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## Week 8, Lec 16

Database Systems -

Introduction to Databases and Data Warehouses

**CHAPTER 2 - Database Requirements and ER**

**Modeling**

**(Part 3)**

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# MAIN TOPICS

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- Multiple ER Diagrams
- ERD Example 2
- Database requirements and ER Model Usage
- Various ER Notations
- Enhanced ERD
- M:N RELATIONSHIPS WITH MULTIPLE INSTANCES BETWEEN THE SAME ENTITIES
- Associative Entity
- **Ternary Relationship**
- ERD Modeling Case Study

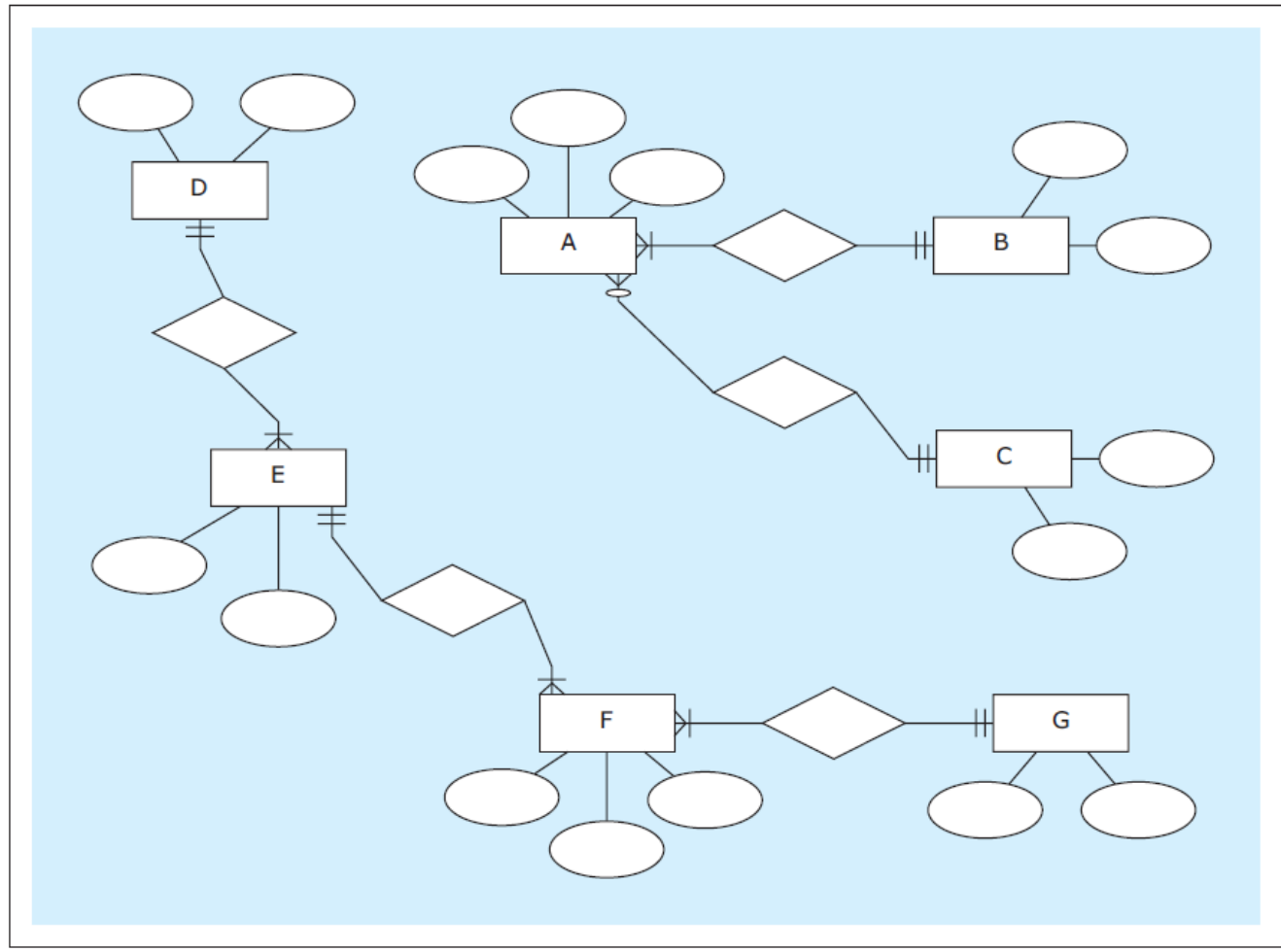
# MULTIPLE ER DIAGRAMS

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- An E-R diagram for a database is always a connected graph
  - There exist a path from one entity to any other entity
- An E-R diagram that is not a connected graph
  - No path from some entity to other entities
  - For **multiple schemas (i.e. databases)**
- When depicting multiple ER diagrams
  - **Visualize each diagram separately**
    - Use **multiple schemas**
    - Present each ER diagram in a separate schema

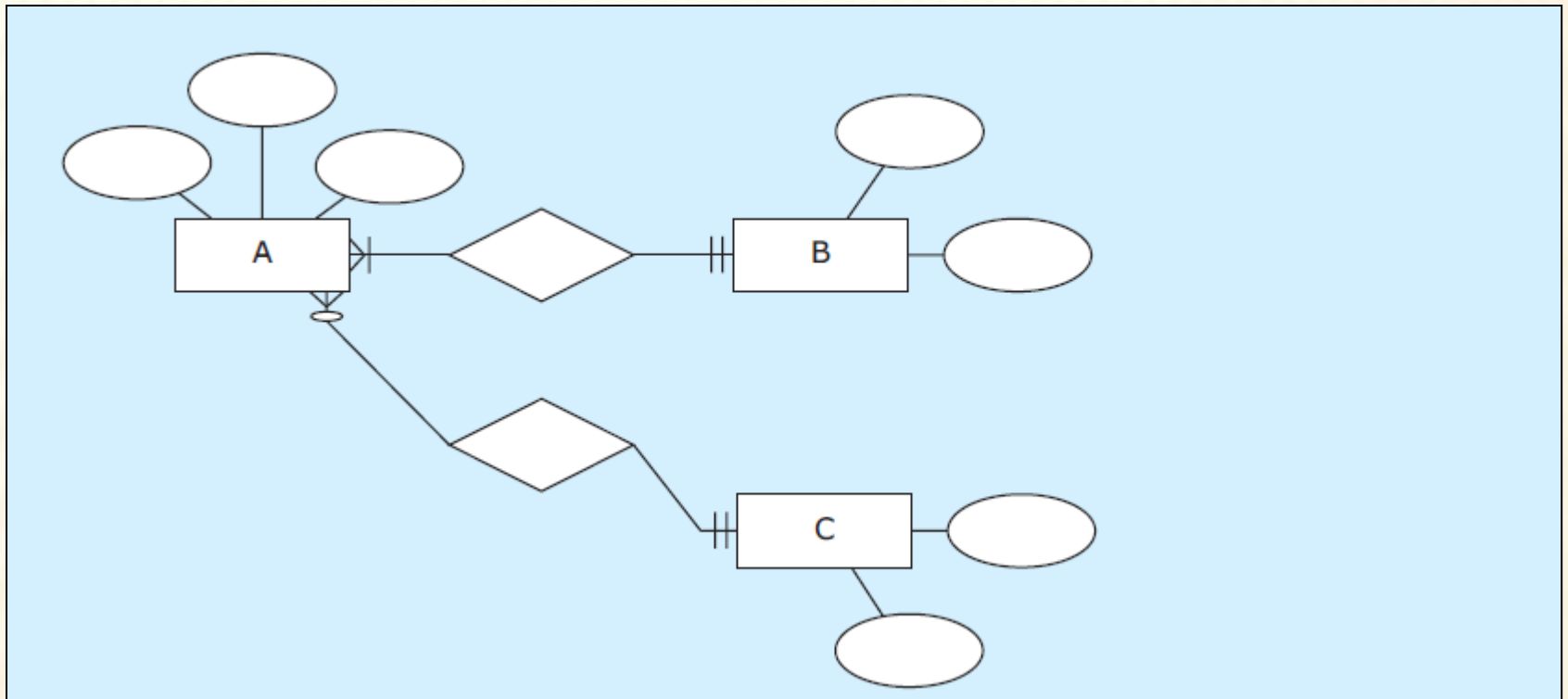
# MULTIPLE ER DIAGRAMS

A schema with two separate ER diagrams (**potentially misleading**)



