
ENTITY RELATIONSHIP DIAGRAM (ERD)

Key Definitions

- **Data model (Conceptual Data Model)**
 - A **formal way** of representing the data that are used and created by a business system.
 - Shows the **people, places and things** about which data is **captured** and the **relationships among them**.
- **Logical data model**
 - Shows the **organization of data without indicating how it is stored, created, or manipulated**.

Key Definitions

- **Physical data model**
 - Shows how the data will actually be stored in databases or files.
- **Normalization is the process**
 - Analysts use to validate data models.
 - Data models should balance with process models.

What Is an ERD?

- A picture showing the information created, stored, and used by a business system.
- Entities generally represent similar kinds of information.
- Lines drawn between entities show relationships among the data.
- High level business rules are also shown.

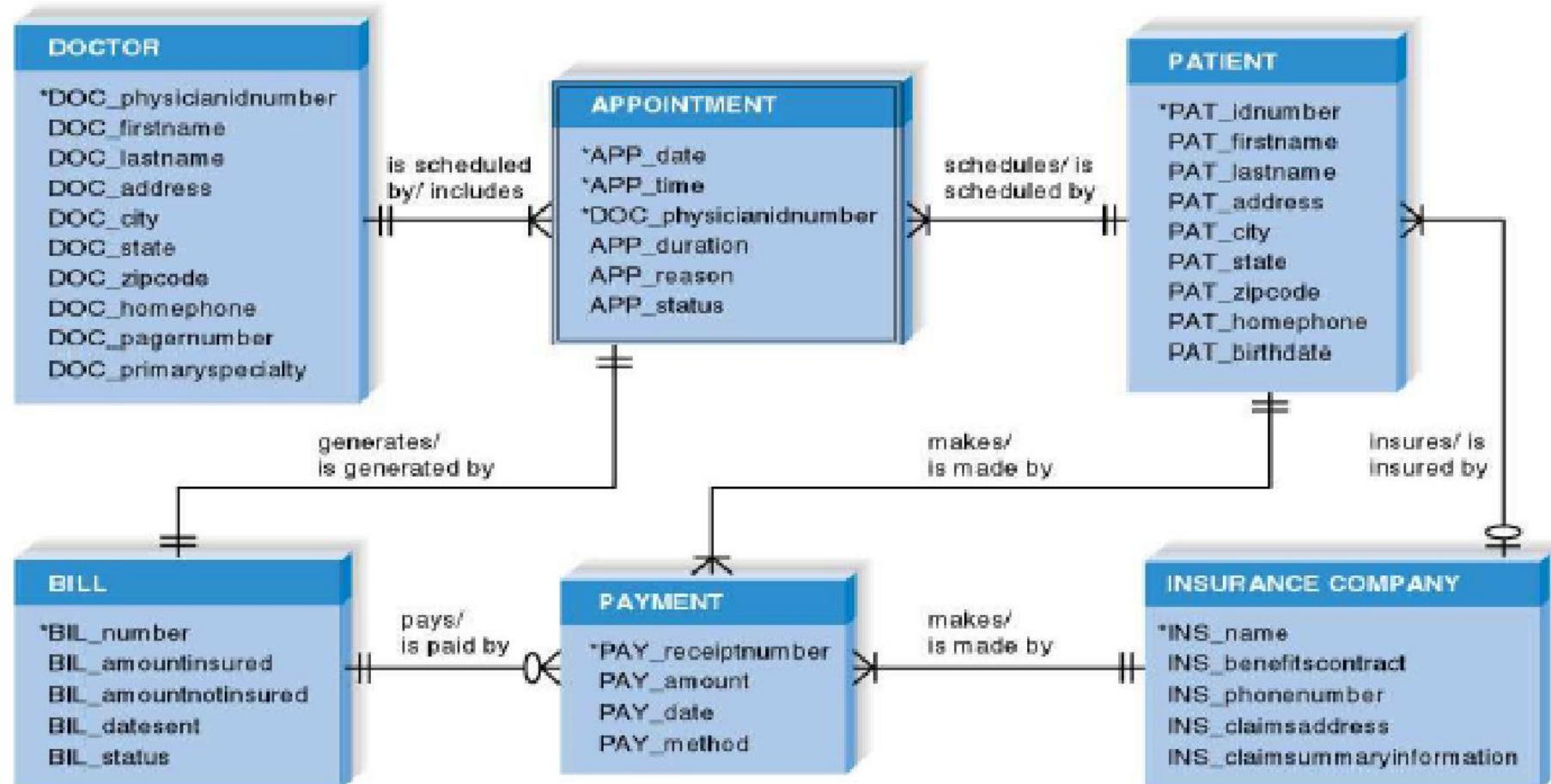
Using the ERD to Show Business Rules

- **Business rules** are **constraints** that are followed when the system is in operation.
- ERD symbols can show when one instance of an entity must exist for an instance of another to exist.
 - A doctor must exist before appointments for the doctor can be made.




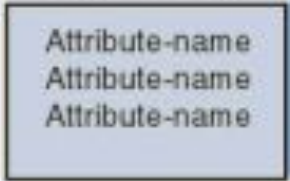

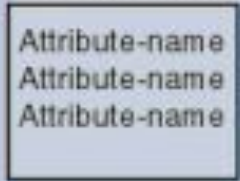



Using the ERD to Show Business Rules

- ERD symbols can show when **one instance of an entity can be related to only one or many instances of another entity.**
 - One doctor can have many patients; each patient may have only one primary doctor.
- ERD symbols show when the **existence of an entity instance is optional for a related entity instance.**
 - A patient may or may not have insurance coverage.

An ERD Example



ERD Elements

	IDEF1X	Chen	Crow's Foot
An ENTITY: <ul style="list-style-type: none"> ✓ Is a person, place, or thing ✓ Has a singular name spelled in all capital letters ✓ Has an identifier ✓ Should contain more than one instance of data 	ENTITY-NAME 	ENTITY-NAME 	ENTITY-NAME 
An ATTRIBUTE: <ul style="list-style-type: none"> ✓ Is a property of an entity ✓ Should be used by at least one business process ✓ Is broken down to its most useful level of detail 	ENTITY-NAME 		ENTITY-NAME 
A RELATIONSHIP: <ul style="list-style-type: none"> ✓ Shows the association between two entities ✓ Has a parent entity and a child entity ✓ Is described with a verb phrase ✓ Has cardinality (1 : 1, 1 : N, or M : N) ✓ Has modality (null, not null) ✓ Is dependent or independent 			

Entity

- A person, place, event, or thing about which data is collected.
- Must be **multiple occurrences** to be an entity.
 - Example: If a firm has only one warehouse, the warehouse is not an entity. However, if the firm has several warehouses, the warehouse could be an entity if the firm wants to store data about each warehouse instance.

