Database Systems

Lecture #04

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Objectives

- To learn conceptual modeling using the entity-relationship (ER) model
  - Concept of entity-relationship model
  - Entity-relationship diagram
  - Conceptual data modeling

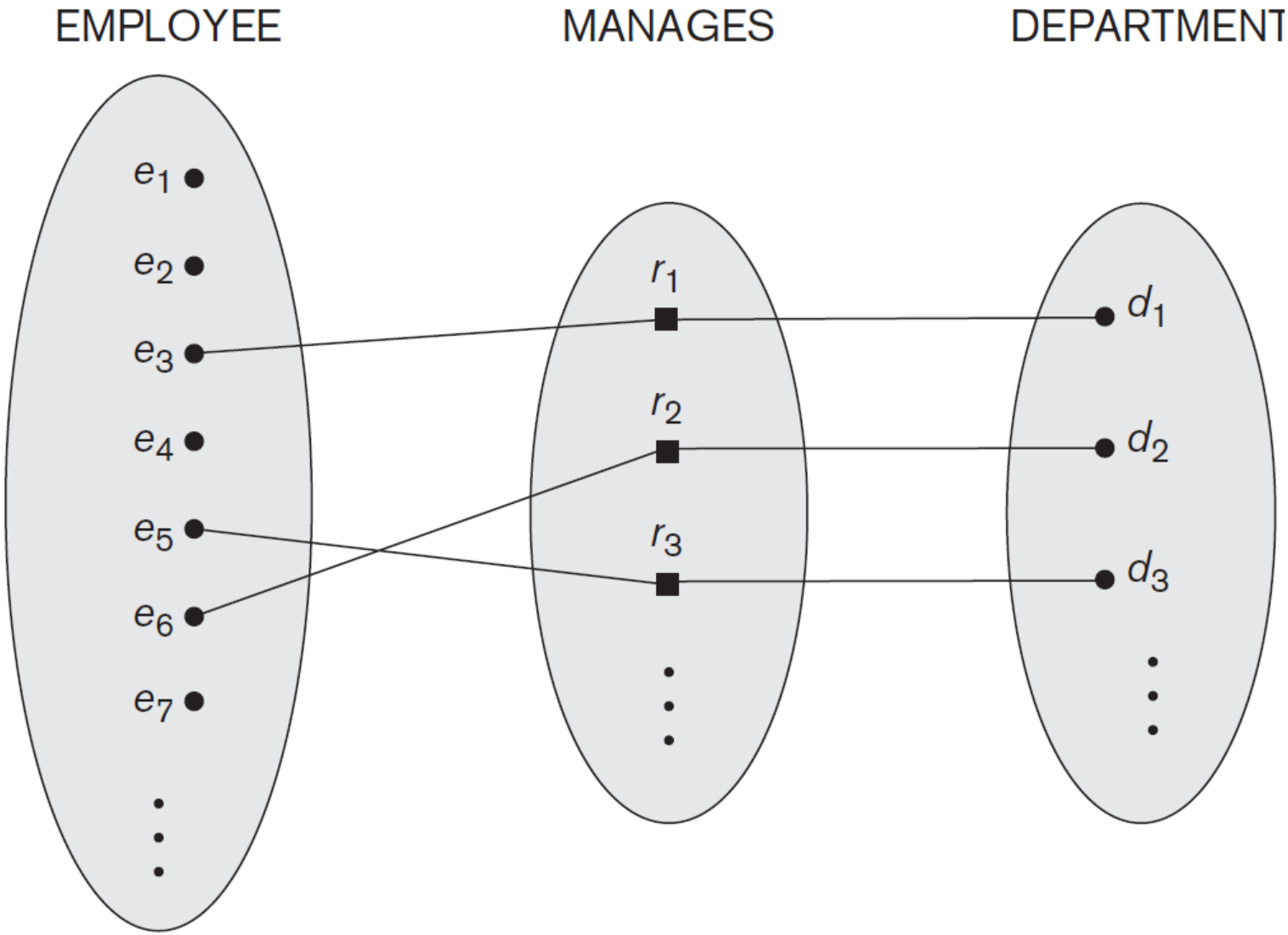
Outline

- Constraints on Relationship Types
- Attributes of Relationship Types
- Weak Entity Types
- Refining the Conceptual Design for a COMPANY Database
- Entity-Relationship Diagram

