COMPUTER SCIENCE

Database Management System

FD's & Normalization

Lecture_09

Vijay Agarwal sir

TOPICS TO BE COVERED

01 Lossy and Lossless Join

02 Dependency Preserving

RDBMS Concept

FD Concept & its type

Attribute Closure

Keys Concept

- Super key
- Candidate key
- Primary key
- AK / SK

Membership set

Equality b/w 2 FD set

Minimal Cover.

Finding # Super key

FD Closure.

Properties of Decomposition

1. Lossless Join Decomposition.
2. Dependency Preserving Decomposition.

Lossless Join Decomposition :

1. BASIC CONCEPT

Imp ~~2~~ Binary Method (Successive Approach)

3. CHASE TEST

Lossless Join Decomposition :

Let R be the Relational Schema with Instances $r_1 r_2 \ldots r_n$

is decomposed into Sub Relation $R_1 R_2 R_3 \ldots \ldots R_n$

If $R_1 \bowtie R_2 \bowtie R_3 \ldots\ldots \bowtie R_n \equiv R$

Lossless Join Decomposition.

If $R_1 \bowtie R_2 \bowtie R_3 \ldots\ldots \bowtie R_n \supset R$ → Supurious (Extra) Tuple.

Lossy Join Decomposition.

Natural Join ($\bowtie$) [$R \bowtie S$]

Step1 CROSS Product of R & S.

R	S
n_1 Tuple	n_2 Tuple
C_1 Attribute	C_2 Attribute

$$R \times S = \begin{matrix} n_1 \times n_2 \text{ Tuple} \\ C_1 + C_2 \text{ Attribute} \end{matrix}$$

Step2: Select the Tuples which Satisfy equality Condition on All Common Attribute (FROM R×S) of R & S.

Step3: Projection of Distinct Attribute.

$\boxed{R_1(ABCD) \quad R_2(CDEFG)}$ $\quad R_3(GIJ)$

$R_1.C = R_2.C$

$\& \; R_1.D = R_2.D$

equality Condition on ALL Common Attribute

Q.

R(ABC)

A	B	C
1	5	5
2	5	8
3	8	8

Decomposed into

Q.1 $R_1(AB)$ & $R_2(BC)$

$3 \times 3 = 9$ Tuples

$2+2=4$ Attribute

A	B
1	5
2	5
3	8

B	C
5	5
5	8
8	8

Step 1

$R_1 \times R_2 =$

RA	R.B	S.B	SC	
1	5	5	5	1
1	5	5	8	2
1	5	8	8	
2	5	5	5	3
2	5	5	8	4
2	5	8	8	
3	8	5	5	
3	8	5	8	
3	8	8	8	5

Step 2

A	B	B	C
1	5	5	5
1	5	5	8
2	5	5	5
2	5	5	8
3	8	8	8

Step 3

A	B	C
1	5	5
1	5	8
2	5	5
2	5	8
3	8	8

$\boxed{R_1 \bowtie R_2 \supset R}$

$\Downarrow$

Lossy Join

(Spurious Tuple (Extra))

Q. R(ABC)

$A \to B$

A	B	C
1	5	5
2	5	8
3	8	8

Decomposed into

Q.1 $R_1(AB)$ & $R_2(BC)$

Q.2 $R_1(AB)$ & $R_2(AC)$

$R(ABC)$ $[A \to B]$

① $R_1(AB) \cup R_2(BC) = ABC$

$R_1(AB) \cap R_2(BC) = B$

$[B]^+ = [B]$ Not super key of R_1 & R_2 Not

Lossy Join

$R(ABC)$ $(A \to B)$

Q.2 $R_1(AB) \cup R_2(AC) = ABC$

$R_1(AB) \cap R_2(AC) = A$

$[A]^+ = [AB]$ Super key of R_1

Lossless Join

Q.

R(ABC)

$A \rightarrow B$

$A \rightarrow C$

A	B	C
1	5	5
2	5	8
3	8	8

Decomposed into

Q.1 $R_1(AB)$ & $R_2(BC)$

Q.2 $R_1(AB)$ & $R_2(AC)$

$R(ABC)$ $[A \rightarrow B$ $A \rightarrow C]$

① $R_1(AB) \cup R_2(BC) = ABC$

$R_1(AB) \cap R_2(BC) = B$

$[B]^+ = [B]$ Not super key of R_1 & R_2 Not

Lossy Join

$R(ABC)$ $[A \rightarrow B, A \rightarrow C]$

Q.2 $R_1(AB) \cup R_2(AC) = ABC$

$R_1(AB) \cap R_2(AC) = A$

$[A]^+ = [ABC]$ Super key of R_1 & R_2

∴ Lossless Join

Q.2

R(ABC) $B \not\to A$, $B \not\to C$

$A \to B$
$A \to C$

A	B	C
1	5	5
2	5	8
3	8	8

Decomposed into

Q.2 $R_1(AB)$ & $R_2(AC)$

A	B
1	5
2	5
3	8

A	C
1	5
2	8
3	8

Step1

$R_1 \times R_2 =$

$R_1.A$	$R_1.B$	$R_2.A$	$R_2.C$
1	5	1	5
1	5	2	8
1	5	3	8
2	5	1	5
2	5	2	8
2	5	3	8
3	8	1	5
3	8	2	8
3	8	3	8

$$R_1.A == R_2.A$$

Step 2

$R_1.A$	$R_1.B$	$R_2.A$	$R_2.C$
1	5	1	5
2	5	2	8
3	8	3	8

Projection of Distinct Attribute.

