

# DATABASE TECHNOLOGY - 1MB025

Fall 2005

An introductory course on database systems

<http://user.it.uu.se/~udbl/dbt-ht2005/>

alt. <http://www.it.uu.se/edu/course/homepage/dbastekn/ht05/>

Kjell Orsborn  
Uppsala Database Laboratory  
Department of Information Technology, Uppsala University,  
Uppsala, Sweden

# Introduction to Database Design Using Entity-Relationship Modeling

Elmasri/Navathe chs 3-4  
Padron-McCarthy/Risch ch 2-3

Kjell Orsborn

Department of Information Technology  
Uppsala University, Uppsala, Sweden



# ER-modeling

- Aims at defining a high-level specification of the information content in the database.
- History
  - Chen, P. P. S., “The entity-relationship model: towards a unified view of data”, ACM TODS, 1, 1 1976, p. 9-36.
- Why ER-models?
  - High-level description - easier to understand for non-technicians
  - More formal than natural language - avoid misconceptions and multiple interpretations
  - Implementation independent (of DBMS) - less technical details
  - Documentation
  - Model transformation to an implementation data model



# Entity type and entity



- An *entity type* represents a physical or abstract concept with some sort of identity. The individual instances of the concept are members of a set of *entities* that have the same set of attributes.
  - Entity types express the *intention*, i.e. the meaning of the concept whereas the set of entities represents the *extension* of that type.
  - Names of entity types are given in singular form.
  - The description of an entity type is called its *schema*.

PERSON

name, ssn, address, phoneno

- Each attribute in an entity type is associated with a domain that indicates the allowed values of that attribute.

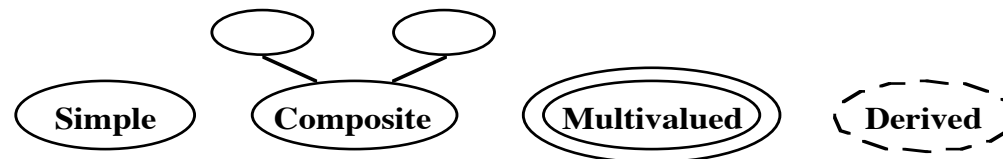


# Attribute

- An attribute is a characteristic or aspect that describe an entity (and is defined on entity types).
  - Every attribute has a *domain* (or *value set*).
  - A domain specifies the set of allowed *values* each individual attribute can be assigned.
  - There is (at least) six different types of values for attributes:
    - **simple/** sex: M or F
    - **composite** name: (Ior, Karlsson)
    - **single-valued/** name: “Ior Karlsson”
    - **multivalued** friends: {Nasse, Puh,...}
    - **stored/** birthdate: 980917
    - **derived** age : 0
    - **null**

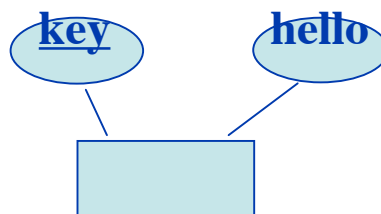
Note!

## ER-diagram

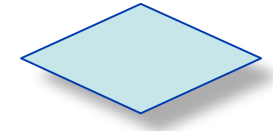


## Attribute cont...

- **Key:** an attribute that has unique values for every instance of an entity type is called a **key attribute**.
- Sometimes *several* attributes are used together to get a unique key.
- An entity type can have more than one key.



## Relationship type and relationship



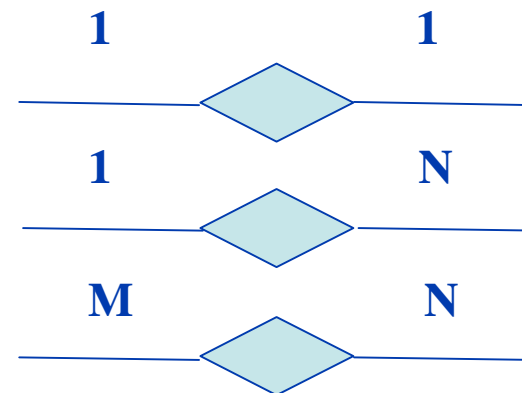
- A ***relationship type*** represents a relationship (or relation/connection), between a number of entity types.
- A relationship type R is a set of ***relationships*** (i.e. *relational instances*) or *tuples*.
- A relationship type, R, can mathematically be defined as:  
$$R \subseteq E_1 \times E_2 \times \dots \times E_n$$
where each  $E_j$  is a entity type.
- A tuple (or an instance)  $t \in R$  is written as  $(e_1, e_2, \dots, e_n)$  or  $\langle e_1, e_2, \dots, e_n \rangle$  where  $e_j \in E_j$ .

## Structural constraints for relationship types

- **Cardinality ratio constraint** specifies the number of relational instances that an entity can take part in.

For binary relationship types:

- one-to-one (1:1)
- one-to-many (1:N)
- many-to-many (M:N)





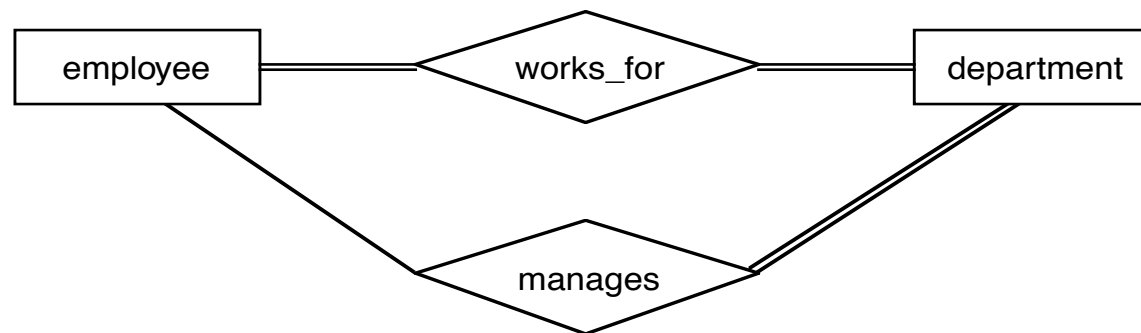
## Structural constraints cont. ...

