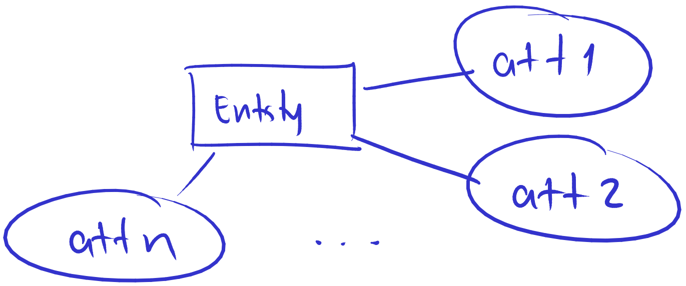
High Level Database Models
Chapter 4

Entity / Relationship Model (E/R)

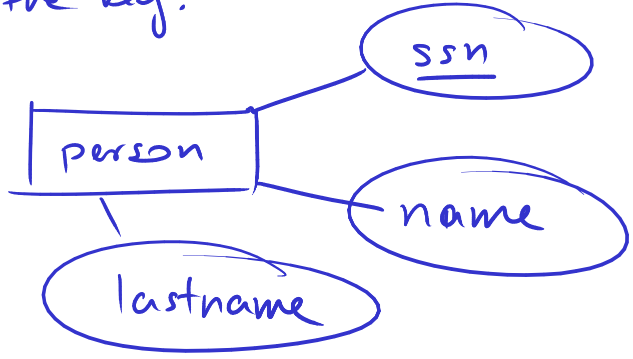
2 parts

1) Entity.

An entity has at least one attribute

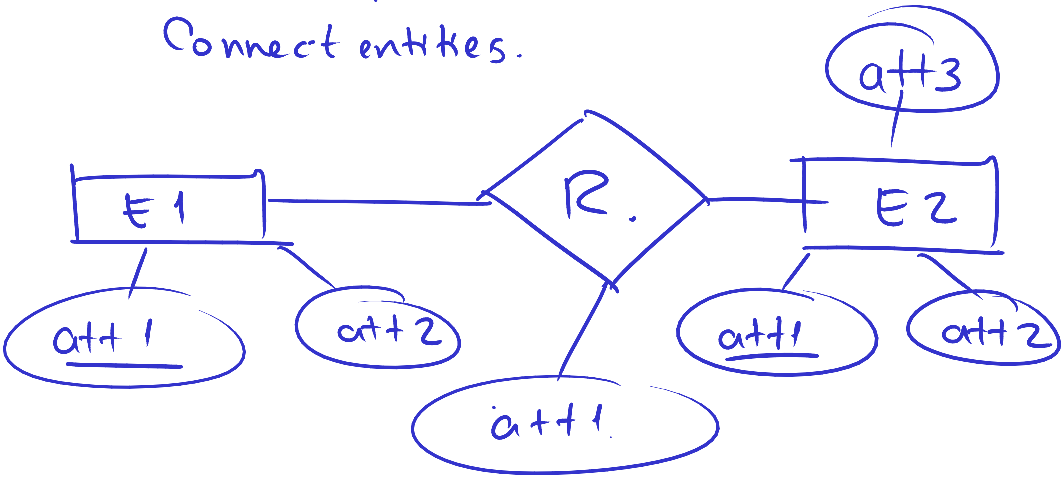


Underscore attributes that are part of the key:



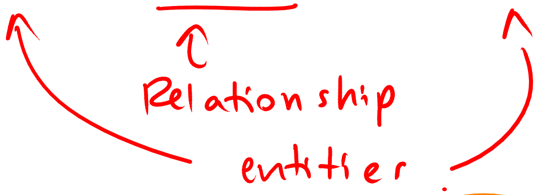
2) Relationships

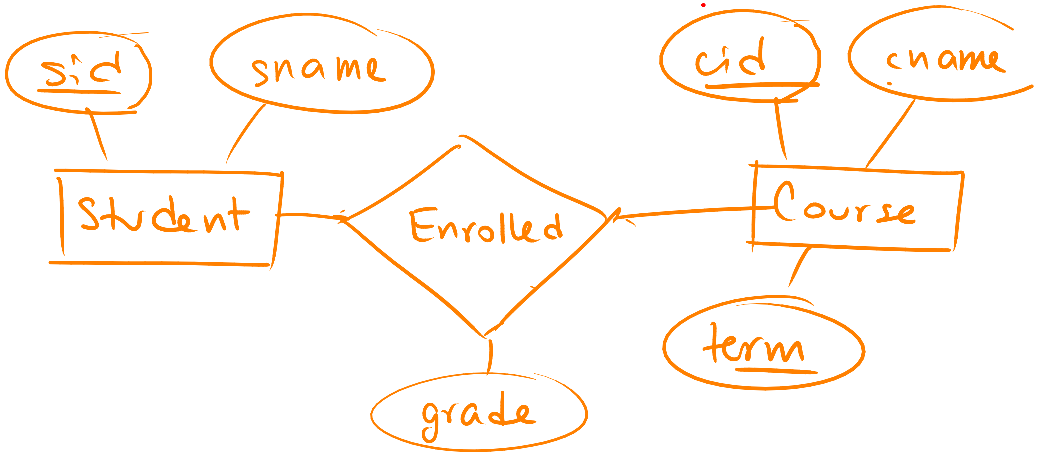
Connect entities.



Relationships can have attributes.

Ex! Students enrolled in courses





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)
);
```

<u>Relationships</u>

Their attributes are

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

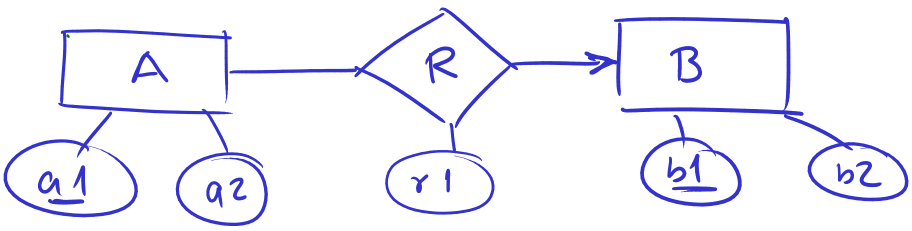
Their primary key is the attributes in the PKs of the participating relations.

```
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, b1, r1)

Arrow in diagram implies a1 → b1, 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

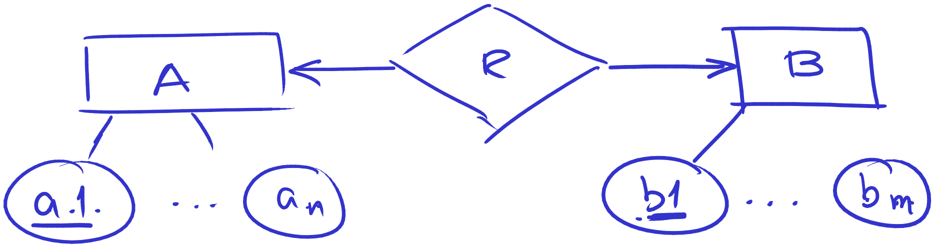
$AR(a1, a2, b1, r1) \quad a_1 \to a2, b1, r1$

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 also a CK for AR

Make b1 unique:

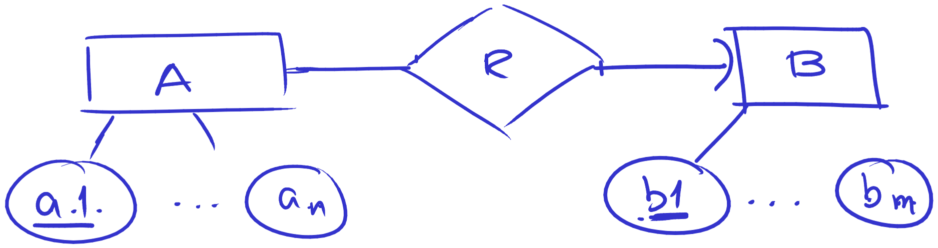
add to AR:

```
⋮
UNIQUE (b1)
⋮
```

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

```
⋮
b1  integer UNIQUE,
⋮
```

