Overview of Database Systems

CPSC 315 – Programming Studio

Spring 2017

Project 1, Lecture 1

Project

- Your first project (next week) will involve putting together a very basic database system
- There will be a few lectures to give you an overview of database systems
- This is nowhere close to what you would get in a full database course
- *Slides adapted from Jennifer Welch (some of hers were from Jeffrey Ullman)*

Database Systems

- Systems designed to manage very large amounts of data, and to query that data to pull out useful information
- Often, key considerations include:
  - Efficiency
  - Reliability
  - Ease of access (querying, distributed)

Databases

- A critical part of most IT operations
- Accessing database information can be as common as accessing any variable/object stored in memory
- But, the process for accessing it is different
  - This can be good in that it helps highlight the difference with data in memory.

Creating a Database

- A database *schema* determines what will be represented in the database
- This should be tightly controlled by a database manager
- Specified through a data definition language

Querying Databases

- Once database has been populated, users can *query* the data
- A data manipulation language controls how the user can specify queries, (and thus what types of queries are allowed)
  - SQL is probably the most well-known

Other Database Topics

- "Real" database courses include lots of other things that we'll be ignoring here
  - More complete theory behind design
  - Query optimization
  - Efficient storage
  - Processing Transactions – grouped queries that provide atomic operations
    - Scheduling, logging, recovery

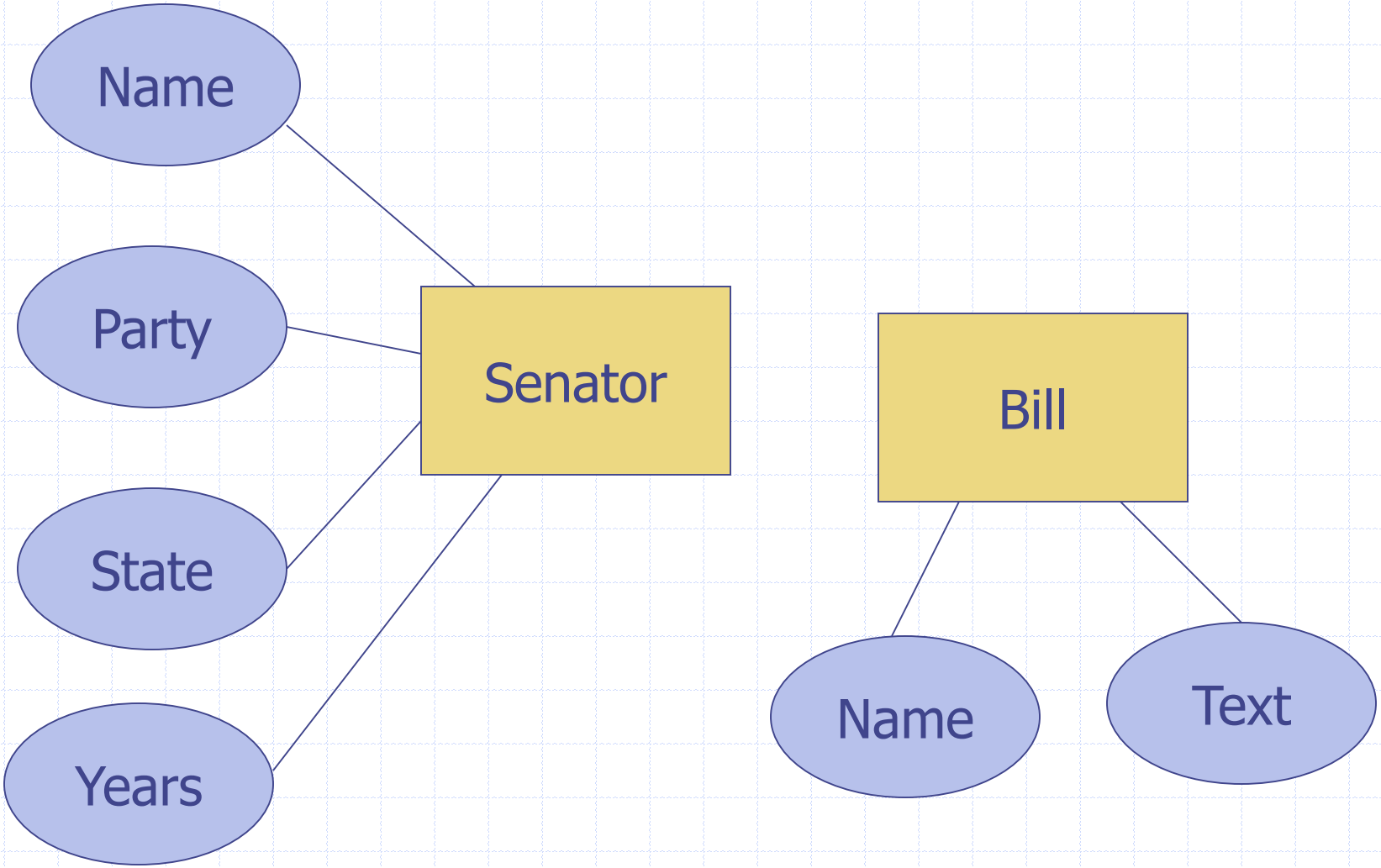
Entity-Relationship Model

- Way of expressing (in diagrammatic form) a database design
  - Kinds of data and how they connect
- Easy first way to think about databases
- Later, relational model described
  - Relational model is the foundation of most databases

