Third Normal Form 3NF

Jain

A Relation, R is in 3NF if it satisfies 2NF and no non-prime attribute of R is transitively dependent on key of 'R'

For 3NF : Relation must be in 2NF and no transitive Dependency

Or

A Relation is in 3NF if FD : $X \to Y$ satisfy any one of the following condition.

(i) $X \to Y$ is a trivial FD i.e $Y \subseteq X$, $AB \to A$

(ii) If $X \to Y$ then X is a superkey, $AD \to E$

(iii) If $X \to Y$ then $(Y - X)$ is a prime attribute

↳ Attribute ~~Are~~ Present in Y but not in X

$\underline{AD}$ is a Key

$C \to D$

$[D] - [C] = [D]$ 3rd condition satisfy

∴ it is in 3NF

Solved Examples

Q1 R(A B C)

$F: \{A \to B, B \to C\}$

find in which Normal form

1 find the candidate key

$(A)^+ : \{ABC\}$

CK : A   it is minimum as well

$\underbrace{A}_{\text{Superkey}} \to B$ 1st condition not True
2nd Condition True

∴ it is in 3NF

$\underbrace{B}_{\text{Not key}} \to C$ 1st False
2nd False

$[Y] - [X] = [B] - [C] = \underbrace{B}_{\text{Non Prime}}$

∴ it is not in 3NF

Q2 R(A B C D E)

$F: \{AB \to C, B \to D, D \to E\}$ (1)

Decompose it into 3NF

1 find candidate key

$(AB)^+ : \{A B C D E\}$

$\underbrace{AB}_{\text{Candidate key}} \to C$ ∴ it is 3NF

$B \to D$ ✗

$D \to E$ ✗

Put all the attributes of FD's in one relation which are in 3NF & those who doesn't satisfy put them in another relation

$R_1(ABC)$ $R_2(BD)$ $R_3(DE)$

Q3 R(A B C)   which NF

$\{AB \to C, C \to A\}$

$(AB)^+ = \{ABC\}$

$(BC)^+ = \{BCA\}$

$\underbrace{AB}_{\text{Key}} \to C$ ∴ 3NF

$BC \to \underbrace{A}_{\text{Prime}}$ ∴ 3NF

Steps to Decompose in 3NF

(1) Eliminate Redundancy FD and make canonical cover of F ie F_c

(2) Create a Relation $R_i = xy$ for each $X \to Y$

(3) If the key, K of R doesnot occur in any relation of R_i, create one more relation $R_i = K$.

3NF

$R(ABCDE)$

$AB \to C$, $B \to D$

$D \to E$

$(AB)^+ = (ABCDE)$ CK

$AB \to C$ 3NF

$B \to D$

Not key

Non Prime

$\therefore$ Not in 3NF

$D \to E$

Not key

Non Prime

$\therefore$ Not in 3NF

$R_1(ABC)$, $R_2(BD)$, $R_3(DE)$

$R_1(BD)$, $R_2(ABCE)$

$AB \to C$

$B \to D$

$D \to E$

$R_1(ABC)$ $R_2(BD)$ $R_3(DE)$

Qs on 2nF

1.

$AB \to C$

$BC \to D$

$(AB)^+ = \{ABCD\}$

$(BC)^+ = \{BCD\}$

$BC \to D$ is partial dependency

$R_2(BCD)$ $R_1(ABC)$

$BC \to D$ ✓ $AB \to C$ ✓

2.

$R(ABCDEFGHIJ)$

$AB \to C$, $BD \to EF$, $AD \to GH$, $A \to I$, $H \to J$

$(ABD)^+ = (ABCDEFGHIJ)$

$AB \to C$ ✗ Not in 2NF ∵ of Partial Depen.

$R_7(HJ)$ $R_1(ABC)$ $R(ABDEFGHIJ)$ $R_3(ABDGHIJ)$

$R_2(BDEF)$ ✓

$R_3(ADGH)$ ✓ $R_4(ABDIJ)$

$R_5(AI)$ ✓ $\boxed{R_6(ABDJ)}$ extra

$R_7(HJ)$ ✓

Boyce-

Extension of 3

Relation in

holds ∴

Ever

Scanned by CamScanner

Boyce - Codd Normal form (BCNF) ②

Extension of 3NF on Strict terms

A Relation is in BCNF if atleast one of the condition holds :-

(i) $X \rightarrow Y$ is a trivial FD

(ii) $X \rightarrow Y$ then X is a superkey

Every BCNF is a 3NF but vice versa is not true

$R(ABC)$ R is in 3NF

$f: \{AB \rightarrow C, C \rightarrow A\}$

$(AB)^+ = \{ABC\}$

$(BC)^+ = \{ABC\}$

$\underbrace{AB}_{\text{Superkey}} \rightarrow C$ ∴ it is 3NF & BCNF

$C \rightarrow A$ ∴ it is 3NF but not in BCNF

Q1 $R(ABCDEFGHIJ)$

$\{AB \rightarrow C, A \rightarrow DE, B \rightarrow F,$
$F \rightarrow GH, D \rightarrow IJ\}$

$(AB)^+ = (ABCDEFGHIJ)$

$\underbrace{AB}_{\text{Smarkey}} \rightarrow C$ ∴ it is BCNF

$R_1(ABC)$

$R_2(DEFGHIJ)$

$F \rightarrow GH,$

$R(ABC)$

$AB \rightarrow C$

$C \rightarrow A$

Pid → Cname, Lot#, Area

Cname, Lot# → Area, P_id

Area → Cname

↓

P.id → Area, Lot#
Area → Cname

BCNF

Student, Course → instructor

instructor → Course

Student	instructor

instructor	Course

Decomposition of BCNF Question on BCNF

R(ABCDE)

f: {A → BC, C → DE}

A+ = {ABCDE} Candidate Key

B+ = B

C+ = CDE

D+ = D

E+ = E

Look at 1st FD $\underbrace{A}_{Key}$ → BC ∴ in BCNF

C → DE

C is not Key ∴ It is not in BCNF

This violate BCNF

Now create two Schemas, one with attributes of Violating FD, and other with original attributes minus the RHS of violating FD

(ABCDE) − DE = ABC

R₁(ABC)

A is still key

$\underbrace{R_2 (CDE)}$ Attributes of violating FD

C is key

Q2

R(A B C D)

F : { AB → C , B → D , C → A }

First of all find the closure of all attr.

A+ : A

B+ - BD

C+ - CA

D+ - D

{AB+ - ABCD } CK

{BC - ABCD } CK

Check FDs one by one

$\underbrace{AB}$ → C — It is key ∴ it is in BCNF

$\underbrace{B}$ → D — B is not in CK ∴ it violates BCNF

Create two relation

All attributes − RHS of violat FD

One with violating

R_2(BD) — B is key ∴ it is BCNF

R_1(A B C)

$\underbrace{AB}$ → C — AB is key ∴ ✓

~~B → B~~

$\underbrace{C}$ → A — C is not key

Break it

R_1(ABC) R_2(BD) — 3NF

R_1(B C) R_3(CA) R_2(BD)

— BCNF, NOT FD Preserving