ISIT312 Big Data Management

Conceptual Data Warehouse Design

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Conceptual Data Warehouse Design

Outline

MultiDim: A Conceptual Multidimensional Model

Conceptual data models

- Allow better communication between designers and users to understand application requirements
- More stable than implementation-oriented (logical) schema, which changes with the platform
- Provide better support for visual user interfaces

No well-established conceptual model for multidimensional data

Several proposals based on UML, on the ER model, or using specific notations

Problems:

- Cannot express complex kinds of hierarchies
- Lack of a mapping to the implementation platform

MultiDim: A Conceptual Multidimensional Model

Currently, data warehouses are designed using mostly logical models (star and snowflake schemas)

- Difficult to express requirements (technical knowledge required
- Limit users to defining only elements that the underlying implementation systems can manage

MultiDim data model is based on the entity-relationship model

Includes concepts like:

- dimensions
- hierarchies
- facts
- measures

Supports various kinds of hierarchies existing in real-world applications

Can be mapped to star or snowflake relational structures

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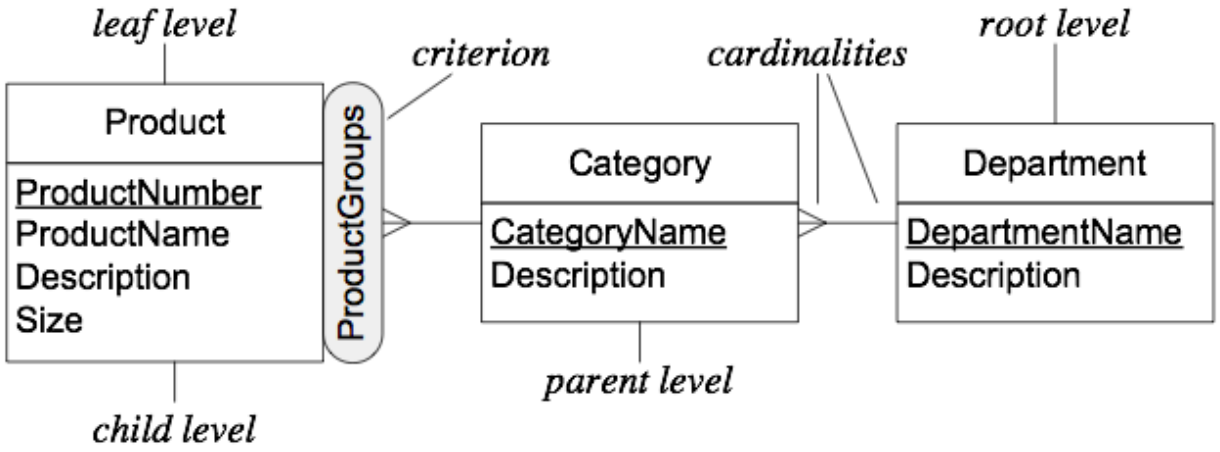
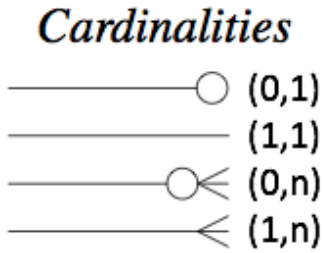
MultiDim Model: Notation

