Chapter 3
The Enhanced E-R Model

Objectives

• Define terms
• Understand use of supertype/subtype relationships
• Understand use of specialization and generalization techniques
• Specify completeness and disjointness constraints
• Develop supertype/subtype hierarchies for realistic business situations
What is the EE-R Model?

- The Enhanced E-R model (EE-R) is an extended E-R model with new modeling constructs.
- Why the EE-R model?
  - The business environment has changed dramatically.
  - Business relationships and data are more complex.

Supertypes and Subtypes

- **Supertype**: A generic entity type that has a relationship with one or more subtypes (Fig. 3-1, 2)
- **Subtype**: A subgrouping of the entities in an entity type which has attributes that are distinct from those in other subgroupings
- **Inheritance**:  
  - Subtype entities inherit values of all attributes of the supertype  
  - An instance of a subtype is also an instance of the supertype
Different modeling tools may have different notation for the same modeling constructs.
Relationships and Subtypes

• Relationships at the **supertype** level indicate that all subtypes will participate in the relationship.

• The instances of a **subtype** may participate in a relationship unique to that subtype. In this situation, the relationship is shown at the subtype level (Fig. 3-3).

• Subtype entities **inherit** values of all attributes of the supertype.

• An occurrence of a subtype is also an occurrence of the supertype.
Generalization and Specialization

- **Generalization**: The process of defining a more general entity type from a set of more specialized entity types. BOTTOM-UP (Fig. 3-4)
- **Specialization**: The process of defining one or more subtypes of the supertype, and forming supertype/subtype relationships. TOP-DOWN (Fig. 3-5)
Figure 3-4 Example of Generalization

a) Three entity types: CAR, TRUCK, and MOTORCYCLE

All these types of vehicles have common attributes

Figure 3-4 Example of Generalization (cont.)

b) Generalization to VEHICLE supertype

So we put the shared attributes in a supertype

Note: no subtype for motorcycle, since it has no unique attributes, and it has no unique relationships.
Figure 3-5 Example of **Specialization**

a) Entity type PART

- **Part No**
- **Description**
- **Qty on Hand**
- **Location**
- **Routing Number**
- {**Supplier**
  - (**Supplier ID**, **Unit Price**)}

- Only applies to manufactured parts
- Applies only to purchased parts

b) Specialization to MANUFACTURED PART and PURCHASED PART

- Created 2 subtypes
- Note: multivalued attribute was replaced by an associative entity relationship to another entity
Constraints in Supertype/Subtype Relationships

- **Completeness Constraints**: Whether an instance of a supertype must also be a member of at least one subtype.
  - Total Specialization Rule: Yes (Fig. 3-6a - double line convention)
  - Partial Specialization Rule: No (Fig. 3-6b - single line convention)

Figure 3-6 Examples of Completeness constraints

a) **Total Specialization rule**

A patient must be either an Outpatient or a Resident Patient.
Figure 3-6 Examples of completeness constraints (cont.)

b) Partial Specialization rule

A vehicle can be a Car, a Truck, but does not have to be either

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At a weekend retreat, the entity type PERSON has three subtypes: CAMPER, BIKER, and RUNNER. Draw a separate EER diagram segment for each of the following situations:

a) At a given time, a person must be exactly one of these subtypes.

b) A person may or may not be one of these subtypes. However, a person who is one of these subtypes cannot at the same time be one of the other subtypes.

c) A person may or may not be one of these subtypes. On the other hand, a person may be any two (or even three) of these subtypes at the same time.

d) At a given time, a person must be at least one of these subtypes.
Constraints in Supertype/
Disjointness constraint

• **Disjointness Constraints**: Whether an instance of a supertype may *simultaneously* be a member of two (or more) subtypes.
  – **Disjoint Rule**: An instance of the supertype can be only ONE of the subtypes
  – **Overlap Rule**: An instance of the supertype could be more than one of the subtypes
Figure 3-7 Examples of disjointness constraints

a) Disjoint rule

A patient can either be an Outpatient or a Resident Patient, but not both.

b) Overlap rule

A part may be both a Purchased Part and a Manufactured Part at the same time, but must be one or the other due to Total Specialization.
Constraints in Supertype/Subtype Discriminators

• **Subtype Discriminator.** An attribute of the supertype whose values determine the target subtype(s)
  
  – **Disjoint** – a *simple* attribute with alternative values to indicate the possible subtypes (Fig. 3-8)
  
  – **Overlapping** – a *composite* attribute whose subparts pertain to different subtypes. Each subpart contains a boolean value to indicate whether or not the instance belongs to the associated subtype (Fig. 3-9)
  
  – Summary Example (Fig. 3-10)

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**Figure 3-8 Introducing a subtype discriminator (disjoint rule)**

- Implementation:
  
  C++:
  ```cpp
  switch(Employee_Type) {
  case 'C':
  ..
  } SQL: IF/THEN/ELSE
  
  A simple attribute with different possible values of H, S, or C for disjoint subtypes/

- Diagram:
Figure 3-9 Subtype discriminator (*overlap* rule)

A composite attribute with sub-attributes indicating “yes”, “no” or both (“yes” and “no”) to determine whether it is of each subtype.

Figure 3-10 Example of supertype/subtype hierarchy

Common attributes for all levels

Inherit all attributes from all supertypes
Add a subtype discriminator for each supertype:
A bank has three types of accounts: checking, savings, and loan.

Following are the attributes for each type of account:
- CHECKING: Acct No, Date Opened, Balance, Service Charge
- SAVINGS: Acct No, Date Opened, Balance, Interest Rate
- LOAN: Acct No, Date Opened, Balance, Interest Rate, Payment

Assume that each bank account must be a member of exactly one of these subtypes. Using generalization, develop an EER model segment to represent this situation using the traditional EER notation.