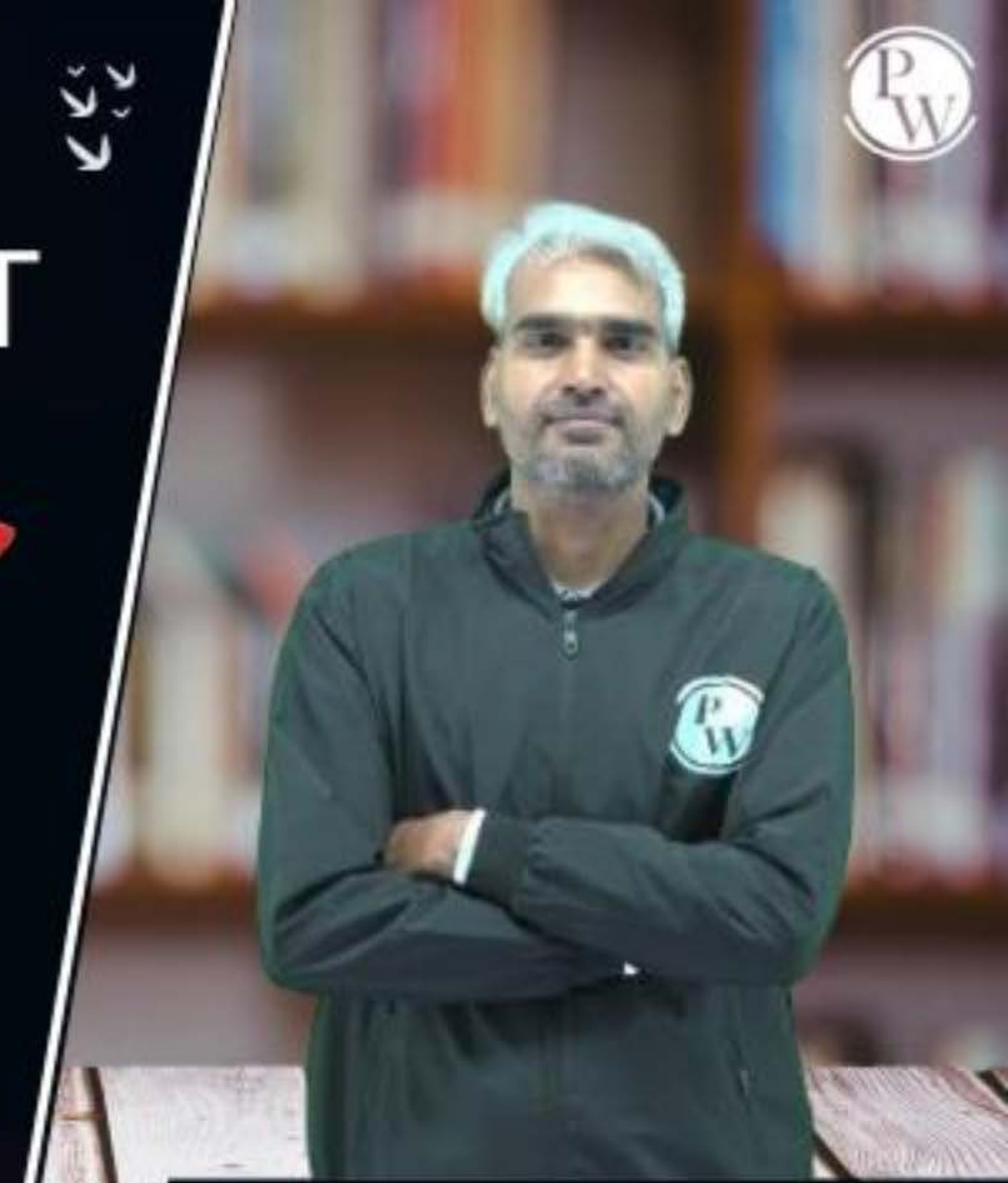
Computer Science & IT

Database Management System

Relational Model & Normal Forms

Lecture No. 05



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Recap of Previous Lecture

Topic Closure of attribute Set

Topic Candidate Key

Slide

Topics to be Covered

Topic Identification of candidate keys in a relation

Topic Membership test

Slide

H.W.

