

# UNIT 1

## Lecture 4 Data Models

# Data Models

- A data model is collection of tools for describing
  - a) data
  - b) data relationships
  - c) data semantics
  - d) data constraints

# Types of Data Models

- There are basically two types of data models
  - a) Record based Data Models.
  - b) Object based Data Models.

# Record based Data Models

- In Record-based models, the database is organized in fixed-format records of several types.
- A fixed number of fields, or attributes, are defined in each record type, and each field is usually of a fixed length.
- The three most popular record-based data models are
  1. Hierarchical Data Model
  2. Network Data Model
  3. Relational Data Model

# Hierarchical Data Model

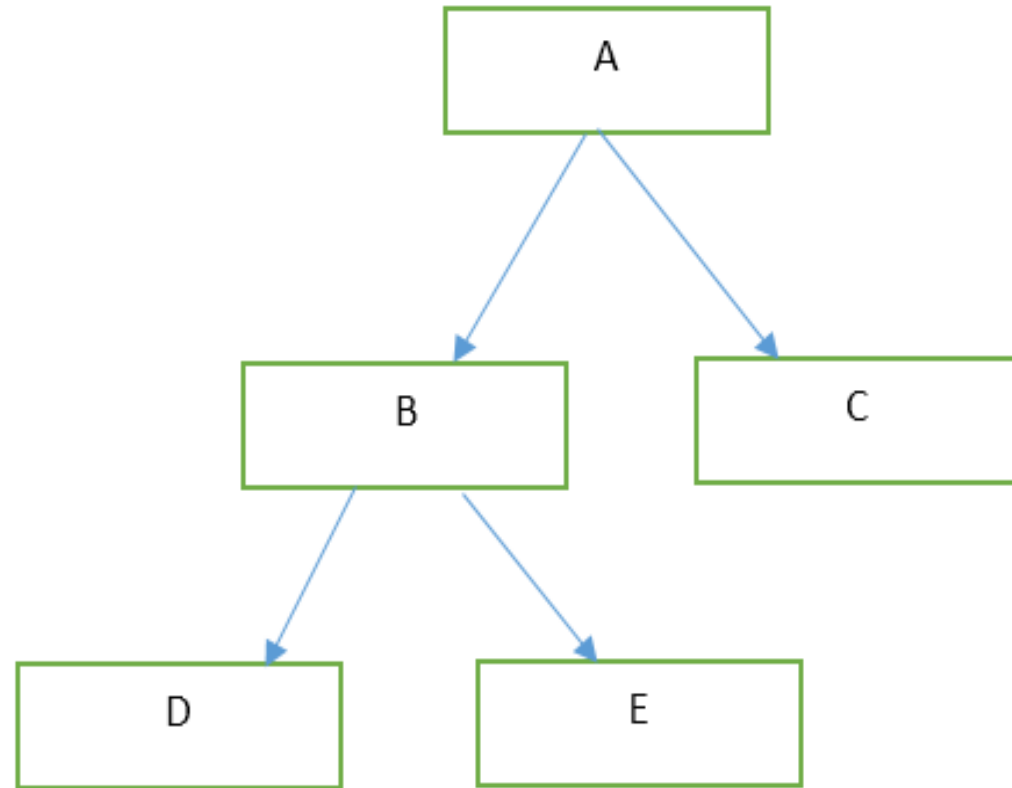
- In the hierarchical model, data are represented by collections of *records*.
- Relationships among data are represented by *links*.
- In this model **Tree data structure** is used.
- There are two concepts associated with the hierarchical model – *segment types* and *parent-child relationships*.
- Segment type is similar to the record types in the network models.
- The information retrieved only by navigating from the root segment type to the nodes segment types. Thus you can access a segment type only via its parent segment type in the parent-child relationship.

