Data Modeling

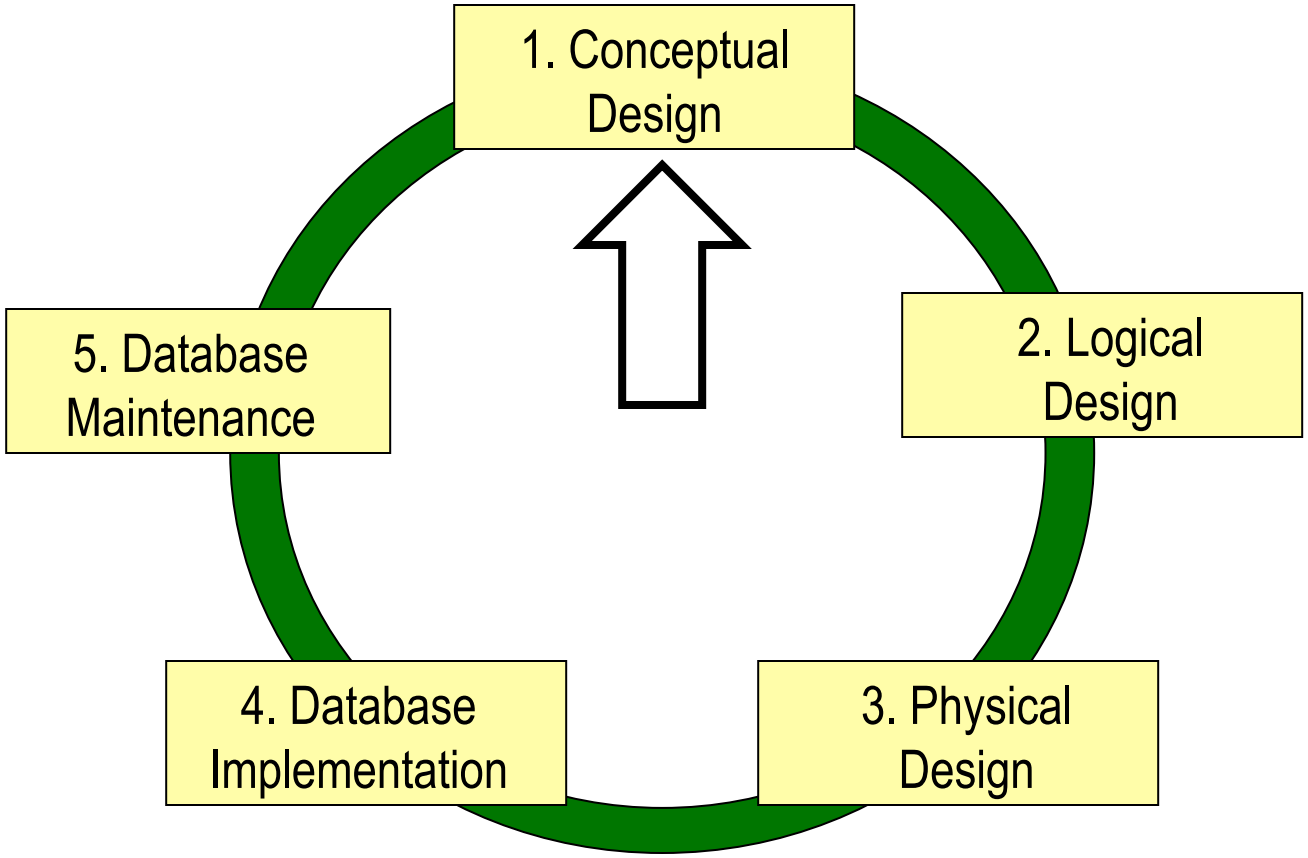
CSCI 5250

Database Design

Outline

- Entities
- Attributes
- Relationships
  - Cardinality
  - Modality
- Exercises

Database Life Cycle

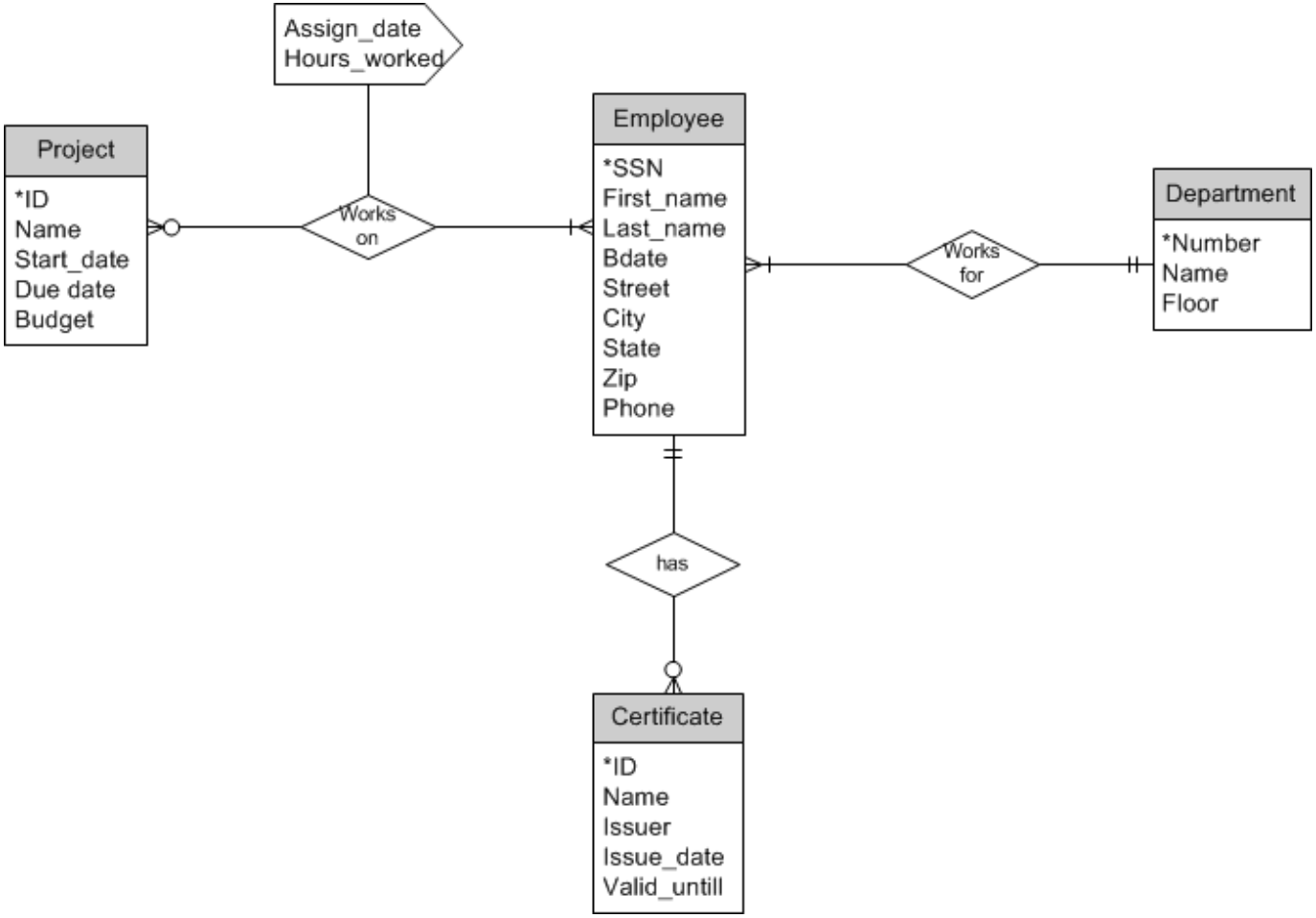


Conceptual Design

- Purpose:
  - To understand an organization's data needs and how that data is related to each other
  - To document the data needs in form of an Entity-relationship diagram (ERD) for database designers
- Data-centric approach:
  - Data is more stable than business processes, which may change as business evolves
  - Accurate data is critical for operations
- Output:
  - ERD or similar model

Goal

- Create an Entity-Relationship Diagram (ERD)