#Q. Assume a relation R (A, B, C, D, E) that has the following functional dependencies:

AB→C,

B→E,

C→D

E→A

Find the Candidate key of R.

Essential attribute = B

$(B)^+ = \{\underbrace{B, E, A, C, D}_{\text{all}}\}$ ∴ B is S.K as well as C.K

B is the only C.K

P.A = {B}, N.P.A = {A, C, D, E}

$(AB)^+ = \{\underbrace{A, B, C, D, E}_{\text{all}}\}$ ∴ AB is S.K

Check for C.K

Proper subsets of {A,B}

$\{A\}^+ = \{A\}$ ∴ A is not a S.K

$\{B\}^+ = \{\underbrace{B, E, A, C, D}_{\text{all}}\}$ ∴ B is a S.K

Proper subset is a S.K.
∴ {A, B} is not minimal
Hence {A, B} is just a S.K. but not a C.K

{B} is a S.K as well as C.K.

'B' is the only C.K.

∴ P.A = {B}

N.P.A = {A, C, D, E}

Topic : Note

If there exists any FD in the set of FDs of the type $X \longrightarrow$ Any of the prime attribute

then we can replace that prime attribute in the corresponding Candidate key by 'X' {i.e. L.H.S of FD}

and by doing so we may get a new Super Key of relation

↳ then we will Check for Candidate Key

#Q. Assume a relation R (A, B, C, D) that has the following functional dependencies:

AB→CD, $\equiv$ AB→C, AB→D

D→A

Find all the Candidate keys of R.

$(AB)^+ = \{\underbrace{A, B, C, D}_{\text{all attributes}}\}$ ∴ AB is a S.K as well as a C.K.

$\boxed{AB}$ is a C.K.

Prime attribute = {A, B}

D → A is present s.t. RHS contains Prime attribute 'A'

∴ Replace A by D

AB → D ∴ Replace D by AB

DB is a S.K. as well as a C.K.

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

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

$\boxed{DB}$ is a C.K.

AB & DB are the only Candidate keys of relation

∴ Prime Attributes = {A, B, D}

Non-prime attribute = {C}

#Q. Assume a relation R (M, N, O, P, Q) that has the following functional dependencies:

MNO →PQ and ⇒ MNO → P, MNO → Q

P → MN

Find the Candidate keys of R.

'O' is Essential, $(O)^+ = \{O\}$

$(MNO)^+ = \{\underbrace{M, N, O, P, Q}_{\text{all attributes}}\}$ ∴ S.K.

Check for Candidate Key → $(MO)^+ = \{M, O\}$, $(NO)^+ = \{N, O\}$ — No Proper Subset is a S.K

$\boxed{MNO}$ is a C.K.

Prime attributes = {M, N, O}

MNO → P. ∴ Replace 'P' by 'MNO'

$P \to \underbrace{MN}_{\text{Prime attributes}}$

∴ Replace 'MN' by P

PO is a S.K as well as a C.K

$\boxed{PO}$ is a C.K.

'MNO' & 'PO' are the only C.Ks of the relation

∴ Prime Attributes = {M, N, O, P}

Non-Prime attributes = {Q}

#Q. Assume a relation R (A, B, C, D) that has the following functional dependencies:

AB → CD ≡ AB → C, AB → D

C → A

D → B

Find the Candidate keys of R.

