CS352 – ADVANCED DATABASE SYSTEMS

UNIT 3 – DATABASE MANAGEMENT SYSTEMS

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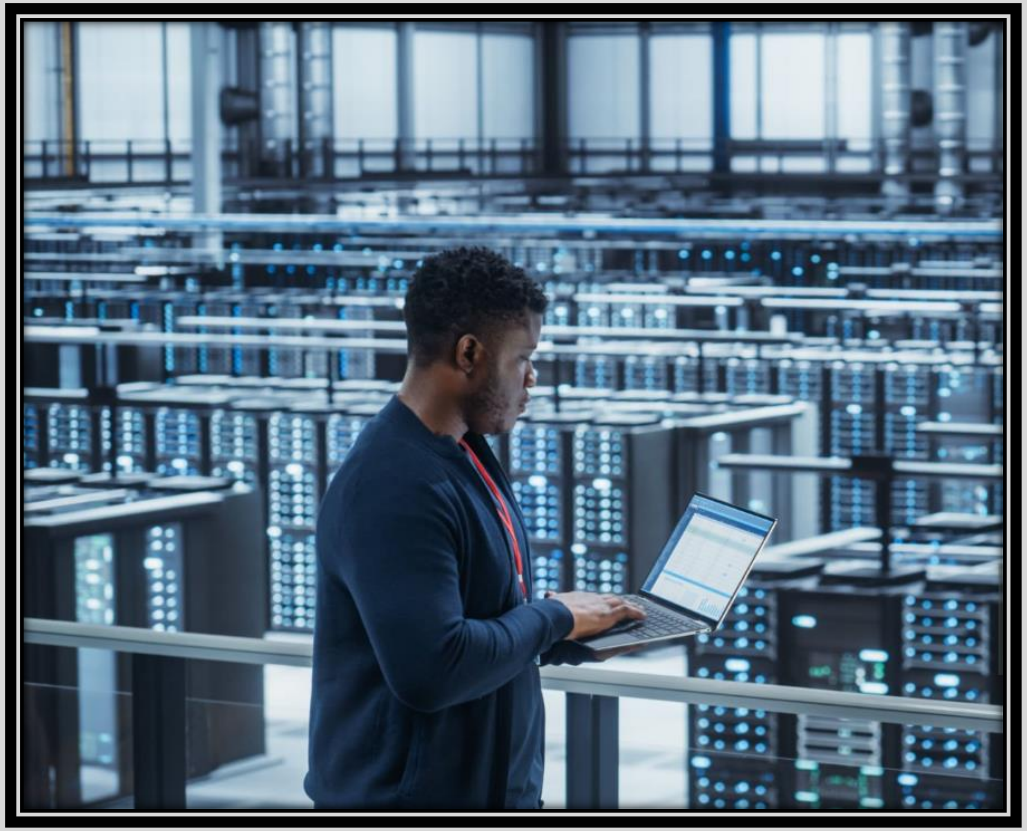
Agenda

- Database Management Systems
- Database Architecture (Components)
- Database Security

