Toward Seoul Road Sign Management on the LarKC Platform

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Abstract. Geo Semantic Technology is evaluated as the core technology for supporting interoperability of geospatial data and building urban computing environment. We made semantic integrations of LOD's Linked Geo Data and Open Street Map with Korean POI data set, and have researched for developing intelligent road sign management system based on the LarKC platform.

Keywords: Geo Semantics, Semantic Web, Reasoning,

1 Introduction

The LarKC[5] project's main goal is to develop a platform for reasoning using massive amounts of heterogeneous information [1]. The platform has a pluggable architecture to exploit techniques and heuristics from diverse areas such as databases, machine learning, and the Semantic Web.

Within LarKC, we are running an Urban Computing [2] use case, with the aim of proving the commercial feasibility of the LarKC platform and its architectures when applied to huge geo semantic and urban data sets. In particular, in this poster, we briefly present our efforts toward developing real-world Road Sign Management systems (RSM) for Seoul.

2 Motivation

A typical building in South Korea is described by the administrative divisions[6] in which it lies rather than street names. If the address is written in Korean, the largest division will be written first, followed by the smaller divisions, and finally the

5 http://www.larkc.eu
6 http://en.wikipedia.org/wiki/Administrative_divisions_of_South_Korea

building and the recipient, in accordance with the East Asian addressing system. Divisions could be identified after the name of the nearest point of interest (POI).

The problem is that Korean cities grow and evolve much faster than western cities. POIs may move, new roads may be built, and road signs may be changed accordingly. Effectively managing road signs, in particular validating if a sequence of road signs leads to a given address, is a major problem. For this reason the Korean Road Traffic Authority maintains a database of all Seoul road signs. The directions given on each road sign are formally described together with their actual location.

3 Research Challenges

Effective management of road signs requires processing the directions that are given on each road sign together with a large amount of urban-related information. Until a couple of years ago the cost of obtaining and maintaining up-to-date urban-related information was high; but nowadays it is much less expensive thanks to collaborative projects such as Open Street Map[7] (OSM), which creates free editable maps of the world, or Wikipedia, where POI descriptions can be found.

In the LarKC project, we have investigated a data integration solution for urban information [3] that can provide a basis for intelligent road sign management. The solution supports data modeling and the integration of massive amounts of linked geo-data, POI data, and road sign data, as well as scalable querying and reasoning.

4 Data Integration

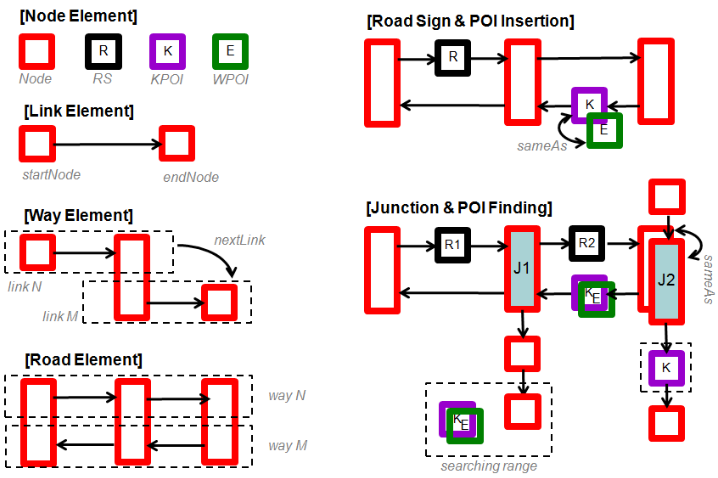

Fig. 1. The mediation ontology we use in our system.

7 http://www.openstreetmap.org/

The data set we are manipulating contains about 1.1 billion triples. 2 million triples describe the streets of Seoul, and were directly extracted from OSM. 4 million triples describe POIs related to road signs and come from the Korean Road Traffic Authority database. Half million triples describe road signs and also come from the Korean Road Traffic Authority database.

