DBMS: **DBMS** stands for **Database Management System**. Database is a collection of data and Management System is a set of programs to store and retrieve those data. Based on this we can define DBMS like this: DBMS is a collection of inter-related data and set of programs to store & access those data in an easy and effective manner.

Advantage of DBMS over file system

There are several advantages of Database management system over file system. Few of them are as follows:

- **No redundant data**: Redundancy removed by data normalization. No data duplication saves storage and improves access time.
- **Data Consistency and Integrity**: As we discussed earlier the root cause of data inconsistency is data redundancy, since data normalization takes care of the data redundancy, data inconsistency also been taken care of as part of it
- **Data Security**: It is easier to apply access constraints in database systems so that only authorized user is able to access the data. Each user has a different set of access thus data is secured from the issues such as identity theft, data leaks and misuse of data.
- **Privacy**: Limited access means privacy of data.
- **Easy access to data** – Database systems manages data in such a way so that the data is easily accessible with fast response times.
- **Easy recovery**: Since database systems keeps the backup of data, it is easier to do a full recovery of data in case of a failure.
- **Flexible**: Database systems are more flexible than file processing systems.

Disadvantages of DBMS:

- DBMS implementation cost is high compared to the file system
- Complexity: Database systems are complex to understand
- Performance: Database systems are generic, making them suitable for various applications. However this feature affect their performance for some applications

Database Applications – DBMS

Applications where we use Database Management Systems are:

- **Telecom**: There is a database to keeps track of the information regarding calls made, network usage, customer details etc. Without the database systems it is hard to maintain that huge amount of data that keeps updating every millisecond.
- **Industry**: Where it is a manufacturing unit, warehouse or distribution centre, each one needs a database to keep the records of ins and outs. For example distribution centre should keep a track of the product units that supplied into the centre as well as the products that got delivered out from the distribution centre on each day; this is where DBMS comes into picture.
- **Banking System**: For storing customer info, tracking day to day credit and debit transactions, generating bank statements etc. All this work has been done with the help of Database management systems.
- **Sales**: To store customer information, production information and invoice details.
- **Airlines**: To travel though airlines, we make early reservations, this reservation information along with flight schedule is stored in database.
- **Education sector**: Database systems are frequently used in schools and colleges to store and retrieve the data regarding student details, staff details, course details, exam details, payroll data, attendance details, fees details etc. There is a hell lot amount of inter-related data that needs to be stored and retrieved in an efficient manner.
- **Online shopping**: You must be aware of the online shopping websites such as Amazon, Flipkart etc. These sites store the product information, your addresses and preferences, credit details and provide you the relevant list of products based on your query. All this involves a Database management system.

DBMS Architecture

The architecture of DBMS depends on the computer system on which it runs. For example, in a client-server DBMS architecture, the database systems at server machine can run several requests made by client machine. We will understand this communication with the help of diagrams.

Types of DBMS Architecture

There are three types of DBMS architecture:

1. Single tier architecture
2. Two tier architecture
3. Three tier architecture

1. Single tier architecture

In this type of architecture, the database is readily available on the client machine, any request made by client doesn’t require a network connection to perform the action on the database.

For example, lets say you want to fetch the records of employee from the database and the database is available on your computer system, so the request to fetch employee details will be done by your computer and the records will be fetched from the database by your computer as well. This type of system is generally referred as local database system.

