The Entity-Relationship Model

Zaki Malik

September 16, 2008

Till the Midterm Examination

- Relational Data Models
  - The Entity-Relationship (ER) model
  - The relational model
  - Converting E/R diagram to relational designs.
- You should know how to
  - Identify all entities and relationships and describe them using an E/R diagram .
  - Convert the E/R model to a number of relations in a relational schema.
- Use all these ideas to design your own database application in your project.

Basic Database Terminology

- Data model : describes high-level conceptual structuring of data
  - Example: Data is set of student records, each with ID, name, address, and courses
  - Example: Data is a graph where nodes represent proteins and edges represent chemical bonds between proteins
- Schema describes how data is to be structured and stored in a database
  - Defined during creation of the database
  - Schemas rarely change
- Data is actual “instance” of database
  - Updated continuously
  - Changes rapidly

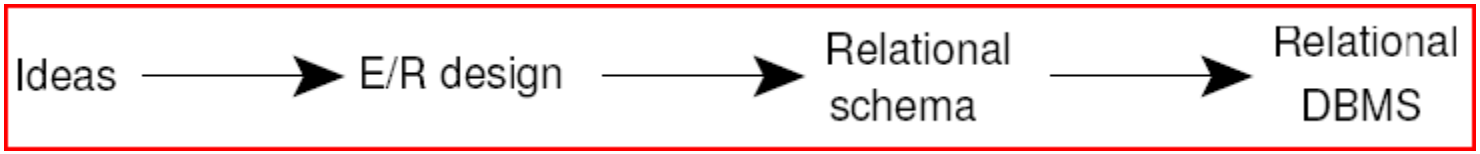
Why Learn About Database Modeling?

- The way in which data is stored is very important for subsequent access and manipulation by SQL.

- Properties of a good data model:
  - It is easy to write correct and easy to understand queries.
  - Minor changes in the problem domain do not change the schema.
  - Major changes in the problem domain can be handled without too much difficulty.
  - Can support efficient database access.

Purpose of E/R Model

- The E/R model allows us to sketch the design of a database informally.
  - Represent different types of data and how they relate to each other
- Designs are pictures called *entity-relationship diagrams*.
- Fairly mechanical ways to convert E/R diagrams to real implementations like relational databases exist.



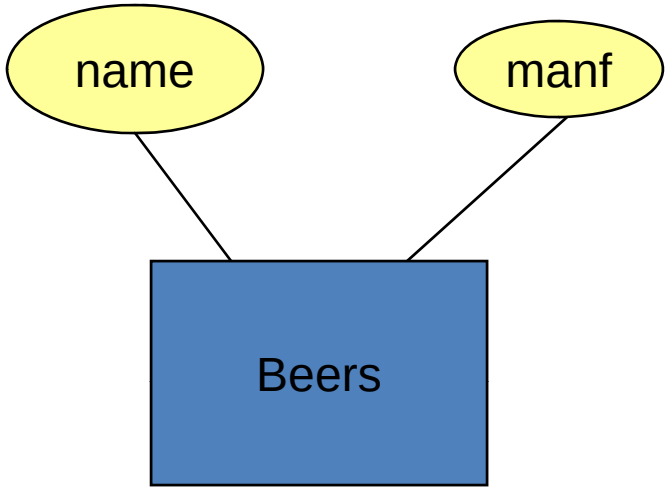
Entity Sets

- *Entity* = "thing" or object.
- *Entity set* = collection of similar entities.
  - Similar to a class in object-oriented languages.
- Attribute = property of an entity set.
  - Generally, all entities in a set have the same properties.
  - Attributes are simple values, e.g. integers or character strings.

E/R Diagrams

- In an entity-relationship diagram, each entity set is represented by a rectangle.
- Each attribute of an entity set is represented by an oval, with a line to the rectangle representing its entity set.

