

# 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:

$EMP_1 = PJ_{EMPNUM, NAME, MGRNUM, DEPTNUM} EMP$

$EMP_2 = PJ_{SAL, TAX} EMP$

\*Question: do you think the fragmentation is acceptable?

# Example

*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<sub>1</sub>*

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

*EMP<sub>2</sub>*

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:

$EMP_1 = PJ_{EMPNUM, NAME, MGRNUM, DEPTNUM} EMP$

$EMP_2 = PJ_{EMPNUM, SAL, TAX} EMP$

# Example

*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<sub>1</sub>*

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

*EMP<sub>2</sub>*

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 ?

$$EMP = EMP_1 \text{ JN }_{EMPNUM=EMPNUM} EMP_2$$

*\*NOT COMPLETE*

*\* EMPNUM TWICE*

**SOLUTION** (*Not Considered in Book*)

$$A = EMP_1 \text{ JN }_{EMPNUM=EMPNUM} EMP_2$$

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

Is it disjoint ?

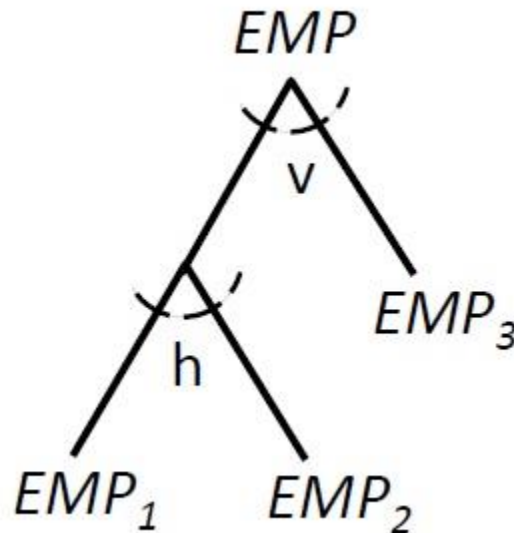
No

# Mixed Fragmentation

Horizontal + Vertical.

Can be applied recursively.

Represented by *Fragmentation tree*.



# Global Schema:

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

## Fragmentation schema:

$EMP_1 = SL_{DEPTNUM \leq 10} PJ_{EMPNUM, NAME, MGRNUM, DEPTNUM} EMP$

$EMP_2 = SL_{DEPTNUM > 10} PJ_{EMPNUM, NAME, MGRNUM, DEPTNUM} EMP$

$EMP_3 = PJ_{EMPNUM, NAME, SAL, TAX} EMP$

# 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<sub>3</sub>*

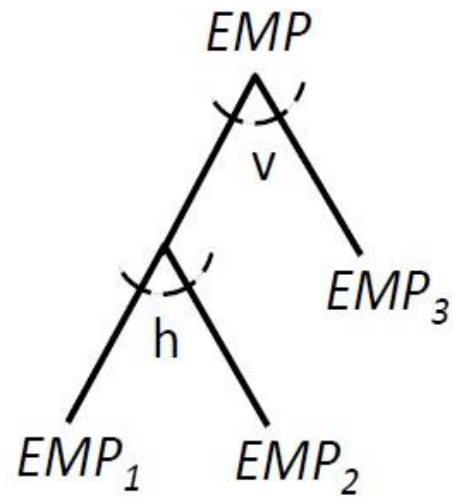
EMPNUM	NAME	MGRNUM	DEPTNUM
1	A	101	10

*EMP<sub>1</sub>*

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

*EMP<sub>2</sub>*

# Fragmentation tree:



## **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<sub>3</sub>*

EMPNUM	NAME	MGRNUM	DEPTNUM
1	A	101	10

*EMP<sub>1</sub>*

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

*EMP<sub>2</sub>*



## Discuss:

?? Is it complete ?

Yes

?? How to reconstruct ?

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

?? Is it disjoint ?

No (Can be yes, when?)