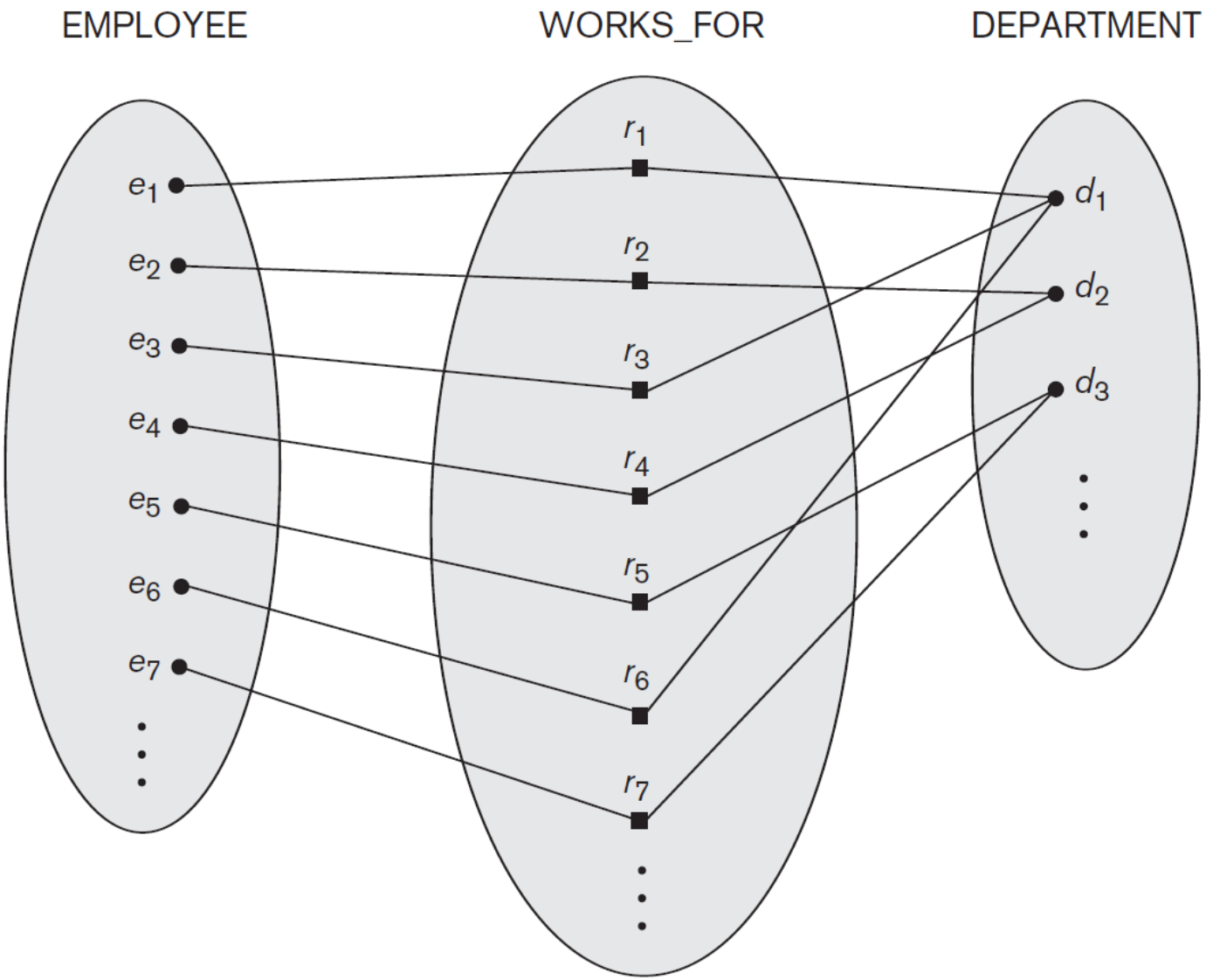
Constraints on Relationship Types

- *Cardinality ratio* constraint
  - Maximum number of relationship instances that an entity can participate in
  - Three types of cardinality ratios for a *binary relationship*
    - 1:1
    - 1:N
    - M:N

