ER to Relational Mapping

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ER Model: Overview

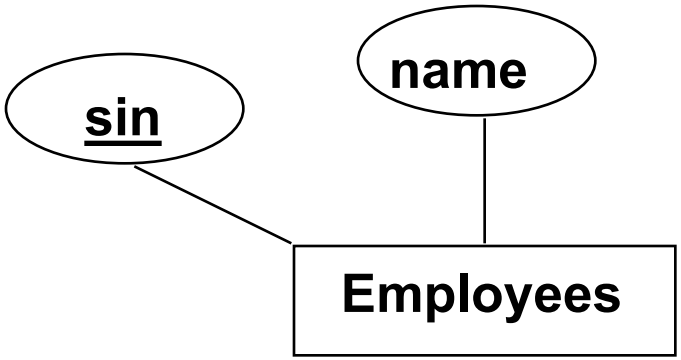
- The "world" is described in terms of
  - Entities
  - Relationships
  - Attributes
- Constraints and Complications
  - Key constraints
  - Participation constraints
  - Set-valued attributes
  - Weak entities
  - ISA hierarchies

Relational Model: Overview

- Database: a set of relations (tables)
- For each table, we specify
  - Columns and the domain of each column,
  - Often the primary key and the foreign keys,
  - Other constraints (if any),
  - The way referential integrities must be enforced.

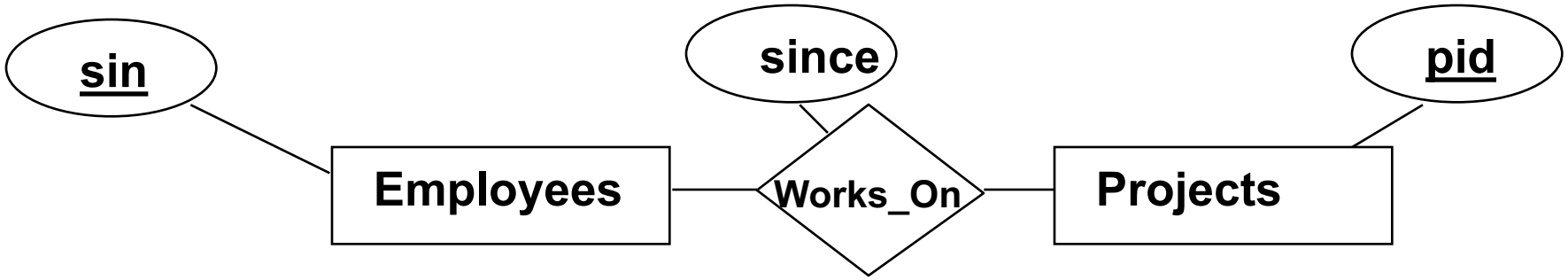
Entity Sets to Tables

- Entity sets to tables.




```
CREATE TABLE Employees
    (sin CHAR(11),
    name CHAR(20),
    PRIMARY KEY  (sin))
```

