The Entity-Relationship Model (Part I)

R &G - Chapter 2

Steps in Database Design

1. **Requirements Analysis**
   - user needs (what must database do?)
2. **Conceptual Design**
   - high level descr
3. **Logical Design**
   - translate ER into DBMS data model

Design a database

4. **Schema Refinement**
   - consistency, normalization

Design a GOOD database

5. **Physical Design** - indexes, disk layout
6. **Security Design** - who accesses what, and how

Today's Class

- Requirements Analysis
  - user needs; what must database do?
- Conceptual Design
  - high level description (often done w/ER model)
- Logical Design
  - translate ER into DBMS data model
- Schema Refinement
  - consistency, normalization
- Physical Design - indexes, disk layout
- Security Design - who accesses what, and how

Conceptual Database Design

- ER model: (E - *entities*, R – *relationships)*
*Informally*
  - Entities are usually (relevant) nouns
    - "Stevens has full-time and part-time students."
    - "Stevens has around one hundred faculty members." (What are the entities?)
  - Relationships are statements about 2 or more objects.
    - Often, verbs.
    - e.g., "a prof teaches a course" (What is the relationship?)

Conceptual Database Design (Cont.)

- Besides entities & relations, what else?
  - What information about entities & relationships should be stored in the database?
  - What rules (called *integrity constraints*) should hold on these entities and relationships?

- In relational databases, this is generally encoded in an **Entity-Relationship (ER) Diagram**

ER Diagram: Entities (Formally)

- *Entity:* 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)*.
    - Each attribute has a *domain.*
    (e.g., float, date, int, colour)
    - Pay attention to the shape of entities and attributes in ER diagram!

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Exercise: ER

dname

did

budget

Departments
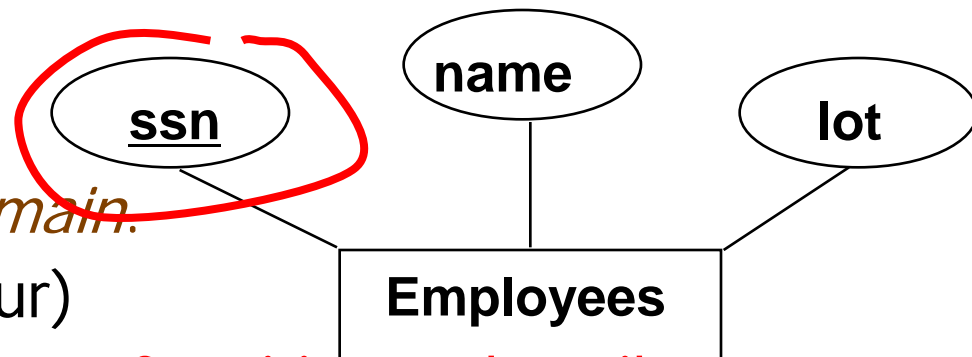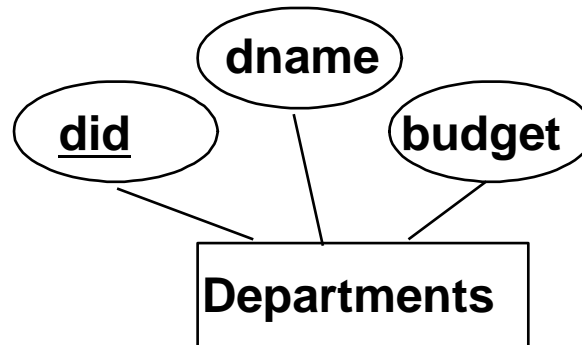
- What is the entity set?
- What are the attributes?
- What is the key?

Exercise: ER Design (1)

- The supermarket ShopRite! hires you to design a database for its product inventory. Each product has the information of ID, description, category, price, and expiry date.

- **Question:**
  - What are the entities?
  - What are the attributes of the entities?
 - Draw the ER diagram.

Exercise: ER Design (2)

- Assume you want to design an annual student directory (a prototype of Facebook II)
- The main concepts you need to describe include
  - Users (ID, age, gender, school)
  - Friend & enemy relations among users

- **Questions**
  - What are the entities?
  - What are the attributes of the entities?
 - Draw the ER diagram (*only the Entity part for now*).

