# Constraints & Triggers

# Why use a DBMS? (Week 1)

- Avoid redundancy and **inconsistency**
- Rich (declarative) access to the data
- Synchronize concurrent data access
- Recovery after system failures
- Security and privacy

- Reduce cost and pain to do something useful
  - There is always an alternative!!!

# Integrity of Data

- Example Constraints
  - Keys
  - attribute domains
  - Referential integrity (foreign keys -> keys)
  - ...
- Static Constraints
  - Constraints that any instance of a DB must meet
- Dynamic Constraints
  - Constraints on a state transition of the DB

# Who checks? DB vs. App

- Why implement constraints in the DB?
  - Good way to annotate & document schema
  - DB is a central point (once and for all cases)
  - Safety: in case you forget it in the app
  - Useful for DB-level optimization
    - Constraint: all students are older than 18 years.
    - Query:  SELECT * FROM Student WHERE age < 17;
    - Query can be evaluated without looking at any student.
- Why implement constraints in the App?
  - Meaningful error messages.
- **It is important to do both!!!**

# Referential Integritity Constraints

## Foreign Keys

- Refer to tuple from a different relation
- E.g., PersID in table Lecture refers to Professor

## Definition: Referential Integritity

For every foreign key one of the two conditions must hold

the value of the foreign key is *NULL* or

the referenced tuple must exist

# Referential Integritity in SQL

- SQL Syntax to declare keys and foreign keys:

  Key: **unique**

  Primary key: **primary key**

  Foreign key: **foreign key**

- Example:

  **create table** *R*

  ( $\alpha$ **integer primary key**,

  $\beta$ **varchar(30) unique,**

  ... );

  **create table** *S*

  ( ...,

  $\kappa$ **integer references** *R* );

# Maintaining referential integrity?

Updates of referenced data which result in a violation

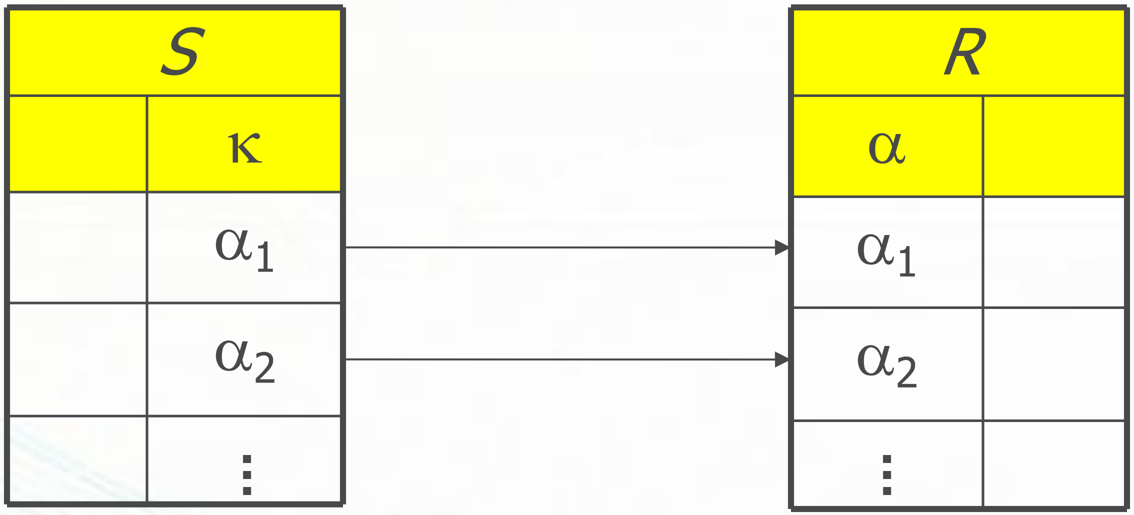
1. Default: reject the update (return an error)
2. **cascade:** propagate update
3. **set null:** set references to null
4. (Set references to default value. Not supported in SQL.)

The right choice depends on the ER model and operations.

- e.g. weak vs. strong entities
- relations that implement N:M relationships
- 1:N relations
- Exercise: extend rules for ER->relational translation!

