Relational Database Design: E/R-Relational Translation

Introduction to Databases

CompSci 316 Fall 2018

DUKE
COMPUTER SCIENCE

Announcements (Thu. Sep. 6)

- Homework 1 due in 1½ week
  - Please please please start early
- Project description to be posted next week

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

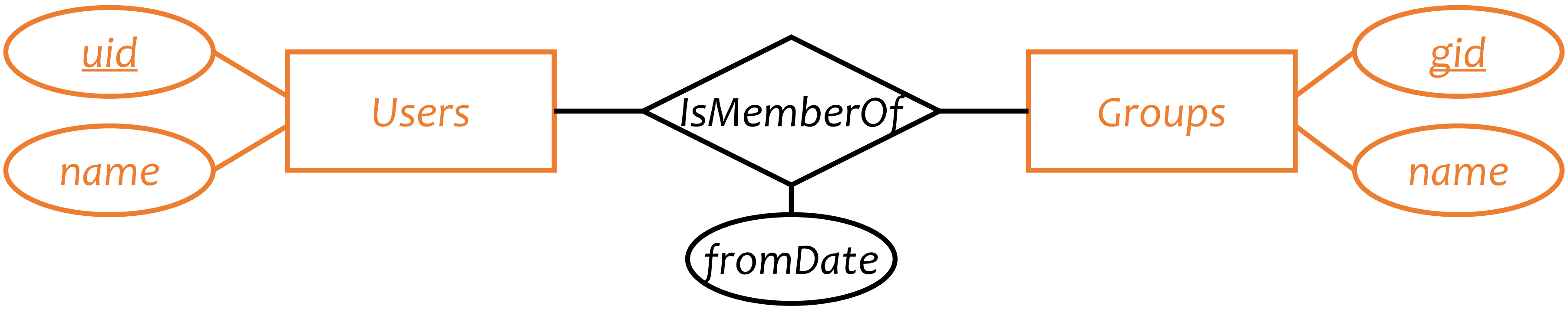
☞Next: translating E/R design to relational schema