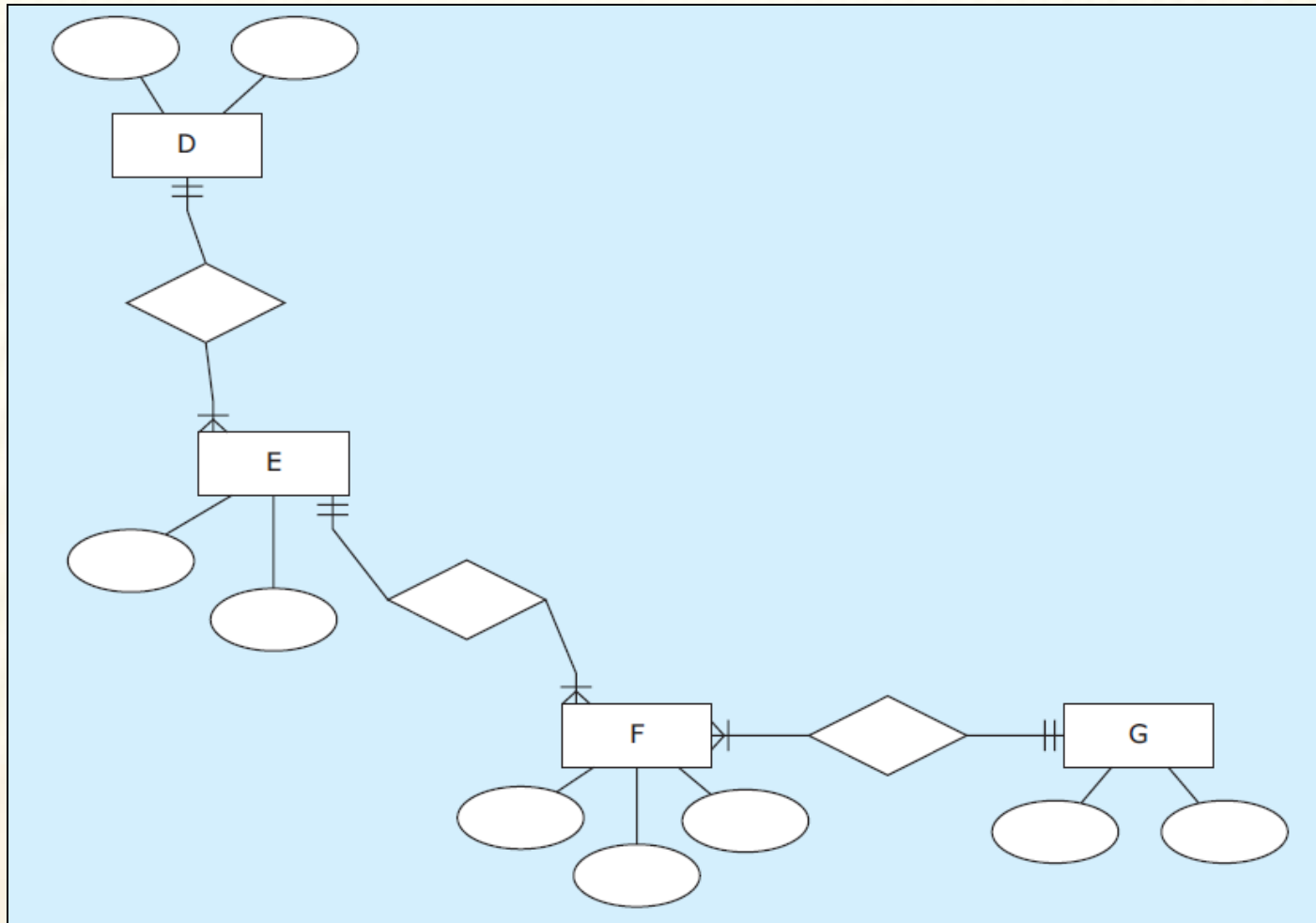
# MULTIPLE ER DIAGRAMS

Separate ER diagrams in separate schemas

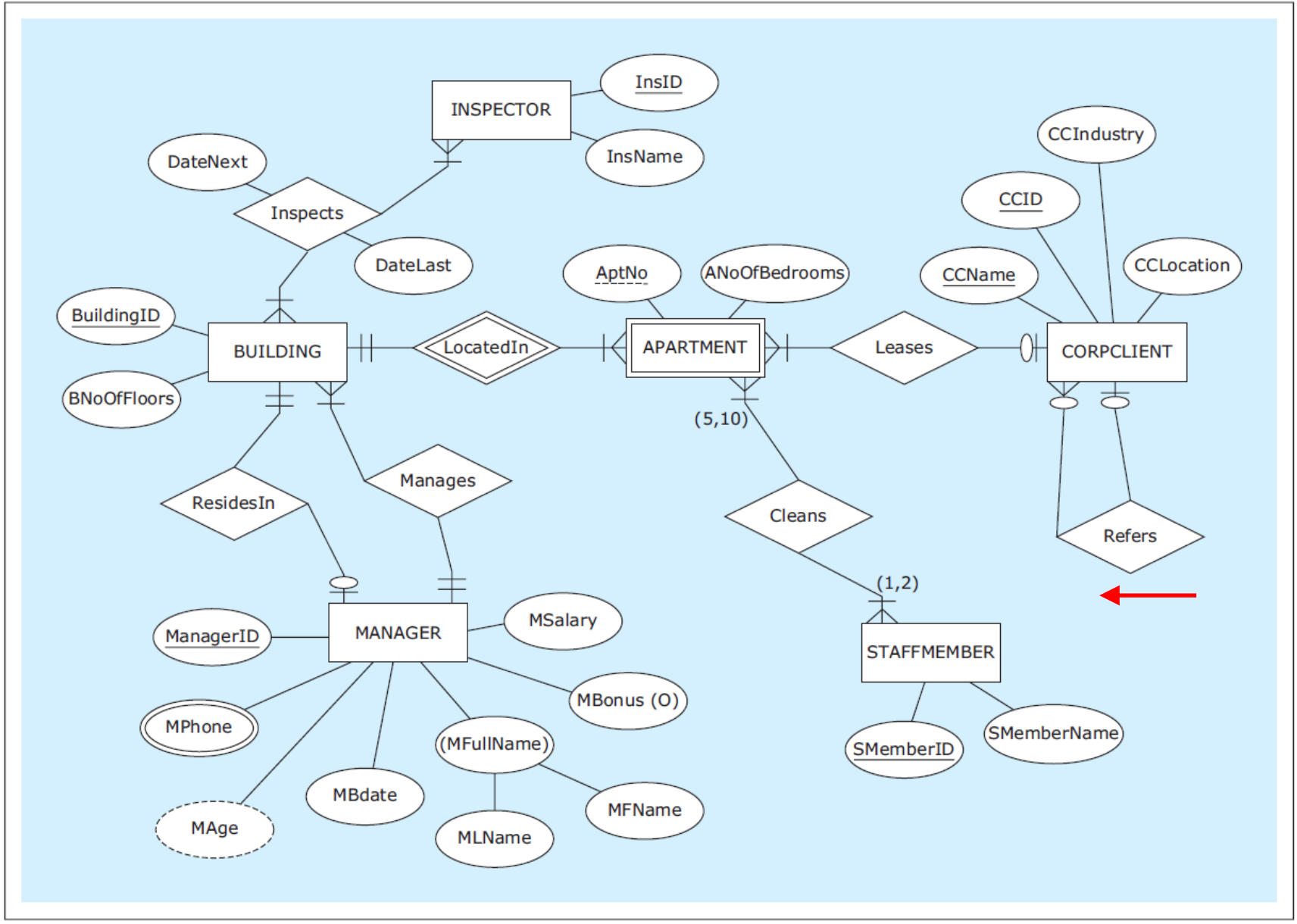


# MULTIPLE ER DIAGRAMS

Separate ER diagrams in separate schemas



Another ER diagram example: HAFH Realty Company Property Management Database



# DATABASE REQUIREMENTS AND ER MODEL USAGE

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- ER modeling
  - A straightforward **technique for collecting**, structuring, and visualizing requirements
    - **Not just for creating ER models based on the requirements**
    - Also for requirements collection
  - Help data modelers **to focus on asking the right questions**
    - To discover the relevant facts about entities, attributes, and relationships



# DATABASE REQUIREMENTS AND ER MODEL USAGE

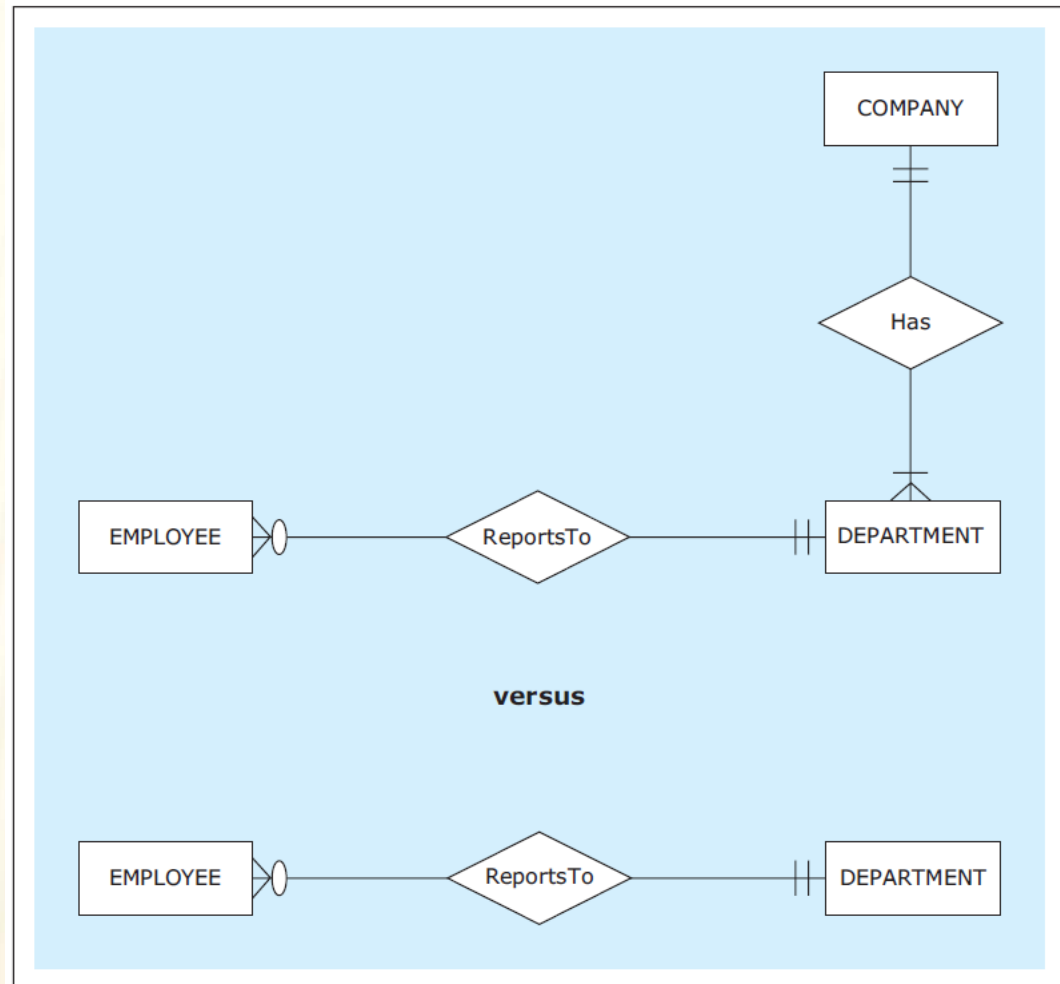
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- One **common mistake** in ER modelling
  - **Not recognize the difference between an entity and the ER diagram itself**
  - E.g. draw ER diagram for the requirements
    - Company X keeps information about its departments, employees who reports to those departments.
    - Each employee reports to exactly one department
    - Each department can have many employees reporting to it but does not have to have any.

