Fundamentals of Database Systems

FIFTH EDITION

VTU

Ramez Elmasri

Shamkant B. Navathe

PEARSON

Unit 1

Introduction: Characteristics of Database approach, Actors on the Scene, Workers behind the scene, Advantages of using DBMS approach, Data models, schemas and instances, Three schema architecture and data independence, Database languages and interfaces, the database system environment, Centralized and client-server architectures, Classification of Database Management systems

Entity-Relationship Model: Conceptual Database using high level conceptual data models for Database Design, A Sample Database Application, Entity types, Entity sets Attributes and Keys Relationship types, Relationship Sets, Roles and Structural Constraints Weak Entity Types.

Data Modeling Using the Entity-Relationship Model (ER Model)

- Entity-Relationship (ER) model, is a popular high-level conceptual data model.

- This model and its variations are frequently used for the conceptual design of database applications.

- The diagrammatic notation associated with the ER model, known as ER diagrams.

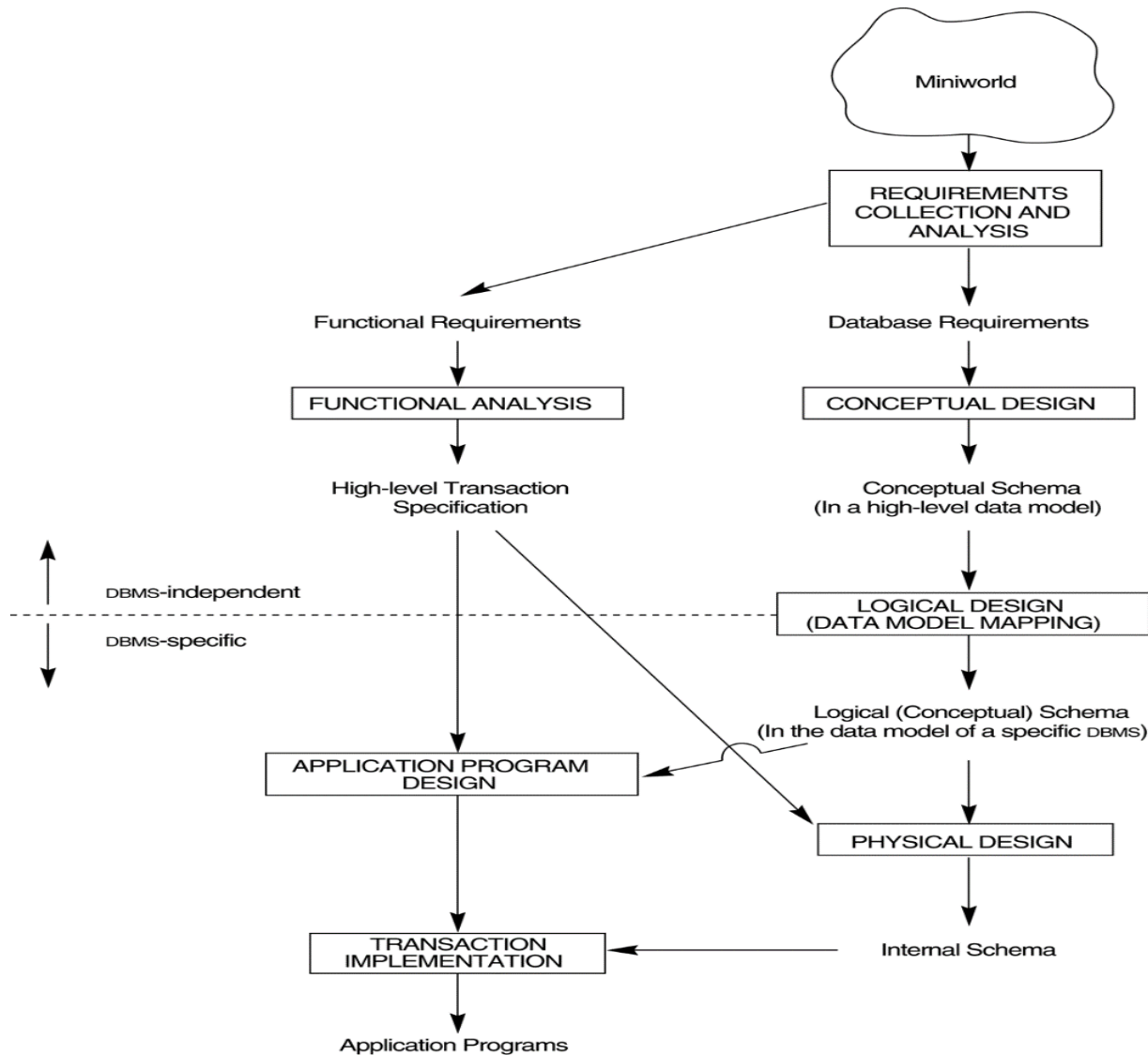# Using High-Level Conceptual Data Models for Database Design

FIGURE 3.1 A simplified diagram to illustrate the main phases of database design.
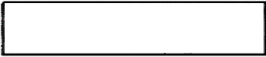
A Sample Database Application:

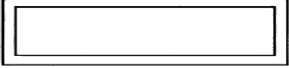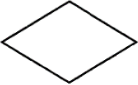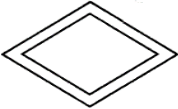A sample database application, called COMPANY, which serves to illustrate the basic ER model concepts and their use in schema design.

■ The company is organized into departments. Each department has a unique name, a unique number, and a particular employee who manages the department. We keep track of the start date when that employee began managing the department. A department may have several locations.

■ A department controls a number of projects, each of which has a unique name, a unique number, and a single location.

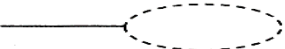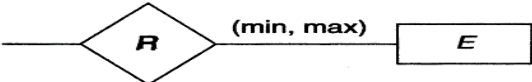■ We store each employee's name, Social Security number,2 address, salary, gender, and birth date. An employee is assigned to one department, but may work on several projects, which are not necessarily controlled by the same department. We keep track of the current number of hours per week that an employee works on each project. We also keep track of the direct supervisor of each employee (who is another employee).

■ We want to keep track of the dependents of each employee for insurance purposes. We keep each dependent's first name, gender, birth date, and relationship to the employee.

