Administrivia

- Two handouts today:
  - Course details
  - Course survey
- Latest info will always be online!
- Come to class!
- Ask questions!
- Give feedback!
- Have fun!

What is a DBMS?

- A Database Management System manages very large amounts of data and provides:
  - efficient access
  - concurrent access
  - secure, atomic access

Relational Model

- Based on tables, as:

<table>
<thead>
<tr>
<th>acct#</th>
<th>name</th>
<th>balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>12345</td>
<td>David</td>
<td>1000.21</td>
</tr>
<tr>
<td>76543</td>
<td>Brian</td>
<td>89.01</td>
</tr>
<tr>
<td>23500</td>
<td>Monik</td>
<td>555999.02</td>
</tr>
<tr>
<td>34567</td>
<td>Sue</td>
<td>285.48</td>
</tr>
</tbody>
</table>

- Today used in most DBMS's.

The DBMS Marketplace

- Relational DBMS companies – Oracle, Sybase – are among the largest software companies in the world.
- IBM offers its relational DB2 system. With IMS, a nonrelational system, IBM is by some accounts the largest DBMS vendor in the world.
- Microsoft offers SQL-Server, plus Microsoft Access for the cheap DBMS on the desktop, answered by “lite” systems from other competitors.
- Relational companies also challenged by “object-oriented DB” companies.
- But countered with “object-relational” systems, which retain the relational core while allowing type extension as in OO systems.

Three Aspects to Studying DBMS's

1. Modeling and design
   - Allows exploration of issues before committing to an implementation.
2. Programming
   - Queries and DB operations like update.
3. DBMS implementation

CMSC235 = (1) + (2), while (3) will be covered in a future course.
Entity/Relationship Model

Diagrams to represent designs.
- **Entity** like object, = “thing.”
- **Entity set** like class = set of “similar” entities/objects.
- **Attribute** = property of entities in an entity set, similar to fields of a struct.
- In diagrams, entity set $\rightarrow$ rectangle; attribute $\rightarrow$ oval.

### Relationships

- Connect two or more entity sets.
- Represented by diamonds.

```
Students (ID, name, email)
```

#### Relationship Set

Think of the “value” of a relationship set as a table.
- One column for each of the connected entity sets.
- One row for each list of entities, one from each set, that are connected by the relationship.

```
<table>
<thead>
<tr>
<th>Students</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sally</td>
<td>CMSC235</td>
</tr>
<tr>
<td>Sally</td>
<td>CMSC174</td>
</tr>
<tr>
<td>Brian</td>
<td>CMSC235</td>
</tr>
</tbody>
</table>
```

#### Multiway Relationships

Works in CS235, because each TA is a TA of all students. Connection student-TA is only via the course.
- But what if students were divided into sections, each headed by a TA?
  - Then, a student in CS235 would be related to only one of the TA’s for CS235. Which one?
- Need a 3-way relationship to tell.
3-Way Relationship

Students | Courses | TAs
--- | --- | ---
Sally | CMSC235 | Jimmy
Brian | CMSC235 | Sam
Eric | CMSC235 | Sam

Beers-Bars-Drinkers Example

Multiplicity of Relationships

Representation of Many-One
- E/R: arrow pointing to “one.”
- Rounded arrow = “exactly one.”

One-One Relationships

Design Issue:
Is the rounded arrow justified?

Attributes on Relationships

- Shorthand for 3-way relationship:
Attributes on Relationships

- A true 3-way relationship.
  - Price depends jointly on beer and bar.
- Notice arrow convention for multiway relationships: “all other E.S. determine one of these.”
  - Not sufficiently general to express any possibility.
  - However, if price, say, depended only on the beer, then we could use two 2-way relationships: price-beer and beer-bar.
  - Or better: just make price an attribute of beer.

Converting Multiway to 2-Way

- Baroque in E/R, but necessary in certain “object-oriented” models.
- Create a new connecting E.S. to represent rows of a relationship set.
  - E.g., (Joe's Bar, Bud, $2.50) for the Sells relationship.
  - Many-one relationships from the connecting E.S. to the others.

Converting Multiway to 2-Way

- Bars
  - BBP
  - Beer
  - Price
- The-Beer
  - The-Bar
- The-Price
- Prices
- Beers

Roles

- Sometimes an E.S. participates more than once in a relationship.
- Label edges with roles to distinguish.

- Notice Buddies is symmetric, Married not.
  - No way to say “symmetric” in E/R.

**Design Question**
Should we replace husband and wife by one relationship spouse?