Entities and Instances

Entity	Example Instances
<div data-bbox="670 739 1098 1043">Patient</div>	John Smith Susan Jones Peter Todd Dale Turner Pat Turner

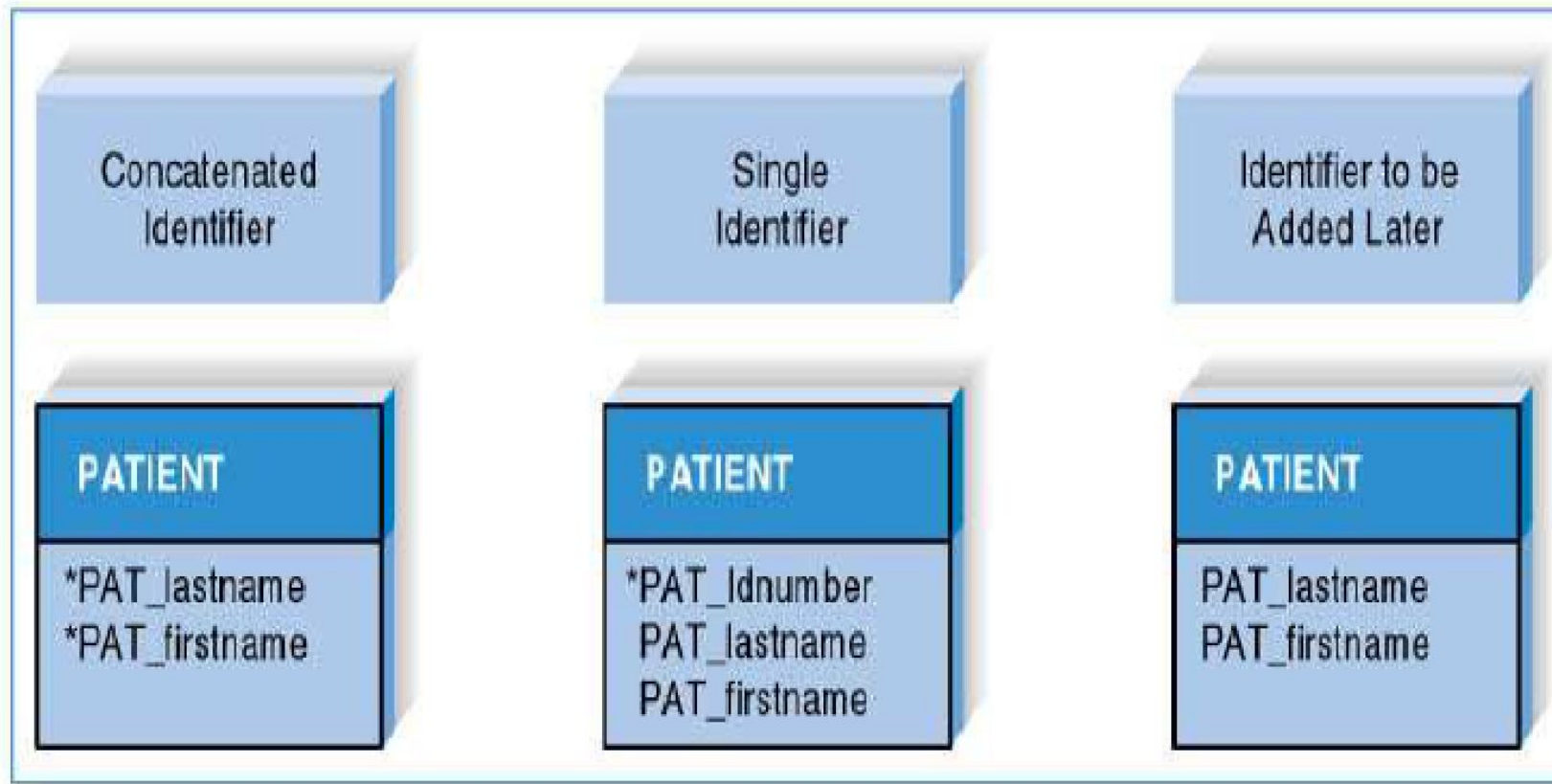
Attributes

- Information captured about an entity.
- **Only those used by the organization** should be included in the model.
- Attribute names are **nouns**.
- Sometimes **entity name** is added at the beginning of the attribute name for clarity.

Identifiers

- **One or more attributes** can serve as the entity identifier, uniquely identifying each entity instance.
- **Concatenated identifier** consists of several attributes.
- An identifier may be '**artificial**', such as creating an ID number.
- Identifiers may not be developed until the Design Phase.

