Database Management System.

① Need for normalization.

② Normal forms.

③ Higher normal form ↔ More joins.

④ Functional Dependency.

- ↳ fully
- ↳ Partially
- ↳ Transitive

Ques)

R	A	B	C
	1	2	3
	4	2	3
	5	3	3

which of the following dependency can you infer does not hold over R?

(a) $A \rightarrow B$ (b) $B \rightarrow C$

~~(c)~~ $BC \rightarrow A$ (d) $AC \rightarrow B$

Ques) Consider the following relation instance

X	Y	Z
1	4	3
1	5	3
4	6	3
3	2	2

which of the following FD are satisfied.

(a) $XY \rightarrow Z$, $Z \rightarrow Y$

~~(b)~~ $XZ \rightarrow X$, $Y \rightarrow Z$

(c) $XY \rightarrow Z$, $Z \rightarrow X$

(d) $XZ \rightarrow Y$, $Y \rightarrow Z$

⑤ Trivial F.D

⑥ Non-trivial F.D

↳ atleast one attribute in R.H.S that is not part of L.H.S.

$AB \rightarrow BC$

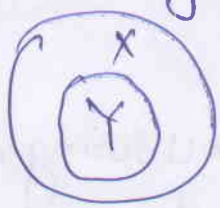
(7) Closure of set of F.D.(F^+)

↳ set of all f.d's logically implied by F is the closure of F.

(8) Inference Rules / closure Properties.

↳ 8.1 Reflexivity:

if $x \supseteq y$ then $x \rightarrow Y$.



eg:- $AB \rightarrow A$

→ 8.2 Augmentation:

if $x \rightarrow Y$, then

$XZ \rightarrow YZ$

→ 8.3 Transitivity:

if $x \rightarrow Y$ and $Y \rightarrow Z$, then

$x \rightarrow Z$.

→ 8.4 Union.

if $x \rightarrow Y$ and $X \rightarrow Z$, then

$X \rightarrow YZ$

→ 8.5 Decomposition

if $X \rightarrow YZ$ then

$X \rightarrow Y$ and

$X \rightarrow Z$.

Armstrong's Axioms.

(9) Closure of Attribute Sets

(X^+)

Ques) R(ABCDEF)

$\{AB \to C, BC \to AD, D \to E, CE \to B\}$

$\left.\begin{array}{l} AB^+ \\ BC^+ \\ D^+ \\ CE^+ \end{array}\right\}$?

Ques) FD $\{A \to B, B \to C, AB \to D\}$

compute A^+.

(10) Applications of attribute closure

↳ 10.1 Find additional F.D's

↳ 10.2 Find keys of a relation

Ques) R(ABCDE)

$\{A \to BC, CD \to E, B \to D, E \to A\}$] Find Candidate Keys of R.

[A, BC, CD, E] Ans.

Ques) R(ABCD)

$F = \{A \to B, B \to C\}$] find candidate key.

[AD] Ans.

Ques) R(ABCDE)

{AB → C, CD → E, DE → B}

Is 'AB' a Candidate Key? If not, is 'ABD'? Explain.

Ques) R(ABCD)

{BC → A, AD → B, CD → B, AC → D}

find all candidate keys of R.

[BC, CD, AC]

(11) Canonical Cover

→ **11.1** Equivalent ($E^+ = F^+$)

F.D in F from E

every F.D in E can be inferred from F.

→ **11.2**. Redundant F.D

→ **11.3** Minimal cover

→ Single attribute on R.H.S

→ Non Redundant F.D's only.

→ **11.4** Canonical cover.

→ No extraneous attribute

{A → C, AB → C}

B is extraneous

→ Each L.H.S is unique

Ques) R(ABC)

$F = \{A \to BC, B \to C, A \to B, AB \to C\}$

Compute Canonical Cover for F.

$\begin{bmatrix} A \to B \\ B \to C \end{bmatrix}$ **Ans.**

$\left.\begin{matrix} A \to BC \\ A \to B \end{matrix}\right] \to \left.\begin{matrix} A \to BC \\ B \to C \end{matrix}\right] \to \begin{matrix} A \to BC \\ AB \to C \\ B \to C \end{matrix} \left.\begin{matrix} A \to B \\ B \to C \end{matrix}\right]$

Note: Canonical cover might not be unique.

(12) Decomposition

↳ 12.1 Loss-less join decomposition

$(R_1 \cap R_2) \to$ Superkey of either R_1 or R_2.

↳ 12.2 lossy

Ques) R(ABC) → R_1(AB), R_2(BC) — lossless / lossy.

$F\{A \to B\}$

$R_1\{A \to B\}$ $R_2\{\}$.

Common attribute (B) → Not Superkey in either R_1 or R_2.

So lossy.

Ques) R(A, B, C) decomposition of R into $\{ F = A \rightarrow B \}$ R_1(A, B) and R_2(A, C) lossless or lossy ?

$\boxed{\text{Lossless}}$ Common attribute 'A' is a key in R_1.

Ques) R(A, B, C) $\{ A \rightarrow B \}$ lossless or lossy ?

R_1 (A, B) R_2(B, C)

→ Common attribute 'B' = Not a key in R_1 or R_2.

$\boxed{\text{Lossy}}$

Ques) R(A, B, C, D)

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

lossless or lossy?

Dependency Preserving ?

R_1(A, B, C) $\{ A \rightarrow B,\ A \rightarrow C \}$

R_2(C, D) $\{ C \rightarrow D \}$

Common attribute is 'C' = Key in R_2, hence lossless.

$(F^+) = (A \rightarrow B,\ A \rightarrow C,\ C \rightarrow D)$

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

Hence dependency Preserving.

