

CSCI 220 -- PA 6

Queues and Deques

Feel free to discuss and help each other out but does not imply that you can give away your code or your answers! Make sure to read all instructions before attempting this lab. You cannot work with a lab partner for this assignment.

You must use an appropriate provided template from Canvas or my website (zeus.mtsac.edu/~tvo) and output "Author: Your Name(s)" for all your programs. If you are modifying an existing program, use "Modified by: Your Name(s)".

Exercise 1: You need to write a program that simulates call lines at a calling center. A line is basically a queue object, and you can assume one customer representative per line. Based on some preliminary estimate, customers are expected to call in random integer intervals of 1 to n minutes (inclusively and two customers are expected to call between that interval so if customer 1 calls at minute 3, then customer 2 is expected to call between minute 4 and 7 when n is 4). Also, it is expected to take a random integer interval of 1 to m minutes to serve each customer. If the call arrival rate is faster than the service rate ($n < m$), the line will grow indefinitely. Even with a "balanced" rate ($n = m$), randomness can still possibly cause a long line over a period. You are going to run the calling center simulation with one line ($l = 1$) for a period of t minutes using the following algorithm (enter input parameters from keyboard and use $l = 1$, $t = 30$, $n = 4$, and $m = 4$ as test case 0):

```
Determine first customer's call time (random
    integer between 1 and n)
For i = 1 to t
    Display "Minute: ", i
    If a customer calls
        Say so;
        Enqueue that customer
        Schedule the call time of the next customer
            (random integer 1 to n is added to the current time;
             next customer comes 1 to n minutes after current customer).
    End if
    If service was just completed for a customer
        Say so;
        Process accordingly
    End if
    If no customer is being served and at least one customer in the queue
        Dequeue next customer to be served
        Determine customer's service time (random integer 1 to m
            is added to the current time)
    End if
End for
Display number of customers served and number of customers left in queue
```

Make sure to provide a reasonable output and it is best to output most information to an output file. Use 1, 2, 3, ..., 30 to label each minute and a customer ID of 1, 2, 3, and so forth. You can use the queue from the language or from the textbook.

Check output for test case 0 to make sure everything works as expected. Now run the remaining 3 test cases below. **For each set of output, provide just the first 15 minutes and last 15 minutes or so and summary information at the end.**

- **Test case 0:** $l = 1$, $t = 30$, $n = 4$, $m = 4$
- **Test case 1:** $l = 1$, $t = 360$, $n = 4$, $m = 4$
- **Test case 2:** $l = 1$, $t = 360$, $n = 3$, $m = 4$
- **Test case 3:** $l = 1$, $t = 360$, $n = 5$, $m = 4$

Exercise 2: Provide a linked implementation of a deque and name it **LinkedDeque** (use **doubly** linked list). It can be a template/generic class, or you can set it up with a certain data type like string. Use a test driver to try out your LinkedDeque by adding and removing values from both ends. Try the following test cases: insert front, insert front, insert rear, remove rear, remove rear, size, and front item.

Question 1: Would you consider an array implementation for the deque? Explain why or why not.

Question 2: Explain how you can go about using your LinkedDeque to implement a queue.

Extra Credit: Modify exercise 1 to add the following features and you can submit just one version for both. Your program must be able to determine the following at the end of the simulation and output appropriate information (add extra steps to the above algorithm):

- Maximum number of customers in the line at any time (longest line)
- Longest wait time that a customer experiences before being served
- Average wait time for all customers that were served (use floating-point value)

Fill out and turn in the PA submission file for this assignment (save as PDF format).