COMPUTER SCIENCE

Database Management System

FD's & Normalization

Lecture_06

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TOPICS TO BE COVERED

01 Minimal Cover

Equality between 2 FD set

F Cover G : True

G Cover F : True.

$X \rightarrow Y$

① Redundant FD.

Extraneous Attribute: Extraneous Attribute is a Attribute if we Remove|Delete that Attribute then After Removal of that Attribute Not effect the Power of FD Set.

eg ① $A\cancel{B} \rightarrow C$, ② $A \rightarrow C$

$\boxed{F \equiv G\ ?}$

B is extra (Bcz $A \rightarrow C$]

$$\boxed{F \equiv G\ ?}$$

eg: $F: [AB \to C,\ A \to C]$

I Lets Assume A is Extra Attribute

$G: [B \to C,\ A \to C]$

$\boxed{\text{Check } F \equiv G\ ?}$

F Cover G

$B \to C \quad (B)^+ = [B]$

$A \to C$

False $\therefore$ A is Not Extra Attribute.

II Lets Assume B is Extra Attribute

$\boxed{G: [A \to C]}$

F Cover G

✓ $A \to C \quad [A]^+ = [AC]$

True

G Cover F

✓ $AB \to C \quad (AB)^+ = (ABC)$

$A \to C \quad (A)^+ = [AC]$

True

$\boxed{F \equiv G}$

B is extraneous Attribute.

Q.2 [$AB \to C$, $A \to B$]

1

Lets Assume A is extra.

G: [$B \to C$, $A \to B$]

F Cover G

$\times$ $B \to C$ $(B)^+ = (B)$

$A \to B$

False

$\therefore$ A is Not Extra Attribute

Lets Assume B is extra.

G: [$A \to C$, $A \to B$]

F Cover G

$\checkmark$ $A \to C$ $(A)^+ = (ABC)$

$\checkmark$ $A \to B$ $(A)^+ = (ABC)$

True

G Cover F

$AB \to C$ $(AB)^+ = (ABC)$

$A \to B$ $(A)^+ = (ABC)$

True.

$\boxed{F \equiv G}$

[$A \to C$, $A \to B$]

$\therefore$ B is extraneous Attribute

Q.2

(2) Alternate Approach

$[AB \to C, \quad A \to B]$

$AB \to C$

A is extra if $(B)^+$ Contain A

B is extra if $(A)^+$ Contain B.

$(B)^+ = (B)$; $\therefore$ A is Not extra.

$(A)^+ = (ABC)$; B is extra Attribute

(3)

$A\cancel{B} \to C, \quad A \to B$

B is extra.

$[A \to C, \; A \to B]$

F Cover G		G Cover F
True	$\boxed{F \equiv G}$	True

F: [xyz → w, y → z, x → y]

$\cancel{xyz} \rightarrow w$

$y \rightarrow z$

z is extra

$x\cancel{y} \rightarrow w$

$x \rightarrow y$

y is extra.

$\boxed{G: [x \rightarrow w, y \rightarrow z, x \rightarrow y]}$

Ans

y & z is extra Attribute.

F Cover G

✓ $x \rightarrow w$ $(x)^+ = [xyzw]$

✓ $y \rightarrow z$ $(y)^+ = [yz]$

✓ $x \rightarrow y$ $(x)^+ = [xyzw]$

True

$\boxed{F \equiv G}$

G Cover F

✓ $xyz \rightarrow w$ $(xyz)^+ = [xyzw]$

✓ $y \rightarrow z$ $(y)^+ = [yz]$

✓ $x \rightarrow y$ $(x)^+ = [xyzw]$

True

Canonical Cover

Minimal cover.

- Sets of functional dependencies may have redundant dependencies that can be inferred from the others
  - For example: $A \to C$ is redundant in: $\{A \to B, B \to C, A \to C\}$

$A \to C$ is Redundant | Extra FD.

$[A \to B,\ B \to C]$

$\therefore$

$(A)^+ = (ABC)$

Q. $AB \to C,\ D \to E,\ E \to C$ is a minimal cover for the set of functional dependencies $AB \to C,\ D \to E,\ AB \to E,\ E \to C$.

$F \equiv G$?

F Cover G : True ?

G Cover F : True ?

Q.

Given the following two statements:

S1: Every table with two single-valued attributes is in 1NF, 2NF, 3NF and BCNF.

