



Өгөгдлийн сангийн үндэс (CSII202 - 3 кр) Database Systems

Lecture1: Introduction to Database Systems



МУИС, ХШУИС, МКУТ-ийн багш

Док. Довдонгийн Энхзол

In this Lecture

- Course Information
- Databases and Database Systems
- Some History
- The Relational Model For more information
 - Д.Энхзол, "Өгөгдлийн сан", 2022 он
 - Connolly and Begg – Chapters 1 and 2
 - Ullman and Widom (2ed.) – Chapter 1

Textbook

- Recommended textbooks:
 - 'Database Systems: A practical approach to design, implementation and management' by Connolly and Begg
 - 'A first course in database systems' by Ullman and Widom.
- Other textbooks:
 - There are *lots* of database texts
 - Most of them would be fine also
 - Dr.Natasha Alechina materials
- For example:
 - 'Database Systems' by CJ Date

Course Information

- **Contact details**

- Enkhzol Dovdon
- Өрөө: 3A байр 225 тоот
- Email: MS Teams,
enkhzol@seas.num.edu.mn

- **Lectures**

- Tuesdays at
09:20-10:50
- Room 310, 3A building

- **Labs**

- Tuesdays at
11:00-13:25
Room 222, 3A building

Assignments	60
One exam	10
Final exam	30
Total	100

Хүн бол энэ ертөнцийн хамгийн төгс төгөлдөр систем юм.

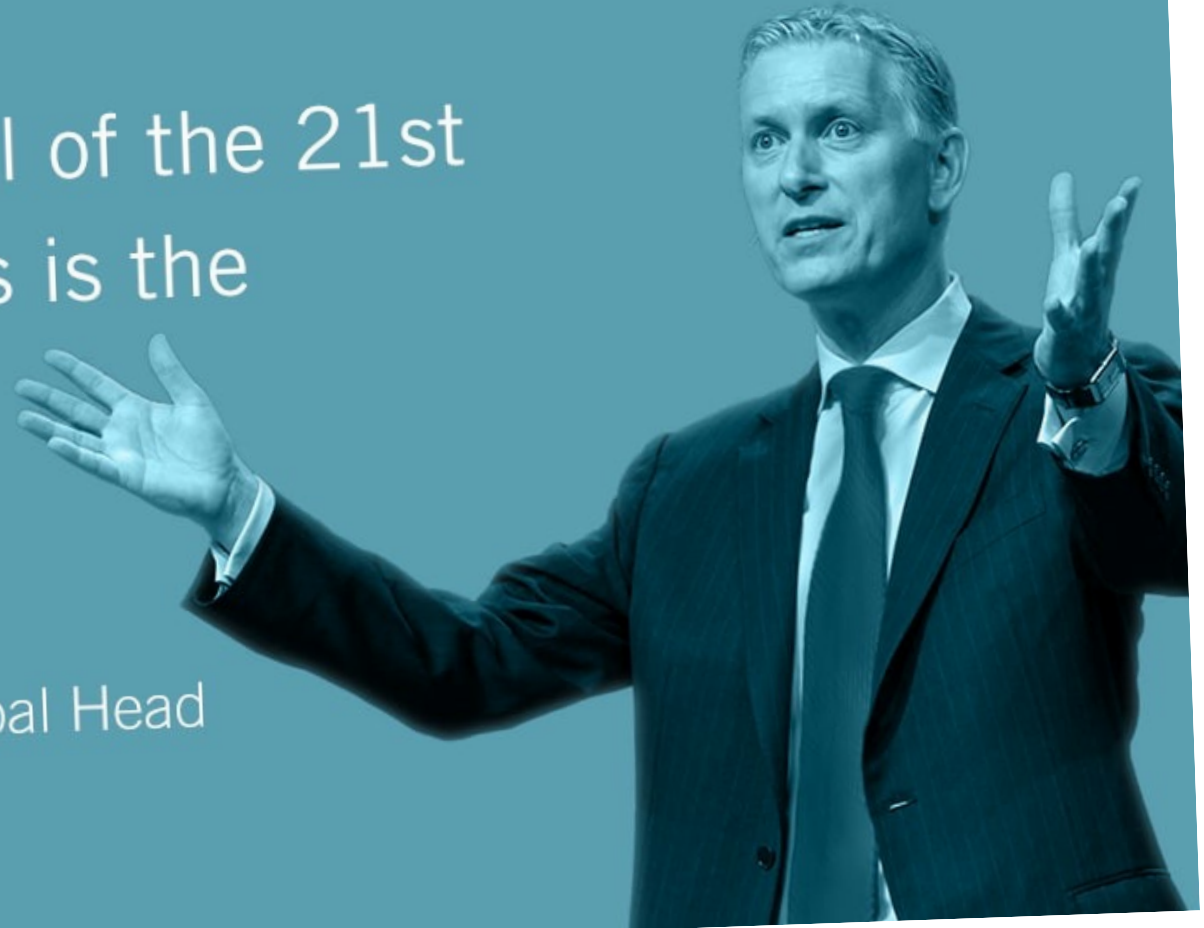
Хүн компьютерийн системийг бүтээсэн тул түүнтэй холбоотой бүхнийг ойлгож чадна.

