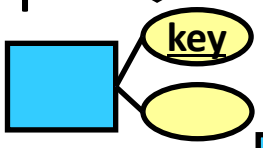
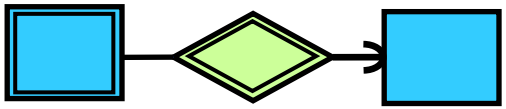
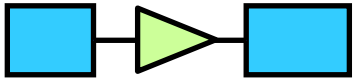
SC2207/CZ2007 Introduction to Database Systems (Week 2)

Topic 1: Entity Relationship Diagram (3)

So far, we learned:

- Elements of ER Diagrams
  - Entities Sets 
  - Relationships 
  - Attributes 

  - Weak Entities Sets 
  - Subclasses 
- How do we design an ER Diagram for an application?

This Lecture

- ER diagram design principles
- ER diagram → relational schema

From Applications to ER Diagrams

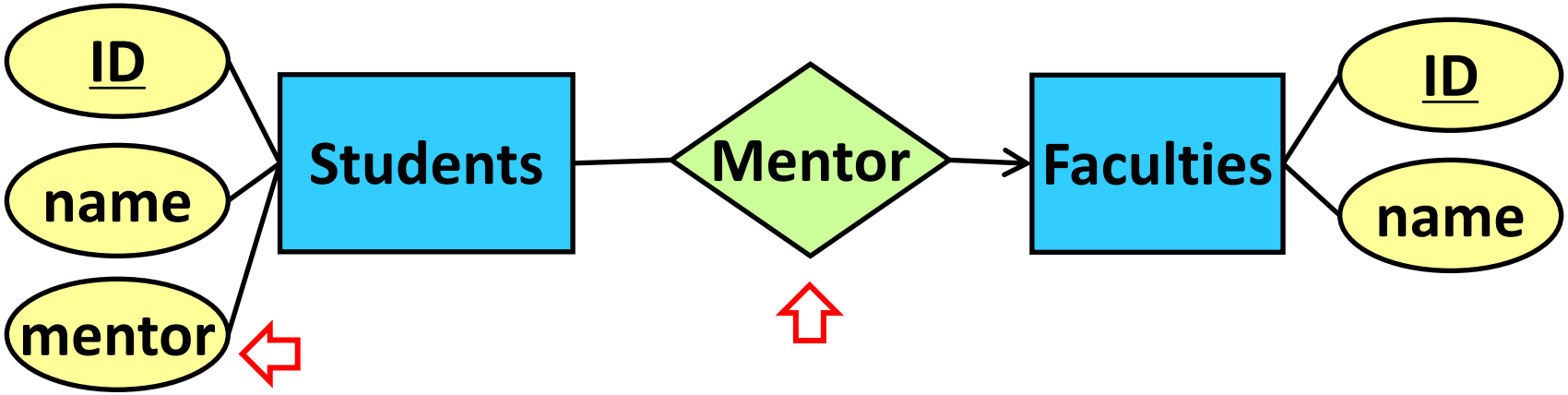
- Identify the objects involved in your application
- Model each type of objects as an entity set
- Identify the attributes of each entity set
- Identify the relationships among the entity sets
- Refine your design
- Example: A database for NTU
  - Objects: Students, Faculties, Schools, Courses…
  - Entity sets: Students, Faculties, Schools, Courses…
  - Relationships: course-enrollment, course-lecturer…

Design Principle 1: Be Faithful

- Be faithful to the specifications of the application
- Capture the requirements as much as possible

Design Principle 2: Avoid Redundancy

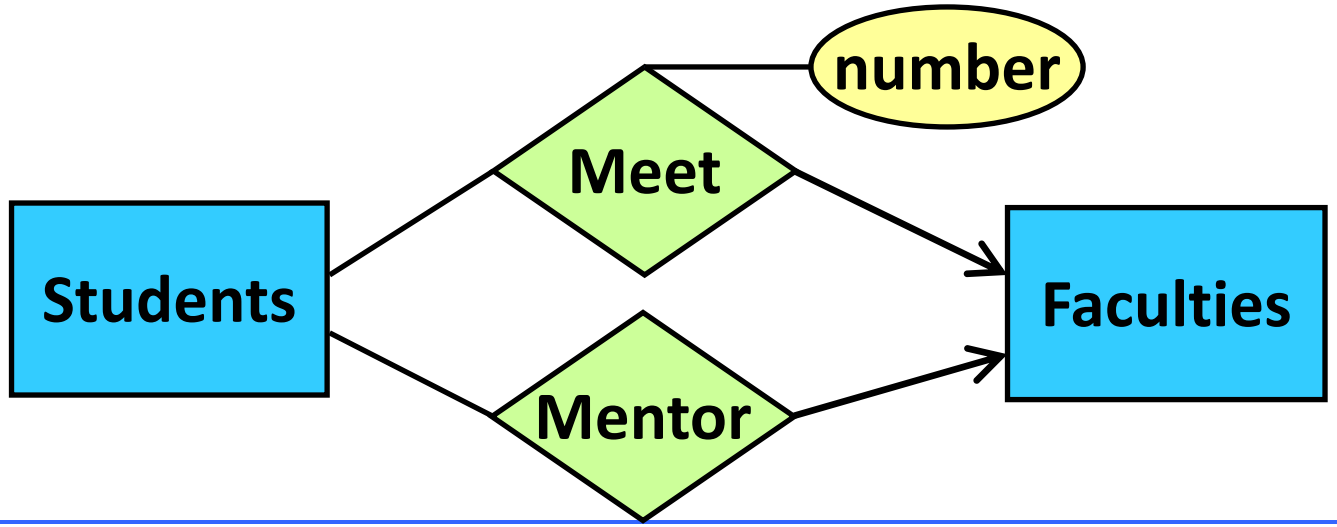
- Avoid repetition of information
- Example



- Problems that can be caused by redundancy
  - Waste of space
  - Possible inconsistency

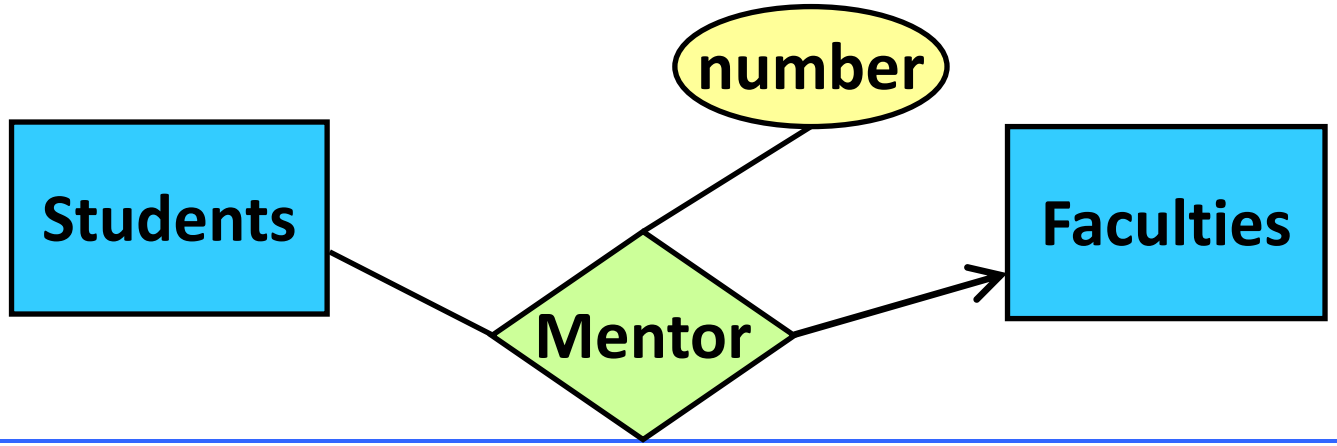
Design Principle 3: Keep It Simple

- Each student is mentored by one faculty
- One faculty can mentor multiple students
- We also record the number of times that a mentee meets with his/her mentor
- Design below: Not wrong, but can be simplified



