Overview

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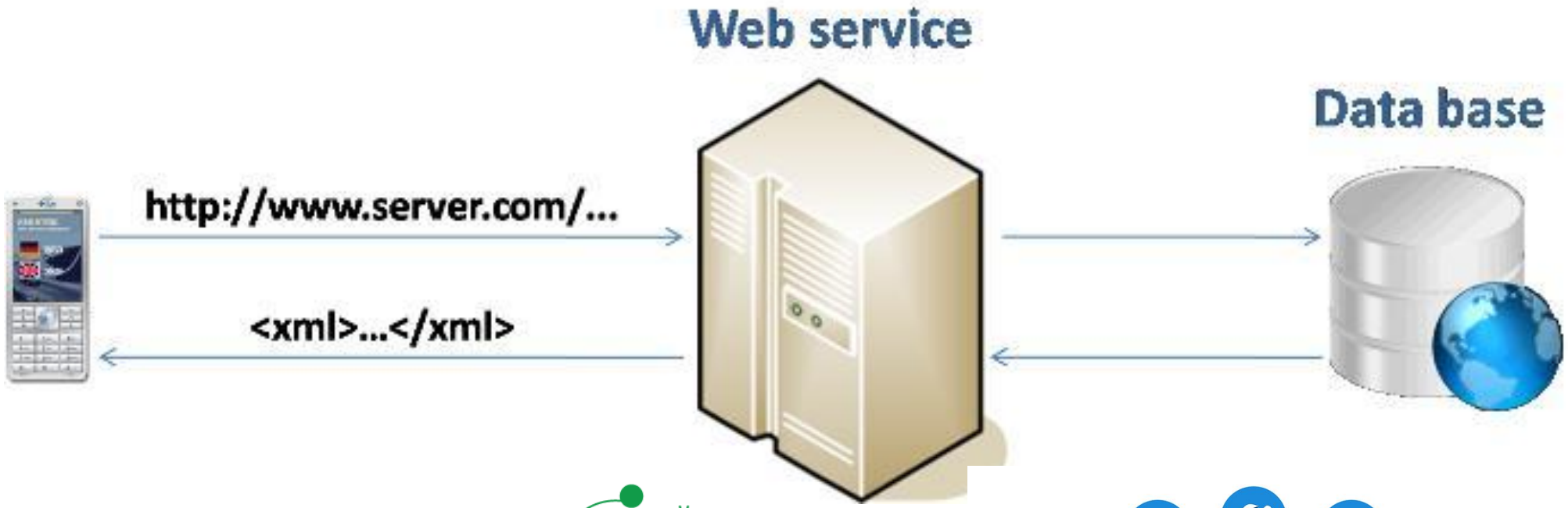
https://sites.google.com/view/seoultech-bigdata

Most parts are based on slides used in Stanford
(http://web.stanford.edu/class/cs145)

