CS 464/564
Introduction to Database Management System
Instructor: Abdullah Mueen

LECTURE 2: E/R MODEL

Purpose of E/R Model

The E/R model allows us to sketch database designs.

- Kinds of data and how they connect.
- Not how data changes.

Designs are pictures called *entity-relationship diagrams*.

Later: convert E/R designs to relational DB designs.

Entity Sets

Entity = "thing" or object.

Entity set = collection of similar entities.

- Similar to a class in object-oriented languages.

Attribute = property of (the entities of) an entity set.

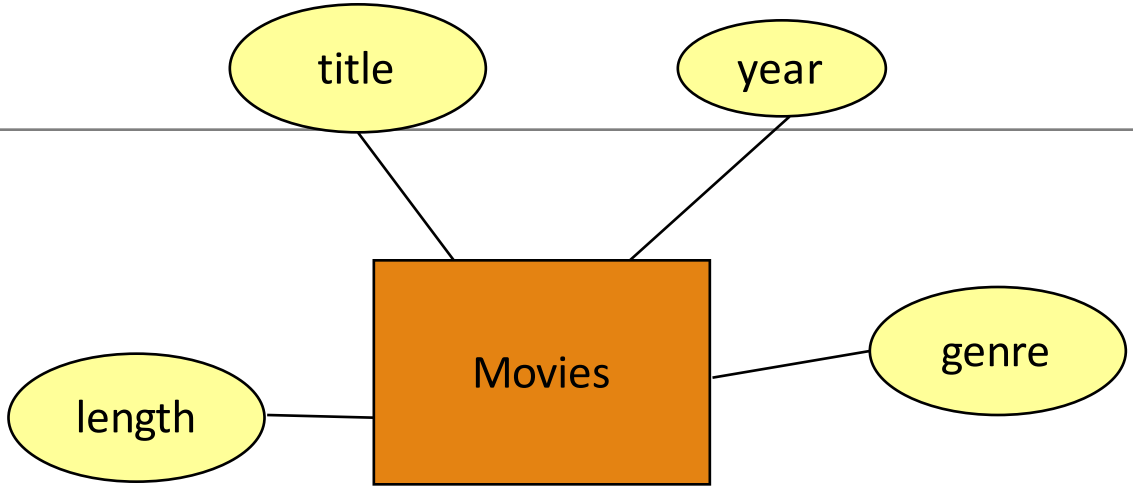
- Attributes can be
  - Basic data types, e.g. integers or characters.
  - Structure of various data types
  - Array of structures or data types

E/R Diagrams

In an entity-relationship diagram:

- Entity set = rectangle.
- Attribute = oval, with a line to the rectangle representing its entity set.

Example



Entity set movies has four attributes

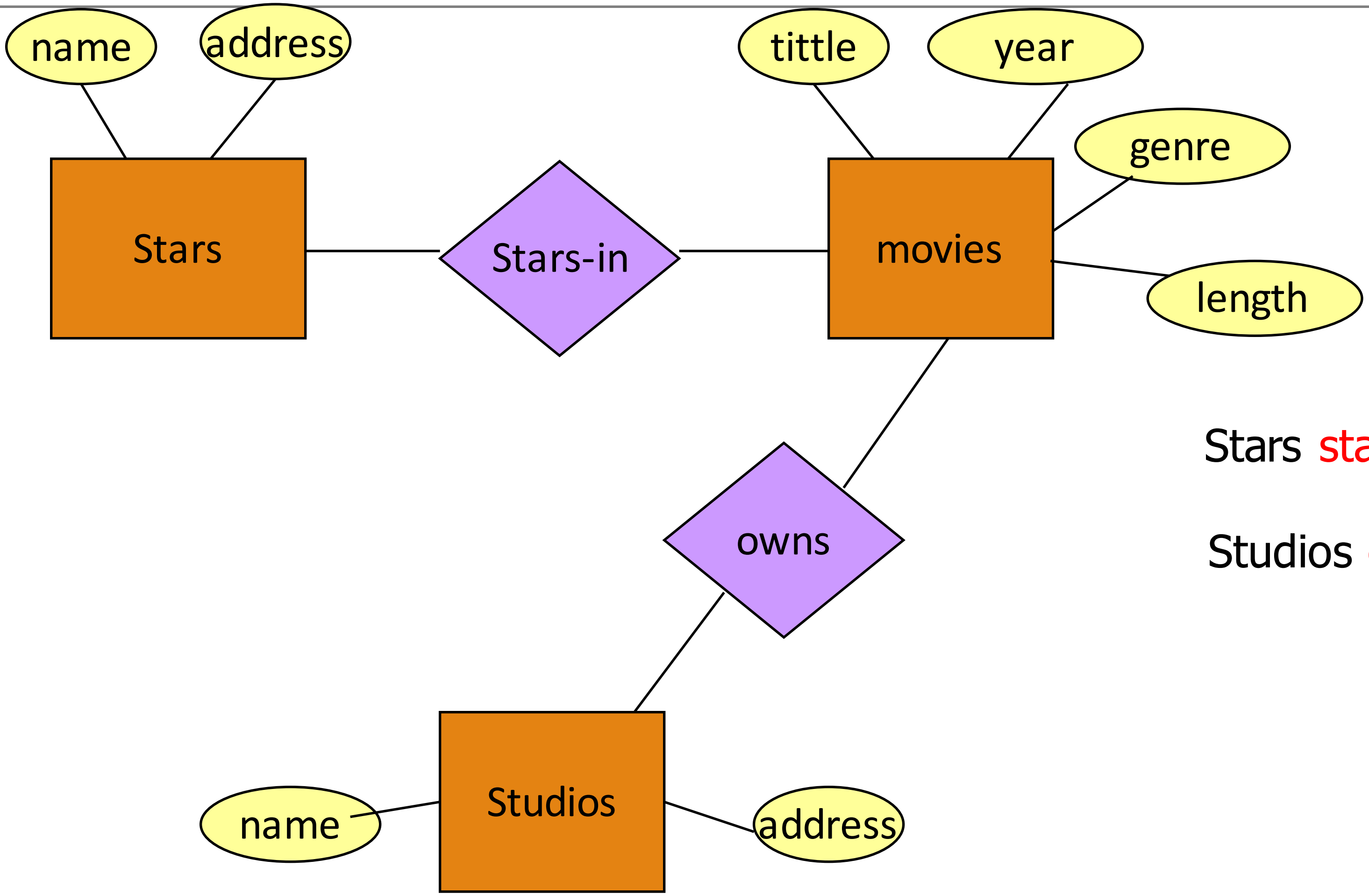
Each movies entity has values for these attributes, e.g. (Forrest Gump, 1994, Drama,142 minutes)

Relationships

A relationship connects two or more entity sets.