A graphical notation used for a sample hierarchy





Dimension: level or one or more hierarchies

Hierarchy: several related levels

Level: entity type

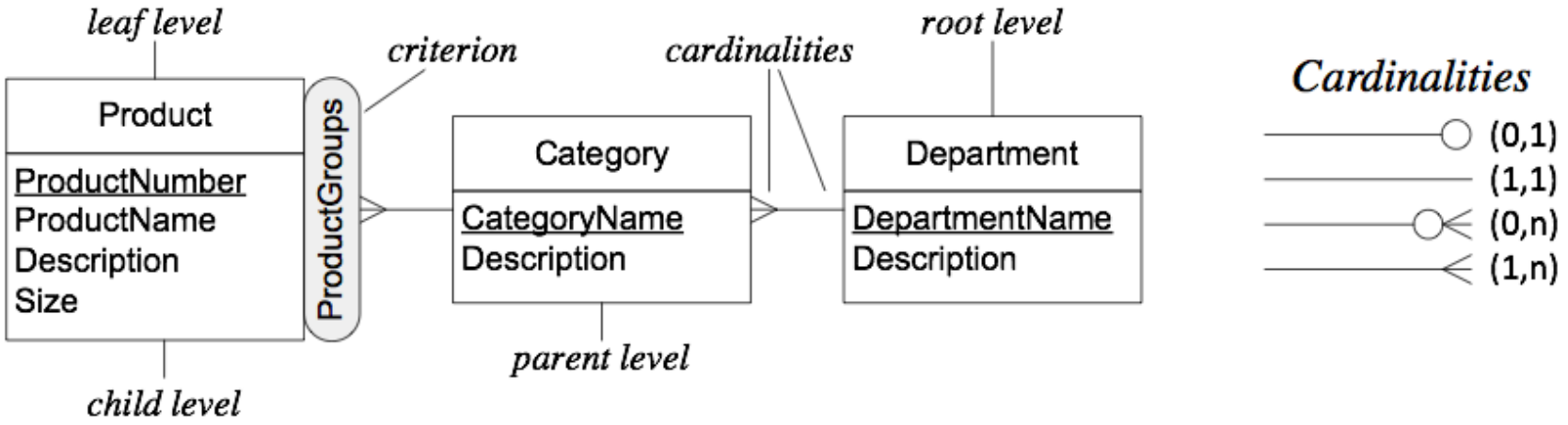
Member: every instance of a level

Child and parent levels: the lower and higher levels

Leaf and root levels: first and last levels in a hierarchy

MultiDim Model: Notation

A graphical notation used for a sample hierarchy



Cardinality: minimum/maximum numbers of members in a level related to members in another level

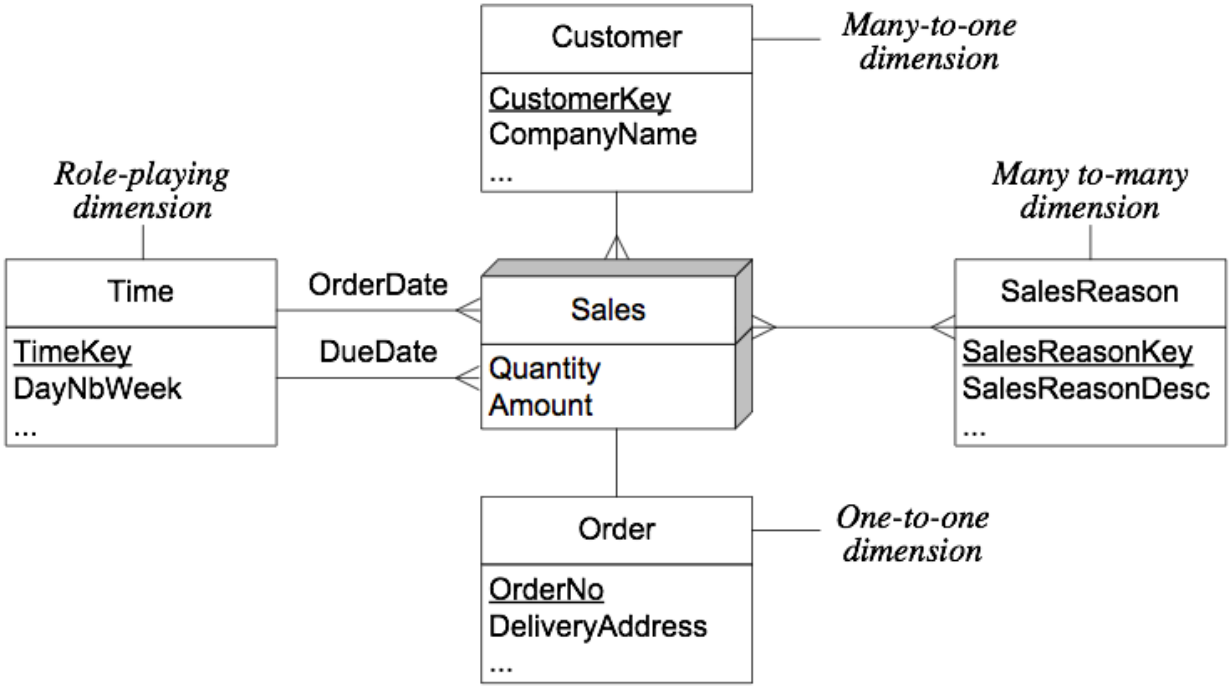
Criterion: expresses different hierarchical structures used for analysis

