

High Level Database Models

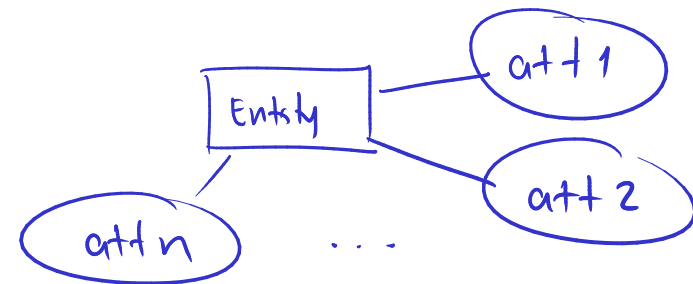
Chapter 4

Entity/Relationship Model (E/R)

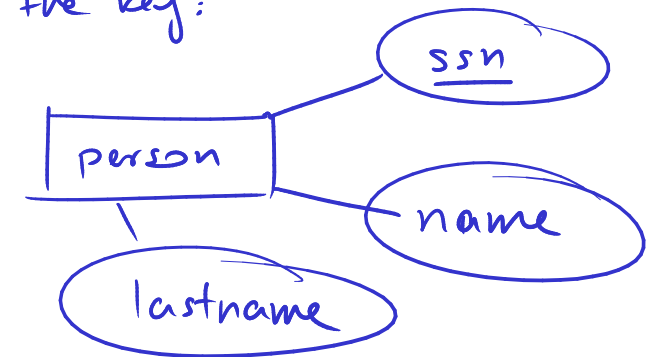
2 parts

1) Entity.

An entity has at least one attribute

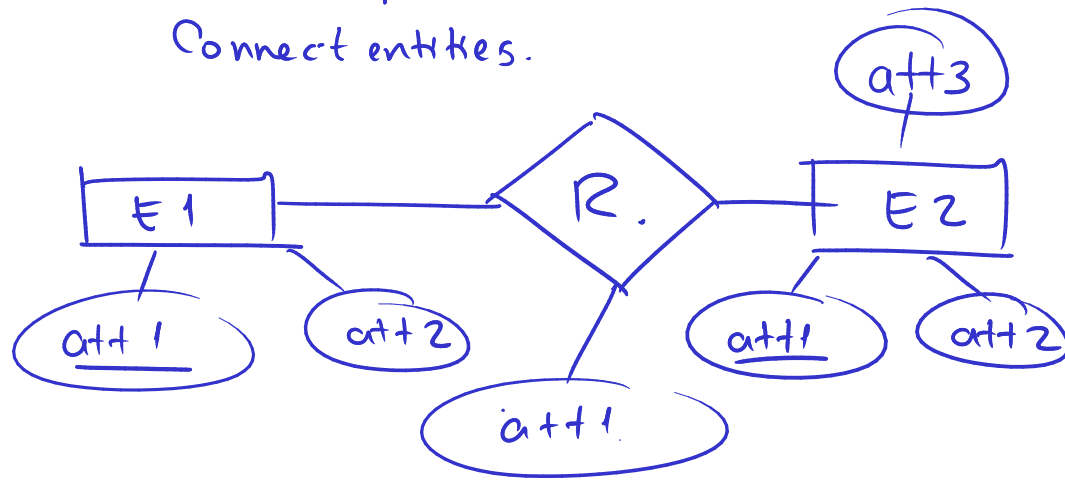


Underscore attributes that are part of the key:



2) Relationships

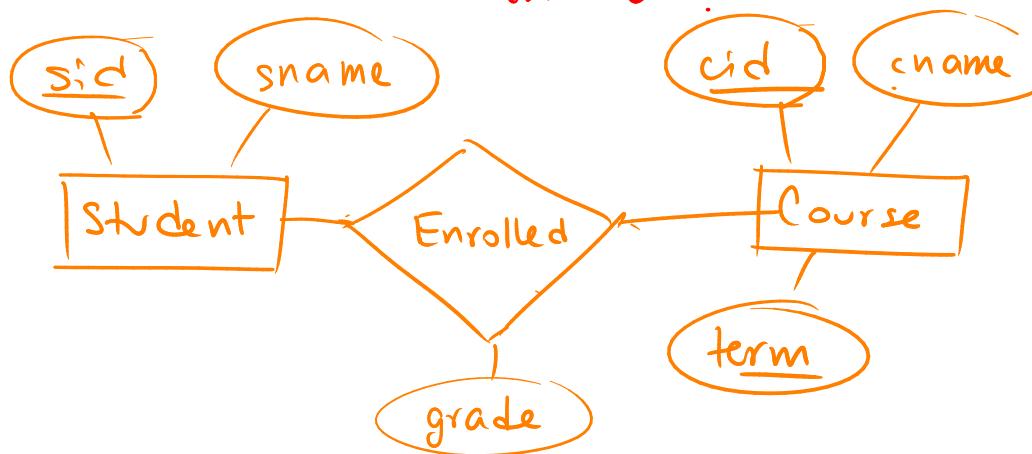
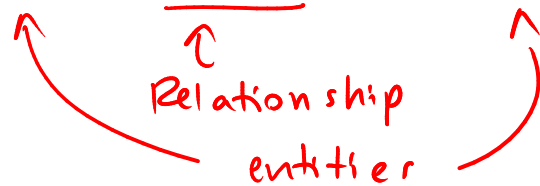
Connect entities.



Relationships can have attributes.

Ex:

Students enrolled in courses



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

- 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),
 age INTEGER,
 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

```
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 ...
```

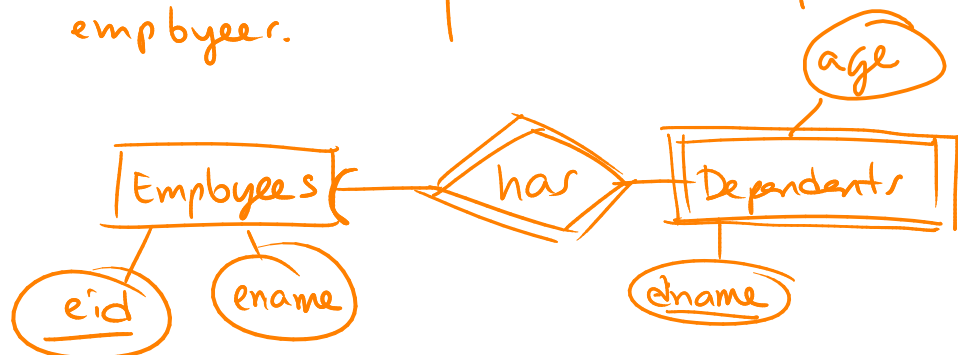
Weak Entities (4.4)

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-employee.



dname does not need to be unique in Dep.

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 entities
- their own attributes

