Spring 2017

ER MODELING

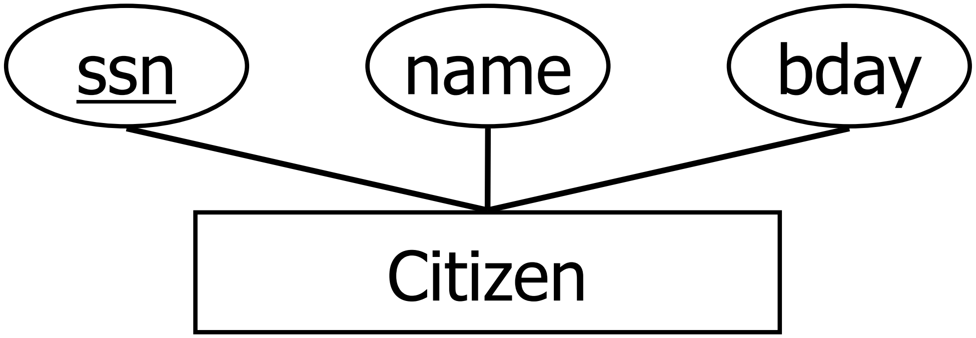
[CH 2: SECTIONS 2.1-2.4.2 AND CH3: SECTIONS 3.5.1 - 3.5.4]

Database Design

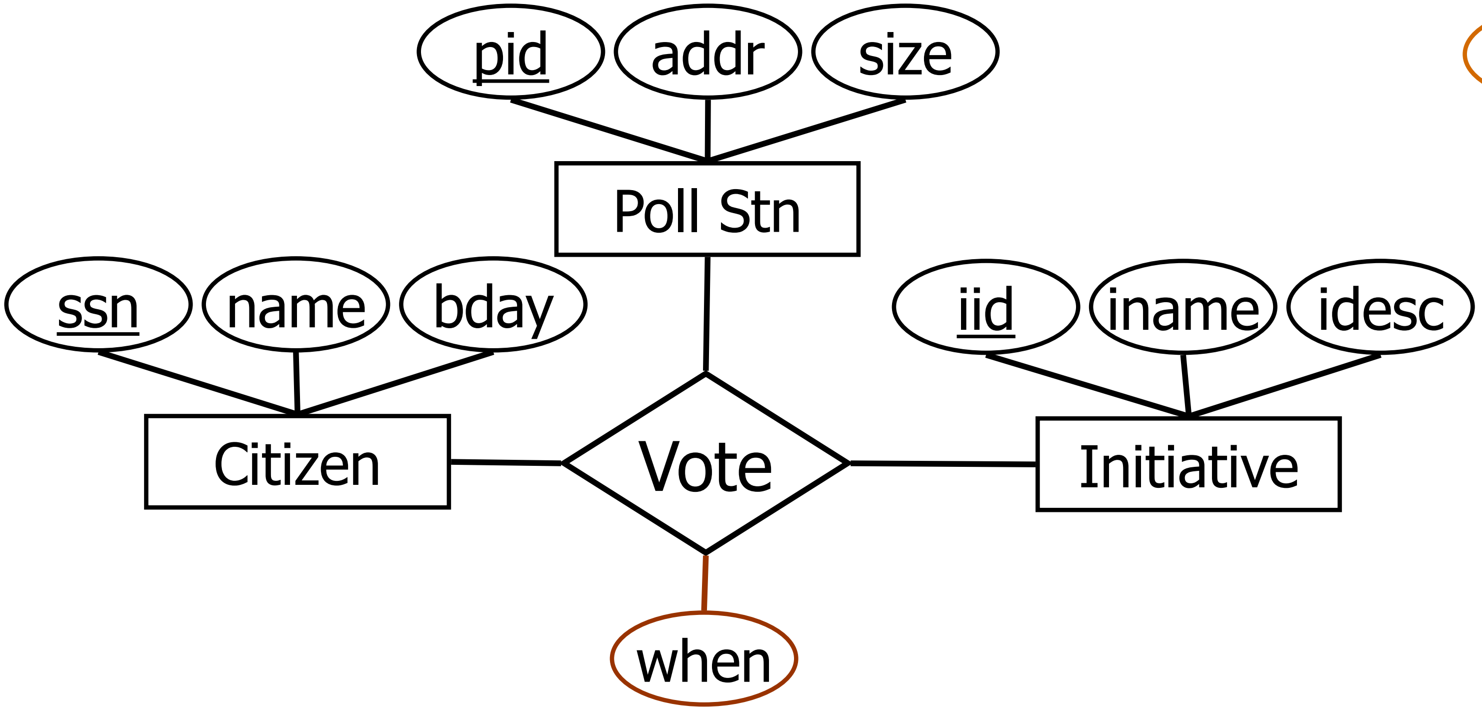
- Requirements Analysis
    - Data stored, operations, apps, …
- Conceptual Database Design
    - Model high-level description of the data, constraints, ER model
- Logical Database Design
    - Choose a DBMS and design a database schema
- Schema Refinement
- Physical Database Design
- Application and Security Design

