CS 4750: Database Systems (Spring 2026)

Activity: Relational Algebra (Santa workshop) — solution

(No submission)

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 3

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 2-3 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"

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

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

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

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

$$\pi_{sbadge,\ number\_elves} ({}_{sbadge}\mathcal{G}_{count(badge)\rightarrow number\_elves} (is\_supervised))$$

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

$$\pi_{sbadge}(\sigma_{wname='NorthStar'} (Elf \bowtie is\_supervised))$$

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

$$sbadge\_of\_NorthStarElf \leftarrow \pi_{is\_supervised.sbadge} (\sigma_{E1.wname='NorthStar'}(Elf \bowtie is\_supervised))$$

$$\pi_{sbadge\_of\_NorthStarElf.sbadge,\ Elf.name}($$
$$\sigma_{Esbadge\_of\_NorthStarElf.sbadge=Elf.badge} (sbadge\_of\_NorthStarElf \times Elf))$$

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

$$\pi_{sbadge}(\sigma_{number\_elves>=3} ({}_{sbadge}\mathcal{G}_{count(badge)\rightarrow number\_elves} (is\_supervised)))$$

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

$$\pi_{toy\_id,\ toy\_name} (\sigma_{wname='NorthStar' \text{ OR } wname='EastStar'} (Toy \bowtie Built\_in))$$

Another example

$$\pi_{toy\_id,\ toy\_name} (\sigma_{wname='NorthStar'} (Toy \bowtie Built\_in)) \cup$$
$$\pi_{toy\_id,\ toy\_name} (\sigma_{wname='EastStar'} (Toy \bowtie Built\_in))$$

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

$$\pi_{toy\_id,\ toy\_name} (\sigma_{wname='NorthStar'} (Toy \bowtie Built\_in)) \cap$$
$$\pi_{toy\_id,\ toy\_name} (\sigma_{wname='EastStar'} (Toy \bowtie Built\_in))$$

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

$$\pi_{toy\_id,\ toy\_name} (\sigma_{wname='NorthStar'} (Toy \bowtie Built\_in)) -$$
$$\pi_{toy\_id,\ toy\_name} (\sigma_{wname='EastStar'} (Toy \bowtie Built\_in))$$

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

$$\pi_{E1.badge,\ E2.badge}\Big(\sigma_{E1.badge=is\_supervised.badge\ AND\ E2.badge=is\_supervised.sbadge\ AND\ E1.wname=E2.wname}\big(\rho_{E1}(Elf) \times \rho_{E2}(Elf) \times is\_supervised\big)\Big)$$

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

$$\pi_{name,number\_eval}\ (\sigma_{badge=rater}\ (Elf \times (\pi_{rater,\ number\_eval}\ ({}_{rater}G_{\ count(*)\rightarrow number\_eval}(Evaluation)\ )\ )$$

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

[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]

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