Database Management Systems

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Example Database

Sailors			
sid	sname	rating	age
22	Dustin	7	45.0
29	Brutus	1	33.0
31	Lubber	8	55.5
32	Andy	8	25.5
58	Rusty	10	35.0
64	Horatio	7	35.0
71	Zorba	10	16.0
74	Horatio	9	35.0
85	Art	3	25.5
95	Bob	3	63.5

Reserves		
sid	bid	day
22	101	10-Oct-2019
22	102	10-Oct-2019
22	103	08-Oct-2019
22	104	07-Oct-2019
31	102	10-Nov-2019
31	103	06-Nov-2019
31	104	12-Nov-2019
64	101	05-Sep-2019
64	102	08-Sep-2019
74	103	08-Sep-2019

Boats		
bid	bname	color
101	Interlake	blue
102	Interlanke	red
103	Clipper	green
104	Marine	red

Queries on Example Database

Queries

Q1 Find the names of the Sailors who have reserved Boat 103

Queries on Example Database

Queries

Q1 Find the names of the Sailors who have reserved Boat 103

Q2 Find the names of the Sailors who reserved a red boat

Queries on Example Database

Queries

Q1 Find the names of the Sailors who have reserved Boat 103

Q2 Find the names of the Sailors who reserved a red boat

Q3 Find the colors of boats reserved by Lubber

Queries on Example Database

Queries

Q1 Find the names of the Sailors who have reserved Boat 103

Q2 Find the names of the Sailors who reserved a red boat

Q3 Find the colors of boats reserved by Lubber

Q4 Find the names of Sailors who have reserved at least one boat

Queries on Example Database

Queries

Q1 Find the names of the Sailors who have reserved Boat 103

Q2 Find the names of the Sailors who reserved a red boat

Q3 Find the colors of boats reserved by Lubber

Q4 Find the names of Sailors who have reserved at least one boat

Q5 Find the names of Sailors who have reserved a red or a green Boat

Queries on Example Database

Queries

Q1 Find the names of the Sailors who have reserved Boat 103

Q2 Find the names of the Sailors who reserved a red boat

Q3 Find the colors of boats reserved by Lubber

Q4 Find the names of Sailors who have reserved at least one boat

Q5 Find the names of Sailors who have reserved a red or a green Boat

Q6 Find the names of Sailors who have reserved a red AND a green Boat

Queries on Example Database

Queries

- Q1 Find the names of the Sailors who have reserved Boat 103
- Q2 Find the names of the Sailors who reserved a red boat
- Q3 Find the colors of boats reserved by Lubber
- Q4 Find the names of Sailors who have reserved at least one boat
- Q5 Find the names of Sailors who have reserved a red or a green Boat
- Q6 Find the names of Sailors who have reserved a red AND a green Boat
- Q7 Find the names of Sailors who have reserved at least two boats

Queries on Example Database

Queries

- Q1 Find the names of the Sailors who have reserved Boat 103
- Q2 Find the names of the Sailors who reserved a red boat
- Q3 Find the colors of boats reserved by Lubber
- Q4 Find the names of Sailors who have reserved at least one boat
- Q5 Find the names of Sailors who have reserved a red or a green Boat
- Q6 Find the names of Sailors who have reserved a red AND a green Boat
- Q7 Find the names of Sailors who have reserved at least two boats
- Q8 Find the sids of Sailors with age over 20 who have not reserved a red boat

Queries on Example Database

Queries

- Q1 Find the names of the Sailors who have reserved Boat 103
- Q2 Find the names of the Sailors who reserved a red boat
- Q3 Find the colors of boats reserved by Lubber
- Q4 Find the names of Sailors who have reserved at least one boat
- Q5 Find the names of Sailors who have reserved a red or a green Boat
- Q6 Find the names of Sailors who have reserved a red AND a green Boat
- Q7 Find the names of Sailors who have reserved at least two boats
- Q8 Find the sids of Sailors with age over 20 who have not reserved a red boat
- Q9 Find the names of sailors who have reserved all boats

Queries on Example Database

Queries

- Q1 Find the names of the Sailors who have reserved Boat 103
- Q2 Find the names of the Sailors who reserved a red boat
- Q3 Find the colors of boats reserved by Lubber
- Q4 Find the names of Sailors who have reserved at least one boat
- Q5 Find the names of Sailors who have reserved a red or a green Boat
- Q6 Find the names of Sailors who have reserved a red AND a green Boat
- Q7 Find the names of Sailors who have reserved at least two boats
- Q8 Find the sids of Sailors with age over 20 who have not reserved a red boat
- Q9 Find the names of sailors who have reserved all boats
- Q10 Find the names of sailors who have reserved all boats with name Interlake

