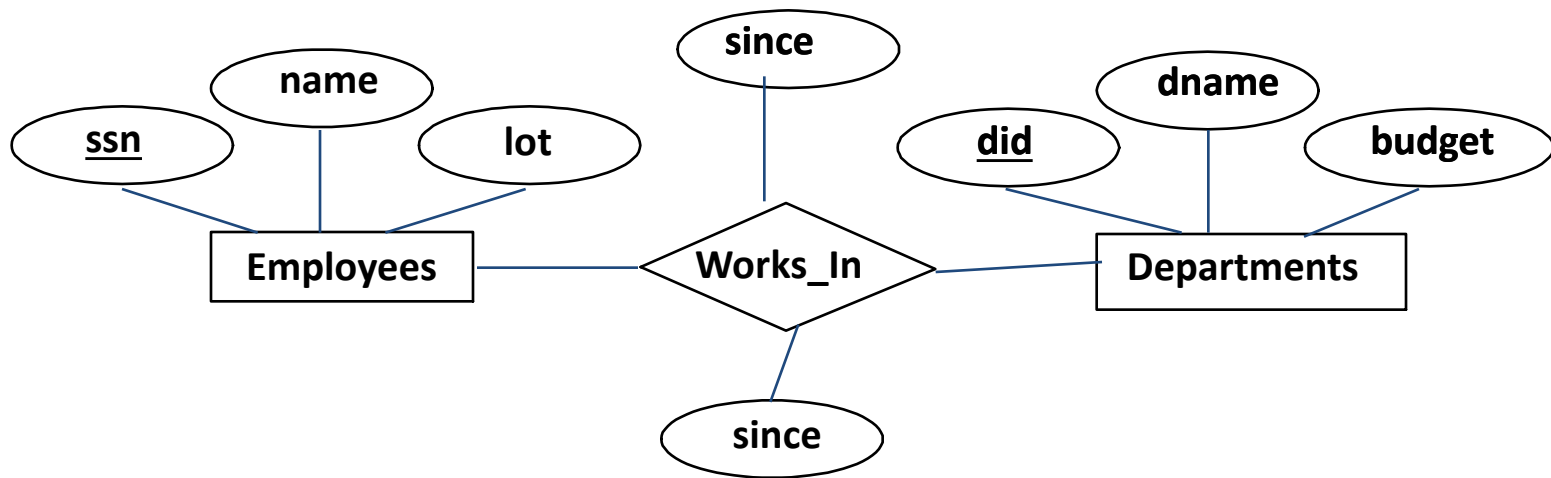# The Entity-Relationship Model (Part II)

R &G - Chapter 2

Last Lecture

- ER model: model data conceptually
  - Entities & entity set
  - Relationships & relationship set
  - Keys (superkey, candidate keys, primary keys)
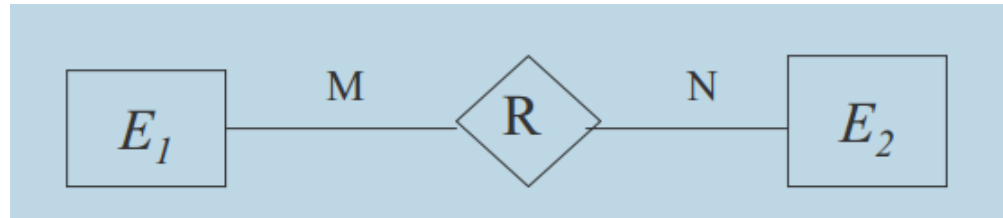
E-R Diagrams

- **Rectangles** represent entity sets.

- **Diamonds** represent relationship sets.

- **Ellipses** represent attributes

- **Underline** indicates primary key attributes

Today's Lecture

- Basic ER diagram design issues:
  - Cardinality constraints in ER diagram
 - Participation constraint
  - Weak entities

Cardinality Constraints in E-R Diagram

E_1 — M — R — N — E_2

- *Cardinality ratio* of R: the number of entities of E2 that an entity of E1 can possibly be associated thru R
- Four possibilities are usually specified:
  - one-to-one (1:1)
  - one-to-many (1:N)
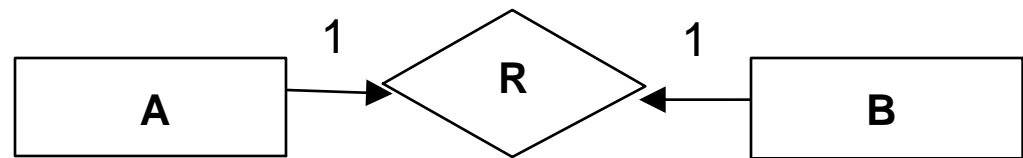 - many-to-one (N:1)
  - many-to-many (M:N)

One-to-One (1:1) Relationship

- An entity in A is associated with at most one entity in B and vice versa

- e.g. A: driver, B: driver's license

- More examples?

