

Chapter 13

Semantic Web Enabled Intelligent Geoprocessing Service Chaining

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ABSTRACT

In a service-oriented environment, large volumes of geospatial data and diverse geoprocessing functions are accessible as services. An intelligent mechanism is required to facilitate discovery and integration of geospatial data and services so as to enable semi-automated or automated geospatial knowledge discovery. This chapter addresses key research issues for Semantic Web enabled intelligent geoprocessing service chaining. A set of applicable solutions are described, including a common data and service environment, semantic descriptions of geoprocessing services, and a general process for intelligent generation of geoprocessing workflow. Some use cases illustrate the applicability of such solutions. A proof-of-concept prototype system is implemented and some use cases help to demonstrate the applicability of the current approach.

INTRODUCTION

With the advancement of sensor and platform technologies, the capability for collecting geospatial data has significantly increased in recent years. For example, the four satellites of the National

Aeronautics and Space Administration (NASA)'s Earth Observing System (EOS) now collect 1000 terabytes annually (Clery and Voss, 2005). The traditional methods of analyzing data by expert analysts fall far short of today's increased demands for geospatial knowledge. As a result, much data may never been analyzed even once after collection. Therefore, technologies for semi-automated

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or automated geospatial knowledge discovery and dissemination are urgently needed for geospatial applications.

Recently, Service-Oriented Architecture (SOA), as a new information infrastructure, is being introduced into scientific research, such as Earth System Grid (ESG), GEONGrid and UK e-science program. In 2005, Ian Foster put forward the concept of Service-Oriented Science (Foster, 2005), referring to the scientific research enabled by the SOA. With this information architecture, large volumes of geospatial data and diverse processing functions are available for worldwide open use. Scientists can use services to contribute their domain knowledge to the community. In such a service-oriented environment, an intelligent mechanism is required to facilitate discovery and integration of geospatial data and services so as to enable semi-automated or automated geospatial knowledge discovery. Semantic Web (Berners-Lee et al., 2001) technologies, which give machine-processable meanings to the documents, allow the semantics of data and services machine-understandable and thus can be processed by machines (reasoning) for more effective discovery, automation, integration, and reuse of geospatial data and services. This chapter addresses the key research issues for Semantic Web enabled intelligent geoprocessing service chaining.

The key research issues include,

1. Developing those syntactically and semantically interoperable geospatial Web Services that can be used to in a distributed environment to discover, request, access, and obtain geospatial data and information;
2. Intelligently orchestrating interoperable geoprocessing services to generate geospatial process models that can transform data into information and information into knowledge for assistance in making decisions;
3. Automatically converting geospatial process models to executable service chains that can be invoked and executed on demand;
4. Management of process models and service chains. The process models and service chains can be archived and catalogued. They can then be advertised as new geospatial services and thus be discovered and used in future geospatial modeling.

A set of applicable solutions are described, including a common data and service environment, semantic descriptions of geoprocessing services, and a general process for intelligent generation of geoprocessing workflow. Some use cases illustrate the applicability of our solutions. A proof-of-concept prototype system is implemented and some use cases help to demonstrate the applicability of our approach.

BACKGROUND

The work described in this chapter builds on and extends work in a variety of domains. In this section, we recapitulate Web Service and the Open Geospatial Consortium (OGC) Web Service technologies relevant to the chapter, briefly introduce Semantic Web Service technologies and current development towards Geospatial Semantic Web, and sketch general approaches to automatic service composition.

Web Service

A Web Service is a software system designed to support interoperable machine-to-machine interaction over a network (Booth et al., 2004). Web Service technologies are a set of technologies for the implementation of SOA. SOA is a way of reorganizing a portfolio of previously siloed software applications and supporting infrastructure into an inter-connected set of services, each accessible through standard interfaces and mes-

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