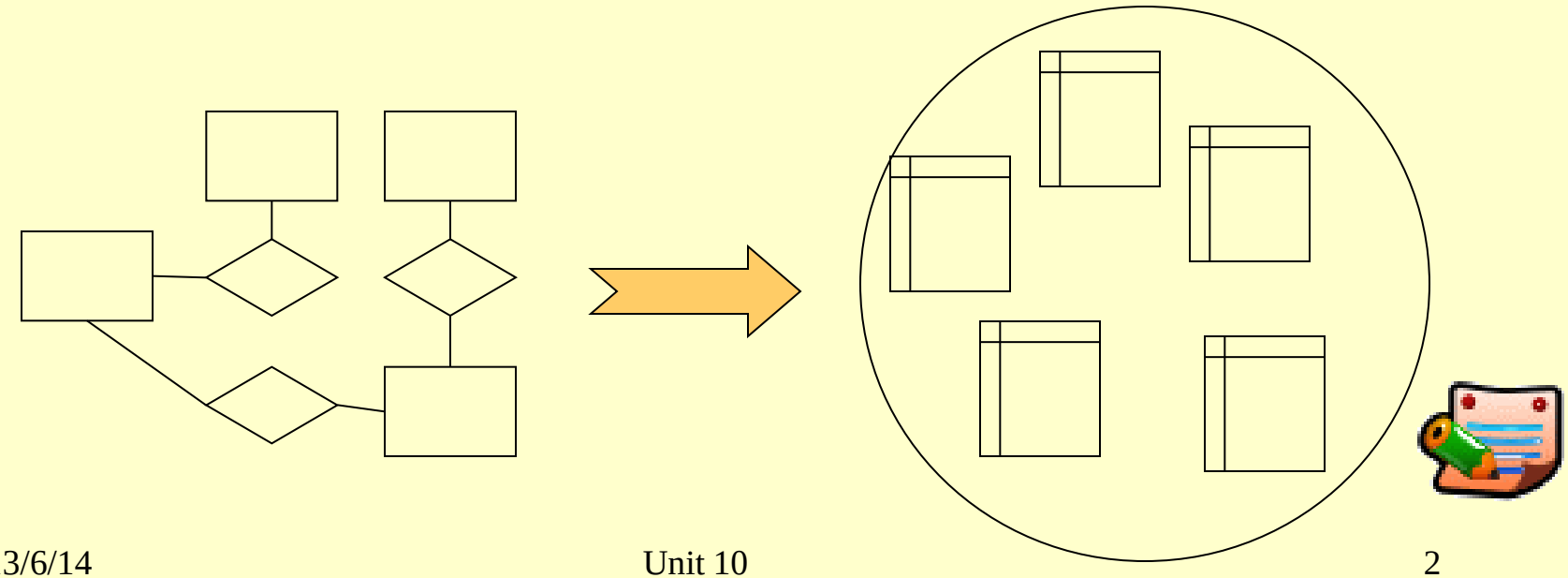
Unit 10

Logical Design for the Relational Model

本單元目的

把 model independent design 結果的資料庫概念架構轉為關聯資料庫管理系統可以描述的關聯資料庫

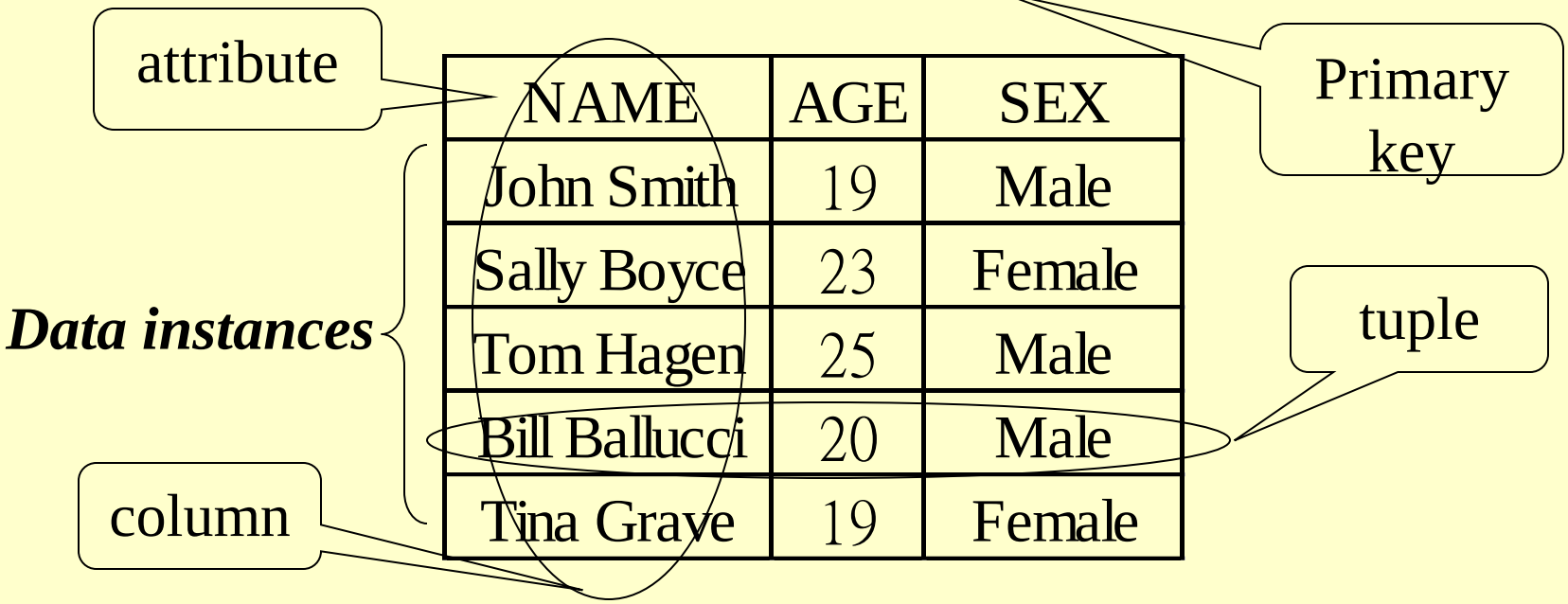


Outlines

- An Introduction to the Relational Model
- Schema Mapping from the ER model to the Relational Model
  - Elimination of external identifier
  - Elimination of composite and multi-value attributes
  - Translation of entities
  - Translation of relationships
  - Mapping the operations to SQL

The Relational Model

✶ ***Schema*** : STUDENT(NAME, AGE, SEX)



- ***Degree*** of a relation means the number of columns.
- ***Cardinality*** of a relation means the number of tuples.

Mathematical definition for a relation

★ A ***domain*** is a collection of values.

$D_1 = \{a, b\}$ attribute A_1 valued from D_1

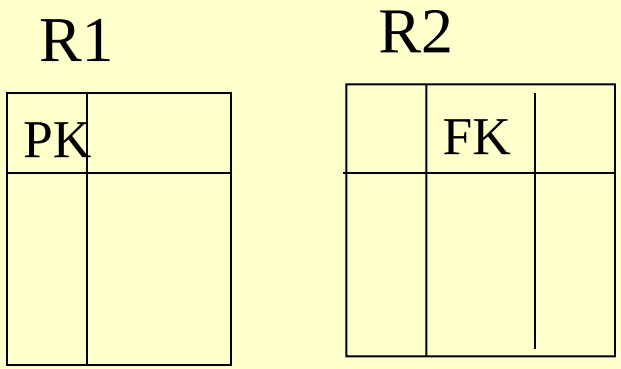
$D_2 = \{c, d, e\}$ attribute A_2 valued from D_2

$$R(A_1, A_2) = D_1 \times D_2$$
$$= \{(a,c),(a,d),(a,e),(b,c),(b,c),(b,d),(b,e)\}$$

Relation R

A1	A2
a	c
a	d
a	e
b	c
b	d
b	e

Integrity rules



- Entity integrity
  - No attribute participate in the primary key (PK) of a base relation is allowed to accept null values.
- Referential integrity
  - If base relation R2 includes a foreign key (FK) matching the PK of some base relation R1, then every values of FK in R2 must either
    - be equal to the value of PK in some tuple of R1 or
    - be wholly null
  - R1 and R2 are not necessarily distinct.

