Amity School of Business

BBA, Semester 2

Analysis and Design of Business System

(ADBS)

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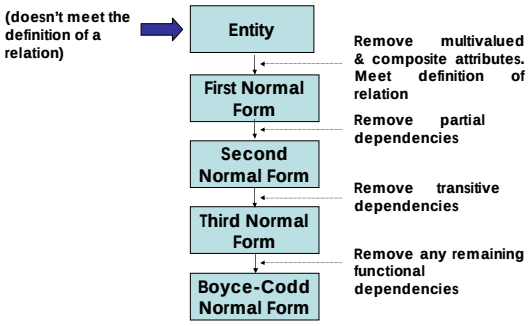
Module-IV

System And Database Design

Types of NF

- First Normal Form (1NF)
- Second Normal Form (2NF)
- Third Normal Form (3NF)
- Boyce-Codd Normal Form (BCNF)

Steps in Normalization



First Normal Form (1NF)

If a table of data meets the definition of a relation, it is in first normal form.

- **Every relation has a unique name.**
- **Every attribute value is atomic (single-valued).**
- **Every row is unique.**
- **Attributes in tables have unique names.**
- **The order of the columns is irrelevant.**
- **The order of the rows is irrelevant.**

Example

- Consider a relation **LIVED_IN** , which keeps the records of person and his residence in different cities
- In this relation, the domain **RESIDENCE** is not simple, e.g. an attribute " Abhishek can have residence in Jamshedpur , Mumbai or Delhi and thus relation is un-normalized.

Relation : LIVED_IN

PERSON	RESIDENCE	
	CITY	DATE-MOVED
Abhishek	Jameshedpur	121202
	Mumbai	070803
	Delhi	050504
	CITY	DATE-MOVED
Thomas	Singapore	100401
	Kolkata	090202
	Bangalore	010105

Un-normalized Relation

Example

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- Now the relation LIVED_IN is normalized by combining each row in residence with its corresponding value of PERSON and making this combination a row of the relation.
- So non-simple domain RESIDENCE is replaced with simple domains

Relation : LIVED_IN		
PERSON	CITY	DATE-MOVED-IN
Abhishek	Jamshedpur	121202
Abhishek	Mumbai	070803
Abhishek	Delhi	050504
Thomas	Singapore	100401
Thomas	Kolkata	090202
Thomas	Bangalore	010105

Normalized Relation

Example

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Relation : Patient_Doctor					
Patient-Name	**DOB**	**Doctor Name**	**Contact No.**	**Date-Time**	**Duration-Minutes**
Mathew	**10/02/1957**	**Abhishek**	**657-2145063**	**10/01/10 10:00**	**15**
Ravi	**27/01/1962**	**Sanjay**	**651-2214381**	**10/01/10 11:00**	**10**
Jose	**30/03/1971**	**Thomas**	**011-2324567**	**10/01/10 10:30**	**10**
Jose	**30/03/1971**	**Thomas**	**011-2324567**	**08/03/10 09:00**	**20**
Ravi	**27/01/1962**	**Abhishek**	**657-2145063**	**10/01/10 10:15**	**15**
Mathew	**10/02/1957**	**Thomas**	**011-2324567**	**10/01/10 10:50**	**20**
Ranjan	**02/11/1970**	**Sanjay**	**651-2214381**	**10/01/10 11:10**	**20**
Mathew	**10/02/1957**	**Abhishek**	**657-2145063**	**05/05/10 16:00**	**15**

Relation Patient_Doctor in 1NF

Problems in 1NF

- 1NF contains redundant information. The Relation PATIENT_DOCTOR is in 1NF, even then this has following problems with the structure-
  - A doctor, who does not currently have an appointment with a patient, cannot be represented.
  - Similarly, we cannot represent a patient who does not currently have an appointment with a doctor
  - There is redundant information such as patient's date of birth& doctor's phone number.
  - While deleting the last remaining records containing details of a patient or a doctor, all records of that patient or doctor will be lost.

Therefore the Relation PATIENT_DOCTOR has to be normalized further by separating the information relating to several distinct entities

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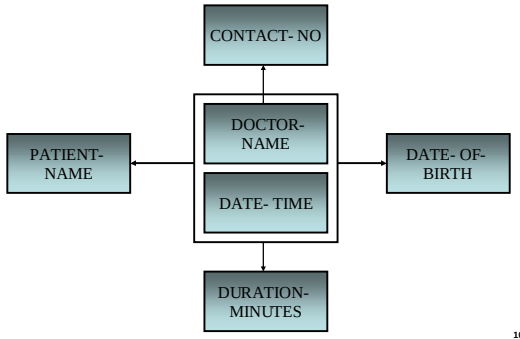
Function Dependency diagram for relation PATIENT_DOCTOR



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Definition of FD …

• Describes the relationship between attributes in a relation.

For example, if ***A*** and ***B*** are attributes of relation ***R*, *B*** is functionally dependent on ***A*** **(denoted *A* → *B*), if** each value of ***A*** **in *R* is associated with exactly one value of *B* in *R*.**

• Functional dependency is a property of the meaning or semantics of the attributes in a relation.