Partial

Total

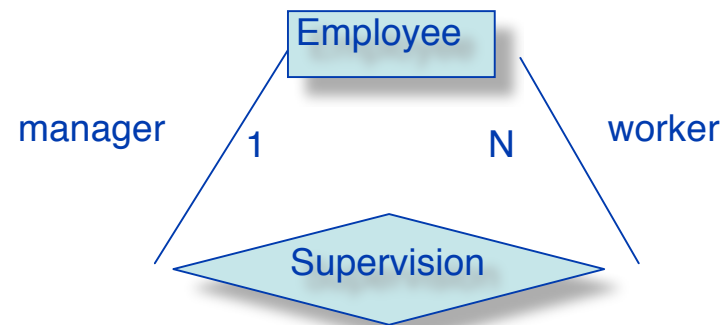
- **Participation constraint**

- specifies whether the entity existence is dependent of another entity via a relationship type.  
E.g. can an employee exist without working for a department?
- Partial participation: the entity can exist without this relationship
- Total participation: the entity requires this relationship in order to exist.

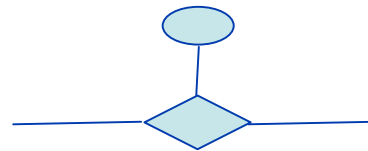


## Roles of relationship types

- A role name specifies what **role** an entity type plays in a specific relationship
- Role names are sometimes used in ER-diagrams to clarify the roles of the participating entity types.



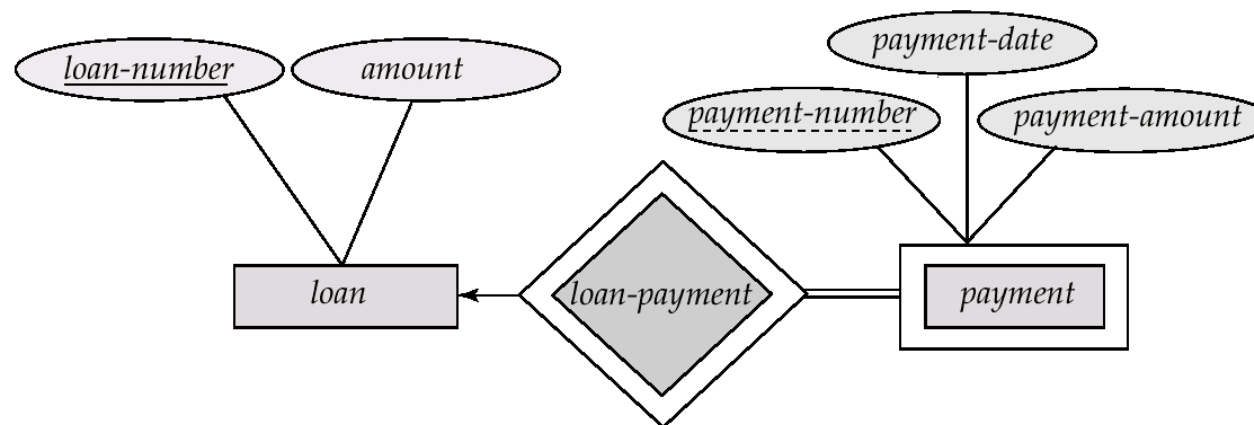
## Attributes for relationship types



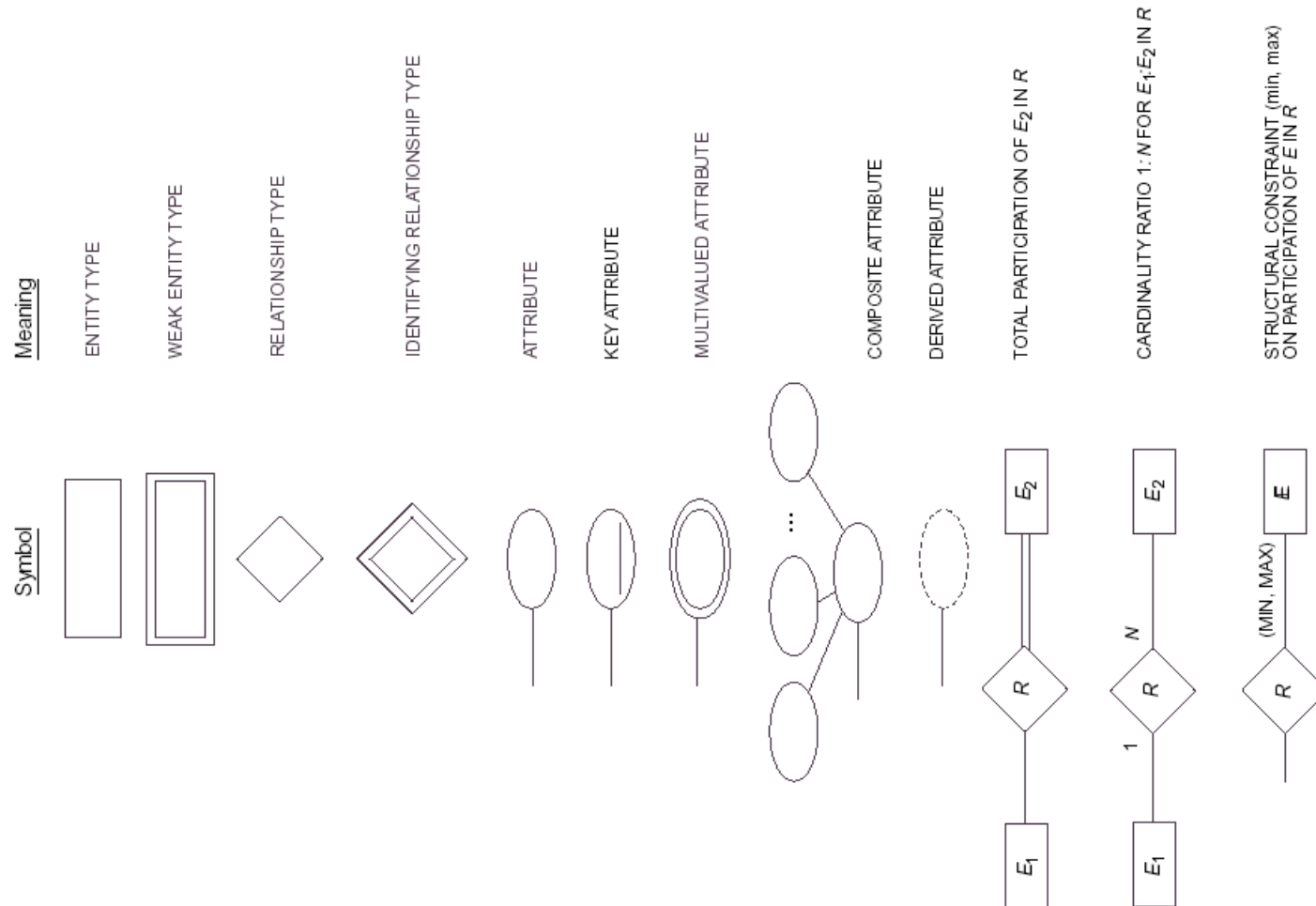
- Also a relationship type can have attributes. E.g. in the case where the weekly number of hours an employee works on a project should be kept, that can be represented for each instance of the relation “works-on”.
- If the relation is a 1:1 or 1:N relation, the attribute can be stored at one of the participating entities.
- When the relation is of the type M:N one must store the attributes with the instance of the relation.

