Differences between database management system and file-processing system:

Some main differences between a database management system and a file-processing system are:

• Both systems contain a collection of data and a set of programs which access that data. A database management system coordinates both the physical and the logical access to the data, whereas a file-processing system coordinates only the physical access.

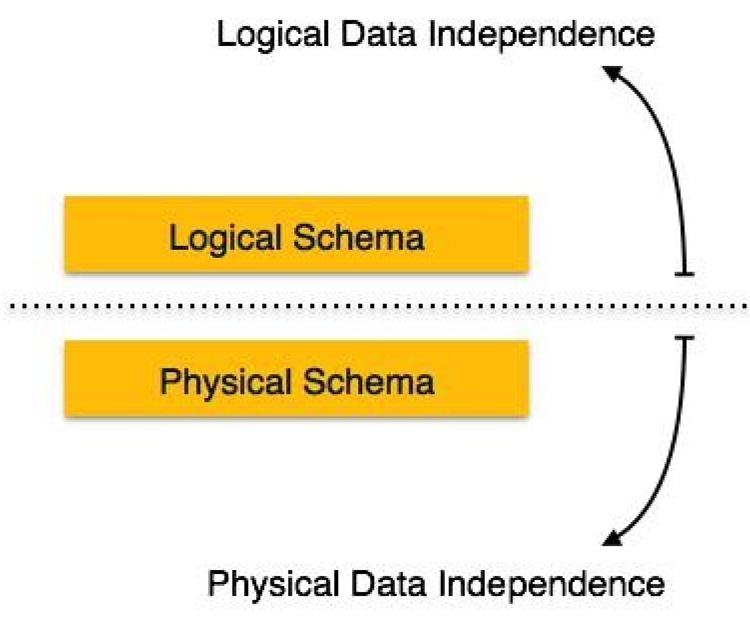
• A database management system reduces the amount of data duplication by ensuring that a physical piece of data is available to all programs authorized to have access to it, whereas data written by one program in a file-processing sstem may not be readable by another program.

• A database management system is designed to allow flexible access to data (i.e., queries), whereas a file-processing system is designed to allow pre-determined access to data (i.e., compiled programs).

• A database management system is designed to coordinate multiple users accessing the same data at the same time. A file-processing system is usually designed to allow one or more programs to access different data files at the same time. In a file-processing system, a file can be accessed by two programs concurrently only if both programs have read-only access to the file.

Data Independence:

A database system normally contains a lot of data in addition to users' data. For example, it stores data about data, known as metadata, to locate and retrieve data easily. It is rather difficult to modify or update a set of metadata once it is stored in the database. But as a DBMS expands, it needs to change over time to satisfy the requirements of the users. If the entire data is dependent, it would become a tedious and highly complex job.



Metadata itself follows a layered architecture, so that when we change data at one layer, it does not affect the data at another level. This data is independent but mapped to each other.

Logical Data Independence

Logical data is data about database, that is, it stores information about how data is managed inside. For example, a table (relation) stored in the database and all its constraints, applied on that relation.

Logical data independence is a kind of mechanism, which liberalizes itself from actual data stored on the disk. If we do some changes on table format, it should not change the data residing on the disk.

Physical Data Independence

All the schemas are logical, and the actual data is stored in bit format on the disk. Physical data independence is the power to change the physical data without impacting the schema or logical data.

For example, in case we want to change or upgrade the storage system itself − suppose we want to replace hard-disks with SSD − it should not have any impact on the logical data or schemas.

<u>Differences :</u>

• Physical data independence is the ability to modify the physical scheme without making it necessary to rewrite application programs. Such modifications include changing from unblocked to blocked record storage, or from sequential to random access files.

• Logical data independence is the ability to modify the conceptual scheme without making it necessary to rewrite application programs. Such a modification might be adding a field to a record; an application program's view hides this change from the program.

Five main functions of a database administrator:

Five main functions of a database administrator are:

• To create the scheme definition

• To define the storage structure and access methods

• To modify the scheme and/or physical organization when necessary

• To grant authorization for data access

• To specify integrity constraints

Database is a collection of related data and data is a collection of facts and figures that can be processed to produce information.

Mostly data represents recordable facts. Data aids in producing information, which is based on facts. For example, if we have data about marks obtained by all students, we can then conclude about toppers and average marks.

A **database management system** stores data in such a way that it becomes easier to retrieve, manipulate, and produce information.

Characteristics:

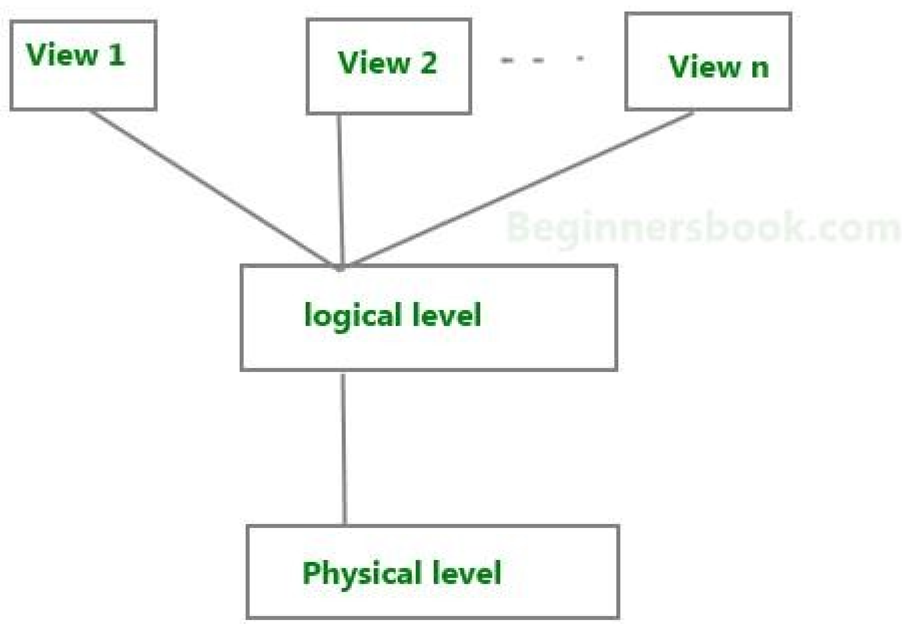
Traditionally, data was organized in file formats. DBMS was a new concept then, and all the research was done to make it overcome the deficiencies in traditional style of data management. A modern DBMS has the following characteristics −

