DATA STRUCTURE AND ALGORITHM

MACHINE PROBLEM 3: CONTACT FINDER

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Main menu

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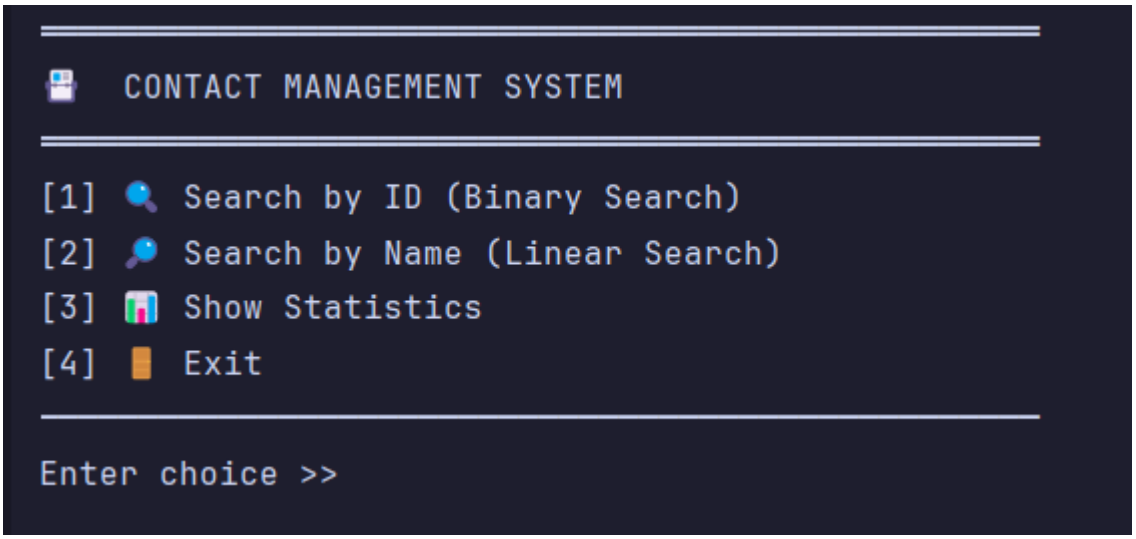
CONTACT MANAGEMENT SYSTEM
[1] Search by ID (Binary Search)
[2] Search by Name (Linear Search)
[3] Show Statistics
[4] Exit
Enter choice >>

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Search by ID (Binary Search)

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The binary search algorithm is a good choice along with the insertion sort *(sorting algorithm)* when searching for an identification especially *unique* identifiers (UIDs). Binary search strength relies on a sorting algorithm, especially at a large dataset such as these **2 000** IDs. Because of its efficiency, the binary search algorithm can search in a large dataset in only less than 20 comparisons.

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Search by Name (Linear Search)

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The linear search algorithm is mostly used in a small dataset. However, the linear search algorithm does not require sorting, unlike the binary search. The linear search algorithm is used for searching names, as the names are not sorted out, whereas if the binary search algorithm is used here, it is most likely that it will take longer to determine the key than the linear search algorithm. Although this algorithm is slower, it is reliable when it comes to unsorted datasets.

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Show Statistics

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Unique Names and Frequency (Under statistics menu)

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📊 CONTACT RECORDS STATISTICS

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Total Contacts       : 2000
Sorted by ID         : false
Minimum ID           : 1003
Maximum ID           : 9995
Linear Searches Done : 1
Binary Searches Done : 0
Last Search Result   : true (John)
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[0] 🔙 Go Back
[1] 📄 Unique Names & Frequency
Enter choice >> 1

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📄 UNIQUE NAMES & FREQUENCY

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1   Alex            (64x)
2   Ava             (63x)
3   Ben             (87x)
4   Chris           (68x)
5   Chloe           (66x)
6   Diana           (75x)
7   Eli             (68x)
8   Ella            (75x)
9   Ethan           (72x)
10  Finn            (44x)
11  Grace           (75x)
12  Hannah          (63x)
13  Ian             (70x)
14  Jake            (76x)
15  James           (61x)
16  John            (1x)
17  Kate            (73x)
18  Lucas           (66x)
19  Liam            (74x)
```

