Chapter4 The enhanced E-R model and business rules

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Outline

- Introduction
- Representing supertypes and subtypes
- Specifying constraints in supertype/subtype relationships
- Entity clustering
- Business rules revisited
- Summary

Introduction

◆ **Complex relationship, complex data**

  E.g., Organizations segment their markets and to customize their products

◆ **EER (Enhanced Entity-Relationship) model**:

  - Extend the original E–R model

  - Important characteristics and constructs of EER model

    ① supertype/subtype (inheritance)

    ② entity clustering

      ＊hierarchical decomposition technique

      ＊give attention to the details of the model that matters most

      ＊get a more macro-level view of the same data

Representing supertypes and subtypes

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Subtype and supertype

◆ **Motivating example**

Student —— graduate student, undergraduate student, …

Vehicle —— car, truck, motorcycle, racing car, …
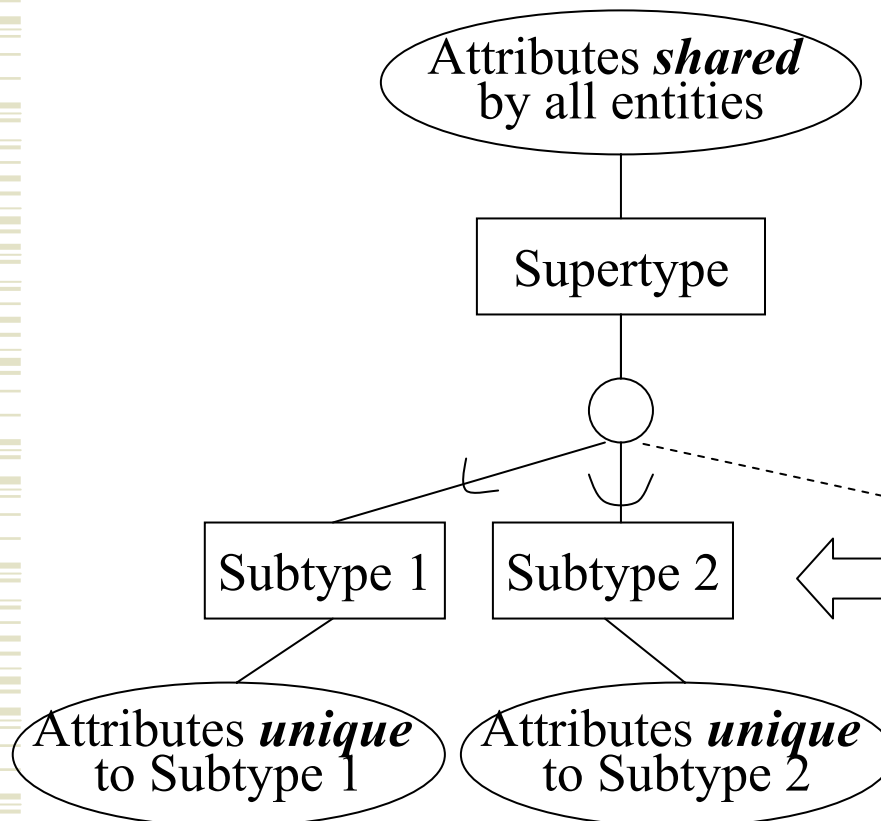
- Subtype:

A subgrouping of the entities in an entity type that is meaningful to the organization and shares common attributes or relationships distinct from other subgroupings.

- Supertype:

A generic entity type that has a relationship with one or more subtypes.
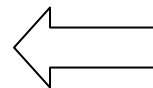
Basic concepts and notation

