Normal forms:

It is used to identify degree of Redundancy.

Redundancy in DB Rel

Non trivial FD's

$X \rightarrow Y$

{ Single valued dependency }

in syllabus

Non trivial multi valued dependency

$X \rightarrow\rightarrow Y$

not in syllabus.

defined over single valued dependency

I NF

II NF

III NF

$\boxed{\text{BCNF}}$

→ important for gate

→ Completely eliminates the redundancy through single valued dependency.

But Redundancy may exist over multivalued Redundancy

not in Gate.

over multi valued dependency

$\boxed{\text{4 NF}}$

0% redundancy over SV FD and MV FD

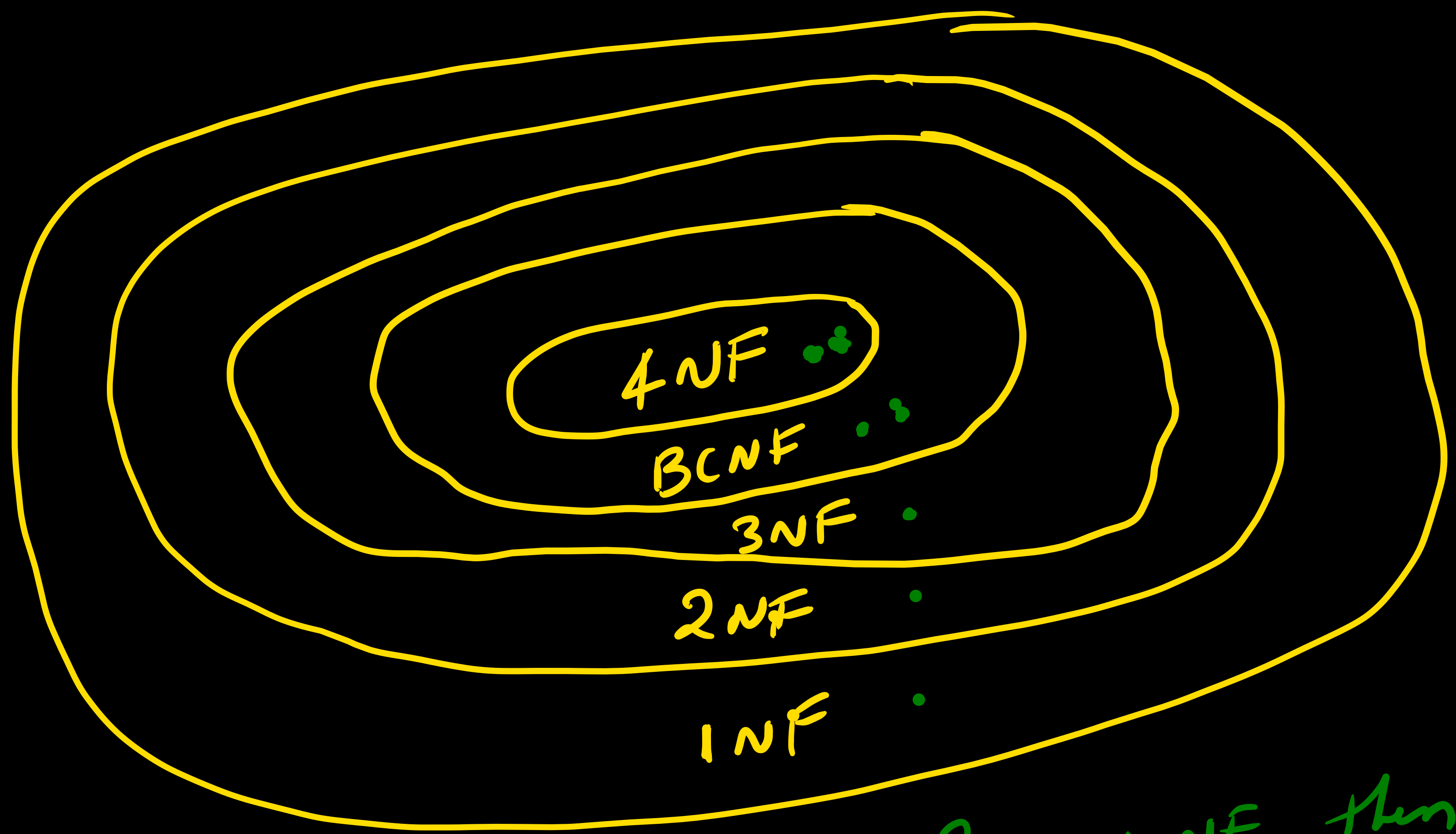
not in ~~the~~ Gate.