Example of a relational data base

EXAM

COURSE_NUMBER	STUCENT_NAME	GRADE
CS347	John sSmith	A+
CS347	Sally Boyce	B-
CS311	Tom Hagen	A
CS144	John Smith	B+
CS144	Sally Boyce	A-

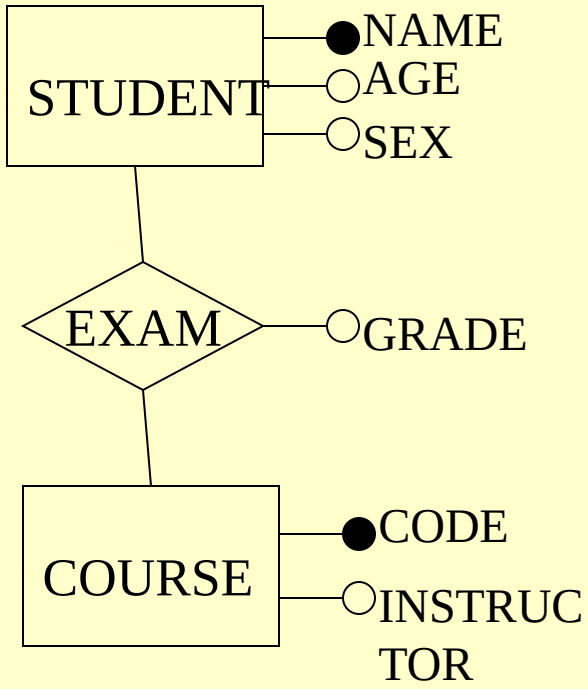
STUDENT

NAME	AGE	SEX
John Smith	19	Male
Sally Boyce	23	Female
Tom Hagen	25	Male
Bill Ballucci	20	Male

COURSE

CODE	INSTRUCTOR
CS347	Ceri
CS311	Batini
CS144	Navathe

CODE 和 COURSE_NUMBER 從同一個 domain 出來
STUDENT_NAME 和 NAME從同一個 domain 出來



EXAM(COURSE_NUMBER, STUDENT_NAME, GRADE)
STUDENT(NAME, AGE, SEX)
COURSE(CODE, INSTRUCTOR)

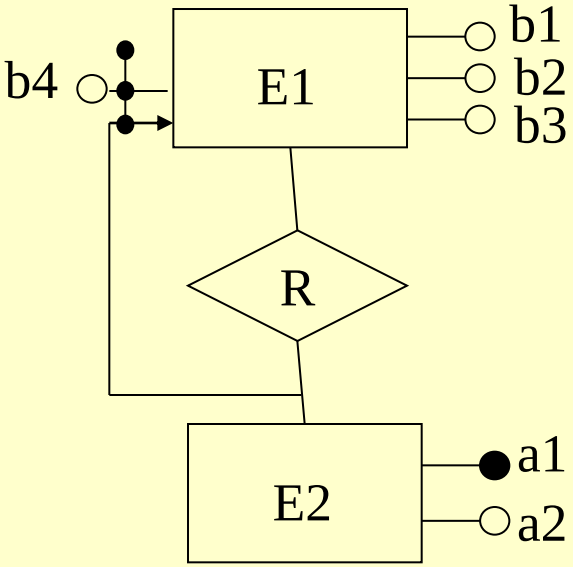
Schema Mapping from the ER model to the Relational Model

Steps:

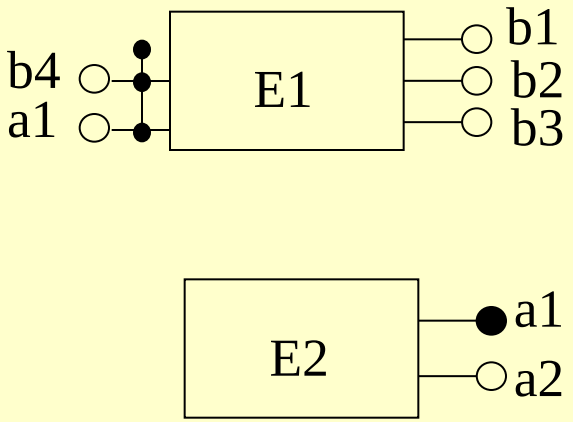
1. Elimination of external identifier
2. Elimination of composite and multi-value attributes
3. Translation of entities
4. Translation of relationships
5. Mapping the operations to SQL

Elimination of external identifier

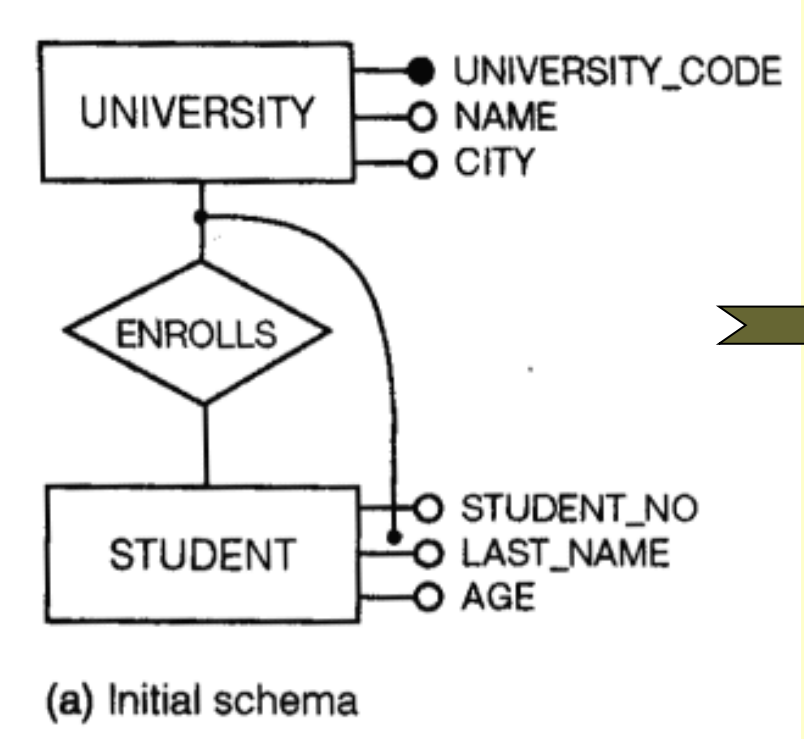
* E2 有 internal identifier
* E1 的 primary key 是由一個屬於 E1 的 attribute 加上 E2 形成 identifier, 是為 external identifier.

