



# INFO20003 Database Systems

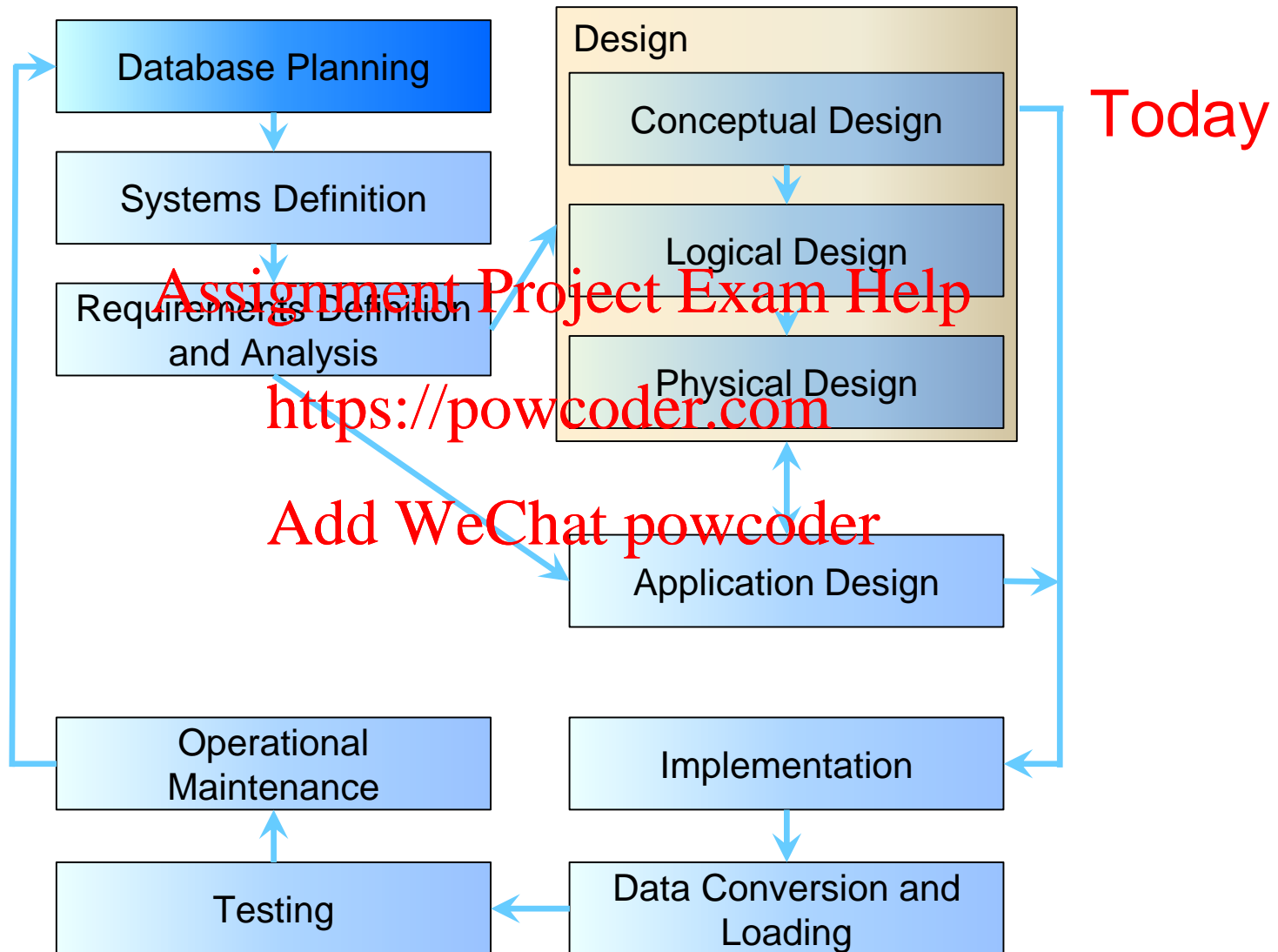
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Dr. Renata Borovica-Gajic  
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Lecture 03

Introduction to Data Modelling (ER)





- Basic ER modeling concepts

- Constraints

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- Conceptual Design <https://powcoder.com>

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*Readings: Chapter 2, Ramakrishnan & Gehrke, Database Systems*



