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8.1

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

answer:

$$\begin{aligned}
&A\rightarrow BC, B\rightarrow D\Rightarrow A\rightarrow D\\
&A\rightarrow BC, A\rightarrow D\Rightarrow A\rightarrow CD\\
&A\rightarrow CD, CD\rightarrow E\Rightarrow A\rightarrow E\\
&\text{综上所述}, A\rightarrow ABCDE, (A)^{+}=ABCDE\\
&\text{令}R_1=(A,B,C), R_2=(A,D,E)\\
&\text{因为}R_1\cap R_2=A, A\rightarrow ABC\\
&\text{因此}R_1\cap R_2\rightarrow R_1\text{成立}\\
&\text{综上所述, 该分解是无损分解}
\end{aligned}$$

8.6

> 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.

$$\begin{aligned}
&\text{由8.1得}, A\text{是候选码}\\
&E\rightarrow A\Rightarrow E\rightarrow ABCDE \qquad \text{因此}E\text{是候选码}\\
&CD\rightarrow E\Rightarrow CD\rightarrow ABCDE \qquad \text{因此}CD\text{是候选码}\\
&B\rightarrow D\Rightarrow BC\rightarrow CD\\
&BC\rightarrow CD, CD\rightarrow E\Rightarrow BC\rightarrow E\Rightarrow BC\rightarrow ABCDE \qquad \text{因此}BC\text{是候选码}\\
&\text{候选码}: A, BC, CD, E\\
&\text{令}\alpha\text{为}A,B,C,D,E\text{中的任意一种组合}, *\text{表示}F\text{中任意一种属性}\\
&F^{+}=\{A*\rightarrow\alpha, BC*\rightarrow\alpha, CD*\rightarrow\alpha, E\rightarrow\alpha, B\rightarrow B, B\rightarrow D, BD\rightarrow B, BD\rightarrow D, BD\rightarrow BD, C\rightarrow C, D\rightarrow D\}
\end{aligned}$$

8.13

> Show that the decomposition in Exercise 8.1 is not a dependency-preserving decomposition.

answer:

有几个函数依赖在分解后未能保持.例如$B\rightarrow D$在R_1和R_2上均未保留,因此不是保持依赖的分解

8.30

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

$$
\begin{gathered}
A \rightarrow BCD \\
BC \rightarrow DE \\
B \rightarrow D \\
D \rightarrow A
\end{gathered}
$$

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.

a

$B^+ = \{A, B, C, D, E\}$

b

$$
\begin{aligned}
A \rightarrow BCD \Rightarrow A \rightarrow BC & \quad \text{(合并率)} \\
A \rightarrow BC, BC \rightarrow DE \Rightarrow A \rightarrow DE & \quad \text{(传递律)} \\
A \rightarrow BC, A \rightarrow DE \Rightarrow A \rightarrow BCDE & \quad \text{(合并律)} \\
A \subset A \Rightarrow A \rightarrow A & \quad \text{(自反律)} \\
A \rightarrow A, A \rightarrow BCDE \Rightarrow A \rightarrow ABCDE & \quad \text{(合并律)} \\
A \rightarrow ABCDE \Rightarrow AG \rightarrow ABCDEG & \quad \text{(增补律)}
\end{aligned}
$$

$$
\begin{gathered}
(AG)^+ = ABCDEG \\
\text{综上}, AG\text{是超码}
\end{gathered}
$$

c

D在$A \rightarrow BCD$中无关, 因为F逻辑蕴涵$(F - \{A \rightarrow BCD\}) \cup \{A \rightarrow BC\}$. 此断言为真, 因为$A \rightarrow BC, BC \rightarrow DE$, 所以$(A)^+$中包括$D$
D在$BC \rightarrow DE$中无关, 因为F逻辑蕴涵$(F - \{BC \rightarrow DE\}) \cup \{BC \rightarrow E\}$. 此断言为真, 因为$B \rightarrow D$, 所以$(BC)^+$中包括$D$
综上, F的正则覆盖$Fc = \{A \rightarrow BC, BC \rightarrow E, B \rightarrow D, D \rightarrow A\}$

d

$A \rightarrow ABCDE \Rightarrow AG \rightarrow ABCDEG$
$(AG)^+ = ABCDEG$
因此AG是R的一个候选码
$Fc = \{A \rightarrow BC, BC \rightarrow E, B \rightarrow D, D \rightarrow A\}$
$R_1 = ABC, R_2 = BCE, R_3 = BD, R_4 = DA$ 其中不包含候选码, 所以添加$R_5 = AG$
因此$3NF$分解为$\{ABC, BCE, BD, DA, AG\}$

