Representing Spatiality in a Conceptual Multidimensional Model

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Introduction

- **Data Warehouse (DW)** – “as a collection of subject-oriented, integrated, non-volatile, and time-variant data supporting management’s decisions”, *W. Inmon*
  - Fact tables
    - Measures (e.g. sales of cost, representing analysis in a quantified form)
  - Dimension tables
    - Descriptive attributes (e.g. store number, manager’s name)
  - Hierarchy
    - Attributes can form *hierarchy* (e.g. City-State-Country)

- **Spatial DW (SDW)** – combines DW and spatial databases (SDB)
  - Where we have included spatial locations
  - Improve data analysis, visualization and manipulation

- **Multidimensional Model**
  - Widely used in DW’s
  - Establish communication between users and designers
Contents

- Introduction
- Conceptual Multidimensional Model
- Multidimensional Model for Spatial Data
- Related work
- Relation to Our Project
- Strong and Weak Points
Conceptual Multidimensional Model (CMM)

- CMM – “as finite set of dimensions and fact relationships”
- Introduce CMM based on ER graphical notations
  - Dimensions includes hierarchies
    - Basic
      - Several levels
    - Cardinality
- Level
  - Category attributes
    - used for grouping
  - Property attributes
    - descriptive

- Criterion
  - Different structures
    - geographical location
    - organizational structure

- Fact relationship
  - Measure
Example of CMM

- CMM model of Sales DW with hierarchy in the Store and Product dimensions
Introduction

Conceptual Multidimensional Model

**Multidimensional Model for Spatial Data**

Related work

Relation to Our Project

Strong and Weak Points
Spatial dimension of CMM

- Spatial dimension
  - Spatial level
  - Geometry represented using spatial data
    - Simple and complex
- Topological relationships
Spatial hierarchy in the Client dimension

- buying behavior
- thematic
- enriches queries
“as a fact relations that requires a spatial join between two or more spatial dimensions”

Model for analyzing the maintenance of a highway:

Query:
- a) “Whether all highway section pass through some cities”
- b) “Whether some highway sections belongs to more than one city”
Spatial measures

- Spatial measure
  - “as a measure that is represented by a geometry and defines a spatial function used for aggregation along the hierarchies”
  - or “represents a numerical value that is calculated using spatial or topological operators”

- Regular functions (e.g. sum, min, count, and average)

- Spatial functions (e.g. geometric union, geometric intersection)

- When geometry is involved then spatial function needs to be specified
Multidimensional model with a spatial measure: location

Queries

<table>
<thead>
<tr>
<th>Sales Model</th>
<th>Accident Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total sales in store X of products of category Y in year Z.</td>
<td>Locations where a client X had accidents covered by an insurance of category Y in year Z.</td>
</tr>
<tr>
<td>Total sales in year X grouped by city.</td>
<td>Locations of accidents in year X grouped by client age group.</td>
</tr>
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Multidimensional model with a non-spatial measure

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Related Work

- Conceptual modeling of SDB and DW based on ER-model or UML

- Miquel et al. distinguish difference between spatial and regular measures
  - Members hold spatial representation

- Jensen et al. present a general-usage scenario for location-based services
  - Multidimensional model with hierarchies
Goals in our project:
- Calculate travel times in road network
- Using GPS logs of taxi, bus and ordinary drivers

Common with our project:
- Using DW with some spatial characteristic
- We can use geometry to defined zones more precisely
Strong and Weak Points

- **Strong Points**
  - Related work
  - Picture examples
  - Contribution to spatial data analyses

- **Weak Points**
  - Implementation is not included
  - High level of abstraction
Thank You!