Overview of Database Systems

CPSC 315 – Programming Studio

Project 1, Lecture 1

Project

- Your first project will involve putting together a very basic database system
- There will be a few lectures to give you an overview of database systems
- This is nowhere close to what you would get in a full database course
- Slides adapted from Jennifer Welch (some of hers were from Jeffrey Ullman)

Database Systems

- Systems designed to manage very large amounts of data, and to query that data to pull out useful information
- Often, key considerations include:
  - Efficiency
  - Reliability
  - Ease of access (querying, distributed)

Creating a Database

- A database schema determines what will be represented in the database
- This should be tightly controlled by a database manager
- Specified through a data definition language
Querying Databases

- Once database has been populated, users can *query* the data
- A data manipulation language controls how the user can specify queries, (and thus what types of queries are allowed)
  - SQL is probably the most well-known

Other Database Topics

- “Real” database courses include lots of other things that we’ll be ignoring here
  - More complete theory behind design
  - Query optimization
  - Efficient storage
  - Processing Transactions – grouped queries that provide atomic operations
    - Scheduling, logging, recovery

Entity-Relationship Model

- Way of expressing (in diagrammatic form) a database design
  - Kinds of data and how they connect
- Easy first way to think about databases
- Later, relational model described

Entities and Attributes

- *Entities* are things
- *Entity sets* are collections of those things
- *Attributes* are properties of entity sets
Entity Sets and Attributes

- **Senator**
  - Name
  - Party
  - State
  - Years

- **Bill**
  - Name
  - Text

Relationships

- Connect two or more entity sets

**Values of Relationships**

- The “value” of an entity set is the entities it contains
- The “value” of a relationship is a list of currently related entities (one from each entity set)

<table>
<thead>
<tr>
<th>Senator</th>
<th>Bill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smith</td>
<td>Tax Bill</td>
</tr>
<tr>
<td>Smith</td>
<td>Defense Bill</td>
</tr>
<tr>
<td>Jones</td>
<td>Tax Bill</td>
</tr>
</tbody>
</table>

**Multi-Way Relationships**

- E.g. Lobbyist lobbied Senator about Bill

Diagram:

1. Senator
2. Bill
3. Name
4. Text
5. Party
6. State
7. Years
8. Name
9. Text
10. Sponsorship
11. Writing
12. Contributed
13. Lobbied
14. Organization
15. Lobbyist
Relationship Types

- Consider binary relationships (two entity groups in a relationship)
- One-to-one
  - Each entity can have at most one in the other category
  - e.g. entity groups: Baseball player, Team
    - relationship: Team MVP
  - A team can only have one MVP, and a player can only be MVP for one team.

- Many-to-one
  - Each entity of first set can go to at most one of the second set
  - e.g. entity groups: Person, Town
    - relationship: BornIn
  - A person can be born in only one town, but a town can have many people born there

- Many-to-many
  - Any number from one set to the other
  - e.g. Senators can sponsor many bills, and each bill can be sponsored by many Senators

Diagrams of Relationships

- Arrow shows “to one”
Attributes on Relationships

- Can be converted to multi-way diagrams

```
Person --Born In--> Town
\  \                  /
\   \                /
  Hospital           Hospital
```

Attributes on Relationships

- Note arrows

```
Person --Injured--> Date
\    \                /
\     \               /
  Hospitals          Hospitals
```

Roles

- If multiple references to same entity set, label edges by roles

```
Team

Team Lead

Programmer

Students

Tester
```
Subclass

- Fewer entities, more properties

```
isa
U.S. Representative
District
```

Subclass

- Entity in all subclasses

```
isa
U.S. Representative
Republican
```

Keys

- A key is a set of attributes for an entity set such that no two entities agree on all the attributes.
- We must have a key for every entity set

```
isa
Elected Official
```

Key for multiple attributes

- Must choose one set of attributes

```
isa
Baseball Player
```

For an isa hierarchy, only root can have a key.
Key for multiple attributes

- Must choose *one* set of attributes

Weak entity sets

- Need “help” to determine key

Design Techniques

- Avoid redundancy
  - Say the same thing two ways

Note arrow indicates many to one.
Design Techniques

- Avoid redundancy
  - Say the same thing two ways

- Don’t use entity set if attribute will do
- Entity lists should either
  - Have some non-key attribute
  - Be the “many” in a many-one/many-many relationship

- Don’t overuse weak entity sets
- Usually use unique key for each entity set (e.g. UIN, SSN, VIN)
  - Not always possible, though