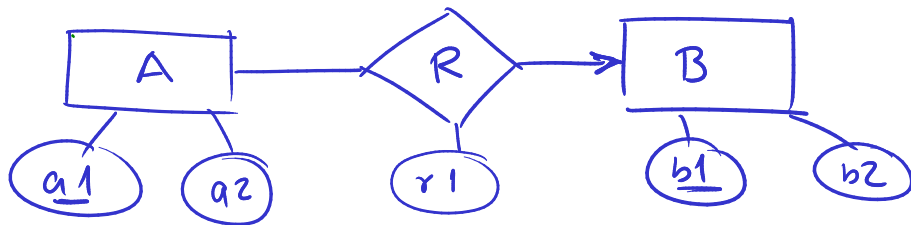
Their primary key is the attributes in the PKs of the participating relations.

```
CREATE TABLE Enrolled (
  sid CHAR(10),
  cid CHAR(10),
  term CHAR(3),
  grade INTEGER,
  PRIMARY KEY (sid, cid, term),
  FOREIGN KEY (sid) REFERENCES
    Students,
  FOREIGN 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)

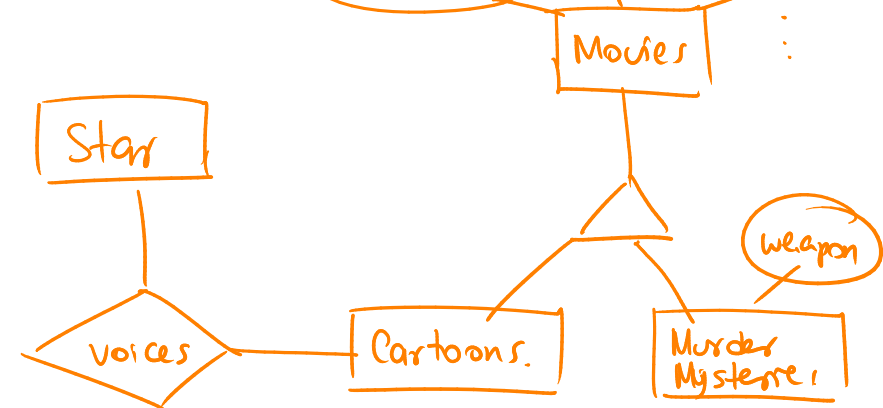
An entity relates to 0 or 1 entity.



In this example $R(a1, b1, r1)$
 Arrow in diagram implies $a1 \rightarrow b1, r1$

Ex:

Some movies are cartoons that are voiced by stars



To convert to relations

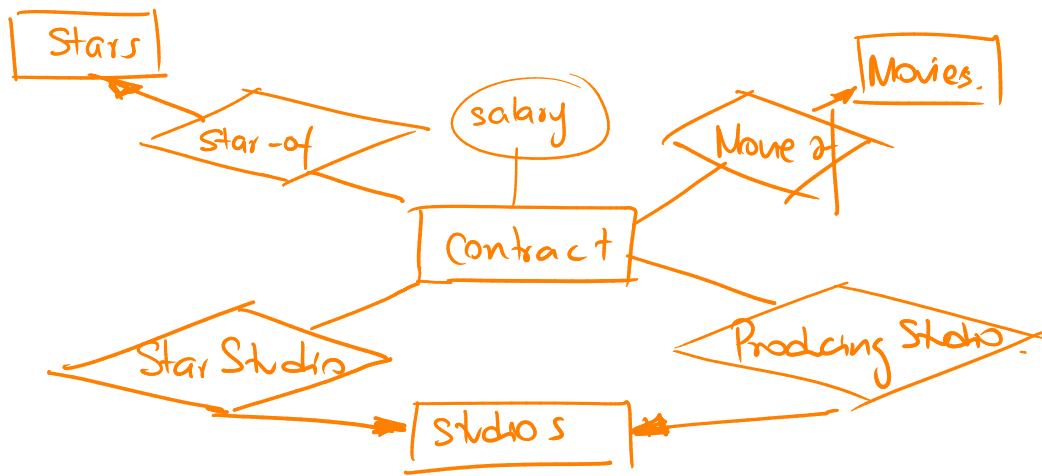
- create relation of main entity
- each sub-entity has the same PK that main entity, plus any extra attributes.

Ex:

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

Ignore 4.6.1
 in textbook.
 Use only 4.6.2

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



The arrows imply that for every contract there is 0 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

In SQL Assume attr are integer.
 CREATE TABLE R (
 a1 integer,
 b1 integer NOT NULL,
 r1 integer,
 PRIMARY KEY (a1)
 FOREIGN KEY (a1) REFERENCES A,
 FOREIGN KEY (b1) REFERENCES B
);

← must not be empty.

