

# Entity Relationship Diagram

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A primary goal of database design is to decide what tables to create. Usually, there are two principles:

- 1 Capture all the information that needs to be captured by the underlying application.
- 2 Achieve the above with little redundancy.

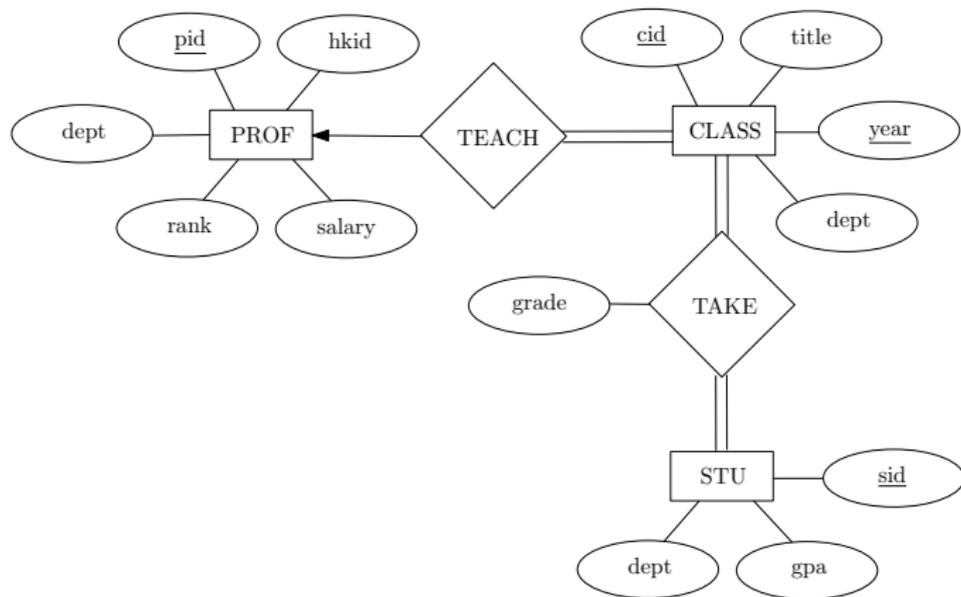
The first principle is enforced with an **entity relationship (ER) diagram**, while the second with **normalization**.

This lecture focuses on the ER diagram.

An ER diagram is a pictorial representation of the information that can be captured by a database. Such a “picture” serves two purposes:

- It allows database professionals to describe an overall design concisely yet accurately.
- (Most of) it can be easily transformed into the relational schema.

# An ER Diagram

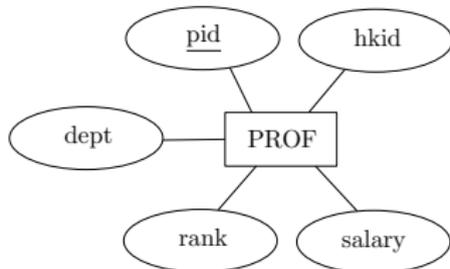


# Entity Set

An **entity** is an atomic object that needs to be represented in the database. An **entity set** is a set of entities with common attributes.

For example, a professor is an entity. PROF is an entity set with all the professors.

The following shows how to describe in an ER-diagram the entity set PROF with attributes pid, hkid, dept, rank, salary, with pid being the **primary key**.

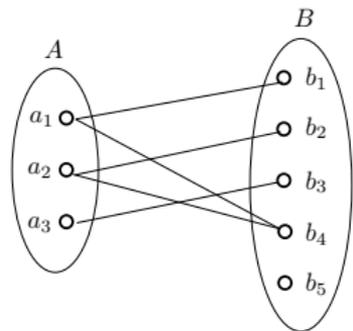


# Relationship Set

A **relationship** is an association among several entities that needs to be represented in the database. We will denote the relationship as  $(e_1, e_2, \dots, e_n)$ , where  $e_1, \dots, e_n$  are the entities participating in the relationship.

A **relationship set** is a set  $R$  of relationships  $(e_1, \dots, e_n)$ , where each  $e_i$  comes from the same entity set  $E_i$ , for  $1 \leq i \leq n$ .

**Example:** The following shows a relationship set  $R$  between entity sets  $A$  and  $B$ .



$$R = \{(a_1, b_1), (a_1, b_4), (a_2, b_2), (a_2, b_4), (a_3, b_3)\}.$$

The next few slides will discuss binary relationship sets, i.e.,  $n = 2$ . For such relationship sets, we can impose two types of constraints.

### Cardinality constraint:

- One-to-one.
- One-to-many (or conversely, many-to-one).
- many-to-many.

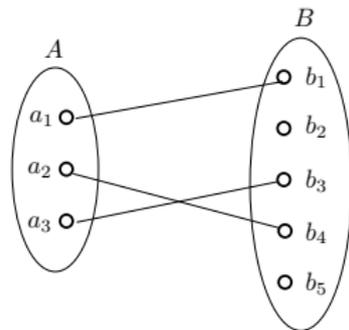
### Participation constraint:

- Total.
- Partial.

We will first talk about cardinality constraints.

# One-to-One

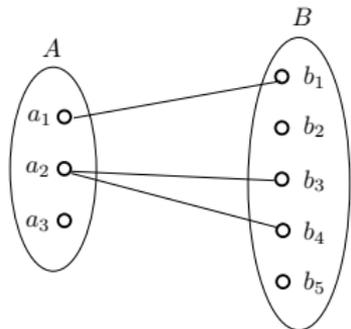
A relationship set  $R$  between entity sets  $A$  and  $B$  is **one-to-one** if every entity in  $A$  and  $B$  can participate in at most one relationship in  $R$ .