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

Translating entity sets

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

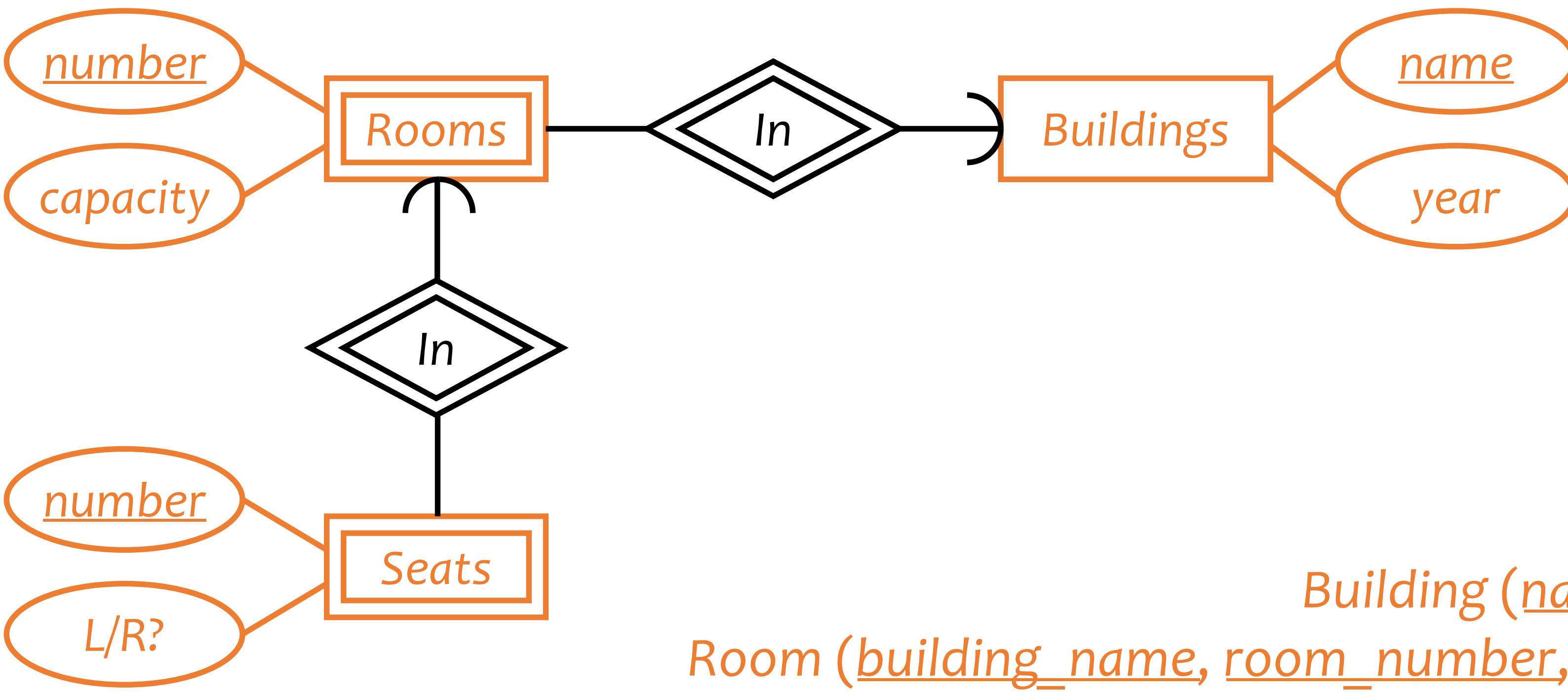


User (<u>uid</u>, name)

Group (<u>gid</u>, name)

Translating weak entity sets

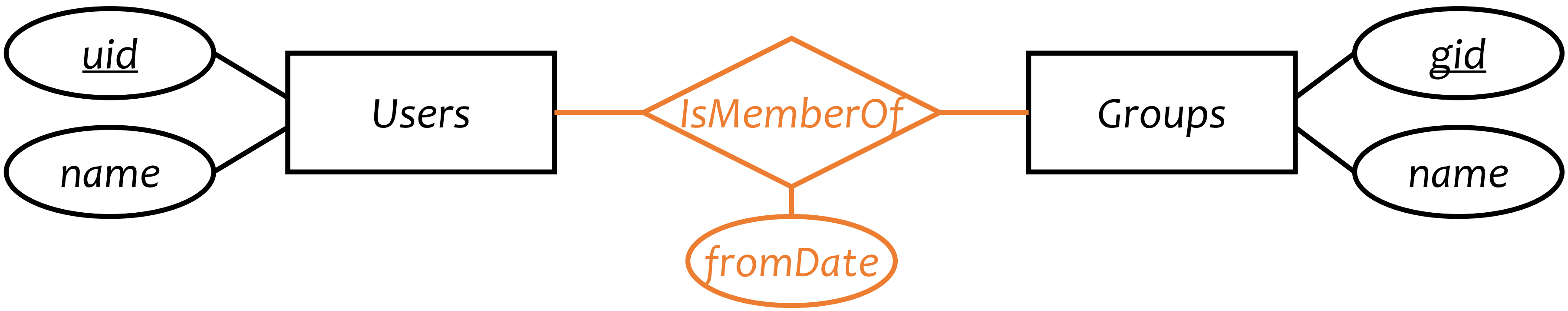
- Remember the “borrowed” key attributes
- Watch out for attribute name conflicts



Building (name, year)
Room (building_name, room_number, capacity)
Seat (building_name, room_number, seat_number, left_or_right)

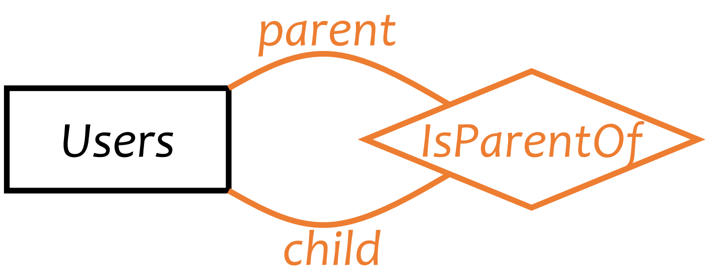
Translating relationship sets

- 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

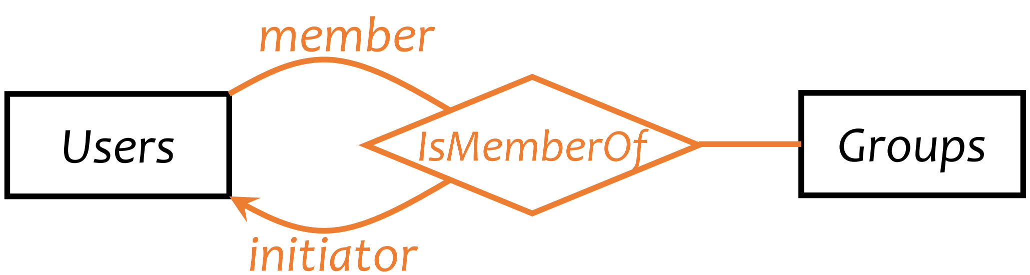


Member (<u>uid</u>, <u>gid</u>, fromDate)

