

Database Management Systems (CSE 220)

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Relational Algebra

Tutorial

Question 1: Consider the following database schema computer products:

- Computer (maker, model, category)
- Model (num, speed, ram, hd, price)
- Maker (name, address, phone)

- Where

- maker indicates the manufacturer of the computer
- category takes values such as “desktop”, “laptop”, “server”;
- Following inclusion dependencies hold
 - $\text{maker} \subseteq \text{name}$
 - $\text{model} \subseteq \text{num}$

- Express following queries in relational algebra:

1. Find all the makers who make some laptop(s)

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$\pi_{\text{maker}} (\sigma_{\text{category} = \text{"laptop"}} (\text{Computer}))$

2. Find all the makers who make at least three different desktop models”

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$$\pi_{\text{maker}}(\sigma_{\text{model1} \neq \text{model2} \wedge \text{model2} \neq \text{model3} \wedge \text{model3} \neq \text{model1}} \\ (\rho_{\text{model1} \leftarrow \text{model}} (\sigma_{\text{category} = \text{"desktop"}}(\text{Computer})) \\ \bowtie \rho_{\text{model2} \leftarrow \text{model}} (\sigma_{\text{category} = \text{"desktop"}}(\text{Computer})) \\ \bowtie \rho_{\text{model3} \leftarrow \text{model}} (\sigma_{\text{category} = \text{"desktop"}}(\text{Computer}))))$$

3. Find the phone numbers of all the makers who make desktops with speed = 3.2''

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$\pi_{\text{maker } \sigma_{\text{model} = \text{num}} (\sigma_{\text{category} = \text{“desktop”}} (\text{Computer}) \times \sigma_{\text{speed} = 3.2} (\text{Model}))}$

4. “Find the makers who don’t make any desktop, and do make some laptop(s)”

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$(\text{Computer} - \sigma_{\text{category}=\text{“desktop”}}(\text{Computer})) \cap \pi_{\text{maker}}(\sigma_{\text{category}=\text{“laptop”}}(\text{Computer}))$

5. Find the makers who make all models with speed faster than 3.2

5. Find the makers who make all models with speed faster than 3.2

$$\pi_{\text{maker, model}}(\text{Computer}) / (\rho_{\text{model} \leftarrow \text{num}} \pi_{\text{num}}(\sigma_{\text{speed} > 3.2}(\text{Model})))$$

Question 2: Consider the following relations:

- Student(ssn, name, address, major)
 - Course(code, title)
 - Registered(ssn, code)
- Express following queries in relational algebra:

1. List the codes of courses in which at least one student is registered (registered courses):

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π_{code} (Registered)

2. List the titles of registered courses (of those in 1.)

2. List the titles of registered courses (of those in 1.)

$\pi_{\text{code}} (\text{Course} \bowtie \text{Registered})$

3. List the codes of courses for which no student is registered

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$\pi_{\text{code}} (\text{Course}) - \pi_{\text{code}} (\text{Registered})$

4. The titles of courses for which no student is registered.

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$$\pi_{\text{name}} ((\pi_{\text{code}} (\text{Course}) - \pi_{\text{code}} (\text{Registered})) \bowtie \text{Course})$$

5. Names of students and the titles of courses they registered to.

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$\pi_{\text{name,title}} (\text{Student} \bowtie \text{Registered} \bowtie \text{Course})$

$\pi_{\text{name,title}} ((\sigma_{1=4 \wedge 5=6} (\text{Student} \times \text{Registered} \times \text{Course})))$

6. SSNs of students who are registered for 'Database Systems' or 'Analysis of Algorithms'.

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$$\pi_{ssn} (\text{Student} \bowtie \text{Registered} \bowtie (\sigma_{\text{title}='Database Systems'} \text{Course})) \cup \pi_{ssn} (\text{Student} \bowtie \text{Registered} \bowtie (\sigma_{\text{title}='Analysis of Algorithms'} \text{Course}))$$

7. SSNs of students who are registered for both 'Database Systems' and 'Analysis of Algorithms'.

7. SSNs of students who are registered for both 'Database Systems' and 'Analysis of Algorithms'.

$$\pi_{ssn} (\text{Student} \bowtie \text{Registered} \bowtie (\sigma_{\text{title}='Database Systems'} \text{Course})) \cap \pi_{ssn} (\text{Student} \bowtie \text{Registered} \bowtie (\sigma_{\text{title}='Analysis of Algorithms'} \text{Course}))$$

8. List of courses in which all students are registered.

8. List of courses in which all students are registered.

$$\pi_{\text{code, ssn}} (\text{Registered}) / \pi_{\text{ssn}} (\text{Student})$$

9. List of courses in which all
'ECMP' major students are
registered.

9. List of courses in which all 'ECMP' major students are registered.

$\pi_{\text{code, ssn}}(\text{Registered}) / \pi_{\text{ssn}}(\sigma_{\text{major}='ECMP'} \text{Student})$