Database Systems

Entity Relationship (ER) Modeling

Objectives

- The main characteristics of entity relationship components
- How relationships between entities are defined, refined, and incorporated into the database design process
- How ERD components affect database design and implementation
- That real-world database design often requires the reconciliation of conflicting goals

Entity–relationship model (ER model)

- An **Entity–relationship model (ER model)** describes the structure of a database with the help of a diagram, which is known as **Entity Relationship Diagram (ER Diagram)**. An ER model is a design or blueprint of a database that can later be implemented as a database. The main components of E-R model are: entity set and relationship set.

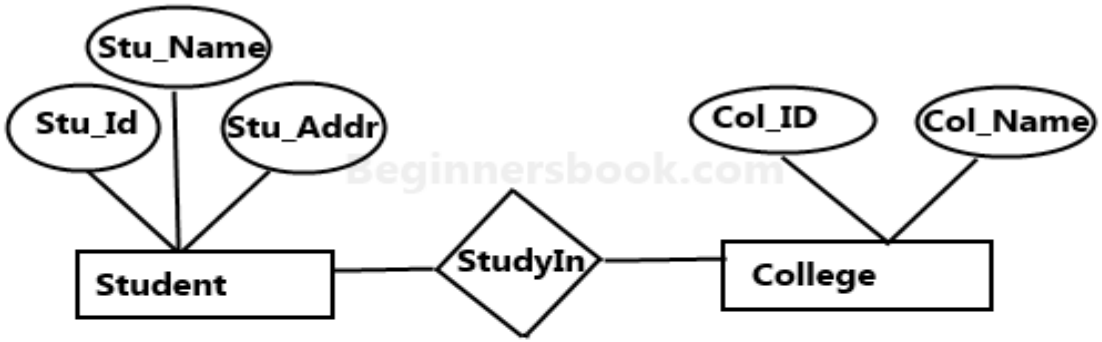
What is an Entity Relationship Diagram (ER Diagram)?

- An ER diagram shows the relationship among entity sets. An entity set is a group of similar entities and these entities can have attributes.
- In terms of DBMS, an entity is a table or attribute of a table in database, so by showing relationship among tables and their attributes, ER diagram shows the complete logical structure of a database.

Data Model Basic Building Blocks

- **Entity**: Unique and distinct object used to collect and store data
  - **Attribute**: Characteristic of an entity
- **Relationship**: Describes an association among entities
  - **One-to-many (1:M)**
  - **Many-to-many (M:N or M:M)**
  - **One-to-one (1:1)**
- **Constraint**: Set of rules to ensure data integrity

A simple ER Diagram



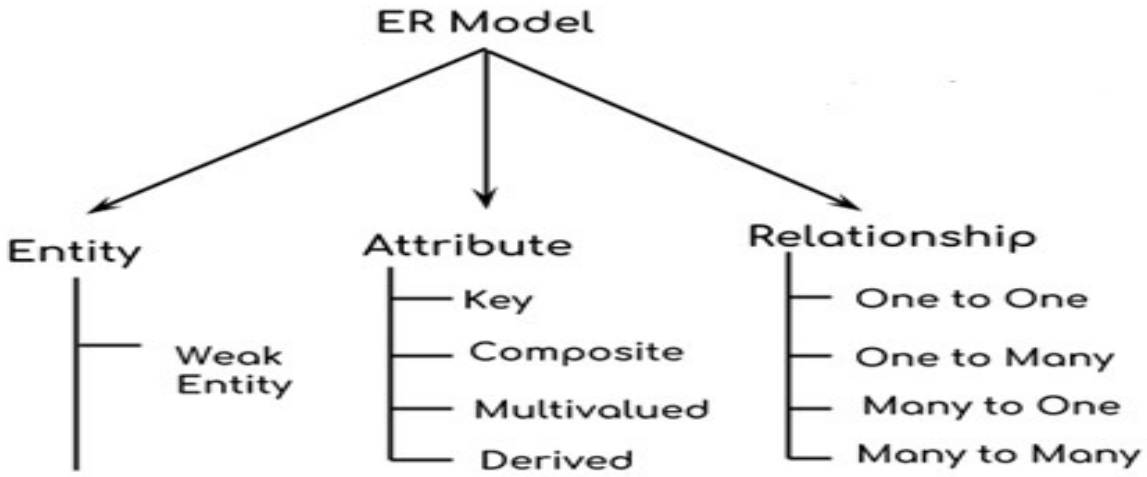
Sample E-R Diagram

Student entity has attributes such as Stu_Id, Stu_Name & Stu_Addr and College entity has attributes such as Col_ID & Col_Name.

