CSE 412 Database Management

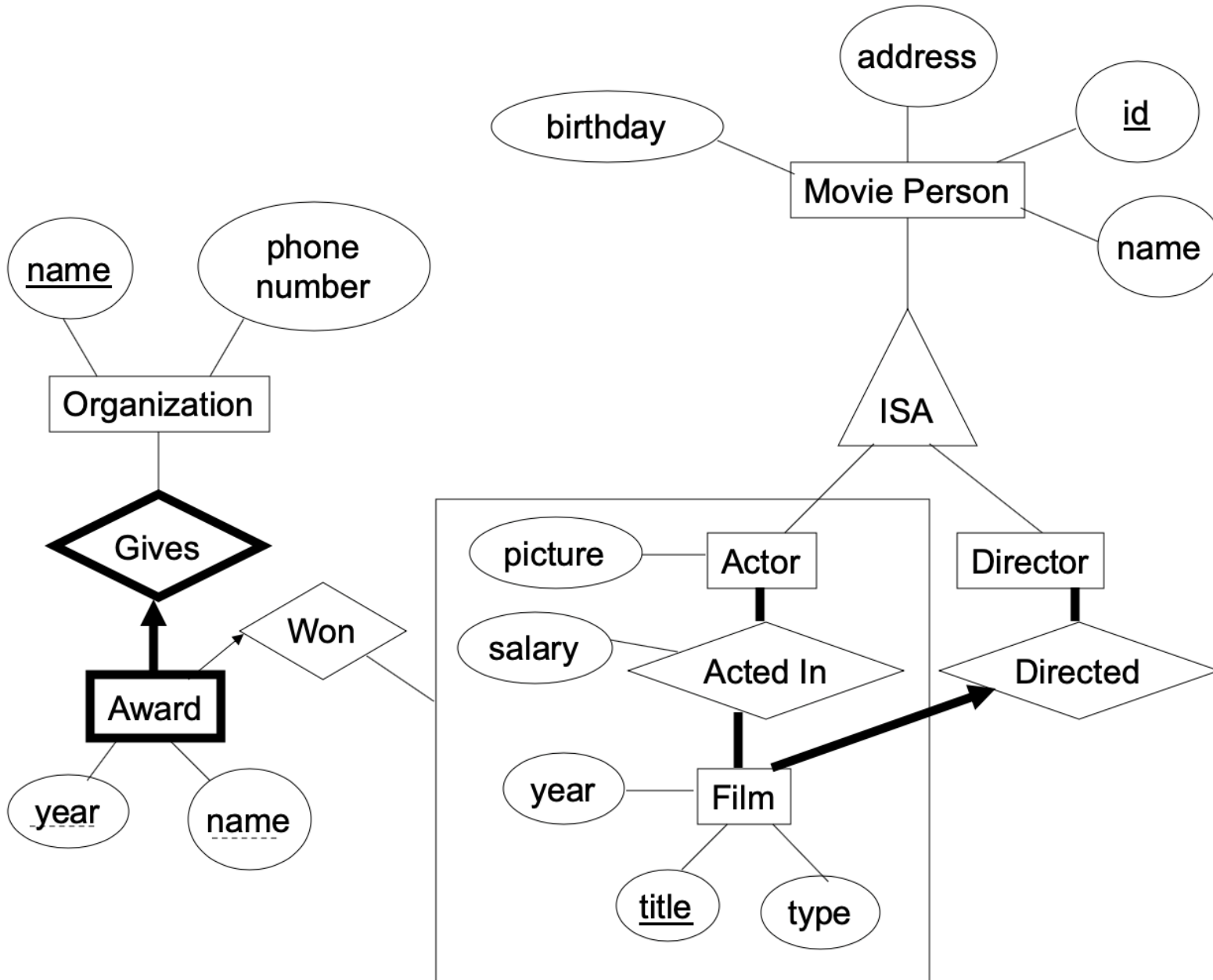## *Dr. Bharatesh Chakravarthi (BC)*

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School of Computing and Augmented Intelligence
Arizona State University

Challenge:
How to Design a Database?

ER Diagram Design

ER Diagram Design

Movie Person
- Attributes:
  - `id` (unique identifier, underlined)
  - `name`
  - `address`
  - `birthday`
- This is a general entity that represents people involved in movies.

Actor and **Director**
- These are **specializations** (sub-classes) of *Movie Person*, shown via the **ISA triangle**.
- Meaning: every actor and director is a movie person, inheriting their attributes (id, name, address, birthday).
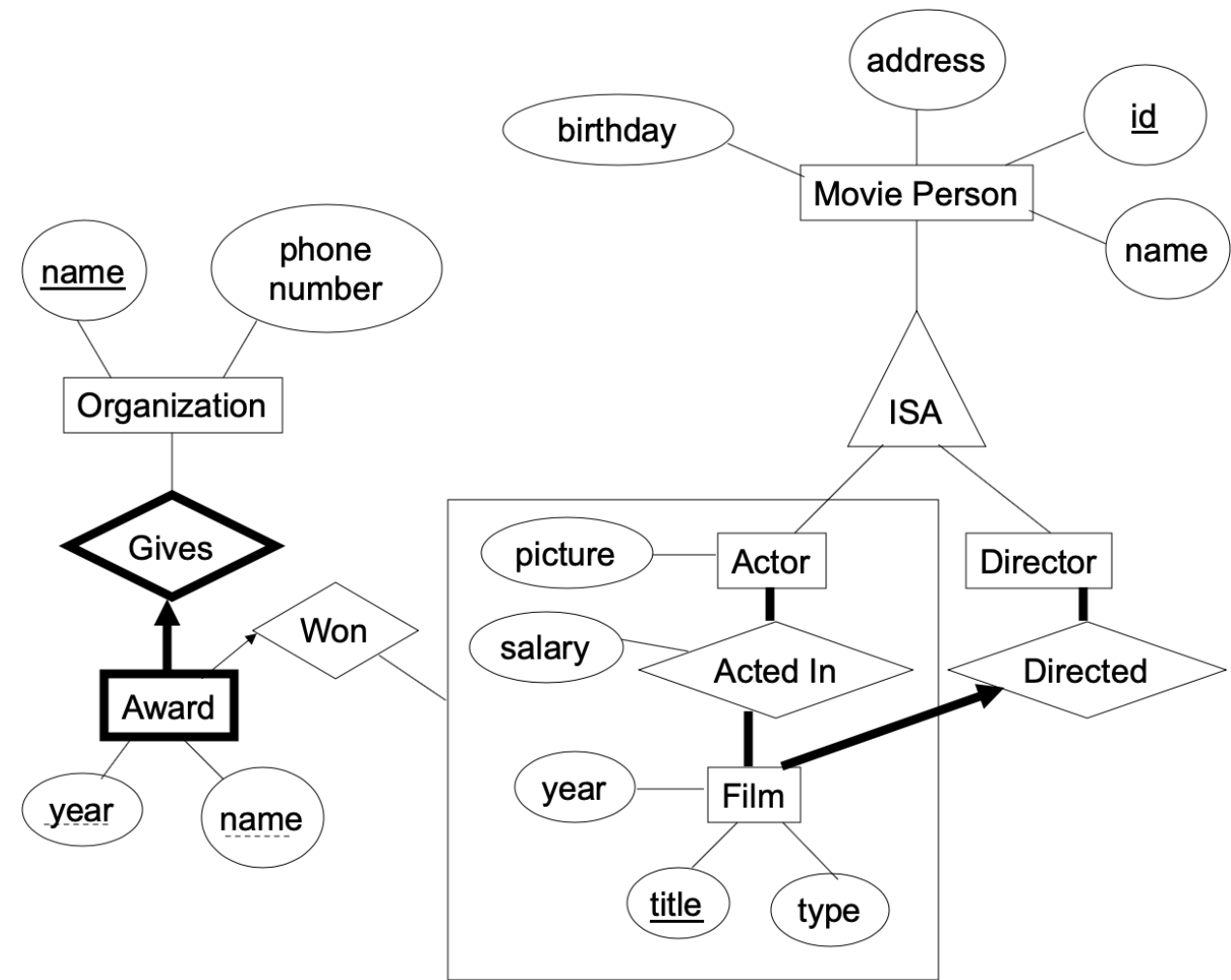
Film
- Attributes:
  - `title` (underlined, key attribute)
  - `type` (e.g., drama, comedy, etc.)
  - `year`

