

By Marina Barsky

Entity-Relationship Model

Lecture 1

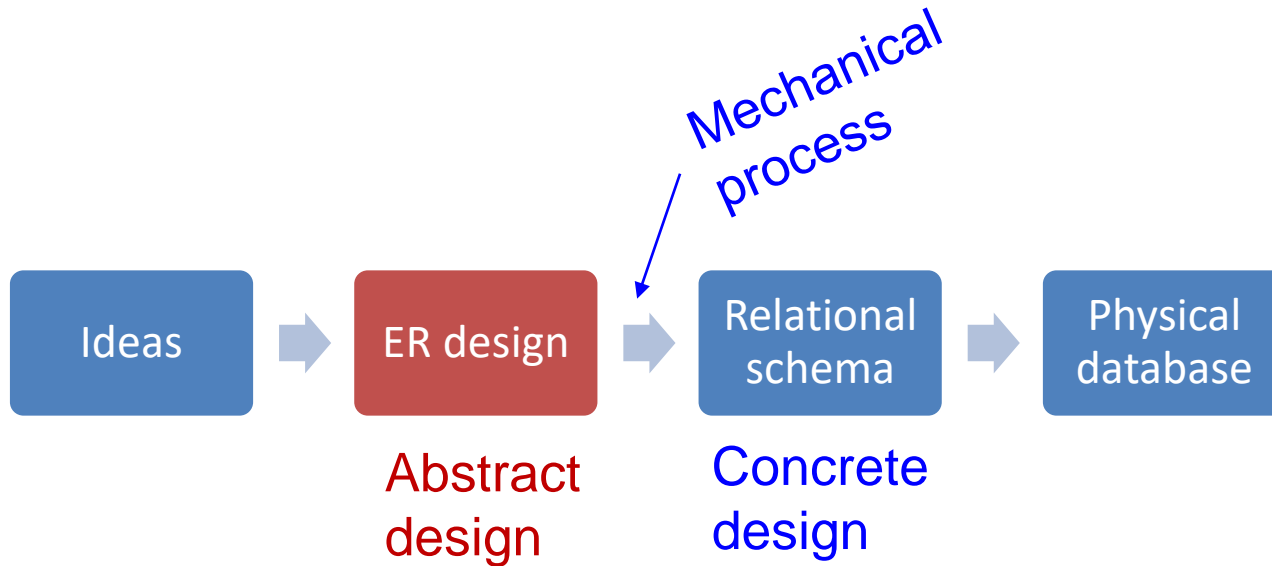
Useful definitions

- A *data model* is a collection of concepts for describing data.
- A *schema* is a description of a particular collection of data, using concepts of a given data model.
- A *database instance* is a collection of data compliant with the schema

Database Design

- **Designing** a database:
 - what **information** the database must hold, and
 - what **relationships** are there among components of that information.
- **Notation** for expressing designs: Entity-Relationship (E/R) model

Process of creating relational database



Databases model the real world

- “Data Model” allows us to translate real world things into structures computers can store
- Many models exist:
 - Relational
 - Object-Oriented
 - XML
 - Semantic
 - Etc.

In relational model:

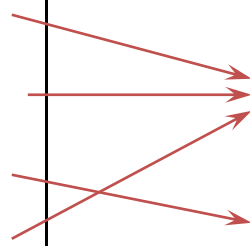
- Database = set of named **relations** (or **tables**)
- Each relation has a set of named **attributes** (or **columns**)
- Each **tuple** (or **row**) has a **value** for each attribute
- Each attribute has a **type** (or **domain**)
- Relations are connected using **keys**

Enrolled

sid	cid	grade
53666	Carnatic101	C
53666	Reggae203	B
53650	Topology112	A
53666	History105	B

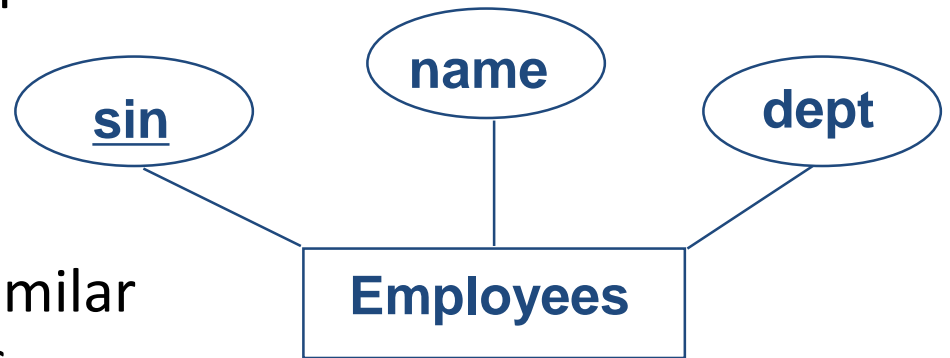
Students

sid	name	login	age	gpa
53666	Jones	jones@cs	18	3.4
53688	Smith	smith@eecs	18	3.2
53650	Smith	smith@math	19	3.8

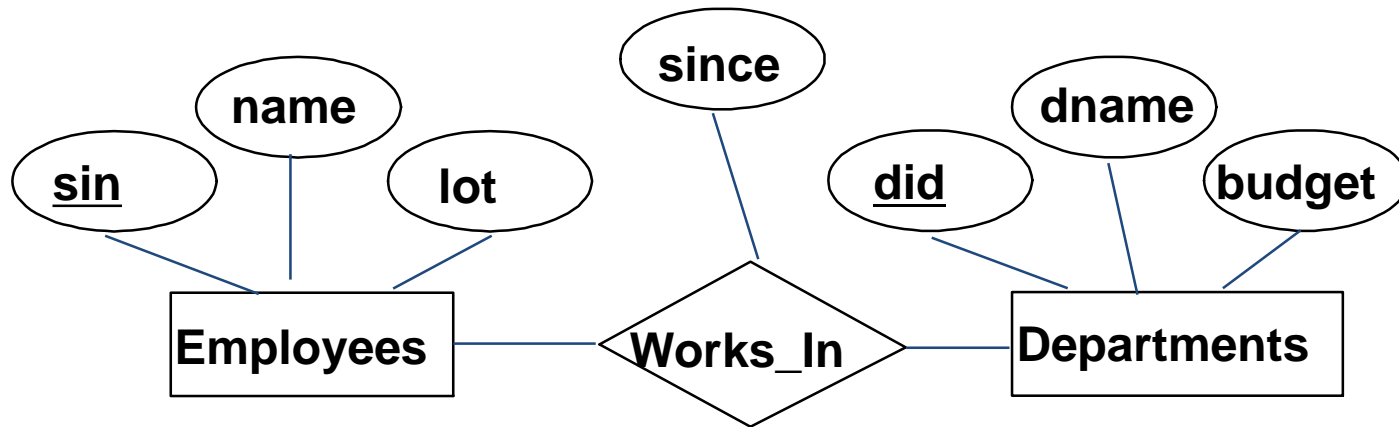


ER Model: **entity**

- **Entity**: a single real-world object, distinguishable from other objects. An entity is described using a set of **attributes**.
- **Entity Set**: A collection of similar entities. E.g., all employees.
- All entities in an entity set have the same set of attributes
- Each entity set has a **key** (*underlined*).



ER Model: relationship



- **Relationship:** Association among two or more entities. E.g., John works in Pharmacy department.
 - relationships can have their own attributes.
- **Relationship Set:** Collection of similar relationships.

Collecting ideas

- What are the *entities* and *relationships* in the enterprise?
- What information about these entities and relationships should we store in the database?
- What *integrity constraints* or *business rules* hold?

