Effective Web Service Selection for Composition using Centrality Measures

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Abstract— With the increasing popularity of Web services and Service-Oriented Architecture, we need sophisticated infrastructure to discover and compose Web services. Dynamic Web service Composition will gain wider acceptance only when users know that the solutions obtained are 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. We present a technique to calculate a reputation score per service using centrality measure of Social Networks.

Keywords - service composition; reputation; social networks;

I. INTRODUCTION

The current challenge in automatic composition of Web services 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. 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 adapt the innovation and help in transportation and diffusion of information throughout the rest of the network. So our rationale is that these central figures play a fundamental role in the network and are trusted by others in the network 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.

II. WEB SERVICE COMPOSITION

Given a formal description of the context in which a service is needed, the service(s) that precisely fulfill that need can be automatically determined. This task is called discovery. If a matching service is not found then the directory can be searched for two or more services that can be composed to synthesize the required service. Composition involves effectively combining and reusing independently developed component services. Traditionally, the task of automatic Web service composition has been split into four phases: (i) Planning, (ii) Discovery, (iii) Selection, and (iv) Execution. Most efforts reported in the literature focus on one or more of these four phases. The first phase involves generating a plan, i.e., all the services and the order in which they are to be composed. The plan may be generated manually, semi-automatically, or automatically. The second phase involves discovering services as per the plan. Depending on the approach, planning and discovery are often combined into one step. After all the appropriate services are discovered, the selection phase involves selecting the optimal solution from the available potential solutions based on non-functional properties like QoS properties. The last phase involves executing the services as per the plan. Fig. 1 shows a sample non-sequential conditional composition from Bioinformatics domain.

III. 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/knowledge 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. 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, Betweenness, and Closeness Centrality.

Degree Centrality: The network activity of a node can be measured using the concept of degrees, i.e., the number of direct connections a node has. In the example network shown in Fig. 2, 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.

**IV. 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, \( s_i \):

\[
C_D(s_i) = \sum^u a(s_i, s_j)
\]

where \( a(s_i, s_j) = 1 \) iff \( s_i \) and \( s_j \) are connected

\( = 0 \) otherwise

\( C_D(s_i) \) is large if service provider \( s_i \) is adjacent to, or in direct contact with, a large number of other service providers, and small if \( s_i \) tends to be cut off from such direct contact. 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. 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.

**REFERENCES**


