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Database Normalization Basics

Posted By : Shailendra Chauhan, 21 May 2012

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🕐 *Version Support : SQL Server 2005,2008,2012*

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Normalization or data normalization is a process to organize the data into tabular format (database tables). A good database design includes the normalization, without normalization a database system may slow, inefficient and might not produce the expected result. Normalization reduces the data redundancy and inconsistent data dependency.

Normal Forms

We organize the data into database tables by using normal forms rules or conditions. Normal forms help us to make a good database design. Generally we organize the data up to third normal form. We rarely use the fourth and fifth normal form.

To understand normal forms consider the following unnormalized database table. Now we will normalize the data of below table using normal forms.

Project Code	Project Name	Project Manager	Project Budget	Employee No.	Employee Name	Department No.	Department Name	Hourly Rate
PC010	Reservation System	Mr. Ajay	120500	S100	Mohan	D03	Database	21.00
PC010	Reservation System	Mr. Ajay	120500	S101	Vipul	D02	Testing	16.50
PC010	Reservation System	Mr. Ajay	120500	S102	Riyaz	D01	IT	22.00
PC011	HR System	Mrs. Charu	500500	S103	Pavan	D03	Database	18.50
PC011	HR System	Mrs. Charu	500500	S104	Jitendra	D02	Testing	17.00
PC011	HR System	Mrs. Charu	500500	S315	Pooja	D01	IT	23.50
PC012	Attendance System	Mr. Rajesh	710700	S137	Rahul	D03	Database	21.50
PC012	Attendance System	Mr. Rajesh	710700	S218	Avneesh	D02	Testing	15.50
PC012	Attendance System	Mr. Rajesh	710700	S109	Vikas	D01	IT	20.50

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01. First Normal Form (1NF)

A database table is said to be in 1NF if it contains no repeating fields/columns. The process of converting the UNF table into 1NF is as follows:

1. Separate the repeating fields into new database tables along with the key from unnormalized database table.

2. The primary key of new database tables may be a composite key

1NF of above UNF table is as follows:

Primary Key

Project Code	Project Name	Project Manager	Project Budget
PC010	Reservation System	Mr. Ajay	120500
PC011	HR System	Mrs. Charu	500500
PC012	Attendance System	Mr. Rajesh	710700

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Composite Key (Unique Key)

Project Code	Employee No.	Employee Name	Department No.	Department Name	Hourly Rate
PC010	S100	Mohan	D03	Database	21.00
PC010	S101	Vipul	D02	Testing	16.50
PC010	S102	Riyaz	D01	IT	22.00
PC011	S103	Pavan	D03	Database	18.50
PC011	S104	Jitendra	D02	Testing	17.00
PC011	S315	Pooja	D01	IT	23.50
PC012	S137	Rahul	D03	Database	21.50
PC012	S218	Avneesh	D02	Testing	15.50
PC012	S109	Vikas	D01	IT	20.50

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02. Second Normal Form (2NF)

A database table is said to be in 2NF if it is in 1NF and contains only those fields/columns that are functionally dependent(means the value of field is determined by the value of another field(s)) on the primary key. In 2NF we remove the partial dependencies of any non-key field.

The process of converting the database table into 2NF is as follows:

1. Remove the partial dependencies(A type of functional dependency where a field is only functionally dependent on the part of primary key) of any non-key field.

2. If field B depends on field A and vice versa. Also for a given value of B, we have only one possible value of A and vice versa, Then we put the field B in to new database table where B will be primary key and also marked as foreign key in parent table.

2NF of above 1NF tables is as follows:

Primary Key

Project Code	Project Name	Project Manager	Project Budget
PC010	Reservation System	Mr. Ajay	120500
PC011	HR System	Mrs. Charu	500500
PC012	Attendance System	Mr. Rajesh	710700

Composite Key

Project Code	Employee No.	Hourly Rate
PC010	S100	21.00
PC010	S101	16.50
PC010	S102	22.00
PC011	S103	18.50
PC011	S104	17.00
PC011	S315	23.50
PC012	S137	21.50
PC012	S218	15.50
PC012	S109	20.50

Primary Key   copyright dotnet-tricks.com

Employee No.	Employee Name	Department No.	Department Name
S100	Mohan	D03	Database
S101	Vipul	D02	Testing
S102	Riyaz	D01	IT
S103	Pavan	D03	Database
S104	Jitendra	D02	Testing
S315	Pooja	D01	IT
S137	Rahul	D03	Database
S218	Avneesh	D02	Testing
S109	Vikas	D01	IT