$(AB)^+ = \{\underbrace{A, B, C, D}_{\text{all}}\}$ ∴ S.K

$(A)^+ = \{A\}$, $(B)^+ = \{B\}$ — No Proper Subset is a S.K

$\boxed{AB}$ is a C.K. Prime attributes = {A, B}

C → A ∴ Replace 'A' by 'C'

CB is a S.K. $(C)^+ = \{C, A\}$, $(B)^+ = \{B\}$

$\boxed{CB}$ is a C.K

D → B ∴ Replace B by D

AD is a S.K. $(A)^+ = \{A\}$, $(D)^+ = \{D, B\}$

$\boxed{AD}$ is a C.K

C → A & D → B ∴ Replace A by C & B by D

D → B ∴ Replace B by D

C → A ∴ Replace A by C

CD is a S.K. $(C)^+ = \{C, A\}$, $(D)^+ = \{D, B\}$

$\boxed{CD}$ is a C.K

AB → CD ∴ Replace 'CD' by 'AB'

AB, CB, AD, CD are the Candidate keys of the relation

Prime Attribute = {A, B, C, D}

Non-Prime = { }

#Q. Assume a relation R (A, B, C, D, E, H) that has the following functional dependencies:

$A \rightarrow B$

$BC \rightarrow D$

$E \rightarrow C$

$D \rightarrow A$

Find the Candidate keys of R.

Essential attributes = E & H

$(EH)^+ = \{E, H, C\}$ it can never be a member of any C.K

$(AEH)^+ = \{\underbrace{A, E, H, B, C, D}_{\text{all attributes}}\}$ ∴ S.K as well as a C.K

$\boxed{AEH}$ is a C.K

Prime Attributes = {A, E, H}

$D \rightarrow A$ ∴ Replace A by D

DEH is a S.K as well as C.K

$\boxed{DEH}$ is a C.K

Prime attributes = {A, E, H, D}

$BC \rightarrow D$ ∴ Replace D by BC

BCEH is a S.K, but not a C.K {if E & H are present then C can be removed}

$\boxed{BEH}$ is a C.K

Prime Attributes = {A, E, H, D, B}

$A \rightarrow B$ ∴ Replace B by A

AEH, DEH & BEH are the Candidate keys.

∴ Prime Attribute = {A, E, H, D, B}

Non-prime attribute = {C}

Topic : Membership test

- Membership test is used to check whether a given FD is a member of $\underbrace{\text{given FD set}}$ or not.

- To check whether $X \to Y$ is a member of FD set F or not (i.e., $F \underset{\text{infer/yields}}{\vDash} X \to Y$ or not)

  We first obtain X^+ (closure of X) w.r.t. FD set F.

  If $Y \in X^+$, then $X \to Y$ is a member of FD set F otherwise not a member of FD set F

* If $X \rightarrow Y$ is a member of FD set F, then we can say that

$X \rightarrow Y$ can be inferred from F

#Q. Let FD set $F = \{A \rightarrow B, B \rightarrow C\}$

Check whether $A \rightarrow C$ is a member of F or not?

$(A)^+ = \{A, B, C\}$

$C \in (A)^+ \therefore$ "$A \rightarrow C$" is a member of F

#Q. Let FD set $F = \{A \to B, B \to C\}$

Check whether $B \to A$ is a member of F or not?

$(B)^+$ w.r.t. $F = \{B, C\}$

$A \notin (B)^+$ w.r.t. F

$\therefore B \to A$ is not a member of F

#Q. Let FD set $F = \{AB \to C, BC \to D\}$

Check whether $AB \to D$ is a member of F or not?

$(AB)^+$ w.r.t. $F = \{A, B, C, D\}$

$D \in (AB)^+$ w.r.t. F.

$\therefore AB \to D$ is a member of F

#Q. Let FD set $F = \{AB \to C, C \to A\}$

Check whether $C \to B$ is a member of F or not?

