Reputation-based Web service selection for Composition

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***Abstract*—The success and acceptance of Web service composition depends on computing solutions comprised of trustworthy services. In this paper, we extend our Web service Composition framework to include selection and ranking of services based on their reputation score. With the increasing popularity of Web-based Social Networks like Linkedin, Facebook, and Twitter, there is great potential in determining the *reputation score* of a particular service provider using Social Network Analysis. We present a technique to calculate a *reputation score* per service using centrality measure of Social Networks. We use this score to produce composition solutions that consist of services provided by trust-worthy and reputed providers.**

***Keywords*-service composition; reputation; social networks;**

I. Introduction

The next milestone in the evolution of the World Wide Web is making services ubiquitously available. We need infrastructure that applications can use to automatically discover, deploy, compose, and synthesize services. Along with the functional attributes there is a need to consider non-functional attributes (Quality of Service parameters) of Web services in the process of building composite Web services. The current challenge in automatic composition of Web services also includes finding a composite Web service that can be trusted by consumers before using it. In this paper, we present our approach that uses analysis of Social Networks to calculate a *reputation score* for each service involved in the composition and further prune results based on this score.

Web-based Social Networks have become increasingly popular these days. Social Network Analysis is the process of mapping and measuring the relationships between connected nodes. These nodes could represent people, groups, organizations, computers, or any knowledge entity. We propose to measure the reputation of a service by measuring the centrality of a service provider and/or a service provider organization in a well-known Social Network. We adopt our idea of computing a *reputation score* using centrality measure based on the notion of *centrality and prestige* being key in the study of social networks [1], [2]. The role of central people (nodes with high centrality) in a network seems to be fundamental as they adopt the innovation and help in transportation and diffusion of information throughout the rest of the network. So our rationale is that these central figures who play a fundamental role in the network are trusted by others in the network who are connected (directly or indirectly) to them.

Our work investigates the following research issues: (i) compute the reputation score of composition solutions based on individual scores of service providers obtained using the centrality measure of social networks (ii) set a threshold for reputation that each and every Web service involved in the composition has to satisfy. Failure to meet the threshold will result in filtering out the Web service and it will not be used in any composition solution.

II. Centrality Measure in Social Networks:

Social Network Analysis focuses on the structure of relationships ranging from casual acquaintance to close bonds. It involves measuring the formal and informal relationships to understand information/knowldege flow that binds the interacting units that could be a person, group, organization, or any knowledge entity. In order to understand social networks and their participants, the location of an actor in a network is evaluated. The network location is measured in terms of centrality of a node that gives an insight into the various roles and groupings in a network.

Centrality gives a rough indication of the social power of a node based on how well they "connect" the network. The graph-theoretic conception of compactness has been extended to the study of Social Networks and simply renamed "graph centrality" [1]. Their measures are all based upon distances between points, and all define graphs as centralized to the degree that their points are all close together. Based on research on communication in Social Networks, the centrality of an entire network should index the tendency of a single point to be more central than all other points in the network. Measures of a graph centrality are based on differences between the centrality of the most central point and that of all others. Thus, they are indexes of the centralization of the network [4]. The three most popular individual centrality measures are *Degree* Centrality, *Betweenness* Centrality, and *Closeness* Centrality.

Degree Centrality: The network activity of a node can be measured using the concept of degrees, i.e., the number

ServiceProvider	*Degree*	*ServiceProvider*	*Degree*
Provider A	*2*	*Provider H*	*3*
Provider B	*3*	*Provider I*	*1*
Provider C	*1*	*Provider J*	*2*
Provider D	*8*	*Provider K*	*4*
Provider E	*3*	*Provider L*	*1*
Provider F	*4*	*Provider M*	*1*
Provider G	*5*		

Table I
DEGREE CENTRALITY OF NODES IN FIGURE 1

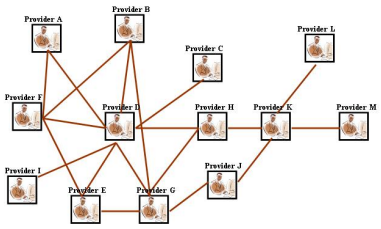

Figure 1. A Social Network of Web service Providers

of direct connections a node has. In the example network shown in figure 1 and table I, Provider D has the most direct connections in the network, making it the most active node in the network. In personal Social Networks, the common thought is that "the more connections, the better".

Betweenness Centrality: Though Provider D has many direct ties, Provider H has fewer direct connections (close to the average in the network). Yet, in many ways, Provider H has one of the best locations in the network by playing the role of a "broker" between two important components.

Closeness Centrality: Provider F and G have fewer connections than Provider D, yet the pattern of their direct and indirect ties allow them to access all the nodes in the network more quickly than anyone else. They have the shortest paths to all other and hence are in an excellent position to have the best visibility into what is happening in the network.

Individual network centralities provide insight into the individual's location in the network. The relationship between the centralities of all nodes can reveal much about the overall network structure.

III. REPUTATION-BASED WEB SERVICE SELECTION FOR COMPOSITION

We extend our previous work on Web service composition [3] (that uses both functional and non-functional parameters to compute composition solutions) by using reputation to filter services. The reputation score of each service in a Web service repository is computed as a measure of the *degree centrality* (C_D) of the social network to which the service provider belongs. It is calculated as the degree or count of the number of adjacencies for a node, s_k:

$$C_D(s_k) = \sum_{i=0}^{n} a(s_i,\, s_k)$$

where $a(s_i, s_k) = 1$ iff s_i and s_k are connected
0 otherwise

As such it is a straightforward index of the extent to which s_k is a focus of activity. $C_D(s_k)$ is large if service provider s_k is adjacent to, or in direct contact with, a large number of other service providers, and small if s_k tends to be cut off from such direct contact. $C_D(s_k) = 0$ for a service provider that is totally isolated from any other point. Our algorithm filters out any services whose provider has a zero degree centrality in a social network, i.e., such services will not be used in building composition solutions. Reputation of the entire composite service is computed as an average of the individual reputation score of the services involved in the composition.

We also need to set a reputation threshold and any service with a reputation score that is below this threshold is not used while generating composition solutions. In our initial prototype implementation we set the reputation threshold to zero, i.e., degree centrality of the service provider in the network is zero. A service provider or service provider organization that is not connected to any other nodes in the Social network is not known to anyone else and is an immediate reason to be pruned out from composition solutions as the service cannot be trusted. Composition solutions can be ranked such that solutions with highest reputation score appear on top of the list.

IV. CONCLUSIONS AND FUTURE WORK

In this paper, we presented our approach to compute reputation of services and use this score to select services for composition. A reputation score is computed for every service in the repository based on degree centrality of the service provider in a well-known Web-based Social Network. Our future work includes exploring other measures of centrality such as betweenness centrality and closeness centrality and analyzing the possibility of using a combination of all three measures of centrality to compute reputation of a service and/or provider.

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