

A decorative graphic on the left side of the slide, consisting of a network of white lines and circles on a teal background, resembling a circuit board or a neural network.

WEEK 4

THE RELATIONAL ALGEBRA - REVIEW

CS3319

STUDENT OBJECTIVES

- Upon completion of this video, you should be able to:
 - List the 9 operations used in Relational Algebra
 - Write some relational algebra expressions
 - Solve some queries given tables and relational algebra expressions

SUMMARY OF OPERATIONS

Table 6.1

Operations of Relational Algebra

Operation	Purpose	Notation
SELECT	Selects all tuples that satisfy the selection condition from a relation R .	$\sigma_{\langle \text{selection condition} \rangle}(R)$
PROJECT	Produces a new relation with only some of the attributes of R , and removes duplicate tuples.	$\pi_{\langle \text{attribute list} \rangle}(R)$
THETA JOIN	Produces all combinations of tuples from R_1 and R_2 that satisfy the join condition.	$R_1 \bowtie_{\langle \text{join condition} \rangle} R_2$
EQUIJOIN	Produces all the combinations of tuples from R_1 and R_2 that satisfy a join condition with only equality comparisons.	$R_1 \bowtie_{\langle \text{join condition} \rangle} R_2$, OR $R_1 \bowtie_{(\langle \text{join attributes 1} \rangle), (\langle \text{join attributes 2} \rangle)} R_2$
NATURAL JOIN	Same as EQUIJOIN except that the join attributes of R_2 are not included in the resulting relation; if the join attributes have the same names, they do not have to be specified at all.	$R_1 *_{\langle \text{join condition} \rangle} R_2$, OR $R_1 *_{(\langle \text{join attributes 1} \rangle), (\langle \text{join attributes 2} \rangle)} R_2$ OR $R_1 * R_2$
UNION	Produces a relation that includes all the tuples in R_1 or R_2 or both R_1 and R_2 ; R_1 and R_2 must be union compatible.	$R_1 \cup R_2$
INTERSECTION	Produces a relation that includes all the tuples in both R_1 and R_2 ; R_1 and R_2 must be union compatible.	$R_1 \cap R_2$
DIFFERENCE	Produces a relation that includes all the tuples in R_1 that are not in R_2 ; R_1 and R_2 must be union compatible.	$R_1 - R_2$
CARTESIAN PRODUCT	Produces a relation that has the attributes of R_1 and R_2 and includes as tuples all possible combinations of tuples from R_1 and R_2 .	$R_1 \times R_2$
DIVISION	Produces a relation $R(X)$ that includes all tuples $t[X]$ in $R_1(Z)$ that appear in R_1 in combination with every tuple from $R_2(Y)$, where $Z = X \cup Y$.	$R_1(Z) \div R_2(Y)$

FINAL REVIEW QUESTIONS

QUESTION: Write the expression to find all the employees last names and salaries who work in Head Office

ProjectNu	ProjectName	ProjLocat	Managing
A1	Accounting Update	Toronto	S7G
A3	Acc3	Springfield	G8H
A6	Acc6	Toronto	S7G
I1	Inventory	Toronto	G8H
I2	Inventory2	London	S7G
P1	Payroll	Springfield	G8H
P2	Payroll2	London	G8H
P3	Payroll3	London	G8H

DeptNum	DeptName	ManagerEmpID	ManagerStartDate	Cli
G8H	Head Office	4	12/12/1999	
S7G	Safety Department	3	11/11/1998	
Y5J	Research Department	6	12/24/1998	

EmpID	LastName	FirstName	DeptNumber	Sex	BDate	SuperSSN	Salary
1	Simpson	Bart	G8H	M	2/2/1995	2	\$1,000.00
2	Smithers	Waylan	S7G	M	1/1/1960	4	\$2,000.00
3	Beauvieu	Patty	Y5J	F	3/3/1959	6	\$4,000.00
4	Burns	Monty	S7G	M	7/7/2020		\$5,000.00
6	Simpson	Lisa	S7G	F	6/6/1990	2	\$1,000.00
12	Simpson	Homer	G8H	M	8/8/1961	2	\$2,000.00

HEADOFF1 $\leftarrow \pi_{\text{DeptNumber}}(\sigma_{\text{deptName}=\text{"Head Office"}}(\text{DEPARTMENT}))$
 ANS $\leftarrow \pi_{\text{LastName}, \text{Salary}}(\text{HEADOFF1} \bowtie \text{EMPLOYEE})$

QUESTION: Write the expression to list the name of each project, along with the name of the department it is assigned to, along with that department managers last name.