It is represented by a diamond, with lines to each of the entity sets involved.

Example



Stars star-in movies

Studios own movies

Relationship Set

The current "value" of an entity set is the set of entities that belong to it.

- Example: the set of all departments in our database.

The "value" of a relationship is a set of lists of currently related entities with all their attributes, one from each of the related entity sets.

Example

For the relationship stars-in, we might have a relationship set like:

Movies	Stars
Forrest Gump	Tom Hanks
Titanic	Kate Winslet
Terminator-2	Arnold Schwarzenegger
Titanic	Leonardo DiCaprio

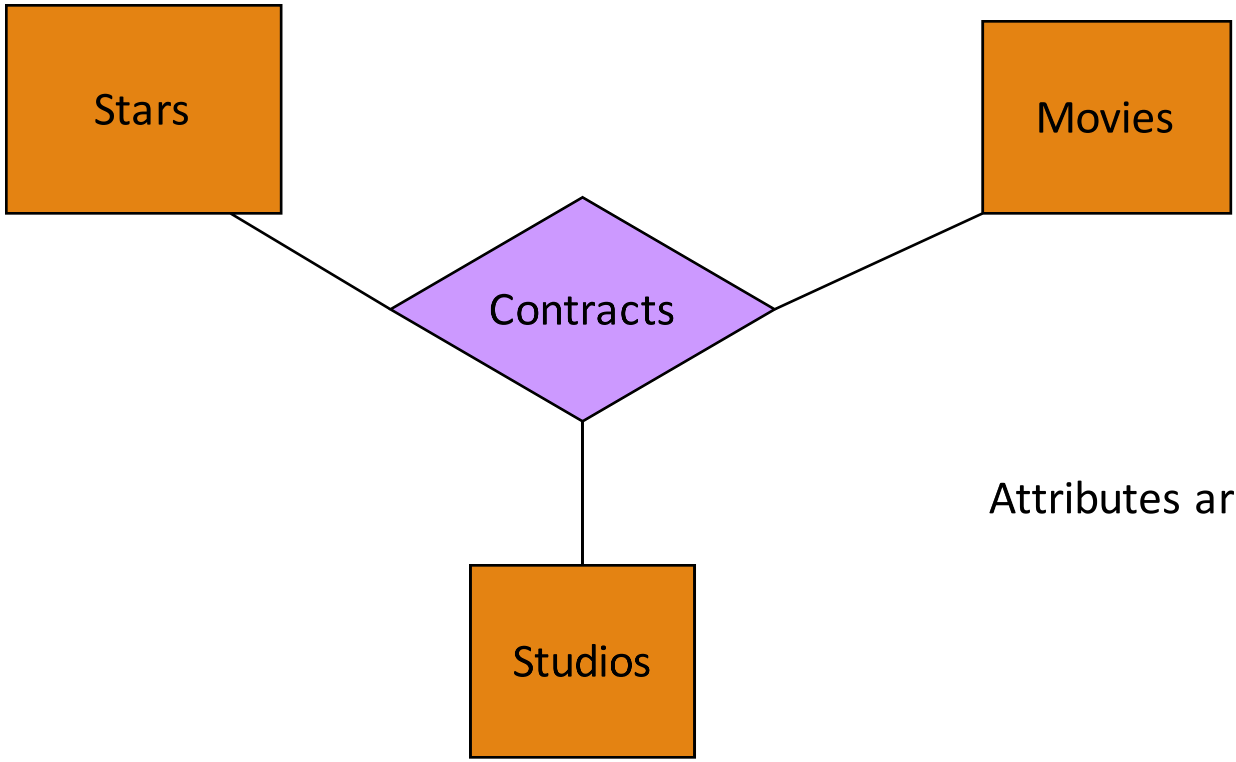
Multiway Relationships

Sometimes, we need a relationship that connects more than two entity sets.

Suppose that a studio will only employ certain stars at certain movies.

- Our two binary relationships stars-in, and owns do not allow us to make this distinction.
- But a 3-way relationship would.

Example



Attributes are omitted for simplicity

A Multi-way Relationship Set

Movies	Stars	Studios
PIRATES OF THE CARIBBEAN	Johnny Depp	Disney
Toy Story	Tom Hanks	Pixar

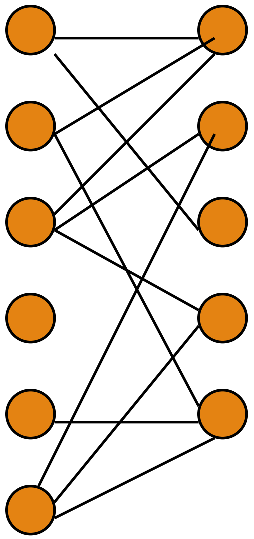
Many-Many Relationships

Focus: binary relationships, such as stars-in between Movies and Stars.

In a *many-many* relationship, an entity of either set can be connected to many entities of the other set.

- E.g., many stars work in a movie; a star works in many movies.

In Pictures:



many-many

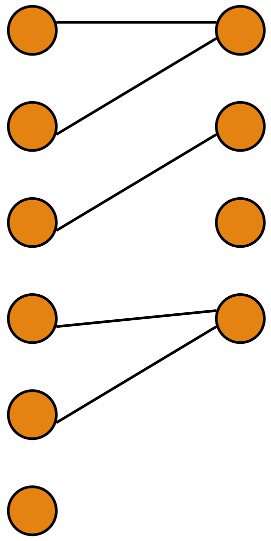
Many-One Relationships

Some binary relationships are *many -one* from one entity set to another.