2. Two tier architecture

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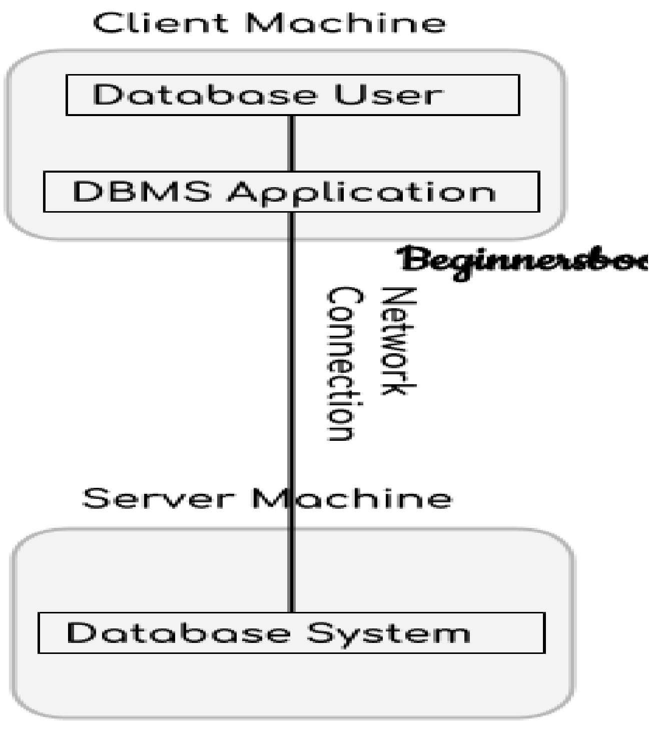
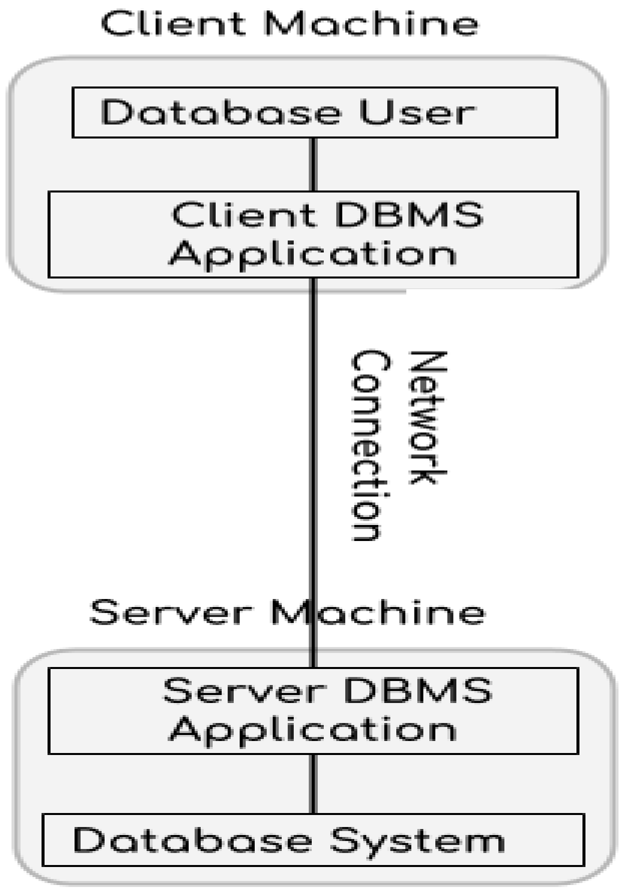


Two-Tier architecture

In two-tier architecture, the Database system is present at the server machine and the DBMS application is present at the client machine, these two machines are connected with each other through a reliable network as shown in the above diagram.

Whenever client machine makes a request to access the database present at server using a query language like sql, the server perform the request on the database and returns the result back to the client. The application connection interface such as JDBC, ODBC are used for the interaction between server and client.