# DATABASE REQUIREMENTS AND ER MODEL USAGE

An ER diagram incorrectly and correctly interpreting requirements

An ER diagram for  
Company X:



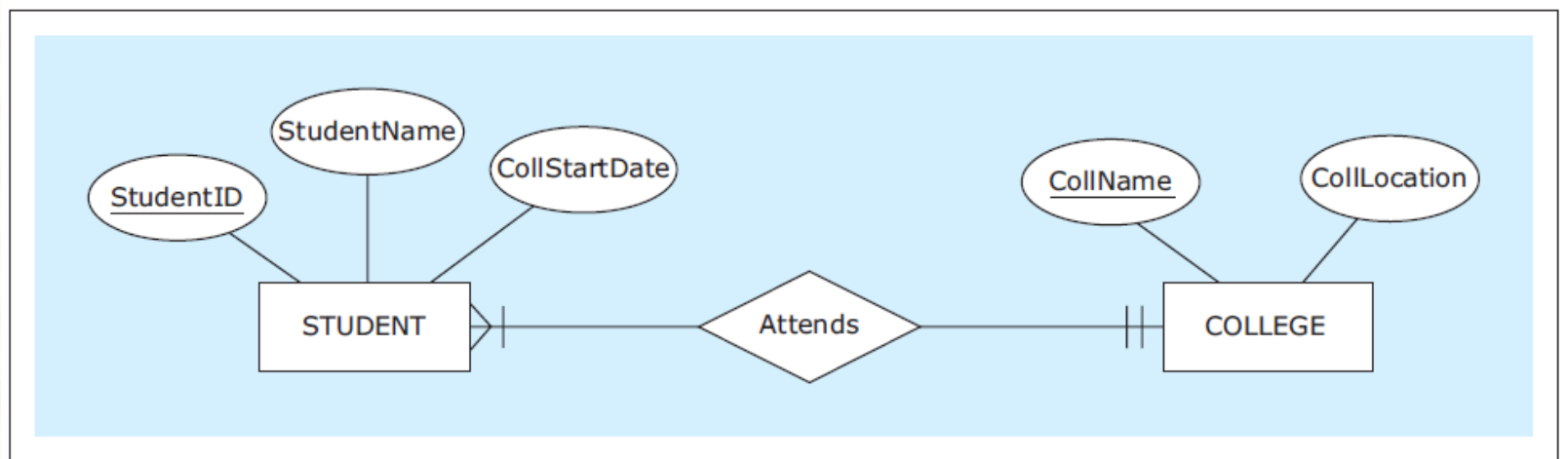
# DATABASE REQUIREMENTS AND ER MODEL USAGE

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- One **common mistake** in ER modelling (cont'd)
  - **Not recognize the difference between an entity and the ER diagram itself**
  - E.g. draw ER diagram for the requirements
    - **An industry association keeps information about its member companies, its departments, and its employees.**
    - Each employee reports to exactly one department
    - Each department can have many employees reporting to it but does not have to have any.

# DATABASE REQUIREMENTS AND ER MODEL USAGE

An ER diagram correctly interpreting requirements  
an ER diagram for Temple University?



# DATABASE REQUIREMENTS AND ER MODEL USAGE

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- One **common mistake** in ER modelling (cont'd)
  - **Not recognize the difference between an entity and the ER diagram itself**
  - E.g. database requirements for a non-profit foundation
    - **A non-profit foundation keeps track of its scholarship recipients that it is funding.**
    - For **each student (scholarship recipient)**, keep unique student id, student name, the start college date
    - For each college attended by each scholarship recipient, keep unique college name, college location
    - Each scholarship recipient attends exactly one college.
    - Each college has at least one scholarship recipient attending.

# DATABASE REQUIREMENTS AND ER MODEL USAGE

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- Another common mistake in database requirements collection and ER modeling
  - Not distinguishing between:

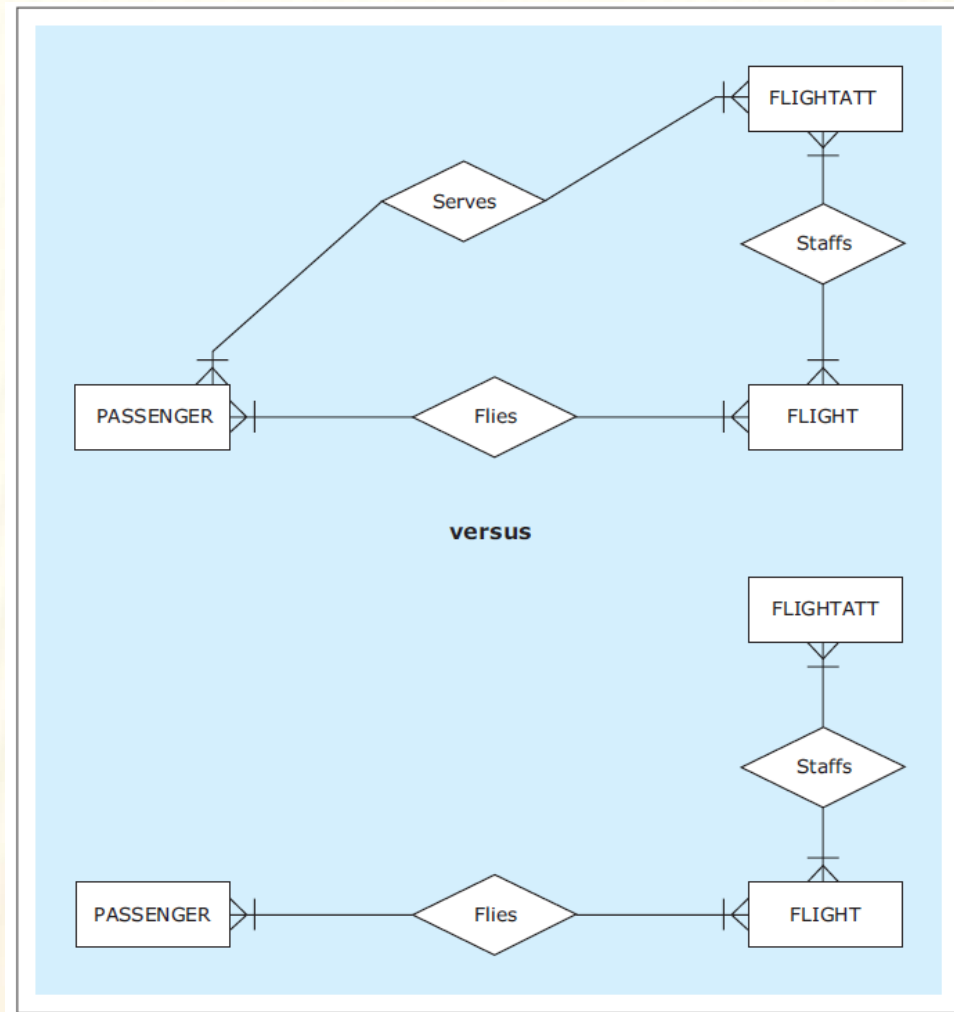
*Modeling of the data that is wanted and can be kept track of*  
versus

*Modeling of everything that takes place in an organization*

# DATABASE REQUIREMENTS AND ER MODEL USAGE

An ER diagram based on unfeasible and proper requirements

ER diagram  
for an airline  
Company:



# VARIOUS ER NOTATIONS

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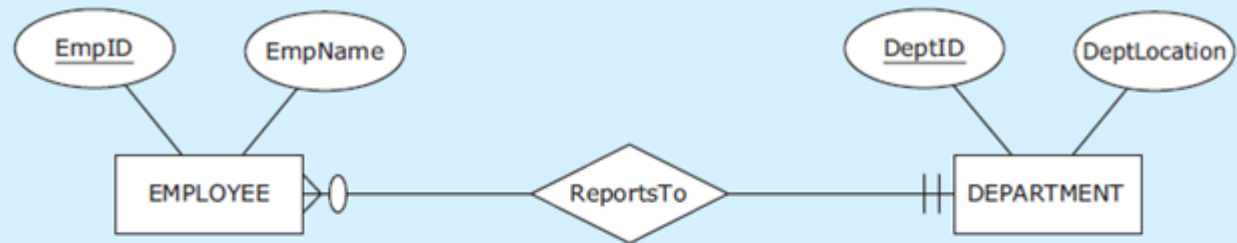
- No universally adopted ER notation to which all database projects conform
- A variety of available ER notations in use
- Familiarity with one ER notation help understanding other alternative ER notations



# VARIOUS ER NOTATIONS

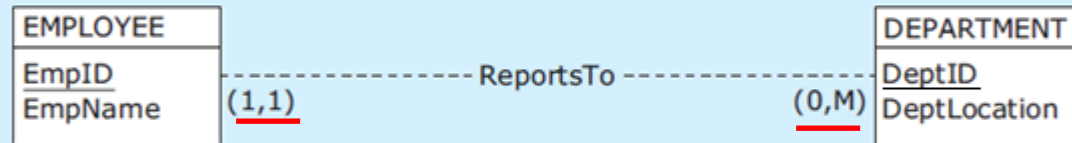
Examples of various ER notations

This book:



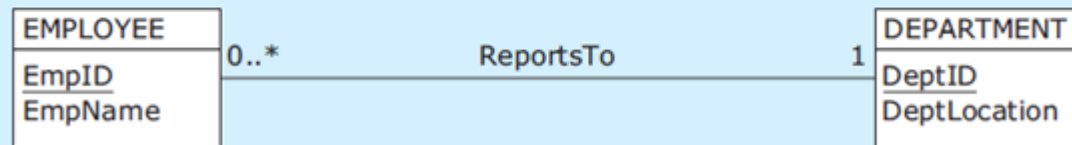
versus

Cardinality  
reversed:



versus

UML  
notation:



versus

...

# Enhanced ER (EER)

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- Expanded ER notation
  - Use additional concepts beyond standard ER modeling
  - Overview in Appendix A
  - Not commonly used by business-related databases

