- Y is a prime attribute, i.e., each element of Y is part of some candidate key.

Let's understand the 3NF using the following examples.

Rollno	Std_Name	Std_Age
10401	A	18
10402	B	19
10403	C	18
10404	D	20
10405	E	19

The Candidate key of the above table is {Rollno}. The non-prime attributes are the attributes except the Rollno. Here, Std_age is dependent on Std_name. The non-prime attributes (Std_Name and Std_Age) are transitively dependent on the super key (Rollno). It violates the rule of the third normal form. That's why we need to decompose the table as follows.

Rollno	Std_Name
10401	A
10402	B
10403	C
10404	D
10405	E

Std_Name	Std_Age
A	18
B	19
C	18
D	20
E	19

iv) Boyce Codd normal form (BCNF): The BCNF is the advanced version of 3NF. A relation is in BCNF if every functional dependency X '! Y, X is the super key of the table. For a BCNF, the relation should be in 3NF, and for every functional dependency, the Left-Hand Side should be super key. Let's understand the BCNF with the help of the following table where one student can take the different subjects of the different department

the actual database design and development. The database administrator and database developers create the physical views of a database.

11.7 SCHEMA AND SUBSCHEMA

A database schema is the frame structure that denotes the logical view of the database. It represents how the data is stored and organized in a database. It also defines how the relations among dataare associated. A database schema representsthe entities and the relationship among the entities. The database designers design the schema to help database programmers to understand the database and make it useful. The schema is the complete description of a database that includes the field names and descriptions of all records, and elements.

A subschema provides a view of the database as seen by an application program. This view is often a subset of the complete schema definition. A subschema is used at runtime to provide the DBMS with a description of those portions of the database that are accessible to the application program.The subschema can restrict access to the database by identifying:

- Areas, records, elements, and sets that are accessible
- The Data Manipulation Language (DML) functions that can be performed

11.8 TYPES OF RELATIONSHIPS IN THE DATABASE

Three types of relations are present in the database:

- **one-to-one (1:1):**The one-to-one relation is used to create a relationship between two tables. Here, a single row of the first table can be related to one and only one record of a second table. Similarly, the row of a second table can also be related to anyone row of the first table. Let's, have two tables, table A and table B. Table A contains the First name of the student of KKHSOU and Table B contains the age of the students, now the one-to-one (1:1) relationship is presented as follows.

Table A: Student Name	Table B: Age
AAAA	20
AAA	21

- **one-to-many (1:M):**It is used to create a relationship between two tables. Any single row of the first table can be related to one or more rows of the second table. But, the rows of the second table can only relate to the only row in the first table. It is also known as a **many-to-one** relationship. Let's, have two tables, table A and table B. Table A contains the First name of the student of KKHSOU and Table B contains the name of the favorite game of the students, now one-to-many (1:M) relationship is presented as follows.

Table A: Student Name	Table B: Favourite Game
AAAA	Cricket
AAA	Football

- **Many-to-many (M:M):**In many to many relationships,each record of the first table can relate to any records (or no records) in the second table. Similarly, each record of the second table can also relate to more than one record of the first table. It is also represented an **N:N** relationship.Let's, have two tables, table A and table B. Table A contains the First name of the student of KKHSOU and Table B contains the name of the favorite game of the students, now one-to-many (1:M) relationship is presented as follows.



CHECK YOUR PROGRESS

Q 6: What is difference between the logical and physical views of data?

ii) 2 NF: A relation will be in 2NF if it is in 1NF and all non-key attributes are fully functional dependent on the primary key. Let's understated the 2NF using the following examples.

Rollno	Name	Age
10401	A	18
10401	A	19
10402	B	18
10403	C	20
10404	D	19

In the above table, the non-prime attribute age is fully functionally dependent on the primary key (**Rollno**). It is a proper subset of candidate keys. That's why, it violates the rule for 2NF. You can convert the given table into 2NF by decomposing the above table into two tables:

Rollno	Name
10401	A
10401	A
10402	B
10403	C
10404	D

Rollno	Age
10401	18
10401	19
10402	18
10403	20
10404	19

iii) 3 NF: Arelation will be in 3NF if it is in 2NF and does not contain any transitive partial dependency. It is used to reduce data duplication and achieve data integrity. A relation must be in third normal form if there is no transitive dependency for non-prime attributes.

A relation is said to be in third normal form if it holds atleast one of the following conditions for every non-trivial function dependency X→Y.

- X is a super key.

