

MDS
Winter Term 2024/25
Relational Algebra

This unit is based on content from Jennifer Widom's video lecture series "Introduction to Databases - Jennifer Widom - Stanford", available on YouTube, as well as her coursework from her database MOOC¹.

We consider the database schema

$College(\underline{cName}, state, enr)$
 $Student(\underline{sID}, sName, GPA, HS)$
 $Apply(\underline{sID}, \underline{cName}, major, dec)$

that was introduced in Jennifer Widom's videos.

1. Translate the following relational algebra query into SQL:

$$\pi_{cName, enr}(\sigma_{state='CA'}(College))$$

2. Translate the following relational algebra query into SQL:

$$\pi_{sID}(\sigma_{state='CA'}(College \bowtie Apply))$$

¹<https://www.edx.org/school/stanfordonline>

3. Translate the following SQL query into relational algebra, using only the operators σ , π , and \times .

```
SELECT DISTINCT cName
FROM Student, Apply
WHERE Student.sID = Apply.sID AND GPA=4.0 AND decision='R'
```

4. Which of the following expressions finds the IDs of all students such that some college and the student have the same name?
- A) $\pi_{sID}(College \bowtie Student)$
- B) $\pi_{sID}(\sigma_{cName=sName}(College \times Student))$
- C) $\pi_{sID}(\pi_{cName}College \bowtie \pi_{cName}(\sigma_{sName=cName}Student))$
5. Write a relational algebra query that finds the student IDs of all students who have applied to Berkeley, but who were not accepted.

6. Can you write a relational algebra query that finds the student IDs of all students who have NOT applied to Berkeley, using only the operators σ , π , and \times ?

7. Which of the following expressions does NOT return the names and GPAs of students with $HS > 1000$ who applied to CS and were rejected?
- A) $\pi_{sName, GPA}(\sigma_{Student.sID=Apply.sID}(\sigma_{HS>1000}(Student) \times \sigma_{major='CS' \wedge dec='R'}(Apply)))$
- B) $\pi_{sName, GPA}(\sigma_{Student.sID=Apply.sID \wedge HS>1000 \wedge major='CS' \wedge dec='R'}(Student \times \pi_{sID, major, dec} Apply))$
- C) $\sigma_{Student.sID=Apply.sID}(\pi_{sName, GPA}(\sigma_{HS>1000} Student \times \sigma_{major='CS' \wedge dec='R'} Apply))$
8. Suppose relation Student has 20 tuples. What is the minimum and maximum number of tuples in the result of this expression:

$$\rho_{s1(i1, n1, g, h)} Student \bowtie \rho_{s2(i2, n2, g, h)} Student$$

- A) minimum = 0, maximum = 400
- B) minimum = 20, maximum = 20
- C) minimum = 20, maximum = 400
- D) minimum = 40, maximum = 40
9. Suppose relations College, Student, and Apply have 5, 20, and 50 tuples in them respectively. Recall that cName is a key for College. Do not assume that sName is a key for Student. However, assume that the college names in Apply also appear in College. What is the minimum and maximum number of tuples in the result of this expression:

$$\pi_{cName} College \cup \rho_{cName}(\pi_{sName} Student) \cup \pi_{cName} Apply$$

- A) minimum = 5, maximum = 25
- B) minimum = 5, maximum = 75
- C) minimum = 25, maximum = 45
- D) minimum = 75, maximum = 75