INTRODUCTION TO DATABASE SYSTEMS
IS211

Dr. Noha Nagy

Lecture 2
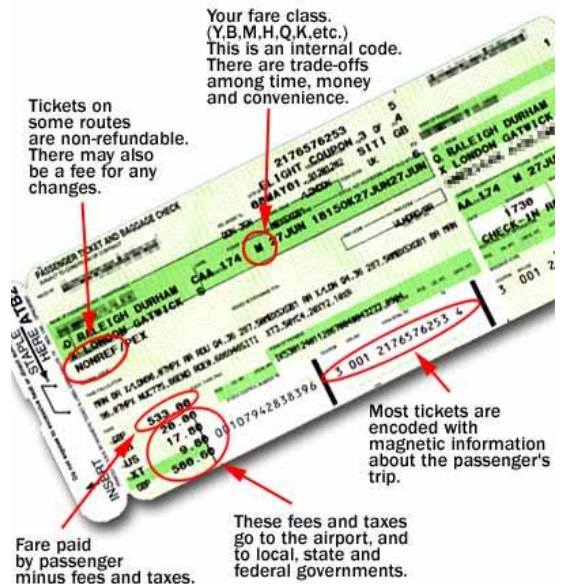
Relational Model

Databases Everywhere

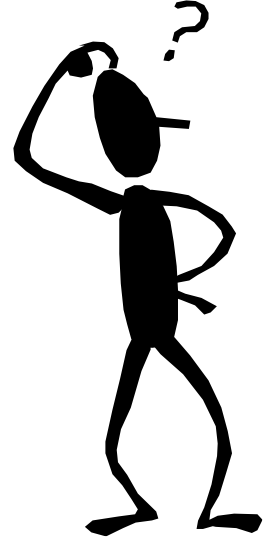# Definitions

- **Database**:
  - Collection of related data.
  - A database contains a model of something!

- **A Database Management System (DBMS):** is a software system designed to store, manage and facilitate access to the database

- **Database/Application Program**: A computer program that interacts with the database through the DBMS

Components of a Database System

Users — Database Application — Database management system (DBMS) — Database
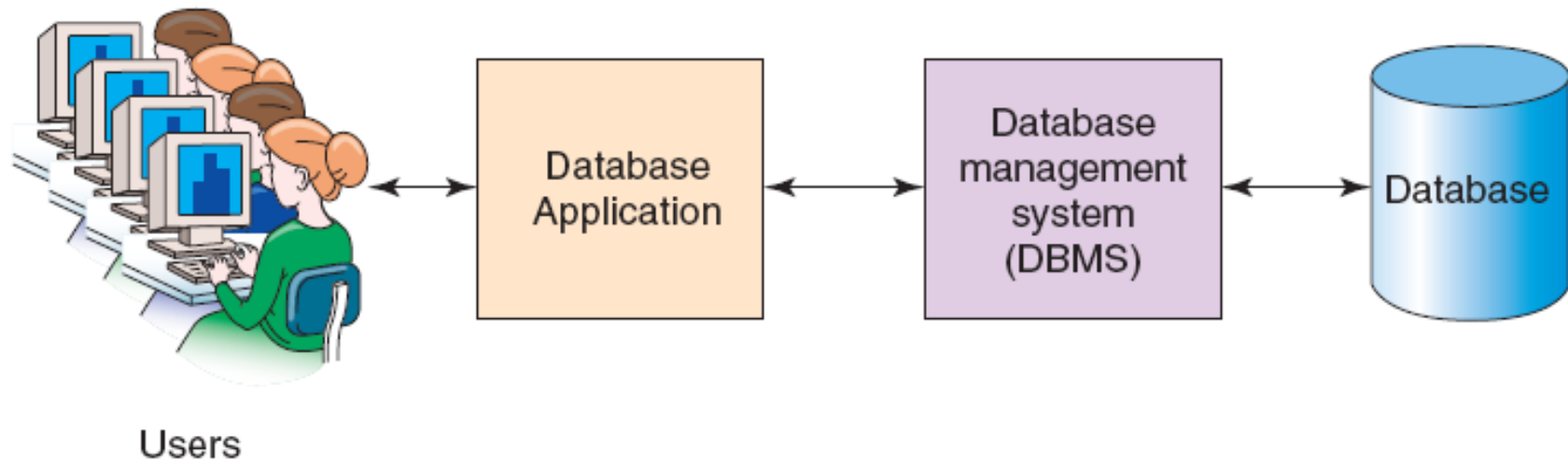
Example