# Hierarchical Data Model

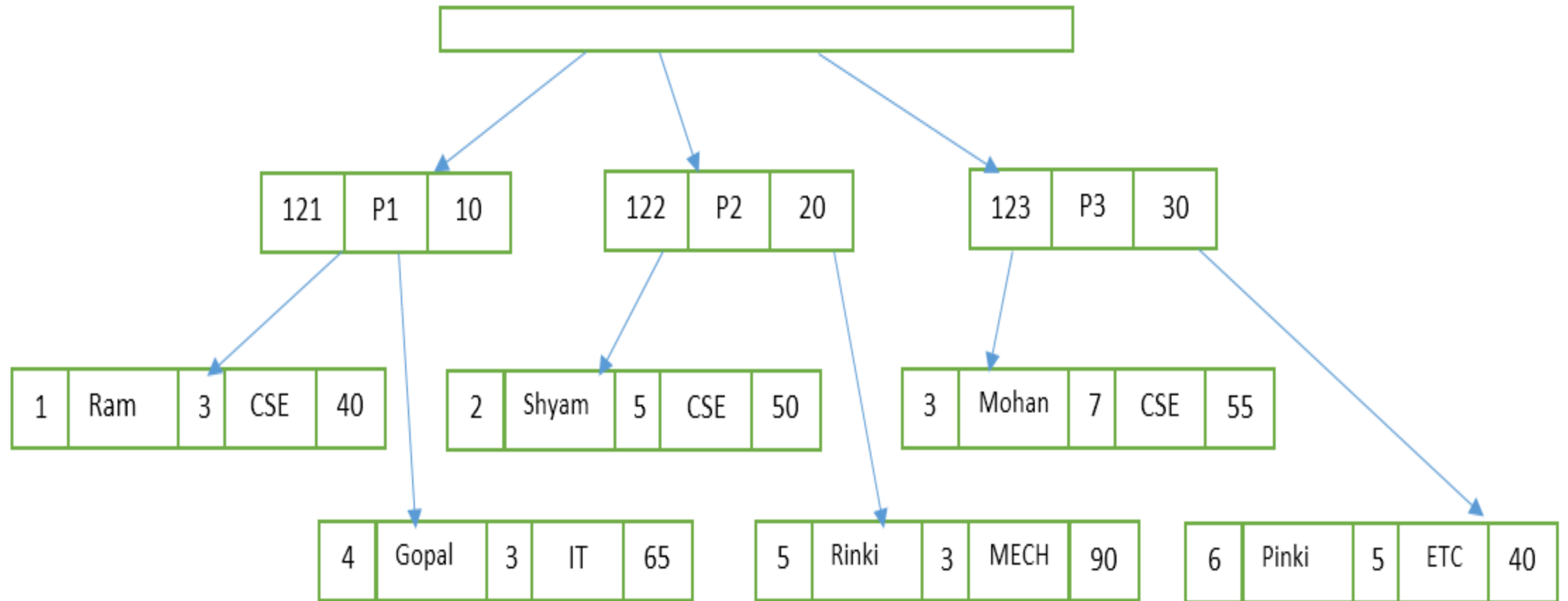
Level – 0: Root Parent  
(Node)

Level – 1: Root children  
(segment)

Level – 2: Segments  
(Level – 1 Children)



# Hierarchical Data Model



# Advantages of Hierarchical Data Model

1. Simplicity
2. Data Security
3. Data Integrity
4. Efficiency



# Disadvantages of Hierarchical Data Model

1. Implementation Complexity
2. Database management problems
3. Lack of structural independence
4. Programming complexity
5. Implementation limitation

# Network Data Model

1. The Database Task Group of the conference on Data System Languages (DBTG/ CODASYL) formalized the network data model in the late 1960s.
2. The network data model is similar to a hierarchical model except that a record can have multiple parents.
3. The network data model has three basic components such as **record type, data items (or fields)** and **links**.

