CSE 4125: Distributed Database Systems
Chapter – 5

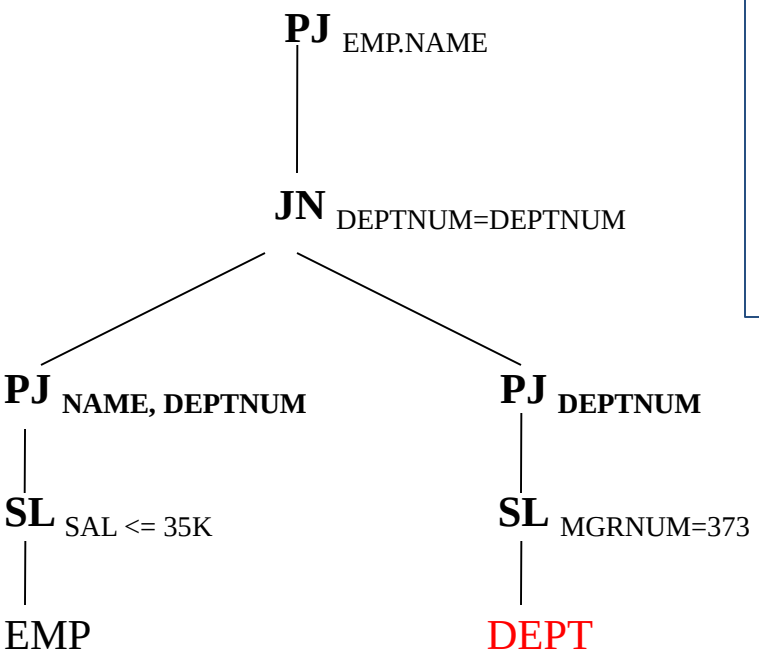
Translation of Global Queries to Fragment Queries.

(Part – G)

Topics to be discussed –

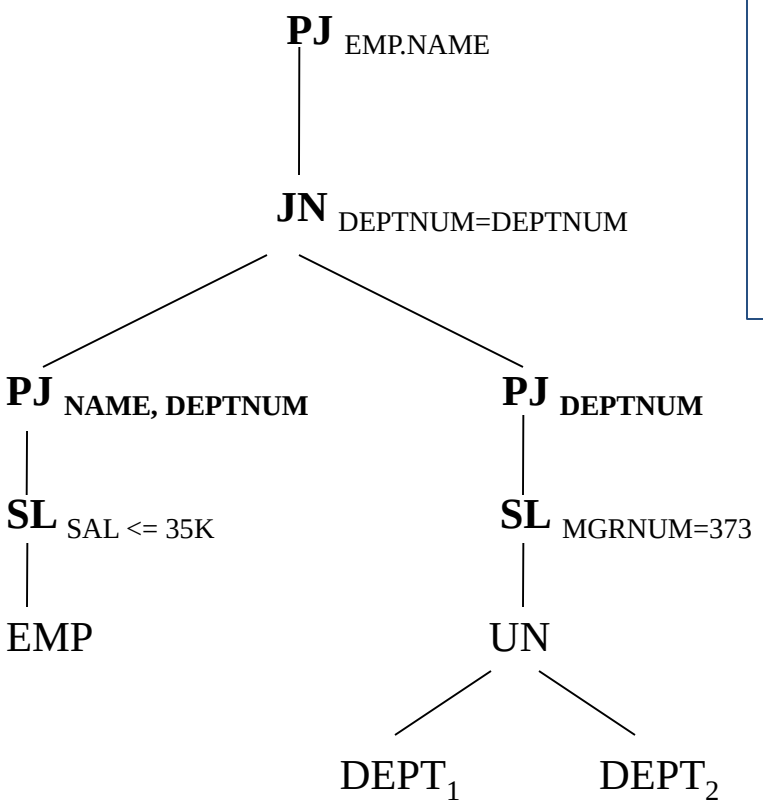
- Qualified Relation

Qualified Relation



Say, DEPT has 2 fragments:
$DEPT_1$ and $DEPT_2$.