Keys of Entities

- A *superkey* = a set of attributes which, taken collectively, identify <u>uniquely</u> an entity in an entity set
  - *Question*: the set of all attributes of the entity set is a superkey (True/false?)
- A **key** (or *candidate* key) = a superkey for which no proper subset is a superkey (~ **minimal** superkey)
  - Each entity set must have a key!
- There can be more than one key for an entity set
  - A *primary* **key** = the key chosen as the principal means to identify entities in an entity set
  - The primary key is <u>underlined</u> in ER diagram

Exercise: Keys
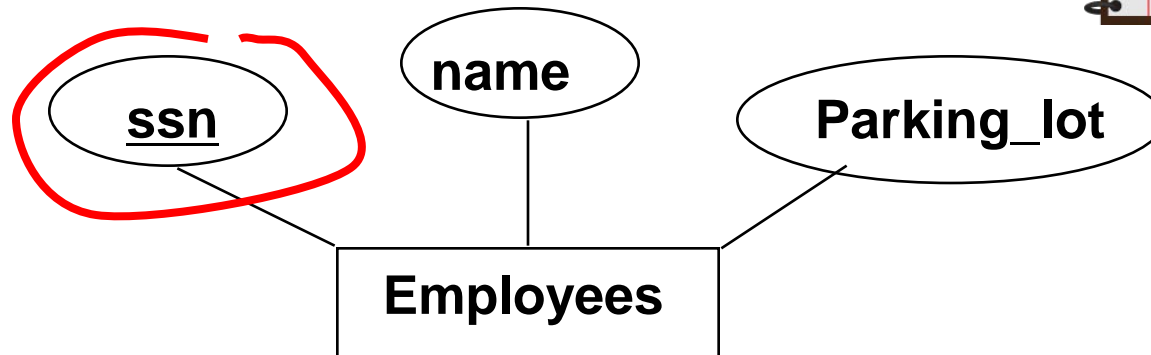
- **Is (ssn) a superkey?**
- **Is (ssn) a key?**
- **Is (ssn, name, parking_lot) a superkey?**
- **Is (ssn, name, parking_lot) a key?**

Relationships
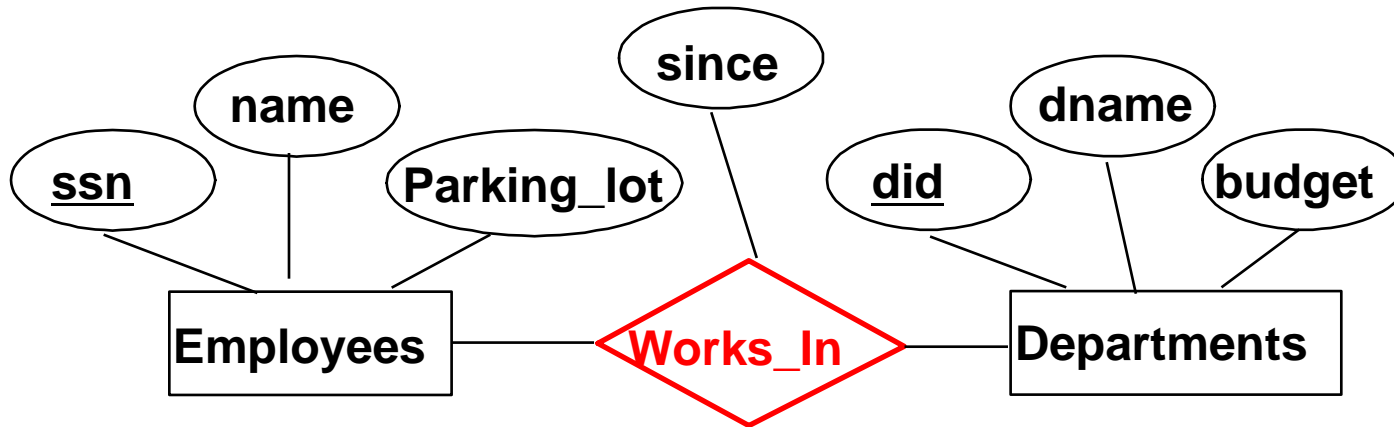
- *Relationship*: **Association among two or more entities.**
  - E.g., Alan works in Pharmacy department. Alice works in HR department

- *Relationship Set*: **Collection of similar relationships.**
  - An n-ary relationship set R relates n entity sets $E_1 \dots E_n$; each relationship in R involves entities $e_1 \in E_1, \dots, e_n \in E_n$
  - Relationship sets can have their own attributes.

