

## Assignment #3

Q1)

$$ABCDE^+ = \{ABCDE\}$$

$$CD^+ = \{CDBAE\}$$

$$C^+ = \{CABE\}$$

$$D^+ = \{DE\}$$

$$CK = CD$$

$$PA = CDB$$

$$\begin{array}{c} CD \\ \downarrow \\ CB \end{array}$$

$$BD^+ = \{ABCDE\}$$

$$D^+ = \{DE\}$$

$$B^+ = \{B\}$$

BD is also candidate key

$$NP = A, E$$

$$CK = CD, BD$$

Q2

$$ABCD^+ = \{ABCD\}$$

$$AD^+ = \{ABCD\}$$

$$A^+ = \{A\}$$

$$D^+ = \{D\}$$

$$CK = AD$$

$$\begin{array}{c} AD \\ \downarrow \\ AC^+ = \{ABCD\} \end{array}$$

$$A^+ = \{A\}$$

$$C^+ = \{C\}$$

$$\begin{array}{c} AD \\ \downarrow \\ AB^+ = \{ABCD\} \end{array}$$

$$A^+ = \{A\}$$

$$B^+ = \{B\}$$

$$PA = ABCD$$

$$NP = \emptyset$$

$$CK = AB, AD, AC$$

$$Q3) ABCDE^+ = \{ABCDE\}$$

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

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

$$E^+ = \{E\}$$

$$CK = AE$$

$$\hookrightarrow DE^+ = \{A B C D F\}$$

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

$$CK = AE, DE, CE$$

$$PA = A D E C$$

$$NP = B$$

Q4)  $F_1 (A \rightarrow C, AB \rightarrow C, C \rightarrow DG, CD \rightarrow G, EC \rightarrow AB, EG \rightarrow C)$   
 $F_2 (A \rightarrow C, C \rightarrow D, C \rightarrow G, EC \rightarrow A, EC \rightarrow AB, EG \rightarrow C)$   
 find m-cover

$F_1' (A \rightarrow C, AB \rightarrow C, C \rightarrow D, C \rightarrow G, EC \rightarrow AB, EG \rightarrow C)$

$F_1' (A \rightarrow C, A \rightarrow C, C \rightarrow D, C \rightarrow G, EC \rightarrow A, EC \rightarrow B, EG \rightarrow C)$

$F_2' = (A \rightarrow C, C \rightarrow D, C \rightarrow G, C \rightarrow G, EC \rightarrow A, EC \rightarrow B, EG \rightarrow C)$

$F_1$  &  $F_2$  are equal so they have equal FDs  
 if any clash at

$EC \rightarrow AB$  then

$EC \rightarrow A = EC \rightarrow B$

Q5)  $F' = \{ABC \rightarrow C, ABC \rightarrow D, ABC \rightarrow E, ABC \rightarrow G, C \rightarrow E, A \rightarrow B, D \rightarrow G\}$

$F' = \{ABC \rightarrow D, C \rightarrow E, A \rightarrow B, D \rightarrow G\}$

$AB C^+ = \{ABC E\}$

$A C^+ = \{ABC E D G\}$

$CK = AC$

$PA = A, C$

$NP = B, E, D, G$

Q6)  $R(A, B, C, D, E, G)$

$F = \{D \rightarrow E, ABC \rightarrow BDE, B \rightarrow G, A \rightarrow C, ABC \rightarrow G\}$

$F' = \{D \rightarrow E, \cancel{ABC \rightarrow B}, \cancel{ABC \rightarrow D}, \cancel{ABC \rightarrow E}, B \rightarrow G, A \rightarrow C, \cancel{ABC \rightarrow G}\}$

$F' = \{D \rightarrow E, ABC \rightarrow D, B \rightarrow G, A \rightarrow C\}$

$AB^+ = \{AC\}$

$B^+ = \{B, G\}$

$PA = A, B$

$CK = AB^+$

$NP = G, D, E, C$

# Normalization for Relational Database

Q1)

a)  $ABCDEFGG^+ = \{A B C D E F G\}$

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

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

$F^+ = \{F E\}$

$CK = AF$

$PA = AF$

$NP = B C D E G$

b)