E/R for movies: elements

Entity – certain movie



The set of all movies constitutes an **Entity set**

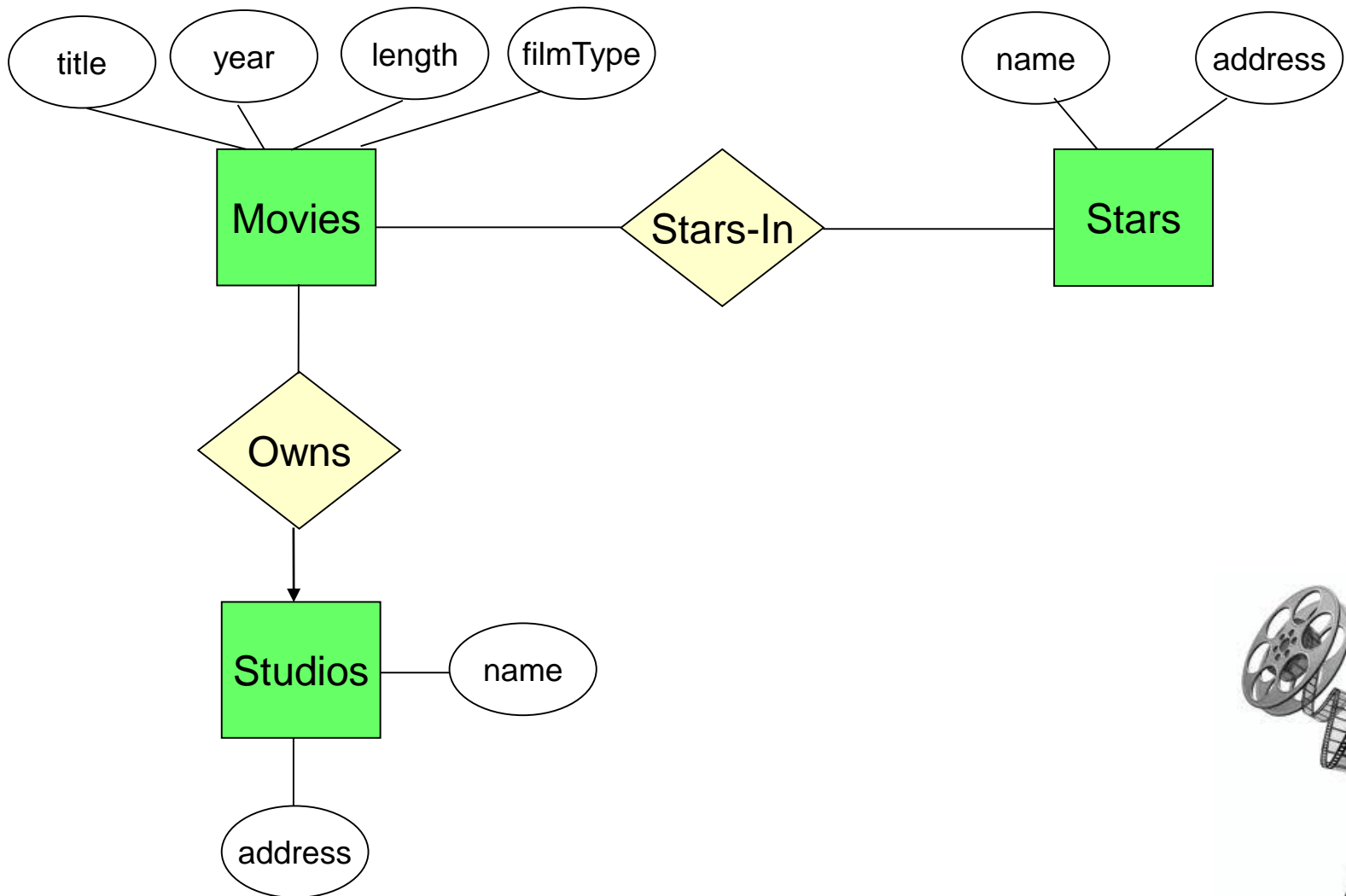
Attributes



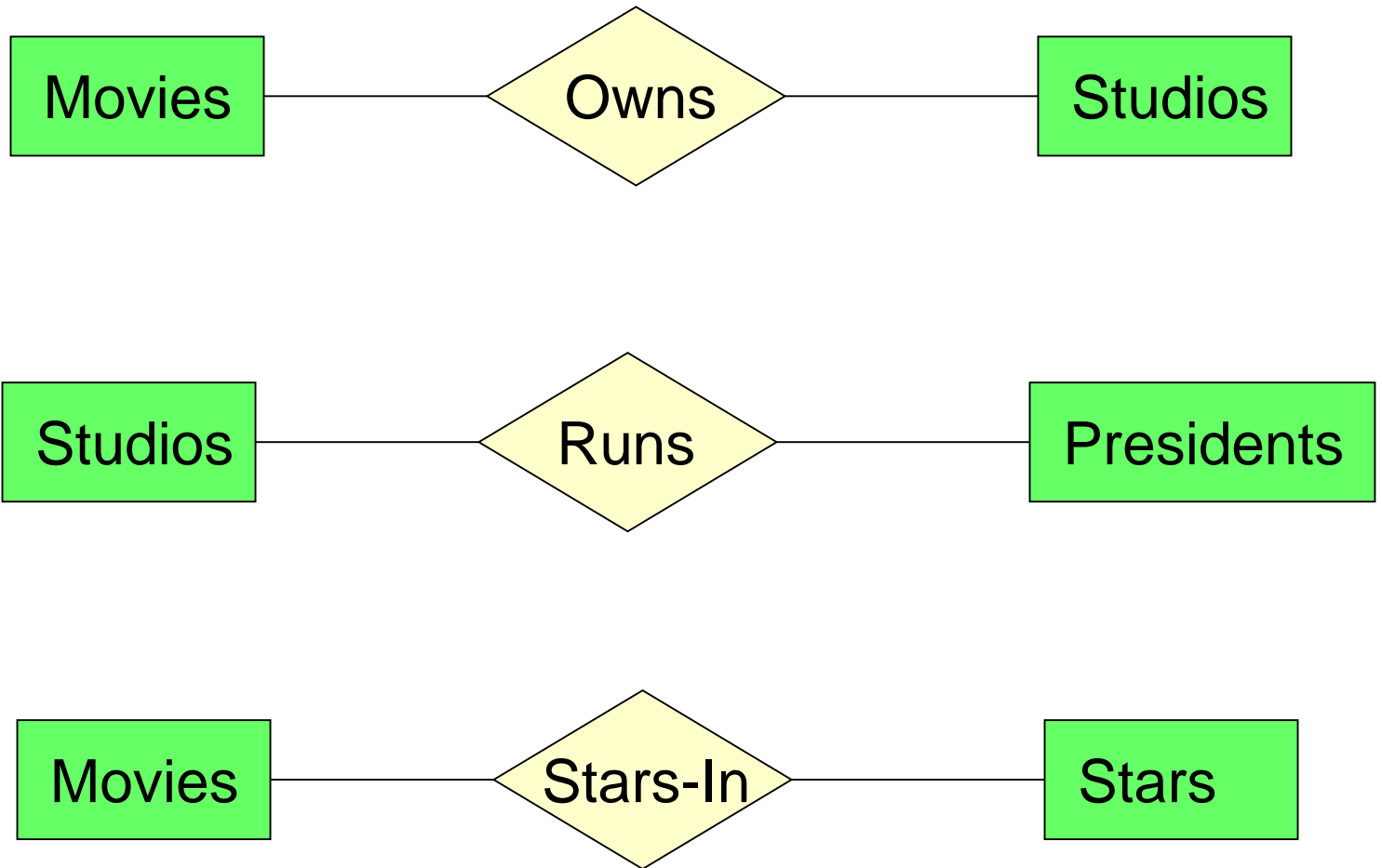
Relationships



Movies: Entity-Relationship diagram

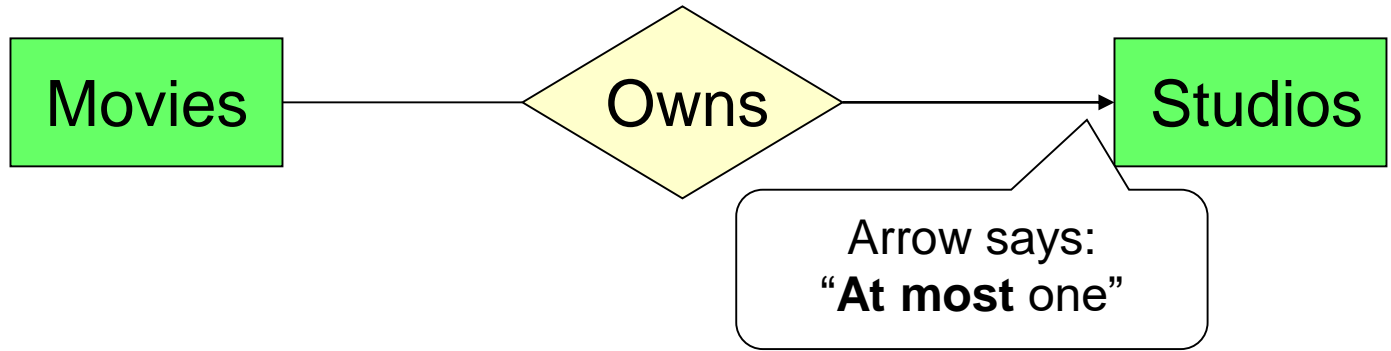