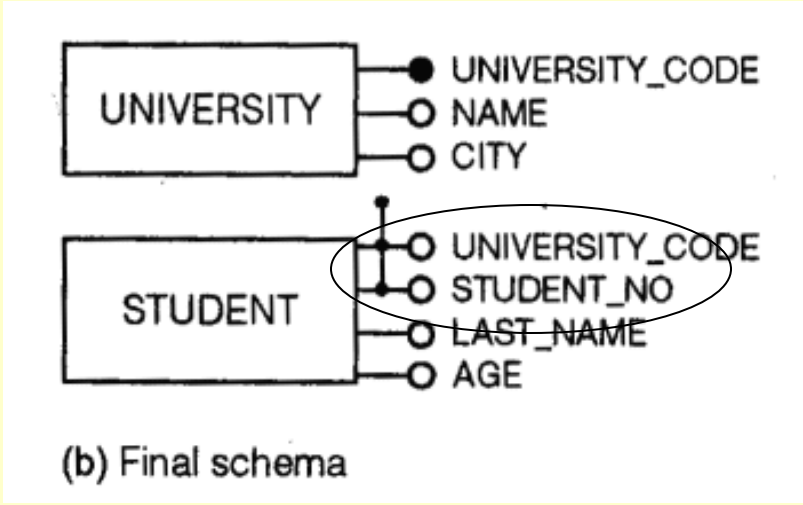


- 把 E2的 primary key 放入 E1
- 把 R 去掉, 因為 R 的關係已在 E1 中表示了



Elimination of external identifier

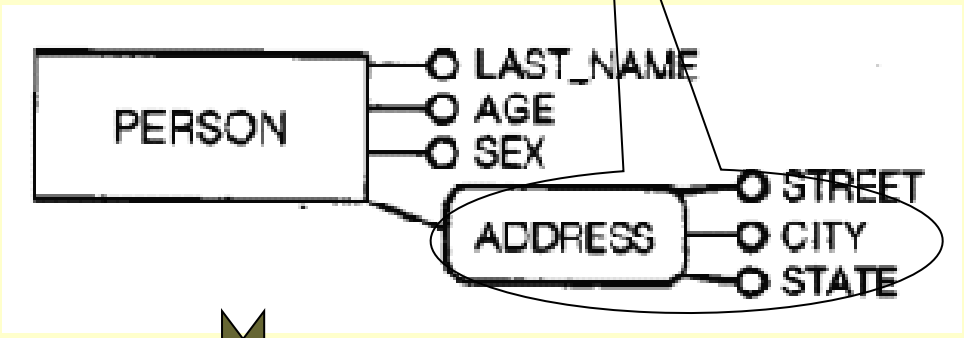




📣 去掉 external id 的動作要從 strong entity 動手, 把依附在該 strong entity 的 weak entity 放入該 strong entity 的 primary.

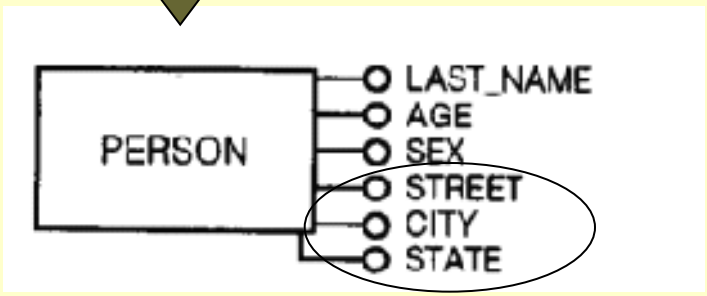
Elimination of composite attribute

(復合屬性)

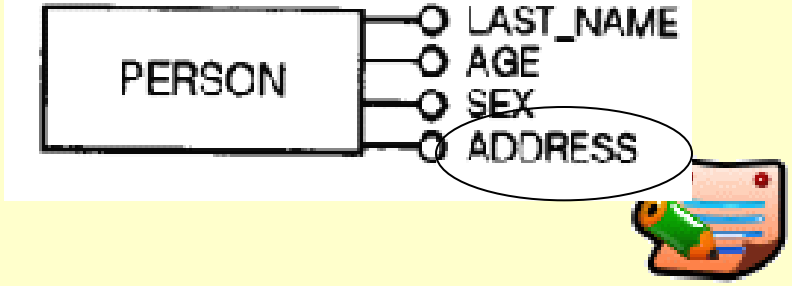


合併好
還是拆開好?

