CSE 412 Database Management

Dr. Bharatesh Chakravarthi (BC)

Assistant Teaching Professor

School of Computing and Augmented Intelligence

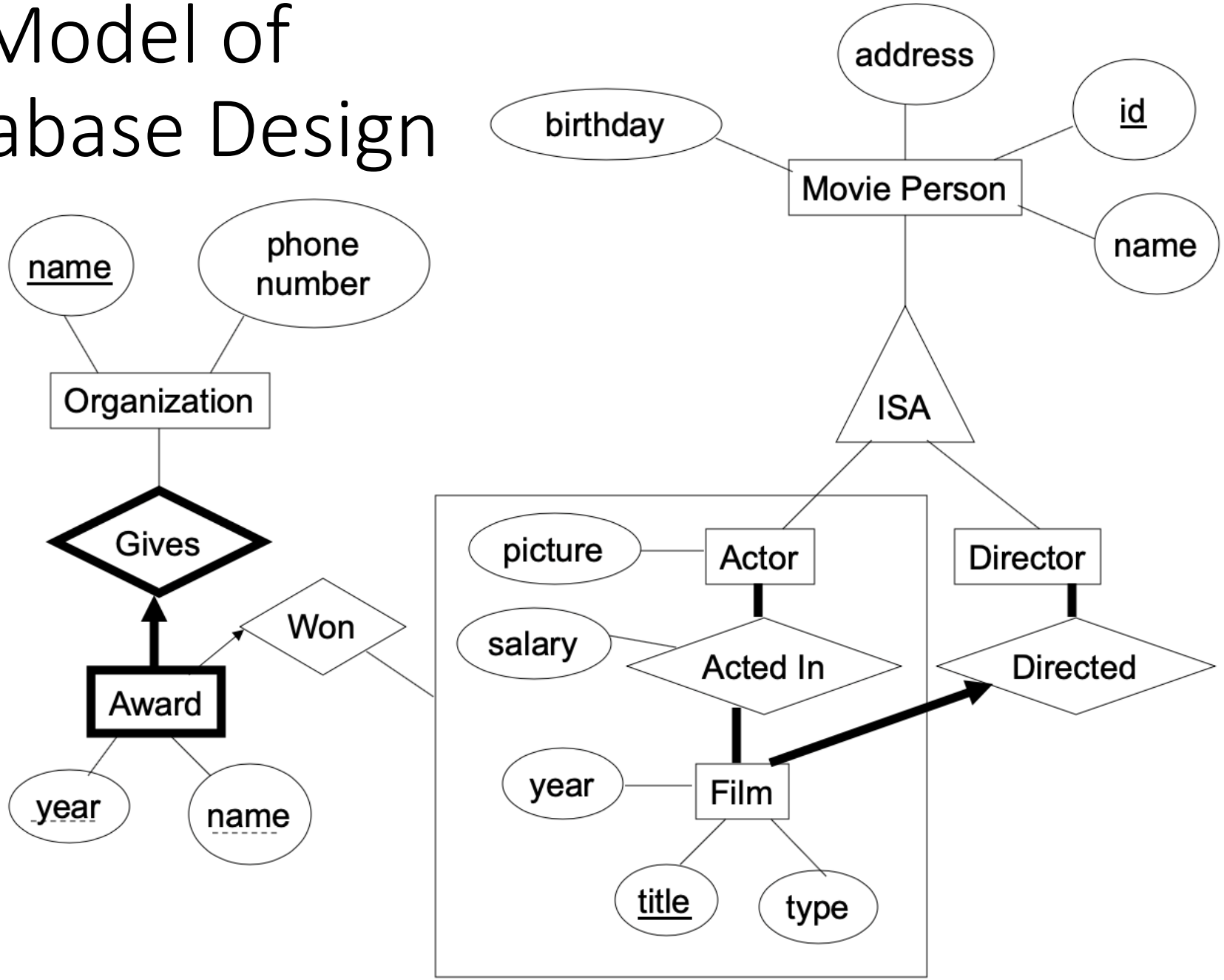
Arizona State University

Challenge:
How to Design a Database?

Scenario

- http://www.myimdb.com wants to store information about movies
- The steps:
  - **Requirement Analysis**
    - **Film (title, type, year, actors, director)**
    - **Movie person (ID, name, address, birthday)**
    - **Actor(ID, picture, salary for each film)**
    - **Director (ID)**
    - **Award (name, year, film, organization)**
    - **Organization (name, phone number)**
  - Conceptual Database Design: High level description of data to be stored (ER model)
  - Logical Database Design: Translation of ER diagram to a relational database schema (description of tables)

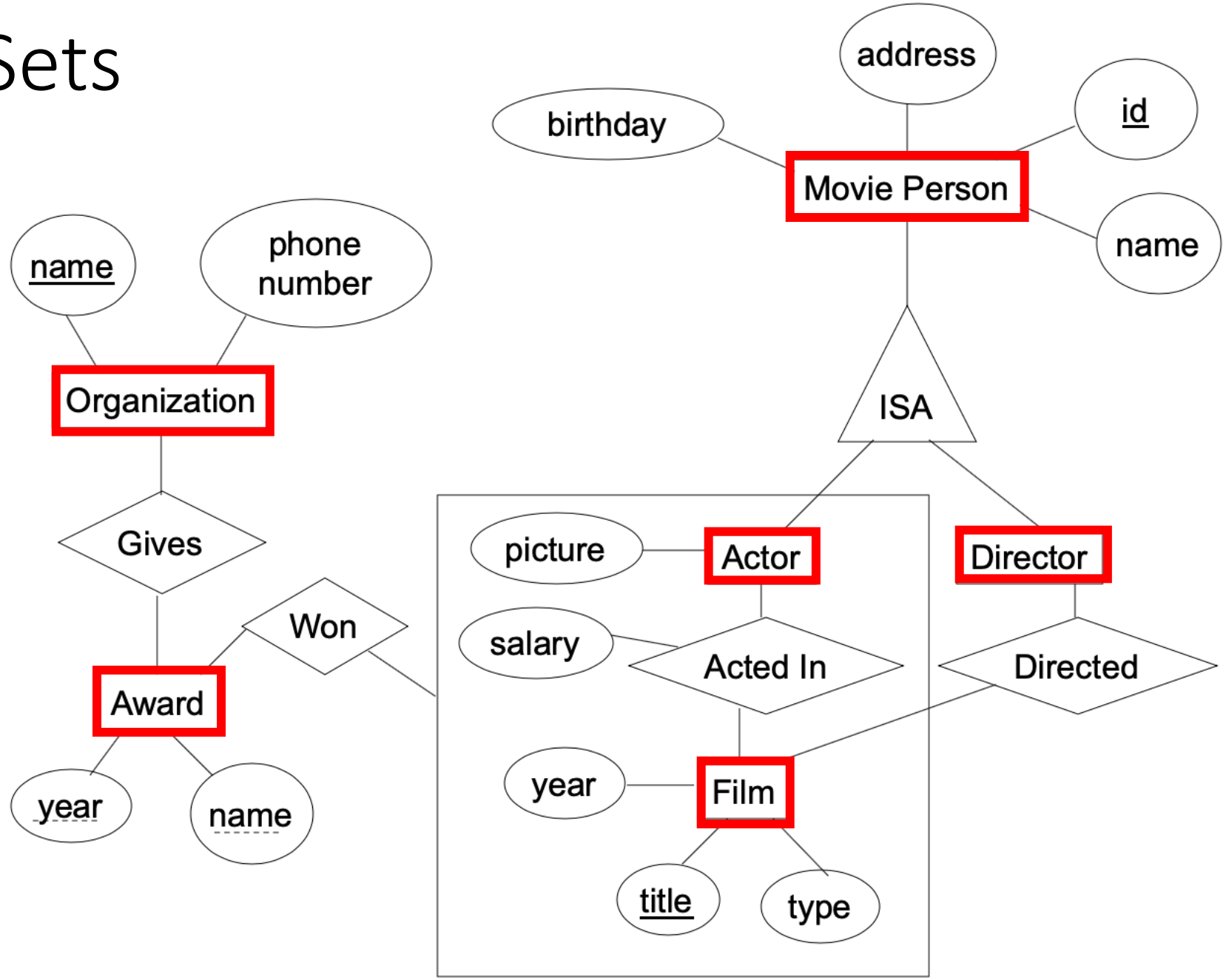
The Output ER Model of Conceptual Database Design



Entities, Entity Sets

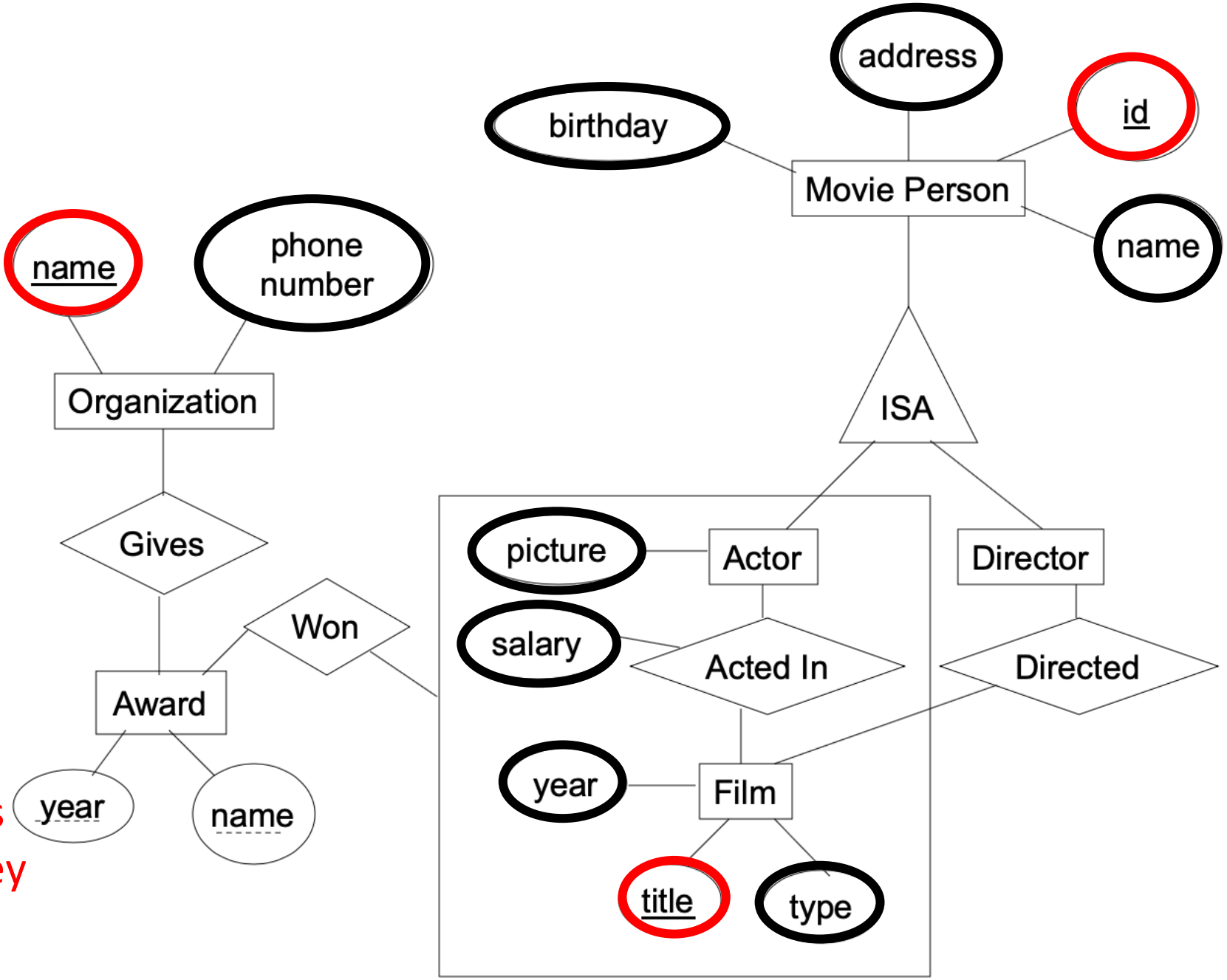
- **Entity:** An object in the world that can be distinguished from other objects
- **Entity set:** A set of similar entities
  - Examples of entity sets:

✎ Entity sets are drawn as rectangles



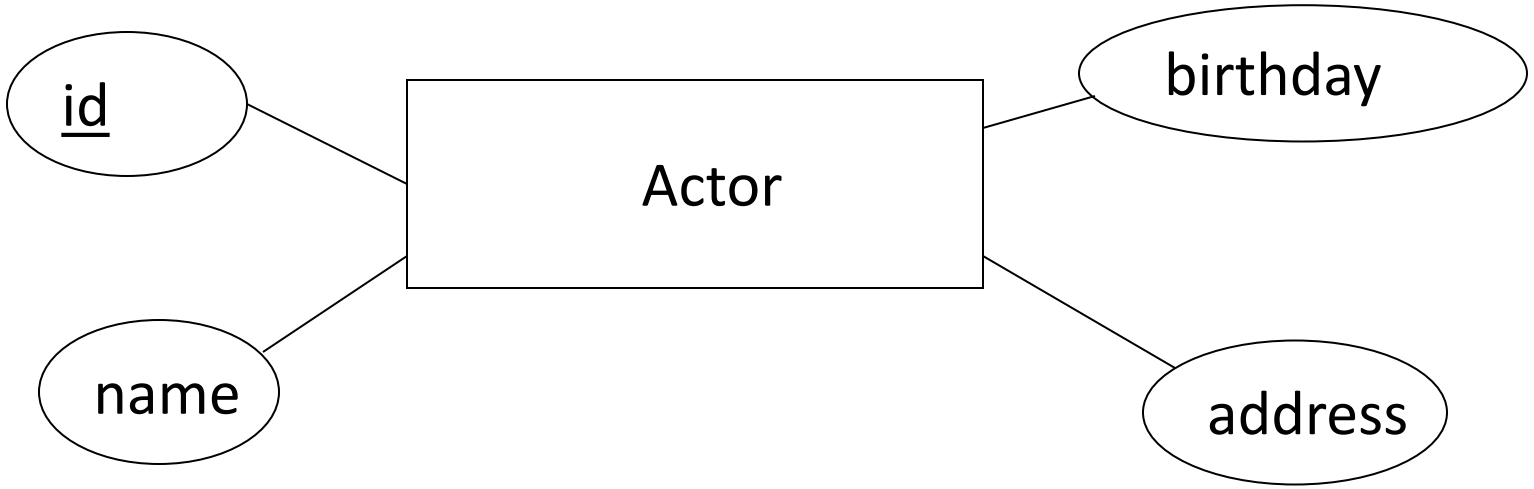
Attributes

- **Attributes**: Used to describe entities
  - All entities in the set have the same attributes
  - A minimal set of attributes that uniquely identify an entity is called a **key**

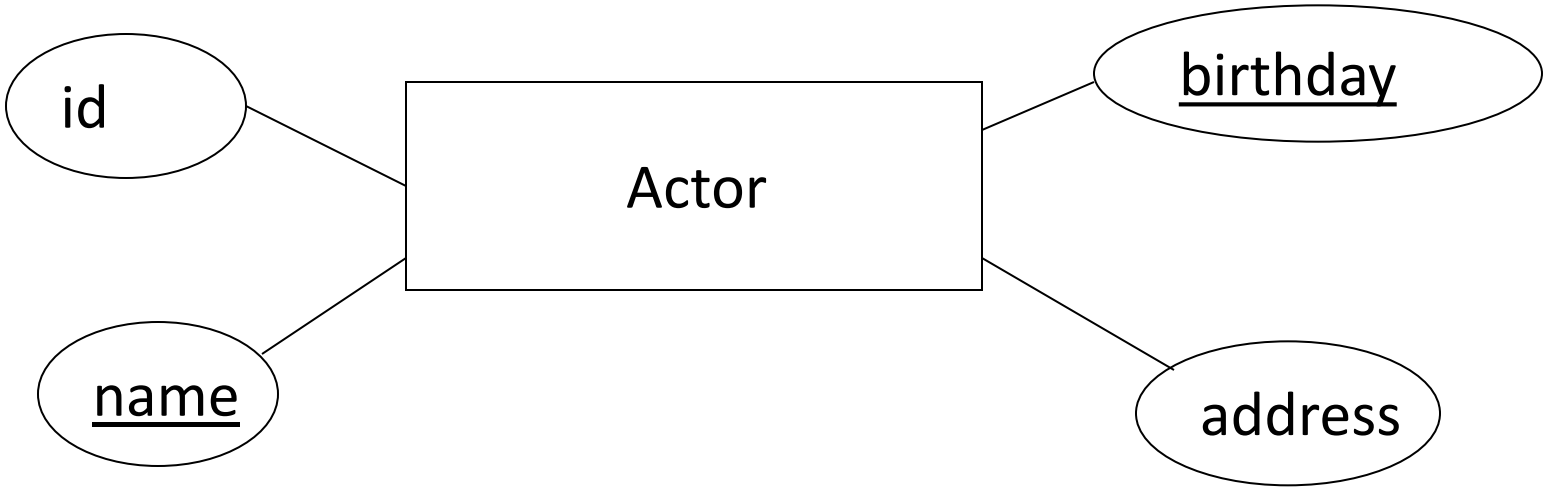


- Attributes are drawn using ovals
- The names of the attributes which make up a primary key are underlined

Example



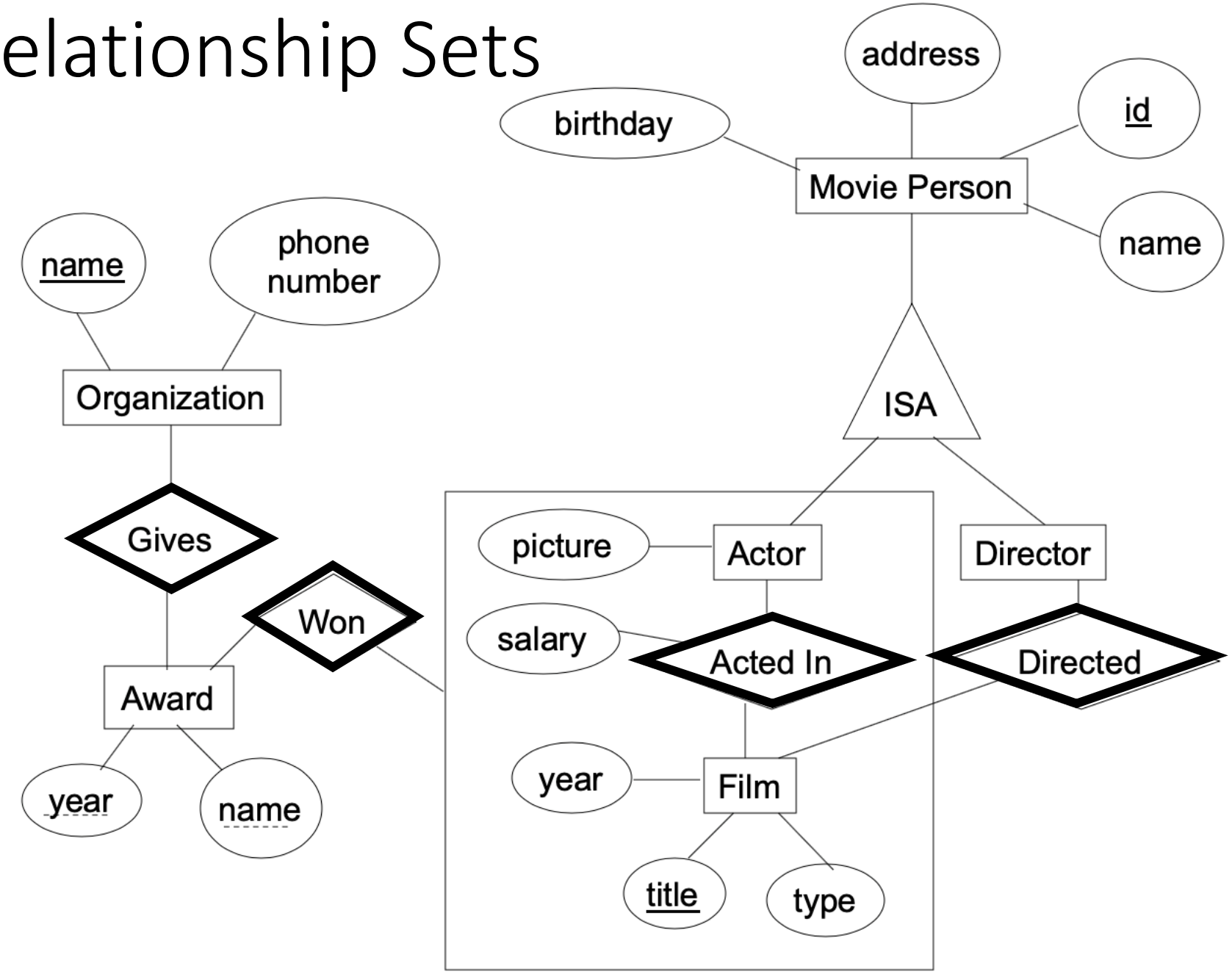
Another Option for a Key?



Relationships, Relationship Sets

- **Relationship:** Association among two or more entities
  - Relationships may have attributes
- **Relationship Set:** Set of similar relationships

✎ Relationship sets are drawn using diamonds



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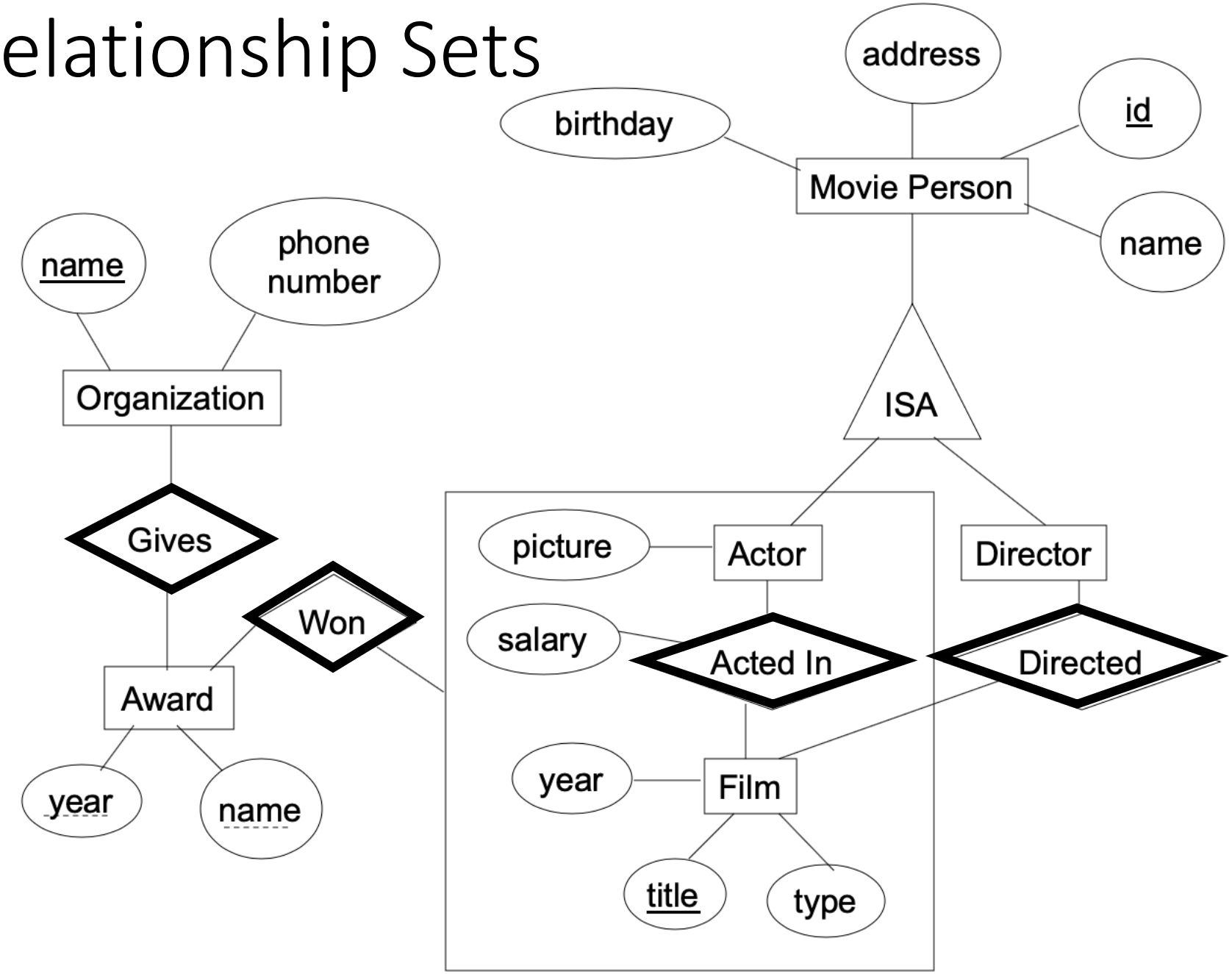
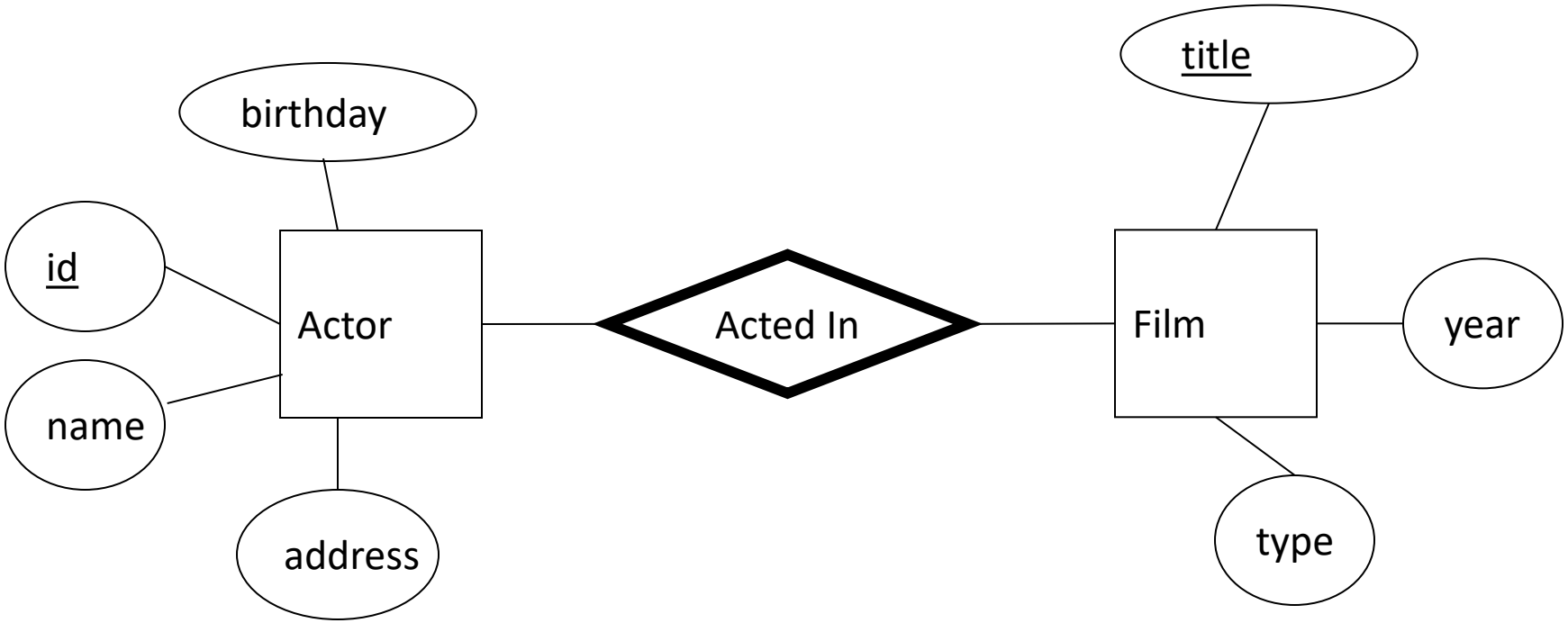