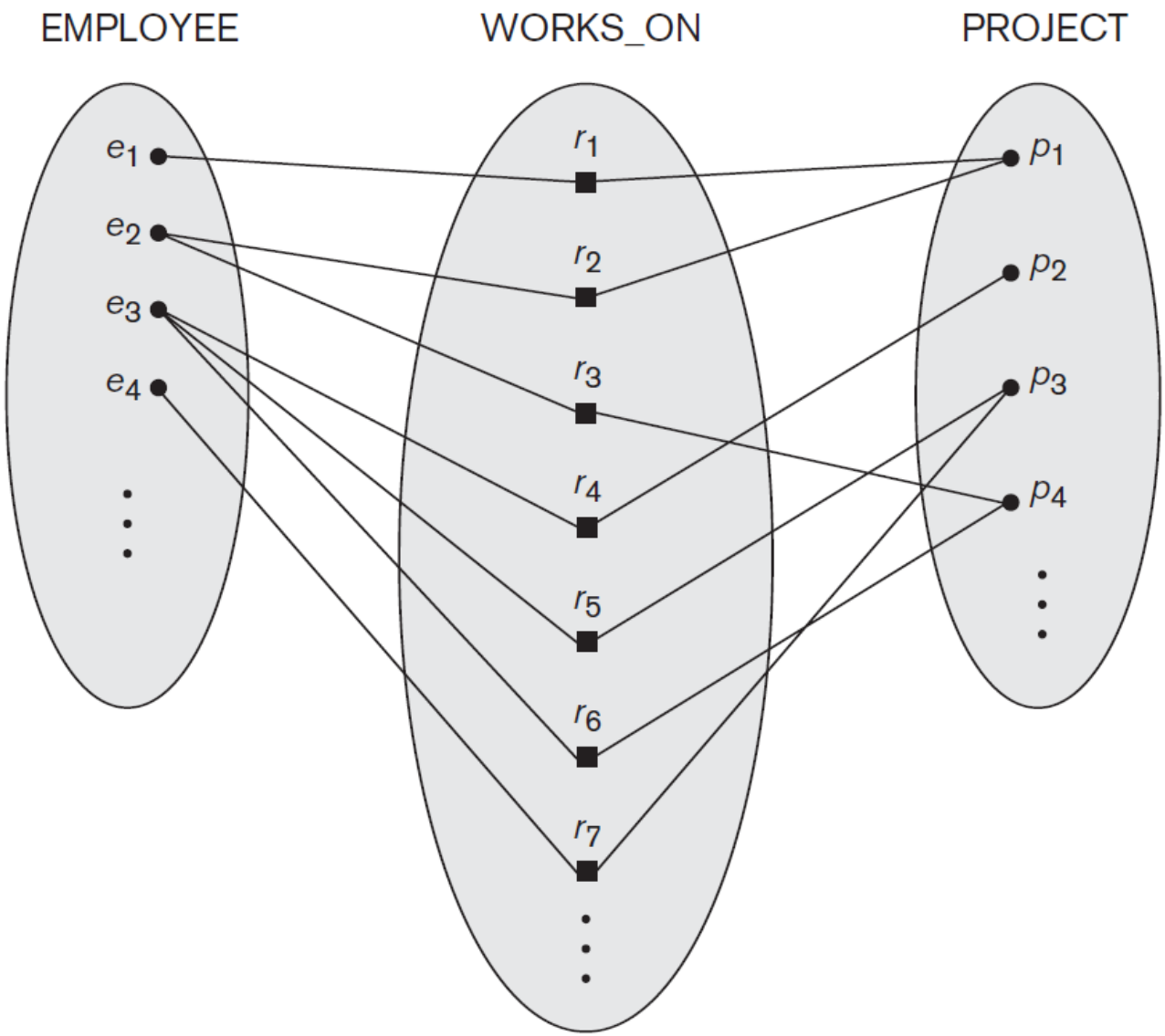
1:1 Cardinality Ratio



1:N Cardinality Ratio



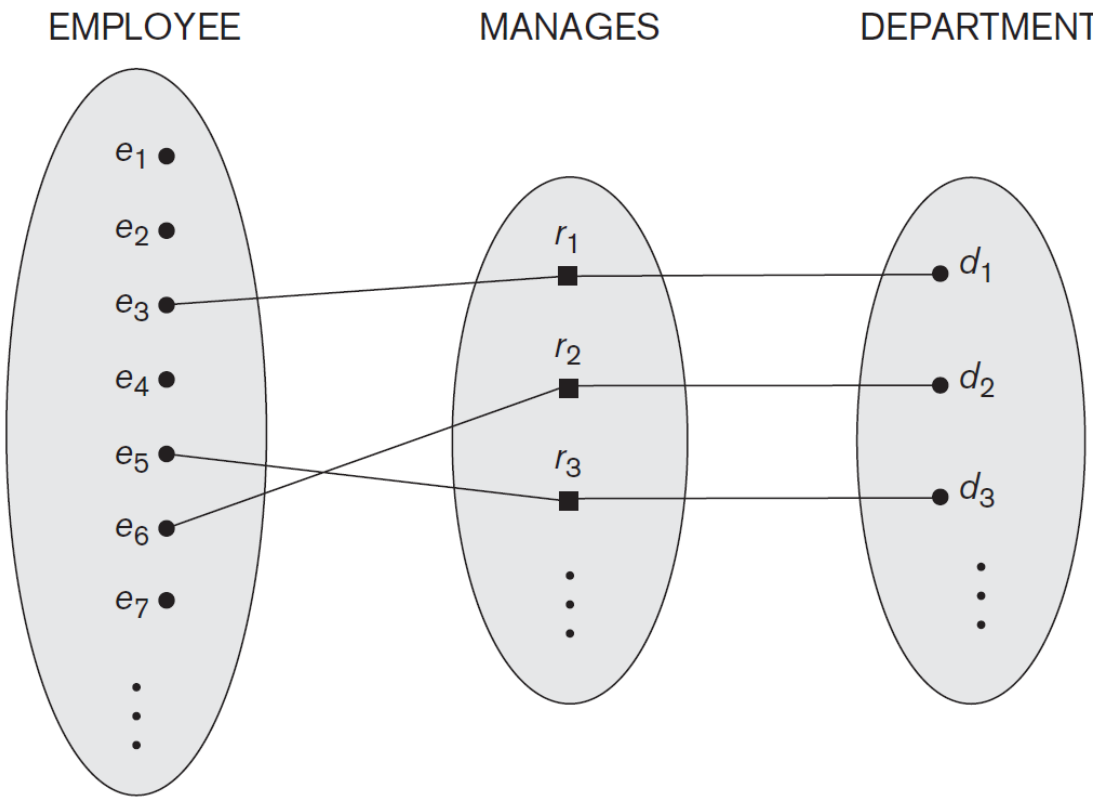
M:N Cardinality Ratio



Constraints on Relationship Types

- ***Participation constraint***
  - Specifies whether the existence of an entity depends on its being related to another entity
  - Types: *total* and *partial*
    - Total: every entity should participate in the relationship

