Entity-Relationship Model

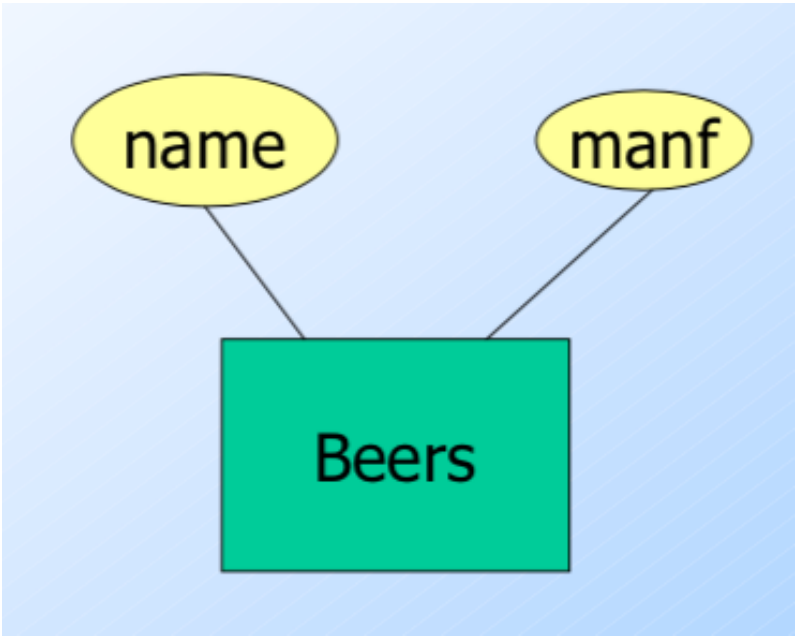
Purpose of E/R Model

- Part of the database design process
  1. Requirements gathering and analysis
  2. **Conceptual database design <- E/R model**
  3. Converting E/R model to relational database
  4. …
- Sketch database schema designs -> entities, relationships and constraints
- Provide common language that even non-technical people can understand
- Think about both current use cases as well as possible ways data and use cases may change in the future

Entity Sets

- **Entity**: object in the real world that is distinguishable from other objects (an *instance* in OOP)
- **Entity set**: collection of similar entities (a *class* in OOP)
- **Attribute**: properties of the entity set
  - Each attribute has a **domain** of possible values
- **Key**: minimal set of attributes that uniquely identifies an entity in an entity set