2NF   copyright dotnet-tricks.com

03. Third Normal Form (3NF)

...uld be dependent on primary key or We can also said a table to be in 3NF if it is in 2NF and no fields of the table is transitively functionally dependent on the primary key.The process of converting the table into 3NF is as follows:

1. Remove the transitive dependecies(A type of functional dependency where a field is functionally dependent on the Field that is not the primary key.Hence its value is determined, indirectly by the primary key)

2. Make separate table for transitive dependent Field.

3NF of above 2NF tables is as follows:

Proj...	...e	Project Manager	Project Budget
P...	...tem	Mr. Ajay	120500
P...		Mrs. Charu	500500
P...	...em	Mr. Rajesh	710700

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Proje...		Hourly Rate
PC...		21.00
PC...		16.50
PC...		22.00
PC...		18.50
PC...		17.00
PC...		23.50
PC...		21.50
PC...		15.50
PC...		20.50

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Empl...		Department No.
S...		D03
S...		D02
S...		D01
S...		D03
S...		D02
S...		D01
S...		D03
S...		D02
S109	Vikas	D01

Primary Key   FK_Relationship

Department No.	Department Name
D01	IT
D02	Testing
D03	Database

3NF

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04. Boyce Code Normal Form (BCNF)

A database table is said to be in BCNF if it is in 3NF and contains each and every determinant as a candidate key.The process of converting the table into BCNF is as follows:

1. Remove the non trival functional dependency.

2. Make separate table for the determinants.

BCNF of below table is as follows:

Supplier ID	Supplier Name	Product ID	Quantity
S001	Mr. X	P001	120
S002	Mr. Y	P002	102
S003	Mr. Z	P001	100

Determinants

Supplier ID	Supplier Name
S001	Mr. X
S002	Mr. Y
S003	Mr. Z

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BCNF

Supplier ID	Product ID	Quantity
S001	P001	120
S002	P002	102
S003	P001	100

05. Fourth Normal Form (4NF)

A database table is said to be in 4NF if it is in BCNF and primary key has one-to-one relationship to all non keys fields or We can also said a table to be in 4NF if it is in BCNF and contains no multi-valued dependencies.The process of converting the table into 4NF is as follows:

1. Remove the multivalued dependency.

2. Make separate table for multivalued Fields.

4NF of below table is as follows:

Employee Name	Skills	Language
Mohan	C Sharp	Hindi
Mohan	Asp.Net	Hindi
Mohan	SQL Server	Hindi
Mohan	C Sharp	English
Mohan	Asp.Net	English
Mohan	SQL Server	English

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Employee Name	Skills
Mohan	C Sharp
Mohan	Asp.Net
Mohan	SQL Server

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Employee Name	Language
Mohan	Hindi
Mohan	English

06. Fifth Normal Form (5NF)

A database table is said to be in 5NF if it is in 4NF and contains no redundant values or We can also said a table to be in 5NF if it is in 4NF and contains no join dependencies.The process of converting the table into 5NF is as follows:

1. Remove the join dependency.

2. Break the database table into smaller and smaller tables to remove all data redundancy.

5NF of below table is as follows:

Company	Product	Supplier
Godrej	Soap	Mr. Amit
Godrej	Shampoo	Mr. Pavan
Godrej	Shampoo	Mr. Amit
H.Lever	Soap	Mr. Amit
H.Lever	Shampoo	Mr. Pavan
H.Lever	Soap	Mr. Sachin

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Company	Product
Godrej	Soap
Godrej	Shampoo
H.Lever	Soap
H.Lever	Shampoo

Company	Supplier
Godrej	Mr. Amit
Godrej	Mr. Pavan
H.Lever	Mr. Amit
H.Lever	Mr. Pavan
H.Lever	Mr. Sachin

5NF

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Product	Supplier
Soap	Mr. Amit
Shampoo	Mr. Pavan
Shampoo	Mr. Amit
Soap	Mr. Sachin

Summary

In this article I try to explain the Normalization with example. I hope after reading this article you will be able to understand Normal Forms. I would like to have feedback from my blog readers. Please post your feedback, question, or comments about this article.

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About the Author

Hey! I'm Shailendra Chauhan full-time author, consultant & trainer. I have more than 6 years of hand over Microsoft .NET technologies and other web technologies. I am the founder & chief editor of www.dotnet-tricks.com and www.webgeekschool.com. I am author of books ASP.NET MVC Interview Questions and Answers & AngularJS Interview Questions and Answers & LINQ Interview Questions and Answers.

