INFO20003 Database Systems

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Lecture 03

Introduction to Data Modelling (ER)

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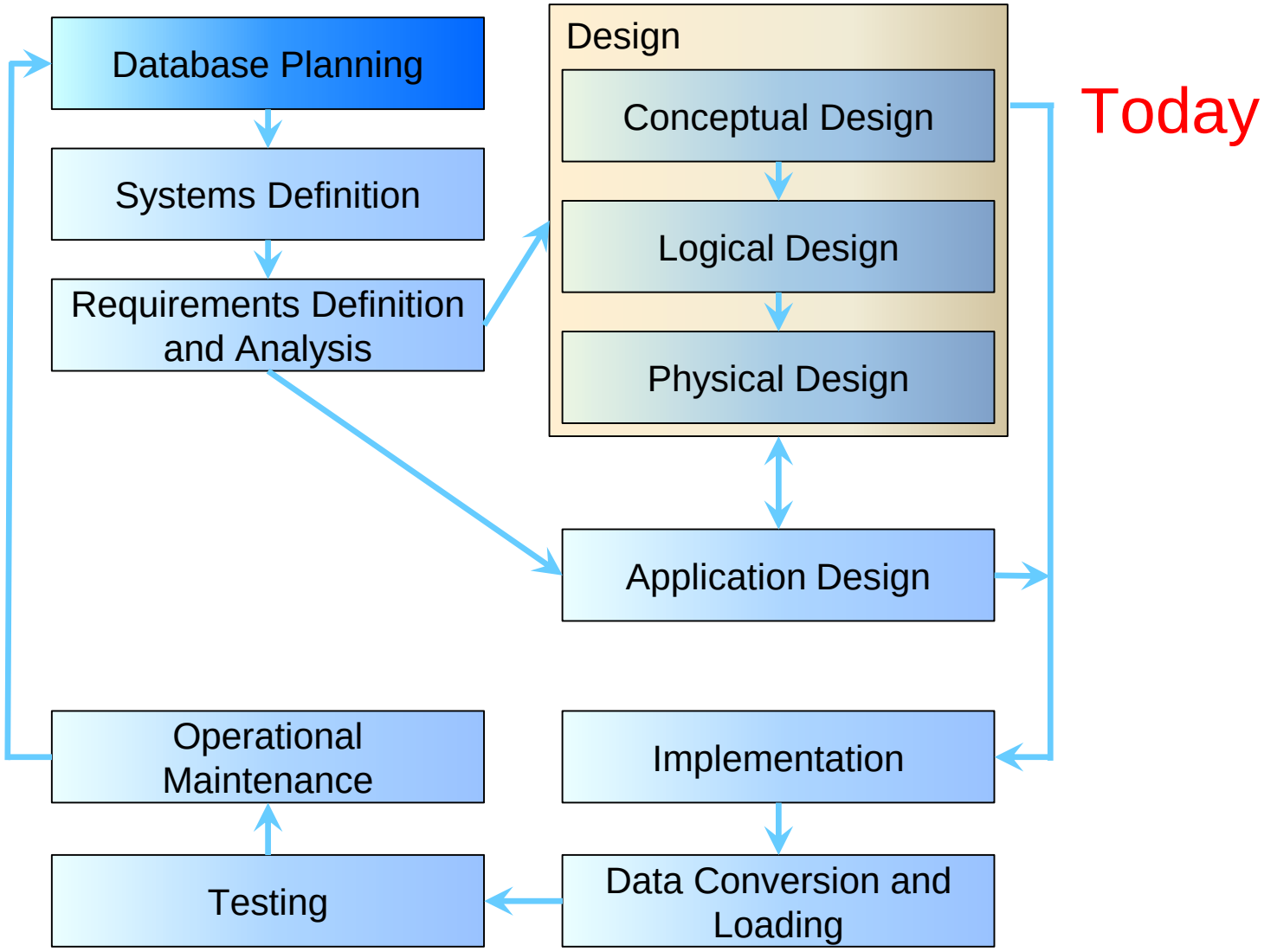
Database Development Lifecycle: Review



The Entity-Relationship Model

- Basic ER modeling concepts
- Constraints
- Conceptual Design

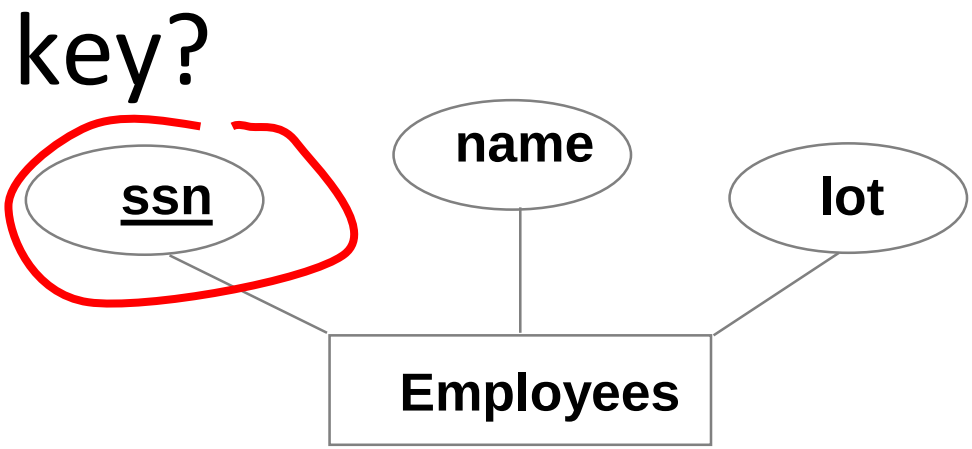
Readings: Chapter 2, Ramakrishnan & Gehrke, Database Systems

