Database Laboratory
Lesson 4

Relational model

Relational Model

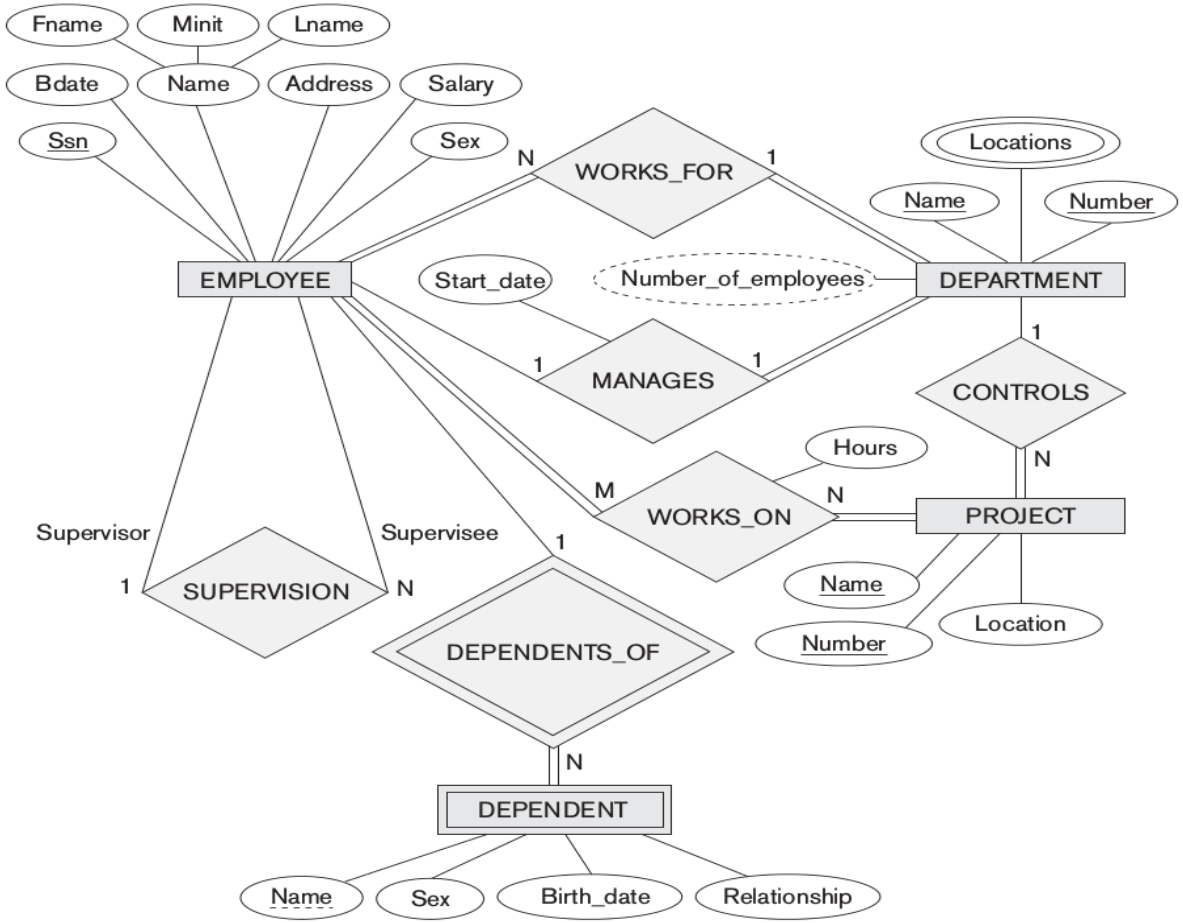


Figure 7.2
An ER schema diagram for the COMPANY database. The diagrammatic notation is introduced gradually throughout this chapter and is summarized in Figure 7.14.

