The Entity-Relationship Model

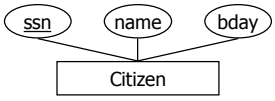
Chapter 2

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

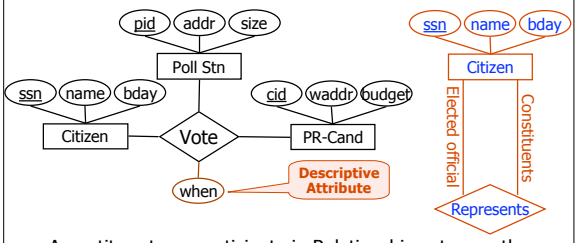
ER Model Basics

- *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
    - 1 *Primary key*
    - Multiple *Candidate keys*
- Pictorially …



ER Model Basics

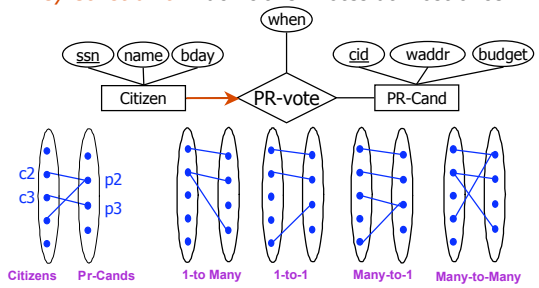
- *Relationship* : Association among two or more entities
- *Relationship Set* : Collection of similar relationships



- An entity set can participate in Relationship set more than once, in different roles

Key Constraints

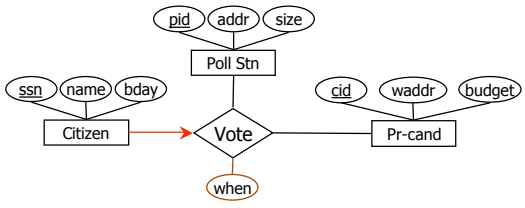
Key Constraint : Each citizen votes at most once



What is Many-to-1? *Many citizens can vote for a single candidate.*

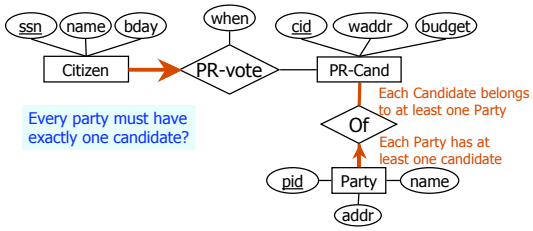
Key Constraints: Generalize

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



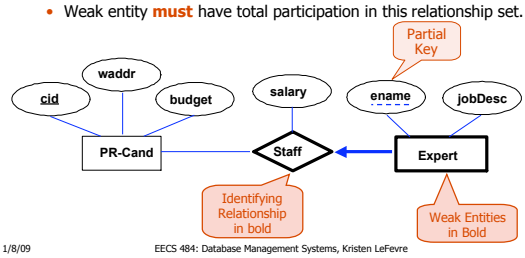
Participation Constraints

- 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*).



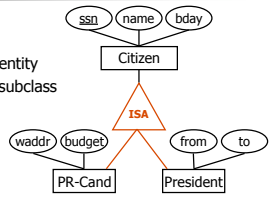
Weak Entities

- *Weak entity* : identified uniquely only by considering the primary key of another (*identifying owner*) entity.
- Relationship set between owner and weak entity set
  - **Must** be one-to-many: one owner, many weak entities
  - Weak entity **must** have total participation in this relationship set.



