Exercise 1: Inventory Management System

Scenario:

You are developing an inventory management system for a warehouse. Efficient data storage and retrieval are crucial.

Steps:

1. **Understand the Problem:**
    - Explain why data structures and algorithms are essential in handling large inventories.
    - Discuss the types of data structures suitable for this problem.

    Data Structure used- hashmap

2. **Setup:**
    - Create a new project for the inventory management system.

3. **Implementation:**

    Product.java

```
package module2.Algorithms_Data_Structures.InventoryManagementSystem;


public class Product {
            private int productId;
              private String productName;
              private int quantity;
              private double price;


              // Constructor
              public Product(int productId, String productName, int quantity, double price) {
                  this.productId = productId;
                  this.productName = productName;
                  this.quantity = quantity;
                  this.price = price;
              }
              // Getters and Setters
```

```
        public int getProductId() {
                return productId;
        }

        public void setProductId(int productId) {
                this.productId = productId;
        }

        public String getProductName() {
                return productName;
        }

        public void setProductName(String productName) {
                this.productName = productName;
        }

        public int getQuantity() {
                return quantity;
        }
        public void setQuantity(int quantity) {
                this.quantity = quantity;
        }
        public double getPrice() {
                return price;
        }
        public void setPrice(double price) {
                this.price = price;
        }
// toString() for display
        @Override
```

```
        public String toString() {
            return "Product [productId=" + productId + ", productName=" +
productName + ", quantity=" + quantity
                    + ", price=" + price + "]";
        }

}
```

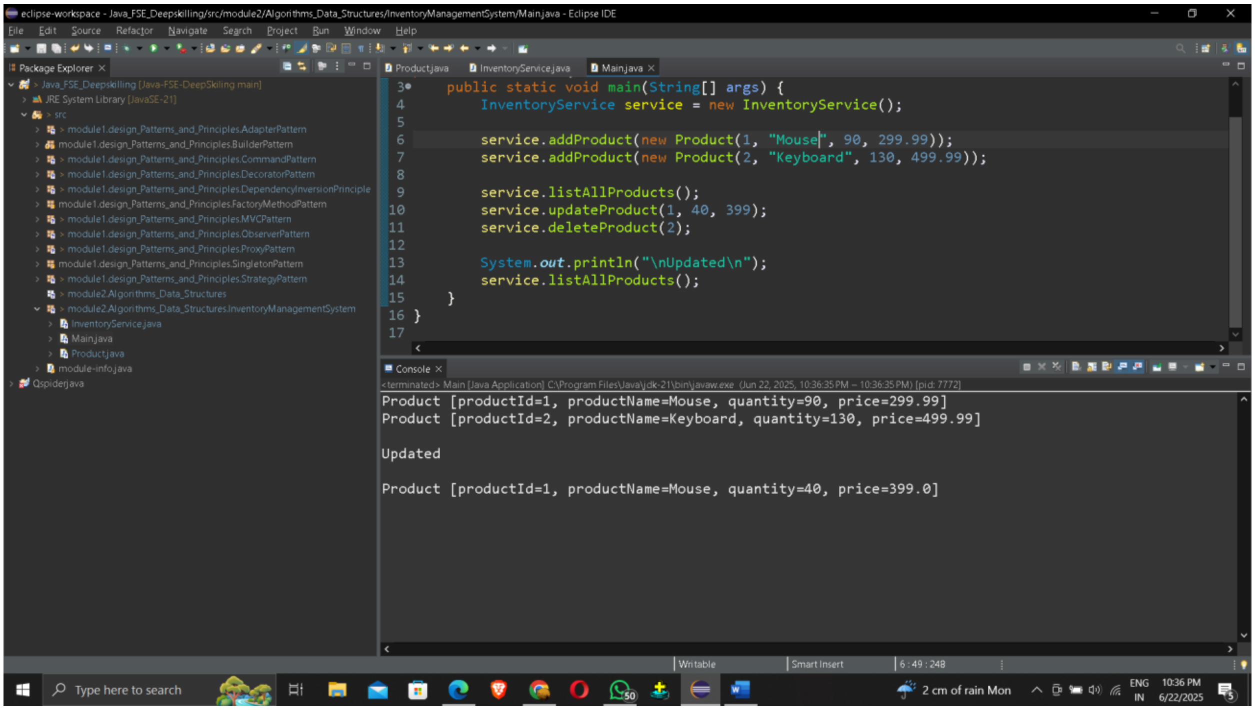
InventoryService.java

```
package module2.Algorithms_Data_Structures.InventoryManagementSystem;
import java.util.HashMap;
public class InventoryService {
    private HashMap<Integer, Product> inventory;
    public InventoryService() {
        inventory = new HashMap<>();
    }
    public void addProduct(Product product) {
        inventory.put(product.getProductId(), product);
    }
    public void updateProduct(int productId, int newQty, double newPrice) {
        Product p = inventory.get(productId);
        if (p != null) {
            p.setQuantity(newQty);
            p.setPrice(newPrice);
        }
    }

    public void deleteProduct(int productId) {
        inventory.remove(productId);
    }
```

```java
    public Product getProduct(int productId) {
        return inventory.get(productId);
    }

    public void listAllProducts() {
        for (Product p : inventory.values()) {
            System.out.println(p);
        }
    }
}
```

