CS5220 Advanced Topics in Web Programming

Entity-Relationship Model

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Designing Tables Is Not Easy

Problem in Real World

#42 **Some Restaurant**

Date: Jul 09, 2008 Time: 03:07PM
Server: John # of Guest: 2
Bill: 0060 Table: 42

1	Boiled Pork Wanton	4.95
1	Dumpling w/Crabmeat	8.00
1	Beef Noodle Soup	6.80

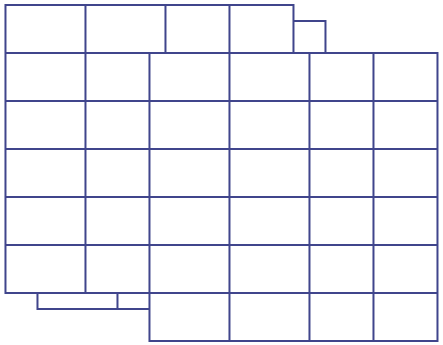
Subtotal:	19.75
GST:	0.99

Total: 20.74

Open Time: Jul 09, 2008 02:57PM
Printed by: Cashier

?

Tables in RDBM



Entity-Relationship (ER) Model

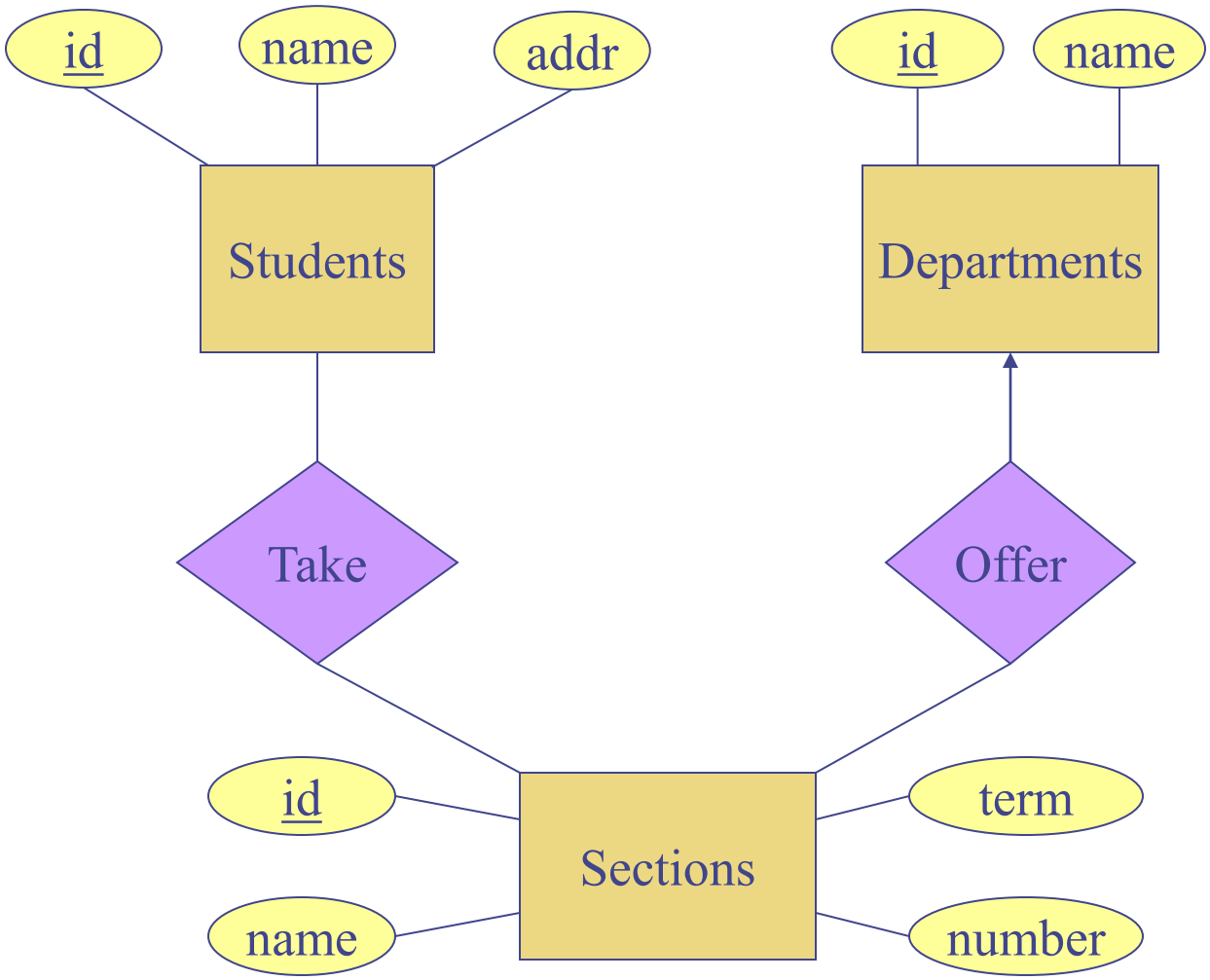
Problem → ER Model → Tables

- An *OO-like* approach
- Easily converted to relational model
- A visual representation of the design – ER Diagram

Example: Problem Description

- Student
  - id, name, address
- Department
  - id, name
- Classes
  - id, name, term, section number
- Class offerings and enrollment

Example: ER Diagram



Entity Set

Attribute

Relationship

Entity Set and Attributes

- Entity Set is similar to *class* in an OO language
- Attributes are the properties of an entity set
  - Similar to the class fields in an OO language
  - Must have simple values like numbers or strings, i.e. *cannot be collection or composite type*

Keys

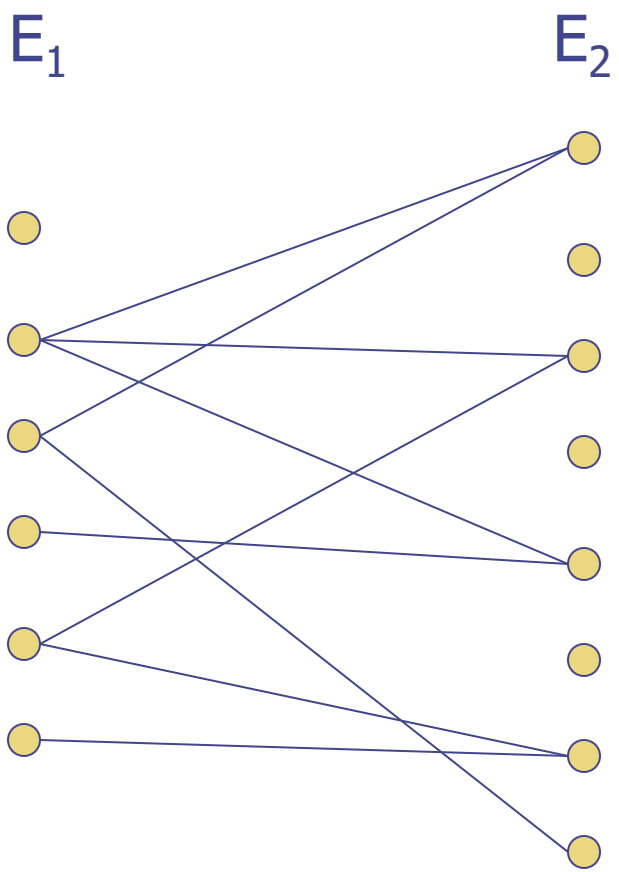
- A key is an attribute or a set of attributes that *uniquely* identify an entity in an entity set.
- Each entity set must have a key
- If there are multiple keys, choose one of them as the primary key (i.e. the underlined attribute(s) in an ER diagram)