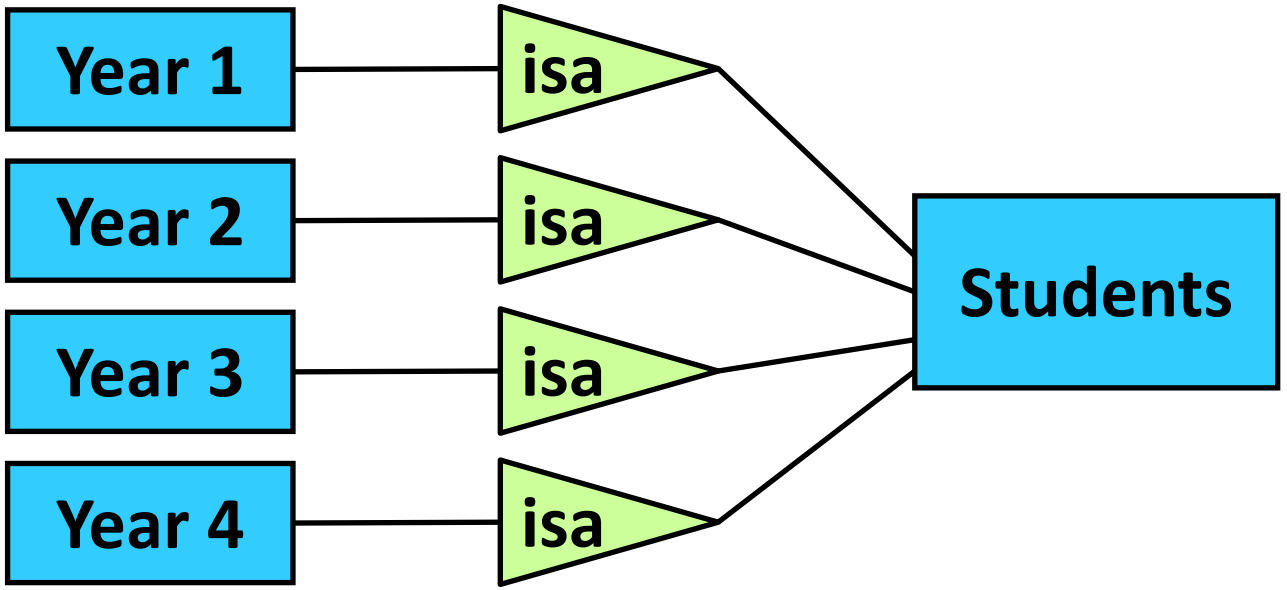
Design Principle 3: Keep It Simple

- Each student is mentored by one faculty
- One faculty can mentor multiple students
- We also record the number of times that a mentee meets with his/her mentor
- Better Design:



Design Principle 3: Keep It Simple

- There are four types of students: Year 1, Year 2, Year 3, Year 4
- Design below: Not wrong, but can be simplified



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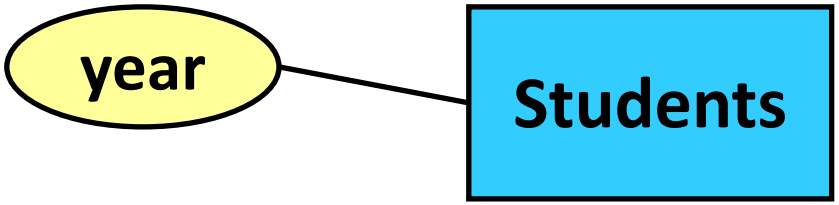
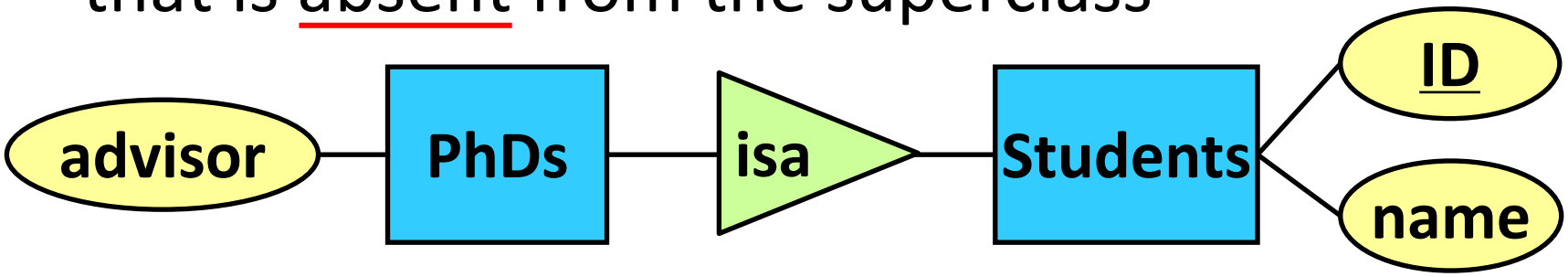
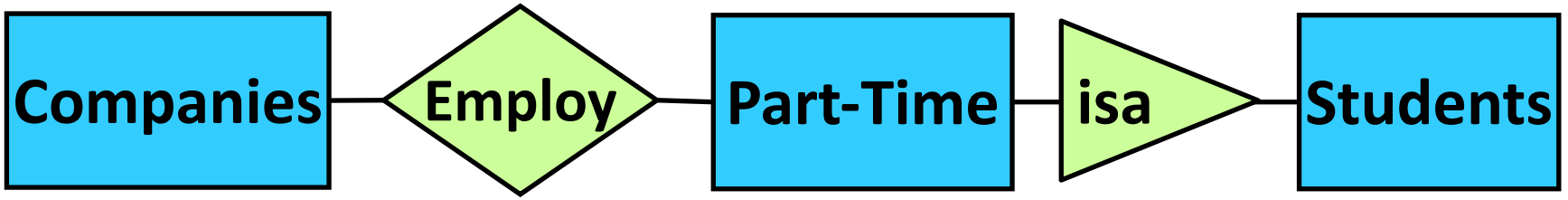


Tips: When to Use Subclasses

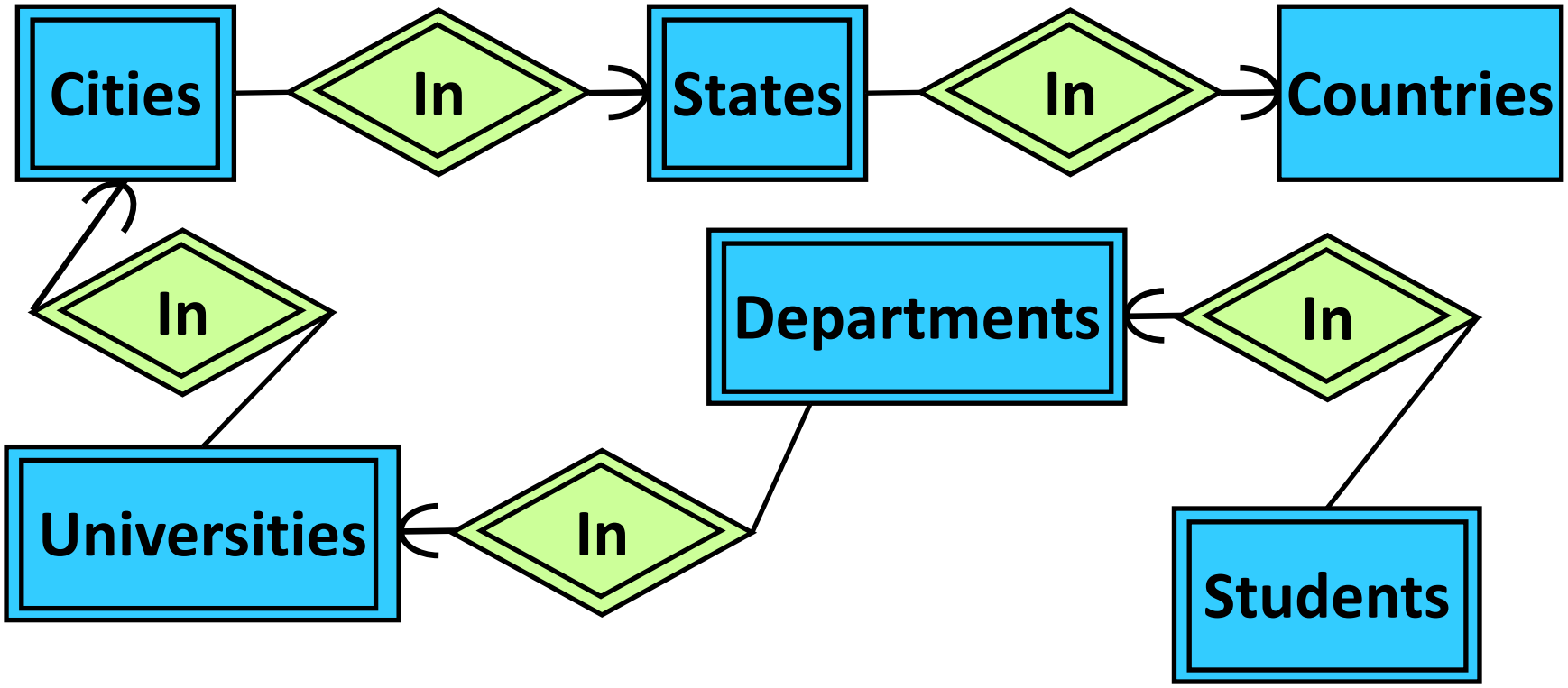
- Case 1: When a subclass has some attribute that is absent from the superclass



