COMP 1029 Java Coursework – Congestion Management and Crowd Control System

Student Name: Anshana Manoharan

Student ID: 20506329

Introduction

Hillsborough, Dasharath Stadium, and the recent Seoul Halloween crowd rush (The Associated Press, 2022) are all examples of crowd rush disasters that resulted in major injuries and fatalities. Hospitals nearby experienced major congestion, making it challenging for staff to manage their patients at their own pace. Clearly, a system must be implemented to reduce the amount of rush at hospitals, allowing patients to be treated in an orderly fashion while ensuring all patients receive the best possible care. The Congestion Management and Crowd Control System assists in alleviating this problem. It allows a hospital to keep track of visitors and patients, allowing regular hospital activities to be carried out in an organized manner despite many patient registrations and visitors.

Classes

The *patients* class creates instances of all currently registered patients who are accommodating their associated wards. This class stores the patient's ward ID as the spot ID, the patient's name and the current number of visitors at the ward (generated randomly in this system).

The *visitors* class is used to create instances of different visitors and aids in keeping track of the visitor's ID, name, selected spot ID, selected spot name and their contact status, throughout their visit at the hospital. The setContactStatus() method sets the contact status attribute in accordance with its parameter (the status calculated by the *dynamicDistancing* class).

The *dynamicDistancing* class is responsible for checking whether a visitor is distancing (safe), casual or close contact. The checkDistances() method calculates and displays the number of steps a visitor must take to move if they are not in safe contact. It returns the contact status, which is a passed to the setContactStatus() method of the *visitor* class.

It uses a specific set of thresholds (Marek Laskowski et al., 2011) (see Table 1.a).

Threshold	*Contact status*
>= 1	Distancing (safe) contact
< 1 and >= 0.5	Casual contact
< 0.5	Close contact

Table 1.a threshold and corresponding contact status (Laskowski et al., 2011)

The *spots* class keeps track of the different spots' ID, name, area, maximum capacity, current capacity and whether it is restricted or not. The length and width of the spot instance can be in either double or integer formats. Thus, to accommodate for both datatypes, constructor overloading is used. This class is the parent class for the *staticDistancing* class.

The *staticDistancing* class inherits from the *spots* class meaning that it is the child class of *spots* class. This class sets the maximum capacity of an instance of the *spots* class using the parent class attribute, spotArea. The method setMax() is in both the parent and child class. Since the max capacity must be initialised in the *spots* class, setMax() in *spots* class initialises it to 1. On the other hand, the setMax() method in *staticDistancing* class assigns it the value calculated according to the spot area. This is implemented using method overriding.

Program Explanation

This system starts by getting details of currently registered patients from a database (entered either automatically, or manually, by the staff). Note, the database section is not implemented here. The patients' details consist of their current ward ID, full name and the current number of visitors in their ward.

Multiple instances of the *patients* class will be placed in an array of *patients* type. So, when a visitor enters the patient's name, whom they wish to visit, the system can search through this array to check whether the entered patient has registered at the hospital, and whether their ward is available for visit.

Similarly, there is an array of type *staticDistancing* called restrictedSpots. This array stores multiple instances of the restricted spots and waiting areas, like the out-patient waiting area, in-patient waiting area, the ICU waiting area, the ER waiting area and the pharmacy.

Initially the visitor is asked to enter their details, like, their visitor ID (assigned to the visitor at reception), their full name and their gender.

```
<System> Do you want to
         (1) visit a patient
         (2) wait
         (3) visit the pharmacy
         (4) exit the hospital?
<System> Please enter 1, 2 or 3:
<Visitor> 1
```

Figure 1.a main choice menu

Then, they are asked to choose whether they wish to visit a patient, wait at the designated waiting areas, visit the pharmacy, or exit the hospital. This is the main choice menu (refer Figure 1.a).

If the visitor wishes to visit a patient, they are required to enter the patient's name. the system then, searches for the name in the patients array which was created initially. If the patient is registered, currently accommodated at the hospital and their ward does not exceed visitor capacity, the visitor is permitted to enter the patient's ward. In addition, the patients details are displayed using the method display() of the *patients* class (refer Figure 1.b). Otherwise, they will be asked where they would like to go based on the main choice menu (refer Figure 1.a).

```
<System> Enter name of patient you would like to visit:
<Visitor> yui

<System> Spot ID: 123
         Patient Name: yui
         Current Visitors: 0

<System> You may now visit patient yui in spot 123
```

Figure 1.b situation when visitor can visit patient.

Assumptions

- This system assumes that other locations, such as the reception, are non-restricted spots. Note, this system is located at the reception (refer Figure 3.a).