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

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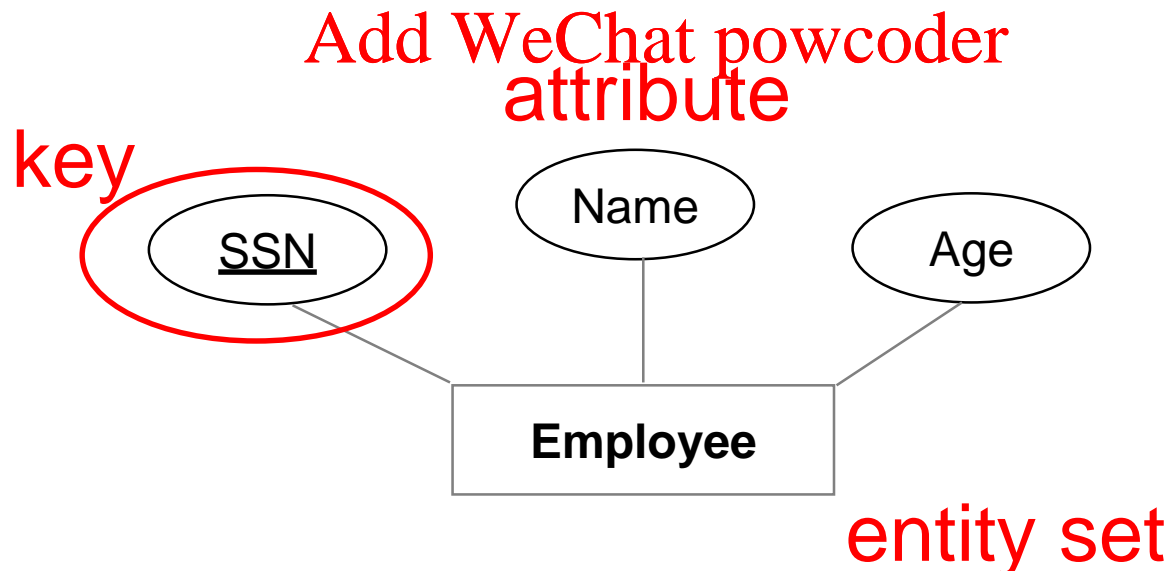
- What are the *integrity constraints* that hold?

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



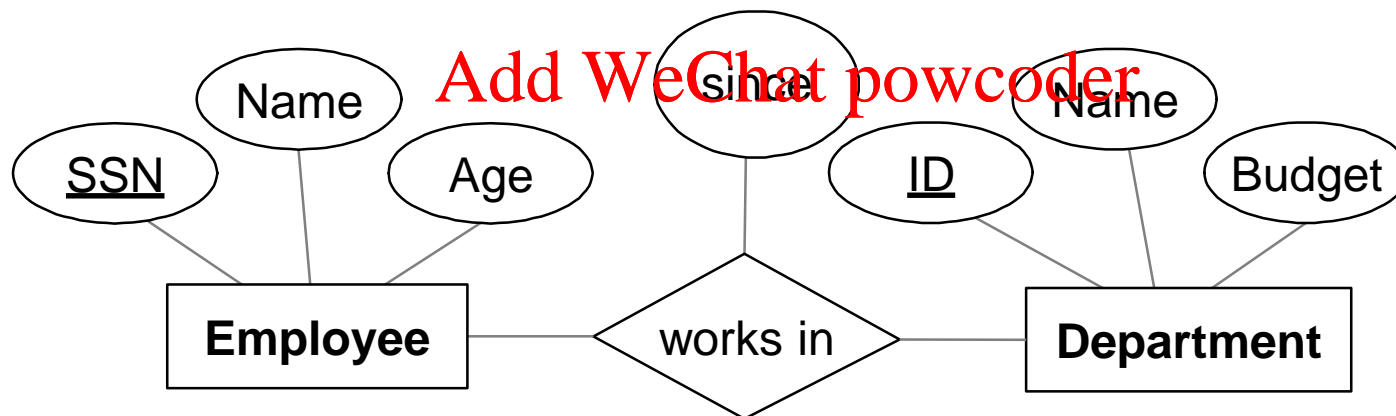


- **Relationship**: Association among two or more entities. Relationships can have their own attributes.
  - Example: Fred *works in* the Pharmacy department.
- **Relationship Set**: Collection of relationships of the same type.
  - Example: Employees *work in* departments.

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relationship set  
(with a descriptive attribute)