Constraints on Relationship Types

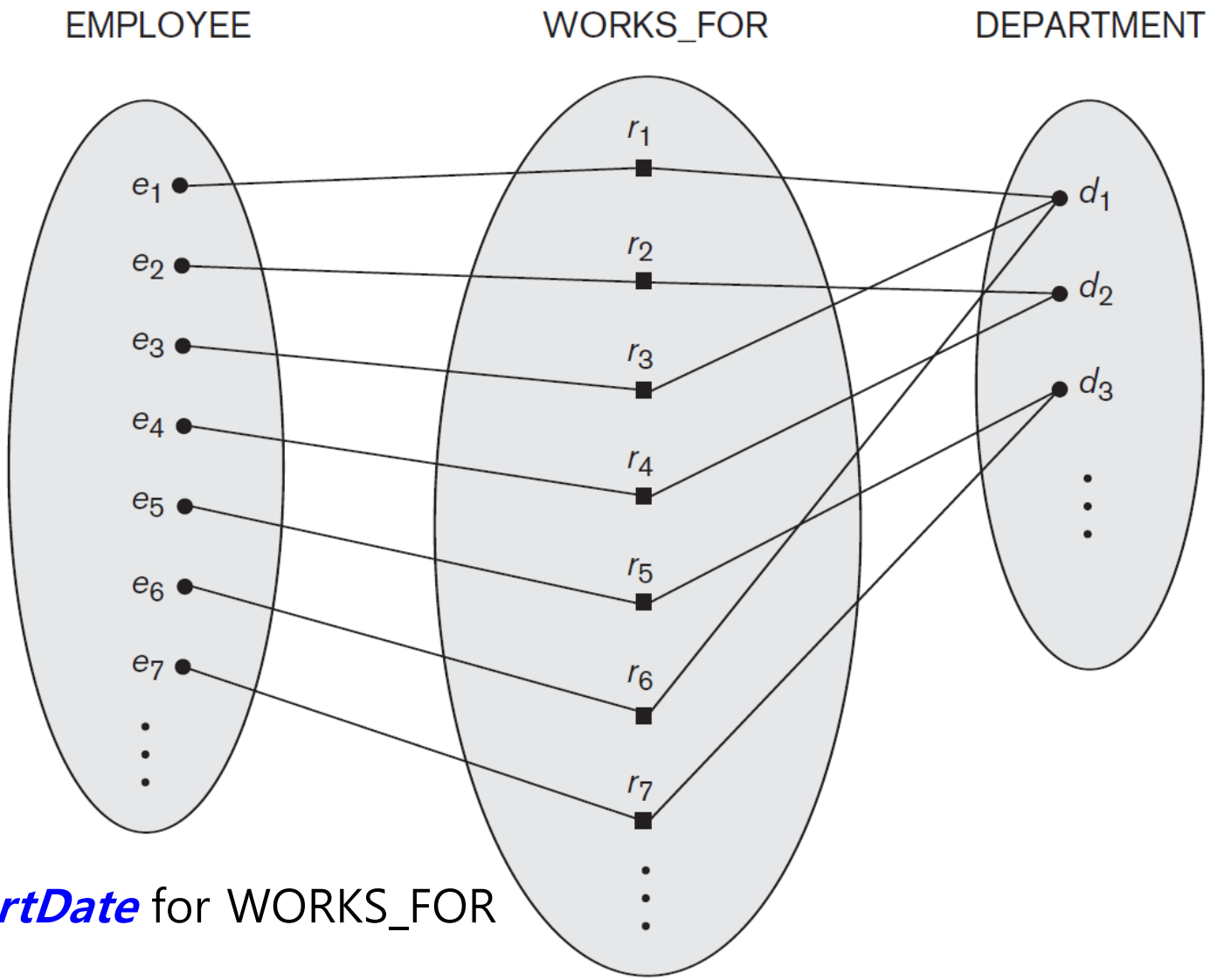


- DEPARTMENT – ***total participation***
- EMPLOYEE – ***partial participation***