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

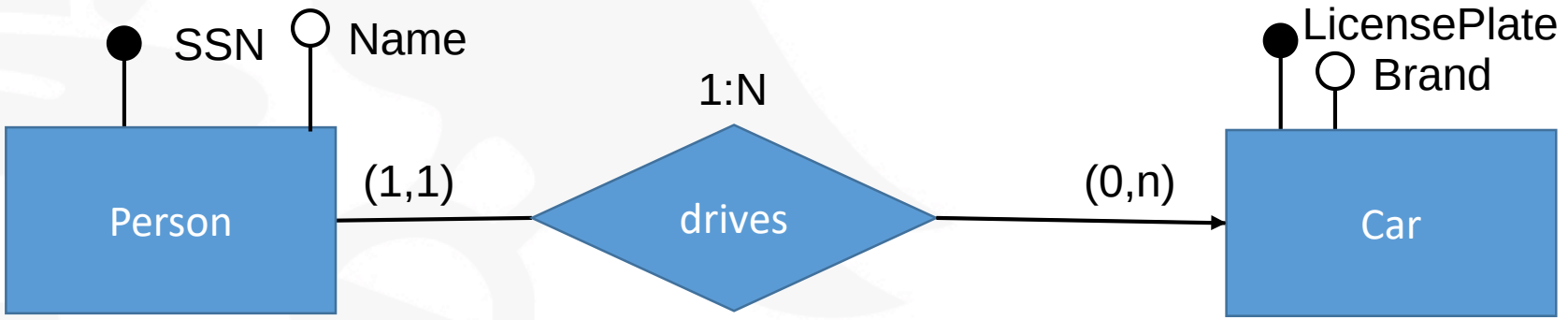
Essn	Dependent_name	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse

Reduction to relation schemas

- **1 table for each entity**
  - Name of the table = name of the entity
- **1 table for each N:M relationship**
  - Name of the table = name of the relationship
- **1 table for each multivalued attribute**
  - Name of the table = name of the attribute
- **Columns**:
  - Normal/strong entities
    - columns = name of the attributes
  - Weak entities
    - columns = PK(Strong entity) U Attributes (weak entity)
  - Relationship R (**N:M**) between entities A, B
    - columns (R) = PK(A) U PK(B) U Attributes(R)
  - Relationship R (**1:1**) between entities A, B
    - columns (A) = Attributes(A) U PK(B) U Attributes(R) OR columns (B) = Attributes(B) U PK(A) U Attributes(R)
  - Relationship R (**1:N**) between A, B
    - columns (B) = attributes(B) U PK(A) U attributes(R)

Foreign Key

- Foreign Key (FK). Attribute (or set of attributes) that are the primary key (PK) of other entity



PERSON

SSN	Name
1	Anthony

CAR

LicensePlate	Brand	SSN
5789KBB	Opel	1

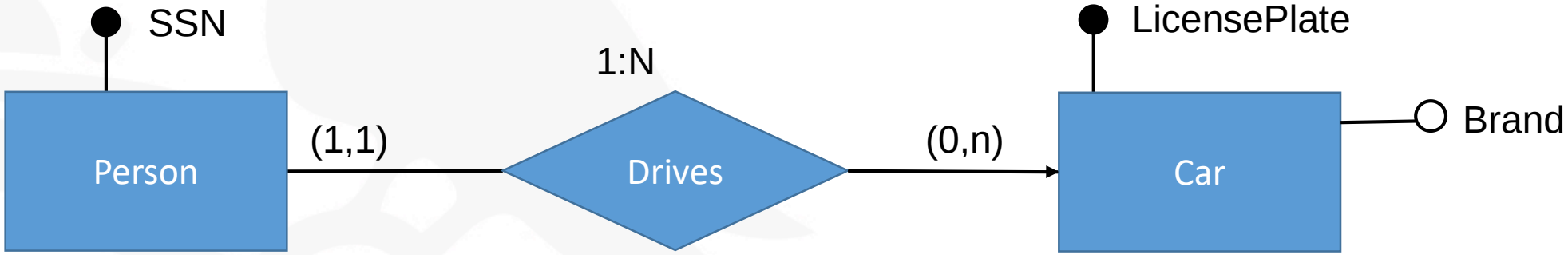
FK

Conversion of Attributes

- **Mandatory attributes**: column of a table, do not admit NULL
- **Optional attributes**: column of a table, admit NULL .
- **Multivalued attributes**: a new table is created with the primary key of the entity and the multivalued attribute. Both are primary key of the new table.
- **Composite attributes**: one column per each simple attribute is added.
- **Derived attributes**: they are not included in the relational model.

