COMPUTER SCIENCE

Database Management System

FD's & Normalization
Normal Forms

Part -1

Lecture_09

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01 Dependency preserving

02 Normal Forms

RDBMS Concept

FD Concept & types

Attribute closure

Key Concept
- Super key
- Candidate key
- Finding Multiple Candidate key.

Membership set

Equality b/w 2 FD set

Minimal Cover

Properties of Decomposition

1. Lossless Join
2. Dependency Preserving

Lossless Join

$(R_1 \cap R_2)^+ \longrightarrow R_1$ ✓

OR

$(R_1 \cap R_2)^+ \longrightarrow R_2$ ✓

Lossless Join

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

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

Any (A).

Which one of the following options is correct?

[MCQ: 2021: 2M]

A. D_1 is a lossless decomposition, but D_2 is a lossy decomposition.

B. D_1 is a lossy decomposition, but D_2 is a lossless decomposition.

C. Both D_1 and D_2 are lossless decomposition.

D. Both D_1 and D_2 are lossy decomposition.

Properties of Decomposition

1. Lossless Join
2. Dependency Preserving

Dependency Preserving : Let R be the Relational Schema with FD Set F

is Decomposed into Sub Relation R_1 R_2 R_3 . . . R_n with FD Set F_1 F_2 F_3 . . . . F_n Respectively.

If $F_1 \cup F_2 \cup F_3 \ldots F_n \equiv F$

Dependency Preserving Decomposition

If $F_1 \cup F_2 \cup F_3 \ldots \cup F_n \subset F$

Dependency Not Preserving

Dependency Preservation

- Let F_i be the set of dependencies F that include only attributes in R_i.
  - A decomposition is dependency preserving,

$$\text{if } (F_1 \cup F_2 \cup \ldots \cup F_n) = F$$

Dependency Preserving.

Procedure to Find Dependency Preserving

① find all Non Trivial FD of each Sub Relation (Take a closure of Attributes & Write all Non Trivial FD for each Sub Relation)

Non Trivial : $X \cap Y = \phi$

② If $F_1 \cup F_2 \cup F_3 \ldots F_n \equiv F$

Dependency Preserved.

R(ABCD) [A→B, C→D]

FD closure [F]$^+$

$(A]^+ = [AB] \Rightarrow 2^2 = 4$ FD

$A \to \phi$
$A \to A$
$A \to B$
$A \to AB$

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

$B \to \phi$, $B \to B$

$(C]^+ = [CD] = 2^2 = 4$ FD

$C \to \phi$, $C \to C$, $C \to D$, $C \to CD$

$(D]^+ = [D] = 2^1 = 2$ FD

$D \to \phi$, $D \to D$

$(F]^+ = 12$ FD

Q) $R(ABCD)$ $[A \to B,\ C \to D]$ is Decomposed into $R_1(AB)$ & $R_2(CD)$ then check D.P or Not ?

$(A)^+ = [AB]$

$(B)^+ = [B]$ ✗

$(C)^+ = [CD]$

$(D)^+ = [D]$ ✗

$R_1(AB)$	$R_2(CD)$
$A \to B$	$C \to D$

$F_1 \cup F_2 \equiv F$

$(A \to B) \cup (C \to D) \equiv F$

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

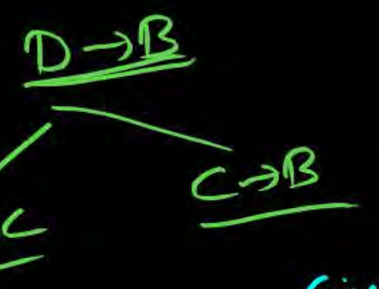
Dependency Preserving

Ans

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 $R_1(AB)$ $R_2(BC)$ $R_3(CD)$ and $R_4(DE)$



