COMPUTER SCIENCE 12

(MS Access and C)

CHAPTER 3: DATABASE DESIGN PROCESS

Topics

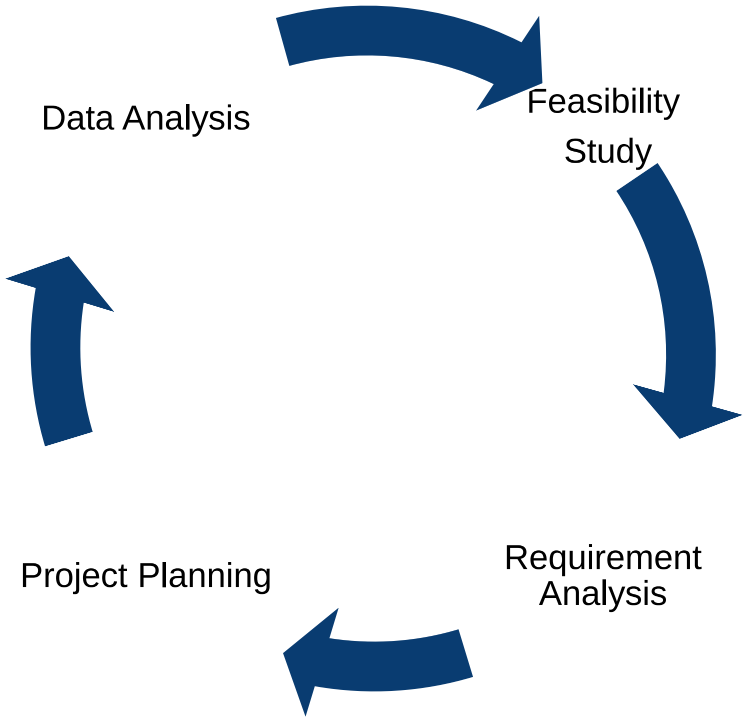
- Analysis and Steps of Analysis Stage
- Data Modeling
- Entity Class & Instance
- Types of Relationships
- Cardinality & Modality
- ER Diagram
- Database Design Process
- Components of Logical Model
- Physical Database Design
- Components of Database Design
- Data Distribution Strategies
- File Organization

Analysis and Steps of Analysis Stage

- Process of Studying the existing system
- Basic purpose is to know which activities are performed in the current system
- Determines what should take place in the new system

Important Steps in Analysis Stage

- Feasibility Study
- Requirement Analysis
- Project Planning
- Data Analysis



Steps of Analysis Stage

Feasibility Study

- Conducted to investigate the required system
- Determines whether the proposed system is affordable, possible and acceptable

Requirement Analysis

- Collect the requirements for the project(proposed system) include:
  - Possible inputs for database
  - Required functionality of project
- The user describe their requirements and expectations from the proposed system

Steps of Analysis Stage

Project Planning

- Comprehensive planning and time schedule must be developed to complete project successfully
- Cost factors (Hardware, Software, Salaries of Team) are taken into consideration

Data Analysis

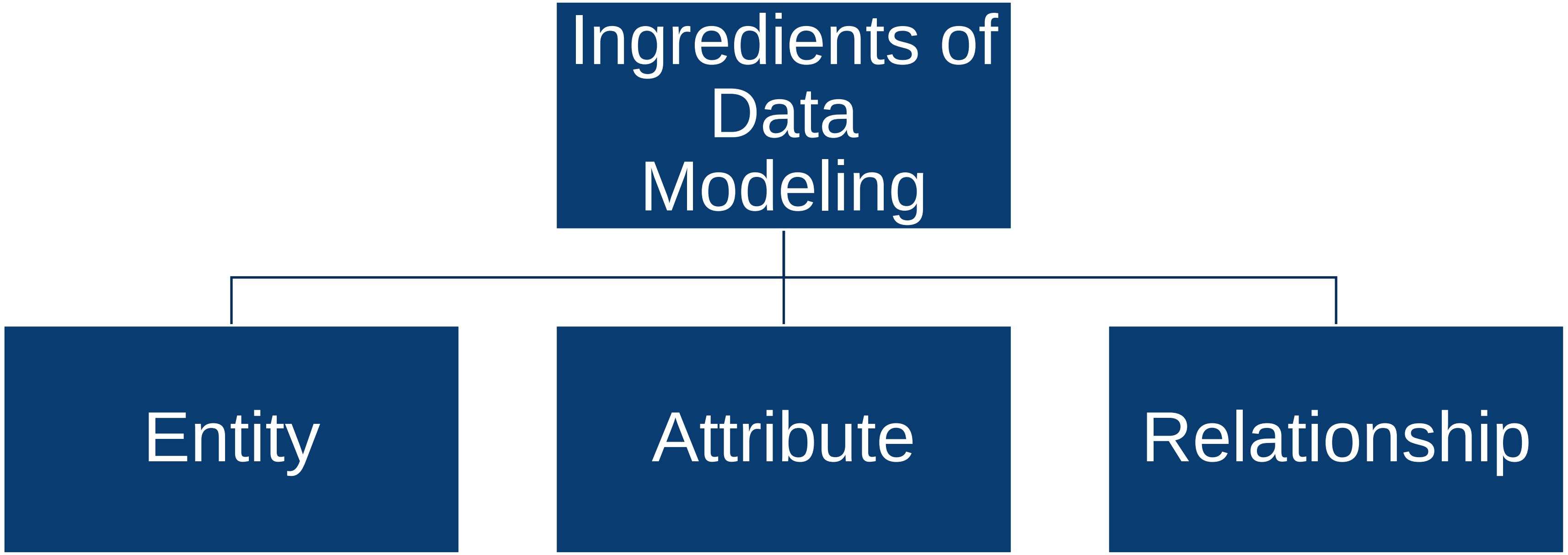
- Activities of data analysis
  - Data Flow Diagrams
  - Decision Tables
  - Decision Trees

