



Principles of Database Systems

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Main Contents

In this course, we will learn the basic concepts, principles and applications of database systems, especially the relational database systems. The contents mainly include :

- The data models, SQL language and user interfaces
- Key principles of DBMS (mainly architecture, query optimization, concurrency control, recovery, etc.)
- The security and integrity constraints of database
- Introduction of distributed database systems
- Some new research and application fields of database technology, such as data warehouse, data mining, XML data management, etc.

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References

- 1) Wang Nengbin, "Textbook of Database Systems"
- 2) Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", 3rd Edition, McGraw-Hill Companies, 2002
- 3) Hector Garcia-Molina, Jeffrey D. Ullman, "Database Systems: the Complete Book"
- 4) C.J. Date, "An Introduction to Database Systems"
- 5) Web Site of our course:
<http://cselab.seu.edu.cn/course/dbprinciple/>

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Table of Contents

1. Introduction

The history, classification, and main research contents of database systems; The database system; the concepts of data model

2. Data Model*

Hierarchical and network model; Relational model; ER model; Object-Oriented model and other data models

3. User Interfaces and SQL Language*

User interface; SQL language, including QL, DDL, DCL, DML, view, embedded SQL and dynamic SQL, etc.

4. Database Management Systems*

The architecture of database systems, query optimization, file structure and index, transaction management, concurrency control, recovery mechanism

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5. The Security and Integrity Constraint

The security model of database system; Integrity constraint and its expression, implementing method, assertion, trigger

6. Database Design*

Design procedure; ER graph; Normalization of Relational Schema

7. Distributed Database Systems

What and Why DDBS, data distribution, distributed database design; Query optimization, distributed transaction management in DDBMS

8. New Research and Application Fields

Data warehouse, OLAP; Data mining; XML data management

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1. Introduction

What Is Database? What Is DBMS?

- A very large, integrated collection of data.
- Models real-world enterprise.
 - Entities (e.g., students, courses)
 - Relationships (e.g., electives)
- A Database Management System (DBMS) is a software package designed to store and manage databases.

Files vs. Databases

- Application must stage large datasets between main memory and secondary storage (e.g., buffering, page-oriented access, 32-bit addressing, etc.)
- Special code for different queries
- Must protect data from inconsistency due to multiple concurrent users
- Crash recovery
- Security and access control

Why Use a DBMS?

- Data independence and efficient access.
- Reduced application development time.
- Data integrity and security.
- Uniform data administration.
- Concurrent access, recovery from crashes.

Why Study Databases ?

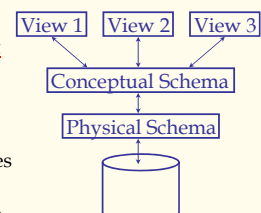
- Shift from computation to information
 - at the “low end”: scramble to webspace (a mess!)
 - at the “high end”: scientific applications
- Datasets increasing in diversity and volume.
 - Digital libraries, interactive video, Human Genome project, EOS project
 - ... need for DBMS exploding
- DBMS encompasses most of CS
 - OS, languages, theory, AI, multimedia, logic

Data, Data Model and Data Schema

- Data are symbols for describing the things of real world. They are existing form of information.
- A data model is a collection of concepts and definitions for describing data.
- A schema is a description of a particular collection of data, using a given data model.
- The relational model of data is the most widely used model today.
 - Main concept: relation, basically a table with rows and columns.
 - Every relation has a schema, which describes the columns, or fields.

Levels of Abstraction

- Many views, single conceptual (logical) schema and physical schema.
 - Views describe how users see the data.
 - Conceptual schema defines logical structure
 - Physical schema describes the files and indexes used.



* Schemas are defined using DDL; data is modified/queried using DML.



Example: University Database

- Conceptual schema:
 - *Students*(sid: string, name: string, login: string, age: integer, gpa: real)
 - *Courses*(cid: string, cname: string, credits: integer)
 - *Enrolled*(sid: string, cid: string, grade: integer)
- Physical schema:
 - Relations stored as unordered files.
 - Index on first column of Students.
- External Schema (View):
 - *Course_info*(cid: string, enrollment: integer)



Data Independence *

- Applications insulated from how data is structured and stored.
- **Logical data independence**: Protection from changes in *logical* structure of data.
- **Physical data independence**: Protection from changes in *physical* structure of data.

* One of the most important benefits of using a DBMS!



The History of Database Technology and its Classification

- (1) According to the development of data model
- No management (before 1960'): Scientific computing
 - File system: Simple data management
 - Demand of data management growing continuously, DBMS emerged.
- 1964, the first DBMS (American): IDS, network
 - 1969, the first commercial DBMS of IBM, hierarchical
 - 1970, E.F.Codd(IBM) bring forward relational data model
 - Other data model: Object Oriented, deductive, ER, ...



(2) According to the development of DBMS architectures

- Centralized database systems
- Parallel database systems
- Distributed database systems (and Federated database systems)
- Mobile database systems

(3) According to the development of architectures of application systems based on databases

- Centralized structure : Host + Terminal
- Distributed structure
- Client/Server structure
- Three tier/ multi-tier structure
- Mobile computing
- Grid computing / Cloud computing

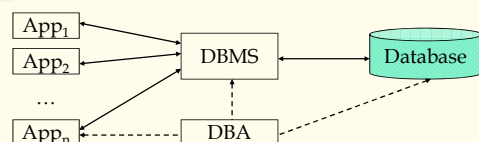


(4) According to the expanding of application fields

- OLTP
- Engineering Database
- Deductive Database
- Multimedia Database
- Temporal Database
- Spatial Database
- Data Warehouse, OLAP, Data Mining
- Knowledge Management
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Database System



- Applications + DBMS + Database + DBA
- DBMS is the core of database system
 - High level user interfaces
 - Query processing and optimization
 - Catalog management
 - Concurrency control and Recovery
 - Integrity constraints checking
 - Access control



Life cycle of database systems

- Database system planning
- Database designing
- Database establishing and loading
- Database running, managing and maintaining
- Database extending and restructuring

