Welcome to
“Advanced Database Systems- 050007071”

Dr. Dang Tran Khanh
Dept. of Information Systems
Faculty of Computer Science & Engineering

Lecturer

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- Office hours: *Thursday, 2:00-4:00pm, must be confirmed by email in advance*

Module Contents

Topic	4 Credits		Ref.
	Lecture		
Intro, Conceptual DB Design: ER & EER Models	3		[1,4]
Logic DB Design – Relational Model	3		[1,4]
Advanced Indexing Techniques & Flexible Query Answering in DBs	6		[papers]
Conceptual DB Design: O-O Model	*6*		*[2]*
Query Processing & Optimization	*6*		*[3]*
O-O Databases	*6*		*[2]*
Temporal DBs	*3*		*[3]*
Advances in Transaction Processing	6		[1]
DB Security	3		[1,4, papers]
Emerging Research Directions in DBs & ISs *	3		[1-6, papers]

References

1. R. Elmasri, S.B. Navathe: "Fundamentals of Database Systems", 5th Edition, Pearson Addison-Wesley, 2007
2. F.R., McFadden, J.A., Hoffer, M.B., Prescott: "*Modern Database Management",* 6th Edition, Prentice-Hall, 2002
3. C.T., Yu, W., Meng: "*Principles of Database Query Processing for Advanced Applications"*, Morgan Kaufmann Publishers, 1998
4. *T. Connolly, C. Begg: "Database Systems – A Practical Approach to Design, Implementation, and Management", 4th Edition, Pearson Addison-Wesley, 2005*
5. N. Shah: "Database Systems Using Oracle", 2nd Edition, Pearson Prentice Hall, 2005
6. Microsoft SQL Server (2005, 2008)
7. www.oracle.com

Exams

- close-book-exams
- Midterm: 30%
  - 45’ written/test
  - Contents: until the exam
- Coursework: 20%
  - Khanh: group coursework (max 4 each group)
  - Talks: weeks 12-14
- Final: 50%
  - 90’: written/test
  - Contents: revised in the last lecture (week 15)

Teaching schedule (this semester)

Go here !

Revision Lecture:

Database System Concepts and Architecture

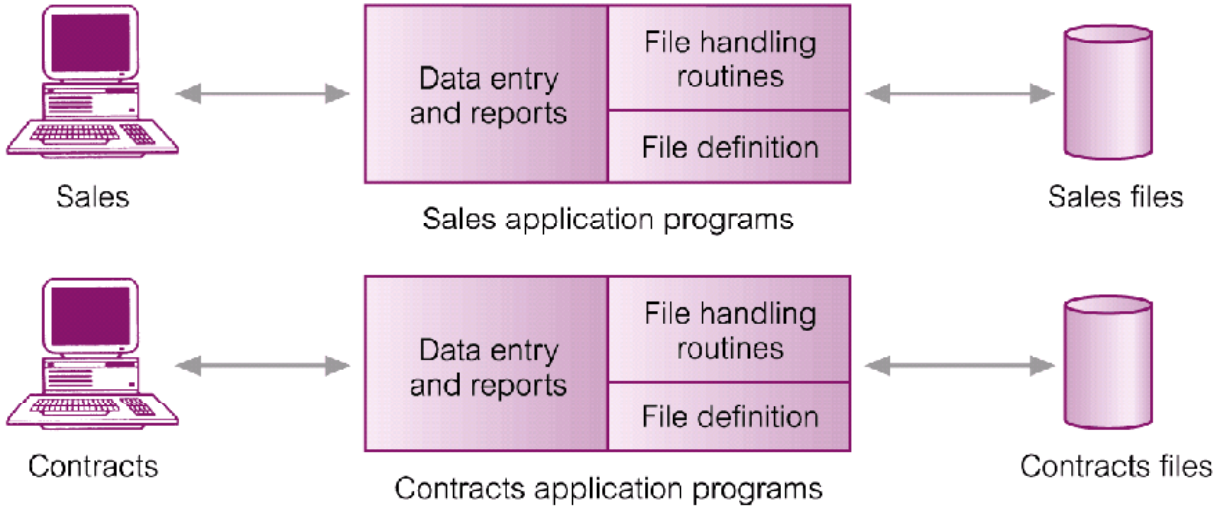
Outline

- File-based Approach
- Database Approach
  - Database Systems
  - Roles in the Database Environment
  - DBMSs
- Three-Schema Architecture and Data Independence
- Database Languages
- Data Models, Database Schema and Database State
- Data Management Systems Framework
  - Where are we?
  - Extending database capabilities for new applications
- Reading Suggestion:
  - [1,4]: chapters 1, 2

File-based Approach

- Data is stored in one or more separate computer files
- Data is then processed by computer programs - **applications**

File-based Approach



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)