Relationships

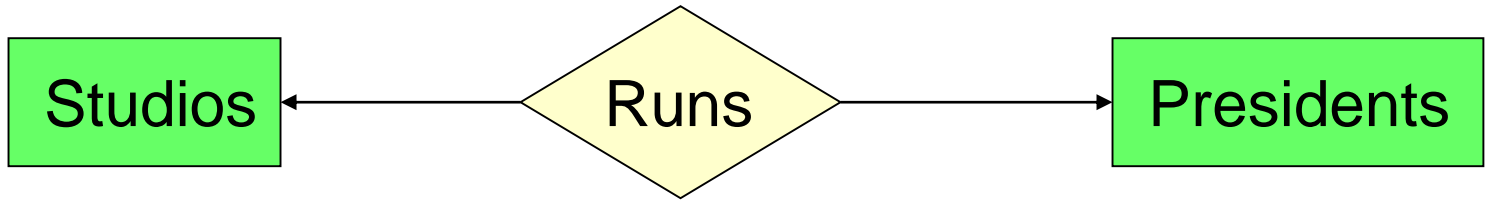


Multiplicity of Relationships

many-one



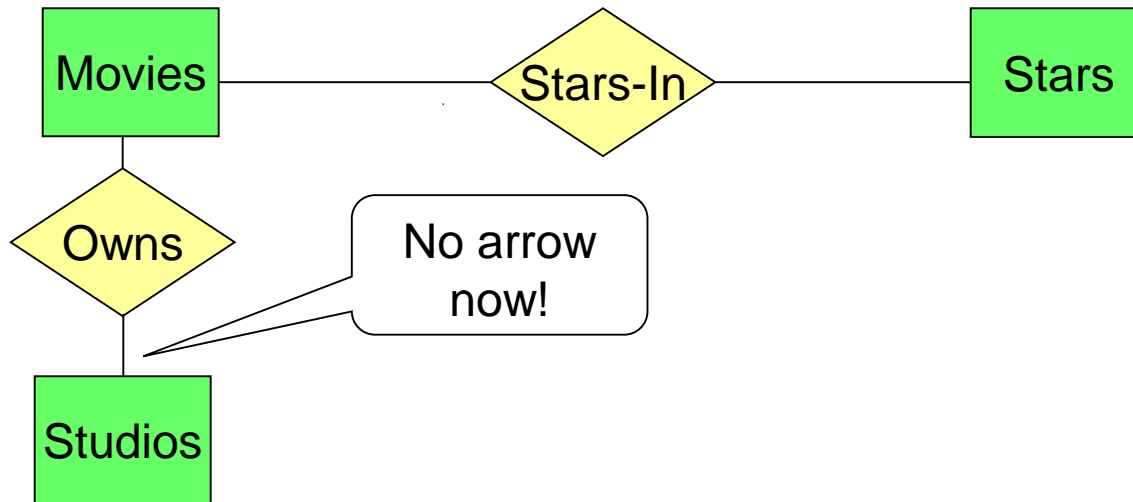
one-one



many-many



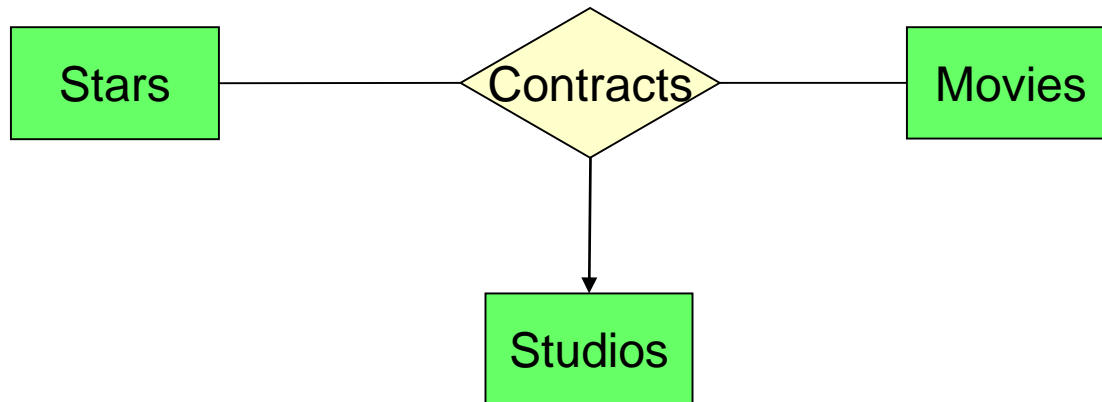
Sometimes binary relationships aren't enough!



