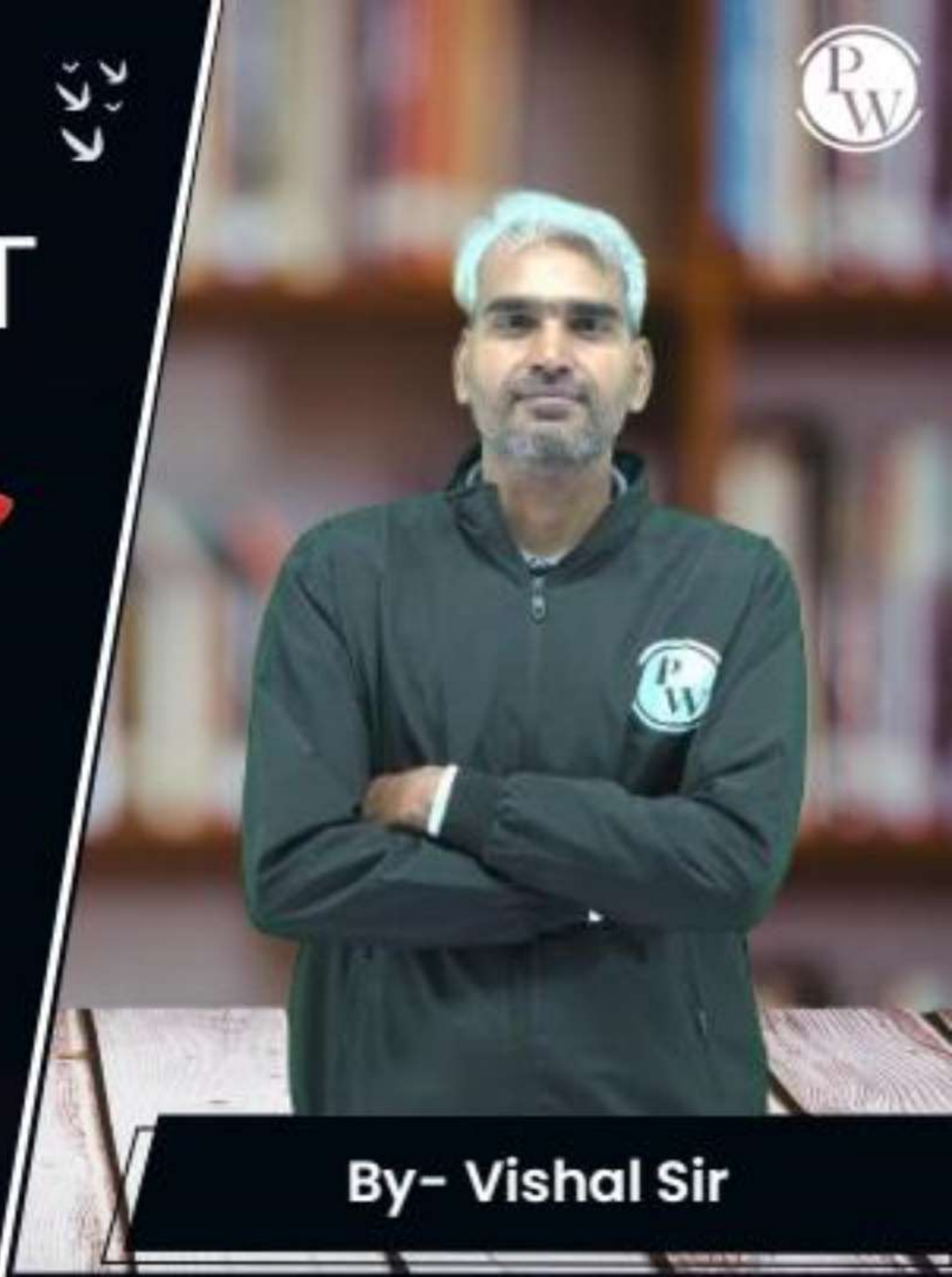
Computer Science & IT

Database Management System

Relational Model & Normal Forms

Lecture No. 15



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Recap of Previous Lecture

Topic Decomposition of relation

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Topics to be Covered

- Topic: Multivalued dependency
- Topic: Properties of multivalued dependency
- Topic: Fourth normal form (4NF)

