

Database Management Systems

Part I: Basic Concepts

Lecture 3

An Introduction to Relational Databases

Contents

- Introduction
- Relational Systems
- Relational Model
- Relational Query Languages
- The SQL Language

Introduction

- Based on the various data models, there are **four** different types of the DBMS:
 - ✓ Hierarchical DBMS (HDBMS)
 - ✓ Networked DBMS (NDBMS)
 - ✓ Relational DBMS (RDBMS)
 - ✓ Object Oriented DBMS (OODBMS)
- Among them, the **RDBMS is mostly used.**

Relational Systems

- **Relational database management system (RDBMS)** is a system in which, at a minimum:
 1. The data is **perceived** by the user **as tables**; and
 2. The operators at the user's disposal – e.g., for data retrieval – are operators that **generate new tables from old**, and those operators include at least SELECT, PROJECT, and JOIN.

Relational Systems (Cont.)

- A simple relational database is shown in figure.
- In the figure, the database is indeed **perceived as tables**.

Department database → DEPT

DEPT#	DNAME	BUDGET
D1	Marketing	10M
D2	Development	12M
D3	Research	5M

Employees database → EMP

EMP#	ENAME	DEPT#	SALARY
E1	Lopez	D1	40K
E2	Cheng	D1	42K
E3	Finzi	D2	30K
E4	Saito	D2	35K

The departments-and-employees database with sample values

Relational Systems (Cont.)

- A **sample SELECT operation** against that database is as follow.
- The **SELECT** operation **extracts specified rows** from a table.

SELECT:

DEPTs where BUDGET > 8M

DEPT	DEPT#	DNAME	BUDGET
	D1	Marketing	10M
	D2	Development	12M
	D3	Research	5M



Result:

DEPT#	DNAME	BUDGET
D1	Marketing	10M
D2	Development	12M

Relational Systems (Cont.)

- A **sample PROJECT operation** against that database is as follow.
- **PROJECT** operation **extracts specified columns** from a table.


PROJECT:

DEPTs over DEPT#, BUDGET

DEPT

DEPT#	DNAME	BUDGET
D1	Marketing	10M
D2	Development	12M
D3	Research	5M

Result:



DEPT#	BUDGET
D1	10M
D2	12M
D3	5M

Relational Systems (Cont.)

- A **sample JOIN operation** against that database is as follow.
- **JOIN** operation **joins together two tables** on the basis of common values in a common column.

JOIN:

DEPTs and EMPs over DEPT#

Result:

DEPT#	DNAME	BUDGET	EMP#	ENAME	SALARY
D1	Marketing	10M	E1	Lopez	40K
D1	Marketing	10M	E2	Cheng	42K
D2	Development	12M	E3	Finzi	30K
D2	Development	12M	E4	Saito	35K

Relational Systems (Cont.)

- Relational systems are based on what is called the **relational model of data**.
- The relational model is an abstract theory of data that is based on certain **aspects of mathematics** (principally set theory and predicate logic).

Relational Model

- The relational model is a way of looking at data – that is, it is
 - ✓ a prescription for a way of **representing data** (by means of **tables**), and
 - ✓ a prescription for a way of **manipulating such a representation** (by means of operators such as JOIN).

Relational Model (Cont.)

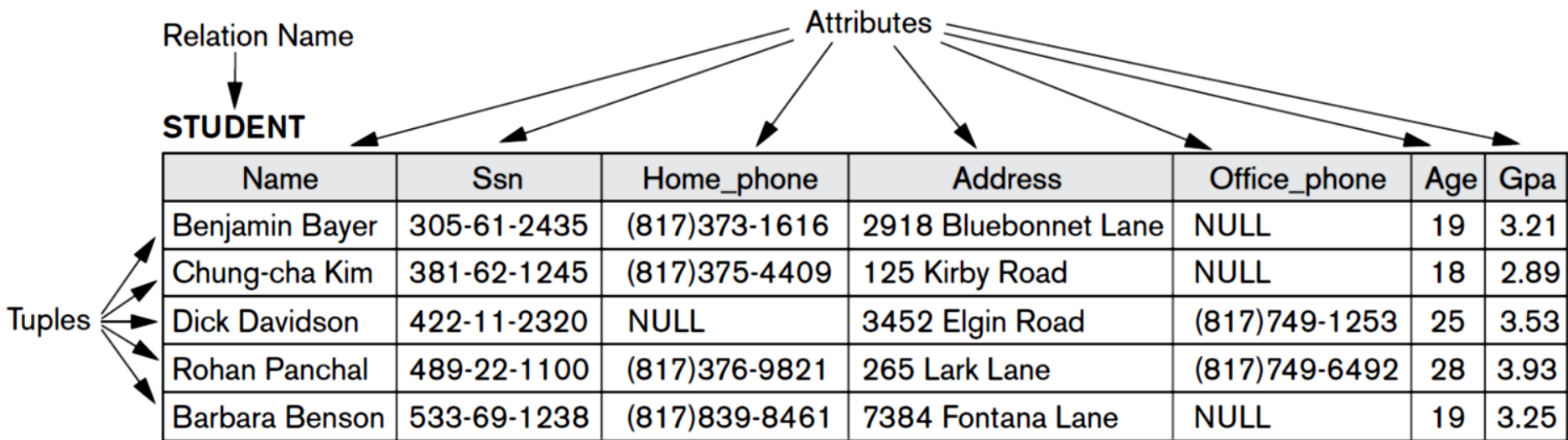
- The relational model represents the database as a collection of relations.
- A relational database consists of a collection of tables, each of which is assigned a unique name.
- The table name and column names are used to help to interpret the meaning of the values in each row.