An entity relates to exactly one entity only



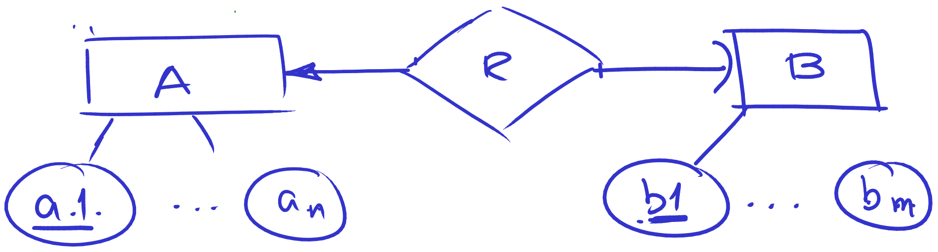
R(a1, b1) still a1 → b1

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

SQL: same schema as AR above, but b1 can not be NULL:

```
⋮
b1  integer NOT NULL
⋮
```

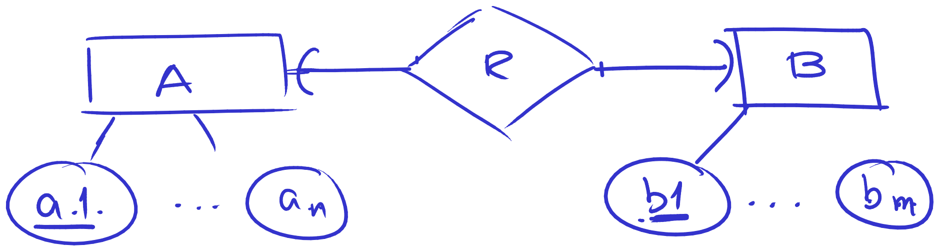
Some Combinations



$a1 \rightarrow b1 \quad b1 \rightarrow a1$

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

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



$a1 \rightarrow b1, \quad b1 \rightarrow a1$

$\forall$ 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

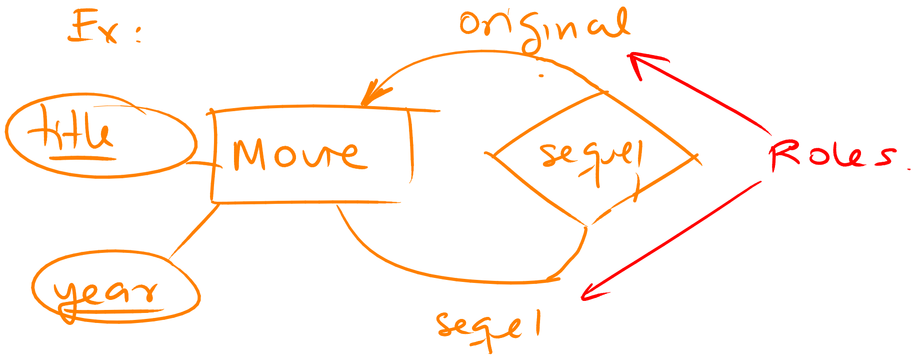
Make A, B and R one relation

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

Roles

Sometimes an entity participates more than once in a relationship:

Ex:



sequeltitle, sequelYear →

original Title, original Year

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

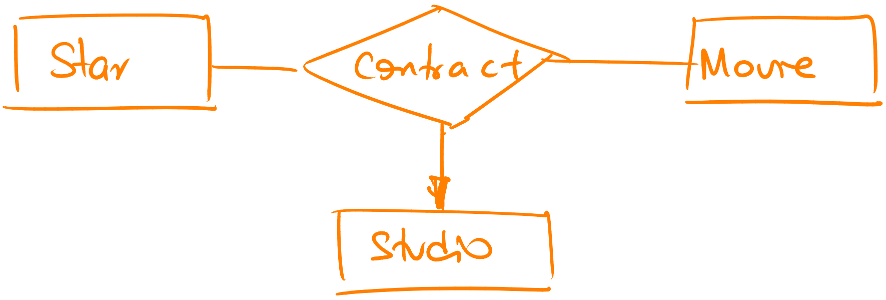
Useful to name attributes of relationship.

