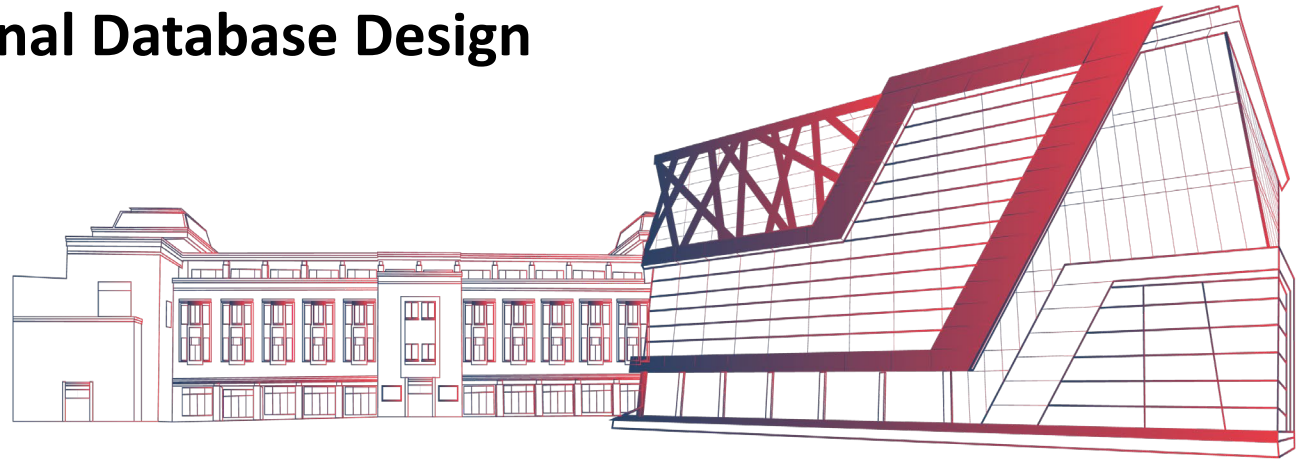


UNIT III

Relational Database Design



Canonical Form

Canonical Form/ Minimal FD Set

A set of FD F is **minimal** if it satisfies the following conditions:

- (1) Every dependency in F has a single attribute for its RHS.
- (2) We cannot remove any dependency from F and have a set of dependencies that is equivalent to F .
- (3) No extraneous attribute



Canonical Form (Cont.)

- Every set of FDs has an equivalent minimal set
- There can be several equivalent minimal sets
- **Example:**

$F = \{A \rightarrow B, B \rightarrow C, A \rightarrow C, AB \rightarrow A, AC \rightarrow B\}$

From transitivity property $A \rightarrow C$
Thus, $A \rightarrow C$ is redundant

Trivial FD,
always implied

$A \rightarrow B$
From augmentation property
 $AC \rightarrow BC$
From split rule
 $AC \rightarrow B, AC \rightarrow C$
Thus, $AC \rightarrow B$ is redundant

$\therefore F_m = \{A \rightarrow B, B \rightarrow C\}$

Extraneous Attribute

- If $XY \rightarrow Z$ and X^+ determines Y or Z in FD set F ,

then “ Y ” is **extraneous** in $XY \rightarrow Z$

- **Example:**

$$F = \{ XY \rightarrow Z, X \rightarrow Y \}$$

Here, Y is extraneous attribute

$$\text{Thus, } F_m = \{ X \rightarrow Z, X \rightarrow Y \}$$

Check if F and F_m are equivalent?



Extraneous Attribute Example

$$F = \{ ABCD \rightarrow E, AB \rightarrow F, F \rightarrow C \}$$

Find extraneous attribute?

$$A^+ = A \quad AB^+ = A, B, F, C$$

$$B^+ = B \quad AD^+ = A, D$$

$$C^+ = C \quad BD^+ = B, D$$

$$D^+ = D \quad ABD^+ = A, B, C, D, E, F \quad \therefore \text{C is extraneous}$$

Extraneous Attribute Drill

Find extraneous attribute in the below FD set

$$F = \{ PQRS \rightarrow T, QR \rightarrow U, U \rightarrow P, R \rightarrow U \}$$



Solution Extraneous Attribute Drill

- $F = \{ PQRS \rightarrow T, QR \rightarrow U, U \rightarrow P, R \rightarrow U \}$

$P^+ = P$

$Q^+ = Q$

$R^+ = R, U, P$

$S^+ = S$

$QR^+ = Q, R, U, P$

$RS^+ = R, S, U, P$

$QS^+ = Q, S$

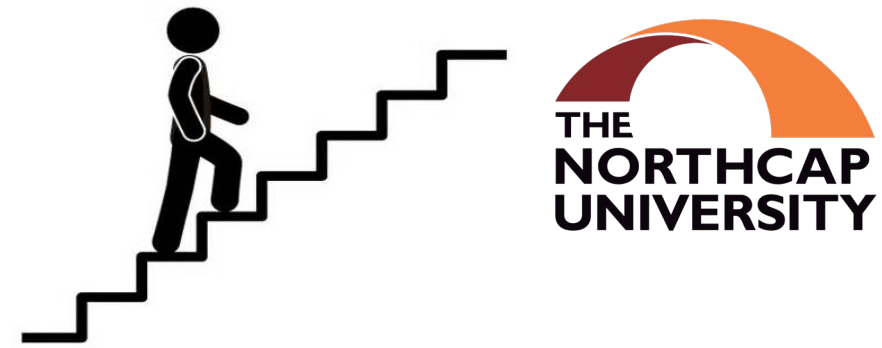
$QR \rightarrow U$

$R \rightarrow U$

$\therefore Q$ is Extraneous

Also, P is Extraneous

Steps for Canonical Cover



- 1) Split FDs such that RHS of every FD has single attribute.
- 2) Discard trivial FDs
- 3) Remove extraneous attributes from LHS of every FD