Main.java

```java
package module2.Algorithms_Data_Structures.InventoryManagementSystem;
public class Main {
    public static void main(String[] args) {
        InventoryService service = new InventoryService();

        service.addProduct(new Product(1, "Mouse", 90, 299.99));
        service.addProduct(new Product(2, "Keyboard", 130, 499.99));

        service.listAllProducts();
        service.updateProduct(1, 40, 399);
        service.deleteProduct(2);

        System.out.println("\nUpdated\n");
        service.listAllProducts();
    }
}
```



Exercise 2: E-commerce Platform Search Function

Scenario:

You are working on the search functionality of an e-commerce platform. The search needs to be optimized for fast performance.

Steps:

1. **Understand Asymptotic Notation:**
   - Explain Big O notation and how it helps in analyzing algorithms.
   - Describe the best, average, and worst-case scenarios for search operations.
2. **Setup:**
   - Create a class **Product** with attributes for searching, such as **productId, productName**, and **category**.
3. **Implementation:**

   Product.java

```
package module2.Algorithms_Data_Structures.Ecommerce_Search;


public class Product {

    private int productId;
```

```
    private String productName;
    private String category;

    public Product(int productId, String productName, String category) {
        this.productId = productId;
        this.productName = productName;
        this.category = category;
    }

    public int getProductId() { return productId; }
    public String getProductName() { return productName; }
    public String getCategory() { return category; }

    @Override
    public String toString() {
        return productId + " - " + productName + " [" + category + "]";
    }
}
```

SearchOperation.java

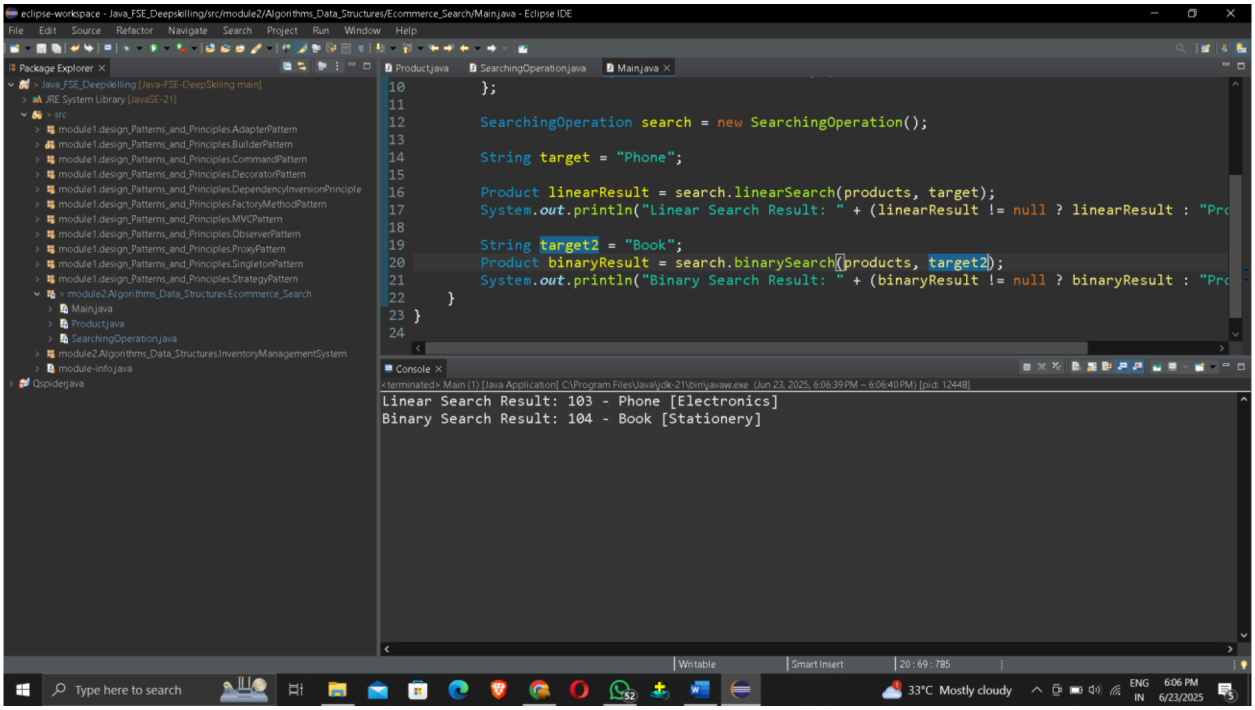
```
package module2.Algorithms_Data_Structures.Ecommerce_Search;

import java.util.Arrays;
import java.util.Comparator;

public class SearchingOperation {

    // Linear Search
    public Product linearSearch(Product[] products, String targetName) {
        for (Product p : products) {
```

```
            if (p.getProductName().equalsIgnoreCase(targetName)) {
                return p;
            }
        }
        return null;
    }

    // Binary Search (requires sorted array)
    public Product binarySearch(Product[] products, String targetName) {
        Arrays.sort(products, Comparator.comparing(Product::getProductName));

        int left = 0, right = products.length - 1;
        while (left <= right) {
            int mid = (left + right) / 2;
            int cmp = products[mid].getProductName().compareToIgnoreCase(targetName);

            if (cmp == 0) return products[mid];
            else if (cmp < 0) left = mid + 1;
            else right = mid - 1;
        }
        return null;
    }
}
```

