

# CSE 4125: Distributed Database Systems Chapter – 5

Translation of Global Queries to  
Fragment Queries.  
(Part – D)

## Topics to be discussed –

- Some properties/rules for query simplification
- Finding common sub – expressions in operator tree
- Removing common sub-expressions using the rules

# Some Rules/Properties

## Properties

- $R \text{ NJN } R \leftrightarrow R$   1
- $R \text{ UN } R \leftrightarrow R$   2
- $R \text{ DF } R \leftrightarrow 0$   3
- $R \text{ NJN } \text{SL}_F R \leftrightarrow \text{SL}_F R$   4
- $R \text{ UN } \text{SL}_F R \leftrightarrow R$   5
- $R \text{ DF } \text{SL}_F R \leftrightarrow \text{SL}_{\text{NOT } F} R$   6
- $(\text{SL}_{F1} R) \text{ NJN } (\text{SL}_{F2} R) \leftrightarrow \text{SL}_{F1 \text{ AND } F2} R$   7
- $(\text{SL}_{F1} R) \text{ UN } (\text{SL}_{F2} R) \leftrightarrow \text{SL}_{F1 \text{ OR } F2} R$   8
- $(\text{SL}_{F1} R) \text{ DF } (\text{SL}_{F2} R) \leftrightarrow \text{SL}_{F1 \text{ AND NOT } F2} R$   9

They will be used to remove common sub-expressions in the simplification of operator tree.

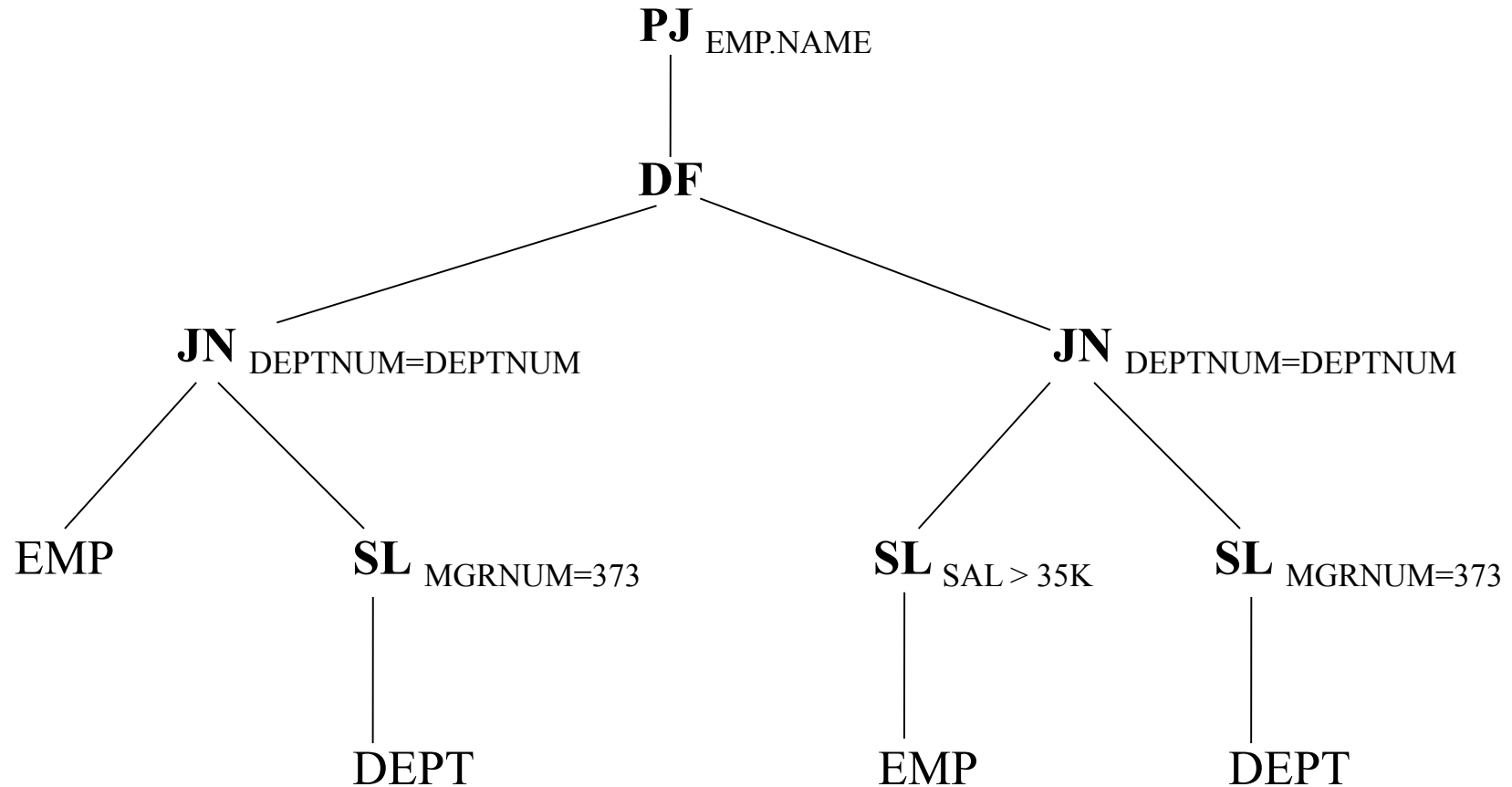
# Finding & Removing Common Sub Expression

# Example 1

*EMP (EMPNUM, DEPTNUM, NAME, SAL, AGE)*  
*DEPT (DEPTNUM, NAME, AREA, MGRNUM)*

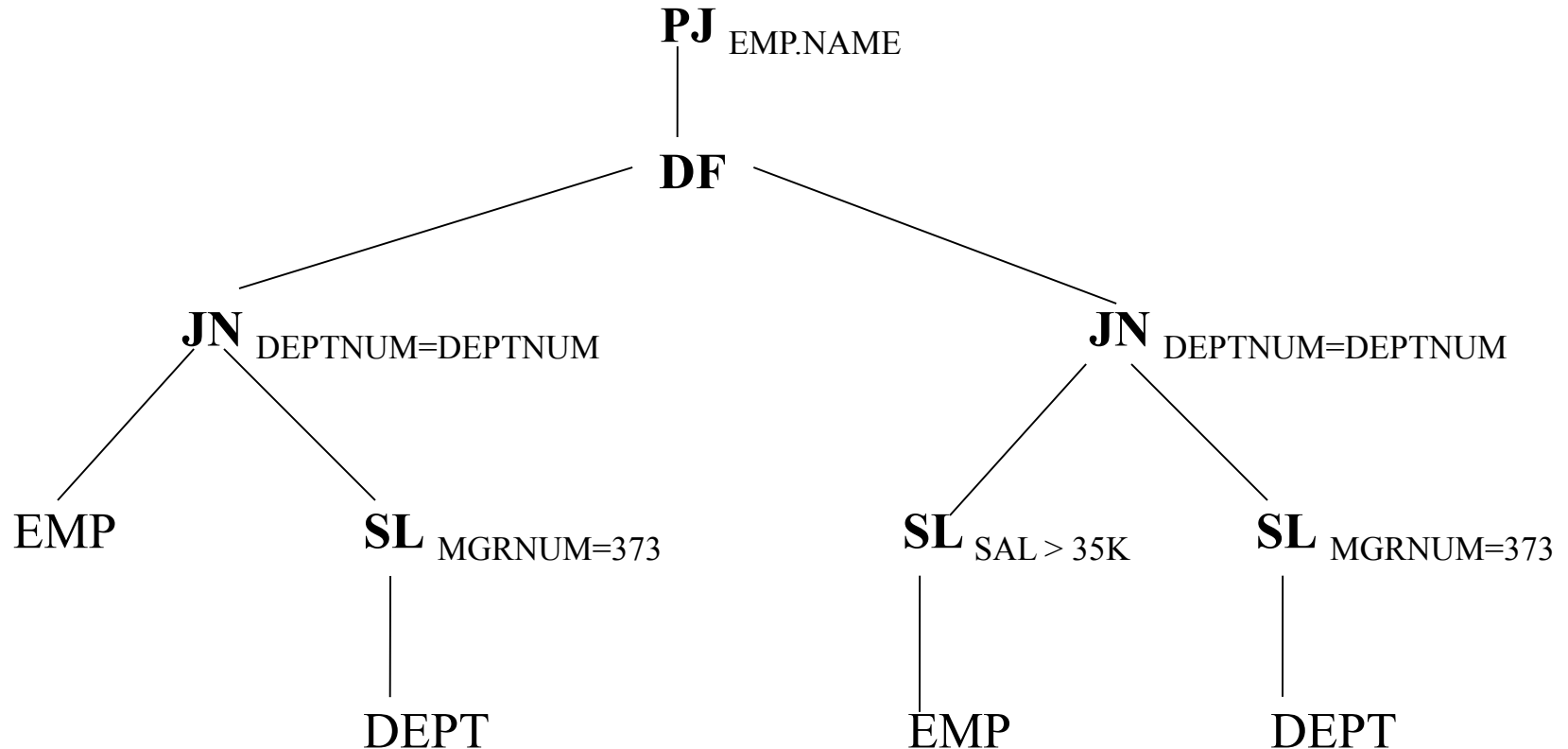
# Given query and Operator Tree

**Q: PJ** <sub>EMP.NAME</sub> ((*EMP* **JN** <sub>DEPTNUM=DEPTNUM</sub> **SL** <sub>MGRNUM=373</sub> *DEPT*) **DF** (**SL** <sub>SAL > 35K</sub> *EMP* **JN** <sub>DEPTNUM=DEPTNUM</sub> **SL** <sub>MGRNUM=373</sub> *DEPT*))



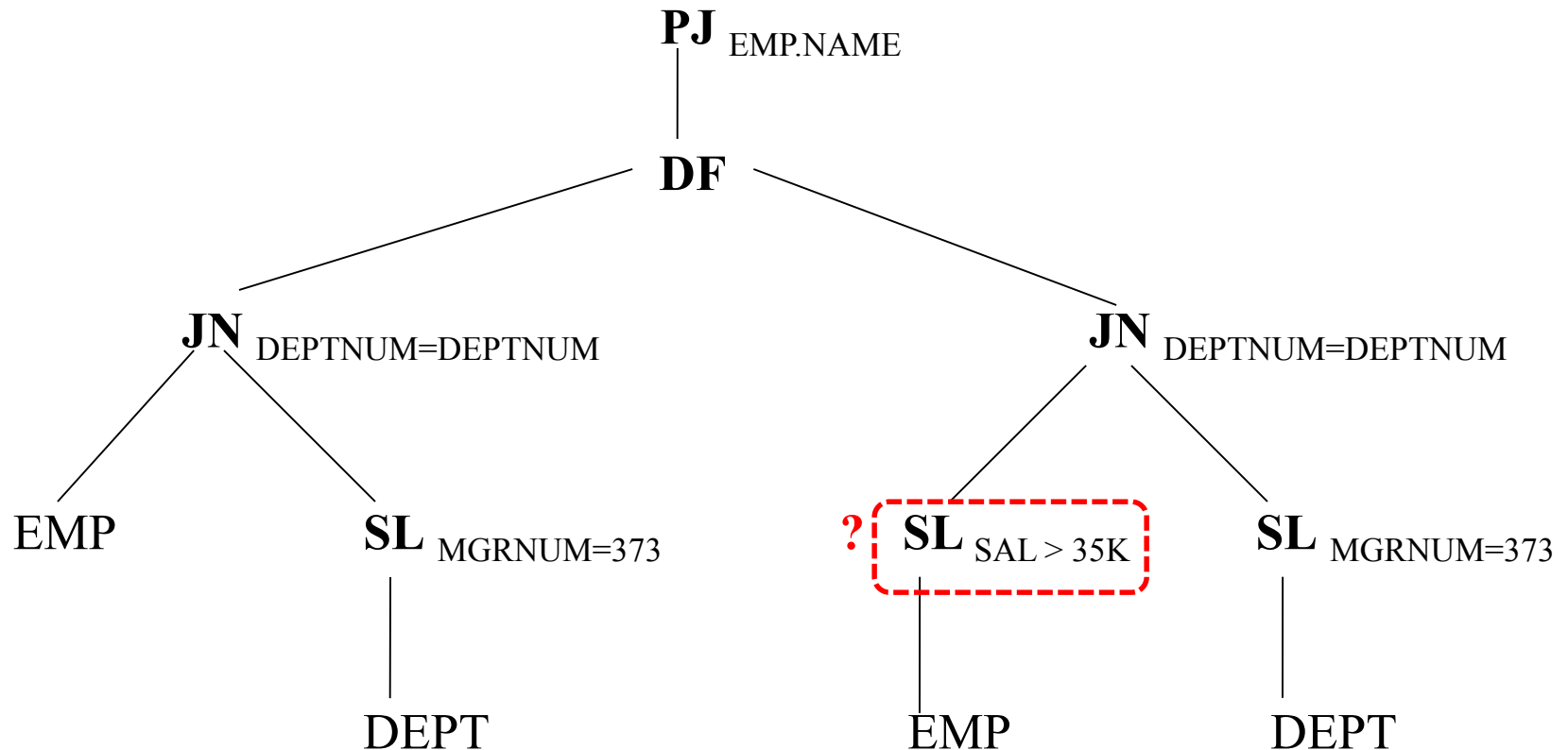
# Finding Common Sub-expression

Any common portion?



# Finding Common Sub-expression

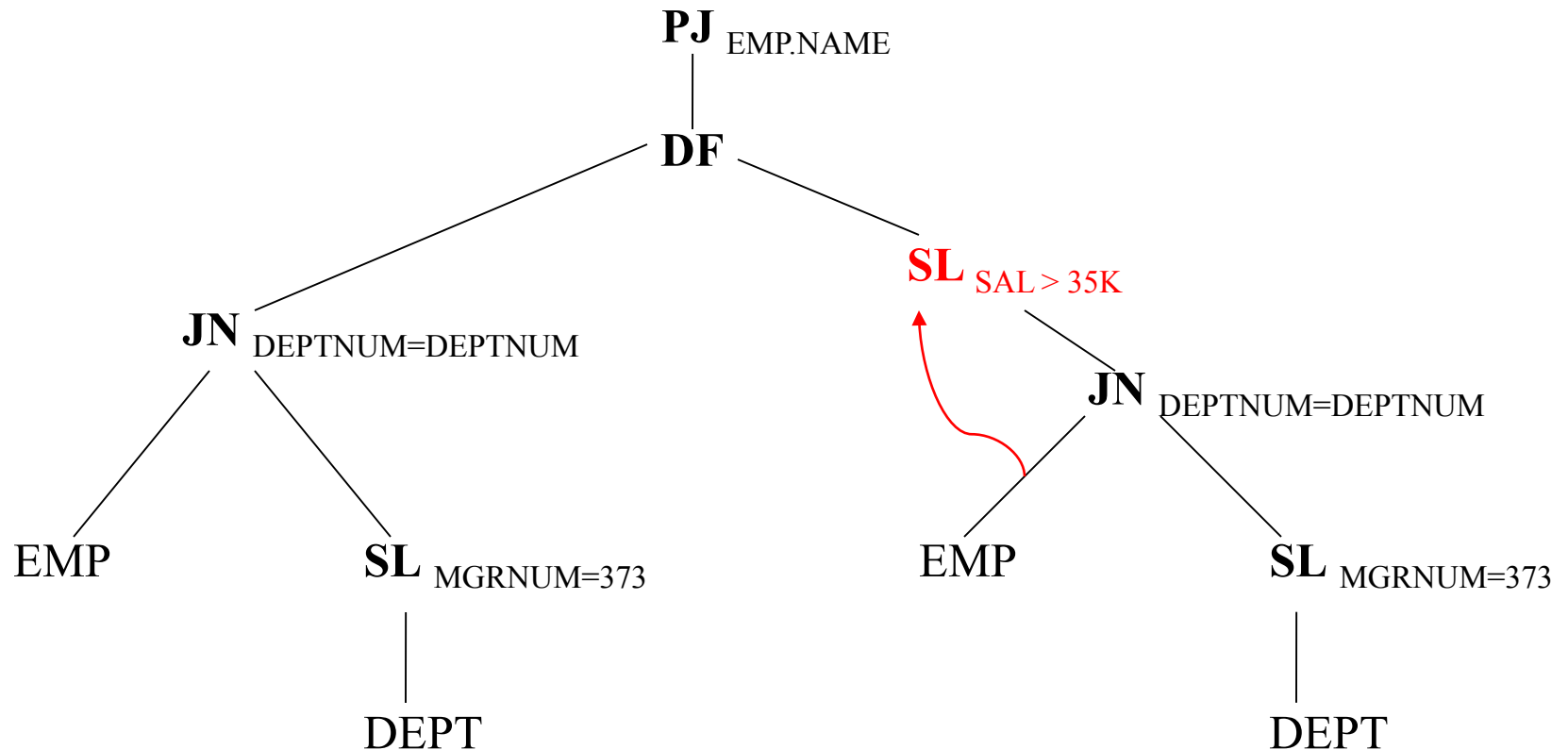
Any common portion?



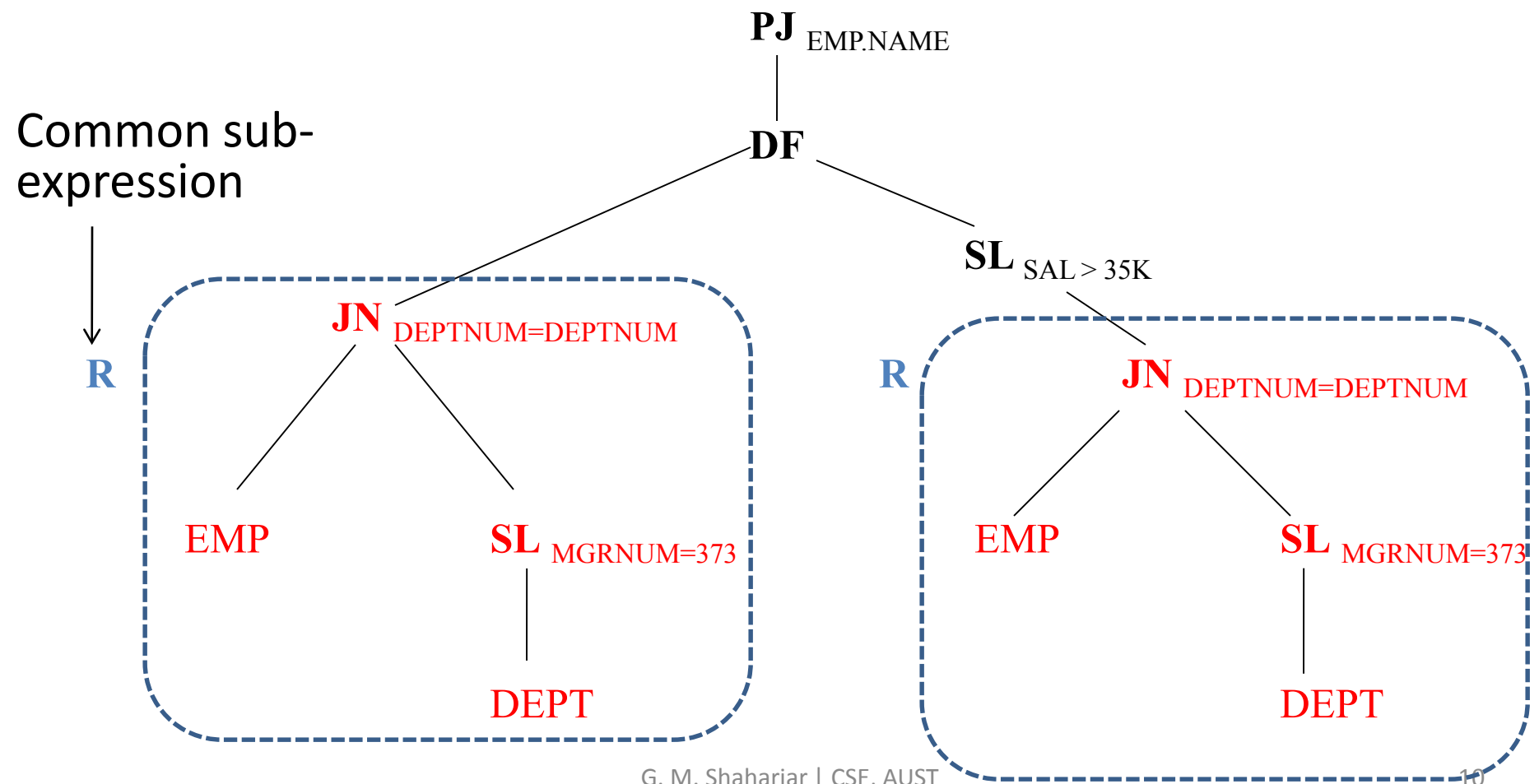


# Finding Common Sub-expression

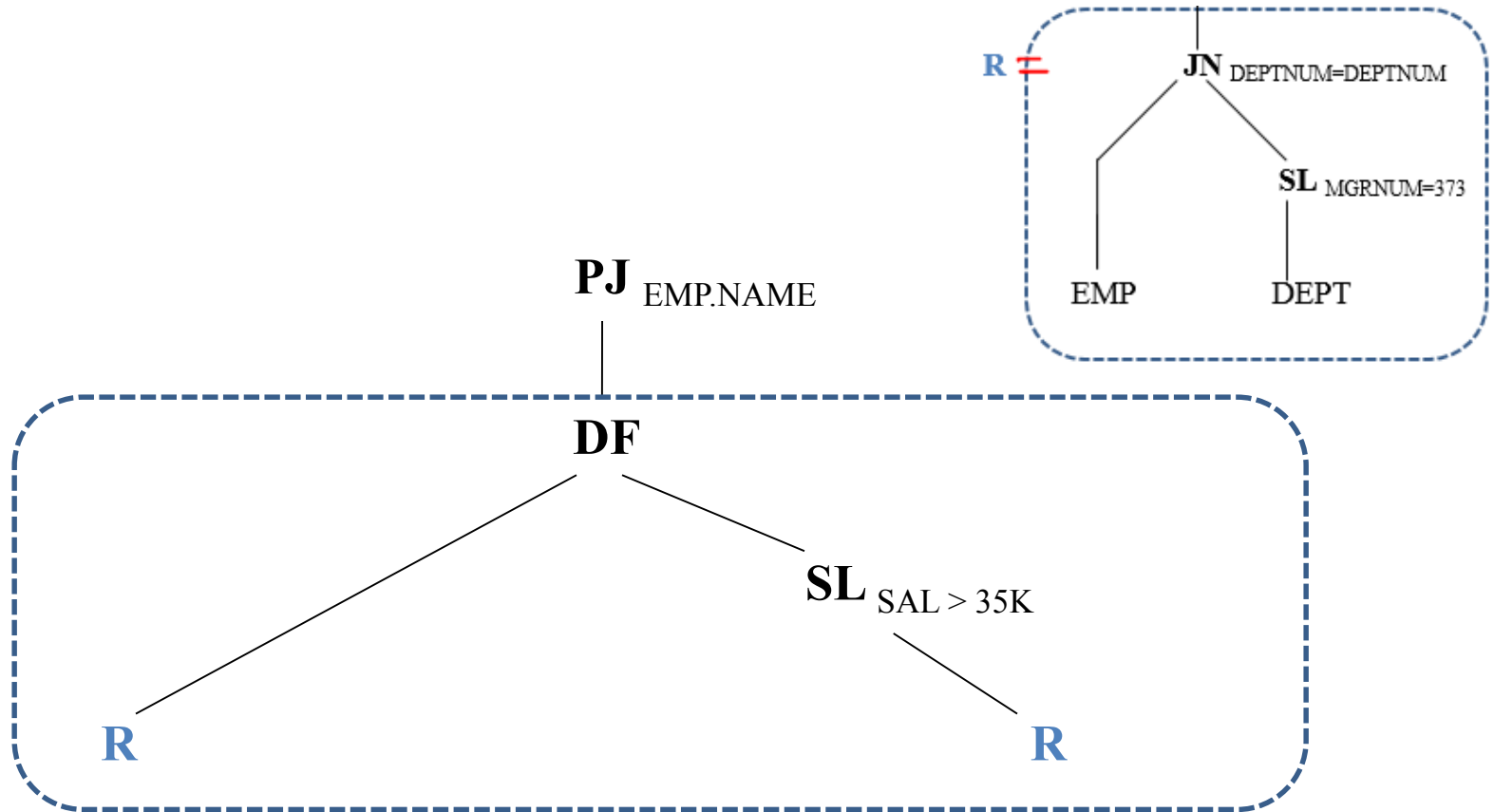
Any common portion? NOW?



# Finding Common Sub-expression

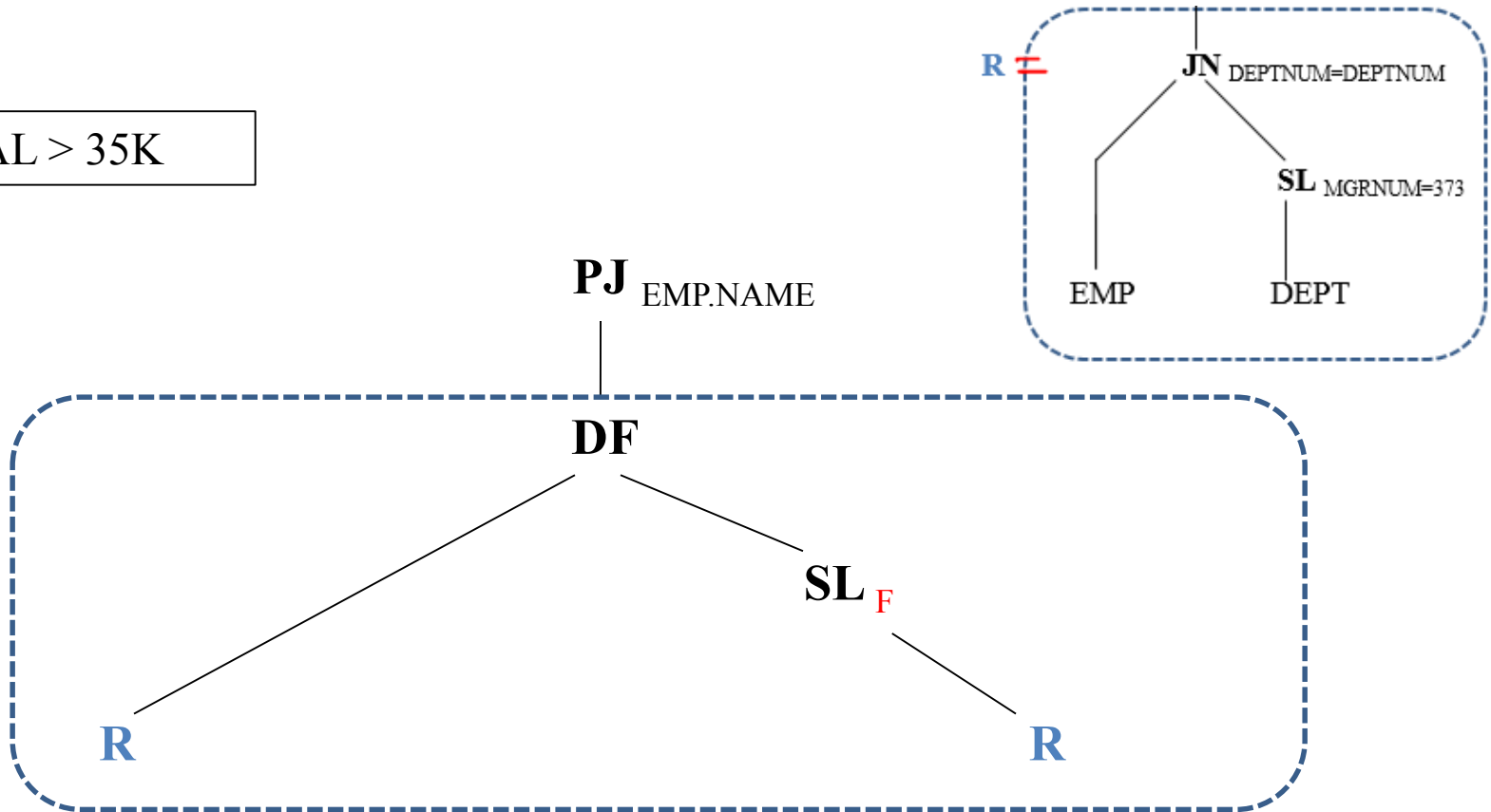


# Finding Common Sub-expression



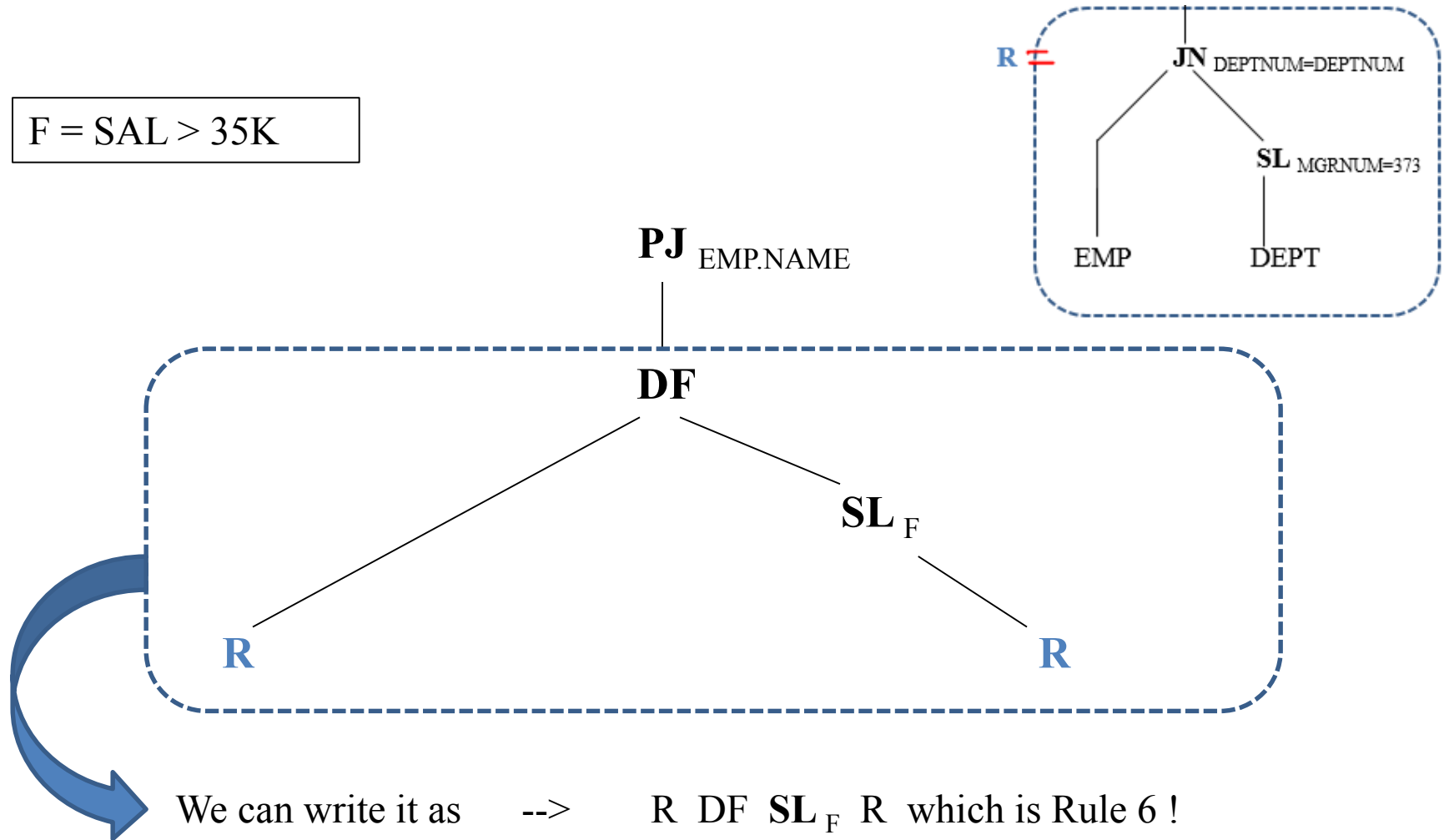
# Finding Common Sub-expression

$F = \text{SAL} > 35\text{K}$



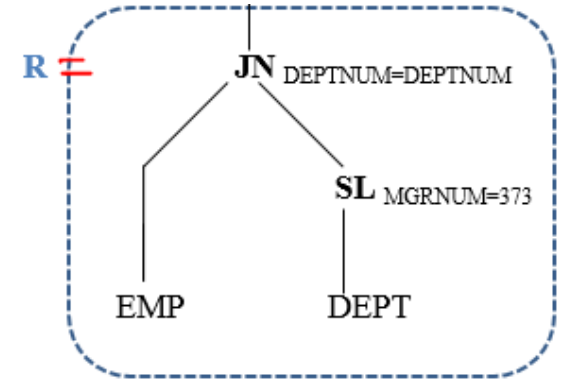
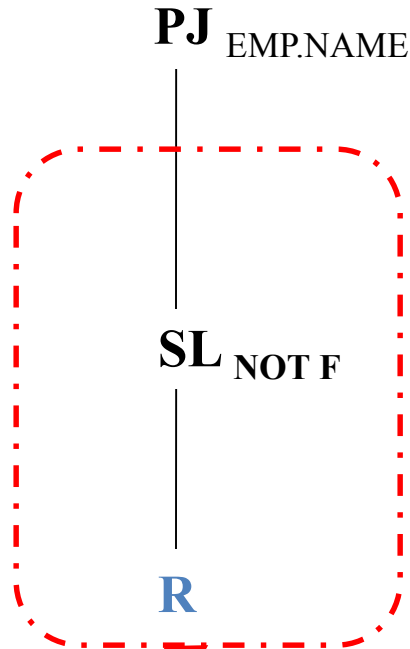
# Finding Common Sub-expression

$F = \text{SAL} > 35K$



# Removing Common Sub-expression

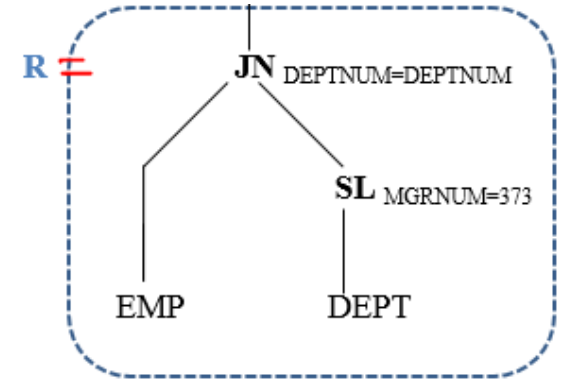
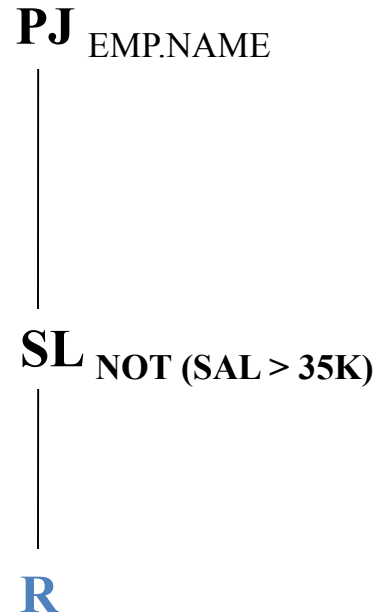
$F = \text{SAL} > 35\text{K}$



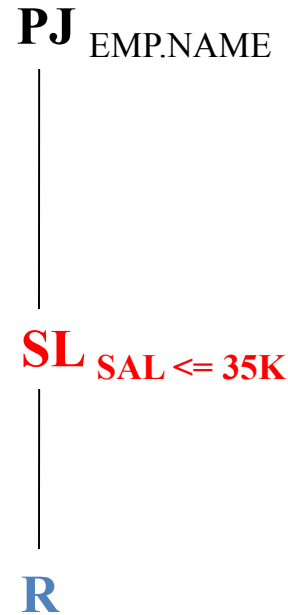
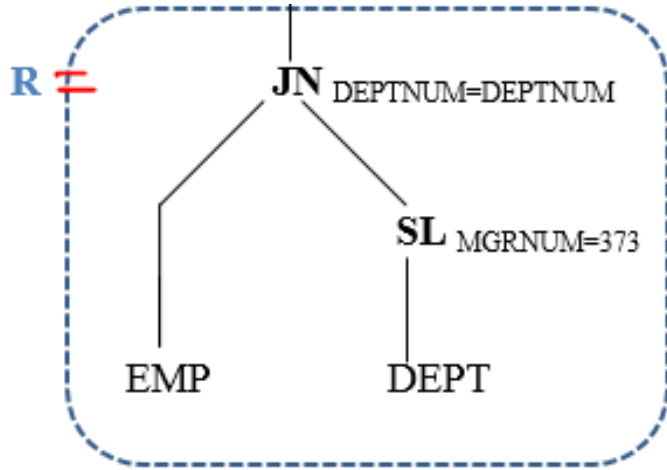
•  $R \text{ DF } SL_F R \leftrightarrow SL_{NOT F} R$

# Removing Common Sub-expression

$F = \text{SAL} > 35\text{K}$

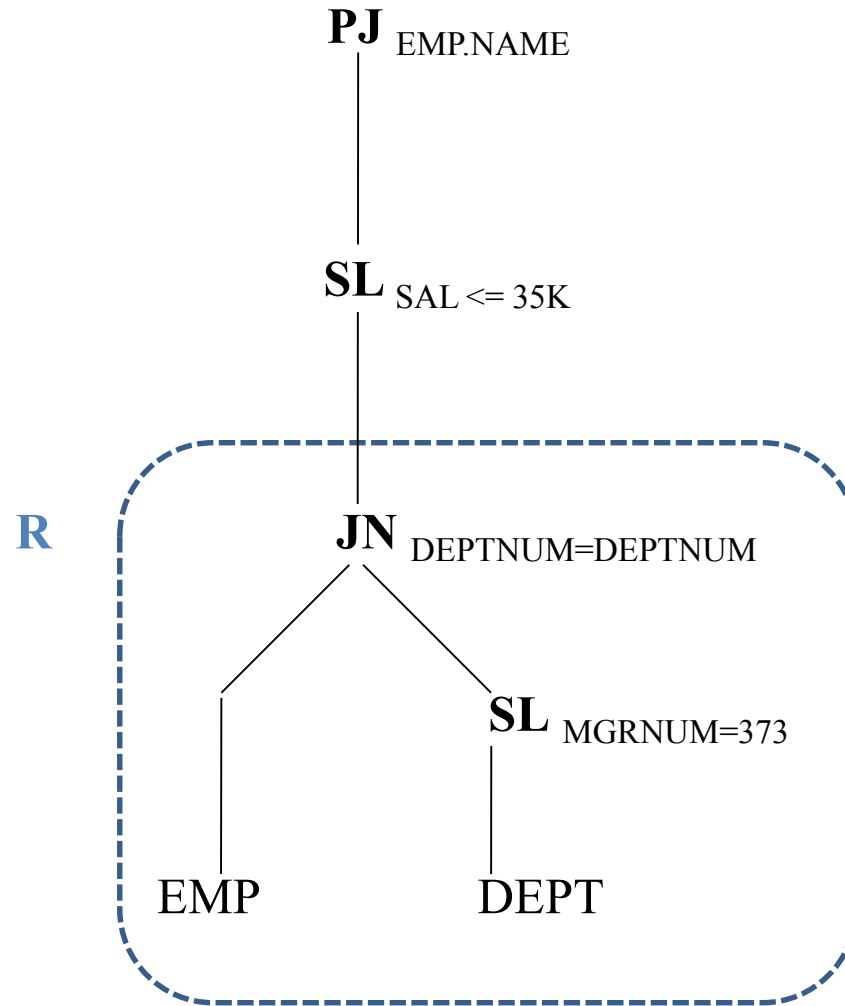


# Removing Common Sub-expression





# Removing Common Sub-expression



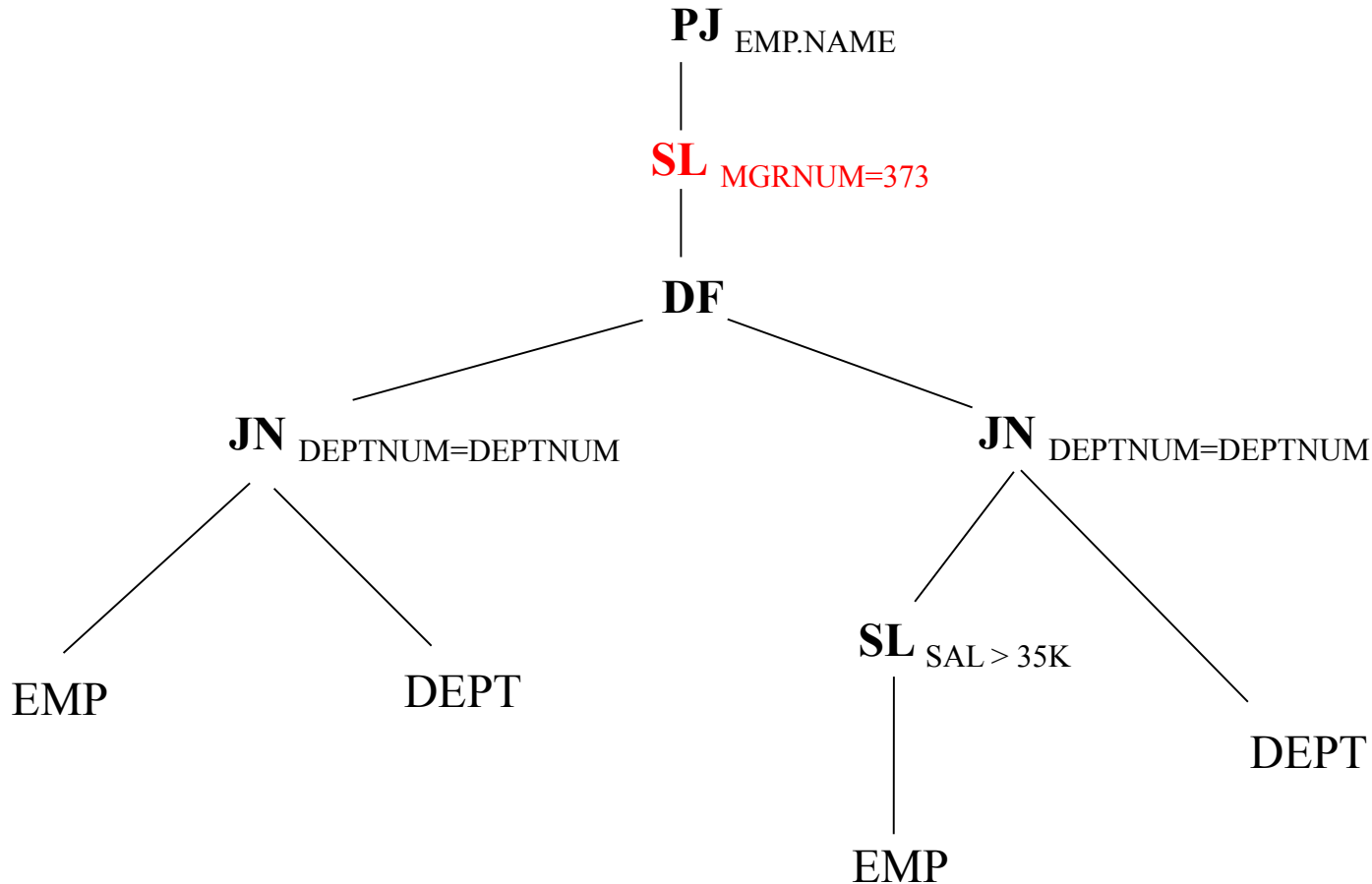
Can you apply Criterion 1 and/or 2 on this tree?