# Maintaining referential integrity

Original




Update

**update** *R*

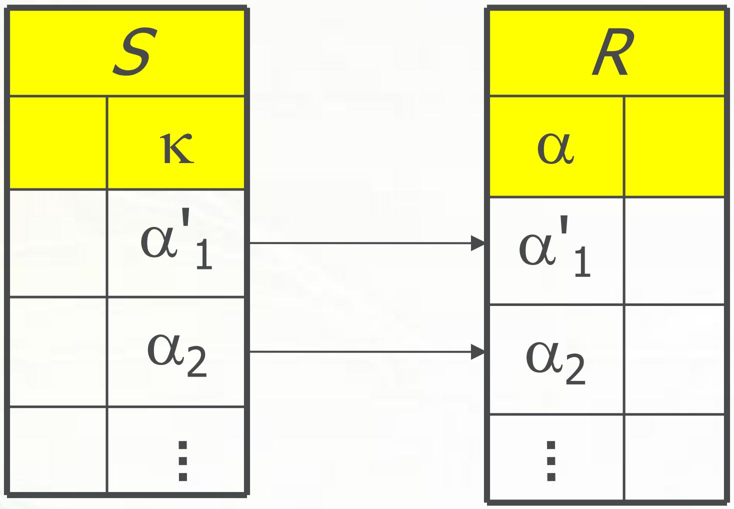
**set** $\alpha = \alpha'_1$

**where** $\alpha = \alpha_1$;

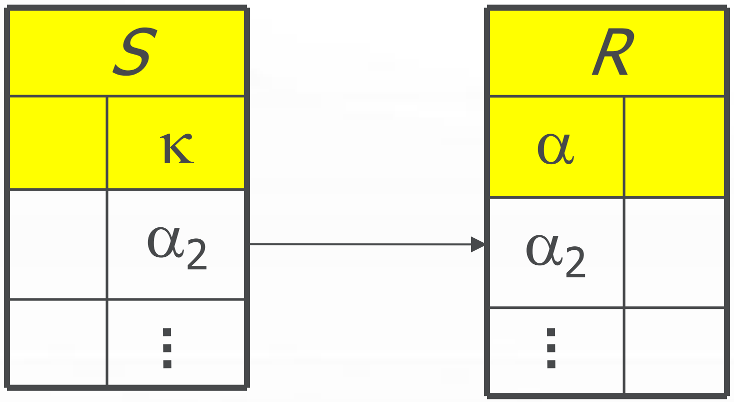
**delete from** *R*

**where** $\alpha = \alpha_1$;

# Cascade (weak entities, n:m relationships)




Update of S




Delete in S

**create table** *S*

( ...,