Entities and Attributes

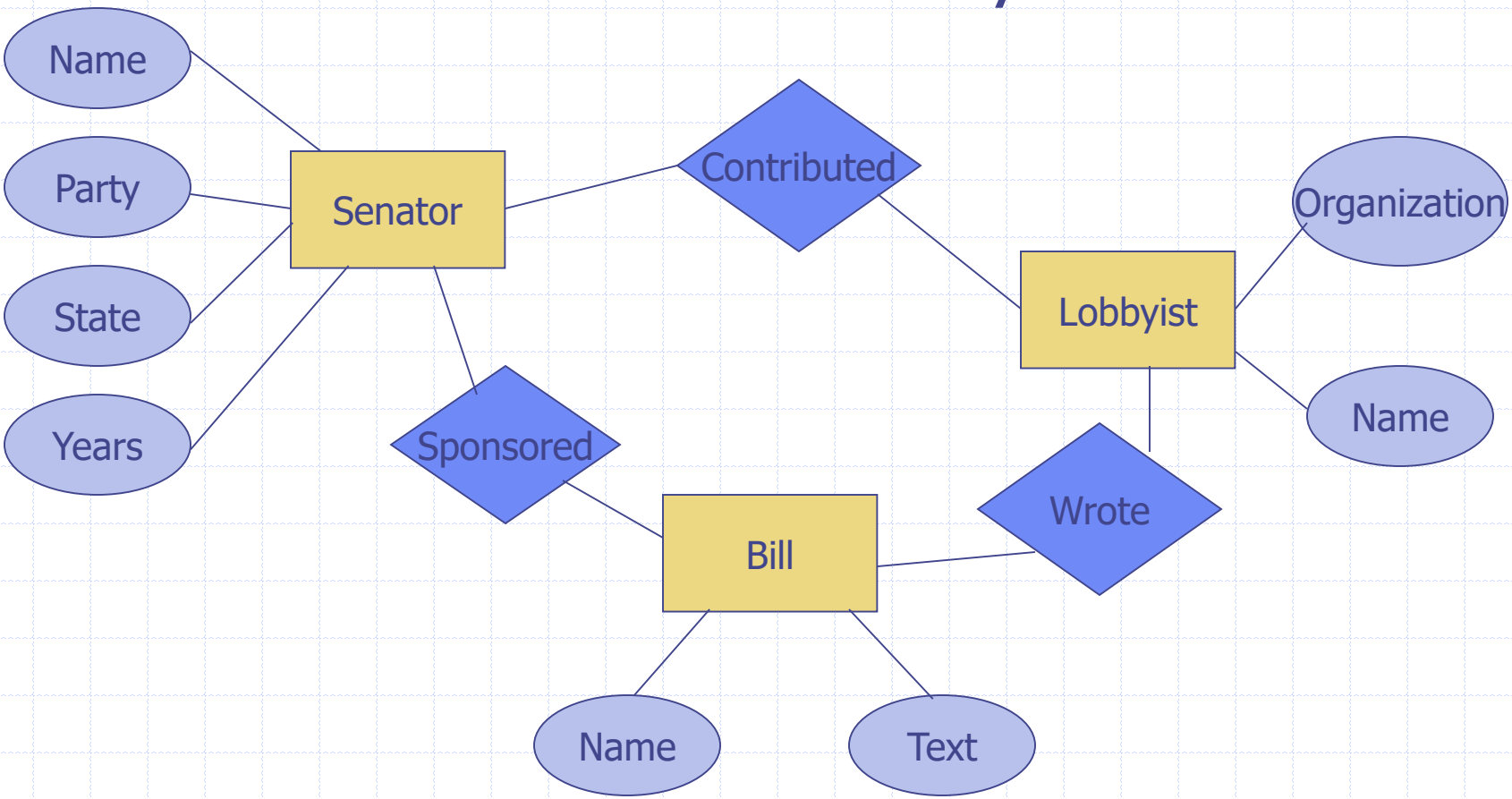
- *Entities* are things
- *Entity sets* are collections of those things
- *Attributes* are properties of entity sets

Entity Sets and Attributes



Relationships

- Connect two or more entity sets



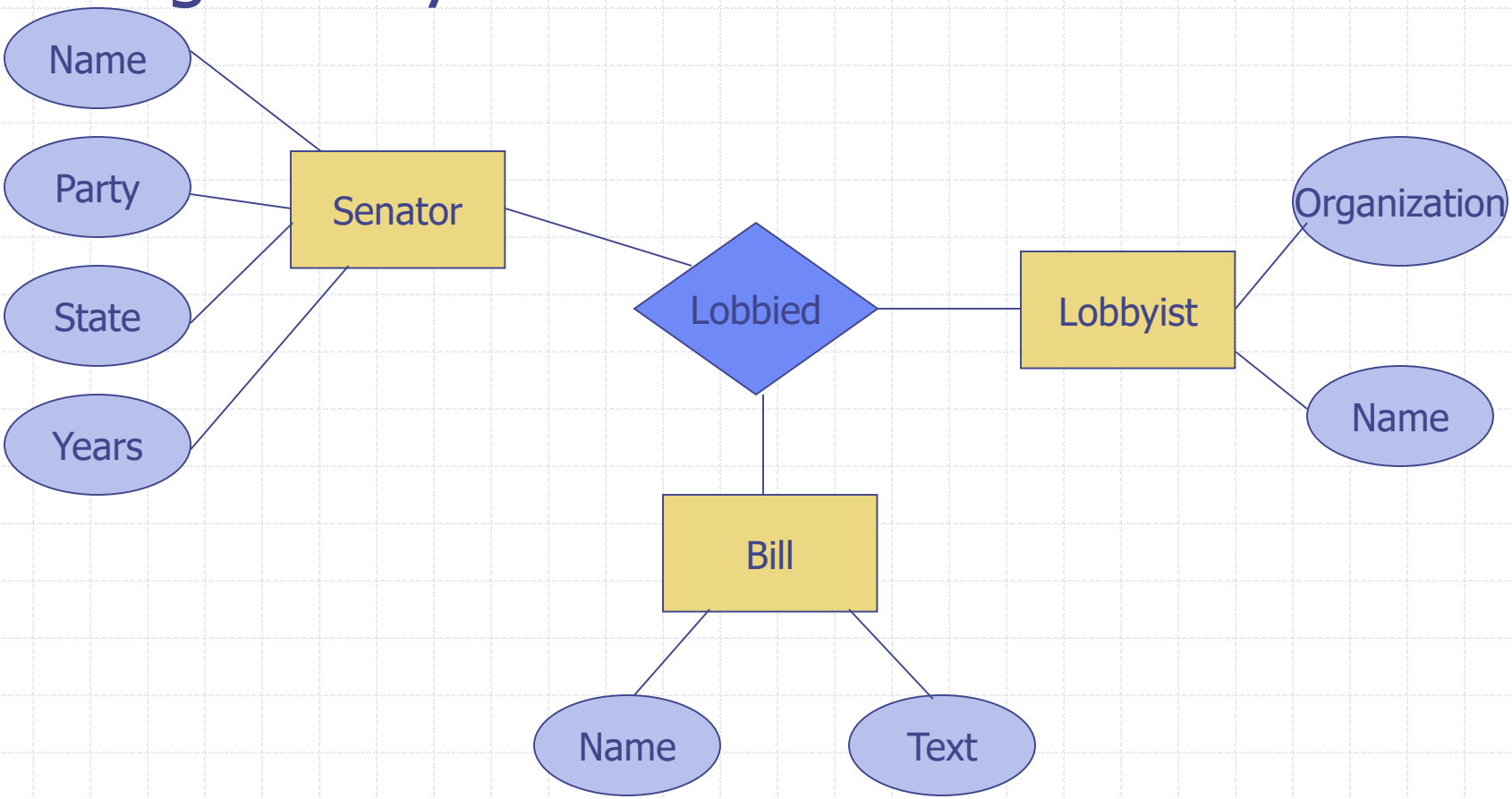
Values of Relationships

- The "value" of an entity set is the entities it contains
- The "value" of a relationship is a list of currently related entities (one from each entity set)

