DBMS

UNIT-1

Data:

Data is a raw fact or unorganized form (such as alphabets, numbers, or symbols) that refers to or represent, condition, ideas or objects. Data is limitless and present everywhere in the universe.

Information :

Data that

- ✓ has been verified to be accurate and timely.
- ✓ Is specific and organized for a purpose.
- ✓ Is represented within a context that gives it meaning and relevance.
- ✓ That can lead to an increase in understanding and decrease in uncertainty is called information.

flat file database

A **flat file database** is a database which is stored on its host computer system as an ordinary unstructured file called a "flat file". To access the structure of the data and manipulate it, the file must be read in its entirety into the computer's memory. Upon completion of the database operations, the file is again written out in its entirety to the host's file system. In this stored mode the database is said to be "flat", meaning that it has no structure for indexing and there are usually no structural relationships between the records. A flat file can be a plain text file or a binary file.

Database :

A database is a collection of information that is organized so that it can easily be accessed managed and update. There are two type of database:

- Conventional Database: Collection of data without use of DBMS. E.g. Telephone diary, register.
- Computerized database: The collection of data with the help of computer and DBMS in the form of data file is known as computerized database. The types of computer systems that can run database management system are Centralized PC and Client/Server and distributed.

Elements of Database:

1. **Field: Smallest unit of Database.**
2. **Record: A Collection of multiple related fields.**
3. **Table: A collection of records or group of records with the row and column order.**
4. **Tuple: A record row in the database.**
5. **Index: It is a process of organizing data in specific order.**
6. **Cell: A cell is a inter section of rows and columns.**

Characteristics of database: 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.

- **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.

- **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.

Data base system :

The database, data collection with DBMS is called data base system. A database system is a way of organizing information on a computer, implemented by a set of computer programs. This kind of organization should offer:

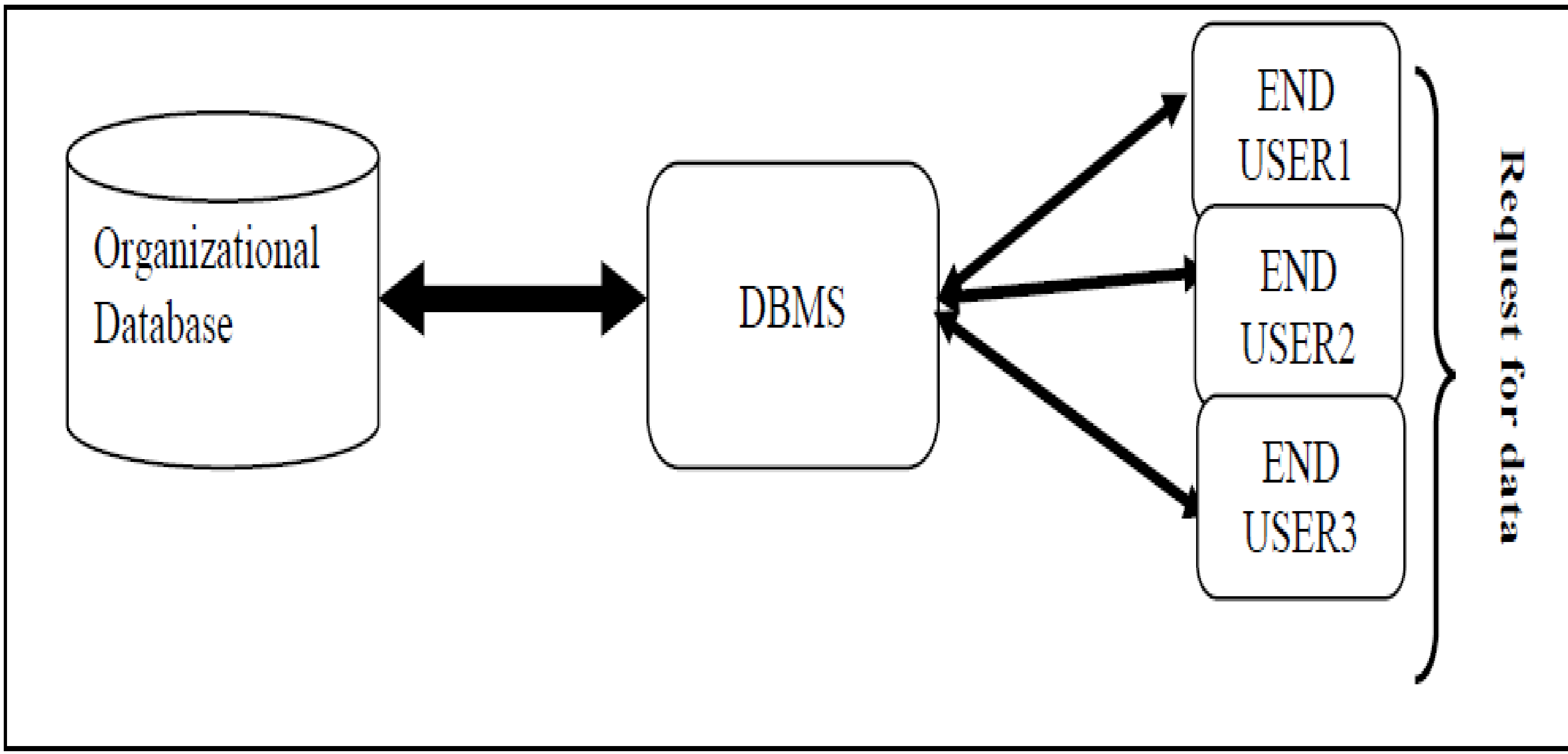
- simplicity - an easy way to collect, access-connect, and display information;
- stability - to prevent unnecessary loss of data;
- security - to protect against unauthorized access to private data;
- speed - for fast results in a short time, and for easy maintenance in case of changes in the organization that stores the information.

DBMS (Database management system):

Database management systems (**DBMS**s) are specially designed software applications that interact with the user, other applications, and the database itself to capture and analyze data. A general-purpose DBMS is a software system designed to allow the definition, creation, querying, update, and administration of databases.

Well-known DBMSs include MySQL, MariaDB, PostgreSQL, SQLite, Microsoft SQL Server, Oracle, SAP HANA, dBASE, FoxPro, IBM DB2, LibreOffice Base, FileMaker Pro, Microsoft Access .

In this figure illustrate that the DBMS stands between the database and the users.



Advantages of DBMS :

- ✓ *Controlling data redundancy*
- ✓ *Elimination of inconsistency*
- ✓ *Betters service to the user*
- ✓ *Flexibility of the system is improved*
- ✓ *Integrity can be improved*
- ✓ *Standards can be enforced .*
- ✓ *Security can be improved*
- ✓ *Provides backup and recovery*

Disadvantages :

- ✓ *Database system are complex, difficult, and time consuming to design.*
- ✓ Qu*alified personnel.*
- ✓ *Extensive conversion costs in moving from a file system to a database system.*
- ✓ *Initial training required for all programmers and users.*

DBMS Evolution/history of DBMS :

i) 1960's(Traditional File System) :

I*n 1960's the traditional file system was invented. The traditional file based system is basically file based system in which we manually or through computer handle the database.*

ii) Early 1970's(Tree Structure Model) :

The emergence of the first types of DBMS, the hierarchical DBMS. IBM had the first model developed on IBM 360, and their DBMS was called IMS. Originally, it was written for the Apollo program. This types of DBMS was based in binary trees, where the shape was like a tree and relations were only limited between parent and child record.

Advantage :

- *Less redundant data*
- *Data independence*
- *Security & integrity*
- *Efficient searching*

Disadvantages :

- *Complex implementation*
- *Harder to handle many relationship*

iii)Late 1970's (Network Data Model):

The emergence of the network DBMS, charles Bachman developed first DBMS at Honeywell database named Integrated data store (IDS). A group called COD ASYL who is responsible for the creation of COBOL and that system standardized network DBMS where we developed for business use. In this model, each record can have multiple parents .

- *Disadvantage :-*

- *Complex to understand*
- *Difficult to design & maintenance*

iv) 1980’s(Relational Data Model):

The emergence of relational DBMS on the hands of Edgar codd . He worked at IBM and he was invented relational data model. This was a new system for entering data and working with big database where the idea was use a table of records.

v) 1990’s & onwards(Object Oriented Model) :

In 1990 the DBMS took on a new objects oriented approach, joint with relational DBMS. In This approach, text multimedia internet and web use in conjunction with DBMS were available and possible.

Data wared house(DW, DWH, EDW):

Data wared house is a data structure that is optimized for distribution. It collects and stores integrated sets of historical data from multiple operational systems and feeds them to one or more data marts. It may also provide end-user access to support enterprise views of data.

Data Mart: A data structure that is optimized for access. It is designed to facilitate end-user analysis of data. It typically supports a single, analytic application used by a distinct set of workers.

Data mining :

Data mining or knowledge discovery is the

computer assisted process of digging through and analyzing enormous sets of data and then extracting the meaning of the data. Data mining tools predict behaviors and future, allowing business to make proactive knowledge driven decisions .

- ***Data independence :*** *The capacity to change the schema at one level without having to change the schema at the next higher level.*

  Data independence is usually consisting from the two points of view.

  - *Physical Data independence*
  - *Logical data independence*
  - ***Physical data independence*** *allows changes in the physical storage devices or organization of the file to be mode without requiring changes in the concept view or any of the external view and hence in the application program using database.*

– Logical data independence

The ability to change the logical (conceptual) schema without changing the External schema (User View) is called logical data independence. For example, the addition or removal of new entities, attributes, or relationships to the conceptual schema should be possible without having to change existing external schemas or having to rewrite existing application programs.

Data Abstraction in DBMS :

Different users require different view of the database which is useful and necessary to them. This is data abstraction by which we abstract useful data from a database for a particular type of users to use.

There are 3 levels of data abstraction, those are as follows:

- **Physical Level:** The lowest level of abstraction describes how the data are actually stored. The physical level describes complex low level data structures.
- **Logical Level:** This level of abstraction describes what data are stored in the database and what relationships exist among those data. Thus it also describe structures but separating them in small parts.
- **View Level:** This level represents only a part of the entire database. Even though logical level is simpler than physical level, view level is required because a database may have tons of data all of which are not useful to all users.

Centralized Database:

A **centralized database** (sometimes abbreviated **CDB**) is a database that is located, stored, and maintained in a single location. This location is most often a central computer or database system, for example a desktop or server CPU, or a mainframe computer. In most cases, a centralized database would be used by an organization (e.g. a business company) or an institution (e.g. a university.) Users access a centralized database through a computer network which is able to give them access to the central CPU, which in turn maintains to the database itself.

Advantages:

- Easier for using by the end-user due to the simplicity of having a single database design.
- Generally easier data portability and database administration..
- All the information can be accessed at the same time from the same location.
- Updates to any given set of data are immediately received by every end-user.

Disadvantages:

– Centralized databases are highly dependent on network connectivity.
– Bottlenecks can occur as a result of high traffic.
– If there is no fault-tolerant setup and hardware failure occurs, all the data within the database will be lost.
– Since there is minimal to no data redundancy, if a set of data is unexpectedly lost it is very hard to retrieve it.

- ***Distributed Database :***

  A **distributed database** is a database in which storage devices are not all attached to a common processor. It may be stored in multiple computers, located in the same physical location; or may be dispersed over a network of interconnected computers. The DDBMS synchronizes all the data periodically and ensures that updates and deletes performed on the data at one location will be automatically reflected in the data stored elsewhere.

Advantages of distributed database:

- In a distributed database, data can be stored in different systems like personal computers, servers, mainframes, etc.
- A user doesn't know where the data is located physically.
- Database can be accessed over different networks.
- Data can be joined and updated from different tables which are located on different machines.

Disadvantages of distributed database:

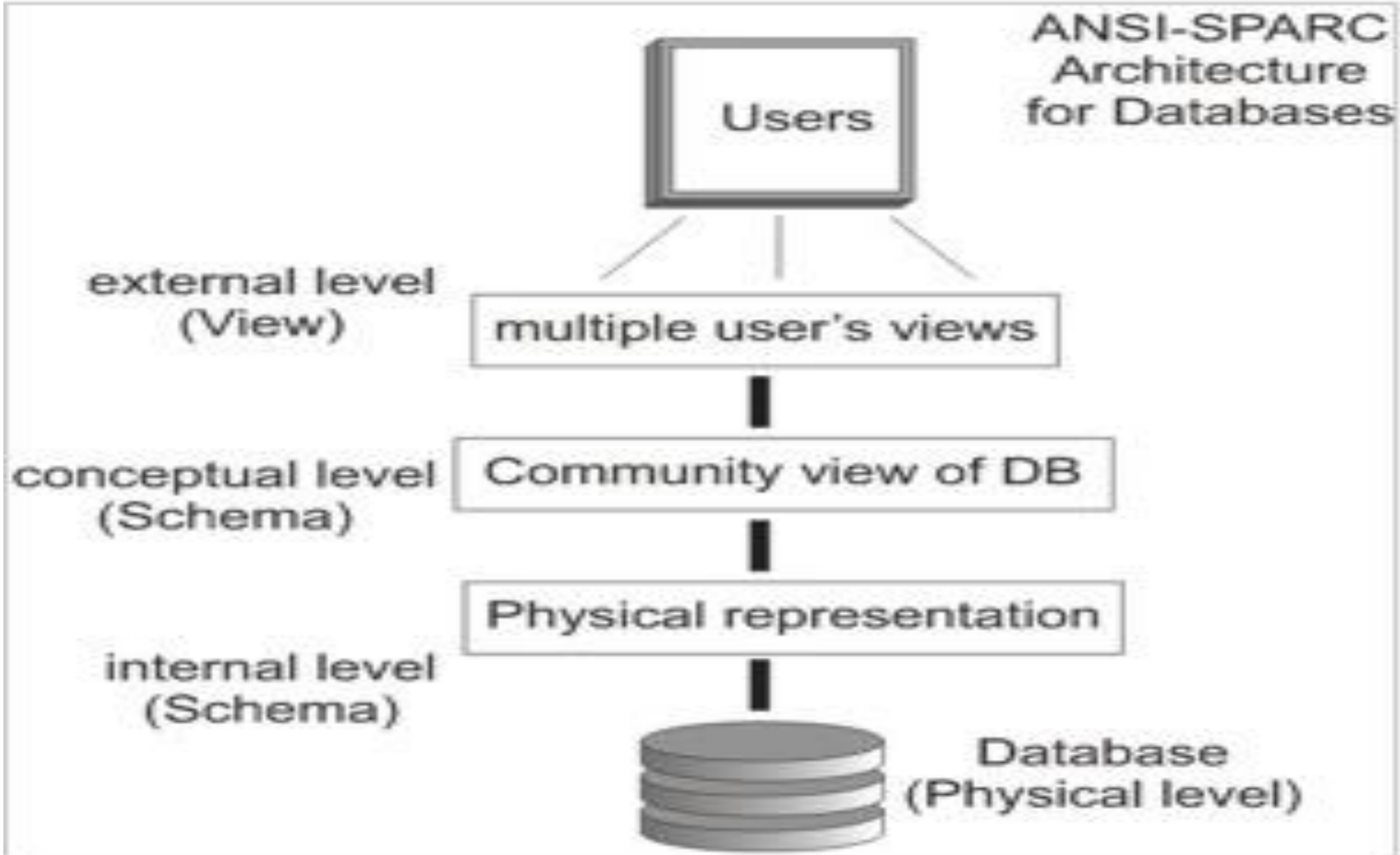
- Since the data is accessed from a remote system, performance is reduced.
- Network traffic is increased in a distributed database.
- Database optimization is difficult in a distributed database.

Database administrator (DBA)

DBA is a person responsible for the installation, configuration, upgrade , monitoring and maintenances of physical database. The role includes the developing and design of database strategies, monitoring database performances capacity and planning for future expansible requirement. They may also plan, co- ordinate and implement security measure to safeguard of the database.

ANSI/SPARC database architecture

The **ANSI-SPARC Architecture**, where ANSI-SPARC stands for *American National Standards Institute, Standards Planning And Requirements Committee*, is an abstract design standard for a Database Management System (DBMS), first proposed in 1975. Most modern commercial DBMS are based on this system. The ANSI-SPARC model however never became a formal standard.



The ANSI-SPARC Three-level architecture.

The objective of the three-level architecture is to separate the users’ view:

- It allows independent customized user views.
- It hides the physical storage details from users.
- The database administrator should be able to change the database storage structures without affecting the users’ views.
- The internal structure of the database should be unaffected by changes to the physical aspects of the storage.

Data Dictionary

A data dictionary contains a list of all files in the database, the number of records in each file, and the names and types of each field. Most database management systems keep the data dictionary hidden from users to prevent them from accidentally destroying its contents. Data dictionaries do not contain any actual data from the database, only bookkeeping information for managing it. Without a data dictionary, however, a database management system
cannot access data from the database.

Unit-2

Data Models

Unit-2

Data model :

Data model is a collection of conceptual tools used for describing data, data relationships and data constraints. The model should enable the designer to incorporate a major portion of semantics of the database in the system.

