Database Technology - Lab 3.

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1

given

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

$$F = \begin{Bmatrix} FD1: A \rightarrow BC \\ FD2: C \rightarrow AD \\ FD3: DE \rightarrow F \end{Bmatrix}$$

a) Find $C \rightarrow B$

FD2 : $C \rightarrow AD$

FD4 : $C \rightarrow A$ (Decomposition of FD2)

FD1 : $A \rightarrow BC$

FD5 : $A \rightarrow B$ (Decomposition of FD1)

FD6 : $C \rightarrow B$ (Transitivity of FD4 and FD5)

b) Find $AE \rightarrow F$

FD1 : $A \rightarrow BC$ (given)

FD4 $A \rightarrow C$ (Decomposition of FD1)

FD2 : $C \rightarrow DE$ (given)

FD5 : $A \rightarrow DE$ (Transitivity of FD4 and FD2)

FD6 : $AE \rightarrow DE$ (Augmentation of FD5 with E)

FD3 : $DE \rightarrow F$ (given)

FD7 : $AE \rightarrow F$ (Transitivity of FD6 and FD3)

2

given

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

$$F = \begin{Bmatrix} FD1: A \rightarrow BC \\ FD2: C \rightarrow AD \\ FD3: DE \rightarrow F \end{Bmatrix}$$

a) Find X^+ for $X = \{A\}$

1) Initialize X^+

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

2) check FD1

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

3) check FD2

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

4) check FD3

$\{DE\}$ not subset of X^+

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

5) Result

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

b) Find X^+ for $X = \{C,E\}$

1) Initialize X^+

$X^+ = X = \{C,E\}$

2) Check FD1

$\{A\}$ not subset of X^+

$X^+ = \{C,E\}$

3) Check FD2

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

4) Check FD3

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

5) Check FD1 again

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

6) Result

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

3) Consider the relation schema R(A, B, C, D, E, F) with the following FDs
FD1: AB → CDEF
FD2: E → F
FD3: D → B

a) Determine the candidate key(s) for R.

Since we know that...

- If an attribute is nowhere in the RHS, it must be part of every candidate key
- If an attribute is in the RHS of FDs but nowhere in the LHS, it cannot be part of any CK

→ A must be part of the candidate key
→ C, F can't be part of the candidate key

We will test the remaining possibilities

$\{A\}^+ = \{A\}$ → no superkey / candidate key
$\{A,B\}^+ = \{A,B,C,D,E,F\}$ → superkey and candidate key
$\{A,D\}^+ = \{A,D,B,C,E,F\}$ → superkey and candidate key
$\{A,E\}^+ = \{A,E,F\}$ → no superkey / candidate key
→ other longer possible subsets (e.g. $\{A,B,D\}$ are not tested anymore because they might be only superkeys and not candidate keys

Result
candidate keys: $\{A,B\}$, $\{A,D\}$

b) Note that R is not in BCNF. Which FD(s) violate the BCNF condition?

FD2 ($\{E\}$ is not a superkey)
FD3 ($\{D\}$ is not a superkey)

c) Decompose R into a set of BCNF relations, and describe the process step by step (don't forget to determine the FDs and the candidate key(s) for all of the relation schemas along the way).

By using FD2, we decompose R into

- R1 (E, F)
  with FD2 : $E \rightarrow F$
  and CK : E

  ✓ in BCNF

- R2 (A, B, C, D, E)
  with FD3 : $D \rightarrow B$ and FD4 : $AB \rightarrow CDE$ (Decomposition of FD1)
  and CK :
  - must contain A (only on LHS of FDs)
  - can't contain C, E (only on RHS of FDs)

  $\{A\}^+ = \{A\} \rightarrow$ no superkey
  $\{A,B\}^+ = \{A,B,C,D,E\} \rightarrow$ candidate key
  $\{A,D\}^+ = \{A,D,B,C,E\} \rightarrow$ candidate key

  $\Rightarrow$ CK : $\{A,B\}$, $\{A,D\}$

  Because of FD3 (D is not a super-key), R2 not in BCNF ↯

By using FD3, we decompose R2 into

- R2X (B, D)
  with FD3 : $D \rightarrow B$
  and CK : $\{D\}$

  ✓ in BCNF

- R2Y (A, C, D, E)
  with FD7 : $AD \rightarrow CE$
  [FD5 : $AD \rightarrow AB$ (by augmentation of FD3 with A)
  FD6 : $AD \rightarrow CDEF$ (by transitivity of FD1 and FD5)
  FD7 : $AD \rightarrow CE$ (by decomposing FD6)]
  and CK : $\{AD\}$

  ✓ in BCNF

4) Consider the relation schema R(A, B, C, D, E) with the following FDs

FD1: ABC → DE

FD2: BCD → AE

FD3: C → D

a) Show that R is not in BCNF.

1) Identifying candidate keys

- {C} has to be part of candidate key
- {E} can't be part of candidate key

We will test the remaining possibilities:

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

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

$\{C,B\}^+ = \{C,B,D,A,E\}$ → superkey and minimum size → candidate key

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

→ other longer possible subsets (e.g. {C,B,A}) are not tested anymore because they might be superkeys but not candidate keys

→ CK: {C,B}

Therefore, FD3 violates BCNF condition, because {C} is not a superkey.

b) Decompose R into a set of BCNF relations (describe the process step by step).

By using FD3, we decompose R into

- R1 (C,D)
  with FD3: C → D
  and CK: {C}

  ✓ in BCNF

- R2 (A,B,C,E)
  with FD4: ABC → E (by decomposition of FD1)
  FD6: BC → AE
  [FD5: BC → DBC (by augmentation of FD3 with BC)
  FD6: BC → AE (by transitivity of FD2 and FD5]
  and CK:
  - must contain BC
  - can't contain E

  $\{BC\}^+ = \{B,C,A,E\}$ → candidate key

  ⟹ CK: {B,C}

  ✓ in BCNF