DATABASE MANAGEMENT SYSTEMS

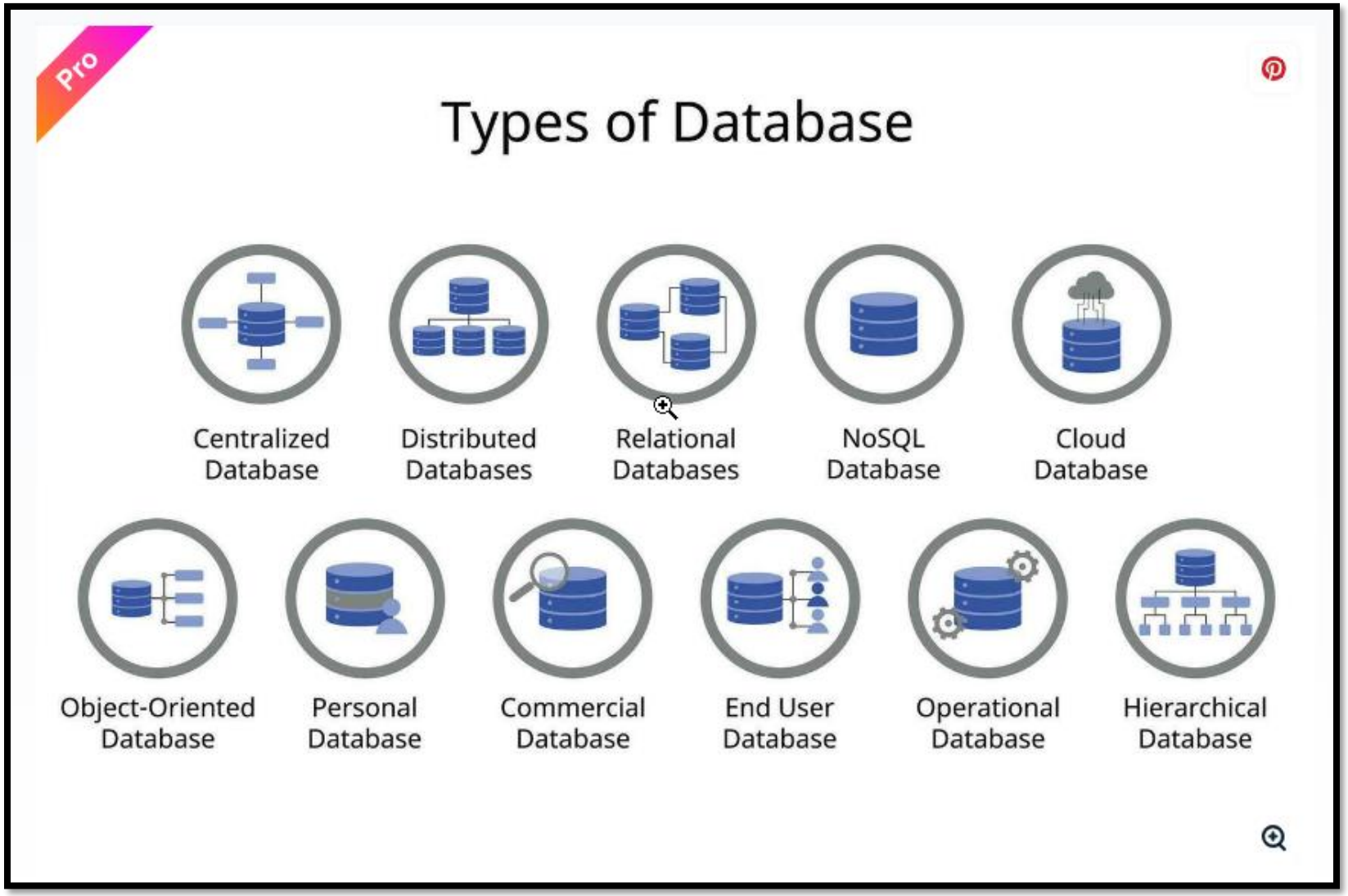
Introduction to Database Management Systems

- **Definition**: A Database Management System (DBMS) is software that uses a standard method of cataloging, retrieving, and running queries on data. It manages and organizes data efficiently and allows multiple users to interact with the data.
- **Importance**: DBMS is crucial for managing large amounts of structured data, ensuring data integrity and security, and supporting data analysis and reporting.



Types of Database Management Systems

- **Relational DBMS (RDBMS)**: Uses tables to store data, with relationships defined between tables (e.g., MySQL, PostgreSQL).
- **NoSQL DBMS**: Designed for unstructured data, providing flexibility in data models (e.g., MongoDB, Cassandra).
- **In-Memory DBMS**: Stores data in the main memory to speed up data retrieval (e.g., SAP HANA).
- **Hierarchical and Network DBMS**: Organizes data in a tree-like or graph structure (e.g., IBM Information Management System).



Icons representing different DBMS types

Key Features of DBMS

- **Data Storage Management**: Efficiently stores and retrieves data.
- **Data Security**: Protects data from unauthorized access and breaches.
- **Data Integrity**: Ensures accuracy and consistency of data.
- **Backup and Recovery**: Provides mechanisms to restore data in case of failures.
- **Multi-User Access Control**: Manages simultaneous data access by multiple users.