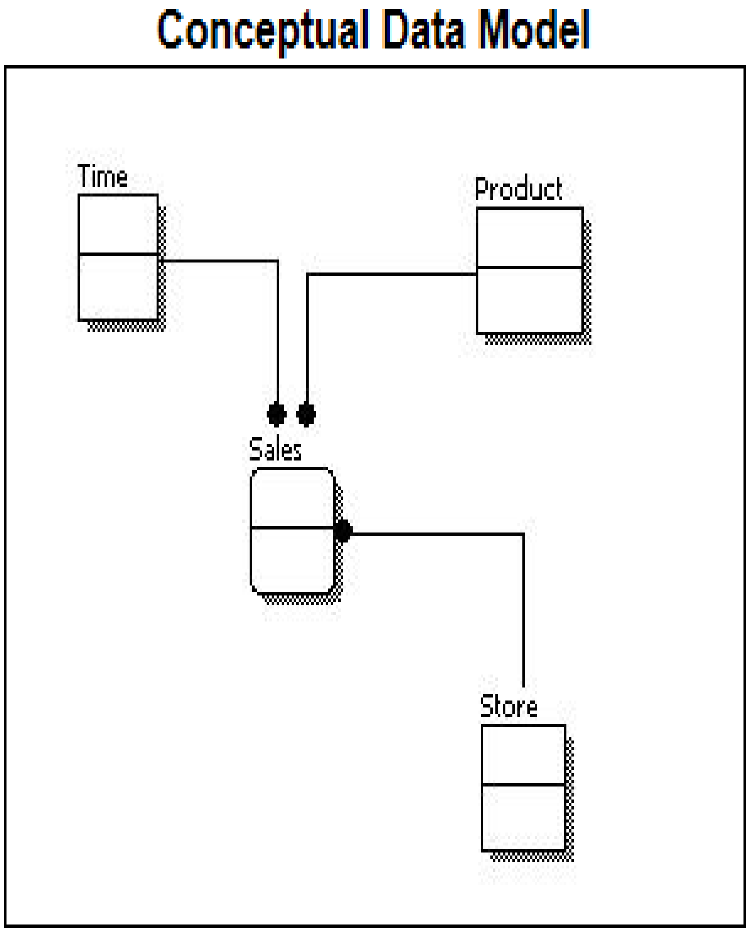
Type of Data Model:

- *Conceptual data model*
- *Logical data model*
- *Physical data model*

i. A **conceptual data model** identifies the highest-level relationships between the different entities. Features of conceptual data model include:

- Includes the important entities and the relationships among them.
- No attribute is specified.
- No primary key is specified.

The figure below is an example of a conceptual data model.



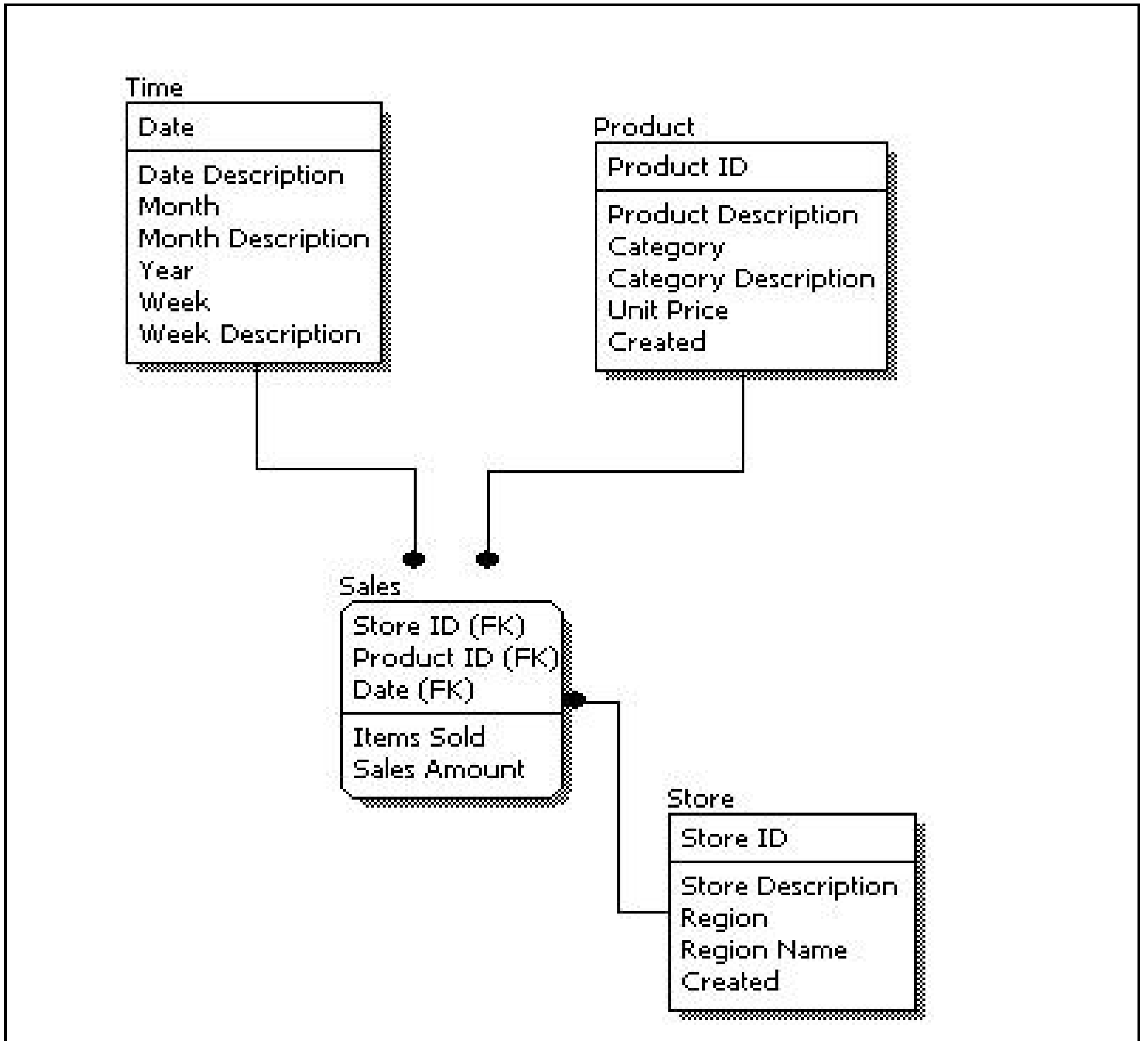
From the figure above, we can see that the only information shown via the conceptual data model is the entities that describe the data and the relationships between those entities. No other information is shown through the conceptual data model.

ii. A **logical data model** describes the data in as much detail as possible, without regard to how they will be physical implemented in the database. Features of a logical data model include:

- Includes all entities and relationships among them.
- All attributes for each entity are specified.
- The primary key for each entity is specified.
- Foreign keys (keys identifying the relationship between different entities) are specified.
- Normalization occurs at this level.

The figure below is an example of a logical data model.

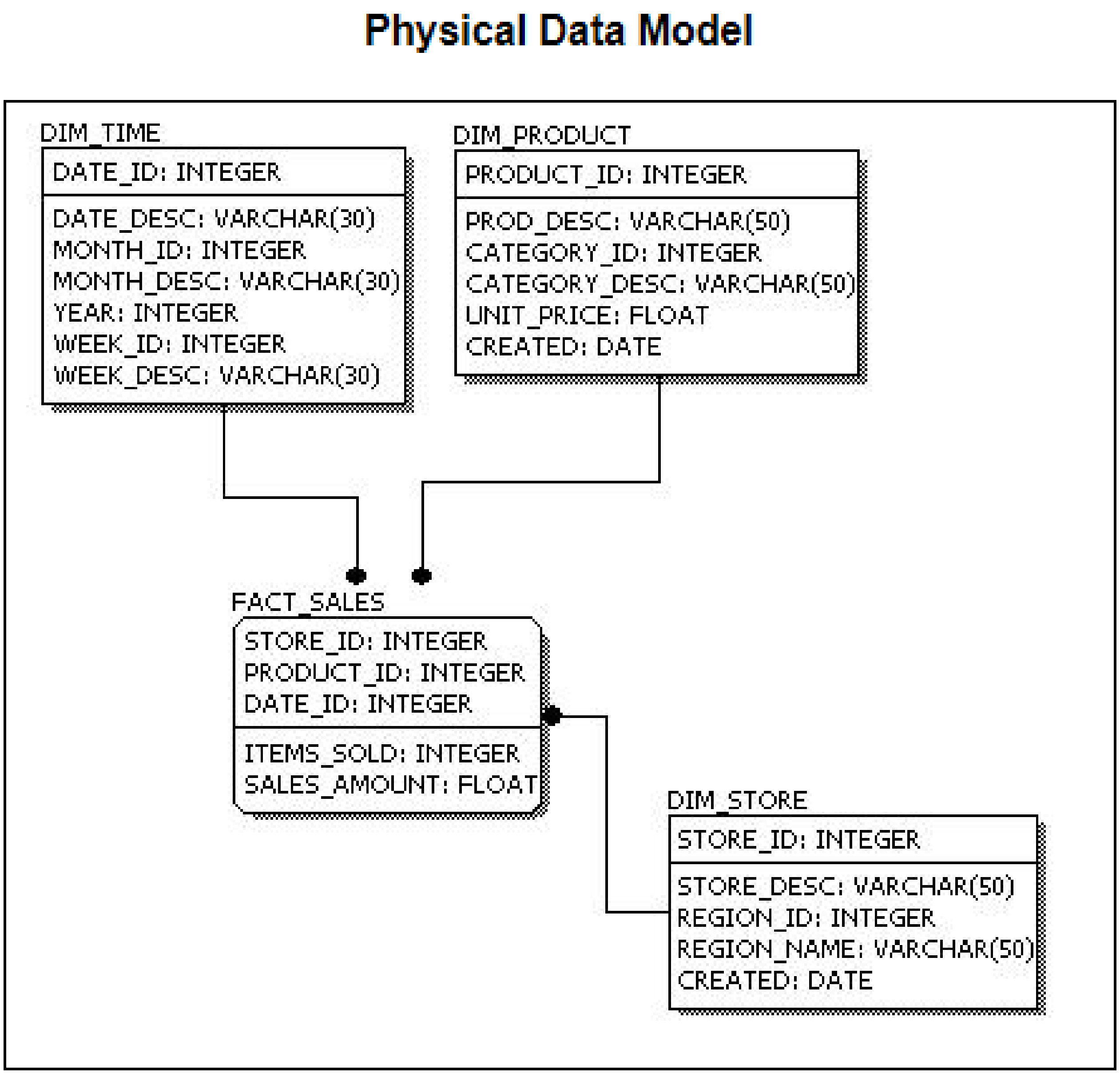
Logical Data Model



iii. **Physical data model** represents how the model will be built in the database. A physical database model shows all table structures, including column name, column data type, column constraints, primary key, foreign key, and relationships between tables. Features of a physical data model include:

- Specification all tables and columns.
- Foreign keys are used to identify relationships between tables.
- Denormalization may occur based on user requirements.
- Physical data model will be different for different RDBMS. For example, data type for a column may be different between MySQL and SQL Server.

The figure below is an example of a physical data model.



Other types of data model :

i) Object based data model :

Object based data model are used in describing data and data relationship in accordance with concept. In general, the object based data models are gaining wide acceptance for their flexible structuring capabilities. The ***Entity relationship model*** *which is an object based model is widely used in practices as an appropriate database design tool.*

ii) Record based data model :

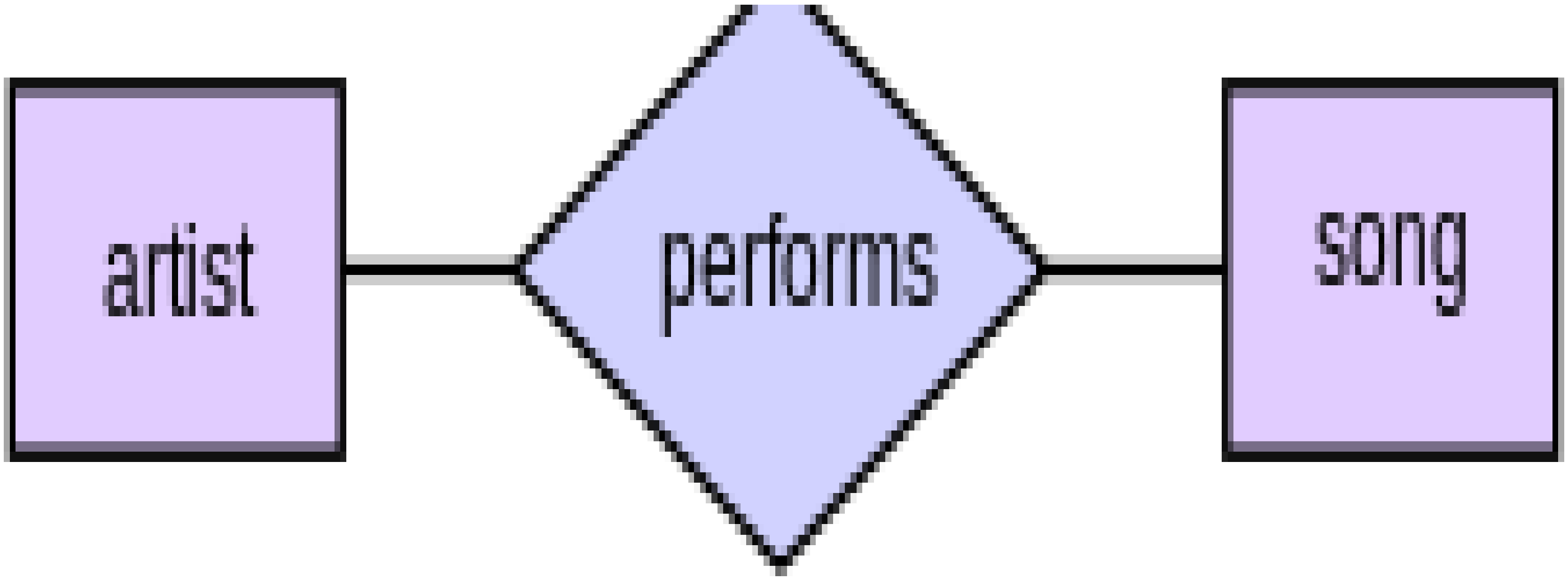
these data models are used to specify the overall logical structure of database. The three widely accepted record based data models are :

- *relational model*
- *network model and*
- *hierarchical model.*

Entity relationship model :

an **entity–relationship model** (**ER model**) is a data model for describing the data or information aspects of a business domain or its process requirements, in an abstract way that lends itself to ultimately being implemented in a database such as a relational database. The main components of ER models are entities (things) and the relationships that can exist among them, and databases.

Fig: e-r model



- *Association(Relationship) :*

  A relationship is an associating among several entities. For example working in relationship associate a project with each employee that she/he is working in .

E-R Diagram :

The overall logical structure of a database can be expressed graphically by E-R diagram which consist of following components :

- Rectangles, which represent entity sets.

- Ellipses, which represent attributes.

- Diamonds which represent relationships among entity sets.

- *Lines, which links attributes to entity sets and entity set to relationship*

Example :

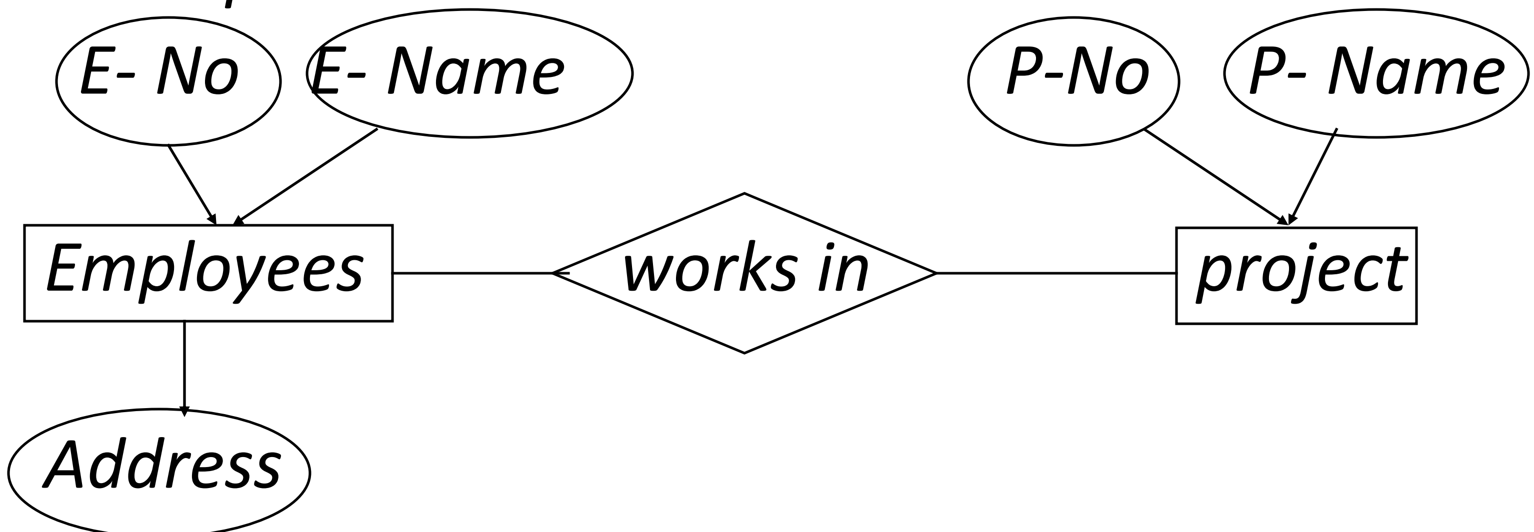


*Figure : E-R diagram for a part of the database of a project management system **entity set:***

- *An **entity set** is represented by a set of attributes. Possible attributes of the employee entity set are E_No, E_ Name and Address.*

Attributes

Entities are represented by means of their properties, called **attributes**. All attributes have values. For example, a student entity may have name, class, and age as attributes.