Key attribute: indicates how child members are grouped

Descriptive attributes: describe characteristics of members

MultiDim Model: Notation

A sample fact with 5 dimensions



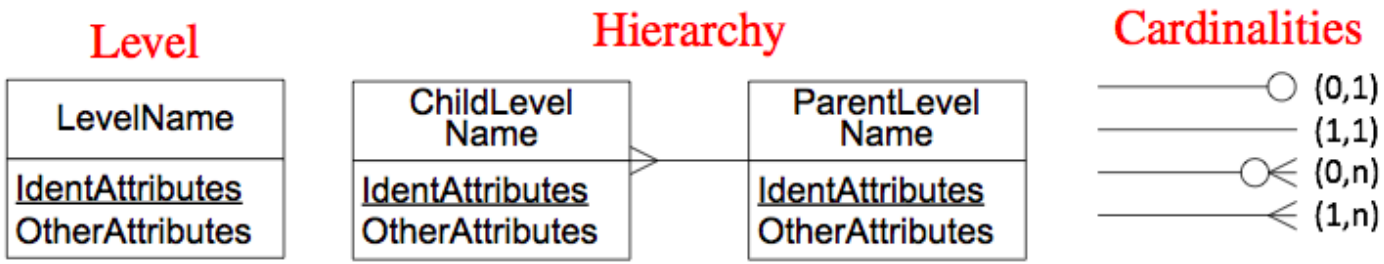
Fact: relates measures to leaf levels in dimensions

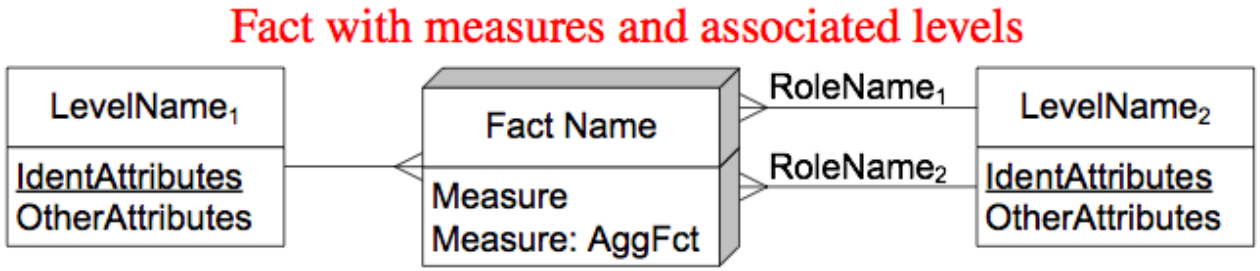
Dimensions can be related to fact with one-to-one, one-to-many, of many-to-many

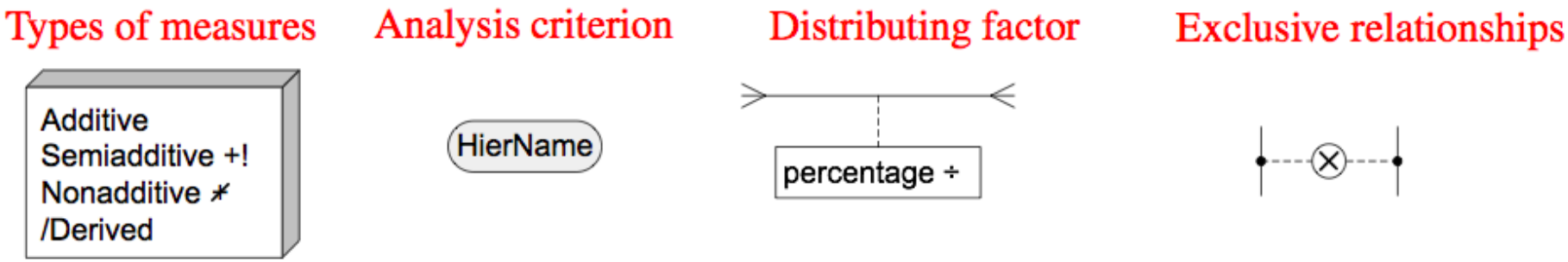
Dimension can be related several times to a fact with different roles

MultiDim Model: Notation

Summary







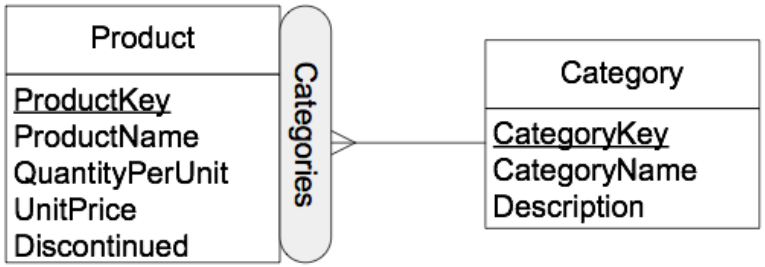
MultiDim Conceptual Schema of the Northwind Data Warehouse

