Representing Spatiality in a Conceptual Multidimensional Model

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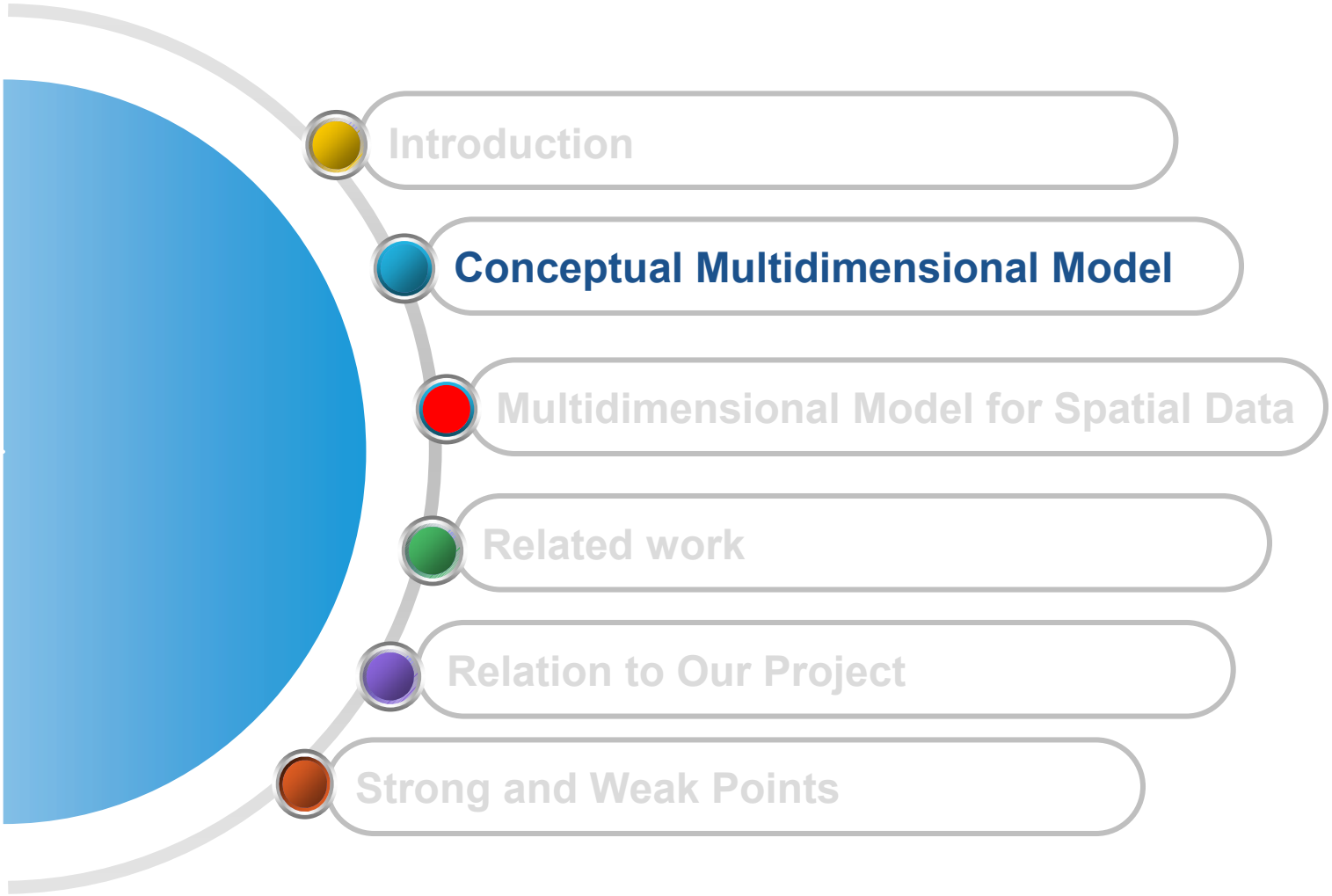
Contents

Introduction

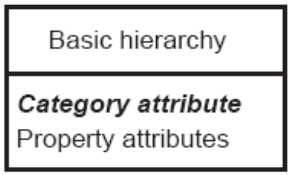
- **Data Warehouse (DW) – "**as a collection of subject-oriented, integrated, non-volatile, and time-variant data supporting management's decisions", *W.Inmon*
  - Fact tables
    - Measures (e.g. sales of cost, representing analysis in a quantified form)
  - Dimension tables
    - Descriptive attributes (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