FIGURE 3.2 An ER schema diagram for the COMPANY database.
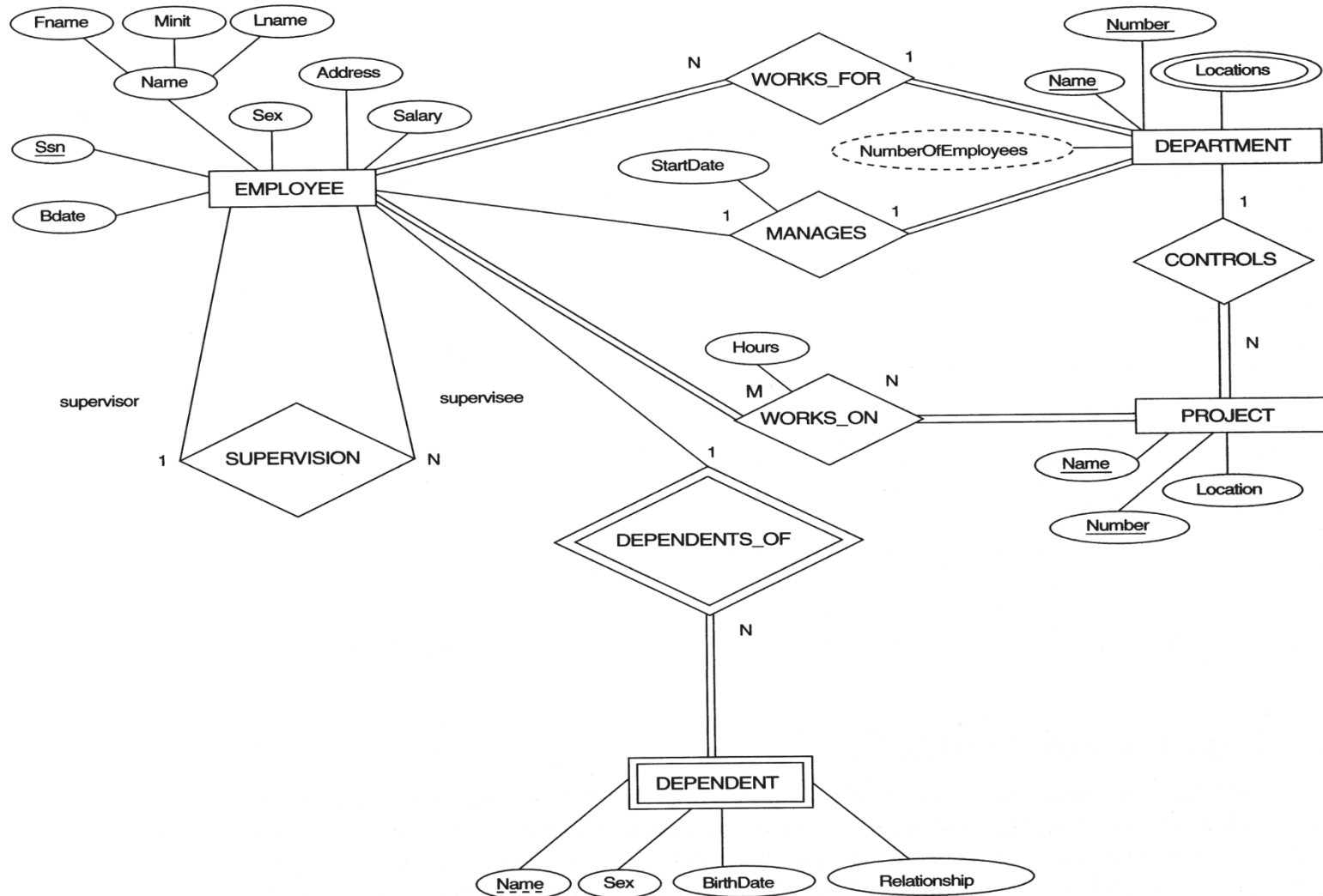
Summary of the notation for ER diagrams.

Symbol	Meaning
	ENTITY
	WEAK ENTITY
	RELATIONSHIP
	IDENTIFYING RELATIONSHIP
	ATTRIBUTE
	KEY ATTRIBUTE
	MULTIVALUED ATTRIBUTE
	COMPOSITE ATTRIBUTE
	DERIVED ATTRIBUTE
E_1 — R = E_2	TOTAL PARTICIPATION OF E_2 IN R
E_1 —1— R —N— E_2	CARDINALITY RATIO 1:N FOR E_1:E_2 IN R
R (min, max) E	STRUCTURAL CONSTRAINT (min, max) ON PARTICIPATION OF E IN R

Types of attributes

- Composite versus Simple (Atomic) Attributes

- Single-Valued versus Multivalued Attributes

- Stored versus Derived Attributes

- Complex Attributes

- NULL Values

FIGURE 3.3
Two entities, employee e_1 and company c_1, and their attributes.

e_1

- Name = John Smith
- Address = 2311 Kirby, Houston, Texas 77001
- Age = 55
- HomePhone = 713-749-2630