Types of Relationships

- Many-to-Many
- Many-to-One / One-to-Many
- One-to-One

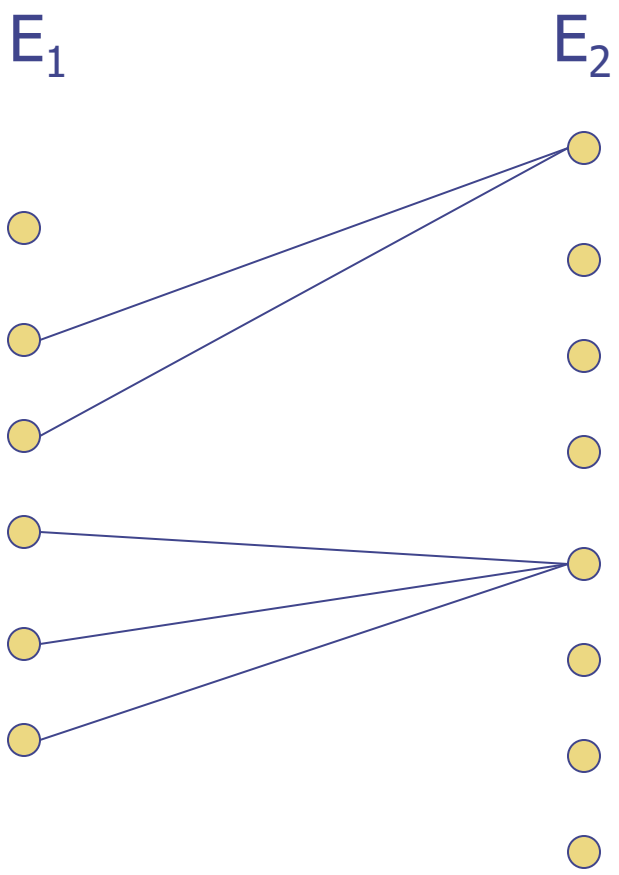
Many-to-Many Relationship

- Each entity in E_1 can be related to many entities in E_2
- Each entity in E_2 can be related to many entities in E_1



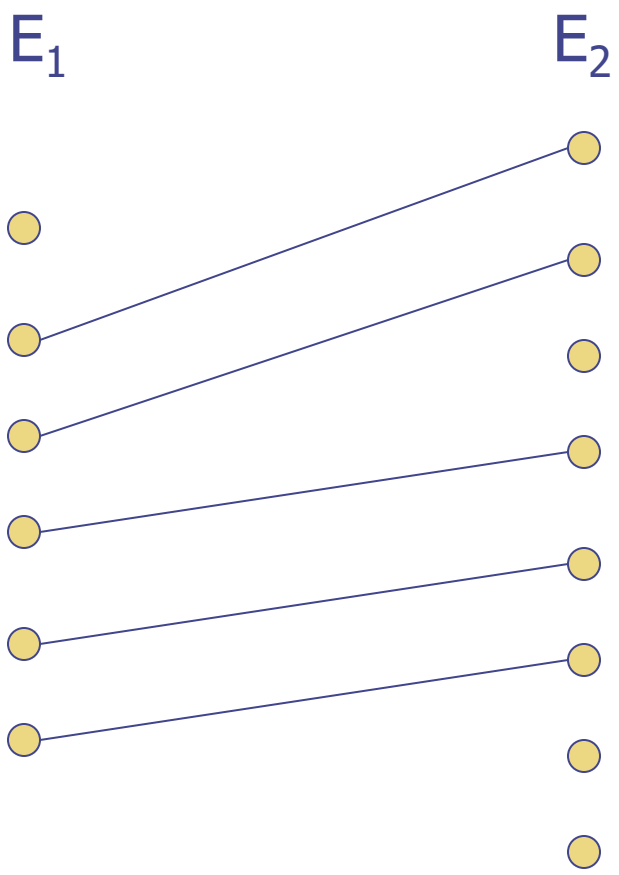
Many-to-One Relationship

- Each entity in E_1 can be related to one entities in E_2
- Each entity in E_2 can be related to many entities in E_1



One-to-One Relationship

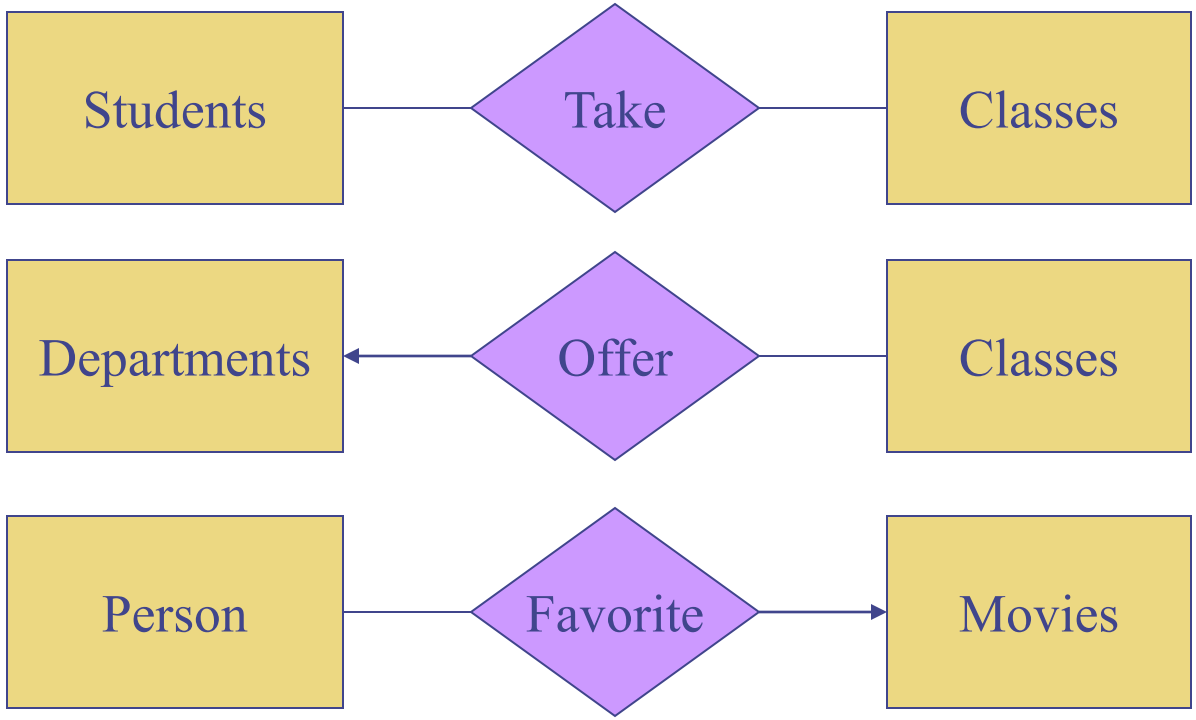
- Each entity in E_1 can be related to one entities in E_2
- Each entity in E_2 can be related to one entities in E_1