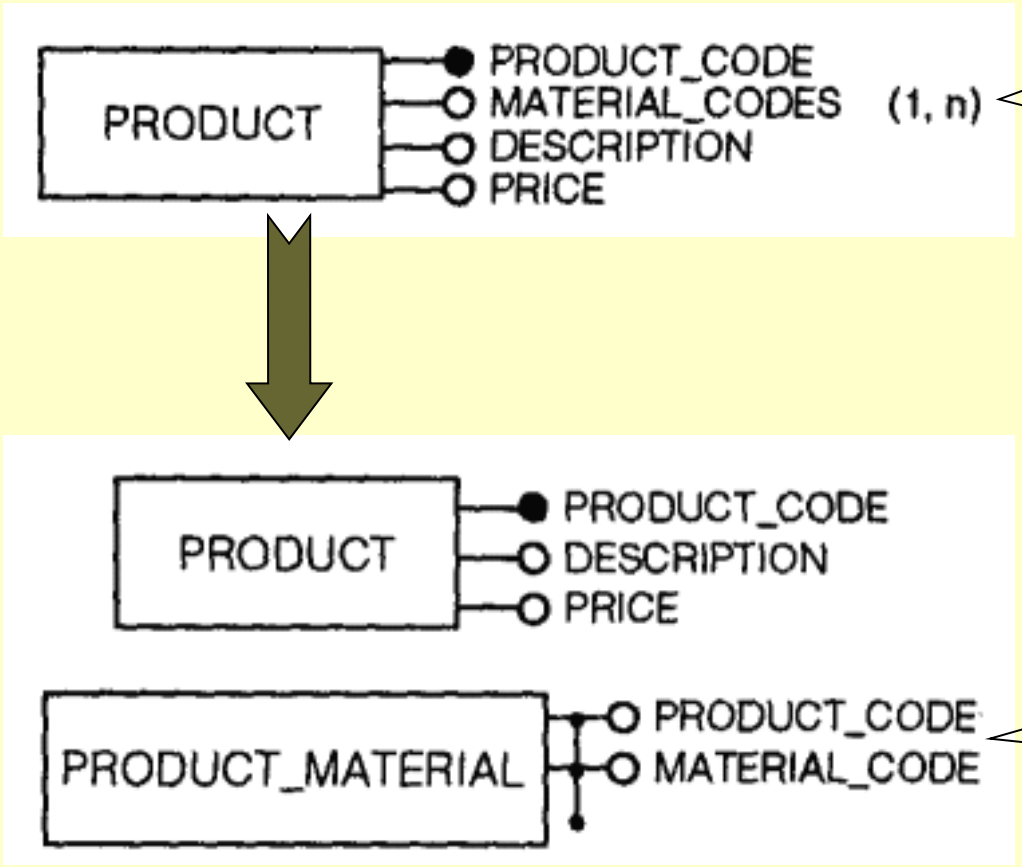
拆開



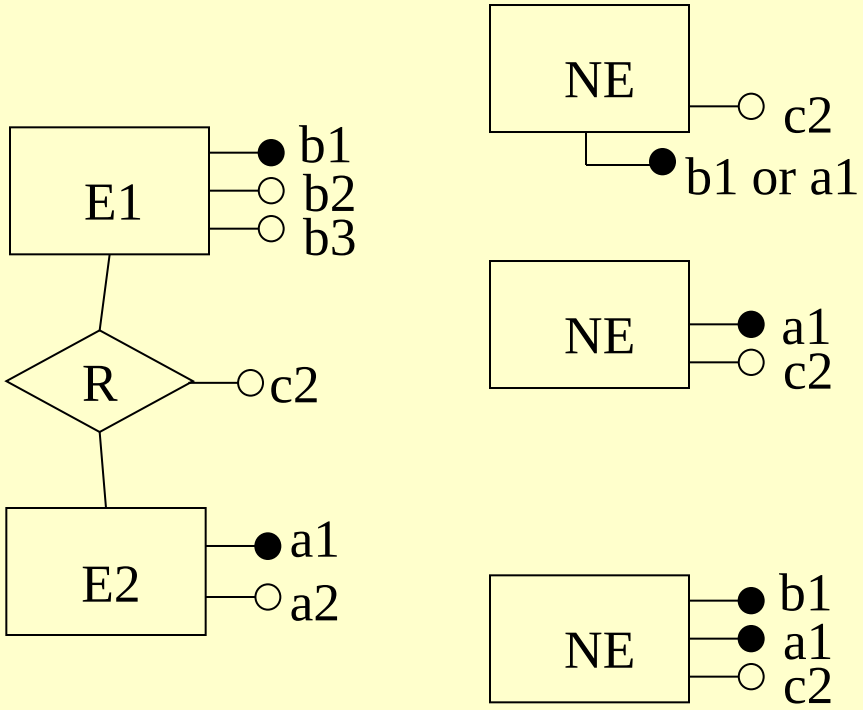
合併



Elimination of multi-value attributes

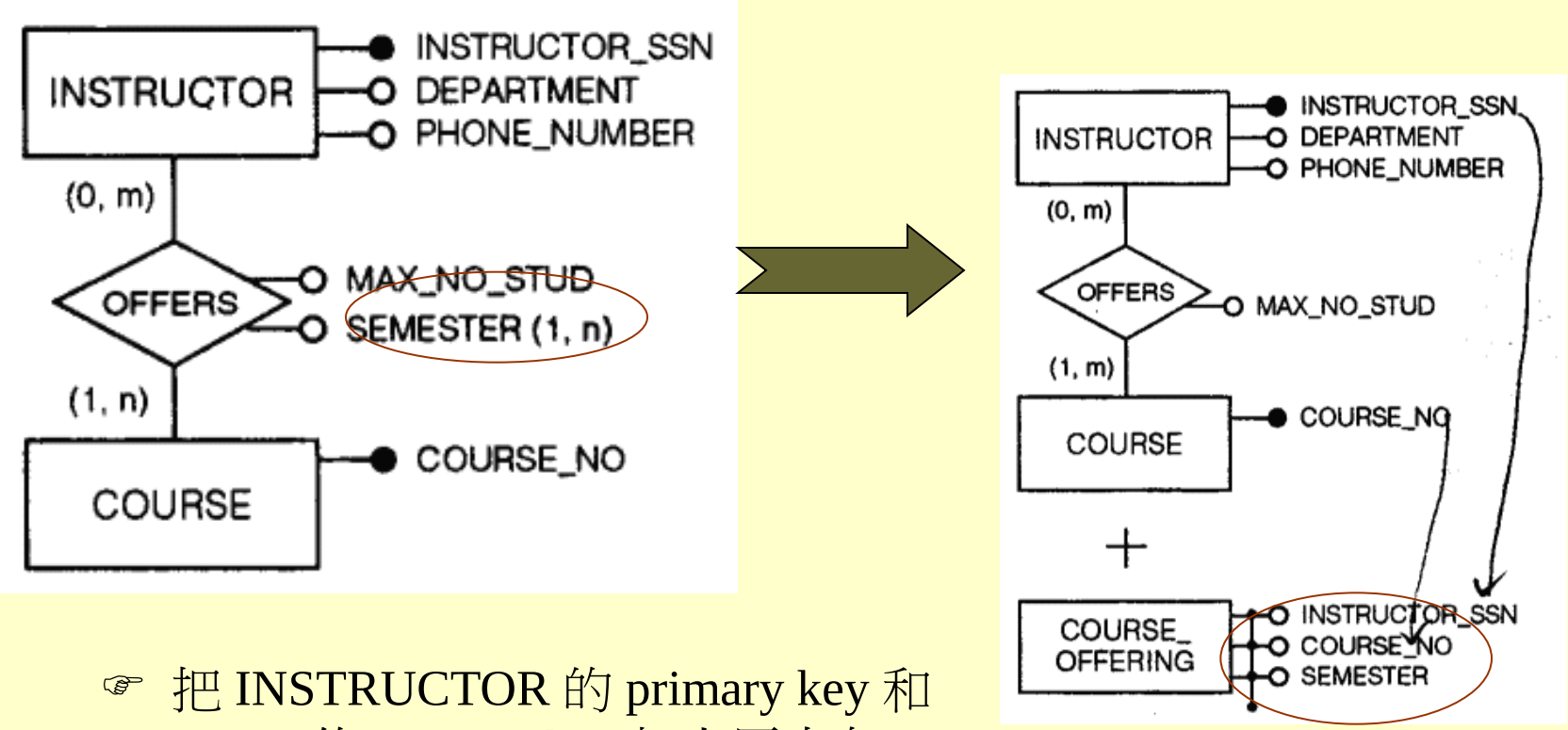


Elimination of multi-value attribute from a relationship by creating a separate entity



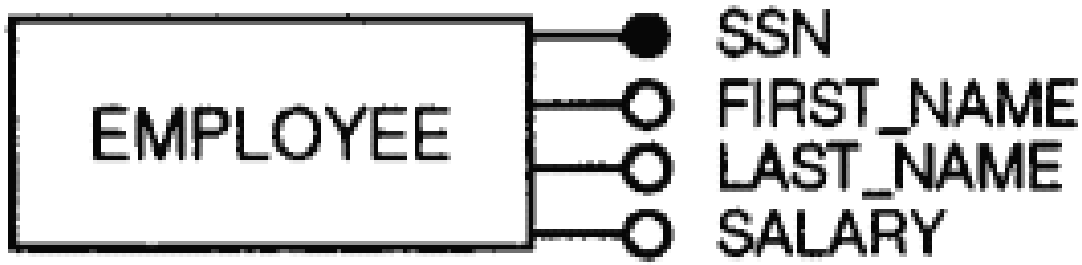
1. If the relationship is one-to-one, NE includes the primary key of either E1 or E2.
2. If the relationship between E1 and E2 is one-to-many, NE includes the primary key of E2 (assuming E2 is on the "many" side).
3. If the relationship between E1. and E2, is many-to-many, NE includes the primary keys of both E1 and E2.

Example of multi-value attribute on a relationship



☞ 把 INSTRUCTOR 的 primary key 和 COURSE 的 primary key 加上原來在 Relationship 上的多重值 attribute 形成另一個 entity.

