Implementation of a Geo-Semantic App by Combining Mobile User Contexts with Geographic Ontologies

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Abstract This paper describes a GIS framework for geo-semantic information retrieval in mobile computing environments. We built geographic ontologies of POI (point of interest) and weather information for use in the combination of semantic, spatial, and temporal functions in a fully integrated database. We also implemented a geo-semantic app for Android-based smartphones that can extract more appropriate POIs in terms of user contexts and geographic ontologies and can visualize the POIs using Google Maps API (application programming interface). The feasibility tests showed our geo-semantic app can provide pertinent POI information according to mobile user contexts such as location, time, schedule, and weather. We can discover a baking CVS (convenience store) in the test of bakery search and can find out a drive-in theater for a not rainy day, which are good examples of the geo-semantic query using semantic, spatial, and temporal functions. As future work, we should need ontology-based inference systems and the LOD (linked open data) of various ontologies for more advanced sharing of geographic knowledge.

Keywords: Geographic ontology, Geo-semantic, Smartphone app, ORDBMS

1. Introduction

Development of computer and internet technologies has enriched knowledge-based society, but it is still not easy to find out pertinent knowledge from a vast amount of information. Existing information retrieval systems have some limitations to fully satisfy user’s needs because the searching mechanism is mainly based on the string match for given keywords, so the search results may not be relevant to the request of users, or not be enough to solve the problems of synonyms and homonyms[16, 28]. Ontology is thought of as an alternative to such problems coming from the inexplicitness of vocabularies[20], because it can define basic terms and relations as well as the rules for combining the terms and relations in a topic area[22].

Recently, ontology is also applied to the web for more effective information retrieval and management of web resources[5]. Semantic web is the implementation of ontology on the web by building vocabularies and rules to handle a set of domain knowledge[32]. It is a new type of web technologies to pursuit high quality web service for knowledge discovery[3, 12]. As our computing capabilities are extended to mobile devices like smartphone and tablet PC[19], semantic web is also anticipated to be implemented for mobile computing.

Understanding situations or contexts of mobile users such as location, time, schedule, and weather will be very important for information retrieval on the mobile environment. Geographic information may be a key to mobile user contexts because it can answer the questions like “How is the weather around me?” or “When and where is it convenient for us to meet?” Smartphone apps...
using GIS also have a challenging task of discovering hidden geographic knowledge in association with mobile user contexts. Geographic ontology may be more complicated because it includes spatial information in addition to the generic ontology[6], and the geo-semantic technology should incorporate the ways of providing geographic ontologies for spatial and attribute information through the network.

Most ontology systems are based on the XML files[2, 10, 18, 28, 34] or relational DBMS[7, 11] [13, 14, 15, 17, 24, 26, 27, 30]. However, both manners are not enough for geo-semantic apps because the file-based system is not well suited to handling big data on a real-time basis, and the relational DBMS does not provide an integrated framework for spatial, temporal, and semantic functionalities. In the information retrieval using RQL (RDF query language) in an XML-based system or using SQL (structured query language) in a relational DBMS, we cannot construct a query statement that combines spatial and ontological functions at the same time. Thus, an ORDBMS (object–relational DBMS) that encompasses spatial, temporal, and semantic functions in a fully integrated way should be employed for geographic ontologies, although it has not yet been introduced into geo-semantic apps for smartphones.

In this paper, we describe a GIS framework for geo-semantic information retrieval in mobile computing environments. We built a geographic ontology that integrates mobile user contexts with POI (point of interest) information using an ORDBMS, so the space, time, and semantic functions can work together in a fully integrated database system. We also implemented a geo-semantic app for Android-based smartphones to consume the geographic ontology with the visualizations of Google Maps. The system applicability was examined through the feasibility tests for POI search based on the mobile user contexts including location, time, schedule, and weather. The flow of our study is summarized in Figure 1.

This section has briefly introduced the background and objective of our study. In section 2, we discuss the geo-semantic technologies focused on the geographic ontologies and mobile user contexts. Section 3 shows our GIS framework for the geo-semantic apps, and Section 4 presents the design and implementation of our geographic ontology using Oracle 11g. Section 5 demonstrates our geo-semantic app for Android-based smartphones working with the ontology. We summarize the study and discuss the implications and limitations of the work in Section 6.

2. Geo-Semantic Technologies

Ontology is an explicit, formal specification of a shared conceptualization[9]. “Conceptualization” means an abstract, simplified view of the world. The world actually refers to some phenomenon, topic, or subject area in the world. Every representation of the knowledge in an area of interest is based on a conceptualization. Every conceptualization is grounded on the concepts, objects, and the rela-