Foundations of Relational Object Management Systems

Andreas Heuer

Institut für Informatik, TU Clausthal
Erzstr. 1, D-3392 Clausthal-Zellerfeld, West Germany

1 Introduction

This paper is dealing with an overview of the foundations for a "relational" object management system to be developed. The object management system is based on relational technology and relational theory in order to use all the advantages of this classical model. Here we describe the ideas for the theoretical basis, especially the object model, the object algebra, some other possibilities to manipulate objects such as rules, functions and complex updates, the object access at the internal level, and the applications of the system based on these techniques.

2 Object model

The basis for our object management system is a data model for complex objects called EXTREM (EXTended RElational Model, [Heu]) which is based on the semantic database model IFO ([AH87]), and the NF2-relational model ([SS86]). The object model concepts such as complex entities, relationships, complex attributes, and is-a-relationships are adequately represented by enhanced NF2-schemes and additional integrity constraints.

More precisely, the EXTREM model is an integration of four different types of data models: there are four description levels having equivalent power (see Figure 1 for an overview).

- The EXTREM model is defined as a restriction of the IFO model [AH87] which consists of atomic or constructed object types, functions between object types, and is-a-relationships between object types. EXTREM is restricted to a subset of IFO concepts which are implementable via (flat or nested) relational concepts.

- The conceptual level of the EXTREM model can be seen as an extension of the Entity-Relationship model [Che76] by type constructors, is-a-relationships, and a formal semantics. The EXTREM concepts include complex entity and relationship types, complex attributes, specialization and generalization of entity and relationship types.

- A tabular representation of the EXTREM concepts is given at the nested relational level of EXTREM. EXTREM relations are a synthesis of NF2-relations [SS86] and RM/T-relations [Cod79] with additional (local and global) dependencies. Especially, nested relations are enhanced by surrogates and "active domains".

- The basis for theoretical investigations and practical implementation is the classical relational level. EXTREM concepts are represented by flat relations with keys, inclusion dependencies, and some other dependencies.
EXTREM provides mappings of schemes, instances, and operations between these levels. So we can use

- theoretical results of classical relational theory or nested relations concerning dependency implication, database design, relational algebra, and query optimization as a foundation for the object model,

- implementation techniques of flat or nested relational systems (see Section 5)
  - for a prototype implementation of an object management system by means of classical relational methods only,
  - but also as a basis for a more efficient object oriented implementation.

Related research issues are

- mappings and equivalences between different data models (including several semantic models and the classical relational one),

- database design methods for EXTREM-schemes (including physical database design, see Section 5),

- exact characterization of relational concepts, which are an adequate representation of the object model concepts.

The results of these research issues are important for the implementation of efficient manipulation and access methods.

### 3 Object algebra

The implicit manipulation operations of the object model are algebraic. Since objects can be represented by enhanced NF2-relations, the object algebra is similar to an NF2-algebra with complex