Relationship Sets to Tables

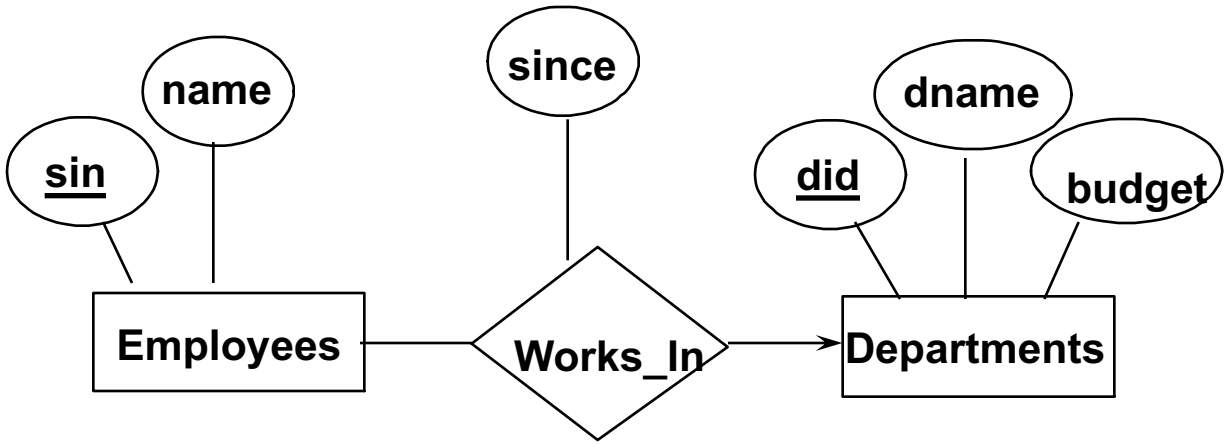


- Constraint: none.
- Attributes of the relation (table):
  - Key of every participating entity set (as foreign keys).
  - All descriptive attributes

```
CREATE TABLE Works_On(
  sin  CHAR(11),
  pid  INTEGER,
  since  DATE,
  PRIMARY KEY (sin, pid),
  FOREIGN KEY (sin)
      REFERENCES Employees,
  FOREIGN KEY (pid)
      REFERENCES Projects)
```

Relationships with Key Constraints

- Constraint: each employee works in at most one department.



- Map the relationship to a table:
  - What is the key now?

```
CREATE TABLE Works_In (
  sin CHAR(11),
  did CHAR(3),
  since DATE,
  PRIMARY KEY (sin),
  FOREIGN KEY (sin) REFERENCES Employees,
  FOREIGN KEY (did) REFERENCES Departments)
```

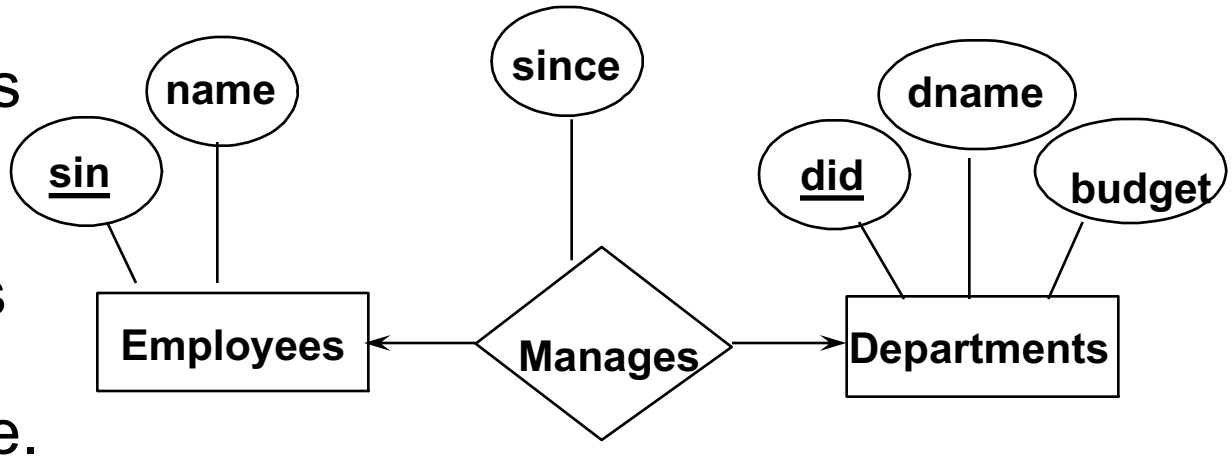
Relationships with Key Constraints (Cont.)

- Better mapping:
  - Since each employee can work in at most one department, we could instead combine Works_In and Employees.
  - Has one less table☺

```
CREATE TABLE Emp_Works(
  sin CHAR(11),
  name CHAR(20),
  did CHAR(3),
  since DATE,
  PRIMARY KEY (sin),
  FOREIGN KEY (did) REFERENCES Departments)
```

Relationships with Key Constraints (Cont.)

- Constraint: each employee manages at most one department and each department is managed by at most one employee.