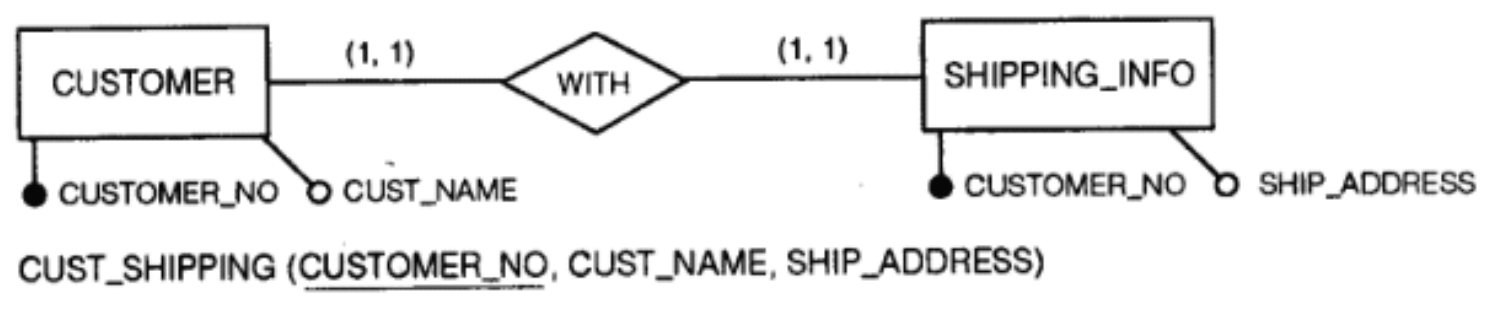
Translation of an entity



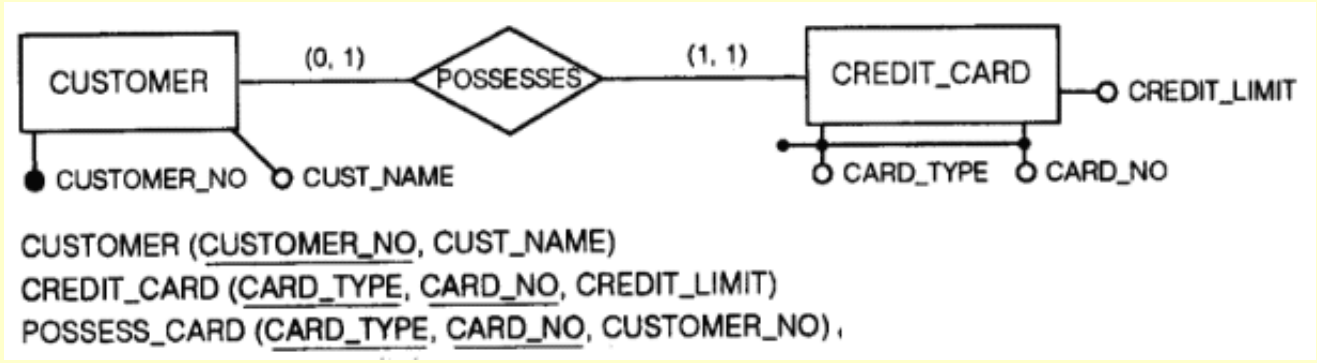
EMPLOYEE (SSN, FIRST_NAME, LAST_NAME, SALARY)

Translation of one-to-one relationships

Case 1: 當 relationship 兩邊的cardinality 都是 (1,1)時, 則合併為一個 relation.

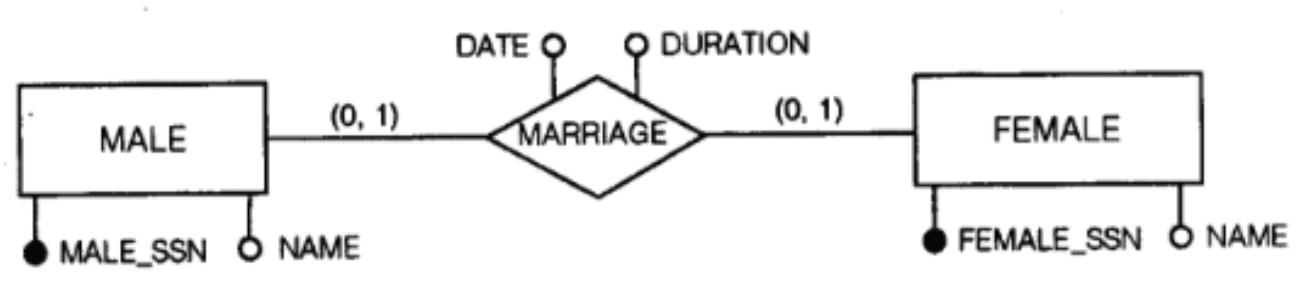


Case 2: 當 cardinality 顯示有一 entity在relationship 發生的情況是 partial 時, 則宜獨立另一 relation.



Translation of one-to-one relationships

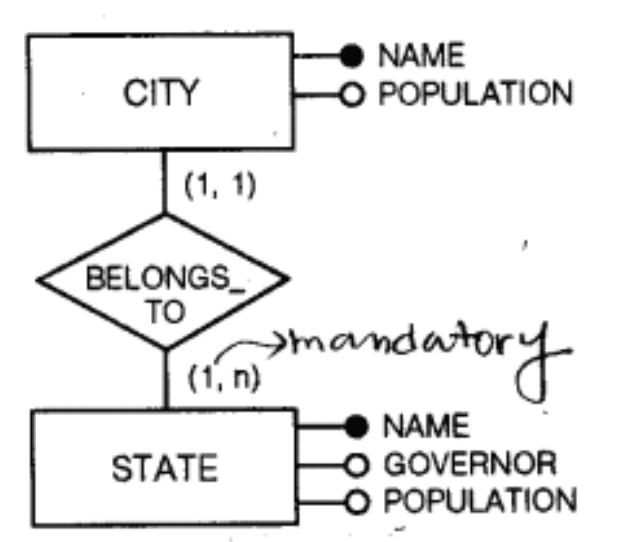
Case 3: 當兩邊 cardinality 發生的情況是皆 partial 時, 則宜獨立另一 relation, 用兩邊相連 entities 之 primary key attribute 加起來當作新成立的 relation primary key.



MALE (MALE_SSN, NAME)
FEMALE (FEMALE_SSN, NAME)
MARRIAGE (MALE_SSN, FEMALE_SSN, DATE, DURATION)

Translation of one-to-many relationships

Case 1: Total participation

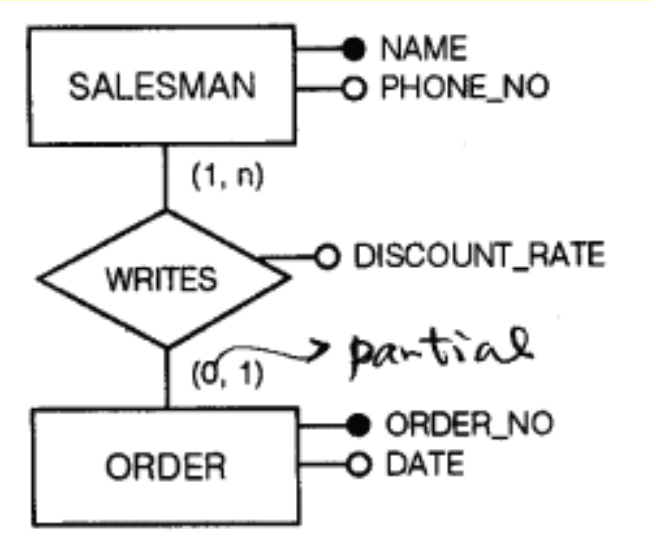


☞ 把 one 那端的 primary key 加入 many 那端的 entity 中

CITY(CITY_NAME, STATE_NAME, POPULATION)
STATE(STATE_NAME, GOVERNOR, POPULATION)

Translation of one-to-many relationships

Case 2: Partial participation

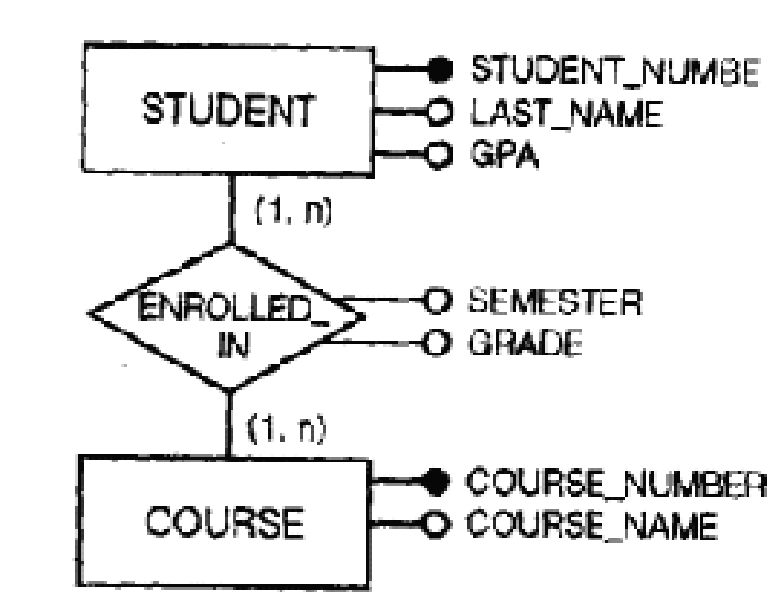


☞ 因為 ORDER的建立若和 SALEMAN有關連，則可有 DISCOUNT_RATE, 亦可能和 SALESMAN無關連。

Alternative 1:
SALESMAN(NAME, PHONE_NO)
ORDER(ORDER_NO, DATE,
SALESMAN_NAME,
DISCOUNT_RATE)

