CSE 4125: Distributed Database Systems
Chapter – 3 : Part C

Levels of Distributed Transparency

Topic

- Vertical Fragmentation
- Mixed Fragmentation

Vertical Fragmentation

Partitioning the attributes of a global relation into subsets.

Example: global relation:

EMP (EMPNUM, NAME, SAL, TAX, MGRNUM, DEPTNUM)

Apply vertical fragmentation.

*Question: what relational algebraic operation can be applied?

Global schema:

EMP (EMPNUM, NAME, SAL, TAX, MGRNUM, DEPTNUM)

Fragmentation schema:

$$EMP_1 = \boldsymbol{PJ}_{EMPNUM,\ NAME,\ MGRNUM,\ DEPTNUM}\ EMP$$

$$EMP_2 = \boldsymbol{PJ}_{SAL,\ TAX}\ EMP$$

*Question: do you think the fragmentation is acceptable?

Example

Complete. But Reconstruct is not possible. So did not need to check disjointness

EMP

EMPNUM	NAME	SAL	TAX	MGRNUM	DEPTNUM
1	A	1000	10	10	100
2	B	2000	20	11	101
3	C	3000	30	12	102

EMP_1

EMPNUM	NAME	MGRNUM	DEPTNUM
1	A	10	100
2	B	11	101
3	C	12	102

EMP_2

SAL	TAX
1000	10
2000	20
3000	30

Discuss:

?? Is it complete ?

?? How to reconstruct ?

?? Is it disjoint ?

Global schema:

EMP (EMPNUM, NAME, SAL, TAX, MGRNUM, DEPTNUM)

Fragmentation schema:

$$EMP_1 = \boldsymbol{PJ}_{EMPNUM,\ NAME,\ MGRNUM,\ DEPTNUM}\ EMP$$

$$EMP_2 = \boldsymbol{PJ}_{EMPNUM,\ SAL,\ TAX}\ EMP$$

Example

Complete & Reconstruct.
Disjointness property is violated in Vertical Fragmentation. It is not a problem.

EMP

EMPNUM	NAME	SAL	TAX	MGRNUM	DEPTNUM
1	A	1000	10	10	100
2	B	2000	20	11	101
3	C	3000	30	12	102

EMP_1

EMPNUM	NAME	MGRNUM	DEPTNUM
1	A	10	100
2	B	11	101
3	C	12	102

EMP_2

EMPNUM	SAL	TAX
1	1000	10
2	2000	20
3	3000	30

Discuss:

?? Is it complete ?

?? How to reconstruct ?

?? Is it disjoint ?

Discuss:

?? Is it complete ?

If each attribute is mapped into at least one attribute of the fragments.

?? How to reconstruct ?

$$EMP = EMP_1 \; \boldsymbol{JN}_{EMPNUM=EMPNUM} \; EMP_2$$

***NOT COMPLETE**

*** EMPNUM TWICE**

SOLUTION *(Not Considered in Book)*

$$A = EMP_1 \; \boldsymbol{JN}_{EMPNUM=EMPNUM} \; EMP_2$$

Emp1 NJN Emp2

$$EMP = PJ_{EMPNUM,NAME,SAL,TAX,MGRNUM,DEPTNUM}(A)$$

Is it disjoint ?

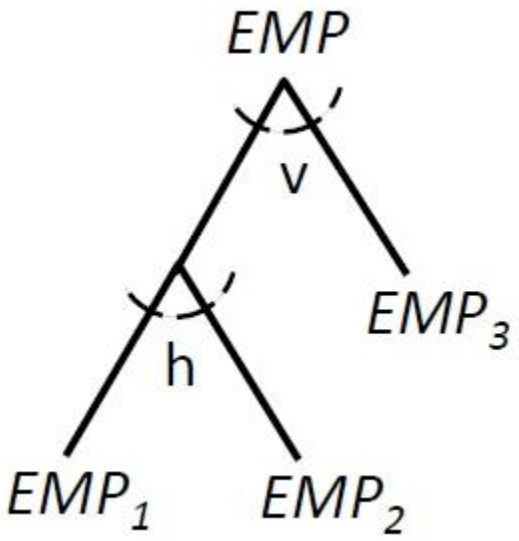
No

Mixed Fragmentation

Horizontal + Vertical.

Can be applied recursively.

Represented by ***Fragmentation tree***.