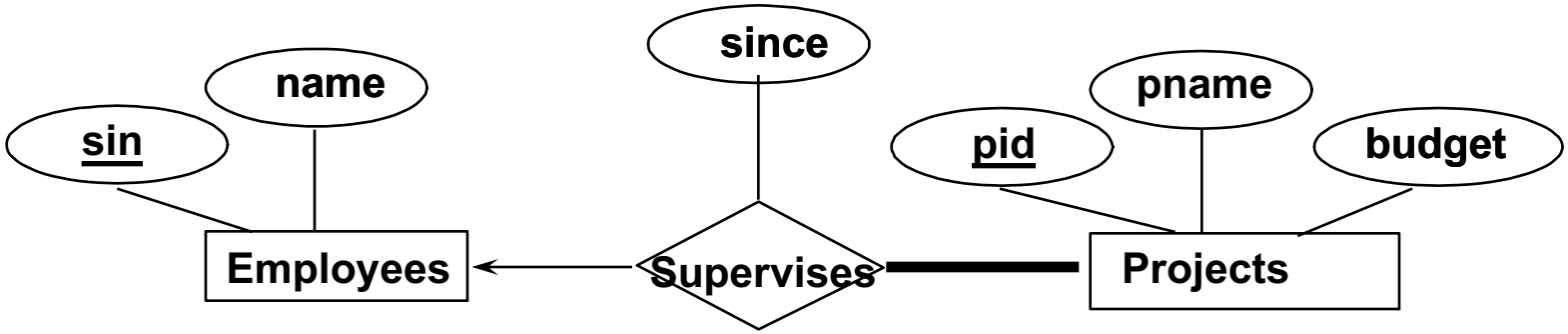


  - We can combine Manages with Departments.
  - We can also combine Manages with Employees.

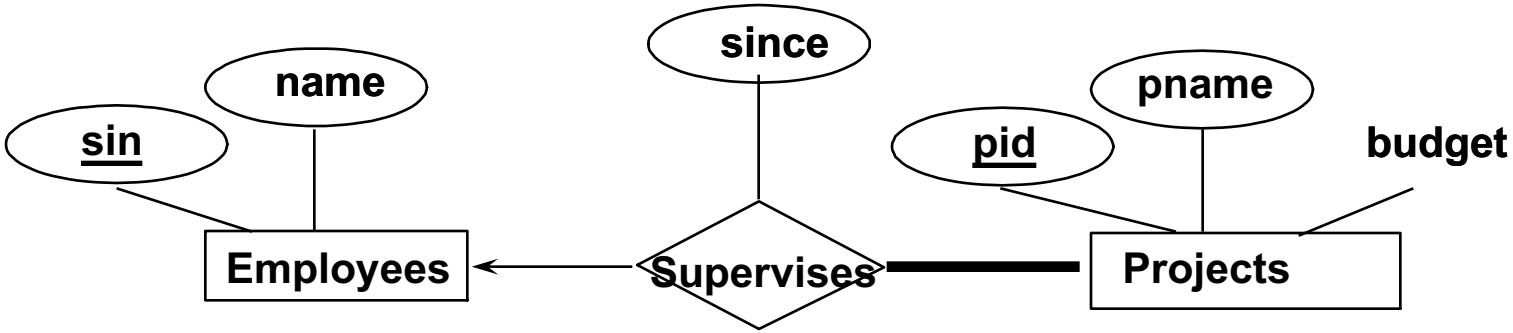
```
CREATE TABLE Dept(
  did CHAR(3),
  dname CHAR(20),
  budget INTEGER,
  mgr CHAR(11) not null,
  since DATE,
  PRIMARY KEY (did),
  FOREIGN KEY (mgr) REFERENCES Employees)
```

Review: Participation Constraints

- Does every project have a supervisor?
  - If so, this is a *participation constraint*: the participation of Projects in Supervises is said to be *total* (vs. *partial*).
    - ✓Every *pid* value in Projects table must appear in a row of the Supervises table (with a non-null *sin* value!)