More examples



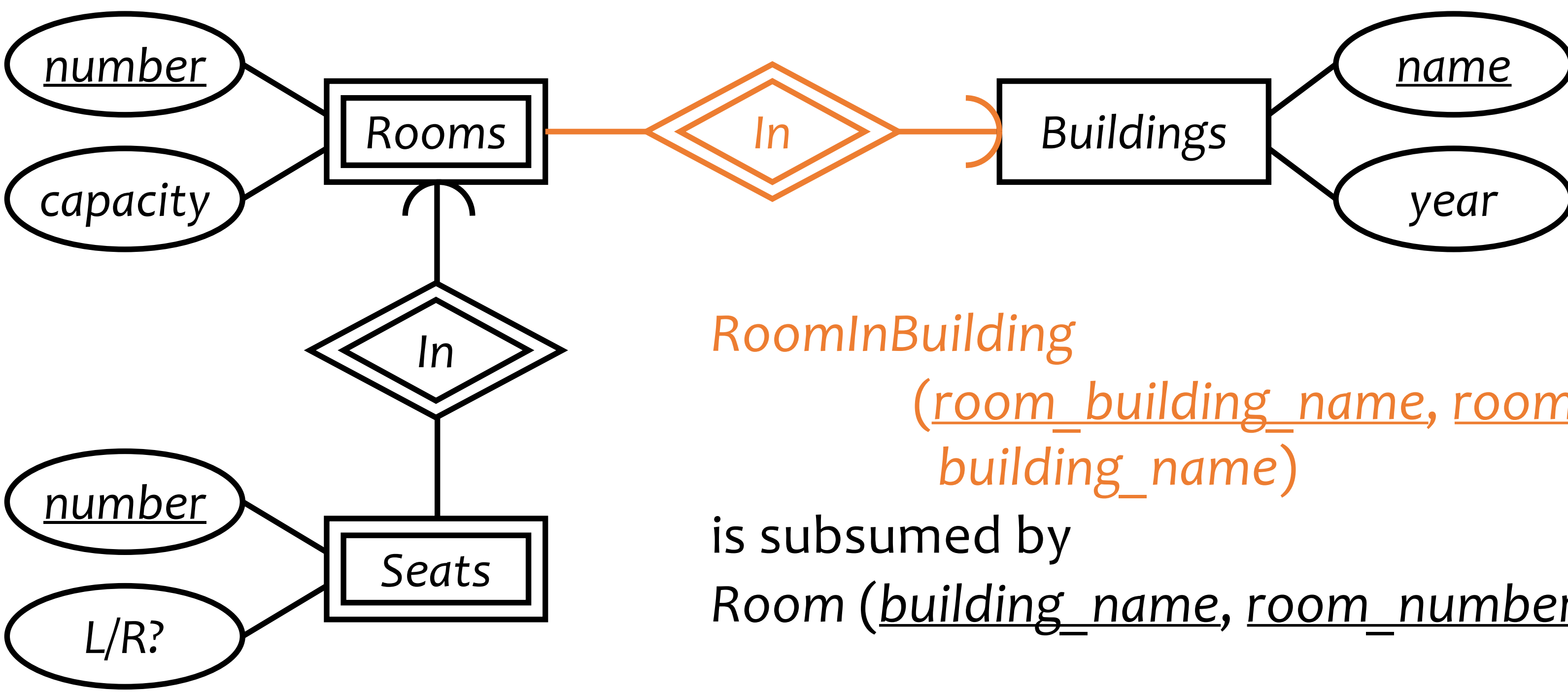
Parent (parent_uid, child_uid)



Member (uid, initiator_uid, gid)

Translating double diamonds?