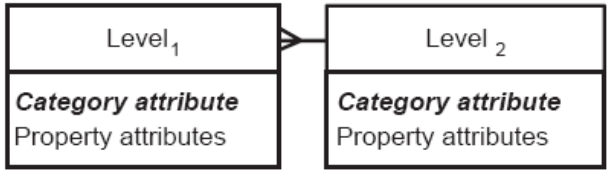

Introduction
Conceptual Multidimensional Model
Multidimensional Model for Spatial Data
Related work
Relation to Our Project
Strong and Weak Points

Conceptual Multidimensional Model (CMM)

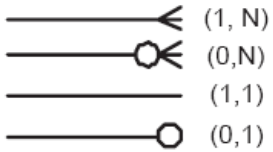
- CMM – "as finite set of dimensions and fact relationships"
- Introduce CMM based on ER graphical notations
  - Dimensions includes hierarchies
    - Basic



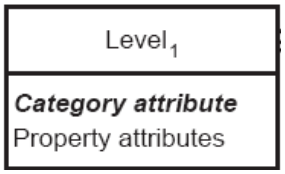
    - Several levels



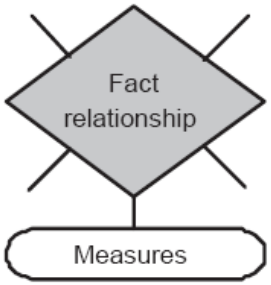
    - Cardinality



- Level
  - Category attributes
    - used for grouping
  - Property attributes
    - descriptive
- Criterion
  - Different structures
    - geographical location
    - organizational structure