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* that hold?
- A database "schema" in the ER Model can be represented pictorially (*ER diagrams*)
- Can map an ER diagram into a relational schema

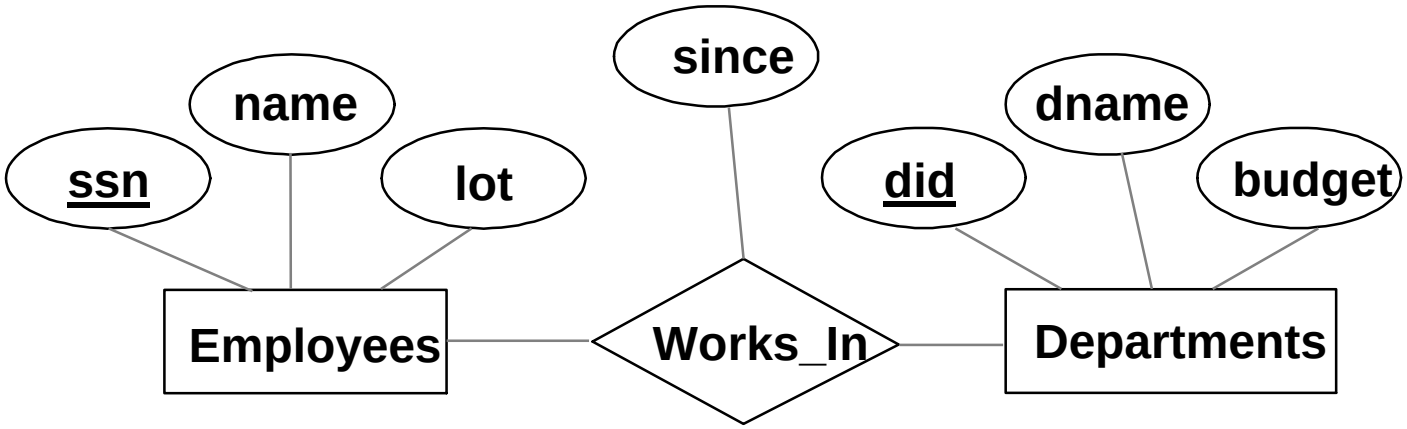
ER Model Basics

- *Entity:* Real-world object distinguishable from other objects. An entity is described (in DB) 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*



