

Obligatory Exercise 4

Submission deadline to avoid lateness penalty: February 23, 2015 at 0800 (8am)

1 Problem Statement

For all problems, work must be shown. Answers which are not accompanied by clear explanations of why they are correct will not receive credit.

1. Given is the relational database schema $R[ABCDEFGH]$, constrained by the FDs in
$$\mathcal{F}_1 = \{ABD \rightarrow C, AF \rightarrow G, B \rightarrow DE, C \rightarrow A, E \rightarrow B, EFG \rightarrow AC, FG \rightarrow B\}.$$
 - (a) Find a canonical cover for \mathcal{F}_1 .
 - (b) Using the synthesis algorithm, find a dependency-preserving 3NF representation of $\langle R, \mathcal{F}_1 \rangle$.
 - (c) Find all keys for \mathcal{F}_1 .
 - (d) Find a lossless extension to the answer of (b).
 - (e) Indicate which of the relations in the answer to (d) are not in BCNF, and explain why.
 - (f) Show that there is no lossless and fully independent of $\langle R, \mathcal{F}_1 \rangle$ into BCNF. In other words, show that the BCNF-decomposition algorithm cannot yield such a decomposition. (Hint: Look for a small subschema with three attributes which is known not to admit such a representation.)
 - (g) Determine whether or not the synthesis found in (b) is fully independent.
(Note: Part (g) carries points, but it is not necessary to solve it in order to receive a satisfactory grade on the overall exercise set.)

2. Given is the relational database schema $R_2[ABCDEF]$, constrained by the FDs in
$$\mathcal{F}_2 = \{BF \rightarrow A, CE \rightarrow D, DF \rightarrow B\}.$$

Determine whether or not there is a lossless and fully independent decomposition of $\langle R_2, \mathcal{F}_2 \rangle$ into BCNF. If there is, draw the join tree which represents your solution. If there is not, explain why.

3. Repeat Problem 2, this time for (R_3, \mathcal{F}_3) with $R_3[ABCDE]$ constrained by the FDs in
$$\mathcal{F}_3 = \{AD \rightarrow B, BD \rightarrow C, CE \rightarrow A\}.$$

2 Submission Rules

1. All solutions must be typeset. Handwritten solutions will not be accepted. Either a markup language such as L^AT_EX (recommended) or a word processor such as LibreOffice

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or Apache OpenOffice may be used. Solutions in plaintext ASCII will not be accepted, because there are special symbols which are required, as well as because it may be necessary to draw a tree.

2. A simple macro in L^AT_EX for functional dependencies is:

```
\newcommand{\fdep}[2]{\mathit{#1} \rightarrow \mathit{#2}}
```

3. A join tree may be drawn using any number of tools. In L^AT_EX even the classical `picture` environment is more than adequate for such simple drawings, although the more modern `tikz` is far more powerful. GUI-based tools such as `dia` and `xfig` may also be used. In the latter case, export the image to a graphical format such as `PDF` or `JPG` and include it like this (if the diagram is to be scaled to 30% of its original size):

```
\includegraphics[scale=0.30]{jointree}}
```

The file extension of `jointree.jpg` will be found automatically. If LibreOffice or Apache OpenOffice is used instead, the associated drawing package is more than adequate for this purpose.

4. Solutions which deviate from these guidelines risk losing points or not being corrected at all.
5. All submissions must be in the form of a single PDF file.
6. A printout of the PDF submission must be placed in the submission mailbox for the course on the fourth floor of MIT-huset.
7. The PDF file must also be uploaded using the submission system found at the following URL:

<https://www8.cs.umu.se/kurser/5DV119/VT15/handin/>

8. The PDF file must include a cover sheet which lists the names and `cs.umu.se` user IDs of all partners.
9. This exercise may be done either individually or in a group consisting of no more than four (4) individuals.

3 Further Notes

- Remember that there are point penalties for late submission. See the course syllabus.
- 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.

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- 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.