

#### 4. The Relational model

# The Relational data model

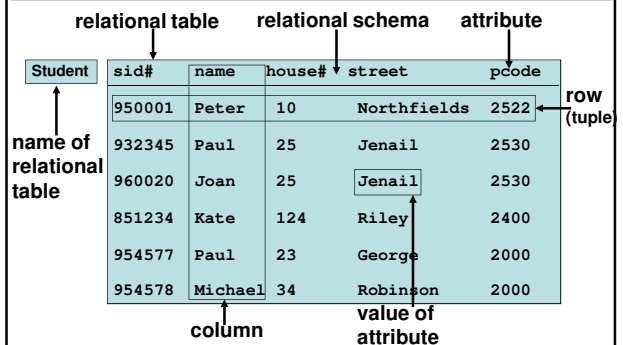
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#### 4. The Relational model

### Basic concepts



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### Basic concepts

#### Database schema

Database schema is a set of relational schemas

#### Database

Database is a set of relational tables

#### Domain of an attribute

Domain of an attribute  $a$  is a set of all possible values of attribute  $a$ ; domain of an attribute  $a$  is denoted by  $\text{dom}(a)$

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### Relational table (E.F. Codd, IBM, 1970)

Let  $S = \{ a_1, a_2, \dots, a_n \}$  be a relational schema

A relational table  $R$  is defined as a subset of Cartesian product:  $\text{dom}(a_1) \times \text{dom}(a_2) \times \dots \times \text{dom}(a_n)$

$$R \subseteq \text{dom}(a_1) \times \text{dom}(a_2) \times \dots \times \text{dom}(a_n)$$

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### "The first normal form" (1NF) rule

**A relational table must NOT have any multivalued attributes and composite attributes**

A relational table that has no multivalued attributes and composite attributes is in the first normal form (1NF)

A relational table given below is NOT in 1NF

e#	name	car used
950001	Peter	Toyota, PKR234 Ford, WER545
932345	Paul	Honda, RTQ456
960020	Joan	Holden, KLR197 Holden, KLR567

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### "Access to the rows by the contents" rule

**We can only retrieve rows by their contents**

It is NOT allowed to say: "give me the second row"

We have to say: "give me a row such that  $e\# = 932345$ "

e#	name	salary
950001	Peter	60K
932345	Paul	80K
960020	Joan	75K

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### "Unique rows" rule

**Relational table cannot contain two identical rows**

This rule is violated by all commercial DBMSs !

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### Keys

Let  $r(a_1, a_2, \dots, a_n)$  be a relational table

A **key** for table  $r$  is a set of attributes

$k = \{a_{k_1}, a_{k_2}, \dots, a_{k_n}\}$  such that:

- (1)  $k \subseteq \{a_1, a_2, \dots, a_n\}$
- (2) for any two rows  $v, w \in r$  their  $k$ -values must be different, i.e.  $v[k] \neq w[k]$
- (3) no proper subset  $k' \subset k$  has property (2)

A key that does not satisfy (3) is a **superkey**

A key that satisfies (1), (2), and (3) is also called as a **minimal key**

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### Examples of keys

#### Student

s# | name | city | street | house# | degree

key<sub>1</sub> = s#

#### Supplier

s# | company | city | mobile phone# | fax#

key<sub>1</sub> = s#,  
key<sub>2</sub> = mobile phone#  
key<sub>3</sub> = fax#

#### Part

p# | name | price | manufacturer

key<sub>1</sub> = p#

#### Shipment

s# | p# | delivery date | delivery address

key<sub>1</sub> = (s#, p#, delivery date,  
delivery address)

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### Candidate keys, primary key

All minimal keys in a relational table are also called as **candidate keys**

A **primary key** is one of the candidate keys arbitrarily chosen by a database designer to uniquely identify the rows in a relational table

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### NULLs

**An attribute in a relational table may have no values at all**

#### Department

name	building#	chairperson	budget
Comp. Sci	3	Peter	800K
Biology	15	NULL	NULL
Chemistry	35	NULL	700K

#### Department

name  
building#  
budget[0..1]

ID

Has

#### Chair

chairperson

0..1

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### "Entity integrity" rules

**No column belonging to a primary key or candidate key is allowed to take on NULLs for any row**

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Foreign key

A set of columns  $F$  in a table  $R$  is a **foreign key** if the combination of values of  $F$  in any row is required to either contain null values or else to match the value combination of a set of columns  $P$  representing a candidate or primary key in some table  $S$

Supplier

s#	company
10	XYZ Inc.
20	XYZ Inc.
40	Speedy

primary key = (s#)

Shipment

s#	p#	quantity
10	200	5000
10	300	4000
40	100	1000

primary key = (p#,s#,quantity)  
foreign key = (s#)  
foreign key = (p#)

Part

p#	name
100	bolt
200	nut
300	screw

primary key = (p#)

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"Referential integrity" rule

Referential integrity rule is in force if the columns of foreign key in any relational table either:

- have NULLs in at least one column that allows NULLs
- have no NULLs and combination of all its values is equal to the combination of primary key values in the other relational table

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A "tourist guide" through the "land of keys"

Minimal key      = the smallest key

Superkey        = minimal key + other attribute(s)

Candidate key   = any minimal key

Primary key     = one of the candidate keys

Foreign key      = an attribute or set of attributes referencing a primary key in another relational table

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Summary

A **database** is a collection of **relational tables**

A **relational table** consists of **rows (tuples)** and **columns(attributes)**

All **attributes** are atomic

Each **attribute** has a **domain**

A **row** represents a **relationship** among a **set of attributes**

A **relational table** is a subset of Cartesian product of **attribute domains**

An **attribute** may have no value (NULL)

Each relational **table** represents a **class of objects**

All definitions of **key constraints** from a conceptual schema have their correspondence in the **keys** of relational table.

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References

Elmasri R., Navathe S. B., *Database Systems*, chapter 3

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