Schema Refinement Examples

Dependency preserving or not

Consider the relation R(A, B, C, D) and
FD ={AB –> C, C –> D, D –> A}.
R is decomposed into

- R_1(A, B, C)
- R_2(C, D).

Let us find closure of F_1 and F_2 (Solution)

- F_1 {C--> A, AB --> C, BC --> A} from given FD's in R
- F_2 { C--> D }

Original FD's of 'R' are { AB --> C , C --> D , D --> A}.

- AB --> C is present in F_1;
- C --> D is present in F_2.
- D --> A is not preserved.

F_1 U F_2 is a subset of F.
So given decomposition is not dependency preserving.

Lossless-join

Suppose that we decompose the schema
R=(A,B,C,D,E) into (A,B,C) (A,D,E).
Show that this decomposition is a lossless-join decomposition if the following set F of functional dependencies holds: $A \rightarrow BC$, $CD \rightarrow E$, $B \rightarrow D$, $E \rightarrow A$

Answer:

A decomposition R into $\{R_1, R_2\}$ is a lossless-join decomposition if $R_1 \cap R_2 \rightarrow R_1$ or $R_1 \cap R_2 \rightarrow R_2$.

Let $R_1=(A,B,C)$, $R_2=(A,D,E)$, and $R_1 \cap R_2 = A$.

Since A is a candidate key, Therefore $R_1 \cap R_2 \rightarrow R_1$.

Find the key

Let R= (A, B, C, D, E, F) be a relation scheme with

the following dependencies: C->F, E->A, EC->D, A->B.

Find the closure set of all the options give. If any closure covers all the attributes of the relation R then that is the key.

Find closure set for EC.

= ECF {C->F}

= ECFA {E->A}

= ECFAD {EC->D}

= ECFADB {A->B}

Closure set of EC covers all the attributes in R.

How many candidate keys

Relation R has 8 fields ABCDEFGH.

F={CH→G, A→BC, B→CFH, E→A, F→EG} is a set of FDs.

Check the Following :

A^+:ABCFHGE B^+: BCFHEGA C^+:C D^+:D

E^+: EABCFHG F^+:FEGABCH G^+:G H^+ : H

A^+,B^+,E^+,F^+ contains all attributes except D.

4 candidate keys DA,DB,DE and DF

Normal Form

A table has fields F1, F2, F3, F4, and F5, with the FDs

F1->F3; F2->F4;(F1,F2)->F5

Above table is in which Normal Form?

Since the primary key is not given we have to derive the primary key of the table.

Using the closure set of attributes we get the primary key as (F1,F2). From functional dependencies, "F1->F3, F2->F4", we can see that there is partial functional dependency therefore it is not in 2NF. Hence the table is in 1NF.

Normal Form

Consider R1 = {A, B, C, D}

We calculated FD = {{A, B}→ {C}, {A}→ {D}}

key for R1: K1 = {A, B}

This relation R1 is not 2NF because there is a partial dependency {A} → {D}.

Exercise-1

Given a relation R with four attributes ABCD

For each of the following sets of FDs, assuming those are the only dependencies that hold for R, do the following:

(a) Identify the candidate key(s) for R

(b) Identify the best normal form that R satisfies

(c) If R is not in BCNF, decompose it into a set of BCNF relations that preserve the dependencies.

Exercise-2

C→D, C→A, B→C

(a) Candidate keys: B

(b) R is in 2NF but not 3NF.

(c) C → D and C→A violations of BCNF

One way to obtain a (lossless) join preserving decomposition is to decompose R into

AC,BC, and CD

Exercise-3

FD's : B→C, D→A

(a) Candidate keys: BD

(b) R is in 1NF but not 2NF.

(c) Both B→C and D→A BCNF violations.

The decomposition: AD,BC, BD(obtained by first decomposing to AD,BCD) is BCNF and lossless and join-preserving

Exercise-4

FD's : ABC→D, D→A

(a) Candidate keys: ABC,BCD

(b) R is in 3NF but not BCNF.

(c) ABCD is not in BCNF since D→A and D is not a key. However if we split up R as AD,BCD we cannot preserve the dependency ABC→D. So there is no BCNF decomposition

Exercise-5

FD's : A→B, BC→D, A→C

(a) Candidate keys: A

(b) R is in 2NF but not 3NF (BC→D).

(c) BC→D violates BCNF since BC does not contain a key. So we split up R as in: BCD, ABC

Exercise-6

FD's : AB→C, AB→D, C→A, D→B

(a) Candidate keys: AB,BC,CD,AD

(b) R is in 3NF but not BCNF (C→A).

(c) C→A and D→B both cause violations. So decompose into: AC,BCD but this does not preserve AB→C and AB→D, and BCD is still not BCNF because D→B. So therefore, there is no BCNF decomposition.

Exercise-7

REFRIG(Model#, Year, Price, Manuf_plant, Color)

which is abbreviated REFRIG(M, Y, P, MP, C)

Set of functional dependencies

FD's :M→ MP, {M, Y}→ P, MP→ C

a. Evaluate the candidate keys:

Consider {M}; isn't a key because M can't determine P.

Consider {M, Y} ; {M, Y} determines all the attributes of REFRIG. Thus, {M, Y} is a key.

Consider {M, C} ; is not a key because M and C cannot determine Y and P.

Exercise-7…..

b. State whether REFRIG is in 3NF and in BCNF

REFRIG is not 2NF because there is M → MP in which M is a part of the key {M, Y}. Thus, REFRIG is not 3NF either. REFRIG is not BCNF either because in the functional dependency M→ MP, M is not the superkey.

Exercise-7……

c. Check the lossless property

Given the decomposition of REFRIG into D:

R_1 (M, Y, P)

R_2 (M, MP, C)

Using the test for Binary Decomposition, we calculate:

$(R_1 \cap R_2) = \{M\}$;$(R_1 - R_2) = \{Y, P\}$;$(R_2 - R_1) = \{MP, C\}$

Then, we have: $\{M\} \rightarrow \{MP\}$ (given) $\{M\} \rightarrow \{C\}$

$\{M\} \rightarrow \{MP\}$ and $\{MP\} \rightarrow \{C\}$) $\{M\} \rightarrow \{MP, C\}$ So,

$(R_1 \cap R_2) \rightarrow (R_2 - R_1)$ or the decomposition D is lossless.