

①

$$R$$

a	b
9	10
3	5
7	2

$$S$$

a	b
4	5
7	2

$$T$$

a	b	c
9	4	1
2	4	8
7	2	0

a) $M_1 \leftarrow \pi_b(T)$

$$\pi_b(T) =$$

b
4
2

e) $M_5 \leftarrow S \bowtie_{S.a = T.b \wedge S.a > C} T$

S.a	S.b	C	T.a	T.b
4	5	1	9	4

b) $R - S$

$M_2 \leftarrow R - S$

a	b
9	10
3	5

f) $\sigma_b \leftarrow S \times T$

S.a	S.b	T.a	T.b	C
4	5	9	4	1
4	5	2	4	8
7	2	9	4	1
7	2	2	4	8
7	2	7	2	0

c) $M_3 \leftarrow R \bowtie S$

a	b
7	2

d) $M_4 \leftarrow S \bowtie T$

a	b	c
7	2	0

②

$$a) R \leftarrow \pi_{\text{buyerID}} \left[\sigma_{(\text{Price} > 200)} (\text{Product}) \bowtie (\text{Purchase}) \right]$$

$$b) R \leftarrow \left[\sigma_{(\text{Country} = \text{USA})} (\text{Company}) \bowtie (\text{Product}) \right] \bowtie_{(\text{MakerCID} = \text{CID})}$$

$$\vee \cdot \pi_{\text{pid}} \left[\sigma_{(\text{name} = \text{Tom Smith})} (\text{Person}) \bowtie_{\text{buyerID} = \text{ID}} (\text{Purchase}) \right]$$

③

$$U \subseteq \{a, b, c, d\}$$

$$F = \{ab \rightarrow c, c \rightarrow d, d \rightarrow a\}$$

$$R(a, b, c, d)$$

$$a) \{a\}^+ = \{a\}$$

$$\{b\}^+ = \{b\}$$

$$\{c\}^+ = \{c\}$$

$$\{d\}^+ = \{d\}$$

$$\{a, b\}^+ = \{a, b, c\}$$

$$\{a, c\}^+ = \{a, c, d\}$$

$$\{a, d\}^+ = \{a, d\}$$

$$\{b, c\}^+ = \{b, c, d, a\}$$

$$\{b, d\}^+ = \{b, d, a, c\}$$

$$\{c, d\}^+ = \{c, d, a\}$$

$$\{a, b, c\}^+ = \{a, b, c, d\}$$

$$\{b, c, d\}^+ = \{b, c, d, a\}$$

$$\{a, c, d\}^+ = \{a, c, d\}$$

$$\{a, b, d\}^+ = \{a, b, d, c\}$$

$$\{a, b, c, d\}^+ = \{a, b, c, d\}$$

⊆

(b) keys of $R = \{a, b\} \{b, c\} \{b, d\}$

(c) Super keys of R that are not keys =

$\{a, b, c\} \{b, c, d\} \{a, b, d\} \{a, b, c, d\}$

(d) Non vital dependencies.

$ab \rightarrow c, ab \rightarrow d, bc \rightarrow d, bc \rightarrow a, cd \rightarrow a, ac \rightarrow d,$
 $bd \rightarrow a, bd \rightarrow c, abc \rightarrow d, bcd \rightarrow a, dab \rightarrow c.$

=