Course Code : 19CAB03

Course Name : RELATIONAL DATABASE MANAGEMENT SYSTEMS

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UNIT-I - INTRODUCTION

- File systems versus Database systems – Data Models – DBMS Architecture – Data Independence – Data Modeling using Entity – Relationship Model – Enhanced E-R Modeling.

UNIT -II - RELATIONAL MODEL AND QUERY EVALUATION

- Relational Model Concepts – Relational Algebra – SQL – Basic Queries – Complex SQL Queries – Views – Constraints – Relational Calculus – Dynamic and embedded SQL - Database Design – Functional Dependencies – Normalization

UNIT-III - TRANSACTION PROCESSING

- Transaction Processing – Properties of Transactions - Serializability – Transaction support in SQL - Locking Techniques – Time Stamp ordering – Validation Techniques – Granularity of Data Items – Recovery concepts – Shadow paging – Concurrency control - Log Based Recovery – Deadlock Handling, Insert and Delete Operations.

UNIT-IV-FILES AND INDEXING

- File operations – Hashing Techniques – Indexing – Single level and Multi-level Indexes – B+ tree – Static Hashing - Indexes on Multiple Keys.

UNIT-V- SPECIAL PURPOSE DATABASES

- OODBMS- - Object-Based Databases - OO Data Model - OO Languages – Persistence – Object Relational Databases - XML – Temporal Databases – Mobile Databases – Spatial Databases.

TEXT BOOK

- Abraham Silberschatz, Henry F.Korth and S.Sundarshan "Database System Concepts", Sixth Edition, McGraw Hill, 2010.
- C.J. Date, "An Introduction to Database Systems", Eight Edition, Pearson Education Delhi, 2008.
- Peter Rob, Carlos Coronel, "Database System Concepts", Cengage Learning, 2008.

REFERENCES

- Ramez Elamassri and Shankant B-Navathe, “Fundamentals of Database Systems”, Sixth Edition, Pearson Education Delhi, 2010.
- Raghu Ramakrishnan, Johannes Gehrke ,’ Database management systems” McGraw Hill, 2003.
- Frank. P. Coyle, “XML, Web Services And The Data Revolution”, Pearson Education, 2012.

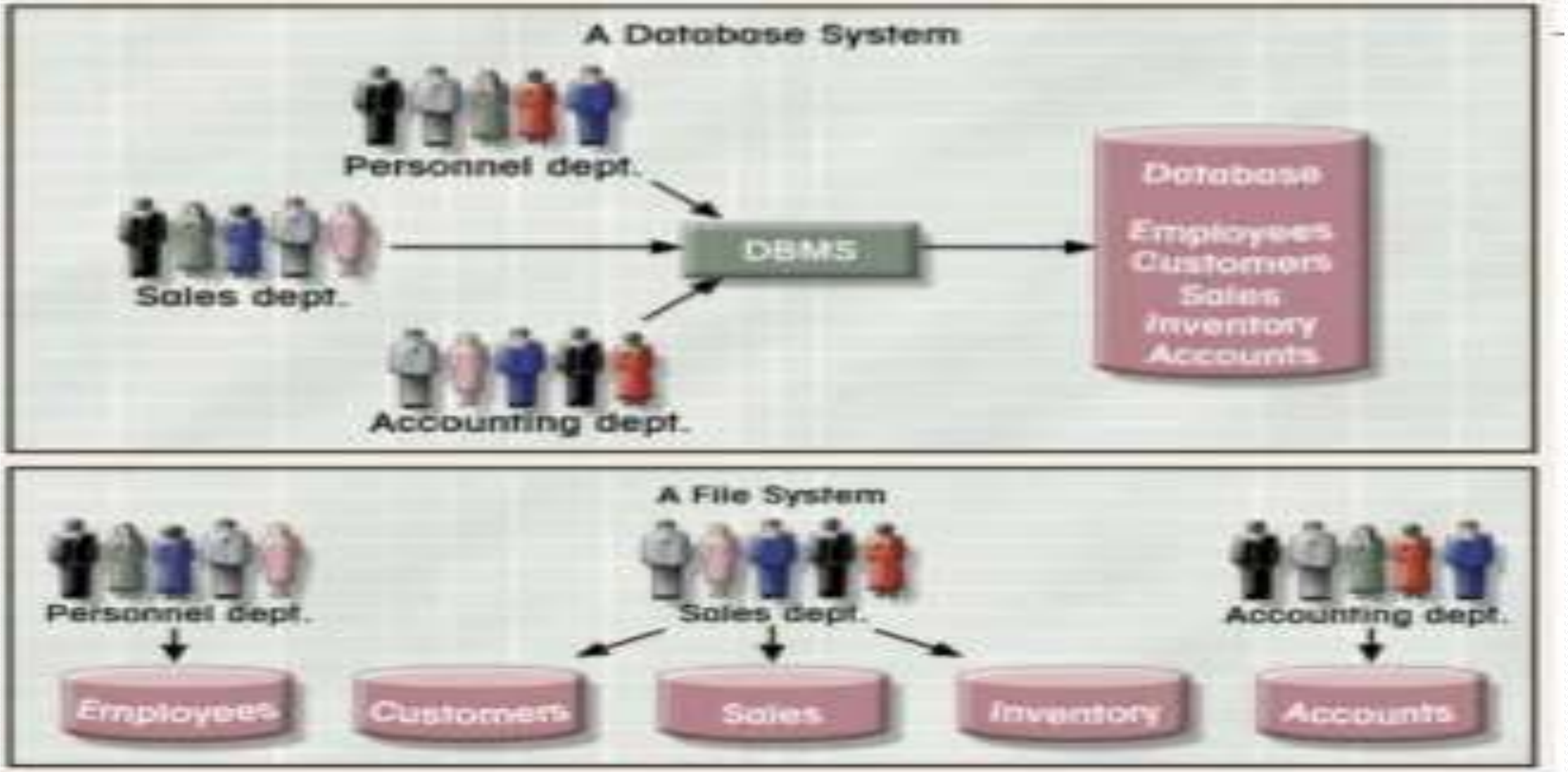
UNIT - I - **INTRODUCTION**

INTRODUCTION :

- A database is an organized collection of data, generally stored and accessed electronically from a computer system.
- The database management system (DBMS) is the software that interacts with end users, applications, and the database itself to capture and analyze the data

File System Versus Database System

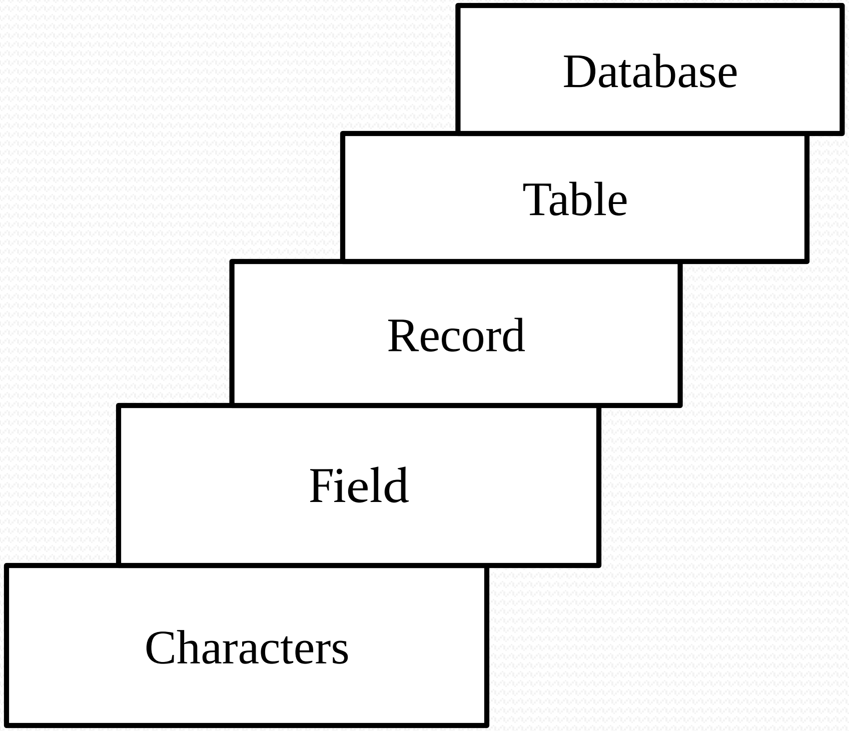
- A File System is a type of data store, Which can be used to store, retrieve and update a set of file.
- A **File System**, data is directly stored in set of **files**. It contains flat **files** that have no relation to other **files** .


A Database System
Personnel dept.
Sales dept.
Accounting dept.
DBMS
Database
Employees
Customers
Sales
Inventory
Accounts
A File System
Personnel dept.
Sales dept.
Accounting dept.
Employees
Customers
Sales
Inventory
Accounts

Disadvantages:

- Data Redundancy
- Data Inconsistency
- Difficulty in Accessing Data
- Data Isolation
- Integrity Problem
- Atomicity Problem
- Concurrent Access Anomalies
- Security Problem

Organization of Database



Database

Table

Record

Field

Characters

Characters

- A byte of typically 8 bits.
- Each byte represent an characters.
- A Characters can be an Upper Case(A,B,C…..Z), Lower case(a,b,c,…..z), Numeric digit(0,1,2,….9) are Special Symbol(.,!,[+],[-]./,…..).

Field

- Character can be combined to form a field.
- Field is a single piece of information.
- It is defined as the smallest unit in a database.
- Eg:
    - Roll No
    - Name
    - Date of Birth
    - Sex
    - Address

Roll Number	Name	Date of Birth	Sex	Address
20MC001	Aarthi	22.02.1999	Female	Salem
20MC002	Dinesh	23.05.1999	Male	Erode
20MC003	Kanishka	09.09.1999	Female	Namakkal

Records

- All the related files for an particular event are called a record.
- In another words records is one complete set of fields.

Table

- Table is a collection of records.

First Name	Last Name	Age	Address	Tel Number
Aarthi	A	21	Salem	XXXXXXXX
Dinesh	S	20	Erode	XXXXXXXX
Kanishka	R	20	Namakkal	XXXXXXXX

Schema

- The term schema is used to mean an overall chart of all the data item types and record types stored in a database.

