

RELATIONAL DATABASES

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OBJECTIVES

- Understand a DBMS and define its components.
- Understand the architecture of a DBMS and its levels.
- Distinguish between different database models.
- Understand the concept of relational database operations on a relation.

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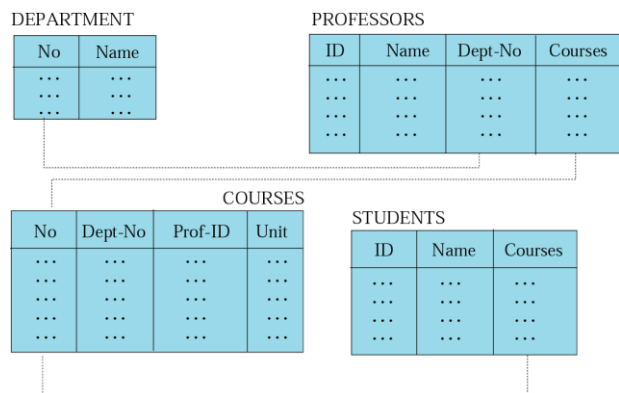
UNDERSTAND A DBMS AND DEFINE ITS COMPONENTS

- **Database** – a collection of data that is **logically coherent**.
- **DBMS – Database Management System**
 - defines, creates, and maintains a database.
 - Allows users **controlled access** to data in the database.
 - A combination of 5 components:
 - Hardware
 - Software
 - Data
 - Users
 - Procedures

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RELATIONAL MODEL

- ❑ Data are organized in **two-dimensional tables** called **relations**.
- ❑ The tables are **related** to each other.
- ❑ The most popular model.



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RELATIONAL MODEL

- RDBMS (Relational Database Management System)
- external view
 - The data are represented as a set of relations.
 - A **relation** is a two-dimensional table.
- This **doesn't** mean that data are stored as tables! The physical storage of the data is **independent** of the way the data are logically organized.

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RELATION

Name – each relation in a relational database should have a name that is **unique** among other relations.

Attribute – each **column** in a relation.

The **degree** of the relation – the total number of attributes for a relation.

Tuple – each **row** in a relation.

The **cardinality** of the relation – the total number of rows in a relation.

Attributes			Tuples
No	Course-Name	Unit	
CIS15	Intro to C	5	
CIS17	Intro to Java	5	
CIS19	UNIX	4	
CIS51	Networking	5	

COURSES

6

OPERATIONS ON RELATIONS

❑ In a relational database, we can define several operations to create new relations out of the existing ones.

❑ Basic operations:

Insert Delete Update Select Project Join Union
Intersection Difference

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INSERT OPERATION

❑ A **unary** operation.

❑ Insert a new tuple into the relation.

COURSES

No	Course-Name	Unit
CIS15	Intro to C	5
CIS17	Intro to Java	5
CIS19	UNIX	4
CIS51	Networking	5



No	Course-Name	Unit
CIS15	Intro to C	5
CIS17	Intro to Java	5
CIS19	UNIX	4
CIS51	Networking	5
CIS52	TCP/IP Protocols	6

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DELETE OPERATION

- ❑ A **unary** operation.
- ❑ Delete a **tuple** defined by a **criterion** from the relation.

COURSES

No	Course-Name	Unit
CIS15	Intro to C	5
CIS17	Intro to Java	5
CIS19	UNIX	4
CIS51	Networking	5
CIS52	TCP/IP Protocols	6



No	Course-Name	Unit
CIS15	Intro to C	5
CIS17	Intro to Java	5
CIS51	Networking	5
CIS52	TCP/IP Protocols	6

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UPDATE OPERATION

- ❑ A **unary** operation.
- ❑ Changes the value of some attributes of a tuple.

COURSES

No	Course-Name	Unit
CIS15	Intro to C	5
CIS17	Intro to Java	5
CIS19	UNIX	4
CIS51	Networking	5
CIS52	TCP/IP Protocols	6



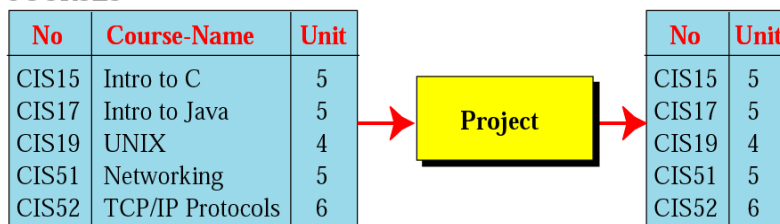
No	Course-Name	Unit
CIS15	Intro to C	5
CIS17	Intro to Java	5
CIS19	UNIX	4
CIS51	Networking	6
CIS52	TCP/IP Protocols	6

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PROJECT OPERATION

- ❑ A **unary** operation.
- ❑ It is applied to one single relation and creates another relation.
- ❑ The attributes in the resulting relation are a subset of the attributes in the original relation.

