Normalization

20 October 2024 11:39

Normalization in database management system is the process of organizing data in a database to minimize redundancy and improve data integrity. It involves dividing a database into two or more tables and defining relationship between them to reduce duplication and ensure data dependencies make sense.

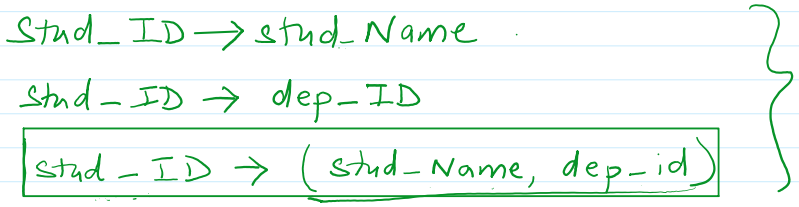
Problems caused by redundancy.

Storing the same information redundantly, that is, in more than one places within a database can lead to several problems.

- **Redundant storage:** Some information is stored repeatedly.
- **Update anomalies:** If one copy of such repeated data is updated and. inconsistency is created unless all copies are similarly updated.
- **Insertion anomalies:** It may not be possible to store some information unless some other information is stored as well.
- **Deletion anomalies:** It may not be possible to delete some information without losing some other information as well.

Functional Dependencies (FD)
A functional dependency in a database refers. to a relationship between two sets of attributes or columns within a table. Specifically of functional dependency, occurs when one attribute or a group of attributes uniquely determines another attribute. If knowing the values of one attribute allows you to know the value of another, then the 2nd attribute is set to be functionally dependent on the first.

Notation: A->B {Attribute A determines attribute B}



1. **Determinant:** The attribute or set of attributes on the left. On the left side of the functional dependency is called the determinant. It uniquely determines the value of the other attribute.
2. **Dependent:** The attribute on the right side. is called the dependent attribute. Its value is determined by the determinant.

TABLE 6.1

A SAMPLE REPORT LAYOUT

PROJECT NUMBER	PROJECT NAME	EMPLOYEE NUMBER	EMPLOYEE NAME	JOB CLASS	CHARGE/ HOUR	HOURS BILLED	TOTAL CHARGE
15	Evergreen	103	June E. Arbough	Elec. Engineer	$ 84.50	23.8	$ 2,011.10
		101	John G. News	Database Designer	$105.00	19.4	$ 2,037.00
		105	Alice K. Johnson *	Database Designer	$105.00	35.7	$ 3,748.50
		106	William Smithfield	Programmer	$ 35.75	12.6	$ 450.45
		102	David H. Senior	Systems Analyst	$ 96.75	23.8	$ 2,302.65
				Subtotal			**$10,549.70**
18	Amber Wave	114	Annelise Jones	Applications Designer	$ 48.10	24.6	$ 1,183.26
		118	James J. Frommer	General Support	$ 18.36	45.3	$ 831.71
		104	Anne K. Ramoras *	Systems Analyst	$ 96.75	32.4	$ 3,134.70
		112	Darlene M. Smithson	DSS Analyst	$ 45.95	44.0	$ 2,021.80
				Subtotal			**$ 7,171.47**
22	Rolling Tide	105	Alice K. Johnson	Database Designer	$105.00	64.7	$ 6,793.50

		112	Darlene M. Smithson	DSS Analyst	$ 45.95	44.0	$ 2,021.80
				Subtotal			**$ 7,171.47**
22	Rolling Tide	105	Alice K. Johnson	Database Designer	$105.00	64.7	$ 6,793.50
		104	Anne K. Ramoras	Systems Analyst	$96.75	48.4	$ 4,682.70
		113	Delbert K. Joenbrood *	Applications Designer	$48.10	23.6	$ 1,135.16
		111	Geoff B. Wabash	Clerical Support	$26.87	22.0	$ 591.14
		106	William Smithfield	Programmer	$35.75	12.8	$ 457.60
				Subtotal			**$13,660.10**
25	Starflight	107	Maria D. Alonzo	Programmer	$ 35.75	24.6	$ 879.45
		115	Travis B. Bawangi	Systems Analyst	$ 96.75	45.8	$ 4,431.15
		101	John G. News *	Database Designer	$105.00	56.3	$ 5,911.50
		114	Annelise Jones	Applications Designer	$ 48.10	33.1	$ 1,592.11
		108	Ralph B. Washington	Systems Analyst	$ 96.75	23.6	$ 2,283.30
		118	James J. Frommer	General Support	$ 18.36	30.5	$ 559.98
		112	Darlene M. Smithson	DSS Analyst	$ 45.95	41.4	$ 1,902.33
				Subtotal			**$17,559.82**
				Total			**$48,941.09**

