CS422 Principles of Database Systems

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

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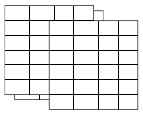
Tables in RDBM



Entity-Relationship (ER) Model

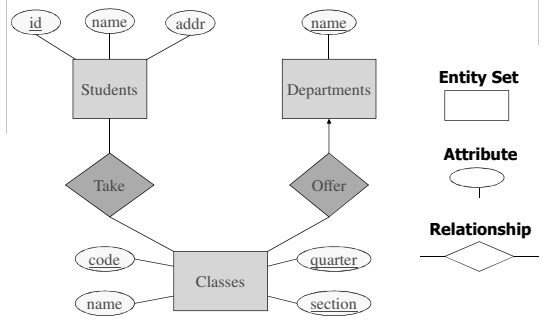
Problem → ER Model → Tables

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

Example: Problem Description

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

Example: ER Diagram



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

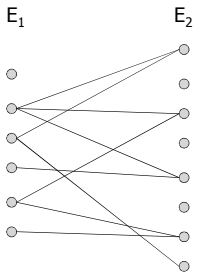
- A key is an attribute or a set of attributes that *uniquely* identify an entity in an entity set.
- Each entity set must have a key
- If there are multiple keys, choose one of them as the *primary key*

Types of Relationships

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

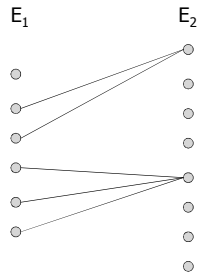
Many-to-Many Relationship

- 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



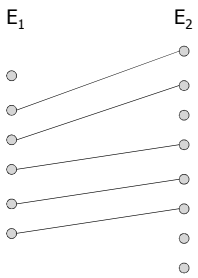
Many-to-One Relationship

- 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

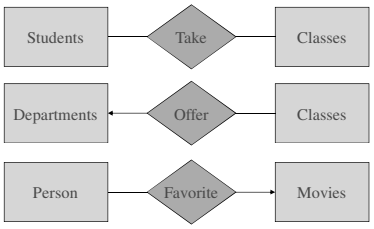
- Each entity in E_1 can be related to one entities in E_2
- Each entity in E_2 can be related to one entities in E_1



Relationship Type Examples

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

Relationship Types in ER Diagram

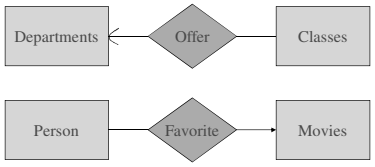


- An arrow is used to indicate the "one" side

A Closer Look at "One" and "Many"

- One
  - 0 or 1
  - Exactly 1 ➔ Referential Integrity
- Many
  - 0..N
  - 1..N
  - N..M (*Example??)*

Referential Integrity in ER Diagram



- An circular arrow is used to indicate "Exactly 1"

One vs. Exactly One

- Both lead to foreign key constraint in SQL
  - One: `foreign key` + `NULL`
  - Exactly one: `foreign key` + `NOT NULL`
- It's usually not too important to distinguish the two in ER design

Design Example: Bank Database

- Design a database for a bank to keep track of customers and accounts. Each account has id, and a balance; each customer has a name and address. A customer can own multiple accounts, and an account can be jointly owned by multiple customers.

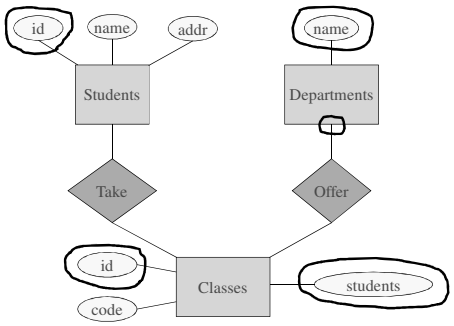
ER Design (I)

- Step 1: identify entity sets, attributes, and relationships.
- Tips:
  - Nouns tend to be entity sets or attributes
    - Attribute: simple data that can be represented by a single value
    - Entity Set: composite data
  - Verbs tend to be relationships

ER Design (II)

- Step 2: determine relationship types
- Step 3: complete entity sets
  - Identify/create keys
  - Add additional attributes if necessary
- Some common problems:
  - No keys
  - Wrong relationship types
  - Collection/composite attributes

Some Common Problems in ER Design



Grades

- Store the grades the students received for their classes
- A grade is a single letter `A`, `B`, `C`, `D`, or `F`

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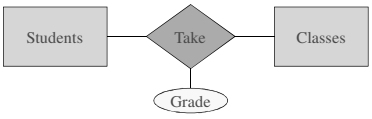
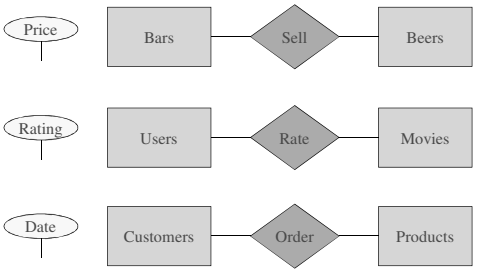
Relationship Attributes

- Sometimes it's useful to attach an attribute to a relationship.

