

Logical Database Design: Mapping ER to Relational

Chapter 3, Section 3.5

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ER Model vs. Relational Model

- ER Model used for conceptual design
- Relational Model implemented by modern DBMS
- Important Step: Translate ER diagram to Relational schema
- Agenda for Today
 - Translating each of the ER constructs
 - Exercise bringing it all together

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Recall ER Constructs

- Basic Constructs
 - Entity Sets
 - Relationship Sets
 - Attributes (of entities and relationships)
- Additional Constructs
 - ISA Hierarchies
 - Weak Entities
 - Aggregation
- Integrity Constraints
 - Key constraints
 - Participation constraints
 - Overlap / Covering constraints for ISA hierarchies

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Entity Sets to Tables

```

CREATE TABLE Citizens
(ssn CHAR(11),
name CHAR(20),
bday DATE,
PRIMARY KEY (ssn))

```

Can ssn have a null value?

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Relationship Sets to Tables

Relationship set -> Table

Attributes:

- Participating entity set primary keys
 - Foreign key
- Descriptive attributes

```

CREATE TABLE Votes(
ssn CHAR(11),
cid INTEGER,
when DATE,
PRIMARY KEY (ssn, cid),
FOREIGN KEY (ssn) REFERENCES Citizens,
FOREIGN KEY (cid) REFERENCES PR-Cands)

```

Generalizes to n-ary relationships

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Relationship Sets to Tables

```

CREATE TABLE Represents(
elected_ssn CHAR(11),
cons_ssn CHAR(11),
PRIMARY KEY (elected_ssn, cons_ssn),
FOREIGN KEY (elected_ssn) REFERENCES Citizens(ssn),
FOREIGN KEY (cons_ssn) REFERENCES Citizens(ssn))

```

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Key Constraints

- Approach 1 – Three Tables

```
CREATE TABLE Votes
(
  ssn CHAR(11),
  cid INTEGER,
  when DATE,
  PRIMARY KEY (ssn),
  FOREIGN KEY (ssn) REFERENCES Citizens,
  FOREIGN KEY (cid) REFERENCES PR-Cands)

```

Same approach as before – Map each entity set and relationship set to a table

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Key Constraints

- Approach 2 – Two Tables

```
CREATE TABLE Citizen_Votes (
  ssn CHAR(11), name CHAR(20),
  bday DATE, when DATE,
  cid INTEGER,
  PRIMARY KEY (ssn),
  FOREIGN KEY (cid) REFERENCES PR-Cands)

```

Each citizen can only vote once, so OK to fold 'Votes' relationship into 'Citizens' entity

Q: Can cid be null?
Q: What if many citizens don't vote?
Q: Which approach is better?

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Key Constraints

What about 1 Table?

No! This is bad design.

e.g., For each citizen that votes for Barack Obama, we have to store Obama's information (cid, waddr, budget)

=> REDUNDANCY!

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Key Constraints

Can generalize to n-ary relationships

```

CREATE TABLE Citizens_Votes
(
  ssn CHAR(11),
  name CHAR(20),
  bday DATE,
  when DATE,
  pid INTEGER,
  cid INTEGER,
  PRIMARY KEY (ssn),
  FOREIGN KEY (cid) REFERENCES PR-Cands,
  FOREIGN KEY (pid) REFERENCES PollStns
)

```

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Participation Constraints

Using Approach 2

```

CREATE TABLE Citizen_Votes(
  ssn CHAR(11),
  name CHAR(20),
  bday DATE,
  when DATE,
  cid INTEGER NOT NULL,
  PRIMARY KEY (ssn),
  FOREIGN KEY (cid) REFERENCES PR_Cands,
  ON DELETE NO ACTION
)

```

Can we enforce participation constraint using Approach 1 (three tables) ?

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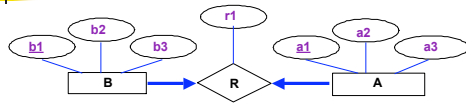
Participation Constraints

Can we enforce constraints on Of relationship?

Need table constraints & assertions – Later.

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Mapping Participation Constraints



```
CREATE TABLE RAB(
  r1 Integer,
  a1 Integer,
  a2 Integer,
  a3 Integer,
  b1 Integer,
  b2 Integer,
  b3 Integer ...)
```

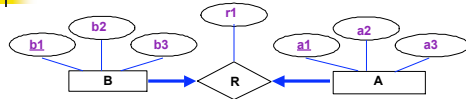
Key constraints?