Each entity of the first set is connected to at most one entity of the second set.

But an entity of the second set can be connected to zero, one, or many entities of the first set.

In Pictures:



many-one

Example

Manages, from Employees to Managers is many-one.

Typically, an employee has at most one manager.

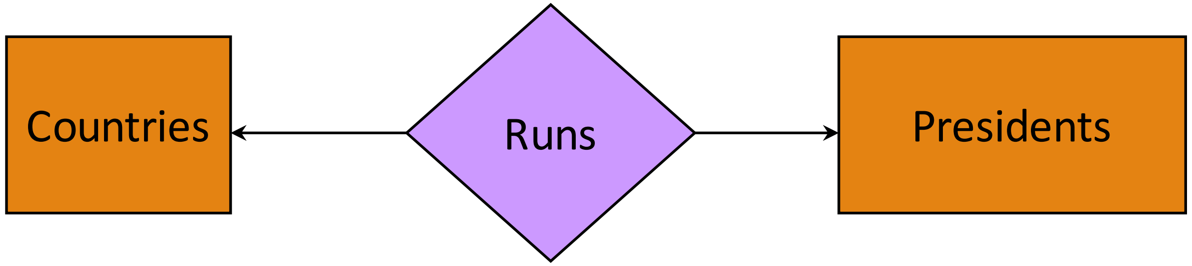
But a manager can have any number of employees working for him/her.

One-One Relationships

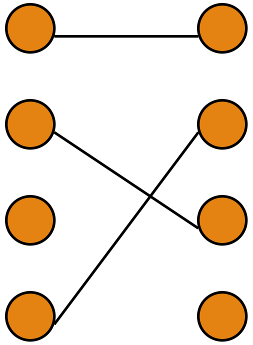
In a *one-one* relationship, each entity of either entity set is related to at most one entity of the other set.

Example: Relationship Runs between entity sets Countries and Presidents.

- A president cannot run zero or more than one countries, and a country can have at most one president.



In Pictures:



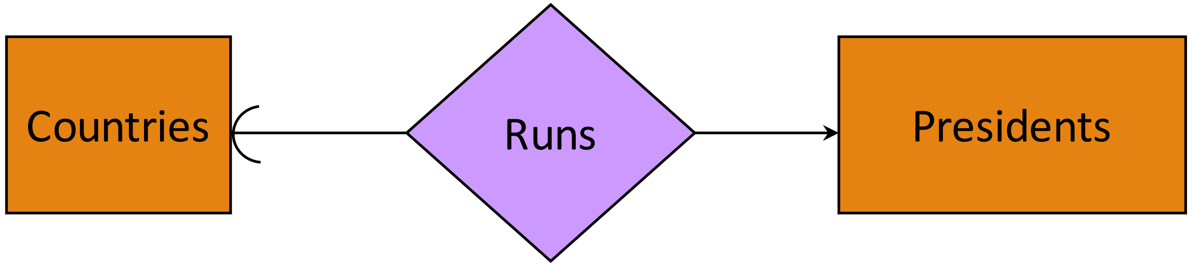
one-one

Representing “Multiplicity”

Show a many-one relationship by an arrow entering the “one” side.

Show a one-one relationship by arrows entering both entity sets.

Rounded arrow = “exactly one,” i.e., each entity of the first set is related to exactly one entity of the target set.

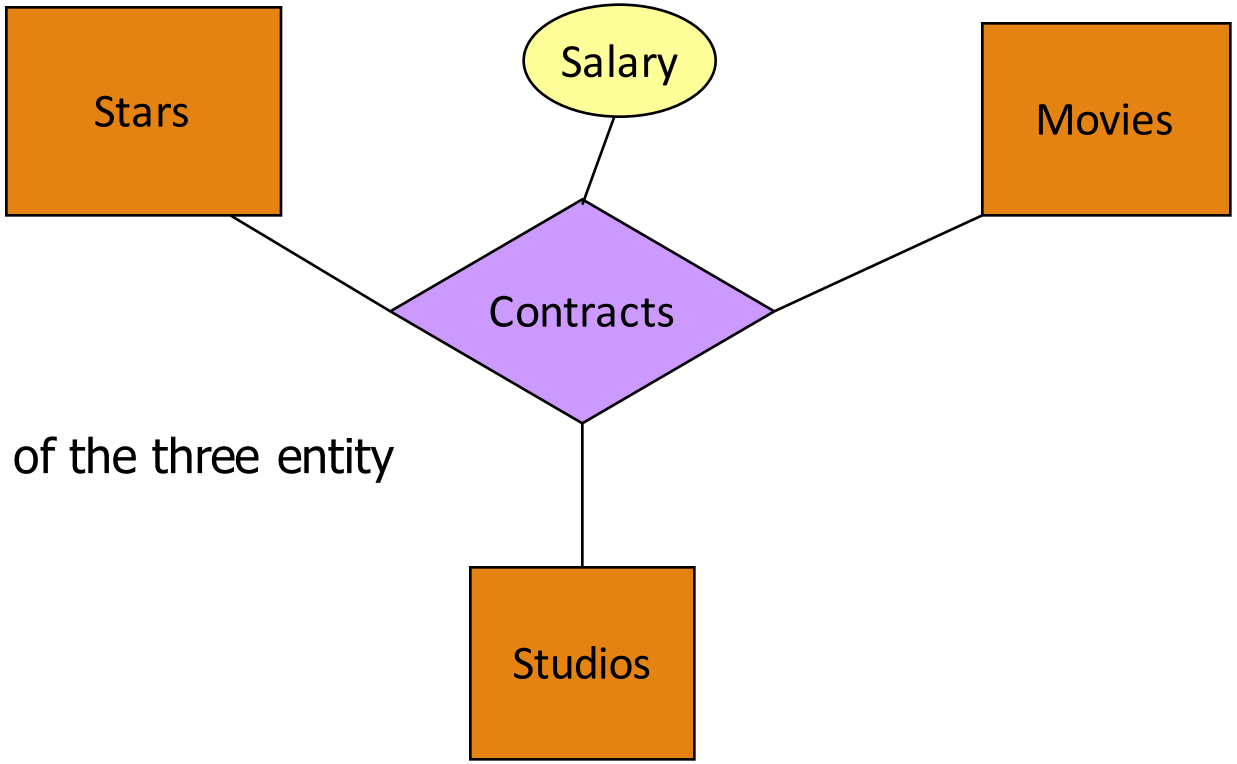


Attributes on Relationships

Sometimes it is useful to attach an attribute to a relationship.

