Relational Database Design
Part II

CPS 116

Introduction to Database Systems

Announcements (September 8)

- ❖ Homework #1 due in 7 days (next Thursday)
- ❖ Details of the course project and a list of suggested ideas will be available next Tuesday

E/R model: review

- ❖ Entity sets
  - Keys
  - Weak entity sets
- ❖ Relationship sets
  - Attributes on relationships
  - Multiplicity
  - Roles
  - Binary versus *N*-ary relationships
    - Modeling *N*-ary relationships with weak entity sets and binary relationships
  - ISA relationships

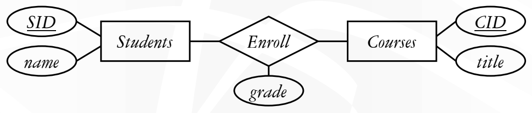
Database design steps: review

❖ Understand the real-world domain being modeled
❖ Specify it using a database design model (e.g., E/R)
❖ Translate specification to the data model of DBMS (e.g., relational)
❖ Create DBMS schema

☞ Next: translating an E/R design to a relational schema

Translating entity sets

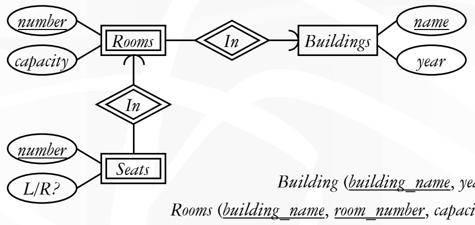
❖ An entity set translates directly to a table
- Attributes → columns
- Key attributes → key columns



Student (*<u>SID</u>*, *name*)   *Course* (*<u>CID</u>*, *title*)

Translating weak entity sets

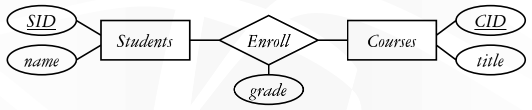
❖ Remember the "borrowed" key attributes
❖ Watch out for attribute name conflicts



Building (*<u>building_name</u>*, *year*)
Rooms (*<u>building_name</u>*, *<u>room_number</u>*, *capacity*)
Seats (*<u>building_name</u>*, *<u>room_number</u>*, *<u>seat_number</u>*, *left_or_right*)

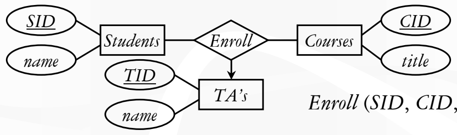
Translating relationship sets

- ❖ A relationship set translates to a table
  - Keys of connected entity sets → columns
  - Attributes of the relationship set (if any) → columns
  - Multiplicity of the relationship set determines the key of the table

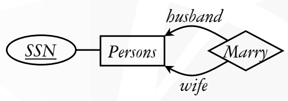


Enroll (<u>*SID*</u>, <u>*CID*</u>, *grade*)

More examples



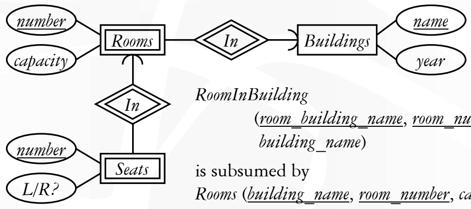
Enroll (*SID*, *CID*, *TID*)



Marry (*husband_SSN*, *wife_SSN*)

Translating double diamonds

- ❖ Recall that a double-diamond relationship set connects a weak entity set to another entity set
- ❖ No need to translate because the relationship is implicit in the weak entity set's translation

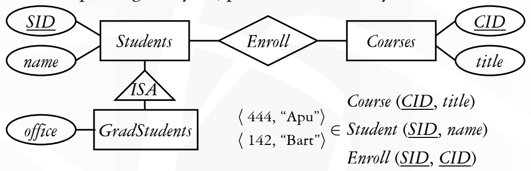


RoomInBuilding
(<u>*room_building_name*</u>, <u>*room_number*</u>, *building_name*)

is subsumed by
Rooms (<u>*building_name*</u>, <u>*room_number*</u>, *capacity*)

Translating subclasses & ISA (approach 1)

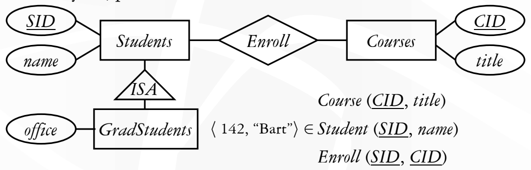
- Entity-in-all-superclasses approach ("E/R style")
  - An entity is represented in the table for each subclass to which it belongs
  - A table includes only the attributes directly attached to the corresponding entity set, plus the inherited key