$(C)^+$ w.r.t. $F = \{C, A\}$

$B \notin (C)^+$ w.r.t. F

$\therefore$ $C \to B$ is not a member of F

Note:-

* Let F is a non-Empty set of FDs

The set of all functional dependencies that can be inferred from F can be denoted by F^+

← Closure of FD set F

#Q. Let FD set $F = \{A \to B, B \to C\}$ over relation $R(A, B, C)$

Find F^+

$\{A\}^+ = \{A, B, C\} = A \to BC$

$\{B\}^+ = \{B, C\}$

$\{C\}^+ = \{C\}$

$\{A, B\}^+ = \{A, B, C\}$

$\{A, C\}^+ = \{A, B, C\}$

$\{BC\}^+ = \{B, C\}$

$\{A, B, C\}^+ = \{A, B, C\}$

$$F^+ = \left\{ \begin{array}{l} A \to BC, \quad B \to C, \\ AB \to C, \quad AC \to B \end{array} \right\}$$

Let A & B are two sets then,

1. $A = B$ iff $A \subseteq B$ & $B \subseteq A$

2. If $A \subseteq B$ but $B \nsubseteq A$, then $A \subset B$ & $A \neq B$

3. If $A \nsubseteq B$ but $B \subseteq A$, then $B \subset A$ & $A \neq B$

4. Neither $A \subseteq B$ nor $B \subseteq A$ $\left\{ \begin{array}{c} A \text{ \& } B \text{ are not} \\ \text{Comparable} \end{array} \right\}$ & $A \neq B$

Relationship between two sets of FDs

Let F & G are two sets of functional dependencies:

1. If all FDs of set F are member of FD set G then $F \subseteq G$, { i.e. all FDs of F can be inferred from FD set G (or) we can say G Covers F }

2. If all FDs of set G are member of FD set F then $G \subseteq F$, { i.e. all FDs of G can be inferred from FD set F (or) we can say F Covers G }

Q: Consider two FD sets

$F_1 = \{A \to B,\ B \to C,\ AB \to D\}$

& $F_2 = \{A \to B,\ B \to C,\ A \to C,\ A \to D\}$

Find the relationship b/w F_1 & F_2

Check if F_1 covers F_2 or not

i.e, check if $F_2 \subseteq F_1$ or not

FDs of F_2	Closure w.r.t. F_1	Member or not	Relationship
$A \to B$	$(A)^+$ w.r.t $F_1 = \{A,B,C,D\}$	$B \in A^+$ ✓	All FDs of F_2 are member of F_1 ∴ $F_2 \subseteq F_1$
$B \to C$	$(B)^+$ w.r.t. $F_1 = \{B,C\}$	$C \in B^+$ ✓	
$A \to C$	$(A)^+$ w.r.t $F_1 = \{A,B,C,D\}$	$C \in A^+$ ✓	
$A \to D$	$(A)^+$ w.r.t $F_1 = \{A,B,C,D\}$	$D \in A^+$ ✓	

Check if F_2 covers F_1 or not

i.e, Check if $F_1 \subseteq F_2$ or not

FDs of F_1	Closure w.r.t. F_2	Member or not	Relationship
$A \to B$	$(A)^+$ w.r.t. $F_2 = \{A,B,C,D\}$	$B \in A^+$ ✓	All FDs of F_1 are member of F_2 ∴ $F_1 \subseteq F_2$
$B \to C$	$(B)^+$ w.r.t. $F_2 = \{B,C\}$	$C \in B^+$ ✓	
$AB \to D$	$(AB)^+$ w.r.t $F_2 = \{A,B,C,D\}$	$D \in (AB)^+$ ✓	

$F_1 \subseteq F_2$ & $F_2 \subseteq F_1$ ∴ $\boxed{F_1 = F_2}$

Q: Consider two FD sets

$F_1 = \{ A \rightarrow B,\ B \rightarrow C,\ AB \rightarrow D \}$

& $F_2 = \{ A \rightarrow B,\ B \rightarrow C,\ A \rightarrow C,\ A \rightarrow D \}$

