Database Systems Concepts and Design

CSC201S2/G2

Chapter 6: Relational Algebra

Outline

- Introduction for Relational Algebra
- Unary Relational Operations
- Relational Algebra Operations from Set Theory

Relational Algebra

- The basic set of operations for the relational model
- Enable the specification of basic retrievals
- Algebra operations thus produce new relations, which can be further manipulated the same algebra.
- A sequence of relational algebra operations forms a relational algebra expression,
- The result will also be a relation that represents the result of a database query

Definitions Relational Algebra

Domain: set of relations

Basic operators: select, project, union, set difference, Cartesian (cross) product

Derived operators: set intersection, division, join

Procedural: Relational expression specifies query by describing an algorithm for determining the result of an expression

Unary Relational Operation

SELECT Operation: select a subset of the tuples from a relation that satisfy a selection condition.

Examples:

$$\sigma_{DNO = 4}(EMPLOYEE)$$

$$\sigma_{SALARY > 30,000}(EMPLOYEE)$$

denoted by $\sigma_{<\text{selection condition}>}(R)$ where the symbol σ (sigma) is used to denote the select operator, and the selection condition is a Boolean expression specified on the attributes of relation R

Unary Relational Operation

The SELECT operation $\sigma_{<\text{selection condition}>}(R)$ produces a relation S that has the same schema as R

The SELECT operation σ is commutative;

$$\sigma_{<\text{condition1}>}(\sigma_{<\text{condition2}>}(R)) = \sigma_{<\text{condition2}>}(\sigma_{<\text{condition1}>}(R))$$

A cascaded SELECT operation may be applied in any order

$$\sigma_{<\text{condition1}>}(\sigma_{<\text{condition2}>}(\sigma_{<\text{condition3}>}(R))) = \sigma_{<\text{condition2}>}(\sigma_{<\text{condition3}>}(\sigma_{<\text{condition1}>}(R)))$$

A cascaded SELECT operation may be replaced by a single selection with a conjunction of all the conditions

$$\sigma_{<\text{condition1}>}(\sigma_{<\text{condition2}>}(\sigma_{<\text{condition3}>}(R))) = \sigma_{<\text{condition1}> \text{ AND } <\text{condition2}> \text{ AND } <\text{condition3}>}(R)))$$

Selection Condition

Operators: $<, \leq, \geq, >, =, \neq$

Simple selection condition:

- <attribute> operator <constant>
- <attribute> operator <attribute>
- <condition> AND <condition>
- <condition> OR <condition>
- NOT <condition>

Examples

Person

Id	*Name*	*Address*	*Hobby*
1123	John	123 Main	stamps
1123	John	123 Main	coins
5556	Mary	7 Lake Dr	hiking
9876	Bart	5 Pine St	stamps

$\sigma_{Id>3000 \text{ OR } Hobby=\text{'hiking'}}(\text{Person})$

$\sigma_{Id>3000 \text{ AND } Id<3999}(\text{Person})$

$\sigma_{\text{NOT}(Hobby=\text{'hiking'})}(\text{Person})$

$\sigma_{Hobby\neq\text{'hiking'}}(\text{Person})$

Unary Relational Operation

- **PROJECT Operation:** selects certain *columns* from the table and discards the others.

  Example: $\pi_{\text{LNAME, FNAME,SALARY}}(\text{EMPLOYEE})$

  The general form of the project operation is: $\pi_{\text{<attribute list>}}(R)$ where π is the symbol used to represent the project operation and <attribute list> is the desired list of attributes.

  PROJECT *removes duplicate tuples*, so the result is a set of tuples and hence a valid relation.

Example

(a) $\sigma_{(DNO=4\ AND\ SALARY>25000)\ OR\ (DNO=5\ AND\ SALARY>30000)}(EMPLOYEE)$

(b) $\pi_{LNAME,\ FNAME,\ SALARY}(EMPLOYEE)$

(c) $\pi_{SEX,\ SALARY}(EMPLOYEE)$

(a)

FNAME	MINIT	LNAME	SSN	BDATE	ADDRESS	SEX	SALARY	SUPERSSN	DNO
Franklin	T	Wong	333445555	1955-12-08	638 Voss,Houston,TX	M	40000	888665555	5
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry,Bellaire,TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 FireOak,Humble,TX	M	38000	333445555	5

(b)

LNAME	FNAME	SALARY
Smith	John	30000
Wong	Franklin	40000
Zelaya	Alicia	25000
Wallace	Jennifer	43000
Narayan	Ramesh	38000
English	Joyce	25000
Jabbar	Ahmad	25000
Borg	James	55000

(c)

SEX	SALARY
M	30000
M	40000
F	25000
F	43000
M	38000
M	25000
M	55000

Exercise

- Consider the following relations

DEPOSIT

Branch name	Account number	Customer name	Balance
Downtown	101	Johnson	500
Mianus	215	Smith	700
Perry ridge	102	Hayes	400
Round Hill	305	Turner	350
Perry ridge	201	Williams	900
Redwood	222	Lindsay	700
Brighton	217	Green	750
Downtown	105	Green	850

BORROW

Branch name	Loan number	Customer name	Amount
Downtown	17	Jones	1000
Redwood	23	Smith	2000
Perry ridge	15	Hayes	1500
Downtown	14	Jackson	1500
Mianus	93	Curry	500
Round Hill	11	Turner	900
Pownal	29	Williams	1200
North Town	16	Adams	1300
Downtown	18	Johnson	2000
Perry ridge	25	Glenn	2500
Brighton	10	Brooks	2200

CLIENT

Customer name	Banker name
Turner	Johnson
Hayes	Jones
Johnson	Johnson

Exercise

- Consider the following relations

CUSTOMER

Customer name	Street	Customer city
Jones	Main	Harrison
Smith	North	Rye
Hayes	Main	Harrison
Curry	North	Rye
Lindsay	Park	Pittsfield
Turner	Putnam	Stamford
Williams	Nissan	Princeton
Adams	Spring	Pittsfield
Johnson	Alma	Palo Alto
Glenn	Sand Hill	Woodside
Brooks	Senator	Brooklyn
Green	Walnut	Stamford

BRANCH

Branch name	Assets	Branch city
Downtown	900000	Brooklyn
Redwood	2100000	Palo Alto
Perry ridge	1700000	Horse neck
Mainus	400000	Horse neck
Round Hill	800000	Horse neck
Pownal	300000	Bennington
North Town	3700000	Rye
Brighton	7100000	Brooklyn

Exercise

Write relational algebra statements to do following:

1. Find the **names** of all **branches** in the **deposit relation**?
2. Find all tuples **having an account at the Perry ridge branch**?
3. Find all tuples **having a loan from the Perry ridge branch**?
4. Find all tuples in which the **amount borrowed is more than $1200**?
5. Find those tuples pertaining loans of **more than $1200 made by the Perryridge branch**?
6. Find all those customers who have the **same name as their personal banker**?

Exercise

7.

   a. Find **all customers with a loan at the Perry ridge branch**?

   b. Find **all customers with an account at the Perry ridge**?

   c. Find **everyone who has a loan, an account, or both**?

8. Find all customers of the Perry ridge branch who **have an account there but not a loan**?

9. Find all customers with **both a loan and an account at the Perry ridge branch**?


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&
A