

# ER to Relational Mapping

COSC 304 – Introduction to Database Systems



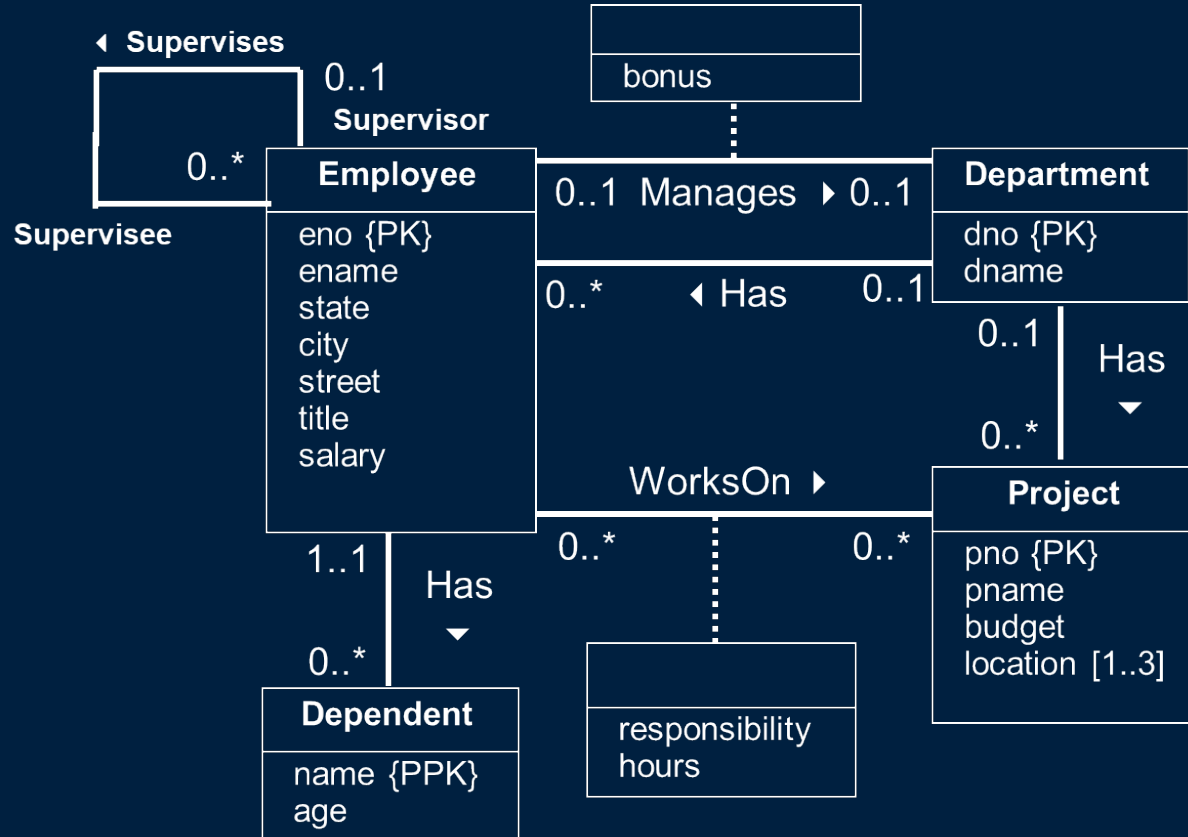
# ER Model to Relational Schemas

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Converting an ER model to a relational database schema involves 8 steps.

In general, these steps convert entities to relations and ER relationships to relations. For 1:1 and 1:N relationships, foreign keys are used instead of separate relations.

# ER to Relational Example

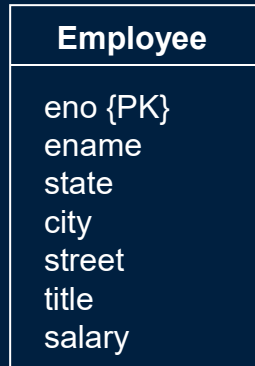


# ER to Relational Mapping

## Step #1: Convert Strong Entities



Step #1: Convert each strong entity to a relation.



Employee (eno, ename, state, city, street, title, salary)

- Notes:

- Attributes of the entity type become attributes of the relation.
- Multi-valued attributes are handled separately (in step #6).
- The primary key of the relation is the key attributes for the entity.

# ER to Relational Mapping

## Current Relational Schema - Step #1

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Employee (eno, ename, state, city, street, title, salary)

Project (pno, pname, budget)

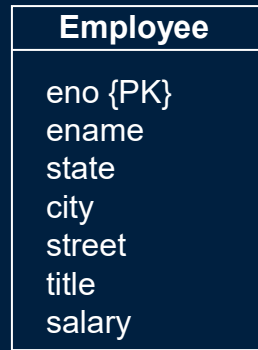
Department (dno, dname)

# ER to Relational Mapping

## Step #2: Convert Weak Entities

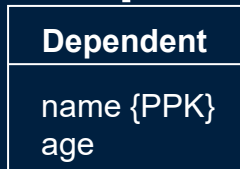


Step #2: Convert each weak entity into a relation with foreign keys to its identifying relations (entities). Example:



Employee (eno, ename, state, city, street, title, salary)

1..1  
Has  
0..\*



Dependent (eno, name, age)

Dependent.eno is a FK to Employee.eno

# ER to Relational Mapping

## Current Relational Schema - Step #2

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Dependent (eno, name, age)



Employee (eno, ename, state, city, street, title, salary)

Project (pno, pname, budget)

Department (dno, dname)

# ER to Relational Mapping

## Steps #3-5: Convert Relationships

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Steps 3 to 5 convert *binary* relationships of cardinality:

- 1:1 - Step #3
- 1:N - Step #4
- M:N - Step #5

M:N relationships are the most general case, and the conversion algorithm for these relationships can be applied to 1:1 and 1:N as well.