There exists a domain or range of values that can be assigned to attributes. For example, a student's name cannot be a numeric value. It has to be alphabetic. A student's age cannot be negative, 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.
- **Complex Attribute:** A complex attribute is an attribute that is both composite and multivalued.

Fig: Composite attribute

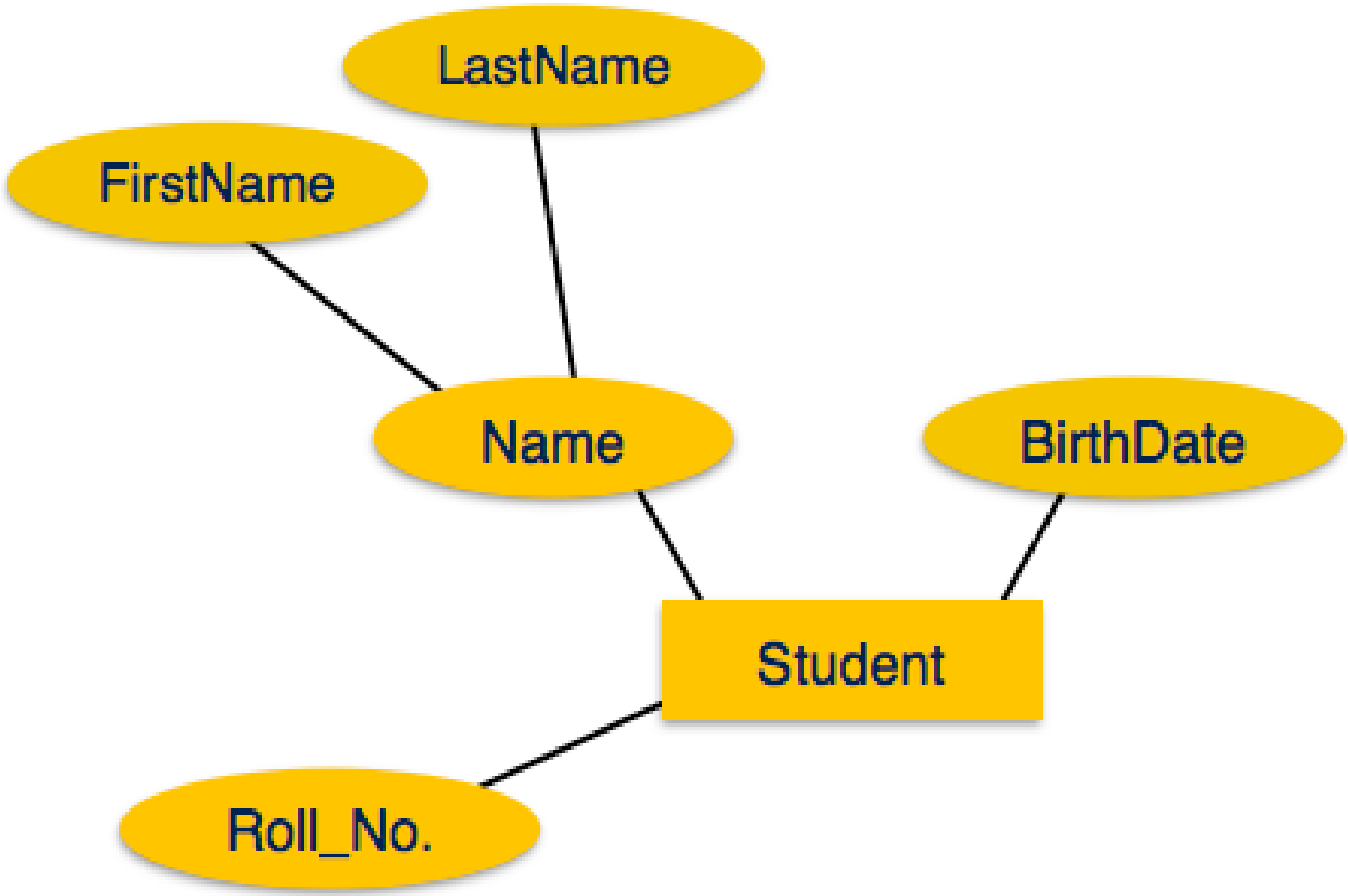


Fig:Multivalued attribute

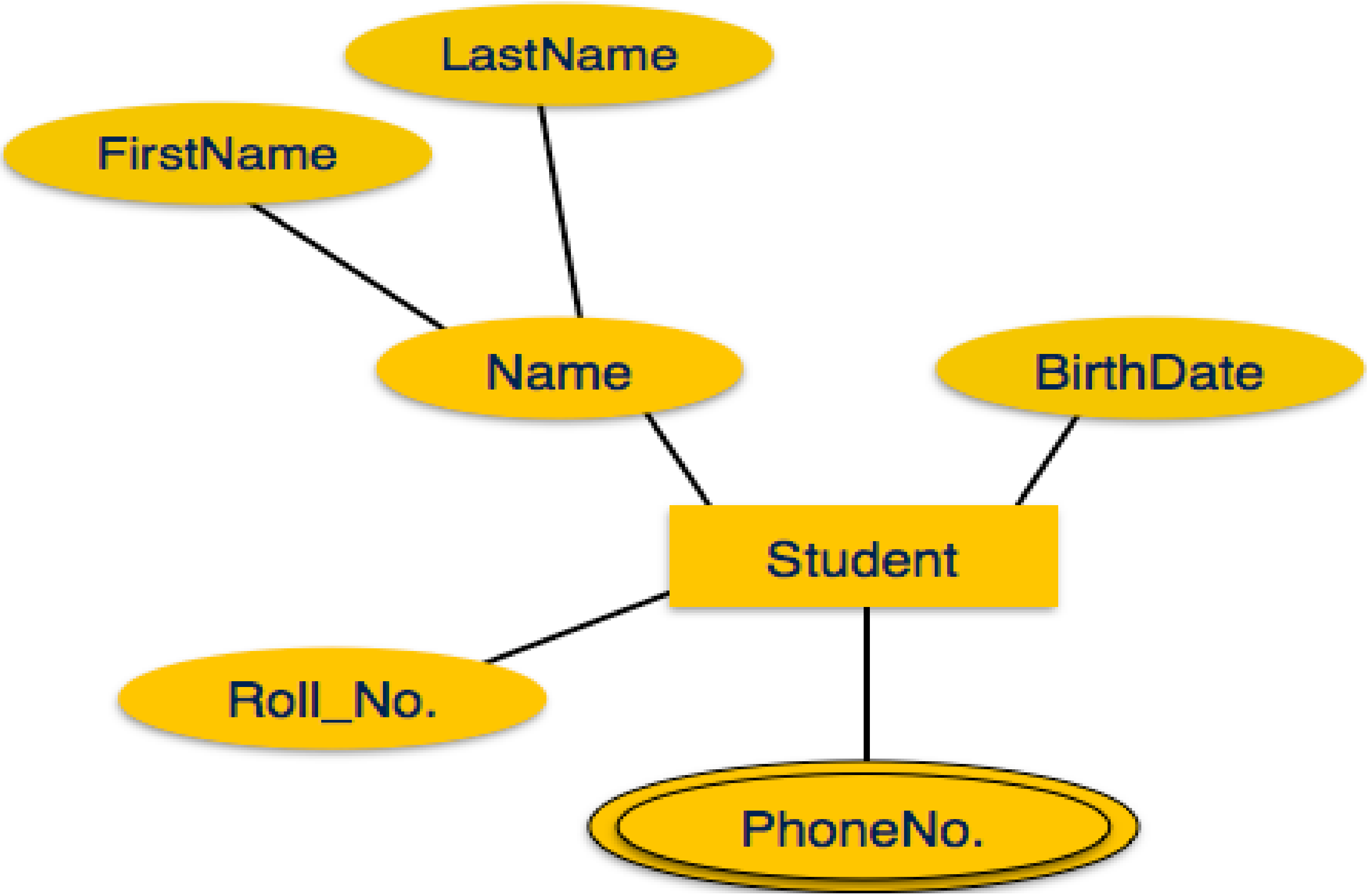
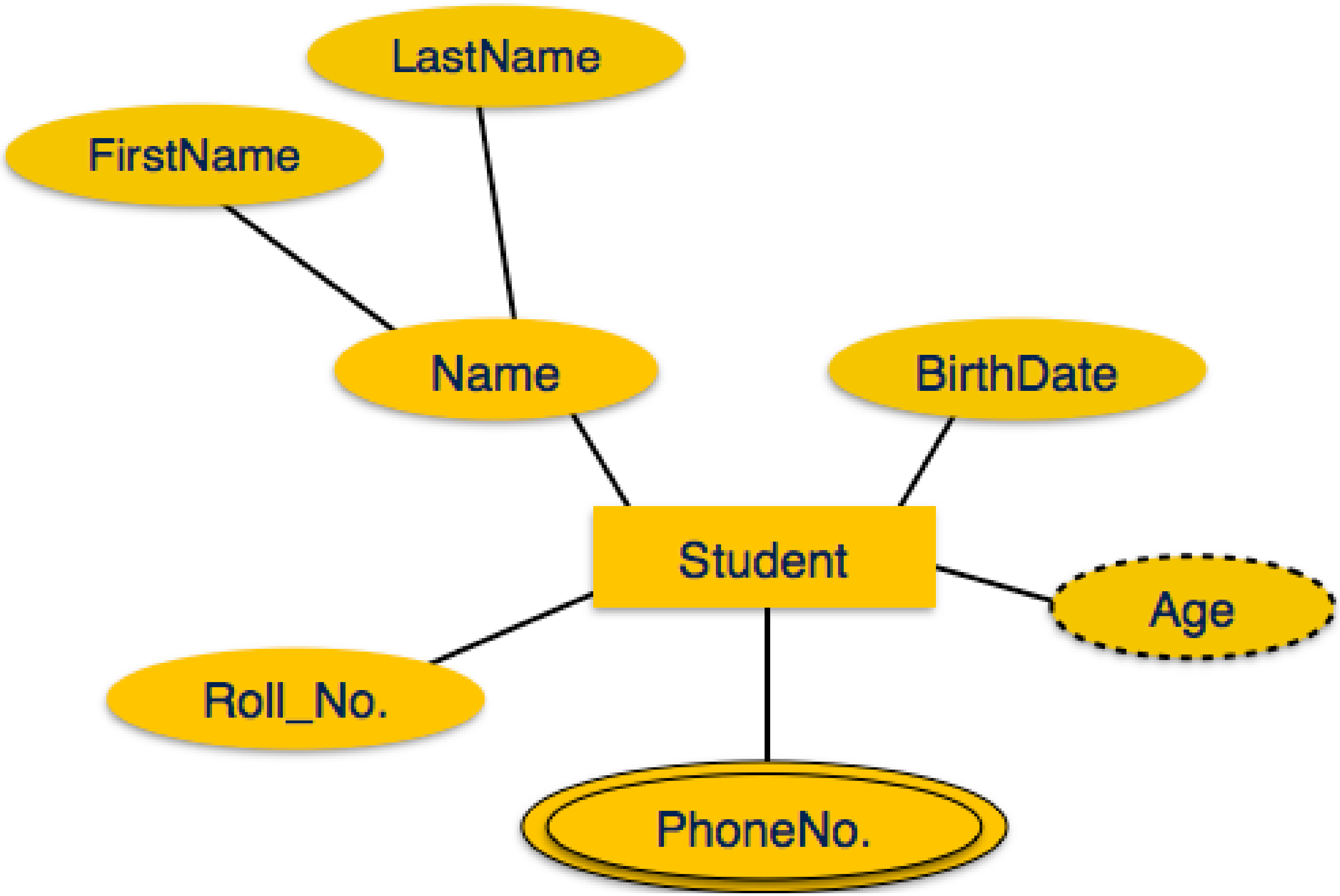


Fig: Derived attribute



Mapping constraints :-

One important constraint is mapping cardinalities which express the no. of entities of an entity set to which entities of another entity set can be associated with a relationship. There are four types of mapping cardinality.

i) One to One :

An entity in A is associated with at must one entity in B and an entity B is also associated with at most one entity in A.

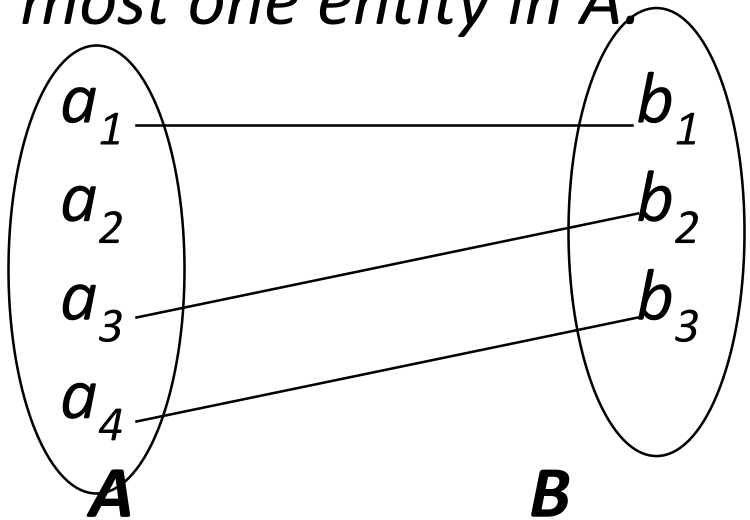


Fig: One to one relationship

ii) One to many :

An entity in A is associated with any number entities in B. An entity in B, however can be associated with at most one entity.

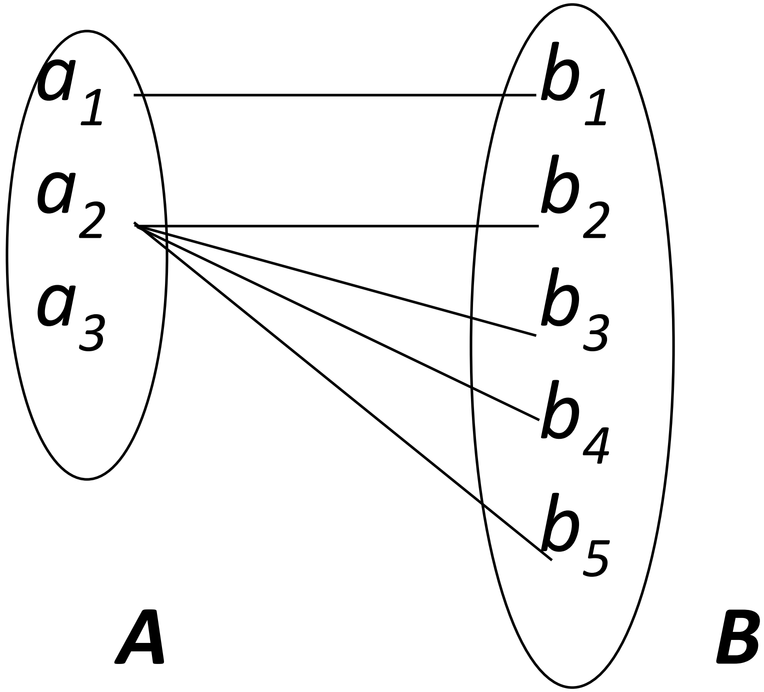


Fig: One to many relationships

iii) Many to one :-

An entity in A is associated with at most one entity in B. An entity in B, however can be associated with any no. of entities in A.