- **Real-world entity** − A modern DBMS is more realistic and uses real-world entities to design its architecture. It uses the behavior and attributes too. For example, a school database may use students as an entity and their age as an attribute.
- **Relation-based tables** − DBMS allows entities and relations among them to form tables. A user can understand the architecture of a database just by looking at the table names.
- **Isolation of data and application** − A database system is entirely different than its data. A database is an active entity, whereas data is said to be passive, on which the database works and organizes. DBMS also stores metadata, which is data about data, to ease its own process.
- **Less redundancy** − DBMS follows the rules of normalization, which splits a relation when any of its attributes is having redundancy in values. Normalization is a mathematically rich and scientific process that reduces data redundancy.
- **Consistency** − Consistency is a state where every relation in a database remains consistent. There exist methods and techniques, which can detect attempt of leaving database in inconsistent state. A DBMS can provide greater consistency as compared to earlier forms of data storing applications like file-processing systems.
- **Query Language** − DBMS is equipped with query language, which makes it more efficient to retrieve and manipulate data. A user can apply as many and as different filtering options as required to retrieve a set of data. Traditionally it was not possible where file-processing system was used.
- **ACID Properties** − DBMS follows the concepts of**A**tomicity, **C**onsistency, **I**solation, and **D**urability (normally shortened as ACID). These concepts are applied on transactions, which manipulate data in a database. ACID properties help the database stay healthy in multi-transactional environments and in case of failure.
- **Multiuser and Concurrent Access** − DBMS supports multi-user environment and allows them to access and manipulate data in parallel. Though there are restrictions on transactions when users attempt to handle the same data item, but users are always unaware of them.
- **Multiple views** − DBMS offers multiple views for different users. A user who is in the Sales department will have a different view of database than a person working in the Production department. This feature enables the users to have a concentrate view of the database according to their requirements.
- **Security** − Features like multiple views offer security to some extent where users are unable to access data of other users and departments. DBMS offers methods to impose constraints while entering data into the database and retrieving the same at a later stage. DBMS offers many different levels of security features, which enables multiple users to have different views with different features. For example, a user in the Sales department cannot see the data that belongs to the Purchase department. Additionally, it can also be managed how much data of the Sales

department should be displayed to the user. Since a DBMS is not saved on the disk as traditional file systems, it is very hard for miscreants to break the code.

Level Of Abstraction in DBMS:

Database systems are made-up of complex data structures. To ease the user interaction with database, the developers hide internal irrelevant details from users. This process of hiding irrelevant details from user is called data abstraction.



Three Levels of data abstraction

We have three levels of abstraction:

Physical level: This is the lowest level of data abstraction. It describes how data is actually stored in database. You can get the complex data structure details at this level.

Logical level: This is the middle level of 3-level data abstraction architecture. It describes what data is stored in database.

View level: Highest level of data abstraction. This level describes the user interaction with database system.

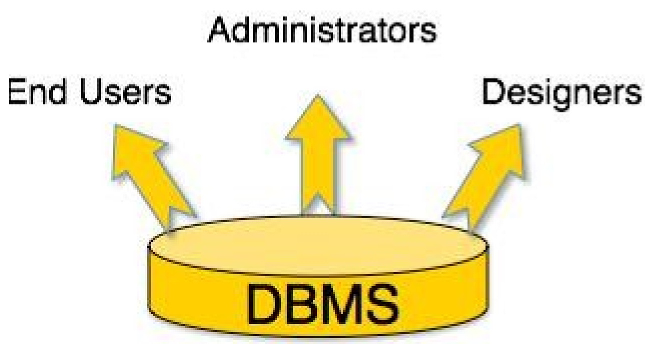
Example: Let's say we are storing customer information in a customer table. At physical level these records can be described as blocks of storage (bytes, gigabytes, terabytes etc.) in memory. These details are often hidden from the programmers.

At the logical level these records can be described as fields and attributes along with their data types, their relationship among each other can be logically implemented. The programmers generally work at this level because they are aware of such things about database systems.

At view level, user just interact with system with the help of GUI and enter the details at the screen, they are not aware of how the data is stored and what data is stored; such details are hidden from them.

Users:

A typical DBMS has users with different rights and permissions who use it for different purposes. Some users retrieve data and some back it up. The users of a DBMS can be broadly categorized as follows –



- **Administrators** − Administrators maintain the DBMS and are responsible for administrating the database. They are responsible to look after its usage and by whom it should be used. They create access profiles for users and apply limitations to maintain isolation and force security. Administrators also look after DBMS resources like system license, required tools, and other software and hardware related maintenance.
- **Designers** − Designers are the group of people who actually work on the designing part of the database. They keep a close watch on what data should be kept and in what format. They identify and design the whole set of entities, relations, constraints, and views.
- **End Users** − End users are those who actually reap the benefits of having a DBMS. End users can range from simple viewers who pay attention to the logs or market rates to sophisticated users such as business analysts.

Data Models in DBMS:

Entity-Relationship Model

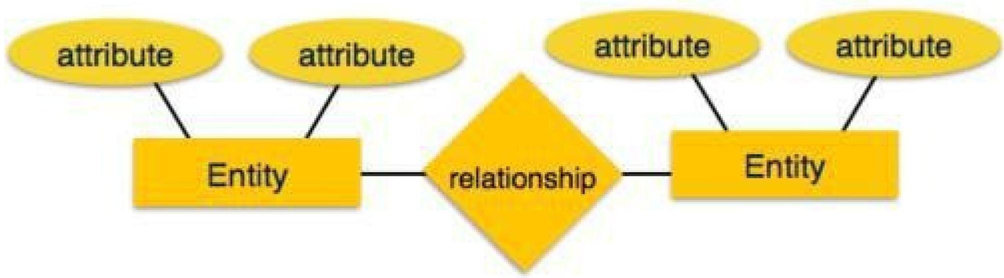
Entity-Relationship (ER) Model is based on the notion of real-world entities and relationships among them. While formulating real-world scenario into the database model, the ER Model creates entity set, relationship set, general attributes and constraints.