- However, for performance reasons, it is more efficient to perform different conversions for each relationship type.
- In general, each ER relationship can be mapped to a relation. However, for 1:1 and 1:N relationships, it is more efficient to combine the relationship with an existing relation instead of creating a new one.

Relationships that are not binary are handled in step #7.



# ER to Relational Mapping

## Step #3: Convert 1:1 Relationships

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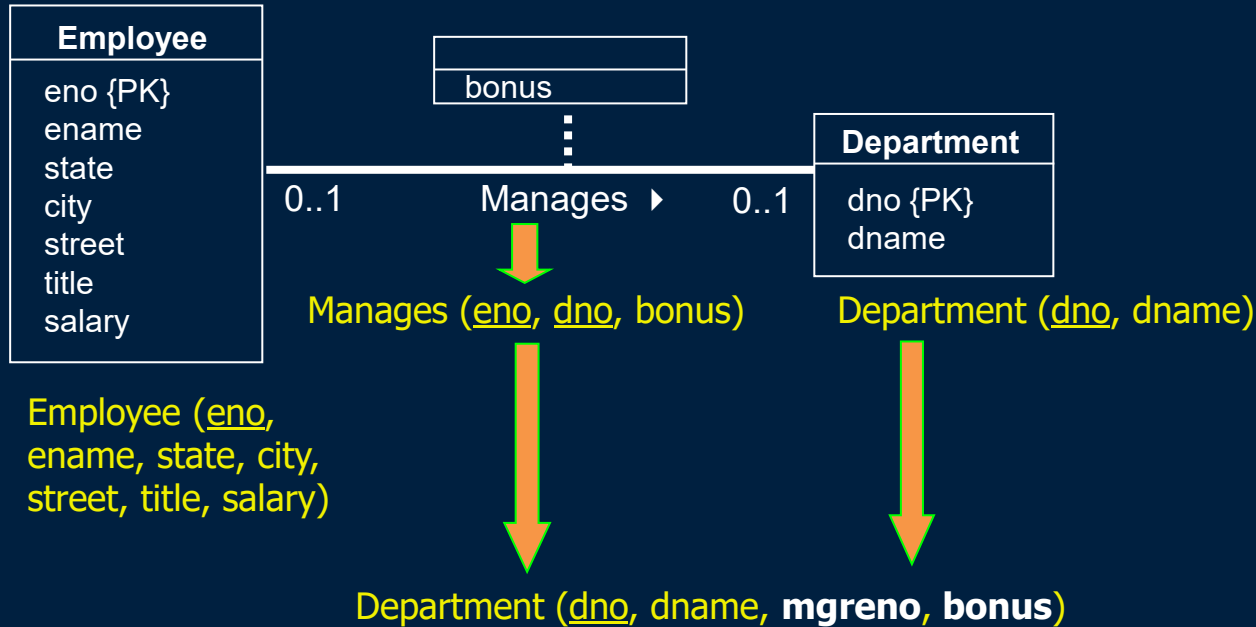
Step #3: Convert binary 1:1 relationships into a `UNIQUE` foreign key reference from one relation to the other.

Chose one of the relations, say  $R$ , and:

- Add the attributes of the relationship to  $R$ .
- Add the primary key attributes of the other relation to  $R$ , and create a foreign key reference to the other relation.
- Declare these added primary key attributes of  $R$  to be `UNIQUE`.
- Note: You can select either relation, but it is best to select the relation that is guaranteed to always participate in the relationship or the one that will participate the most in the relationship.

# ER to Relational Mapping

## Step #3: Convert 1:1 Relationships (2)



Note: Renamed eno to mgreno for clarity.

