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

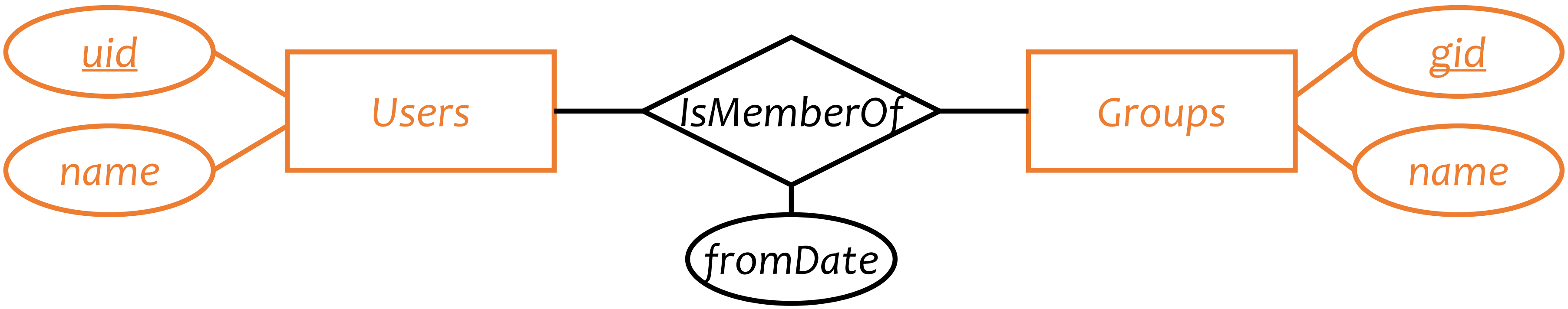
☞Next: translating E/R design to relational schema

