INFO20003 Database Systems

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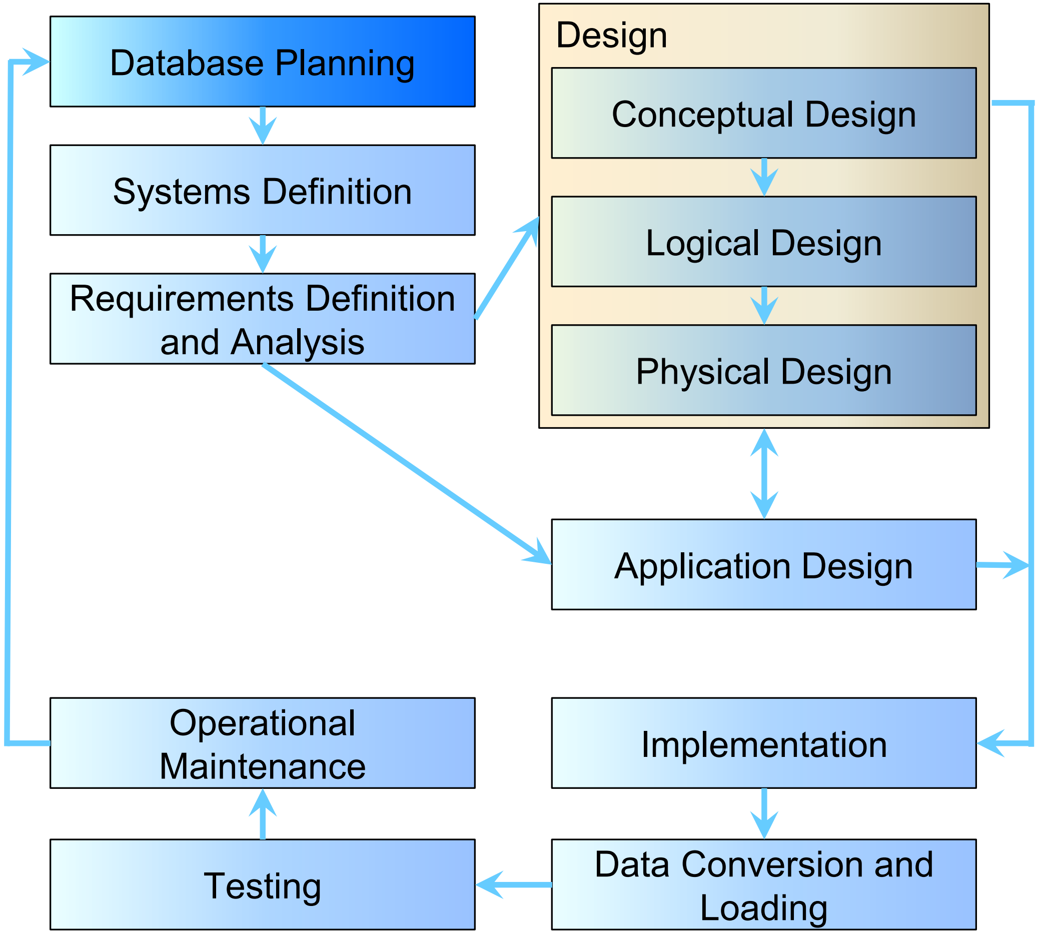
Lecture 03

Introduction to Data Modelling (ER)

Week 2

Database Development Lifecycle: Review



Today

The Entity-Relationship Model

- Basic ER modeling concepts
- Constraints
- Conceptual Design

Readings: Chapter 2, Ramakrishnan & Gehrke, Database Systems

Conceptual Design: Objectives

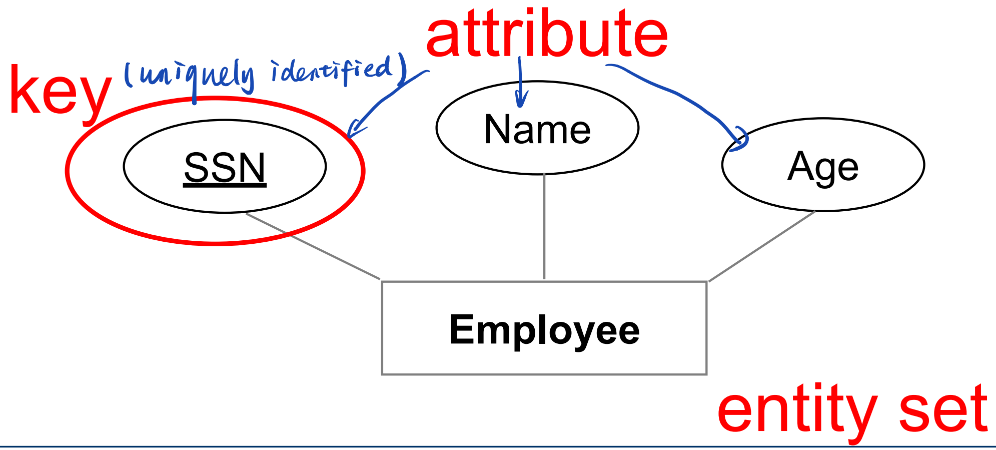
- What are the *entities* and *relationships* in the enterprise?
- What information about these entities and relationships should we store in the database?
- What are the *integrity constraints* that hold?