- Case 2: When a subclass has its own relationship with some other entity sets



Design Principle 4: Don't Over-use Weak Entity Sets



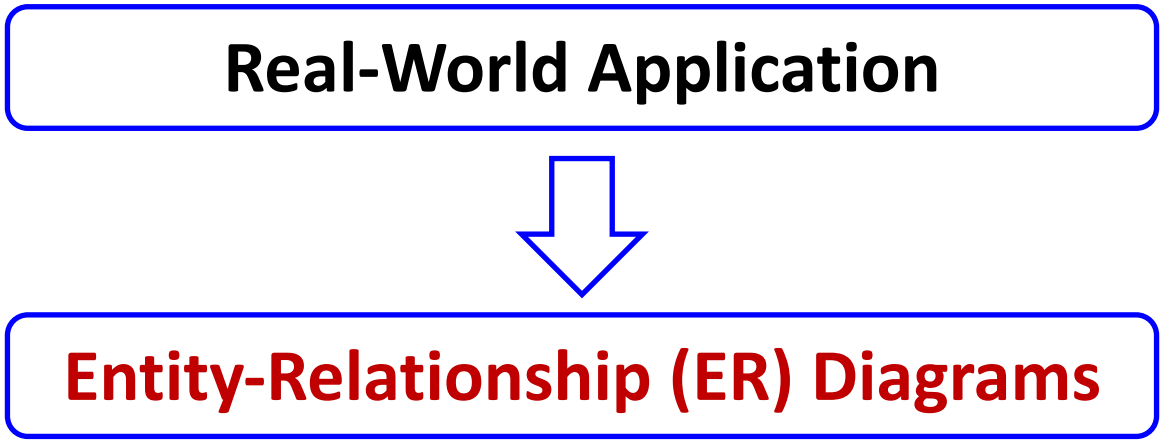
- Too many entity sets that should not be "weak"

This Lecture

- ER diagram design principles
- ER diagram → relational schema

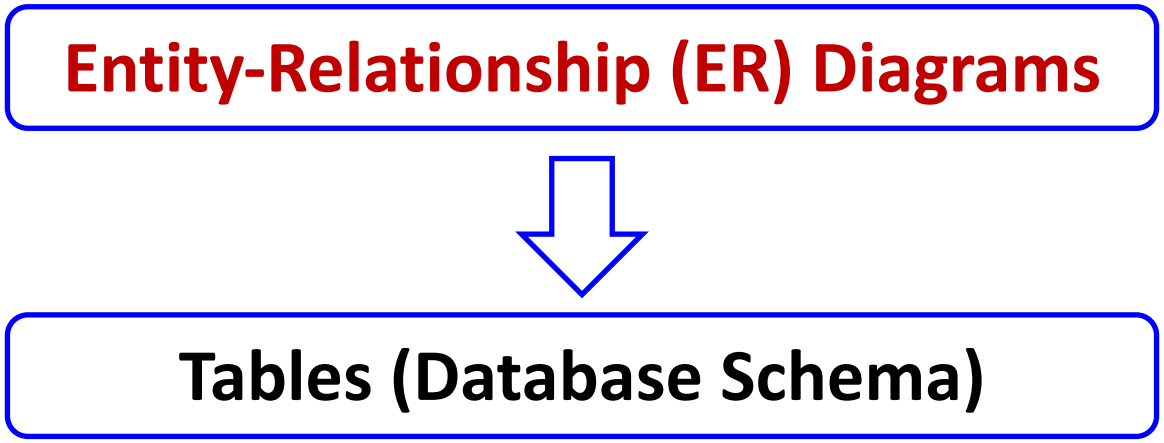
Road Map

- We have discussed
  - Elements of ER Diagrams: Entity Sets, Relationships, Attributes…
  - Design principles of ER Diagrams
- These all concern the conversion below:

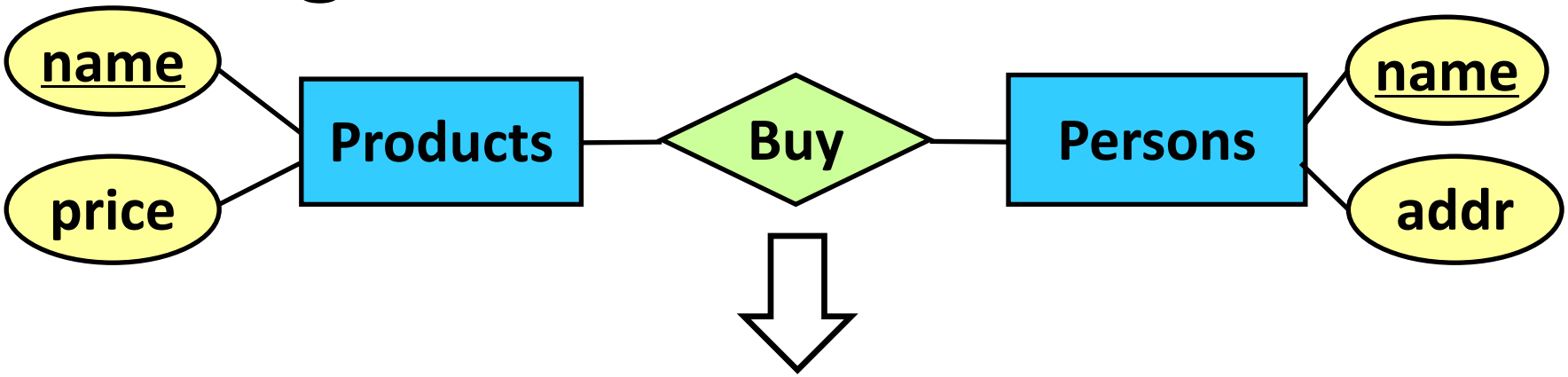


Road Map

- But how do we convert the ER diagrams to a set of tables?
- We will discuss this in the next few slides

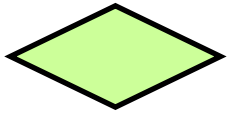
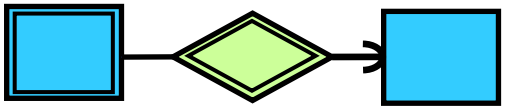
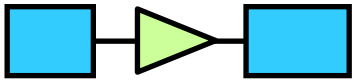
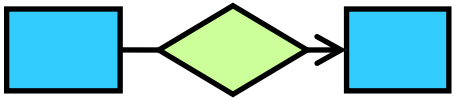
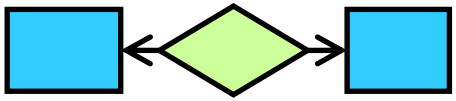


