Assignment #5 (220pt)

- **Due: Two Weeks Later**
  - Before the lecture – 10/19 (Wed)
- **Submission form**
  - *.doc or hand writing okay
- **Method: upload your report in Cyber Campus**
  - Questions are uploaded in Assignment 2 folder
  - Answers must be written in English !
- Answers may vary. There can be multiple answers.

Hw 5-1 (10pt)

7.1 Suppose that we decompose the schema $R = (A, B, C, D, E)$ into

$$(A, B, C)$$
$$(A, D, E).$$

Show that this decomposition is a lossless decomposition if the following set F of functional dependencies holds:

$$A \rightarrow BC$$
$$CD \rightarrow E$$
$$B \rightarrow D$$
$$E \rightarrow A$$

Hw 5-2 (20pt)

- Prove this

7.4 Use Armstrong's axioms to prove the soundness of the union rule. (*Hint*: Use the augmentation rule to show that, if $\alpha \rightarrow \beta$, then $\alpha \rightarrow \alpha\beta$. Apply the augmentation rule again, using $\alpha \rightarrow \gamma$, and then apply the transitivity rule.)

7.5 Use Armstrong's axioms to prove the soundness of the pseudotransitivity rule.

Hw 5-3 (10pt)

7.6 Compute the closure of the following set F of functional dependencies for relation schema $R = (A, B, C, D, E)$.

$$A \rightarrow BC$$
$$CD \rightarrow E$$
$$B \rightarrow D$$
$$E \rightarrow A$$

List the candidate keys for R.

Hw 5-4 (10pt)

7.14 Show that there can be more than one canonical cover for a given set of functional dependencies, using the following set of dependencies:

$$X \rightarrow YZ,\ Y \rightarrow XZ, \text{ and } Z \rightarrow XY.$$

Hw 5-5 (50pt)

7.30 Consider the following set F of functional dependencies on the relation schema (A, B, C, D, E, G):

$$A \rightarrow BCD$$
$$BC \rightarrow DE$$
$$B \rightarrow D$$
$$D \rightarrow A$$

a. Compute B^+.

b. Prove (using Armstrong's axioms) that AG is a superkey.

c. Compute a canonical cover for this set of functional dependencies F; give each step of your derivation with an explanation.

d. Give a 3NF decomposition of the given schema based on a canonical cover.

e. Give a BCNF decomposition of the given schema using the original set F of functional dependencies.

Hw 5-6 (40pt)

7.32 Consider the schema $R = (A, B, C, D, E, G)$ and the set F of functional dependencies:

$$A \rightarrow BC$$
$$BD \rightarrow E$$
$$CD \rightarrow AB$$

a. Find a nontrivial functional dependency containing no extraneous attributes that is logically implied by the above three dependencies and explain how you found it.

b. Use the BCNF decomposition algorithm to find a BCNF decomposition of R. Start with $A \rightarrow BC$. Explain your steps.

c. For your decomposition, state whether it is lossless and explain why.

d. For your decomposition, state whether it is dependency preserving and explain why.

Hw 5-7 (40pt)

7.33 Consider the schema $R = (A, B, C, D, E, G)$ and the set F of functional dependencies:

$$AB \rightarrow CD$$
$$ADE \rightarrow GDE$$
$$B \rightarrow GC$$
$$G \rightarrow DE$$

Use the 3NF decomposition algorithm to generate a 3NF decomposition of R, and show your work. This means:

a. A list of all candidate keys

b. A canonical cover for F, along with an explanation of the steps you took to generate it

c. The remaining steps of the algorithm, with explanation

d. The final decomposition

Hw 5-8 (30pt)

7.42 Normalize the following schema, with given constraints, to 4NF.

$$
\begin{aligned}
&books(accessionno, isbn, title, author, publisher)\\
&users(userid, name, deptid, deptname)\\
&accessionno \rightarrow isbn\\
&isbn \rightarrow title\\
&isbn \rightarrow publisher\\
&isbn \rightarrow\rightarrow author\\
&userid \rightarrow name\\
&userid \rightarrow deptid\\
&deptid \rightarrow deptname
\end{aligned}
$$

Hw 5-9 (10pt)

7.40 Given a relational schema $r(A, B, C, D)$, does $A \rightarrow\rightarrow BC$ logically imply $A \rightarrow\rightarrow B$ and $A \rightarrow\rightarrow C$? If yes prove it, or else give a counter example.