## Weak entity types

- **Weak entity types** are those that are meaningless without an owner entity type.
- Weak entities are uniquely identified in the extension with their owner's key attributes together with its own (broken) underlined attribute.
- The relationship to the owner is called the identifying *relationship*.

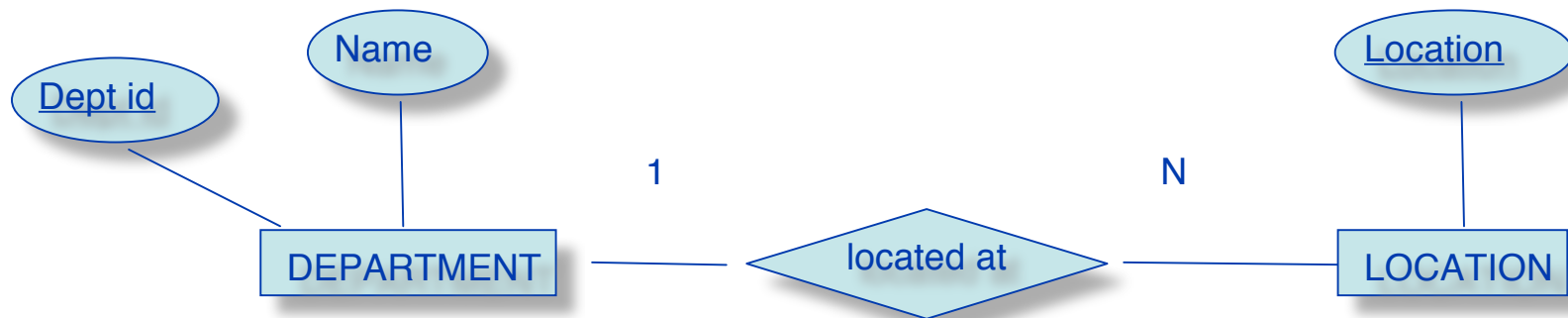
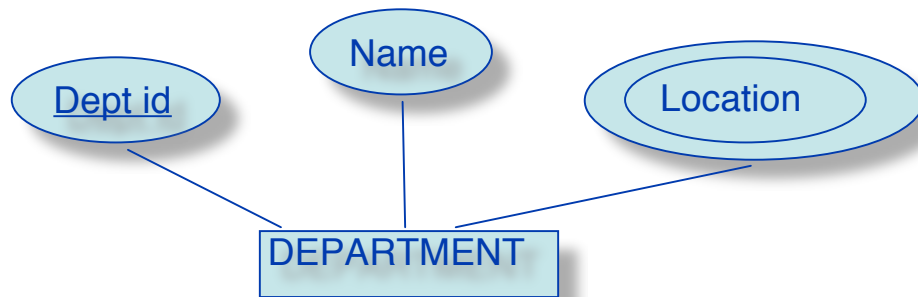