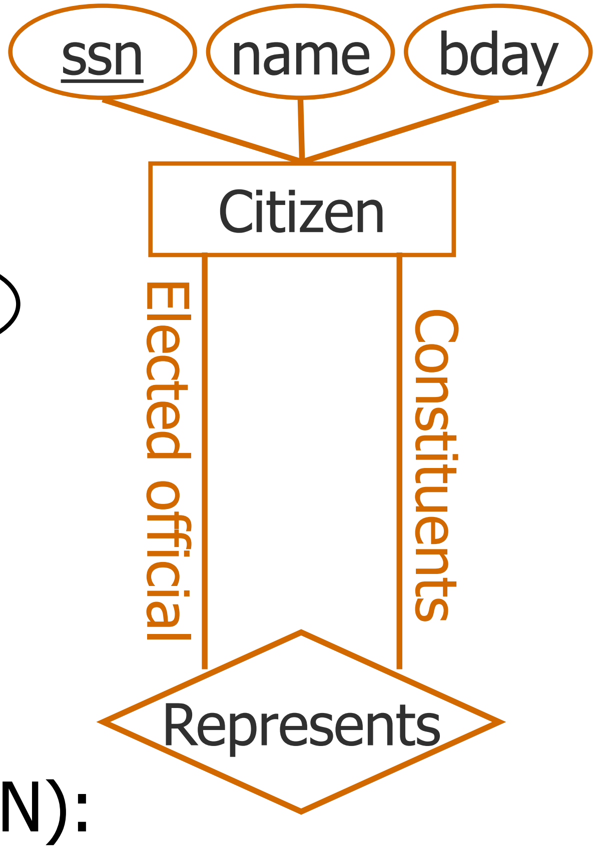
ER Model Basics

- *Entity:* Distinguishable real-world object
  - Described by a set of *attributes,* Each attribute has a *domain*
- *Entity Set*: A collection of similar entities. E.g., all citizens.
  - All entities in an entity set have the same set of attributes. (Until we consider ISA hierarchies!)
  - *Key* : minimal set of attributes whose values uniquely identify an entity in an entity set
    - Primary key
    - Candidate key
- Pictorially ...



- *Relationship* : Association among two or more entities
- *Relationship Set* : Collection of similar relationships





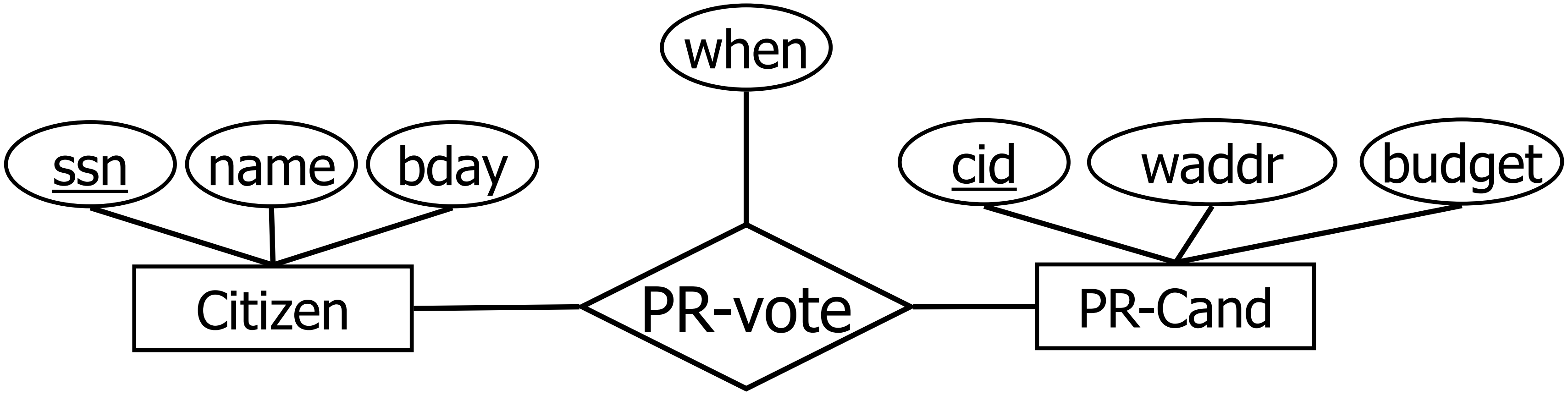
- Mathematical relation on n entities (degree N):