Senator	**Bill**
Smith	Tax Bill
Smith	Defense Bill
Jones	Tax Bill

Multi-Way Relationships

- E.g. Lobbyist lobbied Senator about Bill



Relationship Types

- Consider binary relationships (two entity groups in a relationship)
- One-to-one
  - Each entity can have at most one in the other category
  - e.g. entity groups: Baseball player, Team
  - relationship: Team MVP
  - A team can only have one MVP, and a player can only be MVP for one team.

Relationship Types

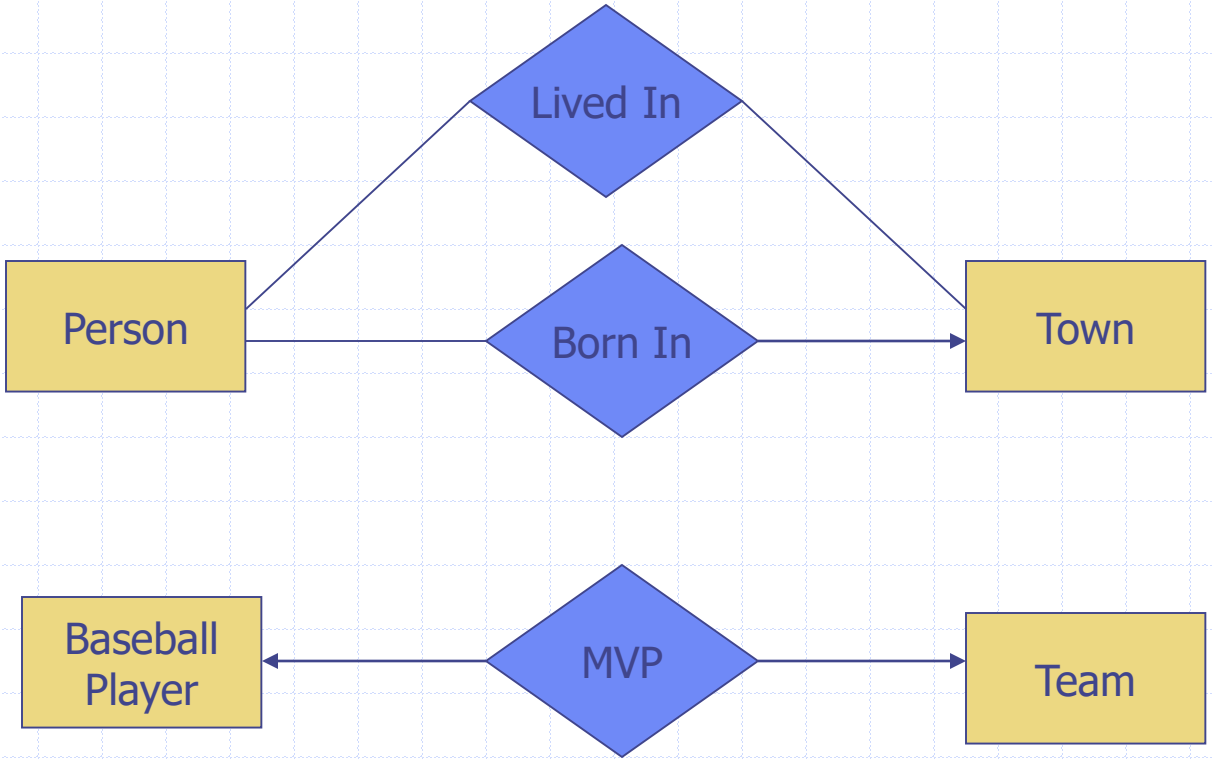
- Consider binary relationships (two entity groups in a relationship)
- One-to-one
- Many-to-one
  - Each entity of first set can go to at most one of the second set
  - e.g. entity groups: Person, Town
  - relationship: BornIn
  - A person can is born in only one town, but a town can have many people born there

Relationship Types

- Consider binary relationships (two entity groups in a relationship)
- One-to-one
- Many-to-one
- Many-to-many
  - Any number from one set to the other
  - e.g. Senators can sponsor many bills, and each bill can be sponsored by many Senators

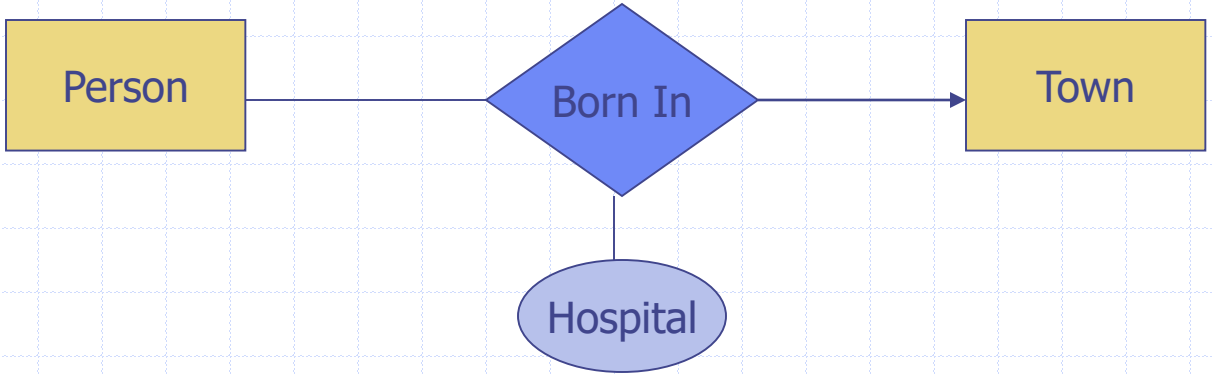
Diagrams of Relationships

- Arrow shows "to one"