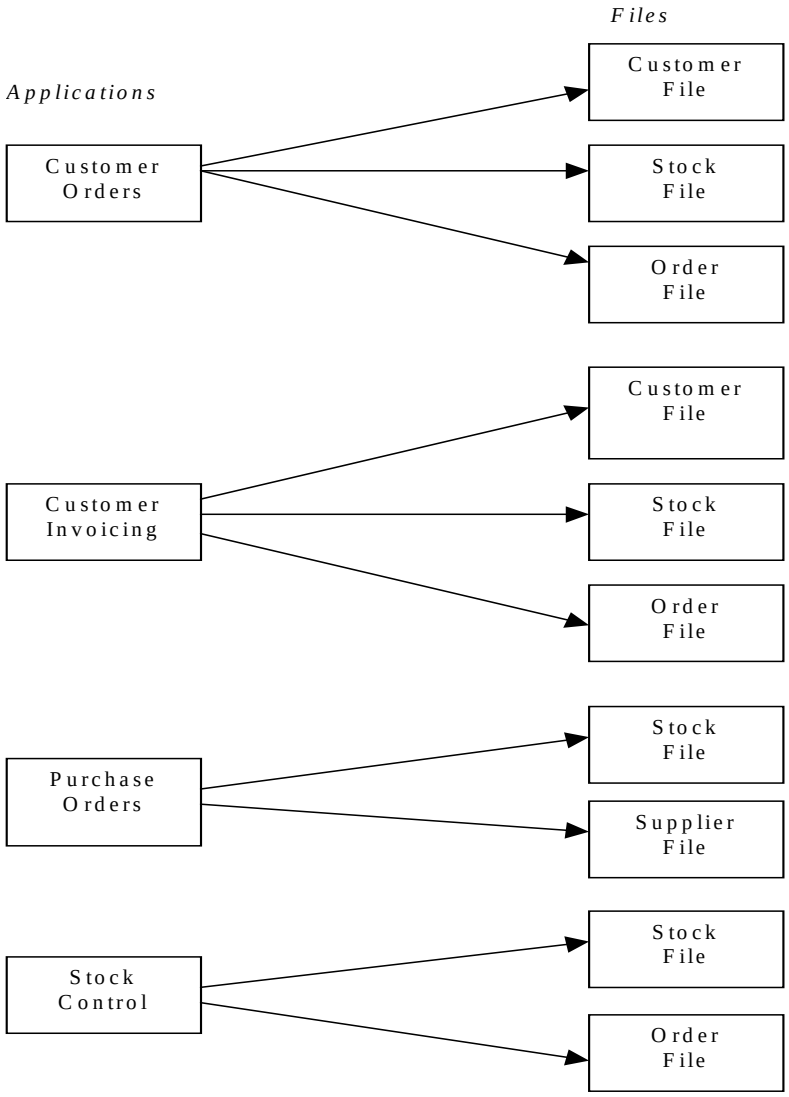
Contracts Files

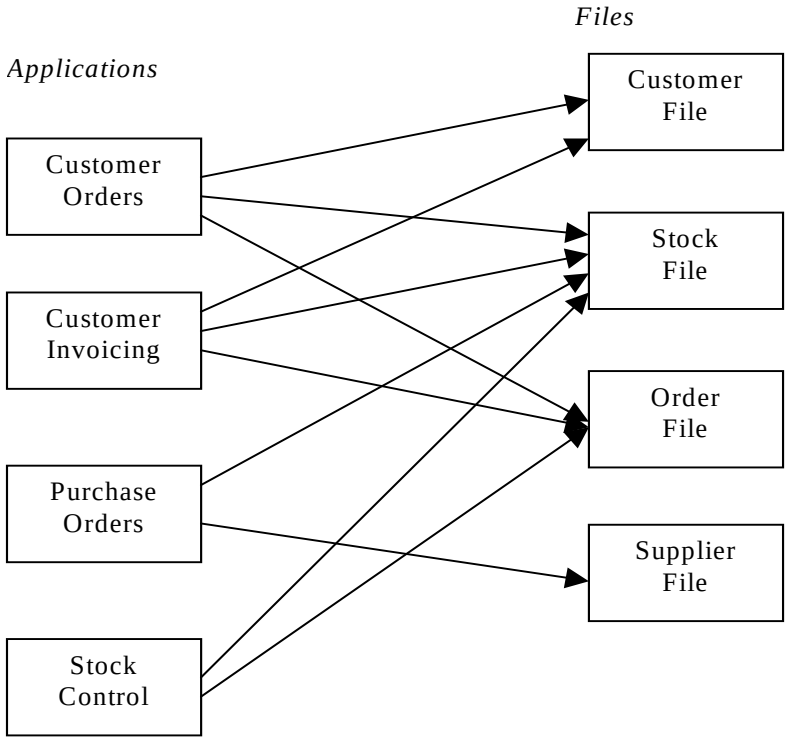
Lease (leaseNo, propertyNo, clientNo, rent, paymentMethod, deposit, paid, rentStart, rentFinish, duration)
PropertyForRent (propertyNo, street, city, postcode, rent)
Client (clientNo, fName, lName, address, telNo)

File-based Approach

- Problems/Limitations
  - Data Redundancy
  - Data Inconsistency
  - *More details: see [4]*

File-based approach





Shared file approach

File-based Approach

- Shared File Approach
  - Data (files) is shared between different applications
  - Data redundancy problem is alleviated
  - Data inconsistency problem across different versions of the same file is solved
  - Other problems:
    - Rigid data structure: If applications have to share files, the file structure that suits one application might not suit another
    - Physical data dependency: If the structure of the data file needs to be changed in some way, this alteration will need to be reflected in all application programs that use that data file
    - No support of concurrency control: While a data file is being processed by one application, the file will not be available for other applications or for ad hoc queries

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Database Approach

- Arose because:
  - Definition of data was embedded in application programs, rather than being stored separately and independently
  - No control over access and manipulation of data beyond that imposed by application programs
- Result:
  - The Database and Database Management System (DBMS).

Database Approach

- Data
  - Known facts that can be recorded and that have implicit meaning
  - Information? Knowledge?
  - More: *www.whatis.com* , wikipedia
- Database: Shared collection of logically related data and a description of this data, designed to meet the information needs of an organization

Database Approach

- System catalog (metadata) provides description of data to enable program–data independence
- Logically related data comprises entities, attributes, and relationships of an organization's information
- **D**ata**B**ase **M**anagement **S**ystem (**DBMS**): a general-purpose software system that facilitates the processes of defining, constructing, manipulating, and sharing databases among various users and applications (*or a software system that enables users to define, create, maintain, and control access to the database*)