E/R Diagrams

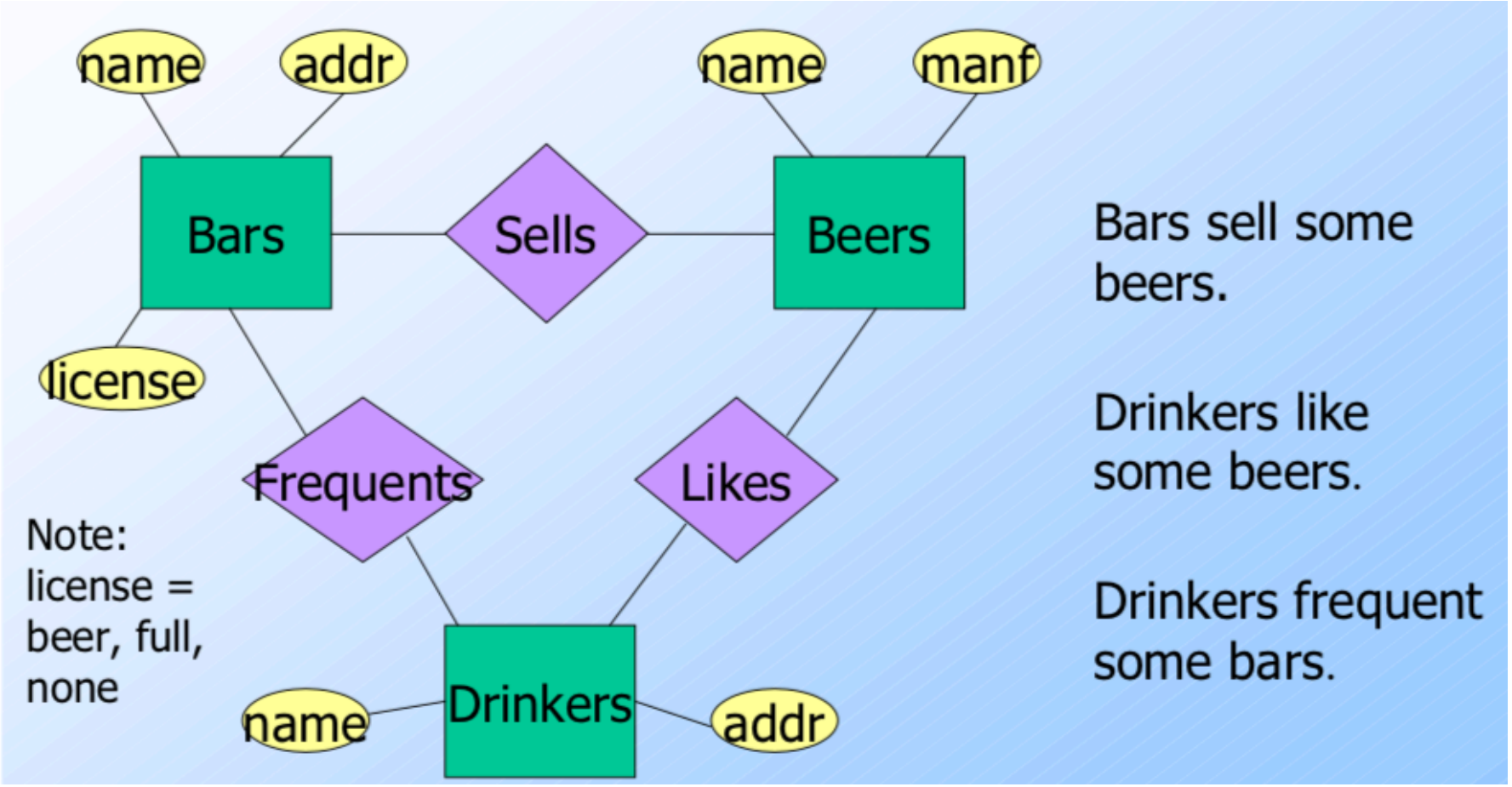


- Entity set -> rectangle
- Attribute -> oval
- Example:
  - Entity set: Beers
  - Beers has two attributes: name and manf (manufacturer)
  - Each Beers entity has values for these two attributes

Relationships

- **Relationship:** an association among two or more entities
  - Eg. Employee1 works in DepartmentB
- **Relationship set:** a collection of similar relationships
  - Eg. Employees Works_In Departments