Attributes on Relationships

- Can be converted to multi-way diagrams



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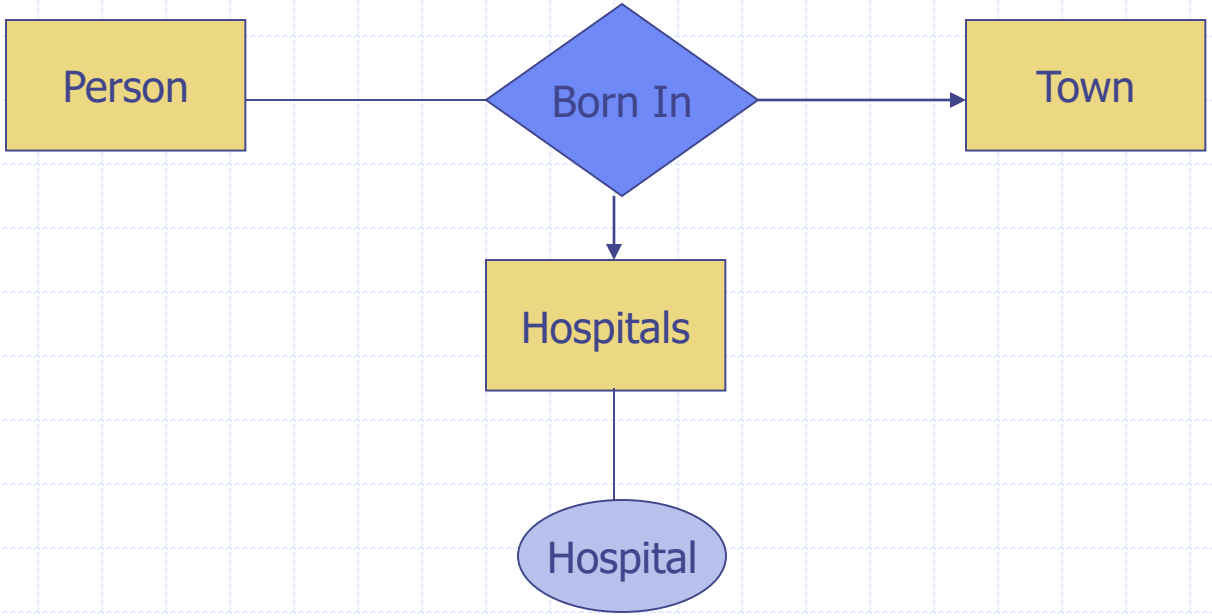
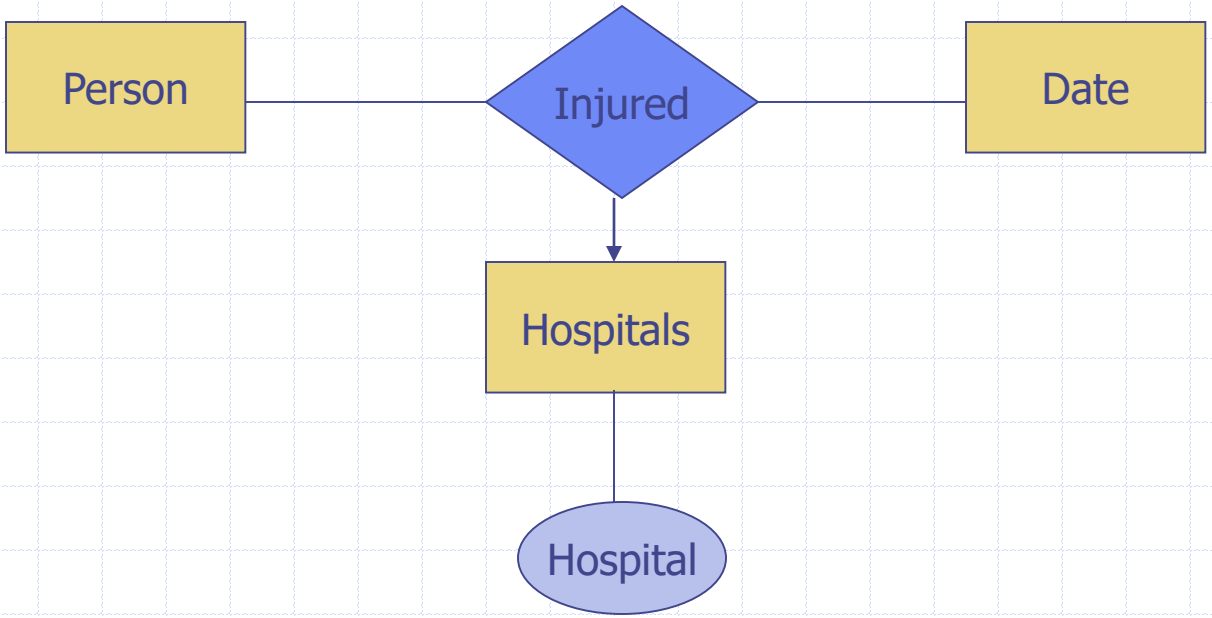