Conceptual Data Warehouse Design

Outline

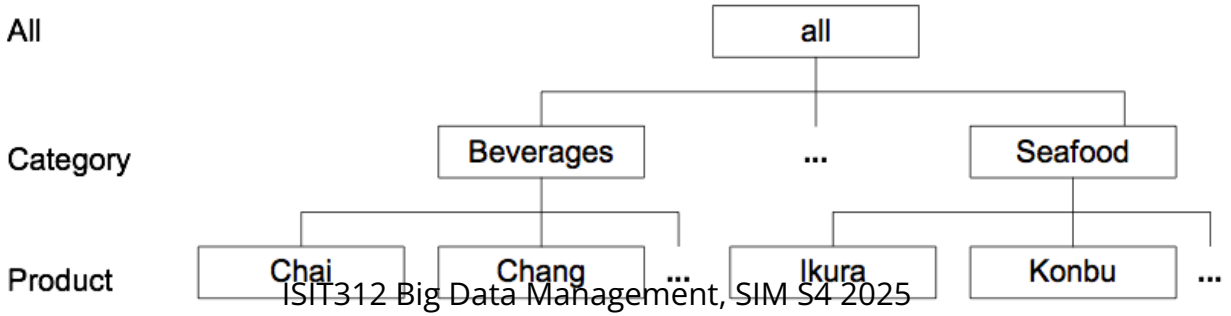
Balanced Hierarchies

At schema level: only one path where all parent-child relationships are many-to-one and mandatory



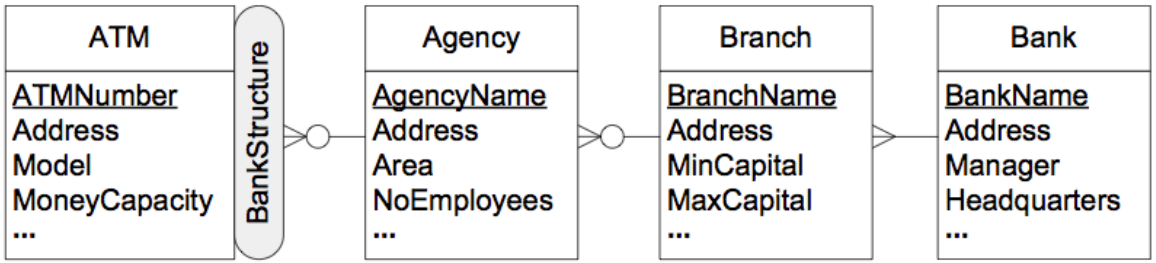
At instance level: members form a balanced tree (all the branches have the same length)

All parent members have at least one child member, and a child belongs exactly to one parent