Choices for Identifiers



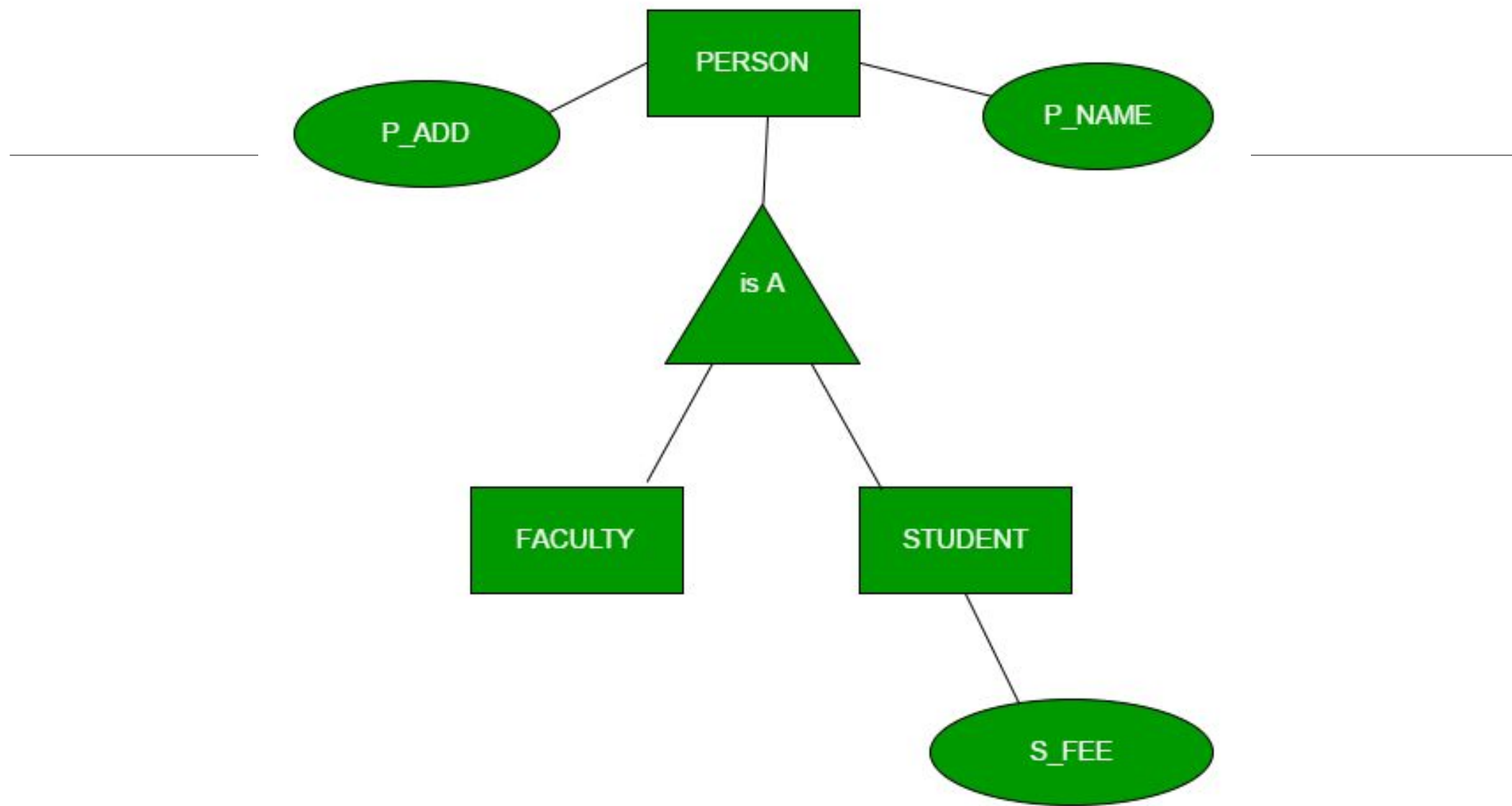
Generalization - Specialization

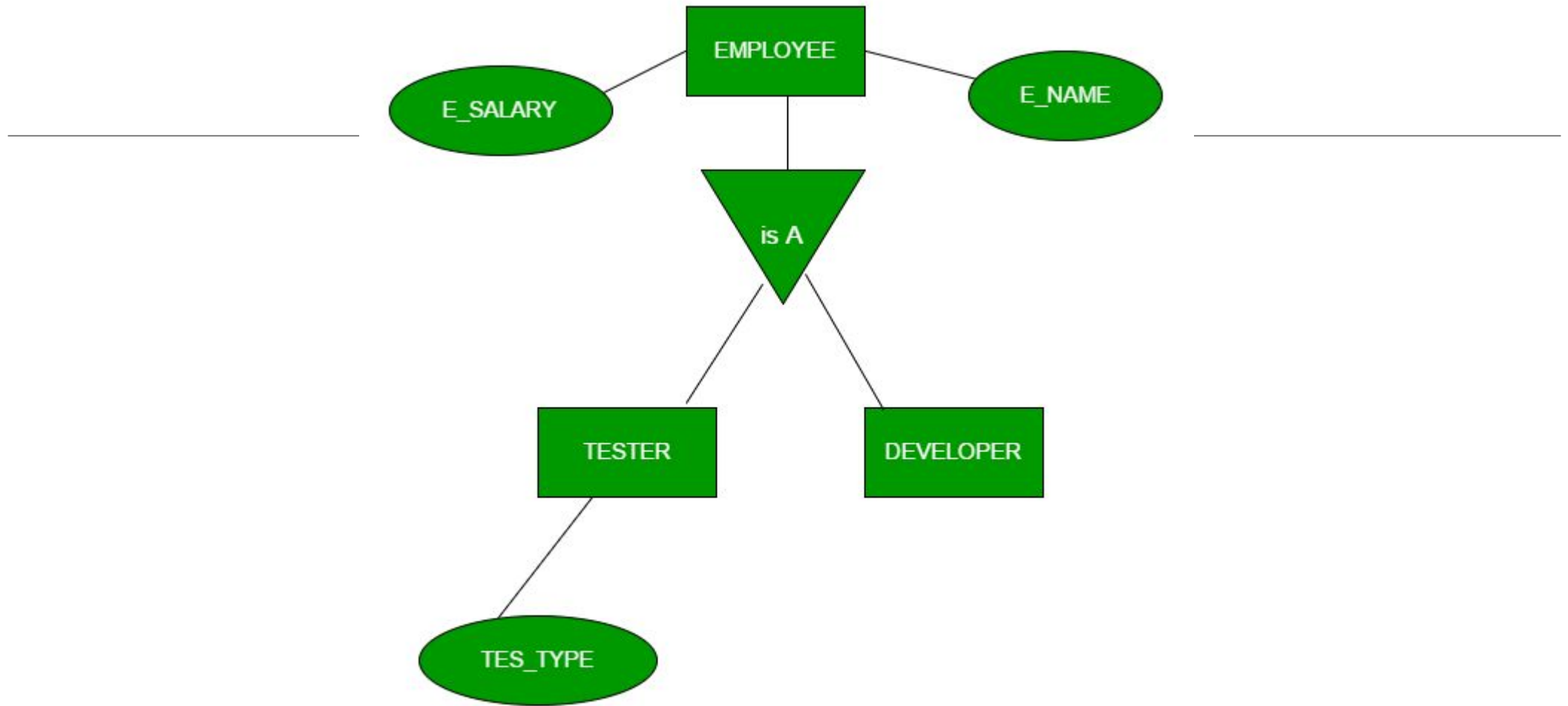
■ Generalization

- It is a **bottom-up approach** in which **two or more entities** can be generalized to a **higher level entity** if they **have some attributes in common**.
- For Example, STUDENT and FACULTY can be generalized to a higher level entity called PERSON.

■ Specialization

- It is a **top-down approach** where **higher level entity** is specialized into **two or more lower level entities**.
- For Example, EMPLOYEE entity in an Employee management system can be specialized into DEVELOPER, TESTER etc.







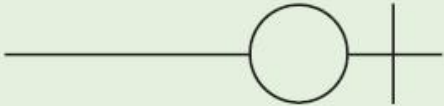
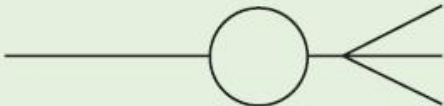
Specialization

Relationships

- **Associations** between entities.
- The first entity in the relationship is the parent entity; the second entity in the relationship is the child entity.
- Relationships should have **active verb names**.
- Relationships **go in both directions**.