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

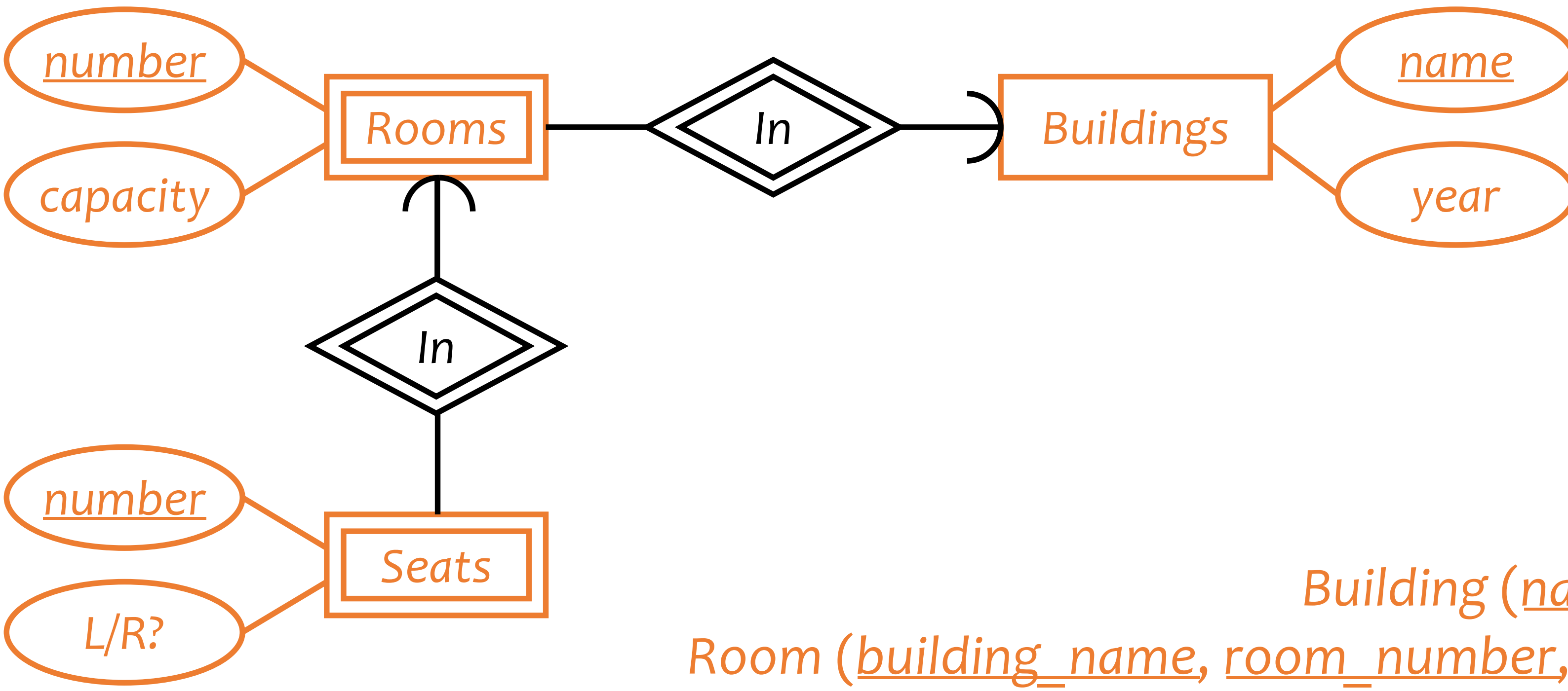


User (uid, name)

Group (gid, name)

Translating weak entity sets

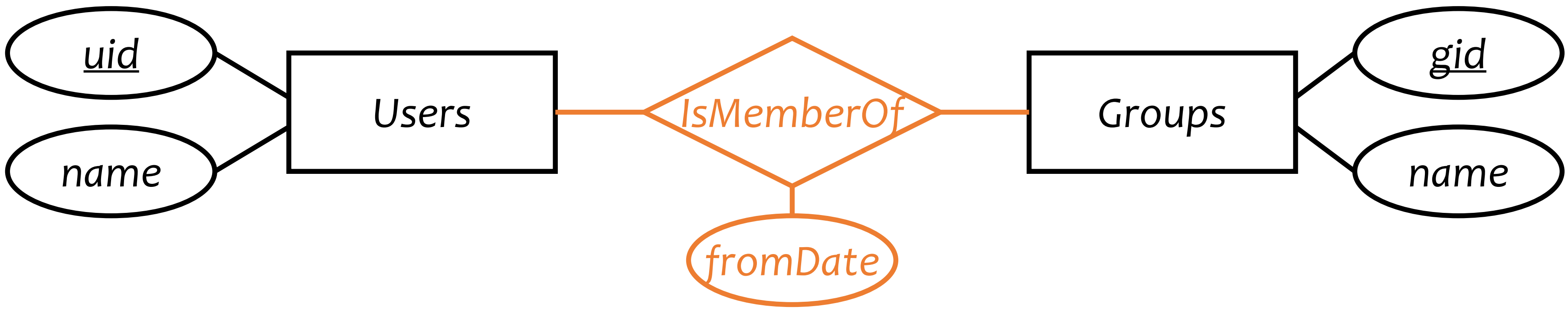
- Remember the "borrowed" key attributes
- Watch out for attribute name conflicts