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Mapping Participation Constraints



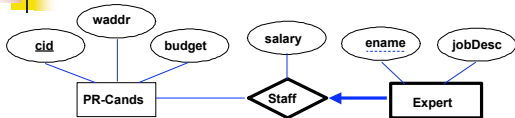
```
CREATE TABLE RAB(
  r1 Integer,
  a1 Integer,
  a2 Integer,
  a3 Integer,
  b1 Integer NOT NULL,
  b2 Integer,
  b3 Integer,
  UNIQUE (b1), PRIMARY KEY (a1))
```

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Weak Entities



- Use approach 2: Combine weak entity and owning entity into one relation
 - Delete all weak entities when an owner entity is deleted.

```
CREATE TABLE Expert_Staff (
  ename CHAR(20),
  jobDesc CHAR(40),
  salary REAL,
  cid INTEGER,
  PRIMARY KEY (ename, cid),
  FOREIGN KEY (cid) REFERENCES PR-Cands ON DELETE CASCADE)
```

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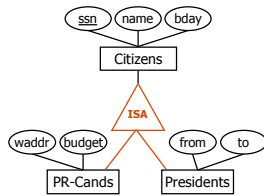
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ISA Hierarchies – General Approach

- Three relations:
 - Citizens (ssn, name, bday)
 - PR-Cands (ssn, waddr, budget)
 - Presidents (ssn, from, to)

Queries

- Involving all citizens => Easy
- Involving just PR-Cands, need to join PR-cands with Citizens to get some attributes



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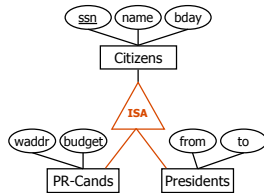
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ISA Hierarchies – Alternative

- Two relations:
 - PR-Cands (ssn, name, bday, waddr, budget)
 - Presidents (ssn, name, bday, from, to)

Problems

- What if citizen is both?
 - Redundancy
- What if citizen is neither?
 - Use General approach



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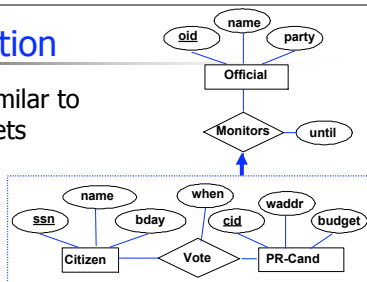
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Aggregation

- Translation similar to relationship sets

Monitors keys

- oid
- (ssn, cid)



What if Vote:

- has no descriptive attributes AND
- total participation in monitors

Fold Vote and Monitors into 1 table

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Exercise – Part 1

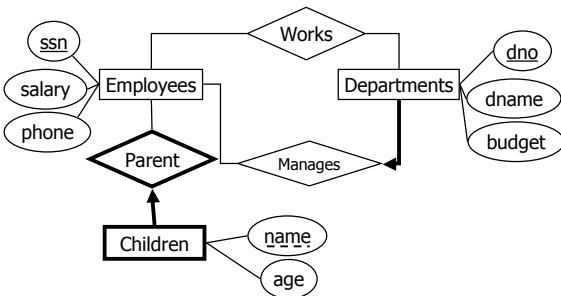
- A company database needs to store information about employees (identified by *ssn*, with *salary* and *phone* attributes), departments (identified by *dno*, with *dname* and *budget* attributes), and children of employees (with *name* and *age* attributes). Employees work in (zero or more) departments; each department is managed by exactly one employee; a child must be identified uniquely by name when the parent (who is an employee; assume only one parent works for the company) is known. We are not interested in information about a child once the parent leaves the company.
- Draw an ER diagram that captures this information

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ER Diagram (One Solution)



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Exercise – Part 2

- Write SQL Statements to create the corresponding relations, and to capture as many of the constraints as possible.

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SQL DDL (One Solution)

```
CREATE TABLE employees (
  ssn INTEGER,
  salary REAL,
  phone CHAR(10),
  PRIMARY KEY(ssn))
```

```
CREATE TABLE works (
  ssn INTEGER,
  dno INTEGER,
  PRIMARY KEY (ssn, dno),
  FOREIGN KEY (ssn)
    REFERENCES employees,
  FOREIGN KEY (dno)
    REFERENCES departments)
```

```
CREATE TABLE departments (
  dno INTEGER,
  dname CHAR(20),
  budget real,
  ssn INTEGER NOT NULL,
  PRIMARY KEY (dno),
  FOREIGN KEY (ssn)
    REFERENCES employees)
```

```
CREATE TABLE children (
  name CHAR(20),
  age REAL,
  ssn INTEGER NOT NULL,
  PRIMARY KEY(name, ssn),
  FOREIGN KEY(ssn)
    REFERENCES employees
  ON DELETE CASCADE)
```

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Announcements

- Optional Exercises: 3.11

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