ISA ('is a') Hierarchies

- ✓ Like C++, attributes are inherited.
- ✓ If A **ISA** B, every A entity is also a B entity
- ✓ Add descriptive attributes to specific subclass
- ✓ Can be multi-level

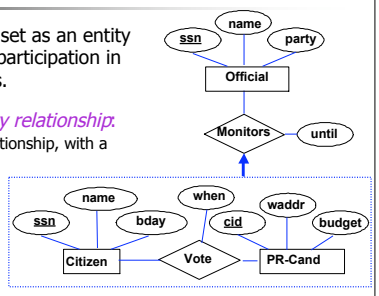


- *Overlap constraints*
  - Can Joe be a PR-Cand as well as a president entity?
  - PR-Cand OVERLAPS President (default: no overlaps)
- *Covering constraints*
  - Must every Citizen entity be either PR-Cand or President entity?
  - Motorboats and Cars COVER Motor-Vehicle (default: no covering constraint)

Aggregation

- Treat a relationship set as an entity set for purposes of participation in (other) relationships.

Aggregation vs. ternary relationship:
- ✓ Monitors is a distinct relationship, with a descriptive attribute.
- ✓ Also, can say that each vote is monitored by precisely one official



Conceptual Design Using the ER Model

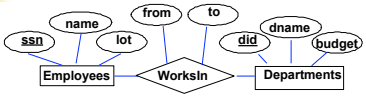
- Design choices:
  - Should a concept be modeled as an entity or an attribute?
  - Should a concept be modeled as an entity or a relationship?
  - Identifying relationships: Binary or ternary? Aggregation?
- Constraints in the ER Model:
  - A lot can (and should) be captured.
  - But some constraints cannot be captured in ER diagrams.

Entity vs. Attribute

- Should *address* be an attribute of Party or an entity (connected to Party by a relationship)?
- Depends on semantics of data, how we plan to use address information
- *address* must be an entity if…
  - Multiple addresses per Party
  - We want to store and query the structure of the address (city, street, zip attributes)

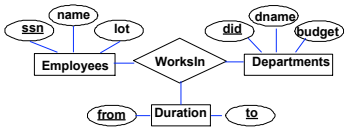
    E.g., Find all parties in 'Ann Arbor'

Entity vs. Attribute
(Another Example)

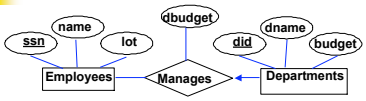


Doesn't allow an employee to work in a department for more than one period of time!

What can we do instead?

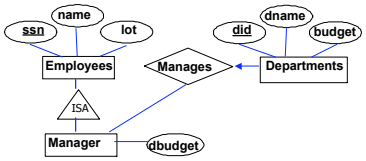


Entity vs. Relationship

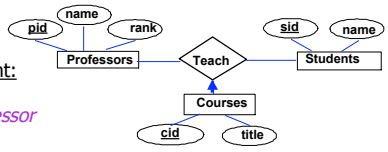


Manager gets discretionary budget for each department.

What if manager gets discretionary budget to cover *all* managed departments?



Binary vs. Ternary Relationships



Desired Constraint:
Each course has exactly one professor

Bad Design

What's wrong?

Key constraint on courses means each course can only have one student!

Binary vs. Ternary Relationships

Exercise: Create a better design…

Binary vs. Ternary Relationships

- An example in the other direction:
  - Ternary relationship **Contracts**
  - Relates Parts, Departments, Suppliers
  - Descriptive attribute *Quantity*
- No combination of binary relationships is an adequate substitute:
  - S "can-supply" P, D "needs" P, and D "deals-with" S does not imply that D has agreed to buy P from S.
  - How do we record *Quantity*?

Summary of Conceptual Design

- High-level (semantic) description of data to be stored
- ER model popular for conceptual design
  - Constructs are expressive and natural
  - Basic constructs: entities, relationships, and attributes (of entities and relationships).
  - Additional constructs: weak entities, ISA, aggregation.
  - Integrity constraints: key constraints, participation constraints, and overlap/covering constraints for ISA hierarchies.
- There are many variations on ER model
- ER designing is subjective! – Best advice is to carefully understand requirements and think through your design.

What's Next?

- Relational Model
  - Chapter 3
- Suggested exercises (ungraded)
  - 1.3
  - 2.1,2.3,2.5,2.7