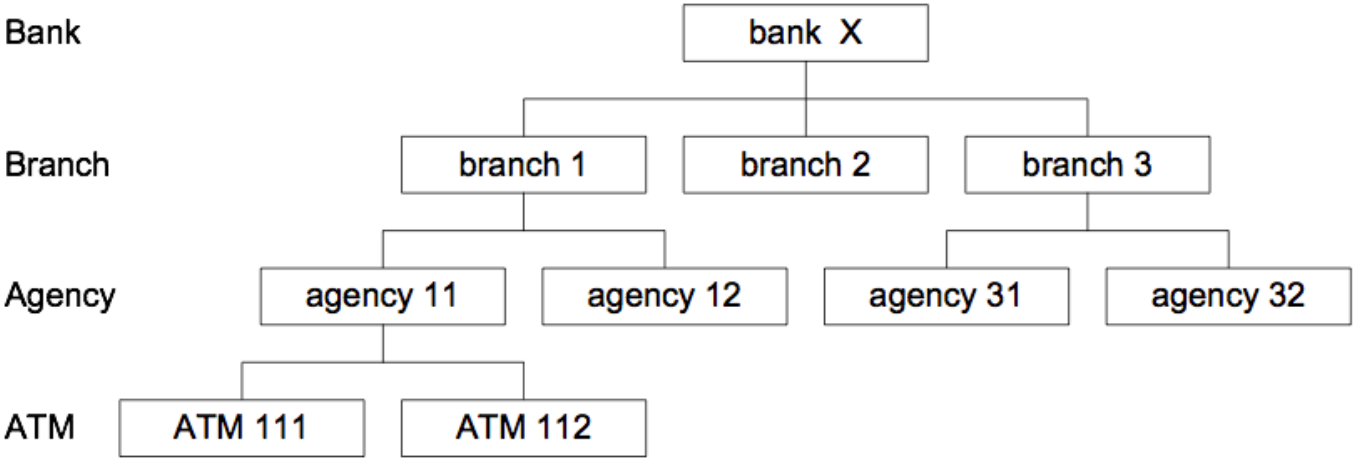


Unbalanced Hierarchies

At schema level: one path where all parent-child relationships are many-to-one, but some are optional



At instance level: members form a unbalanced tree



Recursive Hierarchies

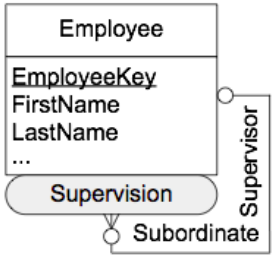
A special case of unbalanced hierarchies

The same level is linked by the two roles of a parent-child relationship

Used when all hierarchy levels express the same semantics

The characteristics of the parent and child are similar (or the same)

Schema level

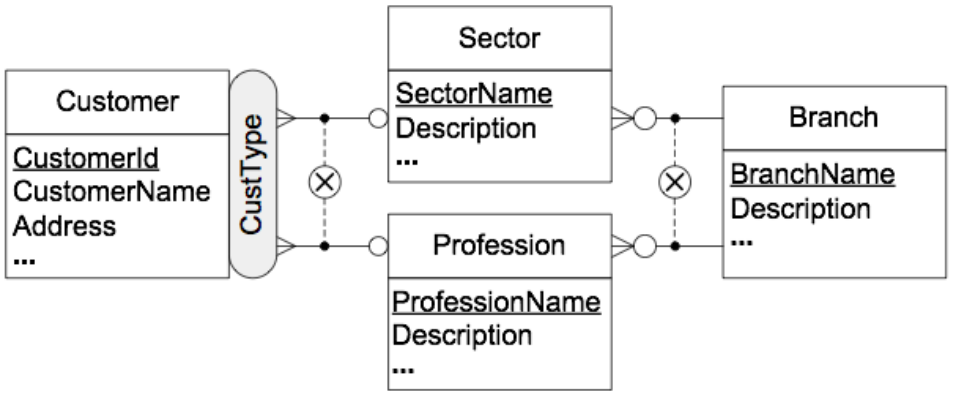


Instance level

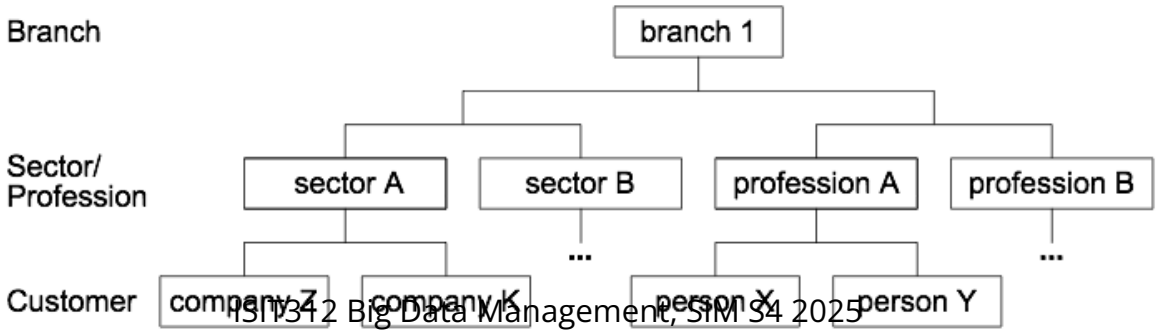
Generalized Hierarchies

At schema level: multiple exclusive paths sharing at least the leaf level; may also share other levels