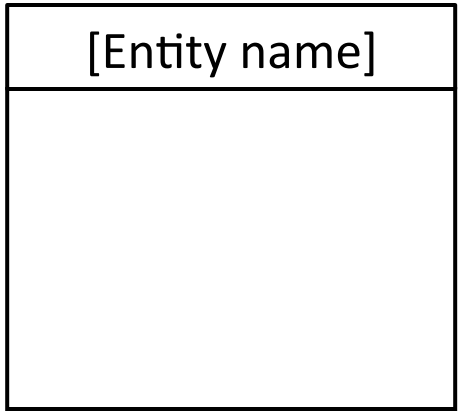


Entity-relationship Model

- History:
  - Developed by Peter Chen in the 1970s
- Definition:
  - A visual representation of entities, their attributes, and the relationships between entities
- Building blocks:
  - Entity – People, places, objects, things, events, or concepts about which data is being collected
  - Attribute – Property or characteristics of entities
  - Relationship – Business rules governing associations between entities

Entities

- People, places, objects, things, events, or concepts (nouns)
- Examples – Employee, salesperson, sale, account, department
- Represented as a rectangle in ERD



Entities

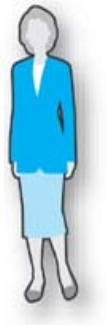
- Entity instance – A single example of an entity
- Entity is a general representation of all entity instances

Entity

EMPLOYEE

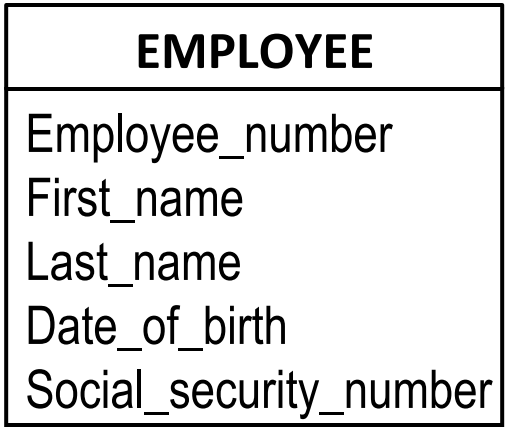
Instance

One employee



Attributes

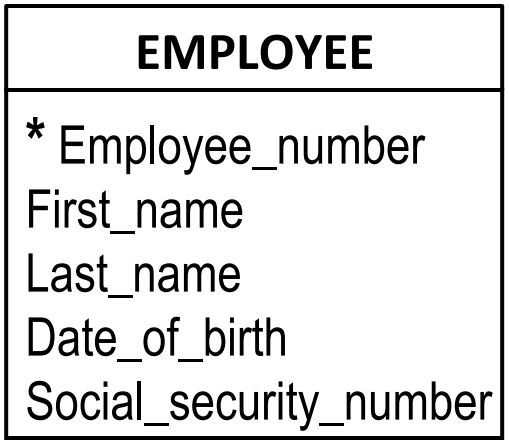
- Characteristics of an entity we want to capture
- Example attributes of "Employee":
  - Employee number, first name, last name, date of birth, social security number, etc.



Identifier

- One or more attributes is a unique identifier
- Candidate keys – All attributes that can uniquely identify an entity instance
- Composite key – candidate key of multiple attributes
- Primary key – The chosen candidate key

- Primary key:
  - Indicated on ERD by asterisk
  - Should not change over time
  - Must have non-null unique values



Are there other possible primary keys?

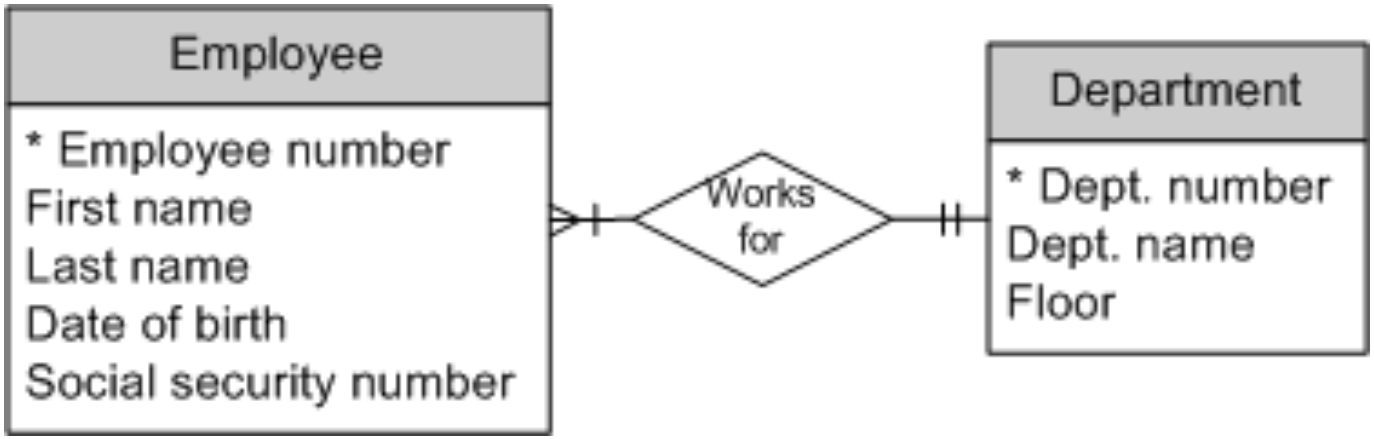
Relationships

- Describe associations between entities
  - Represents the business rules
  - Involve organizational policies, rules, and regulations
- Verbs that link entities

- Examples:
  - Each customer is associated with at least one salesperson
  - An instructor cannot teach more than one course
  - An employee may or may not have a spouse
  - An employee may have many children