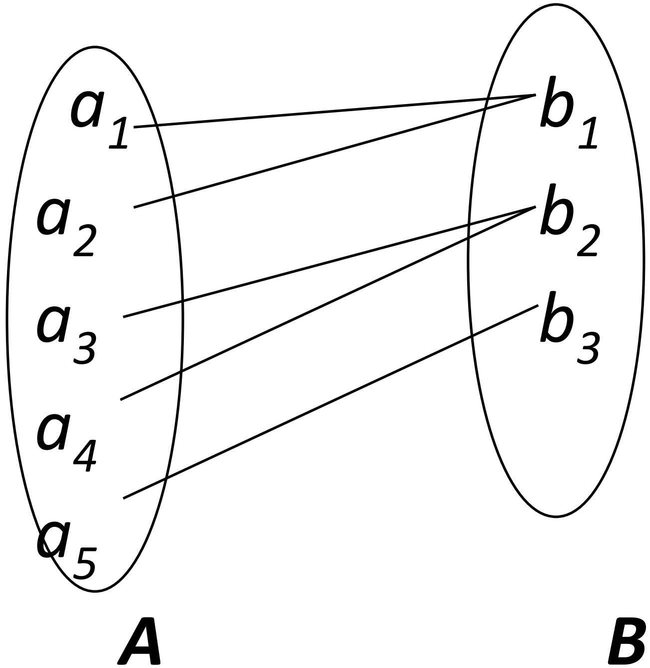
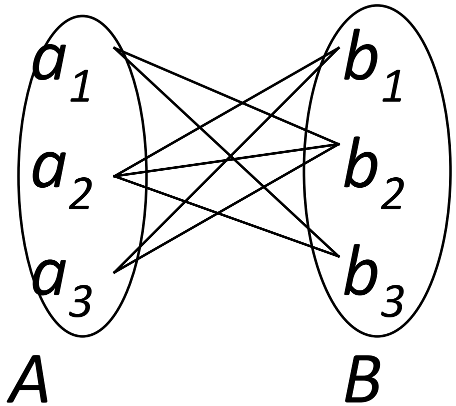


Fig : many to one relationship

iv) Many to many :

An entity in A is associated with any number of entities in B and an entity in B is also associated with any number of entities in A.


a1
a2
a3
b1
b2
b3
A
B

Other Associations:Aggregation

Some special types of associations arise often enough that UML has defined special techniques for handling them. One category is known as an aggregation or a collection. For example, a Sale consists of a collection of Items being purchased. As shown in Figure , aggregation is indicated by a small diamond on the association line next to the class that is the aggregate.

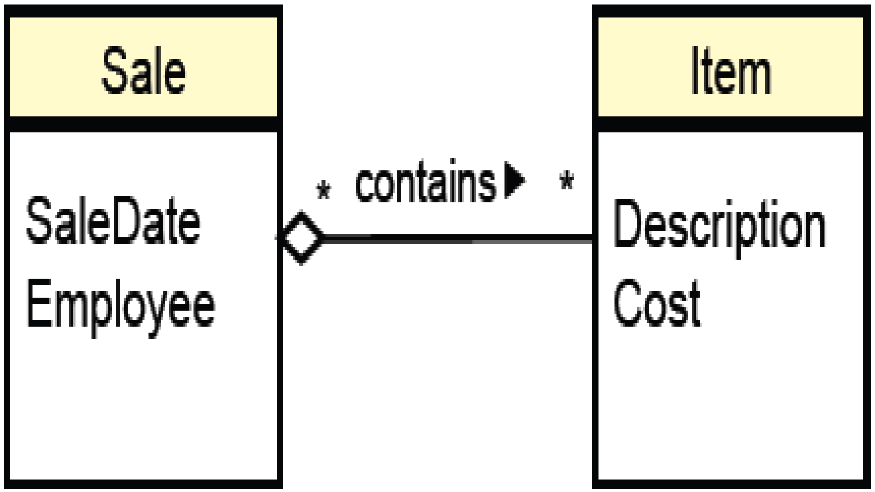


Figure 2.11

Association aggregation. A Sale contains a list of items being purchased. A small diamond is placed on the association to remind us of this special relationship.

Composition

composition is a stronger aggregate association that does arise more often. In a composition, the individual items become the new object. Consider a bicycle, which is built from a set of components (wheels, crank, stem, and so on). UML provides two methods to display composition. In Figure , the individual classes are separated and marked with a filled diamond.

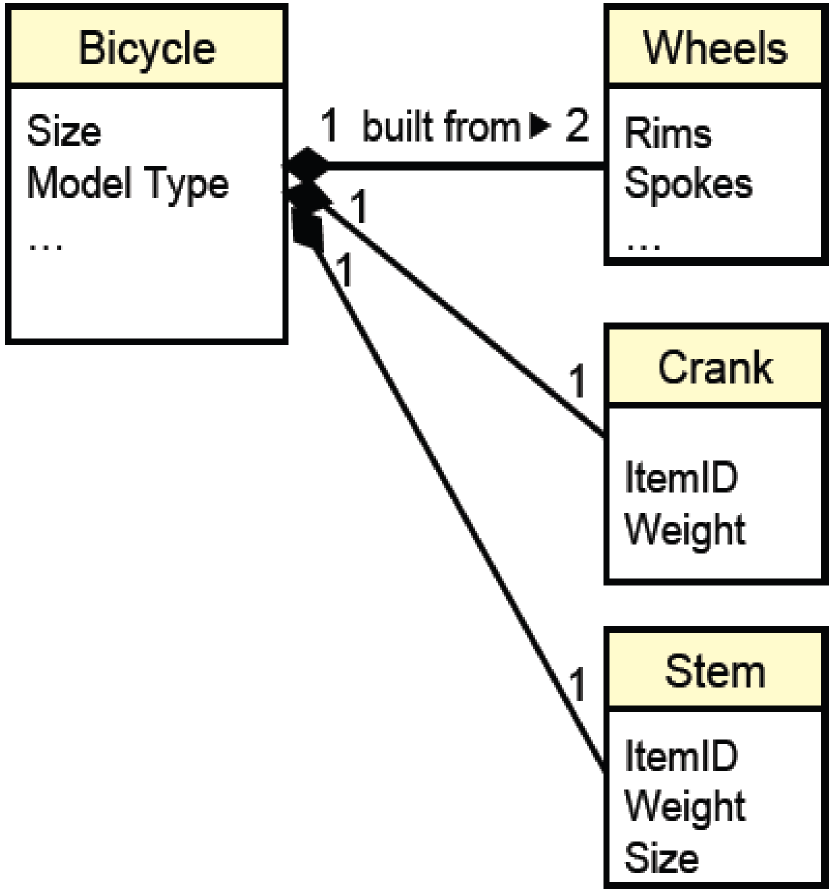


Figure 2.12

Association composition. A bicycle is built from several individual components. These components no longer exist separately; they become the bicycle.

Generalization

Another common association that arises in business settings is generalization. This situation generates a class hierarchy. The most general description is given at the top, and more specific classes are derived from it. Figure presents a sample from Sally’s Pet Store.

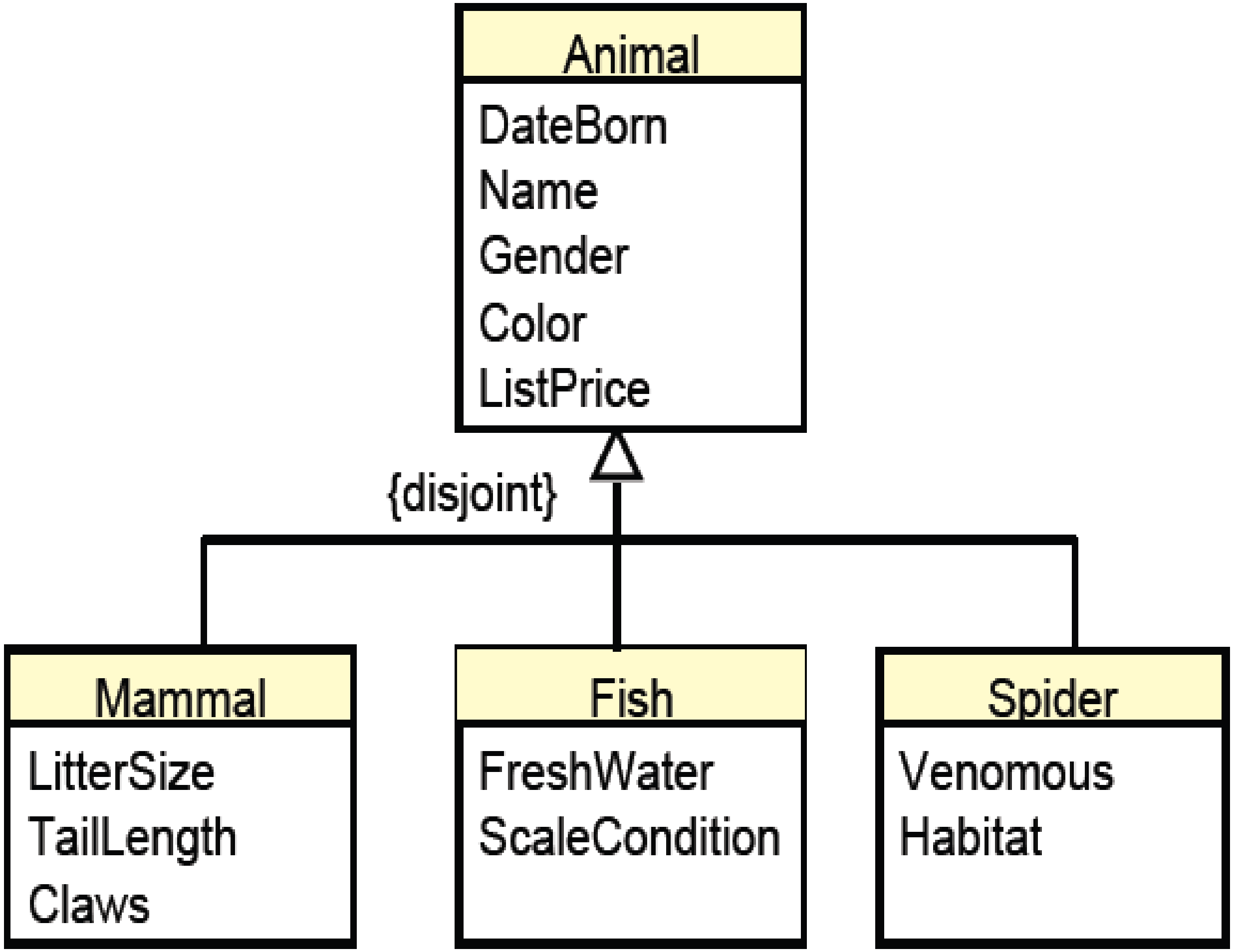


Figure 2.14

Association generalization. The generic Animal class holds data that applies to all animals. The derived subclasses contain data that is specific to each species.

Reflexive Association

A reflexive relationship is another situation that arises in business that requires special handling. A reflexive association is a relationship from one class back to itself. The most common business situation is shown in Figure most employees (worker) have a manager.

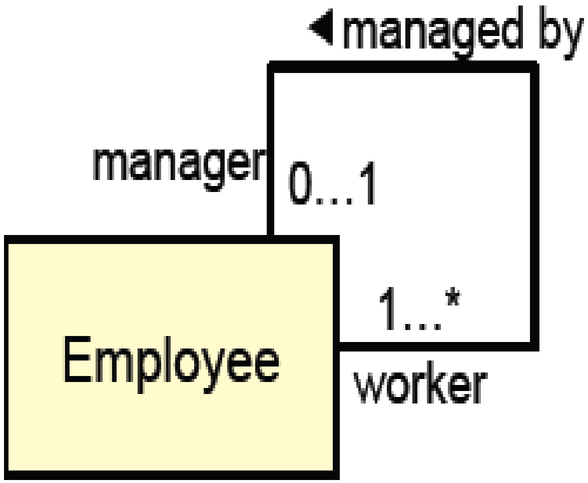


Figure 2.17

Reflexive relationship. A manager is an employee who manages other workers. Notice how the labels explain the purpose of the relationship.

Schema Diagram

- A schema diagram is described in a formal language supported by the database management system (DBMS). In a relational database, the schema defines the tables, the fields in each table, and the relationships between fields and tables.
- Schemas are generally stored in a data dictionary. Although a schema is defined in text database language, the term is often used to refer to a graphical depiction of the database structure

Levels of schema Diagram

- Conceptual schema, a map of concepts and their relationships
- Logical schema, a map of entities and their attributes and relations
- Physical schema, a particular implementation of a logical schema

Unit-3

Relation Databases

Relational Database :-

A relational database consists of a collection of tables i.e, in this model entity sets and relationships all are represented by tables. A row in a table represents a relationship among a set of values. Each row of a relation (table) is called a tuple. Fig shows the ***Structure of relational Database*** *.*

Table Name : student

attributes

S.N.	***Name***	***Address***
224	*Ram joshi*	*Butwal-13*
220	*Hari psd*	*Sukhanager-10*
200	*Gita kharel*	*Milanchowk-10*

Values

Important of relational database :-

- ✓ *Relational database are based on relational set theory. It supports relational algebra like :- (union, intersection, difference and cartessian product) and also support select project, join, division, operations etc.*
- ✓ *Relational database supports concept of dynamic views.*
- ✓ *Relational database use SQL (structured query language)*
- ✓ *Relational database have an excellent security.*
- ✓ *Rational database support to new hardware technologies.*

 # Keys :-

The key is define as the column or attributes of the database table. For example if a table has id, name & address as the column names then each one is known as the key for that table.

i) Super key :-

Super key for an entity set is a set of one or more attribute whose combined value uniquely identifies the entities in the entity set. For example, for an entity set employees the set of attributes (emp_code, emp_name, address) can be considered to be a super key.

ii) Candidate key :

A candidate key is minimal super key that super key which doesn't have any proper subset which is also super key for example (emp_no) and (emp_name, address) are two candidate keys for the entity set employee.

iii) Primary key :-

Primary key is usually the key selected to identify a row when database is physically implemented, for example (emp_no) can be considered to be the primary key for the entity set employees.

iv) Foreign key :

Foreign key is an attribute that appears as a non key attribute in one relation and as primary key attributes in another relation.

Relational Algebra:-

In Data Management, **relational algebra** describes how data is naturally organized into sets of data, apply so as data is the documentation of a real life person, place or thing and the events or transactions between them at a point in time.

The basic set of operation for the relational model is the relational algebra. These operations enable a user to specify basic retrieval request sets of operations include:-

- ⇨ *Select*
- ⇨ *Project*
- ⇨ *Union*
- ⇨ *Set difference*
- ⇨ *Cartesian product*
- ⇨ *Rename*
- ⇨ *Intersection*
- ⇨ *Join*
- ⇨ *Division*

i) Selection operation :-

To identify a set of tuples which is a part of a relation and to extract only these tuples out. The select operation selects tuples that satisfy a given predicate or condition.

⇨ *It is a unary operation defined on a single relation.*

⇨ *It is denoted as sigma (σ).*

⇨ *It supports arithmetic comparison operator and logical operator.*

Note: Arithmetic comparison operator :

⇨ *(<,>,<=,>=,==,!=)*

Logical operator : (NOT, OR, AND)

Example :

Table :Book

Acc.No	*YR_PUB*	*TITLE*
734216	*1982*	*Algorithm Design*
23767	*1995*	*Database Design*
89476	*1992*	*Compiler Design*
54678	*1991*	*Programming Design*
376112	*1992*	*Machine Design*

Select from relation "Book" all books whose year of publication is 1992.

Solution: Relational Algebra:

σ*YR_PUB=1992 (Book)*

SQL : Select from Book where YR_PUB=1992*

ii) Projection operation:

Returns its argument relation with certain attributes left out.

- *It is an unary operation defined on a single relation.*
- *It is a denoted as π (Pie)*

Example;

List all the Title and Acc-No of the "book" relation.

Relation algebra= π Acc_No, Title (Book)

SQL=Select Acc_No, TITLE from Book

Set Operations:

Union :

Union is used when we need attributes that appear in either or both of two relations. It is denoted as U.

Ex. R

a	b	c
d	c	a
b	f	e

S

b	c	a
c	d	f
b	f	e

Output:-

R U S=

a	b	c
d	c	a
b	f	e
b	c	a
c	d	f

For example :

Borrower(customer_name,loan_no)

Depositor (customer_name ,Account_number)

List all the customers who have either an account or loan number or both

relational Algebra= customer_name (borrower) union customer_name (depositor)

SQL= Select customer_name from Borrower union

Select customer name from depositor

Difference Operation (MINUS)/ Except:

Finds tuples in one relation but not in other. It is denoted as "–". Example : (output)

R-S=

a	*b*	*c*
d	*c*	*a*

Example :

Find the names of all customers who have an account but not a loan numbers

Relational Algebra:

π *customer_name (Depositor)- π customer_ name (Borrower)*

***SQL**= Select customer_name from Depositor MINUS select customer_name from borrower*

Cartesian product (cross join operation): -

It allows combining information from two relations.

- It is denoted as $R \times S$ where R and S Are relations.

Example;

$R \times S=$

a	b	c	b	c	a
a	b	c	c	d	f
a	b	c	b	f	e
d	c	a	b	c	a
d	c	a	c	d	f
d	c	a	b	f	e
b	f	e	b	c	a
b	f	e	c	d	f
b	f	e	b	f	e

- *Example : List all information of relation employer and department.*

  Employee (Ename, Department_ID)

  Department (Department_ID, Department_ name)

  Relational Algebra $= \sigma$ *(employee)* $\times$ *(department)*

  SQL=Select* From employee, department

Or

Select* From employee CROSS JOIN Department

Intersection operation :

Find tuples in both the relation. It is denoted as $\cap$.