ER Diagram → Relational Schema

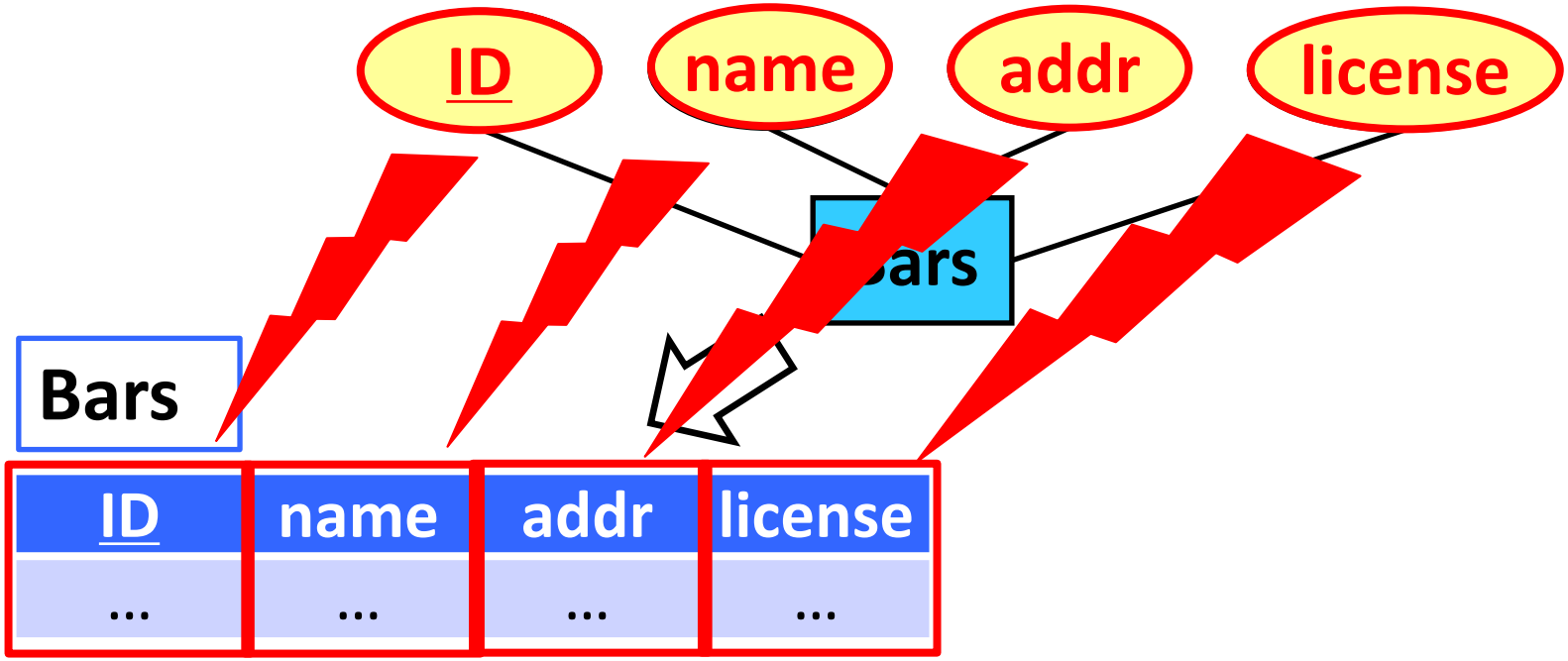


- Products (name, price)
- Persons (name, addr)
- Buy (product_name, person_name)
- Terminology
  - A relation schema = name of a table + names of its attributes
  - A database schema = a set of relation schemas

ER Diagram → Relational Schema

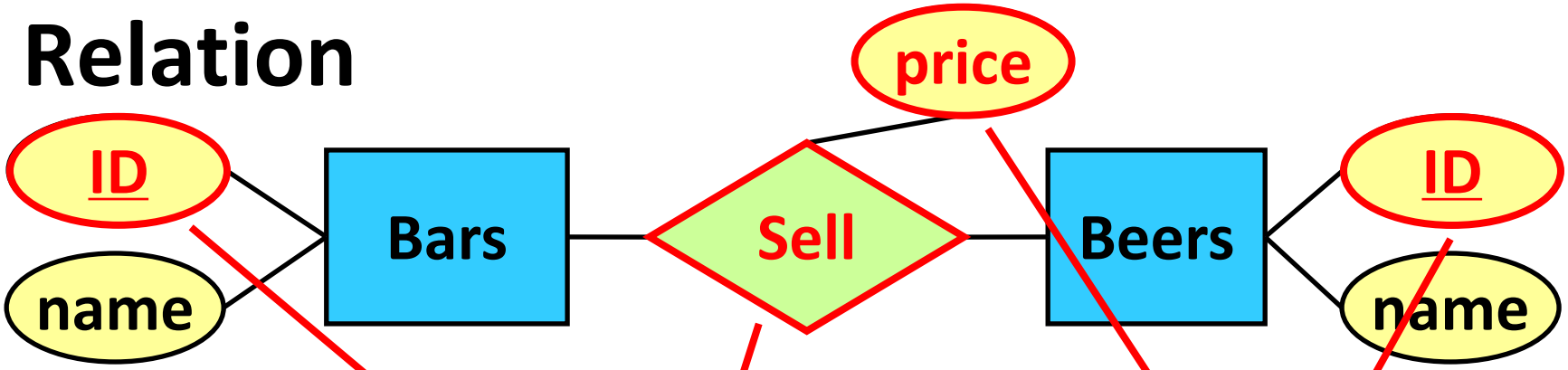
- General rules:
  - Each entity set  becomes a relation 
  - Each many-to-many relationship  becomes a relation 
- Special treatment needed for:
  - Weak entity sets 
  - Subclasses 
  - Many-to-one and one-to-one relationships  

Entity Set → Relation



- Each entity set is converted into a relation that contains all its attributes
- Key of the relation = key of the entity set

