Information And Database Management Systems (CSE 227)

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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
    - maker ⊆ name
    - model ⊆ num
- Express following queries in relational algebra:

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

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

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

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

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

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

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

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

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

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π_{code} (Course $\bowtie$ Registered)

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

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π_{code} (Course) - π_{code} (Registered)

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

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

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

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

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

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

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

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

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

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

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

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

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