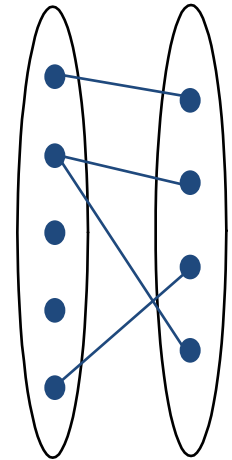- ER diagram of (1:1) relationship
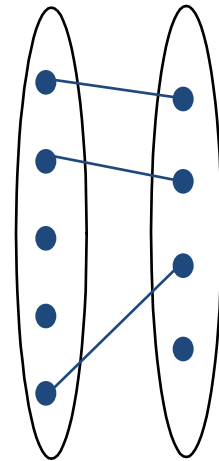
1-to-1

Two arrows are in ER diagram: each arrow pointing to the relationship
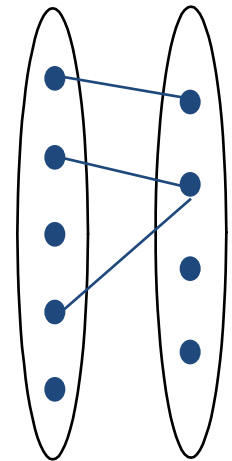
A — 1 → R ← 1 — B

ER diagram

One-to-Many (1:N) Relationship

- One-to-many from A to B
  - An entity in A is associated with any number of entities in B
  - An entity in B is associated with at most one entity in A
    - e.g. A: biological-mother, B: children
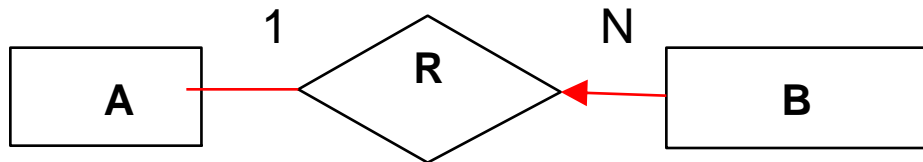 - More examples of 1:N relationships?
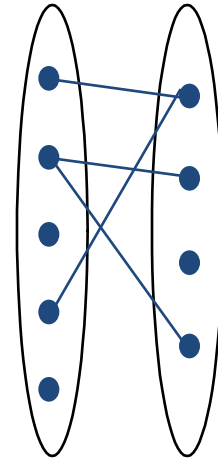
1-to-Many

Many-to-1

ER Diagram of 1:N Relationship

- Assume:
  - R is a 1:N relationship between A and B
  - A is the entity set at 1-side
  - B is the entity set at m-side
- The line between R & B must be arrowed: arrow points to A

```
       1              N
[ A ]------< R >------[ B ]
```
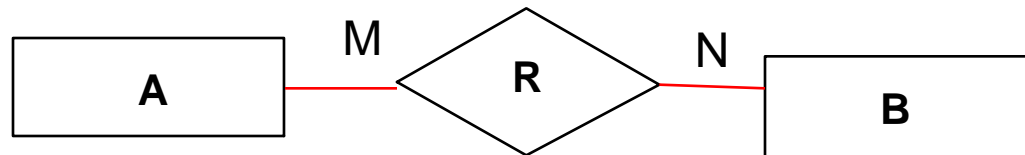
Many-to-Many (M:N) Relationship

- many-to-many from A to B:
  - An entity in A is associated with any number of entities in B and vice versa

- e.g. A: student, B: course

- More examples?
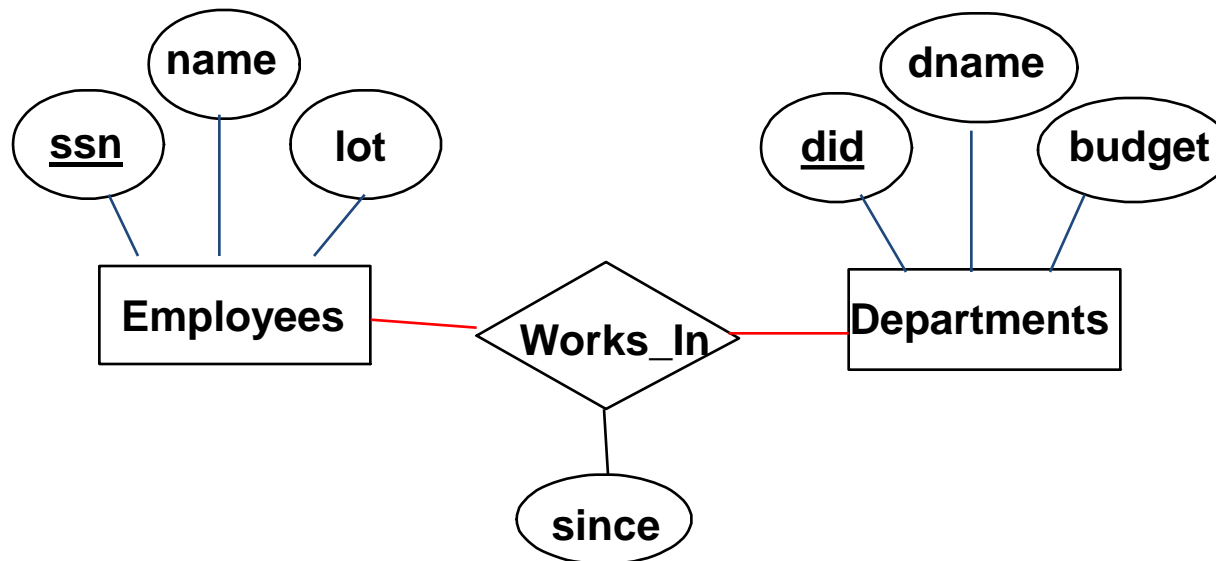
- ER diagram of (M:N) relationship