Many-to-Many Relationship → Relation

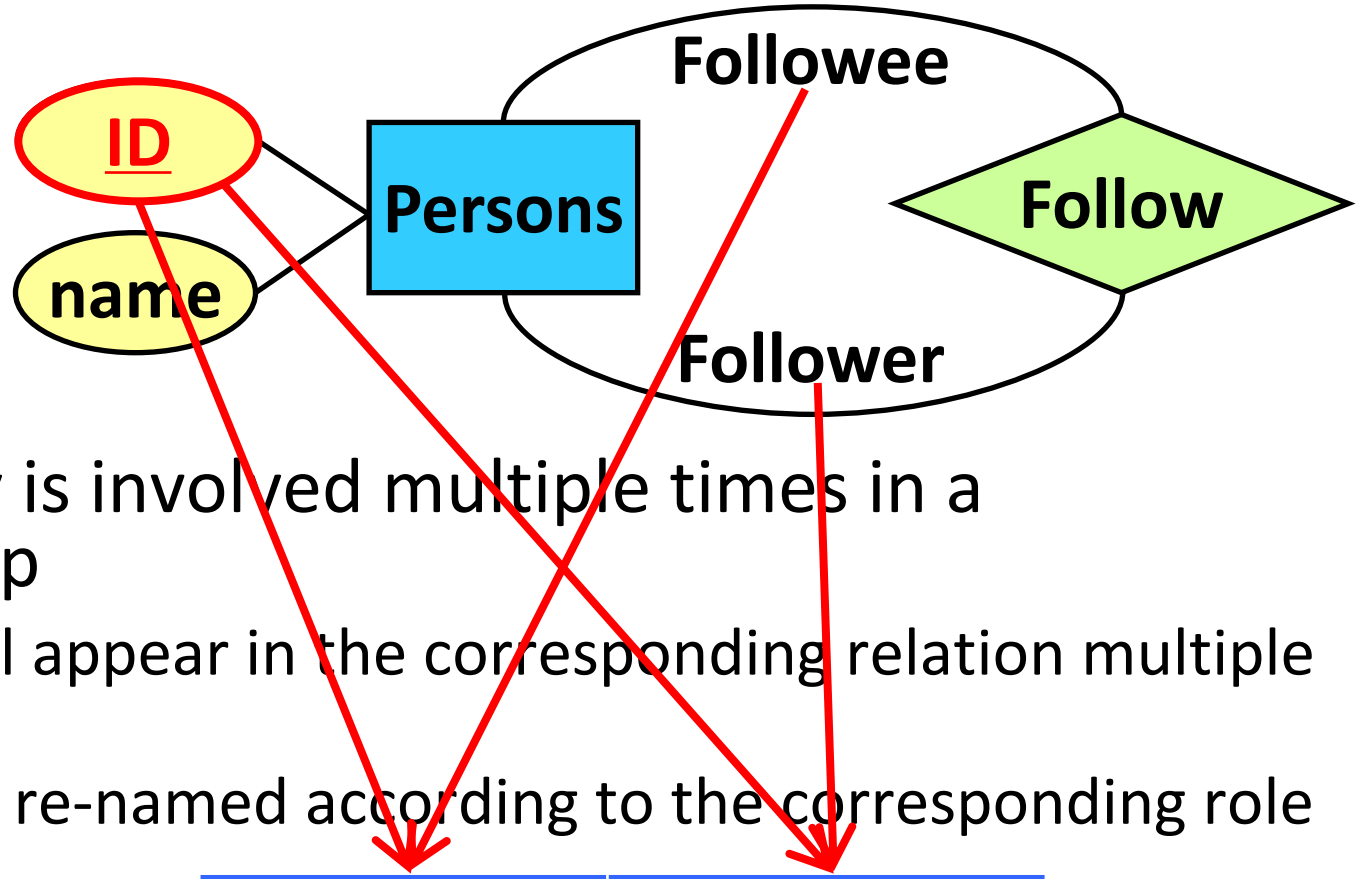


- Converted into a relation that contains
  - all keys of the participating entity sets, and
  - the attributes of the relationship (if any)
- Key of relation = Keys of the participating entity sets

Sell

Bars-ID	Beers-ID	price
…	…	…

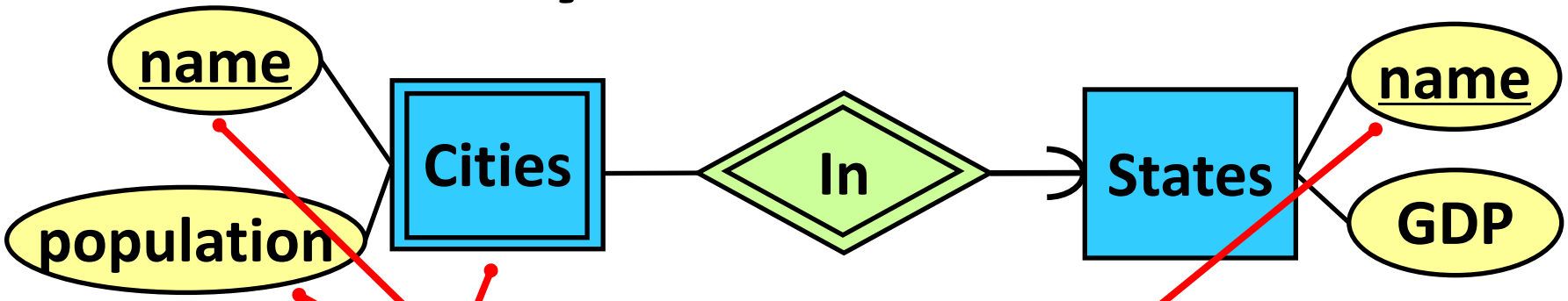
Many-to-Many Relationship → Relation



- If an entity is involved multiple times in a relationship
  - Its key will appear in the corresponding relation multiple times
  - The key is re-named according to the corresponding role

Follow	Followee-ID	Follower-ID
	...	...

Weak Entity Set → Relation

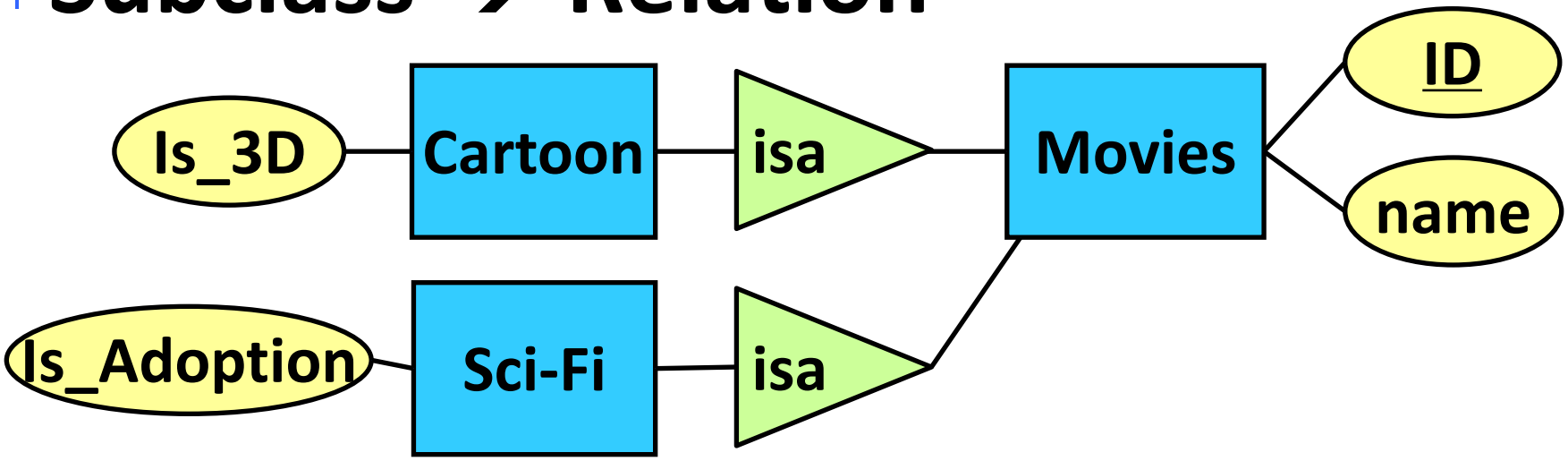


- Each weak entity set is converted to a relation that contains
  - all of its attributes, and
  - the key of the supporting entity set
  - attribute (if any) of supporting relationship
- The supporting relationship is ignored