Think of this attribute as a property of tuples in the relationship set.

Example



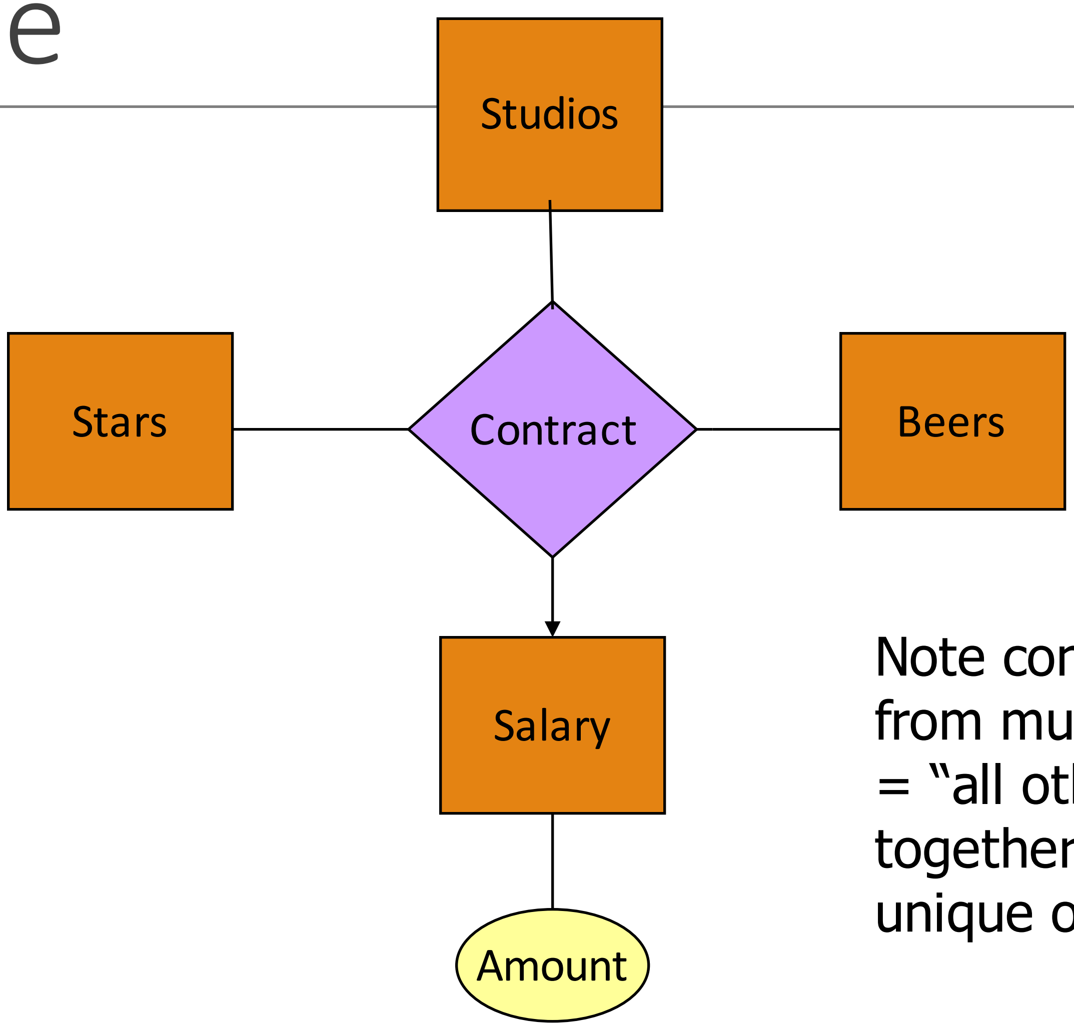
Salary is a function of all of the three entity

Equivalent Diagrams Without Attributes on Relationships

Create an entity set representing values of the attribute.

Make that entity set participate in the relationship.

Example



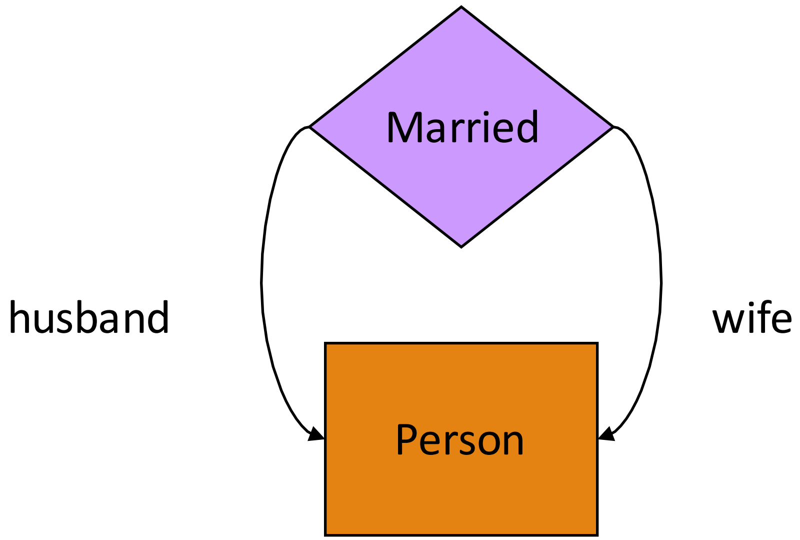
Note convention: arrow from multiway relationship = "all other entity sets together determine a unique one of these."

