Chapter X

A Multidimensional Methodology with Support for Spatio–Temporal Multigranularity in the Conceptual and Logical Phases

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ABSTRACT

The Multidimensional Databases (MDB) are used in the Decision Support Systems (DSS) and in Geographic Information Systems (GIS); the latter locates spatial data on the Earth’s surface and studies its evolution through time. This work presents part of a methodology to design MDB, where it considers the Conceptual and Logical phases, and with related support for multiple spatio-temporal granularities. This will allow us to have multiple representations of the same spatial data, interacting with other, spatial and thematic data. In the Conceptual phase, the conceptual multidimensional model—FactEntity (FE)—is used. In the Logical phase, the rules of transformations are defined, from the FE model, to the Relational and Object Relational logical models, maintaining multidimensional semantics, and under the perspective of multiple spatial, temporal, and thematic granularities. The FE model shows constructors and hierarchical structures to deal with the multidimensional semantics on the one hand, carrying out a study on how to structure “a fact and its associated dimensions.” Thus making up the Basic factEntity, and in addition, showing rules to generate all the possible Virtual factEntities. On the other hand, with the spatial semantics, highlighting the Semantic and Geometric spatial granularities.
INTRODUCTION

The traditional databases methodologies propose to design these in three phases: Conceptual, Logical and Physical.

In the Conceptual phase, the focus is on the data types of the application, their relationships and constraints. The Logical phase is related to the implementation of the conceptual data model in a commercial Database Manager System (DBMS), using a model more near to implementation, as for example the Relational, R model. In the Physical phase, the model of the physical design is totally dependent on the commercial DBMS chosen for the implementation.

In the design of Multidimensional databases (MDB), from a Conceptual focus, most of the models proposed use extensions to operational models such as Entity Relation (ER) or Unified Modeling Language (UML). But these models do not reflect the multidimensional or spatial semantics, because they were created for other purposes. From a Logical focus, the models gather less semantics that conceptual models. The MDB, as commented (Piattini, Marcos, Calero & Vela, 2006), have an immature technology, which suggests that there is no model accepted by the Scientific Community to model these databases.

The MDB allow us to store the data in an appropriate way for its analysis. How to structure data in the analysis and design stage, gives guidelines for physical storage. The data should be ready for the analysis to be easy and fast.

On the other hand the new technologies of databases, allow us the management of terabytes of data in less time than ever. It is now possible, to store space in databases, not as photos or images but as thousands of points and to store the evolution of space over time. But the spatial data cannot be treated as the rest of the data, as they have special features. The same spatial data can be observed and handled with different shapes and sizes. The models must enable us to represent this feature. It is of interest to get multiple interconnected representations of the same spatial object, interacting with other spatial and thematic data.

This proposal seeks to resolve these shortcomings, providing a conceptual model multidimensional, with support for multiple spatial, temporal and thematic related granularities, and rules for converting it into logical models without losing this semantics.

We propose to deal the spatial data in MDB as a dimension, and its different representations with different granularities. But we ask:

• How to divide the spatial area of interest?
• How to represent this area in a database?
• In what way?
• How big?

We answer, with the adequate space granularities. We study the spatial data and we distinguish two spatial granularity types, Semantic and Geometric. Next we define briefly these concepts, for more details read (Gascueña & Guadalupe, 2008c).

In the Semantic spatial granularity the area of interest is classified by means of semantic qualities such as: administrative boundaries, political, etc. A set of Semantic granularities consider the space divided into units that are part of a total, “parts-of”. These parts only change over time. And each Semantic granularity is considered a different spatial element.

A Geometric spatial granularity is defined as the unit of measurement in a Spatial Reference System, (SRS) according to which the properties of space are represented, along with geometry of representation associated with that unit. The geometry of representation can be points, lines and surfaces, or combinations of these. A spatial data can be stored and represented with different granularities. In Figure 1 we see a spatial zone divided into Plot and represented with surface and point geometric types.