

Geospatial Semantics and the Semantic Web

SEMANTIC WEB AND BEYOND

Computing for Human Experience

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Geospatial Semantics and the Semantic Web

Foundations, Algorithms, and Applications

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Preface

The availability of geographic and geo-spatial information and services, especially on the open Web, has become abundant in the last several years with the proliferation of online maps, geo-coding services, geospatial Web services and geospatially enabled applications. Concurrently, the need for geo-spatial reasoning has significantly increased in many everyday applications ranging from personal digital assistants, to Web search applications and local aware mobile services, to specialized systems in critical applications such as emergency response, medical triaging, and intelligence analysis to name a few. In response to the required “intelligent” information processing capabilities, the field of *Geospatial Semantics* has emerged as an exciting new discipline in the recent years. Broadly speaking geospatial semantics can be defined as the area that focuses on the *semantics* aspect in geographic and geo-spatial information processing i.e., where we can provide “meaning” to and intelligence in such information systems. This new area brings together researchers from many different disciplines such as geographic and geo-spatial information science, artificial intelligence – in particular the Semantic Web, and information systems. Alternate descriptions of what geospatial semantics is about can be stated as being the sub-area of geographic or geospatial information systems that deals with knowledge driven or intelligent processing techniques, or the particular domain application of semantics technologies that deal with the geographic and geospatial domain. Work in this area was initiated just a few years ago by visionary researchers who foresaw the need for expanding erstwhile individual disciplines such as GIS or the Semantic Web. Despite being a nascent field by age, we have seen a prolific amount of activity in all arenas, be it basic research, technical product development, community efforts such as developing standards, or the realization of real-world applications powered by such technologies.

Our primary goal in assembling this collection of work in geospatial semantics is to provide a first of a kind, cohesive collection of recent research in the theme of geospatial semantics. Additionally we have sought to present descriptions of fundamentally new information systems *applications* that have a potential for high impact and commercialization, and that become realizable with geospatial

semantic technologies. The discipline of geospatial semantics has really emerged from a marriage between the erstwhile three separate areas of (1) Geographic information systems (GIS) or geo-spatial information processing, (2) Semantic Web technologies, and (3) Applications that are driving the demand for such capabilities, especially in the context of rapidly increasing use of location-aware mobile devices. We believe that the present is an appropriate stage to attempt to consolidate and formally define the new discipline of geospatial semantics. The activity in this area has expanded the horizons of the existing disciplines of GIS, the Semantic Web, as well as key applications. GIS techniques are now embellished with semantics smarts, the Semantic Web technologies have found a new “killer application” in the geo-spatial and GIS domains, and fundamentally new kinds of capabilities are now becoming realizable in key information systems applications.

This collection is mix of chapters on topics in the geospatial semantics area covering foundational aspects, infrastructure, as well as innovative applications. The initial chapters cover foundational aspects on semantic modeling and representation. These are followed by semantic infrastructure related chapters on issues such as effective query languages as well spatial cyber-infrastructure. The last three chapters are focused on applications of geospatial semantic technologies in key areas, namely earth observation systems, location based access control and major geo-informatics applications such as The National Map.

Chapter 1 presents an approach to representing and maintaining a *time series* of spatial ontologies, that is aimed at addressing the problem of retrieval of information with a geospatial context but at possibly different times. Place names and their geographical coverage evolve and change with time, and the time series capability at the ontology level is presented as the approach to achieving accurate information retrieval with such evolution.

Chapter 2 provides an approach to dealing with semantics of geoinformation in terms of *observable* properties. The thesis in the chapter is that observations are the principal source of geographic information and the semantic representation of such observations at the appropriate abstraction level is a key challenge that must be addressed.

Chapter 3 presents SPARQL-ST, an extension of the SPARQL query language, for handling *complex* spatio-temporal queries over semantic data.

Chapter 4 is concerned with geospatial semantic infrastructure, in particular considering spatial data infrastructures (SDI) as the basis for geospatial semantic interoperability. Overall this work is concerned with the development of a path towards realizing a spatial cyber-infrastructure.

Chapter 5 takes a key application area, that of earth observation systems (EOS) and provides an approach for incorporating semantic awareness in such systems. The approach is based on using ontologies to provide a semantic interpretation of the data collected by such earth observations systems in general.

Chapter 6 provides an approach to addressing access control in the context of location based applications. An access control system based on the role-based access control (RBAC) mechanism is presented that enforces *location* as well as context aware access control policies.

Finally Chap. 7 presents a description of the incorporation of semantics and semantic technologies in the important *National Map* effort. The chapter represents an important case study on the incorporation of semantics into a key geospatial information system namely The National Map.

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