- **Pay attention to the shape of relationships in ER diagram!**
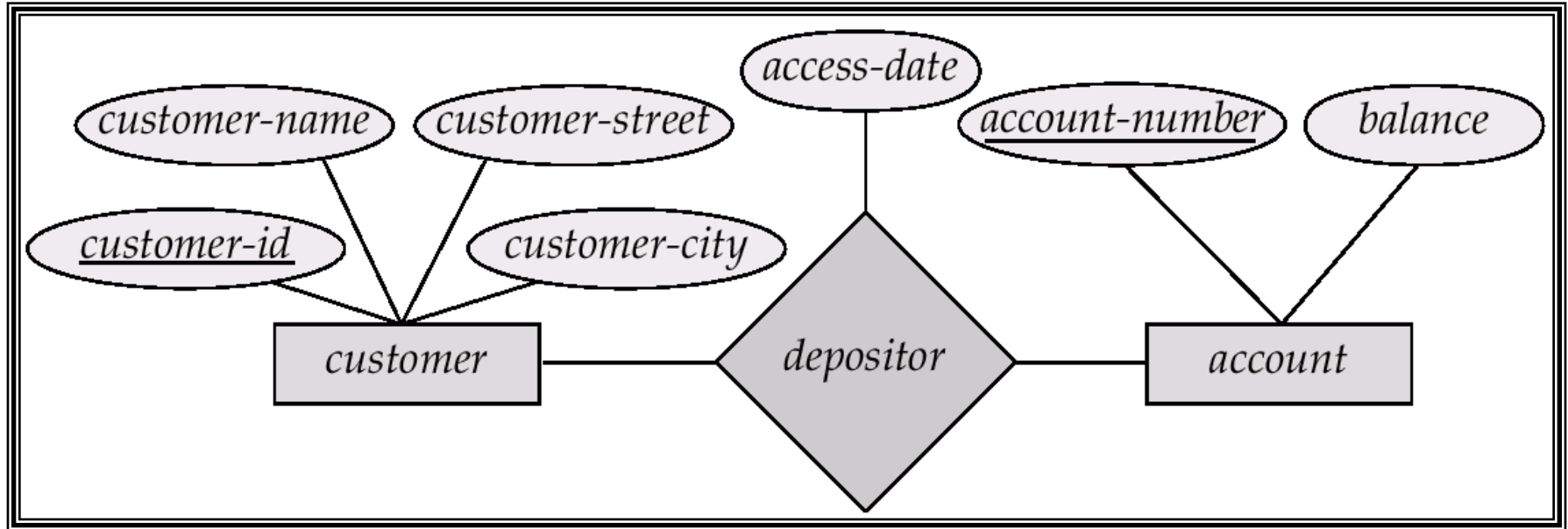
Degree of A Relationship

- **Degree : the number of participating entities.**
  - Degree 2: binary
  - Degree 3: ternary
  - Degree n: n-ary