Referential Integrity

- It is used to maintain the minimum and maximum cardinality



PERSON

SSN	Name
1	Anthony

I:
U:
D:

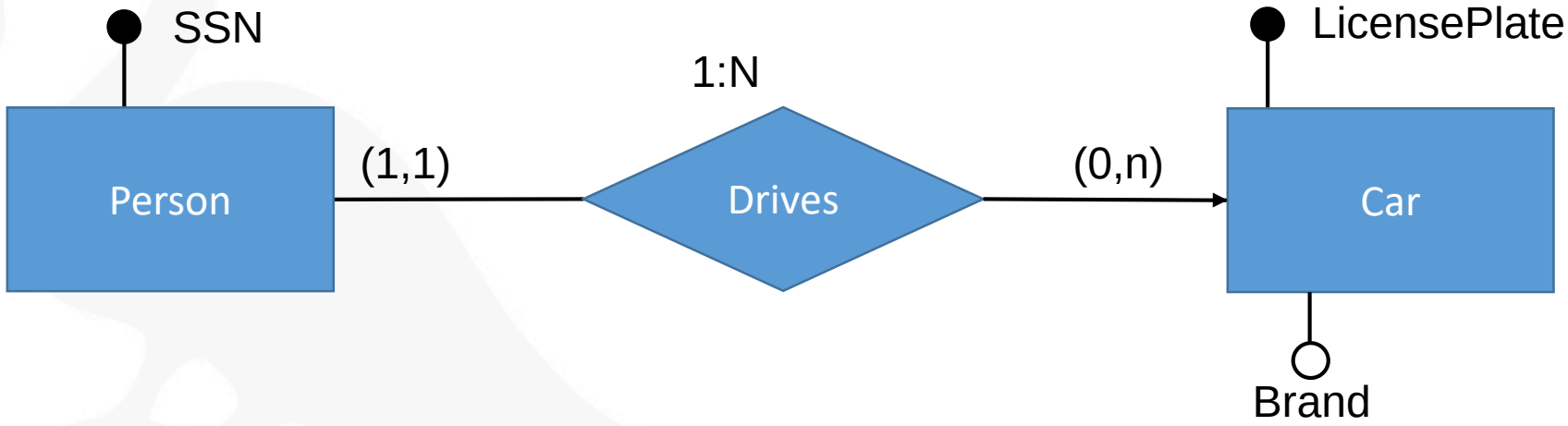
I:
U:
D:

CAR

LicensePlate	Brand	SSN
5789KBB	Opel	1

Referential Integrity: options

- **N**: *No Action*.
- **SD**: *Set Default*
- **SN**: *Set Null*
- **R**: *Restricted*
- **C**: *Cascade*