Figure 3.a hospital floorplan used in this system ()

- The patient class is required because, visitors who come to visit a patient, may not be aware of the ward they are in. This can cause delays, hence increasing the time the visitor is using the system leading to queues increasing. Note, that we are implementing this system to reduce crowds and the amount of time the visitor spends in the hospital. Hence, it is more convenient for the visitor to enter the patients name, and the system returns the patients ward details if the ward is available for more visitors.
- The number of visitors in the patient's ward is calculated using random number generation in this system. Although, in reality, the location of each permitted visitor should be recorded in real-time. For the random number generation, the maximum number of visitors in a patient's ward are 2. (Andorra Women and Children Hospital & Assunta Hospital, 2022 & 2023).

Extra Features

1. **Security features**
    - When the system is initially started, the patients details are loaded into the system. The system clears the screen so that the patient details cannot be read by the visitors. The system uses the clearScreen() function.
    - After the visitor enters their details, the system uses the clearScreen() function to hide the details so that it cannot be read by other visitors.
    - This system has also used the private property for certain attributes in classes to prevent unnecessary.
2. **Accessibility features**
    - The system makes use of the pause() function to prevent abrupt (and potentially missed) outputs.
    - Instead of displaying the distance to be moved (in metres) using the *dynamicDistancing* class, this system calculates the number of steps required to move to get to distancing (safe) contact. Since females have an average walking step length of 0.67m and males have 0.76m (Sayer, 2022), the gender of the visitor is required as an input. This system displays the number for steps instead of the distance in metres because, it is inconvenient for a visitor who follows the imperial system. Additionally, it is more intuitive for the visitor in terms of steps.

Libraries used

- java.util.Random
- java.lang.Math
- java.util.Scanner
- java.io.*
- java.time.LocalDateTime
- java.time.format.DateTimeFormatter
- java.util.Date

Limitations

- This system should be run on command prompt for the clearScreen() function to be performed.
- Since the system is assumed to be using Bluetooth to get the distances, it is not the best method to acquire the data. Because, Bluetooth uses radio frequencies, and many hospital equipment also use radio waves, this can cause interference and give inaccurate distances (Bluetooth Tech World, 2022).
- In addition, radio waves can pass through walls, so considering the situation where a visitor is seated against a wall, and there is another visitor on the other side of the wall, the system will either state casual or close contact although there is a wall in between the two visitors. Because of this, an alternative measuring device should be used or the location of the visitor should be considered (Bluetooth Tech World, 2023).

Code Demo

The following example demonstrates a situation where there are 3 currently registered patients and their details are loaded from the database successfully. To terminate the system, the staff must enter "EXIT_SYSTEM".

```
<System> Staff, to terminate the program, enter 'EXIT_SYSTEM' as the visitor ID.

<System> Loading patients information from database

<System> Enter number of patients:
<Staff> 3
```

```
<System> Loading patients information from database

<System> Enter number of patients:
<Staff> 3

<System> Enter patient's ward spotID:
<Staff> 12345
<System> Enter patient name:
<Staff> Sophia James

<System> Enter patient's ward spotID:
<Staff> 45632
<System> Enter patient name:
<Staff> Charlie Delta

<System> Enter patient's ward spotID:
<Staff> 68453
<System> Enter patient name:
<Staff> Amanda Walker
```

This is the output which the visitor first sees, and they are required to enter their personal details.

```
<System> Welcome to Notts Hospital

<System> Enter visitor ID:
<Visitor> 20506329
<System> Enter visitor full name:
<Visitor> Anshana Manoharan
<System> Enter your gender (F - female and M - male)
<Visitor> F
```

After the visitor enters their personal details, they need to enter 1, 2, 3 or 4 depending on the places they wish to visit. Here, the visitor enters 1, so they are required to enter the patient's name they wish to visit. The program checks if the patient's ward has at most 1 visitor currently and outputs the patient's ward ID if they are permitted. Since the visitor is permitted, they are asked to enter the left, right, front and back distances. Until, they get the distancing(safe) status, they are advised to move to a safer distance.

```
<System> Do you want to
         (1) visit a patient
         (2) wait
         (3) visit the pharmacy
         (4) exit the hospital?
<System> Please enter 1, 2 or 3:
<Visitor> 1

<System> Enter name of patient you would like to visit:
<Visitor> Amanda Walker

<System> Spot ID: 68453
         Patient Name: Amanda Walker
         Current Visitors: 0

<System> You may now visit patient Amanda Walker in spot 68453

<System> Enter left distance:
<Visitor> 1

<System> Enter right distance:
<Visitor> 0.95

<System> Enter front distance:
<Visitor> 0.4

<System> Enter back distance:
<Visitor> 0.5

You are in casual contact, please move 1.0 steps left

You are in casual contact, please move 1.0 steps front

You are in close contact, please move 1.0 steps back

<System> Contact Status: Close Contact
```

```
<System> Enter left distance:
<Visitor> 1

<System> Enter right distance:
<Visitor> 0.95

<System> Enter front distance:
<Visitor> 0.98

<System> Enter back distance:
<Visitor> 1

You are in casual contact, please move 1.0 steps left

You are in casual contact, please move 1.0 steps back

<System> Contact Status: Casual Contact
```

```
<System> Enter left distance:
<Visitor> 1

<System> Enter right distance:
<Visitor> 1

<System> Enter front distance:
<Visitor> 1

<System> Enter back distance:
<Visitor> 1

You are safe in dynamic distancing!

<System> Contact Status: Distancing(Safe) Contact
```