Cities

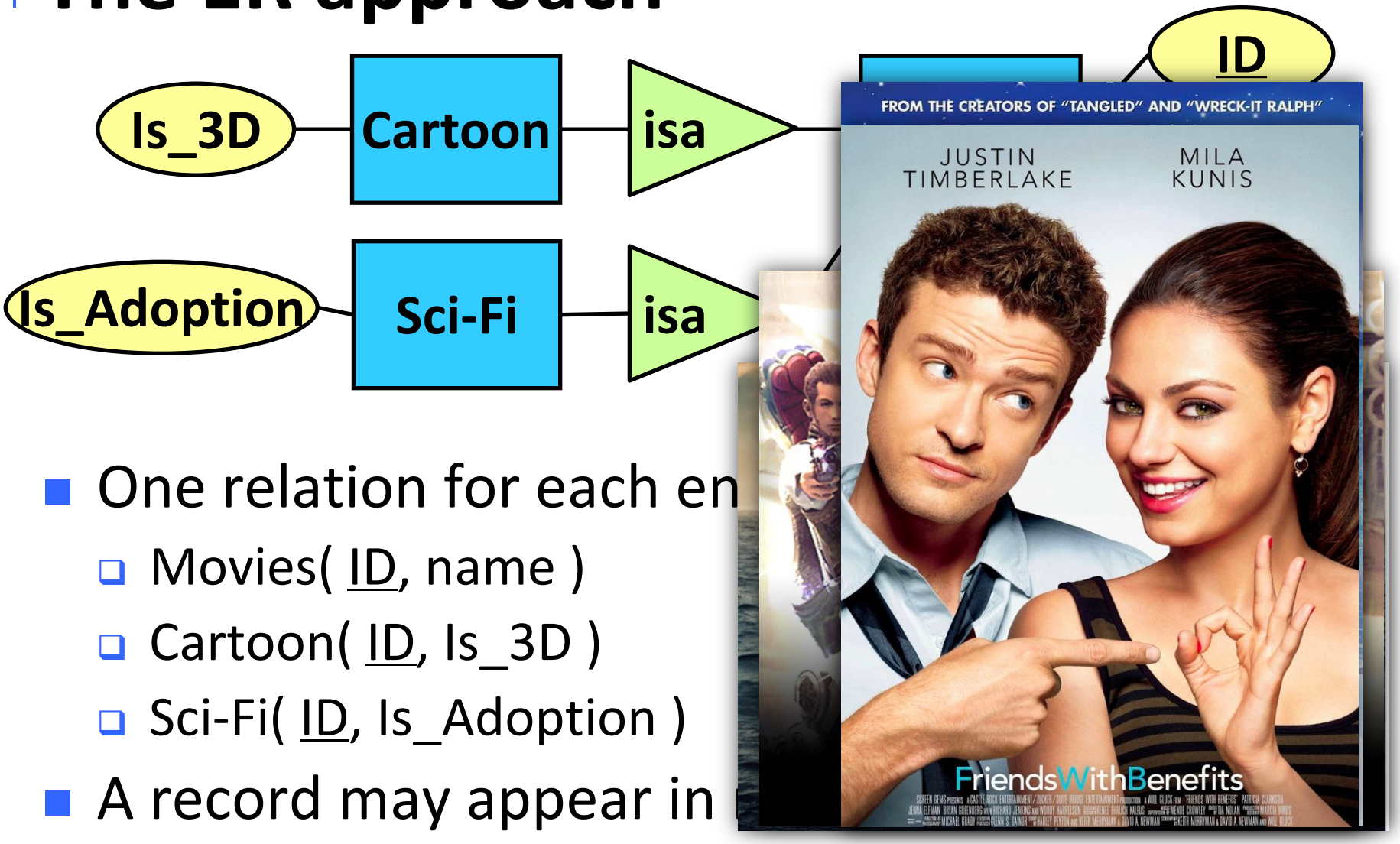
state-name	city-name	population
…	…	…

Subclass → Relation



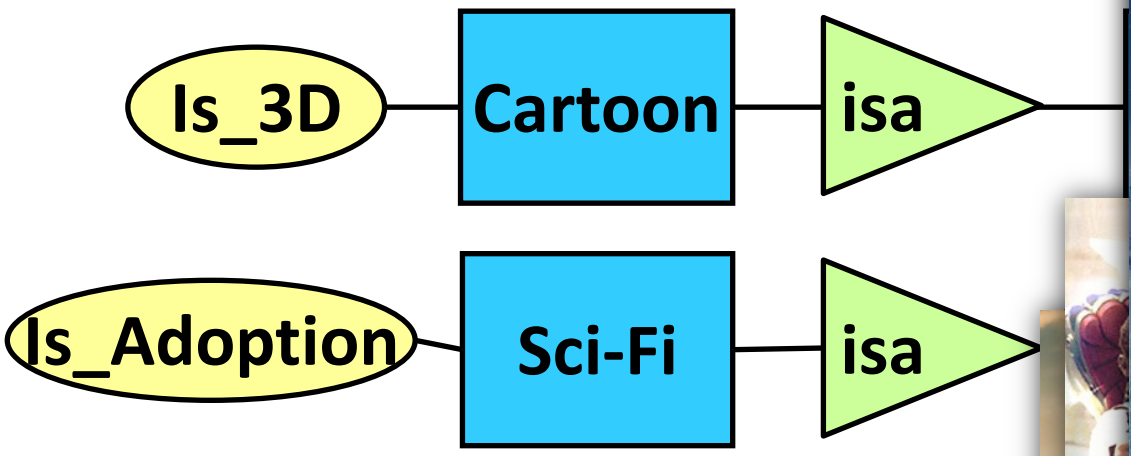
- There are three different ways
  - The ER approach **One record in multiple relations**
  - The OO approach **One record in one relation; potentially many multiple relations**
  - The NULL approach **One big relation, lots of NULLs**

The ER approach



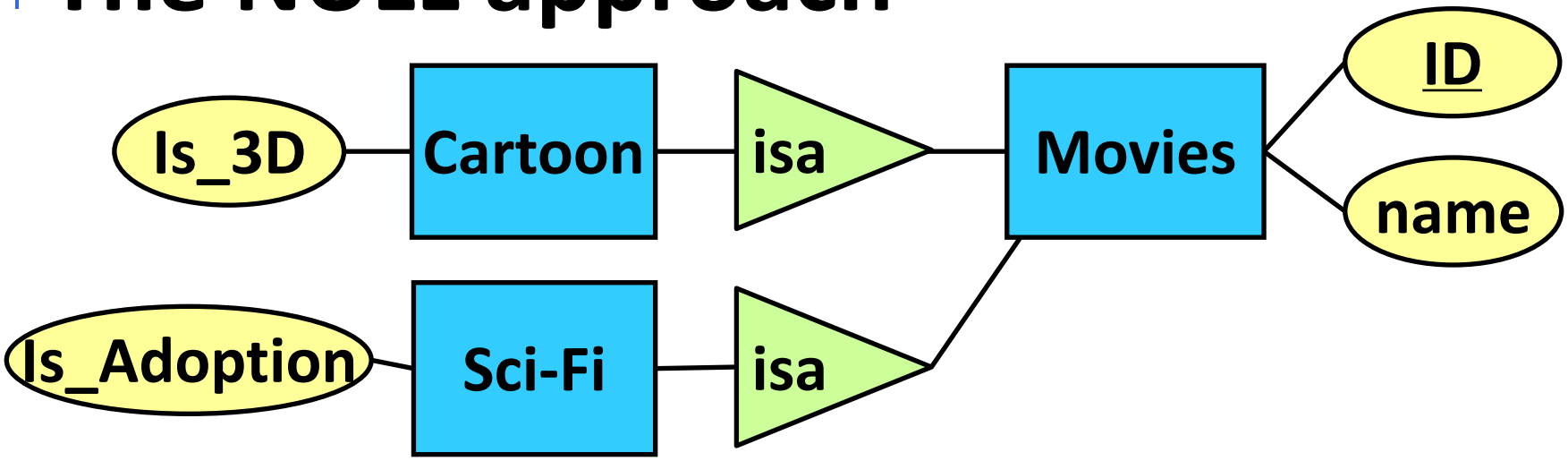
- One relation for each en
  - Movies(ID, name)
  - Cartoon(ID, Is_3D)
  - Sci-Fi(ID, Is_Adoption)
- A record may appear in

The OO approach



- One relation for each entity set subclass combination
  - Movies(ID, name)
  - Cartoon(ID, name, Is_3D)
  - Sci-Fi(ID, name, Is_Adoption)
  - Sci-Fi-Cartoon(ID, name, Is_3D, Is_Adoption)
- Each record appears in only one relation

The NULL approach

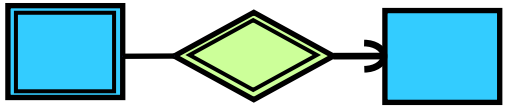
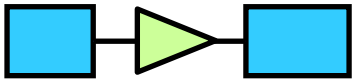
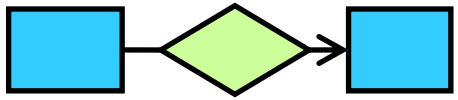
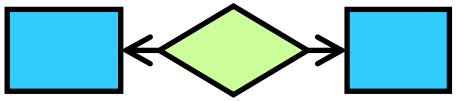


- One relation that includes everything
  - Movies(ID, name, Is_3D, Is_Adoption)
- For non-cartoon movies, its "Is_3D" i NULL
- For non-sci-fi movies, its "Is_Adoptic NULL