```
7   Eli             (68x)
8   Ella            (75x)
9   Ethan           (72x)
10  Finn            (44x)
11  Grace           (75x)
12  Hannah          (63x)
13  Ian             (70x)
14  Jake            (76x)
15  James           (61x)
16  John            (1x)
17  Kate            (73x)
18  Lucas           (66x)
19  Liam            (74x)
20  Leo             (65x)
21  Mia             (56x)
22  Mason           (81x)
23  Nora            (66x)
24  Noah            (62x)
25  Olivia          (68x)
26  Paul            (59x)
27  Quinn           (65x)
28  Ryan            (65x)
29  Sophia          (57x)
30  Tyler           (53x)
31  Zoe             (62x)
─────────────────────────────────────────

[0] 🔙 Go Back
[1] 📄 Unique Names & Frequency
Enter choice >>
```

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Exit

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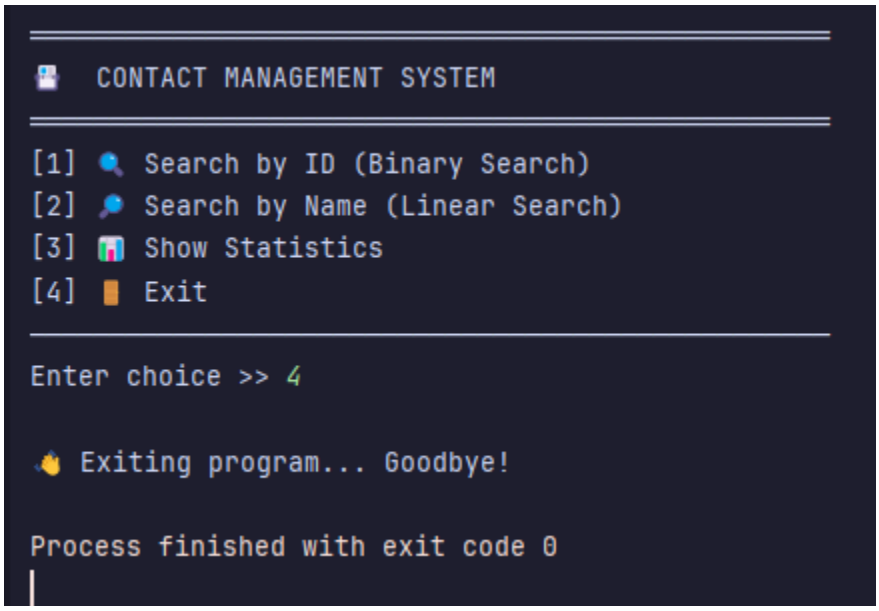
CONTACT MANAGEMENT SYSTEM
[1] Search by ID (Binary Search)
[2] Search by Name (Linear Search)
[3] Show Statistics
[4] Exit
Enter choice >> 4
Exiting program... Goodbye!
Process finished with exit code 0

Main.java

```java
import java.io.BufferedReader;
import java.io.FileNotFoundException;
import java.io.FileReader;
import java.util.ArrayList;
import java.util.Scanner;

public class Main {
    public static int binaryComparisonCount = 0;
    public static int linearComparisonCount = 0;
    public static long binarySearchTime = 0;
    public static long linearSearchTime = 0;
    public static int lastFoundIndex = -1;
    public static String lastFoundValue = "";
    private BufferedReader br;
    private Scanner in = new Scanner(System.in);
    private ArrayList<ArrayList<String>> contactRecords = new ArrayList<>();
    private int binarySearchCount = 0;
    private int linearSearchCount = 0;
    private String recentKeyValue;
    private boolean recentKeyResult = false;
    private boolean isBinarySearchLastUsed = true;

    public Main() {
        try {
            br = new BufferedReader(new FileReader("Contact Records.csv"));
            addToArray();
        } catch (FileNotFoundException ae) {
            System.out.println("File not found");
            throw new RuntimeException();
        }
    }

    public static void main(String[] args) {
        new Main().menu();
    }

    private void menu() {
        while (true) {
            System.out.println();
            System.out.println("=".repeat(50));
            System.out.println("📇  CONTACT MANAGEMENT SYSTEM");
            System.out.println("=".repeat(50));
            System.out.println("[1] 🔍 Search by ID (Binary Search)");
            System.out.println("[2] 🔎 Search by Name (Linear Search)");
            System.out.println("[3] 📊 Show Statistics");
            System.out.println("[4] 🚪 Exit");
            System.out.println("-".repeat(50));
```