κ **integer references** *R*

**on update cascade** );

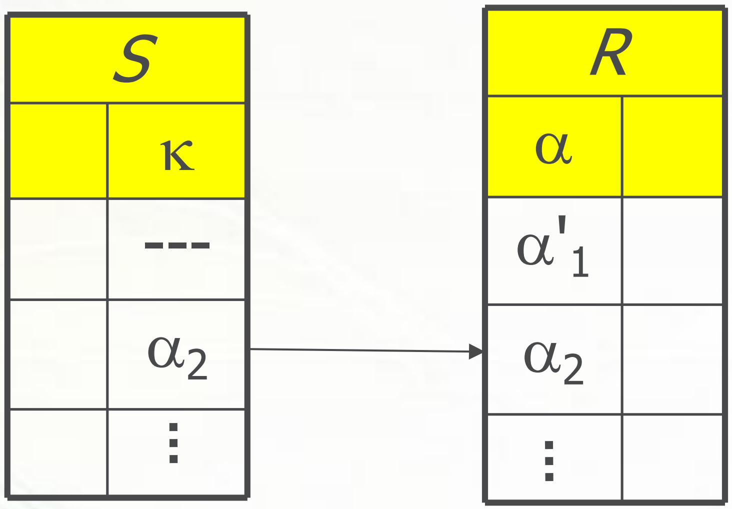
**create table** *S*

( ...,

κ **integer references** *R*

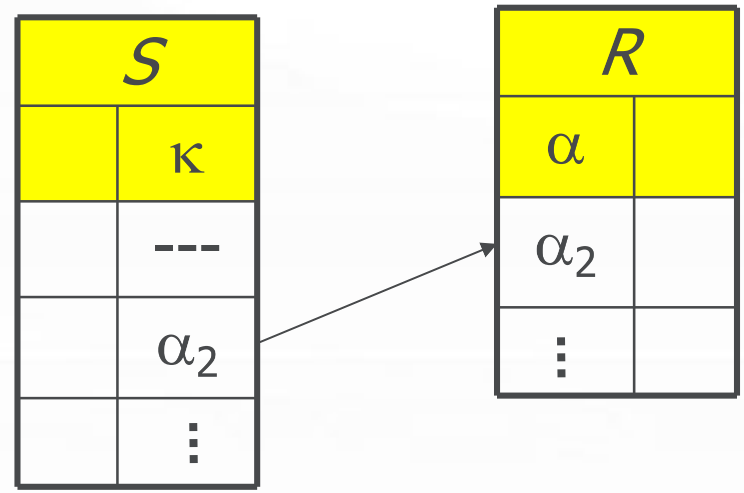
**on delete cascade** );

# Set Null (strong entities)




Update of S

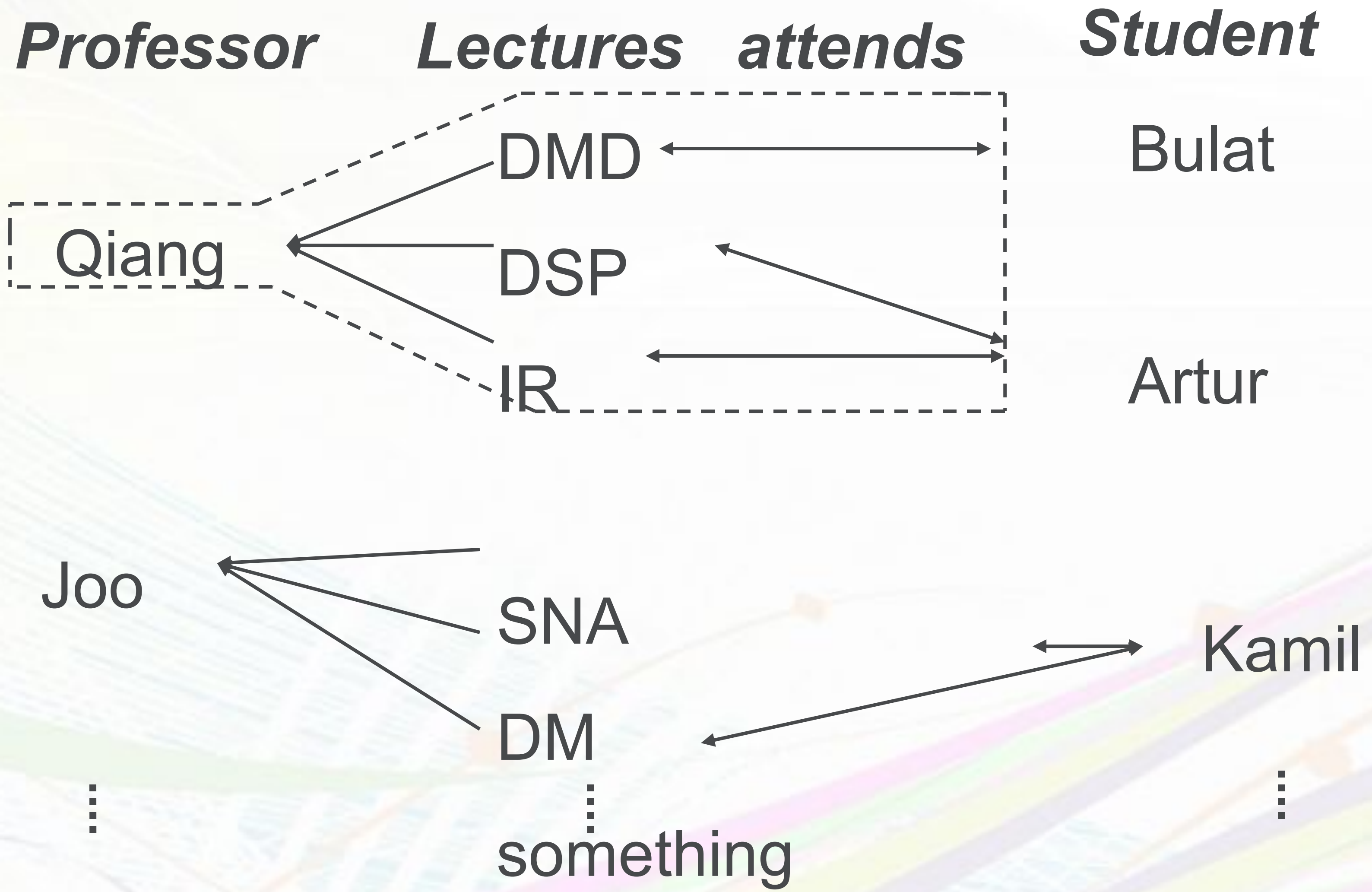
create table *S*
( …,
κ integer references *R*
on update set null );