Many-to-Many

Exercise 1
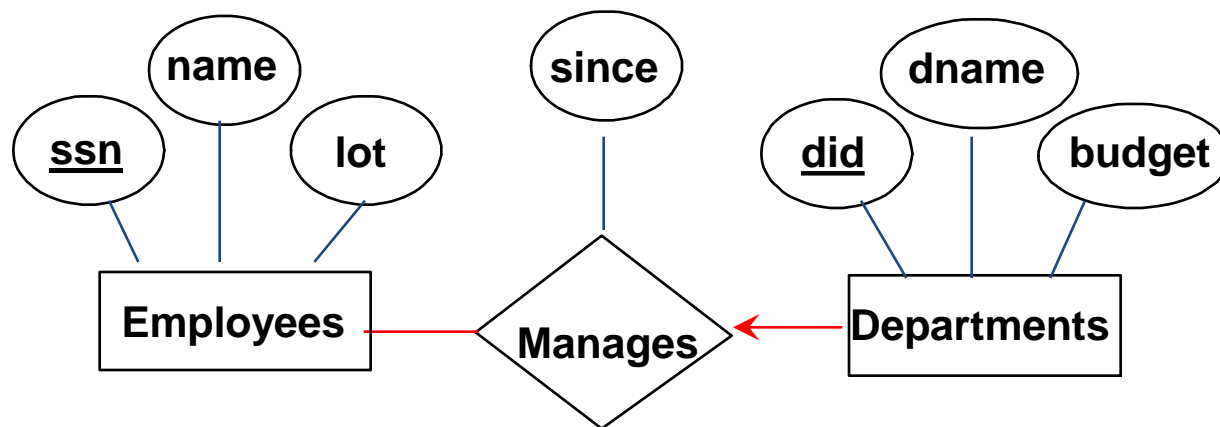
- An employee can work in many departments; a dept can have many employees.
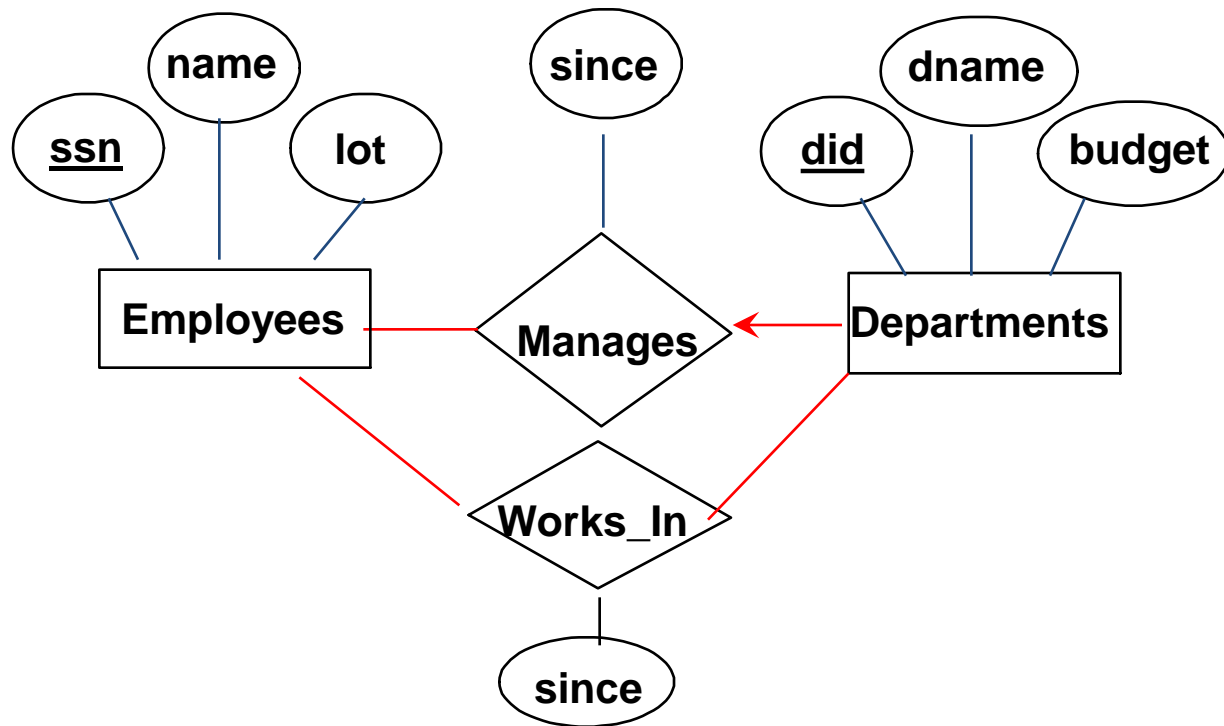 - What is the cardinality constraint of *Works_In* relationship?

