Data Storage and Formats
E-R modeling

Lecture 3
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Some figures are borrowed from the ppt slides from the book used in the course, Database Systems by Kiefer, Bernstein, Lewis. Copyright © 2006 Pearson, Addison-Wesley, all rights reserved.

Today’s lecture
• E-R model
  - The concepts and symbols
    • entities
    • relationships
    • cardinality
    • type hierarchies
    • weak entities
• Translation to a schema in SQL

Problem session
You have learned about E-R modeling in your first year.

Draw an E-R model for the address book containing information about people’s phone numbers and addresses.

Database design
1. E-R or UML modeling
   - E-R stands for Entity-Relationship
   - UML stands for Unified Modeling Language
     • More general design tool than E-R model
2. Design from stage 1 is refined using normalization theory
   - To solve redundancy problems
   - Later in the course

Entity
• An entity models an object
• An entity type models a class of entities (rectangles)
  • Described by attributes (ovals)
  • Can have a key (underlined)

Contrary to the relational model, attributes can be sets (double oval).

A schema for an entity type
• the name,
  • attributes (single valued or set valued) and their domain, and
  • key constraints.
A relationship (diamond) models the mechanism that relates entities to each other. A relationship may have attributes.

A relationship is connected to one, two or more entity types, called roles. A role specifies how an entity participates in a relationship.

One entity can participate in several roles in a relationship.

Cardinality constraints

- Constraints the number of times an entity can participate in a relationship in a specific role.
- Has the form min..max.
- Can be expressed explicitly or by different types of arrows

Example

When min≥1 a cardinality constraint is called a participation constraint.
Cardinality notation

- 0.0 (or nothing at all)
- 0.1
- 1.*
- 1.1 (or just 1)

Example/Problem session

E-R diagram for case in first week’s exercises:

Question 1 from Exam in Introduction to databases, January 2006.

Read the text and find suggestions for entities and relationships

Type hierarchy (IsA)

- When an entity type A is a supertype of entity type B it means that an instance of B is also an instance of A.

- A classification hierarchy where attributes are inherited.

- IsA relationship is a relationship describing a type hierarchy.

- Covering constraint: All instances of a supertype are also instances of some subtype.

- Disjointness constraint: Every instance of a supertype is only an instance of one subtype

Weak entity types
Weak entity types
(or exclusive part-of)

- Definition:
  A \textit{weak entity} needs a foreign key to be uniquely identified.

- In the E-R model the foreign key must be modeled as a relationship. This is called an \textit{identifying relationship}.

Translation of E-R diagrams to relational schemas

- Step-by-step description in the book for translating a E-R diagram to a schema in SQL
- Also a creative process – there is not always only one way of doing it, and there may be things in the E-R diagram that can’t (easily) be expressed in SQL

Entities

(To start with ignore all set valued attributes)
- Entity type becomes a relation
- Attributes become attributes
- The key attributes become primary key

Relationships

- The relationship becomes the relation
- Attributes:
  - Attributes of the relationship
  - The primary keys of the roles involved in the relationship (declare them NOT NULL)
- Candidate keys:
  - The attributes in the key
  - The primary keys from the roles in the key
  - One candidate key is chosen as primary key
- Foreign key constraints:
  - The primary keys of the roles

A very common special case:
One of the entities participate 0 or 1 time in a relationship.

The information can be \textit{merged} instead of creating a new relation.

Examples:
\textit{STUDENT} can store Since and primary key of \textit{PROGRAM}
\textit{EMPLOYEE} can store primary key for the Supervisor
\textit{PERSON} can store Date and SSN for Husband or Wife, resp.
Set valued attributes
- A set valued attribute can be expressed as a relationship instead:

![Diagram showing set valued attributes]

Each set-valued attribute becomes a relation.

IsA
Can be done in different ways.

One way:
Treat is exactly like any other relationship.

Another way:
- each entity type becomes a relation
- all relations use the same primary key
  - the key of the top entity type
- use parent entity type as foreign key to define the hierarchy

Weak entities
- The primary key contains
  - key attributes for the entity type
  - primary key attributes of the master entity types.
- Otherwise as other entity types.

Problem session
Convert the E-R diagram (from IDB04 exam) to relational schemas in SQL (Arrow = 0..1):