



1

Introduction to Databases



Prerequisites for This Section

Readings:

- **Required:** Connolly and Begg, Sections 1.1, 1.3, 2.1, 10.4 and Appendix A
- **Suggested:** Connolly and Begg, Section 1.2.
- **Elective:** Connolly and Begg, Section 1.5.

Assessments:

- Multiple-Choice Quiz 1



Section Objectives

In this section you will learn:

- ① Some common uses of database systems
- ② The characteristics and problems of file-based systems
- ③ The meaning of the term 'database' (DB), 'database management system' (DBMS), and 'database system' (DBS)
- ④ The typical functions of a DBMS
- ⑤ The three-level architecture of DB
- ⑥ The characteristics of DBS
- ⑦ The major components of the DBS
- ⑧ The advantages and disadvantages of DBMS



Agenda

1. Examples of Database Applications
2. File-based System
3. Database Approach
4. History of Database Systems
5. Database Users
6. Advantages and Disadvantages of DBMS



Examples of Database Applications

Example 1: Studying at university

If you are at university, there will be a database system containing information about yourself, the course you are enrolled in, details about your grant, the courses you have taken in previous years or are taking this year, and details of all your examination results.

There may also be a database containing details relating to the next year's admissions and a database containing details of the faculty who work at the university.



Examples of Database Applications

Example 2: Using the local library

Your local library probably has a database containing details of the books in the library, details of the readers, reservations, and so on.

There will be a computerized index that allows readers to find a book based on its title, or its authors, or its subject area.

The database system handles reservations to allow a reader to reserve a book and to be informed by mail when the book is available.

The system also sends reminders to borrowers who have failed to return books by the due date.

Typically, the system will have a bar code reader, which is used to keep track of books coming in and going out of the library.



Examples of Database Applications

Example 3: Purchases from the supermarket

When you purchase goods from your local supermarket, it is likely that a database is accessed.

The checkout assistant uses a bar code reader to scan each of your purchases. This is linked to an application program that uses the bar code to find out the price of the item from a product database.

The program then reduce the number of such items in stock and displays the price on the cash register. If the recorder level falls below a specified threshold, the database system may automatically place an order to obtain more stocks of that item.

If a customer telephones the supermarket, an assistant can check whether an item is in stock by running an application program that determines availability from the database.



The Historical Roots of the Database

- ✿ The historical roots of the database: file and file system
- ✿ Basic file terminology
 - ❏ **Data:** "Raw" facts that have little meaning unless they have been organized in some logical manner.
 - ❏ **Field:** A character or a group of characters (alphabetic or numeric) that has a specific meaning.
 - ❏ **Record:** A logically connected set of one or more fields that describes a person, place, or thing.
 - ❏ **File:** A collection of related records



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File-based Systems

- ❖ Collection of application programs that perform services (e.g. reports) for the end users.
- ❖ Each program defines and manages its own data. (see following slide)



