

Database Creation and Management

Types of Normalization

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Third normal form (3NF)

- A table that is in 1NF and 2NF and in which the values in all non-primary-key column can be determined from only the primary key column(s) and no other columns.
- The formal definition of 3NF is a table that is in 1NF and 2NF and in which no non-primary-key column is transitively dependent on the primary key.

The StaffDistributionCenter table is not in 3NF

StaffDistributionCenter

staffNo	name	position	salary	dCenterNo	dAddress	dTelNo
S1500	Tom Daniels	Manager	48000	D001	8 Jefferson Way, Portland, OR 97201	503-555-3618
S0003	Sally Adams	Assistant	30000	D001	8 Jefferson Way, Portland, OR 97201	503-555-3618
S0010	Mary Martinez	Manager	51000	D002	City Center Plaza, Seattle, WA 98122	206-555-6756
S3250	Robert Chin	Assistant	33000	D002	City Center Plaza, Seattle, WA 98122	206-555-6756
S2250	Sally Stern	Manager	48000	D004	2 W. El Camino, San Francisco, CA 94087	822-555-3131
S0415	Art Peters	Manager	42000	D003	14 – 8th Avenue, New York, NY 10012	212-371-3000



Values in all non-primary-key columns are determined by the primary key, `staffNo`



Values in `dAddress` and `dTelNo` columns are determined by `dCenterNo`, so table *not* in 3NF



Values in `dCenterNo` and `dTelNo` columns are determined by `dAddress`, so table *not* in 3NF



Values in `dCenterNo` and `dAddress` columns are determined by `dTelNo`, so table *not* in 3NF

Converting StaffDistributionCenter table to 3NF

StaffDistributionCenter

staffNo	name	position	salary	dCenterNo	dAddress	dTelNo
S1500	Tom Daniels	Manager	48000	D001	8 Jefferson Way, Portland, OR 97201	503-555-3618
S0003	Sally Adams	Assistant	30000	D001	8 Jefferson Way, Portland, OR 97201	503-555-3618
S0010	Mary Martinez	Manager	51000	D002	City Center Plaza, Seattle, WA 98122	206-555-6756
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S2250	Sally Stern	Manager	48000	D004	2 W. El Camino, San Francisco, CA 94087	822-555-3131
S0415	Art Peters	Manager	42000	D003	14 – 8th Avenue, New York, NY 10012	212-371-3000

Take copy of dCenterNo

Remove dAddress column

Remove dTelNo column

Rename table as staff table

DistributionCenter

dCenterNo	dAddress	dTelNo
D001	8 Jefferson Way, Portland, OR 97201	503-555-3618
D002	City Center Plaza, Seattle, WA 98122	206-555-6756
D003	14 – 8th Avenue, New York, NY 10012	212-371-3000
D004	2 W. El Camino, San Francisco, CA 94087	822-555-3131

Becomes primary key

Becomes alternate key

Becomes alternate key

(fd2)

(fd3)

(fd4)

staff

staffNo	name	position	salary	dCenterNo
S1500	Tom Daniels	Manager	48000	D001
S0003	Sally Adams	Assistant	30000	D001
S0010	Mary Martinez	Manager	51000	D002
S3250	Robert Chin	Assistant	33000	D002
S2250	Sally Stern	Manager	48000	D004
S0415	Art Peters	Manager	42000	D003

Primary key

Becomes foreign key

(fd1)

Boyce-Codd Normal Form (BCNF)

- It is an extension of 3NF on strict terms.
- BCNF states that:
 - A table is already in 3NF.
 - For any non-trivial functional dependency, $X \rightarrow A$, X must be a super-key. In other words, all determinants must be superkey.
 - All determinants that are not superkey are removed to place in another table.

Cont...

- A table not in BCNF as shown in figure.
 - Key: {Student, Course}
- Functional Dependency:
 - {Student, Course} \rightarrow Teacher
 - Teacher \rightarrow Course
- Problem: Teacher is not a superkey but determines Course.
- Decompose the Student table into Stud_Course and Course_Teacher table as shown in figure.

Cont...

Student

<u>Student</u>	<u>Course</u>	Teacher
Sok	DB	John
Sao	DB	William
Chan	E-Commerce	Todd
Sok	E-Commerce	Todd
Chan	DB	William

Not in BCNF

Stud_Course

<u>Student</u>	<u>Course</u>
Sok	DB
Sao	DB
Chan	E-Commerce
Sok	E-Commerce
Chan	DB

Course_Teacher

<u>Course</u>	<u>Teacher</u>
DB	John
DB	William
E-Commerce	Todd

CNF normalization

Fourth normal form (4NF)

- A table is already in BCNF.
- A table contains no multi-valued dependencies.
- For Example: A table not in 4NF as shown in figure.
 - Key: {Student, Major, Hobby}
 - MVD: Student \twoheadrightarrow Major, Hobby
- Decompose to Student_Major and Student_Hobby tables and each table contains MVD as shown in figure.

Cont...

Student_Major

<u>Student</u>	<u>Major</u>	<u>Hobby</u>
Sok	IT	Football
Sok	IT	Volleyball
Sao	IT	Football
Sao	Med	Football
Chan	IT	NULL
Puth	NULL	Football
Tith	NULL	NULL

Not in 4NF



Student_Major

<u>Student</u>	<u>Major</u>
Sok	IT
Sao	IT
Sao	Med
Chan	IT
Puth	NULL
Tith	NULL

Student-Hobby

<u>Student</u>	<u>Hobby</u>
Sok	Football
Sok	Volleyball
Sao	Football
Chan	NULL
Puth	Football
Tith	NULL

4NF

Fifth normal form (5NF)

- A table is already in 4NF.
- If we can decompose table further to eliminate redundancy and anomaly, and when we re-join the decomposed tables by means of candidate keys, we should not be losing the original data or any new record set should not arise. In simple words, joining two or more decomposed table should not lose records nor create new records.

Cont...

Subject

SUBJECT	LECTURER	CLASS
Mathematics	Alex	SEMESTER 1
Mathematics	Rose	SEMESTER 1
Physics	Rose	SEMESTER 1
Physics	Joseph	SEMESTER 2
Chemistry	Adam	SEMESTER 1

Not in 5NF

Subject_Lecturer

SUBJECT	LECTURER
Mathematics	Alex
Mathematics	Rose
Physics	Rose
Physics	Joseph
Chemistry	Adam

Lecturer_Class

CLASS	LECTURER
SEMESTER 1	Alex
SEMESTER 1	Rose
SEMESTER 1	Rose
SEMESTER 2	Joseph
SEMESTER 1	Adam

Subject_Class

CLASS	SUBJECT
SEMESTER 1	Mathematics
SEMESTER 1	Physics
SEMESTER 1	Chemistry
SEMESTER 2	Physics

Example of 5NF