I

II

III

BCNF



R → BCNF

Definitely – 3NF, 2NF, 1NF

may or may not be 4NF.

If a relation is in 4NF, then it is in BCNF, 3NF, 2NF, 1NF

1NF: Relation R is in 1NF, iff no multivalued attributes are in 'R'.

Every attribute of R must be atomic / single valued

→ Default NF of RDBMS is 1NF.

Ex:

Sid	Sname	Cid
S_1	A	C_1/C_2
S_2	B	C_2/C_3
S_3	B	C_3

Cid → MVA ✓

⇒ Not in 1NF $\xrightarrow{\text{convert}}$ to 1NF

Sid	Sname	Cid
S_1	A	C_1
S_1	A	C_2
S_2	B	C_2
S_2	B	C_3
S_3	B	C_3

→ Redundancy

Ex:
Gate

Sid	Sname	cid	phone	email
S_1	A	$\underbrace{c_1/c_2}_{2}$	$\underbrace{p_1/p_2/p_3}_{3}$	$\underbrace{e_1/e_2/e_3/e_4}_{4}$
S_2	B	c_2/c_3	p_4/p_5	e_4/e_5
		2 ×	2 ×	2

S_1	A
S_1	A
⋮	
24 time	
S_2	B
⋮	8 times

→ Redundant

fd:
Sid → Sname

~~Ck~~ CK: Sid cid Pho Email

$2 \times 3 \times 4 = 24$ rows.

$2 \times 2 \times 2 = 8$ times.

The LHS of FD is not SK, so we get Redundancy.

CK: Sid Cid Pho email

FD: Sid → Sname → Partial depency.

↓

not SK → Redundancy.

1NF

default NF of DBMS

2NF 3NF BCNF 4NF

used to eliminate / reduce redundancy

when will we get redundancy:

$X \rightarrow Y$ is a FD of R, then it gives redundancy

iff 1) Non trivial FD ✓

and

2) X is not SK of R.

$X \rightarrow Y$ → Red.

$A \rightarrow B$.

$AB \rightarrow A$.

$B \rightarrow B$.

not SK of R.

$X \to Y$ Fd of R ~~dra~~ does not form redundancy

iff

① Trivial FD ($X \supseteq Y$)

&

② X : is superkey of R.

→ when LHS is not a SK

R (Sid, Sname, Cid)

Sid	Sname	Cid
S_1	A	C_1
S_1	A	C_2
S_1	A	C_3
S_2	B	C_2
S_2	B	C_3

Redundancy

Redn.

{ Sid → Sname }

CK: Sid, Cid

Sid → Sname

Sid	Sname
S_1	A

Sid	Cid

Part of CK is determining non prime attribute.

→ It is called partial dependency.

Ex: R(eid, ename, DOB, rating, Salary)

rating	Salary
8	50K
8	50K
8	50K
10	70K
8	50K.

→ redundancy.

decompose the table.

FD: Eid → Ename DOB Rating

✓ rating → Sal ✓ → Redundancy

CK: Eid.

Superkey - superset of CK.

CK → is also SK ✓

SK may not always be CK. ✓

Ex:

R

Sid	Sname	DOB
S_1		
S_2		
S_3		
S_4		

$Sid \rightarrow Sname\ DOB$

CK : Sid.

LHS is SK. ∴ no redundancy.

Causes of Redundancy:

*****

* R(A B C D E F)

*

{ AB → C

SK.

