WEEK 4

THE RELATIONAL ALGEBRA BINARY OPERATION OF UNION AND DIFFERENCE

STUDENT OBJECTIVES

- Upon completion of this video, you should be able to:
  - Decide if 2 tables are *Union Compatible*
  - Write a relational algebra expression that uses UNION given two tables and a query.
  - Given 2 tables and a UNION relational algebra expression, show the new table that would be returned once the expression is performed.
  - Write a relational algebra expression that uses DIFFERENCE given two tables and a query.
  - Given 2 tables and a DIFFERENCE relational algebra expression, show the new table that would be returned once the expression is performed.

BINARY OPERATIONS

- In arithmetic **8 ÷ 3** would be a binary operation because it has 2 operands: **8** and **3** and one operator: **÷**
- Most of the remaining relational algebra expression we are going to look at use binary operators (i.e. they require TWO tables)
  - For example: Table1 **U** Table2 would return a new table, our result.
  - Could also write: RESULTTABLE ← Table1 **U** Table2

UNION COMPATIBLE

- Two tables are *union compatible*, if and only if:
  - They have the same number of columns
  - Each respective column from each table is from the same domain
- Examples → Are these Union Compatible?
  - TableA and TableB — NO
  - TableA and TableC — NO
  - TableB and TableD — YES

Not same domain!

TableA

ID	Name	Age
22	Bob	46
34	Sam	33

TableB

ID	Age
22	46
34	33

TableC

ID	Age	Name
22	46	Bob
34	33	Sam

TableD

X	Y
55	71
32	64
61	34

UNION

- Creates a new table from the given 2 tables that include every row from both tables with NO repeating identical rows.
- The 2 Tables MUST be union compatible
- Symbol → **U**
- Example Expression:

Table1 U Table2

First Table Name

Symbol for Union

Second Table Name

remove duplicate rows

Table1

ID	FirstName	LastName	Age
12	Homer	Smith	24
24	Gene	Simpson	13
45	Walter	Reid	45

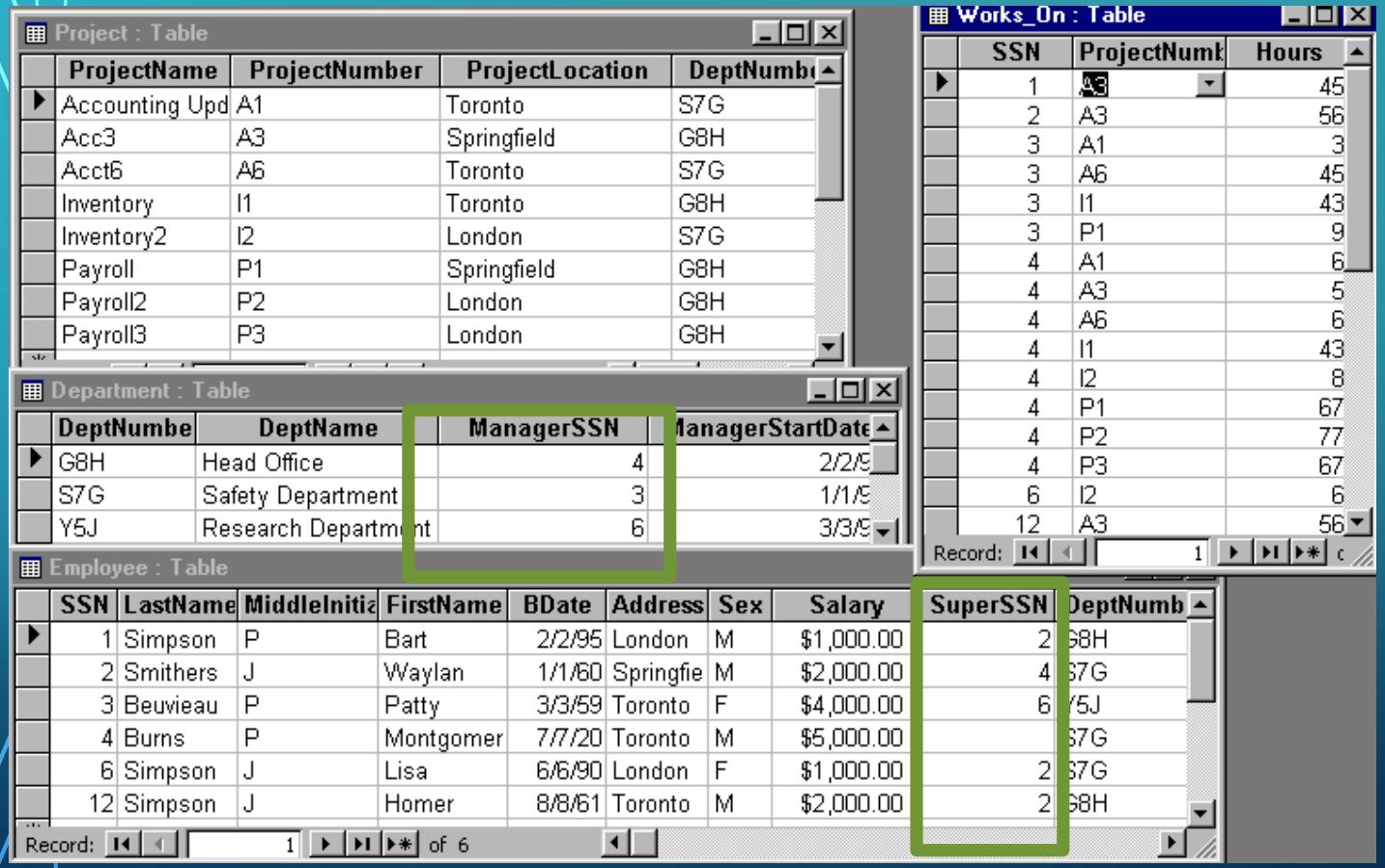
Table2

ID	FirstName	LastName	Age
33	Marg	Jones	28
24	Gene	Simpson	13

ANSWER

ID	FirstName	LastName	Age
12	Homer	Smith	24
24	Gene	Simpson	13
45	Walter	Reid	45
33	Marg	Jones	28

$$Temp1 \leftarrow \pi_{ManagerSSN}(Department)$$
$$Result \leftarrow Temp1 \cup \pi_{SuperSSN}(Employee)$$



Project : Table

ProjectName	ProjectNumber	ProjectLocation	DeptNumb
Accounting Upd	A1	Toronto	S7G
Acc3	A3	Springfield	G8H
Acct6	A6	Toronto	S7G
Inventory	I1	Toronto	G8H
Inventory2	I2	London	S7G
Payroll	P1	Springfield	G8H
Payroll2	P2	London	G8H
Payroll3	P3	London	G8H

Works_On : Table

SSN	ProjectNumb	Hours
1	A3	45
2	A3	56
3	A1	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: 1

Department : Table

DeptNumbe	DeptName	ManagerSSN	ManagerStartDate
G8H	Head Office	4	2/2/9
S7G	Safety Department	3	1/1/9
Y5J	Research Department	6	3/3/9

Employee : Table

SSN	LastName	MiddleInitia	FirstName	BDate	Address	Sex	Salary	SuperSSN	DeptNumb
1	Simpson	P	Bart	2/2/95	London	M	$1,000.00	2	G8H
2	Smithers	J	Waylan	1/1/60	Springfie	M	$2,000.00	4	S7G
3	Beuvieau	P	Patty	3/3/59	Toronto	F	$4,000.00	6	Y5J
4	Burns	P	Montgomer	7/7/20	Toronto	M	$5,000.00		S7G
6	Simpson	J	Lisa	6/6/90	London	F	$1,000.00	2	S7G
12	Simpson	J	Homer	8/8/61	Toronto	M	$2,000.00	2	G8H

Record: 1 of 6

Temp1

SuperSSN
4
3
6

Result

SuperSSN
4
3
6
2

10/2/2023

null is also a value

QUESTION: What would the following relational expression result in?