# Network Data Model

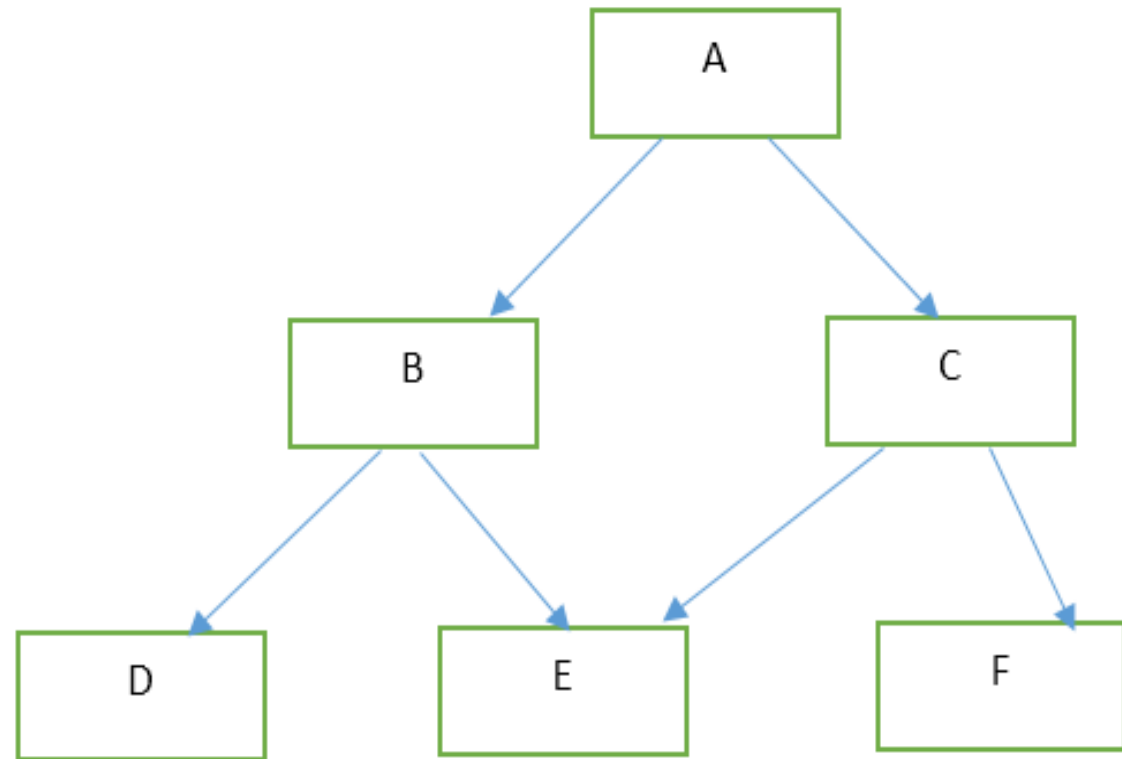
1. In network model, a relationship is called a **set** in which each set is composed of at least two record types.
  1. **Owner record** that is equivalent to the parent in the hierarchical model.
  2. **Member record** that is equivalent to child in the hierarchical model.
2. The connection between an owner and its member records is identified by a link to which database designers assign a **set-name**.
3. This set-name is used to retrieve and manipulate data.