## Step #4: Convert 1:N Relationships

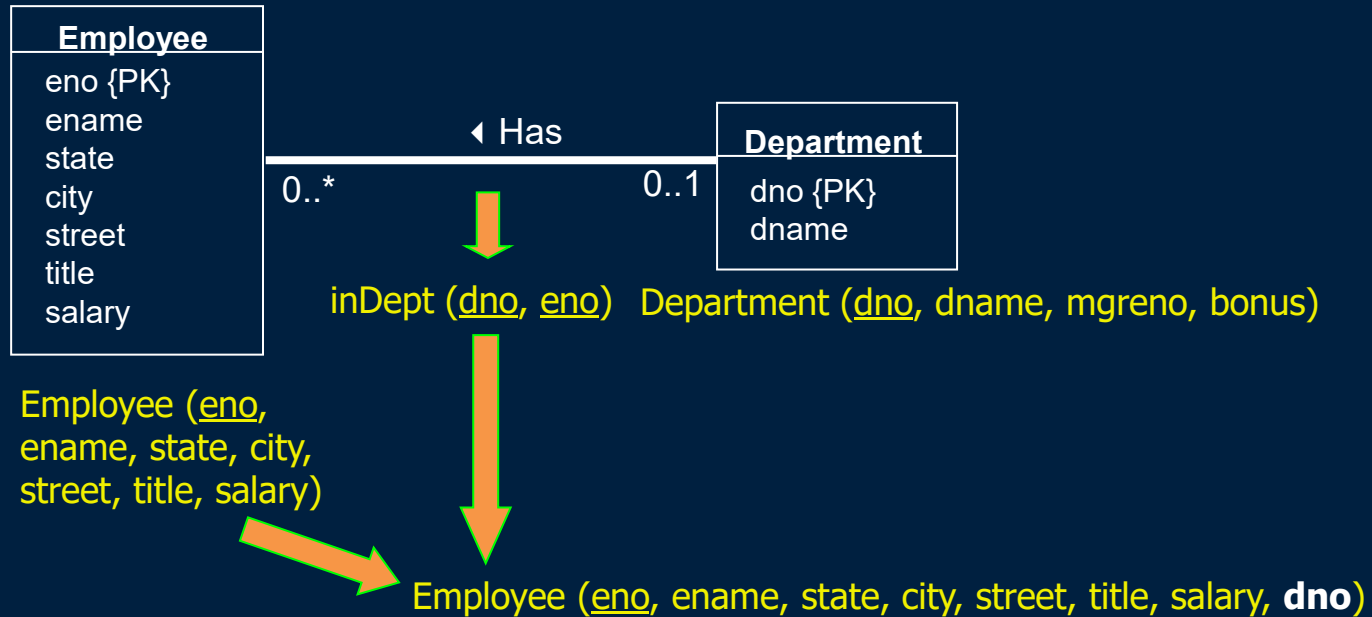
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Step #4: Convert binary 1:N relationships into a foreign key reference from the N-side relation to the 1-side relation.

Note: Unlike 1:1 relationships, you must select the N-side of the relationship as the relation containing the foreign key and relationship attributes.

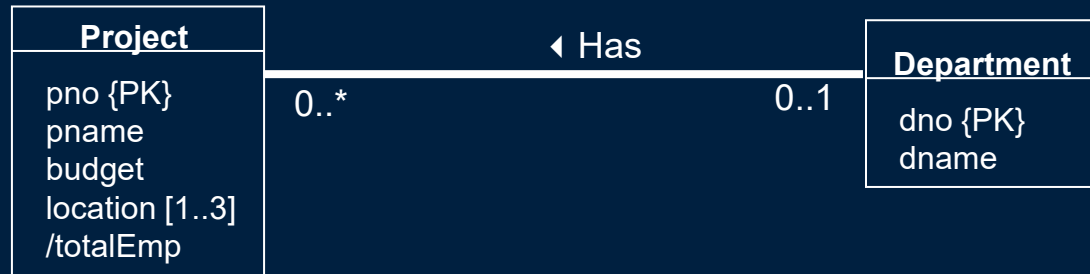
# ER to Relational Mapping

## Step #4: Convert 1:N Relationships



# ER to Relational Mapping

## Step #4: Convert 1:N Relationships



**Question:** What table has the foreign key field?

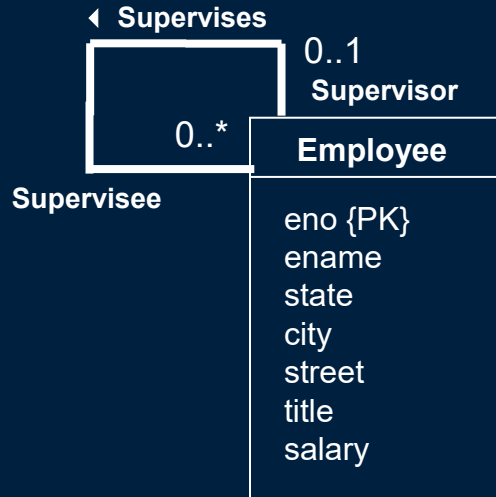
**A)** Project

**B)** Department

**C)** None

# ER to Relational Mapping

## Step #4: Convert 1:N Relationships



→ Supervises (supereno, eno)

