Boyce-Codd Normal Form

In this lesson, we will learn about Boyce-Codd normal form with the help of an example.

Boyce-Codd normal form (BCNF)

For a table to satisfy the Boyce-Codd normal form, it should satisfy the following two conditions:

1. It should be in the third normal form.

2. And, for any dependency A → B, A should be a super key.

The second point sounds a bit tricky, right? In simple words, it means that for a dependency A → B, A cannot be a non-prime attribute if B is a prime attribute.

Example

ENROLMENT table

Std_Id	Subject	Professor
101	CS-100	Eddie Jessup
101	MATH-101	Charles Kingsfield
102	CS-100	Robert Langdon

| 102 | CHEM-101 | John Keating |
| 103 | CS-100 | Eddie Jessup |

In the table above:

- One student can enroll in multiple subjects. For example, the student with `Std_Id` 101, has opted for two subjects: CS-100 and MATH-101.

- `Std_Id` and `Subject` together form the primary key as we can uniquely identify all the tuples in the table.

- One more important point to note here is that one professor teaches only one subject, but one subject may have two different professors. For example, CS-100 is taught by two different professors.

Hence, there is a dependency between the subject and professor where the subject depends on the professor's name.

This table satisfies the 1NF because all the values are atomic, column names are unique and all the values stored in a particular column are of the same domain.

This table also satisfies the 2NF as there is no partial dependency. There is also no transitive dependency, hence the table also satisfies the 3NF.

But this table is not in the Boyce-Codd normal form. The reason being that `Std_Id` and `Subject` form a composite primary key, which means `Subject` is a prime attribute.

But, there is one more dependency, `Professor` → `Subject`, and while `Subject` is a prime attribute, `Professor` is a non-prime attribute, which is not allowed by BCNF.

So, to make this relation (table) satisfy BCNF, we will decompose this table into two tables: the STUDENT table and the PROFESSOR table.

STUDENT table   PROFESSOR table

Std_Id	Professor_Id
101	1
101	2
102	3
102	4
103	1

Professor_Id	Professor	Subject
1	Eddie Jessup	CS-100
2	Charles Kingsfield	MATH-101
3	Robert Langdon	CS-100
4	John Keating	CHEM-101

In the PROFESSOR table, both `Professor` and `Subject` are non-prime attributes and they both depend on the primary key i.e. `Professor_Id`. So, these tables are in BCNF because a prime attribute is not dependent on a non-prime attribute. We also include `Professor_Id` in the STUDENT table as a foreign key so that the two tables can be linked together.

The next lesson will test your knowledge of second normal form.