c_1

- Name = Sunco Oil
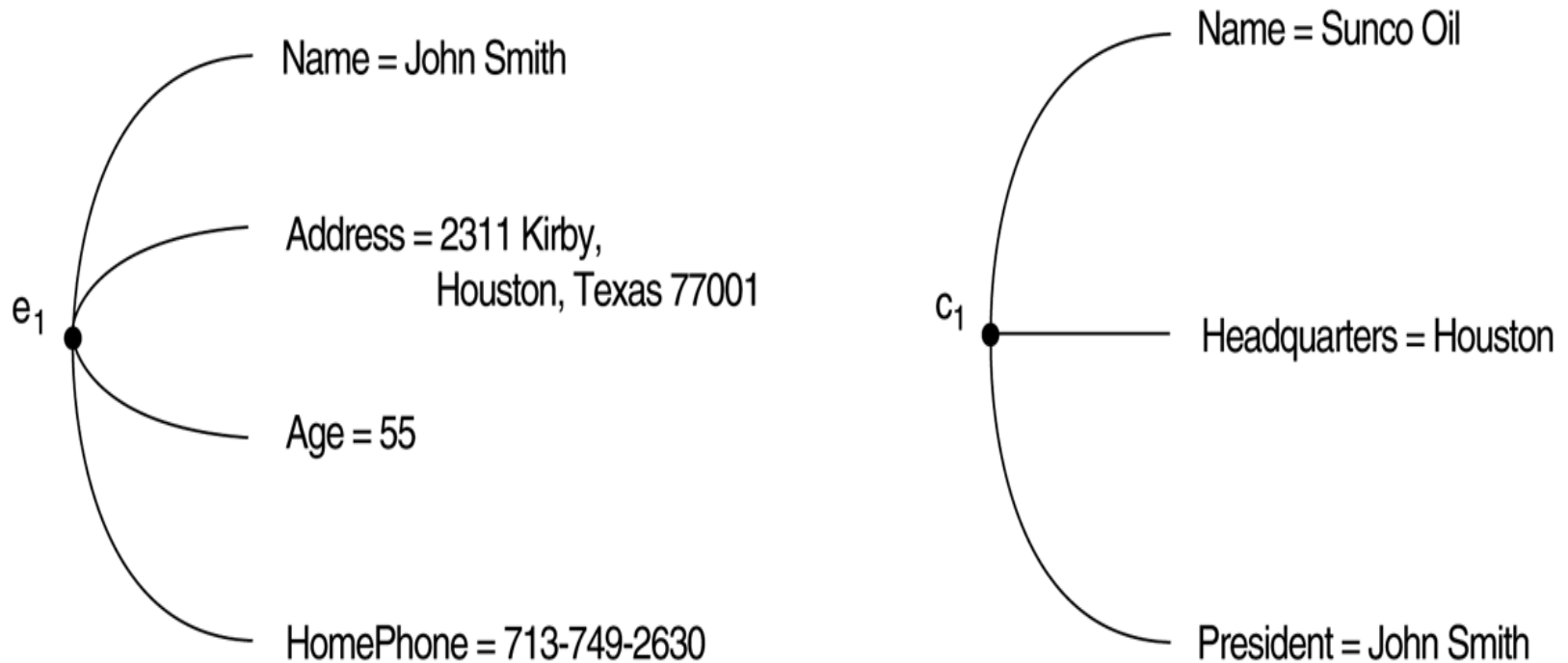- Headquarters = Houston
- President = John Smith
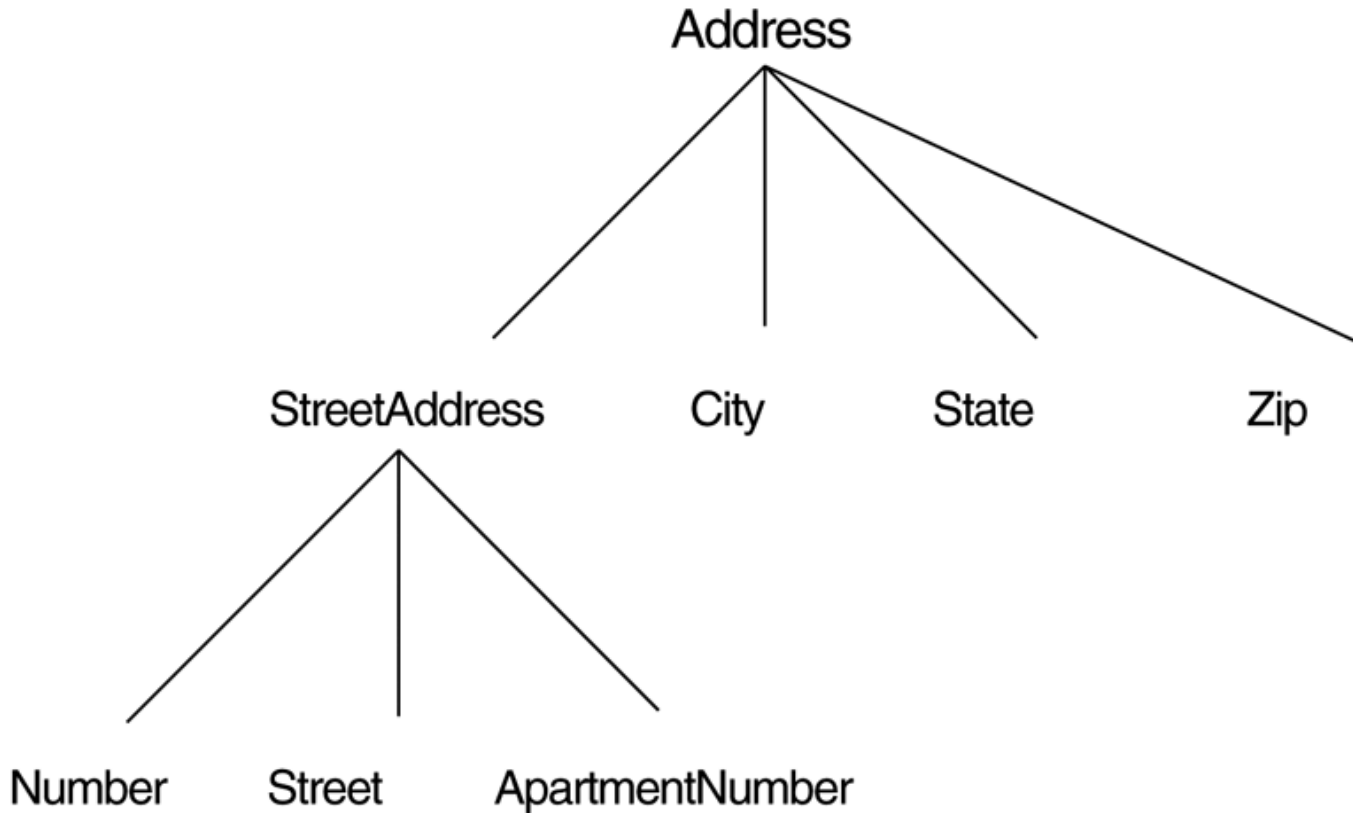
FIGURE 3.4
A hierarchy of composite attributes.

FIGURE 3.5
A complex attribute: AddressPhone.