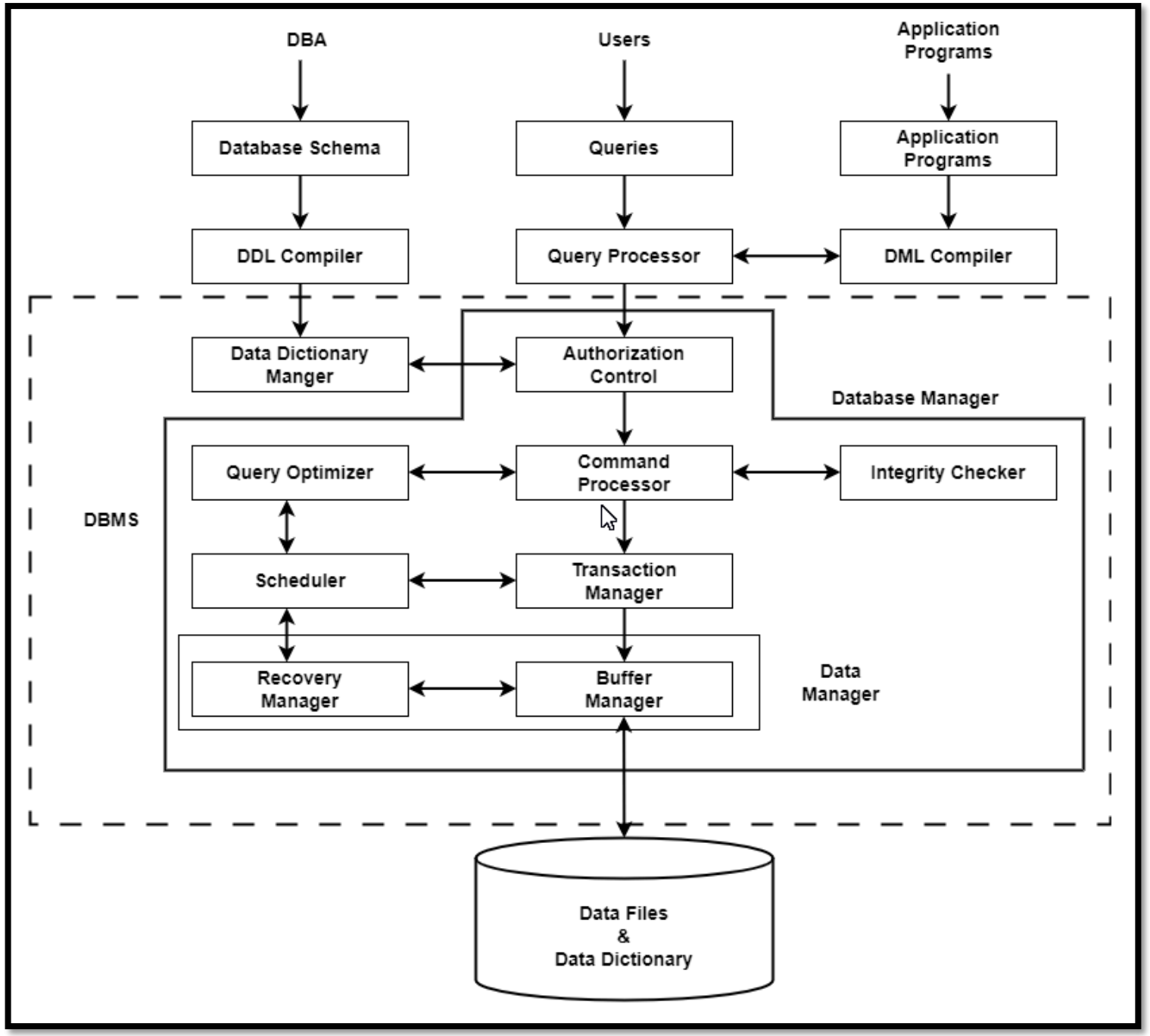
Advantages of Using DBMS

- **Improved Data Sharing**: Facilitates data sharing among multiple users.
- **Better Data Integration**: Centralizes data for better integration and analysis.
- **Enhanced Data Security**: Implements robust security measures to protect data.
- **Reduced Data Redundancy**: Minimizes duplicate data storage.
- **Consistent Data Management**: Ensures consistent and reliable data management practices.