Database Approach

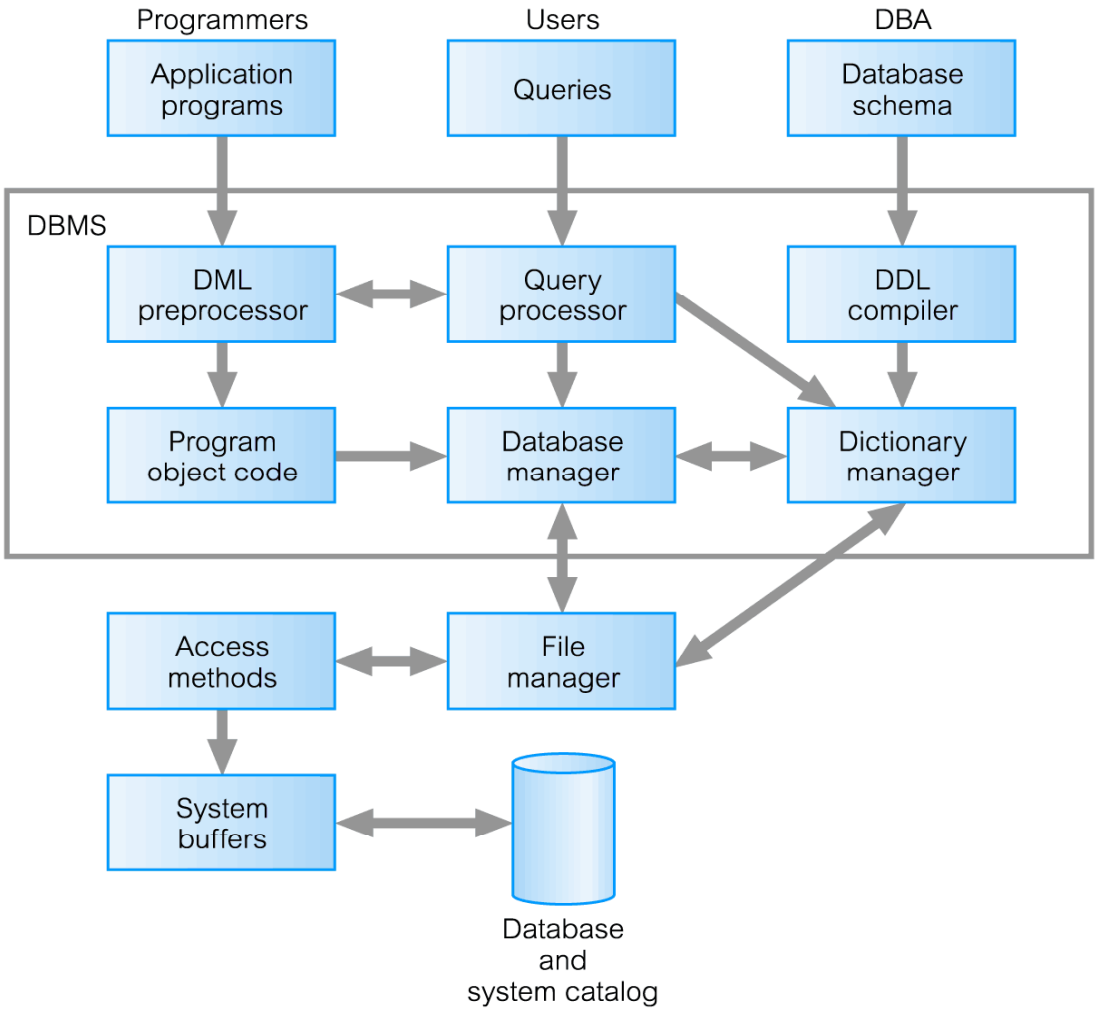
- Data Definition Language (DDL)
  - Permits specification of data types, structures and any data constraints to be stored in the database
  - All specifications are stored in the database
- Data manipulation language (DML).
  - Query language: retrieve, update
- Controlled access to database may include:
  - a security system
  - an integrity system
  - a concurrency control system
  - a recovery control system
  - a user-accessible catalog
- Database System = the Database + DBMS software

