1: Constraint Inference

Consider a relation R(A,B,C,D,E) with FD's, S=AB $\rightarrow$ C, CD $\rightarrow$ E, C $\rightarrow$A, C $\rightarrow$ D, D $\rightarrow$ B:

Determine all the keys of relation R. Do not list super keys that are not a minimal key.

(solution)
Keys: AB, AD, C
To get the key AB, we can do the following:
From AB $\rightarrow$ C and C $\rightarrow$D, we obtain AB $\rightarrow$D.
From AB $\rightarrow$ C and AB $\rightarrow$ D, we obtain AB $\rightarrow$ CD.
From AB $\rightarrow$ CD and CD $\rightarrow$ E, we obtain AB $\rightarrow$ E.
To get the key AD, we can do the following:
From D $\rightarrow$ B, we can get AD $\rightarrow$ AB.
From AB, we can obtain the rest of the attributes.
To get the key C, we can do the following:
From C $\rightarrow$ A and C $\rightarrow$ B, we obtained C $\rightarrow$ AB.
From AB, we can obtain the rest of the attributes.

2: Constraint Inference

Consider a relation R(A, B, C, D, E, F) with the following set of FDs :
S: {A$\rightarrow$BC, CD$\rightarrow$E, B $\rightarrow$D, E$\rightarrow$A, CF$\rightarrow$B}

(a) Give an example of FD that follows from S and explain your answer.

(Solution)
AB $\rightarrow$ D, D is in the closure of AB. Because A$\rightarrow$ B and B$\rightarrow$ D, thus AB $\rightarrow$ D is a valid FD that follows S.

(b) Give an example of FD that does not follow from S and explain your answer.

(Solution)
B $\rightarrow$ C, C is not in the closure of B. B doesnt uniquely identify C accordance to S. So, B$\rightarrow$C is not valid according to S.

3: Schema Decomposition

Consider relation R (A, B, C) with a set of FDs F={AB$\rightarrow$C, C$\rightarrow$A}. Determine whether R is in BCNF.

(solution)
The keys are AB and BC. R is not in BCNF since left hand side of C$\rightarrow$A is not a super key.

4: Schema Decomposition

Consider the relation schema R(A, B, C, D, E) with FDs, A $\rightarrow$BCDE, C $\rightarrow$D, and CE $\rightarrow$ B . Decompose the relation till it follows BCNF.

(solution)
R is not in BCNF because CE $\rightarrow$B and CE is not a super key.
Decompose R: R1= {CEB}, R2={ACDE}
R1 is in BCNF
R2 is not in BCNF, because C $\rightarrow$ D and C is not a super key
Decompose R2: R21= {C,D} , R22={A,C,E}
R1,R21,R22 are in BCNF.

5: Schema Decomposition

Consider a relation R=(A,B,C,D,E) with the following functional dependencies, S= BC $\rightarrow$ ADE, D $\rightarrow$ B.

(a) Find all candidate keys.

(solution)
The keys are {B,C} and {C,D}.
{B,C} is a key from BC $\rightarrow$ ADE.
To get the key {C,D}:
from D$\rightarrow$ B we get B, with B and C we have BC $\rightarrow$ ADE

(b) Identify whether or not R is in BCNF.

(solution)
The relation is not BCNF because D is not a super key which violates BCNF.

6: Schema Decomposition

Consider a relation R = (A,B,C,D,E) with the following functional dependencies:
S= {CE $\rightarrow$ D,D $\rightarrow$ B,C $\rightarrow$ A}.

(a) Find all candidate keys.

(solution)
The only key is {C,E}
To get the key CE, we can do the following: From CE $\rightarrow$ D and D $\rightarrow$B, we obtain CE $\rightarrow$B. From CE $\rightarrow$ D and C $\rightarrow$ A, we obtain CE $\rightarrow$ AD.

(b) If the relation is not in BCNF, decompose it until it becomes BCNF.

(solution)
Relation R is not in BCNF.
Step 1: Decomposes R into R1=(A,C) and R2=(B,C,D,E).
Resulting R1 is in BCNF. R2 is not.
Step 2: Decompose R2 into, R21=(C,D,E) and R22=(B,D).
Both relations are in BCNF.