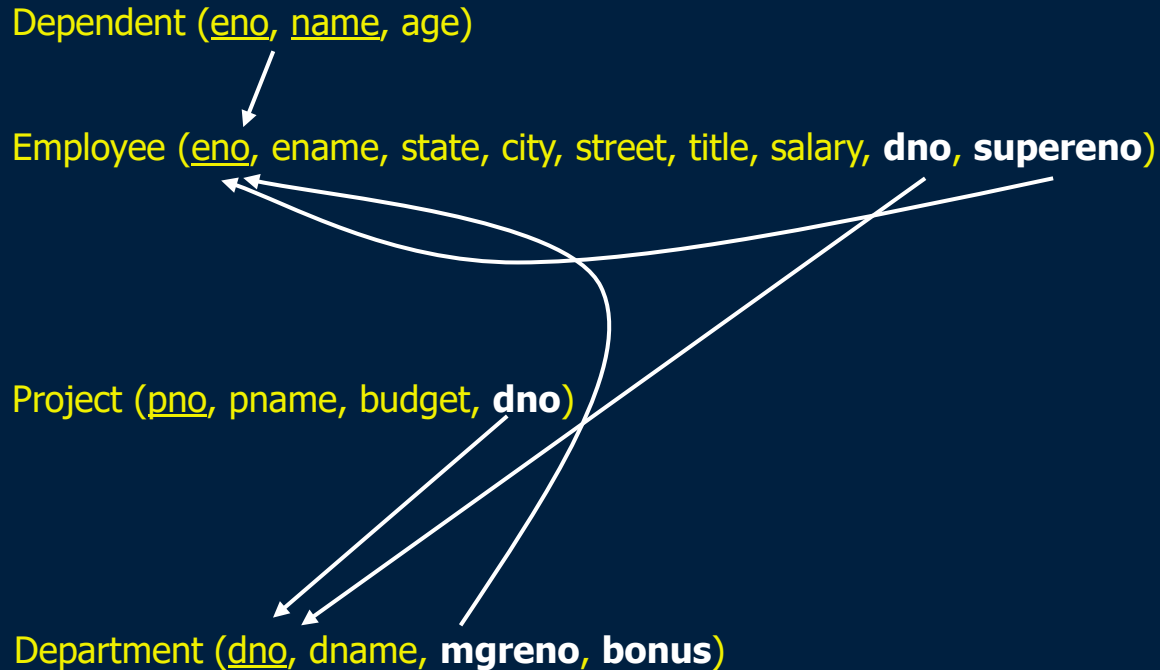
Employee (eno, ename, state, city, street, title, salary, dno)



Employee (eno, ename, state, city, street, title, salary, dno, **supereno**)

# ER to Relational Mapping

## Current Relational Schema - Step #4



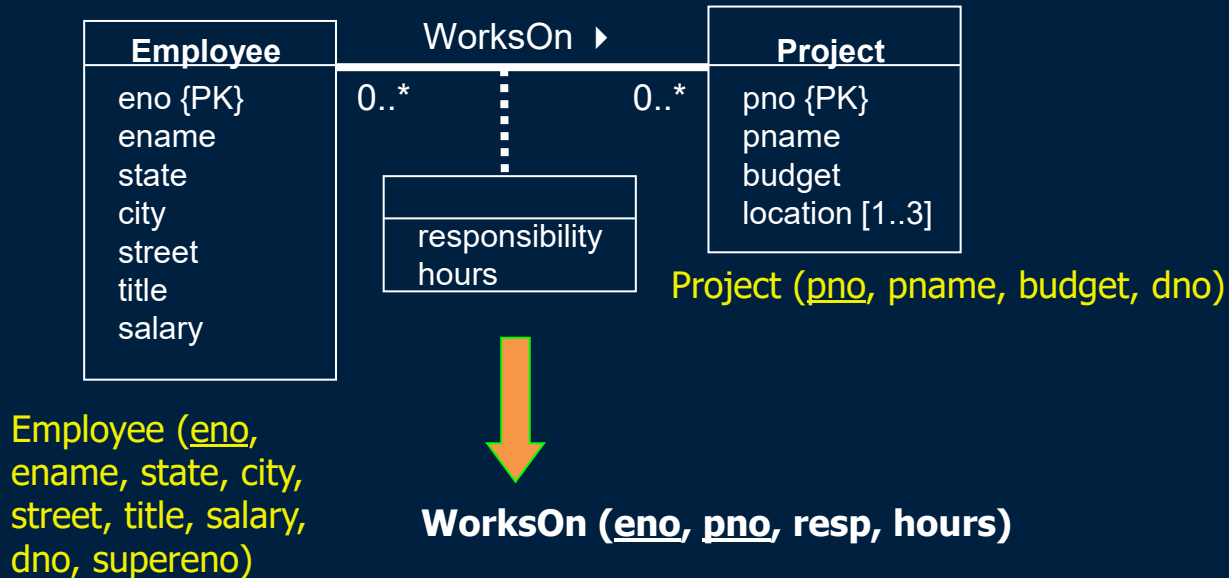
# ER to Relational Mapping

## Step #5: Convert M:N Relationships



Step #5: Convert binary M:N relationships into a new relation with foreign keys to the two participating entities.