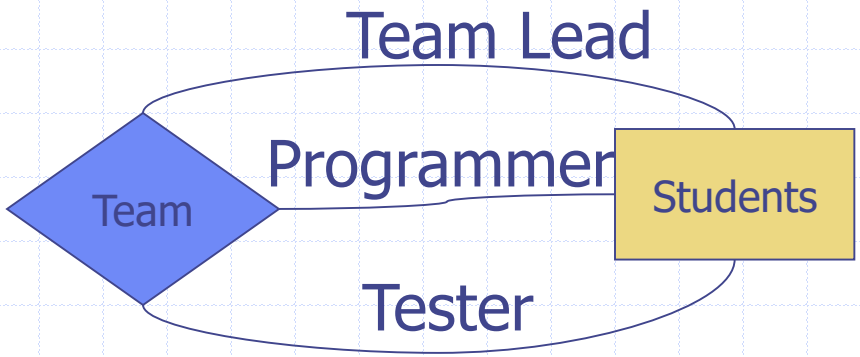
Attributes on Relationships

- Note arrows



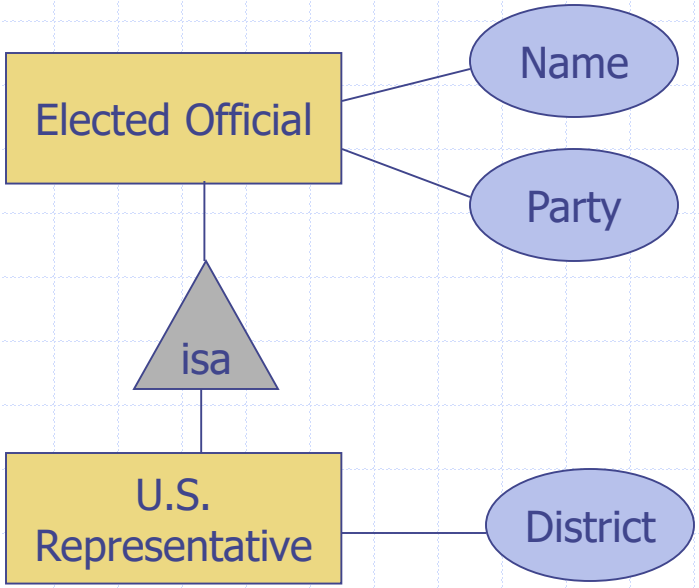
Roles

- If multiple references to same entity set, label edges by roles



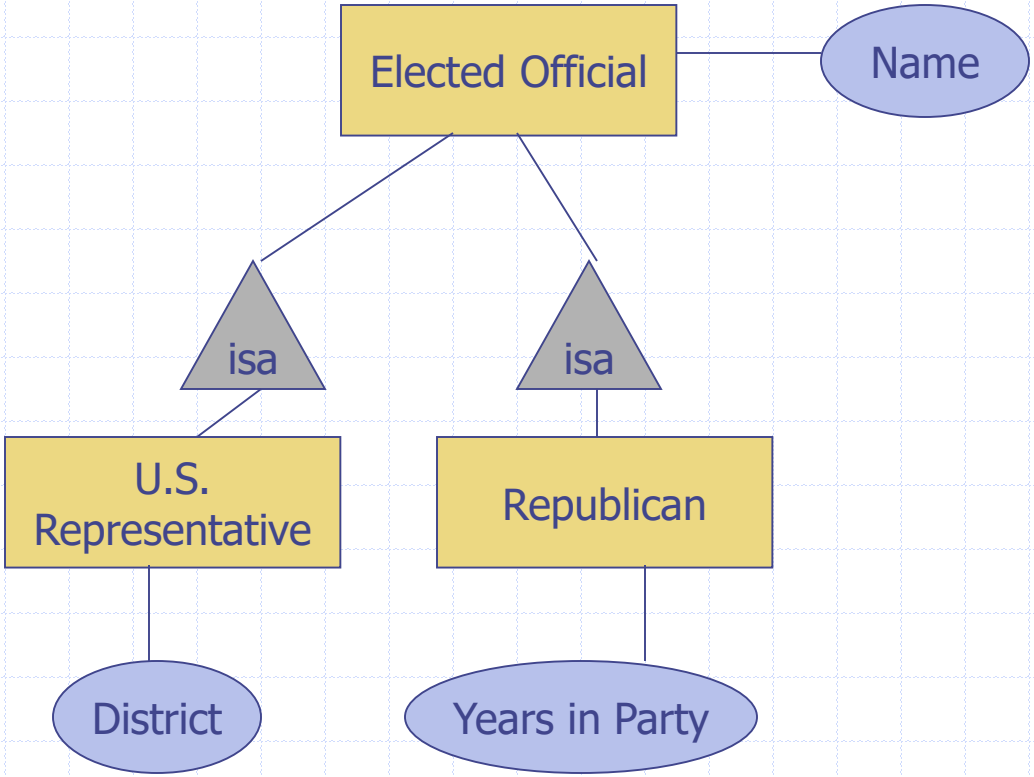
Subclass

- Fewer entities, more properties



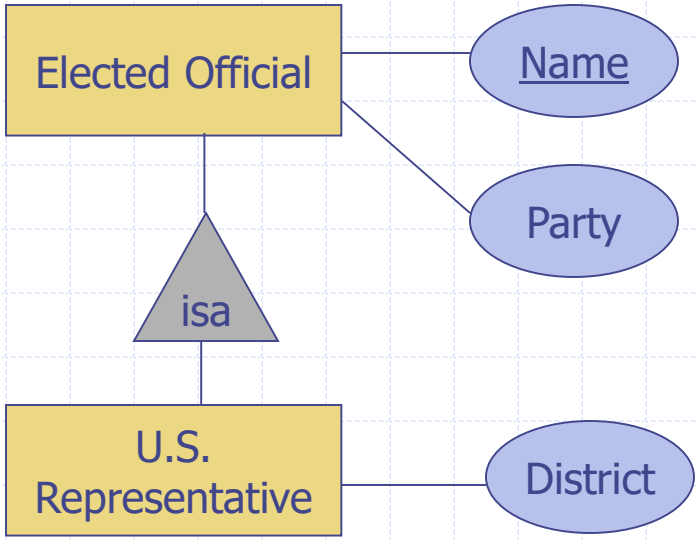
Subclass

- Entity in all subclasses



Keys