◆ **Basic concepts and notation**

Attributes *shared* by all entities

Supertype

Subtype 1   Subtype 2

Attributes *unique* to Subtype 1

Attributes *unique* to Subtype 2

Note:
- supertype/subtype relationship:
  A line + a circle + a line
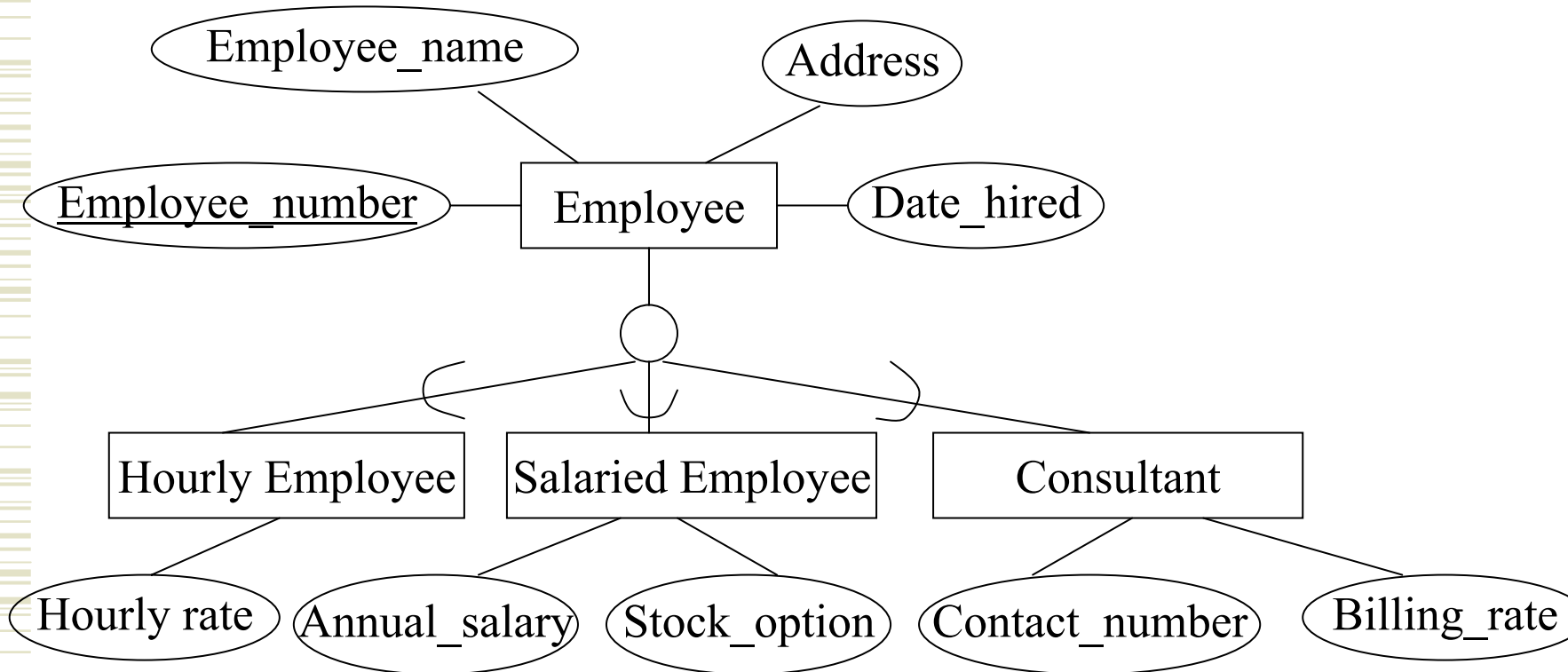- the direction of the supertype/subtype relationship:
  A U-shaped symbol

… …

Specialized versions of Supertype

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An Example of a supertype and subtypes

◆ **An example**

Attribute inheritance

◆ **Attribute inheritance**

- A property by which subtype entities inherit values of all attributed of the supertype

- Makes it unnecessary to include the subtype attributes redundantly with the subtypes

When should supertype-subtype relationships be used ?

- The attribute sets have a intersection, but not completely same
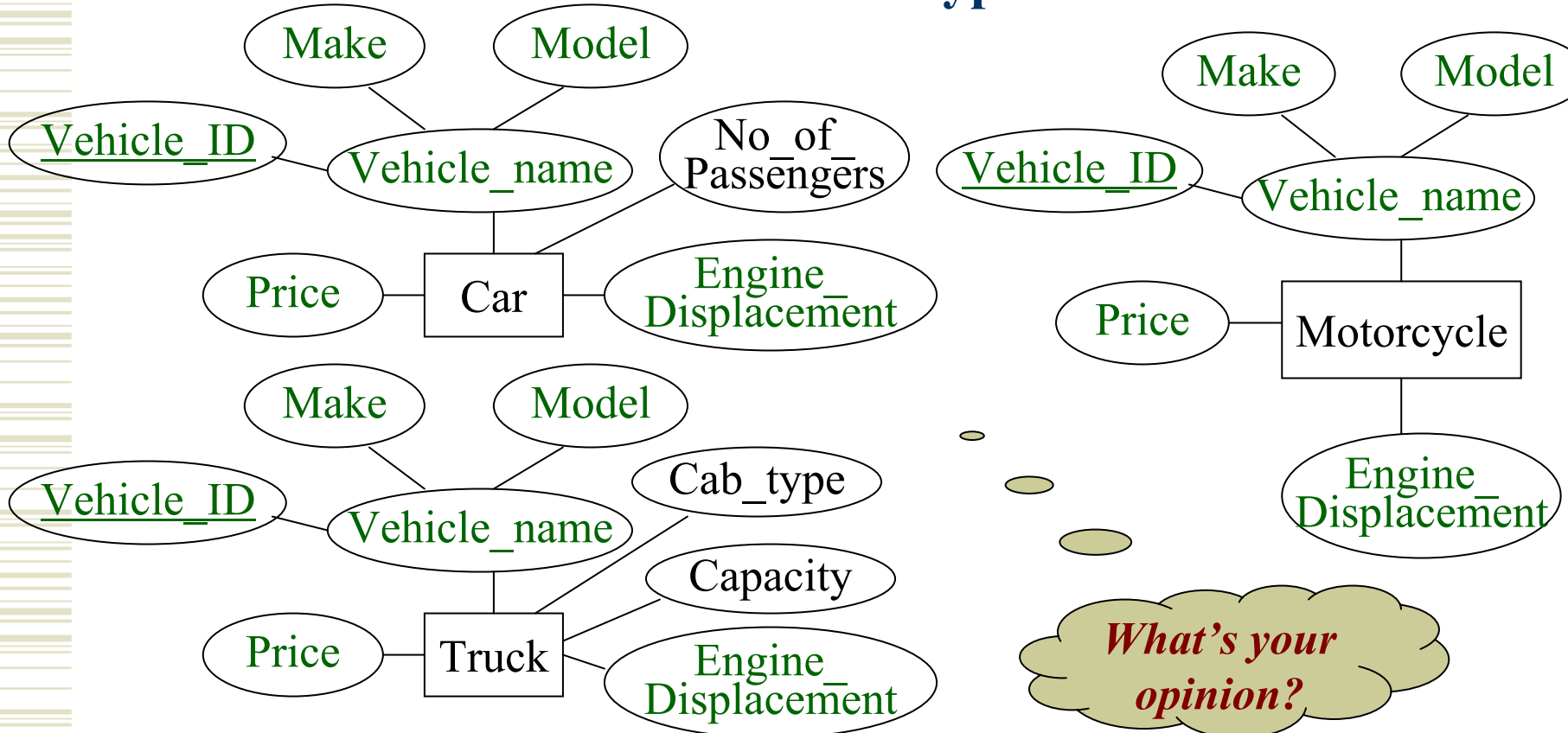- The instances of a subtype participate in a relationship unique to that subtype