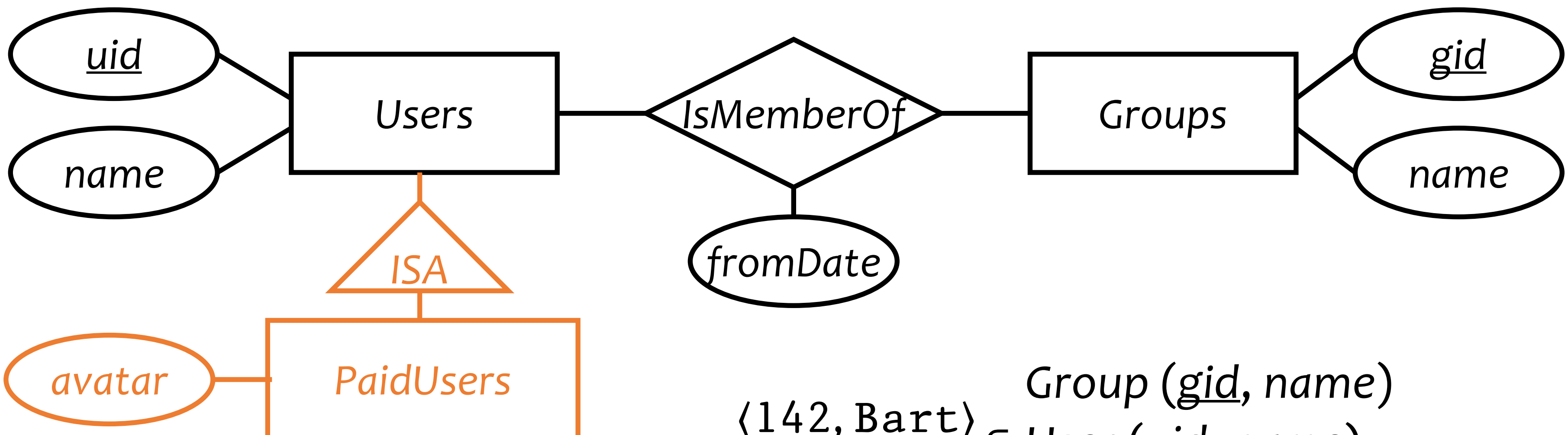
- Recall that a double-diamond (supporting) relationship set connects a weak entity set to another entity set
- No need to translate because the relationship is implicit in the weak entity set's translation



RoomInBuilding
(*room_building_name*, *room_number*, *building_name*)
is subsumed by
Room (*building_name*, *room_number*, *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



Group (gid, name)

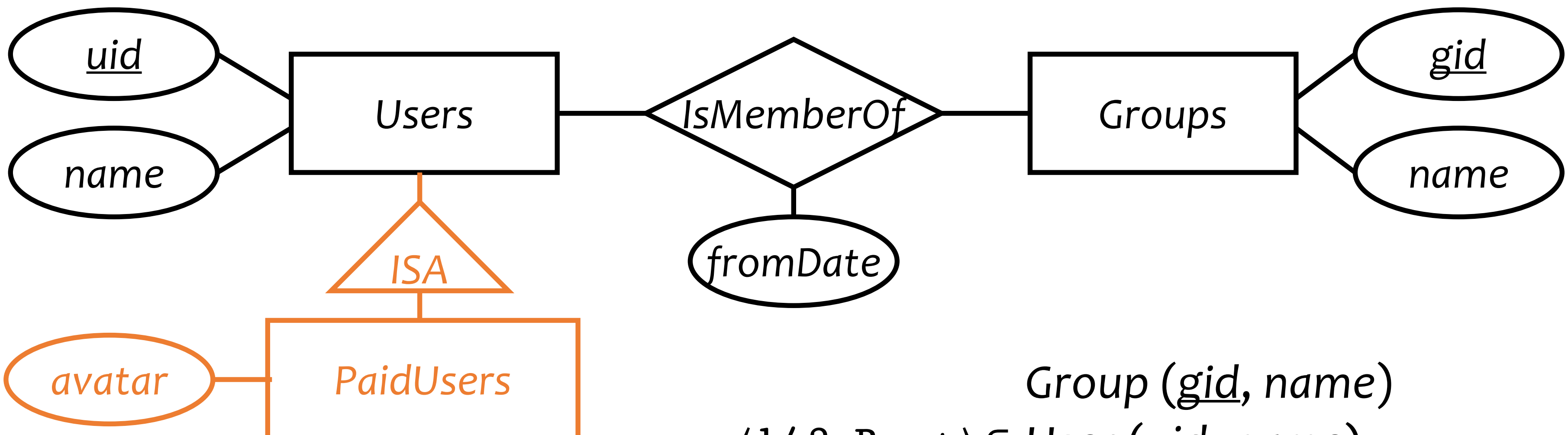
⟨142, Bart⟩, ⟨456, Ralph⟩ ∈ User (uid, name)