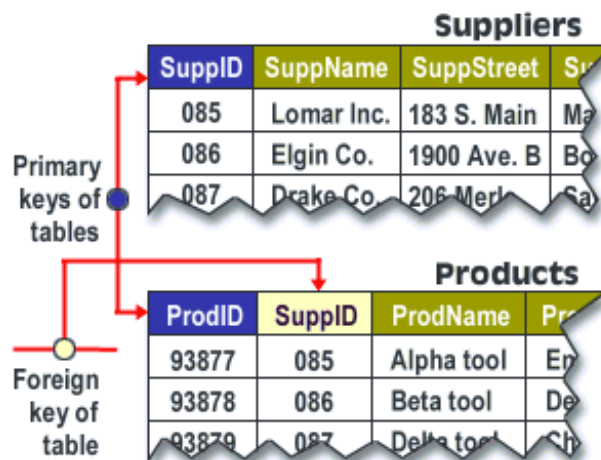
COURSES



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PRIMARY AND FOREIGN KEYS

The **primary key** of a relational table uniquely identifies each record in the table. It is a column, or set of columns, that allows each row in the table to be uniquely identified.



A **foreign key** is a field in a relational table that matches the primary key column of another table.

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JOIN OPERATION

COURSES

No	Course-Name	Unit
CIS15	Intro to C	5
CIS17	Intro to Java	5
CIS19	UNIX	4
CIS51	Networking	5
CIS52	TCP/IP Protocols	6

TAUGHT-BY

No	Professor
CIS15	Lee
CIS17	Lu
CIS19	Walter
CIS51	Lu
CIS52	Lee

❑ A **binary** operation.

❑ Combines two relations based on common attributes.

Join

No	Course-Name	Unit	Professor
CIS15	Intro to C	5	Lee
CIS17	Intro to Java	5	Lu
CIS19	UNIX	4	Walter
CIS51	Networking	5	Lu
CIS52	TCP/IP Protocols	6	Lee

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UNION OPERATION

❑ A **binary** operation.

❑ Creates a new relation in which each tuple is either in the first relation, in the second, or in both.

❑ The two relations must have the same attributes.

CIS15-Roster

Student-ID	F-Name	L-Name
145-67-6754	John	Brown
232-56-5690	George	Yellow
345-89-6580	Anne	Green
459-98-6789	Ted	Purple

CIS52-Roster

Student-ID	F-Name	L-Name
342-88-9999	Rich	White
145-67-6754	John	Brown
232-56-5690	George	Yellow

Union

Student-ID	F-Name	L-Name
145-67-6754	John	Brown
232-56-5690	George	Yellow
345-89-6580	Anne	Green
459-98-6789	Ted	Purple
342-88-9999	Rich	White

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INTERSECTION OPERATION

- ☐ A **binary** operation.
- ☐ Creates a new relation in which each tuple is a member in both relations.
- ☐ The two relations must have the same attributes.

CIS15-Roster

Student-ID	F-Name	L-Name
145-67-6754	John	Brown
232-56-5690	George	Yellow
345-89-6580	Anne	Green
459-98-6789	Ted	Purple

CIS52-Roster

Student-ID	F-Name	L-Name
342-88-9999	Rich	White
145-67-6754	John	Brown
232-56-5690	George	Yellow

Intersection

Student-ID	F-Name	L-Name
145-67-6754	John	Brown
232-56-5690	George	Yellow

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DIFFERENCE OPERATION

- ☐ A **binary** operation.
- ☐ Creates a new relation in which each tuple is in the **first** relation **but not the second**.
- ☐ The two relations must have the same attributes.

CIS15-Roster

Student-ID	F-Name	L-Name
145-67-6754	John	Brown
232-56-5690	George	Yellow
345-89-6580	Anne	Green
459-98-6789	Ted	Purple

CIS52-Roster

Student-ID	F-Name	L-Name
342-88-9999	Rich	White
145-67-6754	John	Brown
232-56-5690	George	Yellow

Difference

Student-ID	F-Name	L-Name
345-89-6580	Anne	Green
459-98-6789	Ted	Purple

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SQL (STRUCTURED QUERY LANGUAGE)

All operations among relational tables can be performed in SQL

- ☐ Standardized by **ANSI** and **ISO** for use on relational databases.
- ☐ It is a declarative (not procedural) language, which means that the users declare what they want without having to write a step-by-step procedure.
- ☐ First implemented by **Oracle** in **1979**.
- ☐ SQL allows you to **combine** the following statements to extract more complex information from database.

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TOOLS FOR QUERYING AND MANAGING DATA

Some common relational database management systems that use SQL are: Oracle, Sybase, Microsoft SQL Server, Access, Ingres, etc. Although most database systems use SQL, most of them also have their own additional proprietary extensions that are usually only used on their system.

Commonly data science programming languages such as Python and R have facilities to run SQL (at least use the common SQL clauses) to query and manage data.

We will use SAS PROC SQL to query relational tables and define analytic data sets.

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