Example:
Patient —— Outpatient, Resident Patient
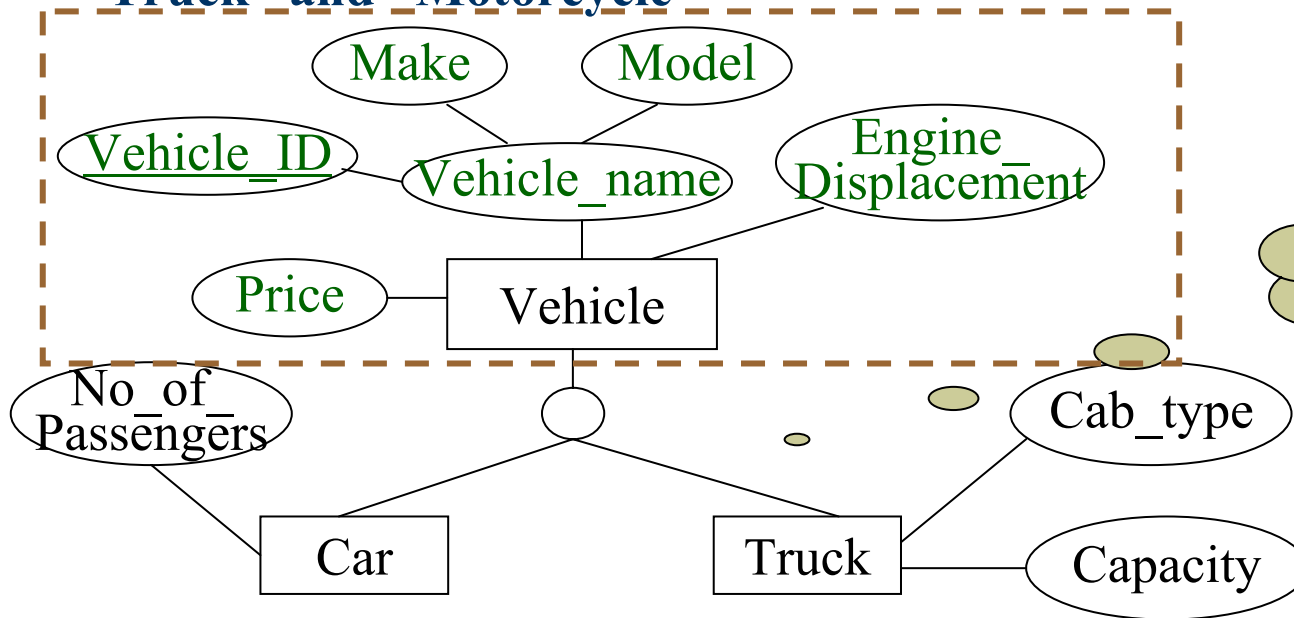One bed should *be assigned to* a resident patient.

Representing generalization and specification (1)

◆ **Generalization of three entities types:**

Make   Model

Vehicle_ID

Vehicle_name   No_of_Passengers

Price   Car   Engine_Displacement

Make   Model

Vehicle_ID   Vehicle_name

Price   Motorcycle

Engine_Displacement

Make   Model

Vehicle_ID   Vehicle_name   Cab_type

Capacity

Price   Truck   Engine_Displacement

What's your opinion?