{AddressPhone({Phone(AreaCode,PhoneNumber)},
Address(StreetAddress(Number,Street,ApartmentNumber),
City,State,Zip)) }

Entity Types, Entity Sets, Keys, and Value Sets

- An **entity type** defines a collection (or set) of entities that have the same attributes.

- Each **entity type** in the database is described by its name and attributes.

- The collection of entities of a particular entity type is grouped into an **entity set**, which is also called the **extension** of the entity type.

FIGURE 3.6
Two entity types, EMPLOYEE and COMPANY, and some member entities of each.

ENTITY TYPE NAME:

EMPLOYEE

Name, Age, Salary

COMPANY

Name, Headquarters, President

e_1 •

(John Smith, 55, 80k)

e_2 •

ENTITY SET:

(EXTENSION)

(Fred Brown, 40, 30K)

e_3 •

(Judy Clark, 25, 20K)

•
•
•

c_1 •

(Sunco Oil, Houston, John Smith)

c_2 •

(Fast Computer, Dallas, Bob King)

•
•
•

FIGURE 3.7
The CAR entity type with two key attributes, Registration and VehicleID.

CAR

Registration(**RegistrationNumber, State**), VehicleID, Make, Model, Year, {Color}

car₁ ●

((ABC 123, TEXAS), TK629, Ford Mustang, convertible, 1998, {red, black})

car₂ ●

((ABC 123, NEW YORK), WP9872, Nissan Maxima, 4-door, 1999, {blue})

car₃ ●

((VSY 720, TEXAS), TD729, Chrysler LeBaron, 4-door, 1995, {white, blue})

⋮

Value Sets (Domains) of Attributes

- Each simple attribute of an entity type is associated with a value set (or domain of values), which specifies the set of values that may be assigned to that attribute for each individual entity.

- Range of ages allowed for employees is between 16 and 70, we can specify the value set of the Age attribute of EMPLOYEE to be the set of integer numbers between 16 and 70.

- Mathematically, an attribute A of entity set E whose value set is V can be defined as a function from E to the power set P(V) of V, where the power set P (V) of a set V is the set of all subsets of V:

$$A : E \rightarrow P(V)$$

- For a composite attribute A, the value set V is the power set of the Cartesian product of P(V1), P(V2), ..., P(Vn), where V1, V2, ..., Vn are the value sets of the simple component attributes that form A:

$$V = P (P(V1) \times P(V2) \times ... \times P(Vn))$$

The value set provides all possible values.

FIGURE 3.8
Preliminary design of entity types for the COMPANY database.

DEPARTMENT
Name, Number, {Locations}, Manager, ManagerStartDate

PROJECT
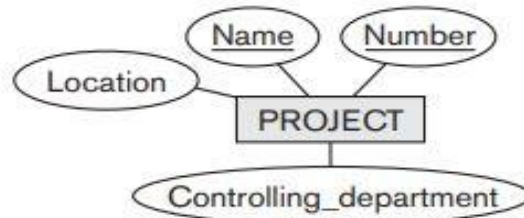Name, Number, Location, ControllingDepartment

EMPLOYEE
Name (FName, MInit, LName), SSN, Sex, Address, Salary,
BirthDate, Department, Supervisor, {WorksOn (Project, Hours)}

DEPENDENT
Employee, DependentName, Sex, BirthDate, Relationship
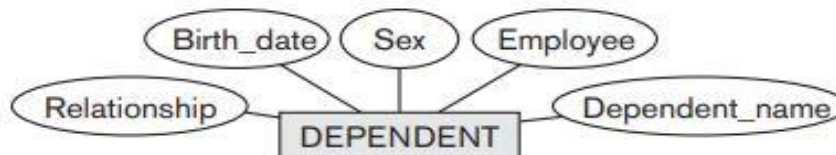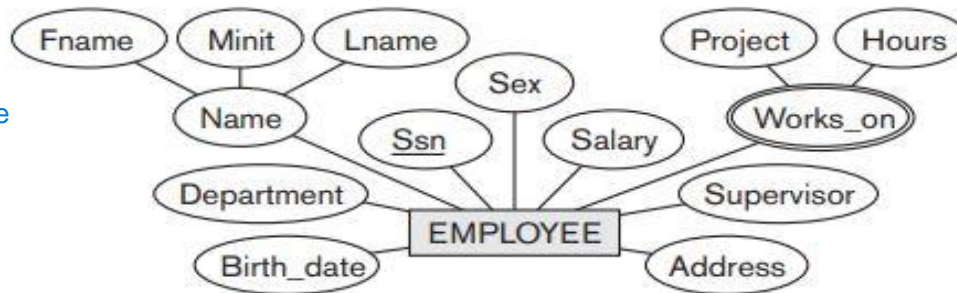
key

multvalued

composite

Figure 7.8
Preliminary design of entity types for the COMPANY database. Some of the shown attributes will be refined into relationships.