Data Modeling and its Ingredients

Model - Representation of real world objects, events and their associations

Data Modeling - Process of identifying data objects and relationship between them

- E-R model is a popular conceptual data model



Ingredients of Data Modeling

Entity

Attribute

Relationship

Ingredients of Data Modeling

Entity

- Anything that is participating in the system is known as entity or object
  - Can be person, place, thing or event

Examples

- **Person:** TEACHER,PLAYER
- **Place:** COUNTRY
- **Object:** VEHICAL
- **Event:** REGISTRAION,SALE, PURCHASE

- Represented by rectangle in data model
- Name of entity is written inside the rectangle

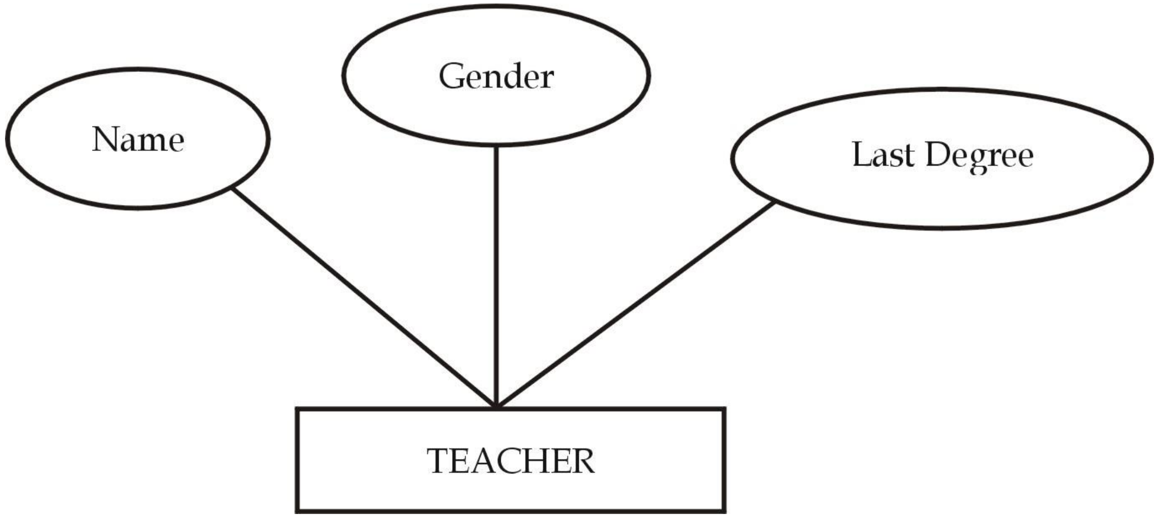
STUDENT

TEACHER

Ingredients of Data Modeling

Attribute

- Characteristics of an entity
- Entity may have many attributes



Example

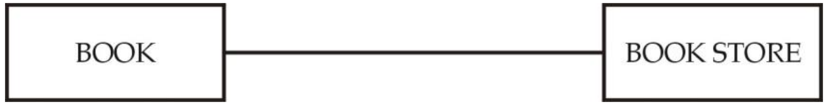
- **Entity -** TEACHER
- **Attributes -** Name, Gender, Last Degree, Appointment Date, Pay Scale , Telephone etc.

- Represented by an oval in the data model
- Name of entity is written inside the oval

Ingredients of Data Modeling

Relationship

- A logical connection between different entities
- Relationship indicates how the entities are related to each other
- **Example**
- Relationship between two entities BOOK and BOOK STORE
- Entities are connected with different ways
  - A BOOK STORE orders BOOK(s)
  - A BOOK STORE displays BOOK(s)
  - A BOOK STORE stocks BOOK(s)
  - A BOOK STORE sells BOOK(s)
  - A BOOK STORE returns BOOK(s)
- All relationships define relevant connections between two entities
- All relationships are bi-directional
- Consider only relevant relationship



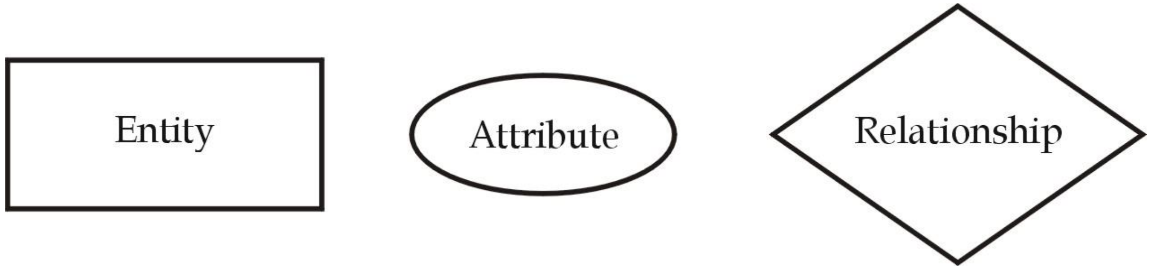
ER Model and ER Diagram

- The Entity Relationship (ER) Model is one of the most widely used method for conceptual design

•The ER Model can be neatly mapped / Convert to a Relational Model

Entity-Relationship model is a logical representation of data in an organization

- ER Model is represented by ER Diagram
  - A visual Representation of ER Model
  - Three types of symbols are used:
    - Rectangle used to represent entities
    - Diamond used to represent relationships
    - Oval is used to represent attributes



Entity Class & Instance

Entity Class

- A group of entities of the same type is called entity class
- It is also known as entity type

Example

- STUDENT entity class is a set of all students

Entity Instance

- A member if an entity class is called entity instance
- It is also known as entity occurrence

Example

- Student Abdullah of STUDENT entity type is an entity instance.