Relationship sets are drawn using diamonds

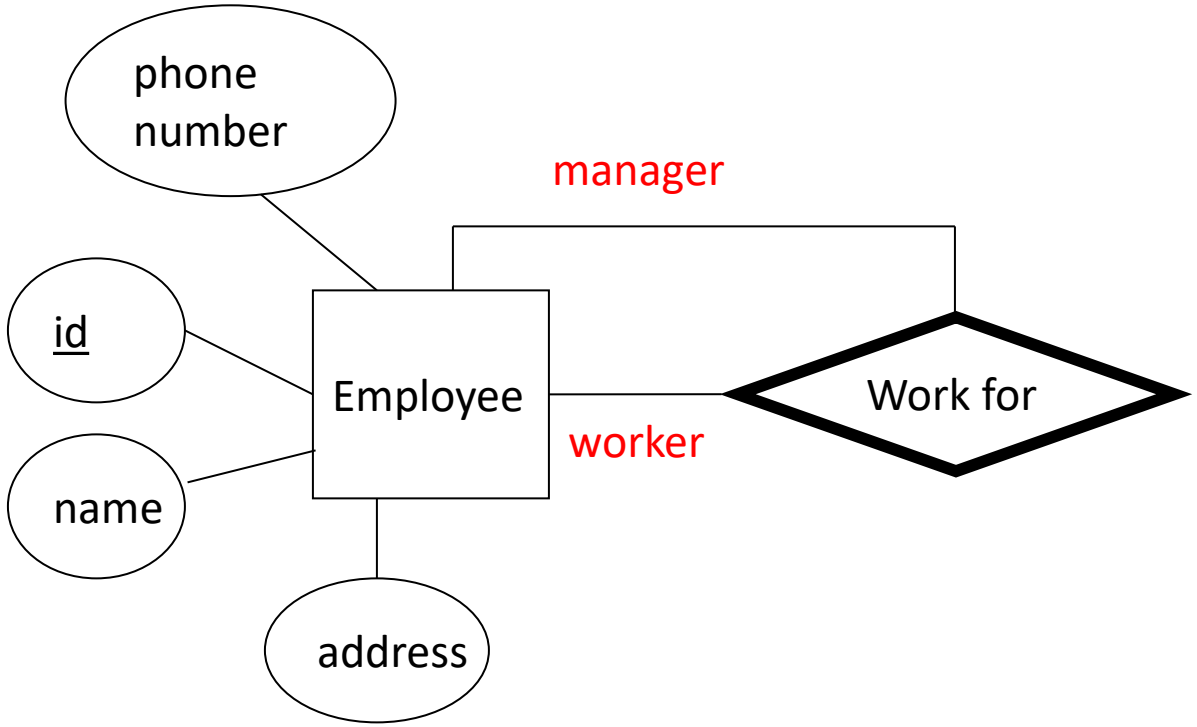
Example



Where does the salary attribute belong?

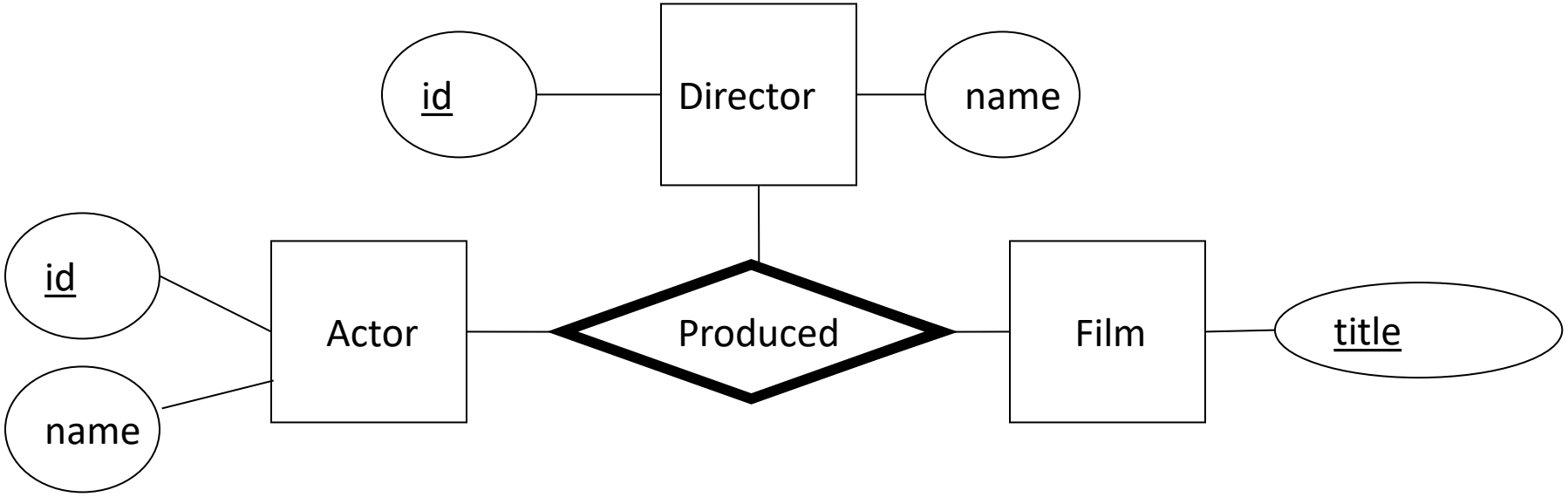
Recursive Relationships

- An entity set can participate more than once in a relationship
- In this case, we add a description of the role to the ER-diagram



n-ary Relationship

- An *n*-ary relationship set *R* involves exactly *n* entity sets: E_1, …, E_n.
- Each relationship in *R* involves exactly *n* entities: $e_1 \varepsilon E_1$, …, $e_n \varepsilon E_n$

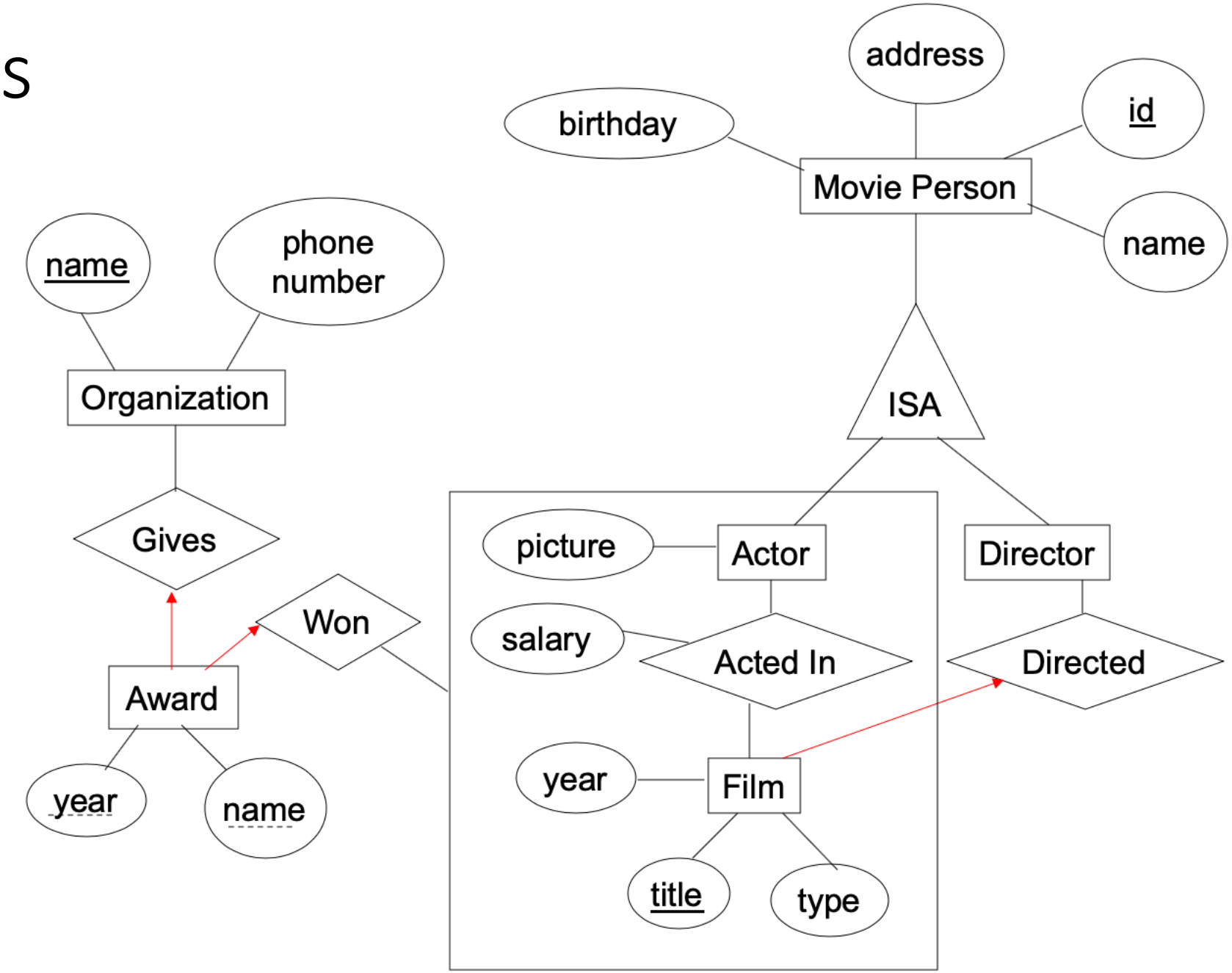


Ternary Relationship

Key Constraints

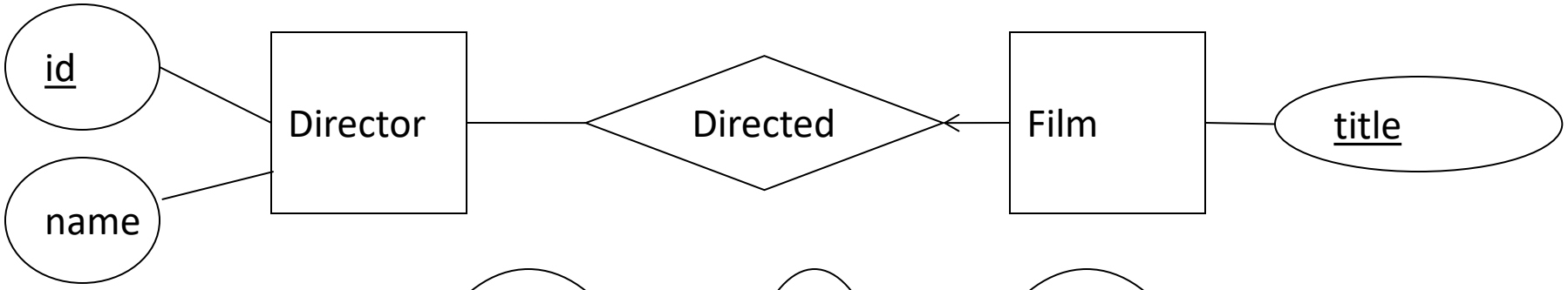
- Key constraints specify whether an entity can participate in one, or more than one, relationships in a relationship set
- When there is no key constraint, an entity can participate any number of times
- When there is a key constraint, the entity can participate **at most one time**