Relationships Example



Relationships Example

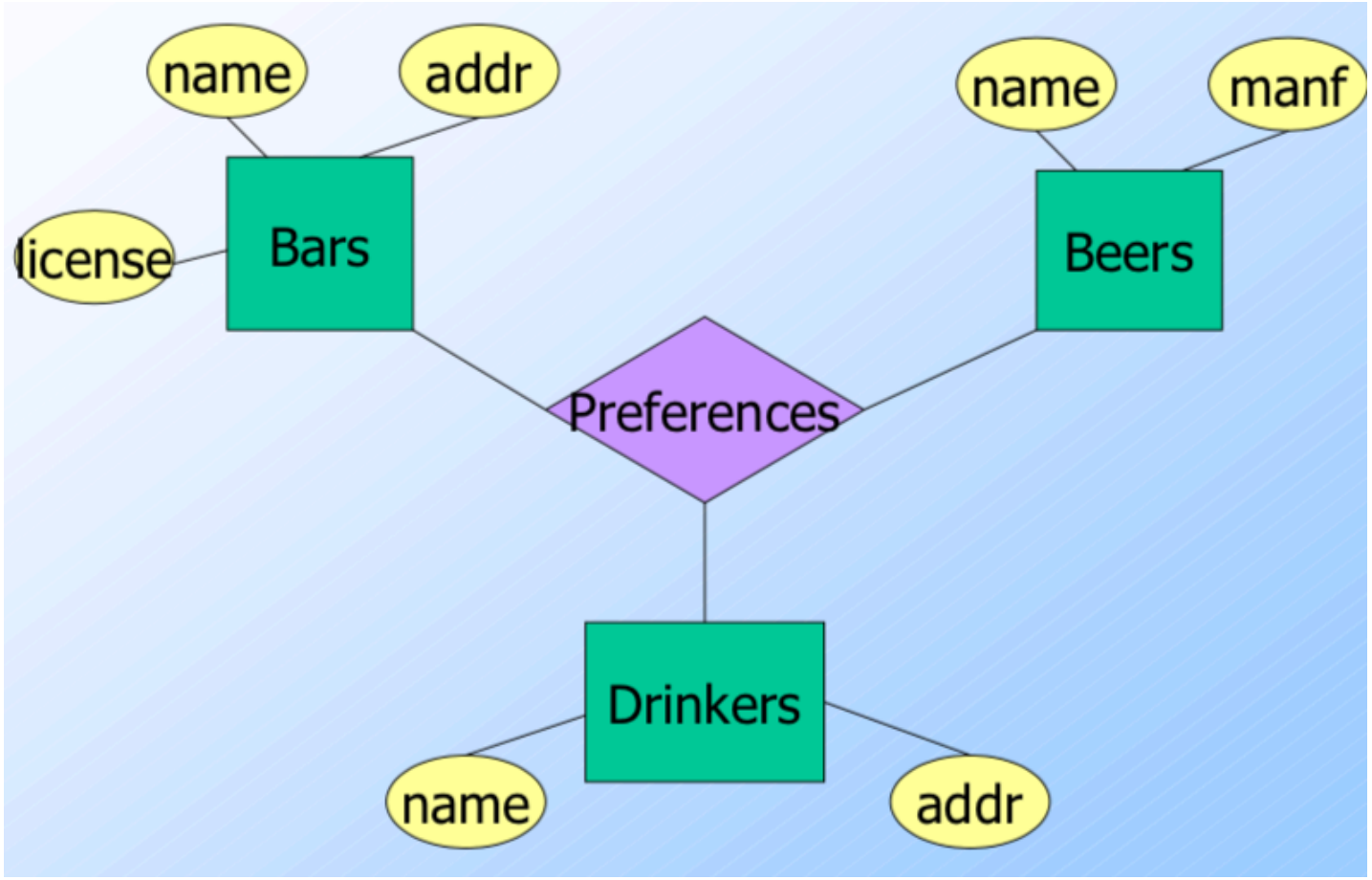
- An **instance** of a relationship set is a snapshot of the relationship set at some instant in time
- Eg. For the Sells relationship set:

Bars	Beers
Joe's Bar	Bud
Joe's Bar	Miller
Sue's Bar	Bud
Sue's Bar	Pete's Ale
Sue's Bar	Bud Lite

Multiway Relationships

- Sometimes, we need a relationship that connects more than two entity sets
- Eg. Suppose drinkers will only drink certain beers at certain bars
  - Drinker1 only drinks Beer1 and Beer2 and Bar1
  - Drinker1 only drinks Beer2 and Beer3 and Bar2