# Global Schema:

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

## Fragmentation schema:

$EMP_1 = PJ_{EMPNUM, SAL, TAX} SL_{DEPTNUM < 10} EMP$

$EMP_2 = PJ_{EMPNUM, NAME, MGRNUM, DEPTNUM} SL_{DEPTNUM < 10} EMP$

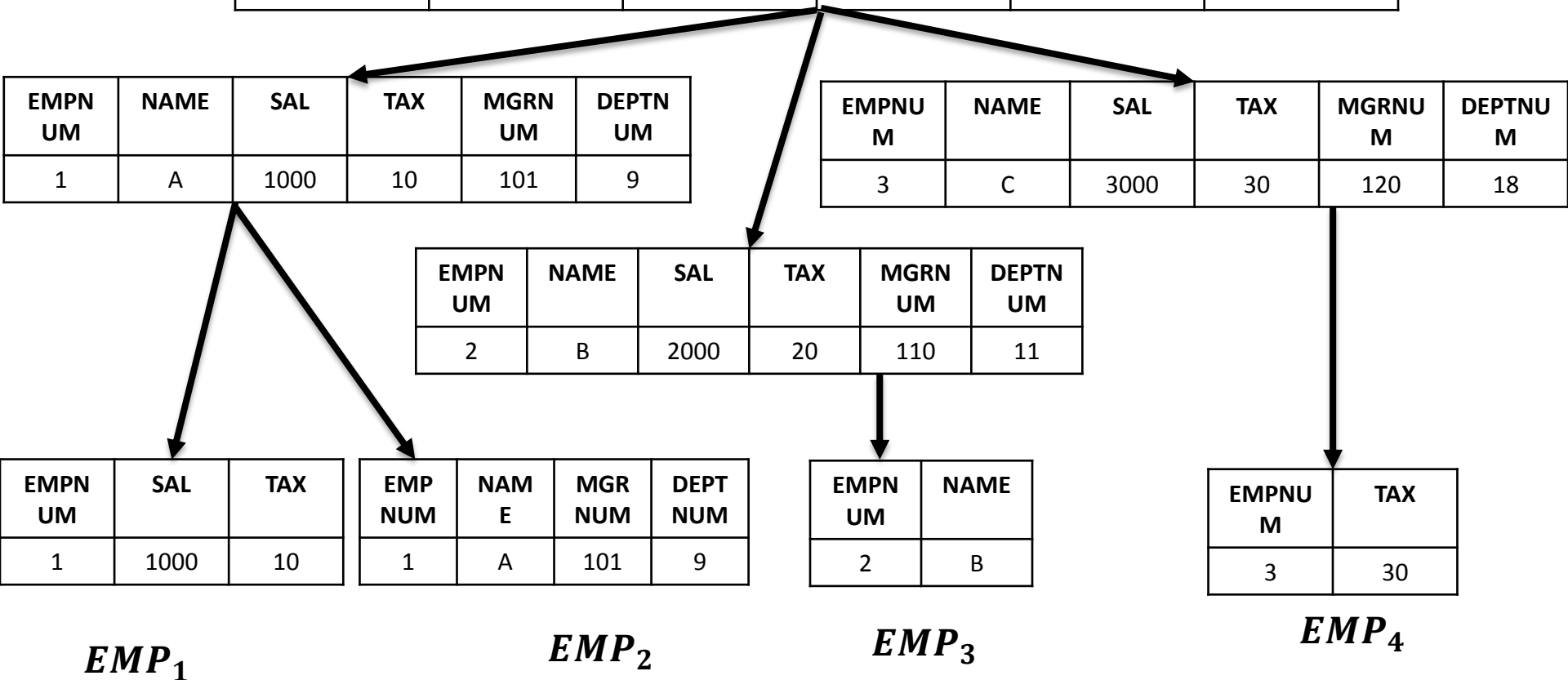
$EMP_3 = PJ_{EMPNUM, NAME} SL_{10 \leq DEPTNUM \leq 12} EMP$

$EMP_4 = PJ_{EMPNUM, TAX} SL_{DEPTNUM > 12} EMP$

# 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



## 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	TAX
3	30

EMPNUM	SAL	TAX
1	1000	10

EMPNUM	NAME	MGRNUM	DEPTNUM
1	A	101	9

EMPNUM	NAME
2	B

EMPNUM	NAME	SAL	MGRNUM	DEPTNUM
3	C	3000	120	18

*EMP<sub>1</sub>*

*EMP<sub>2</sub>*

*EMP<sub>3</sub>*

*TEMP<sub>2</sub>*

EMPNUM	SAL	TAX	MGRNUM	DEPTNUM
2	2000	20	110	11

*TEMP<sub>1</sub>*

# Global Schema:

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

## Fragmentation schema:

$EMP_1 = PJ_{EMPNUM, SAL, TAX} SL_{DEPTNUM < 10} EMP$

$EMP_2 = PJ_{EMPNUM, MGRNUM, DEPTNUM} SL_{DEPTNUM < 10} EMP$

$EMP_3 = PJ_{EMPNUM, NAME} SL_{10 \leq DEPTNUM \leq 12} EMP$

$TEMP_1 = \text{Try to write yourself}$

$EMP_4 = PJ_{EMPNUM, TAX} SL_{DEPTNUM > 12} EMP$

$TEMP_2 = \text{Try to write yourself}$

## Discuss:

?? Is it complete ?

Yes

?? How to reconstruct ?

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

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

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

$$EMP = A \cup B \cup C$$

?? Is it disjoint ?

No (Can be yes, when?)

# Fragmentation tree:

Try to draw yourself



# FAQ

## Global schema:

*EMP* (*EMPNUM*, *NAME*, *SAL*, *TAX*, *MGRNUM*, *DEPTNUM*)  
*SUPPLIER* (*SNUM*, *NAME*, *CITY*)

## Fragmentation Schema:

$EMP_1 = PJ_{EMPNUM, SAL, TAX} SL_{DEPTNUM < 10} EMP$

$EMP_2 = PJ_{EMPNUM, MGRNUM, DEPTNUM} SL_{DEPTNUM < 10} EMP$

$EMP_3 = PJ_{EMPNUM, NAME} SL_{10 \leq DEPTNUM \leq 12} EMP$

$EMP_4 = PJ_{EMPNUM, TAX} SL_{DEPTNUM > 12} EMP$

$SUPPLIER_1 = SL_{CITY = "DHK"} SUPPLIER$

$SUPPLIER_2 = SL_{CITY = "CTG"} SUPPLIER$

# Practice Problems (Fragmentation Tree)

## Global Schema:

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

## Fragmentation Schema:

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

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

$Hospital_3$

$= SL_{RATINGS < 5} SL_{CAPACITY \geq 1000} PJ_{HID, CAPACITY, CHARGE, RATINGS} Hospital$

$Hospital_4$

$= SL_{RATINGS \geq 5} SL_{CAPACITY \geq 1000} PJ_{HID, CAPACITY, CHARGE, RATINGS} Hospital$

# 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