EECS 484 Homework #3

(70 points)

Due: Wednesday, Oct 9th, 2024 at 11:45 pm (ET)

Please read the following instructions before starting the homework:

This homework must be completed individually and can be submitted on Gradescope. Use entry code **XG8VVB** to self-enroll if you don't have access to the Gradescope course page.

No late days for homework! If you miss the due date, you get 0 points. If your PDF gets modified after the due date, you get 0 points. No exceptions on this.

Honor Code

By submitting this homework, you are agreeing to abide by the Honor Code:
I have neither given nor received unauthorized aid on this assignment, nor have I concealed any violations of the Honor Code.

Question 1: RA (16 points)

Consider the following schema for this question. Primary keys [INTEGER] are underlined and attributes in **bold** are foreign keys.

Schema:

AmusementParks(parkID, parkName, parkAddress)
Rides(rideID, **parkID**, rideName, minimumHeight, numberOfSeats, ranking)
Visits(visitID, **parkID**, **agencyID**, date)
BookingAgency(agencyID, agencyName, category)

Write **relational algebra** expressions for the following queries.

1. Find the names of all the rides in amusement parks with parkName = “Six_Flags" that have a minimum height requirement of 48. (4 points)

$\Pi_{rideName}(\sigma_{parkName = \text{"Six\_Flags"}}(AmusementParks) \bowtie_{parkID} \sigma_{minimum\_height = 48}(Rides))$

2. Find the parkIDs of all the amusement parks that have not had any visits. (4 points)

$\Pi_{parkID}(AmusementParks) - \Pi_{parkID}(Visits)$

3. Find the parkIDs of all the amusement parks that have at least one ride with a ranking over 9 or at least one ride with no minimum height requirement (minimumHeight = 0). (4 points)

$\Pi_{parkID}(\sigma_{rankings > 9}(Rides)) \cup \Pi_{parkID}(\sigma_{minimumHeight = 0}(Rides))$

4. Find the names of all the amusement parks that have had visits booked by every single booking agency with a category of “Entertainment”. (4 points)

$\Pi_{parkName}(AmusementParks \div \Pi_{agencyID}(\sigma_{category = \text{"Entertainment"}}(BookAgency)) \bowtie_{agencyID}(Visits))$

Question 2: Normalization (32 points)

Suppose we have a relation R with columns (A, B, C, D, E, F, G) and the following set of functional dependencies F:

F = { A → EG;
G → BD;
E → F;
DF → AC }

A -> EGBDFC
G -> BD
DF -> ACEGBD
FG -> FGBD -> AC.

1. List all of the candidate keys for this relation using only the functional dependencies provided (10 points).

   A, EG, DF, DE, FG

2. For each functional dependency below, identify whether it satisfies 3NF only, BCNF only, both, or neither: (14 points)
   a. A -> E 3NF and BCNF
   b. A -> G 3NF and BCNF
   c. G -> B 3NF only
   d. G -> D 3NF only
   e. E -> F 3NF only
   f. DF -> A 3NF and BCNF
   g. DF -> C 3NF and BCNF

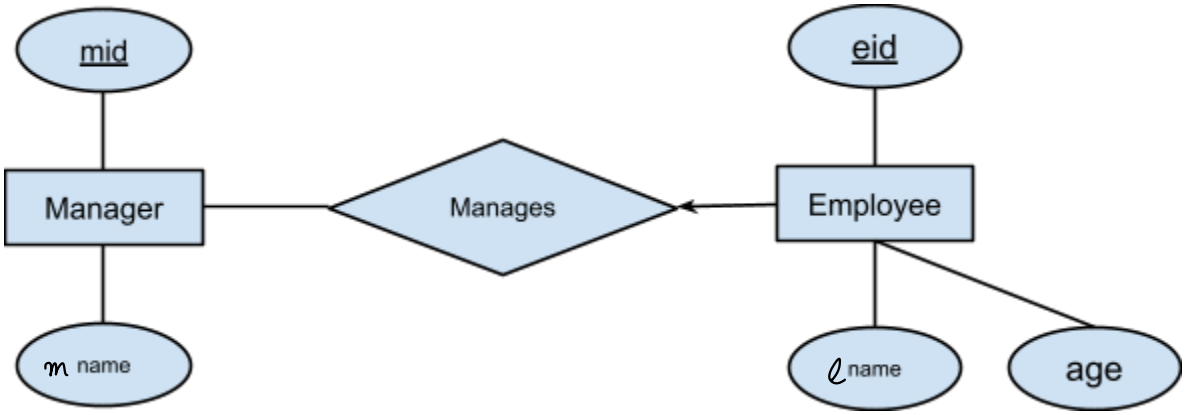
3. Perform one BCNF decomposition on the first functional dependency in the list given in the previous problem that violates BCNF, if any. List the resulting two tables, R1 and R2. (4 points)

   Perform G -> B Decomposition
   R1 (GBD)
   R2 (ACEFG)

4. Does this BCNF decomposition satisfy the lossless-join and dependency-preserving properties? (4 points)

   Lossless-join: satisfied because G is a candidate key in R1
   dependency preserving: not satisfied because DF -> AC not preserved

Question 3: Normalization with ER Diagrams (22 points)



Consider the above ER diagram from HW1. Assume we have a denormalized table R(mid, mname, eid, ename, age). Note that we renamed "name" attributes here to disambiguate. "mname" refers to the manager name and "ename" refers to the employee name.

(a) List all of the (non-trivial) functional dependencies for the denormalized table R that are implied by the ER diagram. (4 points)

mid -> mname
eid -> ename, age
eid -> mid, mname.

(b) List all of the candidate keys for R. (2 point)

eid.

(c) Does table R satisfy BCNF? If not, identify the first FD that violates BCNF from your answer to part A and decompose the table so that FD is no longer violating. Underline keys for each table in your decomposition. (4 points)

No. mid -> mname violates BCNF.
Decomposition: R1 (mid, mname)
R2 (eid, mid, ename, age)

Problem continued on the next page.

(d) What are the FDs assigned to each table from your previous decomposition and what are their keys (if any)? (8 points)

R1: mid -> mname. mid is the key

R2: eid -> mid
eid -> ename, age. eid is the key.

(e) Are the above set of tables in BCNF or not? If not, continue the decomposition until the tables are in BCNF. (4 points)

Both table are BCNF