Relational algebra

Exercise

Given two relations R and S, where R contains m tuples and S contains n tuples, $m \geq n > 0$, give the minimum and maximum possible sizes (in tuples) for the result of each of the following expressions. In each case, state any assumptions about the schemas needed to make the expression meaningful

1. $R \cup S$
2. $R \cap S$
3. $R - S$
4. $R \times S$
5. $\sigma_{A=5} R$
6. $\pi_A R$
7. R/S

Solutions

1. $R \cup S$: $m + n$, m
2. $R \cap S$: n, 0
3. $R - S$: m, 0
4. $R \times S$: mn
5. $\sigma_{A=5}R$: m, 0
6. $\pi_A R$: m, 1 (m, m, when R has schema $R(A)$)
7. R/S: m, 0

Exercise

Consider the following schema

```
Suppliers(sid: integer, sname: string, address: string)
Parts(pid: integer, pname: string, colour: string)
Catalog(sid:integer, pid: integer, cost: real)
```

You can abbreviate the relation names as S, P, and C

Find the names of suppliers who supply some red part

Solution

$$\pi_{\texttt{sname}}(\sigma_{\texttt{colour}=\text{`}red\text{'}} S \bowtie P \bowtie C)$$

Exercise

```
Suppliers(sid: integer, sname: string, address: string)
Parts(pid: integer, pname: string, colour: string)
Catalog(sid:integer, pid: integer, cost: real)
```

Find the sids of suppliers who supply some red or green part

Exercise

```
Suppliers(sid: integer, sname: string, address: string)
Parts(pid: integer, pname: string, colour: string)
Catalog(sid:integer, pid: integer, cost: real)
```

Find the sids of suppliers who supply some red or green part

$$\pi_{\texttt{sid}}(\sigma_{\texttt{colour}=\text{`}red\text{'}\vee\texttt{colour}=\text{`}green\text{'}}P \bowtie C)$$

Exercise

```
Suppliers(sid: integer, sname: string, address: string)
Parts(pid: integer, pname: string, colour: string)
Catalog(sid:integer, pid: integer, cost: real)
```

Find the sids of suppliers who supply some red part or are at 221 Packer Ave

Solution

$$\pi_{\texttt{sid}}\sigma_{\texttt{colour}=\text{`}red\text{'}\vee\texttt{address}=\text{`}221PackerAve\text{'}}(P \bowtie C \bowtie S)$$

Exercise

```
Suppliers(sid: integer, sname: string, address: string)
Parts(pid: integer, pname: string, colour: string)
Catalog(sid:integer, pid: integer, cost: real)
```

Find the sids of suppliers who supply some red part and some green part.

Solution

1. $R_1 = \pi_{\texttt{sid}}\sigma_{\texttt{colour}=\text{`}red\text{'}}(P \bowtie C)$
2. $R_2 = \pi_{\texttt{sid}}\sigma_{\texttt{colour}=\text{`}green\text{'}}(P \bowtie C)$
3. Solution: $R_1 \cap R_2$

Exercise

```
Suppliers(sid: integer, sname: string, address: string)
Parts(pid: integer, pname: string, colour: string)
Catalog(sid:integer, pid: integer, cost: real)
```

Find the sids of suppliers who supply every part

Solution

1. All part ids: $R = \pi_{\texttt{pid}}(C)$
2. All pairs of `sid` and `pid`: $S = \pi_{\texttt{pid},\texttt{sid}}(C)$
3. Solution: S/R

Exercise

```
Suppliers(sid: integer, sname: string, address: string)
Parts(pid: integer, pname: string, colour: string)
Catalog(sid:integer, pid: integer, cost: real)
```

Find the sids of suppliers who supply every red part

Solution

1. All red parts: $R = \pi_{\texttt{pid}}\sigma_{\texttt{colour}=\text{`}red\text{'}}(C)$
2. All pairs of `sid` and `pid`: $S = \pi_{\texttt{pid},\texttt{sid}}(C)$
3. Solution: S/R

Exercise

```
Suppliers(sid: integer, sname: string, address: string)
Parts(pid: integer, pname: string, colour: string)
Catalog(sid:integer, pid: integer, cost: real)
```

