week 5

If you can obtain original table by joining 2 table (decomposed) it is good (lossless) decomposition.

$R(A, B \ldots)$ → R_1, R_2

$R_1 \cap R_2 \to R_1$ or $R_1 \cap R_2 \to R_2$ → lossless decomposition

In the age → hair example

FD: ssn → name, age
age → hair

Person (ssn, name, age, hair, phone)

→ P_1 (ssn, name, age)
ssn → name, age

→ P_2 (ssn, hair color, phone)
→ P_{21} (ssn, hair)
→ P_{22} (ssn, phone)

We lost this constraint.
However, the decomposition is lossless!
In this example (decomposition) if you want to preserve age → hair, we must write trigger.

★ BCNF always does lossless decomposition.

ex:
HasAccount (A, C, O)
A → O
C, O → A

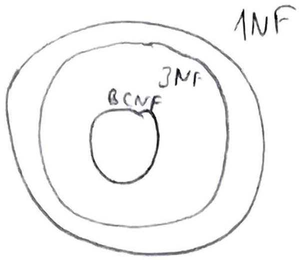
is it BCNF = ?
$A^+ = AO$
$\boxed{CO^+ = COA}$ key

A → O violates.
not BCNF

HasAccount → R1 (AO), R2 (AC)
A → O
{ }
we lost CO → A

- If the update is very frequent (that means we have to change COA again and again by joining 2 tables) that is costly. We can live with HasAccount table.

3NF



If a relation in BCNF, it is 3NF.
If it is 3NF, it might not be BCNF.

HasAC(A, C, O)

$A \to O$
$C, O \to A$

O is in the key (part of key)
we can live with that.

ex:
R(A, B, C, D, E, F, G, H)

$ABH \to CK$
$A \to D$
$C \to E$
$BGH \to F$
$F \to AD$
$E \to F$
$BH \to E$

Step 1 make rhs of each f.d. single ~~at~~ attribute

$ABH \to C$
$ABH \to K$
$A \to D$
$C \to E$
$BGH \to F$
$F \to A$
$F \to D$
$E \to F$
$BH \to E$

Step 2 Try to eliminate attr. from lhs.

i) $ABH \to C$

A^+

$BH^+ = B, H, \underset{BH \to E}{E}, \underset{E \to F}{F}, \underset{F \to A}{A}, \underset{F \to D}{D}, \underset{ABH \to C}{C}$

therefore A is useless

$\boxed{BH \to C}$

ii) $ABH \to K$

$BH^+ = B\,H\,E\,F\,A\,\underset{BHA \to K}{K}$

$\boxed{BH \to K}$

iii) $BGH \to F$

$BH^+ = B, H, E, \underset{E \to F}{F}, A$

G is not necessary

$\boxed{BH \to F}$

iv) $BH \to E$ nothing to remove

Step 3 Can you find rhs fd without lhs?

We have

$BH \to C \longrightarrow$ i) $BH^+ = BHKFDE$, no C, ~~BH→C stays~~

$BH \to K \longrightarrow$ ii) $BH^+ = BHCEFAD$, no K, $BH \to K$ stays

$A \to D \longrightarrow$ Bu stepi yaparken $BH \to K$'yi yok sayarak yapıyorum.

$C \to E \longrightarrow$ ---

$BH \to F$ ~~X~~ $\longrightarrow$) $BH^+ = BHCKEF$ we can find $BH \to F$ without $BH \to F$ remove

$F \to A \longrightarrow$

$F \to D \longrightarrow$ since we deleted $BH \to F$, we cannot directly use $BH \to F$.

$E \to F \longrightarrow$

$BH \to E \longrightarrow$ $BH^+ = BHCK\cancel{F}_{\cancel{BH\to F}}\, E\, F_{E\to F}DA$ $BH \to E$ remove

Remainings are

$BH \to C$
$BH \to K$
$A \to D$
$C \to E$
$F \to A$
$F \to D$
$E \to F$

Step 4 Group remainings

$R_1(BHCK)$ key BH
$R_2(AD)$ key A
$R_3(CE)$ key C
$R_4(FAD)$ key F
$R_5(EF)$ key E

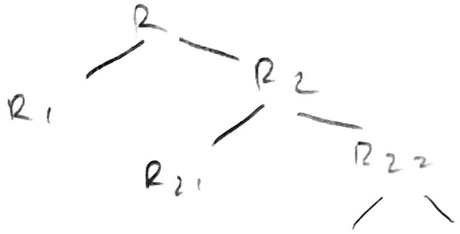
Step 5 if no R_i is superkey of R, add R_0, where R_0 is key of R.

key of $R \longrightarrow BGH$

add $R_0(BGH)$

In 3NF

In BCNF



more like a tree

Multi Value F.D. (MVD)

Suppose, we have the following table

ex
Course

cid	instructor	reference
352	Gicalli	Raghu
352	Gicalli	Ulman
352	altingsude	Raghu
352	altingsude	Ulman

There is no F.D.