ER Model: Entity & its attributes

- ***Entity***: Real-world object distinguishable from other objects. An entity is described (in DB) using a set of ***attributes.***
- ***Entity Set***: A collection of entities of the same type (e.g. *all employees*)

  eg. lecturers: Nic, Renata, Alistar
  subject: INFO20003.

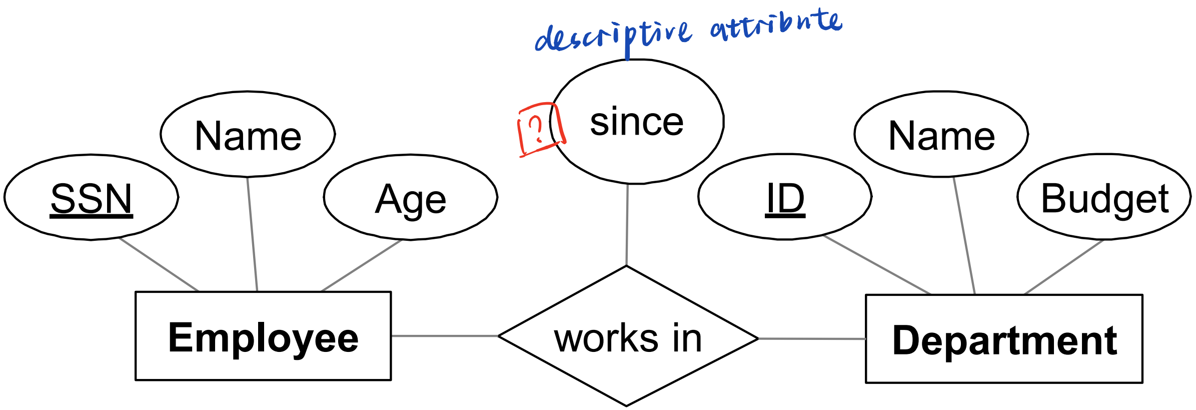
  - All entities in an entity set have the same set of attributes
  - Each entity has a *key* (*underlined*)



ER Model: Relationship

- ***Relationship***: Association among two or more entities. Relationships can have their own attributes.
  - Example: Fred *works in* the Pharmacy department.

- ***Relationship Set***: Collection of relationships of the same type.
  - Example: Employees *work in* departments.

