Introduction to Database Systems

CS 4750
Database Systems

[A. Silberschatz, H. F. Korth, S. Sudarshan, Database System Concepts, Ch. 1]

Outline

- Database vs. database Management System (DBMS)
- Why use database and DBMS
- Why learn about database and DBMS
- Roles in DB environment
- Common features of database system

Database

What is a database?

Give examples of databases

Why do we need databases (in general)?

Types of Databases

Operational databases

- Collect, modify, maintain data
- Backbone of companies
- Store dynamic data (i.e., change constantly, reflect up-to-the-minute info)

Our focus

Analytical databases

- Store and track historical and time-dependent data
- Asset for tracking trends, viewing statistical data over a long period, making strategic business projections
- Store static data (i.e., never or very rarely change, reflect a point-in-time snapshot of the data, not up to date)

Example: Online Bookseller

1. **Purposes/services of the app**

2. **Data that should be maintained in a database**

3. **Functionalities to provide the services**

Let's Brainstorm

Refer to the brainstorm-scheduler activity on the schedule page

Imagine we are working on a reservation system, where users schedule time slots for some centralized resource. There are several parts involved in the system. Today, we will only focus on an appointment scheduler for vaccinations, where the users are patients and caregivers keeping track of vaccine stock and appointments.

(Note: We are not implementing anything; we will only consider functionalities or services the users may expect from this system and data needed to provide the services. Feel free to explore further ☺)

Go to https://padlet.com/UpsornP/4750-brainstorm-liry7gc4i89dtiu2 and share ideas:

- What functionalities/services users may expect?
- What data do we need?
- Based on the data we just list, can you think of how they are related? What data should be put together? How should we connect between sets of data?

