ASSIGNMENT 1 Sleeping barber with multithreading and multicore

Declaration

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I have read and understood the referencing guidelines found recommended in the assignment guidelines.

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Approach

Step 1. First let's create classes for Baber and Customer so that we can create multiple Barber and customer instances out of it, and they are runnable because we are going to create multiple threads out of those.

Explanation of Barber.java (It's class which is specifically handle data and task of barber)

Step 2. ***Run ()*** function handle locks which are semaphore with Boolean in this case on the customer and barber objects.

- `Customers_ready.acquire(); // if barber is free get the lock on the customer`
- `Barbers_ready.release(); // release the barber lock when he is finished with the haircut`

Step 3. ***Cut_hair ()*** is a function which take out customer from the double ended queue and perform hair cut and make customer leave after having the haircut and show time taken to perform hair cut of every customer and the barber which serves the customer.

Explanation of customer.java (It's class which is specifically handle data and task of customer)

Step 4. Similarly, as we did in baber.java we create a class with runnable and make a run function which acquire locks as follows:

- `Customers_ready.release(); // release the lock on the customer when customer is ready for the hair cut`
- `Barbers_ready.acquire(); // acquire the lock on the barber if he is free to cut the customer the hair`

Also, check if the availability of Baber so that we can add customer to the waiting queue if required.

Explanation of class sleeping_baber.java (This class handles the multithreading and multicore operations)

Step 5. ***Main ()*** starts by taking two user inputs which are number barber in the shop and other input for the number of waiting chair.

Step 6. And then checked and print the number of cores available in a system using

- `int cores = Runtime.getRuntime(). availableProcessors();`

Step 7. Then using Executer Service for multicore processing as follows:

- `final ExecutorService executor = Executors.newFixedThreadPool(cores);`

A thread pool is created according to the number of cores available in the system.

Step 8. Then create multiple instances of Baber class as specified by number_of_baber from user input and using execute method spread them across multiple cores.

Step 9. Now create a infinite while loop which keep on creating an customer thread instances using a sleep generated randomly and also check for the availability of space in waiting area and if no space make customer leave the shop.

Correctness

Program is working as I tested it with multiple test input lie changing the number of barber and availability of number of chairs in waiting area and, I am using a barber number/id and customer/id to keep track that the customer get haircut from the assigned barber. And if no space available then customer look for waiting chair and if it's also not available then customer leaves the shop, I also tested this by increasing the customer generated so that customer enters the shop at faster rate. Everything is working fine.

Fairness/ Starvation

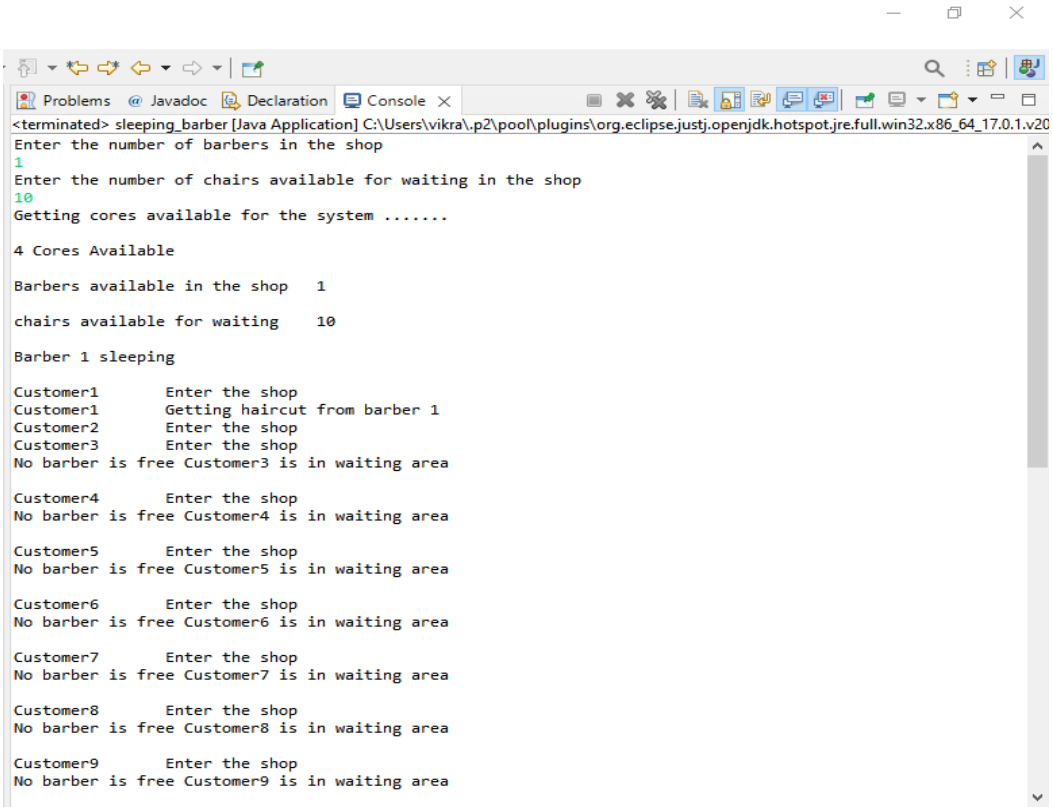
As we are using blocking double ended queue so every thread will get a chance i.e., means every customer will get the barber in the order they inserted because we are inserting at one end and taking element from other end and also double ended queue stops illegal insertion and removal so its better to use with threads.

