ELEVATOR SIMULATION PROJECT

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12.06.2024

COMP-SCI 303 – Data Structures

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PROJECT OVERVIEW

Project Scope

Purpose

The Elevator Simulation Project is a C++ program designed to simulate the operation and management of elevators with a strong focus on the efficient use of data structures and object-oriented programming (OOP) principles. The primary goal is to model real-world elevator behavior in a single or multi-elevator system while optimizing performance in terms of passenger wait time, elevator utilization, and overall system efficiency.

The project incorporates user input to provide full customization of simulation parameters, enabling users to test a wide range of scenarios by adjusting:

- The total number of passengers to simulate
- The number of passengers to generate per second
- The number of floors in the building
- The number and capacity of elevators

Assumptions

System Performance

- In one simulation second, an elevator can travel one floor and pickup/drop off passengers on that floor
- Maximum values for simulation parameters are in place to ensure system efficiency and feasibility
- Passenger generation is uniform on a per-second basis

Building Layout

- There are a fixed number of floors throughout the building
- Every floor is accessible by all elevators

Passenger Behavior

- Passengers do not switch between elevator assignments when waiting on a floor
- Each passenger has a single destination floor that does not change once it is selected

Elevator Behavior

- Elevators move in one direction until they finish their queued destinations in that direction
- Elevator assignment is done with a scoring system where priority is given by idleness, capacity, direction, and proximity to the request floor
- If an elevator has no tasks, it remains idle

Methodology

Report Writing

I wrote this report using **Google Docs** following guidelines set out by my professor. I also took the initiative to add some of my own ideas for a more cohesive and descriptive summary of the project.

Development

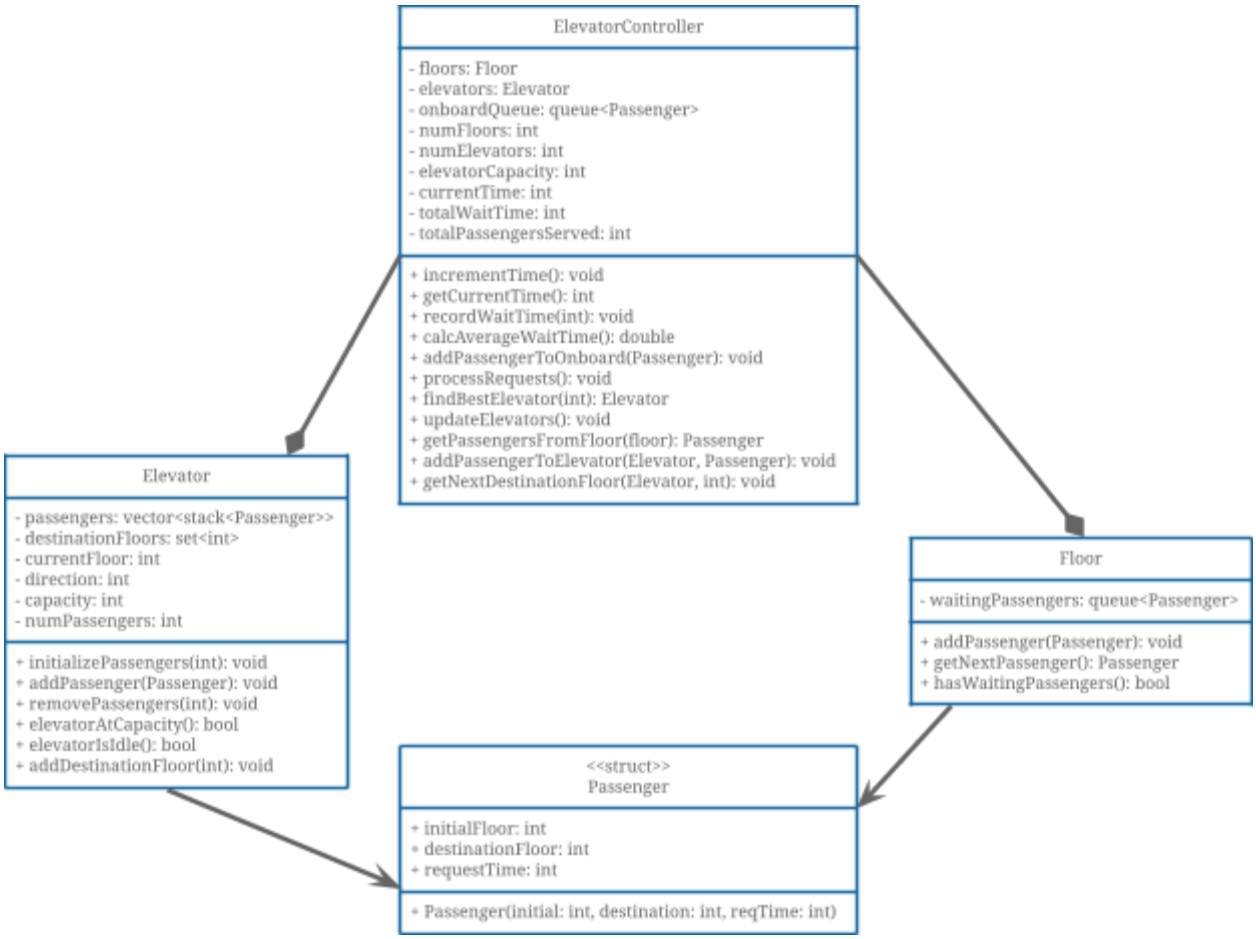
I coded the Elevator Simulation Project in the **C++** programming language using the **CLion** integrated development environment (IDE). No external libraries were used in this project. All functionalities were implemented using core features and tools provided by the **C++ Standard Library**.

ChatGPT

ChatGPT was used as a support tool throughout the brainstorming and development of the project. During brainstorming, I utilized ChatGPT as a “person” to bounce ideas off since I was working by myself and not with a group. During the development phase of the project, it helped me with debugging assistance, suggestions on how to better optimize my elevator assignment algorithm (specifically helping me figure out what score would be reasonable), and helping me come up with realistic numbers to max out the simulation parameters at.

CODE ANALYSIS

UML Class Diagram



Efficiency of Algorithms

Big-O Calculations

processRequests

- Iterates over `n` passengers in `onboardQueue`
    - Calls `findBestElevator` which is `O(m)`
- **Big-O:** `O(n x m)`

findBestElevator

- Iterates through `n` elevators

- **Big-O:** `O(n)`

updateElevators

- Iterates through `n` elevators
    - Removes `m` passengers from the elevator
    - Loops while the elevator is not at capacity and the floor has waiting passengers, which is `O(min(capacity, waitingPassengers))`
    - Calls `getNextDestinationFloor`, which is `O(log d)`
- **Big-O:** `O(n x (m + min(c, w) + log d))`

getNextDestinationFloor

- Uses set operations to get the next destination floor
- **Big-O:** `O(log n)`

Big-O Reflection

Based on the knowledge I have today, I am unsure if any of these time complexities could be improved upon. I tried to optimize every function as much as possible, but I may have missed something that could have improved the efficiency of the function.

REFERENCES

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