

Topic - Normalization

Third Normal form (3NF)

A table design is said to be in 3NF if both the following conditions hold:

Table must be in 2NF

Transitive functional dependency of non-prime attribute on any super key should be removed.

An attribute that is not part of any candidate key is known as non-prime attribute.

In other words 3NF can be explained like this: A table is in 3NF if it is in 2NF and for each functional dependency $X \rightarrow Y$ at least one of the following conditions hold:

X is a super key of table

Y is a prime attribute of table

An attribute that is a part of one of the candidate keys is known as prime attribute.

Example: Suppose a company wants to store the complete address of each employee, they create a table named employee_details that looks like this:

emp_id	emp_name	emp_zip	emp_state	emp_city	emp_district
1001	John	282005	UP	Agra	Dayal Bagh
1002	Ajeet	222008	TN	Chennai	M-City
1006	Lora	282007	TN	Chennai	Urrapakkam
1101	Lilly	292008	UK	Pauri	Bhagwan
1201	Steve	222999	MP	Gwalior	Ratan

Super keys: {emp_id}, {emp_id, emp_name}, {emp_id, emp_name, emp_zip}...so on

Candidate Keys: {emp_id}

Non-prime attributes: all attributes except emp_id are non-prime as they are not part of any candidate keys.

Here, emp_state, emp_city & emp_district dependent on emp_zip. And, emp_zip is dependent on

emp_id that makes non-prime attributes (emp_state, emp_city & emp_district) transitively dependent on super key (emp_id). This violates the rule of 3NF.

To make this table complies with 3NF we have to break the table into two tables to remove the transitive dependency:

employee table:

emp_id	emp_name	emp_zip
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1001	John	282005
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1002	Ajeet	222008
------	-------	--------

1006	Lora	282007
------	------	--------

1101	Lilly	292008
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1201	Steve	222999
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employee_zip table:

emp_zip	emp_state	emp_city	emp_district
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282005	UP	Agra	Dayal Bagh
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222008	TN	Chennai	M-City
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282007	TN	Chennai	Urrapakkam
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292008	UK	Pauri	Bhagwan
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222999	MP	Gwalior	Ratan
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Boyce Codd normal form (BCNF)

It is an advance version of 3NF that's why it is also referred as 3.5NF. BCNF is stricter than 3NF. A table complies with BCNF if it is in 3NF and for every functional dependency $X \rightarrow Y$, X should be the super key of the table.

Example: Suppose there is a company wherein employees work in more than one department. They store the data like this:

emp_id	emp_nationality	emp_dept	dept_type	dept_no_of_emp
1001	Austrian	Production and planning	D001	200
1001	Austrian	stores	D001	250
1002	American	design and technical support	D134	100
1002	American	Purchasing department	D134	600

Functional dependencies in the table above:

emp_id -> emp_nationality

emp_dept -> {dept_type, dept_no_of_emp}

Candidate key: {emp_id, emp_dept}

The table is not in BCNF as neither emp_id nor emp_dept alone are keys.

To make the table comply with BCNF we can break the table in three tables like this:

emp_nationality table:

emp_id	emp_nationality
1001	Austrian
1002	American

emp_dept table:

emp_dept	dept_type	dept_no_of_emp
Production and planning	D001	200

stores D001 250

design and technical support D134 100

Purchasing department D134 600

emp_dept_mapping table:

emp_id emp_dept

1001 Production and planning

1001 stores

1002 design and technical support

1002 Purchasing department

Functional dependencies:

emp_id -> emp_nationality

emp_dept -> {dept_type, dept_no_of_emp}

Candidate keys:

For first table: emp_id

For second table: emp_dept

For third table: {emp_id, emp_dept}

This is now in BCNF as in both the functional dependencies left side part is a key.