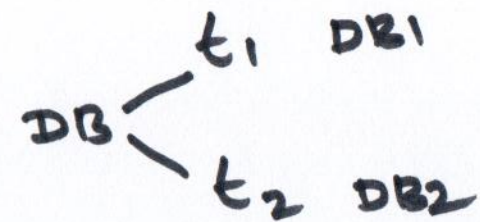


## MVD & 4NF

classes (course, teacher, book)

$(c, t, b) \in \text{classes}$

course	teacher	book
DB	$t_1$	DB1
DB	$t_1$	DB2
DB	$t_2$	DB1
DB	$t_2$	DB2



key = course, teacher, book

in a BCNF.

Redundancy.

## multivalued dependency (MVD)

$\alpha, \beta \subseteq R$ ,  $\alpha \twoheadrightarrow \beta$  holds on  $R$ , if

for all  $t_1, t_2 \in r \ni t_1[\alpha] = t_2[\alpha]$

$\exists t_3, t_4 \in r$  such that

$$t_1[\alpha] = t_2[\alpha] = t_3[\alpha] = t_4[\alpha]$$

$$t_3[\beta] = t_1[\beta] \quad t_1[\beta]$$

$$t_3[R-\beta] = t_2[R-\beta]$$

$$t_4[\beta] = t_2[\beta] \quad t_2[\beta]$$

$$t_4[R-\beta] = t_1[R-\beta]$$

	$\alpha$	$\beta$	$R-\alpha-\beta$
$t_1$	$a_1, a_2$	$a_3, a_4$	$a_5, a_6$
$t_2$	$a_1, a_2$	$b_3, b_4$	$b_5, b_6$
$t_3$	$a_1, a_2$	$a_3, a_4$	$b_5, b_6$
$t_4$	$a_1, a_2$	$b_3, b_4$	$a_5, a_6$



## 4NF

$R$  - relation

$D$  - Functional & MV dependencies.

$\forall \alpha \twoheadrightarrow \beta, \alpha, \beta \subseteq R,$

at least one of the following holds.

- \*  $\alpha \twoheadrightarrow \beta$  is trivial ( $\beta \subseteq \alpha$  or  $\alpha \cup \beta = R$ )

- \*  $\alpha$  is a Super key for  $R$

$$R = (A, B, C, G, H, I)$$

$$D = \left\{ \begin{array}{l} A \twoheadrightarrow B \\ B \twoheadrightarrow HI \\ CG \twoheadrightarrow H \end{array} \right\}$$

Trivial

$$\alpha \twoheadrightarrow \beta$$

$$\beta \subseteq \alpha \text{ (or) } \alpha \cup \beta = R$$

$A \twoheadrightarrow B$  : 4NF, A not a key.

Decomposition:  $R_1 = (A, B)$

$$R_2 = R - \{B\} = \{A, C, G, H, I\}$$

$R_1 = (A, B)$ ,  $D_1$  find from  $D^+$  on  $R_1$ .

$A \twoheadrightarrow B$  Trivial, so, in 4NF

Restriction of MVD:

$$\alpha \twoheadrightarrow (\beta \cap R_i)$$

where  $\alpha \subseteq R_i$  and  $\alpha \twoheadrightarrow \beta$  in  $D^+$ .

$$R_2 = \{A, C, G, H, I\}$$

$$D_2 = \{CG \twoheadrightarrow H, \dots\}$$

Not trivial

not in 4NF.

Decompose  $R_2$ .

$$R_3 = (C, G, H), D_3 = \{CG \twoheadrightarrow H\}$$

Trivial, 4NF

$$R_4 = (A, C, G, I), D_4 = \{$$

$$A \twoheadrightarrow HI \text{ in } D^+$$

$$A \twoheadrightarrow I \text{ in } D_4$$

so, not in 4NF

Decompose:

$$R_5 = (A, I) , D_5 = \{A \twoheadrightarrow I\} \text{ Trivial, 4NF}$$

$$R_6 = (A, C, G) , D_6 = \{ \} \text{ 4NF.}$$