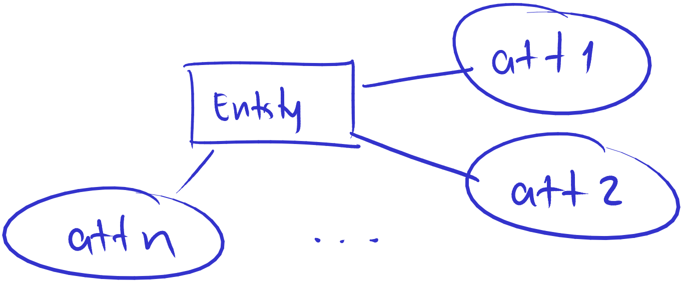
High Level Database Models
Chapter 4

Entity / Relationship Model (E/R)

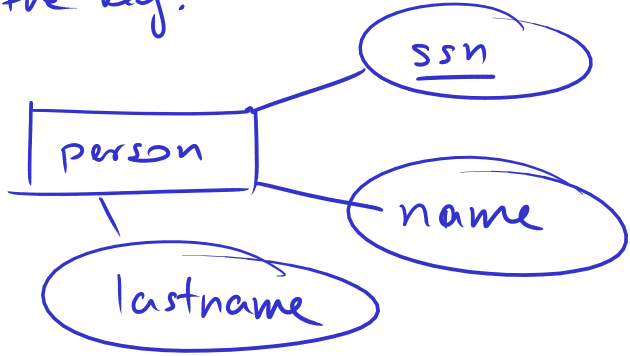
2 parts

1) Entity.

An entity has at least one attribute

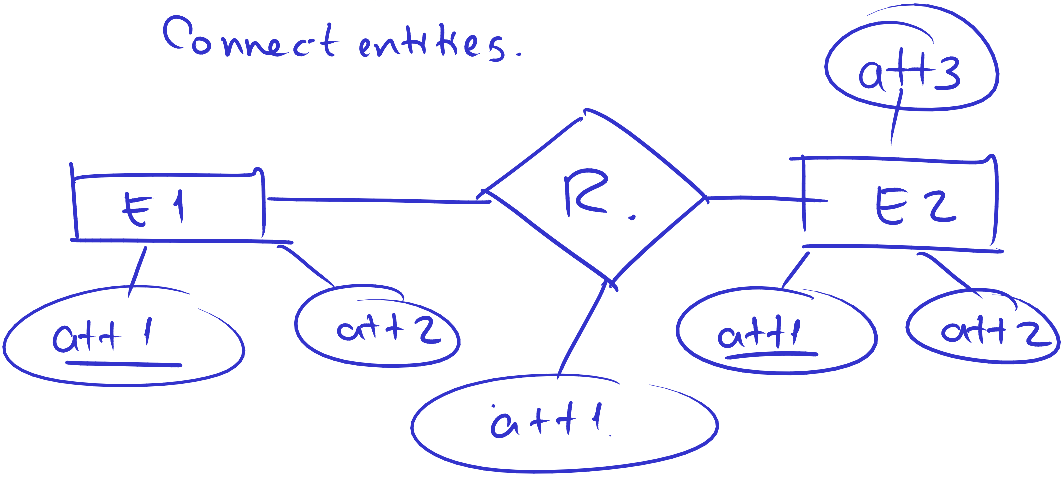


Underscore attributes that are part of the key:



2) Relationships

Connect entities.

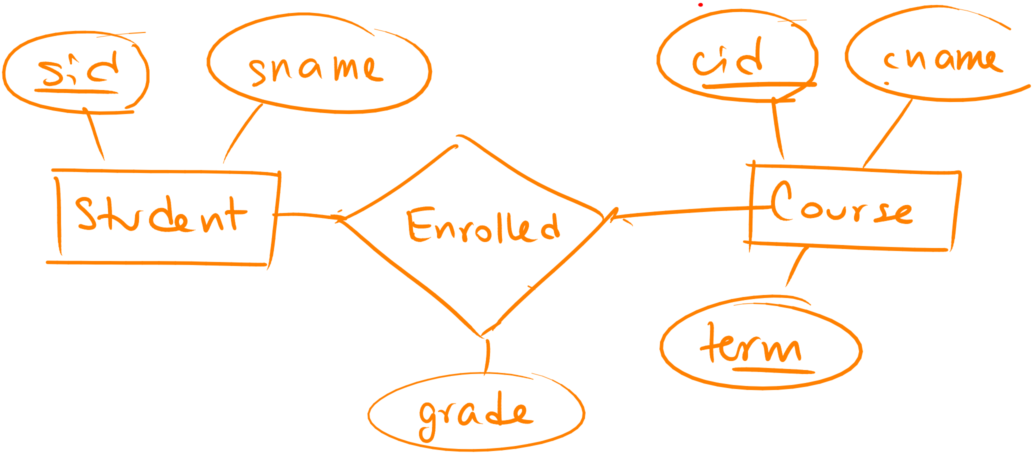


Relationships can have attributes.