ER Model is best used for the conceptual design of a database.

ER Model is based on −

- **Entities** and their *attributes.*
- **Relationships** among entities.

These concepts are explained below.



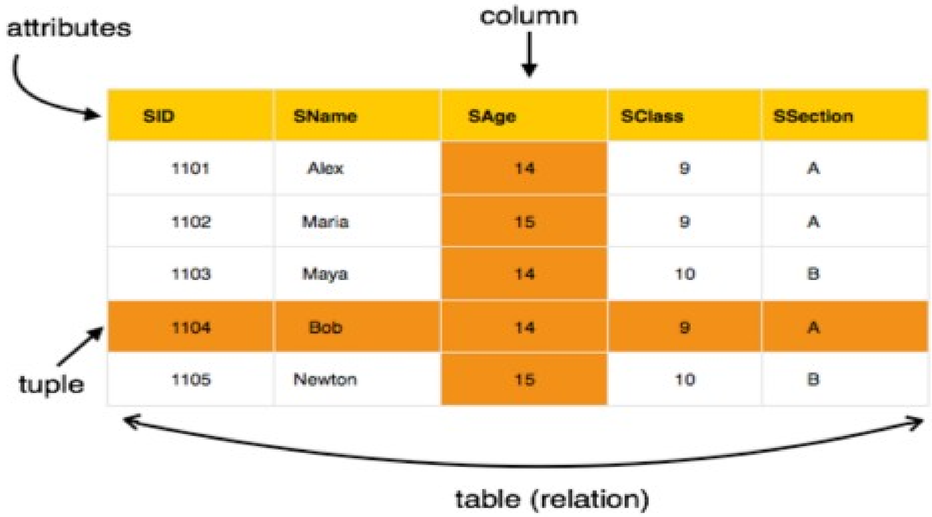
- **Entity** − An entity in an ER Model is a real-world entity having properties called **attributes**. Every **attribute** is defined by its set of values called **domain**. For example, in a school database, a student is considered as an entity. Student has various attributes like name, age, class, etc.
- **Relationship** − The logical association among entities is called ***relationship***. Relationships are mapped with entities in various ways. Mapping cardinalities define the number of association between two entities.

Mapping cardinalities −

- one to one
- one to many
- many to one
- many to many

Relational Model

The most popular data model in DBMS is the Relational Model. It is more scientific a model than others. This model is based on first-order predicate logic and defines a table as an **n-ary relation**.



SID	SName	SAge	SClass	SSection
1101	Alex	14	9	A
1102	Maria	15	9	A
1103	Maya	14	10	B
1104	Bob	14	9	A
1105	Newton	15	10	B

The main highlights of this model are −

- Data is stored in tables called **relations**.
- Relations can be normalized.
- In normalized relations, values saved are atomic values.
- Each row in a relation contains a unique value.
- Each column in a relation contains values from a same domain.

SQL:

SQL is a programming language for Relational Databases. It is designed over relational algebra and tuple relational calculus. SQL comes as a package with all major distributions of RDBMS.

SQL comprises both data definition and data manipulation languages. Using the data definition properties of SQL, one can design and modify database schema, whereas data manipulation properties allows SQL to store and retrieve data from database.

Types of Sql Commands:

Structured Query Language(SQL) as we all know is the database language by the use of which we can perform certain operations on the existing database and also we can use this language to create a database. SQL uses certain commands like Create, Drop, Insert etc. to carry out the required tasks.

These SQL commands are mainly categorized into four categories as discussed below:

1. **DDL(Data Definition Language) :** DDL or Data Definition Language actually consists of the SQL commands that can be used to define the database schema. It simply deals with descriptions of the database schema and is used to create and modify the structure of database objects in database.

Examples of DDL commands:

- CREATE – is used to create the database or its objects (like table, index, function, views, store procedure and triggers).
- DROP – is used to delete objects from the database.
- ALTER-is used to alter the structure of the database.
- TRUNCATE–is used to remove all records from a table, including all spaces allocated for the records are removed.
- COMMENT –is used to add comments to the data dictionary.
- RENAME –is used to rename an object existing in the database.

2. **DML(Data Manipulation Language) :** The SQL commands that deals with the manipulation of data present in database belong to DML or Data Manipulation Language and this includes most of the SQL statements.

Examples of DML:

- SELECT – is used to retrieve data from the a database.
- INSERT – is used to insert data into a table.
- UPDATE – is used to update existing data within a table.
- DELETE – is used to delete records from a database table.

3. **DCL(Data Control Language) :** DCL includes commands such as GRANT and REVOKE which mainly deals with the rights, permissions and other controls of the database system.

Examples of DCL commands:

- GRANT-gives user's access privileges to database.
- REVOKE-withdraw user's access privileges given by using the GRANT command.

4. **TCL(transaction Control Language) :** TCL commands deals with the transaction within the database.

- COMMIT– commits a Transaction.
- ROLLBACK– rollbacks a transaction in case of any error occurs.
- SAVEPOINT–sets a savepoint within a transaction.
- SET TRANSACTION–specify characteristics for the transaction.

Differences between DDL and DML :

DDL	DML
It is Data Definition Language	It is Data Manipulation Language
These are used to define data structure	It is used to manipulate the existing databases.
It is used to define database structure or schema	It is used for managing data within schema objects
Commands are: CREATE, ALTER, DROP, TRUNCATE, RENAME	Commands are: SELECT, INSERT, DELETE, UPDATE, MERGE, CALL
It works on whole table	It works on one or more rows
It do not have a where clause to filter	It have where clause to filter records
Changes done by DDL commands cannot be rolled back	Changes can be rolled back
It is not further classified.	It is further classified as procedural and non procedural DML's
Example:- drop table tablename;	Select * from employee

Basic operations that can modify a database:

INSERT Statements:

The INSERT statement inserts a new row into an SQL table:

```
INSERT INTO Product
   (Name,SKU,Price)
   VALUES ('Ginsu','DPV1486',22.95);
```

You can also issue an INSERT OR UPDATE statement. This statement inserts a new row into an SQL table if the row does not already exist. If the row exists, this statement updates the row data with the supplied field values.

