

3NF Decomposition Alg:

Input: R with all attributes; all FDs

① Compute keys of R using closure property of FDs
 $R' = R$

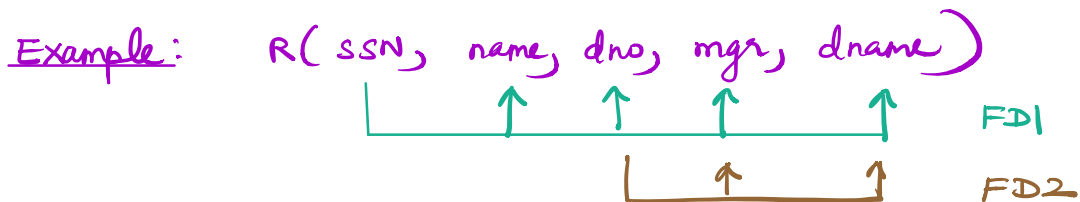
② Repeat until all relations in 3NF

Ⓐ Pick any R' with FD: $\bar{A} \rightarrow \bar{B}$ that violates 3NF.

Ⓑ Divide R' into

$R_1' : (\bar{A}, \bar{B})$ (Note: $\bar{A} \in R_1' \cap R_2'$)

$R_2' : (R' - \bar{B})$



$R : (\underline{\text{SSN}}, \text{name}, \text{dno}, \text{mgr}, \text{dname})$

$R_1' : (\text{dno}, \text{mgr}, \text{dname})$

$R_2' : (\text{SSN}, \text{name}, \text{dno})$

R_1' is in 3NF

R_2' is in 3NF

$R = R_1' \bowtie R_2'$

Example: $R(\text{dno}, \text{dname}, \text{school}, \text{building})$

FD1: $\text{dno} \rightarrow \text{dname}, \text{school}, \text{building}$

FD2: $\text{dname} \rightarrow \text{dno}, \text{school}, \text{building}$

FD3: $\text{building} \rightarrow \text{school}$

Keys (dno) (dname)

R is not in 3NF: FD3 $\text{building} \rightarrow \text{school}$
 \downarrow not key \downarrow non prime

$R_1: (\text{building}, \text{school})$

$R_2: (\text{dno}, \text{dname}, \text{building})$ key (dno) (dname)

$R_1 \bowtie R_2$ in 3NF

$R = R_1 \bowtie R_2$

Example: $R(\text{dno}, \text{school}, \text{dname}, \text{building})$

FD1: $\text{dno}, \text{school} \rightarrow \text{dname}, \text{building}$

FD2: $\text{school} \rightarrow \text{building}$

Is R in 3NF?

Key (dno, school)

FD2: $\text{school} \rightarrow \text{building}$

\downarrow
not key

\downarrow
not prime

R not in 3NF.

$R_1: (\text{school}, \text{building})$

$R_2: (\text{dno}, \text{school}, \text{dname})$

R_1 in 3NF

R_2 in 3NF

$R = R_1 \bowtie R_2$

Example: $R(dno, dname, school, building)$
 FD1: $dno, school \rightarrow dname, building$
 FD2: $building \rightarrow school$

Is R in 3NF?

Key: $(dno, school)$ $(dno, building)$

$a \rightarrow b ; b \rightarrow c \Rightarrow a \rightarrow c$

$building \rightarrow school$ $dno, school \rightarrow \sim$
 $dno, building \rightarrow \sim$

FD2: $building \rightarrow school$

↓
not key

↓
prime attribute

$\therefore R$ is in 3NF.

R:

dno	dname	school	building
1	CS	CEPS	← Kingsbury
2	Earth	CEPS	← Morse
3	math	CEPS	← Kingsbury
1	Nutrition	COLSA	← Thompson
2	Earth	COLSA	← Thompson

* There is Redundancy; insert, delete, update anomalies.

BCNF: R is in 3NF, but not in BCNF.

$R_1: (\underline{\text{building}}, \text{school})$

$R_2: (\underline{\text{dno}}, \underline{\text{building}}, \text{dname})$

BCNF: FD: $\overline{A} \longrightarrow \overline{B}$ in R

then \overline{A} must be key/superkey of R .

R_1 :

building	school
Kingsbury	CERS
Morse	CERS
Thompson	COLSA

R_2 :

dno	building	dname
1	Kings	CS
2	Morse	Earth
3	Kings	Math
1	Thompson	Nutr
2	Thompson	Earth

$R_1: (\underline{\text{building}}, \text{school})$

$R_2: (\underline{\text{dno}}, \underline{\text{building}}, \text{dname})$

R_1, R_2 are in BCNF

$R = R_1 \bowtie R_2$

FD2: $\text{building} \longrightarrow \text{school}$

FD1: $\text{dno}, \text{school} \longrightarrow \text{dname}, \text{building}$

FD1 is lost in $R_1 \bowtie R_2$

* Database designers may leave tables in 3NF since you may lose some FDs when you reduce to BCNF.

What if $R(dno, dname, school, building)$ is
 divided into $R_1' : (\underline{building}, school)$
 $R_2' : (\underline{dno}, \underline{school}, dname)$
 $R'' = R_1' \bowtie R_2' \neq R$

dno	dname	school	building
1	CS	CEPS	Kingsbury
1	CS	CEPS	Morse
2	Earth	CEPS	Kings
2	Earth	CEPS	Morse