Lecture 14: Entity Relationship Modelling

The Entity-Relationship Model

- **Entities**
- **Relationships**
- **Attributes**

Constraining the instances

- Cardinalities
- Identifiers
- Generalization

The Entity Relationship Schema

- Describes data requirements for a new information system
- Direct, easy-to-understand graphical notation
- Translates readily to relational schema for database design
  - But more abstract than relational scheme
  - E.g. can represent an entity without knowing its properties
- Comparable to UML class diagrams

Entities:

- Classes of objects with properties in common and an autonomous existence
  - E.g. City, Department, Employee, Purchase and Sale
  - An instance of an entity is an object in the class represented by the entity
    - E.g. Stockholm, Helsinki, are examples of instances of the entity City

Relationships:

- Logical links between two or more entities
  - E.g. Residence is a relationship that can exist between the City and Employee
  - An instance of a relationship is an n-tuple of instances of entities
    - E.g. the pair (Johanssen, Stockholm), is an instance in the relationship Residence

Examples

- STUDENT
- EXAM
- COURSE
- WORKPLACE
- EMPLOYEE
- RESIDENCE
- CITY

Example Instances for Exam

- Student
- Exam
- Course
- E1
- E2
- E3
- C1
- C2
- C3
- S1
- S2
- S3
What Does An E-R Diagram Really Mean?

→ Course and Room are entities.
  % Their instances are particular courses (e.g., CSC430F) and rooms (e.g., MB128)
→ Meets is a relationship.
  % Its instances describe particular meetings.
  % Each meeting has exactly one associated course and room

Recursive Relationships

→ an entity can have relationships with itself...

Recursive Relationships

→ If the relationship is not symmetric...
  % ...need to indicate the two roles that the entity plays in the relationship.

Ternary Relationships

Contains Order Product Part
Order XOR
Requests Service
FilledBy Shipment
Order AND
Generates Invoice

AND/XOR Relationships

"Each Order either contains a part or requests a service, but not both"

"For any given order, whenever there is at least one invoice there is also at least one shipment and vice versa"
Attributes

→ associates with each instance of an entity (or relationship) a value belonging to a set (the domain of the attribute).

The domain determines the admissible values for the attribute.

Composite Attributes

→ These group attributes of the same entity or relationship that have closely connected meanings or uses.

Cardinalities

→ Cardinalities constrain participation in relationships

- maximum and minimum number of relationship instances in which an entity instance can participate.

E.g.

- If a=0 then entity participation in a relationship is optional
- If a=1 then entity participation in a relationship is mandatory
- If b=1 each instance of the entity is associated at most with a single instance of the relationship
- If b=”N” then each instance of the entity is associated with an arbitrary number of instances of the relationship.
Cardinality Example

“A course meets twice a week”

Course (2,2) —> Meets (0,40) —> Room

“A day can have an unlimited number of meetings”

Day (0,N)

“An ER diagram specifies what states are possible in the world being modeled”

Course (2,2) —> Meets (0,40) —> Room

Instantiating ER diagrams

Cardinalities of Attributes

→ Attributes can have cardinalities

- To describe the minimum and maximum number of values of the attribute associated with each instance of an entity or a relationship.
- The default is (1,1)
- Optional attributes have cardinality (0,1)

→ Multi-valued attribute cardinalities are problematic

- Usually better modeled with additional entities linked by one-to-many (or many-to-many) relationships

Illegal Instantiations

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Identifiers (also known as “keys”)

→ How to uniquely identify instances of an entity?
% An identifier may be identified by one or more attributes of the entity itself
% If attributes of an entity are not sufficient to identify instances uniquely, other entities can be involved in the identification
% A relationship is identified using identifiers for all the entities it relates
  > E.g.: the identifier for the relationship (Person-) Owns-(Car) is a combination of the Person and Car identifiers.

internal, single-attribute

external, multi-attribute

internal, multi-attribute

Schema with Identifiers

Notes on Identifiers

→ Identifiers and cardinality:
% An identifier can involve one or more attributes, provided that each has (1,1) cardinality
% An external identifier can involve one or more attributes, provided that each is a member of a relationship to which the entity to identify participates with cardinality (1,1)

→ Cycles
% An external identifier can involve an entity that is in its turn identified externally, as long as cycles are not generated;

→ Multiple identifiers
% Each entity must have at least one (internal or external) identifier
% An entity can have more than one identifier
  > Note: if there is more than one identifier, then the attributes and entities involved in an identification can be optional (minimum cardinality equal to 0).

Notes on Identifiers

→ Identifiers provide an important modelling tool
% E.g. Assume we want a database storing information about lecture meetings.
  > If we use the identifier <coursename, day, hour> for the Meeting entity,
    > This says there can only be one meeting at any one time for a given course name, day, hour; we can’t have two sections of the same course meeting at the same day+hour
  > If we use only <coursename> as identifier for Meeting,
    > This says that there can only be one meeting per given course name (unreasonable)
  > If we use <courseinstructor, room> as identifier for Meeting,
    > We are stating that there can only be one meeting for a given instructor+room combination, so an instructor must have all her meetings in different rooms!
  > If we use <courseinstructor> by itself as identifier for Meeting,
    > We are stating that each instructor participates in at most one meeting (unreasonable)
### Generalizations

- **Show “is-a” relationships between entities**
  - Inheritance:
    - Every instance of a child entity is also an instance of the parent entity
    - Every property of the parent entity (attribute, identifier, relationship or other generalization) is also a property of a child entity

### Types of Generalizations

- **Total generalizations:**
  - Every instance of the parent entity is an instance of one of its children
  - Shown as a solid arrow
  - (otherwise: Partial, shown as an unfilled arrow)

- **Exclusive generalizations:**
  - Every instance of the parent entity is at most an instance of one of its children
  - (otherwise: overlapping)

### The E-R Meta-Model (as an E-R Diagram)