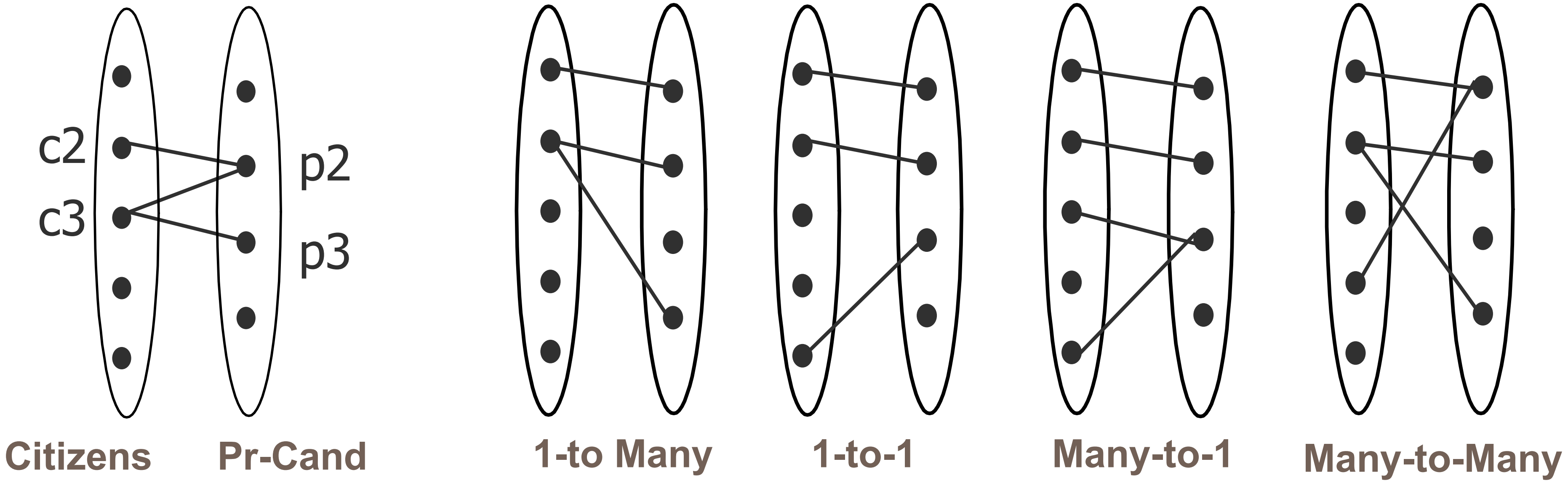
$$\{(e_1, e_2, \ldots, e_n) \mid e_1 \in E_1, e_2 \in E_2, \ldots, e_n \in E_n\}$$

- Entity sets:
  - Can participate in > 1 relationship sets in different “roles”.

Key Constraints

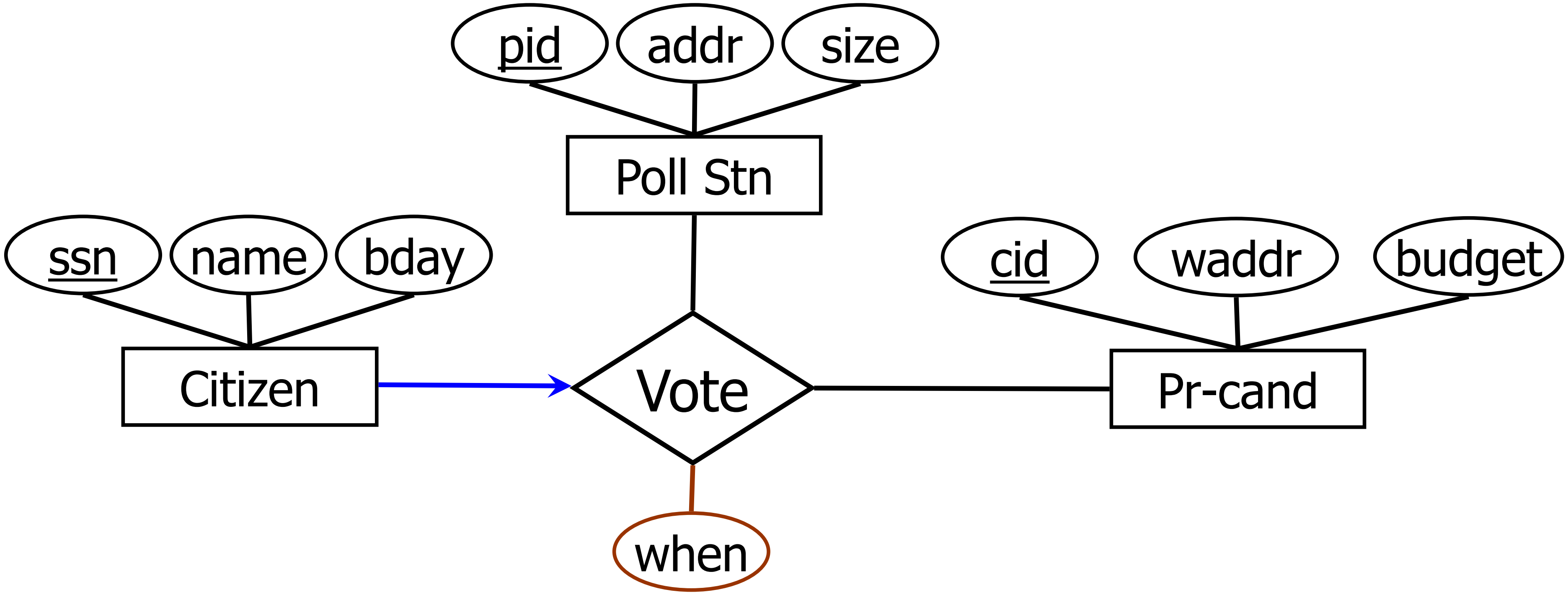
Key Constraint : Each citizen votes at most once