Contents

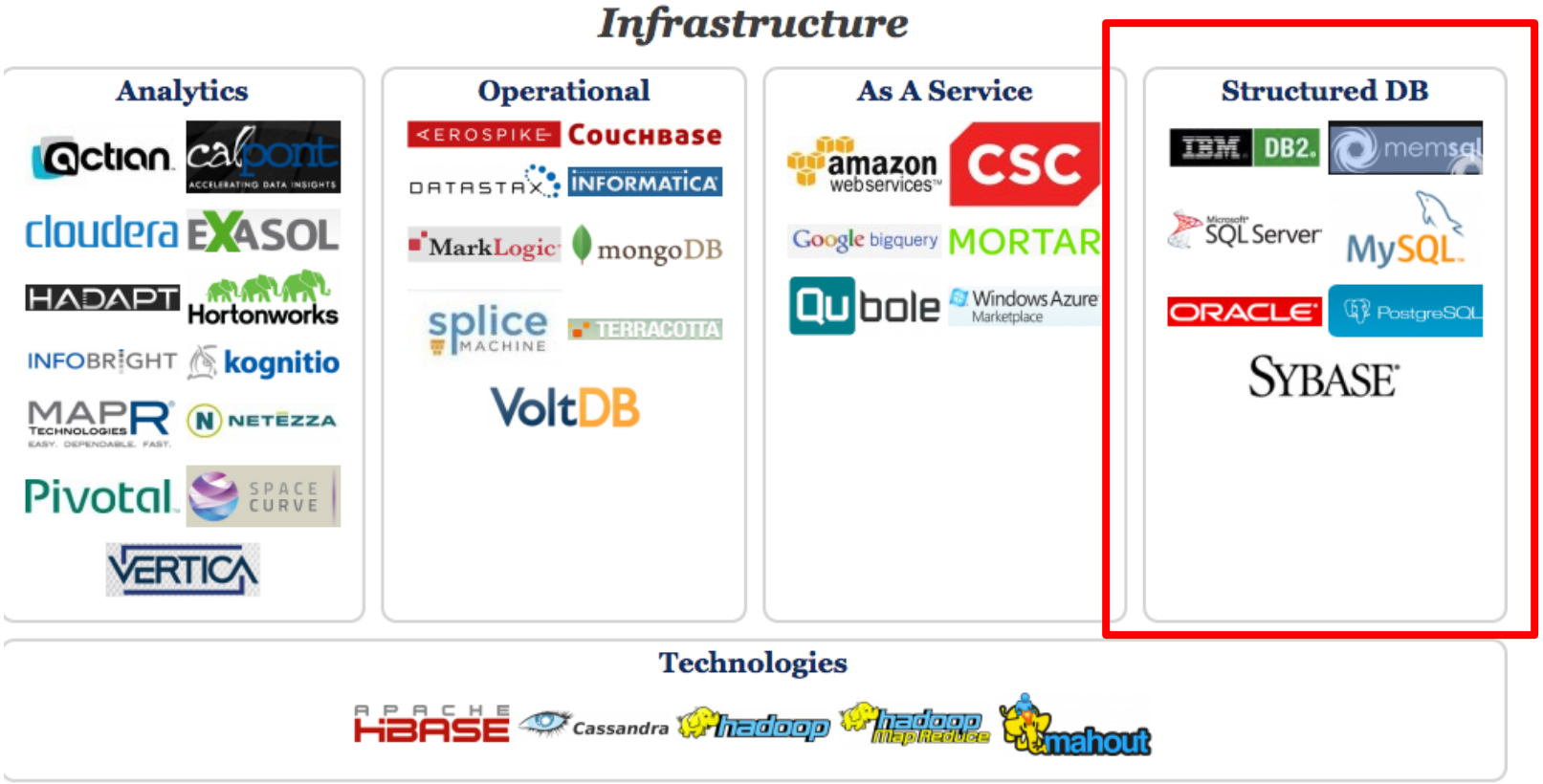
Course Theme

- To learn database theory and practice database



Why Data Is Important?

- **The world is increasingly driven by data…**
- **Big Data Landscape…**
  - Infrastructure is Changing



The Aim of Course

1. **To learn database concepts and basic theory**
2. **To practice database issues such as SQL and database design**
   - Using Oracle Database
3. **To apply the core concepts in the database into simple real applications**

Course Policy: HW and Projects

- **Penalty for cheating**
  - The lowest grade
- **What is cheating?**
  - Sharing code: by copying, retyping, looking at, or supplying a file
  - Searching the Web for solutions
  - Helping your friend to write a lab, line by line
- **What is NOT cheating?**
  - Explaining how to use systems or tools
  - Helping others with high-level design issues
- **Late submission is NOT ALLOWED for all the HW assignments and projects**
  - Be sure the deadline for every assignment and project

Course Policy: Grading

- **Exams (70%)**
  - Mid-term (30%)
  - Final (40%)
- **Lab assignments (10%)**
- **Individual presentation (20%)**