Output

$R \cap S =$ b f e

Example :

Borrow (customername, loan_number)

Depositor (customername, accountnumber)

- *List all the customer's who have both a loan & an account.*

  Relational Algebra=

  π customername(Borrower)$\cap$ π customername (depositor)

  SQL=

  select customername from Borrower intersect

  select customername from Depositor

RENAME operation :

RENAME operation is used rename attributes. It is denoted as ρ(row)

Example : Employee (name, eid)

Change attributes name to employee name

Relational Algebra= ρ employee_name/name (employee)

SQL=ALTER TABLE employee RENAME column name to employee_name;

Also, we can rename table name

SQL= RENAME Employee To student;

Join Operation :

The Join operation is defined by the $\bowtie$ symbol and is used to compound similar tuples from two relation into single longer tuples. Every row of the first table is joined to every row of second table. The result is tuples taken from both tables.

Syntax:

A $\bowtie$<Join condition>B

<u>Types of join</u>

- *inner join (equi-join)*

An inner join creates a new results table by combining column value of two tables A and B based upon the join predicate.

The query compares each row of A with each row of B to find all pairs of rows which satisfy the join predicate.

Relational Algebra= R <R. primary-key=s.foreign-key>s

For Example :

Students

Student#	*Name*	*Course*
100	*Ram*	*PH*
200	*Shyam*	*CM*
300	*Hari*	*CM*

Courses

Course#	*Name*
PH	*Pharmacy*
CM	*Computing*

Relation algebra for inner point join or equi-join

students ⋈ course =course# courses

SQL=

Select from students INNER JOIN*

courses on students.course= courses.course;

- ***Natural join :-***

  A natural join offers a further specialization of equi-joins. The join predicates arise implicitly by comparing all columns in both tables that have the same column-name in the join tables. The resulting tables one column for each pair of equally named columns.

Relation algebra=

Students ⋈<course=course#>courses

SQL=Select*from students natural join courses

Theta Join :

A Cartesian product with a condition applied R<condition>S is called theta join.

SQL= *Select* from student, courses where student#=200;*

Outer Join

An outer join doesn’t require each record in the two joined tables to have a matching record. The joined tables retains each-record-even if no other matching records exists.

There are three types of outer join:

Left outer join

Right outer join

Full outer join

i) Left Outer join :-

The result of the left outer join (left join) for table A and B always contains all records of the “left” table A, even if the join condition doesn’t find any matching record in the “right” table B. It is denoted by ⟕

Syntax;

R ⟕ <r-primary key =s. foreign-key>s

Example

Student ⟕ <student. Course= courses. course#> courses

*SQL=select*from students left outer join courses on student .course= courses. course;*

ii) Right outer join :

A right outer join (right join) closely resembles a left outer join except with treatment of the tables reversed. Every row from the "right" table B will appear in the joined table at list one. Matching row from the left table A exist . Null will appear in columns from A for those records that have no match in A. It is denoted by $⟖$ *.*

Syntax;

R ⋈ *<R-primary –key=s foreign –key>*

Relational Algebra

Student ⋈ *<student. course = courses. Course#> courses*

SQL=select from student right other join courses on student. Course=courses.course#*

iii) Full other join :

A full other join combines the results of both left and right other joins the join table contains all records from both tables, and fill in nulls for missing matches on either side.

It is denoted by ⟗ .

Syntax:

R ⟗<R.primary-key=S.foreign-key>S

Relational Algebra=student ⟗ course <student. course = courses.course#> Courses

SQL=Select from student full other join courses on students.course=courses.course#*

SELF JOIN

The SQL **SELF JOIN** is used to join a table to itself as if the table were two tables, temporarily renaming at least one table in the SQL statement. The self-join statement is necessary when two sets of data, within the same table, are compared.

Syntax:

The basic syntax of **SELF JOIN** is as follows:

SELECT a.column_name, b.column_name... FROM table1 a, table1 b WHERE a.common_field = b.common_field;

Here, WHERE clause could be any given expression based on your requirement.

Example:

Consider the following two tables, (a) CUSTOMERS table is as follows:

```
+----+----------+-----+-----------+----------+
| ID | NAME     | AGE | ADDRESS   | SALARY   |
+----+----------+-----+-----------+----------+
|  1 | Ramesh   |  32 | Ahmedabad |  2000.00 |
|  2 | Khilan   |  25 | Delhi     |  1500.00 |
|  3 | kaushik  |  23 | Kota      |  2000.00 |
|  4 | Chaitali |  25 | Mumbai    |  6500.00 |
|  5 | Hardik   |  27 | Bhopal    |  8500.00 |
|  6 | Komal    |  22 | MP        |  4500.00 |
|  7 | Muffy    |  24 | Indore    | 10000.00 |
+----+----------+-----+-----------+----------+
```

Now, let us join this table using SELF JOIN as follows:

```
SQL> SELECT  a.ID, b.NAME, a.SALARY
     FROM CUSTOMERS a, CUSTOMERS b
     WHERE a.SALARY < b.SALARY;
```

This would produce the following result:

```
+----+----------+---------+
| ID | NAME     | SALARY  |
+----+----------+---------+
|  2 | Ramesh   | 1500.00 |
|  2 | kaushik  | 1500.00 |
|  1 | Chaitali | 2000.00 |
|  2 | Chaitali | 1500.00 |
|  3 | Chaitali | 2000.00 |
|  6 | Chaitali | 4500.00 |
|  1 | Hardik   | 2000.00 |
|  2 | Hardik   | 1500.00 |
|  3 | Hardik   | 2000.00 |
```

Division (Quotient) operation:

The division is a binary operation that is written as $R \div S$. The result consists of the restrictions of tuples in R to the attribute names unique to R, i.e., in the header of R but not in the header of S, for which it holds that all their combinations with tuples in S are present in R. For an example see the tables *Completed*, *DBProject* and their division:

Completed

Student	Task
Fred	Database1
Fred	Database2
Fred	Compiler1
Eugene	Database1
Eugene	Compiler1
Sarah	Database1
Sarah	Database2

DBProject

Task
Database1
Database2

Completed

÷

DBProject

Student
Fred
Sarah

Example

A	*B*	*C*	*D*
b	*c*	*e*	*f*
a	*b*	*i*	*j*
b	*c*	*g*	*h*
b	*c*	*a*	*d*
d	*i*	*g*	*h*
d	*i*	*j*	*k*
d	*i*	*e*	*f*

R

C	*D*
e	*f*
g	*h*

S

Output

A	B
b	c
d	i

Here, Relational Algebra

$R \div S = \pi A,B\ (R) - \pi A,B\ (\pi A,B(R) \times S - R$

Relation calculus :

Relation calculus consist of two calculi:

- *Tuple relational calculus*
- *Domain relational calculus*

That are apart of the relational model to databases and provide a declarative way to specify database queries. The relational calculus would formulate a descriptive declarative way.

For example :

To retrieve the phone numbers and name of book stores that supply some sample Book.

Relational calculus= Get store name, and store phone for supplies such that these exists a title book with the some bookstore ID value and with a Book title value of some sample book.

Note :

The relational algebra and relational calculus are essentially logically equivalent.

-

- *Tuple relational calculus :*

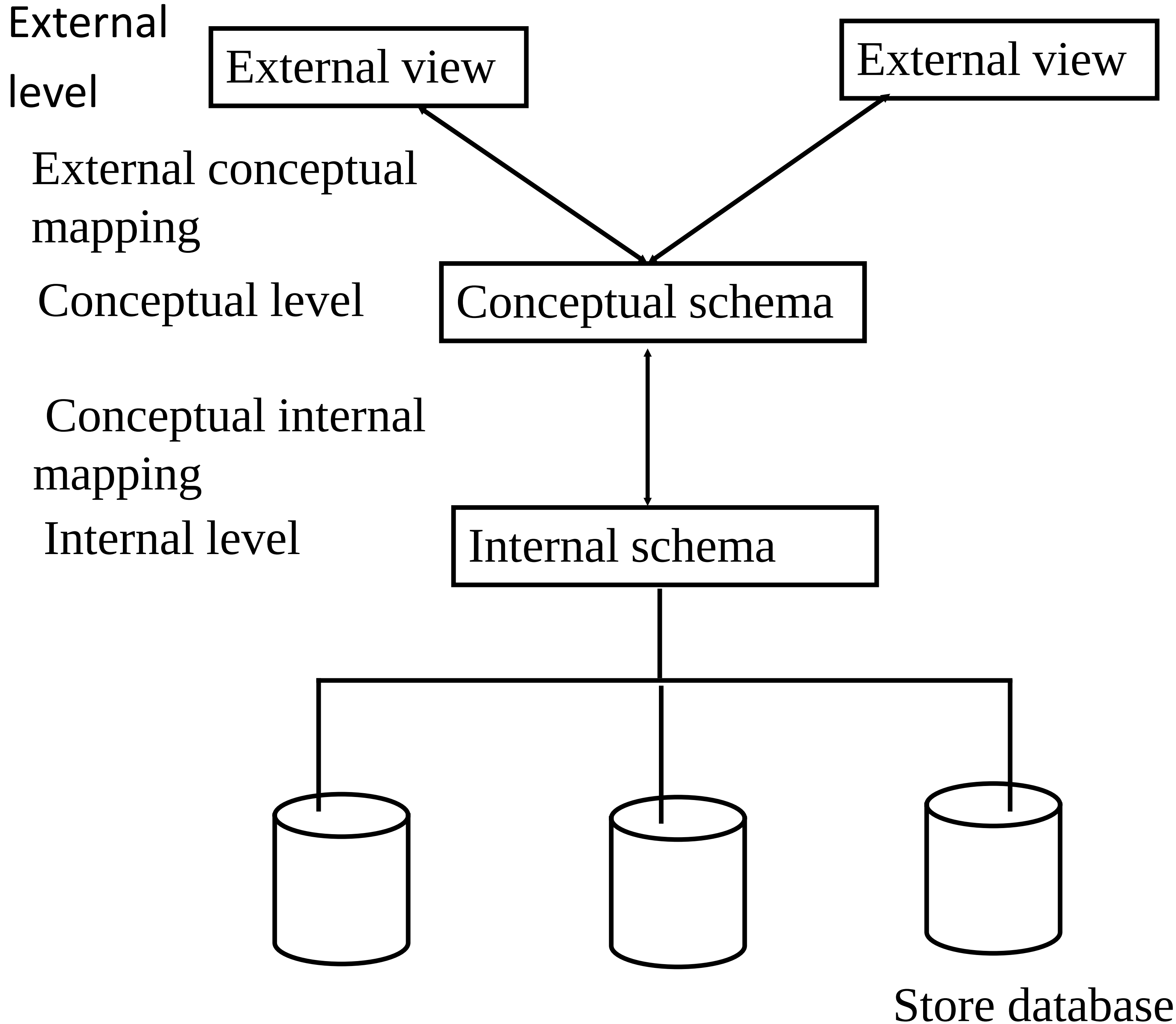
  Is a calculus that was introduced by Edgar F-codd as part of relational model, in order to provide a declarative database query language- for this data model it formed the inspiration for the database- query language QUEL & SQL.

- *Domain relational calculus :*

- *Is a calculus that was introduced by Michel Lacroix & Alain Pirotte as a declarative database query language for relational data model. The operator used in DRC: $\wedge$ (and), $\vee$(or), $>$(not), $\ni$ (existential quantifier), $\forall$ (universal quantifier) etc.*

schema :

schema of a database system is it's structure described in a formal language supported by DBMS and refers to the organization of data to create blue print of how database will be constructed .


External level
External view
External view
External conceptual mapping
Conceptual level
Conceptual schema
Conceptual internal mapping
Internal level
Internal schema
Store database

-Internal level :

Internal level has an internal schema which describe the physical storage structure of the database. The internal schema uses a physical data model and describes the complete details of data storage and access path for the database.

- Conceptual level :

Conceptual level has a conceptual schema, which describe the structure of the whole database for a community of users. The conceptual schema hides the details of physical storage structure and concentrates on describing entities, data types, relationship users operation & constraints.

- External level :-

External level includes a number of external schema or user view. Each external schema describes a part of the database that a particular user group is interested in and hides that rest of the database from that user group.

 # Instance:-

Actual data in the database may change quite frequently. For example, the database change every time we add a student or enter the new grade .The data in the database at a particular moment in time is called a database State or snap shot . It is also called the current set of occurrences or instances in the database.

View:- *View is a single table that is described from other tables. These other tables can be base tables or previously defined views. A view doesn’t necessarlly exist in physical form, it is considered a virtual table.*

Advantages of views:-

- *View can represent a subset of the data contained in a table.*
- *Views can join multiple table into a single virtual table.*
- *View can hide the complexity of data.*
- *View take very little space to store.*

SQL CREATE VIEW Syntax

CREATE VIEW view_name AS SELECT column1, column2..... FROM table_name WHERE [condition];

Example:

Consider the CUSTOMERS table having the following records:

```
+----+----------+-----+-----------+----------+
| ID | NAME     | AGE | ADDRESS   | SALARY   |
+----+----------+-----+-----------+----------+
|  1 | Ramesh   |  32 | Ahmedabad |  2000.00 |
|  2 | Khilan   |  25 | Delhi     |  1500.00 |
|  3 | kaushik  |  23 | Kota      |  2000.00 |
|  4 | Chaitali |  25 | Mumbai    |  6500.00 |
|  5 | Hardik   |  27 | Bhopal    |  8500.00 |
|  6 | Komal    |  22 | MP        |  4500.00 |
|  7 | Muffy    |  24 | Indore    | 10000.00 |
+----+----------+-----+-----------+----------+
```

Now, following is the example to create a view from CUSTOMERS table. This view would be used to have customer name and age from CUSTOMERS table:

```
SQL > CREATE VIEW CUSTOMERS_VIEW AS
SELECT name, age
FROM  CUSTOMERS;
```

Now, you can query CUSTOMERS_VIEW in similar way as you query an actual table. Following is the example:

Unit -4

Relation laguages

SQL(Structure Query Language)

Definition:

SQL (**Structured Query Language** is a special-purpose programming language designed for managing data held in a relational database management system (RDBMS).

Originally based upon relational algebra and tuple relational calculus, SQL consists of a data definition language and a data manipulation language. The scope of SQL includes data insert, query, update and delete, schema creation and modification, and data access control.

History:

SQL was initially developed at IBM by Donald D. Chamberlin and Raymond F. Boyce in the early 1970s. This version, initially called *SEQUEL* (*Structured English Query Language*), was designed to manipulate and retrieve data stored in IBM's original quasi-relational database management system, System R, which a group at IBM San Jose Research Laboratory had developed during the 1970s.The acronym SEQUEL was later changed to SQL.

In the late 1970s, Relational Software, Inc. (now Oracle Corporation) saw the potential of the concepts described by Codd, Chamberlin, and Boyce and developed their own SQL-based RDBMS with aspirations of selling it to the U.S. Navy, Central Intelligence Agency, and other U.S. government agencies.

In June 1979, Relational Software, Inc. introduced the first commercially available implementation of SQL, Oracle V2 (Version2) for VAX computers.

After testing SQL at customer test sites to determine the usefulness and practicality of the system, IBM began developing commercial products based on their System R prototype including System/38, SQL/DS, and DB2, which were commercially available in 1979, 1981, and 1983, respectively.

Query:

- In computers, what a user of a search engine or database enters is sometimes called the query. To query (verb) means to submit a query (noun).
- A database query can be either a *select query* or an *action query*. A select query is simply a data retrieval query. An action query can ask for additional operations on the data, such as insertion, updating, or deletion.

Sub queries :

A sub query is a form of an SQL statement that appears in inside another SQL statement it is also termed nested query. Subqueries can be used with the SELECT, INSERT, UPDATE, and DELETE statements along with the operators like =, <, >, >=, <=, IN, BETWEEN etc.

It can be used by the following commands.

- To insert records in a targets in the table created.
- To update records in a target table .
- To create view

Data types(Domain) in SQL *:*

Is an attribute that specifies the types of data that the object can hold integer data, character data, date and time data and so on.

Some of data types are given below.

- *Char (size)*

  This data types is used to store character string values of fixed length. The size in brackets determine the number of characters the cell can hold.

- *Varchar(size)/ Varchar2(size) :*

  This data types is used in store variable length alphanumeric data.

- *Number :*

  The number is used to store number (fixed or floating point) in database.

- ***Date :***

  This data types is used to represent date & time. The standard format is DD-MM-YY as 21-jun-2012.

- ***Long :***

  This data type is used to store variable length character string containing upto 2 GB.

- ***Boolean :-***

  This data type has values of True and False.

- **Date/Time** Use for dates and times
- **Text:** Use for text or combinations of text and numbers. 255 characters maximum.
- **Memo**: Memo is used for larger amounts of text. Stores up to 65,536 characters.
- Yes/No A logical field can be displayed as Yes/No, True/False, or On/Off.
- **AutoNumber:** AutoNumber fields automatically give each record its own number, usually starting at 1.
- **Currency:** Use for currency. Holds up to 15 digits of whole dollars, plus 4 decimal places.

- **Binary Objects:** A relatively new domain is to separate category for objects or binary large objects (BLOB). It enables us to store any type of object created by the computer. A good e.g. is to use a BLOB to hold files from other software packages. An engineering database might hold drawings and specifications for various components. The advantage is that all of the data is stored together making it easier for users to find the information they need and simplifying backups.

