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1. Given $R = \{A1, A2, A3, A4, A5, A6, A7, A8\}$ and

$F = \{A_1A_3 \rightarrow A_7,$

$A_4 \rightarrow A_5A_7,$

$A_2A_3 \rightarrow A_4,$

$A_3A_7 \rightarrow A_2A_4,$

$A_1A_3A_4 \rightarrow A_2,$

$A_3A_5 \rightarrow A_1A_7\}$

after finding extraneous attributes and eliminating them and all redundant FDs, find the canonical cover of F. you have to define all the steps to get canonical cover. fast.

A canonical cover F_c for F is a set of dependencies such that F logically implies all dependencies in F_c, and F_c logically implies all dependencies in F.

F' if F' doesn't have (i) extraneous attribute / redundant attribute.
(ii) redundant FD.

steps. 1. splitting rule so that in every FD, right hand side has only single attribute

2. remove extraneous attribute

3. remove redundant FD.

Step 1. splitting the FDs.

$F = \{ A_1A_3 \rightarrow A_7,\ A_4 \rightarrow A_5,\ A_4 \rightarrow A_7,\ A_2A_3 \rightarrow A_4,\ A_3A_7 \rightarrow A_2,$
$A_3A_7 \rightarrow A_4,\ A_1A_3A_4 \rightarrow A_2,\ A_3A_5 \rightarrow A_1,\ A_3A_5 \rightarrow A_7 \}$

(decomposition $\rightarrow$ ($A_4 \rightarrow A_5A_7$ $\nearrow$ $A_4 \rightarrow A_5$ $\searrow$ $A_4 \rightarrow A_7$))

decomposition $\rightarrow$ $A_3A_5 \rightarrow A_1A_7$ $\nearrow$ $A_3A_5 \rightarrow A_1$ $\searrow$ $A_3A_5 \rightarrow A_7$

Step 2. remove extraneous attribute.

$A_1A_3A_4 \rightarrow A_2$.

($(A_1A_3)^+ \rightarrow A_1A_3A_7A_2$; hence $A_1A_3\cancel{A_4} \rightarrow A_2$

$A_1A_3 \rightarrow A_2$.

Since $(A_1A_3)^+$ contains A_2, then $(A_1A_3)^+$ can derive A_2.
A_4 is redundant.

Step 3. remove redundant FD.

there is no redundant FD.

canonical cover $F' = \{ A_1A_3 \rightarrow A_7,\ A_4 \rightarrow A_3,\ A_4 \rightarrow A_7,\ A_2A_3 \rightarrow A_4,$
$A_3A_7 \rightarrow A_2,\ A_3A_7 \rightarrow A_4,\ A_1A_3 \rightarrow A_2,\ A_3A_5 \rightarrow A_1,\ A_3A_5 \rightarrow A_7 \}$

2. a Given $R(A_1, A_2, A_3, A_4, A_5, A_6)$ and

$F = \{ A_1, A_2 \rightarrow A_3 \ , A_1 A_4 \rightarrow A_5 \ , A_2 \rightarrow A_4, \ A_1 A_6 \rightarrow A_2 \}$

1) find the $(A_1 A_2)^+$ and $(A_1 A_6)^+$.

$(A_1 A_2)^+$:

all functional dependencies: (direct and indirect)

$A_1 A_2 \rightarrow A_3$ ✓

$A_2 \rightarrow A_4$ ✓

$A_1 A_4 \rightarrow A_5$ ($A_2 \rightarrow A_4$ and $A_1 \cancel{A_4} \rightarrow A_5$)

$(A_1 A_2)^+ = A_1 A_2 A_3 A_4 A_5$

2) $(A_1 A_6)^+$:

$A_1 A_6 \rightarrow A_2$ $\quad$ $A_2 \rightarrow A_4$

$A_1 A_2 \rightarrow A_3$ $\quad$ $A_1 A_4 \rightarrow A_5$

$(A_1 A_6)^+$: $A_1 A_6 A_2 A_3 A_4 A_5$

b. why do we need closure? explain giving eg.