Welcome to University System

Register   Close

Student Registration

ID

Name

Mobile

Address

City

DOB

Submit   Reset

Application

Student Registration

ID	20110021
Name	Mohsan
Mobile	01110054487
Address	55 Mohandseen
City	Giza
DOB	22-2-2002

Submit   Reset

DBMS

DB

ID	Name	Mobile	Address	City	DOB
20110021	Mohsan	01110054487	55 Mohandseen	Giza	22-2-2002

Student Registration

Field	Value
ID	20110032
Name	Ahmed
Mobile	01110056577
Address	5 s1 October
City	Giza
DOB	2-9-2002

Submit   Reset

DBMS

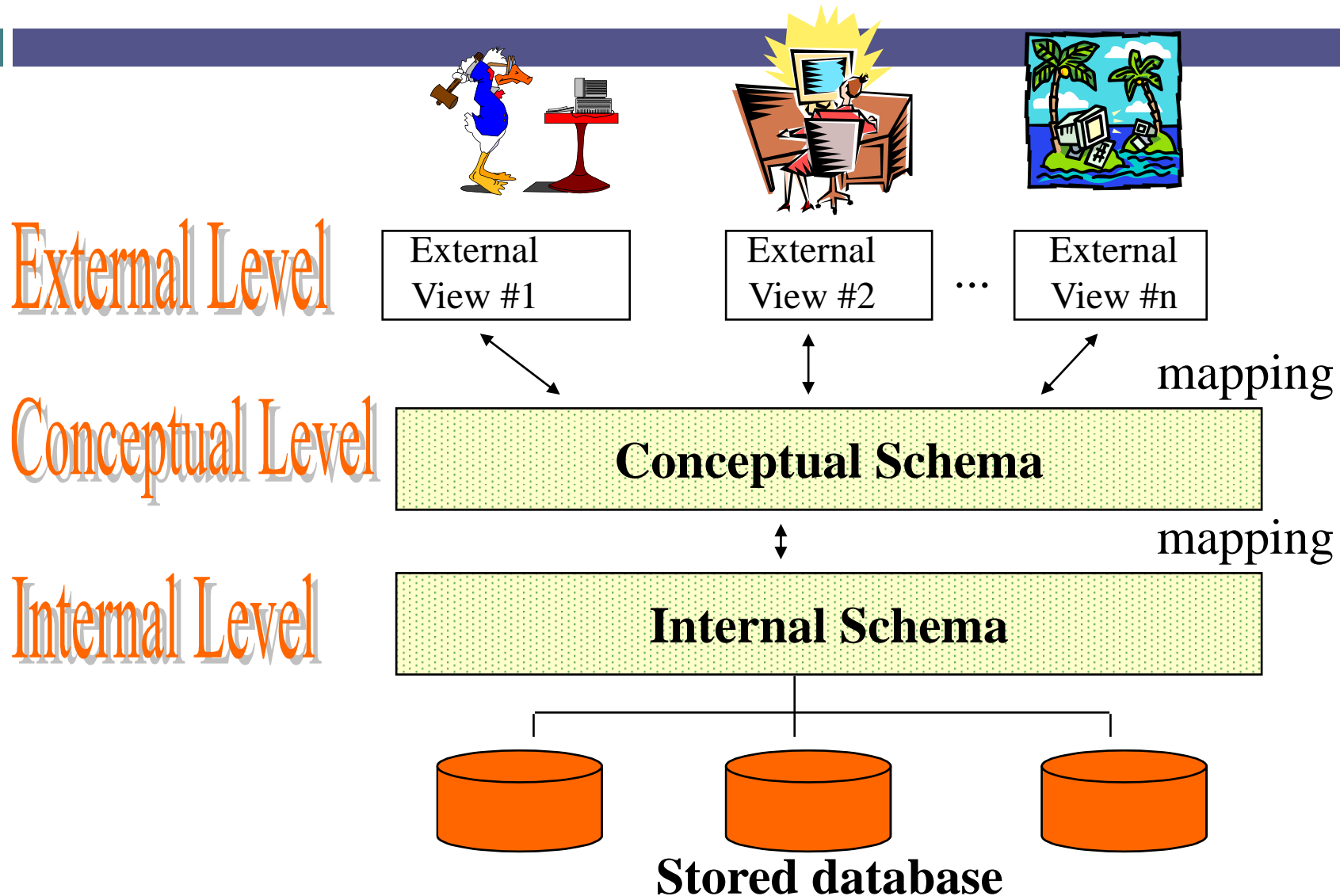| ID	Name	Mobile	Address	City	DOB
20110021	Mohsan	01110054487	55 Mohandseen	Giza	22-2-2002
20110032	Ahmed	01110056577	5 s1 October	Giza	2-9-2002

