CS 235: Introduction to Databases
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Administrivia
- Three handouts today:
  - Course info, Schedule, Slides.
  - 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:
  - persistent storage,
  - efficient access,
  - concurrent access,
  - secure, atomic access.

Examples
- (Almost) Everything is a database!
  - Banking systems
  - Reservation systems
  - Libraries
  - The Web
  - Varying degrees of structure, organization, and efficiency.

Relational Model
- Based on tables, as:

<table>
<thead>
<tr>
<th>acc#</th>
<th>name</th>
<th>balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>12345</td>
<td>Elaine</td>
<td>100000.21</td>
</tr>
<tr>
<td>76543</td>
<td>Cosmo</td>
<td>89.01</td>
</tr>
<tr>
<td>23500</td>
<td>Jerry</td>
<td>555599.02</td>
</tr>
<tr>
<td>34567</td>
<td>Newman</td>
<td>285.48</td>
</tr>
</tbody>
</table>

- Today used in most DBMS’s.

The DBMS Marketplace
- Major vendors:
  - Oracle – 32%
  - IBM: DB2 – 34.6%
  - Microsoft: SQL Server, Access – 16.3%
  - Sybase – 2.6%
- IBM bought Informix for $1B in April 2001.
- Most databases are relational with growing support for XML.
- Most web sites are powered by DBMS.
Relational DBMS Market
- In 2002, $6.6B ($7.1B in 2001)
- Market shares:
  - Oracle has 43%
  - IBM has 33.9%
  - Microsoft has 18%
  - NCR (Teradata) has 2.7%

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; connectivity
3. DBMS implementation
   - What’s under the hood.
   - CS235 = (1) + (2), while (3) will be covered in a future course.

Entity-Relationship Model
- First step of database design.
  - Represent the real world with diagrams.
- Entity corresponds to an object.
- Entity set corresponds to a class.
  - Set of similar objects.
- Attribute = property of entities in entity set.
  - Similar to fields of a struct.

E/R Diagrams
- Entity set \(\rightarrow\) rectangle
- Attribute \(\rightarrow\) oval

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

Relationship Set
- The value of a relationship set is the set of connected entities.
  - Think of the value as a table.
  - One column for each connected entity set.
  - One row for each connection.
Multiway Relationships

- Binary relationships are most common.
- But, sometimes we need a relationship connecting 3 or more entity sets.
- Example: relationship among students, courses, TA's.

Multiway Relationships: Example

Is this E/R diagram correct?

3-Way Relationship

Multiplexity of Relationships

Representation of Many-One
- E/R: arrow pointing to "one."
- Rounded arrow = "exactly one."
- Other conventions also exist.
Drinkers Have Favorite Beers

Bars

\(\text{name} \quad \text{addr} \quad \text{license}\)

Serves

Frequents

Beers

\(\text{name} \quad \text{manf}\)

Likes

Favorite

Drinkers

\(\text{name} \quad \text{addr}\)

One-One Relationships

- Put arrows in both directions.

\[
\begin{array}{ccc}
\text{Manfs} & \searrow & \text{Best-seller} \\
\uparrow & & \downarrow \\
\text{Beers} & & \\
\end{array}
\]

- Design issues:
  - Is the rounded arrow justified?
  - Here, manufacturer is an E.S.; in earlier diagrams it is an attribute. Which is right?

Attributes on Relationships

Bars \(\rightarrow\) Sells \(\rightarrow\) Beers

- Shorthand for 3-way relationship:

Bars \(\rightarrow\) Sells \(\rightarrow\) Beers

Attributes on Relationships

- A true 3-way relationship.
  - Price depends jointly on beer and bar.
- 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.
- Better solution?

Converting Multiway to 2-Way

- Necessary in some object-oriented models.
- Create a new connecting E.S. to represent rows of a relationship set.
  - E.g., (Jimmy’s, Bud, $3.50) for the Sells relationship.
- Many-one relationships from the connecting E.S. to the others.
Roles

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

Notice Buddies is symmetric, Married not.
- Cannot specify symmetric in E/R.
- Should we replace *husband* and *wife* by one relationship *spouse*?