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

• **Subtype**: A subgrouping of the entities in an entity type that has attributes distinct from those in other subgroupings

• **Attribute Inheritance**:
  – Subtype entities inherit 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
Supertypes and Subtypes

- Give another supertype / subtype example.
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.

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Figure 3-3 -- Supertype/subtype relationships in a hospital
Generalization and Specialization

- **Generalization**: The process of defining a more general entity type from a set of more specialized entity types: BOTTOM-UP

- **Specialization**: The process of defining one or more subtypes of the supertype, and forming supertype/subtype relationships: TOP-DOWN

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**Figure 3-4 Example of Generalization**

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

![Diagram showing CAR, TRUCK, and MOTORCYCLE entities with shared attributes]

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

Applies only to manufactured parts

Applies only to purchased parts
b) Specialization to MANUFACTURED PART and PURCHASED PART

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 (double line)
  – Partial Specialization Rule: No (single line)
Figure 3-6 Examples of Completeness constraints

a) Total Specialization rule

b) Partial Specialization rule
Constraints in Supertype/Subtype Relationships

- **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
b) Overlap rule

Constraints in Supertype/Subtype Relationships

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

Implementation:
C++:
```c++
switch(Employee_Type) {
   case 'C':
      ..
}
```
SQL:
```
IF/THEN/ELSE
```

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

Subtype discriminator is a composite attribute when there is an overlap rule.
Figure 3-10 Example of supertype/subtype hierarchy

Common attributes for all levels

PERSON
- SSN
- Name
- Address
- Gender
- Date_of_Birth

EMPLOYEE
- Salary
- Date_Hired

ALUMNUS
- [Degree (Year, Designation, Date)]

STUDENT
- Major_Dept

FACULTY
- Rank

STAFF
- Position

GRADUATE
- STUDENT
- Test_Score

UNDERGRAD
- STUDENT
- Class_Standing

Inherit all attributes from all supertypes

Add a subtype discriminator for each supertype:
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.
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.