Types of Relationships

- Binary relationships exists between the instance of two entities.

Types of relationships

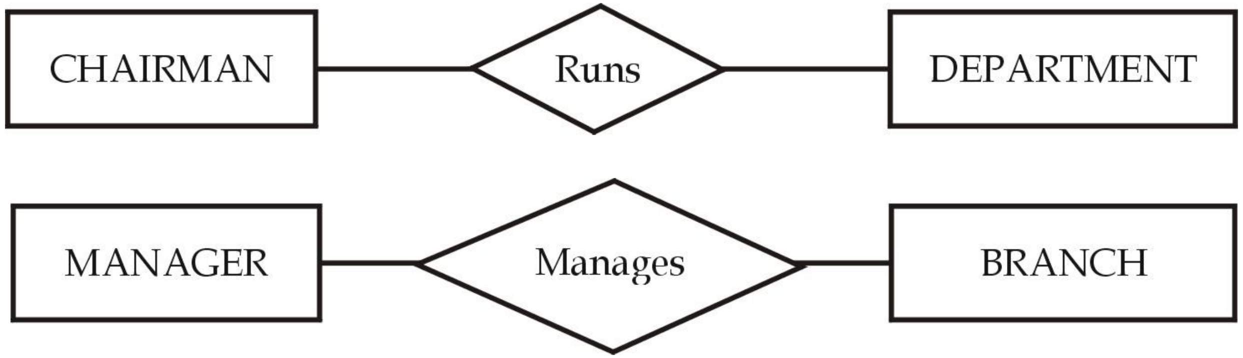
- One-to-One Relationship
- One-to-Many Relationship
- Many-to-Many Relationship

Types of Relationships

One-to-One Relationship

- This type of relationship is used when:
  - For each instance in first entity class, there is only one instance in the second entity class and
  - For each instance in second entity class, there is only one instance in the first entity class

Examples

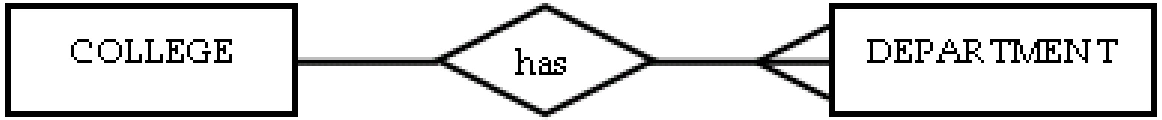


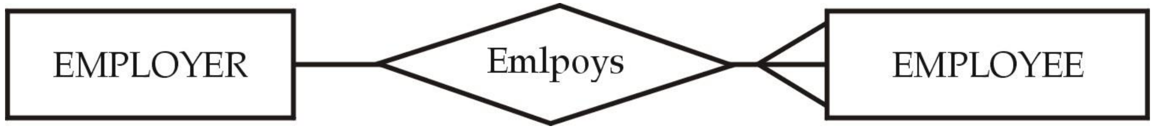
Types of Relationships

One-to-Many Relationship

- This type of relationship is used when:
  - For each instance in first entity class, there can be many instances in the second entity class and
  - For each instance in second entity class, there is only one instance in the first entity class.

Examples





Types of Relationships

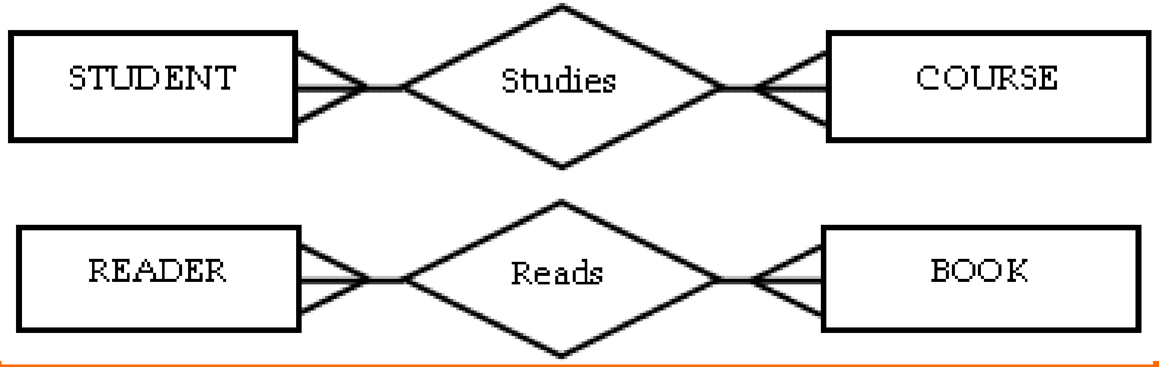
Many-to-Many Relationship

- This type of relationship is used when:
  - For each instance in first entity class, there can be many instances in the second entity class

and

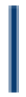
  - For each instance in second entity class, there can be many instances in the first entity class

