Lecture 05:
E/R Diagrams

Wednesday, April 7, 2010
Announcements

• Homework 1 is posted: due April 21st
• You need to create tables, import data:
  – On SQL Server, in your own database, OR
  – On postgres (we will use it for Project 2)
• Follow Web instructions for importing data
• Read book about CREATE TABLE, INSERT, DELETE, UPDATE
Outline

• E/R diagrams
  – Chapter 4.1-4.4

• From E/R diagrams to relations
  – Chapters 4.5
Database Design

• Why do we need it?
  – Agree on structure of the database before deciding on a particular implementation.

• Consider issues such as:
  – What entities to model
  – How entities are related
  – What constraints exist in the domain
  – How to achieve good designs

• Several formalisms exists
  – We discuss E/R diagrams
Entity / Relationship Diagrams

Objects → entities
Classes → entity sets

Attributes:

- first class citizens (not associated with classes)
- not necessarily binary
Keys in E/R Diagrams

- Every entity set must have a key
- May be a *multi-attribute key*:

```
Product:
- prod-ID
- category
- price

Order:
- prod-ID
- cust-ID
- date
```
What is a Relation?

• A mathematical definition:
  – if A, B are sets, then a relation R is a subset of $A \times B$

• $A=\{1,2,3\}, \ B=\{a,b,c,d\}$,
  $A \times B = \{(1,a),(1,b), \ldots, (3,d)\}$
  $R = \{(1,a), (1,c), (3,b)\}$

- makes is a subset of \textbf{Product $\times$ Company}:
Multiplicity of E/R Relations

- one-one:

- many-one

- many-many
What does this say?
Multi-way Relationships

- Product
- Person
- Store
- Purchase
- date
Converting Multi-way Relationships to Binary

Arrows are missing: which ones?
3. Design Principles

What’s wrong?

Product \rightarrow Purchase \rightarrow Person

Country \rightarrow President \rightarrow Person

Moral: be faithful!
Design Principles: What’s Wrong?

Moral: pick the right kind of entities.
Design Principles: What’s Wrong?

Moral: don’t complicate life more than it already is.
From E/R Diagrams to Relational Schema

- Entity set $\rightarrow$ relation
- Relationship $\rightarrow$ relation
Entity Set to Relation

**Product**

<table>
<thead>
<tr>
<th>prod-ID</th>
<th>category</th>
<th>price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gizmo55</td>
<td>Camera</td>
<td>99.99</td>
</tr>
<tr>
<td>Pokemn19</td>
<td>Toy</td>
<td>29.99</td>
</tr>
</tbody>
</table>
CREATE TABLE Product (prod-ID CHAR(30) PRIMARY KEY, category VARCHAR(20), price double)
Relationships to Relations

Shipment \((\text{prod-ID}, \text{cust-ID}, \text{name}, \text{date})\)

<table>
<thead>
<tr>
<th>prod-ID</th>
<th>cust-ID</th>
<th>name</th>
<th>date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gizmo55</td>
<td>Joe12</td>
<td>UPS</td>
<td>4/10/2010</td>
</tr>
<tr>
<td>Gizmo55</td>
<td>Joe12</td>
<td>FEDEX</td>
<td>4/9/2010</td>
</tr>
</tbody>
</table>
Create Table (SQL)

```
CREATE TABLE Shipment(
    name CHAR(30)
      REFERENCES Shipping-Co,
    prod-ID CHAR(30),
    cust-ID VARCHAR(20),
    date DATETIME,
    PRIMARY KEY (name, prod-ID, cust-ID),
    FOREIGN KEY (prod-ID, cust-ID)
      REFERENCES Orders
)
```
Multi-way Relationships to Relations

Product
  prod-ID
  price

Purchase
  name
  address

Store

Person
  ssn
  name

How do we represent that in a relation?
Modeling Subclasses

Products

Software products

Educational products
Understanding Subclasses

• Think in terms of records:
  – Product
    - field1
    - field2
  – SoftwareProduct
    - field1
    - field2
    - field3
  – EducationalProduct
    - field1
    - field2
    - field3
    - field4
    - field5
Subclasses to Relations

Product

<table>
<thead>
<tr>
<th>Name</th>
<th>Price</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gizmo</td>
<td>99</td>
<td>gadget</td>
</tr>
<tr>
<td>Camera</td>
<td>49</td>
<td>photo</td>
</tr>
<tr>
<td>Toy</td>
<td>39</td>
<td>gadget</td>
</tr>
</tbody>
</table>

Sw.Product

<table>
<thead>
<tr>
<th>Name</th>
<th>platforms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gizmo</td>
<td>unix</td>
</tr>
</tbody>
</table>

Ed.Product

<table>
<thead>
<tr>
<th>Name</th>
<th>Age Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gizmo</td>
<td>toddler</td>
</tr>
<tr>
<td>Toy</td>
<td>retired</td>
</tr>
</tbody>
</table>

Dan Suciu -- 444 Spring 2010
Modeling UnionTypes With Subclasses

FurniturePiece

Person

Company

Say: each piece of furniture is owned either by a person, or by a company
Modeling Union Types with Subclasses

Say: each piece of furniture is owned either by a person, or by a company

Solution 1. Acceptable (What’s wrong?)

[Diagram showing classes and relationships: Person, Company, FurniturePiece, ownedByPerson]
Modeling Union Types with Subclasses

Solution 2: More faithful
Constraints in E/R Diagrams

Finding constraints is part of the modeling process. Commonly used constraints:

**Keys:** social security number uniquely identifies a person.

**Single-value constraints:** a person can have only one father.

**Referential integrity constraints:** if you work for a company, it must exist in the database.

**Other constraints:** peoples’ ages are between 0 and 150.
Keys in E/R Diagrams

Underline:

- Multi-attribute key
- v.s.
- Multiple keys

Not possible in E/R
Single Value Constraints

makes

v. s.

makes
Referential Integrity Constraints

Each product made by at most one company. Some products made by no company

Each product made by exactly one company.
Other Constraints

What does this mean?
Weak Entity Sets

Entity sets are weak when their key comes from other classes to which they are related.

Notice: we encountered this when converting multiway relationships to binary relationships.
Handling Weak Entity Sets

How do we represent this with relations?