File-based Processing

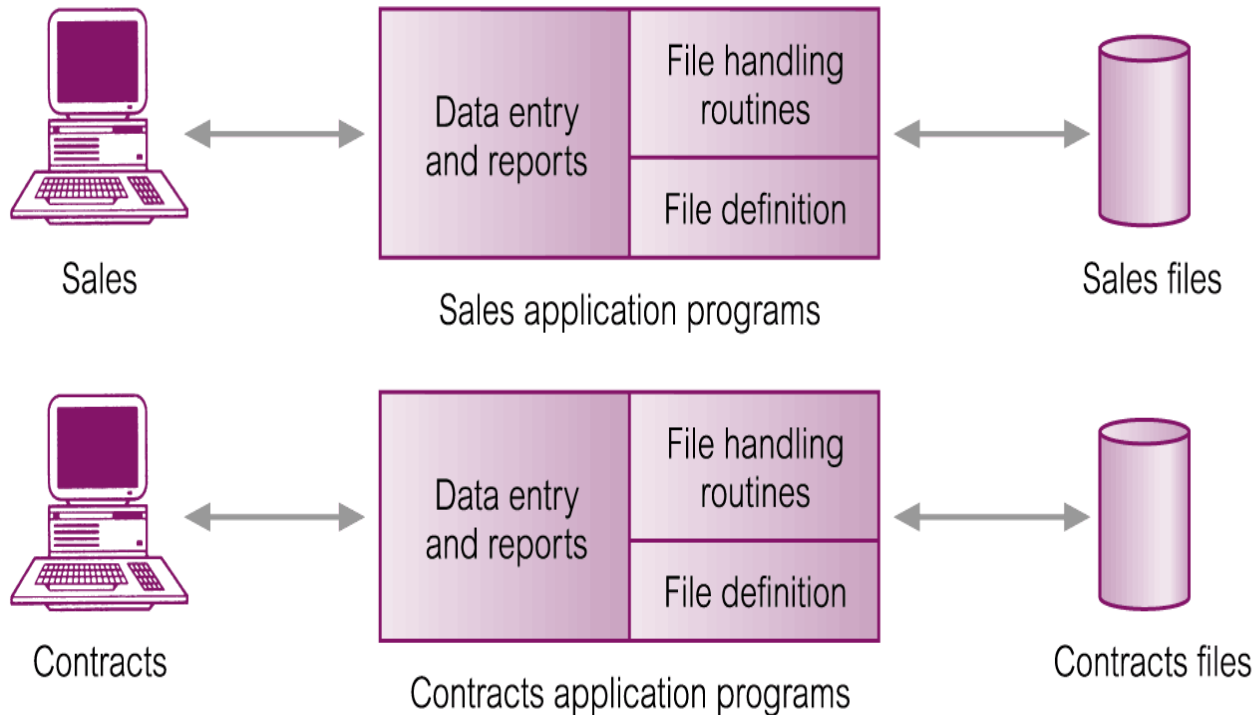


Figure 1.5

File-based processing.

Sales Files

PropertyForRent (propertyNo, street, city, postcode, type, rooms, rent, ownerNo)

PrivateOwner (ownerNo, fName, lName, address, telNo)

Client (clientNo, fName, lName, address, telNo, prefType, maxRent)

Contracts Files

Lease (leaseNo, propertyNo, clientNo, rent, paymentMethod, deposit, paid, rentStart, rentFinish, duration)

PropertyForRent (propertyNo, street, city, postcode, rent)

Client (clientNo, fName, lName, address, telNo)



Limitations of the File-based Approach

① Separation and isolation of data

- ❖ Each program maintains its own set of data.
- ❖ Users of one program may be unaware of potentially useful data held by other programs.

② Duplication of data

- ❖ Same data is held by different programs.
- ❖ Wasted space and potentially different values and/or different formats for the same item.



Limitations of the File-based Approach

③ Data dependence

- ❏ File structure is defined in the program code.

④ Incompatible file formats

- ❏ Programs are written in different languages, and so cannot easily access each other's files.

⑤ Fixed Queries/Proliferation of application programs

- ❏ Programs are written to satisfy particular functions.
- ❏ Any new requirement needs a new program.



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Database Approach

✿ Arose because:

- ① Definition of data was embedded in application programs, rather than being stored separately and independently.
- ② No control over access and manipulation of data beyond that imposed by application programs.

✿ Result:

- ① The Database (DB)
- ② Database Management System (DBMS).



Database

Database (DB)

Shared collection of logically related data, and a description of this data, designed to meet the information needs of an organization.

① **Logically related data**

comprises entities, attributes, and relationships of an organization's information.

② **System catalog (metadata)**

provides description of data to enable program–data independence.



Database Management System

✚ Database Management System (DBMS)

A software system that enables users to define, create, maintain, and control access to the database.

✚ DBMS Products

- ✚ ORACLE
- ✚ IBM DB2 UDB
- ✚ MICROSOFT SQL SERVER
- ✚ MYSQL
- ✚ POSTGRESQL
- ✚ ...



The Functions of DBMS

- ① Data Definition Language (DDL)
- ② Data Manipulation Language (DML)
- ③ Controlled access to the database
 - I. a security system
 - II. an integrity system
 - III. a concurrency control system
 - IV. a recovery control system
 - V. a user-accessible catalog



Database Application Program

✚ **(Database) Application Program (AP):**

A computer program that interacts with database by issuing an appropriate request (SQL statement) to the DBMS.