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

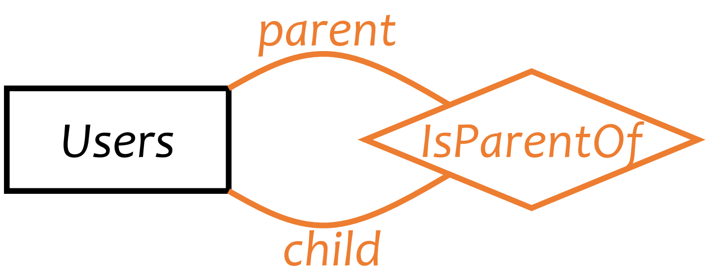
Translating relationship sets

- 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

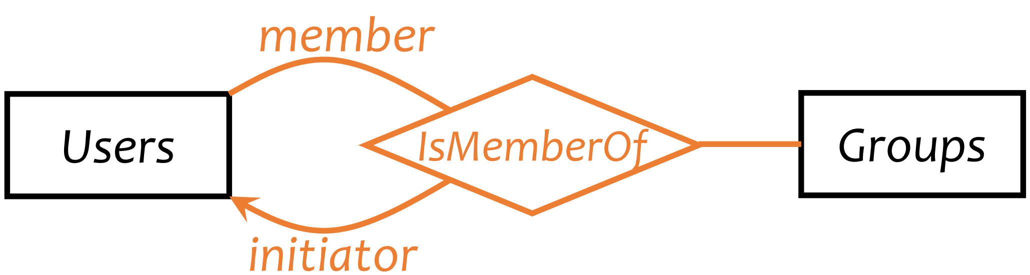


Member (<u>uid</u>, <u>gid</u>, fromDate)

More examples



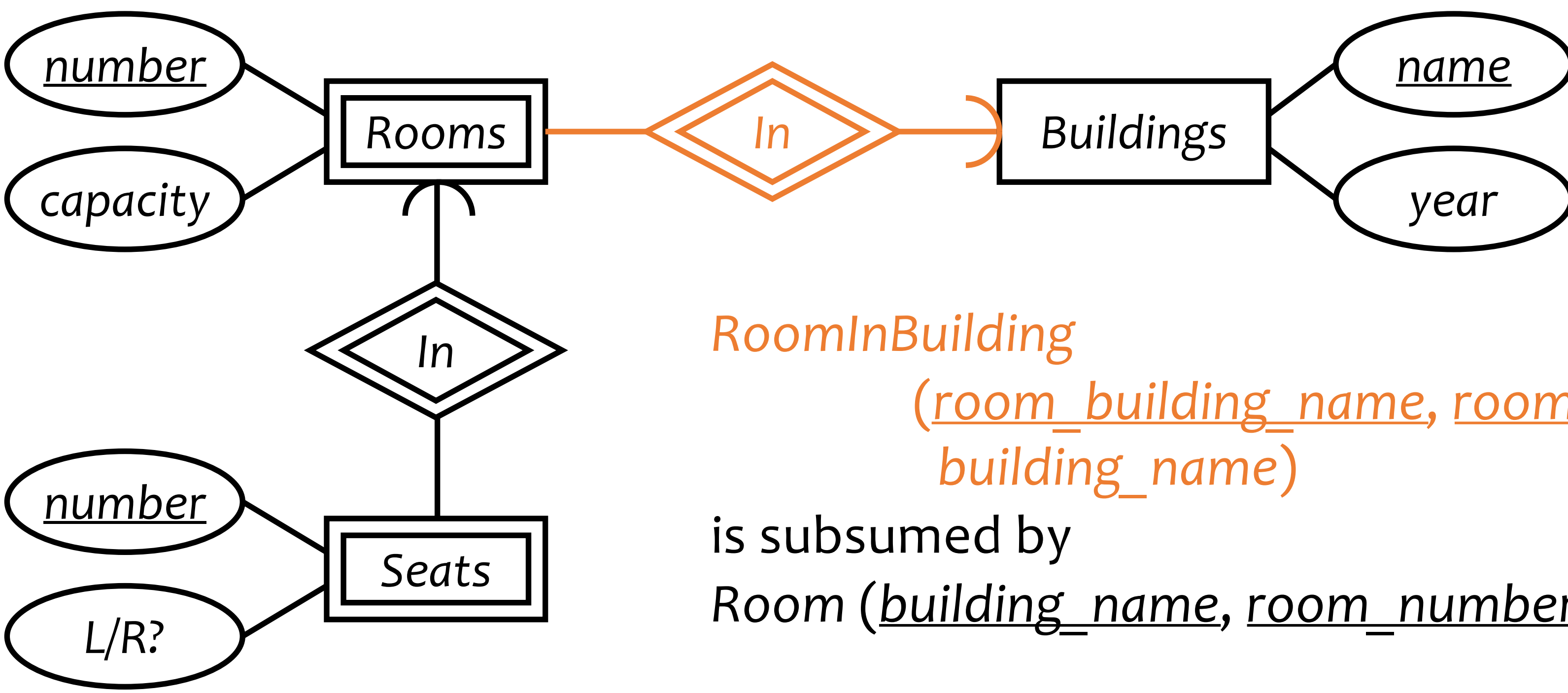
Parent (<u>parent_uid</u>, <u>child_uid</u>)



Member (uid, initiator_uid, gid)

Translating double diamonds?