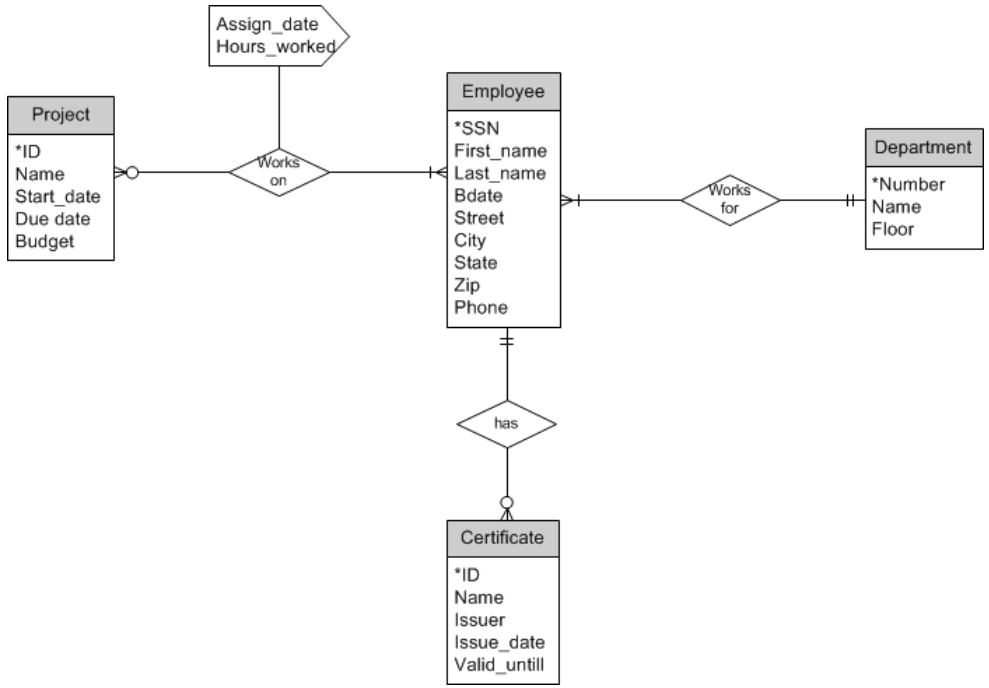
Relationships

- Represented by a diamond on an ERD
- Directional



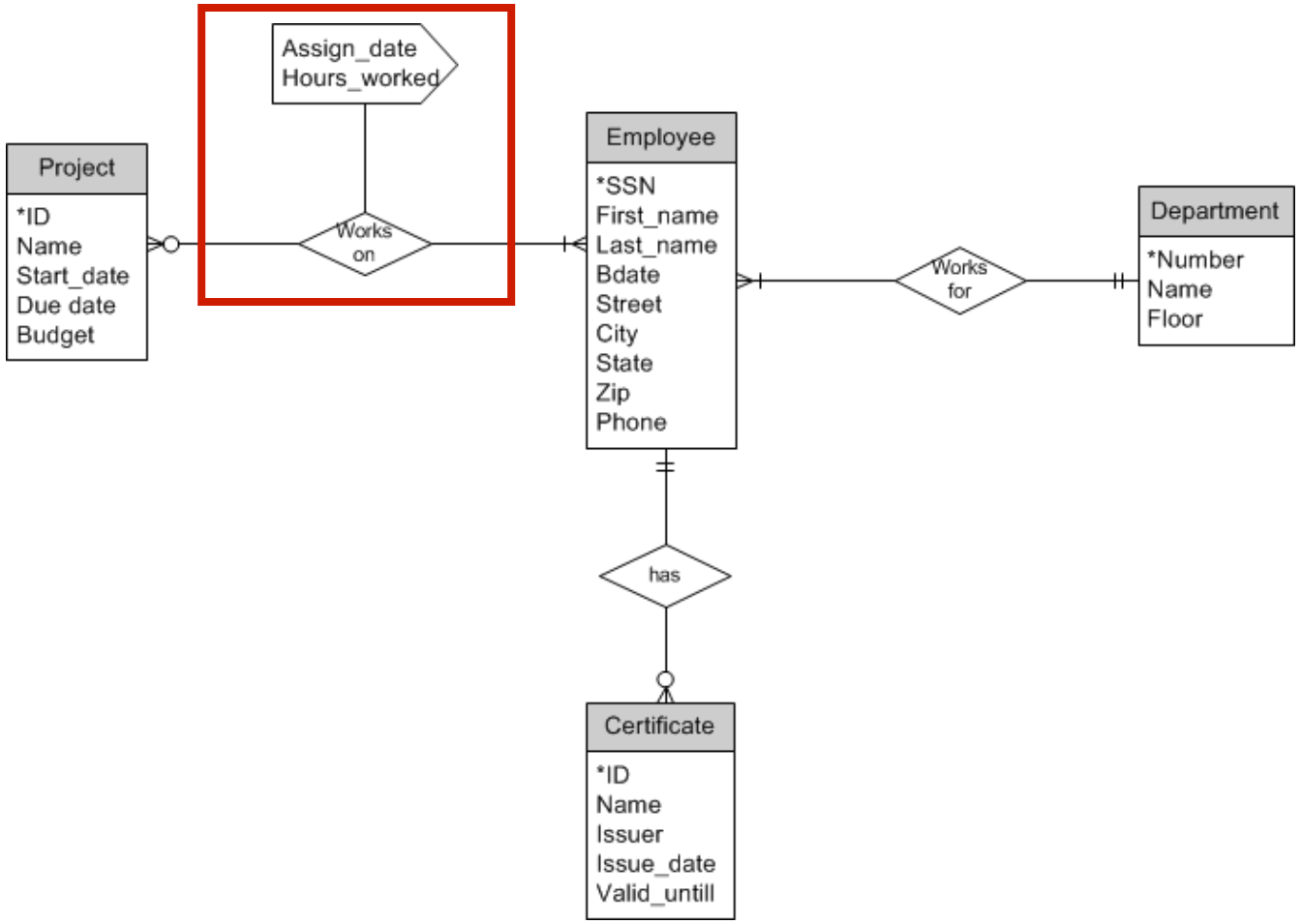
Relationships

- Each entity should have at least one relationship with another entity
- Only create relationships that make sense and are needed
  - You do not need to connect every entity to one another



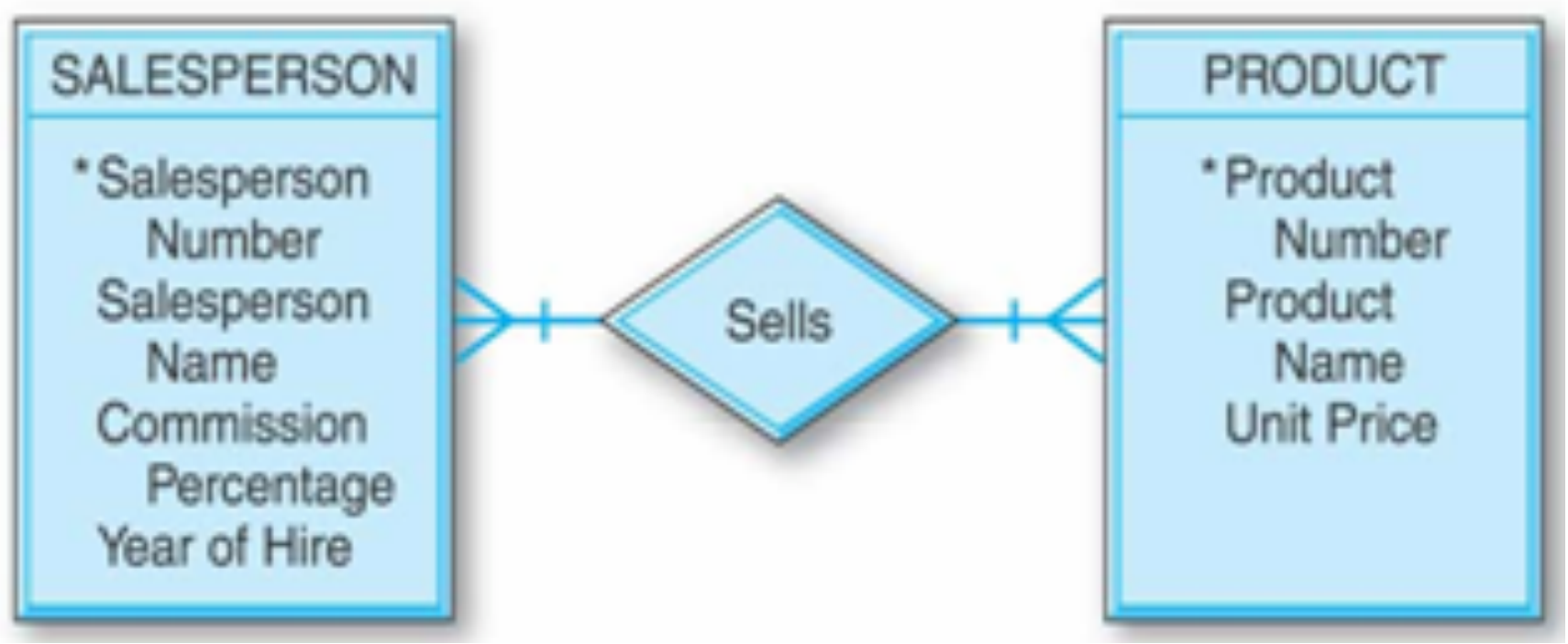
Relationships

- Relationships can also have attributes



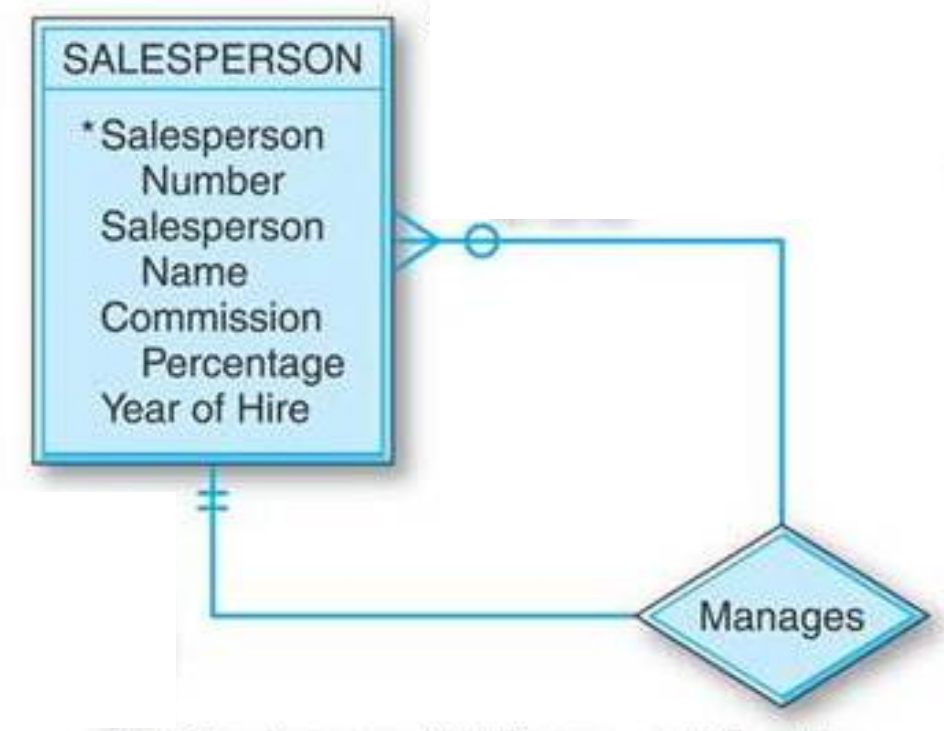
Types of Relationships

- Binary: (the most common type)
  - Relationship between two different entities
  - Salesperson sells a Product