PERSON

SSN	**Name**
1	Anthony
2	James

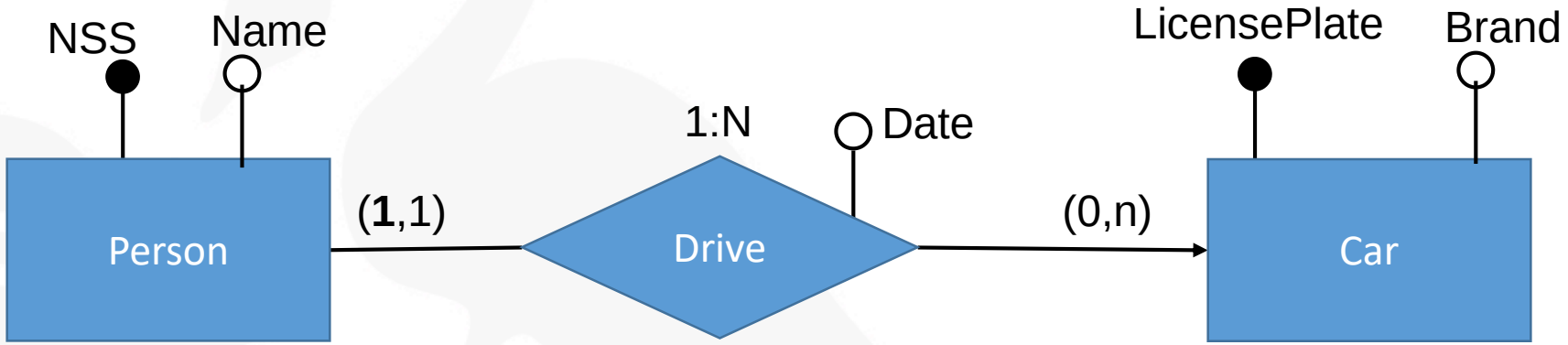
I: **N**
U: R/**C**
D: **R**/C

I: **R**
U: **R**
D: **N**

CAR

LicensePlate	**Brand**	**SSN**
1234JJJ	Ford	2
5678KKK	Nissan	2

1:N. Direct transformation



PERSON

SSN	Name
1	Anthony
2	James

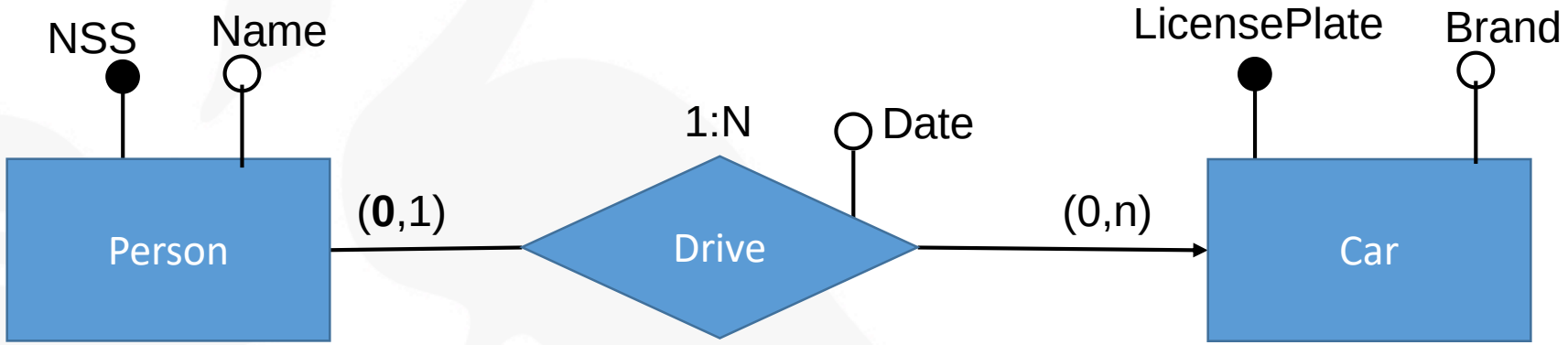
I: **N**
U: R/**C**
D: **R**/C

I: **R**
U: **R**