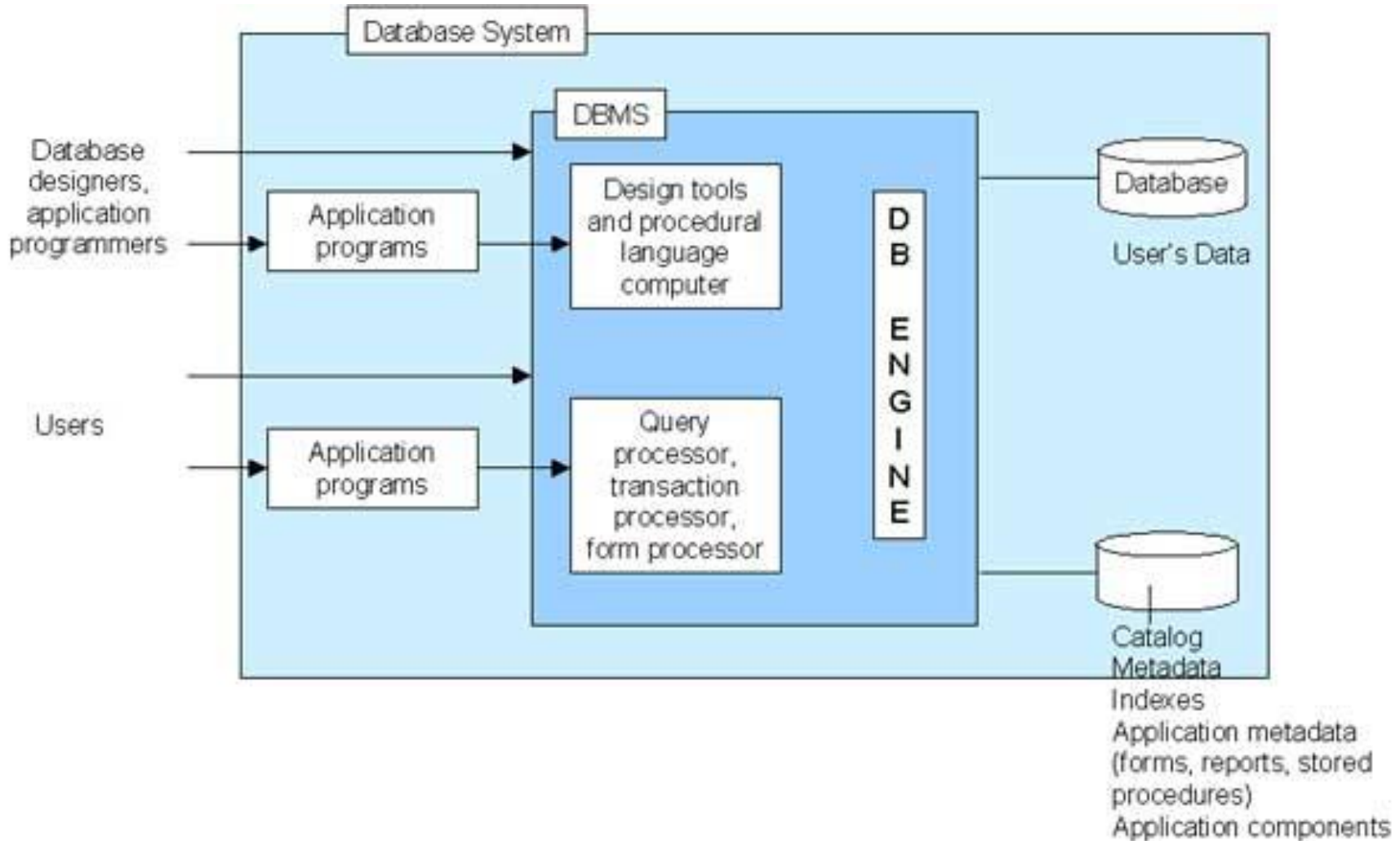
Database System

④ **A Database System (DBS) consists of :**

- ① **DB:** an application specific database
- ② **DBMS:** a software system that enables users to define, create, maintain, and control access to the database
- ③ **AP:** the application software that manipulates the database.