Multiway Relationships



Multiway Relationships

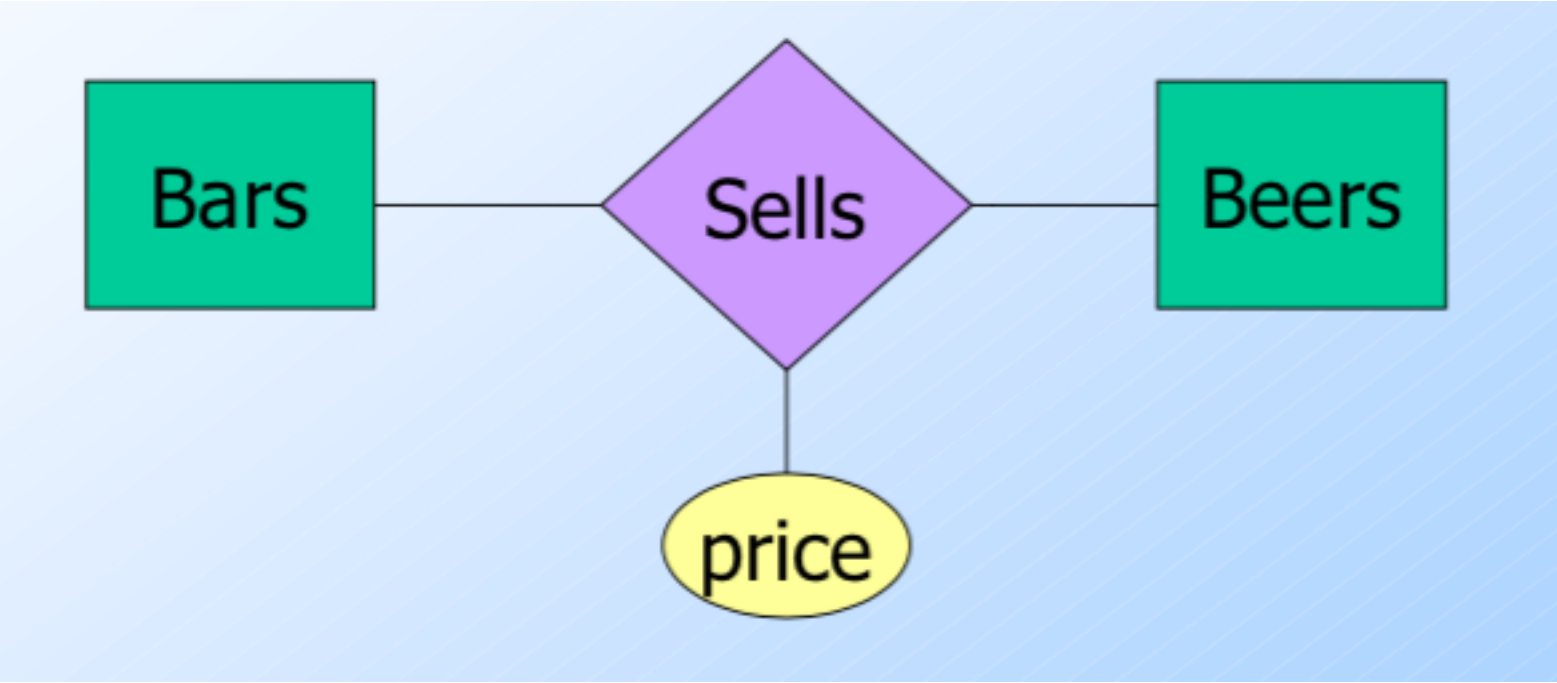
Bar	Drinker	Beer
Joe's Bar	Ann	Miller
Sue's Bar	Ann	Bud
Sue's Bar	Ann	Pete's Ale
Joe's Bar	Bob	Bud
Joe's Bar	Bob	Miller
Joe's Bar	Cal	Miller
Sue's Bar	Cal	Bud Lite

Attributes on Relationships

- Sometimes it is useful to attach an attribute on a relationship
- Used to record information about the relationship, rather than one of the participating entities

Attributes on Relationships

- Price is a function of the relationship between the bar and the beer



Many-to-Many Relationships

- Binary, two-way relationship
- An entity of either set can be connected to many entities of the other set
- Eg. The Sells relationship between Bars and Beers. A bar sells many beers and a beer is sold in many bars.