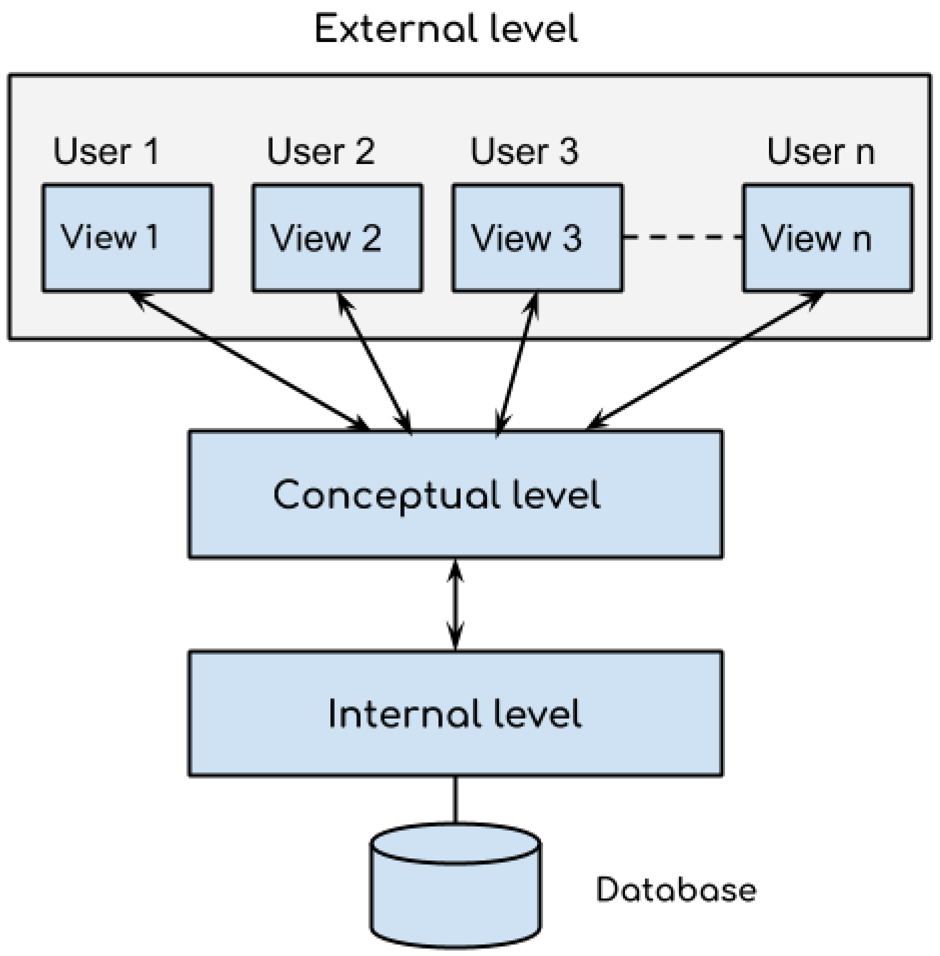
3. Three tier architecture



Three-Tier architecture

In three-tier architecture, another layer is present between the client machine and server machine. In this architecture, the client application doesn't communicate directly with the database systems present at the server machine, rather the client application communicates with server application and the server application internally communicates with the database system present at the server.

DBMS Three Level Architecture Diagram



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This architecture has three levels:
1. External level
2. Conceptual level
3. Internal level

1. External level

It is also called **view level**. The reason this level is called “view” is because several users can view their desired data from this level which is internally fetched from database with the help of conceptual and internal level mapping.

The user doesn’t need to know the database schema details such as data structure, table definition etc. user is only concerned about data which is what returned back to the view level after it has been fetched from database (present at the internal level).

External level is the “**top level**” of the Three Level DBMS Architecture.

2. Conceptual level

It is also called **logical level**. The whole design of the database such as relationship among data, schema of data etc. are described in this level.

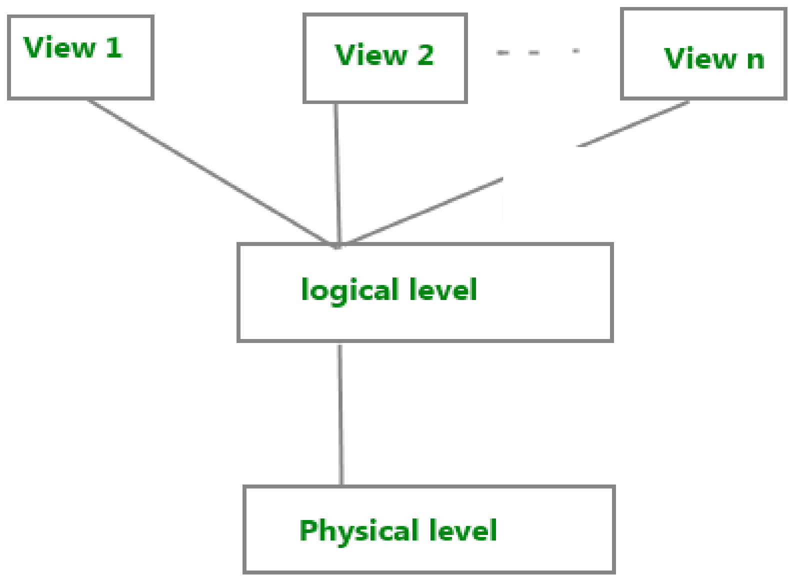
Database constraints and security are also implemented in this level of architecture. This level is maintained by DBA (database administrator).