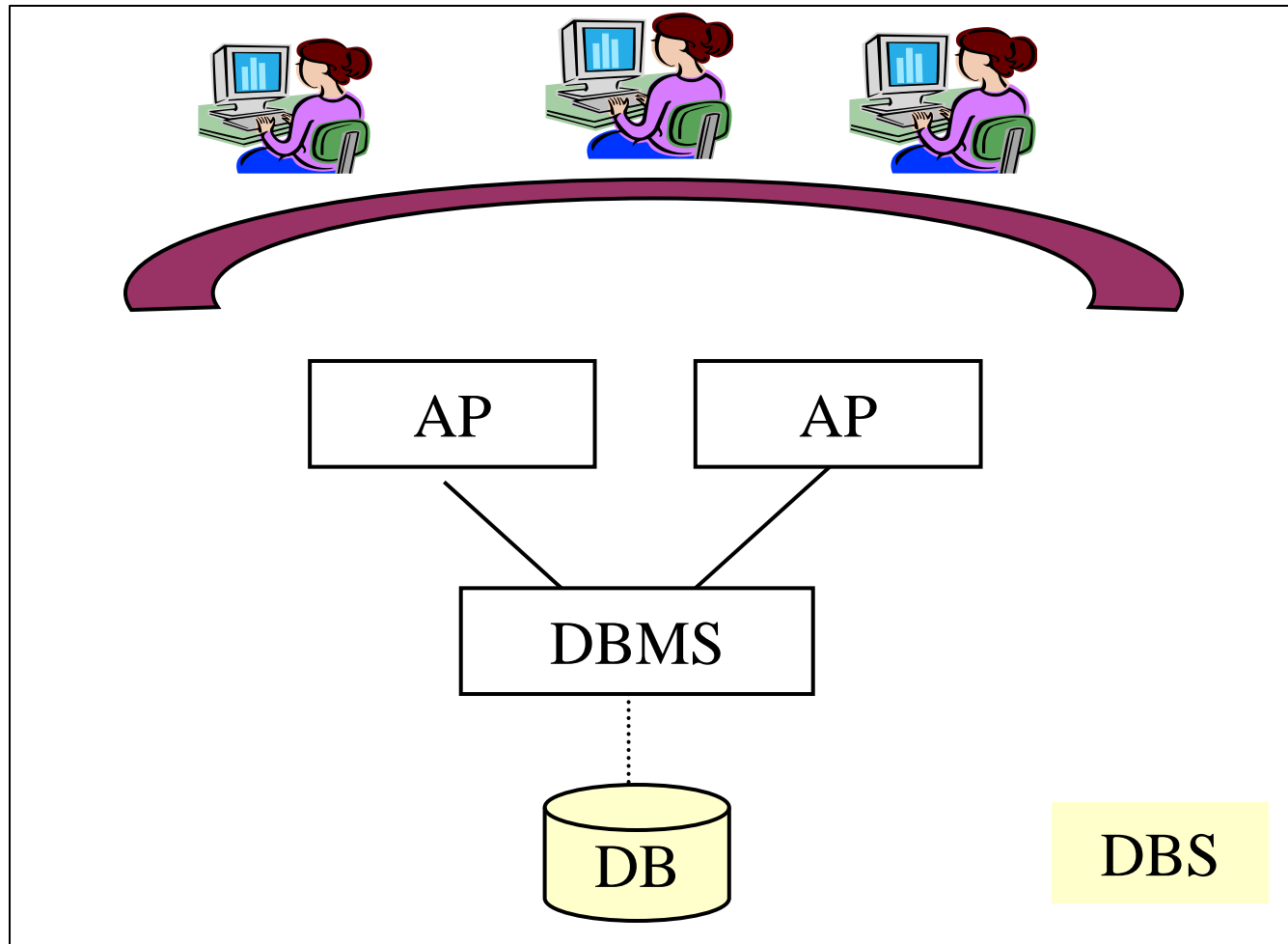


The Architecture of Database System



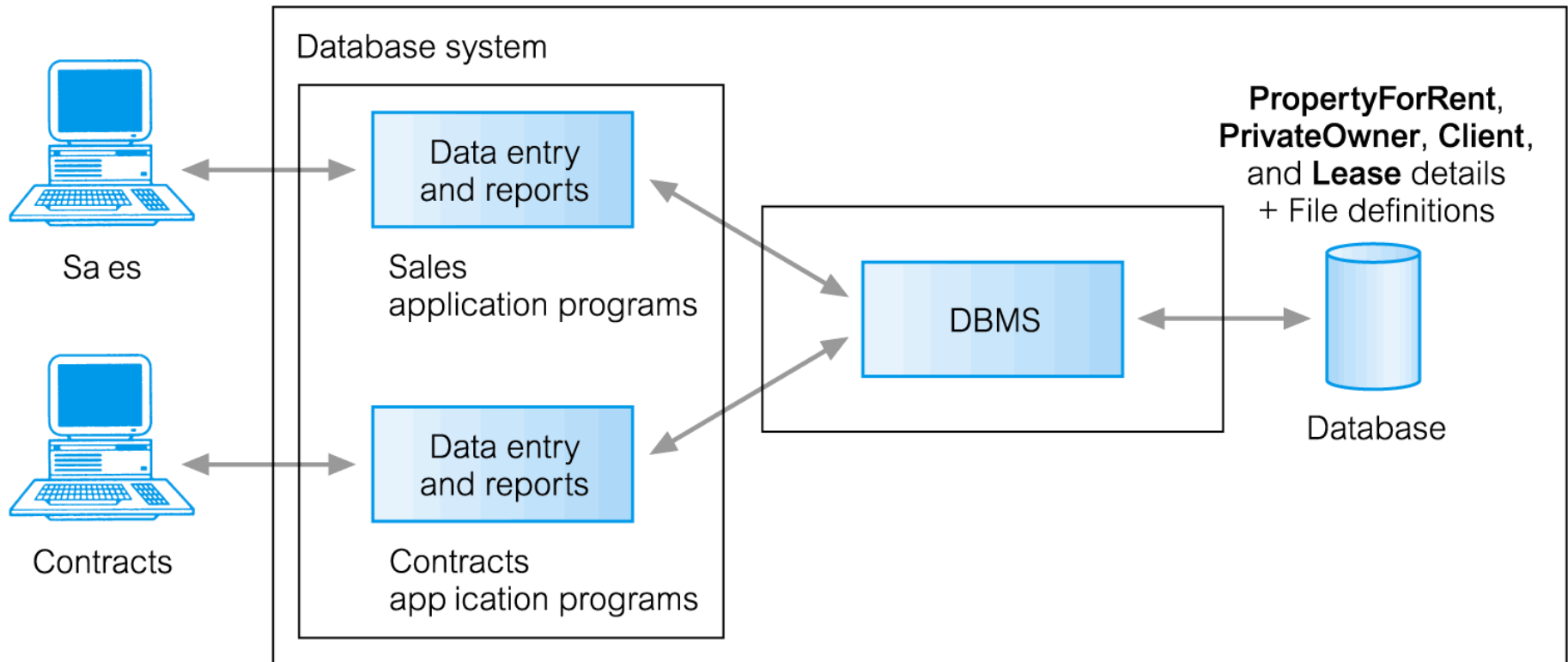


The Architecture of Database System





An Example of Database System



PropertyForRent (propertyNo, street, city, postcode, type, rooms, rent, ownerNo)

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Client (clientNo, fName, lName, address, telNo, prefType, maxRent)

