



# WEEK 4

THE RELATIONAL ALGEBRA BINARY OPERATION OF OUTER JOINS (FULL, RIGHT AND LEFT)

CS3319

# STUDENT OBJECTIVES

- Upon completion of this video, you should be able to:
  - Identify the symbols for FULL, LEFT and RIGHT outer joins.
  - Write a relational algebra expression that uses OUTER JOINS given two tables based on a given query.
  - Given 2 tables and an OUTER JOIN relational algebra expression, show the new table that would be returned once the expression is performed.
  - Given an OUTER JOIN relational algebra expression and two tables, explain in simple English what query is answered by the expression.

# FULL OUTER JOIN

- A full outer join is similar to a join except that it includes all the rows from both tables even if they don't have a matching value in the column that you are joining. If there is no match, put nulls in the columns from the other table.

Table1  Table2 (outer natural join)

Table1  Table2 (outer equi join)  
 columnname<sub>table1</sub> = columnname<sub>table2</sub>

Table1

A	B	C	D
12	Red	Can	24
24	Red	USA	33
45	Blue	Mex	33

Table2

B	F	G
Yellow	Cat	22
Red	Cat	33
Green	Dog	44
Red	Dog	24
Orange	Bird	33

ANSWER FOR Table1  Table2

ANSWER FOR Table1  Table2  
 D=G

A	Table1.B	C	D	Table2.B	F	G
12	Red	Can	24	Red	Dog	24
24	Red	USA	33	Red	Cat	33
24	Red	USA	33	Orange	Bird	33
45	Blue	Mex	33	Red	Cat	33
45	Blue	Mex	33	Orange	Bird	33
Null	Null	Null	Null	Yellow	Cat	22
Null	Null	Null	Null	Green	Dog	44

# FULL OUTER JOIN

- A full outer join is similar to a join except that it includes all the rows from both tables even if they don't have a matching value in the column that you are joining. If there is no match, put nulls in the columns from the other table.

Table1  Table2 (outer natural join)

Table1  columnnametable1=columnnametable2 Table2 (outer equi join)

Table1

A	B	C	D
12	Red	Can	24
24	Red	USA	33
45	Blue	Mex	33

Table2

B	F	G
Yellow	Cat	22
Red	Cat	33
Green	Dog	44
Red	Dog	24
Orange	Bird	33

ANSWER FOR Table1  Table2

ANSWER FOR Table1  D=G Table2

A	B	C	D	F	G
12	Red	Can	24	Cat	33
12	Red	Can	24	Dog	24
24	Red	USA	33	Cat	33
24	Red	USA	33	Dog	24
45	Blue	Mex	33	Null	Null
Null	Yellow	Null	Null	Cat	22
Null	Green	Null	Null	Dog	44
Null	Orange	Null	Null	Bird	33

- **Full Outer Join:**  $R \bowtie S$ : a join in which tuples from R that do not have matching (equal) values in the common columns of S still appear and tuples in S that do not have matching values in the common columns of R still appear in the resulting relation (padding the fields with nulls)
- **Left Outer Join:**  $R \ltimes S$ : a join in which tuples from R that do not have matching values in the common columns of S still appear in the resulting relation
- **Right Outer Join:**  $R \rhd S$ : tuples in S that do not have matching values in the common columns of R still appear in the resulting relation. *include every single row*

## Example: Outer Join

Table1 : Table					Table2 : Table		
	A	B	C	D		B	E
	a1	b1	c1	d2		b1	e1
	a2	b1	c2	d2		b2	e2
	a3	b1	c1	d2		b5	e3
	a1	b4	c1	d2			
	a5	b4	c2	d2			
	a1	b2	c1	d2			

**QUESTION:** What will the following expression result in?

Table1  Table2

A	B	C	D	E
	b5			e3
a1	b1	c1	d2	e1
a2	b1	c2	d2	e1
a3	b1	c1	d2	e1
a1	b4	c1	d2	
a5	b4	c2	d2	
a1	b2	c2	d2	e2

## Example: Left Outer Join

Table 1      Table 2      Table1 ⋈ Table2

The screenshot shows a database application with three windows. The first window, 'Table1 : Table', contains a table with columns A, B, C, and D. The second window, 'Table2...', contains a table with columns B and E. The third window, 'Query4 : Select Query', shows the result of a Left Outer Join between Table1 and Table2 on column B. The result includes all rows from Table1, plus an additional row where B is 'b2' and E is 'e2'.

	A	B	C	D
▶	a1	b1	c1	d2
	a2	b1	c2	d2
	a3	b1	c1	d2
	a1	b4	c1	d2
	a5	b4	c2	d2
	a1	b2	c1	d2
*				

	B	E
▶	b1	e1
	b2	e2
	b5	e3
*		

	a	b	c	d	e
▶	a1	b1	c1	d2	e1
	a2	b1	c2	d2	e1
	a3	b1	c1	d2	e1
	a1	b4	c1	d2	
	a5	b4	c2	d2	
	a1	b2	c1	d2	e2

## Example: Right Outer Join

Table1 ⋈ Table2

The screenshot displays three windows: 'Table1 : Table', 'Table2...', and 'Query4 : Select Query'. Red circles highlight the rows in Table1 and Table2 that match on the join key 'B'. A red arrow points from the row (b5, e3) in Table2 to the corresponding row in the query result.

	A	B	C	D
▶	a1	b1	c1	d2
	a2	b1	c2	d2
	a3	b1	c1	d2
	a1	b4	c1	d2
	a5	b4	c2	d2
	a1	b2	c1	d2
*				

	B	E
▶	b1	e1
	b2	e2
	b5	e3
*		

	a	b	c	d	e
▶	a3	b1	c1	d2	e1
	a2	b1	c2	d2	e1
	a1	b1	c1	d2	e1
	a1	b2	c1	d2	e2
		b5			e3

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Might use an outer join for example in a situation like:

*Find the name of all employees and list the department name if they also manage a department.*

**QUESTION:** Write the relational algebra for the above situation:

$$\text{TEMP} \leftarrow \text{Department} \bowtie_{\text{ManagerEmpID}=\text{EmpID}} \text{Employee}$$
$$\text{ANSWER} \leftarrow \pi_{\text{FirstName, LastName, DeptName}} (\text{TEMP})$$

ProjectNu	ProjectName	ProjLocat	Managing
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

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

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

EmpSSNu	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