

① Find drivers ^{identified by their name} over the age of 40,
where driver(driverName, age).

② Express this in rel. calculus.

③ " " " rel. algebra.

$$\begin{aligned}
 \textcircled{a} \quad & \{ t : \text{driverName} \mid \exists d \in \text{driver} \\
 & \quad d(\text{age}) > 40 \wedge \\
 & \quad t(\text{driverName}) = d(\text{driverName}) \}
 \end{aligned}$$

$$\begin{aligned}
 \textcircled{b} \quad & \pi_{\text{driverName}} (\sigma_{\text{age} > 40} (\text{driver})) \\
 & \quad \updownarrow ? \text{ NO} \\
 & \sigma_{\text{age} > 40} (\underbrace{\pi_{\text{driverName}} (\text{driver})}_{\text{driverName}})
 \end{aligned}$$

② Consider relations $R(A, B, C)$ & $S(D, E, F)$.
Give an expression in rel. calculus
that is equivalent to:

① $\pi_A(R)$

② $\sigma_{B=17}(R)$

③ $R \times S$

④ $\pi_{A, F}(\sigma_{C=D}(R \times S))$

$$(a) \{t: A \mid \exists r \in R (t(A) = r(A))\}$$

$$(b) \{t: A, B, C \mid \exists r \in R (r(B) = 17 \wedge \\ t(A) = r(A) \wedge t(B) = r(B) \wedge \\ t(C) = r(C))\}$$

$$(c) \{t: A, B, C, D, E, F \mid \exists r \in R \exists s \in S \\ (t(A) = r(A) \wedge \dots \wedge t(C) = r(C) \wedge \\ t(D) = s(D) \wedge \dots \wedge t(F) = s(F))\}$$

$$(d) \{t: A, F \mid \exists r \in R \exists s \in S (r(C) = s(D) \wedge \\ t(A) = r(A) \wedge t(F) = s(F))\}$$

③ Do the following expressions return always the same result?

Q₁: SELECT [↓]x
FROM R
WHERE y > 2

Q₂:

2. $\pi_X (G_{Y \times Z}(\mathbb{R}))$

(assume $R(x, y)$)

e.g.,

R	X	Y
	1	3
	1	4
	2	1

Q

 Q_2
$$\begin{array}{r} \times \\ 1 \end{array}$$

④ Consider $R(x, y)$ & $S(x, z)$

① Are $\underbrace{R \times S}$ and $\underbrace{R \bowtie S}$ equivalent?

$R.x$	y	$S.x$	z

x	y	z

② Write a rel. algebra expr. using $\bowtie$ that is equivalent to $R \bowtie S$

$$\sigma_{R.x=S.x}(R \times S)$$
$$\sigma_{R.x=S.x} \left(\pi_{R.x, y, z} \left(\left(\cancel{R \times S} \right) \right) \right)$$

5 List the names of drivers that have rented every red car

a in rel. algebra

b in rel. calculus

a $\left(\pi_{\text{driverName, VIN}}(\text{rental}) \right) \div$

$\left(\pi_{\text{VIN}} \left(\sigma_{\text{color} = \text{'red'}}(\text{car}) \right) \right)$

(b)

$$\{ t: \text{driverName} \mid \exists d \in \text{driver} ($$
$$d(\text{driverName}) = t(\text{driverName}) \wedge$$
$$\forall c \in \text{car} (c(\text{color}) = \text{'red'} \rightarrow$$
$$\exists r \in \text{rental} ($$
$$r(\text{driverName}) = d(\text{driverName}),$$
$$r(\text{VIN}) = c(\text{VIN})$$
$$)$$
$$)$$
$$)\}$$

6 Find drivers that have not rented two different cars of the same color (it is OK if they have rented the same car multiple times).

a In rel. calculus

$$\begin{aligned} & \{ t: \text{driverName} \mid \exists d \in \text{driver} (\\ & \quad d(\text{driverName}) = t(\text{driverName}) \wedge \\ & \quad \forall r_1 \in \text{rental} \forall r_2 \in \text{rental} (\\ & \quad \quad r_1(\text{driverName}) = d(\text{driverName}) \wedge \\ & \quad \quad r_2(\text{driverName}) = d(\text{driverName}) \wedge \\ & \quad \quad r_1(\text{VIN}) \neq r_2(\text{VIN}) \rightarrow \cancel{r_1(\text{color})} \neq \cancel{r_2(\text{color})} \\ & \quad \quad (\exists c_1 \in \text{car} (\cancel{c_1(\text{VIN})} = r_1(\text{VIN}) \wedge \\ & \quad \quad \quad \exists c_2 \in \text{car} \quad c_2(\text{VIN}) = r_2(\text{VIN}) \wedge \\ & \quad \quad \quad c_1(\text{color}) \neq c_2(\text{color})))) \} \end{aligned}$$

b In rel. algebra

$$\begin{aligned}
 & \left[\sigma_{\text{color1} \neq \text{color2}} \wedge \text{color1} = \text{color2} \right] \\
 & \left[\sigma_{\substack{\text{VIN} \rightarrow \text{VIN1} \\ \text{color} \rightarrow \text{color1}}} \pi_{\text{driverName, VIN, color}} (\text{rental} \bowtie \text{car}) \right] \bowtie \\
 & \left[\sigma_{\substack{\text{VIN} \rightarrow \text{VIN2} \\ \text{color} \rightarrow \text{color2}}} \pi_{\text{driverName, VIN, color}} (\text{rental} \bowtie \text{car}) \right]
 \end{aligned}$$

$$\pi_{\text{driverName}}(\text{driver}) - \pi_{\text{driverName}}(\quad)$$