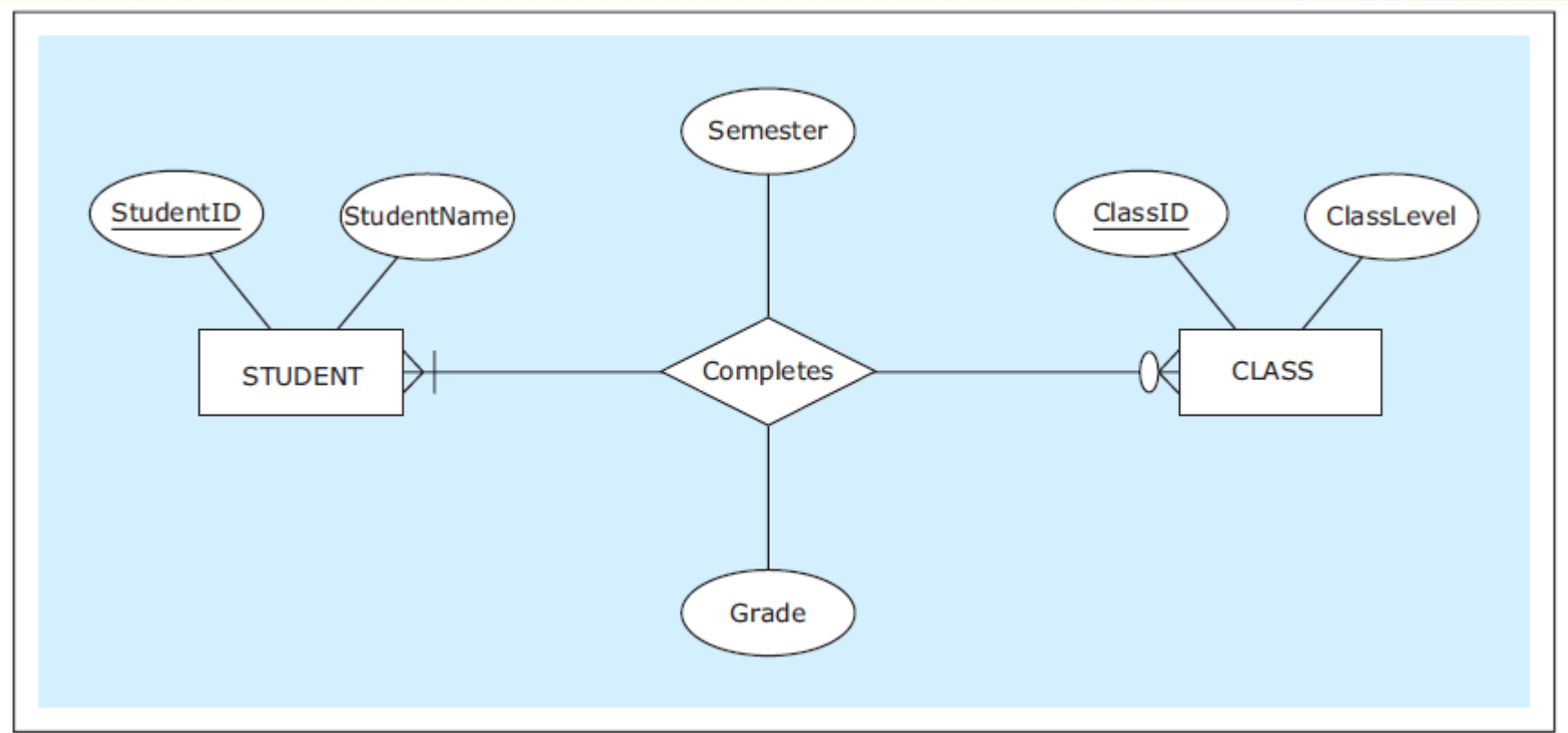
# M:N RELATIONSHIPS WITH MULTIPLE INSTANCES BETWEEN THE SAME ENTITIES

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- M:N relationships may have **multiple occurrences** between the **same instances** of **involved entities**
  - Example in next slide