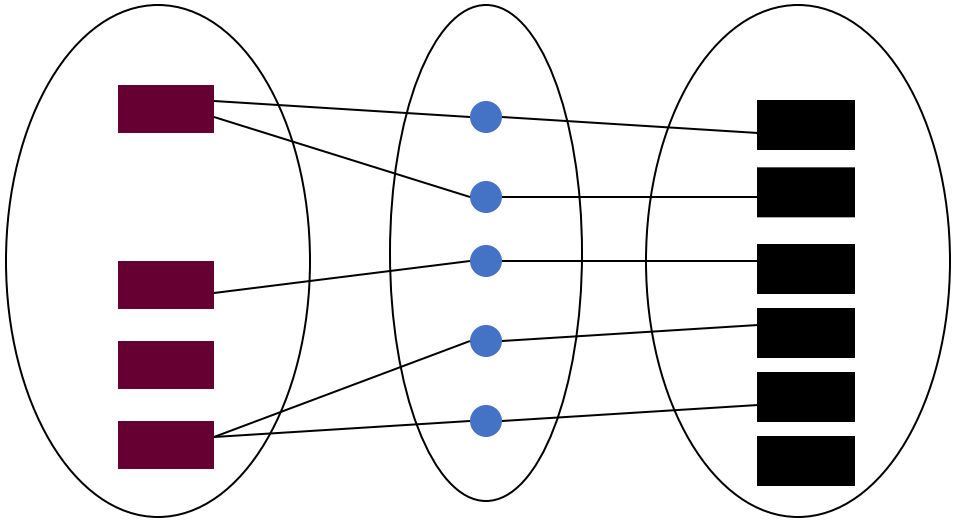
Key constraints are drawn using an arrow from the entity set to the relationship set



One-to-Many

- ✓A film is directed by at most one director
- ✓A director can direct any number of films

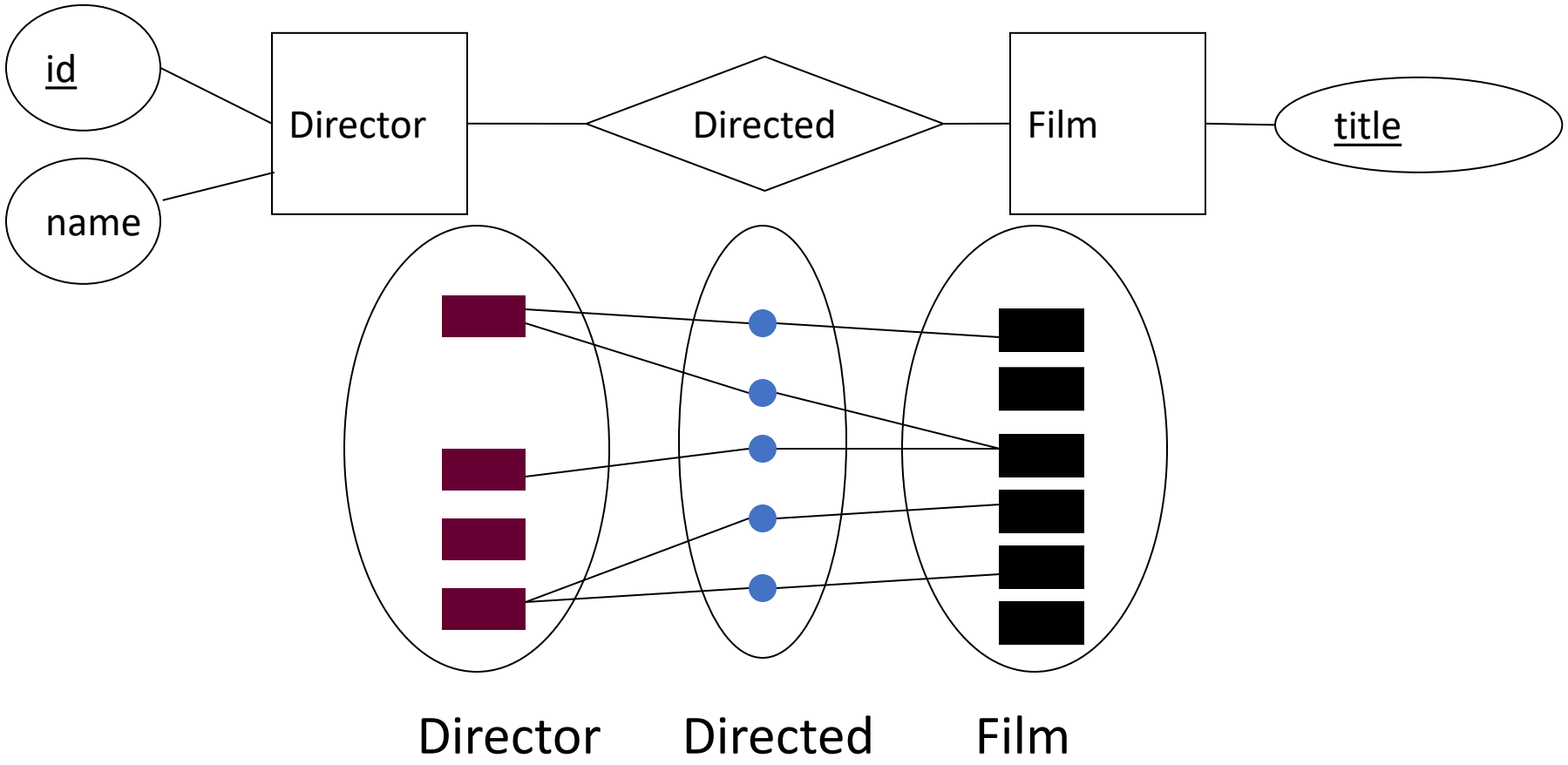




Director Directed Film

Many-to-Many

- ✓A film is directed by any number of directors
- ✓A director can direct any number of films



One-to-One

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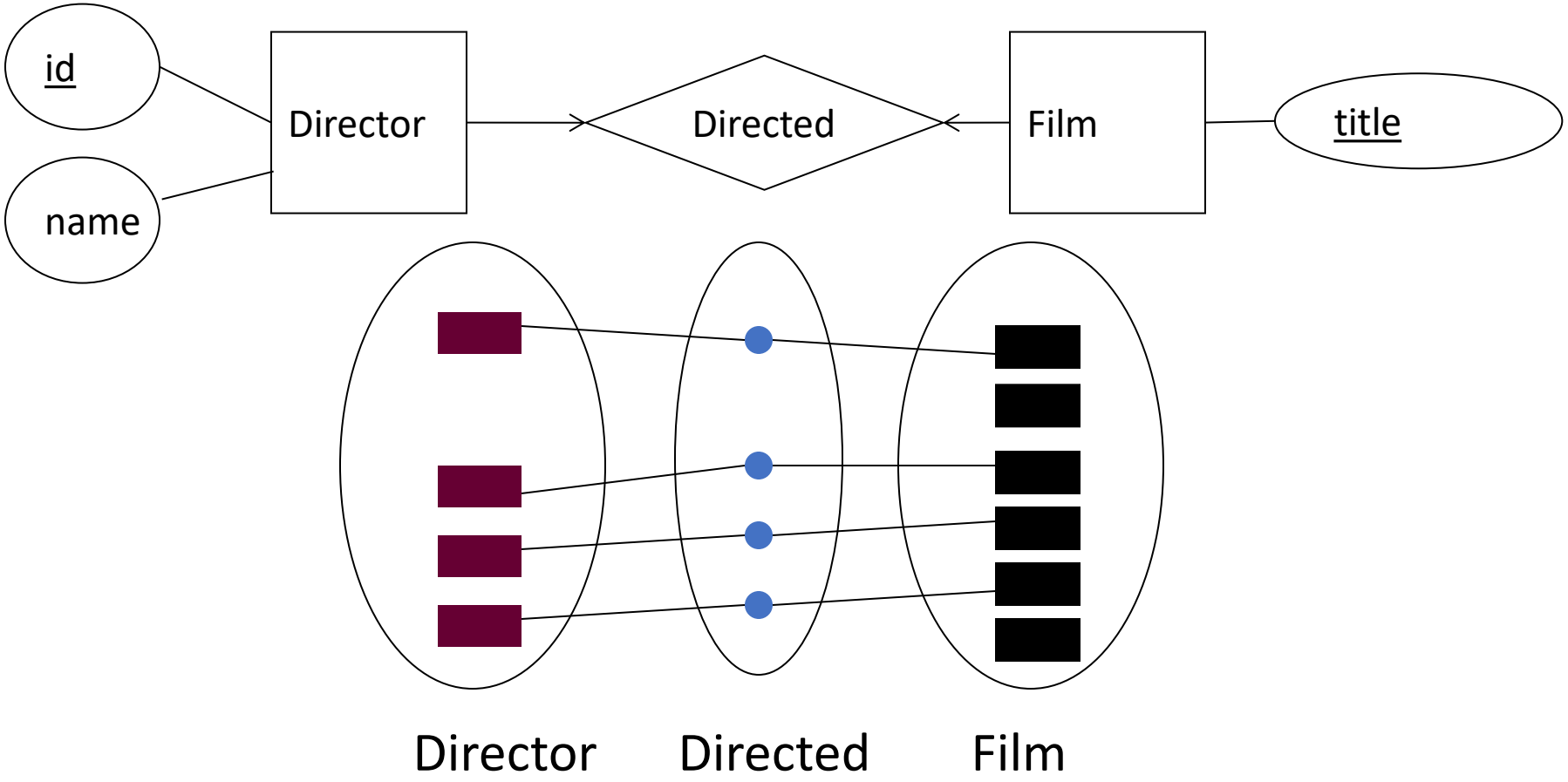
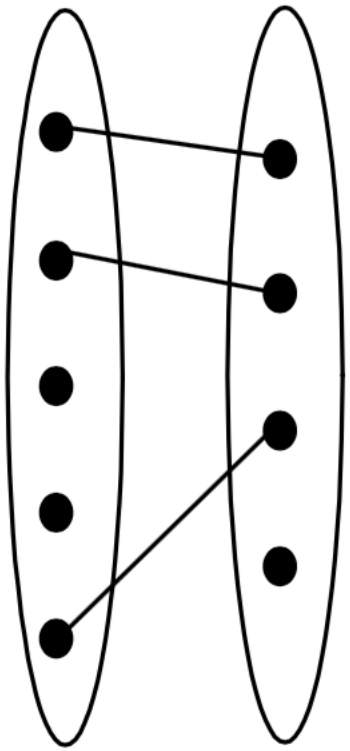
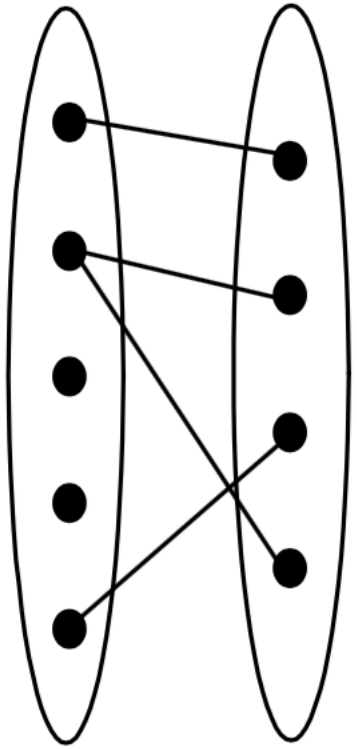


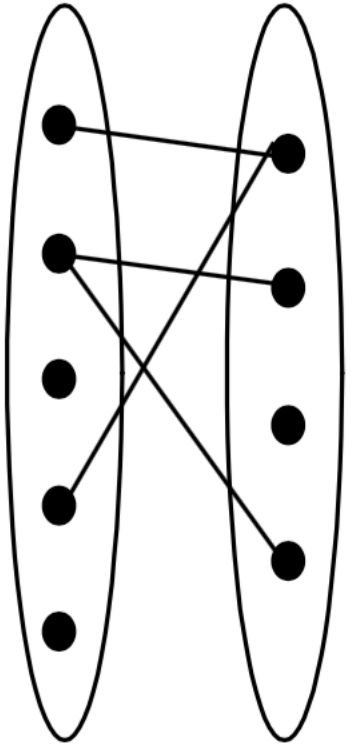
Question



One to One



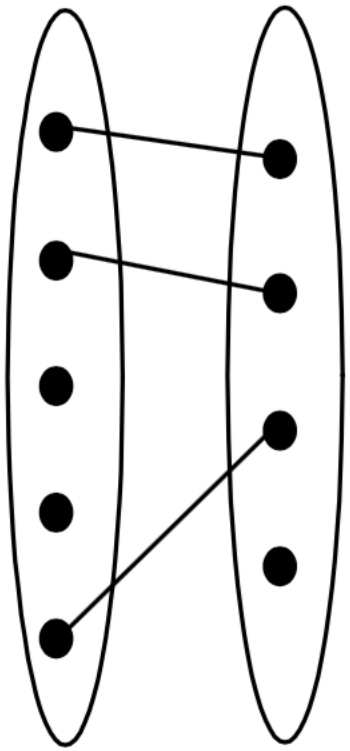
One to Many



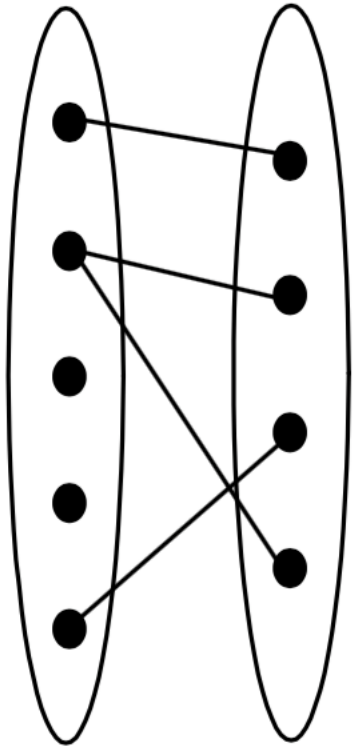
Many to Many

Question

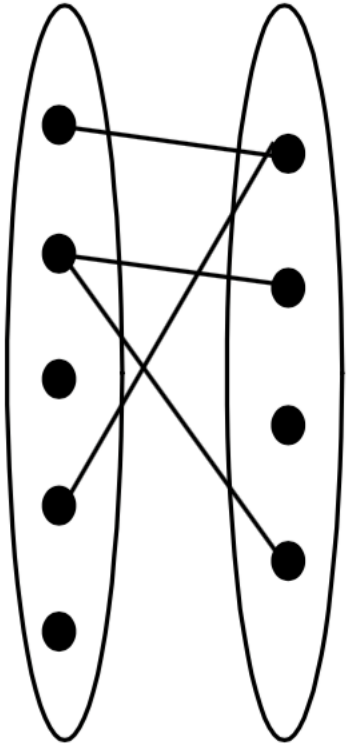
President-leads-Country Supervisee-managed by-supervisor Author-writes-Paper