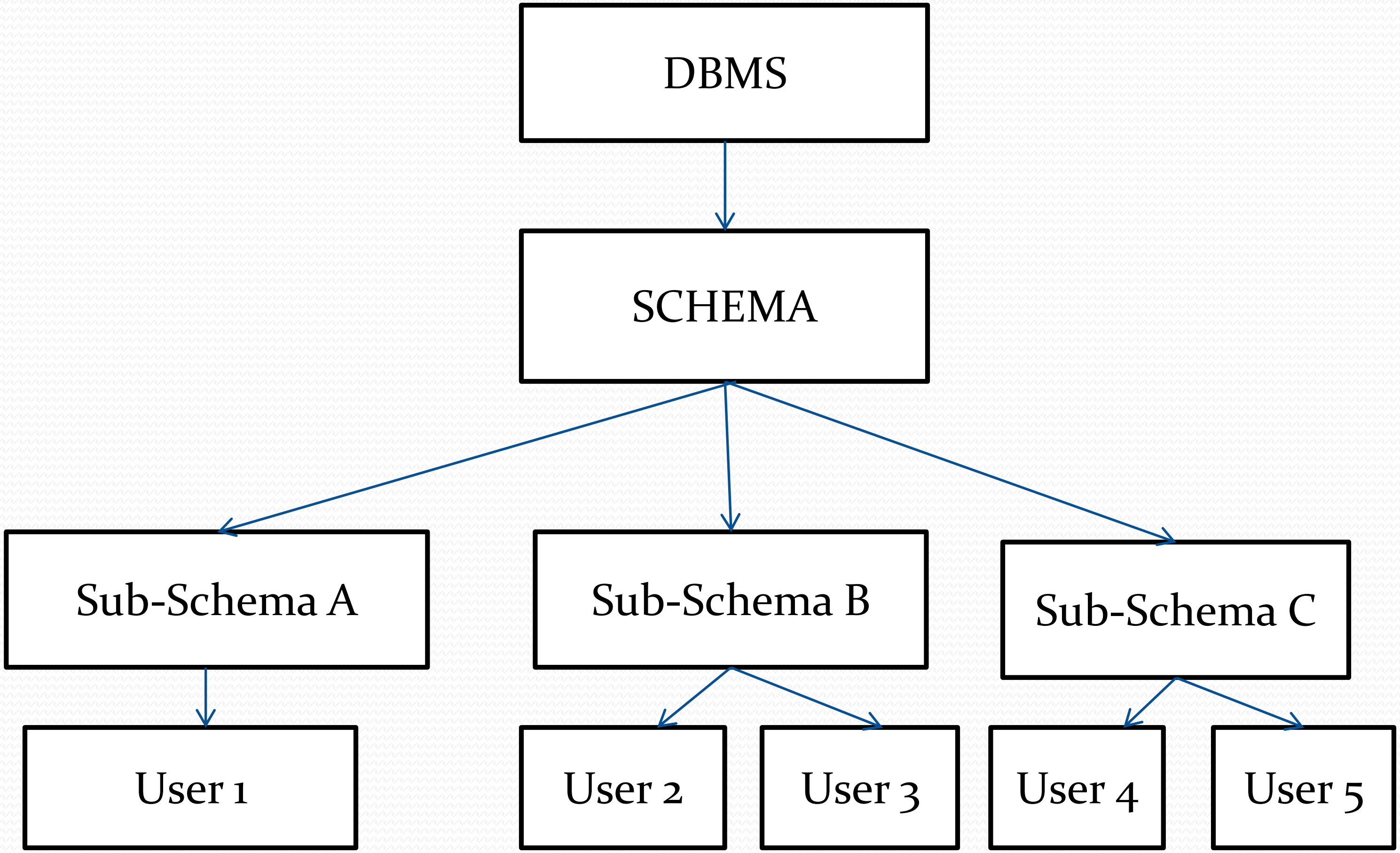
  - One to One
  - One to Many
  - Many to Many

Sub-Schema

- The term sub-schema refers to the same view but for the data item types and record types which a particular user uses in a particular application.

- The many different sub-schema can be derived from one schema.

- This is external view of database.


DBMS
SCHEMA
Sub-Schema A
Sub-Schema B
Sub-Schema C
User 1
User 2
User 3
User 4
User 5

Instance

- It is the actual content of the database at a particular point of time each variable has a particular value at a given instant.

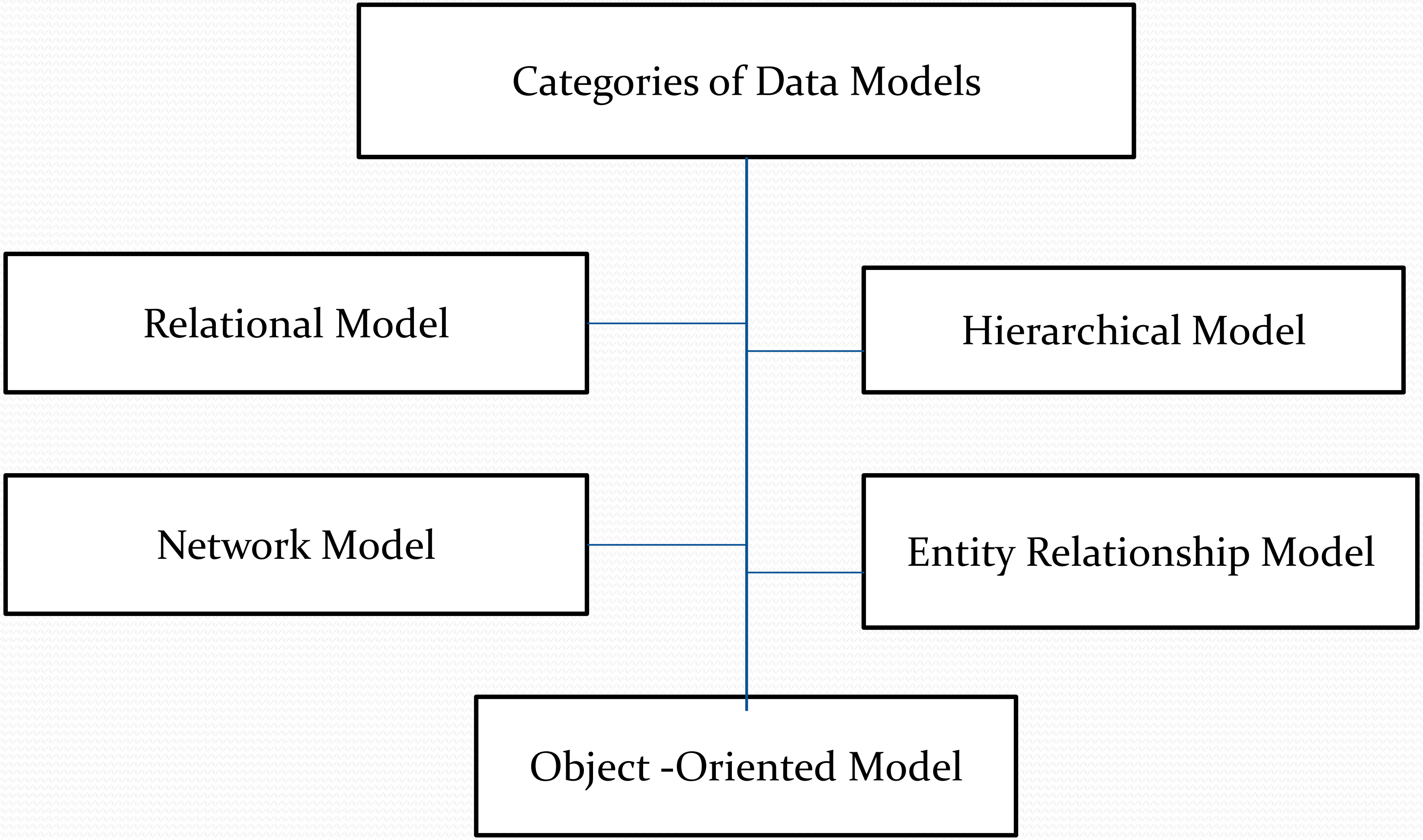
Roll Number	Name	Date of Birth	Sex	Address
20MC001	Aarthi	22.02.1999	Female	Salem
20MC002	Dinesh	23.05.1999	Male	Erode

Data Models

- Data Model is a collection of concept that can be used to describe structure of the database.
- Structure of the database means data type relationship constraints that should hold the data.
- Data model the set of basic operation for specifying retrieve and update the database.
- Data model is a collection of conceptual tools,

  1. Data
  2. Data Relationship
  3. Data Semantics.
  4. Data Constraints.

Categories of Data Models:



Categories of Data Models

Relational Model

Hierarchical Model

Network Model

Entity Relationship Model

Object -Oriented Model

Relational Model

- This model represent data and relationship among data by a collection of tables known as relationship.
- A number of columns unique names.
- Relationship model relate records by the value that contain.

Advantage:

- Easy to use
- Flexibility
- Precision
- Security
- Data Independence

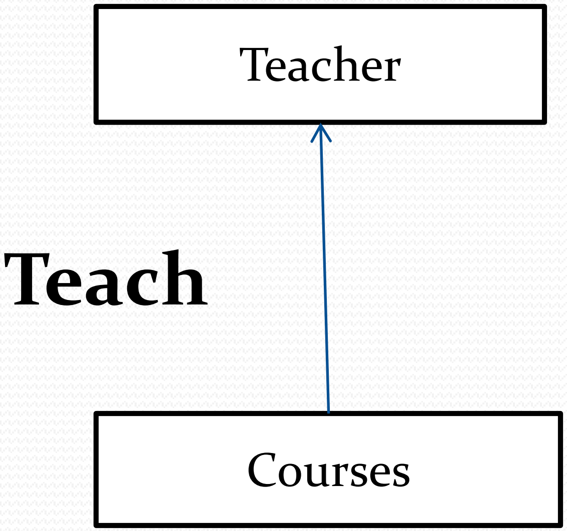
Disadvantage

- Low Performance.
- Physical storage consumption.
- Easy of design can lead to bad design.
- Hardware over heads

Network data Model

- This model represent data by collection of records and relationship among data.
- This is represent by link which can be viewed as pointer.
- There are three components of network models,
    - Record Type
    - Data Elements
    - Link

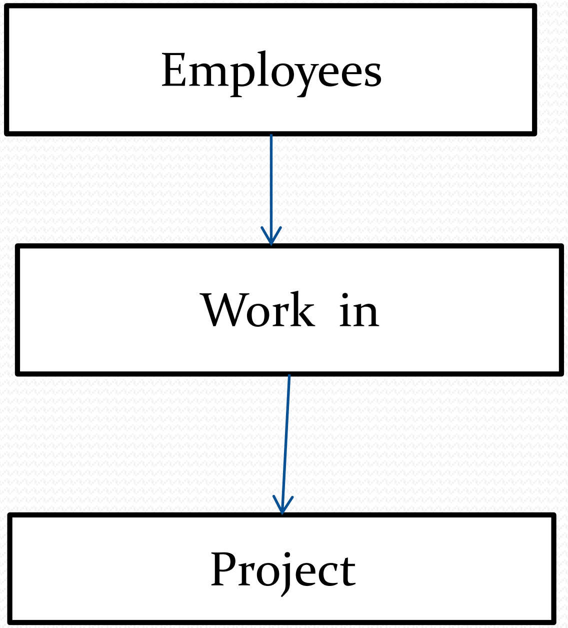
Many to one relationship / Many to many relationship



Teacher

Teach

Courses



Employees

Work in

Project

Advantages

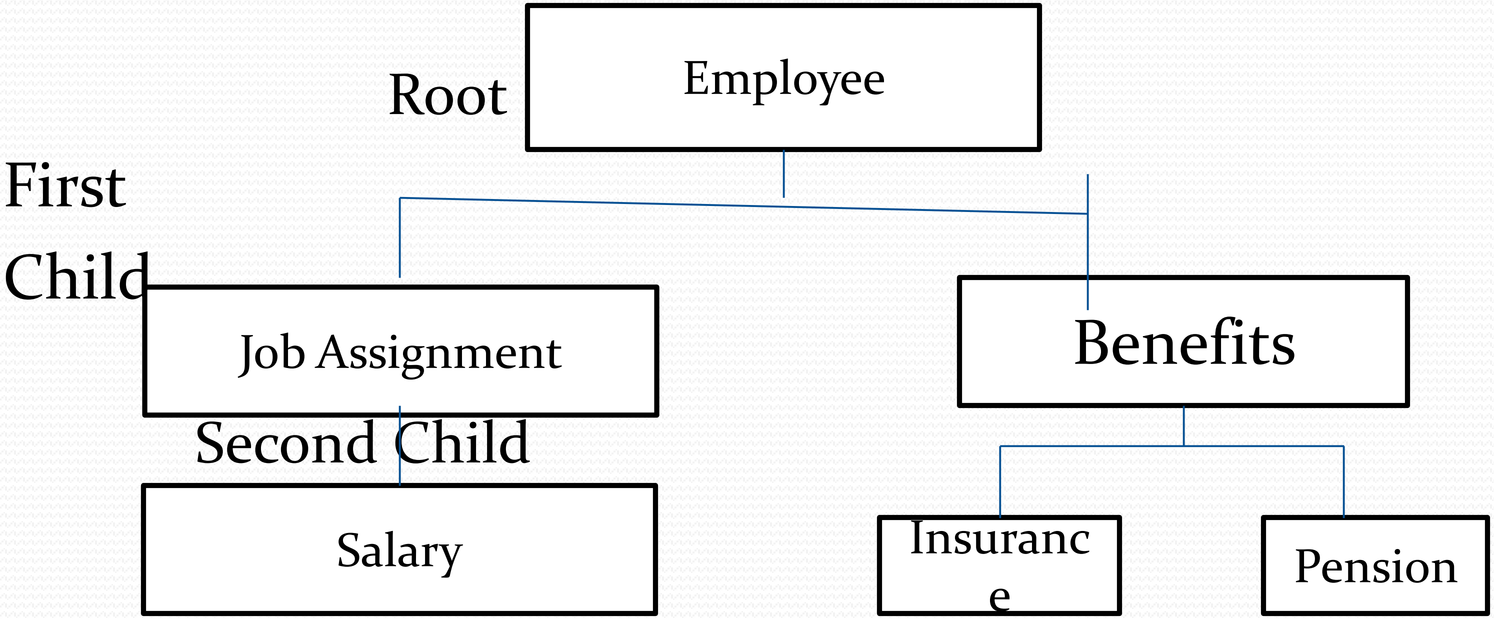
- Easy to access data.
- Capability to handle more relationship type.
- Data Integrity.
- Data Independence.

