COMP207
Database
Development

Tutorial 6 (Week 8)

Relational Algebra-1

Relational Algebra
Query Blocks as Algebra

- Retrieve names of employees in all departments with salary > highest salary in dept-5

SELECT Lname, Fname

  FROM EMPLOYEE

      WHERE Salary > (SELECT MAX(Salary)

               FROM EMPLOYEE

                  WHERE Dno = 5);

Inner block = π max_salary(σdno=5$^{(EMPLOYEE)}$) this give a temporary file to be used by outer block

Outer block = π Lname, Fname(σ salary> temporary file $^{(EMPLOYEE)}$)

Algebra Operations
The 'Complete Set'

- SELECT   =   ϭ   Sigma   (Not SQL Select)
- PROJECT   =   π   Pi   (Not 3.142)
- JOIN   =   ⋈   Natural Join
- RENAME   =   P   Rho
- UNION   =   U   Union
- INTERSECTION   =   ∩   Intersection
- SET DIFFERENCE   =   -   Except
- Cartesian Product   =   X   Chi

Database specific

Maths set

All other operations can be expressed as a sequence from this set

Relational Algebra – Maths Set

- Union (of R and S)
  - Binary operator (applied to two relations)
  - R U S = elements in R or S or Both
    - Includes all tuples that are either in R or in S or in both R and S
    - Duplicate tuples eliminated
    - commutative: R $\cup$ S = S $\cup$ R, and
    - associative R $\cup$ (S $\cup$ T) = (R $\cup$ S) $\cup$ T

Union of two relations

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

Union as the Cartesian Product (X)
In SQL: SELECT * FROM TABLE1, TABLE2;

- CROSS PRODUCT or CROSS JOIN

- Operation is binary

- Cardinality of the result is one tuple for each combination of tuples
  - if *R has cardinality nR and S has cardinality nS then* cardinality of *Q is nQ = nR* nS*

Relational Algebra – Maths Set

- Intersection (of R and S)

  R ∩ S   = elements in both R and S

- Difference (between R and S)

  (R-S) = elements in R but not in S

  (S-R) = elements in S but not in R

Cartesian Product (X)
Given Six Relations

Figure 3.6
One possible database state for the COMPANY relational database schema.

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

DEPARTMENT

Dname	Dnumber	Mgr_ssn	Mgr_start_date
Research	5	333445555	1988-05-22
Administration	4	987654321	1995-01-01
Headquarters	1	888665555	1981-06-19

DEPT_LOCATIONS

Dnumber	Dlocation
1	Houston
4	Stafford
5	Bellaire
5	Sugarland
5	Houston

Cartesian Product (X)
Given Six Relations

WORKS_ON

Essn	Pno	Hours
123456789	1	32.5
123456789	2	7.5
666884444	3	40.0
453453453	1	20.0
453453453	2	20.0
333445555	2	10.0
333445555	3	10.0
333445555	10	10.0
333445555	20	10.0
999887777	30	30.0
999887777	10	10.0
987987987	10	35.0
987987987	30	5.0
987654321	30	20.0
987654321	20	15.0
888665555	20	NULL

PROJECT

Pname	Pnumber	Plocation	Dnum
ProductX	1	Bellaire	5
ProductY	2	Sugarland	5
ProductZ	3	Houston	5
Computerization	10	Stafford	4
Reorganization	20	Houston	1
Newbenefits	30	Stafford	4

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

Cartesian Product (X)

- Retrieve the list of names of each female employee's dependents
- The Cartesian Product is a binary set operation (works on two relations)
  - combines every tuple from one relation (EMPLOYEE) with every tuple from the other relation (DEPENDENT)

Cartesian Product (X)

- Hence
  - John Smith (EMPLOYEE) will combine with all seven tuples in DEPENDENT
- Then
  - Franklin Wong (EMPLOYEE) will combine with all seven tuples in DEPENDENT
- Then
  - Alicia Zelaya (EMPLOYEE) will combine with all seven tuples in DEPENDENT . . . etc

Cartesian Product (X)

- We get a very large file which is generally meaningless

- We want the names of dependents of female employees only

- The Cartesian Product becomes more useful using selection etc to match values of attributes derived from the component relations

Cartesian Product (X)

retrieve the list of names of each female employee's dependents

- Use EMPLOYEE file:
  - Ƃ sex = 'F' and store in FEMALE-EMPS
- Use FEMALE-EMPS file:
  - π Fname, Lname, Ssn and store in EMPNAMES
- Use EMPNAMES and DEPENDENT files:
  - CROSS JOIN (X) the files and store in EMP-DEPENDENTS
- Use EMP-DEPENDENTS file:
  - Ƃ Ssn=Essn and store in ACTUAL-DEPENDENTS
- Use ACTUAL-DEPENDENTS file:
  - π Fname, Lname, Dependent_name and store in RESULT

Cartesian Product (X)

FEMALE_ EMPS	FNAME	MINIT	LNAME	SSN	BDATE	ADDRESS	SEX	SALARY	SUPERSSN	DNO
	Alicia	J	Zelaya	999887777	1968-07-19	3321 Castle,Spring,TX	F	25000	987654321	4
	Jennifer	S	Wallace	987654321	1941-06-20	291 Berry,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

Cartesian Product (X)

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	• • •