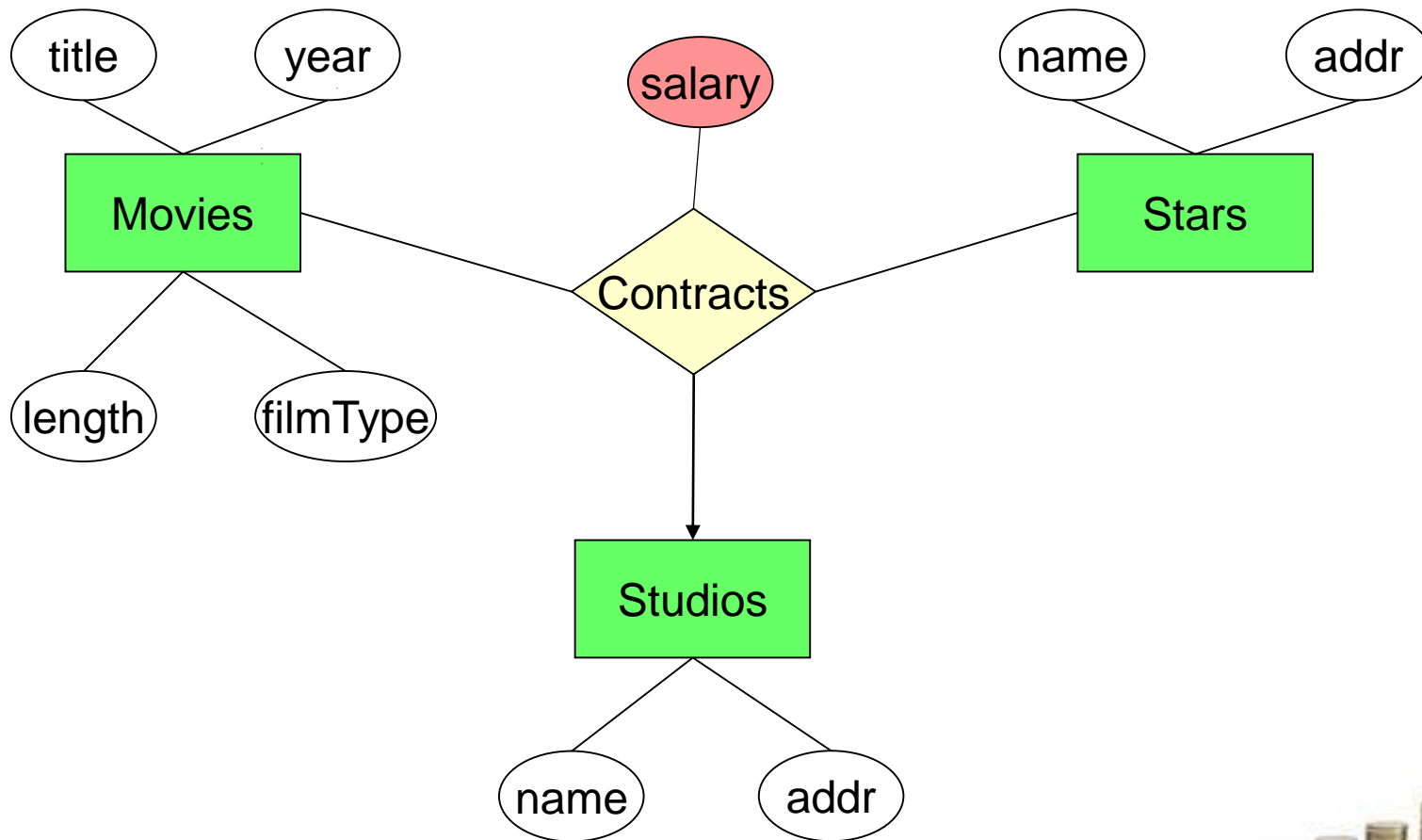
What could go wrong with this design?

Which stars a studio is paying for a given movie?

Solution: Three-way relationship

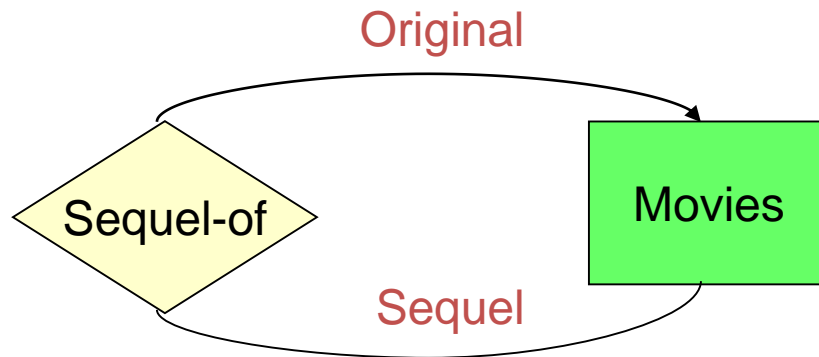


Example: Attributes on Relationships



Example: Roles in a relationship

- An entity set can appear two or more times in a relationship.
- Each line to the entity set represents a different role.



- A movie may have **many sequels**, but for each sequel there is **at most one original movie**.

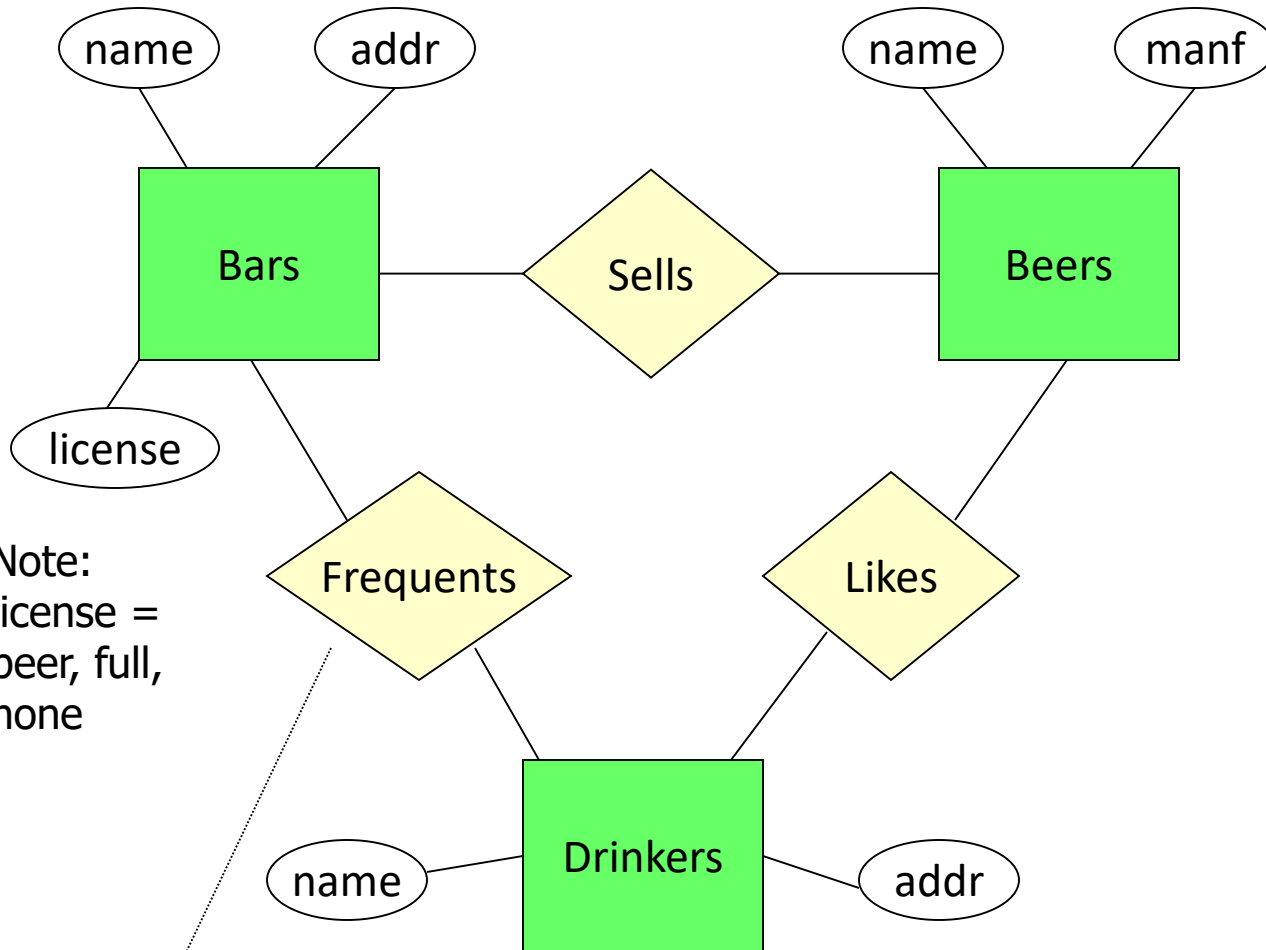
Another design example.

“Bars-Beer-Drinkers” (BBD)

- Bars sell some beers.
- Drinkers like some beers.
- Drinkers frequent some bars.

What would be the E/R diagram?

BDD ER diagram



Bars sell some beers.

Drinkers like some beers.

Drinkers frequent some bars.