3. Internal level

This level is also known as physical level. This level describes how the data is actually stored in the storage devices. This level is also responsible for allocating space to the data. This is the lowest level of the architecture.

Data 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.

Data models in DBMS

Data Model is a logical structure of Database. It describes the design of database to reflect entities, attributes, relationship among data, constrains etc.

Types of Data Models

There are several types of data models in DBMS. We will cover them in detail in separate articles(Links to those separate tutorials are already provided below). In this guide, we will just see a basic overview of types of models.

Object based logical Models – Describe data at the conceptual and view levels.

1. E-R Model
2. Object oriented Model

Record based logical Models – Like Object based model, they also describe data at the conceptual and view levels. These models specify logical structure of database with records, fields and attributes.

1. Relational Model
2. Hierarchical Model
3. Network Model – Network Model is same as hierarchical model except that it has graph-like structure rather than a tree-based structure. Unlike hierarchical model, this model allows each record to have more than one parent record.

Physical Data Models – These models describe data at the lowest level of abstraction.

Entity Relationship Diagram – ER Diagram in DBMS

An **Entity–relationship model (ER model)** describes the structure of a database with the help of a diagram, which is known as **Entity Relationship Diagram (ER Diagram)**. An ER model is a design or blueprint of a database that can later be implemented as a database. The main components of E-R model are: entity set and relationship set.

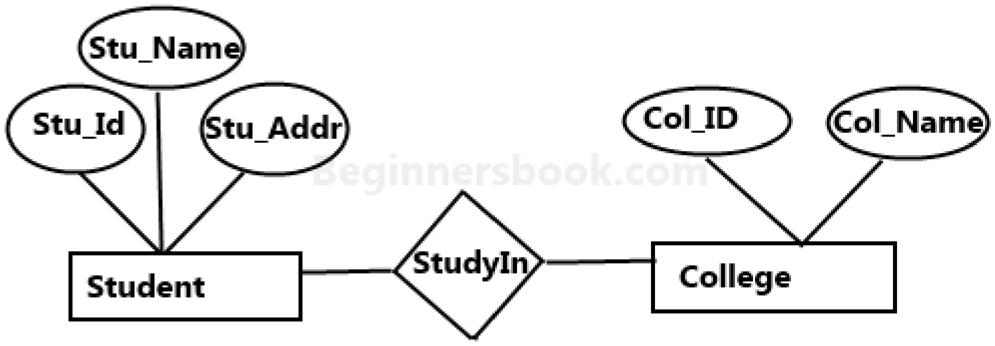
What is an Entity Relationship Diagram (ER Diagram)?

An ER diagram shows the relationship among entity sets. An entity set is a group of similar entities and these entities can have attributes. In terms of DBMS, an entity is a table or attribute of a table in database, so by showing relationship among tables and their attributes, ER diagram shows the complete logical structure of a database. Lets have a look at a simple ER diagram to understand this concept.

A simple ER Diagram:

In the following diagram we have two entities Student and College and their relationship. The relationship between Student and College is many to one as a college can have many students however a student cannot study in multiple colleges at the same time. Student entity has attributes such as Stu_Id, Stu_Name & Stu_Addr and College entity has attributes such as Col_ID &

Col_Name.