FD: →
MVD: →→

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Topic : NOTE

④ If all attributes of relation are prime attributes then relation is at least in 3 NF

⑤ If all candidate keys are simple candidate keys, then relation is at least in 2 NF.

simple candidate keys → a key formed of single attribute

⑥ If all attributes are prime attributes, and all candidate keys are simple candidate keys, then relation is in BCNF

Topic : NOTE

A relation with exactly two attributes

(7) A binary relation is always in BCNF.

Eg: Let R(AB) is the binary relation
W.r.t. R(A,B) following FD sets are possible

$F_1 = \{A \rightarrow B\}$ (BCNF)
A: S.K
C.K : A

$F_2 = \{B \rightarrow A\}$ (BCNF)
B: S.K
C.K : B

$F_3 = \{A \rightarrow B, B \rightarrow A\}$ (BCNF)
A: S.K, B: S.K
C.K : A, B

$F_4 = \{\}$ Empty
∴ BCNF

⑧ If relation is in BCNF, then there will be 0% redundancy in the relation because of functional dependencies.

but such relation may suffer from redundancy because of multi-valued dependency (MVD)

Topic : Multivalued dependency

Consider the following relation

Sid	Cid	Proj_no.
S_1	C_1	P_1
S_1	C_2	P_1
S_1	C_1	P_2
S_1	C_2	P_2
S_2	C_2	P_2

There is no non-trivial functional dependency

∴ Relation is in BCNF.

But redundancy is present in the relation

This redundancy is present in the relation because of Multi-valued dependency.

Topic : Multivalued dependency

X Multi-valued determines Y is denoted by "$X \rightarrow\rightarrow Y$"

- If tere exist two or more independent set of attributes which are dependent on some other set of attributes. then multi-valued dependency exist in the relation.

Topic : Multivalued dependency

Formal definition: Let R be the relation and 'X' & 'Y' be some set of attributes over relation R, then we define $Z = R - (X \cup Y)$

If (there exists four tuples $t_1, t_2, t_3, t_4 \in R$ such that

(i) $t_1.X = t_2.X = t_3.X = t_4.X$

and (ii) $t_1.Y = t_3.Y$ and $t_2.Y = t_4.Y$

and (iii) $t_1.Z : t_2.Z$ and $t_3.Z = t_4.Z$)

then $X \rightarrow\!\!\!\rightarrow Y$ exist in relation R

Topic : Multivalued dependency

Consider the following relation

	X	Y	Z
	Sid	Cid	Proj_no.
t_1	S_1	C_1	P_1
t_2	S_1	C_2	P_1
t_3	S_1	C_1	P_2
t_4	S_1	C_2	P_2
	S_2	C_2	P_2

let X = Sid
Y = Cid
Z = Proj_No.

We can observe

$t_1.X = t_2.X = t_3.X = t_4.X$

and $t_1.Y = t_3.Y$ and $t_2.Y = t_4.Y$

and $t_1.Z = t_2.Z$ and $t_3.Z = t_4.Z$

$\therefore$ Sid $\rightarrow\!\!\!\rightarrow$ Cid exist in the relation

Topic : Multivalued dependency

Consider the following relation

	Sid (X)	Cid (Z)	Proj_no. (Y)
t_1	S_1	C_1	P_1
t_3	S_1	C_2	P_1
t_2	S_1	C_1	P_2
t_4	S_1	C_2	P_2
	S_2	C_2	P_2

