Database Management System – 19 (Relational Algebra – Relational operations from Set Theory)

Ajay James
Asst. Prof in CSE
Government Engineering College Thrissur

Outline

- UNION
- INTERSECTION
- DIFFERENCE
- CARTESIAN PRODUCT

UNION Operation

- Denoted by R ∪ S
- Results in a relation that includes all tuples that are ***either in R or in S or in both R and S***
- Duplicate tuples are eliminated
- **Example:** To retrieve the social security numbers of all employees who either work in department 5 or directly supervise an employee who works in department 5

  DEP5_EMPS ← $\sigma_{DNO=5}$ (EMPLOYEE)
  RESULT1 ← π_{SSN}(DEP5_EMPS)
  RESULT2(SSN) ← $\pi_{SUPERSSN}$(DEP5_EMPS)
  RESULT ← RESULT1 ∪ RESULT2
- Two operands must be "type compatible"

UNION Operation

- **Type Compatibility**
  - Operand relations $R_1(A_1, A_2, ..., A_n)$ and $R_2(B_1, B_2, ..., B_n)$ must have the ***same number of attributes***
  - And the domains of corresponding attributes must be compatible; that is, $dom(A_i)=dom(B_i)$ for i=1, 2, ..., n
- Resulting relation for $R_1 \cup R_2$, $R_1 \cap R_2$, or $R_1 - R_2$ has the same attribute names as the *first* operand relation R1 (by convention)

Example

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

$DEP5\_EMPS \leftarrow \sigma_{Dno=5}(EMPLOYEE)$

$RESULT1 \leftarrow \pi_{Ssn}(DEP5\_EMPS)$

$RESULT2(Ssn) \leftarrow \pi_{Super\_ssn}(DEP5\_EMPS)$

$RESULT \leftarrow RESULT1 \cup RESULT2$

RESULT1

Ssn
123456789
333445555
666884444
453453453

RESULT2

Ssn
333445555
888665555

RESULT

Ssn
123456789
333445555
666884444
453453453
888665555

UNION example

STUDENT

Fn	Ln
Susan	Yao
Ramesh	Shah
Johnny	Kohler
Barbara	Jones
Amy	Ford
Jimmy	Wang
Ernest	Gilbert

INSTRUCTOR

Fname	Lname
John	Smith
Ricardo	Browne
Susan	Yao
Francis	Johnson
Ramesh	Shah

Fn	Ln
Susan	Yao
Ramesh	Shah
Johnny	Kohler
Barbara	Jones
Amy	Ford
Jimmy	Wang
Ernest	Gilbert
John	Smith
Ricardo	Browne
Francis	Johnson

INTERSECTION OPERATION

- Denoted by R ∩ S
- Result is a relation that includes all tuples that are in ***both R and S***
- Two operands must be "type compatible"

STUDENT

Fn	Ln
Susan	Yao
Ramesh	Shah
Johnny	Kohler
Barbara	Jones
Amy	Ford
Jimmy	Wang
Ernest	Gilbert

INSTRUCTOR

Fname	Lname
John	Smith
Ricardo	Browne
Susan	Yao
Francis	Johnson
Ramesh	Shah

Fn	Ln
Susan	Yao
Ramesh	Shah

Set Difference (or MINUS) Operation

- Denoted by R – S
- Result is a relation that includes all tuples that are ***in R but not in S***
- Two operands must be "type compatible"

STUDENT

Fn	Ln
Susan	Yao
Ramesh	Shah
Johnny	Kohler
Barbara	Jones
Amy	Ford
Jimmy	Wang
Ernest	Gilbert

INSTRUCTOR

Fname	Lname
John	Smith
Ricardo	Browne
Susan	Yao
Francis	Johnson
Ramesh	Shah

- Student – Instructor

Fn	Ln
Johnny	Kohler
Barbara	Jones
Amy	Ford
Jimmy	Wang
Ernest	Gilbert

Instructor - Student

Fname	Lname
John	Smith
Ricardo	Browne
Francis	Johnson

Relational Algebra Operations From Set Theory

- Both union and intersection are *commutative operations*

  $R \cup S = S \cup R$, and $R \cap S = S \cap R$

- Both union and intersection can be treated as n-ary operations applicable to any number of relations as both are *associative operations*

  $R \cup (S \cup T) = (R \cup S) \cup T$, and $(R \cap S) \cap T = R \cap (S \cap T)$

- Minus operation is *not commutative*

  $R - S \neq S - R$

CARTESIAN (or cross product) Operation

- Used to combine tuples from two relations in a combinatorial fashion
- $R(A_1, A_2, \ldots, A_n)$ x $S(B_1, B_2, \ldots, B_m)$ is a relation Q with degree ***n + m attributes***
- $Q(A_1, A_2, \ldots, A_n, B_1, B_2, \ldots, B_m)$in that order
- Resulting relation Q has one tuple for each combination of tuples—one from R and one from S
- If R has n_R tuples (denoted as $|R| = n_R$), and S has n_S tuples, then

  | R x S | will have ***n_R * n_S tuples***

- Two operands do NOT have to be "type compatible"