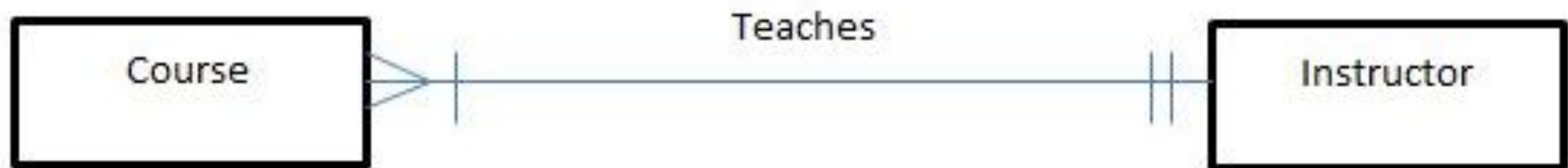
Cardinality

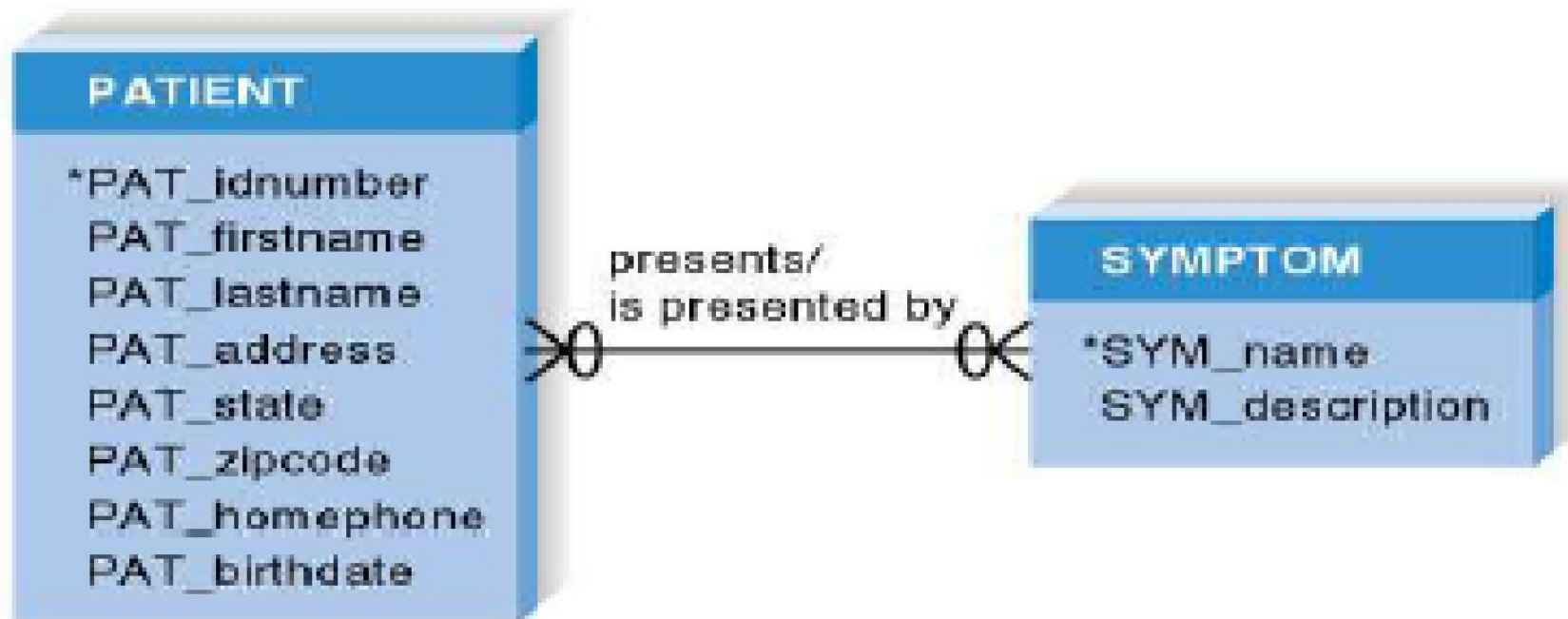
- Refers to the **number of times instances in one entity can be related to instances in another entity**.
 - One instance in an entity refers to one and only one instance in the related entity (1:1).
 - One instance in an entity refers to one or more instances in the related entity (1:N).
 - One or more instances in an entity refer to one or more instances in the related entity (M:N).

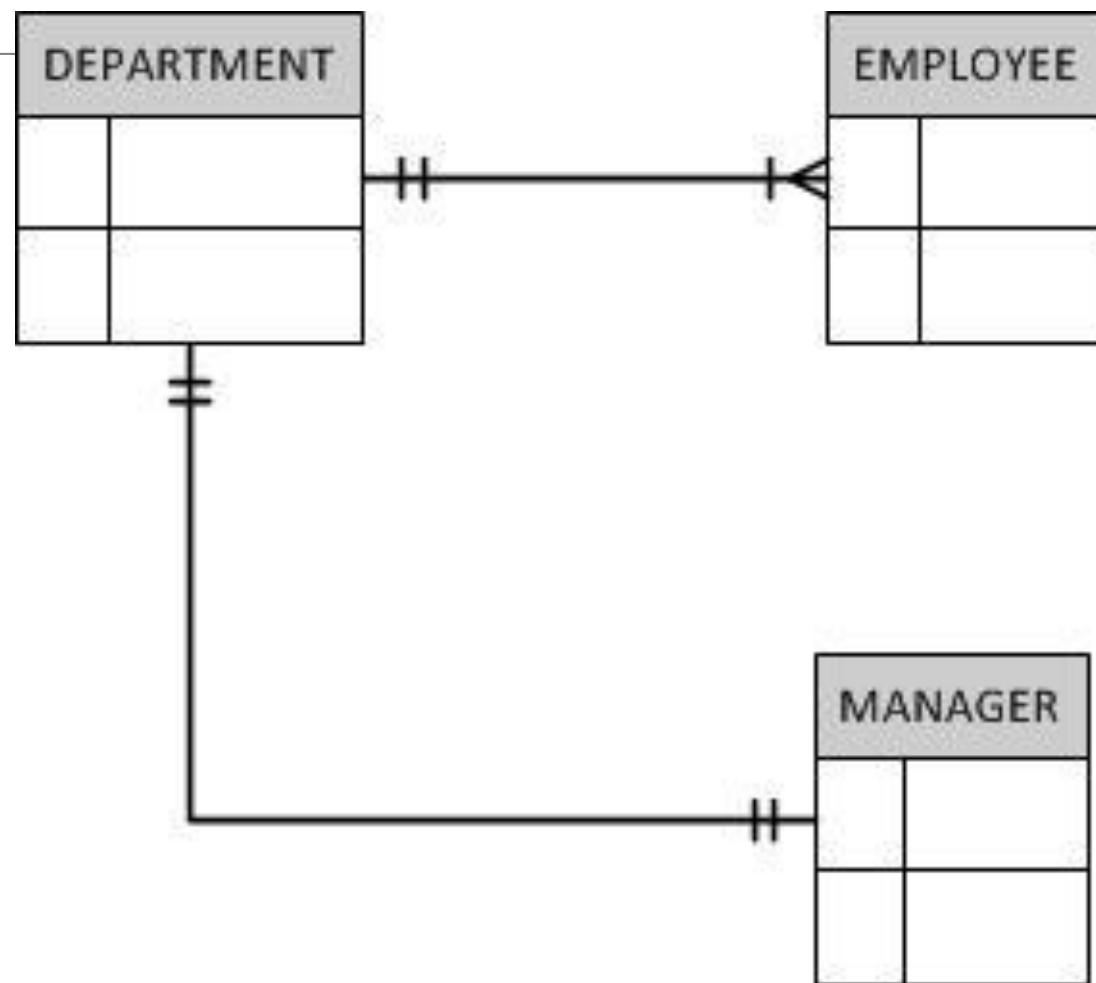
Symbol	Meaning
	One—Mandatory
	Many—Mandatory
	One—Optional
	Many—Optional

Modality

- Refers to **whether or not an instance of a child entity can exist without a related instance in the parent entity.**
- Not Null means that an instance in the related entity must exist for an instance in another entity to be valid.
- Null means that no instance in the related entity is necessary for an instance in another entity to be valid.