Representing generalization and specification (2)

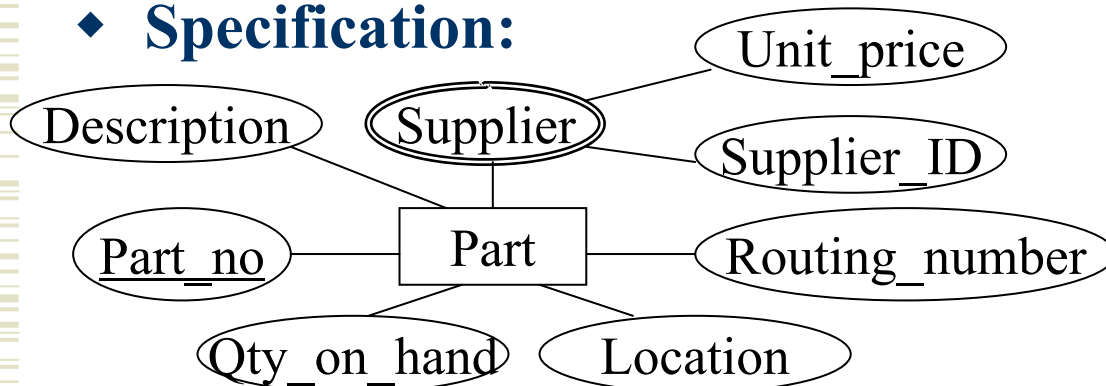◆ **Generalization to "Vehicle" from three entities types: "Car", "Truck" and "Motorcycle"**

Generalization:

① bottom-up process;

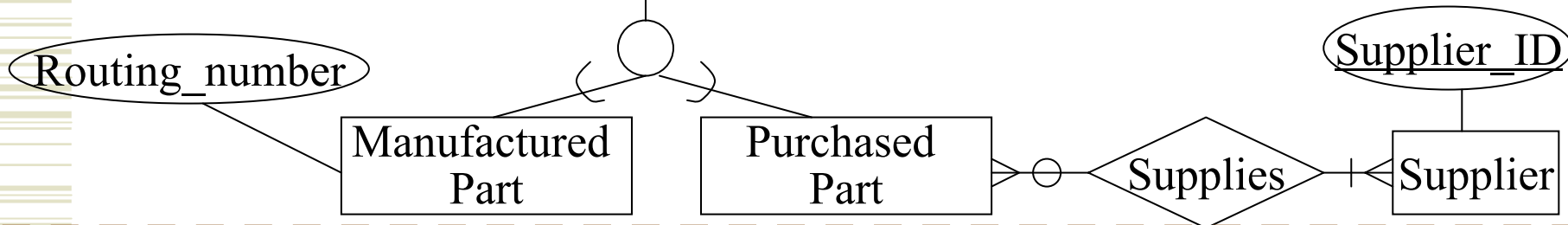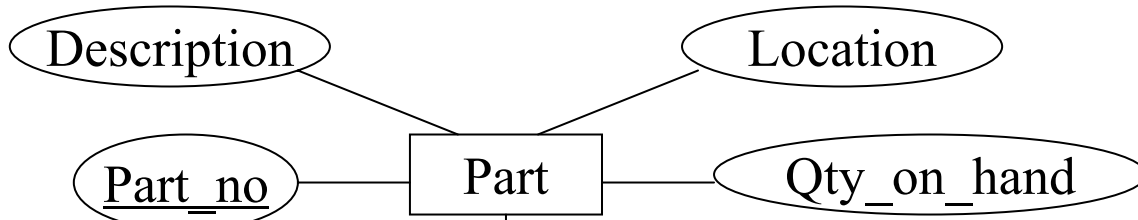② define a more general entity type from a set of more specialized entity types

Representing supertypes and subtypes (3)

◆ **Specification:**

Description · Supplier · Unit_price · Supplier_ID · Part · Part_no · Routing_number · Qty_on_hand · Location

Specification:
① top-down process;
② define one or more subtypes of the supertype, form supertype/subtype relationships

Description · Location · Part · Part_no · Qty_on_hand

Routing_number · Manufactured Part · Purchased Part · Supplies · Supplier · Supplier_ID

Discussion

- The combination of generalization and specification?
- How to apply generalization and specification to practical development?
- Object-oriented ideas in data modeling?

Specifying constraints in supertype/subtype relationship

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Specifying completeness constraints (1)

◆ Whether an instance of a supertype must also be a member of at least one subtype?

◆ **Rules**

- *Total specification rule*:

  Each entity instance of the supertype must be a member of some subtype in the relationship
  E.g., Patient —— Outpatient, Resident Patient
      Each Patient instance must belong to Outpatient or Resident Patient

- *Partial specification rule*:

  An entity instance of the supertype is allowed not to belong to any subtype.
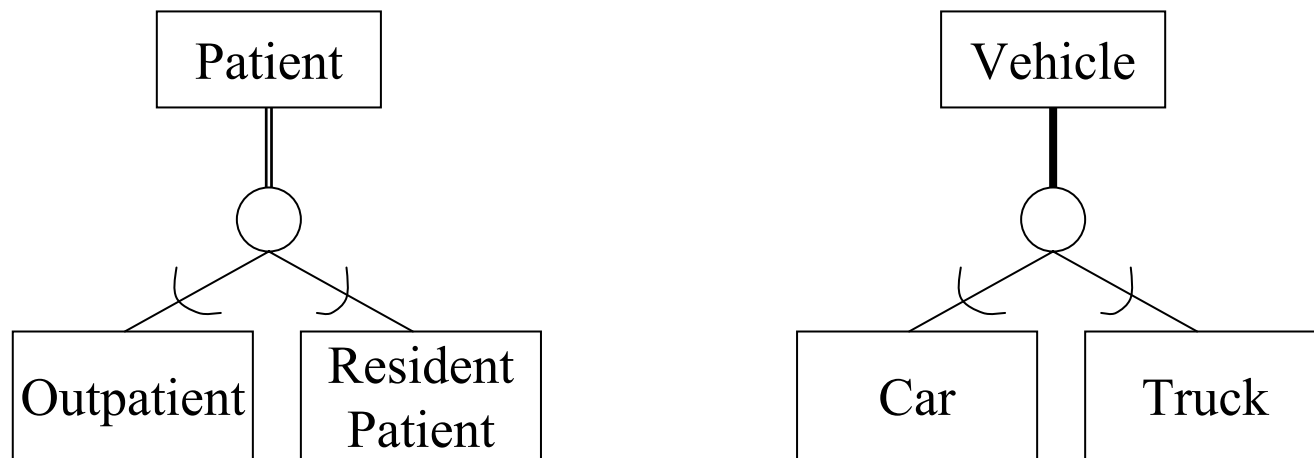 E.g., Vehicle —— Car, Truck
      A vehicle instance may neither belong to Car nor belong to Truck

Specifying completeness constraints (2)

- **Representation in E-R diagram**

  ① total completeness rule   ② partial completeness rule

Outpatient ∪ Resident Patient = Patient?
Car ∪ Truck = Vehicle?

Specifying disjointness constraints (1)

◆ Whether an instance of a supertype may simultaneously be a member of two or more subtypes?

◆ Rules

- *Disjoint rule*:

    If an entity instance of the supertype is a member of one subtype, it cannot simultaneously be a member of any other subtype.

    E.g., Each Patient instance can only belong to one of Outpatient or
    Resident Patient.

- *Overlap rule*:

   An entity instance can simultaneously be a member of two (or more) subtype

    E.g., Part —— Manufactured Part, Purchased Part
    Some Part instances may be simultaneously belong to Manufactured Par
    and Purchased Part

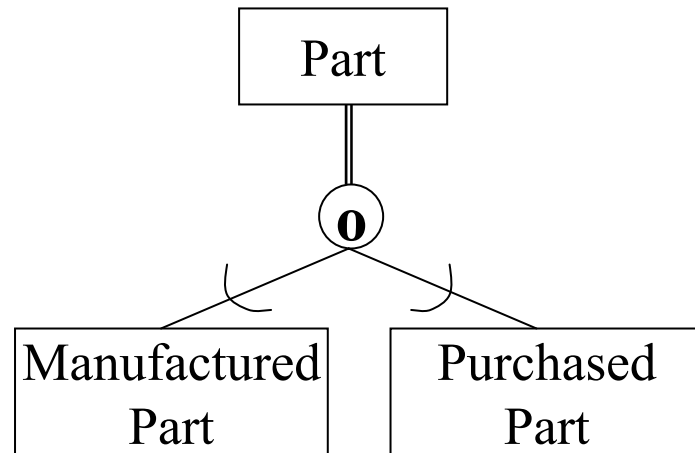The enhanced E-R model and business

Specifying disjointness constraints (2)

◆ **Representation in E-R diagram**

① Disjoint rule

Patient

d

Outpatient   Resident Patient

② Overlap rule

Part

o

Manufactured Part   Purchased Part
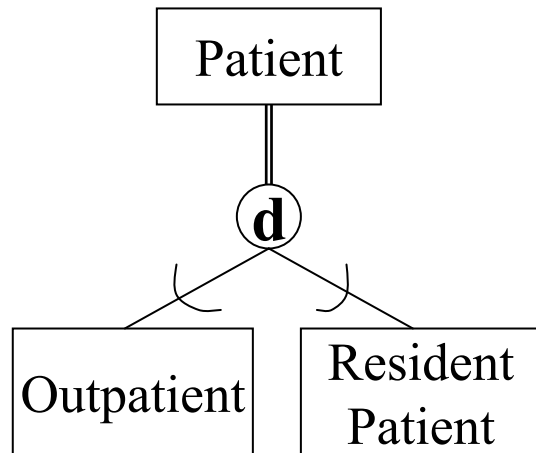
Defining subtype discriminators (1)

- An attribute of the supertype whose values determine the target subtype or subtypes (When the instances of supertype are inserted)