Geometric shapes and their meaning in an E-R Diagram

- **Rectangle**: Represents Entity sets.
  Ellipses: Attributes
  Diamonds: Relationship Set
  Lines: They link attributes to Entity Sets and Entity sets to Relationship Set
  Double Ellipses: Multivalued Attributes
  Dashed Ellipses: Derived Attributes
  Double Rectangles: Weak Entity Sets
  Double Lines: Total participation of an entity in a relationship set

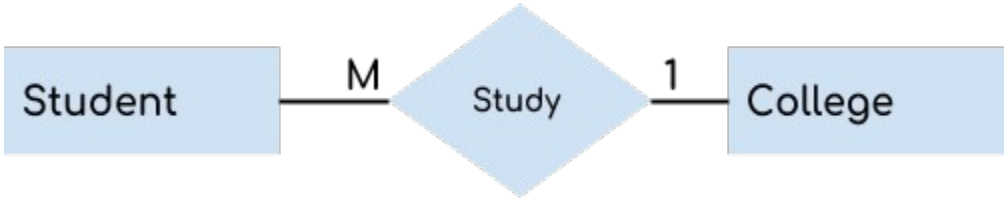
Data Model Basic Building Blocks



Components of ER Diagram

Entity

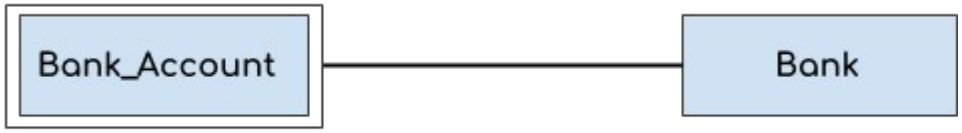
- An entity is an object or component of data. An entity is represented as rectangle in an ER diagram.



In the ER diagram we have two entities Student and College and these two entities have many to one relationship as many students study in a single college.

Weak Entity

- An entity that cannot be uniquely identified by its own attributes and relies on the relationship with other entity is called weak entity. The weak entity is represented by a double rectangle.



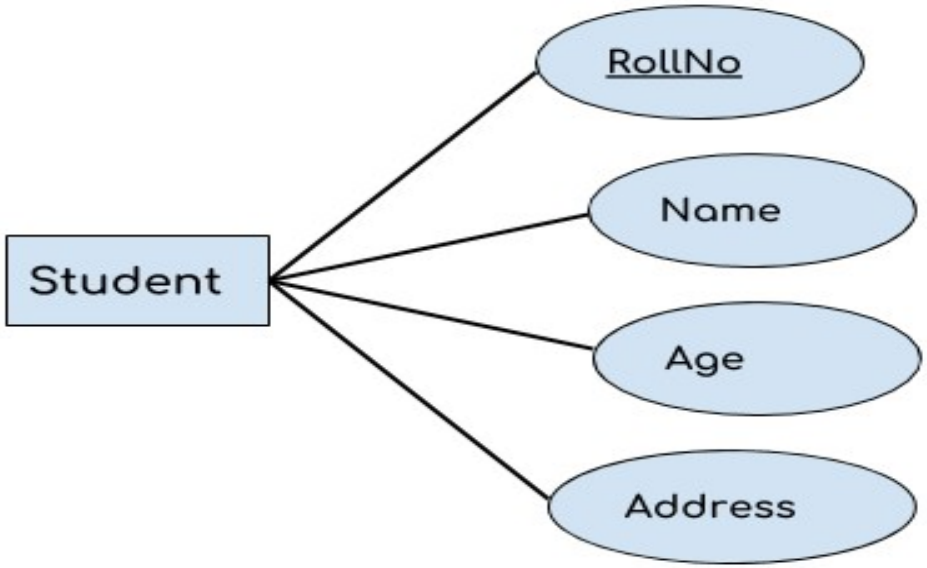
A bank account cannot be uniquely identified without knowing the bank to which the account belongs, so bank account is a weak entity.

Attribute

- An attribute describes the property of an entity. An attribute is represented as Oval in an ER diagram. There are four types of attributes:
- Key attribute

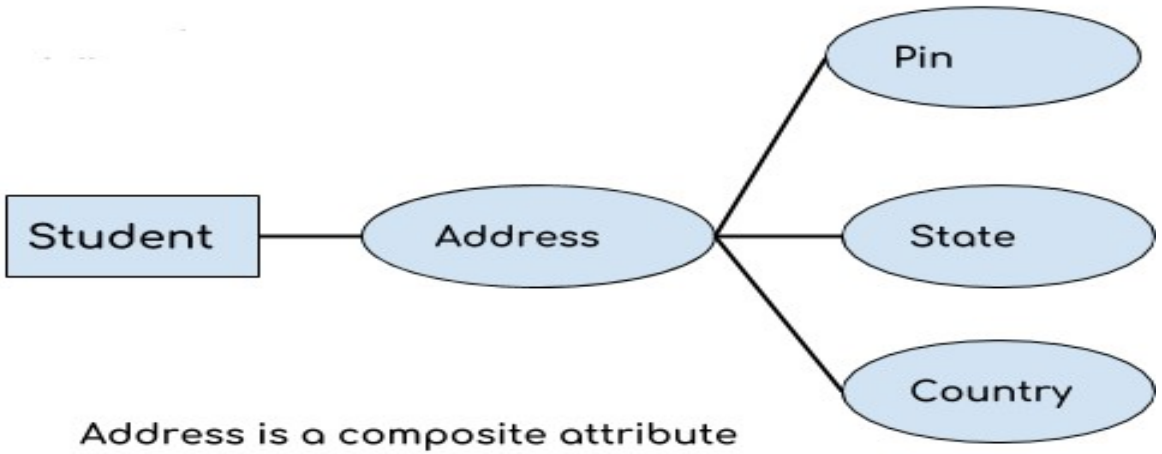
Key attribute

- A key attribute can uniquely identify an entity from an entity set. For example, student roll number can uniquely identify a student from a set of students.