Course Policy: Attendance

- **Attendance is strongly recommended!**
  - Important points are announced only during the lecture
  - Exam problems are inferred from the lecture
- **But, attendance itself is not included in the score**
- **Attendance confirmation is done by e-class**
  - http://eclass.seoultech.ac.kr

Course Policy: Lectures

Lecture time

- 11:00 AM ~ 13:40(~ 50) PM on Tue.
- Please note that Computer Language course will be started from 14:40PM

Lecture place

- Laboratory: Frontier 511

Course Policy: Understanding

- **Encourage questions!**
  - Questions in Korean are allowed
  - After the class, use emails and Q&A in e-class aggressively

- **For the questions that break the flow of class or need to discuss**
  - Please visit me during office hours (or any time if you make reservations)

Course Assumption

- **Recommended: Basic programming knowledge**
  - Any kind of programming languages – Python, Java, or, C/C++

- **This course is designed for ITM students!**

Environments for Practices

- **Oracle Database**
  - Developer version can be found here: http://www.oracle.com/technetwork/database/enterprise-edition/downloads/index.html)

Textbooks

Database Systems, Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom, Pearson

Seven Databases in Seven Weeks, Luc Perkins, Pragmatic Bookshelf

Getting Help

E-class: http://eclass.seoultech.ac.kr

- Complete schedule of lectures, exams, and assignments
- Lecture slides, assignments, exams, solutions
- Clarifications to assignments
- Q&A

Office hours

- Tuesday, 5:00-6:00pm, Frontier 614
- You can schedule 1:1 appointment in advance even not for the office hours

Course Schedule

강의 진도 계획		
주차	강의내용	강의방법, 과제, 평가
1 (영문)	Overview	Offline
2 (영문)	Relational model	Online
3 (영문)	SQL1	Online
4 (영문)	SQL2	Online
5 (영문)	SQL3	Online
6 (영문)	Database design1	Offline
7 (영문)	Individual presentation - Part1	Offline (can be changed to Online)
8 (영문)	Mid-term exam	Offline

9 (영문)	Database design2	Offline
10 (영문)	Indexing1	Online
11 (영문)	Indexing2	Online
12 (영문)	Transactions1	Online
13 (영문)	Transactions2	Offline
14 (영문)	Individual presentation - Part2	Offline (can be changed to Online)
15 (영문)	Final exam	Offline

Introduction to Databases

1. Overview of the DBMS

Contents

What is a DBMS?

- **A large, integrated collection of data**

- **Models a real-world *enterprise***
  - *Entities* (e.g., Students, Courses)
  - *Relationships* (e.g., Alice is enrolled in database course)

A **Database Management System (DBMS)** is a piece of software designed to store and manage databases

A Motivating, Running Example

- **Consider building a course management system (CMS):**

  - Students
  - Courses
  - Professors

  } **Entities**

  entity → 실제 데이터 하나하나 (row) 〈 e.g., 학생 수업 교수 ··· 〉
  entity type → entity 종류 (table)

  저장하고싶은 데이터 대상

  - Who takes what (Student - course)
  - Who teaches what (professor - course)

  } **Relationships**

Attribute
└ entity에 저장하려는 내용 (column)
〈 e.g., 학생 - 학번 - 이름 - 전공 ⋮ / 수업 - 시간 - 과목명 - 전공 ⋮ 〉

Constraint
└ attribute 제약 조건.

Data Models

A data model is a collection of concepts for describing data

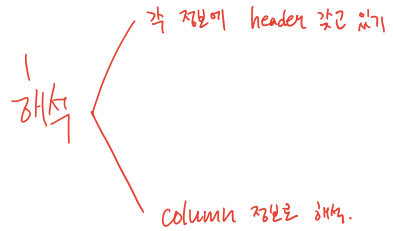
- The relational model of data is the most widely used model today
  - Main Concept: the *relation*- essentially, a table