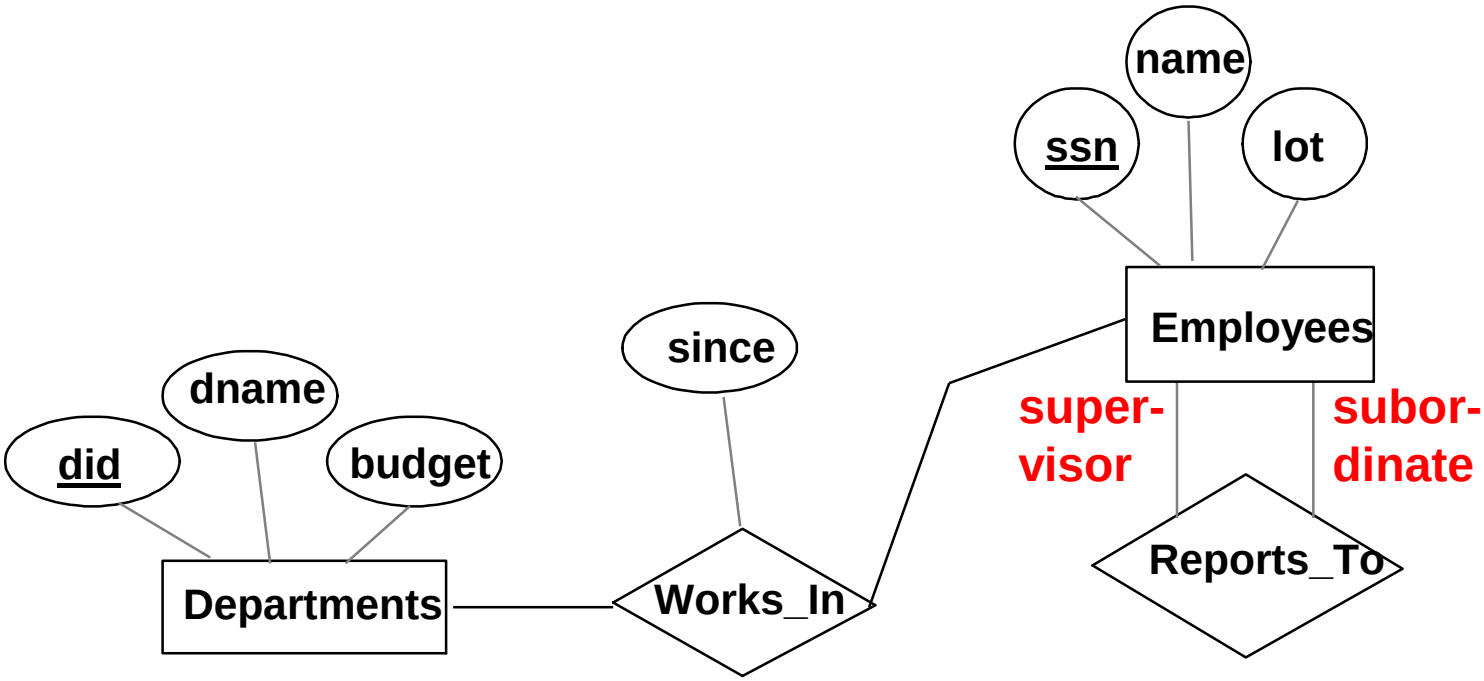
ER Model Basics

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



ER Model Basics (Cont.)

Same entity set can participate in different relationship sets, or in different “roles” in the same set



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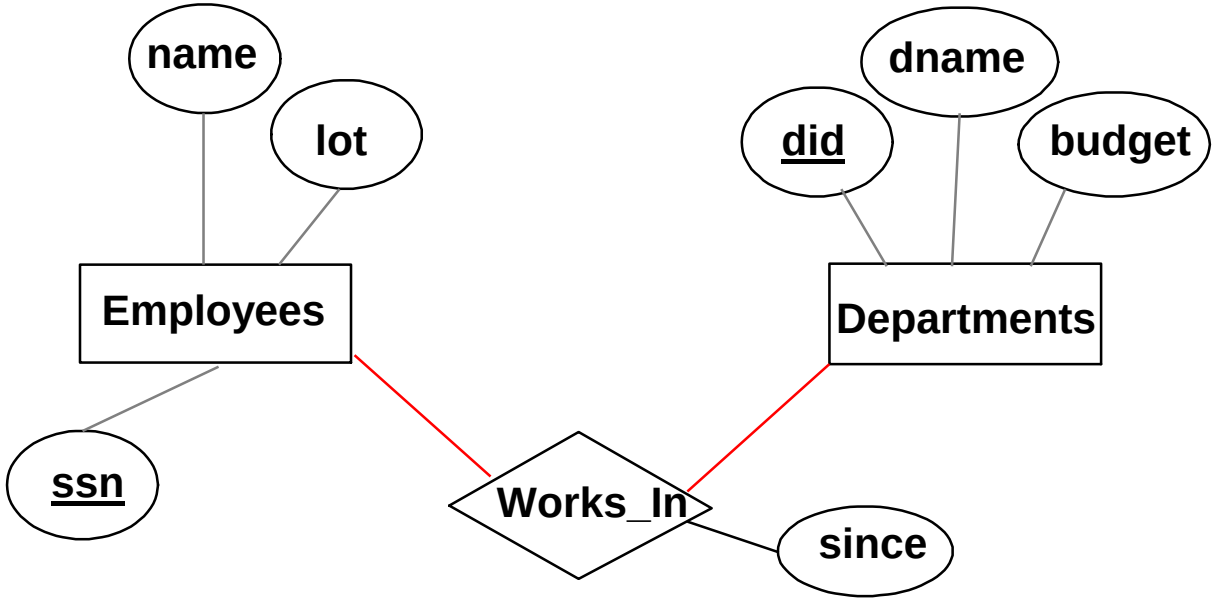
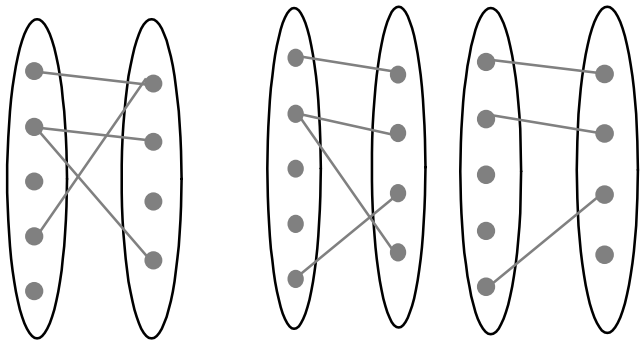
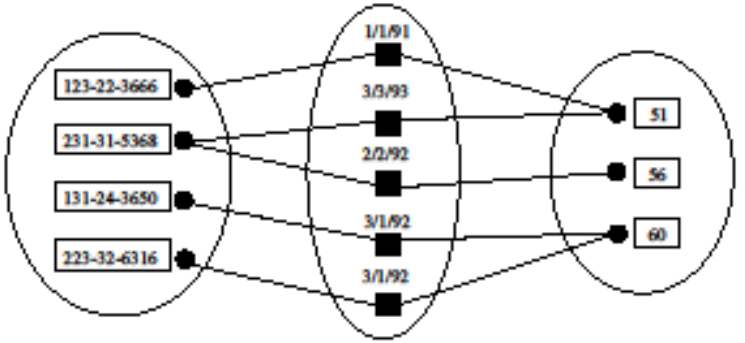
Key Constraints