Examples



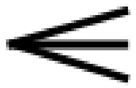
Cardinality

- Maximum number of instances of one entity that can be associated with each instance of another related entity
- The cardinality can be one (1) or many
  - **Cardinality One**
    - Indicates single instance of an entity
    - Denoted by vertical line (|) next to first entity or before second entity



Line Means **One**

  - **Cardinality Many**
    - Indicates multiple instances of an entity
    - Denoted by crow's foot



Crow Foot Means **Many**

Modality

Minimum number of instances of one entity associated with each instance of the related entity

- The modality can be ‘0’ or ‘1’.
  - **Modality ‘0’ (zero) → Optional Relationship** ○ Circle Means **Optional**
    - The relationship is called optional when the minimum number is zero
    - Denoted by small circle O, after cardinality symbol of first entity

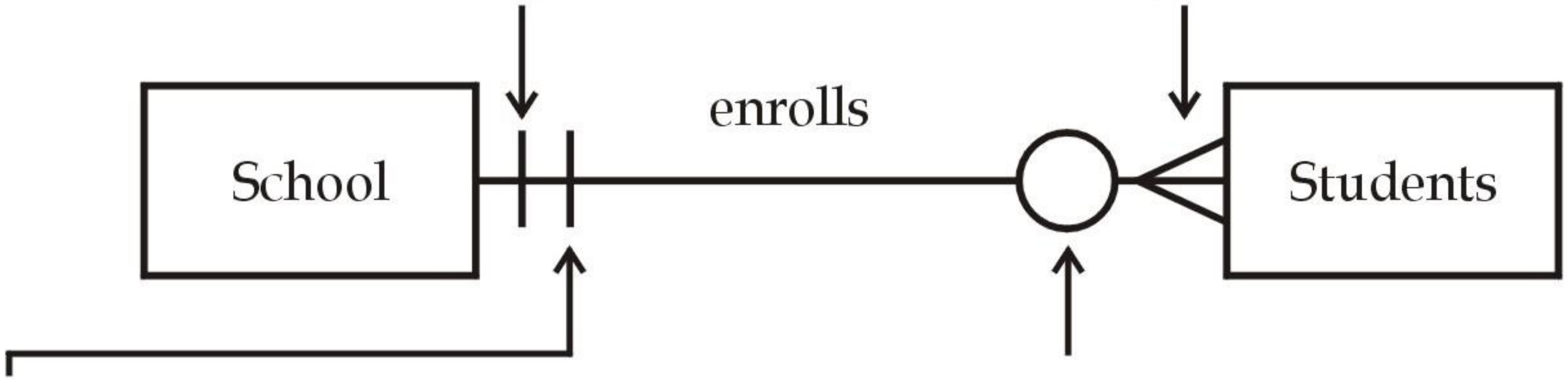
      or before cardinality symbol of second entity
  - **Modality ‘1’ (one) → Mandatory Relationship** | Line Means **Mandatory**
    - The relationship is called mandatory when the minimum number is one
    - Denoted by small vertical line (|), after cardinality symbol of first entity or before cardinality symbol of second entity

Cardinality of Relationship

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

Cardinality:
Indicates that only one school is involved in the relationship

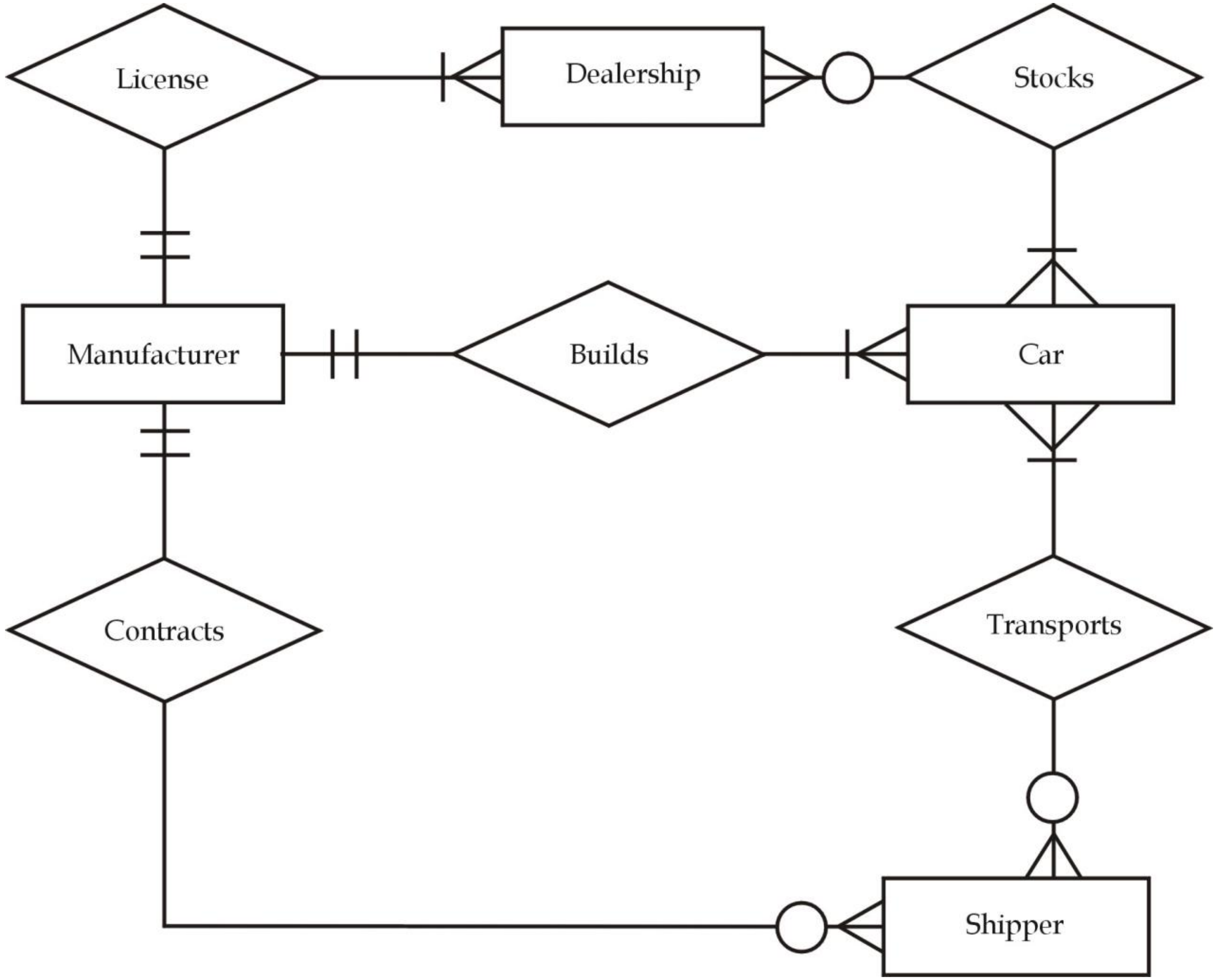
Cardinality:
Indicates that there may be many students in school



