Unit 1:
Relational Databases

1.1. Fundamentals

1.2. The Relational Data Model

1.3. Interpretation of a Relational Database

Unit 1.1 Fundamentals

1. Information system.
2. Database and DBMS.
3. Database characteristics
4. Example.

1 Information system

Computer science (information processing)

A duality between *processing* and *information: They do not make sense alone!*

Processing perspective:

Programming, algorithmic, etc., deal with processing.

Information perspective:

Data representation, knowledge, data access, data storage, etc.

1 Information system

An *information system* (IS) is a collection of elements, which are orderly related to each other following some rules, that provide the entity they serve with the necessary information for the completion of its goals.

Basic functions of an IS:

- Data gathering
- Data processing
- Data storage
- Data elaboration and presentation

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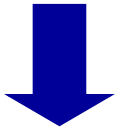
2 Database and DBMS

Database (DB)

Is a collection of structured data



Database management system (DBMS)

Software tool (collection of programs) that enables users to create, manipulate and maintain a database

2 Database and DBMS

- The way in which reality (entities, relationships, etc.) is represented in the context of databases (data structures, constraints, etc.) is known as a *data modelling system* or simply a "***data model***".

- Many different data models have been proposed:
  - Hierarchical, network, relational, object-oriented, multi-dimensional, etc.

- A DBMS assumes one data model and builds everything upon it.
- A Relational DBMS (RDBMS) is a DBMS which is based on the relational model.

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3 Database characteristics

- Integrating all the organization's information.
- Data persistence.
- Shared accesibility to several users (or applications).
- Unified data description, independent of the applications.
- Independence between the applications and the physical representation.
- Description of partial views of the data for different users
- Mechanisms to ensure data integrity and security.

3 Database characteristics

DBs pursue a general goal:

> Global integration of the system's information in order to avoid redundancies, with no loss of the different database perspectives by users.

Additionally, the software tools (DBMSs), specifically designed to apply these techniques, must ensure data independence, integrity and security.

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4 Example

Information System of a University

Goal:
To handle the daily procedures and administrative tasks in a university

Originally, we have different perspectives:

- School administration
- Department
- Students
- Lectures

Keeping these perspectives in a separate way involves redundancy

4 Example

School administration’s perspective

4 Example

Courses

Computer Science Degree (ITIG)					
Term	**Subject**	**Code**	**Dep.**	**Lect.**	**Lab**
1A	Algoritmos y estructuras de datos I	AD1	DSIC	3	3
	Análisis matemático I	AM1	DMA	3	3
	Fundamentos de computadores	FCO	DISCA	4.5	4.5
	Introducción a la programación	IP	DSIC	1.5	1.5
	Matemática discreta	MAD	DMA	3	3
1B	Algoritmos y estructuras de datos II	AD2	DSIC	3	3
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4 Example

Lecturers

Departament	Code	Name	Tel.
DSIC	LBP	Bos Pérez, Luis	3545
	JCP	Cerdá Pérez, Juan	3222
	PMG	Martí García, Pedro	3412
DISCA	MRC	Ruiz Cantó, María	3675
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4 Example

Teaching

Term	Courses	Lec. Groups	Lab. Groups	Lecturers	Credits
1ª	AD1	2	4	Cerdá Perez, Juan Martí García, Pedro	9 9
	IP	2	4	Bos Pérez, Luis Cerdá Perez, Juan	9 9
	AM1	----	----	----	----
1B	AD2	----	---	----	----

4 Example

Department's perspective

4 Example

Lecturers

Code	Name	Address	Category	Tel
LBP	Bos Pérez, Luis	Jesús 91	TEU	3545
JCP	Cerdá Pérez, Juan	Olta 23	TEU	3222
PMG	Martí García, Pedro	Cuenca 12	TEU	3412
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4 Example

Appointed courses

Degree	School	Term	Course	Code	Lec	Lab
ITIG	E.I.	1A	Algoritmos y estructuras de datos I	AD1	3	3
			Introducción a la programación	IP	1.5	1.5
		1B	Algoritmos y estructuras de datos II	AD2	3	3
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4 Example