Slide 3-17

FIGURE 3.9

Some instances in the WORKS_FOR relationship set, which represents a relationship type WORKS_FOR between EMPLOYEE and DEPARTMENT.
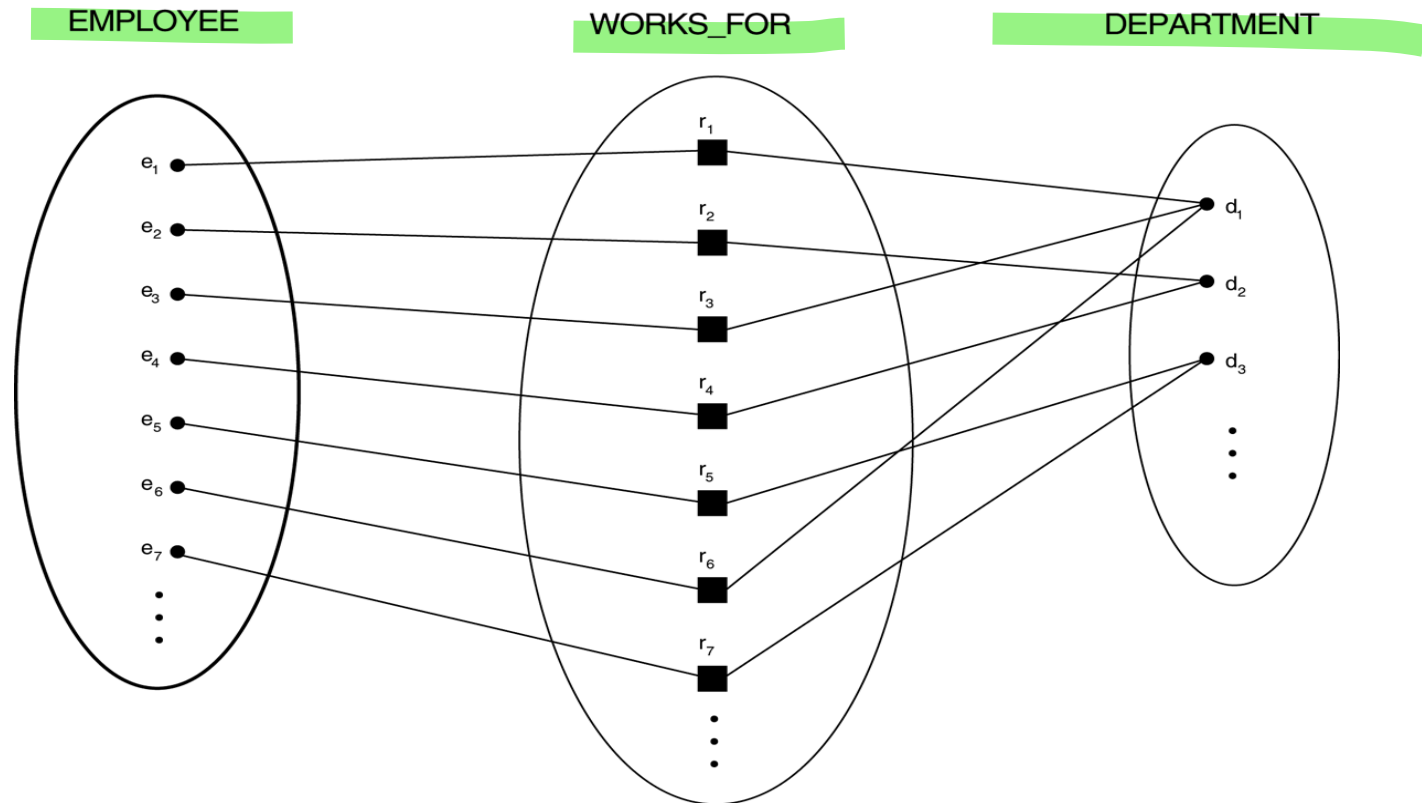
FIGURE 3.10

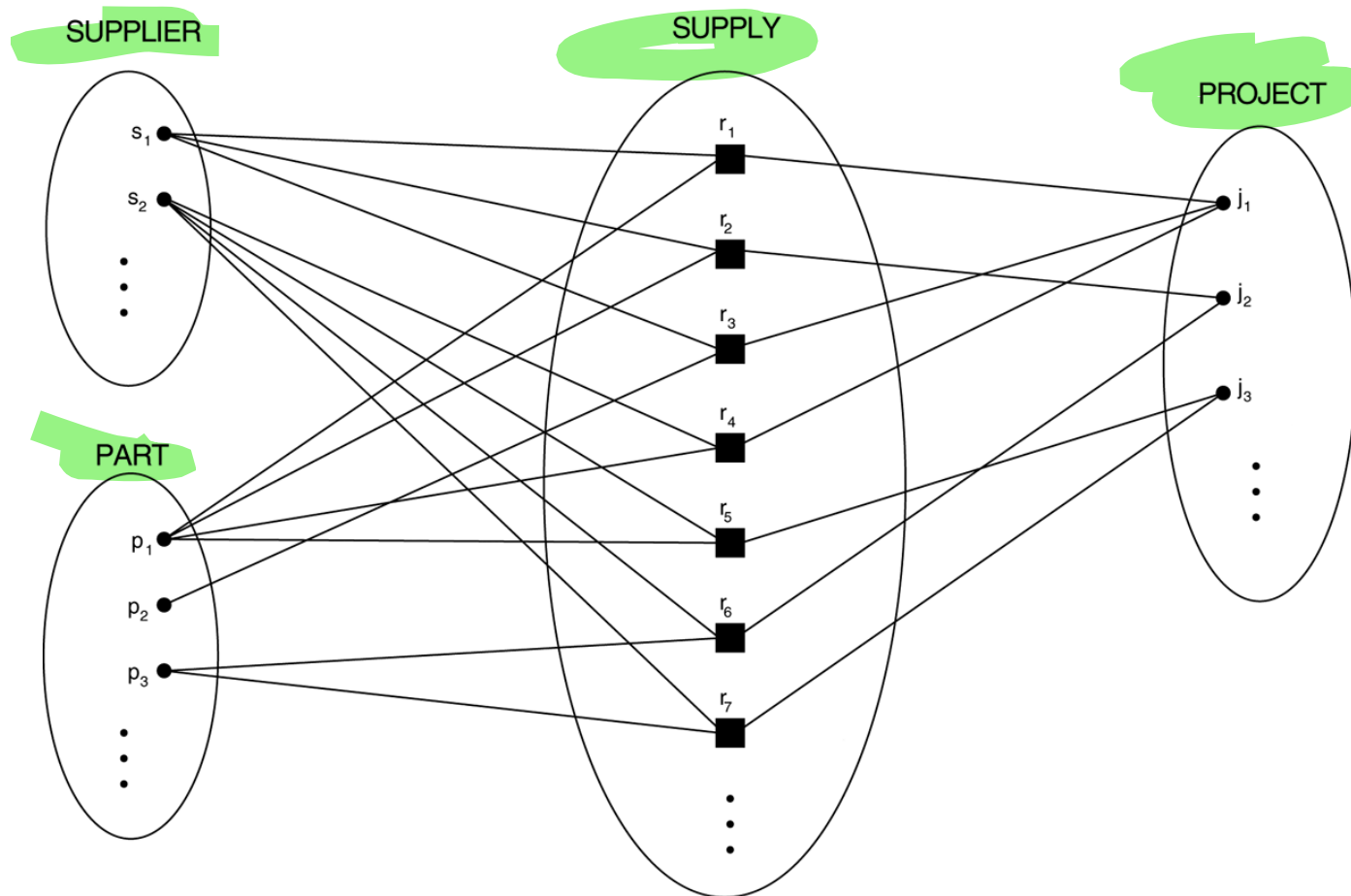Some relationship instances in the SUPPLY ternary relationship set.