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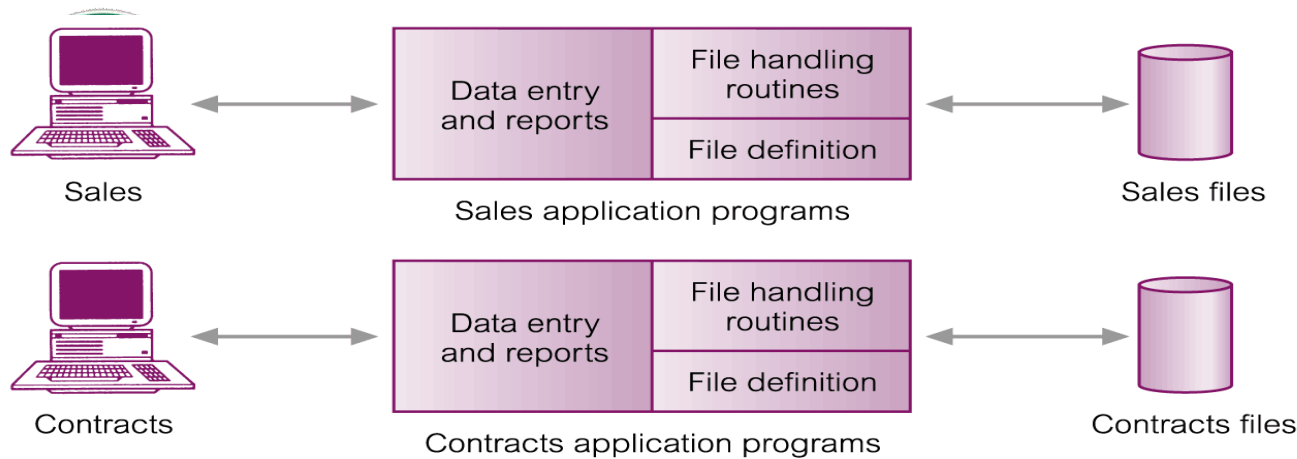


Figure 1.5
File-based
processing.

Sales Files

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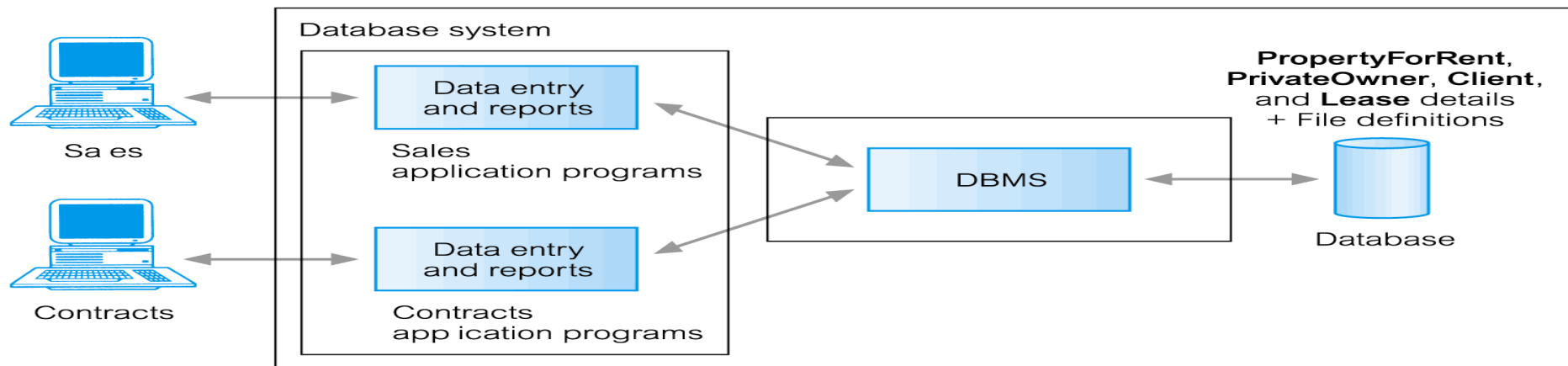
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Characteristics of Database System



Three characteristics

① Data abstraction

Any representation of data in which the implementation details are hidden (abstracted).

② Efficiency

The use of resources so as to maximize the production of goods and services

③ Reliability

The ability of a system to perform and maintain its functions in routine circumstances, as well as hostile or unexpected circumstances



Characteristics of Database System

① Data abstraction

❖ Three aspects

- I. Structured data
- II. Program-data independence
- III. Program-operation independence