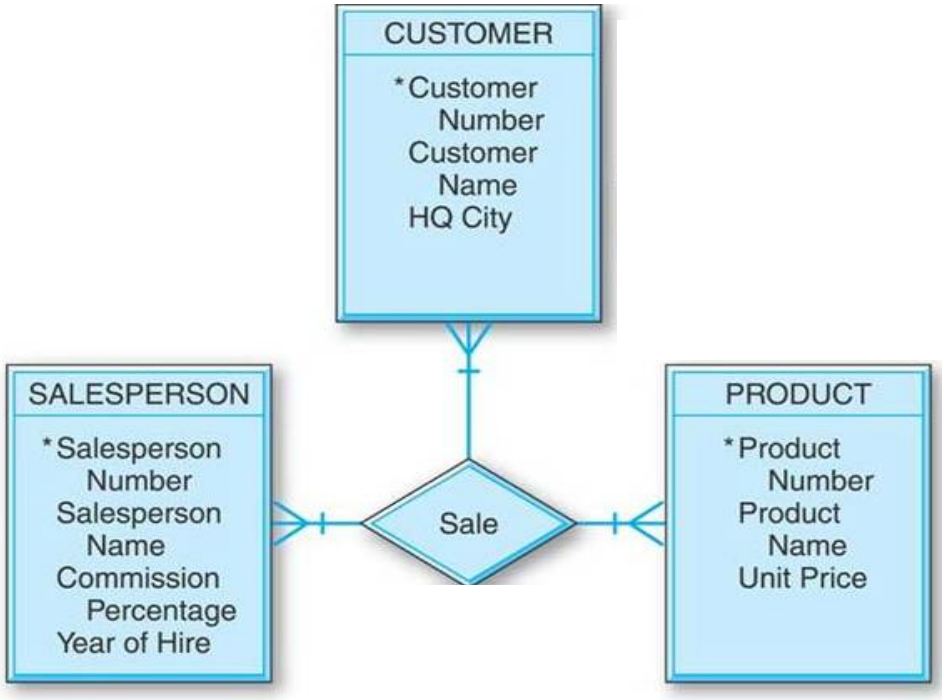
Types of Relationships

- Unary:
  - Recursive relationship between instances of the same entity
  - Salesperson manages a Salesperson



Types of Relationships

- Ternary:
  - Relationship among three different entities
  - Salesperson sells a Product to a Customer



Relationships

- Cardinality:
  - How many instances of one entity are associated with an instance of the other entity?
  - Maximum
- Modality:
  - Can an instance of an entity exist without a related instance of the other entity?
  - Minimum

Cardinality

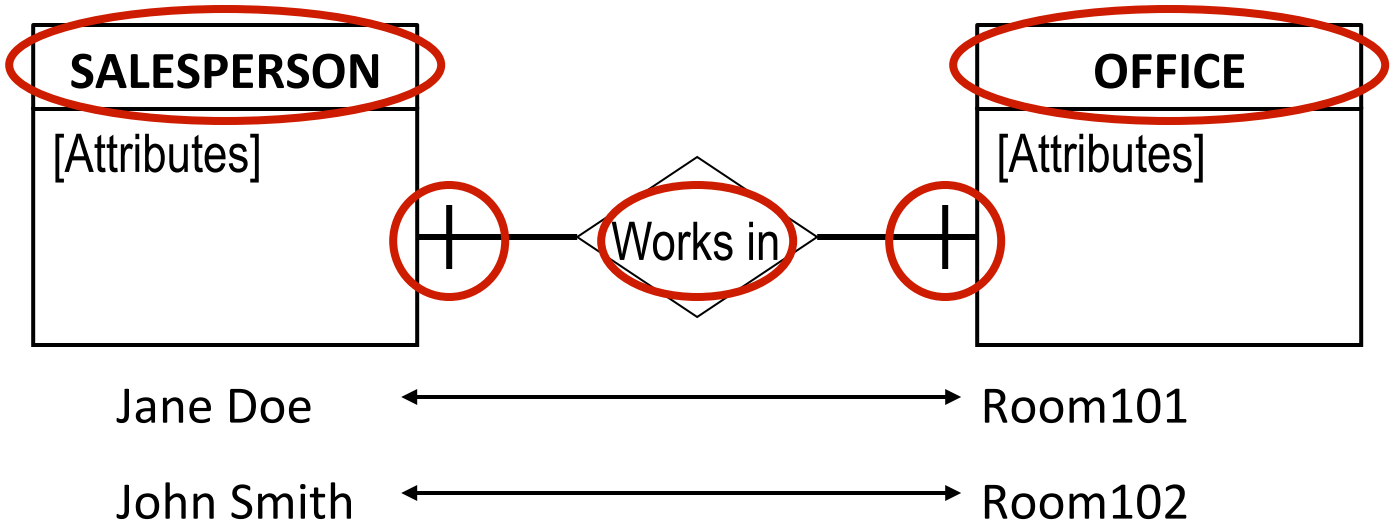
- Cardinality:
  - How many instances of one entity are associated with an instance of the other entity?
  - Maximum
- Outer symbol on the relationship

Represents “one”

Represents “many”

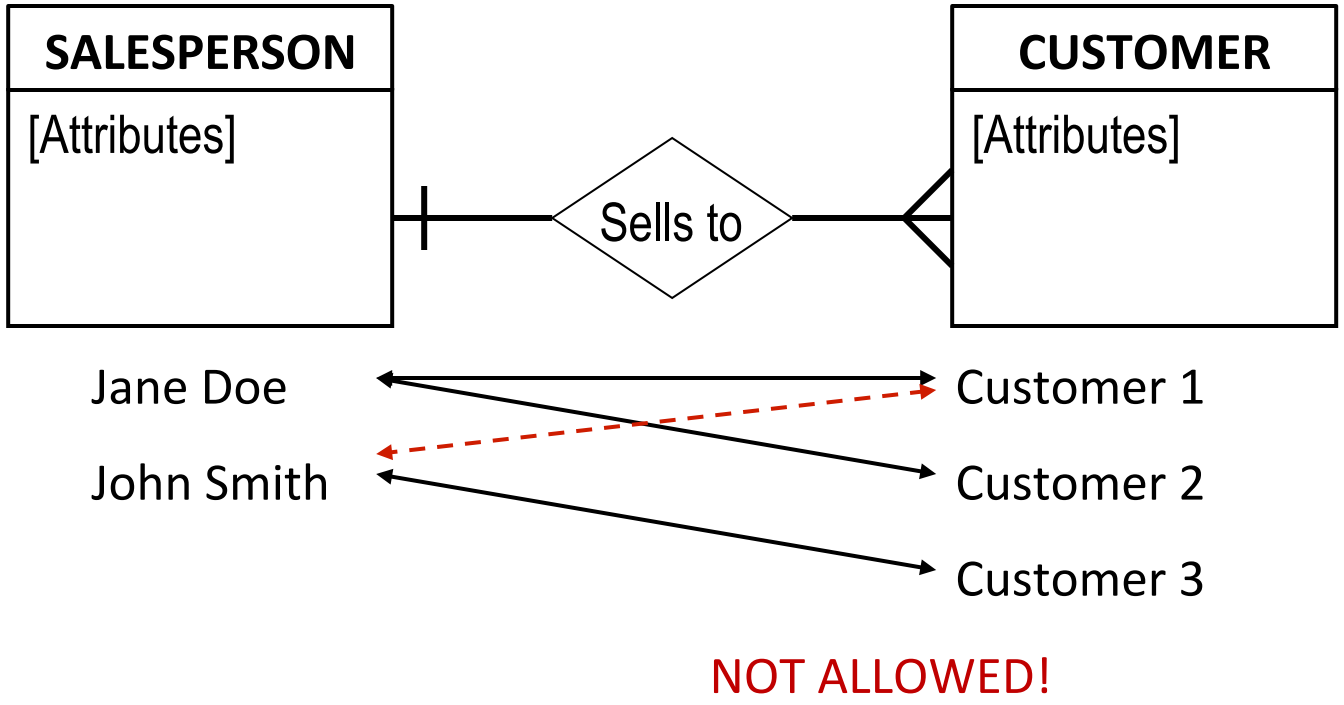
Cardinality

- **One-to-one (1:1) relationship:**
  - One instance of an entity is related to only one instance of another entity (and vice versa)