Exercise 1 (Cont.)

- In contrast, each dept has at most one manager. Each manager can manage multiple departments.
  - What is the cardinality constraint of *Manages* relationship?
  - How to present this constraint in ER diagram?

Exercise 1 (Cont.)

- Putting two relationships together

Exercise 2

- What are the cardinality constraints of following relationships?
    - A: Country; B: Capital.
    - A: Course; B: student.
    - A: Movie; B: Director.
    - A: Movie; B: actor.
    - A: Person; B: email address.
    - A: book; B: author
    - A: doctor; B: patient

Exercise 3

Student — LeaderOf — Team

- If each team can only have 1 leader, but each student can be the leader of multiple teams, what's the cardinality constraint of the *LeaderOf* relationship?

- If each team can have multiple leaders, but each student can be the leader of at most 1 team, what's the cardinality constraint of the *LeaderOf* relationship?

Today's Lecture

- Basic ER diagram design issues:
  - Cardinality constraints in ER diagram
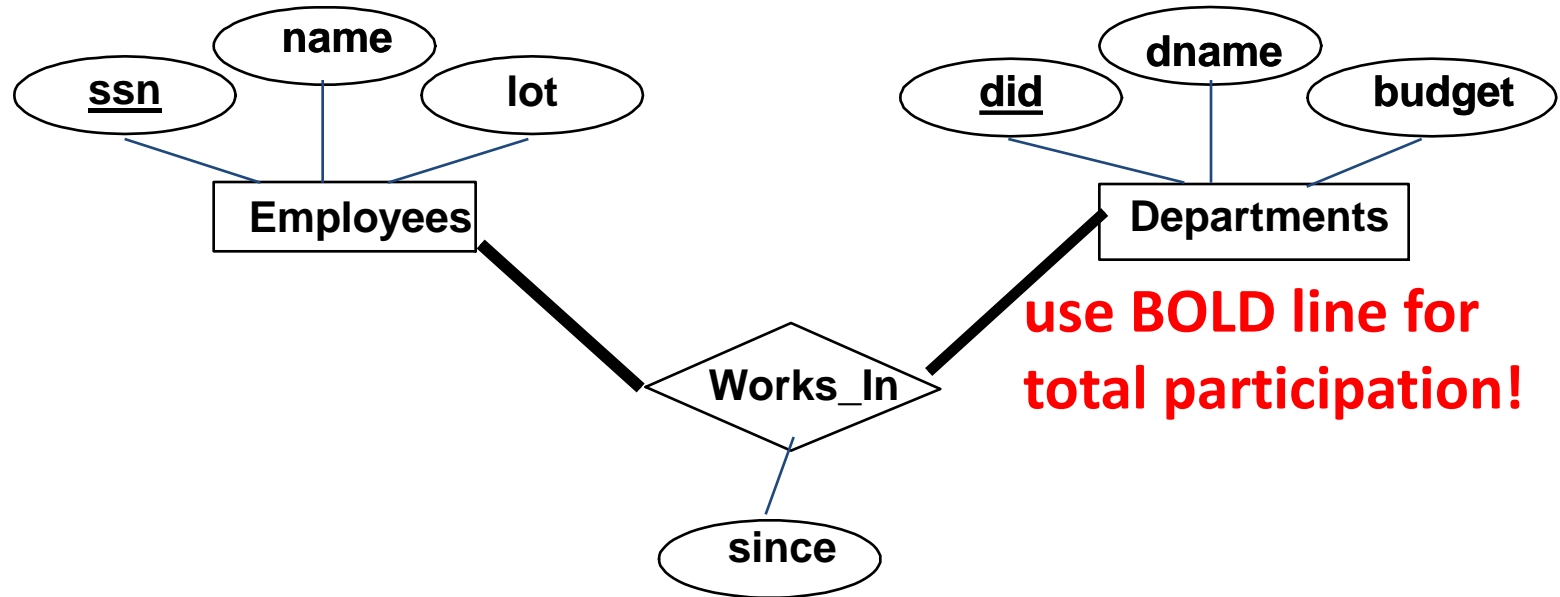 - Participation constraint
  - Weak entities

Participation Constraints

- An entity set may participate in a relation either *totally* or *partially*.
  - **Total participation**: Every entity in the set is involved in some association of the relationship.
  - **Partial participation**: Not all entities in the set are involved in association of the relationship.
- In ER diagram: total participation is represented in bold line