FIGURE 3.11

A recursive relationship SUPERVISION between EMPLOYEE in the *supervisor* role (1) and EMPLOYEE in the *subordinate* role (2).

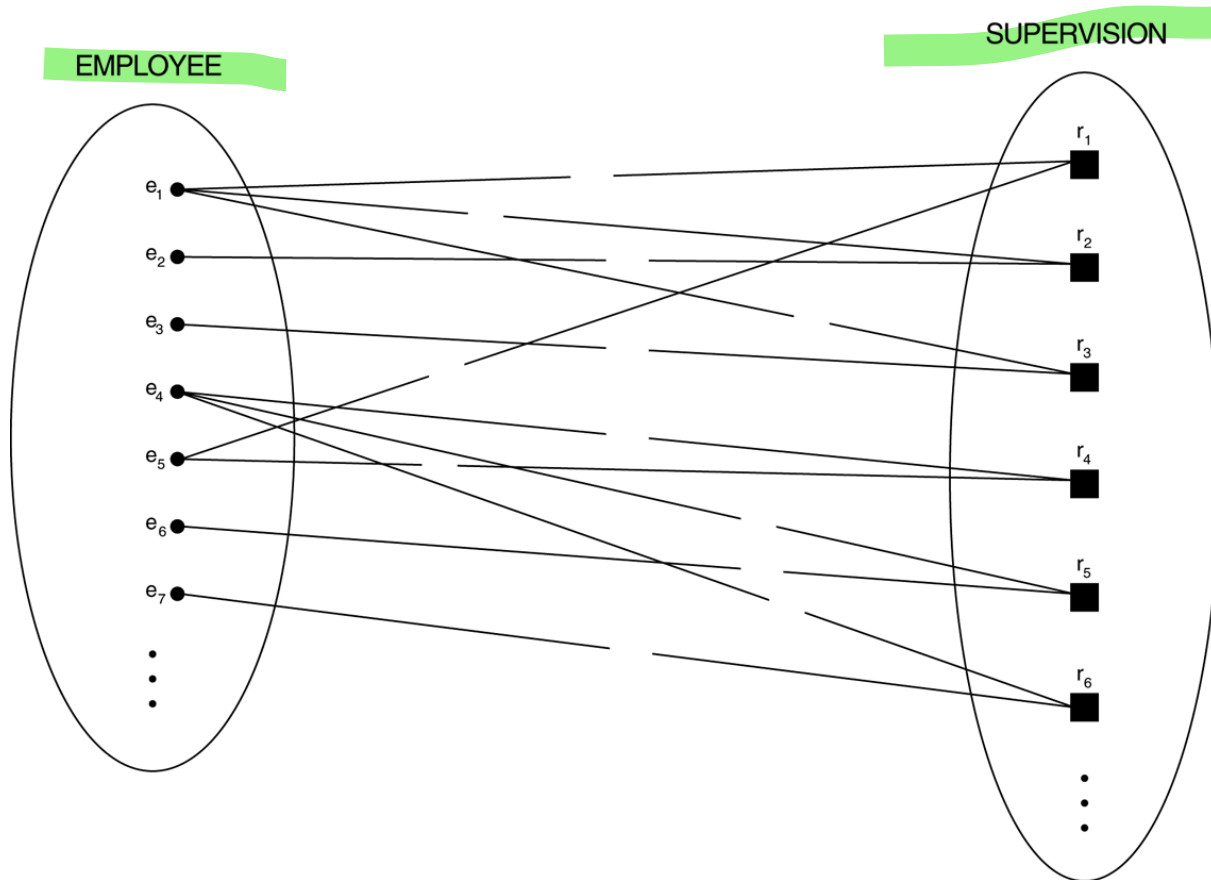# FIGURE 3.12
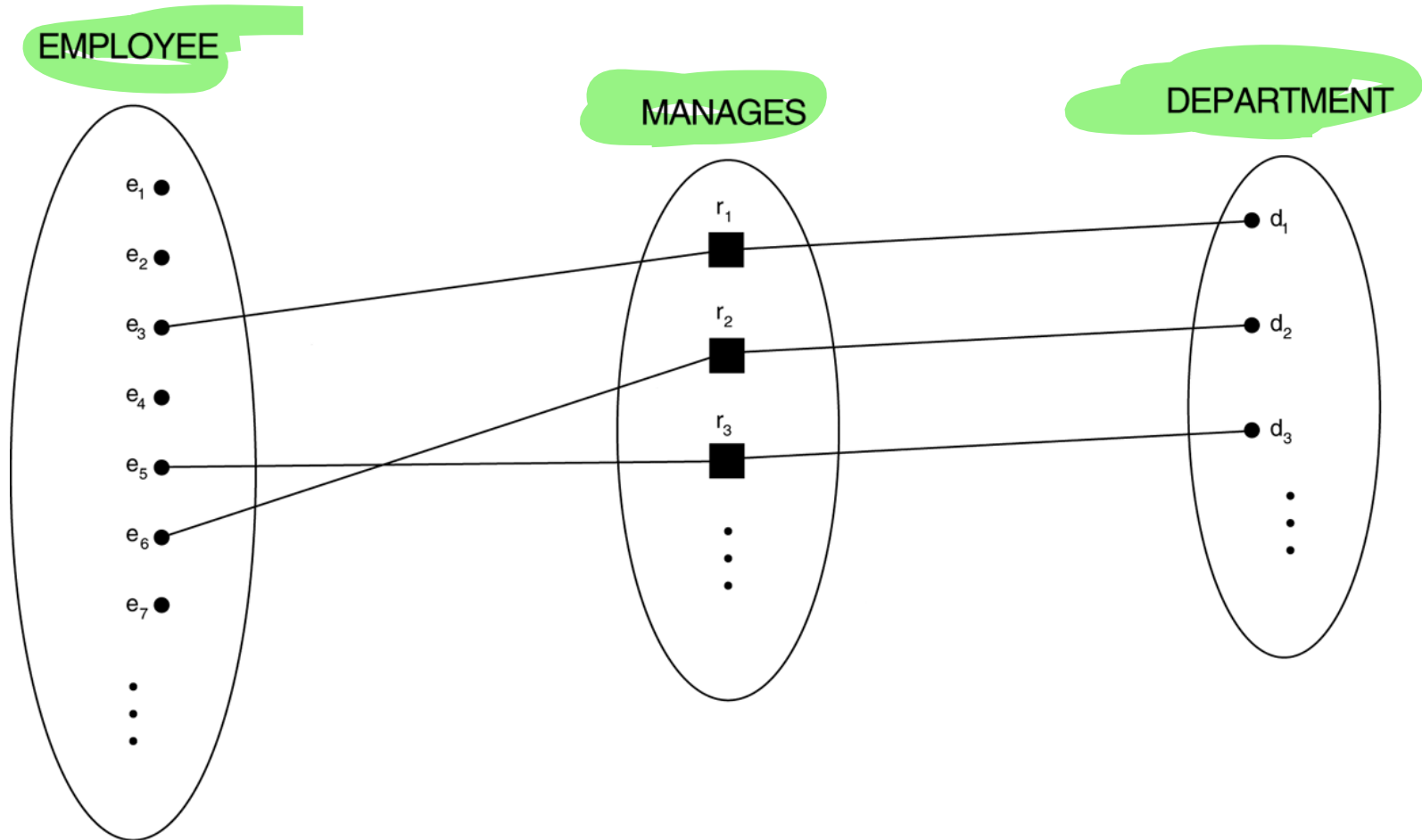## A 1:1 relationship, MANAGES.