# ER-notation (Elmasri/Navathe fig. 3.14)



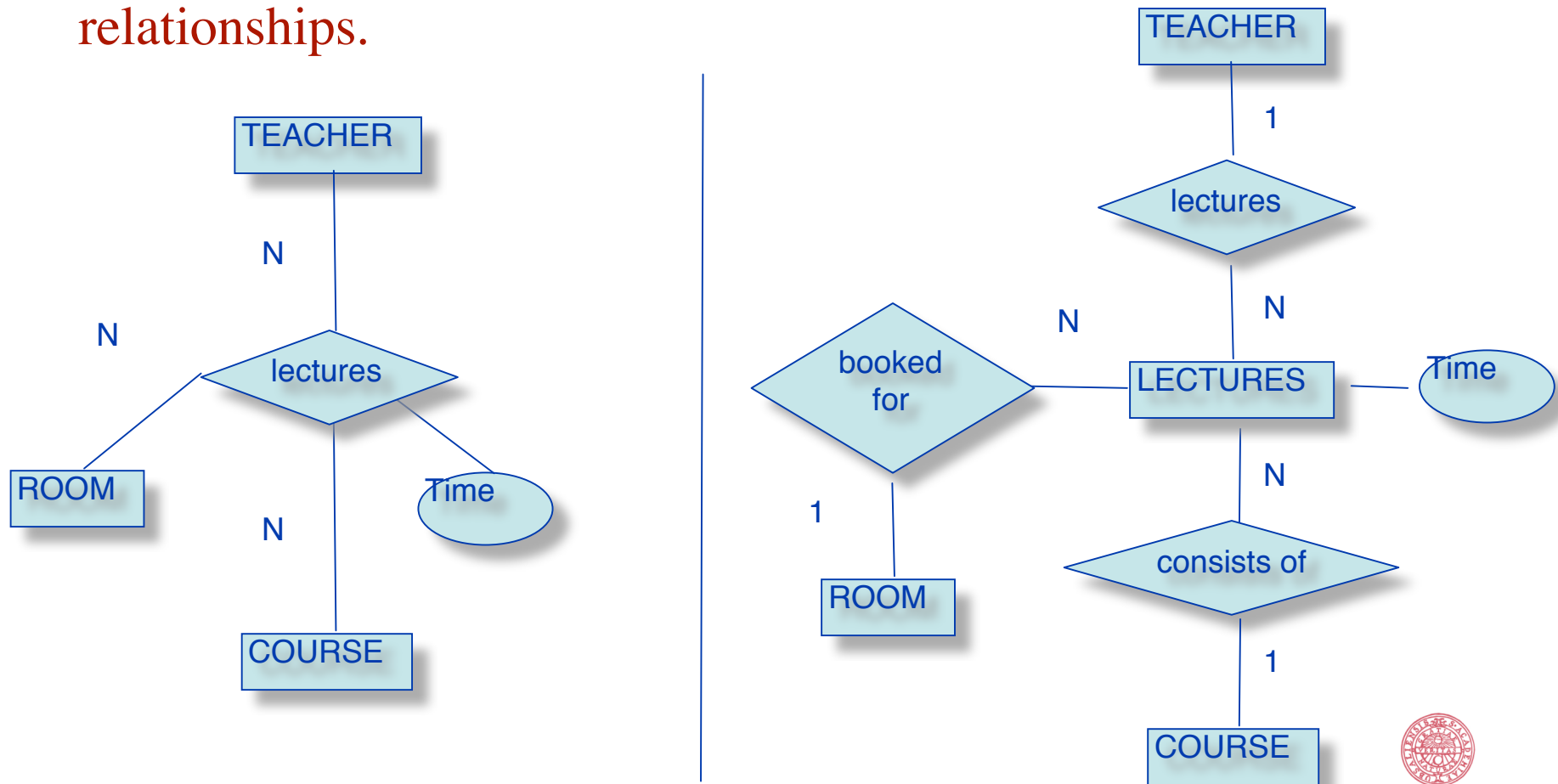
# ER model transformations

- Replacing multi-valued attributes by an entity type



## ER model transf. cont. ...

- Replacing M-N relationships with an entity type and binary relationships.

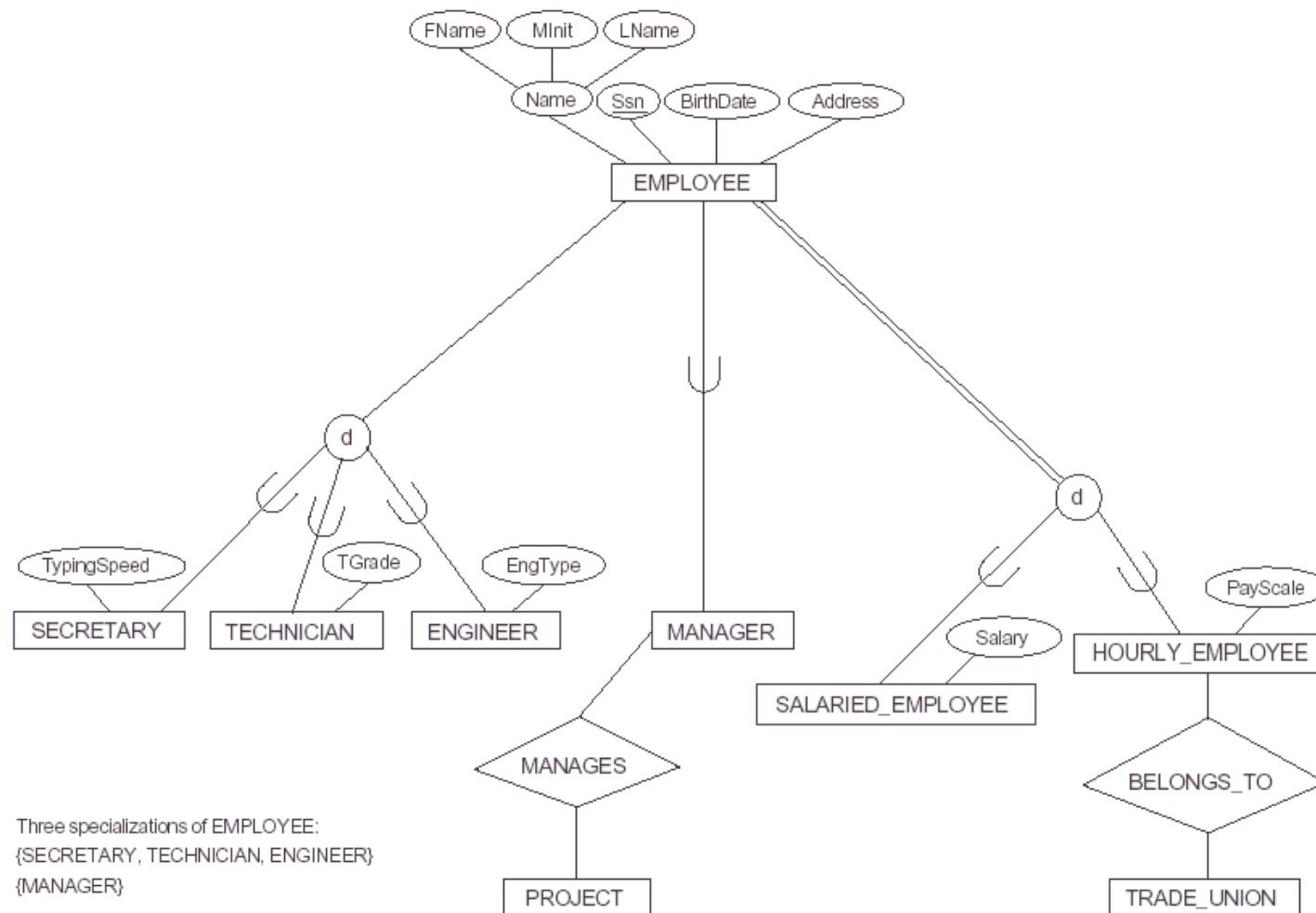


## Extended Entity-Relationship (EER) modeling

- The intention of using an E-R diagram is to use it as a basis for user communication or for getting to a good design specification.
  - i.e. try to make it simple and avoid too much complexity.
- EER (extended or enhanced ER) introduces several notational extensions to deal with concepts such as:
  - Superclass /subclass (supertype/subtype, is-a relationship)
    - specialization/generalization
    - constraints
  - Aggregation (whole/part or part-of relationship)
  - Union types (category)