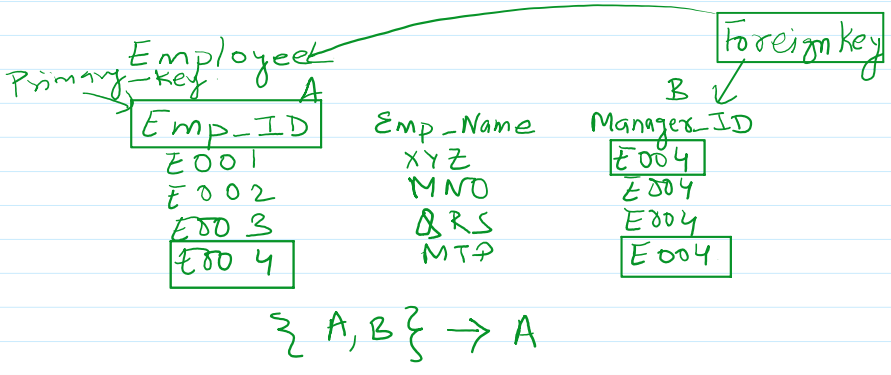
Note: A * indicates the project leader.

FUNCTIONAL DEPENDENCE CONCEPTS

CONCEPT	DEFINITION
Functional dependence	The attribute *B* is fully functionally dependent on the attribute *A* if each value of *A* determines one and only one value of *B*. Example: PROJ_NUM → PROJ_NAME (read as *PROJ_NUM functionally determines PROJ_NAME*) In this case, the attribute PROJ_NUM is known as the determinant attribute, and the attribute PROJ_NAME is known as the dependent attribute.
Functional dependence (generalized definition)	Attribute *A* determines attribute *B* (that is, *B* is functionally dependent on *A*) if all (generalized definition) of the rows in the table that agree in value for attribute *A* also agree in value for attribute *B*.
Fully functional dependence (composite key)	If attribute *B* is functionally dependent on a composite key *A* but not on any subset of that composite key, the attribute *B* is fully functionally dependent on *A*.

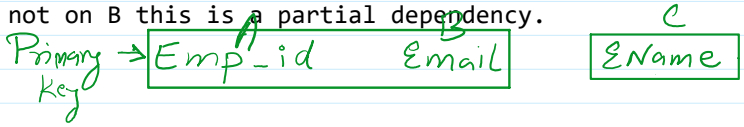
Types of functional dependencies:

1. **Trivial Functional dependency:** Of function dependency is trivial if the dependent attribute is a subset of the determinant. For example, {A,B}->A is a trivial functional dependency because knowing both A and B trivially determines A.
2. **Non-trivial functional dependency**: If the dependent attribute is not a subset of a determinant. it is nontrivial, functional dependency. For example, A->B is non-trivial if is not part of A.



3. **Partial functional dependency:** In the case of composite keys. a partial dependency exist when. an attribute depends on. only part of the composite key rather than the whole key. For example, in a table with a composite key (A,B), if C depends only on A

3. **Partial functional dependency:** In the case of composite keys. a partial dependency exist when. an attribute depends on. only part of the composite key rather than the whole key. For example, in a table with a composite key (A,B), if C depends only on A but not on B this is a partial dependency.



4. **Transitive functional dependency:** A transitive dependency occurs when an attribute depends indirectly on a determinant. For instance, if A->B and B->, then A->C is a transitive functional dependency.

Types of Normal Forms:

NORMAL FORMS	
NORMAL FORM	**CHARACTERISTIC**
First normal form (1NF)	Table format, no repeating groups, and PK identified
Second normal form (2NF)	1NF and no partial dependencies
Third normal form (3NF)	2NF and no transitive dependencies
Boyce-Codd normal form (BCNF)	Every determinant is a candidate key (special case of 3NF)
Fourth normal form (4NF)	3NF and no independent multivalued dependencies

What is Normalization?
It is a process for evaluating and correcting table structures to minimize data redundancies there. reducing the likelihood of data anomalies.

Normalization walks through a series of stages called normal forms. The. first three stages are described as first normal form or (1NF), second normal form (2NF) and third normal form 3NF.
From a structural point of view, 2NF is better than 1NF and 3NF is better than 2NF.

Denormalization:
Produce a lower normal form which is a 3NF will be converted to a 2NF through denormalization. A successful design must also consider end user demand for fast performance. Therefore, you will occasionally be expected to de-normalize some portion of database design in order to meet performance requirement.

The Normalization Process:
We will learn how to use normalization to produce a set of normalized table to store the data that will be used to generate the required information. The objective of normalization is to ensure that each table conforms to the concept of well-formed relation, that is, tables that have the following characteristics.

- Each payable represents a single subject for example. a course table will contain only data that directly pertains. to courses. similarly, a student table will contain only student data
- No data item will be unnecessarily stored in more than one table (In short, tables have minimal. controlled redundancy.) The reason for this requirement is to ensure that the data are updated in one place.
- All non-prime attributes in a table are dependent on the primary key. The reason for this requirement is to ensure that the data are uniquely identifiable by a primary key value.
- Each table is void of insertion update or deletion anomalies. This is to ensure the integrity and consistency of the data.