Roles

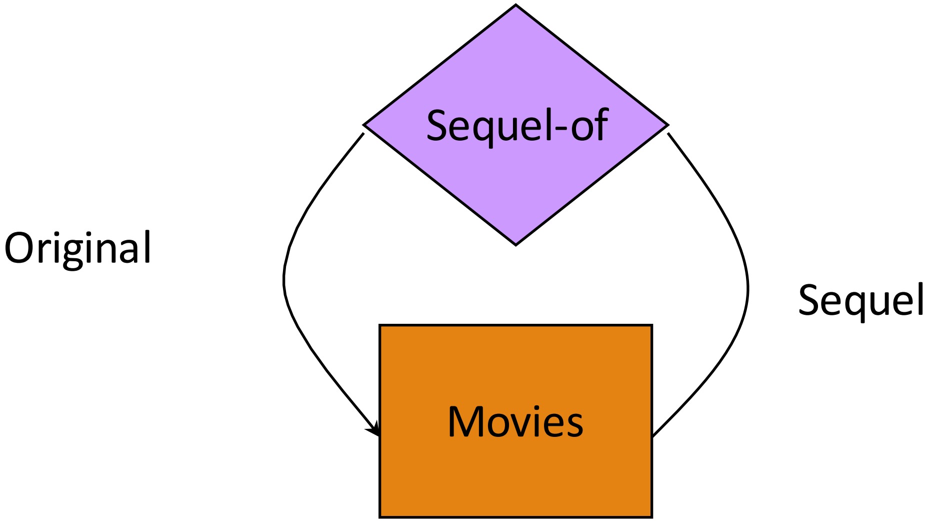
Sometimes an entity set appears more than once in a relationship.

Label the edges between the relationship and the entity set with names called *roles*.

Example



Example



Subclasses

Subclass = special case = fewer entities = more properties.

Example: Ales are a kind of beer.

- Not every beer is an ale, but some are.
- Let us suppose that in addition to all the *properties* (attributes and relationships) of beers, ales also have the attribute color.

Subclasses in E/R Diagrams

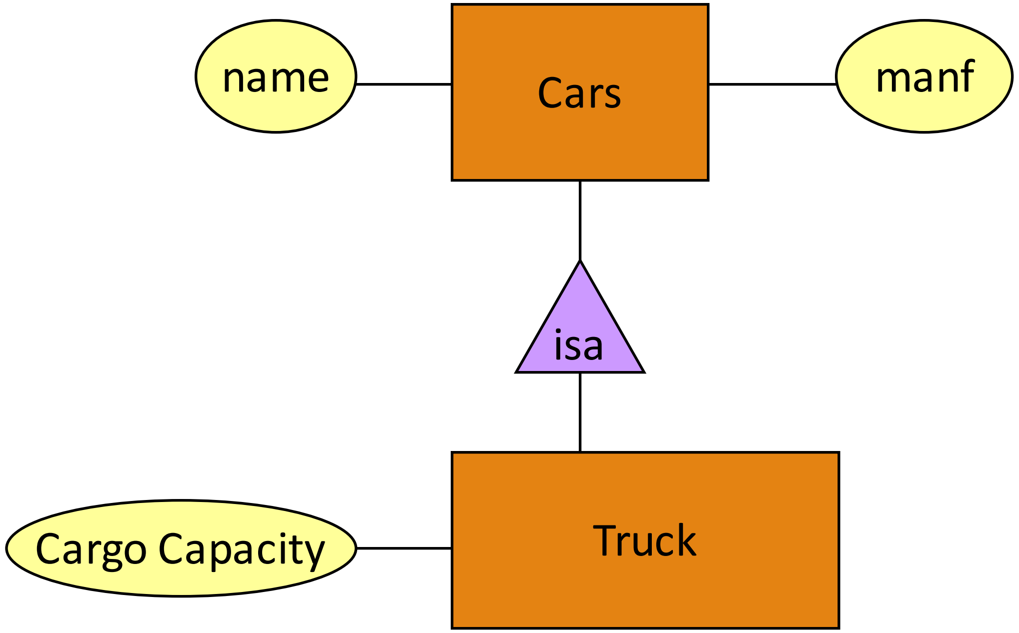
Assume subclasses form a tree.

- I.e., no multiple inheritance.

IsA triangles indicate the subclass relationship.

- Point to the superclass.

Example



E/R Vs. Object-Oriented Subclasses

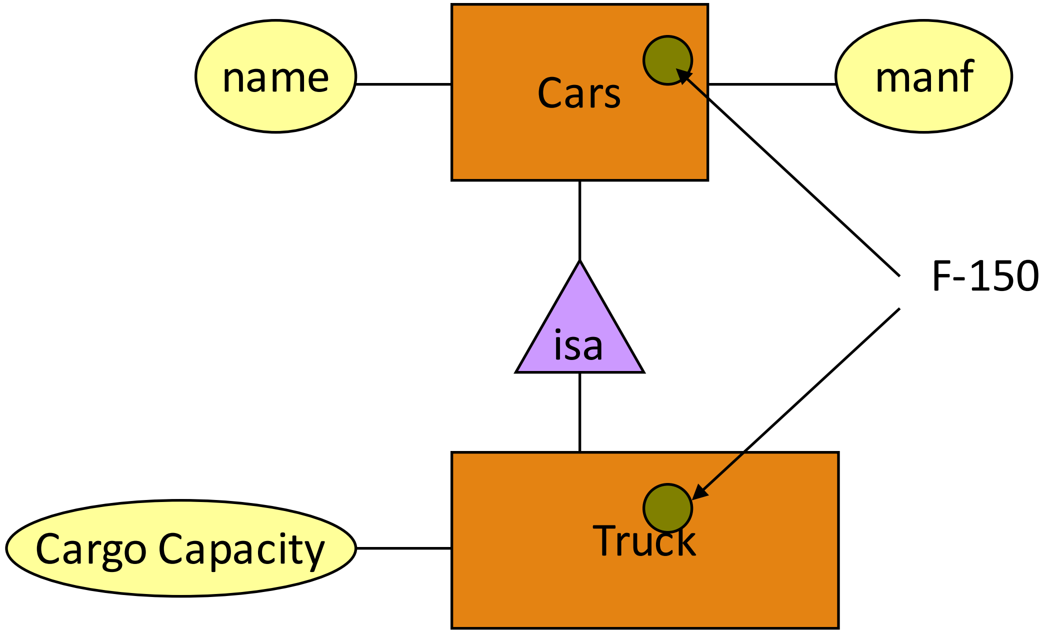
In OO, objects are in one class only.