EMPLOYEE

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno
John	B	Smith	123456789	1965-01-09	731 Fondren, Houston, TX	M	30000	333445555	5
Franklin	T	Wong	333445555	1955-12-08	638 Voss, Houston, TX	M	40000	888665555	5
Alicia	J	Zelaya	999887777	1968-01-19	3321 Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291 Berry, Bellaire, TX	F	43000	888665555	4
Ramesh	K	Narayan	666884444	1962-09-15	975 Fire Oak, Humble, TX	M	38000	333445555	5
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5
Ahmad	V	Jabbar	987987987	1969-03-29	980 Dallas, Houston, TX	M	25000	987654321	4
James	E	Borg	888665555	1937-11-10	450 Stone, Houston, TX	M	55000	NULL	1

FEMALE_EMPS $\leftarrow \sigma_{Sex='F'}(EMPLOYEE)$

EMPNAMES $\leftarrow \pi_{Fname, Lname, Ssn}(FEMALE\_EMPS)$

FEMALE_EMPS

Fname	Minit	Lname	Ssn	Bdate	Address	Sex	Salary	Super_ssn	Dno
Alicia	J	Zelaya	999887777	1968-07-19	3321Castle, Spring, TX	F	25000	987654321	4
Jennifer	S	Wallace	987654321	1941-06-20	291Berry, Bellaire, TX	F	43000	888665555	4
Joyce	A	English	453453453	1972-07-31	5631 Rice, Houston, TX	F	25000	333445555	5

EMPNAMES

Fname	Lname	Ssn
Alicia	Zelaya	999887777
Jennifer	Wallace	987654321
Joyce	English	453453453

EMPNAMES

Fname	Lname	Ssn
Alicia	Zelaya	999887777
Jennifer	Wallace	987654321
Joyce	English	453453453

DEPENDENT

Essn	Dependent_name	Sex	Bdate	Relationship
333445555	Alice	F	1986-04-05	Daughter
333445555	Theodore	M	1983-10-25	Son
333445555	Joy	F	1958-05-03	Spouse
987654321	Abner	M	1942-02-28	Spouse
123456789	Michael	M	1988-01-04	Son
123456789	Alice	F	1988-12-30	Daughter
123456789	Elizabeth	F	1967-05-05	Spouse

$$EMP\_DEPENDENTS \leftarrow EMPNAMES \times DEPENDENT$$

EMP_DEPENDENTS

Fname	Lname	Ssn	Essn	Dependent_name	Sex	Bdate	...
Alicia	Zelaya	999887777	333445555	Alice	F	1986-04-05	...
Alicia	Zelaya	999887777	333445555	Theodore	M	1983-10-25	...
Alicia	Zelaya	999887777	333445555	Joy	F	1958-05-03	...
Alicia	Zelaya	999887777	987654321	Abner	M	1942-02-28	...
Alicia	Zelaya	999887777	123456789	Michael	M	1988-01-04	...
Alicia	Zelaya	999887777	123456789	Alice	F	1988-12-30	...
Alicia	Zelaya	999887777	123456789	Elizabeth	F	1967-05-05	...
Jennifer	Wallace	987654321	333445555	Alice	F	1986-04-05	...
Jennifer	Wallace	987654321	333445555	Theodore	M	1983-10-25	...
Jennifer	Wallace	987654321	333445555	Joy	F	1958-05-03	...
Jennifer	Wallace	987654321	987654321	Abner	M	1942-02-28	...
Jennifer	Wallace	987654321	123456789	Michael	M	1988-01-04	...
Jennifer	Wallace	987654321	123456789	Alice	F	1988-12-30	...
Jennifer	Wallace	987654321	123456789	Elizabeth	F	1967-05-05	...
Joyce	English	453453453	333445555	Alice	F	1986-04-05	...
Joyce	English	453453453	333445555	Theodore	M	1983-10-25	...
Joyce	English	453453453	333445555	Joy	F	1958-05-03	...
Joyce	English	453453453	987654321	Abner	M	1942-02-28	...
Joyce	English	453453453	123456789	Michael	M	1988-01-04	...
Joyce	English	453453453	123456789	Alice	F	1988-12-30	...
Joyce	English	453453453	123456789	Elizabeth	F	1967-05-05	...

Example

$$ACTUAL\_DEPENDENTS \leftarrow \sigma_{Ssn=Essn}(EMP\_DEPENDENTS)$$

ACTUAL_DEPENDENTS

Fname	Lname	Ssn	Essn	Dependent_name	Sex	Bdate	...
Jennifer	Wallace	987654321	987654321	Abner	M	1942-02-28	...

$$RESULT \leftarrow \pi_{Fname,\ Lname,\ Dependent\_name}(ACTUAL\_DEPENDENTS)$$

RESULT

Fname	Lname	Dependent_name
Jennifer	Wallace	Abner

Reference

- Elmasri R. and S. Navathe, Database Systems: Models, Languages, Design and Application Programming, Pearson Education 6th edition and 7th edition

Thank you