TEMP $\leftarrow \pi_{\text{DeptName}, \text{ManagerEmpID}, \text{ProjectName}}(\text{DEPARTMENT} \bowtie_{\text{DeptNumber}=\text{ManagingDeptNum}} \text{PROJECT})$
 ANS $\leftarrow \pi_{\text{LastName}, \text{DeptName}, \text{ProjectName}}(\text{TEMP} \bowtie_{\text{ManagerEmpID}=\text{EmpID}} \text{EMPLOYEE})$

QUESTION: Retrieve the names of employees who have no dependents.

$ALL_EMPS \leftarrow \pi_{EmpID}(EMPLOYEE)$

$EMPS_WITH_DEPS(EmpID) \leftarrow \pi_{ESSN}(DEPENDENT)$

$EMPS_WITHOUT_DEPS \leftarrow (ALL_EMPS - EMPS_WITH_DEPS)$

$RESULT \leftarrow \pi_{LNAME, FNAME}(EMPS_WITHOUT_DEPS \bowtie EMPLOYEE)$

Project				
ProjectNu	ProjectName	ProjLocati	Managing	Clie
A1	Accounting Update	Toronto	S7G	
A3	Acc3	Springfield	G8H	
A6	Acct6	Toronto	S7G	
I1	Inventory	Toronto	G8H	
I2	Inventory2	London	S7G	
P1	Payroll	Springfield	G8H	
P2	Payroll2	London	G8H	
P3	Payroll3	London	G8H	
Record: 14 of 8				

Department			
DeptNun	DeptName	ManagerEmpID	ManagerStartdate
G8H	Head Office	4	12/12/1999
S7G	Safety Department	3	11/11/1998
Y5J	Research Department	6	12/24/1998
Record: 14 of 3			

Employee							
EmpID	LastName	FirstName	DeptNumber	Sex	BDate	SuperSSN	Salary
1	Simpson	Bart	G8H	M	2/2/1995	2	\$1,000.00
2	Smithers	Waylan	S7G	M	1/1/1960	4	\$2,000.00
3	Beauvieu	Patty	Y5J	F	3/3/1959	6	\$4,000.00
4	Burns	Monty	S7G	M	7/7/2020		\$5,000.00
6	Simpson	Lisa	S7G	F	6/6/1990	2	\$1,000.00
12	Simpson	Homer	G8H	M	8/8/1961	2	\$2,000.00
Record: 14 of 16							

WorksOn		
EmpsSSNu	ProjectNu	Hours
1 A3		45
2 A1		56
3 A3		3
3 A6		45
3 I1		43
3 P1		9
4 A1		6
4 A3		5
4 A6		6
4 I1		43
4 I2		8
4 P1		67
4 P2		77
4 P3		67
6 I2		6
12 A3		56
Record: 14 of 16		

Use the following two tables to answer the following questions:

Table AA:

A	B	C	D
2	22	y	z
2	33	x	x
1	22	x	y
1	11	w	x

Table BB:

E	F	D
1	44	z
2	44	x
2	33	x

QUESTION: How many attributes will the following query return?

AA ⋈ BB

QUESTION: How many tuples? List those tuples:

Table AA:

A	B	C	D
2	22	y	z
2	33	x	x
1	22	x	y
1	11	w	x

Table BB:

E	F	D
1	44	z
2	44	x
2	33	x

A	B	C	D	E	F
2	22	y	z	1	44
2	33	x	x	2	44
2	33	x	x	2	33
1	11	w	x	2	44
1	11	w	x	2	33

QUESTION: How many attributes will the following query return?