Д.Энхзол

“Information is the oil of the 21st century, and analytics is the combustion engine.”

Peter Sondergaard

Senior Vice President and Global Head
of Research at Gartner, Inc.



Course Overview

- Several main topics
 - Database systems
 - Data models
 - Database design
 - SQL
 - Transactions
 - Concurrency
 - Administration

Why Study Databases?

- Databases are useful
 - Many computing applications deal with large amounts of information
 - Database systems give a set of tools for storing, searching and managing this information
- Databases in CS
 - Databases are a 'core topic' in computer science
 - Basic concepts and skills with database systems are part of the skill set you will be assumed to have as a CS graduate

Imagination of processing on database – 1/5



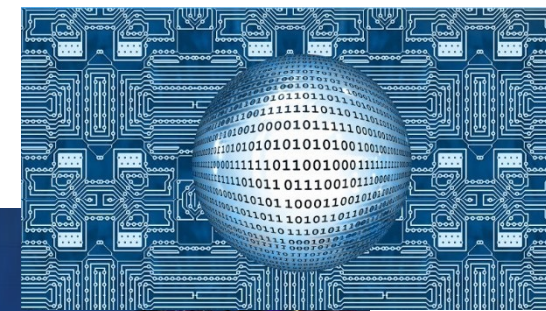
Imagination of processing on database – 2/5