Ex: Students enrolled in courses

Relationship

entities



One entity relates to any number of entities via a relationship.

Both entities and relations become each a SQL relation.

- Entities are simply SQL relations

Ex:

```
CREATE TABLE Student (
    sid  CHAR(10),
    sname  VARCHAR
    PRIMARY KEY (sid)
);

CREATE TABLE Course (
    cid  CHAR(10),
    cname  VARCHAR,
    term  char(3)
    PRIMARY KEY (cid, term)
);
```

Relationships

Their attributes are

- the Primary keys of its participating relations
- their own attributes

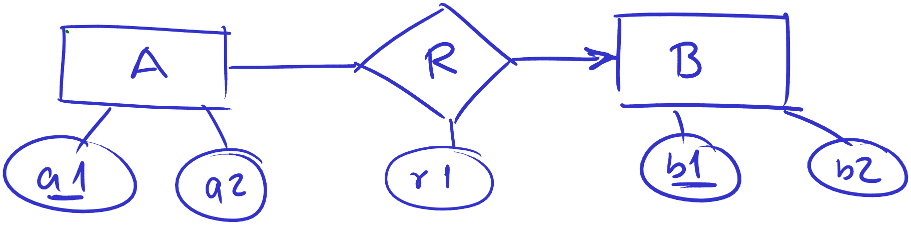
Their primary key is the attributes in the PKs of the participating relations.

```
CREATE TABLE Enrolled (
    sid   CHAR(10),
    cid   CHAR(10),
    term  CHAR(3),
    grade INTEGER,
    PRIMARY KEY (sid, cid, term),
    FOREIGN KEY (sid) REFERENCES
        students,
    FOREING KEY (cid, term) REFERENCES
        Courses
);
```

FOREIGN KEY constraint guarantees that we only keep in Enrolled students and courses that exist (More on that later)

Participation Constraints (4.1.6)

An entity relates to 0 ~~or~~ 1 entity



In this example R(a1, a2, r1)

Arrow in diagram implies a1 → a2, r1

In SQL   Assume attr are integer.

```
CREATE TABLE R(
    a1 integer,
    b1 integer NOT NULL,        must not be empty.
    r1 integer,
    PRIMARY KEY (a1)
    FOREIGN KEY(a1) REFERENCES A,
    FOREIGN KEY(b1) REFERENCES B
);
```

$A(a1, a2) \quad a1 \to a2$

$R(a1, b1, r1) \quad a1 \to b1, r1$

Hence we can combine A and R

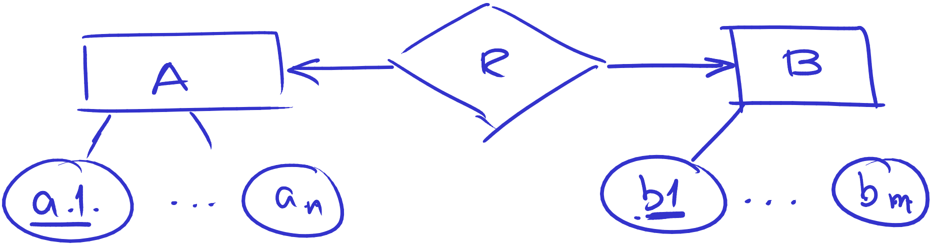
$AR(a1, a2, b1, r1) \quad a1 \to a2, b1, r1$

Instead of 2 relations we create one

```
CREATE TABLE AR(
    a1 integer,
    b1 integer,      can be NULL
    r1 integer,      (empty).
    PRIMARY KEY (a1),
    FOREIGN KEY(b1) REFERENCES B
);
```

Primary keys can <u>never</u> be NULL.

We can have:



It means R(a1, b1)

has FD a1 → b1, b1 → a1

Chose a PK (merge with that relation).

Say we choose A ;, so we create AR as above. This guarantees a1 → b1.

But what about b1 → a1?

b1 is a CK for A!!