D: **N**

CAR

LicensePlate	Brand	Date	SSN
1234JJJ	Ford	01/01/2019	3

1:N. Indirect transformation with NULL



PERSON

SSN	Name
1	Anthony
2	James

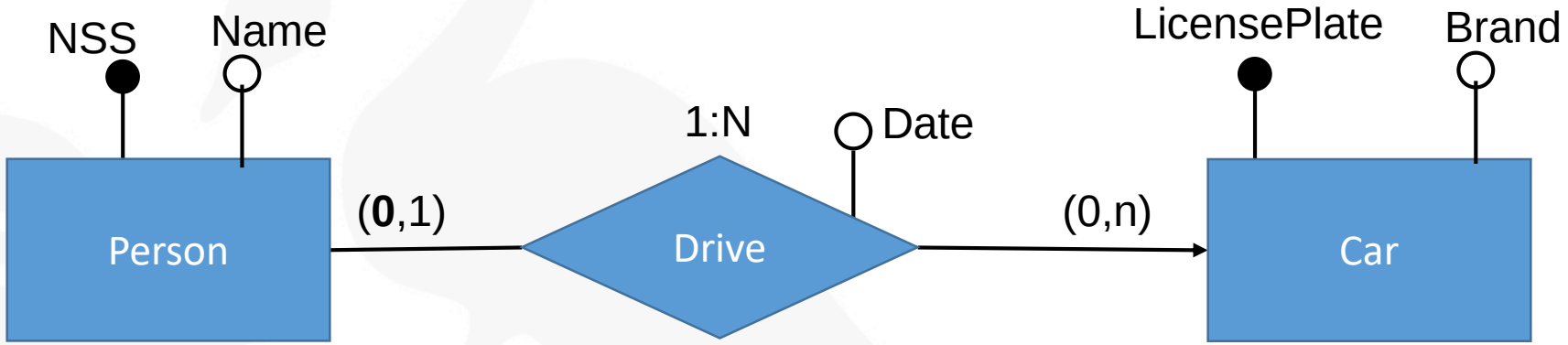
I: **N**
U: R/**C**
D: SN

I: **N**
U: **R**
D: **N**

CAR

LicensePlate	Brand	Date	SSN
1234JJJ	Ford	NULL	NULL

1:N. Indirect transformation without NULL



PERSON

I: **N**
U: **C**