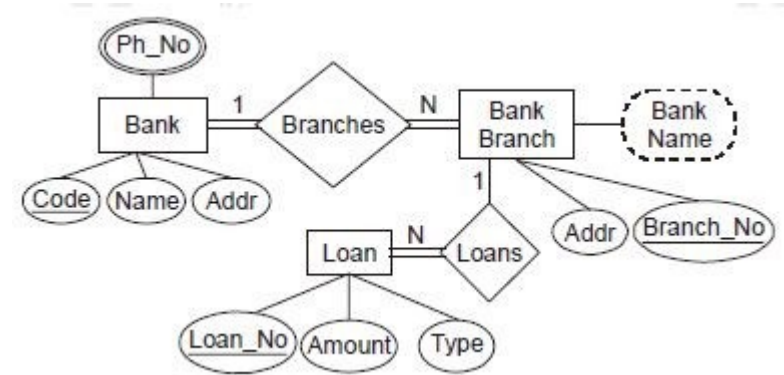
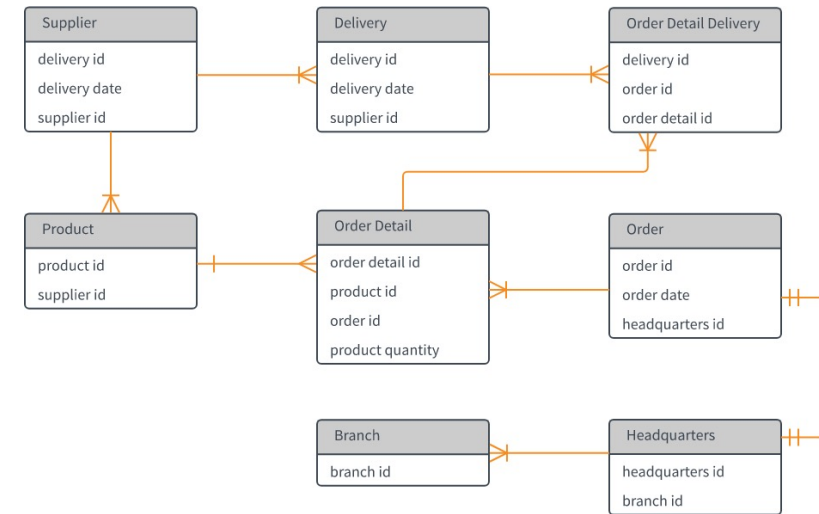
Imagination of processing on database – 3/5



Imagination of processing on database – 4/5



Imagination of processing on database – 5/5



Important concepts

- **Data**

Raw (unprocessed) facts that have some relevancy to an individual or organization.

- **Information**

Data that has been processed or given some structure that brings meaning to an individual or organization.

What is a Database?

- “A set of information held in a computer”

Oxford English Dictionary

- “One or more large structured sets of persistent data, usually associated with software to update and query the data”

Free On-Line Dictionary of Computing

- “A collection of data arranged for ease and speed of search and retrieval”

Dictionary.com

Databases

- Web indexes
- Library catalogues
- Medical records
- Bank accounts
- Stock control
- Personnel systems
- Product catalogues
- Telephone directories
- Train timetables
- Airline bookings
- Credit card details
- Student records
- Customer histories
- Stock market prices
- Discussion boards
- and so on...

Database Systems

- A database system consists of
 - Data (the database)
 - Software
 - Hardware
 - Users
- We focus mainly on the software
- Database systems allow users to
 - Store
 - Update
 - Retrieve
 - Organise
 - Protecttheir data.

Database Users

- End users
 - Use the database system to achieve some goal
- Application developers
 - Write software to allow end users to interface with the database system
- Database Administrator (DBA)
 - Designs & manages the database system
- Database systems programmer
 - Writes the database software itself

Database Management Systems

- A database is a collection of information
- A database management system (DBMS) is the software than controls that information
- Examples:
 - Oracle
 - DB2 (IBM)
 - MS SQL Server
 - MS Access
 - Ingres
 - PostgreSQL
 - MySQL



What the DBMS does

- A software system that enables users to define, create, and maintain the database, and provides controlled access to this database.
- Provides users with
 - Data definition language (DDL)
 - Data manipulation language (DML)
 - Data control language (DCL)
- Often these are all the same language
- DBMS provides
 - Persistence - тогтмол
 - Concurrency - давхцалгүй
 - Integrity - бүтэн
 - Security - найдвартай
 - Data independence – биеэ даасан
- Data Dictionary
 - Describes the database itself

FUNCTIONS OF DBMS

- To store data
- To organize data
- To control access to data
- To protect data

USES OF DBMS

- To provide decision support
- To provide transaction processing

COMPONENTS OF DBMS

The basic components of a DBMS can be divided into three subsystem

1. Design tool

This provide features for creating the data base and various application, forms, and reports

2. Run-time facilities

This process the application created by design tools.

