SCHOOL OF SOFTWARE, TSINGHUA UNIVERSITY

# Computer System Software(2)

## *Normal Form Homework*

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# I PROBLEM 1

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

A→BC
CD→E
B→D
E→A

List the candidate keys for R.
$F^+ is BD \rightarrow BD, B \rightarrow B, D \rightarrow D, C \rightarrow C, BD \rightarrow B, BD \rightarrow D, B \rightarrow D, B \rightarrow BD$. And $A* \rightarrow \beta, BC* \rightarrow \beta, CD* \rightarrow \beta, E* \rightarrow \beta$ where * is any set of attributes in R and $\beta$ is any subset of A, B, C, D, E .So the candidate keys are A, BC, CD and E.
$(A)^+ = A, B, C, D, E$
$(CD)^+ = A, B, C, D, E$
$(BC)^+ = A, B, C, D, E$
$(E)^+ = A, B, C, D, E$

# II PROBLEM 2

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

A→BCD
BC→DE
B→D
D→A

a. Compute $B^+$.
   $\because B \rightarrow D$ and $D \rightarrow A, \therefore B \rightarrow A$.
   and $\because, A \rightarrow BCD, \therefore B \rightarrow ABCD$.
   $\because BC \rightarrow DE, \therefore B \rightarrow ABCDE$
   $B^+ = \{A, B, C, D, E\}$

b. Prove (using Armstrong's axioms) that AF is a superkey.
   $\because A \rightarrow BCD, B \rightarrow ABCDE, \therefore A \rightarrow ABCDE$
   $\because F \rightarrow F, \therefore AF \rightarrow ABCDEF$
   thus, AF is a superkey.

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

   – First, we can test left-hand side. All the functional dependencies in F is not redundant except BC→DE which may be redundant.

Suppose B is extraneous, $C^+$ in F is {C}, $\therefore$ $C^+$does not contain DE, B is not extraneous.
Suppose C is extraneous, $B^+$ in F is {A,B,C,D,E}, $\therefore$ $B^+$ contains DE, C is extraneous.

- Now, we test right-hand side.
  For A→BCD:
  Suppose B is extraneous, $A^+$ in F' is {A,C,D}, $\therefore$ $A^+$ does not contain B, B is not extraneous.
  Suppose C is extraneous,$A^+$ in F' is {A,B,D}, $\therefore$ $A^+$ does not contain C, C is not extraneous.
  Suppose D is extraneous, $A^+$ in F' is {A,B,C,D,E}, $\therefore$ $A^+$ contains D, D is extraneous.
  BC→DE:
  Suppose D is extraneous, $BC^+$ in F' is {A,B,C,D,E}, $\therefore$$BC^+$ contains D, D is extraneous.
  Suppose E is extraneous, $BC^+$ in F' is {A,B,C,D}, $\therefore$ $BC^+$ does not contain E, E is not extraneous.

Thus, the canonical cover of F is

A→BC
B→DE
D→A

## III PROBLEM 3

Given the database schema R(a,b,c), and a relation r on the schema R, write an SQL query to test whether the functional dependency b→c holds on relation r.Also write an SQL assertion that enforces the functional dependency; assume that no null values are present. (Although part of the SQL standard, such assertions are not supported by any database implementation currently.)

**select** b
**from** r
**group by** b
**having count**(**distinct** c) > 1

If the result is empty, b→c holds on r.

**create assertion** assertion_b_c **check**
(**not exists**

(**select** b
**from** r

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        group by b
        having count(distinct c) > 1
        )

)
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