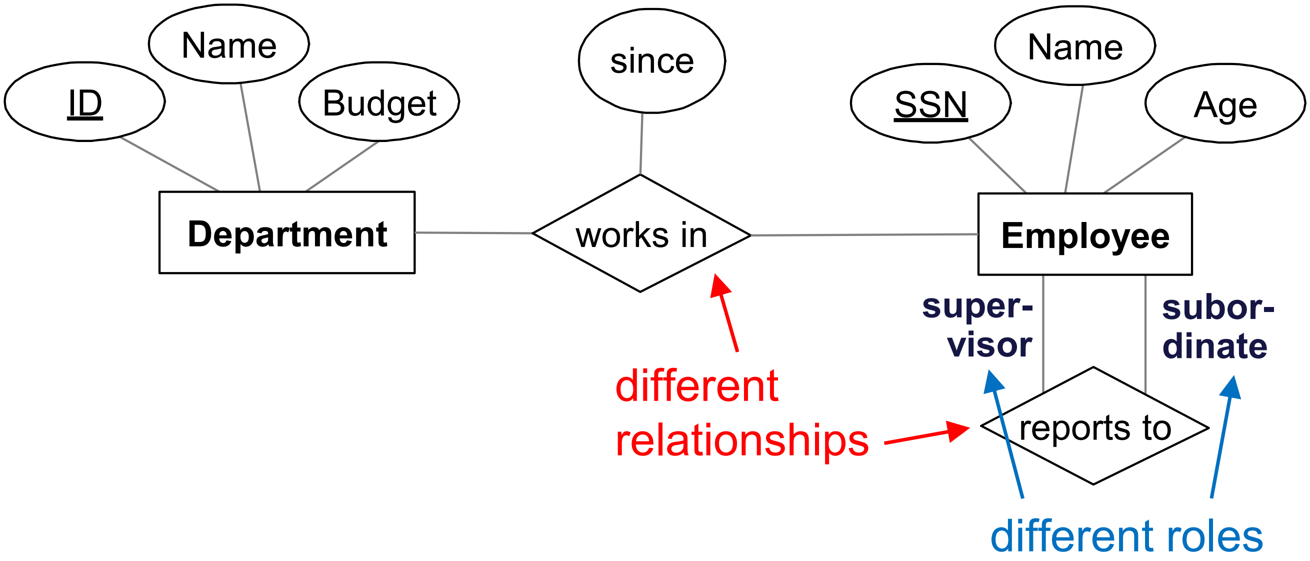


relationship set
(with a descriptive attribute)

ER Model: Relationship roles

Same entity set can participate in:

- *different* relationship sets, or even
- *different “roles”* in the same set



The Entity-Relationship Model

- Basic ER modeling concepts
- Constraints
- Conceptual Design

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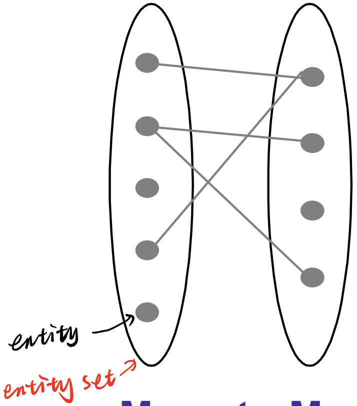
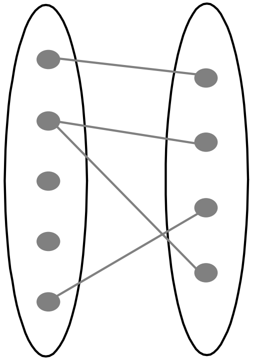
Key Constraints: Types

Key constraints determine the number of objects taking part in the relationship set (how many from each side)

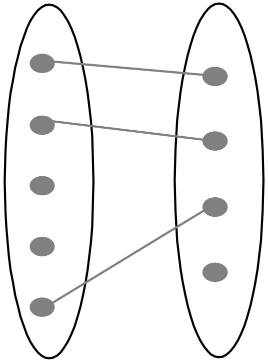
Types of key constraints:



Many-to-Many



One-to-Many (Many-to-One)



One-to-One

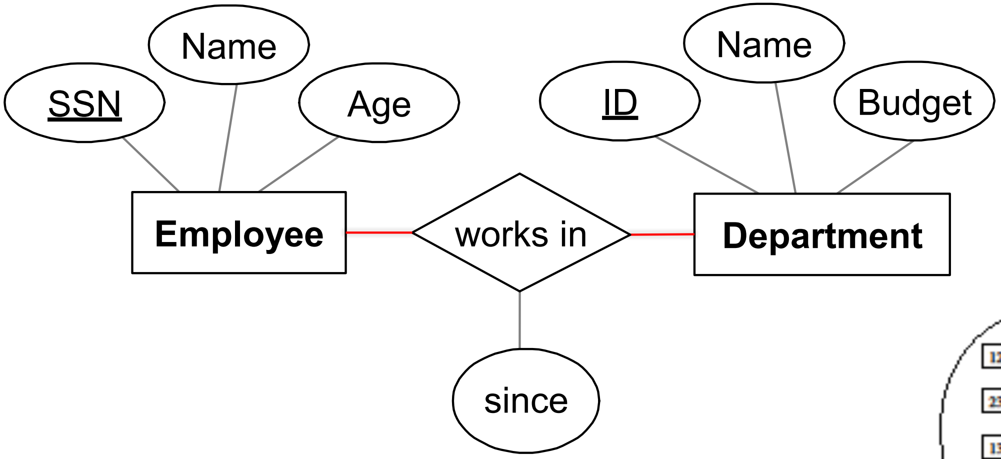
Key Constraints: Many-to-Many

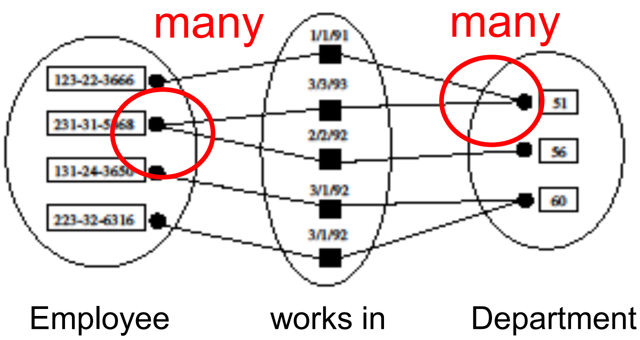
Example:

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

many -to - many

Many is represented by a line *(red is here just to emphasize it – no need to color).*





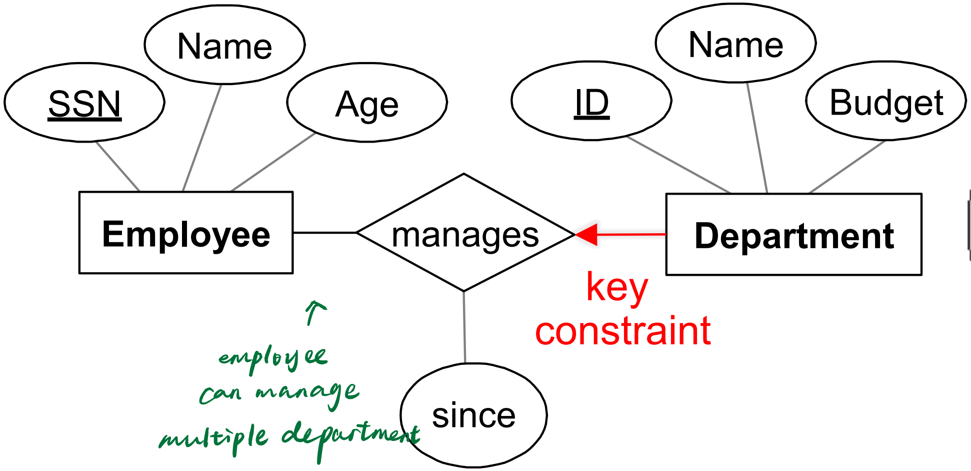
Key Constraints: One-to-Many

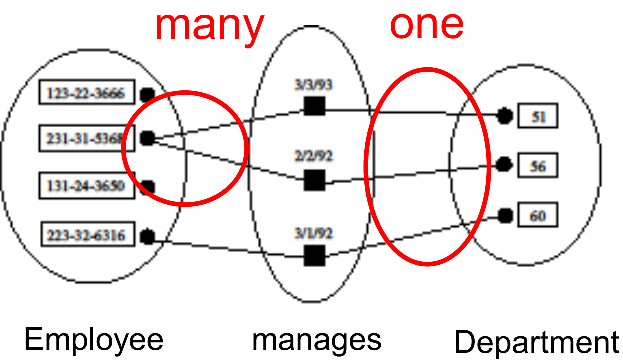
One-to-many constrains one entity set to have a *single* entity per a relationship. An entity of that set can never participate in two relationships of the same relationship set. This is called a **key constraint** and is represented by an arrow.

Example:

Each department has at most one manager.

This is the key constraint on Manages.