UPDATE Statements;

The UPDATE statement modifies values in one or more existing rows within an SQL table:

```
UPDATE Person
    SET HairColor = 'Red'
    WHERE ID = 435;
```

DELETE Statements:

The DELETE statement removes one or more existing rows from an SQL table:

```
DELETE FROM Person
    WHERE HairColor = 'Aqua';
```

You can issue a TRUNCATE TABLE command to delete all rows in a table. You can also delete all rows in a table using DELETE. DELETE (by default) pulls delete triggers; TRUNCATE TABLE does not pull delete triggers. Using DELETE to delete all rows does not reset table counters; TRUNCATE TABLE resets these counters

Relationship:

The association among entities is called a relationship. For example, an employee **works_at** a department, a student**enrolls** in a course. Here, Works_at and Enrolls are called relationships.

Relationship Set

A set of relationships of similar type is called a relationship set. Like entities, a relationship too can have attributes. These attributes are called **descriptive attributes**.

Degree of Relationship

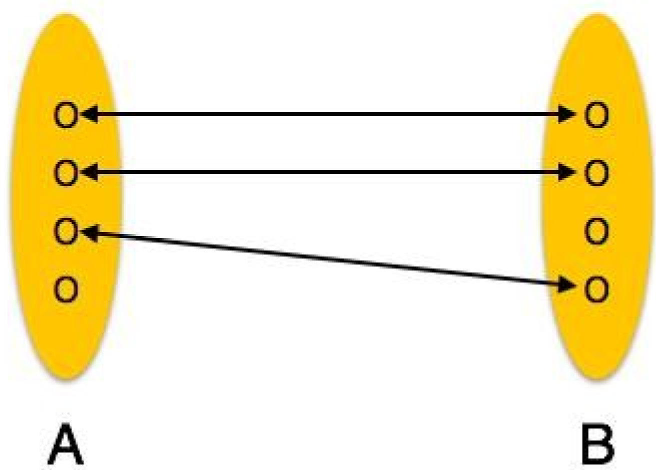
The number of participating entities in a relationship defines the degree of the relationship.

- Binary = degree 2
- Ternary = degree 3
- n-ary = degree

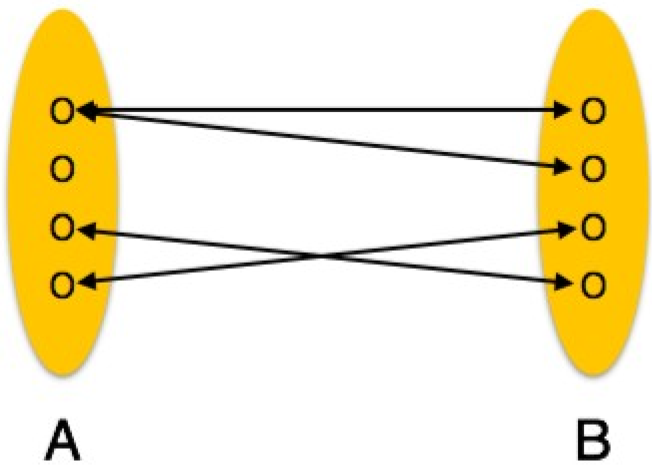
Mapping Cardinalities

Cardinality defines the number of entities in one entity set, which can be associated with the number of entities of other set via relationship set.

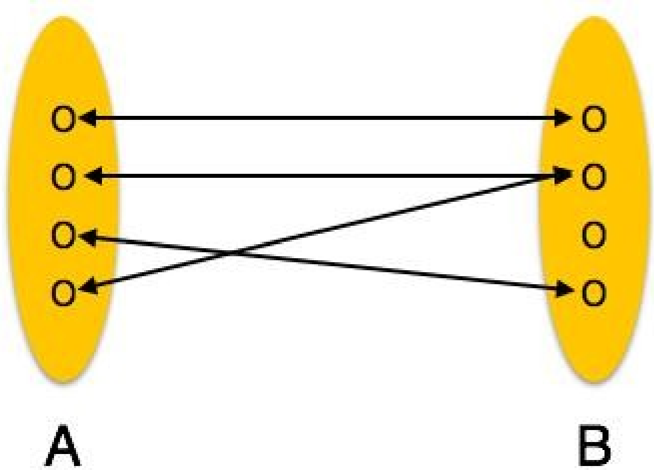
- **One-to-one** − One entity from entity set A can be associated with at most one entity of entity set B and vice versa.



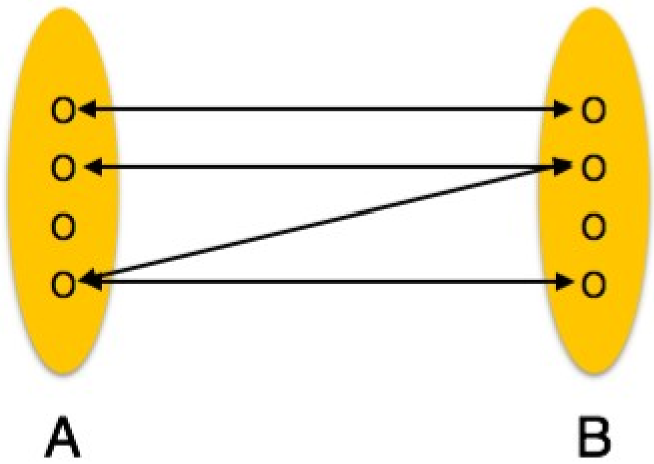
- **One-to-many** − One entity from entity set A can be associated with more than one entities of entity set B however an entity from entity set B, can be associated with at most one entity.