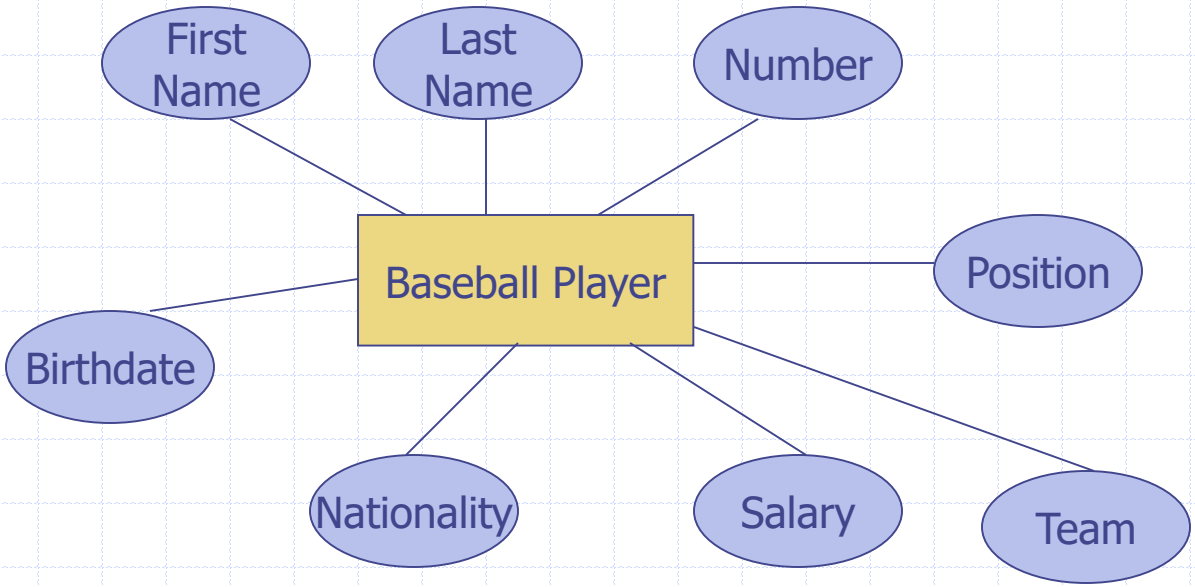
- A *key* is a set of attributes for an entity set such that no two entities agree on all the attributes.
- We must have a key for every entity set



For an isa hierarchy, only root can have a key.

Key for multiple attributes

- Must choose *one* set of attributes



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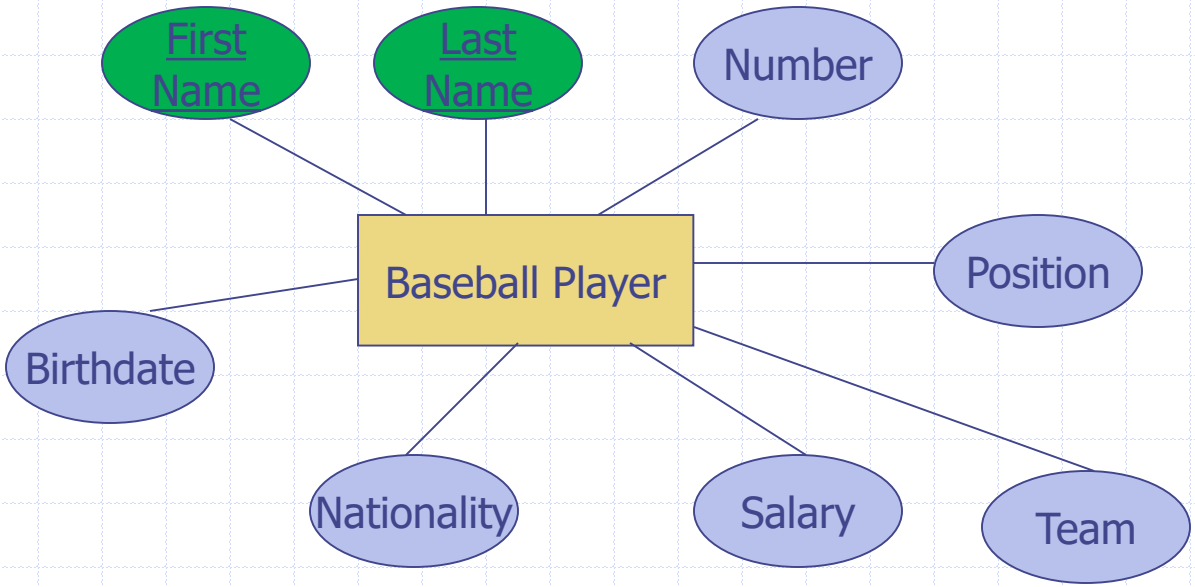

