Data base management system (DBMS)

Decomposition

Closure of attribute.

↳ set of all attributes which can be functional derived from the attribute.

Closure of functional dependency set

↳ Set of all FD's which are possible on F

$F = \{A \rightarrow B, B \rightarrow C\}$

$F^+ = \{ \quad \}$

↑ Application of closure.

$$F^+ = \left\{ \begin{array}{l} A^+ = \{A, B, C\} \\ B^+ = \{B, C\} \\ C^+ = \{C\} \\ (AB)^+ = \{A, B, C\} \end{array} \right.$$

$(BC)^+ = \{B, C\}$

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

$(ABC)^+ = \{A, B, C\}$

$A \rightarrow A$, $A \rightarrow B$, $A \rightarrow C$

$B \rightarrow B$, $B \rightarrow C$

$C \rightarrow C$

$AB \rightarrow A$, $AB \rightarrow B$, $AB \rightarrow C$

$BC \rightarrow B$, $BC \rightarrow C$

$AC \rightarrow A$, $AC \rightarrow B$, $AC \rightarrow C$

$ABC \rightarrow A$, $ABC \rightarrow B$, $ABC \rightarrow C$

$A \rightarrow ABC$

$A \rightarrow AB$

$A \rightarrow AC$

$AB \rightarrow BC$

$\downarrow$

F^+

Main goal of normalization is to reduce redundancies

A	B	C
1	2	3
1	2	4
1	2	5
1	2	6
1	2	7
1	2	8
1	2	9
1	2	10

A	C
1	3
1	4
1	5
1	6
1	7
1	8
1	9
1	10

A	B
1	2

Lossless decomposition

A	B	C
a1	b1	c1
a2	b2	c1
a2	b3	c2

→ Decomposition

A
a1
a2

B	C
b1	c1
b2	c1
b3	c2

Joining tables

→ If no common attribute then cartisein product.

After Joining

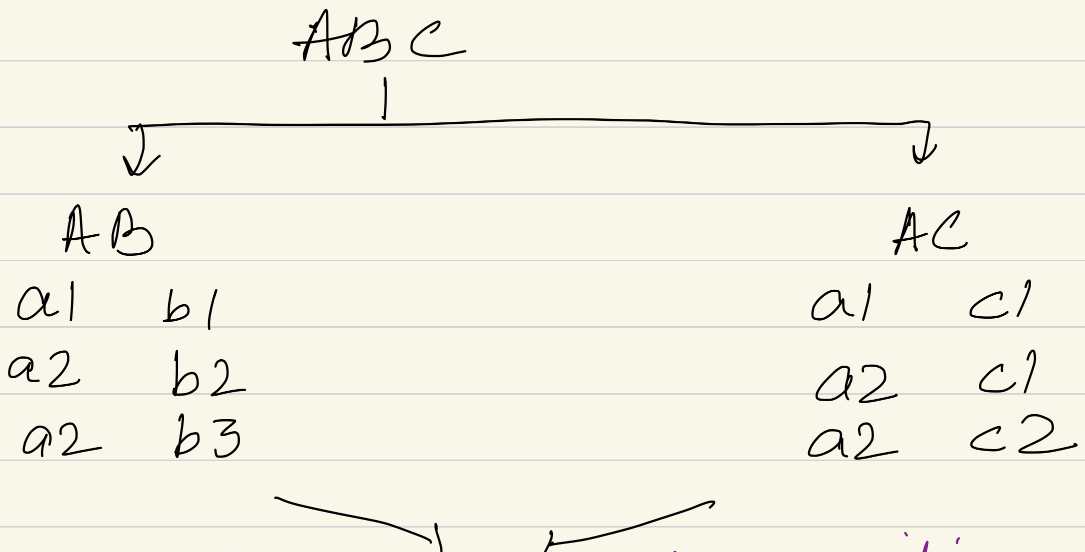
A	B	C	
a1	b1	c1	✓
a1	b2	c1	✗
a1	b3	c2	✗
a2	b1	c1	✗
a2	b2	c1	✓
a2	b3	c2	✓

} → Spurious Tuples.

→ How to perform decomposition.

