COMP 9311: Introduction to Database Systems

Assignment 2

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Question 1:

(1) Given F = $\{A \rightarrow DE,\ B \rightarrow GI,\ E \rightarrow CD,\ CE \rightarrow ADH,\ H \rightarrow G,\ AH \rightarrow I\}$, derive A $\rightarrow$ I

1. A→DE (given)
2. E→CD (given)
3. DE→CD (by F2: Augmentation, from 2)
4. A→CD (by F3: Transitivity, from 1,3)
5. A→CDE (by F4: Additivity, from 1,4)
6. A→CE (by F5: Projectivity, from 5)
7. CE→ADH (given)
8. CE→AH (by F5 Projectivity, from 7)
9. AH→I (given)
10. A→AH (by F3 Transitivity, from 6,8,9)
11. A→I (by F3 Transitivity, from 9,10)

(b) Step 1:
Let X: = {A, B, C, E, H, J}

Step 2:
Try to remove A
{B, C, E, H, J}+ = {A, B, C, D, E, G, H, I, J}
Thus X:= {B, C, E, H, J}

Step 3:
Try to remove B, C, E, H, J
{C, E, H, J}+ = {A, C, D, E, G, H, I, J}
{B, E, H, J}+ = {B, C, D, E, G, H, I, J}
{B, C, H, J}+ = {B, C, G, H, I}
{B, C, E, J}+ = {A, B, C, D, E, G, H, I, J}
{B, C, E, H}+ = {A, B, C, D, E, G, H, I}
Thus X:= {B, C, E, J}

Step 4:
Try to remove B, C, E, J
{C, E, J}+ = {A, C, D, E, G, H, I, J}
{B, E, J}+ = {A, B, C, D, E, G, H, I, J}

{B, C, J}+ = {B, C, G, I, J}
{B,C, E,}+ = {A, B, C, D, E, G, H, I}
Thus X:= {B, E, J}

Step 5:
Try to remove B, E, J
{E, J}+ = {A, C, D, E, G, H, I, J}
{B, J}+ = {B, G, I, J}
{B, E}+ = {A, B, C, D, E, G, H, I}
Thus cannot be removed.

So, {B, C, E} is a candidate key.

(3) As we shown in (2), {B, C, E} is a candidate key for R. Besides, we need to find out all possible candidate keys of the relation. According to the method in (2), as we can see that {A, B, J}+ = {A, B, C, D, E, G, H, I, J}, and none of its subset can determine all attributes of relation. So, {A, B, J} will be a candidate key.
Above, there're two candidate keys for R: {B, C, E}, {A, B, J}.

Then, divide all attributes into two categories:
prime attribute {A, B, E, J}, non-prime attribute {C, D, G, H, I}.

The relation R is in 1NF because R obeys the 1NF rule, as it doesn't have multi-valued or composite attribute.
The relation R is not in 2NF, because A→DE, E→CD, according to the projectivity of Armstrong's axioms, A→D, E→D, which means A→D (or E→D) is a partial dependency. But 2NF doesn't allow partial dependency.

So, the highest normal form of R is 1NF.

(4) R = {A, B, C, D, E, G, H, I, J}
F = {$A \rightarrow DE$, $B \rightarrow GI$, $E \rightarrow CD$, $CE \rightarrow ADH$, $H \rightarrow G$, $AH \rightarrow I$}
Step 1: F' = {A→D, A→E, B→G, B→I, E→C, E→D, H→G, CE→A, CE→D, CE→H,AH→I}

Step 2: CE→A

C+ = {C}; thus C→A is not inferred by F'.
Hence, CE→A cannot be replace by C→A.
E+ = {A, C, D, E, G, H, J}; thus E→A is inferred by F'.
Hence, CE→A can be replace by E→A.
Likewise, we can know CE→D, CE→H,AH→I can be replaced by E→D, E→H, A→I respectively.
F" = {A→D, A→E, B→G, B→I, E→C, E→D, H→G, E→A, E→H, A→I}

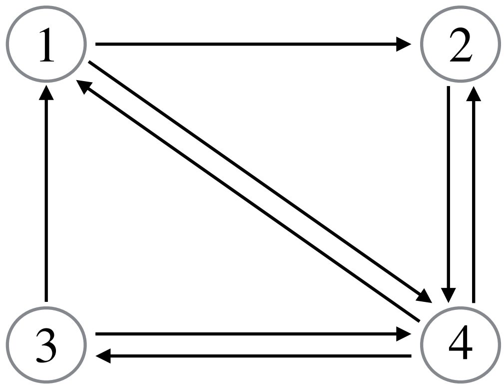
Step 3: A+|F"-{A→D} = {A, C, D, E, G, H, I};
thus, A→D is redundant.
A+|F"-{A→E} = {A, D, I};
that is, A→E is not redundant.
Iteratively, we can remove A→D but not the others.

Thus, F min = {A→E, B→G, B→I, E→C, E→D, H→G, E→A, E→H, A→I}.

(5) R = {A, B, C, D, E, G, H, I, J}
F min = {A→E, B→G, B→I, E→C, E→D, H→G, E→A, E→H, A→I}.
This gives the dependency-preserving and lossless-join decomposition:
R1 = (A, E, I)
R2 = (B, G, I)
R3 = (E, A, C, D, H)
R4 = (H, G)
R5 = (B, E, J) (Add candidate key)

Question 2:

(1)



So, this schedule is NOT conflict-serializable.

(2) The serial schedule of these four transactions:

Time	T1	T2	T3	T4
t1				R(A)
t2				W(A)
t3				R(B)
t4				W(B)
t5			R(A)	
t6			W(A)	
t7	R(B)			
t8	W(B)			
t9	R(A)			
t10	W(A)			
t11		R(B)		
t12		W(B)		

(3) Lock the transactions T1 and T2:

T1	T2
write_lock(B)	
read(B)	
write_lock(A)	
read(A)	
write(B)	
unlock(B)	
	write_lock(B)
	read(B)
write(A)	
unlock(A)	
	write(B)
	unlock(B)