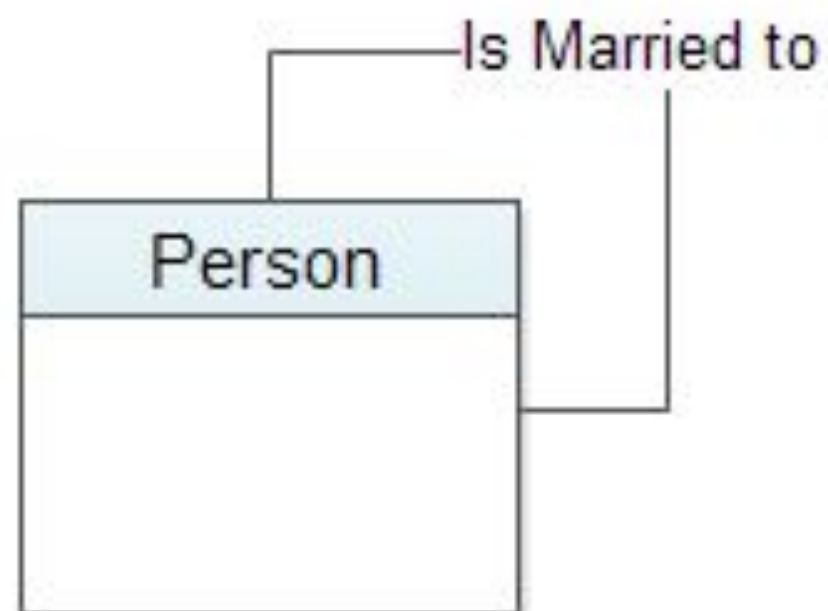




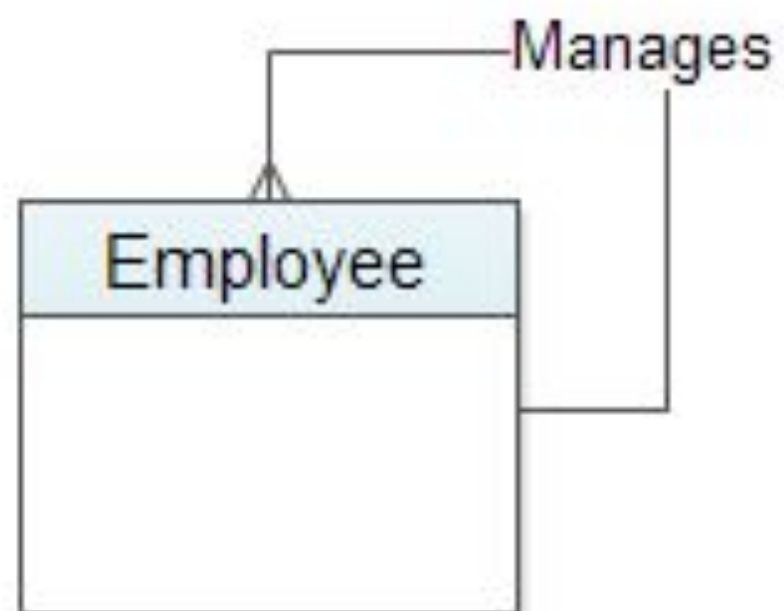


Recursive Relationship

- It's a **relationship with the same entity**.
 - For example, an employee may act as a supervisor for one or more employees, while an employee may be supervised by an employee (it's one-to-many relationship).



One-to-One



One-to-Many

Weak Entity

A weak entity is simply **an entity where its existence depends on another entity**.

A weak entity has what's called a "partial key". It's one or more attributes that uniquely identify a weak entity for a given owner entity.



Attribute relationship

- Relationship can have attributes.
- Weak entity is used to represent attribute relationship.

SUPPLIER			
<u>SUPPLIER_NAME</u>	<pi>	Variable characters (100)	<M>
SUPPLIER_CONTACT		Variable characters (100)	<M>
Identifier_1 <pi>			

Relationship_1

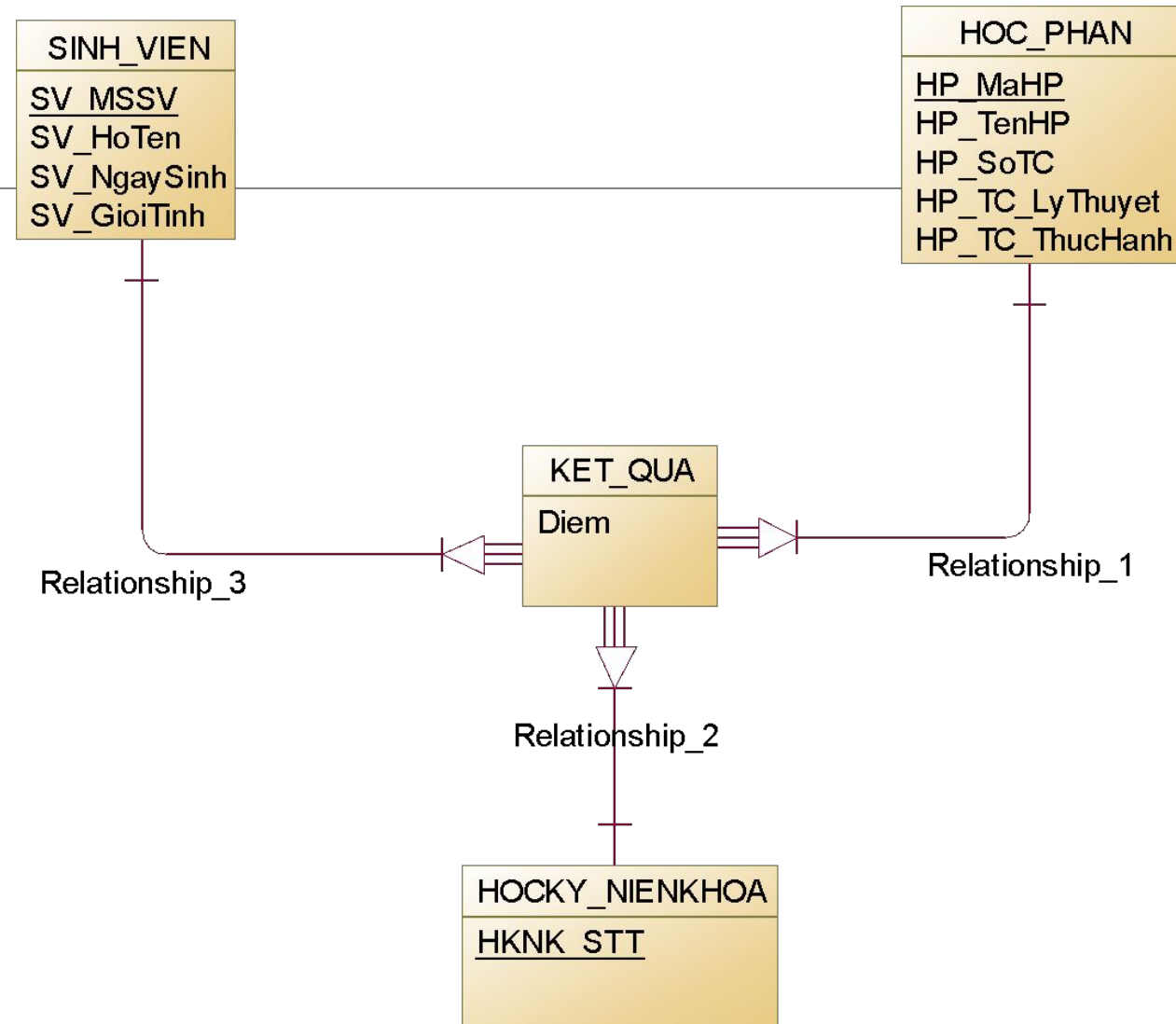
ORDER_DETAIL			
AMOUNT		Integer	<M>
TOTAL_COST		Integer	<M>
PURCHASE_DATE		Date	<M>