Database Approach

- Roles in the Database Environment
  - Database Administrator (DBA): responsible for authorizing access to DB, coordinating & monitoring its use, and for acquiring software and hardware resources as needed
  - Database Designers: responsible for identifying the data to be stored in DB, choosing appropriate structures to represent and store this data
  - Application Programmers
  - End Users
  - More details: see [1,4]-chapter 1

Database Approach

- DBMS components: see [1,4] for the details



Database Approach

- Characteristics of the Database Approach
  - Self-describing nature of a database system
  - Insulation between programs and data, and data abstraction
    - Program-data independence + Program-operation independence = Data abstraction
    - A data model is a type of data abstraction
  - Support of multiple views of the data
  - Sharing of data and multi-user transaction processing
  - Other advantages of using the DBMS approach: see [1]-1.6

Database Approach

- History of database systems
  - First generation: Hierarchical and Network
  - Second generation: Relational
  - Third generation: Object-Relational, Object-Oriented
- Brief history of database applications
  - see [1]-section 1.7

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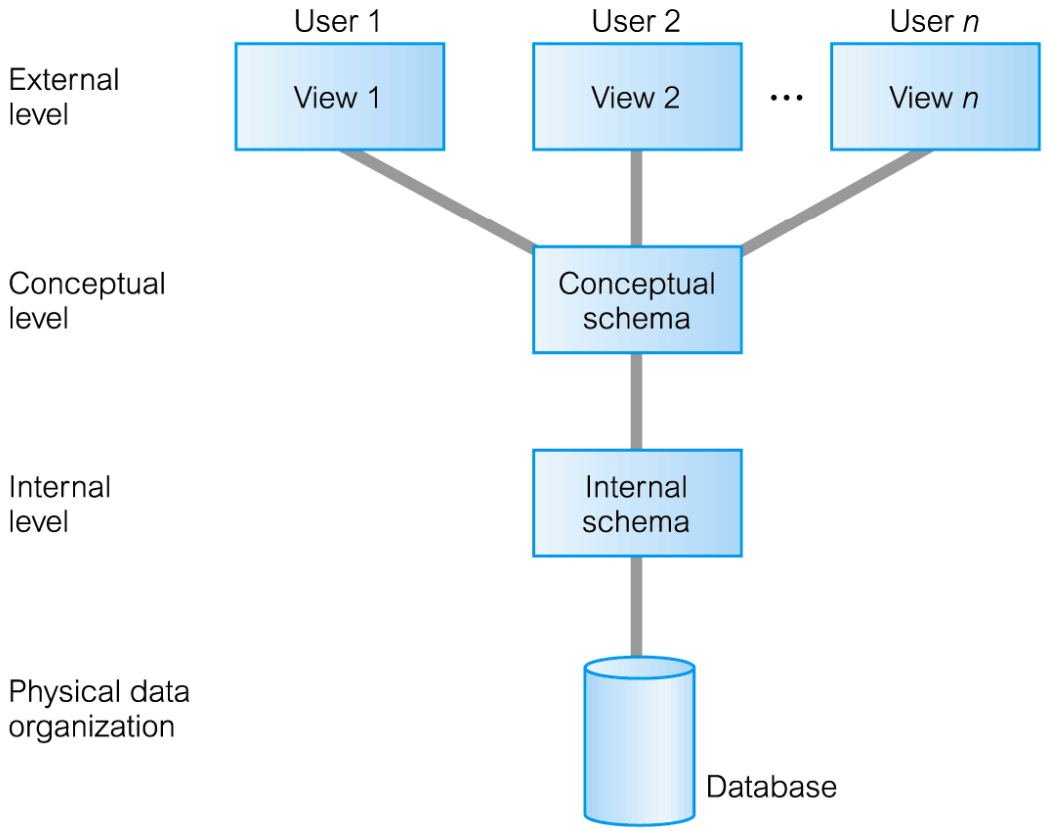
Three-Schema Architecture and Data Independence

