



# The Relational Data Model

Chapter 3



# Chapter Outline

◆ After you have read and studied this chapter, you should be able to know

- The Relational Model Concepts

  - Tuple, domain, instance, schema, role

- The Relational Model Constraints and Relational Database Schemas

- Dealing with Constraint Violations

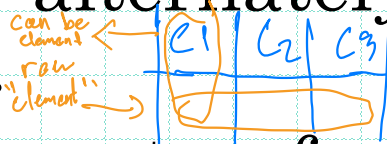
# Relational Model Concepts

- ◆ The relational Data Model is based on the concept of a Relation.
- ◆ A Relation is a mathematical concept based on the ideas of sets.
- ◆ The strength of the relational approach to data management comes from the formal foundation provided by the theory of relations.

# Informal Definitions

◆ RELATION: A table of values

- A relation may be thought of as a set of rows.
- A relation may alternately be thought of as a set of columns.
- Each row represents a fact that corresponds to a real-world entity or relationship.
- Each row has a value of an item or set of items that uniquely identifies that row in the table.
- Sometimes row-ids or sequential numbers are assigned to identify the rows in the table.
- Each column typically is called by its column name or column header or attribute name.



العلاقة = مجموعة من الصفوف  
العلاقة = مجموعة من الأعمدة

# Formal Definitions - Relation

- ◆ A **Relation** has a schema. *العلاقة هي الجدول + الأسماء + البيانات*
- ◆ The **Schema** of a Relation is defined over **attributes**  $A_1, A_2, \dots, A_n$ . R can be written :  $R(A_1, A_2, \dots, A_n)$  *الجدول هو ما بين قوسين*

Example:

$R \subset D_1 \times D_2 \times D_3$   
*جداول* *البيانات* *البيانات*

CUSTOMER (Cust-id, Cust-name, Address, Phone#)

Here, CUSTOMER is a relation defined over the four attributes Cust-id, Cust-name, Address, Phone#, each of which has a **domain** or a set of valid values. For example, the domain of Cust-id is 6 digit numbers.

# Formal Definitions II - Tuple

- ◆ A **tuple** is an ordered set of values
- ◆ Each value is derived from an appropriate domain.
- ◆ Each row in the CUSTOMER table may be referred to as a tuple in the table and would consist of four values.
- ◆  $\langle 632895, \text{"Yasine Shehri"}, \text{"101 Thalatheen Street, Riyadh 54312"}, \text{"(01) 4942060"} \rangle$  is a tuple belonging to the CUSTOMER relation.

# Formal Definitions III - column

- ◆ A **relation** may be regarded as a **set of tuples** (rows).
- ◆ **Columns** in a table are also called **attributes** of the relation.

# Formal Definitions IV - Domain

- ◆ A **domain** has a logical definition: e.g.,  
“Phone\_numbers” are the set of 9 digit phone numbers valid in the S.A.
- ◆ A domain may have a data-type or a format defined for it. The Phone\_numbers may have a format: (dd)-ddd-dddd where each d is a decimal digit. E.g., Dates have various formats such as monthname, date, year or yyyy-mm-dd, or dd mm,yyyy etc.



# Formal Definitions V - Role

- ◆ An attribute designates the **role** played by the domain. E.g., the domain Date may be used to define attributes “**Invoice-date**” and “**Payment-date**”.

# Formal Definitions VI – Cartesian Product

ضرب بیاب مجموعهات = ناتج حاصل از مجموعه‌های

- ◆ The relation is formed over the **Cartesian product** of the sets; each set has values from a domain; that domain is used in a specific role which is conveyed by the attribute name.
- ◆ For example, attribute **Cust-name** is defined over the domain of strings of 25 characters. The role these strings play in the CUSTOMER relation is that of the name of customers.

# Relation Schema

The degree of a relation is the number of attributes of its schema

A database schema is a set of relation Schemes

ex.: Car(Licence#, EngineSerial#, Make, Model, Year) is of degree 5.

# Relation Schema II

◆ Formally,

Given  $R(A_1, A_2, \dots, A_n)$

$$r(R) \subset \text{dom}(A_1) \times \text{dom}(A_2) \times \dots \times \text{dom}(A_n)$$

◆  $R$ : schema of the relation

◆  $r$  of  $R$ : a specific "value" or population of  $R$ .

◆  $R$  is also called the **intension** of a relation

◆  $r$  is also called the **extension** of a relation

# Instance

مثال على ضرب ديكارتية

◆ Let  $S1 = \{0,1\}$

◆ Let  $S2 = \{a,b,c\}$

◆ Let  $R \subset S1 \times S2$

R جزئي من حاصل ضرب الدومين (أقصى قيمة هي ناتج ضربين الدومين)

◆ Then for example:  $r(R) = \{ \langle 0,a \rangle , \langle 0,b \rangle , \langle 1,c \rangle \}$   
is one possible “state” or “population” or  
“extension” r of the relation R, defined over  
domains S1 and S2. It has three tuples.