- **Many-to-one** − More than one entities from entity set A can be associated with at most one entity of entity set B, however an entity from entity set B can be associated with more than one entity from entity set A.



- **Many-to-many** − One entity from A can be associated with more than one entity from B and vice versa.



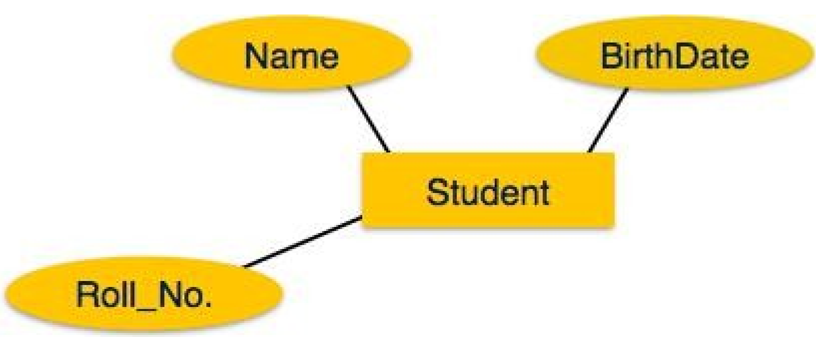
Let us now learn how the ER Model is represented by means of an ER diagram. Any object, for example, entities, attributes of an entity, relationship sets, and attributes of relationship sets, can be represented with the help of an ER diagram.

Entity

Entities are represented by means of rectangles. Rectangles are named with the entity set they represent.

Attributes

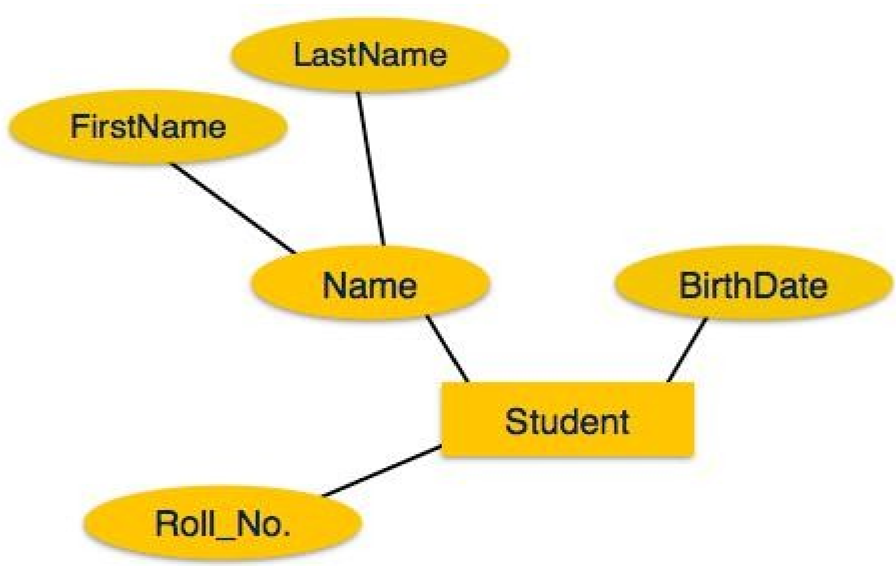
Attributes are the properties of entities. Attributes are represented by means of ellipses. Every ellipse represents one attribute and is directly connected to its entity (rectangle).



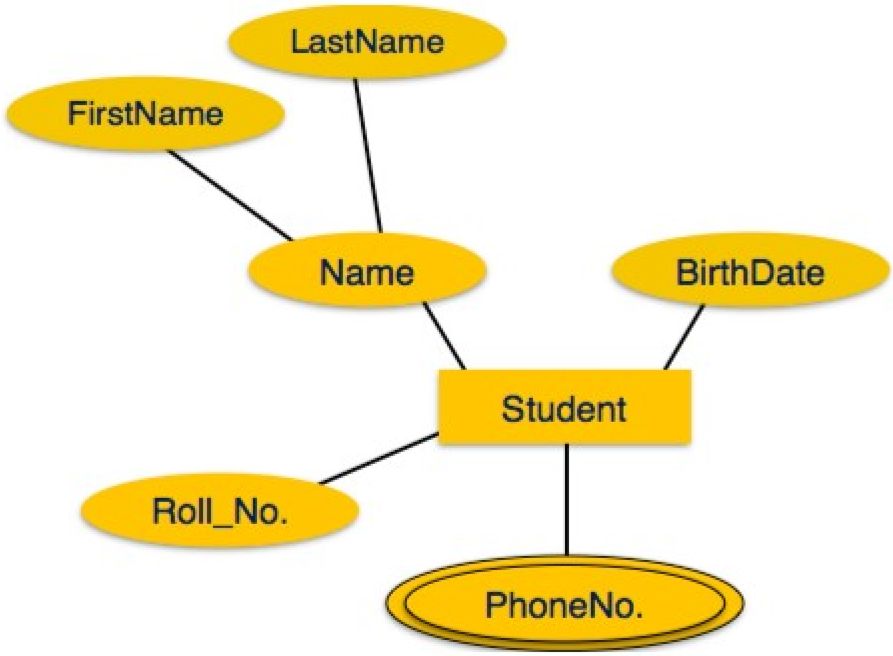
Types of Attributes

- **Simple attribute** − Simple attributes are atomic values, which cannot be divided further. For example, a student's phone number is an atomic value of 10 digits.
- **Composite attribute** − Composite attributes are made of more than one simple attribute. For example, a student's complete name may have first_name and last_name.
- **Derived attribute** − Derived attributes are the attributes that do not exist in the physical database, but their values are derived from other attributes present in the database. For example, average_salary in a department should not be saved directly in the database, instead it can be derived. For another example, age can be derived from data_of_birth.
- **Single-value attribute** − Single-value attributes contain single value. For example − Social_Security_Number.
- **Multi-value attribute** − Multi-value attributes may contain more than one values. For example, a person can have more than one phone number, email_address, etc.

