Name : Kamalesh. S Regn. No : 212720080I040 Subject : Database System

Section : A Branch : Information Technology Assignment - 2

1) Let $r(z)$ & $w(z)$ denote read & write operations respectively on a data item $z$ by a transaction T. Consider 2 schedule :-

S1: $r1(x)$ $r1(y)$ $r2(x)$ $r2(y)$ $w2(y)$ $w1(x)$

S2: $r1(x)$ $r2(x)$ $r2(y)$ $w2(y)$ $r1(y)$ $w1(x)$

Which schedule is conflict serializable ? how?

Sol: S2 is conflict serializable. This is because the transaction series of S2 looks like this

| $T_1$ | $T_2$ |
|---|---|
| $r(x)$ | |
| | $r(x)$ |
| | $r(y)$ |
| | $w(y)$ |
| $r(y)$ | |
| $w(x)$ | |

$T_1 \leftarrow T_2$

2) Consider the relation $R(P, Q, S, T, X, Y, Z, W)$ with following functional dependencies $PQ \rightarrow X$, $P \rightarrow YX$, $Q \rightarrow Y$, $Y \rightarrow ZW$. Consider the decomposition of Relation R into the relations $D_1 = \{PQST\}, \{PTX\}, \{Q, Y\}, \{YZW\}$

$D2 = \{P, Q, S\}, \{T, X\}, \{Q, Y\}, \{Y, Z, W\}$. Identify the type of decomposition (lossy / lossless). Justify.

Sol: $D_1$ is a lossless decomposition, but $D_2$ is a lossy decomposition.

$D_1$: $R = \{(PQST), (PTX), (QY), (YZW)\}$

Take $R_1(PQST)$ & $R_2(PTX)$, common attributes are $PT$ & $PT \rightarrow TX$

$\Rightarrow R_1(PQSTX)$ $R_2(QY)$

$Q \rightarrow Y \Rightarrow R_1(PQSTXY)$

Relation becomes $R_1(PQSTXY)$ $R_2(YZW)$

Common attribute is Y & its key to $R_2$.

Hence, all attributes got combined into one relation & hence this decomposition is lossless.

$D_2$: $R = [(P,Q,S), (T,X), (Q,Y), (Y,Z,W)]$

In relation $(T,X)$, its attribute is not common to any other relations.
Even if we combine
$R_1(P,Q,S,Y,Z,W)$ $R_2(T,X)$, still no common attributes

$\therefore$ this decomposition is lossy.

3) Suppose following functional dependency hold on a relation $U$ with attributes $P, Q, R, S, T$.

$P \to QR$

$RS \to T$.

What FD can be inferred from above, explain.

Sol: $PS \to T$
$\left.\begin{array}{l} P \to R \\ PS \to Q \end{array}\right\}$ These are the inferred FDs.

From $P \to QR$, we can derive $P \to Q$ & $P \to R$

$P \to R \Rightarrow PS \to T$

$P \to Q \Rightarrow PS \to Q$

4) Consider the schedule of 3 transactions
$R_2(Y)$ $R_1(X)$ $R3(Z)$ $R1(Y)$ $W1(X)$ $R2(Z)$ $W2(Y)$ $R3(X)$ $W3(Z)$. Is this schedule a conflict serializable.

Sol: For conflict serializability of a schedule (which gives same effect as a serial schedule) we should check for conflict operations, which are Read-write, write-Read & write-write between each pair of transactions, & based on their conflicts we make a precedence graph, if graph contains a cycle, it's not a conflict serializable schedule.

Conflicts :-

$R_1(Y)$ $W_2(Y)$

$W_1(X)$ $R_3(X)$

$R_2(Z)$ $W_3(Z)$

$R_1(X)$ $R_2(Y)$ $R_3(Z)$ $R_1(Y)$ $W_1(X)$ $R_2(Z)$ $W_2(Y)$ $R_3(X)$ $W_3(Z)$

$R_1(X)$ $R_1(Y)$ $R_3(Z)$ $R_2(Y)$ $W_1(X)$ $R_2(Z)$ $W_2(Y)$ $R_3(X)$ $W_3(Z)$

$R_1(X)$ $R_1(Y)$ $W_1(X)$ $R_2(Y)$ $R_3(Z)$ $R_2(Z)$ $W_2(Y)$ $R_3(X)$ $W_3(Z)$

$R_1(X)$ $R_1(Y)$ $W_1(X)$ $R_2(Y)$ $R_2(Z)$ $W_2(Y)$ $R_3(Z)$ $R_3(X)$ $W_3(Z)$

$\therefore$ it is conflict serializable of $T_1 \to T_2 \to T_3$.

Justify the following statements.

Strict 2PL protocol generates conflict serializable schedules that are also recoverable

Timestamp ordering concurrency protocol with Thomas write rule can generate view seriable schedule that are not conflict serializable.

Sol: Following strict 2-PL ensures that our schedule is: serializability, recoverable & cascadeless.

Thomas write rule for concurrency control does not enforce conflict serializability.

In 2PL, transactions do not release exclusive locks until the transaction has commited or aborted, i.e schedule is recoverable.

Time stamp ordering schedule with Thomas write rule generate view serial schedule with blind write. because of blind write, it won't be conflict serial.