Queries on Example Database

Q1: Find the names of the Sailors who have reserved Boat 103

- Sailor name is in Sailors relation
- Boat id is in Reserves relation
- Which `sid` reserved which `bid` is in Reserves relation
- This query therefore requires joining Sailors relation with Reserves relation

Queries on Example Database

Q1: Find the names of the Sailors who have reserved Boat 103

- $\rho(Temp1, \sigma_{bid=103}(Reserves))$
  All rows in Reserves where every sailor id reserved boat id 103
- Schema for Temp1: `Temp1(sid, bid, day)`

Queries on Example Database

Q1: Find the names of the Sailors who have reserved Boat 103

- Temp1 contains all sid's who reserved boad id 103
- If we were asked to output only sailor's id then we could do a projection of Temp1 that is $\pi_{sid}(Temp1)$

Queries on Example Database

Q1: Find the names of the Sailors who have reserved Boat 103

- But we were asked to provide the names of the sailors
- Sailor's names are not present in Temp1 relation
- If we join Temp1 with Sailors using natural join we get the required result
- $Temp1 \bowtie Sailors$
- $\bowtie$ performs: $Temp1 \underset{Temp1.sid=Sailors.sid}{\bowtie} Sailors$
- $\rho(Temp2, Temp1 \bowtie Sailors)$

Queries on Example Database

Q1: Find the names of the Sailors who have reserved Boat 103

- Schema `Temp2(sid, sname, rating, age, bid, day)`
- Temp2 contains sailors who reserved bid 103
- List names of sailors from Temp2
- $\pi_{sname}(Temp2)$

Queries on Example Database

Q1: Find the names of the Sailors who have reserved Boat 103

Reserves		
sid	bid	day
22	101	10-Oct-2019
22	102	10-Oct-2019
22	103	08-Oct-2019
22	104	07-Oct-2019
31	102	10-Nov-2019
31	103	06-Nov-2019
31	104	12-Nov-2019
64	101	05-Sep-2019
64	102	08-Sep-2019
74	103	08-Sep-2019

$$\rho(Temp1, \sigma_{bid=103}(Reserves))$$

Temp1		
sid	bid	day
22	103	08-Oct-2019
31	103	06-Nov-2019
74	103	08-Sep-2019

Queries on Example Database

Q1: Find the names of the Sailors who have reserved Boat 103

$\rho(Temp2, Temp1 \bowtie Sailors)$

Temp1

sid	bid	day
22	103	08-Oct-2019
31	103	06-Nov-2019
74	103	08-Sep-2019

$\bowtie$

Sailors

sid	sname	rating	age
22	Dustin	7	45.0
29	Brutus	1	33.0
31	Lubber	8	55.5
32	Andy	8	25.5
58	Rusty	10	35.0
64	Horatio	7	35.0
71	Zorba	10	16.0
74	Horatio	9	35.0
85	Art	3	25.5
95	Bob	3	63.5

Temp1 $\bowtie$ Sailors

sid	bid	day	sid	sname	rating	age
22	103	08-Oct-2019	22	Dustin	7	45.0
31	103	06-Nov-2019	31	Lubber	8	55.5
74	103	08-Sep-2019	74	Horatio	9	35.0

Temp2

sid	bid	day	sname	rating	age
22	103	08-Oct-2019	Dustin	7	45.0
31	103	06-Nov-2019	Lubber	8	55.5
74	103	08-Sep-2019	Horatio	9	35.0

Queries on Example Database

Q1: Find the names of the Sailors who have reserved Boat 103

$$\pi_{sname}((\sigma_{bid=103}(Reserves)) \bowtie Sailors)$$

Queries on Example Database

Q2: Find the names of the Sailors who reserved a red boat

$\rho(Temp1, \sigma_{color='red'}(Boats))$

Schema for Temp1: `Temp1(bid, bname, color)`

$\rho(Temp2, Temp1 \bowtie Reserves \bowtie Sailors)$

Schema for Temp2: `Temp2(bid, bname, color, sid, day, sname, rating, age)`

$\pi_{sname}(Temp2)$

Schema for π_{sname}(Temp2): `Temp2(sname)`

Queries on Example Database

Q2: Find the names of the Sailors who reserved a red boat

$$\pi_{sname}((\sigma_{color='red'}(Boats)) \bowtie Reserves \bowtie Sailors)$$

Queries on Example Database

Q3: Find the colors of boats reserved by Lubber

$\pi_{color}((sigma_{sname='Lubber'}(Sailors)) \bowtie Reserves \bowtie Boats)$

Queries on Example Database

Q4: Find the names of Sailors who have reserved at least one boat

$\pi_{sname}(Sailors \bowtie Reserves)$

Queries on Example Database

Q5: Find the names of Sailors who have reserved a red or a green Boat

- $\rho(Tempboats, (\rho_{color='red'}(Boats)) \cup (\rho_{color='green'}(Boats)))$
- $\pi_{sname}(Tempboats \bowtie Reserves \bowtie Sailors)$