# Example 2.1

*EMP (EMPNUM, DEPTNUM, NAME, SAL, AGE)*  
*DEPT (DEPTNUM, NAME, AREA, MGRNUM)*

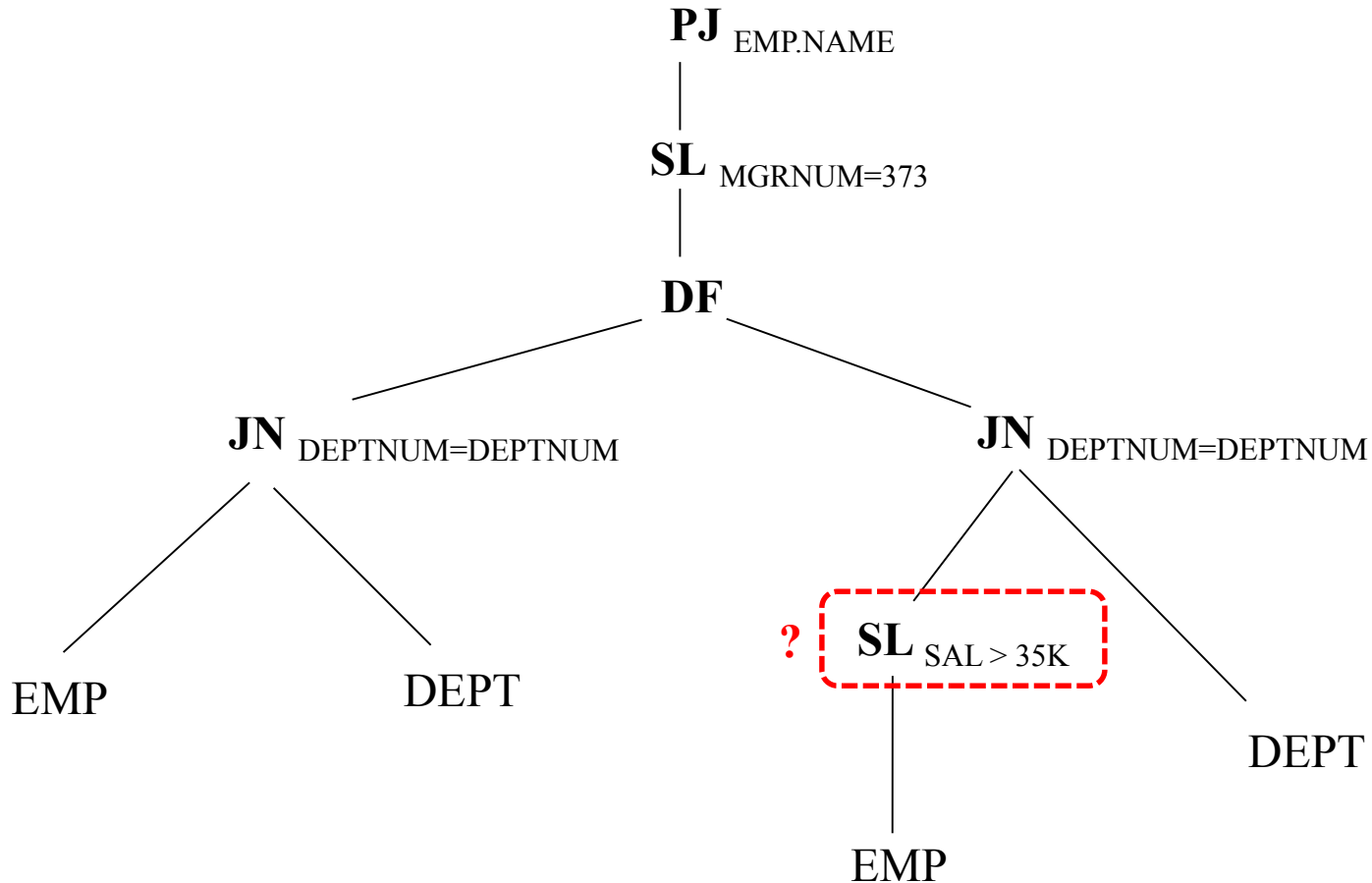
# Given query and Operator Tree

**Q: PJ** EMP.NAME **SL** MGRNUM=373 ((**EMP JN** DEPTNUM=DEPTNUM **DEPT**) **DF**  
(**SL** SAL > 35K **EMP JN** DEPTNUM=DEPTNUM **DEPT**))



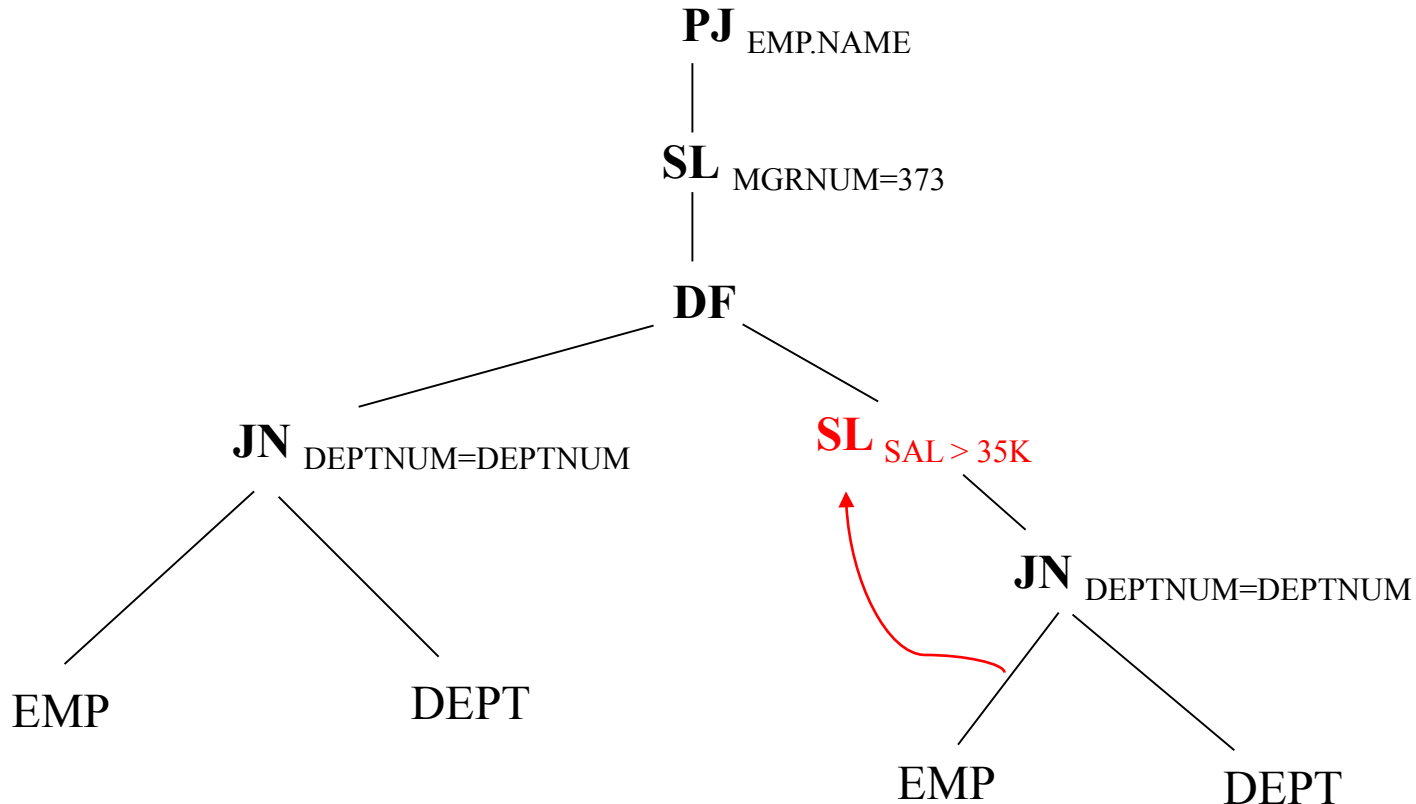
# Finding Common Sub-expression

Any common portion?



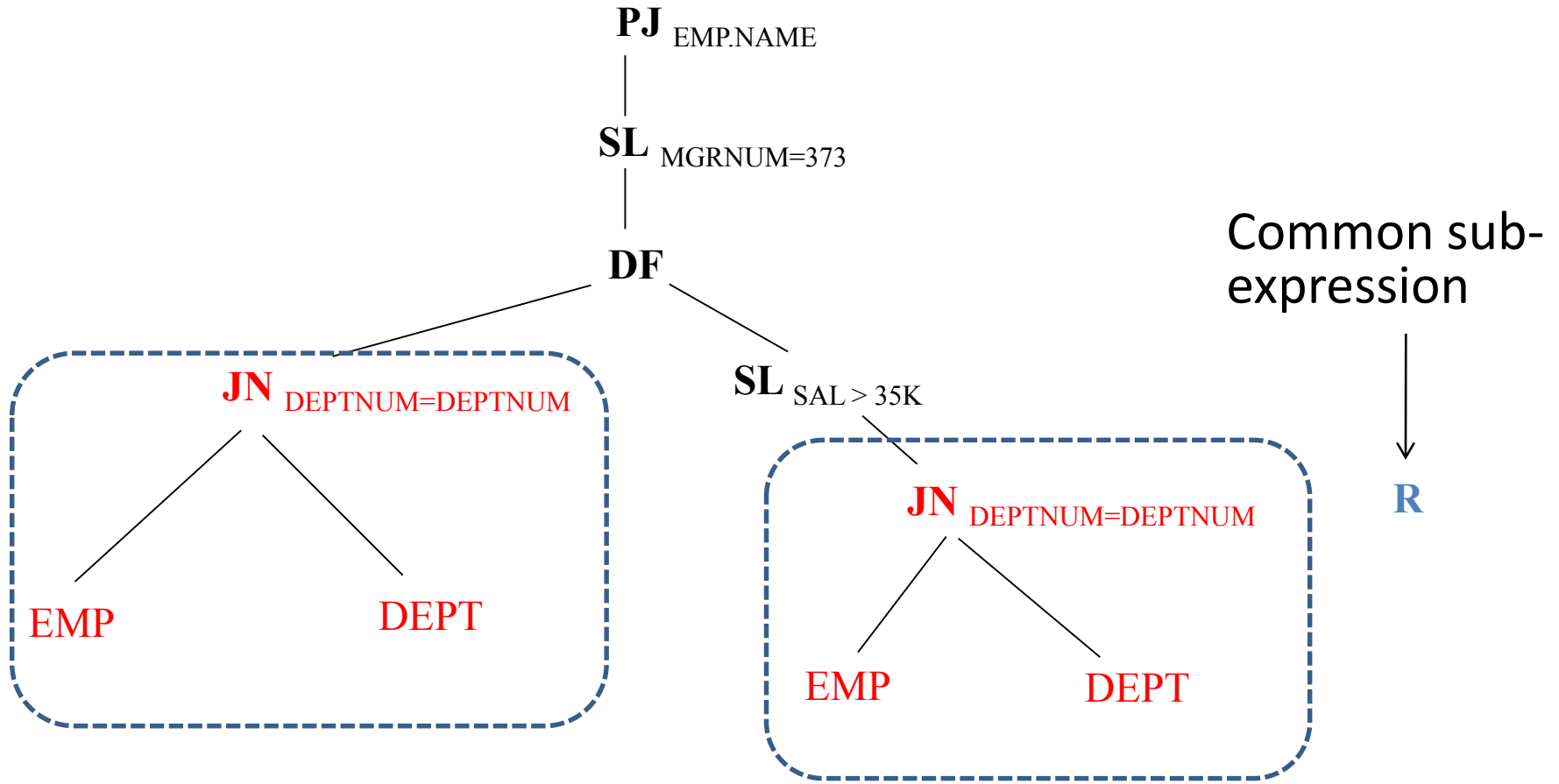
# Finding Common Sub-expression

Any common portion? NOW?

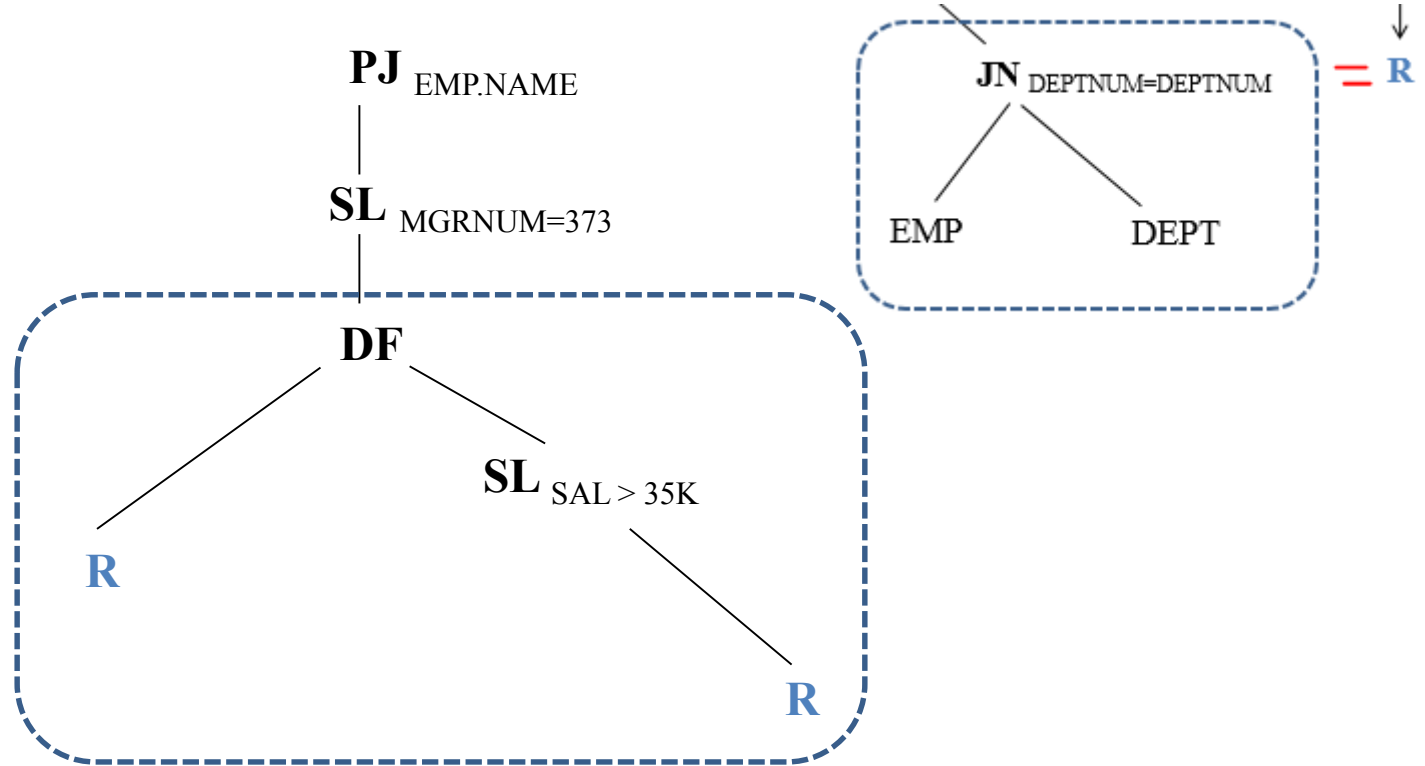


# Finding Common Sub-expression

Any common portion? NOW?

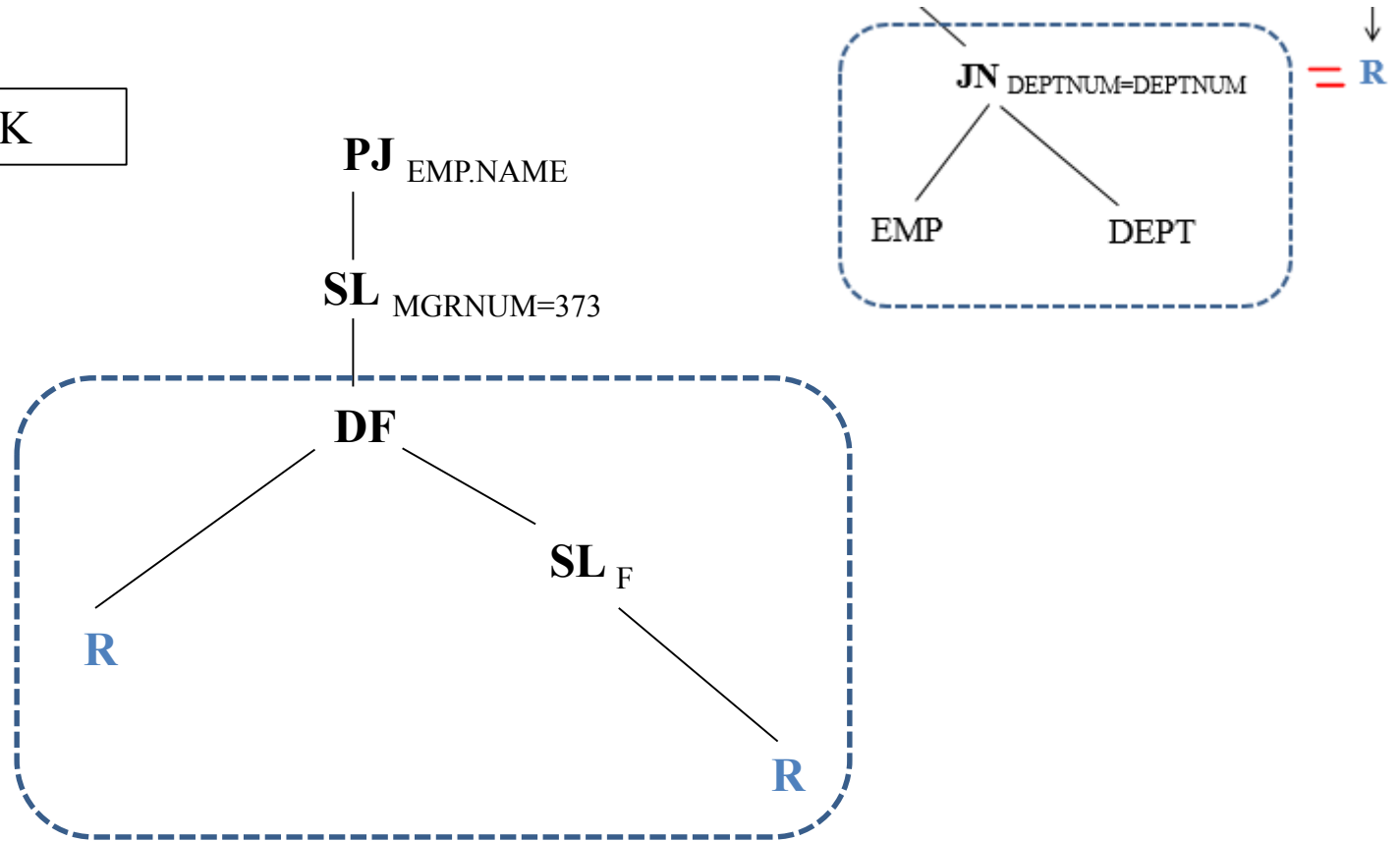


# Finding Common Sub-expression



# Finding Common Sub-expression

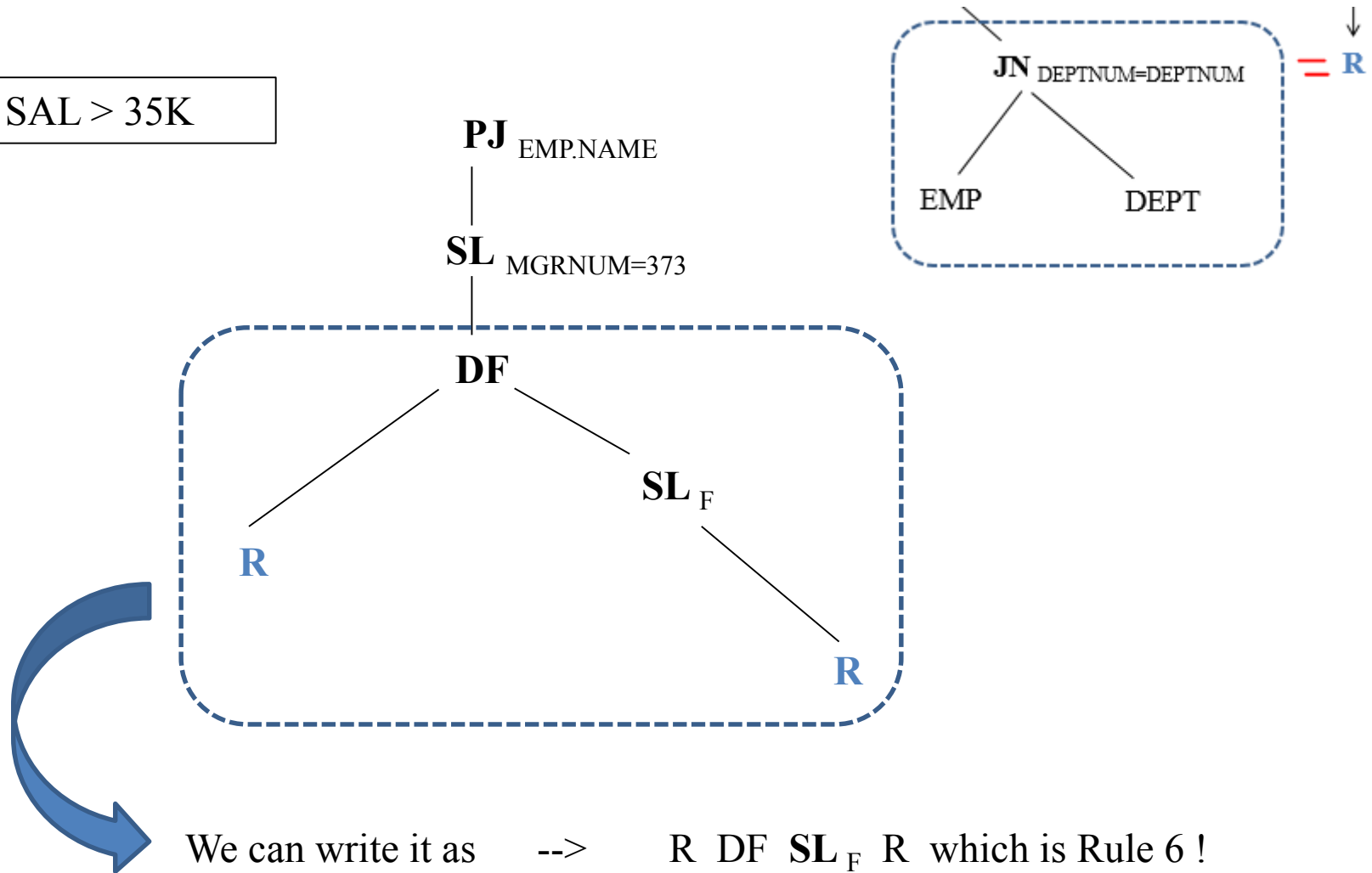
$F = \text{SAL} > 35\text{K}$





# Finding Common Sub-expression

$F = \text{SAL} > 35K$

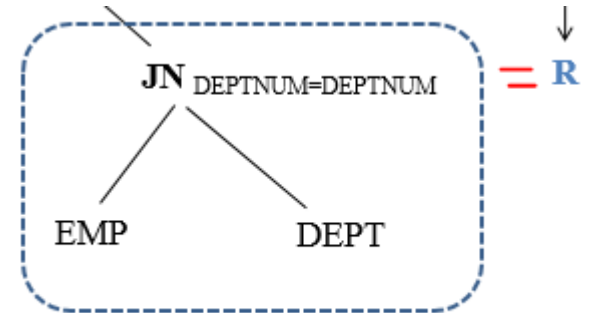


# Removing Common Sub-expression

$F = \text{SAL} > 35\text{K}$

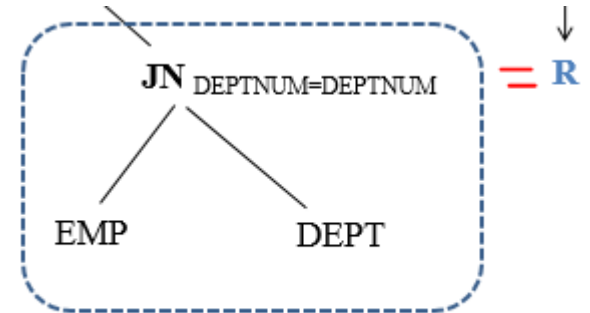
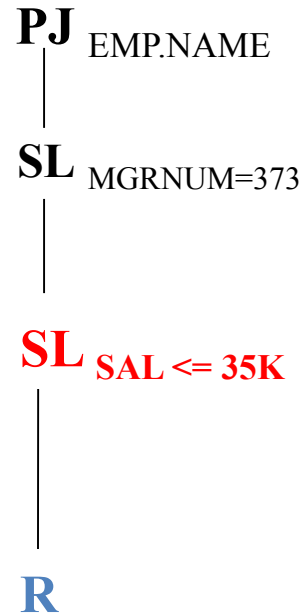
**PJ** EMP.NAME  
|  
**SL** MGRNUM=373

|  
**SL** NOT F  
|  
**R**

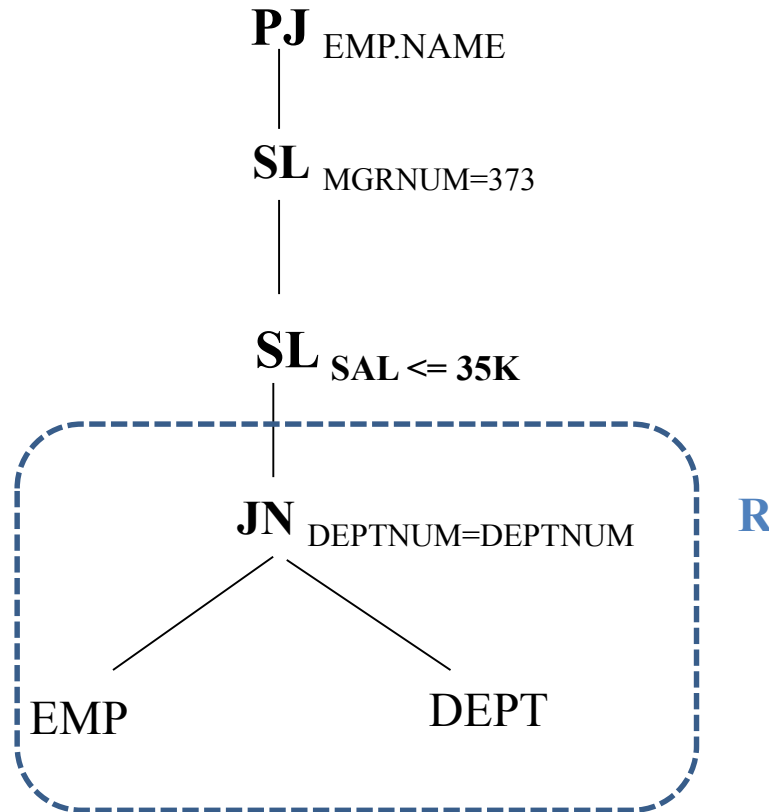


•  $R \text{ DF } \text{SL}_F R \leftrightarrow \text{SL}_{\text{NOT } F} R$

# Removing Common Sub-expression



# Removing Common Sub-expression



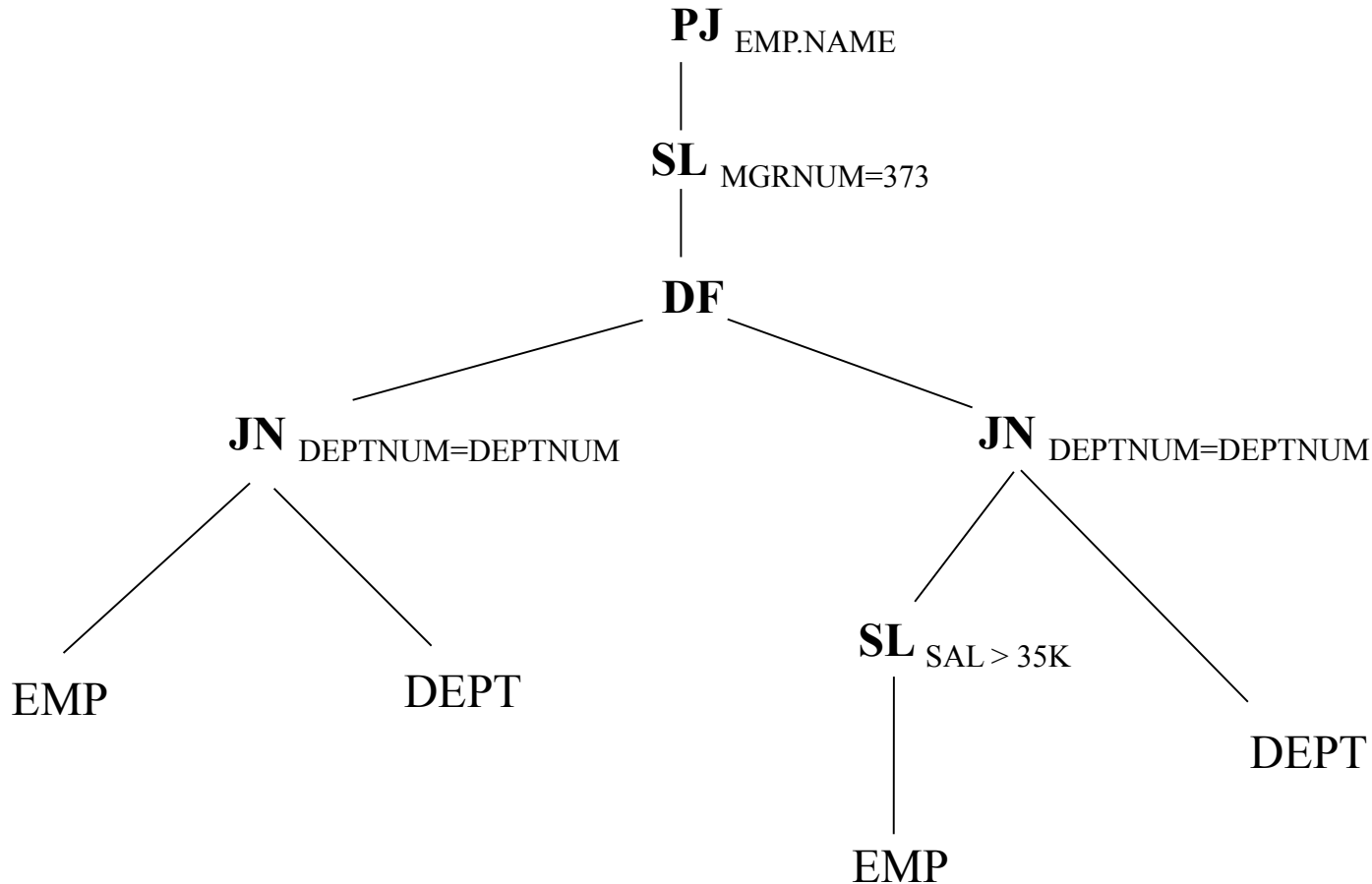
Can you apply Criterion 1 and/or 2 on this tree?

# Example 2.2

*EMP (EMPNUM, DEPTNUM, NAME, SAL, AGE)*  
*DEPT (DEPTNUM, NAME, AREA, MGRNUM)*

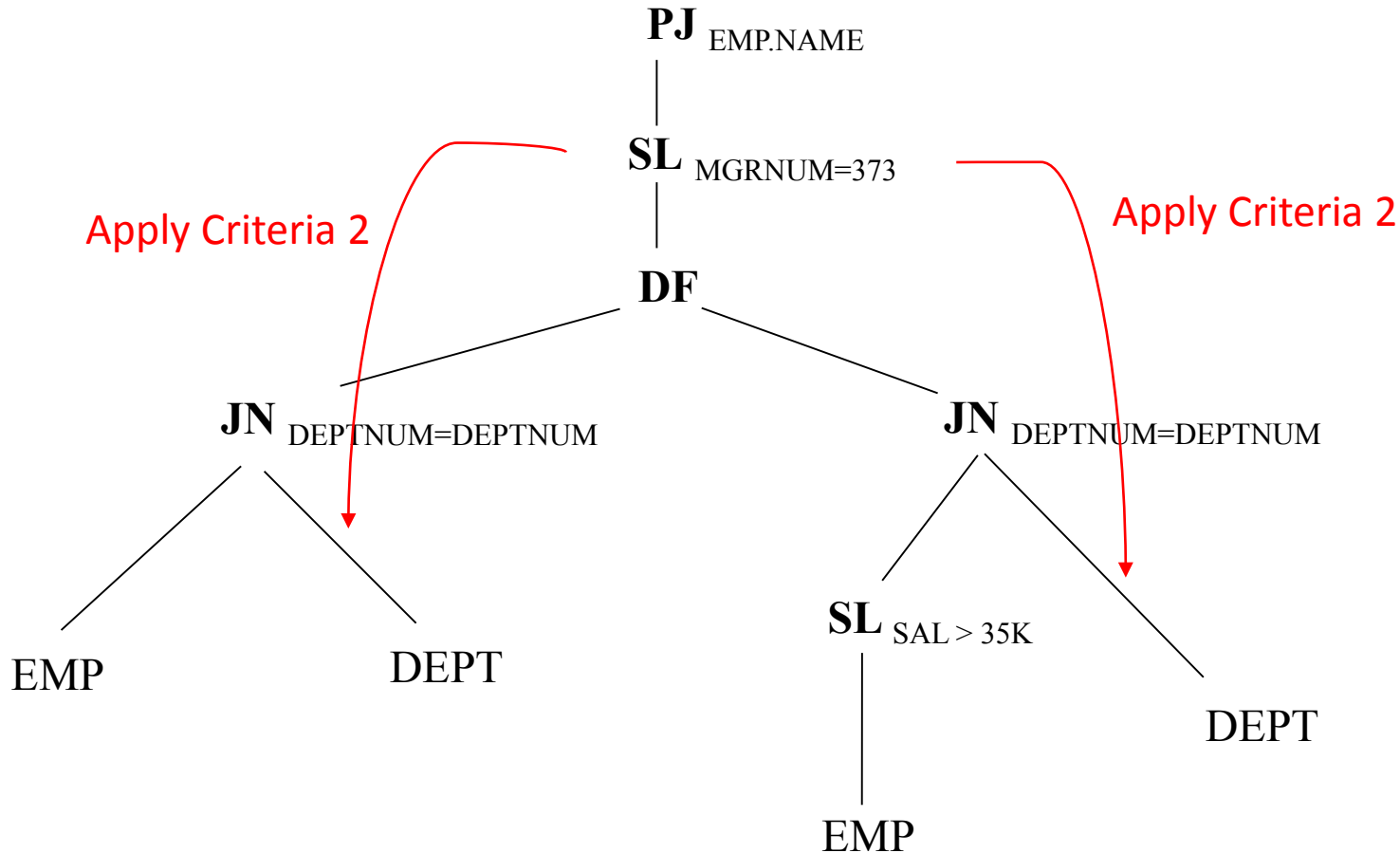
# Given query and Operator Tree

**Q:** **PJ** <sub>EMP.NAME</sub> **SL** <sub>MGRNUM=373</sub> ((**EMP JN** <sub>DEPTNUM=DEPTNUM</sub> **DEPT**) **DF** (**SL** <sub>SAL > 35K</sub> **EMP JN** <sub>DEPTNUM=DEPTNUM</sub> **DEPT**))



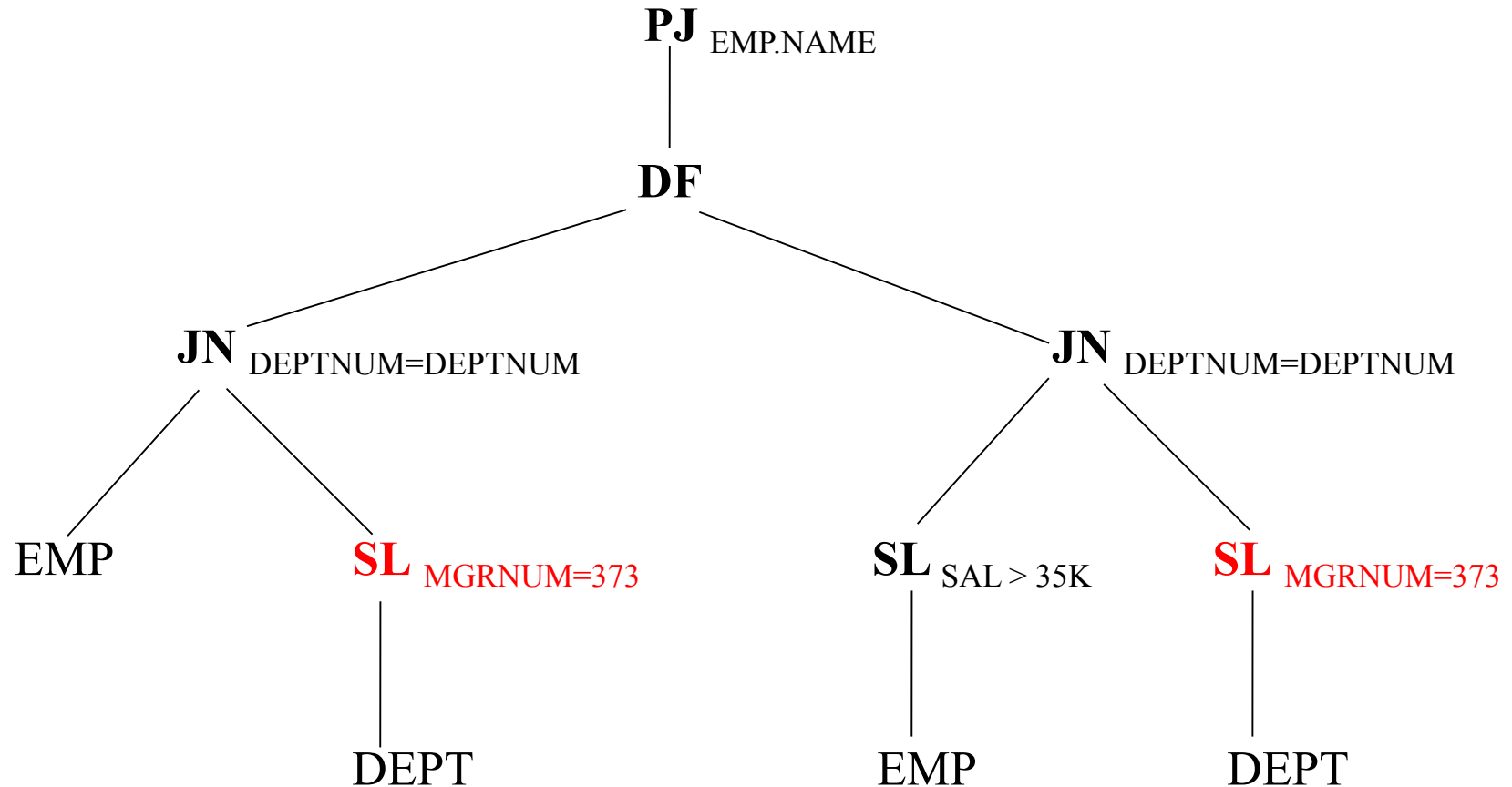
# Finding Common Sub-expression

Any common portion?



# Finding Common Sub-expression

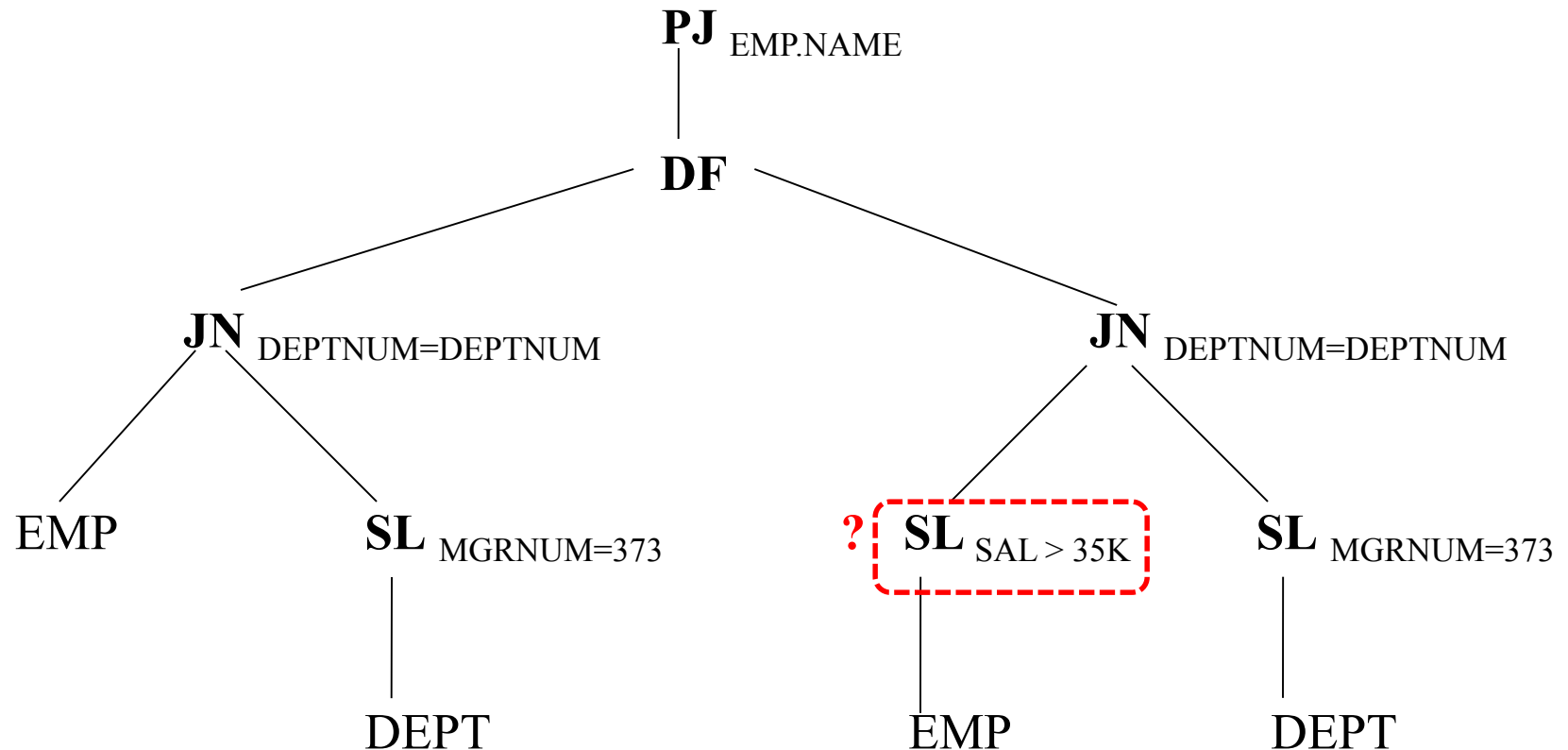
Any common portion?





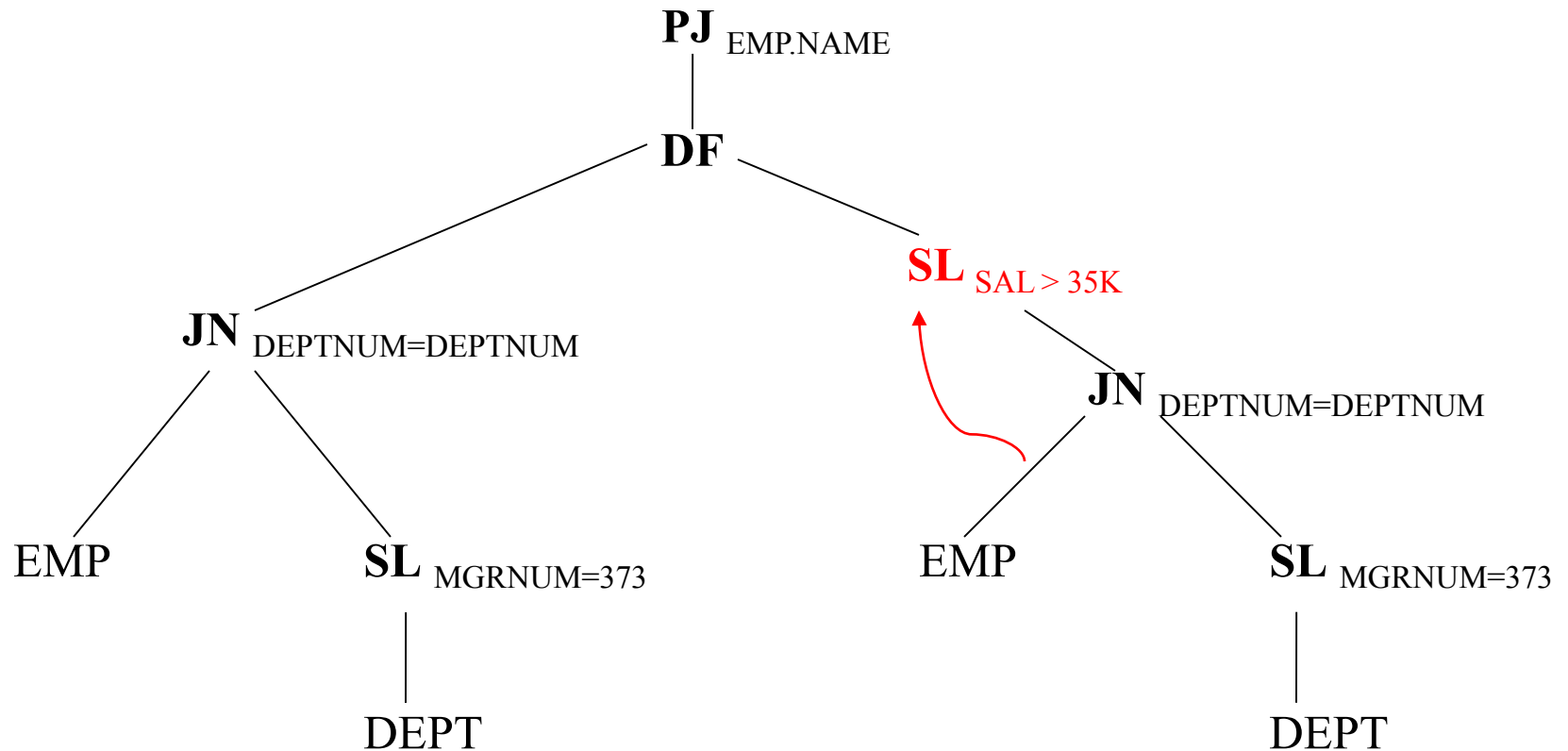
# Finding Common Sub-expression

Any common portion?