Second Normal Form (2NF)

A relation R is said to be in second normal form (2NF) if

- It is in 1NF and every non-prime key attributes of R is fully functionally dependent on each relation (Primary) Key of R i.e. no partial dependency is allowed in the relation R.
- In other words, no attributes of the relation should be functionally dependent on only one part of the concatenated primary key.
- Thus, 2NF can be violated only when a key is a composite key, or one that consisting of more than one attribute.
- 2NF is based on the concept of full functional dependency (FFD)
- 2NF is an intermediate step towards higher normal forms. It eliminates the problems of 1NF

Example

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- It can be observed from the 1NF relational table that a doctor cannot have two simultaneous appointments and thus DOCTOR-NAME and DATE-TIME is a compound key.
- Similarly, a patient cannot have same time from two different doctors. Therefore, PATIENT-NAME and DATE-TIME attributes are also a candidate key.

Example

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- The Relation could be depicted as:
- **PATIENT_DOCTOR** (PATIENT-NAME, DOB, DOCTOR-NAME, DATE-TIME, CONTACT-NO, DURATION-MINUTES)
- In this relation composite key (DOCTOR-NAME, DATE-TIME), is taken as a primary key.
- But there is a partial dependency as CONTACT-NO is Dependent upon DOCTOR-NAME, and hence the relation is not in 2NF.
- Therefore, to bring the relation in 2NF, the information about doctors and their contact numbers have to be separated from information about patients and their appointments with doctors.

Example

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- Thus, the relation is decomposed into two table namely PATIENT_DOCTOR and DOCTOR.
- The relation in 2NF can be depicted as:
  - **PATIENT_DOCTOR**(PATIENT-NAME, DOB, DOCTOR-NAME, DATE-TIME, DURATION-MINUTES)
  - **DOCTOR**(DOCTOR-NAME, CONTACT-NO)

Example

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Relation PATIENT_DOCTOR decomposed into two table for refinement in 2NF

Relation : PATIENT_DOCTOR

Patient-Name	DOB	Doctor Name	Date-Time	Duration-Minutes
Mathew	10/02/1957	Abhishek	10/01/05 10:00	15
Ravi	27/01/1962	Sanjay	10/01/05 11:00	10
Jose	30/03/1971	Thomas	10/01/05 10:30	10
Jose	30/03/1971	Thomas	08/03/05 09:00	20
Ravi	27/01/1962	Abhishek	10/01/05 10:15	15
Mathew	10/02/1957	Thomas	10/01/05 10:50	20
Ranjan	02/11/1970	Sanjay	10/01/05 11:10	20
Mathew	10/02/1957	Abhishek	05/05/05 16:00	15

Example

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Relation : DOCTOR

Doctor Name	Contact No.
Abhishek	657-2145063
Sanjay	651-2214381
Thomas	011-2324567
Thomas	011-2324567
Abhishek	657-2145063
Thomas	011-2324567
Sanjay	651-2214381
Abhishek	657-2145063

Problems in 2NF:

- Deleting a record from relation PATIENT_DOCTOR may lose patient's details
- Any changes in the details of the patient may involve changing multiple occurrences because this information is still stored redundantly.

Example

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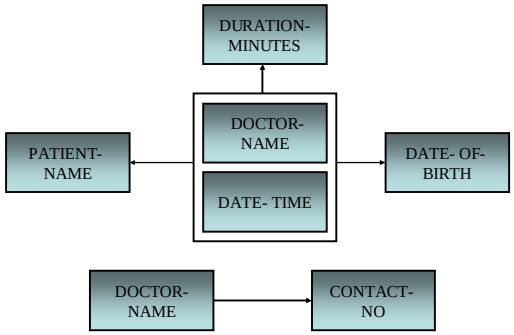


FDDs for Relations PATIENT-DOCTOR AND DOCTOR

TRANSITIVE DEPENDENCY

Let A, B and C be three attributes of a relations such that A ⟶ B and B ⟶ C. From these FDs, we may able to derive A ⟶ C , this dependence A ⟶ C is transitive dependency.

Third Normal Form (3NF)

- A relation R is said to be in Third Normal Form (3NF) if
  - It is in 2NF, and The non-prime attributes are Mutually independent & Functionally dependent on the primary (or relation) key.
  - No attributes of the relation should be transitively functionally dependent on the primary key or no non-prime attribute is functionally dependent on another non-prime attribute.
  - This means that a relation in 3NF consists of the primary key and a set of independent nonprime attributes.
  - 3NF is based on the concept of transitive dependency.