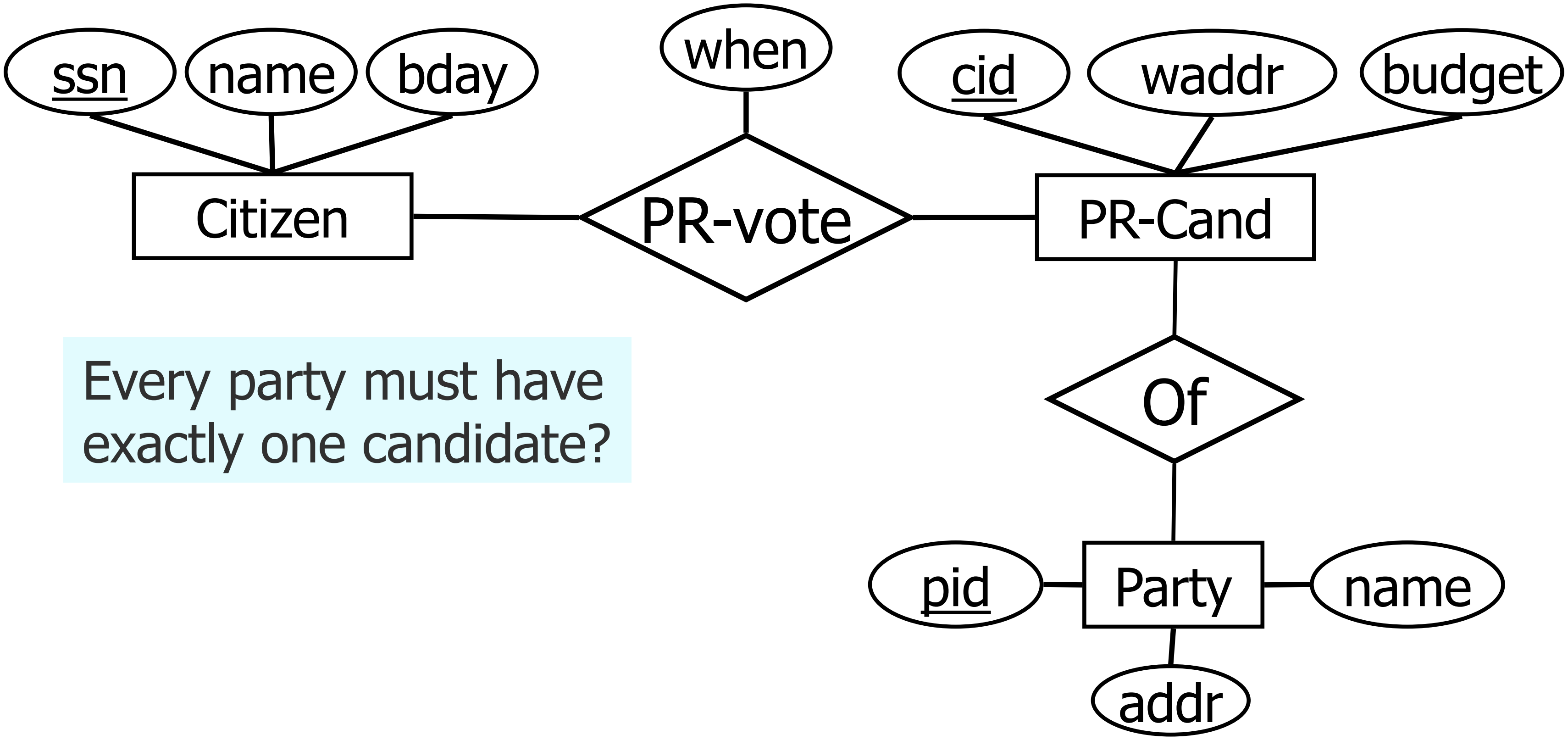
Key Constraints: Generalize

Each voter votes at most once (for one candidate) and at a single location



Participation Constraints

- Key Constraint: A citizen has a single vote
- Q: Must every citizen vote?
  - This is a *participation constraint* : Every citizen must participate (*total* vs. *partial*).



Every party must have exactly one candidate?

Other Constructs in the ER model

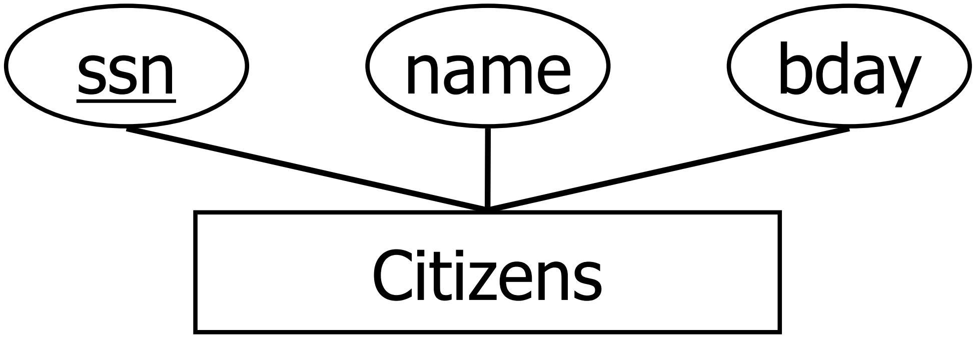
- Weak Entities: an entity that is dependent on another entity
- Hierarchies: Model “IS A” hierarchies.
- Aggregation: Make a relationship act like an entity when participating in another relationship.