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

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

Hence we can combine A and R

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

Instead of 2 relations we create one

CREATE TABLE ARC

 a1 integer,

 a2 integer,

 b1 integer,

 r1 integer,

 PRIMARY KEY (a1),

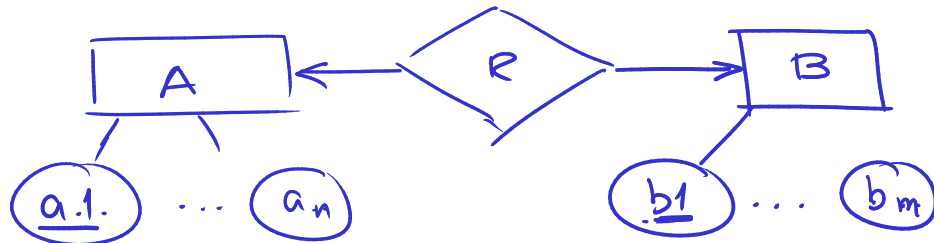
 FOREIGN KEY (b1) REFERENCES B

);

← can be NULL (empty).

Primary keys can never be NULL.

We can have:



It means $R(a1, b1)$
has FD $a1 \rightarrow b1, b1 \rightarrow a1$

Can we merge R with A or B?

Say we choose A; so we create AR
as above. This guarantees $a1 \rightarrow b1$.

But what about $b1 \rightarrow a1$?

$b1$ is also a CK for AR

Make $b1$ unique: and

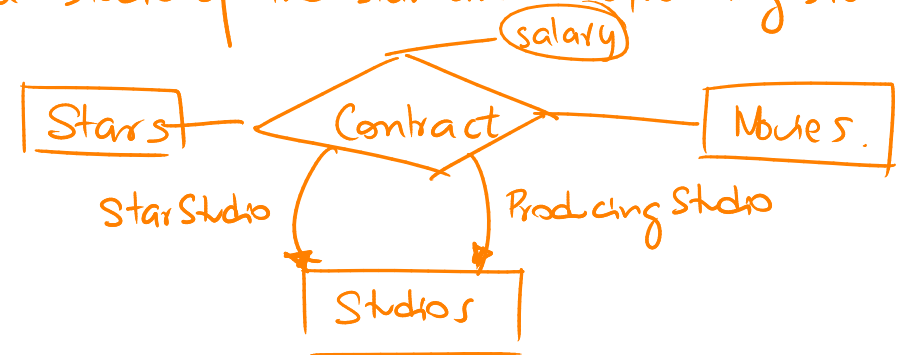
add to AR:

UNIQUE ($b1$)

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

Ex. 2:

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



This implies:

Star, Movie \rightarrow StarStudio

Star, Movie \rightarrow Producing Studio

Often binary relationships are preferred:

To convert a n-way relationship to binary

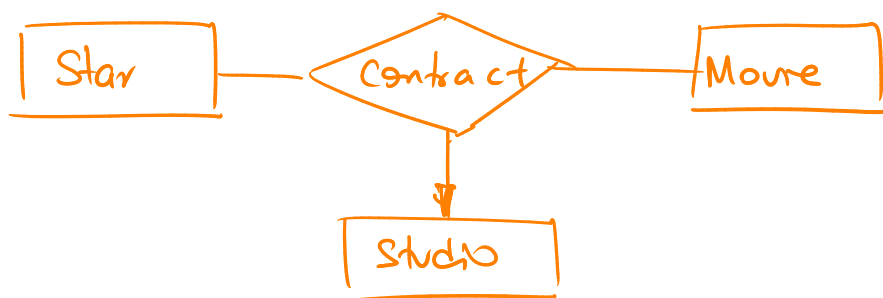
- convert relationship to entity.
 - give it an primary key (perhaps artificial)
