2154312 郑博远

a) 分解规则 $\because AC\to BD \quad \therefore AC\to B$

传递律 $\because AC\to B \quad B\to E \quad \therefore AC\to E$

b) $(A)^+ = \{A\}$

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

c) $F = \{AC\to B, AC\to D, B\to C, C\to D, B\to E\}$

消除冗余后 $F_c = \{AC\to B, C\to D, B\to C, B\to E\}$

合并后 $F_c = \{AC\to B, C\to D, B\to CE\}$

d) $X = \{A\} \quad Y = \{B, C, D\}$

$X^+ = \{A\}$，因此不是候选码

$(AB)^+ = U \quad (AC)^+ = U \quad (AD^+) = \{A, D\}$

$\therefore$ 候选码为(AB)、(AC)

对于 $C\to D$，D部分依赖于键 AC

因此，$R \notin 2NF$

$\therefore$ R为 1NF

e) $U_1 = \{A, B, C\}$，$F_1 = \{AC\to B\}$

$U_2 = \{C, D\}$，$F_2 = \{C\to D\}$

$U_3 = \{B, C, E\}$，$F_3 = \{B\to CE\}$

f)

	A	B	C	D	E
$U_1(A,B,C)$	a_1	a_2	a_3	~~b_{14}~~ a_4	~~b_{15}~~ a_5
$U_2(C,D)$	b_{21}	b_{22}	a_3	a_4	~~b_{25}~~ a_5
$U_3(B,C,E)$	b_{31}	a_2	a_3	~~b_{34}~~ a_4	a_5

→ 所以是lossless-join

$\because (F_1 \cup F_2 \cup F_3)^+ = F^+ \quad \therefore$ 满足dependency preservation

数据库系统原理第四次作业

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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:

$$A \rightarrow BC$$

$$CD \rightarrow E$$

$$B \rightarrow D$$

$$E \rightarrow A$$

Solution:

According to $A \rightarrow BC$ *in* F*:*

$(A, B, C) \cap (A, D, E) = A \rightarrow (A, B, C)$

i.e. $R_1 \cap R_2 \rightarrow R_1$

So, this decomposition is a lossless one.

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.

Solution:

Starting with $A \rightarrow BC$*, we can got* $A \rightarrow B$ *and* $A \rightarrow C$ *(decomposition)*

Since $A \rightarrow B$ *and* $B \rightarrow D$*, got* $A \rightarrow D$ *(transitivity)*

Since $A \rightarrow C, A \rightarrow D, CD \rightarrow E$, *got* $A \rightarrow E$ *(union, transitivity)*

So, $A \rightarrow ABCDE$ *(reflextivity, union)*

Since $E \rightarrow A$*, got* $E \rightarrow ABCDE$ *(transitivity)*

Since $CD \rightarrow E$*, got* $CD \rightarrow ABCDE$ *(transitivity)*

Since $B \rightarrow D$*, we got* $BC \rightarrow ABCDE$ *(pseudotransitivity)*

Besides, we have $C \rightarrow C, B \rightarrow B, D \rightarrow D,\ BD \rightarrow BD$ *(reflextivity)*

Thus, $BD \rightarrow B, BD \rightarrow D$ *(decomposition)*

Also, $B \rightarrow BD$ *(union)*

In conclusion , F^{+}*is* $B \rightarrow B, B \rightarrow D, C \rightarrow C, D \rightarrow D, B \rightarrow BD, BD \rightarrow B, BD \rightarrow D, BD \rightarrow BD$*, and* <u>*all FDs whose LHS contains* A, BC, CD *or* E*, and whose RHS is any subset of* $\{A, B, C, D, E\}$ *.*</u>

The candidate keys are A, BC, CD *and* E*.*

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.

Solution:

a. $X^{(0)} = \{B\}$

$X^{(1)} = \{ B, D \}$*, according to* $B \rightarrow D$

$X^{(2)} = \{ A, B, D \}$, *according to* $D \rightarrow A$

$X^{(3)} = \{ A, B, C, D \}$, *according to* $A \rightarrow BCD$

$X^{(4)} = \{ A, B, C, D, E \}$, *according to* $BC \rightarrow DE$

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

b. *Since* $BC \rightarrow DE$, *we got* $BCD \rightarrow DE$ *(augmentation)*

Since $A \rightarrow BCD$, $BCD \rightarrow DE$, *we got* $A \rightarrow DE$ *(transivity)*

Then we got $A \rightarrow BCDE$ *(union)*

Thus, $AG \rightarrow ABCDEG$ *(augmentation)*

So AG *is a superkey.*

c. (1) $F = \{ A \rightarrow B, A \rightarrow C, A \rightarrow D, BC \rightarrow D, BC \rightarrow E, B \rightarrow D, D \rightarrow A \}$

(2) $A \rightarrow D$ *is implied by* $A \rightarrow B, B \rightarrow C$ *and* $BC \rightarrow D$, *so* $A \rightarrow D$ *is extraneous.*

F_c *is now* $\{A \rightarrow B, A \rightarrow C, BC \rightarrow D, BC \rightarrow E, B \rightarrow D, D \rightarrow A\}$.

(3) $BC \rightarrow D$ *is implied by* $B \rightarrow D$, *so* $BC \rightarrow D$ *is extraneous.*

F_c *is now* $\{A \rightarrow B, A \rightarrow C, BC \rightarrow E, B \rightarrow D, D \rightarrow A\}$.

(4) *combine* $A \rightarrow B$ *with* $A \rightarrow C$ *to get:*

$$F_c = \{ A \rightarrow BC, BC \rightarrow E, B \rightarrow D, D \rightarrow A \}$$

d.

First, find all the candidate keys:

$$X = \{ G \}, Y = \{ A, B, C, D \}$$

Since X *cannot be candidate keys, try:*

$$(AG)^+ = R$$

$$(BG)^+ = R$$

$$(CG)^+ = \{ C, G \}$$

$$(DG)^+ = R$$

So the candidate keys are $(AG), (BG), (DG)$.

Then, give the 3NF decomposition:

$$U_1 = \{ A, B, C \}, F_1 = \{ A \rightarrow BC \}$$

$$U_2 = \{ B, C, E \},\ F_2 = \{ BC \rightarrow E \}$$

$$U_3 = \{ B, D \},\ F_3 = \{ B \rightarrow D \}$$

$$U_3 = \{ A, D \},\ F_3 = \{ D \rightarrow A \}$$

Since none of them contains candidate keys, add:

$$U_4 = \{ A, G \}, F_4 = \emptyset$$

In conclusion, the decomposition is $(A, B, C), (B, C, E), (B, D), (A, D), (A, G)$.

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