See the text book if you are interested in these advanced constructs

Next Step

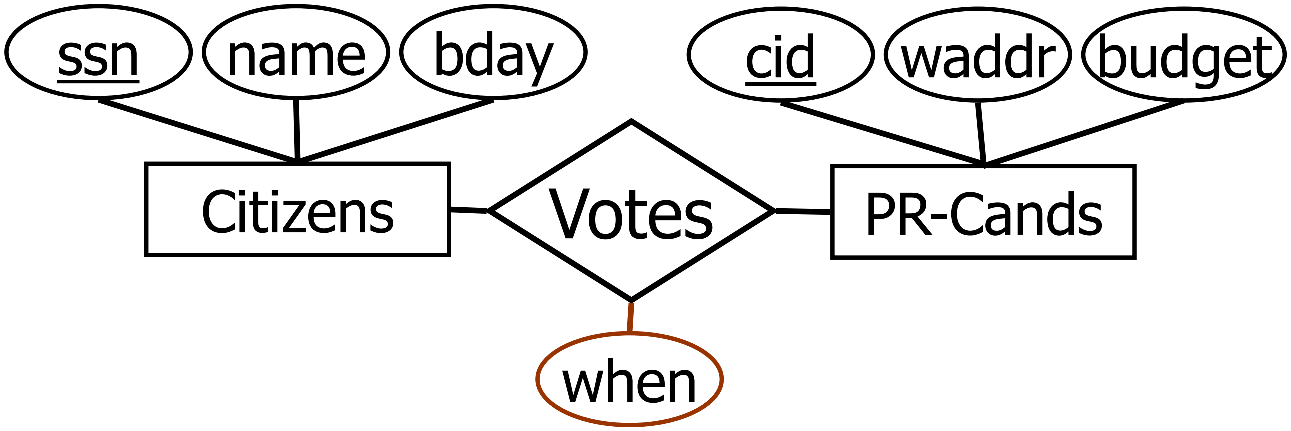
- Need to map the ER diagram to SQL DDL statements

Logical DB Design: ER to Relational



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

Relationship Sets to Tables



Relationship set -> Table

Attributes:

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

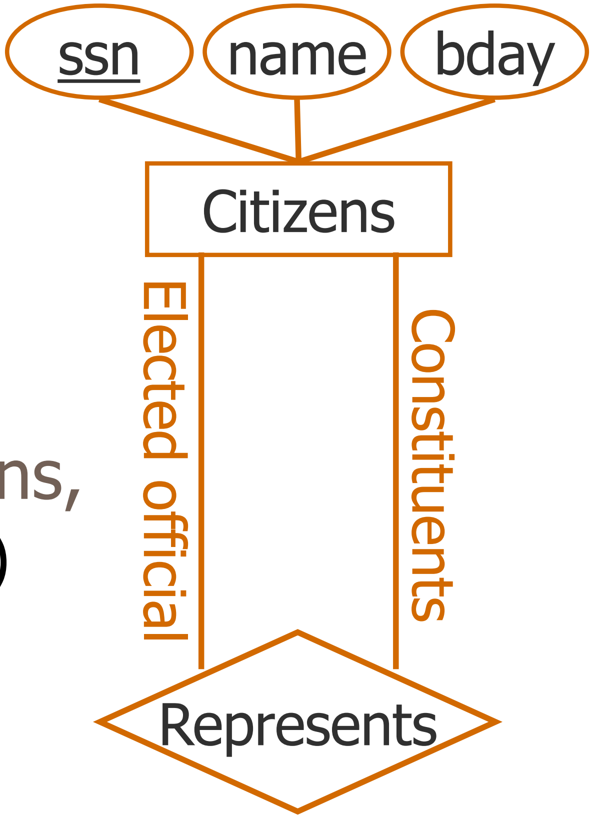
```
CREATE TABLE Votes(
          ssn     CHAR(11),
          cid     INTEGER,
          when    DATE,
PRIMARY KEY (ssn, cid),
FOREIGN KEY (ssn) REFERENCES Citizens,
FOREIGN KEY (cid) REFERENCES PR-Cands)
```

Can ssn have a null value?

