

19/3/24

eid	ename	country	state
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Key \rightarrow eid

eid \rightarrow ename

eid \rightarrow state

state \rightarrow country

1NF \checkmark

2NF \checkmark

3NF \times

Transitive dependencies.

eid	ename	state
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3NF \checkmark

state	country
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Q \Rightarrow Pcode Ptitle Pmang budget. eid ename dno dname hourly rate

1NF

Pcode	Ptitle	Pmang	Pbudget
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Key {Pcode}

2NF \checkmark

Pcode	eid	ename	dno	dname	hourly rate
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Key {Pcode, eid}

2NF \times

Pcode	eid	hourly rate
-------	-----	-------------

\Rightarrow {Pcode, eid}

eid	ename	dno	dname
-----	-------	-----	-------

{eid} \leftarrow

2NF

T1

Pcode	Ptitle	Pmang	Pbudget
-------	--------	-------	---------

Pcode \rightarrow Ptitle

Pcode \rightarrow Pmang

Pcode \rightarrow Pbudget

3NF \checkmark

T3

eid	ename	dno	dname
-----	-------	-----	-------

eid \rightarrow ename eid \rightarrow dname

eid \rightarrow dno.

dno \rightarrow dname

3NF \times

T2

Pcode	eid	hourly rate
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Pcode, eid \rightarrow hourly rate

3NF \checkmark

Q \Rightarrow L.no Lect.name Lect.grade dno dname subcode subname sublevel

Assume each lecturer may teach many subjects but may not belongs to more than 1 department.

2NF \rightarrow T1

Lno.	Lname	Lgrade	dno	dname
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{Key = Lno.}

T2

Scode	Sname	Slevel
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{Key = Scode}

T3

Lno	Scode
-----	-------

{Key = Lno, Scode}

{ Lno \rightarrow dno
dno \rightarrow dname } 3NF \times

T1 \rightarrow

Lno	Lname	Lgrade	dcode
-----	-------	--------	-------

dcode	dname
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BCNF
{ Boyce Codd NF }

{ A Table with 2 attr with
be in always in BCNF }

⇒ A relation is in BCNF if and only if every non-trivial FD has a candidate key as its determinant.

O.P.

⇒ A relation is in BCNF if and only if ~~only~~ only determinants are candidate key.

~~Q.2~~

Q.2)

empid emp country emp dept d-type d.no.

empid → emp country

Key = { empid, empdept }

emp dept → d-type, d.no.

~~do~~

empid | emp country

empid | empdept

empdept | depttype | d.no.

{ empid → emp country }

{ empid → empdept }

{ empdept, depttype }
→ d.no

20/03/2024

Decompositions

Lossless decomposition v/s Lossy decomposition

Emp

cid	ename	did
1	A	101
2	B	101
3	A	102

Decomposition

cid	ename
1	A
2	B
3	A

ename	did
A	101
B	101
A	102

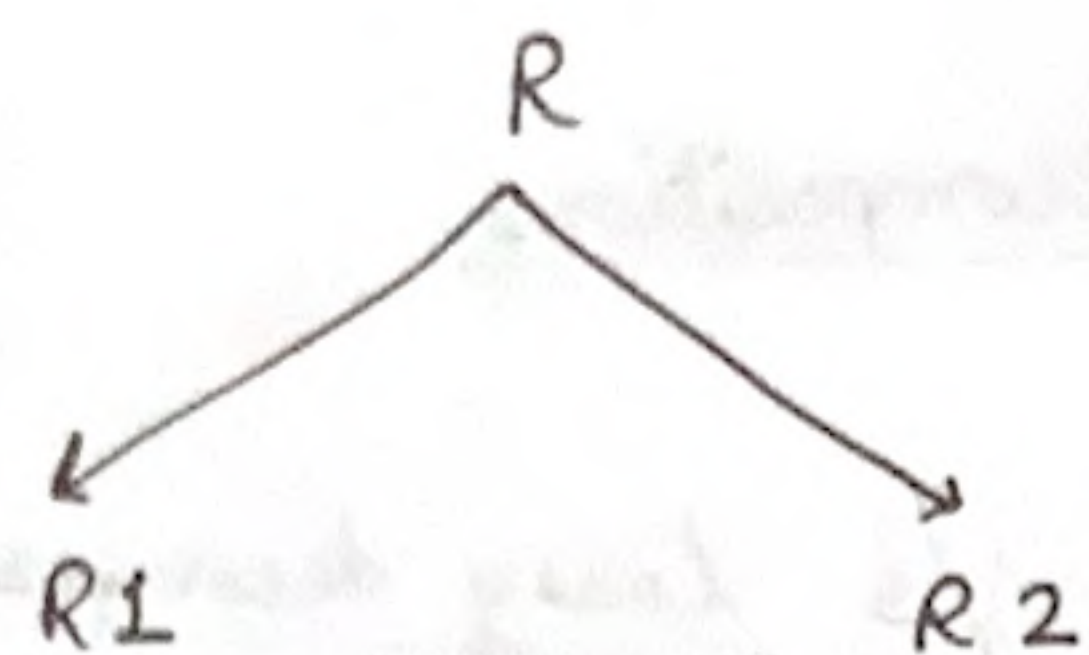
We will do natural join of the decomposed tables and if result is our original table then it will be a lossless decomposition.