One to One



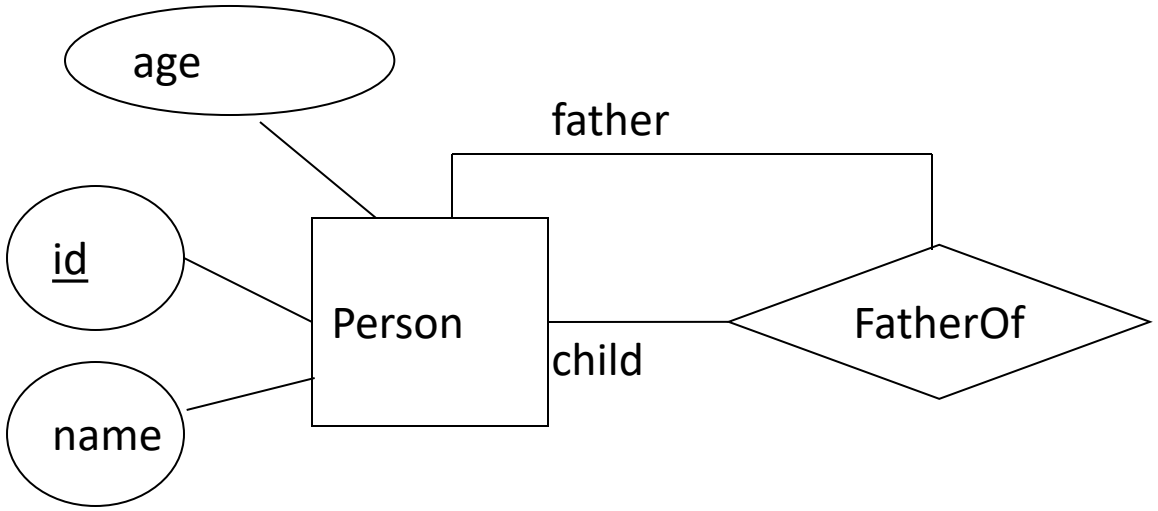
One to Many



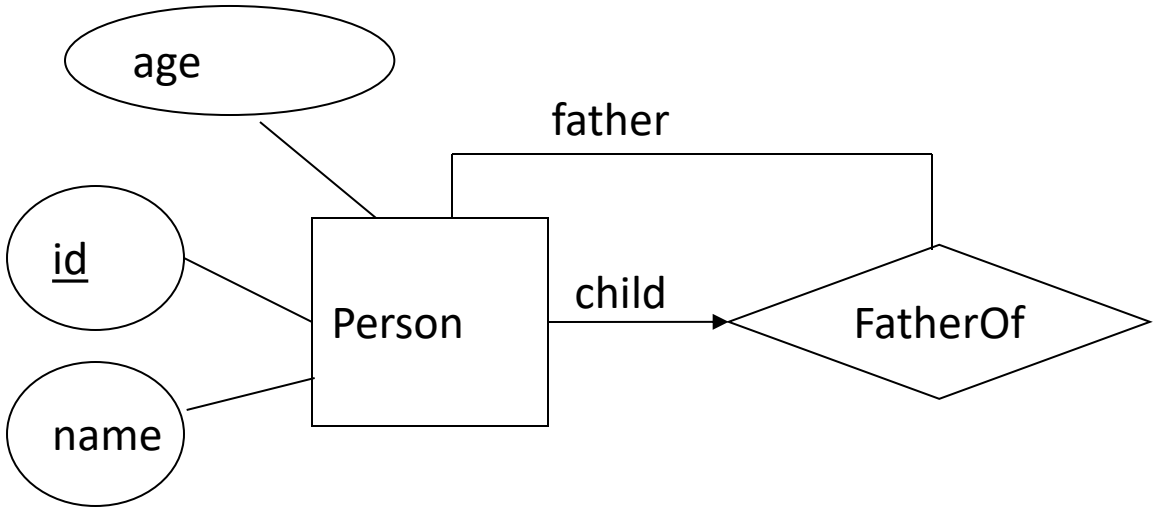
Many to Many

Another Example

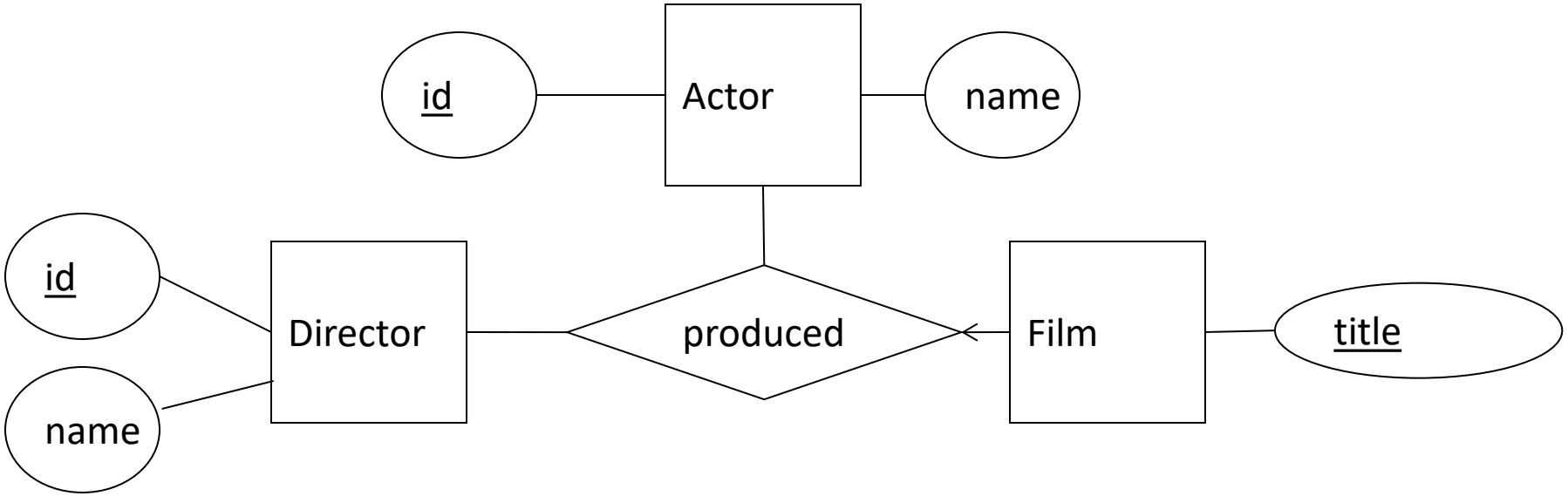
Where would you put the arrow?



Another Example



Key Constraints in Ternary Relationships



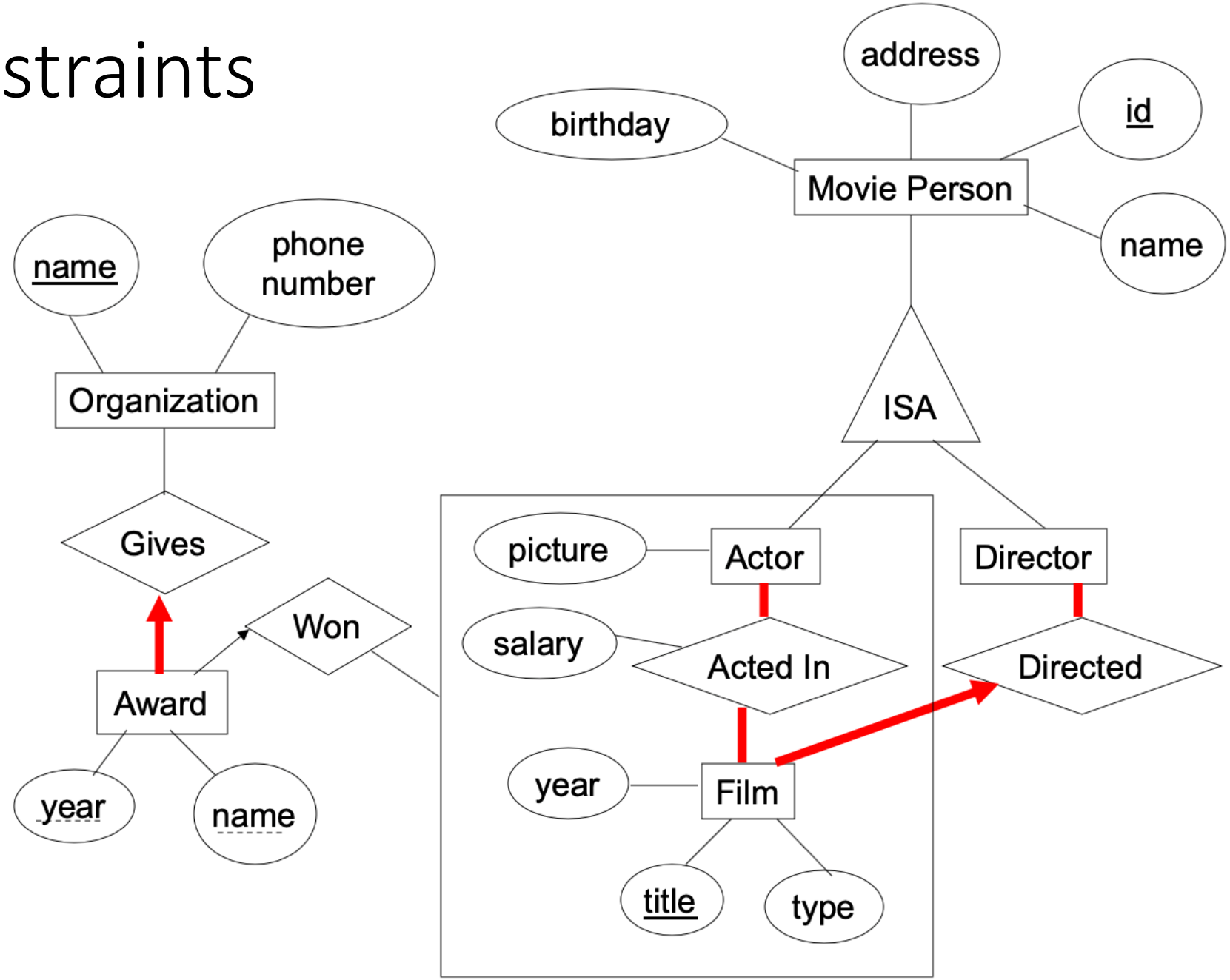
What does this mean?