Course (<u>*CID*</u>, *title*)
⟨ 444, "Apu"⟩
⟨ 142, "Bart"⟩ ∈ *Student* (<u>*SID*</u>, *name*)
Enroll (<u>*SID*</u>, <u>*CID*</u>)
⟨ 444, "D444"⟩ ∈ *GradStudent* (<u>*SID*</u>, *office*)

Translating subclasses & ISA (approach 2)

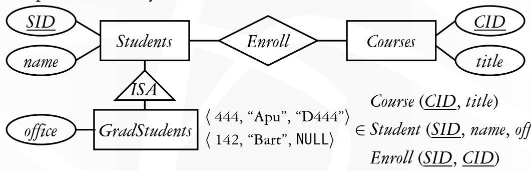
- Entity-in-most-specific-class approach ("OO style")
  - An entity is only represented in one table (corresponding to the most specific entity set to which the entity belongs)
  - A table includes the attributes attached to the corresponding entity set, plus all inherited attributes



Course (<u>*CID*</u>, *title*)
⟨ 142, "Bart"⟩ ∈ *Student* (<u>*SID*</u>, *name*)
Enroll (<u>*SID*</u>, <u>*CID*</u>)
⟨ 444, "Apu", "D444"⟩ ∈ *GradStudent* (<u>*SID*</u>, *name*, *office*)

Translating subclasses & ISA (approach 3)

- All-entities-in-one-table approach ("`NULL` style")
  - One relation for the root entity set, with all attributes found anywhere in the network of subclasses
  - Use a special `NULL` value in columns that are not relevant for a particular entity

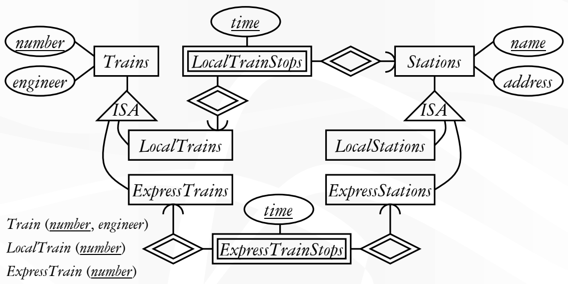


Course (<u>*CID*</u>, *title*)
⟨ 444, "Apu", "D444"⟩
⟨ 142, "Bart", `NULL`⟩ ∈ *Student* (<u>*SID*</u>, *name*, *office*)
Enroll (<u>*SID*</u>, <u>*CID*</u>)

Comparison of three approaches

- Entity-in-all-superclasses
  - *Student* (*SID*, *name*), *GradStudent* (*SID*, *office*)
  - Pro:
  - Con:
- Entity-in-most-specific-class
  - *Student* (*SID*, *name*), *GradStudent* (*SID*, *name*, *office*)
  - Pro:
  - Con:
- All-entities-in-one-table
  - *Student* (*SID*, *name*, *office*)
  - Pro:
  - Con:

A complete example



Train (*number*, *engineer*)
LocalTrain (*number*)
ExpressTrain (*number*)
Station (*name*, *address*)
LocalStation (*name*)
ExpressStation (*name*)

Note that keys for *Local/ExpressTrainStop* come from assumptions not encoded in the E/R design

Simplifications and refinements

Train (*number*, *engineer*), *LocalTrain* (*number*), *ExpressTrain* (*number*)
Station (*name*, *address*), *LocalStation* (*name*), *ExpressStation* (*name*)
LocalTrainStop (*local_train_number*, *station_name*, *time*)
ExpressTrainStop (*express_train_number*, *express_station_name*, *time*)

- Eliminate *LocalTrain* table

- Eliminate *LocalStation* table

An alternative design

Train (*number*, *engineer*, *type*)
Station (*name*, *address*, *type*)
TrainStop (*train_number*, *station_name*, *time*)

- ❖ Encode the type of train/station as a column rather than creating subclasses
- ❖ Some constraints are no longer captured
  - ▪ Type must be either "local" or "express"
  - ▪ Express trains only stop at express stations
  - ☞Fortunately, they can be expressed/declared explicitly as database constraints in SQL
- ☞ Arguably a better design because it is simpler!

Design principles

- ❖ KISS
  - ▪ Keep It Simple, Stupid
- ❖ Avoid redundancy
  - ▪ Redundancy wastes space, complicates updates and deletes, promotes inconsistency
- ❖ Capture essential constraints, but don't introduce unnecessary restrictions
- ❖ Use your common sense
  - ▪ Warning: Mechanical translation procedures given in this lecture are no substitute for your own judgment