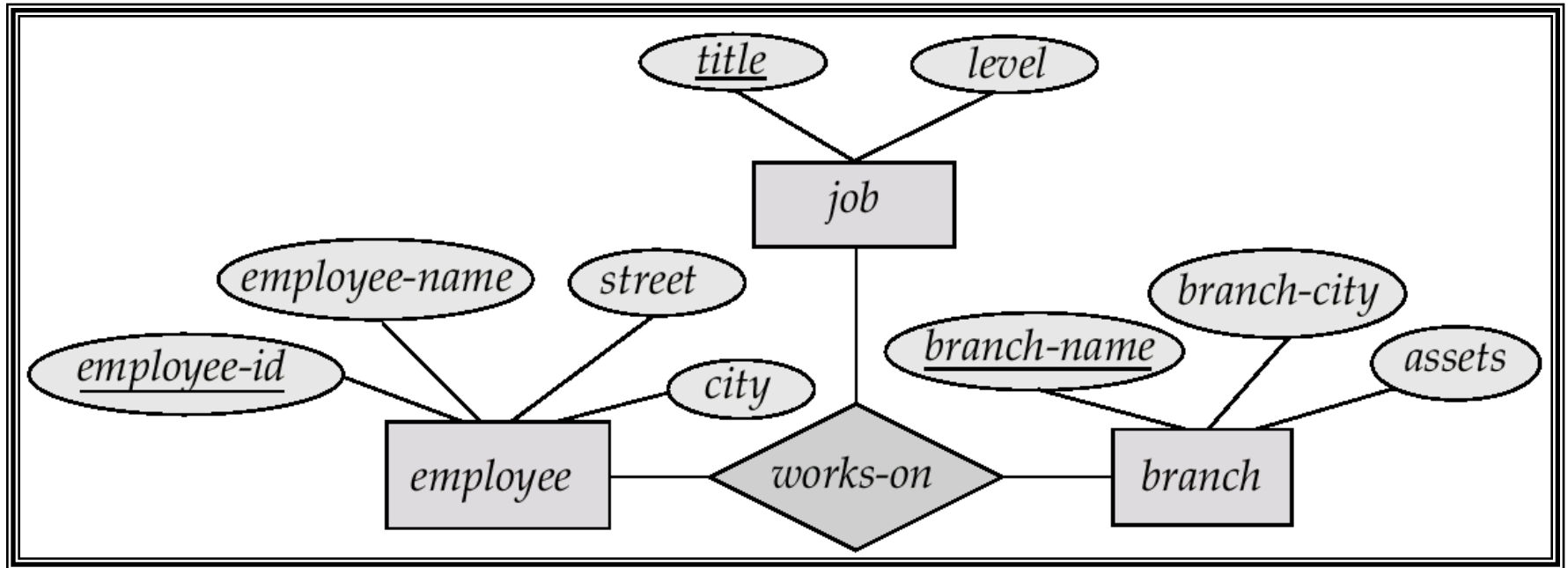- **Binary relationships are very common and widely used.**