Temp1(Field1) ← π MiddleInitial (Employee)

Temp2(Field1) ← π Sex (Employee)

Result ← Temp1 U Temp2

Temp1

Field1
P
J

Temp2

Field1
F
M

Result

Field1
P
J
F
M

this is fine since these are all chars.

Project : Table

ProjectName	ProjectNumber	ProjectLocation	DeptNumbe
Accounting Upd	A1	Toronto	S7G
Acc3	A3	Springfield	G8H
Acct6	A6	Toronto	S7G
Inventory	I1	Toronto	G8H
Inventory2	I2	London	S7G
Payroll	P1	Springfield	G8H
Payroll2	P2	London	G8H
Payroll3	P3	London	G8H

Works_On : Table

SSN	ProjectNumb
1	A3
2	A3
3	A1
3	A6
3	I1
3	P1
4	A1
4	A3
4	A6
4	I1
4	I2
4	P1
4	P2
4	P3
6	I2
12	A3

Record: 1

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Employee : Table

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3	Beuvieau	P	Patty	3/3/59	Toronto	F	$4,000.00	6	Y5J
4	Burns	P	Montgomer	7/7/20	Toronto	M	$5,000.00		S7G
6	Simpson	J	Lisa	6/6/90	London	F	$1,000.00	2	S7G
12	Simpson	J	Homer	8/8/61	Toronto	M	$2,000.00	2	G8H

Record: 1 of 6

QUESTION: What would the following relational expression result in?

Temp1(Loc) ← πProjectLocation (Project)

Temp2(Loc) ← πAddress (σ LastName = "Simpson" (Employee))

Result ← Temp1 U Temp2

Temp1

Loc
Toronto
Springfield
London

Temp2

Loc
London
Toronto

Result

Loc
Toronto
Springfield
London

Project : Table

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Employee : Table

SSN	LastName	MiddleInitia	FirstName	BDate	Address	Sex	Salary
1	Simpson	P	Bart	2/2/95	London	M	$1,000.00
2	Smithers	J	Waylan	1/1/60	Springfie	M	$2,000.00
3	Beuvieau	P	Patty	3/3/59	Toronto	F	$4,000.00
4	Burns	P	Montgomer	7/7/20	Toronto	M	$5,000.00
6	Simpson	J	Lisa	6/6/90	London	F	$1,000.00
12	Simpson	J	Homer	8/8/61	Toronto	M	$2,000.00

Record: 1 of 6

QUESTION: What, in English, does the above expression represent?

Show me all the project locations cities together with the cities that the Simpson employee's live in.

WRITE A RELATIONAL ALGEBRA EXPRESSION THAT WOULD NEED TO USE UNION

- Write the Relation Algebra expression to answer this query:

  Return the first name of all students and faculty at Western whose name starts with D

Faculty

ID	FirstName	LastName	Office Number
12	Dave	Smith	MC316
24	Walter	Simpson	MC416
45	Donald	Reid	SSC22

Student

StudentID	FName	LName	HomeCity	Major
2501	Daisy	Jones	Windso	Math
2509	Walter	Simpson	Arva	CS
2508	Donald	Cook	Milton	Math
2588	Wally	Webster	Milton	CS

rename & selection

$$Temp1_{(FName)} \leftarrow \pi\ FirstName\ (\sigma FirstName\ like\ \text{“D*”}(Faculty))$$

$$Temp2 \leftarrow \pi\ FName(\sigma FName\ like\ \text{“D*”}(Student))$$

$$ANSWER \leftarrow Temp1\ U\ Temp2$$

DIFFERENCE

- Create a new table from the given 2 tables that include every row from the table on the left side that is NOT in the table on the right side.
- The 2 Tables MUST be union compatible
- Symbol → —
- Example Expression:

Table1 – Table2

First Table Name

Symbol for Difference

Second Table Name

Table1

ID	FirstName	LastName	Age
12	Homer	Smith	24
24	Gene	Simpson	13
45	Walter	Reid	45

Table2

ID	FirstName	LastName	Age
33	Marg	Jones	28
24	Gene	Simpson	13

ANSWER

ID	FirstName	LastName	Age
12	Homer	Smith	24
45	Walter	Reid	45

MORE ON DIFFERENCE

- NOTE that Table1 – Table2 does NOT equal Table2 – Table1

e.g Answer ← Table2 – Table1

Table1

ID	FirstName	LastName	Age
12	Homer	Smith	24
24	Gene	Simpson	13
45	Walter	Reid	45

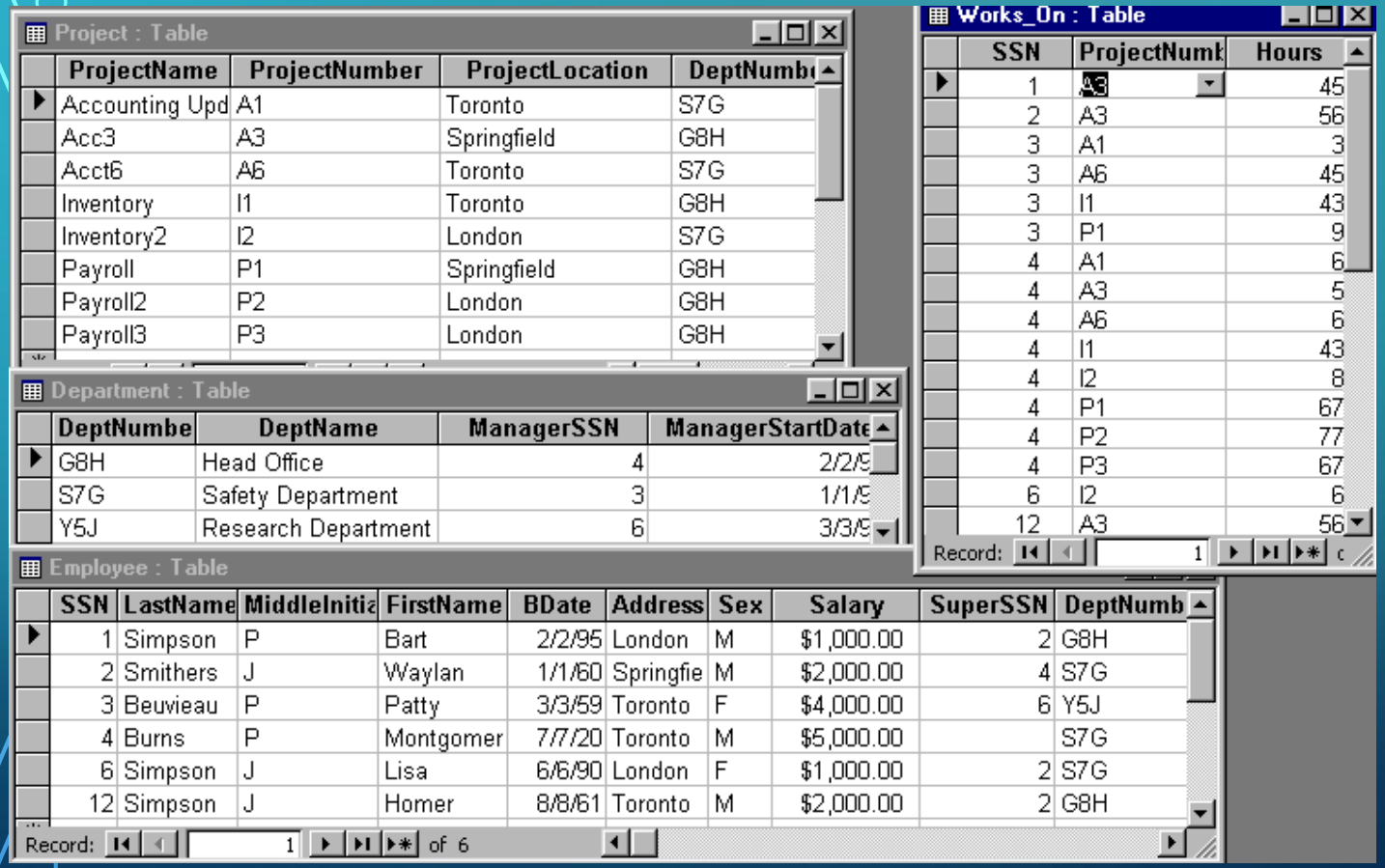
Table2

ID	FirstName	LastName	Age
33	Marg	Jones	28
24	Gene	Simpson	13

ANSWER

ID	FirstName	LastName	Age
33	Marg	Jones	28

RESULT ← $\pi_{LastName}(Employee) - \pi_{LastName}(\sigma_{Sex="M"}(Employee))$



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4	P2	77
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Record: 1 of 6

RESULT

LastName
Beuvieau

QUESTION: What would the following relational expressions result in?

