2b. Relational Algebra Exercises
Find ids of sailors who've reserved boat with bid 103

- We use the following database schema
  Sailors (sid, sname),
  Reserves (sid, bid, date),
  Boats (bid, bname, color)

Question: Give an ER diagram for the above tables.

- $\pi_{\text{sid}}(\sigma_{\text{bid}=103}\text{Reserves})$
Find names of sailors who’ve reserved boat with bid 103

Sailors(sid, sname), Reserves(sid, bid, date), Boats(bid, bname, color)

Solution 1:

\[ \pi_{\text{sname}}(\sigma_{\text{Reserves}.sid = \text{Sailors}.sid \land \text{bid} = 103}(\text{Reserves} \times \text{Sailors}))) \]

Solution 2:

\[ \pi_{\text{sname}}(\sigma_{\text{Reserves}.sid = \text{Sailors}.sid}(\sigma_{\text{bid} = 103}(\text{Reserves}) \times \text{Sailors})) \]

Solution 3:

\[ \pi_{\text{sname}}((\sigma_{\text{bid} = 103}\text{Reserves}) \JOIN_{\text{sid}}\text{Sailors}) \]
Find names of sailors who’ve reserved a red boat

Sailors(sid, sname), Reserves(sid,bid,date), Boats(bid,bname,color)

Solution 1:

$$\pi_{sname}( (\sigma_{color=red} \text{Boats}) \ JOIN_{bid} \text{Reserves} \ JOIN_{sid} \text{Sailors} )$$

Can you give a more efficient solution?

$$\pi_{sname}( (\pi_{bid}(\sigma_{color=red} \text{Boats})) \ JOIN_{bid} \text{Reserves} \ JOIN_{sid} \text{Sailors} )$$

query optimization: real systems do such optimizations based on algebra
Find the names of sailors who’ve reserved a red or a green boat

Sailors(sid, sname), Reserves(sid,bid,date), Boats(bid,bname,color)

- Can identify all red or green boats, then find sailors who’ve reserved one of these boats:

$$\pi_{sname}(\left(\sigma_{color=\text{red} \lor color=\text{green}} \text{Boats}\right) \Join_{bid} \text{Reserves} \Join_{sid} \text{Sailors})$$

What happens if $\lor$ is replaced by $\land$ in this query?
Find the names of sailors who’ve reserved a red and a green boat

Sailors(sid, sname), Reserves(sid, bid, date), Boats(bid, bname, color)

- Previous approach won’t work! Must identify sailors who’ve reserved red boats, sailors who’ve reserved green boats, then find the intersection:

Is this solution correct?

\[ \pi_{sname}(\sigma_{\text{color}=\text{red}} \text{Boats} \text{ JOIN}_{\text{bid}} \text{Reserves } \text{JOIN}_{\text{sid}} \text{Sailors}) \cap \]
\[ \pi_{sname}(\sigma_{\text{color}=\text{green}} \text{Boats} \text{ JOIN}_{\text{bid}} \text{Reserves } \text{JOIN}_{\text{sid}} \text{Sailors}) \]

Correct solution:

\[ \pi_{\text{sname}} \]
\[ [\pi_{\text{sid}, \text{sname}}(\sigma_{\text{color}=\text{red}} \text{Boats} \text{ JOIN}_{\text{bid}} \text{Reserves } \text{JOIN}_{\text{sid}} \text{Sailors}) \cap \]
\[ \pi_{\text{sid}, \text{sname}}(\sigma_{\text{color}=\text{green}} \text{Boats} \text{ JOIN}_{\text{bid}} \text{Reserves } \text{JOIN}_{\text{sid}} \text{Sailors})] \]
Find ids of sailors who have made at least two reservations on the same date

Sailors(sid, sname), Reserves(sid, bid, date), Boats(bid, bname, color)

We have to use rename: $p(R1, \text{Reserves}), p(R2, \text{Reserves})$

$$\pi_{R1.sid}(\sigma_{R1.sid=R2.sid \land R1.date=R2.date \land R1.bid \neq R2.bid} (R1 \times R2))$$

Or equivalently:

$$\pi_{R1.sid}(\sigma_{R1.sid=R2.sid \land R1.date=R2.date \land R1.bid \neq R2.bid} (p(R1, \text{Reserves}) \times p(R2, \text{Reserves})))$$

$$\pi_{R1.sid} (p(R1, \text{Reserves}) \ JOIN_{R1.sid=R2.sid \land R1.date=R2.date \land R1.bid \neq R2.bid} p(R2, \text{Reserves}))$$

What happens if we omit $R1.date=R2.date$?
What happens if we omit $R1.bid \neq R2.bid$?
Find the ids of sailors who’ve reserved all boats

\[ \text{Sailors}(\text{sid, sname}), \text{Reserves}(\text{sid,bid,date}), \text{Boats}(\text{bid,bname,color}) \]

Uses division; schemas of the input relations must be carefully chosen:

\[ (\pi_{\text{sid,bid Reserves}}) / \pi_{\text{bid Boats}} \]

What about the query: find the ids of sailors who have reserved all red boats

\[ (\pi_{\text{sid,bid Reserves}}) / \pi_{\text{bid (σ color=red Boats)}} \]

What about the query: find the \textbf{names} of sailors who have reserved all red boats

\[ \pi_{\text{sname}}(\text{Sailors JOIN} \text{sid (π_{\text{sid,bid Reserves}}) / π_{\text{bid (σ color=red Boats)}}}) \]