We can observe

$t_1.X = t_2.X = t_3.X = t_4.X$

and $t_1.Y = t_3.Y$ and $t_2.Y = t_4.Y$

and $t_1.Z = t_2.Z$ and $t_3.Z = t_4.Z$

$\therefore$ Sid $\rightarrow\!\!\rightarrow$ Proj_No. exist in the relation

Topic : Multivalued dependency

Note :- If we swap the values of attribute set 'Y' in two tuples which agree on value of attribute set X, and

i.e., two tuple in which value of X is same

it does not create any new tuple in the relation

then $X \longrightarrow\!\!\!\!\rightarrow Y$ exist in Relation

Topic : Properties of Multivalued dependency

① Complementation Rule :- Let R be the relation, and X & Y are some set of attributes over relation R, then $Z = R - (X \cup Y)$

If $X \rightarrow\rightarrow Y$ exists in relation R

then $X \rightarrow\rightarrow Z$ will also exist in relation R

Topic : Properties of Multivalued dependency

② Trivial MVD :-

If $X \twoheadrightarrow Y$ exist in relation R, then it is called a trivial MVD if and only if

(i) $X \supseteq Y$

(or) (ii) $X \cup Y = R$

Topic : Properties of Multivalued dependency

③ Transitivity :-

if $X \rightarrow\rightarrow Y$ & $Y \rightarrow\rightarrow Z$

then $X \rightarrow\rightarrow (Z - Y)$ exists in relation.

Topic : Properties of Multivalued dependency

④ Augmentation :

If $X \rightarrow\rightarrow Y$ and $\alpha \supseteq \beta$ { when α, β are some set of attributes over given relation }

then $X\alpha \rightarrow\rightarrow Y\beta$

Topic : Properties of Multivalued dependency

⑤ Replication :-

Every functional dependency is a M.V.D.

i.e. if $X \rightarrow Y$ exists in Relation R
then $X \rightarrow\rightarrow Y$ also exist in relation R

* Every MVD need not imply functional dependency
i.e. if $X \rightarrow\rightarrow Y$ exists in R
then $X \rightarrow Y$ need not exist in R

Topic : Properties of Multivalued dependency

⑥ Splitting Rule :-

MVDs are not allowed to split

i.e. if $X \twoheadrightarrow YZ$, then $X \twoheadrightarrow Y$ & $X \twoheadrightarrow Z$ need not be true

But if $X \twoheadrightarrow YZ$ then $X \twoheadrightarrow Y$ & $X \twoheadrightarrow Z$

$\therefore X \twoheadrightarrow YZ$ & $X \twoheadrightarrow Y$ & $X \twoheadrightarrow Z$

It is happening because of functional dependency $X \rightarrow YZ$

Topic : Fourth normal form (4NF)

A relation R is in 4NF only if

(i) R must be in BCNF

and (ii) Every non-trivial MVD $X \rightarrow\rightarrow Y$ must be with 'X' as a Super key

Super keys & Candidate keys are always obtained w.r.t functional dependencies.

Because FDs are key dependencies whereas, MVDs are data dependency.

Topic : Fourth normal form (4NF)

"R"

Sid	Cid	Proj-No.
S_1	C_1	P_1
S_1	C_2	P_1
S_1	C_1	P_2
S_1	C_2	P_2
S_2	C_2	P_2

No non-trivial FD exist in R
∴ R is in BCNF

MVDs that exist in relation R are,

Sid →→ Cid
Not a Sk & it is non-trivial MVD

Sid →→ Proj-No.
Not a Sk & it is non-trivial MVD

there exist non-trivial MVDs X →→ Y in which 'X' is not a Super key
∴ Not in 4NF

For 4NF,
Decompose w.r.t. non-trivial MVDs

Sid →→ Cid

Sid	Cid
S_1	C_1
S_1	C_2
S_2	C_2

Sid →→ Cid exist but it is trivial MVD

Sid →→ Proj-No

Sid	Proj-No.
S_1	P_1
S_1	P_2
S_2	P_2

Sid →→ Proj-No exist, but it is trivial

2 mins Summary

Topic Multivalued dependency

Topic Properties of multivalued dependency

Topic Fourth normal form (4NF)

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THANK - YOU