$DEPT_1$: SL $_{deptnum <= 10}$DEPT
$DEPT_2$: SL $_{deptnum > 10}$DEPT



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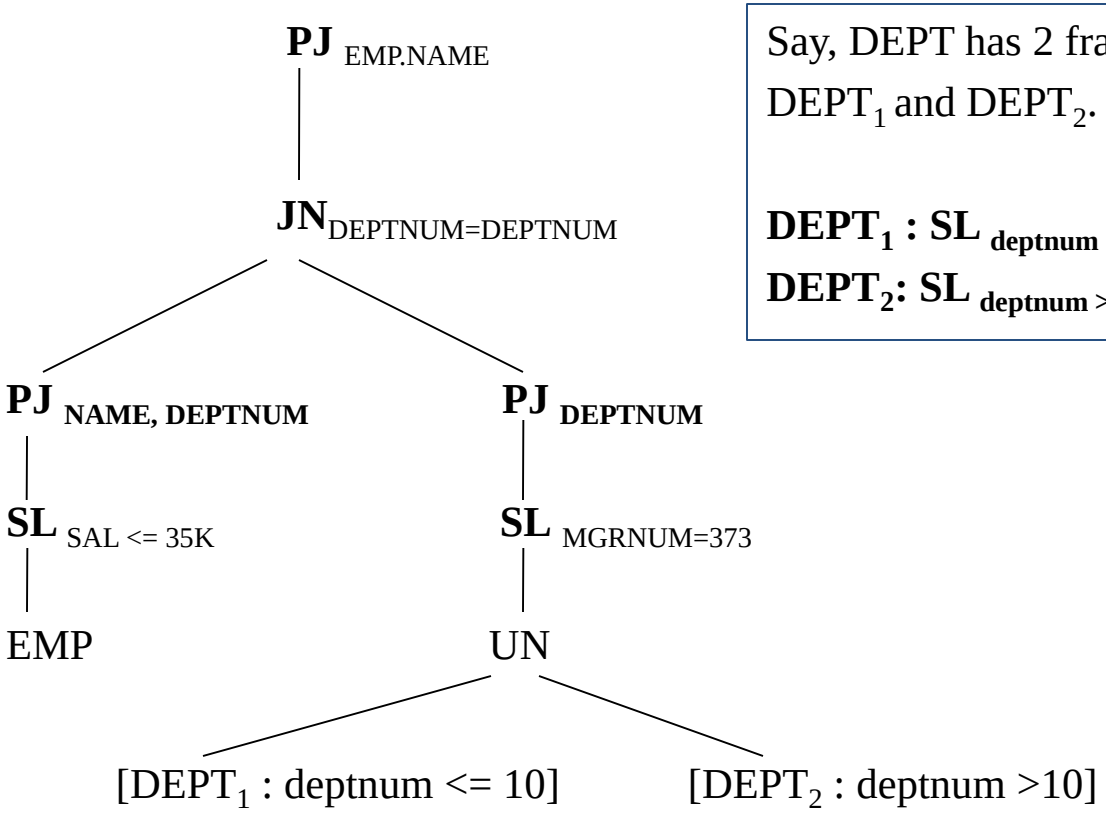