Modality: Mandatory
Indicates that there must be one school to have this relationship

Modality: Optional
Indicates that there may be no students in school

ER Diagram - Car Manufacturing

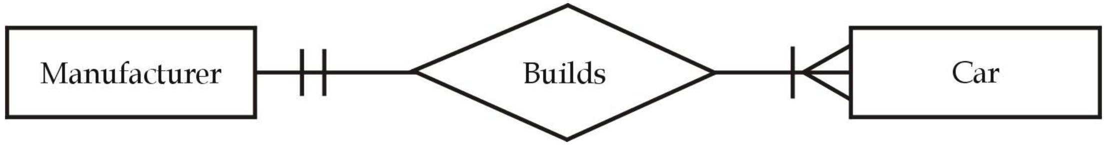


Entities Manufacturer Car

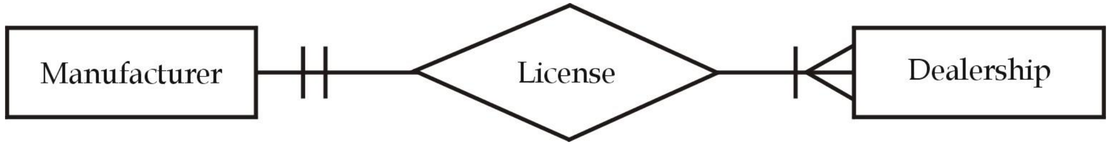
Dealership Shipper

Relationships

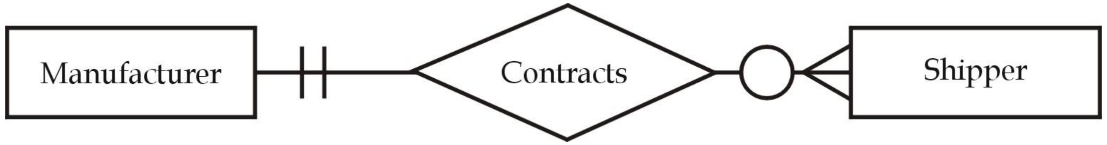
1. MANUFACTURER Builds CAR



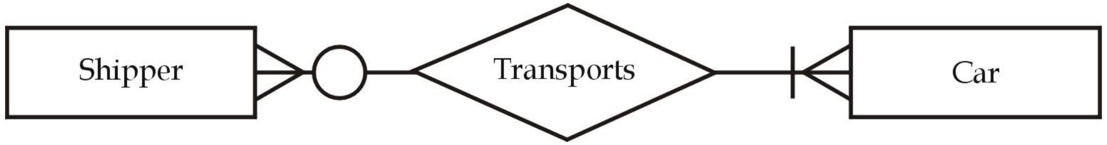
2. MANUFACTURER Lincenses DEALERSHIP



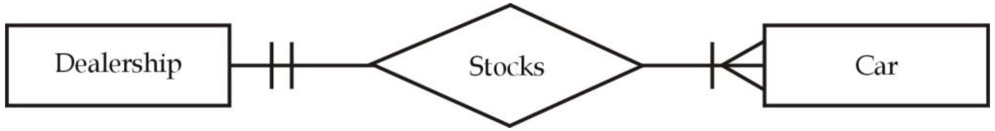
3. MANUFACTURER Contracts SHIPPER



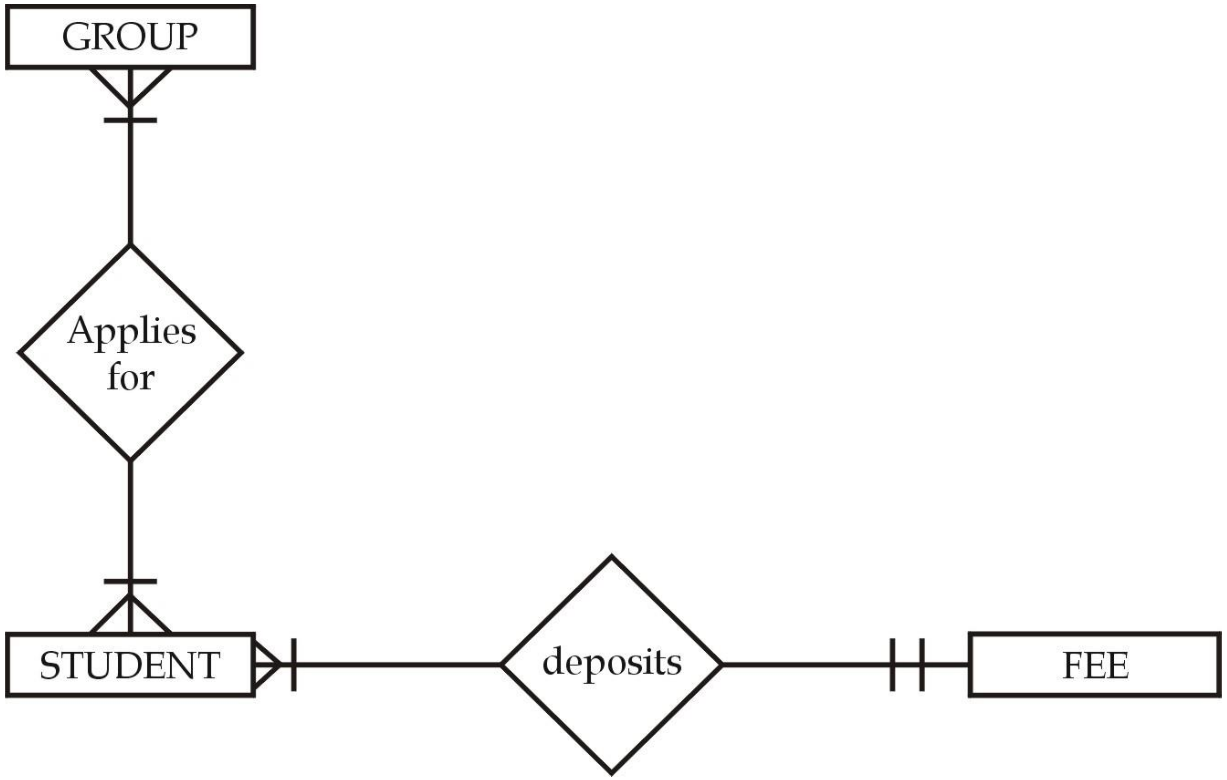
4. SHIPPER Transports CAR



5. DEALERSHIP Stocks CAR



ER Diagram - College Admission System

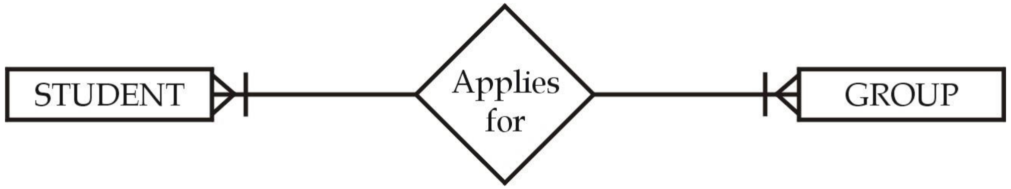