First we will take Cartesian Product

eid	ename	did
1	A	101
1	A	102
2	B	101
3	A	101
3	A	102

eid	ename	ename	dno
1	A	A	101
1	A	B	101
1	A	A	102
2	B	A	101
2	B	B	101
2	B	A	102
3	A	A	101
3	A	B	101
3	A	A	102

Lossy decomposition as we have gotten 2 extra rows, These are called spurious tuples



$$\{R1 \bowtie R2 = R\}$$

Lossless else Lossy.

$R(eid, ename, dno)$



⇒ ① Attributes of $R1 \cup R2 =$ Attributes of R

⇒ ② Attributes of $R1 \cap R2 \neq \emptyset$

⇒ ③ Attributes of $R1 \cap R2 = \left(\begin{matrix} \text{Superkey or} \\ \text{Candidate key} \end{matrix} \right)$ of $\left(\begin{matrix} R1 / \\ R2 / \\ R1, R2 \text{ Both} \end{matrix} \right)$

In our example $R1 \cap R2$ was ename which was not SK. or CK so we had Lossy decomposition

Emp

eid	ename	dno
1	A	101
2	B	101
3	A	102

eid	ename
1	A
2	B
3	A

R2

eid	dno
1	101
2	101
3	102

$(R1 \times R2)$

$(R1 \bowtie R2)$

eid	ename	dno
1	A	101
2	B	101
3	A	102

eid	ename	eid	dno
1	A	1	101
1	A	2	101
1	A	3	102
2	B	1	101
2	B	2	101
2	B	3	102
3	A	1	101
3	A	2	101
3	A	3	102

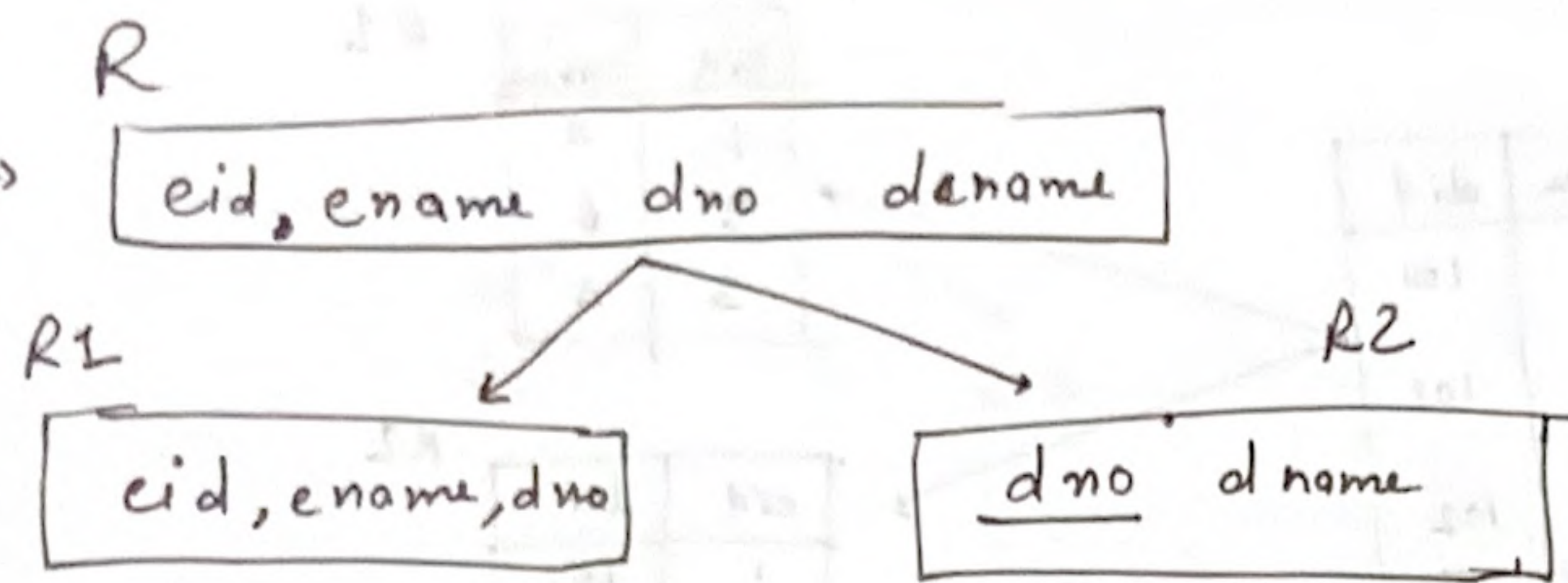
$$R1 \bowtie R2 = \text{Emp} \Rightarrow \{\text{Lossless decomposition}\}$$