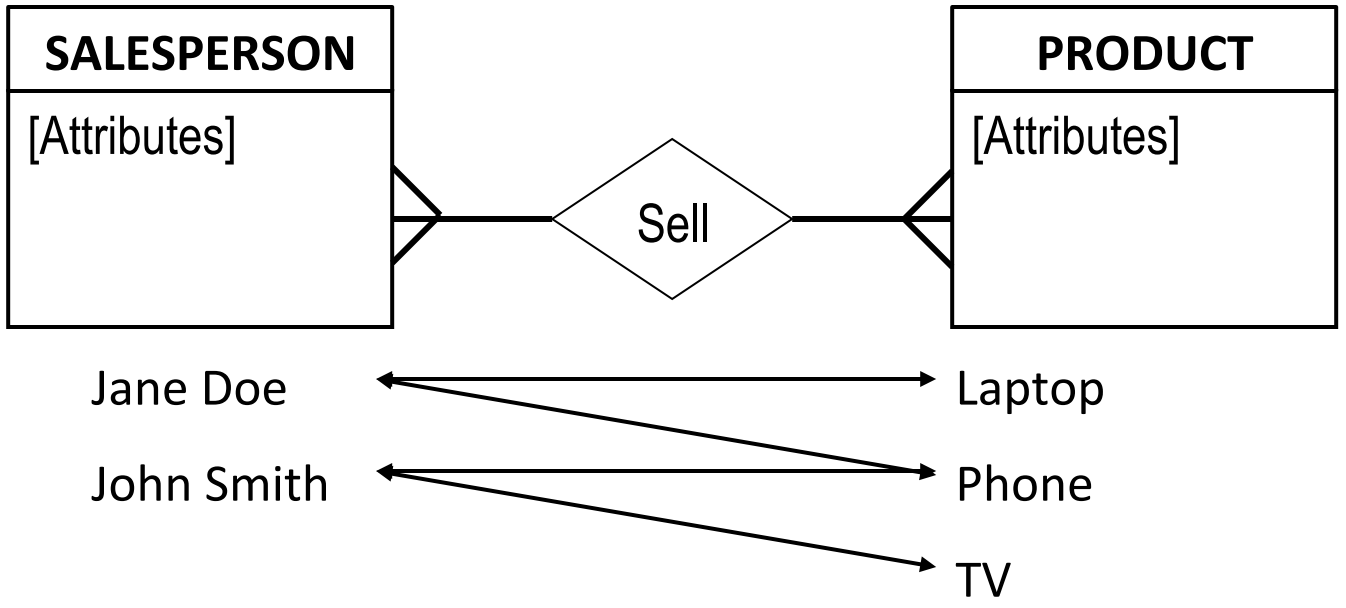
Cardinality

- **One-to-many (1:N) relationship:**
  - One instance of an entity is related to many instances of another entity



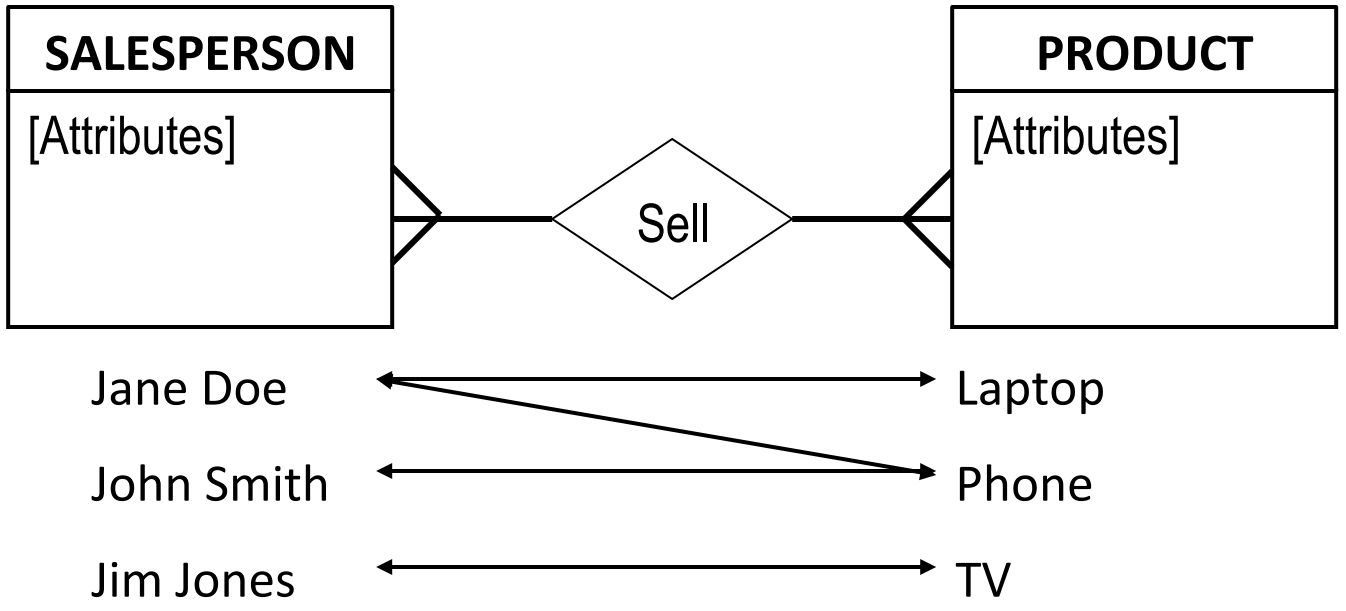
Cardinality

- **Many-to-many (M:N) relationship:**
  - Many instances of one entity can be related to many instances of the other entity



Cardinality

- Can a one-to-one relationship exist in one-to-many? Many-to-many?
- Can a one-to-many relationship exist in many-to-many?



In-class Exercise

- Draw the relationships for the following scenarios:
  - A caretaker can take care of many dogs; a dog can have one caretaker
  - A patient can have more than one treatment; a treatment can be applied to many patients
  - A student can take only one test; each test belongs to a student

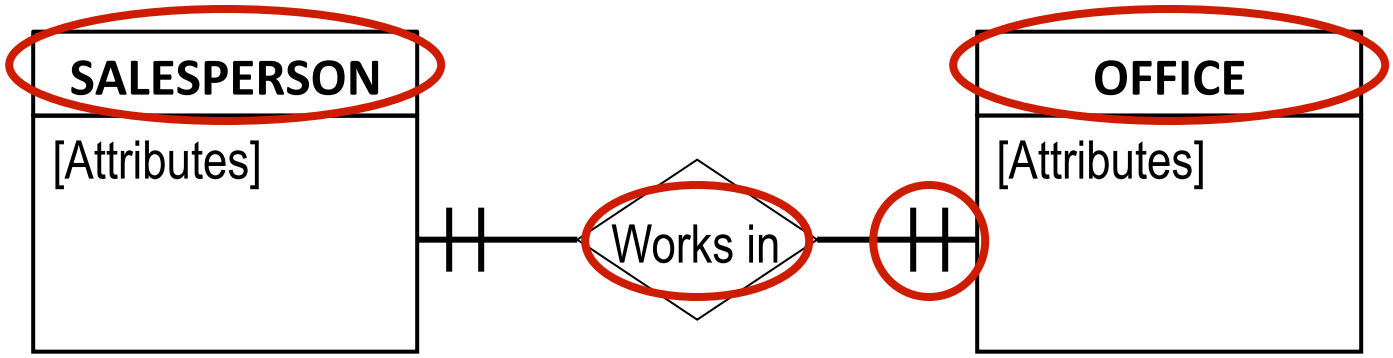
Modality

- Modality:
  - Can an instance of an entity exist without a related instance of the other entity?
  - Minimum
- Inner symbol on the relationship

|	Represents "mandatory" (i.e., 1)
◯	Represents "optional" (i.e., 0)

Modality

- **Mandatory:**
  - An instance in the related entity must exist for an instance in the other entity