Alternative 2:
SALESMAN(NAME, PHONE_NO)
ORDER(ORDER_NO, DATE)
SALES_ORDER(ORDER_NO, SALESMAN_NAME, DISCOUNT_RATE)

Translation of many-to-many relationships

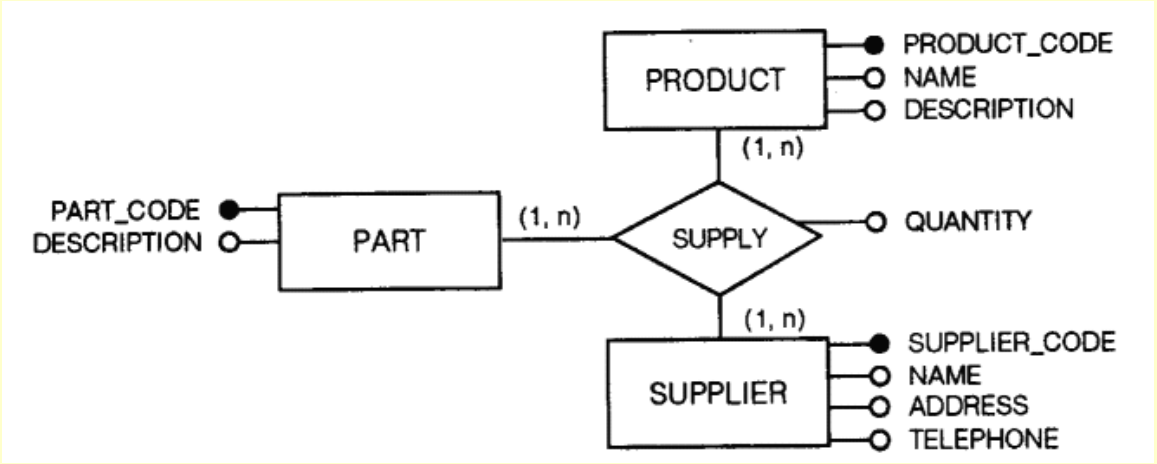


☞ 把STUDENT的 primary key
加上 COURSE的 primary key
加上 ENROLLED_IN 的 attributes
形成另一個 entity

STUDENT(STUDENT_NUMBER, LAST_NAME, GPA)
COURSE(COURSE_NUMBER, COURSE_NAME)
ENROLLED_IN(STUDENT_NUMBER, COURSE_NUMBER,
SEMESTER, GRADE)

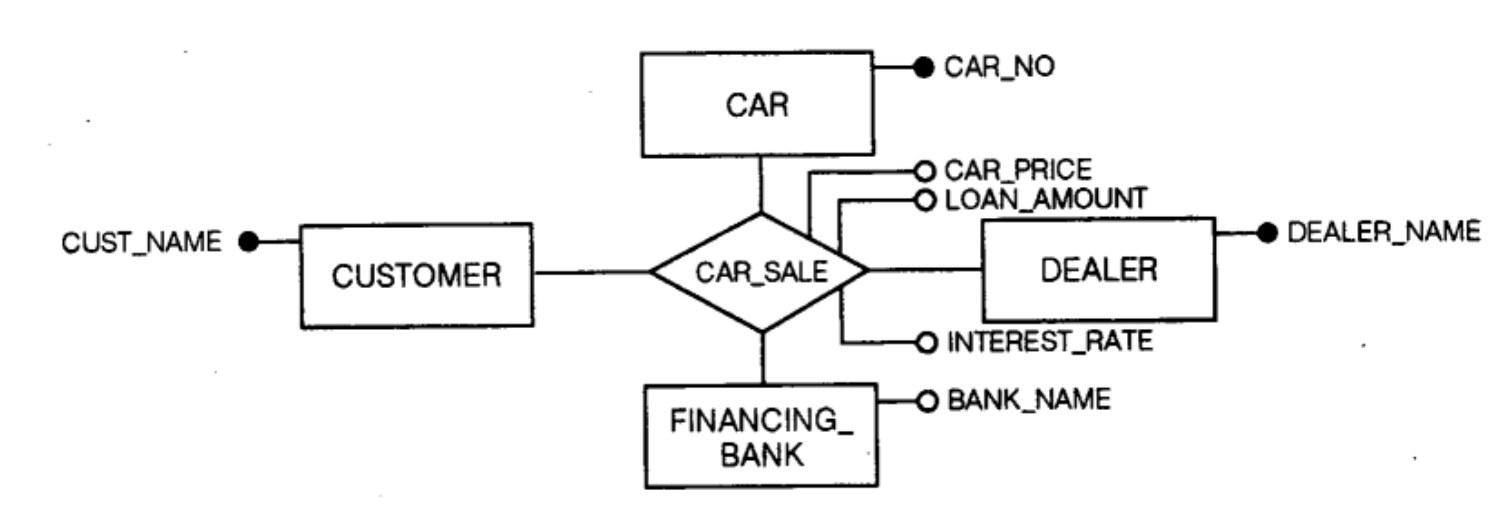
Translation of ternary relationships
(三元關係)

☞ 把三個 entity 的 primary key 加上 relationship 的 attributes 形成另一個 entity



PRODUCT (PRODUCT_CODE, NAME, DESCRIPTION)
PART (PART_CODE, DESCRIPTION)
SUPPLIER (SUPPLIER_CODE, NAME, ADDRESS, TELEPHONE)
SUPPLY (PRODUCT_CODE, PART_CODE, SUPPLIER_CODE, QUANTITY)

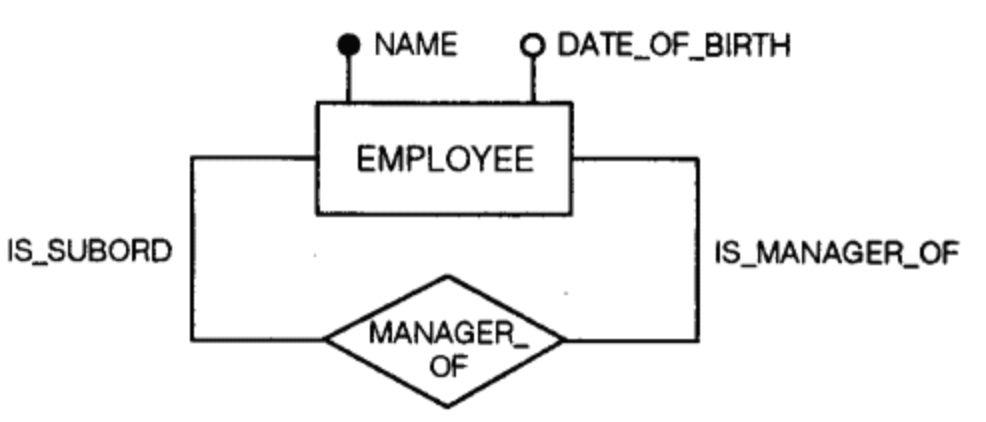
Translation of quaternary relationships
(四元關係)



CAR_SALE(CAR_NO, CUST_NAME, DEALER_NAME, BANK_NAME, CAR_PRICE, LOAN_AMOUNT, INTEREST_RATE)

☞ 新建的 relation 要取 minimal primary key set
例如: 若 CAR_NO →CUST_NAME 則 CUST_NAME 可以不在 primary key set 中

