andpl509 & danhu849

TASK 1

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

a)
FD4 = Decomposition of FD2: {C} → {A}
FD5 = Decomposition of FD1: {A} → {B}
FD6 = Pseudo-transitivity on FD3 and FD4: {C} → {B}

b)
FD7 = Decomposition of FD1: {A} → {C}
FD8 = Transitivity of FD7 and FD2: {A} →{A,D}
FD9 = Decomposition of FD8: {A}→{D}
FD10 = Pseudo-transitivity of FD9 and FD3: {A,E} → {F}

TASK 2

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

a) X = { A }
FD1: {A} → {B,C}
X+ = { A, B, C}

FD2: {C} → {A,D}
X+ = {A, B, C, D}

FD3: {D,E} → {F}
X+ = {A, B, C, D}

b) X = { C, E }
FD2: {C} → {A,D}

X+ = {C, E, A, D}

FD1: {A} → {B,C}
X+ = {C, E, A, D, B}

FD3: {D,E} → {F}
X+ = {C, E, A, D, B, 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.

Defined shortcuts:
1 - If an attribute is nowhere in the right hand side it must be part of every candidate keys.
2 - If an attribute is in the right hand side of FDs but nowhere in the left hand side it cannot be in any candidate keys.

AB ~~AC~~ AD AE ~~AF~~

A ~~B~~ ~~C~~ ~~D~~ ~~E~~ ~~F~~ (shortcut 1)

AC and AF can be removed because they break shortcut 2.

Running closure algorithm on AB, AD, AE to determine if they are superkeys of the relation by computing their closure.

{A,B}+ = {A, B}
FD1 => {A,B}+ = {A,B,C,D,E,F}
{A,B} is a candidate key because it is a superkey and it has the minimal quality.

{A,D}+ = {A,D}

FD3 => {A,D}+ = {A,D,B}
FD1 => {A,D}+ = {A,D,B,C,E,F}
{A,D} is a candidate key because it is a superkey and it has the minimal quality.

{A,E}+ = {A,E}
FD2 => {A,E}+ = {A,E,F}
{A,E} is not a candidate key because it is not a superkey.

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

FD2 and FD3 violated the BCNF condition because their closure is not a super key.
{E}+ = {E,F}
{D}+ = {D, B}

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).

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

1. We look first at FD1 because it is one of the two FDs that violates the BCNF.
2. We will now create two new relations from R, namely R1 and R2
3. In R1 we will put all the all the attrs that are in the violating FD namely, E and F.
4. In R2 we will put all the original attributes of the relation minus the violating ones of the right side of the relation, namely, F.
5. The resulting two relation will be:
    a. R1(E,F)
        i. Which has only one FD, FD2: {E} → {F}, with E as a candidate key.

b. R2(A,B,C,D,E)
   i. FD4: {A,B} → {C,D,E}, {A, B}, {A, D} candidate keys
      1. {A, D} candidate key because pseudo-transitivity between {A,B} → {C,D,E} and {D} ->{B} makes FD5 {A,D} → {C,D,E} and since {D} ->{B} It's logically implied FD6 {A,D} → {C,B,E}.

   ii. FD3: {D} → {B}, {D} candidate key
6. R2 is still in violation of the BCNF because of FD3, we will now do the same thing as above resulting in two more relations:
   a. R2A(D,B)
      i. FD3: {D} → {B} with D as a candidate key.
   b. R2B(A,C,D,E)
      i. FD5: {A,D} → {C,D,E}, {A,D} candidate key
7. The the result will be three relations that don't violate the BCNF:
   a. R1(E,F)
   b. R2A(D,B)
   c. R2B(A,C,D,E)

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.

{A,B,C}+ ={A,B,C,D,E}, super key all attributes are in the closure
{B,C,D}+ = {B,C,D,A,E}, super key
{C}+ = {D, C}, not super key, because closure does not contain all of the attributes of the relation.

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

1. We will start by looking at FD3 because that is the FD that violates the BCNF.

2. We will now create two new relations from R, namely R1 and R2.
3. In R1 we will put all the all the attrs that are in the violating FD namely, C, D.
4. In R2 we will put all the original attributes of the relation minus the violating ones of the right side of the relation, namely, D.
5. Resulting in:
    a. R1(C, D), FD3{C} → {D}, C candidate key
    b. R2(A, B, C, E)
        i. FD4: {A,B,C} → {E}
        ii. FD5: {B,C} → {A,E}, {B, C} candidate key
6. Because the new FDs are all superkeys, the new relations are in BCNF