Concept Lattices as a Formal Method for the Integration of Geographic Ontologies

Margarita Kokla and Marinos Kavouras
National Technical University of Athens
9, H. Polytechniou Str., 157 80 Zografos Campus, Athens - Greece
mkokla, mkav@survey.ntua.gr

In order to achieve information exchange between different geographic databases, it is necessary to develop suitable methods for formally defining and representing geographic knowledge. Different conceptualizations and categorizations of geographic concepts complicate the problem of semantic data association. Semantic differences occur and raise problems when ontologies from heterogeneous contexts are to be integrated.

The methodology presented in this paper, focuses on fusing different contexts and thus generating a single structure from different geographic ontologies. The methodology uses Concept Lattices as a tool for the formalization and integration of geographic concepts and relationships encoded in different domain-specific ontologies, to reveal their association and interaction. Concept Lattices, which are founded on Formal Concept Analysis (Wille, 1992) - a theory for concept formation and classification - have been recognized as important structures for representing, revising, refining and sharing ontologies (Sowa, 2000).

Our methodology uses a formalization of the semantic basis of geographic concepts consisting of two parts: the extension and the intension. The extension includes the instances, which belong to the concept, whereas the intension represents its intrinsic meaning and is usually described in terms of discriminating properties, criteria or conditions.

The method can achieve the integration of geographic ontologies, exhibiting differences in application context and thematic resolution. Related categories in different ontologies may be associated with subtype, supertype or overlapping relationships. The method analyzes and decomposes (extensionally and intensionally) the categories of different ontologies into primitive categories. Then, Formal Concept Analysis is applied, in order to combine these primitive categories and generate what is called a concept

lattice. Besides the original categories, the concept lattice includes additional ones, resulting from the decomposition or fusion of original categories, which make it more symmetric. Concept Lattices, in contrast to trees, are rich structures, which conform to fundamental characteristics of geographic categories, such as multidimensionality and the existence of overlapping relationships.

The methodology is demonstrated using an example of integrating three existing geographic ontologies into a common one. The resulting concept lattice preserves the autonomy of the original ontologies, i.e., does not prohibit their independent use. At the same time, it facilitates information exchange between different applications and for different purposes.

Our future research focuses on the extension of the developed methodology to integrate sublattices produced at the domain-level with a more general lattice of top-level categories.

REFERENCES

Sowa, J. F., 2000. *Knowledge Representation: Logical, Philosophical, and Computational Foundations*. Brooks/Cole, USA.

Wille, R., 1992, Concept Lattices and Conceptual Knowledge Systems. *Computers and Mathematics with Applications*, 23-6-9, 493-515.