```
            System.out.print("Enter choice >> ");
            int userChoice = Integer.parseInt(in.nextLine());

            switch (userChoice) {
                case 1 -> searchByID();
                case 2 -> searchByName();
                case 3 -> {
                    Statistics stats = new Statistics(contactRecords,
linearSearchCount, binarySearchCount,
                            recentKeyValue, recentKeyResult,
isBinarySearchLastUsed);
                    stats.summarizeStats();
                    stats.menu();
                }
                case 4 -> {
                    System.out.println("\n👋 Exiting program... Goodbye!");
                    return;
                }
                default -> System.out.println("⚠️ Invalid option. Try
again.");
            }
        }
    }

    private void searchByID() {
        insertionSort();
        System.out.println("\n= SEARCH BY ID =");
        System.out.print("Enter ID to find >> ");
        int key = Integer.parseInt(in.nextLine());

        long start = System.nanoTime();
        ArrayList<ArrayList<String>> findId = binarySearch(key);
        long end = System.nanoTime();
        binarySearchTime = end - start;

        recentKeyValue = key + "";
        binarySearchCount++;
        System.out.println("-".repeat(50));
        if (findId == null) {
            System.out.println("❌ ID " + key + " not found.");
            recentKeyResult = false;
            return;
        }
        System.out.printf("%-10s | %-30s%n", "ID", "Name");
        System.out.println("-".repeat(50));
        System.out.printf("%-10s | %-30s%n", findId.getFirst().getFirst(),
findId.getFirst().get(1));
        Statistics stats = new Statistics(contactRecords, linearSearchCount,
binarySearchCount,
```

```
                recentKeyValue, recentKeyResult, isBinarySearchLastUsed);
        stats.trackMetrics();
        recentKeyResult = true;
    }

    private void searchByName() {

        System.out.println("\n= SEARCH BY NAME =");
        System.out.print("Enter name to find >> ");
        String name = in.nextLine();

        long start = System.nanoTime();
        ArrayList<ArrayList<String>> findName = linearSearch(name);
        long end = System.nanoTime();
        linearSearchTime = end - start;

        recentKeyValue = name;
        linearSearchCount++;

        System.out.println("\n" + "-".repeat(50));
        System.out.println("🔎 Found " + findName.size() + " record(s) for
name: " + name);
        System.out.println("-".repeat(50));

        if (findName.isEmpty()) {
            System.out.println("❌ No matching name found.");
        } else {
            System.out.printf("%-5s %-10s | %-30s%n", "#", "ID", "Name");
            System.out.println("-".repeat(50));
            for (int i = 0; i < findName.size(); i++) {
                System.out.printf("%-5s %-10s | %-30s%n", (i + 1) + ".",
findName.get(i).get(0), findName.get(i).get(1));
            }
        }
        Statistics stats = new Statistics(contactRecords, linearSearchCount,
binarySearchCount,
                recentKeyValue, recentKeyResult, isBinarySearchLastUsed);
        stats.trackMetrics();
        recentKeyResult = !findName.isEmpty();
    }

    private ArrayList<ArrayList<String>> binarySearch(int key) {
        isBinarySearchLastUsed = true;
        int left = 0;
        int right = contactRecords.size() - 1;
        ArrayList<ArrayList<String>> result = new ArrayList<>();
        binaryComparisonCount = 0;
        lastFoundIndex = -1;
        lastFoundValue = "";
```

```
        while (left <= right) {
            int middle = left + (right - left) / 2;
            binaryComparisonCount++;
            int middleId =
Integer.parseInt(contactRecords.get(middle).getFirst());

            if (middleId == key) {
                lastFoundIndex = middle;
                lastFoundValue = contactRecords.get(middle).get(1);
                result.add(contactRecords.get(middle));
                return result;
            }

            if (middleId < key) {
                left = middle + 1;
            } else {
                right = middle - 1;
            }
        }
        return null;
    }

    private ArrayList<ArrayList<String>> linearSearch(String key) {
        isBinarySearchLastUsed = false;
        ArrayList<ArrayList<String>> names = new ArrayList<>();
        linearComparisonCount = 0;
        lastFoundIndex = -1;
        lastFoundValue = "";

        for (int i = 0; i < contactRecords.size(); i++) {
            linearComparisonCount++;
            String fullName = contactRecords.get(i).get(1);
            String firstName = fullName.substring(0, fullName.indexOf(' '));

            if (firstName.equalsIgnoreCase(key) ||
fullName.equalsIgnoreCase(key)) {
                names.add(contactRecords.get(i));
                lastFoundIndex = i;
                lastFoundValue = fullName;
            }
        }
        return names;
    }

    private void insertionSort() {
        for (int i = 1; i < contactRecords.size(); i++) {
            ArrayList<String> currentRow = contactRecords.get(i);
            int currentValue = Integer.parseInt(currentRow.get(0));
```