Relationship_2

CHEMICAL			
<u>CHEMICAL_NAME</u>	<pi>	Variable characters (100)	<M>
CHEMICAL_FORMULAR		Variable characters (200)	<M>
Identifier_1 <pi>			

N-ary relationship

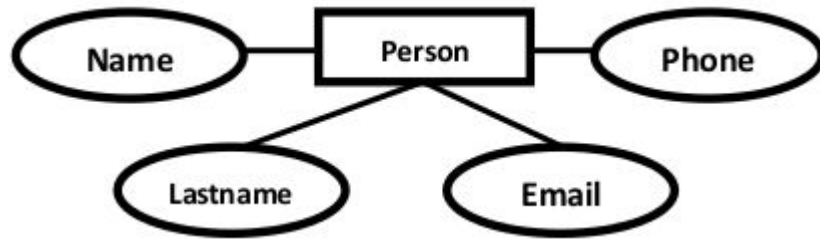
Weak entity is also used to represent n-ary relationship.



Conversion of ER Diagram to Relational model

Mapping (regular/strong) entity

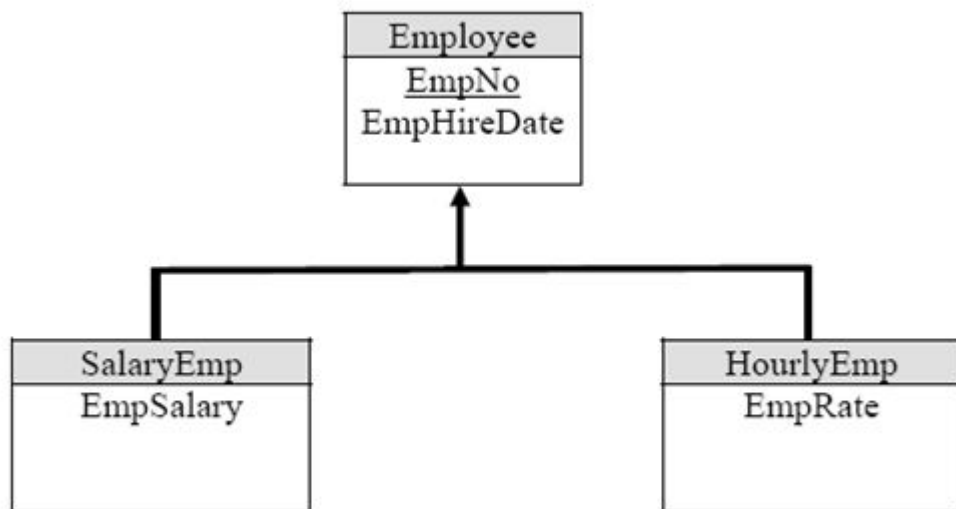
- For each strong entity set create a new relational independent table that includes all attributes as column.



Persons(personid , name, lastname, email)

Converting Generalization Hierarchies

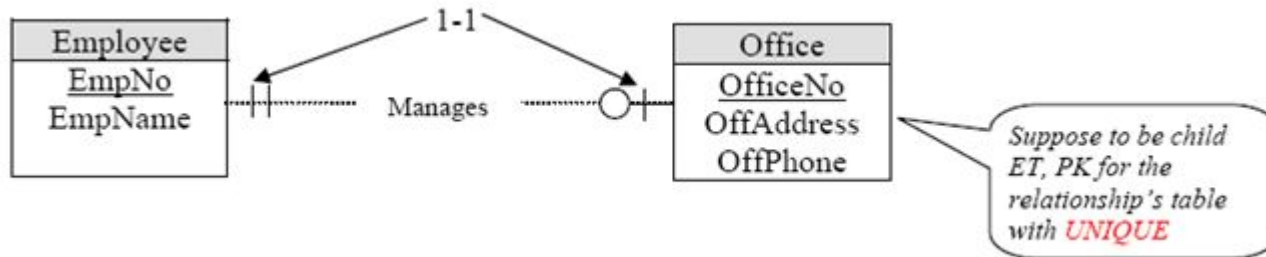
- Convert each entity of a generalization hierarchy into a table.
- The only column appearing that are different from attributes in the associated ERD is the inherited Primary Key.



Employee (**EmpNo**, EmpHireDate)
SalaryEmp (**EmpNo**, EmpSalary)
HourlyEmp (**EmpNo**, EmpRate)

Mapping 1:1 Relationship

- For a 1:1 Relationship between two entities S and T. Choose one of the relations, Example - S and include as foreign key in S the primary key of T.
- It is better to choose on entity total participation on S and include descriptive attribute.

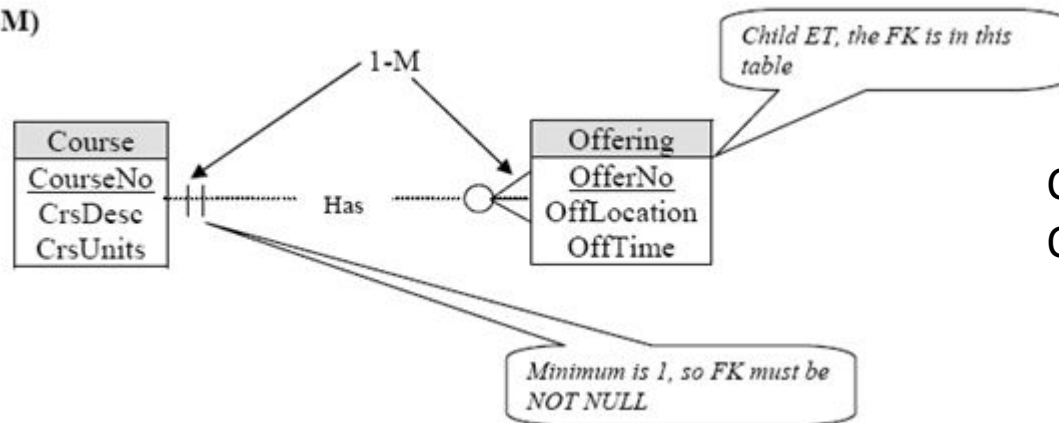


Office (**OfficeNo**, OffAddress, OffPhone)
Employee (**EmpNo**, EmpName, OffNo)

Mapping 1:N Relationship

- For 1:N relationship identify the entity S on N side of the relationship, **include a foreign key in S the Primary key of relation T** also include Discipline attributes of 1:N attribute of S.