- Objectives of Three-Schema Architecture
  - All users should be able to access same data
  - A user's view is immune to changes made in other views
  - Users should not need to know physical database storage details
  - DBA should be able to change database storage structures without affecting the users' views
  - Internal structure of database should be unaffected by changes to physical aspects of storage
  - DBA should be able to change conceptual structure of database without affecting all users

Three-Schema Architecture and Data Independence



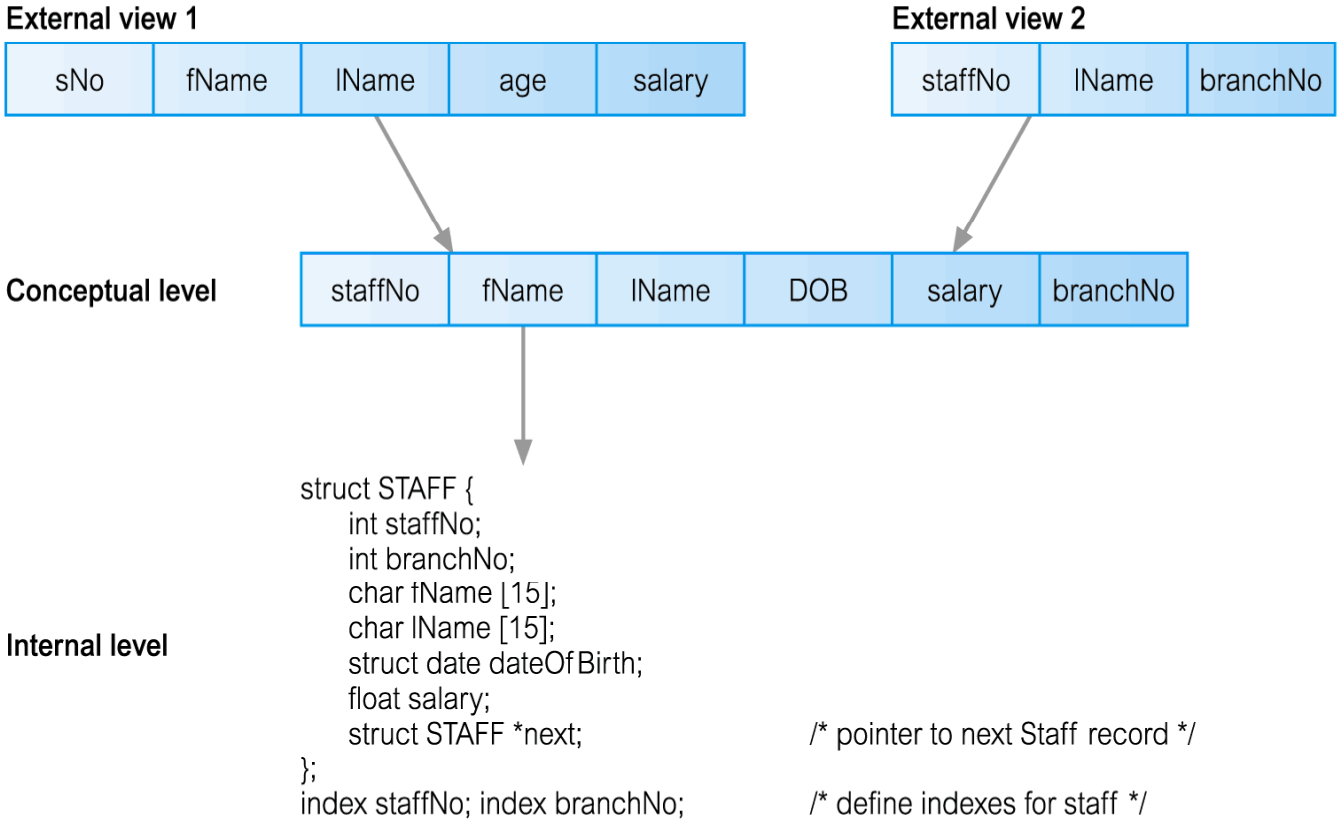
Three-Schema Architecture and Data Independence