6) Let the F.D $F = \{QR \to S, R \to P, S \to Q\}$ hold on a relation schema where $X \Rightarrow PQRS$. X is not in BCNF. Suppose X is decomposed into 2 schemas Y=PR ~~and~~ & Z = QRS. Comment on decomposition. Is Y & Z in BCNF?

Sol: $X(PQRS) = \{QR \to S, R \to P, S \to Q\}$ is decomposed into Y(PR) & Z(QRS).

$\Rightarrow$ Y(PR)     Z(QRS)

$R \to P$     $QR \to S$

         $S \to Q$

candidate key: R

Relation Y is in BCNF

candidate key: {QR, RS}

Relation Z is in 3NF but not BCNF (∵ S is not super key).

7) Consider the schema with non-trivial F.D

(i) Registration (Rollno, courseid, email)

(ii) rollno, courseid → email

(iii) email → rollno.

Justify whether schema is in 3NF & in BCNF.

Sol: Since {rollno, courseid} is primary key so rollno & courseid are prime attributes. email is non-prime attribute.

FD rollno, courseid → email is in BCNF & 3NF but FD email → rollno violates the rule of BCNF because email is not superkey. But it satisfies rule of 3NF because rollno is prime attribute.

So, overall this relation is in 3NF but not in BCNF.

8) A database of research articles in a journal uses the following schema (Volume, Number, Startpage, Endpage, title, year, price) The primary key is (Volume, Number, Startpage, endpage) & the following F.D exist in the schema. (Volume, Number, Startpage, endpage) → Title (volume, number → year (volume, Number, Startpage, endpage) → price.
The database is redesigned to use the following schemas. (Volume, Number, Startpage, endpage, title, Price) (Volume, Number, year). Which is the weakest normal form that the new database satisfies, but old one does not?

Sol: Old relation has functional dependency : Volume, Number → Year as partial dependency. So it does not follow 2NF.
But, there is no partial dependency in the new relation & so it satisfies 2NF as well as 3NF.
Therefore, 2NF is the weakest normal form that the new database satisfies, but old one does not.

9) Consider following 2 phase locking protocol. Suppose a transaction T accesses (for read or write operations), a certain set of objects {O1, ... O}. Consider the following 2PL protocol. Suppose a transaction T accesses (for read/write operations), a certain set of objects O. 1K { This is done in following manner:
Step 1 : T acquires exclusive locks to O1... Ok in increasing order of their addresses
Step 2: The read operations are performed.
Step 3: All locks are released k.
~~This is done in following manner:~~ Can deadlock occur? does transaction achieve serializability.

Sol: The above ~~transaction~~ scenario is conservative 2PL. In conservative 2PL protocol, a transaction has to lock all the items it access before the transaction begins execution. It is used to avoid deadlocks. Also, 2PL is conflict serializable, therefore it guarantees serializability.

10) Consider a schedule of transactions $T_1$ & $T_2$:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | RA | | | RC | | WD | | WB | Commit |
| $T_2$ | | RB | WB | | RD | | WC | | Commit |

Here RX stands for Read (X) & WX stands for W(X). Write its conflict equivalent schedule.

Sol:

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| $T_1$ | | | | RA | RC | WD | WB | | Commit | |
| $T_2$ | RB | WB | RD | | | | | WC | | Commit |

2 transactions $T_1$ & $T_2$ are given as

$T_1$ : r1(X), w1(X), r1(Y), w1(Y)

$T_2$ : r2(Y), w2(Y), r2(Z), w2(Z)

Find the total no. of conflict serializable schedules formed by $T_1$ & $T_2$.

Sol: In $T_1$, conflicting operations => r1(Y) & w1(Y)

In $T_2$, conflicting operations => r2(Y) & w2(Y)

∴ only one way for $T_1 \to T_2$.

For $T_2 \to T_1$, we have $\underbrace{5C1 + 5C2}_{15} + \underbrace{4C1 + 4C2}_{10} + \underbrace{3C1 + 3C2}_{6}$

=> 53

∴ total no. of conflict serializable schedules are 53+1 = 54

12) Given a relation R(P, Q, R, S, T, U, V, W, X, Y, Z) & FD = { PQ→R, P→ST, Q→U, U→VW, S→XYZ }, determine whether given R is in 3NF? If not convert it into 3NF.

Sol: F.D : {
PQ → R
P → ST
Q → U
U → VW
S → XY }

$PQ^+$ = PQRSTUVWXY

=> candidate key = PQZ

Prime attribute = P, Q, Z

Non-prime attribute = R, S, T, U, V, W, X, Y, Z

PQ → R, P → ST, Q → U violates 2NF

to make it 2NF first, so as to make it 3NF

=> $R_1$(PQR), $R_2$(PSTXY), $R_3$(QUVW), $R_4$(Z)

Now this is in 2NF

For 3NF, it should be super key

$R_1$ is in 3NF, with PQ as super key

$R_2$ is not in 3NF => $R_2'$(PST), $R_2''$(SXY)

Now $R_2'$ & $R_2''$ are in 3NF with P & S as super key

$R_3$ is not in 3NF

=> $R_3'$(QU), $R_3''$(UVW)

Now this is in 3NF

$R_4$ is in 3NF

∴ decomposed relation is

$R_1$(PQR) $R_2'$(PST) $R_2''$(SXY), $R_3'$(QU) $R_3''$(UVW) $R_4$(Z).