Multi way relationships

- Relationships can have 2 or more participating entities.
- Same type of participating constraints as with binary relationships.
- PK of relationship is the union of PKs of participating entities.

Ex: Ternary

A star has a contract with a studio to work on a movie.

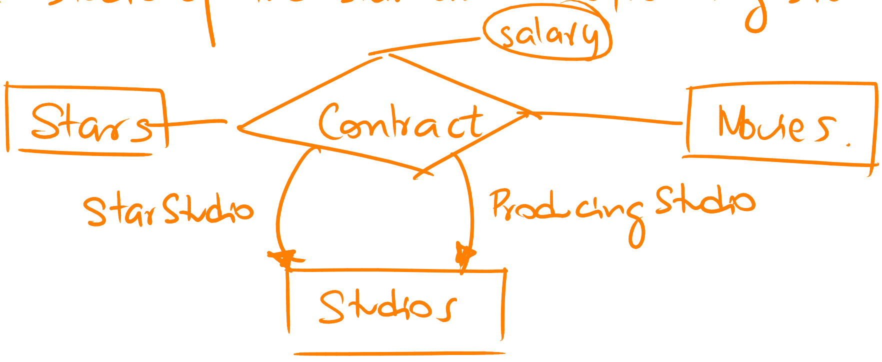


Star, Movie $\rightarrow$ Studio

(Not showing attributes of entities for simplicity).

Ex. 2 :

Stars work on a movie, but now there is a studio of the star and the producing studio.

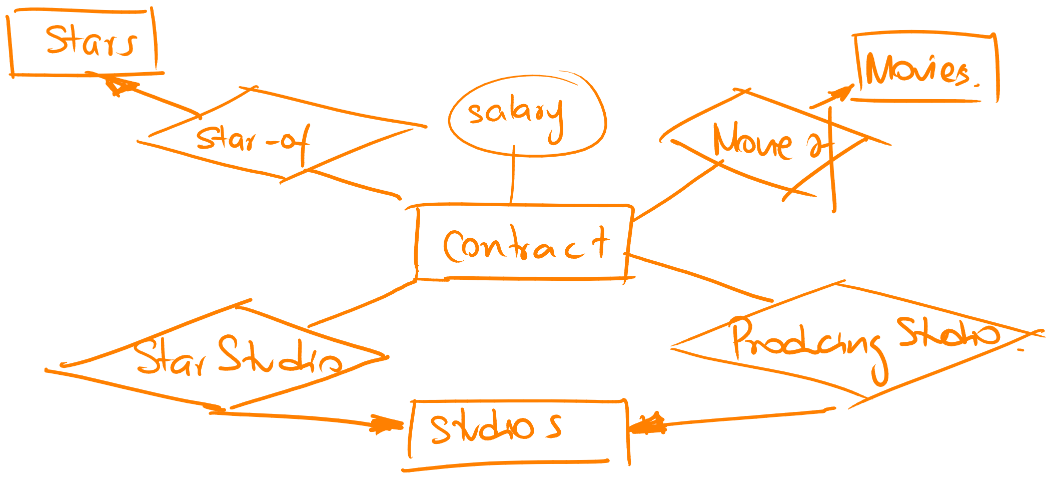


This implies:

Star, Movie → StarStudio
Star, Movie → Producing Studio

Often binary relationships are preferred:

To convert a n-way relationship to binary
- convert relationship to entity.
- give it an primary key (perhaps artificial)
- Create a relationship between new entity and old entity.
  - many-to-one
    newEntity → entity1, entity2 . . . .



The arrows imply that for every contract there is ∅ or 1 participating entity
They could be further constraint to be exactly 1.