- An employee can work in many departments; a department can have many employees





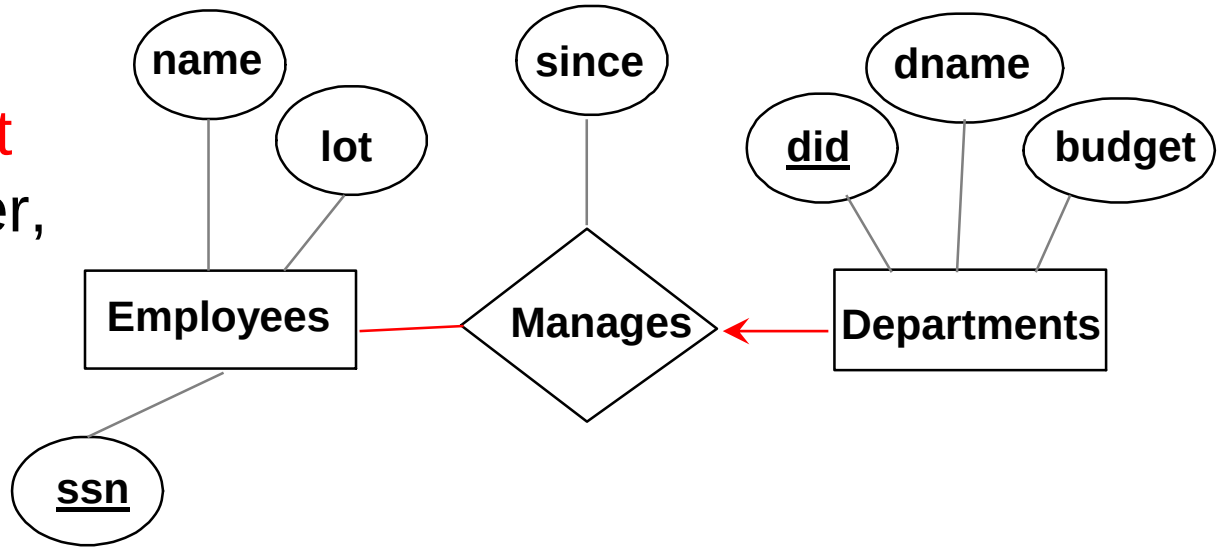
Many-to-Many 1-to Many 1-to-1

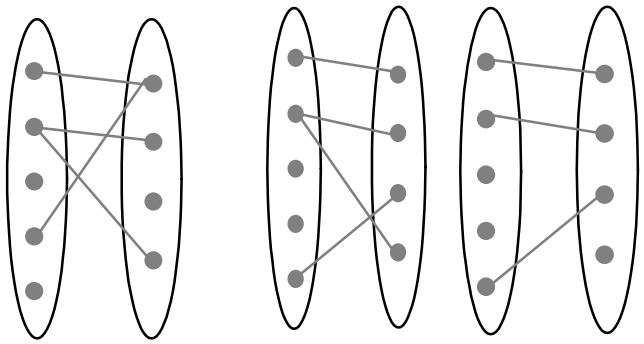


Employees Works_in Departments

Key Constraints

- In contrast, each department has at most one manager, according to the *key constraint* on Manages