(12) Dependency Preserving Decomposition

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

Ques) R(A, B, C, D)

F{ $A \to B$, $A \to C$, $A \to D$ }

R_1(ABD) R_2(BC)

{ $A \to B$, $A \to D$ } { }

Lossless or lossy?

Dependency Preserving?

Common attribute = B not a Key in R_1 or R_2, so lossy.

$(F_1^+) = \{ A \to B, A \to D, A \to BD \}$

$(F_2^+) = \{ \}$

Cannot be implied, hence not dependency Preserving.

$(F^+) = A \to B, A \to C, A \to D, A \to BC, A \to CD, A \to BD, A \to BCD, \ldots$

Ques) R(A, B, C, D)

F{ $A \to B$, $A \to C$, $C \to D$ }

R_1(ABC) and R_2(CD)

Lossless or Lossy?

	A	B	C	D
R_1	α_A	α_B	α_C	$\beta_{1D} \to \alpha_D$
R_2	β_{2A}	β_{2B}	α_C	α_D

$C \to D$

Lossless.

Ques) R(A B C D E)

$F\{AB \rightarrow CD,\ A \rightarrow E,\ C \rightarrow D\}$

$R_1(ABC)$, $R_2(BCD)$, $R_3(CDE)$

Lossless or Lossy decomposition ?

Ans:- Lossy.

~~Normal Forms~~

Ques) Find minimal cover for the following Set of F.D's.

$PQ \rightarrow R$
$PS \rightarrow Q$
$QS \rightarrow P$
$PR \rightarrow Q$
$S \rightarrow R$.

$\{P \rightarrow R,\ P \rightarrow Q,\ S \rightarrow R\}$

Ques) $F = \{A \rightarrow C,\ AC \rightarrow D,\ E \rightarrow AD,\ E \rightarrow H\}$
$G = \{A \rightarrow DC,\ E \rightarrow A\}$

Both FD's are equivalent or not.

Compute FD's closure of G w.r.t F and vice-versa.

Equivalent

Ques) R(ABCDE) find closure of FD's

$A \rightarrow BC$
$CD \rightarrow E$
$B \rightarrow D$
$E \rightarrow A$

Check whether $E \rightarrow D$ holds or not.

compute E^+

Yes

Ques) R (A B C D E F)

$\{AB \to C,\ C \to A,\ BC \to D,\ ACD \to B,\ BE \to C,\ CE \to FA,$
$CF \to BD,\ D \to EF\}$] Find closure of FD's.

Ques) R (A B C D E F G)

$F\{A \to B,\ BC \to DE,\ AEF \to G\}$] Find $[AC]^+$

Normalization

1NF: A relation is in 1NF if every field contains only atomic values i.e the attribute of any tuple must be a single value or null value.

Emp

eno	ename	contact
1	A	{98, 99}
2	B	{99, 100}

⇒

eno	ename	contact
1	A	98
1	A	99
2	B	99
2	B	100

2NF: Based on the concept of full functional dependency (FFD).

→ Relation is in 2NF, if every non-prime (key) attribute of R is fully functional dependent on the key of R.

or

No Non-prime Attribute should be determine by the part of Candidate key.

or

No Partial F.D.

Ques) R(ABCD)

F: { AB → C, B → D } — Find N.F.

CK: AB, Not in 2NF

B → D (Partial F.D)

Ques) R(ABC)

F: { A → B, B → C } — Find N.F

CK: A (R) is in 2NF.

Ques) R(ABCD)

F: { AB → C, A → D }. — decompose 'R' into 2NF

C.K = AB.

2NF → R_1(AD), R_2(ABC)

Note: Decomposition requires the closure of violating dependencies into separate relation and remaining attributes and key attributes of decomposed relations forms another rel^n.

Ques) R(ABCDE)

F: { AB → C, A → D, B → E } — decompose 'R' into 2NF

R_1(AD), R_2(BE), R_3(ABC)

3NF: A relation is in 3NF if F.D '$X \to Y$' satisfy any one of the following condⁿ:

i) $X \to Y$ is a trivial F.D, ie $Y \supseteq X$.

ii) if $X \to Y$, then X is a superkey.

iii) if $X \to Y$, then $(Y - X)$ is a prime attribute.

or

↳ No Transitive dependencies.

Ques) $R(A\,B\,C)$

$F\{A \to B,\ B \to C\}$

'R' is in which Normal form.

'R' is in 2NF but not in 3NF.

Ques) $R(A\,B\,C\,D\,E)$

$F\{AB \to C,\ B \to D,\ D \to E\}$

Decompose the relation upto 3NF.

$R_1\{ABC\}$, $R_2\{DE\}$, $R_3\{BD\}$.

Ques) $R(A\,B\,C)$

$F: \{AB \to C,\ C \to A\}$

'R' is in which Normal form.

3NF, 2NF, 1NF.

BCNF: A relation is in BCNF if atleast one of the condⁿ hold:

i) $X \to Y$ is a trivial F.D

ii) $X \to Y$, X is a superkey

Ques) R(ABC)

F: { AB → C, C → A }

Relation 'R' is in BCNF or 3NF

3NF only.

Ques) R (A B C D E F G H I J)

F: { AB → C, A → DE, B → F, F → GH, D → IJ }

Decompose R into 2NF and 3NF relations.

Ques) Book (Book_title, Authorname, Book_type, listprice, author_affil, publisher)

F.D { Book_title → Publisher, Book_type
Book_type → listprice
Authorname → Author_affil }

Find N.F of the relation and decompose it upto 3NF.

Ques) Car_Sale (Car#, Salesman#, Datesold, comm%, discount)

F.D { Datesold → discount
Salesman# → Comm%.
Car# → Datesold }

Find key of relation and Normalize it till BCNF.

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