- **Computed values:** Some business attributes can be computed. For instance the total value of a sale can be calculated as the sum of the individual sale prices plus the sales tax, or an employee’s age can be computed as the difference between today’s date and Date of Birth. At the design stage, you should indicate which data attributes could be computed. The UML notation is to precede the name with a slash (/) sign and then describe the computation in a note.

- **Events :** Events are another important components of modern database systems that we need to record. Three basic types of events occur in a database environment.
  - Business events that trigger some functions, such as a sale triggering a reduction in inventory
  - Data changes that signal some alert, such as an inventory that drops below a present level, which triggers a new purchase order, and
  - User interface events that trigger some action, such as a user clicking on an icon to send a purchase order to a supplier.

Events are action that is dependent on time.

DDL : (Data definition language)

DDL is a syntax similar to a computer programming language for defining data structures, specially database schemas.

Many data description, language SQL uses a collection of imperative verb whose effect is to modify the schema of database by adding changing and deleting definitions of table or other objects .

Create statements :

To make a new database table, index or view etc.

Syntax.

CREATE TABLE[table name]

(columnname1 data types (size), column name2 data types (size)………));

Example :-

Create employee table having same attributes.

create table employee (id integer primary key, fname varchar(50) , Lname varchar (50) , date_of_Birth date);

<u>Drop statement :</u>

To destroy an existing database, table, index or view.

syntax:

Drop object_type object_name;

Example:

Destroy employee table

Drop TABLE employee;

<u>Alter statement :</u> *To modify an existing data base object.*

Syntax:

A LTER object type object of name parameters;

Example :

The command to add (then remove)

Add a column named bubbles for an existing table named sink .

ALTER TABLE Sink Add bubbles integer;

Drop a column named bubbles for an existing table named sink .

ALTER TABLE sink Drop column bubbles;

DML (Data Manipulation Language): statements are used for managing data within schema objects.

DML is a family of syntax element similar to a computer programming language used for inserting deleting and updating data in database. DML statements are.

- ✓ *Select…………..from…………where*
- ✓ *Insert…………..into …………..values…….*
- ✓ *Update………..set……………..where……..*
- ✓ *Delete …………..from…………..where……*

The SQL SELECT Statement

- The SELECT statement is used to select data from a database.

SQL SELECT Syntax

SELECT *column_name*,*column_name*
FROM *table_name*;

Example:

SELECT * FROM *employee*;

The SQL INSERT INTO Statement

- The INSERT INTO statement is used to insert new records in a table.

SQL INSERT INTO Syntax

INSERT INTO *table_name*
VALUES (*value1*,*value2*,*value3*,...);

Or

INSERT INTO *table_name*
(*column1*,*column2*,*column3*,...)
VALUES (*value1*,*value2*,*value3*,...);

Example:

INSERT INTO Customers (CustomerName, City, Country)
VALUES ('Cardinal', 'Stavanger', 'Norway');

The SQL UPDATE Statement

- The UPDATE statement is used to update existing records in a table.

SQL UPDATE Syntax

UPDATE *table_name*
SET *column1=value1*,*column2=value2*,...
WHERE *some_column=some_value*;

Example

UPDATE Customers
SET ContactName='Alfred Schmidt',
City='Hamburg'
WHERE CustomerName='Alfreds Futterkiste';

The SQL DELETE Statement

- The DELETE statement is used to delete rows in a table.

SQL DELETE Syntax

- DELETE FROM *table_name*
  WHERE *some_column=some_value*;

Example

```
DELETE FROM Customers
WHERE CustomerName='Alfreds Futterkiste'
AND ContactName='Maria Anders';
```

Data Control Language (DCL)

The Data Control Language (DCL) is a subset of the Structured Query Lanaguge (SQL) that allows database administrators to configure security access to relational databases. Some examples:

- GRANT - gives user's access privileges to database
- REVOKE - withdraw access privileges given with the GRANT command

Operator in SQL:

- Relational operator :=,>=, <,>,<=,!=
- Arithmetic operator : +, -,/,*
- Logical operator : AND, OR, NOT

And operator:

Process all rows in a table & display the result only when all of the conditions specified using AND operator is satisfied.

Example :

Retrieve the contents of the columns product_no, description, profit_percent, sell-price from the table product master where the values contained in the field profit_ percent is between 10 & 20 both inclusive.

```
select product_no, description, profit_percent,
sell_price  from product_master
where profit_percent>=10 AND
 Profit_percent<=20;
```

OR operator :

Process all rows in a table & display the result only when any of the conditions, specified using OR operator is satisfied .

Example

Retrieve client information like client _no, name, address, city, pin_code for all the clients where the pin code has the value 400054 or 400057;

select * from client_master where pin_code =400054 OR pin_code=400057;

Not operator :-

Process all the rows in a table and display the result only when non of the conditions specified using the Not operator are satisfied.

Example :

Retrieve specified client information for the clients who are Not in “Butwal” OR “Pokhara”

select client_no, name, address, city pin_code

from client_master

where Not (city=‘Butwal’ or city=‘ pokhara’);

Range Searching:

BETWEEN Operator:

Allows the selection of rows that contains values within a specified lower and upper limit.

Example :

- ✓ *Retrieve all information from the table product-master where the values contain within the field profit-percent is bet^n 10 & 20 both inclusive.*

Select* from product-master

where profit_percent between 10 AND 20;

Pattern matching :

LIKE predicate :

allows for a comparison of one string value with another string value which is not identical.

for character data types :

- ❑ *The percent sign(%) matches any string.*
- ❑ *The underscore (_) matches any single character.*

Example :

- *Retrieve all information about supplier whose name begin with letters 'ja' from supplier_master.*

Select *from supplier_master where supplier_name ='ja%';

select* from supplier_master

Where supplier_name like 'l_r%' or

Supplier_name Like '_h%';

Function In SQL :-

SQL has many built-in functions for performing calculations on data. *Function are also capable of accepting user-supplied variables or constants and operating on them.*

✓ ***Aggregate functions:***

SQL aggregate functions return a single value, calculate from the values in column.

i) Avg : returns the average value.

eg.

select avg(sell-price)“Average” from product_master;

ii) MIN :

Returns the smallest value.

Eg.

select MIN(bal-due) “minimum balance”

from client_master;

iii) Count (expr):

Returns the number of rows where “expr” is not null.

Eg.

select count (product_No) “No of product”

from product_master;

iv) Count (*):

Returns the number of rows in tables including duplicates and those with nulls.

Eg.

select count(*) “total” from client_master;

v) Max():

Returns the largest value.

Exmaple :

select max (bal_due) “maximum” from client-master;

vi) Sum :

Returns the sum.

Example:

select sum (bal_due) “total balance due”

from client_master;

vii) SQRT :-

Returns square root of ‘n’ .

example :

select SQRT (25) “Square Root” from dual;

Group By clause :

Group by clause is another section of the select statement. To group rows based on distinct values that exits for specified column i.e. it creates a data set, containing several set of records grouped together based on a condition.

Table : sales

Detail ord no.	Product No.	Qty ordered	Qty Dispatched
019001	P0001	10	10
019001	P0004	3	3
019001	P0006	1	7
019002	P0002	4	4
019002	P0005	10	10
019003	P0003	2	2
019004	P0001	6	6
019005	P0006	4	4
019005	P0004	1	1
019006	P0006	8	8

Example :

Retrieve the product and the total quantity ordered for each product from the sales tables.

select product_No, Sum (Qty_ordered) “Total Qty” from sales group by product_No;

Having clause:

The HAVING Clause can be used in conjunction with group by clause. HAVING imposes a condition on the group by clause, which further filter the group created by the group by clause. Eg,

- *Retrieve the product No. & total quantity ordered for products 'Pooo1' or 'Pooo4' From sale table .*

Select product_No, Sum (Qty ordered) "Total Qty"
from sales
group by product_No
having product_No="P0001' OR
product_No= 'P0004' ;

ORDER BY clause :

allows data from a table to be viewed in a sorted order. The rows retrieved from the table will be sorted in either ascending or descending order depending on the condition specified in the select sentence.

Eg,

- Retrieve all rows from the table client_masters & display this data sorted on the value contained in the field client no in ascending order.

  select* from client_master

ORDER By client- no;

Note : if we want to descending order then,

Select* from client_master

ORDER by client-No Desc;

Stored Procedure

- A **stored procedure** is a subroutine available to applications that access a relational database system. A stored procedure (sometimes called a **proc**, **sproc**, **StoPro**, **StoredProc**, **sp** or **SP**) is actually stored in the database data dictionary.
- Typical use for stored procedures include data validation (integrated into the database) or access control mechanisms. Furthermore, stored procedures can consolidate and centralize logic that was originally implemented in applications. Extensive or complex processing that requires execution of several SQL statements is moved into stored procedures, and all applications call the procedures. One can use nested stored procedures by executing one stored procedure from within another.
- Stored procedures are similar to user-defined functions (UDFs).

Difference between view and procedure

Views

1. Does not accepts parameters
2. Can be used as a building block in large query.
3. Can contain only one single Select query.
4. Can not perform modification to any table except base table from where it's created.
5. Can be used (sometimes) as the target for Insert, update, delete queries.

Stored Procedure

1. Accept parameters
2. Can not be used as a building block in large query.
3. Can contain several statement like if, else, loop etc.
4. Can perform modification to one or several tables.
5. Can not be used as the target for Insert, update, delete queries.

QBE(Query By Example)& GQBE :

is database query language for relational database. It was devised by Moshe M. Zloof at IBM research during the mid 1970's, in parallel to the development of SQL. It is the first graphical query language, using Visual tables where the user would enter commands, example, elements, & condition. Many graphical front- ends for databases use the ideas from QBE today. Originally limited only for the purpose of retrieving data, QBE was later extended to allow other operations, such as inserts, deletes & updates as well as creation temporary tables.

Unit-5

Relational Database Design

Data Normalization :-

The essence of data normalization is to split your data into several tables that will be connected to each other based on the data within them. The goal of data normalization is to identify the business rules so that you can design good database table. By designing database tables carefully, we

$\Rightarrow$ Save space

$\Rightarrow$Minimize duplication

$\Rightarrow$Project the data to ensure it's consistency

$\Rightarrow$Provide faster transactions by sending less data.

Fundamental rules of Data Normalization.

- ✓ Each cell in a table contain atomic (single-valued) data.
- ✓ Each non-key column depends on all of the primary key columns.
- ✓ Each non-key column depends on nothing outside of the key columns.

- Types of Normalization :-

  i) 1 normal form (1NF)

  ii) 2 normal form (2NF)

  iii) 3 normal form (3NF)

  iv) Boyce codd Normal form (BCNF)

i) 1 normal form (1NF) :-

An entity is in the first normal form if it contains no repeating groups or each cells contain atomic data
Example :

Entity :Customer(cid,full_name,tele_ph)

is not in 1NF & Now converting 1NF we have to split the table.

CID	F-name	Surname	Tele.ph.
123	Rohan	Pandey	071-
456	Hari	Sharma	072-
789	Mohan	K.C	076-

Customer info(CID,first name, surname)

Customer tel(CID, Telephone_ number)

2) Second normal form (2NF):-

A relation R is in second normal form (2NF) if & only if it is in 1NF & every non-key attributes is fully functionally dependent on the primary key.

Note: full functional dependency

- *A&B are attributes of a relation.*
- *B is fully dependent on A if B is functionally dependent on A (E.g. $A \rightarrow B$)*

Figure 3.20

Second normal form definition. Each nonkey column must depend on the entire key. It is only an issue with composite keys. The solution is to split off the parts that only depend on part of the key.

Example

Sale line (sale ID, Item ID, Description, list price, Quantity, Quantity on Hand)

it is not in 2NF, Now converting into 2NF

Item(ItemID, Desription, listprice, Quantity on hand)

Sale_Items (sales ID, ItemID, Quantity)

3) Third normal form (3NF):-

A relation that is in 1NF, 2NF in which no non_primary key attribute is transitively dependent on the primary key.

Note: Transitive Dependency

A,B, & c are attributes of relation such that if $A \rightarrow B$ and $B \rightarrow C$, then $C \rightarrow A$ is transitively dependent on A through B.

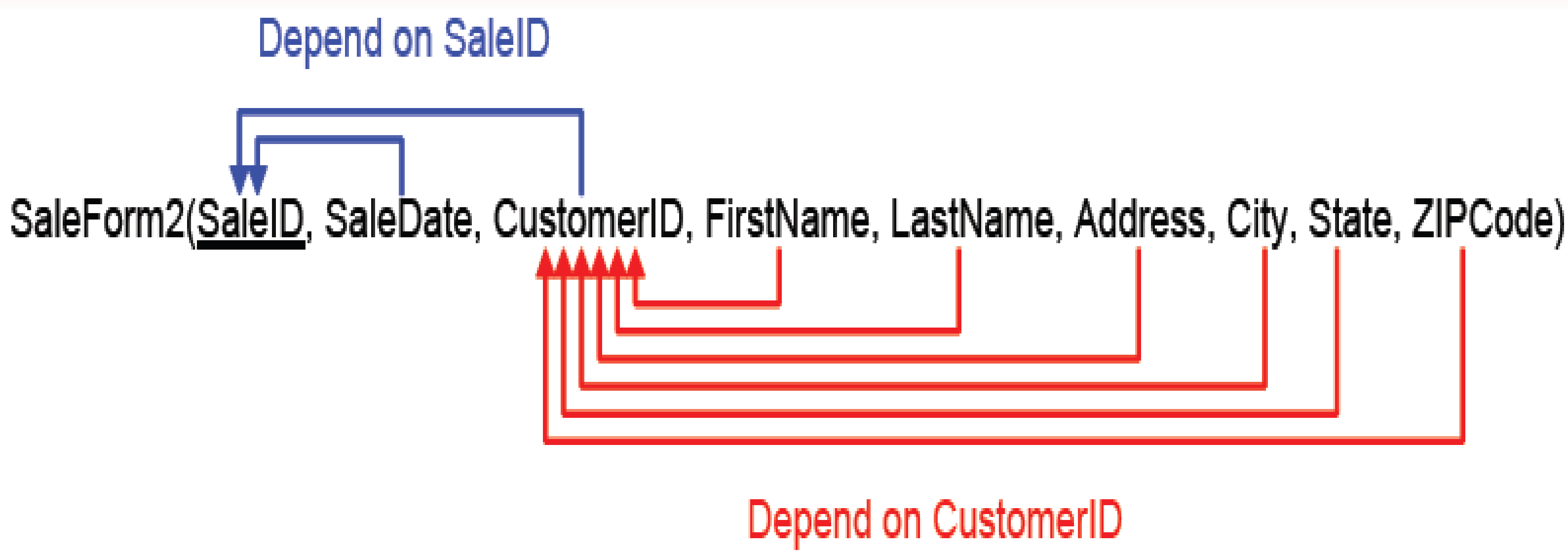


Figure 3.25

Third normal form definition. This table is not in 3NF since some of the columns depend on CustomerID, which is not part of the key.

Example

Sale_form (sale ID, sales date, customers Id, first name, last name, city, state, zip code)

above table is not in 3NF because there is transitive dependency, now, convert into 3NF.

Sale (sales Id, sale Date, customer ID)

customer (customer Id, first name, last name city, state, zip code)

4) BCNF(Boyce codd Normal form) :-

Definition

A relation is in Boyce-Codd normal form if and only if it is in third normal form and every determinant is a candidate key. That is, if there is an FD X → Y, then X must be the primary key (or equivalent to the primary key). In simpler terms: there cannot be a hidden dependency, where hidden means it is not part of the primary key.

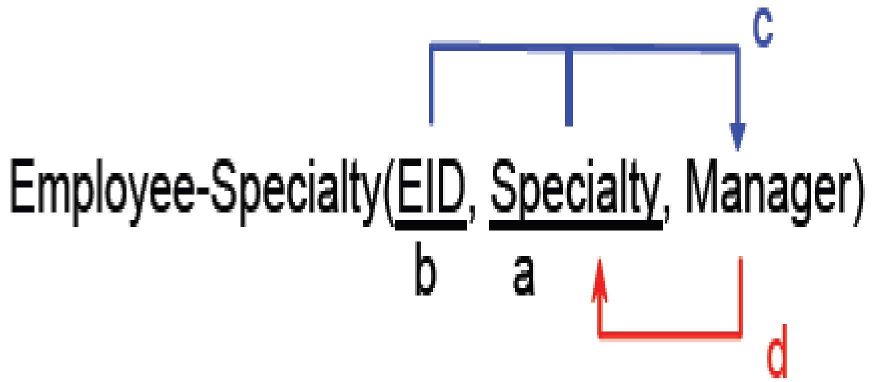


Figure 3.29

Boyce-Codd normal form. There is a hidden dependency (d) between manager and specialty. If we delete rows from the original table, we risk losing data about our managers. The solution is to add a table to make the dependency explicit.

example

Employee.specialty (EID, specialty, manager)

Above table is not in BCNF because there is hidden dependency. Now converting into BCNF.