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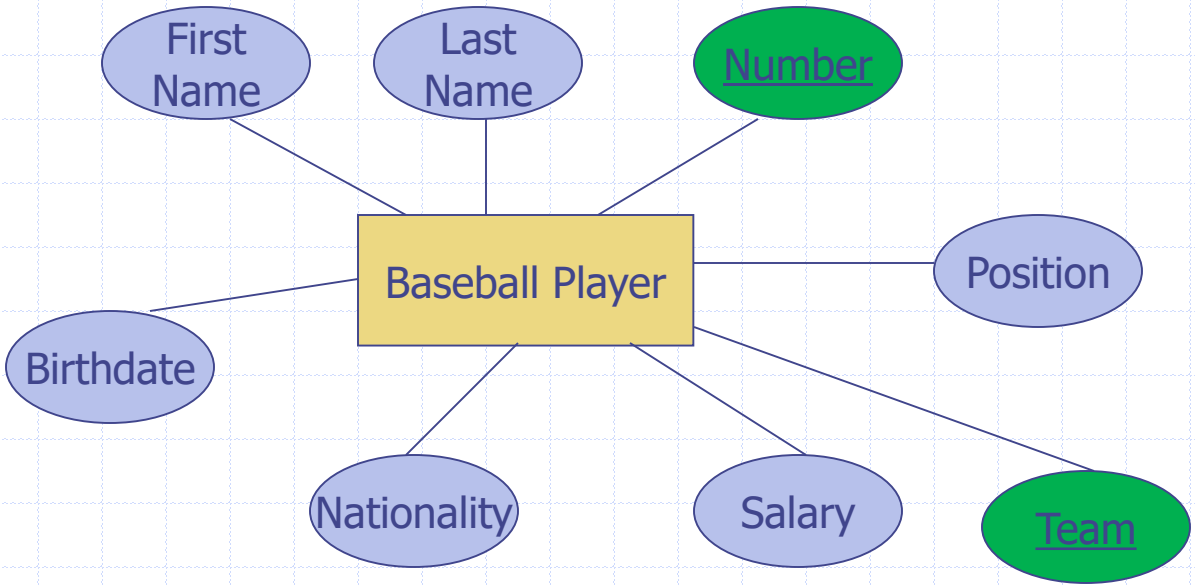
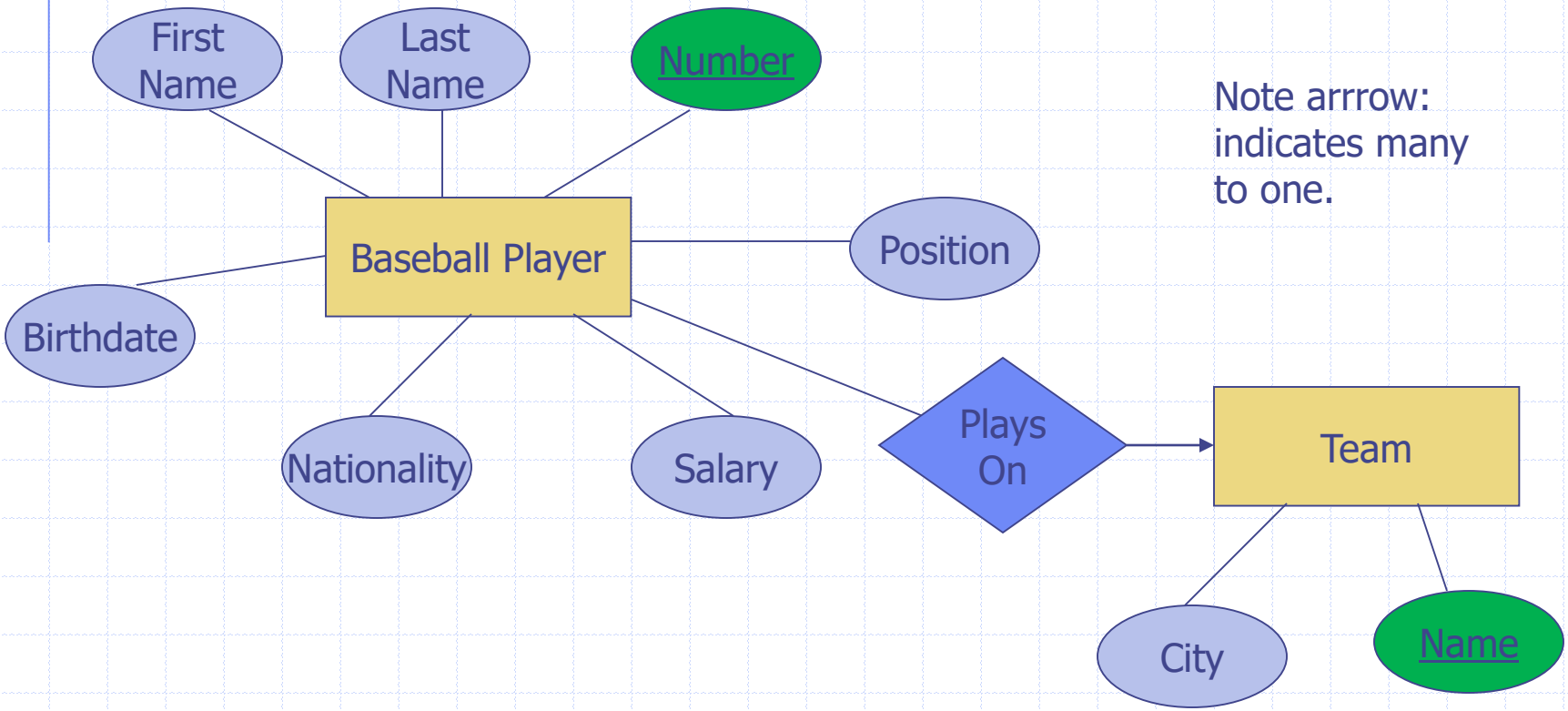