AA ⋈_{C=D} BB

QUESTION: How many tuples? List those tuples:

Table AA:

A	B	C	D
2	22	y	z
2	33	x	x
1	22	x	y
1	11	w	x

Table BB:

E	F	D
1	44	z
2	44	x
2	33	x

A	B	C	AA.D	E	F	BB.D
2	33	x	x	2	44	X
2	33	x	x	2	33	X
1	22	x	y	2	44	X
1	22	x	y	2	33	X

QUESTION: How many attributes will the following query return?

AA ⋈ BB

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Table AA:

A	B	C	D
2	22	y	z
2	33	x	x
1	22	x	y
1	11	w	x

Table BB:

E	F	D
1	44	z
2	44	x
2	33	x

A	B	C	D	E	F
2	22	y	z	1	44
2	33	x	x	2	44
2	33	x	x	2	33
1	11	w	x	2	44
1	11	w	x	2	33

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Table BB:

E	F	D
1	44	z
2	44	x
2	33	x

A	B	C	D	E	F
2	22	y	z	1	44
2	33	x	x	2	44
2	33	x	x	2	33
1	11	w	x	2	44
1	11	w	x	2	33
1	22	x	y	NULL	NULL

QUESTION: How many attributes will the following query return?

AA  BB

QUESTION: How many tuples? List those tuples:

Table AA:

A	B	C	D
2	22	y	z
2	33	x	x
1	22	x	y
1	11	w	x

Table BB:

E	F	D
1	44	z
2	44	x
2	33	x

A	B	C	D	E	F
2	22	y	z	1	44
2	33	x	x	2	44
2	33	x	x	2	33
1	11	w	x	2	44
1	11	w	x	2	33
1	22	x	y	NULL	NULL

QUESTION: How many attributes will the following query return?

$\pi_D(AA) \cap \pi_D(BB)$

QUESTION: How many tuples? List those tuples:

Table AA:

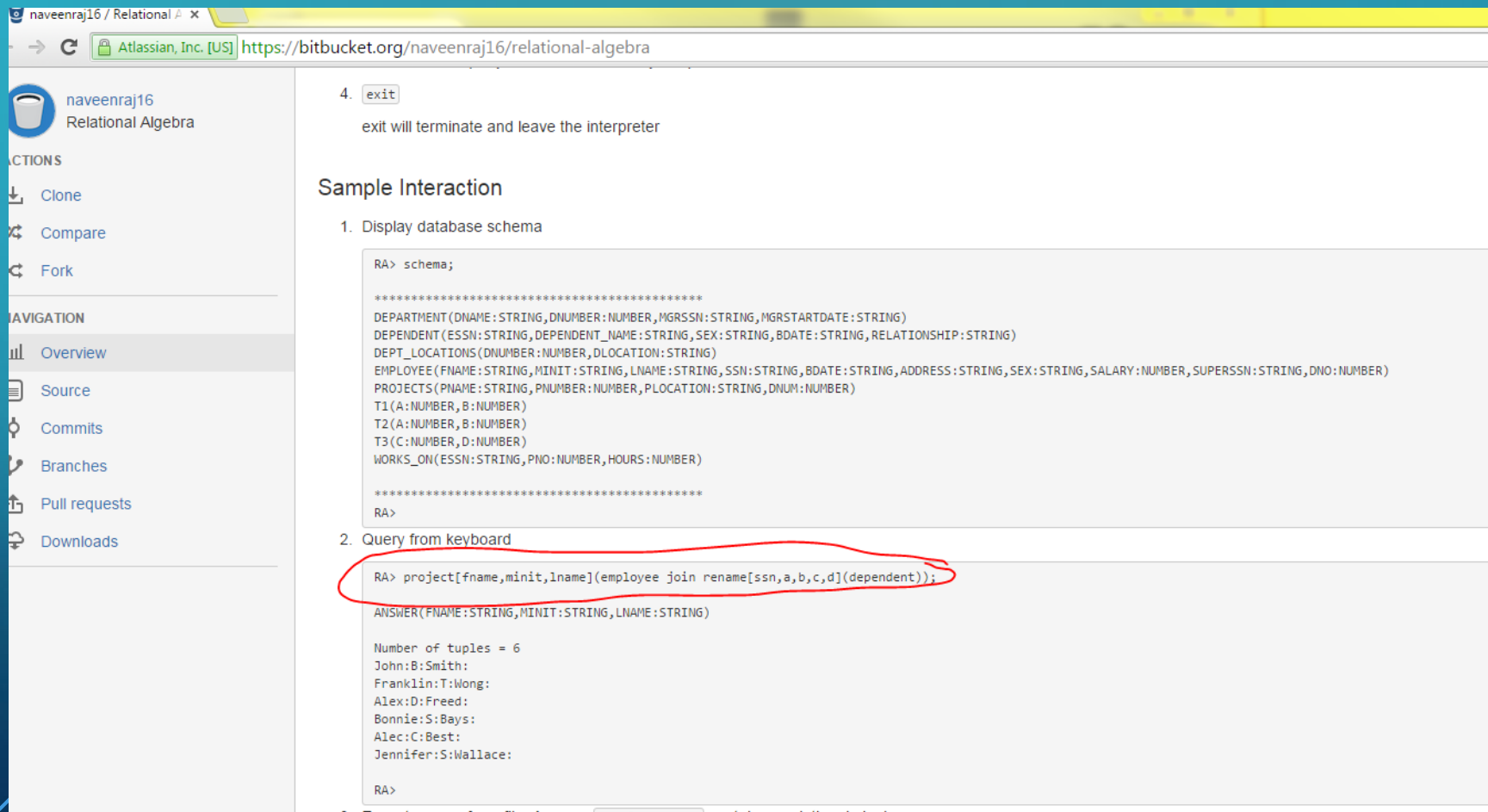
A	B	C	D
2	22	y	z
2	33	x	x
1	22	x	y
1	11	w	x

