

# Social-based Web Services Discovery and Composition for Step-by-step Mashup Completion

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**Abstract**—In this paper, we describe our work in progress on Web services recommendation for services composition in a Mashup environment, by proposing a new approach to assist end-users based social interactions capture and analysis. This approach uses an implicit social graph inferred from the common composition interests of users. We describe the transformation of users-services interactions into a social graph and a possible means to leverage that graph to derive service recommendation. As this work is in progress, this proposal was implemented within a platform called *SoCo* where preliminary experiments show interesting results.

**Index Terms**—Web service composition; Mashup completion; service recommendation

## I. INTRODUCTION

A Mashup is certainly the most interesting instantiation of end users' services composition. A Mashup is a Web application that combines existing services (API, data sources, etc.) into a single integrated service. An example could be the use of cartographic data and interfaces from Google Maps<sup>1</sup> to add location information about real estate data [1]. This creates a new and distinct Web service. Just as Web2.0 technologies enable the well-known concept of *User Generated Content* (UGC), Mashup creation environments enable *User Generated Services* (UGS). Semi-automatic services composition systems, and particularly Mashups, which involve users, contain an unexploited repository of information. Indeed, the different types of interactions between entities involved in semi-automatic composition, i.e., users and services, could feed many systems. Moreover, with the popularity of social networks, this ongoing collaboration has taken on a daily importance in users' social lives and tasks.

Furthermore, the explosion of the number of Web services and APIs [2] exposed through the Web has only accentuated the need for such service composition platforms. Dynamic service recommendation could be a solution to enable service discovery and composition (our proposed method). An interesting study [3] describes the interactions of Yahoo!-Pipes users and how they can be used to extract social structures based on an analysis of user interactions.

Soriano et al. [4] emphasize the growing importance of the user-service relationship in a Service Oriented Architecture

(SOA) for composing services. In addition, [5] emphasizes the phenomenon of what they call "social interaction" between services. In fact, the aspects of trust and reliability between services may indeed impact the service selection for composition. Yu and Woodard [6] propose a very interesting view of Mashup ecosystems. Their study of an API repository<sup>2</sup> shows that utilization of services follows a long-tail effect (power-law distribution).

From the services recommendation perspective, some systems are based on user preferences (user profile) to suggest services [7]. Others rely instead on the concept of domain-specific knowledge. Knowledge (also called language) expressed in a specific area (science, business, etc.) is processed to extract rules that are used to help build services' recommendations [8]. In addition, another team [9] has proposed a community-based approach by recommending popular composition schema.

Our proposal is focused on extracting useful information from social networks to feed a service recommendation construction and assistance feature. Indeed, we believe that we must distinguish between two approaches: one based on communities and the other based on social networks. By definition, a community develops social links between people on the basis of a single common interest (e.g., free software community, medical community, etc.) while a social network develops interesting interactions based on a variety of particular interests. In our approach, we introduce recommendations based on the knowledge generated in social networks through implicit social interaction analysis.

## II. A SNA BASED MASHUPS AUTO-COMPLETION

In Web 2.0, people can create, use, and share services in communities and social networks. The question we are addressing is: *can we define social structures in the services area? If yes, how could we leverage such structures to facilitate the resolution of the problems involved in SOA?* To resolve this problem statement and approach the related work, we propose a general framework, called *Social Composer (SoCo)*, for services discovery and composition. *SoCo* is based on the transformation of *user*  $\rightarrow$  *services* interactions to *user*  $\rightarrow$  *users* social network, on top of which statistical processes

<sup>1</sup><http://maps.google.com/>

<sup>2</sup><http://programmableweb.com>

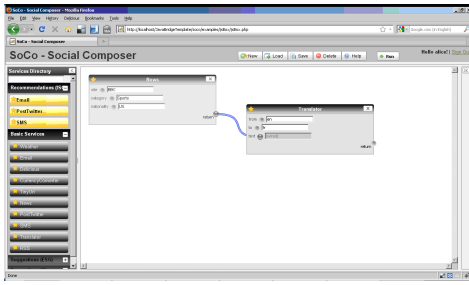


Fig. 1. Illustration of services suggestion (in yellow) after selecting translator service

are applied to determine recommendations for assisting a user in constructing a Mashup (a composition of services).

The explicit social relation has been addressed in our previous work [10] and we focus here on the implicit case, which is richer and enables more sophisticated tasks. An implicit social relation is one that is inferred according to the activities of different users, e.g. when one person uses several services created by another person. As in the explicit case, a graph can be developed, linking the users according to their interests and defined by their composition activities. Social networks, as they are currently constructed, include a profile for each user containing information that describes his/her special interests and preferences, and the history of his/her interactions with the system (i.e., a dynamic profile). Typically, these include statistics on services utilization (consumption and composition). This information allows the system to learn about the expertise of a given person in a particular area, and thus the relevance of services used by that person. A social network also includes a description of the links that define the social network itself. These links are used to calculate the social proximity between two users according to a particular context. This information then allows us to calculate the service recommendation confidence between two individuals based on specific joint interests. To leverage this information, it is therefore very important to extract, analyze and model the information contained in a social network.

We implemented the proposed algorithm in the *SoCo* framework which provides a graphical environment that users utilize to create Mashups. It includes the recommendation algorithm to provide dynamic suggestions to users 1.

In order to evaluate the performance and the behaviour of the proposed approach in terms of response time, we conducted three experiments that show that the main parameter to consider is Mashup size. In fact, we have generated randomly two data sets where services popularity follows first a uniform statistical law, and second a long-tail statistical distribution (which is more realistic [6]). Figure 2 shows that the size of created Mashups has a linear impact on the needed response time for recommending a service. We should notice also that the recommendation algorithm response time is less important for long-tail service popularity when compared to the response time for uniformly distributed dataset.

Overall, these results are interesting and do show that this

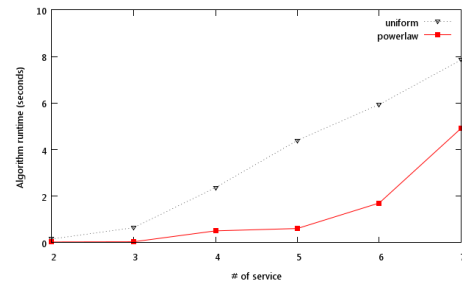


Fig. 2. The long-tail distribution impact on algorithm performance

algorithm is useful in an interactive application. However, they also show that the algorithm's response time is particularly sensitive to Mashup size, which is, according to related studies and our observations on *ProgrammableWeb*, distributed between two and five services (mostly closer to two). From a more general perspective, we believe that there is still room for improvement by optimizing the recommendation strategy.

### III. CONCLUSION

We have presented a new approach for services recommendation in a Mashup environment based on social network analysis. The particularity of this approach is the creation of an implicit social graph based on the interactions between users and services. While the experimental results, implemented in a platform called *SoCo*, show the positive potential of the proposed approach, there are still some challenging issues to be addressed as future work: (i) the newcomers' problem, which deals with the algorithm behaviour regarding the lack of learning information, and (ii) the entire Mashup auto-completion, which has the goal of suggesting a complete composition schema.

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