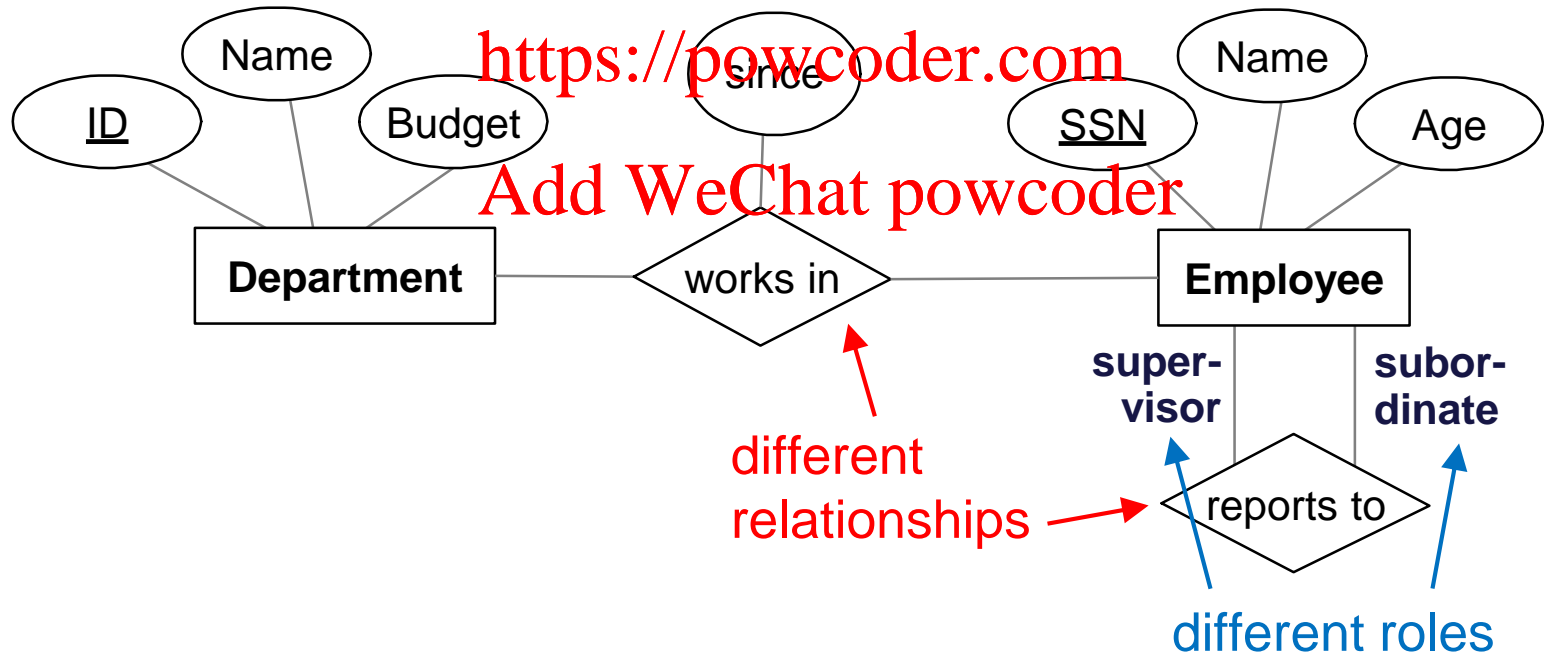
Same entity set can participate in:

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

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## REEDUCATION

- Basic ER modeling concepts

- Constraints

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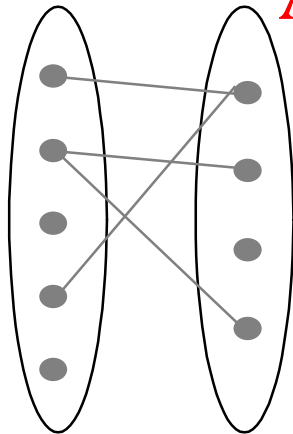
*Readings: Chapter 2, Ramakrishnan & Gehrke, Database Systems*