Main.java

```
package module2.Algorithms_Data_Structures.Ecommerce_Search;

public class Main {
    public static void main(String[] args) {
        Product[] products = {
```

```java
            new Product(101, "Laptop", "Electronics"),
            new Product(102, "Shoes", "Footwear"),
            new Product(103, "Phone", "Electronics"),
            new Product(104, "Book", "Stationery")
        };

        SearchingOperation search = new SearchingOperation();

        String target = "Phone";

        Product linearResult = search.linearSearch(products, target);
        System.out.println("Linear Search Result: " + (linearResult != null ? linearResult : "Product Not Found"));

        String target2 = "Book";
        Product binaryResult = search.binarySearch(products, target2);
        System.out.println("Binary Search Result: " + (binaryResult != null ? binaryResult : "Product Not Found"));
    }
}
```



Exercise 3: Sorting Customer Orders

Scenario:

You are tasked with sorting customer orders by their total price on an e-commerce platform. This helps in prioritizing high-value orders.

Steps:

1. **Understand Sorting Algorithms:**
   - Explain different sorting algorithms (Bubble Sort, Insertion Sort, Quick Sort, Merge Sort).
2. **Setup:**
   - Create a class **Order** with attributes like **orderId**, **customerName**, and **totalPrice**.
3. **Implementation:**

   Order.java

```
package module2.Algorithms_Data_Structures.Sorting_Order;


public class Order {
    private int orderId;
    private String customerName;
```

```java
    private double totalPrice;

    public Order(int orderId, String customerName, double totalPrice) {
        this.orderId = orderId;
        this.customerName = customerName;
        this.totalPrice = totalPrice;
    }

    public int getOrderId() { return orderId; }
    public String getCustomerName() { return customerName; }
    public double getTotalPrice() { return totalPrice; }

    @Override
    public String toString() {
        return orderId + " - " + customerName + " : ₹" + totalPrice;
    }
}
```

SortOrder.java

```java
package module2.Algorithms_Data_Structures.Sorting_Order;

public class SortOrder {

    // Bubble Sort
    public void bubbleSort(Order[] orders) {
        int n = orders.length;
        for (int i = 0; i < n - 1; i++) {
            for (int j = 0; j < n - i - 1; j++) {
                if (orders[j].getTotalPrice() > orders[j + 1].getTotalPrice()) {
                    Order temp = orders[j];
                    orders[j] = orders[j + 1];
```