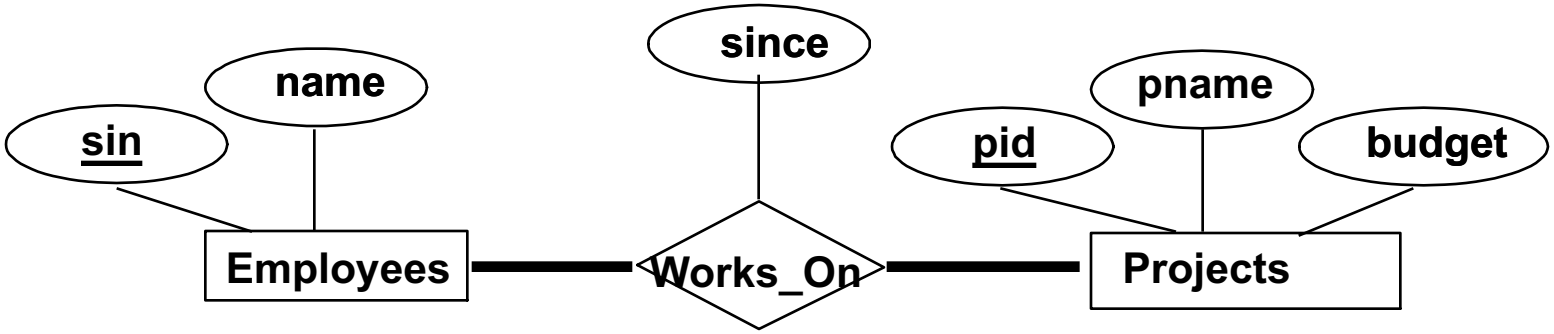
Participation Constraints




```
CREATE TABLE Proj_Supervises (
  pid INTEGER,
  pname CHAR(20),
  budget REAL,
  sin CHAR(11) NOT NULL,
  since DATE,
  PRIMARY KEY (pid),
  FOREIGN KEY (sin) REFERENCES Employees
    ON DELETE NO ACTION)
```

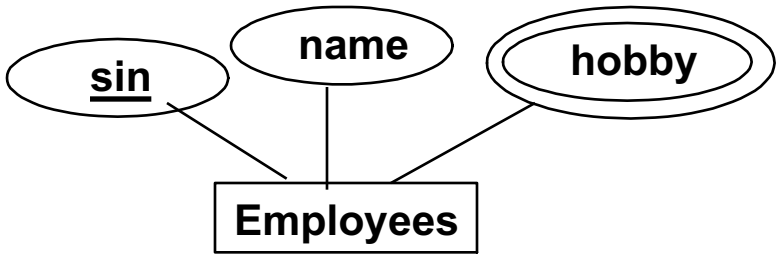
Participation Constraints (Cont.)

- How can we map Works_On relationship to a table and still keep the participation constraints?



- Can't without resorting to CHECK constraints (will be discussed later).

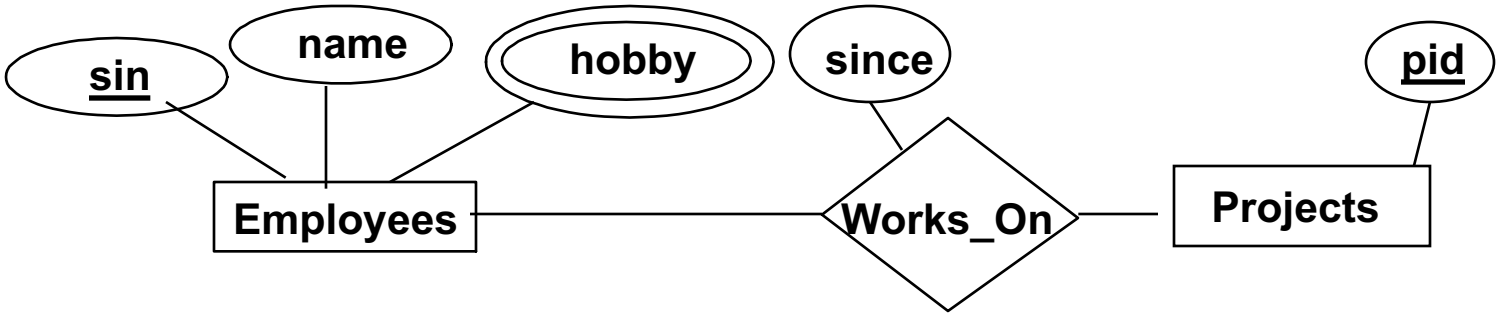
Set-Valued Attributes




```
CREATE TABLE Employees (
  sin CHAR(11),
  name CHAR(20),
  hobby  char(15),
  PRIMARY KEY (sin, hobby)  )
```

- Cannot store more than one value in a field!
- What is the key of the relation?
  - sin cannot be a key!
- The same problem arises in mapping a relationship with a set-valued attribute.