Composite attribute:

- An attribute that is a combination of other attributes is known as composite attribute. For example, In student entity, the student address is a composite attribute as an address is composed of other attributes such as pin code, state, country.



Address is a composite attribute

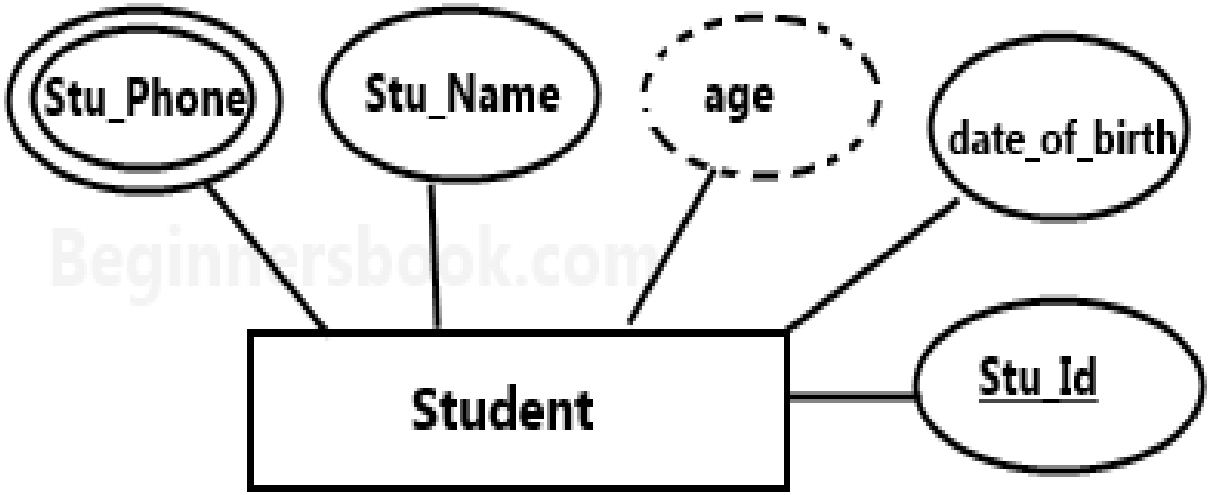
Multivalued attribute

An attribute that can hold multiple values is known as multivalued attribute. It is represented with **double ovals** in an ER Diagram..

Derived attribute

- A derived attribute is one whose value is dynamic and derived from another attribute. It is represented by **dashed oval** in an ER Diagram.

E-R diagram with multivalued and derived attributes:

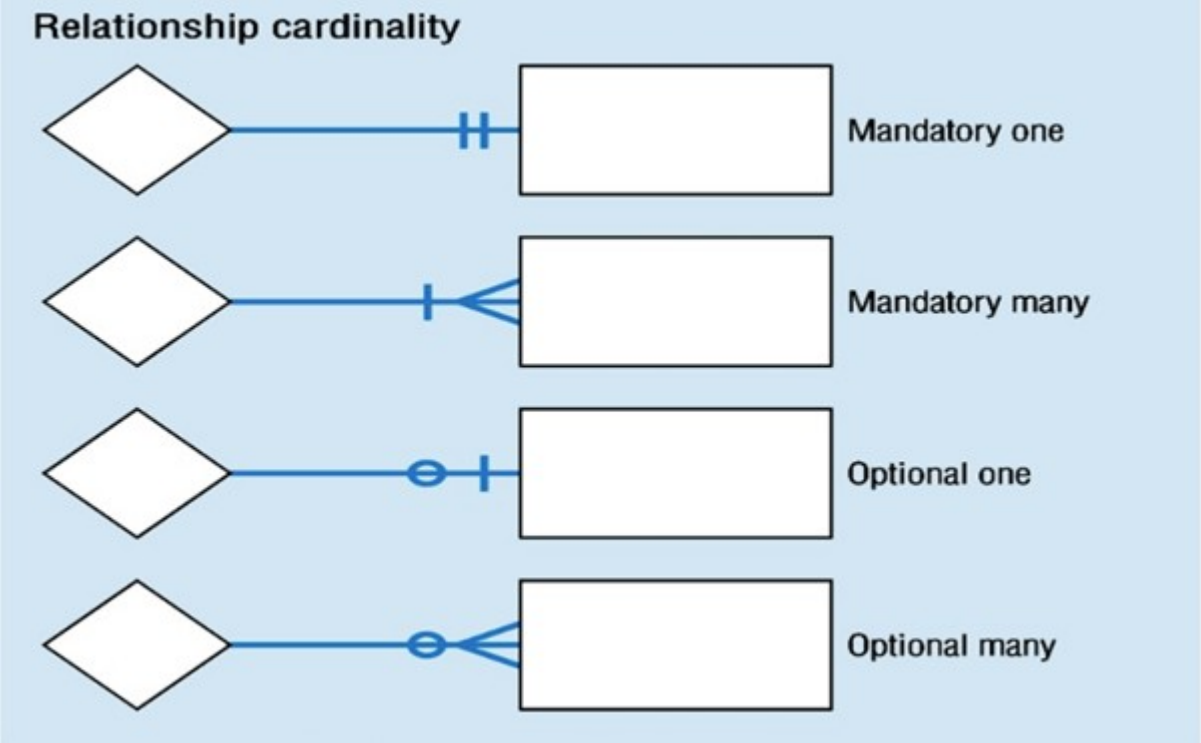


Relationship

A relationship is represented by diamond shape in ER diagram, it shows the relationship among entities. There are four types of relationships:

1. One to One
2. One to Many
3. Many to One
4. Many to Many

Relationship



One to One Relationship

When a single instance of an entity is associated with a single instance of another entity then it is called one to one relationship.

One to Many Relationship

When a single instance of an entity is associated with more than one instances of another entity then it is called one to many relationship.

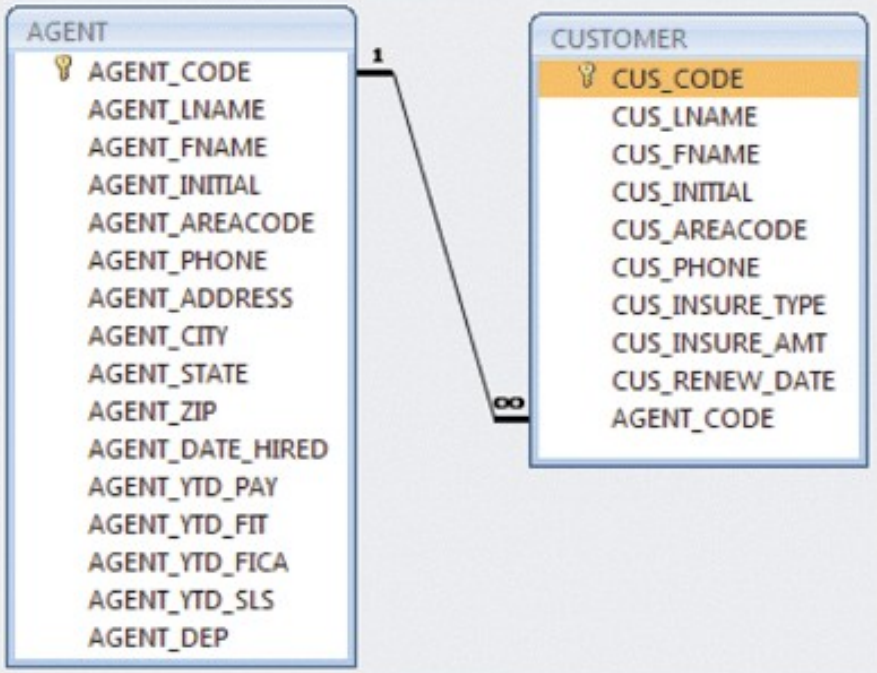
Many to One Relationship

When more than one instances of an entity is associated with a single instance of another entity then it is called many to one relationship.

Many to Many Relationship

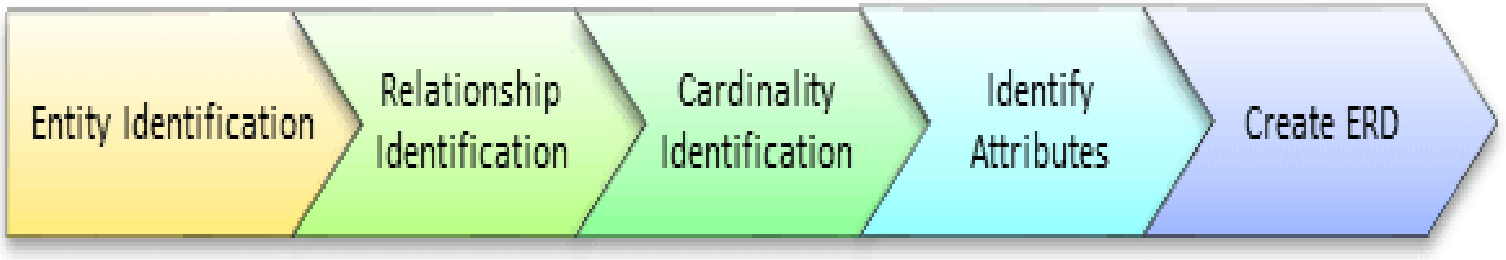
When more than one instances of an entity is associated with more than one instances of another entity then it is called many to many relationship.