# Network Data Model

Level – 0: Owner

Level – 1: Owner/ Member

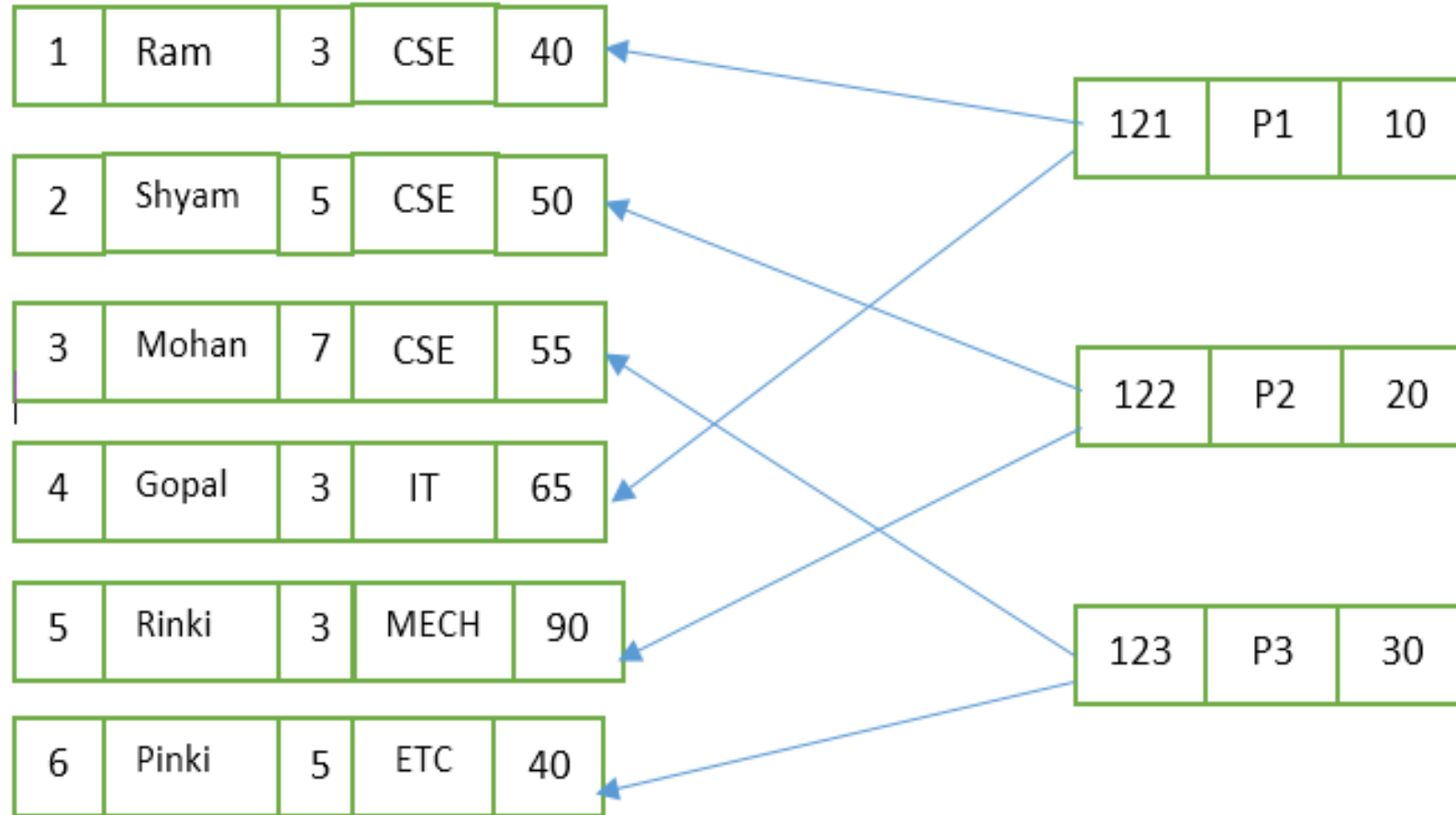
Level – 2: Member



# Network Data Model

1. In the network model, data are represented by collections of *records*.
2. Relationships among data are represented by *links*.
3. In this model **Graph data structure** is used.
4. A network model permits a record to have more than one parent.

# Network Data Model



# Advantages of Network Data Model

1. Simplicity
2. Ability to handle more relationship types
3. Ease of data access
4. Data Integrity
5. Data Independence
6. Database Standards

# Disadvantages of Network Data Model

1. System Complexity
2. Lack of structural independence



# Relational Data Model

1. The relational model was discovered by **Dr. E. F. Codd**.
2. The relational model uses tables to represent the data and the relationships among those data.
3. Each table has multiple columns, and each column is identified by a unique name.
4. It is a low level model.

# Relational Data Model

STUDENT

rollno	sname	sem	br	marks	pno
1	Ram	3	CSE	40	121
2	Shyam	5	CSE	50	122
3	Mohan	7	CSE	55	123
4	Gopal	3	IT	65	121
5	Rinki	3	MECH	90	122
6	Pinki	5	ETC	40	123

PROJECT

pno	pname	duration
121	P1	10
122	P2	20
123	P3	30

# Advantages of Relational Data Model

1. Structural Independence
2. Simplicity
3. Ease of designing, implementation, maintenance, and usage
4. Adhoc query capability

# Disadvantages of Relational Data Model

1. Hardware Overheads
2. Ease of design can result in bad design

# Difference between hierarchical, network and relational data models

SNO	Hierarchical	Network	Relational
1	Relationship between records is of parent child type.	Relationship between records is expressed in the form of pointers or links.	Relationship between record is represented by a relation that contains a key for each record involved in the relations.
2	Many-to-many relationship cannot be expressed in this model.	Many-to-many relationship can also be implemented.	Many-to-many relationship can be easily implemented.
3	It is a simple, straightforward and natural method of implementing record relationships.	Record relationship implementation is quite complex due to the use of pointers.	Relationship implementation is very easy though the use of a key or composite key field(s).

