# (1) F = {A -> B, BC->DE, AD->G} implies AC -> G

Solution:

1. A -> B (Given)
2. AC -> BC (Augmentation on [1] with C)
3. BC -> DE (Given)
4. BC -> D (Decomposition of [3])
5. AC -> D (Transitivity on [2] and [4])
6. AD -> G (Given)
7. AAC -> G (Pseudo-transitivity on [5] and [6])
8. AC -> G (Simplification of [7])

(2) A+=ACB, B+=B, C+=C, D+=DE, E+=E

Solution:

(b) C.K. = AD

(c) Prime: AD

Non-prime: BCE

(d) Canonical cover of F: {A->BC, CD->B, D->E}

(e) 1NF since D->E violates 2NF as E is non-prime attribute.

(f) Yes, the decompositions that satisfy the requirements are:

1. R1 (A,B,C) {A->BC}
2. R2 (B,C,D) {CD->B}
3. R3 (D, E) {D->E}

R4 (A,D) {}

3) Consider R(A,B,C,D,E,F) with

Solution:

F= {A->D, CE->BF, AF->D, BD->C}

a) A+=AD, B+=B, C+= C, D+=D, E+=E

b) ABE+= {ABEDCF} and AEC +={ACEBFD} so ABE and AEC are the candidate keys

c) A,E are prime Attributes and BCDF are non prime attributes

d) {A->D, CE->B, CE->F, BD->C}

e) 1NF since A->D violates 2NF: D is non-prime and A is a proper subset of a CK.

f)  Yes, the decomposition:

1. R1(A,D) {A->D}
2. R2(B,C,E) {CE->B}
3. R3(C,E,F) {CE->F}
4. R4(B,D,C) {BD->C}
5. R5(A,B,E) {}
6. R5(A,C,E) {}

4) It is known that a relation R with arity 3 is in 3NF and has no composite candidate key. Prove that it is also in BCNF.

Solution:

\*) suppose {A,B,C}

\*) as there is no composite keys than A or B or C can be the candidates keys

\*)there functional dependencies are: A-> BC, B->AC, C ->AB

5) Consider that R(A,B,C,D) with a canonical cover of {A->B, X->A} where X is a subset of {C,D}. List all candiate keys. Analyze the highest normal form for various possibility of X (i.e., C, D or CD).

Solution:

There are two possibilities R(A,B,C,D) with fd’s {A->B,CD->A} and R(A,B,C,D) with fd’s {A->B, C-> A,D->A} The candidate key here is CD ( CD+ =C,D,A,B)

The highest normal form is achieved by the first possibility is 2nf. It violates 3nf because of the transitive dependency A->B.

The highest normal form achieved by the second possibility is 1nf as it violates 2nf. C->A where A is non prime attribute and C is subset of the primary key.

(6) Consider R(A,B,C,D,E) with {BC->A, D->AE, B->C}

It is decomposed into R1(C,D), R2(B,D) and R3(A,D,E).

Is the decomposition lossy? You must use the chase matrix algorithm (EN Algorithm 16.3) to show your reasoning.

Given that R(A,B,C,D,E) with F = {BC->A, D->AE, B->C}

It is decomposed into R1(C,D), R2(B,D) and R3(A,D,E).

A canonical form of F is G = {B->A, D->AE, B->C}

The decompoistion of R into R'(A,B,D,E) and R3(B,C) is lossless since the common attribute is B and B->C in R3. The decompoistion of R' into R1(B,D,E) and R2(A,B) is lossless since the common attribute is B and B->DE in R1. Thuis, the overall decomposition is lossless.

Using the chase matrix algorithm:

We use the canonical form: {B->A, D->AE, B->C}

Step 1. Create a table of 5 columns (number of columns and 3 rows (number of relations). Populate it with b(i,j).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Relation** | **A** | **B** | **C** | **D** | **E** |
| R1 | b(1,1) | b(1,2) | b(1,3) | b(1,4) | b(1,5) |
| R2 | b(2,1) | b(2,2) | b(2,3) | b(2,4) | b(2,5) |
| R3 | b(3,1) | b(3,2) | b(3,3) | b(3,4) | b(3,5) |

Step 2. For each relation Ri, set all attribute Aj that appears in Ri from b(i,j) to a(j). R1(C,D), R2(B,D) and R3(A,D,E).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Relation** | **A** | **B** | **C** | **D** | **E** |
| R1 | b(1,1) | b(1,2) | a3 | a4 | b(1,5) |
| R2 | b(2,1) | a2 | b(2,3) | a4 | b(2,5) |
| R3 | a1 | b(3,2) | b(3,3) | a4 | a5 |

Step 3. While changes can be made with a FD X-> Y, with two rows in the table having the common X values in the following manner:

for every attribute W in Y:

* If one cell is an a and the other cell is an b, change the b to the a.
* If both cells are b's, change them to the same b.

Applying B->A-no changes

Applying D->AE

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Relation** | **A** | **B** | **C** | **D** | **E** |
| R1 | a1 | b(1,2) | a3 | a4 | a5 |
| R2 | a1 | a2 | b(2,3) | a4 | a5 |
| R3 | a1 | b(3,2) | b(3,3) | a4 | a5 |

Applying B->C:no change

agian Applying B->A-no changes

since there is no row with only a's and the decomposition is lossy.