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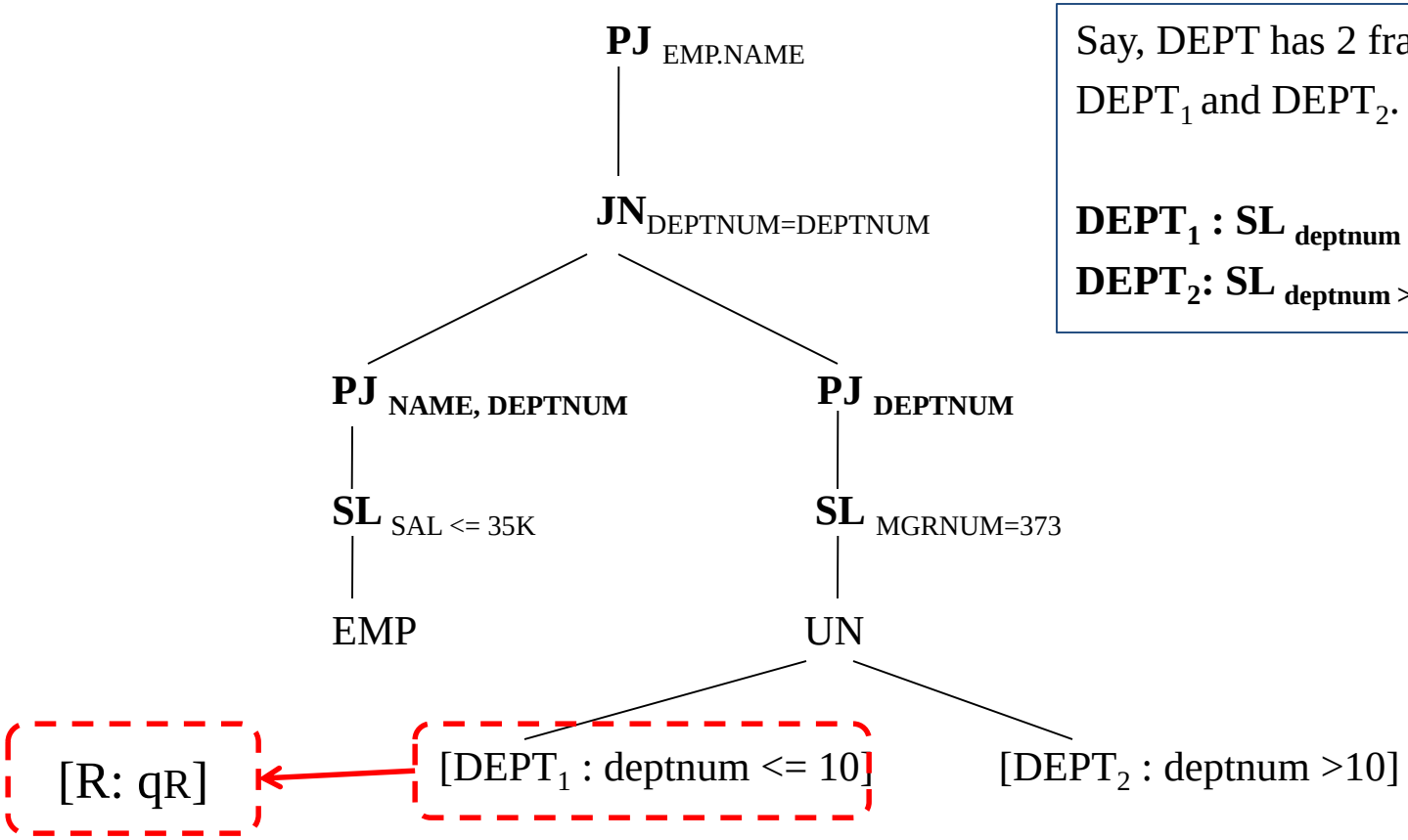

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A Qualified relation –

- Is a relation extended by a qualification.
- Is denoted as a pair **[R : q_R],** where **R** is a relation called **body** and **q_R** is a predicate called **qualification**.
  - Qualifications can be seen as an intentional property possessed by all the tuples of the relation. For example all the tuples in **R** satisfies **q_R.**

Algebra of Qualified Relation

- We know **relational algebra** uses **relations** as operands.
  - For example, SL_F **R**

- **Algebra of qualified relation** uses **qualified relations** as operands.
  - For example, SL_F **[R: qR]**

Rules of Algebra of Qualified Relation

Rule 1: $\mathbf{SL_F}\,[\mathrm{R} : qR] \rightarrow [\mathbf{SL_F}\,\mathrm{R} : F \textit{ and } qR]$

Rule 2: $\mathbf{PJ_A}\,[\mathrm{R} : qR] \rightarrow [\mathbf{PJ_A}\,\mathrm{R} : qR]$

