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Multidimensional model and OLAP operations

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ABSTRACT *Data warehousing and On-Line Analytical Processing (OLAP) applications include the need for complex-data modeling features, advanced temporal support, advanced classification structures, continuously valued data, dimensionally reduced data, and the integration of complex data. This paper identifies modeling requirements for multidimensional data models. These requirements are derived from a realistic assessment of complex data found in real-world applications. This paper defines a multidimensional data model and OLAP operations that address all the requirements.*

1) Introduction
Multidimensional modeling is a technique for structuring data around the business concepts. The multidimensional data model is composed of logical cubes, measures, dimensions, hierarchies, levels, and attributes. Analysts know which business measures they are interested in examining, which dimensions and attributes make the data meaningful, and how the dimensions of their business are organized into levels and hierarchies.

2) Multidimensional Data Cube
A data cube is constructed from a subset of attributes in the database.

The Figure 1 below depicts a small, practical data cube consider a hypothetical database of sales information maintained by a company. This particular data cube has three dimensions - location, item, and time.

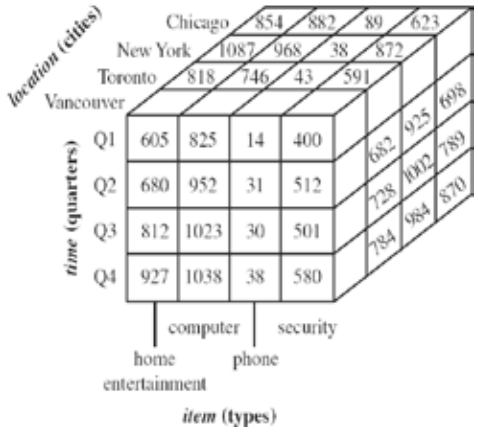

Figure 1: Cube View of Data

3) OLAP operations
In the multidimensional model, data are organized into multiple dimensions. And each dimension contains multiple levels of abstraction defined by concept hierarchies.

Using these hierarchies different types of OLAP operations are possible.

3.1) Roll up (drill-up)
Summarize data by climbing up hierarchy or by dimension reduction. In the given example of Figure 2, the Roll up operation on the dimension Location is given. It shows the Roll up from Cities to Countries and reduces the dimensions. It provides the summarized view of the dimension Location.

3.2) Drill down (roll down)
Reverse of roll-up from higher level summary to lower level summary or detailed data, or introducing new dimensions. In the given example of Figure 2, the Drill down operation on the time dimension is given. It shows the Drill down from Quarters to Months. It provides the detailed view of the dimension Time.

3.3) Slicing
Look at a subcube to provide more specific information. In the given example of Figure 2, the Slice operation on Time Q1 is given.

3.4) Dicing
Rotate cube to look at another dimension or provides subcube. It shows the Dice operation for (location="Toronto" or "Vancouver") and (time= "Q1"or "Q2") and (item="home entertainment" or" computer").

3.5) Pivoting
Reorient the cube, visualization, 3D to series of 2D planes. It rotates the cube against axis and reset the whole dimension on another axis. In the given example of Figure 2, the Pivot operation is given by rotating cube.

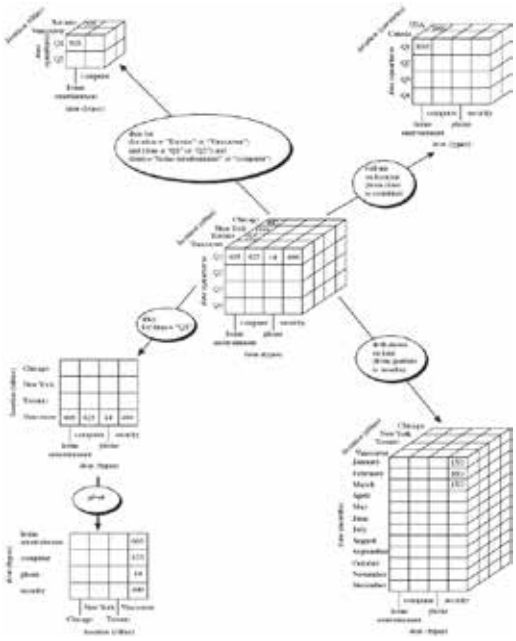

Figure 2: Typical OLAP operations using example

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4) Conclusion and Future Work

This model is implementation independent. It supports for correct aggregation, different levels of granularity, concept hierarchies, and generalization and specialization hierarchies. It is very useful as a decision support system in business. It represents the major relevant multi dimension properties at conceptual level.

One possible future work may be implementing a more complex case study using real world application data, perform performance tests using the three logical models compared to support the comparison on logical design models presented in the paper.

This work can be continued to other areas like database security, temporal issues, query optimization, and translation to logical/physical level methodologies.

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