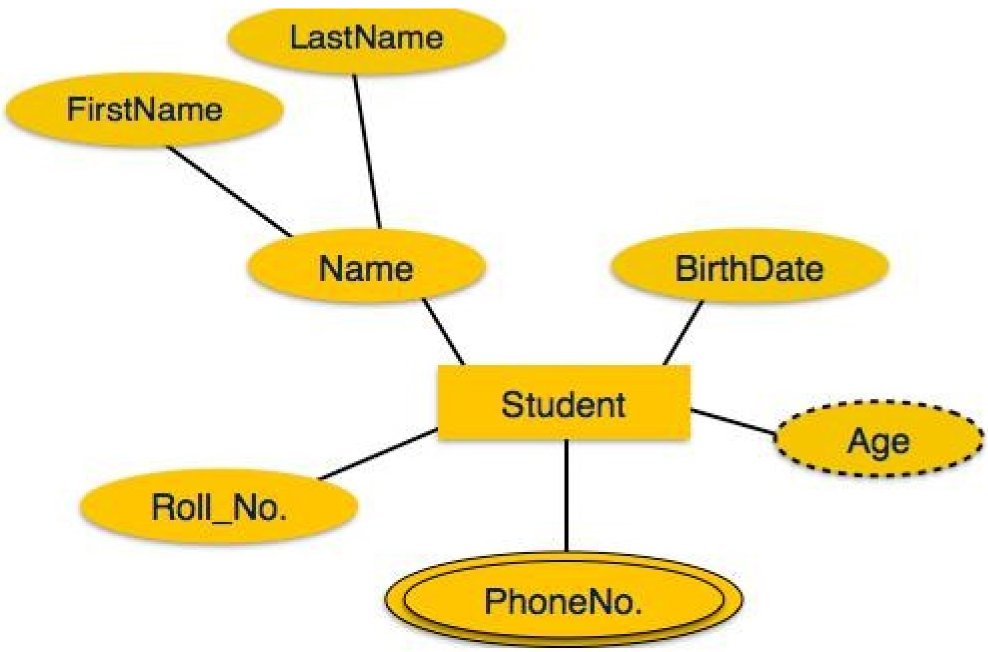
If the attributes are **composite**, they are further divided in a tree like structure. Every node is then connected to its attribute. That is, composite attributes are represented by ellipses that are connected with an ellipse.



Multivalued attributes are depicted by double ellipse.



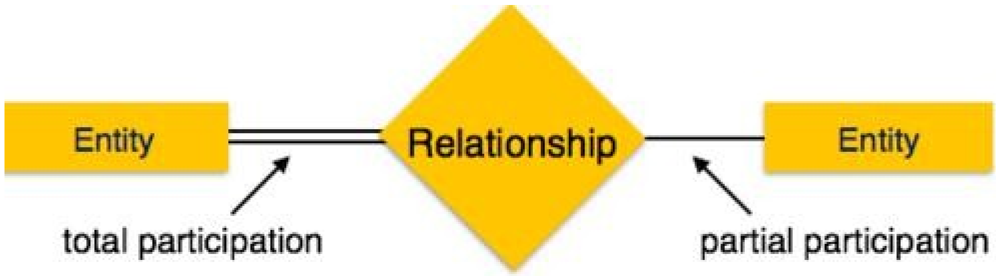
Derived attributes are depicted by dashed ellipse.



Participation Constraints

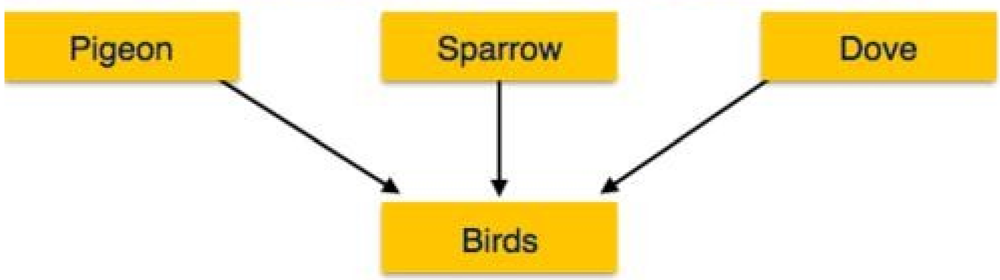
- **Total Participation** − Each entity is involved in the relationship. Total participation is represented by double lines.

- **Partial participation** − Not all entities are involved in the relationship. Partial participation is represented by single lines.



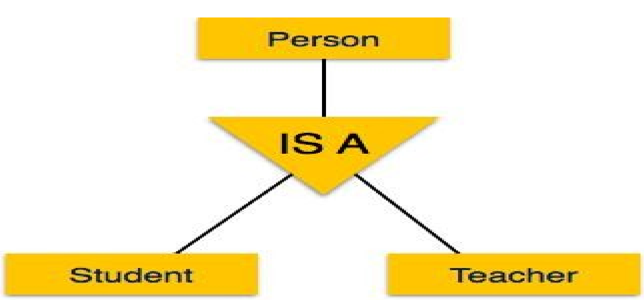
Generalization

As mentioned above, the process of generalizing entities, where the generalized entities contain the properties of all the generalized entities, is called generalization. In generalization, a number of entities are brought together into one generalized entity based on their similar characteristics. For example, pigeon, house sparrow, crow and dove can all be generalized as Birds.



Specialization

Specialization is the opposite of generalization. In specialization, a group of entities is divided into sub-groups based on their characteristics. Take a group 'Person' for example. A person has name, date of birth, gender, etc. These properties are common in all persons, human beings. But in a company, persons can be identified as employee, employer, customer, or vendor, based on what role they play in the company.



Dr Edgar F. Codd, after his extensive research on the Relational Model of database systems, came up with twelve rules of his own, which according to him, a database must obey in order to be regarded as a true relational database.

These rules can be applied on any database system that manages stored data using only its relational capabilities. This is a foundation rule, which acts as a base for all the other rules.

Rule 1: Information Rule

The data stored in a database, may it be user data or metadata, must be a value of some table cell. Everything in a database must be stored in a table format.