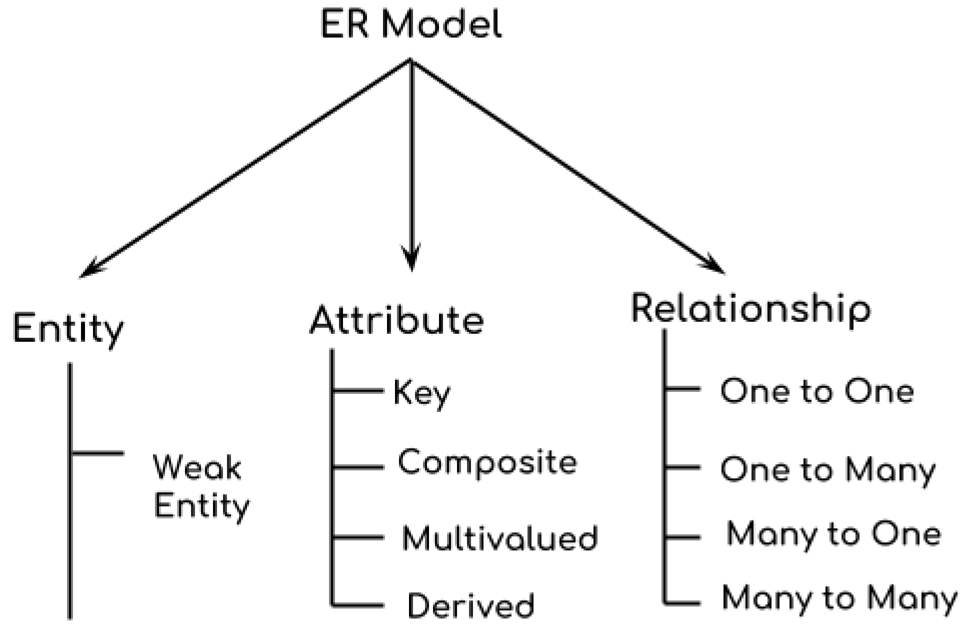


Sample E-R Diagram

Here are the geometric shapes and their meaning in an E-R Diagram. We will discuss these terms in detail in the next section(Components of a ER Diagram) of this guide so don’t worry too much about these terms now, just go through them once.

Rectangle: Represents Entity sets.
Ellipses: Attributes
Diamonds: Relationship Set
Lines: They link attributes to Entity Sets and Entity sets to Relationship Set
Double Ellipses: Multivalued Attributes
Dashed Ellipses: Derived Attributes
Double Rectangles: Weak Entity Sets
Double Lines: Total participation of an entity in a relationship set

Components of a ER Diagram



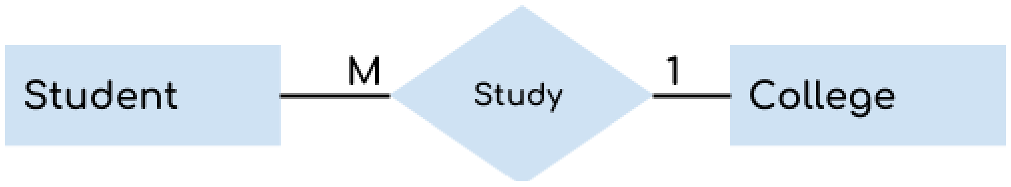
Components of ER Diagram

As shown in the above diagram, an ER diagram has three main components:
1. Entity
2. Attribute
3. Relationship

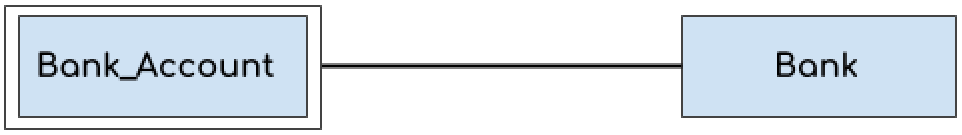
1. Entity

An entity is an object or component of data. An entity is represented as rectangle in an ER diagram.

For example: In the following ER diagram we have two entities Student and College and these two entities have many to one relationship as many students study in a single college. We will read more about relationships later, for now focus on entities.



Weak Entity:
An entity that cannot be uniquely identified by its own attributes and relies on the relationship with other entity is called weak entity. The weak entity is represented by a double rectangle. For example – a bank account cannot be uniquely identified without knowing the bank to which the account belongs, so bank account is a weak entity.



