

Automatization of construction of  
dimension hierarchies of  
multidimensional data models

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# OLAP technology basics

- OLAP – On-Line Analytical Processing
- Multidimensional data model – cube:
  - dimensions – textual
  - measures – numerical
  - dimension hierarchies are necessary for realizing roll-up and drill-down operations

# Relational data model

CITY	STATE	POPULATION
San Diego	Texas	4490
Miami	Oklahoma	13880
Pittsburg	Iowa	509

*Example of relation*

Attributes: city, state, population

(San Diego, Texas, 4490) – tuple

Functional dependencies, multivalued dependencies

# «Composition table» data model

- «Composition table» forms from source relational database
- Schema of data model representation

$$Sch(R^*) = \{ X, \bigcup_{i=1}^N Dom(Y_i) \times \{ Z_i \} \}$$

$X, Y_i, Z_i$  – sets of attributes.  $X, Y_i$  – generalized coordinates,  $Z_i$  – values in cells of two-dimensional table

# «Composition table» data model

	Semester				Examination	Test
	1		2			
	Lectures	Practical	Lectures	Practical		
Subject name	<i>Hours amount</i>	<i>Hours amount</i>	<i>Hours amount</i>	<i>Hours amount</i>	<i>Semester</i>	<i>Semester</i>
Foreign language		3		2	4	1,2,3
Physical training		2		2		1,2,3,4
Domestic History	2	2			1,2	
Philosophy	2	2			1,2,3	
Economics			2	2	2	

## *University Curriculum*

Hierarchies of attributes in  $X$  and  $Y_i$  ( $i=1, 2, \dots, N$ ) defines order of arrangement of attribute values in headings of strings and columns

# Hierarchy schema

- Definition 1. A hierarchy schema is a directed, acyclic and weakly connected graph  $H=(A, E)$ , where  $A$  is a set of attributes,  $E$  is a set of arcs.
- Definition 2. Let  $C, D$  be attributes.  $H$  is a hierarchy schema.  $C \prec D$  if there is a path in  $H$  from  $C$  to  $D$ .

# Partial order

- For functional dependency  $C \rightarrow D$ ,  $C_k \in C$ ,  $D_l \in D \forall k, l$   $C_k \prec D_l$
- For multivalued dependency  $C \twoheadrightarrow D(E)$ ,  $C_k \in C$ ,  $I_l \in D \cup E \forall k, l$   $I_l \prec C_k$
- Order given by user

# Construction of hierarchy schema

$L$  is a set of dimension levels: attributes.

*Step 1.* Add arcs  $AB$  in  $H$ , where  $A \prec B$ :

1. given by user.
2. got from functional dependency.
3. got from multivalued dependency.

*Step 2.* While graph  $H$  contains cycles, remove one arc from each cycle.

*Step 3.* Add in  $H$  vertices from  $L$  that are absent in  $H$ . Add in  $H$  arcs if  $H$  is a disconnected graph.



## Example for «University Curriculum» database

- $L = \{ \textit{semester number}, \textit{studies type} \}$
- Multivalued dependency:  $\textit{subject code}, \textit{semester number} \twoheadrightarrow \textit{studies type}$  (*semester arrangement*)
- $\textit{studies type} \prec \textit{semester number}$
- Hierarchy schema formed by algorithm:

