

IS 503

Assignment #3

Deadline: December 22, 2019 23:59

The red ones indicate the redundant rules, whereas the green ones show the minimal cover.

1. Consider the following relation and the set of functional dependencies (FDs):

$R = (A\ B\ C\ D\ E\ F\ G)$

$D \rightarrow G$

$D \rightarrow C$

$C \rightarrow G$

$AF \rightarrow B$

$AD \rightarrow AGC$

$ACD \rightarrow FB$

$AC \rightarrow F$

$DF \rightarrow BE$

a) Find the minimal cover of FD set (10 pts). Justify your solution.

$D \rightarrow G$ ($D \rightarrow C, C \rightarrow G$)

$D \rightarrow C$

$C \rightarrow G$

$AF \rightarrow B$

$AD \rightarrow A$ (Reflexivity)

$AD \rightarrow G$ ($D \rightarrow C, C \rightarrow G$)

$AD \rightarrow C$ ($D \rightarrow C$)

$ACD \rightarrow F$ ($AC \rightarrow F$)

$ACD \rightarrow B$ ($AC \rightarrow F, AF \rightarrow B$)

$AC \rightarrow F$

$DF \rightarrow B$

$DF \rightarrow E$

b. Find the candidate key(s) of R (5 pts).

AD

2. Consider the following relation and the set of functional dependencies (FDs):

$R = (A\ B\ C\ D\ E\ F\ G\ H\ I\ J\ K)$

$C \rightarrow G$

$AEF \rightarrow BJ$

$DE \rightarrow GJ$

$J \rightarrow AC$

$F \rightarrow DGI$

$AF \rightarrow B$

$DJ \rightarrow G$

$H \rightarrow ABF$

$B \rightarrow GH$

$AC \rightarrow D$

a) Find the minimal cover of FD set (15 pts). Justify your solution.

$C \rightarrow G$
 $AEF \rightarrow B$ ($AF \rightarrow B$)
 $AEF \rightarrow J$ ($F \rightarrow D, DE \rightarrow J$)
 $DE \rightarrow G$ ($DE \rightarrow J, J \rightarrow C, C \rightarrow G$)
 $DE \rightarrow J$
 $J \rightarrow A$
 $J \rightarrow C$
 $F \rightarrow D$
 $F \rightarrow G$
 $F \rightarrow I$
 $AF \rightarrow B$
 $DJ \rightarrow G$ ($J \rightarrow C, C \rightarrow G$)
 $H \rightarrow A$
 $H \rightarrow B$ ($H \rightarrow A, H \rightarrow F, AF \rightarrow B$)
 $H \rightarrow F$
 $B \rightarrow G$ ($B \rightarrow H, H \rightarrow F, F \rightarrow G$)
 $B \rightarrow H$
 $AC \rightarrow D$

b) Find the candidate key(s) of R (15 pts).

EFK, EHK, BEK

c) Identify the best normal form that R satisfies (5 pts). Justify your answer.

Every attribute can be identified by the key. So, it is in 1NF. There are attributes that do not depend on the whole key, so it is not 2NF. Therefore, it is not 3NF and not BCNF as well.

d) If R is not in BCNF, decompose it into a set of relations that satisfy BCNF (10 pts).

\underline{BH}
 \underline{CG}
 \underline{DEI}
 \underline{ACD}
 \underline{ACI}
 \underline{AFH}
 \underline{AEB}
 \underline{DEJ}
 \underline{K}

3. Consider the following relation and the set of functional dependencies (FDs):

$R = (A \ B \ C \ D \ E \ F \ G \ H \ I \ J)$

$A \rightarrow C$
 $BC \rightarrow D$
 $EFG \rightarrow HIJ$
 $ADE \rightarrow BG$
 $AF \rightarrow EG$

$DJ \rightarrow F$
 $B \rightarrow E$
 $CF \rightarrow BHI$

a) Find the minimal cover of FD set (10 pts).

$A \rightarrow C$
 $BC \rightarrow D$
 $EFG \rightarrow H$
 $EFG \rightarrow I$
 $EFG \rightarrow J$
 $AF \rightarrow E$ ($A \rightarrow C, CF \rightarrow B, B \rightarrow E$)
 $AF \rightarrow G$ ($A \rightarrow C, CF \rightarrow B, BC \rightarrow D, B \rightarrow E, AED \rightarrow G$)
 $ADE \rightarrow B$
 $ADE \rightarrow G$
 $DJ \rightarrow F$
 $B \rightarrow E$
 $CF \rightarrow B$
 $CF \rightarrow H$
 $CF \rightarrow I$

b) For each of the following decompositions, comment on whether they are dependency-preserving and they give a lossless join. Explain your approach (10*3 pts):

i. $R_1(ACFH), R_2(ABCDE), R_3(BDEFGIJ), R_4(ABCFGI)$

$A \rightarrow C$
 $CF \rightarrow H$
 $BC \rightarrow D$
 $B \rightarrow E$
 $ADE \rightarrow B$
 $EFG \rightarrow I$
 $EFG \rightarrow J$
 $DJ \rightarrow F$
 $CF \rightarrow B$
 $CF \rightarrow I$

It is not dependency-preserving, because $EFG \rightarrow H$ and $ADE \rightarrow G$ are missing.

It gives a lossless join since we can complete a row.

	A	B	C	D	E	F	G	H	I	J
R1	a1		a3			a6		a8		
R2	a1	a2	a3	a4	a5					
R3		a2		a4	a	a6	a7		a9	a10

R4	a1	a2	a3	a	a	a6	a7	a	a9	a
----	----	----	----	----------	----------	----	----	----------	----	----------

ii. R1(CEFGH), R2(CDEFGIJ), R3(ABCF), R4(ABCDEG)

Dependency-preserving, and it produces a lossless join since we can obtain a full row.

	A	B	C	D	E	F	G	H	I	J
R1			a3		a5	a6	a7	a8	a	a
R2			a3	a4	a5	a6	a7	a	a9	a10
R3	a1	a2	a3	a	a	a6	a	a	a	a
R4	a1	a2	a3	a4	a5		a7			

iii. R1(ACDEFG), R2(ABCD FGI), R(ADJFHI)

$A \rightarrow C$
 $ADE \rightarrow G$
 $BC \rightarrow D$
 $CF \rightarrow B$
 $CF \rightarrow I$
 $DJ \rightarrow F$

It is not dependency-preserving, because $EFG \rightarrow H$, $EFG \rightarrow I$, $EFG \rightarrow J$, $ADE \rightarrow B$, $B \rightarrow E$, and $CF \rightarrow H$ are not preserved.

It does not give a lossless join since we cannot complete a row.

	A	B	C	D	E	F	G	H	I	J
R1	a1	a	a3	a4	a5	a6	a7		a	
R2	a1	a2	a3	a4		a6	a7		a9	
R3	a1	a	a	a4		a6		a8	a9	a10