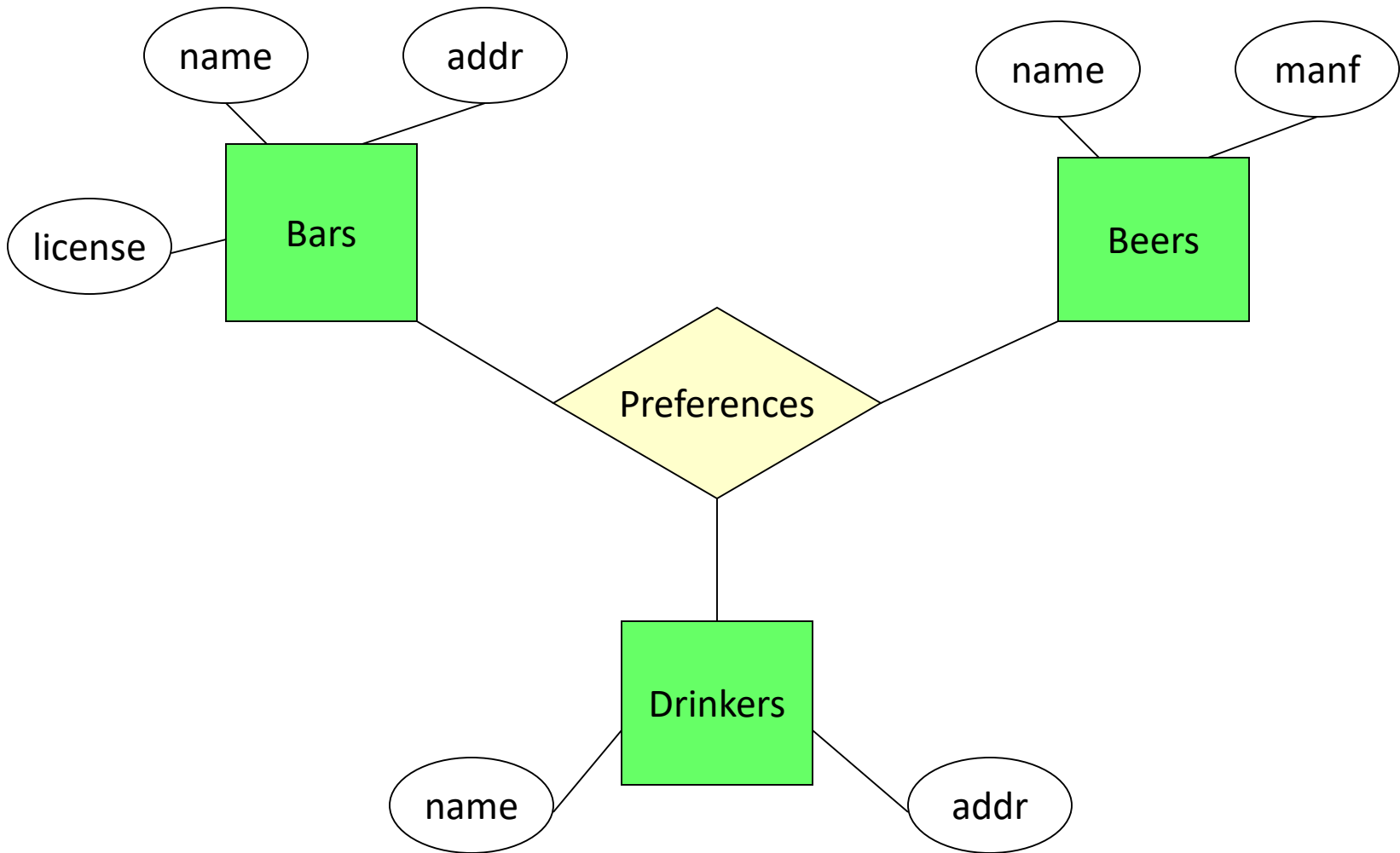
Note:
license =
beer, full,
none

Why we need it?

BBD Multiway Relationship

- Suppose that drinkers prefer drink certain beers at certain bars (many beer types at multiple bars).
- How do we reflect their preferences in ER diagram?

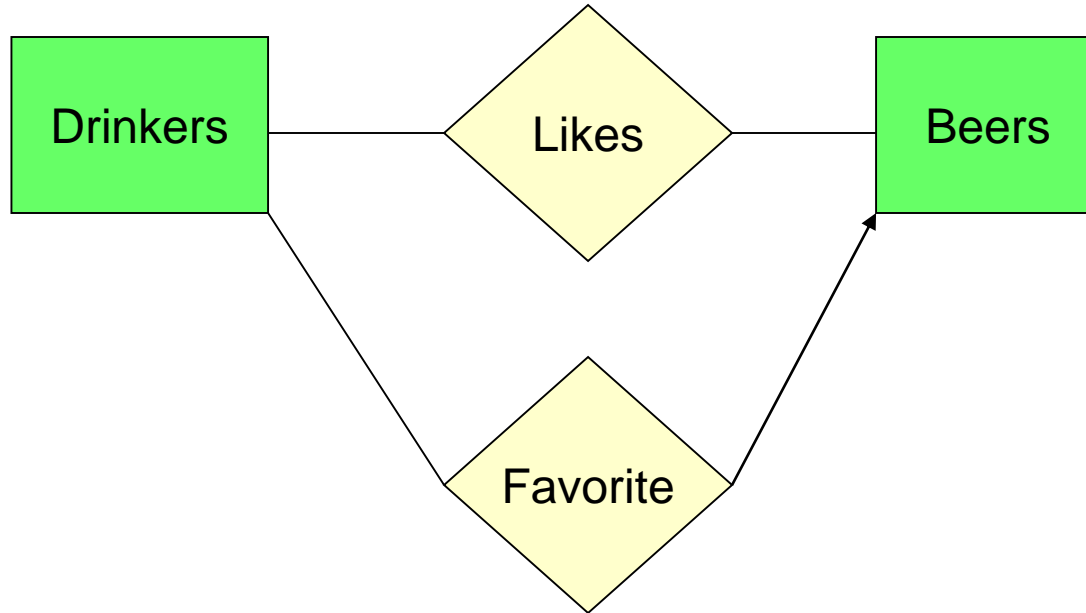
BBD Multi-way Relationship



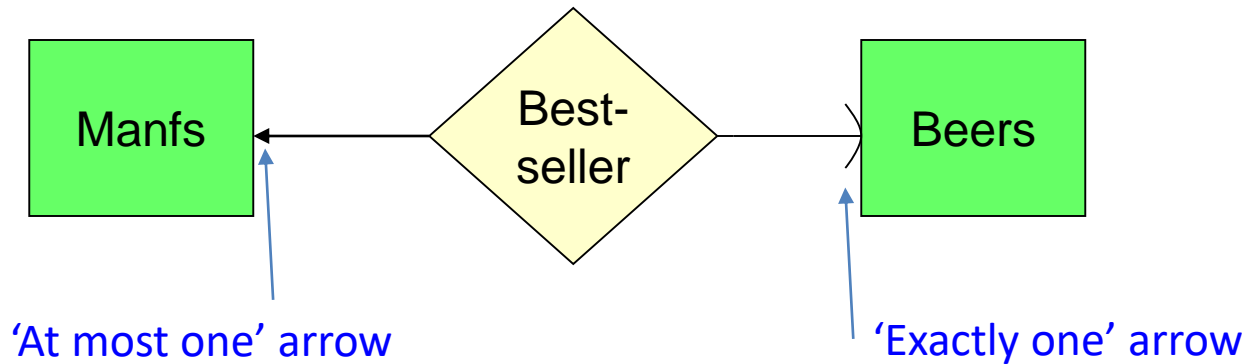
Example table for ternary (three-way) relationships

Bar	Drinker	Beer
Joe's Bar	Ann	Miller
Sue's Bar	Ann	Bud
Sue's Bar	Ann	Pete's Ale
Joe's Bar	Bob	Bud
Joe's Bar	Bob	Miller
Joe's Bar	Cal	Miller
Sue's Bar	Cal	Bud Lite