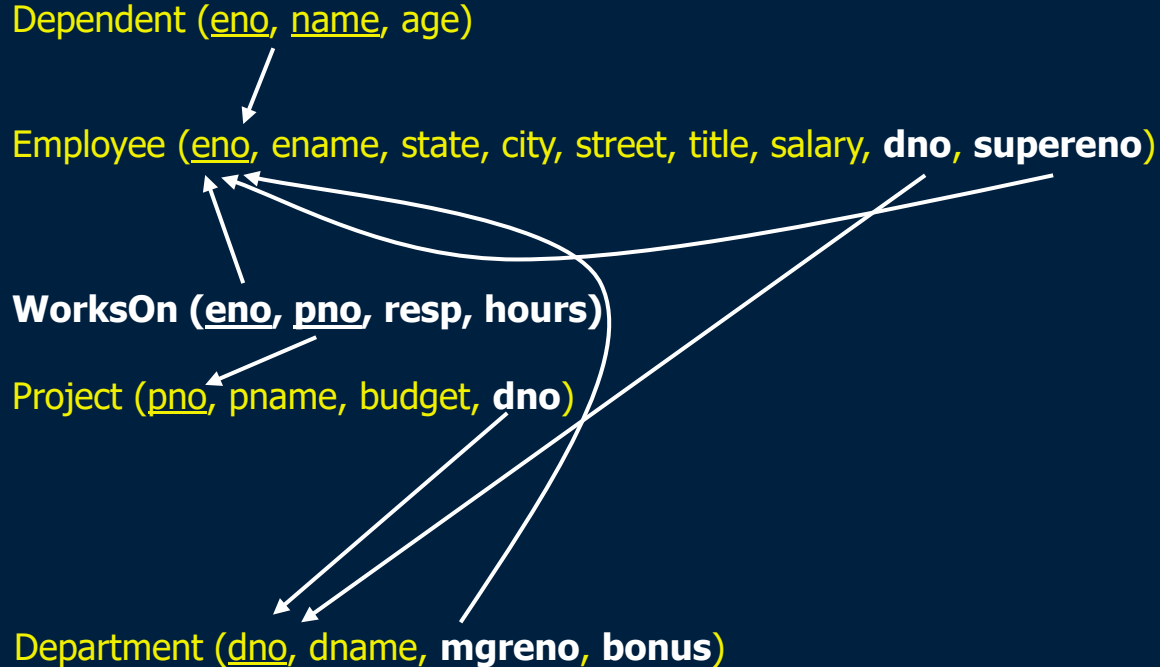
- The primary key consists of the primary keys of the two relations.





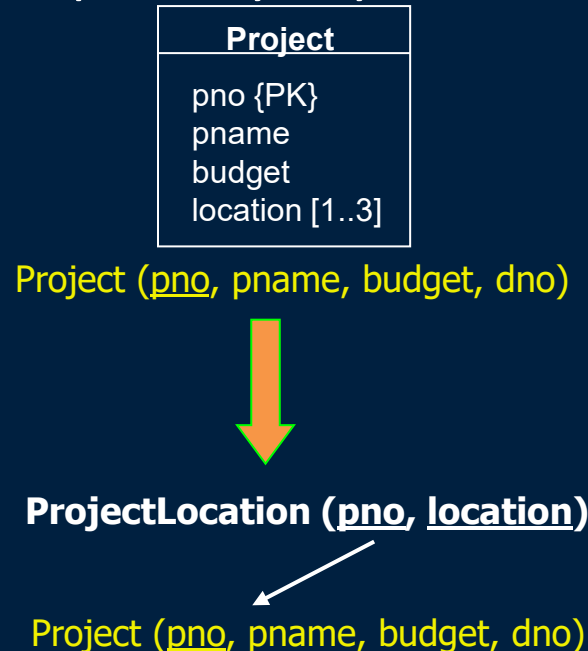
# ER to Relational Mapping

## Current Relational Schema - Step #5



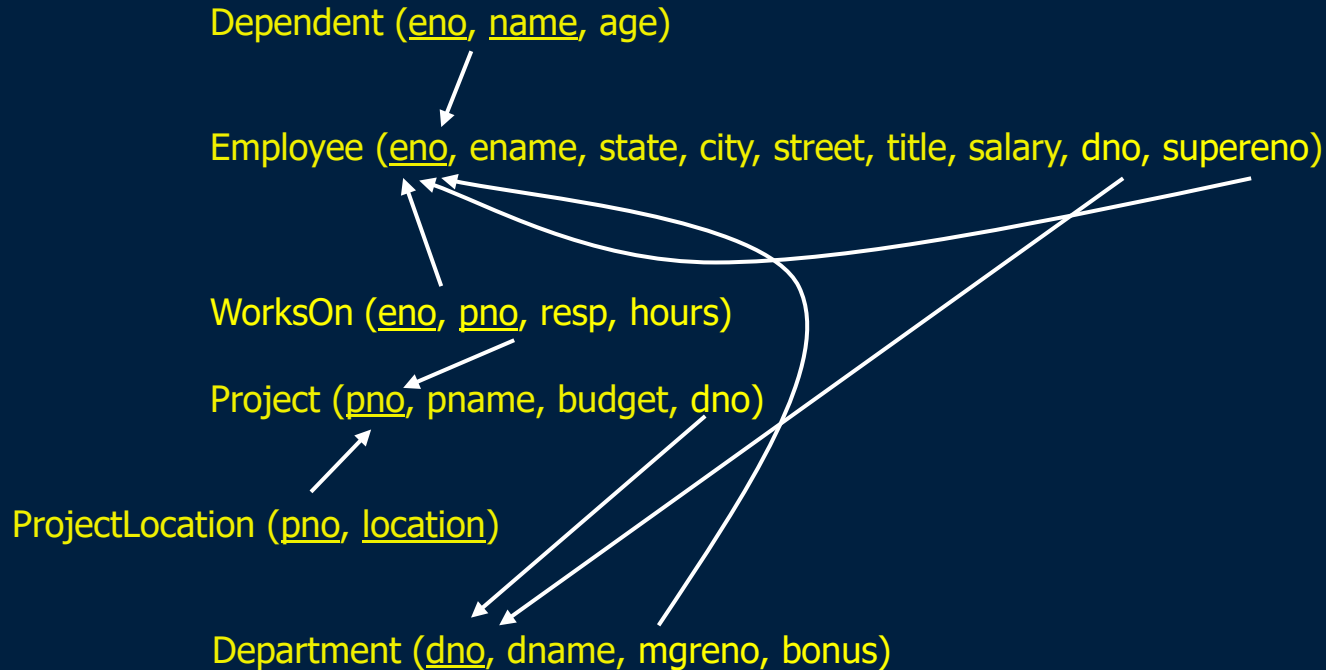
## Step #6: Convert Multi-Valued Attributes

Step #6: Convert a multi-valued attribute into a relation with composite (two or more attributes) primary key consisting of the attribute value plus the primary key of the attribute's entity.