Global Schema:

EMP (EMPNUM, NAME, SAL, TAX, MGRNUM, DEPTNUM)

Fragmentation schema:

$$EMP_1 = \mathbf{SL}_{DEPTNUM \leq 10} \mathbf{PJ}_{EMPNUM, NAME, MGRNUM, DEPTNUM} EMP$$

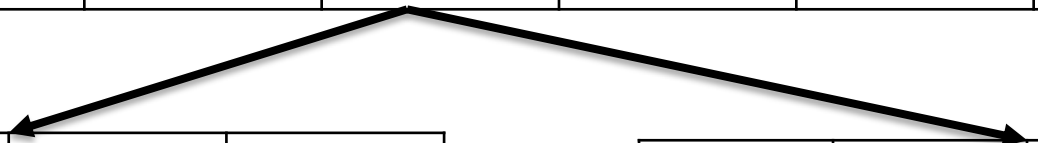
$$EMP_2 = \mathbf{SL}_{DEPTNUM > 10} \mathbf{PJ}_{EMPNUM, NAME, MGRNUM, DEPTNUM} EMP$$

$$EMP_3 = \mathbf{PJ}_{EMPNUM, NAME, SAL, TAX} EMP$$

Example

EMP

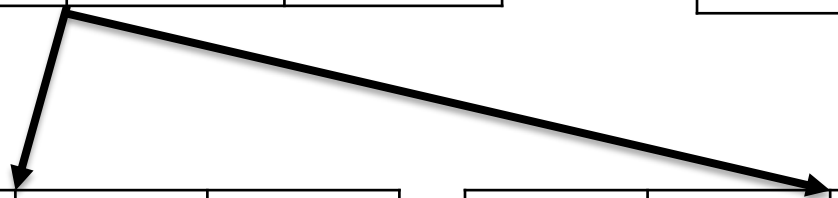
EMPNUM	NAME	SAL	TAX	MGRNUM	DEPTNUM
1	A	1000	10	101	10
2	B	2000	20	110	11
3	C	3000	30	120	12



EMPNUM	NAME	MGRNUM	DEPTNUM
1	A	101	10
2	B	110	11
3	C	120	12

EMPNUM	NAME	SAL	TAX
1	A	1000	10
2	B	2000	20
3	C	3000	30

EMP_3



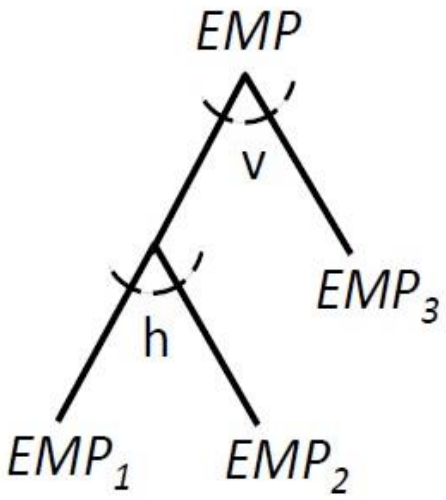
EMPNUM	NAME	MGRNUM	DEPTNUM
1	A	101	10

EMP_1

EMPNUM	NAME	MGRNUM	DEPTNUM
2	B	110	11
3	C	120	12

EMP_2

Fragmentation tree:



v- Projection
h- Selection

Discuss:

?? Is it complete ?

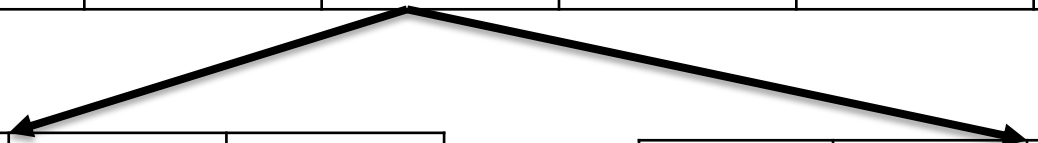
?? How to reconstruct ?

?? Is it disjoint ?