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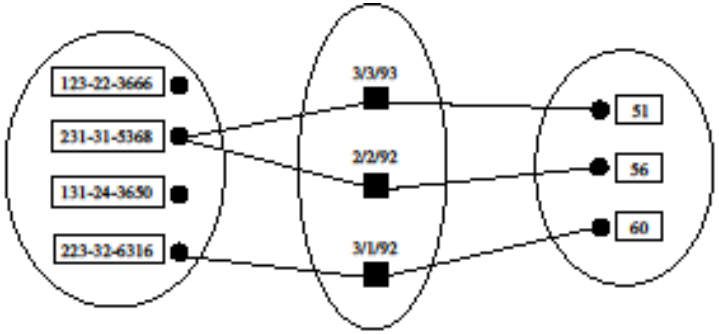
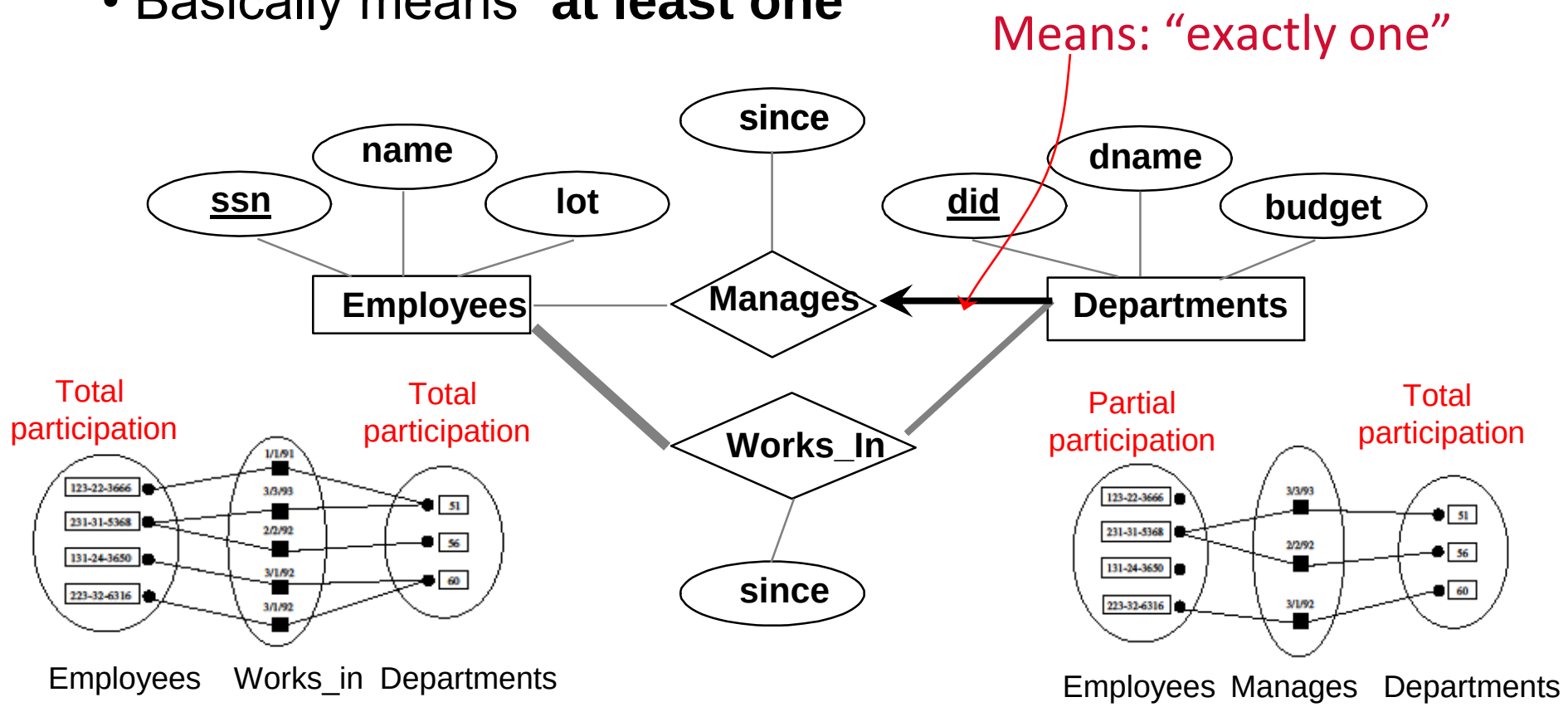


Employees Manages Departments

Participation Constraints

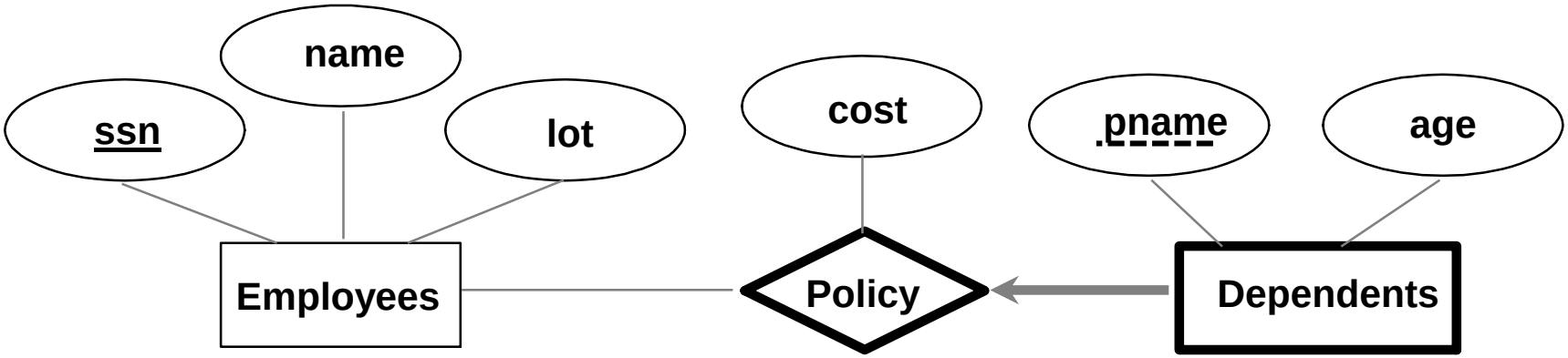
- Does **every** employee work in a department?
- If so, this is a *participation constraint*: the participation of Departments in Manages is said to be *total* (vs. *partial*)
- Basically means "**at least one**"



