Introduction to Databases

B242849

Q.1

1(a).

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1. $C \to A$ [given in Σ]
2. $CB \to AB$ [from 1. by augmentation with B]
3. $B \to D$ [given in Σ]
4. $AB \to AD$ [from 3. by augmentation with A]
5. $CB \to AD$ [from 2. and 4. by transitivity]
6. $AD \to E$ [given in Σ]
7. $CB \to E$ [from 5. and 6. by transitivity]

(b).

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1. $B \to D$ [given in Σ]
2. $AB \to AD$ [from 1. by augmentation with A]
3. $AD \to E$ [given in Σ]
4. $AB \to E$ [from 2. and 3. by transitivity]
5. $AB \to C$ [given in Σ]
6. $ABC \to EC$ [from 4. by augmentation with C]
7. $AB \to ABC$ [from 5. by augmentation with AB]
8. $AB \to EC$ [from 7. and 6. by trancitivity]

Q 2

2 (a).

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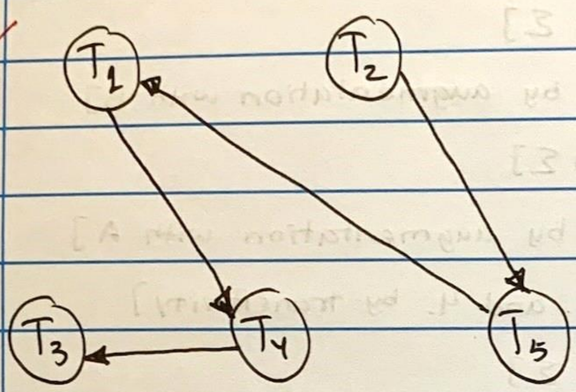

$T_1 \rightarrow T_4$ because T_1 reads B at step 5 before T_4 writes B at step 9

$T_5 \rightarrow T_1$ because T_5 reads D at step 6 before T_1 writes D at step 10

$T_2 \rightarrow T_5$ because T_2 writes C at step 7 before T_5 reads D at step 8

$T_4 \rightarrow T_3$ because T_4 writes B at step 9 before T_3 reads B at step 11

2 (b).

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The schedule is conflict serializable because the precedence graph has no cycles.

An equivalent serial schedule is T_2, T_5, T_1, T_4, T_3

Q3

8.5/10

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3 $R(A, B, C)$; $S(A, B, C, D)$

$\forall u \neg R \equiv \neg \exists u \neg\neg R \equiv \neg \exists u R$

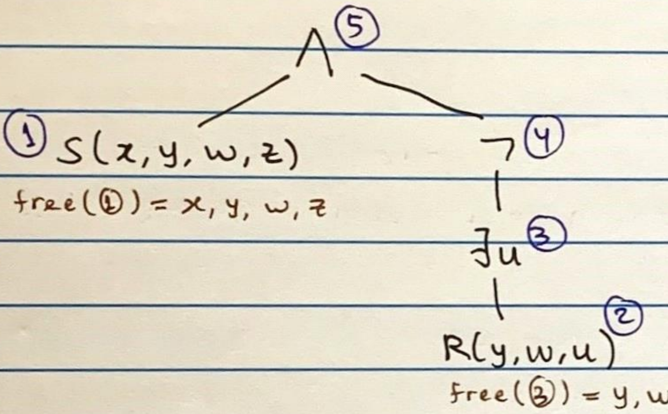
$\{x, x, y, w, z \mid S(x, y, w, z) \wedge \forall u \neg R(y, w, u)\}$

$\equiv \{x, x', y, w, z \mid (x = x') \wedge \underbrace{S(x, y, w, z) \wedge \neg \exists u R(y, w, u)}_{\varphi}\}$

~~Let $A = \{w \mapsto A, x \mapsto B, y \mapsto C, z \mapsto D, x' \mapsto E\}$~~

Let $\eta = \{u \mapsto A,\ w \mapsto B,\ x \mapsto C,\ y \mapsto D,\ z \mapsto E,\ x' \mapsto C'\}$

We first try to translate φ:



①. $\rho_{A\to C,\ B\to D,\ C\to B,\ D\to E}(S)$

②. $\rho_{A\to D,\ C\to A}(R)$

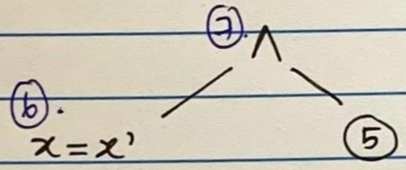
③ $\pi_{B,D}(②)$

④. $Adom_B \times Adom_D - ③$

⑤ $① \cap (Adom_C \times Adom_E) \times ④$

Next, we handle the repetition in the head of the query:

⑥. $x = x'$ is translated to $\sigma_{C=C'}(Adom_C \times Adom_{C'})$



free (⑤) = $\{u, w, x, y, z\}$

free (⑥) = $\{x, x'\}$

⑦. $(Adom_A \times Adom_B \times Adom_D \times Adom_E) \times ⑥ \cap (Adom_{C'} \times ⑤)$

$\therefore (Adom_A \times Adom_B \times Adom_D \times Adom_E) \times \sigma_{C=C'}(Adom_C \times Adom_{C'}) \cap (Adom_{C'} \times F)$

where F is $\rho_{A\to C,\ B\to D,\ C\to B,\ D\to E}(S) \cap \left((Adom_C \times Adom_E) \times (Adom_B \times Adom_D - \pi_{B,D}(\rho_{A\to D,\ C\to A}(R)))\right)$

(F is the translation of φ)

7.5/8

Q 4

4. $R(A, B, C)$

Use the mapping $\eta = \{A \mapsto u$

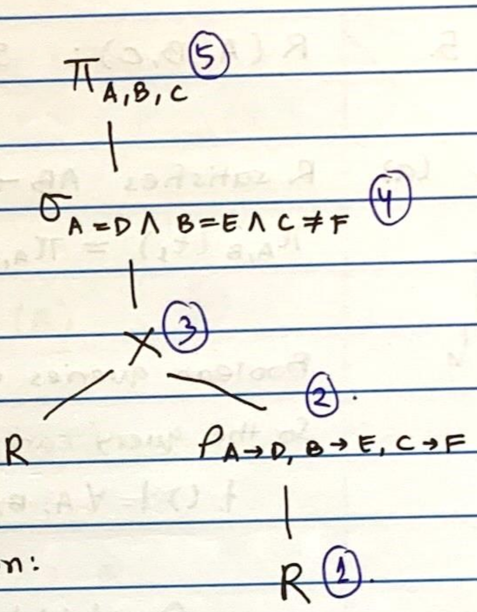
$B \mapsto v$

$C \mapsto w$

$D \mapsto x$

$E \mapsto y$

$F \mapsto z\}$



We get the following translations of each subexpression:

1. $R(u, v, w)$
2. $R(x, y, z)$
3. $R(u, v, w) \wedge R(x, y, z)$
4. ③ $\wedge\ u = x \wedge v = y \wedge w \neq z$
5. $\exists x, y, z$ ④ [The free variables of ④ are u, v, w, x, y, z]

[So, $\{u, v, w, x, y, z\} - \{u, v, w\} = \{x, y, z\}$]

The RC is given by:

$\{u, v, w \mid \exists x, y, z\ R(u, v, w) \wedge R(x, y, z) \wedge u = x \wedge v = y \wedge w \neq z\}$

5. $R(A, B, C)$; $S(A, B, C, D)$ $\boxed{\forall x\, R \equiv \neg \exists x \neg R}$

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(a). R satisfies $AB \rightarrow C$ if for every 2 tuples $t_1, t_2 \in R$,

$\pi_{A,B}(t_1) = \pi_{A,B}(t_2) \rightarrow \pi_C(t_1) = \pi_C(t_2)$

Boolean queries return true whenever formula in body is satisfied.

So the query can be written as, under the mapping:

$\eta = \{ A \mapsto x,\ B \mapsto y,\ C \mapsto z \}$

$$Q = \{ () \mid \forall x, y, z, z'\ R(x,y,z) \land R(x,y,z') \rightarrow z = z' \}$$

$$\equiv \{ () \mid \neg \exists x, y, z, z'\ \neg (R(x,y,z) \land R(x,y,z') \rightarrow z = z') \}$$

5(b) S and R satisfies $S[B,C] \subseteq R[A,B]$ if for every $t_1 \in S$ there exists $t_2 \in R$ such that $\pi_{B,C}(t_1) = \pi_{A,B}(t_2)$

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We want tuples of S, hence $\underbrace{\pi_{A,B,C,D}}$ ①

Rename R to be $R(A', B', C)$: $\underbrace{\rho_{A\to A',\, B\to B'}(R)}$ ②

We only need A' and B' : $\pi_{A',B'}$(②)

~~$\pi_{A,B,C,D}(\sigma_{B\neq A' \wedge C\neq B'}(S \times \rho_{A\to A', B\to B', C\to C'}(R)))$~~

To find tuples that satisfies, we can do $\sigma_{B=A' \wedge C=B'}$

~~To find tuples that does not satisfy the IND, we can do $\sigma_{B\neq}$~~

So the tuples of S that satisfy the IND is given by :

$$\pi_{A,B,C,D}(\sigma_{B=A' \wedge C=B'}(S \times \pi_{A',B'}(\rho_{A\to A',\, B\to B'}(R))))$$

To find tuples of S that does not satisfy, use the difference operator:

$$S - \pi_{A,B,C,D}(\sigma_{B=A' \wedge C=B'}(S \times \pi_{A',B'}(\rho_{A\to A',\, B\to B'}(R))))$$