- External Level
  - Users' view of the database
  - Describes that part of database that is relevant to a particular user
- Conceptual Level
  - Community view of the database
  - Describes what data is stored in database and relationships among the data

Three-Schema Architecture and Data Independence

- Internal Level
  - Physical representation of the database on the computer.
  - Describes how the data is stored in the database

Three-Schema Architecture and Data Independence



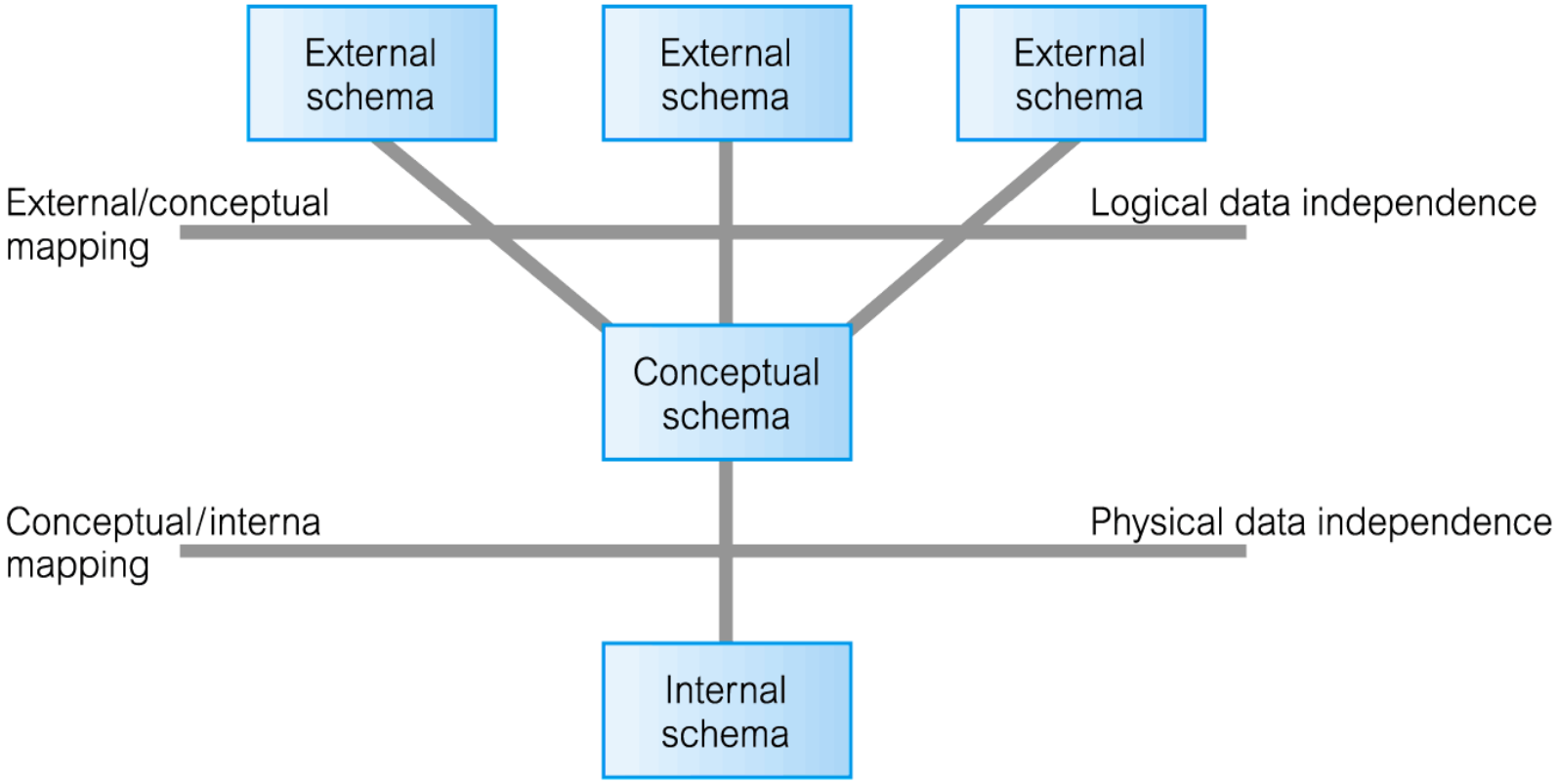
Three-Schema Architecture and Data Independence