## EER diagram notation for specialization and subclass (Elmasri/Navathe fig. 4.1)

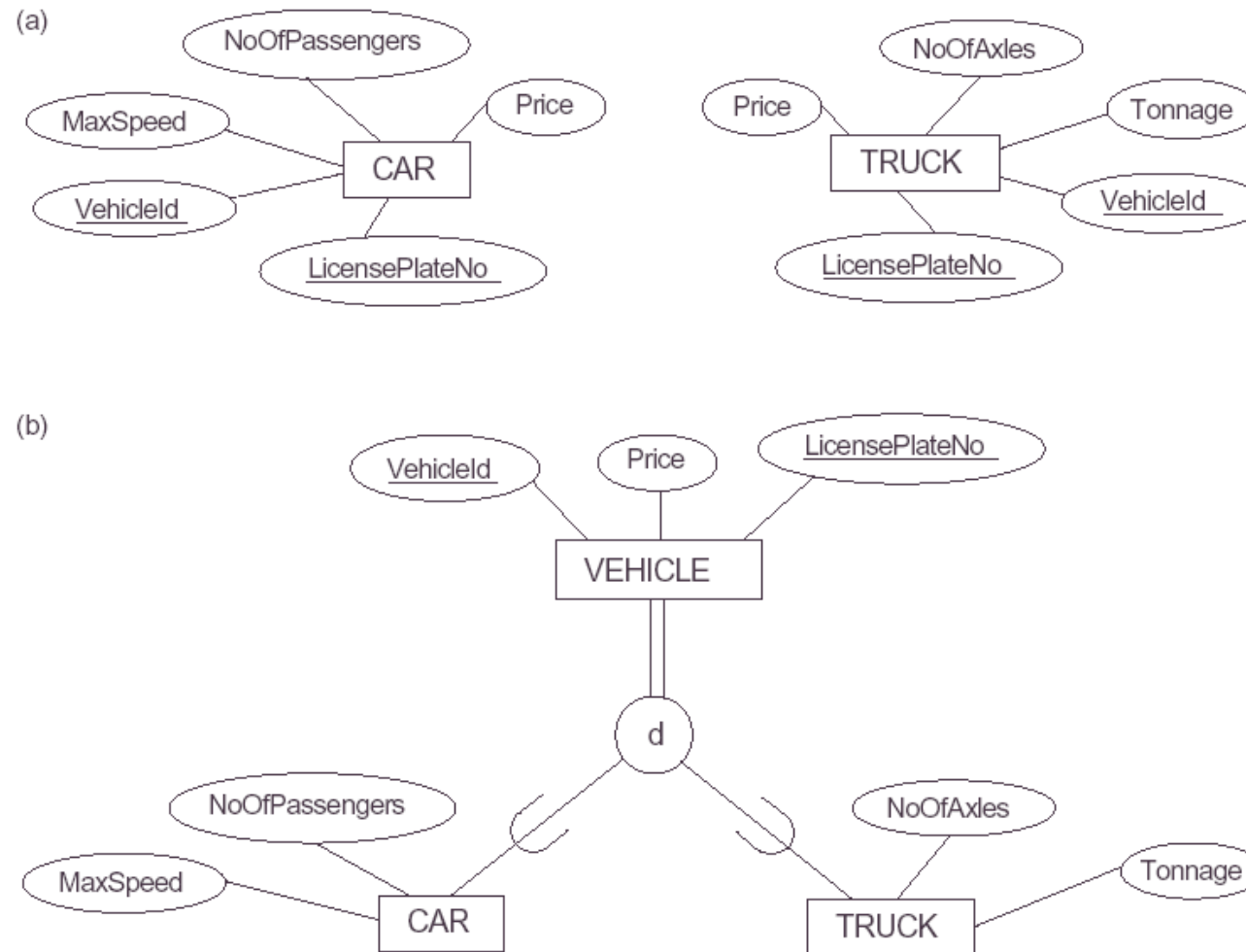


## Subclasses, superclasses & inheritance

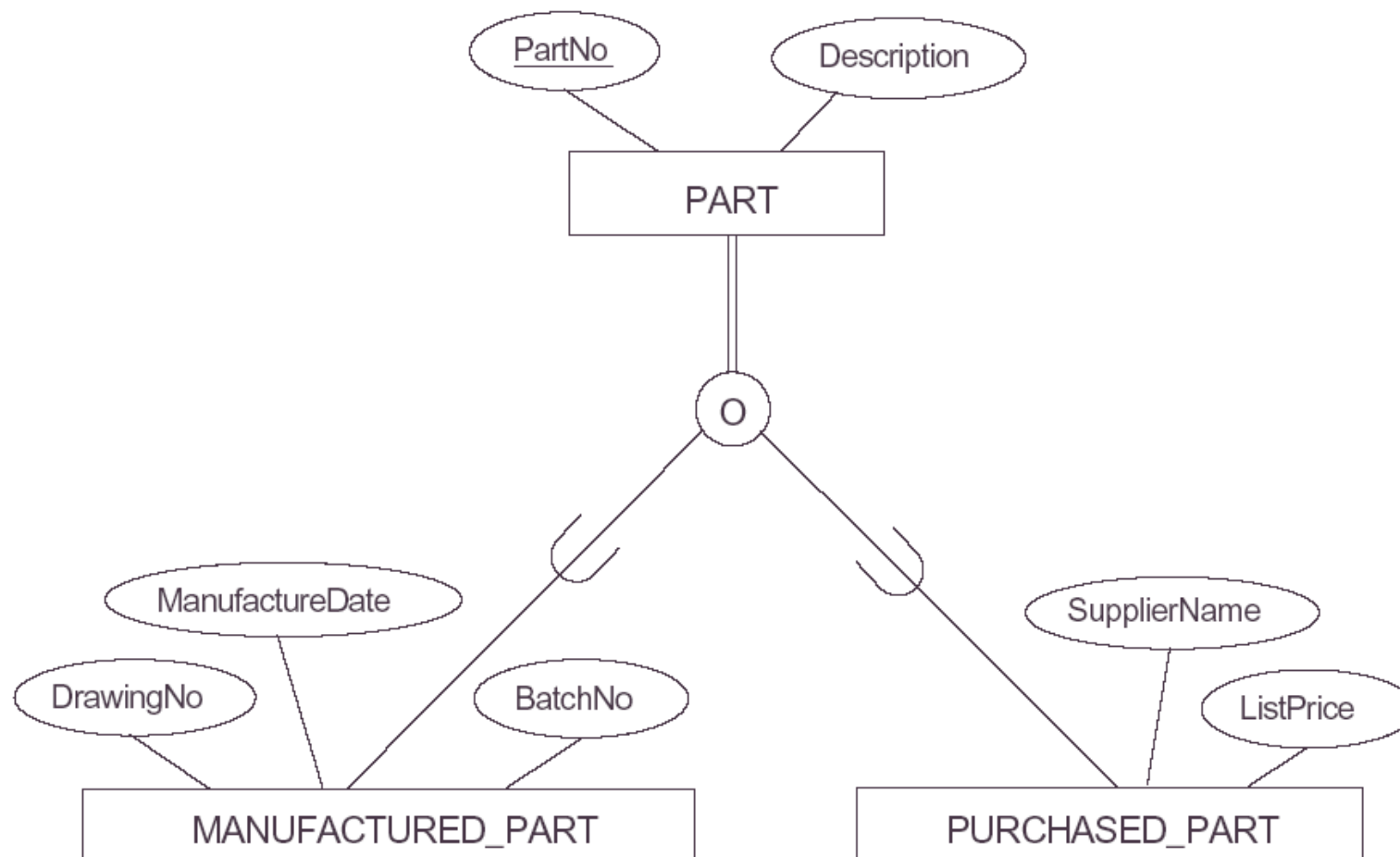
- Two generic ideas for creating superclass/subclass relationships
  - Specialization of superclass into subclasses
  - Generalization of subclasses into a superclass
- Constraints and characteristics of spec. & gen.
  - Constraints
    - Predicate-defined (condition-defined) sub-classes
    - Attribute-defined
    - User-defined
  - Disjointness
    - Disjoint
    - Overlapping
  - Completeness
    - Total
    - Partial