Teaching arrangement by subject

Term	Degree	School	Course	LecG	LabG	Lecturers	Credits
A	ITIG	E.I.	AD1	2	4	Cerdá Perez, Juan	9
						Martí García, Pedro	9
			IP	2	4	Bos Pérez, Luis	9
						Cerdá Perez, Juan	9
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B	ITIG	E.I.	AD2	----	----	---------	
			----	----	----	---------	

4 Example

Teaching arrangement by lecturer

Lecturer	Subject	Degree	School	Term	Credits
Bos Pérez, Luis	IP	ITIG	E.I.	A	9
Cerdá Pérez, Juan	AD1	ITIG	E.I.	A	9
	IP	ITIG	E.I.	A	9
Martí García,Pedro	AD1	ITIG	E.I.	A	9
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4 Example

We have duplicate information.

Is this a problem?

- Storage space is not optimised
- Higher update cost.
- Inconsistencies can appear.

  For instance, the credits for the same course could differ depending on the view.

We can integrate everything into the same “logical” schema.

4 Example

Logical schema

Lecturer

Code	Name	Address	Tel	Category	Dep

Course

Code	Name	Sem	Lec	Lab	LecG	LabG	Degree	Dep

Teaching

lecturer_id	course_id	credits

School

Code	Name	Head	Tel

Degree

Code	Name	School

Department

Code	Name	Head	Tel

4 Example

Relational Database

Department Relation

Code	Name	Head	Tel
DSIC	Sistemas Informáticos y Computación	Juan García	3570
DFA	Física Aplicada	José Ruíz	3540
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Degree Relation

Code	Name	School
ITIG	Ingeniero Técnico en Informática de Gestión	E.I.
ITIS	Ingeniero Técnico en Informática de Sistemas	E.I.
II	Ingeniero Informático	FI
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4 Example

Relational Database

School Relation

Code	Name	Head	Tel
E.I.	Escuela Universitaria de Informática	Pedro Ruiz	3578
FI	Facultad de Informática	José Esteban	3776
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Lecturer Relation

Code	Name	Address	Tel	Category	Dep
JCP	Juan Cerdá Pérez	Olta 23	3222	TEU	DSIC
LBP	Luis Bos Pérez	Jesús 91	3545	TU	DSIC
PMG	Pedro Martí García	Cuenca 12	3412	CU	DSIC
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4 Example

Relational Database

Course Relation

Code	Name	Sem	Lec	Lab	LecG	LabG	Degree	Dep
AD1	Algoritmos y estructuras de datos I	1A	3	3	2	4	ITIG	DSIC
IP	Introducción a la programación	1A	1.5	1.5	2	4	ITIG	DSIC
AD2	Algoritmos y estructuras de datos II	1B	3	3	--	--	ITIG	DSIC
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Teaching Relation

lecturer_id	course_id	credits
JCP	AD1	9
JCP	IP	9
LBP	IP	9
PMG	AD1	9
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4 Example

Redundancy has been eliminated

What about the partial views of the data for different users?

Partial views of the logical schema

External schema (views)

4 Example

Logical schema

External schema for DSIC

Lecturer

Code	Name	Address	Tel	Category	Dep
…	…	…	…	…	…

SELECT rows WHERE
Dep = ‘DSIC’

Lecturers from DSIC

Code	Name	Address	Tel	Cat
…	…	…	…	…

Course

Code	Name	Sem	Lec	Lab	LecG	LabG	Degree	Dep
…	…	…	…	…	…	…	…	…

SELECT rows WHERE
Dep = ‘DSIC’

Courses from DSIC

Code	Name	Sem	Lec	Lab	LecG	LabG	Degree
…	…	…	…	…	…	…	…

Teaching

lecturer_id	course_id	credits
…	…	…

SELECT rows in *teaching* which
correspond to courses assigned to DSIC

Teaching from DSIC

lecturer_id	course_id	credits
…	…	…

Course

Code	Name	Sem	Lec	Lab	LecG	LabG	Degree	Dep
…	…	…	…	…	…	…	…	…

Degree

Code	Name	School
…	…	…

The whole relation is included

Degrees from DSIC

Code	Name	School
…	…	…

4 Example

Physical schema