① **Disjoint rule**

Employee_name   Address   Date_hired

Employee_number — Employee — Employee_Type

Employee_Type=

Discriminator

d

H   S   C

Hourly Employee   Salaried Employee   Consultant

Hourly rate   Annual_salary   Stock_option   Contact_number   Billing_rate

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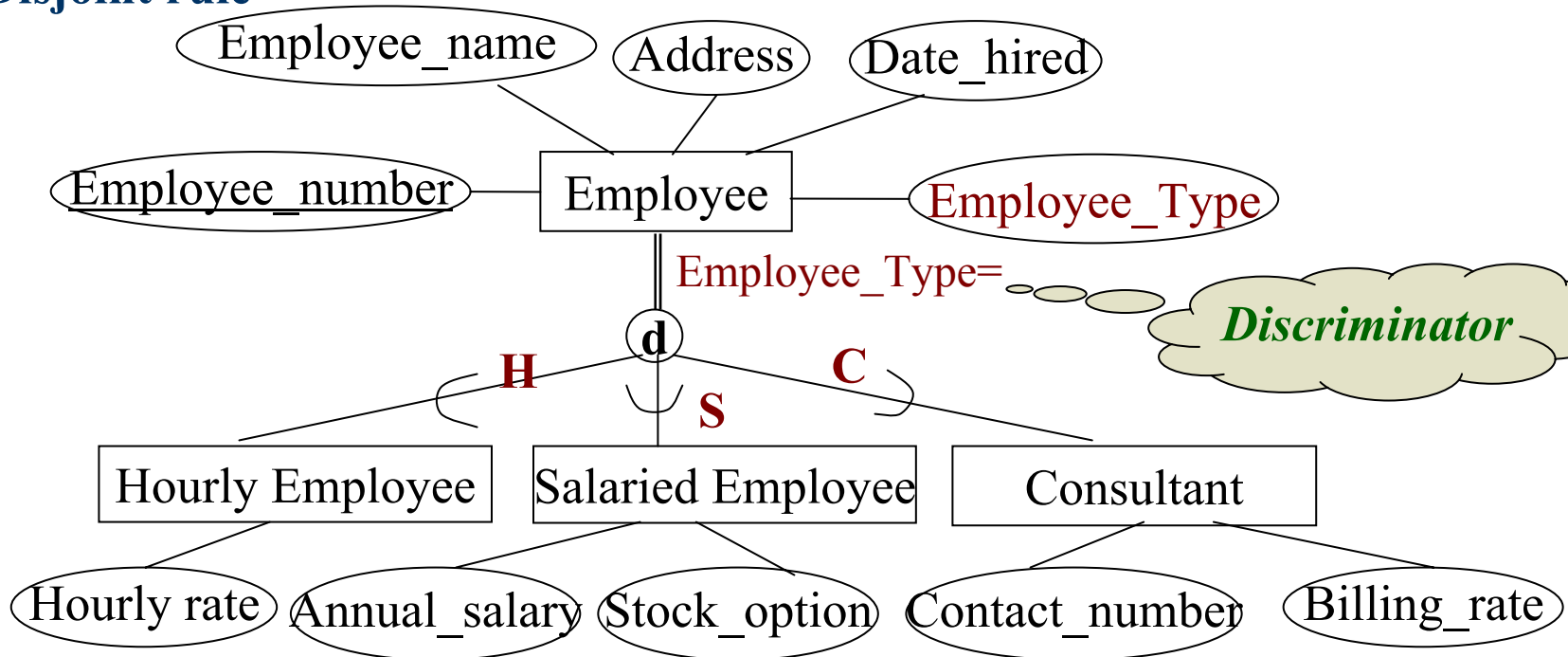
Defining subtype discriminators (2)

② Overlap rule
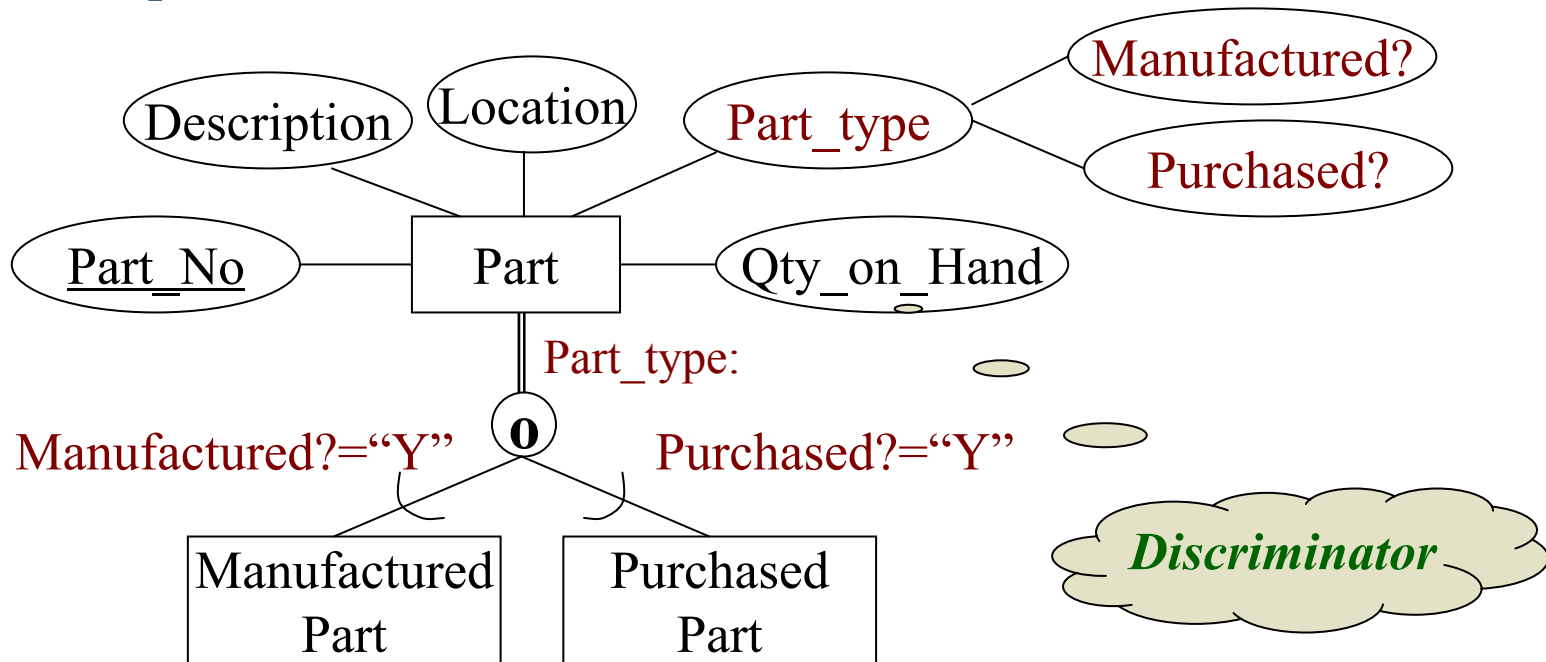
You need to set the constant values for the discriminator!☺

