Web and Databases
- E-commerce sites
  - Products, order, customers
- News sites
  - Subscribers, articles
- Web boards
  - Users, postings
- ... anywhere where a large amount of information needs to be managed safely and efficiently

Database vs. File
- More efficient search
- ACID
  - Atomicity
  - Consistency
  - Isolation
  - Durability

Relational Model
- Proposed by Edgar F. Codd in early 1970's
- All major DBMS are relational (and the good ones are object-relational)

A Relational DB Example

<table>
<thead>
<tr>
<th>orders</th>
<th>products</th>
</tr>
</thead>
<tbody>
<tr>
<td>CID</td>
<td>CID</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CID</th>
<th>FNAME</th>
<th>LNAME</th>
<th>ADDRESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chengyu</td>
<td>Sun</td>
<td>Street #215</td>
</tr>
<tr>
<td>2</td>
<td>Steve</td>
<td>Sun</td>
<td>Street #711</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>order_details</th>
<th>products</th>
</tr>
</thead>
<tbody>
<tr>
<td>CID</td>
<td>PID</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Terminology
- Database Management System (DBMS)
- Database
- Table, relation
- Attribute, field
  - Type
- Record, tuple, row
- Column
- Schema
**SQL**

- Standard query language of relational databases
- Supported by all major relational databases with some variations

**MySQL**

- Not a good DBMS in the traditional sense
- Very popular in web development
  - Very fast search
  - Full text indexing and search
  - Many small things
    - `drop if exists`
    - `insert into values`
    - `/* */`
    - `...`

**Databases in MySQL**

- MySQL Server
  - tables
  - indexes
  - constraints
  - views
  - ...
  - database
  - database
  - database
  - mysql
  - *user information*
  - *access privileges*

**MySQL on the CS3 Server**

- Version 5.0.45
- One database per user
  - DB name is the same as the server account user name. E.g. cs320stu31
  - Username and password are the same as the ones for the server account
- Connect to the database
  - `mysql -p`

**mysql Command Line Options**

- `mysql [database]`
- `-?`
- `-u username`
  - default: current user
- `-p`
  - required if the password for the account is not empty
- `-h hostname`
  - default: localhost

**Some MySQL Commands**

- Status
  - `status;`
- Help
  - `-h` or `help;`
- Quite MySQL client
  - `-q` or `quit;` or `exit;`
- Change password
  - `set password = password ('something');`
  - `set password for 'user'@'host' = password('something');`
More MySQL Commands ...

- Show databases
  - `SHOW DATABASES;`
- Use database
  - `USE dbname;`
- Show tables
  - `SHOW TABLES;`
- Show table schema
  - `DESCRIBE tablename;`

... More MySQL Commands

- Run a script
  - `\ demo.sql`
  - `SOURCE demo.sql;`
- Run a script at command prompt
  - `mysql < demo.sql`

Access MySQL Using a GUI

- MySQL GUI Tools —
  - [http://dev.mysql.com/downloads gui-tools/5.0.html](http://dev.mysql.com/downloads gui-tools/5.0.html)

Create a Table

```sql
CREATE TABLE products (
  prod_id CHAR(8) NOT NULL,  -- product id
  description TEXT,  -- product description
  price DECIMAL(12,2),  -- price
  PRIMARY KEY (prod_id)
);
```

Field Types

- Numerical types
  - `int`, `float`, `double`, `decimal(m,n)`
- String types
  - `char(n)`, `varchar(n)`
- Date and time
  - `date`, `time`, `datetime`, `timestamp`
    - `’yyyy-mm-dd hh:mm:ss’`

Auto Increment Field

```sql
CREATE TABLE users (
  id INT AUTO_INCREMENT PRIMARY KEY,
  username VARCHAR(64) NOT NULL UNIQUE,
  password CHAR(16)
);
```

```sql
INSERT INTO users (username, password) VALUES ('cysun', 'abcd');
INSERT INTO users (username, password) VALUES ('csun', 'xyz');
```
Populate Tables

- Insert a record
  - `insert into orders values (1000, 1, '2004-04-29', '2004-05-01');`
  - `insert into orders values (1001, 2, '2004-05-01', NULL);`
- Load a data file
  - `load data local infile 'orders.txt' into table orders;`
- Import a data file (at command prompt)
  - `mysqImimport -u cs320stu31 -p orders.txt`
  - `\N` for NULL

Search for Records

- Select field(s) from table(s) where condition(s);
  - `select description, price from products;`
  - `select * from products;`
  - `select * from products where price < 300;`
  - `select * from products where prod_id = 'cpu-0001';`

Pattern Matching

- LIKE, REGEXP
  - `%` -- any zero or more characters
  - `_` -- any single character
  - `[abc], [a-z], [0-9]` -- range
  - `*` -- zero or more instances of the preceding character
  - `^` -- beginning of a string
  - `$` -- end of a string
- `select * from products where description like '%intel%';`

Update Records

- Update table set field=value [,...] where condition(s);
  - `update products set price=320 where prod_id = 'cpu-0001';`
  - `update products set price=200, description='Intel Pentium M 1.7GHz' where prod_id = 'cpu-0001';`

Delete Records

- `delete from table where condition(s);`
- Examples:
  - `delete from orders;`
  - `delete from orders where order_date < '2003-12-31' and ship_date is not null;`
- Drop a database
  - `drop database cs320stu31; -- Don't do this!`
- Drop a table
  - `drop table products;`

Schema Design Example ...

- `public class Customer {
  int id;
  String lastName;
  String firstName;
  String address;
}
public class Product {
  int id;
  String description;
  double price;
} `
**... Schema Design Example**

```java
public class Order {
    int id;
    Date dateOrdered;
    Date dateShipped;
    Customer customer;
    Map<Product, int> products;
}
```

**Simple Schema Design Rules**

<table>
<thead>
<tr>
<th><strong>OO</strong></th>
<th><strong>Relational</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>Table</td>
</tr>
<tr>
<td>Class variables</td>
<td>Attributes</td>
</tr>
<tr>
<td>Java types</td>
<td>SQL types</td>
</tr>
<tr>
<td>References</td>
<td>ID</td>
</tr>
<tr>
<td>Collection</td>
<td>New Table</td>
</tr>
</tbody>
</table>

**Exercises**

- Read MySQL Reference Manual
  - String functions
  - Date and time functions