#### **COMPUTER SCIENCE**



Database Management System

FD's & Normalization



Vijay Agarwal sir





01 Lo

Lossless Join Decomposition

02

**Dependency Preserving** 





#### Lossles Join De composition

Lossless Join

RIURZURg. URGER

FB Common Attorbuk of R, 2 R2 Cither a Super Kepp of R,

Super Key of Rz



#### CHASE TEST

11th Any you Tibe.

•



#### R(ABC)



A	В	С
1	5	5
2	5	8
3	8	8

Decomposed into

Q.1 R<sub>1</sub>(AB) & R<sub>2</sub>(BC)



#### R(ABC)



A	В	С
1	5	5
2	5	8
3	8	8

Decomposed into

 $Q.2 R_1(AB) \& R_2(AC)$ 





#### Lossless - Join Decomposition

For the case of  $R = (R_1, R_2)$ , we require that for all possible relations r on schema R

$$r = \pi_{R_1}(r) \bowtie \pi_{R_2}(r)$$

- A decomposition of R into R<sub>1</sub> and R<sub>2</sub> is lossless join if at least one of the following dependencies is in F+:
  - $R_1 \cap R_2 \rightarrow R_1$
  - $R_1 \cap R_2 \rightarrow R_2$

### X>y

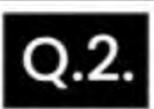
If the text then they = tely must be some.



R(ABCDEFG) {AB  $\rightarrow$  CD, D  $\rightarrow$  E, E  $\rightarrow$  FG} Decomposed into R<sub>1</sub>(ABCD) and R<sub>2</sub>(DEFG) By CHASE TEST.



ABOCD		A	B	C	P	E	F	5	_
BYE	RI(ABCD)	a	a	a	$/\!\!/a$	(a)	a	à	
E->FG	R2(DEFG)				a	a	a	a	
		gett	iz a	Tuple	With	all a	ente	sies	_
				(	OSSIC	288	Join		



R(ABCDEFG) {AB  $\rightarrow$  C, C  $\rightarrow$  D, D  $\rightarrow$  EFG} Decomposed into R<sub>1</sub>(ABCE) and R<sub>2</sub>(DEFG) By CHASE TEST.