Table BB:

E	F	D
1	44	z
2	44	x
2	33	x

D
z
x

INTERESTING PROJECT – RELATIONAL ALGEBRA INTERPRETER



The screenshot shows a web browser window with the URL <https://bitbucket.org/naveenraj16/relational-algebra>. The page title is "naveenraj16 / Relational Algebra". The sidebar on the left contains the following sections:

- ACTIONS
 - Clone
 - Compare
 - Fork
- NAVIGATION
 - Overview
 - Source
 - Commits
 - Branches
 - Pull requests
 - Downloads

The main content area displays a "Sample Interaction" section with the following steps:

1. Display database schema
2. Query from keyboard

The interaction shows the following commands and output:

```
RA> schema;

*****
DEPARTMENT(DNAME:STRING,DNUMBER:NUMBER,MGRSSN:STRING,MGRSTARTDATE:STRING)
DEPENDENT(ESSN:STRING,DEPENDENT_NAME:STRING,SEX:STRING,BDATE:STRING,RELATIONSHIP:STRING)
DEPT_LOCATIONS(DNUMBER:NUMBER,DLOCATION:STRING)
EMPLOYEE(FNAME:STRING,MINIT:STRING,LNAME:STRING,SSN:STRING,BDATE:STRING,ADDRESS:STRING,SEX:STRING,SALARY:NUMBER,SUPERSSN:STRING,DNO:NUMBER)
PROJECTS(PNAME:STRING,PNUMBER:NUMBER,PLOCATION:STRING,DNUM:NUMBER)
T1(A:NUMBER,B:NUMBER)
T2(A:NUMBER,B:NUMBER)
T3(C:NUMBER,D:NUMBER)
WORKS_ON(ESSN:STRING,PNO:NUMBER,HOURS:NUMBER)

*****
RA>
```

Step 2, "Query from keyboard", is circled in red. The command entered is:

```
RA> project[fname,minit,lname](employee join rename[ssn,a,b,c,d](dependent));
```

The output of the query is:

```
ANSWER(FNAME:STRING,MINIT:STRING,LNAME:STRING)

Number of tuples = 6
John:B:Smith:
Franklin:T:Wong:
Alex:D:Freed:
Bonnie:S:Bays:
Alec:C:Best:
Jennifer:S:Wallace:
```

The interaction ends with the prompt `RA>`.