

CS 4750: Database Systems (Spring 2024)

POTD 6: Relational Algebra (Santa workshop) – Solution

Due 28-Mar-2024, 12pm/noon EST

Purpose:

- Be familiar with relational algebra
- Practice writing and interpreting relational algebra database queries
- Get ready to work on homework assignment and course project
- Prepare for exam 2

You may make a copy of a worksheet and complete this activity, or type your answers in any text editor. You may work alone or with 3-4 other students in this course.

Consider the following schemas for the `Santa_Workshop` database. Refer to the [Santa's workshop](#) database scenario Write RA to solve the problems.

```
Elf(badge, name, wname)
    -- FK: wname references Workshop(wname)
is_supervised(badge, sbadge)
    -- PK: badge, an elf can have at most one supervisor,
    a supervisor can supervise many elves
    -- FK: badge references Elf(badge)
    -- FK: sbadge references Elf(badge)
Workshop(wname, location)
Toy(toy_id, toy_name)
Built_in(toy_id, wname)
    -- FK: toy_id references Toy(toy_id)
    -- FK: wname references Workshop(wname)
Evaluation(badge, rater, rate_date, rating)
    -- FK: badge references Elf(badge)
    -- FK: rater references Elf(badge)
    -- assume rating is of type INT
```

Write RA to solve the following problems

Note: There are multiple ways to solve the problems and some of these RA queries may not exactly match your solutions. For more practice, you are encouraged to try solving the problems in multiple ways.

[Optional: For more practice, (1) write SQL to solve the problems, inspect and compare your SQL and RA; (2) try to solve as many problems & alternative ways as possible]

1. Find the badges and names of all elves who work in a workshop named "NorthStar"

$$\pi_{\text{badge, name}} (\sigma_{\text{wname}='NorthStar'} (\text{Elf}))$$

2. Find the badges and names of all elves who work at the 'NorthStar' or 'EastStar' workshops

$$\pi_{\text{badge, name}} (\sigma_{\text{wname}='NorthStar' \text{ OR } \text{wname}='EastStar'} (\text{Elf}))$$

3. Find the number of elves each supervisor supervises. Display the supervisors' badges along with the number of elves.

$$\pi_{\text{sbadge, number_elves}} (\text{sbadge } \mathbf{G} \text{ count}(\text{badge}) \rightarrow \text{number_elves} (\text{is_supervised}))$$

4. Consider all elves who work in the “NorthStar” workshop. Find the badges of their supervisors.

$$\pi_{\text{sbadge}}(\sigma_{\text{wname}='NorthStar'}(\text{Elf} \bowtie \text{is_supervised}))$$

5. Consider all elves who work in the “NorthStar” workshop. Find their supervisors’ badges and names

$$\begin{aligned} \text{sbadge_of_NorthStarElf} &\leftarrow \pi_{\text{is_supervised.sbadge}}(\sigma_{\text{E1.wname}='NorthStar'}(\text{Elf} \bowtie \text{is_supervised})) \\ \pi_{\text{sbadge_of_NorthStarElf.sbadge, Elf.name}} &(\sigma_{\text{Esbadge_of_NorthStarElf.sbadge=Elf.badge}}(\text{sbadge_of_NorthStarElf} \times \text{Elf})) \end{aligned}$$

6. List the badges of all supervisors who supervise at least 3 elves

$$\pi_{\text{sbadge}}(\sigma_{\text{number_elves} \geq 3}(\text{sbadge} \text{ G count}(\text{badge}) \rightarrow \text{number_elves}(\text{is_supervised})))$$

7. Find the information of all toys built in “NorthStar” or “EastStar” workshops

$$\pi_{\text{toy_id, toy_name}}(\sigma_{\text{wname}='NorthStar' \text{ OR } \text{wname}='EastStar'}(\text{Toy} \bowtie \text{Built_in}))$$

Another example

$$\begin{aligned} \pi_{\text{toy_id, toy_name}}(\sigma_{\text{wname}='NorthStar'}(\text{Toy} \bowtie \text{Built_in})) \cup \\ \pi_{\text{toy_id, toy_name}}(\sigma_{\text{wname}='EastStar'}(\text{Toy} \bowtie \text{Built_in})) \end{aligned}$$

8. Find the information of all toys built in “NorthStar” and “EastStar” workshops

$$\begin{aligned} \pi_{\text{toy_id, toy_name}}(\sigma_{\text{wname}='NorthStar'}(\text{Toy} \bowtie \text{Built_in})) \cap \\ \pi_{\text{toy_id, toy_name}}(\sigma_{\text{wname}='EastStar'}(\text{Toy} \bowtie \text{Built_in})) \end{aligned}$$

Be careful!! Similar to any programming languages, wname cannot have 2 values at the same time. select (wname='NorthStar' AND wname='EastStar') does *NOT* solve this problem

9. Find the information of all toys built in “NorthStar” workshop but not in “EastStar” workshop

$$\begin{aligned} \pi_{\text{toy_id, toy_name}}(\sigma_{\text{wname}='NorthStar'}(\text{Toy} \bowtie \text{Built_in})) - \\ \pi_{\text{toy_id, toy_name}}(\sigma_{\text{wname}='EastStar'}(\text{Toy} \bowtie \text{Built_in})) \end{aligned}$$

10. Find the elves who work in the same workshop as their supervisors. Display the elves' badges and their supervisors' badges.

$$\pi_{E1.badge, E2.badge} (\sigma_{E1.badge=is_supervised.badge \text{ AND } E2.badge=is_supervised.sbadge \text{ AND } E1.wname=E2.wname} (\rho_{E1}(Elf) \times \rho_{E2}(Elf) \times is_supervised))$$

11. Find the number of evaluations each rater has rated. List the names of the raters along with the number evaluations

$$\pi_{name,number_eval} (\sigma_{badge=rater} (Elf \times (\pi_{rater, number_eval} (rater \overset{G}{\text{count}(*)} \rightarrow number_eval(Evaluation))))$$

12. [Create your own problem, and write RA to solve it]

Grading rubric

[Total: 10 points]: Done (or provide evidence of your attempt, full or reasonable effort)

- (5 points) — Providing evidence of your attempt, minimal effort

(-2.5 points) for 24 hours late (submitted after 28-Mar-2024 12pm/noon, by 29-Mar-2024 12pm/noon)

(-5 points) for 48 hours late (submitted after 29-Mar-2024 12pm/noon, by 30-Mar-2024 12pm/noon)

Submission

- [optional] Take a selfie (or picture) of your team and submit it with your POTD
- Include all team member names and computingIDs in the report.
- Submit your RA queries
- You may do one of the following:
 - Write on the paper and take screenshot(s) of your POTD, or
 - Type and save your POTD as a .pdf file — No Word document.
- Each team submits only **one** copy.
- Upload your report to **POTD 6 on Gradescope**. Make sure you **connect your partner** to your group on Gradescope so that everyone receives credit.
- Please verify that your POTD is accessible. Making your submission available to instructors and course staff is your responsibility; if we cannot access or open your file(s), we have to assign a zero grade. Be sure to test access to your file(s) before the due date.

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