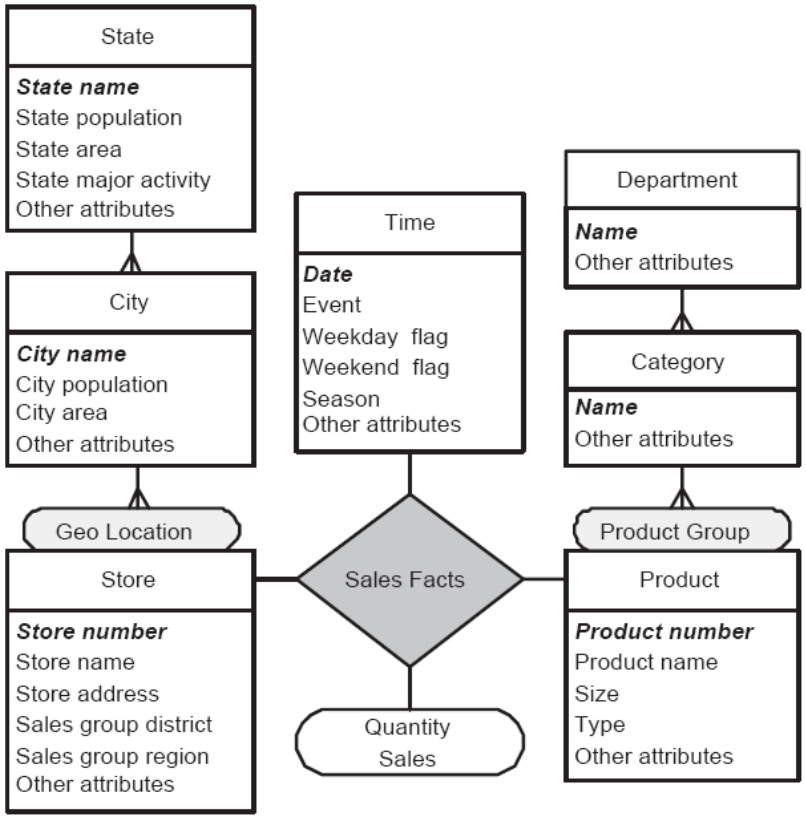


- Fact relationship
  - Mesaure



Example of CMM

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



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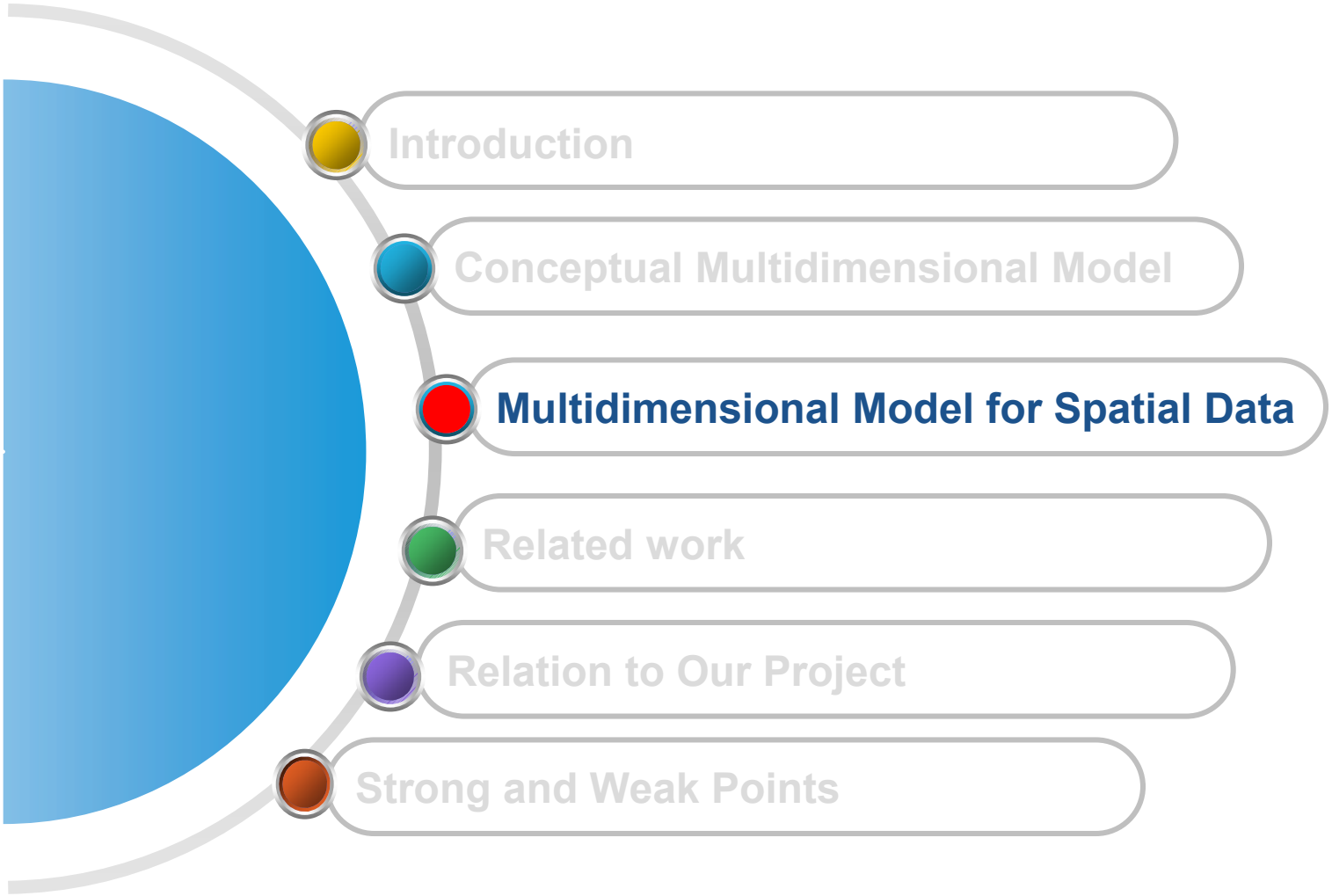
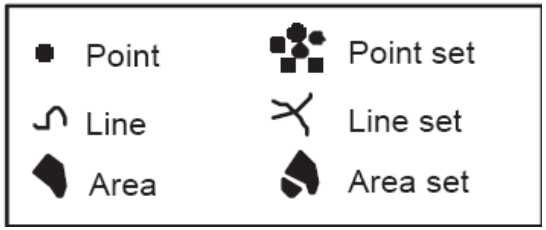
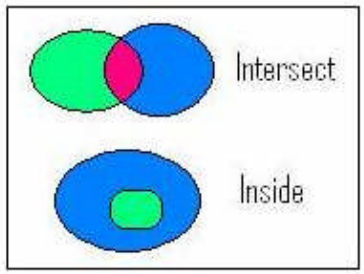

Introduction
Conceptual Multidimensional Model
Multidimensional Model for Spatial Data
Related work
Relation to Our Project
Strong and Weak Points

Spatial dimension of CMM

- Spatial dimension
  - Spatial level
  - Geometry represented using spatial data
    - Simple and complex