Organization
- Attributes:
  - `name` (underlined, key)
  - `phone number`

Award
- Attributes:
  - `name` (dotted underlined, partial key)
  - `year`

ER Diagram Design

Relationships

1. Acted In (between Actor and Film)
1. An actor can act in multiple films, and a film can have multiple actors.
2. Attributes of this relationship:
   1. `salary` (payment for acting in that film)
   2. `picture` (maybe a role or promotional still from the movie).

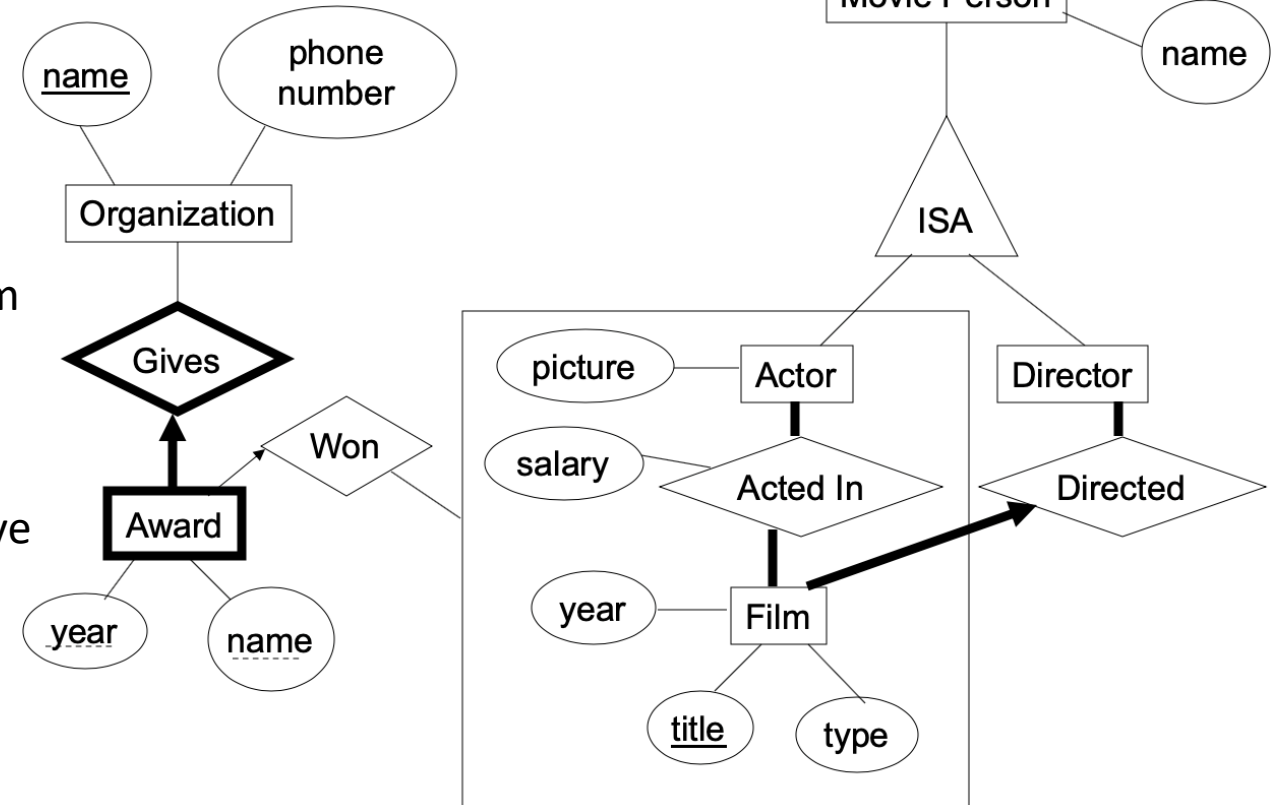**2. Directed** (between Director and Film)
1. A director can direct multiple films, and a film can have one or more directors.

3. Gives (between Organization and Award)
1. Organizations give awards.
2. Thick border = **identifying/strong relationship** (important one).