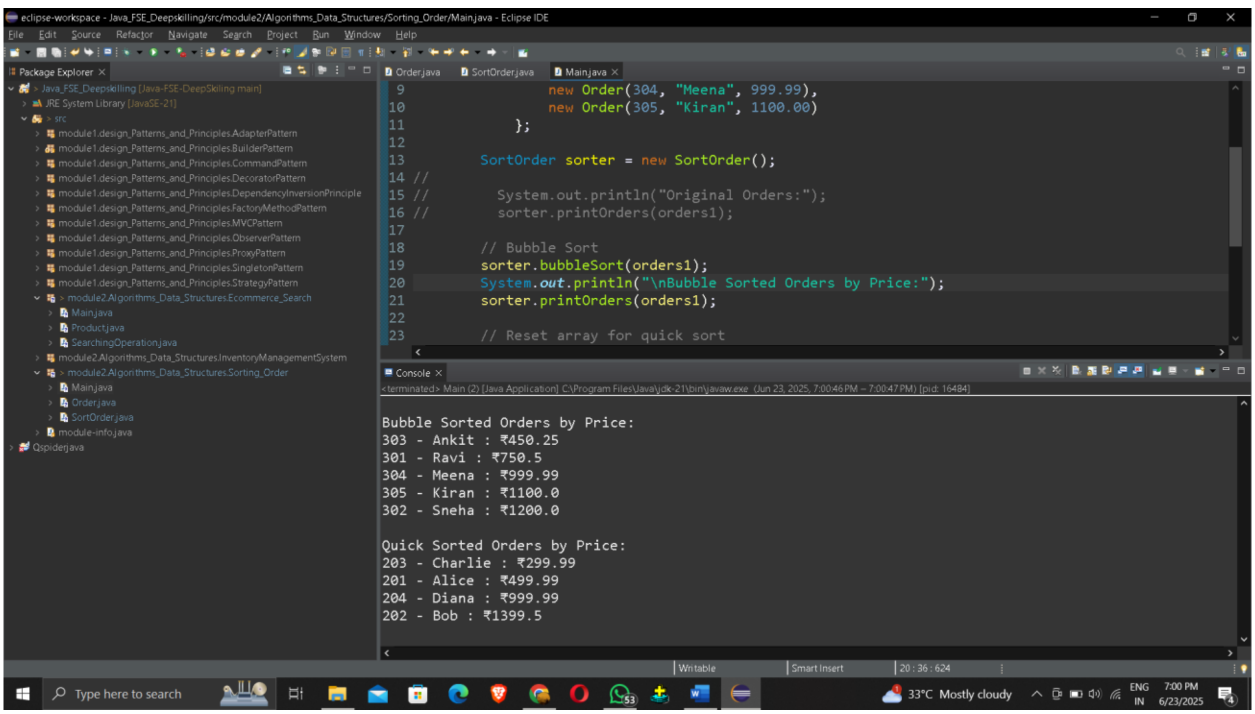
```
                orders[j + 1] = temp;
            }
        }
    }
}
// Quick Sort
public void quickSort(Order[] orders, int low, int high) {
    if (low < high) {
        int pi = partition(orders, low, high);
        quickSort(orders, low, pi - 1);
        quickSort(orders, pi + 1, high);
    }
}
private int partition(Order[] orders, int low, int high) {
    double pivot = orders[high].getTotalPrice();
    int i = low - 1;
    for (int j = low; j < high; j++) {
        if (orders[j].getTotalPrice() < pivot) {
            i++;
            Order temp = orders[i];
            orders[i] = orders[j];
            orders[j] = temp;
        }
    }
    Order temp = orders[i + 1];
    orders[i + 1] = orders[high];
    orders[high] = temp;
    return i + 1;
}
```

```
    // Utility to print array
    public void printOrders(Order[] orders) {
        for (Order o : orders) {
            System.out.println(o);
        }
    }
}
```

Main.java

```
package module2.Algorithms_Data_Structures.Sorting_Order;
public class Main {
    public static void main(String[] args) {
        Order[] orders1 = {
                new Order(301, "Ravi", 750.50),
                new Order(302, "Sneha", 1200.00),
                new Order(303, "Ankit", 450.25),
                new Order(304, "Meena", 999.99),
                new Order(305, "Kiran", 1100.00)
            };

        SortOrder sorter = new SortOrder();
//
//        System.out.println("Original Orders:");
//        sorter.printOrders(orders1);

        // Bubble Sort
        sorter.bubbleSort(orders1);
        System.out.println("\nBubble Sorted Orders by Price:");
        sorter.printOrders(orders1);

        // Reset array for quick sort
```

```
        Order []orders2 = new Order[] {
            new Order(201, "Alice", 499.99),
            new Order(202, "Bob", 1399.50),
            new Order(203, "Charlie", 299.99),
            new Order(204, "Diana", 999.99)
        };

        sorter.quickSort(orders2, 0, orders2.length - 1);
        System.out.println("\nQuick Sorted Orders by Price:");
        sorter.printOrders(orders2);
    }
}
```



Exercise 4: Employee Management System

Scenario:

You are developing an employee management system for a company. Efficiently managing employee records is crucial.

Steps:

1. **Understand Array Representation:**
    - Explain how arrays are represented in memory and their advantages.
2. **Setup:**
    - Create a class Employee with attributes like **employeeId**, **name**, **position**, and **salary**.
3. **Implementation:**
    - Use an array to store employee records.
    - Implement methods to **add**, **search**, **traverse**, and **delete** employees in the array.

