

Task 1:

a) Derive $C \rightarrow B$ using stated FDs

$C \rightarrow AD$ (FD2)

$C \rightarrow A$ (Decompose FD2)

$A \rightarrow BC$ (FD1)

$A \rightarrow B$ (Decompose FD1)

$C \rightarrow B$ (Transitivity)

b) Derive $AE \rightarrow F$

$A \rightarrow BC$ (FD1)

$A \rightarrow C$ (Decomposition FD1)

$C \rightarrow AD$ (FD2)

$C \rightarrow D$ (Decompose FD2)

$A \rightarrow D$ (Transitivity)

$AE \rightarrow F$ (Pseudo-transitivity, through $A \rightarrow D$ and FD3)

Pseudo-transitivity explanation:

$A \rightarrow D \sim X \rightarrow Y$

$DE \rightarrow F \sim YW - Z$

$AE \rightarrow F \sim XW - Z$

Task 2:

a)

$\{A\}$ (Add attribute set to result)

$\{A,B,C\}$ ($A \rightarrow BC$, FD1, add B and C)

$\{A,B,C,D\}$ (B adds nothing, $C \rightarrow AD$, FD2, add D)

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

b)

$\{C,E\}$ (Add attribute set to result)

$\{C,E,A,D\}$ ($C \rightarrow AD$, FD2, add A and D)

$\{C,E,A,D,F\}$ ($DE \rightarrow F$, FD3, add F)

$\{C,E,A,D,F,B\}$ ($A \rightarrow BC$, FD1, add B)

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

Task 3:

a) Find candidate keys

C and F only on RHS which means they cannot be a part of a CK

A is only on the LHS which means it has to be part of every CK

$\{A,B,D\}^+ = \{A,B,D,C,E,F\}$

$\{A,B,E\}^+ = \{A,B,E,C,D,F\}$

$\{A,D,E\}^+ = \{A,D,E,F,B,C\}$

All are still superkeys so we can not eliminate any yet

$\{A,B\}^+ = \{A,B,C,D,E,F\}$ (Candidate key)

$\{A,D\}^+ = \{A,D,B,C,E,F\}$ (Candidate key)

$\{A,E\}^+ = \{A,E,F\}$ (not a superkey)

b) Which FD violate BCNF?

FD2 violates BCNF because E by itself is not a superkey of R

FD3 also violates BCNF because D by itself is not a superkey of R

c) Decompose R into BCNF

First we choose FD2 since it violates BCNF

$\{E\} \rightarrow \{F\}$ ($X \rightarrow Y$)

R = {A,B,C,D,E,F} decompose into R1 and R2

R1 = {E,F} with FD2; candidate key is {E}

R2 = {A,B,C,D,E} with new FD($AB \rightarrow CDE$) and FD3; candidate keys are {A,B} and {A,D}

FD3 violates bcnf in R2 as well.

$\{D\} \rightarrow \{B\}$ ($X \rightarrow Y$)

R2 = {A,B,C,D,E} decompose into R2A and R2B

R2A = {D,B} with FD3; candidate key is {D}

R2B = {A,C,D,E} only trivial FDs; CK is all of the attributes {A,C,D,E}

R after decomposition results in:

R1 = {E,F} with FD2; candidate key is {E}

R2A = {D,B} with FD3; candidate key is {D}

R2B = {A,C,D,E} only trivial FDs; candidate key is all of the attributes {A,C,D,E}

Task 4:

To determine if any FD is violating BCNF we must first find all the superkeys and candidate keys

E is only on RHS which means it cannot be a part of a CK

B and C are only on the LHS which means they have to be part of every CK

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

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

All are still superkeys so we can not eliminate any yet

$\{B,C\}^+ = \{B,C, D, A, E\}$ (candidate key)

a) Show why R is not BCNF

Since C is not a superkey FD3 violates BCNF

b) Decompose R into BCNF

FD3 violates BCNF

$\{C\} \rightarrow \{D\}$ ($X \rightarrow Y$)

$R = \{A,B,C,D,E\}$ decompose into R1 and R2

$R1 = \{C,D\}$ with FD3; candidate key is $\{C\}$

$R2 = \{A,B,C,E\}$ with new FD ($ABC \rightarrow E$); candidate key $\{A,B,C\}$