Participation constraints in ER diagrm
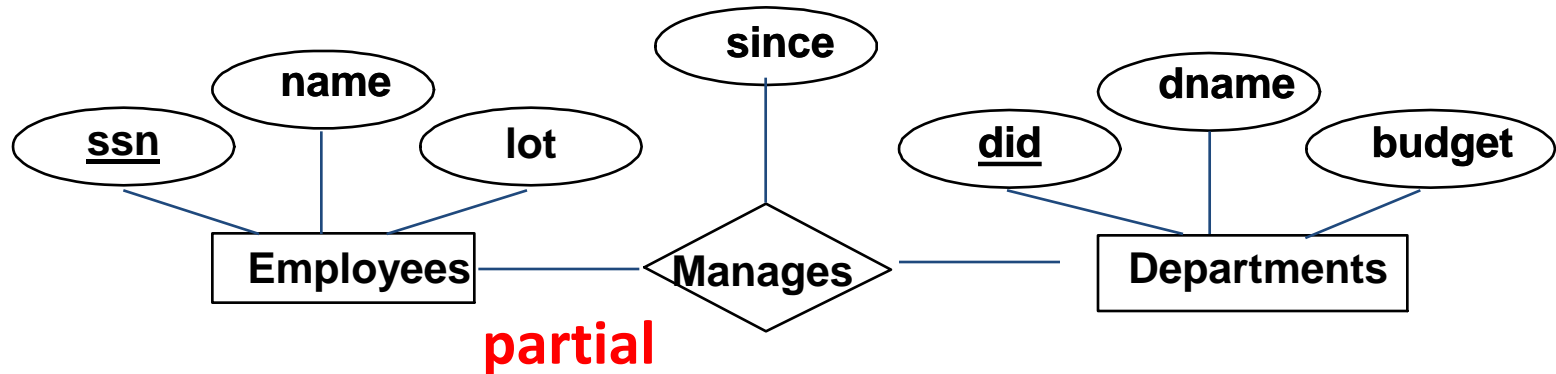
Example: Total Participation
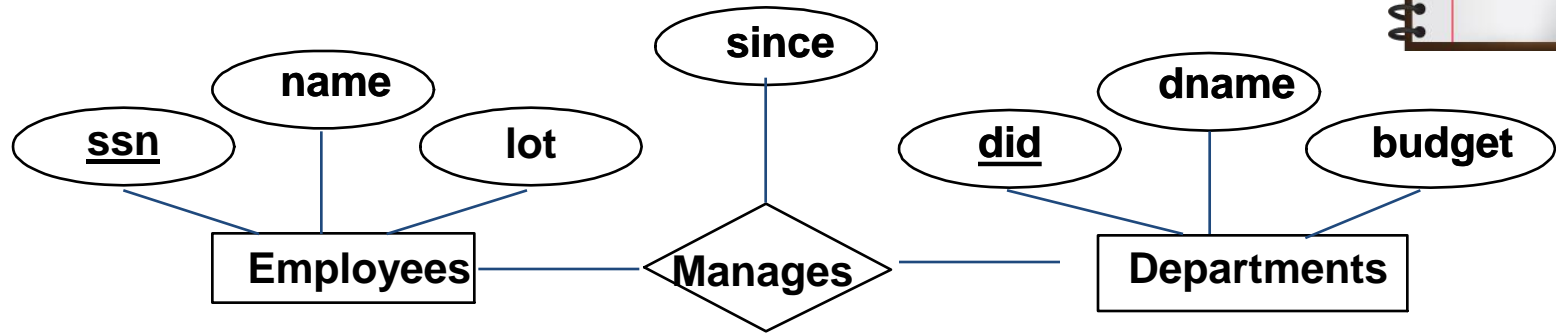

use BOLD line for total participation!
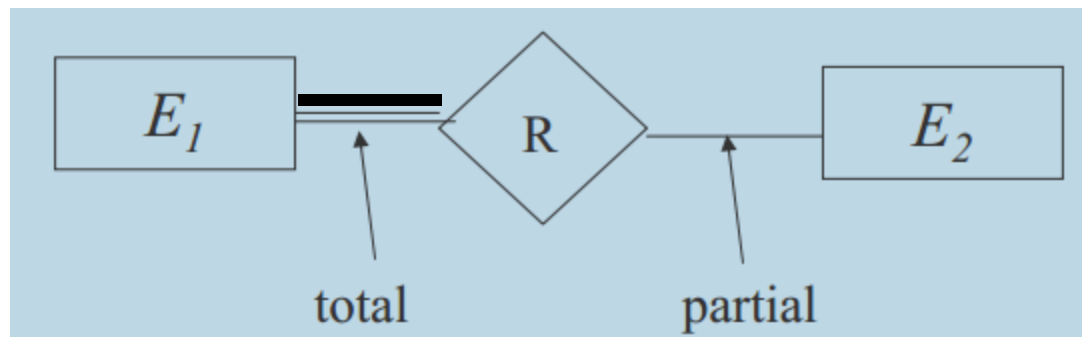
- Facts:
  - Every employee works in at least one department
  - Every department has at least one employee
- What are the participation constraints in ER diagram?

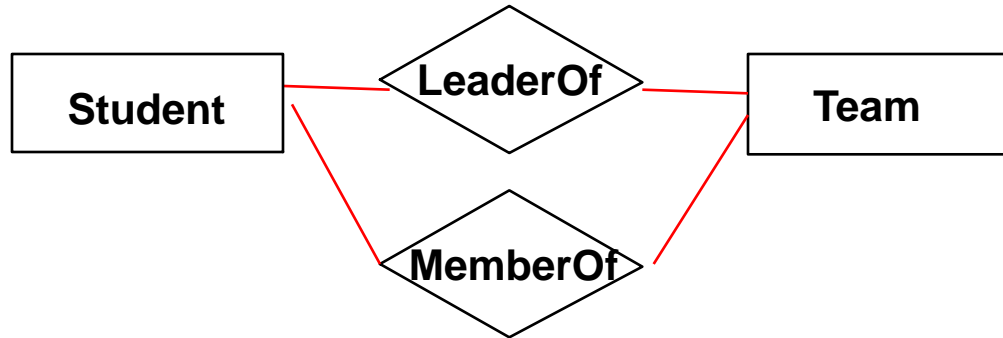# Example: Partial Participation

- Fact:

  – Not every employee manages a department

- So this a partial participation between Employees and Manages

Exercise 4

- Question
  - What is the participation constraint for the fact that "every department must have a manager"?