Rule 2: Guaranteed Access Rule

Every single data element (value) is guaranteed to be accessible logically with a combination of table-name, primary-key (row value), and attribute-name (column value). No other means, such as pointers, can be used to access data.

Rule 3: Systematic Treatment of NULL Values

The NULL values in a database must be given a systematic and uniform treatment. This is a very important rule because a NULL can be interpreted as one the following − data is missing, data is not known, or data is not applicable.

Rule 4: Active Online Catalog

The structure description of the entire database must be stored in an online catalog, known as data dictionary, which can be accessed by authorized users. Users can use the same query language to access the catalog which they use to access the database itself.

Rule 5: Comprehensive Data Sub-Language Rule

A database can only be accessed using a language having linear syntax that supports data definition, data manipulation, and transaction management operations. This language can be used directly or by means of some application. If the database allows access to data without any help of this language, then it is considered as a violation.

Rule 6: View Updating Rule

All the views of a database, which can theoretically be updated, must also be updatable by the system.

Rule 7: High-Level Insert, Update, and Delete Rule

A database must support high-level insertion, updation, and deletion. This must not be limited to a single row, that is, it must also support union, intersection and minus operations to yield sets of data records.

Rule 8: Physical Data Independence:The data stored in a database must be independent of the applications that access the database. Any change in the physical structure of a database must not have any impact on how the data is being accessed by external applications.

Rule 9: Logical Data Independence:The logical data in a database must be independent of its user's view (application). Any change in logical data must not affect the applications using it. For example, if two tables are merged or one is split into two different tables, there should be no impact or change on the user application. This is one of the most difficult rule to apply.

Rule 10: Integrity Independence:A database must be independent of the application that uses it. All its integrity constraints can be independently modified without the need of any change in the application. This rule makes a database independent of the front-end application and its interface.

Rule 11: Distribution Independence:The end-user must not be able to see that the data is distributed over various locations. Users should always get the impression that the data is located at one site only. This rule has been regarded as the foundation of distributed database systems.

Rule 12: Non-Subversion Rule:If a system has an interface that provides access to low-level records, then the interface must not be able to subvert the system and bypass security and integrity constraints.

Properties of relational data model

Relational data model is the primary data model, which is used widely around the world for data storage and processing. This model is simple and it has all the properties and capabilities required to process data with storage efficiency.

Tables − In relational data model, relations are saved in the format of Tables. This format stores the relation among entities. A table has rows and columns, where rows represents records and columns represent the attributes.

Tuple − A single row of a table, which contains a single record for that relation is called a tuple.

Relation instance − A finite set of tuples in the relational database system represents relation instance. Relation instances do not have duplicate tuples.

Relation schema − A relation schema describes the relation name (table name), attributes, and their names.

Relation key − Each row has one or more attributes, known as relation key, which can identify the row in the relation (table) uniquely.

Attribute domain − Every attribute has some pre-defined value scope, known as attribute domain.

Construction of E-R diagram:

Example-1:

Construct an E-R diagram for a hospital with a set of patients and a set of medical doctors. Associate with each patient a log of the various tests and examinations conducted.

Answer:

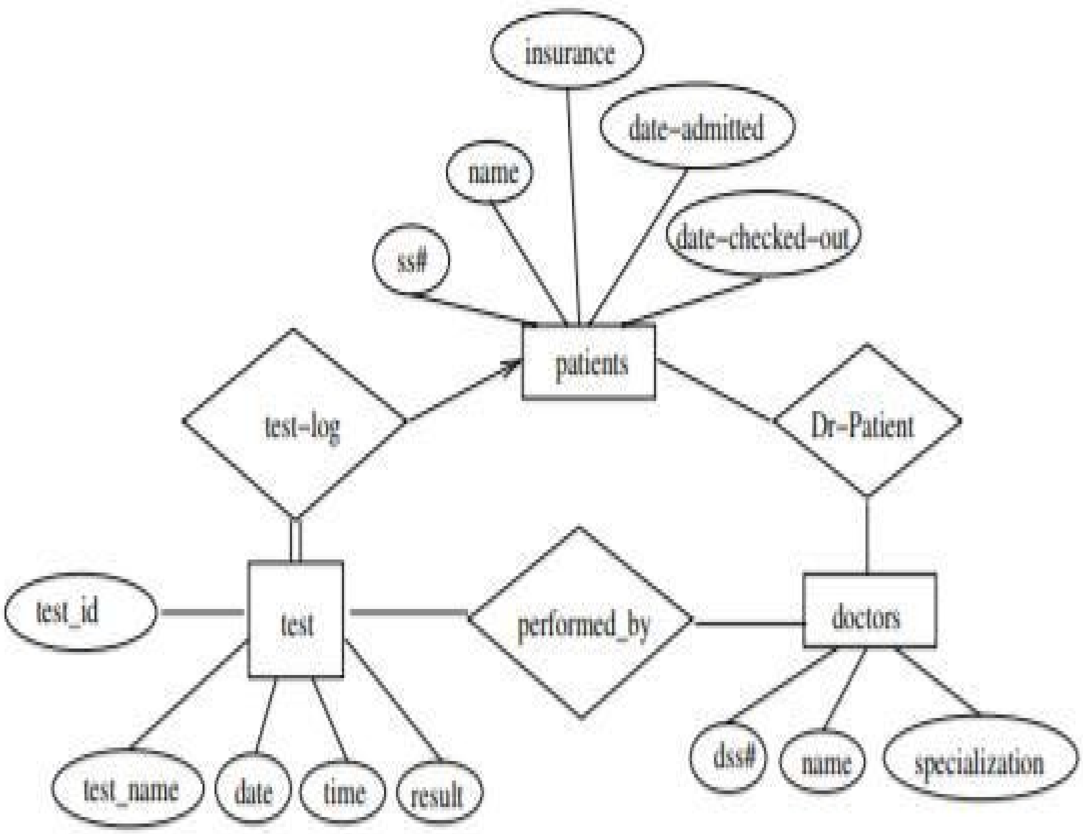


Figure 2.2 E-R diagram for a hospital.