- Data Independence is the capacity to change the schema at one level of a database system without having to change the schema at the next higher level
- Logical Data Independence
  - Refers to immunity of external schemas to changes in conceptual schema
  - Conceptual schema changes (e.g. addition/removal of entities) should not require changes to external schema or rewrites of application programs

Three-Schema Architecture and Data Independence

- Physical Data Independence
  - Refers to immunity of conceptual schema to changes in the internal schema
  - Internal schema changes (e.g. using different file organizations, storage structures/devices) should not require changes to conceptual or external schemas

Three-Schema Architecture and Data Independence



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Database Languages

- Data Definition Language (DDL) allows the DBA or user to describe and name entities, attributes, and relationships required for the application plus any associated integrity and security constraints
- Data Manipulation Language (DML) provides basic data manipulation operations on data held in the database
- Data Control Language (DCL) defines activities that are not in the categories of those for the DDL and DML, such as granting privileges to users, and defining when proposed changes to a databases should be irrevocably made

Database Languages

- Procedural DML allows user to tell system exactly how to manipulate data (e.g., Network and hierarchical DMLs)
- Non-Procedural DML (declarative language) allows user to state what data is needed rather than how it is to be retrieved (e.g., SQL, QBE)
- Fourth Generation Languages (4GLs)
  - Non-procedural languages: SQL, QBE, etc.
  - Application generators, report generators, etc. (see [4])

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Data Models, Database Schema and Database State

- Data Model: An integrated collection of concepts for describing data, relationships between data, and constraints on the data in an organization
- Categories of data models include:
  - Object-based (Conceptual)
    - ER, Object-Oriented, …
  - Record-based (Representational)
    - Relational, Network, Hierarchical
  - Physical: used to describe data at the internal level

Describe data at the conceptual & external levels

- Homework: do revise the network & hierarchical data models (resources: [1,4] & the Web)

Data Models, Database Schema and Database State

- Database Schema: the description of a database, which is specified during database design and is not expected to change frequently
- Schema Diagram: a displayed schema
- Database State (Snapshot): the data in the database at a particular moment in time

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Data Management Systems Framework

- Where are we?

Application Layer	Visualization, Collaborative Computing, Mobile Computing, Knowledge-based Systems
Data Management Layer	**Layer 3: information extraction & sharing** Data Warehousing, Data Mining, Internet DBs, Collaborative, P2P & Grid Data Management
	Layer 2: interoperability & migration Heterogeneous DB Systems, Client/Server DBs, Multimedia DB Systems, Migrating Legacy DBs
	Layer 1: DB technologies DB Systems, Distributed DB Systems
Supporting Layer	Networking, Mass Storage, Agents, Grid Computing Infrastructure, Parallel & Distributed Processing, Distributed Object Management

Data Management Systems Framework

- Extending database capabilities for new applications
  - Example applications: storage and retrieval of images, videos, data mining (large amounts of data need to be stored and analyzed), spatial databases, time series applications, …
  - More complex data structures than relational representation
  - New data types except for the basic numeric and character string types
  - New operations and query languages for new data types
  - New storage and retrieval methods

Summary

- File-based Approach
- Database Approach
- Three-Schema Architecture and Data Independence
- Database Languages
- Data Models Database Schema and Database State
- Data Management Systems Framework (where are we?)
- Reading Suggestion & Homework: do not forget !!
- Next lecture: Conceptual DB Design-ER&EER Models

Q&A

Questions ??

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