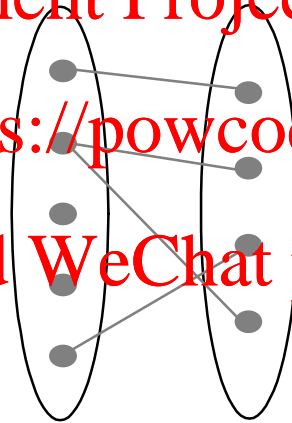
# Key Constraints: Types

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

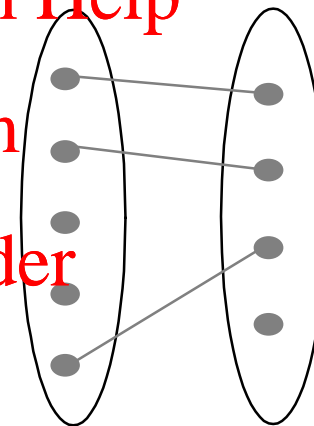
**Types of key constraints:**



**Many-to-Many**



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



**One-to-One**

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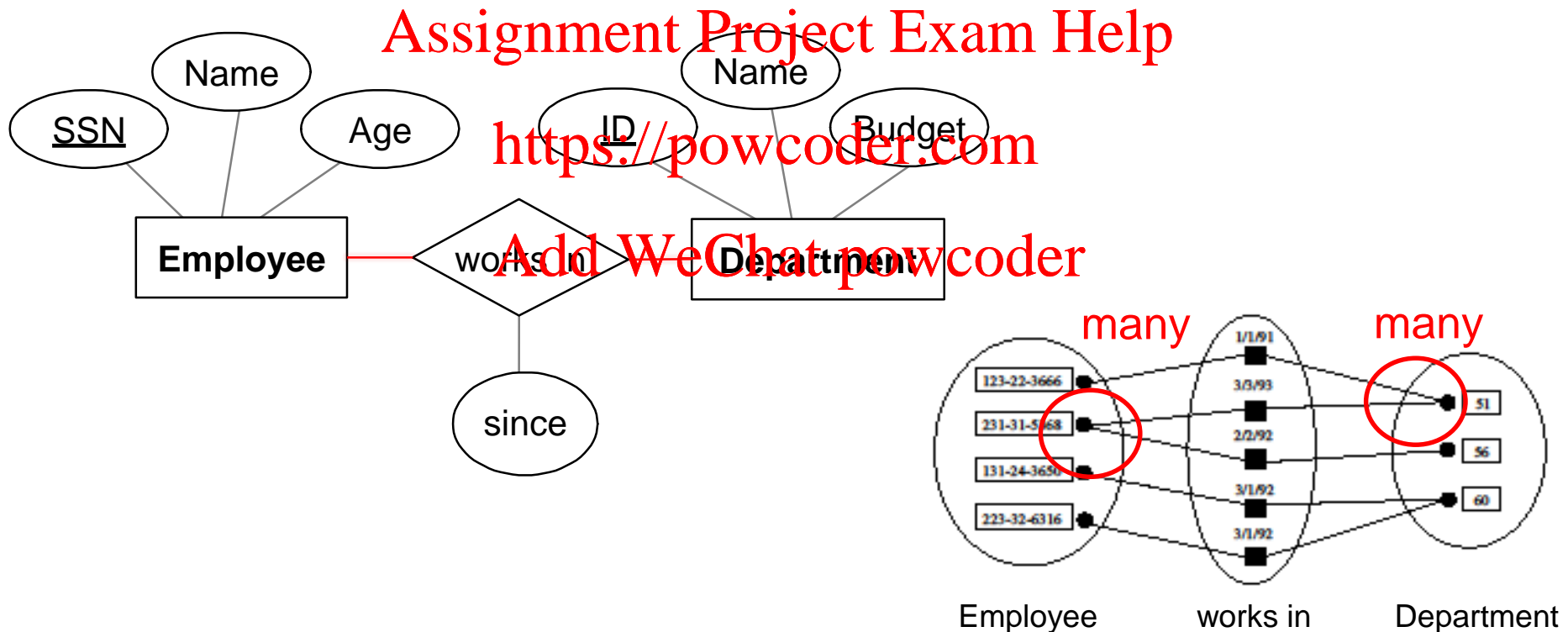
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# Key Constraints: Many-to-Many

## Example:

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

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



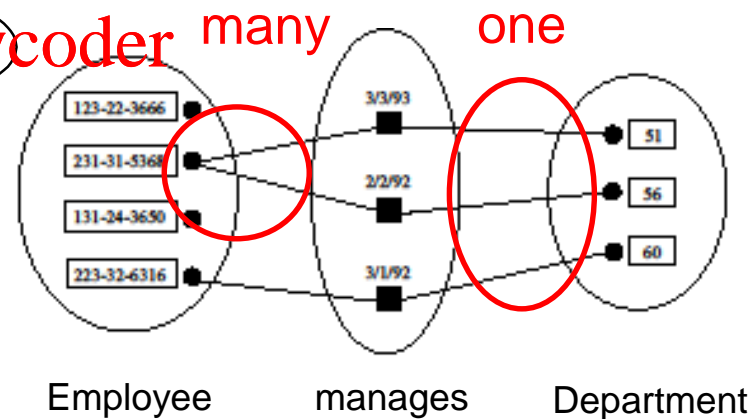
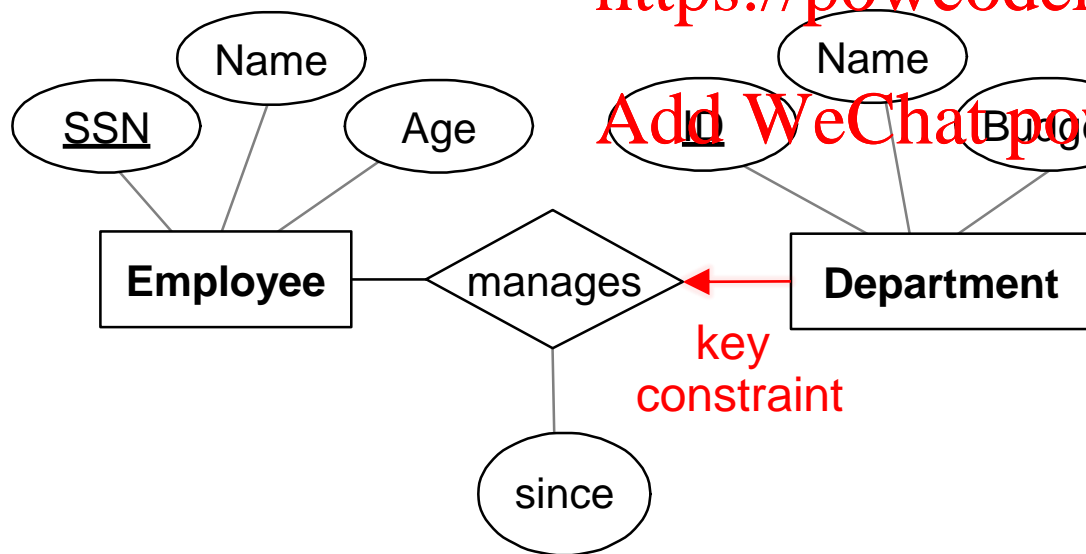
# Key Constraints: One-to-Many

