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Chapter III

Preserving Relationship Cardinality Constraints in Relational Schemata

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INTRODUCTION

Database modelling is a complex task that involves conceiving, understanding, structuring and describing real Universes of Discourse (UD) through the definition of schemata using abstraction processes and data models. To face this problem, methodologies that incorporate intelligent assistance are required. Some current methodologies only provide some recommendations or heuristics while others give well established and formalised processes. Traditionally, three phases are identified in database design: conceptual, logical and physical design. Conceptual modelling phase represents the most abstract level since it is independent of any database management system (DBMS) and, consequently, is very close to the user and allows him to collect almost completely the semantics of the real world to be modelled.

A conceptual schema, independent of the data formalism used, plays two main roles in the conceptual design phase: a *semantic* role, in which user requirements are gathered together and the entities and relationships in a UD are documented, and a *representational* role that provides a framework that allows a mapping to the logical design of database development. Three topics are involved in the database conceptual modelling process: data modelling formalism, methodological approach and CASE tool support. One of the most

extended data modelling formalisms, the Extended Entity Relationship (EER) model has proven to be a precise and comprehensive tool for representing data requirements in information systems development, mainly due to an adequate degree of abstraction of the constructs that it includes. Although the original ER model was proposed by Chen (1976), many extensions and variations as well as different diagrammatic styles have been defined (Hull & King, 1987; McAllister, 1998; Peckhan & Maryanski, 1988).

In database conceptual analysis, one of the most difficult concepts to be modelled are relationships, especially higher order relationships, as well as its associated cardinalities. Some textbooks (Boman et al., 1997; Ullman & Widom, 1997) assume that any conceptual design can be addressed by considering only binary relationships since its aim is to create a computer oriented model. We understand the advantages of this approach although we believe that it may produce certain loss of semantics (some biases are introduced in user requirements) and it forces us to represent information in rather artificial and sometimes unnatural ways.

Concerning the logical design, the transformation process of conceptual schemata into relational schemata should be performed trying to completely preserve the semantics included in the conceptual schema; the final objective is to keep the semantics in the database itself and not in the applications accessing the database. Nevertheless, sometimes a certain loss of semantics is produced; for instance, foreign key and not null options in the relational model are not enough to control ER cardinality constraints.

This chapter is devoted to the study of the transformation of conceptual into logical schemata in a methodological framework focusing on a special ER construct: the relationship and its associated cardinality constraints. The section entitled "EER Model Revised: relationships and cardinality constraint" reviews the relationship and cardinality constraint constructs through different methodological approaches to establish the cardinality constraint definition that will be followed in next sections. The section "Transformation of EER Schemata into Relational Schemata" is related to the transformation of conceptual n-ary relationships ($n \geq 2$) into the relational model following an active rules approach. Finally, several practical implications as well as future research paths are presented.

EER MODEL REVISITED: RELATIONSHIPS AND CARDINALITY CONSTRAINTS

This section reviews entity, relationship and cardinality constraint constructs of different data models in order to highlight some special semantic