❖ Methods

- I. System catalog
- II. Three-level architecture
- III. Relational algebra



Characteristics of Database System

① Data abstraction

I. Structured data

students

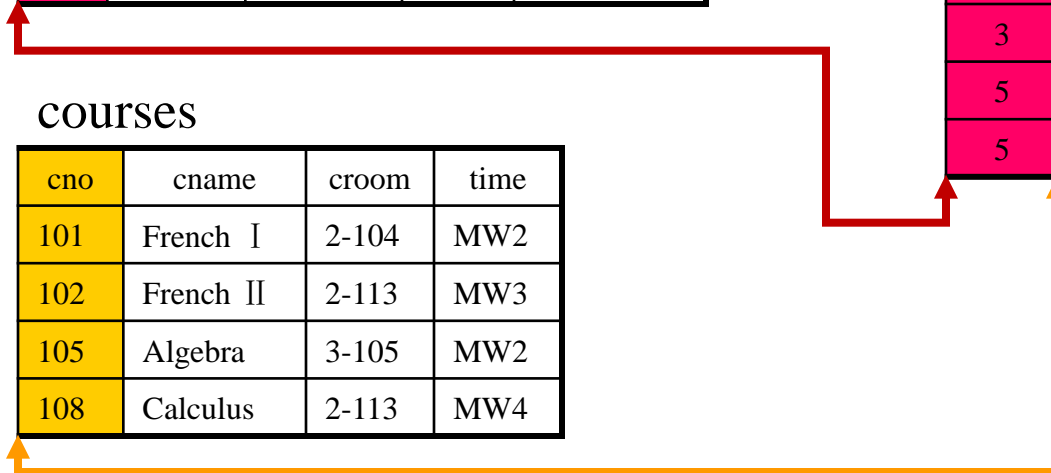
sid	fname	lname	class	telephone
1	Jones	Allan	2	555-1234
2	Smith	John	3	555-4321
3	Brown	Harry	2	555-1122
5	White	Edward	3	555-3344

enrollment

sid	cno	major
1	101	No
1	108	Yes
2	105	No
3	101	Yes
3	108	No
5	102	No
5	105	No

courses

cno	cname	croom	time
101	French I	2-104	MW2
102	French II	2-113	MW3
105	Algebra	3-105	MW2
108	Calculus	2-113	MW4





Characteristics of Database System

① Data abstraction

II. Program-data independence

- Logical data independence

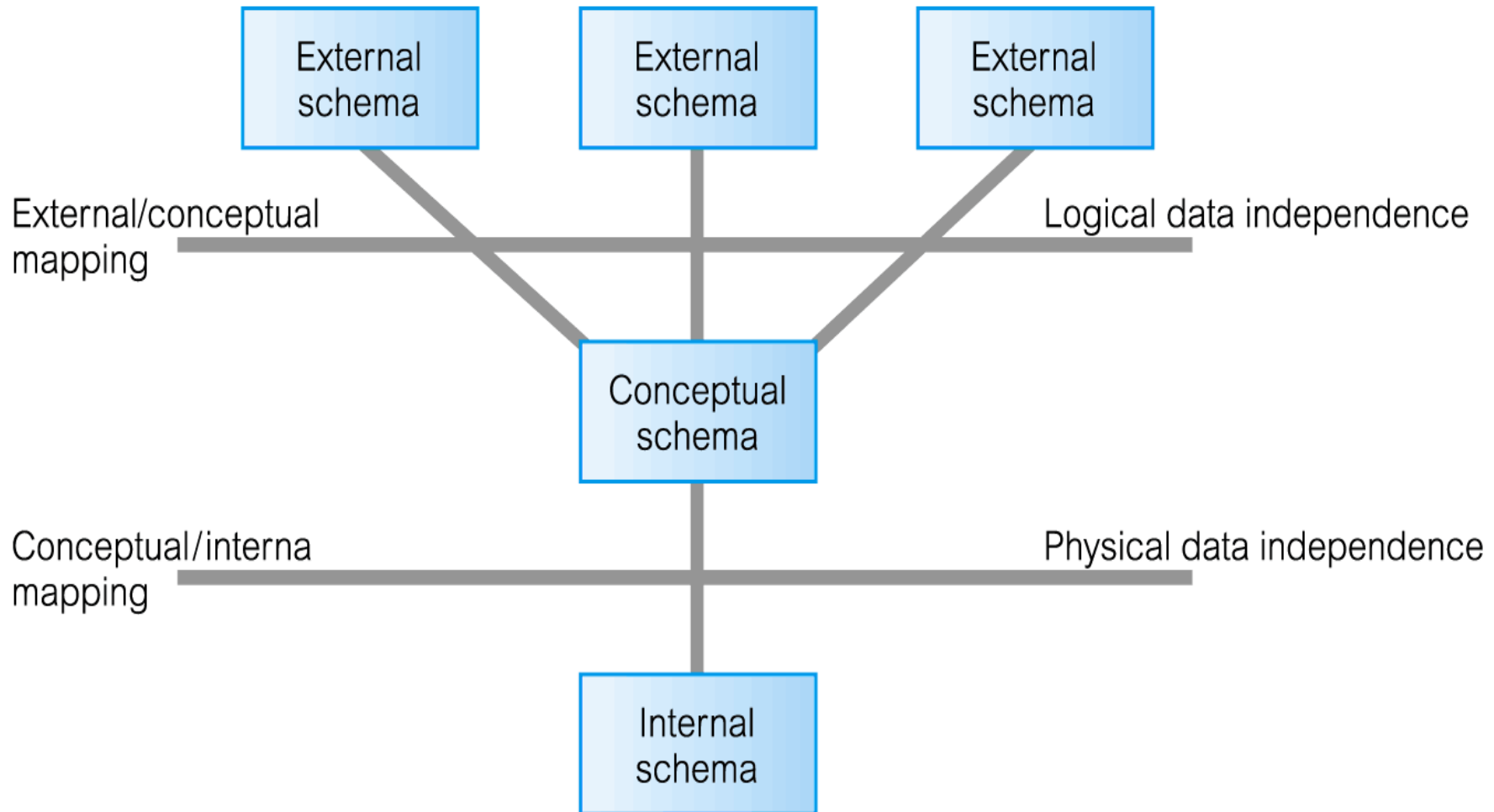
Refers to the immunity of the external schemas to changes in the conceptual schema

