ENTITY-RELATIONSHIP MODEL

Overview of Database Design

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

Purpose of E/R Model

- The Entity/Relationship (E/R) model allows us to sketch database schema designs.
  - Includes some constraints
- Schema designs are pictures called *entity-relationship diagrams*.
- Later: convert E/R designs to relational DB designs.

Credit: Renee J. Miller

Framework for E/R

- Design is a necessity.
- Management know they want a database, but they don't know what they want in it.
- Sketching the key components is an efficient way to develop a working database.

Entity Sets

5

- *Entity* = "thing" or object.
- *Entity set* = collection of similar entities.
  - Similar to a class in object-oriented languages.
- *Attribute* = property of an entity set.
  - Attributes are simple values, e.g. integers or character strings, not structs, sets, etc.
  - Each attribute has a *domain*.

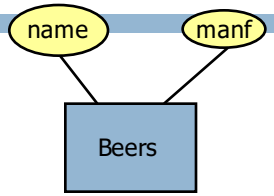
E/R Diagrams

6

- In an entity-relationship diagram:
  - Entity set = rectangle.
  - Attribute = oval, with a line to the rectangle representing its entity set.
  - Notation varies: some textbooks represents attributes within the (entity) rectangle

Example

7



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

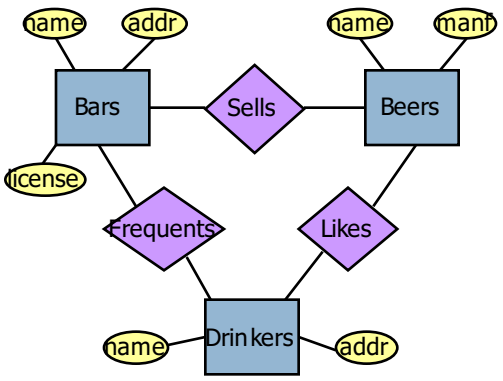
Relationships

8

- A relationship connects two or more entity sets.
- It is represented by a diamond, with lines to each of the entity sets involved.

Example: Relationships

9



Bars sell some beers.

Drinkers like some beers.

Drinkers frequent some bars.

Relationship Set

10

- 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 *relationship set*, a set of tuples with one component for each related entity set.

Example: Relationship Set

11

- 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

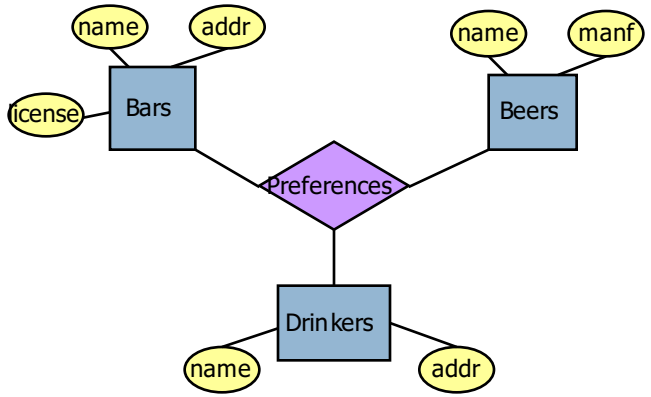
Multiway Relationships

12

- 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: 3-Way Relationship

13



A Typical Relationship Set

14

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

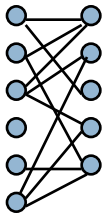
Many-Many Relationships

15

- Focus: binary relationships, 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.

In Pictures:

16



many-many

Note: each line is an instance of the binary relationship

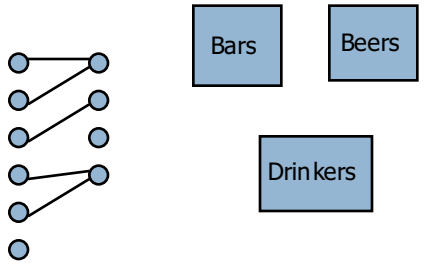
Many-One Relationships

17

- 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:

18



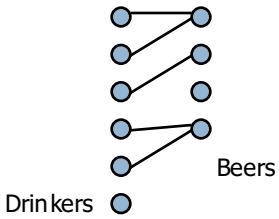
many-one

(Partial) Function on entity set

Example: Many-One Relationship

19

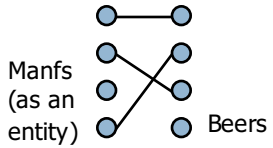
- Favourite, from Drinkers to Beers is many-one.
- A drinker has at most one favourite beer.
- But a beer can be the favorite of any number of drinkers, including zero.



One-One Relationships

20

- 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 is the best seller for 0 or 1 manufacturers, and no manufacturer can have more than one best-seller (assume no ties).



Representing "Multiplicity"

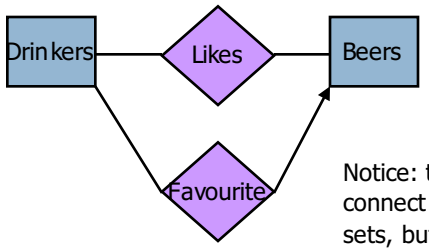
21

- Show a many-one relationship by an arrow entering the "one" side.
  - "at most one"
- Show a one-one relationship by arrows entering both entity sets.

