CS1555 Recitation 10 Solution

Objective: to practice normalization, finding canonical forms, checking for lossless decompositions.

Part 1: For each of the following relations R and sets of functional dependencies F, find the canonical cover (minimal cover) of F.

1. Consider the following set of functional dependencies F on a relation R (A, B, C, D, E):

$A \rightarrow BC$
$A \rightarrow D$
$B \rightarrow C$
$C \rightarrow D$
$DE \rightarrow C$
$BC \rightarrow D$

Finding the canonical form:

- Transform all FDs to canonical form (i.e., one attributes on the right):

  $A \rightarrow B$
  $A \rightarrow C$
  $A \rightarrow D$
  $B \rightarrow C$
  $C \rightarrow D$
  $DE \rightarrow C$
  $BC \rightarrow D$

- Drop extraneous attributes:
  B in $BC \rightarrow D$ is extraneous, since we already have $C \rightarrow D$. The set of FDs becomes:

  $A \rightarrow B$
  $A \rightarrow C$
  $A \rightarrow D$
  $B \rightarrow C$
  $C \rightarrow D$
  $DE \rightarrow C$

- Drop redundant FDs:
  $A \rightarrow B$ and $B \rightarrow C$ implies $A \rightarrow C$, so we drop $A \rightarrow C$.
  $A \rightarrow B$, $B \rightarrow C$ and $C \rightarrow D$ implies $A \rightarrow D$, so we drop $A \rightarrow D$.
  The set of FDs becomes:

  $A \rightarrow B$
  $B \rightarrow C$
  $C \rightarrow D$
  $DE \rightarrow C$

  which is the canonical cover of F.

2. Consider the following set of functional dependencies F on relation R (A, B, C, D, E, H):

$A \rightarrow C$
$AC \rightarrow D$
$E \rightarrow AD$
$E \rightarrow H$
$A \rightarrow CD$
$E \rightarrow AH$

<u>Finding the canonical form:</u>

- Transform all FDs to canonical form (i.e., one attribute on the right):

  $A \rightarrow C$
  $AC \rightarrow D$
  $E \rightarrow AD$ becomes $E \rightarrow A$ and $E \rightarrow D$
  $E \rightarrow H$
  $A \rightarrow CD$ becomes $A \rightarrow C$ and $A \rightarrow D$
  $E \rightarrow AH$ becomes $E \rightarrow A$ and $E \rightarrow H$
- Remove redundant dependencies:

  $A \rightarrow C$
  $AC \rightarrow D$
  $E \rightarrow A$
  $E \rightarrow D$
  $E \rightarrow H$
  $A \rightarrow D$

- Drop extraneous attributes:
  AC→D can be removed because we have A→D so C is redundant:

  $A \rightarrow C$
  $E \rightarrow A$
  $E \rightarrow D$
  $E \rightarrow H$
  $A \rightarrow D$

- Drop redundant FDs:
  Try removing some dependencies in F and still have a set of dependencies equivalent to F.
  E→D can be deduced from E→A and A→D so we can remove E→D.
  The set of FDs becomes:

  $A \rightarrow C$
  $E \rightarrow A$
  $E \rightarrow H$
  $A \rightarrow D$

  which is the canonical cover of F.

Part 2: Assume that R is decomposed into:

R1 (A, B), F1 = {A → B}
R2 (B, C), F2 = {B → C}
R3 (C, D, E), F3 = {C → D, DE → C}
Is this decomposition a lossless-join decomposition? Use the table method.

Checking for lossless-join:

Initially the Table looks like this:

	A	B	C	D	E
R1(A,B)	a1	a2	U13	U14	U15
R2(B,C)	U21	a2	a3	U24	U25
R3(C,D,E)	U31	U32	a3	a4	a5

Using B → C: we can replace U13 by a3

	A	B	C	D	E
R1(A,B)	a1	a2	**a3**	U14	U15
R2(B,C)	U21	a2	a3	U24	U25
R3(C,D,E)	U31	U32	a3	a4	a5

Using C → D: we can replace U14 and U24 by a4

	A	B	C	D	E
R1(A,B)	a1	a2	**a3**	**a4**	U15
R2(B,C)	U21	a2	a3	**a4**	U25
R3(C,D,E)	U31	U32	a3	a4	a5

We cannot proceed and there is no row of all known values → the decomposition is lossy.