Disadvantages:

- ❖System Complexity.
- ❖Operational Anomalies.
- ❖Structural Independence.

Hierarchical Data Model

- A DBMS to the hierarchical data model uses tree structure to relationship among records.
- A hierarchical database consist of a collection of records which are connected with each other through link



Advantages

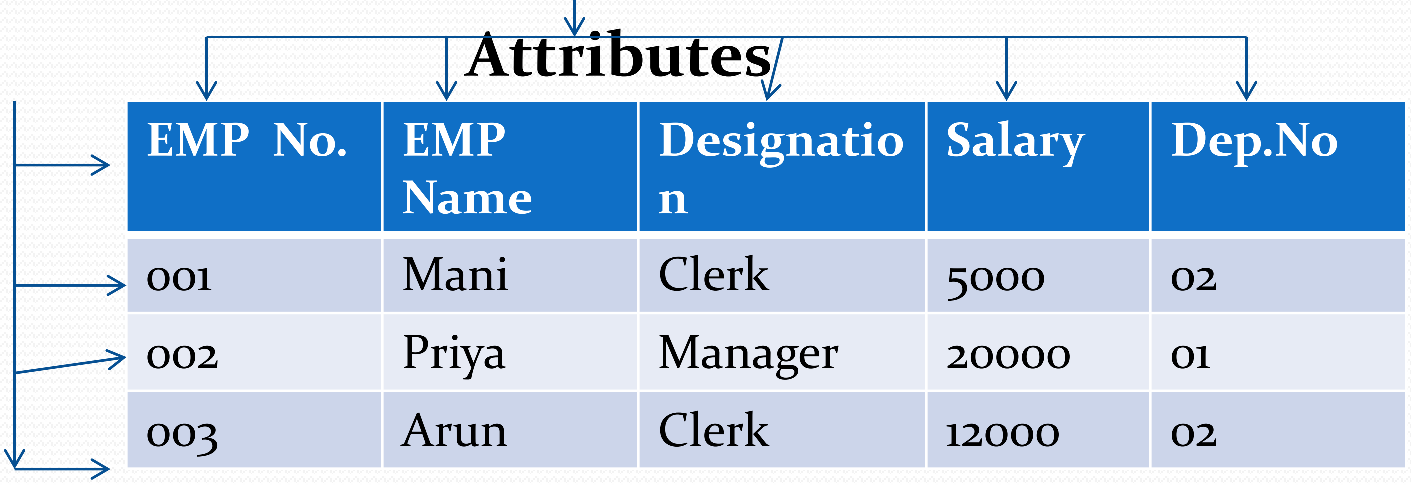
- It is a simple, straight forward and natural method of implementing.
- It is a useful when there is some hierarchical character in the database.

Disadvantages:

- The hierarchical model cannot represent all the relationship that occurs in the real world.
- It cannot represent many to many relationship.
- The hierarchical model use only there is a hierarchical character in the consider database.

Entity Relationship Model

- The basic E-R diagram was conceived by Peter Chen in 1976.
- Its requirements in a top-down fashion.
- Diagram created using this process are called entity-relationship diagram or ER diagram.



Attributes

EMP No.	EMP Name	Designation	Salary	Dep.No
001	Mani	Clerk	5000	02
002	Priya	Manager	20000	01
003	Arun	Clerk	12000	02

Advantages

- The database structure can be efficiently used even with a PC that has limited main memory and processing.
- ER database is very effective for small database.
- It is very simple and represent logical relationship among the data items.

Disadvantages:

- Quite complex to hate handle large database.
- Less hierarchical structure of database.
- Limited constraints representation.
- Limited relationship representation.
- No data manipulation languages.
- Less of information content.

Object Oriented Data Model

- A object oriented data model is a logic organization real world object.
- A database language is concrete syntax for a data model.
- A database system implement the following basic object oriented concept,
  - Object and object identifies.
  - Attributes and methods.
  - Class.
  - Class hierarchical inheritance.

Database Management System(DBMS)

- A DBMS is software designed to assist in maintaining and utilizing large collection of data.
- DBMS provides an environment that is both convenient and efficient to use.
- A DBMS is a combination of hardware and software that can be used to setup and monitor a database and manage the updating and retrieval of database.

- Microsoft access.
- SQL Server
- Oracle
- DB-2
- MYSOR
- SYBASE

Objective of DBMS

Shareability :

- An ability to share data resources is a fundamentals objective of DBMS.
- The different people and different processes using the same actual data at virtually the same time.

Availability:

- It means the data of an organization to the user of that data.
- The system which manage the data resource should be easily accessible to the people within an organization.

Evolvability:

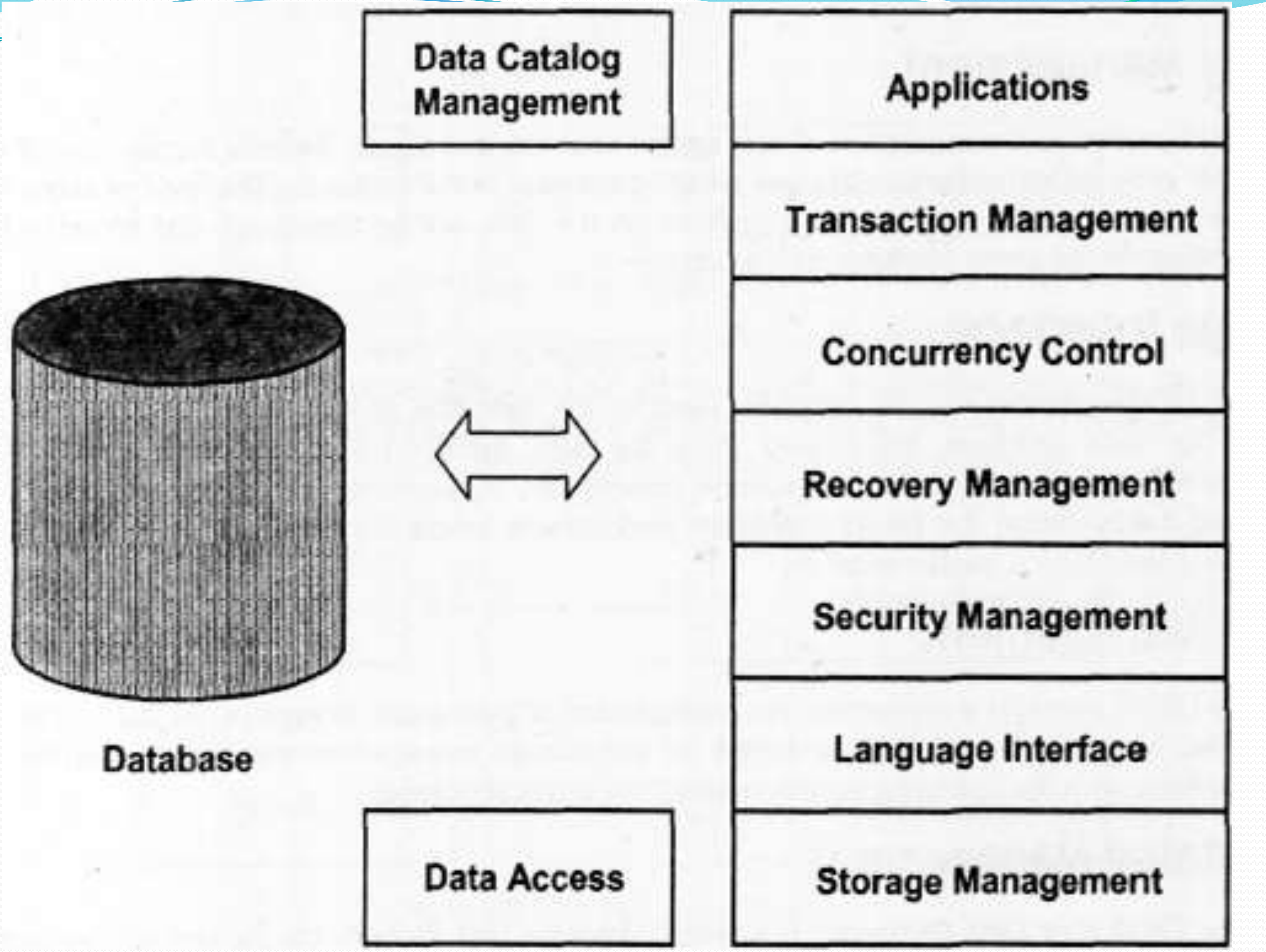
- It refers to the ability of the DBMS to change in response to growing user needed and advising technology.

Integrity

- Protecting the extension of the database.
- Maintaining the quality of the database.
- Ensuring the privacy of the database.

DBMS Interaction with Users:

- The database allows users to database without the knowledge.
- The communication between the DBMS software.


Data Catalog Management
Applications
Transaction Management
Concurrency Control
Database
Recovery Management
Security Management
Language Interface
Data Access
Storage Management

Transaction Management:

- A transaction is a sequence of database operations that represents a logical unit of work and that access a database and transform it form one step to another.

Concurrency Control:

- Concurrency control is the database management activity of coordinating the actions of database manipulation process that operate concurrently that access shared data.

Recovery Management:

- The recovery management system in a database ensure that the aborted are failed transaction create no efforts on the database or the other transactions.

Security Management:

- Security management to the production of data against unauthorized access.
- Security mechanisms of the DBMS make sure that only authorized user are given access to the given data in the database.

Language Interface:

- DBMS support language used for the definition and manipulation of the data in the database.
- The data structure are created by using the data definition language comments.

