

Chapter 4

DATA INTEGRITY AND NORMALIZATION

Q1. What is data integrity? Also discuss its two types.

Ans.

Data integrity:

- Data integrity refers to the correctness and consistency of data.
- Integrity means reliable and trustable. It is another form of data protection.
- Security means the protection of data from unauthorized operations where as integrity is concerned with the quality of data.
- Integrity is expressed in the terms of certain rules which are also called consistency constraints. These rules act as a filter that purifies incoming data.
- DBMS uses these rules to maintain quality of data.

Types of Data Integrity

- There are two types of data Integrity.
 - Entity Integrity
 - Referential Integrity

Entity integrity

- It is a primary key constraint i.e. no attribute of a primary key should contain null.
- Every relation must have a primary key, that primary key attribute cannot have a null or duplicate values.
- It is also called **record integrity**.

Referential integrity

- It is a foreign key constraint.
- If a foreign key exists in a relation then either the foreign key value must match the primary key value of the same tuple in its parent table or the foreign key value must be completely NULL.
- Referential integrity can be achieved by specifying relationship between two tables and it is applied by using foreign key.

- A referential integrity constraint requires that the foreign key has the same name and data type as primary key in parent table.
- Referential integrity ensures that the relationship between the records of related tables remains consistent.

Q2. Explain the difference between data integrity and data security.

Ans.

	Data Integrity	Data Security
1.	It refers to the validity of data. It relates to the logical protection (complete correct and consistent) of data.	It is defined as protection of data with respect to physical form of data against accidental or intentional loss, destruction or misuse.
2.	Data integrity avoids from • Human errors when data is entered • Errors that occur, when data is transmitted from one place to another.	Data security avoids from • Unauthorized access of data. • Unauthorized edit, update and loss of data.
3.	Data integrity can be implemented by following rules • Primary key • Foreign key • Relationship	Data security can be implemented through • User accounts (password and rights) • Authentication schemes (A security plan which positively identify a user attempting to gain access to data)

Q3. Define the terms Synonyms, Homonyms, Redundant information and mutually exclusive data.

Ans.

Synonyms

- A synonym is created when two different names are used for the same information or attribute.
- The name of attribute must be same if it exists in two or more entities.

Example:

<u>STUDENT</u>		<u>STDSUBJECT</u>	
STD_ID	→	STD_NO	(error)
STD_NAME		SUB_ID	
STD_ADDRESS		SUB_NAME	

In above example two entities are related and have common field STD_ID. But here it is used with different name. It is an error. It must be used with same name and STD_NO in STDSUBJECT table must be replaced with STD_ID.

Homonyms

- It is a problem of having same name for two different attributes.

Example:

<u>STUDENT</u>	<u>SUBJECT</u>	
STD_ID	STD_ID	(error)
STD_NAME	SUB_NAME	
STD_ADDRESS		

In above example both relations have the same field i.e. STD_ID which is creating confusion. To avoid this we must replace the STD_ID attribute in SUBJECT relation with SUB_ID.

Redundant information

- It is a problem of storing the same information in two different ways or forms.

Example:

<u>STUDENT</u>
STD_ID
STD_DOB
STD_DOB_D
STD_DOB_M
STD_DOB_Y

In above example the same information i.e. date of birth of the student is stored in two different ways at different places.

So the attributes STD_DOB_D, STD_DOB_M and STD_DOB_Y are redundant.

Mutually exclusive data

- Mutually exclusive mean having one out of a few options.
- In mutual exclusion only one option or set of specified options can be selected.

Example:

<u>STUDENT</u>
STD_ID
STD_MARRIED
STD_SINGLE

In above example attributes STD_MARRIED and STD_SINGLE are mutually exclusive fields. Only one field can give the required information therefore only one field is required instead of two i.e. STD_MARTIAL_STATUS.

Q4. What are database anomalies? Briefly discuss insertion deletion and modification anomalies.**Database Anomalies:**

- Database anomalies mean errors and inconsistencies. It creates problems while performing the operations like insertion, deletion and modification.
- It is necessary to remove anomalies for error free processing in relations.
- The anomalies can be eliminated by redefining a relation into two or more relations.

Insertion anomaly:

It occurs when a user try to enter a new record in the relation but due to insertion anomaly, the actual fact cannot be inserted until the user may provide many unnecessary attributes of the same relation.

Deletion anomaly:

It occurs when a user try to delete a record in the relation but due to deletion anomaly, the deletion of target record automatically deletes many facts about another relation.

Modification anomaly:

It occurs when a user try to update a record in the relation but due to modification anomaly, the modification in the value of specific attribute require modification in all attributes in which that value occurs.

Q5. Define Normalization and different steps involved in it.**Ans. Normalization:**

Normalization is a process of efficiently organizing data in database.