Data Independence

- Does data have to be part of programs?
- Do we need to change one if the other changes?
- Three-tier architecture of databases

Three-Schema Architecture

External Level

External View #1	External View #2	...	External View #n

mapping

Conceptual Level

Conceptual Schema

mapping

Internal Level

Internal Schema

Stored database

Levels of Abstraction

□ **Views**

 define how users see the data

(use of data)
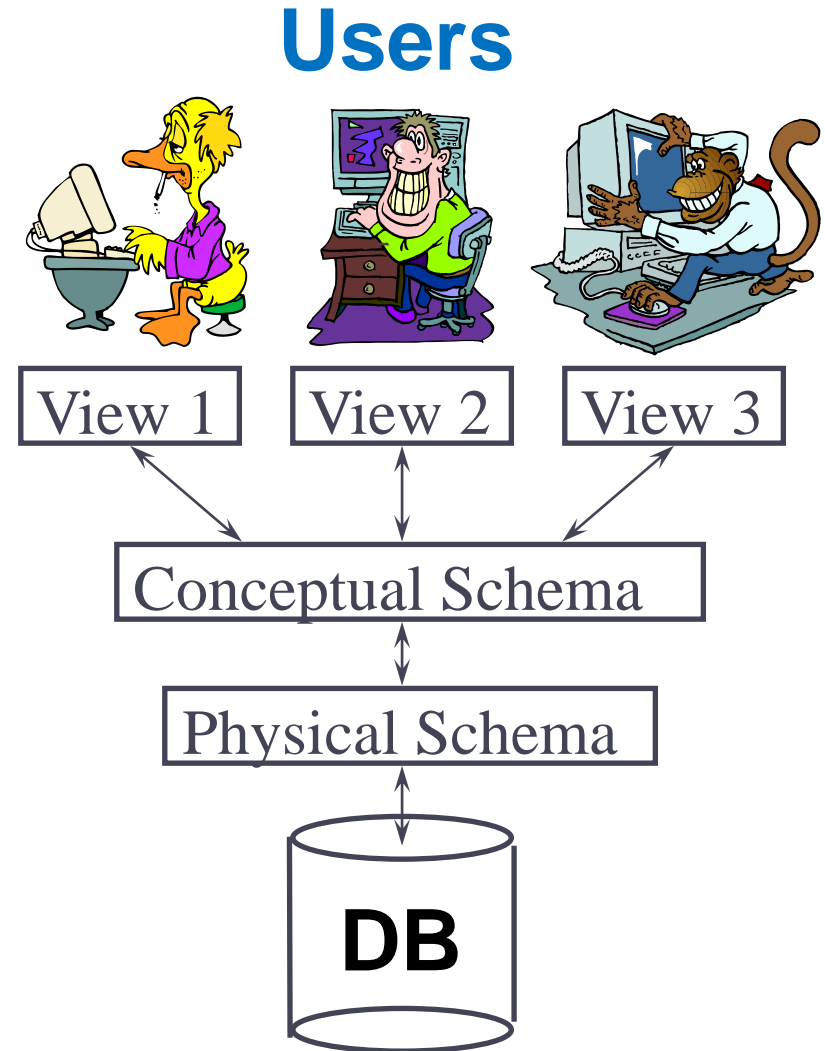
□ **Conceptual schema**

defines logical structure

(meaning of data)

□ **Physical schema**

describes the files and indexes used.

(storage of data)

Users

Three-Schema Architecture

- **Defines DBMS schemas at *three* levels:**
  - **Internal schema** is used to describe physical storage structures and access paths (e.g indexes).
    - Typically uses a physical data model.
  - **Conceptual schema** is used to describe the structure and constraints for the whole database for a community of users.
  - **External schemas** is used to describe the various user views.

Data Models

A Map is a Model of Reality

Data Models

☐ A collection of tools for describing
  ▪ data
  ▪ data relationships
  ▪ data constraints

☐ Models:

  ▪ Relational Model

  ▪ object-oriented model
  ▪ semi-structured data models