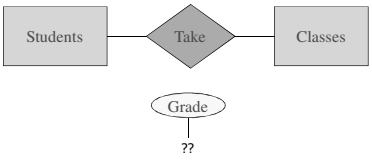


Other Relationship Attribute Examples



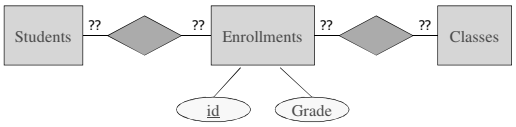
From Relationship with Attributes to Entity Set …

- Some variations of ER model does not allow relationships to have attributes



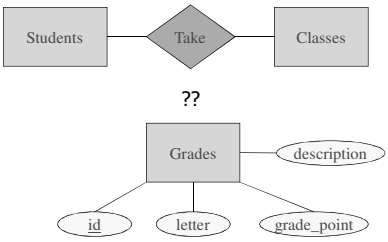
… From Relationship with Attributes to Entity Set

- If something needs an attribute, it probably should be an entity set

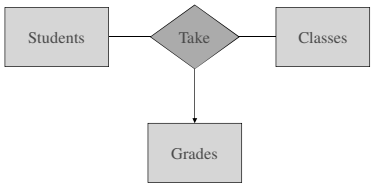


Grades as an Entity Set

- Need to store more than just the letter



Multiway Relationship



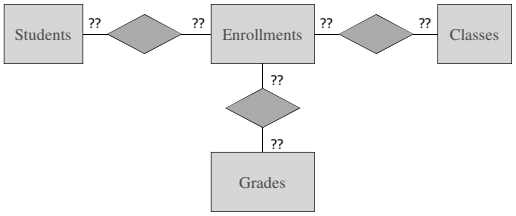
- Why there is an arrow pointing to `Grades`??

"Arrows" in Multiway Relationships

- In multiway relationships, an arrow points to an entity set **E** means that if we select one entity from each of the other entity sets in the relationship, those entities are related to at most one entity in **E**.

Convert Multiway Relationship to Binary Relationship

- A multiway relationship can *always* be converted to binary relationships by replacing the multiway relationship with an entity set

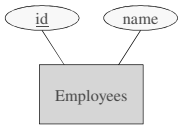


Compare the Ways to Model Grades

- A. Relationship attribute
- B. Entity set attribute
- C. Entity set in a multiway relationship
- D. Entity set in a binary relationship

Employees and Supervisors

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



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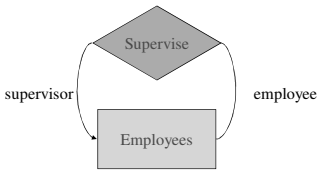
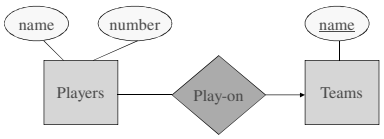
Roles

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



Players and Teams

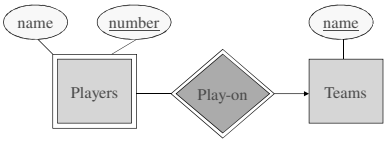


- What's the key for *Players*??

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

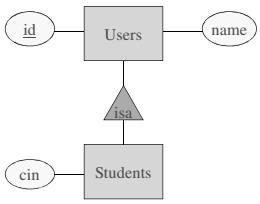


- The key of a weak entity set consists of its own key attributes *and* the key attributes of the supporting set

From Weak to Strong

- We can usually create unique IDs for entity sets

Subclass



- Super class must have all the key attributes

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

Summary of ER Diagram

- Entity Set
  - Attributes, key
  - Weak entity set
- Relationship
  - Many-to-Many, Many-to-One, One-to-One
  - Attributes
  - Multiway and binary relationships
  - Subclass

Design Example 1: Restaurant

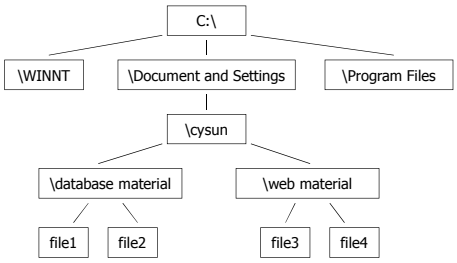
#42 **Some Restaurant**

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

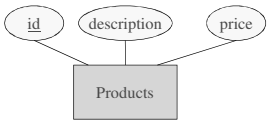
1	Boiled Pork Wanton	4.95
1	Dumpling w/Crabmeat	8.00
1	Beef Noodle Soup	6.80
	Subtotal:	19.75
	GST:	0.99
	Total:	20.74

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

Design Example 2: Folders and Files



Design Example 3: Price Changes



What if we want to model price changes??