Or

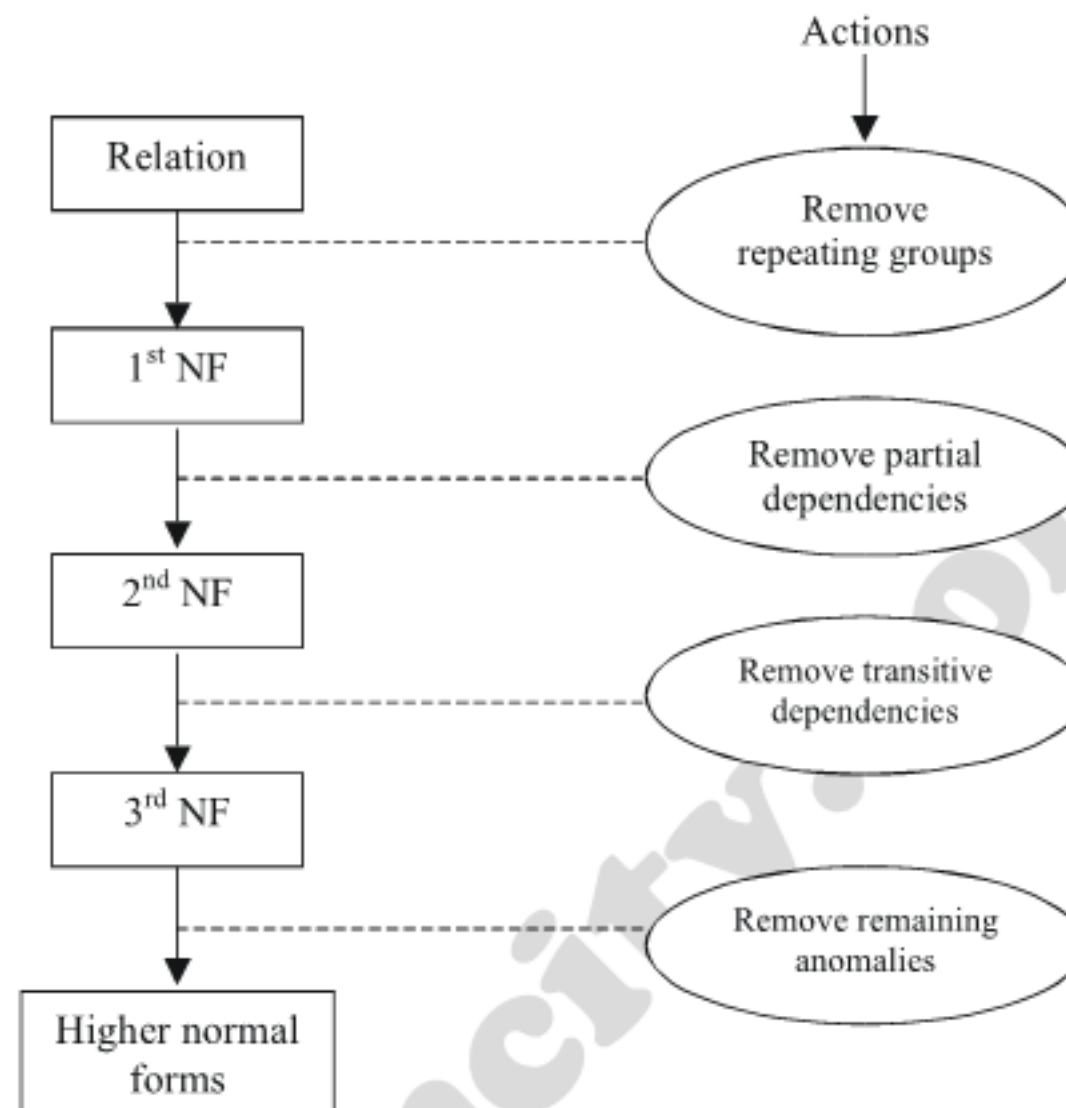
Normalization is a process of converting complex data structures into simple and stable data structures.

- Normalization was first proposed by Dr. E.F. Codd.
- Normalization is a technique for reviewing the list of entities and their attributes to ensure that attributes are stored from where they belong.
- In other words we can say that it is a process of analyzing the dependencies of attributes within entities and it is performed as a series of tests on a relation.
- Attributes of each entity are checked against the rules called Normal form and each normal form has some specific conditions.

Before normalization a few terms must be discussed.

Normalization steps:

Normalization is accomplished in steps, each of which represents a normal form. A normal form is a state of relation that can be determined by applying simple rules to that relation. The flow of normalization through different steps can be explained as follows.



There are three types of normal forms.

- (1) First normal form.
- (2) Second normal form.
- (3) Third normal form.

Q6. When a relation is in First Normal Form? Explain with the help of an example.