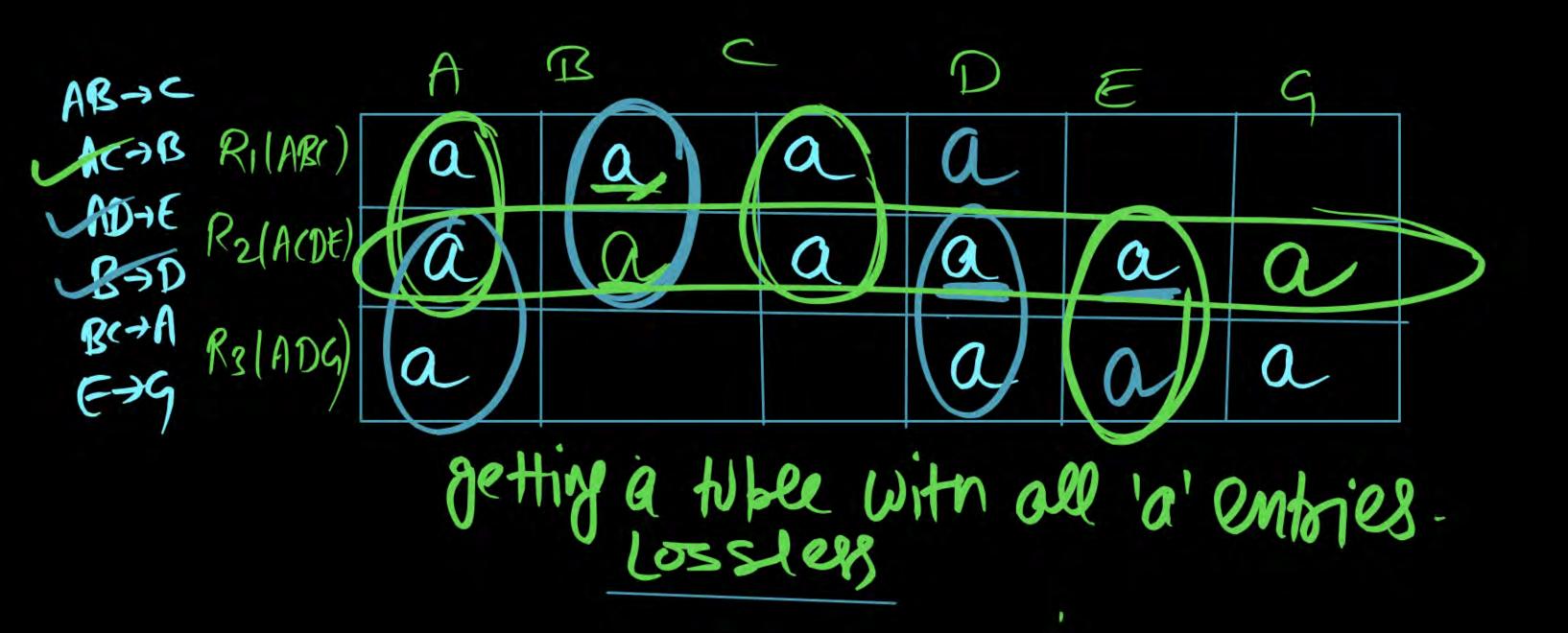


X AB>C		A	R		D (	<b>E</b>	F	9	
XC>D>EFG	RILABCE)	a	a	a.		a			
	R2/DEFG				a	a	a	a	
	Not	getting	any	One To	pole Wr	tu al	lai	ento	es
						Join			



#### R(ABCDEFG) {AB $\rightarrow$ C, AC $\rightarrow$ B, AD $\rightarrow$ E, B $\rightarrow$ D, BC $\rightarrow$ A, E $\rightarrow$ G} Decomposed into R<sub>1</sub>(ABC) R<sub>2</sub>(ACDE) and R<sub>3</sub>(ADG)





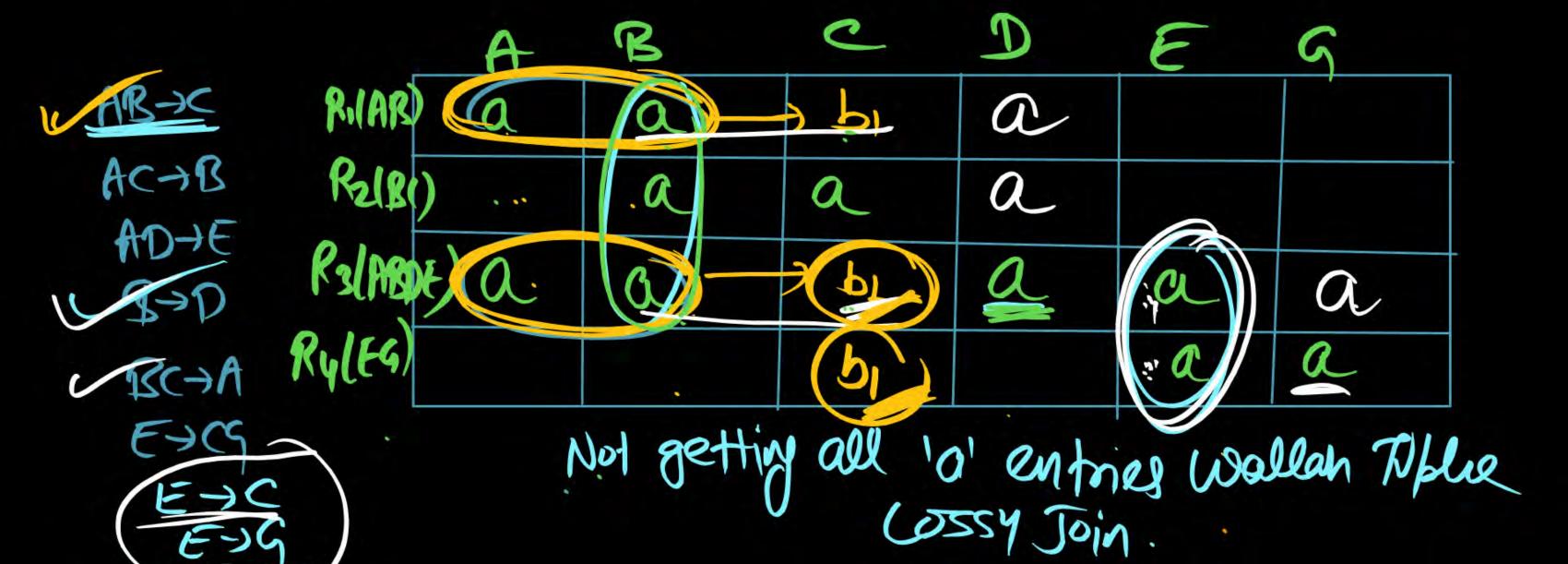
The tix =tz.x then tiy =tz.y Must be same.