B → D ✓

D → E ✓ → Redundancy

AE → F ✓

C → A ✓

}

CK: { AB, CB }

C → A.

CK: AB, BC

Prime = {A BC} non prime = {D E F}

B → D.

B ↓ Proper Subset of CK also called partial key

D ↓ non prime.

Partial key → non prime attribute

redundancy.

CK: AB, BC

D $\longrightarrow$ E

D $\rightarrow$ non prime

E $\rightarrow$ non prime.

$\therefore$ non prime $\rightarrow$ non prime.

$\rightarrow$ Redundancy.

CK: AB, BC

$AE \rightarrow F$

A: Prime (proper subset of CK)

E: non prime

F: non prime

Prime + non prime $\rightarrow$ non prime

Prime: Proper subset of CK

$\Downarrow$

Redundancy

C ⟶ A

Proper subset of CK

Proper subset of CK ⟹ redundancy.

∴ All the four possibilities following redundancy.

∴ 4 Cases for redundancy.

5 min break.

30th: → midterm exam — Python

Friday:

7 - 9 → RBR

9 - 10 → math/aptitude ⟶ weekends ↓ math aptitude.

2NF, 3NF, BCNF reduce redundancy one set at a time.

2NF: R is in 2NF iff no partial dependencies in R.

CK: AB   P: {A, B}

NP: {C, D}

× partial.

$A \rightarrow B$ $A \rightarrow C$

Prime

X is CK. $Y \subset X$. Z is non prime.

$\cancel{X}$ $Y \rightarrow Z$ is called partial dependency.

Part of a key

or

partial key → non prime attribute

↓

Partial dependency.

⇓ not allowed

in 2 NF.

3NF: Relational scheme R is in 3NF iff every non trivial FD $X \rightarrow Y$ is in R with

a) X must be SK

or

b) Y must be prime attribute.

$X \rightarrow Y$

$X \rightarrow$ SK or $Y \rightarrow$ prime

Ex: CK $\{AB\}, \{CD\}$

$P = \{A, B, C, D\}$

$AB \rightarrow E$.

SK

$D \rightarrow B$

prime

Prime → Prime ✓

allowed in BCNF
because RHS is prime.

2NF ✓, 3NF ✓

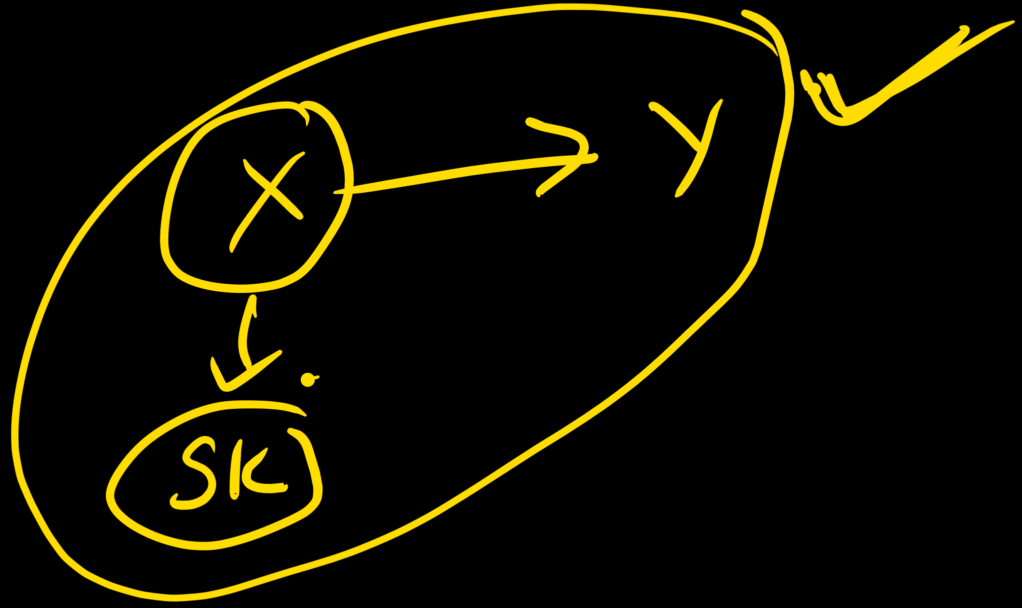
not free from ✓
Redundancy. ✓

BCNF (Boyce Codd NF)

It does not allow any kind of redundancy.

