Lossless join Decomposition

Nonadditive (Lossless) Join Property of a Decomposition

Let R be a relation schema and let F be a set of FDs over R. A decomposition of R into two schemas with attribute sets X and Y is said to be a **lossless-join decomposition with respect to F** if for every instance r of R that satisfies the dependencies in F, $\pi_X(r) \bowtie \pi_Y(r) = r$.

The word loss in lossless refers to loss of information, not to loss of tuples. If a decomposition does not have the lossless join property, we may get additional spurious tuples after the PROJECT and NATURAL JOIN operations are applied; these additional tuples represent erroneous or invalid information.

Let R be a relation and F be a set of FDs that hold over R. The decomposition of R into relations with attribute sets R_1 and R_2 is lossless if and only if F^+ contains either the FD $R_1 \cap R_2 \rightarrow R_1$ or the FD $R_1 \cap R_2 \rightarrow R_2$.

In other words, if R1∩R2 forms a superkey for either R1 or R2, the decomposition of R is a lossless decomposition.

Q.1. R(ABCD)

F: $\{AB \rightarrow C,\ C \rightarrow A,\ C \rightarrow D\}$

D: $\{\overset{R_1}{AB},\ \overset{R_2}{ACD}\}$

$AB \cap ACD = A$

$A \rightarrow R_1$ ✗

$A \rightarrow R_2$ ✗

lossy

R(ABCDEF)

F: $\{A \rightarrow B,\ C \rightarrow DE,\ AC \rightarrow F\}$

D: $\{BE,\ ACDEF\}$

$R_1 \cap R_2 = E$

lossy

$E \rightarrow R_1$ ✗

$E \rightarrow R_2$ ✗

$R(ABCDE)$

$\{A \to BC,\ CD \to E,\ B \to D,\ E \to A\}$

$D: \{ABC,\ ACDE\}$

lossless

$AC \to R_1$ ✓

$AC \to R_2$ ✓

$(AC)^+ = ACBDE$

$R_1 \cap R_2 = \phi$ lossy

R

R_1 R_2

✓ (1) $R_1 \cap R_2 \neq \phi$

✓ (2) $att(R_1) \cup att(R_2) = att(R)$

AB ACD ABCDE lossy

$\cup$ ABCD

✓ (3) $R_1 \cap R_2 \to R_1$ ✓

or OR

$R_1 \cap R_2 \to R_2$ ✓

$R(ABCDEG)$

$\{AB \to C,\ AC \to B,\ AD \to E,\ B \to D,\ BC \to A,\ E \to G\}$

(4) $D: \{AB,\ BC,\ ABDE,\ EG)$ $E^+ = EG$

$R_1 \quad R_2 \quad R_3 \quad R_4$

$R_1 R_2$ ✗

$R_2 R_3$ ✗

$R_1 R_4$ ✗

$R_2 R_4$ ✗

$R_1 \cap R_3 = AB \quad AB \to R_1$

$AB \to R_3$

$R_{13}(ABDE),\ R_2(BC),\ R_4(EG)$

$R_{13} \cap R_4 = E \quad E \to R_4$ ✓ $\quad E \to R_{13}$ ✗

$R_{13} \quad R_2$ ✗

$R_{13} \quad R_4$ ✓

$R_{134}(ABDEG) \quad R_2(BC)$

$R_{134} \quad R_2$

$B \to R_2$ ✗

$B \to R_{134}$ ✗

lossy

$D: \{ \overset{R_1}{ABC},\ \overset{R_2}{ACDE},\ \overset{R_3}{ADG} \}$

$R(ABCDEG)$

$\{AB \to C,\ AC \to B,\ AD \to E,\ B \to D,\ BC \to A,\ E \to G\}$

$R_1 R_2$ ✓

$R_{12}(ABCDE) \quad R_3(ADG)$

$R_{12} \cap R_3 = AD$

$AD \to R_3$

$R_1 \quad R_2 \quad R_3$

$R_{12} \quad R_3$

R_{123}

lossless ✓