Jane Doe ⟷ Room101

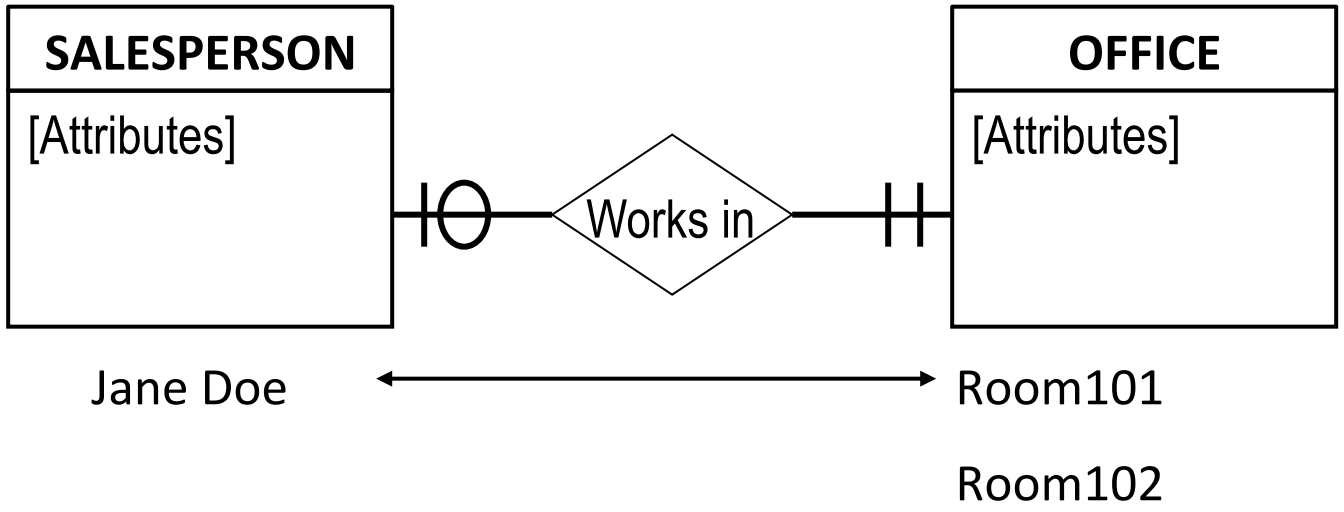
John Smith ⟷ Room102

Doug Jones

NOT ALLOWED!

Modality

- **Optional:**
  - No instance in the related entity is necessary for an instance in the other entity

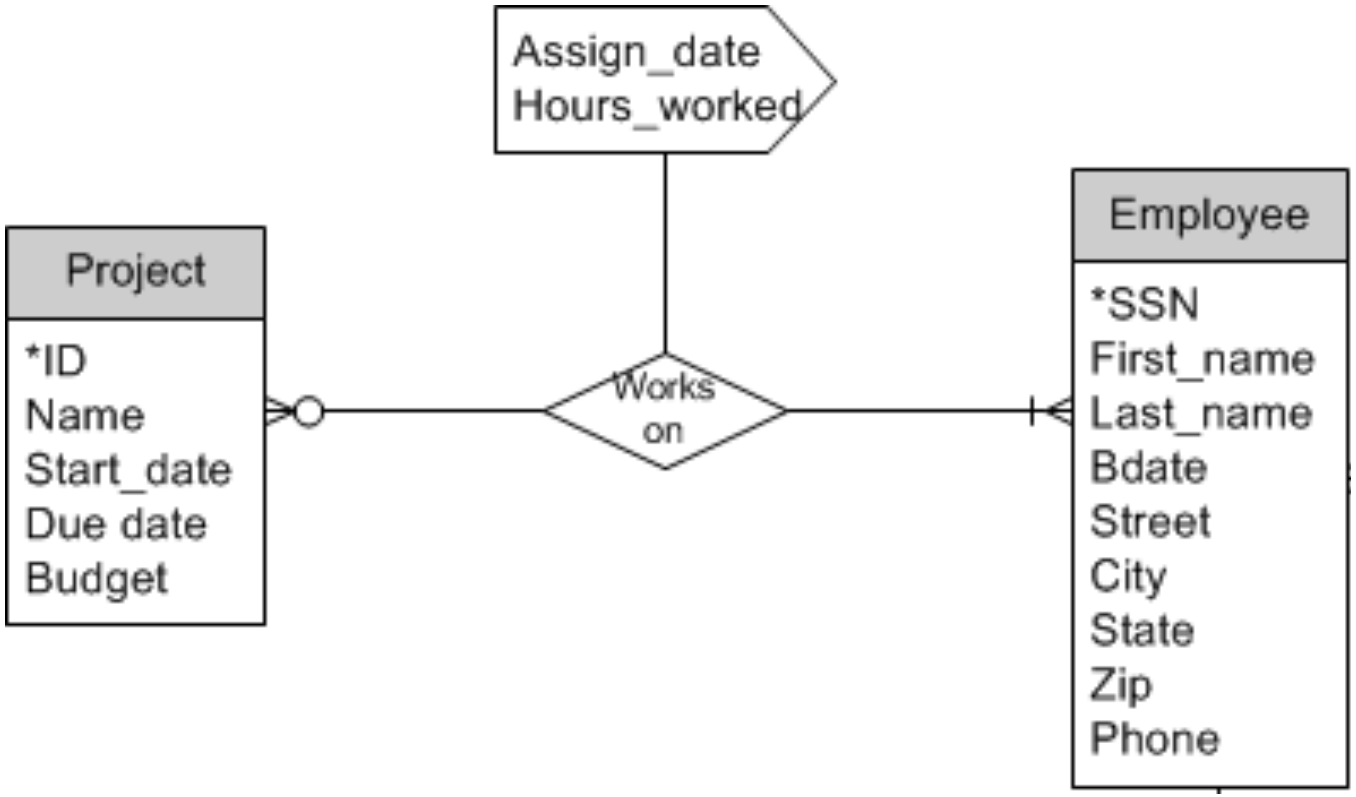


Question

- Where do you store an employee's "hours" on a project?

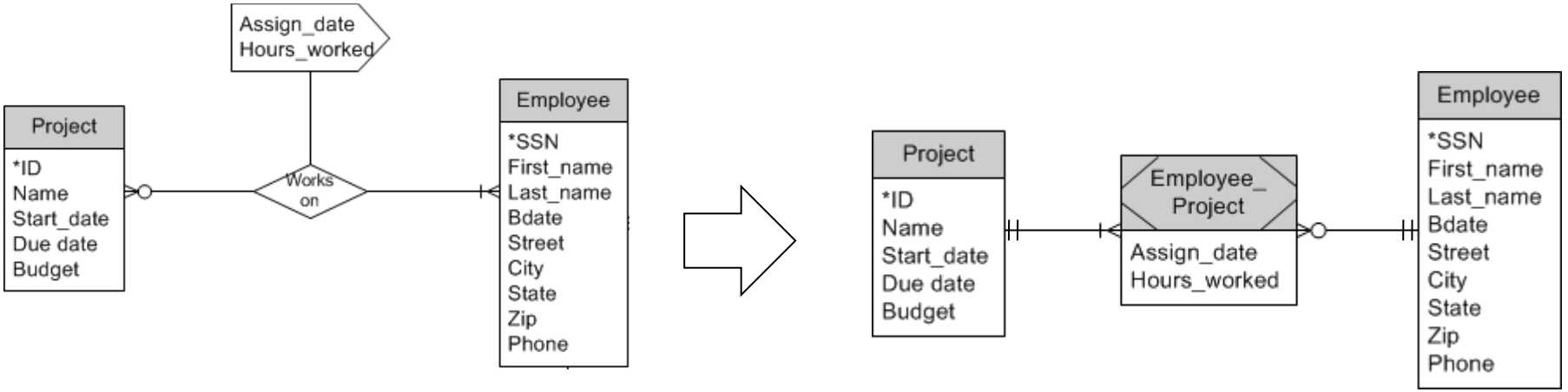
Intersection Data

- Some (M:N) relationships can have their own attributes (intersection data)
  - An employee can work for several hours on a project