Relationship Type Examples

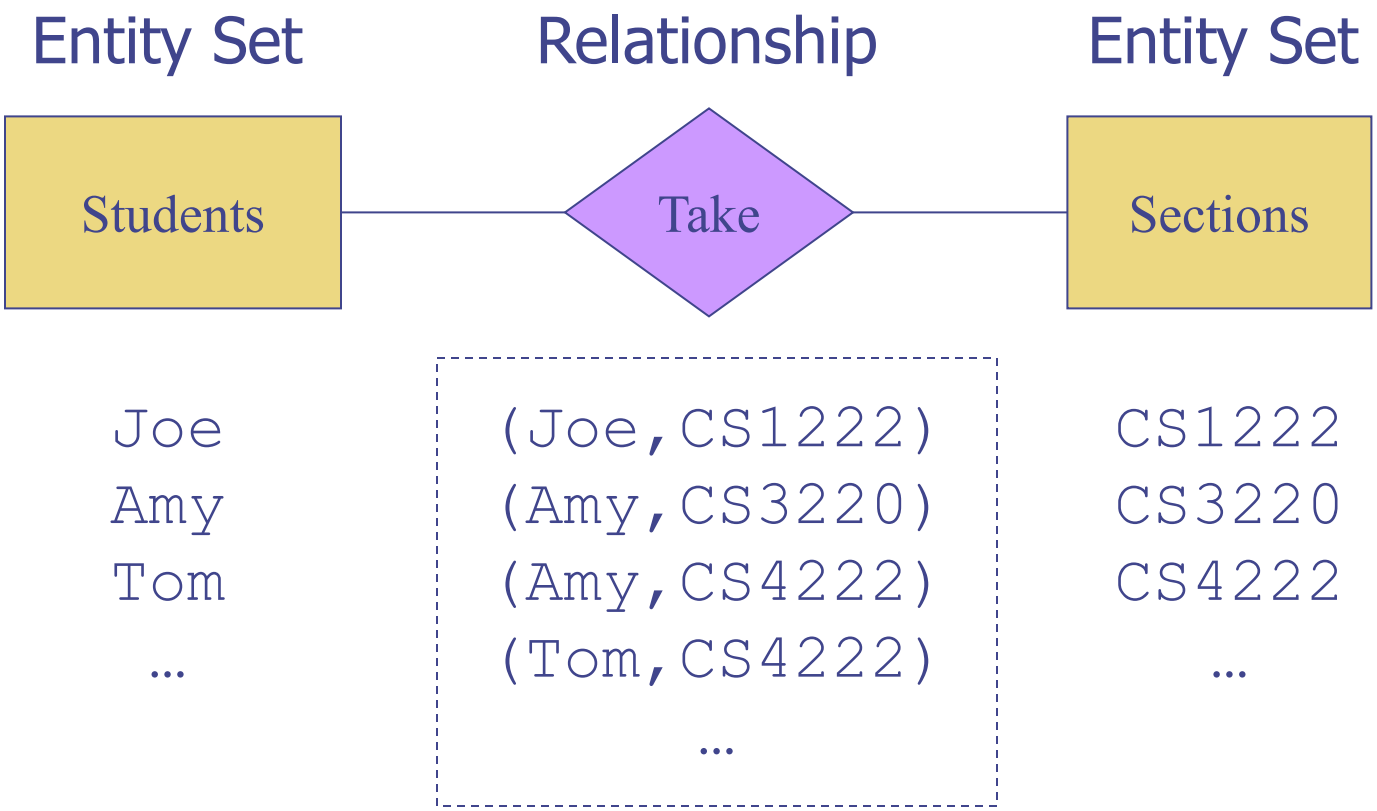
- Students and classes??
- Departments and classes??
- Person and Favorite movie??

Relationship Types in ER Diagram



- An arrow is used to indicate the "one" side

Data in a Relationship



Design Example: Company Database

- Design a database for a company to keep track of their employees and projects. Each employees has an id, first name, last name, and date hired. Each project has a leader and a number of members, who are all employees.