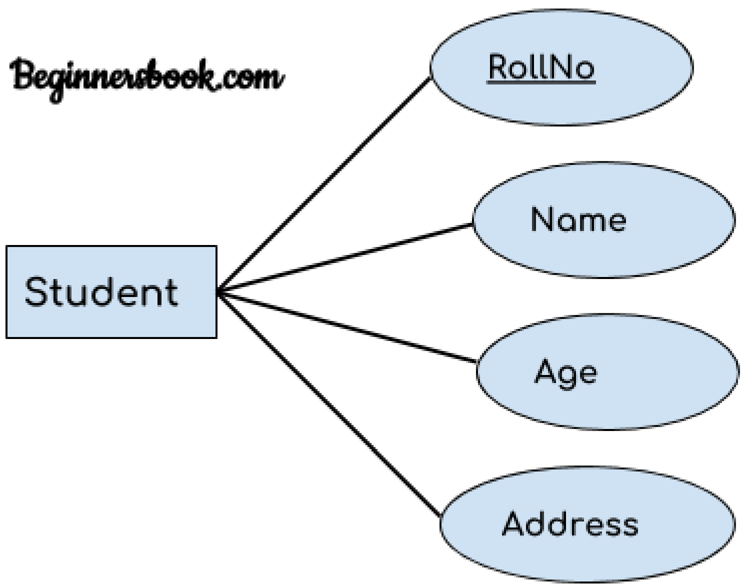
An attribute describes the property of an entity. An attribute is as Oval in an ER diagram. There are four types of attributes:

1. Key attribute
2. Composite attribute
3. Multivalued attribute
4. Derived attribute

1. Key attribute:

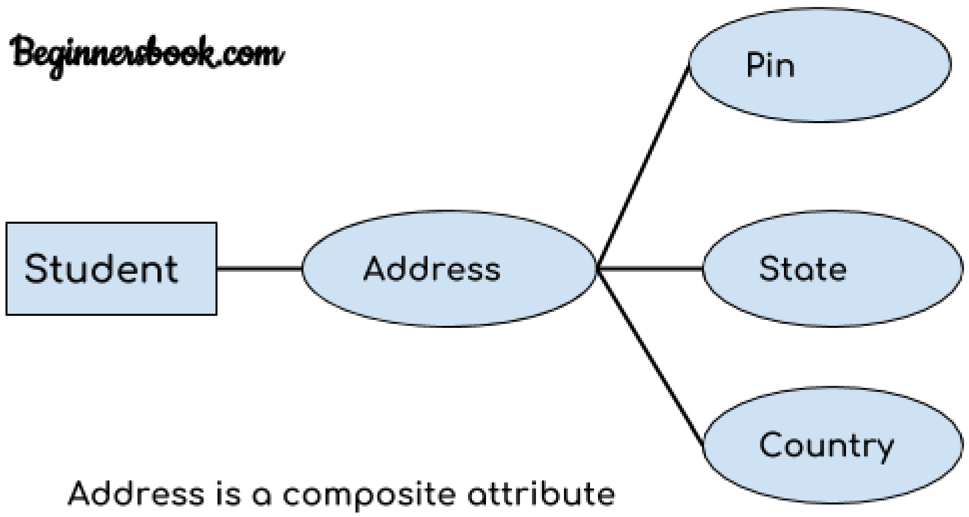
A key attribute can uniquely identify an entity from an entity set. For example, student roll number can uniquely identify a student from a set of students. Key attribute is represented by oval same as other attributes however the **text of key**

attribute is underlined.



2. Composite attribute:

An attribute that is a combination of other attributes is known as composite attribute. For example, In student entity, the student address is a composite a osed of other attributes such as pin code, state, c



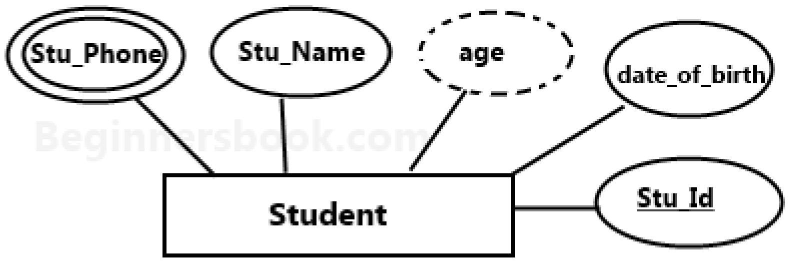
3. Multivalued attribute:

An attribute that can hold multiple values is known as multivalued attribute. It is represented with **double ovals** in an ER Diagram. For example – A person can have more than one phone numbers so the phone number attribute is multivalued.