Given Question

- A→B
- B→C
- C→D
- D→BE

$(A)^+ = [ABCDE]$

$(B)^+ = [BCDE]$

$(C)^+ = [CDEB]$

$(D)^+ = [DBEC]$

$(E)^+ = [E]$

$R_1(AB)$	$R_2(BC)$	$R_3(CD)$	$R_4(DE)$
$A \rightarrow B$	$B \rightarrow C$	$C \rightarrow D$	$D \rightarrow E$
	$C \rightarrow B$	$D \rightarrow C$	

$[(A \rightarrow B) \cup (B \rightarrow C, C \rightarrow B) \cup (C \rightarrow D) \cup (D \rightarrow E)]$

$[A \rightarrow B \quad B \rightarrow C, \quad C \rightarrow D, \quad D \rightarrow E, \quad C \rightarrow B, \quad D \rightarrow C]$

$D \rightarrow B$

$D \rightarrow BE$

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

2nd Alternate

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

Decomposed into $R_1(AB)$ $R_2(BC)$ $R_3(CD)$ and $R_4(DE)$

$D \rightarrow BE$, $D \rightarrow B$, $D \rightarrow E$

$R_1(AB)$	$R_2(BC)$	$R_3(CD)$	$R_4(DE)$
$A \rightarrow B$	$B \rightarrow C$	$C \rightarrow D$	$D \rightarrow E$

$D \rightarrow B$

$D \rightarrow C$

$C \rightarrow B$

$(C)^+ = (CDBE)$

$(D)^+ = (DBEC)$

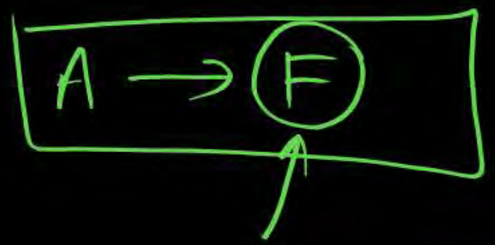
D.P

$D \rightarrow B$ is Indirectly Preserved.

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 $R_1(AB)$ $R_2(BC)$ $R_3(CD)$ and $R_4(DE)$



F: Final Balance

If Not getting F from Directly or Indirectly then Dep. Not Preserving.

Q.

R(ABCDEFG) {AB → C, AC → B, AD → E, B → D, BC → A, E → G}

Decomposed into R_1(ABC) R_2(ACDE) and R_3(ADG)

[Home Work]

Q. 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 $R_2(CD)$ is

[MCQ: 2M]

A. Dependency preserving and lossless join

B. Lossless join but not dependency preserving

C. Dependency preserving but not lossless join

D. Not dependency preserving and not lossless join

$R_1(AB)$	$R_2(CD)$
$A \rightarrow B$	$C \rightarrow D$
D.P	

$R_1(AB) \cap R_2(CD)$

No Common Attribute

Lossy

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]

Ans(A)