I love to work with web applications and mobile apps using Microsoft technology including ASP.NET, MVC, C#, SQL Server, WCF, Web API, Entity Framework,Cloud Computing, Windows Azure, jQuery, jQuery Mobile, Knockout.js, Angular.js and many more web technologies. More...

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Vivek Kumar · 4 months ago
Thanks for this Article..this gives clear picture about DB Normalization and its different forms.
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Kamal Bhasha Mahammad · 10 months ago
very nice article, can u pls explain eknf,dknf and 6NF .
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bhagi · 10 months ago
how to normalize for these columns and rows
columns : institution,
registration number,
year of completion,
points,
fees paid per year.
rows : university,
tertiary,
level,
a'level,
primary.
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Video Beagle · a year ago
I appreciate the work done in this, but It all just seems to break down in my mind when moving from 3NF to BCNF. In the examples, I don't see the difference, and I'm not sure how'd you get to a BCNF table like the one at the start of the 4NF example.

∧ | ✓ • Reply • Share ›

Raghavnedra Dasara · a year ago

Good Example,Happy Reading.. :)

∧ | ✓ • Reply • Share ›

Venkat · a year ago

Very good explanation.....Really hekps a lot

∧ | ✓ • Reply • Share ›

Ashutosh · a year ago

Thanks a lot..very much helpful topics.

∧ | ✓ • Reply • Share ›

Rohan · a year ago

Thanks man very much helpful

∧ | ✓ • Reply • Share ›

Mohideen · a year ago

I referred Normalization and join and these are very useful for me. Thank you very much.
Mohideen

∧ | ✓ • Reply • Share ›

Kingston · a year ago

Yes Noted, one more clarification after 3NF why are we not having all employee related information
i.e., EmployeeNo,Projectcode,Employeename,Departmentno and hourlyrate in one table?

∧ | ✓ • Reply • Share ›

Kingston · a year ago

Can't we have the same table example throughout all the NFs, After 3rd NF there is no continuation.

∧ | ✓ • Reply • Share ›

Shailendra Chauhan Dot Net Tricks → Kingston · a year ago

Hi Kingston, normally a database table is normalized up to 3NF. Table structure is also play a
key role in normalization, so at the time of normalization you need to think where this
structure is fit to do normalization i.e. in 3NF, or 4NF or 5NF. In the above example, first Table
structure does not fit into 4NF, that why, I have taken another Table example.

∧ | ✓ • Reply • Share ›

Bongo · 2 years ago

Great tutorial man...keep up the good work

∧ | ✓ • Reply • Share ›

RamuChennai · 2 years ago

Excellent this...

∧ | ✓ • Reply • Share ›

fdghfhh · 2 years ago

hgjghjghj

∧ | ∨ · Reply · Share ›

Aarti Tushar Borole · 2 years ago

First time with nice examples I understand whole noramlaization. earlier I saw all tutorials upto BCNF. But 4and 5 NF I didnt know earlier. Good. keep it up. Best luck

∧ | ∨ · Reply · Share ›

rani · 2 years ago

It's really good

∧ | ∨ · Reply · Share ›

saiful · 2 years ago

May allah bless on you to make this type of more explanation on various parts of sql server which are really helping people to understand more precisely. Thanks.

∧ | ∨ · Reply · Share ›

vin · 2 years ago

its good

∧ | ∨ · Reply · Share ›

vin · 2 years ago

Can you explain BCNF with the initial table or any proper defn of table mean new table and then apply bcnf in that form .

∧ | ∨ · Reply · Share ›

Bhagyashri · 2 years ago

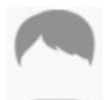thanks ,,,,its a very good something about normalization

∧ | ∨ · Reply · Share ›

Husain Sayed Abdel Kawy · 2 years ago

Thanks too much, the best place for explaining normalization with examples

∧ | ∨ · Reply · Share ›

Kunal · 2 years ago

very nice.. clear concept.

1 ∧ | ∨ · Reply · Share ›

sandeep · 2 years ago

1st time i got something about normalization

2 ∧ | ∨ · Reply · Share ›

demo@program · 2 years ago

First of all Big thanx to you.

Can you explain BCNF with the initial table or any proper defn of table mean new table and then

apply bcnf in that form .

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roshan · 2 years ago

thanks for such useful information...

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very usefull informations from this website.keep posting with good tutorials.thanks.........................

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