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 MOOC[1].

We consider the database schema

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

that was introduced in Jennifer Widom's videos.

1. Translate the following relational algebra query into SQL:

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

2. Translate the following relational algebra query into SQL:

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

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[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