$$① (eid, ename) \cup (eid, dno) \Rightarrow (eid, ename, dno) \text{ Emp}$$

$$② (eid, ename) \cap (eid, dno) \neq \underline{eid} \quad \{\neq \emptyset\}$$

$$③ R1 \cap R2 = \underline{eid} \Rightarrow \underline{(C.K.)}$$

Example ①

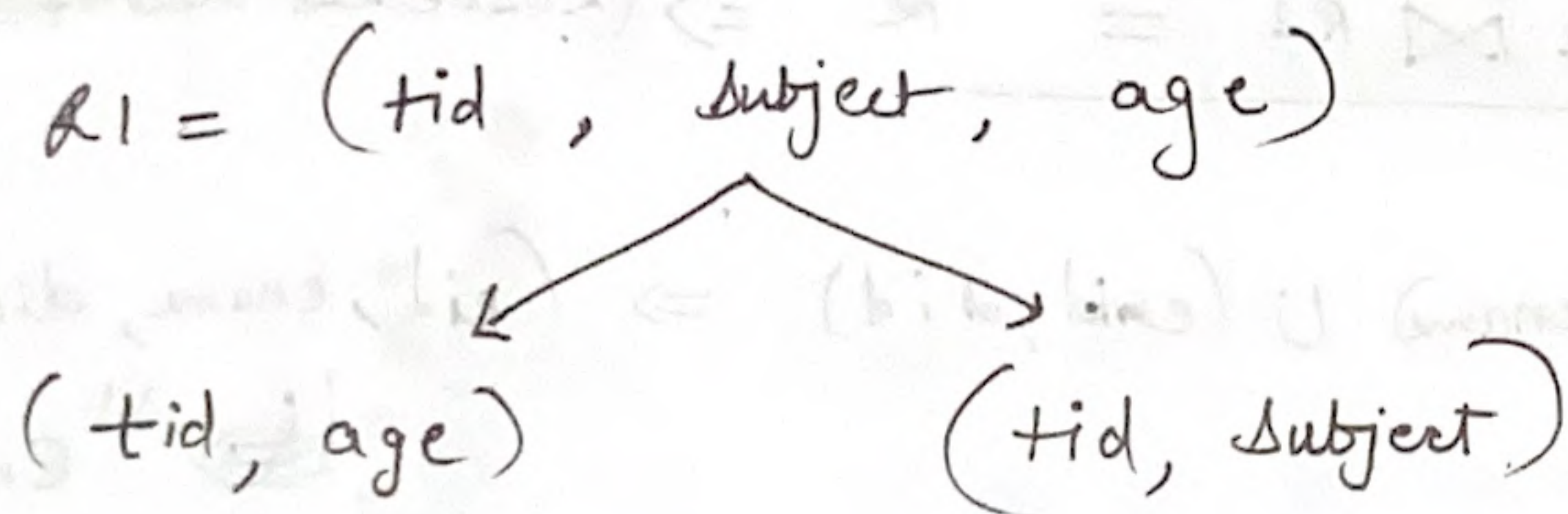


Lossy or Lossless?