Employee_info (EID, manager)

manager_specialty (manager, specialty)

Multivalued dependencies

Multivalued dependencies are also referred to as tuple generating dependencies. After the Boyce -Codd normal form the results may be devoid of any functional dependencies but it may encounter multivalued dependencies as the multivalued dependencies also cause redundancy of data.

For eg:
If there are 3 attributes involved in a relation,A,B, and C.. Then for every value of A we will have respective values for B and C. Then it is called multivalue dependency.

MVD or Multivalued Dependency is a dependency where one attribute value is potentially a "multivalued fact" about another and the attributes must be independent of each other.

Data constraints/Data rules and integrity :-

Rules which are enforced on data being entered and prevents the user from entering invalid data into tables are called constraints. Thus constraints control data being entered in tables for permanent storage.

Data constraints to be attached to table column via SQL syntax that will check data for integrity.

Types of data constraints :

i)I/O Constraints :

This data constraint determine the speed at which data can be inserted or extracted from a table. I/O constraints divided into two parts.

a. Primary key constraints

- that the data entered in the table column is unique.
- That none of the cells belonging to the table column left empty.

b. Foreign key constraints :

This constraints establishes a relationship between records. This relationship ensures :

- Records can not be inserted into a detail table if corresponding records in the master table do not exist.

ii) Business Rule constraints :

DBMS allows the application of business rules to table columns. Business manager determine, business rules. These rules are applied to data prior the data being inserted into table columns eg,

The rule that no employee in the company shall get salary less than Rs.1000/- is a business rule.

$\Rightarrow$ **Trigger :**

A database trigger is procedural code that is automatically executed in response to certain events on a particular table or view in a database. In addition to trigger that fire when data is modified & when user logon or logoff events occur. There are four type of trigger:

$\rightarrow$ **Row level Trigger :**This gets executed before or after any column value of a row changes

$\rightarrow$**Column level Trigger :**This gets executed before or after the specified column changes.

$\rightarrow$ **For each row types :** This trigger gets executed once for each row of the result set cause by insert/update/delete.

$\rightarrow$For each statement : This trigger executed only once for the entire result set, but fires each time the statement is executed.

Unit- 6

Security :

- The security of a database can be thought of as a barrier which prevents unauthorized access of data.
- Database security concerns the use of a broad range of information security controls to protect database (potentially including the data, the database application or stored functions, the data base systems, the database severs and the associated networks links) against compromises of their confidentily, integrity and availability.

- It involves various types or categories of control, such as technical, procedural administrative and physical.

Need of security :

- Unauthorized or unintended activity or misuse by authorized database users, database administrator or network system managers, or by unauthorized user or hackers.
- Mal ware infections causing incidents such as unauthorized access, leakage or disclosure of personal or proprietary data, deletion or damage to the data or program.
- Overloads, performance constraints and capacity issues resulting in the inability of authorized users to use databases as intended.

- Physical damage to database serves caused by computer room fires or floods, overheating, lightning, accidental liquid spills, static discharge, electronic breakdown/ equipment failures.

 # Access Control :

- Access control mechanisms enforce rules about who can perform what operation or who can access which data.
- Thus any access control mechanism must concern itself which three basic components, namely.

i) Identification and authentication of Accessor :

- The process of identification may involves several parameters such as personal identification of accessor, location of accessor, time and day of access, frequency of access etc.
- Personal identification may be performs with the help of passwords, voice prints, finger prints signatures etc.
- The process of authentication requires supplying information known only to the person the accessor has claimed to be.
- This may be done by quoting a password or by answering some question from system.

- The location of the accessor or time and day of access are also useful in detecting unauthorized access.

ii) Object to be locked :-

a) Data object :

The data objects to be locked may be files or some records of a file. Sometimes if may be necessary to lock and privacy keys are used to control access to a particular record type.

b) View :

The another levels of security provided by DBMS is defining views or the external model of the schema. The owner of a database may grant views which may consist of the entire data base or a certain portion of the database.

c) Type of Access :-

Once an object is created, the own may grant other genuine accessors any of the following access right the object. Read, Run, modify, delete insert, create , Destroy.

iii) Crypto System:

A cryptosystem is the combination of three elements an encryption engine keying information, and operational procedures for their secure use.

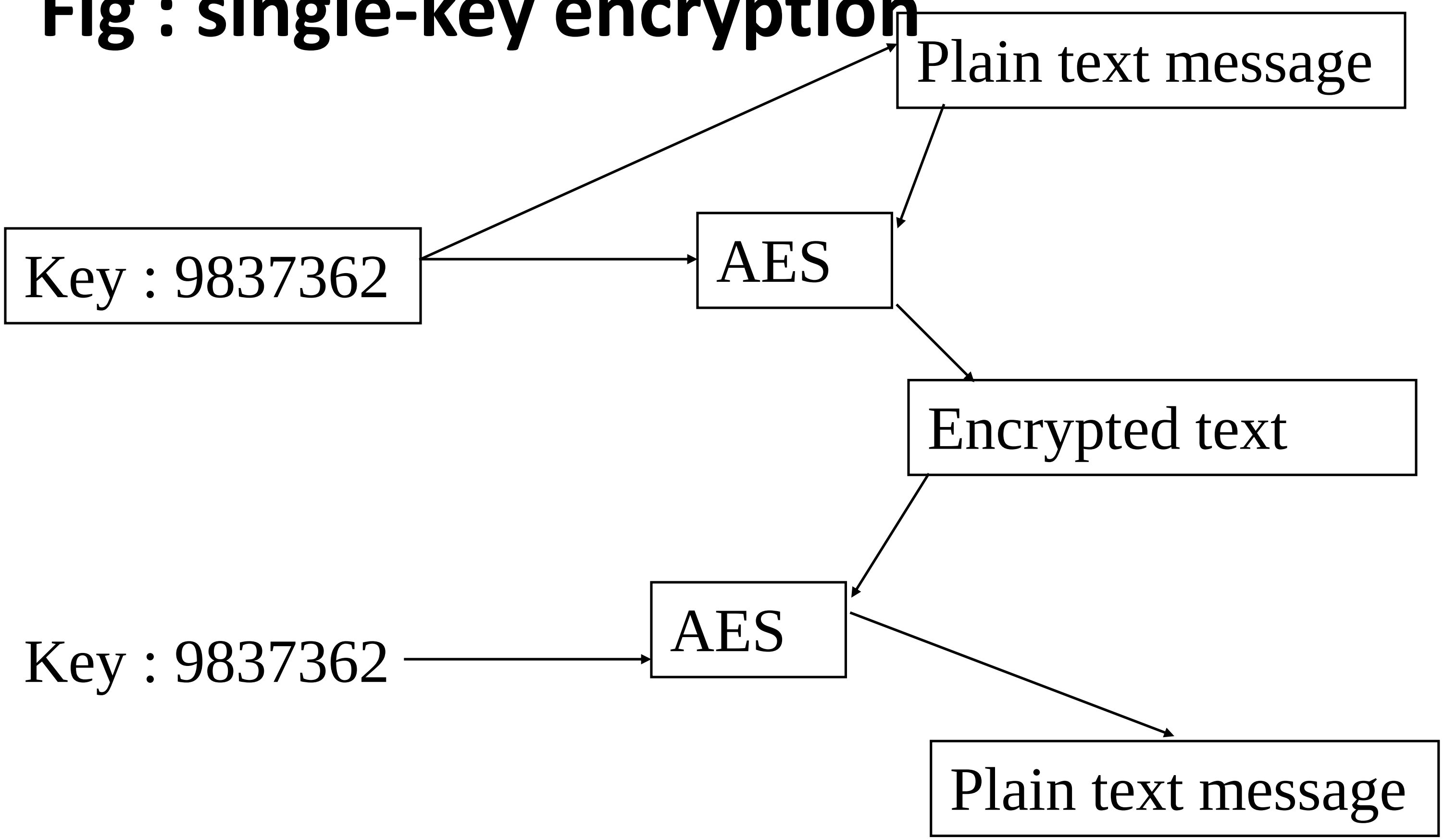
In other to cryptographically secure high-value data on a hard disk (or on back-up media), it is necessary to employ a high-grade cryptosystem: one which even an attacker processing both a copy of your encryption engine and knowledge of your operating procedures cannot break without your keying information.

Encryption and Decryption :

- Encryption is a method of modifying the original information according to some code so that it can be read only if the user known the decryption key.
- - Encryption should be used when transmitting information from one computer to another particularly when using the internet.
- Sensitive information store within a database also can be encrypted.
- Decryption is the reserve operation of encryption.

- The process of decoding data that has been encrypted into a secret format decryption requires a secret key or password. **(Advanced encryption Standard)**

Fig : single-key encryption

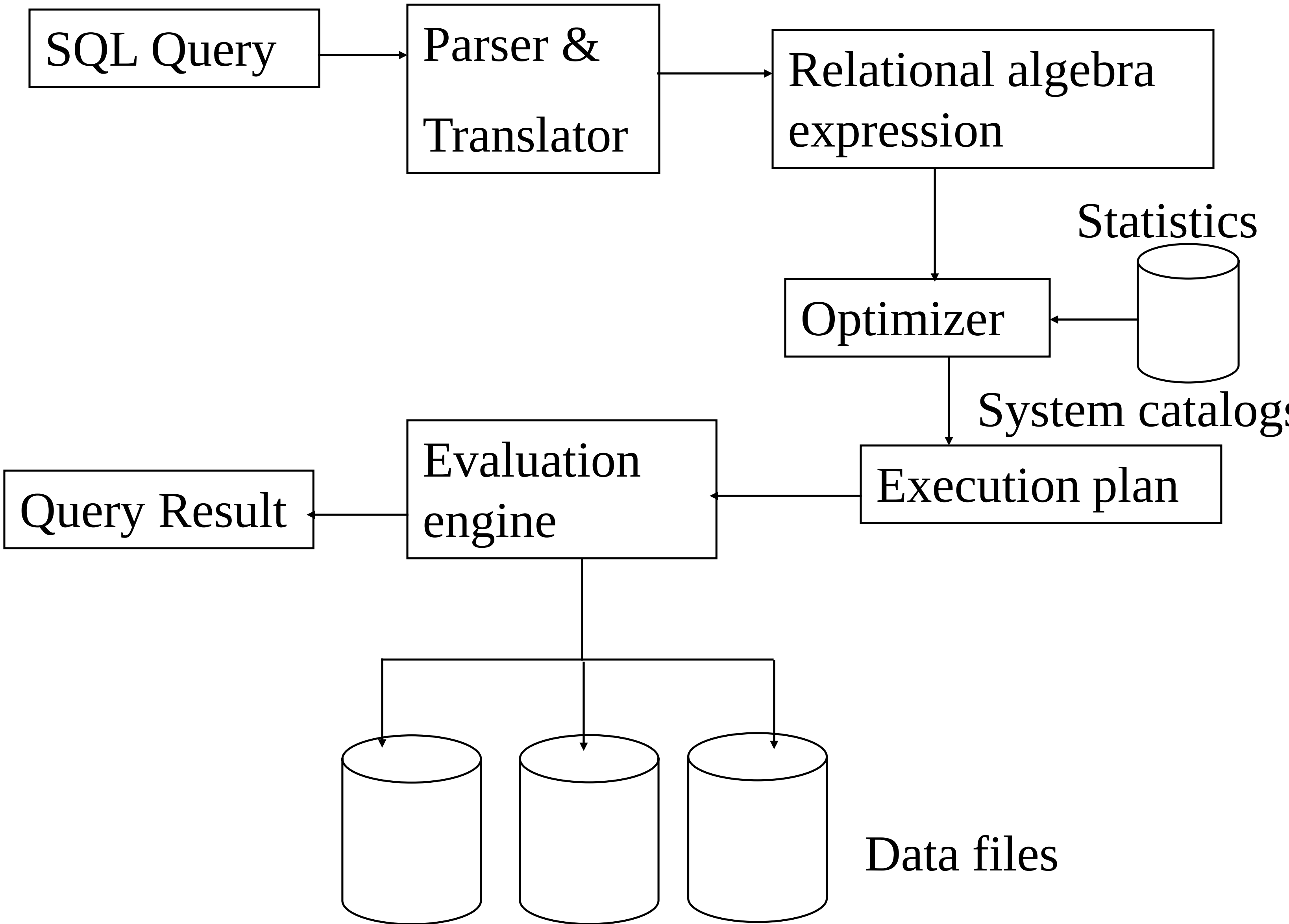


Unit-7

Query Processing :

- *All database systems must be able to respond to request for information from the user- I.e process queries.*
- *Obtaining the desired information from a database system in a predictable and reliable fashion is the scientific art of query processing.*

Basic steps in processing on SQL Query



Basic Steps in Query Processing

- Parsing and translation
- Optimization
- Evaluation

1. **Parsing and translation**
   - Translate the query into its internal form. This is then translated into relational algebra.
   - Parser checks syntax, verifies relation.
2. **Optimization**
   - SQL is a very high level language:
     - The users specify what to search for- not how the search is actually done
     - The algorithms are chosen automatically by the DBMS.
   - For a given SQL query there may be many possible execution plans.
   - Amongst all equivalent plans choose the one with lowest cost.
   - Cost is estimated using statistical information from the database catalog.
3. **Evaluation**
   - The query evaluation engine takes a query evaluation plan, executes that plan and returns the answer to that query.

Parsing and translating :

- *Translate the query into its internal form (parse free)*
- *This is then translated into an expression of the relational algebra.*
- *Parser checks syntax, validates relations, attributes and access permissions.*

Query interpretation (Query translation)

Given a query there are a number of ways to process the query; in SQL or relational algebra we can have equivalent expressions. Each method of expressing a query suggests a strategy for processing the query system must transform user query to an equivalent more efficient query- optimization similar to compiler code optimization. In relational models, commercial database system provide a query optimizer there by reducing the burden on the users.

i) Translating SQL Queries into Relational Algebra (Equivalence to expression)

-SQL query is first translated into an equivalent extended relational algebra expression.

- *SQL queries are decomposed into query blocks, which form the basic units that translated into the algebraic operators & optimized.*
- *Query block contains a single SELECT FROM-WHERE expression, as well as Group by and Having clauses.*
- *Nested queries within a query are identified as separate query block.*

Query optimization :

- *The query optimization or more accurately improving query processing strategy helps in reducing query execution time and overhead.*
- *Find the "cheapest" execution plan for a query.*
- *Query optimization is a function of many relational database management systems in which multiple query plans for satisfying a query are examined and a good query plan is identified.*
- *The set of query plans examined is formed (e.g. primary index access, secondary index access, full file scan) and various relational table join techniques (e.g, merge join,hash join, product join).*

Objectives of query optimization

- main objective is to retrieve data quickly.
- Query optimization is the refining process in database administration and it helps to bring down speed of execution.
- Most of the databases after are built and filled with data, and used come down on speed.
- The time taken to execute a query and return results exponentially grows as the amount of data increases in the database leading to more waiting times on the user, and application sides.

There are two types of optimization:

- These consist of logical optimization which generates a sequences of relational algebra to solve the query.

- In addition, there is physical optimization which is used to determine the means of carrying out each operation to join.

Join strategies :

- The join operation can be implemented in a variety of ways.
- In terms of disk accesses, the join operations can be very expansive, so implementing.
- Utilizing efficient join algorithms is critical in minimizing a query is execution time.

The following are 4 well-known types of join algorithms.

i) Nested-loop join (Brute force)

- For each record t in R (outer loop) retrieve every record D for S (inner loop) and test whether the two record satisfy the join condition t[A]=s[e].

ii) Single-loop join (using an access structure to retrieve the matching records)

- If an index (or hash key) exists for one of the two join attributes (e.g B of S) retrieve each record t in R, one at a time (single loop), and then use the access structure to retrieve directly all matching records S from S that satisfy S[B]=t[A].

iii) Sort-merge join:-

- If the records of R and S are physically sorted (ordered) by value of the join attributes A and B, respectively, we can implemented join in the most efficient way.

- *Both files are scanned concurrently in order of the join attributes, matching the records that have the same values for A and B.*
- *If the files are not sorted they may be sorted first by using external sorting.*

iv) Query Decomposition :

- The basic idea behind query decomposition is to break a complex query into simpler sub queries which can more easily be evaluated.

Query decomposistion consists of 4 steps:

1. Normalization: Transform query to a normalized form
2. Analysis: Detect and reject ”incorrect” queries; possible only for a subset of relational calculus
3. Elimination of redundancy: Eliminate redundant predicates
4. Rewriting: Transform query to optimize query

Unit-8

Filing and file structure :-

File :-

The file consist of records and the record may consist of several fields the typical operations that may be performed on the information stored in the file are as follows.

-Retrieve :

To find the record having a particular value of the particular field or where the field values satisfy certain conditions.

-Insert :

Insert a record at some specific locations.

- Delete :

Deletes a particular record.

- **Update :**

Modifies the field values of a record.

 # Factors affecting physical organization of Data:

- Efficient use of storage.
- Minimization of Data Redundancy.
- Expandability
- Recovery from data loss.

 # Buffer Management :-

- The buffer is that part of the main memory available for the storage of the contents of some of the blocks.

