Chapter II

Applying UML for Designing Multidimensional Databases and OLAP Applications

Juan Trujillo
Universidad de Alicante, Spain

Sergio Luján-Mora
Universidad de Alicante, Spain

Il-Yeol Song
Drexel University, USA

ABSTRACT

Multidimensional (MD) modeling is the basis for Data warehouses (DW), multidimensional databases (MDB), and On-Line Analytical Processing (OLAP) applications. In this chapter, we present how the Unified Modeling Language (UML) can be successfully used to represent both structural and dynamic properties of these systems at the conceptual level. The structure of the system is specified by means of a UML class diagram that considers the main properties of MD modeling with minimal use of constraints and extensions of the UML. If the system to be modeled is too complex, thereby leading us to a considerable number of classes and relationships, we sketch out how to use the package grouping mechanism provided by the UML to
simplify the final model. Furthermore, we provide a UML-compliant class notation (called cube class) to represent OLAP initial user requirements. We also describe how we can use the UML state and interaction diagrams to model the behavior of a data warehouse system. We believe that our innovative approach provides a theoretical foundation for simplifying the conceptual design of multidimensional systems, and our examples illustrate the use of our approach.

INTRODUCTION

It is widely accepted that DW, MDB, and OLAP applications are based on multidimensional modeling. The benefit of using this MD modeling is two-fold. On one hand, the MD model is close to data analyzers’ way of thinking; therefore, it helps users understand data. On the other hand, the MD model supports performance improvement, as its simple structure allows us to predict final users’ intentions.

Some approaches have been proposed lately (presented in Section 3) to accomplish the conceptual design of these systems. Unfortunately, none of them have been accepted as a standard for DW conceptual modeling. These proposals try to represent main MD properties at the conceptual level with special emphasis on MD data structures. A conceptual modeling approach for DW, however, should also concern other relevant aspects such as initial user requirements, the behavior of the system (e.g., main operations to be accomplished on MD data structures), available data sources, specific issues for automatic generation of the database schema, and so on. We claim that object orientation with the UML provides an adequate notation for modeling every aspect of a DW system (MD data structures, the behavior of the system, etc.) from user requirements to implementation.

In this chapter, we present an object-oriented (OO) approach to accomplish the conceptual modeling of DW, MDB and OLAP applications. Our approach introduces a set of minimal constraints and extensions of the UML (Booch, 1998; OMG, 2001) needed for an adequate representation of MD modeling properties. These extensions are based on the standard mechanisms provided by the UML to adapt to a specific method or model (e.g., constraints, tagged values). We also present how to group classes into packages to simplify the final model in case that the model becomes too complex due to the high number of classes. Furthermore, we provide a UML-compliant class notation to represent OLAP initial user requirements (called cube class). From these cube classes, we then describe the use of state and interaction diagrams to model the behavior of the system based on...
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