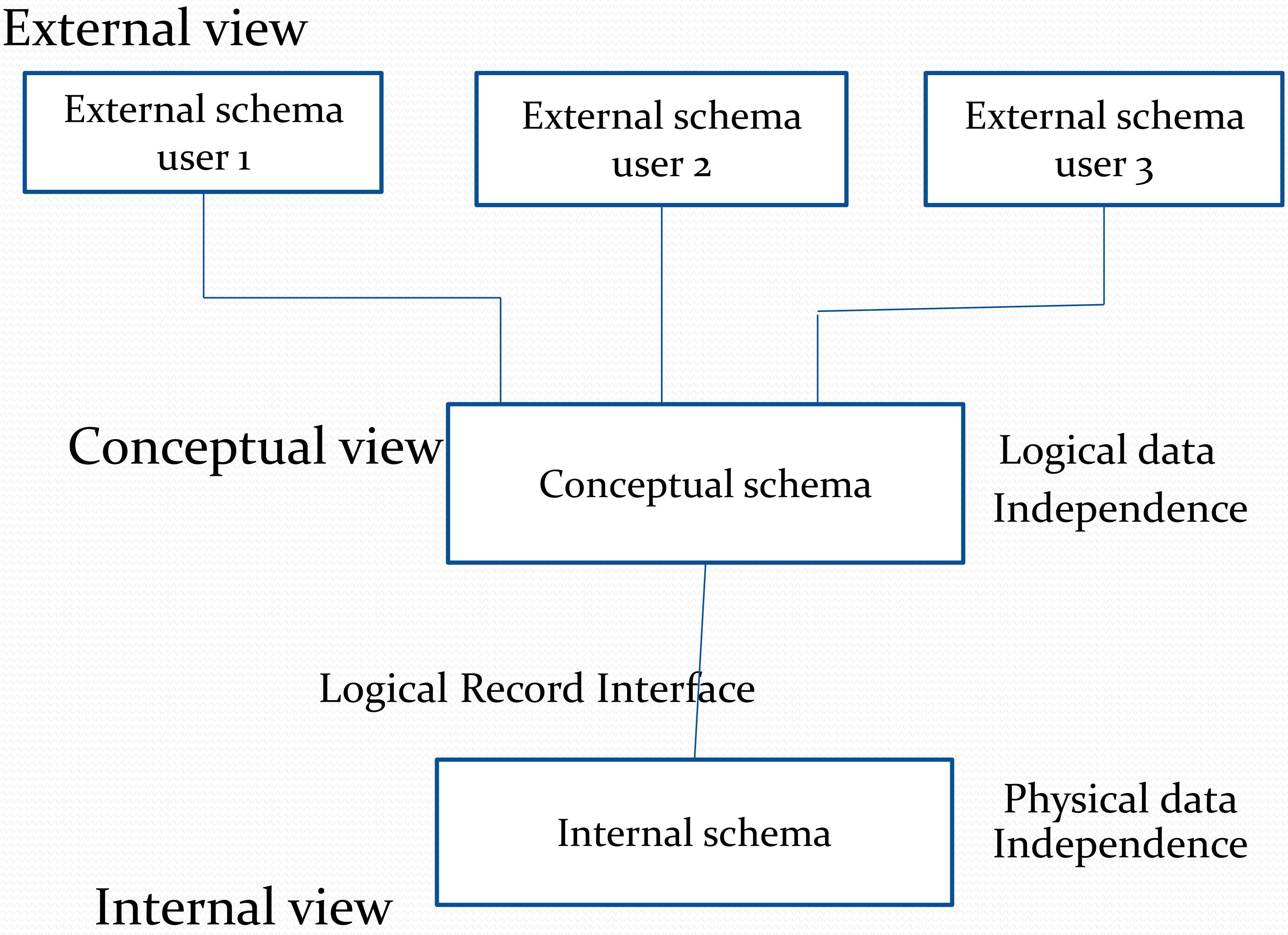
Storage Management:

- DBMS provide a mechanisms for management of permanent storage of data.
- The internet schema management mechanisms and the storage manager interface with the operating system to access the physical storage.

Data Architecture

- A DBMS that provides three levels of data views called “three level architecture”.
- The objective of the three level architecture is to separate each user view of the database from the way the database is physically represented.

  - External view.
  - Conceptual view.
  - Internal view.



External view

External schema user 1

External schema user 2

External schema user 3

Conceptual view

Conceptual schema

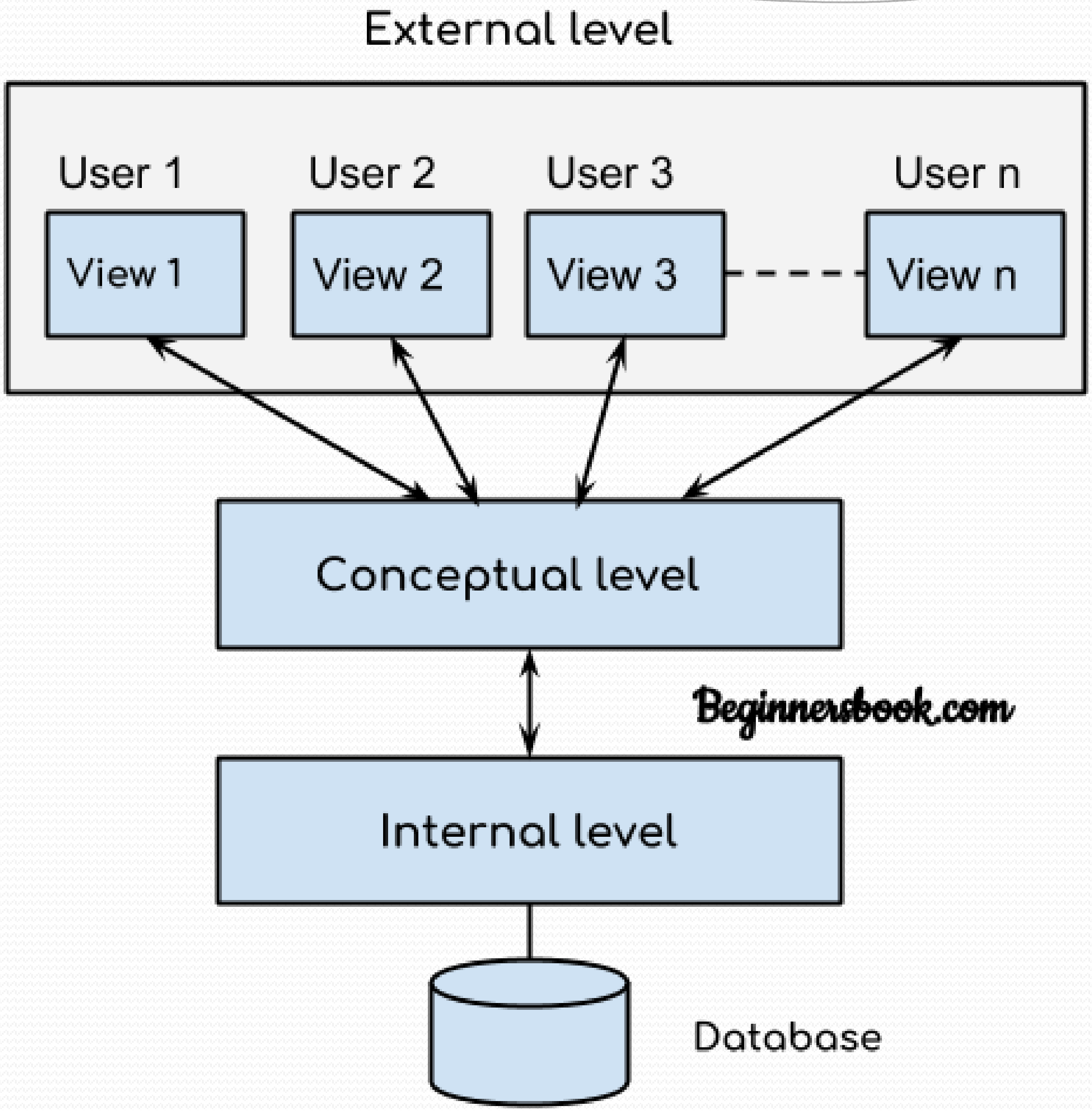
Logical data Independence

Logical Record Interface

Internal schema

Physical data Independence

Internal view


External level
User 1
User 2
User 3
User n
View 1
View 2
View 3
View n
Conceptual level
Beginnersbook.com
Internal level
Database

External View

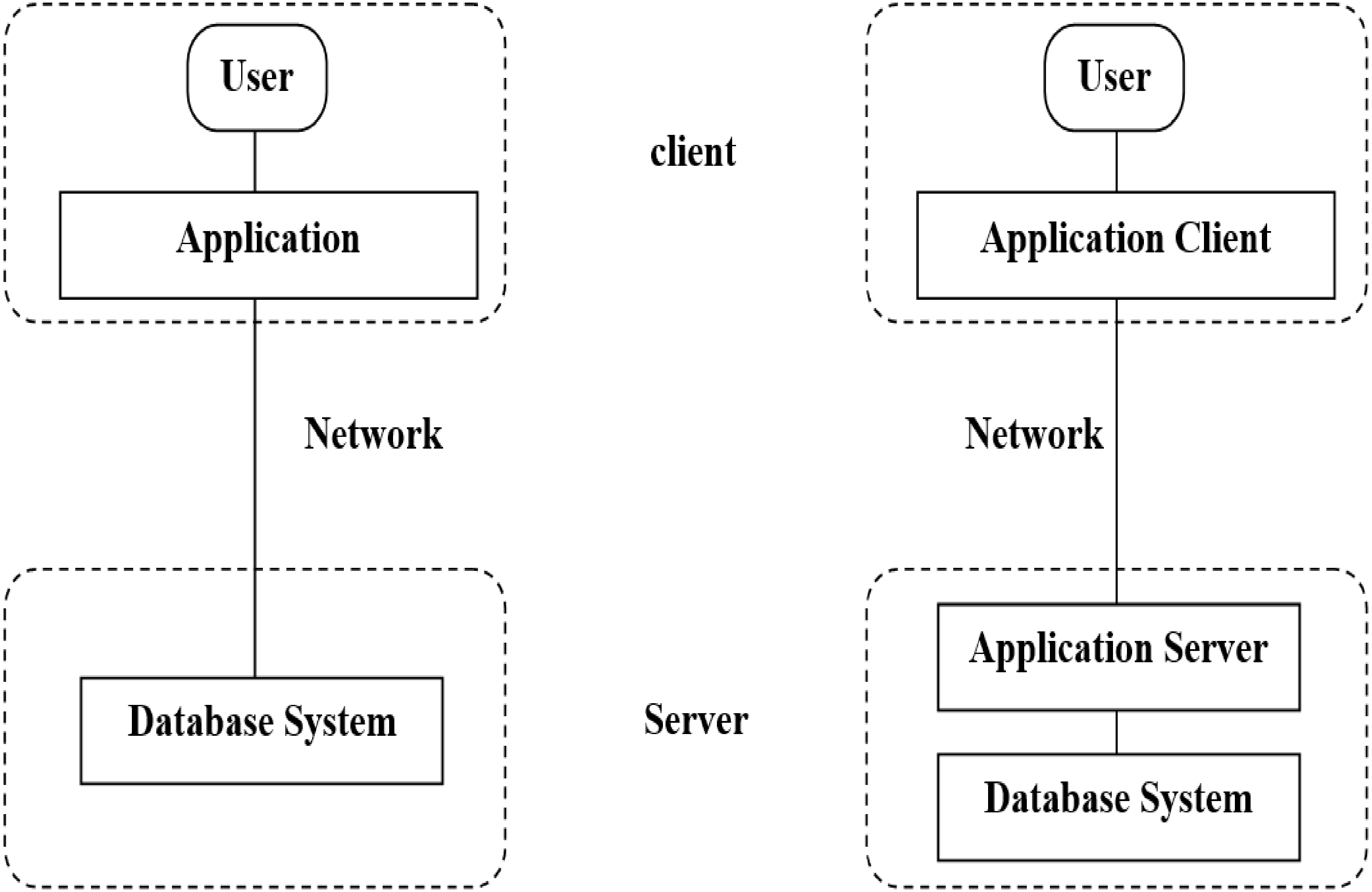
- The external level is at the highest level of database abstraction were only those portions of the database concurrence to a user are application program.
- Any number of user views may exist for a given global or conceptual view.
- Each external view is described by means of a schema called an external schema or sub-schema.
- The external schema consists of the logical records and the relationship in the external view.