D: C

SSN	**Name**
1	Anthony
2	James

DRIVE

I: **R**
U: **R**
D: **N**

SSN	**LicensePlate**	**Date**
2	1234JJJ	01/01/2019

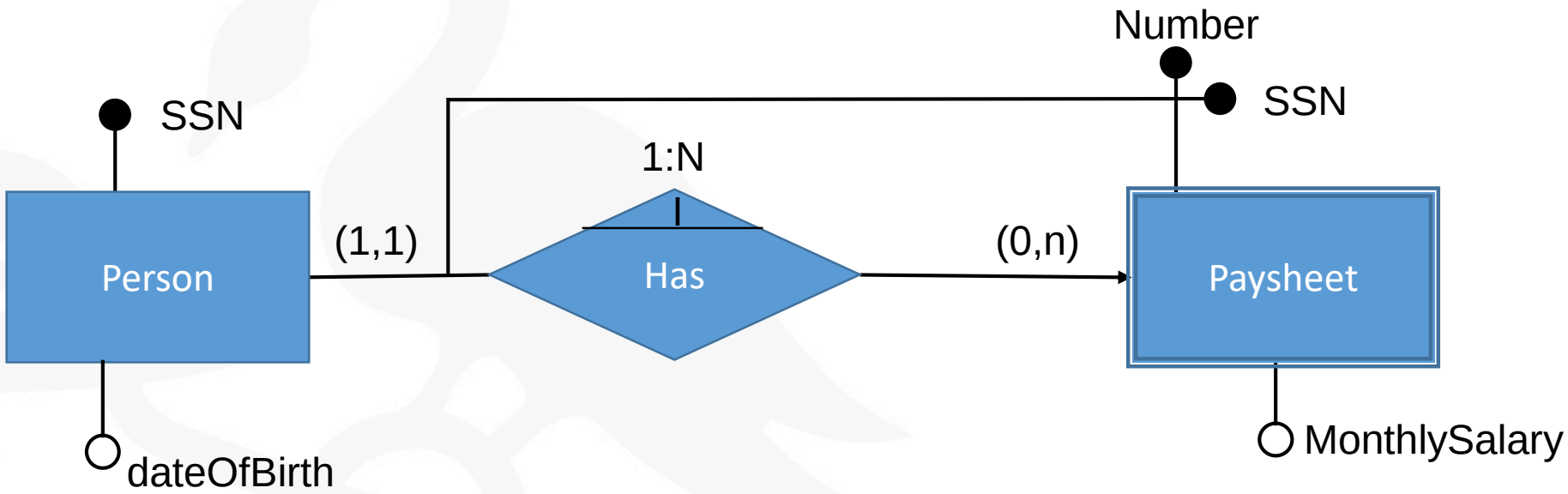
CAR

I: **N**
U: **C**
D: **C**

I: **R**
U: **R**
D: **N**

LicensePlate	**Brand**
1234JJJ	Ford
5789KBB	Opel

Weak entities



PERSON

SSN	dateOfBirth

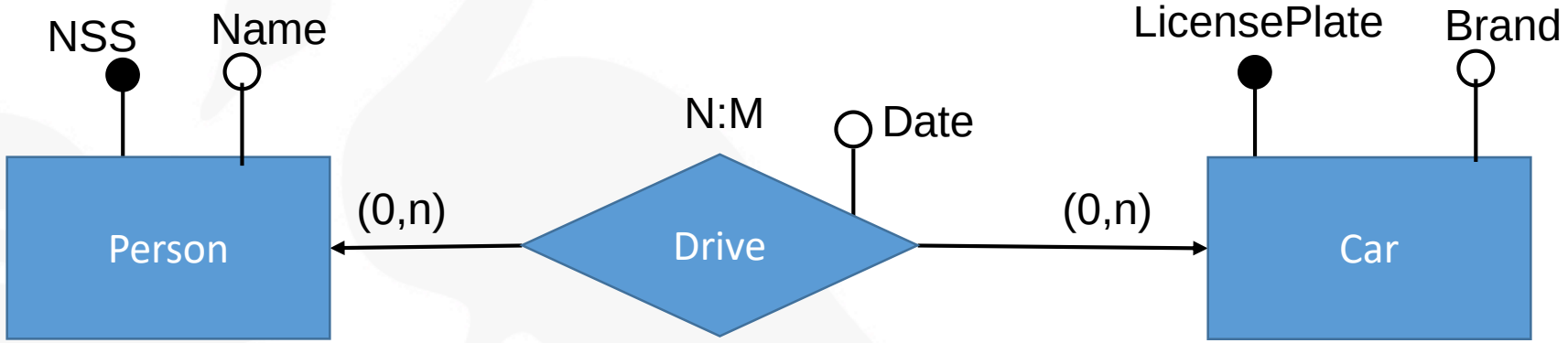
I: **N**