Conversion to First Normal Form(1NF)
Step-1:: Eliminate the Repeating Groups

Start by presenting the data in tabular format where each cell has a single value and there are no repeating groups. A repeating group derives its name from the fact that a group of multiple entries of the same type can exist for any single key attribute occurrence. To eliminate the repeating groups, eliminate the nulls by making sure that each repeating group attribute contains an appropriate data value.

FIGURE 6.2 A TABLE IN FIRST NORMAL FORM

Table name: DATA_ORG_1NF **Database name: Ch06_ConstructCo**

PROJ_NUM	PROJ_NAME	EMP_NUM	EMP_NAME	JOB_CLASS	CHG_HOUR	HOURS
15	Evergreen	103	June E. Arbough	Elect. Engineer	84.50	23.8
15	Evergreen	101	John G. News	Database Designer	105.00	19.4
15	Evergreen	105	Alice K. Johnson *	Database Designer	105.00	35.7
15	Evergreen	106	William Smithfield	Programmer	35.75	12.6
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22	Rolling Tide	104	Anne K. Ramoras	Systems Analyst	96.75	48.4
22	Rolling Tide	113	Delbert K. Joenbrood *	Applications Designer	48.10	23.6
22	Rolling Tide	111	Geoff B. Wabash	Clerical Support	26.87	22.0
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25	Starflight	101	John G. News *	Database Designer	105.00	56.3
25	Starflight	114	Annelise Jones	Applications Designer	48.10	33.1
25	Starflight	108	Ralph B. Washington	Systems Analyst	96.75	23.6
25	Starflight	118	James J. Frommer	General Support	18.36	30.5
25	Starflight	112	Darlene M. Smithson	DSS Analyst	45.95	41.4

Step-2::Identify the primary key

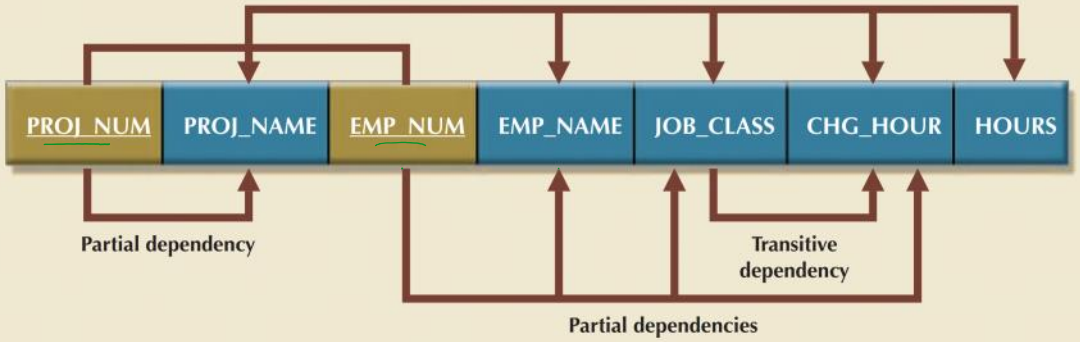
Even casual observers will note that PROJ_NUM is not an adequate primary key because the project number does not uniquely identify all of the remaining entity (row) attributes. To maintain a proper primary key that will uniquely identify any attribute value. The new key must be. composed of combination of a PROJ_NUM and EMP_NUM.

Step-3::Identify All Dependencies:

The identification of the primary key in step 2 means that you have already identified the following dependencies:

* PROJ_NUM, EMP_NUM → PROJ_NAME, EMP_NAME, JOB_CLASS. CHG_HOUR, HOURS.
* PROJ_NUM → PORJ_NAME
* EMP_NUM → (EMP_NAME, JOB_CLASS, CHG_HOUR)
* JOB_CLASS → CHG_HOUR.

FIGURE 6.3 FIRST NORMAL FORM (1NF) DEPENDENCY DIAGRAM



1NF (PROJ_NUM, EMP_NUM, PROJ_NAME, EMP_NAME, JOB_CLASS, CHG_HOURS, HOURS)

PARTIAL DEPENDENCIES:
(PROJ_NUM → PROJ_NAME)
(EMP_NUM → EMP_NAME, JOB_CLASS, CHG_HOUR)

TRANSITIVE DEPENDENCY:
(JOB_CLASS → CHG_HOUR)

composite key

} a dependency based on only a part of a composite Primary key.

↑ Non-prime ↑ Non-prime.

Step-1: Eliminate the repeating Groups.

Step-2: Identify the Primary-key

Step-3: Identify all dependencies.

The Tom first normal form describes the tabular format in which:

- All of the key attributes are defined.
- There are no repeating groups in the table. In other words, each row or column intersection contains 1 and only 1 value, not a set of values.
- All attributes are dependent on the primary key.

The problem with the first normal form table structure is that it contains partial dependencies, while, partial dependencies are sometimes used for performance reason, they should be used with caution.