4. Derived attribute:

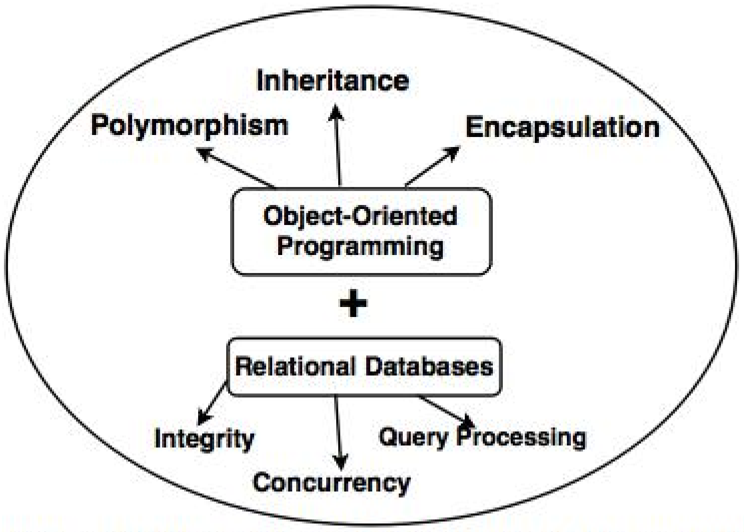
A derived attribute is one whose value is dynamic and derived from another attribute. It is represented by **dashed oval** in an ER Diagram. For example – Person age is a derived attribute as it changes over time and can be derived from another attribute (Date of birth).

E-R diagram with multivalued and derived attributes:



Object based databases

- Object oriented database systems are alternative to relational database and other database systems.
- In object oriented database, information is represented in the form of objects.
- Object oriented databases are exactly same as object oriented programming languages. If we can combine the features of relational model (transaction, concurrency, recovery) to object oriented databases, the resultant model is called as object oriented database model.



(Object-Oriented database is product of OOP and RDB)

Object-Oriented database

Features of OODBMS

In OODBMS, every entity is considered as object and represented in a table. Similar objects are classified to classes and subclasses and relationship between two object is maintained using concept of inverse reference.

Some of the features of OODBMS are as follows:

1. Complexity
OODBMS has the ability to represent the complex internal structure (of object) with multilevel complexity.

2. Inheritance
Creating a new object from an existing object in such a way that new object inherits all characteristics of an existing object.

3. Encapsulation
It is an data hiding concept in OOPL which binds the data and functions together which can manipulate data and not visible to outside world.

4. Persistency
OODBMS allows to create persistent object (Object remains in memory even after execution). This feature can automatically solve the problem of recovery and concurrency.

Relational model in DBMS

In relational model, the data and relationships are represented by collection of inter-related tables. Each table is a group of column and rows, where column represents attribute of an entity and rows represents records.

Sample relationship Model: Student table with 3 columns and four records.

Table: Student

Stu_Id	Stu_Name	Stu_Age
111	Ashish	23
123	Saurav	22
169	Lester	24
234	Lou	26

Table: Course

Stu_Id	Course_Id	Course_Name
111	C01	Science
111	C02	DBMS
169	C22	Java
169	C39	Computer Networks