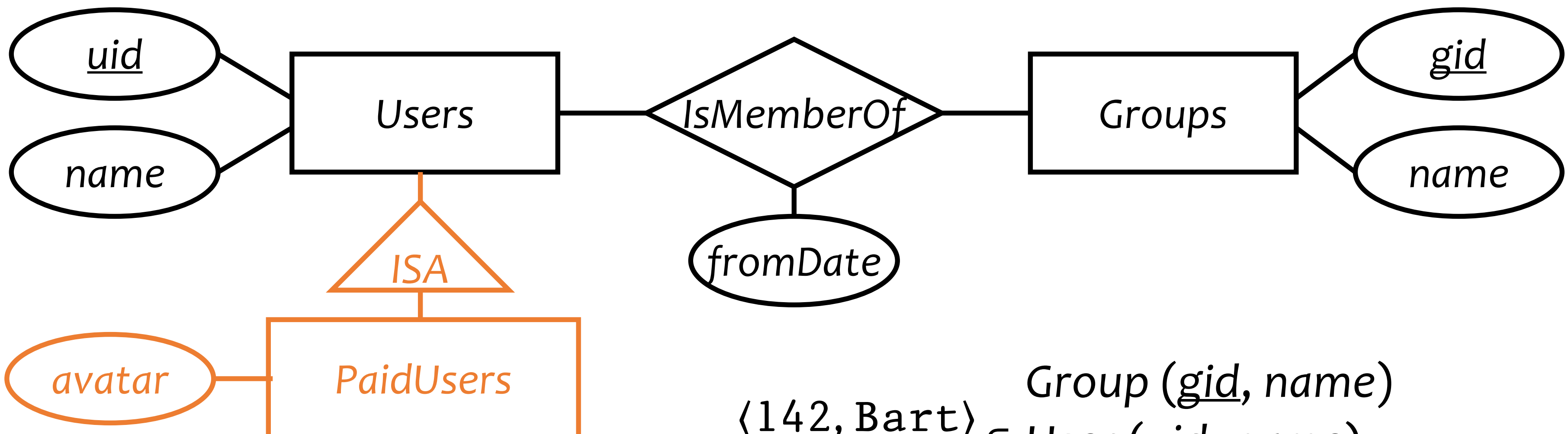
- Recall that a double-diamond (supporting) relationship set connects a weak entity set to another entity set
- No need to translate because the relationship is implicit in the weak entity set's translation



RoomInBuilding
(<u>room_building_name</u>, <u>room_number</u>, <u>building_name</u>)
is subsumed by
Room (<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