Columns – 4개

Product

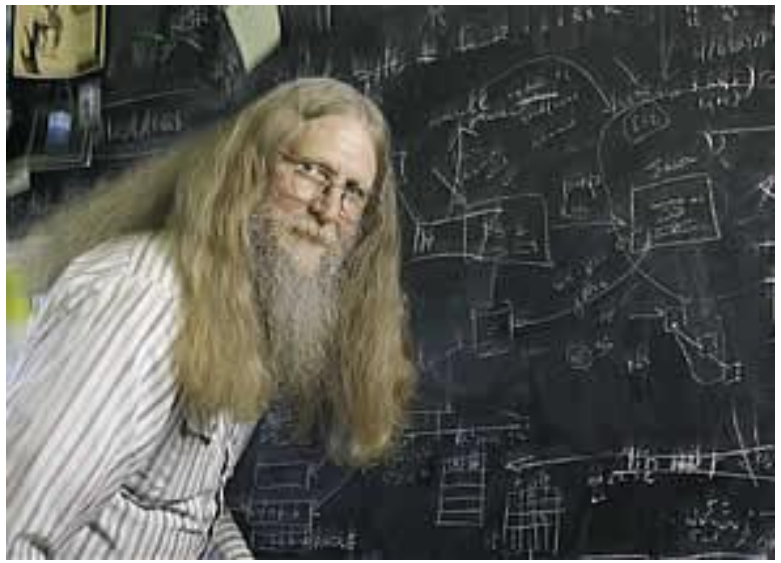
PName	Price	Category	Manufacturer
Gizmo	$19.99	Gadgets	GizmoWorks
Powergizmo	$29.99	Gadgets	GizmoWorks
SingleTouch	$149.99	Photography	Canon
MultiTouch	$203.99	Household	Hitachi

Rows
4개



A schema is a description of a particular collection of data, using the given data model

- E.g. every *relation* in a relational data model has a *schema* describing types, etc.



“Relational databases form the bedrock of western civilization”

- Bruce Lindsay, IBM Research

Modeling the CMS

credits | 학점

Logical Schema

- Students(sid: *string*, name: *string*, gpa: *float*)
- Courses(cid: *string*, cname: *string*, credits: *int*)
- Enrolled(sid: *string,* cid*: string,* grade*: string*)

Relations

sid	Name	Gpa
101	Bob	3.2
123	Mary	3.8

Students

cid	cname	credits
564	564-2	4
308	417	2

Courses

sid-cid relationship 있어야 함. 확정X.

