TDBC86 Database Concepts Fall 2001

Obligatory Exercise 4
Due date: December 7, 2001 at 1700

1. Given is a relational database schema on ocean-going shipping. The schema consists of a single relation, with attributes as follows:

R(Ship_ID, Ship_Name, Ship_Type, Ship_Country,
Voyage_ID, Start_Date, End_Date, Cargo, Port, Dock_Date)

The following functional dependencies hold.

- {Ship_ID} $\rightarrow$ {Ship_Name, Ship_Type, Ship_Country}
- {Ship_Name, Ship_Country} $\rightarrow$ {Ship_ID}
- {Voyage_ID} $\rightarrow$ {Ship_ID, Cargo, Start_Date, End_Date)}
- {Ship_ID, Dock_Date} $\rightarrow$ {Voyage_ID, Port}

(a) Identify the candidate keys.

(b) Construct a lossless, dependency-preserving decomposition into 3NF. It is not necessary to use Algorithm 15.4 of the text, but it is necessary to provide a clear justification as to why the answer which you provide is in 3NF.

(c) Construct a lossless decomposition into BCNF.

(d) Explain why there is no lossless, dependency-preserving decomposition into BCNF.

2. Given is the relational database schema R(A,B,C,D,E), constrained by the functional dependency set $\mathcal{F}$ = {B $\rightarrow$ CD, D $\rightarrow$ E, E$\rightarrow$ C}. Answer the following:

(a) Determine a minimal cover for the set $\mathcal{F}$. It is not necessary to follow a formal algorithm, but a clear justification of why the answer is correct must be given.

(b) Provide a 3NF decomposition, using Algorithm 15.1 of the textbook.

(c) Indicate whether or not the decomposition of (b) is lossless. Justify your answer.

(d) If your answer to (c) is no, then apply Algorithm 15.4 of the textbook to obtain a lossless, dependency-preserving 3NF decomposition.

(e) Indicate whether or not the decomposition of (d) is a BCNF decomposition. Justify your answer. (If the answer to (c) is yes, so no new decomposition is constructed for (d), then use the decomposition of part (b)).

3. Given is a relational database schema R(A,B,C) constrained by the functional dependency $A \rightarrow BC$. For each of the decompositions {R[AB], R[AC]}, {R[AB], R[BC]}, and {R[AC], R[BC]}, answer the following questions.

   (a) State whether or not the decomposition is lossless.

   (b) If the decomposition is lossless, state the rule which mandates it to be so.

   (c) If the decomposition is not lossless, give a specific example of an instance r of R[ABC] whose two projections, defined by the decomposition, do not join together to obtain r. For example, if {R[AB], R[AC]} is not lossless, then provide an example r for which $\pi_{\{A,B\}}(r) \bowtie \pi_{\{B,C\}}(r)$ is not the same as r.

Notes:

- As stipulated in the course syllabus, this exercise may be done either individually, in a group of two, or in a group of three.
- Remember that there are point penalties for late submission. See the course syllabus.
- It is strongly recommended that you use a text-processing tool to display your results. If you write them by hand, they must be *very* neat.
- It is not allowed to copy the work of others. The submission must be the original work of the individual(s) in the working group.
- The grader reserves the right to interview members of the working group about the solution.
- So that solutions may be discussed in a class meeting, students and/or groups that are very late in preparing a solution may be required to solve an alternate problem to receive credit for this exercise.
- The join notation indicated on the slides entitled “join_notation” should be used for joins. If you can not / will not use this notation then you must provide a table defining your notation.
- If you have solved this problem for a previous offering of the course, you may re-use your old solution, subject to the following conditions: (a) You may not work with any partners, except possibly those with whom you worked to prepare the solution in the previous course. (b) You must explicitly note any partners from the previous course with whom you submitted a joint solution for that course. Note that grading criteria may not be identical between years, so that a solution which was found to be

satisfactory last year may not be evaluated similarly this year. Note also that the problems themselves may be different from those of previous years. You must in any case solve the problems for this year!