- Subclasses inherit from superclasses.

In contrast, E/R entities have representatives in all subclasses to which they belong.

- Rule: if entity *e* is represented in a subclass, then *e* is represented in the superclass.

Example



Keys

A *key* is a set of attributes for one entity set such that no two entities in this set agree on all the attributes of the key.

- It is allowed for two entities to agree on some, but not all, of the key attributes.

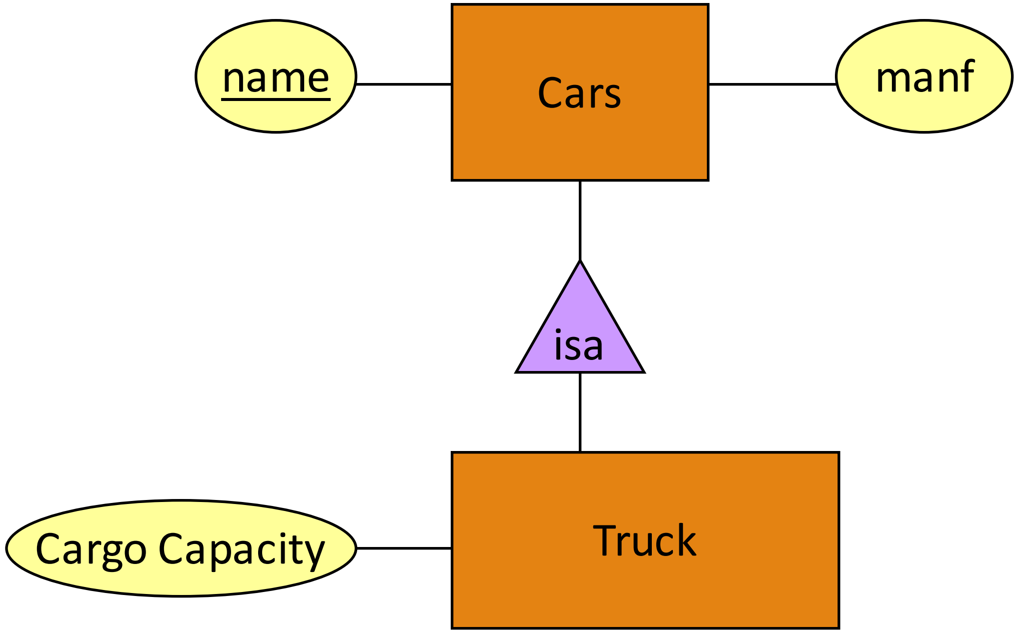
We must designate a key for every entity set.

Keys in E/R Diagrams

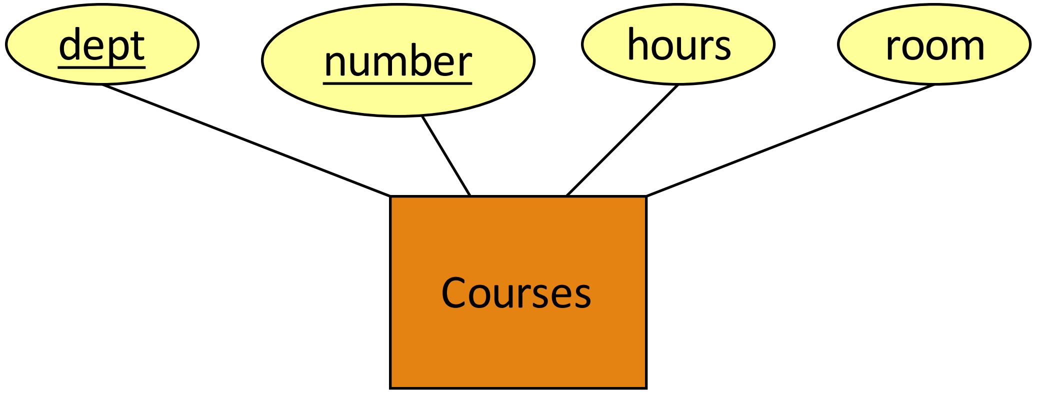
Underline the key attribute(s).

In an Isa hierarchy, only the root entity set has a key, and it must serve as the key for all entities in the hierarchy.

Example: name is Key for Cars



Example: a Multi-attribute Key



- Note that hours and room could also serve as a key, but we must select only one key.

Weak Entity Sets

Occasionally, entities of an entity set need “help” to identify them uniquely.

Entity set *E* is said to be *weak* if in order to identify entities of *E* uniquely, we need to follow one or more many-one relationships from *E* and include the key of the related entities from the connected entity sets.

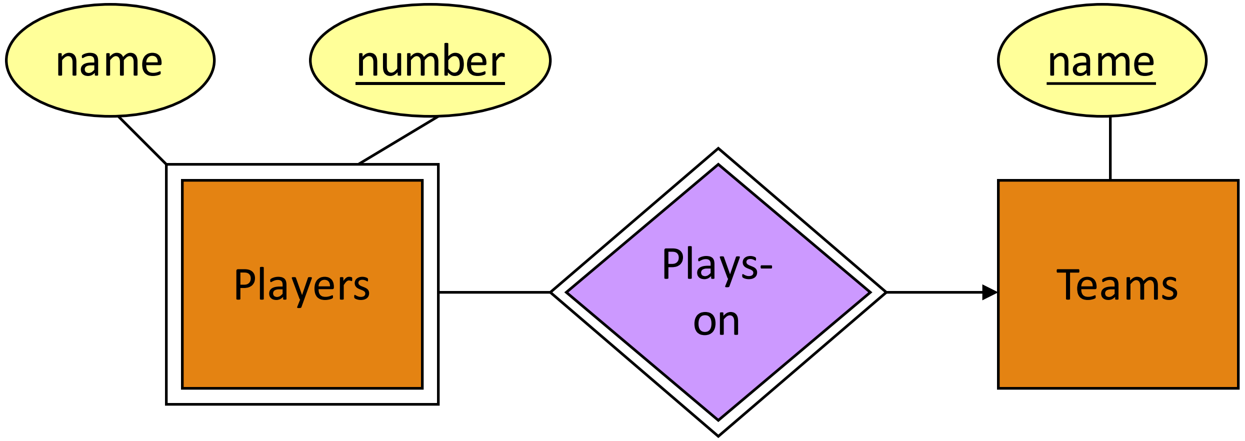
Example

name is almost a key for football players, but there might be two with the same name.

number is certainly not a key, since players on two teams could have the same number.