BCNF	x	x	x	x
3NF	x	x	x	x
2NF	x	x	✓	✓
1NF	✓	✓	✓	✓

Highest form = 1NF

Because we have NPA in proper subsets of CK.

c)

$R_1(A B C D G)$

$F_1(A \rightarrow B C D G, D \rightarrow C, G \rightarrow D B C)$

$A^+ = \{A B C D G\}$

$A \rightarrow B C D G$

$B^+ = \{B\}$

$C^+ = \{C\}$

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

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

$CK = A$  in 2NF

$(R_1 \cup R_2 \cup R_3)$

$F_1 \cup F_2 \cup F_3$

$\{A \rightarrow B C D G, D \rightarrow C, G \rightarrow D B C, F \rightarrow E\}$

$R_2(F E)$

$F^+ = \{F E\}$

$CK = F$  in BCNF

↓

$R_3(A F)$

$A^+ = \{A\}$

$F^+ = \{F\}$

$F$  in BCNF

d)  $R_1$  highest NF = 2NF  
decomposing it

$A^+ = \{A B C D G\}$

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

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

$R_4(DC)$

$D^+ = \{DC\}$

$C^+ = \{C\}$

$CK = D$

BCNF

↓

$R_6(AD)$

$A^+ = \{AD\}$

$D^+ = \{D\}$

$CK = A$   
BCNF

$R_5(GDBC)$

$G^+ = \{GDBC\}$

$D^+ = \{DC\}$

$C^+ = \{C\}$

$B^+ = \{B\}$

$CK = G$

not in 3NF

↓  
 $R_7(DC)$

$D^+ = \{DC\}$

$C^+ = \{C\}$

$CK = D$

BCNF

$R_8(GBD)$

$G^+ = \{GBD\}$

$CK = G$

BCNF

$(R_2 \cup R_3 \cup R_4 \cup R_6 \cup R_8)$

↓  
3NF?

2) Complete set of BCNFs schema relations

$(R_2 \cup R_3 \cup R_4 \cup R_6 \cup R_8)$

union of these fs

$= \{F \rightarrow E, D \rightarrow C, G \rightarrow DB, A \rightarrow D\}$

only  $A \rightarrow G$  was not preserved

Q2)  $R(A, B, C, D, E)$   $F \rightarrow A \rightarrow BC, C \rightarrow D, E \rightarrow D, BE \rightarrow A$

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

$CK = AE, BE$

$BE^+ = \{BE A B C D\}$

$PA = A, B, E$

$NP = C, D$

Highest form = 1NF

Its not in 2NF because of  $A \rightarrow C, E \rightarrow D$

b)  $A^+ = \{A B C D\}$

$R_1(A B C D)$

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

$B^+ = \{B\}$

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

$D^+ = \{D\}$

$CK = A$

2NF

$E^+ = \{E D\}$

$R_2(E D)$

$E \rightarrow D$

$CK = E$

$R_1 \cup R_2$

$F_1 \cup F_2$   
 $= \{A \rightarrow B C D, C \rightarrow D, E \rightarrow D\}$

c)  $R_1$  is not in 3NF

$R_3(CD)$

$C^+ = \{CD\}$

$D^+ = \{D\}$

$CK = C$

BCNF

$R_4(ABC)$

$A^+ = \{ABC\}$

$B^+ = \{B\}$

$C^+ = \{C\}$

$CK = A$

BCNF

BCNF Relations:

$F_2 \cup F_3 \cup F_4 = \{E \rightarrow D, C \rightarrow D, A \rightarrow BC\}$

d) All dependencies are not preserved such as  $BE \rightarrow A$  is lost. So it is loss.

