

Barbershop Simulation in C: README

This program simulates a barbershop scenario with multiple barbers and customers, using threads to handle concurrent activities such as serving customers, waiting in line, and calculating waiting times. The program also uses mutexes and condition variables to synchronize access to shared resources like the queue and barbers' status.

Features:

- **Multiple Barbers:** Simulate up to 3 barbers serving customers.
- **Customer Queues:** Customers wait in a queue to be served. The program handles a chair queue, a sofa queue, and a standing queue.
- **Monitor Thread:** A monitor watches the queue and broadcasts a signal when customers are waiting, notifying barbers that they can start working.
- **Random Wait Time for Customers:** Customers are added to the queue after waiting for a random time.
- **Customer Thread:** Simulates a customer who waits for a random time before joining the queue.
- **Barber Thread:** Handles customer service by taking customers from the queue, serving them, and logging the total number of customers served by each barber.
- **Mutexes and Condition Variables:** Synchronize access to shared resources, such as the queue and barbers' status, ensuring thread safety.
- **Queue Management:** Handles three types of queues: chair queue (for customers in chairs), sofa queue, and standing queue. Customers are moved from the queues as barbers become available.

Compilation:

To compile and run the program, you can use `gcc` with the necessary libraries for threading:

```
gcc -o barbershop barbershop.c -lpthread
```

Or

```
gcc -o barbershop barbershop.c
```

Running the Program:

You will be prompted to enter the duration for which the barbershop will be open. The program will run until that time elapses, simulating the activities of customers and barbers.

```
./barbershop
```

Key Functions:

- `add____to____queue`: Adds a customer to the queue after a random wait time.
- `remove____and____shift____queue`: Removes and shifts customers in the queue after being served by a barber.
- `register1`: Simulates the checkout process for a customer.
- `monitor____function`: Monitors the queue and broadcasts a signal to notify barbers when a customer is ready.
- `barber____function`: Barber thread function that serves customers.
- `print____barbershop____state`: Prints the current state of the barbershop, including barbers' statuses and the current customer queues.

Output:

- Program start:

```
Dec 5 18:53
osboxes@osboxes: ~
Current secured and ready for use.
Shared memory cleared.

Enter the time to run the program for: 1
Program will run for 1 minutes.
Current time: 09:00:00
Generated random number (wait time): 19 minutes
Monitor is watching
-----
Barber 2 is ready to work.
Barber 2 is waiting for customers.
Barber 1 is ready to work.
Barber 1 is waiting for customers.
Barber 3 is ready to work.
Barber 3 is waiting for customers.
Thread 132501345404608 waiting for 19 minutes before adding itself to the queue...
Current time: 09:00:01
Generated random number (wait time): 22 minutes
Thread 132501334918848 waiting for 22 minutes before adding itself to the queue...
Monitor is watching
-----
Current time: 09:00:02
Generated random number (wait time): 12 minutes
Thread 132501324433088 waiting for 12 minutes before adding itself to the queue...
Current time: 09:00:03
Generated random number (wait time): 15 minutes
Thread 132501313947328 waiting for 15 minutes before adding itself to the queue...
Monitor is watching
-----
Current time: 09:00:04
Generated random number (wait time): 8 minutes
Thread 132501303461568 waiting for 8 minutes before adding itself to the queue...
Current time: 09:00:05
```

- Barbershop activity log

```
Dec 5 19:19
osboxes@osboxes: ~
-----adding thread to queue-----
Thread 137380149331648 adding itself to the queue after waiting.
Customer 137380149331648 started waiting at 1733444317000 seconds.

----- Queue Status -----
Chair:
Sofa: customer 137380149331648
Standing:
-----
----- customer wait time-----
Customer 0 started waiting at 1733444317000 seconds.
broadcast received
Customer 137380149331648 stop waiting at 1733444317000 seconds.

-----
added customer to queue 137380149331648
Customer 137380149331648 moved to chair queue.
Barber 2 is removing customer thread 137380149331648.
Before shifting: customer 137380149331648
After shifting:

----- Queue Status -----
Chair: customer 137380149331648
Sofa:
Standing:
-----
Barber 2 is serving customer thread 137380149331648.

----- customer wait time-----
Customer 0 stopped waiting at 1733444317000 seconds.
```

```

Dec 5 19:21
osboxes@osboxes: ~
-----adding thread to queue-----
Thread 137379740387008 adding itself to the queue after waiting.
Customer 137379740387008 started waiting at 1733444335000 seconds.
----- Queue Status -----
Chair: customer 137380149331648
Sofa: customer 137379740387008
Standing:
-----
----- customer wait time-----
Customer 1 started waiting at 1733444335000 seconds.
broadcast received
Customer 137379740387008 stop waiting at 1733444335000 seconds.
-----
added customer to queue 137379740387008
Customer 137379740387008 moved to chair queue.
Barber 1 is removing customer thread 137379740387008.
Before shifting: customer 137379740387008
After shifting:
----- Queue Status -----
Chair: customer 137380149331648      customer 137379740387008
Sofa:
Standing:
-----
Barber 1 is serving customer thread 137379740387008.
----- customer wait time-----