**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:

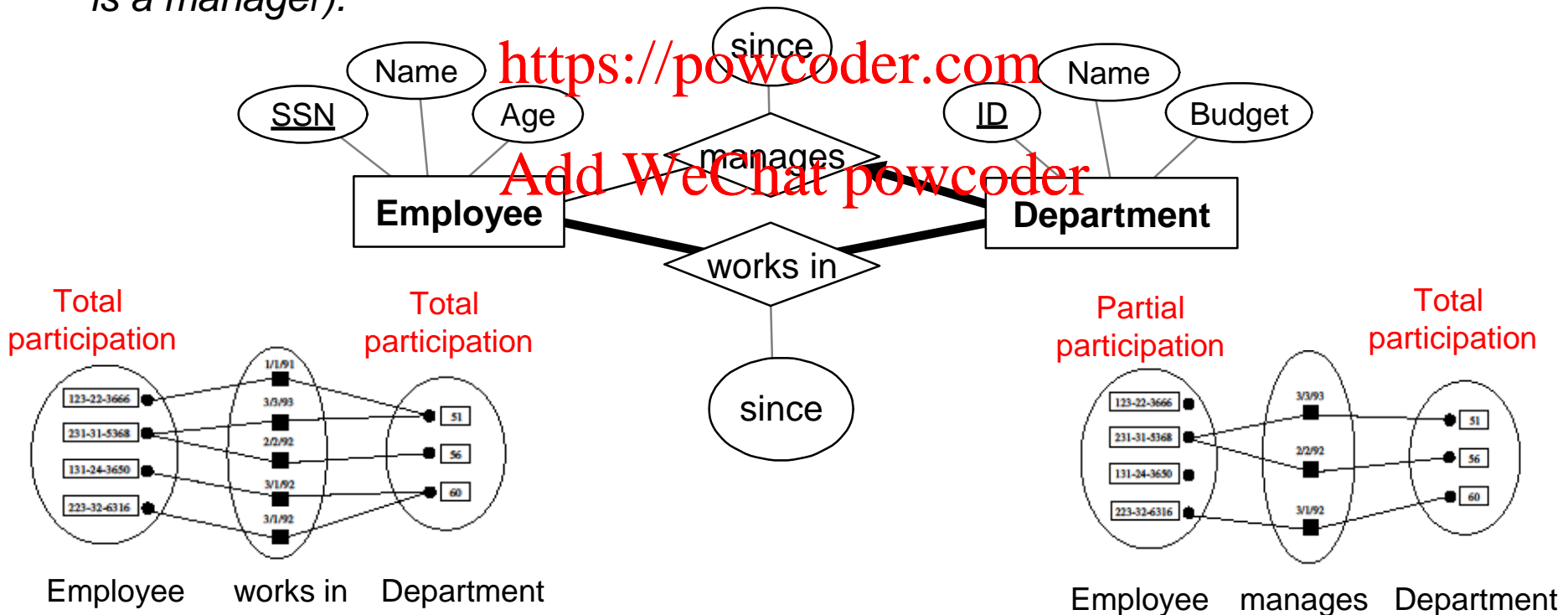
Each department has ~~at most one~~ manager.

This is the key constraint on Manages.



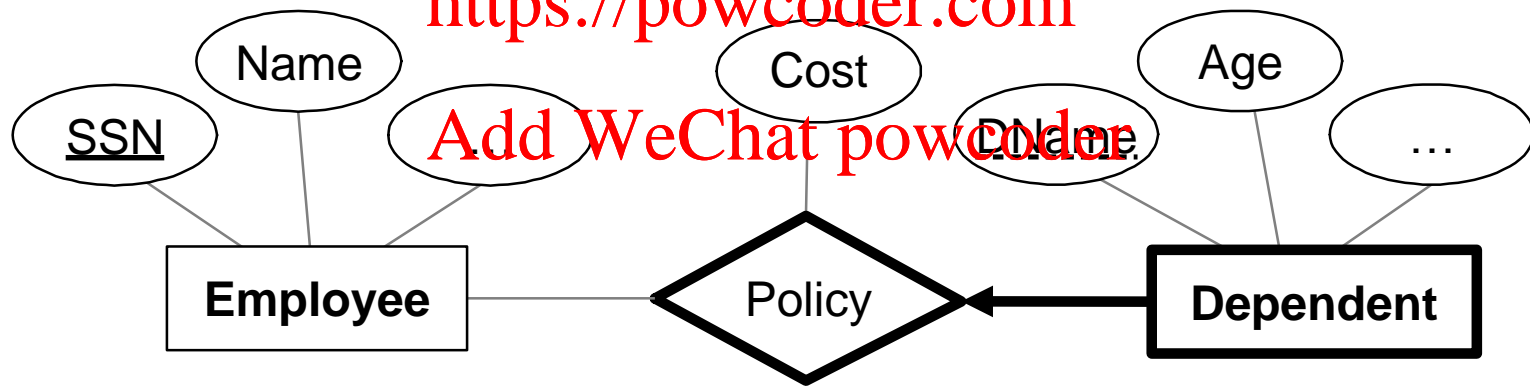
**Participation constraint** explores whether all entities of one entity set take part in a relationship. If yes this is a **total** participation, otherwise it is **partial**. Total participation says that each entity takes part in “**at least one**” relationship, and is represented by a bold line.

