Extending the UML for Multidimensional Modeling*

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Abstract. Multidimensional (MD) modeling is the foundation of data warehouses, MD databases, and On-Line Analytical Processing (OLAP) applications. In the past few years, there have been some proposals for representing the main MD properties at the conceptual level providing their own notations. In this paper, we present an extension of the Unified Modeling Language (UML), by means of stereotypes, to elegantly represent main structural and dynamic MD properties at the conceptual level. We make use of the Object Constraint Language (OCL) to specify the constraints attached to the defined stereotypes, thereby avoiding an arbitrary use of these stereotypes. The main advantage of our proposal is that it is based on a well-known standard modeling language, thereby designers can avoid learning a new specific notation or language for MD systems. Finally, we show how to use these stereotypes in Rational Rose 2000 for MD modeling.

Keywords: UML, UML extensions, multidimensional modeling, OCL, Rational Rose

1 Introduction

Multidimensional (MD) modeling is the foundation of data warehouses (DW), MD databases, and On-Line Analytical Processing (OLAP) applications. These systems provide companies with many years of historical information for the decision making process. Various approaches for the conceptual design of MD systems have been proposed in the last few years such as [1][2][3][4][5] to represent main MD structural and dynamic properties. These approaches provide their own graphical notations, which forces designers to learn a new specific model together with its corresponding MD modeling notation. Furthermore, none of these approaches has been widely accepted as a standard conceptual model for

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Due to space constraints, we refer the reader to [6] for a detailed comparison and discussion about most of these models.

On the other hand, the Unified Modeling Language (UML) [7][8] has been widely accepted as the standard object-oriented (OO) modeling language for modeling various aspects of software systems. Therefore, any approach using the UML will minimize the effort of developers to learn new notations or methodologies for every subsystem to be modeled. Following this consideration, we have previously proposed in [5] an OO conceptual MD modeling approach, based on the UML for a powerful conceptual MD modeling. This proposal considers major relevant structural and dynamic MD properties at the conceptual level in an elegant and easy way.

The UML is an extensible language, in the sense that it provides mechanisms (stereotypes, tagged values, and constraints) to introduce new elements for specific domains if necessary, such as web applications, database applications, business modeling, software development processes, etc. [9,10]. A collection of enhancements that extend an existing diagram type to support a new purpose is called a profile.

In this paper, we present a UML profile for MD modeling based on our previously proposed approach [5], which easily and elegantly considers main MD properties at the conceptual level, such as the many-to-many relationships between facts and dimensions, degenerate dimensions, multiple and alternative path classification hierarchies, and non-strict and complete hierarchies. Our extension uses the Object Constraint Language (OCL) [8] for expressing well-formedness rules of the new defined elements, thereby avoiding an arbitrary use of this extension. Moreover, we program this extension in a well-known model-driven development tool such as Rational Rose to show its applicability.

The remainder of this paper is structured as follows: Section 2 briefly presents other works related to extending the UML for database design. Section 3 introduces the main MD concepts such as fact, dimension, and hierarchy level that our approach comprises. Section 4 summarizes the UML Extensibility Mechanism. Section 5 proposes the new UML extension for MD modeling. Section 6 shows how to use our MD extension in Rational Rose. Finally, Section 7 presents the main conclusions and introduces our future work.

2 Related Work

In the past few years, some proposals to extend the UML for database design have been presented, since the UML does not explicitly include a data model. In [11], “...a profile that extends the existing class diagram definition to support persistence modeling” is presented. This profile is intended to make objects persistent in different storages: files, relational databases, object-relational databases, etc. In [12], the Data Modeling profile for the UML is described, “...including descriptions and examples for each concept including database, schema, table, key, index, relationship, column, constraint and trigger”. In [10], the process of UML-based database modeling and design is explained; it presents the UML Profile