1. Both the tables should have at least one common attribute

2. The common attribute(s) should be a candidate key of at least one of the relations.

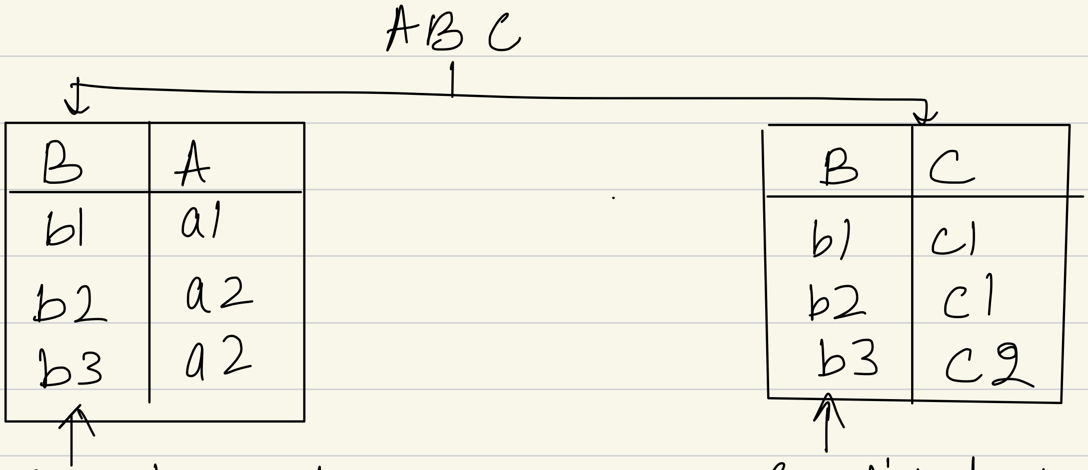


A	B
a1	b1
a2	b2
a2	b3

A	C
a1	c1
a2	c1
a2	c2

Not proper decomposition

∵ common attribute (A here) is not candidate key.



B	A
b1	a1
b2	a2
b3	a2

B	C
b1	c1
b2	c1
b3	c2

Candidate Key

Candidate Key

∵ No spurious tuples

Joining

B	A	B	C
b1	a1	b1	c1
~~b1~~	~~a1~~	~~b2~~	~~c1~~
~~b1~~	~~a1~~	~~b3~~	~~c2~~
~~b2~~	~~a2~~	~~b1~~	~~c1~~
b2	a2	b2	c1
~~b2~~	~~a2~~	~~b3~~	~~c2~~
~~b3~~	~~a2~~	~~b1~~	~~c1~~
~~b3~~	~~a2~~	~~b2~~	~~c1~~
b3	a2	b3	c2

LOSSLESS DECOMP-OSITION ←

B	A	C
b1	a1	c1
b2	a2	c1
b3	a2	c2

→ NO spurious tuples

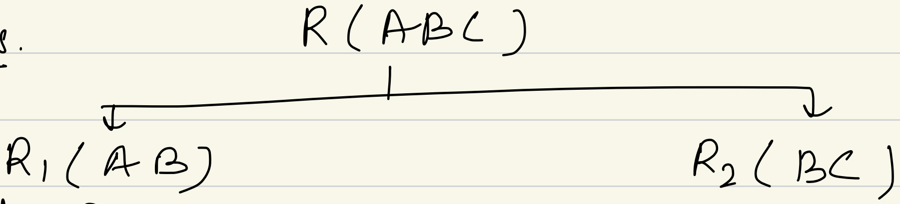
Problem on lossless Decomposition

Q: $R(ABC)$

FD's : $\{A \rightarrow B, B \rightarrow C, C \rightarrow A\}$

Let $R_1(AB)$ and $R_2(BC)$ be decompositions of $R(ABC)$. Check whether it is a lossless decomposition (or) not ?

Ans.



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

B is candidate key of this relation.

Common attribute = B

Is candidate key or not ? Yes.

∴ It is a losless decomposition.

Q. R(ABC)

FD's of R_1 $F = \{A \to B, B \to C, C \to A\}$

$R_1(AB)$ and $R_2(BC)$ be decompositions of R

Is the decomposition of R into R_1 and R_2

1. Lossless ?
2. Attribute preserving ?
3. Dependency preserving ?

Ans 1. Yes. [same as previous question]

2. Attribute preserving

↳ All the attributes are present in atleast one of the relations.

∴ Yes.

3. Dependency preserving ?

↳ Functional dependency

$$F \subseteq (F_1 \cup F_2)^+$$

$R(ABC)$ → $B^+ = \{B, C, A\}$

→ $C^+ = \{C, A, B\}$

$R_1(AB)$

$A \rightarrow B$

$A \rightarrow A$ $B \rightarrow B$

$AB \rightarrow A$

$B \rightarrow A$

→ F1

$R_2(BC)$

F2

$B \rightarrow C$

$C \rightarrow B$

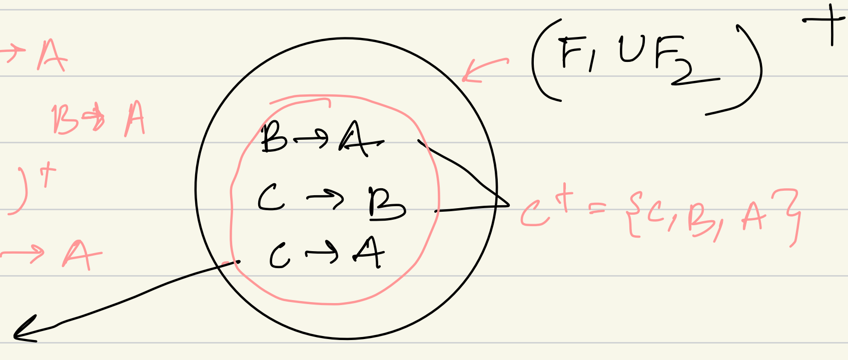
$$F \subseteq (F_1 \cup F_2)^+$$

$F_1 \rightarrow B \rightarrow A$

$F_1 \cup F_2$ $B \rightarrow A$

$(F_1 \cup F_2)^+$

$= B \rightarrow A$



$F_1 \cup F_2$ closure is set of all dependencies which we can create further.

