3NF & BCNF

Student

ID	Name	State	Country	Pincode
1	a	AP	IN	5006
2	b	AP	IN	5006
3	c	AP	IN	5006
4	d	TS	IN	5005

Key ID. - Simple 2NF.

pincode → state, country

X → R

{ID}

3rd Normal Form:

Def: A relation R is in 3NF, if

$\forall$ FDs $\alpha \rightarrow \beta$ in F^+, where $\alpha \subseteq R$, $\beta \subseteq R$,

at least one of the following holds:

1). $\alpha \rightarrow \beta$ is trivial ($\beta \subseteq \alpha$)

2). α is a super key for R

3). Each attribute A in $(\beta - \alpha)$ is contained in a candidate key for R.

Ex: $R = (A, B, C, D, E, F)$

$F = \{A \to B,\ B \to D,\ C \to D,\ E \to F\}$

$(ABCDEF)^+ = ABCDEF$

$(ACE)^+ = ABCDEF$ → ACE Super key.

$(A)^+ = ABD$	$(AC)^+ = ACBD$
$(C)^+ = CD$	$(AE)^+ = AEBDF$
$(E)^+ = EF$	$(CE)^+ = CEDF$

Not Super key

∴ ACE - Candidate key. — only one candidate key.

prime attributes = {A, C, E}

Non-prime attributes = {B, D, F}

2NF ✗

$A \to B$ in F.

violating.

3NF : ✗

{B} → {A}

= {B}

violating.

EX: $R = (A, B, C)$

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

$(ABC)^+ = ABC$

$(AB)^+ = ABC$

$(A)^+ = A$ Not super key.

$(B)^+ = B$ Not super key.

$\therefore$ AB is a candidate key.

$pA = \{A, B\}$

$C \to A$

AB — CK

|

CB — CK

$(C)^+ = CA$ Not SK.

Prime Attributes = $\{A, B, C\}$.

$C \to A$ ⟸

$(\beta - \alpha)$

$\{A\} - \{C\} = \{A\}$.

Not violating.

$AB \to C$

AB is a key.

Not violating.

Conclude: 3NF.

Not in BCNF.

Boyce Codd Normal Form

Def: R is in BCNF wrt F, if

for all $\alpha \to \beta$ in F, one of the following holds.

(1). $\alpha \to \beta$ is trivial

(2). α is super key.

BCNF $\Rightarrow$ 3NF

EX: $R = (A, B, C, D, E)$

$F = \{A \to B,\ C \to DE\}$.

Q: BCNF ? 3NF ?

BCNF: $A \to B$

$(A)^+ = AB$ - Not super key.

$\therefore$ R is not in BCNF.

$A \to B$

$B - Z = \{B\} - \{A\}$

$= \{B\}$.

B is non-prime attribute.

$\Rightarrow$ violating (3).

$\therefore$ Not in 3NF.

$(ABCDE)^+ = ABCDE$

$(AC)^+ = ABCDE$

$(A)^+ = AB$ Not Sk.

$(C)^+ = CDE$

AC - candidate key.

prime Att. $\{A, C\}$.