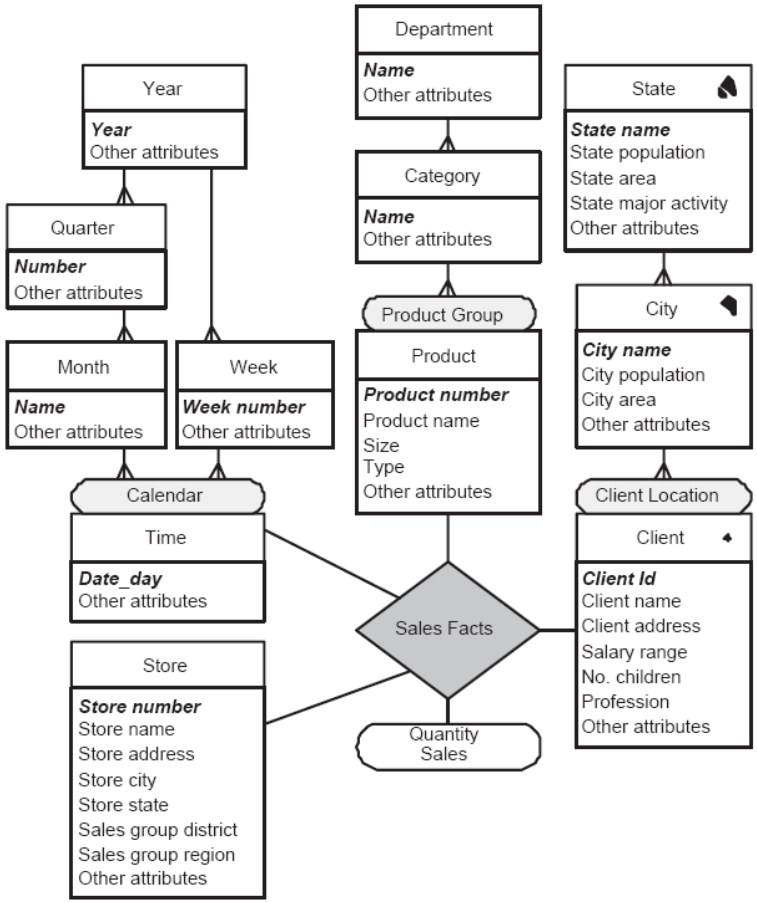


    - Topological relationships



Example of Spatial Dimension in CMM

- Spatial hierarchy in the Client dimension



- buying behavior
- thematic
- enriches queries

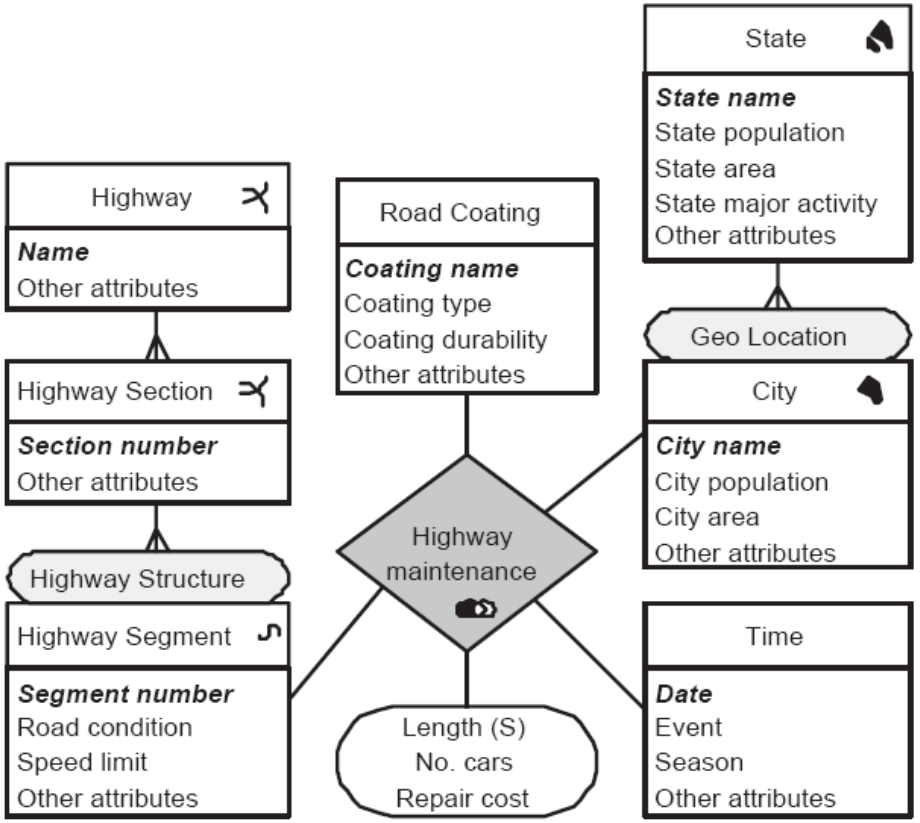
Spatial fact relationship

- "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”