# Difference between hierarchical, network and relational data models

SNO	Hierarchical	Network	Relational
4	This type of model is useful only when there is some hierarchical character in the database.	Network model is useful for representing such records which have many-to-many relationships.	Relational model is useful for representing most of the real world objects and relationships among them.
5	In order to represent links among records, pointers are used. Thus relationships among records are physical.	In Network model also the relationship among records are physical.	Relational model does not maintain physical connection among records. Data is organized logically in the form of rows and columns and stored in table.

# Difference between hierarchical, network and relational data models

SNO	Hierarchical	Network	Relational
6	Searching for a record is very difficult since one can retrieve a child only after going through its parent record.	Searching a record is easy since there are multiple access paths to a data element.	A unique, indexed key field is used to search for a data element.
7	During updation or deletion process, chance of data inconsistency is involved.	No problem of inconsistency exists in network model because a data element is physically located at just one place.	Data integrity maintaining methods like Normalization process, etc. are adopted for consistency.

# Object Based Data Models

- In Object-based models, the database is organized in real world objects of several types. A number of fields, or attributes, are defined in each object type, and each field is usually of a variable length.
- The two most popular object-based data models are
  - a) E R Model (Entity Relationship Model)
  - b) Object oriented model



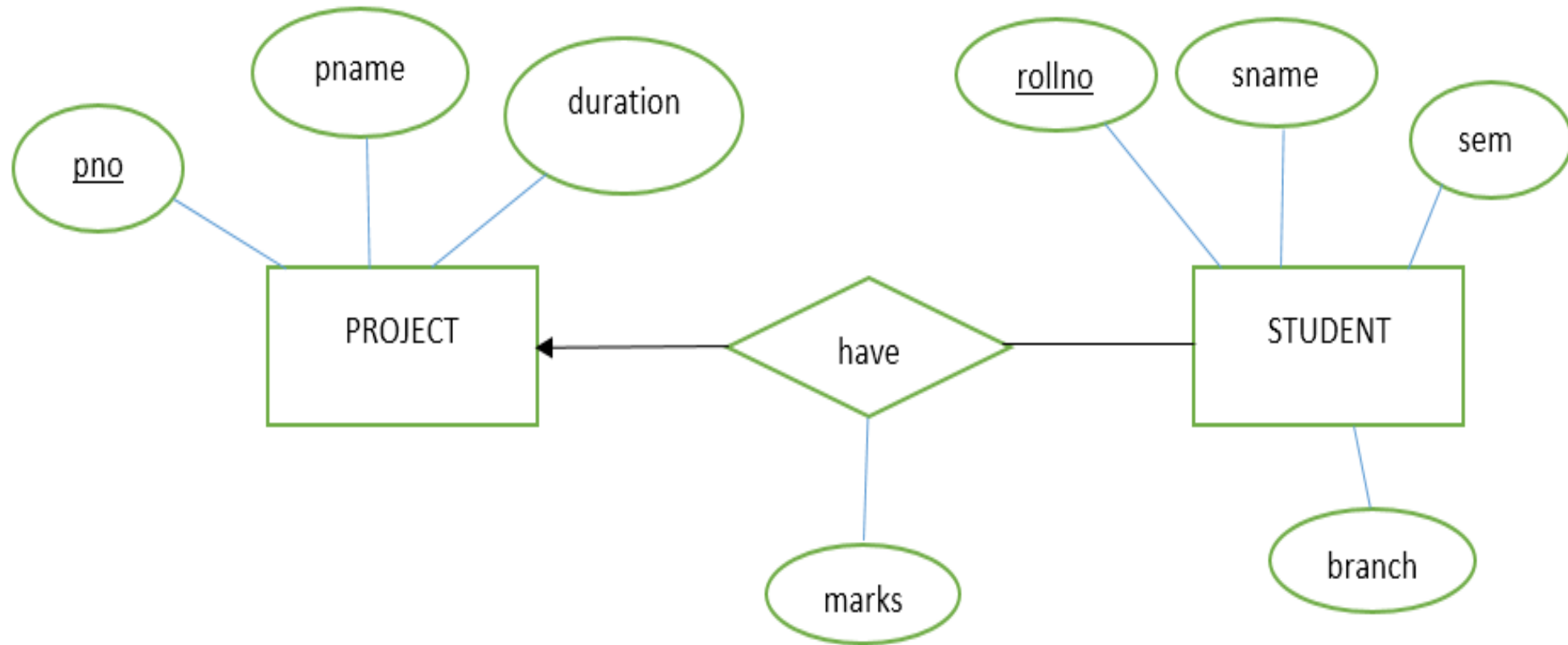
# ER Model (Entity Relationship Model)

