Chapter 16

A Feature Selection-Based Method for an Ontological Enrichment Process in Geographic Knowledge Modelling

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ABSTRACT

Nowadays, geographic information becomes too complex and abundant, thus recent research projects have been undertaken to make it manageable and exploitable. Ontologies are considered as a valuable support for geographic information representation. Building geographic ontologies could be viewed as an enrichment process. Alignment of concepts coming from different ontologies is central to the enrichment process and deeply affects the quality of the resulting ontology. The alignment of ontologies is based on using similarity measures. In the literature, there are many models for ontology alignment that mainly differ with respect to the similarity measures they use and the way they are combined. Most of the alignment methods do not deal with the problem of correlation between similarity measures. In this chapter, we address this issue to better decide which similarity measures we should consider to better assess the true similarity between concepts. Our proposal consists of using feature selection methods, in order to select a reduced set of relevant similarity measures.

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INTRODUCTION

Remote sensing provides a useful source of data that may be used in several environmental applications such as soil quality studies, water resources research, meteorology simulations and environmental protection (Chopard & Lagrava, 2006). One of the most important steps towards better interpreting satellite remote sensing image content was moving from a pixel-level analysis to an object-level one, called Geographic Object-Based Image Analysis (GEOBIA) (Andrés et al., 2012).

This approach has led to significant improvements in the interpretation of remote sensing images. Nevertheless, it suffers from the following drawbacks: 1) the ambiguity of the representation since each domain expert interprets information contained in satellite images depending on his own conceptualization that is usually ambiguous and consequently cannot be used in an automatic process; 2) the scalability of the treatment of image content given the continuous technological progress of satellite sensor technology and the phenomenal increase of multi-resolution, multi-spectral and multi-temporal satellite images series, and 3) the difficulty of communicating and sharing the results with other scientists (Andrés et al., 2012). Therefore, formalizing expert knowledge is a prerequisite toward an automatic semantic interpretation of remote sensing images (Iakovidis et al., 2009).

One of the most critical problems in the automatic interpretation of images is the 'semantic gap' which is the lack of concordance between low-level and high-level information (De Bertrand De Beuvron et al., 2013). In remote sensing, the semantic gap refers to the differences between the visual interpretation of the spectral information and the semantic interpretation of the pixels, mainly due to the different levels of abstraction. Ontologies can help reducing the semantic gap by creating geographic object recognition systems that are able to bridge the symbolic information and the information extracted from the image phenomenon (Kokar & Wang, 2002). Ontology-based recognition systems allow classifying an object as an instance of a specific class if it satisfies the constraints of that class in the ontology. Thus, a domain ontology that models the properties of earth observation sensors, including wavelength, temporal and spatial resolutions corresponding to observable objects as well as their spatial relationships can be a good support for automatic annotation and retrieval of satellite images content.

Actually, several ontology-based approaches for remote sensing image have been developed (Hashimoto et al., 2011; Wiegand & García, 2007; Fonseca & Llano, 2011) but have not included a formalized integration of geographic data and knowledge. Nevertheless, there are several geographic ontologies such as SatellitesSceneOntology (Charlet et al., 2010), BDTopo (IGN, 2002), BDCarto (IGN, 2005) and OntoGeo. In order to build satellite image ontology, Nefzi et al. (2014) proposed to start from a core satellite image ontology such as the one of Durand et al. (2007) and enrich it using several geographic ontologies. Ontology matching is one of the critical activities in the ontology enrichment process. It allows discovering mappings between two ontologies, where each mapping is a couple of entities brought from each ontology and linked together either by equivalence or subsumption relations. Nefzi et al. (2014) show how ontologies help modelling and reasoning upon remote sensing images, as well as reducing the semantic gap between images features and their semantics. They propose to align an existing core ontology that models the remote sensing satellite image content by new entities that are extracted from other geographic ontologies.

To be able to detect relevant source ontology entities, we require means for measuring their similarities to the entities of the core ontology. The quality of the expected outcome, i.e. the resulting ontology, strongly depends on the similarity measures that are considered as well as the way they are combined together.