Deadlocks

As we are using semaphore to acquire and release the shared resources, where customer can acquire lock and call the ***cut_hair ()*** and after haircut barber release the lock and also customer release the lock and look for availability and if available then barbe acquire a lock, otherwise customer send to the waiting area. So, they kind of synchronizing locks with each other so only one customer can access the single barber at a particular time.

Output Samples

Sample 1: With barber = 1 and waiting chairs = 10




```
<terminated> sleeping_barber [Java Application] C:\Users\vikra\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_64_17.0.1.
No barber is free Customer8 is in waiting area

Customer9       Enter the shop
No barber is free Customer9 is in waiting area

Time took by barber 1 to cut the hair of customer is 20 secs

Customer1       Done with haircut exiting ......
Customer2       Getting haircut from barber 1
Customer10      Enter the shop
No barber is free Customer10 is in waiting area

Customer11      Enter the shop
No barber is free Customer11 is in waiting area

Customer12      Enter the shop
No barber is free Customer12 is in waiting area

Customer13      Enter the shop
Customer exits as no seats are available

Customer14      Enter the shop
Customer exits as no seats are available

Time took by barber 1 to cut the hair of customer is 10 secs

Customer2       Done with haircut exiting ......
Customer3       Getting haircut from barber 1
Customer15      Enter the shop
No barber is free Customer15 is in waiting area

Customer16      Enter the shop
Customer exits as no seats are available

Customer17      Enter the shop
Customer exits as no seats are available

Customer18      Enter the shop
```

Sample 2: With barbers = 3 and waiting chairs = 3

```
Enter the number of barbers in the shop
3
Enter the number of chairs available for waiting in the shop
3
Getting cores available for the system .......

4 Cores Available

Barbers available in the shop   3

chairs available for waiting    3

Barber 1 sleeping

Barber 2 sleeping

Barber 3 sleeping

Customer1       Enter the shop
Customer1       Getting haircut from barber 1
Customer2       Enter the shop
Customer2       Getting haircut from barber 3
Customer3       Enter the shop
Customer3       Getting haircut from barber 2
Customer4       Enter the shop
Customer5       Enter the shop
No barber is free Customer5 is in waiting area

Customer6       Enter the shop
No barber is free Customer6 is in waiting area

Customer7       Enter the shop
Customer exits as no seats are available

Time took by barber 1 to cut the hair of customer is 15 secs

Customer1       Done with haircut exiting ......
Customer4       Getting haircut from barber 1
```

```
Customer1       Done with haircut exiting ......
Customer4       Getting haircut from barber 1
Customer8       Enter the shop
No barber is free Customer8 is in waiting area

Time took by barber 3 to cut the hair of customer is 15 secs

Customer2       Done with haircut exiting ......
Customer5       Getting haircut from barber 3
Customer9       Enter the shop
No barber is free Customer9 is in waiting area

Time took by barber 2 to cut the hair of customer is 15 secs

Customer3       Done with haircut exiting ......
Customer6       Getting haircut from barber 2
Customer10      Enter the shop
No barber is free Customer10 is in waiting area

Customer11      Enter the shop
Customer exits as no seats are available

Customer12      Enter the shop
Customer exits as no seats are available

Customer13      Enter the shop
Customer exits as no seats are available

Customer14      Enter the shop
Customer exits as no seats are available

Customer15      Enter the shop
Customer exits as no seats are available

Customer16      Enter the shop
Customer exits as no seats are available

Customer17      Enter the shop
```

Sample 3: With barber = 5 and waiting chairs = 1

This case is quite interesting as my system has only 4 cores so only 4 barber instances are created**.** So, we can create barbers according to number of cores as mentioned above;

```
<terminated> sleeping_barber [Java Application] C:\Users\vikra\.p2\pool\plugins\org.eclipse.justj.openjdk.hotspot.jre.full.win32.x86_
Enter the number of barbers in the shop
5
Enter the number of chairs available for waiting in the shop
1
Getting cores available for the system .......

4 Cores Available

Barbers available in the shop   5

chairs available for waiting    1

Barber 1 sleeping

Barber 2 sleeping

Barber 3 sleeping

Barber 4 sleeping

Barber 5 sleeping

Customer1       Enter the shop
Customer1       Getting haircut from barber 1
Customer2       Enter the shop
Customer2       Getting haircut from barber 3
Customer3       Enter the shop
Customer3       Getting haircut from barber 4
Customer4       Enter the shop
Customer4       Getting haircut from barber 2
Customer5       Enter the shop
Customer6       Enter the shop
Customer exits as no seats are available

Customer7       Enter the shop
Customer exits as no seats are available
```

Practical use sleeping barber

I think the use of sleeping barber is like how some servers handle the request and resource allocation on cloud. As, they allow time to each person/request to access the resources and no other can access those resources in that time and everyone is given a time frame to work and if all the resources are in use the user must wait or they can leave the server.

References

[1] C. Turkoglu, “Java Concurrency with Barbershop Problem,” 30 May 2020. [Online]. Available: https://turkogluc.com/java-concurrency-sleeping-barber/. [Accessed Feb 2022].

[2] ManasiKirloskar, “BlockingDeque in Java,” 24 Sep 2020. [Online]. Available: https://www.geeksforgeeks.org/blockingdeque-in-java/. [Accessed Feb 2022].