Challenges and Future Trends in DBMS

- **Challenges:**
  - Scalability issues with growing data volumes.
  - Complexity in managing and maintaining large DBMS.
  - Data security and privacy concerns.
- **Future Trends:**
  - Integration with AI and machine learning for predictive analytics.
  - Cloud-based DBMS solutions for enhanced scalability and flexibility.
  - Increased focus on real-time data processing and analytics.

DATABASE ARCHITECTURE



Basic Architecture of a DBMS

Introduction to Database Architecture

- **Definition**: Database architecture refers to the design, development, implementation, and maintenance of a database management system (DBMS). It involves a systematic approach to managing and organizing data.
- **Importance**: Effective database architecture ensures data integrity, security, and efficient data management, enabling seamless data retrieval and manipulation.

Components of Database Architecture

- **Hardware**: The physical devices that store and run the database, such as servers, storage devices, and network infrastructure.
- **Software**: The DBMS software that manages the database, including servers and client applications.
- **Data**: The data stored in the database, organized in tables, indexes, and other structures.
- **Procedures**: The instructions and rules governing database usage, maintenance, and security.

Database Users and Administrators

- **Database Users**: Individuals or applications that interact with the database to perform operations such as querying, updating, and reporting.
- **Database Administrators (DBAs)**: Professionals responsible for managing and maintaining the database, ensuring its performance, security, and availability.

Logical and Physical Database Design

- **Logical Design**: Defines the data model and relationships between data entities without considering physical aspects. It includes schema design and entity-relationship diagrams.
- **Physical Design**: Specifies how data is stored physically in the database, including file structures, indexing, and partitioning strategies.

Data Integrity, Security, and Backup

- **Data Integrity**: Ensures data accuracy and consistency through constraints, normalization, and validation rules.
- **Data Security**: Protects data from unauthorized access and breaches using encryption, authentication, and access control mechanisms.
- **Backup and Recovery**: Provides data backup and restoration strategies to prevent data loss and ensure data availability in case of failures.

DATABASE SECURITY

Introduction to Database Security

- **Definition**: Database security involves measures and controls to protect the confidentiality, integrity, and availability of data stored in databases.
- **Importance**: Ensuring database security is crucial to protect sensitive information, prevent data breaches, and comply with regulatory requirements.

Common Threats to Database Security

- **SQL Injection**: Malicious SQL code is inserted into queries to manipulate database operations.
- **Malware and Viruses**: Malicious software that can corrupt or steal data.
- **Unauthorized Access**: Gaining access to the database without permission.
- **Insider Threats**: Employees or contractors with legitimate access who misuse their privileges.

Database Security Measures

- **Authentication**: Verifying the identity of users before granting access (e.g., passwords, biometrics).
- **Access Control**: Defining and enforcing who can access what data (e.g., role-based access control).
- **Encryption**: Protecting data by converting it into an unreadable format at rest and in transit.
- **Auditing and Monitoring**: Tracking database activities to detect and respond to suspicious actions.

Best Practices for Database Security

- **Regular Updates and Patch Management**: Keeping database software updated to fix vulnerabilities.
- **Strong Password Policies**: Enforcing the use of strong, unique passwords.
- **Least Privilege Principle**: Granting users the minimum level of access necessary for their roles.
- **Data Backup and Recovery**: Regularly back up data and have a recovery plan.

Database Security Tools and Technologies

- **Database Firewalls**: Filtering and monitoring database traffic to block harmful requests.
- **Data Masking**: Hiding sensitive data by replacing it with fictional data for non-production environments.
- **Intrusion Detection Systems (IDS)**: Identifying and responding to potential security breaches.
- **Security Information and Event Management (SIEM)**: Collecting and analyzing database security data for comprehensive monitoring.