Many-to-One Relationship

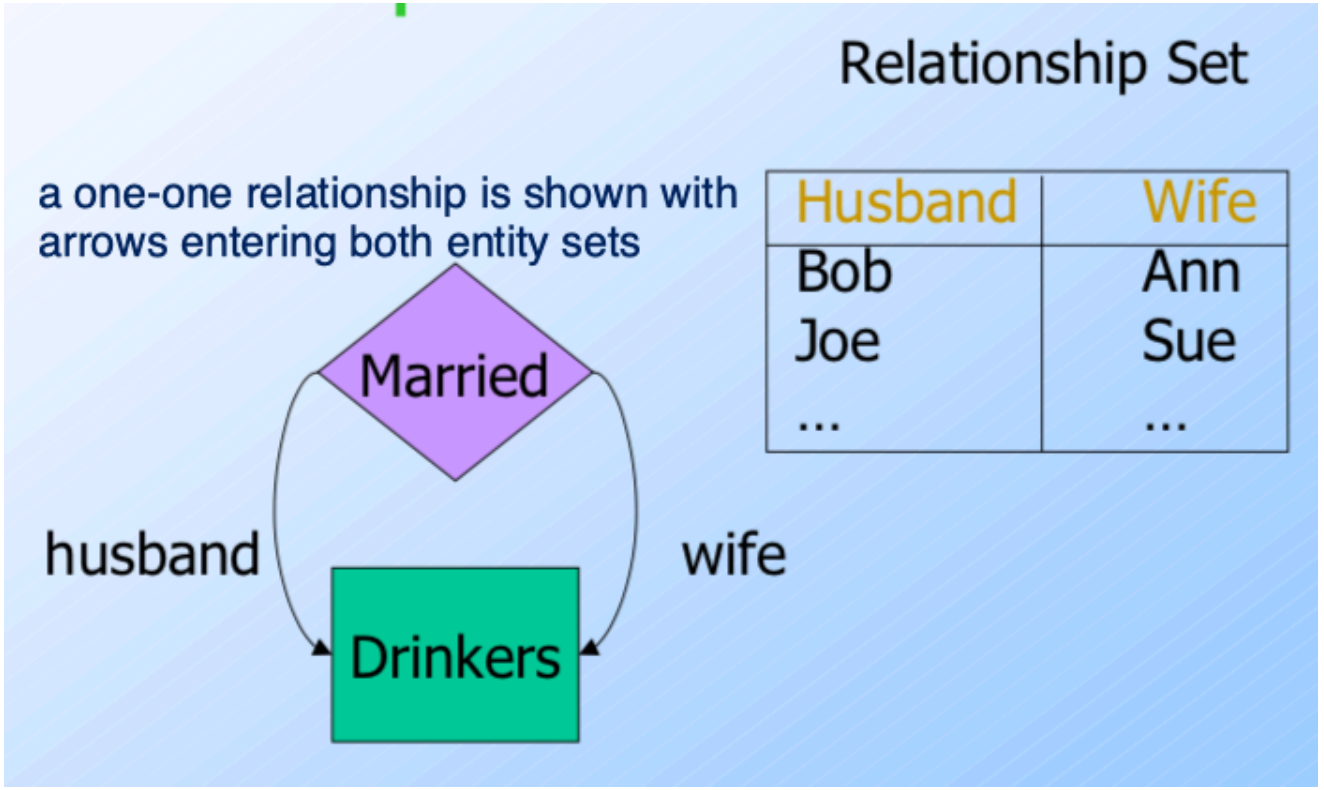
- Each entity of the first set is connected to at most one entity of the second set
- Entity of second set can be connected to zero, one, or many entities of the first set
- Eg. A Favorite relationship from Drinkers to Beers is many-to-one
  - Drinker has at most one favorite beer
  - Beer can be the favorite of any number of drinkers (including zero).