Employee.java

```
package module2.Algorithms_Data_Structures.EmployeeManagement;

public class Employee {
    private int employeeId;
    private String name;
    private String position;
    private double salary;

    public Employee(int employeeId, String name, String position, double salary) {
        this.employeeId = employeeId;
        this.name = name;
        this.position = position;
        this.salary = salary;
    }

    public int getEmployeeId() { return employeeId; }
    public String getName() { return name; }
    public String getPosition() { return position; }
    public double getSalary() { return salary; }

    @Override
    public String toString() {
        return employeeId + " - " + name + " [" + position + "] ₹" + salary;
    }
}
```

EmployeeService.java

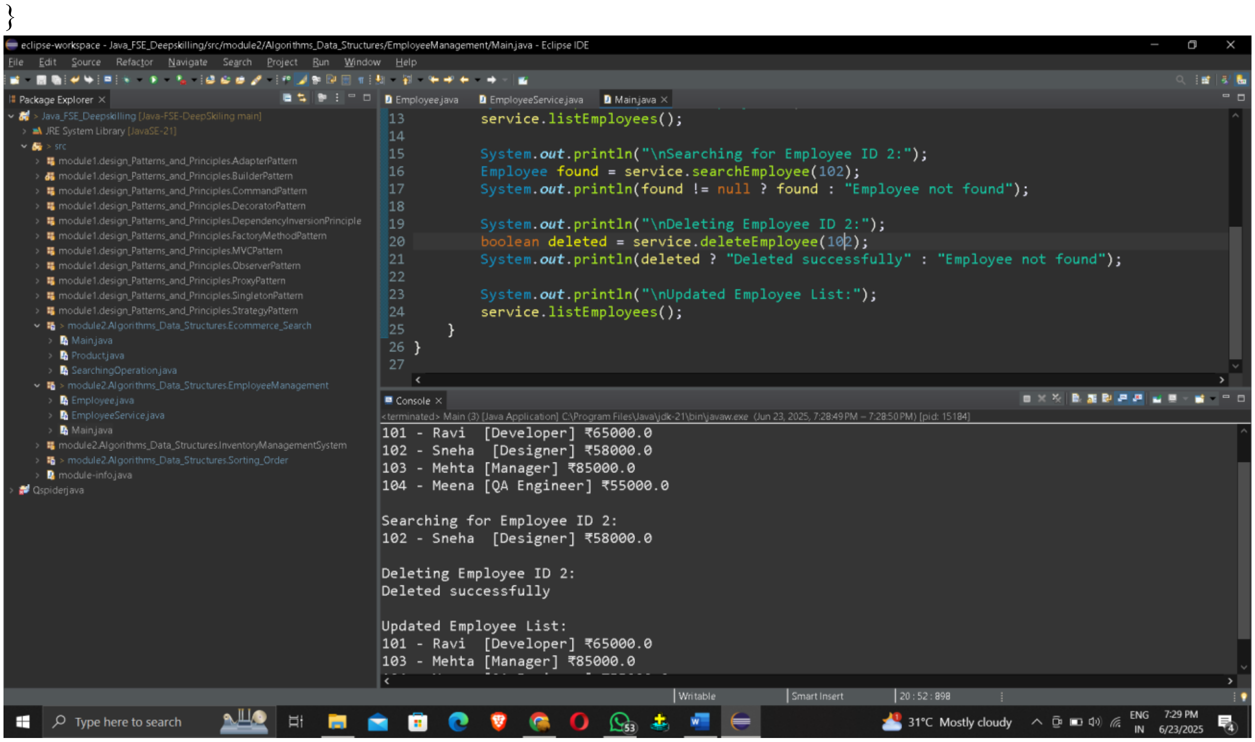
```
package module2.Algorithms_Data_Structures.EmployeeManagement;

public class EmployeeService {
    private Employee[] employees;
    private int size;
```

```java
    public EmployeeService(int capacity) {
        employees = new Employee[capacity];
        size = 0;
    }

    // Add Employee
    public void addEmployee(Employee emp) {
        if (size < employees.length) {
            employees[size++] = emp;
        } else {
            System.out.println("Employee array is full!");
        }
    }
    // Search Employee by ID
    public Employee searchEmployee(int empId) {
        for (int i = 0; i < size; i++) {
            if (employees[i].getEmployeeId() == empId) {
                return employees[i];
            }
        }
        return null;
    }
    // Traverse All Employees
    public void listEmployees() {
        for (int i = 0; i < size; i++) {
            System.out.println(employees[i]);
        }
    }
    // Delete Employee by ID
    public boolean deleteEmployee(int empId) {
        for (int i = 0; i < size; i++) {
            if (employees[i].getEmployeeId() == empId) {
                for (int j = i; j < size - 1; j++) {
                    employees[j] = employees[j + 1];
                }
                employees[--size] = null;
                return true;
            }
        }
        return false;
    }
}
```

Main.java

```java
package module2.Algorithms_Data_Structures.EmployeeManagement;
```

```
public class Main {
    public static void main(String[] args) {
        EmployeeService service = new EmployeeService(10);

        service.addEmployee(new Employee(101, "Ravi ", "Developer", 65000));
        service.addEmployee(new Employee(102, "Sneha ", "Designer", 58000));
        service.addEmployee(new Employee(103, "Mehta", "Manager", 85000));
        service.addEmployee(new Employee(104, "Meena", "QA Engineer", 55000));

        System.out.println("\nAll Employees:");
        service.listEmployees();

        System.out.println("\nSearching for Employee ID 2:");
        Employee found = service.searchEmployee(102);
        System.out.println(found != null ? found : "Employee not found");

        System.out.println("\nDeleting Employee ID 2:");
        boolean deleted = service.deleteEmployee(102);
        System.out.println(deleted ? "Deleted successfully" : "Employee not found");

        System.out.println("\nUpdated Employee List:");
        service.listEmployees();
    }
}
```



Exercise 5: Task Management System

Scenario:

You are developing a task management system where tasks need to be added, deleted, and traversed efficiently.