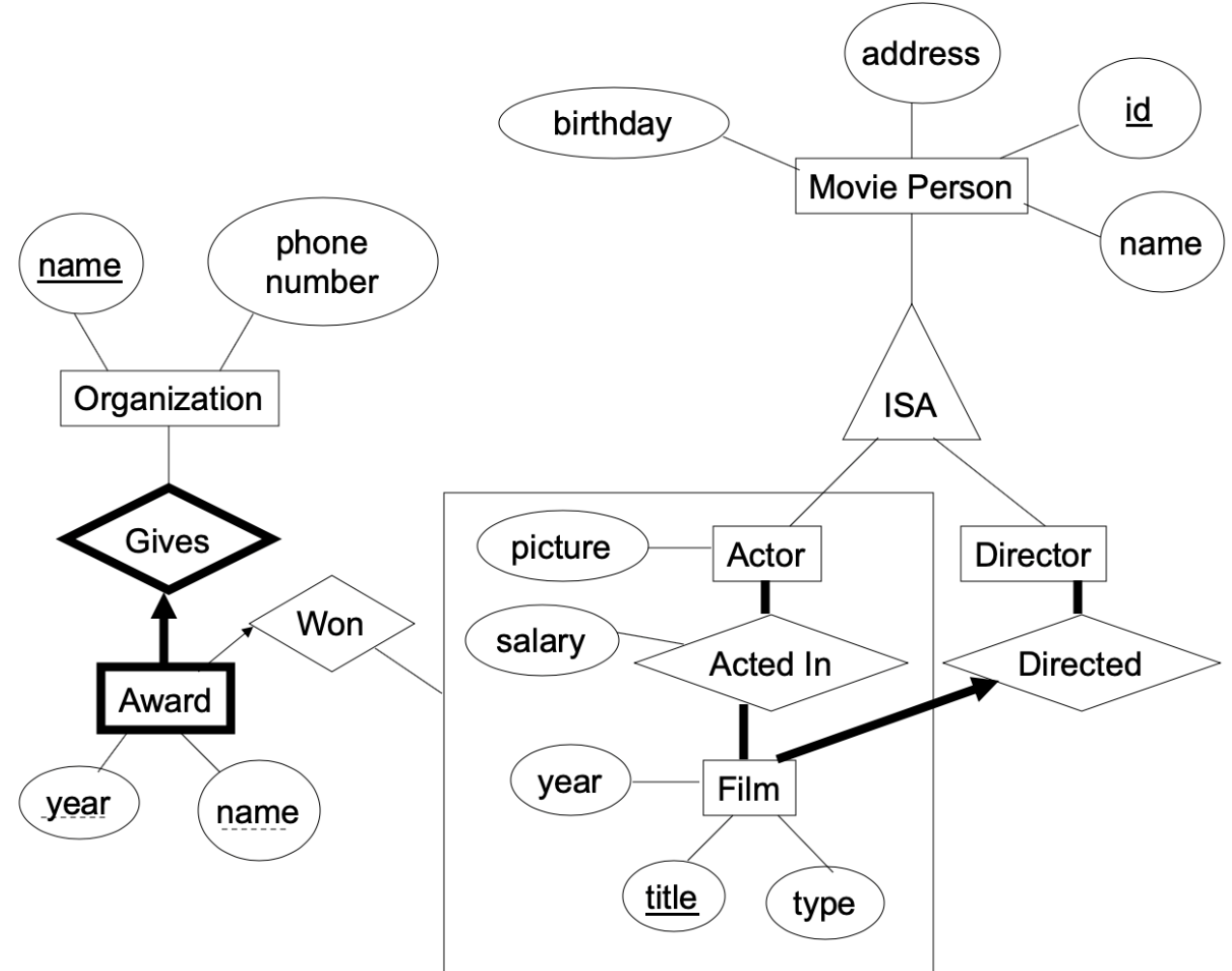**4. Won** (between Movie Person and Award)
1. Connects who won the award.

ER Diagram Design

Cardinalities and Strength

- The thick diamond and rectangle for **Gives–Award**
  means that an **Award must be given by an**
  Organization, i.e., it depends on it.

Similarly, thick lines around **Film–Directed/Acted In**
show that these are strong and essential relationships.

ER Diagram Design

The schema models a **movie ecosystem**:

- A *Movie Person* (actor/director) works in films.

- Actors **act** in films (with details like salary, pictures).

- Directors **direct** films.

- Films have a title, year, and type.

- Organizations **give awards** each year.

- People (actors/directors) can **win awards**.

ER Diagram Design Challenge

STUDENT

Name	Student_number	Class	Major

COURSE

Course_name	Course_number	Credit_hours	Department

PREREQUISITE

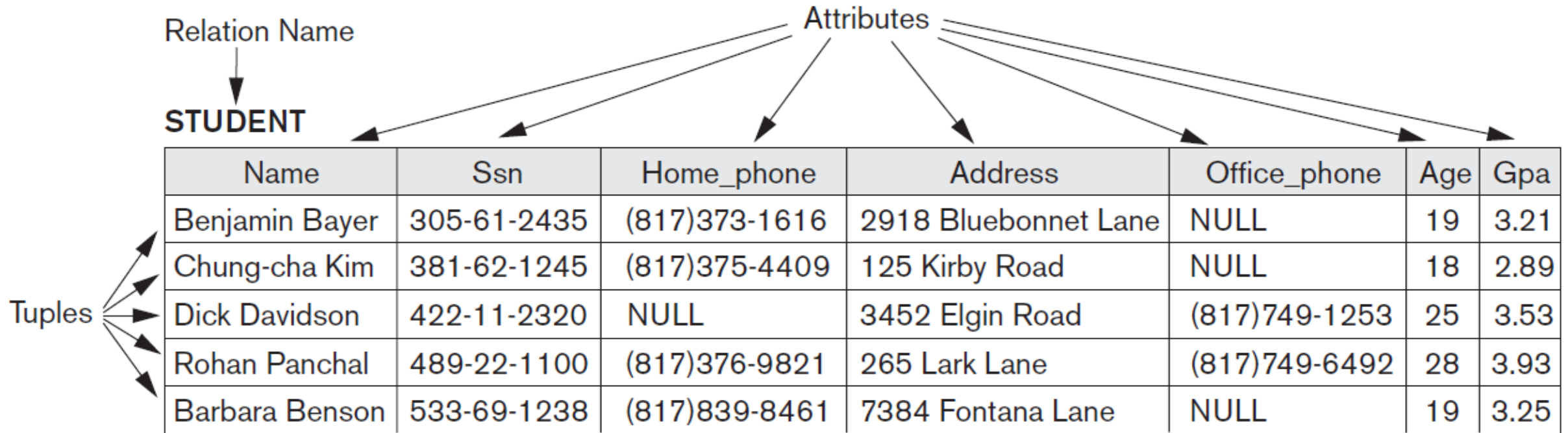| Course_number	Prerequisite_number

SECTION

Section_identifier	Course_number	Semester	Year	Instructor

GRADE_REPORT

Student_number	Section_identifier	Grade

ER Diagram Design Challenge

Relation Name → STUDENT

Attributes

Name	Ssn	Home_phone	Address	Office_phone	Age	Gpa
Benjamin Bayer	305-61-2435	(817)373-1616	2918 Bluebonnet Lane	NULL	19	3.21
Chung-cha Kim	381-62-1245	(817)375-4409	125 Kirby Road	NULL	18	2.89
Dick Davidson	422-11-2320	NULL	3452 Elgin Road	(817)749-1253	25	3.53
Rohan Panchal	489-22-1100	(817)376-9821	265 Lark Lane	(817)749-6492	28	3.93
Barbara Benson	533-69-1238	(817)839-8461	7384 Fontana Lane	NULL	19	3.25

