Data Structures and Algorithms

HEALTHCARE MANAGEMENT SYSTEM

Course Project Report

School of Computer Science and Engineering
2024-25

Contents

1. Course and Team Details

1.1 Course details

Course Name	Design and Analysis of Algorithms
Course Code	24ECSC205
Semester	III
Division	A
Year	2024-25
Instructor	Mallikarjun Akki

1.2 Team Details

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2. Introduction

The Healthcare Management System (HMS) is a project that uses efficient algorithms and data structures to optimize healthcare operations. In a city, health of citizens matters the most. So this project is picked although there were many problems that may be addressed. HMS addresses four key areas:
Emergency Incident Categorization – categorizing and prioritizing medical emergencies;
Patient Appointment Scheduling – scheduling appointments for patients in an efficient manner;
Medical Supply Inventory Management – tracking and restocking of medical supplies;
Healthcare Resource Allocation – optimizing the critical distribution of healthcare resources.
HMS is done with the help of algorithms of Dijkstra's Algorithm, the Rabin-Karp string matching, QuickSort, Depth First Search, and Priority Queues, BST, and Union Find to bring improved efficiency in timely real-time decision making.

It is based on the principles from algorithmic problem-solving and data structures, discussed in key references like Data Structures and Algorithm Analysis in C++ by Weiss [1] and Introduction to Algorithms by Cormen et al. [2]. This helped choose suitable algorithms for every module, scalable enough for the healthcare scenario, while being very efficient in practice.

3. Problem Statement

3.1 Domain

The HMS automates healthcare operations such as incident management, patient scheduling, resource allocation and inventory management. These tasks are full of inefficiencies and delays, leading to poor service quality and increased costs. The system's objective is to resolve these challenges by providing an algorithm-driven, scalable, and user-friendly solution.

3.2 Module Description

Emergency Medical Incident Categorization is essential for classifying and prioritizing medical incidents based on urgency and severity. The goal is to ensure that resources are allocated efficiently and that patients receive the right care promptly. In this system, specific algorithms are used to improve the categorization process, enabling rapid decision-making and optimized emergency response .

Key Algorithms Used:

1. **Rabin-Karp Algorithm** – In a hospital's emergency room, this algorithm can be used to rapidly scan through incoming text data .
2. **Quick Sort** – Quick Sort can be used to sort the incidents by severity .
3. **Depth-First Search (DFS)** – DFS can be utilized in analysing medical cases where a sequence of events or conditions need to be explored in depth .

4. Functionality Selection

Si. No.	Functionality Name	Known	Unknown	Principles applicable	Algorithms	Data Structures
	Name the functionality within the module	What information do you already know about the module? What kind of data you already have? How much of process information is known?	What are the pain points? What information needs to be explored and understood? What are challenges?	What are the supporting principles and design techniques?	List all the algorithms you will use	What are the supporting data structures?
1	Incident Description Matching	Incident descriptions contain key terms like "critical" or "severe." String matching can help automate identification.	Requires an efficient algorithm for real-time keyword matching without scanning the entire text repeatedly.	Pattern Matching	Rabin-Karp Algorithm	Strings
2	Sorting Incidents by Urgency	Each incident has a severity level. Sorting ensures that critical cases are handled first.	Sorting must be fast and efficient, as the number of incidents may be large.	Divide & Conquer	QuickSort	Arrays
3	Grouping Similar Incidents	Some incidents are related (e.g., multiple fire cases in the same region). Clustering can improve management.	Efficiently identifying and categorizing related incidents dynamically.	Graph Traversal	Depth-First Search (DFS)	Graphs

5. Functionality Analysis

5.1 Incident Description Matching (Rabin-Karp Algorithm)

- **Workflow:**
  1. Accepts an incident description.
  2. Uses the Rabin-Karp algorithm to identify critical keywords.
  3. Flags incidents as high, medium, or low priority based on detected terms.
- **Efficiency:**

- Time Complexity: O(n + m) (average case), where n is the text length and mmm is the pattern length.
- Space Complexity: O(1), as only a few variables are used.

5.2 Sorting Incidents by Urgency (QuickSort Algorithm)

- **Workflow:**
  1. Incidents are sorted based on priority.
  2. QuickSort partitions the data recursively.
  3. The sorted list allows immediate retrieval of high-priority incidents.
- Efficiency:
  - Time Complexity: O(nlogn) (average case), O(n^2) (worst case).
  - Space Complexity: O(logn) due to recursive function calls.

5.3 Grouping Similar Incidents (Depth-First Search - DFS)

- **Workflow:**
  1. Converts incidents into a graph where similar cases are connected.
  2. Uses DFS to traverse and classify similar incidents into clusters.
  3. Helps emergency response teams handle cases collectively.
- **Efficiency:**
  - Time Complexity: O(V + E), where V is the number of incidents and E is the connections between them.
  - Space Complexity: O(V) for maintaining the graph and visited nodes.

6. Conclusion

The Emergency Medical Incident Categorization System plays a crucial role in healthcare by enabling faster incident detection and prioritization. By utilizing Rabin-Karp for string matching, QuickSort for priority sorting, and DFS for incident clustering, the system ensures that critical emergencies receive immediate attention.

This module highlights the importance of efficient search and sorting techniques in real-time healthcare applications. Implementing graph traversal (DFS) for categorization further enhances the system’s ability to group related incidents and improve response times. Overall, this system contributes to better decision-making and patient safety in emergency scenarios.

7. References

[1] **Weiss, Mark Allen.** *Data Structures and Algorithm Analysis in C++ (4th Edition).* Pearson, 2013.

[2] **Thomas H. Cormen, Clifford Stein, Ronald L. Rivest, and Charles E. Leiserson.** *Introduction to Algorithms (3rd ed.).* The MIT Press, 2009.

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