FIGURE 3.13
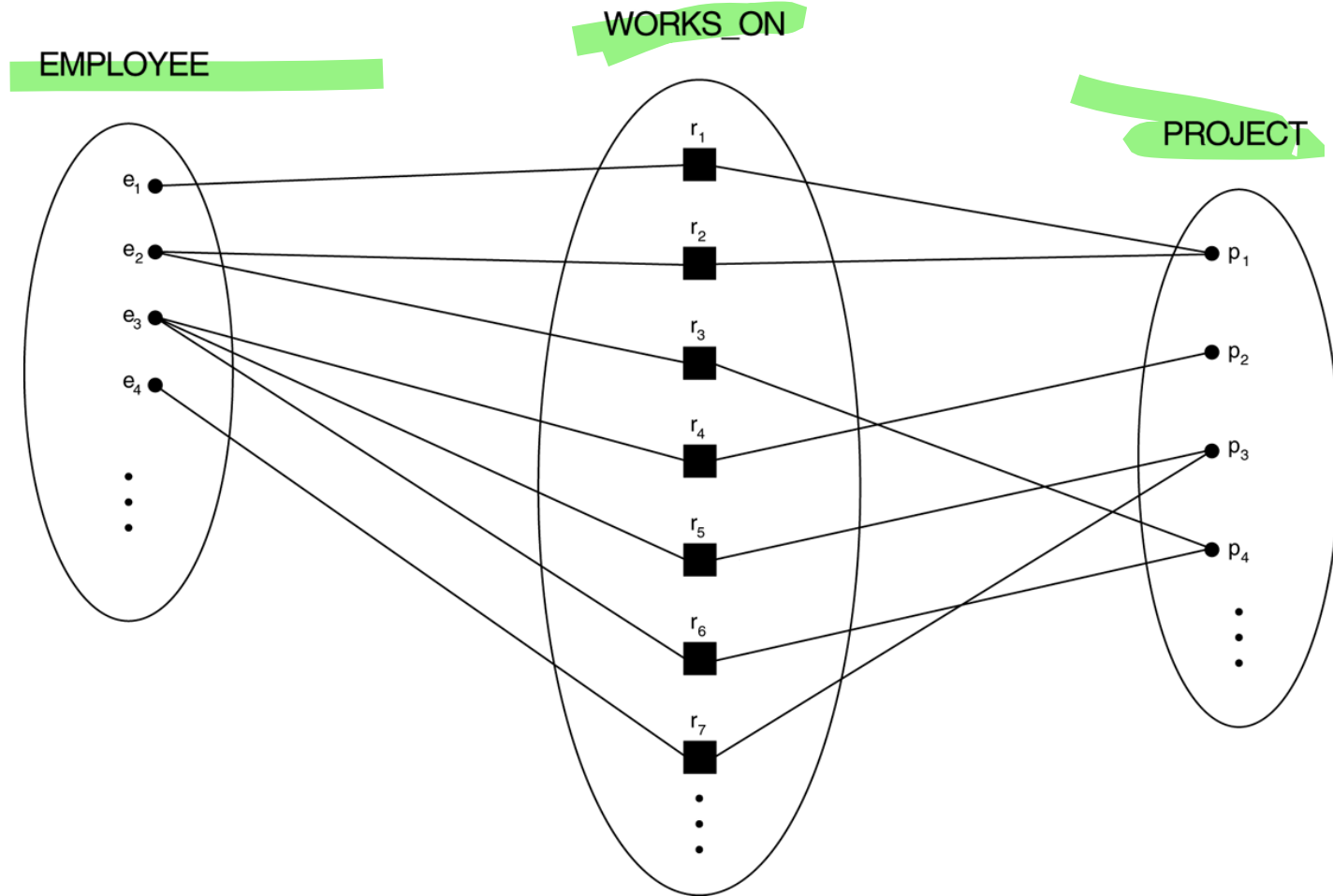An M:N relationship, WORKS_ON.