#### R(ABCDEFG) $\{AB \rightarrow C, AC \rightarrow B, AD \rightarrow E, B \rightarrow D, BC \rightarrow A, E \rightarrow CG\}$



- 1. Decomposed into R<sub>1</sub>(AB) R<sub>2</sub>(BC) R<sub>3</sub>(ABDE) and R<sub>4</sub>(EG)
- 2. Decomposed into R<sub>1</sub>(AB) R<sub>2</sub>(BC) R<sub>3</sub>(ABDE) and R<sub>4</sub>(ECG)





#### R(ABCDEFG) $\{AB \rightarrow C, AC \rightarrow B, AD \rightarrow E, B \rightarrow D, BC \rightarrow A, E \rightarrow CG\}$



- 1. Decomposed into R<sub>1</sub>(AB) R<sub>2</sub>(BC) R<sub>3</sub>(ABDE) and R<sub>4</sub>(EG)
- 2. Decomposed into R<sub>1</sub>(AB) R<sub>2</sub>(BC) R<sub>3</sub>(ABDE) and R<sub>4</sub>(ECG)

		A	B		C	D	E	9
AB>C	RI(AB)	a.	a		اطرد	a		
AC>B AD>E	R2(BC)		a		a	a		
B-D	R3(ABDE)(	a	(a)		Ha	a	a	a
BC-)A	Ry(Ecg)				a		a	a
E>CG	•	ge	Hir	a to	bee wit	n all	'a' ON	tried
とうと					So L	ossle	2	7

Q.

Consider the relation R (P, Q, S, T, X, Y, Z, W) with the following functional dependencies.



$$PQ \rightarrow X; P \rightarrow YX; Q \rightarrow Y; Y \rightarrow ZW$$

Consider the decomposition of the relation R into the constituent relations according to the following two decomposition schemes.

$$D_1$$
:  $R = [(P, Q, S, T); (P, T, X); (Q, Y); (Y, Z, W)]$ 

$$D_2$$
: R = [(P, Q, S); (T, X); (Q, Y); (Y, Z, W)]

Which one of the following options is correct?

[MCQ: 2021: 2M]

- A D<sub>1</sub> is a lossless decomposition, but D<sub>2</sub> is a lossy decomposition.
- B D<sub>1</sub> is a lossy decomposition, but D<sub>2</sub> is a lossless decomposition.
- C Both D<sub>1</sub> and D<sub>2</sub> are lossless decomposition.
- D Both D<sub>1</sub> and D<sub>2</sub> are lossy decomposition.

## Decombosition

1 Lossler Join

50 Bosic Concept

- 2) Binary Method
- 3 CHASE TEST

@ Dependency Preserving

## Dependency freezewing Decomposition:



let R be the Relational Schema With FD Set F is Decomposed into Sub Relations R, R2 Rz... Rn With FD Set Fi Fz Fz. - . . Fn Respectively.

II FIUF2UF3....UFn=F
Dependency Proserving Decomposition

FI FIUFZUF3---- UFN CFF
Dependency Not Preserved.



#### Dependency Preservation

- Let F<sub>i</sub> be the set of dependencies F that include only attributes in R<sub>i</sub>.
  - A decomposition is dependency preserving,

if 
$$(F_1 \cup F_2 \cup ... \cup F_n) = F$$
  
Dependency Proximed.



Birst take the closure of the Attributes than
Write ALL Non Trivial FD in the Respective

Sub Relation.

XMY = & & X->y Must Satisfy FD Defination

Let R(A, B, C, D, E) be a relational schema with the following

function dependencies:

$$A \rightarrow B$$
,  $B \rightarrow C$ ,  $C \rightarrow D$  and  $D \rightarrow BE$ .

