Chapter XX
Concept–Oriented Model

Alexandr Savinov
University of Bonn, Germany

## INTRODUCTION

Background

The concept-oriented model (CoM) is a new approach to data modeling (Savinov, 2004) that is being developed along with concept-oriented programming (CoP) (Savinov, 2005a). Its major goal consists of providing simple and effective means for representing and manipulating multidimensional and hierarchical data while retaining the possibility to model how the data are represented physically. Thus, this model has two sides or flavors: logical and physical. From the point of view of logical structure, CoM belongs to a class of multidimensional models (Agrawal, Gupta, & Sarawagi, 1997; Gyssens & Lakshmanan, 1997; Li & Wang, 1996) and OLAP technologies (Berson & Smith, 1997). The main difference from the existing approaches is that CoM is based on the theory of ordered sets. Particularly, one source of inspiration when developing CoM was formal concept analysis (FCA) and lattice theory (Ganter & Wille, 1999).

Elements in the concept-oriented model are living among other elements within a multidimensional hierarchical structure (Savinov, 2005b). This means that any element has a number of parents and children. The direct and indirect neighbors determine its semantic properties while the element itself is thought of as an identifier. So the meaning of an element is distributed all over the model within the ordered structure and depends on its relative position among other elements. One important property of CoM that is absent in most other models is that it possesses canonical semantics. It makes many problem formulations and solutions much simpler because operations can be applied directly to the semantics of the whole model represented using primitive dimensions rather than to different local elements. In particular, it is very important for such a mechanism as grouping and aggregation (Savinov, 2006a), and constraint propagation and inference (Savinov, 2006b). In this sense, CoM is analogous to the universal relation model (URM) where all relations are assumed to be projections of a single relation (Fagin, Mendelzon, & Ullman, 1982; Kent, 1981; Maier, Ullman, & Vardi, 1984).

The multidimensional and hierarchical structure underlying the concept-oriented model can be used for navigational purposes (Savinov, 2005c). This means that data can be accessed by specifying a logical path rather than using joins. In this sense, CoM is similar to the functional data model (FDM; Gray, Kerschberg, King, &

Figure 1. Physical and logical structure of the model
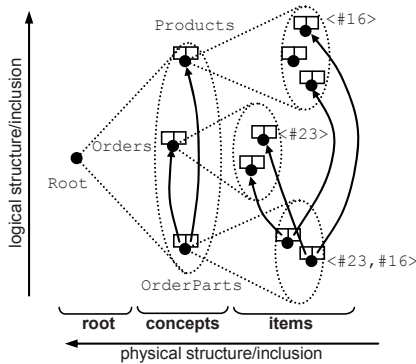
Poulovassilis, 2004; Gray, King, & Kerschberg, 1999; Shipman, 1981). The difference is that the mechanism of logical navigation in CoM relies on the ordered structure of elements rather than using an arbitrary graph.

Duality

An important notion in the whole concept-oriented paradigm is that of duality. In CoM it exhibits itself via the existence of two structures called the physical (or hard) and the logical (or soft). In Figure 1, the physical structure spreads horizontally while the logical structure spreads vertically. Physical structure has a hierarchical form where each element has one permanent parent called also its physical context. For example, the model in Figure 1 has one root element (a database) that physically consists of three internal elements

(tables), Orders, Products, and OrderParts, which in turn consist of their own internal elements (records). Logical structure has a multidimensional hierarchical form where each element has many parents that can change during their lifetime. In Figure 1 logical parents are denoted by arrows and a parent is positioned above its children. For example, element OrderParts belongs to two parents Orders and Products (while all the three elements physically belong to Root). Operations within physical structure mean creating or deleting elements while operations with elements within logical structure result in only a change of their properties. For data modeling it is important to understand that both of these structures can be used to represent information from the problem domain. Interestingly, physical structure is similar to the hierarchical data model while logical structure is similar to the network data model (with one important exception discussed in the next section being that its elements are ordered). In this sense, CoM can be viewed as uniting in one approach the two classical data models.

Order of Elements

The order of elements is of crucial importance in CoM; that is, it is precisely order that determines all its syntactic and semantic aspects. To define a concrete model using the concept-oriented approach, it is necessary to take a number of elements and then position them one under another without cycles. All other properties of the model can then be derived from this ordered structure.

Figure 2. Model as an arbitrary graph and as an ordered structure
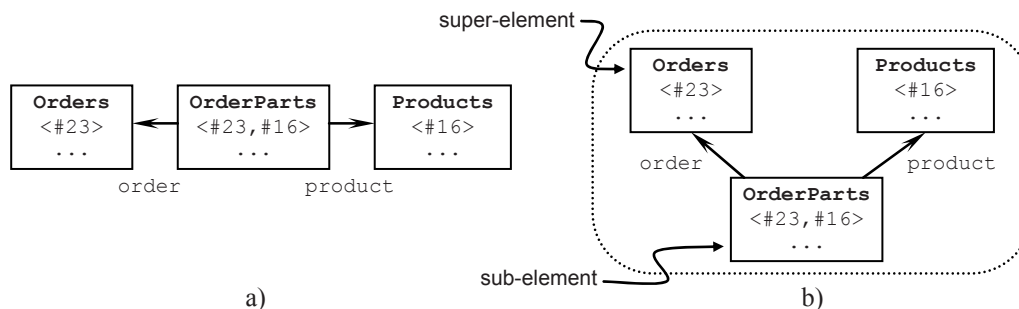
Related Content

Using Regression to Compromise Statistical Databases: A Modification of the Attribute Correlation Modeling Approach

Myun J. Cheonand Patrick R. Philipoom (1991). *Journal of Database Administration (pp. 15-22).*

www.irma-international.org/article/using-regression-compromise-statistical-databases/51087

Combined Use of Conceptual Models in Practice: An Exploratory Study

Mohammad Ali Jabbari Sabeghand Jan Recker (2017). *Journal of Database Management (pp. 56-88).*

www.irma-international.org/article/combined-use-of-conceptual-models-in-practice/182869

Agile Modeling, Agile Software Development, and Extreme Programming: The State of Research

John Erickson, Kalle Lyytinenand Keng Siau (2005). *Journal of Database Management (pp. 88-100).*

www.irma-international.org/article/agile-modeling-agile-software-development/3343

Cross-Correlation Measure for Mining Spatio-Temporal Patterns

James Ma, Daniel Zeng, Huimin Zhaoand Chunyang Liu (2013). *Journal of Database Management (pp. 13-34).*

www.irma-international.org/article/cross-correlation-measure-for-mining-spatio-temporal-patterns/86282

Exploring the Concept of Method Rationale: A Conceptual Tool to Understand Method Tailoring

Pär J. Aerfalkand Brian Fitzgerald (2006). *Advanced Topics in Database Research, Volume 5 (pp. 63-78).*

www.irma-international.org/chapter/exploring-concept-method-rationale/4386