Chapter 9
A Sub-Chain Ranking and Recommendation Mechanism for Facilitating Geospatial Web Service Composition

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ABSTRACT

With a huge volume of geospatial information being collected and a huge number of domain-specific functions being developed for processing these geospatial information, an increasing number of Open Geospatial Consortium Web services (OWSs) are built and being available on the Web for the accessibility and processing of these information. Given the specific requirement specified by a certain user, normally, a composition (or chain) of OWSs, rather than a single OWS, can fulfill this requirement. Consequently, retrieving and recommending sub-chains of possible service invocations is an important research challenge. Leveraging the semantic similarity between the name and text description of parameters, a degree that represents the invocation possibility between operations in OWSs is calculated. Thereafter, a service network model is constructed for capturing possible invocations between operations. Given a user's requirement which is represented in terms of a pair of initial and ending operations, possible sub-chains of operations are retrieved, ranked and recommended. Based on which the user can select the most appropriate sub-chain with respect to her specific requirement. The result of evaluation leveraging a real OWSs set indicates that our technique is applicable in real applications from both the functional and performance perspectives.

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INTRODUCTION

With the rapid development of geospatial information acquisition techniques, the huge amount of aerial and satellite imagery has been collected (Foody et al., 2013), and is widely available on the Internet for supporting the analysis in many domains, including emergency response (i.e., earthquake) Farnaghi & Mansourian, 2013; H. Li & Wu, 2013), earth science applications (Yue et al., 2009), and so forth. Geospatial information is born heterogeneous and applications are often developed independently for achieving certain requirements of specific domains. In this setting, sharing and usability of geospatial information is a big challenge (S. Wang et al., 2013). On the other hand, along with the rapid development and wide applicability of service and cloud computing, applications are encapsulated according to Web service standards and invocable through the web (Borges, de Souza et al., 2014; L.-J. Zhang, 2012; Choi, Lee et al., 2014). Open standards, such as *Web Map Service*, *Web Feature Service*, *Web Coverage Service*, *Web Processing Service*, and *Sensor Observation Service*, have been developed. The utilization of these services makes geospatial information available more easily, and promotes to a large extent the growth of the *Open Geospatial Consortium (OGC) Web services* (*OWS*; Dietz, 2010). For instance, the *Center for Spatial Information Science and Systems (CSISS)* at *George Mason University* has developed nearly 70 geospatial Web services (referred as CSISS OWSs in the following sections) to support geospatial processing and analysis based on existing software or geosciences modules (X. Li, Di et al., 2010), and these services can be downloaded from the link[1]. Besides, crawlers are developed and OGC Web services (such as *Web Map Services*) have been retrieved from the web (Shen, Zhang et al., 2012).

Intuitively, individual OGC Web services can provide atomic and relatively simple functionalities. In order to achieve a relatively complex task which is beyond the capability of any single service, several services are required to be chained (or orchestrated, or composed) together to construct a processing workflow across domains and applications (Antunes et al., 2013; Yue, Gong et al., 2011; Zhao, Foerster et al., 2012). Service composition has been studied extensively in service computing domain (Costante, Paci et al., 2013; Leitner, Hummer et al., 2013; S. A. Ali et al., 2013; Wu & Chu, 2013; Alfrez & Pelechano, 2013). Service chaining is also well explored for facilitating the integration and interoperation of OGC Web services (Alameh, 2003; Daz, Pepe et al., 2010; H. Li & Wu, 2013; Yang, Chen et al., 2012). Besides, the Earth Cube Community[2] has initialized in designing a roadmap for workflows in Geosciences, where *workflows are used to manage complex computations that have many steps or use large data, and workflow systems assist scientists to select models appropriate for their data, configure them with appropriate parameters, and execute them efficiently*. During the service chaining procedure, users are typically required to discover and select appropriate services, or several chains of services, with respect to their specific requirements, and thereafter, orchestrate these (chains of) services into a workflow which can achieve their certain goals. For instance, the services of "*Raster_CovarianceCorrelationService*" and "*Grass_Fire_SpreadSimulationService*" in *CSISS OWSs* can be chained together for the processing of raster map layers. Hence, techniques that can discover and recommend (chains of) services are critical for facilitating the chaining (or composition) of operations in services (W. Zhang, Sun et al., 2014; Sun, Zheng et al., 2013).

Currently, there are some techniques developed for the classification (Y. Wang et al., 2012; Yue et al., 2011), discovery (Mastroianni & Papuzzo, 2014; Fitzner, Hoffmann et al., 2011; Brazier, Chebotko et al., 2010), and chaining (H. Li & Wu, 2013; W. Li et al., 2011), of OGC Web services. Generally, these techniques categorize services into multiple categories, develop methods for the discovery of single services, and orchestrate services as service chains with respect to certain requirements. During