Exercise 5

- When does the Student entity set has *total participation* constraint with MemberOf relationship?

- When does the student entity set has *partial participation* constraint with LeaderOf relationship?

Today's Lecture

- Basic ER diagram design issues:
  - Cardinality constraints in ER diagram
  - Participation constraint
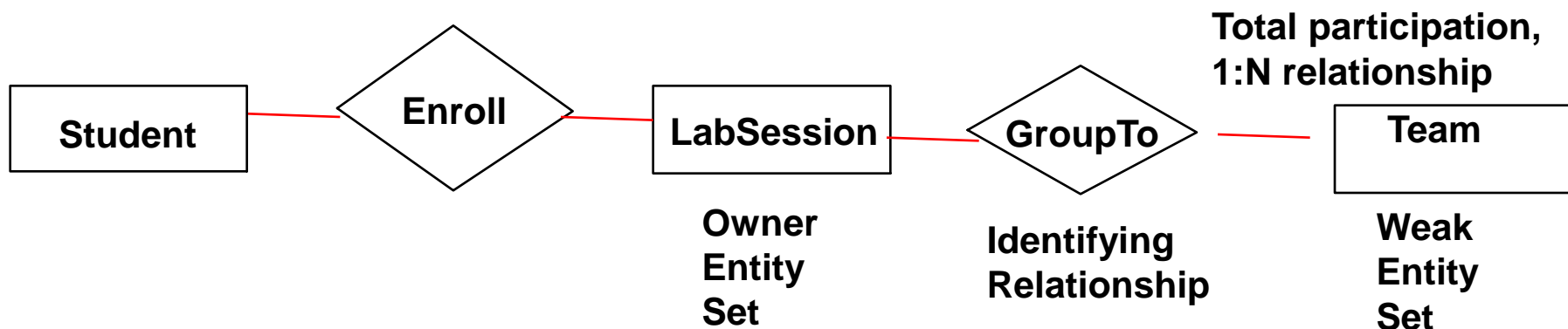 - Weak entities

Strong and Weak Entities
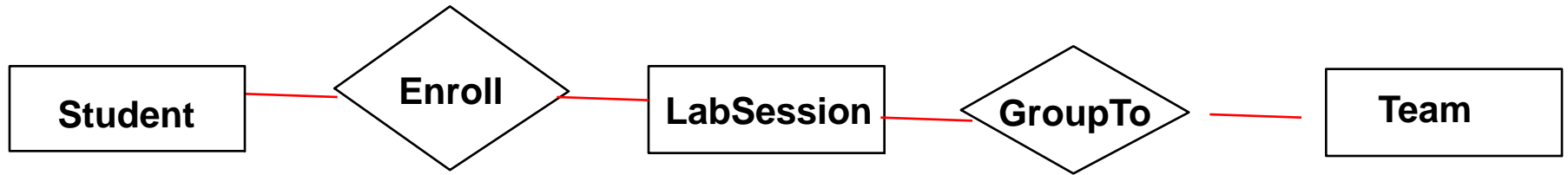
- In practice, some entities can exist independently.
  - E.g., *Student* entity;
  - These entities are **strong.**
- Some entities depend on other entities
  - The existence of *team* entity depends on the existence of *LabSession* entity.
  - These entities are **weak**.