Relational Model (Cont.)

- In the formal relational model terminology,
 - ✓ a **row** is called a **tuple**,
 - ✓ a **column header** is called an **attribute**, and
 - ✓ the **table** is called a **relation**.
- **No two tuples** in a relation are allowed to have **exactly the same value for all attributes**.

Relational Model (Cont.)

- Figure shows an example of a STUDENT relation.



The attributes and tuples of a relation STUDENT

Relational Model (Cont.)

Candidate Key

- In general, a relation schema may have more than one key.
- Each of the keys is called a **candidate key**.
- For example, the **CAR relation** in Figure has **two candidate keys**:
License_number and Engine_serial_number.

CAR

<u>License_number</u>	Engine_serial_number	Make	Model	Year
Texas ABC-739	A69352	Ford	Mustang	02
Florida TVP-347	B43696	Oldsmobile	Cutlass	05
New York MPO-22	X83554	Oldsmobile	Delta	01
California 432-TFY	C43742	Mercedes	190-D	99
California RSK-629	Y82935	Toyota	Camry	04
Texas RSK-629	U028365	Jaguar	XJS	04

Relational Model (Cont.)

Primary Key

- The candidate key whose values are used to identify tuples in the relation is called **primary key**.
- The attributes that form the primary key of a relation schema are **underlined**.
- Primary key value **cannot be NULL**.
- This is because the primary key value is used to identify individual tuples in a relation.

Relational Model (Cont.)

- In the following CAR relation, it is common to designate one of the candidate keys as the primary key of the relation.
- In this case, License_number is designated as **the primary key** of the relation.

CAR

<u>License_number</u>	Engine_serial_number	Make	Model	Year
Texas ABC-739	A69352	Ford	Mustang	02
Florida TVP-347	B43696	Oldsmobile	Cutlass	05
New York MPO-22	X83554	Oldsmobile	Delta	01
California 432-TFY	C43742	Mercedes	190-D	99
California RSK-629	Y82935	Toyota	Camry	04
Texas RSK-629	U028365	Jaguar	XJS	04

Relational Model (Cont.)

- Note that, when a relation schema has several candidate keys, it is usually better to choose a primary key with a single attribute or a small number of attributes.
- The other candidate keys are designated as unique keys, and are not underlined.

Relational Model (Cont.)

- Figure shows a relational database schema called COMPANY = {EMPLOYEE, DEPARTMENT, DEPT_LOCATIONS, PROJECT, WORKS_ON, DEPENDENT}.
- The underlined attributes represent primary keys.

EMPLOYEE

Fname	Minit	Lname	<u>Ssn</u>	Bdate	Address	Sex	Salary	Super_ssn	Dno
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DEPARTMENT

Dname	<u>Dnumber</u>	Mgr_ssn	Mgr_start_date
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DEPT_LOCATIONS

<u>Dnumber</u>	<u>Dlocation</u>
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PROJECT

Pname	<u>Pnumber</u>	Plocation	Dnum
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WORKS_ON

<u>Essn</u>	<u>Pno</u>	Hours
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DEPENDENT

<u>Essn</u>	<u>Dependent_name</u>	Sex	Bdate	Relationship
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Relational Query Languages

- A **query language** is a language in which a user requests information from the database.
- The **relational query languages** define a set of operations that operate on tables, an output tables as their results.
- Query languages can be categorized as either **procedural** or **nonprocedural**.

Relational Query Languages (Cont.)

- In a procedural language, the user instructs the system to perform a sequence of operations on the database to compute the desired result.
- In a nonprocedural language, the user describes the desired information without giving a specific procedure for obtaining that information.

The SQL Language

- All procedural relational query languages provide a set of operations that can be applied to either a single relation or a pair of relations.
- **SQL** is used to formulate relational operations.
- The SQL operation for creating a new base table is **CREATE TABLE**.
- The SQL retrieval operation is **SELECT**.
- The SQL update operations are **INSERT, UPDATE and DELETE**.

The SQL Language (Cont.)

- The relational operations on the data can be performed by using the SQL data manipulation statement **SELECT**.
- Figure shows how the **SELECT** and **PROJECT** examples could be formulated using SQL.

SELECT (RESTRICT): Result:

```
SELECT DEPT#, DNAME, BUDGET
FROM DEPT
WHERE BUDGET > 8M ;
```

DEPT#	DNAME	BUDGET
D1	Marketing	10M
D2	Development	12M

PROJECT:

```
SELECT DEPT#, BUDGET
FROM DEPT ;
```

Result:

DEPT#	BUDGET
D1	10M
D2	12M
D3	5M

The SQL Language (Cont.)

- Figure shows how the **JOIN** example could be formulated using **SQL**.

JOIN:

```
SELECT DEPT.DEPT#, DNAME, BUDGET, EMP#, ENAME, SALARY
FROM   DEPT, EMP
WHERE  DEPT.DEPT# = EMP.DEPT# ;
```

Result:

DEPT#	DNAME	BUDGET	EMP#	ENAME	SALARY
D1	Marketing	10M	E1	Lopez	40K
D1	Marketing	10M	E2	Cheng	42K
D2	Development	12M	E3	Finzi	30K
D2	Development	12M	E4	Saito	35K

Summary

- A relational database is a database that is perceived by its users as a **collection of relations or tables**.
- A relational system is a system that **supports relational databases and operations** on such databases.
- The standard language for interacting with relational databases is **SQL**.

Next Lecture

Part II: The Relational Model

Relational Data Objects

- Domains
- Relations

Textbook and References

Textbook

- C. J. Date, “An Introduction to Database Systems”, 6th Edition, 1994.

Additional References

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