Inheritance (4.1.11)

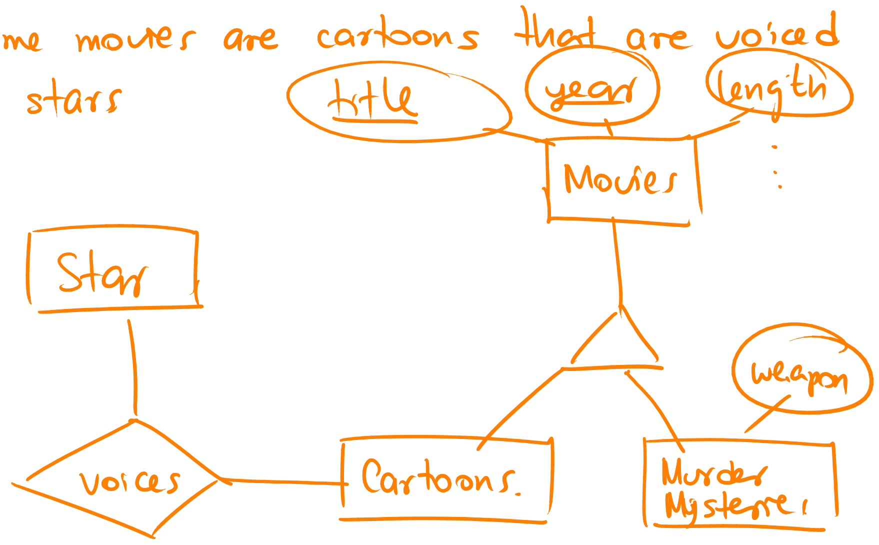
- Some type some entities in an entity set have special properties (extra attributes)

or

- Only a subset of entities is involved in a relationship

Ex:

Some movies are cartoons that are voiced by stars



To convert to relations

- create relation of main entity
- each sub-entity has the same PK that main entity. plus any extra attributes.

Ex:

```
CREATE TABLE Movies ( . . .
        . . . as usual . . .
   );

CREATE TABLE MurderMysteries (
   title    CHAR(30),
   year     INTEGER,
   weapon    VARCHAR,
   PRIMARY KEY (title, year),
   FOREIGN KEY (title, year) REFERENCES
      Movies
 );
```

Ignore 4.6.1 in textbook
Use only 4.6.2

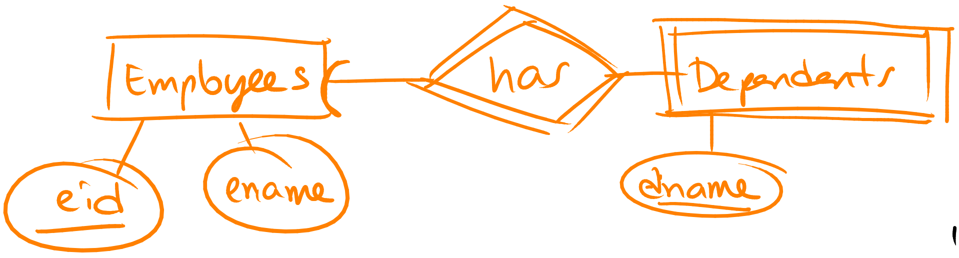
```
CREATE TABLE Cartoons (
    title CHAR(30),
    year INTEGER,
    PRIMARY KEY (title, year),
    FOREIGN KEY (title, year) REFERENCES
      Movies
  );
CREATE TABLE Voices (
    ... as usual but reference Cartoons ...
```

Weak Entities (4.4)

Some times an entity that do not have an identifying attribute of their own.

- We need another entity to properly identify them

Ex: Employees and their dependent.
We do not care for dependents of non-employees.



dname does not need to be uniqe in Dep.

- Each Dependent has exactly one employee associated with it.
- If employee does not exist we don't care for her/his dependents.

```
CREATE TABLE Dependents (
    eid   CHAR(10),
    dname CHAR(30)
    PRIMARY KEY (eid, dname),
    FOREIGN KEY (eid) REFERENCES
        Employees ON DELETE CASCADE
);
```

↑ if referenced employee is deleted, then Dependents are deleted too !!

- More on this later.

Ex 2:

See Figure 4.2.2 for a Contracts entity as a weak entity