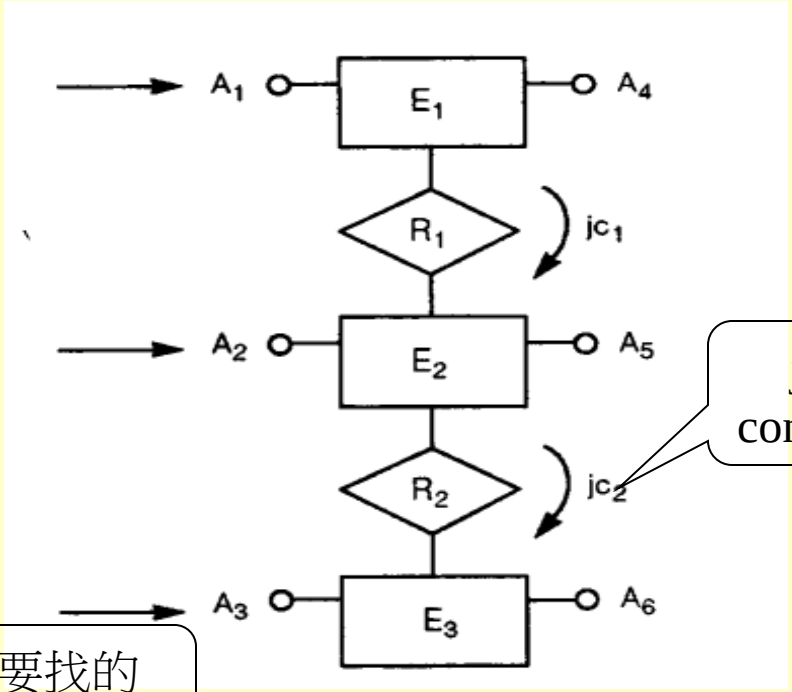
Translation of recursive relationships
(遞迴關係)



Many-to-many relationship:
EMPLOYEE(NAME, DATE_OF_BIRTH)
MANAGER_OF(NAME_OF_MANAGER, NAME_OF_SUBORDIINATE)

One-to many relationship:
EMPLOYEE(NAME, DATE_OF_BIRTH)
MANAGER_OF(NAME_OF_SUBORDINATE, NAME_OF_MANAGER)
or
EMPLOYEE(NAME, DATE_OF_BIRTH, NAME_OF_MANAGER)

Mapping the operations to SQL



join condition

要找的 attributes

經過的 entity

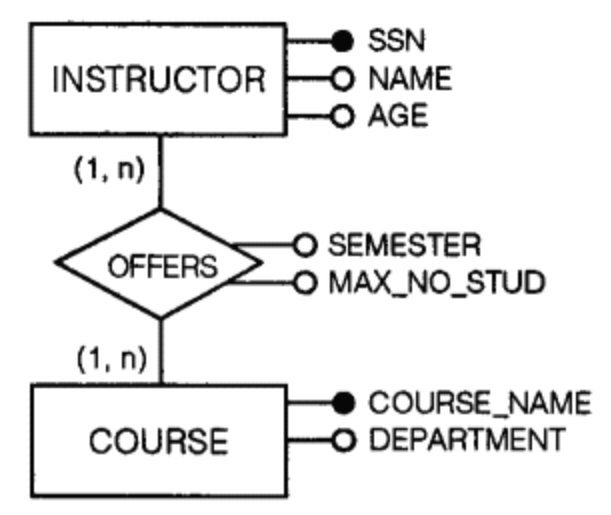
```
SELECT A4, A5, A6
FROM   E1, E2, E3
WHERE jc1 and jc2 and COND(A1,A2,A3)
```

條件

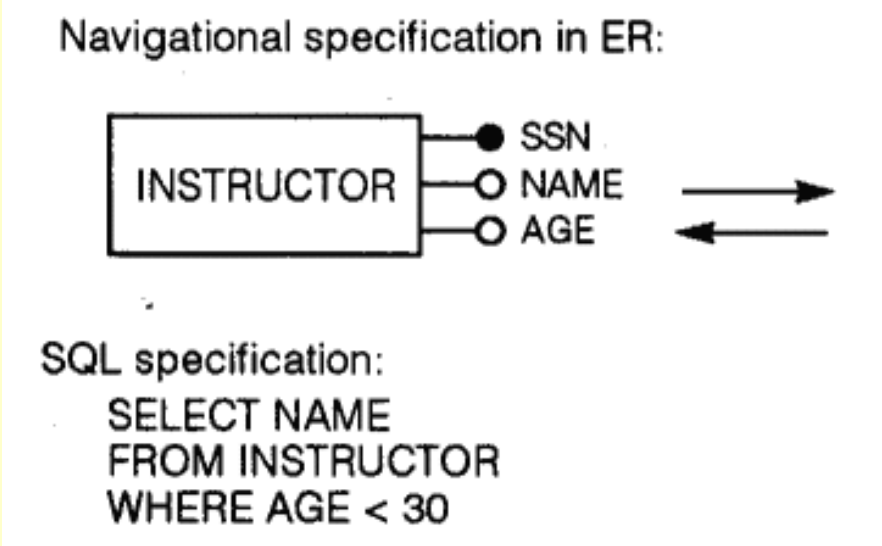
- 找單一entity資料時, FROM 單一entity_name
- 透過另一 entity 時, 經過的 entity name 出現在 FROM 後面
- 條件出現在 WHERE子句
- GROUP BY and HAVING 子句在 navigation schema 看不出, 要在 SQL 加入.

Example of translating navigation schema to SQL

ER schema :



Q1: 找出年齡小於 30 的 instructors



Relation schema:

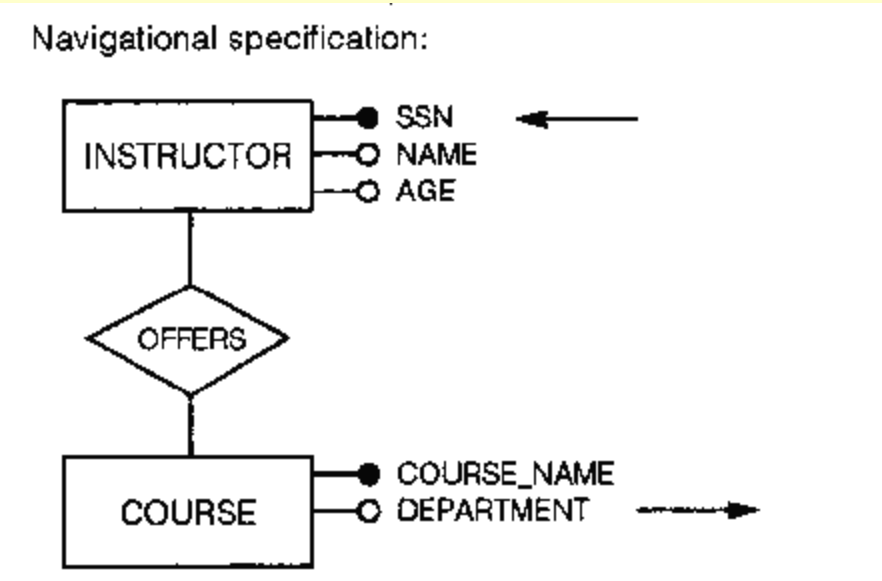
INSTRUCTOR(SSN, NAME, AGE)

OFFERS(SSN, COURSE_NAME, SEMESTER, MAX_NO_STUD)

COURSE(COURSE_NAME, DEPARTMENT)

Example of translating navigation schema to SQL

Q2: 給某老師的 SSN, 找出他所開的課程所屬的 department.



Alternative 1:

```
SELECT DEPARTMENT
FROM COURSE
WHERE COURSE_NAME IN
    SELECT COURSE_NAME
    FROM OFFERS
    WHERE SSN=$X
```

Alternative 2:

```
SELECT DEPARTMENT
FROM COURSE, OFFERS
WHERE COURSE, COURSE_NAME =OFFERS.COURSE_NAME AND SSN=$X
```

Exercises

1. Consider the following ER diagram of a database for a city's traffic and parks departments. Draw navigational schemas in ER form for the following queries:

(1) List all street names in a given city.

(2) List all intersections on Main street in the city of Gainesville, Georgia.