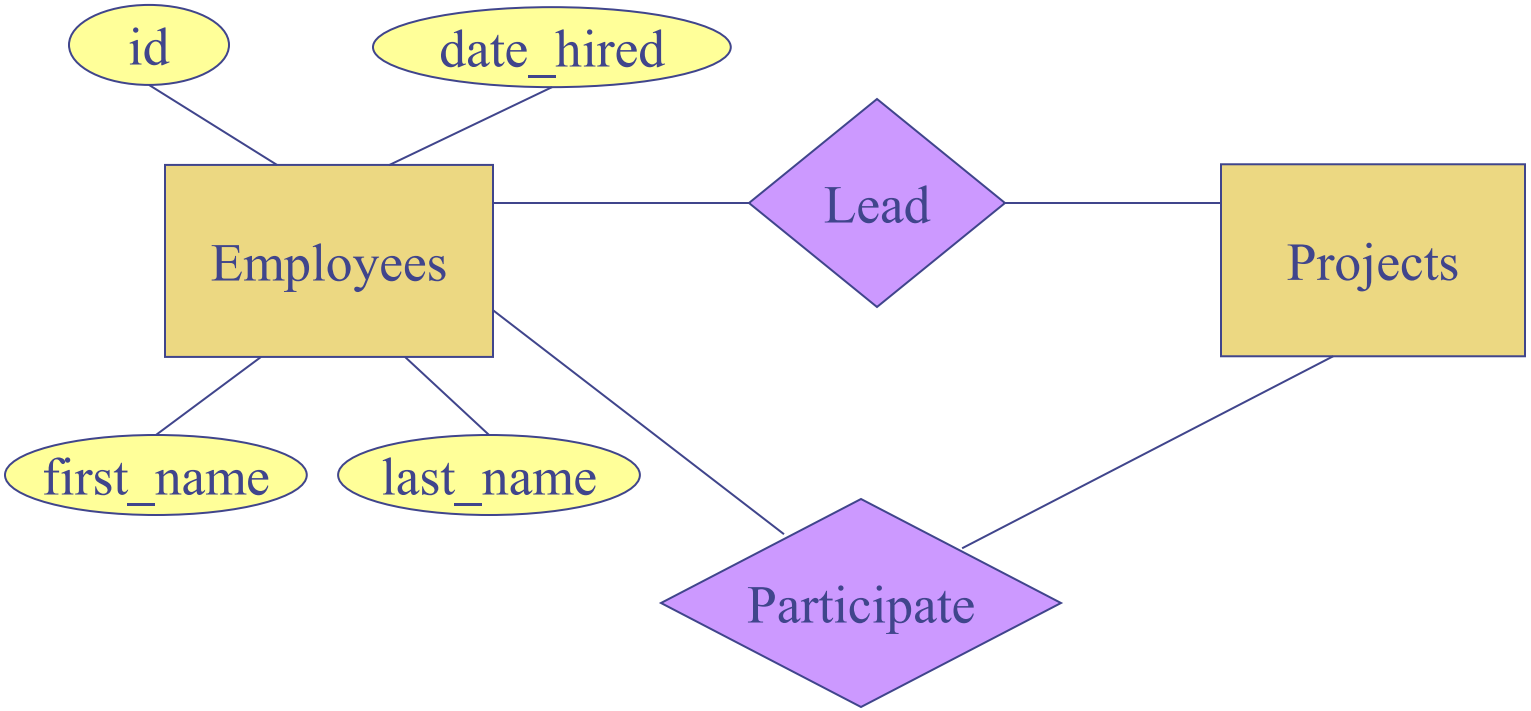
ER Design (I)

- Step 1: identify entity sets, attributes, and relationships

ER Design Tips

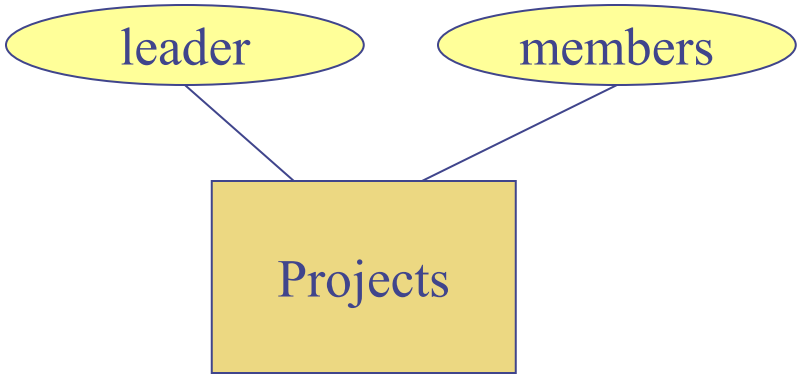
- Nouns tend to be entity sets or attributes
  - Attribute: something can be represented by a single value, e.g. first name
  - Entity set: something includes multiple values, e.g. employee
- Verbs tend to be relationships, e.g. students *take* classes
- Something looks like an attribute but is an entity or collection must also be a relationship, e.g. project leader and members