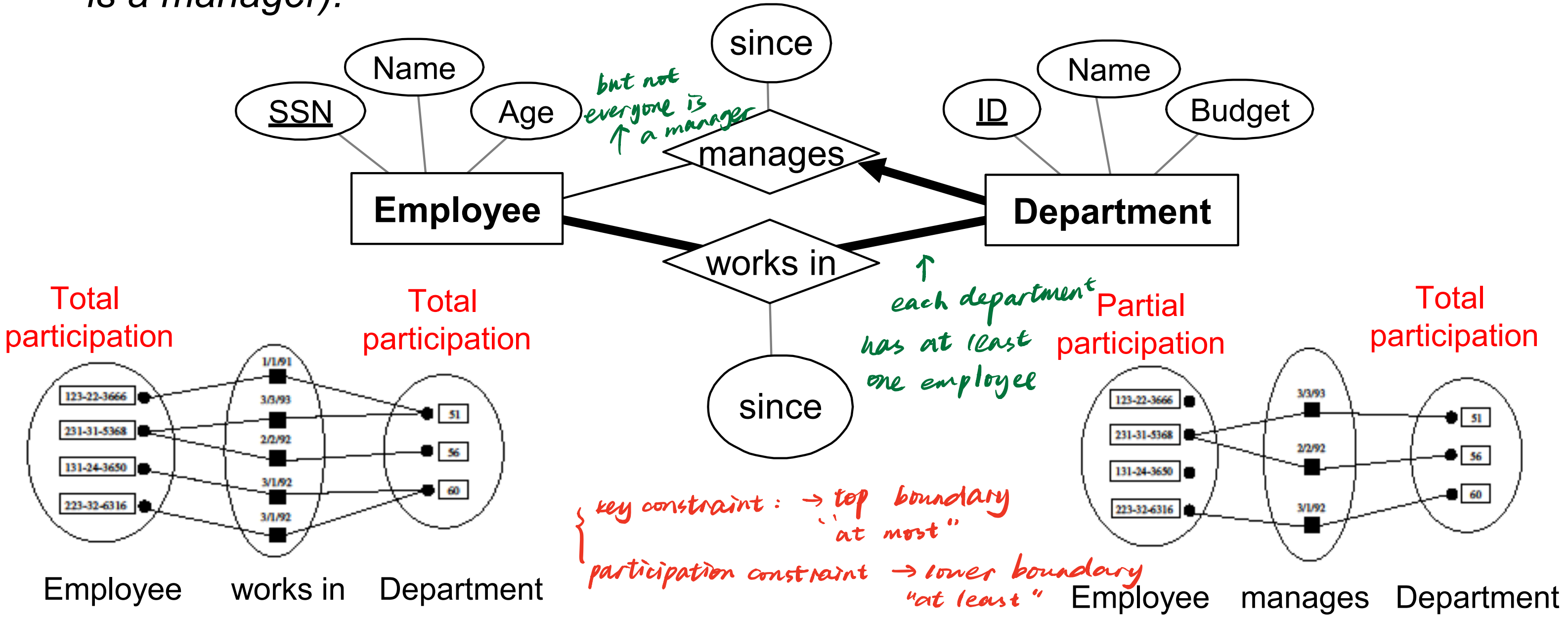




Participation Constraints

Participation constraint explores whether all entities of one entity set take part in a relationship. If yes this is a **total** participation, otherwise it is **partial**. Total participation says that each entity takes part in "**at least one**" relationship, and is represented by a bold line.

Example: *Every employee must work in a department. Each department has at least one employee. Each department has to have a manager (but not everyone is a manager).*



but not everyone is a manager

each department has at least one employee

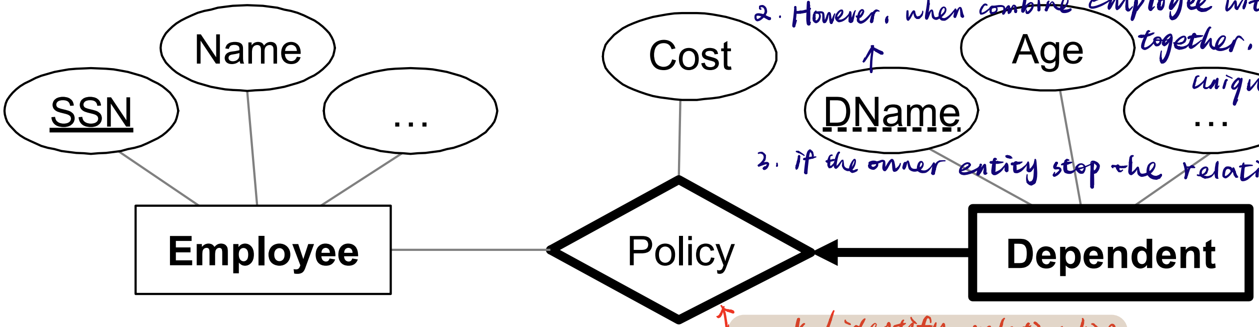
key constraint: → top boundary "at most"

participation constraint → lower boundary "at least"

Weak Entities

A ***weak entity*** can be identified uniquely only by considering (the primary key of) another (*owner*) entity. They are represented as a “bold” rectangle.

- Owner entity set and weak entity set must participate in a relationship where each weak entity has one and only one strong entity to depend on (key constraint)
- Weak entity set must have total participation in this relationship set. Such relationship is called *identifying* and is represented as “bold”.



