

1(a) With S as Student
B₁, B₂ as Buys

$$\pi_{s.sid, b_1.bookno} \left[\sigma_{\substack{s.sid = b_1.sid \\ \text{and } s.sid = b_2.sid \\ \text{and } b_1.bookno \neq b_2.bookno \\ \text{and } s.sname = 'Eric' \\ \text{and } b_1.bookno \neq '2010'}} \right] (S \times B_1 \times B_2))$$

optimized

$$E = \pi_{sid} (\sigma_{sname = 'Eric'} (S))$$

$$EB = \pi_{sid, bookno} (Buys \times E)$$

$$R = \pi_{eb_1.sid, eb_2.bookno} \left[\sigma_{\substack{eb_1.bookno \\ \neq eb_2.bookno}} \right] (EB_1 \times EB_2)$$

$$\pi_{sid, bookno} (\sigma_{bookno \neq '2010'} (R))$$

1(b)

With t as Buys
 b_1, b_2 as Book
 s as student

$$E_1 = \pi_{b_2.\text{bookno}, s.\text{sid}} \left[\sigma_{\substack{b_1.\text{price} > 50 \\ \text{and } s.\text{sid} = t.\text{sid} \\ t.\text{bookno} = b_1.\text{bookno} \\ b_1.\text{price} = b_2.\text{price}}} (t \times b_1 \times b_2 \times s) \right]$$

$$\pi_{\text{bookno}, \text{title}} [(B \times S) \times E_1]$$

optimized

$$\pi_{\text{bookno}, \text{title}} \left[\sigma_{\text{price} > 50} (B \times \text{Buys}) \right]$$

1(c)

With b_1, b_2 as Book

$$E_1 = \pi_{b_2.bookno} \left[\sigma_{b_1.price > 50} \text{ and } b_2.bookno = b_1.bookno \right] (B_1 \times B_2)$$

$$\pi_{bookno} (B \bowtie E_1) \cup \pi_{bookno} (cites)$$

optimized

$$\pi_{bookno} \left[\sigma_{price > 50} (B) \right] \cup \pi_{bookno} (cites)$$

1(d) With b_1, b_2 as Book

$$E_1 = \pi_{b_2.\text{bookno}, b_2.\text{price}} \left[\sigma_{b_1.\text{price} > b_2.\text{price}} (B_1 \times B_2) \right]$$

$$\pi_{\text{bookno}} \left[\sigma_{\text{price} \geq 80} (B) \right] - \pi_{\text{bookno}} \left[B \times E_1 \right]$$

1(e)

With t as Buys
B as Book
S as student

$$E_0 = \pi_{b, \text{bookno}, s, \text{sid}} \left[\sigma_{s.\text{sid} = t.\text{sid} \text{ and } s.\text{sname} = \text{'Eric'} \text{ and } t.\text{bookno} = b.\text{bookno}} \right] \quad (t \times B \times S)$$

$$\pi_{\text{bookno}, \text{sid}} \left[\sigma_{\text{price}} (B \times S) \times E_0 \right]$$

optimized

$$\text{eric} = \pi_{\text{sid}} \left[\sigma_{\text{sname} = \text{'Eric'}} (S) \right]$$

$$E_0 = \pi_{\text{bookno}, \text{sid}} [B \times \text{eric}]$$

$$E_1 = \pi_{\text{bookno}, \text{sid}} [E_0 \times \sigma_{\text{price} > 50} (B)]$$

$$\pi_{\text{sid}} [S \times E_1]$$