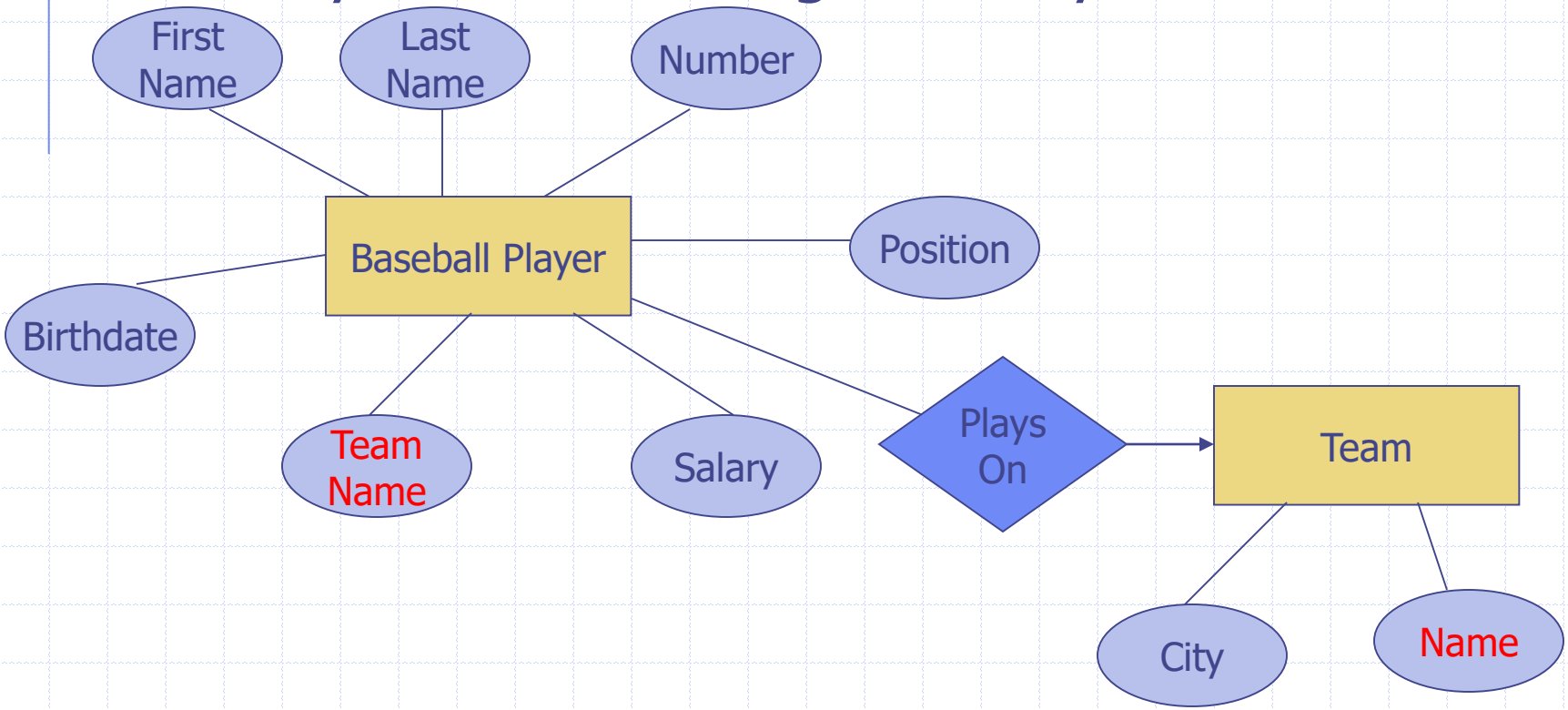
Weak entity sets

- Need "help" to determine key



Design Techniques

- Avoid redundancy
  - Say the same thing two ways



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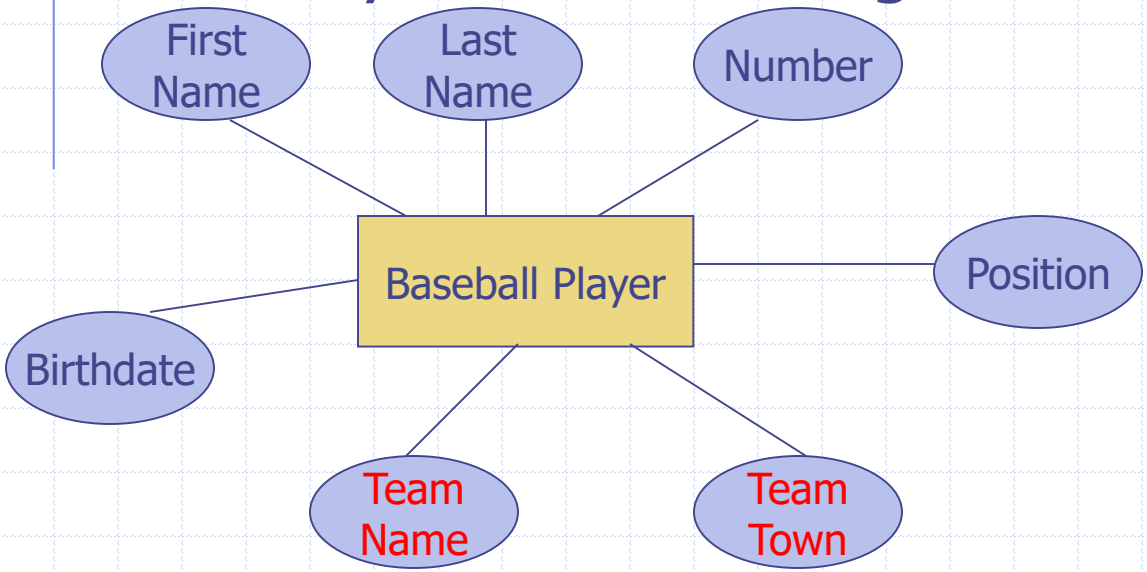
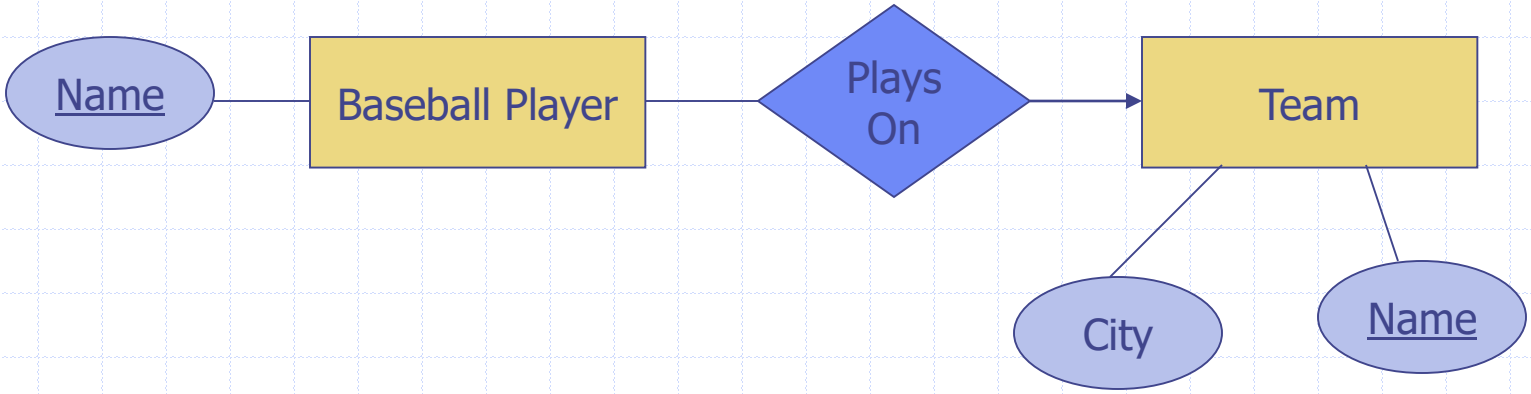


Design Techniques

- Don't use entity set if attribute will do
- Entity lists should either
  - Have some non-key attribute
  - Be the "many" in a many-one/many-many relationship



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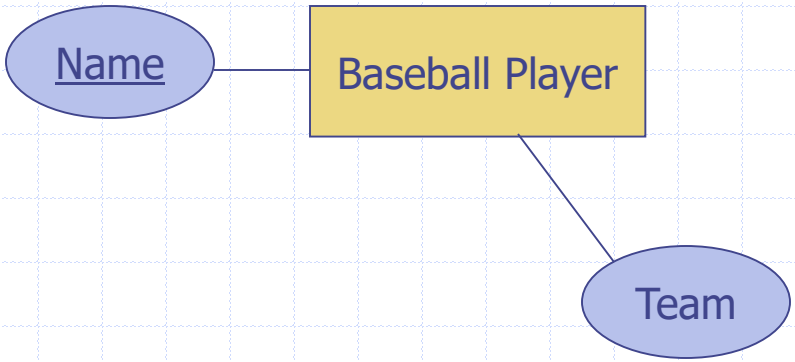

Design Techniques

- Don’t overuse weak entity sets
- Usually use unique key for each entity set (e.g. UIN, SSN, VIN)
- Not always possible, though