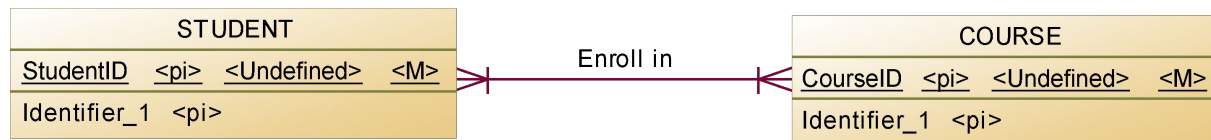
EXAMPLE (1-M)



Course (**CourseNo**, CrsDesc, CrsUnits)
Offering (**OfferNo**, OffLocation, OffTime, *CourseNo*)

Mapping N:N Relationship

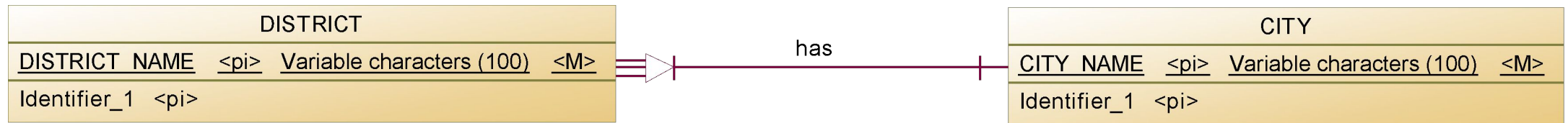
- For each M:N relationship
 - Create a new relational table include in the new relation,
 - The primary key of the participating entities as a well as descriptive attributes,
 - The primary key of the table will be the combination of primary keys of participating entities.



STUDENT (**StudentID**)
COURSE (**CourseID**)
EnrollIn (**StudentID**, **CourseID**)

Mapping weak entity

- Convert **every weak entity set into a table** where
 - we take the discrimination attribute of the weak entity set and **takes the primary key of the strong entity set as a foreign key.**
 - and then **declared the combination of discriminator attribute and foreign key as a primary key.**



CITY (**CITY_NAME**)

DISTRICT (**DISTRICT_NAME**, *CITY_NAME*)