Example

- ***The following Relation in 1NF was depicted as:***

  PATIENT_DOCTOR (PATIENT-NAME, DOB, DOCTOR-NAME, DATE-TIME, CONTACT-NO, DURATION-MINUTES)
- ***The relation in 2NF can be depicted as:***

  PATIENT_DOCTOR (PATIENT-NAME, DOB, DOCTOR-NAME, DATE-TIME, DURATION-MINUTES)

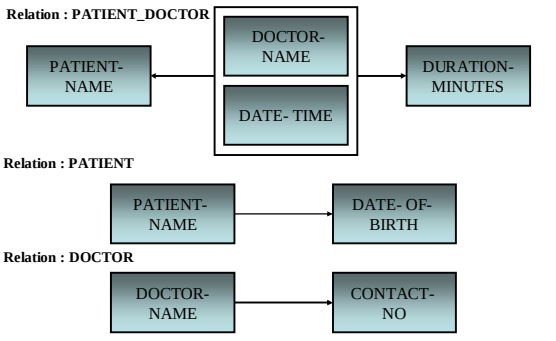
  DOCTOR(DOCTOR-NAME, CONTACT-NO)
- ***Thus the relation in 3NF is depicted as:***

  PATIENT(PATIENT-NAME, DOB)

  PATIENT_DOCTOR (PATIENT-NAME, DOCTOR- NAME, DATE-TIME, DURATION-MINUTES)

  DOCTOR (DOCTOR-NAME, CONTACT-NO)

Example



Relation in 3NF

Boyce-Codd Normal Form (BCNF)

To eliminate the problems and redundancy of 3NF, R.F. Boyce proposed a normal form known as *Boyce Codd Normal Form* (BCNF).

Relation R is in BCNF :

- if for every nontrivial FD: X → Y between attributes X and Y holds in R That means
  - X is super key of R
  - X → Y is a trivial FD, i.e. Y ⊂ X

In Other words, a relation must only have candidate keys as determinants.

Boyce-Codd Normal Form (BCNF)

- 3NF and every determinant is a candidate key.

✓ BCNF is based on the concept of a *determinant.*

✓ A determinant is any attribute (simple or composite) on which some other attribute is fully functionally dependent.

✓ A relation is in BCNF is, and only if, every determinant is a candidate key.

Example

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Let us consider relation PROJECT_PART

PROJECT_PART(PROJECT-NAME, PART-CODE, VENDER-NAME, QTY)

Relation : PROJECT_PART			
PROJECT-NAME	**PART-CODE**	**QTY**	**VENDER-NAME**
P1	ABC	10	Thomas
P1	BCA	20	John
P2	ABC	30	Thomas
P2	BCA	40	Alok

Relation : PROJECT_VENDOR is in 3NF

Example

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In this table lists the projects, the parts, the quantities of those parts they use and the vender who supply these parts. There are two assumptions.

- Each project is supplied with a specific part by only one vendor, although a vender can supply that part to more than one project.
- A vendor makes only one part but the same part made by other vendors.

The primary key of the relation PROJECT_PART are PROJECT-NAME and PART-CODE.

Example

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The relation PROJECT _PART is in 3NF, since there is no transitive functional dependencies on the prime key. However, it is not in BCNF because the attribute VENDER-NAME is the determinant of PART-CODE.

To Convert this relation form 3NF to BCNF by decomposing this single relation PROJECT_PART into two relation PROJECT_VENDOR and VENDOR_PART.

The decompose relations are

PROJECT_VENDOR(PROJECT-NAME, VENDOR NAME, QTY)

VENDOR_PART(VENDOR-NAME, PART-CODE)

Example

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Relation: PROJECT_VENDOR		
PROJECT-NAME	VENDOR-NAME	QTY
P1	Thomas	10
P1	John	20
P2	Thomas	30
P2	Alok	40

Relation : VENDOR_PART	
VENDOR-NAME	PART-CODE
Thomas	ABC
John	BCA
Alok	BCA

Relation : PROJECT_VENDOR and VENDOR_PART is in BCNF

DBMS – Users

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- **Database Administrator**

Person having central control over data and programs accessing that data.

Roles and Duties of the Database Administrator include:

- Scheme definition
- Storage structure and access method definition
- Scheme and physical organization modification
- Granting of authorization for data access
- Integrity constraint specification

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- **Application Programmers**
  computer professionals interacting with the system through application programs written in a host language.
- **Sophisticated users**
  Interact with the system without writing programs. They form requests by writing queries in a database query language.
- **Specialized users**
  Sophisticated users writing special database application programs. These may be CADD systems, knowledge-based and expert systems, complex data systems (audio/video), etc.
- **Naive users**
  Unsophisticated users who interact with the system by using permanent application programs (e.g. automated teller machine).

Benefits of Normalization

- Searching, sorting, and creating indexes is faster, since tables are narrower, and more rows fit on a data page.
- Index searching is often faster, since indexes tend to be narrower and shorter.
- You usually have fewer indexes per table, so data modification commands are faster.
- Fewer null values and less redundant data, making your database more compact.

- Triggers execute more quickly if you are not maintaining redundant data.
- Data modification anomalies are reduced thus maintains data integrity.
- Normalization is conceptually cleaner and easier to maintain and change as your needs change.
- Optimized and faster queries.
- Faster update performance.

The End