Can generalize to n-ary relationships

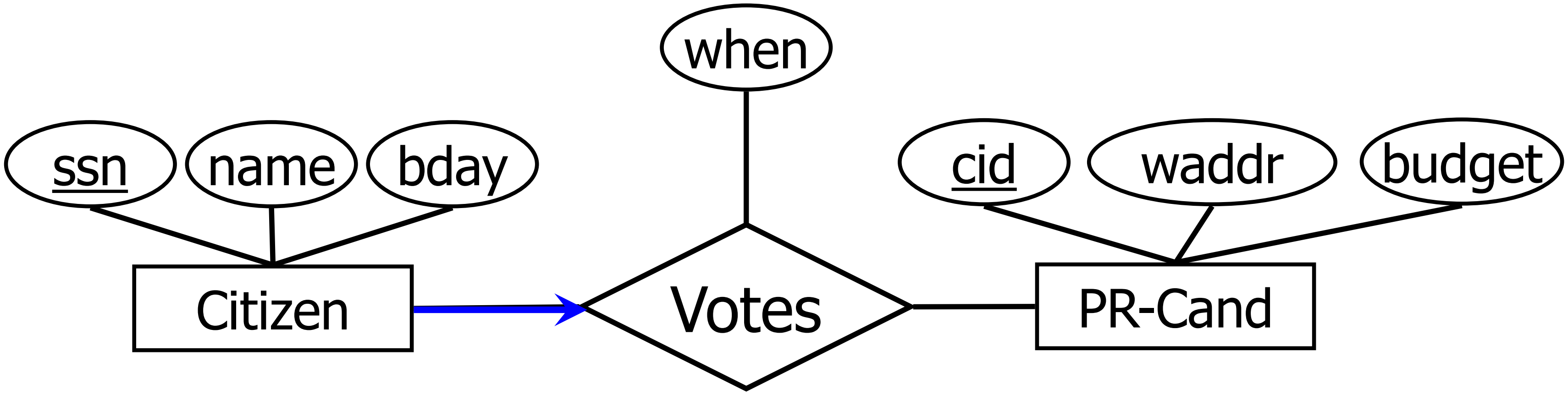
Relationship Sets to Tables

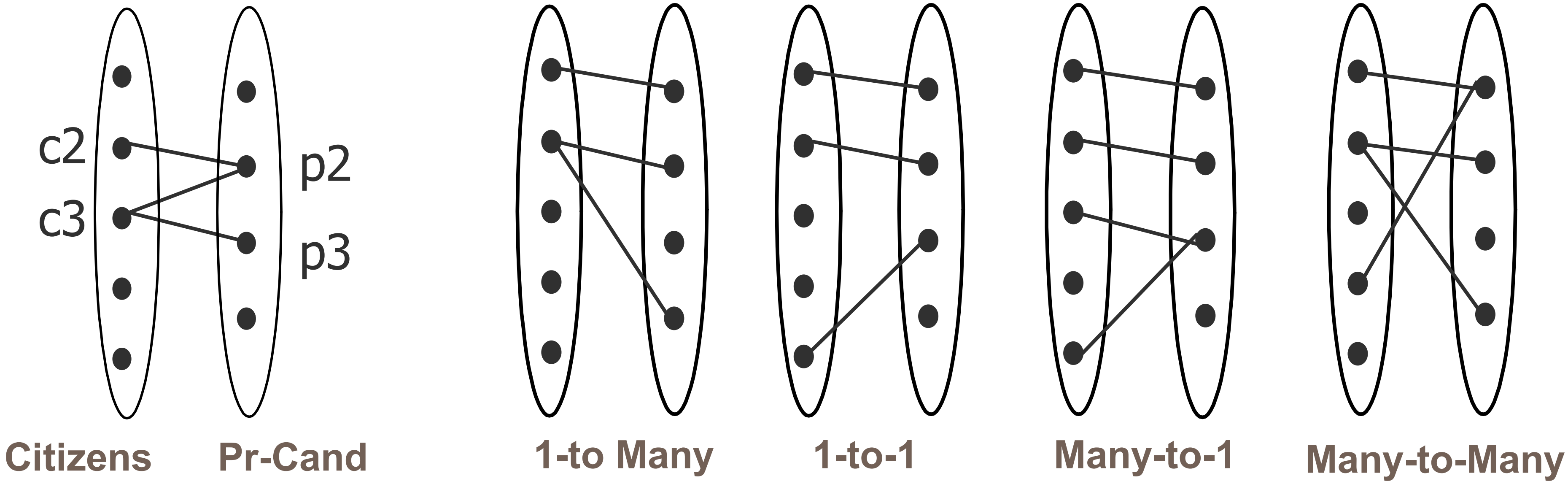
```
CREATE TABLE Represents(
          elected_ssn  CHAR(11),
          cons_ssn  CHAR(11),
PRIMARY KEY (elected_ssn, cons_ssn),
FOREIGN KEY (elected_ssn) REFERENCES Citizens,
FOREIGN KEY (cons_ssn) REFERENCES Citizens)
```