Weak Entity Sets

- Weak entity set: An entity set whose members owe their existence to some entity in a strong entity set.
  - The strong entity: the *owner entity set*.
  - The relationship between owner and weak entity sets: the *identifying relationship*.
  - Weak entities must relate to the owner entity set via a *total participation, one-to-many* relationship set
    - With the weak entity set at the many-side.
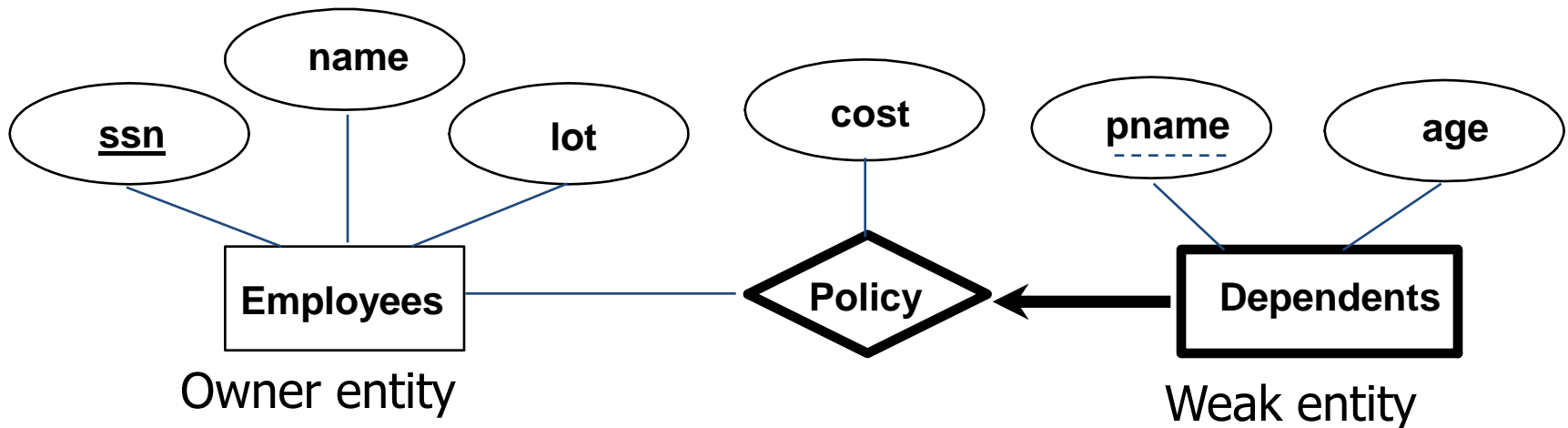
Weak Entity Sets in ER Diagram

- Weak entity set W: rectangle of bold line
- Identifying relationship R: diamond in bold line
- Line connecting R and W:
  - Bold line (total participation)
  - Arrow points to R (one-to-many relationship)
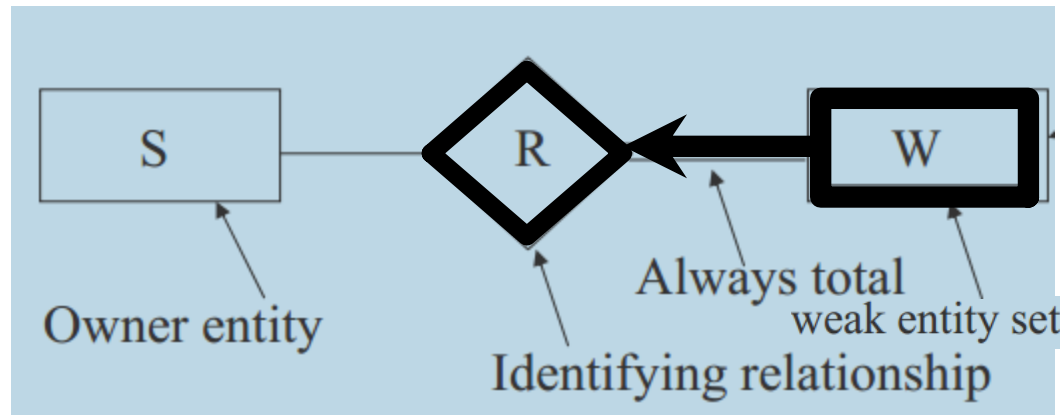
Weak entity set in ER diagram

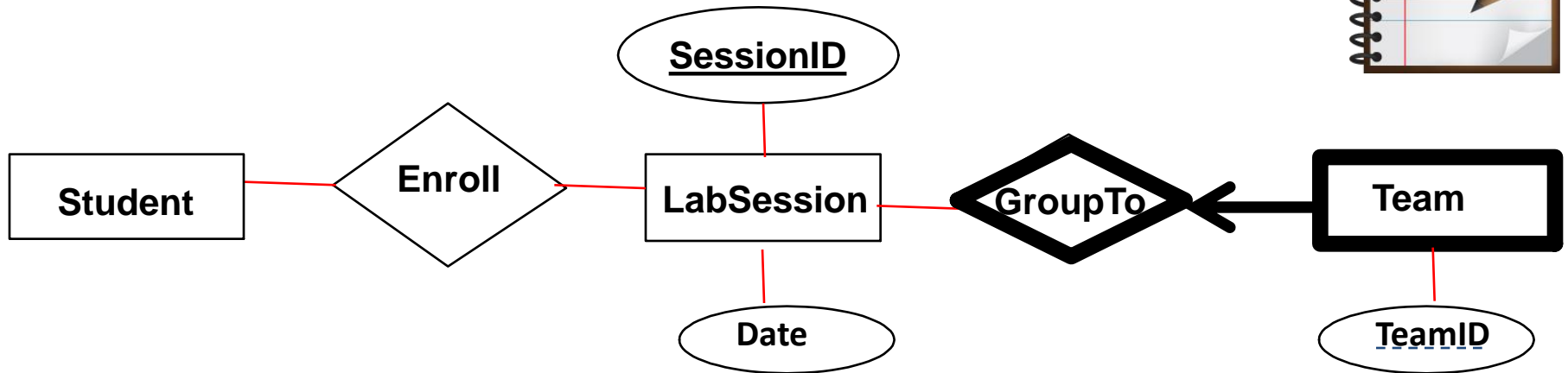# Key of Weak Entities

- A *weak entity set* only have a "partial key" (**dashed underline**)
- Key of weak entities
  - Key = <u>primary key</u> of the owner entity + <u>partial key</u> of itself
  - Example: Key of *Dependents* entity: (ssn, pname)

Owner entity

Weak entity

Exercise 6

SessionID

Student — Enroll — LabSession — GroupTo — Team

Date

TeamID

- What's the key of *Team* entity?