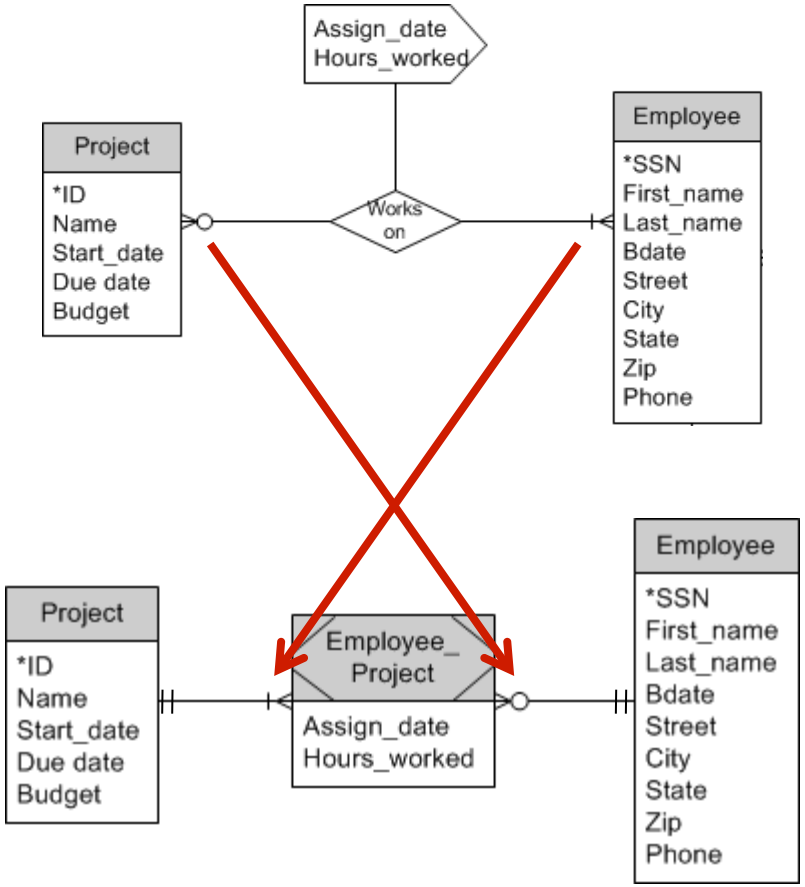
Associative Entity

- When there is a many-to-many relationship, there is always an "intersection" entity (called "associative entity")
  - Intersection data is stored in the associative entity

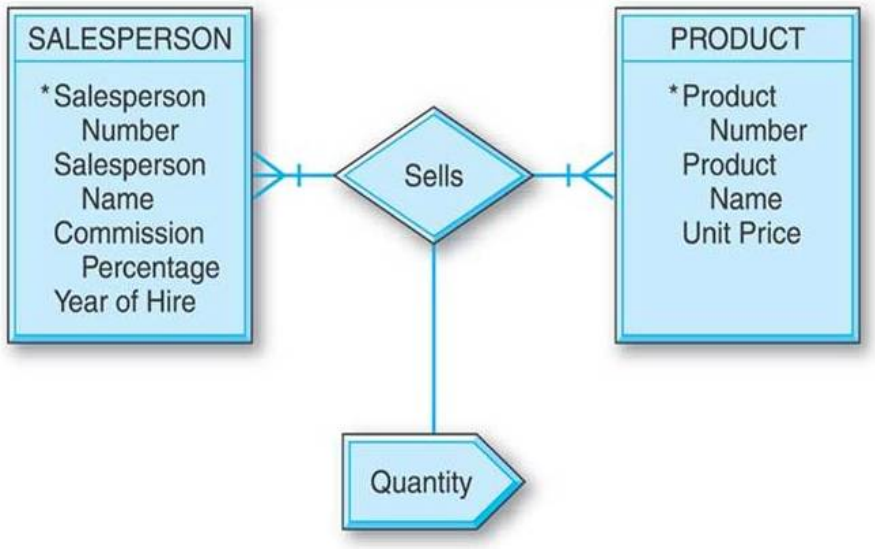


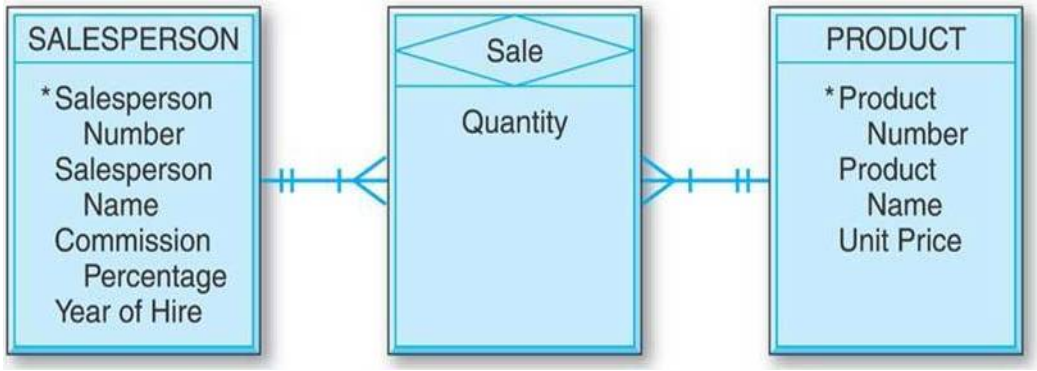
Associative Entity

- Be careful: cardinality and modality are reversed!



Associative Entity

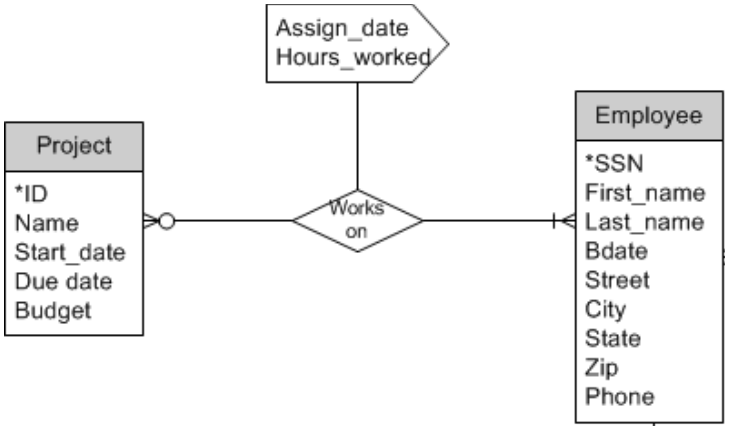




Associative Entity

- Which format to use?

?



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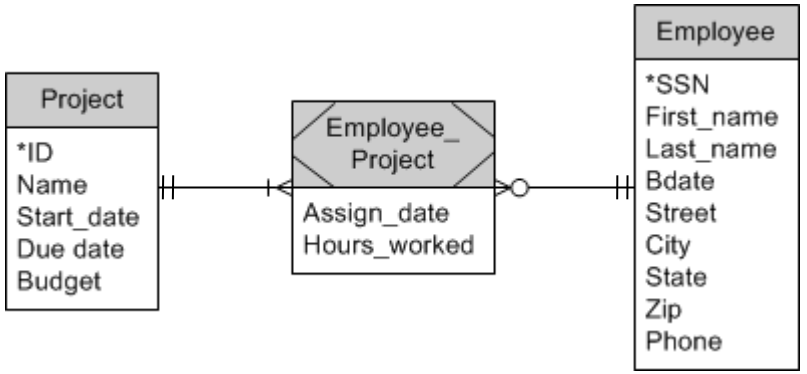
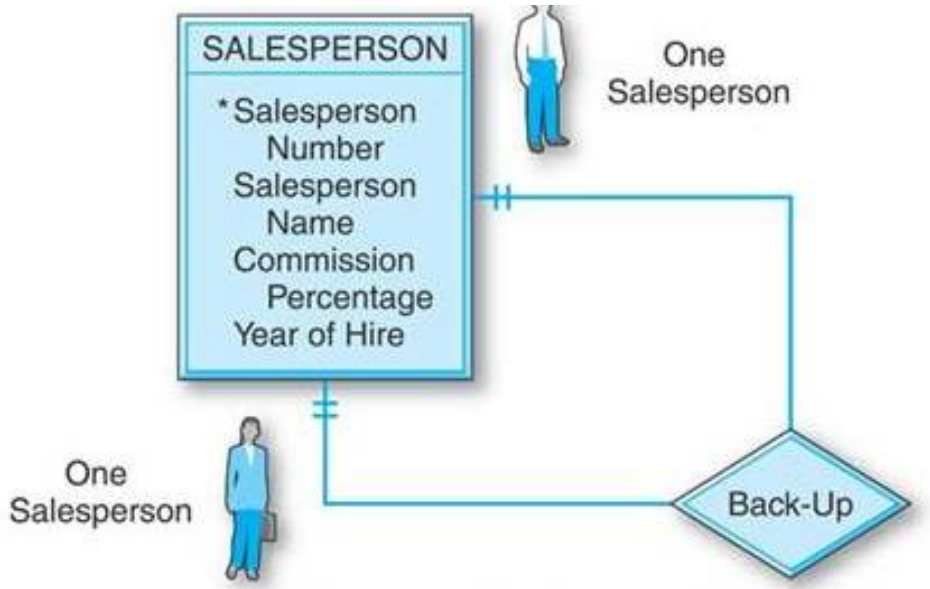