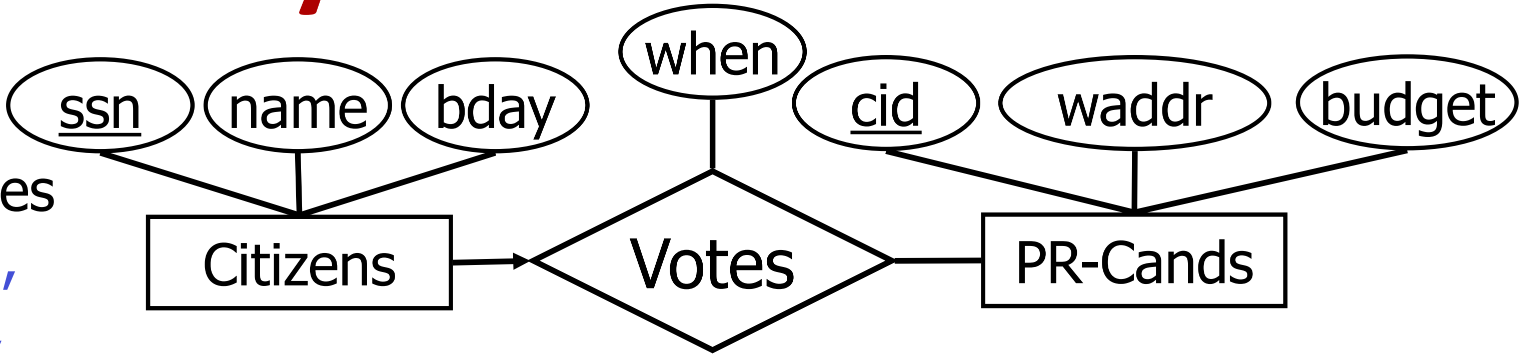
Key Constraints: Review

Key Constraint : Each citizen votes at most once





Key Constraints



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

⇐ Approach 1: Three 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)
```

Approach 2: Two tables!

- Fold into Citizens.

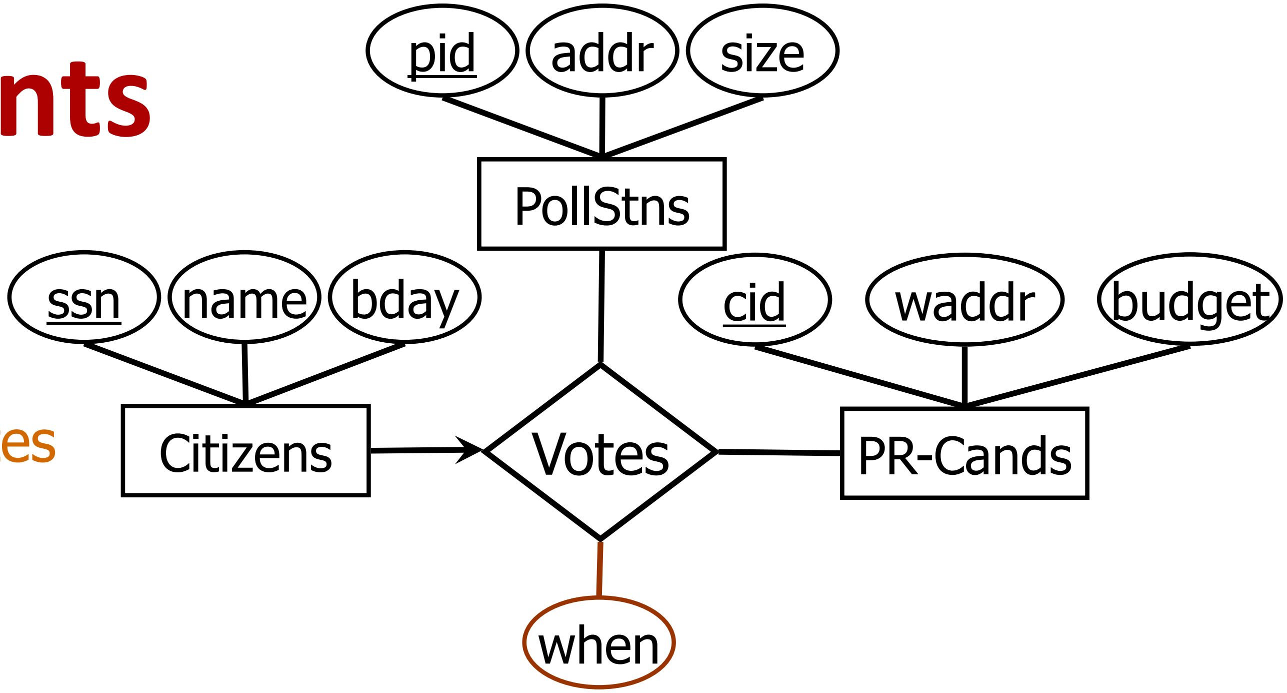
Q: Can cid be null?

Q: What if many citizens don't vote

Q: Which approach is better?

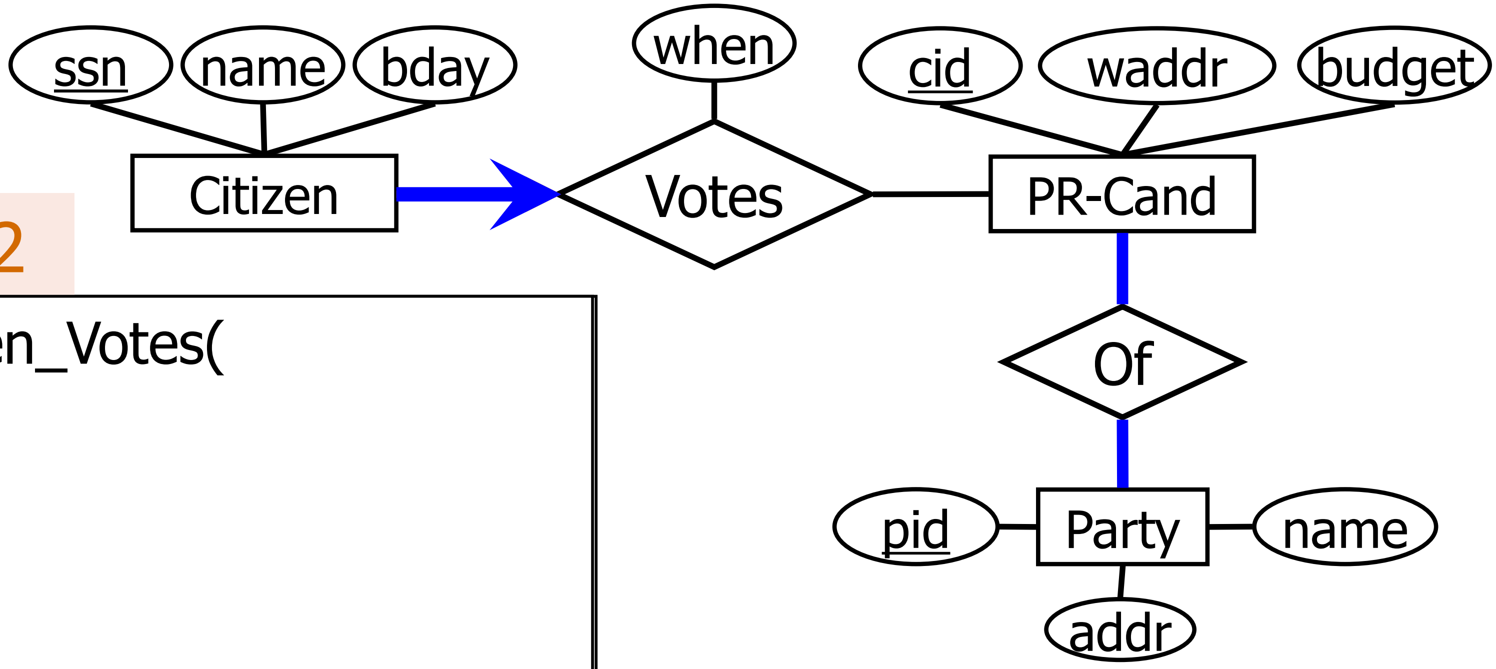
Can generalize to n-ary relationships

Key Constraints