# Definition Summary

## Definition Summary

<u>Formal Terms</u>	<u>Informal Terms</u>
Relation	Table
Attribute/Domain	Column
Tuple	Row
Domain	Values in a column
Schema of a Relation	Table Definition
Extension	Populated Table

# Relation Instance

- ◆ The current values (*relation instance*) of a relation are specified by a table
- ◆ An element  $t$  of  $r$  is a *tuple*, represented by a *row* in a table

The diagram shows a table representing a relation instance. The table has three columns: *name*, *Address*, and *city*. The rows represent tuples. Annotations include: three arrows pointing from the label 'attributes' to the column headers; three arrows pointing from the label 'tuples' to the rows; and the label 'customer' centered below the table.

<i>name</i>	<i>Address</i>	<i>city</i>
Majed	21, Tahlia st,	Riyadh
Fahad	124, Olaya st.	Diryia
Ali	98, Ourouba st,	Jeddah

*customer*

# Characteristics Of Relations

- ◆ **Ordering of tuples in a relation  $r(R)$ :** The tuples are *not* considered to be ordered, even though they appear to be in the tabular form.
- ◆ **Ordering of attributes in a relation schema  $R$ :** We will consider the attributes in  $R(A_1, A_2, \dots, A_n)$  and the values in  $t = \langle v_1, v_2, \dots, v_n \rangle$  to be *ordered*.



# Characteristics Of Relations II

- ◆ **Values in a tuple:** All values are considered *atomic* (indivisible). A special **null** value is used to represent values that are unknown or inapplicable to certain tuples.
- ◆ We refer to **component values** of a tuple  $t$  by  $t[A_i] = v_i$  (the value of attribute  $A_i$  for tuple  $t$ ).  
Similarly,  $t[A_u, A_v, \dots, A_w]$  refers to the subtuple of  $t$  containing the values of attributes  $A_u, A_v, \dots, A_w$ , respectively.

# Database Schema

It is a set of relation schemes

$S = \{R_1, R_2, \dots, R_n, \}$  and a set on integrity constraints

Example of database schema:

Employee(SSN, Name, Address, Salary, DepN)

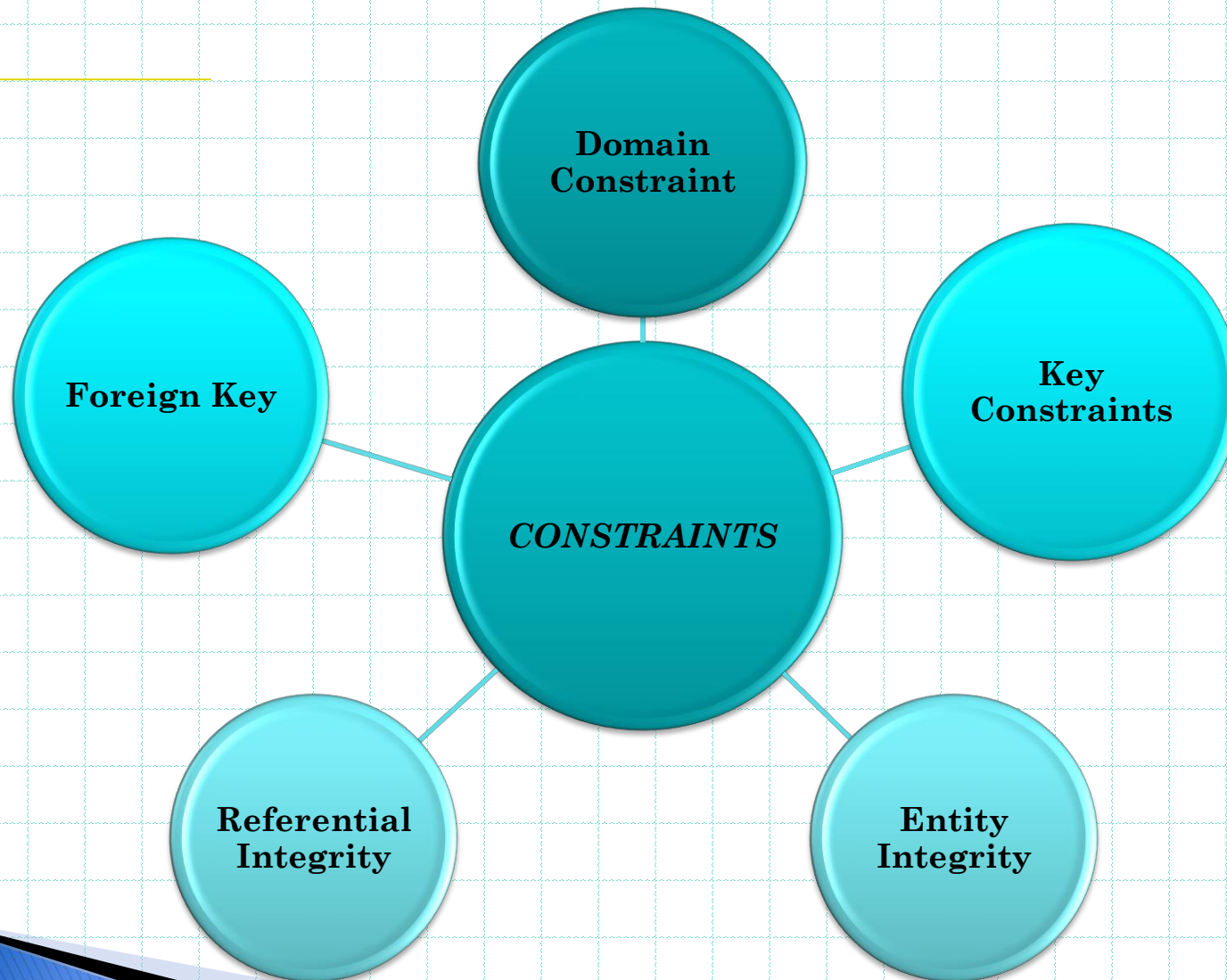
Dept(Dep#, Name, MGRSSN)