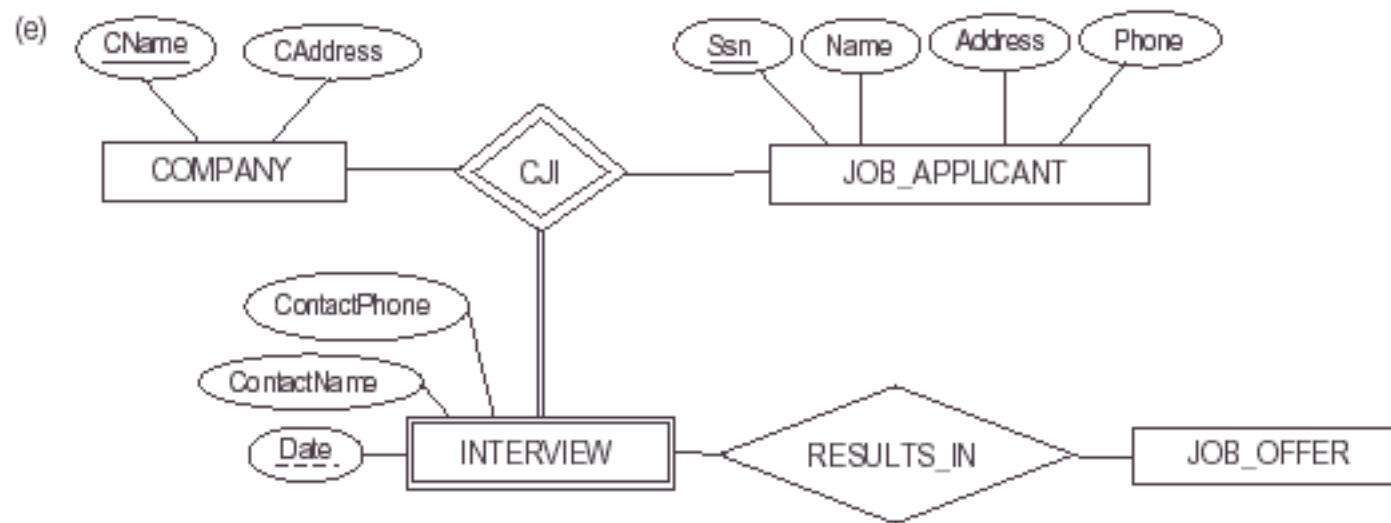
## Generalization of subclasses (Elmasri/Navathe fig. 4.3)



## Overlapping (nondisjoint) subclasses (Elmasri/Navathe fig. 4.5)



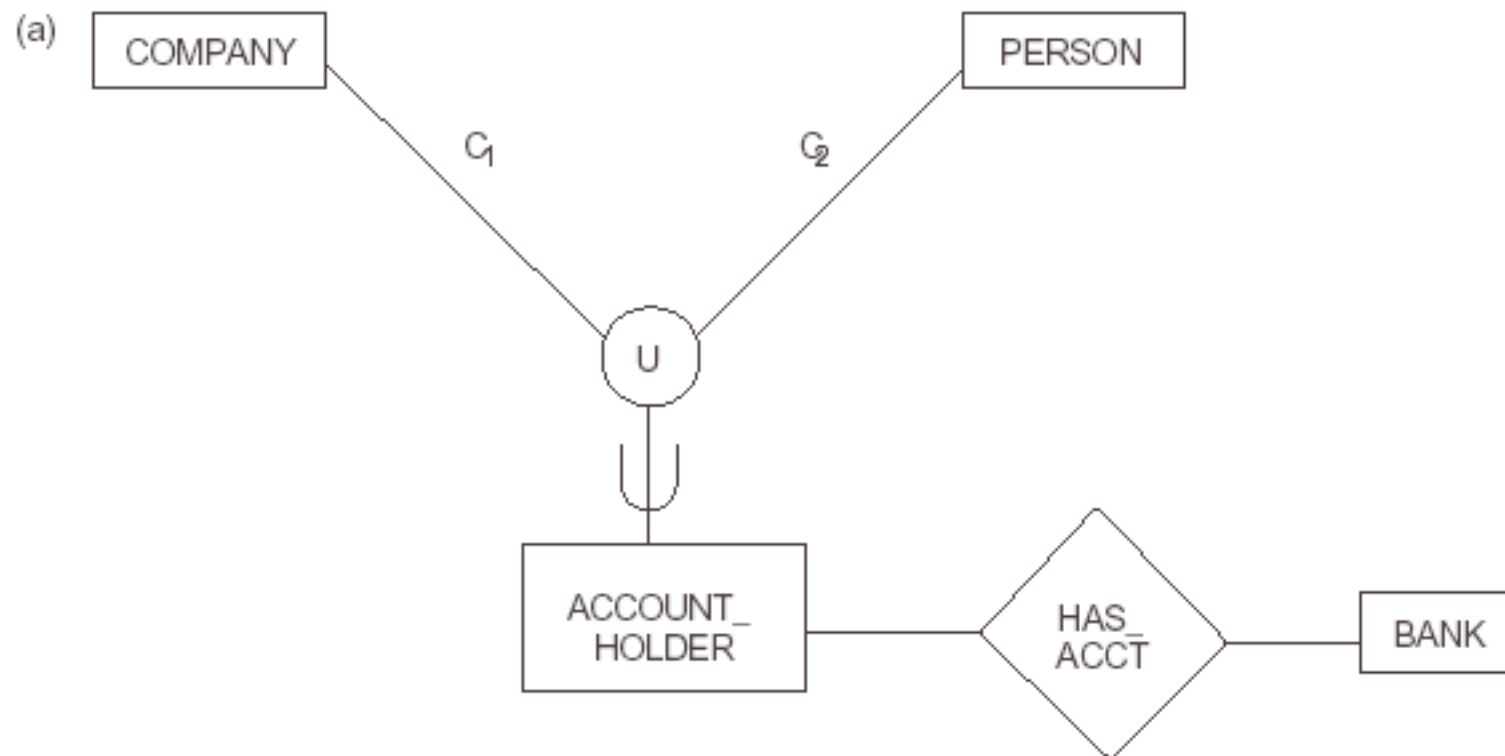
## Representation of aggregation in ER notation (Elmasri/Navathe fig. 4.16e)