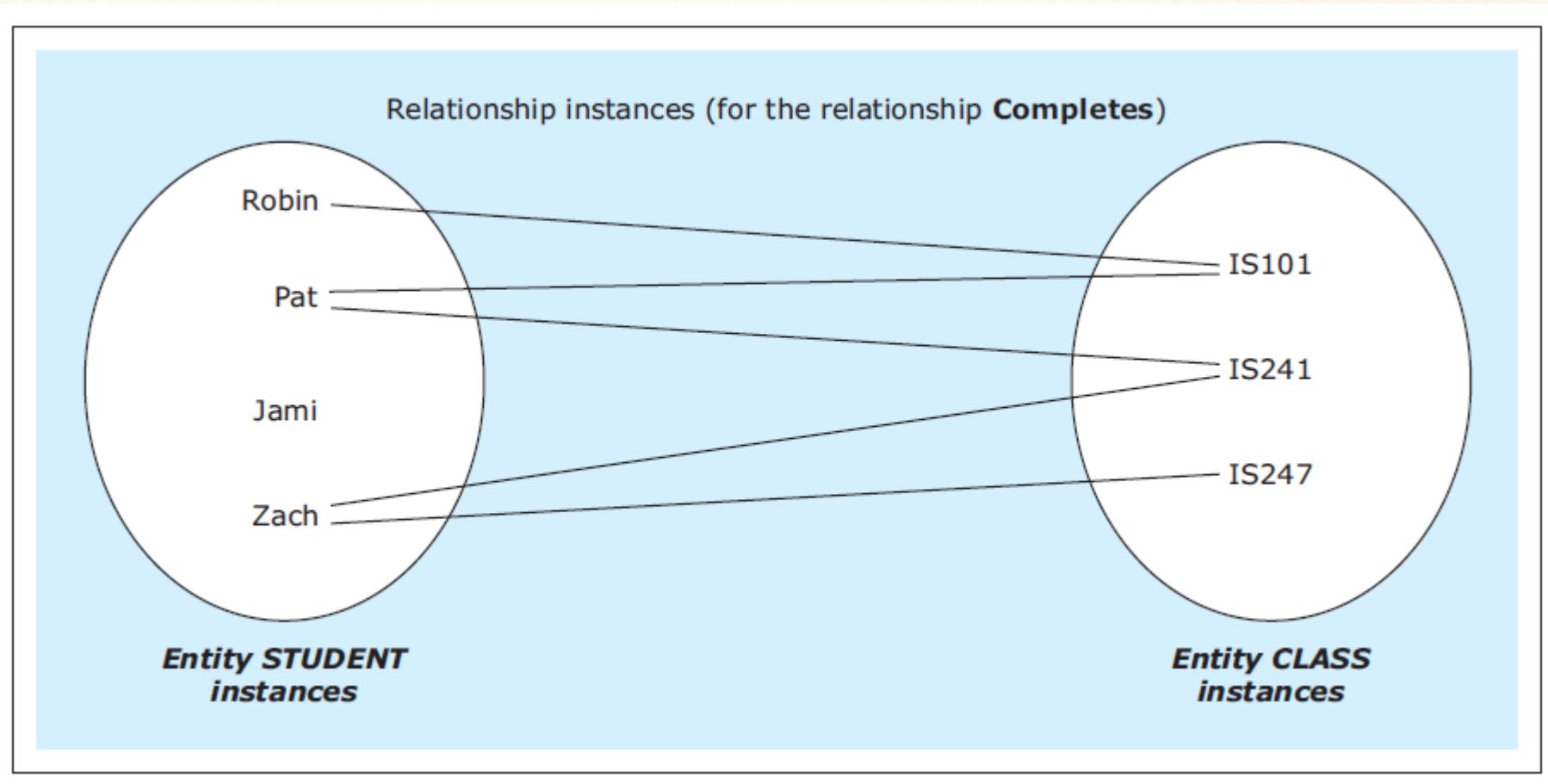
# M:N RELATIONSHIPS WITH MULTIPLE INSTANCES BETWEEN THE SAME ENTITIES

An ER diagram for an M:N relationship depicting students completing classes



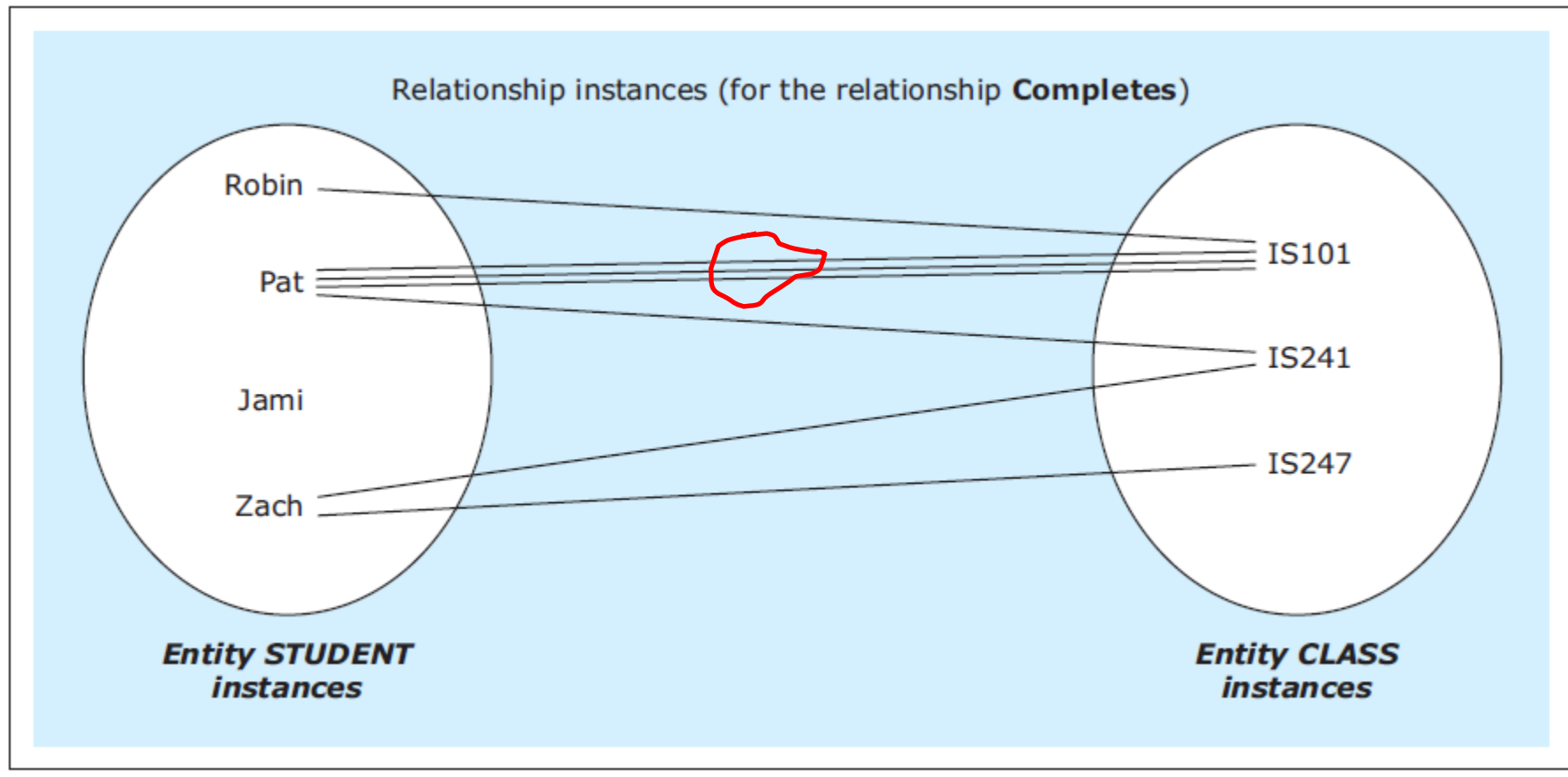
# M:N RELATIONSHIPS WITH MULTIPLE INSTANCES BETWEEN THE SAME ENTITIES

Instances of the M:N relationship Completes



# M:N RELATIONSHIPS WITH MULTIPLE INSTANCES BETWEEN THE SAME ENTITIES

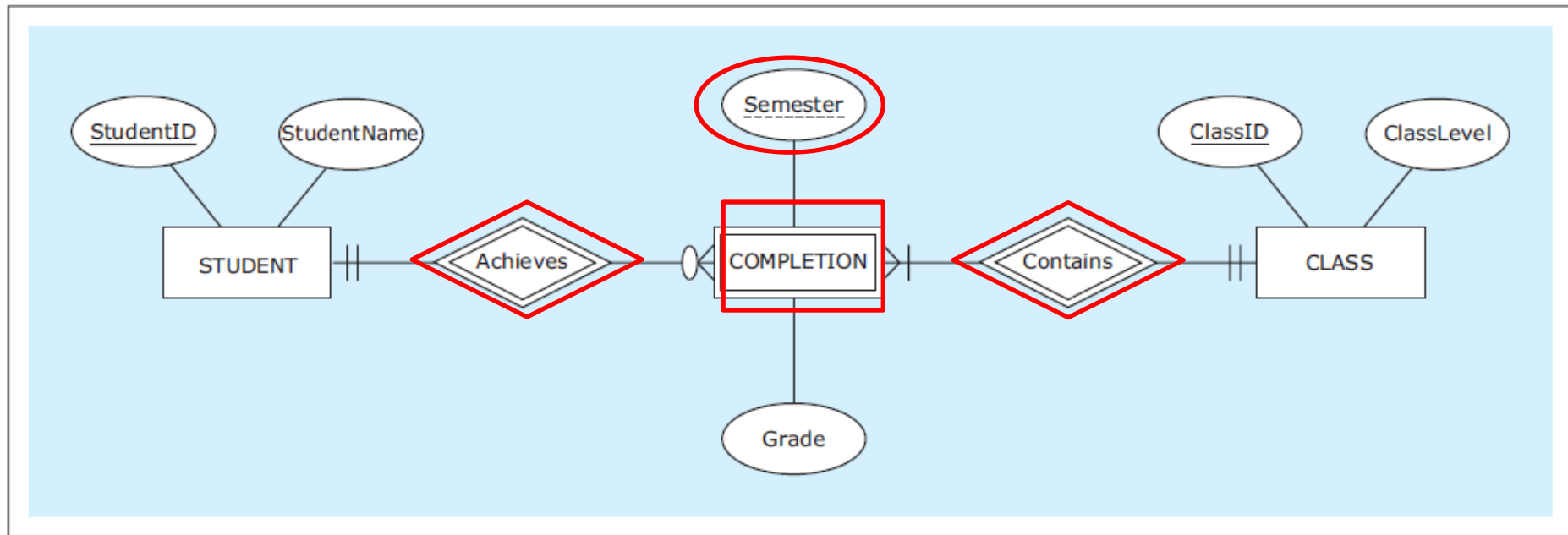
Instances of the M:N relationship **Completes** with an **additional requirement: one student takes same class multiple times**



# M:N RELATIONSHIPS WITH MULTIPLE INSTANCES BETWEEN THE SAME ENTITIES

CanNOT be represented in a M:N relationship

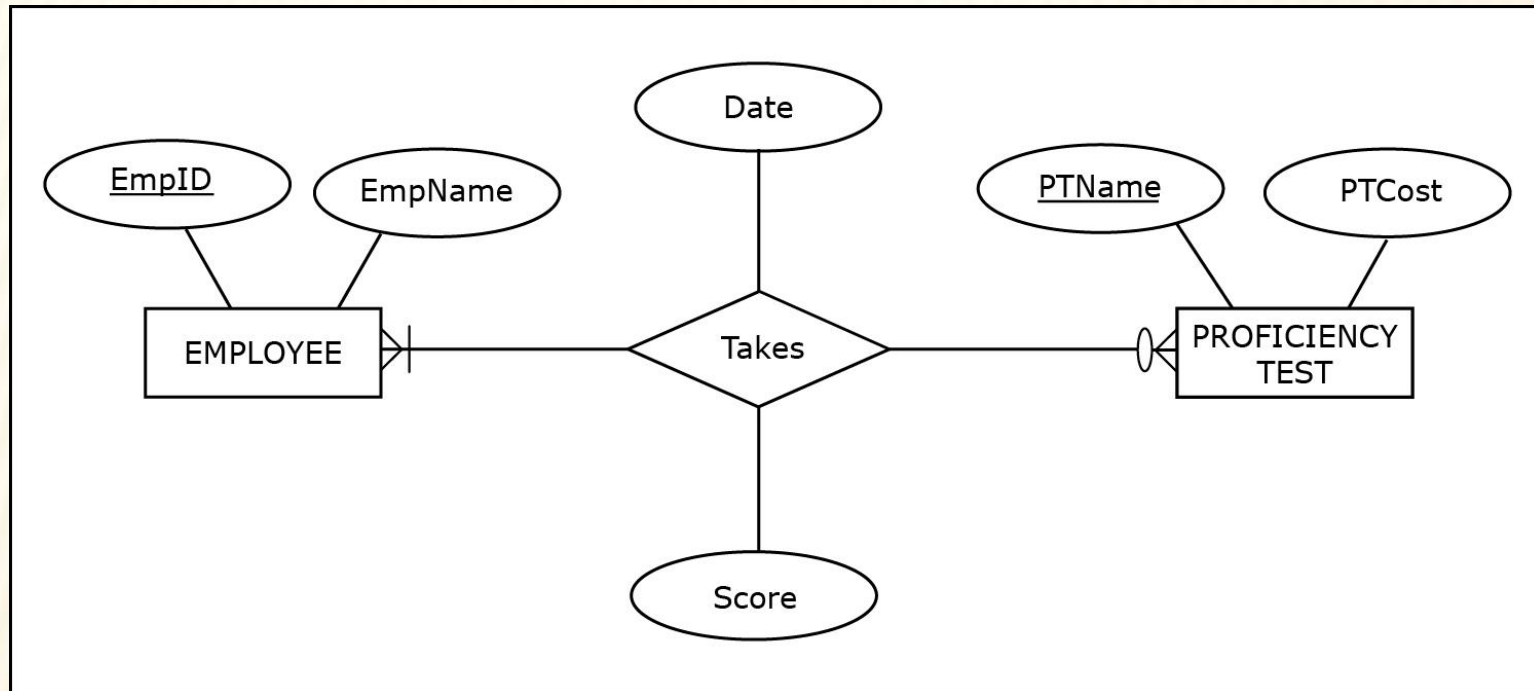
Can be represented as a weak entity with partial key and multiple owner entities. Example:



Note the cardinality constraints

# M:N RELATIONSHIPS WITH MULTIPLE INSTANCES BETWEEN THE SAME ENTITIES

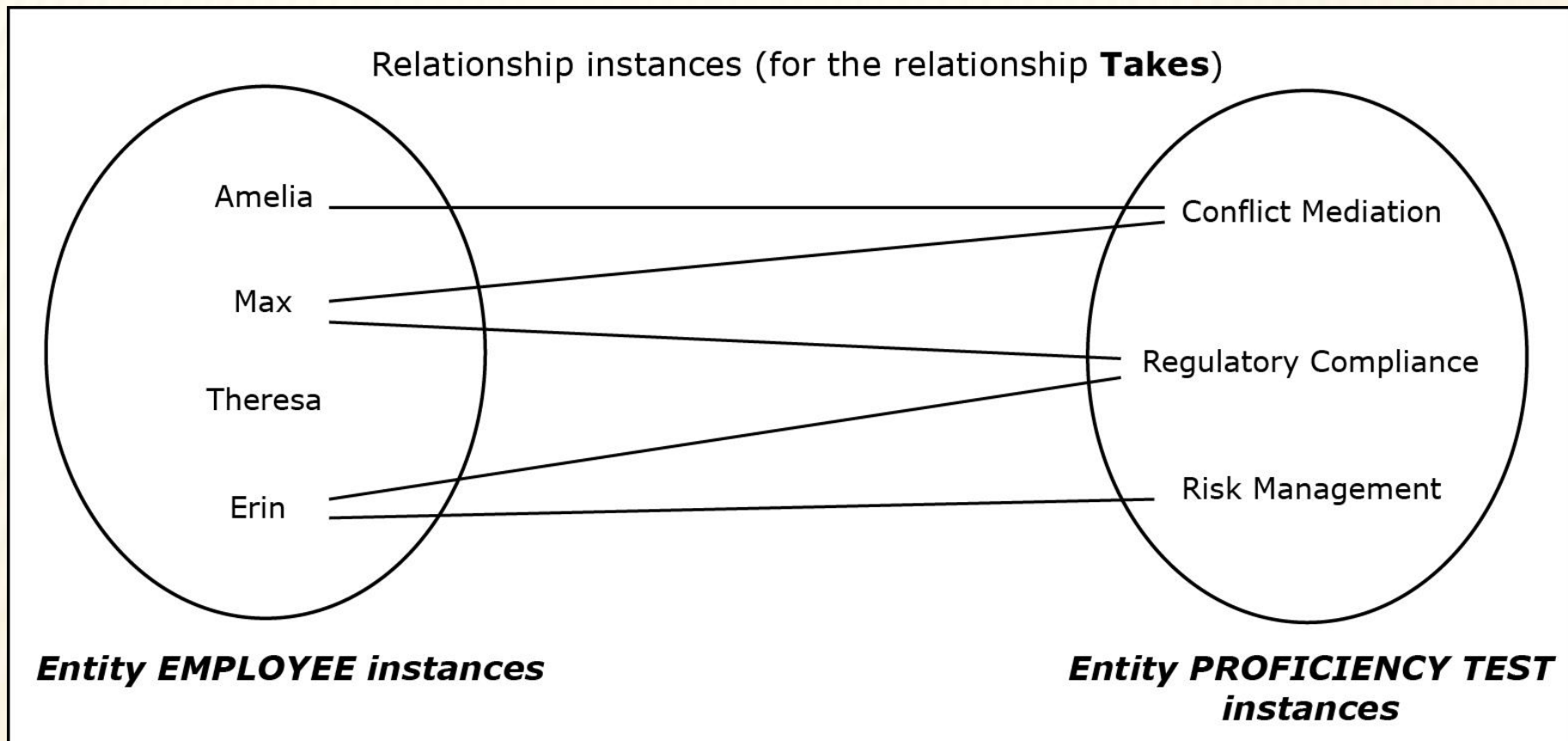
An ER diagram for an M:N relationship depicting students completing classes