S2: $AB \rightarrow C, D \rightarrow E, E \rightarrow C$ is a minimal cover for the set of functional dependencies $AB \rightarrow C,\ D \rightarrow E, AB \rightarrow E, E \rightarrow C$.

Which one of the following is CORRECT?

[MCQ: 2014: 2M]

(A) S1 is TRUE and S2 is FALSE.

(B) Both S1 and S2 are TRUE.

(C) S1 is FALSE and S2 is TRUE.

(D) Both S1 and S2 are FALSE.

Procedure to find Minimal Cover :

(Right Hand side)
Step1 : Split the FD Such that R.H.S Contain Single Attribute.

ⓐ $A \rightarrow BC \Rightarrow A \rightarrow B, \; A \rightarrow C.$

(Left Hand side)
Step2 : Find the Redundant (Extra) Attribute On L.H.S & Delete them FROM FD Set.

$AB \rightarrow C$; A is extra if $(B)^+$ Contain 'A' ; $(B)^+ = [\ldots\ldots A]$

B is extra if $[A]^+$ Contain 'B' ; $[A]^+ = [\ldots\ldots B]$

A Extra if $(B)^+ = [\ldots A]$

B Extra if $(A)^+ = [\ldots B]$

Step 3 : Find the Redundant FD & Delete them FROM FD Set

(Q) $[\overset{①}{A \to B},\ \overset{②}{B \to C},\ \overset{③}{A \to C}]$; $A \to C$ is extra FD

So $[A \to B,\ B \to C]$.

Procedure to find minimal set

Step (1)

Split the FD such that RHS contain single Attribute.

Ex. $A \rightarrow BC, \quad \Rightarrow \quad A \rightarrow B$ and $A \rightarrow C$

Step (2)

Find the redundant attribute on L.H.S and delete them.

Ex. $AB \rightarrow C,$

A – Can be deleted $[B]^+ = [A]$ $\quad B^+$ Contains ‘A’

OR

B can be delete if A^+ contain ‘B’ $\quad [A]^+ = [\ldots B]$

Step

(3)

Find the redundant FD and delete them from the set

Ex. $\{A \rightarrow B,\ B \rightarrow C,\ A \rightarrow C\}$

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

Example1:

$$[AB \to CD,\ A \to E,\ E \to C]$$

Step1 (R.H.S) : $AB \to C$, $AB \to D$, $A \to E$, $E \to C$.

Step2 (L.H.S)

Check Extra Attribute

$AB \to C$

$(A)^+ = (AEC)$; B is Not extra.

$(B)^+ = (B)$; A is Not extra.

Step3 (Redundant FD)

Extra ~~$AB \to C$~~

$(AB)^+ = (ABDEC)$

$AB \to D$ ✓ $(AB)^+ = (ABEC)$

$A \to E$ ✓ $(A)^+ = (A)$

$E \to C$ ✓ $(E)^+ = (E)$

$AB \to D$
$A \to E$
$E \to C$.

Ans

Example 2:

Q. $[A \to C,\ AC \to D,\ E \to AD,\ E \to H]$

Step 1: Split the FD Such that R.H.S Contain Single Attribute.

$A \to C$, $AC \to D$, $E \to A$, $E \to D$, $E \to H$

Step 2: Find the Redundant Attribute On L.H.S & Delete them FROM FD Set

$AC \to D$: A is extra if $[C]^+$ Contain A
C is extra if $[A]^+$ Contain C.

$[C]^+ = [C]$; A is Not Extra Bcz $(C)^+$ Not Contain A.

$[A]^+ = [AC\ldots]$ C is extra Bcz $(A)^+$ Contain C.

$\boxed{A \to D}$

① $A \to C$ ② $A \to D$ ③ $E \to A$ ④ $E \to D$ ⑤ $E \to H$

Step 3 : Find the Redundant FD & Delete them FROM FD Set.

① ✓ $A \to C$

$[A]^+ = [AD]$

② ✓ $A \to D$

$[A]^+ = [AC]$

③ ✓ $E \to A$

$[E]^+ = [EDH]$

④ ✗ $E \to D$

$[E]^+ = [EHACD]$

$E \to D$ is extra.