# ER to Relational Mapping

## Final Relational Schema

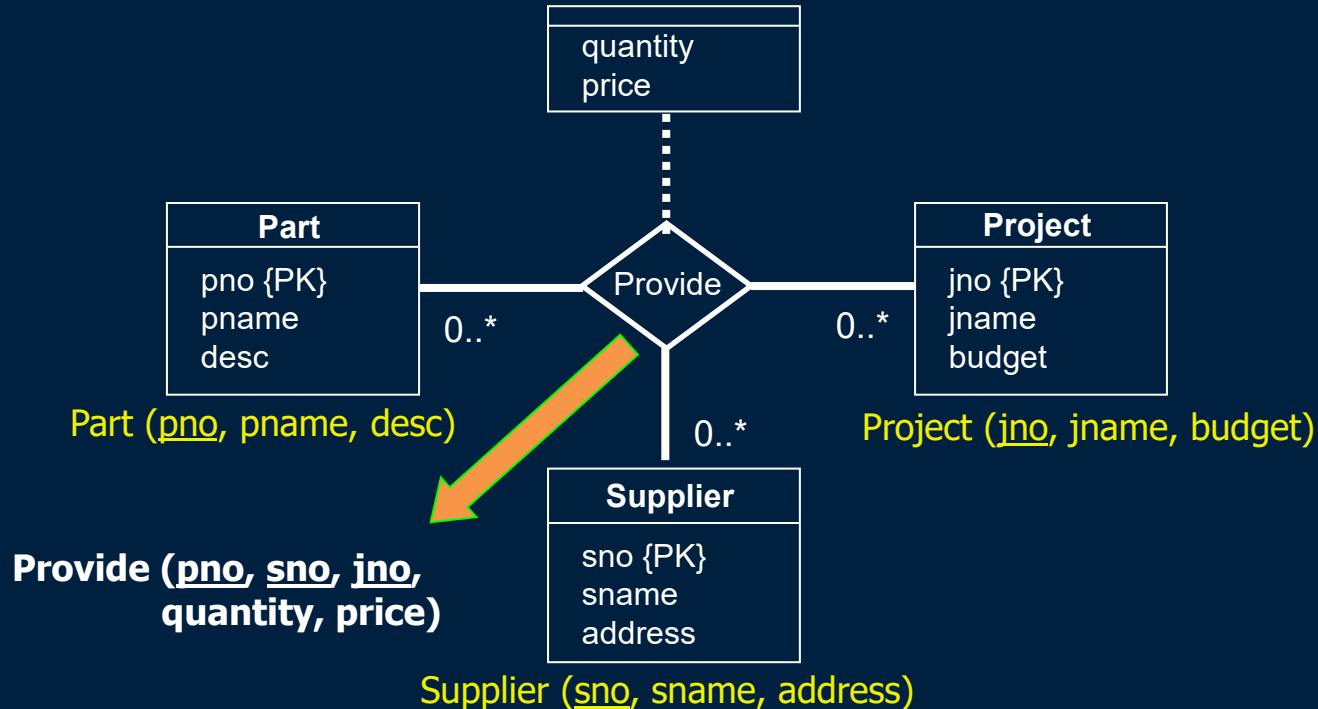


# ER to Relational Mapping

## Step #7: Convert $n$ -ary Relationships



Step #7: Convert  $n$ -ary relationships by creating a new relation with primary keys from all entities and foreign keys back to them.



# EER to Relational Mapping

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An additional step is necessary to convert subclasses and superclasses to the relational model.

We have several different approaches:

- 1) Create a separate relation for each superclass and subclass.
  - Most general technique that we will use.
- 2) Create relations for subclass only.
  - Only works if superclass has mandatory participation.
- 3) Create a single relation with one type attribute.
  - Attribute is used to indicate the type of object (subclass) in the row.
  - Works only if the subclasses are disjoint.
- 4) Create a single relation with multiple type attributes.
  - Have a boolean valued attribute for each subclass. True if in subclass.
  - Works if subclasses may be overlapping.

# ER to Relational Mapping

## Step #8: Convert Subclasses

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Step #8: Convert subclasses and superclasses by creating a relation for each subclass and superclass. Link the subclasses to the superclass using foreign key references.