Example

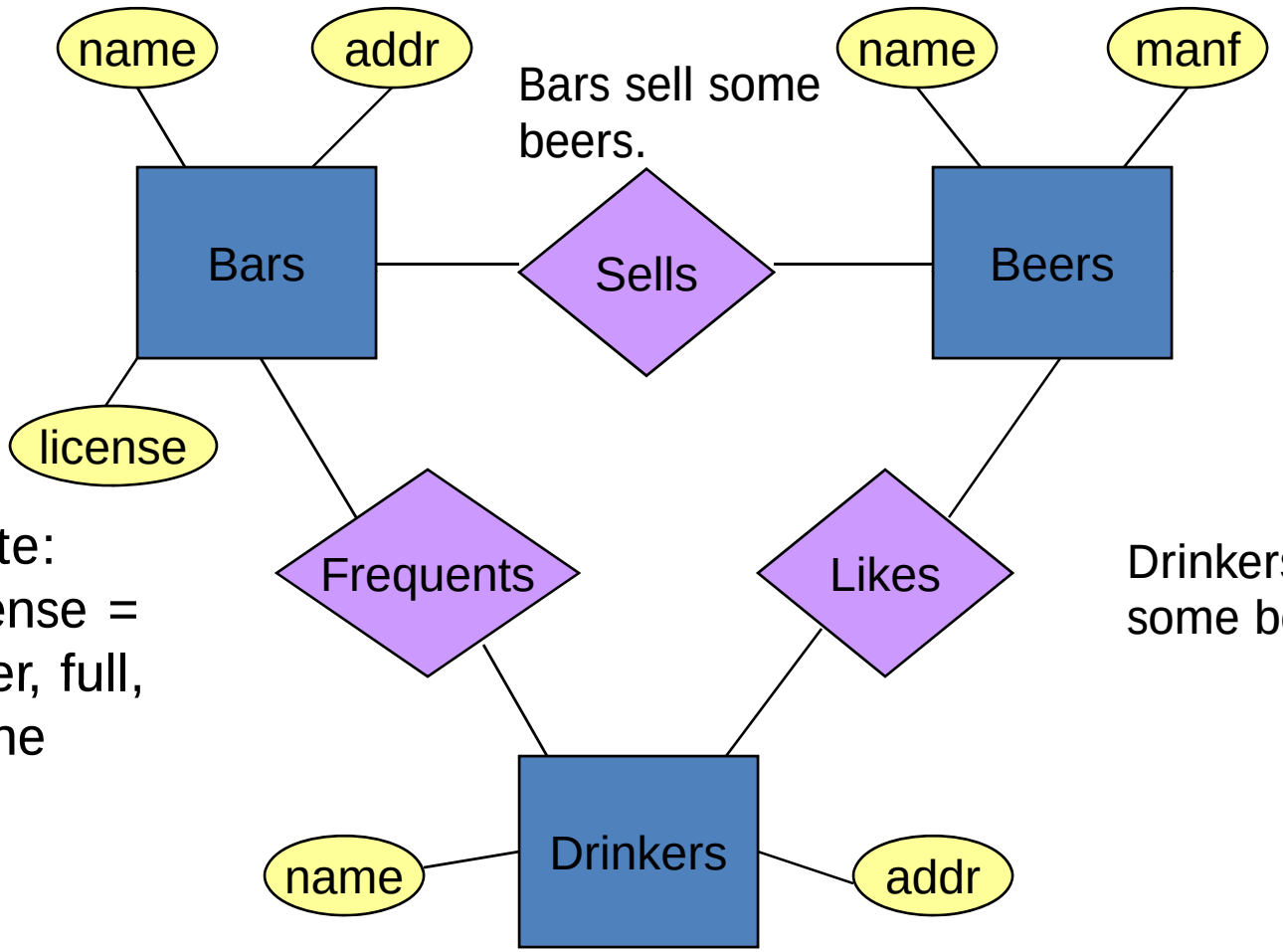


- Entity set Beers has two attributes, name and manf (manufacturer).
- Each Beer entity has values for these two attributes, e.g. (Bud, Anheuser-Busch)

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



Note: license = beer, full, none

Relationship Set

- The current "value" of an entity set is the set of entities that belong to it.
  - Example: the set of all bars in our database.
- The "value" of a relationship is a set of lists of currently related entities, one from each of the related entity sets.