e

$$\text{候选码}:AG,BG,DG\quad F\text{中不满足}\alpha\rightarrow\beta\text{是平凡的函数依赖或}\alpha\text{是超码},\text{因此}F\text{不符合}BCNF$$
$$F=\{A\rightarrow BCD,BC\rightarrow DE,B\rightarrow D,D\rightarrow A\}\quad R=\{A,B,C,D,E,G\}$$
$$result=\{R\}=\{R(A,B,C,D,E,G)\}$$
$$B\rightarrow D\text{不符合}BCNF$$
$$result=\{R_1,R_2\}=\{R_1(B,D),R_2(A,B,C,E,G)\}$$
$$R_1(B,D)\text{符合}BCNF,\text{因为}B\rightarrow D,\text{其中}(B)^+=\{B,D\},B\text{是}R_1\text{的超码}$$
$$R_2(A,B,C,E,G)\text{不符合}BCNF,\text{因为其中}A\rightarrow BC\text{不满足}$$
$$result=\{R_1,R_2,R_3\}=\{R_1(B,D),R_2(A,B,C),R_3(A,E,G)\}$$
$$R_2(A,B,C)\text{符合}BCNF,\text{因为}A\rightarrow BC,\text{其中}(A)^+=\{ABC\},A\text{是}R_2\text{的超码}$$
$$R_3(A,E,G)\text{不符合}BCNF,\text{因为}R_3\text{中}A\rightarrow E\text{不满足}$$
$$result=\{R_1,R_2,R_3,R_4\}=\{R_1(B,D),R_2(A,B,C),R_3(A,E),R_4(A,G)\}$$
$$\text{其中}result\text{中的所有关系均满足}BCNF$$
$$F\text{的}BCNF\text{分解的结果}:result=\{R_1(B,D),R_2(A,B,C),R_3(A,E),R_4(A,G)\}$$

8.31

> Consider the schema $R=(A,B,C,D,E,G)$ and the set F of functional dependencies:
>
> $$AB\rightarrow CD$$
> $$B\rightarrow D$$
> $$DE\rightarrow B$$
> $$DEG\rightarrow AB$$
> $$AC\rightarrow DE$$
>
> R is not in BCNF for many reasons, one of which arises from the functional dependency $AB\rightarrow CD$. Explain why $AB\rightarrow CD$ shows that R is not in BCNF and then use the BCNF decomposition algorithm starting with $AB\rightarrow CD$ to generate a BCNF decomposition of R. Once that is done, determine whether your result is or is not dependency preserving, and explain your reasoning.

- R的BCNF分解

$$R=(A,B,C,D,E,G)$$
$$F=\{AB\rightarrow CD,B\rightarrow D,DE\rightarrow B,DEG\rightarrow AB,AC\rightarrow DE\}$$
$$AB\rightarrow CD\text{不是平凡的函数依赖},\text{且}(AB)^+\text{中不包括}G,\text{因此}AB\text{不是超码},\text{所以}AB\rightarrow CD\text{不满足}BCNF$$
$$result=\{R\}=\{R(A,B,C,D,E,G)\}$$
$$R\text{中}AB\rightarrow CD\text{不符合}BCNF,\text{分解}R\text{为}R(A,B,C,D),R(A,B,E,G)$$
$$result=\{R_1,R_2\}=\{R_1(A,B,C,D),R_2(A,B,E,G)\}$$
$$R_1\text{中}B\rightarrow D\text{不符合}BCNF,\text{分解}R_1\text{为}R(B,D),R(A,B,C)$$
$$result=\{R_1,R_2,R_3\}=\{R_1(B,D),R_2(A,B,C),R_3(A,B,E,G)\}$$
$$R_3\text{中}AB\rightarrow E\text{不符合}BCNF,\text{分解}R_3\text{为}R(A,B,E),R(A,B,G)$$
$$result=\{R_1,R_2,R_3,R_4\}=\{R_1(B,D),R_2(A,B,C),R_3(A,B,E),R_4(A,B,G)\}$$
$$\text{此时}result\text{中的每个关系都符合}BCNF,\text{因此}R\text{的}BCNF\text{为}:$$
$$result=\{R_1,R_2,R_3,R_4\}=\{R_1(B,D),R_2(A,B,C),R_3(A,B,E),R_4(A,B,G)\}$$

- BCNF分解的结果是否保持依赖

BCNF的结果不保持依赖,例如$DE\rightarrow B$的函数依赖不存在在分解之后的任何一个关系R中