```
            int j = i - 1;

            while (j >= 0 && Integer.parseInt(contactRecords.get(j).get(0)) >
currentValue) {
                contactRecords.set(j + 1, contactRecords.get(j));
                j--;
            }
            contactRecords.set(j + 1, currentRow);
        }
    }

    private void addToArray() {
        try {
            String line = br.readLine();
            while ((line = br.readLine()) != null) {
                String[] tempLine = line.split(",");
                ArrayList<String> row = new ArrayList<>();
                row.add(tempLine[0]);
                row.add(tempLine[1]);
                contactRecords.add(row);
            }
        } catch (Exception e) {
            throw new RuntimeException(e);
        }
    }
}
```

Statistics.java

```
import java.util.ArrayList;
import java.util.Scanner;

public class Statistics {
    private final Scanner in = new Scanner(System.in);
    private final int totalNumberOfContacts;
    private final ArrayList<ArrayList<String>> contactRecords;
    private final int minimumID;
    private final int maximumID;
    private final int linearSearchCount;
    private final int binarySearchCount;
    private final String recentKeyValue;
    private final boolean recentKeyResult;
    private boolean isBinarySearchLastUsed;
    private ArrayList<String> uniqueNames = new ArrayList<>();

    public Statistics(ArrayList<ArrayList<String>> contactRecords, int
linearSearchCount, int binarySearchCount,
                      String recentKeyValue, boolean recentKeyResult, boolean
isBinarySearchLastUsed) {
        this.contactRecords = contactRecords;
        this.linearSearchCount = linearSearchCount;
        this.binarySearchCount = binarySearchCount;
        this.recentKeyValue = (recentKeyValue == null) ? "" : recentKeyValue;
        this.recentKeyResult = recentKeyResult;
        this.isBinarySearchLastUsed = isBinarySearchLastUsed;
        uniqueNames = compileUniqueFirstNames();
        totalNumberOfContacts = contactRecords.size();
        minimumID = getMinimumID();
        maximumID = getMaximumID();
    }

    public void summarizeStats() {
        System.out.println("\n" + "=".repeat(50));
        System.out.println("📊 CONTACT RECORDS STATISTICS");
        System.out.println("=".repeat(50));
        System.out.printf("Total Contacts       : %d%n",
totalNumberOfContacts);
        System.out.printf("Sorted by ID         : %b%n", isSorted());
        System.out.printf("Minimum ID           : %d%n", minimumID);
        System.out.printf("Maximum ID           : %d%n", maximumID);
        System.out.printf("Linear Searches Done : %d%n", linearSearchCount);
        System.out.printf("Binary Searches Done : %d%n", binarySearchCount);
        System.out.printf("Last Search Result   : %s (%s)%n", recentKeyResult,
recentKeyValue);
        System.out.println("-".repeat(50));
    }
```

```
    public void menu() {
        while (true) {
            System.out.println("\n[0] 🔙 BACK Go Back");
            System.out.println("[1] 📄 Unique Names & Frequency");
            System.out.print("Enter choice >> ");
            int choice = Integer.parseInt(in.nextLine());
            switch (choice) {
                case 0 -> {
                    return;
                }
                case 1 -> displayNameStats();
                default -> System.out.println("⚠️ Invalid option. Try
again.");
            }
        }
    }

