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CS & DA

Database Management System

DPP: 3

Relational model and Normal forms

Q1 Assume a relation schema R with 5 attributes P, Q, R, S, T and the set of FD'S P → RS, Q → RT, T→ Q consider the statements:

S_1: The only candidate key of R is PQ and PT.

S_2: The highest normal form satisfied by R is 2NF.

Which of the statement is true?

(A) Only S_1 is true

(B) Only S_2 is true

(C) Both S_1 and S_2 and true

(D) Neither S_1 nor S_2 is true

Q2 Assume a relation R = (P, Q, R, S) and a set F of functional dependencies:

F = {PR → S, S → P, S → Q, S → R}, highest normal form satisfied by the relation R is?

(A) 2NF (B) 3NF

(C) BCNF (D) 1NF

Q3 Consider a relation R(P, Q, R, S, T, U, V, W) with the following functional dependencies:

{RW→V, P→QR, Q→RUW, T→P, U→TV}, then the relation R is in _____.

(A) 1NF (B) 2NF

(C) 3NF (D) BCNF

Q4 Consider a table/Relation R has one candidate key, then which of the following is always true?

(A) If R is in 2NF, then it is also in 3NF

(B) If R is in 3NF, then it is also in BCNF

(C) If R is in 2NF, but it is not in 3NF

(D) None of the above.

Q5 Consider a relation R(P, Q, R, S, T) with the set of FD's {PQR→ ST and T → QRS} which of the following statements is true?

(A) R is not in 2NF

(B) R is in 2NF but not in 3NF

(C) R is in 3NF but not in BCNF

(D) R is in BCNF

Q6 Consider a relation R (L, M, N, O) with the functional dependencies:

L → M,

M → N,

N → O

which one of the following decompositions is not lossless?

(A) R_1 (L, M), R_2(M, N), R_3 (N, O)

(B) R_1(L, M), R_2(L, N), R_3 (L, O)

(C) R_1(L, O), R_2(M, O), R_3 (N, O)

(D) All of the above are lossless

Q7 Suppose functional dependency Q → R holds in relation R (P, Q, R, S) which additional FD will make R be in 3NF, but not BCNF?

(A) S → PQ (B) PR → S

(C) RS → Q (D) PS → Q

Q8 Consider a relation schema S = { A, B, C, D, E, F, G, H } with the following set of functional dependencies:

AB → E

A → CF

B → D

D → GH

Now, consider the following decompositions of S:

Decomposition 1: D_1 = { S_1, S_2, S_3, S_4 }

S_1 = { A, B, C }

S_2 = { A, D, F }

S_3 = { B, E }

S_4 = { D, G, H }

Decomposition 2: D_2 = { S_1, S_2, S_3, S_4 }

S_1 = { A, B, C }

S_2 = { D, F }

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$S_3 = \{ B, E \}$

$S_4 = \{ D, G, H \}$

Which of the above decompositions has the lossless join property?

(A) Only D_1

(B) Only D_2

(C) Both D_1 and D_2

(D) Neither D_1 nor D_2

Q9 Which of the following statements is FALSE ?

(A) Any relation with 2 attributes is in BCNF.

(B) A relation in which every key has only one attribute is in 2NF.

(C) A prime attribute can be transitively dependent on a key in a 3NF relation.

(D) A prime attribute can be transitively dependent on a key in a BCNF relation.

Q10 A functional dependency of the form $P \rightarrow Q$ is trivial if:

(A) $Q \subseteq P$

(B) $P \subset Q$

(C) $P \subseteq Q$

(D) $P \subseteq Q$ and $Q \subseteq P$

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Answer Key

Q1	(A)	Q6	(C)
Q2	(C)	Q7	(C)
Q3	(A)	Q8	(D)
Q4	(B)	Q9	(D)
Q5	(A)	Q10	(A)

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Hints & Solutions

Q1 Text Solution:

S_1: P → RS, Q → RT, T → Q

$\{PQ\}^+ = \{PQRST\}$, $\{PT\}^+ = \{PQTRS\}$

So, candidate key of R is PQ and PT.

Hence, S_1 is true.

S_2: False, we have partial dependency in the relation

"Q → R". Hence, the given relation is in 1NF.

Q2 Text Solution:

PR and S are the super key of the relation. LHS of each FD is super key therefore highest normal form satisfied by R is BCNF.

Q3 Text Solution:

RW→V

P→Q

P→R

Q→R

Q→U

Q→W

T→P

U→T

U→V

As we can see in the 3rd FD P→R, P is prime attribute and Q is non-prime attribute, therefore this relation does not satisfy 2NF and higher normal form. So, the highest normal form satisfied by the above relation is 1NF.

Q4 Text Solution:

If there is only one candidate key and relation is 3NF, that means all functional dependency determinants is Candidate key thus relation is in BCNF, Hence, option (B) is true.

Q5 Text Solution:

PQR→ST

T→QRS

$(PQR)^+ = \{P, Q, R, S, T\}$

$(PT)^+ = \{P, Q, R, S, T\}$

Candidate key = {PQR, PT}

PQR→ST

PQR is candidate key therefore PQR→ST

Satisfy BCNF

T→QRS

T → Q

T → R

T → S

Violate 2NF.

So not in 2NF

Q6 Text Solution:

(a) It is lossless because the relations are decomposed based on the FD's and thus each relation has a common attribute which is also the primary key in either of them.

(b) It is also lossless as it has common attribute L in three of them and L is also the key in R_1, R_2, as well as in R_3.

(c) It is a lossy decomposition because the common attribute is O and O is not the key in either of them.

Hence, the correct option is(c).

Q7 Text Solution:

(a) In this, S is the only key, so Q ® R is both a 3NF and BCNF violation.

(b) Here, PQ is the only key, so both FD's are 3NF and BCNF violations.

(c) Here, we can check that the keys are PRS and PQS. Both FD's violate BCNF, but all the attributes are prime, so there can be no 3NF violation.

(d) PS is the only key, so Q ® R violates both normal forms.

Hence, the correct option is (c)

Q8 Text Solution:

For a decomposition to be lossless, at least one subset in each decomposition must contain a key or be able to derive the original relation through functional dependencies.

In both D_1 and D_2, $S_3 = \{ B, E \}$ can be joined only with $S_1 = \{ A, B, C \}$ as the remaining two relations do not have B or E.

Now, the common attribute between S_1 and S_3 is B which is neither the key for S_1 nor for S_3. So,

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both decompositions are lossy.

Q9 **Text Solution:**
Consider the functional dependency: X → Y.
In 3NF, this dependency is allowed if Y is a prime attribute and X is not a candidate key. However, BCNF does not permit this, as it requires X to be a superkey.

Q10 **Text Solution:**
Consider for example, a relation T with attributes (D, E).
In this relation:

- D → D will always hold as a trivial dependency.
- Similarly, DE → D will also hold as a trivial dependency.