But number, together with the team name related to the player by Plays-on should be unique.

In E/R Diagrams



- Double diamond for *supporting* many-one relationship.
- Double rectangle for the weak entity set.

Weak Entity-Set Rules

A weak entity set has one or more many-one relationships to other (supporting) entity sets.

- Not every many-one relationship from a weak entity set need be supporting.

The key for a weak entity set is its own underlined attributes and the keys for the supporting entity sets.

- E.g., (player) number and (team) name is a key for Players in the previous example.

Design Techniques

1. Avoid redundancy.
2. Limit the use of weak entity sets.
3. Don’t use an entity set when an attribute will do.

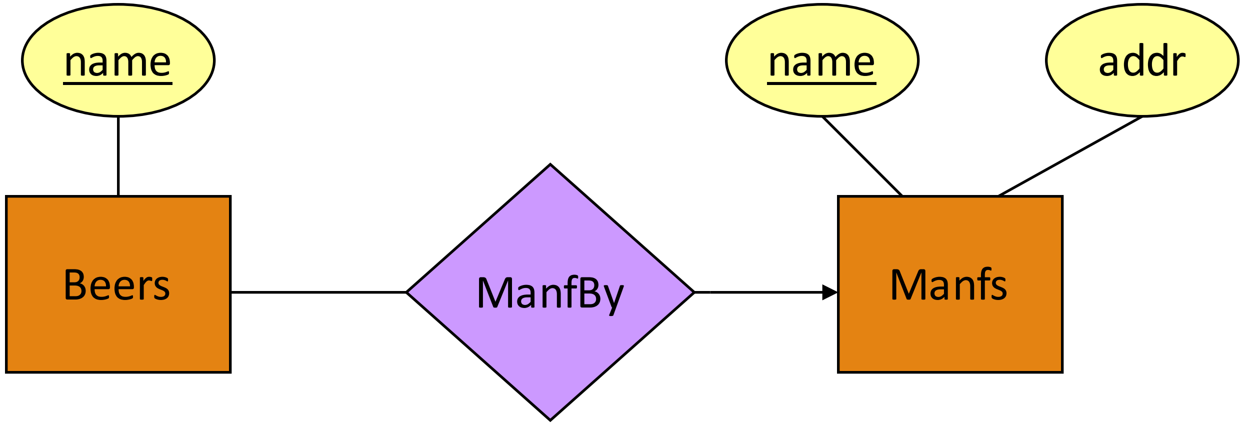
Avoiding Redundancy

Redundancy occurs when we say the same thing in two or more different ways.

Redundancy wastes space and (more importantly) encourages inconsistency.

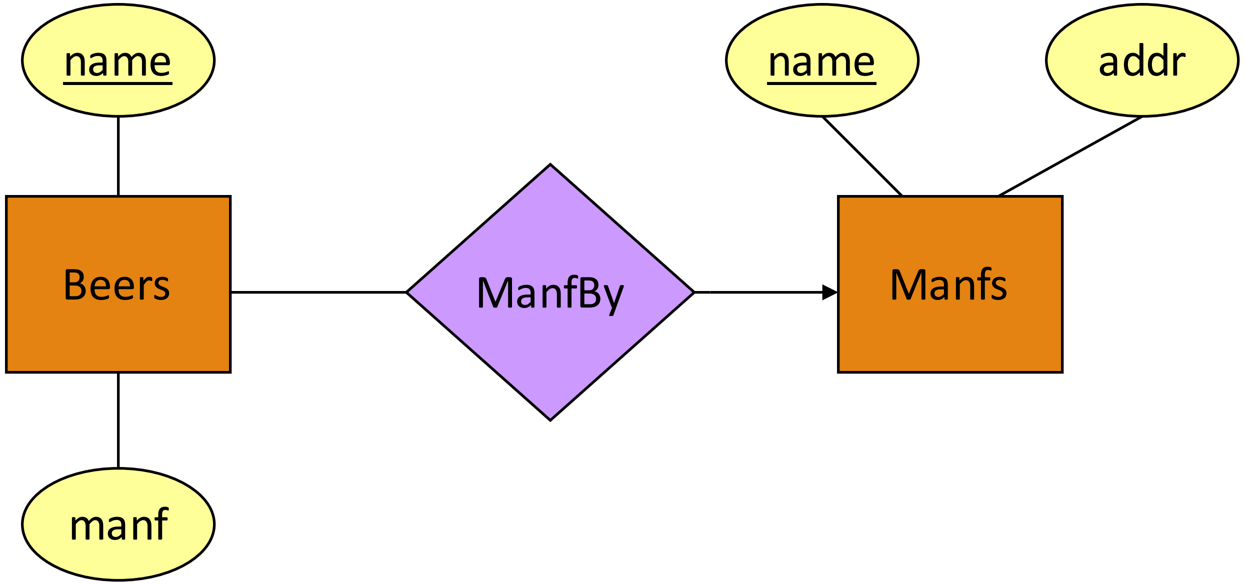
- The two instances of the same fact may become inconsistent if we change one and forget to change the other.