Example

- A relationship R between entity sets E and F relates some entities in E to some entities in F.
- R is a set of pairs of tuples (e, f) where e is in E and f is in F.

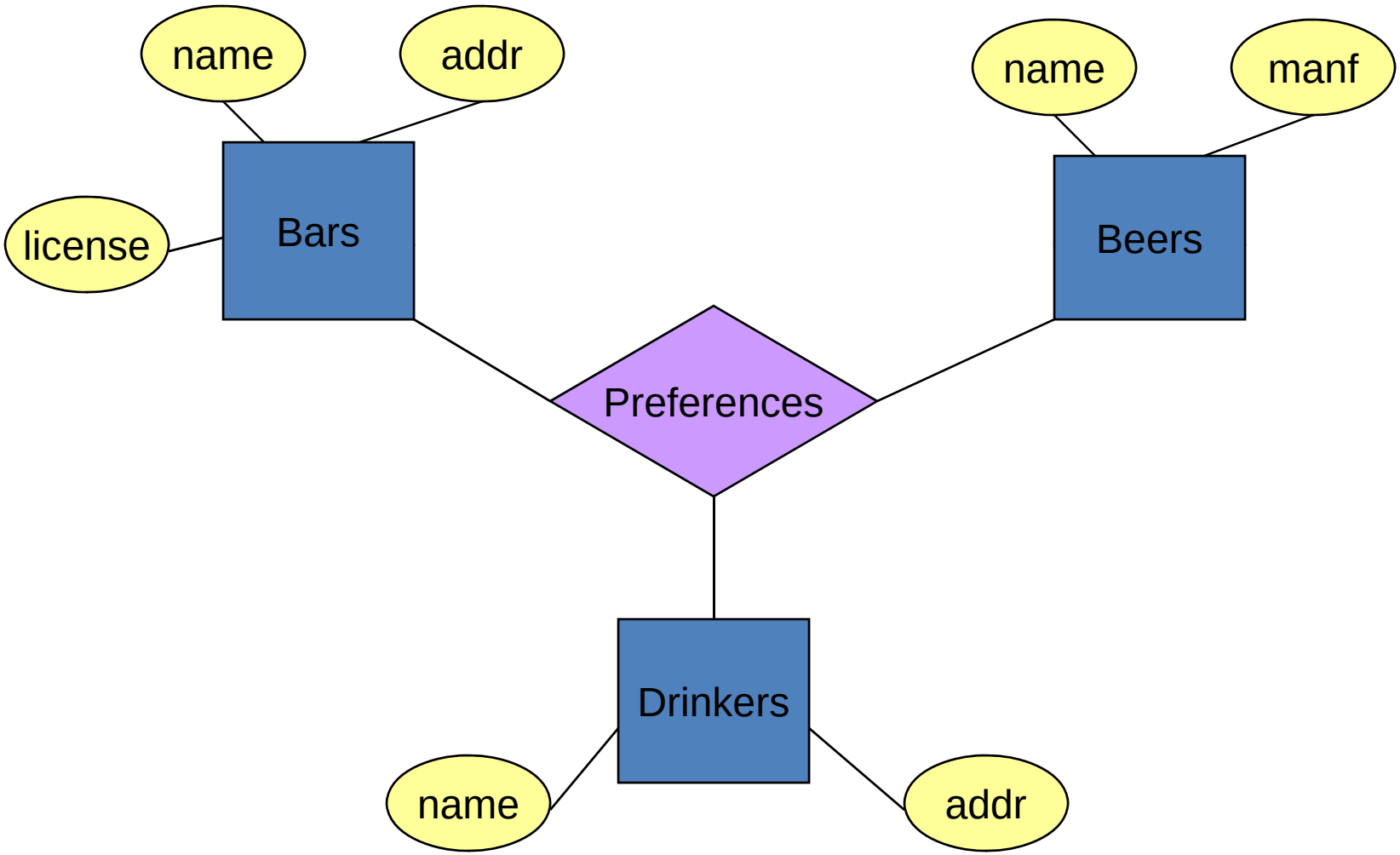
- For the relationship *Sells*, we might have a relationship set like:

Bar	Beer
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.
- Suppose that drinkers will only drink certain beers at certain bars.
  - Our three binary relationships Likes, Sells, and Frequents do not allow us to make this distinction.
  - But a 3-way relationship would.

Example


name
addr
license
Bars
name
manf
Beers
Preferences
Drinkers
name
addr

A Typical Relationship Set

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

Many-Many Relationships

- Think of a relationship between two entity sets, such as *Sells* between *Bars* and *Beers*.
- In a *many-many* relationship, an entity of either set can be connected to many entities of the other set.
  - E.g., a bar sells many beers; a beer is sold by many bars.

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.

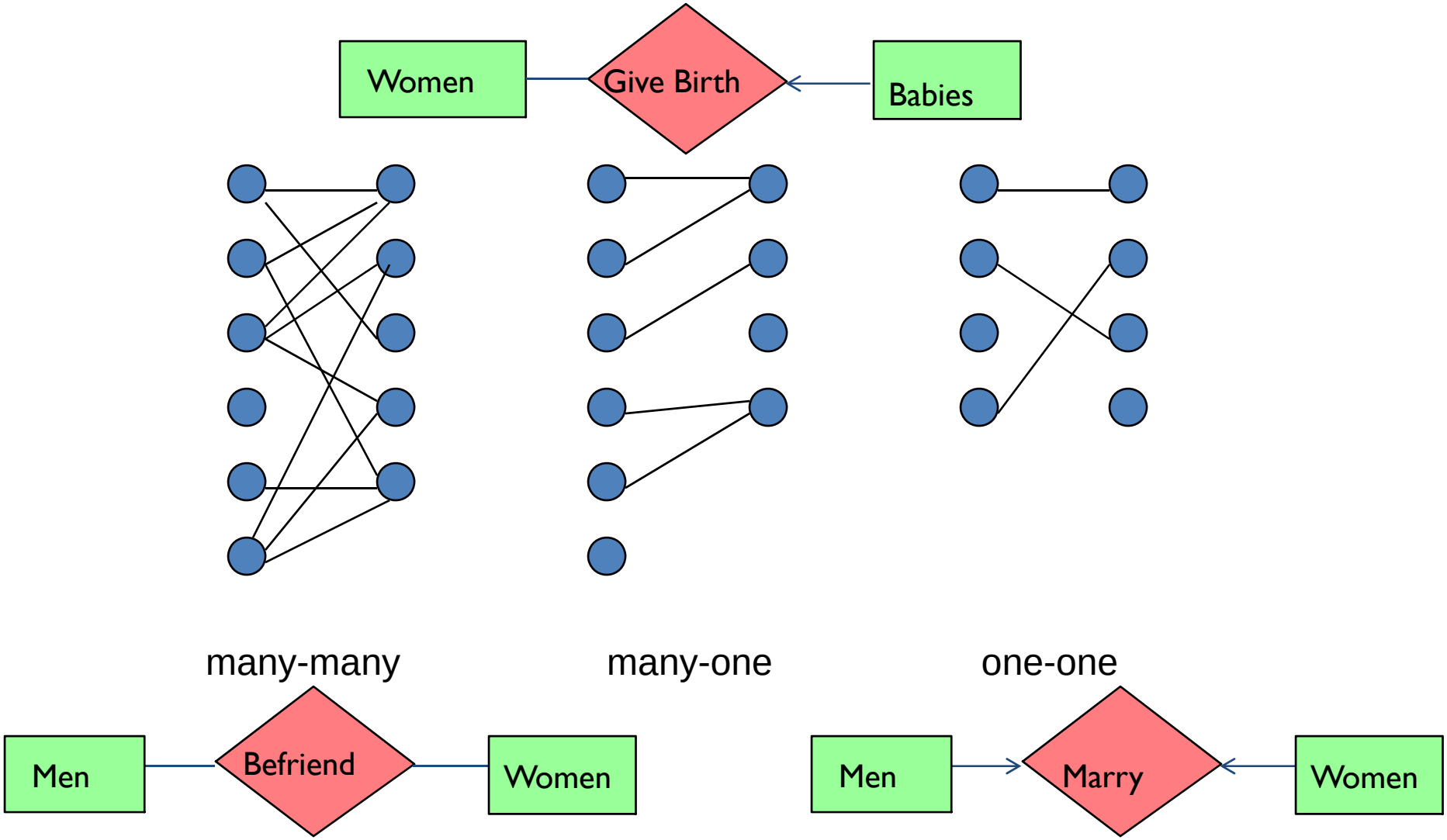