Find the relationship b/w F_1 & F_2

Q: Consider two FD sets

$F_1 = \{ A \to B,\ B \to C,\ A \to C \}$

& $F_2 = \{ A \to B,\ B \to C,\ A \to D \}$

Find the relationship b/w F_1 & F_2

$F_1 = \{ A \to B,\ B \to C,\ A \to C \}$

$(A)^+$ w.r.t $F_2 = \{A, B, C, D\}$

$\therefore F_1 \subseteq F_2$

$F_2 = \{ A \to B,\ B \to C,\ A \to D \}$

$(A)^+$ w.r.t $F_1 = \{A, B, C\}$

$D \notin A^+$

$\therefore A \to D$ is not inferred by F_1

$\therefore F_2 \not\subseteq F_1$

$F_1 \subseteq F_2$ but $F_2 \not\subseteq F_1$, $\therefore F_1 \not\equiv F_2$ but $F_1 \subset F_2$

Q:- Consider two FD sets

$F_1 = \{A \to B,\ AB \to C,\ D \to AC,\ D \to E\}$

& $F_2 = \{A \to BC,\ D \to AE\}$

Find the relationship b/w F_1 & F_2

$F_1 = \{A \to B \checkmark,\ AB \to C \checkmark,\ D \to AC \checkmark,\ D \to E \checkmark\}$ $\therefore F_1 \subseteq F_2$

$F_2 = \{A \to BC \checkmark,\ D \to AE \checkmark\}$ $\therefore F_2 \subseteq F_1$

Hence $F_1 = F_2$

FD set of a Sub-relation

- Let R be the relation with FD set F, and R_1 is any sub-relation of R.
  Concept of membership test can be used to identify the FDs of sub-relation
- Let R(A, B, C, D, E) is a relation, then R_1(A, B, E) can be called a subrelation of relation R

Q:. Let $R(A, B, C, D, E)$ is a relation with FD set F.

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

and let $R_1(A, B, E)$ is a sub-relation of relation $R(A,B,C,D,E)$

Find the Candidate keys of sub-relation $R_1(A, B, E)$

Solun. To find the candidate keys of any relation we need the set of functional dependencies w.r.t. that relation

∴ First we need to identify the FDs that exists in sub-relation $R_1(A, B, E)$

Q:. Let $R(A,B,C,D,E)$ is a relation with FD set F.

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

and let $R_1(A,B,E)$ is a sub-relation relation $R(A,B,C,D,E)$

We need to find FD set F_1 w.r.t. sub-relation R_1

i.e. we need identify the relationship b/w A, B & E

$(A)^+$ w.r.t. $F = \{A, B, C\}$

i.e. $A \to \cancel{A}\ B\ \cancel{C}$ $\therefore$ $\boxed{A \to B}$

trivial Not in relation R_1

$(B)^+$ w.r.t. $F = \{\cancel{B}\}$ $\therefore$ No useful FD

$(E)^+$ w.r.t. $F = \{\cancel{E}\}$ $\therefore$ No useful FD

$(AB)^+$ w.r.t. $F = \{\cancel{A}, \cancel{B}, \cancel{C}\}$ $\therefore$ No useful FD

$(AE)^+$ w.r.t. $F = \{\cancel{A}, \cancel{E}, B, \cancel{C}\}$ $\therefore$ $\boxed{AE \to B}$

$(BE)^+$ w.r.t. $F = \{\cancel{B}, \cancel{E}\}$ $\therefore$ No useful FD

Hence FD set F_1 w.r.t sub relation $R_1(A,B,E)$ is

$$F_1 = \left\{ \begin{array}{l} A \to B \\ AE \to B \end{array} \right\}$$

$\therefore$ CK of R_1 is (AE)

H.W.

Q:. Let $R(A,B,C,D,E,F)$ is a relation with FD set F.

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

and let $R_1(A,B,C,D)$ is a sub-relation of relation $R(A,B,C,D,E,F)$

Find the Candidate keys of sub-relation $R_1(A,B,C,D)$

2 mins Summary

Topic Identification of candidate keys in a relation

Topic Membership test

Slide

THANK - YOU

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