Decomposed into R<sub>1</sub>(AB) R<sub>2</sub>(BC) R<sub>3</sub>(CD) and R<sub>4</sub>(DE)

(A) = (ABCDE)
(B)+ (BCDE)
(C)=(CDBE)
D) - (DBEK)
(E) = (E) ET

RI(AB)	Re(MC)	(R3(CD))	Ry(DE)
A->B	BC	$C \rightarrow D$	DIE
	CAB	D-C	
A -> B. B -		$C \rightarrow D$ , $D \rightarrow C$	DAG
A->B, B	oc, COD	D-JE D-	C,C>B)D-J

Deb Preserve



Consider a schema R(A, B, C, D) and functional dependencies



 $A \rightarrow B$  and  $C \rightarrow D$ . Then the decomposition of R into  $R_1(AB)$  and

R2(CD) is RILABIA R2(CD)

Dependency preserving and lossless join

Dependency preserving and lossiess join (C) (C)

B Lossless join but not dependency preserving

R, (AB)	R2(CD)
A-B	C->D

Dependency preserving but not lossless join

D Not dependency preserving and not lossless join

Ang (c)

A)B, C)D

Dep. Preferred

Q.

Let R(A, B, C, D) be a relational schema with the following function dependencies:



 $A \rightarrow B$ ,  $B \rightarrow C$ ,  $C \rightarrow D$  and  $D \rightarrow B$ .

The decomposition of R into (A, B), (B, C), (B, D)

[MCQ: 2M]



Gives a lossless join, and is dependency preserving



Gives a lossless join, but is not dependency preserving



Does not give a lossless join, but is dependency preserving



Does not give a lossless join and is not dependency preserving

RIABCD) [A>B B>C, C>D, D>B) RI(AB) R2(BC) R3(BD) LOSSIES JOIN ? RILAB) 1 R2 (BC) = B (B) - (BCD) Super Key of Re. RIZ (ABC) (RBD) = B (B)= [BD C] Super ky of R3 R123 (ABCD) LOSSRESS Join RIABCD) EA>B B>C (C>D) D-B)

RI(AB)

R2(BC)

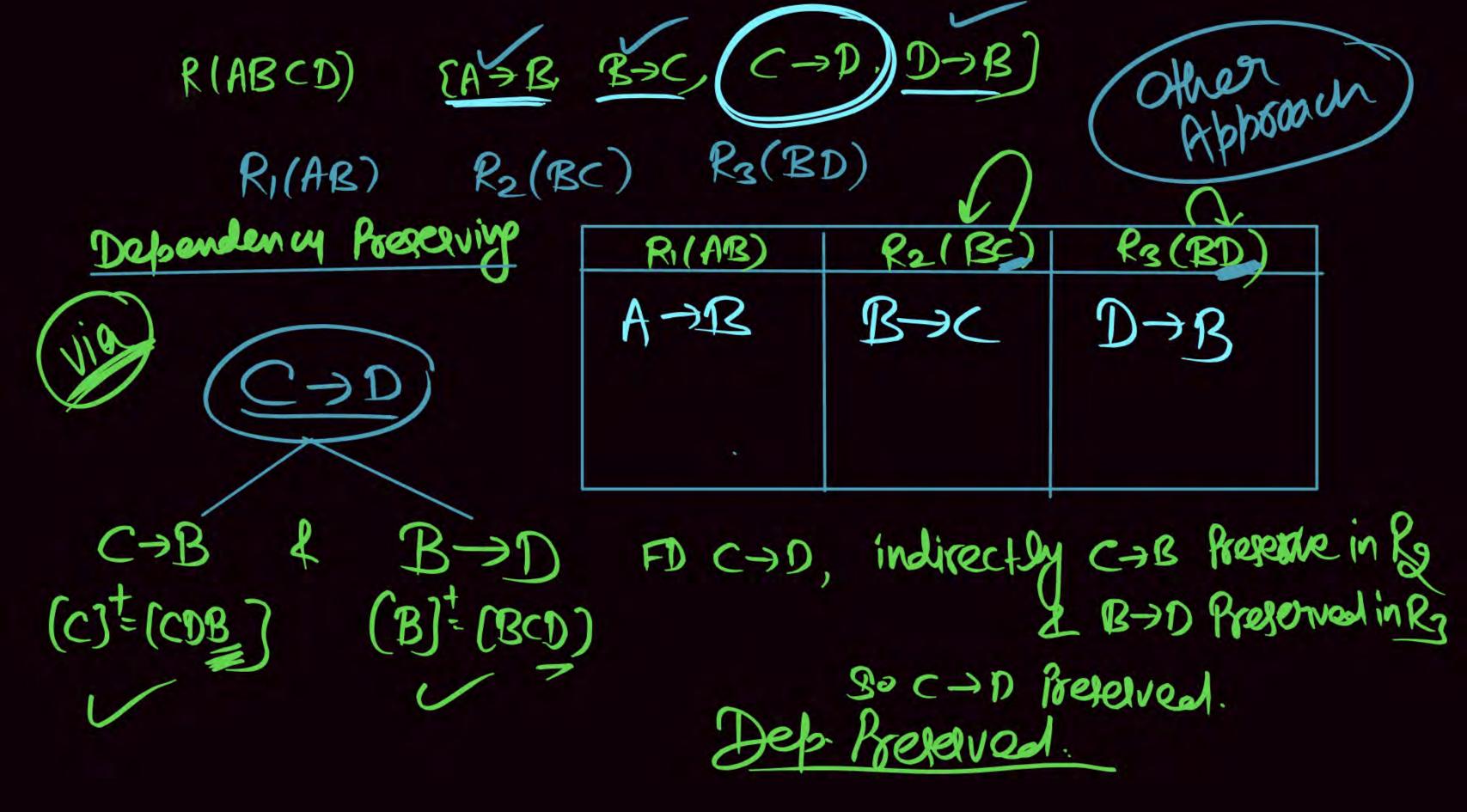
R3(BD)