After their status becomes safe, they will be asked to enter the amount of time they will be at the selected spot. The system waits for that period of time and then loads the main choice menu.

```
<System> Visitor Details
         Visitor ID: 20506329
         Visitor Name: Anshana Manoharan
         Gender: F
         Selected Restricted Spot ID: 68453
         Selected Restricted Spot Name: Amanda Walker's ward
         Date: 2023-04-19
         Time: 14:26
<System> Enter an approximate duration of time you will spend in the current spot (in minutes):
<Visitor> 1
<System> Visitor is waiting
```

```
<System> Visitor is waiting

<System> Do you want to
         (1) visit a patient
         (2) wait
         (3) visit the pharmacy
         (4) exit the hospital?
<System> Please enter 1, 2 or 3:
<Visitor>
```

```
<System> Do you want to
         (1) visit a patient
         (2) wait
         (3) visit the pharmacy
         (4) exit the hospital?
<System> Please enter 1, 2 or 3:
<Visitor> 2

<System> Enter
         (1) Out-patient Visitor Waiting Area
         (2) In-patient Visitor Waiting Area
         (3) ICU-patient Visitor Waiting Area
         (4) Emergency Room Visitor Waiting Area
<System> Please enter 1, 2, 3 or 4:
<Visitor>
```

Here the user enters a waiting area number, where the system checks its availability. After they are permitted to enter, the distances are checked along with their statuses again.

```
<System> You may enter ICU-patient Visitor Waiting Area

<System> Enter left distance:
<Visitor> 0.9

<System> Enter right distance:
<Visitor> 1

<System> Enter front distance:
<Visitor> 1

<System> Enter back distance:
<Visitor> 1

You are in casual contact, please move 1.0 steps right

<System> Contact Status: Casual Contact

<System> Enter left distance:
<Visitor> 1

<System> Enter right distance:
<Visitor> 1

<System> Enter front distance:
<Visitor> 1

<System> Enter back distance:
<Visitor> 1
```

Here, the visitor enters 3 for pharmacy, where the system checks its availability. After they are permitted to enter, the distances are checked along with their statuses again.

```
<System> Do you want to
         (1) visit a patient
         (2) wait
         (3) visit the pharmacy
         (4) exit the hospital?
<System> Please enter 1, 2 or 3:
<Visitor> 3

You may enter Pharmacy

<System> Enter left distance:
<Visitor> 1

<System> Enter right distance:
<Visitor> 1

<System> Enter front distance:
<Visitor> 1

<System> Enter back distance:
<Visitor> 1
```

After the visitor enters the amount of time spent at the pharmacy and after that period of time was completed, the main choice menu is displayed again, and the visitor enters 4 (exit the hospital). The system clears the screen and restarts for the next visitor.

```
<System> Enter an approximate duration of time you will spend in the current spot (in minutes):
<Visitor> 4
<System> Visitor is waiting

<System> Do you want to
         (1) visit a patient
         (2) wait
         (3) visit the pharmacy
         (4) exit the hospital?
<System> Please enter 1, 2 or 3:
<Visitor> 4

Exiting the hospital

<System> Welcome to Notts Hospital

<System> Enter visitor ID:
<Visitor>
```

When the staff wants to shut down the system, they are required to enter “EXIT_SYSTEM” as the visitor ID. This allows the system to shut down.

```
<System> Welcome to Notts Hospital

<System> Enter visitor ID:
<Visitor> EXIT_SYSTEM

Terminating the system.

C:\Users\ansha\OneDrive\Desktop>
```

References

(Andorra Women and Children Hospital, 2022) https://www.andorracare.com/visitors-guide-andorra

(Assunta Hospital, 2023) https://www.assunta.com.my/patient-and-visitor-guide/

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