FIGURE 2.2 A relational diagram

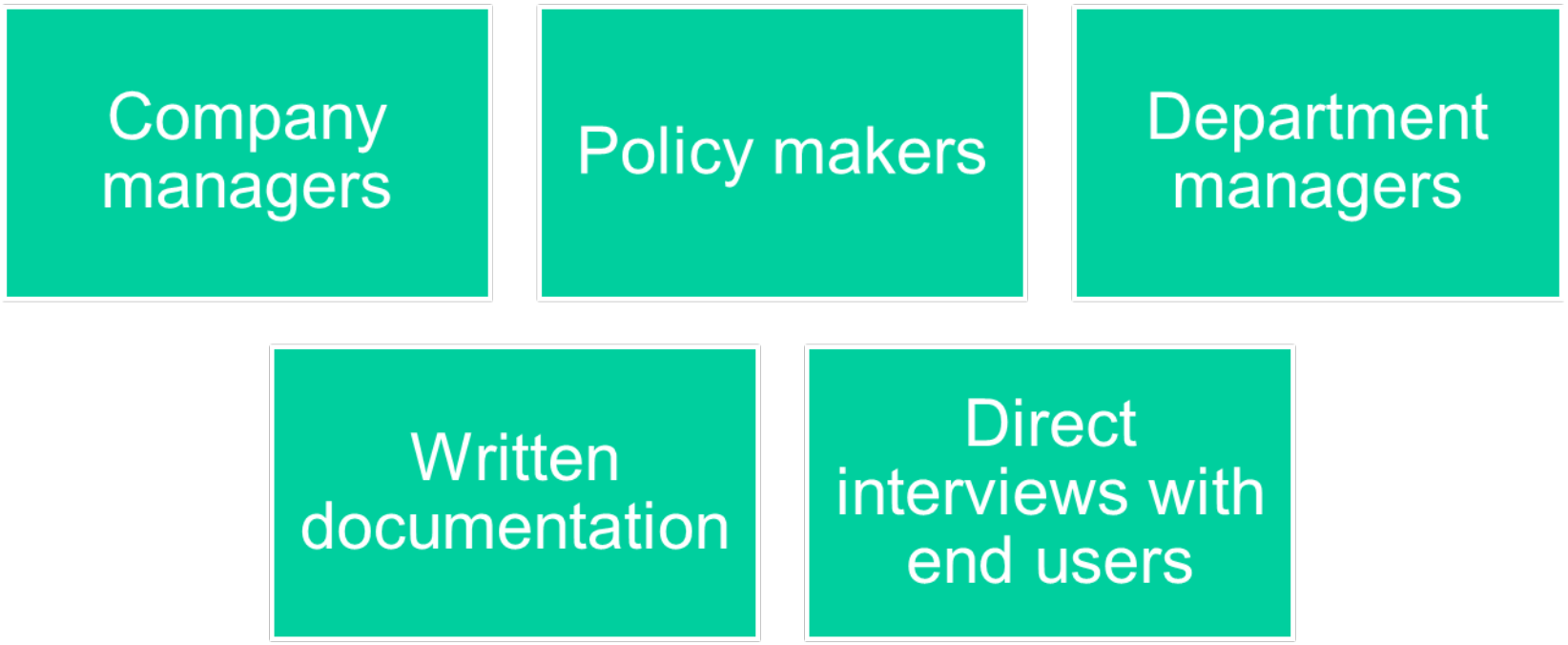


SOURCE: Course Technology/Cengage Learning

Steps to Create an ERD



Sources of Business Rules



Reasons for Identifying and Documenting Business Rules

- Help standardize company's view of data
- Communications tool between users and designers
- Allow designer to:
  - Understand the nature, role, scope of data, and business processes
  - Develop appropriate relationship participation rules and constraints
  - Create an accurate data model

Translating Business Rules into Data Model Components

- Nouns translate into entities
- Verbs translate into relationships among entities
- Relationships are bidirectional
- Questions to identify the relationship type
  - How many instances of B are related to one instance of A?
  - How many instances of A are related to one instance of B?

Naming Conventions

- Entity names - Required to:
  - Be descriptive of the objects in the business environment
  - Use terminology that is familiar to the users
- Attribute name - Required to be descriptive of the data represented by the attribute
- Proper naming:
  - Facilitates communication between parties
  - Promotes self-documentation

How to Create an ERD

Example

In a university, a Student enrolls in Courses.

A student must be assigned to at least one or more Courses.

Each course is taught by a single Professor.