Rounded (open) arrow = "exactly one," i.e., each entity of the first set is related to exactly one entity of the target set.

Example: Many-One Relationship

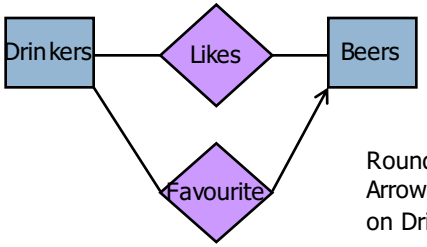
22



Notice: two relationships connect the same entity sets, but are different.

Example: Many-One Relationship

23



Rounded (open)
Arrow = total function on Drinkers

Example: One-One Relationship

24

- Consider Best-seller between Manfs and Beers.
- Some beers are not the best-seller of any manufacturer
- But a beer manufacturer has to have a best-seller.

In the E/R Diagram

25

A beer is the best-seller for 0 or 1 manufacturer.

A manufacturer has exactly one best seller.

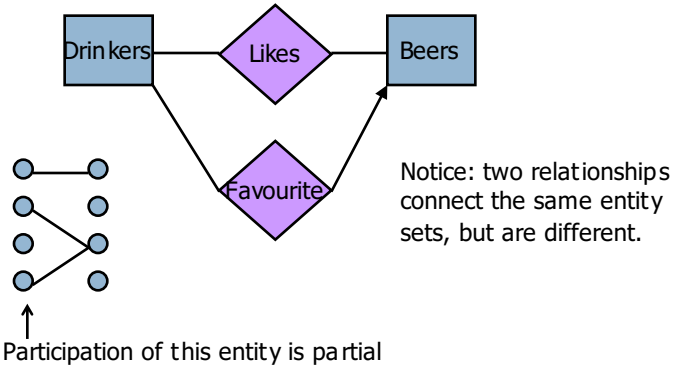
Participation Constraints

26

- Does every student have to take a course?
  - If so, this is a *participation constraint*: the participation of Students in Enrolled is said to be *total* (vs. *partial*).
  - Every *sid* value in Students table must appear in a row of the Enrolled table (with a non-null *sid* value!)
- Textbook notation: total participation represented by a thick (bolded) line originating from entity

Example: Many-One Relationship

27

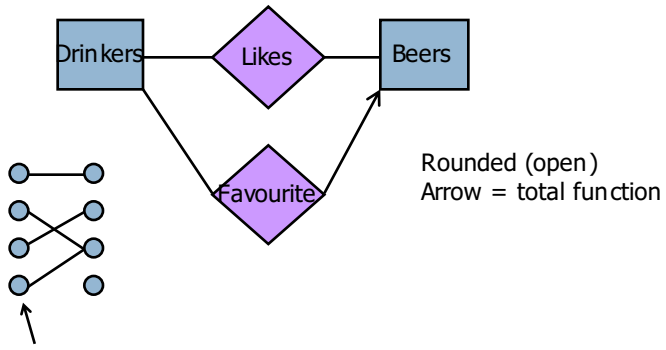


Notice: two relationships connect the same entity sets, but are different.

Participation of this entity is partial

Example: Many-One Relationship

28

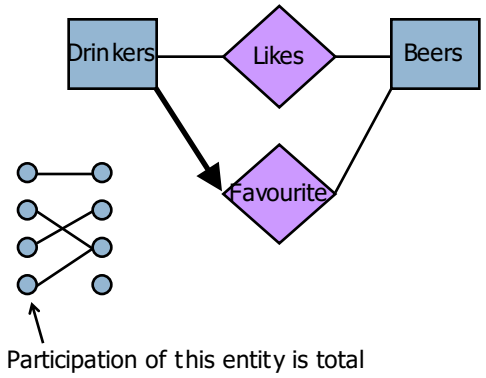


Rounded (open)
Arrow = total function

Participation of this entity is total

Alternative (Textbook) Notation

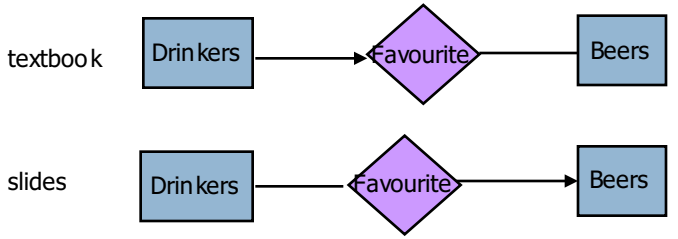
29



Notation

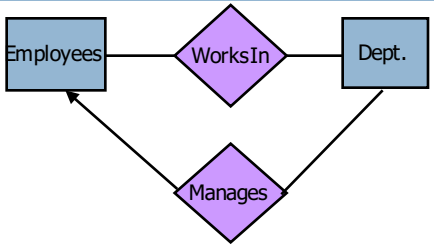
30

- Be consistent with your chosen notation!



Key Constraints

31



- Many-many: "An employee can work in many depts, and a dept. can have many employees
- One-many: A dept has at most one manager, and employees can manage many departments

Participation Constraints

32

- Does every dept. have to have a manager?
  - If yes, then every dept. must appear in the manages relation: total participation (vs. partial)