# 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

**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**

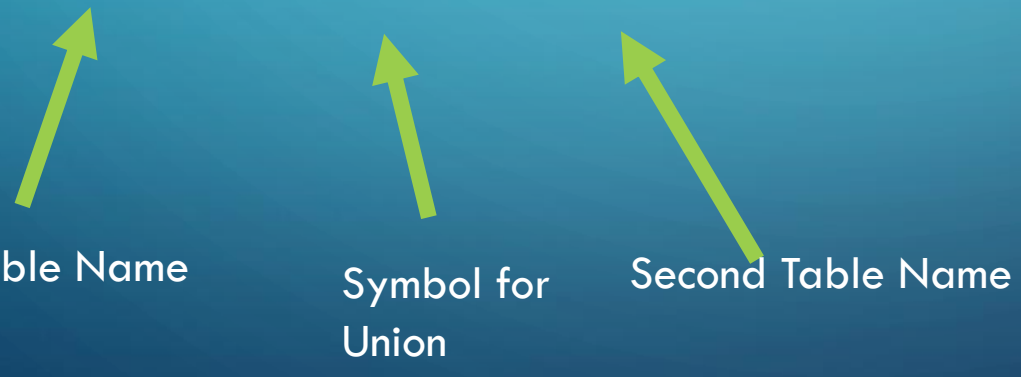



**Table1**

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

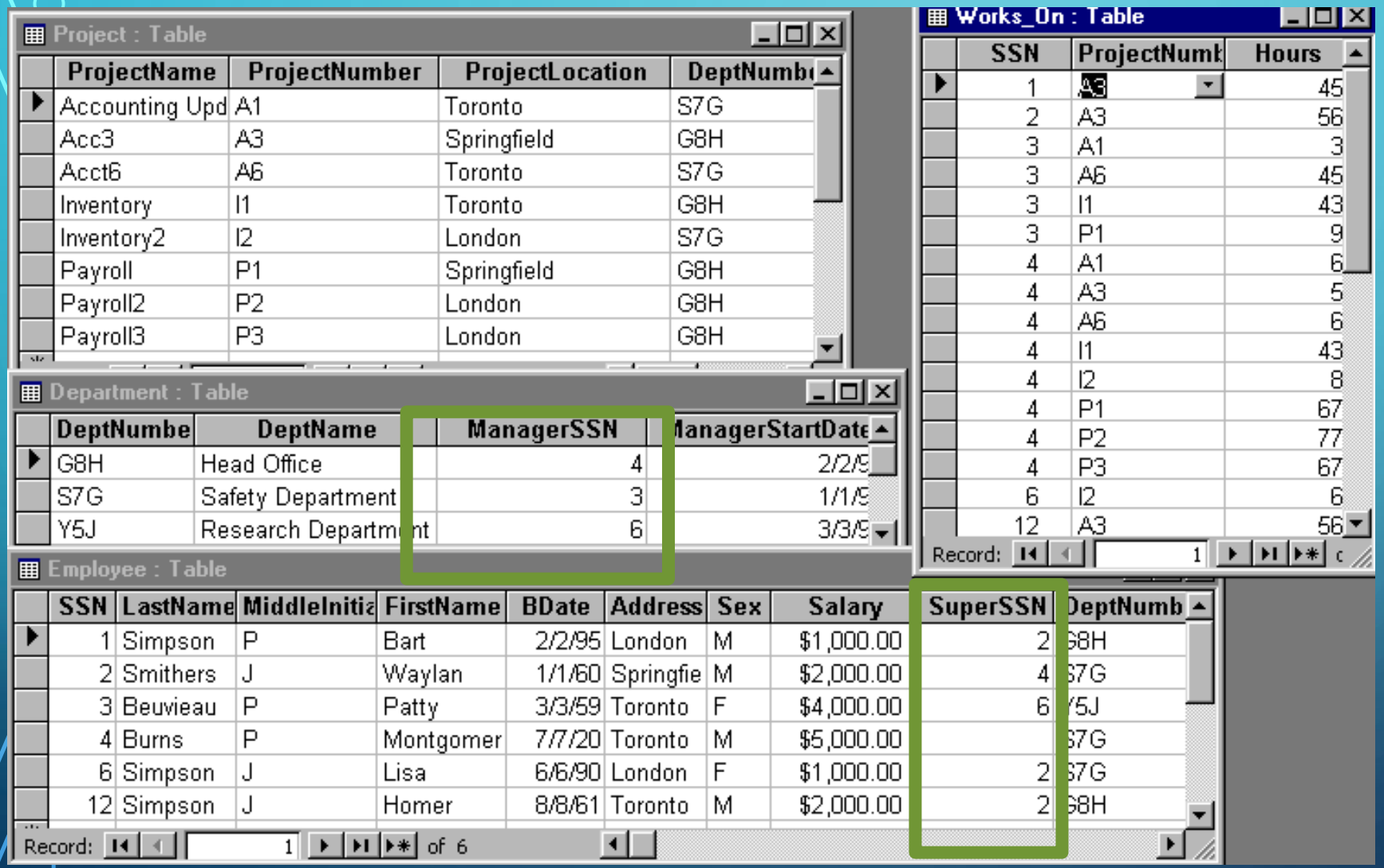
**Table2**

| 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 |

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



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 Departm nt | 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 |