Example

EMP

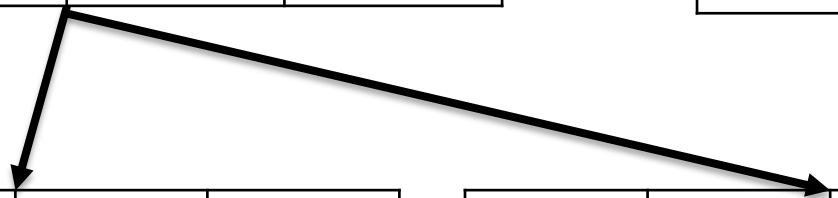
EMPNUM	NAME	SAL	TAX	MGRNUM	DEPTNUM
1	A	1000	10	101	10
2	B	2000	20	110	11
3	C	3000	30	120	12



EMPNUM	NAME	MGRNUM	DEPTNUM
1	A	101	10
2	B	110	11
3	C	120	12

EMPNUM	NAME	SAL	TAX
1	A	1000	10
2	B	2000	20
3	C	3000	30

EMP_3



EMPNUM	NAME	MGRNUM	DEPTNUM
1	A	101	10

EMP_1

EMPNUM	NAME	MGRNUM	DEPTNUM
2	B	110	11
3	C	120	12

EMP_2

Discuss:

?? Is it complete ?

Yes

For Horizontal:
Reconstruct -> UN

For Vertical:
Reconstruct -> NJN

?? How to reconstruct ?

$$EMP = PJ_{EMPNUM,NAME,SAL,TAX,MGRNUM,DEPTNUM}\ ((EMP_1\ \mathbf{UN}\ EMP_2)\ \mathbf{JN}_{EMPNUM=EMPNUM}\ EMP_3)$$

?? Is it disjoint ?

No (Can be yes, when?)

If there exist Projection operation, then disjoint property does not exist.

Global Schema:

EMP (EMPNUM, NAME, SAL, TAX, MGRNUM, DEPTNUM)

Fragmentation schema:

$$EMP_1 = \mathbf{PJ}_{EMPNUM,\ SAL,\ TAX}\ \mathbf{SL}_{DEPTNUM < 10}\ EMP$$

$$EMP_2 = \mathbf{PJ}_{EMPNUM,\ NAME,\ MGRNUM,\ DEPTNUM}\ \mathbf{SL}_{DEPTNUM < 10}\ EMP$$

$$EMP_3 = \mathbf{PJ}_{EMPNUM,\ NAME}\ \mathbf{SL}_{10 <= DEPTNUM <= 12}\ EMP$$

$$EMP_4 = \mathbf{PJ}_{EMPNUM,\ TAX}\ \mathbf{SL}_{DEPTNUM > 12}\ EMP$$

Complete But reconstruct is not possible. So we don't need to check disjoint property

Example

EMP

EMPNUM	NAME	SAL	TAX	MGRNUM	DEPTNUM
1	A	1000	10	101	9
2	B	2000	20	110	11
3	C	3000	30	120	18

EMPNUM	NAME	SAL	TAX	MGRNUM	DEPTNUM
1	A	1000	10	101	9

EMPNUM	NAME	SAL	TAX	MGRNUM	DEPTNUM
2	B	2000	20	110	11

EMPNUM	NAME	SAL	TAX	MGRNUM	DEPTNUM
3	C	3000	30	120	18

EMPNUM	SAL	TAX
1	1000	10

EMP_1

EMPNUM	NAME	MGRNUM	DEPTNUM
1	A	101	9

EMP_2

EMPNUM	NAME
2	B

EMP_3

EMPNUM	TAX
3	30

EMP_4

Discuss:

?? Is it complete ?

Yes

?? How to reconstruct ?

$EMP = ??$

?? Is it disjoint ?

No (Can be yes, when?)

EMP

EMPNUM	NAME	SAL	TAX	MGRNUM	DEPTNUM
1	A	1000	10	101	9
2	B	2000	20	110	11
3	C	3000	30	120	18

EMPNUM	NAME	SAL	TAX	MGRNUM	DEPTNUM
1	A	1000	10	101	9

EMPNUM	NAME	SAL	TAX	MGRNUM	DEPTNUM
3	C	3000	30	120	18

EMPNUM	NAME	SAL	TAX	MGRNUM	DEPTNUM
2	B	2000	20	110	11

EMPNUM	SAL	TAX
1	1000	10

EMP_1

EMPNUM	NAME	MGRNUM	DEPTNUM
1	A	101	9

EMP_2

EMPNUM	NAME
2	B

EMP_3

EMPNUM	TAX
3	30

EMP_4

EMPNUM	NAME	SAL	MGRNUM	DEPTNUM
3	C	3000	120	18

$TEMP_2$

EMPNUM	SAL	TAX	MGRNUM	DEPTNUM
2	2000	20	110	11

$TEMP_1$

Global Schema:

$$EMP\ (EMPNUM, NAME, SAL, TAX, MGRNUM, DEPTNUM)$$

Fragmentation schema:

$$EMP_1 = \mathbf{PJ}_{EMPNUM,\ SAL,\ TAX}\ \mathbf{SL}_{DEPTNUM < 10}\ EMP$$

$$EMP_2 = \mathbf{PJ}_{EMPNUM,\ MGRNUM,\ DEPTNUM}\ \mathbf{SL}_{DEPTNUM < 10}\ EMP$$

$$EMP_3 = \mathbf{PJ}_{EMPNUM,\ NAME}\ \mathbf{SL}_{10 <= DEPTNUM <= 12}\ EMP$$

$TEMP_1 = Try\ to\ write\ yourself$ PJ empnum, sal, tax, mgrnum, deptnum SL 10<=deptnum <= 12 EMP

$$EMP_4 = \mathbf{PJ}_{EMPNUM,\ TAX}\ \mathbf{SL}_{DEPTNUM > 12}\ EMP$$

$TEMP_2 = Try\ to\ write\ yourself$ PJ empnum, name, sal, mgrnum, deptnum SL deptnum > 12 EMP

Discuss:

?? Is it complete ?

Yes

?? How to reconstruct ?

$A = PJ_{EMPNUM,NAME,SAL,TAX,MGRNUM,DEPTNUM}(EMP_1\ JN_{EMPNUM=EMPNUM}\ EMP_2)$

$B = PJ_{EMPNUM,NAME,SAL,TAX,MGRNUM,DEPTNUM}(EMP_3\ JN_{EMPNUM=EMPNUM}\ TEMP_1)$

$C = PJ_{EMPNUM,NAME,SAL,TAX,MGRNUM,DEPTNUM}(EMP_4\ JN_{EMPNUM=EMPNUM}\ TEMP_2)$

$EMP = A\ UN\ B\ UN\ C$

?? Is it disjoint ?

No (Can be yes, when?)

Fragmentation tree:

Try to draw yourself

FAQ

Emp has 1 Fragmentation tree, Supplier has another different Fragmentation tree

Global schema:

EMP (EMPNUM, NAME, SAL, TAX, MGRNUM, DEPTNUM)

SUPPLIER (SNUM, NAME, CITY)

Fragmentation Schema:

$$EMP_1 = \boldsymbol{PJ}_{EMPNUM,\ SAL,\ TAX}\ \boldsymbol{SL}_{DEPTNUM < 10}\ EMP$$

$$EMP_2 = \boldsymbol{PJ}_{EMPNUM,\ MGRNUM,\ DEPTNUM}\ \boldsymbol{SL}_{DEPTNUM < 10}\ EMP$$

$$EMP_3 = \boldsymbol{PJ}_{EMPNUM,\ NAME}\ \boldsymbol{SL}_{10 <= DEPTNUM <= 12}\ EMP$$

$$EMP_4 = \boldsymbol{PJ}_{EMPNUM,\ TAX}\ \boldsymbol{SL}_{DEPTNUM > 12}\ EMP$$

$$SUPPLIER_1 = \boldsymbol{SL}_{CITY = \text{“DHK”}}\ SUPPLIER$$

$$SUPPLIER_2 = \boldsymbol{SL}_{CITY = \text{“CTG”}}\ SUPPLIER$$

Practice Problems (Fragmentation Tree)

Global Schema:

$Hospital(HNAME, HID, CITY, MGRID, CAPACITY, CHARGE, RATINGS)$

Fragmentation Schema:

$Hospital_1 = PJ_{HNAME,HID,CITY,MGRID}\ Hospital$

$Hospital_2 = SL_{CAPACITY<1000}\ PJ_{HID,CAPACITY,CHARGE,RATINGS}\ Hospital$

$Hospital_3$

$= SL_{RATINGS<5}\ SL_{CAPACITY\geq1000}\ PJ_{HID,CAPACITY,CHARGE,RATINGS}\ Hospital$

$Hospital_4$

$= SL_{RATINGS\geq5}\ SL_{CAPACITY\geq1000}\ PJ_{HID,CAPACITY,CHARGE,RATINGS}\ Hospital$

Practice Problems/ Questions

a) Draw the fragmentation tree for the fragmentation schema presented in the text book figure 3.4 (page - 46).

b) Write the reconstruction formula for the fragmentation schema presented in the text book figure 3.9a (page - 56).

c) Text book:

Exercise: 3.1