Attributes of Relationship Types

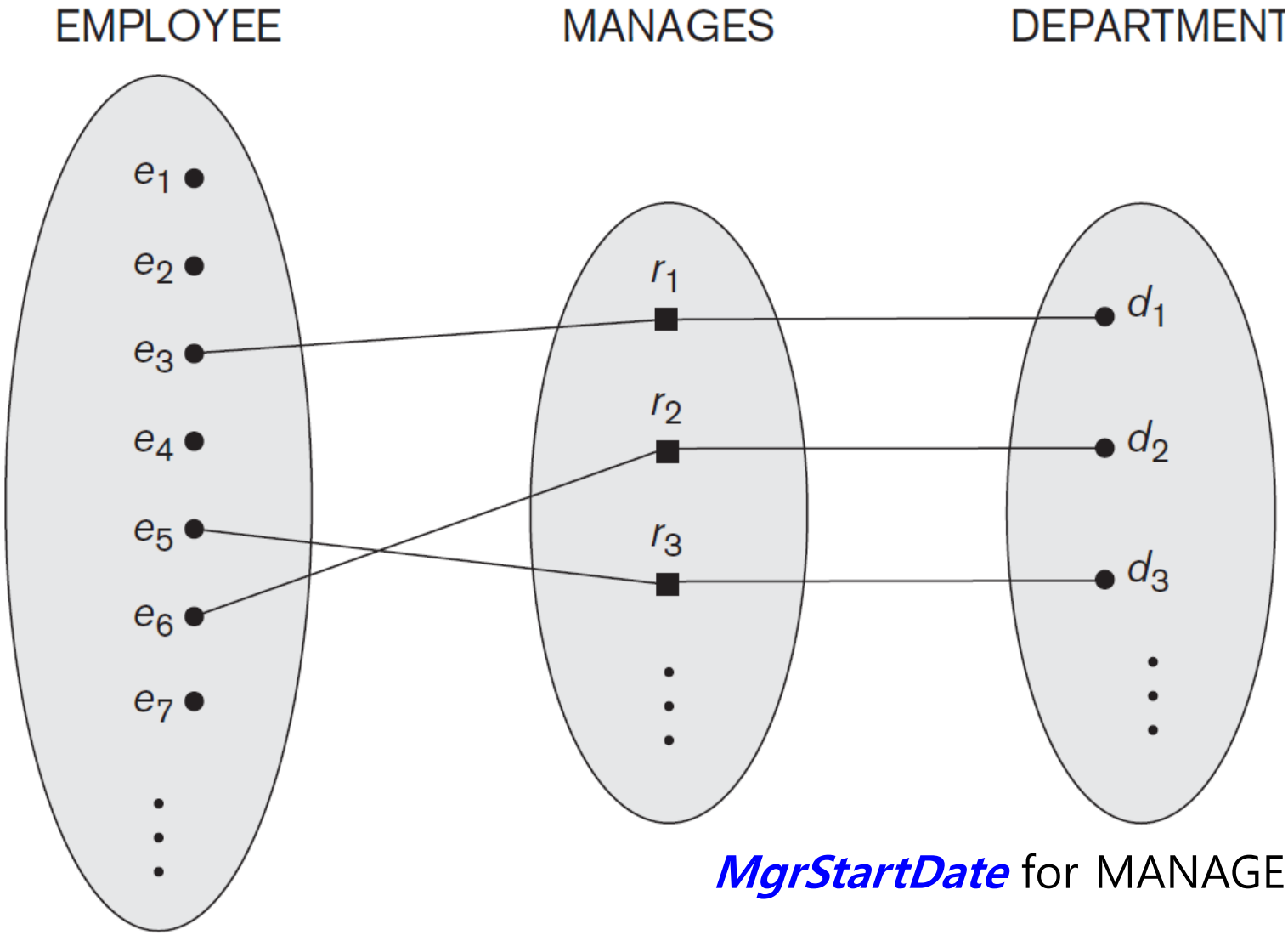
- ***Relationship types*** can also have ***attributes***
  - Determined by *a combination of participating entities*
  - Represent the characteristics of each *relationship instance*
  - Used when the attributes are *not proper for one participating entity type*
- Proper for M:N relationship types
  - The attributes of 1:1 or 1:N relationship types can be migrated to one entity type

