Chapter 19

Relational Data Modeling for Geographic Information Systems

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This chapter addresses data modeling problems inherent in the use of geographic information systems (GIS) that are not adequately covered by traditional modeling techniques. GIS technology has only recently begun to be used for traditional system development by large numbers of organizations and there are few procedures for modeling GIS data and applications in a business context. This circumstance is partially a result of the fact that GIS developers have traditionally been knowledgeable end users or facilitators and they have generally been called on to build standalone systems, often for their own use. This paper discusses geographic systems and proposes relational modeling techniques that document organizational data integrity rules when systems that include spatial data are developed for more widespread use.

Data modeling is an effective design and communication tool associated with the development of relational databases and associated applications. A

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fully developed data model includes a rich set of information on tables; fields; relationships, and, most importantly, the organization’s business rules. Data models facilitate communication between developers and clients and, in modern development environments, CASE tools can be used to translate many model specifications directly into the physical database. Whether implemented in the physical database or enforced at the application level, the vision of the relationship between data and its uses that are expressed in the data model becomes a crucial contributor to the usability of the resulting database and suite of applications.

This paper addresses a data modeling problem inherent in the use of geographic information systems (GIS) which is not adequately covered by traditional modeling techniques. GIS are computer-based systems designed to capture, store, integrate, update, modify, create, display, and analyze geographic data. Though businesses and governments have used GIS technology for decades, it has only recently begun to be used for the development of databases and systems of the sort for which data modeling is appropriate. This situation is partially a result of the fact that GIS developers have traditionally been knowledgeable end users or facilitators who have been called on to build stand-alone systems for experienced end users, not “enterprise-wide systems” or systems for use by decision makers not familiar with GIS technology. Changes in these patterns have made the modeling issue much more important, yet we still lack standards for representing and communicating the use of and relationships between tables when one or more contain geographic coverages.

The goal of this paper is to suggest techniques for modeling relational databases that include a mix of both traditional tables and spatial coverages so that traditional business rules and data integrity rules can be documented for spatial databases. To accomplish this goal, the next section begins by defining several of the relevant terms used in the GIS field. Next, we discuss the important characteristics of spatial data and several of the modeling problems that are inherent in working with this data. After establishing the foundations for differences between spatial database systems and conventional relational systems, existing work in the field is discussed leading to the conclusion that there is no established modeling technique for GIS-based database systems. Following this discussion, two sections present a methodology for modeling spatial relationships as part of a comprehensive data model. The first of these sections addresses graphical representations of spatial entities and relationships, while the second covers modeling data integrity rules in spatial relationships. The paper concludes with a discussion of the implications of GIS technology in mainstream systems.
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