

Boyce-Codd Normal Forms

Lecture 10

Sections 15.1 - 15.4

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- 1 Third Normal Form
- 2 Boyce-Codd Normal Form
- 3 Assignment

Outline

- 1 Third Normal Form
- 2 Boyce-Codd Normal Form
- 3 Assignment

Third Normal Form

Definition (Transitive Dependence)

A set of attributes Z is **transitively dependent** on a set of attributes X if there exists a set of attributes Y such that $X \rightarrow Y$ and $Y \rightarrow Z$.

Definition (Third Normal Form)

A relation R is in **third normal form** (3NF) if it is in 2NF and there is no nonprime attribute of R that is transitively dependent on any key of R .

- 3NF is violated if there is a nonprime attribute A that depends on something less than a key.

Example

Example

<i>order_no</i>	<i>cust_no</i>	<i>cust_name</i>
222-1	3333	Joe Smith
444-2	4444	Sue Taylor
555-1	3333	Joe Smith
777-2	7777	Bob Sponge
888-3	4444	Sue Taylor

Table 3

- Table 3 is in 2NF, but it is not in 3NF because

$[\text{order_no}] \rightarrow [\text{cust_no}] \rightarrow [\text{cust_name}]$.

3NF Normalization

- To put a relation into 3NF, for each set of transitive function dependencies $X \rightarrow Y \rightarrow Z$, make two tables, one for $X \rightarrow Y$ and another for $Y \rightarrow Z$.

Example – 3NF Normalized Tables

Example – 3NF Normalized Table

<i>order_no</i>	<i>cat_no</i>	quant
222-1	1234	2
222-1	3456	2
444-2	4567	2
555-1	5678	3
555-1	6789	1
777-2	4567	2
888-3	1234	1

Table 1

<i>order_no</i>	<i>cust_no</i>
222-1	3333
444-2	4444
555-1	3333
777-2	7777
888-3	4444

Table 4

<i>order_no</i>	dept	sales_person
222-1	hardware	John Wilson
444-2	lumber	Tim Gramm
555-1	garden	David Simon
777-2	lumber	Tim Gramm
888-3	hardware	Ben Sherman

Table 2

<i>cust_no</i>	<i>cust_name</i>
3333	Joe Smith
4444	Sue Taylor
7777	Bob Sponge

Table 5

- The four tables above are in 3NF.

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Boyce-Codd Normal Form

Definition (Boyce-Codd Normal Form)

A relation R is in **Boyce-Codd normal form** (BCNF) if for every nontrivial functional dependency $X \rightarrow A$, X is a superkey of R .

- That is, no attribute (prime or nonprime) depends on anything less than a superkey.

Example

Example

Bldg	Room	Start	End	Prof
Bagby	111	9:30	10:20	Valente
Bagby	020	10:30	11:20	Koether
Bagby	020	12:30	1:20	Koether
Morton	120	12:30	1:20	Marion
Morton	112	10:30	11:20	Booker
Gilmer	025	9:30	10:20	Thurman
Gilmer	012	9:30	10:20	Bloom

- What are the candidate keys?

Example

- The candidate keys are
 - (Bldg, Room, Start)
 - (Bldg, Room, End)
 - (Start, Prof)
 - (End, Prof)
- Verify that this relation is in 3NF.

Example

- However, each professor teaches in only one building.
- Therefore, $\text{Prof} \rightarrow \text{Bldg}$, but Prof is not a superkey.
- What to do?

BCNF Normalization

Example

Room	Start	End	Prof
111	9:30	10:20	Valente
020	10:30	11:20	Koether
020	12:30	1:20	Koether
120	12:30	1:20	Marion
112	10:30	11:20	Booker
025	9:30	10:20	Thurman
012	9:30	10:20	Bloom

Bldg	Prof
Bagby	Valente
Bagby	Koether
Morton	Marion
Morton	Booker
Gilmer	Thurman
Gilmer	Bloom

- To put the relation in BCNF, create a separate table based on the functional dependency $X \rightarrow A$ that violates BCNF.
- In this case, remove (Prof, Bldg) to a separate table.

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Assignment

Assignment

- Read Section 15.5.