Chapter 8.16
Introducing Elasticity for Spatial Knowledge Management

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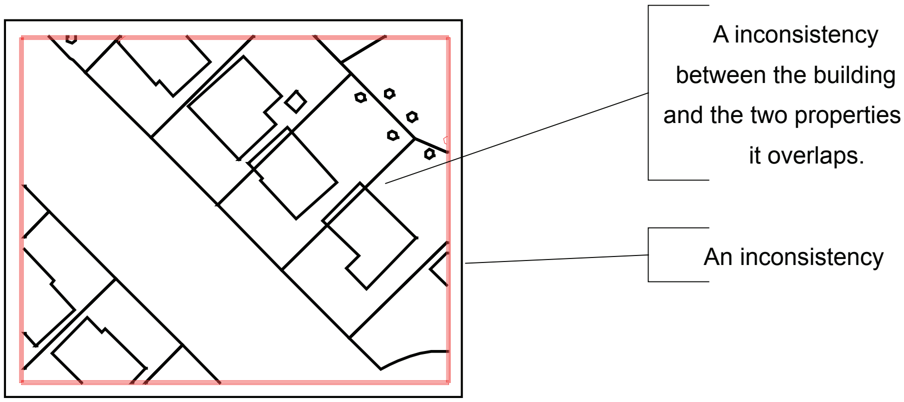
ABSTRACT

The internal validity of a spatial database can be discovered using the data contained within one or more databases. Spatial consistency includes topological consistency, or the conformance to topological rules. Discovery of inconsistencies in spatial data is an important step for improvement of spatial data quality as part of the knowledge management initiative. An approach for detecting topo-semantic inconsistencies in spatial data is presented. Inconsistencies between pairs of neighboring spatial objects are discovered by comparing relations between spatial objects to rules. A property of spatial objects, called elasticity, has been defined to measure the contribution of each of the objects to inconsistent behavior. Grouping of multiple objects, which are inconsistent with one another, based on their elasticity is proposed. The ability to discover groups of neighboring objects that are inconsistent with one another can serve as the basis of an effort to understand and increase the quality of spatial data sets. Elasticity should therefore be incorporated into knowledge management systems that handle spatial data.

INTRODUCTION

Geographic information systems (GIS) databases have gained popularity in different business sectors in recent years. GIS databases, which consist of vector based data elements including points, lines, and polygons (Aronoff, 1995). The elements in these databases are related to one another in terms of their location as well as in terms of their semantic interpretation (Clementini et al., 1993; Egenhoffer, 1991). Consistency is a measure of internal validity of these databases. Inconsistency is the opposite of consistency (Kainz, 1991). Inconsistency can be measured in terms of the number of objects that are in relations with one or multiple objects that do not satisfy one or more rules which describe the data (Cockcroft, 2004; Lutz et al., 2007; Xu, 2007). For example, it would be inconsistent to map a property boundary to the

Figure 1. Example of inconsistencies in spatial data



center of an adjacent road. Consistency is assessed using information contained within one or more databases. Spatial consistency includes topological consistency, or the conformance to topological rules (Kainz, 1995). An example of spatial inconsistency is illustrated in Figure 1 where two buildings slightly overlap their properties.

Detection of inconsistencies in spatial data is a key activity in an effort to manage the consistency of spatial data (Servigne et al., 2000). It is useful for evaluating, maintaining and enhancing spatial data quality. Since data in spatial databases is constantly evolving, there is an on-going need for detection and adjustment of inconsistencies. This need is amplified as two or more spatial databases are combined to discover and manage knowledge.

An approach for detecting inconsistencies in spatial data is presented. Inconsistencies between pairs of neighboring spatial objects (consisting of spatial geometry and non-spatial attributes) are detected by comparing relations between spatial objects to rules. A property of spatial objects (or simply objects), called elasticity, is defined to indicate the contribution of each of the objects to inconsistent behavior. Grouping of multiple objects, which are inconsistent with one another, based on their elasticity is proposed. These groupings become the basis for an effort to increase the quality of spatial data. This process is illustrated in Figure 2.

Elasticity and related concepts discussed in this paper could be incorporated into a Knowledge Management toolkits such as those covered by Balmisse et al. (2007). The ability to determine and enhance the quality of data will help quantify and strengthen the validity of discovered organizational knowledge.

More and more organizations in all business sectors are integrating spatial (location based) data with their existing non-spatial data sets. Spatial data integration and the resulting quality of this integration is therefore critical to integration of more and more non-spatial databases and to knowledge discovery in these combined data sets.

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