Attributes of Relationship Types



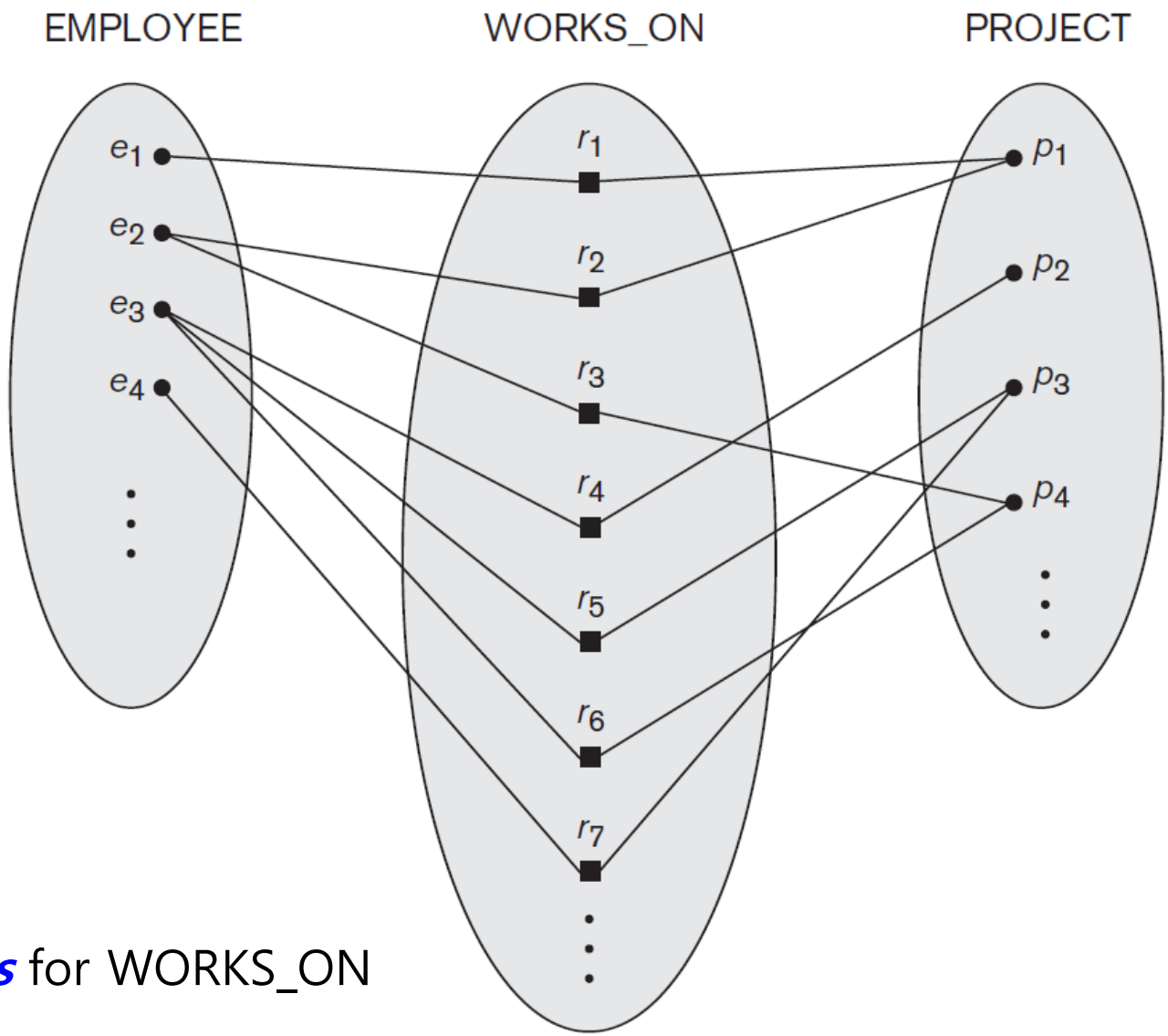
StartDate for WORKS_FOR

Attributes of Relationship Types



MgrStartDate for MANAGES

Attributes of Relationship Types



Hours for WORKS_ON

Weak Entity Types

- Weak entity types
  - Do have *no key attributes* of their own inside the entity type
  - Example: DEPENDENT entity type
    - (DependentName, BirthDate, Sex, Relationship)
    - A's son (Gildong, 1/1/14, M, son)
    - B's son (Gildong, 1/1/14, M, son)

Weak Entity Types

- Identifying owner
  - Identifies specific entities in a *weak entity type*
  - Example: EMPLOYEE entity type
    - Identifies DEPENDENT entities
    - A's son (Gildong, 1/1/14, M, son): linked to A
    - B's son (Gildong, 1/1/14, M, son): linked to B

Weak Entity Types

- Identifying relationship type
  - Relates a ***weak entity type*** to its ***identifying owner***
  - Always has a *total participation constraint*
  - Example: DEPENDENTS_OF
    - A's son (Gildong, 1/1/14, M, son): linked to A
    - B's son (Gildong, 1/1/14, M, son): linked to B

Weak Entity Types

- Partial key
  - Uniquely identify weak entities that are *related to the same owner entity*
    - Could be used as a key together with the identifying relationship
  - Example
    - DependentName attribute of DEPENDENT entity type

Refining Conceptual Design for the COMPANY Database

- Result of the initial conceptual design

DEPARTMENT
Name, Number, {Locations}, Manager, ManagerStartDate

PROJECT
Name, Number, Location, ControllingDepartment

EMPLOYEE
Name(FName, MInit, LName), SSN, Sex, Address, Salary, BirthDate, Department, Supervisor, {WorksOn (Project, Hours)}

DEPENDENT
Employee, DependentName, Sex, BirthDate, Relationship

Add Relationship Types

- MANAGES:
  - 1:1 relationship type between EMPLOYEE and DEPARTMENT
  - EMPLOYEE participation is partial
  - DEPARTMENT participation is total
  - Has **MgrStartDate** attribute