Find the sids of suppliers who supply every red or green part

Solution

1. All red parts: $R_1 = \pi_{\texttt{pid}}\sigma_{\texttt{colour}=\text{`}red\text{'}}(C)$
2. All green parts: $R_2 = \pi_{\texttt{pid}}\sigma_{\texttt{colour}=\text{`}green\text{'}}(C)$
3. All pairs of `sid` and `pid`: $S = \pi_{\texttt{pid},\texttt{sid}}(C)$
4. Solution: $S/(R_1 \cup R_2)$

Exercise

```
Suppliers(sid: integer, sname: string, address: string)
Parts(pid: integer, pname: string, colour: string)
Catalog(sid:integer, pid: integer, cost: real)
```

Find the sids of suppliers who supply every red part or supply every green part

Solution

1. All red parts: $R_1 = \pi_{\texttt{pid}}\sigma_{\texttt{colour}=\text{`}red\text{'}}(C \bowtie P)$
2. $S_1 = \pi_{\texttt{pid,sid}}(C)$
3. Supply all red parts: $T_1 = S_1/R_1$
4. All green parts: $R_2 = \pi_{\texttt{pid}}\sigma_{\texttt{colour}=\text{`}green\text{'}}(C \bowtie P)$
5. $S_2 = \pi_{\texttt{pid,sid}}(C)$
6. Supply all red parts: $T_1 = S_2/R_2$
7. Solution $T_1 \cup T_2$

Exercise

```
Suppliers(sid: integer, sname: string, address: string)
Parts(pid: integer, pname: string, colour: string)
Catalog(sid:integer, pid: integer, cost: real)
```

Find pairs of sids such that the supplier with the first sid charges more for some part than the supplier with the second sid

Solution

1. $R = \pi_{\texttt{pid,sid,cost}}(P \bowtie C)$
2. $R' = \rho(\texttt{sid} \to \texttt{sid1}, \texttt{cost} \to \texttt{cost1}), R)$
3. $T = R \bowtie R'$
4. Solution: $\pi_{\texttt{sid,sid1}}\sigma_{\texttt{cost}>\texttt{cost1}}(T)$

Exercise

```
Suppliers(sid: integer, sname: string, address: string)
Parts(pid: integer, pname: string, colour: string)
Catalog(sid:integer, pid: integer, cost: real)
```

Find the pids of parts supplied by at least two different suppliers

Solution

1. $R1 = C$
2. $R2 = C$
3. $\pi_{\texttt{R1.pid}}\sigma_{\texttt{R1.pid}=\texttt{R2.pid} \wedge \texttt{R1.sid} \neq \texttt{R2.sid}}(R1 \times R2)$

Exercise

```
Suppliers(sid: integer, sname: string, address: string)
Parts(pid: integer, pname: string, colour: string)
Catalog(sid:integer, pid: integer, cost: real)
```

Find the pids of the most expensive parts supplied by suppliers named Yosemite Sham

Solution

1. $R_1 = \pi_{\texttt{sid}} \sigma_{\texttt{sname}=\text{`}\texttt{YosemiteSham}\text{'}} S$
2. $R_2 = R_1 \bowtie C$
3. $R_3 = R_2$
4. $R_4 = \sigma_{R_3.\texttt{cost}<R_2.\texttt{cost}}(R_3 \times R_2)$
5. Solution: $\pi_{\texttt{pid}}(R_2) - \pi_{R_3.\texttt{pid}}(R_4)$

Exercise

```
Suppliers(sid: integer, sname: string, address: string)
Parts(pid: integer, pname: string, colour: string)
Catalog(sid:integer, pid: integer, cost: real)
```

Find the pids of parts supplied by every supplier at less than $200. (If any supplier either does not supply the part or charges more than $200 for it, the part is not selected.)

Solution

1. $R = \pi_{\texttt{pid,sid}}\sigma_{\texttt{cost}<200}(S \bowtie P \bowtie C)$
2. Solution: $\pi_{\texttt{pid}}(R/\pi_{\texttt{sid}}P)$