Conceptual View

- At the level of database abstraction all the database entities and the relationship.
- One conceptual view represented the entire database.
- The record and the relationship include in the conceptual view.
- The description of data at this level is in a format independent of its physical representation.

Internal View

- The lowest level of abstraction closest to the physical storage method used.
- It the data will be stored and described the data structure and access methods to be used by database.
- The internet schema contains the storage record the method of representation the data field, expresses the internal view.



User

Application

client

Network

Database System

Server

User

Application Client

Network

Application Server

Database System

(a) Two-tier Architecture

(a) Three-tier Architecture

Data Independence

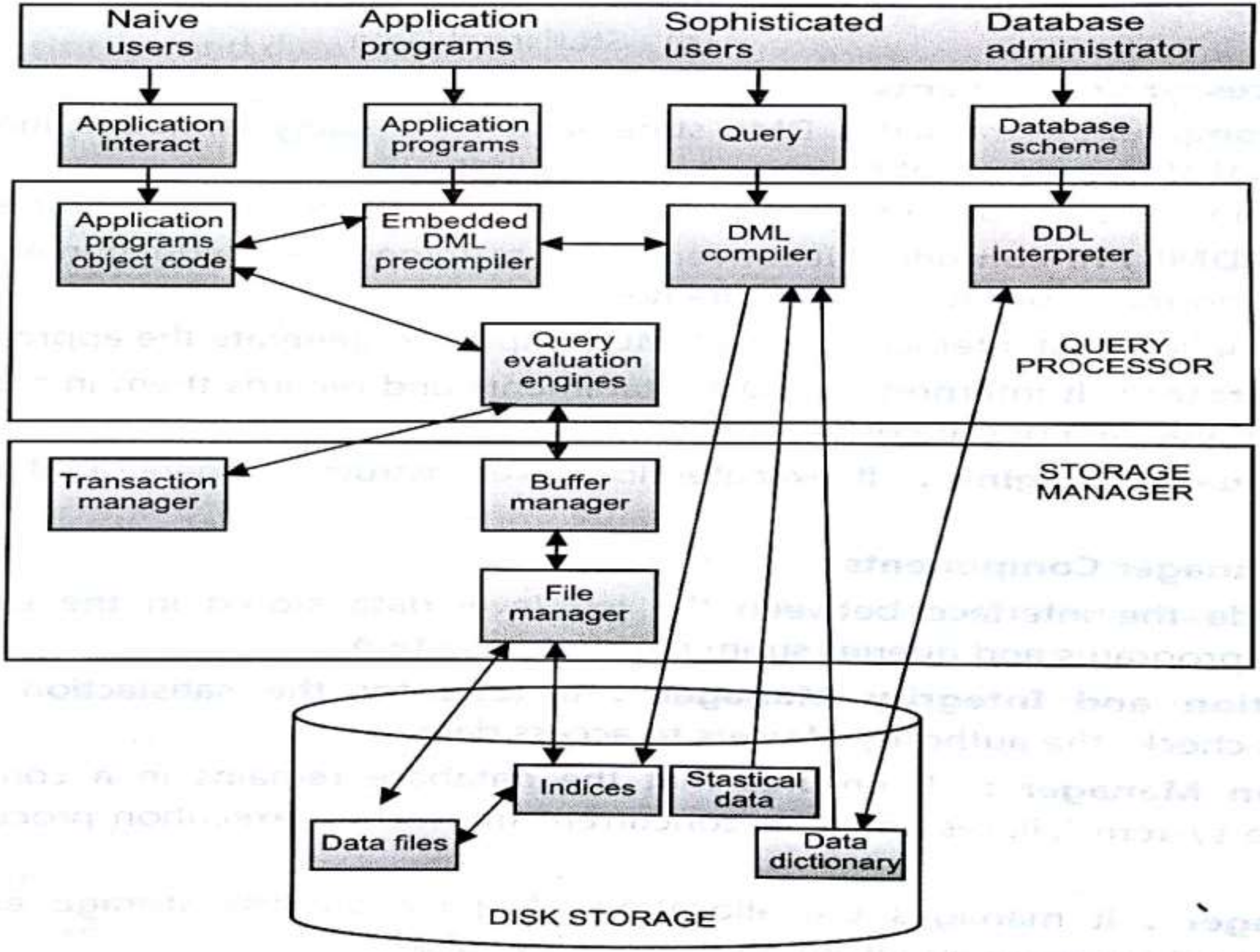
- Data Independency is the capacity to change the schema at one level of database system without changing the schema at the next higher level.
- Immunity to lower level implementation details.
- Possibility of adding new application without having to restructure the database.

Categories of Data Independence:

- ❖ Physical Data Independence
- ❖ Logical Data Independence

Advantages Data Independence

- Redundancy and inconsistence can be reduce.
- Better service to user.
- Cost of developing and maintaining system is lower.
- Security can be improved.
- Enterprise requirement can be identified.



System structure

DML Pre-Compiler

- The DML(Data Manipulation Language) statement embedded in an application program to normal produce calls in the host languages.
- The pre-compiler must interact with the query processor in order to generate the approximated quote code.

DDL Interpreter:

- The DDL(Data Definition Languages) interpreter converts the definition statement into a set of tables.

File Manager:

- File manager manage the allocation of space on disk storage and the data structure used to represent information stored on disk.

Database Manager:

- The database manager is a program module which provides the interface between low level data stored.
- The database and the application programs and query to be submitted to the system.

Query Processor

- The query is used to interpret the online user query and convert into an efficient service of operation.
- This the sent of the data manager for exception.

Database Administrator:

- Database Administration is a high level function that is responsible for overall management of data resources in an organization.

Responsibilities of DBA

- Schema definition
- ‘performance monitoring and tuning
- Schema and physical organization modification
- Granting of authorization for data access.
- Availability, Backup and Recovery.
- Integrity constraints specification.

Data Dictionary:

The data dictionary (or) system catalog is an important part of the DBMS.

It contains data about data.

It contains the actual database description used by the DBMS.

Storage Manager:

- It is storing , retrieving and updating data in the database.

Buffer Manager:

- The area into a block from the file is read termed as a buffer. The management of the buffer the objective maximizing the performance of the secondary storage system.
- At the same time keeping the demand on CPU resource tolerably low.

Database Users:

- One of the most important futures of DBMS is relatively inexperienced user is called end user.
- The empowered to retrieve information from the database.

Types of Users:

- Casual end user.
- Naive and parametric end user.
- Sophisticated end user.
- Application Programmers.

Advantages Of DBMS:

- Redundancy can be reduced.
- Inconsistency can be avoided.
- Data can be shared.
- Standard can be enforced.
- Security can be applied.
- Integrity can be maintained.

Disadvantages of DBMS:

- High cost.
- Problem associated with centralization.
- Complexity of backup and recovery.
- Confidentiality privacy and security.
- Data quality.

Database Application:

- Airlines.
- Education.
- Banking.
- Telecommunications.
- Credit card Transaction.
- E-Commerce.
- Finance.
- Sales.
- Human Resources.

Data Modeling using Entity Relationship Model

Introduction:

- The basic E-R diagram was conceived by Peter Chen in 1976.
- Its requirements in a top-down fashion.
- Diagram created using this process are called entity-relationship diagram or ER diagram.
- It is simple and easy to understand with a minimum of training.
- The model can be used by the database designer to communicate the designer to the enduser.

Entity:

- Entity is the object that exit and is distinguishable from other object.

EX:

A particular person.

A particular department.

A particular place.

Entity Set:

Entity set is a collection or set all entities of a particular entity type at any point of time is called entity set or extension of a entity type.

EX:

Bucket of apple, etc….,

Types of Entity set

- **Strong Entity Set**
- **Weak Entity Set**

Strong Entity Set:

- A strong entity set is one that has a complete identifies values may be used to identifying instance uniquely.
- A weak entities is dependent on strong entity.

Weak Entity Set:

- Entity belong to a weak entity type are identified by being related to specify entities from another entity type in communication with some of their attributes values.

Difference between Strong and Weak Entity Set:

Strong Entity	Weak Entity
• It has its own Primary key.	• It does not have sufficient attributes to from a Primary key on its own.
• It is represented by a rectangle.	• It is represented by a double rectangle.
• It contains a primary key represented by an underline.	• It contains a partial key represented by an dashed underline.
• The line connection strong entity set with the relationship in single.	• The line connection Weak entity set with the relationship in double.
• The relationship between two strong entity set is represented by a diamond symbol.	• The relationship between one strong and a weak entity set is represented by a double diamond symbol
• Total participation in the relationship may or may not exit.	• Total participation in the identifying relationship always exits.

ATTRIBUTES

- A Particular entity will have a value for each of its attributes.
- The attributes values that describe each entity become a major part of the data stored in the database.

EX:

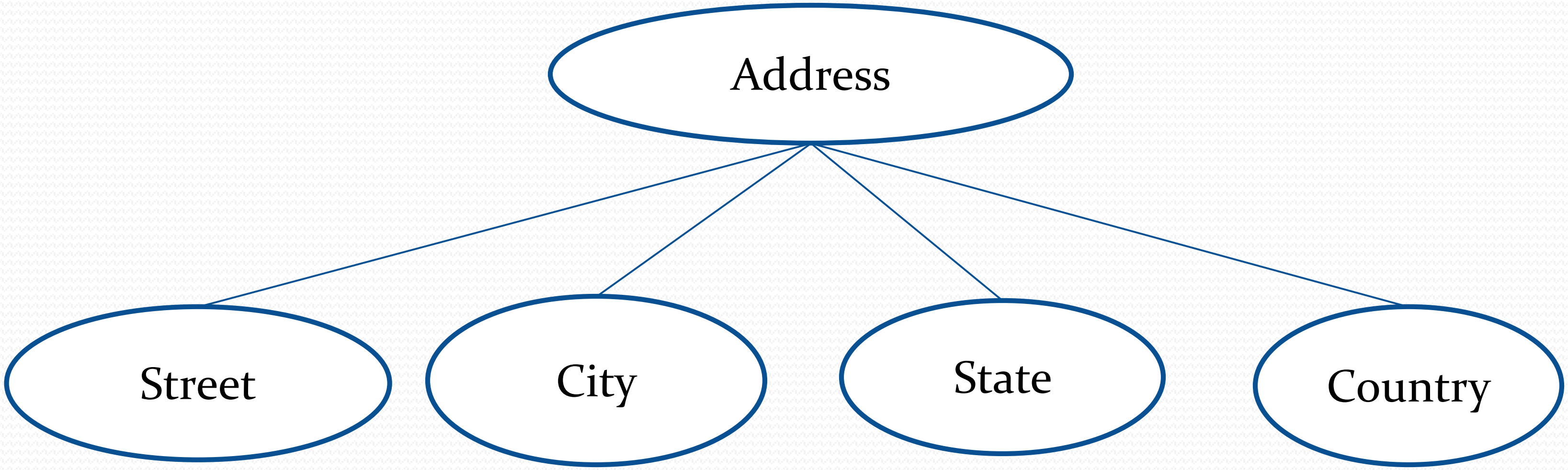
- An employee entity may be described by the employees, name, age, address, salary and job

Types of Attributes:

- Composite Attributes.
- Simple Attributes.
- Single and Multi Valued.
- Stored and Derived Attributes.

Composite Attributes:

- Attributes can be divided into smaller sub parts, which represent more basic attributes with independent meaning for their own.



Simple Attributes:

- If the composite attributes is referenced only as a whole there is no need to sub-divide it into component attributes.

Single Valued and Multi Valued:

- Most attributes have a single value for a particular entity such attributes are called single valued.
- A single valued attributed is one that holds for a single value for a single attribute.