Example

- *Favorite*, from *Drinkers* to *Beers* is many-one.
- A drinker has at most one favorite beer.
- But a beer can be the favorite of any number of drinkers, including zero.

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 *Best-seller* between entity sets *Manfs* (manufacturer) and *Beers*.
  - A beer cannot be made by more than one manufacturer, and no manufacturer can have more than one best-seller (assume no ties).

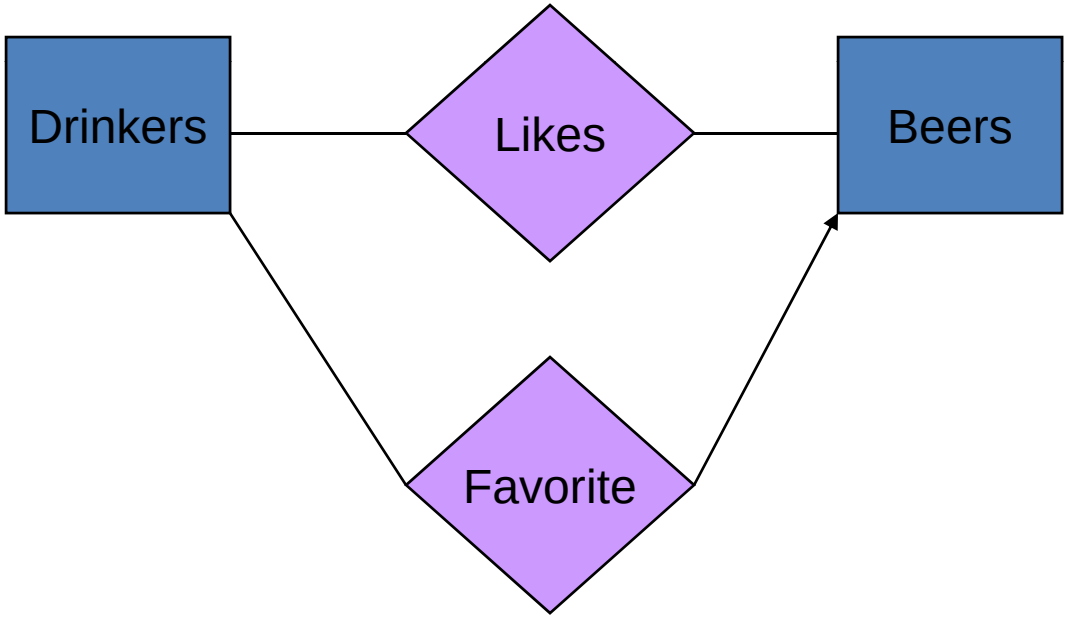
In Pictures:


Women
Give Birth
Babies
many-many
many-one
one-one
Men
Befriend
Women
Men
Marry
Women

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.
- In some situations, we can also assert "exactly one," i.e., each entity of one set must be related to exactly one entity of the other set. To do so, we use a rounded arrow.