Member (uid, gid, from_date)

⟨456, ☺⟩ ∈ PaidUser (uid, avatar)

Translating subclasses & ISA: approach 2

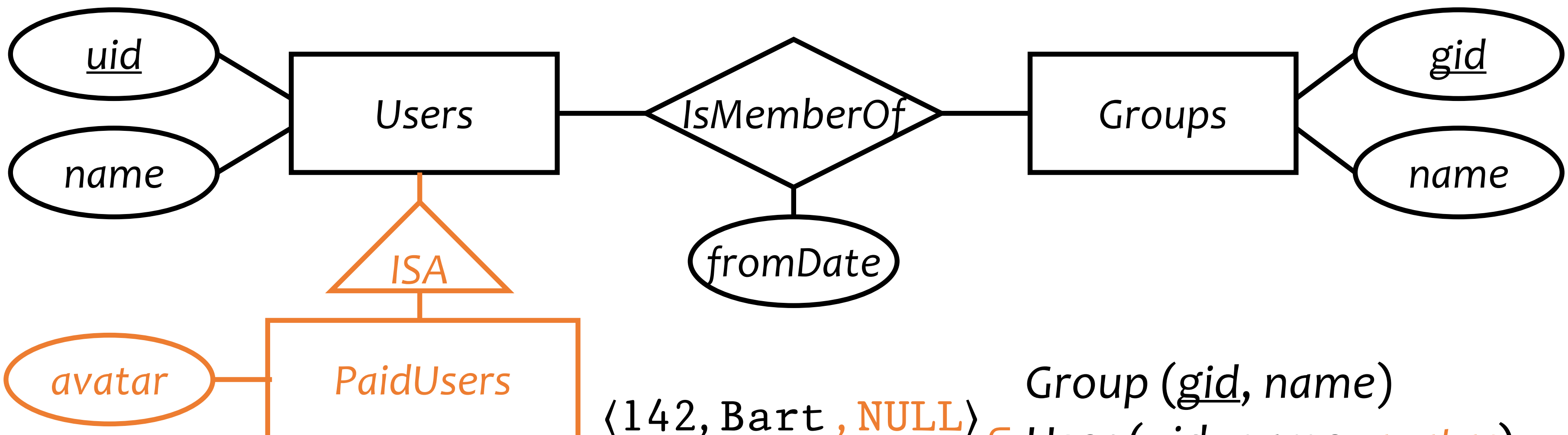
- Entity-in-most-specific-class approach ("OO style")
  - An entity is only represented in one table (the most specific entity set to which the entity belongs)
  - A table includes the attributes attached to the corresponding entity set, plus all inherited attributes



Group (gid, name)
⟨142, Bart⟩ ∈ User (uid, name)
Member (uid, gid, from_date)
⟨456, Ralph, ☺⟩ ∈ PaidUser (uid, name, avatar)