Tuples

ER Diagram Design Challenge

STUDENT

Name	Student_number	Class	Major
Smith	17	1	CS
Brown	8	2	CS

COURSE

Course_name	Course_number	Credit_hours	Department
Intro to Computer Science	CS1310	4	CS
Data Structures	CS3320	4	CS
Discrete Mathematics	MATH2410	3	MATH
Database	CS3380	3	CS

SECTION

Section_identifier	Course_number	Semester	Year	Instructor
85	MATH2410	Fall	07	King
92	CS1310	Fall	07	Anderson
102	CS3320	Spring	08	Knuth
112	MATH2410	Fall	08	Chang
119	CS1310	Fall	08	Anderson
135	CS3380	Fall	08	Stone

GRADE_REPORT

Student_number	Section_identifier	Grade
17	112	B
17	119	C
8	85	A
8	92	A
8	102	B
8	135	A

PREREQUISITE

Course_number	Prerequisite_number
CS3380	CS3320
CS3380	MATH2410
CS3320	CS1310

ER Diagram Design Challenge

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date

DEPT_LOCATIONS

Dnumber	Dlocation

PROJECT

Pname	Pnumber	Plocation	Dnum

WORKS_ON

Essn	Pno	Hours

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship

Figure 3.5

Schema diagram for the COMPANY relational database schema.

ER Diagram Design Challenge

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19

DEPT_LOCATIONS

Dnumber	Dlocation
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston

WORKS_ON

Essn	Pno	Hours
123456789	1	32.5
123456789	2	7.5
666884444	3	40.0
453453453	1	20.0
453453453	2	20.0
333445555	2	10.0
333445555	3	10.0
333445555	10	10.0
333445555	20	10.0
999887777	30	30.0
999887777	10	10.0
987987987	10	35.0
987987987	30	5.0
987654321	30	20.0
987654321	20	15.0
888665555	20	NULL

PROJECT

Pname	Pnumber	Plocation	Dnum
ProductX	1	Bellaire	5
ProductY	2	Sugarland	5
ProductZ	3	Houston	5
Computerization	10	Stafford	4
Reorganization	20	Houston	1
Newbenefits	30	Stafford	4

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse

ER Diagram Design Challenge

Figure 7.2
An ER schema diagram for the COMPANY database. The diagrammatic notation is introduced gradually throughout this chapter and is summarized in Figure 7.14.
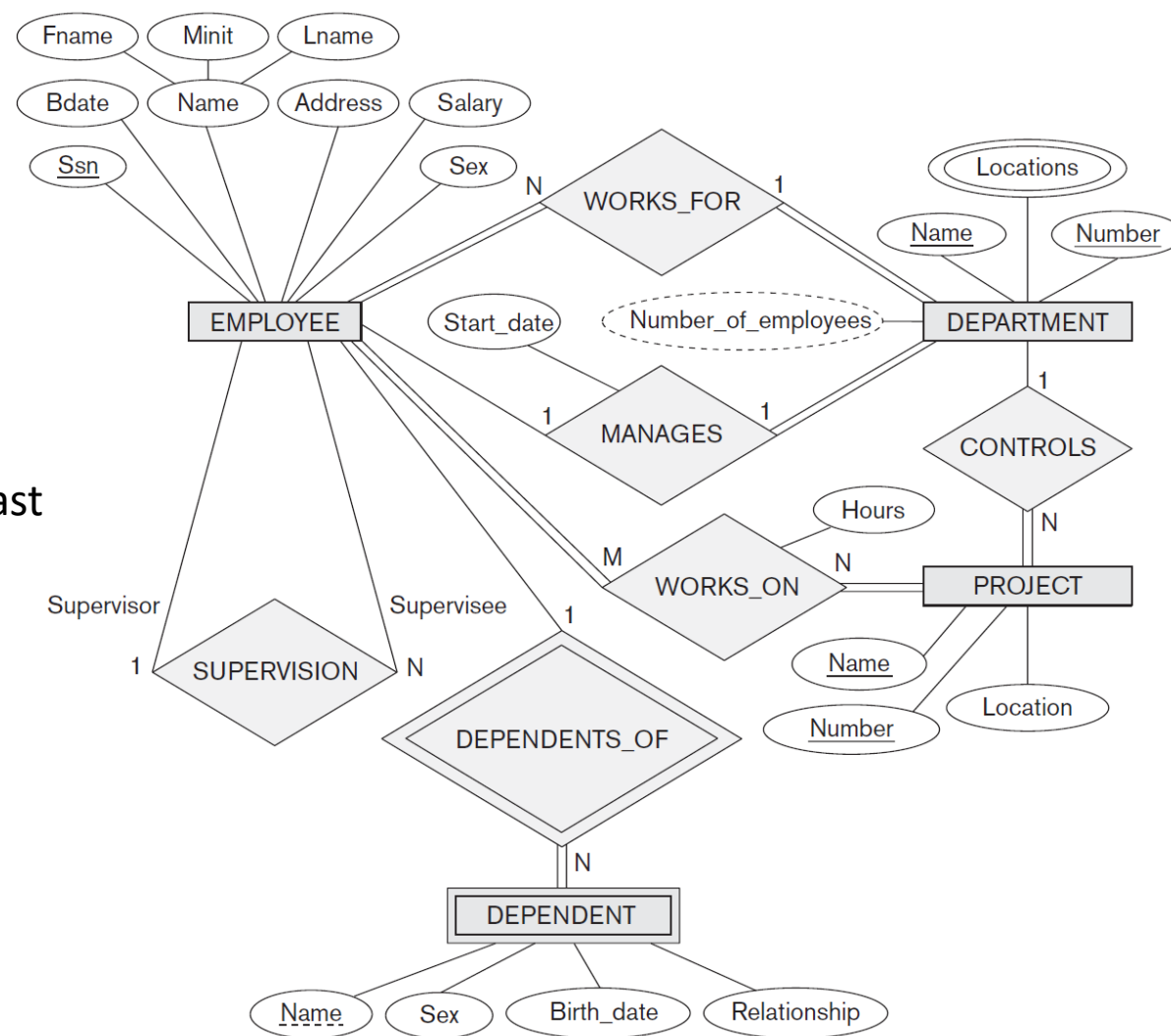
ER Diagram Design Challenge

EMPLOYEE

- Attributes:
  - `Fname` (first name), `Minit` (middle initial), `Lname` (last name)
  - `Ssn` (social security number, primary key)
  - `Bdate` (birth date), `Address`, `Sex`, `Salary`
- Role: central entity; participates in many relationships.