Make b1 unique:

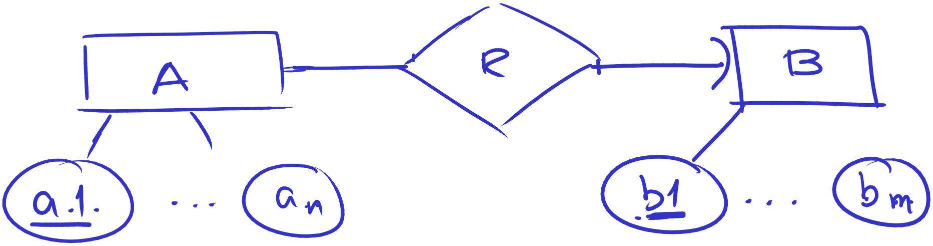
add to AR:

```
:
:
UNIQUE (b1)
:
:
```

or if Key of B is one attribute add it after its declaration:

```
:
:
b1 integer UNIQUE,
:
:
```

An entity relates to exactly <u>one</u> entity only



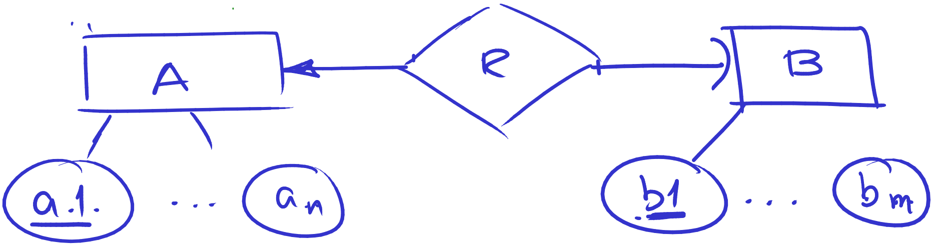
R(a1, b1) still a1 → b1

and ∀ value in a1 ∃ a corresponding value b1 (one tuple in B)

SQL: same schema as AR above, but b1 <u>can not</u> be NULL:

```
⋮
b1 integer NOT NULL
⋮
```

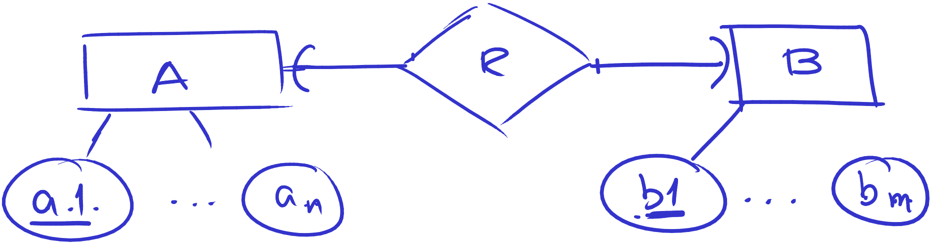
Some Combinations



$a1 \to b1 \quad b1 \to a1$

$\forall$ values of a1 $\Rightarrow \exists$ a value of b1.

Create AR, make key of B in AR unique and not NULL.



$a1 \to b1, \quad b1 \to a1$

$\forall$ value of a1 $\Rightarrow \exists$ value of b1

$\forall$ value of b1 $\Rightarrow \exists$ vale of a1

$$\Rightarrow |A| = |B|$$

tuples in A

tuples in B

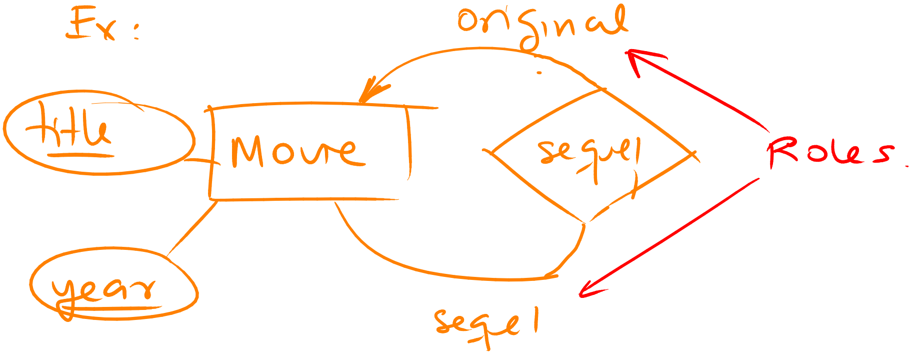
Make A, B and R one relation

key? a1 or b1, make the other unique, not null.

Roles

Sometimes an entity participates more than once in a relationship:

Ex:



sequeltitle, sequelYear →
orginal Title, orginal Year

The name of the role allows to identify each of the two entities involved in the relationship.

Useful to name attributes of relationship.