⑤ 4 & 5 NOT take

$E \to H$ ✓

$[E]^+ = [EACD]$

Minimal Cover

$A \to C,\ A \to D,\ E \to A,\ E \to H$

OR

$A \to CD,\ E \to AH$

Ans

Procedure to find Redundant FD Directly :

Assume we want to check Any $A \to B$ is Redundant FD or Not ? in Given FD Set.

First Hide that $(A \to B)$ FD, then take the Closure of A in all the Remaining FD Set. if from $[A]^+$ we getting B from all other FD then we can say $A \to B$ is Extra FD.

① $A \to B$ ✓

② $B \to C$ ✓

③ $A \to C$ → Redundant (Extra) FD

$[A]^+ = [AC]$ $[B]^+ = [B]$ $(A)^+ = [ABC]$

$A \to C$ is Extra FD

$\boxed{A \to B,\ B \to C}$ Ans

Example3:

$$[B \to A,\ D \to A,\ AB \to D]$$

$B \to A$, $D \to A$, $AB \to D$.

$\cancel{A}B \to D$: $(A)^+ = [A]$

$(B)^+ = [BA]$; A is extra

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

$(B)^+ = [BDA]$ $(D)^+ = [D]$ $(B)^+ = (B)$

$$\boxed{\begin{array}{l} D \to A \\ B \to D. \end{array}}$$

Example 4: HW

$[A \rightarrow BC,\ CD \rightarrow E,\ E \rightarrow C,\ D \rightarrow AEH,\ ABH \rightarrow BD,\ DH \rightarrow BC]$

Q.

Given the following two statements:

S1: Every table with two single-valued attributes is in 1NF, 2NF, 3NF and BCNF.

S2: $AB \rightarrow C, D \rightarrow E, E \rightarrow C$ is a minimal cover for the set of functional dependencies $AB \rightarrow C,\ D \rightarrow E, AB \rightarrow E, E \rightarrow C$.

Which one of the following is CORRECT?

[MCQ: 2014: 2M]

A) S1 is TRUE and S2 is FALSE.

B) Both S1 and S2 are TRUE.

C) S1 is FALSE and S2 is TRUE.

D) Both S1 and S2 are FALSE.

Q.

The following functional dependencies hold true for the relational schema R{V, W, X, Y, Z}:

$V \to W$

$VW \to X$

$Y \to VX$

$Y \to Z$

Which of the following is irreducible equivalent for this set of functional dependencies? [MCQ:2017]

(A) $V \to W$, $V \to X$, $Y \to V$, $Y \to Z$

(B) $V \to W$, $W \to X$, $Y \to V$, $Y \to Z$

(C) $V \to W$, $V \to X$, $Y \to V$, $Y \to X$, $Y \to Z$

(D) $V \to W$, $W \to X$, $Y \to V$, $Y \to X$, $Y \to Z$

$[V \to W \quad VW \to X \quad Y \to VX, \quad Y \to Z]$

Step1 $V \to W, \quad VW \to X, \quad Y \to V, \quad Y \to X, \quad Y \to Z$

Step2

$VW \to X$

$(W)^+ = [W]$ V is Not Extra

$(V)^+ = [VW\ldots]$ W is extra.

$V\cancel{W} \to X$ So $\boxed{V \to X}$

$\boxed{\begin{array}{l} V \to W \\ V \to X \\ Y \to V \\ Y \to Z \end{array}}$

$V \to W$ ✓ $(V)^+ = [VX]$

$V \to X$ ✓ $(V)^+ = [VW]$

$Y \to V$ ✓ $(Y)^+ = [YXZ]$

$Y \to X$ ✗ $(Y)^+ = [YZVWX]$

$Y \to Z$ ✓ $(Y)^+ = [YVWX]$

Note

Minimal Cover May or May Not be Unique.

ie More than One Minimal Cover is possible.

Q.

Consider the following FD Set: $\{P \rightarrow QR, Q \rightarrow PR, R \rightarrow PQ\}$ which of the following is/are the minimal cover for the above FD set?

[MSQ]

(A) $P \rightarrow Q, Q \rightarrow R, R \rightarrow P$

(B) $P \rightarrow R, Q \rightarrow R, R \rightarrow PQ$

(C) $Q \rightarrow P, P \rightarrow R, R \rightarrow Q$

(D) $P \rightarrow QR, Q \rightarrow P, R \rightarrow P$

Ans (A)
(B)
(C) &
(D)

[Home Work]

THANK YOU!