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

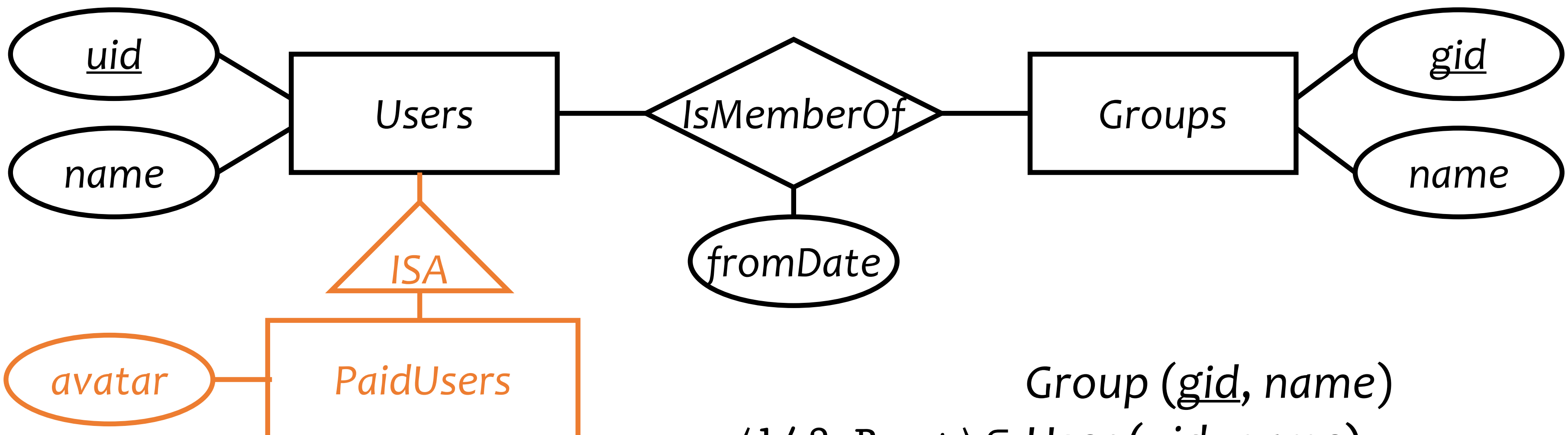
⟨142, Bart⟩ ⟨456, Ralph⟩ ∈ User (<u>uid</u>, name)

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

⟨456, ☺⟩ ∈ PaidUser (<u>uid</u>, 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)

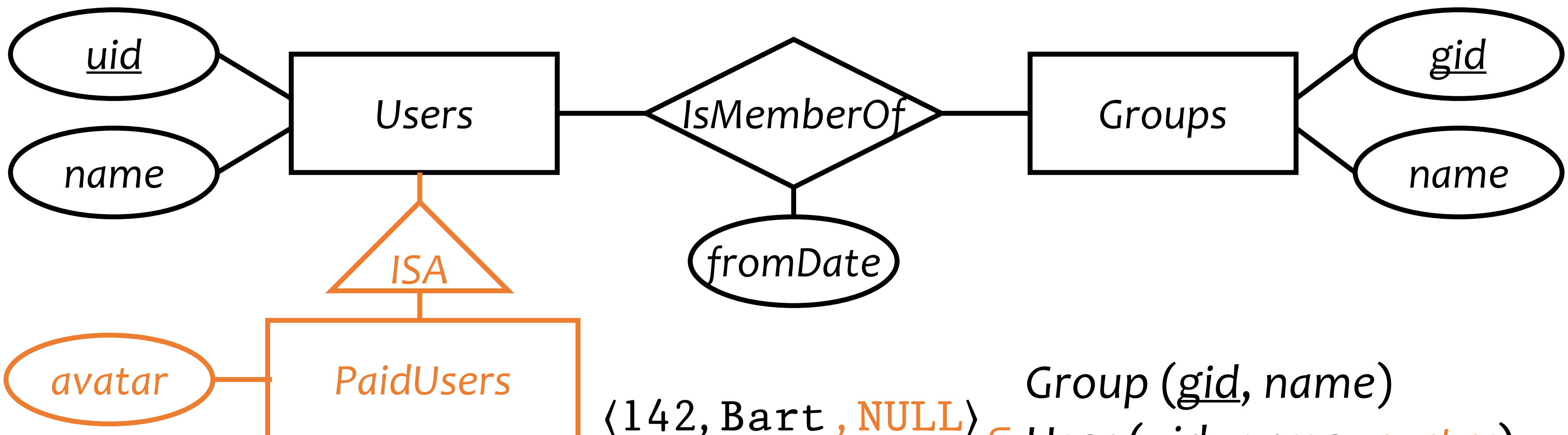
⟨142, Bart⟩ ∈ User (uid, name)