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ER Diagram Design Challenge

DEPARTMENT

•Attributes:

- `Name`
- `Number` (primary key)
- `Locations` (multivalued attribute, because a department can have multiple locations)
- `Number_of_employees` (derived attribute, dotted oval).
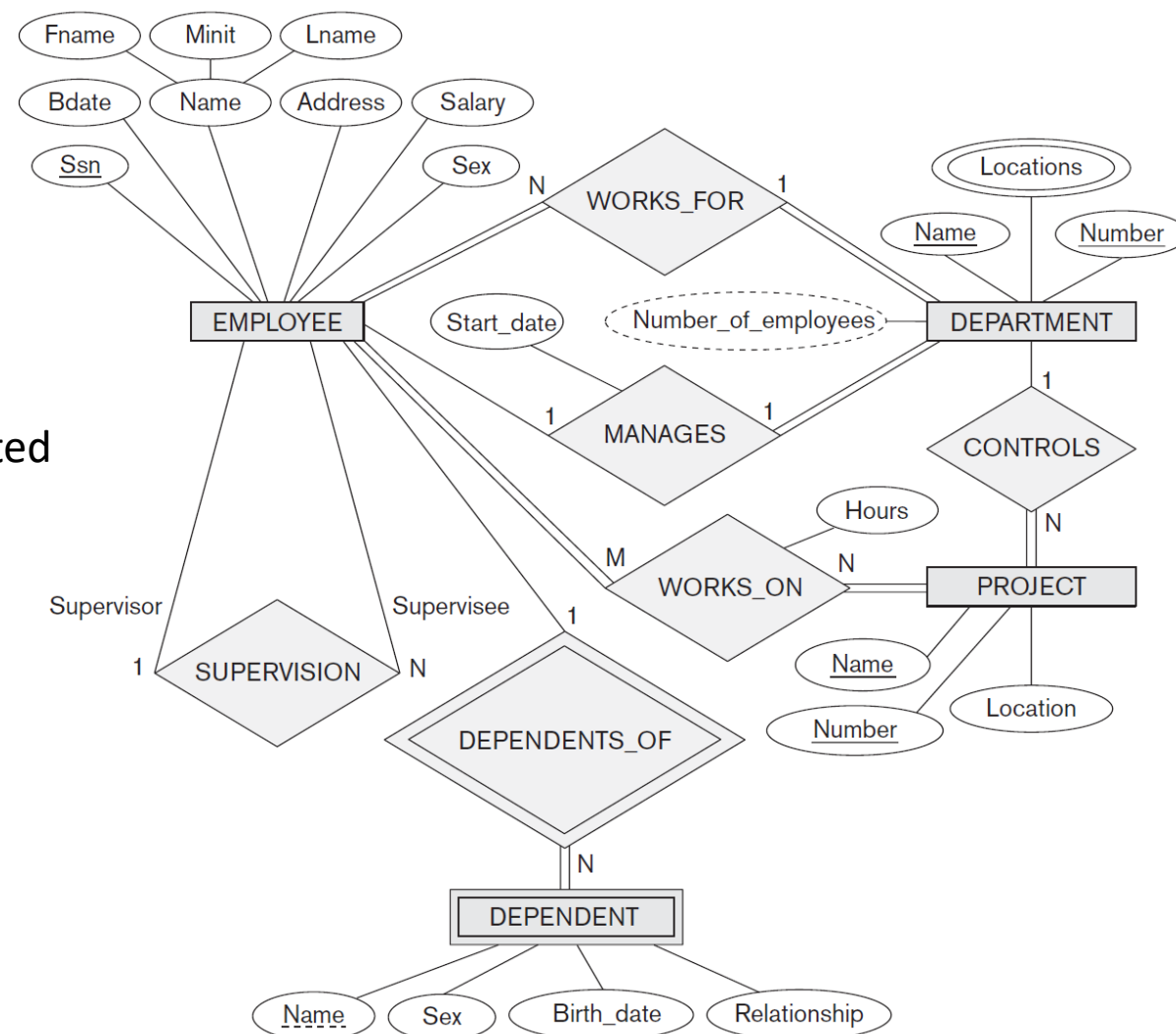
PROJECT

•Attributes:

- `Name`
- `Number` (primary key)
- `Location`

DEPENDENT

•Attributes:

- `Name`
- `Sex`
- `Birth_date`
- `Relationship` (to the employee)

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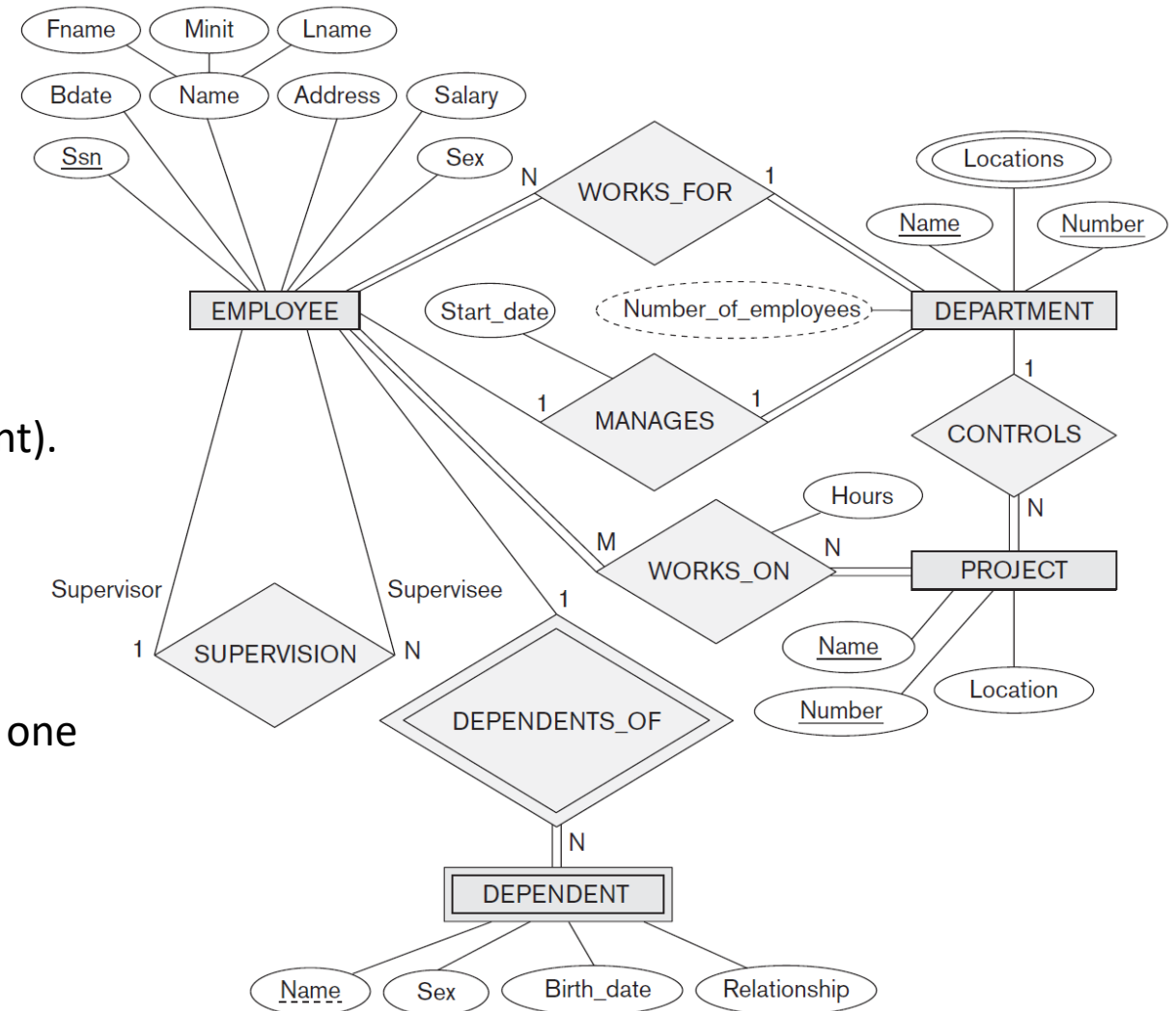
ER Diagram Design Challenge