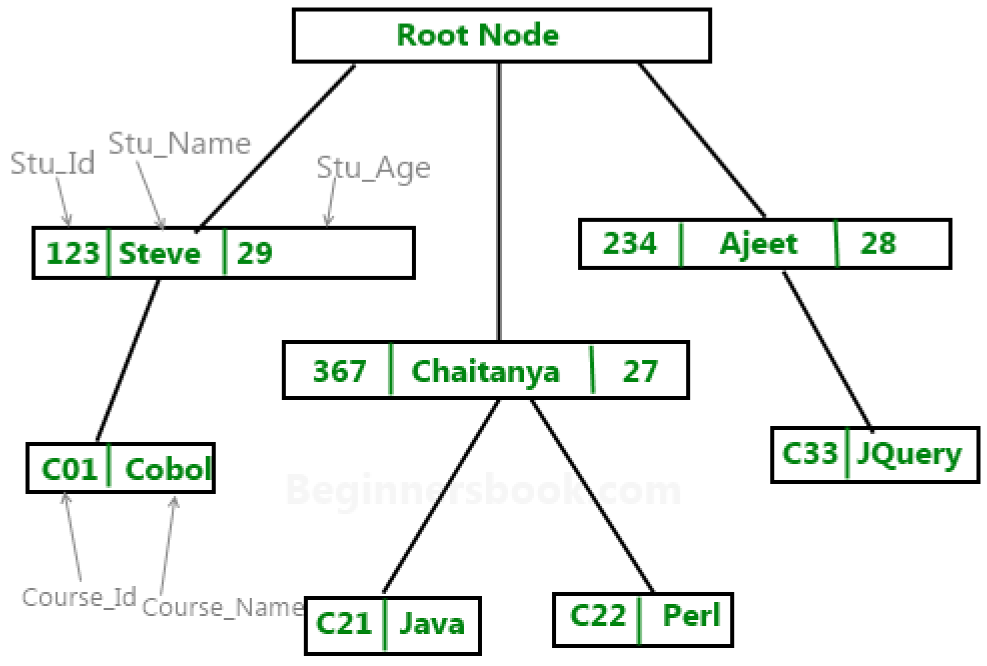
Here Stu_Id, Stu_Name & Stu_Age are attributes of table Student and Stu_Id, Course_Id & Course_Name are attributes of table Course. The rows with values are the records (commonly known as tuples).

Hierarchical model in DBMS

In **hierarchical model**, data is organized into a tree like structure with each record is having one parent record and many children. The main drawback of this model is that, it can have only one to many relationships between nodes.

Note: Hierarchical models are rarely used now.

Sample Hierarchical Model Diagram:
Lets say we have few students and few courses and a course can be assigned to a single student only, however a student take any number of courses so this relationship becomes one to many.



Example of hierarchical data represented as relational tables: The above hierarchical model can be represented as relational tables like this:

Stu_Id	Stu_Name	Stu_Age

123	Steve	29
367	Chaitanya	27
234	Ajeet	28

Course Table:

Course_Id	Course_Name	Stu_Id
C01	Cobol	123
C21	Java	367
C22	Perl	367
C33	JQuery	234

Network model:

In the network model of database, there are no levels and a record can have any number of owners and also can have ownership of several records.

Thus, the problem raised above in the sales order processing will not arise in the network model.

As there is no definite path defined for retrieval of data, the number of links is very large and thus network databases are complex, slow and difficult to implement. In view of the difficulty in implementation, network model is used only when all other options are closed.

The typical example of a network database may be the employee and the department he/she has worked or can work with in future. Figure 9.5 shows the network model of data for an employee information system.

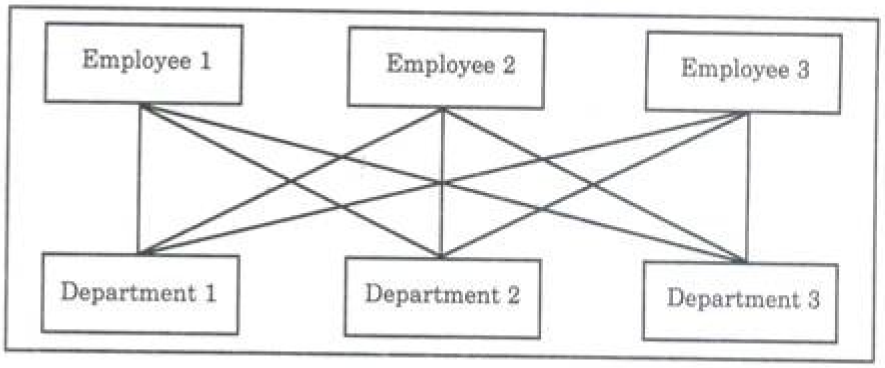


Fig. 9.5 Network model of employee information systems