Rollno	Name	Program
10401	A	Computer Science
10402	B	Computer Science
10403	C	Computer Science
10404	D	Computer Science

In the table above, you have data of 3 Computer Science students. As you can see, data for the field Program is repeated for the students who are in the same programComputer Science in KKHSOU, this is Data Redundancy.To minimize the anomalies, different normalization techniques are used in the database. They are presented below.

i) **1 NF:** A relation is said to be in 1NF if it contains an atomic value. If a relation contains more than one value or composite or multi-valued attribute, it violates the first normal form. A relation is in first normal form if the relation has a single-valued attribute. The following table is in 1 NF.

Rollno	Name	Program
10401	A	Computer Science
10402	B	Computer Science
10403	C	Computer Science
10404	D	Computer Science

But, the following table is not in 1-NF.

Rollno	Name	Phone No
10401	A	111,222
10402	B	333
10403	C	444
10404	D	444

But, you can decompose the table into 1NF and it has been shown below:

Rollno	Name	Phone No
10401	A	111
10401	A	222
10402	B	333
10403	C	444
10404	D	444

Q 7: What is a schema in database?

Q 8: What is subschema in database?

Q 9: What is a one-to-many relationship of tables in database?

Q 10: A relational database consists of a collection of _____.

Q 11: A _____ in a table represents a relationship among a set of values.

11.9 TYPES OF DATABASES

Databases can be organized into the following categories:

a. **Centralised Database:** Centralized database stores data or information at a centralized database system or server. Users can access the stored data from different locations through several applications. The authentication process ensures the users access data securely. For example, Central Library. It decreases the risk of data management, i.e., manipulation of data will not affect the core data. Data consistency is properly maintained. The main issue of a centralized database is the larger size of the centralized database which increases the response time for fetching the data.If any central server failure occurs, entire data will be lost.

b. **Distributed Database:** Unlike a centralized database system, in a distributed database, the information or data is distributed among different database systems. These database systems are connected via communication links. For Example, Apache, Ignite, etc. A distributed database system may be either a homogeneous or heterogeneous distributed database. The homogeneous database systems execute on the same operating system, use the same application process, and carry the same hardware devices to execute the user queries. The heterogeneous database systems execute on different operating systems with different application procedures and different hardware devices. Failures of the server will not affect the entire data set.

c. **Relational Database:** The relational databases are based on the relational data model. In the relational data model, the data are stored in the form of rows(tuple) and columns(attributes), and these rows and columns are from a table(relation). A SQL language is used for storing, manipulating, as well as maintaining the data. For Example, MySQL, Microsoft SQL Server, Oracle, etc, are relational databases. In this type of database, the ACID properties are maintained where ACID stands for atomicity, consistency, isolations, and durability.

d. **NoSQL Database:** Non-SQL/Not Only SQL is a type of database that is used for storing a wide range of data sets. Apart from the tabular format, it stores data in several different ways such as key-value storage, documented oriented database, graph database, and wide column database, and that is the reason that it is not a relational database. It is applicable for building modern applications database systems.

e. **Cloud Database:** When data are stored in a virtual environment and executing over the cloud computing platform, then these types of databases are known as cloud databases. It provides different cloud computing services, such as SaaS, PaaS, IaaS, etc. for accessing the data from the database. Following are the different cloud platforms.
   - Amazon Web Services (AWS)
   - Microsoft Azure
   - Google Cloud SQL, etc.

f. **Object-oriented Databases:** In object-oriented databases, the object-oriented models are used to storethe data in the database system. The data present in the object-oriented databases are known as objects.

g. **Hierarchical Databases:** It is the type of database that stores data in the form of Hierarchical order or parent-children relationship nodes. Here, it organizes data in a tree-like structure.Data are stored in the tree nodes, which are connected via links in the Hierarchical model.

h. **Network Databases:**It is the database that is based on the network data model. Here, the data is in the form of nodes that are connected via links between them. Unlike the hierarchical database, it allows each record to have multiple children and parent nodes to form a generalized graph structure.

11.10 ROLE OF A DATABASE ADMINISTRATOR

A Database Administrator (DBA) takes care of the design, organize, update, etc. of a computer database so that a user gets the necessary information from the database at the time of the request. The followings are the responsibilities of a DBA.

i) A DBA works with a database and finds the best possible way to store, organize, and manage data in the database.
ii) A DBA handles the database troubleshooting.
iii) A DBA keeps the database update.
iv) A DBA manages the database access.
v) A DBA ensures to meet the user demands during the query processing.
vi) A DBA backup the data of a database.
vii) A DBA writes the reports, documentation, and operation manuals of a database.
viii) A DBA implements the security measure of a database.
ix) A DBA achieves the data of a database.

11.11 NORMALIZATION

A database may have redundant data. Normalization is a process of minimizing the redundancy from a database by minimizing the redundancy from the relations. Redundant data may cause insertion, deletion, and update anomalies. To understand the data redundancy, let's take an example of the student table of KKHSOU.