Relationships

WORKS_FOR
- Between **EMPLOYEE** and **DEPARTMENT**.
- Cardinality: **N:1** (many employees work for one department).

MANAGES
- Between **EMPLOYEE** and **DEPARTMENT**.
- Cardinality: **1:1** (each department has one manager, and one employee manages one department).
- Attribute: `Start_date` (when the employee began managing).

Figure 7.2
An ER schema diagram for the COMPANY database. The diagrammatic notation is introduced gradually throughout this chapter and is summarized in Figure 7.14.

ER Diagram Design Challenge

CONTROLS
- Between **DEPARTMENT** and **PROJECT**.
- Cardinality: **1:N** (one department controls many projects; each project is controlled by exactly one department).

WORKS_ON
- Between **EMPLOYEE** and **PROJECT**.
- Cardinality: **M:N** (an employee can work on many projects, and a project can have many employees).
- Attribute: `Hours` (hours worked on a project by that employee).

SUPERVISION
- A recursive relationship on **EMPLOYEE**.
- Cardinality: **1:N** (one employee supervises many other employees, but each employee has one supervisor).
- Roles: Supervisor and Supervisee.

DEPENDENTS_OF
- Between **EMPLOYEE** and **DEPENDENT**.
- Cardinality: **1:N** (one employee can have many dependents, each dependent belongs to exactly one employee).
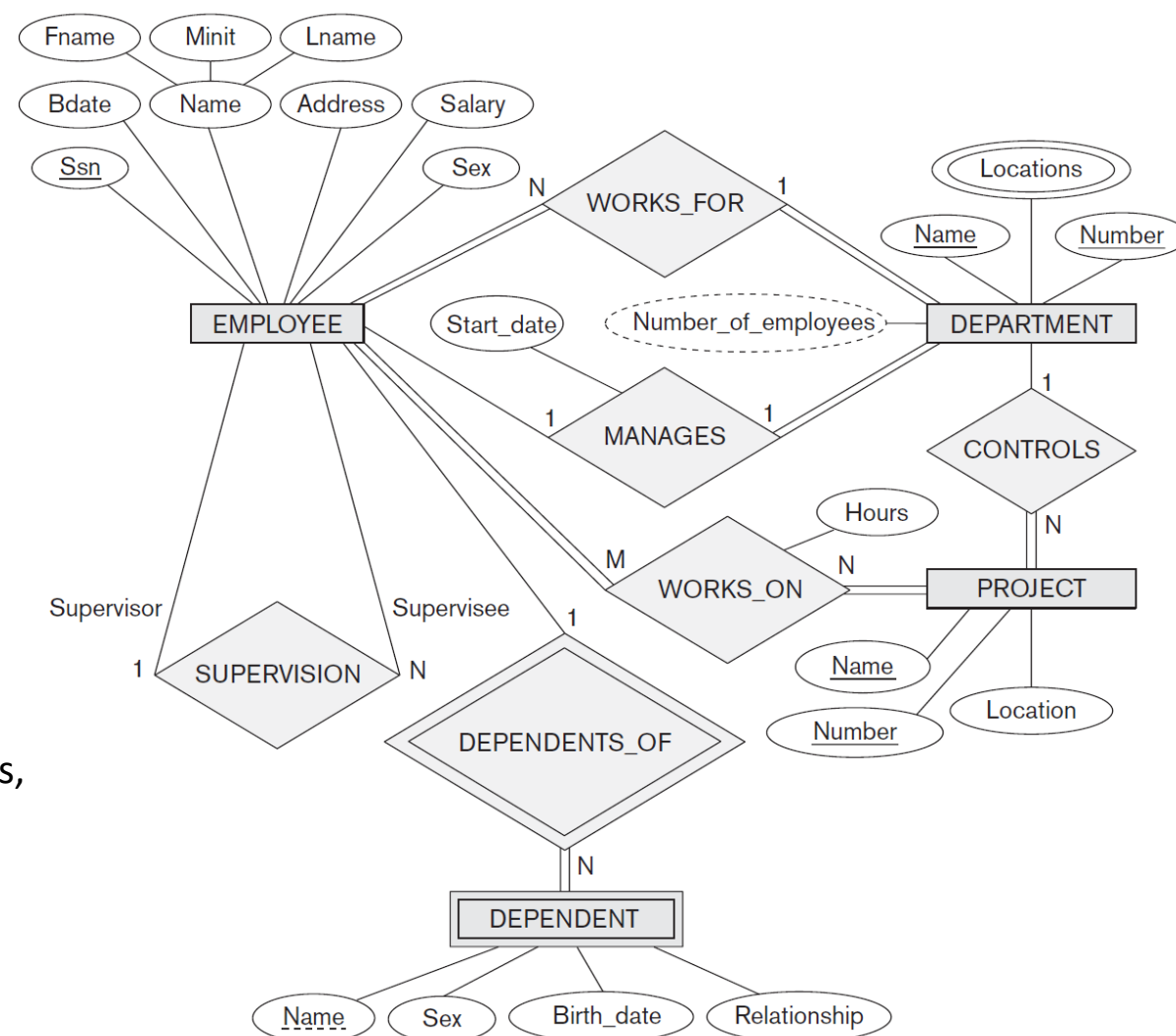