EX: Age, Roll No and so on.

Multi valued attributes is one that holds multiple values for a single entity .

EX: Person may have two or more degrees (MSc, PhD).

Stored and Derived Attributes:

- The stored attributes which are already stored in the database and from which the values of another attributes is derived is called stored attributes.

EX: Date of Birth.

The Derived attributes are such attributes for which the values is derived or calculated from stored attributes.

EX: Date of Birth of an employee is the stored attributes but the age is the derived attributes.

KEYS

- A key is single attribute are combination of two or more attributes of an entity set that is used to identify one or more instances of set.

KEY

Login	Frist	Last
Vino	Kani	Anandh
Priya	Deepa	Riyan
Sona	Geetha	Janani

Login	Phone
Vino	9843744345

Types of Keys:

- Primary Key.
- Super Key.
- Candidate Key.
- Foreign Key.
- Alternate Key.

Primary Key:

- A primary key is a field that uniquely identified each record in a table.
- It contain can’t null values and duplicate values.

Super Key:

- A super key is a set of one or more attributes that allows identifying uniquely an entity in the entity set.

Candidate Key:

- A candidate key can be any column or a combination of columns that can qualify as unique key in database.
- There can be multiple candidate key in one table.

Foreign Key:

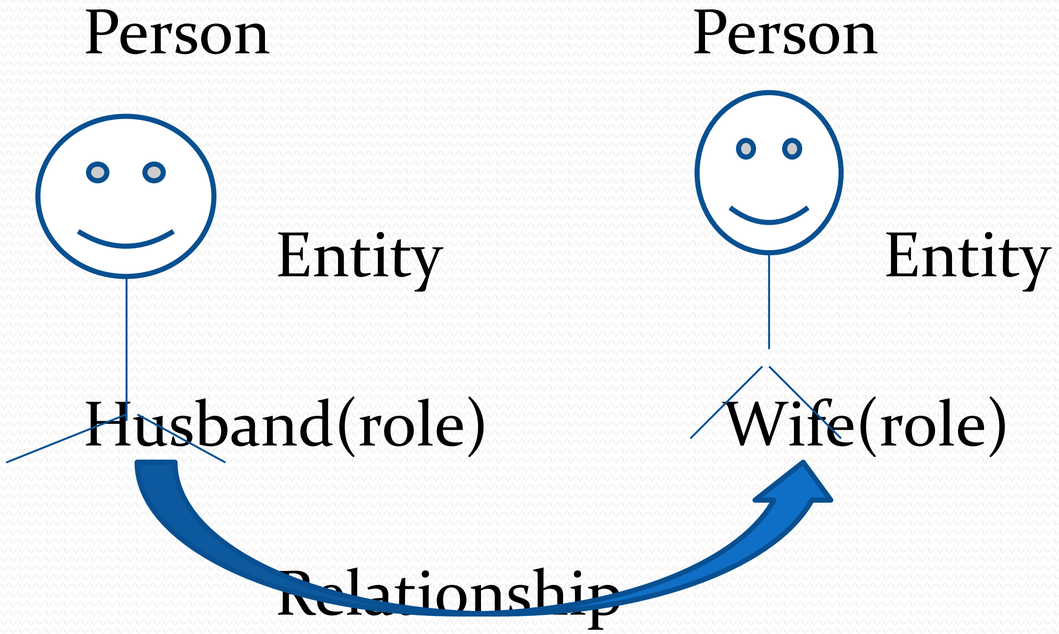
- An attributes or set of attributes within one relation that matches the candidate key of some relation.

Alternate Key:

- A candidate key that is not the primary key is called an alternate key.

Relationship Model

- There are two entities, both of them are of the person type.
- There is a relationship called married between the two person.
- In this relationship each of these two person entity has a role.
- One person play the role of husband and another person plays the role of wife.



Person

Person

Entity

Entity

Husband(role)

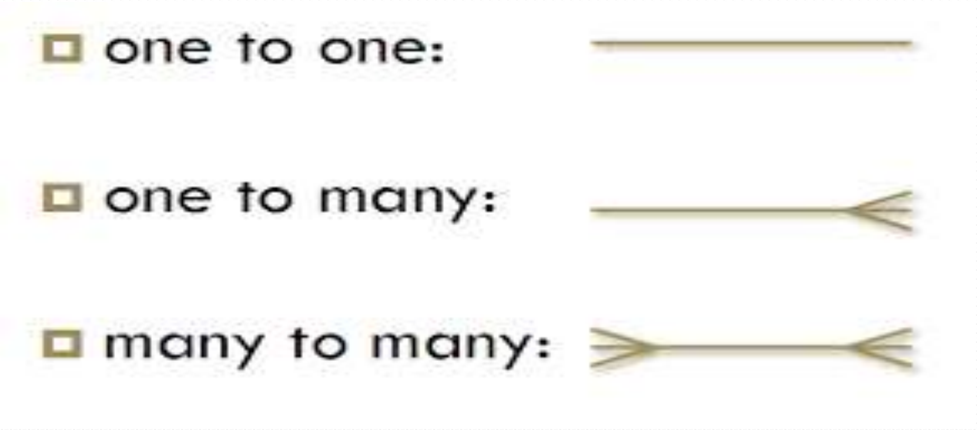
Wife(role)

Relationship

Mathematical Relationship on Entity Set

- A relationship type R among n entity types R1,R2,.......Rn define a set of association among entities from this types.
- Mathematically R is a set of relationship instance ri associate an n entities(e1,e2,....en) and each entity Ei in ri is a member of entity type.

Types of relationship:



□ one to one:

□ one to many:

□ many to many:

One-to-One:

- The one-to-one relationship also denoted as 1:1 is simple.
- An entity there is exactly one occurrence of another entity.

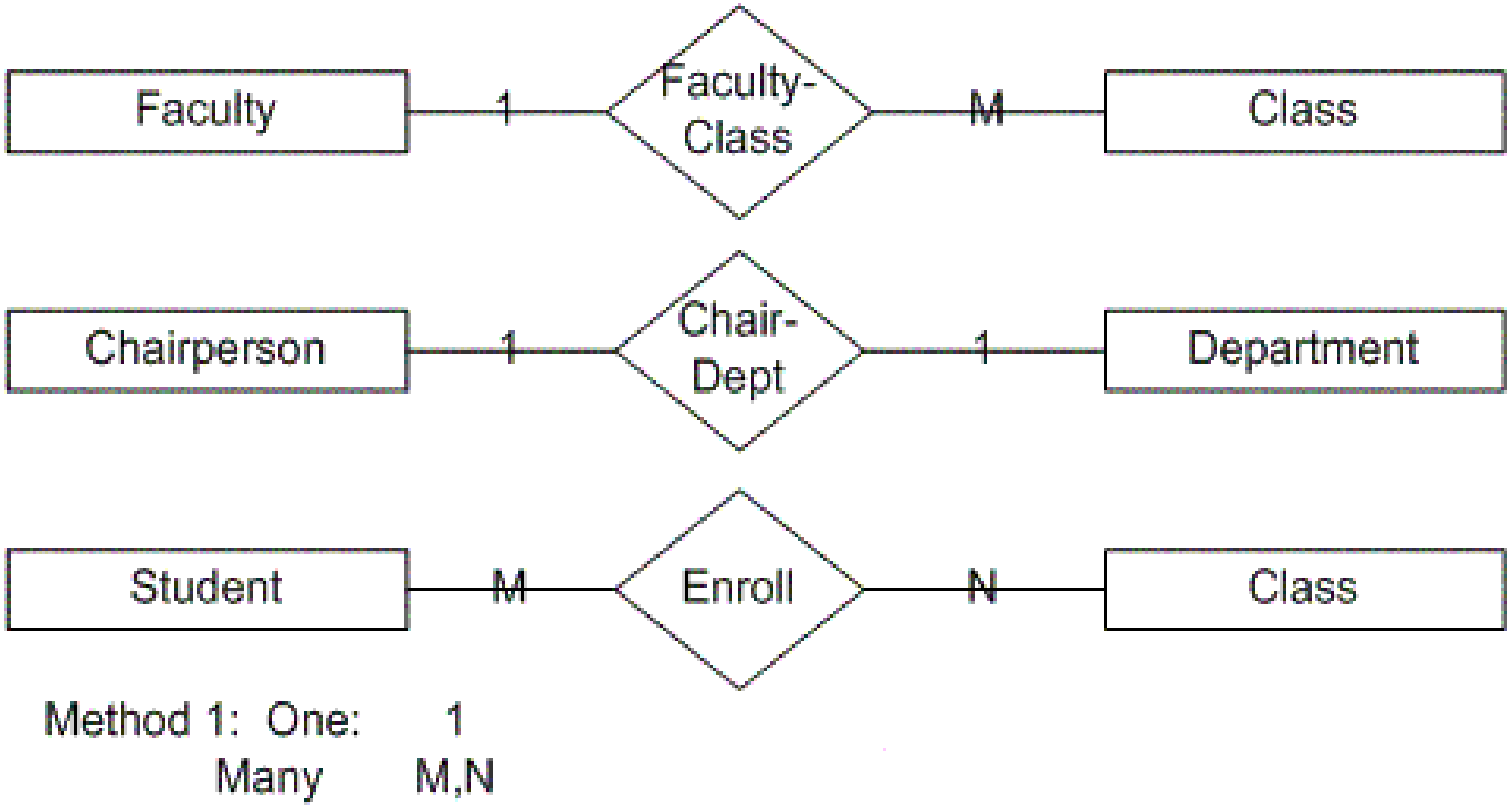
One-to-Many:

- In a one-to-many relationship also denoted as 1:M for given occurrence of an entity there can be one or more occurrence of another entity.

Many-to-Many:

- In a many-to-many relationship also denoted as M:N there can be one or more values on both relationship of values.

- **Example:**


Faculty
1
Faculty-Class
M
Class
Chairperson
1
Chair-Dept
1
Department
Student
M
Enroll
N
Class
Method 1: One: 1
Many M,N

Degree of Relationship:

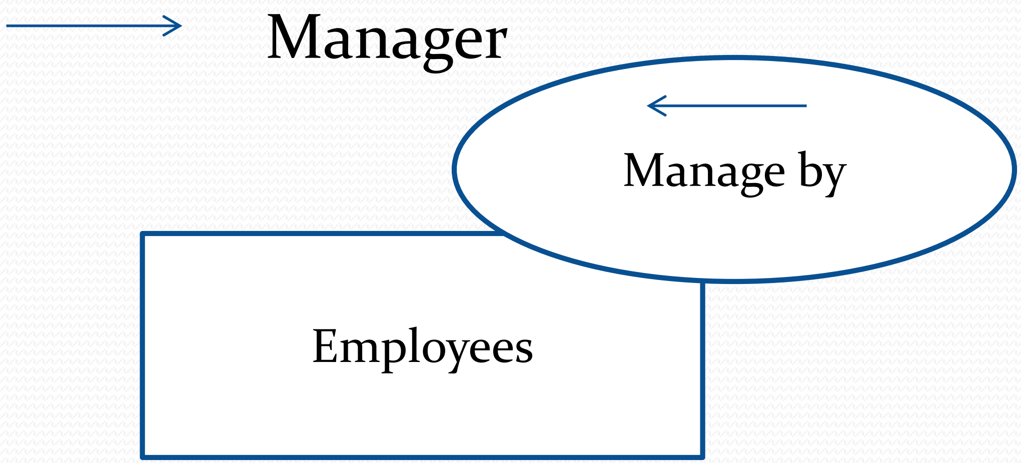
- The degree of relationship is the number of entities associated in the relationship.
- Relationship of degree greater than two are called higher degree relationship.

Degree of Relationship:

- Unary Relationship.
- Binary Relationship.
  Ternary Relationship.
- Quaternary Relationship.