Queries on Example Database

Q6: Find the names of Sailors who have reserved a red AND a green Boat

$$\rho(Tempboats, (\sigma_{color='red'}(Boats)) \cup (\sigma_{color='green'}(Boats)))$$

Boats		
bid	bname	color
101	Interlake	blue
102	Interlanke	red
103	Clipper	green
104	Marine	red

Boats		
bid	bname	color
101	Interlake	blue
102	Interlanke	red
103	Clipper	green
104	Marine	red

$(\sigma_{color='red'}(Boats))$		
bid	bname	color
102	Interlanke	red

$(\sigma_{color='green'}(Boats))$		
bid	bname	color
103	Clipper	green

Queries on Example Database

Q6: Find the names of Sailors who have reserved a red AND a green Boat

- $\rho(Tempboats, (\sigma_{color='red'}(Boats)) \cap (\sigma_{color='green'}(Boats)))$
- $\pi_{sname}(Tempboats \bowtie Reserves \bowtie Sailors)$
- Will it work?
- NO!

Queries on Example Database

Q6: Find the names of Sailors who have reserved a red AND a green Boat

$$\rho(Tempboats, (\sigma_{color='red'}(Boats)) \cap (\sigma_{color='green'}(Boats)))$$

Boats		
bid	bname	color
101	Interlake	blue
102	Interlanke	red
103	Clipper	green
104	Marine	red

Boats		
bid	bname	color
101	Interlake	blue
102	Interlanke	red
103	Clipper	green
104	Marine	red

$(\sigma_{color='red'}(Boats))$		
bid	bname	color
102	Interlanke	red

$(\sigma_{color='green'}(Boats))$		
bid	bname	color
103	Clipper	green

Queries on Example Database

Q7: Find the names of Sailors who have reserved at least two boats

- One rwo of Reserves has one reservation information
- Across rows, information about same sid reserving on same bid is available
- For these kinds of queries, we employ cross product relation on itself

Queries on Example Database

Q7: Find the names of Sailors who have reserved at least two boats

- $\rho(Reservations, \pi_{sid,sname,bid}(Sailors \bowtie Reserves))$
- $\rho(Two\_Reservations(1 \rightarrow sid_1, 2 \rightarrow sname_1, 3 \rightarrow bid_1, 4 \rightarrow sid_2, 5 \rightarrow sname_2, 6 \rightarrow bid_2), Reservations \times Reservations)$
- $\pi_{sname_1}(\sigma_{(sid_1=sid_2)\&(bid_1 \neq bid_2)}(Two\_Reservations))$

Queries on Example Database

Q8: Find the sids of Sailors with age over 20 who have not reserved a red boat

- Compute Sailors whose age is more than 20 years
- $\pi_{sid}(\sigma_{age>20}(Sailors))$
- Compute Sailors who have reserved red boat
- $\pi_{sid}((\sigma_{color='red'}(Boats)) \bowtie Reserves \bowtie Sailors)$
- Obtain set difference between the above two results
- $\pi_{sid}(\sigma_{age>20}(Sailors)) - \pi_{sid}((\sigma_{color='red'}(Boats)) \bowtie Reserves \bowtie Sailors)$

Queries on Example Database

Q9: Find the names of sailors who have reserved all boats

- To answer queries involving all we have to obtain two relations A, B; A having two attributes; B having one attribute
- One relation is: $\pi_{(sid,bid)}(Reserves)$
- Another relation is: $\pi_{(bid)}(Boats)$
- Now we can apply division operator on the above two relations

Queries on Example Database

Q9: Find the names of sailors who have reserved all boats

- $\pi_{(sid,bid)}(Reserves)/\pi_{(bid)}(Boats)$
- $rho(Tempsids, \pi_{(sid,bid)}(Reserves)/\pi_{(bid)}(Boats))$
- $\pi_{sname}(Tempsids \bowtie Sailors)$

Queries on Example Database

Q10: Find the names of sailors who have reserved all boats with name Interlake

- $\pi_{(sid,bid)}(Reserves)/\pi_{(bid)}(\sigma_{bname='Interlake'}(Boats))$
- $rho(Tempsids, \pi_{(sid,bid)}(Reserves)/\pi_{(bid)}(Boats))$
- $\pi_{sname}(Tempsids \bowtie Sailors)$