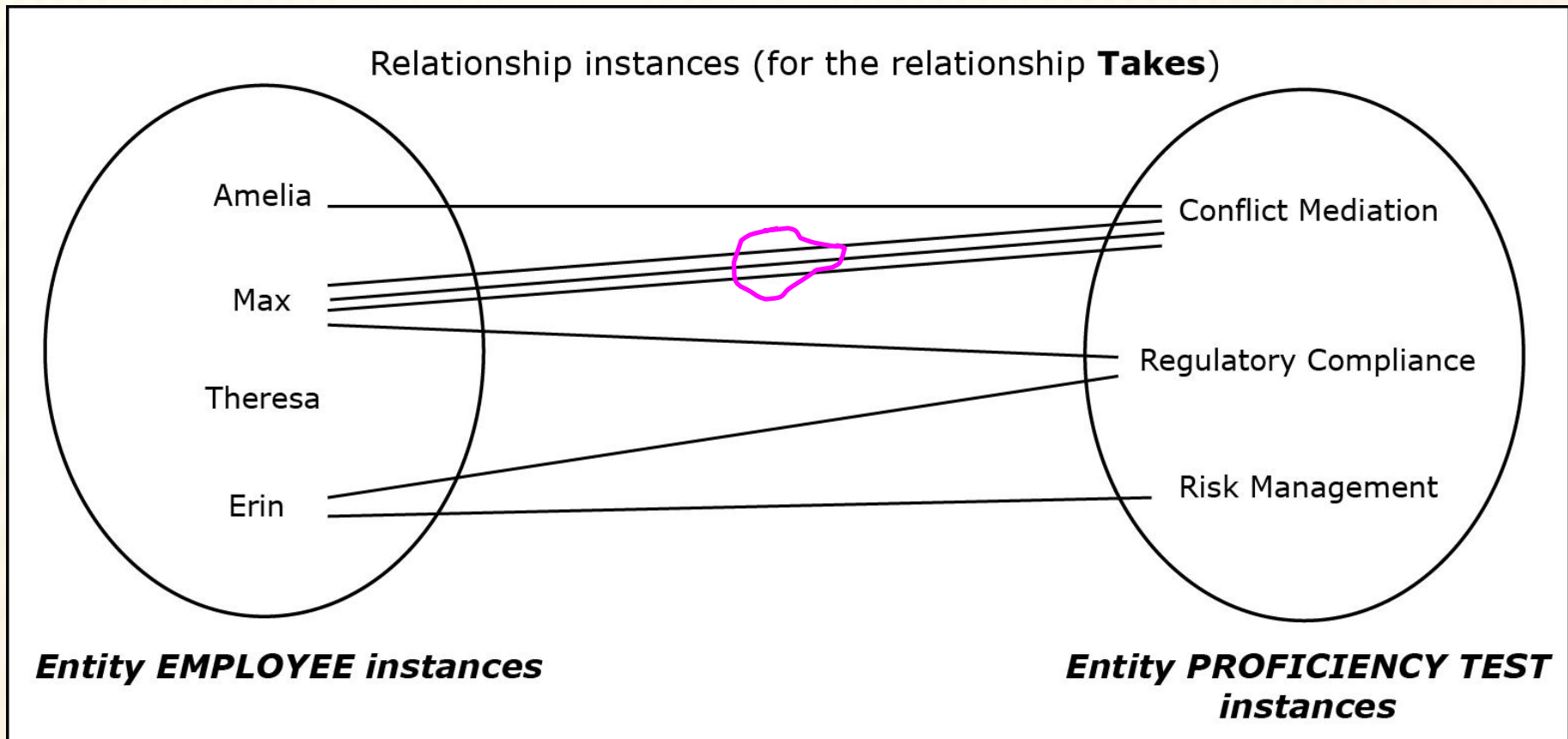
# M:N RELATIONSHIPS WITH MULTIPLE INSTANCES BETWEEN THE SAME ENTITIES

Instances of the M:N relationship Completes



# M:N RELATIONSHIPS WITH MULTIPLE INSTANCES BETWEEN THE SAME ENTITIES

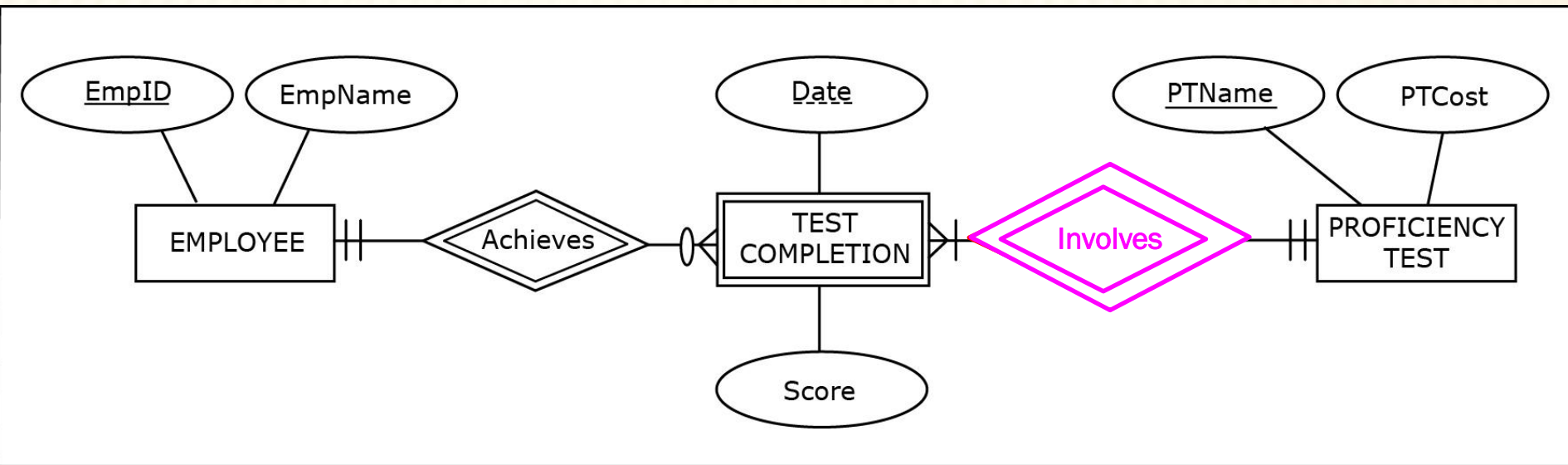
Instances of the M:N relationship **Completes** with an additional requirement: **Max can complete the same test 3 times.**



# M:N RELATIONSHIPS WITH MULTIPLE INSTANCES BETWEEN THE SAME ENTITIES

An ER diagram for an M:N relationship represented as a weak entity

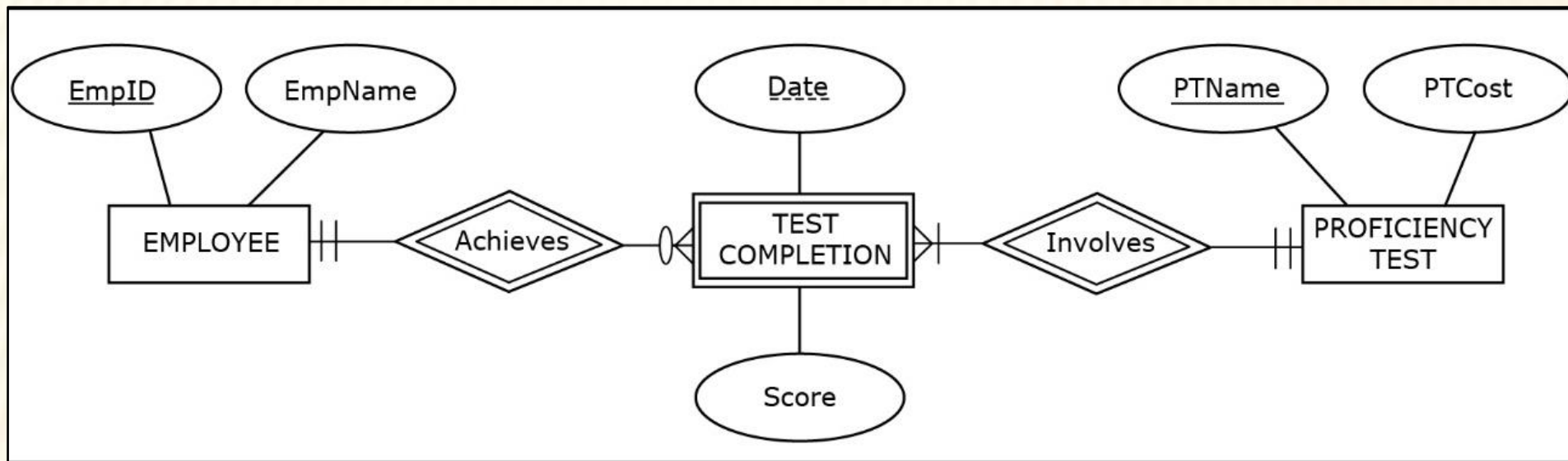
Each employee can complete a test only one time on a given date.  
Each employee can complete the same test multiple times.



# M:N RELATIONSHIPS WITH MULTIPLE INSTANCES BETWEEN THE SAME ENTITIES

An ER diagram for an M:N relationship represented as a weak entity

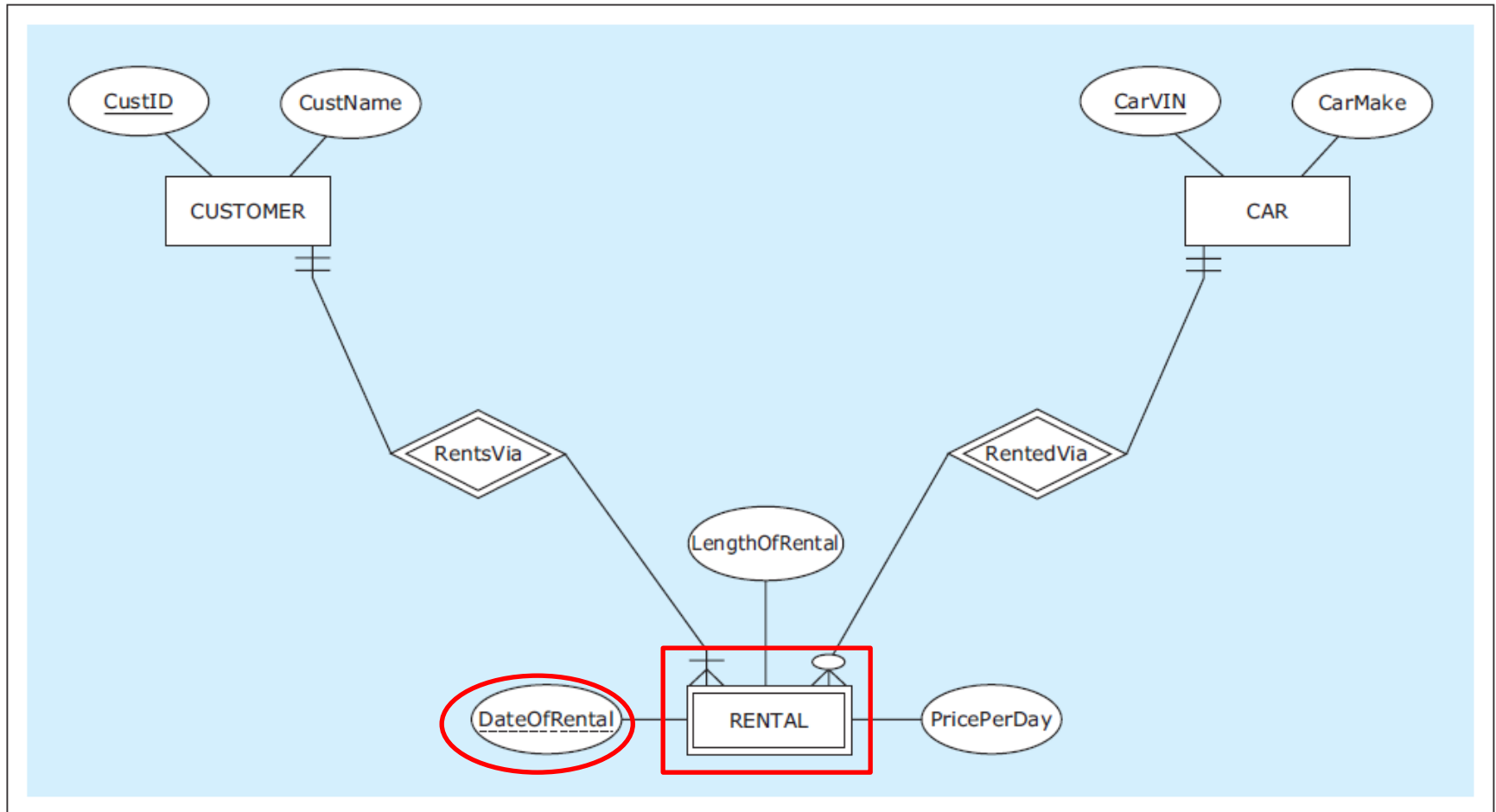
Each employee can complete multiple Different proficiency tests on a given date.