F.D = { }

However, there is MVD.

cid $\twoheadrightarrow$ instructor

cid $\twoheadrightarrow$ reference

ex: Drinkers (name, addr, phones, beersliked)

name $\twoheadrightarrow$ phones (a name can have more than 1 phone)

name $\twoheadrightarrow$ beersliked

But there is only 1 F.D

name $\rightarrow$ addr (a person can only have 1 addr)

name $\twoheadrightarrow$ phones
name $\twoheadrightarrow$ beersliked } $\rightarrow$

sue a p1 b1
sue a p2 b2

$\hookrightarrow$ swap $\rightarrow$

sue a p2 b1
sue a p1 b2 } $\rightarrow$ 2 new rows.

These 2 rows must be in the table

sue	a	p1	b1
sue	a	p2	b2
sue	a	p2	b1
sue	a	p1	b2

$\rightarrow$ Sue a $\begin{Bmatrix} p1 \\ p2 \end{Bmatrix} \begin{Bmatrix} b1 \\ b2 \end{Bmatrix}$

Trivial MVD

a MVD $A \twoheadrightarrow B$ is trivial if

a) $B \subseteq A$ or

b) $A \cup B = R$

ex: $R(A,B,C)$

$AB \twoheadrightarrow C$

or

$BC \twoheadrightarrow A$

Promotion

if $X \rightarrow Y$ then $X \twoheadrightarrow Y$

reverse is not true!

Complementation

If $X \twoheadrightarrow Y$, Z all other attributes, then $X \twoheadrightarrow Z$?

does not hold in MVD.

☆ Armstrong's splitting rule

$F \rightarrow AD$
$F \rightarrow A$ ✓
$F \rightarrow D$

$\cancel{F \twoheadrightarrow AD}$
$\cancel{F \twoheadrightarrow A}$
$\cancel{F \twoheadrightarrow D}$

ex: Multiattribute rhs.

Drinkers (name, areacode, phone, beerliked, manuf)

name $\twoheadrightarrow$ areacode, phone

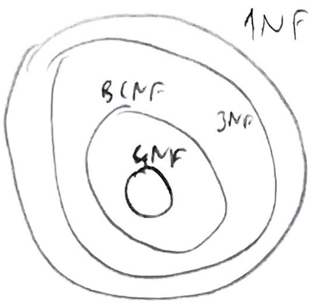
name $\twoheadrightarrow$ beer, manuf

we cannot split this

name $\begin{Bmatrix} a.c1 & p1 \\ ac2 & p2 \end{Bmatrix} \times \begin{Bmatrix} b1 & m1 \\ b2 & m2 \end{Bmatrix}$

4NF

a relation R is 4NF, if whenever $X \twoheadrightarrow Y$ is a nontrivial MVD, then X is superkey.
→ ☆ Superkey depends on FD's $\boxed{\text{only}}$.



☆ $X \rightarrow Y$ is also $X \twoheadrightarrow Y$.
Thus, if R is in 4NF, then it is in BCNF.

ex: Drinkers(<u>name</u>, addr, <u>phones</u>, beersliked)

FD: name → addr
MVD: name ↠ phones
name ↠ beersliked

all three violates 4NF.

Key is (name, phone, beer)

? 4NF'de ayırırken FD varken MVD seçebilir miyiz?

1) Pick name → addr.

$name^+$ = name, addr

Drinkers1 (name, addr) name → addr ✓
Drinkers2 (name, phone, beer) name ↠ phones
name ↠ beer

→ since, there is no FD, all three attributes are key.

name ↠ phones
name ↠ beer
→ violates the key.

Drinker3 (name, phones)
Drinker4 (name, beers)

ex: Slide 71. Solve by using descriptions

FD: ProductId, SupplierId → Purch.price
ProductId → Quantity
ProductId → Saleprice

MVD: ProductId →→ substitute
ProductId →→ Supplier, Purchaseprice

this is hard to see. It is like areacode, phone

pid1 { s1 pp1
s2 pp2 }

Apply 4NF

pid → saleprice
pid → quantity
bad F.D.

union

pid → saleprice, quantity bad F.D
pid, sid → p.price bad F.D.
not keys

R

R1 (pid, saleprice, quantity) ✓
F.D: pid → saleprice, quantity ✓

R2 (pid, supid, purprice, subst.)
pid, supid → purprice is not a key

We can use MVD's

using pid →→ substitute

R21 (pid, substitute)
F: { }
MVD: pid →→ subs

this is not a key.
But it is trivial. OK ✓

using pid →→ supid, pprice

R22 (pid, supid, pprice)
FD: pid, supid → pprice
MVD: pid →→ supid pprice

it is key

trivial MVD. ok ✓

ex: Slide 75

$R(P, S, T, C)$

FD: $P \to S$
$P \to T$
$T \to C$

Is R in BCNF=?

key is $\boxed{P}$, $T \to C$ violates.

$T^+ = TC$

R

$R_1(TC)$ F: $T \to C$ ✓

$R_2(TPS)$ FD: $P \to S$, $P \to T$ ✓ key is P^+

lossless $\to$ yes
preserve dependencies $\to$ yes

ex: Suppose that we ~~divide~~ decompose using $P \to C$.

R

$R_1(PC)$
$P \to C$

$R_2(PST)$
$P \to S$
$P \to T$

This is lossless, but we lost $T \to C$ f.d.