3. DBMS engine

Translates between the **design tools** and **run time facilities** and **data**

ADVANTAGES OF DBMS

1. Centralized data reduce management problems
2. Decentralized
3. Data redundancy and consistency are controllable
4. Program-data interdependence is diminished
5. Flexibility of data is increased

DISADVANTAGES OF DBMS

1. Reduction in speed of data access time
2. Require special knowledge
3. Possible dependency of application programs to specific DBMS versions

Data Dictionary - Metadata

- The dictionary or catalog stores information about the database itself
- This is data about data or 'metadata'
- Almost every aspect of the DBMS uses the dictionary
- The dictionary holds
 - Descriptions of database objects (tables, users, rules, views, indexes,...)
 - Information about who is using which data (locks)
 - Schemas and mappings

File Based Systems

- File based systems
 - Data is stored in files
 - Each file has a specific format
 - Programs that use these files depend on knowledge about that format
- Problems:
 - No standards
 - Data duplication
 - Data dependence
 - No way to generate ad hoc queries
 - No provision for security, recovery, concurrency, etc.

TYPES OF DATABASES

There are four common types of database models, which are:

- Hierarchical database model
- Relational model
- Network model
- Object-oriented database model
- Entity-relationship model
- Document model
- Entity-attribute-value model
- Star schema
- The object-relational model, which combines the two that make up its name

Relational Systems

- Problems with early databases
 - Navigating the records requires complex programs
 - There is minimal data independence
 - No theoretical foundations
- Then, in 1970, E. F. Codd wrote “A Relational Model of Data for Large Shared Databanks” and introduced the relational model

Relational Systems

- Information is stored as *tuples* or *records* in *relations* or *tables*
- There is a sound mathematical theory of relations
- Most modern DBMS are based on the relational model
- The relational model covers 3 areas:
 - Data structure
 - Data integrity
 - Data manipulation
- More details in the next lecture...

ANSI/SPARC Architecture

- ANSI - American National Standards Institute
- SPARC - Standards Planning and Requirements Committee
- 1975 - proposed a framework for DBs
- A three-level architecture
 - Internal level: For systems designers
 - Conceptual level: For database designers and administrators
 - External level: For database users

Internal Level

- Deals with physical storage of data
 - Structure of records on disk - files, pages, blocks
 - Indexes and ordering of records
 - Used by database system programmers

•Internal Schema

RECORD EMP

LENGTH=44

HEADER: BYTE(5)

OFFSET=0

NAME: BYTE(25)

OFFSET=5

SALARY:

FULLWORD

OFFSET=30

DEPT: BYTE(10)

OFFSET=34

Conceptual Level

- Deals with the organisation of the data as a whole
 - Abstractions are used to remove unnecessary details of the internal level
 - Used by DBAs and application programmers

- Conceptual Schema

```
CREATE TABLE  
Employee (  
  Name  
    VARCHAR(25),  
  Salary REAL,  
  Dept_Name  
    VARCHAR(10))
```

External Level

- Provides a view of the database tailored to a user
 - Parts of the data may be hidden
 - Data is presented in a useful form
 - Used by end users and application programmers

- External Schemas

Payroll:

String Name

double Salary

Personnel:

char *Name

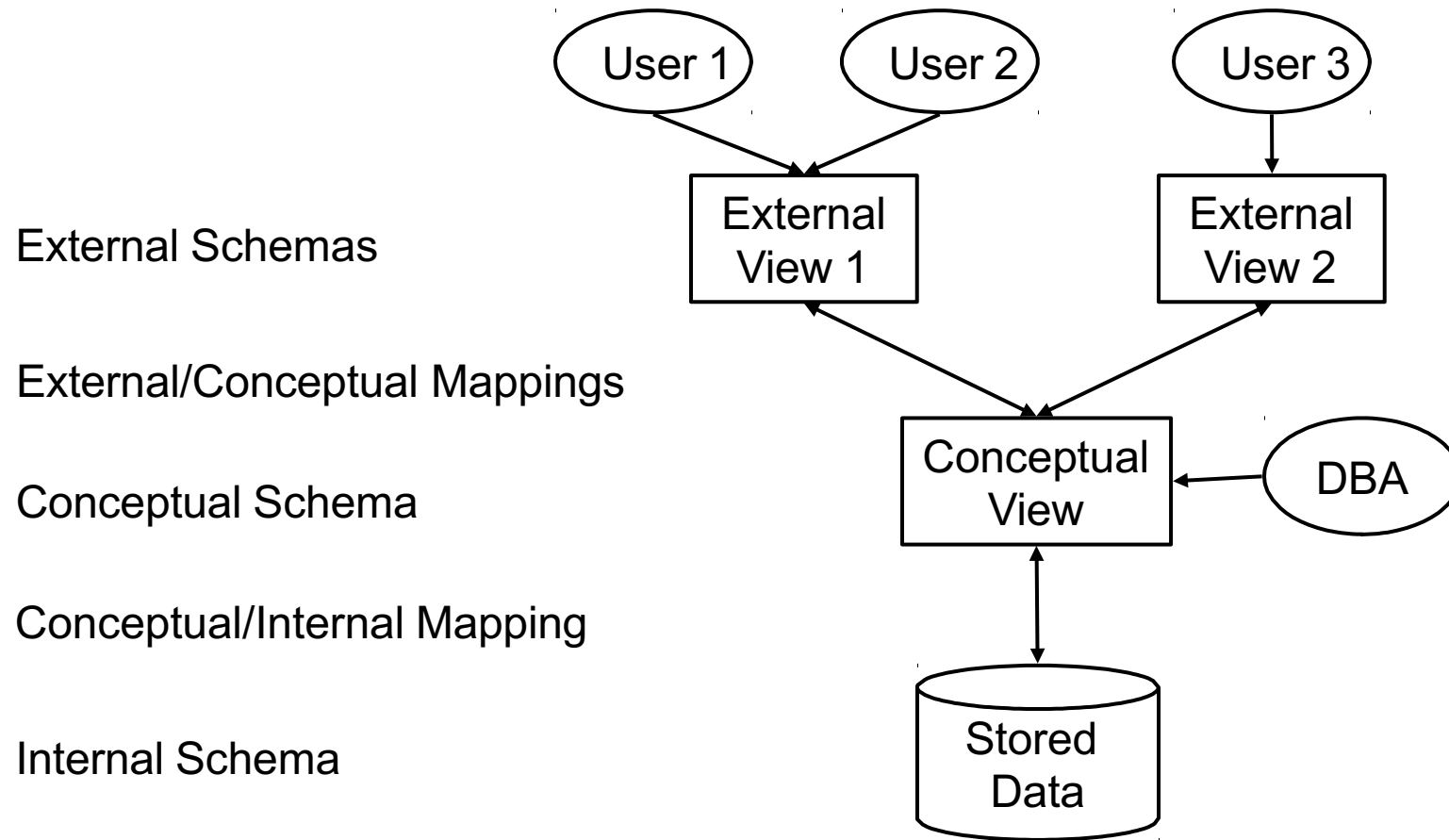
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***Department**

Mappings

- Mappings translate information from one level to the next
 - External/Conceptual
 - Conceptual/Internal
- These mappings provide data independence
- Physical data independence
 - Changes to internal level shouldn't affect conceptual level
- Logical data independence
 - Conceptual level changes shouldn't affect external levels

ANSI/SPARC Architecture



This Lecture in Exams

- Describe the three levels of the ANSI/SPARC model. You should include information about what each level is for, which users might be interested in which levels, and how the levels relate to one another. (2004/05, 7 marks)

Next Lecture

The Relational Model

- Relational data structure
- Relational data integrity
- Relational data manipulation

For more information

- Connolly and Begg chapters 3 and 4
- Ullman and Widom (2 ed.) Chapter 3.1, 5.1
- E.F. Codd's paper

(there is a link on last year's G51DBS webpage)