More Relationship Examples
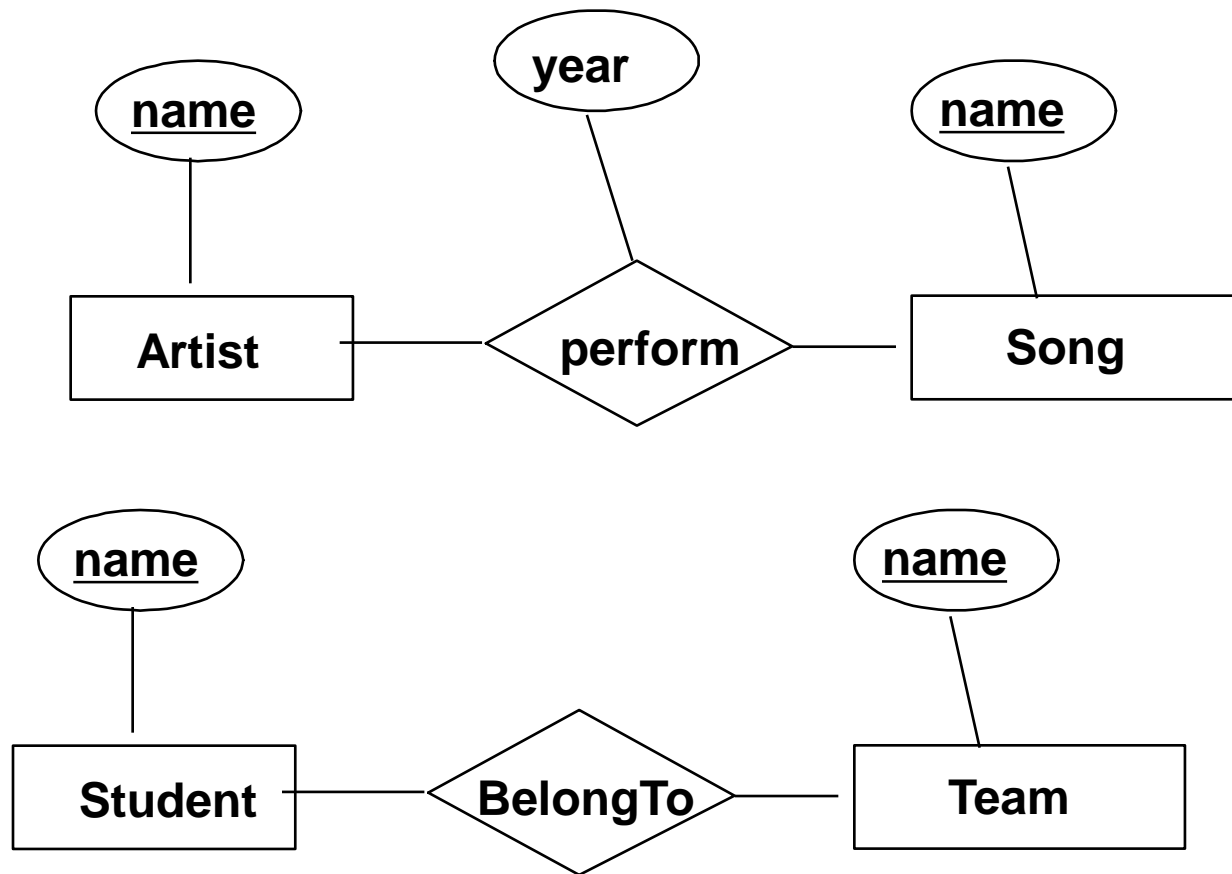
More Relationship Examples (Cont.)

Relationships of More than 2 Entity Sets

Ternary Relationship

# Exercise: Facebook II (cont.)

- Assume you want to design an annual student directory (a prototype of Facebook II)
- The main concepts you need to describe include
  - Users (ID, age, gender, address, ...)
  - Friend & enemy relations among users

Questions
  - What are the entities in the directory?
  - What are the attributes of the entities?
  - What are the relationships between the entities?
 - Draw the ER diagram