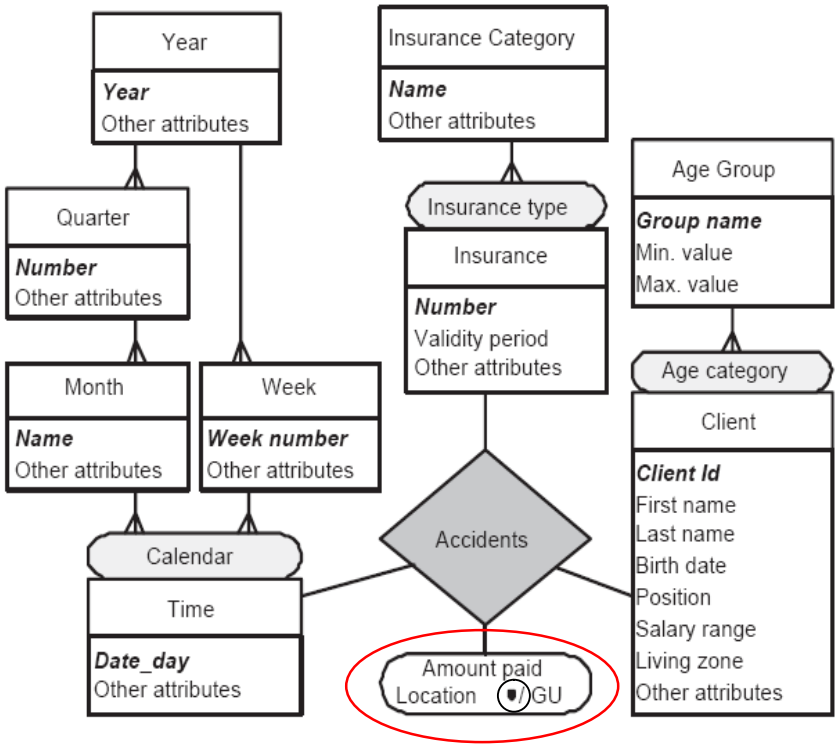
- Regular functions (*e.g. sum*, *min, count,* and *average*)

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

- When geometry is involved then spatial function needs to be specified

Spatial measures

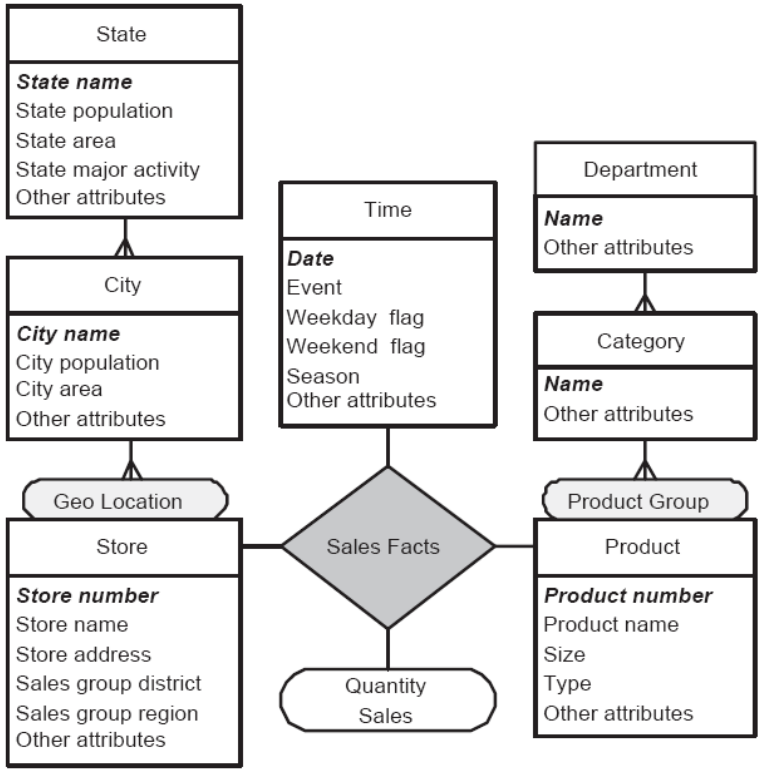
- Multidimensional model with a spatial measure: location



Queries	
Sales Model	Accident Model
Total sales in store X of products of category Y in year Z.	Locations where a client X had accidents covered by an insurance of category Y in year Z.
Total sales in year X grouped by city.	Locations of accidents in year X grouped by client age group.

