nodes. We propose two kinds of links or associations between Web services: Collaboration-based associations (C) and Recommendation-based associations (R).

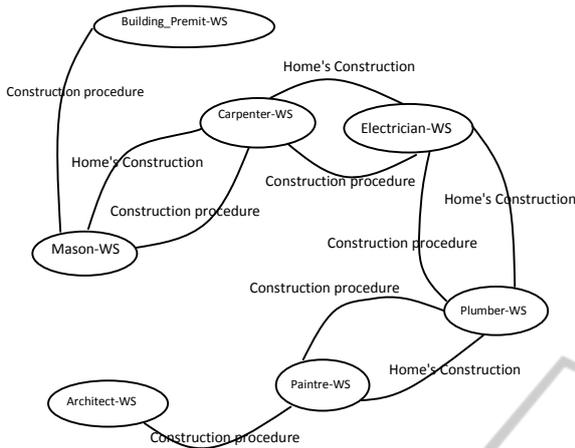


Figure 1: Example of Web services communities definition in a social networks of Web services.

**Collaboration-based Association (C):** The associations of collaboration are defined upon Web services communities. Each community is defined by a tree of Web services; community “Home’s Construction” in Figure 1, for example. Add a Web service to a particular community means inserting it at the end of the corresponding tree. A Web service may belong to one or more communities; in Figure1, the Web services *Painter-WS*, *Mason-WS*, *Electrician-WS*, *Plumber-WS* and *Carpenter-WS* are belonging simultaneously to both communities “Home’s construction” and “Construction procedure”.

**Recommendation-based Association (R):** in the same Web services community, a Web service could propose that new Web services resulting from recommendation-based associations should be part of a composition. Web services resulting from recommendation-based associations may be required to satisfy a user query. For example, under a subcontract, a prime contractor wanting to build a house could call an electrician, a painter or a carpenter. This last one could or not express explicitly this interest. But if a contracting authority wishes to manage himself building construction and thus assumes the role of prime contractor. He will need to involve all stakeholders.

Example:  $WS_i$  will recommend that  $WS_j$  could be part of the composition scenario with a weight  $wR_{ij}$ .  $WS_j$  could also recommend  $WS_i$  with a weight  $wR_{ji}$ .

The weight of the recommendation-based association  $wR_{ij}$  (or  $wR_{ji}$ ) is a calculated numerical value between 0 and 1 and is given by the following equation:

$$wR_{ij}(WS_i, WS_j) = \frac{|WS_j \text{ selection}|}{|WS_i \text{ participation}|} \quad (1)$$

$|WS_i \text{ participation}|$  and  $|WS_j \text{ selection}|$  represent the number of times that  $WS_i$  participated in scenarios composition and number of times that  $WS_j$  has been appointed by  $WS_i$  to participate in these scenarios composition.  $wR_{ji}$  is calculated by the same equation.

The equation (1) is inspired by the works of Maamar et al. (2009) and Maamar, Hacid and Huhns (2011).

## 4.2 Algorithm for Web Services Discovery

The proposed algorithm is based on the definition of three subgraphs of the graph  $G$  associated with the social network of Web services; a subgraph of collaboration  $cG$  that defines communities associated with Web services whose associations are characterized by no weight; a subgraph of recommendation  $rG$  that defines associations of recommendation characterized by weight between 0 and 1 given by the equation (1) and an undirected graph  $rG'$  which is a graph associated to the graph of recommendation  $rG$  whose weights of associations are defined by the equation (2).

Formally, we define the graph  $G$  as a triple  $(S, C, R)$ , where  $S$  is the set of vertices,  $C$  is the set of edges of Collaboration and  $R$  is the set of arcs of Recommendation. Furthermore, the graphs formed by  $S$  and  $C$ , on the one hand, and  $S$  and  $R$ , on the other hand, are respectively called  $cG$  (Graph of collaboration) and  $rG$  (Graph of recommendation) of  $G$ . We also define an undirected graph  $rG'=(S, R')$  corresponding to the directed graph  $rG=(S, R)$  whose edges  $R'$  are valued by the equation (2).  $WS_i$  and  $WS_j$  are two Web services of the graph  $rG'$ . The weight  $wR(WS_i, WS_j)$  of the edge  $(WS_i, WS_j)$  is given by the following equation:

$$wR(WS_i, WS_j) = \frac{wR_j(WS_i, WS_j) + wR_i(WS_j, WS_i)}{2} \quad (2)$$

Web services communities that form the social network are identified and indexed at the time of their inscription. In fact, the interface is performed in order to exploit these communities directly. Semantic techniques can be used for extracting the community associated with the user query. It is also supposed that it concerns only one community.

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ALGORITHM Discovery of WSs from the graph
 $G = (S, C, R)$  associated with the corresponding social
network of WSs, where  $S$ : the set of nodes or Web
services,  $C$ : the set of edges of collaboration and  $R$ :
the set of edges of recommendation
{
INPUTS  $rG' = (S, R')$  undirected and weighted graph
resulting from the directed and weighted
graph  $rG(S, R)$ ;
 $cG = (S, C)$  graph of the collaboration-based
associations;
OUTPUT  $WS_{dis}$  set of the discovered Web services;
 $WS_{dis} := \emptyset$ ;
Mark arbitrarily a vertex  $x$  of the graph
 $cG = (S, C)$  associated with the community extracted
from the user request;
Mark the vertex  $x$  in the graph  $rG' = (S, R')$ ;
 $WS_{dis} := x$ ;
WHILE exists an adjacent vertex not marked at a
vertex in  $rG' = (S, R')$  DO
  Select a vertex  $y$  not marked and adjacent at a
  marked vertex  $x$ ;
  IF  $(x, y)$  is the outgoing edge of the highest weight
  AND  $y \in$  to the tree associated with the community
  extracted from the user request of the graph  $cG$ 
  THEN
     $WS_{dis} := WS_{dis} \cup \{y\}$ ;
    Mark  $y$ ;
  END IF
END WHILE
Return  $WS_{dis}$ ;
}

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Figure 2: Algorithm for Web services discovery process based on social networks.

## 5 CONCLUSIONS AND FUTURE WORKS

In this paper, we focused on Web services discovery in the context of social networks. We have defined two types of links in a social network of Web services. Links or collaboration-based associations formed from Web services communities, and links or recommendation-based associations within these same communities. We defined a community as the report between Web services correlated (home construction, organization of a trip, hotel reservation) without any particular weight. The combined exploitation of these two types of associations as part of an algorithm for Web services discovery, allowed us to reduce considerably this task.

Our implementation is a work in progress. We are presently implementing the proposed algorithm where we considered a graph  $G$  associated with the

Web services social network of 2100 nodes (Web services) and 5000 edges.

The current work could be extended by introducing the notion of community multi-criteria in the formation of the collaboration-based associations. We could also review the recommendation-based associations and suggest that the users take part more in the process of recommendation of these last ones.

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