Multiple relationships between two entity sets



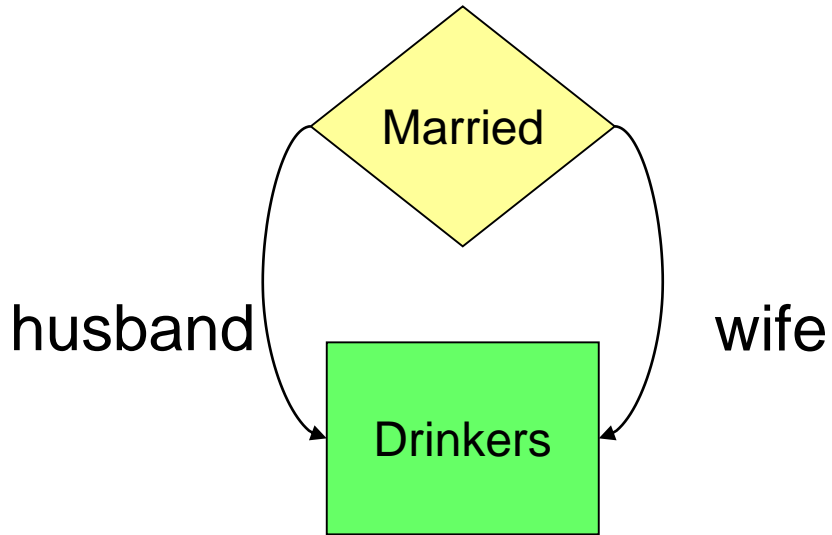
“Exactly one” Multiplicity



- Some beers are not the best-seller of any manufacturer, so a **rounded arrow** to *Manfs* would be inappropriate.
- But a manufacturer has to have a best-seller (in our model)

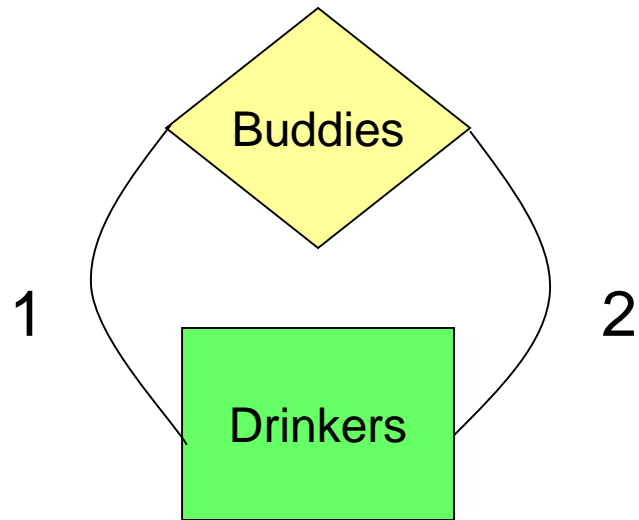


Roles



Husband	Wife
Bob	Ann
Joe	Sue
...	...

Another role



Buddy1	Buddy2
Bob	Ann
Joe	Sue
Ann	Bob
Joe	Moe
...	...

Design choices

- Should a concept be modeled as an **entity or an attribute**?
- Should a concept be modeled as an **entity or a relationship**?
- Identifying relationships: **binary or ternary**?

Entity vs. Attribute

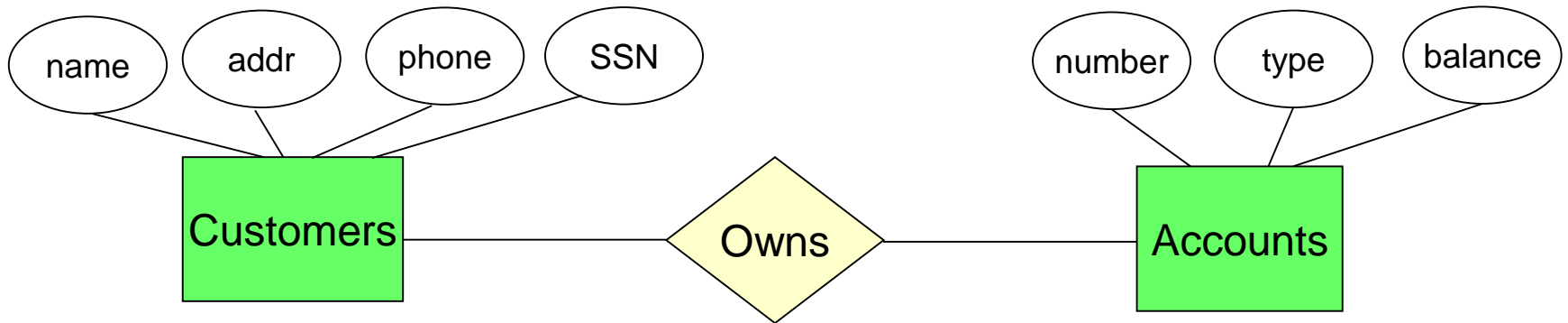
- Should *address* be an attribute of Employees or an entity (related to Employees)?
- **Depends** upon the semantics of the data:
 - If we have **several addresses per employee**, *address* must be an entity (since attributes cannot be set-valued).
 - If the **structure** (city, street, etc.) **is important**, *address* must be modeled as an entity (since attribute values are atomic).
 - If the **lifetime** of the address differs from the entity, *address* must be modeled as an entity (since attributes are deleted with their entity).

Exercise 1. Bank database

- Let us design a database for a bank, including information about customers and their accounts.

Information about a customer includes their **name**, **address**, **phone**, and **SSN** number. Accounts have **numbers**, **types** (e.g., savings, checking) and **balances**. We also need to record the customer(s) who own an account. Draw the E/R diagram for this database.

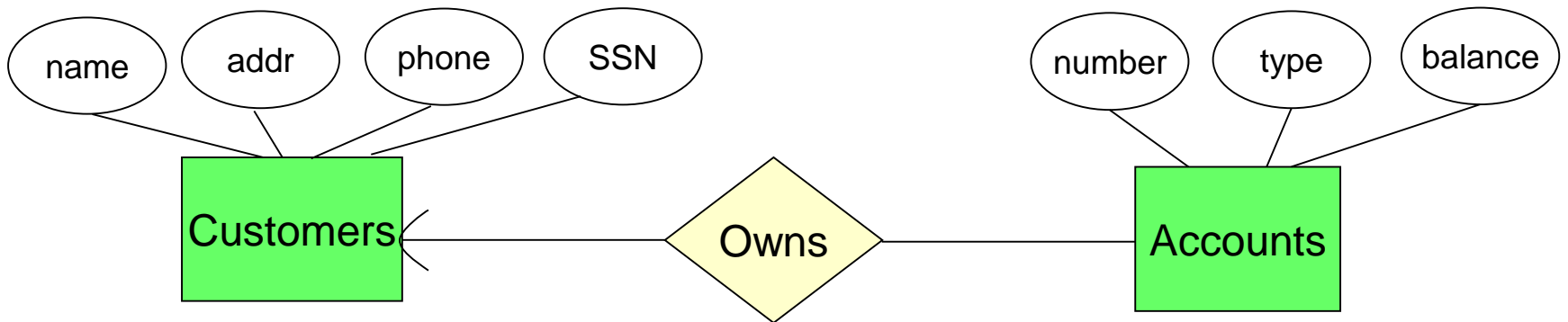
Exercise 1 solution



Exercise 1A. Bank database

- Modify your solution as follows:
 - a) **Change your diagram so an account can belong to only one customer.**