U: **C**
D: **C**

I: **R**
U: **R**
D: **N**

PAYSHEET

SSN	Number	MonthlySalary

Relationships N:M



PERSON

I: **N**
U: **C**
D: C

SSN	**Name**
1	Anthony
2	James

DRIVE

I: **R**
U: **R**
D: **N**

I: **R**
U: **R**
D: **N**

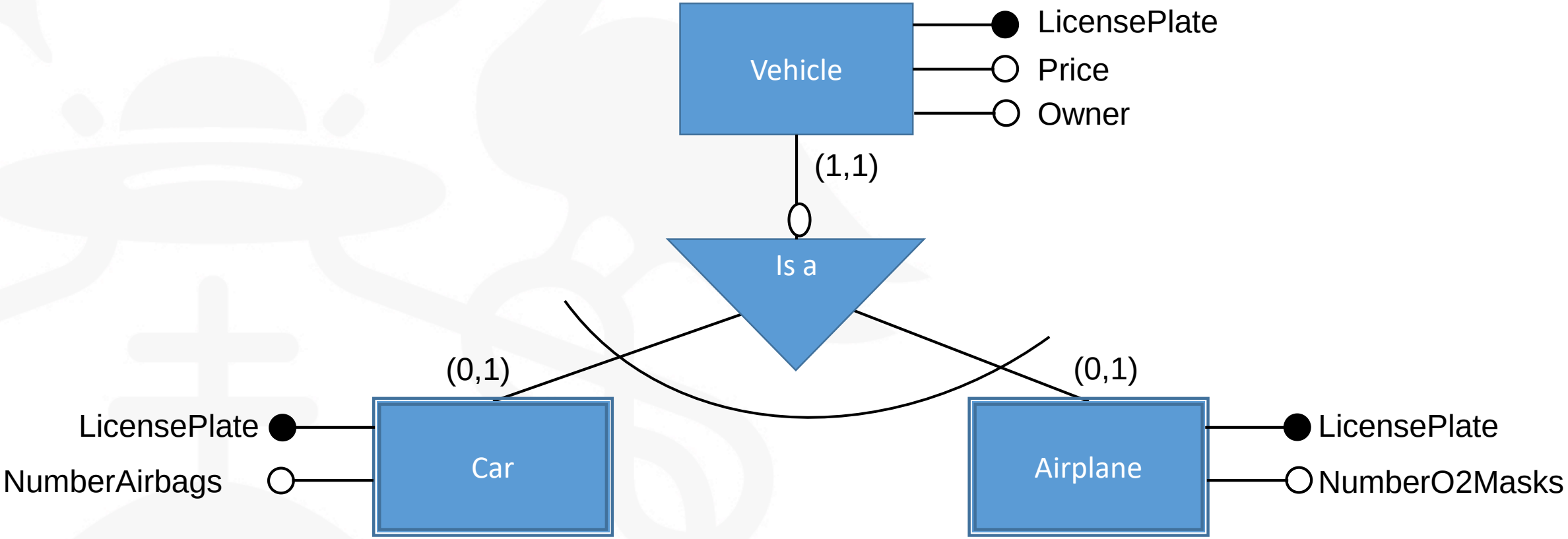
DNI	**LicensePlate**	**Date**
2	1234JJJ	01/07/2017
3	1234JJJ	01/10/2018
3	5789KBB	01/01/2019