- Physical data independence

Refers to the immunity of the conceptual schemas to changes in the internal schema



Three-Level Architecture





Three-Level Architecture

- ✿ External schema
 - ✦ Users' view of the database.
 - ✦ Describes that part of database that is relevant to a particular user.
- ✿ Conceptual schema
 - ✦ Community view of the database.
 - ✦ Describes what data is stored in database and relationships among the data.
- ✿ Internal schema
 - ✦ Physical representation of the database on the computer.
 - ✦ Describes how the data is stored in the database.



An Example of Three Levels of Architecture

External view 1

sNo	fName	lName	age	salary
-----	-------	-------	-----	--------

External view 2

staffNo	lName	branchNo
---------	-------	----------

Conceptual level

staffNo	fName	lName	DOB	salary	branchNo
---------	-------	-------	-----	--------	----------

Internal level

```
struct STAFF {  
    int staffNo;  
    int branchNo;  
    char fName [15];  
    char lName [15];  
    struct date dateOf Birth;  
    float salary;  
    struct STAFF *next;  
};  
index staffNo; index branchNo;
```

/* pointer to next Staff record */
/* define indexes for staff */



Characteristics of Database System

① Data abstraction

III. Program-operation independence

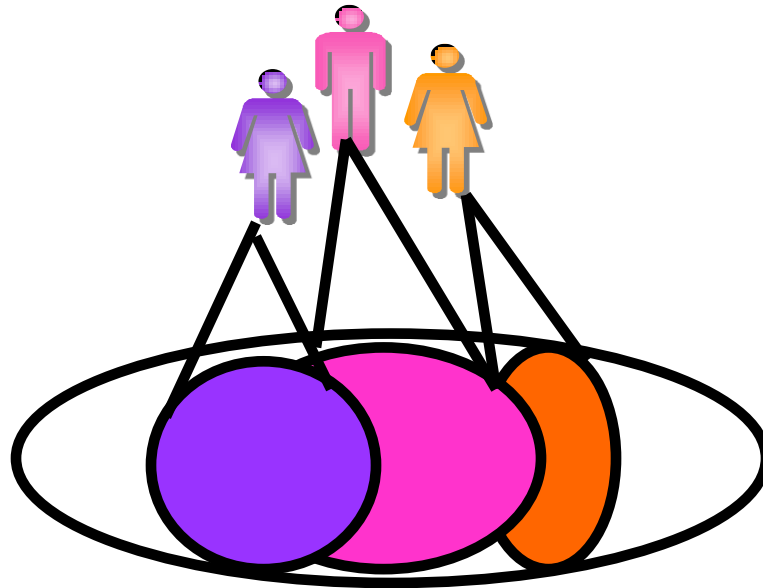
The implementation of abstract operations can be changed without affecting the code of the application programs



Characteristics of Database System

② Efficiency

- ❏ Efficiency = efficient space utilization + efficient access to data
- ❏ Method: Shared data





Characteristics of Database System

③ Reliability

❏ Method:

DBMSs provide high reliability by

- I. Enforcing *integrity constraints*
- II. Ensuring *data consistency* despite hardware or software failures.



Components of the Database System

① **Hardware**

Can range from a PC to a network of computers.

② **Software**

DBMS, operating system, network software (if necessary) and also the application programs.

③ **Data**

Used by the organization and a description of this data called the schema.

④ **Procedures**

Instructions and rules that should be applied to the design and use of the database and DBMS.

⑤ **People**



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History of Database Systems

① First-generation

❏ Hierarchical and Network

Data is represented as collections of records, and relationships are represented by sets.