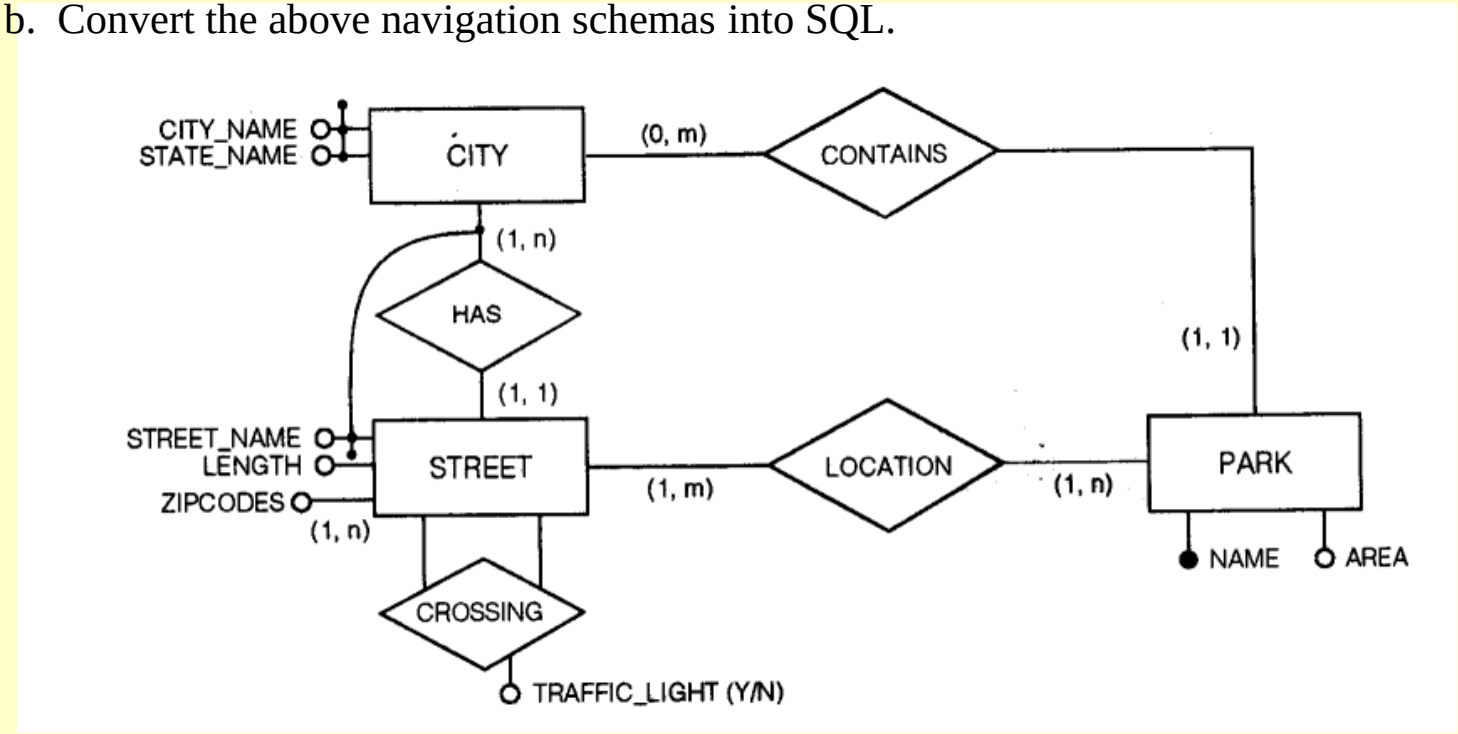
(3) List all parks in the city of Gainesville, Florida.

(4) List all parks located on Huron Street in Ann Arbor, Michigan.

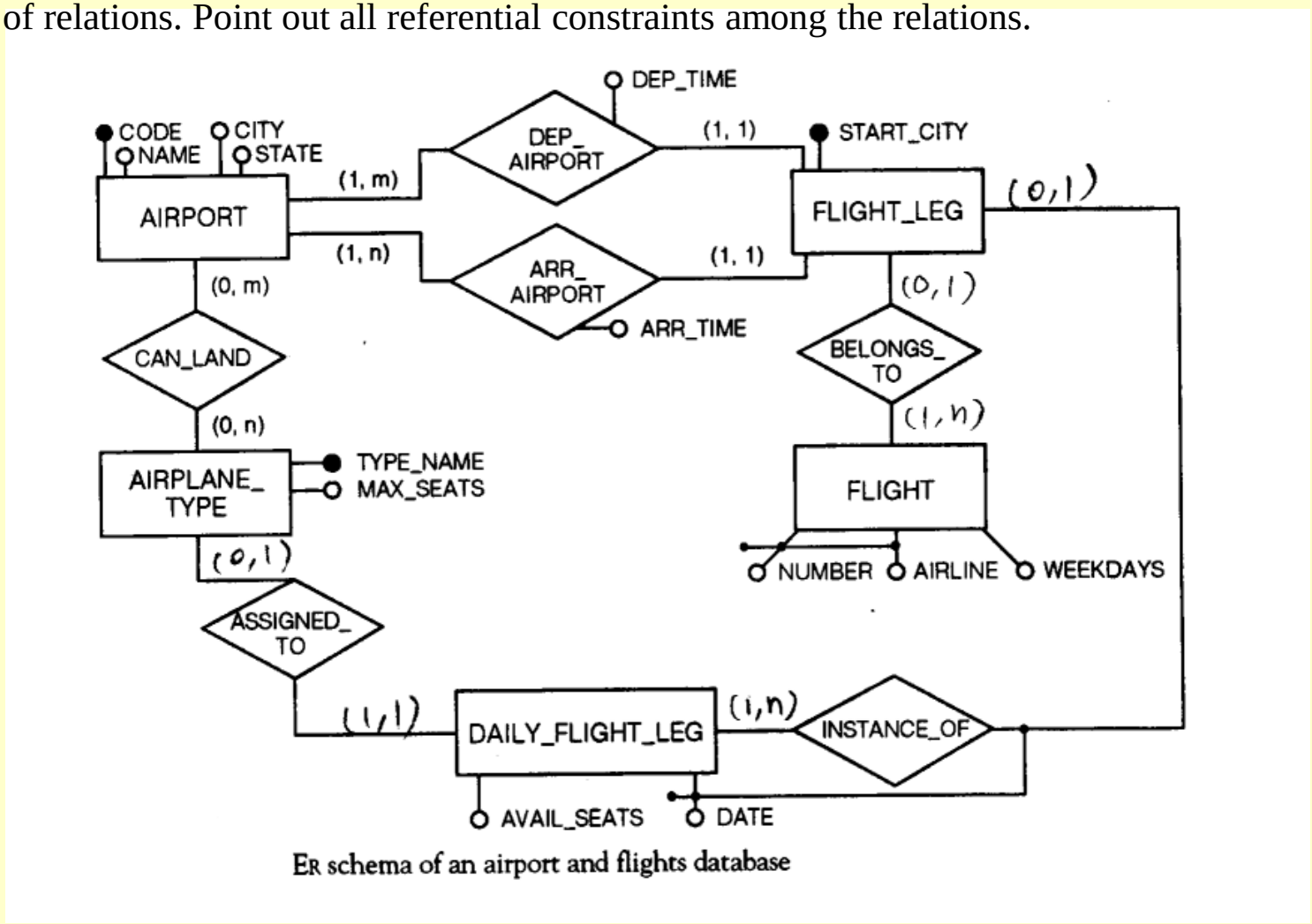
Proceed as follows:

a. First convert the ER model to a relational database.

b. Convert the above navigation schemas into SQL.



2. Consider the following ER schema of the airport and flights database. Convert it into a set of relations. Point out all referential constraints among the relations.



ER schema of an airport and flights database