CSC343 Assignment 3

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1

R_1 = DEFGHIJK, $S_1 = \{D \to FG, E \to HK, F \to EIJ, F \to K\}$

1. $D^+ = DEFGHIJK$
   $E^+ = EHK$
   $F^+ = EFHIJK$
   Since E and F are not superkeys of the relation, we know that each of them violates BCNF:
   $E \to H, K$
   $F \to E, I, J, K$

2. First, we can create the relation $R_1 = EHK$ with the functional dependency $E \to HK$. This relation is now in BCNF.

   However, the original relation $R_2 = DEFGIJ$ is still not in BCNF because $F^+ = EFIJ$. Therefore, we need to further decompose R.

   We can create two new relations: $R_3 = EFIJ$ and $R_4 = DFG$. R_3 and R_4 is now in BCNF.

   The result is $\{R_1 = EHK, R_3 = EFIJ, R_4 = DFG\}$
   The relations is $\{DFG, EFIJ, EHK\}$

3. The BCNF decomposition does not guarantee dependencies but dependencies are preserved this time.
   Because the removed relation $F \to K$ can be derived by $F \to E$ and $E \to H$.

4. **1.1**

D	**E**	**F**	**G**	**H**	**I**	**J**	**K**
d	e	f	g	h	i	j	k
	e			h			k
	w	f		h	i	j	k
	e	f			i	j	k

A whole row is filled, so lossless.

2

$R_2 = JKLMNOPQ$
$S_2 = \{JLM \rightarrow N, K \rightarrow LM, KN \rightarrow JLO, M \rightarrow JKO, N \rightarrow JL\}$

1. Step 1. Split RHS

   - JLM→N
   - K→L
   - K→M
   - KN→J
   - KN→L
   - KN→O
   - M→J
   - M→K
   - M→O
   - N→J
   - N→L

   JLM→N can't be saved as $J = J$, $L = L$, $M = M$, $JL = JL$, $JM = JM$, and $LM = LM$.

   K→L, K→M, M→J, M→K, M→O, and N→J, N→L can't be saved as they are singleton.

   For KN→J, KN→L, and KN→O, $K^* = JKLMNO$ covers all of them, so they can be saved as K→J, K→L, and K→O.

   So we are left with

   - JLM→N
   - K→L
   - K→M
   - K→J
   - K→O

- M→J
- M→K
- M→O
- N→J
- N→L

(a)

	FD		**J**	**K**	**L**	**M**	**N**	**O**	**P**	**Q**	
a	JLM → N	$S_{2-\{a\}}$	J	K	L	M		O			need
b	K → L	$S_{2-\{b\}}$	J	K		M		O			need
c	K → M	$S_{2-\{c\}}$	J	K	L			O			need
d	K → J	$S_{2-\{d\}}$	J	K	L	M	N	O			no need
e	K → O	$S_{2-\{d,e\}}$	J	K	L	M	N	O			no need
f	M → J	$S_{2-\{d,e,f\}}$		K	L	M		O			need
g	M → K	$S_{2-\{d,e,g\}}$	J			M		O			need
h	M → O	$S_{2-\{d,e,h\}}$	J	K	L	M	N				need
i	N → J	$S_{2-\{d,e,i\}}$			L		N				need
j	N → L	$S_{2-\{d,e,j\}}$	J				N				need

$$\{JLM \to N, K \to LM, M \to JKO, N \to JL\}$$

2. Attributes on the left but not right: none
Attributes on the right but not left: O, it's in no key
Attributes on both left and right: JKLMN, need to check
Attributes on neither left and right: P, Q, in every key

(a) :

J	**K**	**L**	**M**	**N**	Closure
1	0	0	0	0	JPQ* = JPQ(no)
0	1	0	0	0	KPQ* = JKLMNOPQ(yes)
0	0	1	0	0	LPQ* = LPQ(no)
0	0	0	1	0	MPQ* = JKLMNOPQ(yes)
0	0	0	0	1	NPQ* = JLNPQ(no)
1	1	0	0	0	no
1	0	1	0	0	JLPQ* = JLPQ(no)
1	0	0	1	0	no
1	0	0	0	1	JNPQ* = JLPQ(no)
0	1	1	0	0	no
0	1	0	1	0	no
0	1	0	0	1	no
0	0	1	1	0	no
0	0	1	0	1	no
0	0	0	1	1	no

The keys: KPQ, MPQ

3. Relation: JLMN, KLM, MJKO, NJL
   But still, no relation is a superkey of P and Q
   Take a key KPQ
   JLMN, KLM, MJKO, NJL, KPQ Becomes: JLMN, KLM, MJKO, KPQ
   as NJL contained in JLMN