Dependen 4	Prescring

(A)+= (ABCD)
(B)+= (BCD)
(C)+= (CDB)
(D)+= (DBC)

RI(AB)	R2 (BC)	(R3(BD))
A-B	BIC	B-D
	COB	D-2B
A-B, B-O	CAB, E	D-R.

Dependency Preserving





R( E RI RZ RZ RY Attribute closure [X] : Set of ALL possible Attribute

Which is logically determined

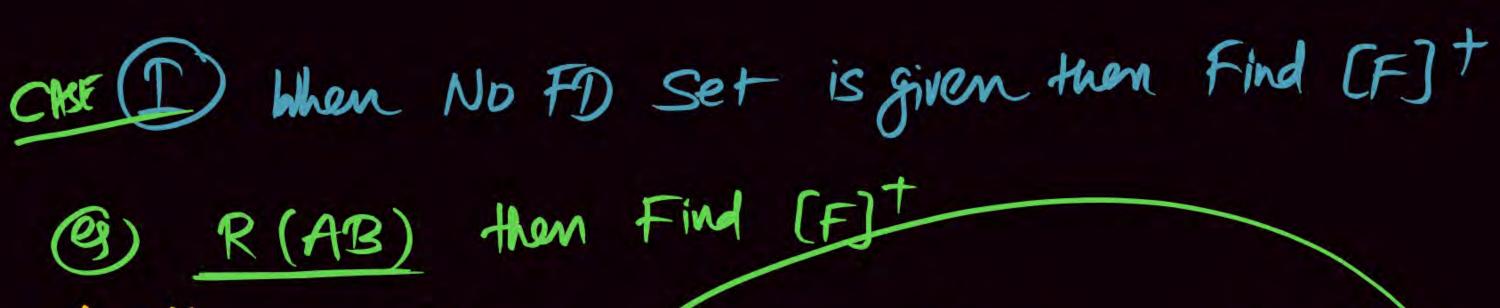
by attribute X is called Attribute

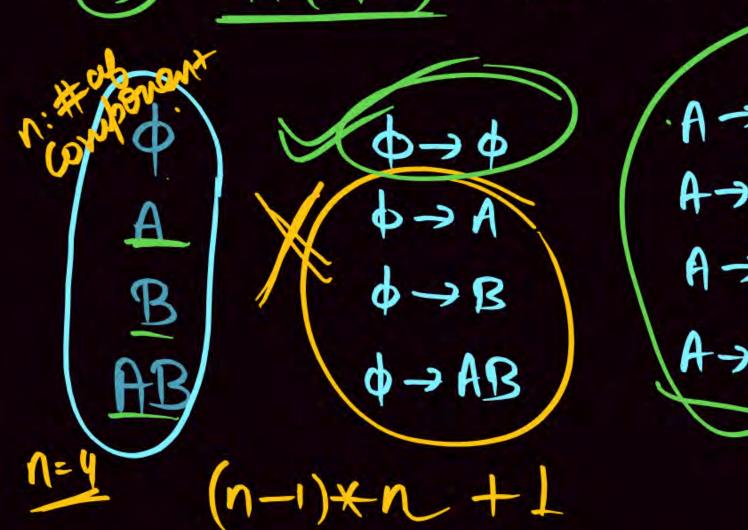
Closure of X. [X].