A film has at most one actor and one director

Participation Constraints

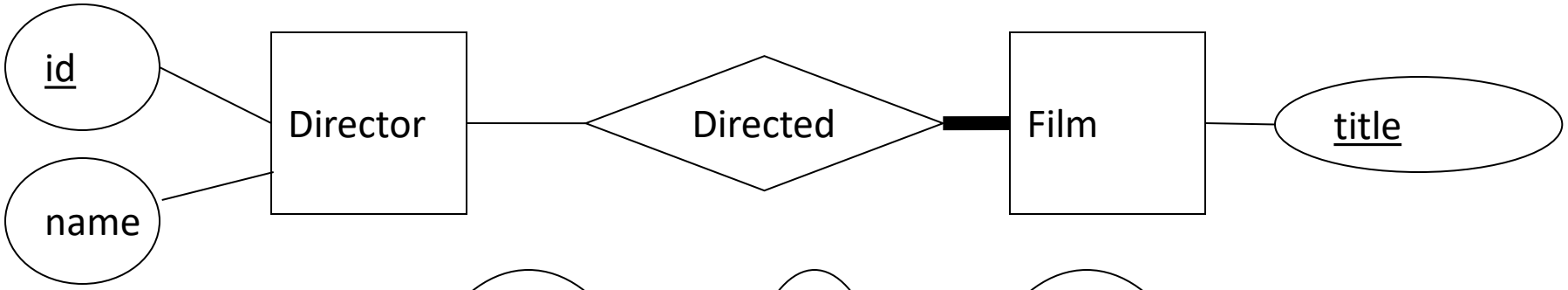
- Participation constraints specify whether or not an entity must participate in a relationship set
- When there is no participation constraint, it is possible that an entity will not participate in a relationship set
- When there is a participation constraint, the entity must participate **at least once (total), otherwise it is called partial**

✎ Participation constraints are drawn using a thick line from the entity set to the relationship set

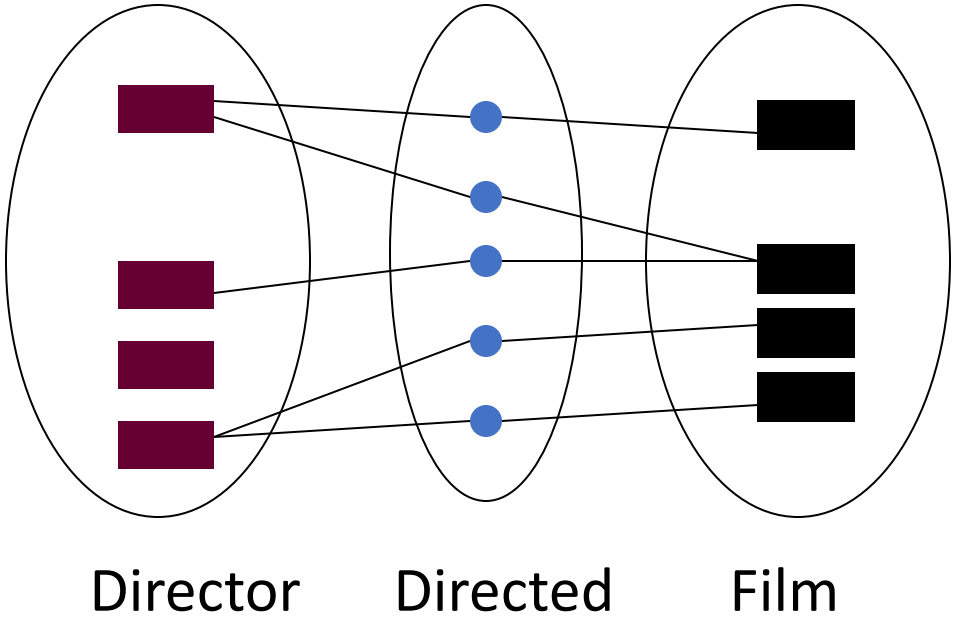


Example (1)

- A film has at least one director
- A director can direct any number of films

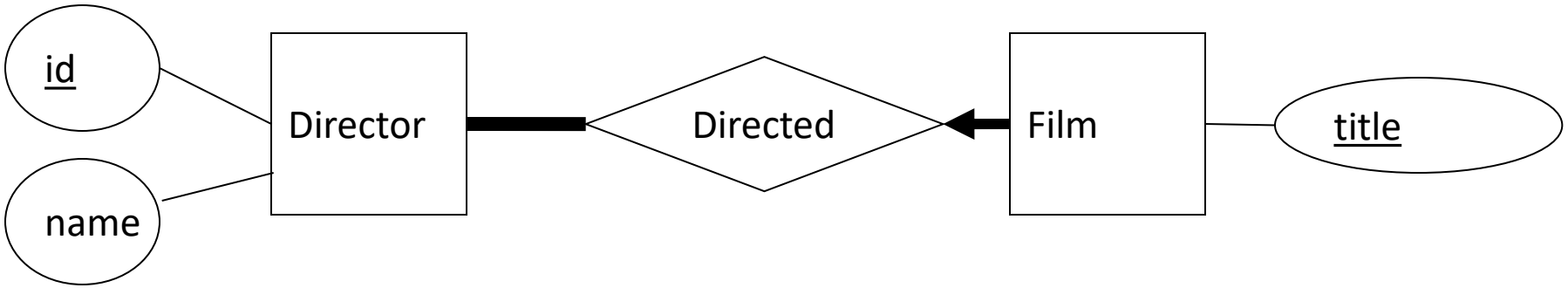


Do you think that there should be a participation constraint from Director to Directed?



Example (2)

- We can combine key and participation constraints.
- What does this diagram mean?

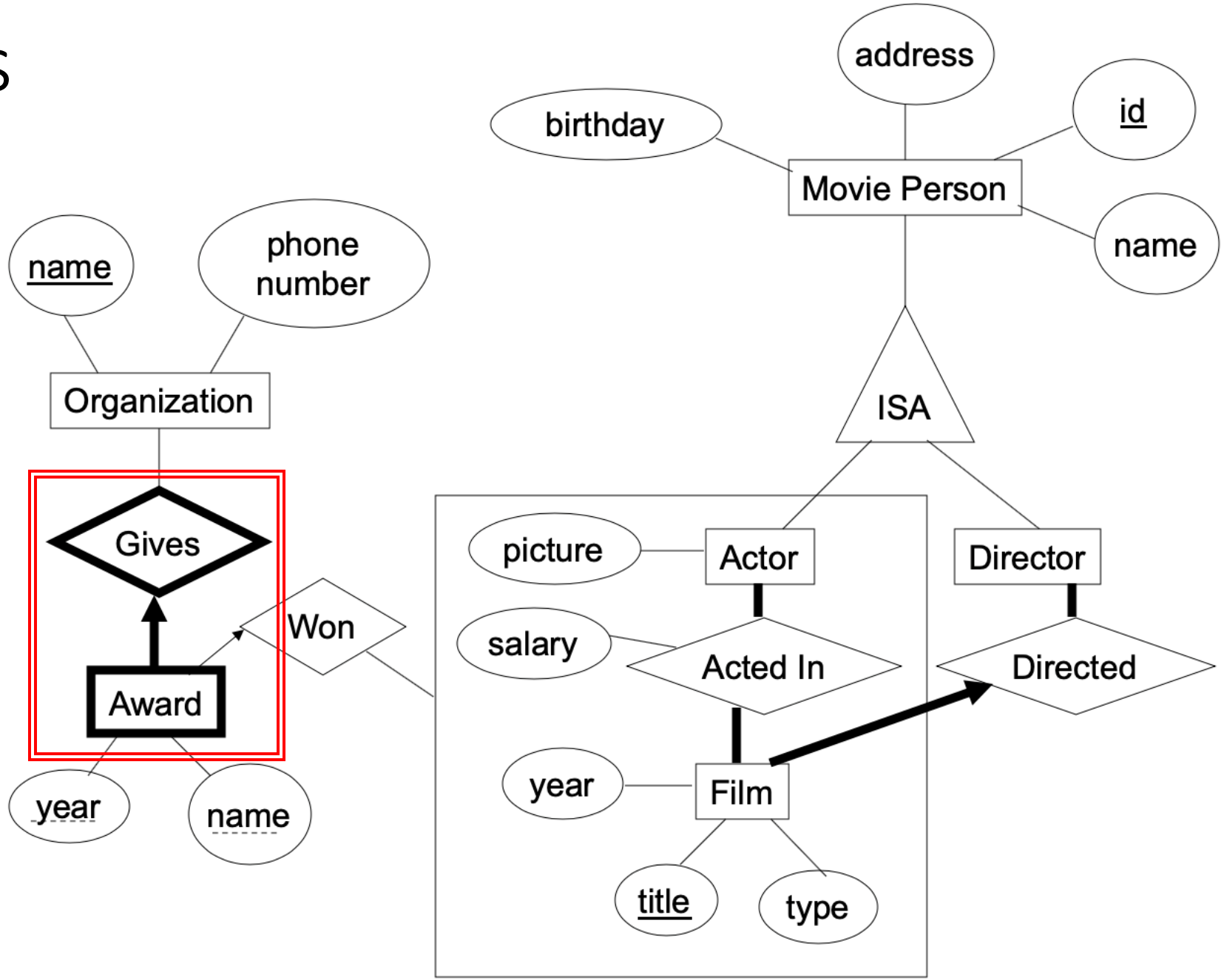


A film has exactly one director.

A director manages at least one film.

Weak Entity Sets

- Weak entity sets are entity sets that are not uniquely identified by their attributes
- A weak entity set has an "identifying relationship“ with an entity set that is the "identifying owner“ of the weak entity set

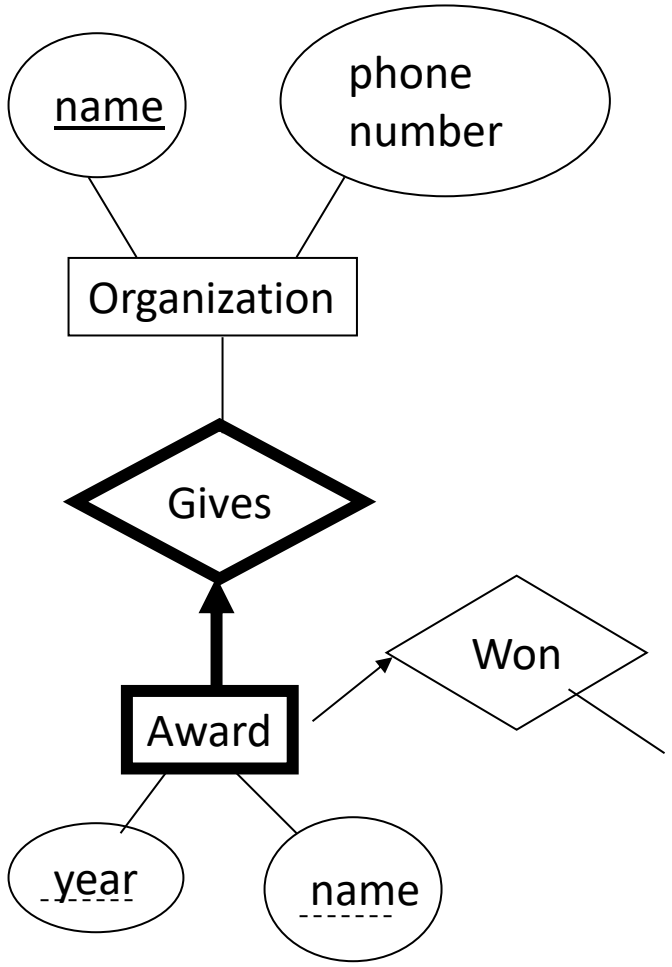


Weak Entity Sets

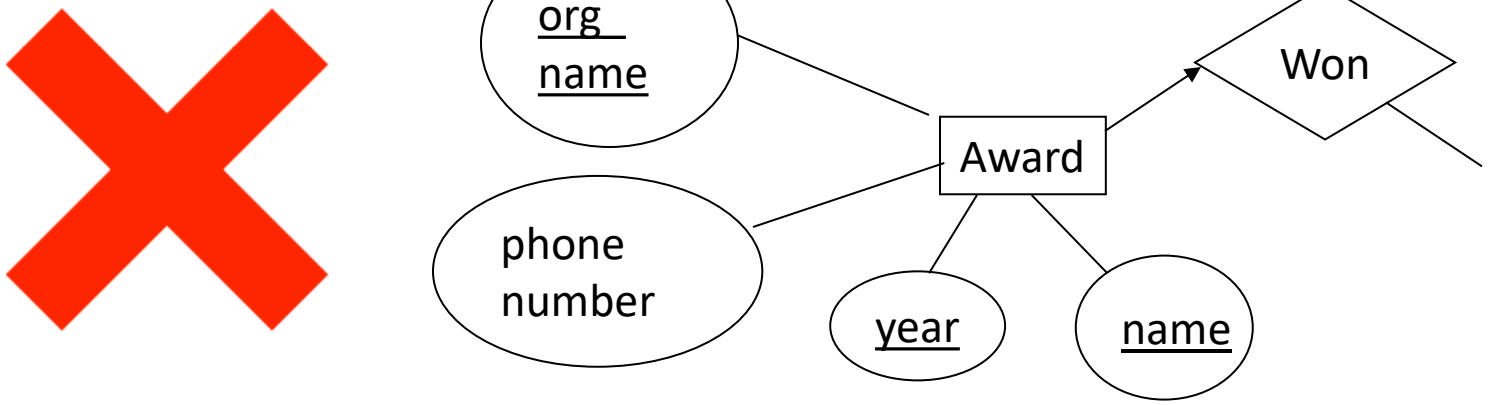
A weak entity set must:

- participate at least once in the identifying relationship (✎ a thick line)
- participate at most once with the identifying owner (✎ an arrow)

✎ Weak entity sets have a thick rectangle, their keys are underlined with a broken line, and the identifying relationship has a thick diamond

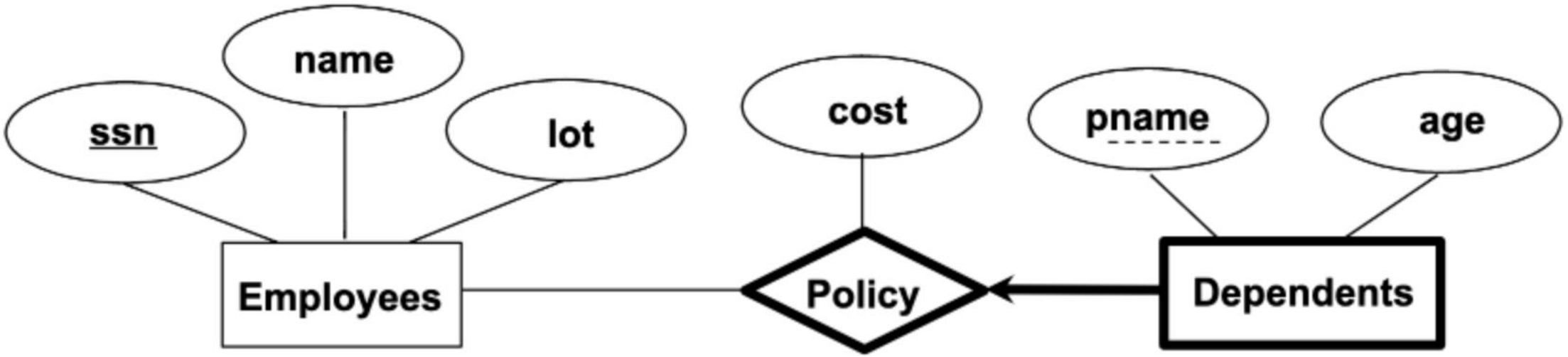


Why Not:

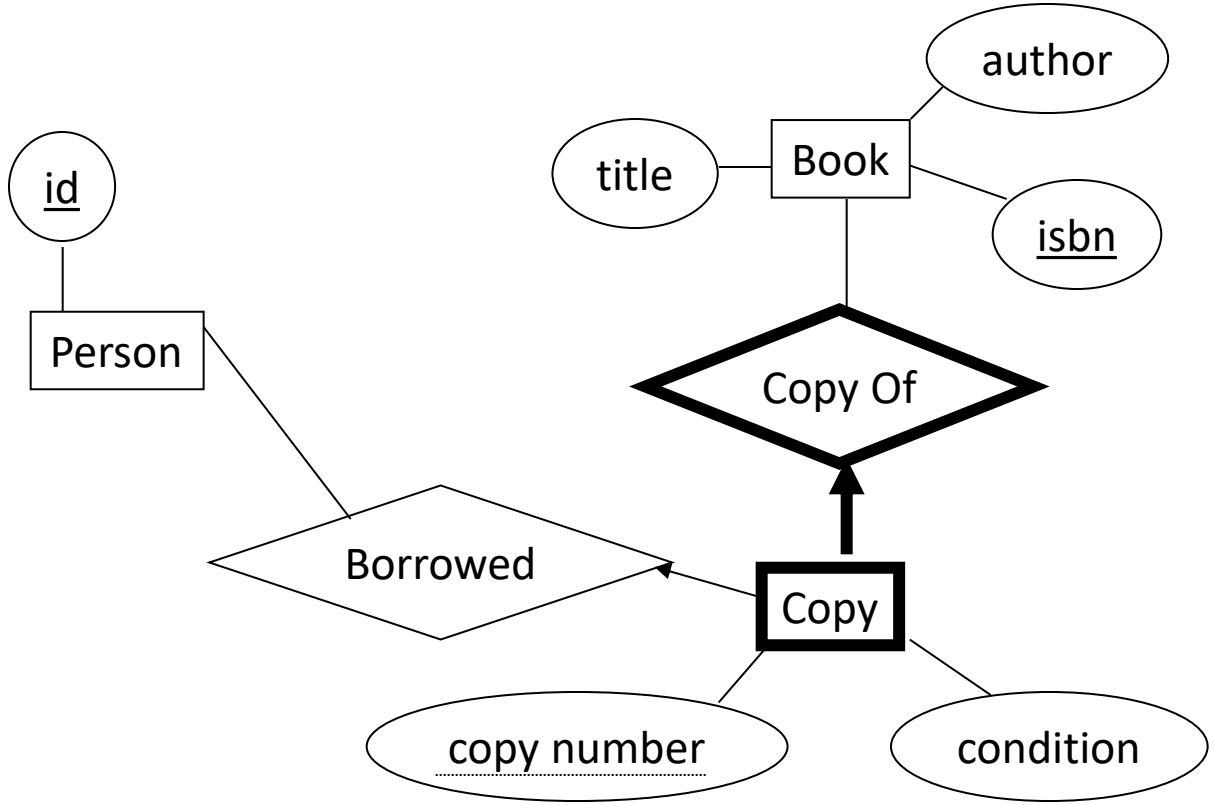


- Other relationships with the entity set organization
- They are inherently two different entities

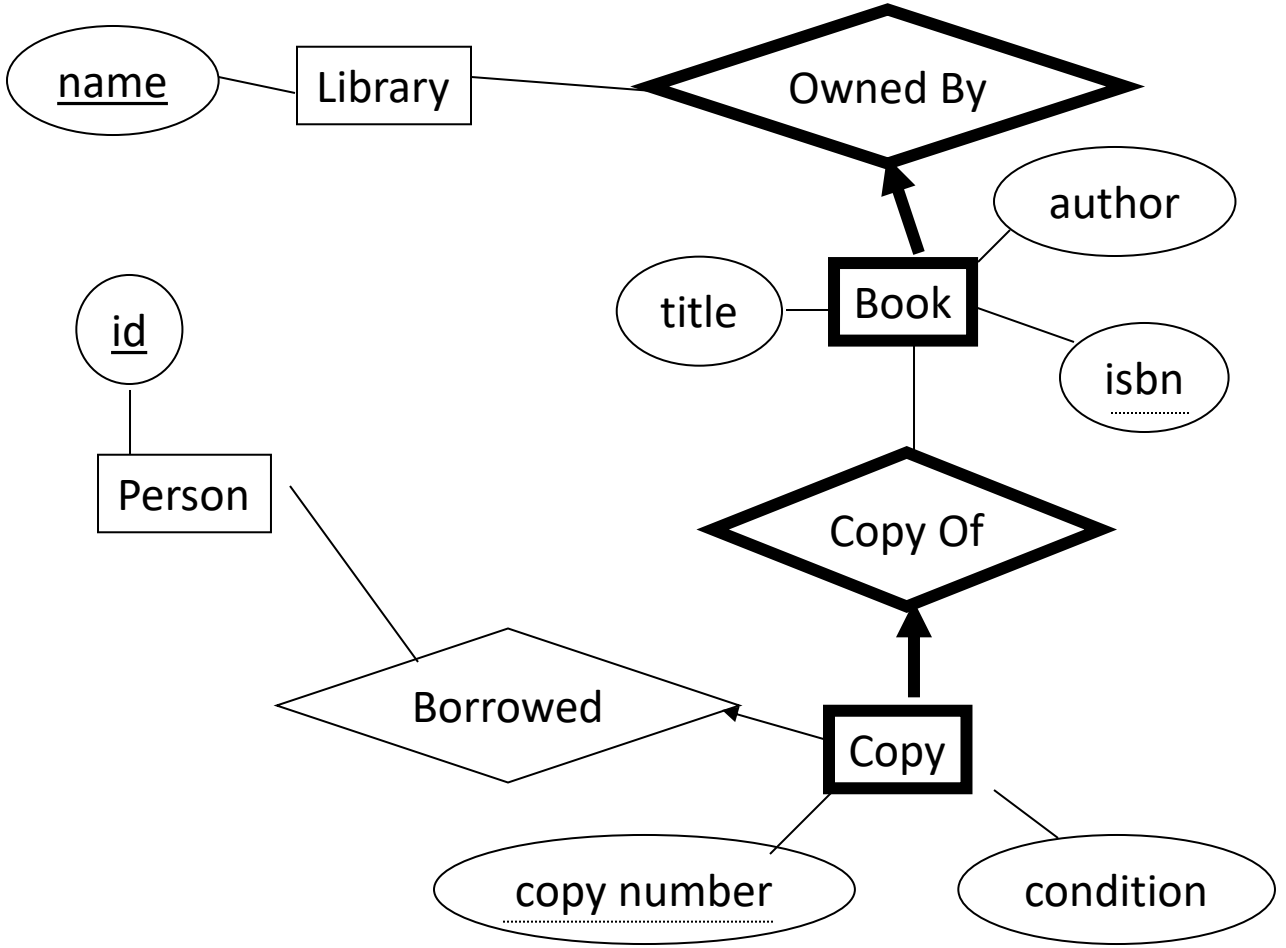
Example



Example


author
id
title
Book
isbn
Person
Copy Of
Borrowed
Copy
copy number
condition

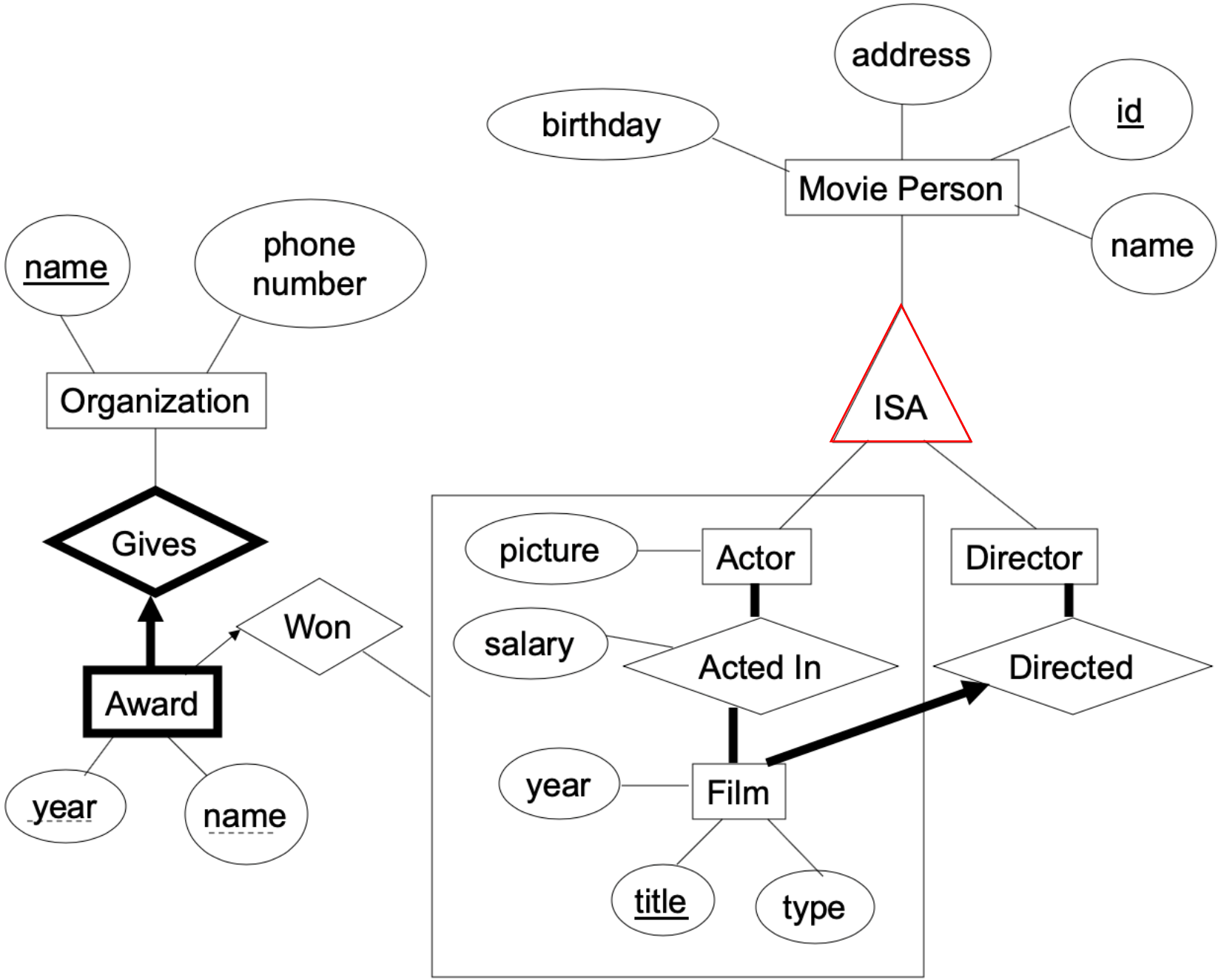
What if We Store Information About Many Libraries?



