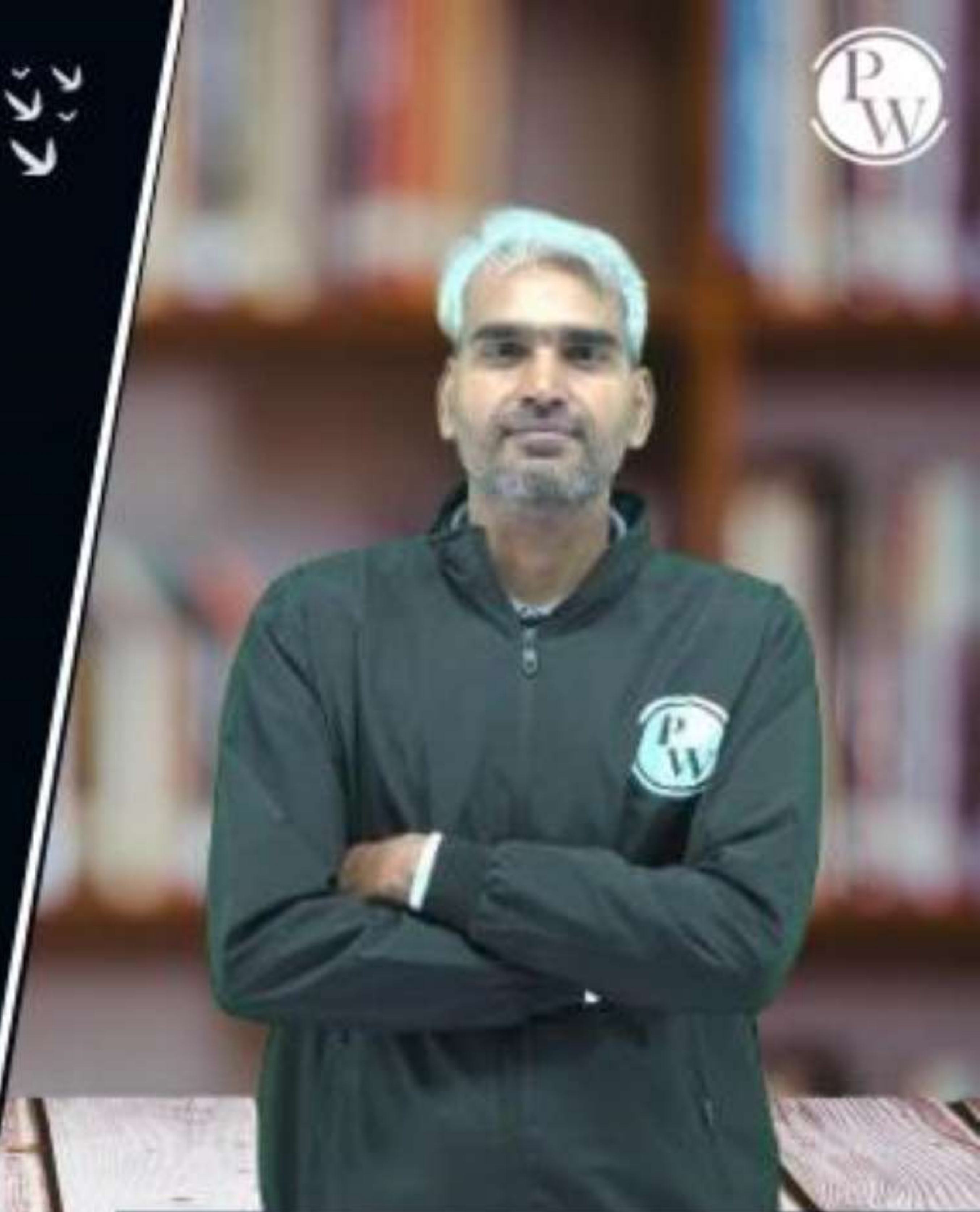
Computer Science & IT

Database Management System

Relational Model & Normal Forms

Lecture No. 12



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Recap of Previous Lecture

Topic Lossless join decomposition

Topic Projection, Selection, and Cross product

Topic Natural join

Topic Lossless Natural Join

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Topics to be Covered

Topic Normal forms

Topic First normal form (1NF)

Topic Redundancy in relation because of FD

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Topic : NOTE

(1) Natural Join is commutative

$$R_1 \bowtie R_2 = R_2 \bowtie R_1$$

(2) Natural Join is associative

$$(R_1 \bowtie R_2) \bowtie R_3 = R_1 \bowtie (R_2 \bowtie R_3)$$

i.e. Does not matter in which order we perform the natural join, final result will be same.

#Q. Let R (A, B, C, D, E, F) be the relational schema with following FD set

$F = \{ AB \to C, BC \to A, AC \to B, AD \to E, B \to D, E \to F)$

Which of the following decomposition is/are lossless join decomposition.