Weak Entities

A *weak entity* can be identified uniquely only by considering the primary key of another (*owner*) entity

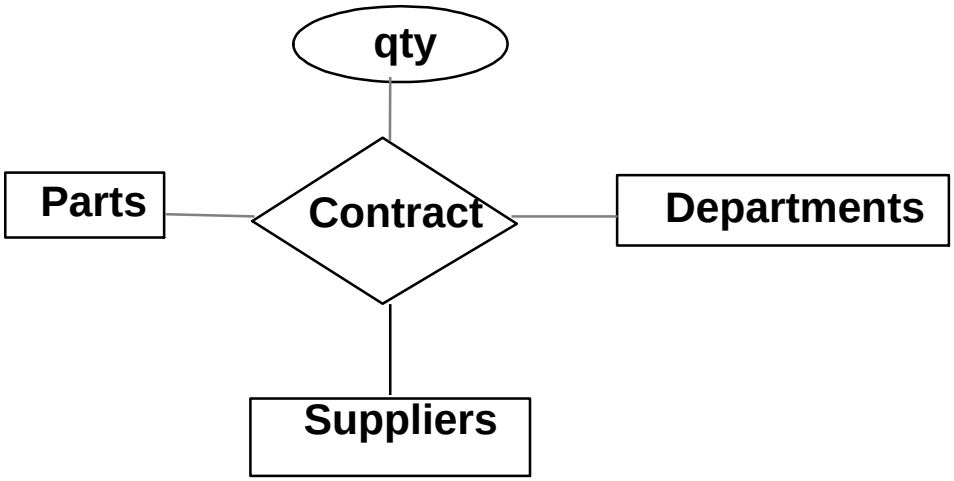
- Owner entity set and weak entity set must participate in a one-to-many relationship set (one owner, many weak entities)
- Weak entity set must have total participation in this *identifying* relationship set



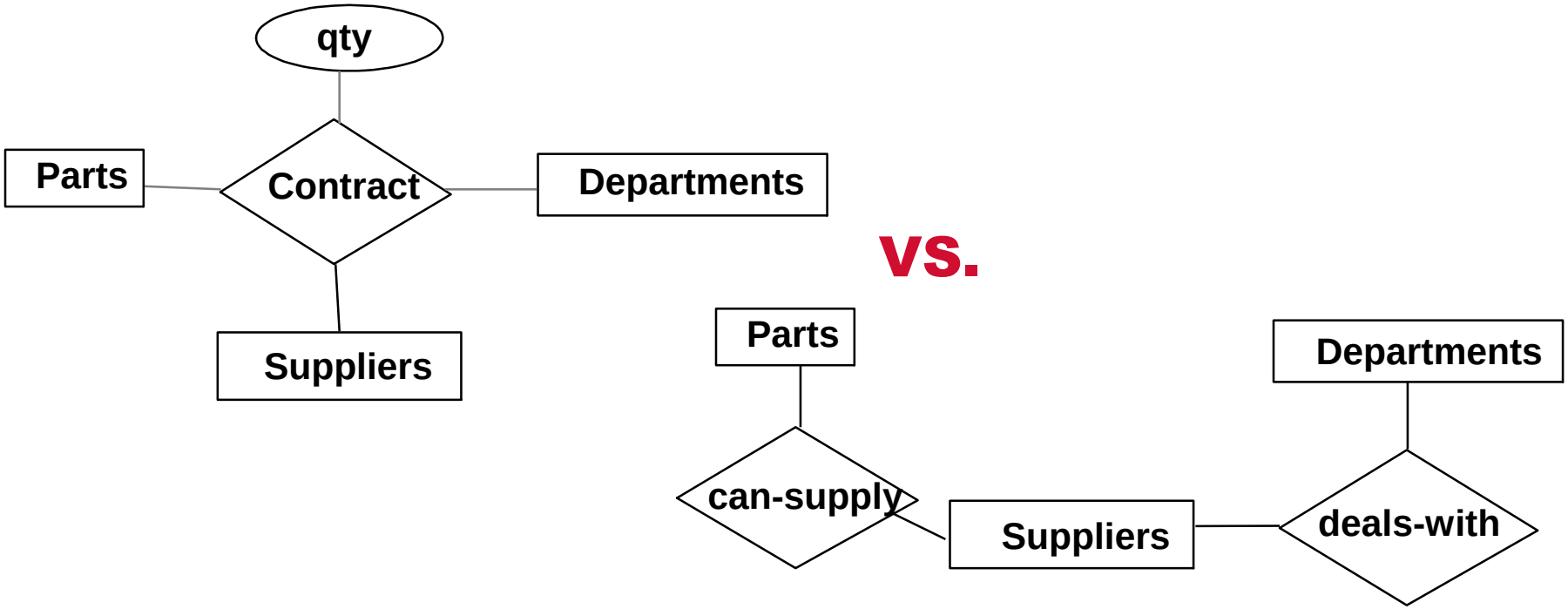
Weak entities have only a "partial key" (dashed underline)

Ternary Relationships

- In general, **n**-ary relationships



Ternary vs. Binary Relationships



- S “can-supply” P, D “needs” P, and D “deals-with” S does not imply that D has agreed to buy P from S
- How do we record *qty*?