Defining supertype/subtype hierarchies

♦ Tree structured hierarchical arrangement of supertypes and subtypes
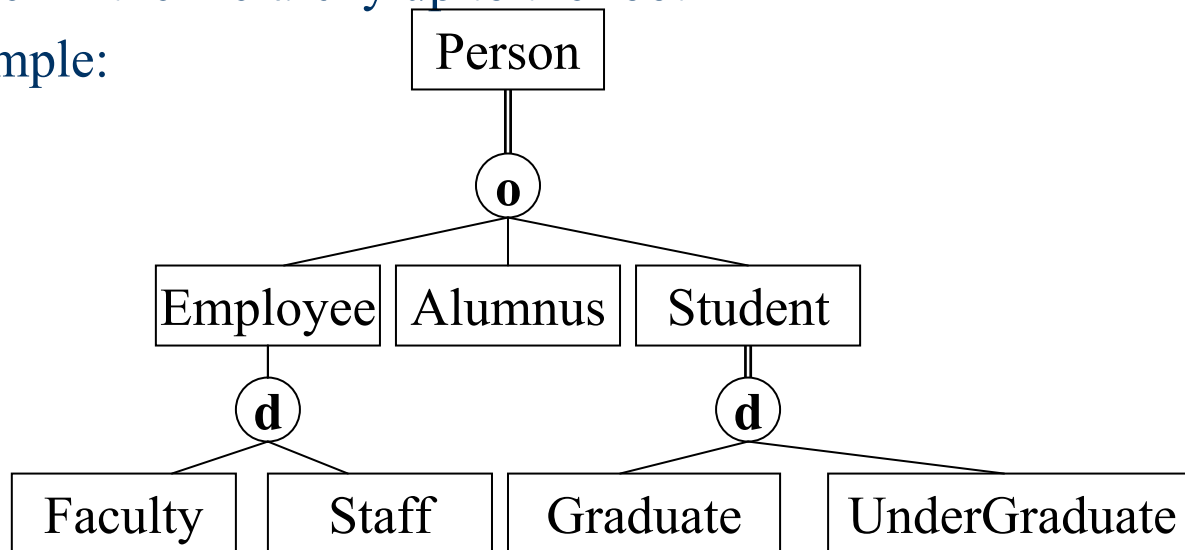
♦ Attributes are assigned at the highest logical level that is possible in the hierarchy

♦ Subtypes (lower in the hierarchy) inherit attributes from all supertypes higher in the hierarchy up to the root

♦ Example:

```
                    ┌──────────┐
                    │  Person  │
                    └────┬─────┘
                        (o)
            ┌────────────┼────────────┐
       ┌─────────┐  ┌─────────┐  ┌─────────┐
       │Employee │  │ Alumnus │  │ Student │
       └────┬────┘  └─────────┘  └────┬────┘
           (d)                       (d)
        ┌───┴───┐               ┌──────┴──────┐
    ┌───────┐ ┌───────┐    ┌──────────┐ ┌──────────────┐
    │Faculty│ │ Staff │    │ Graduate │ │UnderGraduate │
    └───────┘ └───────┘    └──────────┘ └──────────────┘
```

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Entity clustering

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Entity clustering (1)

◆ **An entity cluster**

A set of one or more entity types and associated relationships grouped into a single abstract entity type.

◆ **Why entity clustering?**

- Form a high-level cluster of entities

- Frequently, people care much on the data and their relationships, rather than the details of all entities and relationships.

- Based on the entity cluster, we can refine some certain part in the data model

What's the measure for clustering?