- The entity-relationship model is based on a perception of the world as consisting of a collection of basic objects (entities) and relationships among these objects.
- It was discovered by **Peter Chen** in 1976.
- It is a high-level data model.
- An entity is a distinguishable object that exists.
- Each entity has associated with it a set of attributes describing it.
- A relationship is an association among several entities.

# ER Model (Entity Relationship Model)

- The set of all entities or relationships of the same type is called the entity set or relationship set.
- Another essential element is the E-R diagram in which the mapping cardinalities express the number of entities to which another entity can be associated via a relationship set.
- The overall logical structure of a database can be expressed graphically by an E-R diagram:
  - a) **Rectangles** : represent entity sets.
  - b) **Ellipses** : represent attributes.
  - c) **Diamonds** : represent relationships among entity sets.
  - d) **Lines** : link attributes to entity sets and entity sets to relationships.

# ER Model (Entity Relationship Model)



# Advantages of ER Model

1. Straightforward relational representation
2. Easy conversion for ER to other data model
3. Graphical representation for better understanding

# Disadvantages of ER Model

1. No industry standard for notation
2. Popular for high-level design

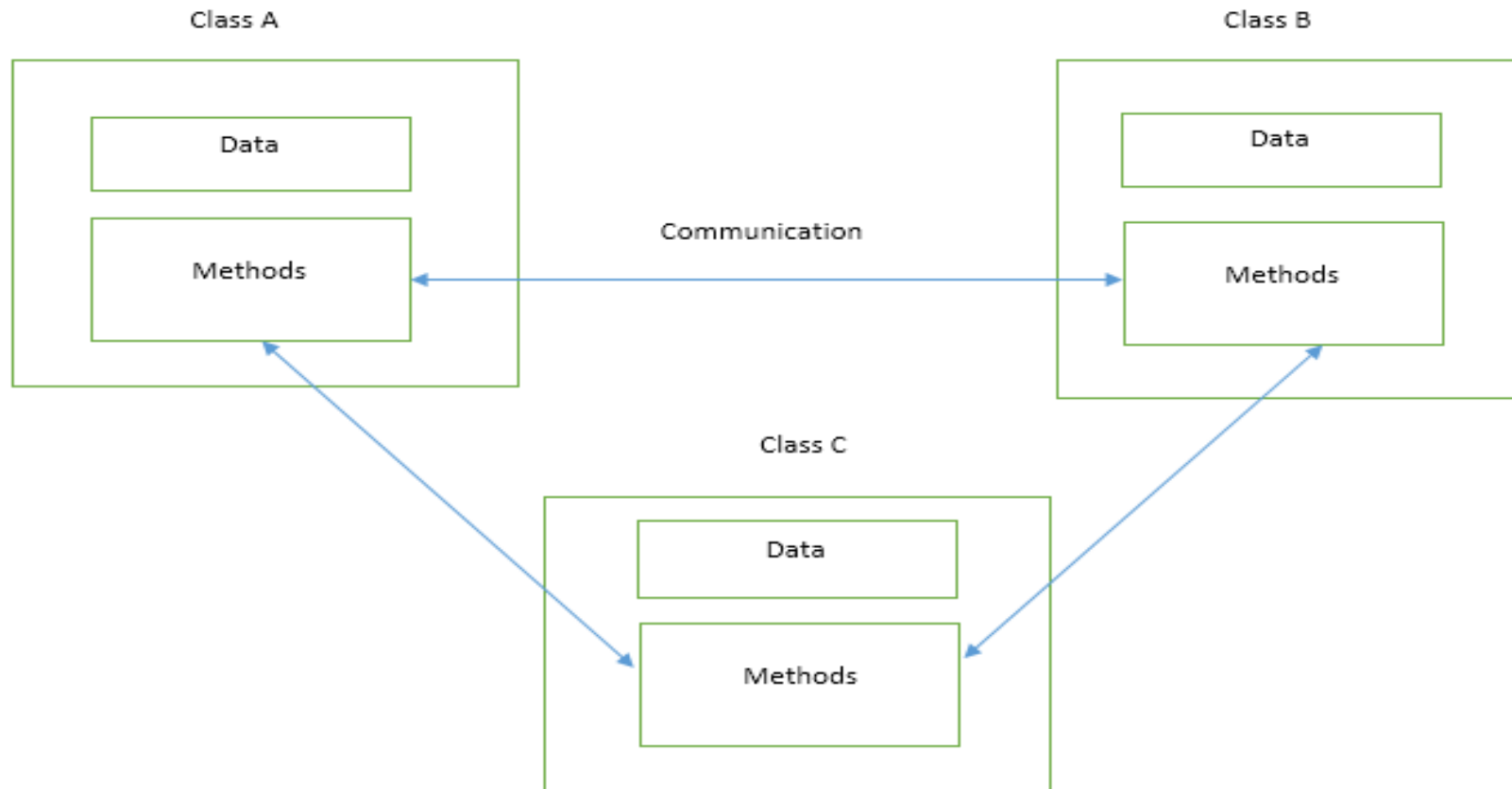
# Object Oriented Data Model

- The object-oriented model is based on a collection of objects, like the E-R model.
- An object contains values stored in instance variables within the object.
- Unlike the record-oriented models, these values are themselves objects.
- Thus objects contain objects to an arbitrarily deep level of nesting.
- An object also contains bodies of code that operate on the object. These bodies of code are called **methods**.
- Objects that contain the same types of values and the same methods are grouped into classes.