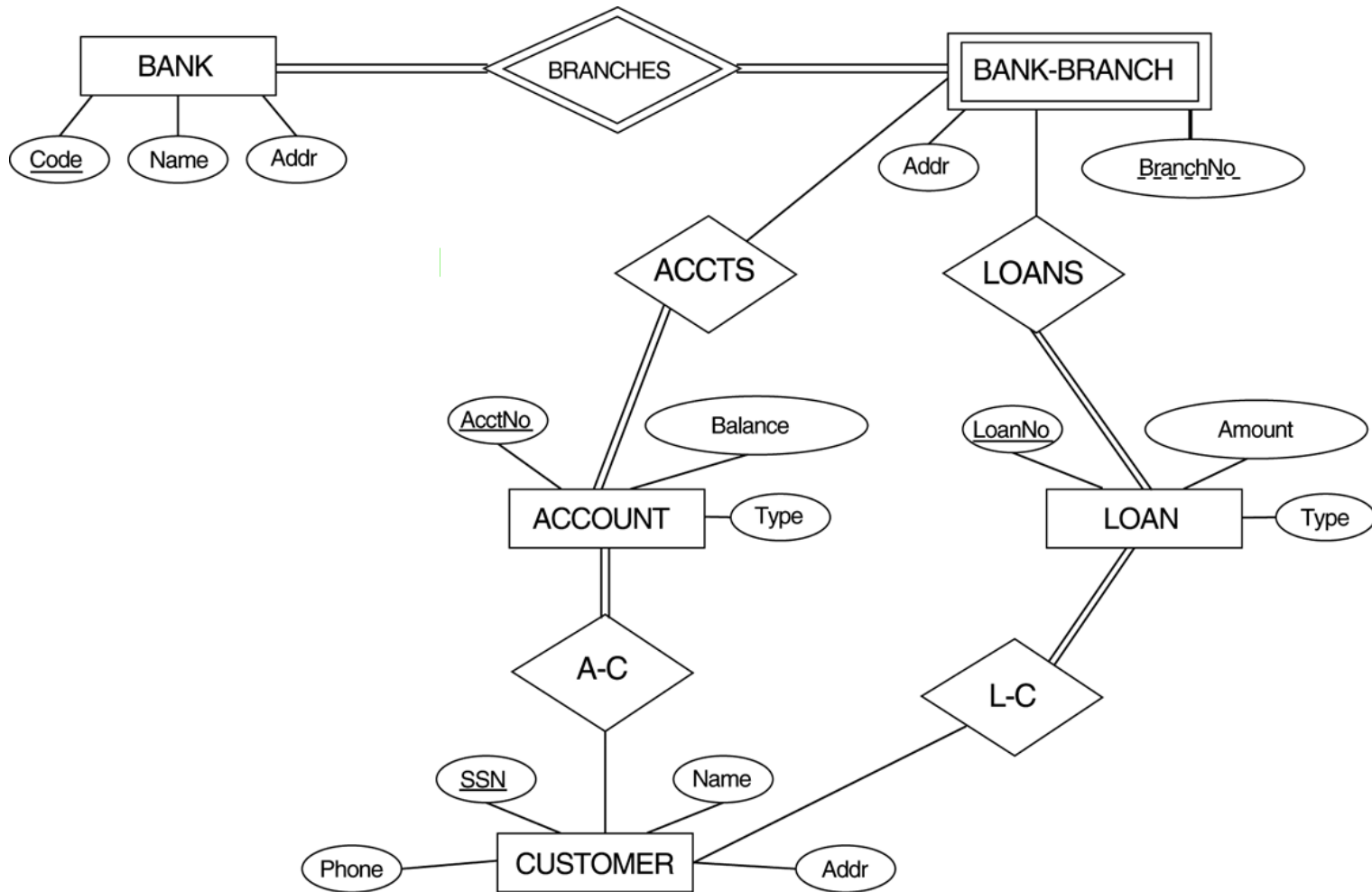# FIGURE: An ER diagram for a BANK database schema.
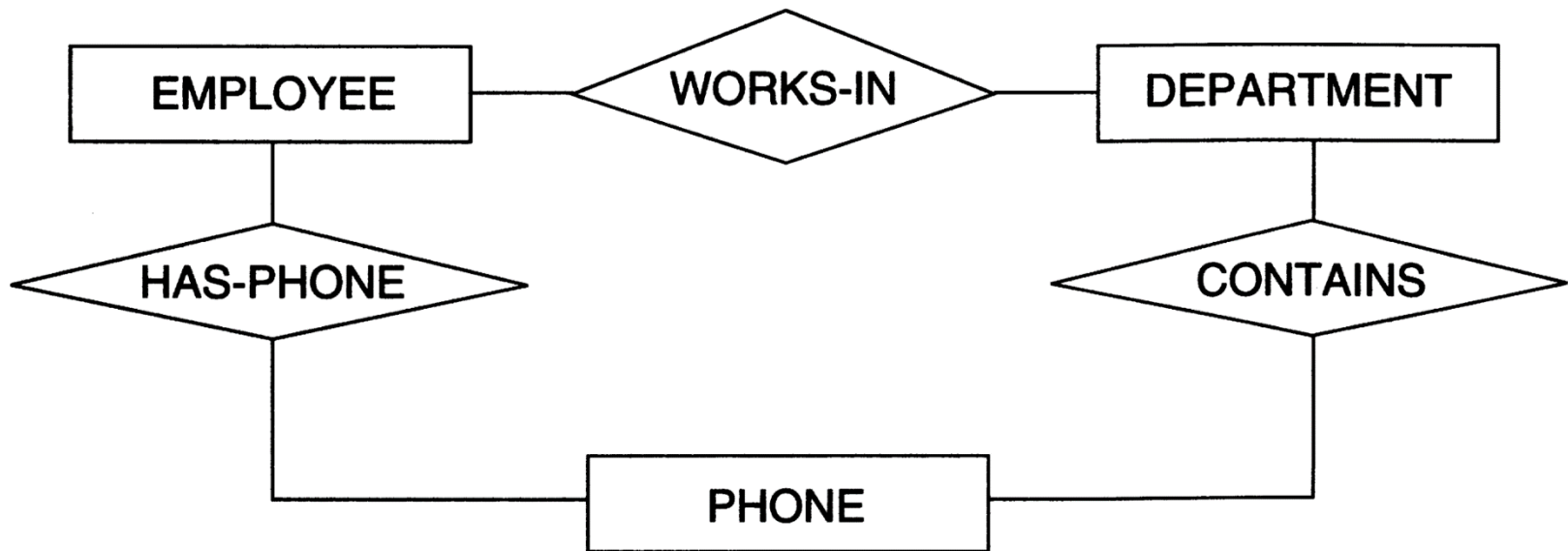
FIGURE 3.19
Part of an ER diagram for a COMPANY database.

FIGURE 3.20
Part of an ER diagram for a COURSES database.