DepLct(Dep#, DepLocation)

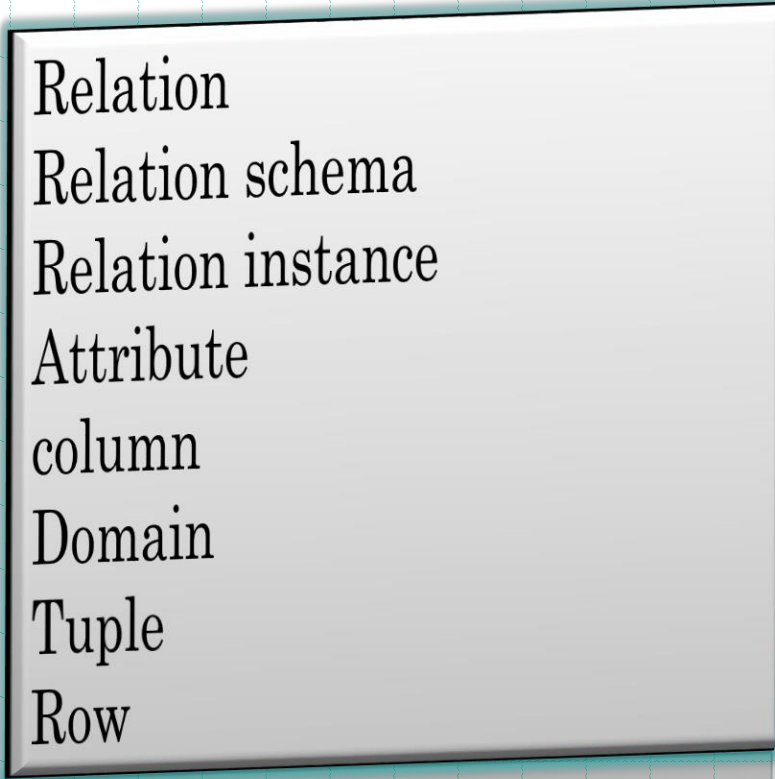
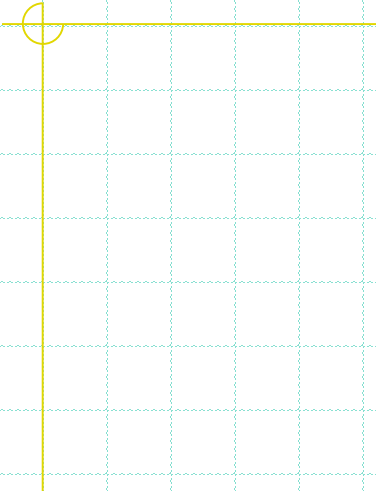
Prjct(Proj#, Name, ProjLoc, Dep#)

Works\_on(SSN, Prj#, firs)

# Constraints



# Keys of the Relation Data model



- Relation
- Relation schema
- Relation instance
- Attribute
- column
- Domain
- Tuple
- Row