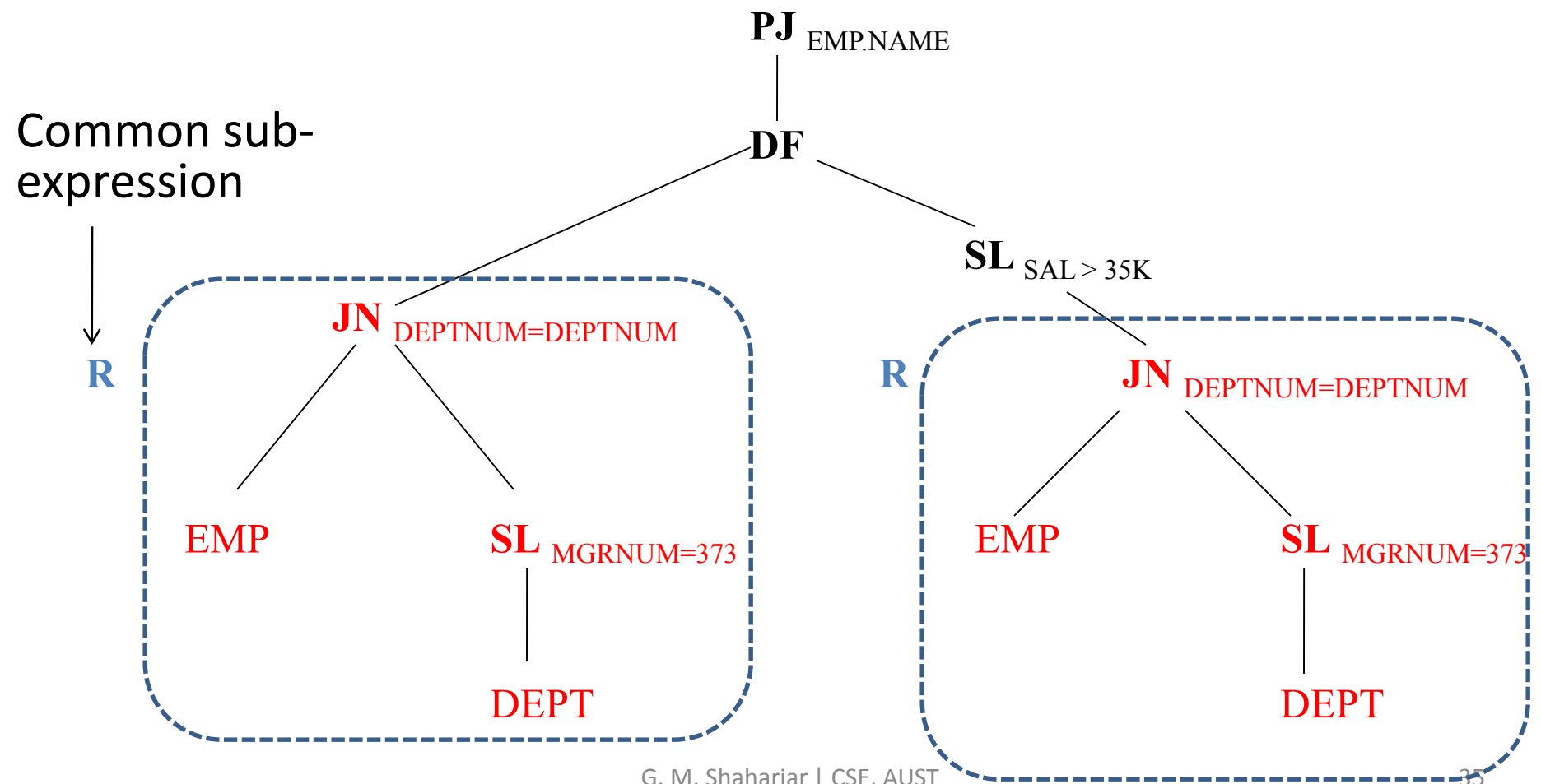


# Finding Common Sub-expression

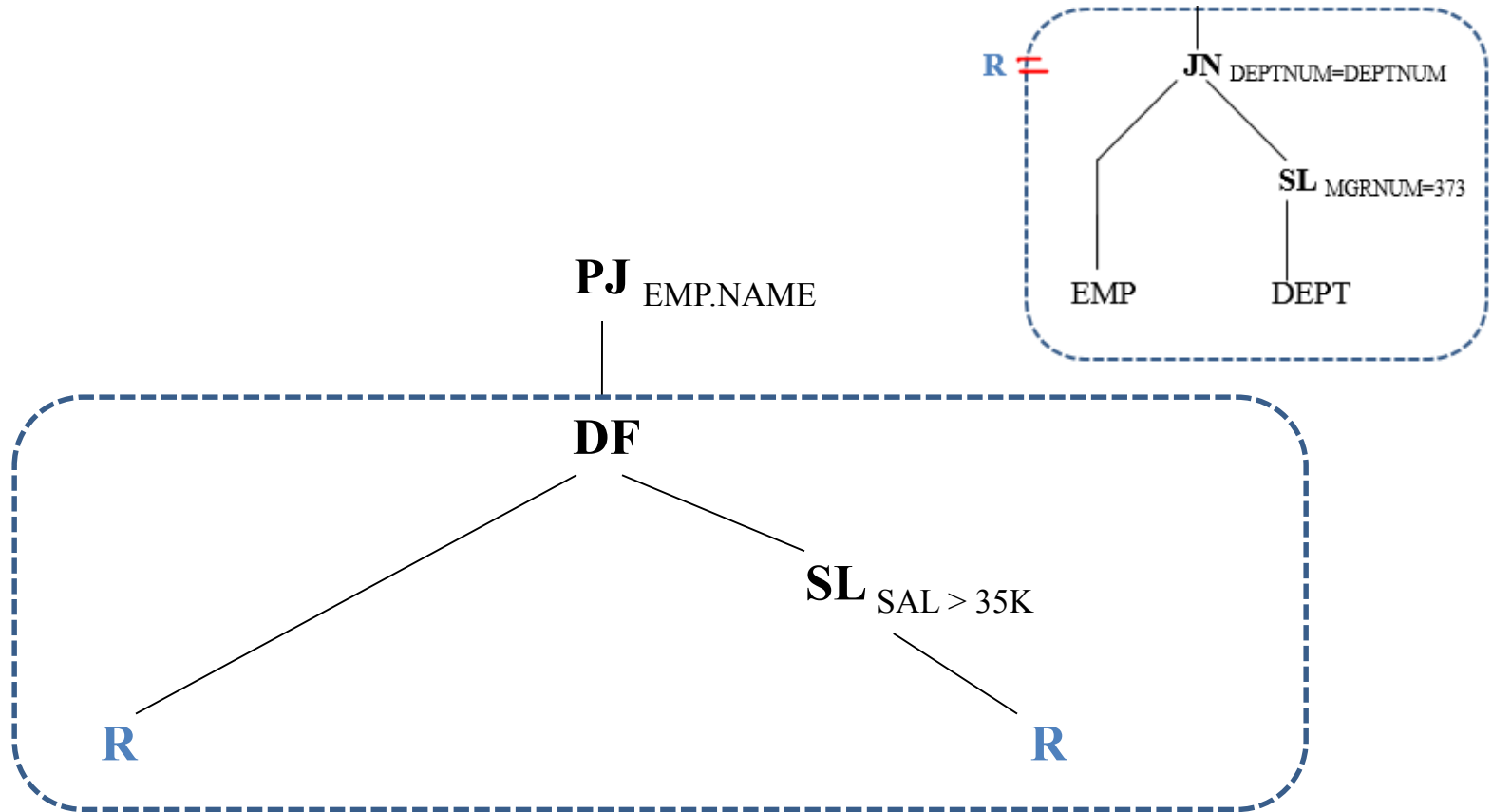
Any common portion? NOW?



# Finding Common Sub-expression

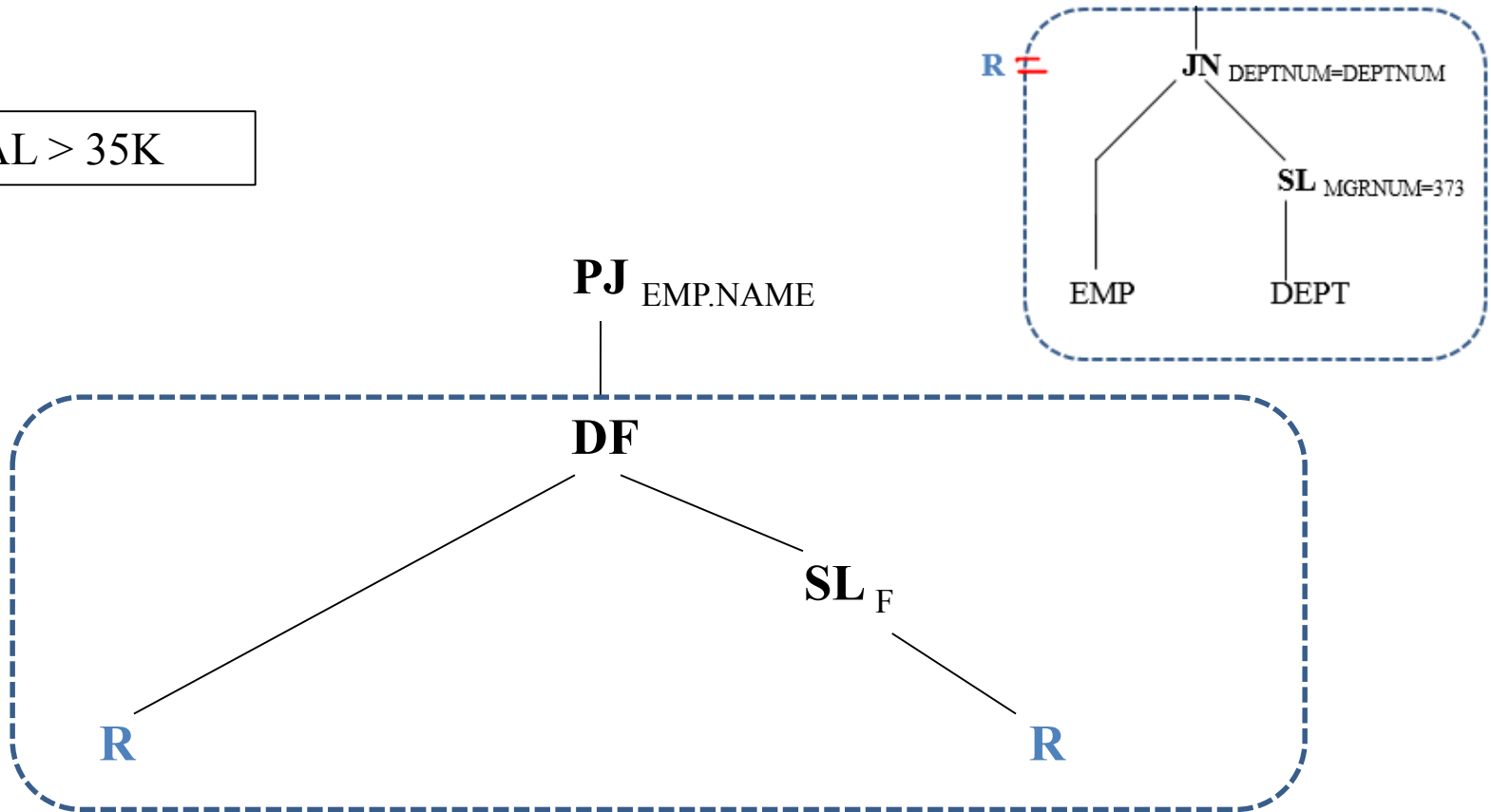


# Finding Common Sub-expression



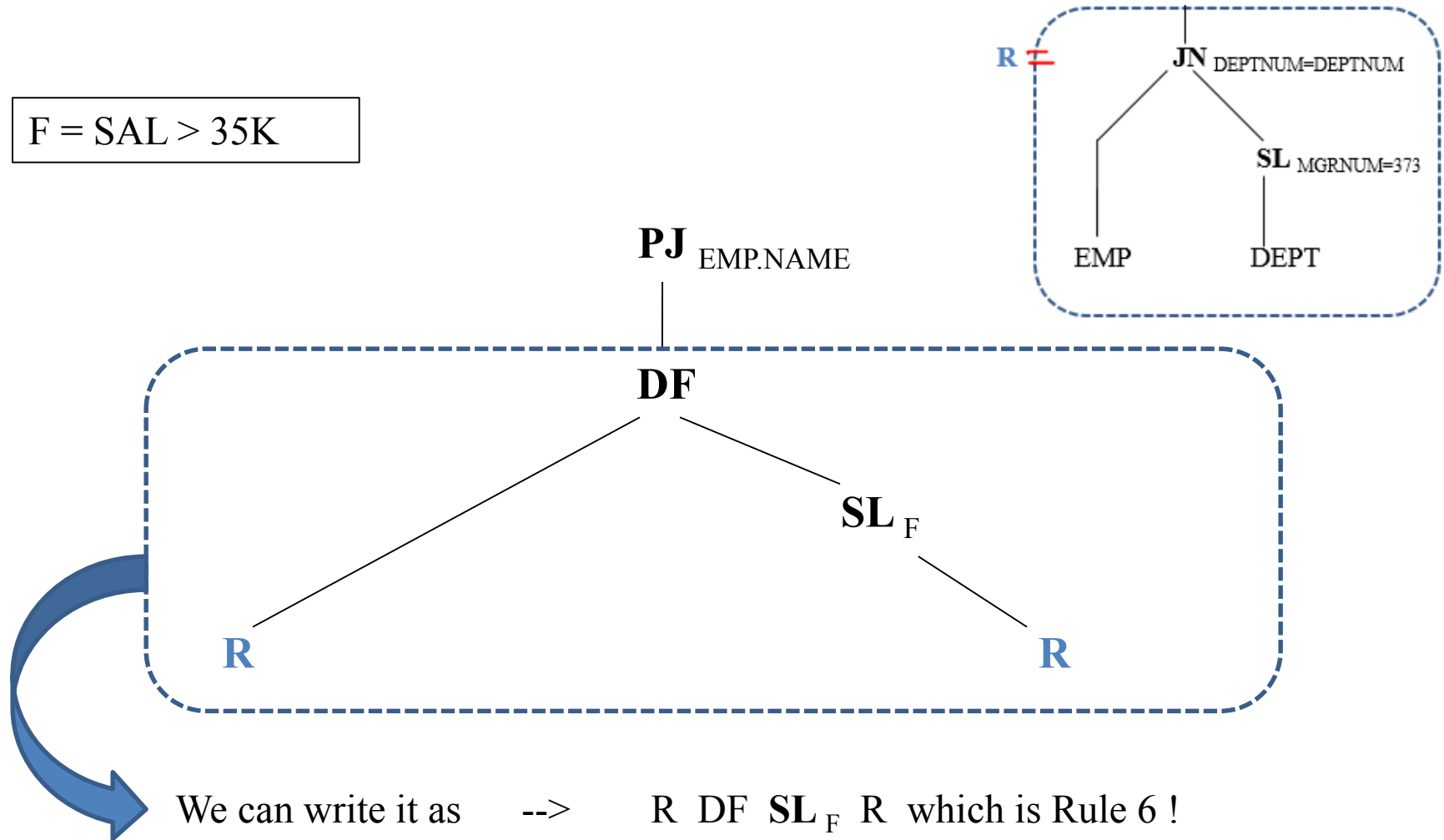
# Finding Common Sub-expression

$F = \text{SAL} > 35K$



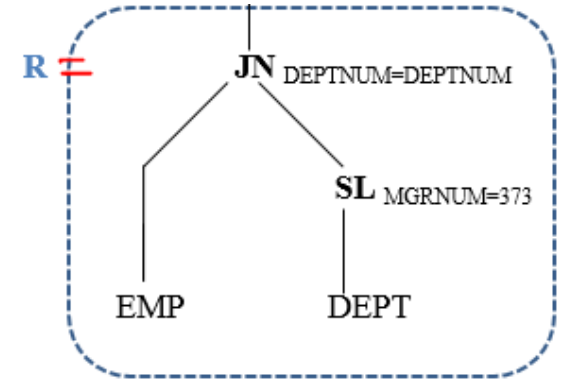
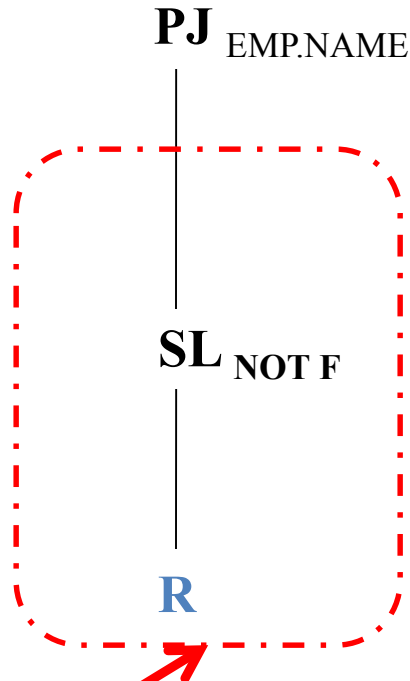
# Finding Common Sub-expression

$F = \text{SAL} > 35K$



# Removing Common Sub-expression

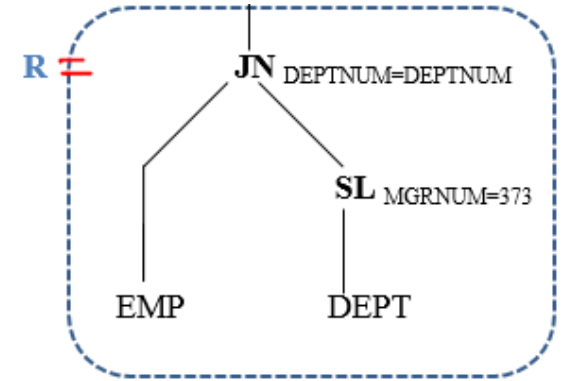
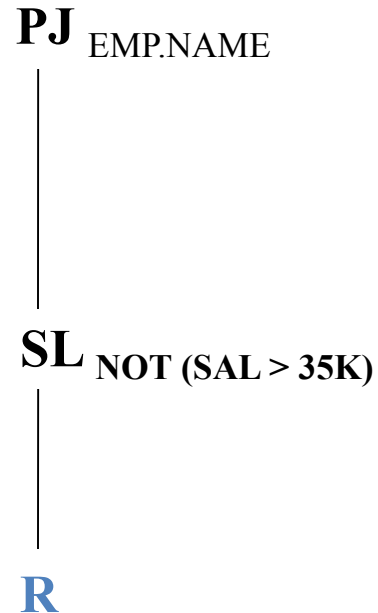
$F = \text{SAL} > 35K$



•  $R \text{ DF } SL_F R \leftrightarrow SL_{NOT F} R$

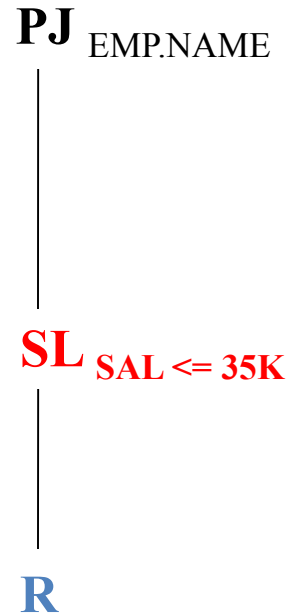
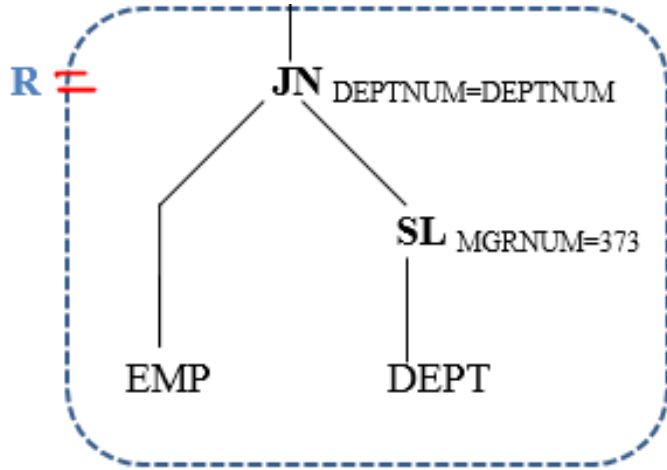
# Removing Common Sub-expression

$F = \text{SAL} > 35\text{K}$

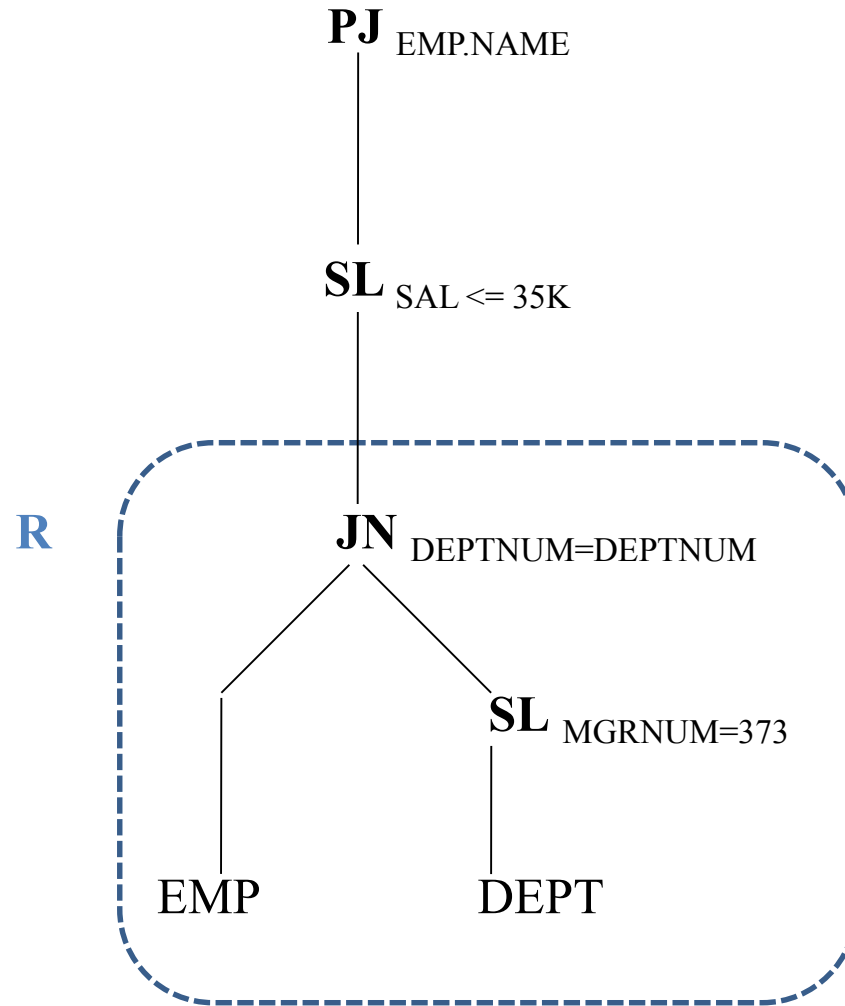




# Removing Common Sub-expression



# Removing Common Sub-expression



Can you apply Criterion 1 and/or 2 on this tree?