# M:N RELATIONSHIPS WITH MULTIPLE INSTANCES BETWEEN THE SAME ENTITIES

Another M:N relationship represented as **a weak entity**

ER diagram for a rental company:

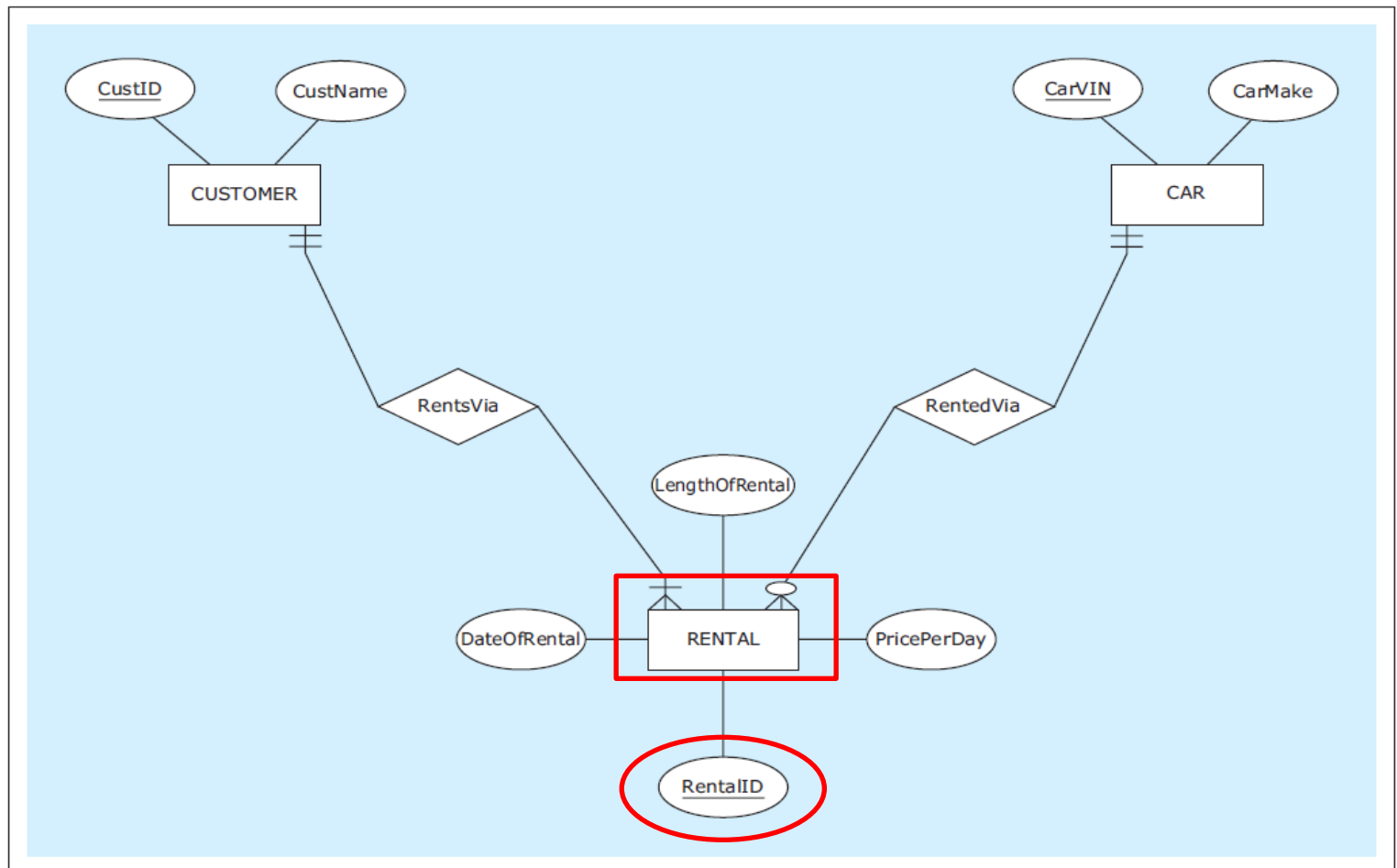


# M:N RELATIONSHIPS WITH MULTIPLE INSTANCES BETWEEN THE SAME ENTITIES

Use a **regular entity with a unique attribute** for a M:N relationship with multiple instances between same entities

Common  
Technique

- Add a unique attribute



# ASSOCIATIVE ENTITY

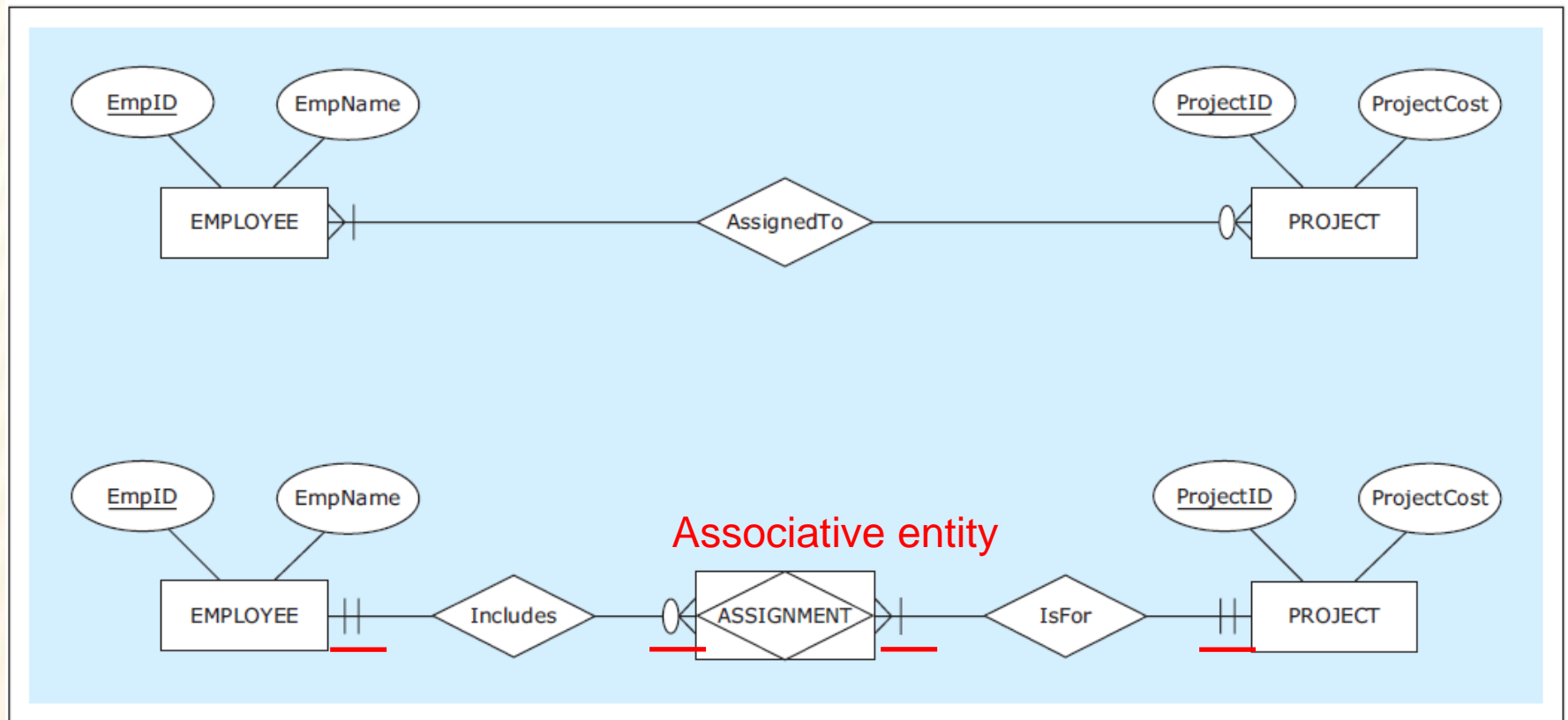
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## ■ Associative entity

- An **alternative way of depicting M:N relationships**
- Do **not have unique or partially unique** attributes
- **Often do not have any attributes** at all
- Example in next slide
  - Relationship AssignedTo = entity ASSIGNMENT entity
    - \* Equivalent attributes
    - \* Equivalent cardinality
- **Always have mandatory one cardinality** in a relationship