Set-Valued Attributes (Cont)

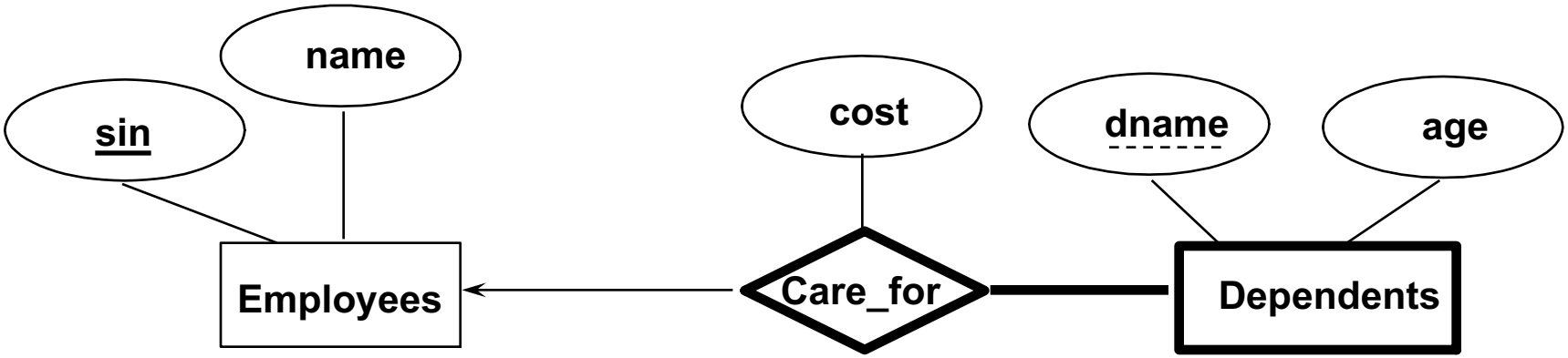


- Can sin reference employees any more?
  - No. We cannot define sin as a foreign key any longer.

```
CREATE TABLE Works_On(
  sin  CHAR(11),
  pid  INTEGER,
  since  DATE,
  PRIMARY KEY (sin, pid),
  FOREIGN KEY (pid)
      REFERENCES Projects,
  FOREIGN KEY (sin)
      REFERENCES Employees
)
```

Review: Weak Entities

- A *weak entity* can be identified uniquely only by considering the primary key of another (*owner*) entity.
  - Owner entity set and weak entity set must participate in a one-to-many relationship set (1 owner, many weak entities).
  - Weak entity set must have total participation in this *identifying* relationship set.



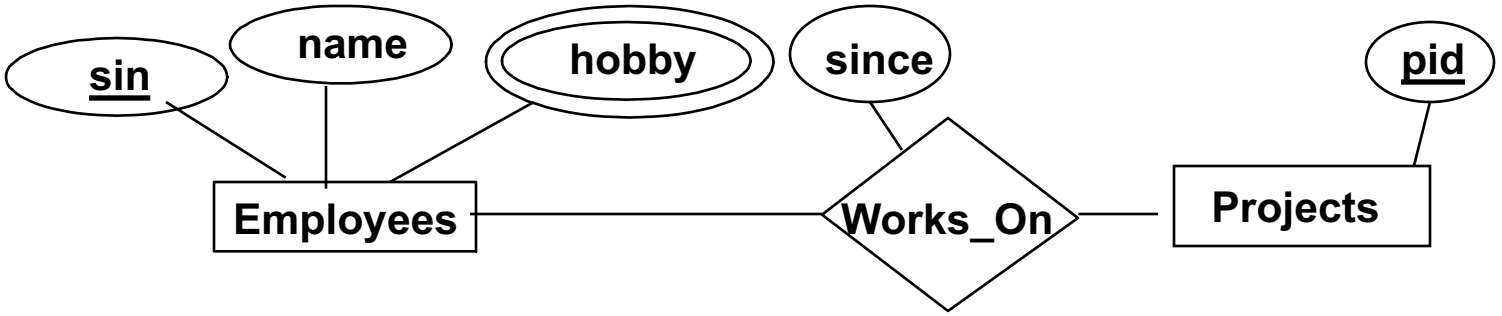
Translating Weak Entity Sets

- Weak entity set and identifying relationship set are translated into a single table.

```
CREATE TABLE Dep_Care (
   dname  CHAR(20),
   age  INTEGER,
   cost  REAL,
   sin  CHAR(11)  NOT NULL,
   PRIMARY KEY (dname, sin),
   FOREIGN KEY  (sin) REFERENCES Employees
      ON DELETE CASCADE)
```

  - When the owner entity is deleted, all owned weak entities must also be deleted.