  ▪ Older models: network model and hierarchical model

History of Relational Model

- Introduced by Ted Codd in 1970 in a classic paper
- Ted Codd was an IBM Researcher
- Many database concepts & products based on this model

Relational Model

Relations

- A relational database is a set of **relations**
- Relations are basically tables of data
- Each row represents a record in the relation
- Each relation has a unique name in the database
- Each row in the table specifies a relationship between the values in that row

acct_id	branch_name	balance
A-301	New York	350
A-307	Seattle	275
A-318	Los Angeles	550
…	…	…

The *account* relation

- Example :

The account ID "A-307", branch name "Seattle", and balance "275" are all related to each other

Relation in RDB

Student

Attribute

Table Heading

SID	Name	City	Phone
012520	Rana	Cairo	01225928765
875466	Nawal	Giza	01228796457
897555	Omar	Cairo	01110097564
987458	Ali	Cairo	01110968874

Relation Degree

Relation Cardinality

Definition Summary

Informal Terms		Formal Terms
Table		Relation
Column Header		Attribute
All possible Column Values		Domain
Row		Tuple
Table Definition		Schema of a Relation
Populated Table		State of the Relation

Relation Example
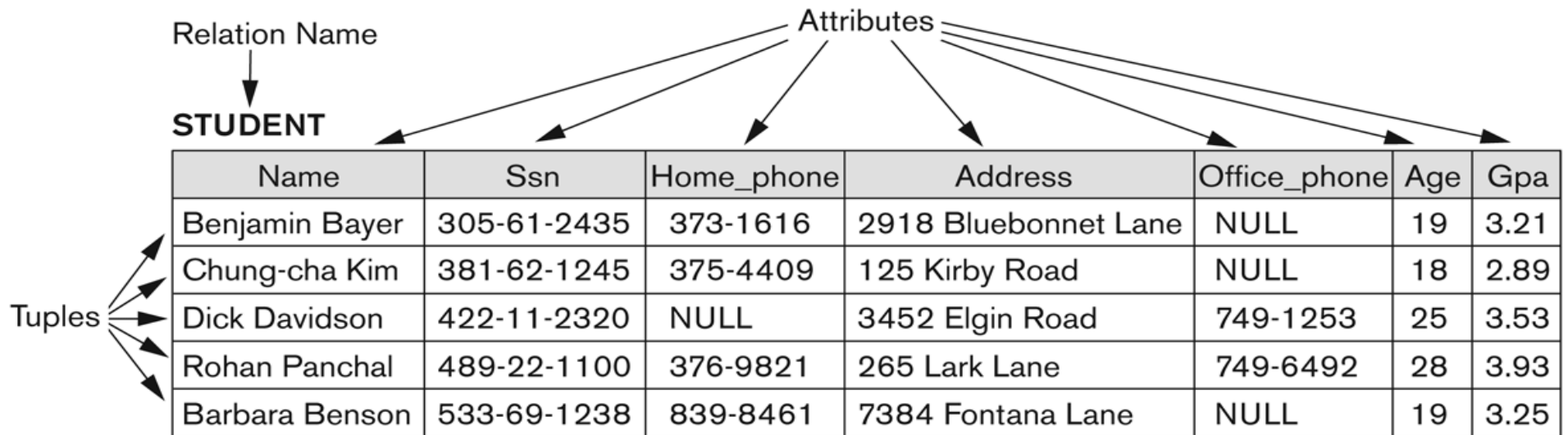
The attributes and tuples of a relation STUDENT.