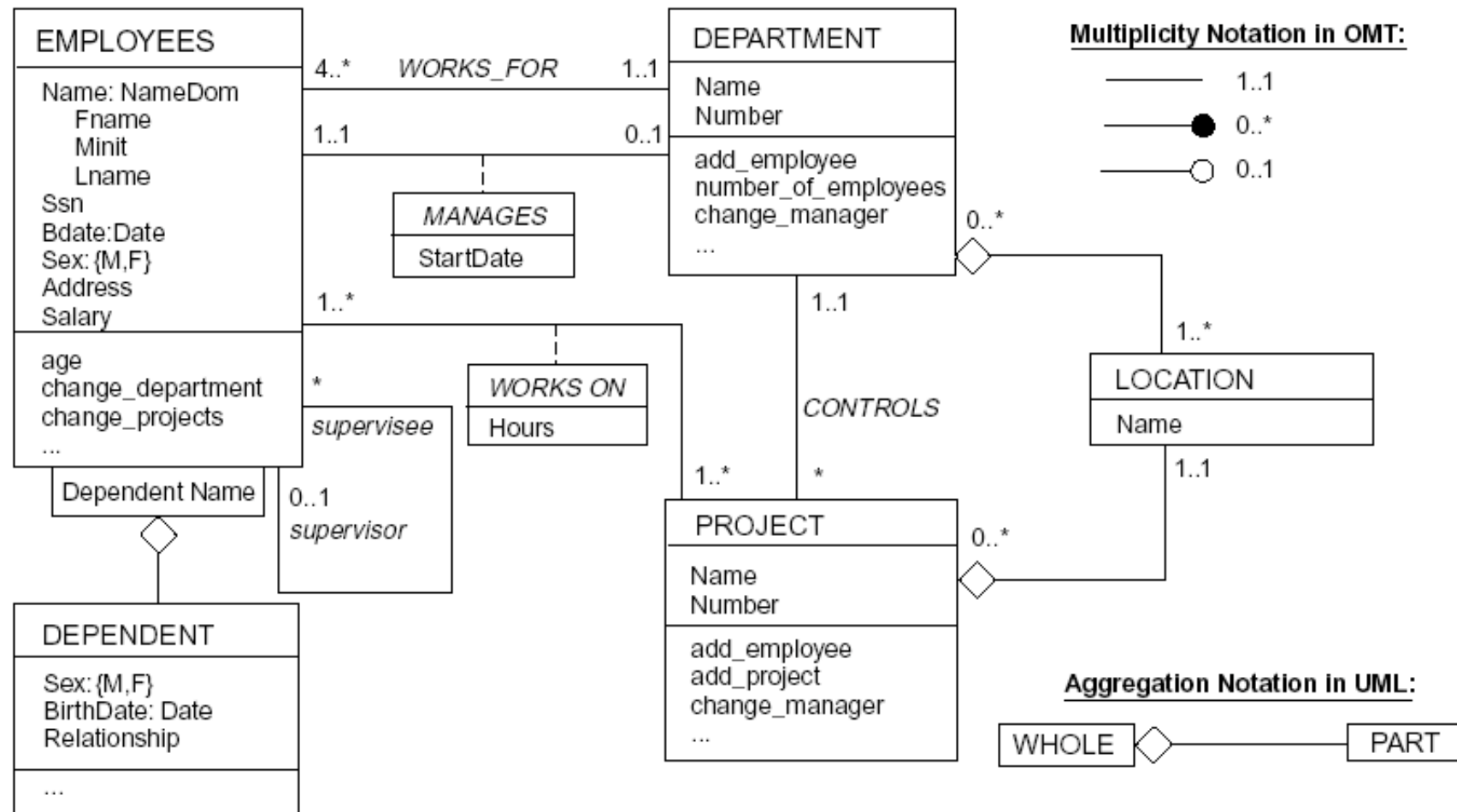
# New aggregation example inserted here

# Union of two entity types

(Elmasri/Navathe fig. 4.5a)