Example

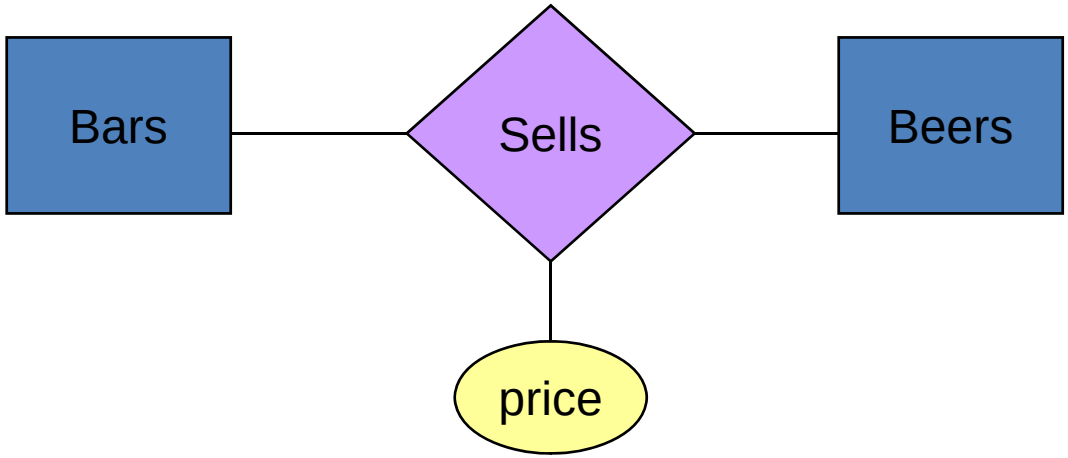


Example

- Consider *Best-seller* between *Manfs* and *Beers*.
- 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 (we assume they are beer manufacturers).

Attributes on Relationships

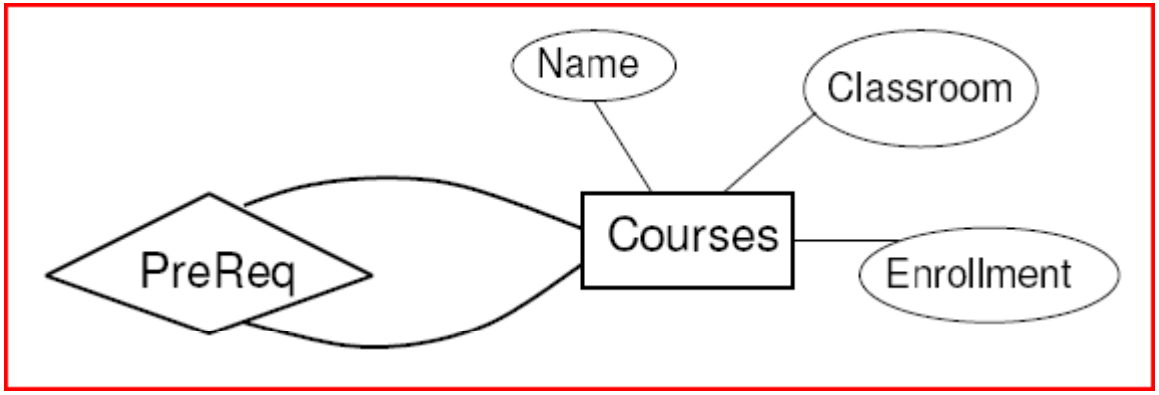
- Sometimes it is useful to attach an attribute to a relationship.
- Think of this attribute as a property of tuples in the relationship set.



Price is a function of both the bar and the beer, not of one alone.