    public void trackMetrics() {
        System.out.println("\n" + "=".repeat(50));
        System.out.println("⚙️  SEARCH METRICS");
        System.out.println("=".repeat(50));
        if (isBinarySearchLastUsed) {
            System.out.println("Algorithm Used   : Binary Search");
            System.out.println("Reason           : Best for sorted dataset,
and is efficient.");
            System.out.println("Comparisons Made : " +
Main.binaryComparisonCount);
            System.out.println("Execution Time   : " + Main.binarySearchTime +
" ns");
        } else {
            System.out.println("Algorithm Used   : Linear Search");
            System.out.println("Reason           : Names are unsorted.");
            System.out.println("Comparisons Made : " +
Main.linearComparisonCount);
            System.out.println("Execution Time   : " + Main.linearSearchTime +
" ns");
        }
        System.out.println("Found Index      : " + (Main.lastFoundIndex == -1
? "N/A" : Main.lastFoundIndex));
        System.out.println("Found Value      : " +
(Main.lastFoundValue.isEmpty() ? "N/A" : Main.lastFoundValue));
        System.out.println("-".repeat(50));
    }

    private void displayNameStats() {
        System.out.println("\n" + "=".repeat(50));
        System.out.println("📄 UNIQUE NAMES & FREQUENCY");
        System.out.println("=".repeat(50));
```

```
        ArrayList<String> uniqueNames = compileUniqueFirstNames();
        ArrayList<Integer> nameCounts = countFirstNameFrequency();
        bubbleSort(uniqueNames, nameCounts);
        for (int i = 0; i < uniqueNames.size(); i++) {
            System.out.printf("%-3d %-15s (%dx)%n", i + 1, uniqueNames.get(i),
nameCounts.get(i));
        }
        System.out.println("-".repeat(50));
    }

    private ArrayList<Integer> countFirstNameFrequency() {
        ArrayList<Integer> nameCountList = new ArrayList<>();

        for (String name : uniqueNames) {
            int count = 0;
            for (ArrayList<String> contactRecord : contactRecords) {
                String fullName = contactRecord.get(1);
                int spaceIndex = fullName.indexOf(' ');
                String firstName = (spaceIndex != -1) ? fullName.substring(0,
spaceIndex) : fullName;

                if (firstName.equals(name)) {
                    count++;
                }
            }
            nameCountList.add(count);
        }

        return nameCountList;
    }

    private ArrayList<String> compileUniqueFirstNames() {
        ArrayList<String> uniqueNamesList = new ArrayList<>();

        for (ArrayList<String> contactRecord : contactRecords) {
            String fullName = contactRecord.get(1);
            int spaceIndex = fullName.indexOf(' ');
            String firstName = (spaceIndex != -1) ? fullName.substring(0,
spaceIndex) : fullName;

            if (!uniqueNamesList.contains(firstName)) {
                uniqueNamesList.add(firstName);
            }
        }

        return uniqueNamesList;
    }

    private boolean isSorted() {
```

```
        for (int i = 0; i < contactRecords.size() - 1; i++) {
            if (Integer.parseInt(contactRecords.get(i).getFirst()) >
Integer.parseInt(contactRecords.get(i + 1).getFirst())) {
                return false;
            }
        }
        return true;
    }

    private int getMinimumID() {
        int minimumID =
Integer.parseInt(contactRecords.getFirst().getFirst());
        for (int i = 1; i < contactRecords.size(); i++) {
            int currentIDIndex =
Integer.parseInt(contactRecords.get(i).getFirst());
            if (currentIDIndex < minimumID) {
                minimumID = currentIDIndex;
            }
        }
        return minimumID;
    }

    private int getMaximumID() {
        int maximumID =
Integer.parseInt(contactRecords.getFirst().getFirst());
        for (int i = 1; i < contactRecords.size(); i++) {
            int currentIDIndex =
Integer.parseInt(contactRecords.get(i).getFirst());
            if (currentIDIndex > maximumID) {
                maximumID = currentIDIndex;
            }
        }
        return maximumID;
    }

    private void bubbleSort(ArrayList<String> unsortedArray,
ArrayList<Integer> counts) {
        for (int i = 0; i < unsortedArray.size() - 1; i++) {
            for (int j = 0; j < unsortedArray.size() - 1; j++) {
                int firstLetter = unsortedArray.get(j).charAt(0);
                int secondLetter = unsortedArray.get(j + 1).charAt(0);

                if (firstLetter > secondLetter) {  //Swap if out of order
                    String temp = unsortedArray.get(j);
                    unsortedArray.set(j, unsortedArray.get(j + 1));
                    unsortedArray.set(j + 1, temp);

                    int tempCount = counts.get(j);
                    counts.set(j, counts.get(j + 1));
```

```
                    counts.set(j + 1, tempCount);
                }
            }
        }
    }
}
```