Translating subclasses & ISA: approach 3

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



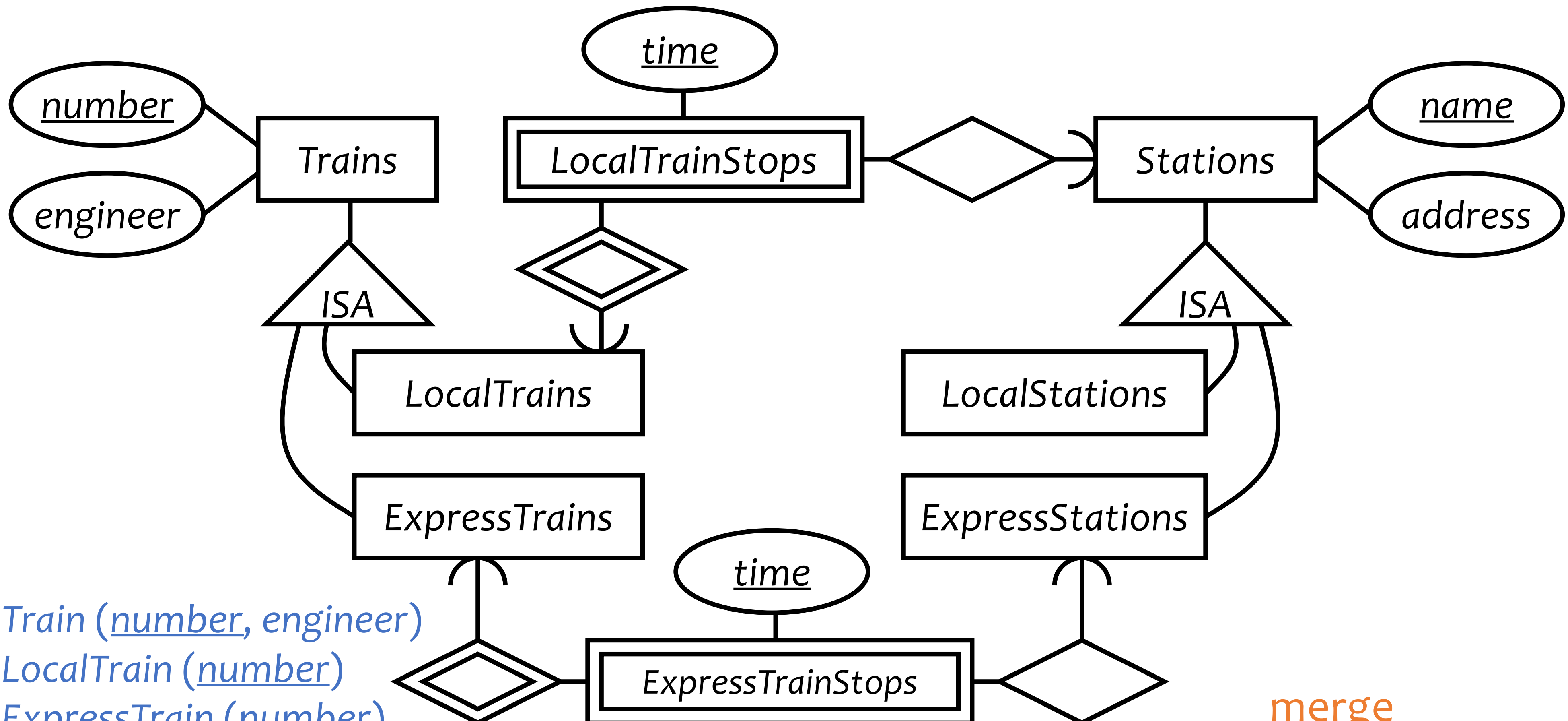
⟨142, Bart, NULL⟩
⟨456, Ralph, ☺⟩ ∈

Group (<u>gid</u>, name)
User (<u>uid</u>, name, avatar)
Member (<u>uid</u>, <u>gid</u>, from_date)

Comparison of three approaches

- Entity-in-all-superclasses
  - *User* (<u>*uid*</u>, *name*), *PaidUser* (<u>*uid*</u>, *avatar*)
  - Pro: All users are found in one table
  - Con: Attributes of paid users are scattered in different tables
- Entity-in-most-specific-class
  - *User* (<u>*uid*</u>, *name*), *PaidUser* (<u>*uid*</u>, *name*, *avatar*)
  - Pro: All attributes of paid users are found in one table
  - Con: Users are scattered in different tables
- All-entities-in-one-table
  - *User* (<u>*uid*</u>, [*type*,]*name*, *avatar*)
  - Pro: Everything is in one table
  - Con: Lots of `NULL`'s; complicated if class hierarchy is complex

A complete example



Train (number, engineer)
LocalTrain (number)
ExpressTrain (number)

Station (name, address)
LocalStation (name)
ExpressStation (name)

merge

LocalTrainStop (local_train_number, time)
LocalTrainStopsAtStation (local_train_number, time, station_name)

ExpressTrainStop (express_train_number, time)
ExpressTrainStopsAtStation (express_train_number, time, express_station_name)

merge

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
  - Redundant: can be computed as
    $$\pi_{number}(Train) - ExpressTrain$$
  - Slightly harder to check that *local_train_number* is indeed a local train number
- Eliminate *LocalStation* table
  - It can be computed as $\pi_{number}(Station) - ExpressStation$

An alternative design

Train (<u>number</u>, engineer, type)

Station (<u>name</u>, address, type)

TrainStop (<u>train_number</u>, station_name, <u>time</u>)

- Encode the type of train/station as a column rather than creating subclasses
- What about the following constraints?
  - Type must be either "local" or "express"
  - Express trains only stop at express stations
  - ☞They can be expressed/declared explicitly as database constraints in SQL (as we will see later in course)
- Arguably a better design because it is simpler!

Design principles

- KISS
  - Keep It Simple, Stupid
- Avoid redundancy
  - Redundancy wastes space, complicates modifications, 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

http://ungenius.files.wordpress.com/2010/03/thehomer.jpg