ERD After Step 1

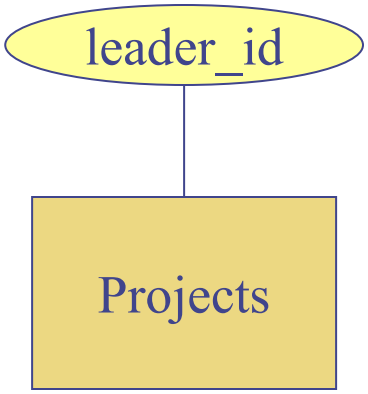


Common Problems

Attribute cannot be an entity or a collection

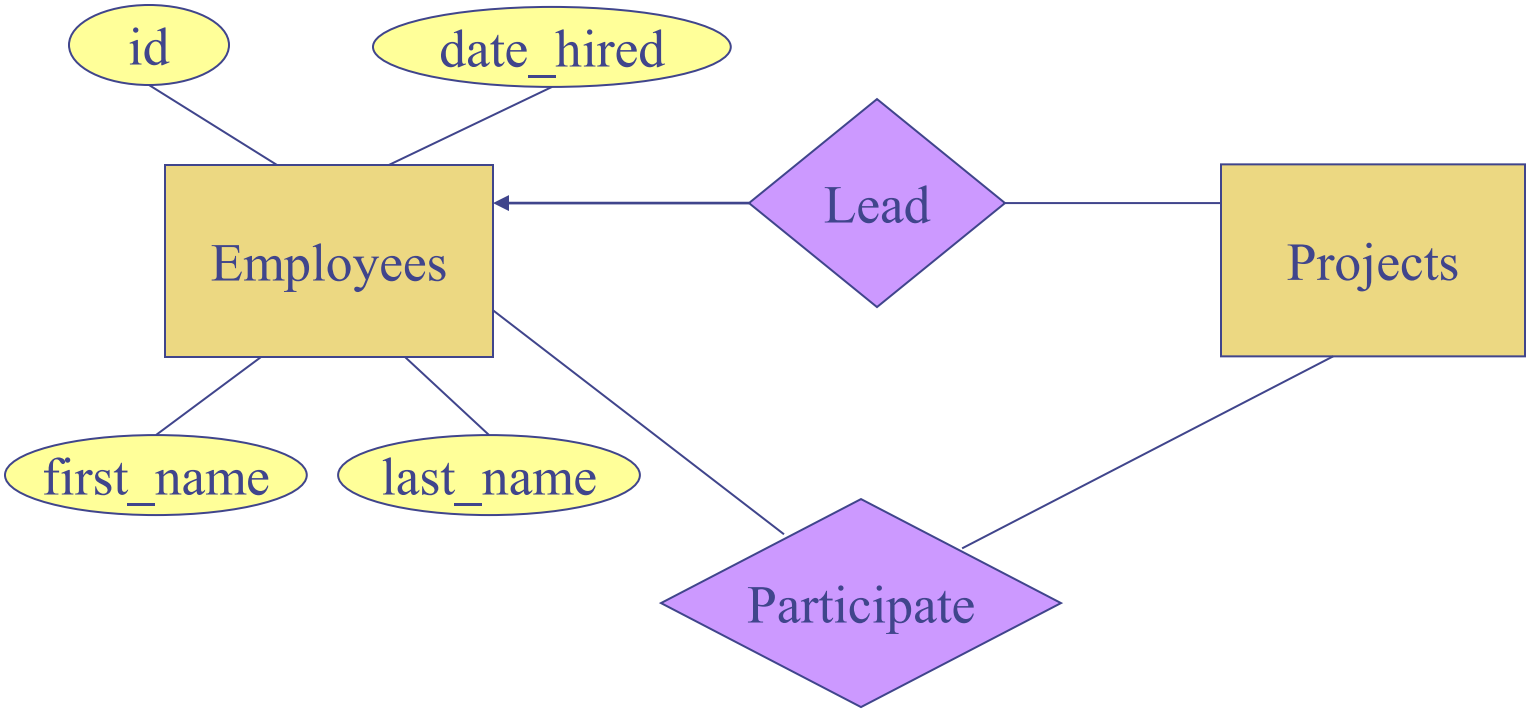


There's no foreign key in ER



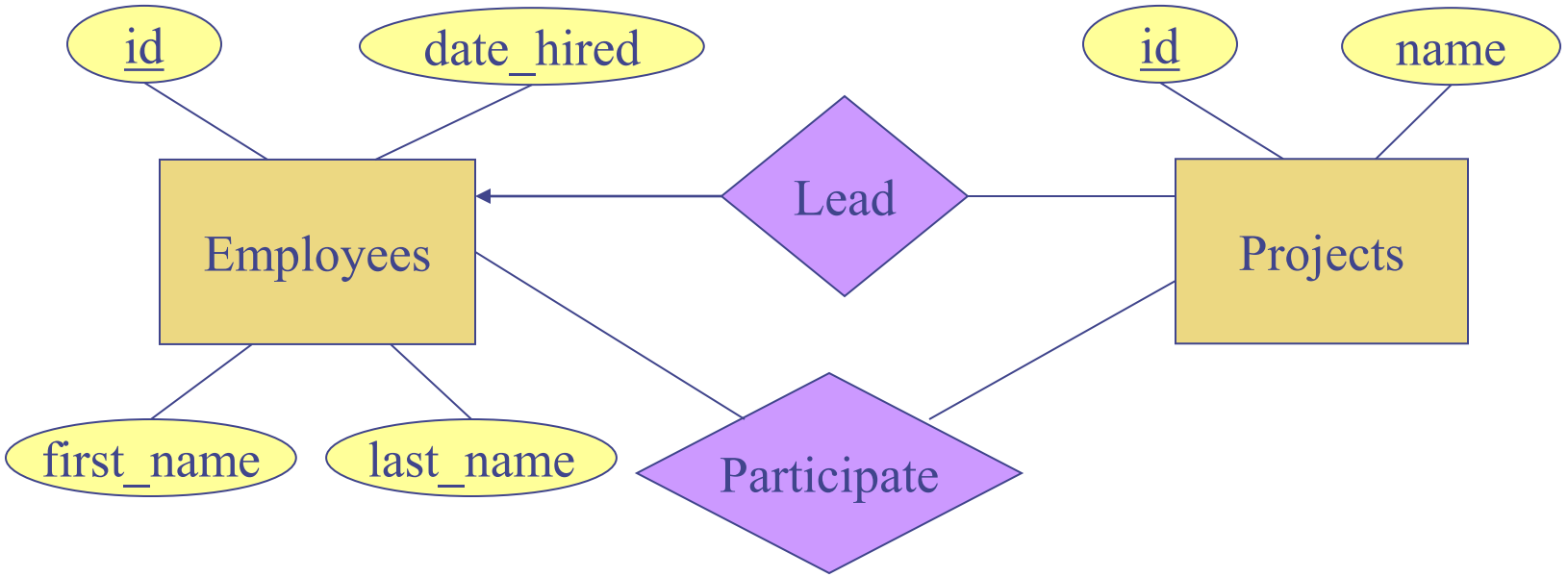
ER Design (II)

- Step 2: determine relationship types



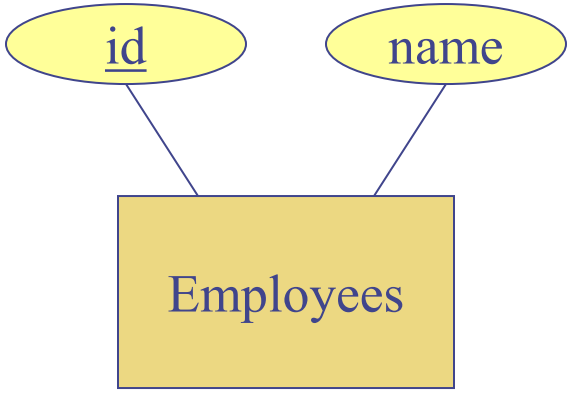
ER Design (III)

- Step 3: complete entity sets
  - Identify/create keys
  - Add additional attributes if necessary



Employees and Supervisors

- Each employee has a supervisor
- A supervisor is an employee



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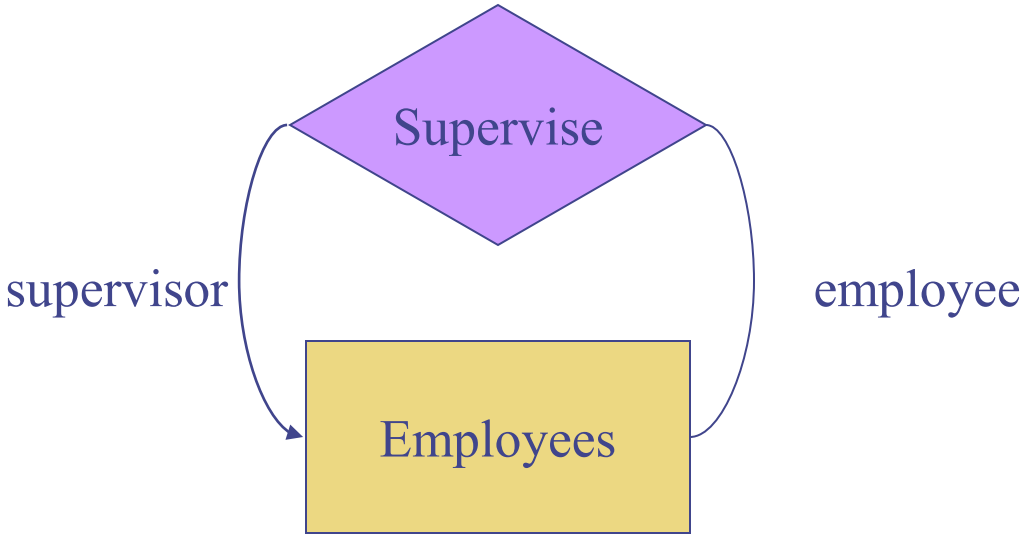
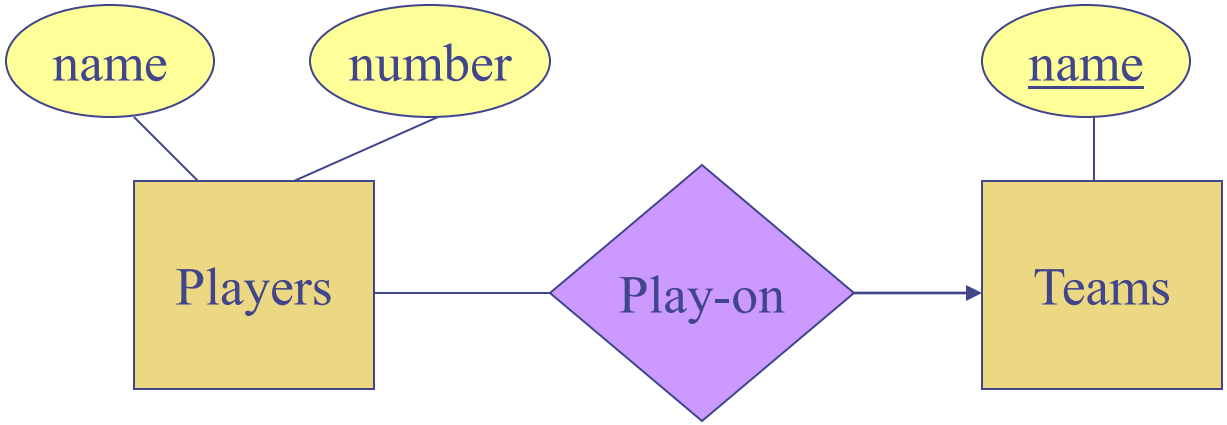
Roles