```

- Register

```

Dec 5 19:26
osboxes@osboxes: ~
Generated random number (wait time): 17 minutes
Thread 137374510089920 waiting for 17 minutes before adding itself to the queue...
Barber 3 finished serving customer thread 137379348219584 after 5 seconds.
----- Customer has started Checking out-----
Register is being used for 3 seconds.
-----
Current time: 09:05:35
Generated random number (wait time): 16 minutes
Thread 137374499604160 waiting for 16 minutes before adding itself to the queue...
Monitor is watching
-----
Current time: 09:05:36
Generated random number (wait time): 19 minutes
Thread 137374489118400 waiting for 19 minutes before adding itself to the queue...
Current time: 09:05:37
Generated random number (wait time): 14 minutes
Thread 137374478632640 waiting for 14 minutes before adding itself to the queue...
Monitor is watching
-----
----- Customer has finished Checking out-----
Register is now free.
-----
Barber 3 is serving currently: has now served 1 customers.
----- Barber totals customers Checking out-----
Barber 1 has now served 0 customers. with total price= 0
Barber 2 has now served 0 customers. with total price = 0
Barber 3 has now served 1 customers. with total price = 12
-----
Barber is heckling ---
Current time: 09:05:38
Generated random number (wait time): 5 minutes

```

- Start and stop times : in the logs
- Total amount for each barber: price and customer

```
Dec 5 19:30
osboxes@osboxes: ~
Register is being used for 3 seconds.
-----
Current time: 09:05:35
Generated random number (wait time): 16 minutes
Thread 137374499604160 waiting for 16 minutes before adding itself to the queue...
Monitor is watching
-----
Current time: 09:05:36
Generated random number (wait time): 19 minutes
Thread 137374489118400 waiting for 19 minutes before adding itself to the queue...
Current time: 09:05:37
Generated random number (wait time): 14 minutes
Thread 137374478632640 waiting for 14 minutes before adding itself to the queue...
Monitor is watching
-----
----- Customer has finished Checking out-----
Register is now free.
-----
Barber 3 is serving currently: has now served 1 customers.
----- Barber totals customers Checking out-----
Barber 1 has now served 0 customers. with total price= 0
Barber 2 has now served 0 customers. with total price = 0
Barber 3 has now served 1 customers. with total price = 12
-----
Barber is heckling ---
Current time: 09:05:38
Generated random number (wait time): 5 minutes
Thread 137374468146880 waiting for 5 minutes before adding itself to the queue...
Current time: 09:05:39
Generated random number (wait time): 5 minutes
Thread 137374457661120 waiting for 5 minutes before adding itself to the queue...
```

- Average wait time

```
Dec 5 19:34
osboxes@osboxes: ~
Store is closed at 09:20:00.
Customer 0 waited for 0 seconds.
Average waiting time per customer: 0.00 seconds.

===== BARBER SHOP STATE =====
Barber Thread 1: Busy
Barber Thread 2: Busy
Barber Thread 3: Busy
Cashier: Idle

--- Barbershop Queue Status ---
Chair Queue (Barber chairs): customer 137379740387008 customer 137379348219584 customer 137379998336704
Sofa Queue: customer 137379874604736 customer 137377525794496 customer 137376785499840
Standing Queue: customer 137378511455936 customer 137378500970176 customer 137380029793984 customer 13737988509049
6 customer 137377494337216

----- Summary: in store status -----
Total Customers in the shop: 11
Seated customers: 3
Sofa Queue Count: 3
Standing Queue Count: 5
```

```
Dec 5 19:35
osboxes@osboxes: ~
-----
All customers have been served and the barbershop is closing: printing final register.
----- Customer has started Checking out-----
Register is being used for 0 seconds.
-----
----- Customer has finished Checking out-----
Register is now free.
-----
Invalid barber ID: 0
----- Barber totals customers Checking out-----
Barber 1 has now served 0 customers. with total price= 0
Barber 2 has now served 0 customers. with total price = 0
Barber 3 has now served 1 customers. with total price = 12
-----
Monitor is watching
-----
Monitor is watching
-----
Monitor is watching
-----
Monitor is watching
-----
Monitor is watching
-----
Monitor is watching
-----
```