Exercise 1A solution

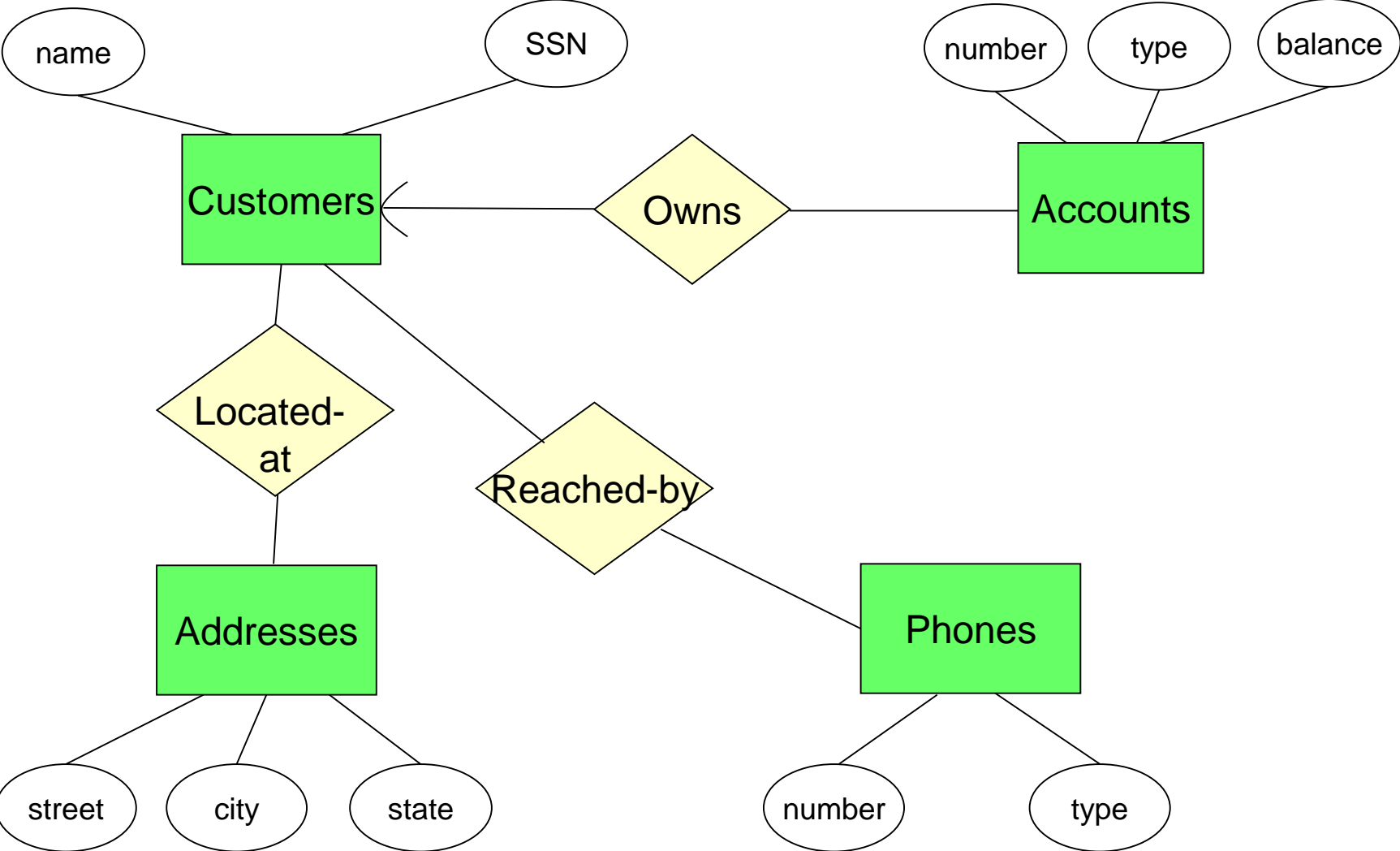


Exercise 1B. Bank database

- Modify your solution as follows:
 - a) Change your diagram so an account can have only one customer.
 - b) Change your diagram so that a customer can have a **set** of addresses (which are street-city-state triples) and a **set** of phones.

Remember that we do not allow attributes to have non-atomic types, such as sets, in the E/R model.

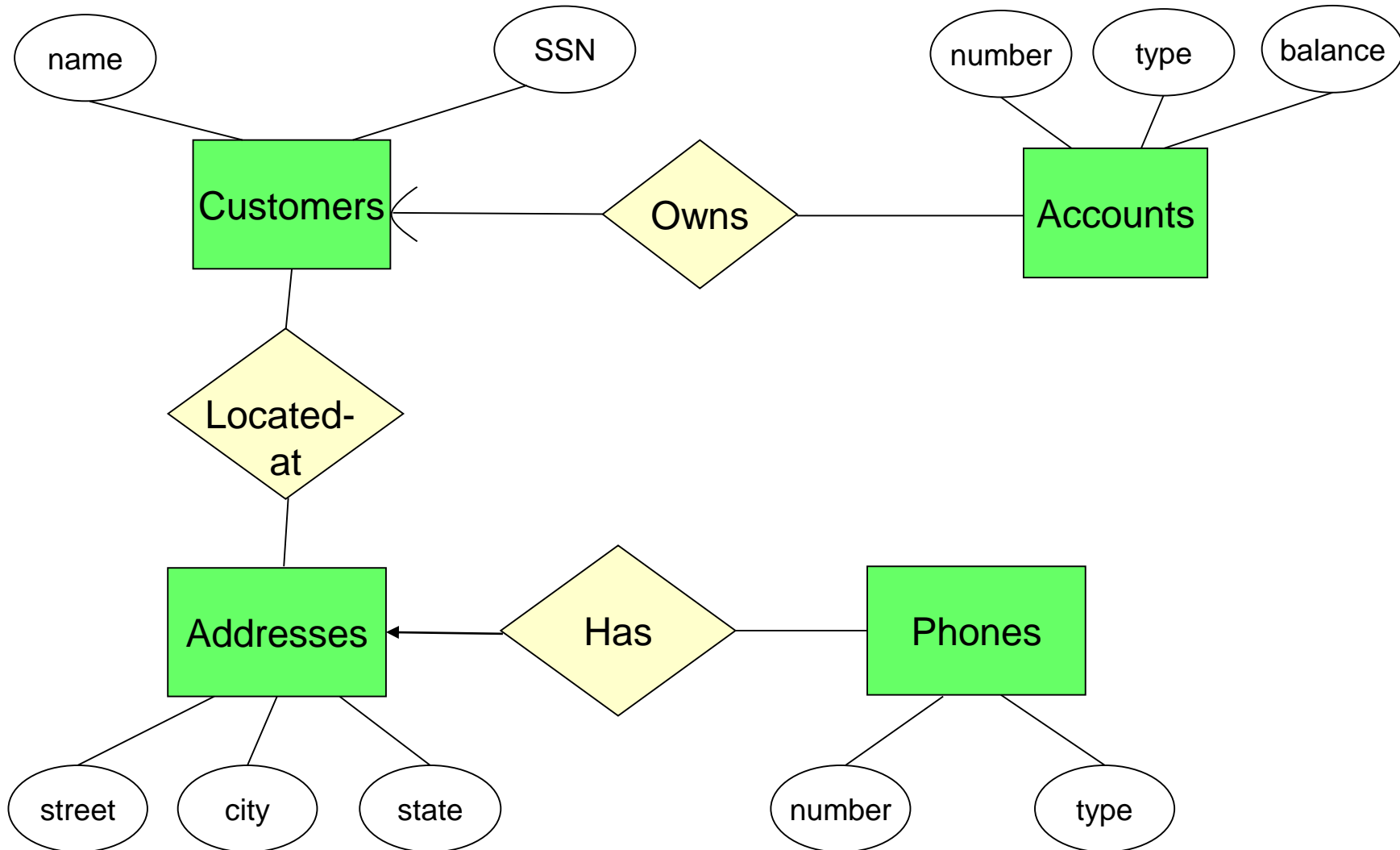
Exercise 1B solution



Exercise 1C. Bank database

- Modify your solution as follows:
 - a) Change your diagram so an account can have only one customer.
 - b) Change your diagram so that a customer can have a set of addresses (which are street-city-state triples) and a set of phones.
 - c) Further modify your diagram so that customers can have a set of addresses, and **at each address there is a set of phones.**