First normal form:

- A relation is in first normal form if and only if all underlying domain contain atomic values only. Each cell should contain only one value and relation does not contain any repeating groups.
- A repeating group is an attribute in which data items may repeat in each tuple at variable number of times.

Example:

Suppose we have a relation DEPARTMENT.

DEPARTMENT

DEPT_NO	DEPT_NAME	EMP_NO	EMP_NAME
D01	Management	E01	Kashif Basher

		E02	Qasim
D02	Finance	E05	Huma Khalid
D03	Marketing	E03 E21	Hamid Ai Imran Shakeel

- In above example the relation contains repeating groups.
- The EMP_NO and EMP_NAME are repeated for single occurrence of DEPT_NO and DEPT_NAME.
- To bring it into 1st NF eliminate the repeating groups from the table and fill in the missing information.

DEPARTMENT

DEPT_NO	DEPT_NAME	EMP_NO	EMP_NAME
D01	Management	E01	Kashif Basher
D01	Management	E02	Qasim
D02	Finance	E05	Huma Khalid
D03	Marketing	E03	Hamid Ai
D03	Marketing	E21	Imran Shakeel

- For any tuple of an entity, each attribute must have one and only one value or “an attribute must have no repeating groups”.
- The error exists in the above example because some attributes are being repeated for a single occurrence of each record.

Following steps should be taken to overcome this problem

- Repeating attributes must be removed and placed where it belongs, under the entity that defines it.
- Analyze the relationship of where the repeating attribute come from and where the attribute went to. Determine the relationship whether it is 1:M or M:N.

case 1: If the relationship between entities is 1:M e.g. one department have more than one employees and one employee can belong to only one department at a time. There is no need to do any further change.

case 2: If in a situation relationship is M:N i.e. one department have many employees and one employee can work for more than one department then we need another table to store intersection data. The new table can be EMP_DEPT.

Q7. When a relation is in Second Normal Form? Explain with the help of an example.

Second Normal Form:

- A relation is in 2nd NF if it is in 1st NF and every non-key attribute is fully functionally dependent on the primary key. All non key attributes must depend on all parts of primary key.

Following are few conditions for 2nd NF.

- The primary key consists of only one attribute
- Every non-key attribute is fully functionally dependant on the all the parts of primary key.

Partial Functional Dependency:

A partial dependency occurs only in a relation with a composite key. It occurs when a non-key attribute also depends on only part of the primary key.

For example, consider the following relation with three attributes.

$R(\underline{A}, \underline{B}, C)$

Relation 'R' has a composite primary key consisting of attributes A and B. As the primary key is unique, the following dependencies must be true:

$A, B \rightarrow C$

C depends on A and B together. That is, A and B together determine C.

A partial dependency exists when only some of the attributes in a composite key can also determine a non-key attribute. That is a partial dependency occurs if one of the following dependencies is true.

$A \rightarrow C$ C depends on A alone. A alone determines C.

$B \rightarrow C$ C depends on B alone. B alone determines C.

Example:

In the following example STUDENT relation is in first normal form

STUDENT

STDID	STDNAME	CLASS	FEE	CRSNO	CRSDATE
D01	Imran	C01	10000	CR101	120898
D01	Imran	C01	10000	CR205	150998
D02	Saeed	C01	10000	CR207	071098
D03	Baqir	C02	15000	CR201	060499
D03	Baqir	C02	15000	CR205	150998
D04	Nazir	C03	12000	CR305	120999

The above relation contains different redundancies. The relation can be expressed using another notation.

STUDENT (STDID, STDNAME, CLASS, FEE, CRSNO, CRSDATE)

- The above relation contains a composite primary key of STDID and CRSNO.
- The functional dependencies in this relation are as follows.

STDID $\rightarrow$ STDNAME, CLASS, FEE

STDID, CRSNO $\rightarrow$ CRSDATE

- The non-key attributes NAME, CLASS and FEE are functionally dependent on part of primary key i.e. STDID.
- STDID is not a complete key.
- A type of dependency in which one or more non-key attributes are functionally dependent on a part of primary key is called partial dependency.
- The partial dependency creates redundancy.
- It also results certain database anomalies when database is updated.

Insertion anomaly:

- Suppose a new course is to be added in the relation.
- The new course cannot be inserted without the insertion of a STDID because it is part of primary key and cannot be NULL.

Deletion anomaly:

- Suppose the record of STDID is D04 is to be deleted.
- The information about CRSNO will also be deleted.

Modification anomaly:

- Suppose the name of STDID D01 is to be updated.
- It requires updating all records in which STDID D01 appears.

A relation with redundant data can be converted into 2nd NF by decomposing it into two relations. The above relation can be split into two relations STUDENT and COURSE.

