

Geospatial Semantic Web Research at LAITS

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Introduction

Geospatial science is the science and art of acquiring, archiving, manipulating, analyzing, communicating, and utilizing spatially explicit data for understanding both physical, biological, and social systems on the Earth's surface or near the surface. Because of their importance in social and economic activities, large amounts of geospatial data have been collected by various public and private organizations mainly using remote sensing methods. Those data must be converted to information and knowledge before they become useful.

Geospatial Semantic Web

Traditionally, the conversion from geospatial data to knowledge requires the users at their local site having significant amount of domain knowledge on information/knowledge extraction from raw data and on the geospatial data processing. The conversion also requires significant amount of local computer hardware and software resources. As a result, currently the use of geospatial data is still very expensive and most of potential users of geospatial data don't have such luxury. The fundamental problem is that current data and information systems at data providers' site can only provide on-line data ordering and access at best, not the user-specific information and knowledge. We are rich in geospatial data but poor in up-to-date geospatial information and knowledge that are ready to be used by anyone who wants to use. In the past several years, the geospatial community has been worked on solving the problem. The major goal is to make the geospatial information the mainstream information so that anyone can easily obtain the ready-to-use customized geospatial information and knowledge when they want. The major enabling technology is the service-oriented architecture (SOA) and associated interoperable web/Grid service technology.

Geospatial services are the services that handle the geospatial data and information. It is envisioned in the near future, many standard-compliant, interoperable geospatial services will be available on the Web. Those interoperable services form the geospatial semantic web that enables users to obtain their specific geospatial information and knowledge from it. Although there are still many technology issues remaining, the geospatial semantic web is rapidly changing the paradigm of geospatial knowledge discovery from everything owned and operated locally to large-scale sharing of geospatial data, information, software, hardware and other resources over the web.

The Laboratory for Advanced Information Technology and Standards (LAITS), George Mason University, has been working for many years on making the geospatial semantic web a reality. The major work includes leading the development of many federal, national, and international standards in geospatial data and service interoperability and developing advanced information technologies and systems for automating the processes from geospatial data to information and

knowledge. This position paper briefs some of LAITS's research projects related to geospatial semantic web.

Interoperability Standards

In order for SOA to work, interoperability standards related to all aspects of geospatial service operations at data, information, and knowledge levels are needed. The geospatial community has developed a set of geospatial standards through the standard-setting bodies, including ISO TC 211, the Open GIS Consortium (OGC), and the U.S. Federal Geographic Data Committee (FGDC). Among those standard bodies, OGC is the one primarily concerned with the establishment of implementation specifications for geospatial interoperability. LAITS has been involved in standard-setting activities of all those organizations. It has led or is leading the development of several major standards, including ISO 19130 Sensor and Data Models for Imagery and Grid, ISO Rule for Encoding Imagery and Gridded Data, ISO Radiometric Calibration and Validation of Remote Sensing Data, FGDC Content Standard for Remote Sensing Swath data, FGDC Content Standard for Digital Geospatial Metadata, Extensions for Remote Sensing Metadata, OGC Web Coverage Service (WCS) Implementation Specification, OGC Web Image Classification Service (WICS) IPR, etc.

Geospatial Web Services

Recently, LAITS received a grant from NASA REASoN program to conduct research on geospatial web services. The project title is "NASA EOS Higher-Education Alliance: Mobilization of NASA EOS Data and Information Through Web Services and Knowledge Management Technologies for Higher-Education Teaching and Research." This project is developing geospatial web service technologies based on Geo-object and Geo-tree concepts, OGC, ISO, W3C standards for interoperability, and service chaining for construction of complex geospatial models. Through the technologies developed by the project, we will make NASA EOSDIS data and computational resources more easily accessible and usable by higher-education community. A geospatial web service system, called GeoBrain, is being developed by the project. GeoBrain is a distributed, interoperable, federal-able, web-service based geospatial knowledge system. The system will enable anyone with an Internet connected PC to explore the peta-bytes of geospatial data at various data repositories, the huge computing power and scientific algorithms available at NASA and other federal agencies, and the fast network just like they possess such resources. The major components of the system are the geospatial service modules and models that can be integrated just in time for fulfill users' request on geospatial information. More information can be found at <http://reason.laits.gmu.edu>.

Geospatial Grid Services

Grids are persistent environments that enable software applications to integrate instruments, displays, computational and information resources that are managed by diverse organizations in widespread locations. The Globus toolkit is the de-facto standards for Grids. The implementation of SOA in the web environment is called Web services and in the Grid environment the open Grid Services. Currently the web service and grid service are converged with the introduction of Web Service Resource Framework (WSRF). Geospatial Grids are the extensions and domain-specific applications of the fundamental Grid technology in the geospatial discipline. LAITS has been worked on development of geospatial Grids for many years. Currently, LAITS is working on a project for integration of OGC geospatial Web service technology with Grid technology for

geospatial modeling and applications. The objectives of the project are 1) to enable the management of geospatial data by Grids; 2) to provide OGC standard compliant access to Grid-managed geospatial data; and 3) enable geospatial modeling and the production of virtual geospatial products in the Grid environment.

Intelligent Geospatial Knowledge Systems

The geospatial data, standards, interoperable services, and computational resources form the infrastructure of geospatial semantic web. How to automatically convert geospatial data to user-specific geospatial information and knowledge by using such an infrastructure is one of major research issues in geospatial semantic web. An intelligent geospatial knowledge system should be able to answer many “what if” questions by automatically and intelligently chaining individual service modules to form a complex geospatial model, matching the input data with the model, and executing the model to deliver the answer to the users. Currently, LAITS has three research projects funded by NGA and NASA for studying all aspects of web-service-based intelligent geospatial knowledge systems, from knowledge mining to system architecture and prototyping. The key research areas of those projects are 1) standard-based automated geospatial data and services discovery and access; 2) domain knowledge-driven intelligent decomposition of user query into geospatial processing model for workflow construction; 3) automated geospatial web service chaining, binding, and execution based on the workflow; 4) management of workflows and geospatial models.