$R_1(AB) \cap R_2(BC) = B$

$(B)^+ = [BCD]$ Super key of R_2

$R_{12}(ABC) \cap R_3(BD)$

$(B)^+ = [BCD]$

Super key of R_3

$R_{123}(ABCD)$

Lossless

(A) Gives a lossless join, and is dependency preserving

(B) Gives a lossless join, but is not dependency preserving

(C) Does not give a lossless join, but is dependency preserving

(D) Does not give a lossless join and is not dependency preserving

$R(ABCD)$ $[A \to B,\ B \to C,\ C \to D,\ D \to B]$

II Approach

$R_1(AB)$ $R_2(BC)$ $R_3(BD)$

Via

Dependency Preserved

$R_1(AB)$	$R_2(BC)$	$R_3(BD)$
$A \to B$	$B \to C$	$D \to B$

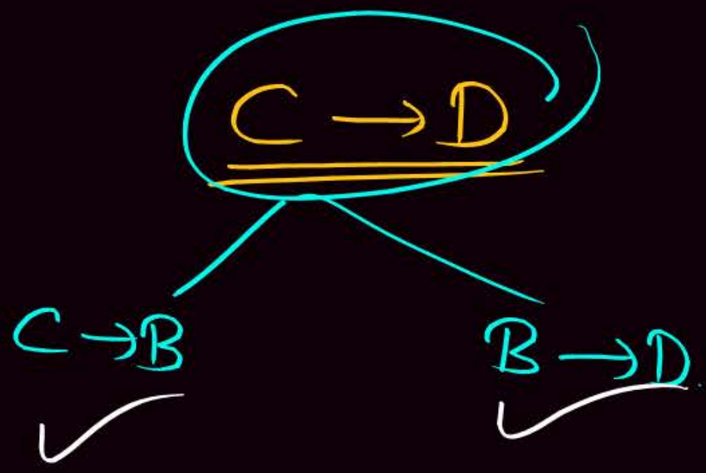
$C \to D$ is Indirectly Preserved $(R_2)[C \to B]$ &

$B \to D$ in (R_3)

$(C)^+ = [CDB]$

$(B)^+ = [BCD]$

Dependency Preserved



$R(ABCD)$ $[A \to B,\ B \to C,\ C \to D,\ D \to B]$

$R_1(AB)$ $R_2(BC)$ $R_3(BD)$

$(A)^+ = [ABCD]$
$(B)^+ = [BCD]$
$(C)^+ = [CDB]$
$(D)^+ = [DBC]$

$R_1(AB)$	$R_2(BC)$	$R_3(BD)$
$A \to B$	$B \to C$	$B \to D$
	$C \to B$	$D \to B$

$A \to B,\ B \to C,\ C \to B,\ B \to D,\ D \to B$

$C \to D$

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]

$R_1(AB)$ | $R_2(BC)$ | $R_3(BD)$

A. Gives a lossless join, and is dependency preserving

B. Gives a lossless join, but is not dependency preserving

C. Does not give a lossless join, but is dependency preserving

D. Does not give a lossless join and is not dependency preserving

1. RDBMS Concept
2. FD Concept & its type
3. Attribute closure $[x]^+$
4. Keys Concept
   - Super key
   - Candidate key
5. finding Multiple C.k
6. Membership set
7. Equality b/w 2 FD
8. Minimal Cover
9. Closure of FD Set $[F]^+$
10. finding Number of Super key
11. Properties of Decomposition
    - (i) lossless Join
    - (ii) Dependency Preserving

$R(ABCDEF)$ $[AB \to C,\ C \to D,\ D \to E,\ E \to F)$

Note: Which Attribute Not Present in R.H.S (OR) Not Given in Any FD Set (Right Hand Side) that Must be in a C.K

$(AB)^+ = [ABCDEF]$

$(A)^+ = [A]$

$(B)^+ = [B]$

AB is C.K.

Super keys ?

AB

ABC

ABCDEF

$2^{n-2} \Rightarrow 2^{6-2} = 2^4$

= 16 Super keys

Normal Forms

Normal Form is a Set of Rules which are Used to Reduce/eliminate the Redundancy.

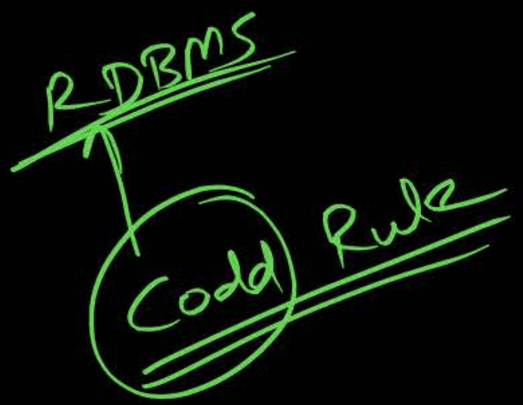
Redundancy is the Unnecessary Repeation of DATA.

Normalization is a Process to Reduce the Redundancy.

Why Need of Normalization ?

(i) Insertion Anomalies
(ii) Deletion Anomalies
(iii) Update Anomalies

Normal Forms



There are various Normal Forms.