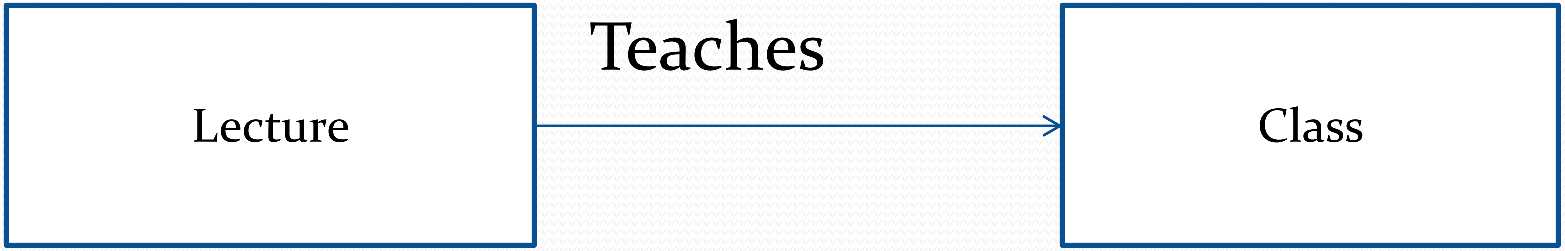
Unary Relationship:

- If a relationship type is between entity type it is called an unary relationship type.



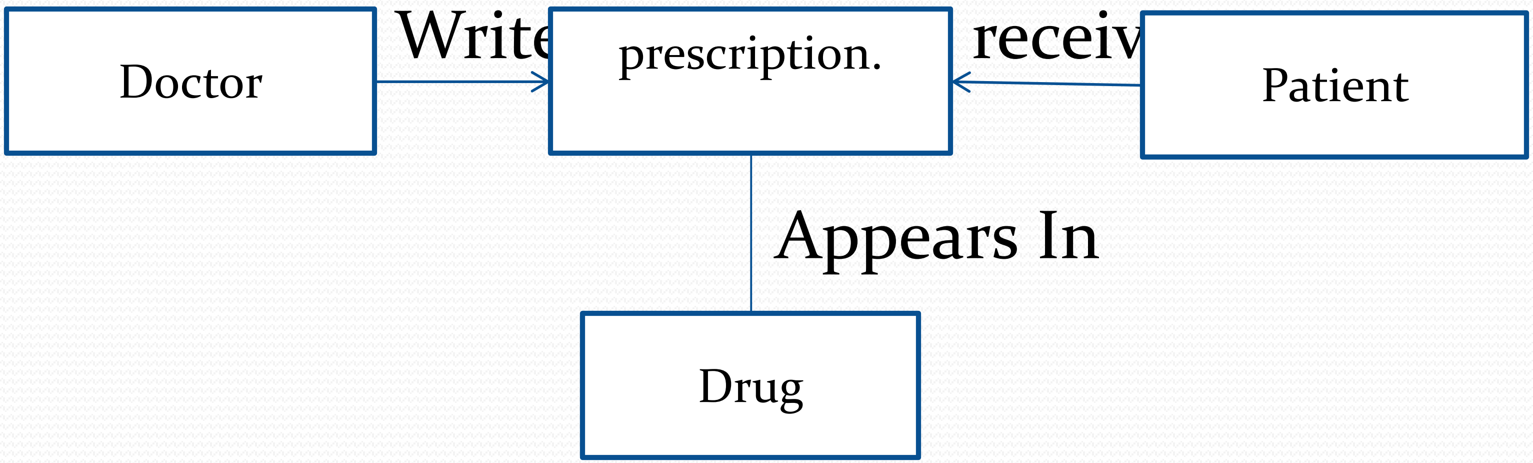
Binary Relationship:

- A binary relationship exist when two entities are associated in a relationship .
- Binary relationship are most common conceptual design, possible most higher order relationship.



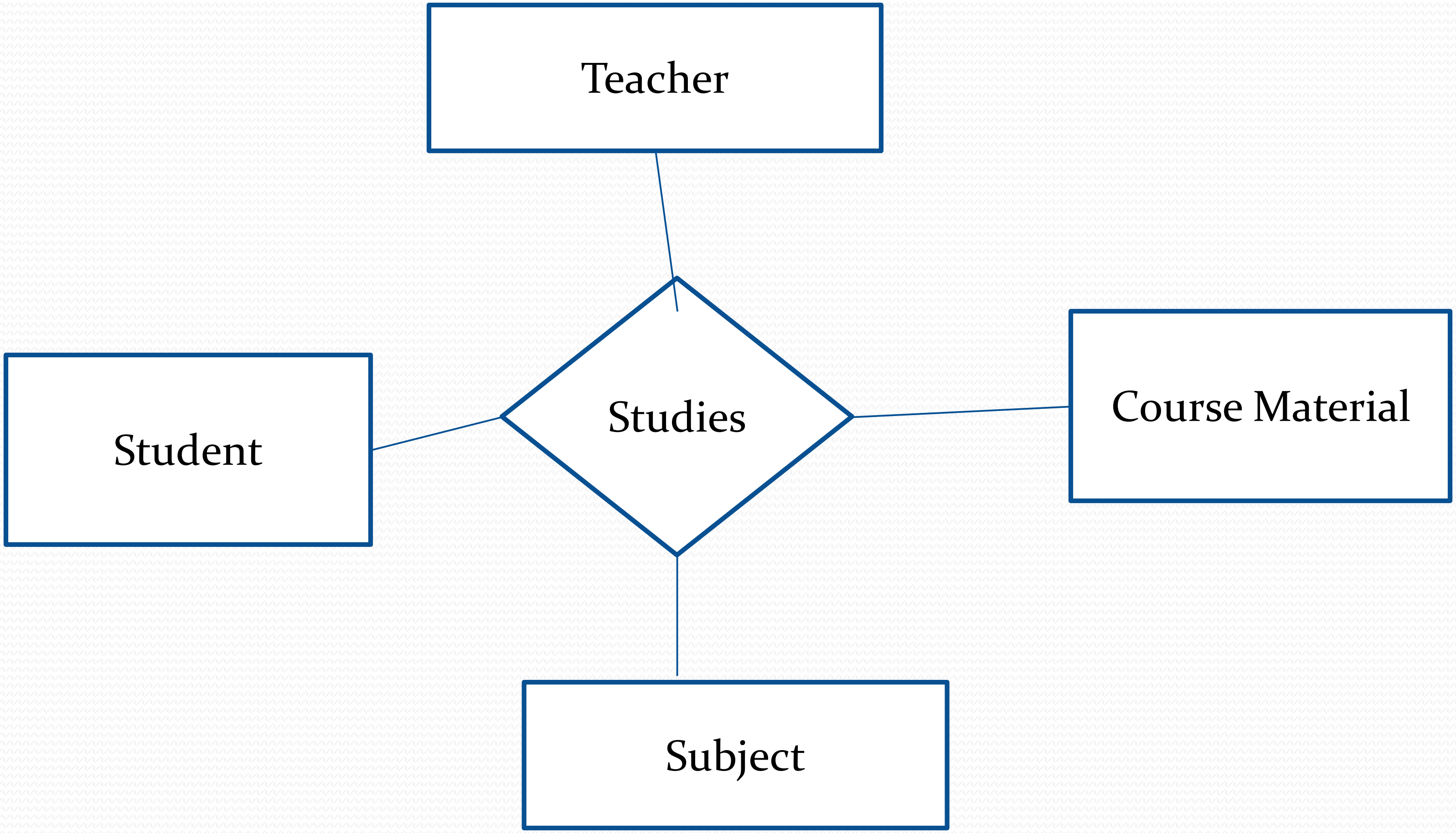
Ternary Relationship:

- A ternary relationship implies an association among three different entities.
- A doctor writes one or more prescription.
- A patient may receive one or more prescription.
- A drug may appear in one or more prescription.



Quaternary Relationship:

- A quaternary relationship exit there are four entity associated.



Structural Constraints:

- Structural constraints are information about how two or more entities are related to one another.

Types of Structural Constraints:

- Cardinality Constraints/Ratio
- Participation Constraints

Cardinality Constraints/Ratio

- The cardinality specify the maximum number of relationship instant that the entity can participate. The term used in database relation to denote the occurrence on data on either side of the relationship.
- The possible cardinality ratio binary relationship types are,
- 1 : 1
- 1 : M
- M : N

Types of Cardinality:

- Link Cardinality.
- Sub-type Cardinality.
- Physical segment Cardinality.
- Possession Cardinality.
- Child Cardinality.
- Characteristic Cardinality.
- Paradox Cardinality.
- Association Cardinality.

Participation Constraints:

- A Participation constraints specifies the existence of an entity depends on its related to another entity relationship type.

Types of Participation Constraints:

- Total Participation Constraints
- Partial Participation Constraints

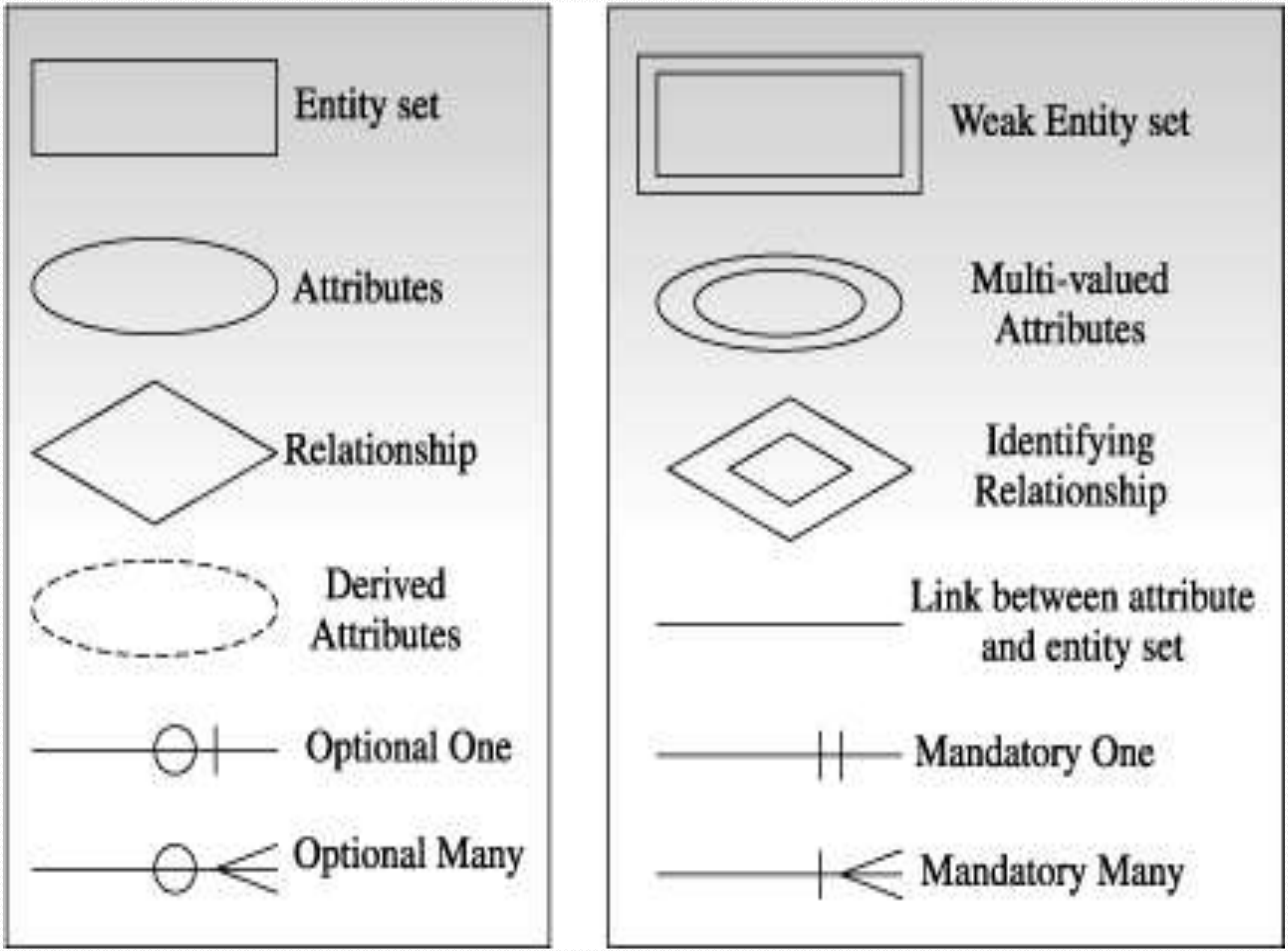
Entity Relationship diagram

- The basic ER diagram was conceived by Peter Chen 1976 as a unifying data model for all data models that existed at that time.
- ER diagram or data schema map or data map is another means of capturing the data and their organization.