Degree =7
Cardinality=5

Relations and Attributes

- Each relation has some number of attributes   Sometimes called "columns"

- Each attribute has a domain Specifies the set of valid values for the attribute

acct_id	branch_name	balance
A-301	New York	350
A-307	Seattle	275
A-318	Los Angeles	550
…	…	…

The *account* relation

- The *account* relation:

  - 3 attributes
  - Domain of *balance* is the set of nonnegative integers
  - Domain of *branch_name* is the set of all valid branch names in the bank

DOMAINS

- A domain D is a set (pool) of values, from which one or more attributes takes their values.

- Example

CITY = {London, Paris, Doha, Cairo, Athens, Rome, Dobai, Madrid}

CITY is a pool of cities from which The attributes Supplier.City, Customer.City take their own values.

DATE = (DAY, MONTH, YEAR)

Where:

DAY = {1..31}, MONTH = {1..12}, YEAR = {1990..2100}

CITY is a simple domain, but DATE is a **composite** Domain

Tuples and Attributes

☐ Each row is called a tuple

  ▪ A fixed-size, ordered set of name-value pairs

☐ Each attribute in the tuple has a unique name

acct_id	branch_name	balance
A-301	New York	350
A-307	Seattle	275
A-318	Los Angeles	550
…	…	…

The *account* relation

Tuples and Relations

- A relation is a set of tuples
- Each tuple appears **exactly once**
- The order of tuples in a relation is not relevant

Instructor

ID	name	dept_name	salary
22222	Einstein	Physics	95000
12121	Wu	Finance	90000
32343	El Said	History	60000
45565	Katz	Comp. Sci.	75000
98345	Kim	Elec. Eng.	80000
76766	Crick	Biology	72000
10101	Srinivasan	Comp. Sci.	65000
58583	Califieri	History	62000
83821	Brandt	Comp. Sci.	92000
15151	Mozart	Music	40000
33456	Gold	Physics	87000
76543	Singh	Finance	80000

Schema VS Instance

- ☐ the name of the relation and the set of attributes is called the **schema**

- ☐ the current values contained in the relation represent an **instance**

Relation Schemas

- ☐ Every relation has a schema
- ☐ A relation schema includes:
  - ◻ an ordered set of attributes
  - ◻ the domain of each attribute

acct_id	branch_name	balance
A-301	New York	350
A-307	Seattle	275
A-318	Los Angeles	550
…	…	…

The *account* relation

- ☐ The relation schema of *account* is:

Account_schema = (*acct_id, branch_name, balance*)

- ☐ Database schema is a collection of relation schemas

COMPANY Database Schema

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

DEPT_LOCATIONS

Dnumber	Dlocation

PROJECT

Pname	Pnumber	Plocation	Dnum

WORKS_ON

Essn	Pno	Hours

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship

Schema diagram for the COMPANY relational database schema.