# Example 3

## Practise

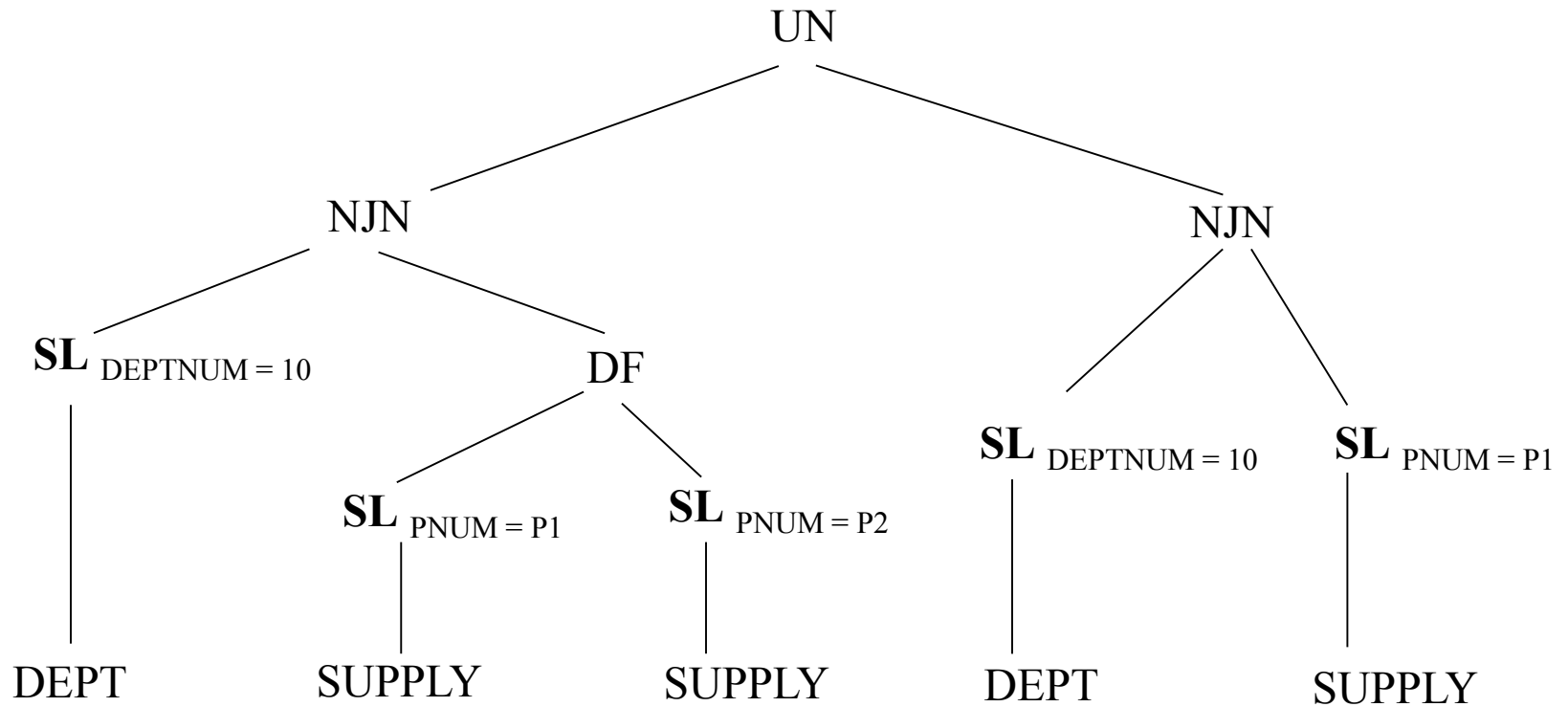
\* Draw Operator Tree for the following queries:

①  
SUPPLY (SNUM, PNUM, DEPTNUM, QUAN)  
DEPT (DEPTNUM, NAME, AREA, MGRNUM)

Query:

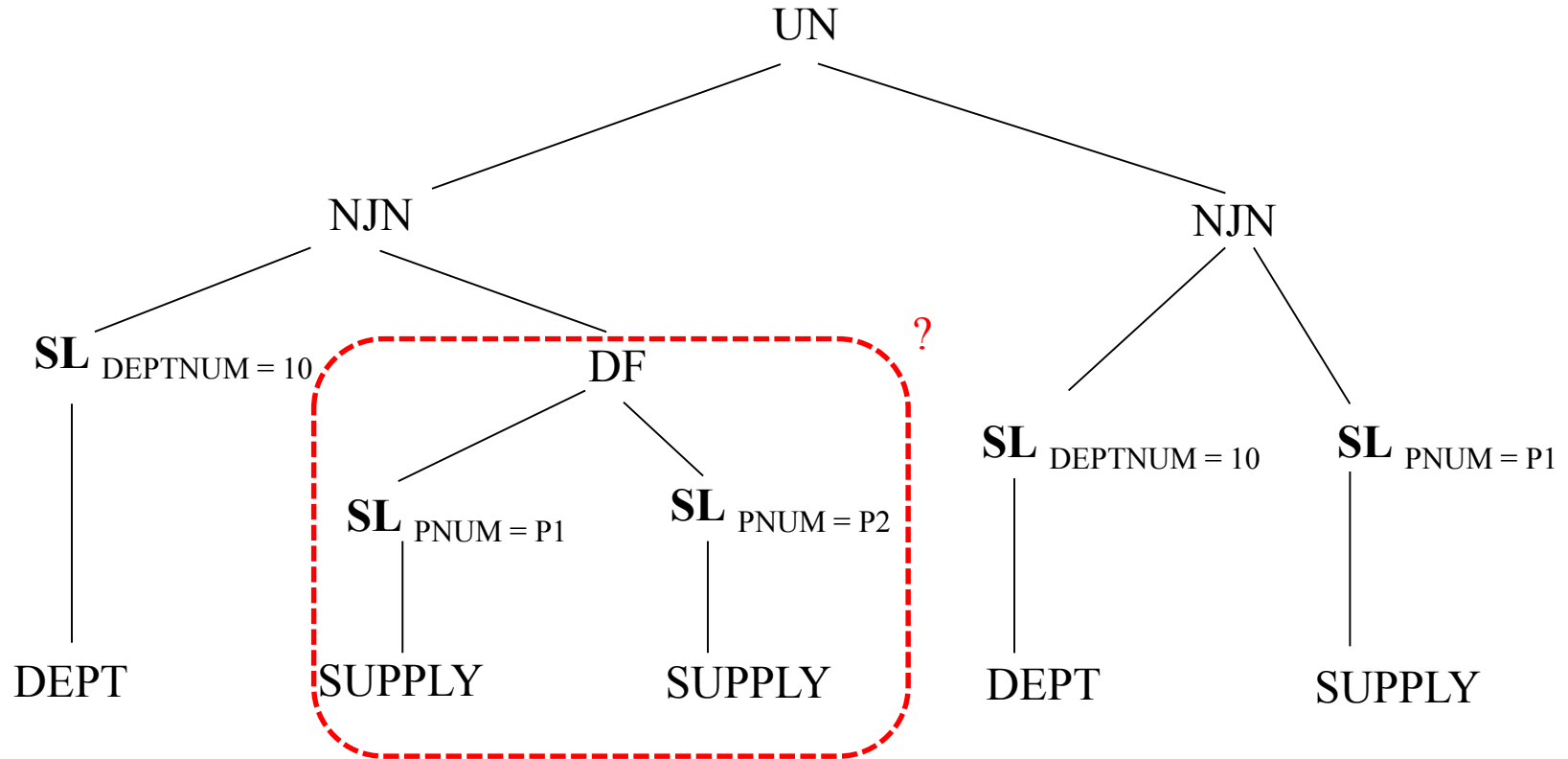
$(\sigma_{DEPTNUM=10} DEPT \bowtie (\sigma_{PNUM="P_1"} SUPPLY$   
 $\cup (\sigma_{PNUM="P_2"} SUPPLY))) \bowtie (\sigma_{DEPTNUM=10} DEPT$   
 $\bowtie (\sigma_{PNUM="P_1"} SUPPLY))$

# Operator Tree



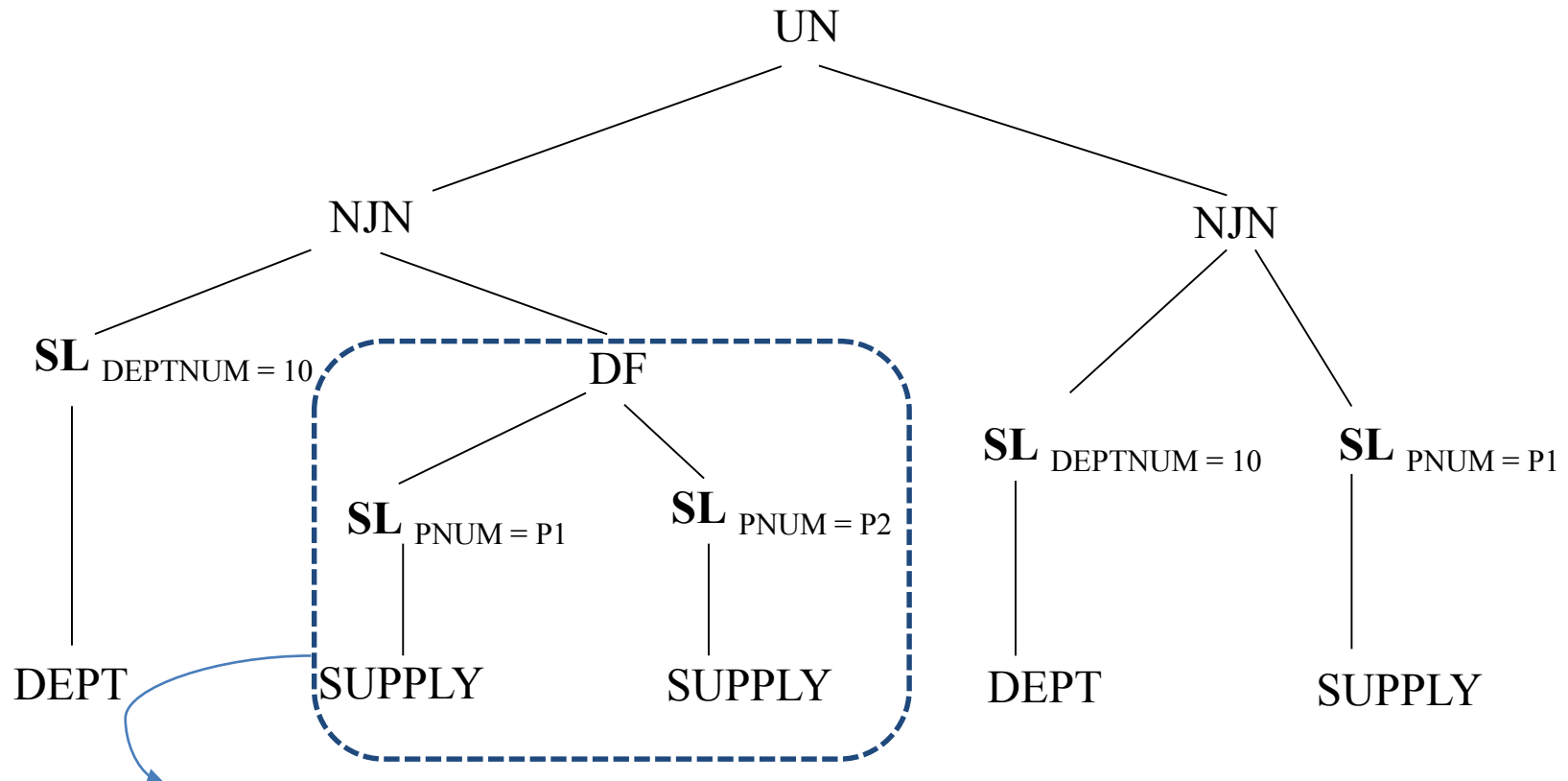
# Finding Common Sub - Expression

Any common portion?



# Finding Common Sub - Expression

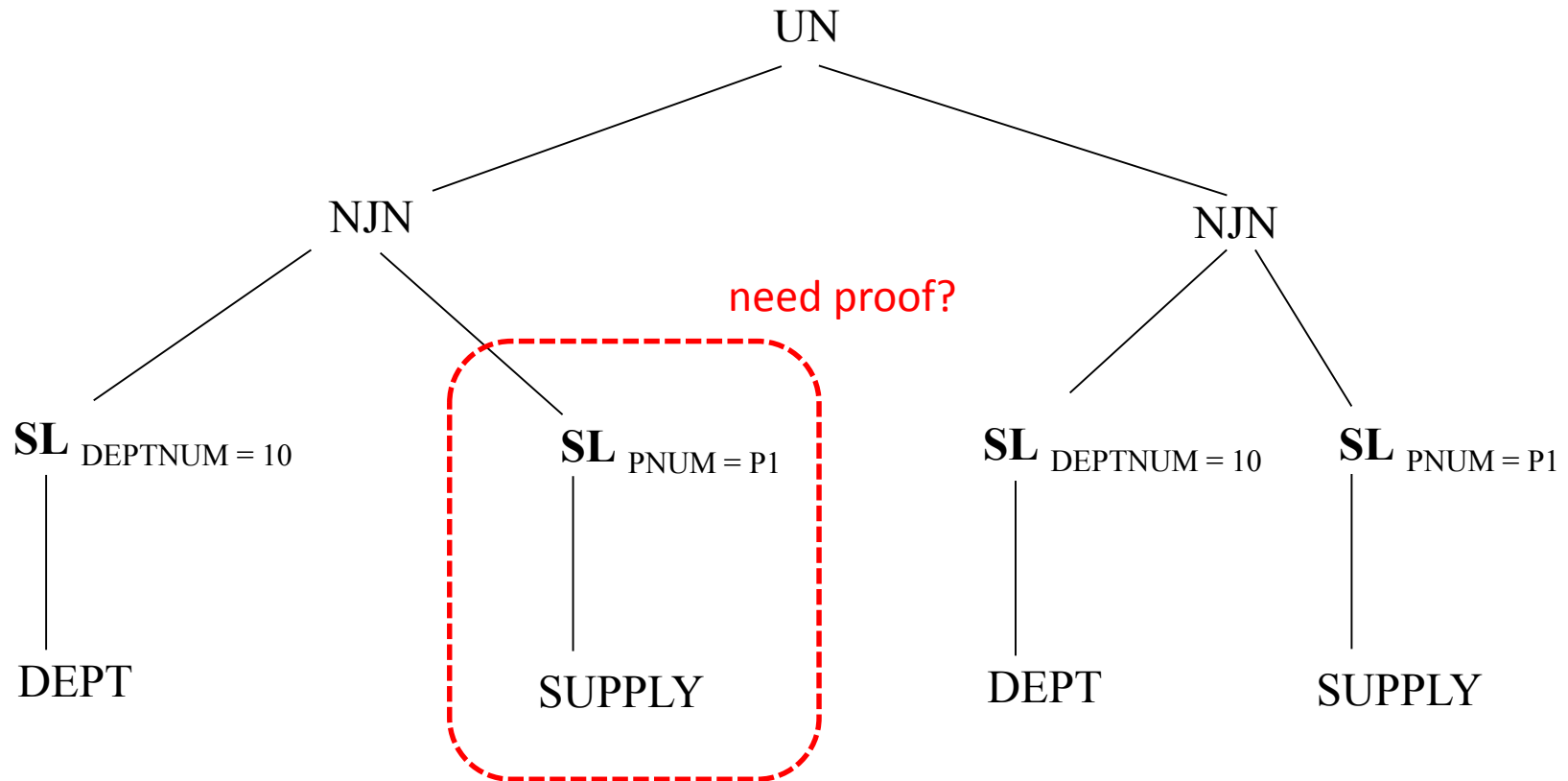
Any common portion?



We can use Rule 9.  $SL_{F1} R \text{ DF } SL_{F2} R = SL_{F1 \text{ AND NOT } F2} R$

# Finding Common Sub - Expression

Any common portion?



# Need Proof?

SUPPLY

SNUM	PNUM	DEPTNUM	QUAN
1	P1	1	10
2	P2	2	20
3	P1	1	30
4	P2	1	40
5	P1	2	50
6	P2	1	60

A

SL<sub>PNUM = P1</sub> SUPPLY

SNUM	PNUM	DEPTNUM	QUAN
1	P1	1	10
3	P1	1	30
5	P1	2	50

B

SL<sub>PNUM = P2</sub> SUPPLY

SNUM	PNUM	DEPTNUM	QUAN
2	P2	2	20
4	P2	1	40
6	P2	1	60

A

DF

B

=

A

SNUM	PNUM	DEPT NUM	QUAN
1	P1	1	10
3	P1	1	30
5	P1	2	50

-

SNUM	PNUM	DEPT NUM	QUAN
2	P2	2	20
4	P2	1	40
6	P2	1	60

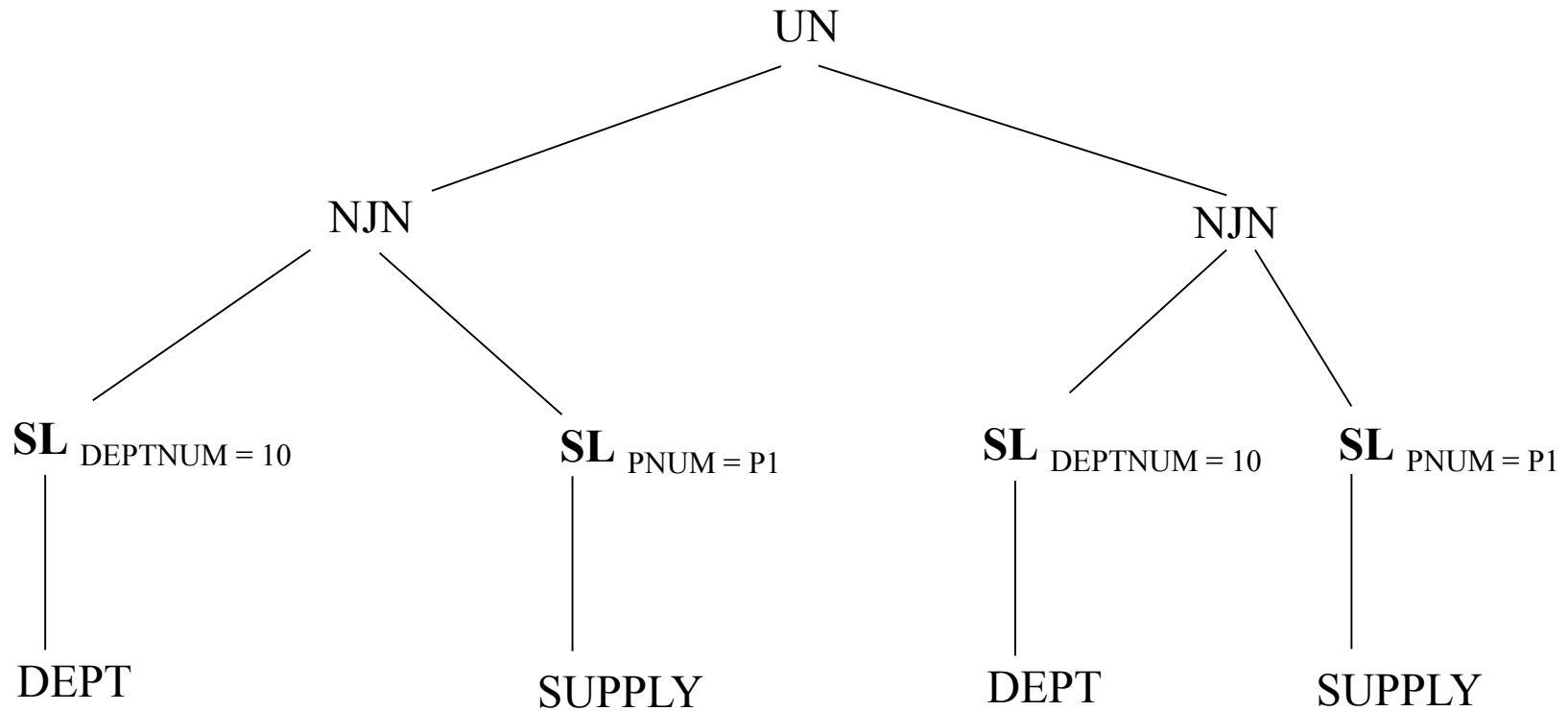
=

SNUM	PNUM	DEPT NUM	QUAN
1	P1	1	10
3	P1	1	30
5	P1	2	50



# Finding Common Sub - Expression

Any common portion?