Entities Student Group

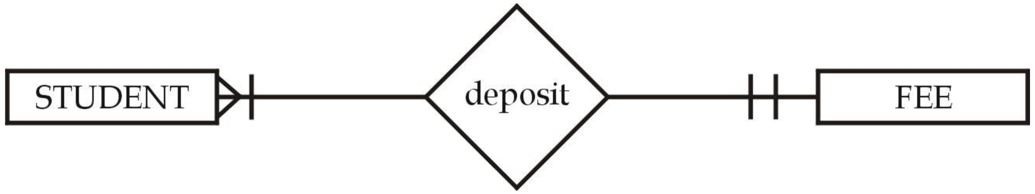
Fee

Relationships

1. STUDENT Applies for GROUP



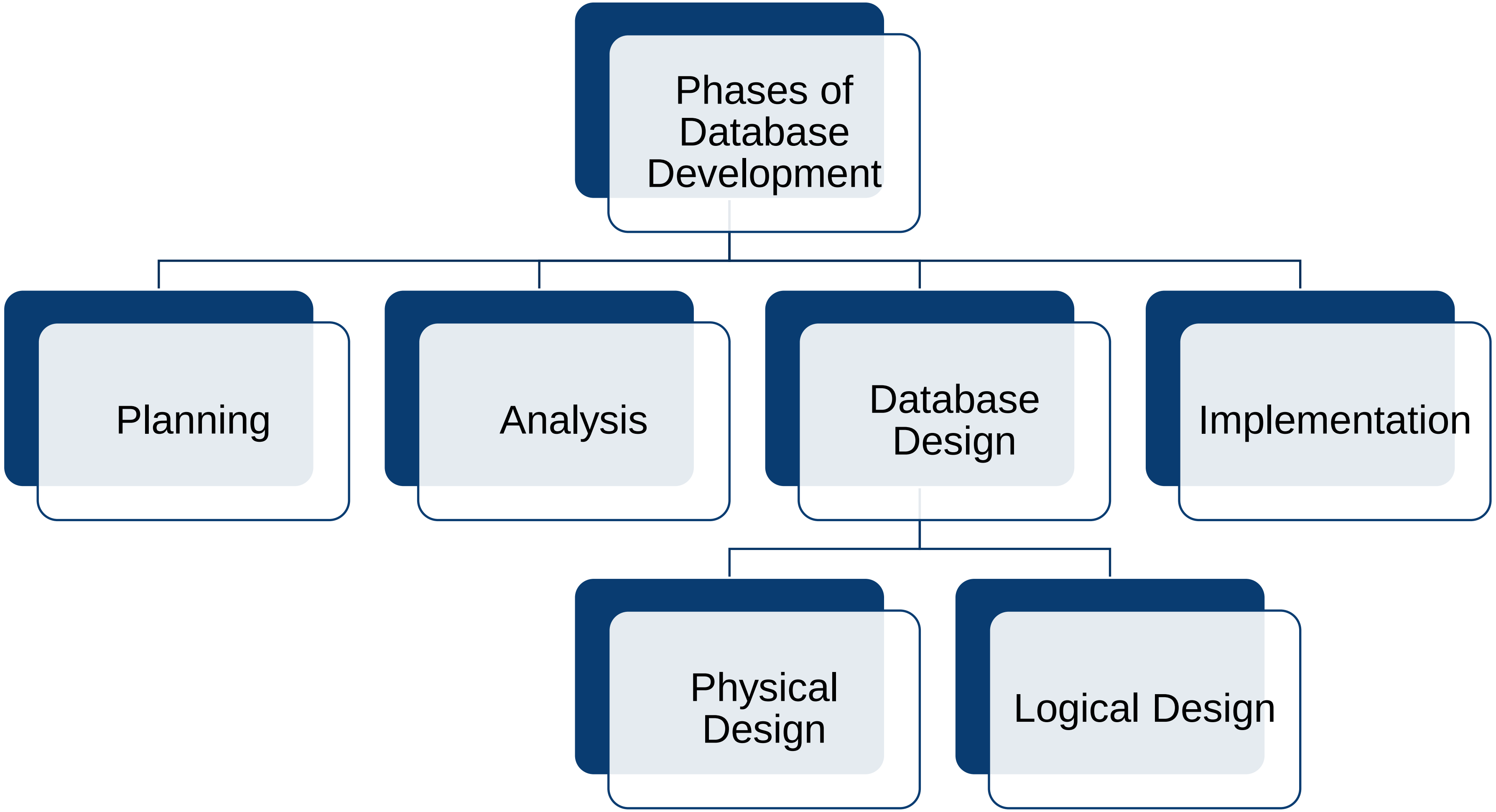
2. STUDENT deposit FEE



Database Design Process

- Map the conceptual data model (ERD) to an implementation model
- A particular DBMS must be able to process this model
- Performance of DBMS must be acceptable to all users throughout the organization
- Users also need to access the information quickly and easily

Phases of Database Development Process



Phases of Database Development Process

1. Planning

- Begins when customer requests to develop a database system
- Consists of various activities
  - Used to identify the resource needed to develop the system
  - Also identifies the time limits for the completion of the system