To maintain instruction quality, a Professor can deliver only one course

Step 1) Entity Identification

- Student
- Course
- Professor

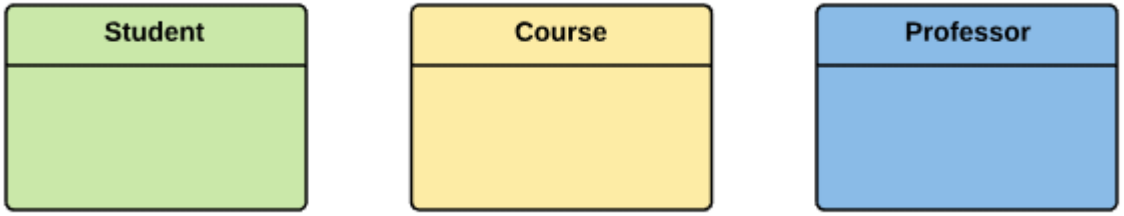
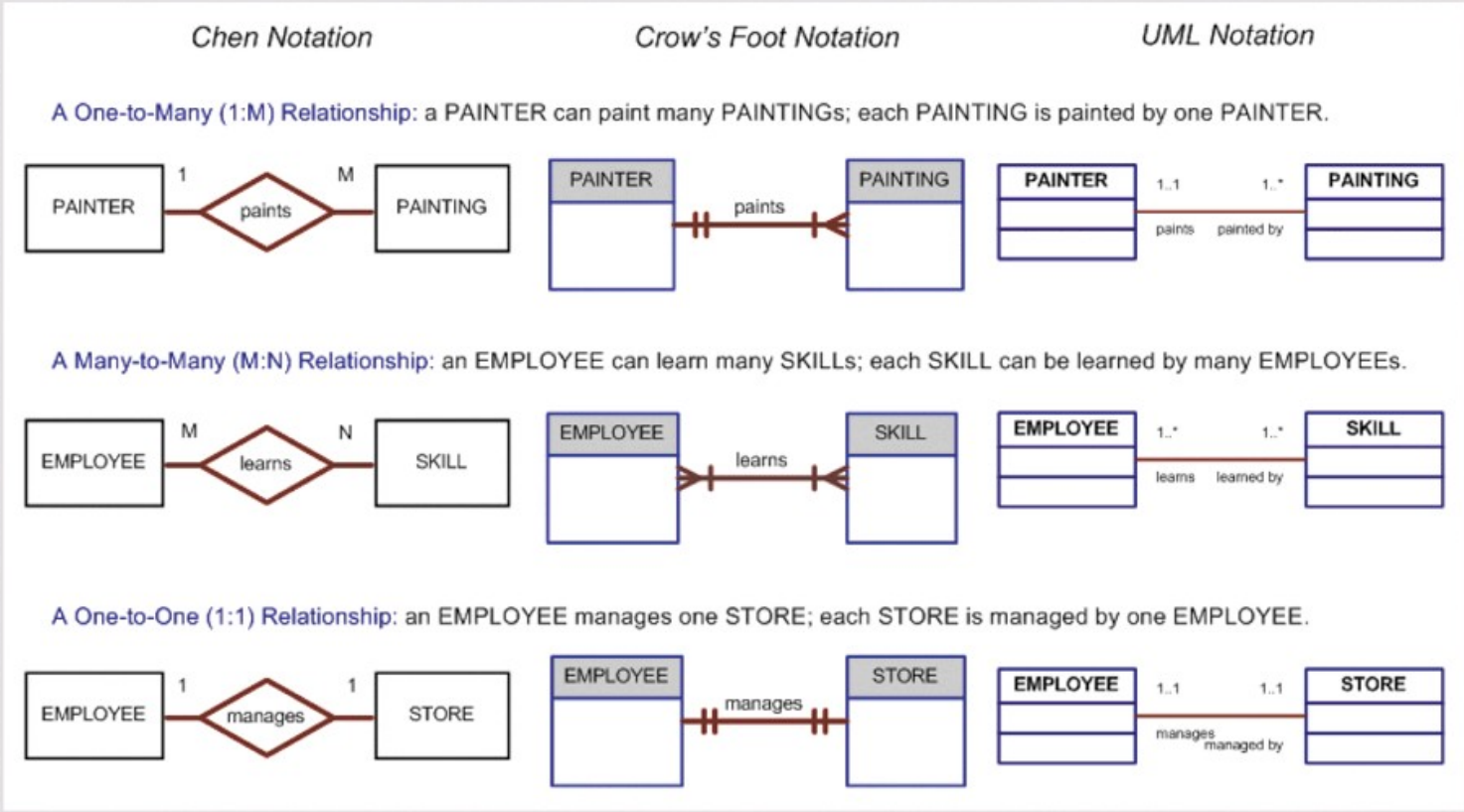