Q3)

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

$F = \{B \rightarrow D, D \rightarrow A\}$

$ABC^+ = \{ABCD\}$

$CK = BC$

$PA = B, C$

$NP = A, D$

$B \rightarrow D$  violates 2NF

$B^+ = \{BDA\}$

$R_1(ABD)$

$D^+ = \{DA\}$

$B^+ = \{BDA\}$

$A^+ = \{A\}$

$CK = B$

2NF

$R_2(CB)$

$C^+ = \{C\}$

$B^+ = \{B\}$

No FDs

$R_{11}(DA)$

$D \rightarrow A$

BCNF

$R_{12}(BD)$

$B \rightarrow D$

$CK = B$

BCNF

All dependencies are preserved



Q4)  $R(A, B, C, D, E)$   $F = \{A \rightarrow BC, C \rightarrow D, E \rightarrow D, BE \rightarrow A\}$

a)  $R_1(A, E)$        $R_2(A, B, C)$        $R_3(D, E)$   
 $A \rightarrow BC$        $E \rightarrow D$

$\therefore$  It is lossless decomposition but all dependencies are not preserved because

$$R_1 \cup R_2 \cup R_3 = R \quad \& \quad R_1 \cap R_2 \cap R_3 = \emptyset$$

and  $R_1, R_2$  and  $R_3$  can be joined successfully.

b)  $R_1 \cup R_2 \cup R_3 = A B C D E$   
 $R_1 \cap R_2 \cap R_3 = \emptyset$

$A$  &  $C$  are common and are CK

$\therefore$  All dependencies are not preserved but the decomposition is lossless.

c)  $R_1 \cup R_2 \cup R_3 = A B C D E$   
 $R \cap R_2 \cap R_3 = \emptyset$

$C$  &  $D$  are common elements but  $D$  is not a CK.

$R_1(A, B, C)$        $R_2(C, D)$        $R_3(D, E)$   
 $A \rightarrow BC$        $C \rightarrow D$        $E \rightarrow D$

$\therefore$  All dependencies are not preserved because of  $E \rightarrow D$  so the decomposition is not lossless.

Q5)  $F_1' = \{A \rightarrow C, A \cancel{\rightarrow} C, C \rightarrow D, C \rightarrow I, \cancel{C} \rightarrow I, EC \rightarrow A, EC \rightarrow B, EI \rightarrow C\}$

$F_1' = \{A \rightarrow C, C \rightarrow D, C \rightarrow I, EC \rightarrow A, EC \rightarrow B, EI \rightarrow C\}$

$F_1' = F_2$

So  $F_1' = F_2$

$F_1$  &  $F_2$  are equivalent

$\therefore$  All dependencies of  $F_1$  are present in  $F_2$  and vice versa so all FDs are equal.

Q6)  $R(ABCDE)$   $F = \{A \rightarrow BC, C \rightarrow D, E \rightarrow D, BE \rightarrow A\}$

a)  $R_1(A, E)$  ,  $R_2(A, B, C)$   $R_3(D, E)$   
 $A \rightarrow BC$   $E \rightarrow E$

$R_1 \bowtie R_2$

We have A common so we will check if A is candidate key in  $R_2$

CK of  $R_2 = A$

so it is lossless decomposition.

$R_1(A, E)$   $R_2(A, B, C)$   
 $\swarrow \searrow$   
 $R_{12}(A, B, C, E)$   $R_3(D, E)$   
 $\swarrow \searrow$   
 $R_{123}(A, B, C, D, E) = R(ABCDE)$

Here E is common from  $R_{12}$  and  $R_3$

$E^+ = \{E, D\}$

we will check if E is CK in  $R_3$

CK of  $R_3 = E$

so  $R_1, R_2$  and  $R_3$  are lossless decomposition

b)  $R_1(A, E)$   $R_2(A, B, C)$   $R_3(A, B, C, D)$   
 $R_1 \bowtie R_2$

A is common  
 and A is CK in  $R_2$

$R_1(A, E)$   $R_2(A, B, C)$   
 $\swarrow \searrow$   
 $R_{12}(A, B, C, E)$   $R_3(A, B, C, D)$   
 $\swarrow \searrow$   
 $R_{123}(A, B, C, D, E) = R(A, B, C, D, E)$

$\therefore C^+$  is CK in  $R_3$

so  $R_1, R_2$  and  $R_3$  are lossless decomposition.