**Example:** Husbands and wives.

# One-to-Many

A relationship set  $R$  between entity sets  $A$  and  $B$  is **one-to-many** if every entity in  $A$  can participate in any number of relationships in  $R$ , but an entity in  $B$  can participate in at most one relationship in  $R$ .

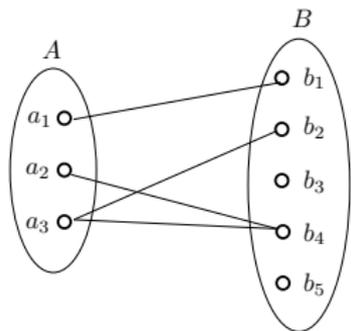


**Example:** Parents and Children.

**Many-to-one** is defined analogously.

# Many-to-Many

A relationship set  $R$  between entity sets  $A$  and  $B$  is **many-to-many** if every entity in  $A$  and  $B$  can participate in any number of relationships in  $R$ .



**Example:** Students and classes.

## Cardinality constraint:

- One-to-one.
- One-to-many (or conversely, many-to-one).
- many-to-many.

## Participation constraint:

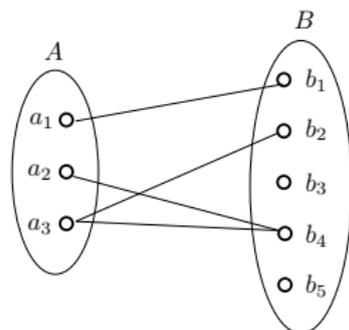
- Total.
- Partial.

Next we talk about participation constraints.

# Total/Partial Participation

Let  $R$  be a relationship set between entity sets  $A$  and  $B$ . The participation of  $A$  is **total** if every entity of  $A$  must participate in at least one relationship in  $R$ . Otherwise, the participation of  $A$  is **partial**. Likewise, we can define total or participation of  $B$ .

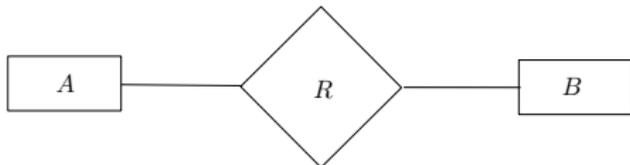
**Example:** In the following relationship, the participation of  $A$  is total, while that of  $B$  is partial.



Patents and professors.

# Representation a Relationship Set in ER Diagrams

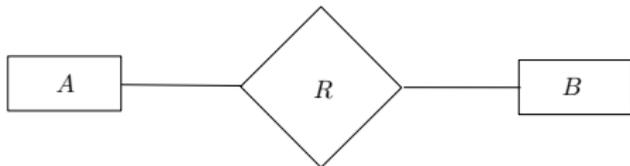
Basic representation of a binary relationship set  $R$  between entity sets  $A$  and  $B$ .



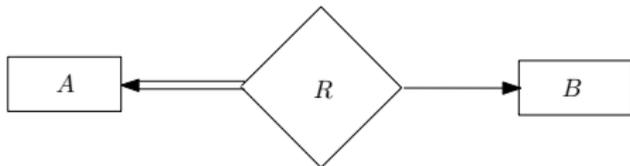
The line connecting  $A$  and  $R$  may:

- Carry an arrow: Meaning **one** (as in one-to-many).
- Not carry an arrow: Meaning **many**.
- Be a double line: Meaning **total participation**.
- Be a single line: Meaning **partial participation**.

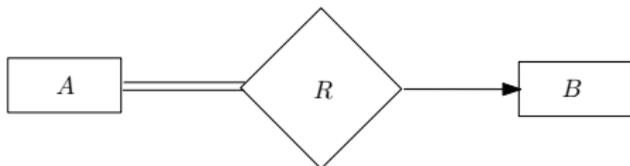
## Examples:



Many-to-many, partial participation on both

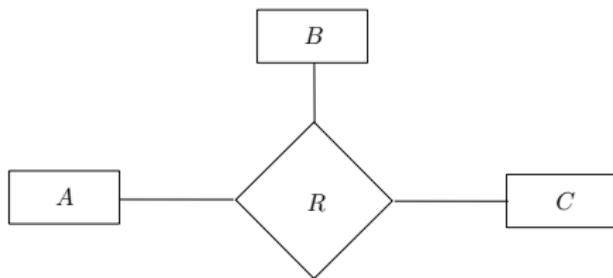


One-to-one, total (partial) participation on left (right)



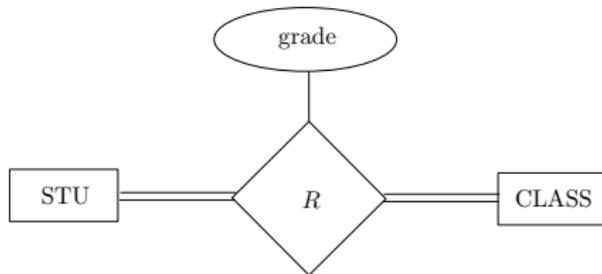
Many-to-one, total (partial) participation on left (right)

Representation a 3-way relationship set:

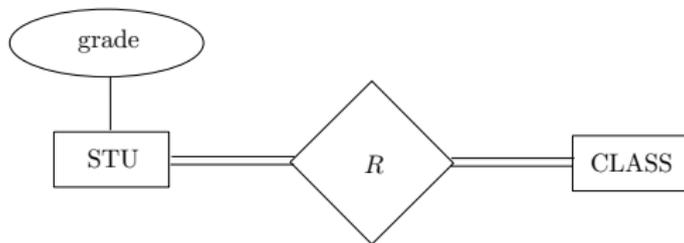


**Example:** Professors, students, and projects.

We can associate a relationship set with attributes:



What is its difference from the design below?



Revisit the ER diagram on Slide 4 to understand all of its components.