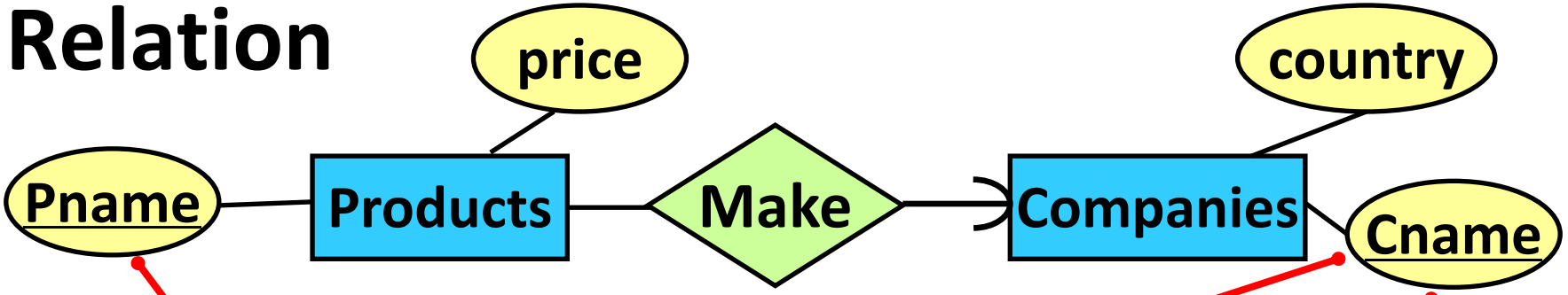
Which Approach is the Best?

- It depends
- The NULL approach
  - Advantage: Needs only one relation
  - Disadvantage: May have many NULL values
- The OO approach
  - Advantage: Good for searching subclass combinations
  - Disadvantage: May have too many tables
- The ER approach
  - A middle ground between OO and NULL

ER Diagram → Relational Schema

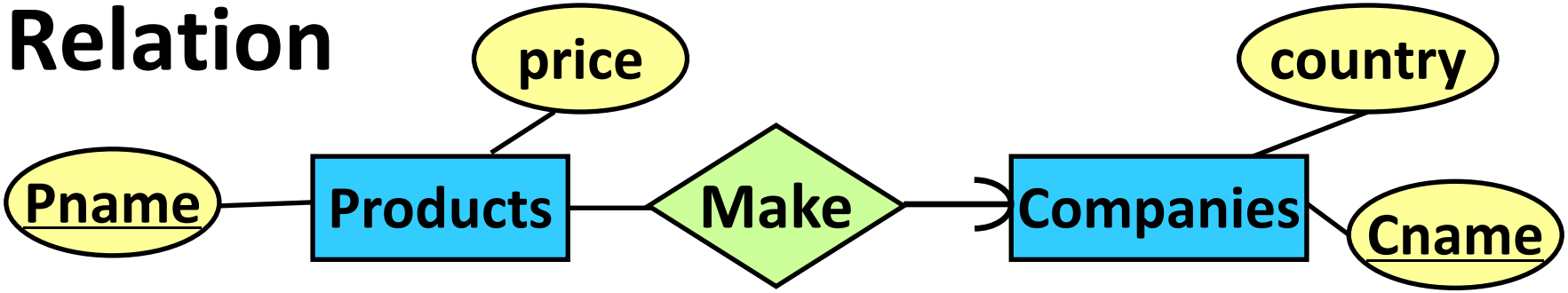
- General rules:
  - Each entity set becomes a relation
  - Each many-to-many relationship becomes a relation
- Special treatment needed for:
  - ✓ Weak entity sets 
  - ✓ Subclasses 
  - ➡ Many-to-one and one-to-one relationships  

Many-to-One Relationship → Relation



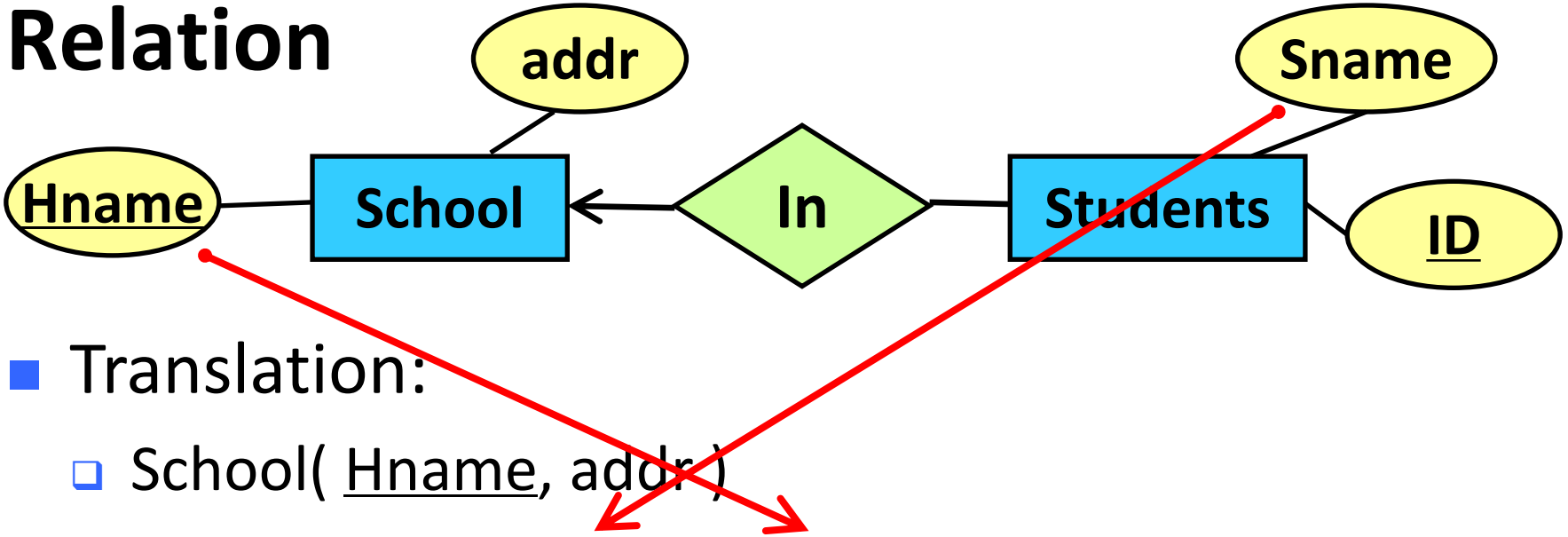
- Intuitive translation:
  - Products(Pname, price)
  - Companies(Cname, country)
  - Make(Pname, Cname) **=> Make(Pname, Cname)**
- Observation: in "Make", each Pname has
- Simplification: Merge "Make" and "Produ
- Results:
  - Products(Pname, price, Cname)
  - Companies(Cname, country)

Many-to-One Relationship → Relation



- In general, we do not need to create a relation for a many-to-one relationship
- Instead, we only need to put the key of the "one" side into the relation of the "many" side
- If relationship has attribute, it also goes to the "many" side relation