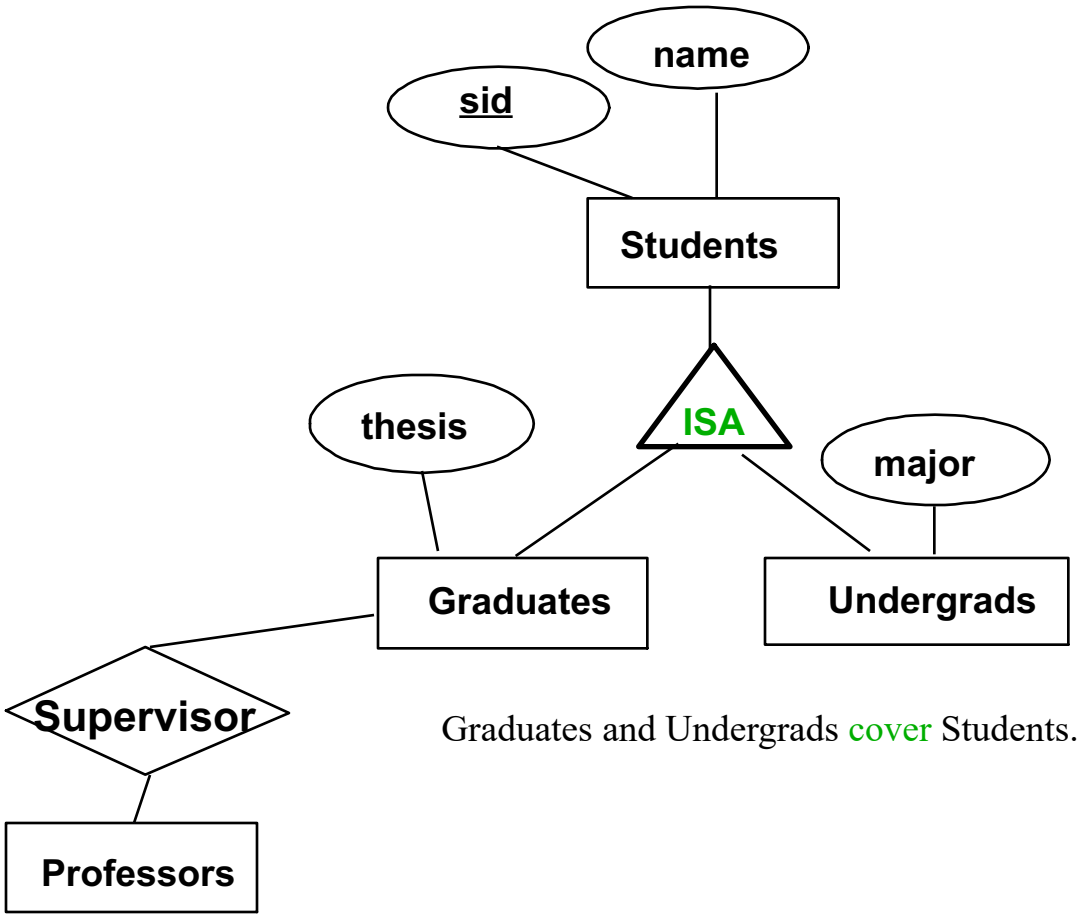
Set-Valued Attributes Again



- Treat hobby similar to a weak entity

```
CREATE TABLE Emp_Hobby(
  sin  CHAR(11),
  hobby  CHAR(15),
  PRIMARY KEY (sin, hobby),
  FOREIGN KEY (sin)
      REFERENCES Employees,
      ON DELETE CASCADE
)
```

Review: ISA Hierarchies



Graduates and Undergrads cover Students.