R is in BCNF iff every non trivial FD

$X \to Y$ in R has X as SK.



2NF: No partial dependancy.

part of a key → non prime.

3NF: $X \rightarrow Y$

SK or PA.

BCNF — $X \rightarrow Y$

SK.

In all the problems related to normalization,

we we have to compute CKs.

R (A B C D E)   CK {ABD, ABC}

{ABD → C, BC → D, CD → E}

What is the Highest NF of R:

BCFN. ✓

3NF. ✓

2NF

Test for BCNF: ✓

ABD → C ✓

SK

BC → D

SK

X → fails

CD → E

X fails.

∴ not in BCNF.

Test for 3NF: CK: ABD, ABC

$\underbrace{ABD}_{\checkmark \text{ SK}} \rightarrow \underbrace{C}_{\checkmark}$

$\underbrace{BC}_{\times \text{ SK}} \xrightarrow{\checkmark} \underbrace{D}_{\checkmark \text{ prime}}$

$\underbrace{CD}_{\times \text{ SK}} \rightarrow \underbrace{E}_{\times \text{ prime}}$.

$\therefore$ Not in 3NF.

~~Test~~

Test for 2NF:

$$\left(\begin{matrix}\text{Proper subset of} \\ \text{Candidate key}\end{matrix}\right)^+ \rightarrow \left(\begin{matrix}\text{only} \\ \text{prime}\end{matrix}\right)$$

CK: ABD, ABC

ABD:
$A^+ = A$
$B^+ = B$
$D^+ = D$
$AB^+ = AB$
$BD^+ = BD$
$AD^+ = AD$

ABC:
$A^+ = A$
$B^+ = B$
$C^+ = C$
$AB^+ = AB$
$BC^+ = BCDE$
AC^+

E → non prime

I ✓

$\Rightarrow$ ✗ II nd normal form.

BC → E → non prime

BC ↓ no partial key

② ABCD

CK : AB

Prime = {A, B}

non prime = {C, D}

SK ← AB → C

BC → D

x SK, non prime

BCNF ✓ ×

3NF ✓ × → fails

2NF

AB

$A^+ = A$ ∴ no partial dependencies.

$B^+ = B$

AB CK.

$A \to A$

$B \to B$

∴ Table is in 2NF

If a FD passes BCNF, then it passes 3NF, ~~also~~ 2NF also.

③ $R(ABCD)$ $CK = \{AB, BC\}$ $A, B, C \rightarrow$ prime

$D \rightarrow$ non prime.

$\{AB \rightarrow C,\ C \rightarrow A,\ AC \rightarrow D\}$

$\underline{\text{I NF}}$ ✓

Test for BCNF: $\underset{\text{SK}}{AB} \rightarrow C$, $C \rightarrow A$, $AC \rightarrow D$ $\rightarrow$ not BCNF.

✓ ✗

Test for 3NF: $AB \rightarrow C$, $C \rightarrow A$, $AC \rightarrow D$ $\rightarrow$ non prime

SK ✓ ✗ ✓ prime Sk ✗ ✗

Test 2NF: AB: $A^+ = A$

$B^+ = B$

BC: B^+

$C^+ = ACD$ non prime

$C \rightarrow D$

non prime.

✗ 2NF

4) R(ABCDEF)

$\{AB \to C,\ C \to DE,\ E \to F,\ F \to B\}$

$\therefore$ highest is INF.

CKs: {AB, AF, AE, AC}

Prime: {A, B, C, D, E, F}

BCNF

AB → C, C → DE, E → F, F → B.

✓ ✗ ✗ ✗

III NF: ✓ C → D C → E → ∴ ✗ III NF.

✗ C → D ✓ → ✗ II NF → ✗ II NF.

Partial depency.

II :