

Part A: Relational Algebra

You will need to write the following queries in relational algebra. Make sure that the final result contains the attributes (and only those attributes) specified by the question. Please make sure you write clearly. We cannot grade what we cannot read. If you wish, you can use the rename operator (ρ) to assign a name to an intermediate result, if that helps simplify the specification of your query. For example:

$$\rho(R_1, \sigma_{age > 50} Emp) \\ \pi_{ename} R_1$$

You may omit the join condition when it is clear from the context. For example, you can write $Emp \bowtie Works$ instead of $Emp \bowtie_{eid=eid} Works$.

Submission instructions:

- Print pages 2–4 of this document, and handwrite your solutions in the corresponding spaces. *Please write clearly!*
- Scan your solutions into a single PDF. Make sure that the quality of the PDF is good and your writing is clear and readable.
- Upload your PDF to the corresponding assignment on Gradescope.
- Check here for helpful tips on scanning and uploading assignments to Gradescope: <https://gradescope.com/help#help-center-section-student-workflow>

1. Retrieve the name and age of each employee who works in the 'Legal' department.

..... $\rho(R_1, \pi_{ename, age}(\sigma_{dept='Legal'}(Dept \bowtie Works)))$
 $\pi_{ename, age}(\rho(R_1, \pi_{ename, age}(R_1 \bowtie Emp)))$
 $S(R_2)$

2. Retrieve the names of the employees who work in a department with a budget exceeding \$1,000,000.

..... $\rho(R_1, \pi_{ename}(\sigma_{budget > 1000000}(Dept \bowtie Works)))$
 $S(\pi_{ename}(\rho(R_1, \pi_{ename}(R_1 \bowtie Emp))))$

3. Retrieve the names of the employees who work in the 'Software' department more than 60% of time.

..... $\rho(R_1, \dots, \tau_{\text{pct-time} > 60}(\text{Works}), \dots, \tau_{\text{dname} = \text{"Software"}}(\text{Dept}))$
 $\sigma(\pi_{\text{ename}}(R_1 \bowtie \text{Emp}))$

4. Retrieve the names of the employees who work in the 'Software' department more than 60% of time, or the 'Hardware' department more than 20% of the time.

..... $\rho(R_1, \dots, \tau_{\text{pct-time} > 60}(\text{Works}), \dots, \tau_{\text{dname} = \text{"Software"}}(\text{Dept}))$
 $\rho(R_2, \dots, \tau_{\text{pct-time} > 20}(\text{Works}), \dots, \tau_{\text{dname} = \text{"Hardware"}}(\text{Dept}))$

 $\sigma(\pi_{\text{ename}}((R_1 \cup R_2) \bowtie \text{Emp}))$

5. Retrieve the names of the employees who work in the 'Software' department more than 60% of time, and the 'Hardware' department more than 20% of the time.

..... $\rho(R_1, \dots, \tau_{\text{pct-time} > 60}(\text{Works}), \dots, \tau_{\text{dname} = \text{"Software"}}(\text{Dept}))$

 $\rho(R_2, \dots, \tau_{\text{pct-time} > 20}(\text{Works}), \dots, \tau_{\text{dname} = \text{"Hardware"}}(\text{Dept}))$

 $\sigma(\pi_{\text{ename}}((R_1 \cap R_2) \bowtie \text{Emp}))$

6. Retrieve the dids of departments with at least two employees.

$\sigma_{(R_1, \dots, did \neq did, count(eid) \geq 2)}(Works.)$
 $\sigma_{(\pi_{did}(\sigma_{count(eid) \geq 2}(R_1)))}$

7. Retrieve the names of the employees who work in all departments with budget greater than 12 million.

$\sigma_{(R_1, \dots, \tau_{budget > 12000000}(Dept.))}$
 $\sigma_{(\pi_{ename}((Works / R_1) \bowtie Emp.))}$

8. Retrieve the names of the employees who work only in departments with budget less than 1 million.

$\sigma_{(R_1, \dots, \tau_{budget < 1000000}(Dept.) \bowtie Works.)}$
 $\sigma_{(R_2, \dots, \pi_{ename}(R_1 \bowtie Emp.))}$
 $\sigma_{(R_3, \dots, \tau_{budget > 1000000}(Dept.) \bowtie Works.)}$
 $\sigma_{(R_4, \dots, \pi_{ename}(R_3 \bowtie Emp.))}$
 $\sigma(R_1 - R_2)$