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

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

∴ Decomposition is dependency preserving.

Problems on Decomposition

Q1. R(ABCD)

$F = \{ A \rightarrow B,\ B \rightarrow C,\ C \rightarrow D,\ D \rightarrow A \}$

$D = \{ AB, BC, CD \}$

Ans. → Attribute preserving

→ Lossless ?

AB   BC

→ Common attribute B
→ Check wether B is candidate key one of the relation : yes

ABC   CD

C is common

C is candidate key

ABCD.

↳ Lossless decomposition

$c^+ = \{C, D, A, B\}$ ← R(ABCD) → $D^+ = \{D, A, B, C\}$

$F_1(BC)$	$F_2(CD)$	$F_3(AB)$
$B \rightarrow C$	$C \rightarrow D$	$A \rightarrow B$
$C \rightarrow B$	$D \rightarrow C$	

FD preserving or not? → yes.

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

To prove: $D^+ = \{\_\_\_, A\}$

$(F_1 \cup F_2 \cup F_3)^+ =$ $C \rightarrow B$, $D \rightarrow C$, $B \rightarrow A$, $D \rightarrow A$

Problem 2: R(MNOPQR)

$F = \{MN \to O,\ MO \to N,\ MP \to Q,\ N \to P,\ NO \to P,\ Q \to R\}$

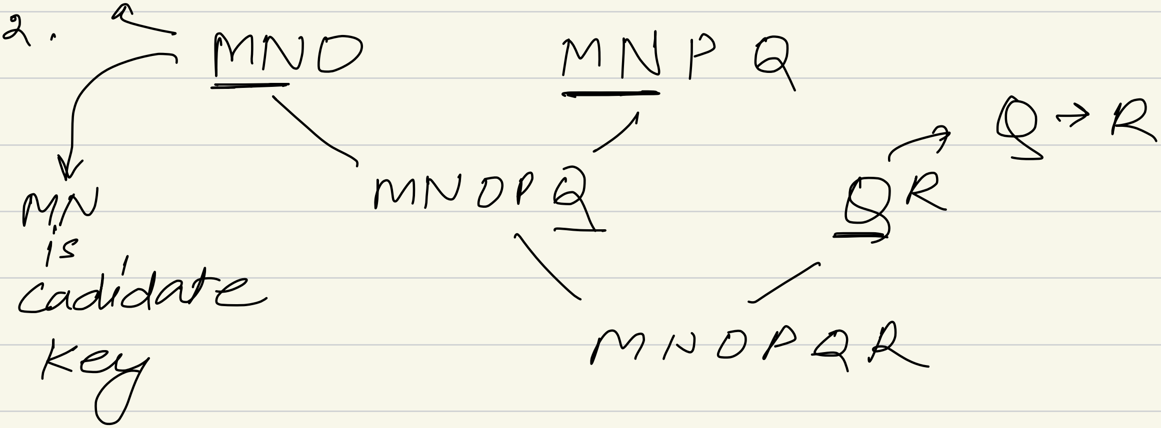
D{MNO, MNPQ, QR}

Ans.

1. Attribute preserving

$MN \to O$

2.



∴ Lossless decomposition.

3. R(MNOPQR)

$R_1(MNO)$ $R_2(MNPQ)$ $R_3(QR)$

$MN \to O$, $MO \to N$, ⋮ F_1

$MP \to Q$, $N \to P$ F_2

F_3 $Q \to R$ ⋮

$NO \to P$ ✓

$(F_1 \cup F_2 \cup F_3)^+ \to \{N \to P,\ NO \to P,\ \vdots\}$

$F \subseteq (F_1 \cup F_2 \cup F_3)^+$

$NO \to \{N, O, P\}$

∴ Dependency Preservision

Problem 3: $R(MNOP)$

$F = \{MN \to OP,\ P \to M\}$ $D = \{MP, NOP\}$

Ans: Attribute Preserving ✓

lossless ✓

MP NOP

$P \to M$

$MNOP$

→ Dependency Preserving

$R(MNOP)$

$R_1(MP)$ $R_2(NOP)$

$P \to M$ ⋮ F_1

F_2 ⋮

No non-trivial FD

$(F_1 \cup F_2)^+ = \{P \to M\}$

$(MN)^+ = \{M, N, \}$

Functional Dependency is not preserved