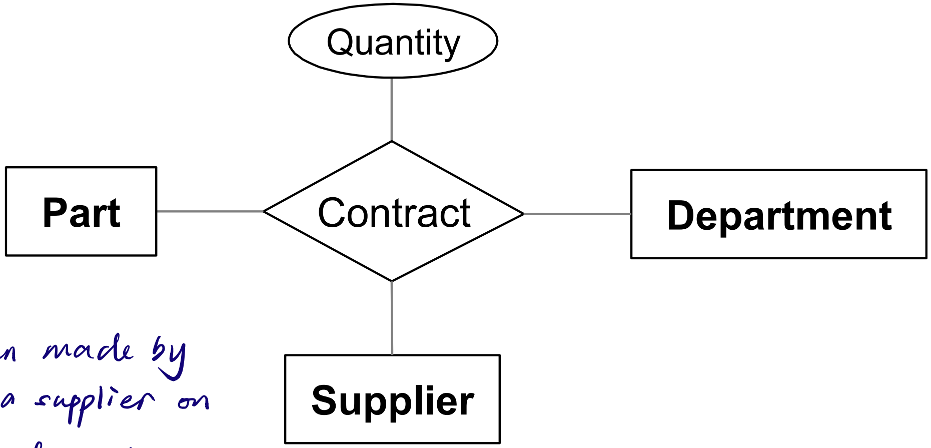
1. we can have 2 dependent have the same name
2. However, when combine employee with dependent together, they can be uniquely identified
3. if the owner entity stop the relationship, all dependent show be removed.

weak / identify relationship

Weak entities have only a “partial key” (dashed underline) and they are identified uniquely only when considering the primary key of the owner entity

Ternary Relationships

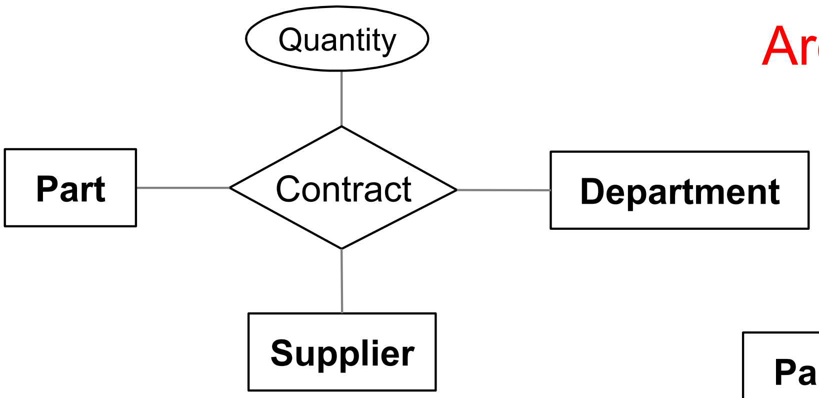
In general, we can have **n**-ary relationships, and relationships can have attributes



a contract has been made by a department, and a supplier on a given quantity of part

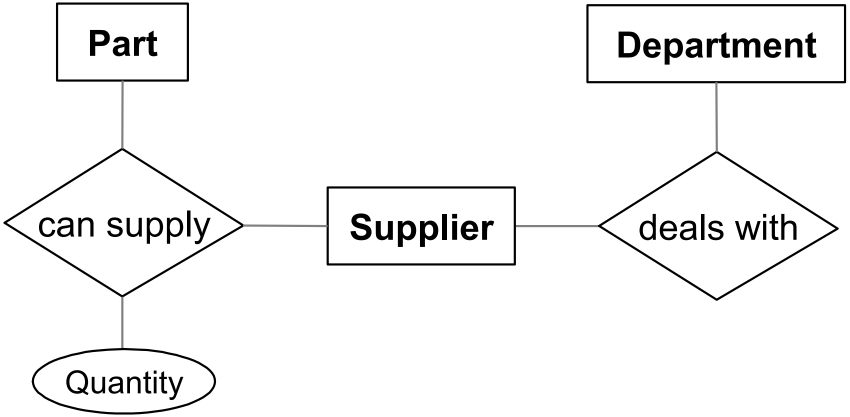
This is a ternary relationship with one relationship attribute

Ternary vs. Binary Relationships



Are these two models the same?

vs.



Second model:

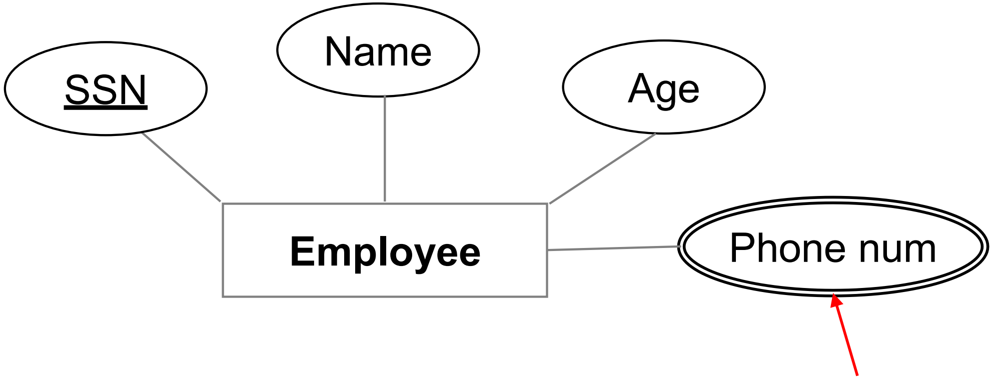
- S "can supply" P, D "needs" P, and D "deals with" S does not imply that D has agreed to buy P from S. Not the same!