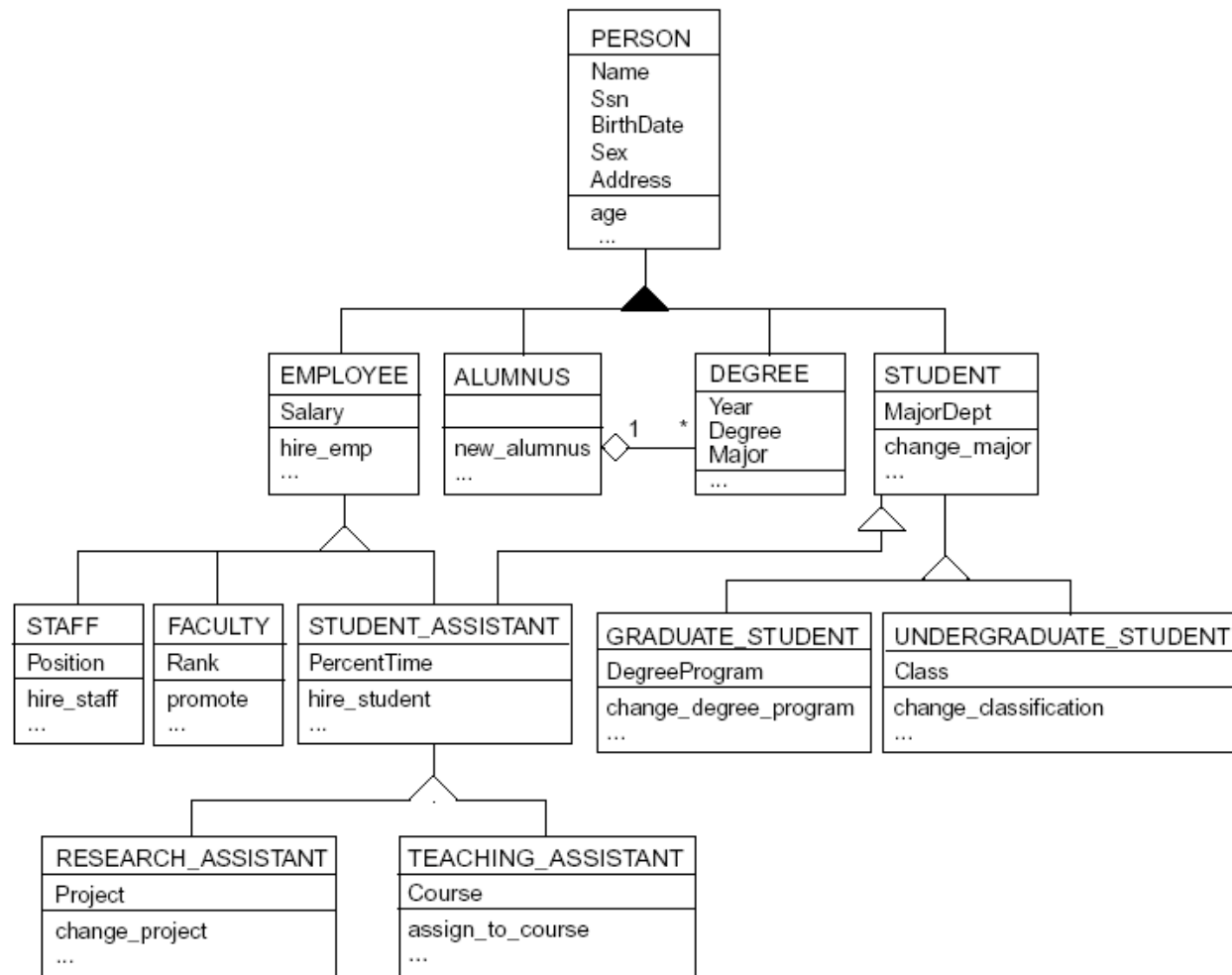


# A UML conceptual schema (Elmasri/Navathe fig. 4.11)

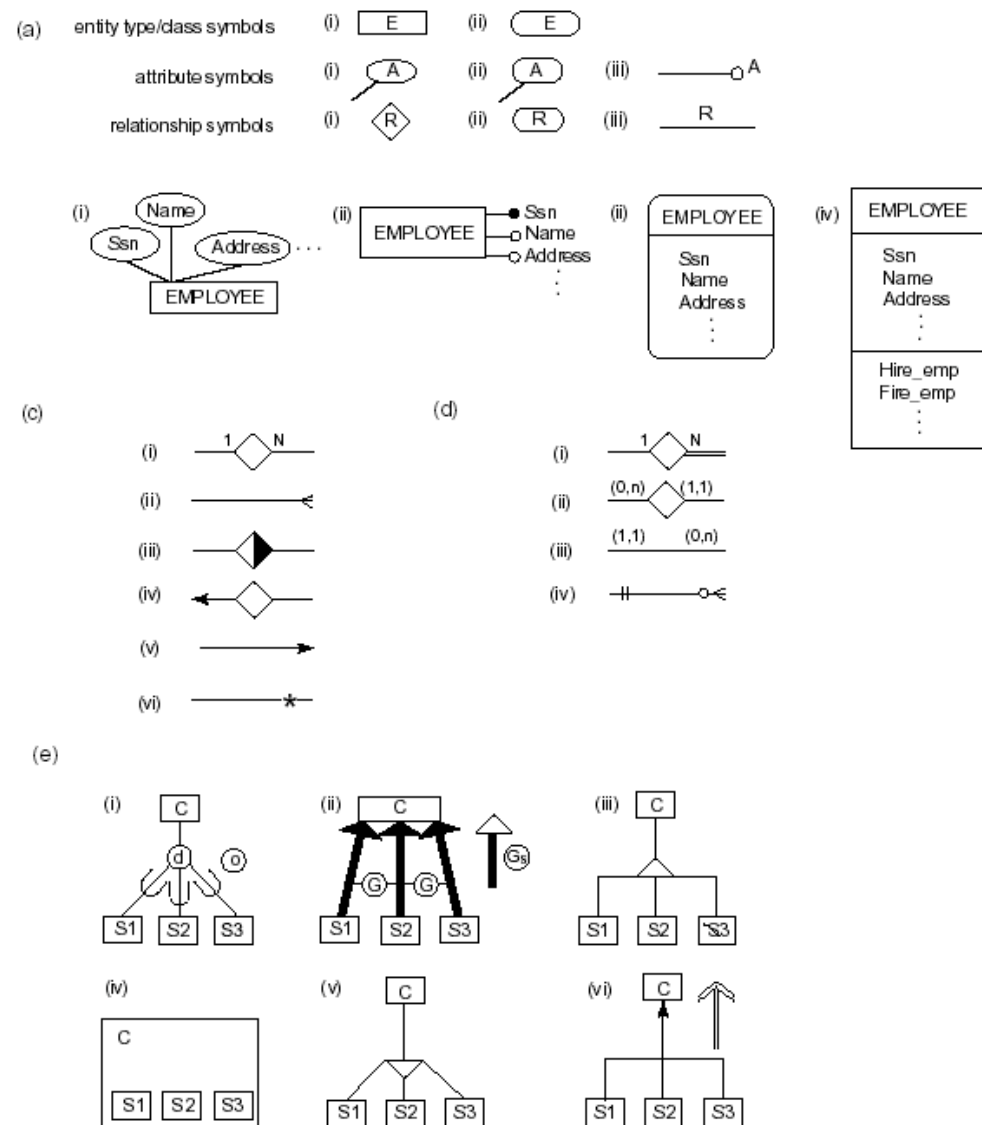




## Specialization/generalization in UML (Elmasri/Navathe fig. 4.12)



# Alternative diagrammatic notation for ER/EER (Elmasri/Navathe fig. A.1)



## Example ER-modeling

- An enterprise consists of a number of departments. Each department has a name, a number, a manager, and a number of employees. The starting date for every department manager should also be registered. A department can have several office rooms.
- Every department finances a number of projects. Each project has a name, a number and an office room.
- For each employee, the following information is kept: name, social security number, address, salary and sex. An employee works for only one department but can work with several projects that can be related to different departments. Information about the number of hours (per week) that an employee work with a project should be stored. Information about the employees manager should also be stored.