| |

# QUESTION: What would the following relational expression result in?

Temp1(Field1) ← π MiddleInitial (Employee)

Temp2(Field1) ← π Sex (Employee)

Result ← Temp1 U Temp2

**Temp1**

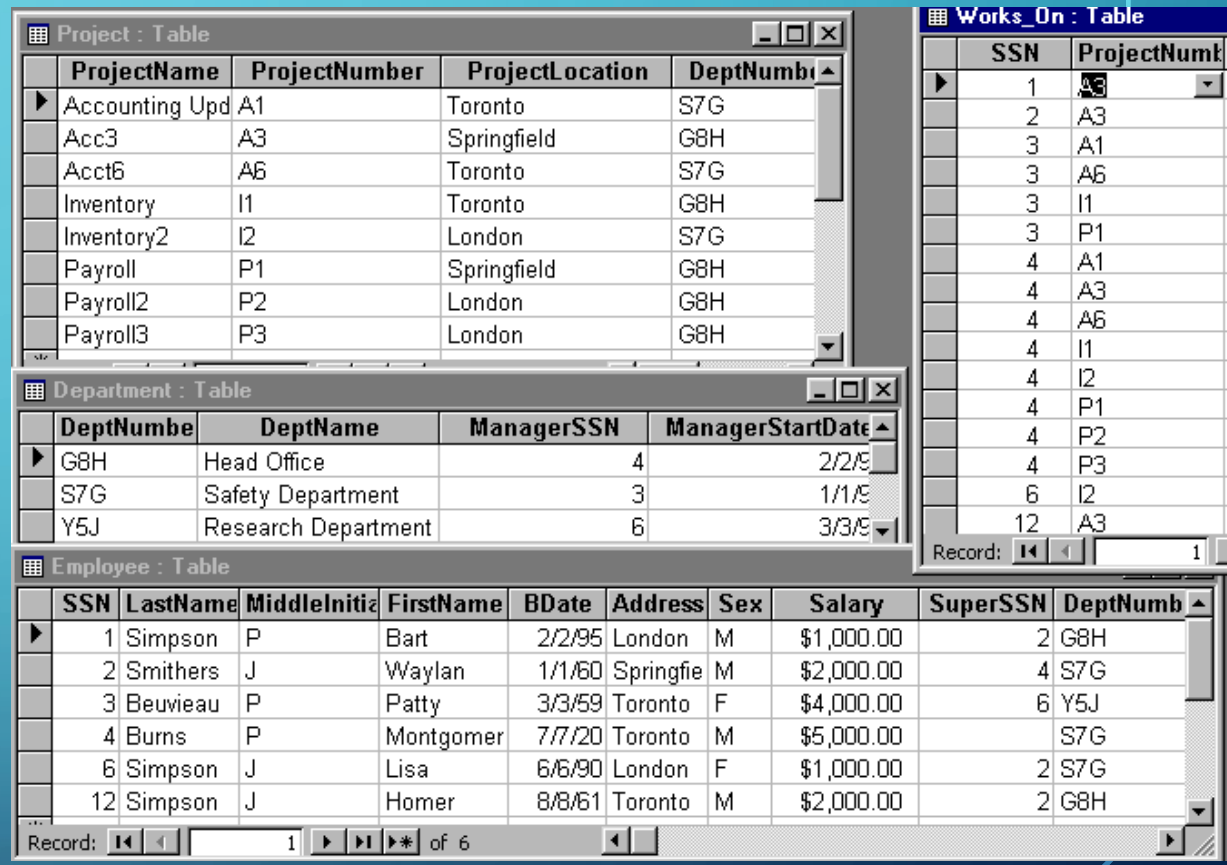
| Field1 |
|---|
| P |
| J |

**Temp2**

| Field1 |
|---|
| F |
| M |

**Result**

| Field1 |
|---|
| P |
| J |
| F |
| M |



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 |
|---|---|
| 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