One-to-One Relationship

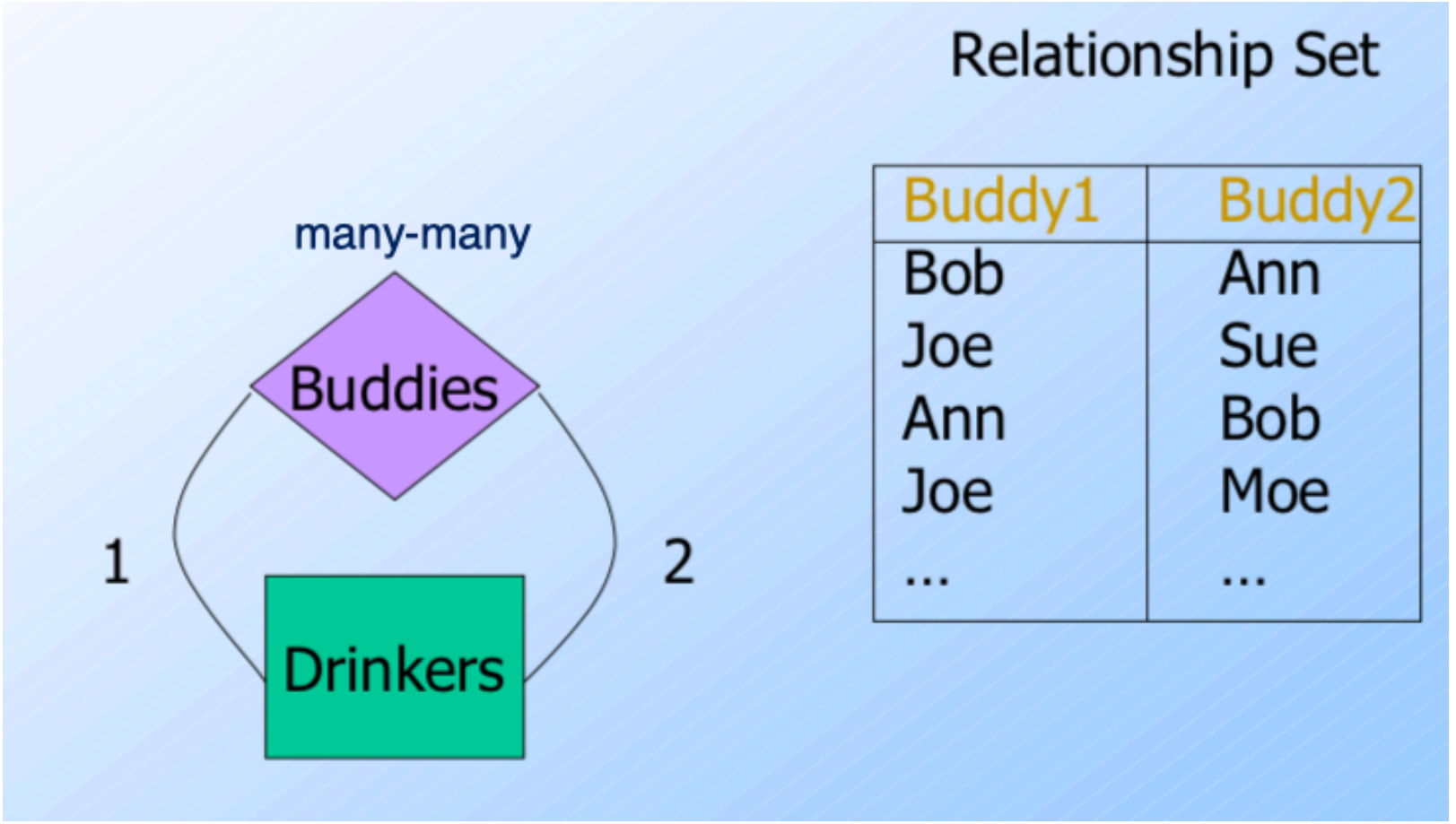
- Each entity of either entity set is related to at most one entity of the other set
- Eg. A Best-seller relationship between Manufacturer and Beers
  - A beer is only made by one manufacturer
  - A manufacturer can only have one best seller

Roles

- Entity set can appear more than once in a relationship
- Label the edges between the relationship and the entity set with names called **roles**