Example: Good



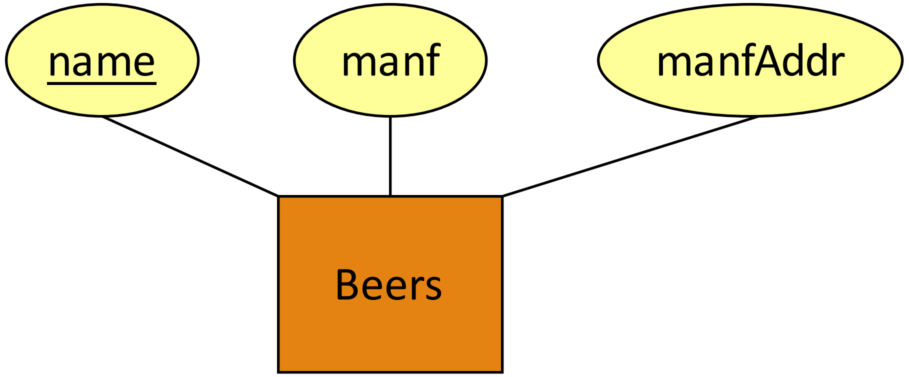
This design gives the address of each manufacturer exactly once.

Example: Bad



This design states the manufacturer of a beer twice: as an attribute and as a related entity.

Example: Bad



This design repeats the manufacturer's address once for each beer and loses the address if there are temporarily no beers for a manufacturer.

Entity Sets Versus Attributes

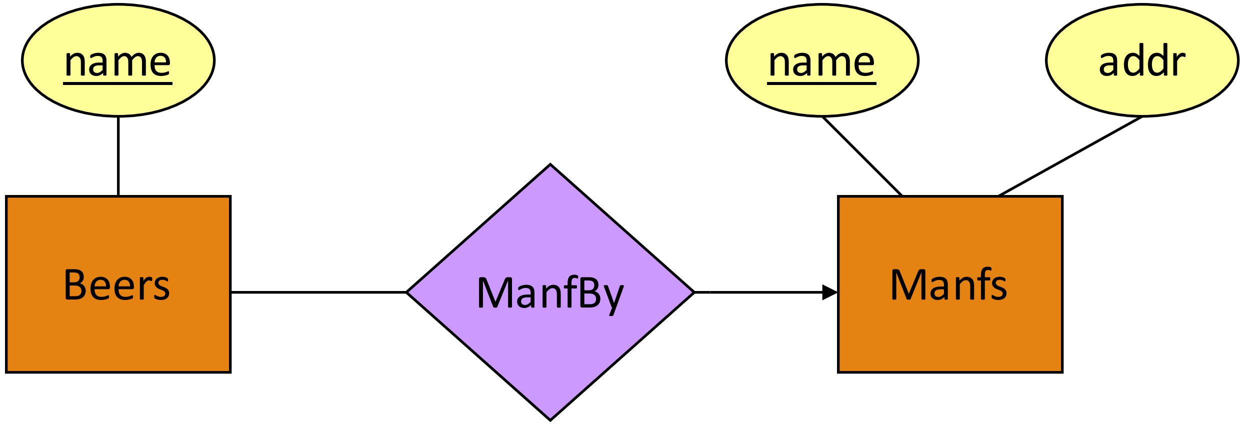
An entity set should satisfy at least one of the following conditions:

- It is more than the name of something; it has at least one nonkey attribute.

or

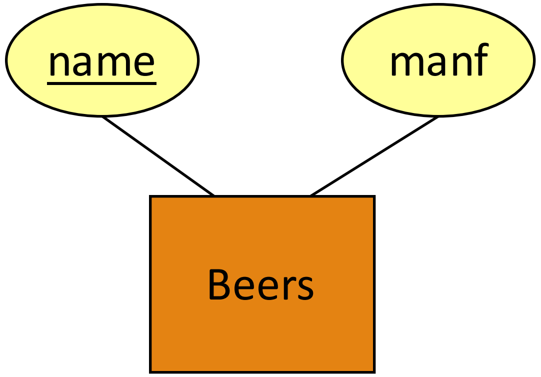
- It is the “many” in a many-one or many-many relationship.

Example: Good



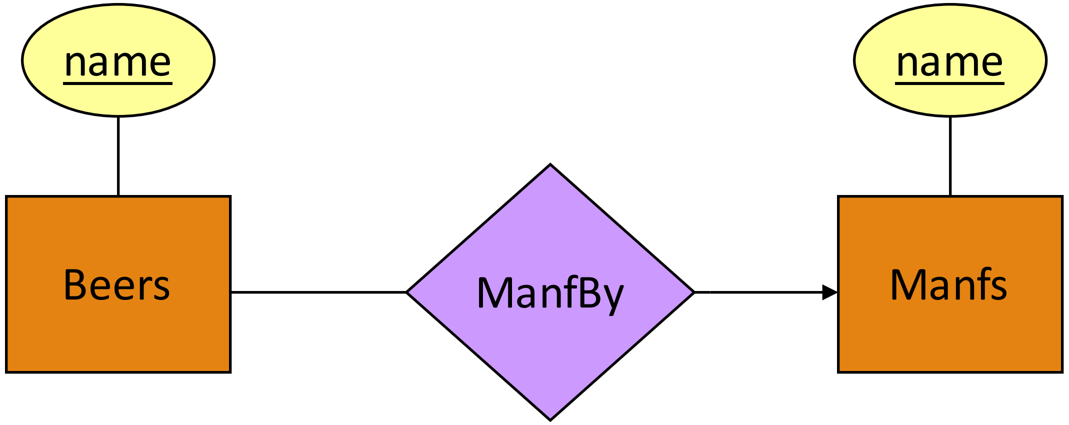
- Manfs deserves to be an entity set because of the nonkey attribute addr.
- Beers deserves to be an entity set because it is the "many" of the many-one relationship ManfBy.

Example: Good



There is no need to make the manufacturer an entity set, because we record nothing about manufacturers besides their name.

Example: Bad



Since the manufacturer is nothing but a name, and is not at the "many" end of any relationship, it should not be an entity set.

Don’t Overuse Weak Entity Sets

Beginning database designers often doubt that anything could be a key by itself.

- They make all entity sets weak, supported by all other entity sets to which they are linked.

In reality, we usually create unique ID’s for entity sets.

- Examples include social-security numbers, automobile VIN’s etc.