FIGURE 2.3 The ER model notations



SOURCE: Course Technology/Cengage Learning

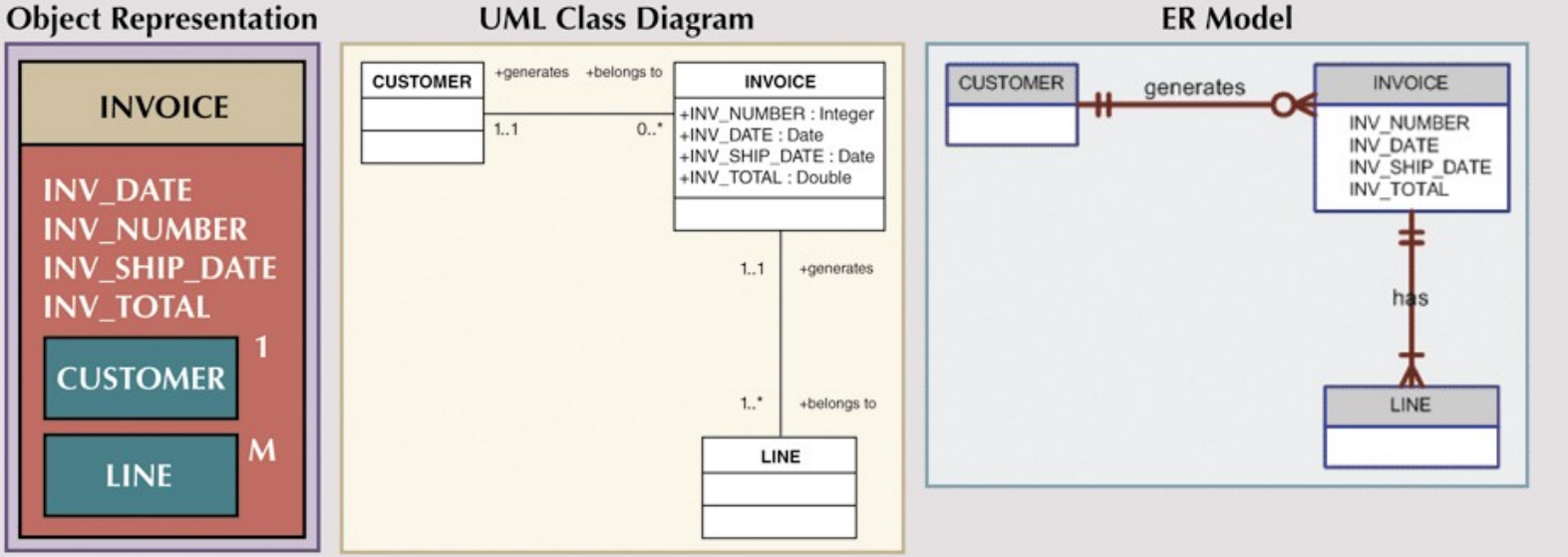
The Object-Oriented (OO) Model

- Data and relationships are contained in a single structure known as an object
- OODM (object-oriented data model) is the basis for OODBMS
  - Semantic data model
- An object:
  - Contains operations
  - Are self-contained: a basic building-block for autonomous structures
  - Is an abstraction of a real-world entity

The Object-Oriented (OO) Model (cont'd.)

- Attributes describe the properties of an object
- Objects that share similar characteristics are grouped in classes
- Classes are organized in a class hierarchy
- Inheritance: object inherits methods and attributes of parent class
- UML based on OO concepts that describe diagrams and symbols
  - Used to graphically model a system

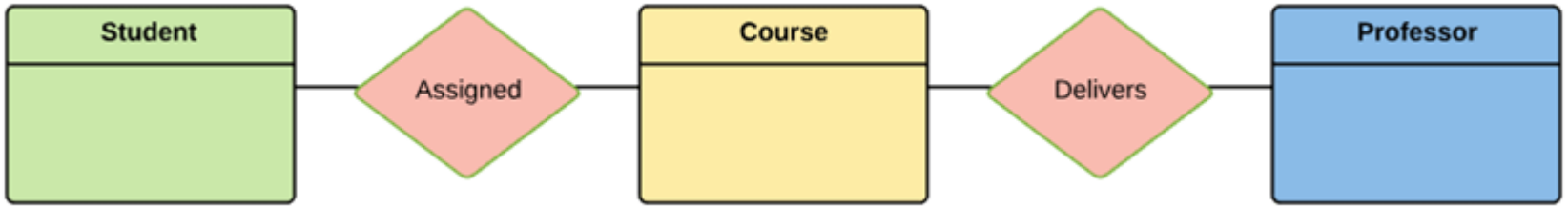
FIGURE 2.4 A comparison of OO, UML, and ER models



