

CS 440 – Databases

Homework 3

Due: Wednesday February 24, 2021

- P. 92–93, Ex. 3.3.1
- P. 102, Ex. 3.4.1
- P. 105, Ex. 3.5.1, 3.5.2, 3.5.3, 3.5.4

Solutions

3.3.1

- a.) This is the relation from 3.2.1
BCNF Violations: $C \rightarrow D, D \rightarrow A, AC \rightarrow D, CD \rightarrow A$
Decompose with $C \rightarrow D$
 $R_1(B, C), R_2(A, C, D)$
- b.) Key: $\{A, B\}$
BCNF Violations: $B \rightarrow C, B \rightarrow D, BC \rightarrow D$
Decompose with $B \rightarrow C$
 $R_1(B, C, D), R_2(A, B)$
- c.) This is the relation from 3.2.2.ii.
BCNF Violations: None
- d.) This is the relation from 3.2.2.iii.
BCNF Violations: None
- e.) Key: $\{A, B, E\}$
BCNF Violations: $DE \rightarrow C, B \rightarrow D$
Decompose with $DE \rightarrow C$
 $R_1(C, D, E), R_2(A, B, D, E)$
Key of R_2 are A, B, E so $B \rightarrow D$ is a BCNF violation.
Final result:
 $R_1(C, D, E), R_2(B, D), R_3(A, B, E)$
- f.) Keys: $\{A, B\}, \{A, D\}, \{A, C\}$
BCNF Violations: $C \rightarrow D, D \rightarrow B, D \rightarrow E$
Decompose with $C \rightarrow D$
 $R_1(B, C, D, E), R_2(A, C)$
 R_1 key is $\{C\}$ decompose with $D \rightarrow B$
Final result:
 $R_1(B, D, E), R_2(C, D), R_3(A, C)$

3.4.1

- a) $B \rightarrow E, CE \rightarrow A$

A	B	C	D	E
a	b	c	d1	e1
a2	b	c	d	e2
a	b3	c	d3	e

Chasing $B \rightarrow E$:

A	B	C	D	E
a	b	c	d1	e1
a2	b	c	d	e1
a	b3	c	d3	e

Chasing $CE \rightarrow A$:

A	B	C	D	E
a	b	c	d1	e1
a	b	c	d	e1
a	b3	c	d3	e

This is lossy and the final tableau gives an R that when projected and recombined is too many rows.
Example:

A	B	C	-	B	C	D	-	A	C	E
a	b	c	-	b	c	d1	-	a	c	e1
a	b3	c	-	b	c	d	-	a	c	e
			-	b3	c	d3	-			

Joining the first two yields:

A	B	C	D	-	A	C	E
a	b	c	d1	-	a	c	e1
a	b	c	d	-	a	c	e
a	b3	c	d3	-			

Joining the last two:

A	B	C	D	E
a	b	c	d1	e1
a	b	c	d1	e
a	b	c	s	e1
a	b	c	d	e
a	b3	c	d3	e1
a	b3	c	d3	e

Note: This is always the case, so I won't demonstrate the rejoin on the final tableau each time.

b) $AC \rightarrow E, BC \rightarrow D$

A	B	C	D	E
a	b	c	d1	e1
a2	b	c	d	e2
a	b3	c	d3	e

Chasing $AC \rightarrow E$

A	B	C	D	E
a	b	c	d1	e
a2	b	c	d	e2
a	b3	c	d3	e

Chasing $BC \rightarrow D$

A	B	C	D	E
a	b	c	d	e
a2	b	c	d	e2
a	b3	c	d3	e

Since the first row is unsubscripted, the decomposition is lossless

c) $A \rightarrow D, D \rightarrow E, B \rightarrow D$

A	B	C	D	E
a	b	c	d1	e1
a2	b	c	d	e2
a	b3	c	d3	e

Chasing $A \rightarrow D$

A	B	C	D	E
a	b	c	d1	e1
a2	b	c	d	e2
a	b3	c	d1	e

Chasing $D \rightarrow E$

A	B	C	D	E
a	b	c	d1	e
a2	b	c	d	e2
a	b3	c	d1	e

Chasing $B \rightarrow D$

A	B	C	D	E
a	b	c	d	e
a2	b	c	d	e2
a	b3	c	d1	e

Lossless.

d) $A \rightarrow D, CD \rightarrow E, E \rightarrow D$

A	B	C	D	E
a	b	c	d1	e1
a2	b	c	d	e2
a	b3	c	d3	e

Chasing $A \rightarrow D$

A	B	C	D	E
a	b	c	d1	e1
a2	b	c	d	e2
a	b3	c	d1	e

Chasing $CD \rightarrow E$

A	B	C	D	E
a	b	c	d1	e
a2	b	c	d	e2
a	b3	c	d1	e

Chasing $E \rightarrow D$

A	B	C	D	E
a	b	c	d1	e
a2	b	c	d	e2
a	b3	c	d1	e

Lossy.

3.5.1

a.) This is the relation from 3.2.1

3NF Violations: None

b.) Key: $\{A, B\}$

3NF Violations: $B \rightarrow C, B \rightarrow D, BC \rightarrow D$

Decompose with both original FDs.

$R_1(B, C), R_2(B, D)$

Since the key isn't in either relation, add $R_3(A, B)$

c.) This is the relation from 3.2.2.ii.

3NF Violations: None

d.) This is the relation from 3.2.2.iii.

3NF Violations: None

3.5.2

a) $\{C, H, S\}, \{H, T, S\}$

b) None of them follow from any others and none of the left-hand side attributes can be removed.

c)

$R_1(C, T)$
 $R_2(C, H, R)$ Not in BCNF
 $R_3(T, H, R)$
 $R_4(H, R, S)$
 $R_5(C, S, G)$
 $R_6(C, H, S)$ Required to add key

3.5.3

a) $\{I, S\}$

b) None of them follow from any others and none of the left-hand side attributes can be removed.

c)

$R_1(S, D)$
 $R_2(I, B)$
 $R_3(I, S, Q)$
 $R_4(B, O)$

3.5.4

A	B	C	D	E
a	b	c	d1	e1
a	b2	c2	d	e2
a	b	c3	d3	e

Chasing $AB \rightarrow C$:

A	B	C	D	E
a	b	c	d1	e1
a	b2	c2	d	e2
a	b	c	d3	e

Chasing $C \rightarrow B$ gets us no change. So chasing $A \rightarrow D$:

A	B	C	D	E
a	b	c	d	e1
a	b2	c2	d	e2
a	b	c	d	e

The last row is unsubscripted, so the join is lossless.