Rule 3: $[\mathrm{R} : qR]\ \mathbf{CP}\ [\mathrm{S} : qS] \rightarrow [\mathrm{R}\ \mathbf{CP}\ \mathrm{S}: qR \textit{ and } qS]$

Rule 4: $[\mathrm{R} : qR]\ \mathbf{DF}\ [\mathrm{S} : qS] \rightarrow [\mathrm{R}\ \mathbf{DF}\ \mathrm{S}: qR]$

Rule 5: [R : qR] **UN** [S : qS] $\rightarrow$[R **UN** S: qR *or* qS]

Rule 6: [R : qR] $\mathbf{JN_F}$[S : qS] $\rightarrow$[R $\mathbf{JN_F}$ S: qR *and* qS *and* F]

Rule 7: [R : qR] $\mathbf{SJ_F}$[S : qS] $\rightarrow$[R $\mathbf{SJ_F}$ S: qR *and* qS *and* F]

Rules of Algebra of Qualified Relation

Rule 1: $SL_F[R : q_R] \rightarrow [SL_F R : F \text{ and } q_R]$

[ACCOUNT $_1$: *ID < 5*]

ID	*NAME*	*CITY*
1	a	dhk
2	b	dhk
3	c	ctg
4	d	ctg

SL $_{CITY = dhk}$ [ACCOUNT $_1$: *ID < 5*]

ID	*NAME*	*CITY*
1	a	dhk
2	b	dhk

[SL $_{CITY = dhk}$ ACCOUNT $_1$: *ID < 5 and CITY = dhk*]

ID	*NAME*	*CITY*
1	a	dhk
2	b	dhk

Proof of **Rule 6**

Rule 6: $[R : q_R]\ \mathbf{JN_F}[S : q_S] \rightarrow [R\ \mathbf{JN_F}\ S: q_R \textit{ and } q_S \textit{ and } F]$

$[R : q_R]\ \mathbf{JN_F}[S : q_S]$

$\Rightarrow \mathbf{SL_F}\ ([R : q_R]\ \mathbf{CP}\ [S : q_S])$ → Rule 3

$\Rightarrow \mathbf{SL_F}\ [R\ \mathbf{CP}\ S: q_R \textit{ and } q_S]$ → Rule 1

$\Rightarrow [\mathbf{SL_F}\ (R\ \mathbf{CP}\ S): q_R \textit{ and } q_S \textit{ and } F\ ]$

$\Rightarrow [R\ \mathbf{JN_F}\ S: q_R \textit{ and } q_S \textit{ and } F\ ]$

Proof of **Rule 7**

Rule 7: $[R : q_R]\ SJ_F[S : q_S] \rightarrow [R\ SJ_F\ S: q_R \text{ and } q_S \text{ and } F]$

$[R : q_R]\ SJ_F[S : q_S]$

$\Rightarrow PJ_{Attr(R)}\ ([R : q_R]\ JN_F\ [S : q_S])$ → Rule 6

$\Rightarrow PJ_{Attr(R)}\ [R\ JN_F\ S: q_R \text{ and } q_S \text{ and } F\ ]$ → Rule 2

$\Rightarrow [PJ_{Attr(R)}\ (R\ JN_F\ S): q_R \text{ and } q_S \text{ and } F\ ]$

$\Rightarrow [R\ SJ_F\ S: q_R \text{ and } q_S \text{ and } F\ ]$

Example 1

* Compute the following expression using algebra of qualified relation:

$$SL_{qs}((\underbrace{[R : qr]\ CP\ [S : qs]}) JN_F (\underbrace{[M : qm]\ DF\ [S : qs]}))$$

$$\Rightarrow SL_{qs}(\underbrace{[R\ CP\ S : qr\ AND\ qs]\ JN_F [M\ DF\ S : qm]})$$

$$\Rightarrow SL_{qs}\ \underbrace{[(R\ CP\ S)\ JN_F\ (M\ DF\ S) : (qr\ AND\ qs)\ AND\ qm\ AND\ F]}$$

$$\Rightarrow [SL_{qs}((R\ CP\ S)\ JN_F\ (M\ DF\ S)) : ((qr\ AND\ qs)\ AND\ qm\ AND\ F)\ AND\ qs]$$