Special attribute type: Multi-valued attributes

- Multi-valued attributes can have multiple (finite set of) values of the same type.

Example:

For employees we need to capture their home phone number and work phone number.



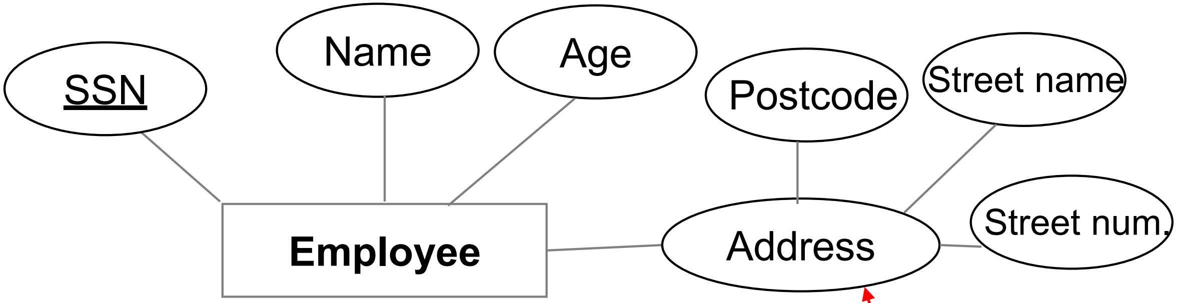
Multi-valued attribute

Special attribute type: Composite attributes

- Composite attributes have a structure hidden inside (each element can be of different type).

Example:

For employees we need to capture an address consisting of a postcode, street name and number.



Composite attribute

Now you try

University database schema:

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

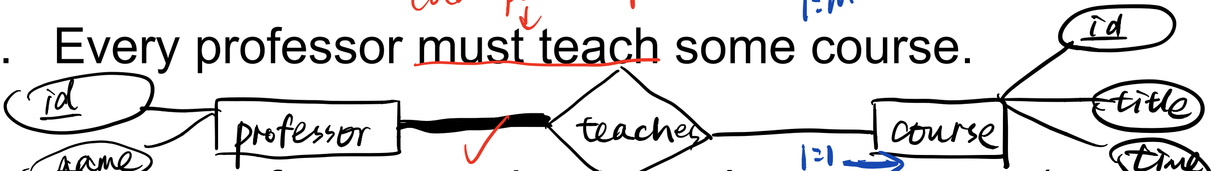
- Make up suitable attributes for professors

Now you try

total participation

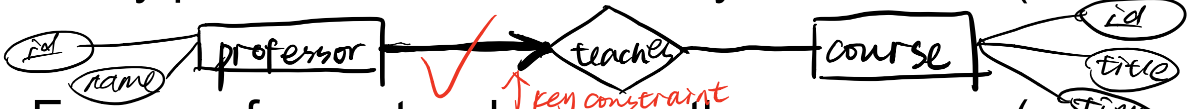
1:m

1. Every professor must teach some course.



1:1

2. Every professor teaches exactly one course (no more, no less).

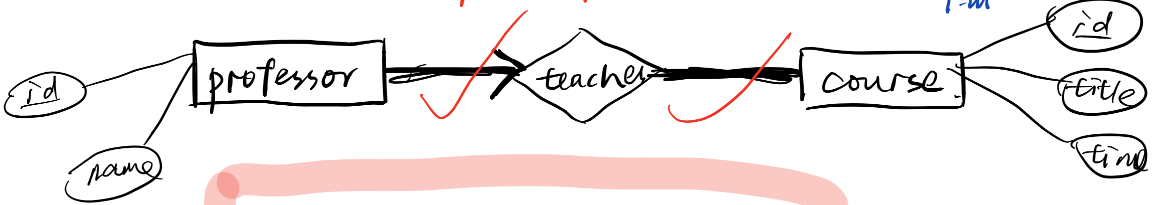


key constraint

3. Every professor teaches exactly one course (no more, no less), and every course must be taught by some professor.

total participation

1:m



—	ϕ	m	lower bound is 0
━	1	m	lower bound is 1
→	ϕ	1	lower bound is 0
➡	1	1	- - - is 1

The Entity-Relationship Model

- Basic ER modeling concepts
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- Conceptual Design

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Conceptual Design Using the ER Model

- **Design choices:**
  - Should a concept be modelled as an entity or an attribute?
  - Should a concept be modelled as an entity or a relationship?
  - Should we model relationships as binary, ternary, n-ary?