- An entity set may appear in the same relationship more than once.
- Label the edges with names called Roles



Players and Teams

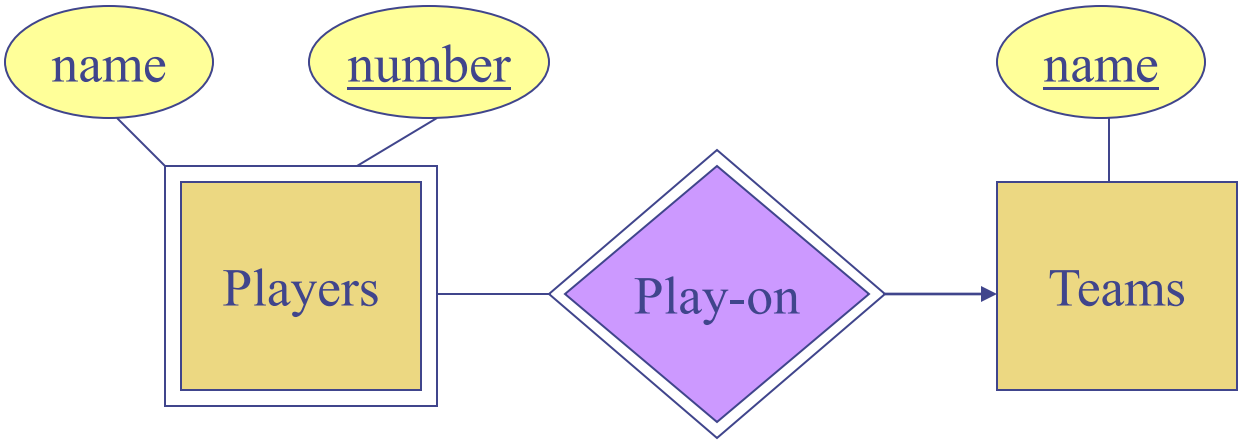


- What's the key for *Players*??

Weak Entity Set

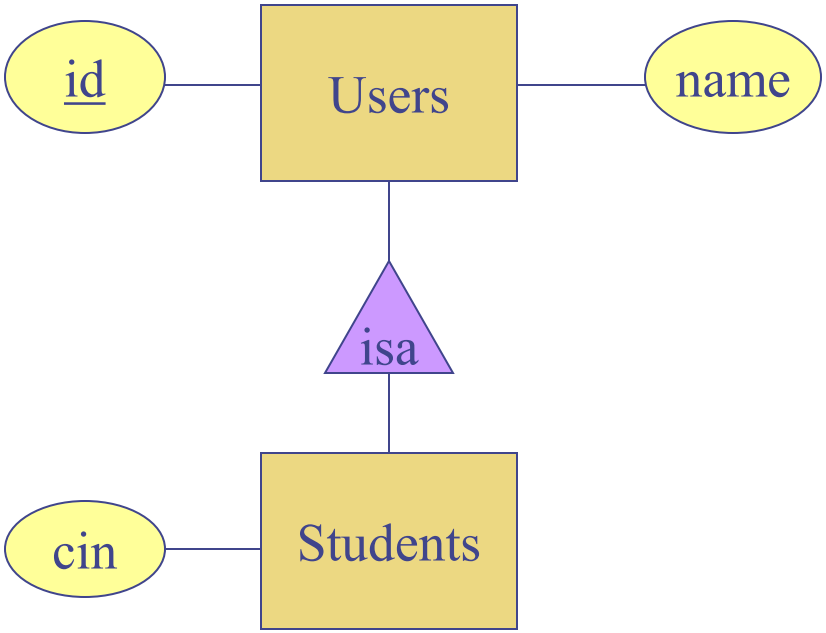
- Entity set **E** is said to be *weak* if in order to identify entities of **E** uniquely, we need to follow one or more many-one relationships from **E** and include the key of the related entities from the connected entity sets.

Weak Entity Sets in ER Diagram



- The key of a weak entity set consists of its own key attributes and the key attributes of the supporting set

Subclass



- In ER design, a subclass is only needed if it has more attributes than the superclass.

When to Use (and When Not to Use) Subclass

- A: salaried employees and hourly employees
- B: administrator users and regular users
- C: pop songs and country songs
- D: beer and wine

Basic Rules of ER to Relational Conversion ...