2. Analysis

- Used to study the current system in detail
- Identifies how the current system works and where the improvements are required
- It includes a detailed study of various operations performed in the system

Phases of Database Development Process

3. Database Design

- Divided into two parts
- **Logical Database Design**
  - Complete description of data to be stored in database
- **Physical Database Design**
  - Translate the logical database design into physical storage structure
    - Implement the database as a set of records, files, indexes etc.

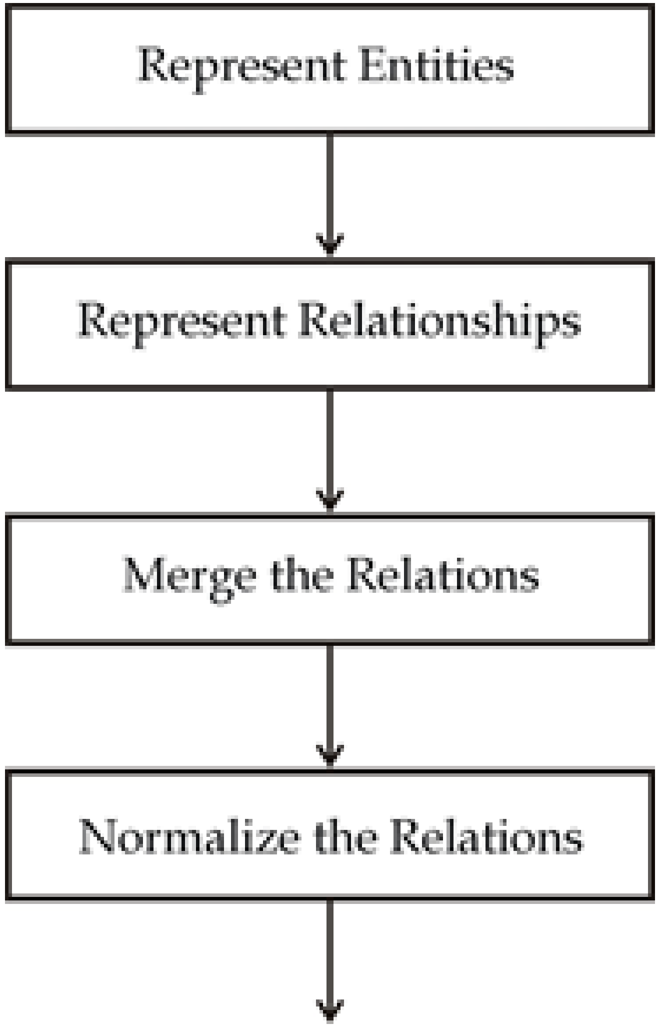
Bad logical database design results in bad physical database design, and generally results in poor database performance