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Roles in Relationships

- Same entity set can participate more than once in the same relationship, with different "roles".
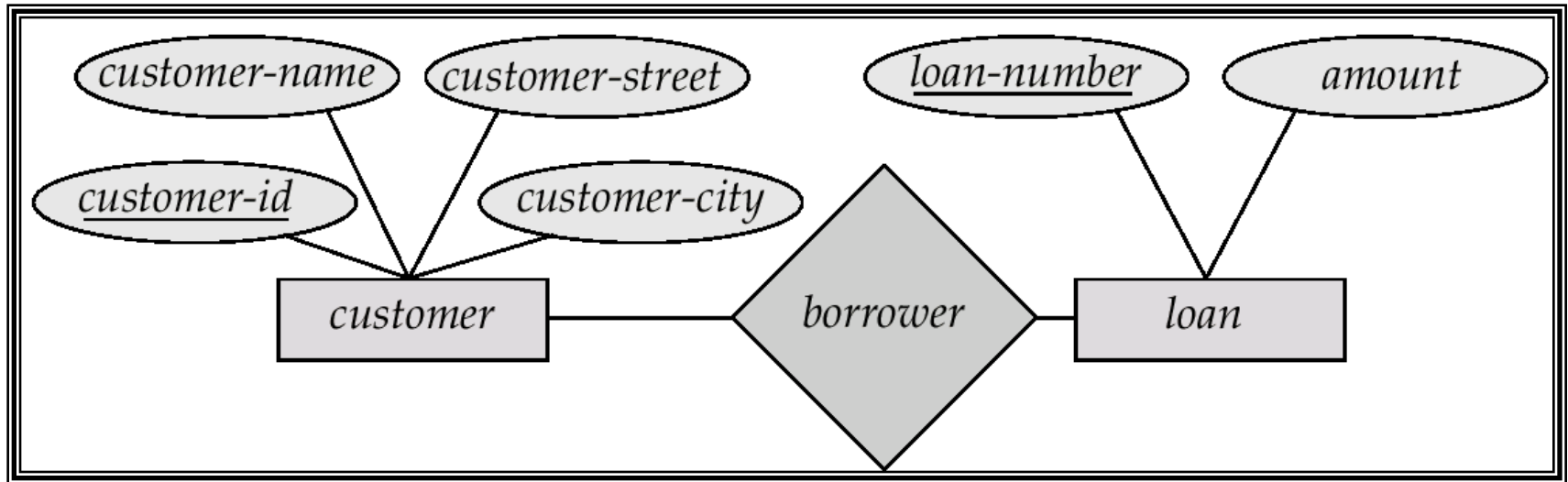 - Also called as **recursive relationship**
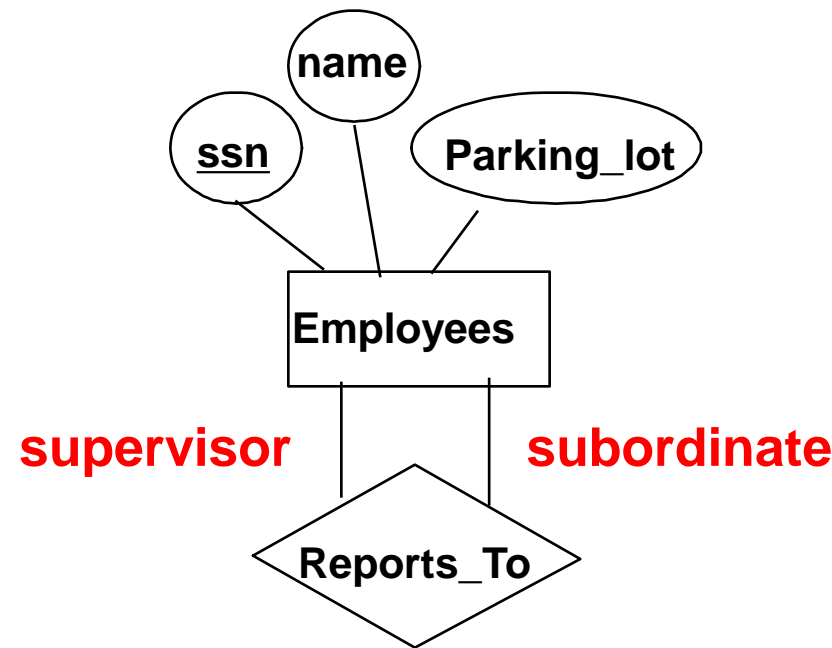
Exercise: Relationships in Twitter

- **In Twitter, there are two types of relationships between users**
  - *Following others:* you are subscribing to their Tweets as a follower
  - *Being followed*: You have followers
- **Question:**
  - Draw the ER diagram of the relationship *Connect*

name

ID email

User

Connect
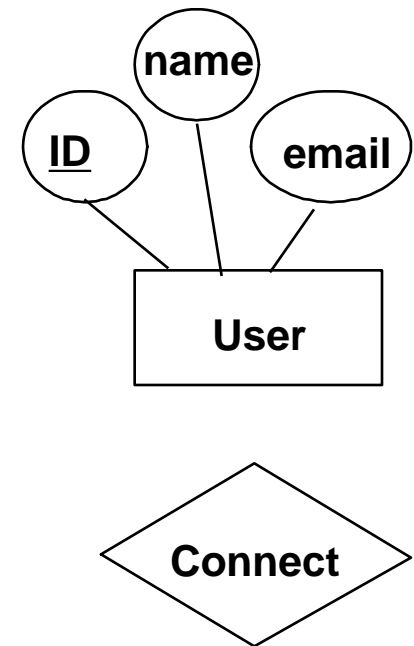
Summary: E-R Diagrams

- **Rectangles** represent entity sets.
- **Diamonds** represent relationship sets.
- **Lines** link attributes to entity sets and entity sets to relationship sets.
- **Ellipses** represent attributes of entity/relationship sets
- **Underline** indicates primary key attributes