```
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)
```

(Total) Participation Constraints



Using Approach 2

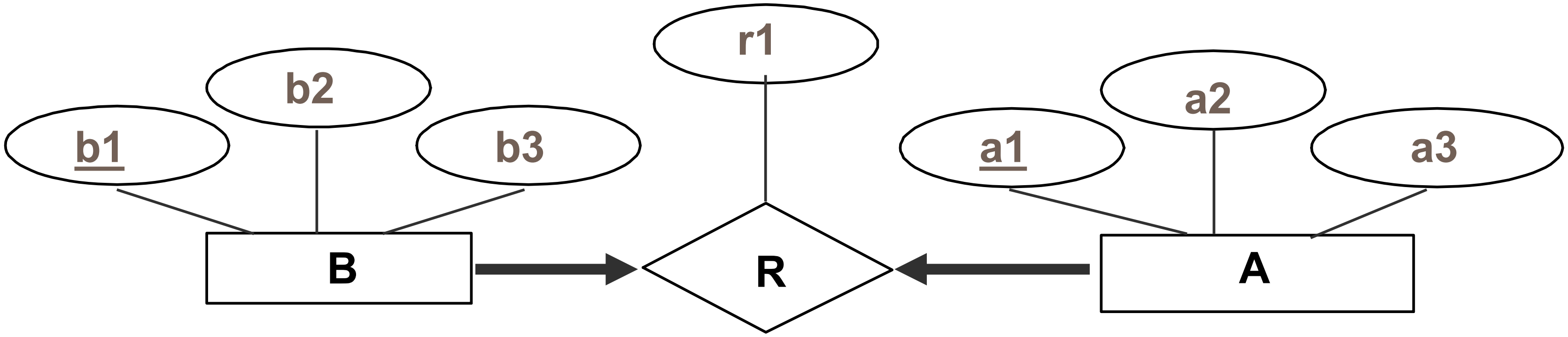
```
CREATE TABLE  Citizen_Votes(
   ssn      CHAR(11),
   name  CHAR(20),
   bday   DATE,
   when  DATE,
   cid      INTEGER NOT NULL,
PRIMARY KEY  (ssn),
FOREIGN KEY  (cid) REFERENCES PR_Cands,
     ON DELETE NO ACTION)
```

Approach 1?

- **Make ssn and cid not null**
- **ssn Fkey in Citizens pointing to Votes**

- Participation constraint on OF
  - Use Table constraints and assertions: Expressive but expensive!

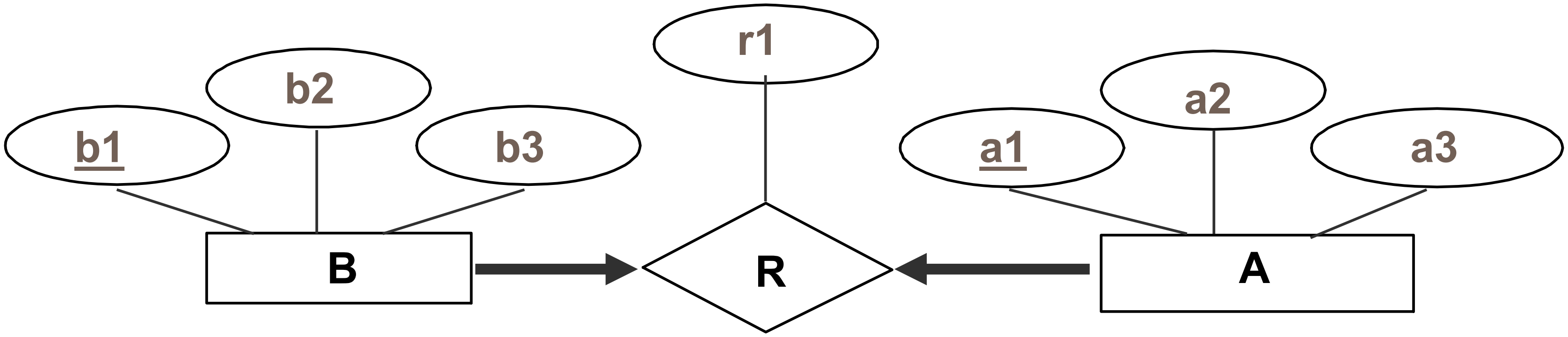
Mapping Participating Constraints



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

Key constraints?

Mapping Participating 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))
```

More modeling

- There are well-known techniques to map the advanced ER techniques (e.g. aggregation). See the book if you are interested.

- There are more than one ways to draw the ER diagram. A popular model is the “Crow’s Foot Notation.”

- Often the diagrams are generated using tools, and initial mappings are produced in automated ways.