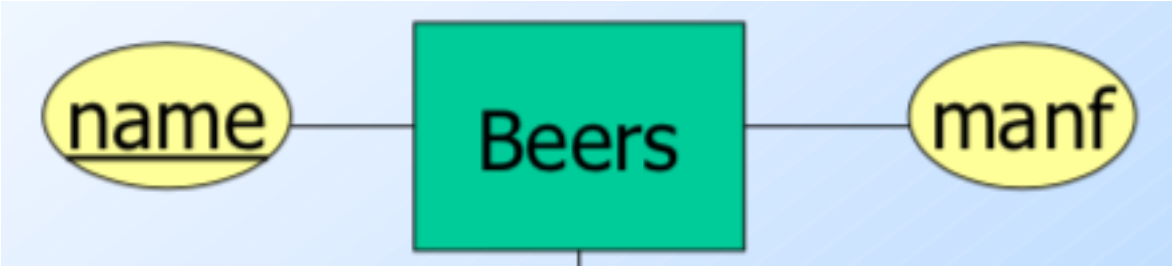


Roles


Relationship Set
many-many
Buddies
1
2
Drinkers
Buddy1
Buddy2
Bob
Ann
Joe
Sue
Ann
Bob
Joe
Moe
...
...

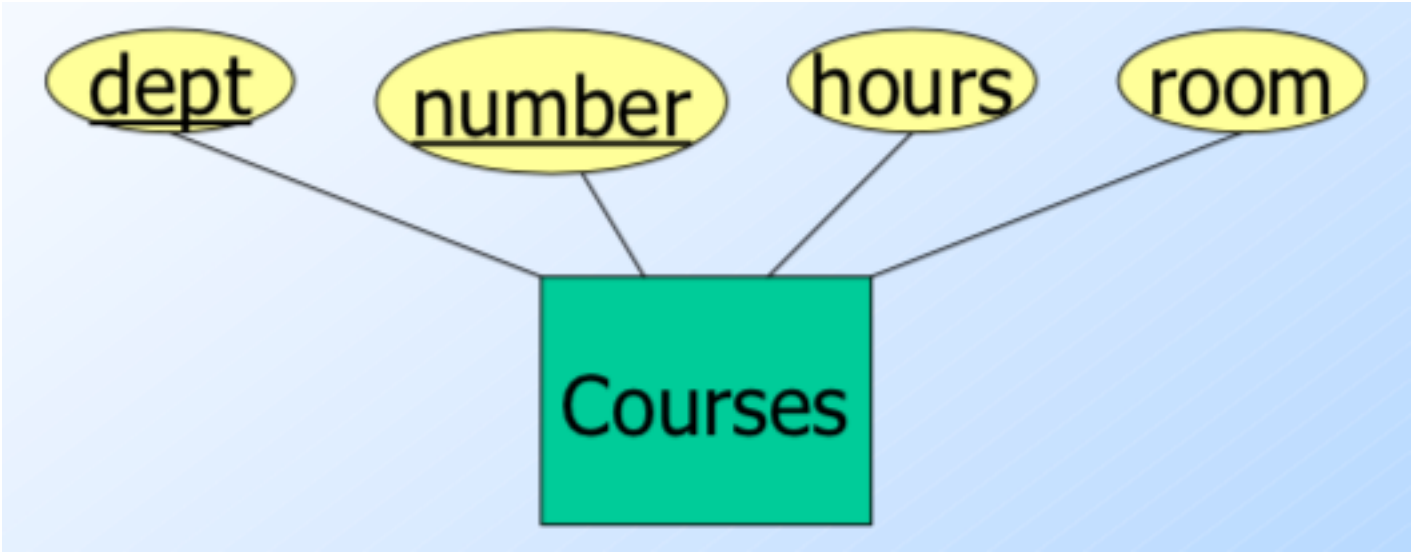
Keys

- **Key**: minimal set of attributes that uniquely identifies an entity in an entity set
  - Two entities can share the same values for some key attributes, but not all
- Every entity set must have a key
- In diagrams, underline the key attribute(s)



Multi-attribute key

- Department is not enough to uniquely identify a course
- Number may also be repeated across departments (eg. Math 336)



Weak Entity Sets

- Occasionally an entity set cannot be identified uniquely without following one or more many-to-one relationships
- Entity set is called **weak** if we need to follow one or more of these relationships and include the key of the related entities from the connected entity sets to uniquely identify entity
- The key for a weak entity set is its own underlined attributes and the keys of the connected entity sets

Weak Entity Sets

- Name is almost a key for football players, but two players might have the same name
- Number is not a key, since players on two teams can have the same number
- Together, the number of the player and the team uniquely identifies the player