IT214 Lab 9 Report
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Contents

1 Compute Key, Determine Normal Form, Decompose into BCNF

1. R(ABCD)
   AB → CD, B → C, C → D

   AB → C
   AB → D
   B → C
   C → D

   $AB^+ = \{A,B,C,D\}$
   So, the key is AB.

   ∵ B → C and C → D FD do not have keys on left side, thus it is not BCNF, 3NF .
   B → C also violates 2NF.
   ∴ It follows 1NF.

   Using BCNF Decomposition algorithm on R :
   $B^+ = \{B,C,D\}$
   R1(AB) with key AB and F1=$\{\phi\}$. It is in BCNF.
   R2(BCD) with key B and F2=$\{$B → C,C → D$\}$.
   It is not in BCNF as C → D violates the property. It is in 2NF.

   Using BCNF Decomposition algorithm on R2 :
   $C^+ = \{C,D\}$
   R21(CD) with key C and F21=$\{$C → D$\}$. It is in BCNF.
   R22(BC) with key B and F22=$\{$B → C$\}$. It is in BCNF.

   After decomposition, the relations are :
   R1(AB) with key AB and F1=$\{\phi\}$.
   R21(CD) with key C and F21=$\{$C → D$\}$.
   R22(BC) with key B and F22=$\{$B → C$\}$.

2. R(ABCD)
   A → BC, B → C, A → B, AB → C

   A → B
   A → C
   B → C
   AB → C

   $AD^+ = \{A,B,C,D\}$
   So, the key is AD.

∵ No FDs have keys on left side, thus it is not BCNF, 3NF . Except B → C, all other FDs also violates 2NF.
∴ It follows 1NF.

Using BCNF Decomposition algorithm on R :
A^+ = {A,B,C}
R1(ABC) with key A and F1={A → B, A → C,B → C,AB → C}.
It is not in BCNF as B → C violates the property. It is in 2NF.
R2(AD) with key AD and F2={ϕ}. It is in BCNF.

Using BCNF Decomposition algorithm on R1 :
B^+ = {B,C}
R11(BC) with key B and F11={B → C}. It is in BCNF.
R12(AB) with key A and F12={A → B}. It is in BCNF.

After decomposition, the relations are :
R11(BC) with key B and F11={B → C}.
R12(AB) with key A and F12={A → B}.
R2(AD) with key AD and F2={ϕ}. It is in BCNF.

3. R(ABCD)
AB → C, C → D

AB → C
C → D

AB^+ = {A,B,C,D}
So, the key is AB.

∵ C → D
do not have key on left side, thus it is not BCNF, 3NF .
∴ It follows 2NF.

Using BCNF Decomposition algorithm on R :
C^+ = {C,D}
R1(CD) with key C and F1={C → D} It is in BCNF.
R2(ABC) with key AB and F2={AB → C}. It is in BCNF.

After decomposition, the relations are :
R1(CD) with key C and F1={C → D}
R2(ABC) with key AB and F2={AB → C}.

4. R(ABCDE)
   $A \rightarrow BCD, B \rightarrow C, C \rightarrow E$

   $A \rightarrow B$
   $A \rightarrow C$
   $A \rightarrow D$
   $B \rightarrow C$
   $C \rightarrow E$

   $A^+ = \{A,B,C,D,E\}$
   So, the key is A.

   $\because B \rightarrow C$ and $C \rightarrow E$ do not have keys on left side, thus it is not BCNF, 3NF .
   $\therefore$ It follows 2NF.

   Using BCNF Decomposition algorithm on R :
   $B^+ = \{B,C,E\}$
   R1(BCE) with key A and F1=$\{B \rightarrow C, C \rightarrow E\}$.
   It is not in BCNF as $C \rightarrow E$ violates the property. It is in 2NF.
   R2(ABD) with key ABD and F2=$\{A \rightarrow B, A \rightarrow D\}$. It is in BCNF.

   Using BCNF Decomposition algorithm on R1 :
   $C^+ = \{C,E\}$
   R11(CE) with key C and F11=$\{C \rightarrow E\}$. It is in BCNF.
   R12(BC) with key B and F12=$\{B \rightarrow C\}$. It is in BCNF.

   After decomposition, the relations are :
   R11(CE) with key C and F11=$\{C \rightarrow E\}$.
   R12(BC) with key B and F12=$\{B \rightarrow C\}$.
   R2(ABD) with key ABD and F2=$\{A \rightarrow B, A \rightarrow D\}$.

5. R(ABCDE)
   $A \rightarrow CD, B \rightarrow DE, C \rightarrow D$

   $A \rightarrow C$
   $A \rightarrow D$
   $B \rightarrow D$
   $B \rightarrow E$
   $C \rightarrow D$

   $AB^+ = \{A,B,C,D,E\}$
   So, the key is AB.

   $\because$ No FDs have keys on left side, thus it is not BCNF, 3NF . $C \rightarrow D$ also violates 2NF.
   $\therefore$ It follows 1NF.