SOURCE: Course Technology/Cengage Learning

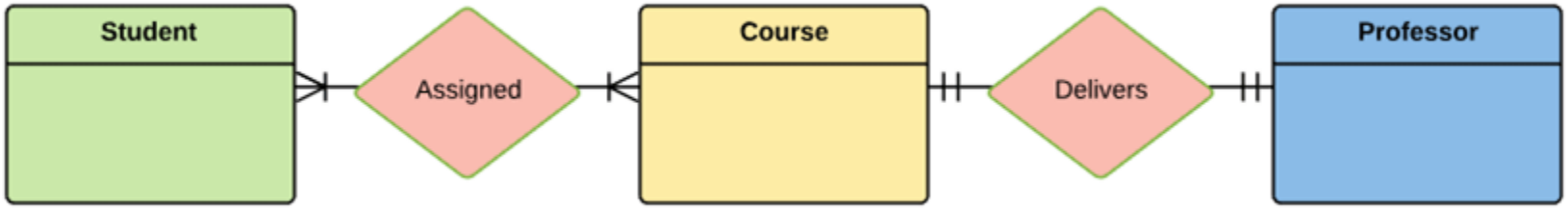
Step 2) Relationship Identification

- The student is **assigned** a course
- Professor **delivers** a course



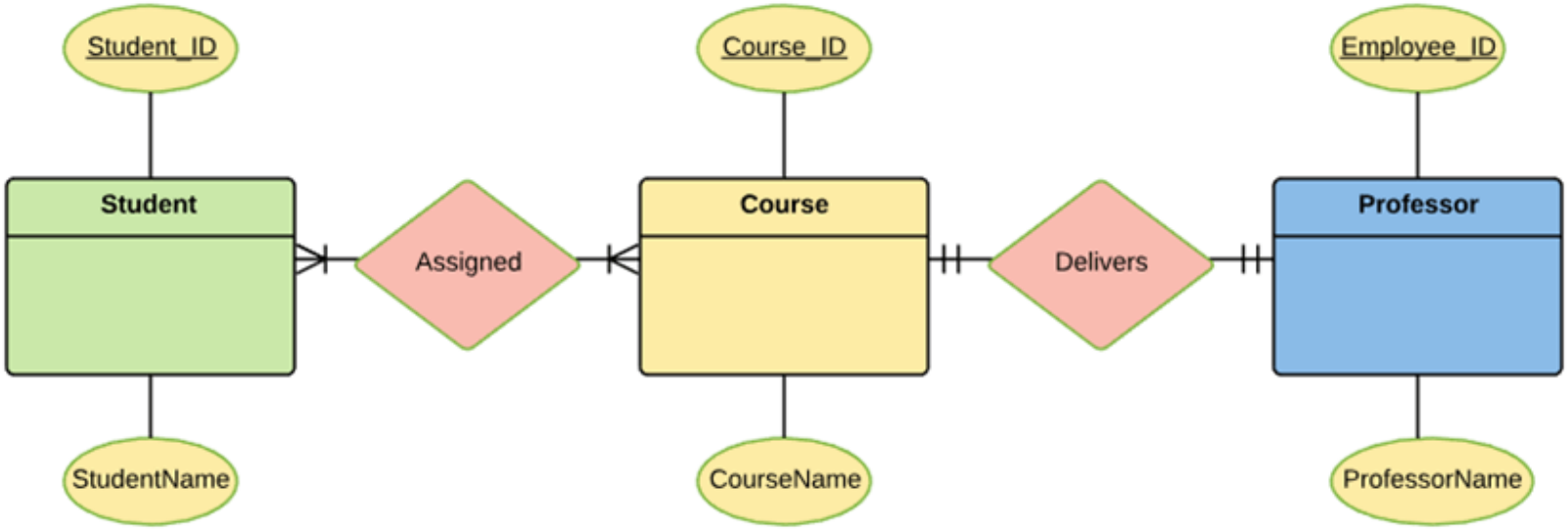
Step 3) Cardinality Identification

- A student can be assigned **multiple** courses
- A Professor can deliver only **one** course

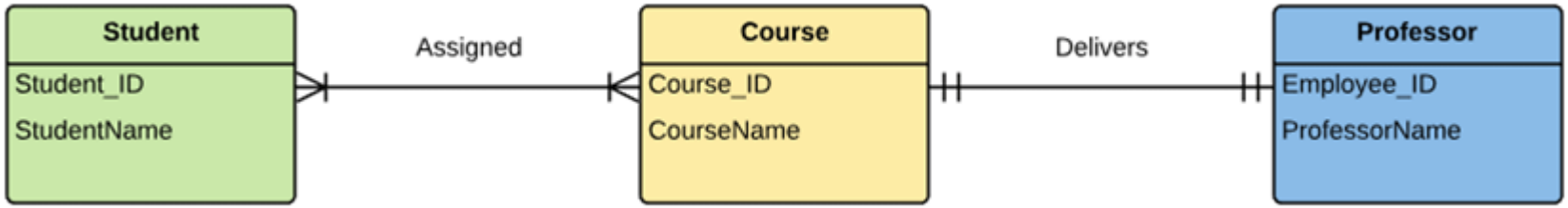


Step 4) Identify Attributes

- You need to study the files, forms, reports, data currently maintained by the organization to identify attributes. You can also conduct interviews with various stakeholders to identify entities. Initially, it's important to identify the attributes without mapping them to a particular entity.


Student_ID
Course_ID
Employee_ID
Student
Assigned
Course
Delivers
Professor
StudentName
CourseName
ProfessorName

Step 5) Create the ERD



Assignment 1

- Create the initial ER diagram for a car dealership at Bolga. The dealership sells both new and used cars,
- and it operates a service facility. Base your design on the following business rules:

a. *A salesperson can sell many cars but each car is sold by only one salesperson.*

b. *A customer can buy many cars but each car is sold to only one customer.*

c. *A salesperson writes a single invoice for each car sold.*

Assignment 1(cont'd.)

d. *A customer gets an invoice for each car (s)he buys.*

e. *A customer might come in just to have a car serviced; that is, one need not buy a car to be*

classified as a customer. When a customer takes one or more cars in for repair or service, one service ticket is

written for each car.

g. *The car dealership maintains a service history for each car serviced. The service records are referenced by the car's serial number.*

h. *A car brought in for service can be worked on by many mechanics, and each mechanic may work on many cars*.

Assignment 1

i. *A car that is serviced may or may not need parts. (For example, parts are not necessary to*

adjust a carburetor or to clean a fuel injector nozzle.)