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



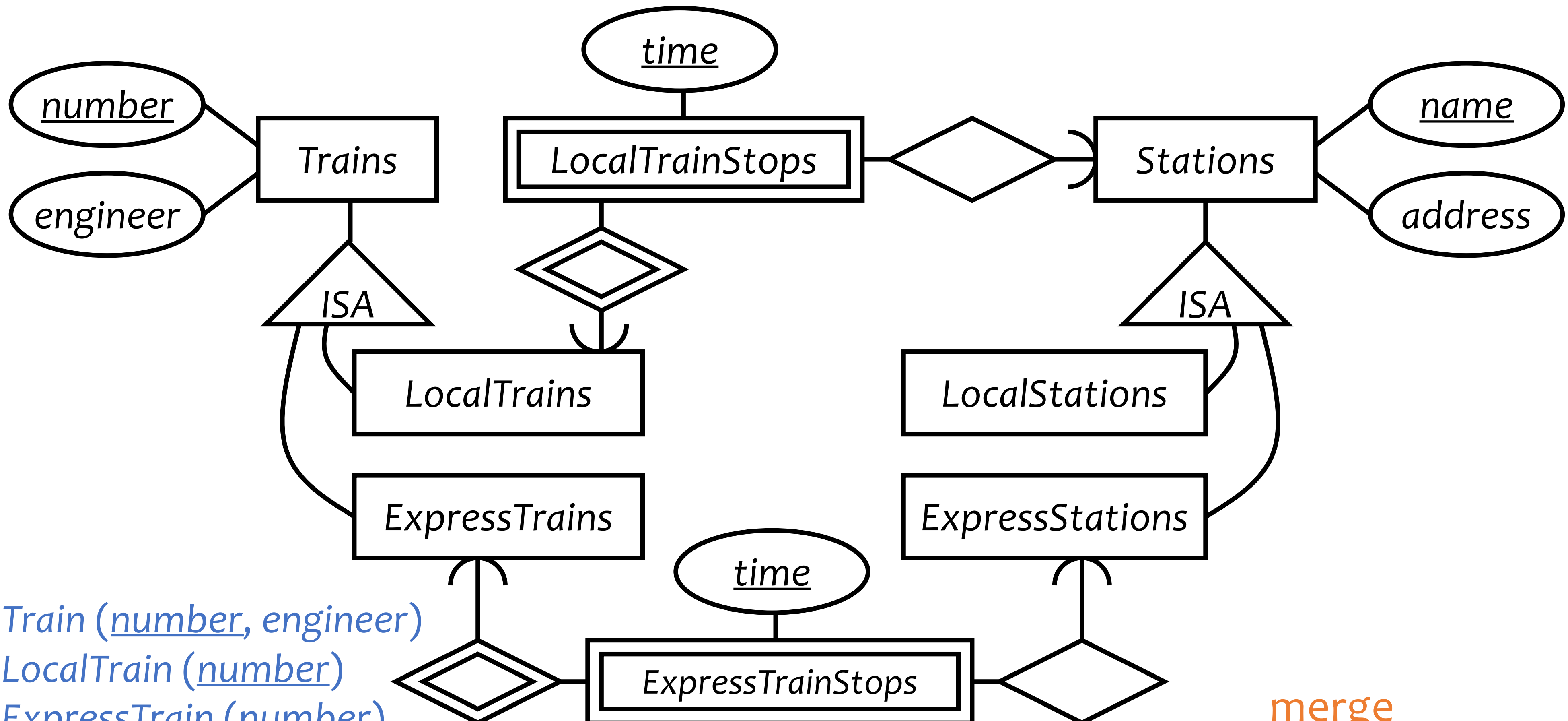
⟨142, Bart , NULL⟩
⟨456, Ralph, ☺⟩ ∈ User (uid, name, avatar)

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:
  - Con:
- All-entities-in-one-table
  - *User* (<u>*uid*</u>, [*type*,]*name*, *avatar*)
  - Pro:
  - Con:

A complete example



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

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

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

Simplifications and refinements

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

- 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