Conditions

- ① $R_1 \cup R_2 \Rightarrow \{eid, ename, dno, dname\}$
- ② $R_1 \cap R_2 \Rightarrow \{dno\} \neq \emptyset$
- ③ $R_1 \cap R_2 \Rightarrow \underline{dno} \rightarrow \underline{ck of R_2}$
(hence, Lossless)

②



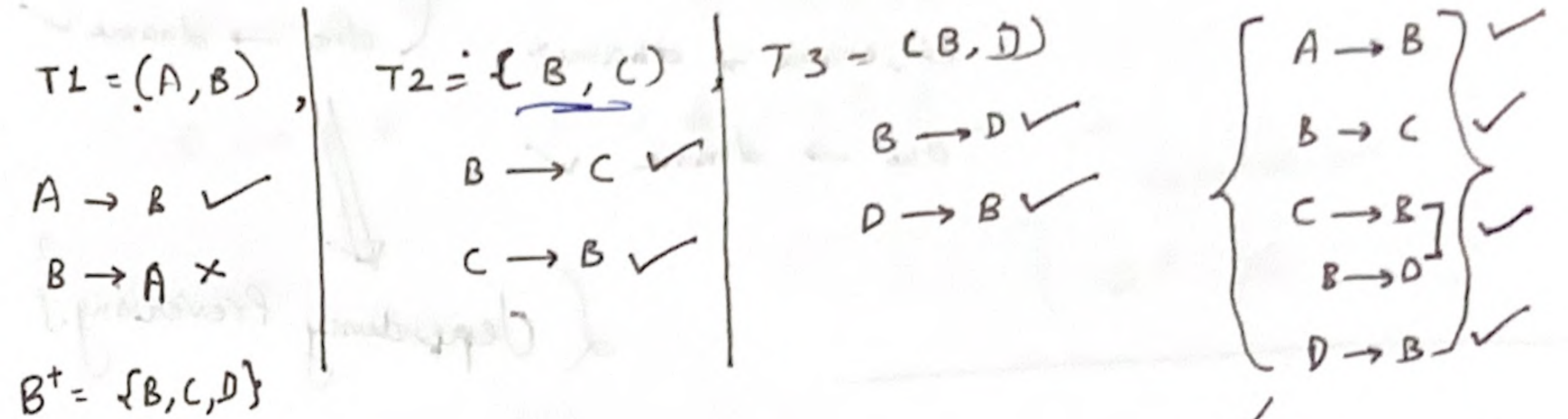
Lossless

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Dependency Preservation

$R(A, B, C, D)$

$A \rightarrow B, B \rightarrow C, C \rightarrow D, D \rightarrow B$

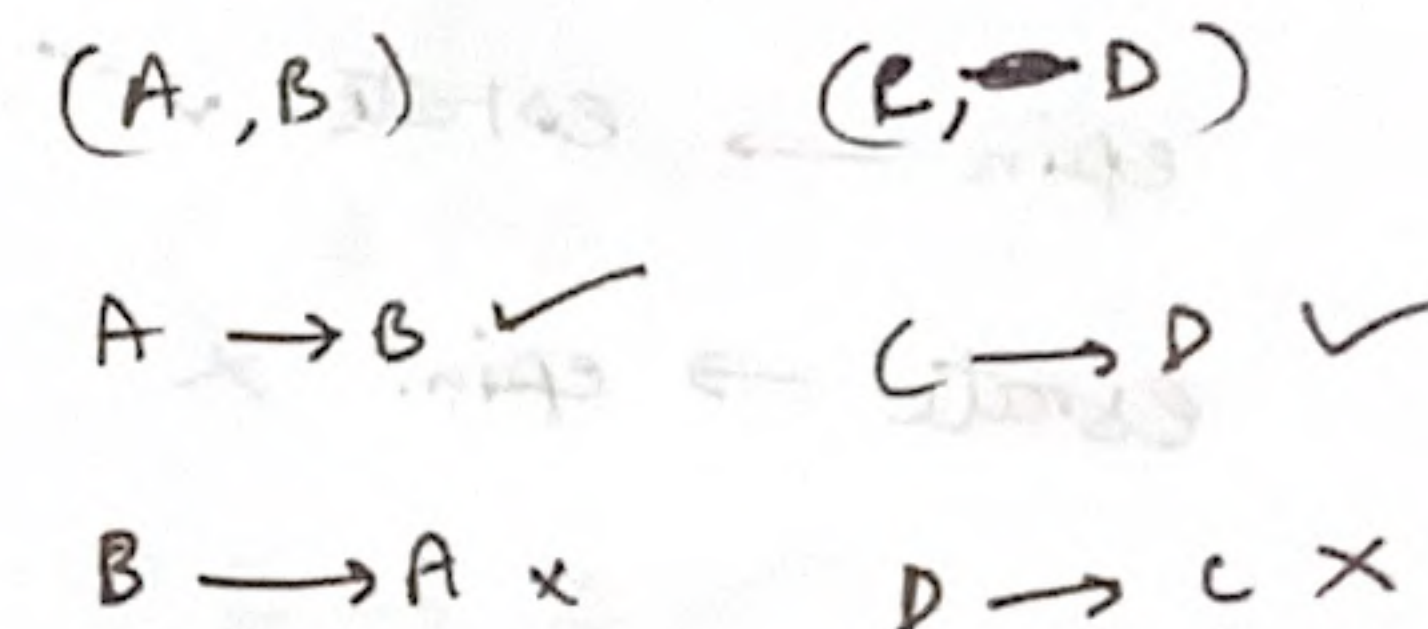


$B^+ = \{B, C, D\}$

(Dependencies Preserved.)

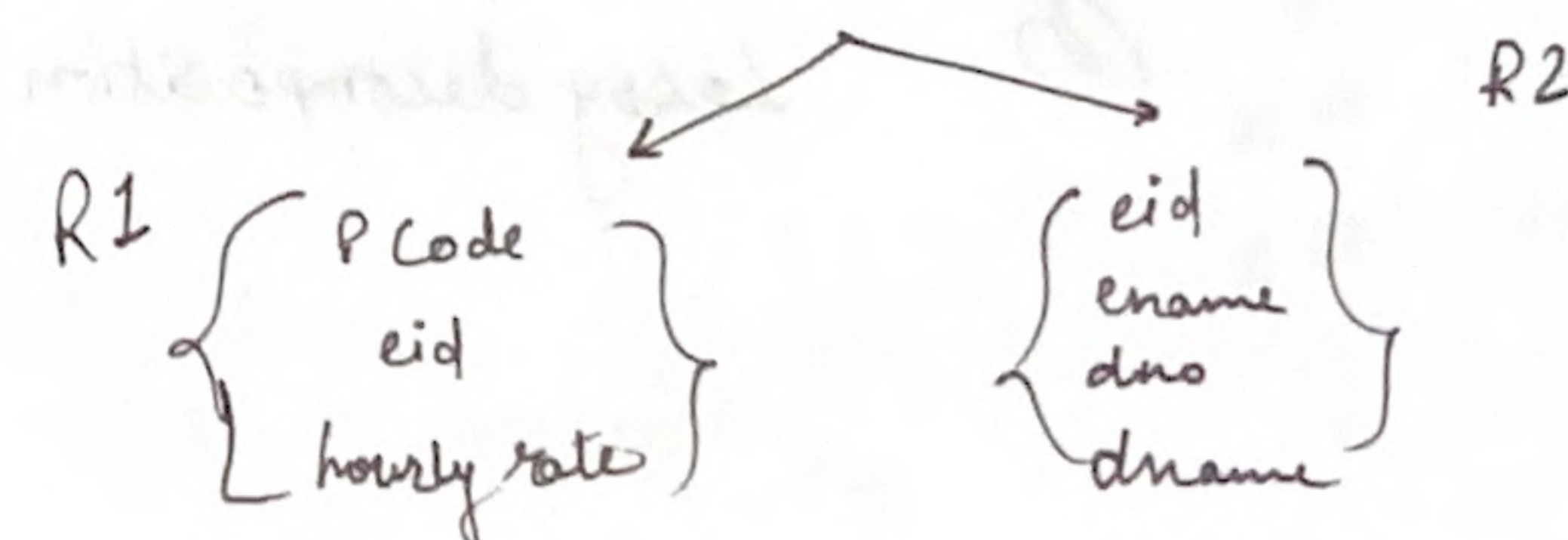
$R(A, B, C, D)$
 $A \rightarrow B, B \rightarrow C, C \rightarrow D$
 $T_1(A, B), T_2(C, D)$