Once we find the closure set of a function dependency, we basically find all attributes which can be derived directly or indirectly from that dependency. As the name suggest, the result is a closure set ~~be~~ because the dependency → 3 is closing all that attributes. it is needed, for many reasons. eg, we can use it to remove the redundant attributes; it is useful in that manner because we can see the closure set of a. FD, check whether that attribute changes anything for that closure, hence understand if that attribute is redundant or not.

or, ~~the~~ we can use closure to determine whether the key of the dataset is candidate key. if the closure of FD is derived all attributes, it is candidate.

3. Given $R(A_1, A_2, A_3, A_4)$ under $F = \{A_1 \to A_2, A_2 \to A_3\}$

A_1 and A_2 are superkeys.

a. Is R in BCNF? give the proof.

Note: if A_1 and A_2 are superkeys, A_1^+ and A_2^+ must close the all attributes. But from given FD's, ~~then~~ this is not satisfied. if ~~the~~ we are to ignore the last information saying that "A_1 and A_2 are superkeys", I will change my answer.

if A_1 and A_2 are superkeys, the relation will be in BCNF.

if that's the case, the relation is in BCNF; ~~hence~~ ~~when~~ since the functional dependency are in the form of: superkey : {attributes}

hence, A_1 and A_2 are superkeys, the R is in BCNF.

but, if we are to look at only the FD's, ~~they~~ we're the superkeys, and the answer will change accordingly as ~~~~ not BCNF. I just assumed that, not all of the FDs are given.

Continues →

b. suppose that we decomposed R_1 into $R_1(A_1A_2)$, $R_2(A_1A_3)$, $R_3(A_1A_4)$. Are each of the relations in BCNF? give the proof.

FD is in BCNF, when the FD is in the form of: superkey = {attributes}

decomposing that three tables:

$\nearrow R_1(A_1A_2)$ $A_1 \rightarrow A_2$

$\rightarrow R_2(A_1A_3)$ $A_1 \rightarrow A_3$

$\searrow R_3(A_1A_4)$ no function dependency.

for R, A_1 and A_2 are superkeys, that means they can derive all attributes; $\{A_1A_2A_3A_4\}$

1. for R1, R_1 has (A_1, A_2). A_1 and A_2 are superkeys, it is in BCNF.
2. for R_2, R2 has $(A_2 \cdot A_3)$. $(A_1^+) = \{A_1A_2A_3\}$ from the given questions. so A_1 can derive A_3. $A_1 \rightarrow A_3$. A_1 is superkey.

It is BCNF.

3. for R_3, R_3 has (A_1A_4). important Note: there is no FD given in the questions, Hence ~~we~~ it seems we can't derive, $A_1 \rightarrow A_4$. BUT, it says that in the question, A_1 is superkey. I am assuming that ~~#~~ not all of the FDs are given in the question.

Hence, considering A_1 is superkey, $(A_1)^+ \rightarrow A_1A_2A_3A_4$. it can derive A_4!

it is BCNF

C - Is the decomposition dependency preserving? give the proof.

$$R(A_1, A_2, A_3, A_4) \xrightarrow{\text{decomposition}} \begin{cases} R(A_1, A_2) \\ R(A_1, A_3) \\ R(A_3, A_4) \end{cases}$$

regarding to the decomposition given in the question 2.B;

for $R_1 \Rightarrow A_1 \to A_2$ for R_3. No f.D.

$R_2 \to A_1^+ \{A_1 A_2, A_3\}$

since, A_1.

to be able, for the decomposition to be dependency preserving, the F set should be the same as F_U, (which is the union of all functional fs, for each R_x.

in this case, $F \neq F_1 \cup F_2$.

hence, decompositions dependency not preserved.