



NORMALIZATION – BCNF

CIS-673, LECTURE#16

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2 BCNF

- BCNF (3.5 NF)
 - Should be in 3NF
 - For all the dependencies, the LHS should be a super (candidate) key

	SUBSET OF CK → NPA (PD)	NPA → NPA (TD)	NPA → PA, PA → PA	CK → PA OR CK → NPA
2NF	NO	YES	YES	YES
3NF	NO	NO	YES	YES
BCNF (3.5NF)	NO	NO	NO	YES

3 BCNF EXAMPLE

- BCNF
 - Should be in 3NF
 - For all FDs, LHS should be a super key (SK)
- $R(A, B, C)$, $FD = \{A \rightarrow B, B \rightarrow C, C \rightarrow A\}$
- $CK = \{A, B, C\}$, $PA = \{A, B, C\}$, $NPA = \{\}$

Depend encies	PD?	TD?	BCNF Violation?
$A \rightarrow B$	No	No	No
$B \rightarrow C$	No	No	No
$C \rightarrow A$	No	No	No

- R is in BCNF

4 BCNF EXAMPLE#2

- $R(J, K, L)$
- $F = \{ JK \rightarrow L, L \rightarrow K \}$
- $CK = \{ (JK), (JL) \}$, $PA = \{ J, K, L \}$, $NPA = \{ \}$

Dependencies	PD?	TD?	BCNF Violation?
$JK \rightarrow L$	No	No	No
$L \rightarrow K$	No	No	YES

- R is in 3NF, but not in BCNF

Redundancy in 3NF

- Consider the schema R below, which is in 3NF
 - $R = (J, K, L)$
 - $F = \{ JK \rightarrow L, L \rightarrow K \}$
 - And an instance table:

J	L	K
j_1	l_1	k_1
j_2	l_1	k_1
j_3	l_1	k_1
null	l_2	k_2

- What is wrong with the table?
 - Repetition of information
 - Need to use null values (e.g., to represent the relationship l_2, k_2 where there is no corresponding value for J)

5 DECOMPOSITION

- Eliminate redundancy by splitting the table, and creating a separate table for the dependency violating BCNF.
- Decompose $R(J,K,L)$ into R_1, R_2 .
- Dependency that violated BCNF: $L \rightarrow K$
- $R_2(L, K)$
- $R_1(J,L)$

6 AFTER DECOMPOSITION

<u>J</u>	L
j ₁	l ₁
j ₂	l ₁
j ₃	l ₁

<u>L</u>	K
l ₁	k ₁
l ₂	k ₂

- R1(J, L)
- FD = { }
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- R1 is in BCNF

- R2(L, K)
- FD = {L → K}
- CK = { (L) },
- PA = {L}, NPA = {K}

Dependencies	BCNF violation?
L → K	No

- R2 is in BCNF

Is the decomposition lossless?

7 BCNF EXAMPLE#3

- dept_advisor(s_ID, i_ID, dept_name)
- FD = {i_ID → dept_name, (s_ID, dept_name) → i_ID}
- CK = { (s_ID, i_ID), (s_ID, dept_name) }
- PA = {s_ID, i_ID, dept_name} , NPA = {}

Dependencies	PD?	TD?	BCNF Violation?
i_ID → dept_name	No	No	Yes
(s_ID, dept_name) → i_ID	No	No	No

- Dept_advisor is in 3NF, but not in BCNF

8 AFTER DECOMPOSITION

- Eliminate redundancy by splitting the table, and creating a separate table for the dependency violating BCNF.
- Decompose dept_advisor(s_ID, i_ID, dept_name)
- Dependency that violated BCNF: $i_ID \rightarrow dept_name$
- R2(i_ID, dept_name)
- R1(s_ID, i_ID)