Add Relationship Types

- WORKS_FOR:
  - 1:N relationship type between DEPARTMENT and PROJECT
  - Both participations are total

Add Relationship Types

- CONTROLS:
  - 1:N relationship type between DEPARTMENT and EMPLOYEE
  - PROJECT participation is total
  - DEPARTMENT participation is partial

Add Relationship Types

- SUPERVISON:
  - 1:N relationship type between EMPLOYEE (supervisor) and EMPLOYEE (supervisee)
  - Both participations are partial

Add Relationship Types

- WORKS_ON:
  - M:N relationship type between EMPLOYEE and PROJECT
  - Both participations are total
  - Has **Hours** attribute

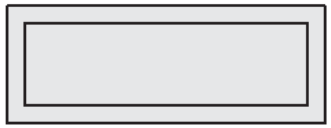
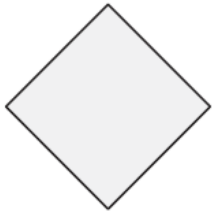
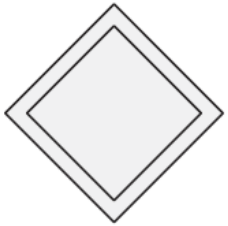
Add Relationship Types

- DEPENDENTS_OF:
  - 1:N relationship type between EMPLOYEE and DEPENDENT
  - Identifying relationship for DEPENDENT
  - EMPLOYEE participation is partial
  - DEPENDENT participation is total

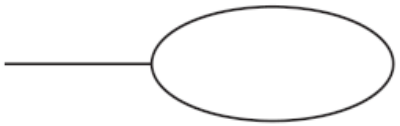
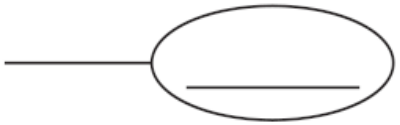
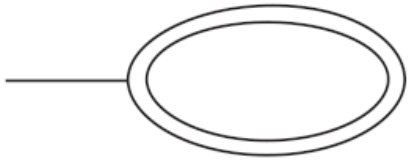
Entity-Relationship Diagram

- Result of conceptual design using the entity-relationship model
- Displayed as a diagram (ER diagram)

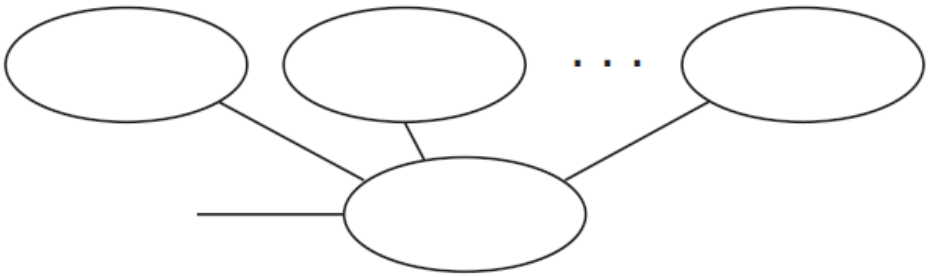
Entity-Relationship Diagram

Symbol	Meaning
	Entity
	Weak Entity
	Relationship
	Indentifying Relationship

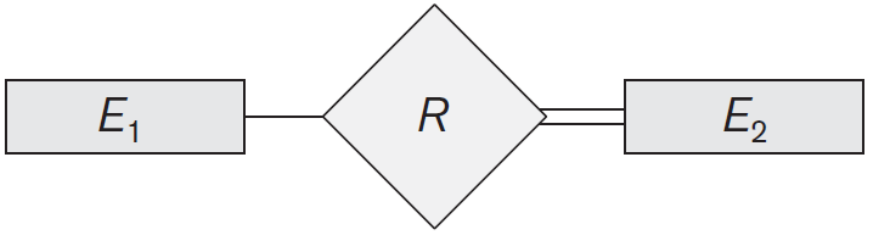
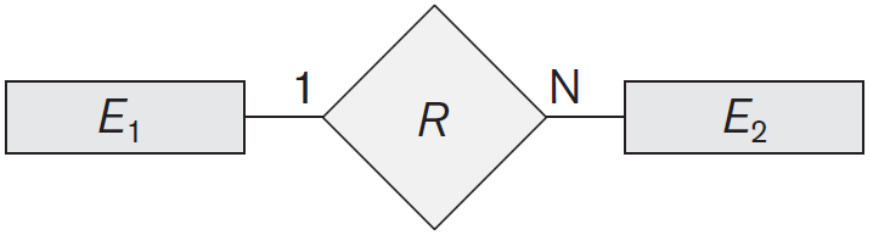
Entity-Relationship Diagram