Given a superclass  $C$  and set of subclasses  $S_1, S_2, \dots, S_n$ :

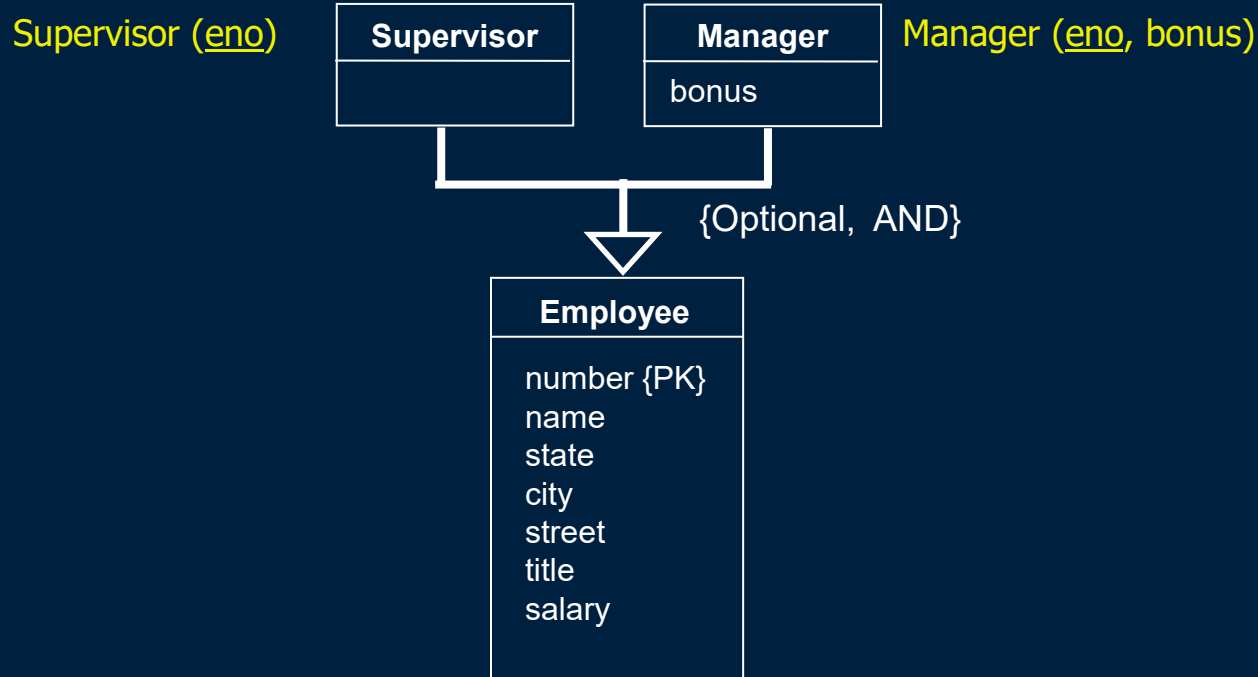
- Create a relation  $R$  for  $C$ .
- The primary key for  $R$  is the primary key of the superclass.
- Create relations  $R_1, R_2, \dots, R_n$  for subclasses  $S_1, S_2, \dots, S_n$ .
- The primary key for each  $R_i$  is the primary key of the superclass.
- For each  $R_i$ , create a foreign key to  $R$  using the primary key attributes.

# ER to Relational Mapping

## Step #8: Convert Subclasses



Step #8: Create a relation for each subclass and superclass. Link the subclasses to the superclass using foreign key references.



Employee (eno, ename, state, city, street, title, salary, supereno)

# Summary of ER to Relational Mapping

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## ER Model

Strong Entity

Weak Entity

1:1 or 1:N Relationship Type

M:N Relationship Type

$n$ -ary Relationship Type

Multi-valued attribute

Key attribute

## Relational Model

Relation

Relation with PK combining all PKs of identifying entities

Foreign key (from N-side to 1-side)

"Relationship" relation and 2 foreign keys

"Relationship" relation and  $n$  foreign keys

Relation and foreign key

Primary key attribute



# ER to Relational Mapping Question

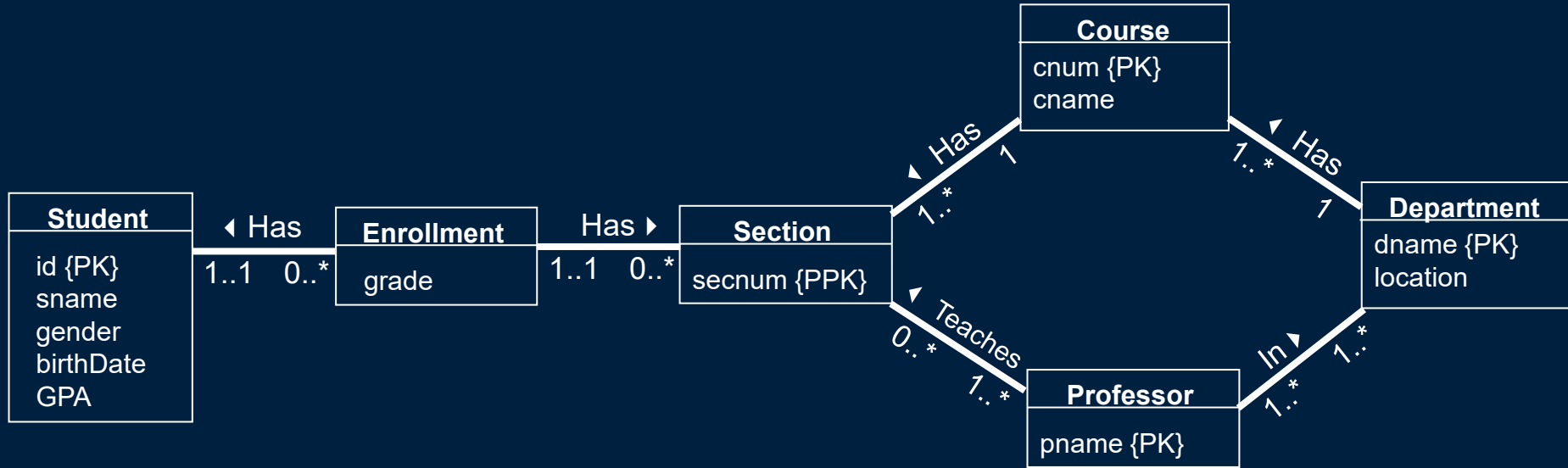
**Question:** How many of the following statements are **true**?