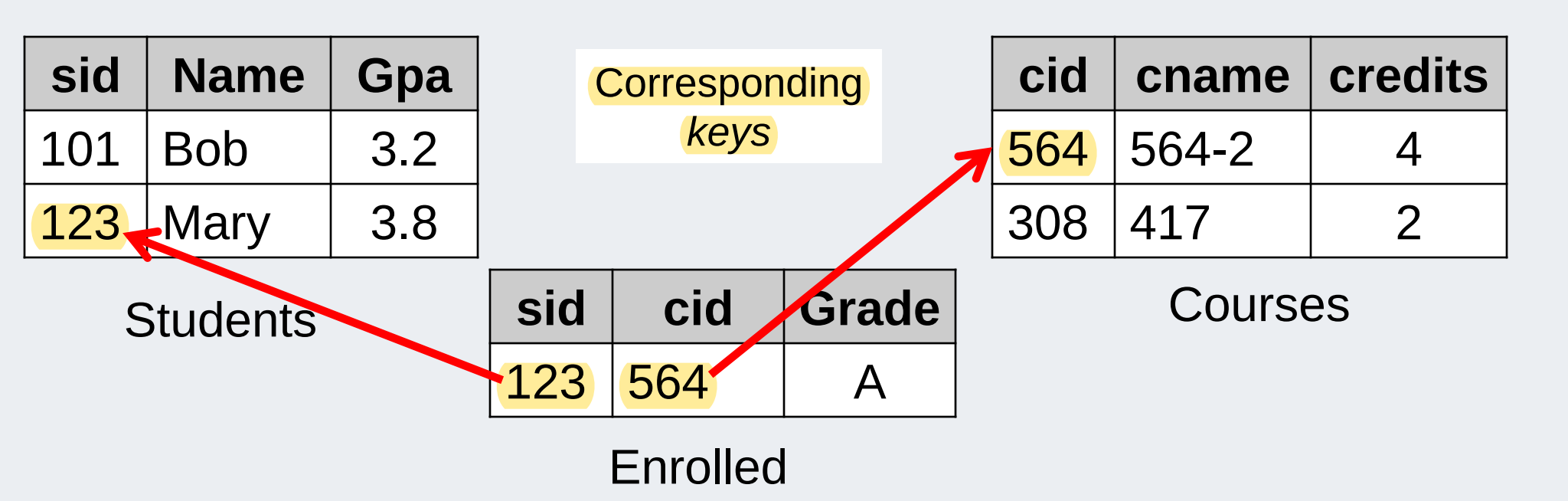
sid	cid	Grade
123	564	A

Enrolled

Modeling the CMS

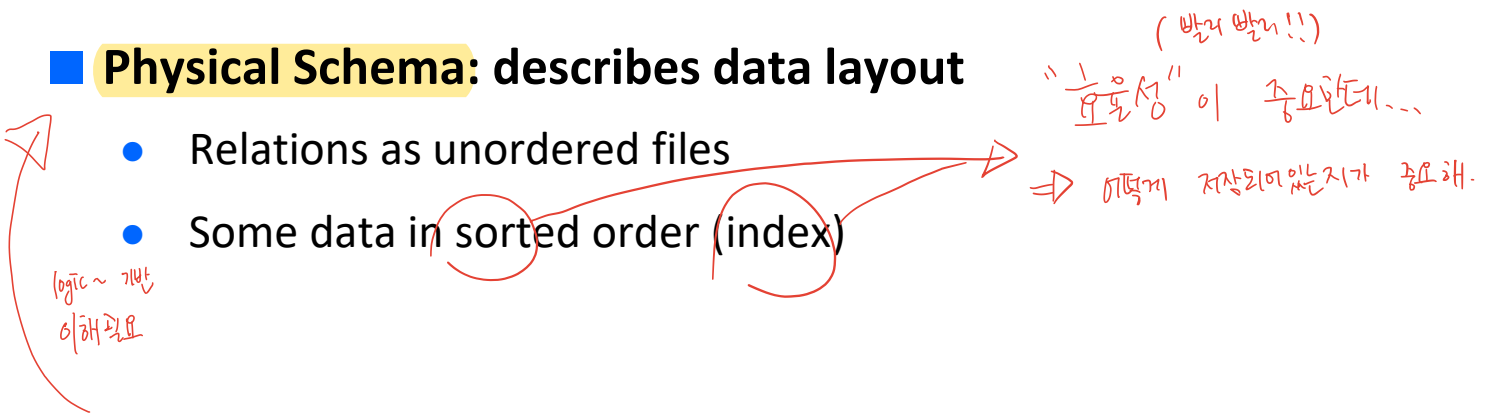
Logical Schema

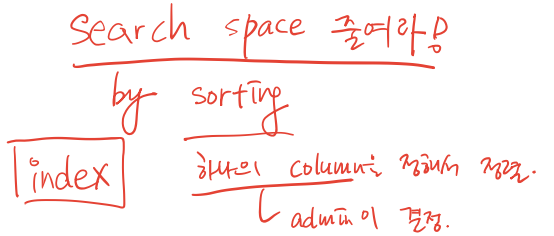
- Students(sid: *string*, name: *string*, gpa: *float*)
- Courses(cid: *string*, cname: *string*, credits: *int*)
- Enrolled(sid: *string,* cid*: string,* grade*: string*)