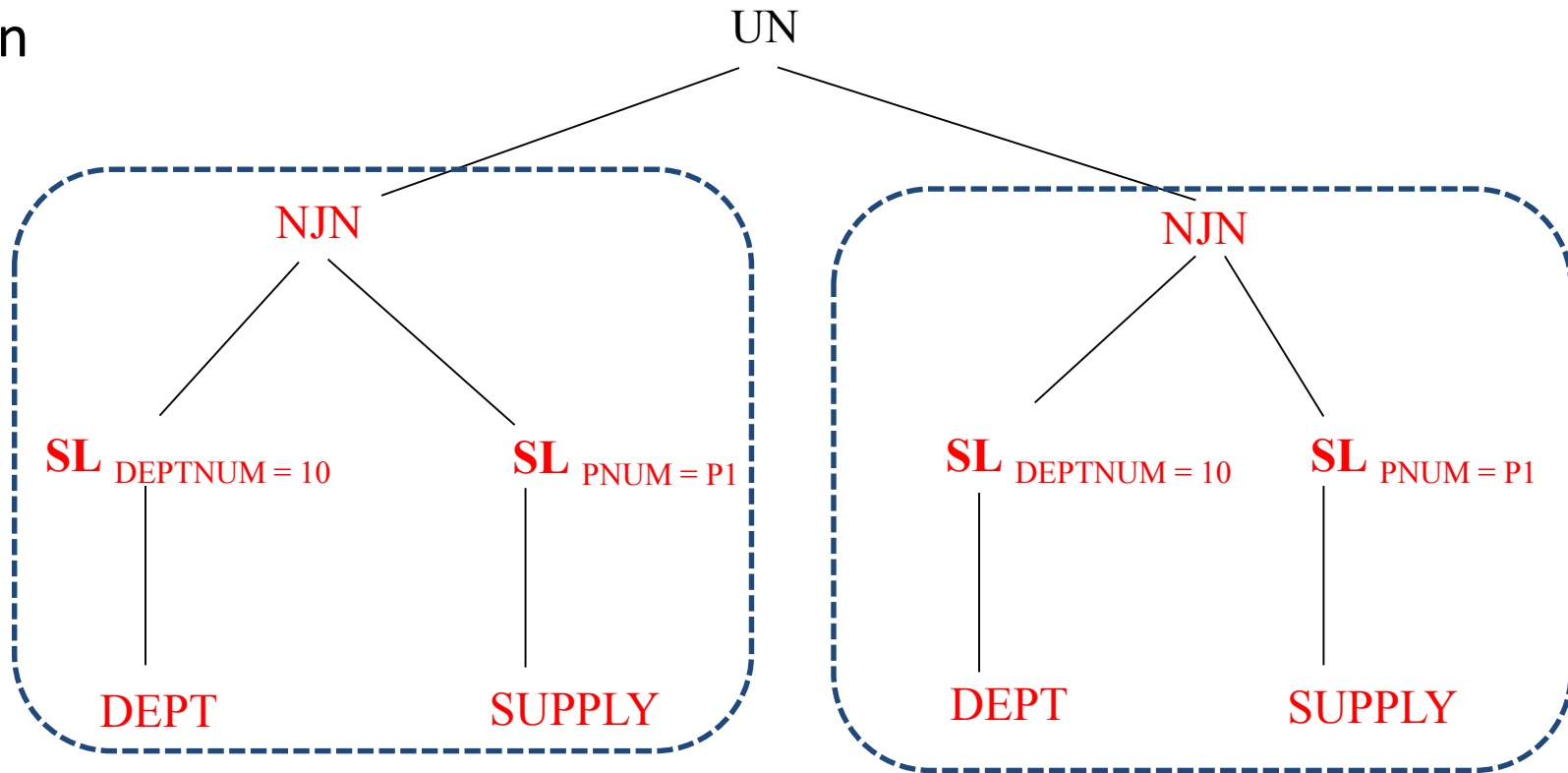


# Finding Common Sub - Expression

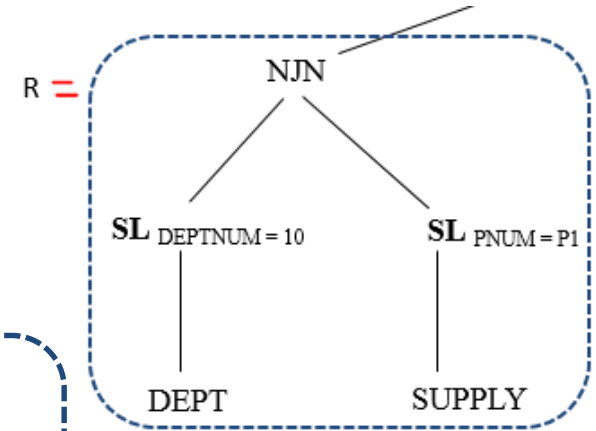
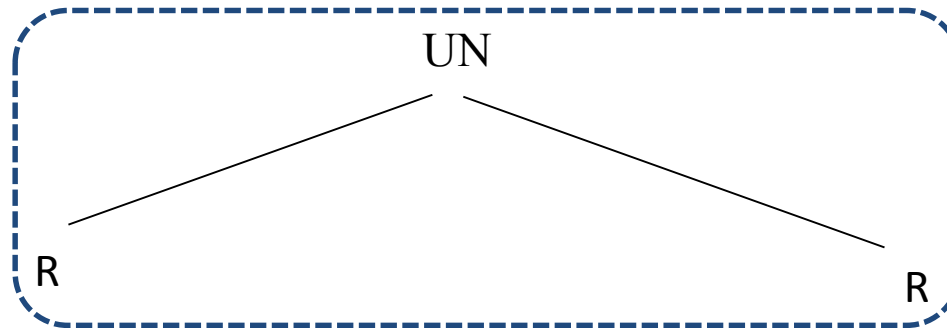
Any common portion? NOW?

Common sub-expression

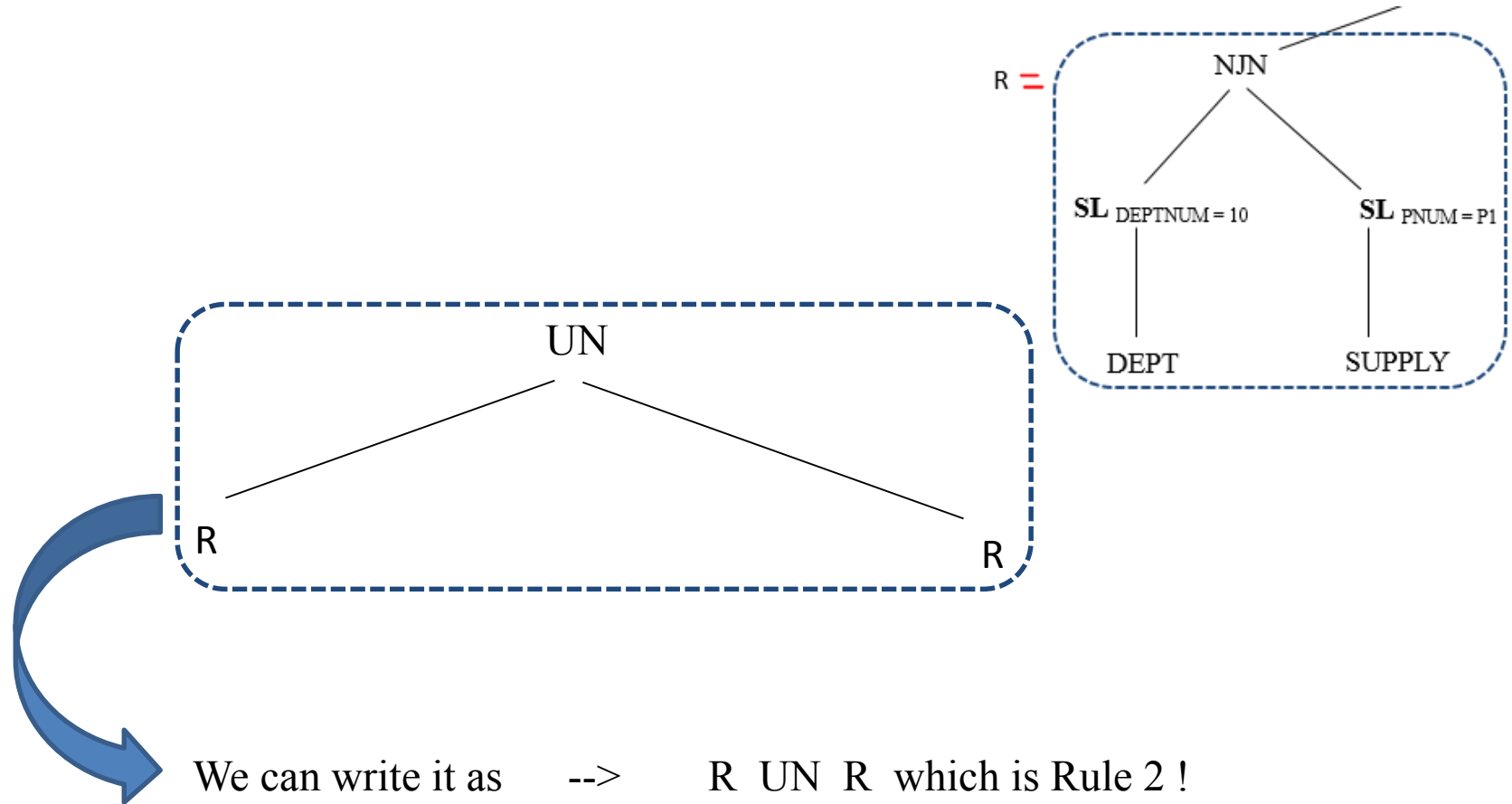
R



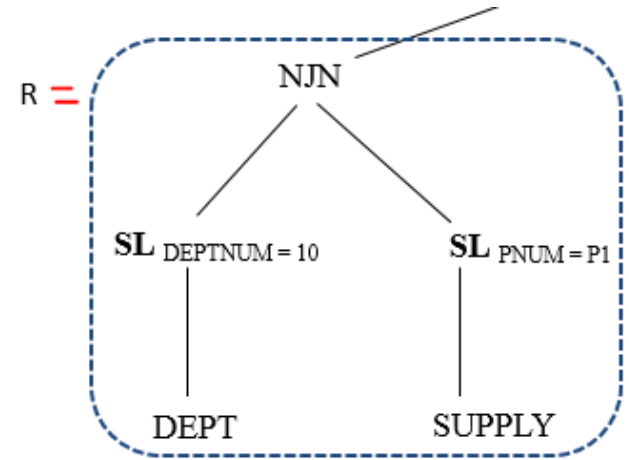
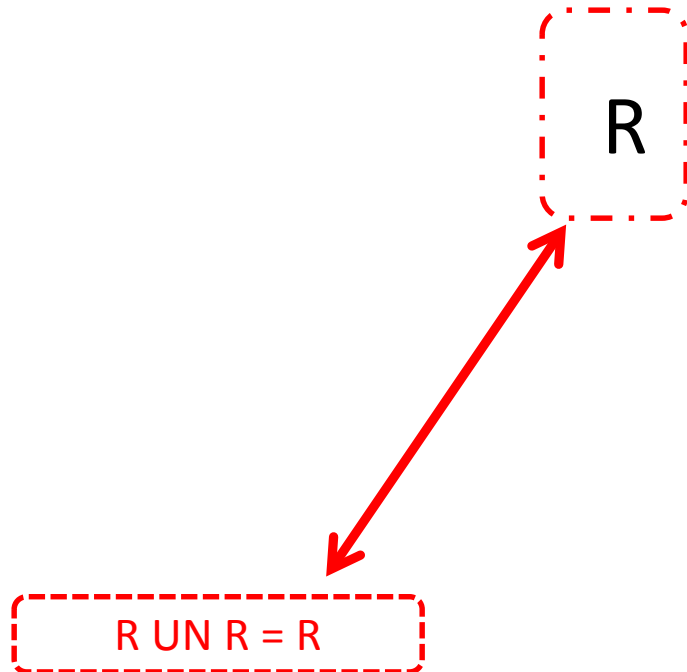
# Finding Common Sub - Expression



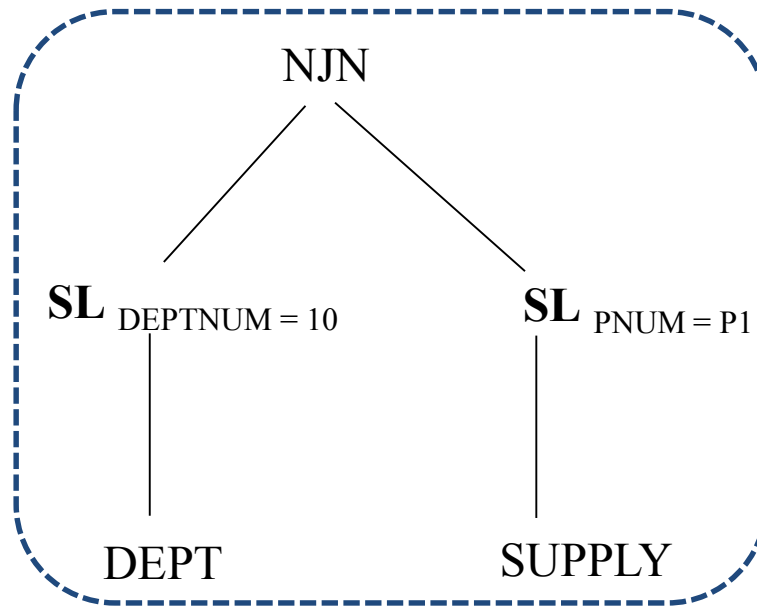
# Finding Common Sub - Expression



# Removing Common Sub - Expression



# Removing Common Sub - Expression



Do we need to apply criteria 1 and/or 2?

# Last Example

*EMP (EMPNUM, DEPTNUM, NAME, SAL, AGE)*  
*DEPT (DEPTNUM, NAME, AREA, MGRNUM)*

Consider the following global query:

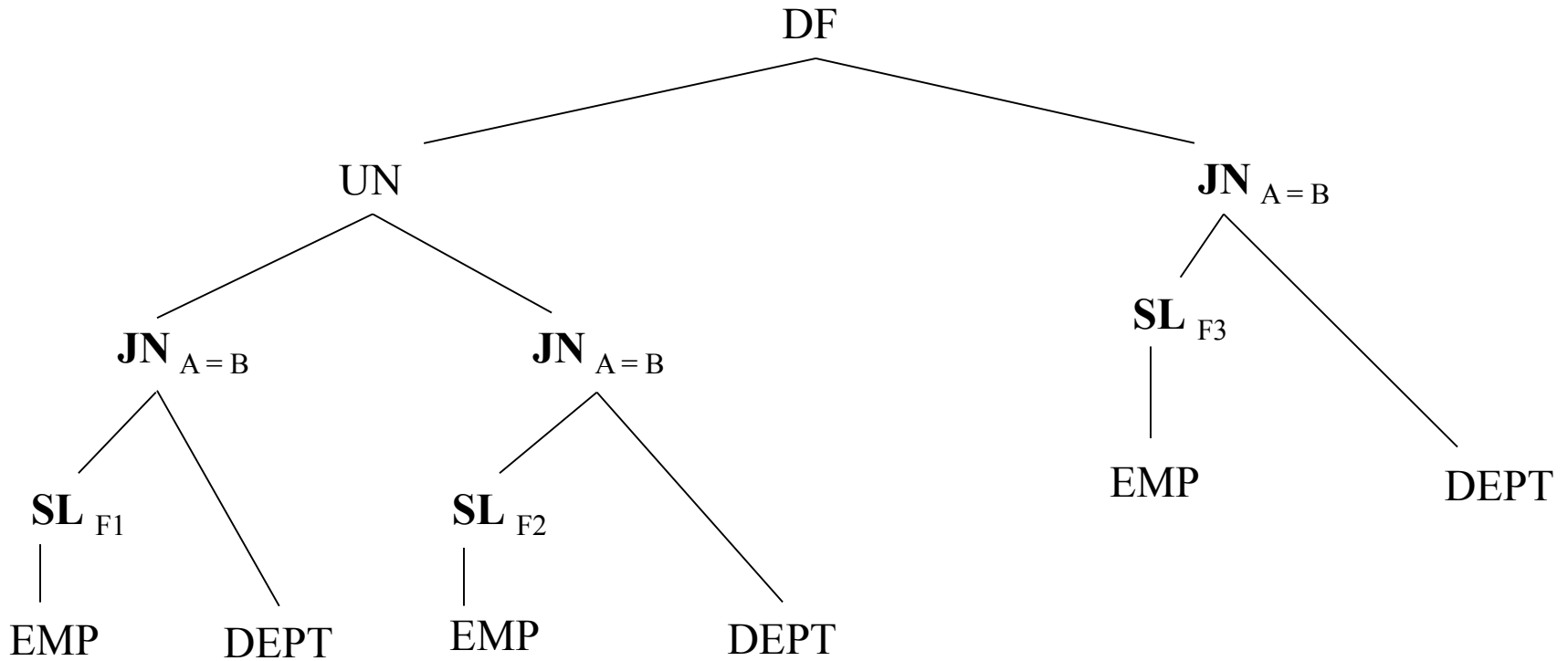
$((SL_{F1} \text{ EMP } JN_{A=B} \text{ DEPT}) \text{ UN } (SL_{F2} \text{ EMP } JN_{A=B} \text{ DEPT})) \text{ DF } (SL_{F3} \text{ EMP } JN_{A=B} \text{ DEPT})$

Here,

F1, F2, F3 can represent any condition. In this example consider none of them are same.

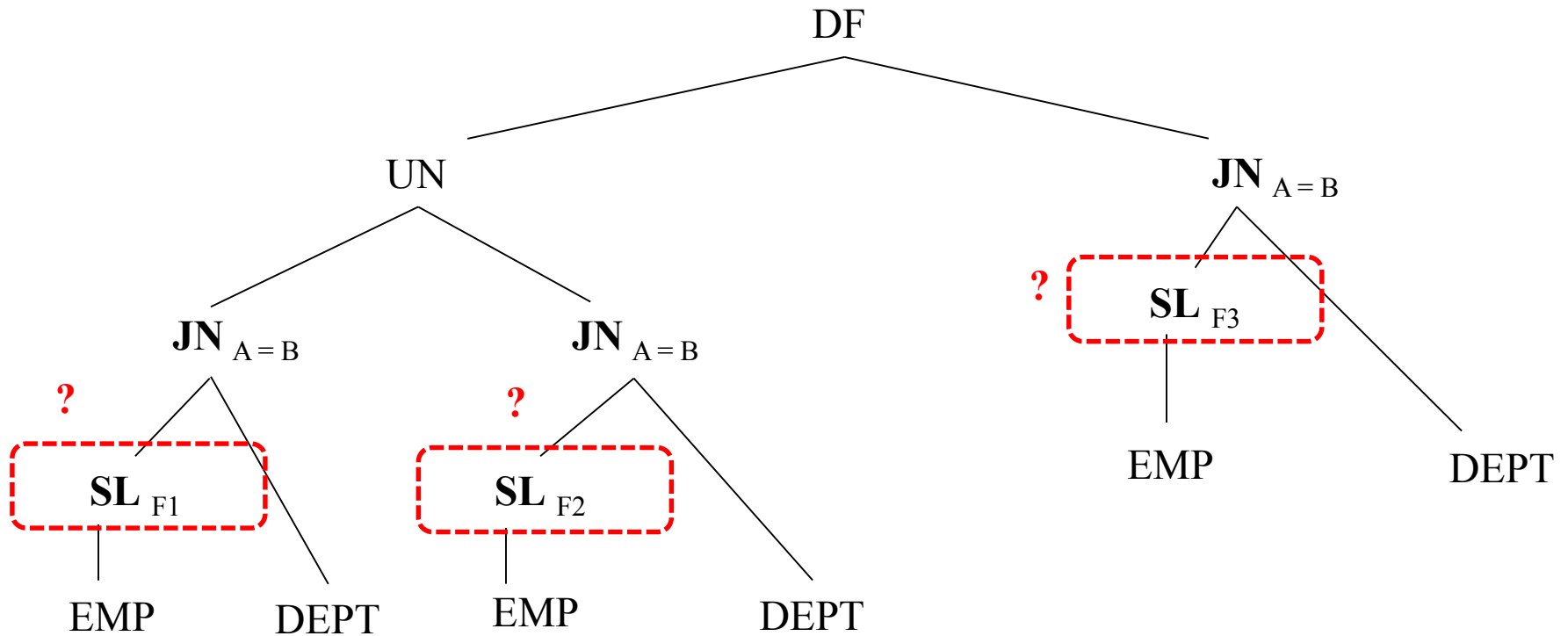
Imagine,  $A = B = \text{DEPTNUM}$

# Operator Tree



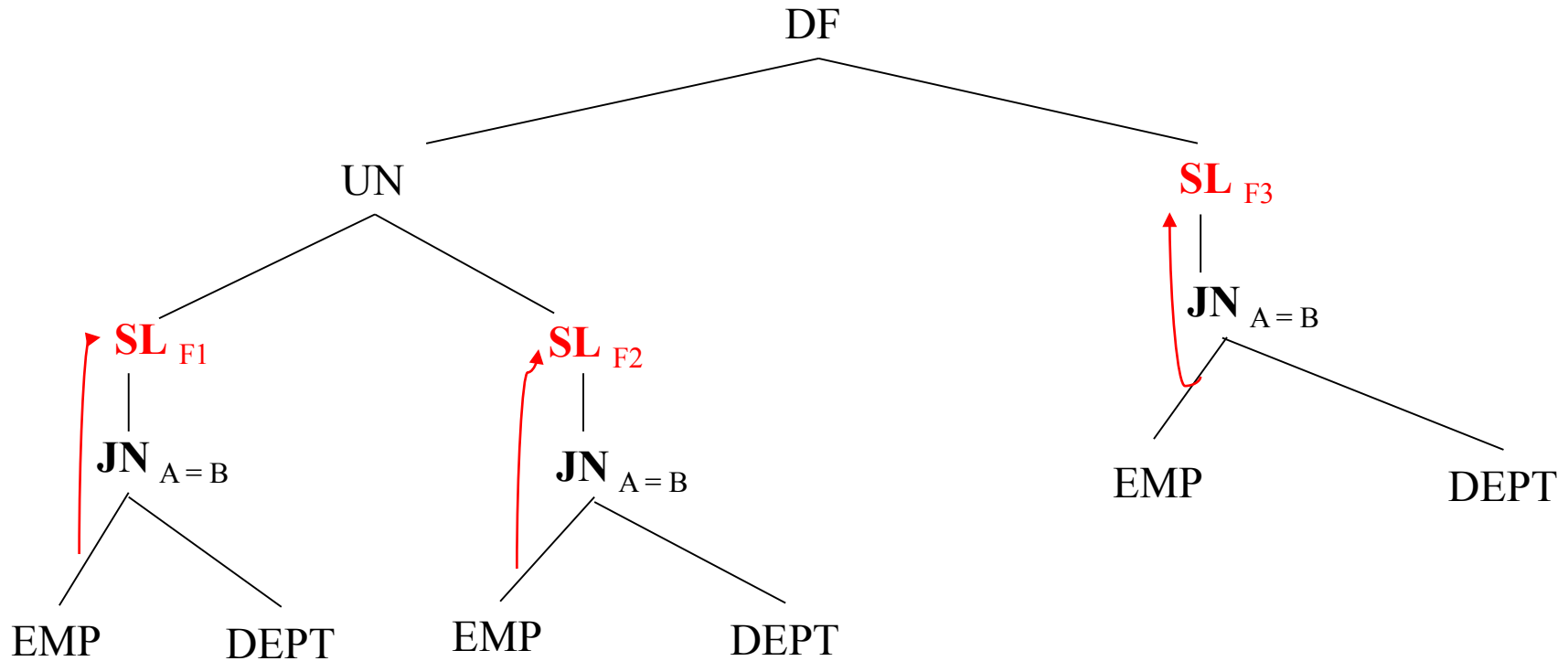


# Finding Common Sub-Expression



# Finding Common Sub-expression

Any common portion?