- An entity set is converted to a table
  - Entity set name → table name
  - Entity set attributes → table columns
  - Entity set key → table key
- A many-to-many relationship is also converted to a table that includes the key attributes from the associated entity sets

… Basic Rules of ER to Relational Conversion

- A many-to-one relationship is converted to a foreign key column on the "many" side referencing the "one" side

Classes (id, name, term, section, department_id)

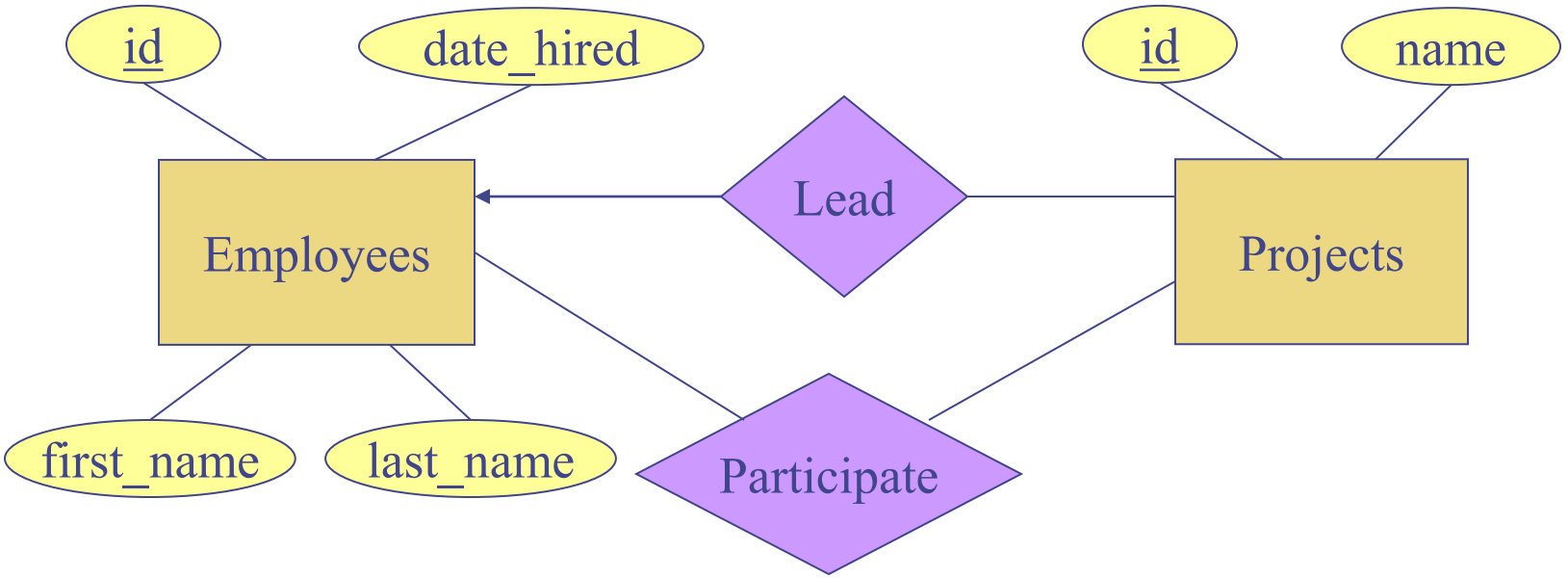
About Foreign Key

- Foreign key in relational model
  - Represents a connection of two tables
  - A data integrity constraint
- There is NO foreign key in ER model, *because the connection is already expressed as a relationship*

Basic ER to Relational Conversion Steps

- Step 1: convert entity sets to tables
- Step 2: convert relationships
  - Many-to-many → table
  - Many-to-one → foreign key column
- Step 3: rename tables and columns if necessary

Example: Convert ER to Relational



ER to Relational (I)

Employees(id, first_name, last_name, date_hired)

Projects(id, name)

ER to Relational (II)

Employees(id, first_name, last_name, date_hired)

Projects(id, name, Employees_id)

Participate(Employees_id, Projects_id)

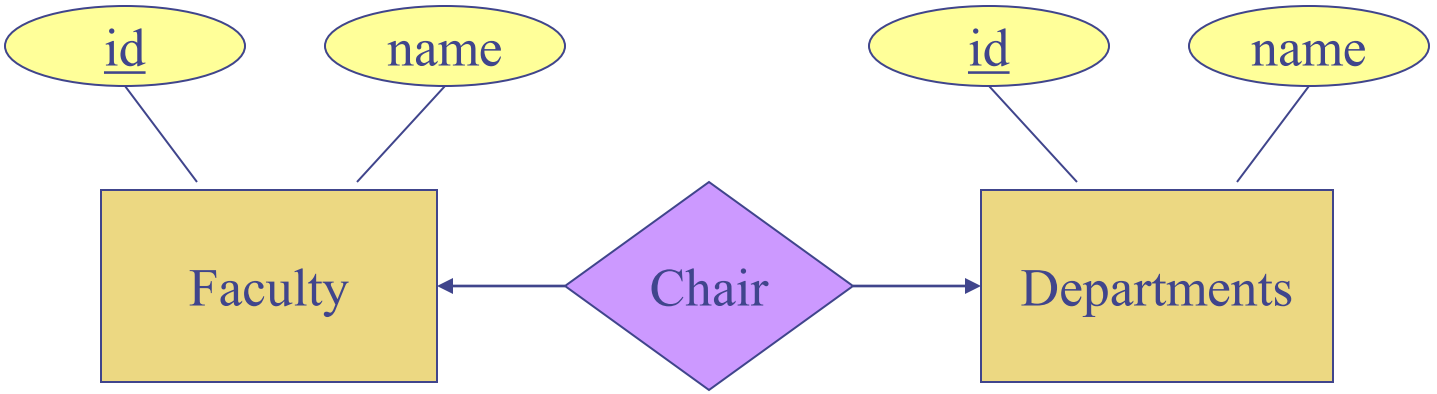
ER to Relational (III)

Employees(id, first_name, last_name, date_hired)

Projects(id, name, leader_id)

Project_Members(Employee_id, Project_id)

Converting One-to-One Relationship ...



… Converting One-to-One Relationship

- Which one of the following is better??

id of the department for which this faculty is the chair

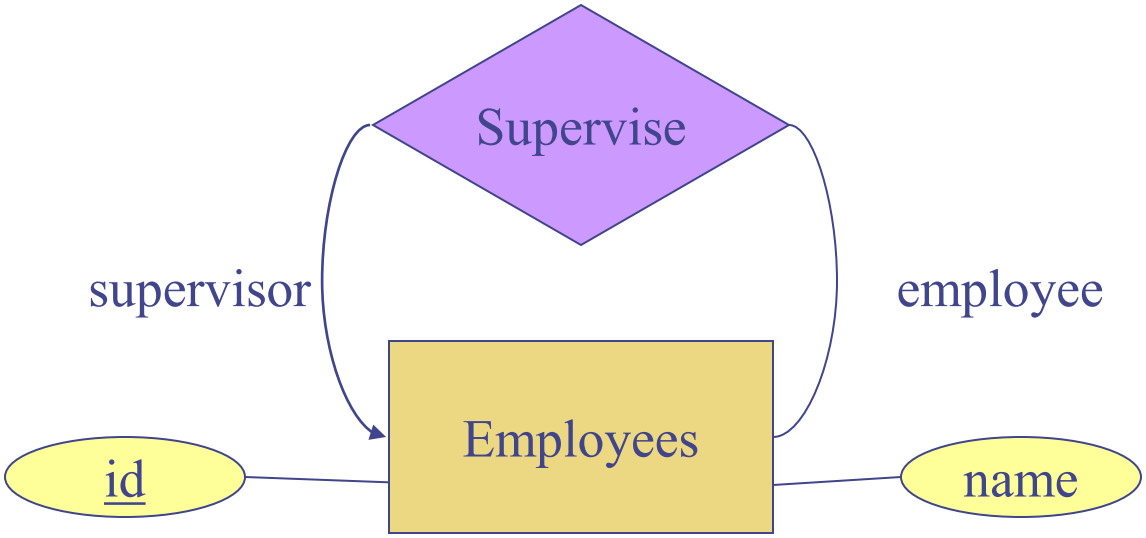
Faculty(id, name, department_id)
Departments(id, name)