Steps:

1. **Understand Linked Lists:**
    - Explain the different types of linked lists (Singly Linked List, Doubly Linked List).
2. **Setup:**
    - Create a class **Task** with attributes like **taskId**, **taskName**, and **status**.
3. **Implementation:**
    - Implement a singly linked list to manage tasks.
    - Implement methods to **add**, **search**, **traverse**, and **delete** tasks in the linked list.

Task.java

```
package module2.Algorithms_Data_Structures.TaskManagement;

public class Task {
    private int taskId;
    private String taskName;
    private String status;

    public Task(int taskId, String taskName, String status) {
        this.taskId = taskId;
        this.taskName = taskName;
        this.status = status;
    }

    public int getTaskId() { return taskId; }
    public String getTaskName() { return taskName; }
    public String getStatus() { return status; }

    @Override
    public String toString() {
        return taskId + " - " + taskName + " [" + status + "]";
    }
}
```

TaskLL.java

```
package module2.Algorithms_Data_Structures.TaskManagement;
```

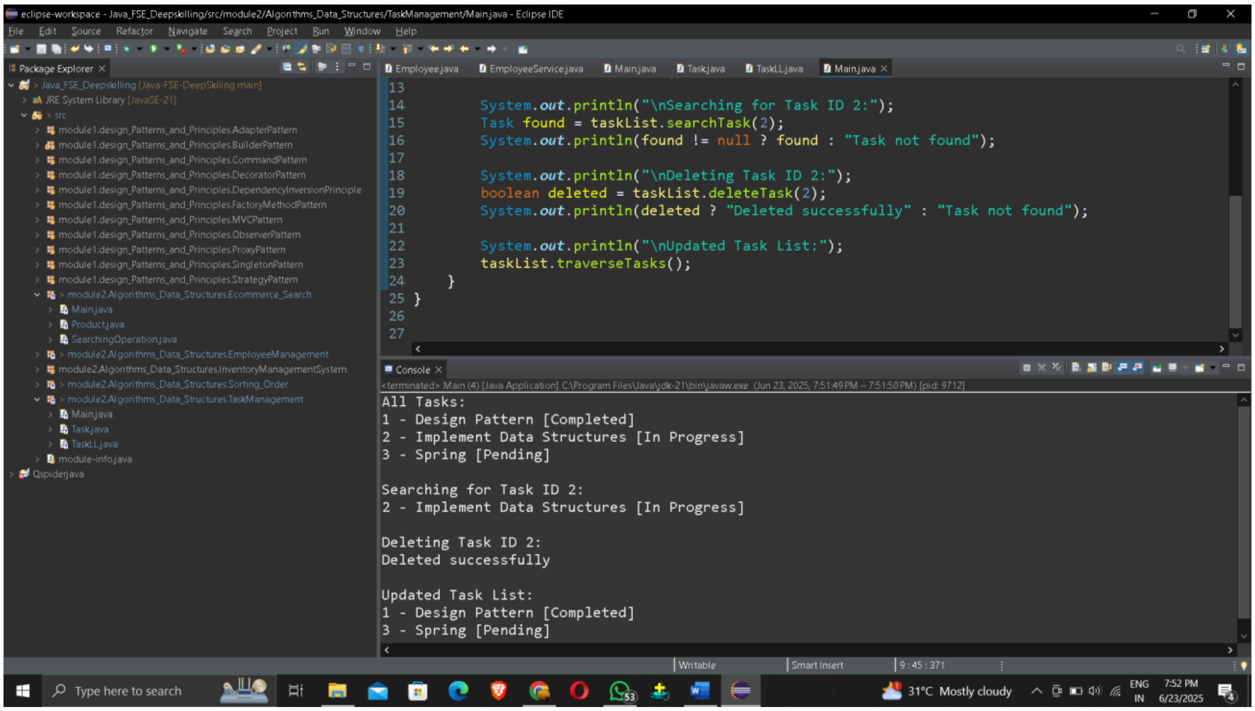
```java
public class TaskLL {
    class Node {
        Task task;
        Node next;

        Node(Task task) {
            this.task = task;
            this.next = null;
        }
    }

    private Node head;

    // Add task at end
    public void addTask(Task task) {
        Node newNode = new Node(task);
        if (head == null) {
            head = newNode;
        } else {
            Node temp = head;
            while (temp.next != null)
                temp = temp.next;
            temp.next = newNode;
        }
    }
    // Traverse and display tasks
    public void traverseTasks() {
        Node temp = head;
        if (temp == null) {
            System.out.println("Task list is empty.");
            return;
        }
        while (temp != null) {
            System.out.println(temp.task);
            temp = temp.next;
        }
    }
    // Search by taskId
    public Task searchTask(int id) {
        Node temp = head;
        while (temp != null) {
            if (temp.task.getTaskId() == id)
                return temp.task;
            temp = temp.next;
```

```java
        }
        return null;
    }
    // Delete by taskId
    public boolean deleteTask(int id) {
        if (head == null) return false;

        if (head.task.getTaskId() == id) {
            head = head.next;
            return true;
        }
        Node prev = head;
        Node curr = head.next;

        while (curr != null) {
            if (curr.task.getTaskId() == id) {
                prev.next = curr.next;
                return true;
            }
            prev = curr;
            curr = curr.next;
        }

        return false;
    }
}
```