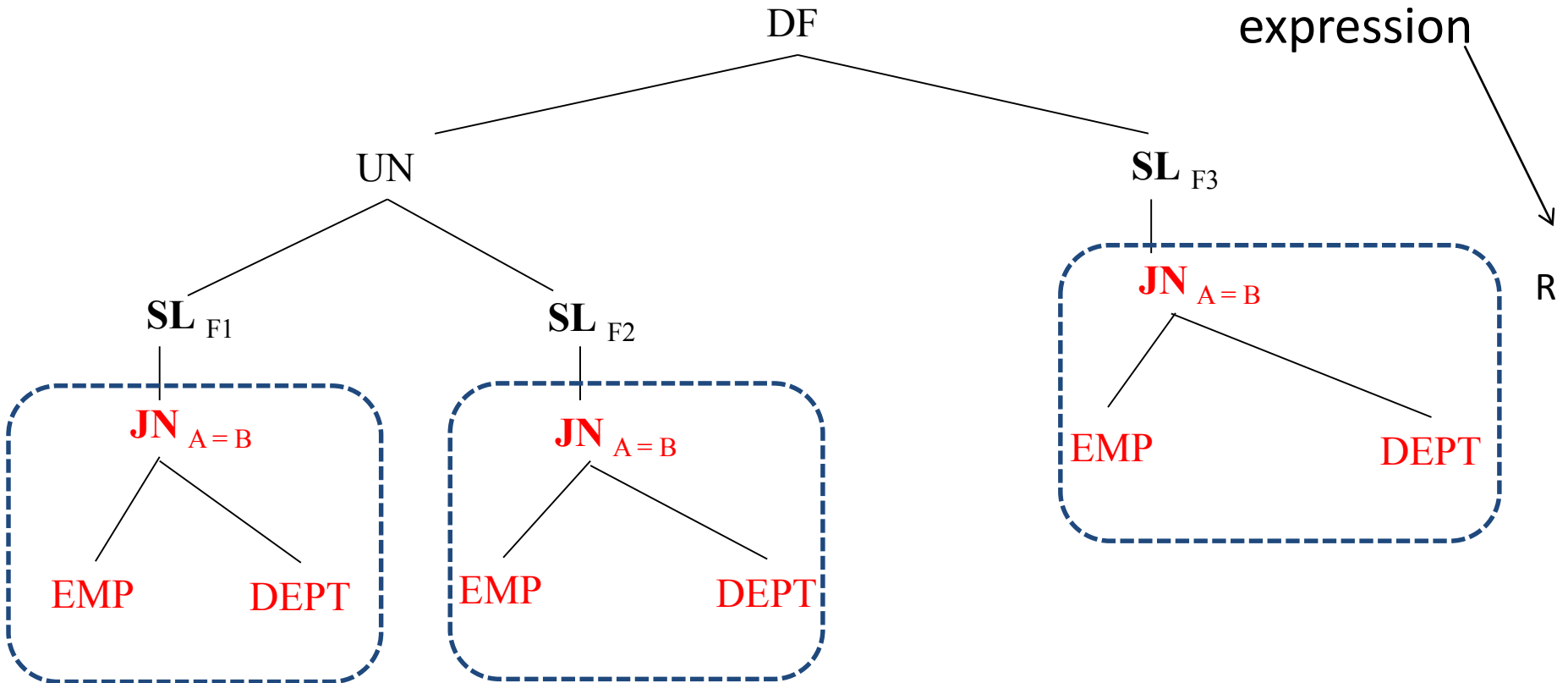


# Finding Common Sub-expression

Any common portion?

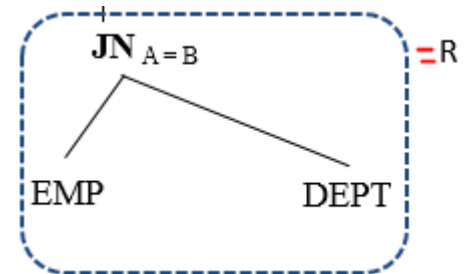
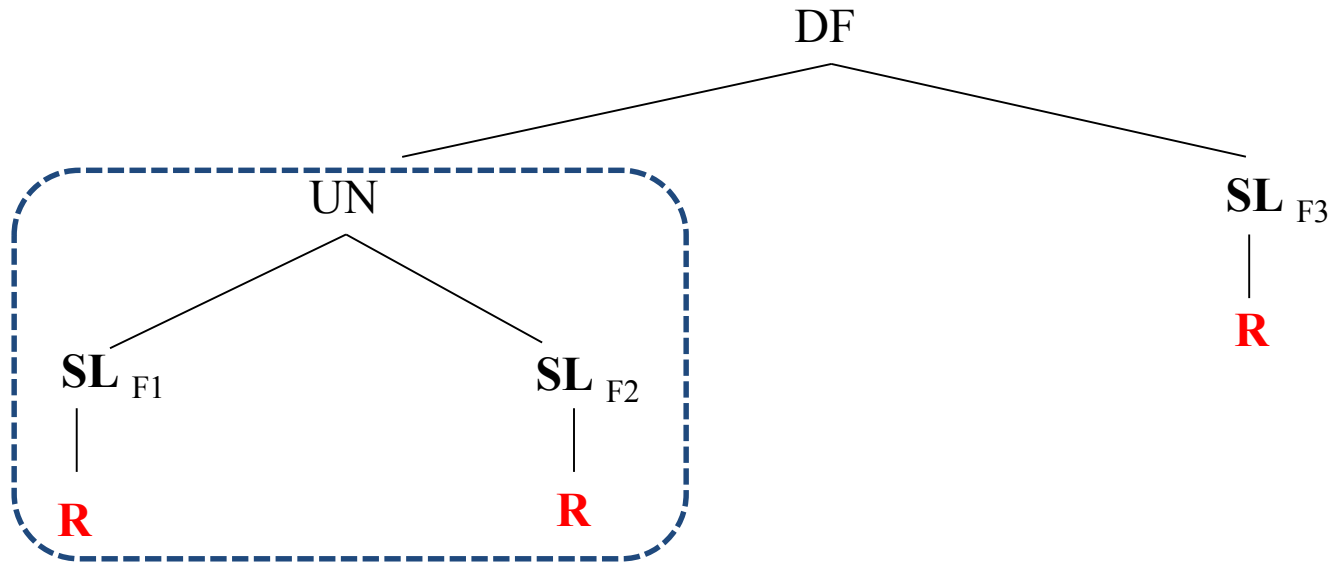
Common sub-expression

R



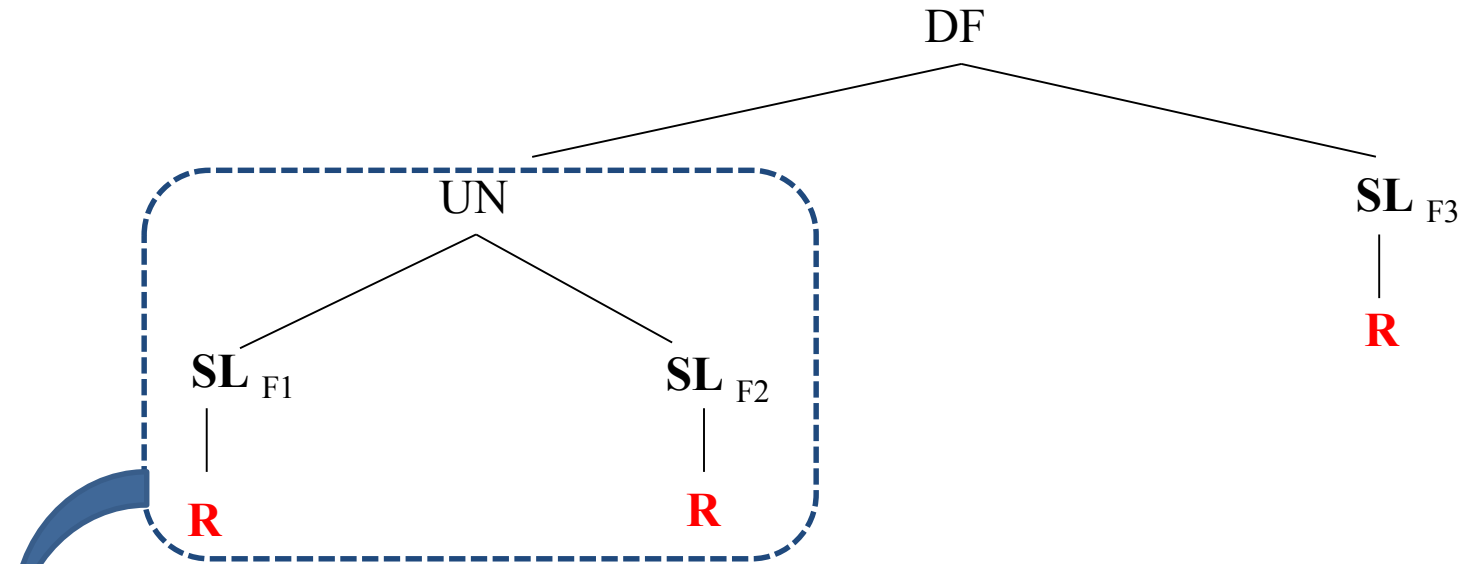
# Finding Common Sub-expression

Any common portion?

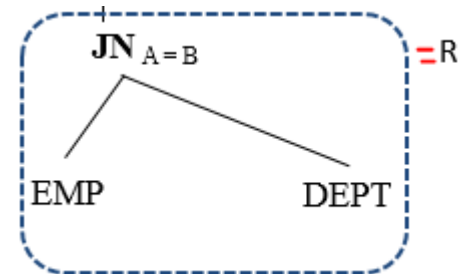


# Finding Common Sub-expression

Any common portion?

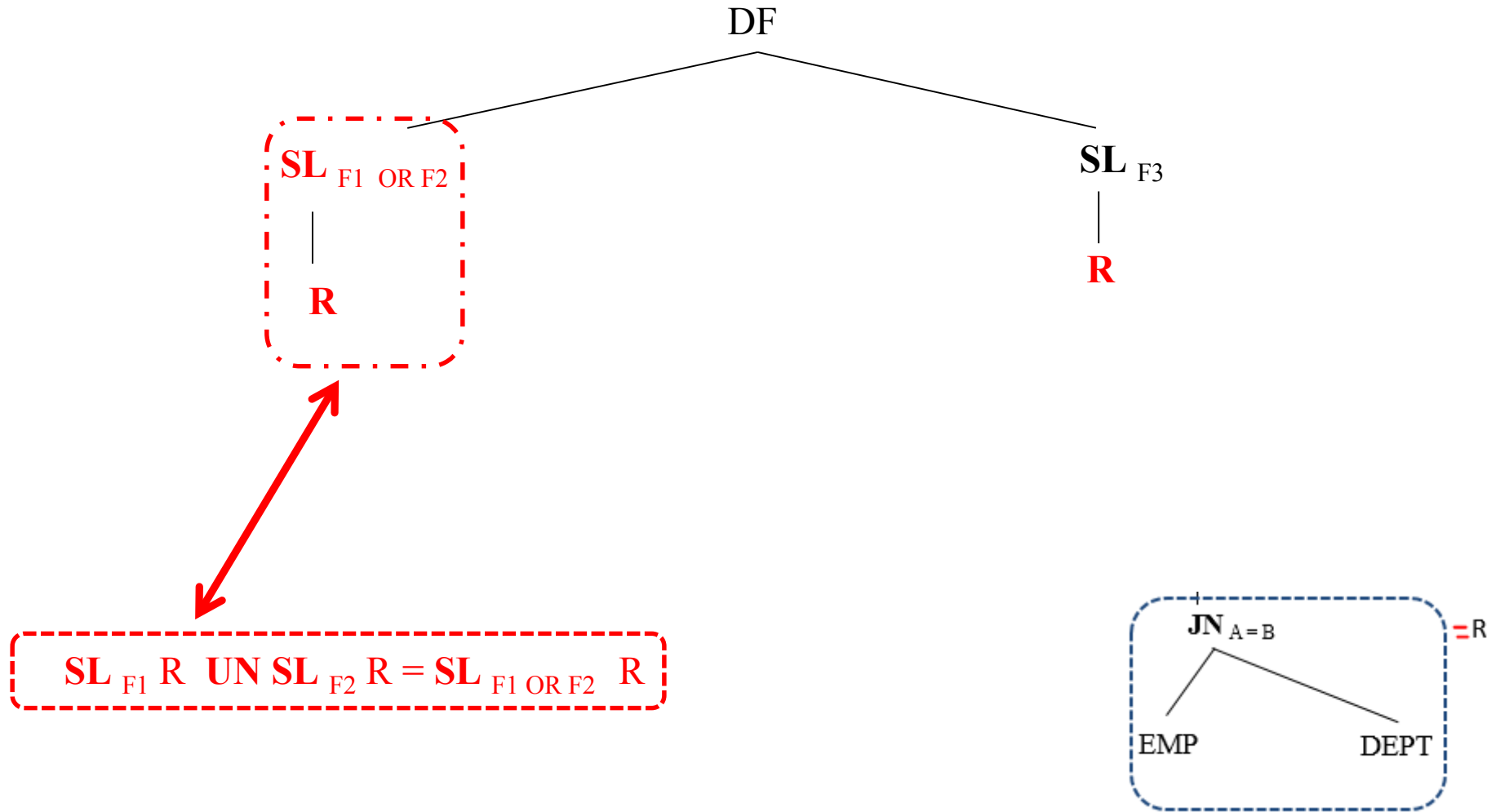


We can write it as  $SL_{F1} R \text{ UN } SL_{F2} R$  which is Rule 8 !



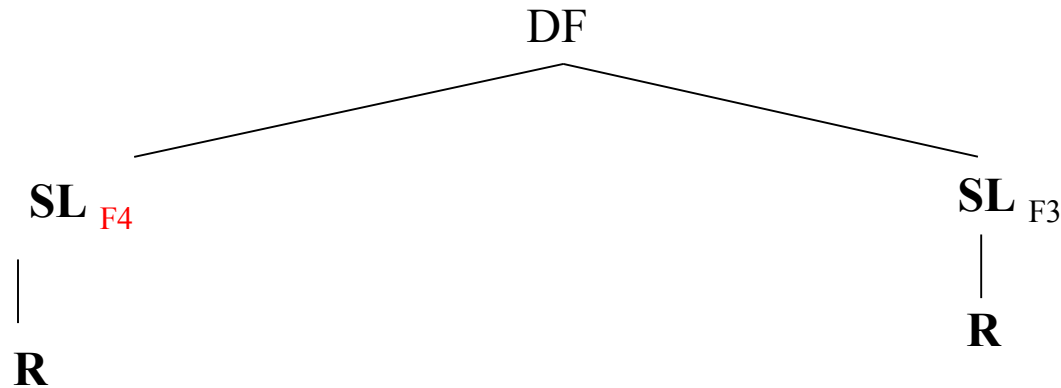
# Removing Common Sub-expression

Any common portion?

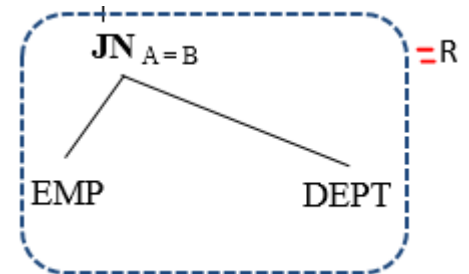


# Finding Common Sub-expression

Any common portion?

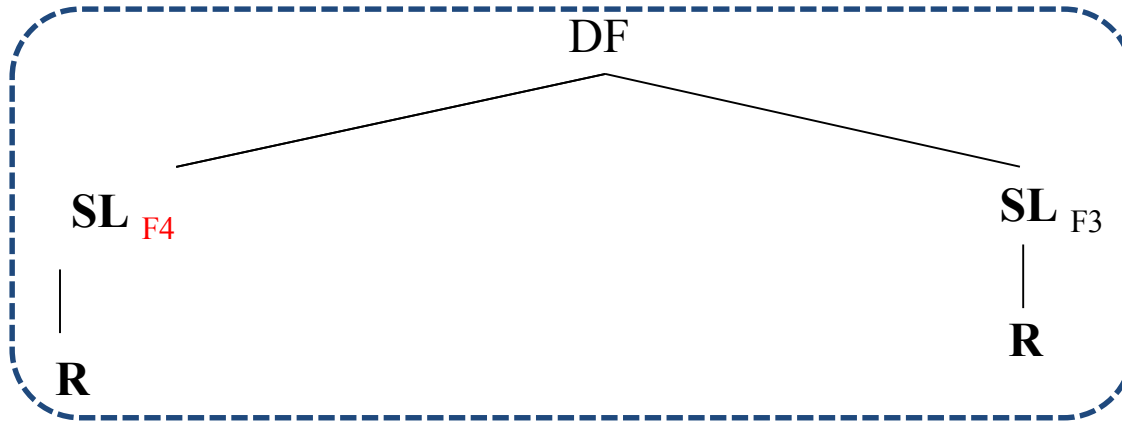


Let,  $F4 = F1 \text{ OR } F2$



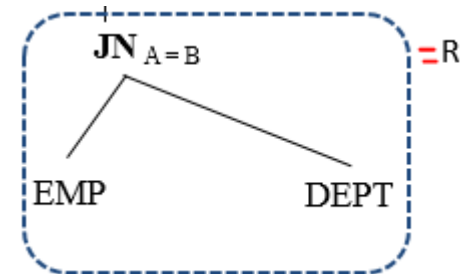
# Finding Common Sub-expression

Any common portion?



We can write it as  $SL_{F4} R \quad DF \quad SL_{F3} R$  which is Rule 9 !

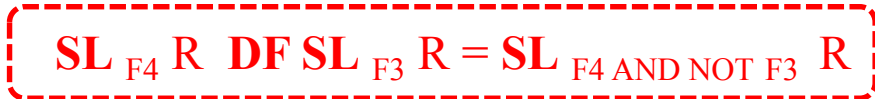
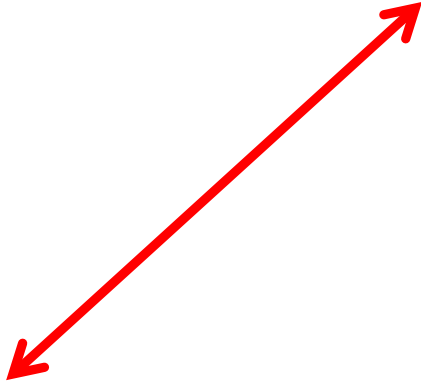
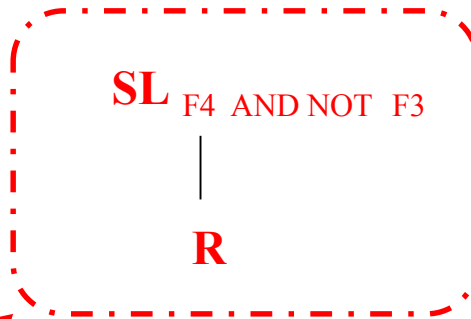
Let,  $F4 = F1 \text{ OR } F2$



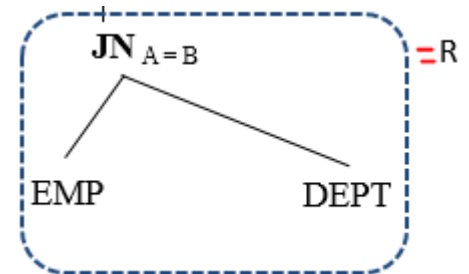


# Removing Common Sub-expression

Any common portion?



Let,  $F4 = F1 \text{ OR } F2$

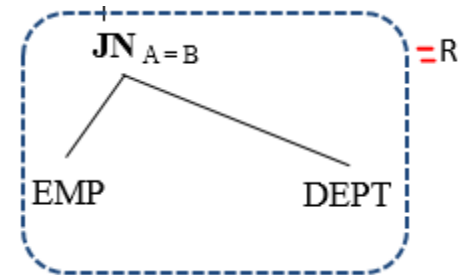


# Removing Common Sub-expression

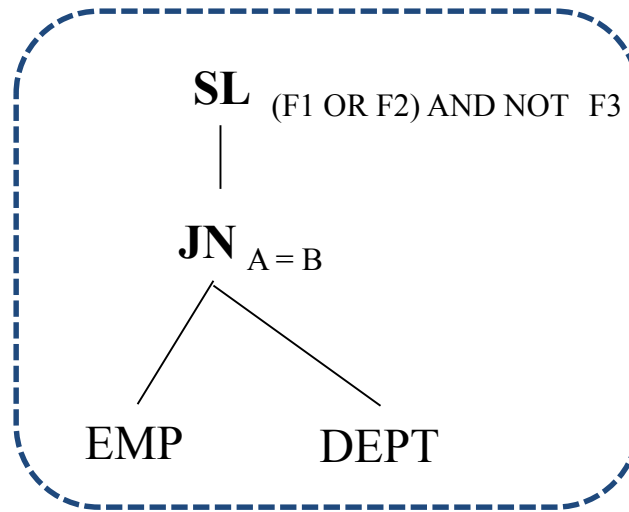
**SL** (F1 OR F2) AND NOT F3

|

**R**



# Removing Common Sub-expression



Can we apply Criterion 1 and/or 2?

# Exercise 1

② EMP (EMPNUM, DEPTNUM, NAME, SAL, AGE)  
DEPT (DEPTNUM, NAME, AREA, MGRNUM)

Query: PJ NAME, AGE ((EMP JN DEPTNUM=DEPTNUM SL AREA="North"  
DEPT) DF (EMP JN DEPTNUM=DEPTNUM SL DEPTNUM < 10 DEPT))

# Exercise 2

4. Consider the following global relational schemata.

*EMP (ID, NAME, SAL, AGE, MGRNUM, DEPTNUM)*

*DEPT (ID, AREA, DEPTNUM, MGRNUM)*

Corresponding fragmentation schemata:

$EMP_1 = SL_{SAL \leq 25K} EMP$

$EMP_2 = SL_{SAL > 25K} EMP$

$DEPT_1 = SL_{AREA = "North"} DEPT$

$DEPT_2 = SL_{AREA = "South"} DEPT$

Also consider the following global query.

$PJ_{NAME, AREA}(((SL_{SAL > 25K} EMP \Join_{ID=ID} SL_{AREA = "North"} DEPT) \Join_{ID=ID} SL_{SAL \leq 25K} EMP \Join_{ID=ID} SL_{AREA = "North"} DEPT)) \Join_{ID=ID} (SL_{AREA = "North"} (EMP \Join_{ID=ID} DEPT)))$

# Exercise 3

*EMP (EMPNUM, DEPTNUM, NAME, SAL, AGE)*  
*DEPT (DEPTNUM, NAME, AREA, MGRNUM)*

Consider the following global query:

$$\left( (SL_{F1} \text{ EMP } JN_{A=B} \text{ DEPT}) \text{ DF } (SL_{F2} \text{ EMP } JN_{A=B} \text{ DEPT}) \right) \text{ NJN } \\ \left( (\text{EMP } JN_{A=B} \text{ DEPT}) \text{ UN } (SL_{F3} \text{ EMP } JN_{A=B} \text{ DEPT}) \right)$$

Here,  
F1, F2, F3 can represent any condition. In this example consider none of them are same.  
Imagine,  $A = B = \text{DEPTNUM}$

# Exercise 4

*EMP (EMPNUM, DEPTNUM, NAME, SAL, AGE)*  
*DEPT (DEPTNUM, NAME, AREA, MGRNUM)*

Consider the following global query:

$$\left( (SL_{F_1} \text{ EMP } JN_{A=B} \text{ DEPT}) \text{ UN } (SL_{F_2} \text{ EMP } JN_{A=B} \text{ DEPT}) \right) \text{ NJN } \\ \left( (\text{EMP } JN_{A=B} \text{ DEPT}) \text{ DF } (SL_{F_3} \text{ EMP } JN_{A=B} \text{ DEPT}) \right)$$

Here,  
F1, F2, F3 can represent any condition. In this example consider none of them are same.  
Imagine,  $A = B = \text{DEPTNUM}$