More Examples

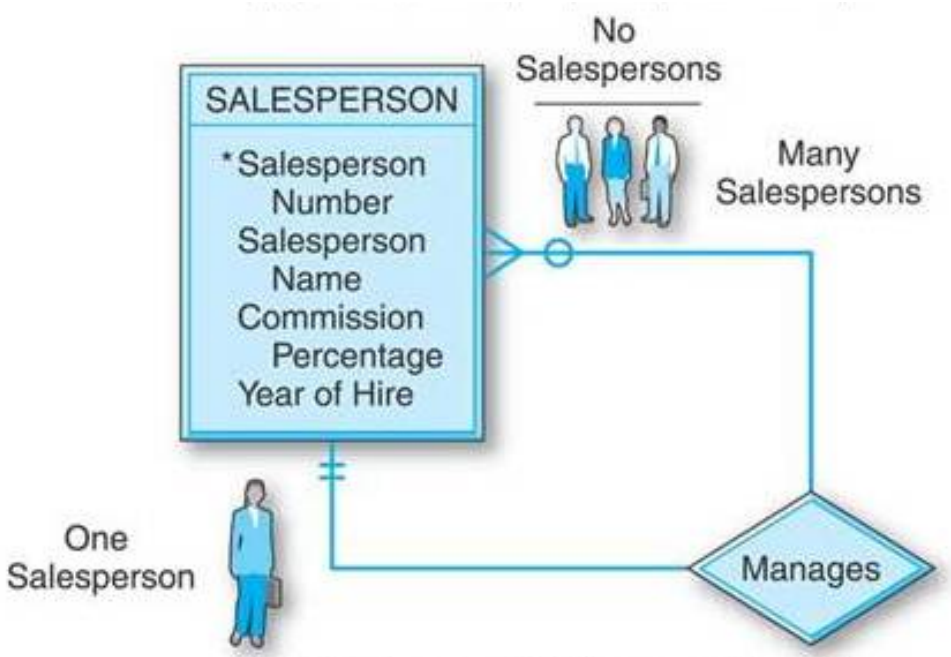
- Unary relationships:
  - One salesperson backs up only one salesperson and vice versa



(a.) One-to-one (1–1) unary relationship

More Examples

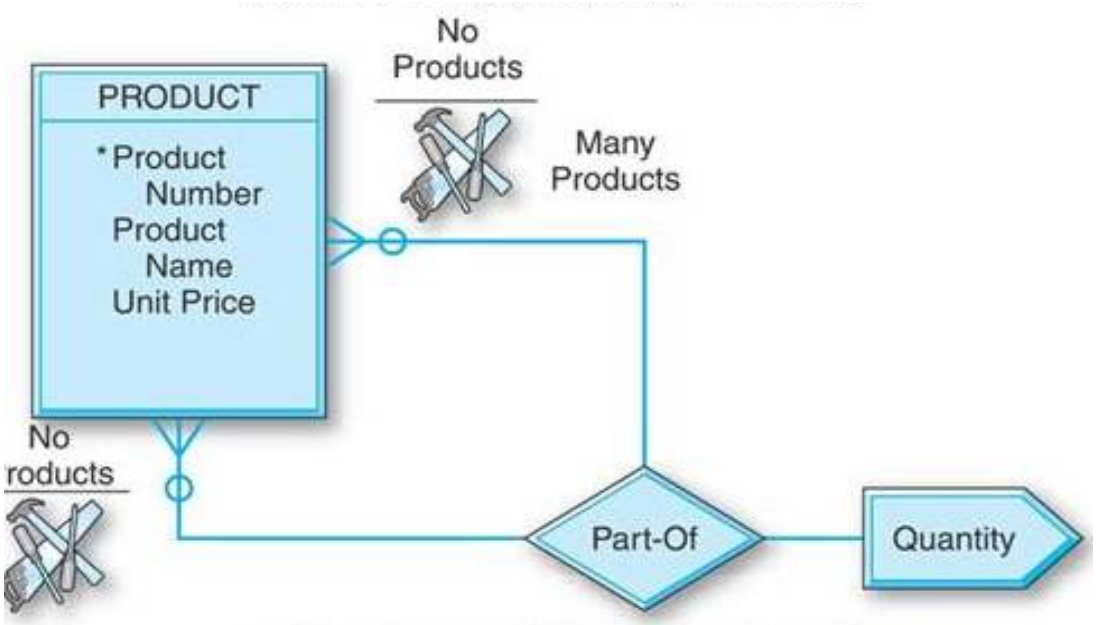
- Unary relationships:
  - One salesperson manages many salespersons, but is managed by only one other salesperson



(b.) One-to-many (1–M) unary relationship

More Examples

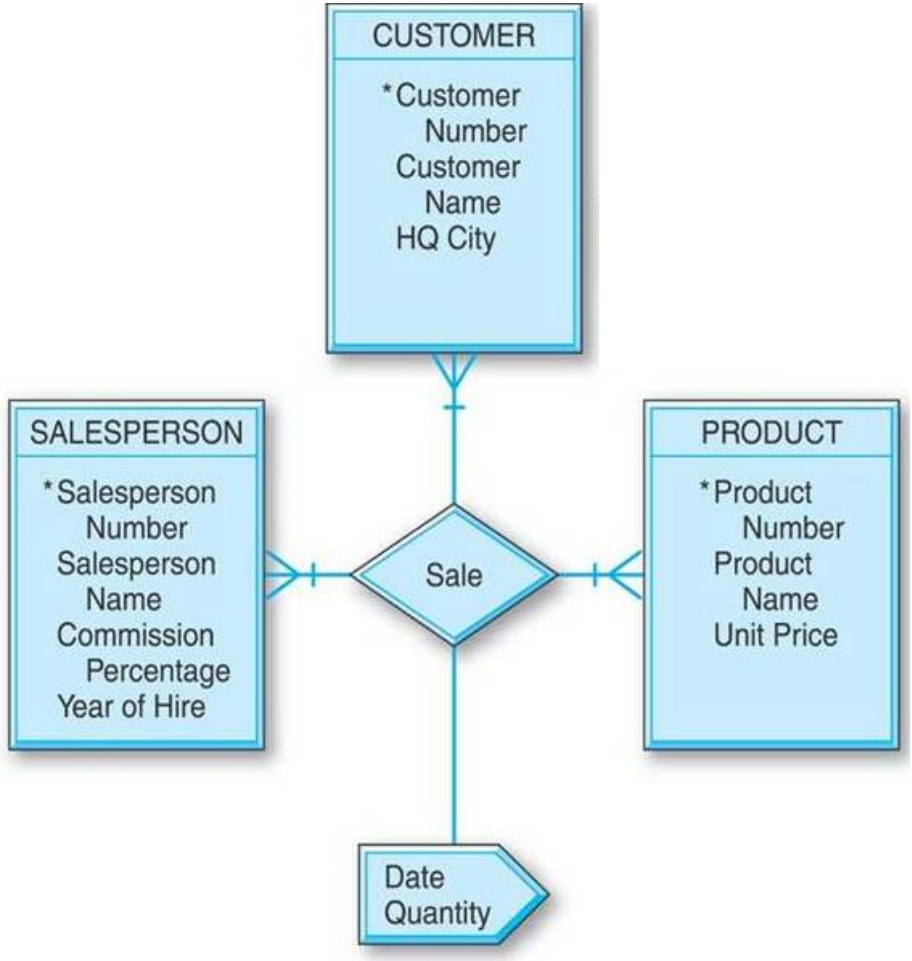
- Unary relationships:
  - Many products can be part of other products and vice versa



(c.) Many-to-many (M–M) unary relationship

More Examples

- Ternary Relationship:
  - Salespersons sell products to customers



Tips for Creating an ERD

- Read the narrative to
  - Identify entities
  - Identify attributes
  - Develop relationships between entities using business rules

Next

- OO
- EER