* Minimize the FDs:

Set 1

FD1: SSN → name, mgr, dno

FD2: dno → dname, mgr

FD3: pno → pname, dno, Plocation, mgr

FD4: SSN, pno → hours, dno

Set 2:

FD1: SSN → name, dno

FD2: dno → dname, mgr

FD3: pno → pname, Plocation, dno

FD4: SSN, pno → hours

Example: R(a, b, c, d, E)

FDs: ab → c; aE → d; d → b

Which of the following are true:

ad → c ✓ $(ad)^+ = \{a, d, b, c\}$

adE → bc ✓ $(adE)^+ = \{a, d, E, b, c\}$

abc → d ✗ $(abc)^+ = \{a, b, c\}$

Example: R(a, b, c, d, E)

FDs: ab → c; c → d; bd → E

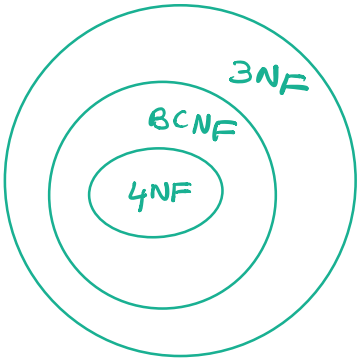
abc → E ✓

ab → E ✓

ac → E ✗

Normal Forms

~~1NF~~, ~~2NF~~, 3NF, BCNF, 4NF, ~~5NF~~



Input: 1) Relation R with all the attributes
$R(A_1, A_2, \ldots,)$
2) All the FDs on the attributes

Output: $R_1, R_2, \ldots, R_n$

where $R = R_1 \bowtie R_2 \bowtie \ldots \bowtie R_n$

↓

no insert, delete, update anomalies
loss less join & no false tuples

3NF

A relation R is in 3NF if $\forall$ FDs: $\overline{A} \longrightarrow \overline{B}$

$\overline{A}$ :: $A_1 A_2 A_3 \ldots$ $\overline{B}$ :: $B_1 B_2 B_3 \ldots$

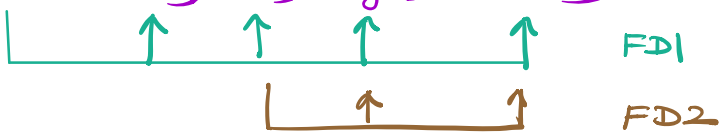
$A_1 A_2 \ldots A_i \ldots \longrightarrow B_1 B_2 B_3 \ldots$

1) $\overline{A}$ must be key / superkey

OR

2) $\bar{B}$ must be a prime attribute. (i.e., $\bar{B}$ must be part of a key)

Example: R(SSN, name, dno, mgr, dname)



(I) What is key of R: (SSN)

(II) dno ⟶ dname, mgr FD2

But dno is not key; nor are dname, mgr prime attributes.

⟹ R is not in 3NF.

3NF Decomposition Alg:

Input: R with all attributes; all FDs

① Compute keys of R using closure property of FDs

$R' = R$

② Repeat until all relations in 3NF

ⓐ Pick any R' with FD: $\bar{A} \longrightarrow \bar{B}$ that violates 3NF.

ⓑ Divide R' into $R_1'(\bar{A}, \bar{B})$ and $R_2'(\bar{A}, R' - \bar{B})$

$R_2'(R' - \bar{B})$

Going back to Example:

FD2: R_1' (dno, dname, mgr)

R_2' (dno, SSN, name)