Update of S

create table *S*
( …,
κ integer references *R*
on delete set null );

# Cascading Deletes



```
create table Lecture
    ( ...,
    PersID    integer
              references Professor
                  on delete cascade);

create table attends
    ( ...,
    ID  integer
          references Lecture
          on delete cascade);
```

# Constraints on Attribute Domains

- Integer domains

  ... **check** Semester **between** 1 **and** 13

- Enum types

  ... **check** Level **in** (`Assistant´, `Associate´, `Full´) ...

# Uni-DB schema with Constraints

```
create table Student
    ( StuID      integer primary key,
    Name         varchar(30) not null,
    Semester     integer check (Semester between 1 and 13));


create table Professor
    ( PersID     integer primary key,
    Name         varchar(30) not null,
    Level        character(2) check (Level in (`AP´,`CP´,`FP´)),
    Room         integer unique );
```

```
create table Assistant
    ( PersID        integer primary key,
      Name          varchar(30) not null,
      Area          varchar(30),
      Boss          integer,
      foreign key   (Boss) references Professor
                    on delete set null);
create table Lecture
    ( LecID         integer primary key,
      Title         varchar(30),
      CP            integer,
      PersID        integer references Professor
                    on delete set null);
```

```
create table attends
  ( StuID          integer references Student
                   on delete cascade,
    LecID          integer references Lecture
                   on delete cascade,
    primary key    (StuID, LecID));
create table requires
  ( Prerequisite   integer references Lecture
                   on delete cascade,
    Follow-up      integer references Lecture
                   on delete cascade,
    primary key    (Prerequisite, Follow-up));
```

```
create table tests
    ( StuID        integer references Student
                   on delete cascade,
    LecID          integer references Lecture,
    PersID         integer references Professor
                   on delete set null,
    Grade          numeric (3,2)
                   check (Grade between 1.0 and 6.0),
    primary key    (StuID, LecID));
```

# constraints on tuple

```
create table Student
    ( StuID         integer primary key,
    Name            varchar(30) not null,
    Semester        integer,
    check (Semester between 1 and 13)
);
```

# 1:1 Relationships (Wedding)

```
create table Man(
    name   varchar(30)  primary key;
    spouse varchar(30)  references Woman);
create table Woman(
    name    varchar(30) primary key;
    spouse  varchar(30) references Man);
```

- Legal: Helga marries Hugo, but Hugo does not marry Helga.
  Mutual marriage cannot be expressed in SQL.
  How would you model marriage in SQL?
  (cha 7.1.3)

- N.B.: The real implementation is based on **transactions!**

# Trigger (ECA Rules)

```
create trigger noDegradation
before update on Professor
for each row (or statement)
when (old.Level is not null)
begin
    if :old.Level = 'Associate' and :new.Level = 'Assistant' then
        :new.Level := 'Associate';
    end if;
    if :old.Level = 'Full' then
        :new.Level := 'Full'
    end if;
    if :new.Level is null then
      :new.Level := :old.Level;
    end if;
end
```

Event

Condition

Action

# Dangers of Triggers

```
create trigger weddingMan
after update on Man
for each row
when (true)
begin
    update Woman set spouse = :new.Name
    where name = :new.spouse;
    update Woman set spouse = null
    where name = :old.spouse;
end
```

What happens if we write a weddingWoman trigger?

Is marriage better modeled statically or dynamically?

# Exercise

- 1. What is theta join?
- 2. Write an example of theta join.

Template:

BS1#1, First_name Last_name

Solution_1:.....