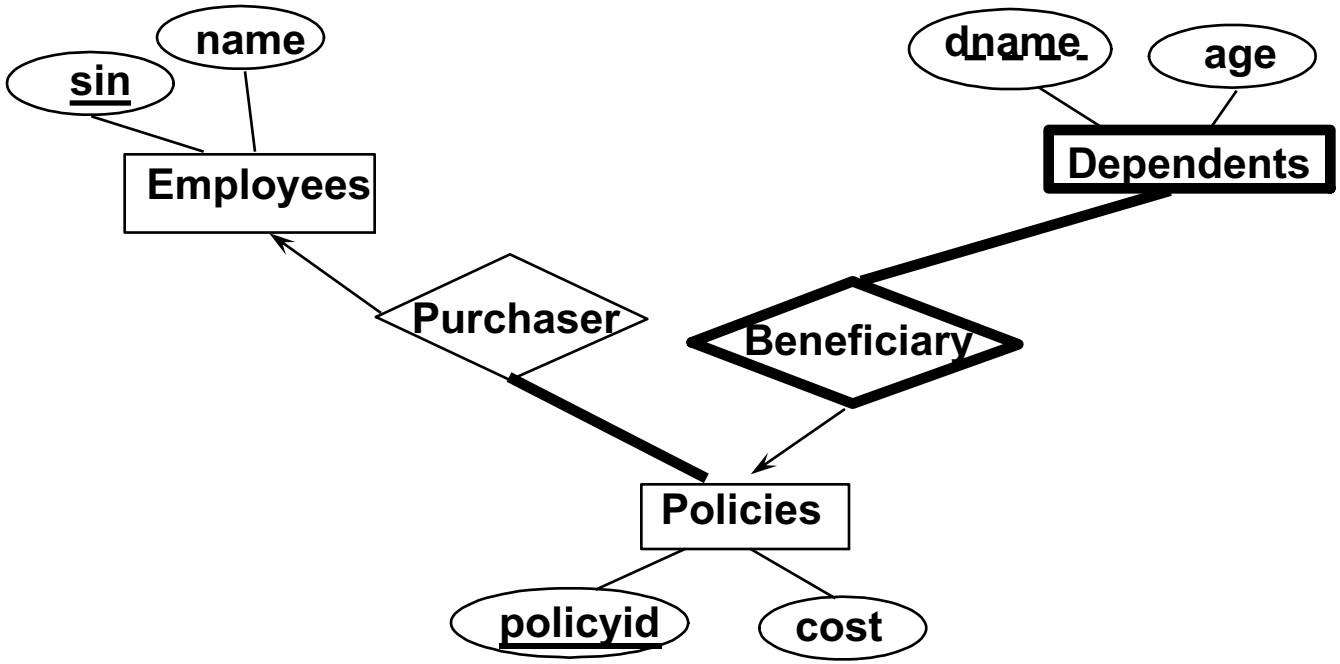
Translating ISA Hierarchies to Relations

- ***General approach:*** 3 relations
  - ✓ *Students(sid, name)*
  - ✓ *Graduates(sid, thesis)*
  - ✓ *Undergrads(sid, major)*

```
CREATE TABLE Undergrads (
  sid CHAR(8) NOT NULL,
  major CHAR(12),
  PRIMARY KEY (sid),
  FOREIGN KEY (sid) REFERENCES Students
    ON DELETE CASCADE )
```

- Alternative: Graduates and Undergrads
  - If Graduates and Undergrads Cover Students.
    - ✓ *Graduates(sid, name, thesis).*
    - ✓ Undergrads(sid, name, major)

Exercise: Map to Relations



Exercise: Answer

- The key constraints allow us to combine Purchaser with Policies and Beneficiary with Dependents.
- Participation constraints lead to NOT NULL constraints.