INDIVIDUAL PROJECT

Individual Project

- **Description:** Phase 3 IP has 2 parts:
- **Part 1:** Analyze the following table (see the Word document called *CS352 - IP3*), and reorganize the table into Boyce-Codd Normal Form, at each step describing what is needed to move to the next Normal Form and why each step meets the Normal Form requirements.
- Show un-normalized table given and progression through the normal forms up to Boyce Codd in logical data models.
- Include explanation of how each normal form is met as you progress through the process of breaking down this un-normalized table to tables meeting Boyce Codd normal form.
- **Part 2:** In addition, transform your data model (your EERD created in phase 2 IP) into a logical model, to third normal form. Describe why each table is in third Normal Form. In your logical data model identify the primary keys in each table as **bolded and underlined** and each foreign key as *italicized and underlined*.

Individual Project

Submission for phase 3 IP includes:

1. Logical Data Model for the supplied table (**Part 1**) with a description of how it moved through UNF to 1NF to 2NF to 3NF and Boyce Codd.
2. Logical Data Model for **Part 2** with a description of how each table is in third normal form.

Add both parts described to the project template section titled "Database Management Systems."

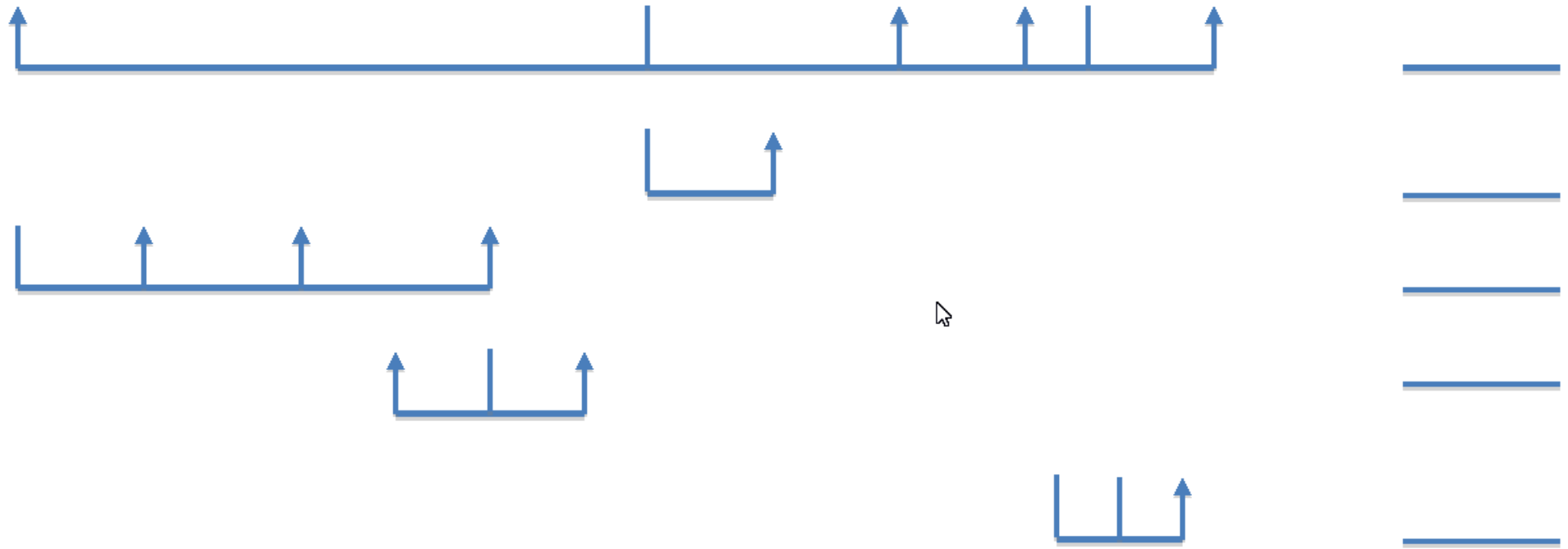
Name the document CS352_<First and Last Name>_IP2.doc, and submit the document for grading.

Please submit your assignment.

For assistance with your assignment, please use your textbook and all course resources.

IP3 Table

Charity ID	Charity Name	Charity Location	POC Name	POC ID	Tel Extn.	Customer ID	Customer Name	Date Contribution Started	No of Month	Date Places	Expected Contribution End



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