◆ **How to form the entity cluster?**

- By abstracting a supertype and its subtypes

- By combining directly related entity types and their relationships

- By combining a strong entity and its associated weak entity types

Entity clustering (2)

Entity clusters in EER diagram:
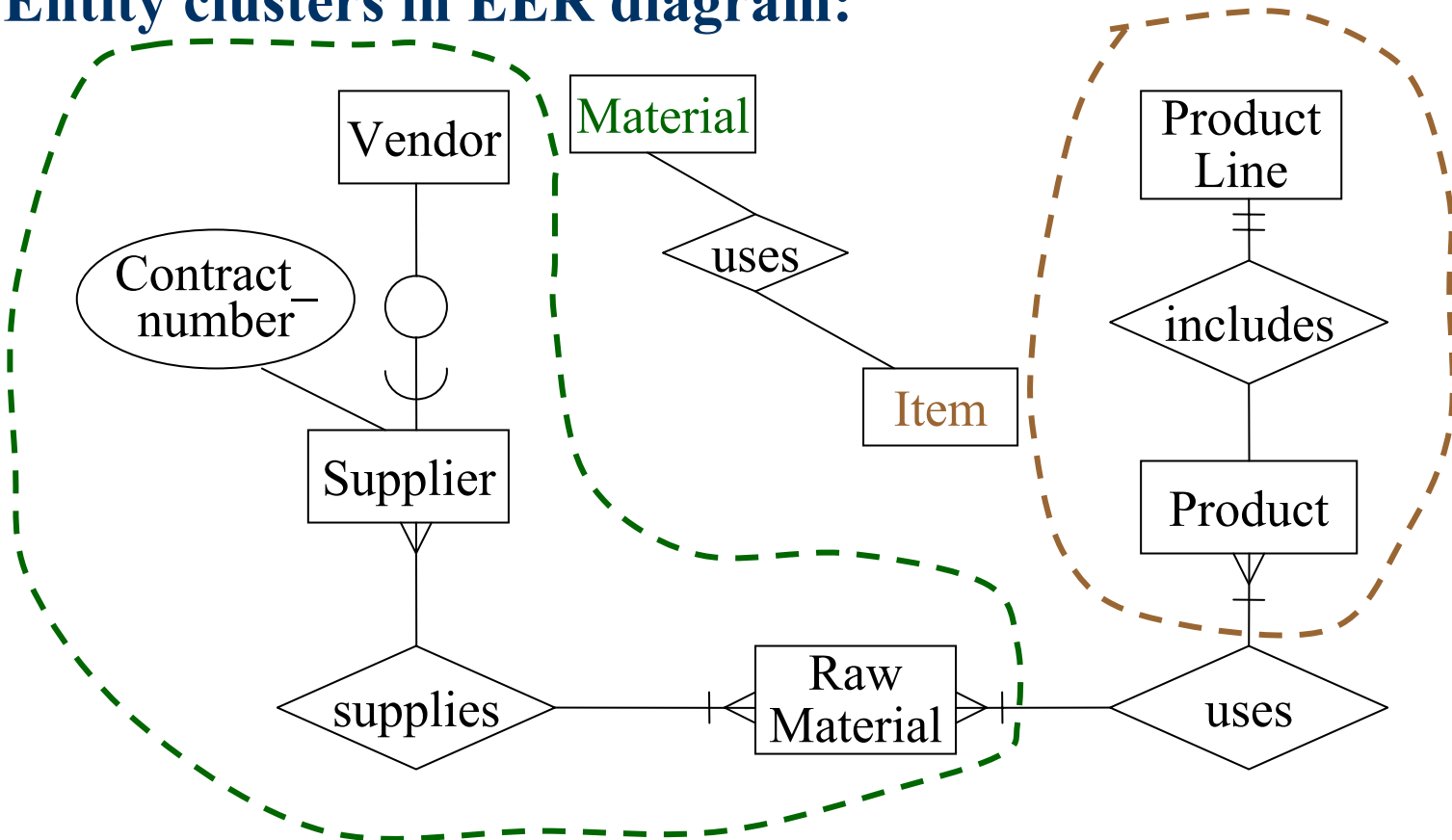
Entity clustering (3)

- **Similarity definition and measures?** (e.g., distance)
- **Clustering in data mining and machine learning?**
- **How about the granularity of the entity clusters?**
- **Note:**
  - An entity cluster should focus on an area of interest to some community of users
  - An entity cluster depends on your purpose
  - The entity clusters are not unique

Business rules revisited

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Business rules revisited

Express some important types of rules that elude the standard E-R or EER notation

♦ **Classification of business rules:**

- **derivation**: inference, derived from other knowledge

- **structural assertion**: some static structure, term, fact

- **action assertion**: constraints and control; actions performed on data objects; dynamic aspects of the organization

♦ **Representing and enforcing business rules:**

- declare action assertions at a conceptual level without specifying how the rule will be implemented (procedural logic)

- graphical (E-R, EER) or grammatical (SQL structured grammar)

Summary

- **Motivation, basic concepts and notation of EER**
- **Representing supertypes and subtypes, attribute inheritance**
- **Representing generalization and specification**
  - bottom-up generalization
  - top-down specialization
- **Specifying constraints in supertype/subtype relationship**
  - completeness: total specification and partial specification;
  - disjointness constraints: disjoint and overlap
  - subtype discriminators: disjoint and overlap discriminator
  - supertype/subtype hierarchies
- **Entity clustering: What, why and how**
- **Business rules revisited: types and approaches**

Assignments

- Page 157: 3(b), 5.
- Page 158: 3.

The end

Thanks!