Now you try

University database schema:

- *Entities:* Courses, Professors
- Each course has id, title, time

- **Make up suitable attributes for professors**

Now you try

1. Professors can teach the same course in several semesters, and each offering must be recorded.
2. Professors can teach the same course in several semesters, and only the most recent such offering needs to be recorded (assume this further).
3. Every professor must teach some course.
4. Every professor teaches exactly one course (no more, no less).
5. Every professor teaches exactly one course (no more, no less), and every course must be taught by some professor.

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Conceptual Design Using the ER Model

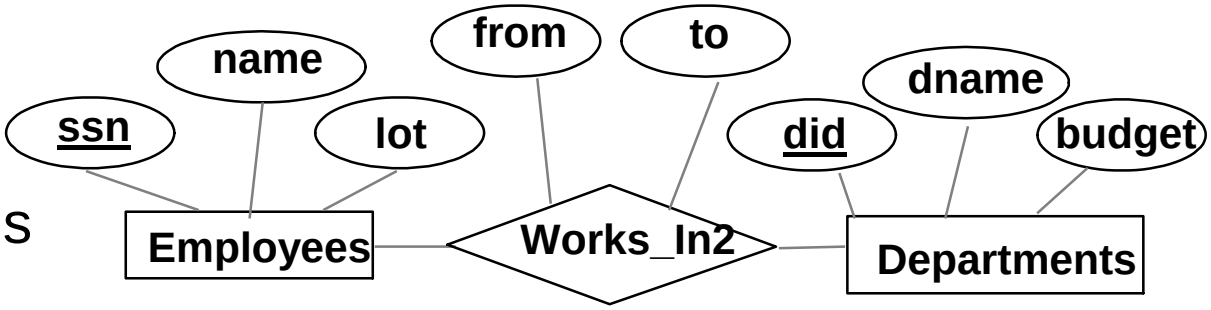
- Design choices:
  - Should a concept be modeled as an entity or an attribute?
  - Should a concept be modeled as an entity or a relationship?
  - Identifying relationships: Binary or ternary?
- Constraints in the ER Model:
  - A lot of data semantics can (and should) be captured

Entity vs. Attribute

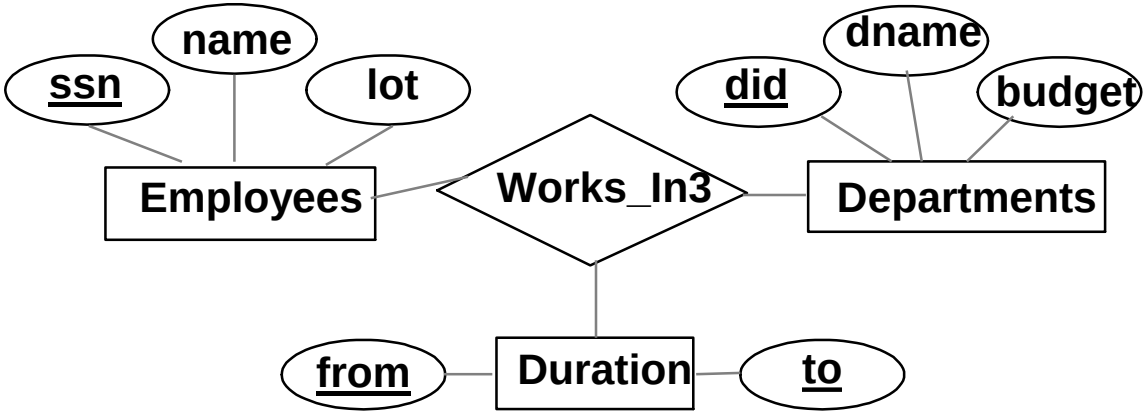
- Should *address* be an attribute of Employees or an entity (related to Employees)?
- Depends upon how we want to use address information, and the semantics of the data:
  - If we have several addresses per employee, *address* must be an entity
  - If the structure (city, street, etc.) is important, *address* should be modeled as an entity

Entity vs. Attribute (Cont.)