Exercise 7

- **Facts:**
  - The university provides several courses, each course has its name, ID, and number of credits.
  - A popular course may have several sections, each taught by a different professor. Each section has its own ID, classroom and meeting times.
  - It is possible that the sections of different courses may have the same ID.

- **Question**:
  - Design the ER diagram of the *course* and *section* entity sets, and the *has* relationship between them.
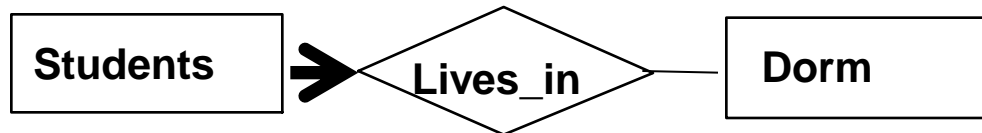
Summary: E-R Diagrams
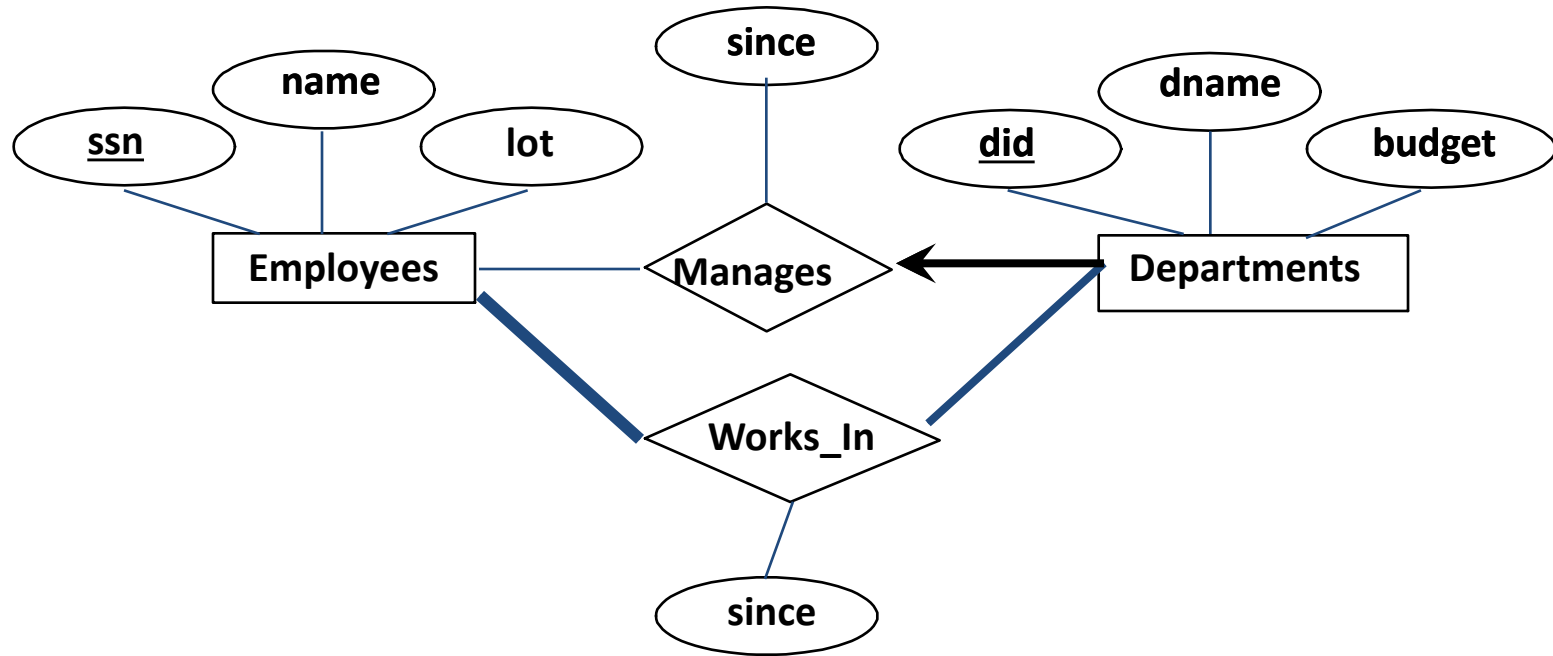
- **Rectangles** represent entity sets.
- **Diamonds** represent relationship sets.
- **Ellipses** represent attributes
- **Underline** indicates primary key attributes
- **Arrow** indicates 1-to-many relationship (leaving the many- side, point to the 1- side)
- **Bold line** indicates total relationship

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Summary: Line Types

- Plain lines mean many-to-many constraint

Students	Register	Courses

- Arrows mean the other side has a cardinality of one (1:N constraint)

Students	Lives_in	Dorm

- A thick line requires total participation

Employees	Policy	Dependents
Owner entity	Identification Relationship	Weak entity

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