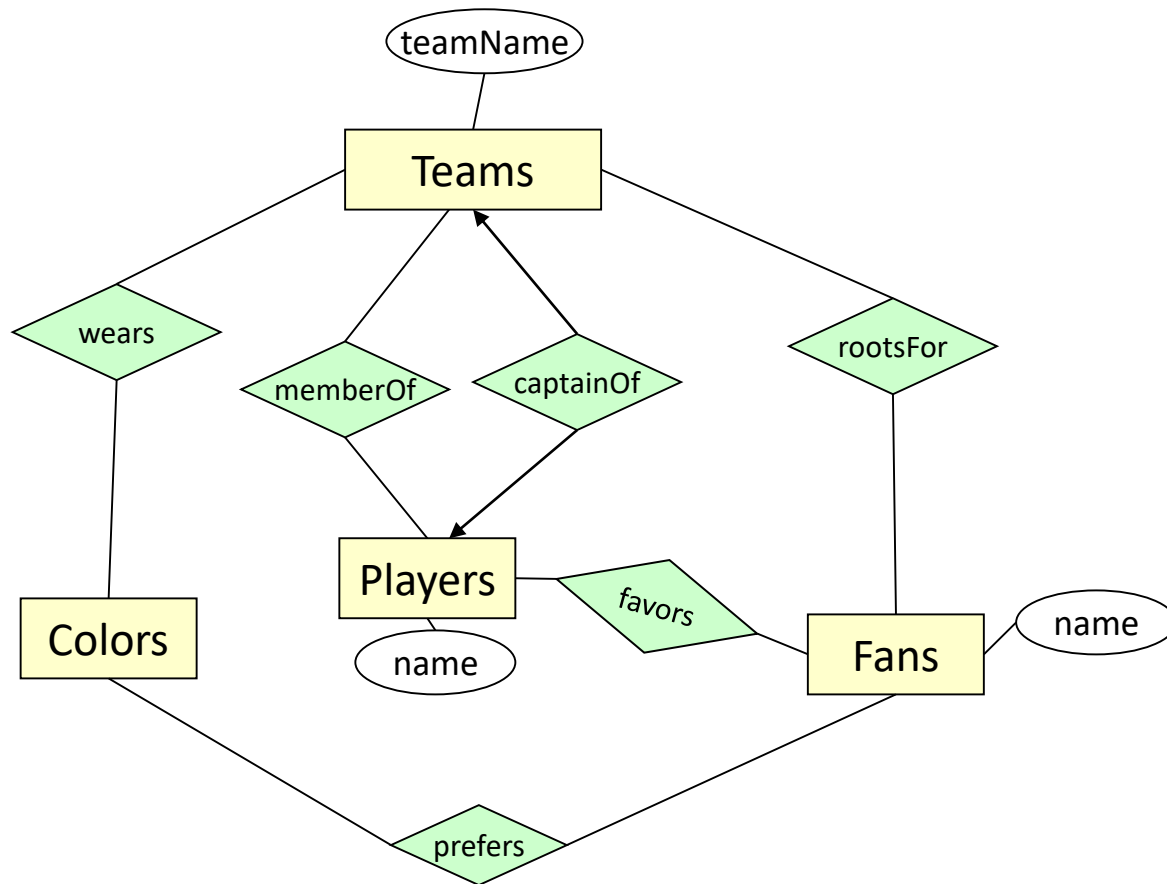
Exercise 1C solution



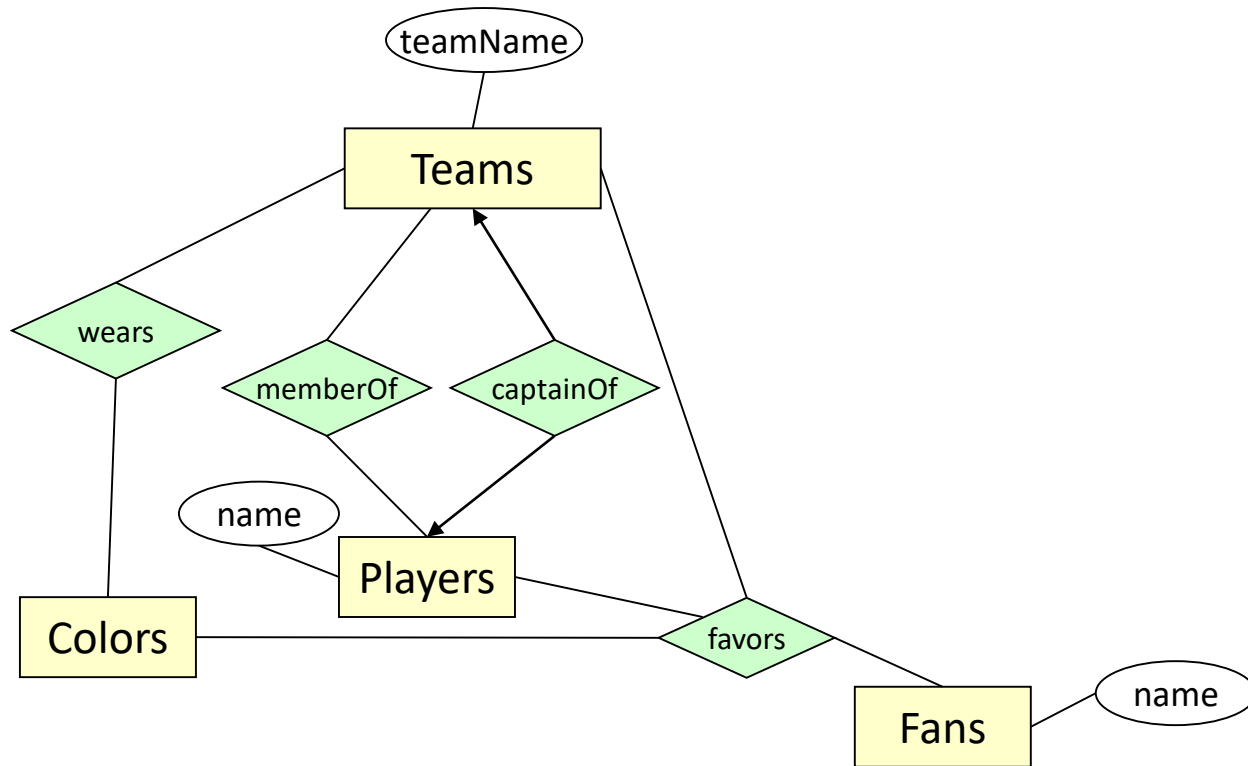
Exercise 2. Teams and fans database

- Give an E/R diagram for a database recording information about **teams**, **players**, and their **fans**, including:
 - For each team, its **name**, its **players**, its team **captain** (one of its players), and the **colors of its uniform**.
 - For each player, his/her **name**.
 - For each fan, his/her **name**, **favorite teams**, **favorite players**, and **favorite color**.

Exercise 2 solution (Variant I)



Exercise 2 solution (Variant II)



Exercise 2A. Teams and fans database

- Modification A:

- Suppose we wish to add to the schema a relationship “Led-by” among two players and a team. The intention is that this relationship set consists of triples

(player1, player2, team)

such that player 1 played on the team at a time when some

other player 2 was the team captain.

Draw the modification to the E/R diagram.

Exercise 2A solution