Symbol	Meaning
	Attribute
	Key Attribute
	Multivalued Attribute

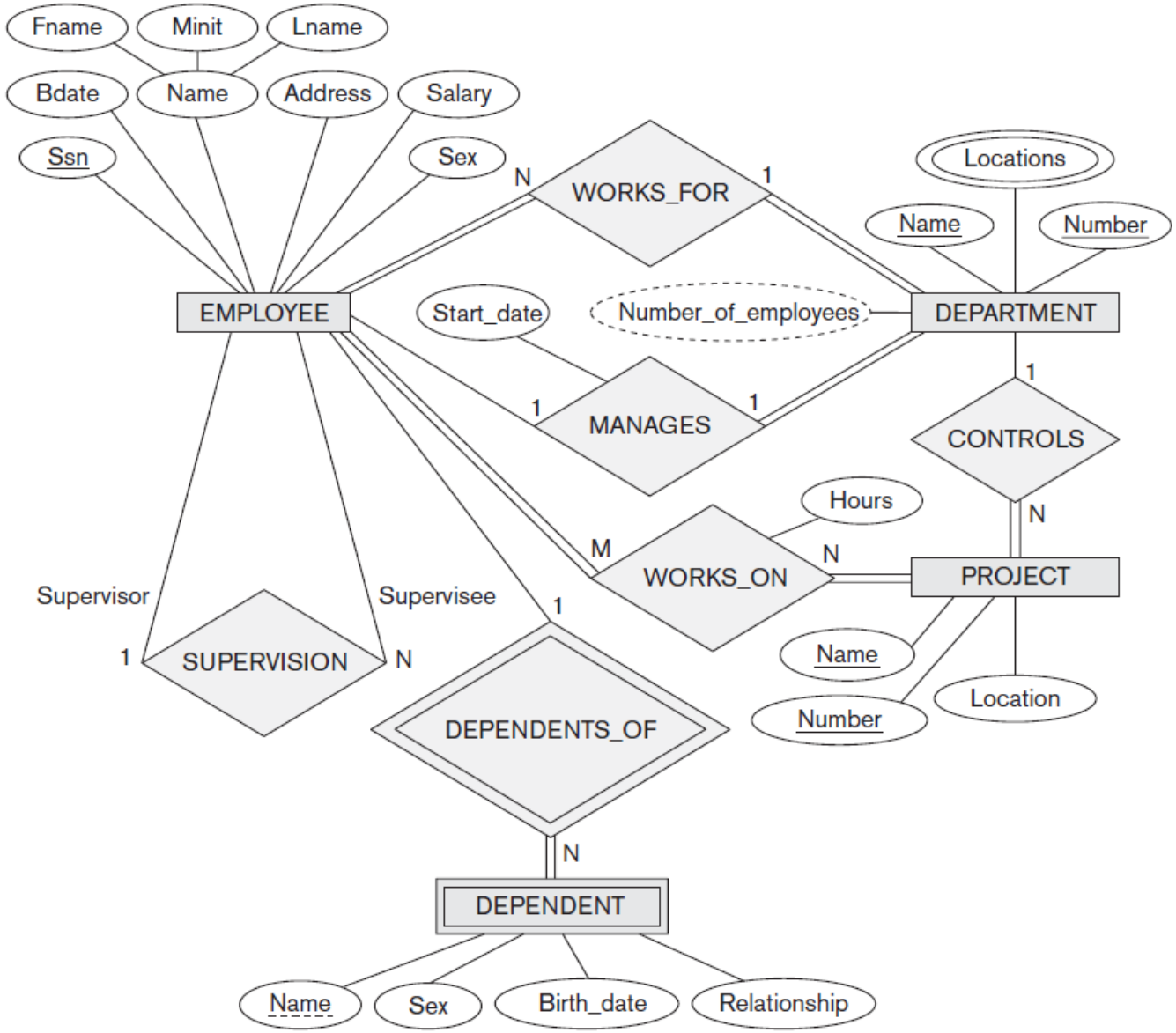
Entity-Relationship Diagram

Symbol	Meaning
	Composite Attribute
	Derived Attribute

Entity-Relationship Diagram

Symbol	Meaning
	Total Participation of E_2 in R
	Cardinality Ratio 1: N for E_1:E_2 in R

ER Diagram of COMPANY database



Summary

- Basic ER model concepts of entities and their attributes
  - Structural constraints on relationships
  - Attributes on relationships
- ER diagrams represent E-R schemas in a simple diagram

References

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3. Senko, Michael E. "Information systems: records, relations, sets, entities, and things." *Information systems* 1.1 (1975): 3-13.
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5. Abrial, Jean Raymond. *Data semantics*. Université scientifique et médicale, 1974.
6. Elmasri, Ramez, and Gio Wiederhold. "Properties of Relationships and their Representation." *Proceedings of the May 19-22, 1980, national computer conference*. ACM, 1980.

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8. Parent, Christine, and Stefano Spaccapietra. "An algebra for a general entity-relationship model." *Software Engineering, IEEE Transactions on* 7 (1985): 634-643.
9. Gogolla, Martin, and Uwe Hohenstein. "Towards a semantic view of an extended entity-relationship model." *ACM Transactions on Database Systems (TODS)* 16.3 (1991): 369-416.
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Have a nice day!