Using BCNF Decomposition algorithm on R :
$A^+ = \{A,C,D\}$
R1(ACD) with key A and F1=$\{A \rightarrow C, C \rightarrow D\}$.
It is not in BCNF as $C \rightarrow D$ violates the property. It is in 2NF.
R2(ABE) with key A and F2=$\{A \rightarrow B, B \rightarrow E\}$.
It is not in BCNF as $B \rightarrow E$ violates the property. It is in 2NF.

Using BCNF Decomposition algorithm on R1 :
$C^+ = \{C,D\}$
R11(CD) with key C and F11=$\{C \rightarrow D\}$. It is in BCNF.
R12(AC) with key A and F12=$\{A \rightarrow C\}$. It is in BCNF.

Using BCNF Decomposition algorithm on R2 :
$B^+ = \{B,E\}$
R21(BE) with key B and F21=$\{B \rightarrow E\}$. It is in BCNF.
R22(AB) with key A and F22=$\{\phi\}$. It is in BCNF.

After decomposition, the relations are :
R11(CD) with key C and F11=$\{C \rightarrow D\}$.
R12(AC) with key A and F12=$\{A \rightarrow C\}$.
R21(BE) with key B and F21=$\{B \rightarrow E\}$.
R22(AB) with key A and F22=$\{\phi\}$.

6. R(ABCDE) $A \rightarrow BC, B \rightarrow DE, D \rightarrow A$

$A \rightarrow B$
$A \rightarrow C$
$B \rightarrow D$
$B \rightarrow E$
$D \rightarrow A$

$A^+ = \{A,B,C,D\}$
$B^+ = \{A,B,C,D\}$
$D^+ = \{A,B,C,D\}$
So, the key is A or B or D.

$\because$ All FDs have key on left side. It is BCNF.

2 Database of Indian Railways

1. R(TN, DAY, SRC_SCODE, DST_SCODE, SCODE, DATE, SAT, SDT, EAT)

   (a) Minimal FD set

   TN → SRCCODE
   TN → DSTCODE
   DATE → DAY
   {TN,SCODE} → SAT
   {TN,SCODE} → SDT
   {TN,DATE,SCODE} → EAT

   {TN,DATE,SCODE}$^+$ = {TN, DAY, SRC_SCODE, DST_SCODE, SCODE, DATE, SAT, SDT, EAT}
   So, the key is {TN, DATE, SCODE}.

   ∵ Not all FDs have keys on left side, thus it is not BCNF, 3NF. Except {TN,DATE,SCODE} → EAT, all other FDs also violates 2NF.
   ∴ It follows 1NF.

   (b) Decomposing into BCNF.

   Using BCNF Decomposition algorithm on R :
   TN$^+$ = {TN, SRC_SCODE, DST_SCODE}

   R1(TN, SRC_SCODE, DST_SCODE) with key TN and
   F1={TN → SRCCODE, TN → DSTCODE}. It is in BCNF.

   R2(TN, DAY, SCODE, DATE, SAT, SDT, EAT) with key {TN,DATE,SCODE}
   and F2={DATE → DAY, {TN,SCODE} → SAT, {TN,SCODE} → SDT,
   {TN,DATE,SCODE} → EAT}.
   It is not in BCNF as DATE → DAY violates the property. It is in 1NF.

   Using BCNF Decomposition algorithm on R2 :
   DATE$^+$ = {DATE, DAY}

   R21(DATE, DAY) with key DATE and F21={DATE → DAY}. It is in BCNF.

   R22(TN, SCODE, DATE, SAT, SDT, EAT) with key {TN,DATE,SCODE} and
   F22={{TN,SCODE} → SAT, {TN,SCODE} → SDT,
   {TN,DATE,SCODE} → EAT}.
   It is not in BCNF as {TN,SCODE} → SAT violates the property. It is in 1NF.

Using BCNF Decomposition algorithm on R22 :
$\{TN, SCODE\}^+ = \{TN, SCODE, SAT, SDT\}$

R221(TN, SCODE, SAT, SDT) with key {TN, SCODE} and F221={{TN,SCODE} $\rightarrow$ SAT, {TN,SCODE} $\rightarrow$ SDT}. It is in BCNF.

R222(TN, SCODE, DATE, EAT) with key {TN,DATE,SCODE} and F222={{TN,DATE,SCODE} $\rightarrow$ EAT}. It is in BCNF.

After decomposition, the relations are :

R1(TN, SRC_SCODE, DST_SCODE) with key TN and F1={TN $\rightarrow$ SRCCODE, TN $\rightarrow$ DSTCODE}.

R21(DATE, DAY) with key DATE and F21={DATE $\rightarrow$ DAY}.

R221(TN, SCODE, SAT, SDT) with key {TN, SCODE} and F221={{TN,SCODE} $\rightarrow$ SAT, {TN,SCODE} $\rightarrow$ SDT}.

R222(TN, SCODE, DATE, EAT) with key {TN,DATE,SCODE} and F222={{TN,DATE,SCODE} $\rightarrow$ EAT}.