Database Design I: The Entity-Relationship Model

Chapter 5

1

Database Design

- Goal: specification of database schema
- Methodology:
  - Use *E-R model* to get a high-level graphical view of essential components of enterprise and how they are related
  - Convert E-R diagram to DDL
- *E-R Model*: enterprise viewed as set of
  - *Entities*
  - *Relationships* among entities

2

Entities

- *Entity*: an object that is involved in the enterprise
  - Ex: John, CSE305
- *Entity Type*: set of similar objects
  - Ex: students, courses
- *Attribute*: describes one aspect of an entity type
  - Ex: name, maximum enrollment

3

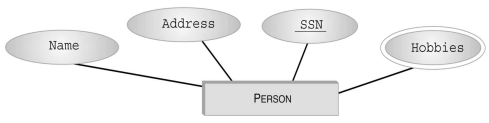
Entity Type

- Entity type described by set of attributes
  - Student: *Id*, *Name*, *Address*, *Hobbies*
- *Domain*: possible values of an attribute
  - Value can be a set (in contrast to relational model)
    - (111111, John, 123 Main St, (stamps, coins))
- *Key*: minimum set of attributes that uniquely identifies an entity (candidate key)
- *Entity Schema*: entity type name, attributes (and associated domain), key constraints

4

Entity Type (con't)

- Graphical Representation in E-R diagram:



6

Representation in Relational Model

- Entity type corresponds to a relation
- Relation's attributes = entity type's attributes
  - *Problem*: entity type can have set valued attributes.
  - *Solution*: Use several rows to represent a single entity
    - (111111, John, 123 Main St, stamps)
    - (111111, John, 123 Main St, coins)
  - Problems with solution:
    - Redundancy
    - Key of entity type not key of relation
    - => resulting relation must be further transformed

5

Relationship

- Relationship: relates two or more entities
  - John *majors in* Computer Science
- Relationship Type: set of similar relationships
  - Student (entity type) related to Department (entity type) by MajorsIn (relationship type).
- Distinction -
  - relation (relational model) - set of tuples
  - relationship (E-R Model) – describes relationship between entities of an enterprise
  - Both entity types and relationship types (E-R model) are mapped to relations (relational model)

7

Attributes and Roles

- *Attribute* of a relationship type describes the relationship
  - e.g., John majors in CS *since* 2000
    - John and CS are related
    - 2000 describes relationship - value of SINCE attribute of MajorsIn relationship type
- *Role* of a relationship type names one of the related entities
  - e.g., John is value of *Student* role, CS value of *Department* role of MajorsIn relationship type
  - (John, CS, 2000) describes a relationship

8

Relationship Type

- Described by set of attributes and roles
  - e.g., MajorsIn: *Student*, *Department*, *Since*
  - Here we have used as the role name (*Student*) the name of the entity type (Student) of the participant in the relationship, but ...

9

Roles

- *Problem*: relationship can relate elements of same entity type
  - e.g., *ReportsTo* relationship type relates two elements of Employee entity type:
    - Bob reports to Mary since 2000
  - We do not have distinct names for the roles
  - It is not clear who reports to whom

10

Roles (con't)

- *Solution*: role name of relationship type need not be same as name of entity type from which participants are drawn
  - ReportsTo has roles *Subordinate* and *Supervisor* and attribute *Since*
  - Values of *Subordinate* and *Supervisor* both drawn from entity type Employee

11

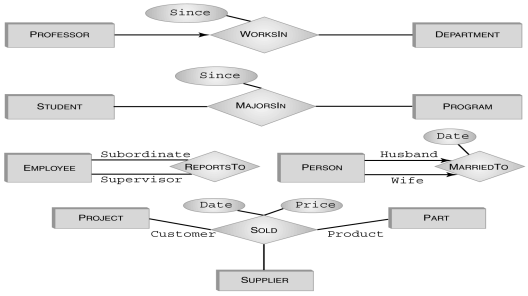
Schema of a Relationship Type

- *Role names*, R_i, and their corresponding entity sets. Roles must be single valued (number of roles = degree)
- *Attribute names*, A_j, and their corresponding domains. Attributes may be set valued
- *Key*: Minimum set of roles and attributes that uniquely identify a relationship
- *Relationship*: $<e_1, \ldots e_n; a_1, \ldots a_k>$
  - e_i is an entity, a value from R_i's entity set
  - a_j is a set of attribute values with elements from domain of A_j

12

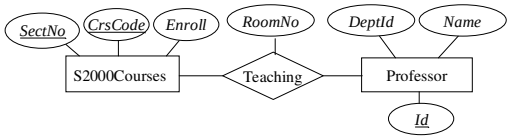
Graphical Representation

- Roles are edges labeled with role names (omitted if role name = name of entity set). Most attributes have been omitted.



Representation of Relationship Type in Relational Model

- Attributes of corresponding relation are
  - Attributes of relationship type
  - For each role, the primary key of the entity type associated with that role
- Ex.:



  - S2000Courses (*CrsCode*, *SectNo*, *Enroll*)
  - Professor (*Id*, *DeptId*, *Name*)
  - Teaching (*CrsCode*, *SecNo*, *Id*, *RoomNo*)

14

Representation in Relational Model

- Candidate key of corresponding table = candidate key of relation
  - Except when there are set valued attributes
  - Example: Teaching (*CrsCode, SectNo, Id, RoomNo, TA*)
    - Key of relationship type = (*CrsCode, SectNo*)
    - Key of relation = (*CrsCode, SectNo, TA*)

CrsCode	*SectNo*	*Id*	*RoomNo*	*TA*
CSE305	1	1234	Hum 22	Joe
CSE305	1	1234	Hum 22	Mary

15