or

Faculty(id, name)
Departments(id, name, faculty_id)

id of the faculty who chairs this department

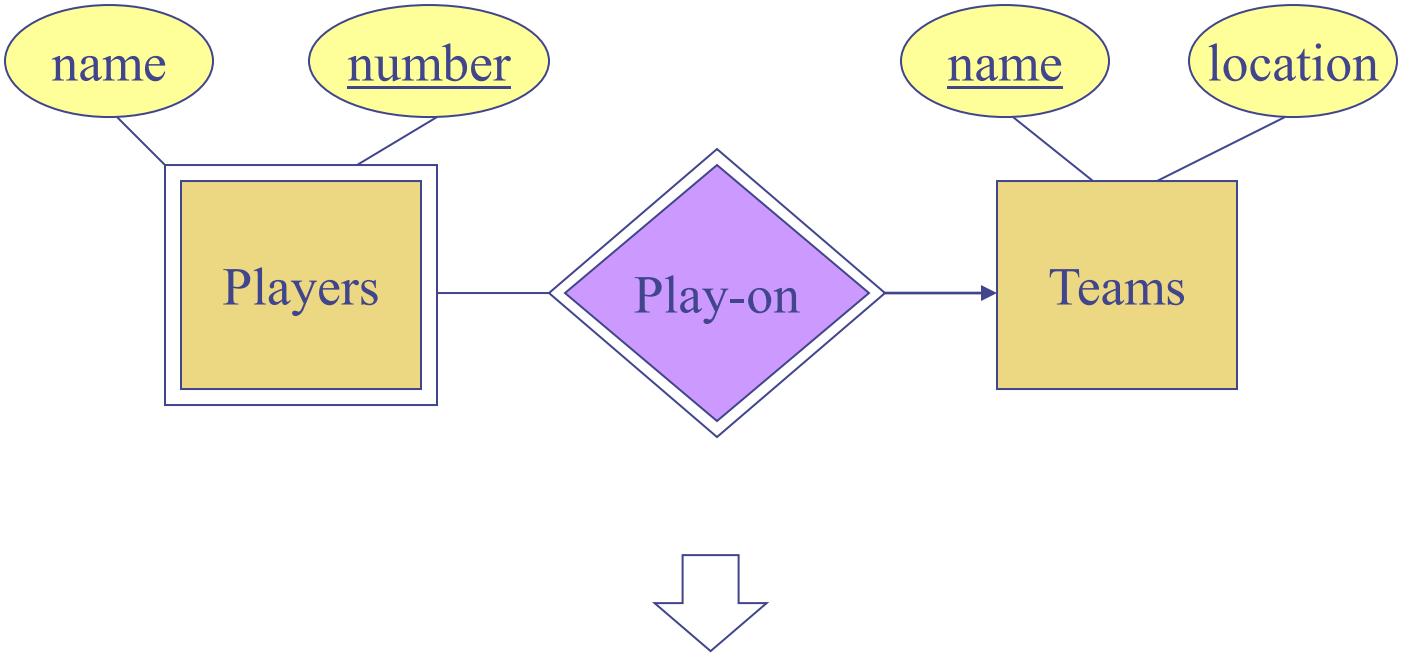
Converting Relationship with Roles



Converting Weak Entity Set ...

- The table for a weak entity set includes its *complete key* as well as it's own non-key attributes
- A supporting relationship is redundant and yields no relation

… Converting Weak Entity Set



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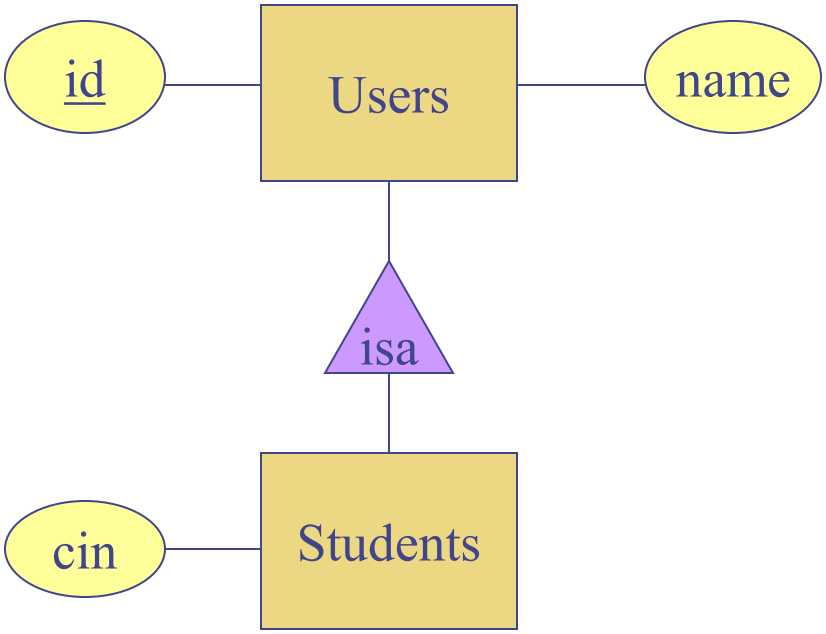
Converting Subclass ...



… Converting Subclass

- Object-oriented approach
  - One table per concrete class
  - Each entity belongs to exact one table
- ER approach
  - One table per subclass
  - Each entity may appear in multiple tables
- NULL approach
  - One table per class hierarchy

Object-Oriented Approach

id	name
1000	John

Users

id	name	cin
1001	Jane	212345678

Students

ER Approach

id	name
1000	John
1001	Jane

Users

user_id	cin
1001	212345678

Students

NULL Approach ...

id	name	cin
1000	John	NULL
1001	Jane	212345678

Users

… NULL Approach

Discriminator field

id	user_type	name	cin
1000	staff	John	NULL
1001	student	Jane	212345677

Users

Comparison of Subclass Conversion Approaches

- Constraints and data integrity
- Query performance

  Q1: list all students
  Q2: list all non-student users
  Q3: list all users

Exercise

- The HBO show Game of Thrones has lots of characters. Design a database that helps people to keep track of the characters and their relationships illustrated in this figure