Chapter VII

From Conceptual Models to Data Models

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Abstract

This chapter describes transformations between conceptual models (mainly entity-relationship diagrams and also UML) and data models. It describes algorithms to transform a given conceptual model into a data model for a relational, object-relational, object-oriented and XML database. Some examples are used to illustrate the transformations. While some transformations are well known, some (like the transformation into XML or into object-relational schemas) have not been investigated in depth. The chapter shows that most of these transformations offer options which involve important trade-offs that database designers should be aware of.

Introduction

Conceptual models aim at capturing the structure of reality, are high-level and computer independent. Data models, on the other hand, aim at representing reality in the computer, and are therefore less abstract. It is assumed that, in creating an Information System, a conceptual model will be developed as part of the Requirements Specification, from which a data model will be derived later on,
in the Design phase (Davis, 1993). Thus, mappings between conceptual models and data models are one of the most vital transformations in the development of an Information System (Elmasri and Navathe, 2003). The purpose of this chapter is to present transformations between conceptual models and data models. Transformations between well known and used conceptual models (Entity-Relationship diagrams and UML Class Diagrams) and the most common and important data models (relational and object-oriented) have been developed and are well understood. However, new data models like XML and the Object-Relational data model are not included in these mappings. Translation into XML is the focus of some research lately, but this is a relatively new area and not much work has been done yet. Translation into Object-Relational databases is a virtually unexplored topic, perhaps because it is felt that existing mappings into the (pure) relational models are easy to extend to this case. However, Object-Relational databases provide options to the designer that are not available in the relational case. Therefore, some guidance is needed for the choices that appear in the mapping process.

In this chapter, we review existing mappings and extend them to include these new data models. We start with a review of the basic concepts, to establish some vocabulary and make the chapter self-contained, followed by a description of recent work in the area, including new and existing translations. One of the purposes of the chapter is to put all of this research in a wider perspective and examine the different approaches, something that is missing from the current literature.

**Background**

For lack of space, we do not discuss conceptual or data models in depth; we assume the reader is familiar with the basic ideas. However, we review some basic concepts to establish a vocabulary.

**Conceptual Models**

We briefly review Entity-Relationship models and UML class diagrams. There are other conceptual models, like Object-Role-Modeling (ORM); we will not include them here.

An **Entity-Relationship (E-R)** (Chen, 1976; Thalheim, 2000) model is based on three basic concepts: *entity types, attributes* and *relationships*. E-R models are usually depicted in *E-R diagrams*; an example is given in Figure 1. Entity
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