* Note: You will stop when you reach all the expressions as a form of qualified relation (inside the [ ])

Example 2

* Compute the following expression using algebra of qualified relation:

$$SL_{qr}((\,[R : qr]\ UN\ [S : qs]\,)\ JN_F\ ([M : qm]\ CP\ [S : qs]\,))$$

$$\Rightarrow SL_{qr}((\,[R : qr]\ UN\ [S : qs])\ JN_F\ [M\ CP\ S : qm\ AND\ qs]\,)$$

$$\Rightarrow SL_{qr}(\,[R\ UN\ S : qr\ OR\ qs]\ JN_F\ [M\ CP\ S : qm\ AND\ qs]\,)$$

$$\Rightarrow SL_{qr}\,[\,(R\ UN\ S)\ JN_F\ (M\ CP\ S) : (qr\ OR\ qs)\ AND\ (qm\ AND\ qs)\ AND\ F\,]$$

$$\Rightarrow [\,SL_{qr}(\,(R\ UN\ S)\ JN_F\ (M\ CP\ S))\,:(\,(qr\ OR\ qs)\ AND\ (qm\ AND\ qs)\ AND\ F)\ AND\ qr)\,]$$

Example 3

* Evaluate the following expression using the rules of algebra of qualified relations.

$$[M : qm] \text{ DF } ((\underbrace{[R : qr] \text{ UN } [S : qs]}) \text{ SJ}_F ([M : qm] \text{ CP } [S : qs]))$$

$$\Rightarrow [M : qm] \text{ DF } (\underbrace{[R \text{ UN } S : qr \text{ OR } qs] \text{ SJ}_F ([M : qm] \text{ CP } [S : qs])})$$

$$\Rightarrow [M : qm] \text{ DF } (\underbrace{[R \text{ UN } S : qr \text{ OR } qs] \text{ SJ}_F [M \text{ CP } S : qm \text{ AND } qs]})$$

$$\Rightarrow [M : qm] \text{ DF } \underbrace{[(R \text{ UN } S) \text{ SJ}_F (M \text{ CP } S) : (qr \text{ OR } qs) \text{ AND } (qm \text{ AND } qs) \text{ AND } F]}$$

$$\Rightarrow [M \text{ DF } ((R \text{ UN } S) \text{ SJ}_F (M \text{ CP } S)) : qm]$$

Exercise :

Evaluate the following expression using the rules of algebra of qualified relations. Show the steps and indicate the rules applied.

① $(([R : qr] \text{ UN } [S : qs])\ SJ_F\ ([P : qp]\ JN_H\ [T : qt]))$

$DF\ [M : qm]$

② $SL_{\text{NOT } b}\ (((\ [R_1 : a]\ JN_f\ [S_1 : b])\ UN\ ([R_2 : \text{NOT } a]\ JN_F$

$[S_1 : b]))\ DF\ ([T_1 : c]\ JN_f\ [S_2 : \text{NOT } b]))$

Some More Rules

$$\mathbf{SL}_F(\emptyset) \leftrightarrow \emptyset$$

$$\mathbf{PJ}_A(\emptyset) \leftrightarrow \emptyset$$

$$R\,\mathbf{CP}\,\emptyset \leftrightarrow \emptyset$$

$$R\,\mathbf{UN}\,\emptyset \leftrightarrow R$$

$$R\,\mathbf{DF}\,\emptyset \leftrightarrow R$$

$$\emptyset\,\mathbf{DF}\,R \leftrightarrow \emptyset$$

$$R\,\mathbf{JN}_F\,\emptyset \leftrightarrow \emptyset$$

$$R\,\mathbf{SJ}_F\,\emptyset \leftrightarrow \emptyset$$

$$\emptyset\,\mathbf{SJ}_F\,R \leftrightarrow \emptyset$$

THANK YOU FROM CHAPTER 5