**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).



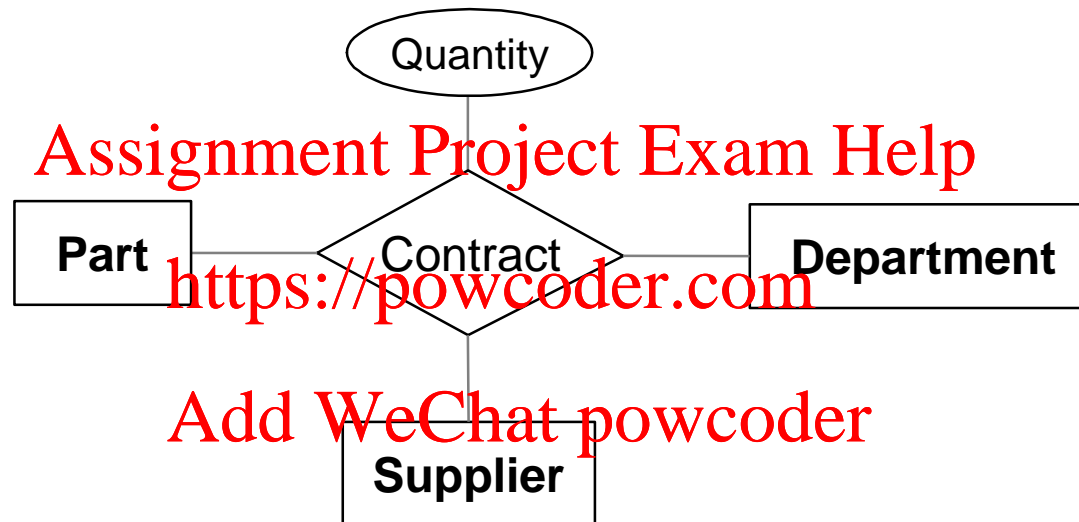
A **weak entity** can be identified uniquely only by considering (the primary key of) another (owner) entity. They are represented as a “bold” rectangle.

- 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”.



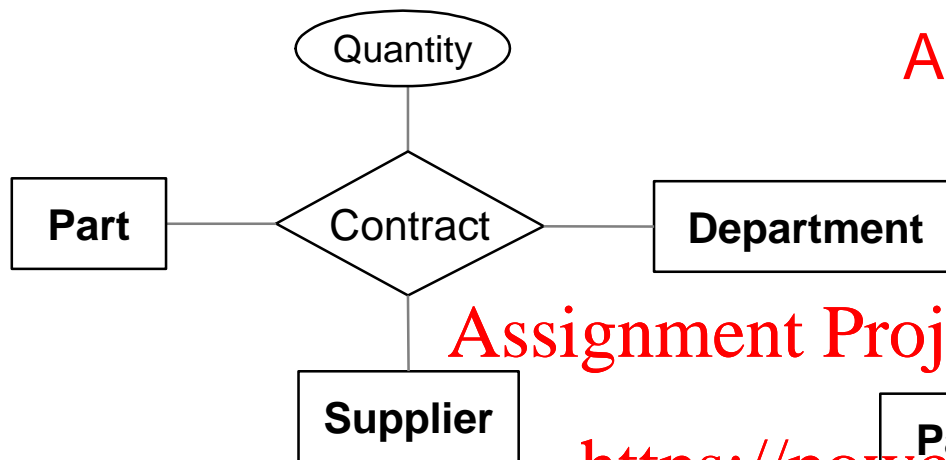
Weak entities have only a “partial key” (dashed underline) and they are identified uniquely only when considering the primary key of the owner entity

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



This is a ternary relationship  
with one relationship attribute

# Ternary vs. Binary Relationships

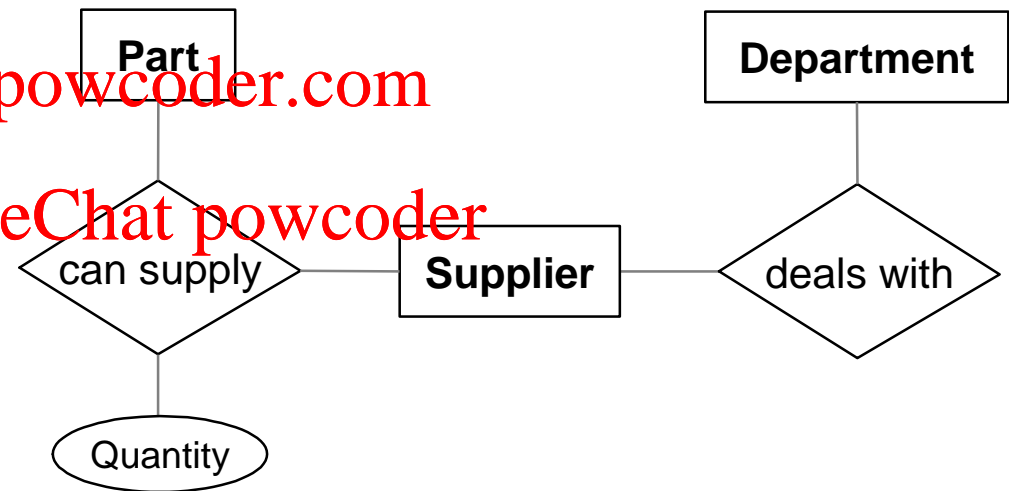


Are these two models the same?