Other Schemas…

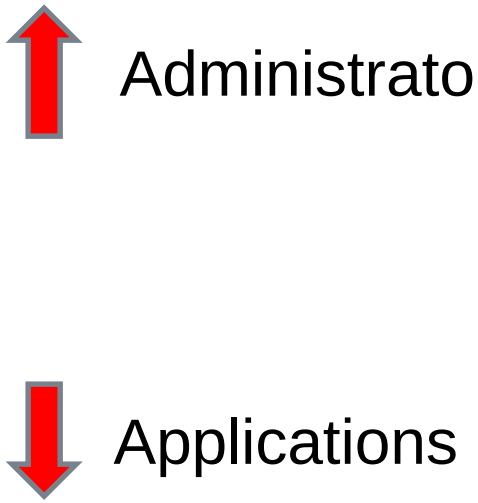
- **Physical Schema: describes data layout**
  - Relations as unordered files
  - Some data in sorted order (index)





- **Logical Schema: Previous slide**

- **External Schema: (Views)** 기존 관계 (logic ~)로부터 새로운 관계 형성.
  - Course_info(cid: *string*, enrollment: *integer*)
  - Derived from other tables



Data Independence

Concept: **Applications do not need to worry about *how the data is structured and stored***

Logical data independence: protection from changes in the *logical structure of the data*

I.e. should not need to ask: can we add a new entity or attribute without rewriting the application?

Physical data independence: protection from *physical layout changes*

I.e. should not need to ask: which disks are the data stored on? Is the data indexed?

One of the most important reasons to use a DBMS

2. Overview of DBMS Topics: Key Concepts & Challenges

Contents

Challenges with Many Users

- **Suppose that our CMS application serves 1000's of users or more- what are some challenges?**

- Security: Different users, different roles

We won't look at too much in this course, but is extremely important

- Performance: Need to provide concurrent access

Disk/SSD access is slow, DBMS hide the latency by doing more CPU work concurrently

- Consistency: Concurrency can lead to update problems

DBMS allows user to write programs as if they were the **only** user

Transactions

- **A key concept is the transaction: an atomic sequence of DB actions (reads/writes)**

Atomicity: An action either completes *entirely* or *not at all*

Acct	Balance
a10	20,000
a20	15,000

Transfer $3k from a10 to a20:
1. 출금 Debit $3k from a10
2. 입금 Credit $3k to a20

Acct	Balance
a10	17,000
a20	18,000

Written naively, in which states is **atomicity** preserved?

- Crash before 1,
- After 1 but before 2, ⇒ atomicity X
- After 2.

DB Always preserves atomicity!

Concurrency: Scheduling Concurrent Transactions

- **The DBMS ensures that the execution of $\{T_1,\ldots,T_n\}$ is equivalent to some serial execution**

A set of transactions is **isolated** if their effect is as if all were executed serially

- **One way to accomplish this: Locking**
  - Before reading or writing, transaction requires a lock from DBMS, holds until the end

- **Key Idea: If T_i wants to write to an item x and T_j wants to read x, then T_i, T_j conflict. Solution via locking:**
  - only one winner gets the lock
  - loser is blocked (waits) until winner finishes

All concurrency issues handled by the DBMS…

Ensuring Atomicity

- **DBMS ensures atomicity even if a transaction crashes!**
- **One way to accomplish this: Write-ahead logging (WAL)**
- **Key Idea*:* Keep a log of all the writes done.**
  - After a crash, the partially executed transactions are undone using the log

Write-ahead Logging (WAL): Before any action is finalized, a corresponding log entry is forced to disk

All atomicity issues also handled by the DBMS…

A Well-Designed DBMS makes many people happy!

- **End users and DBMS vendors**
  - Reduces cost and makes money
- **DB application programmers**
  - Can handle more users, faster, for cheaper, and with better reliability / sec urity guarantees!
- **Database administrators (DBA)**
  - Easier time of designing logical/physical schema, handling security/authoriz ation, tuning, crash recovery, and more…

Must still understand DB internals

Summary

- **Key abstractions give data independence**

- **DBMS are used to maintain, query, and manage large datasets.**
  - Provide concurrency, recovery from crashes, quick application development, integrity, and security

Welcome and Enjoy!