② Second-generation

❏ Relational

Data and relationships are represented as tables

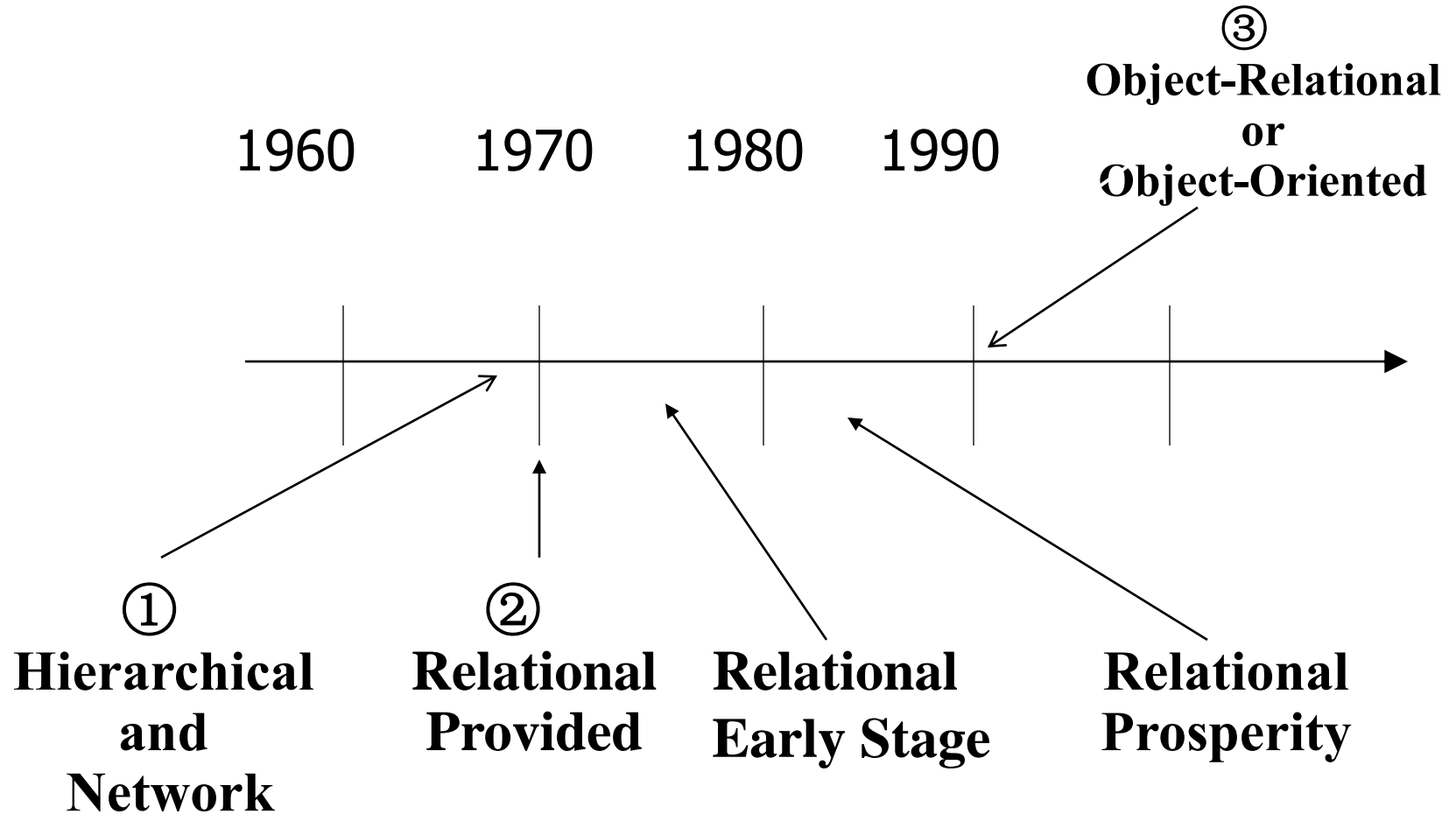
③ Third-generation

❏ Object-Relational or Object-Oriented

Provide a relational database management that allows developers to integrate databases with their data types and methods. It is essentially a relational model that allows users to integrate object-oriented features into it.



History of Database Systems





Commercial DBMS in the Market

- ① ORACLE
- ② SYBASE
- ③ UDB DB2
- ④ INGRES
- ⑤ Informix
- ⑥ SQL Server
- ⑦ Foxpro
- ⑧ ...



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Database Users

- ① Data Administrator (DA)
- ② Database Administrator (DBA)
- ③ Database Designers (Logical and Physical)
- ④ Application Programmers
- ⑤ End Users
 - ❖ Naive user
 - ❖ Sophisticated user



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Advantages of DBMSs

- ① Control of data redundancy
- ② Data consistency
- ③ More information from the same amount of data
- ④ Sharing of data
- ⑤ Improved data integrity
- ⑥ Improved security
- ⑦ Enforcement of standards
- ⑧ Improved data accessibility and responsiveness
- ⑨ Improved maintenance through data independence
- ⑩ Increased concurrency
- (11) Improved backup and recovery services



Disadvantages of DBMSs

- ① Complexity
- ② Size
- ③ Cost of DBMS
- ④ Additional hardware costs
- ⑤ Cost of conversion
- ⑥ Performance
- ⑦ Higher impact of a failure



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Questions?





Assignments

❊ **Multiple-Choice Quiz 1**

❊ **Exercise1 : part I**



Prerequisites for Next Section

✚ Readings:

- ✚ **Required:** Connolly and Begg, sections 3.1, 3.2, and 3.3.

✚ Assessments:

- ✚ Multiple-Choice Quiz 2