Task 1

Consider the relation schema R(A, B, C, D, E, F) and the following three FDs:

FD1: {A} → {B,C}   FD2: {C} → {A,D}   FD3: {D,E} → {F}

Use the Armstrong rules to derive each of the following two FDs. In both cases, describe the derivation process step by step (i.e., which rule did you apply to which FDs).

a) {C} → {B}   b) {A,E} → {F}

Answer

a) FD1: {A} -> {C}, FD2: {C} -> {A} according to the reflexivity rule, and because {A} also -> {B} (reflexivity) then {C} -> {B} according to the rule of transitivity.

b) Because {C} -> {A, D}, and from a) we know {A} -> {C}, then A must also imply {A} -> {D} according to transitivity, resulting in {A, E} . {A, E} then -> {D,E} according to the augmentation rule, finally giving us: {A, E} -> {F}.

Task 2

For the aforementioned relation schema with its functional dependencies, compute the attribute closure X^+ for each of the following two sets of attributes.

a) X = { A }   b) X = { C, E }

Answer

a) A gets {B,C} from FD1, and D from {A} -> {C} and {C} -> {D} (transitivity). Of course A also implies A, finally resulting in {A, B, C, D}. Since A cant determine E in any way neither E or F is part of A’s attribute closure. X+ = {A,B,C,D}

b) C implies everything A implies ({C} -> {A}), so {A,B,C,D}, {D,E} -> {F} so since {C} -> {D}, then {C,E} -> {F} and therefore X+ = {A,B,C,D,E,F}.

Task 3

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

FD1: {A,B} → {C,D,E,F}

FD2: {E} → {F}

FD3: {D} → {B}

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

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

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).

Answer

a) {A,B} -> {C,D,E,F}, we also know that {D} -> {B} so therefore {A,D} -> {C,D,E,F}. Both {A,B} and {A,D} are candidate keys.

b) FD2 and FD3 violate the BCNF condition since they are not superkeys.

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

1. R1(E,F) - Create a new table consisting of X and Y for FD2 that violates BCNF.
   - FD1: {E} -> {F}
   - E is the candidate key

2. R2(A,B,C,D,E) - Remove all attributes that were in Y for FD2 from R.
   - FD1: {A,B} -> {C,D,F}
   - {A,B} is the candidate key

3. R3(D,B) - Create a new table consisting of X and Y for FD3 that violates BCNF.
   - FD1: {D} -> {B}
   - D is the candidate key

4. R4(A,C,D,E) - Remove all attributes that were in Y for FD2 from R2.
   - FD1: {A, D} -> {C, E}
   - AD is the candidate key

Final BCNF relations are: R4(A,C,D,E) - R3(D, B) - R1(E,F).

Task 4

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

FD1: {A,B,C} → {D,E}

FD2: {B,C,D} → {A,E}

FD3: {C} → {D}

a) Show that R is not in BCNF.

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

Answer

a) FD3 is not a superkey, violating the BCNF condition.
b) 1. R1(C,D) - Create a new table consisting of X and Y for FD3 that violates BCNF.
   - FD1: {C} -> {D}
   - C is the candidate key

   2. R2(A,B,C,E) - Remove all attributes that were in Y for FD3 from R.
   - FD1: {A,B,C} -> {E}
   - {A,B,C} is the candidate key