1. 1NF (First Normal Form)
2. 2NF (second Normal Form)
3. 3NF (Third Normal Form)
4. BCNF (Boyce Codd Normal Form)
5. 4NF
6. 5NF

Note

Every Higher Normal Form Contain the Lower Normal Form ⟵ (Satisfied)

If Relation R is in 2NF, that means its already in 1NF.

If Relation R is in 3NF, ie its already is in 2NF & 1NF also

If Relation R is in BCNF, that means R is in 3NF, 2NF & 1NF also.

FIRST NORMAL FORM (1NF)

A Relation R is in 1NF, if R does not Contain Any Multivalued Attribute.

(OR)

A Relation R is in 1NF iff all attribute of R are atomic

Note Default RDBMS is in 1NF.

Note RDBMS Not Contain Any Multi Valued Attribute.

But In 1NF Redundancy Level is Too High.

Redundancy Level: 1NF > 2NF > 3NF > BCNF

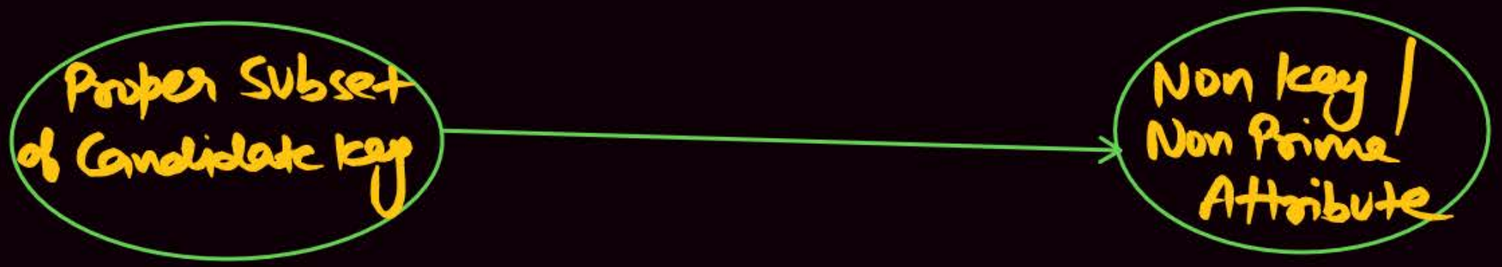
2NF

3NF

BCNF

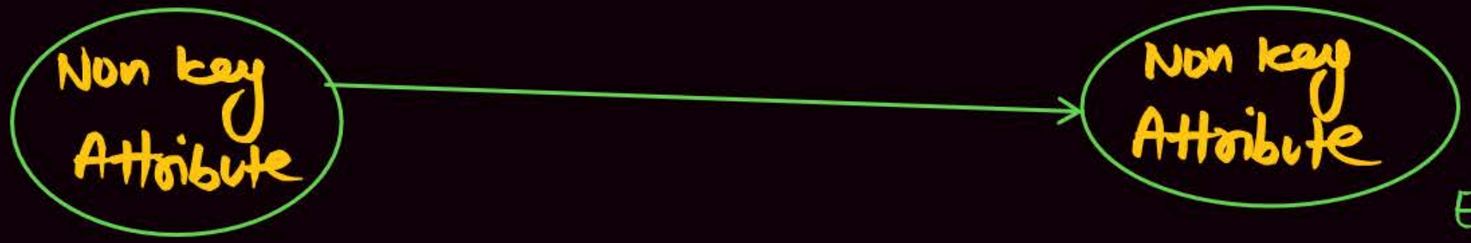
Possible Non Trivial FD's which Cause Redundancy :

CASE I



Violation of 2NF
OR
Eliminated by 2NF

CASE II



Violation of 3NF
OR
Eliminated by 3NF

CASE III

Violation of BCNF
OR
Eliminated by BCNF.

Any Doubt ?

THANK YOU!