The data were integrated using the mediation ontology illustrated in Figure 1. Roads are modeled as a sequence of nodes and links. Four types of node are modeled: the generic nodes that can identify either a junction between multiple roads or a bend in a road; the road sign (RS) nodes that indicate the presence of a road sign; the Korean POIs (KPOI) that indicate POIs from the Korean Road Traffic Authority database; and the Wikipedia POIs (WPOI) that indicate POIs from Wikipedia (obtained through DBpedia). A way is composed of links. A road is composed of ways. Road signs and points of interest are placed along the roads. If KPOIs and WPOIs are understood to be same, owl:sameAs is used to state it. Due to quality issues in the OSM data set, not all the junctions are explicitly stated; where necessary owl:sameAs is also used to state that two nodes are the same node and, thus, that a junction is present among multiple roads. Finally, note that not all POIs are directly on the roads - some of them may be places nearby a node in the road.

5 Queries and Reasoning for RS validation

In Figure 2, we give an idea of the queries and reasoning required for the intelligent management of the road signs that we are developing. Sign R1 indicates that two POIs (i.e., G1 and G2) can be found straight ahead. R2 indicates that POIs G2 and G3 are straight ahead while G1 can be reached by turning right. R3 indicates that G3 is straight ahead, while G2 can be reached by turning right.

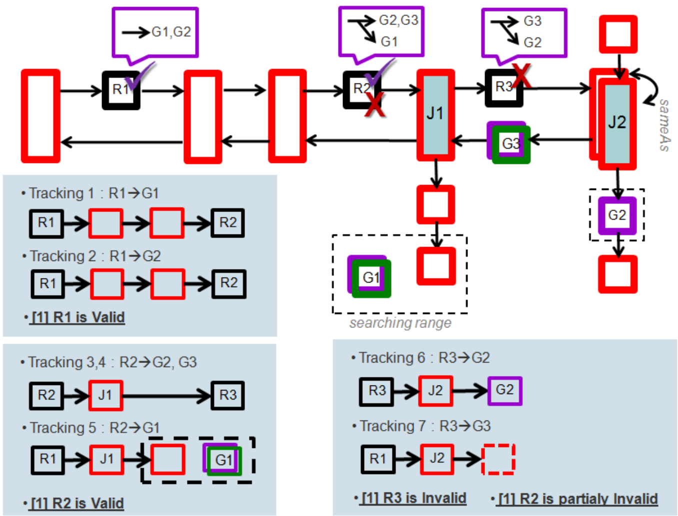

Fig. 2. Road sign validations by using SPARQL and OWL Horst Reasoning

In the boxes we show the validation process of the three road signs. The directions for G1 and G2 on R1 are valid because going straight in two nodes we can find road sign R2 that contains further indications for G1 and G2. Similarly the direction for G2 and G3 on R2 are valid because going straight at the junction we can find road sign R3 that contains further indications for G2 and G3. The direction for G1 on R2 is also valid, because turning right, G1 can be found near the second node of the street. The direction for G2 on R3 is valid, but the direction for G3 is not valid: G3 is reachable only by executing a U-turn. This also means that the direction for G3 on R2, which we previously stated to be valid, is not valid because it refers to a road sign R3 which is not valid.

Current implementation of the RSM system is based on 40 SPARQL queries executed under the Owl Horst entailment regime including some axioms of rdfs:subClassOf, rdfs:subPropertyOf, owl:inverseOf and owl:sameAS. They encode 30 Korean road sign regulations related to positioning and naming.

4 Conclusions and Future work

In the work done so far we have found several data quality issues, which are due to the presence in OSM of a lot of useless information, together with poor accuracy and missing data. We have partially solved this issue by cleaning up data manually; automatic cleaning support is under investigation. Data errors are also present in the Korean Road Traffic Authority database data set in terms of direction and location errors. An important issue is that different names for the same POI are present both in OSM and in the Korean Road Traffic Authority database, e.g., Seoul Univ. and Seoul National University. We used a semi-automatic technique to assert owl:sameAs relationships. Finally, we are investigating techniques for rewriting SPARQL queries in SQL/MM Spatial for efficiently evaluating SPARQL queries that manipulate geographic knowledge [4] including real world reasoning with noisy data.

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