- 1) The M:N relationship mapping rule could be applied to 1:1 and 1:N relationships, as it is more general.
- 2) A M:N relationship is mapped to a relation in the relational model.
- 3) The designer has a choice on which side to put the foreign key when mapping a 1:N relationship.
- 4) When mapping a multi-value attribute, the new table containing the multi-value attribute will have a composite key.

A) 0                      B) 1                      C) 2                      D) 3                      E) 4

# ER to Relational Mapping

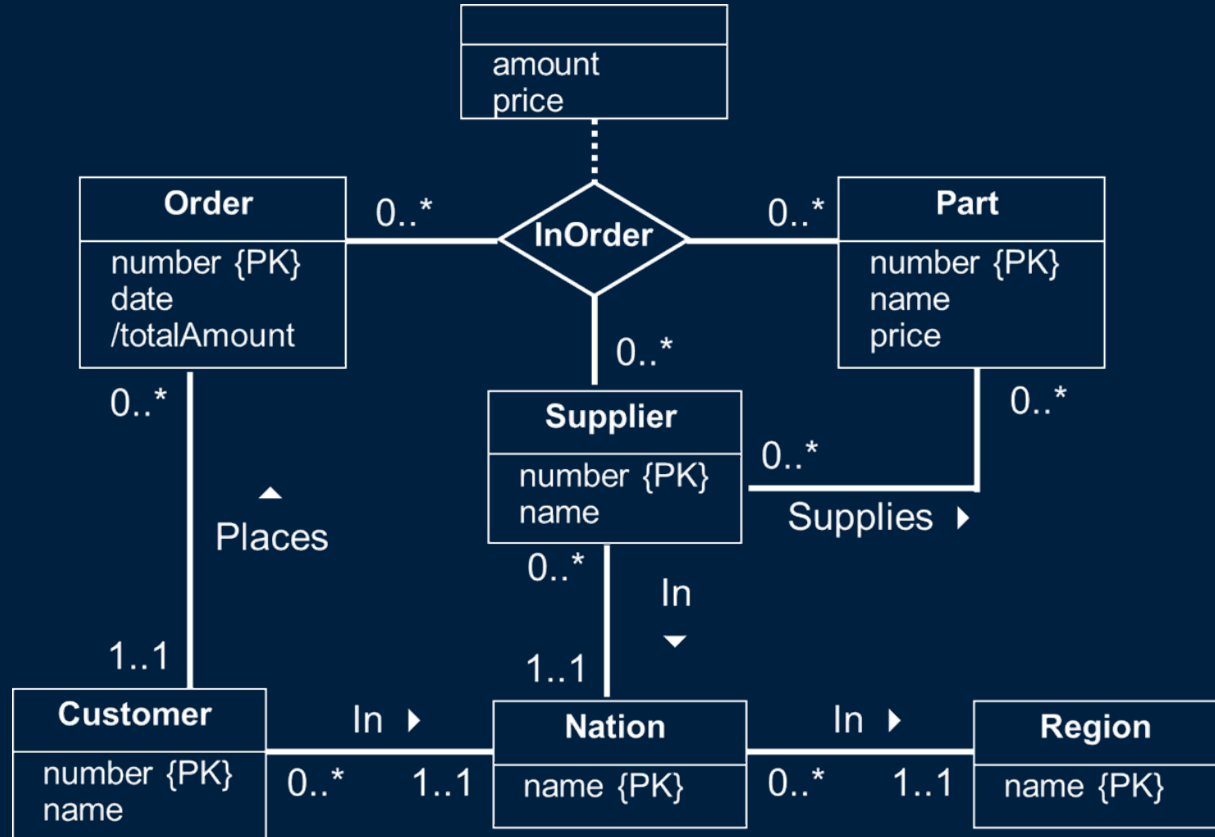
## University Question



**Question:** Convert to the relational model.

# ER to Relational Mapping

## TPC-H Standard Question



# Conclusion

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There is a straightforward algorithm for converting ER models to relational schemas.

The algorithm involves 7 steps for converting regular ER models, and 8 steps for converting EER models.

In general, these steps convert entities to relations and ER relationships to relations. For 1:1 and 1:N relationships, foreign keys can be used instead of separate relations.

# Objectives

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Given an ER/EER diagram, convert it into a relational schema using the eight steps.

Discuss the different ways of converting subclasses/superclasses into relational schemas.



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