Step 3

A	B	C
1	5	5
2	5	8
3	8	8

$$R_1(AB) \bowtie R_2(AC) \equiv R$$

Lossless Join Decomposition.

1. BASIC CONCEPT

WHY ?

Lossless – Join Decomposition

- For the case of $R = (R_1, R_2)$, we require that for all possible relations r on schema R

$$\boxed{r = \pi_{R_1}(r) \bowtie \pi_{R_2}(r)}$$

- A decomposition of R into R_1 and R_2 is lossless join if at least one of the following dependencies is in F^+:
  - $R_1 \cap R_2 \rightarrow R_1$
  - $R_1 \cap R_2 \rightarrow R_2$

Lossless JOIN

A Relational Schema R with FD Set F is decomposed into SubRelation R_1 & R_2.

$R_1 \bowtie R_2$ is Lossless iff

1. $R_1 \cup R_2 \equiv R$
2. If Common Attribute of R_1 & R_2 either a Super key of R_1 OR Super key of R_2

$[R_1 \cap R_2]^+ \longrightarrow R_1$

OR

$[R_1 \cap R_2]^+ \longrightarrow R_2$

Lossy Join Decomposition

$R_1 \bowtie R_2$ is Lossy iff

① If Common Attribute of R_1 & R_2 neither a super key of R_1 nor super key of R_2.

$[R_1 \cap R_2]^+ \not\rightarrow R_1$

$[R_1 \cap R_2]^+ \not\rightarrow R_2$

② $R(ABCD)$ decomposed into $R_1(AB)$ and $R_2(CD)$ — Lossy Join Bcz No Common Attribute

③ $R(ABCDE)$ decomposed into $R_1(ABC)$ and $R_2(BCD)$ — Lossy Bcz Attribute E Missing.

Q.1 R(ABCDEFG) {AB → CD, D → E, E → FG}

Decomposed into R_1(ABCD) and R_2(DEFG)

Soln:- (i) $R_1(ABCD) \cup R_2(DEFG) = ABCDEFG \equiv R$

$R_1(ABCD) \cap R_2(DEFG) = D$

$[D]^+ = [DEFG]$ Super key of R_2.

Lossless Join

Q.1

$R(ABCDEFG)\ \{AB \to CD,\ D \to E,\ E \to FG\}$

Decomposed into $R_1(ABCD)$ and $R_2(DEFG)$

By CHASE TEST.

Q.2. R(ABCDEFG) {AB → C, C → D, D → EFG}

Decomposed into R_1(ABCE) and R_2(DEFG)

$R_1(ABCE) \cup R_2(DEFG) = ABCDEFG.$

$R_1(ABCE) \cap R_2(DEFG) = E$

$[E]^+ = [E]$ Neither Super key of R_1 nor Super key of R_2.

Lossy Join Decomposition. Ans

Q.2. $R(ABCDEFG)\ \{AB \rightarrow C,\ C \rightarrow D,\ D \rightarrow EFG\}$

Decomposed into $R_1(ABCE)$ and $R_2(DEFG)$

By CHASE TEST.

Q. R(ABCDEG) {AB → C, AC → B, AD → E, B → D, BC → A, E → G}

Decomposed into $R_1(ABC)$ $R_2(ACDE)$ and $R_3(ADG)$

$R_1(ABC) \cap R_2(ACDE) = AC$

$[AC]^+ = [\underline{ACB}\,D.....]$ Super key of R_1.

$R_{12}(ABCDE) \cap R_3(ADG) = AD$

$(AD)^+ = [\underline{AD}\,E\,\underline{G}...]$ Super key of R_3.

$R_{123}(ABCDEG)$ Lossless Join

Q.

$R(ABCDEG)$ $\{AB \rightarrow C, AC \rightarrow B, AD \rightarrow E, B \rightarrow D, BC \rightarrow A, E \rightarrow CG\}$

1. Decomposed into $R_1(AB)$ $R_2(BC)$ $R_3(ABDE)$ and $R_4(EG)$
2. Decomposed into $R_1(AB)$ $R_2(BC)$ $R_3(ABDE)$ and $R_4(ECG)$

THANK YOU!