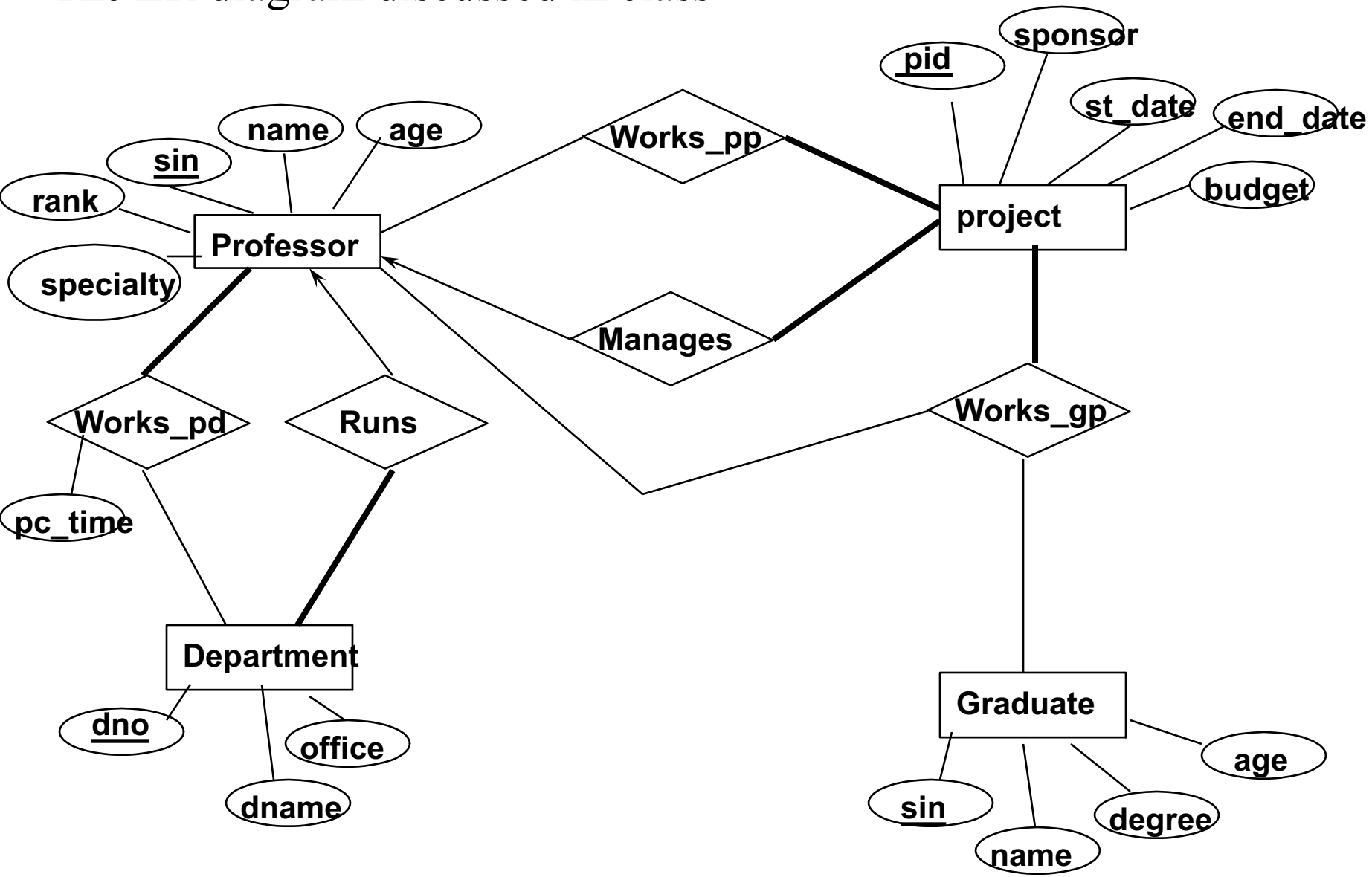
```
CREATE TABLE Policies (
    policyid  INTEGER,
    cost  REAL,
    sin  CHAR(11)  NOT NULL,
    PRIMARY KEY (policyid),
    FOREIGN KEY (sin) REFERENCES Employees
        ON DELETE NO ACTION)

CREATE TABLE Dependents (
    dname  CHAR(20),
    age  INTEGER,
    policyid  INTEGER NOT NULL,
    PRIMARY KEY (dname, policyid),
    FOREIGN KEY (policyid) REFERENCES Policies
        ON DELETE CASCADE)
```

Relational Model: Summary

- A tabular representation of data.
- Simple and intuitive, currently the most widely used.
- Integrity constraints can be specified by the DBA, based on application semantics. DBMS checks for violations.
  - Two important ICs: primary and foreign keys
  - In addition, we *always* have domain constraints.
- Powerful and natural query languages exist.
- Rules to translate ER to relational model

The ER diagram discussed in class



Map it into relations…