Main.java

```java
package module2.Algorithms_Data_Structures.TaskManagement;

public class Main {
    public static void main(String[] args) {
        TaskLL taskList = new TaskLL();

        taskList.addTask(new Task(1, "Design Pattern", "Completed"));
        taskList.addTask(new Task(2, "Implement Data Structures", "In Progress"));
        taskList.addTask(new Task(3, "Spring", "Pending"));

        System.out.println("All Tasks:");
        taskList.traverseTasks();

        System.out.println("\nSearching for Task ID 2:");
        Task found = taskList.searchTask(2);
        System.out.println(found != null ? found : "Task not found");
```

```
        System.out.println("\nDeleting Task ID 2:");
        boolean deleted = taskList.deleteTask(2);
        System.out.println(deleted ? "Deleted successfully" : "Task not found");

        System.out.println("\nUpdated Task List:");
        taskList.traverseTasks();
    }
}
```



Exercise 6: Library Management System

Scenario:

You are developing a library management system where users can search for books by title or author.

Steps:

1. **Understand Search Algorithms:**
    - Explain linear search and binary search algorithms.
2. **Setup:**
    - Create a class **Book** with attributes like **bookId**, **title**, and **author**.
3. **Implementation:**

- Implement linear search to find books by title.
- Implement binary search to find books by title (assuming the list is sorted).

Book.java

```java
package module2.Algorithms_Data_Structures.LibraryManagement;

public class Book {
    private int bookId;
    private String title;
    private String author;

    public Book(int bookId, String title, String author) {
        this.bookId = bookId;
        this.title = title;
        this.author = author;
    }

    public int getBookId() { return bookId; }
    public String getTitle() { return title; }
    public String getAuthor() { return author; }

    @Override
    public String toString() {
        return bookId + " - " + title + " by " + author;
    }
}
```