- **Constraints in the ER Model:**
  - A lot of data semantics can (and should) be captured

Entity vs. Attribute

Example:

Should "*address*" be an attribute of Employees or an entity (related to Employees)?

Answer:

- *Depends* upon how we want to use address information, and the semantics of the data:

  if just potantially considered as a multi-valued attribute

  if the address just a line (no structure), however, if we want to capture a structure ie postcode/street name/number, cannot create sth both a composite attribute and multi-valued attribute, → just a new entity

  - ① If we have several addresses per employee, *address* must be an entity

    ↑ or structure hidden inside

② a single address per employee, just a long string.

→ attribute

Notes on the ER design

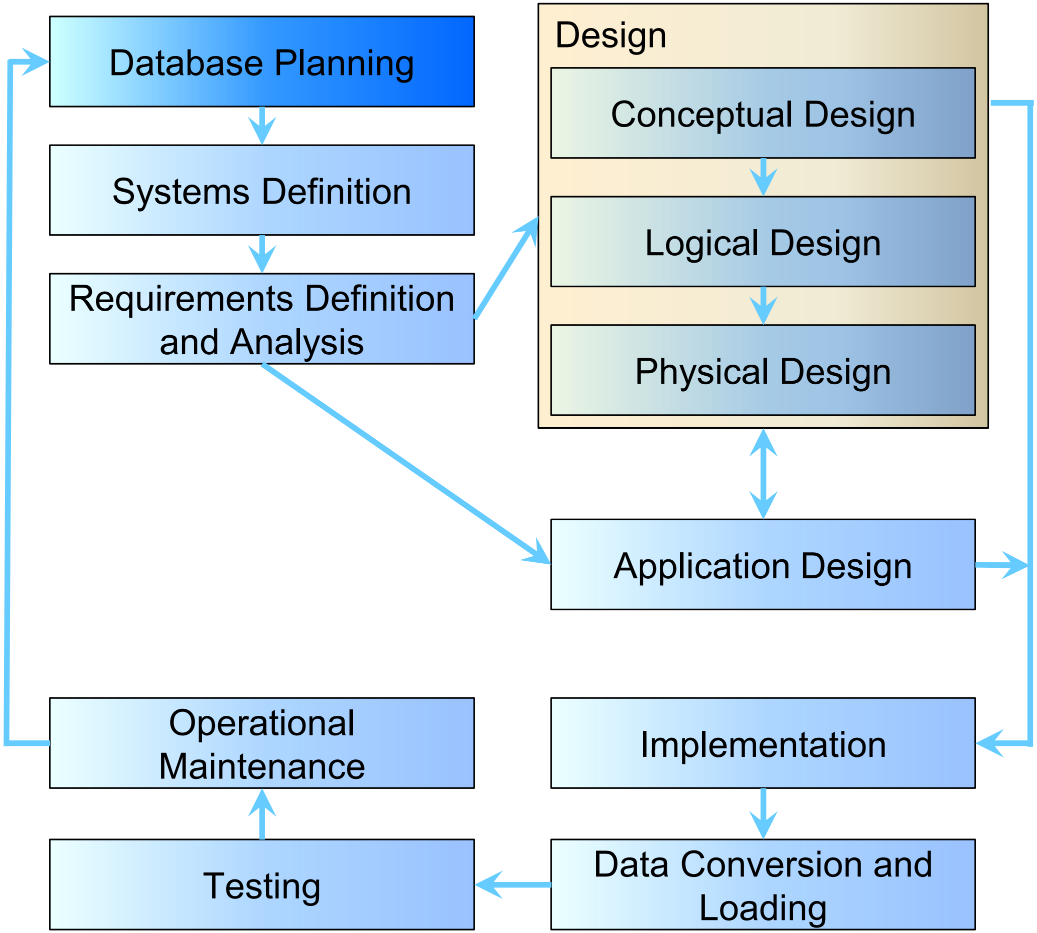
- ER design is *subjective*. There are often many ways to model a given scenario.
- Analyzing alternatives can be tricky, especially for a large enterprise. Common choices include:
  - Entity vs. attribute, entity vs. relationship, binary or n-ary relationship.
- There is no standard/notation (we will cover two notations, today we learned **Chen's** notation)

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*

Database Development Lifecycle: Review



Today

Next time

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**