**VS.**  
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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!



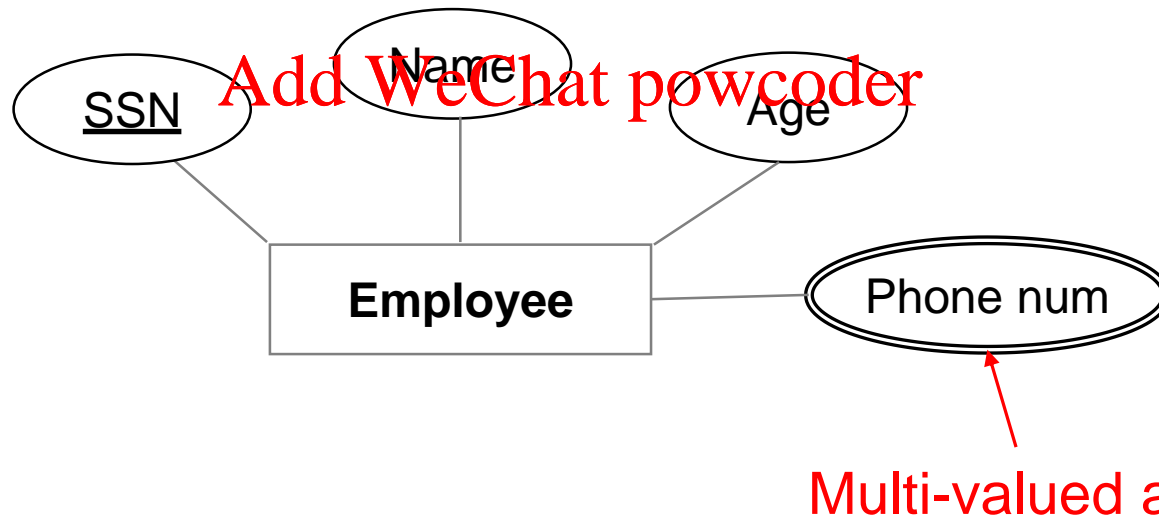
- Multi-valued attributes can have multiple (finite set of) values of the same type.

## Example:

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

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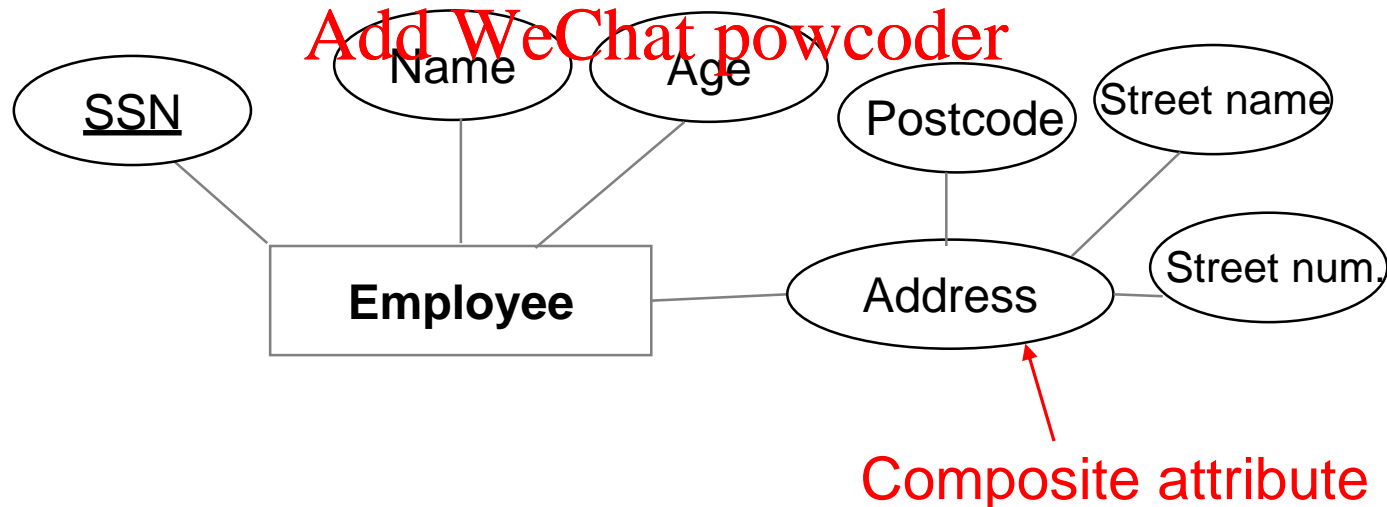




- Composite attributes have a structure hidden inside (each element can be of different type).