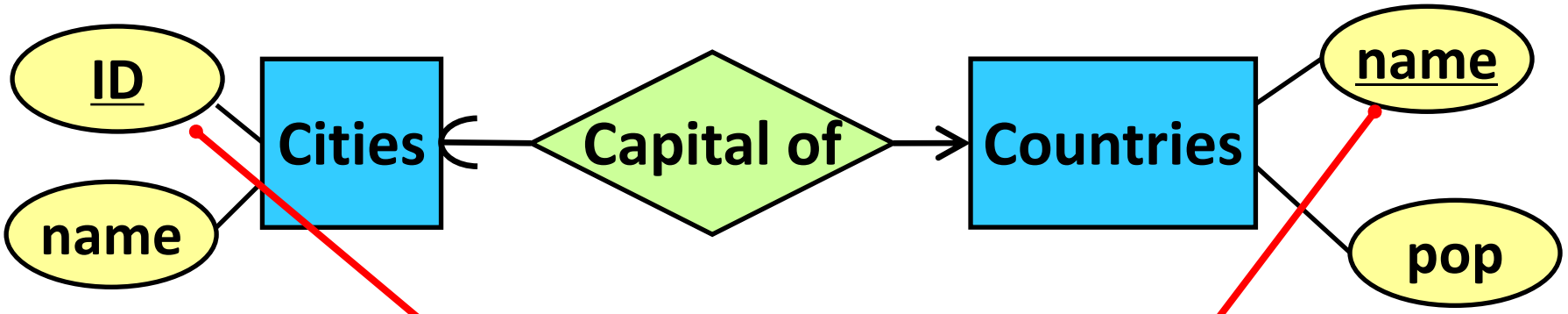
Many-to-One Relationship → Relation



- Translation:
  - School(Hname, addr)
  - Students(ID, Sname, Hname)

- Only need to put the key of the “one” side into the relation of the “many” side

One-to-One Relationship → Relation

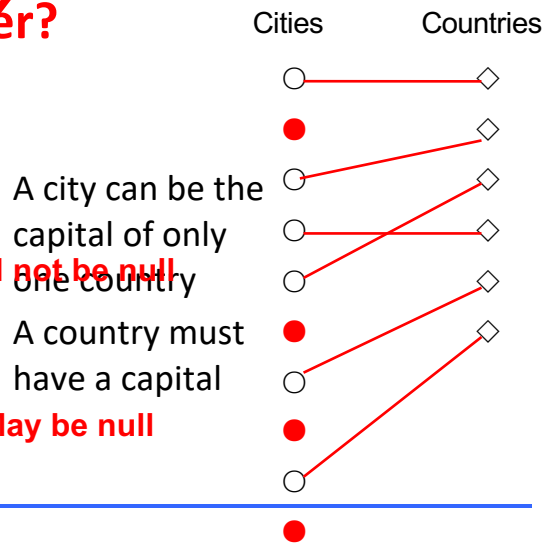


- No need to create a relation for a one-to-one relationship
- Only need to put the key of one side into the relation of the other
- Solution 1
  - Cities(CityID, Cityname)
  - Countries(Countryname, pop, CityID)
- Solution 2
  - Cities(CityID, Cityname, Countryname)
  - Countries(Countryname, pop)

Sol 1 vs Sol 2: Which one is better?

Will not be null

May be null



Summary

- General rules:
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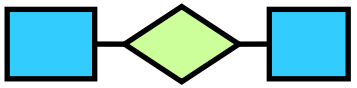
  - Each many-to-many relationship  becomes a relation 
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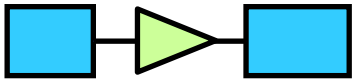
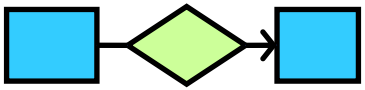
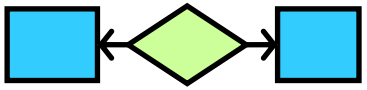
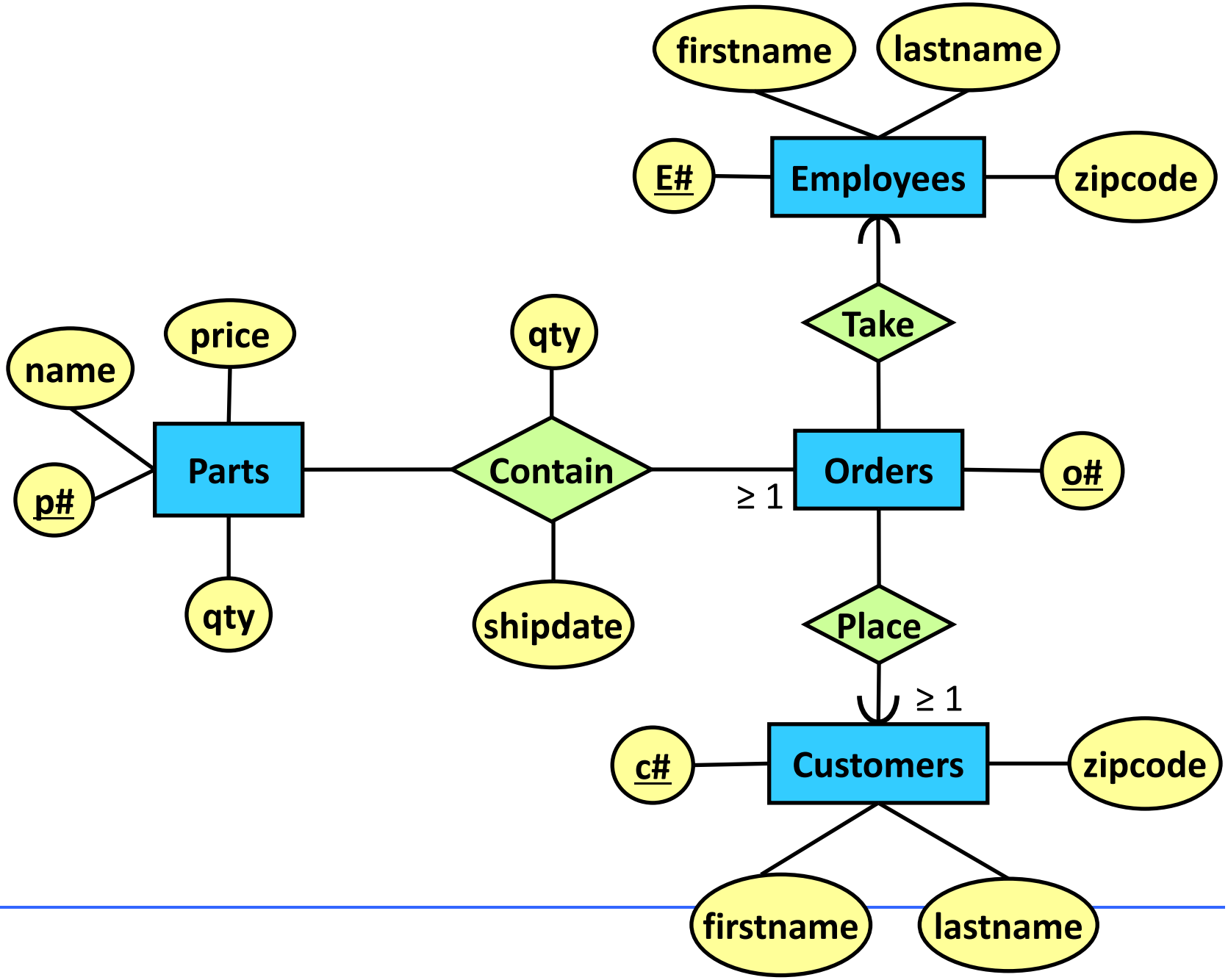
  - Weak entity sets 
  - Subclasses 
  - Many-to-one and one-to-one relationships  

ER Diagram Design: Example

- Consider a mail order database in which employees take orders for parts from customers. The requirements are:
- Each employee is identified by a unique employee number, and has a first name, a last name, and a zip code.
- Each customer is identified by a unique customer number, and has a first name, last names, and a zip code.
- Each part being sold is identified by a unique part number. It has a part name, a price, and a quantity in stock.
- Each order placed by a customer is taken by one employee and is given a unique order number. Each order may contain certain quantities of one or more parts. The shipping date of each part is also recorded.


firstname
lastname
E#
Employees
zipcode
Take
price
name
qty
Parts
Contain
Orders
o#
p#
≥ 1
qty
shipdate
Place
≥ 1
c#
Customers
zipcode
firstname
lastname

Relational Schema

- Parts(p#, name, price, stock)
- Employees(e#, fname, lname, ZIP)
- Customers(c#, fname, lname, ZIP)
- Orders(o#, e#, c#) – from two many-to-one relationships
- Contain(o#, p#, qty, shipdate) – from many-to-many relationships

Next lecture:

Topic 2: Functional Dependencies (1)