# Object Oriented Data Model

- A class may be viewed as a type definition for objects.
- The only way in which one object can access the data of another object is by invoking the method of that other object. This is called **sending a message** to the object.
- Internal parts of the object, the instance variables and method code, are not visible externally.
- Result is two levels of data abstraction.
- Unlike entities in the E-R model, each object has its own unique identity, independent of the values it contains:
  1. Two objects containing the same values are distinct.
  2. Distinction is maintained in physical level by assigning distinct object identifiers.

# Object Oriented Data Model





# Object Oriented Data Model

<b>Class : STUDENT</b>
<b>DATA</b>
<b>rollno</b> <b>sname</b> <b>sem</b> <b>br</b> <b>marks</b> <b>pno</b>
<b>METHODS</b>
<b>get ()</b> <b>show ()</b> <b>setpno ()</b>

<b>Class : PROJECT</b>
<b>DATA</b>
<b>pno</b> <b>pname</b> <b>duration</b>
<b>METHODS</b>
<b>get ()</b> <b>show ()</b> <b>setproject ()</b>

# Advantages of OO Model

1. Capable of handling a large variety of data types.
2. Combining object-oriented programming with database technology
3. Improved productivity
4. Improved data access

# Disadvantages of OO Model

1. No precise definition
2. Difficult to maintain
3. Not suited for all applications

# University Questions

- What are data models?
- Describe different types of data models.
- Enumerate the different types of data models existing for structured data storage.
- What are the various types of data model? Explain in brief.
- What is the difference between hierarchical, network and relational data model?

For Video lecture on this topic please subscribe to my youtube channel.

The link for my youtube channel is

[https://www.youtube.com/channel/UCRWGtE76JITp1iim6aOTRuW?sub\\_confirmation=1](https://www.youtube.com/channel/UCRWGtE76JITp1iim6aOTRuW?sub_confirmation=1)