## Example:

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





## University database schema:

- *Entities*: Courses, Professors
  - Each course has id, title, time
  - Make up suitable attributes for professors
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WEEK 10/11

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

- Basic ER modeling concepts

- Constraints

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- Conceptual Design <https://powcoder.com>

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*Readings: Chapter 2, Ramakrishnan & Gehrke, Database Systems*



- **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?

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- **Constraints in the ER Model:**

- A lot of data semantics can (and should) be captured

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## Example:

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

**Answer:** [Assignment Project Exam Help](https://powcoder.com)

- *Depends* upon how we want to use address information, and the semantics of the data.
  - If we have [several addresses per employee](https://powcoder.com), [address](https://powcoder.com) must be an entity



- 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)

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- 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

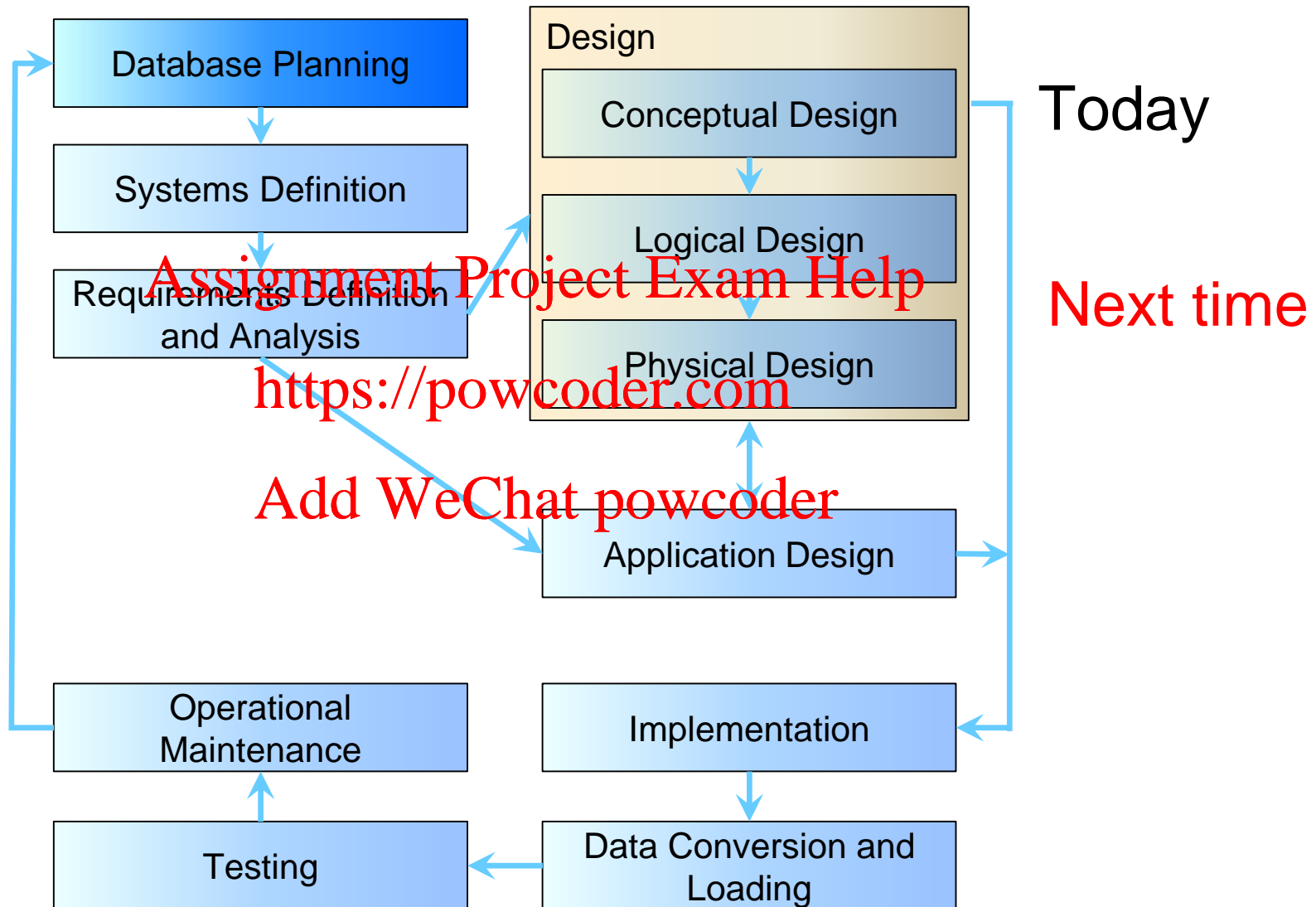
- Basic constructs: *entities*, *relationships*, and *attributes* (of entities and relationships)
- Some additional constructs: *weak entities*

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- 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

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- Continue exploring modelling
  - From conceptual through to physical
  - Introducing **relational model**

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