- Works_In2 does not allow an employee to work in a department for two or more periods



- Similar to the problem of wanting to record several addresses for an employee: we want to record *several values of the descriptive attributes for each instance of this relationship*



Notes on the ER design

- ER design is *subjective*. There are often many ways to model a given scenario!
- Analyzing alternatives can be tricky, especially for a large enterprise. Common choices include:
  - Entity vs. attribute, entity vs. relationship, binary or n-ary relationship.
- Other modeling languages available, e.g. UML
- There is no standard/notation (we will cover two notations)

Summary of Conceptual Design

- *Conceptual design* follows *requirements analysis*
  - Yields a high-level description of data to be stored
- ER model popular for conceptual design
  - Constructs are expressive, close to the way people think about their applications
  - Originally proposed by Peter Chen, 1976

    Note: there are many variations on ER model
- Basic constructs: *entities*, *relationships*, and *attributes* (of entities and relationships)
- Some additional constructs: *weak entities*

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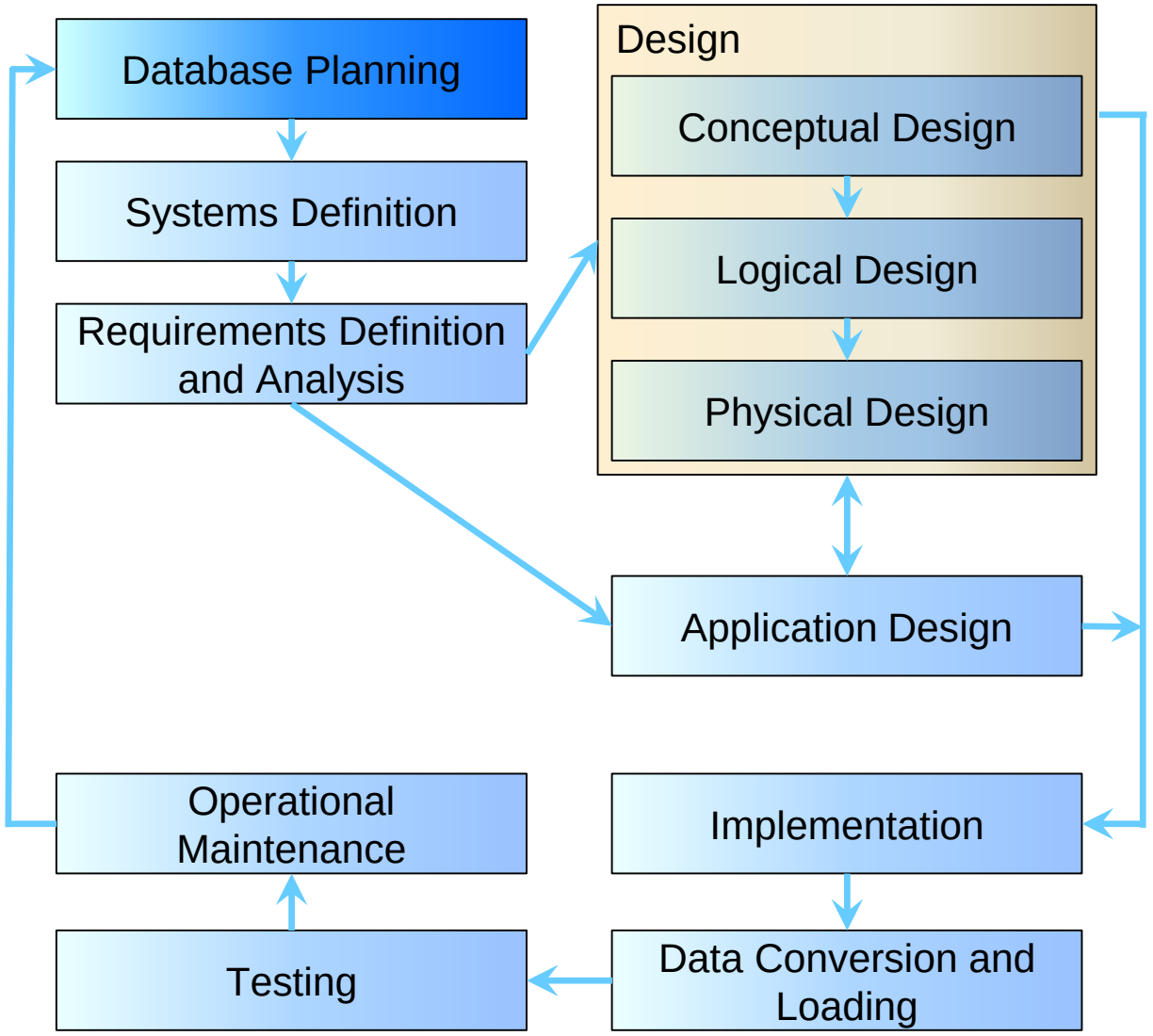

What's Examinable

- Need to be able to draw conceptual diagrams on your own
  - Given a problem, *determine entities, attributes, relationships*
  - What is key constraint and participation constraint, weak entity?
  - Determine constraints for the given entities & their relationships

Next Lecture

- Continue exploring modelling
  - From conceptual through to physical
  - Introducing **relational model** (yay!)