Two aggregation paths, one for each type of customer



At instance level: each member belongs to only one path

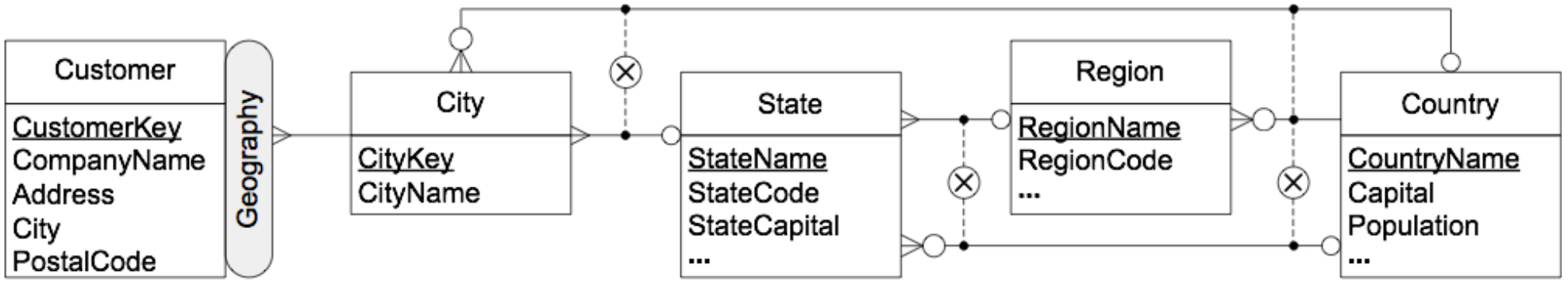


Noncovering Hierarchies

Also known as ragged or level-skipping hierarchies

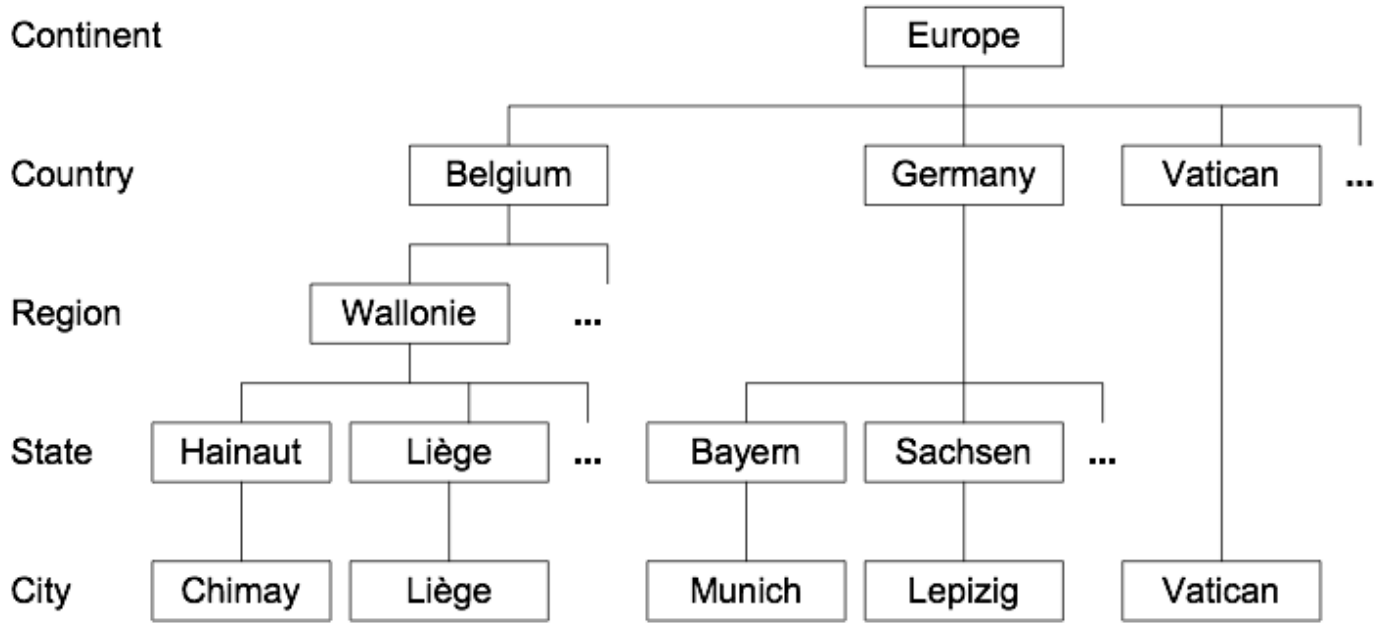
A special case of generalized hierarchies

At the schema level: Alternative paths are obtained by skipping one or several intermediate levels



Noncovering Hierarchies

At instance level: Path length from the leaves to the same parent can be different for different members



References

A. VAISMAN, E. ZIMANYI, Data Warehouse Systems: Design and Implementation, Chapter 4 Conceptual Data Warehouse Design, Springer Verlag, 2014