Database Management System (DBMS)

Lecture-21

Dharmendra Kumar

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Domain Relational Calculus

It uses domain variables that take on values from an attributes domain, rather than values for an entire tuple. The domain relational calculus, however, is closely related to the tuple relational calculus. An expression in the domain relational calculus is of the form

$$\{< x_1, x_2, ..., x_n > | P(x_1, x_2, ..., x_n)\}$$

where $x_1, x_2, ..., x_n$ represent domain variables. P represents a formula composed of atoms, as was the case in the tuple relational calculus.

Example Queries

- Find the branch-name, loan-number, and amount for loans of over \$1200.
  Solution: $\{ < l, b, a > \ | \ < l, b, a > \in loan \wedge a > 1200 \ \}$

- Find the loan number for each loan of an amount greater than \$1200.
  Solution: $\{ < l > \ | \ \exists \ b, a \ (< l, b, a > \in loan \wedge a > 1200) \ \}$

Domain Relational Calculus

- Find the names of all customers who have a loan from the Perryridge branch and find the loan amount.
  Solution: $\{ < c, a > \ | \ \exists \ l(< c, l > \in borrower \land \exists b \ (< l, b, a > \in loan \land b = "Perryridge"))\}$

- Find all customers who have a loan, an account, or both at the Perryridge branch.
  Solution: $\{< c > |\exists l(< c, l > \in borrower \land \exists b, a(< l, b, a > \in loan \land b = "Perryridge")) \lor \exists a(< c, a > \in depositor \land \exists b, n(< a, b, n > \in account \land b = "Perryridge"))\}$

Domain Relational Calculus

- Find all customers who have an account at all branches located in Brooklyn.

  Solution:

  $\{< c > \mid \forall x, y, z(< x, y, z > \in branch \wedge y = "Brooklyn" \Rightarrow \exists a, b(< a, x, b > \in account \wedge < c, a > \in depositor))\}$

Exercise

Ques. 1: Consider the following relational database, where the primary keys are underlined.
employee (<u>person-name</u>, street, city)
works (<u>person-name</u>, company-name, salary)
company (<u>company-name</u>, city)
manages (<u>person-name</u>, manager-name)

Give an expression in the relational algebra to express each of the following queries:
1. Find the names of all employees who work for First Bank Corporation.
2. Find the names and cities of residence of all employees who work for First Bank Corporation.

Exercise

3. Find the names, street address, and cities of residence of all employees who work for First Bank Corporation and earn more than \$10,000 per annum.
4. Find the names of all employees in this database who live in the same city as the company for which they work.
5. Find the names of all employees who live in the same city and on the same street as do their managers.
6. Find the names of all employees in this database who do not work for First Bank Corporation.
7. Find the names of all employees who earn more than every employee of Small Bank Corporation.

Exercise

8. Assume the companies may be located in several cities. Find all companies located in every city in which Small Bank Corporation is located.
9. Find the company with the most employees.
10. Find the company with the smallest payroll.
11. Find those companies whose employees earn a higher salary, on average, than the average salary at First Bank Corporation.

Solution of Question 1

1. $\Pi_{person-name}(\sigma_{company-name="First\ \ Bank\ \ Corporation"}(works))$

2. $\Pi_{person-name,city}(\sigma_{company-name="First\ \ Bank\ \ Corporation"}(employee \bowtie works))$

3. $\Pi_{person-name,street,city}(\sigma_{company-name="First\ \ Bank\ \ Corporation" \wedge salary>10000}$ $(\mathrm{employee} \bowtie works))$

4. $\Pi_{person-name}(employee \bowtie works \bowtie company))$

5. $temp \leftarrow \Pi_{manager-name,street,city}$ $(\sigma_{employee.person-name=manages.manager-name}(employee \times manages)$ $\Pi_{person-name}(employee \bowtie manages \bowtie temp)$

Exercise

6. $\Pi_{person-name}(\sigma_{company-name \neq \text{" FirstBankCorporation"}}(works))$

7. $\Pi_{person-name}(works) - \Pi_{works.person-name}(\sigma_{works.salary \leq r.salary}(works \times (\rho_r(\sigma_{company-name = \text{" Small Bank corporation"}}(works)))))$

8. $company \div \Pi_{city}(\sigma_{company-name = \text{" Small Bank Corporation"}}(company)))$

9. $temp \leftarrow {}_{company-name}\mathcal{G}_{count(person-name)\ as\ person-count}(works)$
$\Pi_{company-name}(\sigma_{temp.person-count = r.max-employee}(temp \times \rho_r(\mathcal{G}_{max(person-count)\ as\ max-employee}(temp))))$

Exercise

10. $temp \leftarrow \ _{company-name}\mathcal{G}_{sum(salary)\ as\ payroll}(works)$
$\Pi_{company-name}(\sigma_{temp.payroll=r.min-payroll}(temp \times$
$\rho_r(\mathcal{G}_{min(payroll)\ as\ min-payroll}(temp))))$

11. $temp1 \leftarrow \mathcal{G}_{avg(salary)\ as\ avg-salary}$
$(\sigma_{company-name="First\ Bank\ Corporation"}(works)$
$temp2 \leftarrow_{company-name}\ \mathcal{G}_{avg(salary)\ as\ avg-salary}(works)$
$\Pi_{company-name}(\sigma_{temp2.avg-salary>temp1.avg-salary}(temp2 \times temp1))$