

TDDD81 Assignment 3

1.

$$FD1: \{A\} \rightarrow \{B, C\} \quad FD2: \{C\} \rightarrow \{A, D\} \quad FD3: \{D, E\} \rightarrow \{F\}$$

a) $\{C\} \rightarrow \{A, D\} \Rightarrow \{C\} \rightarrow \{A\} \Rightarrow \{A\} \rightarrow \{B, C\} \Rightarrow \{A\} \rightarrow \{B\}$ (Decomposition)
 $\Rightarrow \{C\} \rightarrow \{B\}$ (Transitivity)

b) $\{A\} \rightarrow \{B, C\} \Rightarrow \{A\} \rightarrow \{C\}$ (Decomposition)
 $\{C\} \rightarrow \{A, D\} \Rightarrow \{C\} \rightarrow \{D\}$ (Transitivity)
 $\{A\} \rightarrow \{D\}$ (pseudo-transitivity)
 $\{D, E\} \rightarrow \{F\} \Rightarrow \{A, E\} \rightarrow \{F\}$

2.

a) $X^+ = \{A, B, C, D\}$ b) $X^+ = \{A, B, C, D, E, F\}$

3. a) $D^+ = \{D, B\}$ (Using FD3). $A^+ = A$
 $E^+ = \{E, F\}$ (Using FD2)
 $(A, B)^+ = \{A, B, C, D, E, F\}$ (Using FD1)
 $(A, B)^+$ is a superkey since all attributes are covered, $(A, B)^+ \rightarrow R$ and has to be included in the candidate key(s).
 A is not determined in the right side of the FD's, and $A^+ = A$ therefore A is not a candidate key.
 $B^+ = B$, B is not a candidate key. (or $B \rightarrow C, D, E, F$)

b) Therefore $(A, B)^+$ is a candidate key.

(A, C) won't work since C does not determine anything in the right side.
 $(A, D)^+ = \{A, B, C, D, E, F\}$ which is a candidate key & superkey.
 $(A, E)^+ = \{A, E, F\}$, Not a superkey.
 $(A, F)^+ = \{A, F\}$, Not a superkey.

Answer: (A, B) & (A, D) are candidate keys

b) FD2 & FD3 violate BCNF since the left hand sides are not superkeys

c) F2 violates BCNF

$R_1(\underline{E}, F)$
with FD2

$R_2(\underline{A}, \underline{B}, \underline{C}, D, E)$
with FD1, FD3

R1: E is candidate key

FD2: $E \rightarrow \{F\}$

R2: {A, B, C} is candidate key

FD1: $\{A, B\} \rightarrow \{C, D, E\}$ and Preserves through transitivity rule since $E \rightarrow \{F\}$
FD3: $\{D\} \rightarrow \{B\}$

Decompose R_2 since FD3 violates BCNF

$R_1(\underline{E}, F)$

FD2

$R_2(\underline{D}, B)$

FD3

$R_3(\underline{A}, \underline{B}, \underline{C}, D, E)$

R1: candidate key is E

R2: candidate key is D

R3: candidate key is {A, B}

FD1 then R_3 {A, B} is candidate key

$C \rightarrow \{D\}$ so $\{A, B\} \rightarrow \{C, D, E\}$ and

$E \rightarrow \{F\}$ so FD1 is preserved

4.

a) $(A, B, C)^+ = \{A, B, C, D, E\}$, (A, B, C) is a superkey

$(B, C, D)^+ = \{A, B, C, D, E\}$ (B, C, D) is a superkey

$(C)^+ = \{D, E\}$, C is not a superkey which violates BCNF. Q.E.D

b) FD3 violates BCNF

$R_1(\underline{C}, D)$

FD3

$R_2(\underline{A}, \underline{B}, \underline{C}, E, F)$

FD1: $\{A, B, C\} \rightarrow \{E\}$ and $C \rightarrow \{D\}$ so FD1 is preserved

FD2: $\{C\} \rightarrow \{D\}$ so we have $\{B, C, D\} \rightarrow \{A, E\}$ FD2 is preserved

R1: C is candidate key

R2: {A, B, C} is a superkey but candidate key

Since B, C is not on the right hand side of any FD they need to be in the candidate key.

Since $\{C\} \rightarrow \{D\}$ then the $\{B, C, D\} \rightarrow \{A, E\}$ and

therefore {B, C} is a candidate key.