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An ER schema diagram for the COMPANY database. The diagrammatic notation is introduced gradually throughout this chapter and is summarized in Figure 7.14.
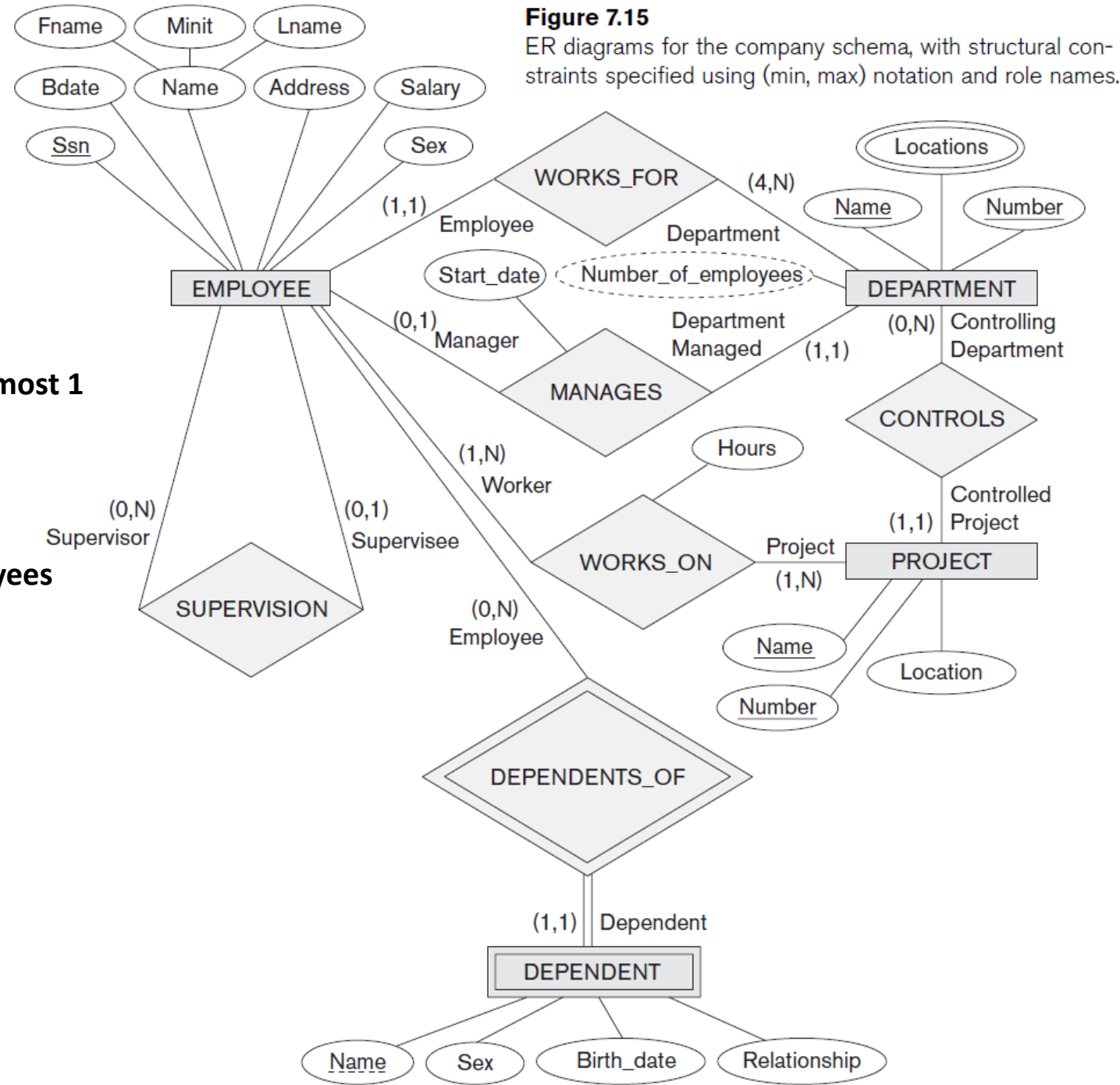
ER Diagram Design Challenge

WORKS_FOR (EMPLOYEE side (1,1))

- Each **EMPLOYEE** must work for **at least 1 and at most 1 department**.

WORKS_FOR (DEPARTMENT side (4,N))

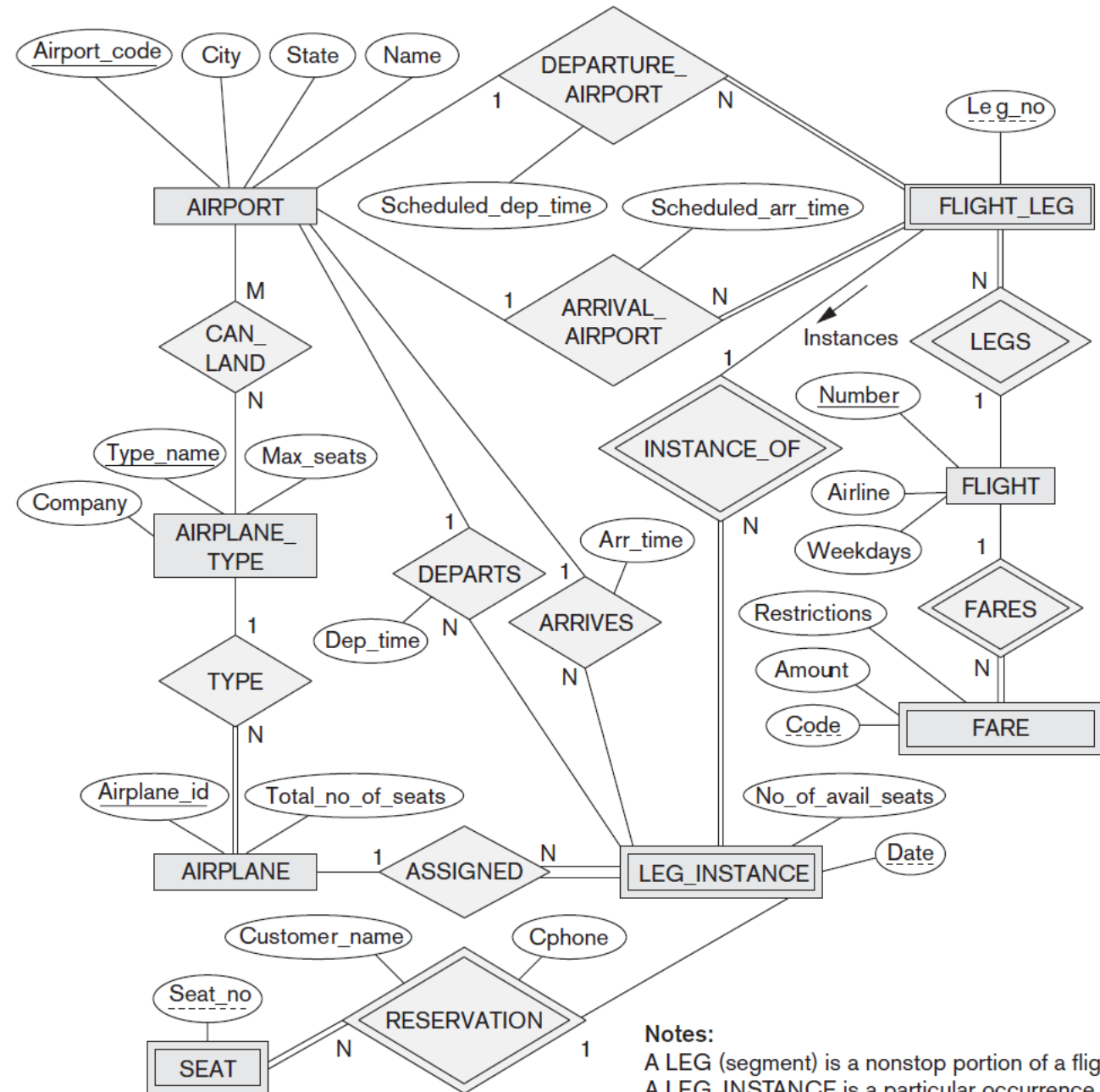- **Each DEPARTMENT must have at least 4 employees and possibly many (N).**