Lossy decomposition



Lossy ①
dependency Preserving ②

$Pcode, eid \rightarrow hourlyrate, eid \rightarrow ename, eid \rightarrow dno, eid \rightarrow dname$
 $dno \rightarrow dname.$



R1

$Pcode \rightarrow eid \times$

$Pcode \rightarrow h-rate \times$

$eid, Pcode \rightarrow h-rate \checkmark$

R2

$eid \rightarrow ename \checkmark$

$eid \rightarrow dno. \checkmark$

$eid \rightarrow dname \checkmark$

$eid, ename \rightarrow dno \times$

$eid, ename \rightarrow dname \times$

$dno \rightarrow dname \checkmark$

$eid, Pcode \rightarrow h-rate \checkmark$

$eid \rightarrow ename \checkmark$

$eid \rightarrow dno \checkmark$

$eid \rightarrow dname \checkmark$

$dno \rightarrow dname \checkmark$

Dependency Preserving?

Q

$R(A, B, C)$

$A \rightarrow B, B \rightarrow C$

$R1(A, B)$

$R2(A, C)$

$A \rightarrow B \checkmark$

$A \rightarrow C \times$

$B \rightarrow A \times$

$C \rightarrow A \times$

$\{A \rightarrow B\}$

Lossless
DP X

Q $R = (eid, ename, epin, estate)$

$\{eid \rightarrow ename, eid \rightarrow epin, epin \rightarrow estate\}$

$R1 = \{eid, ename\}$

$R2 = \{epin, estate\}$

$eid \rightarrow ename \checkmark$

$ename \rightarrow eid \times$

$epin \rightarrow estate \checkmark$

$estate \rightarrow epin. \times$

$eid \rightarrow ename$

$epin \rightarrow estate$

① Dependency preserving X

② Lossy decomposition

Q

$R(x, y, z, w, p, q)$

$xy \rightarrow w, xw \rightarrow p, pq \rightarrow z, xy \rightarrow q$

R1

(x, p, q)

$p, q \rightarrow z \checkmark$

~~xxxxx~~

~~xxxxx~~

$z \rightarrow p, q \times$

R2

(x, y, w, p, q)

$x \rightarrow y \times$

$x \rightarrow w \times$

$x \rightarrow p \times$

$x \rightarrow q \times$

$xy \rightarrow w \checkmark$

$xy \rightarrow p \checkmark$

$xy \rightarrow q \checkmark$

$xw \rightarrow p \checkmark$

$xw \rightarrow q \times$

Lossless
PP ✓

22/3/2024

Minimal Cover / Canonical Cover

→ Irreducible set of F.D.

Conversion

- ① Make RHS of each FD as atomic.
- ② Remove redundant FDs {where LHS is atomic as well}
- ③ Remove extraneous attributes from left hand side.

Example →

$A \rightarrow B, A \rightarrow C, B \rightarrow C, AB \rightarrow B, AB \rightarrow C$

$AC \rightarrow B$

find minimal set

Solution ⇒

Step 1 → All RHS are atomic, so no change.

Step 2 →

$A \rightarrow B, B \rightarrow C, A \rightarrow C, AB \rightarrow B, AB \rightarrow C, AC \rightarrow B$

if we remove $A \rightarrow B$ then can we still access same attributes

~~after $A \rightarrow B$ removed~~

LHS atomic values

Let's first consider $A \rightarrow B, B \rightarrow C, A \rightarrow C$

we can remove $A \rightarrow C$ as this can be achieved by $(A \rightarrow B \wedge B \rightarrow C)$

$A \rightarrow B, B \rightarrow C, AB \rightarrow B, AB \rightarrow C, AC \rightarrow B$
↳ trivial dependency

LHS non-atomic

③ when

$A \rightarrow B, B \rightarrow C, \frac{AB \rightarrow C}{B \rightarrow C}, AC \rightarrow B$
 $\frac{AC \rightarrow B}{A \rightarrow B}$

⇓

(Minimal Set)

$\{A \rightarrow B, B \rightarrow C\}$