# ASSOCIATIVE ENTITY

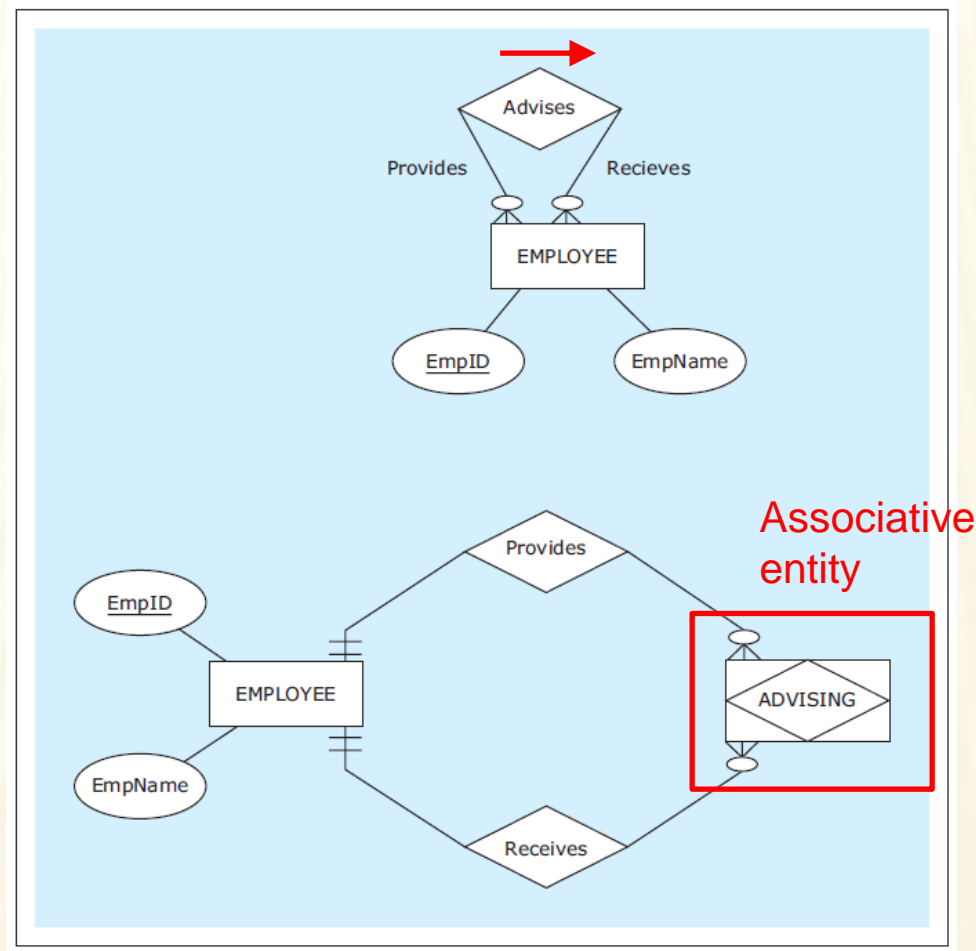
An identical relationship represented as a M:N relationship and as an associative entity





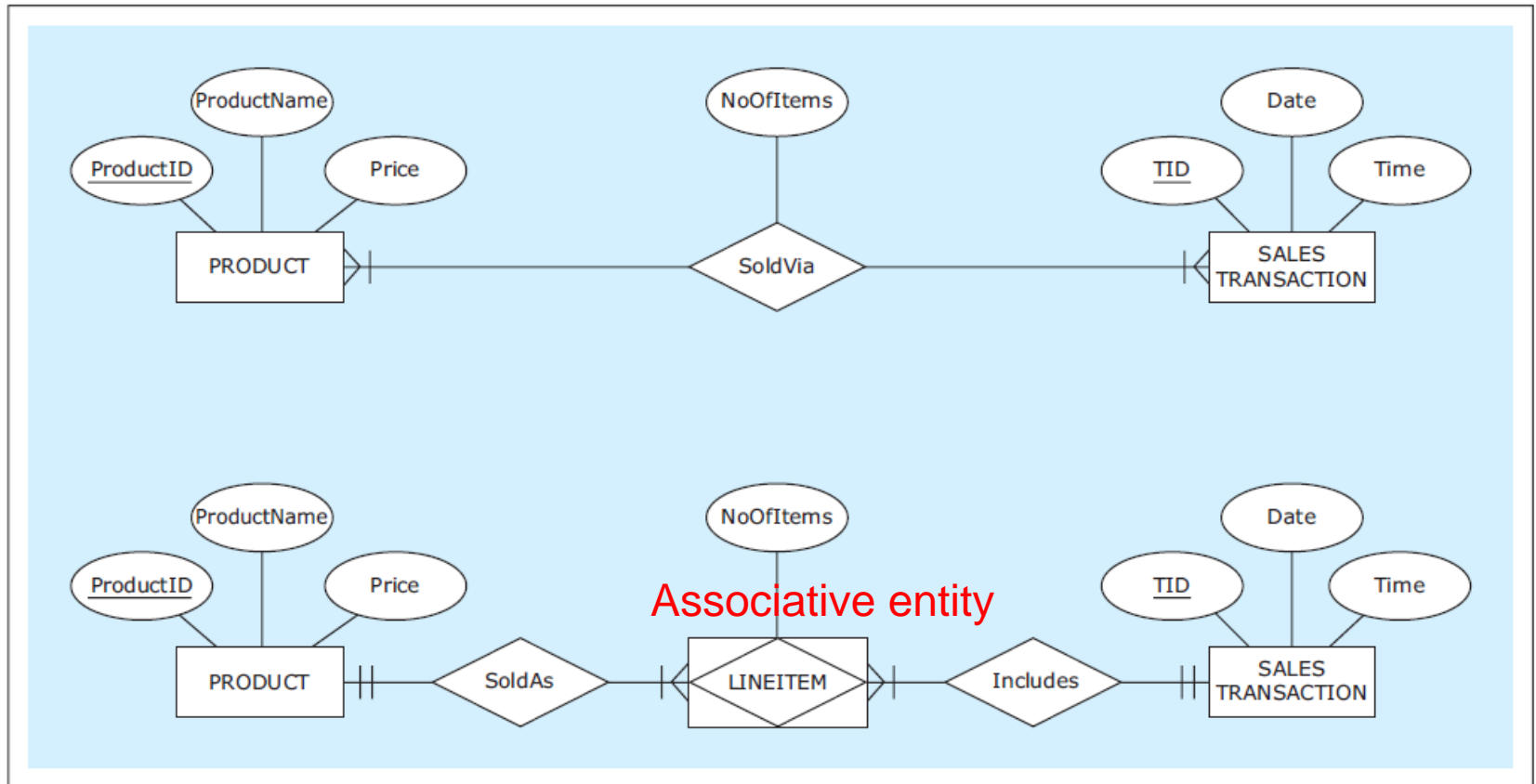
# ASSOCIATIVE ENTITY

An identical relationship represented as a unary M:N relationship and as an associative entity



# ASSOCIATIVE ENTITY

An identical relationship represented as an M:N relationship with an attribute and as an **associative entity with an attribute**



# ASSOCIATIVE ENTITY

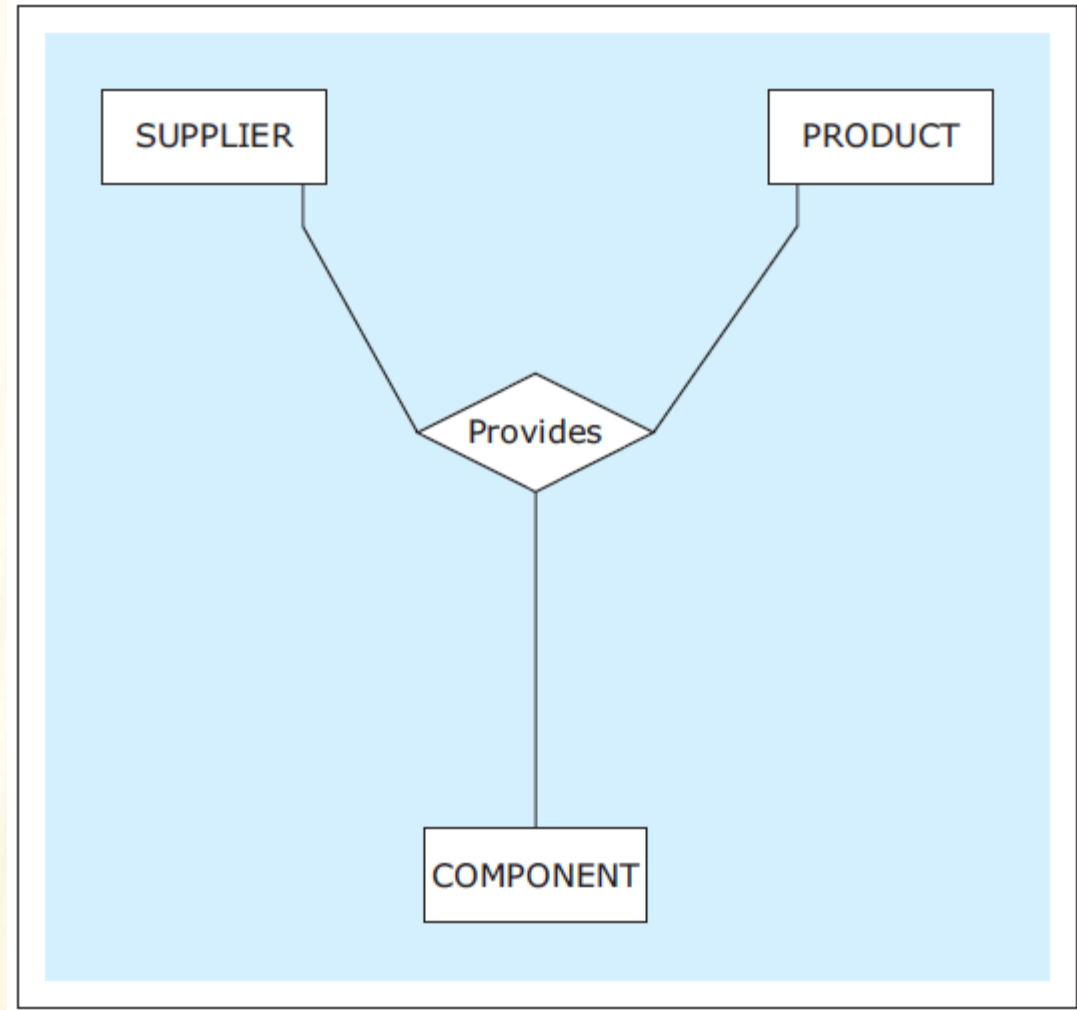
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- Simply another way of depicting a binary or unary relationship
- But eliminate potential ambiguities in the ER diagrams
  - For relationships with a **degree higher than 2** such as ternary relationships

# TERNARY RELATIONSHIP

## A ternary relationship

- Involving 3 entities
- Degree: 3
- This example depicts  
A specific supplier S1  
provides a specific  
component C1 for a  
specific product P1.



# TERNARY RELATIONSHIP

Three binary relationships that are insufficient for depicting a ternary relationship

Can not depict  
clearly which  
supplier provide  
which component  
for which product.