STUDENT

STDID	STDNAME	CLASS	FEE
D01	Imran	C01	10000
D02	Saeed	C01	10000
D03	Baqir	C02	15000
D04	Nazir	C03	12000

COURSE

STDID	CRSNO	CRSDATE
D01	CR101	120898
D01	CR205	150998
D02	CR207	071098

D03	CR201	060499
D03	CR205	150998
D04	CR305	120999

- The primary key in STUDENT relation consists of only one attribute.
- It satisfies first condition.
- The attribute CRSDATE in COURSE relation fully functionally depends on whole composite key.
- It satisfies the third condition.
- It means that both relation are in second normal form.

Q8. When a relation is in Third Normal Form? Explain with the help of an example.

Third normal form:

A relation is in 3rd NF if it is in 2nd NF and no transitive dependencies exist.

Transitive dependency:

- It is a functional dependency between two or more non-key attributes of a relation and for 3rd NF a non-key attribute must not depend on any other non-key attribute.

Example:

Consider a relation

SALES (CUSNO, NAME, SALESMAN, REGION)

Where CUSNO is a primary key

The following functional dependencies exist in the relation.

$CUSNO \rightarrow NAME, SALESMAN$

$SALESMAN \rightarrow REGION$

- SALES table is in 2nd NF because the primary key consists of only one attribute.
- But REGION only depends on SALESPERSON therefore it is transitive dependency which is violation of 3rd NF.
- As a result there are update anomalies in relation SALES.

SALES

CUSNO	NAME	SALESMAN	REGION
C001	HEWAD	Tahir	East
C002	ALLIED	Muneer	South
C006	AWAN	Azam	East

C003	HAJVAIRY	Asghar	West
C008	PUNJAB	Muneer	South
C004	HITECH	Imran	East

Insertion anomaly:

A new salesman assigned to the north region can not be entered until a customer has been assigned to him.

Deletion anomaly:

If CUSNO C004 we loose the information that SALESMAN Imran is assigned to the East region.

Modification anomaly:

If SALESMAN Muneer is reassigned to the East region, several rows must be changed to reflect the fact.

These anomalies arise as a result of the transitive dependency. This problem can be removed by decomposing the relation.

SALESMAN

CUSNO	NAME	SALESMAN
C001	HEWAD	Tahir
C002	ALLIED	Muneer
C006	AWAN	Azam
C003	HAJVAIRY	Asghar
C008	PUNJAB	Muneer
C004	HITECH	Imran

SALES

SALESMAN	REGION
Tahir	East
Muneer	South
Azam	East
Asghar	West
Imran	East

Now both the relations are in 3rd NF because no transitive dependency exists.

Q.9 Define functional dependency.

Ans. Functional Dependency:

Case 1: When primary key consist of single column.

A functional dependency occurs when one attribute in a relation uniquely determines another attribute. It shows a relationship between two attributes in a relation.

For example, an attribute B is functionally dependent upon an attribute A if each value of attribute A determines only one value of attribute B.

The functional dependency of B on A is represented by an arrow as:

$$A \rightarrow B$$

This expression is read as “B depend on A”. The attribute on the left-hand side of the arrow (A in this example) is called the determinant. This expression, therefore, is also read as “A determine B”.

For example, consider the following relation:

STUDENT (Std-ID, Std-Address, Std-Phone)

In this relation, Std-ID uniquely defines other attributes in the relation. It means that in this relation, the name of a student can be found referring to that student's Std-ID. This means that Std-ID defines a student's name.

The word “defines”, means that for every Std-ID, there will be one and only one name. Thus, Std-Name is functionally dependent on Std-ID. Similarly, Std-Address and Std-Phone are also functionally dependent upon Std-ID. This dependency is shown as:

$\text{Std-ID} \rightarrow \text{Std-Name, Std-Address, Std-Phone}$

Following are some common examples of functional dependencies.

$\text{ID Card Number} \rightarrow \text{Name, Address, Date of Birth}$

A person's name, address, and date of birth are functionally dependent upon the person's national identity card number.

$\text{ISBN} \rightarrow \text{Title, Author's Name}$

The title and author's name of a book are functionally dependent upon the International Standard Book Number (ISBN) of the book.

Full Functional Dependency:

Case 2: When primary key consist of more than one column.

Full functional dependency occurs when all non-key attributes in a relation depend only upon the key attribute of the relation.

For example, consider the following relation:

RESULT (Roll-No, Class, Marks)

The relation RESULT has a composite key consisting of two attributes Roll-No and Class. Sample data for this relation is shown below:

RESULT

Roll-No	Class	Marks
45	C++	75
45	VB.Net	55
53	Java	85
48	Oracle	66
48	C#	92

In this relation, the following dependency occurs:

$\text{Roll-No, Course} \rightarrow \text{Marks}$

This is a full dependency. Both the attributes in the composite primary key are needed to determine Marks.

The attribute Roll-No alone cannot determine Marks. Similarly, Marks also cannot be determined with the Class attribute alone.

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