Relationships

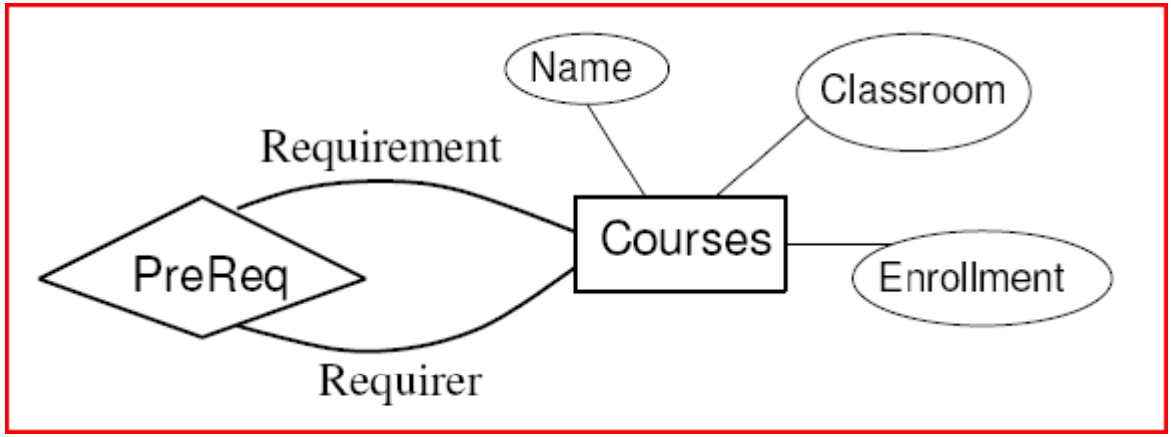
- Can the same entity set appear more than once in the same relationship?
- Prerequisite relationship between two Courses



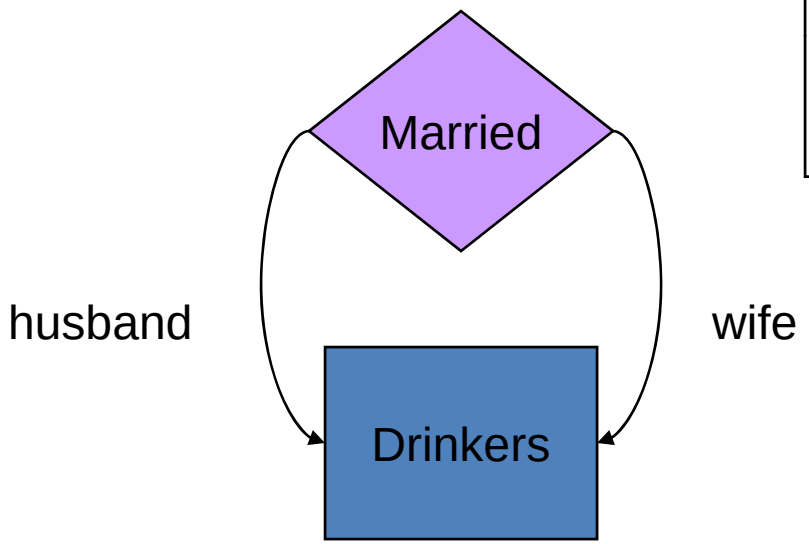
- Which course is the pre-requisite?