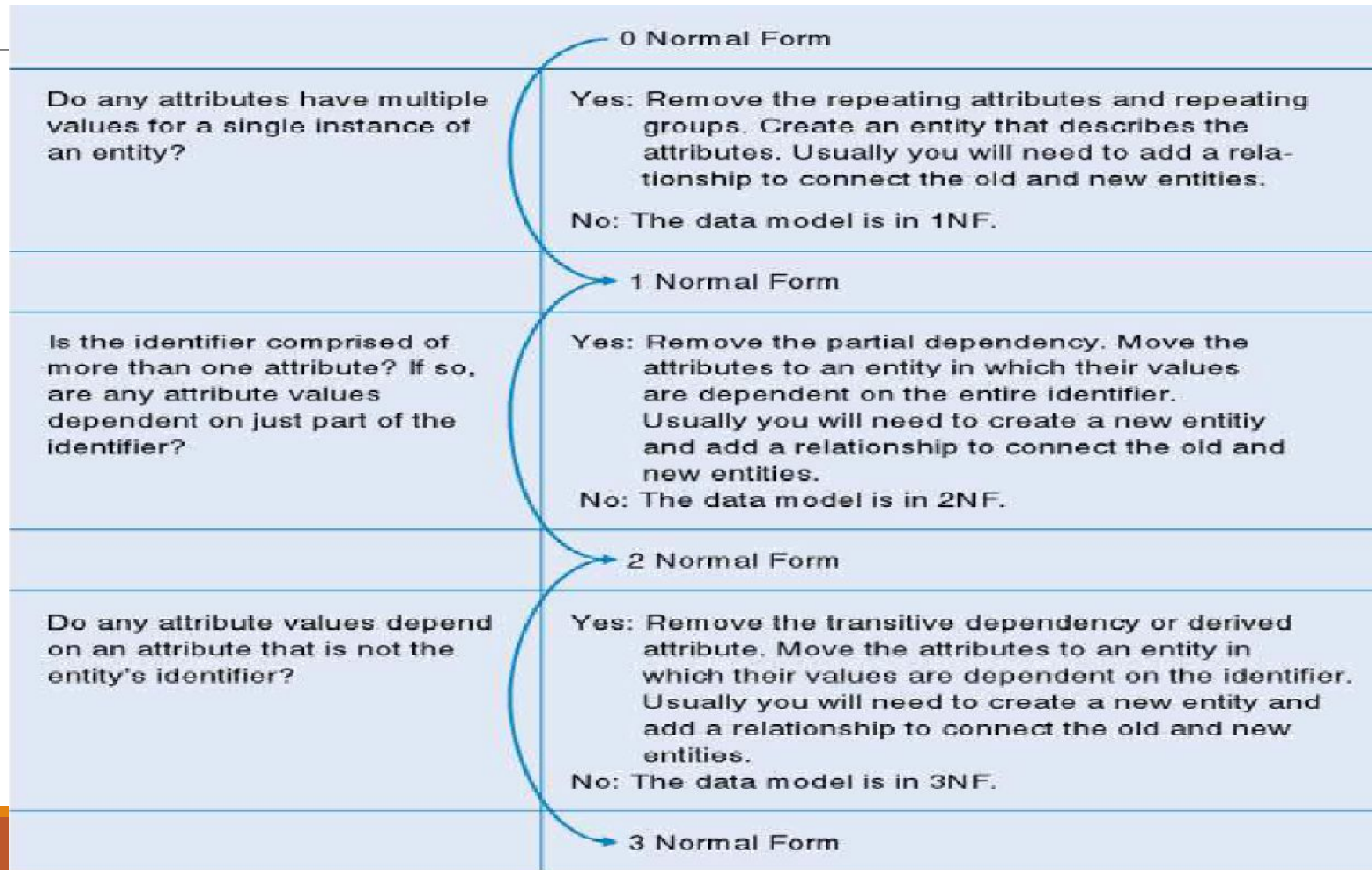
VALIDATING AN ERD



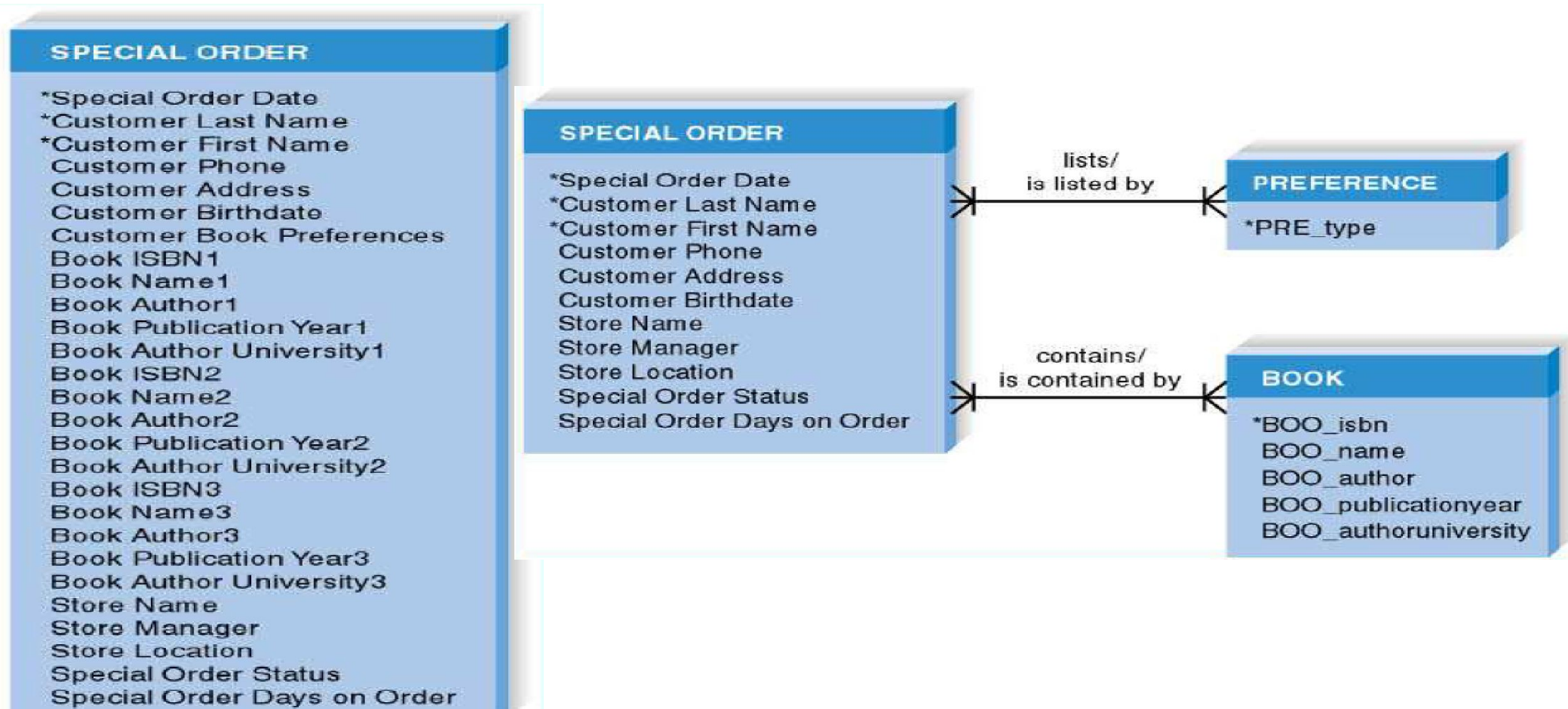
Normalization

- Technique used to validate data models.
- Series of rules applied to logical data model to improve its organization.
- Three normalization rules are common.

Normalization Steps

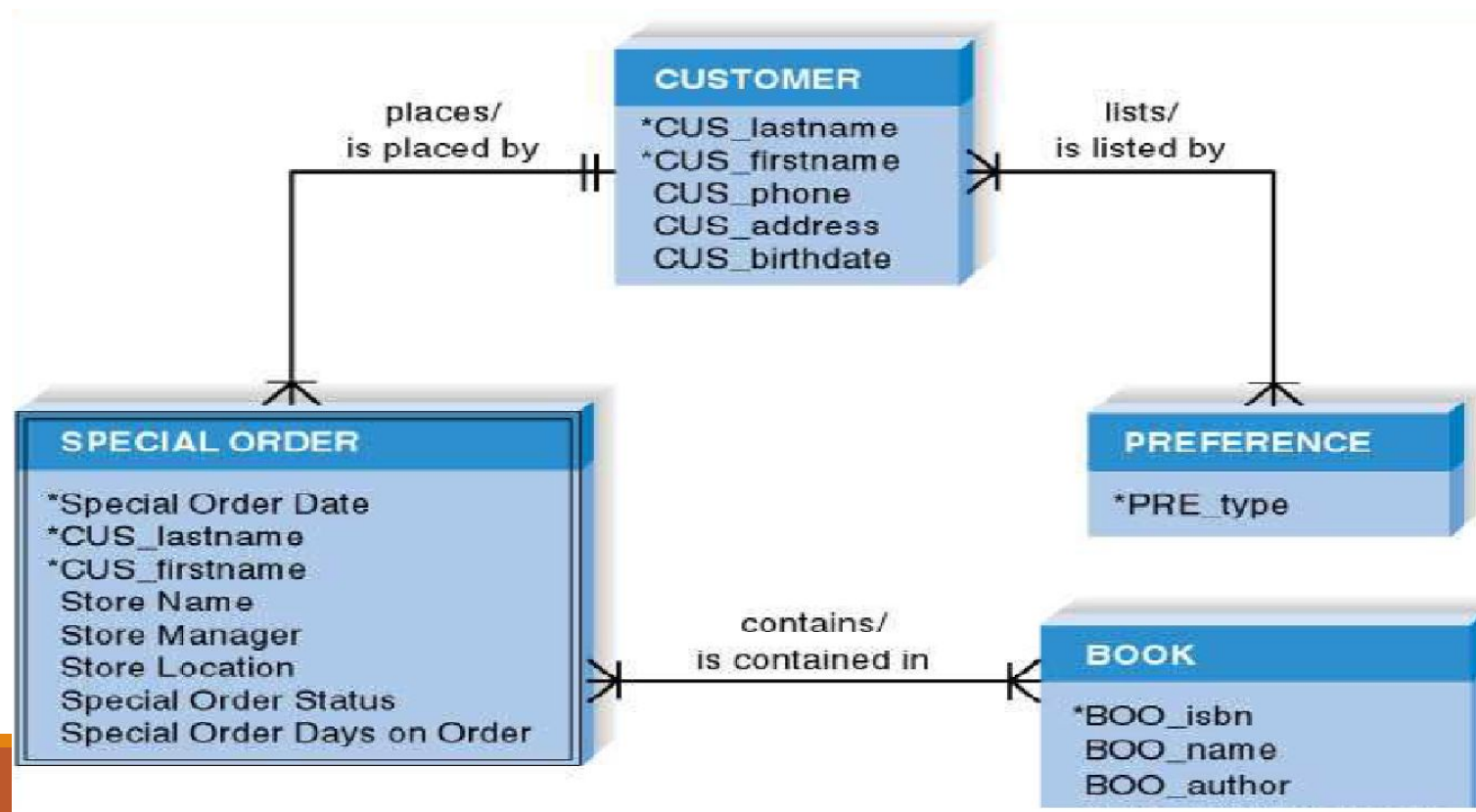


First Normal Form (1NF)



Second Normal Form (2NF)

- If an **entity has a concatenated identifier**, look for attributes that depend only on part of the identifier. If found, remove to new entity.



Third Normal Form (3NF)

- Look for attributes that depend only on another non-identifying attribute. If found, remove to new entity. Also remove any calculated attributes.

