Introduction to Database Systems

CS 4750 Database Systems

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

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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?

Organized collection of related data

Database may be as simple as a text file or a csv file or may be as complex as a large relational, integrated collection of data

Give examples of databases

 Bank account database; payroll database; UVA's student database; Amazon's product database; Hotel reservation database; your notes for this class

Why do we need databases (in general)?

- Contain details about the organization or domain application
- Manage large amounts of data deal with "big data"

Types of Databases

Operational databases

- Collect, modify, maintain data
- Backbone of companies
- Store dynamic data (i.e., change constantly, reflect upto-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)

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



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



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