 - Create a relationship between new entity and old entity.
 - many-to-one
- newEntity \rightarrow entity1, entity2, ...

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.

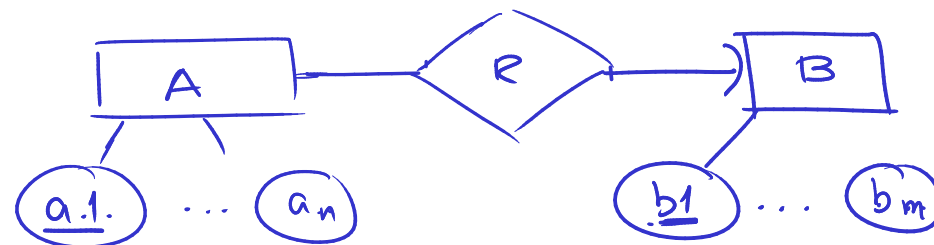


Star, Movie \rightarrow Studio

(Not showing attributes of entities for simplicity).

$b1$ \vdots integers UNIQUE

An entity relates to exactly one entity only



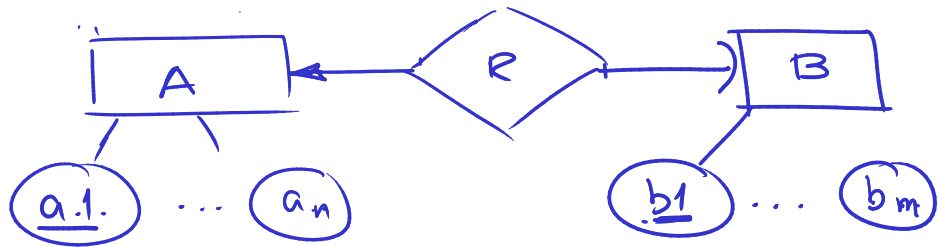
$R(a1, b1)$ still $a1 \rightarrow b1$

and \forall value $a1$ in A \rightarrow at most one corresponding value $b1$ in B .
(Zero or one)

SQL: same schema as AR above,
but $b1$ cannot be NULL:

$b1$ \vdots integer NOT NULL

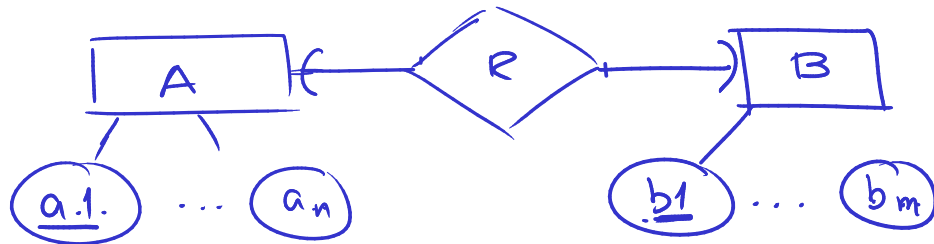
Some Combinations



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

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

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

\uparrow # tuples in A \uparrow # tuples in B

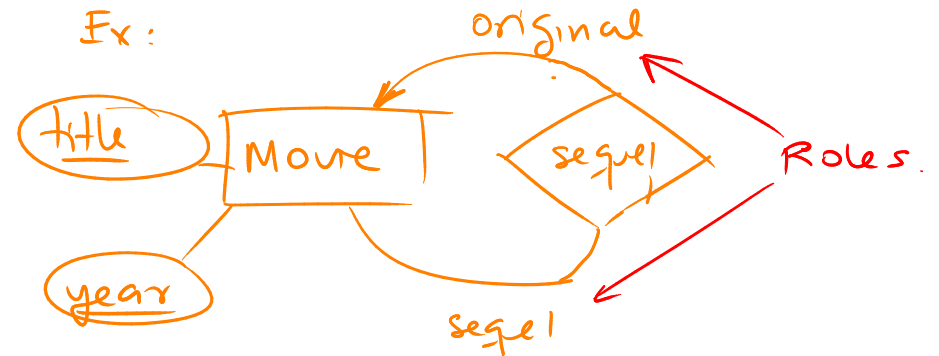
Make A, B and R one relation

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

Roles

Sometimes an entity participates in more than once in a relationship:

Ex:



sequel title, sequel year \rightarrow

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.