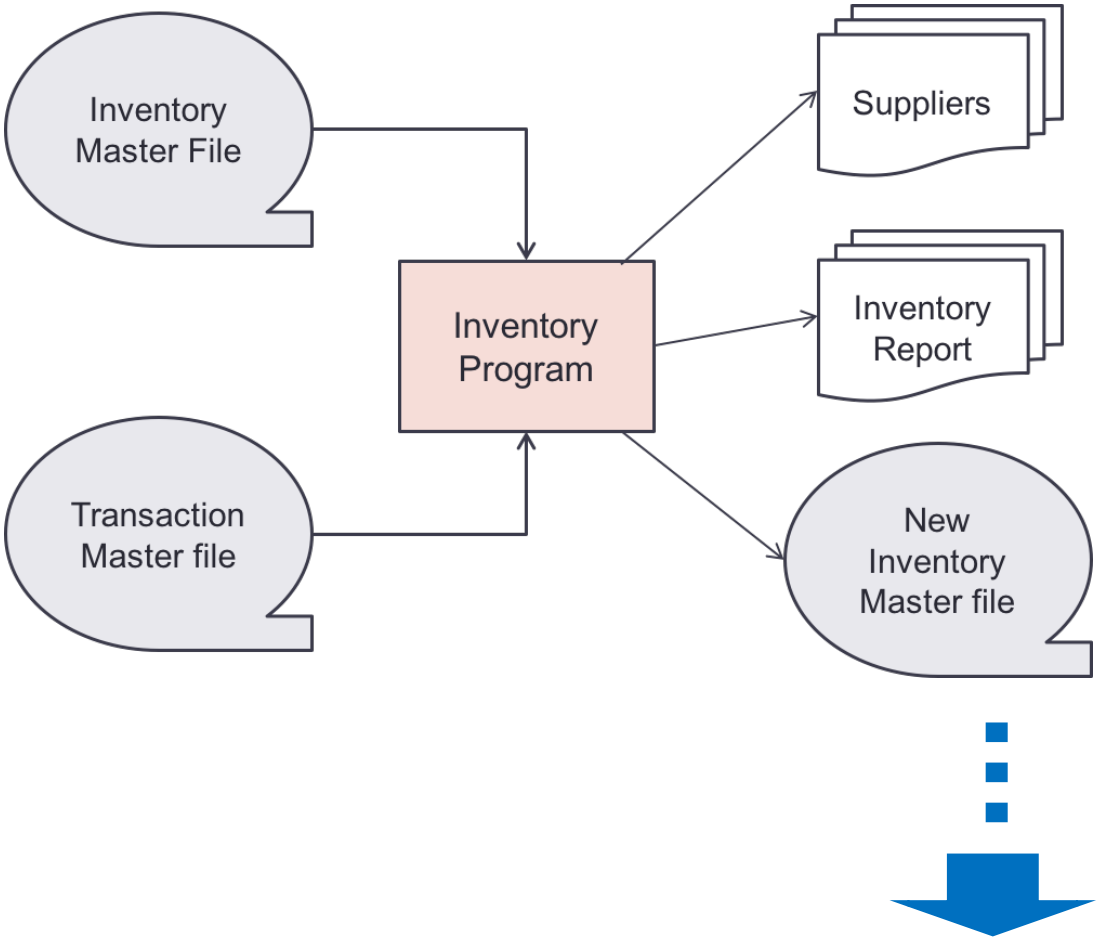
Needs for Data management

Data must be persistent.
However, data are large – can't fit all in memory

- Describe real-world entities in terms of stored data
- Persist large datasets
- Efficiently query and update data
- Change structure of data stored (add, update, remove attributes)
- Simultaneously updates
- Recover from failures
- Ensure security and integrity
- Minimize redundancy

Why do we want to minimize redundancy in databases?

Early Attempt ... to Relational Model



- Rely on file systems
- Programmers must visualize data much as they were stored
- Use several different data models for describing the structure of information in a DB

Ted Codd introduced database systems based on "**relations**"

[Codd, E.F., "A relational model for large shared data banks," Comm. ACM, 13:6, pp. 377-387, 1970]

Database Management System

What is a DBMS?

- Software to create, manage, maintain, persist databases over long periods of time

- Manage: data, database engine, database schema

  Allow data to be accessed, locked, and modified

  Define the database's logical structure

Provide concurrency, security, data integrity and uniform administration procedures

Examples:

MySQL, SQLite, MongoDB, PostgreSQL, Oracle, DB2, MS-SQL, Derby

DBMS Properties

- Queryable: Provide a way to ask DB questions and retrieve data
- Durable: Ensure the safety of information stored (data persists)
  - In-memory DB trade durability for speed?
- Have schema: Define structure for storage of information
  - What about Semi-structured DB?
- No redundancy: Reduce space
  - Indexes trade space for speed?

Difficult to achieve all – balance and tradeoff

- Optimizes queries: Make query run faster
  - What about complex queries? NoSQL DB has a "WYSIWYG" flavor
- Handle concurrent transactions: Manage database engine
  - Turn off serialization for speed?

Key Roles in DB Environment

- DB Administrator (DBA): load data, tune system, keep thing running
- DB designers: specify structure (schema) of data to be stored
- Application developers: write programs that access and manipulate data
- Data analyst: clean and correct, mine, integrate data
- DBMS implementer: build DBMS

[Ricardo C.M. and Urban S.D., Databases Illuminated, Ch.1]

Common Features / Key Concepts

- Data models: how to describe real-world data
- Schema: description of tables
- Instance: snapshot of data stored in DB at a given time
- Data Definition Language (DDL): effect schema
- Data Manipulation language (DML): effect instance
- Physical data independence: change how data are stored on disk w/o affecting apps
- Logical data independence: change schema w/o affecting apps
- Query processing and cost estimation: estimate cost of execution, choose the plan with the least estimated cost
- Transactions: atomicity, consistency, isolation, and durability

Wrap-Up

- Database vs. database Management System (DBMS)
- Why use database and DBMS
- Why learn about database and DBMS
- Roles in DB environment
- Common features of database system

What's next?

- DB architecture
- Data model
- Relational data model

- Start thinking about your project, form a team of 3-4 members