(i){R1(ABC), R2(ABDE), R3(EF)}

(ii){R1(ABC), R2(ADF), R3(ACDE)}

(iii){R1(AB), R2(BC), R3(ABDE), R4(EF)}

(i) $R_1(A,B,C)$ $R_2(A,B,D,E)$ $R_3(EF)$

$\cap = AB$

$(AB)^+ = \{A,B,C,D,E,F\}$

$\therefore$ AB is a S.K of both relation

Hence we can join R_1 & R_2

$R_1 \bowtie R_2 (ABCDE)$

$\cap = E$, $(E)^+ = \{E,F\}$ $\therefore$ E is S.K of R_3

$\therefore$ we can join $(R_1 \bowtie R_2)$ with R_3

$(R_1 \bowtie R_2) \bowtie R_3 (A,B,C,D,E,F)$

If join is lossless at every point of join, then overall decomposition is Lossless join decomposition

(ii) $R_1(A,B,C)$ $R_2(ADF)$ $R_3(ACDE)$

$\cap = A$

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

A is not a S.k of any of R_1 or R_2

∴ we can not join in this order

$\cap = AC$, $(AC)^+ = \{A,C,B,D,E,F\}$

'AC' is a S.K. of both relation

∴ We can join R_1 & R_3

$R_1 \bowtie R_3(ABCDE)$

$\cap = AD$, $(AD)^+ = \{\underbrace{A,D,E,F}\}$

all attributes of R_2 are present ∴ S.k. of R_2

Hence we can join $(R_1 \bowtie R_3)$ with R_2

$(R_1 \bowtie R_3) \bowtie R_2(A,\underline{B,C,D,E,F})$

These exist an order $((R_1 \bowtie R_3) \bowtie R_2)$ in which relations can be joined s.t join is lossless at every point of join.

∴ Overall decomposition is lossless join decomposition.

* **Note:** If there exist any order in which relations can be joined, such that join is lossless at every point of join, then overall decomposition is lossless join decomposition,

If there exist no such order in which join is lossless at every point of join then overall decomposition is Lossy join decomposition

(iii) $R_1(AB)$ $R_2(BC)$ $R_3(ABDE)$ $R_4(EF)$

C is not present in any other relation

∴ Whenever we try to join $R_2(BC)$ with any other combination of R_1, R_3, & R_4 then common attribute will be B only

$(B)^+ = \{B, D\}$

B can not be a S.K. of any relation containing any other attribute apart from B & D

there is no sub-relation which contain B & D only

∴ Common attribute B can not be a S.K. of any combination of given relations.

Hence $R_2(BC)$ can not be joined in lossless manner

Hence overall decomposition is lossy join decomposition

Topic : Normalization

Normalization is the process of reducing/eliminating the redundancy present in the relation

↳ For the purpose of normalization we define "normal forms"

Topic : Normal forms

Boyce Codd Normal Form

There are various types of normal forms :-

1NF 2NF 3NF BCNF | 4NF

- Upto BCNF we will try to eliminate redundancy present in the relation because of functional dependencies.
- If relation is in BCNF, then there will be no redundancy because of functional dependency but it may still suffer from redundancy present in the relation because of Multi-valued dependency.

- 4NF is related to multi-valued dependency.
- In 4NF we eliminate redundancy present in the relation because of Multi-valued dependency.

* Upto BCNF we don't need to worry about multi-valued dependency.

* If relation is in BCNF, then there will be 0% redundancy because of functional dependency.

Topic : Normal forms

* If relation is in 2NF, then it is also in 1 NF

* If relation is in 3NF, then it is also in 2NF and hence also in 1 NF

. and so on

Topic : First normal form (1NF)

- A database is in 1NF only if it does not Contain multi-valued attributes. {i.e. all attributes must be atomic}

Multi-valued attribute

Sid	Proj-No.
S_1	$\{P_1, P_2\}$
S_2	$\{P_2, P_3\}$
S_3	P_4

it is not a relation

Multi-valued attribute is Present, ∴ it is not in "1 NF"

Bring database into 1NF

{i.e. Convert multi-valued attribute into single valued attribute}

Converted into single-valued attribute.

Sid	Proj-NO
S_1	P_1
S_1	P_2
S_2	P_2
S_2	P_3
S_3	P_4

it is a relational table

No multi-valued attribute, ∴ it is in 1NF

Topic : First normal form (1NF)

* By default normal form of a relation is 1 NF.

  i.e. Every relation is at least in 1 NF.

Topic : Redundancy in relation because of FD

<u>Rule 1</u>:- A non-trivial functional dependency $X \rightarrow Y$ does not cause any redundancy in the relation if "X" is the superkey of that relation.

Let,
$AB \longrightarrow C$

$\therefore$ AB is a superkey.

$\downarrow$

i.e, All values of A & B together will be distinct.

A	B	C
1	1	1
1	2	1
2	1	1
3	1	2
3	2	2

Even if the values of C are duplicated in some tuples then it will not correspond to redundancy w.r.t. $\underline{AB \longrightarrow C}$

Topic : Redundancy in relation because of FD

Rule 2 : A non-trivial functional dependency $X \longrightarrow Y$ will always cause redundancy in the relation if "X" is not a Super Key of that relation.

X → Y

$F = \{ A \rightarrow C \}$

C.K. = AB

i.e. A is not a S.K.

↓

∴ Values of A may be duplicated

A	B	C
1	1	3
2	1	1
1	3	3
1	2	3
2	3	1
3	3	1

Redundancy

→ Whenever values of A are same values of C will also B same in those tuples → ∴ $A \rightarrow C$ will represent redundancy.

Topic : Redundancy in relation because of FD

- In $X \longrightarrow Y$, if X is not a Super key, then Y can never be a Super key.

- If $X \longrightarrow Y$ is a non-trivial functional dependency such that it causes redundancy in the relation, then neither X can be a Super key nor Y can be a Super key.

Possible non-trivial FDs "$X \longrightarrow Y$" that may cause redundancy in the relation are,

H.W.

$X \longrightarrow Y$

X	Y
$\downarrow$	$\downarrow$
?	?

2 mins Summary

- **Topic** Normal forms
- **Topic** First normal form (1NF)
- **Topic** Redundancy in relation because of FD

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THANK - YOU

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