Ubiquity of Databases

- Anywhere where a large amount of information needs to be managed safely and efficiently
  - Utility companies, grocery stores
  - Schools
  - Doctor’s offices, hospitals
  - Government agencies
  - Web sites
  - …

An Example of a Database Application

Hierarchical Model

Relational Model

Network Model

- Proposed by Edgar F. Codd in early 1970’s
- Data is stored in tables
- All major database systems these day are relational

<table>
<thead>
<tr>
<th>student_id</th>
<th>first_name</th>
<th>last_name</th>
<th>birthday</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000001</td>
<td>John</td>
<td>Doe</td>
<td>1970-1-1</td>
</tr>
<tr>
<td>2000002</td>
<td>Jane</td>
<td>Doe</td>
<td>1971-1-1</td>
</tr>
<tr>
<td>2000003</td>
<td>Tom</td>
<td>Smith</td>
<td>1962-2-2</td>
</tr>
</tbody>
</table>

So how do we store the directory structure in a table??
**The Big Picture**

- **DBMS**
  - Database Management System (DBMS) is a software that manages databases
  - Common DBMS
    - Commercial – Oracle, IBM DB2, MS SQL Server, Access
    - Open source – MySQL, PostgreSQL

**Database and Schema**

- A database is a collection of data managed by a DBMS
- A database contains one or more schemas
- A schema contains a number of schema elements, such as tables, indexes, stored procedures, and so on.

**More Terminology**

<table>
<thead>
<tr>
<th>Table (relation)</th>
<th>Attributes (fields)</th>
</tr>
</thead>
<tbody>
<tr>
<td>students</td>
<td>student_id, name</td>
</tr>
<tr>
<td></td>
<td>1001: John Doe</td>
</tr>
<tr>
<td></td>
<td>1002: Jane Doe</td>
</tr>
</tbody>
</table>

Table (relation) schema:
```
students( student_id, name )
```

Database schema: database name + table schemas

**Attribute Type**

- Determines the storage required for a field
- Common attribute types
  - String types
  - Numeric types
  - Date and time types
  - Other types

**SQL**

- Structured Query Language
- A standard query language for relational databases
- Supported by all major DBMS (with some variations)
Some SQL Examples
- Create a table
- Populate the table
- Find some information
- Delete the table

Database Development

Design
- Given an application scenario, design the database schema.

Implementation
- Implement the schema in a specific DBMS with constraints, indexes, stored procedures

Access
- Input and retrieve data.