Hierarchical Data Model

- The first important logical database model.
- Primarily implemented on mainframe today.
- Records are arranged in a top-down structure that resembles an upside-down tree.
- The parent and child are often used in describing hierarchical model.
- An important characteristic is that a child is related to only one parent.
- The leading hierarchical DBMS in use today is IBM’s Information Management System (IMS).

IMS Physical Databases

- The physical database record is a basic building block in IMS.
- A Physical Database Record (PDBR) consists of a set of related fields.
- A PDBR consists of a root segment and its subordinate segments called child segments.
IMS Logical Database

- External views of individual users in IMS are reflected in Logical Database Records (LDBR).
- Each LDBR type is a subset of a corresponding PDBR type.
- Any segment type (except the root segment) of a PDBR may be omitted from an LDBR.
- Any field types that occur in a PDBR may be omitted in the corresponding LDBR.

Network Data Model

- There is no distinction between parent and child record types.
- Any record type may be associated with an number of different record types.
- A set is the definition of a directed relationship from an owner record type to one or more member record types.
Network Data Model

- Generally, we can assume that set is implemented as a ring data structures with the owner at the head of the chain and with the last member pointing to the owner.

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The Conference on Data System Languages (CODASYL) through its Data Base Task Group (DBTG) is a standard organization that has developed and issued descriptions of language for defining and processing data in Network DBMS.

- IDMS (Integrated Database Management System) is the leading DBTG DBMS on IBM computers.

Relational Data Model

- A data model that represents data in the form of tables or relation.
- The relational database model consists of the following three components:
  - **Data Structure**: Data are organized in the form of tables or relations.
  - **Data Manipulation**: Powerful operations such as SQL languages or Query-by-example, are used to manipulate data stored in the database.
  - **Data Integrity**: Business rules are specified to maintain the integrity of data when they are manipulated.

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<tr>
<th>COLUMN NAMES</th>
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Physical Properties

- A relation consists of 1 or more columns and 0 or more rows.
- A row is called a tuple.
- Each relation is given a unique name.
- Each column has a name unique within the relation.
- Each row contains an instance of the data associated with the relation.
- A relation with no rows is empty (contains no data), but still exists.
Logical Properties

- Ordering of columns
- Ordering of rows
- Uniqueness
- The sequence of columns (Left to right) is significant
- The sequence of rows (Top to bottom) is significant

Ordering of Columns

- Columns are unordered, left to right.
- This property is designed to preserve the independence of each column.

Ordering of Rows

- Rows are unordered, top to bottom.
- This is designed to preserve the independence of each row.

Uniqueness

- No row may be duplicated in a given relation. Uniqueness in a relation is guaranteed by the designation of a primary key for each relation.
- A candidate key in a relation is an attribute that uniquely identifies a row in that relation.
- A primary key is a candidate key that has been selected to be the unique identifier for each row.
- Primary key values cannot be null, since they would then not identify a row.
The Sequence of Columns (Left to right) is Significant
- The columns of a relation can be interchanged without changing the meaning or use of the relation.
- There is no hidden meaning implied by the ordering.

The Sequence of Rows (Top to bottom) is Significant
- The rows of a relation may be interchanged or stored in any sequences.
- It makes no differences as whether to insert a new row in front or at the end of the table.

Relational vs. Network Models
- In relational model, connections between two relations are represented by including two attributes with the same domain – one in each of relations (Foreign Key).
- In network model, 1:N connections between two record types are explicitly represented by the set type construct.

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Relational vs. Network Models

- In relational model, individual tuples that have the same value for that attributes are logically related, even though they are not physically connected together.
- In network model, the DBMS connects related records together in a set instance by some physical method. Records are physical connected together when they participate in the same set instance.
- A set type physically represents a logical 1:N relationship type.

Hierarchical vs. Network Models

- Both represent relationship explicitly.
- A record type in the network model can be a member in any number of set types.
- In hierarchical, a record type can have one real parent. This creates problems when modeling M:N and n-ary relationship types.
- If many relationship types exists, we will have to duplicate records and pointers to design a hierarchical representation.

Hierarchical vs. Network vs. Relational Models

- The hierarchical model is considered inferior to both the relational and network models as far as modeling capability is concerned.

Strengths of OO Data Model

- A closer representation of real-world problem domains and has a greater productivity in applications productivity.
- It has ability to model complex data types such as images and documents.
Weakness of OO Data Model

- Lack of accepted standards
  - There are no initial standards at the national and international level yet.
- Lack of development tools
  - Tools such as CASE and 4GL are still under development, hence but not widely available.
- Performance
  - The performance of ODBMS technology with large numbers of concurrent users and frequent transactions has yet been tested or demonstrated.

Review Questions

- Compare and contrast the following:
  - Inheritance vs generalization hierarchy
  - Generalization vs specialization
  - Candidate key vs primary key
  - Subtype vs super type
  - Physical database record vs logical database record
  - Encapsulation vs inheritance
  - Relational model vs network model
  - Hierarchical model vs network model
- What are the limitations of ODBMS technology?