ISA Hierarchies

ISA Relationships:
Define a hierarchy between entity sets

- ISA is similar to inheritance
- ISA relationships are drawn as a triangle with the word ISA inside it. The "super entity-set" is above the triangle and the "sub entity-sets" are below



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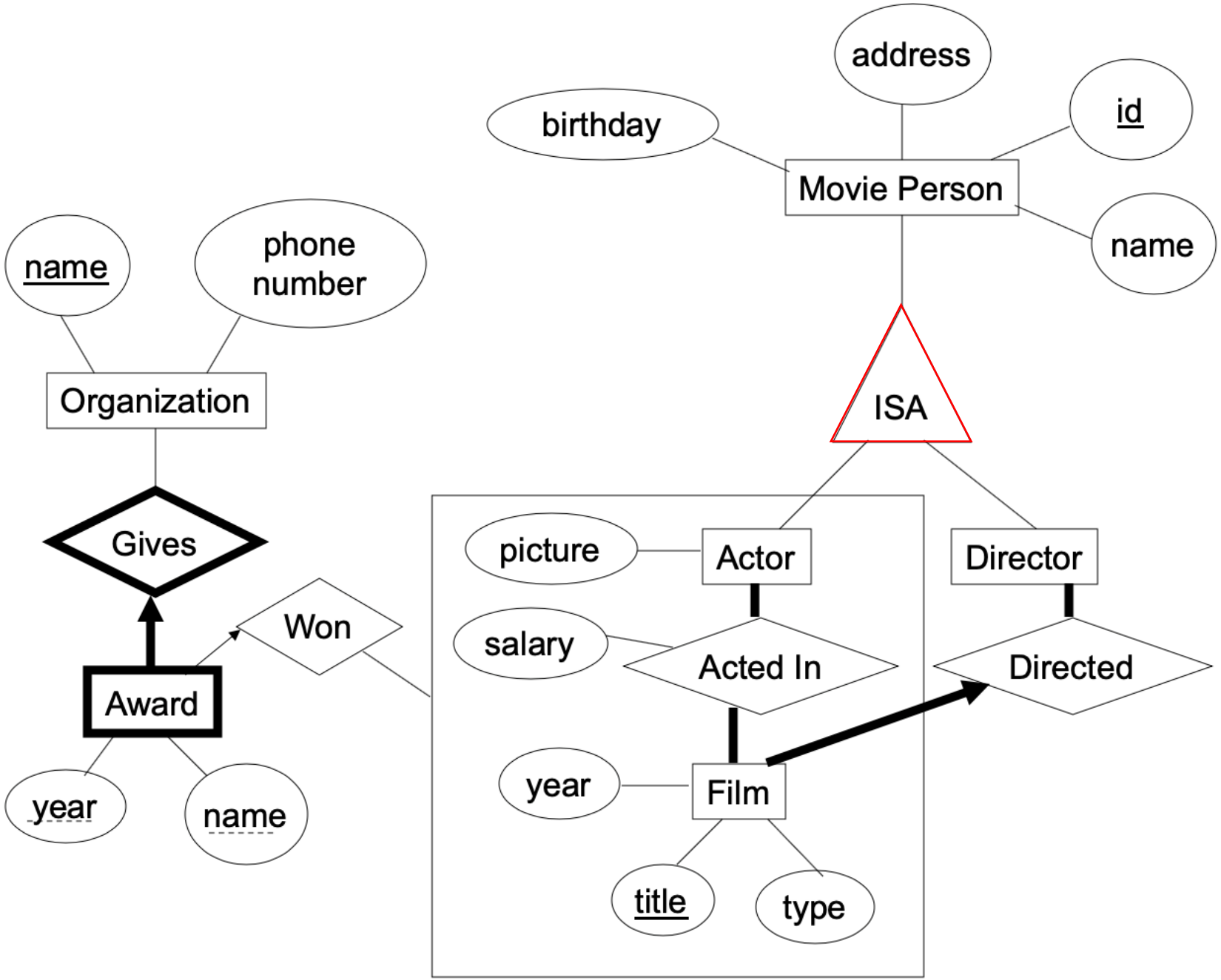
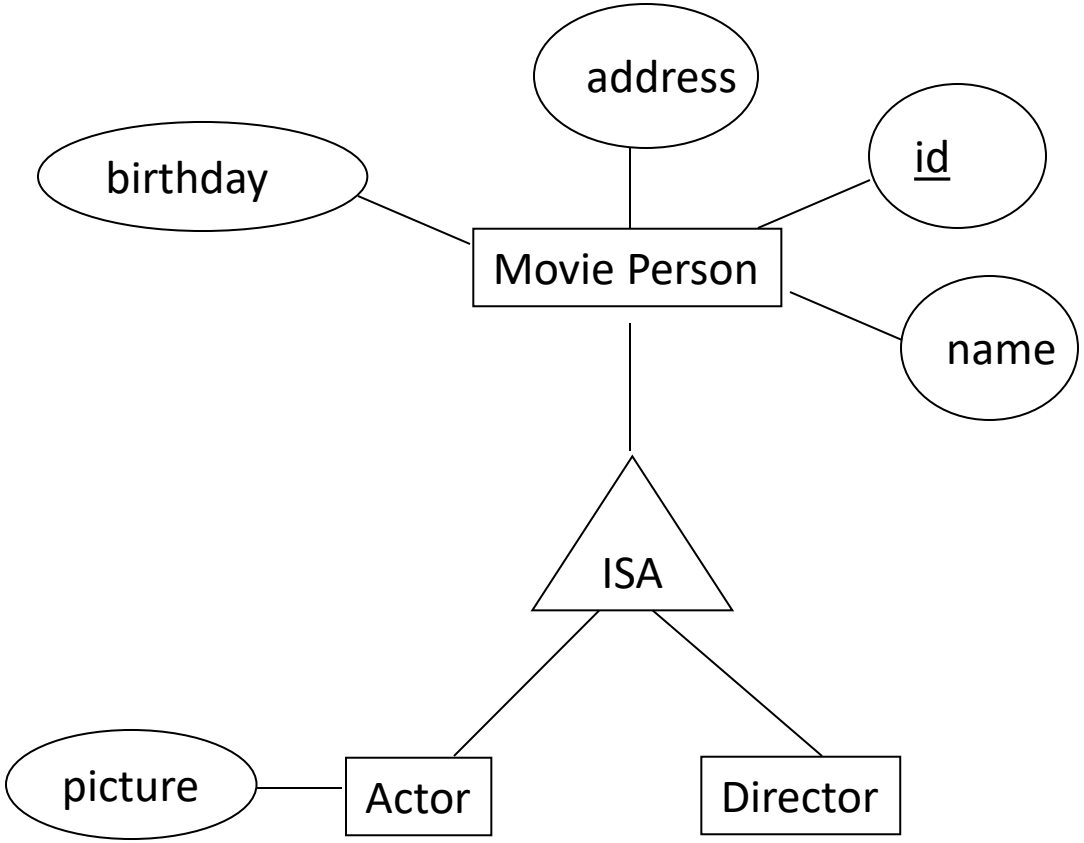


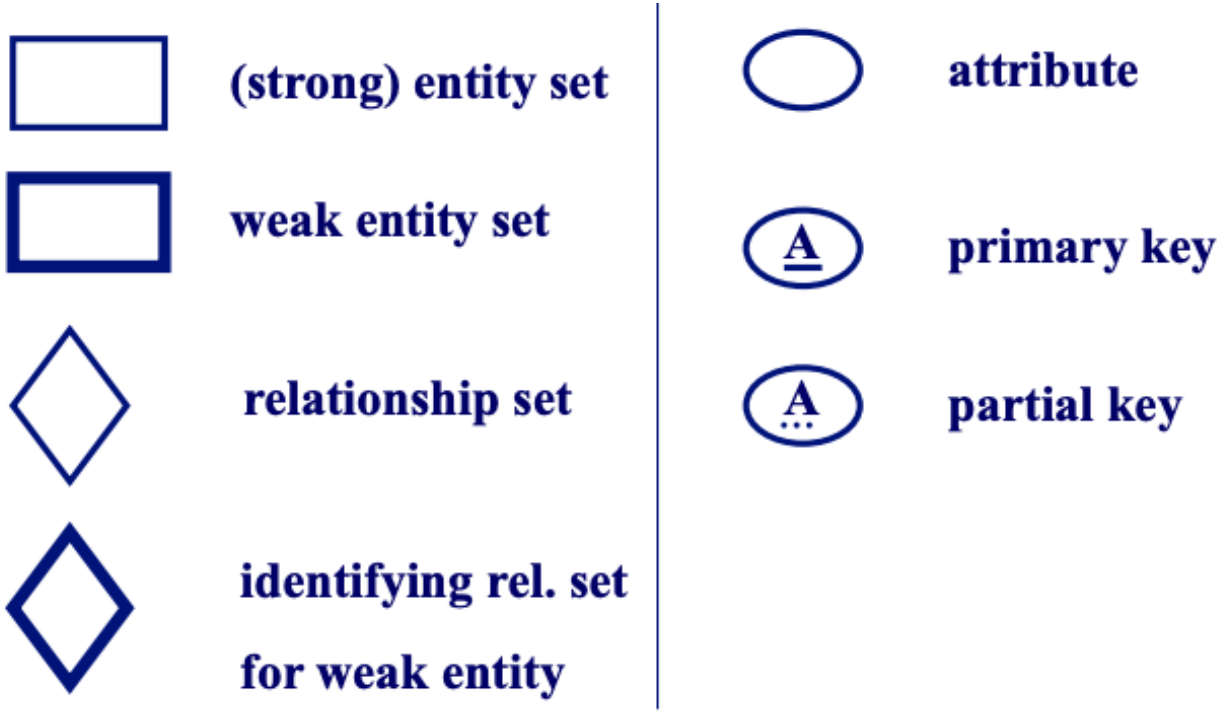
Example



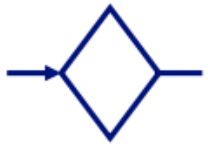
What are the keys of:

1. Movie Person
2. Actor
3. Director

Wrap-up


(strong) entity set
weak entity set
relationship set
identifying rel. set
for weak entity
attribute
A
primary key
A
partial key

Wrap-up

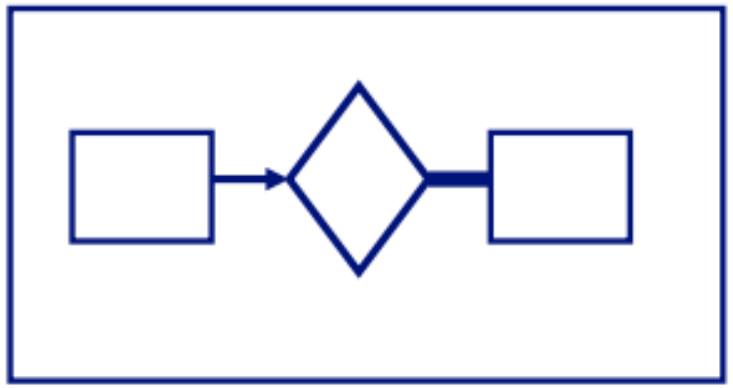


cardinalities

partial/total

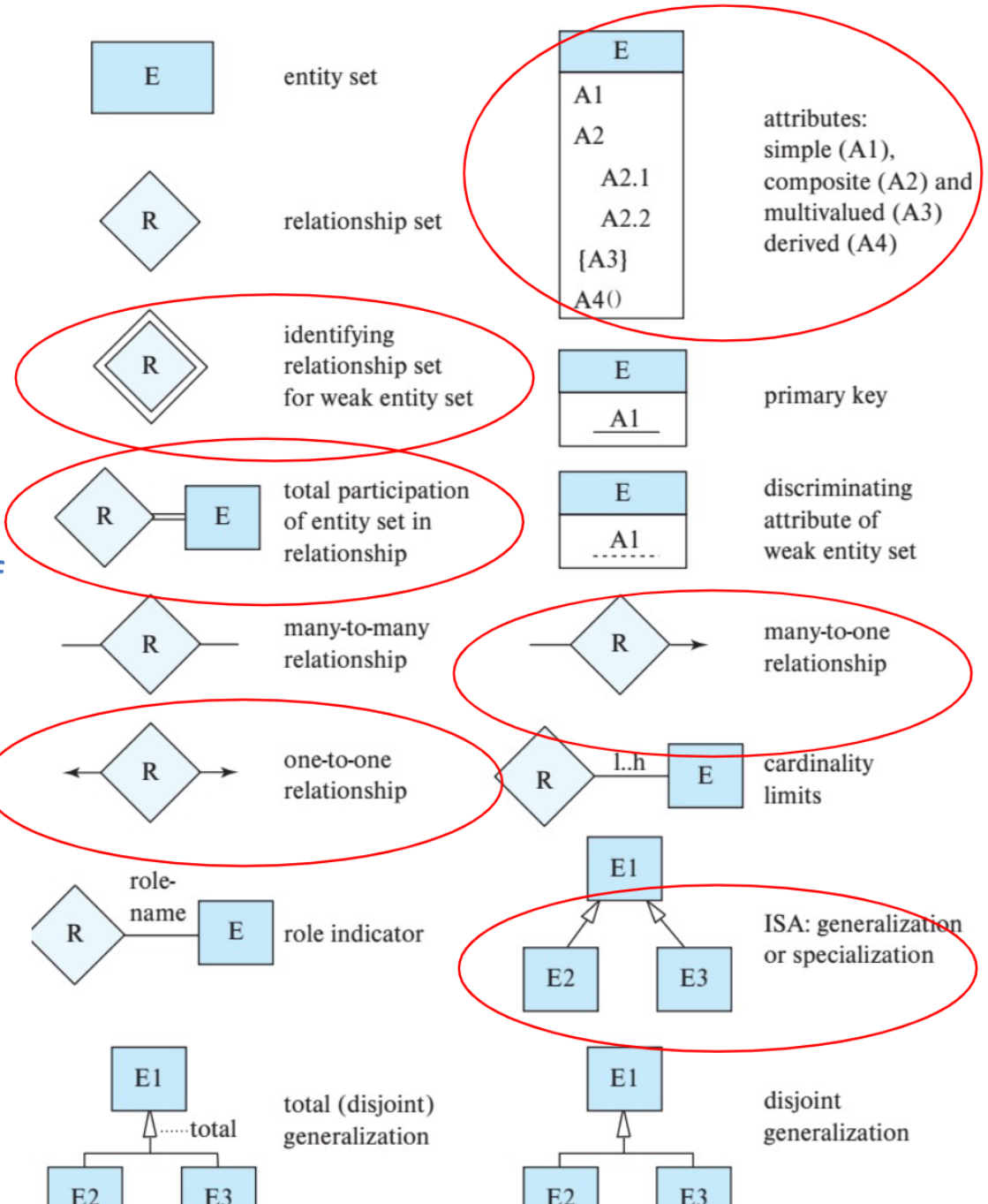
Wrap-up

IS-A



aggregation

SKS notation



Difference 1: UML style attributes

Difference 2: double diamond for weak entity set instead of bold diamond

Difference 3: double line for total participation instead of bold line

Difference 4: outward arrows for key constraints instead of inward arrows

Difference 5: empty arrows for inheritance instead of a triangle containing text ISA