Closure of FD Set [F]<sup>†</sup>: Set of All possible FD's Which is determined by given FD Set is Colled Closure of FD Set

Case (1) 7 When NO FD set is given then find (F)+ Closure of FD Set [F] + When FD Set is given then Find (F)<sup>t</sup>

# CASEI: When FD Bet is Not given in Question. then Find (F).



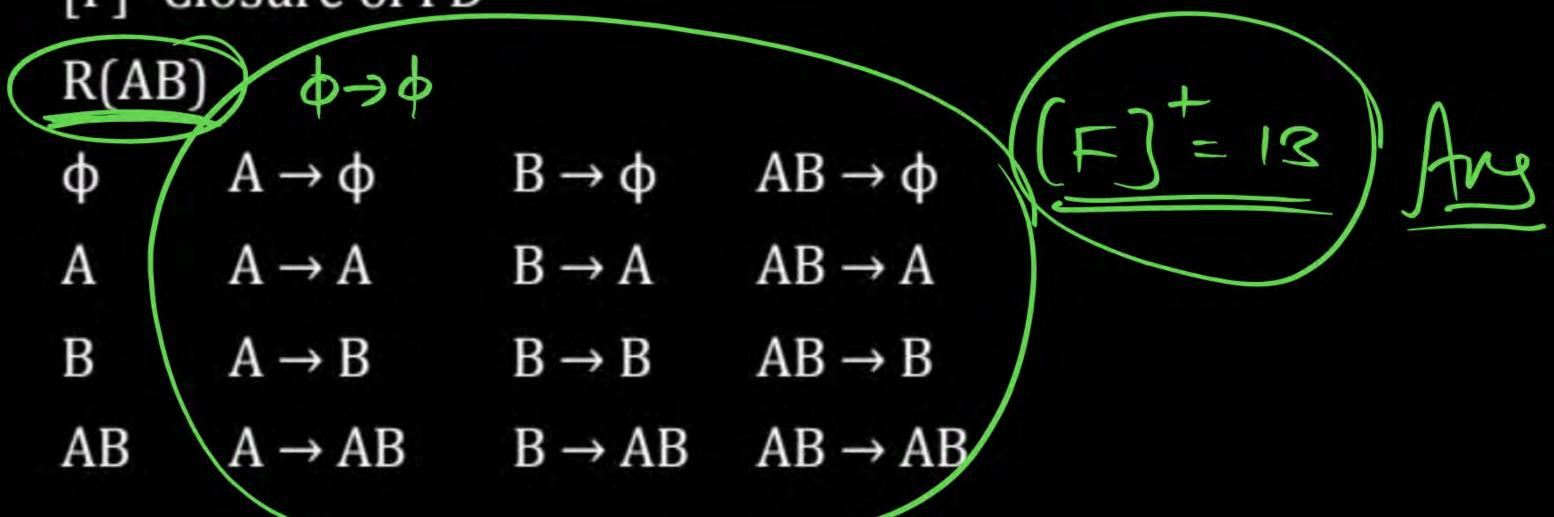


3\*4+1 (F] =13 Am

#### Closure of FD Set [F]+

Set of all possible FD's which can be derived from given FD set is called closure of FD set. [F]<sup>+</sup>

[F]+ Closure of FD



## R(ABC) then Find (F) ?

$$(n-1) \times n + 1$$
  
 $\Rightarrow (8-1) \times 8 + 1$   
 $\Rightarrow 7 \times 8 + 1$   
 $= (57 \text{Mg}) \times 1$ 

Case II: When FD Set is given in the Quartien than Find (F)