Figure 7.15
ER diagrams for the company schema, with structural constraints specified using (min, max) notation and role names.
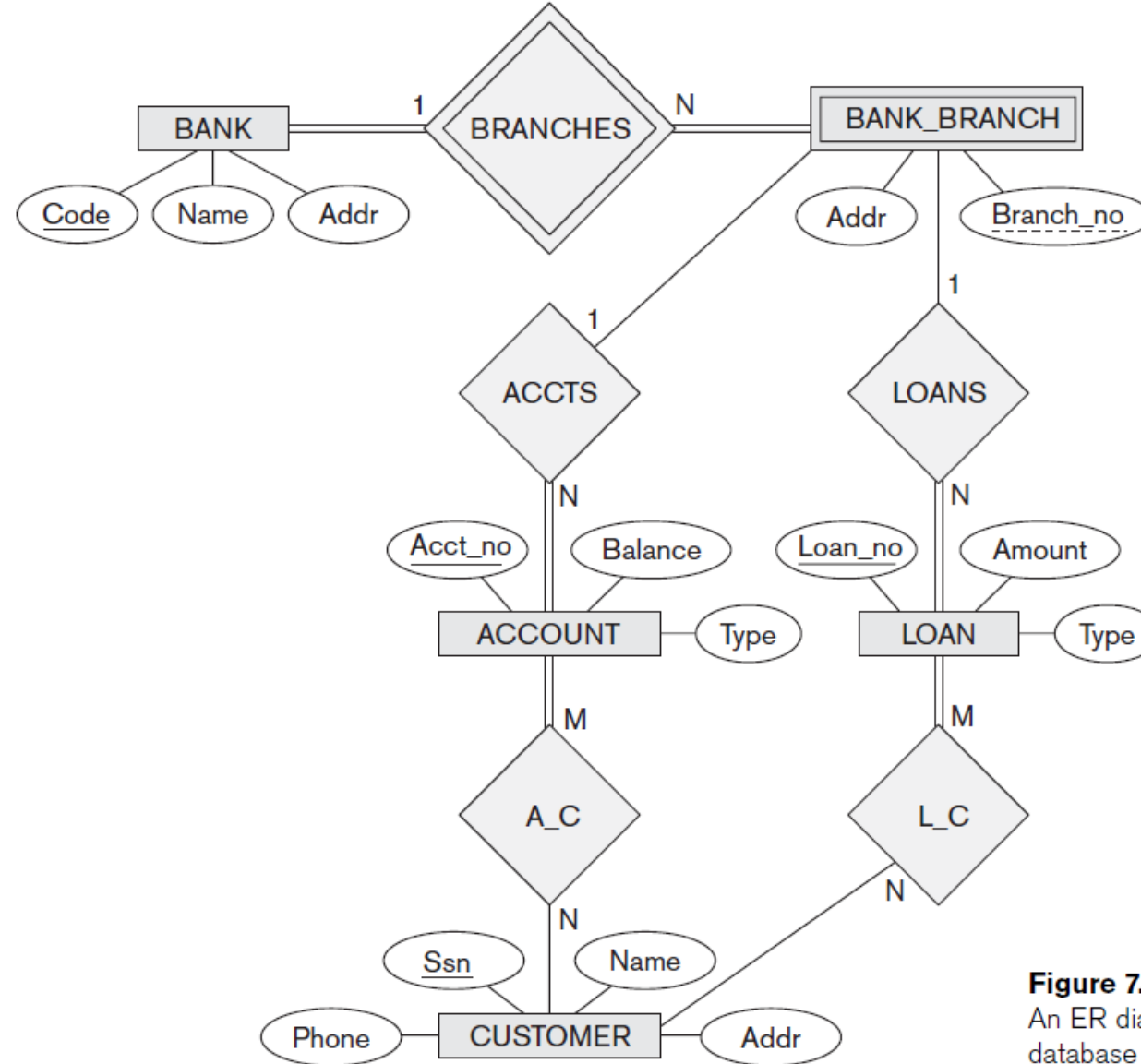
ER Diagram Design Challenge

Figure 7.20
An ER diagram for an AIRLINE database schema.

Airport_code | City | State | Name

DEPARTURE_AIRPORT
Leg_no

AIRPORT

Scheduled_dep_time | Scheduled_arr_time

FLIGHT_LEG

CAN_LAND

ARRIVAL_AIRPORT

Instances

LEGS

Number

INSTANCE_OF

Type_name | Max_seats

Company

AIRPLANE_TYPE

Airline

FLIGHT

Arr_time

Weekdays

DEPARTS

ARRIVES

Restrictions

FARES

TYPE

Dep_time

Amount

Code

FARE

Airplane_id | Total_no_of_seats

No_of_avail_seats

AIRPLANE

ASSIGNED

LEG_INSTANCE

Date

Customer_name | Cphone

Seat_no

RESERVATION

SEAT

Notes:
A LEG (segment) is a nonstop portion of a flight
A LEG_INSTANCE is a particular occurrence
of a LEG on a particular date.

ER Diagram Design Challenge

Figure 7.21
An ER diagram for a BANK database schema.