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

# 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

| ProjectName | ProjectNumber | ProjectLocation | DeptNumb |
|---|---|---|---|
| Accounting Upd | A1 | Toronto | S7G |
| Acc3 | A3 | Springfield | G8H |
| Acct6 | A6 | Toronto | S7G |
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| Payroll | P1 | Springfield | G8H |
| Payroll2 | P2 | London | G8H |
| Payroll3 | P3 | London | G8H |

Department : Table

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Employee : Table

| SSN | LastName | MiddleInitia | FirstName | BDate | Address | Sex | Salary |
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| 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 |

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

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

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

# 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) – $\pi_{LastName}$($\sigma_{Sex=\text{“M”}}$(Employee))

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| 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

**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**

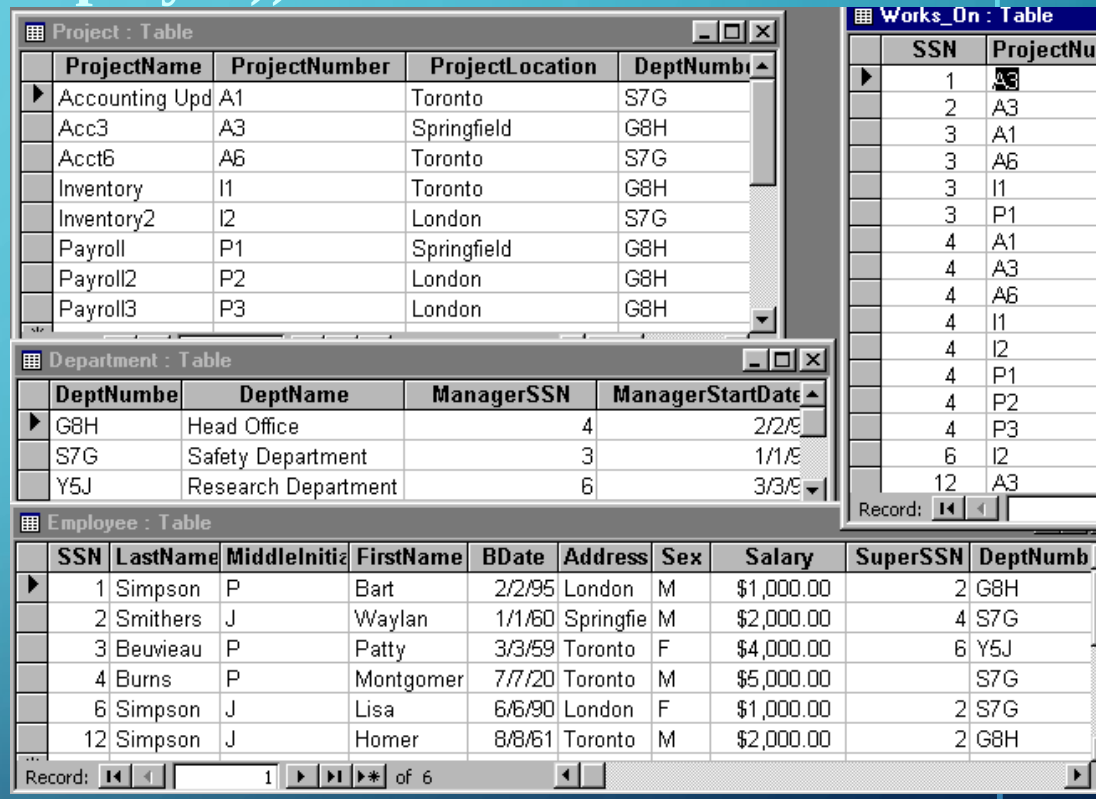
| SSN |
|---|
| 2 |
| 4 |
| 6 |

**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 |

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

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

$$ANSWER \leftarrow Temp1 - Temp2$$