Temp1 (SSN) ← π ManagerSSN (Department)

Temp2 (SSN) ← π SuperSSN ($\sigma_{SuperSSN <> Null}$(Employee))

Result1 ← Temp1 – Temp2

Result2 ← Temp2 – Temp1

Temp1

SSN
4
3
6

Temp2

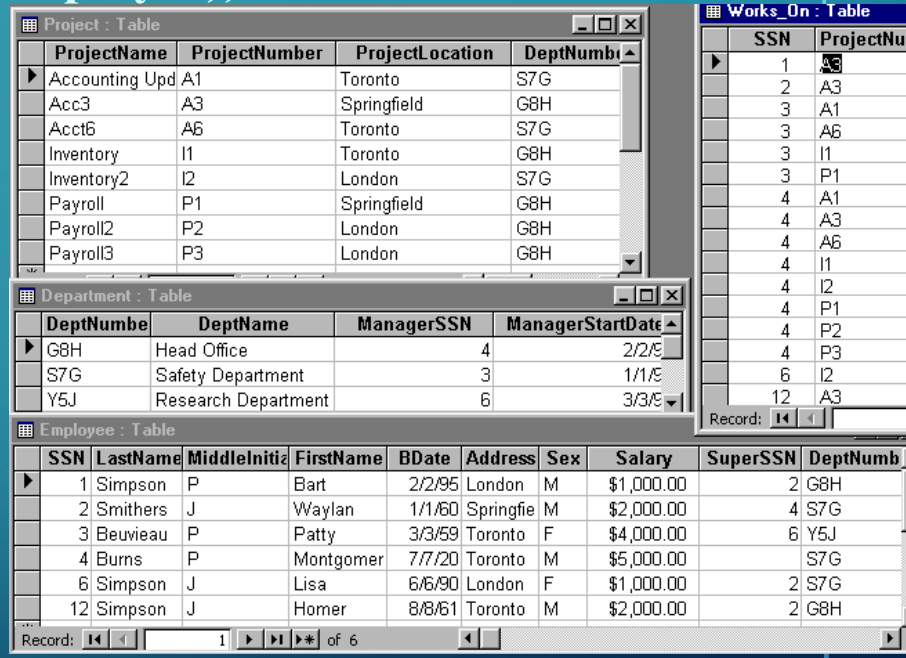
SSN
2
4
6

Result1

SSN
3

Result2

SSN
2



QUESTION: What do they mean in English?

Result1 means: ***Show me all the employee ids for people who are departmental managers but not also supervisors.***

Result2 means: ***Show me all the ids for people who are employee supervisors but not also departmental managers.***

WRITE A RELATIONAL ALGEBRA EXPRESSION THAT WOULD NEED TO USE DIFFERENCE

- Write the Relation Algebra expression to answer this query:

  Return the first name of all faculty members who don't have the same first name as any of our students.

Faculty

ID	FirstName	LastName	Office Number
12	Dave	Smith	MC316
24	Walter	Simpson	MC416
45	Donald	Reid	SSC22

Student

StudentID	FName	LName	HomeCity	Major
2501	Daisy	Jones	Windso	Math
2509	Walter	Simpson	Arva	CS
2508	Donald	Cook	Milton	Math
2588	Wally	Webster	Milton	CS

$$Temp1_{(FName)} \leftarrow \pi_{FirstName}(Faculty)$$

$$Temp2 \leftarrow \pi_{FName}(Student)$$

$$ANSWER \leftarrow Temp1 - Temp2$$