Lecture 07
Data Modeling: E/R Diagrams
Monday, October 14, 2002

Outline
- E/R diagrams (Chapter 2)
- From E/R diagrams to relations (3.2, 3.3)

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

Database Design Formalisms
1. Object Definition Language (ODL):
  - Closer in spirit to object-oriented models
  - Will not cover in class
2. Entity/Relationship model (E/R):
  - More relational in nature.
  - Very widely used
- Both can be translated (semi-automatically) to
  relational schemas
- ODL to OO-schema: direct transformation (C++
or Smalltalk based system).

Entity / Relationship Diagrams

Objects ——> entities
Classes ——> entity sets

Attributes are like in ODL.
Relationships: like in ODL except
  - first class citizens (not associated with classes)
  - not necessarily binary
Keys in E/R Diagrams

- Every entity set must have a key

![Diagram showing key attributes in an E/R diagram]

What is a Relation?

- A mathematical definition:
  - if A, B are sets, then a relation R is a subset of A x B
  - \( A = \{1,2,3\}, \ B = \{a,b,c,d\}, \ A = \{1,a\}, (1,c), (3,b) \)
  - \textit{makes} is a subset of \textbf{Product \times Company}:

![Diagram showing a relation between Product and Company]

Multiplicity of E/R Relations

- one-one:
- many-one:
- many-many:

![Diagrams depicting various multiplicity relations]

Multi-way Relationships

How do we model a purchase relationship between buyers, products and stores?

![Diagram showing multi-way relationships]

Can still model as a mathematical set (how?)

Arrows in Multiway Relationships

Q: what does the arrow mean?

A: if I know the store, person, invoice, I know the movie too

![Diagram showing multi-way relationships with arrows]

1. Keys in E/R Diagrams
2. What is a Relation?
3. Multiplicity of E/R Relations
4. Multi-way Relationships
5. Arrows in Multiway Relationships
Arrows in Multiway Relationships

Q: what do these arrows mean?

A: store, person, invoice determines movie and store, invoice, movie determines person

Q: how do I say “invoice determines store”?

A: no good way; best approximation:

Q: Why is this incomplete?

Roles in Relationships

What if we need an entity set twice in one relationship?

Attributes on Relationships

Converting Multi-way Relationships to Binary

From E/R Diagrams to Relational Schema

- Entity set \( \rightarrow \) relation
- Relationship \( \rightarrow \) relation
Entity Set to Relation

Product

<table>
<thead>
<tr>
<th>name</th>
<th>category</th>
<th>price</th>
</tr>
</thead>
<tbody>
<tr>
<td>gizmo</td>
<td>gadgets</td>
<td>$19.99</td>
</tr>
</tbody>
</table>

Relationships to Relations

Makes

<table>
<thead>
<tr>
<th>product-name</th>
<th>product-category</th>
<th>company-name</th>
<th>year</th>
</tr>
</thead>
<tbody>
<tr>
<td>gizmo</td>
<td>gadgets</td>
<td>gizmoWorks</td>
<td>1963</td>
</tr>
</tbody>
</table>

(no watch out for attribute name conflicts)

Relationships to Relations

No need for Makes. Modify Product:

<table>
<thead>
<tr>
<th>name</th>
<th>category</th>
<th>price</th>
<th>StartYear</th>
<th>companyName</th>
</tr>
</thead>
<tbody>
<tr>
<td>gizmo</td>
<td>gadgets</td>
<td>19.99</td>
<td>1963</td>
<td>gizmoWorks</td>
</tr>
</tbody>
</table>

Multi-way Relationships to Relations

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.

Modeling Subclasses

Some objects in a class may be special
• define a new class
• better: define a subclass

So --- we define subclasses in E/R

Subclasses

Understanding Subclasses

• Think in terms of records:
  – Product
    field1
    field2
  – SoftwareProduct
    field1
    field2
  – EducationalProduct
    field1
    field2

Difference between ODL and E/R inheritance

• ODL: classes are disjoint
Difference between ODL and E/R inheritance

- E/R: entity sets overlap

Modeling Subclass Structure

Modeling Union Types with Subclasses

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

Solution 1. Acceptable, imperfect (What’s wrong?)

Modeling Union Types with Subclasses

Solution 2: better, more laborious