CAR

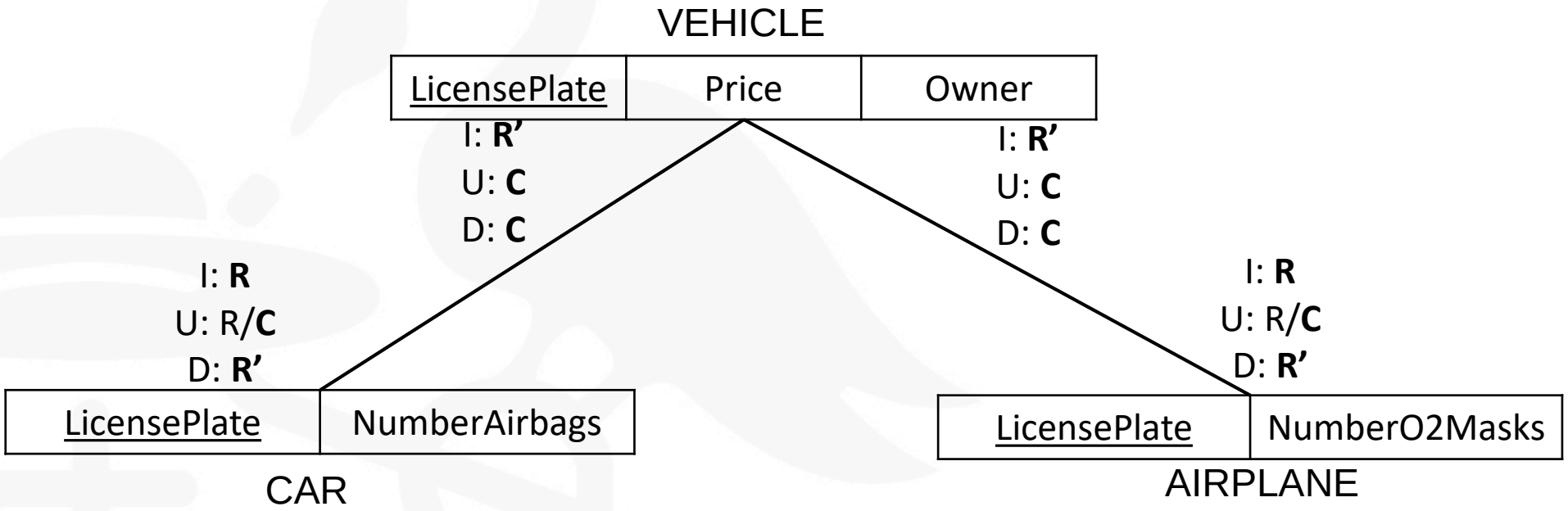
I: **N**
U: **C**
D: **C**

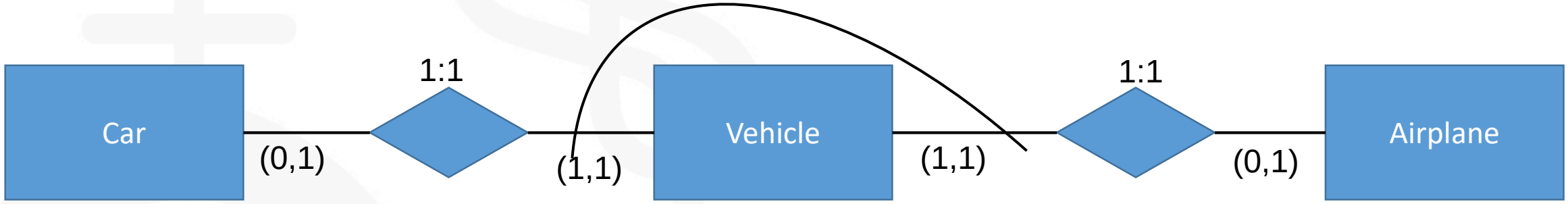
LicensePlate	**Brand**
1234JJJ	Ford
5789KBB	Opel

Hierarchy


Vehicle
LicensePlate
Price
Owner
(1,1)
Is a
(0,1)
(0,1)
LicensePlate
NumberAirbags
Car
Airplane
LicensePlate
NumberO2Masks

Transformation of hierarchies





Exercises

Exercise 1

- Design a relational database for a company that has to manage employees, departments and projects.
  - The company is organized into departments. Each department has a number and name that are unique and there is a certain employee who manage it. We are interested in the date on which that employee began to manage the department. In addition a department can be distributed in several places of the company.
  - Each department controls a certain number of projects. Each project has a unique name and number, and is carried out in a single place.
  - The name, social security number, address, salary, sex and date of birth will be stored for each employee. Every employee is assigned to a department, but can work on several projects, which will not necessarily be controlled by the same department. We are interested in the number of hours per week an employee works on each project and we are also interested in who is the direct supervisor of each employee.
  - We also want to keep data of the family members of each employee in order to manage their insurance. The name, sex, date of birth and family relationship will be stored for each family member.

Exercise 2

- A video club has decided to use a database to store information regarding the films it offers for rent. The information is as follows:
  - A film is characterized by its title, nationality, producer, date and role played by the main actors.
  - Several actors can participate in a movie (name, nationality, sex), some of them as main actors.
  - A film is directed by a director (name, nationality).
  - Each film has one or several copies identified by a copy number and characterized by their state of preservation.
  - A copy can be found rented to a client (ID, name, address, telephone). We want to store the rental start date and the return date.
  - A client has to be endorsed by another client who responds to him in case of problems in the rental.

Exercise 3

- Design a database with a schema that captures all the information that art galleries need to maintain.
  - Galleries keep information about artists, their names (which are unique), birthplaces, age, and style of art.
  - For each piece of artwork, the artist, the year it was made, its unique title, its type of art (e.g., painting, lithograph, sculpture, photograph), and its price must be stored. Pieces of artwork are also classified into groups of various kinds, for example, portraits, still lifes, works by Picasso, or works of the 19th century; a given piece may belong to more than one group. Each group is identified by a name (like those just given) that describes the group.
  - Finally, galleries keep information about customers. For each customer, galleries keep that person's unique name, address, total amount of dollars spent in the gallery (very important!), and the artists and groups of art that the customer tends to like. Draw the ER diagram for the database.