Phases of Database Development Process

4. Implementation

- Database System is implemented after design and developed
- Database system installed and executed for the user
- It may require a particular type of computer like server
- May require network hardware if accessed at multiple locations
- Users are provided authorization by managers
- Example of NADRA & CRICKINFO

Components of Logical Database Design



Components of Logical Database Design

1. Represent Entities

- Each Entity is represented as a relation in relational model
- The identifier of entity type becomes the primary key of relation
- The remaining attributes of the entity type become non-key attributes of the relation
- ER Model is one of the most widely used model for conceptual design
- ER Model is represented by ER Diagram

Example

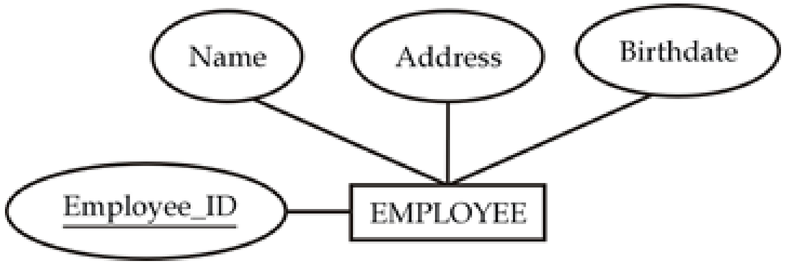


Figure : EMPLOYEE entity

Employee_ID	Name	Address	Birthdate

Figure : EMPLOYEE Relation

- **EMPLOYEE** entity is converted into relation
- **EmployeeID** as an identifier and is underlined
- **EmployeeID** as primary key for the relation

Components of Logical Database Design

2. Represent Relationships

- Each relationship in an ER diagram must be represented in relational model
- Depends upon nature of relationship
  - Represent a relationship by making primary key of one relation a foreign key of another relation
  - Create a separate relation to represent a relationship

Components of Logical Database Design

3. Merge the Relations

- There may be redundant relations
  - Means two or more relations may describe the same entity type
- **View integration** is the process of merging relations to remove the redundancy

Example

- **EMP1** (<u>EmployeeID</u>, Name, Address, Phone)
- **EMP2** (<u>EmployeeID</u>, EmpName, Addr, Designation, DOB)
- The above relations EMP1 and EMP2 describe the same entity EMPLOYEE
- They can be merged into one relation
- **EMP** (EmployeeID, Name, Address, Phone, Designation, DOB)

Components of Logical Database Design

4. Normalize the Relations

- The relations that are created in step (1) and (2) may have:
  - Unnecessary redundancy
  - Anomalies (errors) may arise while updating relations
- Normalize the relations to avoid these problems
- **Normalization** is the process of producing a simpler and more reliable database structure

Physical Database Design

- Last stage of database design process
- A process of mapping logical database structure into actual database structure:
  - Set of records
  - Files
  - Indexes etc.

Major Inputs to Physical Database Design

1. Logical Database Structures

- Developed during logical database design such as normalized relations

2. User Processing Requirements

- Includes size & frequency of use of database, response time, security, backup, recovery etc.

3. Characteristics of the DBMS

- Includes characteristics of DBMS and other components of computer operating environment

Elements or Components of Physical Database Design

1. Data Volume and Usage Analysis

- Estimates of database size are used to select physical storage devices and storage cost estimation

- Estimates of usage paths or patterns are used to select file organization and access methods, plans for the use of indexes and strategy for data distribution

Elements or Components of Physical Database Design

2. Data Distribution Strategy

- For organization which uses distributed computing networks, there is necessity to decide which nodes (or sites) in the network to locate the data physically
- Data allocation or distribution – A process of deciding where to locate the data
- Data Distribution Strategies are:
  - **Centralized** - All data is located at a single site
  - **Partitioned** - Database is divided into partitions (fragments)
  - **Replicated** - Full copy of database is assigned to more than one site on network
  - **Hybrid** - Database is partitioned into critical & non-critical fragments

Elements or Components of Physical Database Design

3. File Organization

- Technique for arranging the records of file on secondary storage devices
- System designer must recognize several constraints for selecting a file organization
  - Physical characteristics of secondary storage devices
  - Available operating systems & file management software
  - User requirements for storing & accessing data

4. Indexes

- A separate table that contains organization of records for quick retrieval
- May be created on primary key, secondary key, foreign key etc.

Elements or Components Physical Database Design

5. Integrity Constraints

- Data integrity means correctness and consistency of data
- Another form of database protection or security
- Integrity is related to the quality of data
  - Maintained with help of integrity constraints
- Integrity constraints are rules designed to keep data consistent and correct
- These rules act like a check on the incoming data
- **Example**
- Fee of the student should not be greater than 10000
- The ID should not be assigned to two or more employees

Data Distribution Strategies

1. Centralized

- All data is located at single site
- **Advantage**
  - Simple and easy to conduct
- **Disadvantages**
  - Data stored at remote sites is not accessible readily
  - Data communication cost is high
  - The database system fails totally when the central system fails

2. Partitioned

- Database is divided into partitions or fragments
- Each partition is assigned to a particular site
- **Advantages**
  - Data is moved closer to local users
  - Data becomes more easily accessible

Data Distribution Strategies

3. Replicated

- Full Copy of database is assigned to more than one site in the network
- This strategy maximizes local access but it creates update problems

4. Hybrid

- Database is divided into critical and non critical fragments
- Critical fragments are stored at multiple sites
- Non Critical fragments are stored at one site only

Thank you!