i.e. if $XY \rightarrow Z$ and X^+ determines Y or Z in FD set F ,

then “ Y ” is extraneous in $XY \rightarrow Z$

- 4) Remove redundant FDs

i.e. $F - \{X \rightarrow Y\} = F$

Canonical Cover Drill

Given FD set $F = \{ a, b, c \rightarrow c, d, e, f ; c \rightarrow e ; a \rightarrow b ; d \rightarrow f \}$

Solution

$a, b, c \rightarrow c$

$a, b, c \rightarrow d$

$a, b, c \rightarrow e$

$a, b, c \rightarrow f$

- Remove $a, b, c \rightarrow c$ (trivial FD)

Now, $F = \{ a, b, c \rightarrow d ; a, b, c \rightarrow e ; a, b, c \rightarrow f ; c \rightarrow e ; a \rightarrow b ; d \rightarrow f \}$

Finding extraneous attributes:

- b is extraneous in $a, b, c \rightarrow d$ and $a, b, c \rightarrow e$ and $a, b, c \rightarrow f$ as $a \rightarrow b$
- a is extraneous in $a, c \rightarrow e$ as $c \rightarrow e$

Thus, $F = \{ a, c \rightarrow d ; c \rightarrow e ; a, c \rightarrow f ; c \rightarrow e ; a \rightarrow b ; d \rightarrow f \}$

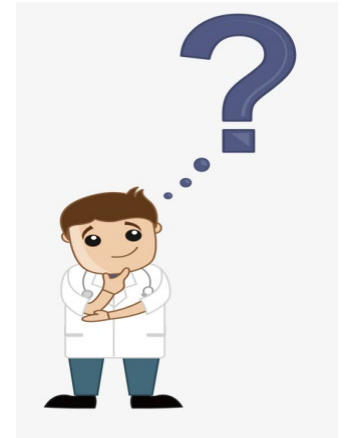
- Remove $a, c \rightarrow f$ (since it is implied by $a, c \rightarrow d$ and $d \rightarrow f$)

$F = \{ a, c \rightarrow d ; c \rightarrow e ; a \rightarrow b ; d \rightarrow f \}$

Canonical Cover Drill

- Consider the following set F of functional dependencies:

- $F = \{ A \rightarrow BC, B \rightarrow C, A \rightarrow B, AB \rightarrow C \}$



- Consider the following set F of functional dependencies: $F = \{$

$AB \rightarrow C, BC \rightarrow D, A \rightarrow BCD, BC \rightarrow BCD \}$

Solution Canonical Cover Drill

1. $F = \{ A \rightarrow BC, B \rightarrow C, A \rightarrow B, AB \rightarrow C \}$

$A \rightarrow B$ is redundant in $A \rightarrow BC$

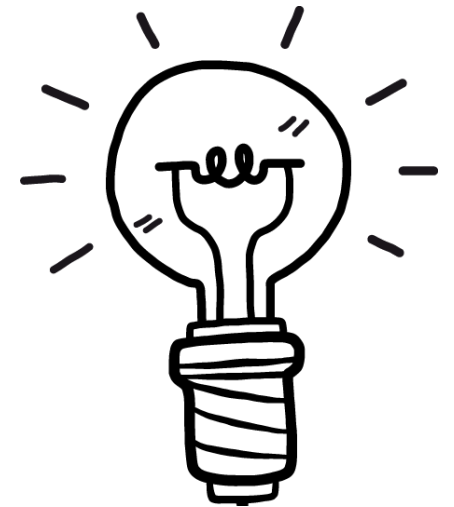
Now, $F = \{ A \rightarrow B, A \rightarrow C, B \rightarrow C, AB \rightarrow C \}$

A is extraneous in $AB \rightarrow C$ as $B \rightarrow C$

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

$A \rightarrow C$ is redundant since because of transitivity property in $A \rightarrow B$ and $B \rightarrow C$, $A \rightarrow C$ is already implied.

Thus, $F_m = \{ A \rightarrow B, B \rightarrow C \}$



Solution Canonical Cover Drill

2. $F = \{ AB \rightarrow C, BC \rightarrow D, A \rightarrow BCD, BC \rightarrow BCD \}$

$BC \rightarrow BC$ is trivial in $BC \rightarrow BCD$

$$F = \{ AB \rightarrow C, BC \rightarrow D, A \rightarrow BCD, BC \rightarrow D \}$$

$BC \rightarrow D$ is redundant

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

B is extraneous in $AB \rightarrow C$ as $A \rightarrow B$

$$F = \{ A \rightarrow C, BC \rightarrow D, A \rightarrow B, A \rightarrow D \}$$

$A \rightarrow D$ is redundant as $A \rightarrow C, A \rightarrow B, BC \rightarrow D$ (property of transitivity)

$$\therefore F_m = \{ A \rightarrow BC, BC \rightarrow D \}$$

Thanks!!