Sales Model

- Multidimensional model with a non-spatial measure



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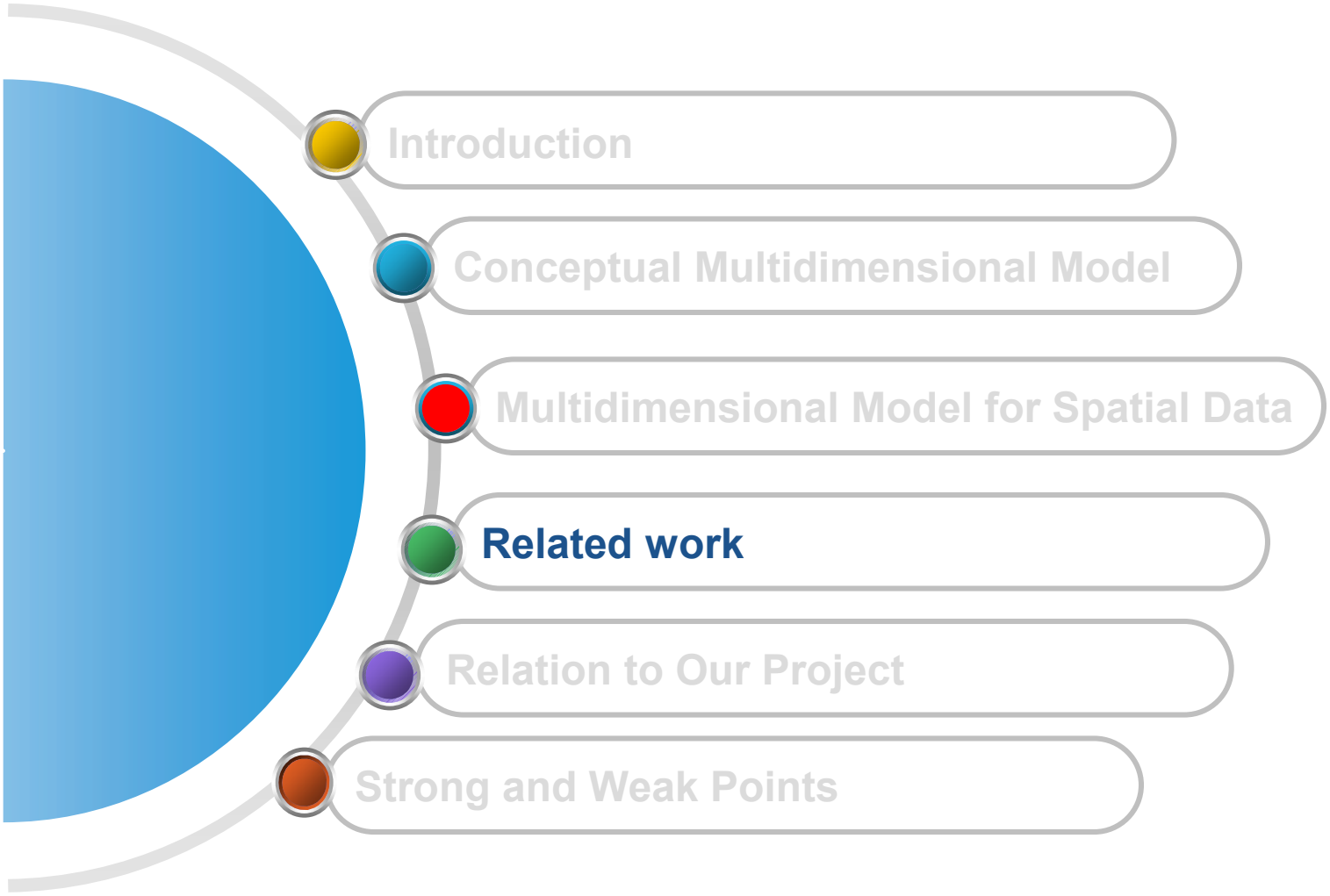
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Relation to Our Project
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Related Work

- 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

Relation to Our Project

- 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 !