Importance of ERD:

- Straight forward relationship representation.
- Easy conversion of ER to other data model.
- Graphical representation for better understanding.

ER Symbol


Entity set
Attributes
Relationship
Derived Attributes
Optional One
Optional Many
Weak Entity set
Multi-valued Attributes
Identifying Relationship
Link between attribute and entity set
Mandatory One
Mandatory Many

Enhanced ER Modeling

- ER model was introduced for modeling most common business problems and has widespread use.
- The term enhanced entity relationship model is used to identify the result for extending the original ER model with the new modeling constructs.

Super types and Sub types:

- A super type is a sub grouping of the entities in an entity type that is meaningful to the organization.
- A sub type is a generic entity type that has a relationship with one or more sub type.

EX : Student – Subtype.

Graduate , not graduate – Super type.

Reasons of using Super type/Sub type:

Two important reasons:

- It eliminate the requirements of describing similar to concept more than one. The saving time from data modeling and also results in more readable ER diagram.
- The super type / sub type relationship add more semantic concept and information of the design.

Basic concepts and Notation:

- The line to each sub type that has been U – Shaped symbol on each line connecting a sub type to the circle emphasises that the sub type is a sub set of the super type.

EX

- That the organisation has three types of employees,
- Hourly Employees, Salaried Employees and Contract consultants.

Hourly Employees:

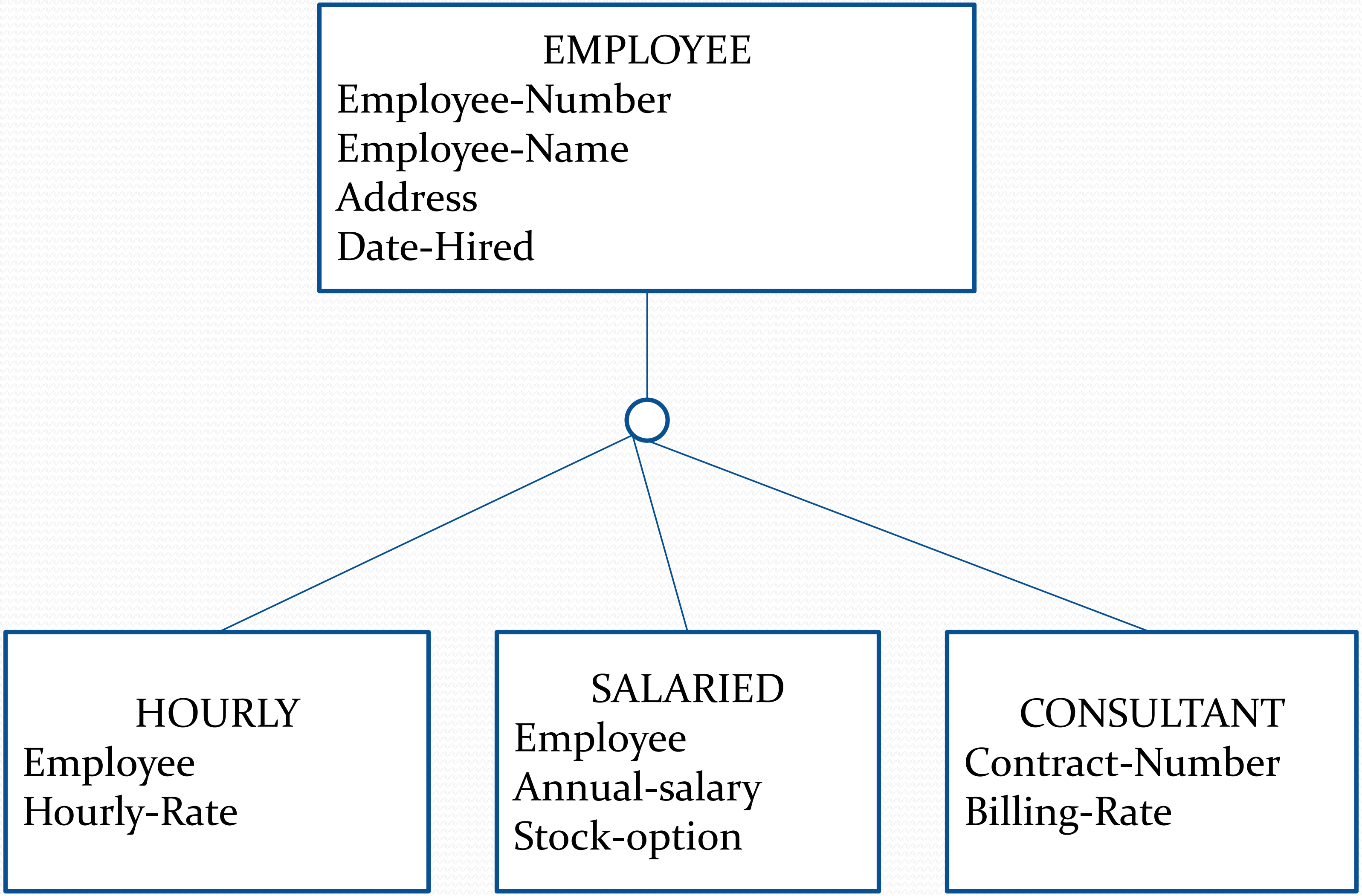
Employee-no, Name, Address, date-hired, hourly –rate.

Salaried Employees:

Employee-Number, Employee-Name, Address, Date-Hired, Annual-Salary, Stock-Option.

Contract Consultants:

Employee-No, Name, Address, date-hired, contact no, billing rate.



EMPLOYEE
Employee-Number
Employee-Name
Address
Date-Hired

HOURLY
Employee
Hourly-Rate

SALARIED
Employee
Annual-salary
Stock-option

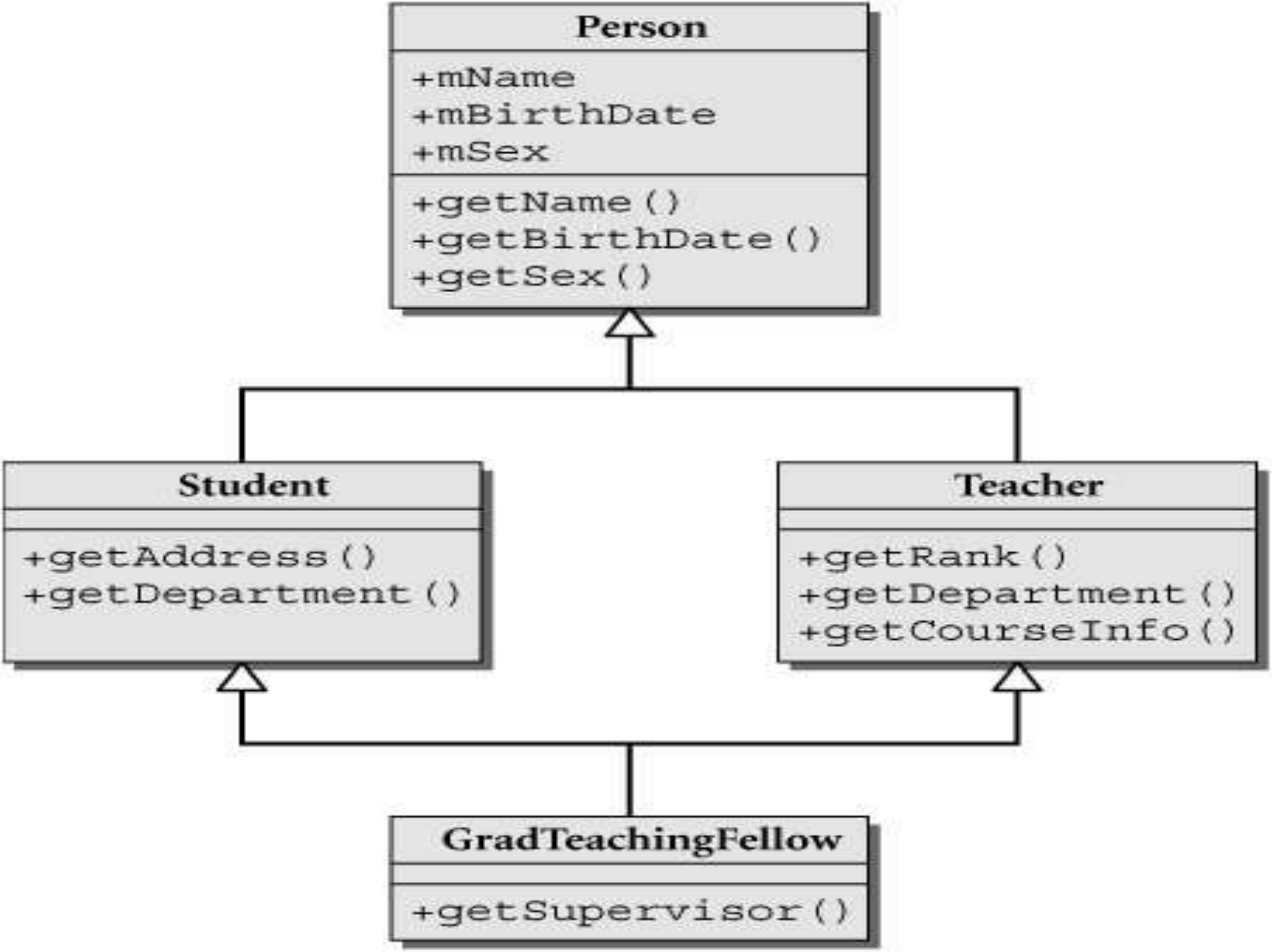
CONSULTANT
Contract-Number
Billing-Rate

IS-A Relationship and Attributes Inheritance

- The relationship support attribute inheritance and relationship participation.
- In the EER diagram, the sub class relationship is represented by IS-A relationship.

Multiple Inheritances:

- A sub class with more than one super class is called a shared sub class.
- A sub class inherit attributes not only of its direct class.
- In multiple inheritance a sub class be sub class has more than one super class.



Person

+mName
+mBirthDate
+mSex

+getName()
+getBirthDate()
+getSex()

Student

+getAddress()
+getDepartment()

Teacher

+getRank()
+getDepartment()
+getCourseInfo()

GradTeachingFellow

+getSupervisor()

Generalisation:

- A unique accept of human intelligence in the ability to classify object and experience to generalise the properties.
- In data modeling generalisation is the process of defining a more general entity type from a set of more specialised entity types.
- This is an generalisation is a bottom up process.

Specialisation:

- Generalisation is a bottom up process
- Specialisation is a top down process the direct reverse order of generalisation .
- Specialisation is the process of one or more sub type of the super type and forming relationship.