Roles

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



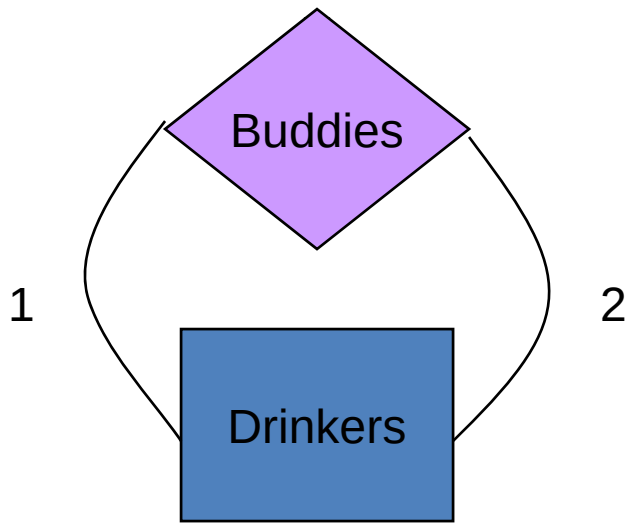
Example



Relationship Set

Husband	Wife
Bob	Ann
Joe	Sue
…	…

Example

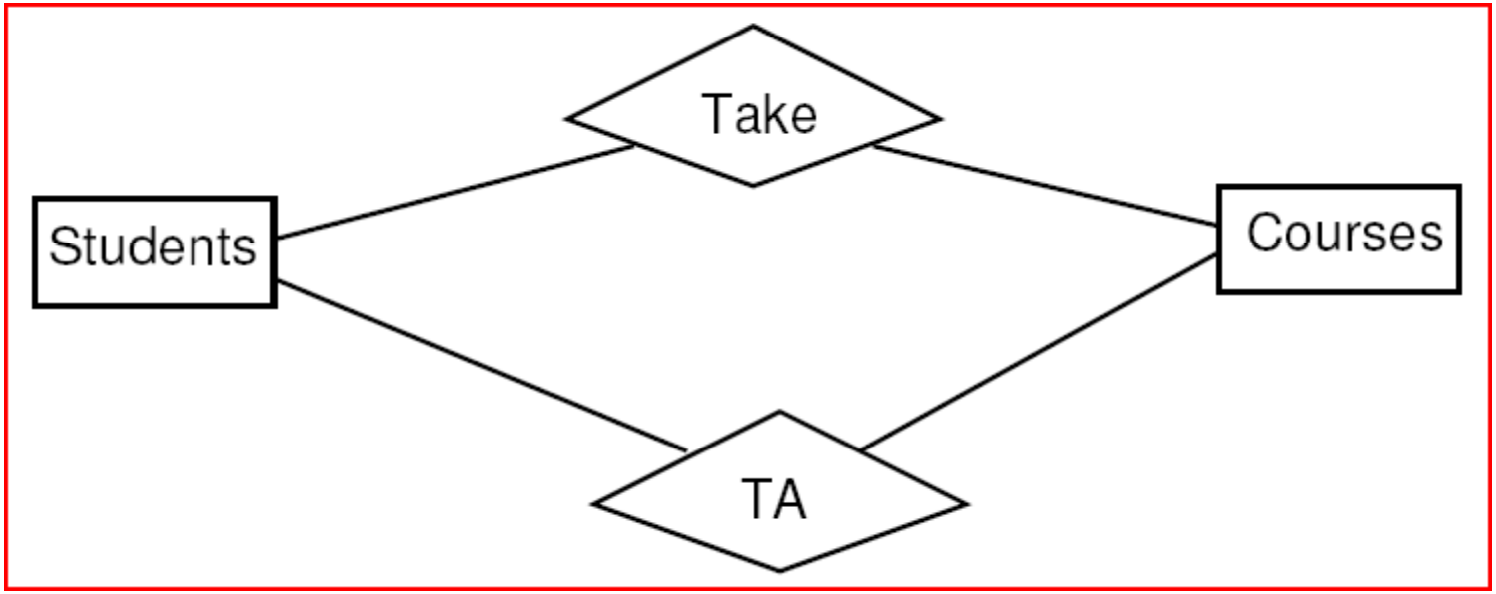


Relationship Set

Buddy1	Buddy2
Bob	Ann
Joe	Sue
Ann	Bob
Joe	Moe
…	…

Parallel Relationships

- Can there be more than one relationship between the same pair of entities?
- TA and Take relationship between Students and Classes



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