B

AB

$$(B)^{\dagger} = (B) = 2^{1}$$

[A>B, B>C) then find (F)=? R(ABC) O Attribute > **ゆ** ラ ゆ A 1 Attribute: (A)= (ABC) = 2  $(B)^{+} (BC) = 2^{2} = (4)^{(B)} (B)^{+} (B)^{-} (B)$ B 8 CAB+O, AB+A, AB+BC, AB+ABC AB=AB, AB=BC, AB+AC, AB+ABC = (2)  $(c \rightarrow \phi, c \rightarrow c)$  $(c)^{t}$  - (c)AB CBCAD, BCOB, BCOC, BCOBC) (AR) = (ARC) = 2" = 8 [AC>D, AC>A, AC>B, AC>C, AC>BC)

O CAD (AC>BC, AC>BC)  $\mathbb{R}^{2}(\mathbb{R}^{2}) = \mathbb{R}^{2}$  $(AC)^T = (ABC) = 2^3$ = 8 (ABC) \$, ABC) A, ABC) B, ABC) C, ABC) = (ABC) = 23 ARCJAB, ABCJBC, ABCJAC, ARCJAB

**R(ABC)** [A 
$$\to$$
 B, B  $\to$  C] [F] + = 43 Ans.

$$[F] + = 43 \text{ Ans.}$$



$$\phi$$
 0 attribute =  $\phi \rightarrow \phi$ 

A 
$$1$$
Attribute =  $[A] + = [ABC] = 2^3$ 

B 
$$[B]^+ = [BC] = 2^2$$

$$[C]^+ = [C] = 2^1$$

AB 
$$2Attribute = [AB]^+ = [ABC] = 2^3$$

$$[BC]^+ = [BC] = 2^2$$

$$[AC]^{+} = [ABC] = 2^{3}$$

ABC 
$$3 \text{ Attribute} = [ABC]^+ = [ABC] = 2^3$$

$$[A]^{+} = \begin{bmatrix} A \rightarrow \phi, A \rightarrow A, A \rightarrow B, A \rightarrow C \\ A \rightarrow AB, A \rightarrow BC, A \rightarrow AC, A \rightarrow ABC \end{bmatrix}$$

$$[B]^{+} = [B \rightarrow \phi, B \rightarrow B, B \rightarrow C, B \rightarrow BC]$$

$$[B]^+ = [B \rightarrow \phi, B \rightarrow B, B \rightarrow C, B \rightarrow BC]$$

$$[C]^+ = [C \rightarrow \varphi, C \rightarrow C]$$

$$[AB]^{+} = \begin{bmatrix} AB \rightarrow \phi, AB \rightarrow A, AB \rightarrow B, AB \rightarrow C \\ AB \rightarrow AB, AB \rightarrow BC, AB \rightarrow AC, AB \rightarrow ABC \end{bmatrix}$$

$$[BC]^+ = [BC \rightarrow \varphi, BC \rightarrow B, BC \rightarrow C, BC \rightarrow BC]$$

$$[AC]^{+} = \begin{bmatrix} AC \rightarrow \phi, AC \rightarrow A, AC \rightarrow B, AC \rightarrow C \\ AC \rightarrow AB, AC \rightarrow BC, AC \rightarrow AC, AC \rightarrow ABC \end{bmatrix}$$

$$[ABC]^{+} = \begin{bmatrix} ABC \rightarrow \emptyset, ABC \rightarrow A, ABC \rightarrow B, ABC \rightarrow C \\ ABC \rightarrow AB, ABC \rightarrow BC, ABC \rightarrow AC, ABC \rightarrow ABC \end{bmatrix}$$

#### $R(AB)[A \rightarrow B]$

$$\phi$$
 0 attribute = 1

A 1 Attribute = 
$$[A]^+$$
  $[AB] = 2^2$ 

B 
$$[B]^+ = [B] = 2^1$$

AB 
$$2 \text{ Attribute} = [AB]^+ = [AB] = 2^2$$

$$(A \rightarrow \phi, A \rightarrow A, A \rightarrow B, A \rightarrow AB)$$
  
 $(B \rightarrow \phi, B \rightarrow B)$ 

$$\begin{pmatrix} AB \rightarrow \phi, AB \rightarrow A \\ AB \rightarrow B, AB \rightarrow AB \end{pmatrix}$$



## Any Doubt?