- *The subsystems responsible for the allocation of buffer space is called the buffer manager .*
- *The buffer manager services all request made by the file management system for blocks on the file currently being operated upon by the DBMS.*
- *If a requested block is already in the buffer, a address of the block in the main memory is passed on to the file manager & subsequently to the DBMS.*
- *The most commonly used technique for buffer management is the buffer cache.*

 # File Organization :-

Define :

A file organization essentially measure organization of records in the file. Some basic file organization techniques are given below.

- *Heap (or pile)*
- *Sequential*
- *Indexed sequential*
- *Direct (or hashed)*

- ***Heap (or pile or unordered) :***

Basically theses files are unordered files. It is the simplest & most basic type. These files consist of randomly ordered records. The records will have no particular order. The operations we can perform on the record are insert, retrieve and

Delete. The features of the heap file or the pile file organization are

- New records can be inserted in any empty space that can accommodate them.
- When old records are deleted, the occupied space becomes empty & available for any new insertion.
- If updated records grow; they may need to be relocated (moved) to new empty space. This needs to keep a list of empty space.

Advantages of heap files

- this is a simple file organization method.
- Insertion is some how efficient.
- Good for bulk-loading data into a table best if the file scans are common or insertions are frequent.

Disadvantages of heap files.

-Retrieval requires a linear search and is inefficient.

- *Deletion can result in unused space need for reorganization.*

Sequential file organization :

- *The most basic way to organize the collection of records in a file is to use sequential organization.*
- *Records of the file are stored in sequence by the primary key field values. They are accessible only in the order stored, I.e, in the primary key order.*
- *This kind of file organization works well for tasks which need to access nearly every record in a file, e.g. payroll*

- Sequential files are inefficient for random access, however, are suitable for sequential access.
- A sequential file can be stored on device like magnetic tape that allow sequential access.

Advantages of sequential file organization.

- It is the fast and efficient which dealing with large volumes of data that need to be processed periodically (batch system).

Disadvantages of sequential file organization:

-Requires that all new transactions be sorted into the proper sequence for sequential access processing.

-Locating, sorting, modifying, deleting or adding records in the file require rearranging the file.

The method is too slow to handle applications requiring immediate updating or responses.

Indexed (indexed sequential) file organization.

-It organizes the file like a large dictionary I.e; records are stored in order of the key but an index is kept which also permits a type of direct access.

- The records are stored sequentially by primary key values and there is an index built over the primary key field.

- *An index is set of index value, address pairs. Indexing associated a set of objects to a set of orderable quantities that are usually smaller in number or their properties .*
- *Thus an index is a mechanism for faster search.*

Hashed file organization :

- *Hashing is the most common form of purely random access to a file or data base.*
- *It is also used to access columns that do not have an index as an optimization technique.*
- *Hash functions calculate the address of the page in which the records is to be stored based on one or more filed in the record.*
- *The record in a hash file appear randomly distributed across the available space.*

-It requires some hashing algorithm and the technique.

- *Hashing algorithms converts a primary key value into record address .*

Advantage of hashed file organization :

- *Insertion or search on hash key is fast.*
- *Best if equality search is needed on hash key.*

Disadvantages of hashed file organization :

- *It is a complex file organization method.*
- *Range search is slow.*
- *It suffers from disk space overhead.*
- *Unbalanced buckets degrade performance.*

Unit- 9

Crash Recovery:

- Recovery restoring the database to a state that is known be correct after some failure has rendered the current state.
- Correct– does not violate any integrity rule.

  A database is correct if it satisfies the logic AND of all known rules.
- Failure- can be local or global.

Importance of DBMS Recovery

- Recovery—that is, the return to a fully operational environment after a hardware or software failure—is an important process.
- Moreover, the effects of a system failure on the organization must be curtailed to minimize any substantial financial loss.
- Actions must be taken to prevent DBMS failures or resolve them quickly if they occur.
- A review of DBMS recovery ensures adherence to appropriate practices and procedures and minimizes business losses.

Categories of failures

There are many causes of DBMS failure. When a DBMS fails, it falls into an incorrect state and will likely contain erroneous data. Typical causes of DBMS failures include errors in the application program, an error by the terminal user, an operator error, loss of data validity and consistency, a hardware error, media failures, an error introduced by the environment, and errors caused by mischief or catastrophe. Type of failures are given below:

- **Transaction Failure.**

  Transaction failures occur when the transaction is not processed and the processing steps are rolled back to a specific point in the processing cycle. In a distributed data base environment, a single logical data base may be spread across several physical data bases. Transaction failure can occur when some, but not all, physical data bases are updated at the same time.

- **System Failure.**

  System failure can be caused by bugs in the data base, operating system, or hardware. In each case, the Transaction processing is terminated without control of the application. Data in the memory is lost; however, disk storage remains stable. The system must recover in the amount of time it takes to complete all interrupted transactions. At one transaction per second, the system should recover in a few seconds. System failures may occur as often as several times a week.

- **Media Failure.**

  Disk crashes or controller failures can occur because of disk-write bugs in the operating system release, hardware errors in the channel or controller, head crashes, or media degradation. These failures are rare but costly.

Recovery facilities :

DBMS should provide following facilities to assist with recovery.

- *Backup mechanism, which makes periodic backup copies of database.*
- *Logging facilities, which keep track of current state of transactions and database changes.*
- *Check point facility, which enables updates to database in progress to be made permanent.*
- *Recovery manager, which allows DBMS to store the database to a consistent state following failures.*

Log based recovery

- Every action starting from the database start up and also each and every transaction is recorded in a log file step by step
- In case, if within an ongoing transaction, the system crashes or may be for some reason u cannot complete the transaction, then the database will remain in an inconsistent state
- So using the log files we can return back to our previous state as if nothing has happened to the database.
- and also to recover some data log files are used..
- There are various types of log files like redo log files, event viewer log files etc.

Shadow Paging

Shadow paging is an alternative to log-based recovery; this scheme is useful if transactions execute serially

Idea: maintain *two* page tables during the lifetime of a transaction – the **current page table**, and the **shadow page table**

Store the shadow page table in nonvolatile storage, such that state of the database prior to transaction execution may be recovered.

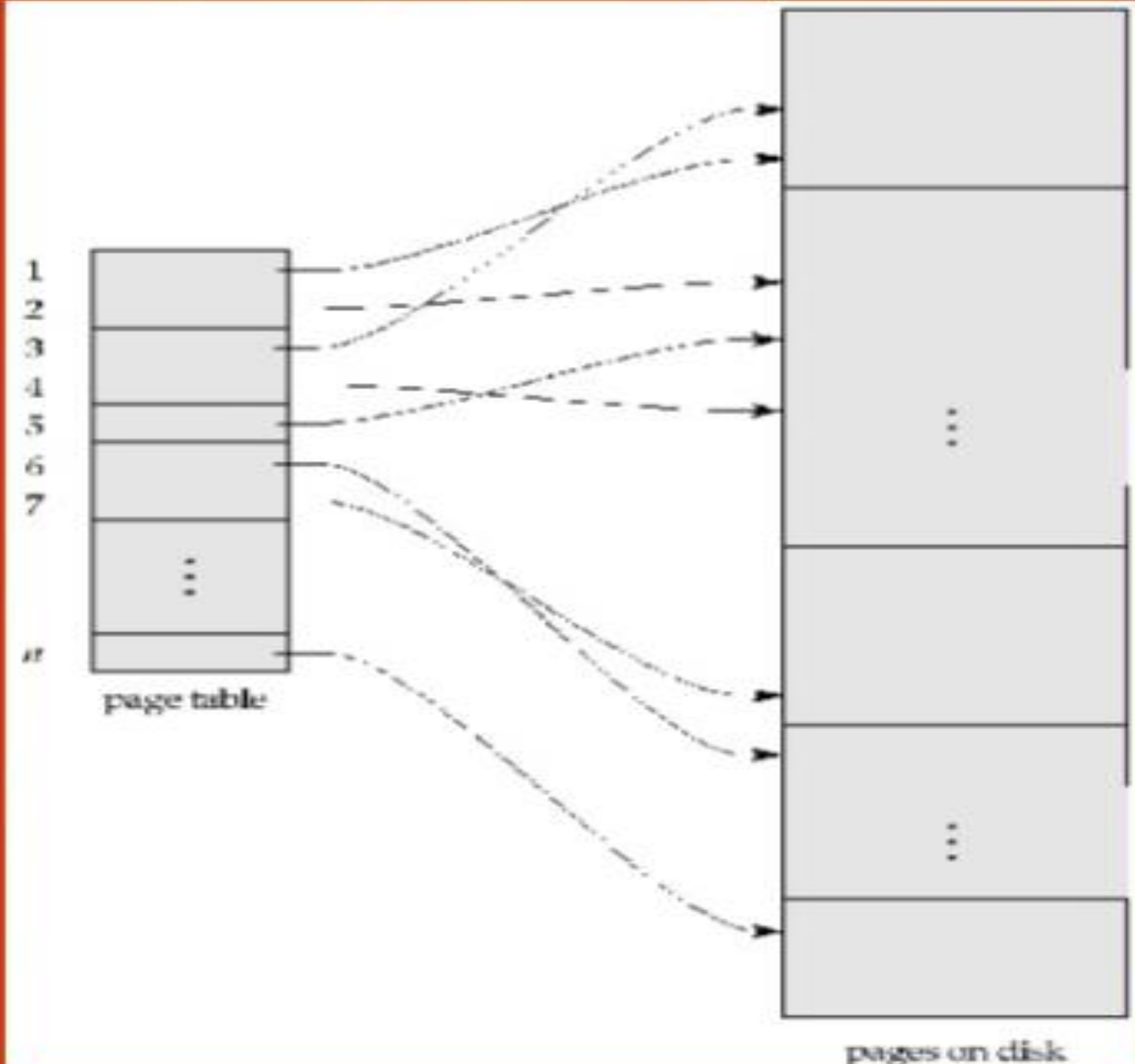
- Shadow page table is never modified during execution

To start with, both the page tables are identical. Only current page table is used for data item accesses during execution of the transaction.

Whenever any page is about to be written for the first time

- A copy of this page is made onto an unused page.
- The current page table is then made to point to the copy
- The update is performed on the copy

Sample Page Table



Data Backup

- A **data backup** is the result of copying or archiving files and folders for the purpose of being able to restore them in case of data loss.
- Data loss can be caused by many things ranging from computer viruses to hardware failures to file corruption to fire, flood, or theft (etc). If you are responsible for business data, a loss may involve critical financial, customer, and company data. If the data is on a personal computer, you could lose financial data and other key files, pictures, music, etc that would be hard to replace.

As part of a data backup plan, you should consider the following:

- What data (files and folders) to backup
- What compression method to use
- How often to run your backups
- What type of backups to run*
- What kind of media on which to store the backups
- Where to store the backup data for safekeeping

Remote Backup

- In storage terminology, a remote backup refers to an online managed backup service for backing up data to a remote, cloud-based server ("cloud backup").
- To update or restore a cloud backup, customers need to use the service provider's specific client application or Web browser interface. Files and data can be automatically saved to the cloud backup service on a regular, scheduled basis, or the information can be automatically backed up anytime changes are made.

Unit 10.Transaction Processing and Concurrency Control

What is database transaction?

In database, a **database transaction** is a logical unit of database operations which are executed as a whole to process user requests for retrieving data or updating the database. Transactions in a database environment have two main purposes:

- To provide reliable units of work that allow correct recovery from failures and keep a database consistent even in cases of system failure, when execution stops (completely or partially) and many operations upon a database remain uncompleted, with unclear status.
- To provide isolation between programs accessing a database concurrently.

Properties of database transactions are often referred to by the acronym **ACID**.

- **Atomicity:** A transaction is an indivisible unit. It is included in all operations or have done or not done.
- **Consistency:** Transaction must keep the database from one consistent state to another consistent state variable.
- **Isolation:** A transaction is implemented and can not be interfered with by other transactions. That is, an internal operation of a transaction and the use of the data is isolated with other transaction, the concurrent implementation of all transactions can not interfere between with each other.
- **Durability:** It's also called permanence. It refers to a transaction which is submitted, and the data in the database it changes should be permanent. The next operation or other faults should not have any impact on them.

Concurrency control

Definition

Concurrency control is a database management systems (DBMS) concept that is used to address conflicts with the simultaneous accessing or altering of data that can occur with a multi-user system. Concurrency control, when applied to a DBMS, is meant to coordinate simultaneous transactions while preserving data integrity. The Concurrency is about to control the multi-user access of Database.

Schedules

In the fields of databases and transaction processing (transaction management), a **schedule** (or **history**) of a system is an abstract model to describe execution of transactions running in the system. Often it is a *list* of operations (actions) ordered by time, performed by a set of transactions that are executed together in the system. If order in time between certain operations is not determined by the system, then a *partial order* is used. Examples of such operations are requesting a read operation, reading, writing, aborting, committing, requesting lock, locking, etc. Not all transaction operation types should be included in a schedule, and typically only selected operation types (e.g., data access operations) are included, as needed to reason about and describe certain phenomena.

Serializability :

- *Serializability is a property of a transaction schedule (history). It relates to the isolation property of a database transaction.*
- *Serializability of a schedule means equivalence (in the outcomes, the database state, data values) to a serial schedule (i.e; sequential with no transaction overlap in time) with the same transactions. It, is the major criterion for the correctness of concurrent transactions schedule, and thus supported in all general purpose database system.*

Locking :-

- *A lock is a system object associated with the shared resource such as data item of an elementary type, a row in a database or a page or memory.*
- *In a database, a lock an a database object (a data access lock) may need to be acquired by a transactions before accessing the object.*
- *Correct use of locks prevents undesired, incorrect or inconsistent operation on shared resources by other concurrent transactions.*
- *When a database object with an existing lock acquired by one transactions needs to be accessed by another transactions the existing lock for the objects and the type the intended access are checked by the system .*

Two phase locking (locking):

- *in database and transactions processing, two phase locking (2pl) is a concurrency control method that guarantees seralizability. It is also the name of the resulting set of the data base transaction schedules (histories).*
- *The protocol utilizes locks, applied by a transaction to data, which may block (interpreted as signals to stop) other transaction form accessing the same data during the transactions life. By the 2PL protocol locks are applied and removed in two phases*
  - ***Expanding phase:***

    Locks are acquired and no locks are released.
  - ***Shrinking phase :***

    Locks are released and no lock are acquired .

Two major types of locks are utilized:

- *Write lock (exclusive lock) is associated with a database object by a transaction (terminology " the transaction locks the object, "or" acquires lock for it") before writing (inserting/modifying/deleting) this object.*
- *Read lock (shared lock) is associated with a database object by a transaction before reading (retrieving the state of) this object.*

Timestamp based concurrency control:

Definition :

In computer science, a **timestamp-based concurrency control** algorithm is a non-lock concurrency control method. It is used in some databases to safely handle transactions, using timestamps.

- Every timestamp value is unique and accurately represents an instant in time.
- No two timestamps can be the same.
- A higher-valued timestamp occurs later in time than a lower-valued timestamp.

Unit 11

Advanced Database Concepts

OBJECT-ORIENTEDDATABASE MODEL : In the object oriented data model the (OODM). Both data and their relationship are contained in a single structure known us an object. An object includes information about relationship between the facts within the object, as well as information about its relationship with other objects. An object is the abstraction of the real- word entity. An object represents only one occurrence of entity. Attributes describe the property of an object. Objects that are similar in characteristics are grouped in class.

Class: is a collection of similar objects with shared structure (attributes) and behavior (method).

Method: represents areal word action such as finding a selected person’s name, changing person’s name or printing a persons address.

Inheritance is the ability of an object within the class hierarchy to inherit the attributes and methods of the class above it.

Object-relational database/Model

- An **object-relational database** (**ORD**), or **object-relational database management system** (**ORDBMS**), is a database management system (DBMS) similar to a relational database, but with an object-oriented database model: objects, classes and inheritance are directly supported in database schemas and in the query language. In addition, just as with pure relational systems, it supports extension of the data model with custom data-types and methods.

An object-relational database can be said to provide a middle ground between relational databases and *object-oriented databases* (OODBMS). In object-relational databases, the approach is essentially that of relational databases: the data resides in the database and is manipulated collectively with queries in a query language; at the other extreme are OODBMSes in which the database is essentially a persistent object store for software written in an object-oriented programming language, with a programming API for storing and retrieving objects, and little or no specific support for querying.

Distributed Databases

A distributed database is a database in which portions of the database are stored on multiple computers within a network. Users have access to the portion of the database at their location so that they can access the data relevant to their tasks without interfering with the work of others. A centralized distributed database management system (DDBMS) manages the database as if it were all stored on the same computer. The DDBMS synchronizes all the data periodically and, in cases where multiple users must access the same data, ensures that updates and deletes performed on the data at one location will be automatically reflected in the data stored elsewhere.

Data ware house:

A data structure that is optimized for distribution. It collects and stores integrated sets of historical data from multiple operational systems and feeds them to one or more data marts. It may also provide end-user access to support enterprise views of data.

Data Mart: A data structure that is optimized for access. It is designed to facilitate end-user analysis of data. It typically supports a single, analytic application used by a distinct set of workers.