Example-2:

A university registrar's office maintains data about the following entities: (a) courses, including number, title, credits, syllabus, and prerequisites; (b) course offerings, including course number, year, semester, section number, instructor(s), timings, and classroom; (c) students, including student-id, name, and program; and (d) instructors, including identification number, name, department, and title. Further, the enrollment of students in courses and grades awarded to students in each course they are enrolled for must be appropriately modeled.

Construct an E-R diagram forthe registrar's office.

Answer:

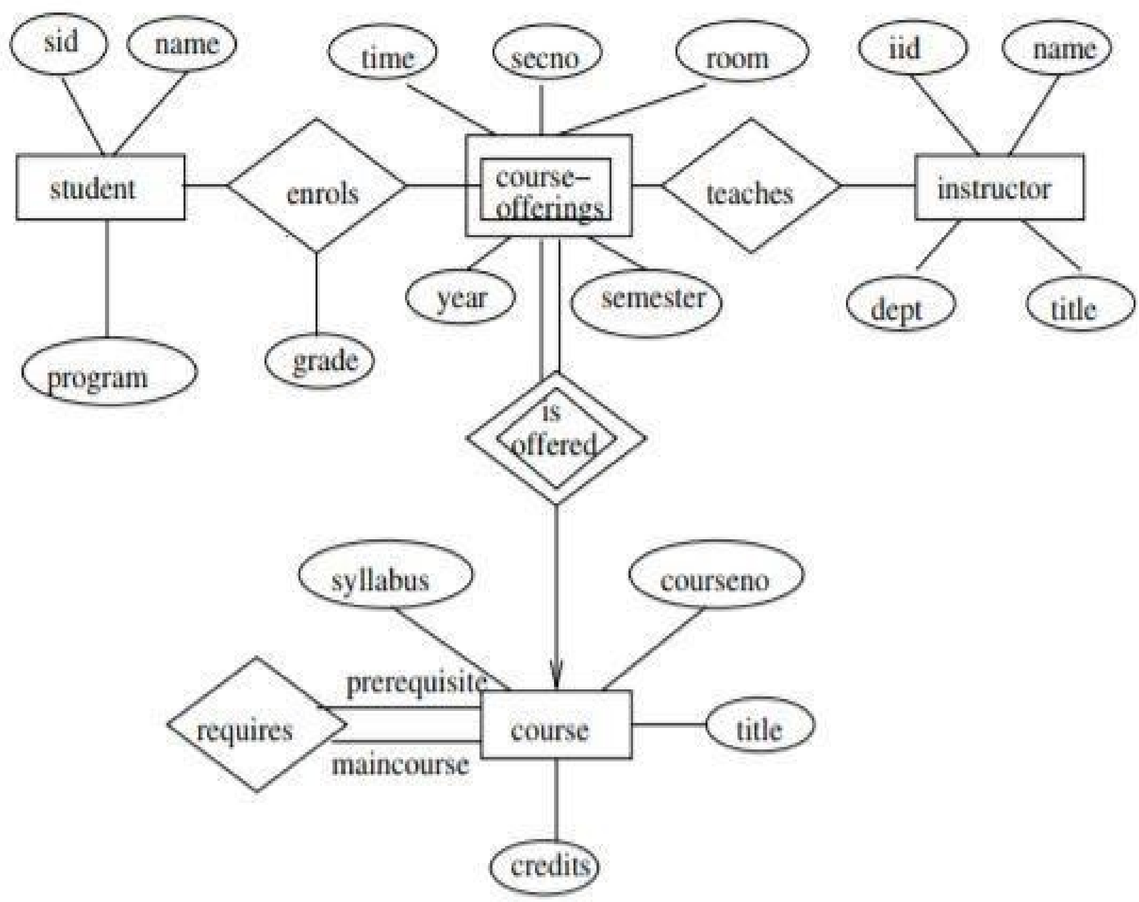


Figure 2.3 E-R diagram for a university.

Example-3: Consider a database used to record the marks that students get in different exams of different course offerings.

Answer:

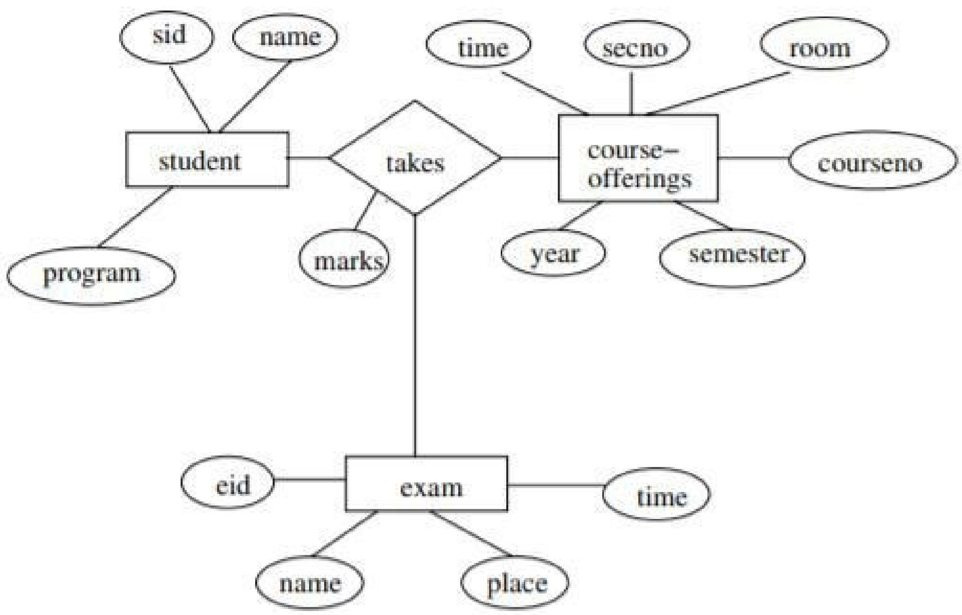


Figure 2.4 E-R diagram for marks database.

S.N : Prepare all Lab queries done before the mid.