Library.java

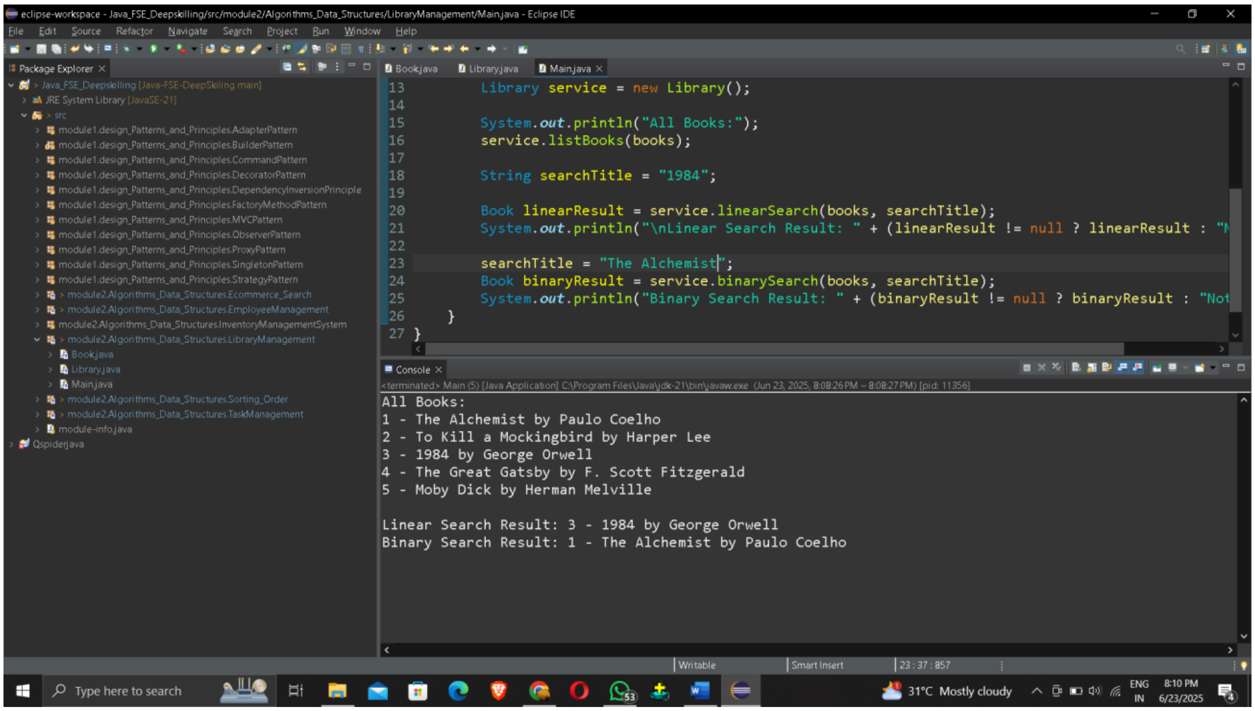
```java
package module2.Algorithms_Data_Structures.LibraryManagement;

import java.util.Arrays;
import java.util.Comparator;

public class Library {

    // Linear Search by Title
    public Book linearSearch(Book[] books, String targetTitle) {
        for (Book b : books) {
            if (b.getTitle().equalsIgnoreCase(targetTitle)) {
                return b;
            }
        }
        return null;
    }
```

```java
    // Binary Search by Title (Assumes sorted list)
    public Book binarySearch(Book[] books, String targetTitle) {
        Arrays.sort(books, Comparator.comparing(Book::getTitle)); // Ensure sorted

        int left = 0, right = books.length - 1;
        while (left <= right) {
            int mid = (left + right) / 2;
            int cmp = books[mid].getTitle().compareToIgnoreCase(targetTitle);
            if (cmp == 0) return books[mid];
            else if (cmp < 0) left = mid + 1;
            else right = mid - 1;
        }
        return null;
    }

    //Print all books
    public void listBooks(Book[] books) {
        for (Book b : books) {
            System.out.println(b);
        }
    }
}
```

Main.java

```java
package module2.Algorithms_Data_Structures.LibraryManagement;

public class Main {
    public static void main(String[] args) {
        Book[] books = {
            new Book(1, "The Alchemist", "Paulo Coelho"),
            new Book(2, "To Kill a Mockingbird", "Harper Lee"),
            new Book(3, "1984", "George Orwell"),
            new Book(4, "The Great Gatsby", "F. Scott Fitzgerald"),
            new Book(5, "Moby Dick", "Herman Melville")
        };

        Library service = new Library();

        System.out.println("All Books:");
        service.listBooks(books);

        String searchTitle = "1984";
```

```
        Book linearResult = service.linearSearch(books, searchTitle);
        System.out.println("\nLinear Search Result: " + (linearResult != null ? linearResult : "Not Found"));

        searchTitle = "The Alchemist";
        Book binaryResult = service.binarySearch(books, searchTitle);
        System.out.println("Binary Search Result: " + (binaryResult != null ? binaryResult : "Not Found"));
    }
}
```



Exercise 7: Financial Forecasting

Scenario:

You are developing a financial forecasting tool that predicts future values based on past data.

Steps:

1. **Understand Recursive Algorithms:**
    - Explain the concept of recursion and how it can simplify certain problems.
2. **Setup:**
    - Create a method to calculate the future value using a recursive approach.

3. **Implementation:**
    - Implement a recursive algorithm to predict future values based on past growth rates.

Forecast.java

```
package module2.Algorithms_Data_Structures.FinancialForecast;

public class Forecast {

    // Recursive function to calculate future value
    public double forecastValue(double initialValue, double growthRate, int n) {
        if (n == 0) return initialValue;
        return forecastValue(initialValue, growthRate, n - 1) * (1 + growthRate);
    }

    // Optimized: Tail recursion using helper (optional)
    public double forecastValueTail(double initialValue, double growthRate, int n) {
        return forecastHelper(initialValue, growthRate, n);
    }
    private double forecastHelper(double value, double rate, int n) {
        if (n == 0) return value;
        return forecastHelper(value * (1 + rate), rate, n - 1);
    }
}
```

Main.java

```
package module2.Algorithms_Data_Structures.FinancialForecast;

public class Main {
    public static void main(String[] args) {
        Forecast service = new Forecast();

        double initial = 10000.0;
```

```
        double growthRate = 0.10; // 10% annual growth
        int years = 5;

        double result = service.forecastValue(initial, growthRate, years);
        System.out.printf("Recursive Forecast (%.0f%% for %d years): ₹%.2f\n", growthRate * 100, years, result);

        double tailResult = service.forecastValueTail(initial, growthRate, years);
        System.out.printf("Tail Recursion Forecast: ₹%.2f\n", tailResult);
    }
}
```